WISCONSIN DEPARTMENT OF NATURAL RESOURCES

LAKE SUPERIOR SPRING LAKE TROUT ASSESSMENT REPORT 2022

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INTRODUCTION

Lean Lake Trout *Salvelinus namaycush* populations in Lake Superior declined drastically from the 1930s to the 1950s due to the combined effects of overfishing and predation by invasive Sea Lamprey *Petromyzon marinus*. Recovery of Lake Trout was spurred by establishing conservative fishing regulations, fish refuges, supplemental stocking programs, and Sea Lamprey control strategies and is now seen as one of the best examples of native species restoration in the Great Lakes (Hansen 1996). After a long period of rehabilitation, management agencies are now focused on maintaining sustainable rates of harvest for both commercial and recreational fisheries. Thus, the primary objective of the Spring Lake Trout Assessment is to monitor Lake Trout population dynamics (e.g., relative abundance, size, age, etc.) at both management unit and lake-wide scales (Hansen 1996). This assessment is conducted by all management agencies around the lake, which allows biologists to pool data together from consistent, standardized surveys to compare results among different areas of the lake. This dataset serves as one of the primary inputs for a Lake Trout statistical catch-at-age (SCAA) model, which is used by state, tribal and federal biologists to determine recommended Lake Trout harvest quotas in management unit WI-2. In addition, Sea Lamprey wounding rates of Lake Trout from this assessment are one metric used to track mortality rates due to Sea Lamprey and to direct effort and funding from the Great Lakes Fishery Commission Sea Lamprey control program.

METHODS

The Spring Lake Trout Assessment consists of 16 fixed sampling locations in WI-1 (i.e., waters west of Bark Point) and 31 fixed sampling locations in WI-2 (i.e., waters east of Bark Point; Figure 1). This assessment follows protocols guided by the Lake Superior Technical Committee (LSTC) to ensure standardized sampling among all agencies around the lake. Stations in WI-1 are sampled with 274 m gill net gangs, while stations in WI-2 are sampled with 823 m gill net gangs. Gill nets are constructed of 114 mm (stretch mesh) multifilament nylon and set on the bottom for one night (24 hours).

All sampling is done aboard the R/V Hack Noyes. Biological information was collected from fish using standardized protocols. Relative abundance was assessed using catch-per-unit-effort (CPE), which was summarized using the geometric mean. Historical catches were adjusted using the saturation equation provided in Hansen et al. (1998). Otoliths were taken from a subsample of fish and aged using the grind method (smaller, younger fish) or mounted cross-sections (larger, older fish). Unaged fish were assigned an age using a standard age-length key approach using only age samples within a given year and management unit (Isermann and Knight 2005; Ogle et al. 2020). Sea Lamprey wounding rates were calculated as the total number of A-1, A-2 and A-3 wounds per 100 fish within size categories (< 432 mm, 432-532 mm, 533-634 mm, 635-736 mm, and > 736 mm) and all sizes combined (King 1980; Eshenroder and Koonce 1984).

Analyses were conducted using the program R (version 4.1.3) with help from packages tidyverse (Wickham et al. 2019) and FSA (Ogle et al. 2020), and this report was formatted using the package rmarkdown (Allaire et al. 2020).

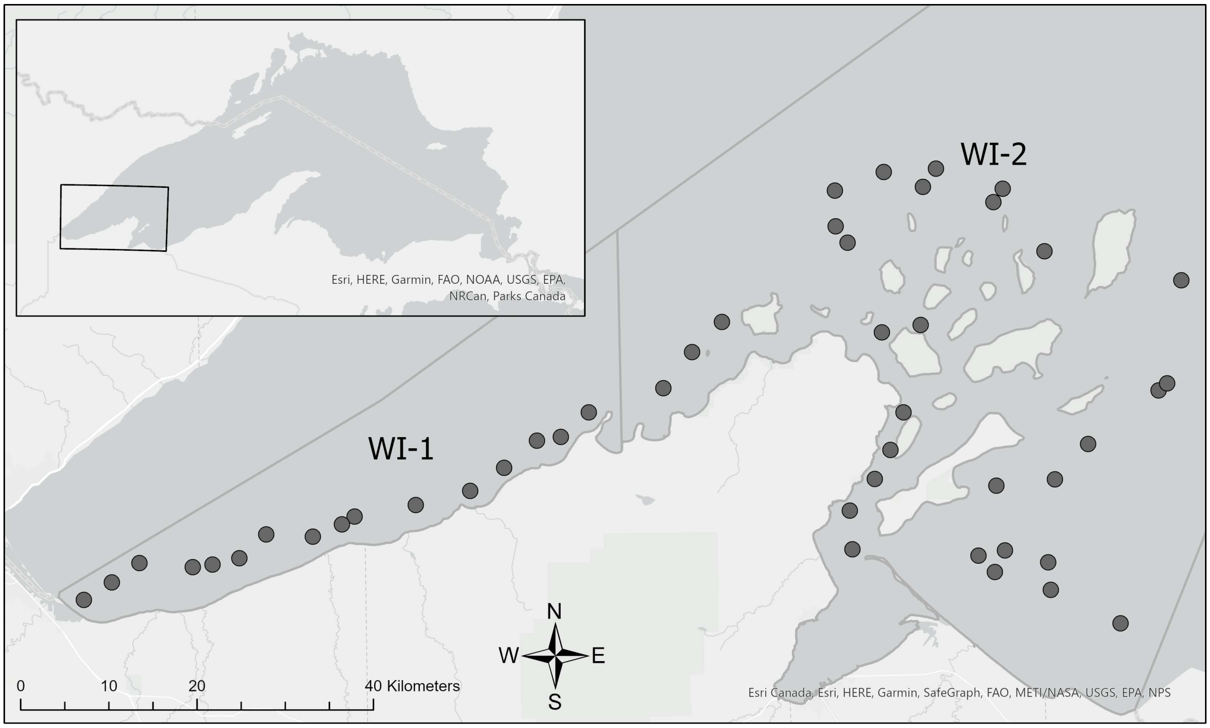

Figure 1. Map of Wisconsin waters of Lake Superior and the inside-end buoy locations of all sampling stations in the Wisconsin DNR Spring Lake Trout Assessment, 2022. Wisconsin management units include WI-1 (Western Arm region) and WI-2 (Apostle Islands region).

RESULTS

WI-1 LAKE TROUT

In WI-1, a total of 233 Lean Lake Trout were captured among 16 stations in 2022, of which 148 (63.5%) were of wild-origin, and 85 were of hatchery-origin (Figure 2). The proportion of Wild Lean Lake Trout in Wisconsin waters increased from the 1980s to the early 2000s and has been relatively stable since around 2005 (Figure 2). The geometric mean CPE of Hatchery Lean Lake Trout has remained stable in WI-1 after slightly decreasing from the late 1980s to the early 2000s (Figure 3). The geometric mean CPE of Wild Lean Lake Trout in WI-1 has increased throughout the time series and remained high in 2022 (Figure 3).

The median total length of Hatchery and Wild Lean Lake Trout was 620 mm and 599 mm in WI-1, respectively (Figure 4). The median length of Wild Lean Lake Trout in WI-1 was noticeably shorter in 2021 compared to the previous few years, and the length distribution of these new recruits grew in the 2022 survey (Figure 5). Age compositions in WI-1 suggest stronger year-class strengths of the 2015 and 2016 cohorts, which have recently entered the fishery (Figure 6).

Currently, Wild Lean Lake Trout growth rates (mean length at ages 6, 7 and 8) are slightly greater in WI-1 than in WI-2 (Figure 7). Growth rates for ages 6, 7 and 8 Wild Lean Lake Trout have been variable through time in WI-1, but missing data in some years prevents much analysis (Figure 7).

The Sea Lamprey wounding rate (number of A1-A3 wounds per 100 fish) was above the LSTC threshold of five wounds per 100 fish in WI-1 for all sizes of Lean Lake Trout (Figure 8). The wounding rate for all sizes of Lake Trout was above 10 wounds per 100 fish, on par with rates observed in 2018 and 2019, suggesting the extremely low rate observed in 2021 was an outlier caused by very high numbers of small Lean Lake Trout in the survey. Bigger Lean Lake Trout generally have a higher wounding rate than smaller Lean Lake Trout, mainly because bigger fish have a higher probability of surviving a lamprey attack.

WI-2 LAKE TROUT

In WI-2, a total of 561 Lean Lake Trout were captured among 31 stations, of which 526 (93.8%) were of wild-origin and 35 were of hatchery-origin (Figure 2). The geometric mean CPE of Hatchery Lean Lake Trout in WI-2 remains very low and stable, as no stocking occurs in this management unit (Figure 3). The geometric mean CPE of Wild Lean Lake Trout in WI-2 steadily increased from 1981 to a high in 2002, decreased to a modern-day low in 2013, and has since increased. Relative abundance was similar in 2022 compared to the past few years.

The median total length of Hatchery and Wild Lean Lake Trout was 559 mm and 572 mm in WI-2, respectively (Figure 4). The median length of Wild Lean Lake Trout in WI-2 increased from 2015 to 2018 as abundant year-classes from the late 2000s grew bigger, and younger age-classes were not as abundant (Figure 5). In 2021, the median length in WI-2 remained similar to the previous couple of years, as some smaller fish recruited to the survey gear. Median length and overall length distribution of Wild Lean Lake Trout in WI-2 was smaller in 2022 as it appeared that many younger fish recruited to the survey gear. Age composition of Lean Lake Trout in 2022 indicated relatively strong recruitment from the 2015 and 2016 cohorts entering the fishery (Figure 6).

The age structure of Wild Lean Lake Trout in WI-2 is generally dominated by fish ages 6 through 9 but can vary annually based on the abundance of certain year-classes (Figure 6). For example, a particularly strong (high abundance) year-class can be observed through time, such as the case with the 2007 year-class in WI-2. Particularly strong year-classes in the late 2000s in WI-2 (darker shades of blue of 6-9 year old fish from 2013 to 2019) helped the population rebound from its modern-day low abundance levels.

Growth rates of Lean Lake Trout decreased in WI-2 from 1985 to around 2000, likely due to increasing population size and associated density-dependent factors during that time period (Figure 7). Since 2000, growth rates of age-7 and 8 fish have been stable and possibly increasing in recent years.

The Sea Lamprey wounding rate (number of A1-A3 wounds per 100 fish) was below the LSTC threshold of five wounds per 100 fish in WI-2 for all sizes of Lean Lake Trout, and wounding rates have been underneath the LSTC threshold in WI-2 since 2009 (Figure 8). As expected, the largest Lean Lake Trout (> 736 mm) still had a higher wounding rate, but the overall low wounding rates of all fish indicate the success of GLFC Sea Lamprey Control in WI-2, helping preserve multiple important fisheries.

LAKE WHITEFISH

Lake Whitefish relative abundance is variable in the Spring Lake Trout Assessment, and the Summer Community Assessment is likely a better indicator of Lake Whitefish relative abundance (Figure 9). However, Spring Assessment Lake Whitefish CPE's suggest that relative abundance in WI-1 has increased throughout the time series, and the 2022 survey recorded the highest relative abundance in the time series. In WI-2, relative abundance increased from the 1980s to the early 2000s and has likely stabilized since. Median Lake Whitefish total length was slightly larger in WI-1 (478 mm) than in WI-2 (470 mm) in 2022 (Figure 10). Lake Whitefish growth rates (mean length at age 10) in WI-2 decreased from the early 2000s to around 2012 but have slightly increased since (Figure 11).

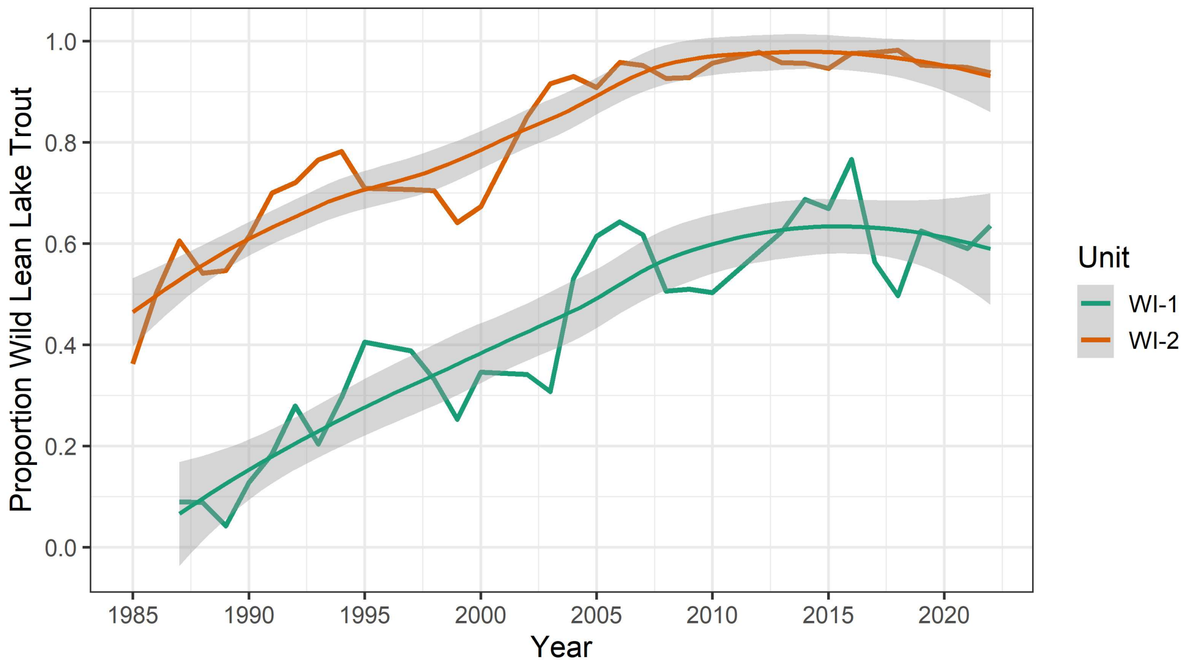

Figure 2. Proportion of total Lean Lake Trout catch that was Wild (non-hatchery origin) determined by presence of fin clips on hatchery-origin fish in WI-1 (green) and WI-2 (orange).

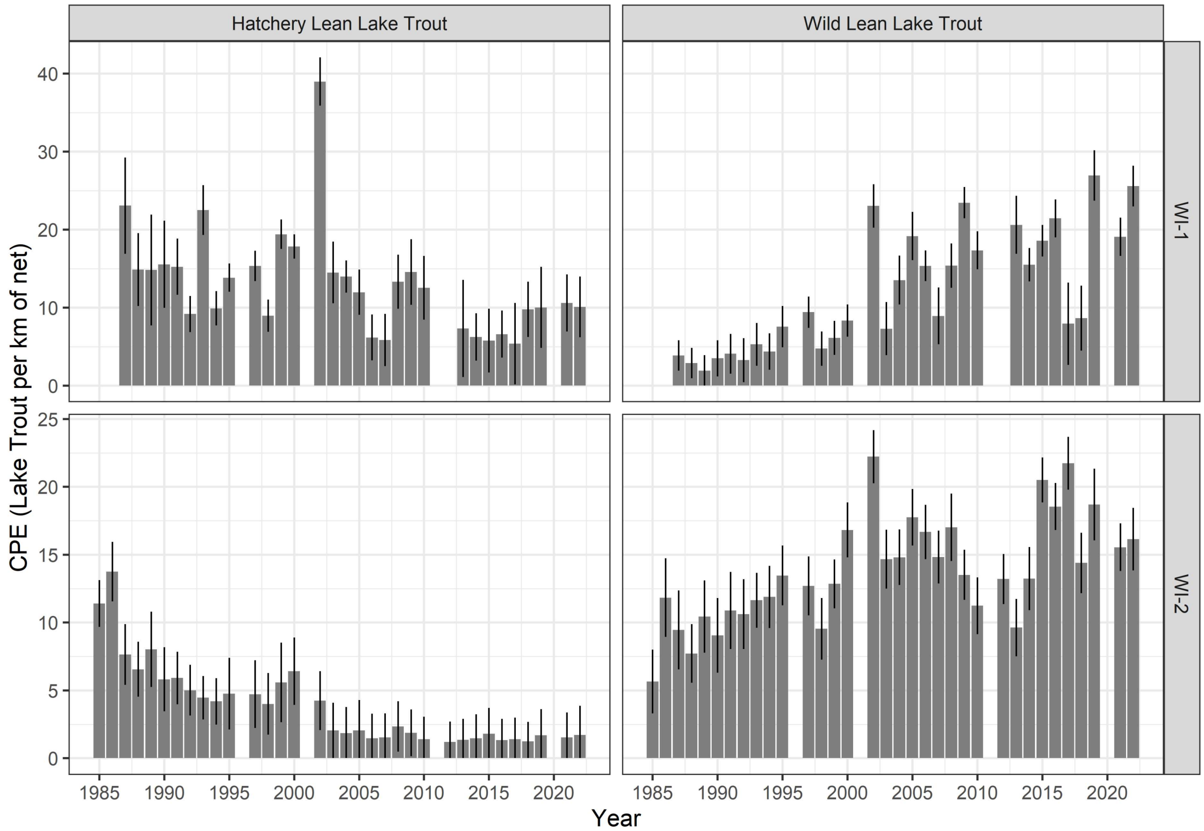

Figure 3. Spring survey geometric mean CPE+1 (+/- one standard deviation) of hatchery-origin (left) and Wild (right) Lean Lake Trout in WI-1 (top) and WI-2 (bottom) waters of Lake Superior from 1981 to 2022. CPE is total catch per kilometer of gill net and is standardized for set duration using the LSTC saturation equation (Hansen et al. 1998).

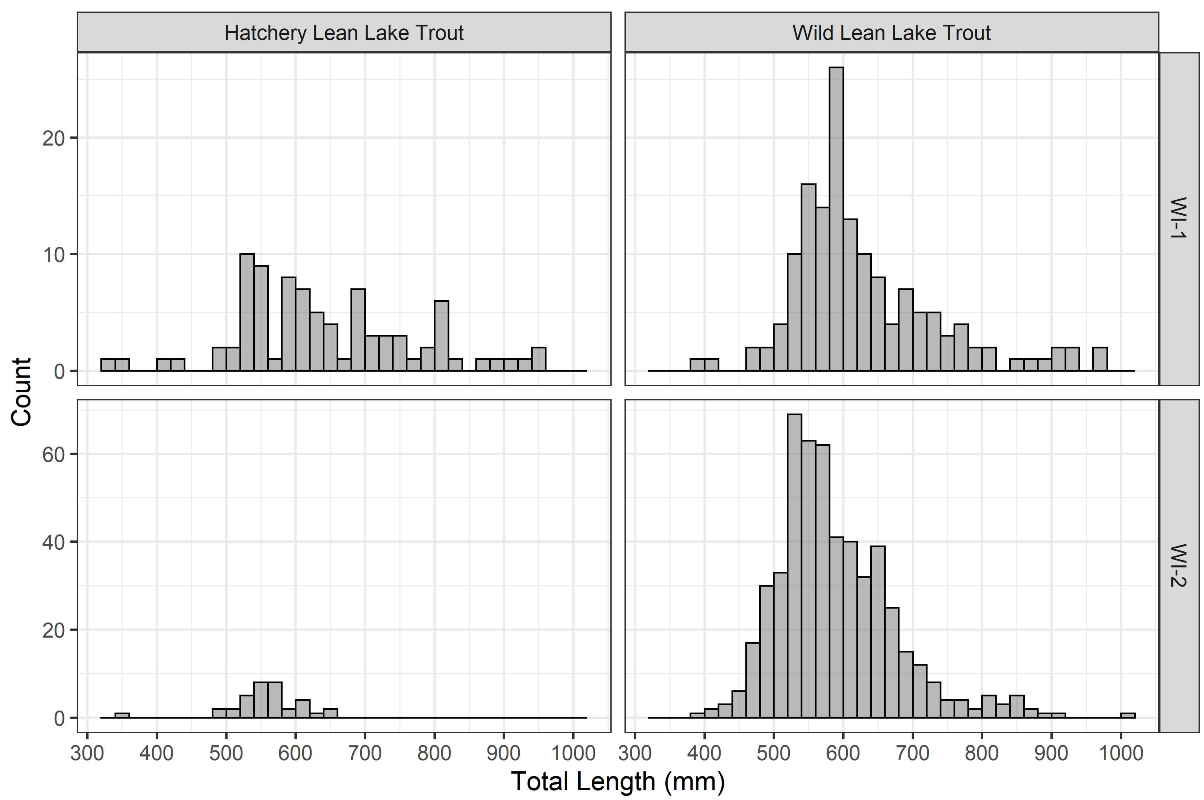

Figure 4. Length frequency histograms of hatchery-origin (left) and Wild (right) Lean Lake Trout in WI-1 (top) and WI-2 (bottom) waters of Lake Superior during the 2022 spring survey.

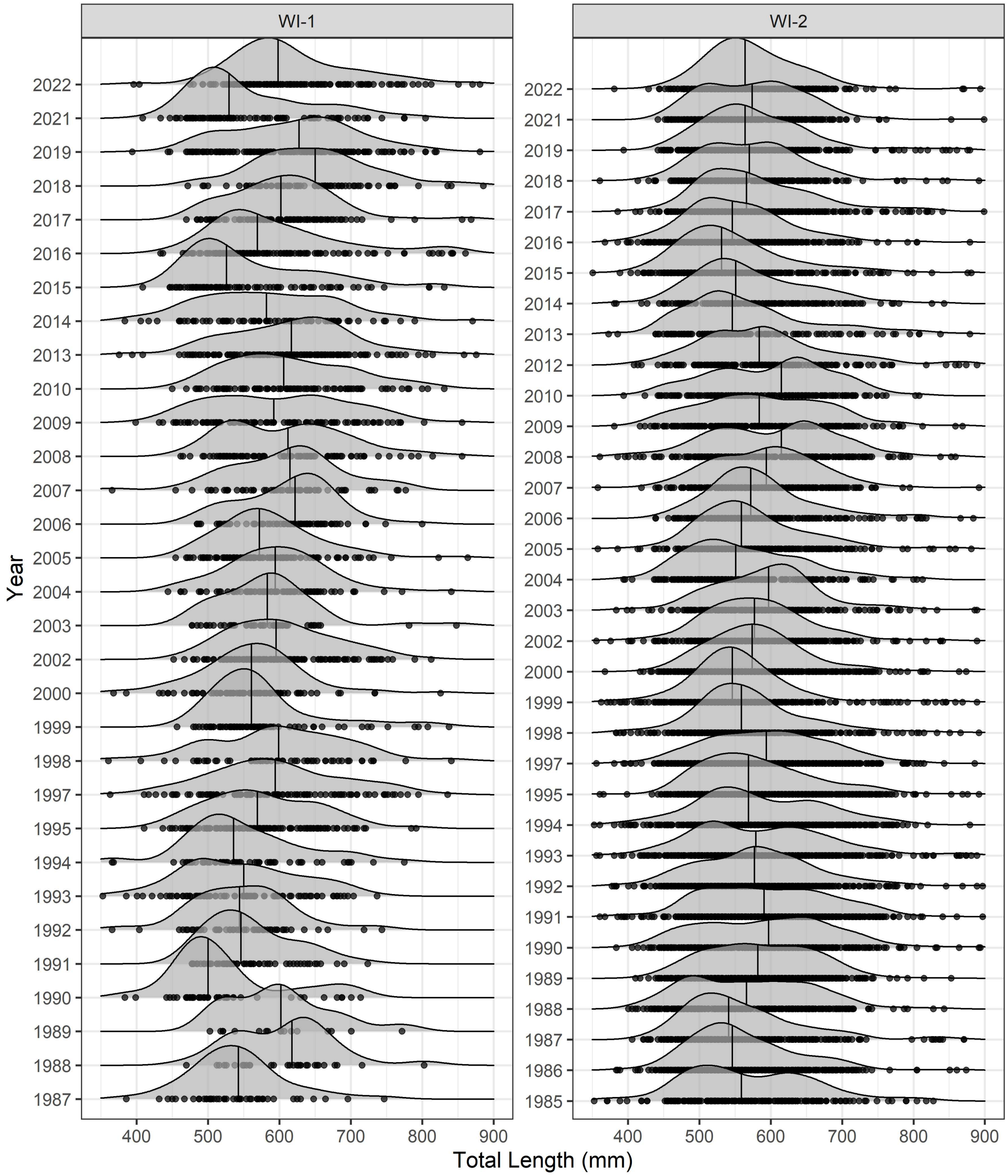

Figure 5. Time series of Wild Lean Lake Trout relative length frequency from 1985 to 2022. Vertical lines represent the median total length sampled in a given year.

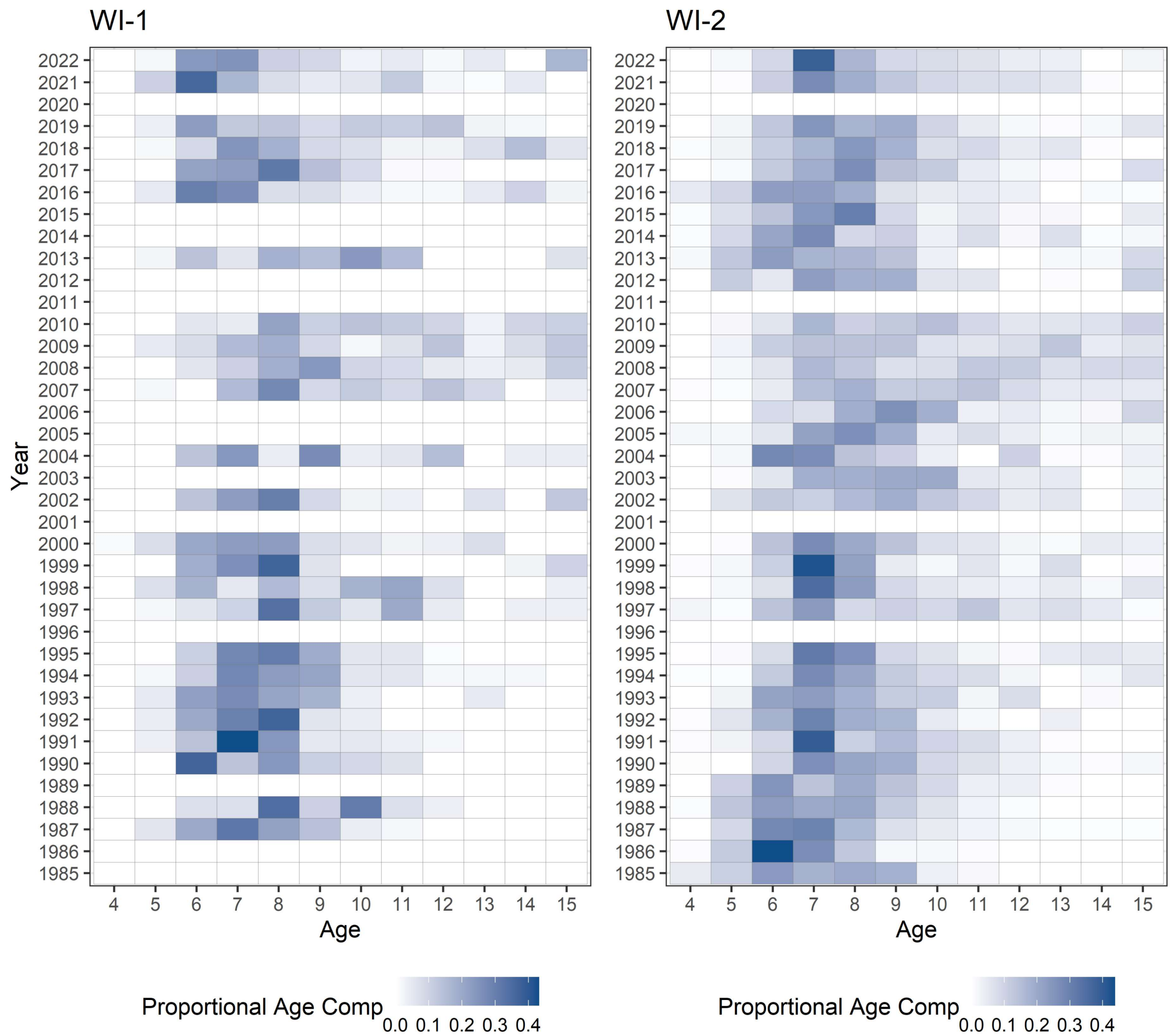

Figure 6. Proportional age composition of Wild Lean Lake Trout in WI-1 (left) and WI-2 (right) waters of Lake Superior from the 1985 to 2022 spring surveys. Darker shading represents larger proportional age composition for a given age-class. Years when no age data were collected are represented with no shading. Age 15 represents a combined group of all ages 15 and up (i.e., 15+).

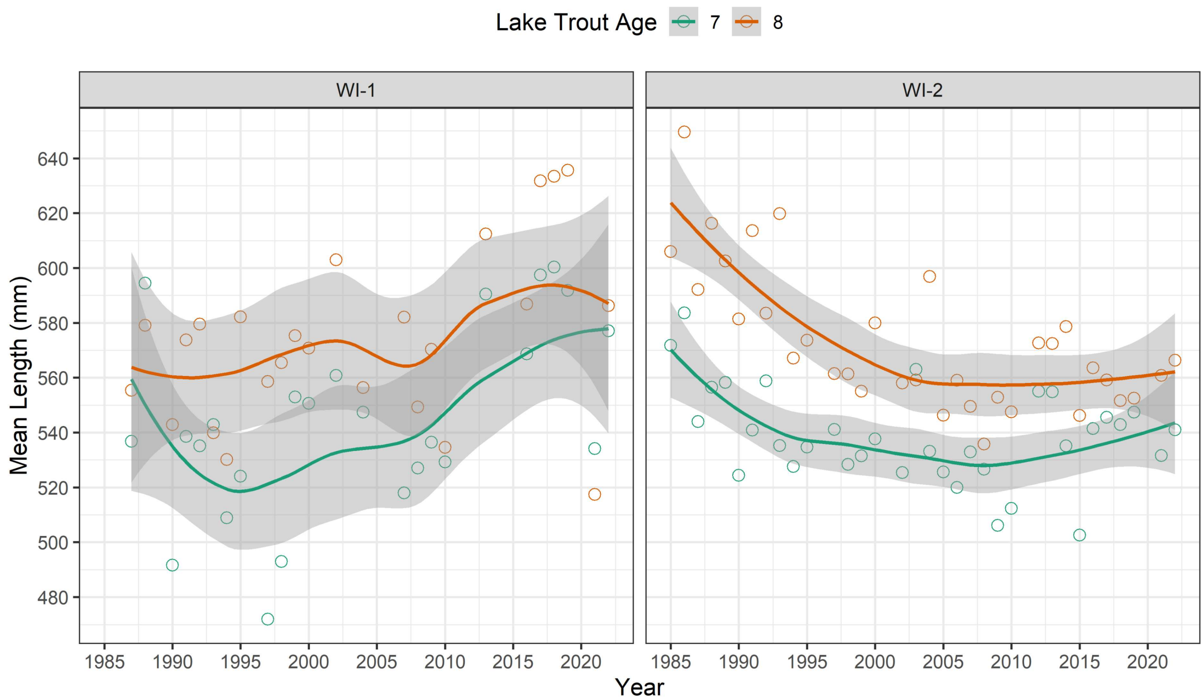

Figure 7. Wild Lean Lake Trout mean length at age in WI-1 (left) and WI-2 (right) for the two ages with the highest gear-selectivity in the spring survey: age-7 (green) and age-8 (orange). Data are from 1985 to 2022.

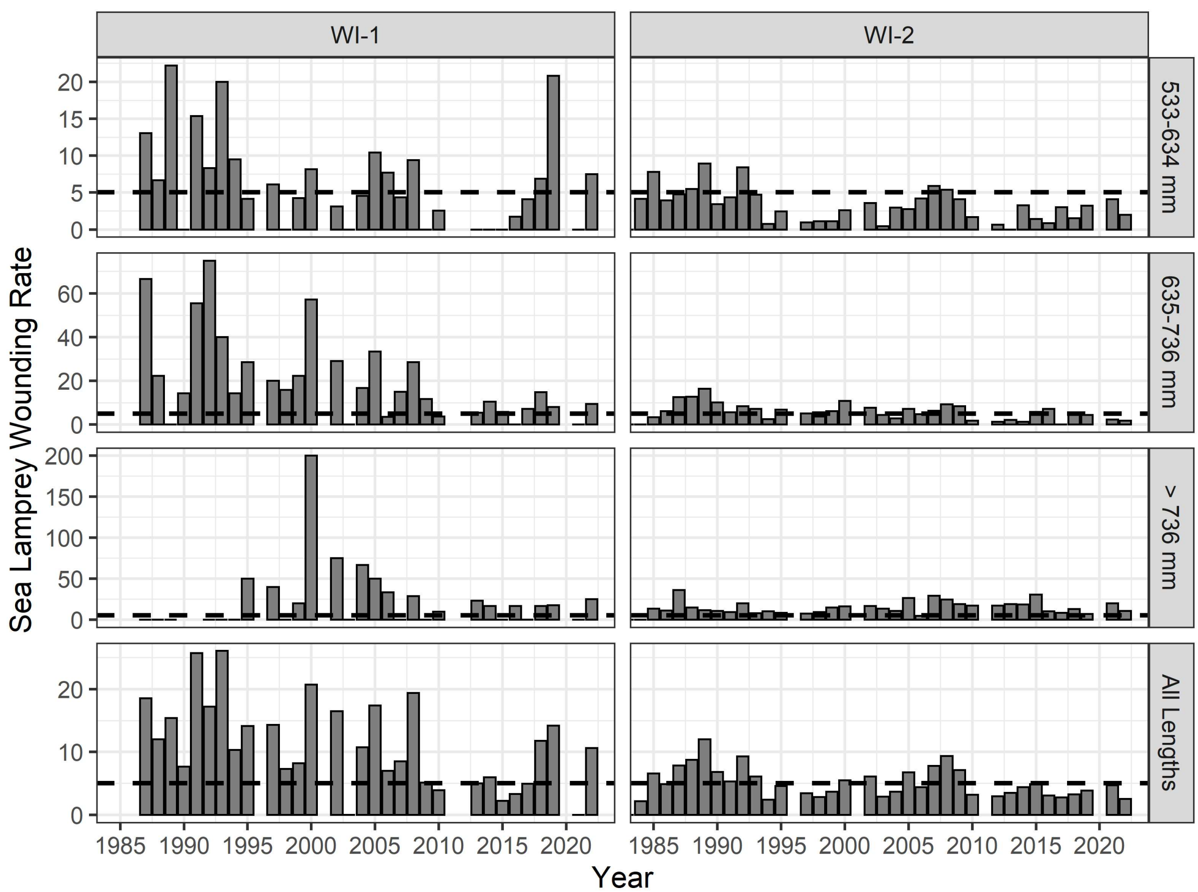

Figure 8. Sea Lamprey wounding rates of Wild Lean Lake Trout in WI-1 (left) and WI-2 (right) waters of Lake Superior during the spring survey from 1985 to 2022. Wounding rates are represented as the number of A-1 through A-3 type wounds per 100 fish (King 1980; Eshenroder and Koonce 1984). Wounding rates are grouped by total length (LSTC Protocol), and the wounding rate for all fish combined is shown on the bottom panel. The LSTC benchmark wounding rate of 5 wounds per 100 fish is represented by the dotted line. Wounding rates are used to estimate potential Sea Lamprey induced mortality rates of Lean Lake Trout and to prioritize areas for the GLFC Sea Lamprey control program.

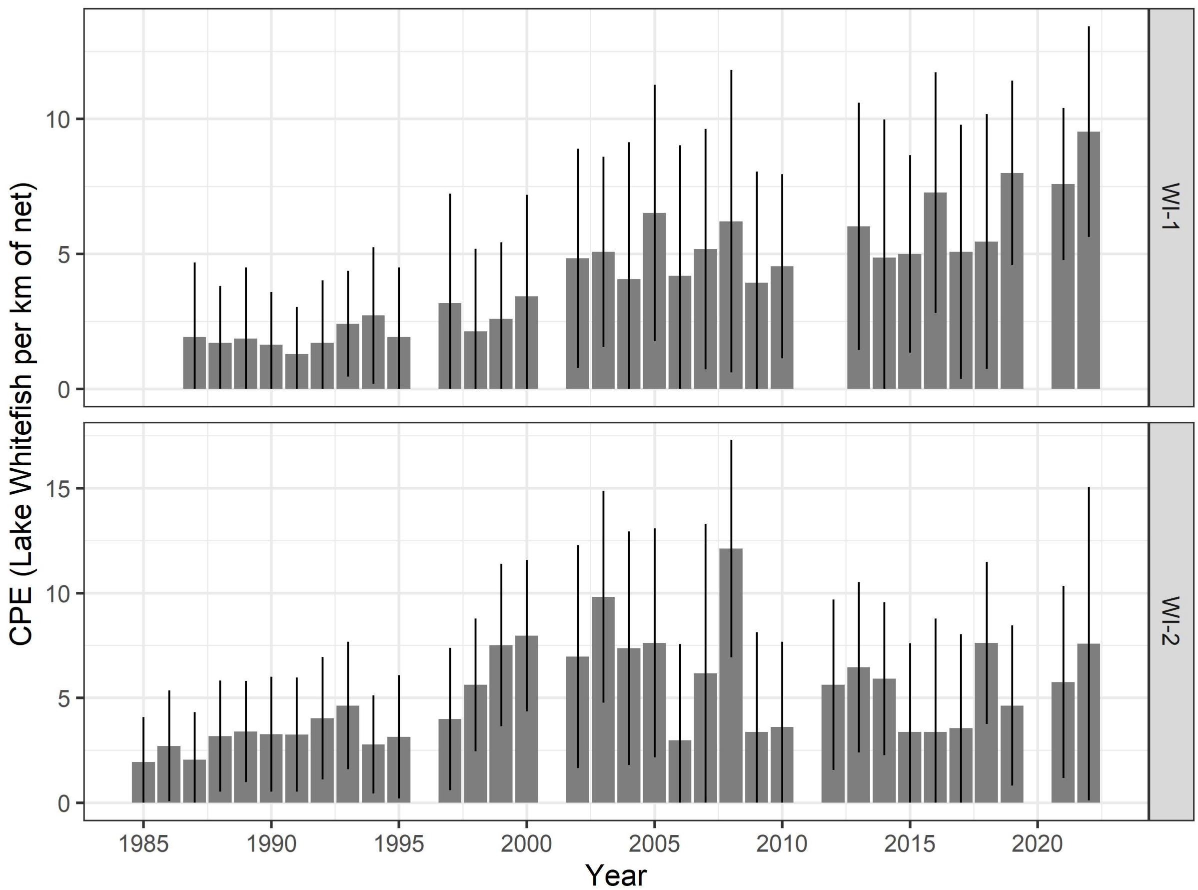

Figure 9. Spring survey geometric mean CPE+1 (+/- one standard deviation) of Lake Whitefish in WI-1 (top) and WI-2 (bottom) waters of Lake Superior from 1985 to 2022. CPE is total catch per kilometer of gill net per night.

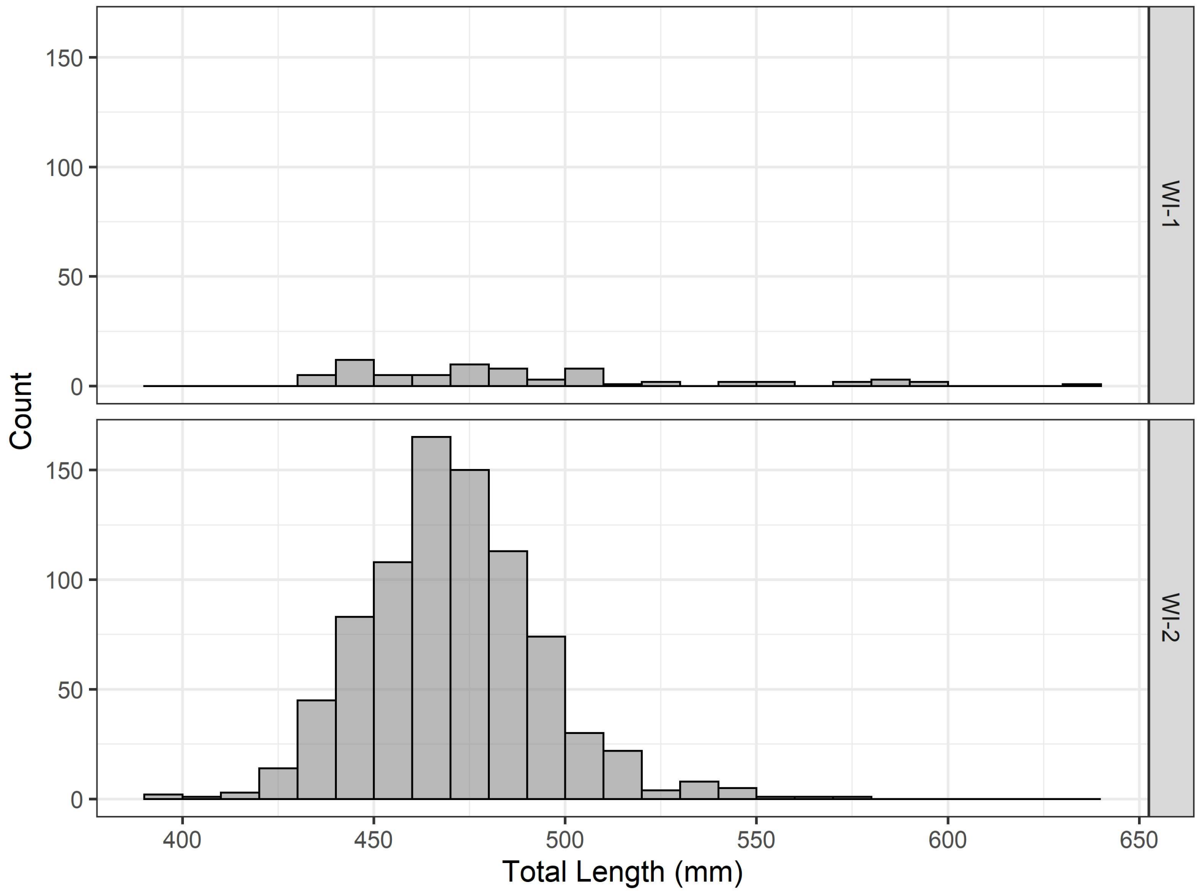

Figure 10. Length frequency histograms of Lake Whitefish in WI-1 (top) and WI-2 (bottom) waters of Lake Superior during the 2022 spring survey.

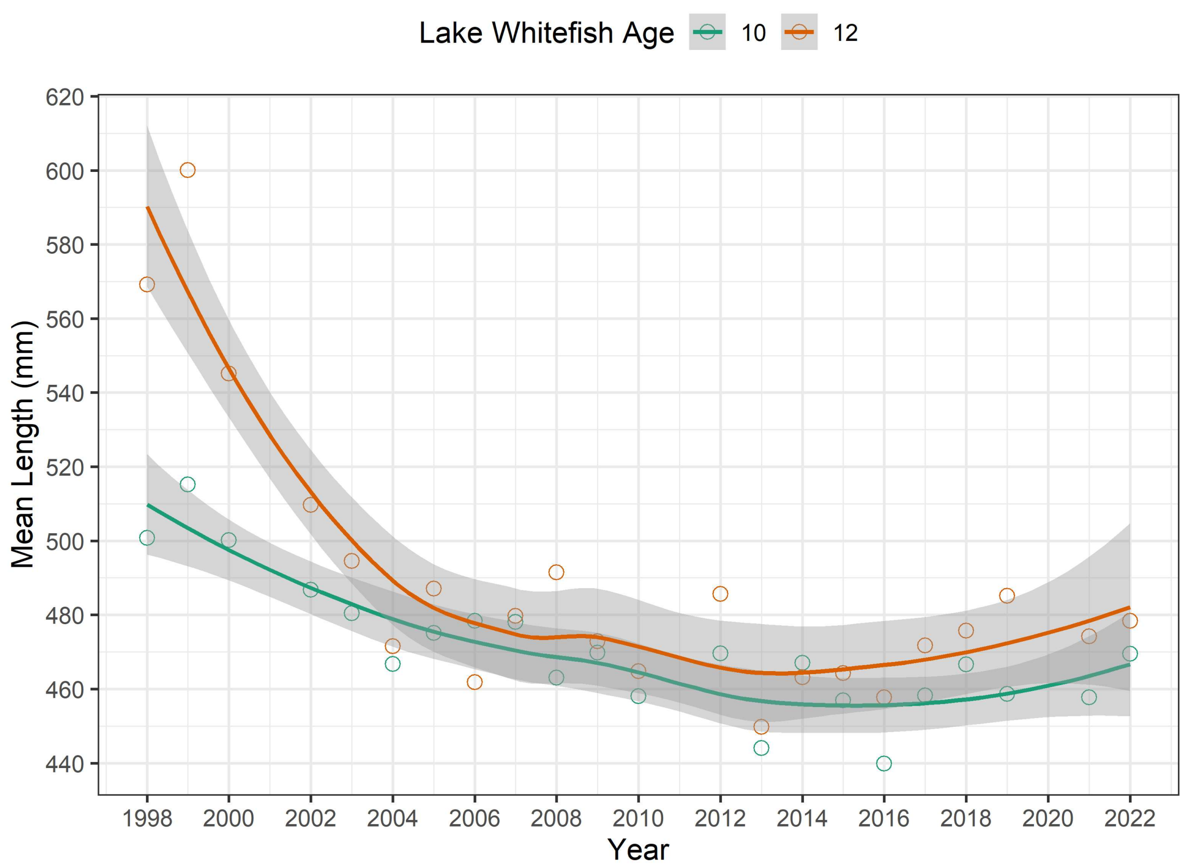

Figure 11. Lake Whitefish mean length at ages 10 and 12 in management unit WI-2 in the spring survey from 2002 to 2022

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