Lake Ontario August gillnet survey and Lake Trout assessment, 2024

Brian P. O'Malley[1], Scott P. Minihkeim[1], Olivia M. Mitchinson[1], Scott D. Stahl[1], Brian C. Weidel[1], Michael J. Connerton[2], Jessica A. Goretzke[2], Lucus Sunderland[3], Emma J. Bloomfield[3], Collin J. Farrell[4], Dimitry Gorsky[4]

[1] U.S. Geological Survey (USGS), Great Lakes Science Center, Oswego, NY 13126
[2] New York State Department of Environmental Conservation (NYSDEC), Lake Ontario Research Unit, Cape Vincent, NY 13618
[3]Ontario Ministry of Natural Resources (OMNR), Lake Ontario Management Unit, Picton, Ontario, Canada, K0K 2T0
[4] U.S. Fish and Wildlife Service (USFWS), Lower Great Lakes Fish and Wildlife Conservation Office, Basom, NY 14013

Abstract

Lake Ontario Lake Trout (*Salvelinus namaycush*) rehabilitation has been assessed with fishery independent surveys to evaluate program benchmarks and compare observations with management objectives since 1983. These surveys provide information on the abundance, strain composition, and performance of stocked Lake Trout, as well as information on levels of natural recruitment, and Sea Lamprey (*Petromyzon marinus*) wounding rates. In 2024, the gillnet survey occurred in United States (US) and Canadian waters marking the first lake-wide Lake Trout assessment since 2008. Lake Trout catch per unit effort (CPUE) was higher in US than Canadian waters. Recaptures of stocked fish with coded wire tags occurred mostly in US waters, and were composed of the following strains: Lake Champlain, Seneca Lake, Superior Klondike Reef, and Huron Parry Sound. Percentage of naturally produced Lake Trout in US waters continued to be relatively low for mature and immature fish. Interestingly, the percentage of naturally produced Lake Trout was higher in Canadian waters, despite lower total numbers of Lake Trout caught. Sea Lamprey wounding rates on Lake Trout > 432 mm in 2024 were above management targets in US and Canadian waters. Overall, the 2024 survey results suggest that Lake Trout indicators continue to meet some of the management objectives and show spatial differences in overall abundance and the proportion of stocked vs wild fish between the US and Canadian stocks.

Data Release

The data associated with this report are currently under review and will be publicly available in 2025. Previous versions of the data may be accessed at U.S. Geological Survey, Great Lakes Science Center, 2019, Great Lakes Research Vessel Operations 1958-2018. (ver. 3.0, April 2019): U.S. Geological Survey data release, https://doi.org/10.5066/F75M63X0. Please direct questions to our Data Management Librarian, Sofia Silvis, at ssilvis@usgs.gov.

Introduction

Restoration of a self-sustaining Lake Trout (*Salvelinus namaycush*) population in Lake Ontario is a binational management objective (Lantry et al. 2014, Stewart et al. 2017). In Lake Ontario, Lake Trout were historically abundant prior to European settlement, and served as a native top predator in the coldwater fish community along with Burbot (*Lota lota*) and Atlantic Salmon (*Salmo salar*) (Smith 1995, Owens et al. 2003). By the mid-1950s, Lake Trout were considered extirpated in Lake Ontario, largely due to anthropogenic influences, such as overfishing, habitat degradation, and Sea Lamprey (*Petromyzon marinus*) predation (Christie 1972; Elrod et al. 1995). Initial attempts to rehabilitate the Lake Trout population by stocking fry (1896-1947) and fingerlings/yearlings (1953-1964) failed (Elrod et al. 1995). The advent of Sea Lamprey suppression in Lake Ontario in 1971 coincided with resumed attempts to stock Lake Trout with annual yearling and fingerling stocking events. Since the 1970s, annual stocking rates in United States (US) waters have varied from approximately 1 million spring yearling equivalents per year during the 1980s, to approximately 300,000 per year since 2019 (Elrod et al. 1995; Lantry et al. 2021; USFWS/GLFC 2025). Managers have stocked a variety of genetically distinct strains, and more recently, have broadened functional diversity by stocking a presumed deeper water morph (i.e., Lake Superior Klondike Reef [SKW] 'humper' strain). In their wild source populations, 'humper' strains, are more easily explained as an intermediate between 'lean' and 'deepwater' morphs, have higher fat content, deeper bodies, and tend to feed mainly on benthic prey than lean morphs which rely more on pelagic prey (Muir et al. 2012). In Lake Erie, stocked Lake Trout from Klondike Reef broodstock exhibited differences in diet, maturation, and survival, compared to strains derived from lean morphs (Rogers et al. 2019).

To measure progress on Lake Trout rehabilitation in Lake Ontario, collaborative fishery independent surveys using gillnets began in 1983 in US waters and expanded to include Canadian waters in 1985. This binational survey occurred lake-wide during 1985-1995 and 2008. From 1996 to 2023 (except for 2008), the Lake Trout gillnet survey occurred in US waters only. However, some Lake Trout are also captured in Canadian waters during long term annual gillnet surveys carried out by the Ontario Ministry of Natural Resources known as the Community Index program (OMNR 2023). While the Community Index gillnet survey uses slightly different methods and does not specifically target Lake Trout, it provides information on Lake Trout rehabilitation progress in Canadian waters through time (Brenden et al. 2011; Bronte et al. 2022). At the time of the last coordinated lake-wide Lake Trout assessment in 2008, the abundance of mature fish was below restoration objectives and was attributed to poor survival of stocked fish (Lantry et al. 2010). Since 2008, our annual report on the status of Lake Trout has focused only on the US waters of Lake Ontario because of standard survey methods (e.g., O'Malley et al. 2024). Survival and condition of adult Lake Trout has improved; however, the abundance of wild mature Lake Trout has not shown substantial increase (O'Malley et al. 2024), spurring renewed interest in a lake-wide assessment to evaluate whether trends in US waters are consistent across Lake Ontario.

In this report, we summarized findings from the 2024 Lake Ontario August gillnet survey in context with long term trends from 1983 to 2024. Because 2024 survey efforts expanded to Canadian sites, we report on US (1983-2024) and Canadian (1985-1995, 2008, and 2024) indices of Lake Trout indicators relevant to the binational Lake Trout management strategy defined measures (Lantry et al. 2014).

Methods

Gillnet Survey

During 1983-2021, the adult Lake Trout stock in US waters of Lake Ontario was assessed on an annual basis during September with gillnets fished along transects at randomly selected locations distributed across a subset of 17 (1983-1993) or 14 (1994-present) geographic areas (Elrod et al. 1995). In 2022, the survey timing shifted to begin in August to accommodate room for experimental trawling scheduled in September. During 1985-1995, and in 2008 and 2024, seven to ten areas were also fished in Canadian waters, along transects in the main basin and fixed sites in the Kingston Basin. To standardize effort, all indices in this report were generated separately for US and Canadian sites. The standard effort was typically three to four gillnets per transect. Survey design and gillnet construction (multi vs mono-filament netting) have changed through the years. For a description of survey history, including gear changes and corrections, refer to Elrod et al. (1995) and Owens et al. (2003). Since 1993, standard survey gillnets have consisted of monofilament netting with nine 15.2 x 2.4 m (50 x 8 ft) panels of 51 to 151 mm (2- to 6-in stretched measure) mesh in 12.5 mm (0.5 in) increments. Prior to 1993, standard survey gillnets were composed of multifilament netting with the same dimensions, except during 1990–1992 when one additional gillnet composed of monofilament netting was fished at each location for comparison.

During 2024, gillnets were fished from August-06 to September-06. Gillnets were fished at 12 areas in US waters, and at seven areas in Canadian waters (Figure 1), in depths ranging from 3 to 75 m. Because the U.S. Geological Survey (USGS) R/V Kaho was unavailable for the 2024 survey due to emergency repairs, staff from the U.S. Fish and Wildlife Service (USFWS) and USGS made use of smaller research vessels with electric gillnet lifters to complete sampling at transects off ports in Youngstown, Olcott, Oak Orchard, Oswego, and Fairhaven, New York. At each location, two or four standard gillnets were set parallel to depth contours beginning at the 10°C isotherm and successively deeper at 10-m depth increments. At each of the Canadian transects and a subset of the US transects, an additional fifth gillnet was set shallower to target 12°C water, to test the hypothesis that Lake Trout are more abundant in waters > 10°C. At each of the fixed sites in Canadian waters of the Kingston Basin (Figure 1), three gillnets strapped together were fished per site. Catches for each gillnet panel were sorted by species; total lengths (TL) and weights of individual fish were measured. Sex and maturity were determined by visual inspection of gonads. Presence and types of fin clips were recorded, and when present, coded wire tags (CWTs) were removed and decoded to retrieve information on age and strain for recaptured fish of hatchery-origin. Sea lamprey wounds on Lake Trout were counted and graded according to King Jr. and Edsall (1979) and Ebener et al. (2006).

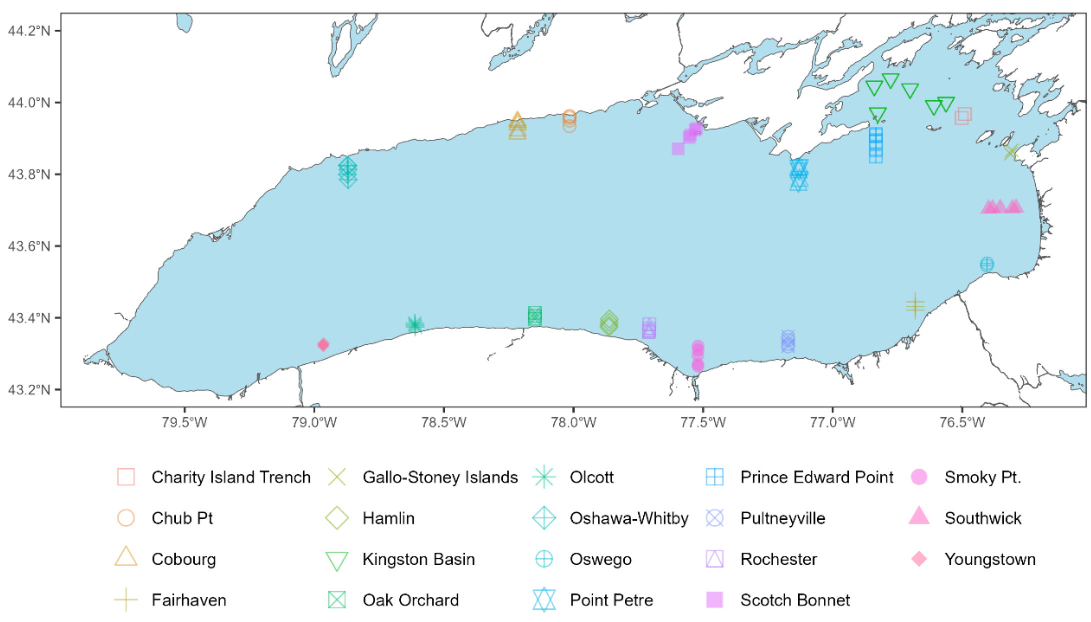


Figure 1. Map of Lake Ontario gillnet sets from the 2024 Lake Ontario August gillnet survey and Lake Trout assessment.

Because effort varied across locations and catch per net generally decreases with depth from the thermocline, a stratified catch per unit effort (CPUE) was calculated using four depth-based strata, representing net position from shallowest to deepest. Abundance indices were calculated from the standard 2-4 gillnets fished starting at 10°C. Catch data from the additional gillnets fished in > 10°C water were only used when comparing catches between the additional net and the first standard net at sites where they occurred. Gillnets were fished for one night and the unit of effort was one overnight set per net. Survival of different year-classes and strains was estimated by taking the antilog slope from the linear regression of the natural logarithm (CPUE) as a function of age for fish ages 7 to 11 years that received CWTs. Population survival was based on catches for all strains combined for the 1983-1995 and 2003-2014 cohorts, as all fish stocked during those periods received CWTs. We summarized demographic trends by sex and maturity, and for large (≥ 4,000 g) female Lake Trout. We calculated wounding rates from Sea Lamprey as the number of A1 (fresh wounds where a lamprey has recently detached) wounds per 100 Lake Trout > 432 mm TL. For indices of natural reproduction, based on gillnet catches, we quantified the percentage and CPUE of hatchery-origin Lake Trout (i.e., those with CWTs or fin clip marks) to putative-wild fish (i.e., unmarked fish). We also derived an index of natural reproduction from the Lake Ontario April bottom trawl survey expressed as the depth-stratified number of fish per hectare. Bottom trawl indices are presented for US (1978-2024) and Canadian (2015-2024) waters separately by size class (greater or less than 500 mm TL). For more details on the April bottom trawl survey refer to Weidel et al. (2024a). We also report on the estimated number of Lake Trout harvested by anglers. The New York State Department of Environmental Conservation (NYSDEC) fishing boat survey has been conducted each year from 1985 to 2024 (except 2020). For more details on the fishing boat survey and methods used to estimate angler harvest, refer to Connerton and Moore (2025).

Results and Discussion

The goal of the Lake Ontario Lake Trout Management Strategy is to restore a self-sustaining population of Lake Trout. In the results below, we first summarize findings from the 2024 survey in terms of total catch, abundance, and strain composition, then list specific management objectives or strategies, and their respective measures from Lantry et al. (2014), along with supporting evidence from our surveys that inform these population measures.

Total Catch, Abundance, and Strain Composition in 2024

Overall, a total of 652 Lake Trout were caught across all 88 gillnets fished in 2024 (Appendix 1). After excluding the additional gillnets that targeted 12°C water (N=6 Canada; N=3 United States), and one standard gillnet at Smoky Point, NY and six gillnets from the Canadian Kingston Basin that fished in undesirably warm water (>12°C), this resulted in a total of 583 Lake Trout captured in standard sets for abundance and trend analyses. Comparing Lake Trout catches between gillnets that targeted 12° vs 10°C water showed no support for the hypothesis that Lake Trout are more abundant in waters > 10°C. A total of 13 and 16 Lake Trout were caught in gillnets that targeted 10°C and 12°C respectively, however the means were not significantly different after excluding Smoky Point (Appendix 2; t-test: $t = 0.31$, $df = 8.59$, $p = 0.76$). It is important to note that most of the additional 12°C comparison sets were in Canadian waters, with only one paired set at Southwick on the US side (Figure 1), so to maintain consistency with the time series we did not include 12°C gillnets in further analyses given the limited amount of data in hand to draw conclusions. Among the standard gillnet sets used for analysis, a total of 520 Lake Trout were caught in 36 standard gillnets at US sites, and 63 total Lake Trout were caught in 36 standard gillnets at Canadian sites.

Lake Trout relative abundance (stratified CPUE) was lower in Canadian than US waters across all categories of sex and maturity in 2024 likely due in part to higher stocking rates on the US side, bathymetric differences. Depth contours are more gradual and cold water is more widely dispersed along the north shore than on the US side where Lake Trout are likely more concentrated. The pattern of higher Lake Trout CPUE in US waters is consistent with previous years. Total Lake Trout CPUE in 2024 was 13.1 (fish/net) in US waters and 2.2 (fish/net) in Canadian waters (Figure 2a). Total Lake Trout CPUE in

US waters in 2024 was higher than the amount observed in the 2023 survey (12.1 fish/net) but significantly lower than the mean during the past 10 survey years (2014-2023 mean = 15.3 fish/net ± 2.5 SD; one-sample t-test: $t_9 = 2.82$, $p = 0.02$). In Canadian waters, total Lake Trout CPUE in 2024 was close to the 2008 value (1.8 fish/net) but significantly lower than the 1985-1995 mean (15.5 fish/net ± 2.6 SD; one-sample t-test: $t_{10} = 16.67$, $p < 0.01$).

Mature male Lake Trout CPUE (6.9 fish/net) in US waters increased in 2024 but was significantly lower compared to the average during 2014-2023 (Figure 2b; 10-year mean = 8.2 fish/net ± 1.4 SD; one-sample t-test: $t_9 = 2.79$, $p = 0.02$). In contrast, mature female CPUE in US waters in 2024 (4.3 fish/net) increased from a relatively low value in 2023 and was similar to the average during 2014-2023 (Figure 2c; 10-year mean = 4.3 fish/net ± 0.8 SD; one-sample t-test: $t_9 = 0.01$, $p = 0.98$). Total immature Lake Trout CPUE in US waters (1.9 fish/net) was lower than in 2023 and significantly lower than the 2014-2023 average (Figure 2d; 10-year mean = 2.8 fish/net ± 1.0 SD; one-sample t-test: $t_9 = 2.7$, $p = 0.02$). In Canadian waters, CPUE in 2024 for mature males (1.3 fish/net), mature females (0.5 fish/net), and immatures (0.3 fish/net) were all similar to 2008 values, but significantly lower than the 1985-1995 means ($p < 0.01$).

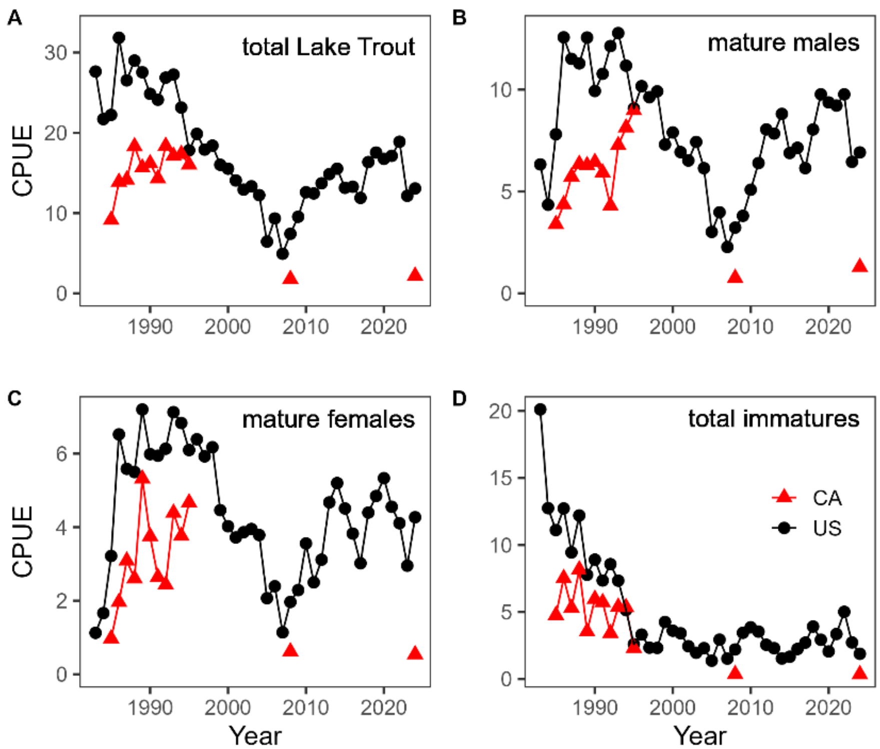


Figure 2. Abundance (stratified catch per unit effort, CPUE) of (A) total Lake Trout, (B) mature male Lake Trout, (C) mature female Lake Trout, and (d) total immature Lake Trout captured in the Lake Ontario August gillnet survey and Lake Trout assessment 1983–2024. Note the difference in y-axis scales among panels.

In total, 457 hatchery-origin Lake Trout with CWTs were recaptured in the 2024 survey (Appendix 3). Most of these recaptures occurred in US waters (N = 449 fish). Lake Trout with CWTs recaptured in 2024 in US waters ranged from 1 to 35 years in age (Appendix 4) and were represented by four different strains: SKW (41.9%), Seneca Lake (SEN, 24.0%), Lake Champlain (LC, 23.2%), and Huron Parry Sound (HPW, 10.9%). Of the eight Lake Trout recaptured in Canadian waters with CWTs, ages ranged from 3 to 18 years, and were made up of SEN (N = 4), LC (N = 3), and HPW (N = 1) strains.

Management Objective 1: Increase abundance of stocked Lake Trout to a level allowing for significant natural reproduction.

> *<u>Measure:</u> CPUE of mature females ≥ 4,000 g greater than 2.0 and 1.1 fish per standard assessment gill net set in US and Canadian waters, respectively.*

In 2024, CPUE (unstratified) of mature female Lake Trout ≥ 4,000 g in US waters was 2.2 fish/net (Figure 3) and above the 2.0 fish/net target level established in the management strategy (Schneider et al. 1998; Lantry et al. 2014). This represents an increase from 1.6 fish/net in 2023 which fell below the target for the first time in more than 10 years, suggesting that the Lake Trout population in US waters has had an abundance of mature females of reproductive size over the past decade. Since 2010 the CPUE of mature females ≥ 4,000 g has appeared to recover from a below-target period during 2005–2009 (average CPUE = 1.4 fish/net ± 0.4 SD). In contrast, the CPUE of mature females of reproductive size in Canadian waters in 2024 was 0.3 fish/net, below the target of 1.1 fish/net established for Canadian waters in the management strategy (Lantry et al. 2014), and similar to the 2008 observation, when some of the lowest values were observed on the US side. Overall, despite a recovery in females of reproductive size on the US side to now be at or above the target levels, the Canadian side remains below target.

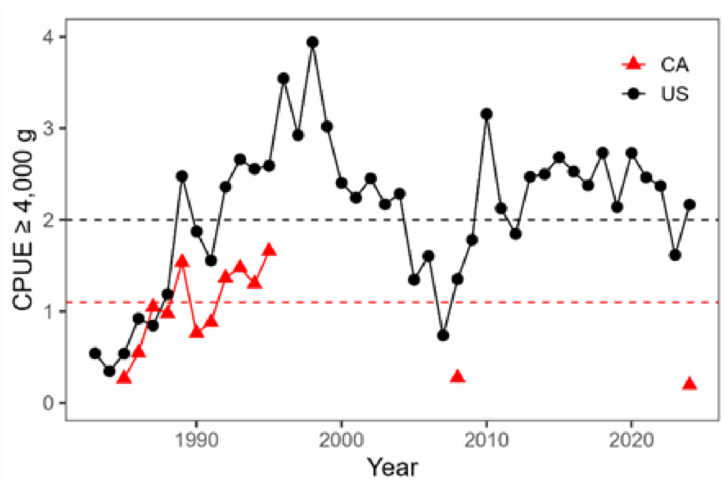


Figure 3. Abundance (catch per unit effort (CPUE) unstratified) of mature female Lake Trout ≥ 4,000 g calculated from gillnet catches in the Lake Ontario August gillnet survey and Lake Trout assessment 1983-2024. The dashed lines represent the target CPUEs for the Management Objective 1 Measure: “CPUE of mature females ≥ 4,000 g greater than 2.0 and 1.1 fish per standard assessment gill net set in US and Canadian waters, respectively” (Lantry et al. 2014). Black and red dashed lines denote US and Canadian targets, respectively.

Management Objective 2: Increase populations of wild Lake Trout across a range of age groups.

> *<u>Measure:</u> Measurable increase in catches of wild juveniles and adults in assessment catches, with values exceeding those observed during 1994-2011.*

Young, naturally reproduced (i.e., wild) Lake Trout have been detected in Lake Ontario gillnet and bottom trawl surveys (Lantry et al. 2021; Weidel et al. 2024a), however the percentage of wild mature fish in gillnet surveys has generally remained low and has not shown substantive increase through time (Figure 4). In 2024, 36 of the 583 Lake Trout (6.2%) were identified as wild in our standard gillnets, 26 of which were in Canadian waters and 10 in US waters. In Canadian waters, 5 out of 9 immature (55.6%), and 21 out of 54 mature (38.9%) Lake Trout were identified as wild. In contrast, a lower percentage of the Lake Trout catch in US waters were wild. In US waters, 5 out of 76 immature (6.6%), and 5 out of 444 mature (1.1%) Lake Trout were identified as wild. In US waters, the mean CPUE (unstratified) of immature wilds during 2020-2024 (0.25 ± 0.11 fish/net) was significantly higher compared to 1994-2011 (t-test: t = 3.39, df = 4.32, *p* = 0.02), however the mean of mature wilds (0.21 ± 0.09 fish/net) was not significantly different (t-test: t = 0.94, df = 6.88, *p* = 0.38). Since 2011, both immature and mature Lake

Trout CPUEs in US waters have not shown an increasing or decreasing trend during 2012-2024 (immature: $F_{1,10} = 4.84$, $p = 0.05$, $R^2 = 0.26$; mature: $F_{1,10} = 1.30$, $p = 0.28$, $R^2 = 0.03$). In Canadian waters, the CPUE of immature wilds was higher in 2024 (0.14 fish/net) than the 1994-1995 mean (0 fish/net), and the CPUE of mature wilds (0.58 fish/net) was also higher in 2024 than 1994-1995 (0.10 fish/net). April bottom trawling has generally detected few wild juvenile (< 500 mm) and adult (> 500 mm) Lake Trout since trawling began in US waters in 1978 and in Canadian waters in 2015 (Figure 5; Weidel et al. 2024a). However, since 2015 wild juvenile fish have become more frequent in trawl catches especially in the Niagara vicinity.

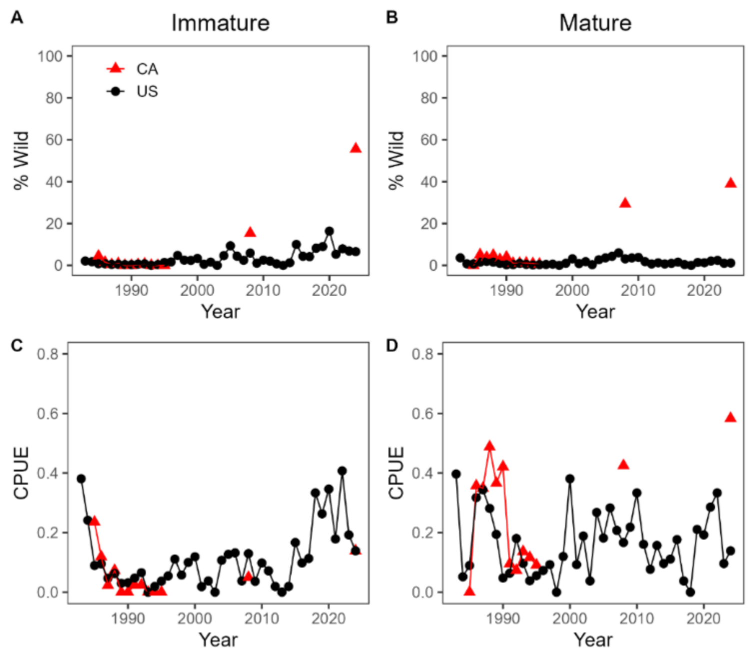


Figure 4. (top panels) The percentage of wild (no fin clip markings or coded wire tags) Lake Trout for (A) immature and (B) mature fish by year, and (bottom panels) the catch per unit effort (CPUE) of wild (C) immature and (D) mature Lake Trout in the Lake Ontario August gillnet survey. Red triangles represent catches in Canadian waters (1985-1995, 2008, and 2024) and black circles represent catches in US waters (1983–2024).

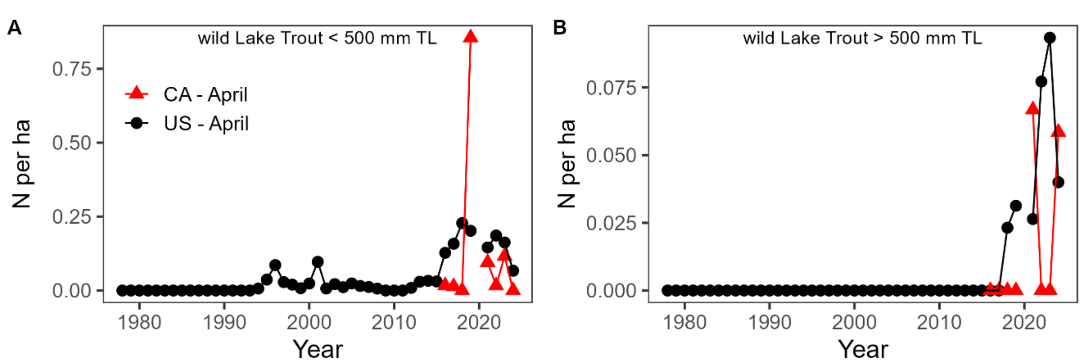


Figure 5. Wild Lake Trout density (number per hectare) by size class (A) < 500 mm total length (TL), and (B) > 500 mm TL in US and Canadian waters of April bottom trawl surveys in Lake Ontario from Weidel et al. (2024a); data are available in a U.S. Geological Survey data release (Weidel et al. 2024b). Note the difference in y-axis scales between panels.

Management Strategy 3: Maintain high survival of older fish by controlling Sea Lamprey and fishing mortality.

<u>*Measures:*</u>

- *Yearly survival of adult fish > 60 %*
- *Maintain the Sea Lamprey wounding rate in fall gillnetting at ≤ 2 A1 wounds per 100 Lake Trout > 432 mm total length*
- *Maintain annual harvest to < 10,000 fish in US waters and < 5,000 fish in Canadian waters*

Adult Survival

Survival of Seneca Lake (SEN) strain Lake Trout (ages 7 to 11) was consistently greater than that of Lake Superior (SUP) strain Lake Trout for the 1980-2003 year-classes (Figure 6; Appendix 5). Lower survival of SUP strain fish was likely due to higher mortality from Sea Lamprey predation (Schneider et al. 1996). Survival of both Jenny and Lewis Lake (JEN-LEW) strains (1984-1995 year-classes) were similar to the SUP strain, suggesting that those strains might also be highly vulnerable to Sea Lamprey. The Lake Ontario strain (ONT) was developed from egg collections of feral adults at a time when the composition of survey catches was predominantly SUP, SEN, and Clear Water Lake (CWL) strains (Elrod et al. 1995; Schneider et al. 1996); and the survival of 1983-1991 year-classes was intermediate to that of SENs and SUPs.

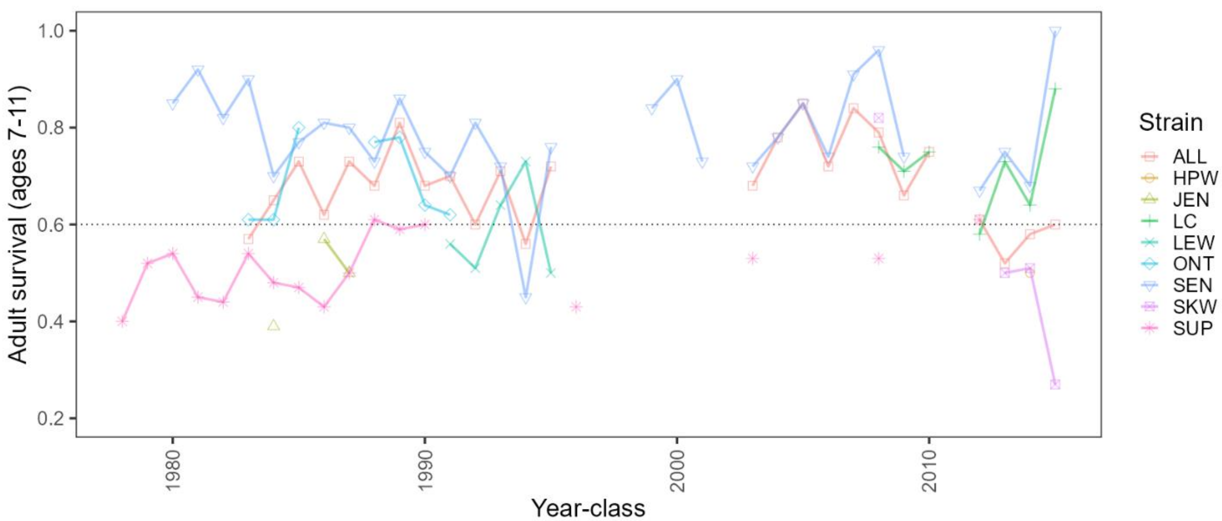


Figure 6. Annual survival of adult Lake Trout (ages 7-11) by strain and year-class, sampled from US waters of Lake Ontario during the Lake Ontario August gillnet survey 1985-2024. The 2014 and 2015 year-classes are represented by ages 7-10 and 7-9, respectively. Dashed line denotes the desired minimum survival rate of 60% from Lantry et al. (2014). "ALL" is population survival of all strains combined using only coded wire tagged fishes. Strain abbreviations are: HPW = Huron Parry Sound, JEN = Jenny Lake, LC = Lake Champlain, LEW = Lewis Lake, ONT = Lake Ontario, SEN = Seneca Lake, SKW = Superior Klondike Reef, SUP = Lake Superior. Refer to Appendix 5 for more information.

Population survival (ALL) exceeded the management strategy target of 60% beginning with the 1984 year-class and remained above target for most year-classes thereafter. However, population survival from the 2013 and 2014 year-classes, which represents cohorts that have reached ages 7-11 and 7-10 in recent survey years, has fallen below the target level (e.g., 55% for 2013 year-class; 58% for 2014 year-class). Population survival of the 2015 year-class, which reached age 9 in 2024, met the target level (60%).

The SUP strain was no longer available in 2006 and the Traverse Island strain (STW) and Apostle Island strain (SAW), also both of Lake Superior origin, replaced SUPs in stockings from 2007-2009 and in 2009 and 2013, respectively. For simplicity, we grouped all Lake Superior strains except for the Klondike Reef strain under the SUP strain category. Strains from Seneca Lake origins included feral and domestic Lake Champlain strains (LCW and LC, respectively) beginning with the 2009 stockings. Survival for LC 2008-2010 and 2012 year-classes (58-76%) resembled their mostly SEN origins. Only one year-class of LCWs was stocked (2009) and its survival (73%, not shown in Appendix 5) was also similar to SENs. Survival rates could not be calculated for the first large stocking of STWs (225,000 of the 2006 year-class) as they disappeared from survey catches after age 8. Survival for the 2007 (36%, ages 7-11) and the 2008 (41%, ages 7-11) year-classes of STWs was relatively low and similar to early values for SUPs. Survival rates for the SAW (53%, 2008 year-class grouped as SUP in Appendix 5) strain was also low and no 2008 SAWs were caught in 2018 or 2019. There were no SAWs stocked during 2010-2012 (2009-2011 year-classes), but the 2012 year-class of SAWs (stocked in 2013) observed in survey catches at ages 7-11 during 2019-2023 also experienced relatively low survival (61%).

The first stocking of SKW occurred in 2009 (2008 year-class) which reached age 11 in 2019. SKW survival for the 2008 year-class was 82% (ages 7-11) and similar to SEN strain survival for the 2007 and 2008 year-classes, which were > 90%. Further stockings of SKWs occurred during 2014-2018, with the 2013 year-classes reaching age 11 in 2024. Survival of the 2013 year-class of SKWs age 7-11 (50%) was lower than the 2008 year-class. The SKW 2008 year-class reached age 16 in 2024 and were still present in gillnet catches in 2024. The first stocking of the HPW strain occurred in 2015, and survival of the 2014 year-class of HPW age 7-10 (50%) was low, along with the 2014 year-class of SKWs (51%) when compared to other strains in the 2014 year-class (i.e. SEN and LC both > 60%). Survival of the 2015 year-class of HPW could not be calculated because too few fish were caught in 2024. Similarly, survival of the 2015 year-class of SEN was difficult to estimate with confidence because CPUE of age 9 SEN from that year-class was greater than at age 7 and 8.

Sea Lamprey Wounding

Rates of A1 Sea Lamprey wounds on Lake Trout were low in most years since the mid-1980s in US and Canadian waters compared to high rates in US waters during 1975-1980 (Lantry et al. 2021; Figure 7). In 2024, a total of 13 A1 wounds were observed in US waters across 495 Lake Trout > 432 mm TL for a wounding rate of 2.62 A1 wounds per 100 fish, which is above the management target level (< 2 A1 wounds per 100 Lake Trout > 432 mm TL) specified in Lantry et al. (2014). Similarly, in Canadian waters in 2024, 2 A1 wounds were observed out of 62 fish > 432 mm TL for a wounding rate of 3.22 A1 wounds per 100 fish, also above target. The last assessment in 2008 for Canadian waters did not detect any A1 wounds. Host CPUE (Lake Trout per net unstratified), expressed as the CPUE of Lake Trout > 432 mm TL, was higher in US waters in 2024 (13.8 fish/net) than in Canadian waters (1.7 fish/net).

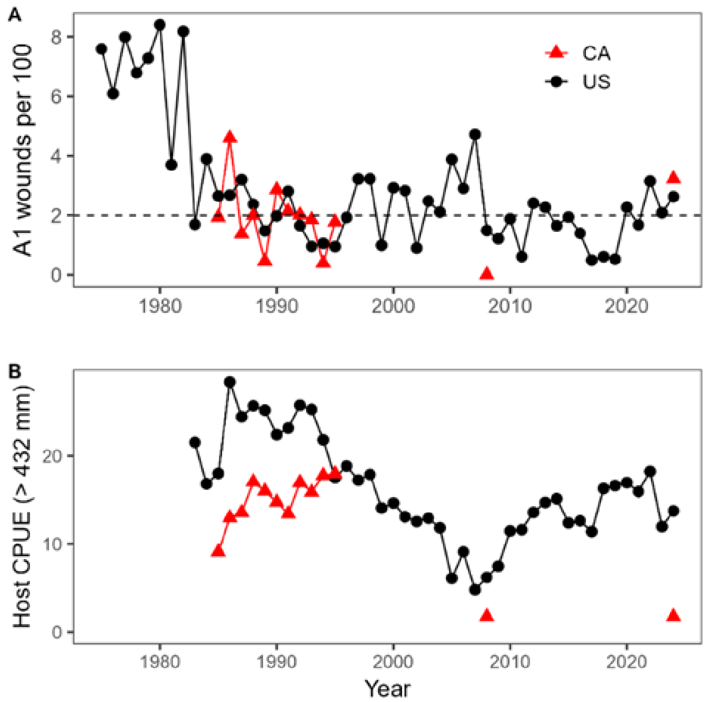


Figure 7. (A) Wounding rates (A1 wounds per 100 Lake Trout) inflicted by Sea Lamprey on fish > 432 mm total length (TL) and (B) the gillnet CPUE of Lake Trout hosts > 432 mm TL during 1983–2024. Dashed line denotes the recommended target level (≤ 2 wounds per 100 Lake Trout > 432 mm TL). Data from 1975–1982 are from Lantry et al. (2021).

Harvest

Fishing regulations, Lake Trout population size, and availability of other trout and salmon species influenced angler harvest through time (Connerton et al. 2020). During 1988-1992, managers implemented a slot size limit to decrease harvest of mature Lake Trout and increase the number and ages of spawning adults in the population (Elrod et al. 1995). The slot limit from 1992 persisted through 2006, permitting a limit of three Lake Trout harvested outside of the protected length interval of 635 to 762 mm (25 to 30 inches). Effective October 1, 2006, the Lake Trout creel limit was reduced to two fish per day per angler, one of which could be within the 635 to 762 mm slot.

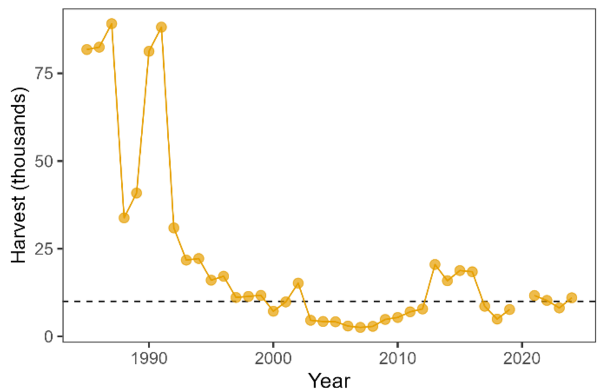


Figure 8. Estimated amount (number of fish in thousands) of Lake Trout harvest by fishing boat anglers in US waters of Lake Ontario, during April 15 – September 30, 1985-2024 (Connerton and Moore 2025). Beginning in 2012, all values have been reported reflecting a 5.5-month sampling interval. Prior reports were based on a 6-month sampling interval. Dashed line indicates the 10,000 fish harvest target level established for US waters (Lantry et al. 2014).

The estimated Lake Trout harvest in US waters of Lake Ontario in 2024 was 11,009 from April 15 to September 30, 2024 (Figure 8). Harvest was above the 10,000 fish target level for US waters established by the Lake Trout management strategy (Lantry et al. 2014). Mean catch rate among anglers targeting trout and salmon in 2024 was slightly below the long term and recent 10-year averages (Connerton and Moore 2025). Catch rates for Lake Trout have been below average for the last seven years. However, Lake Trout are targeted less when fishing quality for other species (e.g., Chinook Salmon [*Oncorhynchus* *tshawytscha*]) is high and Chinook Salmon catch rates since 2017 have been the highest observed in the 39-year survey (Connerton and Moore 2025). No angler creel survey was conducted for Lake Trout in Canadian waters in 2024. The last survey with Canadian Lake Trout harvest was in 2022 (OMNR 2023).

Acknowledgements: We thank the staff of the USGS, NYSDEC, OMNR, and FWS over the decades that made data collection possible. We thank Nikki Berry, Stacy Furgal, Krystal Dixon, and Lyndsie Collis for providing reviews. USGS fish handling was carried out in accordance with guidelines from the American Fisheries Society. Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

References

Brenden, T.O., Bence, J.R., Lantry, B.F., Lantry, J.R., Schaner, T. 2011. Population dynamics of Lake Ontario lake trout during 1985–2007. North American Journal of Fisheries Management 31: 962-979.

Bronte, C.R., C. Davis, J.X. He, J. Holden, B.F. Lantry, J.L. Markham, S.P. Sitar. 2022 State of the Great Lakes 2022 Technical Report: Lake Trout Subindicator. Environment and Climate Change Canada and the U.S. Environmental Protection Agency. Available from: https://binational.net/wp-content/uploads/2023/11/State-of-the-Great-Lakes-2022-–-Technical-Report.pdf

Christie, W.J. 1972. Lake Ontario: effects of exploitation, introductions, and eutrophication on the salmonid community. Journal of the Fisheries Board of Canada, 29: 913-929.

Connerton, M.J., and R. J. Moore. 2025. Lake Ontario Fishing Boat Survey 1985-2024. Section 2 *In* NYSDEC 2024 Annual Report, Bureau of Fisheries, Lake Ontario Unit and St. Lawrence River Unit to the Great Lake Fishery Commission's Lake Ontario Committee.

Connerton, M.J.., N.V. Farese and R. J. Moore. 2020. Lake Ontario Fishing Boat Survey 1985-2019. Section 2 *In* NYSDEC 2019 Annual Report, Bureau of Fisheries, Lake Ontario Unit and St. Lawrence River Unit to the Great Lake Fishery Commission's Lake Ontario Committee.

Ebener, M. P., E. L. King Jr., and T. A. Edsall. 2006. Application of a dichotomous key to the classification of sea lamprey marks on great lakes fish. Great Lakes Fishery Commission Report.

Elrod, J. H., R. O'Gorman, C. P. Schneider, T. H. Eckert, T. Schaner, J. N. Bowlby, and L. P. Schleen. 1995. Lake Trout Rehabilitation in Lake Ontario. Journal of Great Lakes Research 21:83–107.

King Jr., E. L., and T. A. Edsall. 1979. Illustrated field guide for the classification of sea lamprey attack marks on great lakes lake trout. Great Lakes Fishery Commission Report.

Lantry, B.F, Lantry, J.R., Schaner, T. 2010. 2008 Lake Ontario Lakewide Fishery Assessment. Technical Reports Paper 65. http://digitalcommons.brockport.edu/tech_rep/65

Lantry, B. F., B. C. Weidel, S. P. Minihkeim, M. J. Connerton, J. A. Goretzke, D. Gorsky, and C. Osborne. 2021. Lake trout rehabilitation in Lake Ontario, 2020. NYSDEC Lake Ontario Unit Annual Report.

Lantry, J., T. Schaner, and T. Copeland. 2014. A management strategy for the restoration of lake trout in Lake Ontario, 2014 update. Available from: http://www.glfc.org/pubs/lake_committees/ontario/Lake%20Ontario_Lake_Trout_Strategy_Nov_2014.pdf

Muir, A. M., C. C. Krueger, and M. J. Hansen. 2012. Re-Establishing Lake Trout in the Laurentian Great Lakes: Past, Present, and Future. Pages 533–588. 2nd ed. Michigan State University Press, East Lansing.

O'Malley, B.P., S.P. Minihkeim, S.D. Stahl, O.M. Mitchinson, M. Connerton, J.A. Goretzke, C. Farrell, D. Gorsky. 2024. Lake Ontario August gillnet survey and Lake Trout assessment, 2023. Report to the Great Lakes Fishery Commission. 22 pp.

Ontario Ministry of Natural Resources and Forestry. 2023. Lake Ontario Fish Communities and Fisheries: 2022 Annual Report of the Lake Ontario Management Unit. Ontario Ministry of Natural Resources and Forestry, Picton, Ontario, Canada. Available from: http://www.glfc.org/lakecom/loc/mgmt_unit/index.html

Owens, R. W., R. O'Gorman, T. H. Eckert, and B. F. Lantry. 2003. The offshore fish community in southern Lake Ontario 1972-1998. Pages 407-441 *In* (Ed.) Munawar State of Lake Ontario (SOLO) – Past, Present, and Future. Aquatic Ecosystem Health & Management Society.

Rogers, M. W., J. L. Markham, T. MacDougall, C. Murray, and C. S. Vandergoot. 2019. Life history and ecological characteristics of humper and lean ecotypes of lake trout stocked in Lake Erie. Hydrobiologia 840:363–377.

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

Schneider, C. P., T. Shaner, S. Orsatti, S. Lary, and D. Busch. 1998. A management strategy for Lake Ontario lake trout. Report to the Lake Ontario Committee.

Smith, S. H. 1995. Early changes in the fish community of Lake Ontario. Great Lakes Fishery Commission Technical Report no. 60. 41 pp. Ann Arbor, MI.

Stewart, T. J., A. Toddy, and S. LaPan. 2017. Fish community objectives for Lake Ontario. Available from: http://glfc.int/pubs/lake_committees/ontario/LO-FCO-2013-Final.pdf#:~:text=This%20document%20updates%20the%201999%20goals%20and%20objectives,ecosystem%20evolves%20and%20our%20understanding%20of%20it%20improves.

USFWS/GLFC. 2025. Great Lakes Fish Stocking Database. Available from: http://fsis.glfc.org/ [Accessed: January, 2025]

Weidel, B. C., Goretzke, J. A., Holden, J. P., Stahl, S. D., Mitchinson, O. M., Minihkeim, S. P. 2024a. Lake Ontario April prey fish survey results and Alewife assessment, 2024. Available from: Weidel_etal_2024_LkOntarioAprilPreyfishAlewifeReport.pdf

Weidel, B.C., Holden, J.P., Goretzke, J., Stahl, S.D., Mitchinson, O.M., and Minihkeim, S.P., 2024b, Lake Ontario April Prey Fish Bottom Trawl Survey, 1978-2024: U.S. Geological Survey data release, https://doi.org/10.5066/P13DDWT5.

Appendices

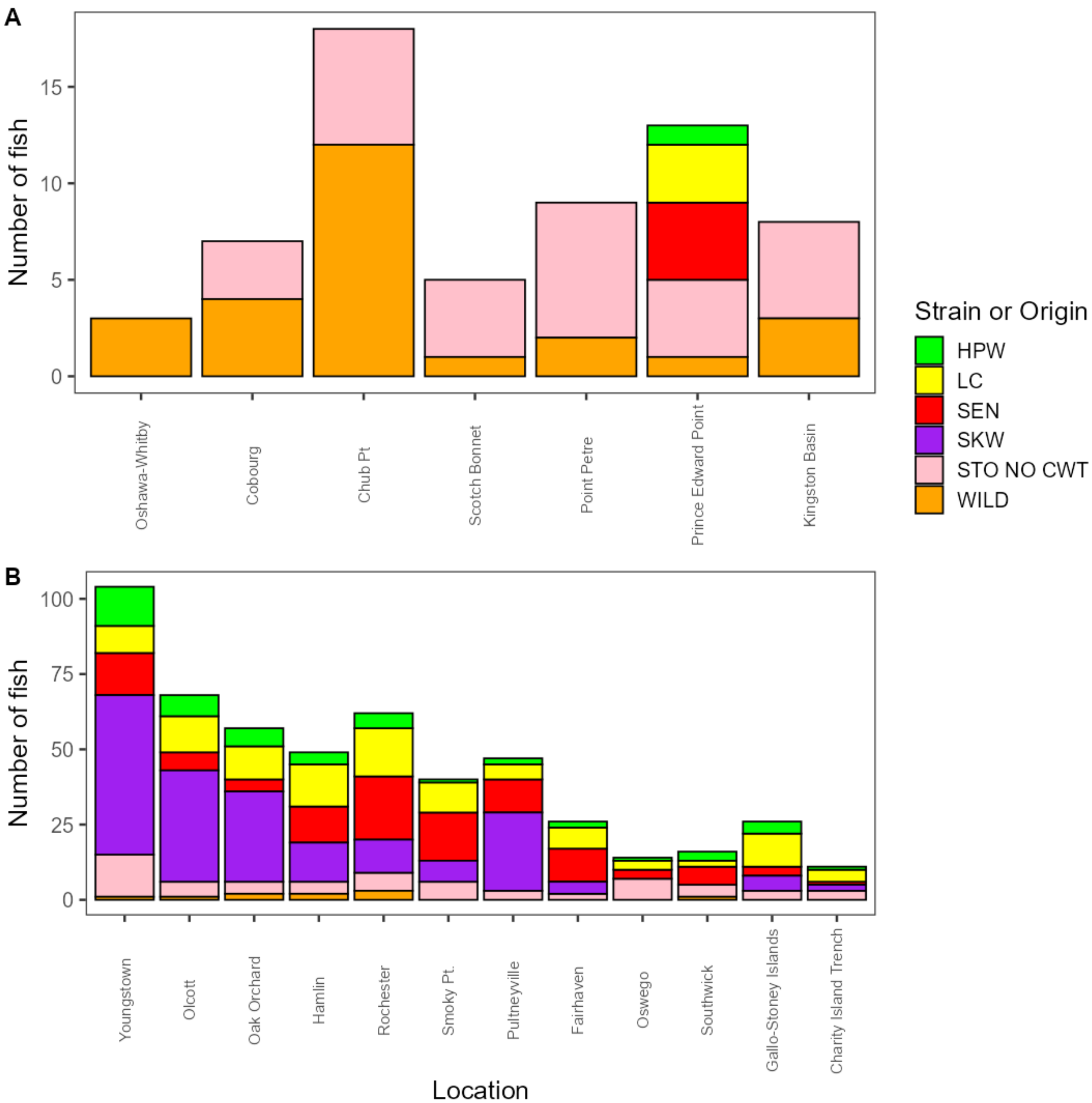
Appendix 1. Number of fish caught by species in gillnets in the 2024 Lake Ontario August gillnet survey and Lake Trout assessment.

Common name	Scientific name	Number caught in all gillnets	Number caught in standard nets used for abundance and trend analyses
Alewife	*Alosa pseudoharengus*	142	104
Brown Trout	*Salmo trutta*	49	14
Burbot	*Lota lota*	2	1
Chinook Salmon	*Oncorhynchus tshawytscha*	32	9
Cisco	*Coregonus artedi*	30	11
Coho Salmon	*Oncorhynchus kisutch*	9	
Lake Trout	*Salvelinus namaycush*	652	583
Lake Whitefish	*Coregonus clupeaformis*	17	7
Rainbow Smelt	*Osmerus mordax*	3	
Rainbow Trout	*Oncorhynchus mykiss*	1	
Round Goby	*Neogobius melanostomus*	2	2
Smallmouth Bass	*Micropterus dolomieu*	1	
Walleye	*Sander vitreus*	1	

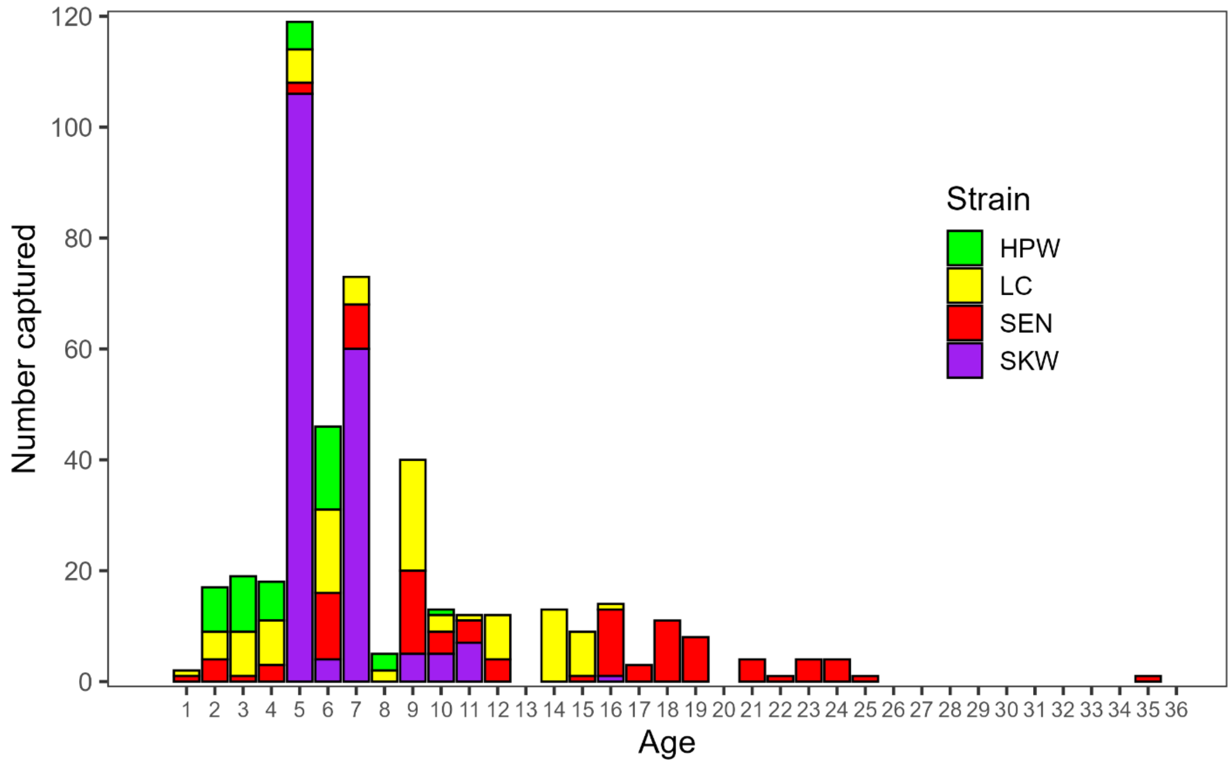
Appendix 2. Number of Lake Trout caught in gillnets fished in 10°C and 12°C bottom temperature water by location during the 2024 Lake Ontario August gillnet survey and Lake Trout assessment. The 10°C net at Smoky Pt was excluded because temperatures exceeded 15°C. For location information, please refer to Figure 1.

		Number of Lake Trout	
Country	Location	10°C Net	12°C Net
United States	Southwick	5	2
	Smoky Pt		0
Canada	Scotch Bonnet	2	0
	Cobourg	0	4
	Chub Pt	2	9
	Prince Edward Point	1	1
	Point Petre	2	0
	Oshawa-Whitby	1	0

Appendix 3. Number of Lake Trout caught by strain/origin and location during the 2024 Lake Ontario August gillnet survey and Lake Trout assessment for (A) Canadian waters, and (B) US waters. If a coded wire tag was present, then the fish was assigned to the corresponding strain. If a coded wire tag was not present, then the fish was categorized by origin – hatchery ("STO NO CWT" = stocked fish with a fin clip, but no coded wire tag) or wild ("WILD" = unclipped and unmarked). Note the difference in y-axis scales. Strain abbreviations are: HPW = Huron Parry Sound, LC = Lake Champlain, SEN = Seneca Lake, SKW = Superior Klondike Reef. For detailed strain descriptions, refer to Lantry et al. (2021).



Appendix 4. Age-strain distribution of coded wire tagged Lake Trout captured in US waters during the Lake Ontario August gillnet survey and Lake Trout assessment in 2024. Strain abbreviations are: HPW = Huron Parry Sound, LC = Lake Champlain, SEN = Seneca Lake, SKW = Superior Klondike Reef. For detailed strain descriptions, refer to Lantry et al. (2021).



Appendix 5. Annual survival of different Lake Trout strains sampled from US waters of Lake Ontario during the adult Lake Trout gillnet survey 1985-2024. Dashes represent missing values due to no or low numbers of tagged Lake Trout stocked for the strain, or when the strain was not in the US federal hatchery system. ALL is population survival of all strains combined using only coded wire tagged fishes. Values for ALL in some years are influenced by strains not included in the table because they only appeared in the lake for a short while (e.g., the 1991-1993 cohorts of OXS; the 2009 cohort of LCW) or because they only occurred before successful Sea Lamprey control was established (1974-1983 cohorts of CWL). Missing survival values for 1997, 1998, and 2002 year-classes were caused by low tagged proportions of total stockings. There were no Lake Trout stocked from the 2011 year-class. Reduced survey effort in 2020 contributed to missing values for the 2009 year-class of SENs at age 11. Strain abbreviations are: JEN = Jenny Lake, LEW = Lewis Lake, ONT = Lake Ontario, SUP = Lake Superior, STW = Traverse Island, SEN = Seneca Lake, LC = Lake Champlain, SKW = Superior Klondike Reef, HPW = Huron Parry Sound.

		STRAIN									
Year-class	Ages	JEN	LEW	ONT	SUP	STW	SEN	LC	SKW	HPW	ALL
1978	7-10	-	-	-	0.40	-	-	-	-	-	-
1979	7-10	-	-	-	0.52	-	-	-	-	-	-
1980	7-11	-	-	-	0.54	-	0.85	-	-	-	-
1981	7-11	-	-	-	0.45	-	0.92	-	-	-	-
1982	7-11	-	-	-	0.44	-	0.82	-	-	-	-
1983	7-11	-	-	0.61	0.54	-	0.90	-	-	-	0.57
1984	7-11	0.39	-	0.61	0.48	-	0.70	-	-	-	0.65
1985	7-11	-	-	0.80	0.47	-	0.77	-	-	-	0.73
1986	7-11	0.57	-	-	0.43	-	0.81	-	-	-	0.62
1987	7-11	0.50	-	-	0.50	-	0.80	-	-	-	0.73
1988	7-11	-	-	0.77	0.61	-	0.73	-	-	-	0.68
1989	7-11	-	-	0.78	0.59	-	0.86	-	-	-	0.81
1990	7-11	-	-	0.64	0.60	-	0.75	-	-	-	0.68
1991	7-11	-	0.56	0.62	-	-	0.70	-	-	-	0.70
1992	7-11	-	0.51	-	-	-	0.81	-	-	-	0.60
1993	7-11	-	0.64	-	-	-	0.72	-	-	-	0.71
1994	7-11	-	0.73	-	-	-	0.45	-	-	-	0.56
1995	7-11	-	0.50	-	-	-	0.76	-	-	-	0.72
1996	7-10	-	-	-	0.43	-	-	-	-	-	-
1999	7-11	-	-	-	-	-	0.84	-	-	-	-
2000	7-11	-	-	-	-	-	0.90	-	-	-	-
2001	7-11	-	-	-	-	-	0.73	-	-	-	-
2003	7-11	-	-	-	0.53	-	0.72	-	-	-	0.68
2004	7-11	-	-	-	-	-	0.78	-	-	-	0.78
2005	7-11	-	-	-	-	-	0.85	-	-	-	0.85
2006	7-11	-	-	-	-	-	0.74	-	-	-	0.72
2007	7-11	-	-	-	-	0.36	0.91	-	-	-	0.84
2008	7-11	-	-	-	0.53	0.41	0.96	0.76	0.82	-	0.79
2009	7-11	-	-	-	-	-	0.74	0.71	-	-	0.66
2010	7-11	-	-	-	-	-	-	0.75	-	-	0.75
2012	7-11	-	-	-	0.61	-	0.67	0.58	-	-	0.61
2013	7-11	-	-	-	-	-	0.75	0.73	0.50	-	0.55
2014	7-10	-	-	-	-	-	0.68	0.64	0.51	0.50	0.58
2015	7-9	-	-	-	-	-	1.00*	0.88	0.27	-#	0.60

*Catch per unit effort (CPUE) of SENs at age 9 was greater than at age 7 and 8 so survival value was set to 1.00.
#Survival for 2015 year class HPWs was excluded because no age 9 HPWs were collected in 2024.