WISCONSIN DEPARTMENT OF NATURAL RESOURCES

LAKE SUPERIOR SPRING LAKE TROUT ASSESSMENT REPORT 2021

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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 conservative fishing regulations, established fish refuges, supplemental stocking, and control of Sea Lamprey 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 resulting 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, but otoliths from 2021 are still being processed. Aging structures transitioned from scales to otoliths in the late 1990s. 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 3.6.1) 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).

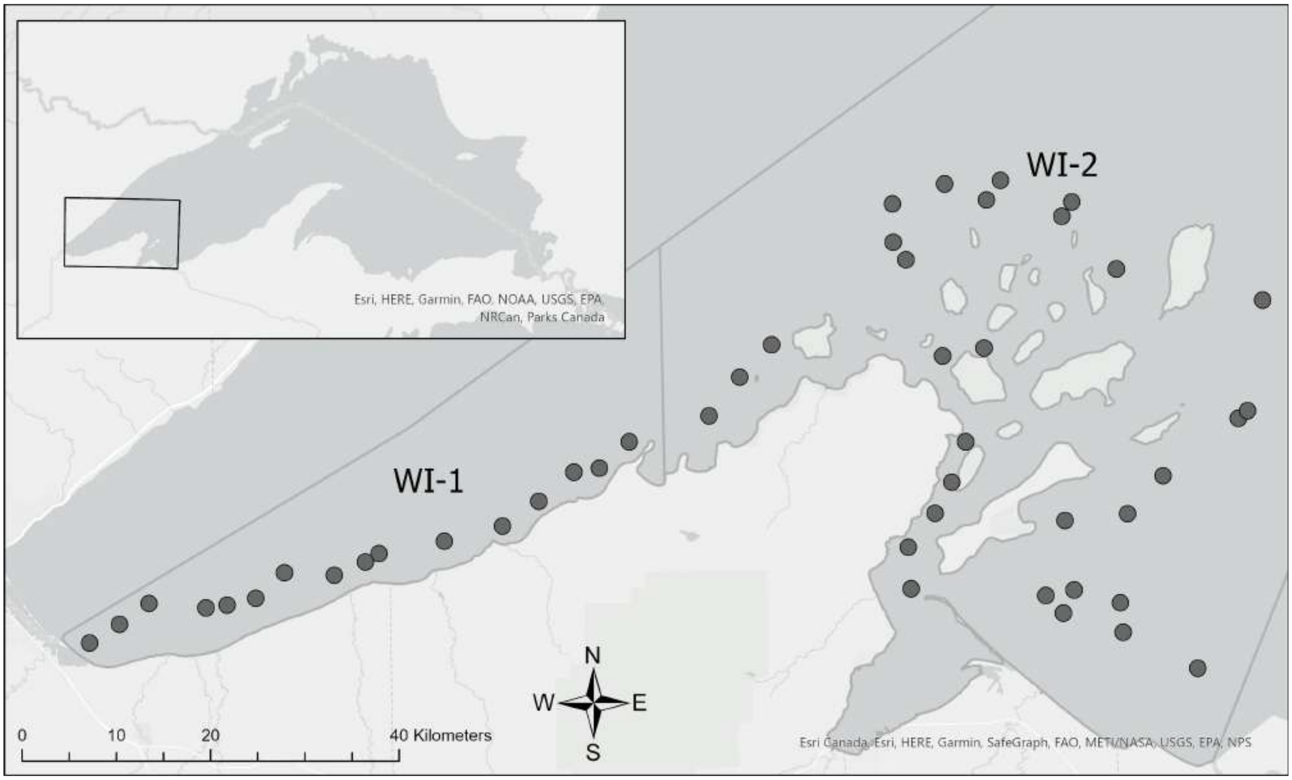

Figure 1. Map of Wisconsin waters of Lake Superior and the inside-end buoy locations of all sampling stations in the Wisconsin DNR Spring Lake Trout Assessment, 2021. Wisconsin management units include WI-1 (Western Arm region) and WI-2 (Apostle Islands region).

RESULTS

In WI-1, a total of 183 Lean Lake Trout were captured among 16 stations in 2021, of which 108 (59.0%) were of wild-origin, and 75 were of hatchery-origin (Figure 2). In WI-2, a total of 444 Lean Lake Trout were captured among 31 stations, of which 421 (94.8%) were of wild-origin and 23 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). 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, and geometric mean CPE of Hatchery Lean Lake Trout in WI-2 remains very low and stable (Figure 3). Geometric mean CPE of Wild Lean Lake Trout in WI-1 has increased throughout the time series and remained relatively high in 2021 (Figure 3). 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 and potentially stabilized (Figure 3).

Median total length of Hatchery Lean Lake Trout was 587 mm in WI-1 and 516 mm in WI-2 (Figure 4). Median total length of Wild Lean Lake Trout was 529.5 mm in WI-1 and 582 mm in WI-2 (Figure 4). 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 indicated a large amount of smaller fish in the survey (Figure 5). This length distribution in WI-1 was very similar to the 2015 assessment, so it was not out of the ordinary and likely indicates strong recruitment from one or more younger age classes (Figure 5). The length distribution of Wild Lean Lake Trout in WI-2 was slightly bimodal in 2021, compared to the more typical normal distribution in previous years (Figure 5). Median length of Wild Lean Lake Trout in WI-2 increased from 2015 to 2018 as abundant year-classes from the late 2000s grew longer and younger age-classes were not as abundant (Figure 5). In 2021, median length in WI-2 remained similar to the previous couple years, as some smaller fish recruited to the assessment gear (Figure 5).

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 (Figure 6). Particularly strong year-classes in the late 2000s in WI-2 (darker shades of blue of 6-9 year old fish in 2013 to 2019) helped the population rebound from its modern-day low abundance levels (Figure 6). The status of the current age structure will be determined when age samples are processed later this year.

Currently, Wild Lean Lake Trout growth rates (mean length at age 6, 7 and 8) are faster in WI-1 than in WI-2 (Figure 7). Growth rates for ages 6, 7, and 8 Wild Lean Lake Trout have increased substantially in WI-1 in the recent decade and have somewhat increased in WI-2 in the recent decade (Figure 7). Growth rates decreased in WI-2 from 1985 to around 2000 (Figure 7). This is likely due to 1) transitioning from scale to otolith aging structures (scales generally underestimate Lake Trout age) and 2) increasing population size and associated density-dependent factors during that time period (1985-2000).

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 both management units for all sizes of Lean Lake Trout for the first time since 2015 (Figure 8). Wounding rates have been underneath the LSTC threshold in WI-2 since 2009, however, the wounding rate increased slightly in 2021, especially in the largest size category (Figure 8). Wounding rate for all sizes of Lake Trout was significantly less in WI-1 than in the previous few years, but this metric can be somewhat biased based on the size distribution of Lean Lake Trout caught 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. Lean Lake Trout in WI-1 between 635 and 736 mm still had a wounding rate higher than the LSTC threshold and was similar to the previous few surveys, but Lean Lake Trout in WI-1 between 533 and 634 mm had a wounding rate near zero in 2021, much less than the previous few surveys (Figure 8).

Lake Whitefish geometric mean CPE is variable in the Spring Lake Trout Assessment, and the Summer 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 (Figure 9). In WI-2, relative abundance increased from the 1980s to the early 2000s and has likely stabilized since (Figure 9). Median Lake Whitefish total length was larger in WI-1 (479 mm) than in WI-2 (462 mm) in 2021 (Figure 10). Lake Whitefish growth rates (mean length at age 8 and 9) in WI-2 decreased from the late 1990's to around 2012 as population numbers increased substantially during the same time period, but growth rates have slightly increased since then as population levels have stabilized (Figure 11).

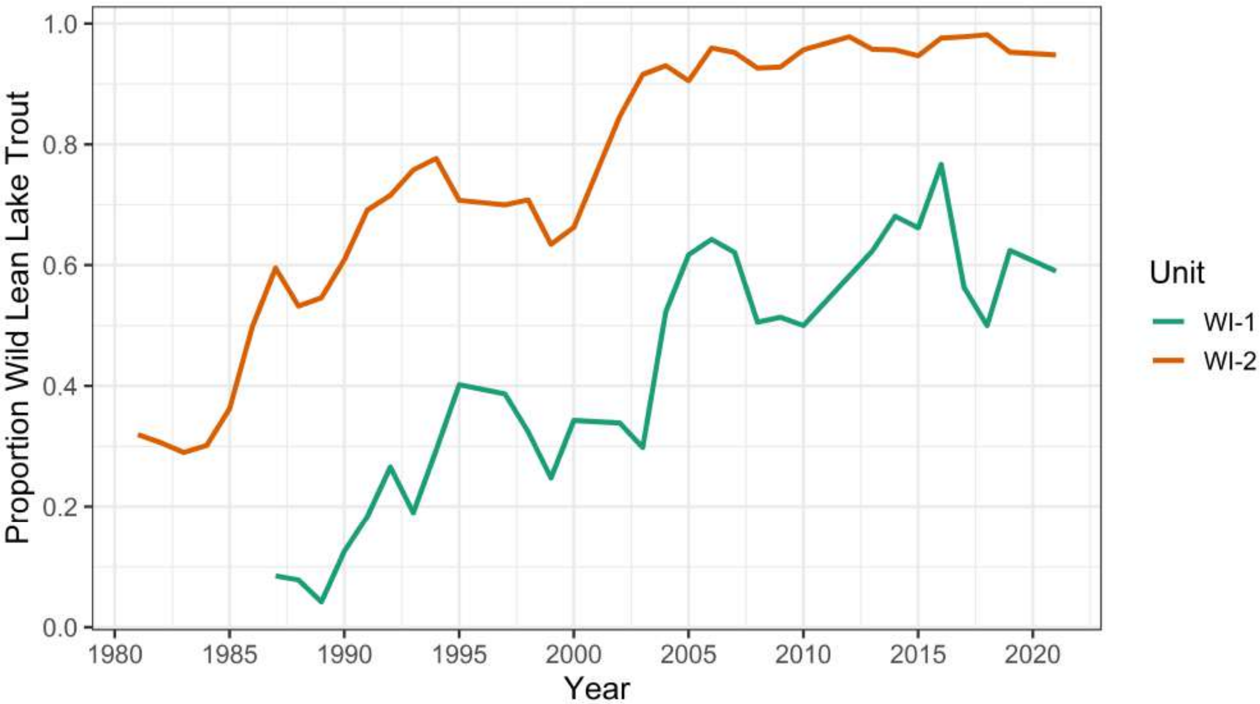

Figure 2. Proportion of total Lean Lake Trout catch that was wild (non-hatchery origin) determined by presence of fin clips on hatchery-origin fish in WI-1 (green) and WI-2 (orange).

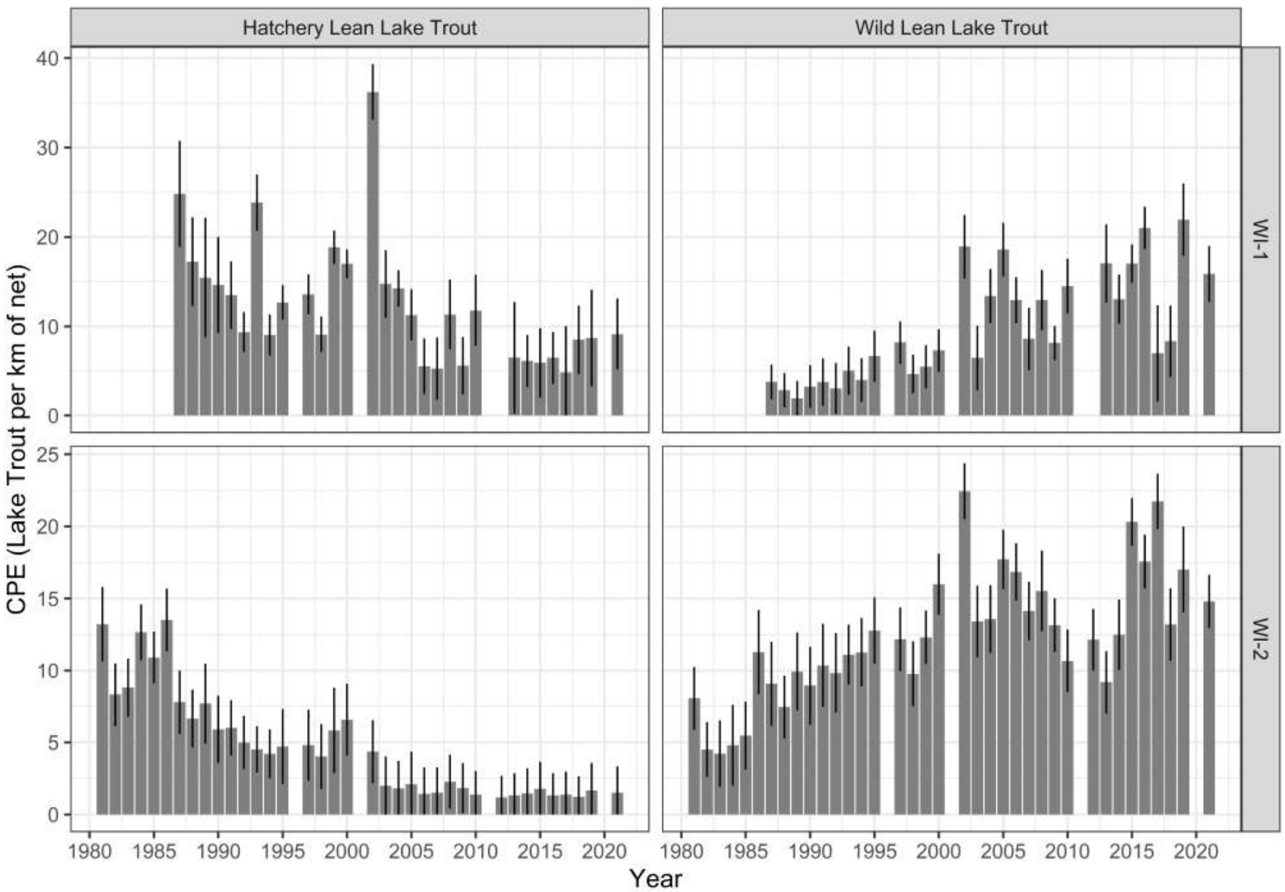

Figure 3. Spring survey geometric mean CPE+1 (+/- one standard deviation) of hatchery-origin (left) and wild (right) Lean Lake Trout in WI-1 (top) and WI-2 (bottom) waters of Lake Superior from 1981 to 2021. CPE is total catch per kilometer of gill net and is standardized for set duration using the LSTC saturation equation (Hansen et al. 1998).

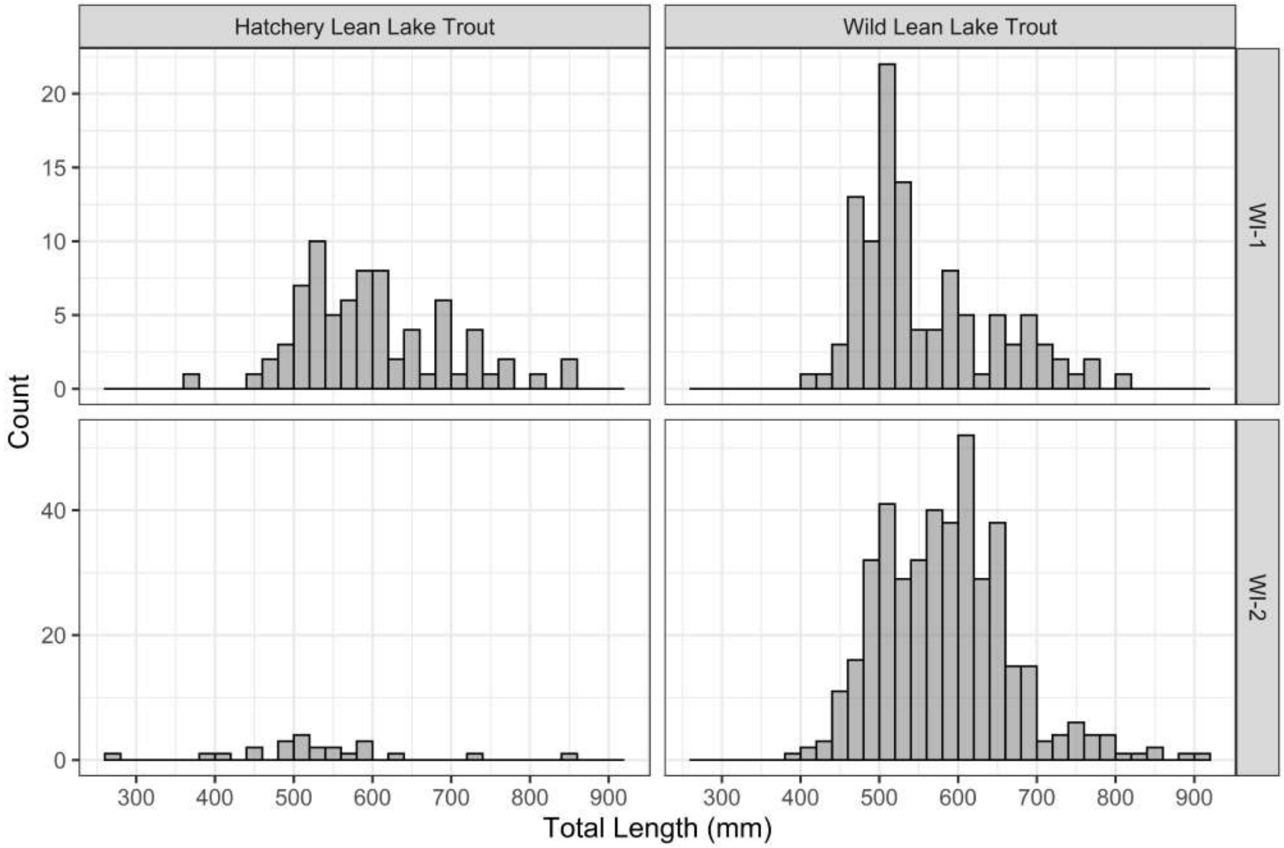

Figure 4. Length frequency histograms of hatchery-origin (left) and wild (right) Lean Lake Trout in WI-1 (top) and WI-2 (bottom) waters of Lake Superior during the 2021 spring survey.

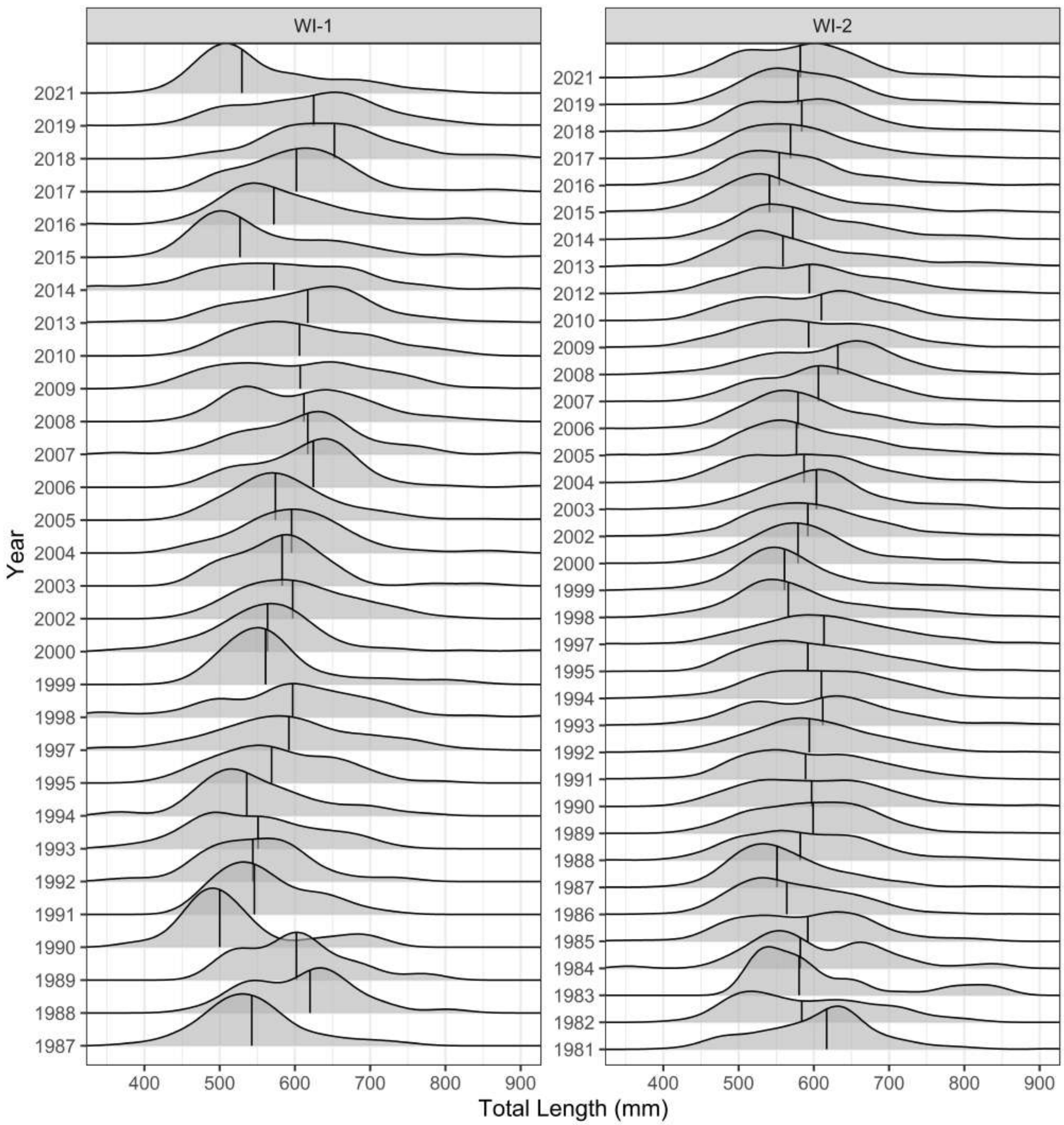

Figure 5. Time series of wild Lean Lake Trout relative length frequency from 1987 to 2021. Vertical lines represent the median total length sampled in a given year.

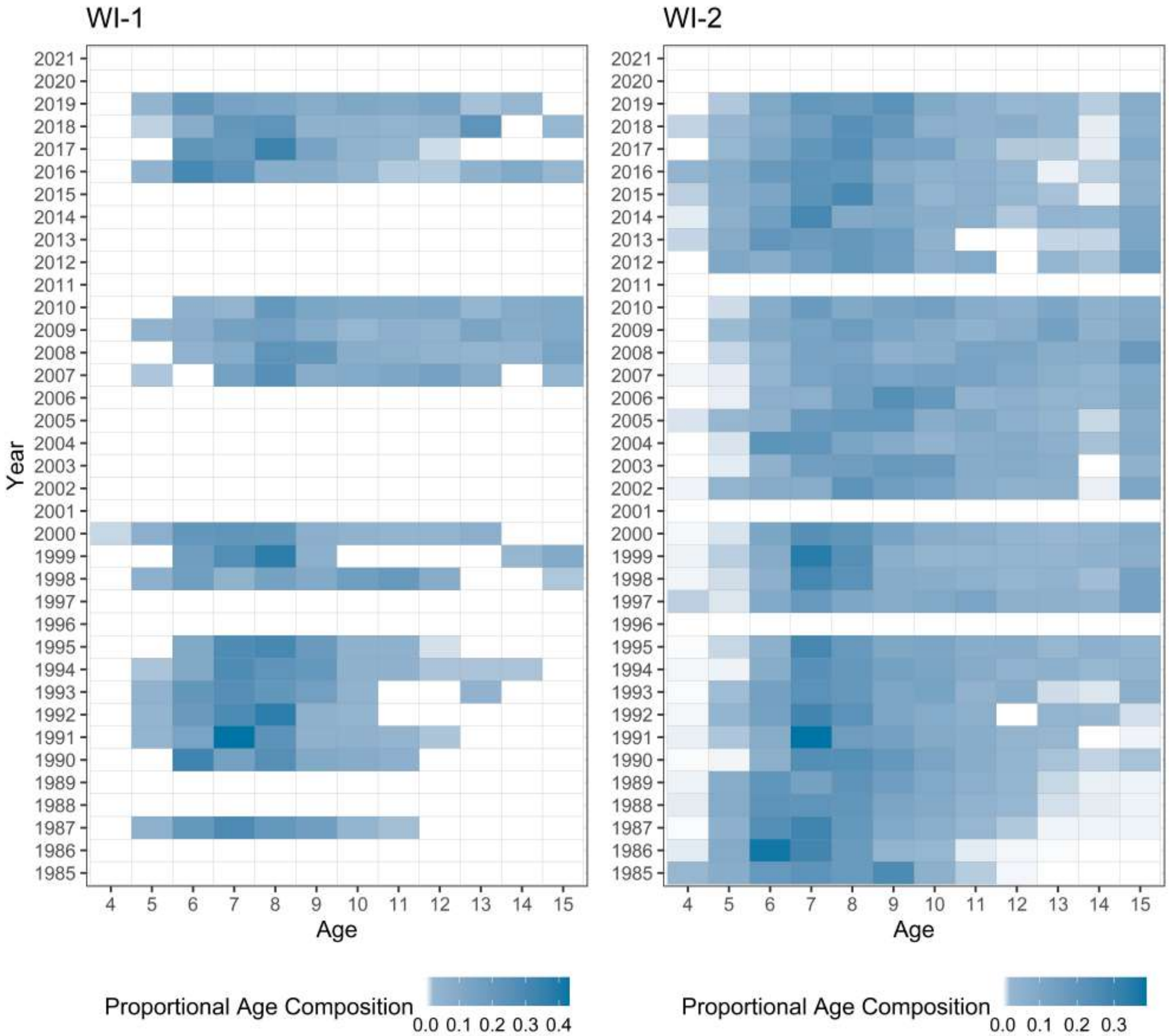

Figure 6. Proportional age composition of wild Lean Lake Trout in WI-1 (left) and WI-2 (right) waters of Lake Superior from the 1985 to 2019 spring surveys. Darker shading represents larger proportional age composition for a given age-class. Years when no age data were collected are represented with no shading. Age 15 represents a combined group of all ages 15 and up (i.e., 15+). Age samples from 2021 are still being processed.

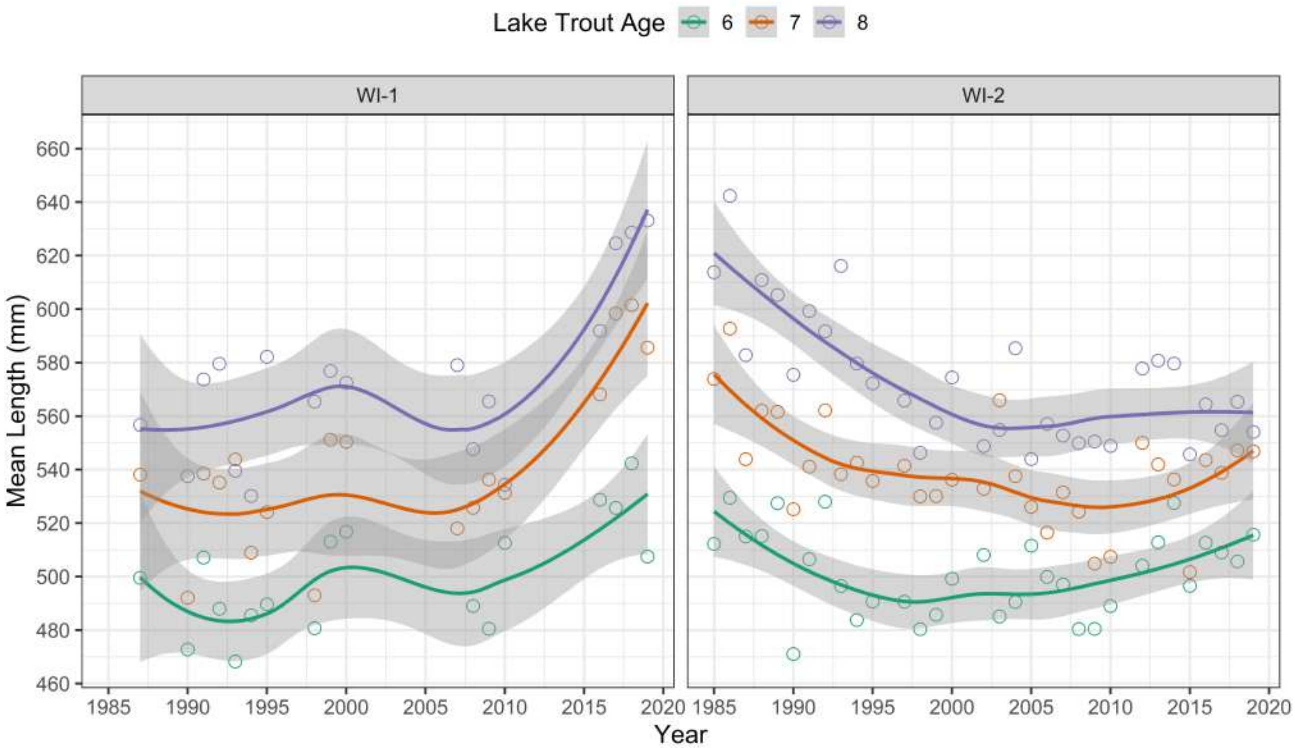

Figure 7. Wild Lean Lake Trout mean length at age in WI-1 (left) and WI-2 (right) for the three ages with the generally highest gear-selectivity in the spring survey: age-6 (green), age-7 (orange), and age-8 (purple). Data are from 1985 to 2019, and age samples from 2021 are still being processed.

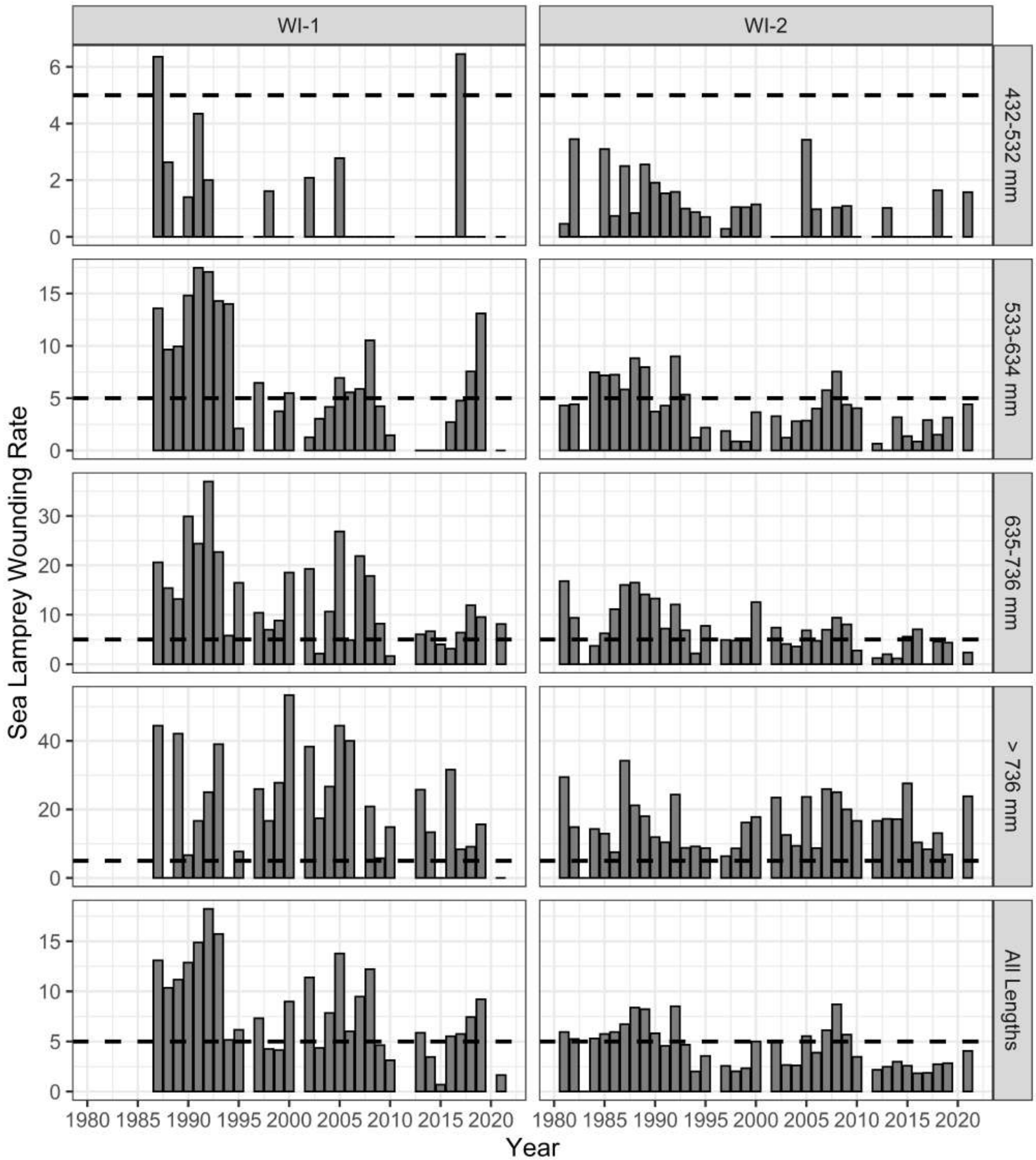

Figure 8. Sea Lamprey wounding rates of Lean Lake Trout (hatchery-origin and wild) in WI-1 (left) and WI-2 (right) waters of Lake Superior during the spring survey from 1981 to 2021. Wounding rates are represented as the number of A-1 through A-3 type wounds per 100 fish (King 1980; Eshenroder and Koonce 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 Sea Lamprey control program.

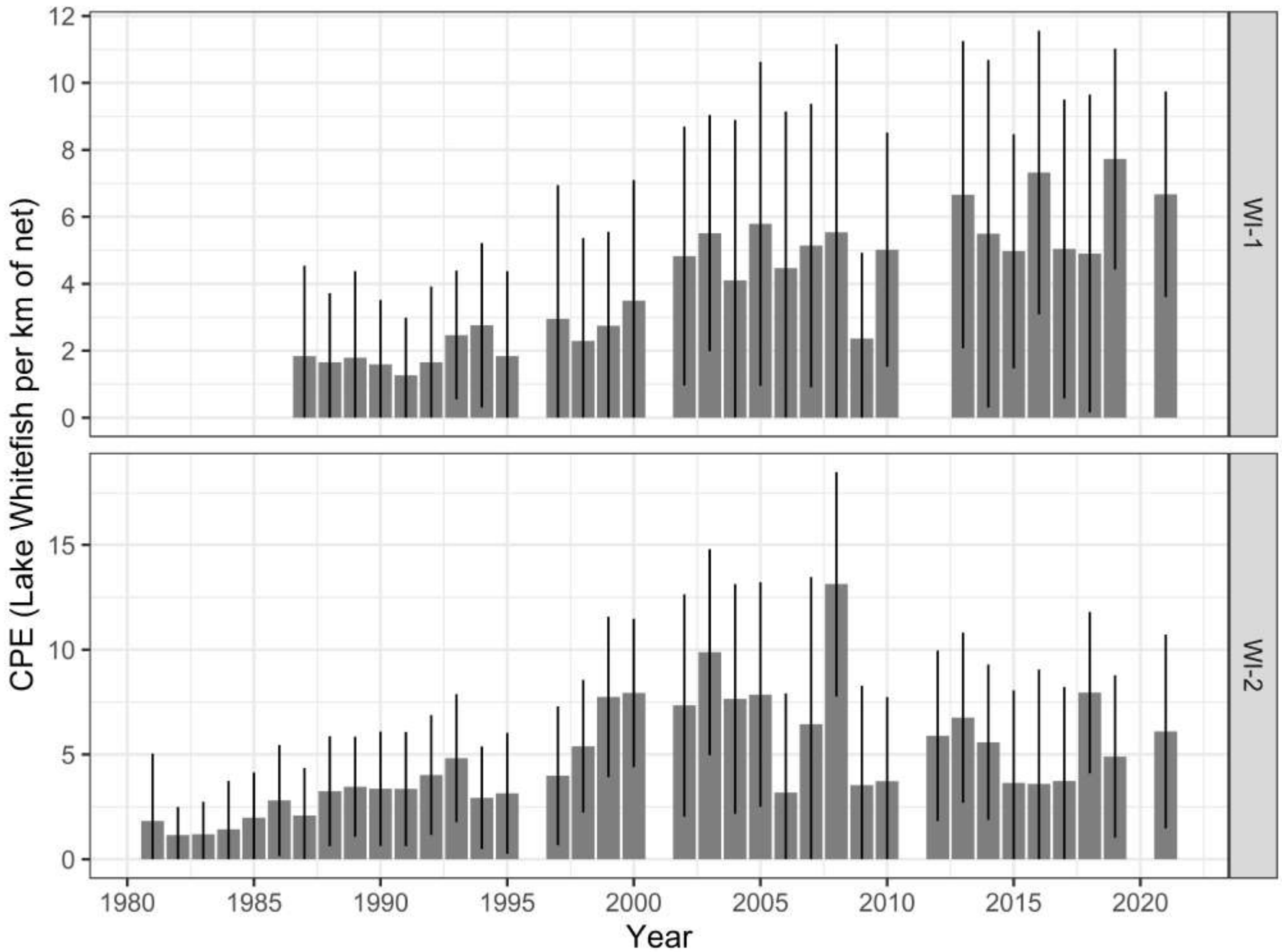

Figure 9. Spring survey geometric mean CPE+1 (+/- one standard deviation) of Lake Whitefish in WI-1 (top) and WI-2 (bottom) waters of Lake Superior from 1981 to 2021. CPE is total catch per kilometer of gill net per night.

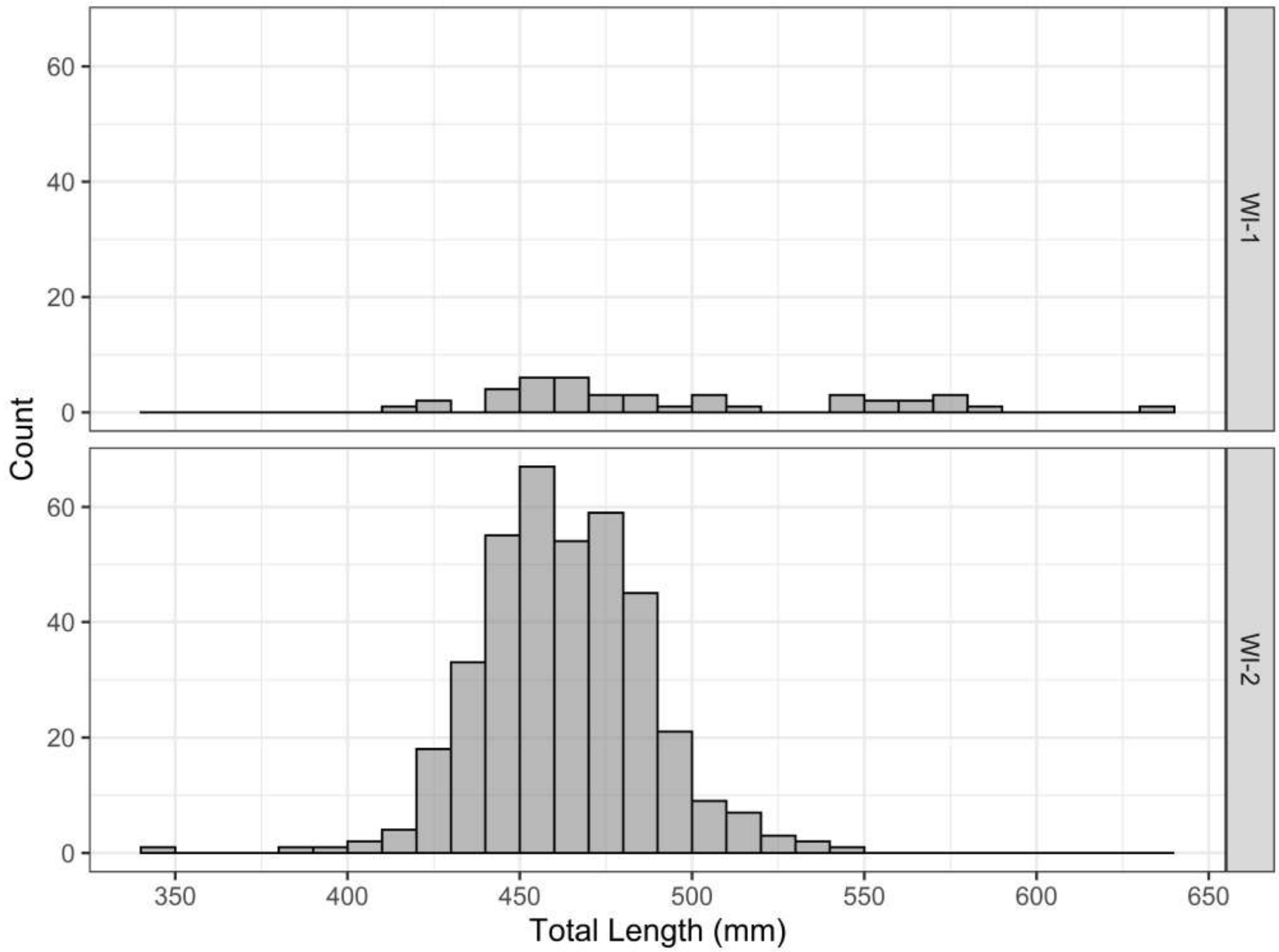

Figure 10. Length frequency histograms of Lake Whitefish in WI-1 (top) and WI-2 (bottom) waters of Lake Superior during the 2021 spring survey.

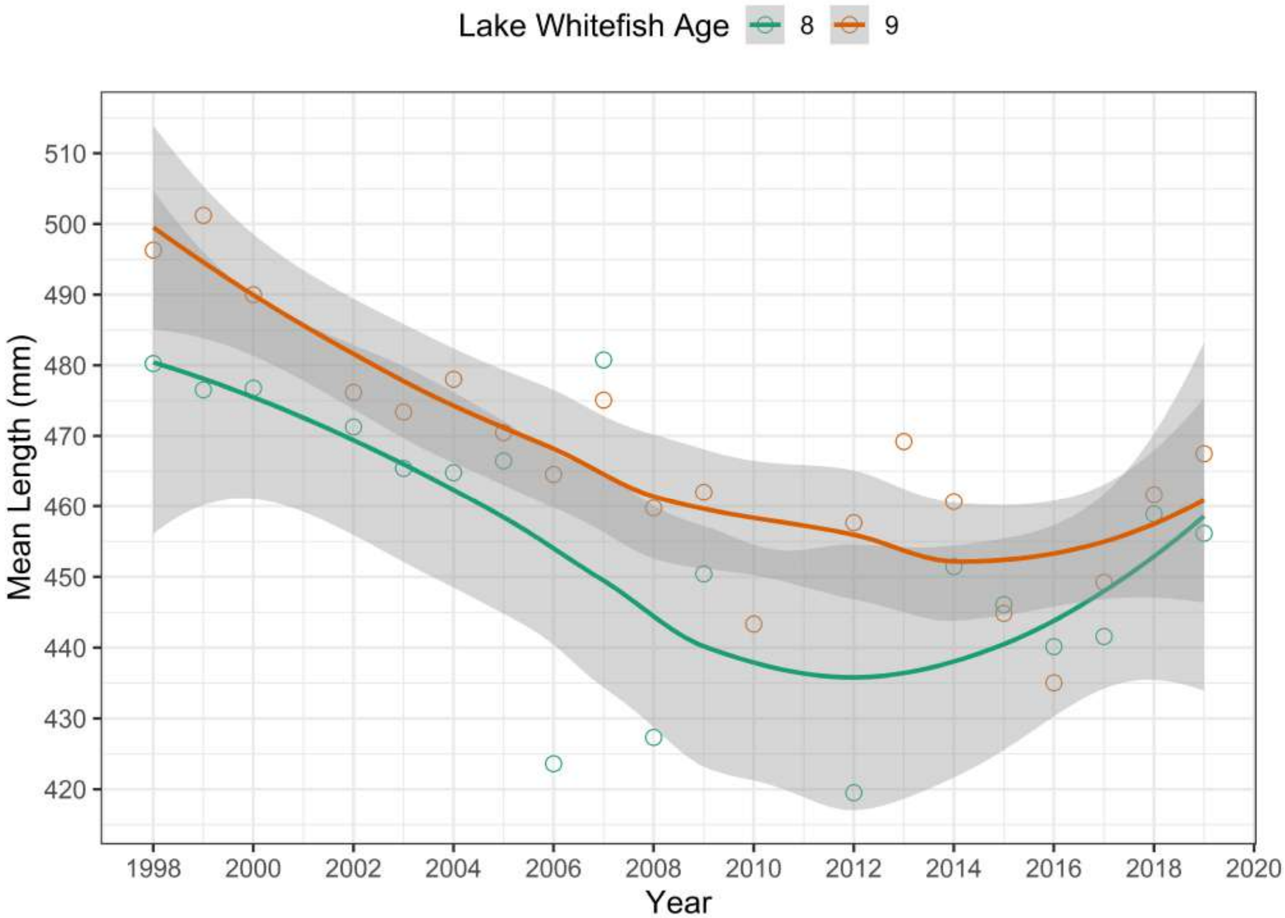

Figure 11. Lake Whitefish mean length at age in management unit WI-2 for the two ages with the generally highest gear-selectivity in the spring survey: age-8 (green) and age-9 (orange). Data are from 1998 to 2019, and age samples from 2021 are still being processed.

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