WISCONSIN DEPARTMENT OF NATURAL RESOURCES

LAKE SUPERIOR SPRING LAKE TROUT ASSESSMENT REPORT 2023

DRAY CARL, CHRIS ZUNKER, and SCOTT SAPPER

DNR Lake Superior Fisheries Management Team

April 29, 2024

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).

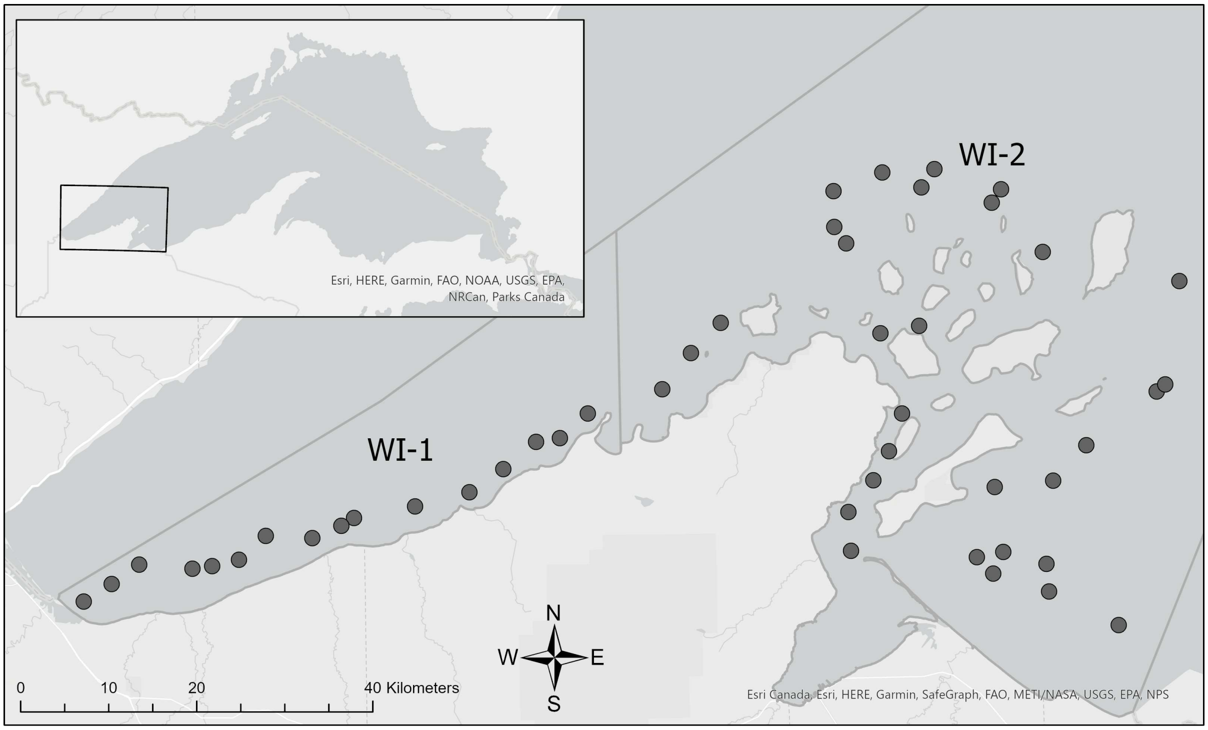

Figure 1. Map of Wisconsin waters of Lake Superior and the inside-end buoy locations of all sampling stations in the Wisconsin DNR Spring Lake Trout Survey, 2023. Wisconsin management units include WI-1 (Western Arm region) and WI-2 (Apostle Islands region).

RESULTS

WI-1 LAKE TROUT

In WI-1, a total of 211 lean lake trout were captured among 16 stations in 2023, of which 124 (58.8%) were of wild-origin, and 87 were of hatchery-origin (Figure 2). The proportion of wild lean lake trout in WI-1 increased from the 1980s to the early 2000s and has been relatively stable since around 2005 (Figure 2). Relative abundance of hatchery lean lake trout has remained stable in WI-1 after slightly decreasing from the late 1980s to the early 2000s (Figure 3). Relative abundance of wild lean lake trout in WI-1 has increased throughout the time series but was lower in 2022 compared to the last couple surveys (Figure 3).

The median total length of hatchery and wild lean lake trout was 589 mm and 622 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 increasingly larger in the 2022 and 2023 surveys (Figure 5). Age compositions in WI-1 suggested stronger year-class strengths of the 2015 and 2016 cohorts, which entered the fishery over the past couple years (Figure 6).

In general, wild lean lake trout growth rates (mean length at ages 6 and 8) are more variable in WI-1 than in WI-2 (Figure 7). WI-1 lean lake trout growth rates have been relatively stable since 2000.

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 the past few years. 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 491 lean lake trout were captured among 31 stations, of which 463 (94.3%) were of wild-origin and 28 were of hatchery-origin (Figure 2). Relative abundance of hatchery lean lake trout in WI-2 remains very low and stable, as no stocking has occured in this management unit since 1995 (Figure 3). Relative abundance 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, increased again to another peak in 2017, and has since decreased. Relative abundance in 2023 was lower than the past few surveys.

The median total length of hatchery and wild lean lake trout was 542 mm and 577 mm in WI-2, respectively (Figure 4). Median length and overall length distribution of wild lean lake trout in WI-2 decreased slightly for the past two years, suggesting some recruitment of younger fish to the survey gear (Figure 5). Age composition of wild lean lake trout in 2022 and 2023 indicated relatively strong recruitment from the 2015 and 2016 cohorts entering the fishery (Figure 6).

Growth rates of age-7 and 8 wild lean lake trout have been relatively stable since 2000 (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-2 for all sizes of lean lake trout for the first time since 2009 (Figure 8). This indicates a recent increase in sea lamprey predation on wild lean lake trout, which could have effects on future abundance and fisheries. As expected, the largest lean lake trout (> 736 mm) had the highest wounding rates.

LAKE WHITEFISH

Lake whitefish relative abundance is variable in the Spring Lake Trout Survey, and the Summer Community Survey provides a better index (Figure 9). However, Spring Survey lake whitefish relative abundance in 2023 was the second-highest recorded in both WI-1 and WI-2. Lake whitefish relative abundance in WI-1 has increased throughout the time series. In WI-2, relative abundance increased from the 1980s to the late 2000s, decreased for about a decade, and has been increasing recently. Median Lake whitefish total length was slightly larger in WI-1 (490 mm) than in WI-2 (472 mm) in 2023 (Figure 10). Lake whitefish growth rates (mean length at ages 10 and 12) in WI-2 have been relatively stable since about 2003 (Figure 11).

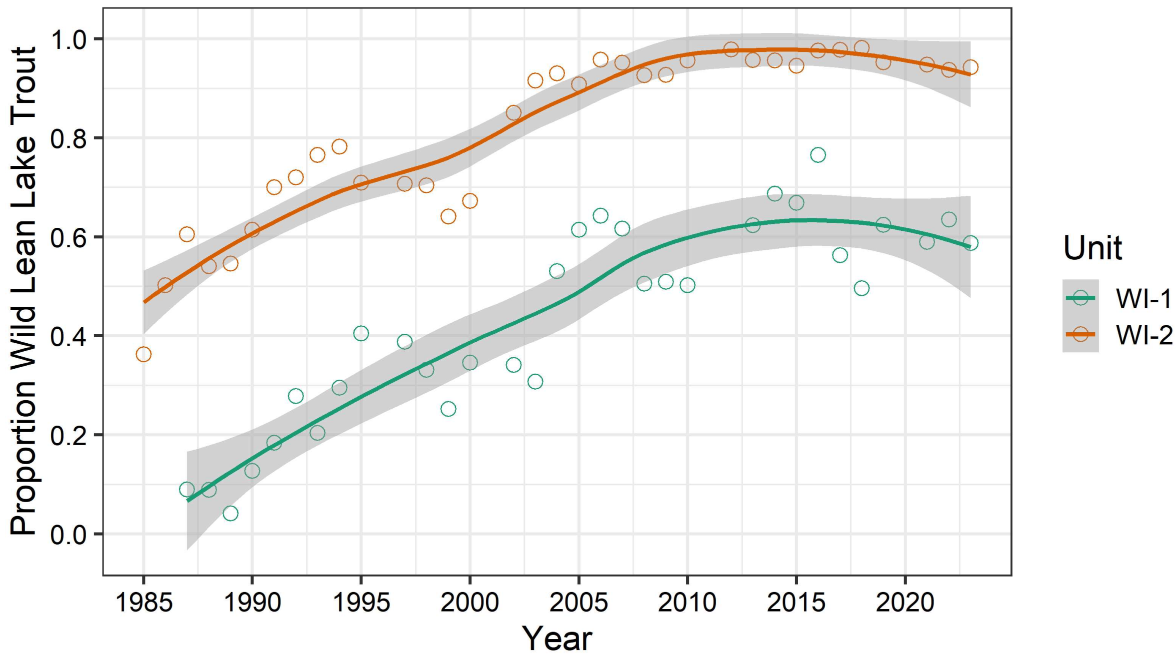

Figure 2. Proportion of total lean lake trout catch that was wild (non-hatchery origin) determined by presence of fin clips on hatchery-origin fish in WI-1 (green) and WI-2 (orange).

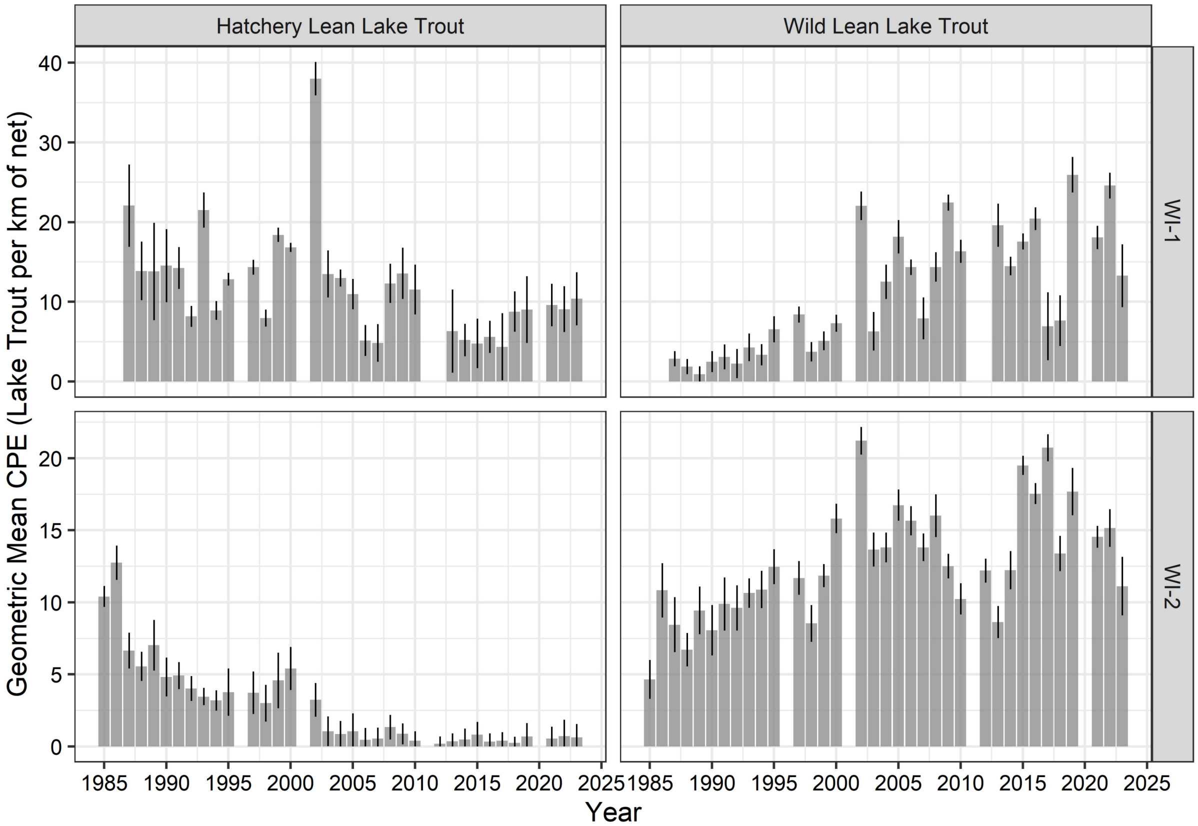

Figure 3. Spring survey geometric mean CPE+1 (+/- one standard deviation) of hatchery-origin (left) and wild (right) lean lake trout in WI-1 (top) and WI-2 (bottom) waters of Lake Superior from 1985 to 2023. CPE is total catch per kilometer of gill net and is standardized for set duration using the LSTC saturation equation (Hansen et al. 1998).

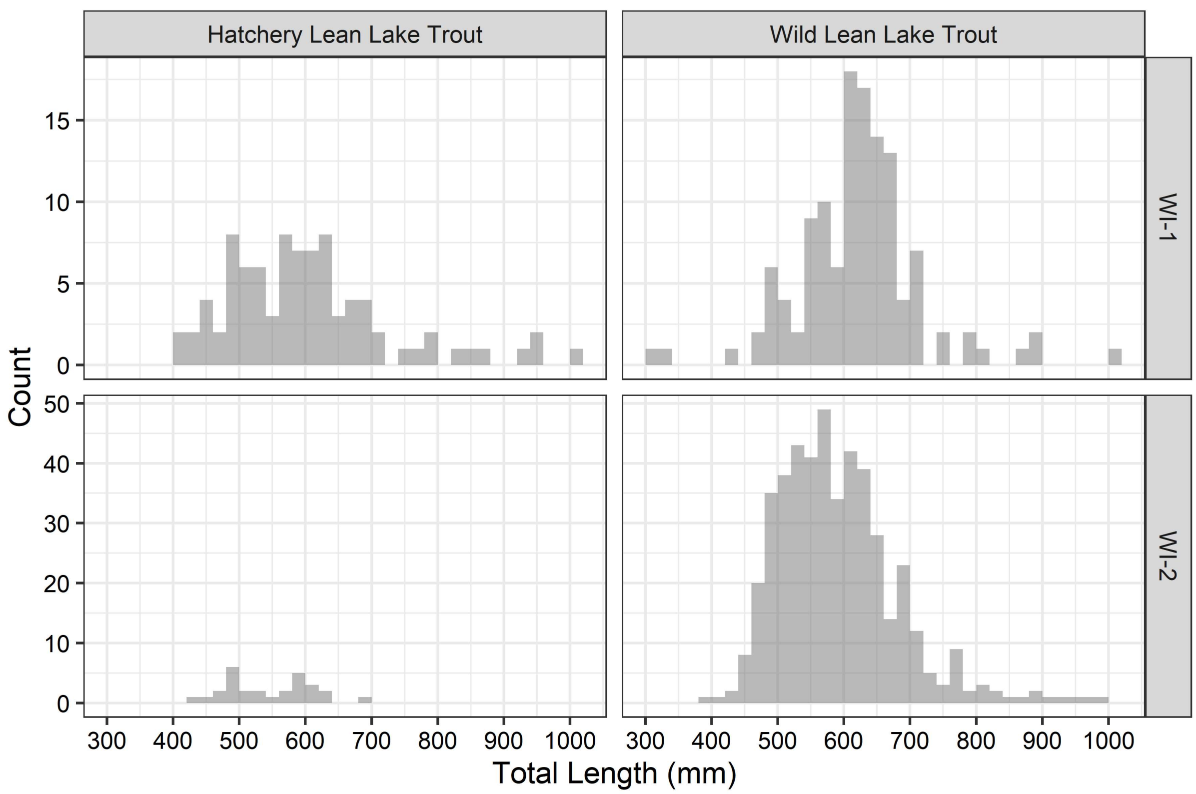

Figure 4. Length frequency histograms of hatchery-origin (left) and wild (right) lean lake trout in WI-1 (top) and WI-2 (bottom) waters of Lake Superior during the 2023 spring survey.

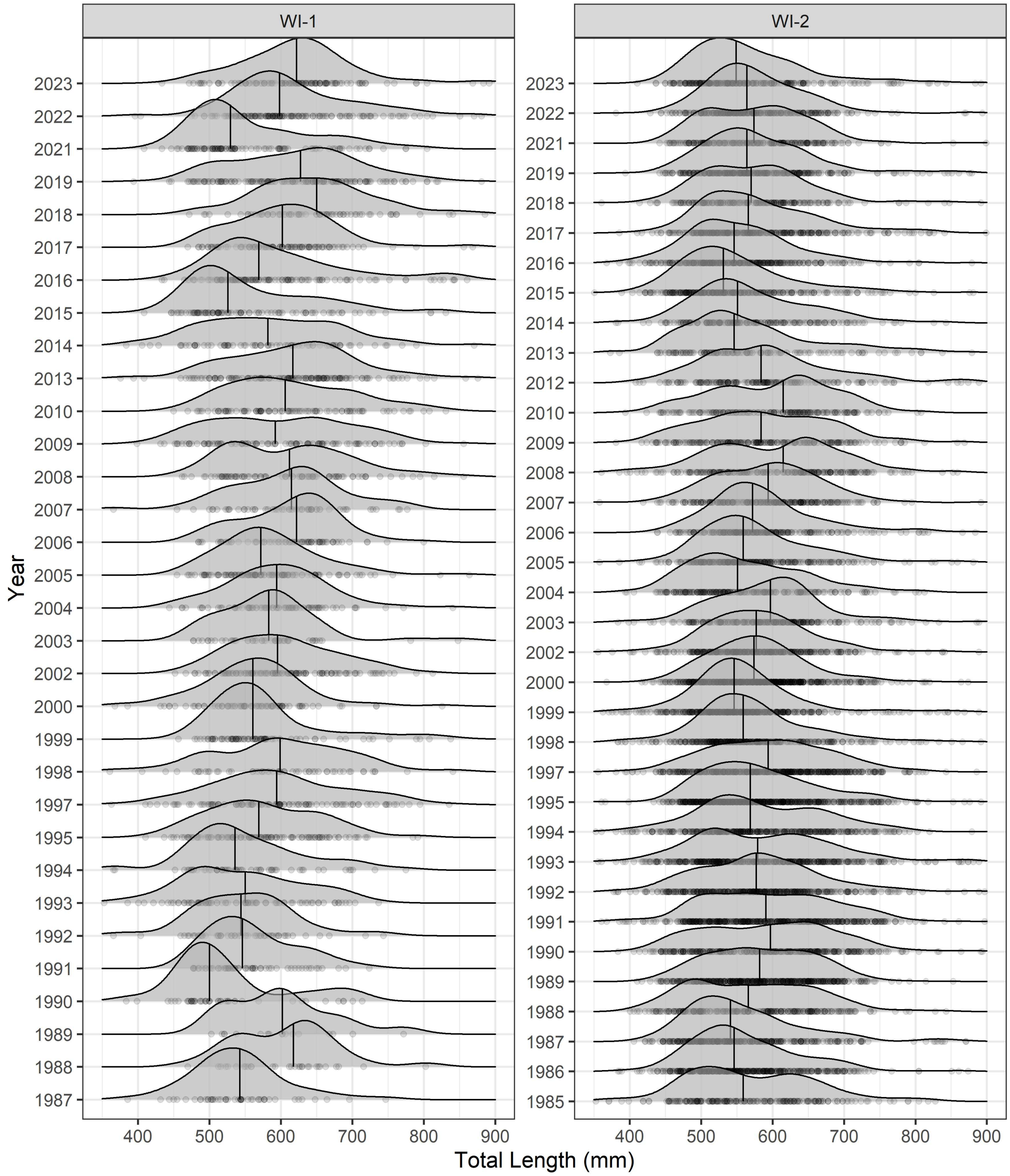

Figure 5. Time series of wild lean lake trout length frequency from 1985 to 2023. Vertical lines represent the median total length sampled in a given year.

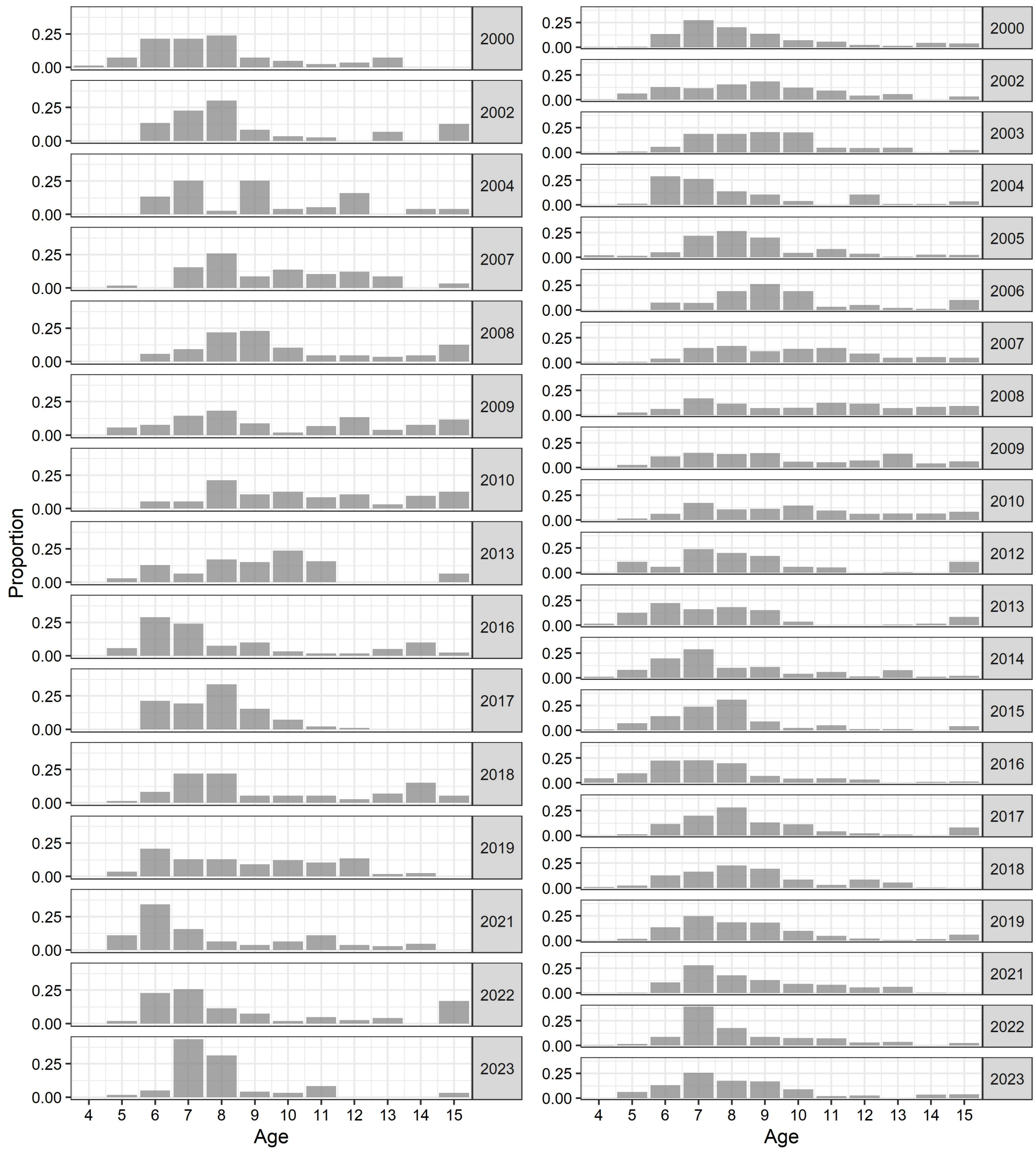

Figure 6. Age compositions of wild lean lake trout in WI-1 (left) and WI-2 (right) waters of Lake Superior from 2000 to 2023 spring surveys. Age 15 represents a combined group of all ages 15 and up (i.e., 15+).

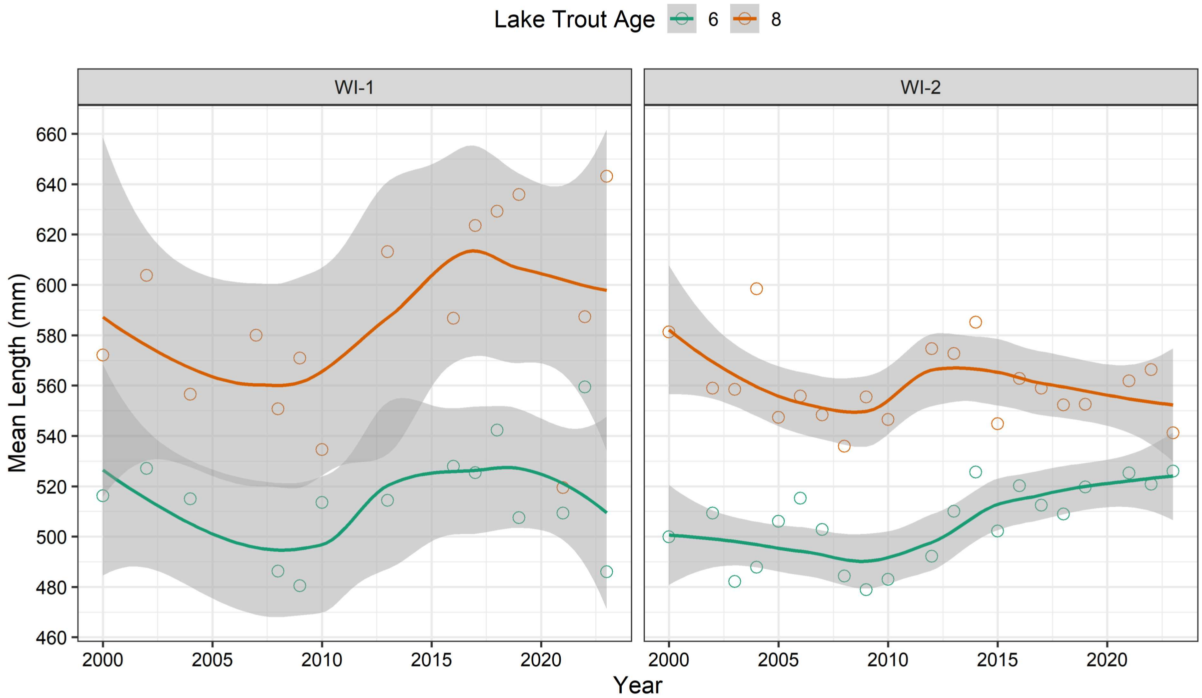

Figure 7. Mean length of age-6 (green) and age-8 (orange) wild lean lake trout in WI-1 (left) and WI-2 (right), 2000-2023.

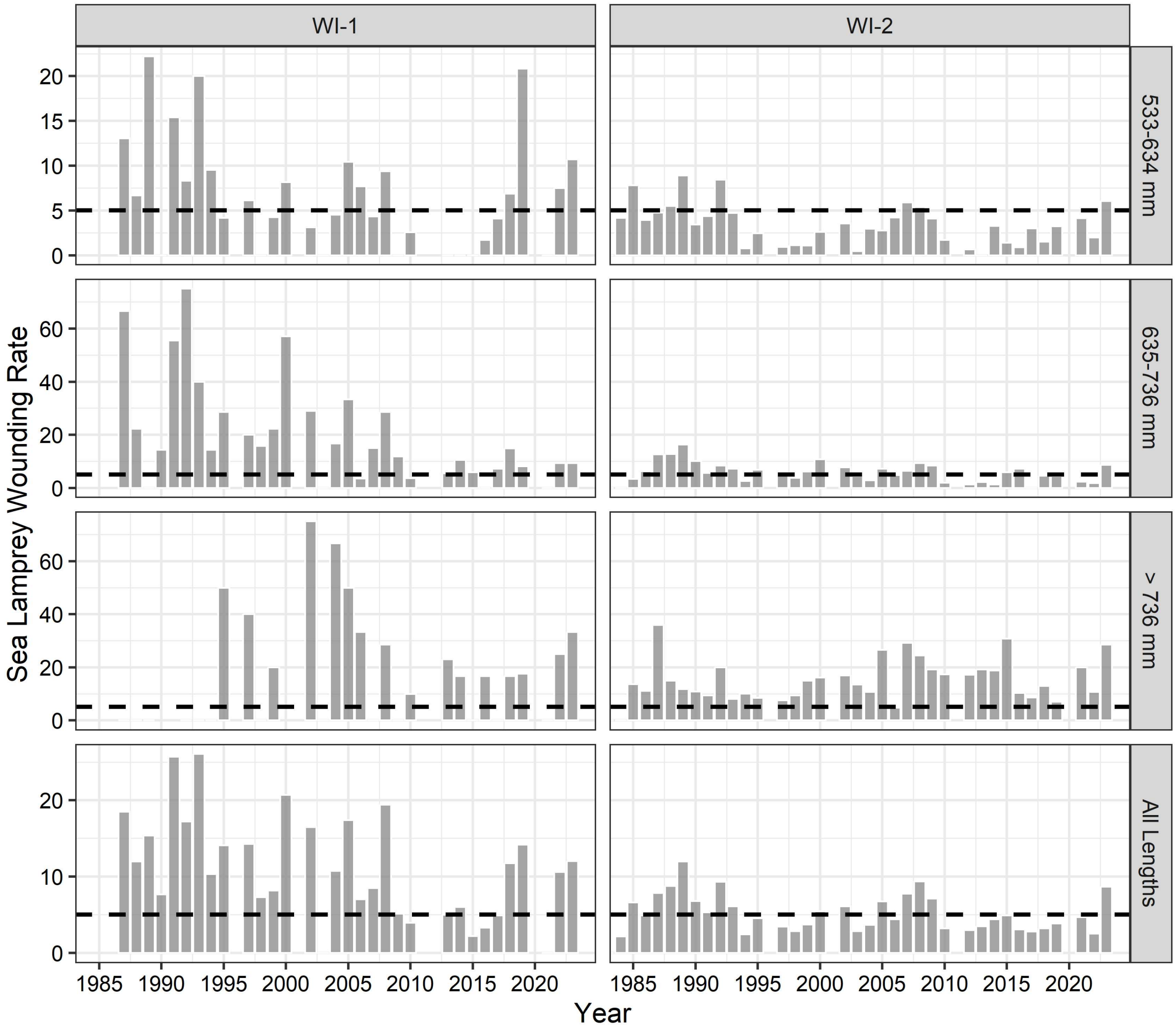

Figure 8. Sea lamprey wounding rates of wild lean lake trout in WI-1 (left) and WI-2 (right) waters of Lake Superior during the spring survey from 1985 to 2023. Wounding rates are represented as the number of A-1 through A-3 type wounds per 100 fish (King 1980; Eshenroder and Koonce 1984). Wounding rates 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 provide indicators for the GLFC Sea Lamprey control program.

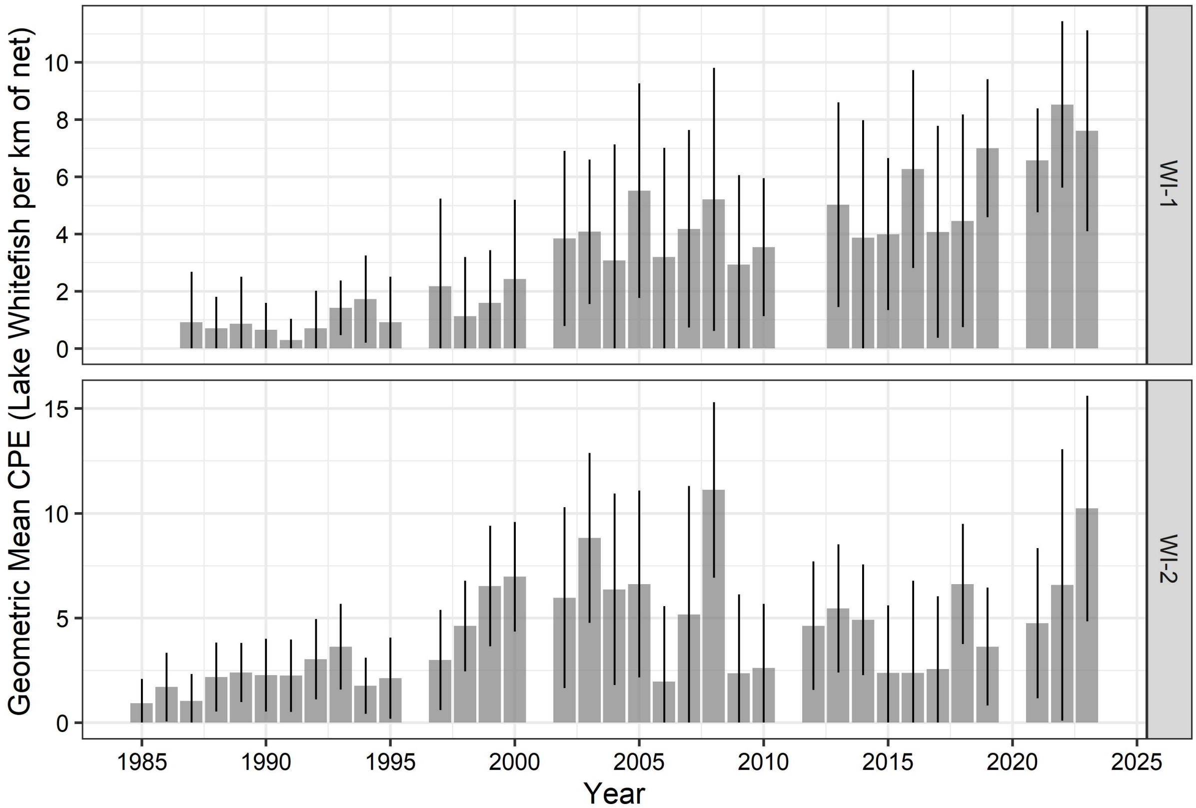

Figure 9. Spring survey geometric mean CPE+1 (+/- one standard deviation) of lake whitefish in WI-1 (top) and WI-2 (bottom) waters of Lake Superior from 1985 to 2023. CPE is total catch per kilometer of gill net per night.

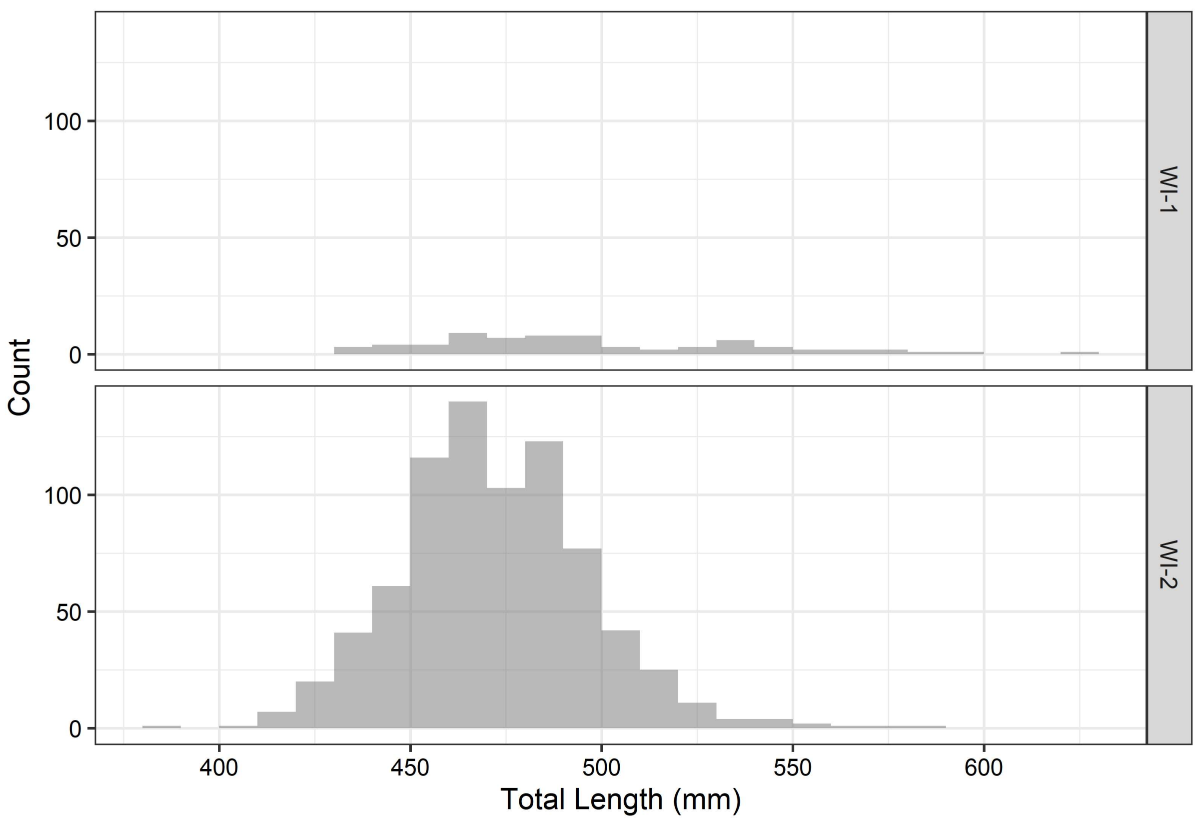

Figure 10. Length frequency histograms of lake whitefish in WI-1 (top) and WI-2 (bottom) waters of Lake Superior during the 2023 spring survey.

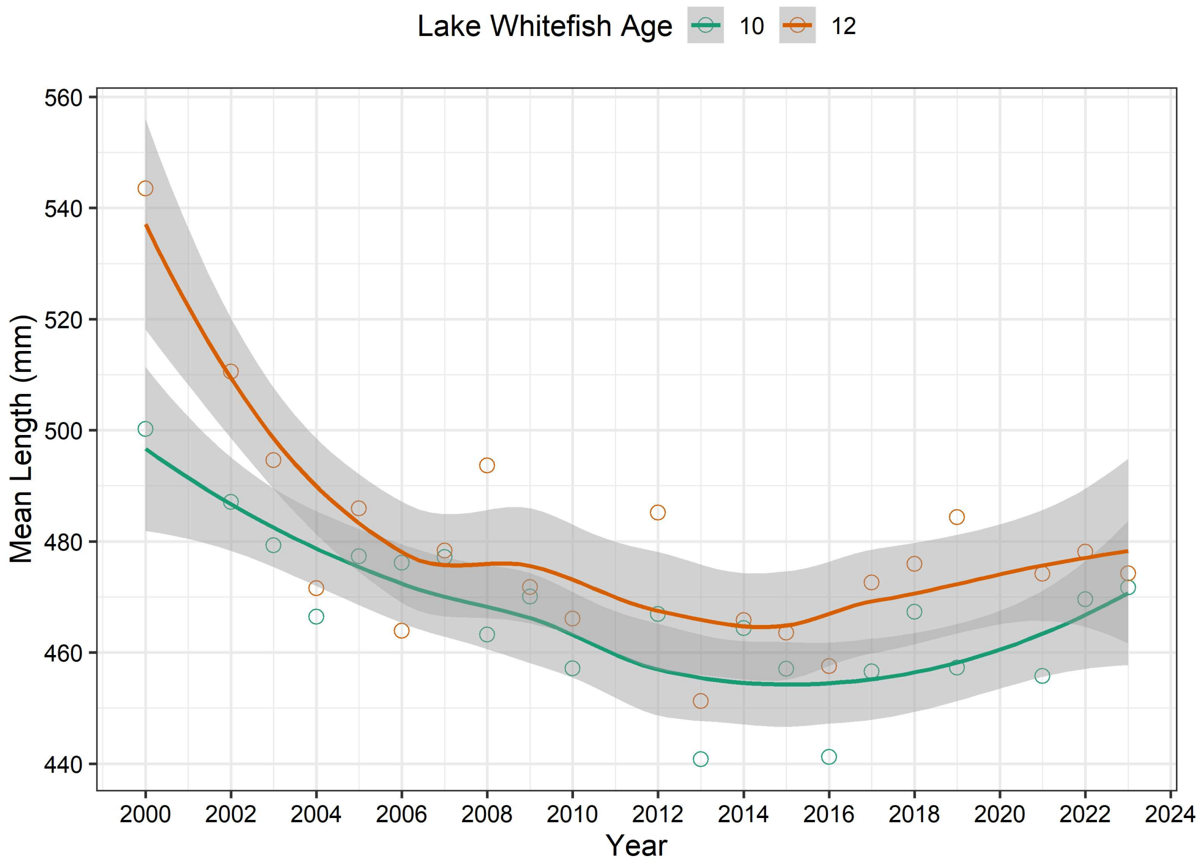

Figure 11. Lake whitefish mean length at ages 10 and 12 in management unit WI-2 in the spring survey from 2002 to 2023

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