

Lake Trout Rehabilitation in Lake Ontario, 2004

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Abstract

Each year we report on the progress toward rehabilitation of the Lake Ontario lake trout population covering the results of stocking, annual assessment surveys, creel surveys, and evidence of natural reproduction observed from all standard surveys performed by USGS and NYSDEC. In 2004 the number of yearling lake trout stocked in May was 8.6% below the target level of 500,000. During the July bottom trawling survey all 14 sites were fished. The total catch of 83 age-2 lake trout, although a 2.1-fold increase over the 2003 catch, was only 32% of the average for the 1983 to 1989 year classes. During the September gill net survey 56 nets were lifted and a total of 685 lake trout were captured. When adjusted for effort this catch was equivalent to the 2003 catch, but was 53% below the 1986-98 average. The rate of wounding by sea lampreys on lake trout caught in gill nets was at the target level and continued to provide evidence of the excellent control seen in Lake Ontario since the mid-1980's. Lake trout harvest fell to a record-low level in 2004, likely due in part to increased angling effort directed at Chinook salmon. The condition of adult lake trout indexed from annual length – weight regressions fell to the lowest level in 13 years. Despite continued low abundance of age-2 lake trout, the condition of juvenile lake trout remained relatively low and was similar to the values observed through the 1980's. Reproductive potential for the adult stock from the annual egg deposition index remained at the level of the last four years which was about 42% below the average for 1993 to 1999. Survey catches of four naturally produced lake trout yearlings confirmed the existence of the 11th consecutive year class of natural recruits.

Introduction

Restoration of a naturally reproducing population of lake trout is the focus of a major international effort in Lake Ontario. Coordinated through the Lake Ontario Committee of the Great Lakes Fishery Commission, representatives from cooperating agencies (New York State Department of Environmental Conservation (NYSDEC), United States Geological Survey (USGS), United States Fish and Wildlife Service (USFWS) and Ontario Ministry of Natural Resources (OMNR)) developed the Joint Plan for Rehabilitation of Lake Trout in Lake Ontario (Schneider et al. 1983, 1997), identifying a goal, interim objectives, and strategies. The present report documents progress towards restoration through 2004.

Methods

Adult Gill Net Survey:

During September 2004, USGS R/V *Kaho* and NYSDEC R/V *Seth Green* fished standard gill nets for adult lake trout at 14 geographic locations encompassing the entire U.S. shore in Lake Ontario. Survey gill nets consisted of nine, 15.2- x 2.4-m (50 x 8 ft) panels of 51- to 151-mm (2- to 6.5-in stretched measure) mesh in 12.5-mm (0.5-in) increments. At 12 sites four survey nets were fished along randomly chosen transects, parallel to contours beginning at the 10° C (50° F) isotherm and proceeding deeper in 10 m (32.8 ft) increments. At the two eastern basin sites, eight nets were fished at fixed sites covering 4 sequentially deeper locations per site ranging in depth from 20 to 50 m. For a complete description of survey history including gear changes and corrections see Elrod et al. (1995).

A stratified catch per unit effort (CPUE) was calculated using four strata based on net position from shallowest to deepest. Depth stratification was used because effort was not equal between years and catch per net decreased uniformly with increasing depth below the thermocline. Survival of various year classes and strains was estimated by taking the antilog of the slope of the regression of log_e CPUE on age, starting at age 7. Adult condition was indexed from the predicted weights of a 700-mm (27.6 in) fish calculated from annual length-weight regressions based on all lake trout caught that were not deformed. Potential population egg deposition was indexed from age specific fecundities and strain specific survivorships.

Creel Census:

Harvest by U.S. anglers fishing from boats is measured by a direct contact creel survey, which covers the open lake fishery from the Niagara River in the western end of the lake to Association Island near Henderson in the eastern basin. This survey is conducted during the months of April through September and measures about 85% of the total lake trout harvest (Eckert 2005a). The survey used boat trips as the primary unit of effort; boat counts were made at boat access locations and interviews were based on completed trips.

Juvenile Trawl Survey:

From mid-July to early-August 1980-2004, crews from USGS and NYSDEC used the R/V *Kaho* and the R/V *Seth Green* to capture juvenile lake trout (targeting age-2 fish) with bottom trawls. Trawling was conducted at 13 locations in U.S. waters distributed evenly along the southern shore and within the eastern basin and one location in Canadian waters off the Niagara River. A standard tow was 10-min long. From 1980 to 1996 trawling was conducted with a 12-m (39.4-ft; headrope) trawl at 5-m (16.4-ft) depth intervals, beginning at the metalimnion (15°C (59°F) isotherm) and progressing into deeper water until few or no lake trout were captured. Because of an abrupt shift in the depth distribution of juvenile lake trout to deeper waters in 1993 (O’Gorman et al. 2000) and fouling of the gear by dreissenid mussels in 1996, the sampling scheme and gear were changed. In 1997 the 12-m (39.4-ft) trawl was replaced with a 3 in 1 trawl (20.4-m or 66.9-ft headrope, 7.6-m or 24.9-ft spread) equipped

with roller gear along the foot rope. In addition, effort was decreased at depths < 55 m (180.4 ft) and increased at depths > 70 m (229.6 ft). For years after 1997, the sampling protocol was modified by alternating between odd and even depths (5-m or 16.4-ft increments) between adjacent sites and adjacent years. At four sites where depth did not exceed 60 m (196.8 ft), all 5-m (16.4-ft) contours at and below the 15°C (59°F) isotherm were fished. From July 6 to August 11, 2004, trawling was conducted at all 14 locations along the south shore.

Results and Discussion

Stocking:

From 1973 to 1977 lake trout stocked in Lake Ontario were raised at a mix of NYSDEC and USFWS (Michigan and Pennsylvania) hatcheries with annual releases ranging from 0.07 million for the 1973 year class to 0.28 million for the 1975 year class (Figure 1). By 1978 the USFWS Allegheny National Fish Hatchery (Pennsylvania) was raising all lake trout stocked in U.S. waters of Lake Ontario and annual releases exceeded 0.55 million fish. In 1983 the first official Lake Ontario lake trout rehabilitation plan (Schneider et al. 1983) was formalized calling for a target of 1.25 million fish stocked annually in U.S. waters. The stockings of the 1979-1986 year classes approached that level averaging about 1.07 million annually. The number of yearling equivalents declined by about 22% between the stockings of the 1981 and 1988 year classes. Stocking declined by 47% in 1992 (1991 year class) due to problems encountered at the hatchery. In 1993, because of a predator-prey imbalance in Lake Ontario, and following recommendations from an international panel of scientists and extensive public review, managers reduced the lake trout stocking target to the current level of 500,000 yearlings. In the 12 years since the stocking cuts (1992-2003 year classes), the annual stockings were at the target level in seven and below it in five.

A total of 456,800 yearling lake trout were stocked at five sites in U.S. waters of Lake Ontario during May 12 to 19, 2004 (Figure 1). The strain composition was 67% Seneca Lake wild (SEN) and 33% Lake Superior domestic (SMD). All fish stocked near Stony Island were

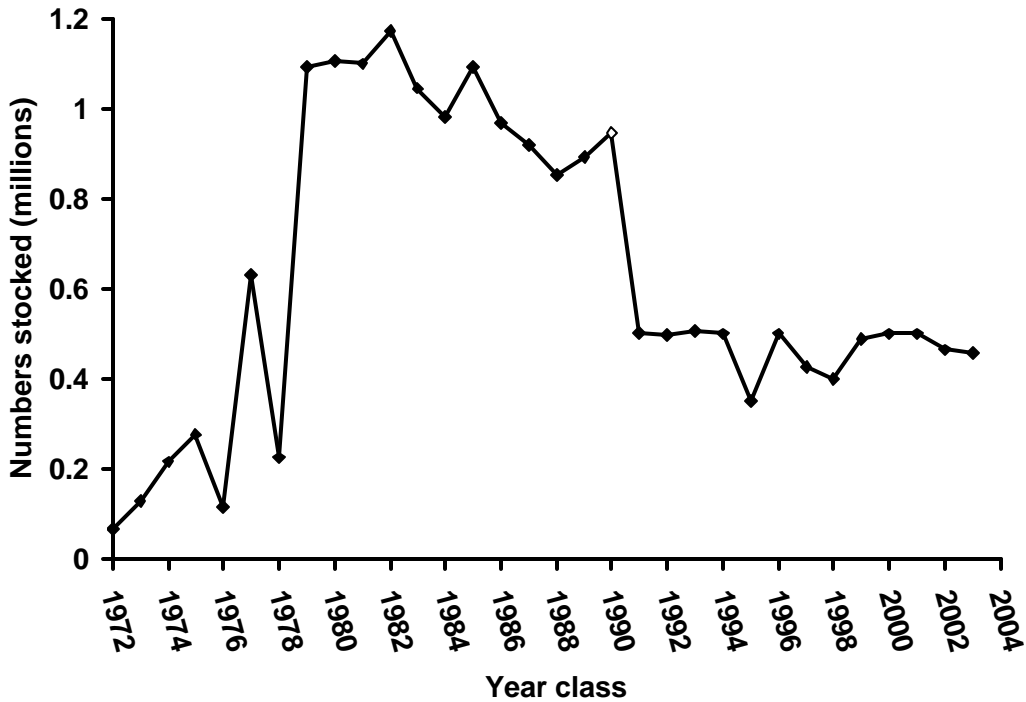


Figure 1. Total yearling equivalents of lake trout stocked in U.S. waters of Lake Ontario for the 1972 – 2003 year classes. A yearling equivalent was equal to 1 spring yearling or 2.4 fall fingerlings for 1973 - 1991. Fall fingerlings were not stocked after 1991. The clear diamond (1990 year class) represents a stocking in which about 0.27 million fish were in poor condition at stocking and experiencing elevated mortality in transit.



Figure 2. For lake trout stocked as yearlings in U.S. waters of Lake Ontario in 1980 - 2003, total catch per 500,000 fish stocked at age-2 from trawls fished in July-August and CPUE at age-3 from gill nets in September. (Note: White bars represent trawl data collected with the new trawl configuration which did not fish as hard on the lake bottom as the old trawl).

stocked from a landing craft offshore near waters 35 m (115 ft) in depth. All fish stocked at Oswego, Sodus, Oak Orchard, and Olcott were stocked offshore over 55 m (180 ft) of water. Detailed stocking information appears in Eckert (2005b), section 1 of this volume.

Abundance (age-2 and age-3 lake trout):

From 1981 to 1996 (1979-1994 year-classes), trends in CPUE were adjusted for strain, stocking location, and numbers stocked. Data obtained on the 1995 year-class were not adjusted for strain or stocking location because of poor retention rates of coded wire tags (CWT's). Among the age-2 lake trout caught in trawls in 1997, 36% of adipose-fin clipped individuals did not have tags. Data for year-classes stocked since 1997 were not adjusted for strain or stocking location because from 36% to 84% of fish in those year-classes did not receive coded wire tags (CWT's). Catches of the 1995 through 2002 year-classes were, however, adjusted for numbers stocked. Most fish stocked since 1997 without CWT's received paired fin clips that facilitated year class identification through at least age 4. The ages of unmarked fish and fish with poor clips were estimated with age-length plots developed from fish that had CWT's.

Trends were similar for the catch from U.S. waters of lake trout at age 2 in trawls and a year later at age 3 in gill nets for the 1975 to 1995 year classes (Figure 2). This indicated that recruitment of hatchery fish to the population was governed by survival during their first year in the lake and that survival during their second year in the lake from age 2 to age 3 was relatively constant. Since 1995, low catches of age-3 lake trout in gill nets precluded comparison of trends.

First-year survival was relatively high for the 1979-1982 year classes but then declined by about 32% and fluctuated without trend for the 1983-1989 year-classes. First-year survival declined further for the 1990 year class and continued to decline for the 1991-1996 year classes. Catches of age-2 and age-3 lake trout during trawl and gill net surveys declined to an all time low during the period from 1996 to 1998. The average abundance of the 1994-1996 year classes at age 2 was only 6% of the average for the 1979-1982 year classes and only 9% of

the average for the 1983-1989 year classes. In 2004 the catch was up to about 32% of the average for the 1983-1989 year classes. In four out the last six years the catch (for the 1997, 1999, 2000, and 2002 year classes) was about 3.5 times higher than the lows seen for the 1994-1996 year classes. Although this modest increase in the recruitment index is encouraging, nearly all of the age-2 fish were caught at sites near the western end of the lake which suggests that survival of fish stocked in western Lake Ontario is higher than survival of fish stocked in eastern Lake Ontario.

Abundance (age-3 and older lake trout):

A total of 685 lake trout were captured in the September 2004 gill net survey (Figure 3). Catches of lake trout between sample locations has been similar within years with the relative standard error ($RSE = 100 * \{ \text{standard error} / \text{mean} \}$) for the CPUE of adults fully recruited to the gear (age-6 and older) averaging only about 9% for the entire data series (Figure 4). The CPUE of mature lake trout had remained relatively stable from 1986 to 1998, but then declined by 30% between 1998 and 1999 due to the poor recruitment of the weak 1993 year class. Declines in adult numbers after 1998 were likely due to poor survival of hatchery fish in their first year post-stocking and lower numbers of fish stocked since the early 1990's. In comparison to the 1986-1998 average, the CPUE for mature lake trout in 2004 was down by 43% and the average CPUE for the last six years (1999 - 2004) was down by 36%.

Angler Harvest:

The annual harvest of lake trout from U.S. waters of Lake Ontario (Figure 5) has been more than 4 times lower since the protected slot limit (635 - 762 mm, 25 - 30 in.) was re-instated in 1992, compared to previous years when no size limits were in effect (Eckert 2005a). Harvest was the lowest on record in 2004 at 4,250 fish. In 2004, lake trout catch and harvest rates also reached new record lows. The relatively poor fishing for lake trout seems related both to the substantial declines in adult population size since 1998 and to good fishing for Chinook salmon in 2004 (Eckert 2005a). The percentage of harvested lake trout larger than the protected slot (>762 mm or >30 in.) remained near 25% during 1997-2000, but varied between 22.5% and 48% over from

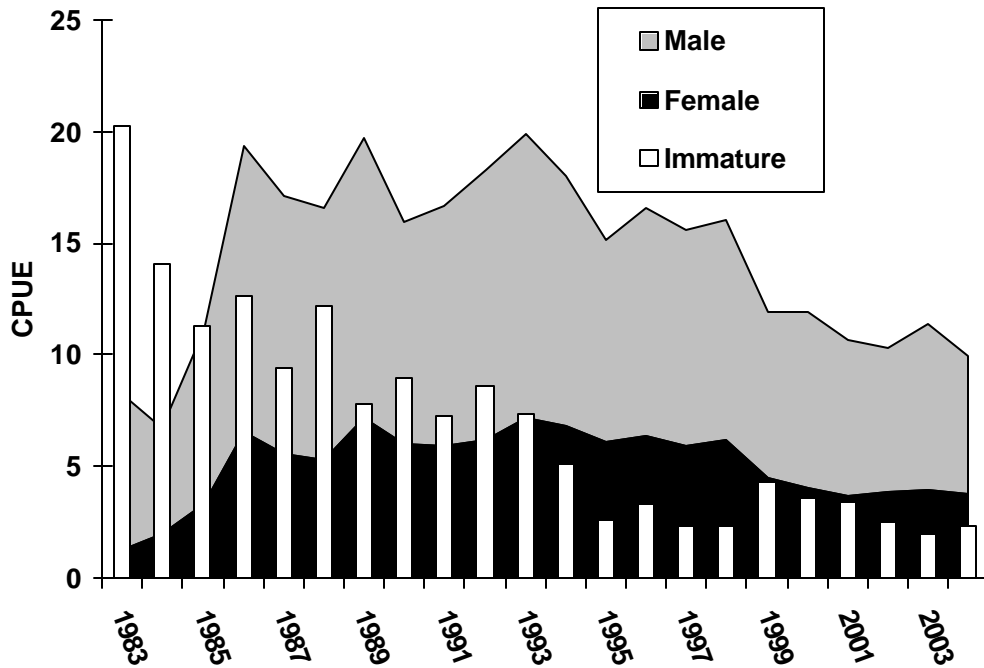


Figure 3. Abundance of lake trout calculated from catches made with gill nets set in U.S. waters of Lake Ontario, during September 1980 - 2004. CPUE was calculated based on 4 strata representing net position in relation to depth of the sets.

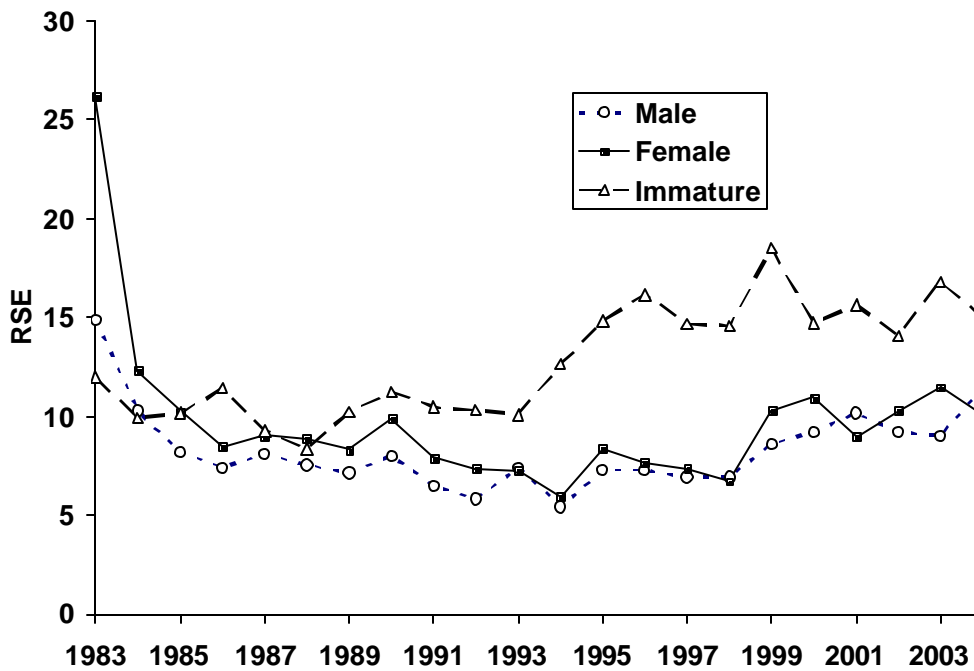


Figure 4. The relative standard error ($RSE = \{SE / Mean\} * 100$) for the annual CPUE for lake trout caught with gill nets set in U.S. waters of Lake Ontario, during September 1980 - 2004.

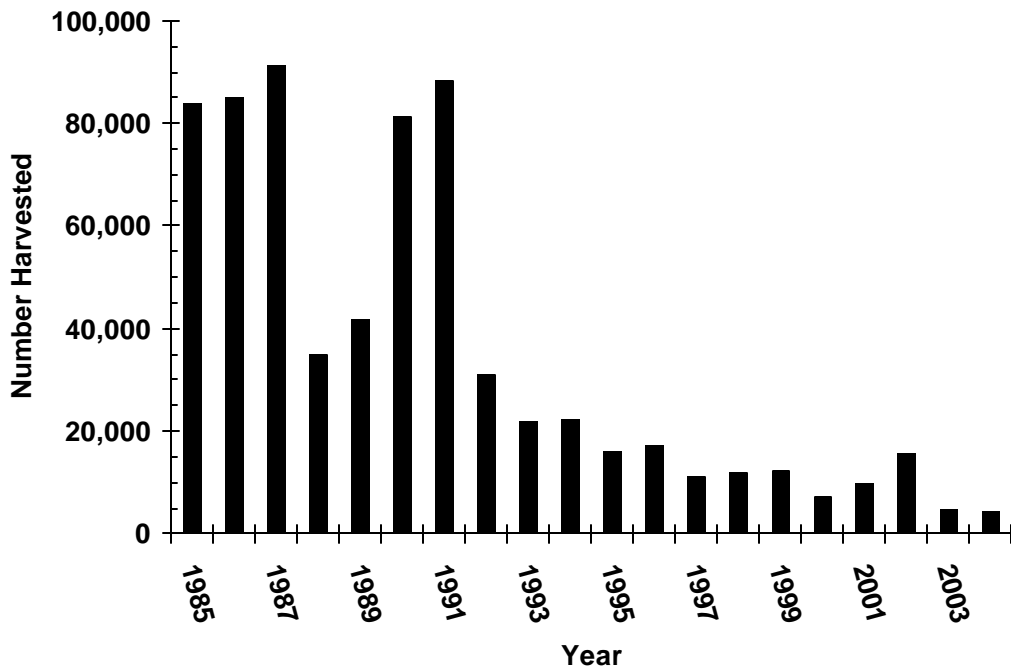


Figure 5. Estimated numbers of lake trout harvested by boat anglers from U.S. waters of Lake Ontario, 1985 - 2004.

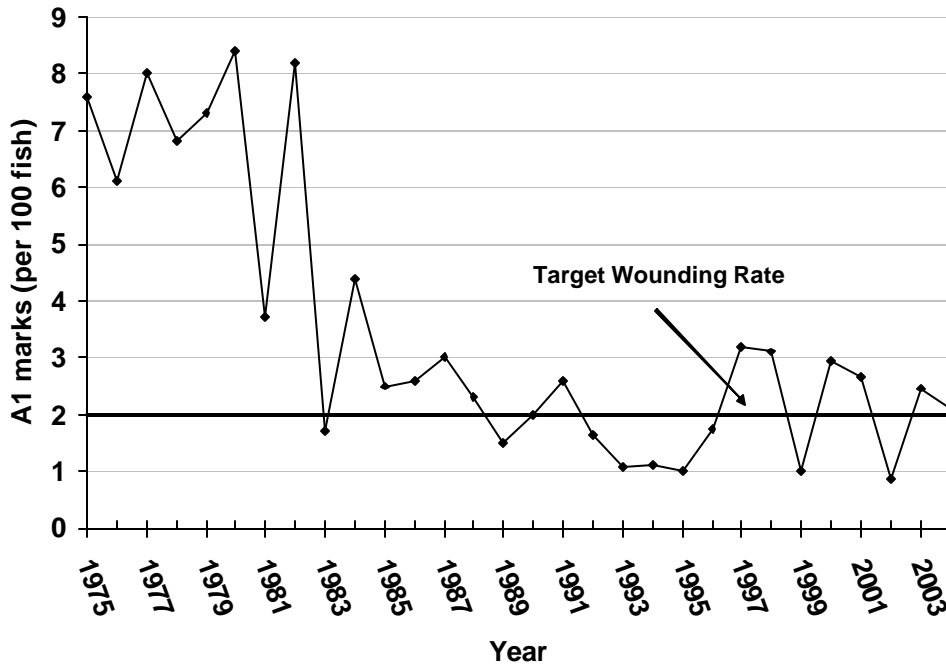


Figure 6. Number of A1 wounds per 100 fish inflicted by sea lamprey on lake trout longer than 433 mm (17.1 in) TL collected from Lake Ontario in fall, 1975 - 2004.

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2001 to 2004. Of fish caught in index gill nets, 48% fell within the size protected by the slot limit and 26% were above the protected slot size.

Sea Lamprey Predation:

Although percentage of fresh (A1) sea lamprey marks on lake trout has remained low since the mid 1980s, marking in six out of eight years between 1997 and 2004 was higher than from 1992 to 1996 (Figure 6). The 1997, 1998, 2000, 2001 and 2003 wounding rates were above the target level of 2 per 100 fish. The 1999 and 2002 wounding rates were below the target and similar to the 1992 to 1996 levels of about 1.0 wound per 100 fish. The 2004 A1 wounding rate of 2.12 wounds per 100 fish was nearly equal to the target level. The length of A1 marked fish in 2004 ranged from 467 to 877 mm (18.4 to 34.5 in, n = 14, mean = 712 mm or 28.1 in). The impact of the current wounding rate on the lake trout population is difficult to assess without measures of lake trout carcass density. Dreissenid mussels have made trawling for carcasses impossible since 1996.

Wounding rates may be related to sea lamprey abundance, host density, lake trout strain composition, or changes in sea lamprey search behavior. Significant correlations between numbers of A1 wounds on Superior strain lake trout and carcass density (Schneider et al. 1996) in the past provided a basis for relating A1 wounds to sea lamprey induced mortality on lake trout and other salmonines. Currently, Seneca strain fish dominate the population and are less frequently attacked by sea lamprey than Superior strain fish. Additionally, the poorly recruited lake trout year classes since 1993 began becoming vulnerable to attack by lampreys in 1997. The elevated wounding rates during 1997 to 2004 may have been related to increased numbers of sea lampreys or to declines in numbers of lake trout longer than 433 mm (17.1 in) since 1997. Hence, caution is warranted in interpreting A1 wounding rates.

Survival of Adults:

Survival of Seneca strain lake trout has been about 30 to 50% greater than that of the Superior strain for most of the 1984-1995 year classes (Table 1). Lower survival of Superior strain

Growth and Condition:

To assess the condition of adult lake trout, we

lake trout was likely due to higher mortality from sea lampreys (Schneider et al. 1996). Lewis and Jenny Lake strain lake trout share a common genetic origin that can be traced back to native Lake Michigan fish. Survival of both of those strains was similar to the Superior strain, suggesting that Jenny and Lewis Lakes fish are also highly vulnerable to sea lampreys. Ontario strain lake trout are progeny of Seneca and Superior strains; a portion were pure Seneca strain, some were pure Superior strain, and others were a Seneca x Superior cross. Survival of Ontario strain fish has been intermediate to that of the Seneca and Superior strain fish, perhaps because mortality from sea lampreys is high only among fish of the Ontario strain that were of pure Superior strain heritage. In recent years survival of the remaining Ontario strain fish has approached that of the Seneca strain indicating many of the members of these cohorts that were highly vulnerable to sea lamprey predation have been removed from the population.

Table 1 Annual survival of various strains of lake trout, U.S. waters of Lake Ontario, 1985 - 2004. Note: the most recent cohort examined the 1996 year class of SUP strain fish was calculated with data for age-6 to age-8 fish. All other year classes were calculated based on age-7 and older fish.

YEAR	CLASS AGES	STRAIN				
		SEN	ONT	SUP	JEN	LEW
78	7-10	-	-	0.4	-	-
79	7-12	-	-	0.41	-	-
80	7-13	-	-	0.54	-	-
81	7-13	-	-	0.54	-	-
82	7-15	-	-	0.55	-	-
83	7-14	-	-	0.54	-	-
84	7-19	0.82	0.80	0.54	-	-
85	7-18	0.80	0.79	0.46	-	-
86	7-17	0.83	-	0.45	0.54	-
87	7-16	0.81	-	0.55	0.51	-
88	7-15	0.69	-	0.77	-	-
89	7-14	0.80	0.74	0.58	-	-
90	7-13	0.80	0.56	0.62	-	-
91	7-12	0.66	0.68	-	-	0.57
92	7-11	0.89	-	-	-	0.48
93	7-10	0.71	-	-	-	0.67
94	7-9	0.54	-	-	-	0.52
95	6-8	0.78	-	0.42	-	0.49
96				0.47		
Mean		0.76	0.71	0.53	0.53	0.55

use the weight of a 700-mm (27.6 in) total length (TL) fish. Weights were calculated from

length-weight regressions of all adult fish captured during the annual gill net surveys for lake trout. We grouped data across strains because Elrod et al. (1996) found no difference between strains in the slopes or intercepts of annual length-weight regressions in 172 of 176 comparisons for the 1978 to 1993 surveys. The weight of a 700-mm fish decreased from 1983 to 1986, but increased irregularly from 1986 to 1996 and remained relatively constant to 1999 (Figure 7). Mean weight declined by 167.4 g (5.9 oz) between 1999 and 2004. The 2004 mean was about 176.4 g (6.2 oz) lower than the mean for 1996 to 1999 and was the lowest recorded for the last 13 years. The past trend of improving condition through 1996 was likely related to the build-up of older lake trout in the population. Our data suggest that for lake trout of similar length, older fish are heavier. Recent declines in condition since 1999, however, may be indicative of resource limitation as they have coincided with frequent observations of emaciated fish in index gill net catches.

To assess the condition of juvenile lake trout we used the weight of a 400-mm (15.8 in) TL fish (range: 250 mm to 500 mm, 9.8 in to 19.7 in) predicted from annual weight-length regressions (Figure 8). A 400-mm fish would be age 2 or age 3. Predicted weight was highest at the beginning of the data set for 1980 lake trout that were likely from stockings of the 1978 year class in 1979. That was the end of the early stockings (1973-1979) where numbers planted ranged from 66,000 to 728,240 yearling equivalents (Figure 1). Lake trout condition remained high through 1981. Stocking first exceeded 1,000,000 yearling equivalents in 1980 and between 1980 and 1981 the CPUE of immature lake trout from gill net catches doubled (Lantry et al. 2003). From 1981 to 1983 predicted weight fell by 69 g and remained relatively constant (mean = 576 g) through 1992. Predicted weights were inversely related to both total numbers stocked and the CPUE of immature fish captured with gill nets in September (Figures 1 and 3). Stocking remained at a relatively high rate from 1980 to 1991 (846,260 to 1,165,530 fish) and declined to its' current level (500,000 fish) in 1992 and has remained there through 2004. Predicted weight rose in 1993 and the 1993-1998 mean was 22 g (0.78 oz) higher than the mean for 1983-1992.

Increased condition of young lake trout from 1993 to 1998 was likely related to reduced stocking rates, lower survival of juveniles, and the resultant low numbers of immature fish. This indicated that declines in survival of stocked fish were likely not due to resource limitation. After 1998, condition declined to a level similar to the mid-1980's and may reflect resource limitation.

In contrast to our observations, immature lake trout sampled from gill nets set in Canadian waters of eastern Lake Ontario by the Ontario Ministry of Resources have been declining in condition since 1993 (Hoyle and Schaner 2000). Most of the immature lake trout sampled from U.S. waters through the late 1990's were from southwestern Lake Ontario. Condition of fish in the west may differ from that in the east.

Reproductive Potential:

Previously, we used the CPUE of mature females as a measure of reproductive potential of lake trout in Lake Ontario. The CPUE of mature females in September, however, is not a precise measure of reproductive potential because fecundity changes with age and length (O'Gorman et al. 1998), both of which have increased through the years. Also, sea lampreys kill mature lake trout each fall, mostly between our September assessment and November spawning (Bergstedt and Schneider 1988, Elrod et al. 1995). Furthermore, the numbers of lake trout killed have varied through time, and not all strains of lake trout are equally vulnerable to attack by sea lampreys or are as likely to succumb to an attack. Compared with Superior strain fish, Seneca strain lake trout were 0.41 times as likely to be attacked and they were much less likely to die from an attack (Schneider et al. 1996). Thus, change in age and strain composition of mature females has to be considered when judging reproductive potential from September gill net catches.

To better gauge reproductive potential of the population, we calculated indices of egg deposition from catches of mature females in September gill nets, length/age-fecundity relationships, and observed differences in mortality rates among strains. Appropriate length-fecundity relationships were determined

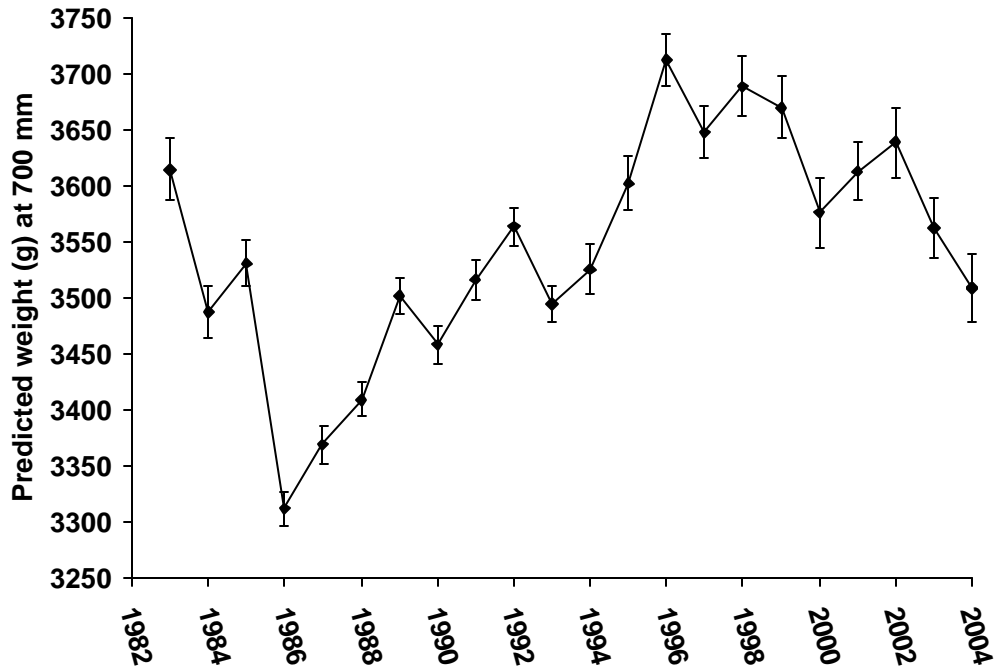


Figure 7. Weight of a 700-mm (27.6 in) TL Lake Ontario lake trout predicted from weight - length regressions calculated from all fish collected during each annual gill net survey, September 1983 – 2004. Error bars represent the regression confidence limits for each annual value.

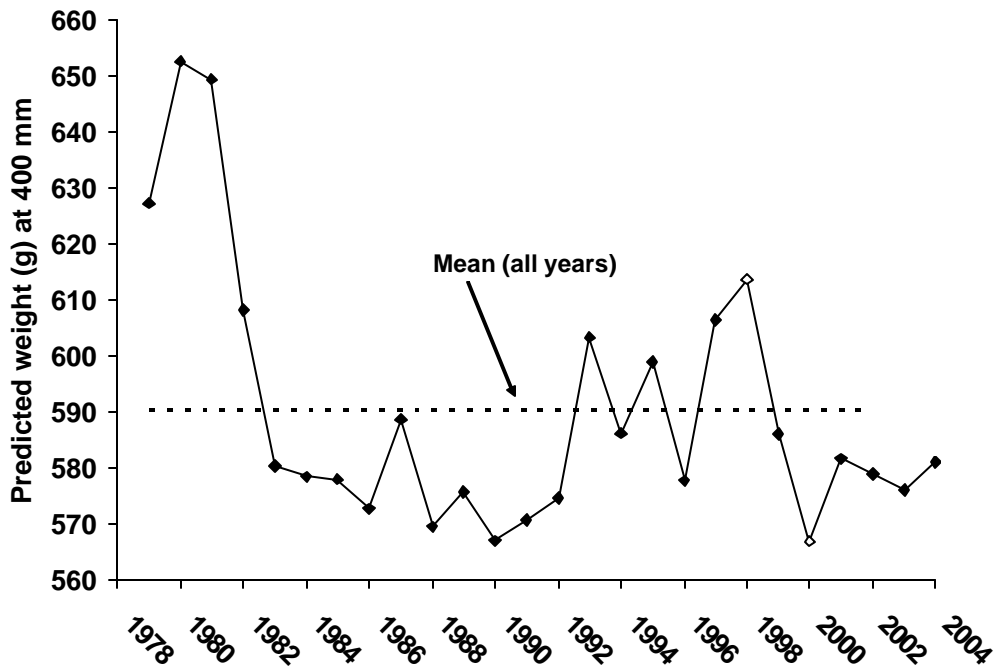


Figure 8. Weight of a 400 mm (15.8 in) TL Lake Ontario lake trout predicted from annual weight-length regressions calculated from fish 250 mm - 500 mm (9.8 to 19.7 in) sampled from bottom trawls, July - August 1994 - 2004. Sample size varied from 39 to 934 except for 1997 and 2000 (n = 13 and 15, clear diamonds).

from the fecundity of individual lake trout collected with gill nets in September and early October each year during 1977 - 1981 and in September 1994 (O’Gorman et al. 1998). In 1977 - 1981, fecundity-length relationships were not different among fish of various ages but in 1994, age-5 and age-6 fish had fewer eggs ($P < 0.003$) than age-7 fish, and age-7 fish had fewer eggs ($P < 0.003$) than fish of ages 8, 9, or 10. This suggests that at some point between the early 1980s and the mid 1990s, age began to influence fecundity. The lake trout population in the earlier period was small with few mature fish whereas the population in the 1990s was relatively large with many mature fish (Elrod et al. 1995).

Elrod et al. (1996) demonstrated that the weight of a 700-mm mature female lake trout was much higher in 1978-1981 than in 1982-1993 and they attributed the better condition in 1978-1981 to a lack of competition for food or space at low population levels. Therefore, we used the fecundity-length regression for 1977-1981 to calculate indices of egg deposition during 1980-1981 and the fecundity-length regressions for 1994 to calculate indices of egg deposition during 1982-2002. To account for sea lamprey induced mortality that occurred between September gill net sampling and November spawning, we reduced catches of mature females, other than Seneca strain fish, by $1 - \text{EXP}[-(Z_{\text{SEN}} - Z_{\text{SUP}})]$. Where Z = instantaneous rate of mortality, EXP is the exponential of e , SEN = Seneca Lake strain, and SUP = Lake Superior strain. Elrod et al. (1995) reported that mature SUP lake trout had a higher annual mortality rate than mature SEN fish. The difference was most likely due to the large numbers of SUP fish killed each fall by sea lampreys. Because SUP fish were present in large numbers throughout the study period, they were our standard for judging mortality rates of those lake trout strains susceptible to sea lamprey induced mortality.

Temporal changes in lake trout reproductive potential measured by the egg deposition index (Figure 9) differed considerably from those measured by the CPUE of mature females (Figure 3). The CPUE of mature females suggests that reproductive potential quadrupled from 1983 to 1986 and then fluctuated around a

high level through 1998. In contrast, the egg index suggests that reproductive potential quadrupled from 1985 to 1993 and then remained high through 1998. Strain composition of the eggs was mostly SUP during 1983-1990 and mostly SEN during 1991-2002. After 2002 it has become increasingly difficult to assess strain specific contribution to the egg deposition index because most fish stocked since 1997 were not marked with coded wire tags. In most years during the recent period SEN strain has predominated in the stockings and we assume that they continue to contribute the greatest proportion to the egg index. The reproductive potential of the lake trout population in Lake Ontario declined by 13% in 1999 from the mean 1993 - 1998 value. That decline was concurrent with a 31% decline in the CPUE of mature females. Although CPUE was constant from 1999 to 2000, reproductive potential dropped by 27% after 1999. The first predominantly untagged cohort since 1983 was stocked as spring yearlings in 1997 and began to show up in substantial numbers as mature females at age 5 in 2001. For the first two years (2001 and 2002, Fig. 11, Lantry et al. 2003) we adjusted up the strain-specific mean fecundities for the tagged population by proportioning numbers of untagged fish to the strain makeup of the tagged population. It became evident, however, that mean fecundities based on tagged fish represented values for substantially older individuals than those for untagged fish. Simply raising fecundity indexes based on tagged fish to account for the untagged proportion of the population was biasing population values high. In 2003 we began to calculate size and age-specific fecundities for untagged fish with paired fin clips that permitted aging. We then applied strain related mortality correction factors to those values by calculating the strain composition of untagged fish based on the strain composition for the specific cohorts at stocking. The new calculations lowered the previous egg deposition index values for 2001 and 2002 by 12% and 26% respectively. The resulting egg deposition index changed little between 2001 and 2004 and the average for those years was 42% lower than the average for 1993 to 1999.

Natural Reproduction:

In 2004, four naturally produced yearling lake trout were caught with bottom trawls. They

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ranged in size from 85 to 151 mm (3.4 to 5.9 in). Survival of naturally produced lake trout to the fingerling stage in summer and fall occurred each year during 1993-2003 (Figure 10). Further, survival to older ages, based on length-frequency, has also been observed. This modest level of reproductive success (11 successive year-classes) is an important early sign of successful natural reproduction and meets the plan objective to demonstrate the feasibility of lake trout rehabilitation in Lake Ontario (Schneider et al. 1997). Low numbers of small fish (<100 mm, 3.9 in) captured in recent years (1997-2003) may be due in part to a change in our trawl gear that was necessary to avoid abundant dreissenid mussels. Our new bottom trawls do not fish as hard on bottom as the old gear and are not as efficient at capturing small benthic fishes. We were encouraged by good

catches of age-1 wild fish near Oswego in 2001. Low catches during 2002 to 2004, however, may also indicate increases in predation on young wild lake trout.

The distribution of catches of wild fish suggests that lake trout are reproducing throughout New York waters (Figure 11). Although these signs are encouraging, achieving the goal of a self-sustaining population will require continued improvement in production of wild lake trout. Surviving members of the 1993-1997 year classes were all sexually mature by the fall of 2004. As successive naturally reproduced year classes approach reproductive age over the next several years, we anticipate observing greater catch rates of young, naturally reproduced lake trout in our trawl surveys including second generation fish.

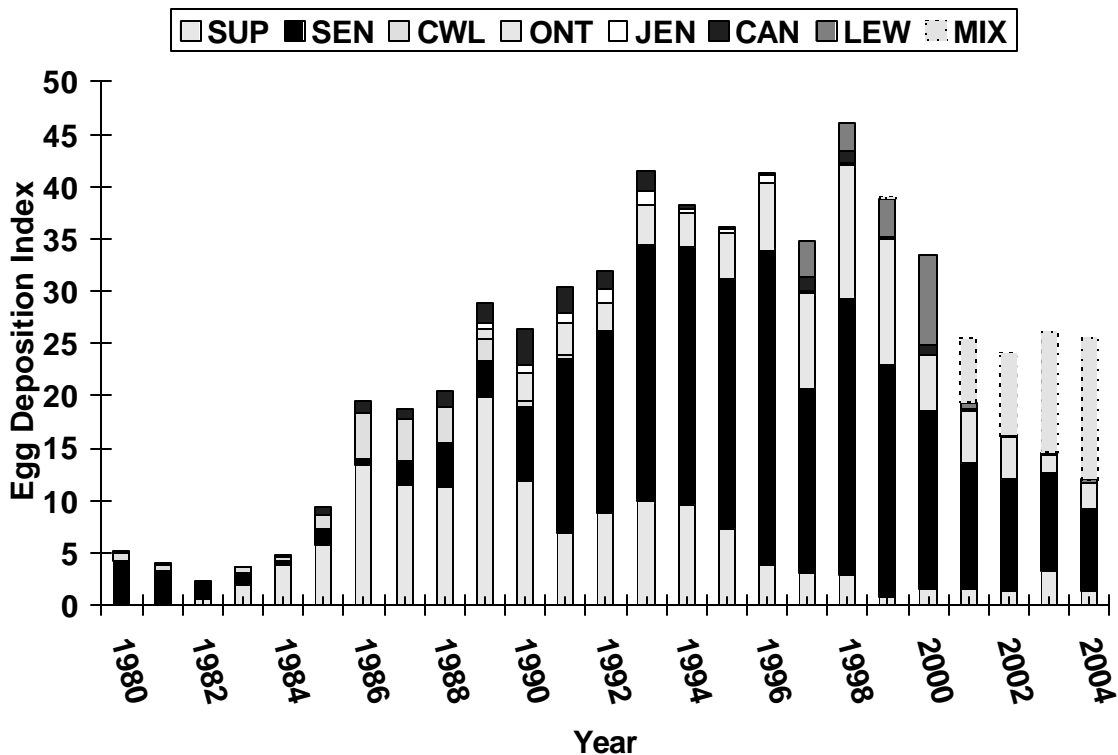


Figure 9. For lake trout in U.S. waters of Lake Ontario, egg deposition indices by strain 1980 - 2004. Mix represents the egg deposition index for untagged females stocked since 1997 for which strain could not be determined.

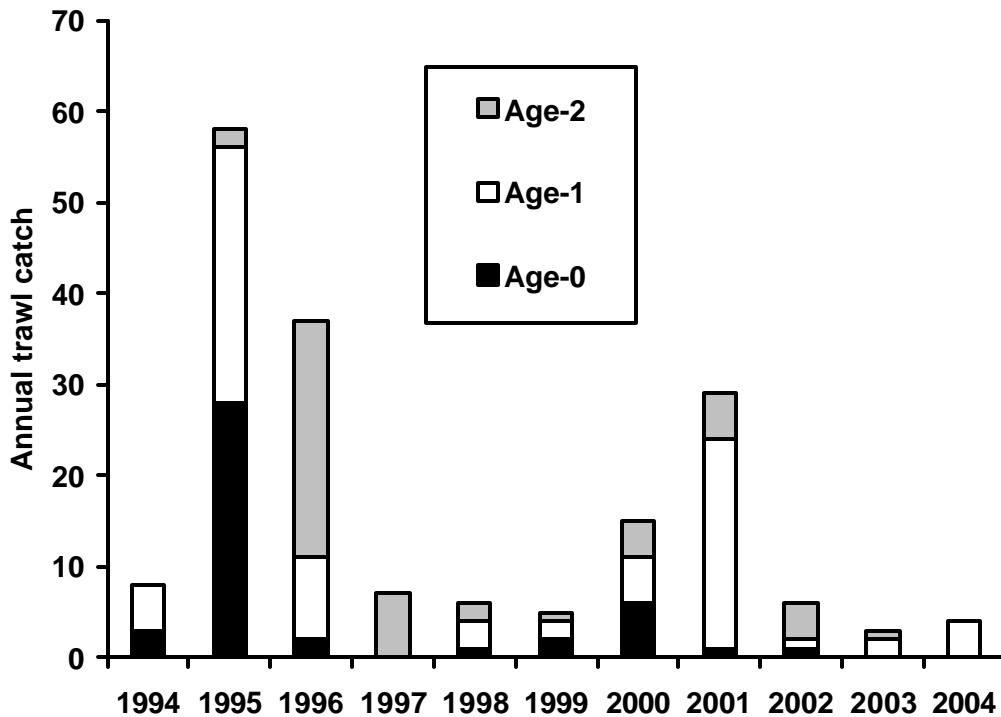


Figure 10. Numbers and lengths of naturally produced (wild) lake trout captured with bottom trawls in Lake Ontario by NYDEC and USGS, 1994 - 2004.

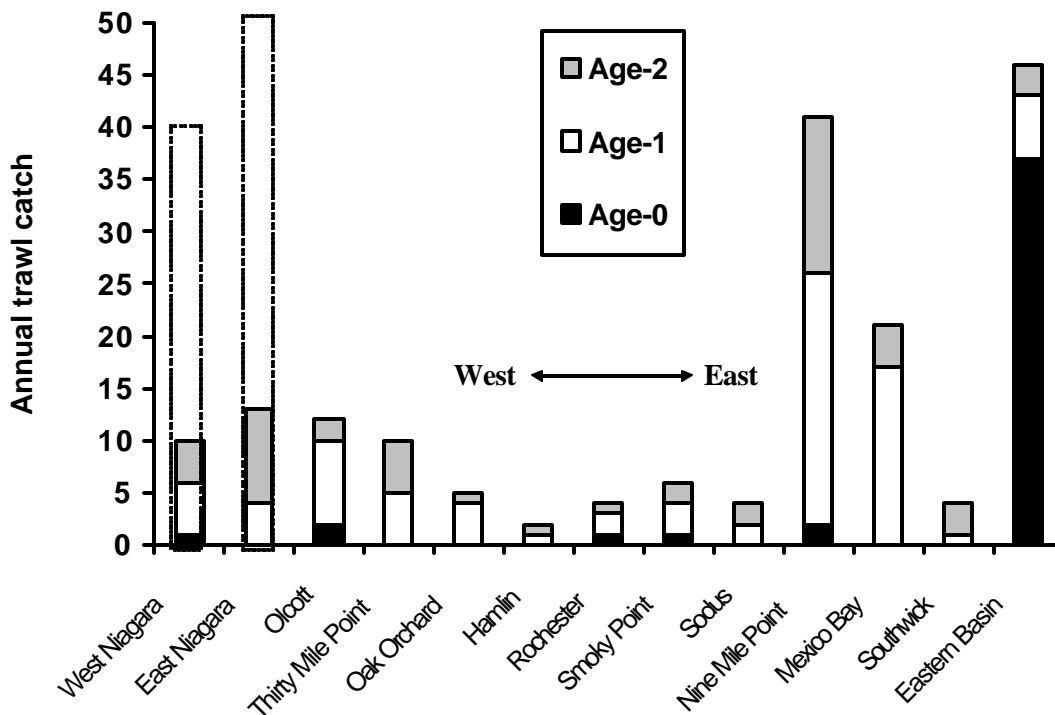


Figure 11. Numbers of wild lake trout (age 0 to 2) captured with bottom trawls at various locations in Lake Ontario by NYSDEC and USGS, 1994 - 2004. (Note: east and west Niagara are only sampled once per year whereas the other locations are usually sampled four times per year. Dashed lines show these catches adjusted for effort).

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