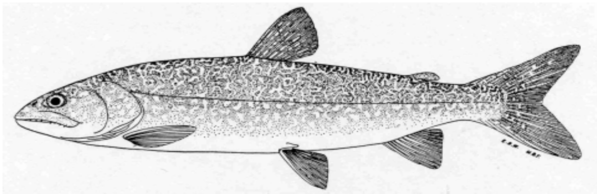
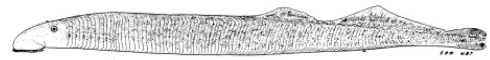
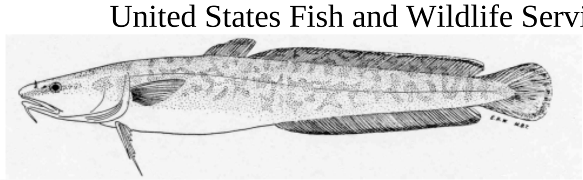
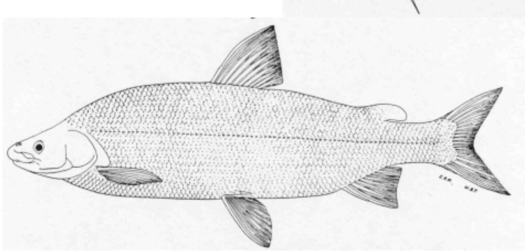
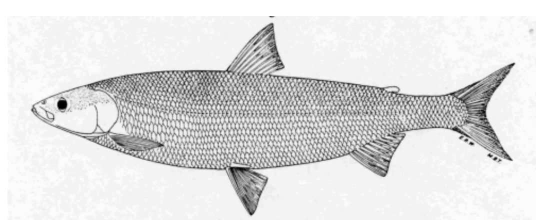



Report of the Coldwater Task Group To the Standing Technical Committee Of the Lake Erie Committee

25 March 2003

Members:

Martin Stapanian	United States Geological Survey (Co-Chair)
Phil Ryan	Ontario Ministry of Natural Resources (Co-Chair)
Mike Bur	United States Geological Survey
Andy Cook	Ontario Ministry of Natural Resources
John Fitzsimons	Department of Fisheries and Oceans, Canada
Mike Fodale	United States Fish and Wildlife Service
Jim Francis	Michigan Department of Natural Resources
Kevin Kayle	Ohio Department of Natural Resources
Jim Markham	New York Department of Environmental Conservation
Chuck Murray	Pennsylvania Fish and Boat Commission
Paul Sullivan	Department of Fisheries and Oceans, Canada
Elizabeth Trometer	United States Fish and Wildlife Service

Line drawings from Trautman (1981)

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Background

The Cold Water Task Group (CWTG) is one of several technical groups under the Lake Erie Committee (LEC) that addresses specific charges related to the fish community. Originally, the CWTG's primary function was the coordination, collation, analyses, and reporting of annual lake trout assessments among its 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 Pennsylvania Fish and Boat Commission (PFBC), the U.S. Fish and Wildlife Service (USFWS), and the New York Department of Environmental Conservation (NYSDEC) formed a cooperative partnership for lake trout rehabilitation in Lake Erie. From 1982-1994 an average of approximately 200,000 yearlings were stocked. A formal rehabilitation plan was developed in 1985 and still serves as the working document guiding current assessment efforts.

In more recent years, interest in the expanding burbot and lake whitefish populations, as well as predator/prey relationships involving salmonines and rainbow smelt interactions have prompted additional charges 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.

This report is specifically designed to address each charge presented to the CWTG at the LEC annual meeting, held 24-25 March 2003. 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 letterhead.

Charge 1: Coordinate standardized lake trout assessments among all eastern basin agencies, and prepare a report of the status of lake trout rehabilitation. (by J. Markham)

Methods:

A stratified, random design, deepwater gill net assessment protocol for lake trout has been in place since 1986. NYSDEC modified the protocol in 1996 by using nets made of monofilament mesh, instead of the standard multifilament nylon mesh. This modification was made following two years of comparative data 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. Some question still exists about the compatibility of PFBC's gear to standardization due to their use of nylon mesh graded by 6.4-mm increments (0.25-in.), rather than the 12.7-mm increment (0.5-in.) used by the remaining agencies.

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 38mm (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.

Sampling design divides the eastern basin of Lake Erie into eight equal areas 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 1.01). Each area contains 13 equidistant north/south-oriented LOPs that serve as transects. Three transects are randomly selected in each area and sampled first. Once completed, the whole process is repeated, including random selection. 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.

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 2002 by the combined agencies was 115 unbiased standard lake trout assessment lifts in the eastern basin of Lake Erie. This included 59 lifts by NYSDEC, 20 by PFBC, and 36 by USGS/OMNR.

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. Scale samples and otoliths are also retained from most fish for aging when CWTs are not retrievable at the laboratory. Stomach data are usually collected as on-site enumeration or as preserved samples.

Results and Discussion:

Abundance

Sampling was conducted in seven of the eight standard areas in 2002 (Figure 1.01), collecting a total of 302 lake trout. Sixteen (16) year-classes were represented from age 1 to 17 (Table 1.01). Younger cohorts (ages 2, 3, and 4) were the most abundant, representing 79% of the total catch (Fig. 1.02). These results were similar to 2001. Unlike previous years, however, no lake trout aged 7, 8, and 9 were caught, and individuals age 10 and older represented a relatively small proportion (6.1%) of the catch.

Overall lake trout catches in 2002 by standard assessment suggest that lake trout were most abundant in New York waters (Fig. 1.01), a result also found in 1998, 1999, and 2001. In general, lake trout catch per lift (i.e., catch per unit effort, or CPE) decreased along northerly and westerly gradients. Areas A1-A3 continued to produce the most consistent values of CPE from year to year, coinciding with the areas in which stocking of yearling lake trout occurs. Lake trout abundance in Canadian waters (areas A5–A8) was consistent (range 0.57 – 0.60 lake trout/lift) with the exception of area A6, which was substantially higher at 1.56 lake trout/lift.

The overall relative abundance of lake trout in 2002 was 2.32 individuals per standard lift (Figure 1.03). This represented the second consecutive year in which the CPE in standard assessment nets (mesh sizes 38 - 152 mm) increased, mainly due to the abundance of the younger cohorts. However, the CPE in 2002 was still lower than the overall CPE for the interval between 1992 and 1997 (average = 2.63 lake trout/lift).

The response of adult (age-5-and-older) lake trout to sea lamprey treatments (initiated in 1986) has been monitored annually from standard assessments (Figure 1.04). 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. The CPE for age-5-and-older lake trout (0.47 individuals/lift) declined again in 2002 after showing a slight rebound in 2001, and represented the lowest value since 1988. As shown below, poor recruitment of stocked lake trout from 1992 through 1998 probably contributed to the relatively low proportion of the population aged 5-11 in the lake-wide gill net surveys.

Recruitment

An increase in the abundance index of juveniles aged 1-3 occurred in 2002, marking the third consecutive year in which an increase has occurred (Figure 1.05). Age-1 and age-3 lake trout registered the highest catch rates since 1986 and 1988 respectively. The overall index of 2.10 was at its highest level since 1988. There are a number of factors that may have contributed to the increase in recruitment over the past three years, including improved stocking methods and locations, improved fish condition and size, and a decrease in the adult lake trout population.

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. The results suggest a significant decline ($P<0.001$, $r^2 = 0.80$) in recruitment to age 2 from 1986 through 1999 (Figure 1.06). Virtually none of the yearlings stocked from 1993 through 1998 survived to age 2 in 1994 through 1999. The index increased in 2000 and 2001 but showed a slight decrease in 2002. The decrease may be due to fish being shore-stocked in New York in 2001, as opposed to boat-stocked in 1999 and 2000. The overall index for 2002 was still relatively high and comparable to the late 1980's and early 1990's when recruitment of stocked fish to age 2 was considered good.

Survival

Estimates of annual survival from standard eastern basin assessment gill net catches will not be reported by the CWTG until further analysis can be completed. Previous estimates of annual survival were calculated from age-based catch curves. The CWTG was not confident that survival estimates based upon age-based catch curves were accurately estimating the survival of lake trout in Lake Erie. The lake trout rehabilitation plan calls for survival of 60 percent or better (Lake Trout Task Group 1985).

Growth

Mean lengths-at-age and mean weights-at-age of sampled eastern basin lake trout were higher than the long-term average for ages 1 through 7 (Figures 1.07 and 1.08). Means for 2002 for ages 9 through 17 were based on small sample sizes, resulting in relatively large variances in growth, and in large differences from the long-term means for some of these age classes. Overall growth of lake trout in Lake Erie continues to be some of the best in the Great Lakes basin.

Maturity

Twenty-nine mature females ranging in age from 4 through 16 were sampled in standard assessment gill nets in 2002, generating a mean age of maturity of 6.7 years (Figure 1.09). This is the first time since 1997 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 older lake trout caught during the standard assessment gill net survey. 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 (Culligan et al. 2003).

Natural Reproduction

Despite more than 20 years of stocking, no naturally reproduced lake trout have been documented in Lake Erie. Only one potentially wild fish was caught in the NYSDEC coldwater gill net survey in 2002, making a total of 13 potentially wild lake trout recorded over the past three years. A reliable method for distinguishing between a fry-stocked fish and a naturally produced fish has not been found at this time. However, a stock discrimination study, using otolith microchemistry, will be funded through the Great Lakes Fishery Commission in 2004. Results of this research should be available for the 2004 Coldwater Task Group Report.

Charge 2: Continue to assess the burbot and whitefish population age structure, growth, diet, seasonal distribution and other population parameters (by P. Ryan and E. Trometer)

Burbot

Commercial Harvest

Burbot has been increasing in the commercial harvest since the late 1980's (Table 2.01). This increase coincided with the increase in abundance of lake whitefish. Most commercial harvest occurs in the eastern end of the lake. Harvest decreased in Pennsylvania waters after 1995 with a shift from gill net to trap-net commercial fishery, which resulted 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. As a result, the commercial harvest in Ontario increased dramatically (Table 2.01). However, this market did not continue, resulting in declining annual harvests from 2000 through 2002.

Assessment Programs

Burbot is the most commonly caught species in the annual deepwater gill net assessment. The catch of burbot increased steadily from 1993 through 2000 in all jurisdictions (Figure 2.01). In 2001, the catch declined in both Pennsylvania and Ontario waters, but increased slightly in New York waters. In 2002, the catch was similar to that in 2001. Since 1997, the highest catches of burbot have occurred in Ontario waters.

Burbot was one of the target species in the OMNR Partnership gill net assessment conducted annually since 1989 in Canadian waters during the months of September and October. There was no sampling in the eastern basin in 1996 and 1997. Burbot catches increased in the eastern basin and Pennsylvania Ridge from 1992 to 1998, with a 4-fold increase in catch occurring between 1995 and 1998 (Figure 2.02). Burbot catch has been very low in the central basin in all years examined, with lowest catches in the western portion of the central basin. Catch declined in the Pennsylvanian Ridge basins from 1999 through 2000, increased to an all time high in 2001 and declined in 2002. The catch declined in the eastern basin from a high in 1998 through 2001, but increased for 2002.

The Ohio Department of Natural Resources, Division of Wildlife (ODW) has collected age-1+ burbot in their October bottom trawling assessment in the central basin (Districts 2 and 3) since 1990. In this assessment, the catch increased from 1992 through 1998 (District 2) and 1999 (District 3), declined through 2001, but increased in 2002 (Figure 2.03).

Age Structure & Growth

Most of the burbot otoliths collected during the CWTG gill net assessment between 1995 and 2002 have not been analyzed. In January 2003, the CWTG received funding from the Great Lakes Fishery Commission to age approximately 3,000 burbot otoliths collected from 1990 through 2002 as well as any collected in 2003 and 2004. Until these samples are analyzed, age structure and age-specific growth will not be reported. A total of 542 burbot were collected in the CWTG gill net assessment in 2002. Lengths ranged from 407 to 878 mm, with 94% of the catch between 500 and 750 mm (Figure 2.04). Mass ranged from 0.76 to 5.64 kg, with 93% of the catch between 1.00 and 3.5 kg (Figure 2.05).

Seasonal Distribution

There is no information on seasonal distribution.

Whitefish

Commercial Harvest

The total harvest of Lake Erie whitefish in 2002 was approximately 1.05 million pounds (Figure 2.06). This was 11.7% less than the 2001 harvest of 1.2 million lbs. The whitefish harvest increased during the 1990s, and peaked at 1.35 million lbs in 2000. The harvest in 2002 represents a decline of 21.8% from the peak harvest in 2000. Ontario accounted for virtually all (99.4%) of the catch in 2002, most of which was from gill nets. Ohio harvested 0.6% and Pennsylvania harvested less than 0.1%. The whitefish fishery in Ohio was conducted with trap nets set around islands in the western basin (District O1) in November and December.

There was a major shift in the distribution of the Ontario harvest in 2002. More of the fish were harvested from the central basin in 2002 (70.8% versus 46.6% in 2001) and less from the western basin (27.7% versus 52% in 2001). Proportions of total harvests from gill nets in Ontario waters in 2002 from Districts OE1, OE2, and OE3 were 28%, 60%, and 11%, respectively. This represents an increase in each district from their respective proportions of 52%, 42%, and 5% in 2001. The remaining statistical districts continued to produce small portions of the harvest: 1% in District OE4 in 2002 compared to 0.5% in 2001 and 0.4% in 2002 in District OE5 compared to 0.2% in 2001. The majority of the Ontario harvest from the western basin (267,675 lbs) was caught from October to December with most (95.3%) occurring during November. However, this represented only 25.5% of the total harvest in Ontario. In the central basin, most of the harvest (92%) occurred from January to July, with the peak in March. Whitefish catches in Ontario statistical districts 4 and 5 were negligible.

The age composition of whitefish caught during Ontario's fall fishery in statistical district 1 included fish ages 3 to 13, but age 5- and 6-year-old fish were most common (48.1%). The 5-year-olds (1997 year class) provided 25.3% of the catch, and 6-year-olds (1996 year class) provided 22.7% of the catch (Figure 2.07).

Whitefish ages 3 to 13 comprised Ohio's harvest, with age 6 (1996 year class) representing the largest component (16%). The mean age of whitefish harvested from Ohio waters (7.6) was higher than the previous year (6.7) and higher than the mean age of Ontario's fall harvest in the western basin (6.6) (Figure 2.08).

Ontario's 2002 fall commercial gill net CPE (14.59 kg/km) decreased 57% from 2001 (33.61 kg / km) and 64% from 2000 CPE (41.22 kg/km; Figure 2.08). There was a similar level of targeting for whitefish in the fall fishery as in 2001, and targeting produced a much higher CPE. However, targeting has potential to bias the CPE, so the contribution of targeted CPE to the average CPE was limited to the ratio observed in 1999, for data years 2000, 2001 and 2003.

A catch curve analysis was used to estimate mortality rate in previous years (Figure 2.09). The 2002 data have been added to this Figure 2.09, but the analysis was not conducted because observations for ages 3-5 fell well below the transformed CPE data for those age classes as determined for previous years. Alternative approaches for estimation of mortality will be developed for 2003.

Index Fishing

New York's deep-water assessment work showed a major decline in the number of whitefish caught per standard gill net lift (1.71) in 2002, compared to the 2001 CPE (6.23 fish/lift) (Figure 2.10). The Ontario partnership gill net survey recorded whitefish in the east basin in 2002, compared to nil catches during 2000 and 2001 (Figure 2.11). Catches increased slightly for the Pennsylvania Ridge, east central basin and west central basins in 2002. The low numbers of fish caught and the high variability indicate that this species is not abundant and that its distribution is patchy, particularly in the eastern basin.

The 2001 year class is expected to be strong, based on its occurrence as yearlings in the Ohio central basin trawl index in 2002. Age 1 whitefish made up 30% of the fish caught in the partnership survey (Figure 2.12). The distribution of young whitefish may be changing or expanding based on last year's records of small numbers of 2001 year class whitefish caught in Pennsylvania, New York and Ontario in 2001. This is a significant change because index trawling conducted by the PFBC has not produced juvenile whitefish since 1992, despite frequent catches of young fish during the previous decade**.** Similarly, catches from New York and Ontario occurred in areas that have not been noted as having young whitefish present.

Growth and Diet

Diet studies from Ohio waters of the Central Basin in 2002 (Ohio DNR 2003) indicated that age 1 whitefish (n = 75) consumed mainly chironomids (36%), isopods (21%), *Bythotrephes cederstroemi* (12%), *Leptodora* sp. (7%), *Dreissena sp.* (6%) and Sphaeriidae (5%) (Figure 2.13). Age 2 and older whitefish (n=60) consumed mainly on *Dreissena sp*. (33%), followed by Isopoda (17%), Hirudinea (14%), chironomids (10%), Sphaeriidae (10%) and *B. cederstroemi (*3%) (Figure 2.14)

Lake Whitefish Population Reconstruction and Perspective

A rough estimate of whitefish population size (mature fish) in 2002 and for the years 1939-1953, was constructed in order to provide a perspective on the current whitefish population size and density (Table 2.02). The estimate of mortality rate from catch curve analysis (Z = 0.674, this report) was combined with an estimate of natural mortality rate (M = 0.38 from mean water temperature and growth, Hardy 1994) to estimate fishing mortality (F = Z-M) and exploitation rate (u = FA/Z = 0.22, where S = 0.51, this report) using formulas from Ricker (1975). The size of fish harvested in the fall fishery in Ontario was determined from the ratio of CPEs (kg/km/no/km) as 1.61 kg (Table 2.02). This was used to estimate the number of fish harvested as 0.30 million (all jurisdictions). This estimate represents 22% (exploitation rate) of the number of mature fish vulnerable to the fishery. Therefore, the population size is estimated as 1.33 million mature fish. Hardy (1994) mapped the area of summer habitat for whitefish. The 20-m contour provides a crude approximation of that area as of summer habitat as 386,700 ha in PA, New York and Ontario waters (data from Cox 1983). During spawning season, these fish are likely distributed across the western basin (124,700 ha, from Cox 1983). Christie and Regier (1988) reported the average harvest for the period 1939-53. The value of Z was similar in this time period (Hardy 1994, citing Z=0.71 as mean from Van Oosten and Hile 1947). Assuming the same M and size of fish in the fishery, the population size was estimated as 5 million fish.

These comparisons provide a perspective on the population size. The current fishery relies on 1.33 million fish that during summer may have a density of 3.4 fish/ha in the eastern basin habitat, but are much more concentrated in the western basin during spawning (10.7 fish/ha). During the period 1939-53, whitefish were more abundant in the summer habitat (12.8 fish/ha).

Goodyear et al. (1982) identified five spawning areas in eastern Lake Erie. These may have supported stocks within the overall population. There is little evidence from targeted fishing, that whitefish may be using them to any extent and the whitefish fishery in eastern Lake Erie does not attract much fishing effort overall. Whitefish are rare in most of their summer habitat in eastern Lake Erie. Restoration of a significant fishery in the eastern basin may require restoration of spawning stocks in eastern Lake Erie. Food web changes and interactions with smelt are likely responsible for the current low abundance of whitefish in eastern Lake Erie.

Research Efforts

Lake whitefish are difficult to assess in Lake Erie, due to their population size and their migratory and schooling behavior. The CWTG has been assembling the whitefish data in order to support a stock assessment review. A series of reports were produced in 2001. A synthesis of this material was produced for a workshop in February 2002, and a manuscript is in preparation. The individual who prepared the draft reports in 2001 is beginning a M.Sc. project concerning whitefish bioenergetics at the University of Windsor, in 2003. This research is important to understanding the potential for whitefish to increase in Lake Erie.

Charge 3: 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 P. Sullivan, M. Fodale, and J. Markham)

The Great Lakes Fishery Commission and its control agents (the U.S. Fish and Wildlife Service and Department of Fisheries and Oceans, Canada) continue to implement Integrated Management of Sea Lamprey (IMSL) on Lake Erie, including quantitative selection of streams for treatment and implementation of alternative control methods. The Lake Erie Cold Water Task Group has provided the forum for the discussion concerns about wounding and mortality of lake trout.

Lake Trout Wounding Rates

The effects of regular sea lamprey treatments in Lake Erie tributaries by the Great Lakes Fisheries Commission began to show in the lake trout population in 2002. For lake trout greater than 532 mm total length, the rate of fresh wounds (Types A1 through A3) plummeted from 20.3 wounds per 100 fish in 2001 to 3.3 wounds per 100 fish in 2002, and was the lowest rate since 1992 (Figure 3.01). This also marked the first time since 1994 that wounding rates were below the target rate of 5 wounds per 100 fish established by the Lake Trout Task Group (1985b) and ends a series of five consecutive years of relatively high fresh wounding rates. All of the fresh wounds recorded in 2002 were found on fish between 533 and 734 mm total length. No fresh wounds were found on lake trout >734 mm, which in recent years has been the length group with the highest wounding rates. These results may be reflective of the age structure of the lake trout caught in the 2002 survey, which were predominantly smaller fish (age 4 and less).

Type A4 wounds, which indicate the past year's cumulative attacks, were lower than 2001 rates, but still higher than rates found in the early to mid-1990's (Figure 3.02). The Type A4 wounding rate for lake trout >532 mm was 15.8 wounds per 100 fish in 2002. Unlike the fresh (A1-A3) wounding rate, most (74%) of the Type A4 wounds were observed on lake trout longer than 734mm. Type A4 wounding rates should show a decline in 2003 in response to the lower fresh wounding rates found in 2002.

2002 Actions

During 2002, assessments were conducted in four streams (one in Canada, three in the U.S.) to rank them for lampricide treatment, and another seven streams (five in Canada, two in the U. S.) to determine presence or absence of sea lamprey larvae (Tables 3.01 and 3.02). The populations considered for treatment were either re-established (Big, Canadaway, Grand) or residual to treatment (Conneaut). In addition, sea lamprey larvae were detected in Silver, Big Otter and Cattaraugus creeks.

Control effort, which had been enhanced to counter observed increases in sea lamprey abundance, continued in 2002 with lampricide treatment of Crooked Creek. This marked the ninth treatment since 1999. In contrast, only three Lake Erie stream treatments had been conducted between 1991 and 1998.

The estimated numbers of spawning-phase sea lampreys declined for the second consecutive year in Lake Erie for the first time since 1994 (Fig 3.03). The 2002 spawning population was estimated at 3170 (Klar and Young 2003), down from 4317 in 2001 (Schleen and Klar 2002). A total of 314 spawning-phase sea lampreys were trapped in 4 tributaries (Cattaraugus, Grand (Ohio), Big and Young's), a reduction of 74% from the 2001 catch. Declining trap efficiency in Cattaraugus Creek, and unforeseen interruptions to trapping operations on Big Creek likely resulted in reduced catch during 2002.

Several barrier projects are proceeding on Lake Erie. Although the Big Creek inflatable barrier was successful in blocking migrating sea lampreys in 2001, it was deactivated for part of the 2002 spawning run. Positive larval surveys indicate that some adult sea lampreys had passed. Improvements were made to the Young's Creek barrier, and planning for the proposed low-head barrier on Conneaut Creek continued.

Existing dams on the Grand, Chagrin and Maumee rivers in Ohio are being examined for possible modification or removal to improve fish passage. Similar plans for the dam on the Grand River in Caledonia, Ontario have been put on hold. Areas suitable to sea lamprey reproduction and larval survival exist above most of these structures, and future actions that impair their capacity to block spawning-phase sea lampreys would pose significant environmental and economic risks.

2003 Plans

Sea lamprey management plans for Lake Erie in 2003 include lampricide treatment of Big and Conneaut creeks and the Grand River, based on a comparison of cost-per-transformer estimates for all Great Lakes streams that were quantitatively assessed in 2002. Larval assessments are planned on 26 Lake Erie streams (six in Canada, 20 in the U. S.), three of which (Big Otter, Young's, Cattaraugus) will be considered for lampricide treatment in 2004 (Tables 3.01 and 3.02). In addition, four tributaries to Lake St. Clair with histories of sea lamprey production will be assessed. Construction is planned for a new spawning-phase trap at the Springville dam on Cattaraugus Creek. A control dam located on a tributary to Rogers Creek in the Taquanyah Conservation Area is slated for removal. This coldwater tributary, which enters the Grand River (ON) near the town Cayuga, is a potential sea lamprey producer and will require future monitoring.

Charge 4: **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 C. Murray and J. Markham)**

Stocking of Lake Trout

The current goal of 120,000 yearling lake trout stocked was met for the fourth straight year (Figure 4.01). This was equal to 2001 effort and a 27% decrease from the long-term average. Stocking in 2003 will be maintained at 120,000 yearling lake trout. As discussed below, stocking effort of yearling lake trout is expected to increase in 2004, when stocking will be supplemented with the Klondike strain.

The Allegheny National Fish Hatchery (ANFH) supplied all of the lake trout, with 80,000 Superior strain fish delivered to New York and 40,000 Seneca (Finger Lakes) strain stocked in Pennsylvania waters of Lake Erie. New York fish were stocked offshore of Dunkirk on 7-8 May 2002 while Pennsylvania fish were shore stocked at Safe Harbor Marina on 10 May 2002. All stocked lake trout were implanted with coded-wire tags (CWT) and had adipose fins clipped prior to release. Lake trout sac fry from ANFH were tube-stocked over cobble material on Brocton Shoal by NYSDEC personnel on 22 May 2002. The 283,500 fry stocked was the most fry available since 1997, but was still well below the goal of 500,000. All fry were otolith marked, by exposure to temperature change, prior to release for future identification.

A paired planting of yearling lake trout to compare survival and growth rates of large- versus small stocking size, begun in 2000, was continued in 2002. Yearling lake trout averaging 14.0 and 8.7 fish/pound, respectively, were stocked north of Dunkirk in May 2002. Each of the size groups consisted of 40,000 fish and had different coded-wire tag (CWT) numbers. In all three years of this study, the larger stocked fish had greater survival rates. Return ratios from stocking favored the larger stocked fish 2.5:1 (66 large, 26 small) in 2000, 2:1 (16 large, 8 small) in 2001, and 2:1 (8 large, 4 small) in 2002. However, these differences were significant for only the 2000 data set ($X^2 = 13.16$, $P < 0.001$). Differences in average sizes were apparent in ages 1 and 2, but were not significant by age 3. Future assessments will continue to evaluate the growth and frequency of these size groups to determine if the size of the yearlings stocked affects recruitment to adult ages.

To address the lack of natural recruitment in the Lake Erie system and declining adult numbers, a new strain of lake trout from Lake Superior is currently being raised at ANFH for stocking in Lake Erie beginning in 2004. The Klondike strain, also referred to as humpers or bankers, is an offshore form that lives its entire life around deep-water reef areas. The Klondike appears to have characteristics that are more conducive for spawning in the Lake Erie than those of the forms currently stocked. Further, it is the most genetically diverse strain of all the Federal Hatchery fish. This combination of characteristics may improve the chances of establishing a self-sustaining lake trout population in Lake Erie. Approximately 30,000 Klondike yearlings are scheduled to be stocked in Lake Erie in Spring 2004, with 80,000 yearlings targeted for 2005. Overall stocking will also increase from 120,000 to 160,000 yearlings beginning in 2005.

Stocking of Other Salmonids

In 2002, 2.28 million yearling trout and salmon were stocked in Lake Erie, including rainbow trout, lake trout, brown trout and coho salmon (Table 4.01). Numbers stocked ranged from approximately 60,000 in Michigan to approximately 1.3 million in Pennsylvania. Total stocking of salmonines in 2002 was slightly greater (0.8%) than the 2001 effort and was 3.6% less than the long-term average (1989-2002).

All riparian agencies stocked rainbow trout in 2002. A total of 1,940,207 yearling rainbow trout were stocked in 2002, representing a 2.7% decrease from 2001. Rainbow trout stocking in 2002 had increased over 26% from the long-term average, primarily a result of the increased prominence of this species in jurisdictional fisheries over that last decade and replacement of other Pacific salmon by this species. Slight reductions in overall rainbow trout stocking are anticipated in 2003 due to a 20% reduction in stocking in Pennsylvania because of production shortfalls. Details on strain and stocking location for rainbow trout are provided in Charge 6 of this report.

Stocking of brown trout in Lake Erie totaled 116,975 yearlings in 2002. This represents an increase of 584% from 2001, and a 32% increase from the long-term average. This increase was due primarily to NYSDEC substituting domestic rainbow trout with brown trout and incorporating PFBC “put and take” brown trout into the database. Ontario stocked 4,000 yearling brown trout in 2002.

The PFBC remains the only agency that stocks coho salmon in Lake Erie. A total of 100,289 yearling coho salmon were stocked in 2002, representing a 21% decrease from 2001, and a 67% decrease from the 1989-2002 annual average. The Commission is discontinuing the coho salmon program after 2003, with no plans to stock this species in the future.

Charge 5: Assist FTG with bioenergetics analysis of the diets of coldwater predator species (by J. Markham, K. Kayle, and E. Trometer)

The most recent charge to the bioenergetics subgroup of the FTG was to update past bioenergetics modeling efforts to estimate the consumption of smelt and other prey fish by the main lake predators (i.e., walleye, lake trout, burbot, and steelhead). Until recently, population estimates of walleyes, the main lake predator, have been in question and have hindered completion of this charge. However, recent changes to the walleye population model have provided better estimates of walleye abundance and allowed the completion of updated walleye forage consumption estimates. With walleye model completed, the focus of the bioenergetics charge has now shifted to the four major coldwater predator species, each of which is updated below.

Lake Trout

Diet

Analysis of the stomach contents of lake trout caught during coldwater assessment gill netting during August 2002 in the eastern basin of Lake Erie revealed a diet exclusively made of fish (Figure 5.01). Rainbow smelt were the most important component of their diet, occurring in over 90% of the stomachs (Figure 5.02). This is almost identical to last year when smelt were found in 89% of the stomachs. Rounds gobies, absent in lake trout stomachs until now, were found in 4% of the stomachs. Alewife, gizzard shad, and unknown fish were also found in the lake trout diet.

Lake Trout Population Model

The CWTG has assisted the 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 using stocked numbers of lake trout and annual mortality to generate an estimated population. It was initially created to predict the number of adult lake trout in the population to gauge the Lake Erie 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 (CWTG 2001). 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, more recent runs of the model depict a departure between the model and annual surveys with the model showing a high, increasing lake trout population while surveys indicate a dropping population (Figure 5.03). 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. The most recent working version of the LTPM (Figure 5.03) incorporates some changes in sea lamprey mortality, fishing mortality, and stocking strain survival. Estimates of the adult population (age 5 and older) using the new model are around 13,000 fish, about one-third the estimate of the original lake trout model. The Strategic Plan for Lake Trout Restoration (1985) suggested that successful Lake Erie rehabilitation required an adult population of 75,000 lake trout.

The biggest needs still identified while working with the model is better estimates of annual mortality due to fishing, sea lampreys, and natural causes, and the effects of stocking survival on the adult population. A lake-wide lake trout database is in the process of being created with annual coldwater survey data from the NYSDEC, PFBC, and the USGS/OMNR. Once the database if finished, the annual assessment surveys will be used to obtain revised estimates of mortality using cohort analysis, effects of sea lampreys wounding rates, and survival at various life stages and by stocking strain. Additionally, the current LTPM may be converted to a more current model using AD Model Builder (ADMB), following a pre-existing working lake trout model in place for Lake Huron.

Burbot

Diet

Seasonal diet information is incomplete, with most of the data coming from burbot collected in the standard lake trout assessment in August in the eastern basin of Lake Erie. Stomach contents were identified in burbot collected May through October 2000 by ODW, PFBC, NYSDEC, and OMNR (Table 5.01). Rainbow smelt were present in the diet for May, June and August. Round goby were in the diet for June, August, September and October. Round goby were present in the diet in all areas. In New York waters, round gobies occurred in 4% of the burbot collected in 2000, in 20% of the burbot collected in 2001, and 37% of the burbot collected in 2002. There appears to be a concurrent decrease in the importance of smelt in their diet, with a decline from almost 80% in 2000 to around 50% in 2001 and 2002 in New York waters. In Ontario waters in August, smelt was the most common fish prey followed by alewife. Dreissenids were the most common invertebrate prey.

Population Parameters

Burbot were not included in the initial bioenergetics modeling effort by Einhouse et al. (1999). Although burbot were an abundant in Lake Erie coldwater habitats prior to 1950, their numbers declined markedly thereafter (Trautman 1981). Burbot were not considered a major predator species in Lake Erie until their recent revitalization in the early 1990's. Burbot are now the most common species caught in all Lake Erie coldwater assessment programs.

Currently, little is known about the population parameters (recruitment, age structure, growth, survival, mortality, fecundity) of burbot in Lake Erie. Funding was recently acquired for a burbot otolith study, which should provide timely information on the age structure of the Lake Erie burbot population and allow for estimates of mortality, growth, and survival. Since 1996, the highest burbot catches in the CWTG's coldwater assessment survey have been recorded in Ontario waters. OMNR began a pilot program of bottom trawling in 2002 in order to estimate burbot biomass by an "area swept" strategy. The trawling will be conducted at the sites where the cold-water assessment has occurred so that biomass data from trawl catches can be used to calibrate gillnet catch data for burbot across the basin. Other estimates of the numbers of burbot might be obtained from the Lake Trout Population Model (LTPM) and annual coldwater surveys. Since burbot and lake trout are both caught in the same gill net sets, the ratio of lake trout to burbot could be applied to the LTPM to estimate the burbot population. This approach assumes that lake trout and burbot populations experience similar catchability and selectivity rates in experimental gill nets. These assumptions have not been rigorously tested.

Steelhead

Diet

Steelhead are not sampled effectively in any of the partner agency's current assessment efforts. In 2002, ODW initiated a pilot project to examine the diets of steelhead in the open water of Lake Erie's Central Basin during the summer. This information is valuable for describing steelhead movements and life habits during a time period when data are lacking. Further, this information would be useful for describing steelhead food web interactions and for including the bioenergetics of steelhead and predators in the models developed by various Great Lakes Fishery Commission task groups. This pilot project is being used as a precursor to a larger, interagency project on Lake Erie salmonid diets and bioenergetics.

From the end of June through early September, ODW contacted charter boat fishers, who had completed the day's angling, at a local fish-cleaning station in Fairport Harbor, Ohio. Sampling days when charter boats fished and ODW personnel were available were selected at random for the diet analyses. All steelhead sampled were caught in Ohio waters. Locations (latitude/longitude and 10-minute Lake Erie Committee sampling grid) were recorded for each fishing trip. All steelhead from the trip were examined for the presence of food items. Steelhead stomachs were removed at the fish-processing house on afternoon of charter trip return and processed on site. All diet items were identified and enumerated (numbers of zooplankton were field estimated), and fish were measured to length (either vertebral, standard, fork or total length depending on condition). Known conversions of length to wet weight to dry weight for central basin diet items were used to calculate the biomass of prey items consumed.

A total of 310 steelhead were analyzed for diet composition. Length of steelhead ranged from 315-742 mm (median length= 580 mm). Most fish had spent two summers in the lake and ranged from 550 - 650 mm. Only 25.8% of the stomachs examined were empty. The most common item recorded in steelhead diets was the spiny water flea, *Bythotrephes cederstroemi* (Table 6.02), followed by smelt and emerald shiners. Twelve diet items were recorded, not including unidentified fish remains. More than 99% of the biomass of the stomach contents was composed of fish (Table 6.03). Smelt was the most important item in terms of biomass consumed, followed by white perch, emerald shiners, freshwater drum and alewife. Round goby, yellow perch, insects and plankton made up smaller proportions.

The results of this small pilot study suggest that adequate numbers of steelhead can be sampled through this charter-encounter method. The results suggest that in the summer, steelhead in the Central Basin are generalists, regarding numbers and types of food items consumed. However, they obtain the majority of their energy from fish.

A more complete data set is needed for state, provincial and interagency projects such as bioenergetics modeling. Clearly, this would require a much larger sampling effort. Setting specific assessment gear (e.g., gill nets) in areas in which trout are concentrated can also be used as a control for temporal comparisons of diets and consumption. The project results and the interagency bioenergetics models can also be enhanced by paralleling or incorporating diet analysis of other species (e.g., walleye and smallmouth bass) for direct comparisons.

Population Parameters

Aside from lake trout, the salmonine community stocked into Lake Erie has changed considerably since the 1991 bioenergetics modeling effort. Chinook salmon are no longer stocked and coho salmon are only stocked by Pennsylvania. Conversely, stockings of rainbow trout, mostly of the steelhead trout subspecies, have been expanded to almost 2 million fish per year and are now the most abundant salmonine in Lake Erie. Despite the vast expansion and popularity of this species in Lake Erie over the last few years, little additional data on steelhead trout growth, abundance, and mortality exists from the initial bioenergetics modeling effort (Einhouse 1991). An additional unknown is the contribution of natural reproduction, which was formerly believed to be insignificant. Recent studies (Culligan 2002, Roth 2001, Goehle 1999) have shown that natural reproduction is a contributing factor to the steelhead population, but the overall significance remains unknown.

The Lake Erie CWTG recently discussed the lack of critical population information on steelhead. Unfortunately, major obstacles prohibit any assessment surveys in the near future to address these issues. However, current surveys might be able obtain some preliminary information. While the majority of the angler effort directed at this species is still conducted in the Lake Erie tributaries during the fall and spring, summertime offshore steelhead fisheries are just expanding and future creel census may provide an avenue for determining information on growth and summertime diet. Fin-clip studies on pen-reared steelhead released in Dunkirk Harbor, NY may also provide data on growth and longevity. Recommendations are that current bioenergetics modeling will have to use population information from the scarce Lake Erie studies and the literature. In the near future, the Lake Erie CWTG will need to address this lack of information on steelhead trout and determine effective ways of obtaining current population attributes of the Lake Erie steelhead population.

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 K. Kayle, J. Markham, and C. Murray)

Stocking

All jurisdictions stocked rainbow trout in 2002 (Table 6.01), and approximately 1.9 million were stocked. Nearly all (99.9%) rainbow trout stocked in Lake Erie originated from naturalized Great Lakes strains. A naturalized Lake Erie strain comprises approximately 59% of the strain composition followed by a Lake Michigan strain (24%) and a Lake Ontario strain (17%); about 0.1% of the stocked rainbow trout were of domestic origin.

Assessment of Natural Reproduction

A comprehensive, multi-year stream electrofishing survey cataloging New York's Lake Erie tributaries for potential of natural reproduction by steelhead began in Fall 2002. A total of 10 streams were sampled between August 28 and October 2, 2002, bringing the two-year total to 13 streams cataloged. Nine of the 10 streams sampled this fall were lake plain streams, typically not considered ideal for trout production. However, 4 of these streams had young-of-year (YOY) steelhead present, and a few also contained older trout. Modest numbers of YOY steelhead were found in both Reiter Creek and 2nd Gulf. Both of these streams possessed gravel areas for spawning, deep riffle and rock areas, and a full tree canopy to stabilize summer water temperatures. Delaware Creek and 1st Gulf also produced some YOY trout, but both were limited by the overall habitat and water conditions. The five creeks in which no trout were found (Big Sister, Muddy, Beaver, Slippery Rock, and Crooked Brook) all lacked adequate spawning habitat, had low flows, and had high summer water temperatures.

Exploitation

The total estimated harvest from the summer fishery in 2002 (Figure 6.01) was 123,200 rainbow trout, a 123% increase from 2001 estimates. Open lake harvest increased significantly in Ontario (370%), and moderately in Ohio (42%), New York (66%) and Michigan. Harvest in Pennsylvania decreased 25%. Harvest estimates by basin showed that most (90%) of the harvest was in central basin waters, followed by the eastern basin waters (10%). The harvest in western basin waters is nearly immeasurable. Relative harvest estimates follow the seasonal distribution of rainbow trout as well as relative fishing intensity in each basin.

Most of the angling effort directed at rainbow trout is concentrated in the tributaries. No agencies are presently estimating total harvest in the streams. Ontario, New York and Pennsylvania coordinate an angler diary program that provides some measure of the quality (catch rate) of the rainbow trout fishery in the streams on an annual basis. Results from all diary programs show a general trend of increased catch rate since the mid-1990's.

Results from the Pennsylvania Cooperative Angler Log have shown steady increases in catch rates since 1998 (Figure 6.02). The estimated catch rate of slightly less than one rainbow trout per line hour in Pennsylvania tributaries to Lake Erie in 2002 was down slightly from 2001, but continues to provide an exceptional fishery. Catch rate estimates from the Ontario Sport Fish

Diary Program showed a rebound in 2002, with a catch rate of 0.22 rainbow trout/hour, doubling from 2001 (Figure 6.03). NYSDEC diary data is only reported through 2001, but shows increased catch rates since 1996 (Figure 6.04). A catch rate of 0.63 fish/angler hour by stream anglers is the second highest rate in the time series, and well above the long-term average of 0.44 fish per hour.

Charge 7: Monitor the current status of Lake Herring. Review ecology and history of this species and assess potential for recovery (by M. Bur, P. Ryan, and E. Trometer)

Lake herring (*Coregonus artedii*) is indigenous to the Great Lakes and historically supported one of the most productive fisheries in Lake Erie (Scott and Crossman 1973, Trautman 1981). Lake herring is considered extirpated in Lake Erie, although commercial fishermen report it 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 over-fishing, although habitat degradation and competition likely contributed to recruitment failure (Greeley 1929, Hartman 1973, Scott and Crossman 1973). Siltation of spawning shoals, low dissolved oxygen, and chemical pollution are a few factors contributing to habitat degradation (Hartman 1973). 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 1990s. Two large specimens (lengths 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 (J. Omstead, Omstead Foods, Wheatley, Ont. pers. com.).

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, unpubl. 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, OH, pers.com.) and one from Ontario (L.Witzel, OMNR, Port Dover, Ont., pers. com.). Two additional specimens were recorded at Port Stanley in 2001. OMNR biologists believe that the level of reporting has declined. 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. The herring caught in 2002 should have been larger than those caught in previous years and would have been highly prized for smoked fish.

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 over-winter survival of alewife in eastern Lake Erie, while smelt numbers have continued to decline (L.D. Witzel, OMNR Port Dover, ON unpubl. 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 2002-03 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).

The USGS is considering strategies to assist in the rehabilitation of lake herring. Specimens from Lake Erie that were gathered recently by the Ontario Ministry of Natural Resources have been frozen and stored. The USGS's Conte Anadromous Fish Laboratory has offered to conduct DNA testing on the specimens to determine their origin. The DNA sequences of the specimens from Lake Erie will then be compared to DNA sequences of lake herring collected from Lake Huron. If the sequences of the specimens from Lake Erie are distinct from those of herring from Lake Huron, further efforts will be directed at monitoring and assessing the population. However, if the sequences from Lakes Erie match those of Lake Huron, then the CWTG will present a proposal to the Lake Erie Committee to reintroduce lake herring from Lake Huron stock. The proposal will include four elements: 1) Lake Huron herring broodstock acquisition, 2) rearing and marking at the USGS's Northern Appalachian Research Laboratory in Wellsboro, Pennsylvania, 3) stocking fingerlings into eastern Lake Erie, and 4) evaluation through assessment cruises by the USGS's Lake Erie Biological Station.

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Table 1.01: 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, 2002.

AGE	SEX	NUMBER	MEAN LENGTH (mm)	MEAN WEIGHT (g)
I	Combined	16	256	158
II	Male Female	18 9	437 437	915 920
III	Male Female	79 24	570 568	2273 2069
IV	Male Female	51 18	671 672	3651 3440
V	Male Female	12 9	683 715	3999 4428
VI	Male Female	0 3	---- 751	----- 5067
VII	Male Female	1 0	770 ----	6040 -----
VIII	Male Female	0 0	---- ----	----- -----
IX	Male Female	0 1	---- 782	----- 5360
X	Male Female	0 3	---- 797	----- 6620
XI	Male Female	4 1	864 852	8665 -----
XII	Male Female	1 2	747 769	4245 5140
XIII	Male Female	1 1	886 741	8480 5180
XIV	Male Female	3 1	835 805	7300 5960
XV	Male Female	0 1	---- 847	----- 8180
XVI	Male Female	1 1	745 832	4120 6120
XVII	Male Female	1 0	895 ----	11596 -----

Table 2.01. Total burbot commercial harvest (thousands of pounds) in Lake Erie by jurisdiction, 1980-2002.

Year	New York	Pennsylvania	Ohio	Ontario
1980	0	2.00	0	0
1981	0	2.00	0	0
1982	0	0	0	0
1983	0	2.00	0	6.00
1984	0	1.00	0	1.00
1985	0	1.00	0	1.00
1986	0	3.00	0	2.00
1987	0	0	0	4.00
1988	0	1.00	0	0.00
1989	0	4.00	0	0.80
1990	0	15.50	0	1.70
1991	0	33.40	0	1.20
1992	0.70	22.20	0	5.90
1993	2.60	4.20	0	3.10
1994	3.00	12.10	0	6.80
1995	1.90	30.90	1.20	8.90
1996	3.40	2.30	1.20	8.60
1997	2.90	8.90	1.70	7.40
1998	0.20	9.00	1.50	9.90
1999	0.97	7.94	1.15	394.78
2000	0.09	2.28	0.08	30.13
2001	0.39	4.36	0.05	6.45
2002	0.87	5.18	0.06	3.37

Table 2.02: Reconstruction of the number of mature whitefish (3 and older) present in Lake Erie to provide the fisheries from 2002 and 1939-53.

2002 fall fishery (Ontario)

No./km	9.06
Kg/km	14.59
Mean size	1.61

Lakewide estimates

Harvest 2002:	0.30 million fish	0.48 million kg
Harvest 1939-53:	1.10 million fish	1.78 million kg (Christie and Regier 1988)

Catch-curve analysis 2001

Z = 0.67
S = 0.51
M = 0.38 (Hardy 1994)
F = Z – M = 0.29
u = FA/Z = 0.22

Estimate number of mature fish

2002:	1.33 million fish
	3.4/ha in summer habitat
	10.7/ha in western basin
1939-53:	4.96 million fish
	12.8/ha in summer habitat

Table 3.01: Larval sea lamprey assessments of Canadian Lake Erie tributaries in 2002 and plans for 2003. Definitions of survey types: Evaluation – conducted to determine requirement for quantitative assessment; Detection – conducted to determine larval presence or absence in streams with no history of sea lamprey infestation; Quantitative - evaluation of population residual to lampricide treatment.

Stream	History	Surveyed In 2002	Survey Type	Results	Plans for 2003
Big Creek	Positive	Yes	Quantitative	Positive	**Lampricide treatment**
Kettle Creek	**Negative**	**Yes**	**Detection**	**Negative**	**-**
East Creek	**Positive**	**Yes**	**Evaluation**	**Negative**	-
Catfish Creek	**Positive**	**No**	**-**	**-**	**Evaluation survey**
Silver Creek	**Positive**	**Yes**	**Evaluation**	**Positive**	**Evaluation survey**
Big Otter Creek	**Positive**	**Yes**	**Evaluation**	**Positive**	**Quantitative survey**
South Otter Creek	Positive	No	-	-	-
Clear Creek	Positive	No	-	-	-
Forestville Creek	Positive	No	-	-	-
Normandale Creek	**Positive**	**No**	**-**	**-**	**-**
Fishers Creek	**Positive**	**No**	**-**	**-**	**-**
Young's Creek	Positive	No	-	-	Quantitative survey
Grand River	Negative	Yes	Detection	Negative	Detection survey
St. Clair tributaries					
Thames River	Positive	No	-	-	Evaluation survey

Table 3.02: Larval sea lamprey assessments of U.S. Lake Erie tributaries conducted in 2002 and plans for 2003. Definitions for survey types are given in Table 3.01.

Stream	History	Surveyed In 2002	Survey Type	Results	Plans for 2003
Conneaut Creek	Positive	**Yes**	Quantitative[1]	Positive	**Lampricide treatment**
Grand River	Positive	**Yes**	Quantitative	Positive	**Lampricide treatment**
Buffalo River					
Cayuga Creek	Positive	**Yes**	Evaluation	Negative	Evaluation survey
Little Sister Creek	Negative	No	-	-	Detection survey
Delaware Creek	Positive	No	-	-	Evaluation survey
Cattaraugus Creek	Positive	**Yes**	Treatment Eval	Positive	Quantitative survey
Halfway Brook	Positive	No	-	-	Evaluation survey
Canadaway Creek	Positive	**Yes**	Quantitative	Positive	
Chautaqua Creek	Negative	No	-	-	Detection survey
Walnut Creek	Negative	No	-	-	Detection survey
Crooked Creek	Positive	No	-	-	Evaluation survey
Raccoon Creek	Positive	No	-	-	Evaluation survey
Ashtabula River	Negative	No	-	-	Detection survey
Wheeler Creek	**Positive**	**No**	-	-	**Evaluation survey**
Chagrin River	Negative	No	-	-	Detection survey
Black River	Negative	No	-	-	Detection survey
Vermilion River	Negative	No	-	-	Detection survey
Sandusky River	Negative	No	-	-	Detection survey
Portage River	Negative	No	-	-	Detection survey
Maumee River	Negative	No	-	-	Detection survey
St. Clair tributaries					
St. Clair River	Positive	No	-	-	Evaluation survey
Clinton River	Positive	No	-	-	Evaluation survey
Belle River	Positive	No	-	-	Evaluation survey

Table 4.01 : Summary of salmonid stocking in number of yearling equivalents, Lake Erie 1989 – 2002.

Jurisdiction	Lake Trout	Coho	Chinook	Brown Trout	Rainbow/Steelhead	Total
ONTARIO	--	--	--		14,370	14,370
NEW YORK	143,200	154,210	70,370	54,590	141,740	564,110
PENNSYLVANIA	80,000	1,166,480	--	62,450	720,920	2,029,850
OHIO	--	--	--	92,120	242,000	334,120
MICHIGAN	--	400,190	--	50,350	69,560	520,100
1989 Total	**223,200**	**1,720,880**	**70,370**	**259,510**	**1,188,590**	**3,462,550**
ONTARIO	--	--	--	--	31,530	31,530
NEW YORK	113,730	5,730	65,170	48,320	160,500	393,450
PENNSYLVANIA	82,000	249,810	5,670	55,670	889,470	1,282,620
OHIO	--	--	--	--	485,310	485,310
MICHIGAN	--	--	--	51,090	85,290	136,380
1990 Total	**195,730**	**255,540**	**70,840**	**155,080**	**1,652,100**	**2,329,290**
ONTARIO	--	--	--	--	98,200	98,200
NEW YORK	125,930	5,690	59,590	43,500	181,800	416,510
PENNSYLVANIA	84,000	984,000	40,970	124,500	641,390	1,874,860
OHIO	--	--	--	--	367,910	367,910
MICHIGAN	--	--	--	52,500	58,980	111,480
1991 Total	**209,930**	**989,690**	**100,560**	**220,500**	**1,348,280**	**2,868,960**
ONTARIO	--	--	--	--	89,160	89,160
NEW YORK	108,900	4,670	56,750	46,600	149,050	365,970
PENNSYLVANIA	115,700	98,950	15,890	61,560	1,485,760	1,777,860
OHIO	--	--	--	--	561,600	561,600
MICHIGAN	–	--	--	--	14,500	14,500
1992 Total	**224,600**	**103,620**	**72,640**	**108,160**	**2,300,070**	**2,809,090**
ONTARIO	--	--	--	650	16,680	17,330
NEW YORK	142,700	--	56,390	47,000	256,440	502,530
PENNSYLVANIA	74,200	271,700	--	36,010	973,300	1,355,210
OHIO	--	--	--	--	421,570	421,570
MICHIGAN	--	--	--	--	22,200	22,200
1993 Total	**216,900**	**271,700**	**56,390**	**83,660**	**1,690,190**	**2,318,840**
ONTARIO	--	--	--	--	69,200	69,200
NEW YORK	120,000	--	56,750	--	251,660	428,410
PENNSYLVANIA	80,000	112,900	128,000	112,460	1,240,200	1,673,560
OHIO	--	--	--	--	165,520	165,520
MICHIGAN	--	--	--	--	25,300	25,300
1994 Total	**200,000**	**112,900**	**184,750**	**112,460**	**1,751,880**	**2,361,990**
ONTARIO	--	--	--	--	56,000	56,000
NEW YORK	96,290	--	56,750	--	220,940	373,980
PENNSYLVANIA	80,000	119,000	40,000	30,350	1,223,450	1,492,800
OHIO	--	--	--	--	112,950	112,950
MICHIGAN	--	--	--	--	50,460	50,460
1995 Total	**176,290**	**119,000**	**96,750**	**30,350**	**1,663,800**	**2,086,190**

Table 4.01 (Continued): Summary of salmonid stocking in number of yearling equivalents, Lake Erie 1989 – 2002.

Jurisdiction	Lake Trout	Coho	Chinook	Brown Trout	Rainbow/Steelhead	Total
ONTARIO	--	--	--	--	38,900	38,900
NEW YORK	46,900	--	56,750	--	318,900	422,550
PENNSYLVANIA	37,000	72,000	--	38,850	1,091,750	1,239,600
OHIO	--	--	--	--	205,350	205,350
MICHIGAN	--	--	--	--	59,200	59,200
1996 Total	**83,900**	**72,000**	**56,750**	**38,850**	**1,714,100**	**1,965,600**
ONTARIO	--	--	--	1,763	51,000	52,763
NEW YORK	80,000	--	56,750	--	277,042	413,792
PENNSYLVANIA	40,000	68,061	--	31,845	1,153,606	1,293,512
OHIO	--	--	–	--	197,897	197,897
MICHIGAN	--	--	--	--	71,317	71,317
1997 Total	**120,000**	**68,061**	**56,750**	**33,608**	**1,750,862**	**2,029,281**
ONTARIO	--	--	--	--	61,000	61,000
NEW YORK	106,900	--	--	--	299,610	406,510
PENNSYLVANIA	--	100,000	--	28,030	1,271,651	1,399,681
OHIO	--	--	--	--	266,383	266,383
MICHIGAN	--	--	--	--	60,030	60,030
1998 Total	**106,900**	**100,000**	**0**	**28,030**	**1,958,674**	**2,193,604**
ONTARIO			--		85,235	85,235
NEW YORK	143,320		--		310,300	453,620
PENNSYLVANIA	40,000	100,000	--	20,780	835,931	996,711
OHIO			--		238,467	238,467
MICHIGAN			--		69,234	69,234
1999 Total	**183,320**	**100,000**	**0**	**20,780**	**1,539,167**	**1,843,267**
ONTARIO	--	--	--	--	10,787	10,787
NEW YORK	92,200	--	--	--	298,330	390,530
PENNSYLVANIA	40,000	137,204	--	17,163	1,237,870	1,432,237
OHIO	--	--	--	--	375,022	375,022
MICHIGAN	--	--	--	--	60,000	60,000
2000 Total	**132,200**	**137,204**	**0**	**17,163**	**1,982,009**	**2,268,576**
ONTARIO	--	--	--	100	40,860	40,960
NEW YORK	80,000	--	--	--	276,300	356,300
PENNSYLVANIA	40,000	127,641	--	17,000	1,185,239	1,369,880
OHIO	--	--	--	--	424,530	424,530
MICHIGAN	--	--	--	--	67,789	67,789
2001 Total	**120,000**	**127,641**	**0**	**17,100**	**1,994,718**	**2,259,459**
ONTARIO	--	--	--	4,000	66,275	70,275
NEW YORK	80,000	--	--	72,300	257,200	409,500
PENNSYLVANIA	40,000	100,289	--	40,675	1,145,131	1,326,095
OHIO	--	--	--	--	411,601	411,601
MICHIGAN	--	--	--	--	60,000	60,000
2002 Total	**120,000**	**100,289**	**0**	**116,975**	**1,940,207**	**2,277,471**

Table 5.01: Prey of burbot collected in Ohio, Pennsylvania and New York and the eastern basin of Ontario waters of Lake Erie in 2002 by month. Unit of measure: (A) mean % dry weight in grams or (B) % Occurrence. Burbot with empty or everted stomachs were not included.

Month	May	June	August	August	August	August	September	October
Area of Lake Erie	OH	OH	OH	PA	NY	Ontario	PA	OH
Unit of Measure	(A)	(A)	(A)	(B)	(B)	(B)	(B)	(A)
Sample size	1	3	2	22	92	79	12	1
Rainbow Smelt	100.0	1.4	50.0	-	53.3	63.3	-	0.0
Goby	0.0	98.6	50.0	4.5	37.0	3.8	25.0	100.0
Yellow Perch	-	-	-	-	6.5	3.8	-	-
White Perch	-	-	-	-	-	2.5	-	-
White Bass	-	-	-	-	1.1	-	-	-
Alewife	-	-	-	-	1.1	11.4	-	-
Gizzard Shad	-	-	-	-	4.3	-	-	-
Freshwater Drum	-	-	-	-	2.2	-	-	-
Emerald Shiner	-	-	-	-	-	2.5	-	-
Trout Perch	-	-	-	-	1.1	-	-	-
Unidentified fish	-	-	-	100.0	10.9	31.6	91.7	-
Dreissena	-	-	-	31.8	5.4	6.3	16.7	-
Gastropods	-	-	-	-	-	1.3	-	-
Decopods (crayfish)	-	-	-	-	1.1	-	-	-

Table 6.01: Rainbow trout /steelhead stocking by jurisdiction for 2002.

	Location	Strain	Fin Clips	Number	Life Stage	Yearling Eqivalents	
Michigan	Huron River	Manistee River, L. Michigan	RP	60,000	Yearling	60,000	
						60,000	**Sub-Total**
Ontario	Young's Creek	Ganaraska River, L. Ontario	NO	12,875	Yearling	12,875	
	Port Stanley	Ganaraska River, L. Ontario	"	20,000	Yearling	20,000	
	Erieu Harbor	Ganaraska River, L. Ontario	"	33,400	Yearling	33,400	
						66,275	**Sub-Total**
Pennsylvania	Conneaut Creek	Trout Run & Godfrey Run, L. Erie	NO	75,000	Yearling	75,000	
	Crooked Creek	Trout Run & Godfrey Run, L. Erie	"	45,508	Yearling	45,508	
	Elk Creek	Trout Run & Godfrey Run, L. Erie	"	258,500	Yearling	258,500	
	Fourmile Creek	Trout Run & Godfrey Run, L. Erie	"	10,400	Yearling	10,400	
	Godfrey Run	Trout Run & Godfrey Run, L. Erie	"	98,531	Yearling	98,531	
	Orchard Beach Run	Trout Run & Godfrey Run, L. Erie	"	25,000	Yearling	25,000	
	Peck Run	Trout Run & Godfrey Run, L. Erie	"	5,000	Yearling	5,000	
	Presque Isle Bay	Trout Run & Godfrey Run, L. Erie	"	28,440	Yearling	28,440	
	Raccoon Creek	Trout Run & Godfrey Run, L. Erie	"	41,572	Yearling	41,572	
	Sevenmile Creek	Trout Run & Godfrey Run, L. Erie	"	15,670	Yearling	15,670	
	Trout Run	Trout Run & Godfrey Run, L. Erie	"	218,000	Yearling	218,000	
	Twelvemile Creek	Trout Run & Godfrey Run, L. Erie	"	25,250	Yearling	25,250	
	Twentymile Creek	Trout Run & Godfrey Run, L. Erie	"	20,000	Yearling	20,000	
	Walnut Creek	Trout Run & Godfrey Run, L. Erie	"	276,997	Yearling	276,997	
						1,143,868	**Sub-Total**
Ohio	Chagrin River	Manistee River, L. Michigan	NO		Yearling	90,156	
	Conneaut Creek	Manistee River, L. Michigan	"		Yearling	75,005	
	Grand River	Manistee River, L. Michigan	"		Yearling	90,131	
	Rocky River	Manistee River, L. Michigan	"		Yearling	90,110	
	Vermilion River	Manistee River, L. Michigan	"		Yearling	66,199	
						411,601	**Sub-Total**
New York	Buffalo Creek	Chambers Creek, L. Ontario	NO	20,000	Yearling	20,000	
	Buffalo Harbor	Domestic- Randolf	"	2,200	Yearling	2,200	
	Canadaway Creek	Chambers Creek, L. Ontario	"	20,000	Yearling	20,000	
	Cattaraugus Creek	Chambers Creek, L. Ontario	"	90,000	Yearling	90,000	
	Cayuga Creek	Chambers Creek, L. Ontario	"	15,000	Yearling	15,000	
	Chautauqua Creek	Chambers Creek, L. Ontario	"	50,000	Yearling	50,000	
	Dunkirk Harbor	Chambers Creek, L. Ontario	ADLV	10,000	Yearling	10,000	
	Eighteen-mile Creek	Chambers Creek, L. Ontario	NO	40,000	Yearling	40,000	
	Silver Creek	Chambers Creek, L. Ontario	"	5,000	Yearling	5,000	
	Walnut Creek	Chambers Creek, L. Ontario	"	5,000	Yearling	5,000	
						257,200	**Sub-Total**
						1,938,944	**Grand Total**

Table 6.02: Diet items (by frequency of occurrence) for steelhead recorded in a pilot study conducted in the Central Basin from July to September 2002.

Item	% Occurrence (N=310)	% with food (N=230)	% with fish (N=117)
Bythotrephes cederstroemi	49.4	66.5	--
Smelt	23.9	32.2	63.2
Emerald Shiners	8.1	10.9	21.4
Unidentified fish remains	3.9	5.2	10.3
Asian Lady Beetles	2.3	3.0	--
Freshwater Drum	1.6	2.2	4.3
White Perch	1.6	2.2	4.3
Alewife	1.0	1.3	2.6
Chironomid larvae	1.0	1.3	--
Round Goby	1.0	1.3	2.6
Fingernail Clams	0.6	0.9	--
Dreissena Mussels	0.6	0.9	--
Yellow Perch	0.3	0.4	0.9
empty	25.8	--	--

Table 6.03: Proportions of biomass (by dry weight) of prey items recorded in stomachs of steelhead from a pilot study conducted in the Central Basin from July to September 2002.

Item	% Dry Weight (N=230)
Smelt	37.7%
White Perch	24.6
Emerald Shiners	16.3
Freshwater Drum	8.7
Alewife	7.0
Unidentified fish remains	2.6
Round Goby	1.7
Yellow Perch	1.4
Bythotrephes cederstroemi	0.1
Asian Lady Beetles	< 0.1
Chironomid larvae	< 0.1
Fingernail Clams	< 0.1
Dreissena sp. mussels	< 0.1

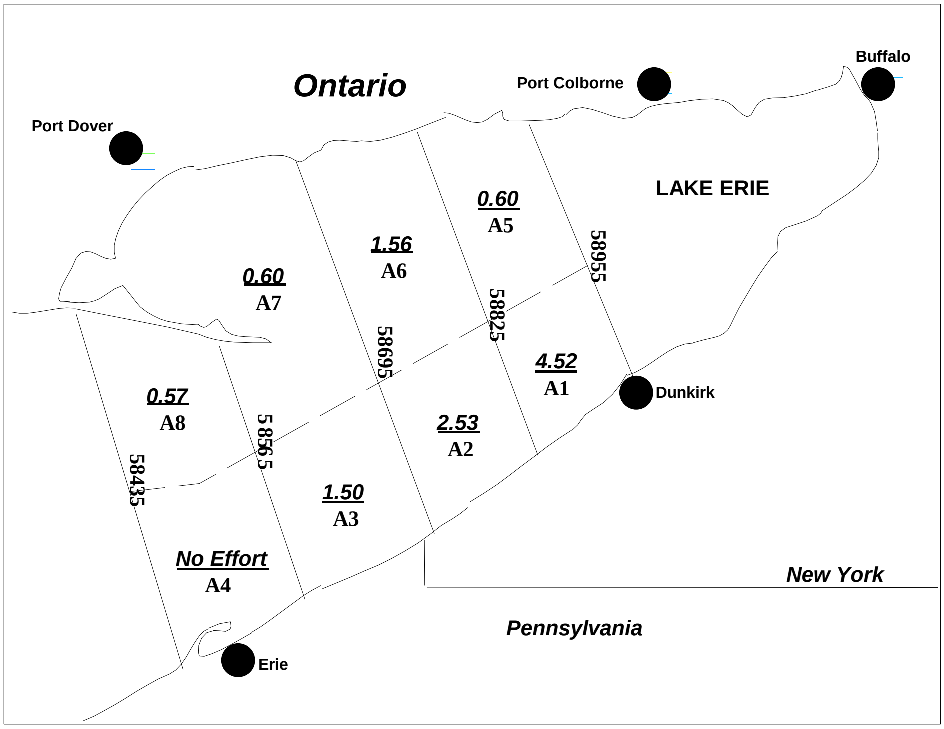

Figure 1.01: Standard sampling areas (A1 – A8) used for assessment of lake trout in the eastern basin of Lake Erie. The numbers in each area represent 2002 CPE (number/lift) for total lake trout catch within that area.

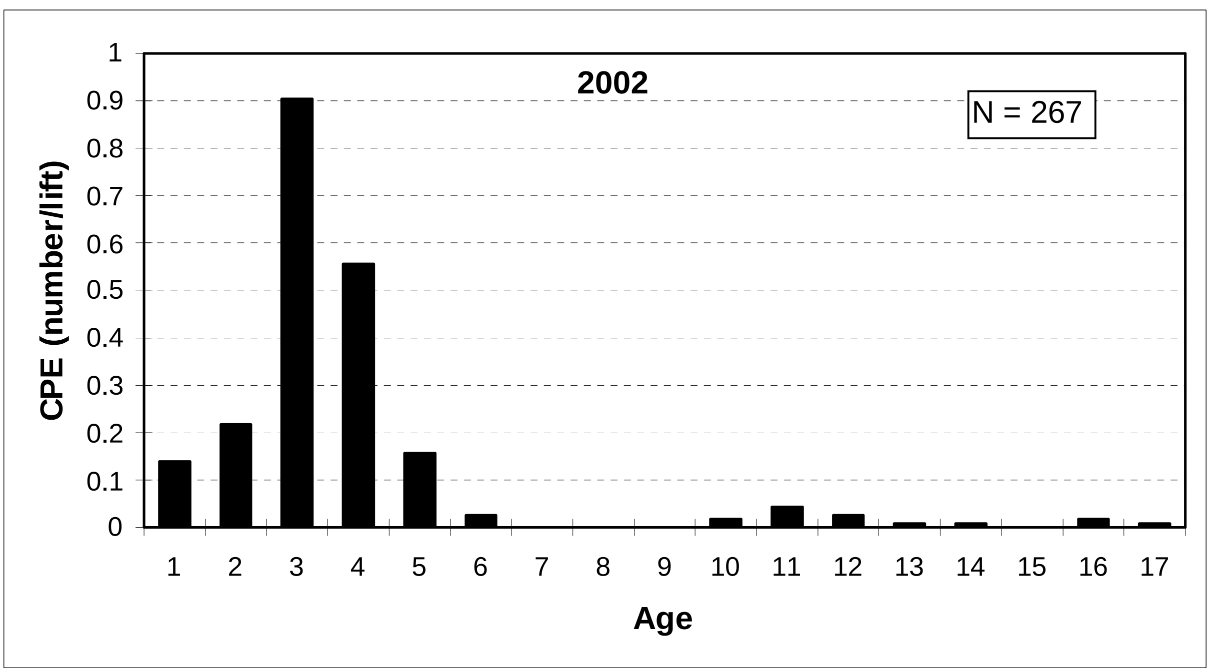

Figure 1.02: Relative abundance at age of lake trout collected from standard assessment gill nets fished in the eastern basin of Lake Erie, August 2002.

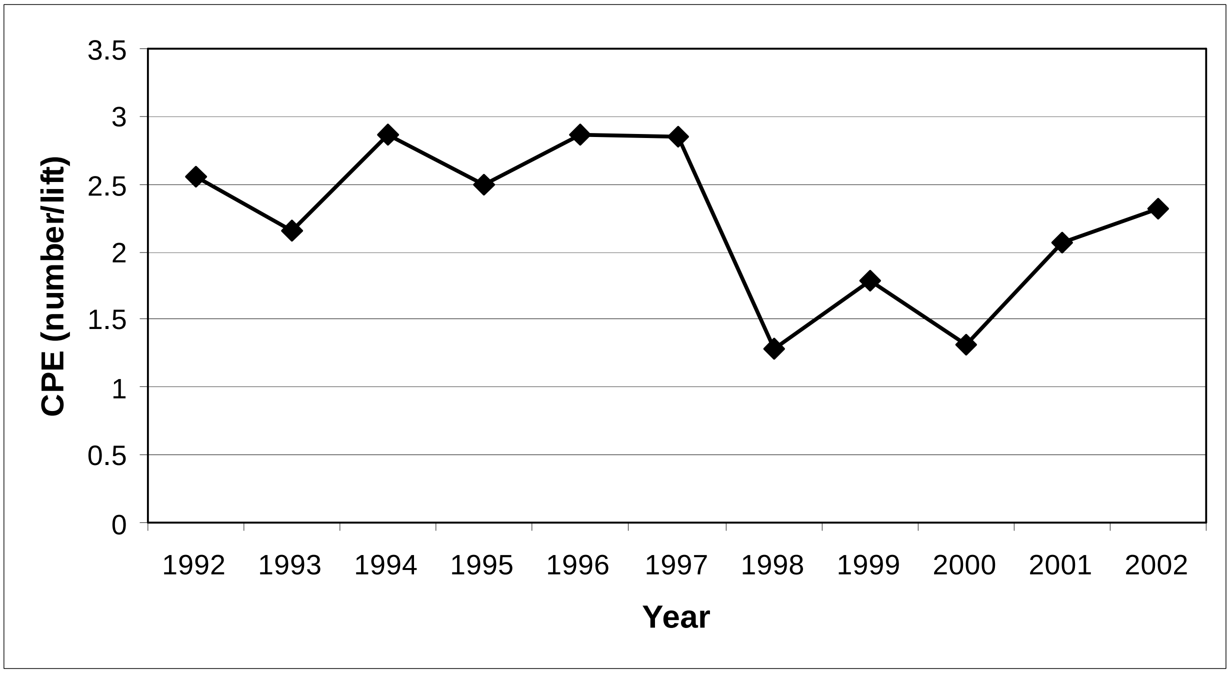

Figure 1.03: Relative abundance (number fish/lift) of all lake trout from a standard gill net assessment survey for Eastern Lake Erie, 1992 - 2002.

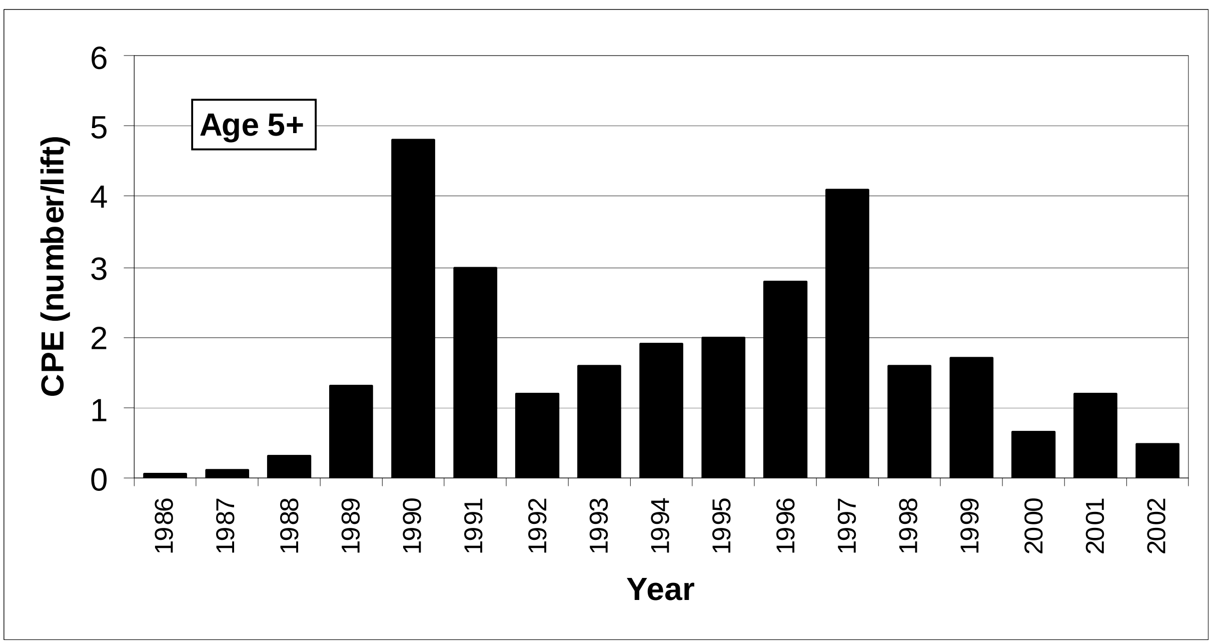

Figure 1.04: Relative abundance of age 5 and older lake trout sampled in gill nets from New York waters of Lake Erie, August, 1986 - 2002.

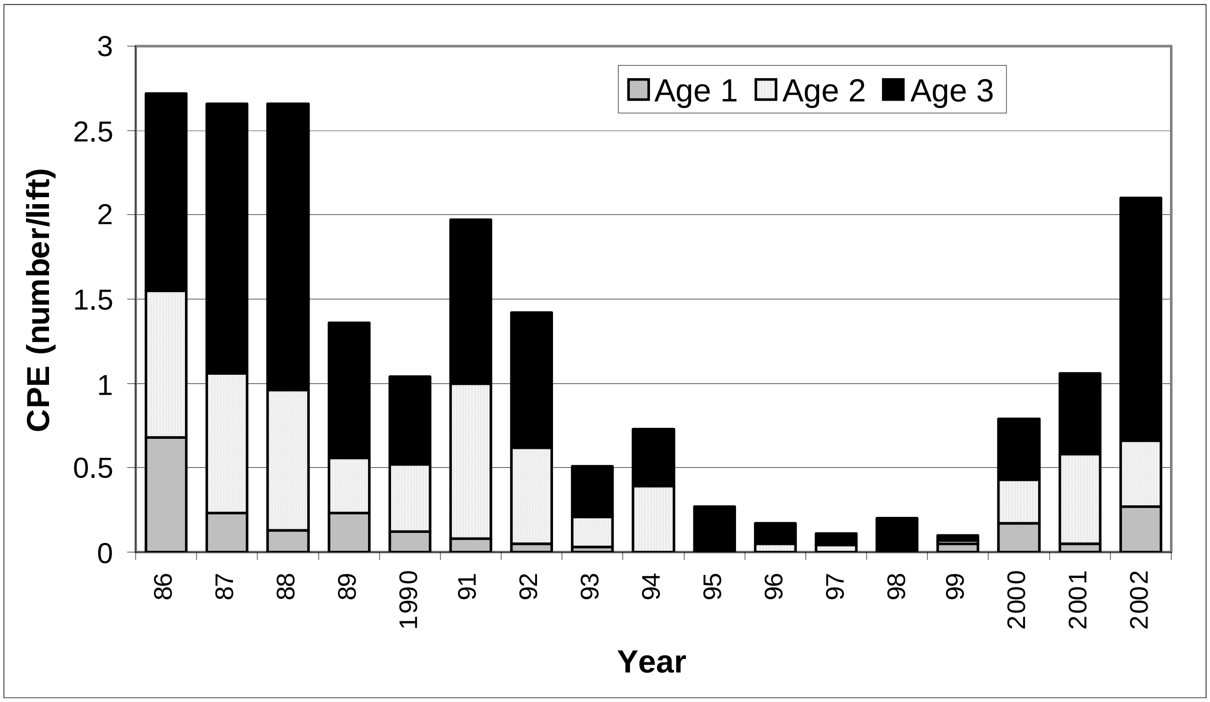

Figure 1.05: Relative abundance of juvenile (ages 1-3) lake trout collected from standard assessment gill nets fished in the New York waters of Lake Erie, August, 1986 - 2002.

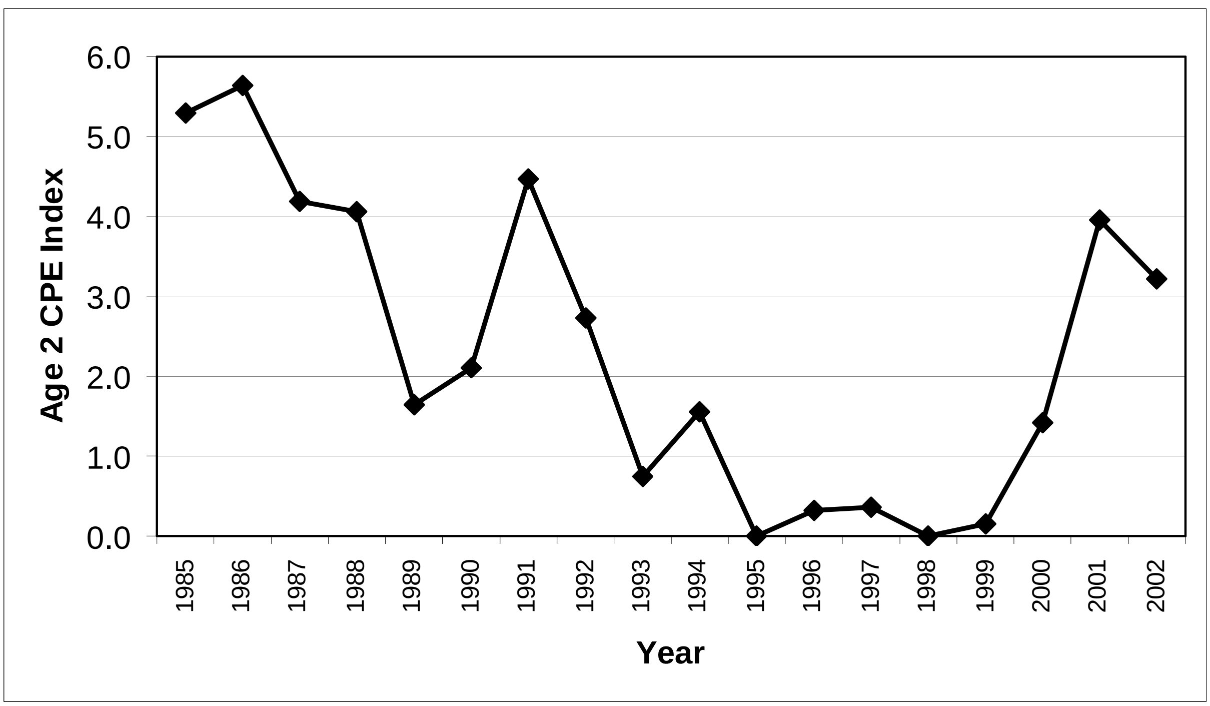

Figure 1.06: Index of age-2 recruitment of lake trout sampled in standard assessment gill nets from New York waters of Lake Erie, 1985 - 2002. The index is calculated by dividing the age 2 CPE by the stocking rate for each cohort.

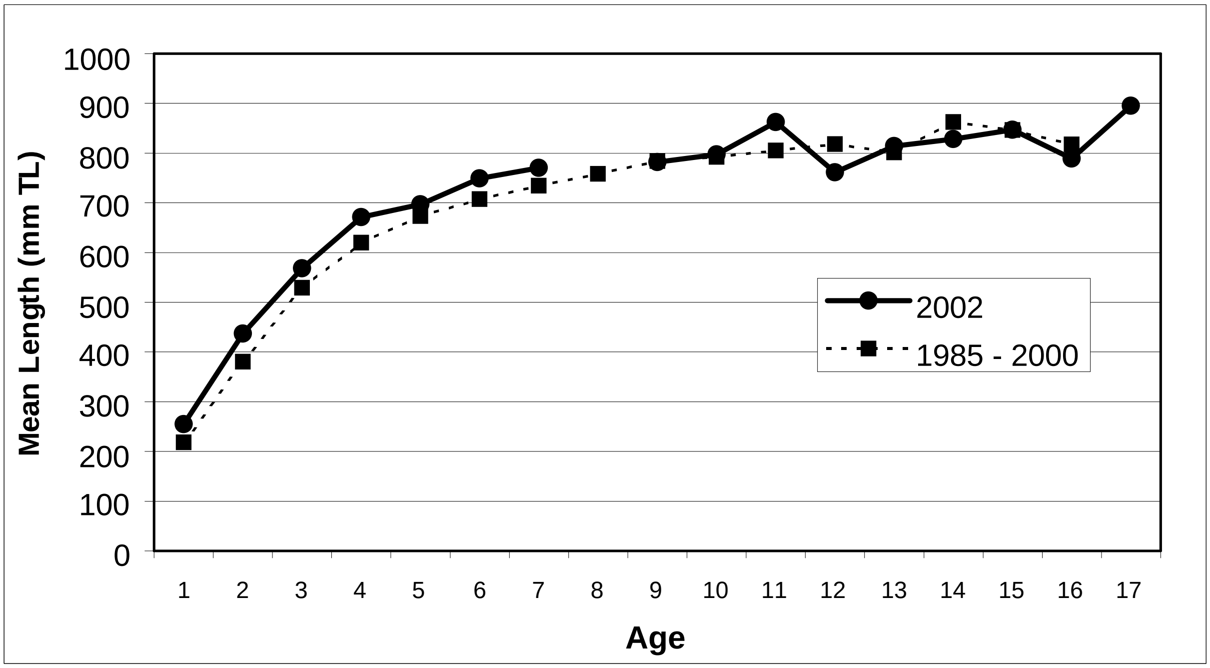

Figure 1.07: Mean length-at-age of lake trout collected in gill nets from the eastern basin of Lake Erie, August 2002. The long-term average from New York, 1985 - 2000, is also shown to compare current growth rates.

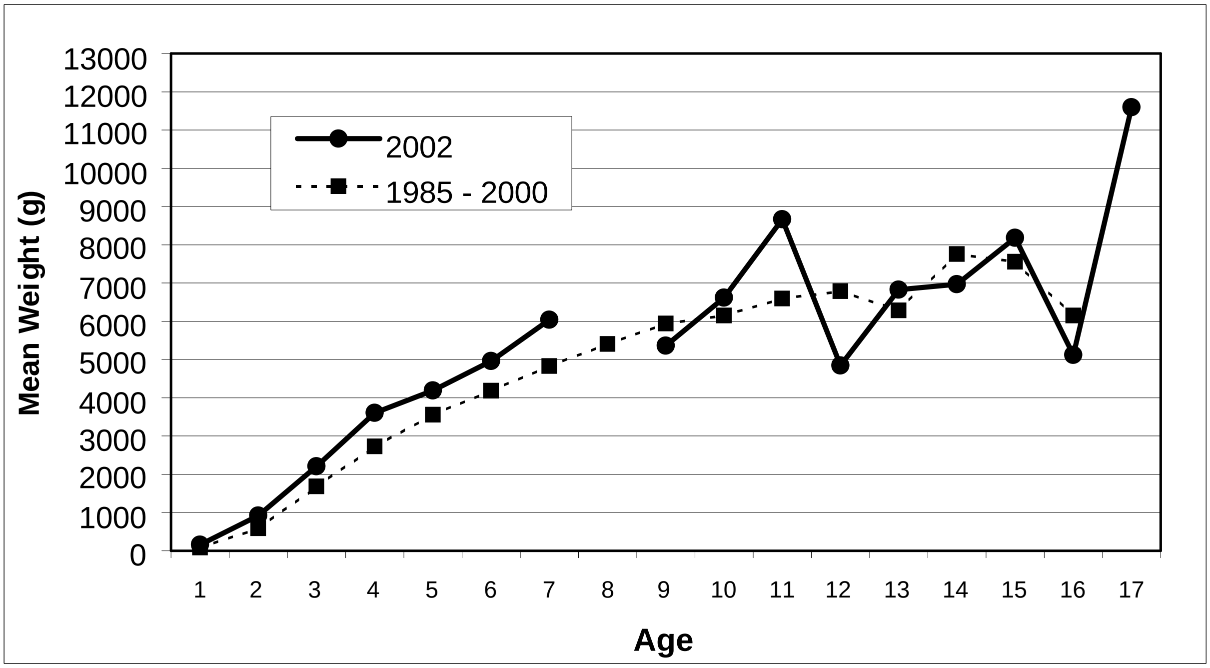

Figure 1.08: Mean weight-at-age of lake trout collected in gill nets from the eastern basin of Lake Erie, August 2002. The long-term average from New York, 1985 - 2000, is also shown to compare current growth rates.

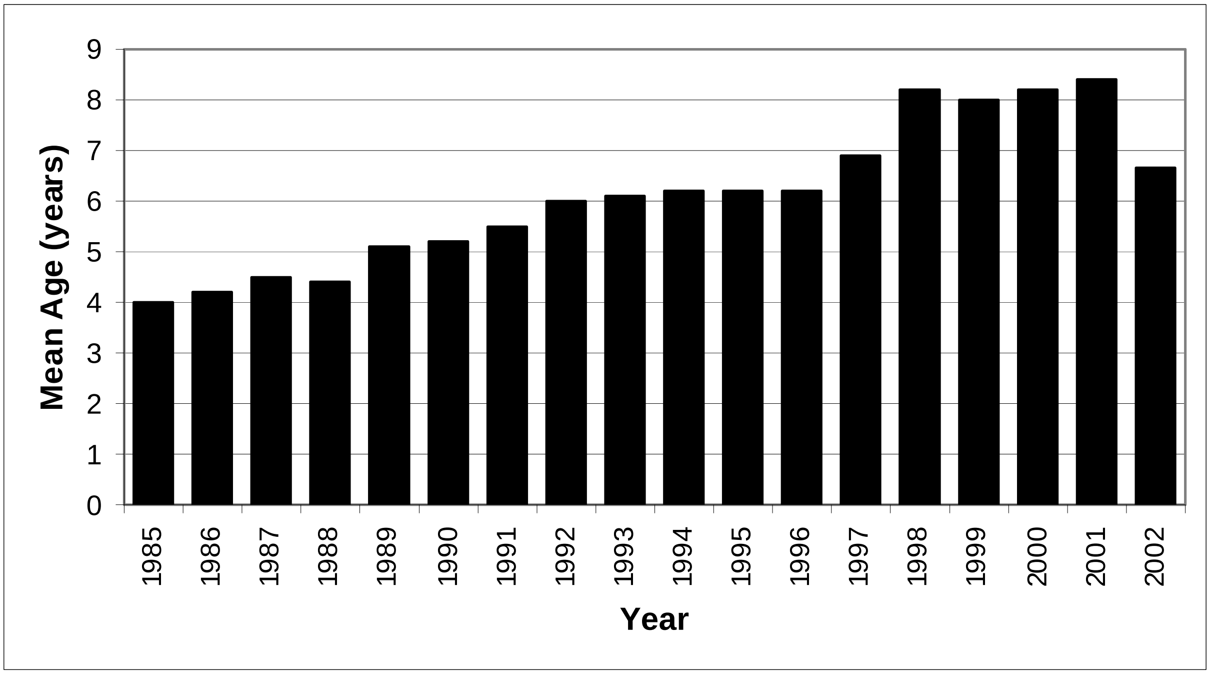

Figure 1.09: Mean age of mature female lake trout sampled in standard assessment gill nets from the eastern basin of Lake Erie, 1985 - 2001.

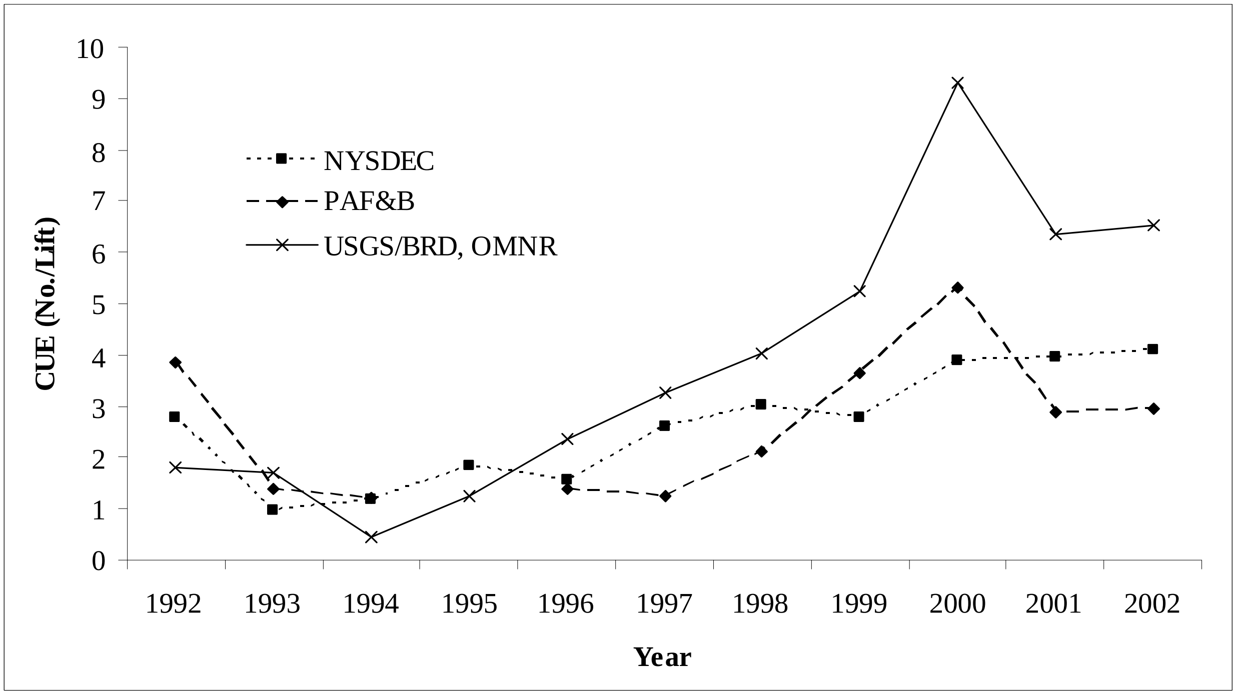

Figure 2.01: Burbot catch rate (fish/lift) from August gillnet assessment by Agency, 1992-2002.

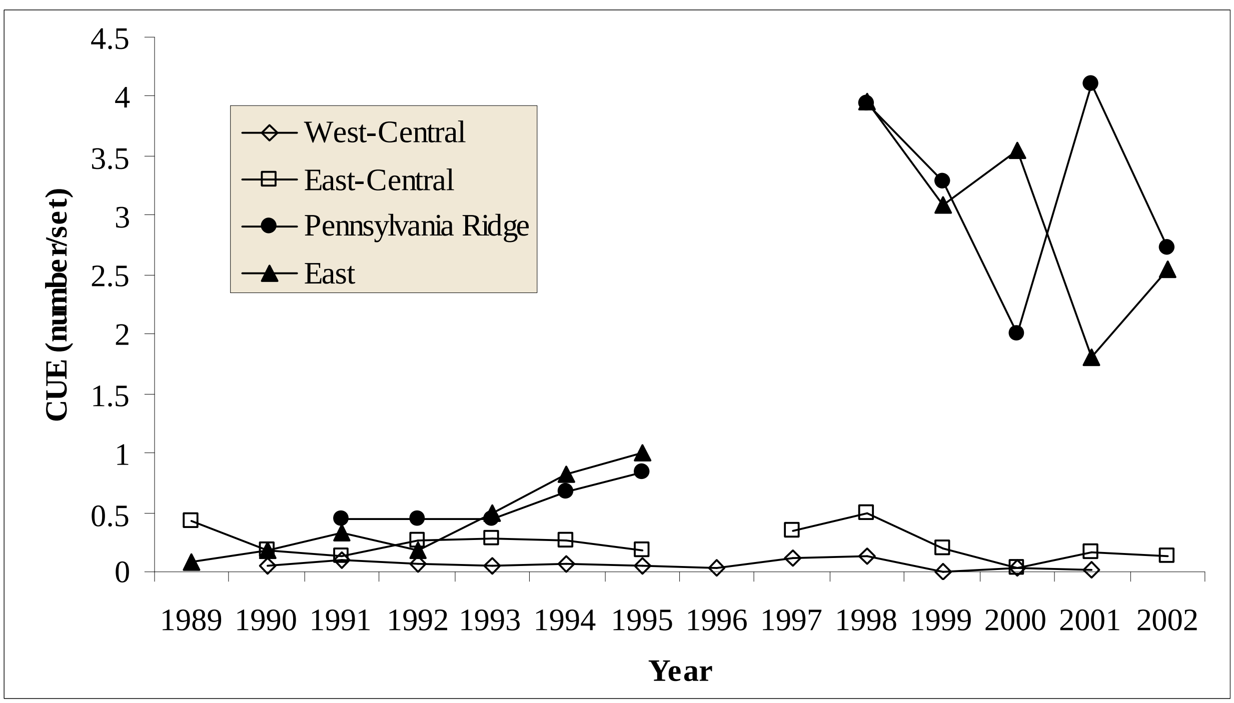

Figure 2.02: Burbot CUE by basin from the OMNR Partnership Index Fishing Program, 1989 - 2001. (Includes canned and bottom nets, all mesh sizes, except thermocline sets.)

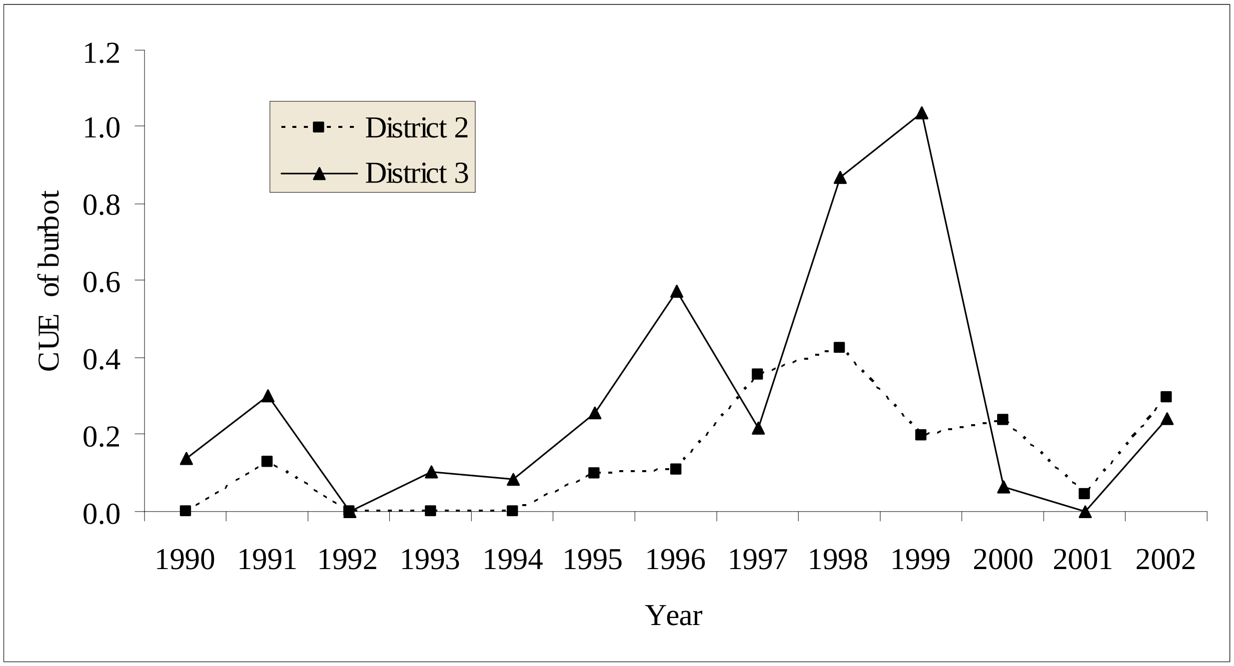

Figure 2.03: Geometric mean catch-per-hour-trawling for age-1+ burbot during October trawls in Ohio Districts 2 and 3 of Lake Erie, 1990-2002.

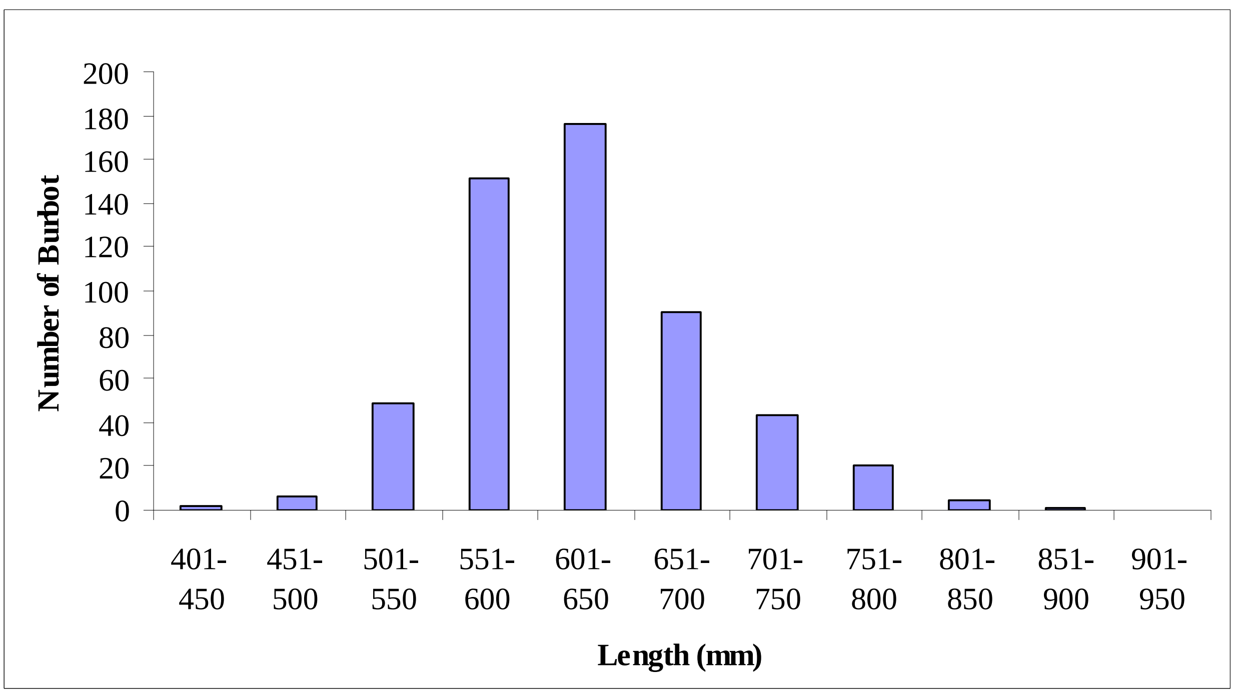

Figure 2.04: Length distribution of burbot collected in the Lake Trout Summer Assessment, 2002 (n=542).

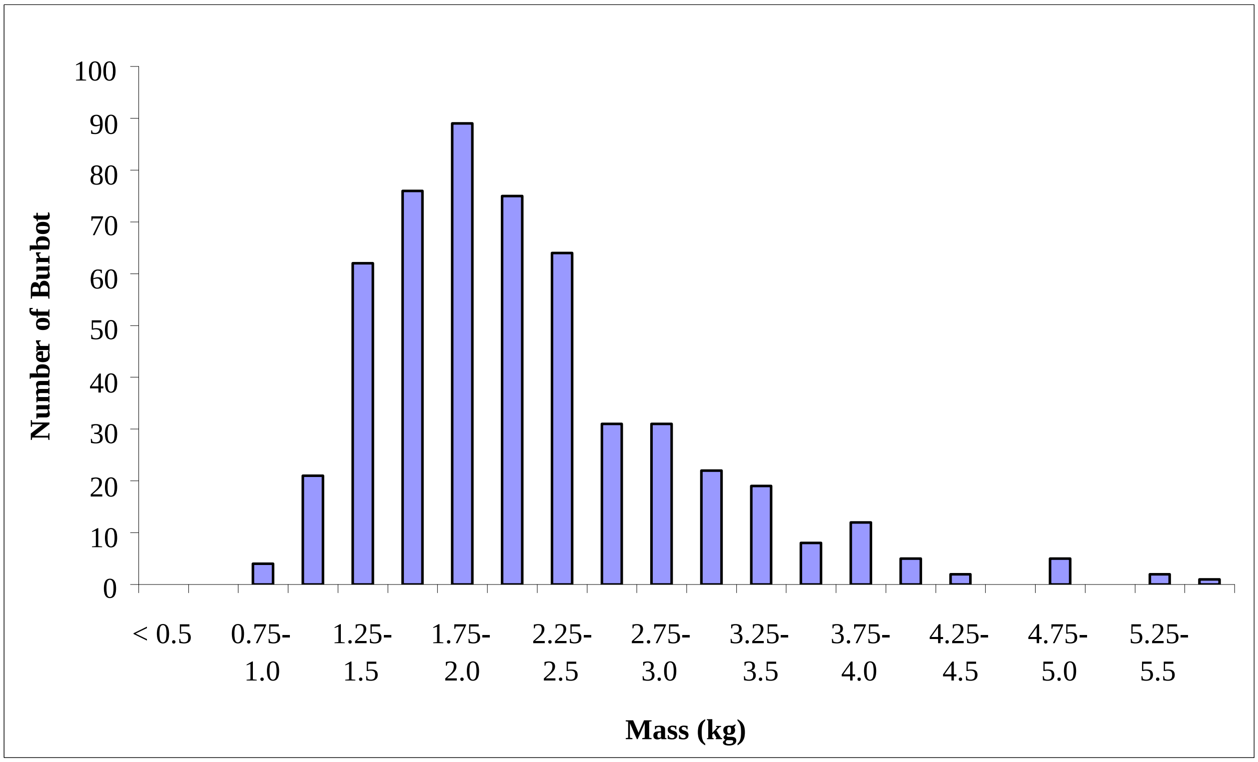

Figure 2.05. Mass distribution of burbot collected in the lake trout summer assessment, 2002 (n=529).

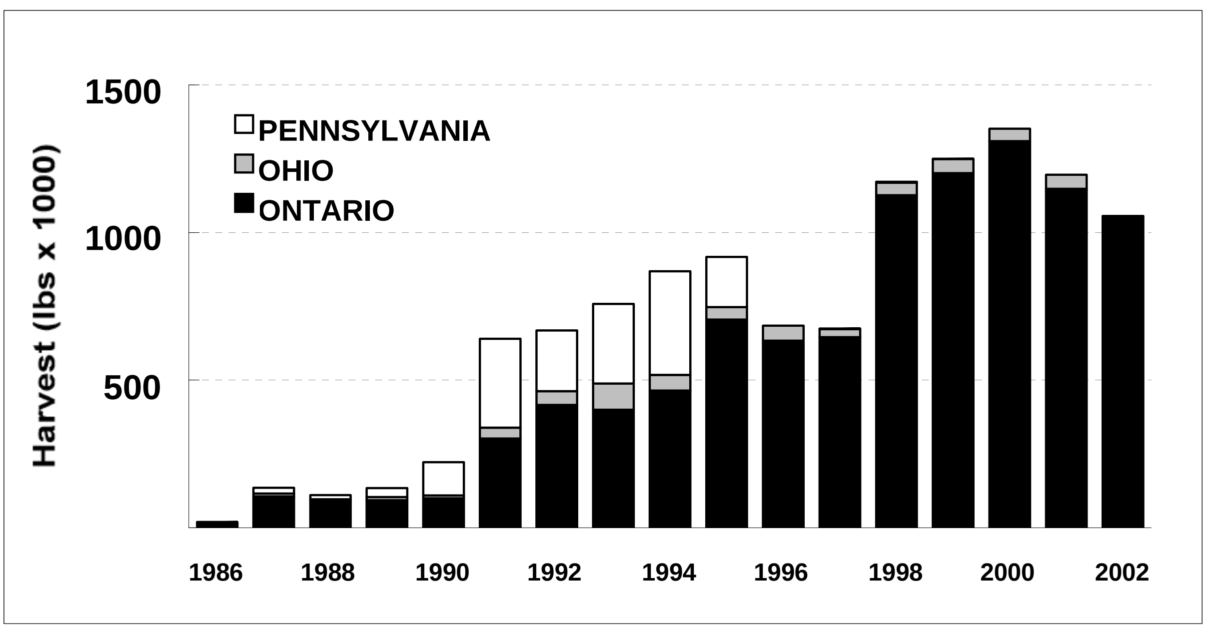

Figure 2.06: Total Lake Erie commercial whitefish harvest from 1986-2002 by jurisdiction. Pennsylvania ceased gill netting after 1995.

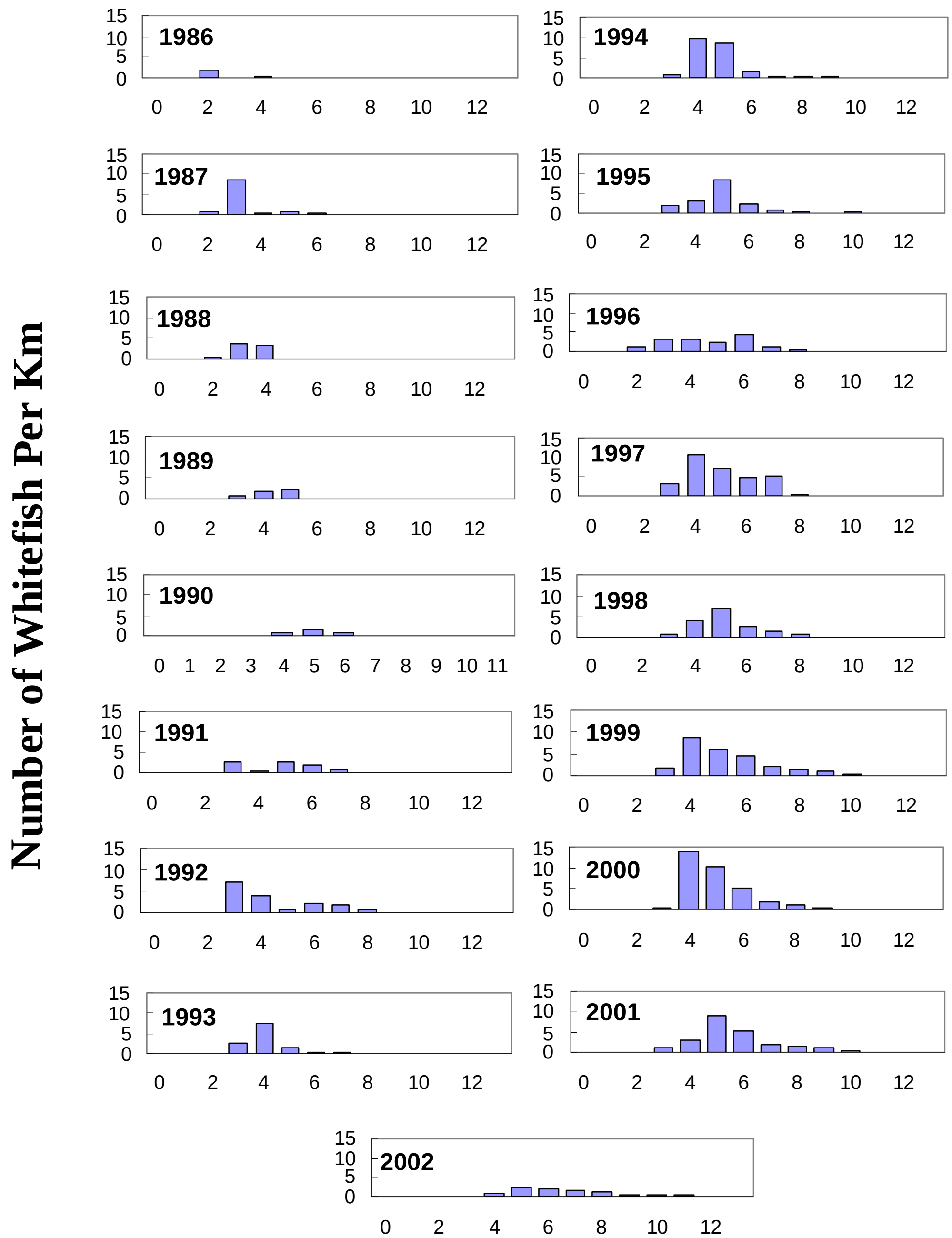

Figure 2.07: Ontario fall commercial whitefish CUE at age (#/km gill net) in statistical district 1, 1986-2002. Effort with gill net ≥ 3 inches, with whitefish in catch from October to December.

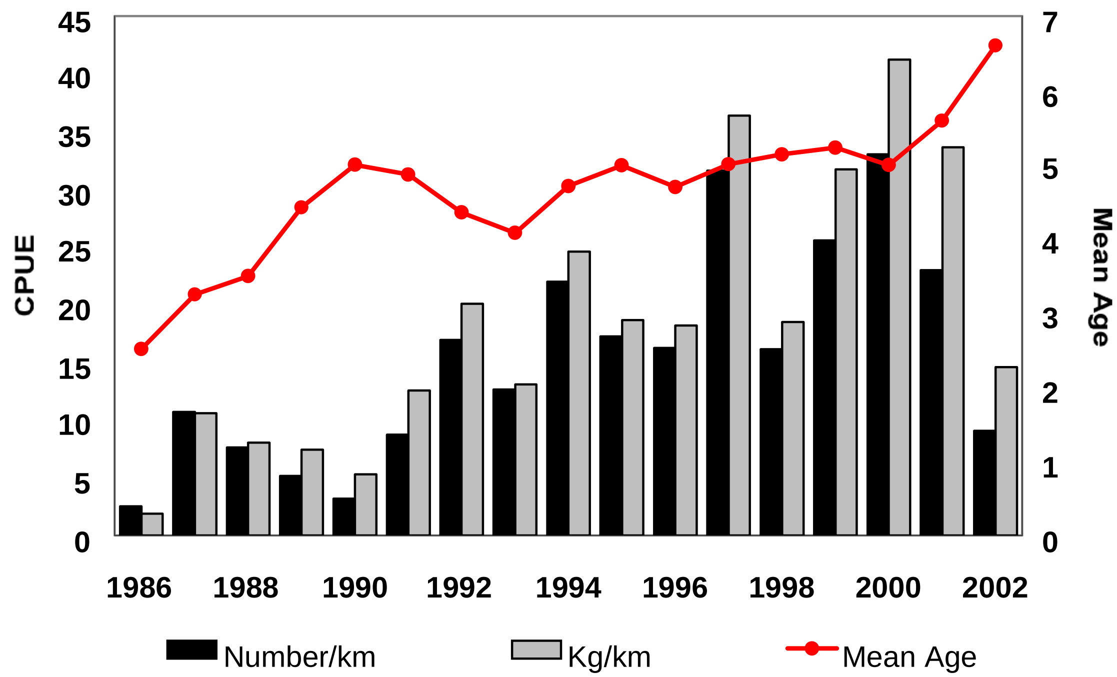

Figure 2.08: Catch rate (number and weight per km) and mean age of lake whitefish harvested by the Ontario fall gill net fishery, OE1, 1986-2002. (Fall = October to December).

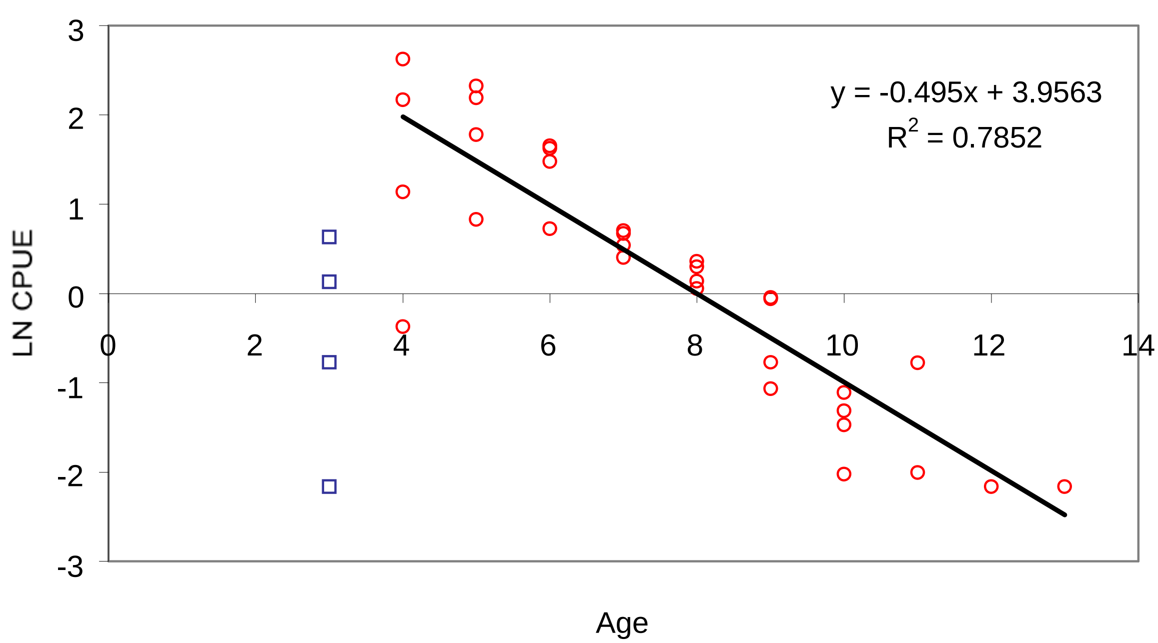

Figure 2.09: Catch curve for lake whitefish using Ontario fall large mesh gill net CPUE (number/km) from 1999-2001. Open circles represent ages of whitefish (5 and older) fully recruited used in regression. Squares indicate ages of partial recruitment to the gear.

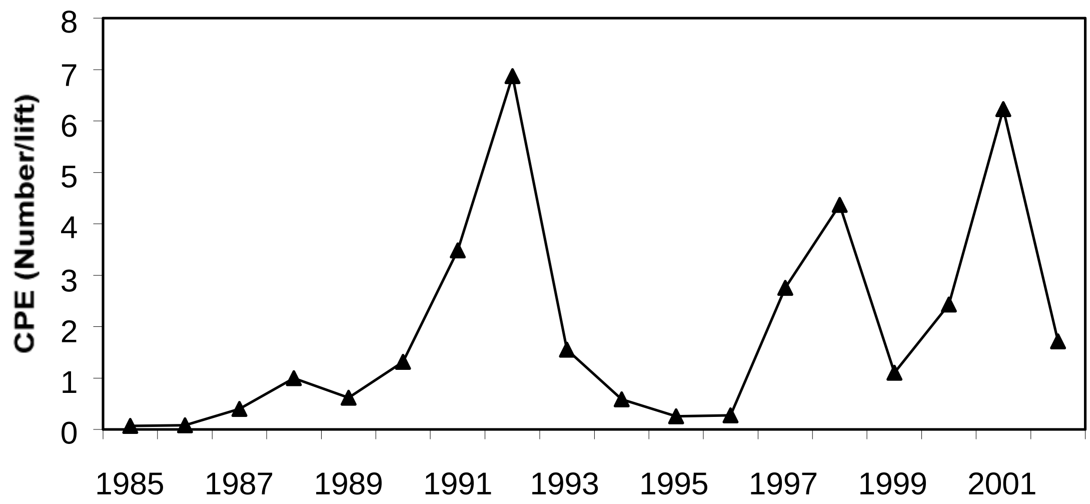

Figure 2.10: Catch per effort (number per lift) of lake whitefish caught in standard assessment gill net from New York waters of Lake Erie, August 1985 – 2002.

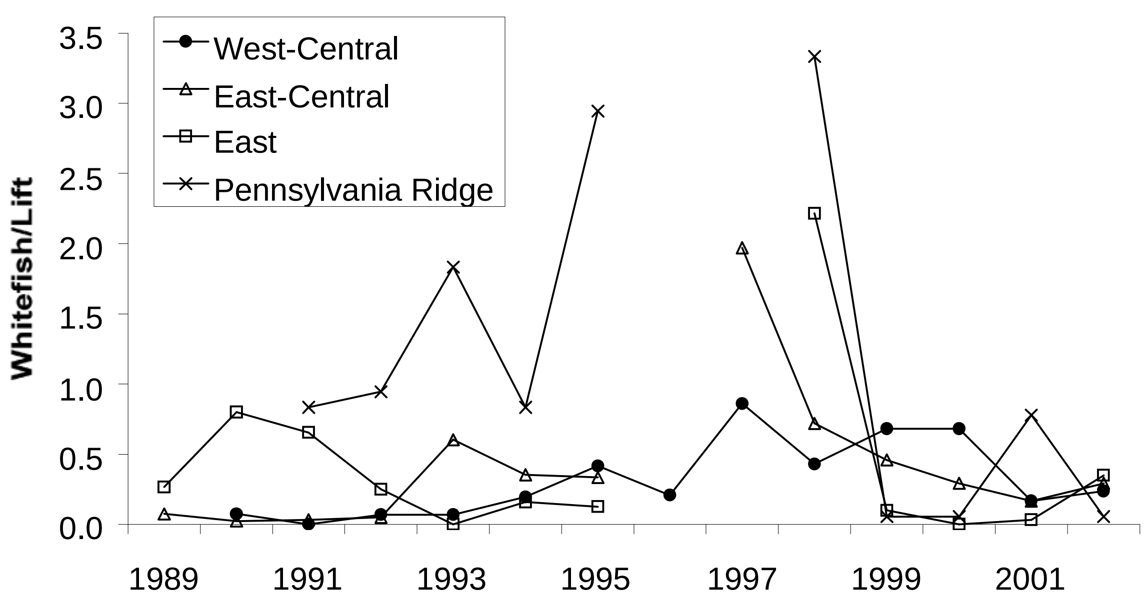

Figure 2.11: Catch rate (number per lift) of lake whitefish from Ontario partnership index gill netting by basin, Lake Erie, 1989 to 2002. West-central basin not surveyed in 1989. East-central not surveyed in 1996. East basin and Pennsylvania Ridge not surveyed in 1996 and 1997, Pennsylvania Ridge also not surveyed in 1989 and 1990. Includes canned (suspended) nets.

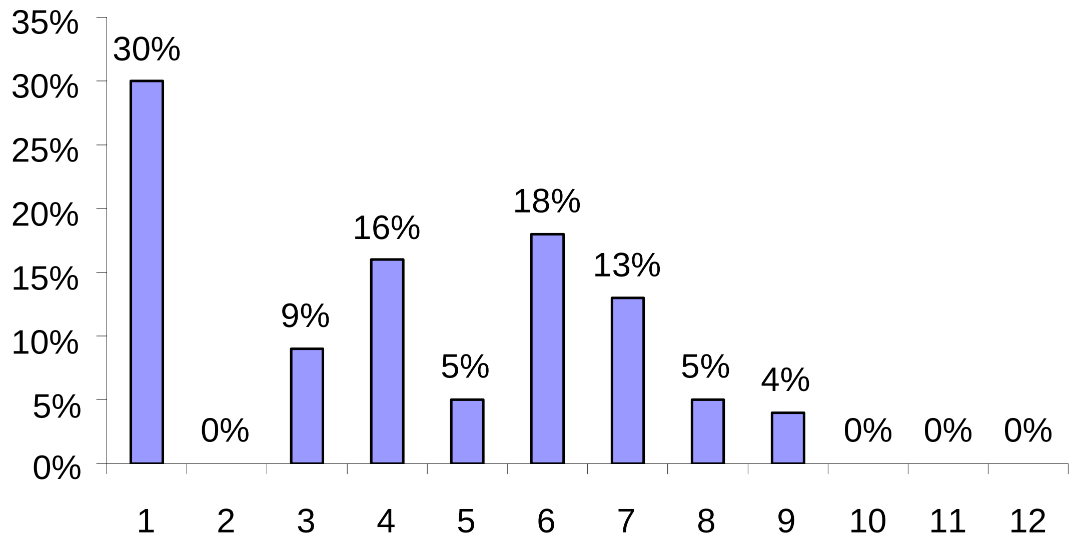

Figure 2.12: Age composition of lake whitefish collected from Ontario partnership index fishing, 2002. Whitefish were caught in the west, west-central, east-central and Pennsylvania Ridge surveys.

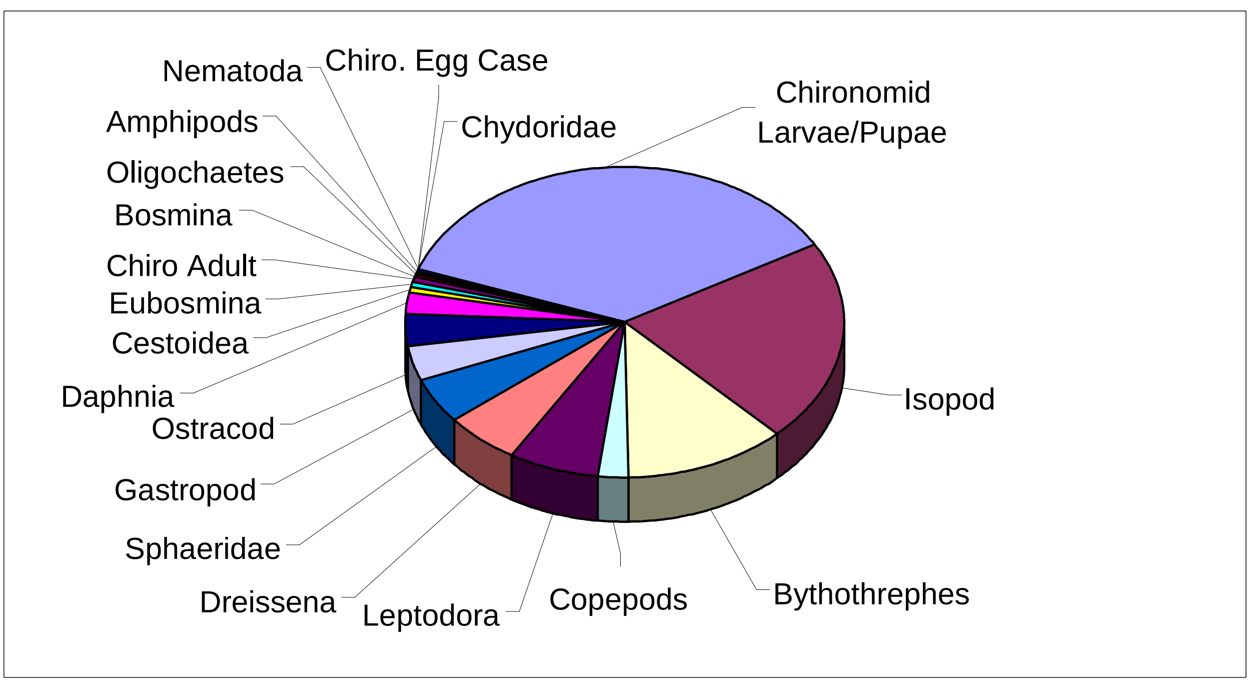

Figure 2.13: Stomach contents (mean % dry weight) of age 1 whitefish, pooled months, collected from central Lake Erie in 2002. Ohio Division of Wildlife. N = 75.

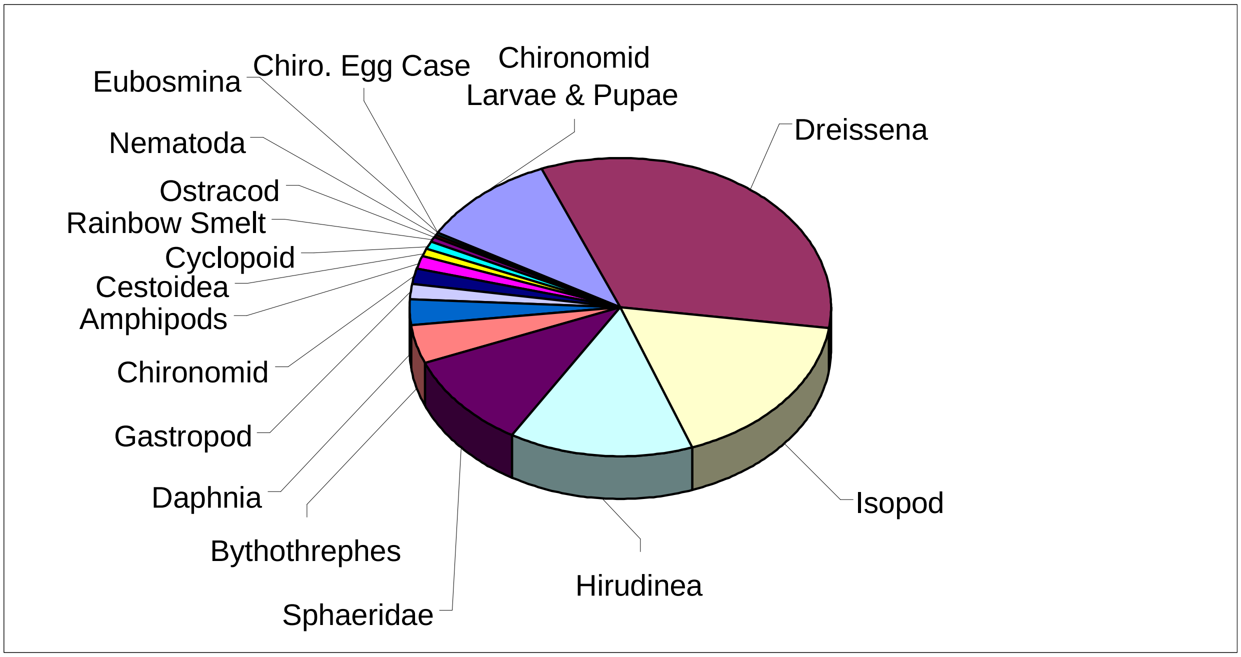

Figure 2.14: Stomach contents (mean % dry weight) of whitefish ages 2 and older, pooled months, collected from central Lake Erie in 2002. Ohio Division of Wildlife. N = 60.

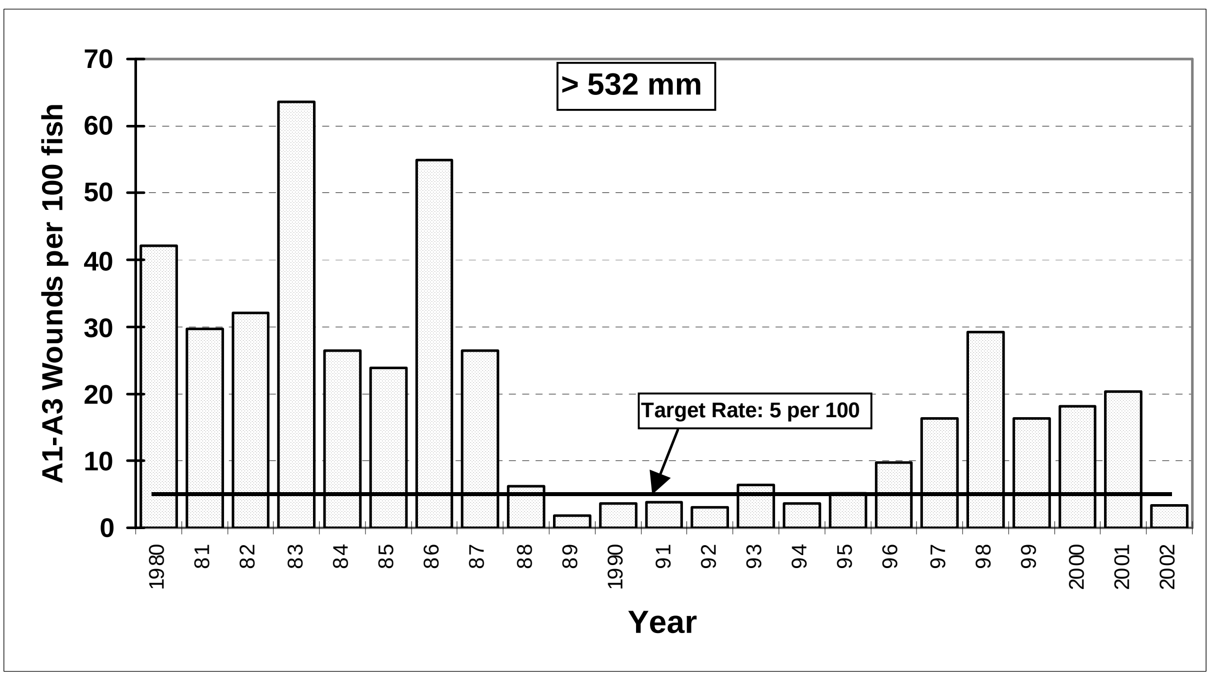

Figure 3.01: Number of fresh (A1-A3) sea lamprey wounds per 100 adult lake trout (>532 mm) observed in standard assessment gill net surveys from New York waters of Lake Erie, August, 1980 - 2002. The Strategic Plan target rate is 5 wounds per 100 fish.

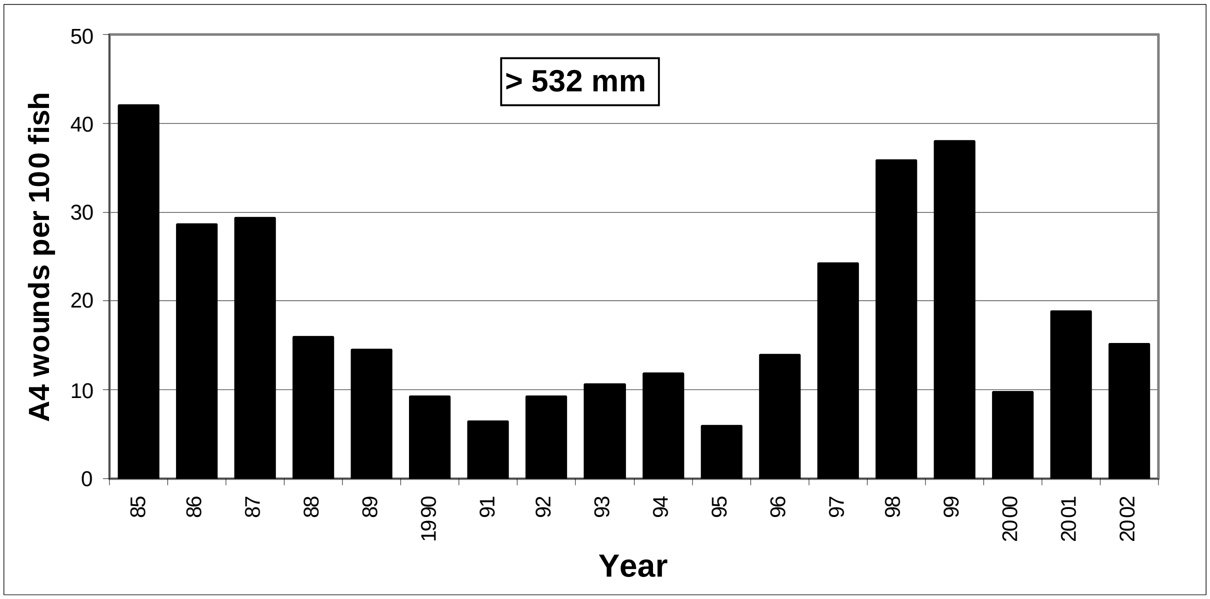

Figure 3.02: Number of Type A4 sea lamprey wounds per 100 lake trout (> 523 mm length) sampled in standard assessment gill nets from New York waters of Lake Erie, August 1985-2002.

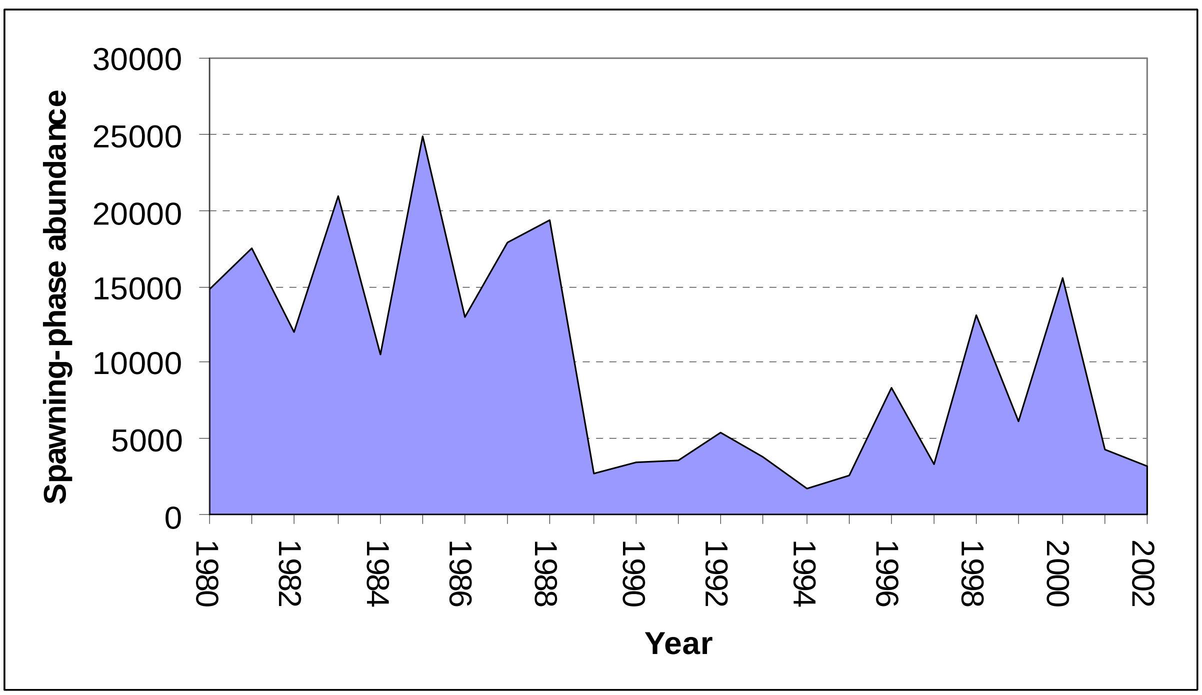

Figure 3.03: Lake-wide estimate of spawning-phase sea lampreys in Lake Erie, 1980-2002.

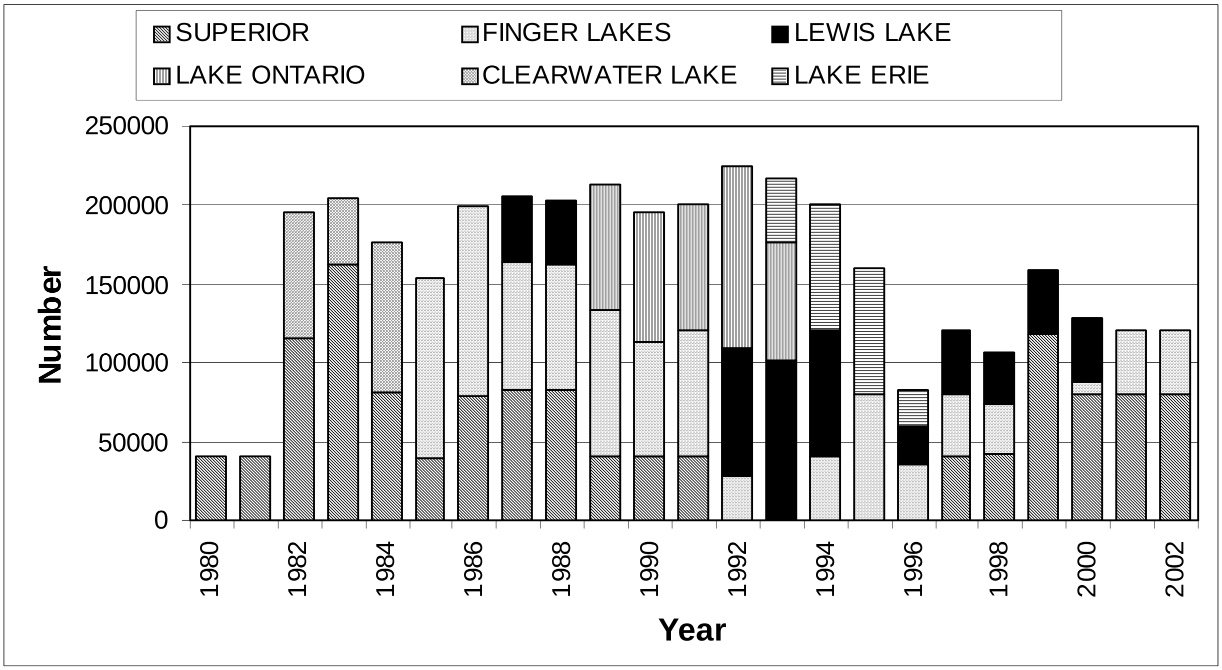

Figure 4.01: Yearling lake trout stocked in U.S. waters of the eastern basin of Lake Erie, 1980 - 2002, by strain. The current stocking goal is 120,000 yearlings per year.

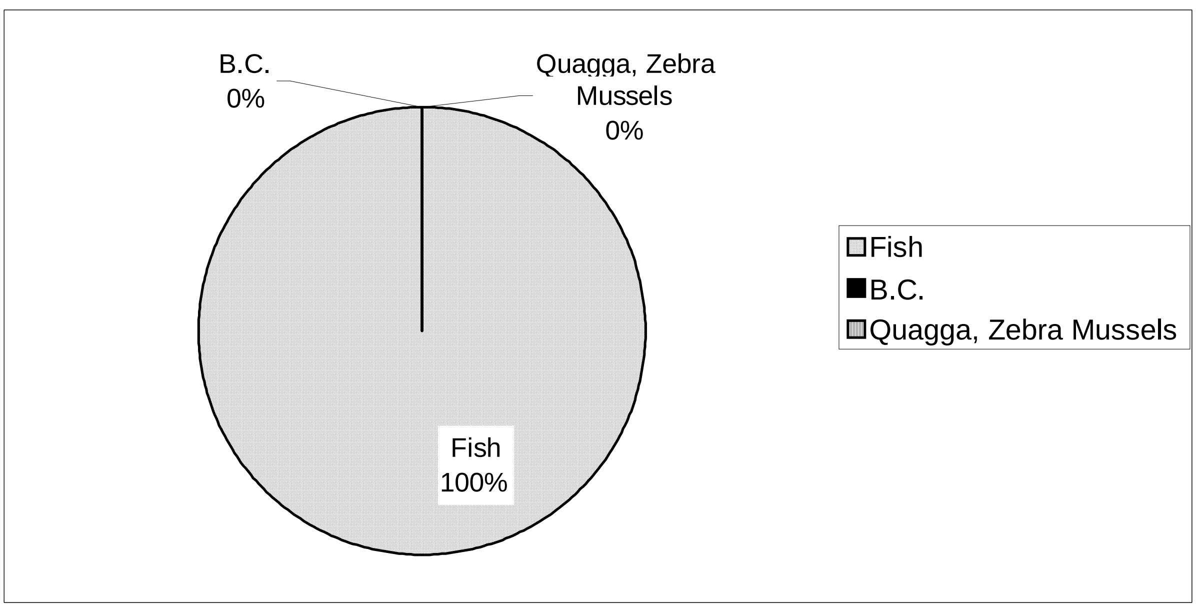

Figure 5.01: Diet composition of lake trout sampled in gill nets from the eastern basin of Lake Erie, August 2002.

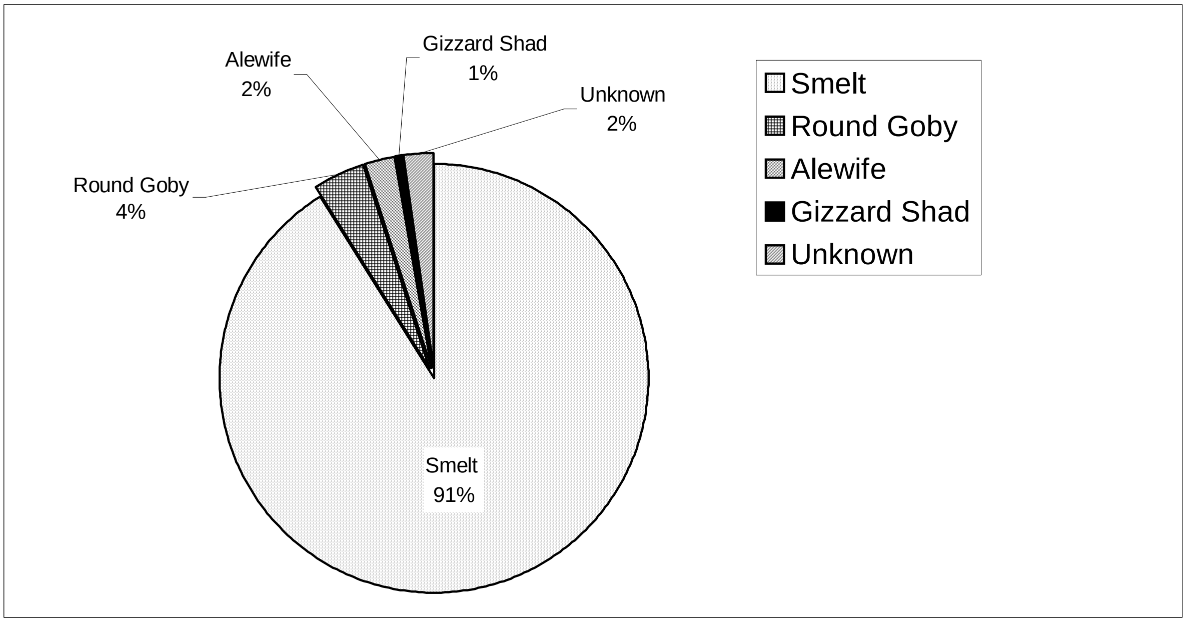

Figure 5.02: Frequency of occurrence of fish in the diet of lake trout sampled in gill nets from the eastern basin of Lake Erie, August 2002.

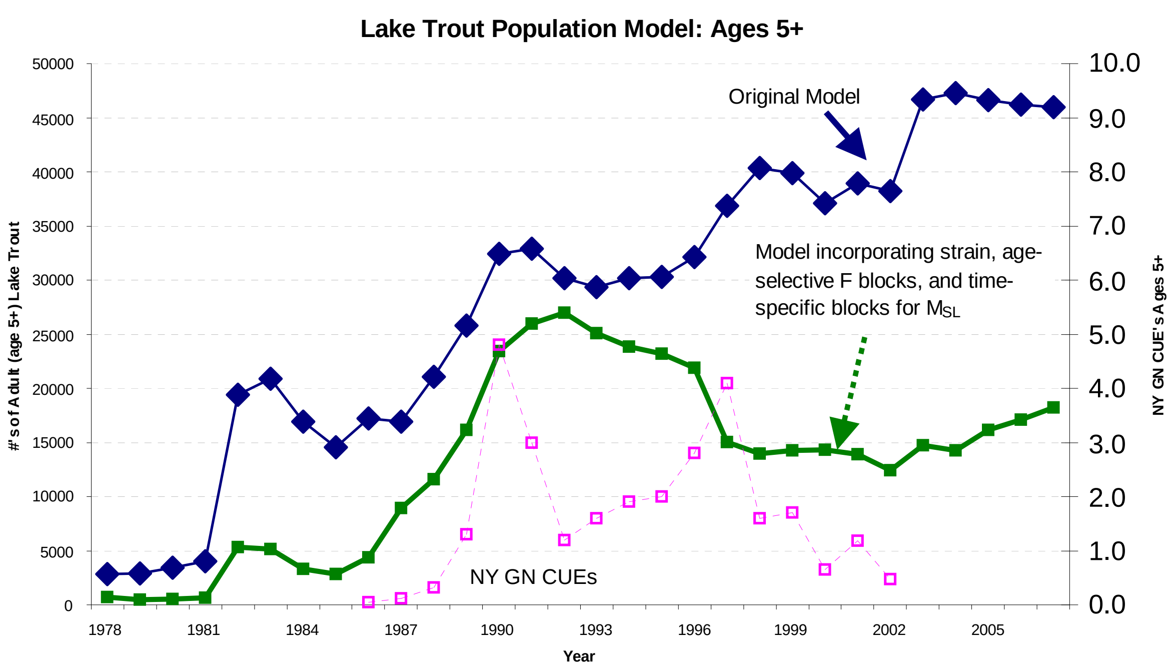

Fig. 5.03: A simulation of the Lake Erie adult lake trout population model incorporating age-selective fishing mortality (F) and sea lamprey mortality (M_{SL}). The original lake model and NYS DEC gill nets CUEs are also included to compare sampling trends in adult lake trout abundance.

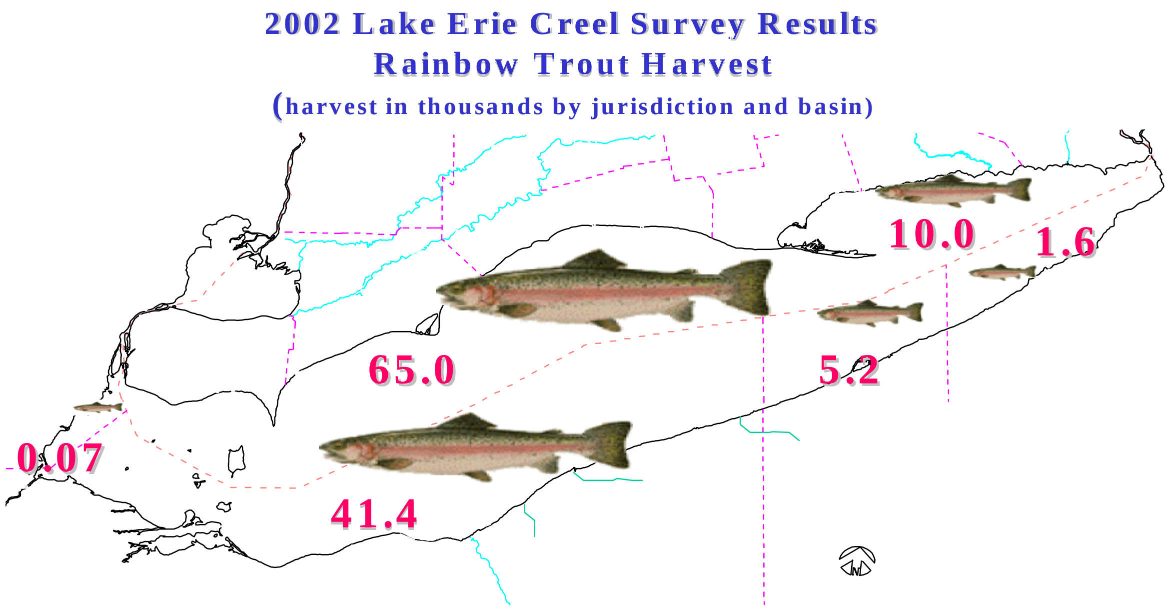

Figure 6.01: Estimated harvest of rainbow trout by open lake boat anglers by jurisdiction during 2002.

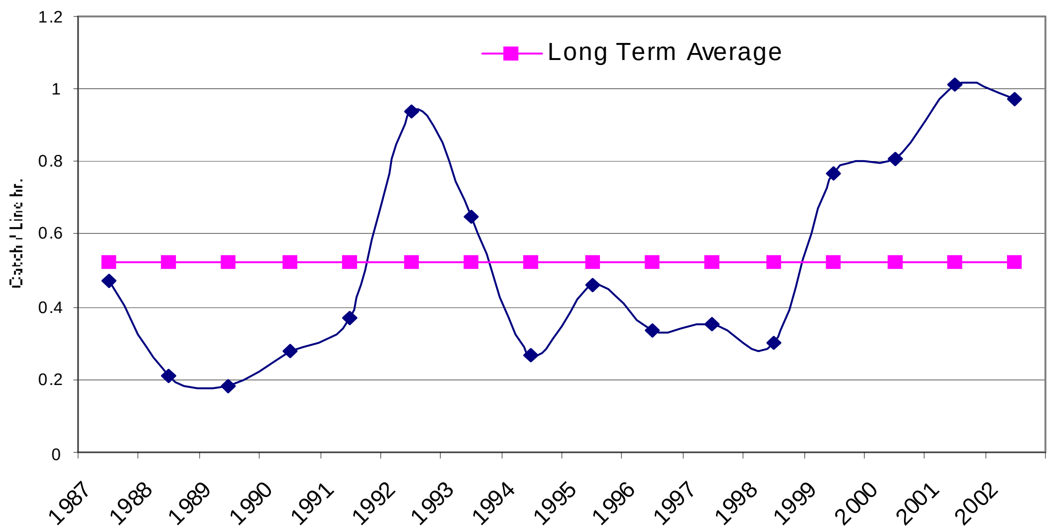

Figure 6.02: Rainbow trout catch per line hour as estimated from data supplied by anglers participating in the PFBC Cooperative Angler Log.

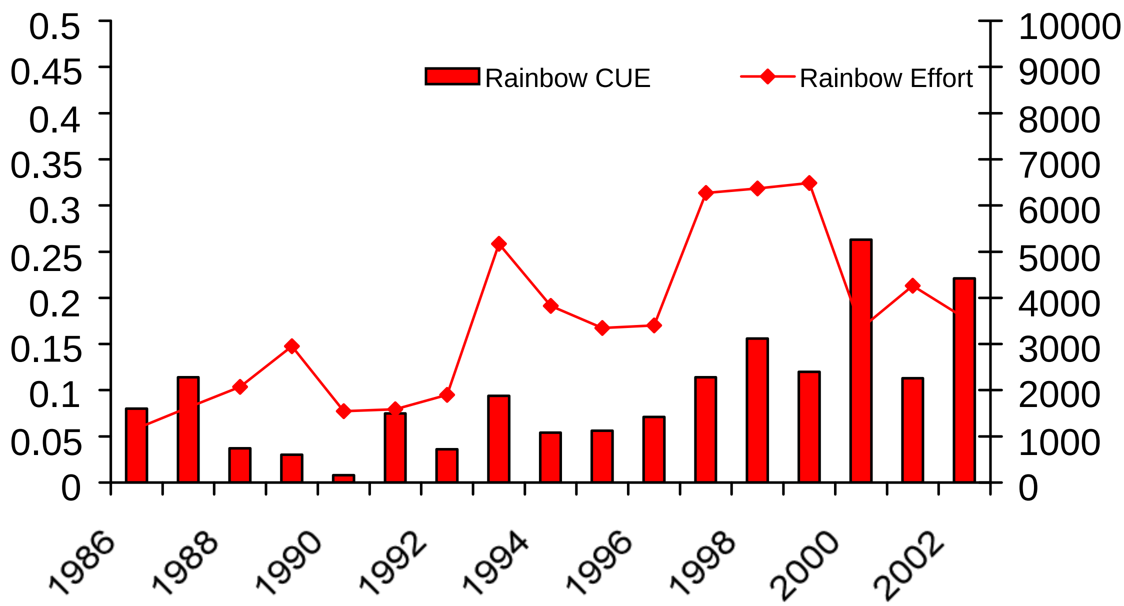

Figure 6.03: Rainbow trout angler effort and catch rate from the OMNR Lake Erie Sport Fish Diary Program 1986 – 2002.

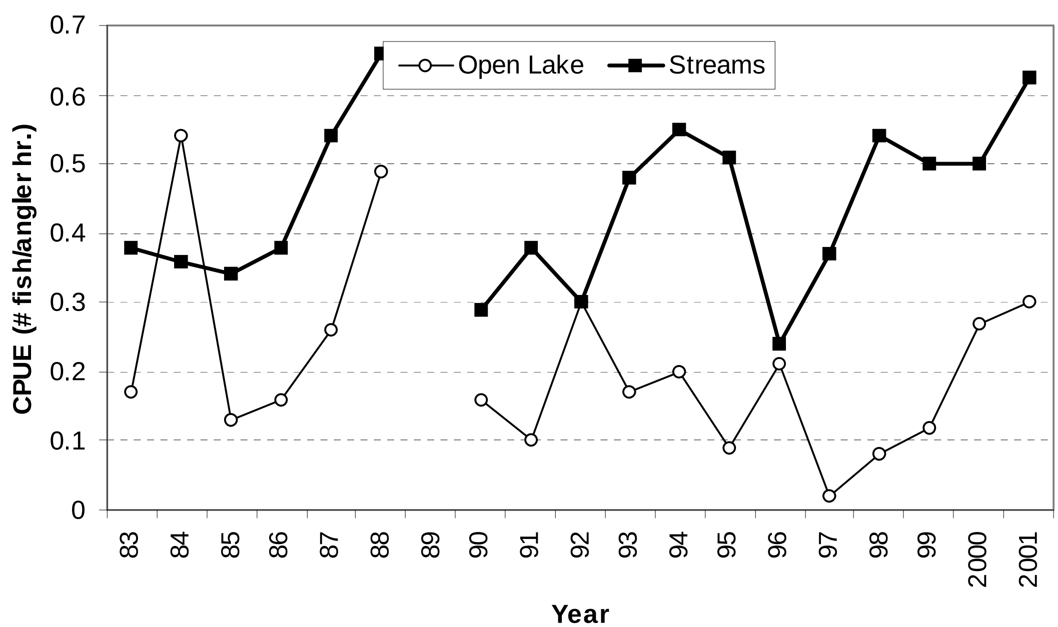

Figure 6.04. Catch rates (# fish/angler hr.) of salmonids for the Open Lake and Stream fisheries reported in NYSDEC Lake Erie Angler Diaries, 1983 - 2001.

Appendix

Status of Early Mortality Syndromes and Thiamine Levels in Top Predators From Eastern Lake Erie 1996-1997

by John D. Fitzsimons

In 1992 Fisher et al. (1996) noted an early mortality syndrome (EMS) in Lake Erie lake trout where mortality averaged 25.2%, based on six fish. At the time this represented the first and only observation of EMS in this lake although EMS had already been noted in lake trout from Lake Huron (Marcquenski and Brown 1997) but more so in Lakes Ontario (Fitzsimons et al 1995) and Michigan (Mac and Edsall 1991), as well as in other salmonids from Lakes Ontario and Michigan (Marcquenski and Brown 1997). EMS affects larval salmonids generally at or just before swim-up when they display loss of equilibrium, hyperexcitability, anorexia and eventually death. In lake trout, where EMS is associated with low egg concentrations of thiamine (Brown et al. 1998), EMS can be reversed with thiamine treatments (Fitzsimons 1995; Fitzsimons and Brown 1998a) and induced with thiamine antagonists (Fitzsimons and Brown 1998a). It is thus apparent that thiamine plays a major role in EMS although other factors may also be involved.

Low egg concentrations of thiamine in Lake Erie lake trout may be the result of having smelt as a major component of their diet. Smelt, like alewives, have high levels of thiaminase (Ji and Adelman 1998), an enzyme that, as a post mortem change, breaks down thiamine in the gut. Fitzsimons and Brown (1998b) proposed that the low egg thiamine levels measured in lake trout that had a high proportion of smelt in their diet was due to the thiaminase rather than thiamine content of these smelt (Fitzsimons et al. 1998).

In 1996-1997 additional studies were conducted to assess the occurrence of EMS in Lake Erie lake trout as well as rainbow trout, a species for which there was some preliminary information for this lake indicating the presence of a thiamine-responsive EMS (P. Hunter, OMNR, Aylmer, ON, pers. comm.). Thiamine levels were also measured in egg samples to determine current levels and how these levels related to published thresholds.

Of the eggs of 12 lake trout collected at Barcelona, New York in 1996, none of the swim-up fry developed EMS compared with all six samples from 1992. The lack of EMS was consistent with the mean level of total thiamine and free thiamine of 4.25 and 2.79 nmol/g in the eggs and the threshold concentration of free thiamine for development of EMS of 0.8 nmol/g (Brown et al 1998). Compared to 1992 the measured total thiamine concentration for the 1996 samples represents a 37% increase. Whether this is the result of a declining proportion of smelt in the diet or some other factor is not known. Nevertheless thiamine levels in 1996 were still only one-sixth of those measured in Lake Superior lake trout that do not consume smelt (Fitzsimons and Brown 1998b). No other obvious early developmental problems were observed with the 12 egg samples as blue-sac averaged below 2% while hatching averaged above 90%. Additional samples collected in 1997 indicated a decline in average egg thiamine to 3.31 nmol/g (N=6) to close to the level of 1992 although no observations were made of EMS. This is now of even more concern than before since current research indicates an egg thiamine threshold concentration for increased susceptibility to predation of approximately 3 nmol/g (J. Fitzsimons, unpublished data).

The eggs from nine individual rainbow trout kept until eye up at the Kettle Creek hatchery and then moved to CCIW where they were reared until swim-up, all developed EMS. This EMS that started at 469 degree-days (DD) and lasted until 713 DD resulted in an average mortality of 14.9% with a range of 1.4 to 31.6%. Thiamine concentrations measured in the eggs of five females with mean EMS mortality of 8.5%, averaged 4.39 nmol/g. The relatively low occurrence of EMS is consistent with the threshold for steelhead that is in excess of 2 nmol/g based on the work of Hornung et al. (1998) but below 12.9 nmol/g (Marcquenski and Brown 1997). The occurrence of EMS in Lake Erie rainbow trout was lower than that recorded previously for Lake Ontario (30%) for the period 1978-1984 by Skea et al (1985) and that noted for Lake Michigan (43%) for 1993 noted by Hornung et al (1998).

One other top predator that also feeds heavily on smelt in Lake Erie has also been evaluated. Walleye were sampled for egg thiamine levels and this indicated that average levels in eastern Lake Erie walleye (2.6 nmol/g) were less than 40% of those measured for Oneida Lake walleye (7 nmol/g) where walleye do not consume smelt but instead yellow perch (W.D. Busch, USFWS, Amherst, NY, pers. comm.). Whether these reduced thiamine levels are affecting reproduction of eastern Lake Erie walleye is not known and further work is required.

In conclusion it is evident that various top predators from eastern Lake Erie appear to be affected by a diet high in smelt, being manifested either as EMS or low egg thiamine concentrations or both. How this affects recruitment of these species is not known. It is recommended therefore that further studies be conducted to determine the full implications of the reduced thiamine levels measured in these species. In addition samples of burbot eggs should be analyzed for thiamine as this species also feeds heavily on smelt in eastern Lake Erie.

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