WISCONSIN DEPARTMENT OF NATURAL RESOURCES

LAKE SUPERIOR SPRING LAKE TROUT SURVEY REPORT 2024

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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, which is now seen as one of the best examples of native species restoration in the Great Lakes (Hansen 1996; Sitar et al. 2024). After a long period of rehabilitation, management agencies are now focused on maintaining sustainable rates of harvest for both commercial and recreational fisheries (Sitar et al. 2024). Thus, the primary objective of the Spring Lake Trout Survey 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 Survey 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 was conducted 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 collected 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 type wounds per 100 fish within size categories (533-634 mm, 635-736 mm, > 736 mm, and all fish $\geq$ 533 mm) and all sizes combined (King 1980; Eshenroder and Koonce 1984).

Analyses were conducted using the program R (version 4.4.2) with help from packages tidyverse (Wickham et al. 2019) and FSA (Ogle et al. 2020).

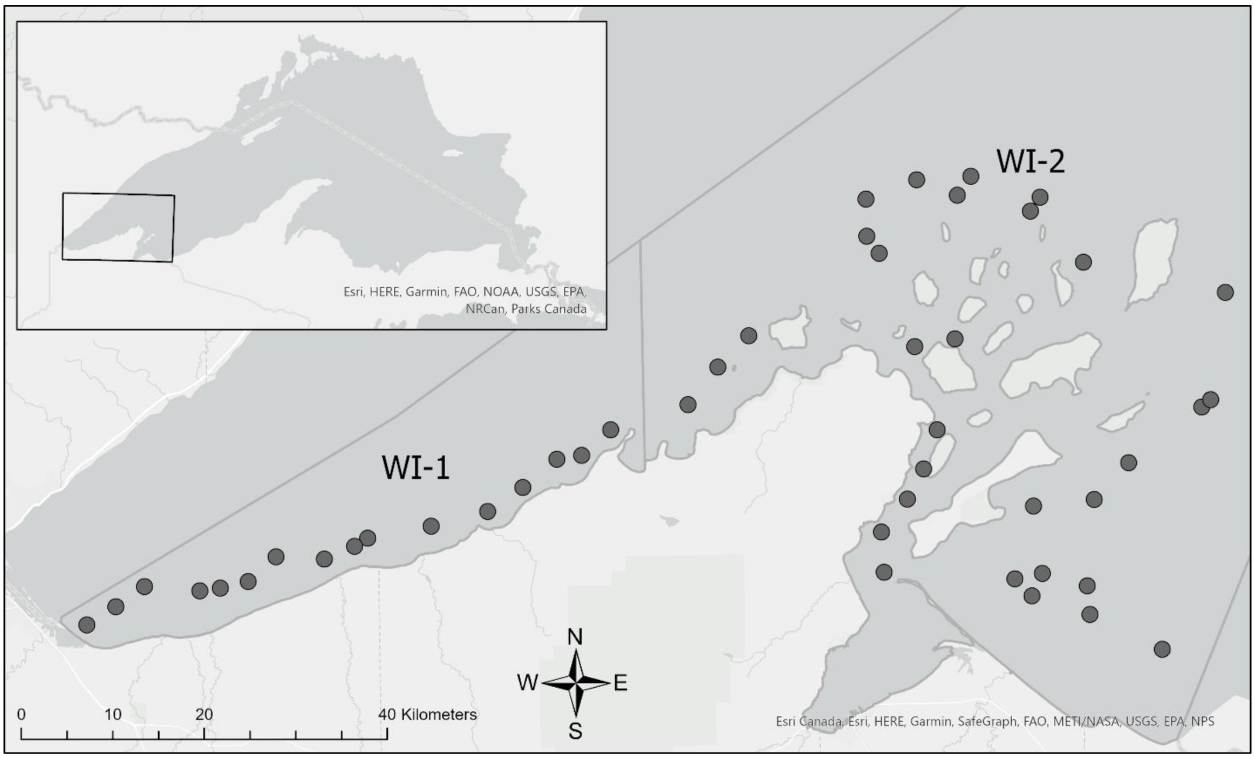

Figure 1. Map of Wisconsin waters of Lake Superior and the inside-end buoy locations of all sampling stations in the Wisconsin DNR Spring Lake Trout Survey, 2024. Wisconsin management units include WI-1 (Western Arm region) and WI-2 (Apostle Islands region).

RESULTS AND DISCUSSION

WI-1 LAKE TROUT

In WI-1, a total of 114 lean lake trout were captured among 16 stations in 2024, of which 57 (50.0%) were of wild-origin, and 57 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 between 50% and 65% (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 2023 and 2024 compared 2019-2022 (Figure 3).

The median total length of hatchery and wild lean lake trout was 584 mm and 612 mm in WI-1, respectively (Figure 4). The median length of wild lean lake trout in WI-1 was similar to last year, as some smaller recruits (ages 4 and 5) were detected and offset the increasing sizes of the abundant 2015 and 2016 cohorts (Figures 5 and 6). A noticeable recruitment gap was present from the 2017 and 2018 cohorts (ages 6 and 7; Figure 6). The WI-1 stock of wild lean lake trout has recently been buoyed by the 2015 and 2016 cohorts, which collectively made up 74.6% and 60.0% of the fish captured in this survey in 2023 and 2024, respectively (Figure 6).

In general, wild lean lake trout growth rates (mean lengths of lake trout ages 6-10) are more variable in WI-1 than in WI-2 (Figure 7). WI-1 lean lake trout growth rates have increased slightly in recent years (Figure 7), possibly due to recent warm years (e.g., 2021) and abundant prey (2022-2023).

The sea lamprey wounding rate (number of A1-A3 wounds per 100 fish) was almost four times above the LSTC-recommended threshold of five wounds per 100 fish in WI-1 for all sizes (> 533 mm) of lean lake trout (Figure 8). This was the fourth-highest wounding rate on record in WI-1 in this survey and the highest since 1992 (Figure 8). This indicates a recent increase in sea lamprey predation on wild lean lake trout, which will likely have a negative impact on future recruitment to the fisheries and may partially explain the recruitment gap identified in age compositions of lake trout in recent years.

WI-2 LAKE TROUT

In WI-2, a total of 418 lean lake trout were captured among 31 stations, of which 383 (91.6%) were of wild-origin and 35 were of hatchery-origin (Figure 2). This was the lowest proportion of wild lean lake trout in WI-2 since 2005 (Figure 2). Relative abundance of hatchery lean lake trout in WI-2 remains very low and stable, as no stocking has occurred 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 2024 remained lower than 2015-2022 (Figure 3).

The median total length of hatchery and wild lean lake trout was 505 mm and 625 mm in WI-2, respectively (Figure 4). Median length and overall length distribution of wild lean lake trout in WI-2 increased substantially in 2024, indicating very little recruitment of younger fish to the survey (Figure 5). Age compositions of wild lean lake trout the past few years indicated relatively strong recruitment from the 2015 and 2016 cohorts with weak recruitment from subsequent cohorts (2017 and 2018; Figure 6). We observed an early indication of a strong cohort of age-4 fish in both management units (2020 year-class; Figure 6).

Growth rates of ages 6-10 wild lean lake trout have been relatively stable since 2000 but have increased in recent years (Figure 7), possibly due to recent warm years (e.g., 2021) and abundant prey (2022-2023).

Last year in 2023, the sea lamprey wounding rate (number of A1-A3 wounds per 100 fish) was above the LSTC-recommended threshold of five wounds per 100 fish in WI-2 for all sizes of lean lake trout (> 533 mm) for the first time since 2009 (Figure 8). In 2024, the wounding rate increased again to the second-highest rate observed in the history of this survey (11.9) and highest since 1988. This indicates a recent increase in sea lamprey predation on wild lean lake trout, which will likely have a negative impact on future recruitment to the fisheries and may partially explain the recruitment gap identified in age compositions of lake trout in recent years.

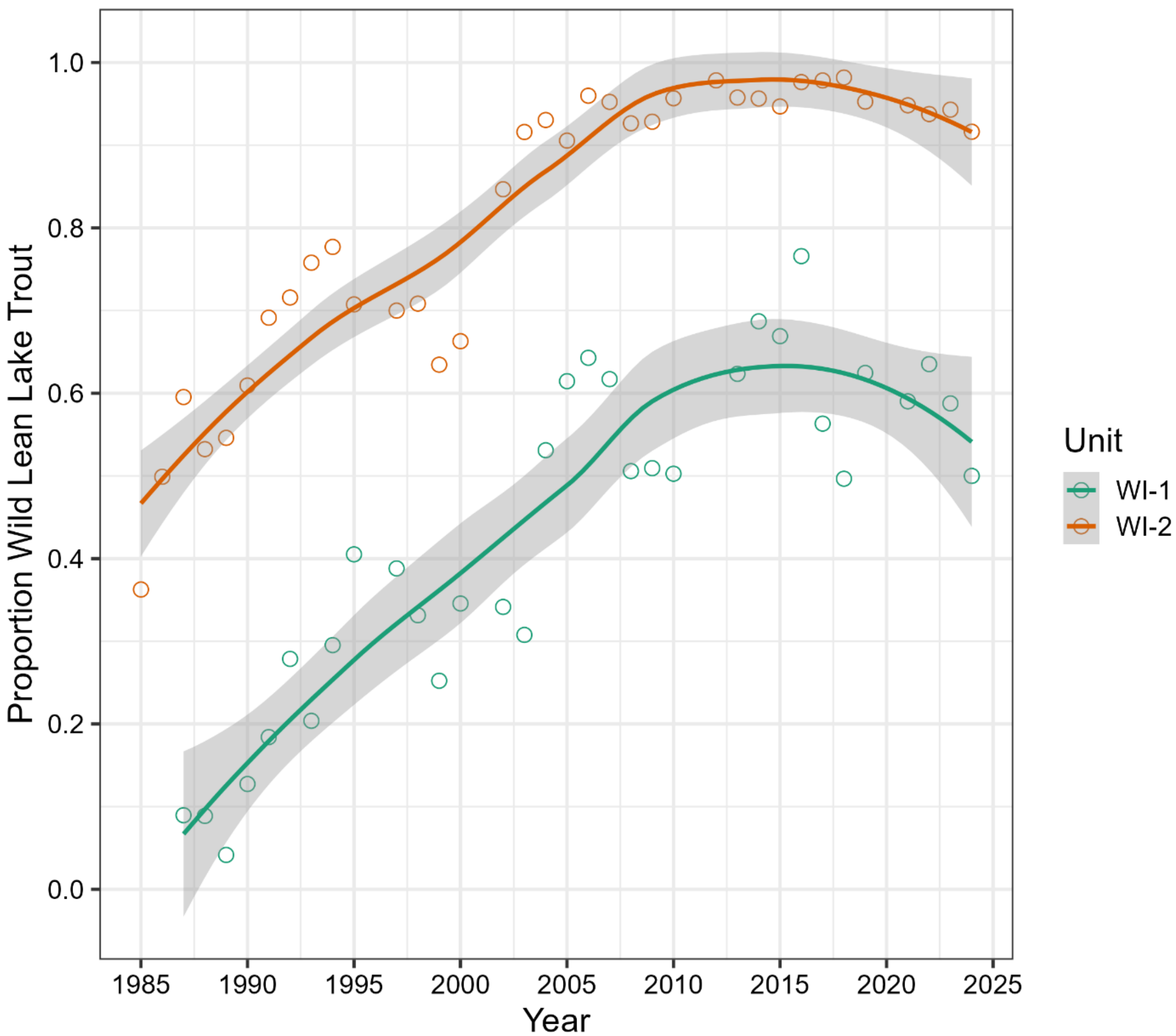

Figure 2. Proportion of lean lake trout catch which was wild (non-hatchery origin) determined by presence of fin clips on hatchery-origin fish in WI-1 (green) and WI-2 (orange) from 1985 to 2024.

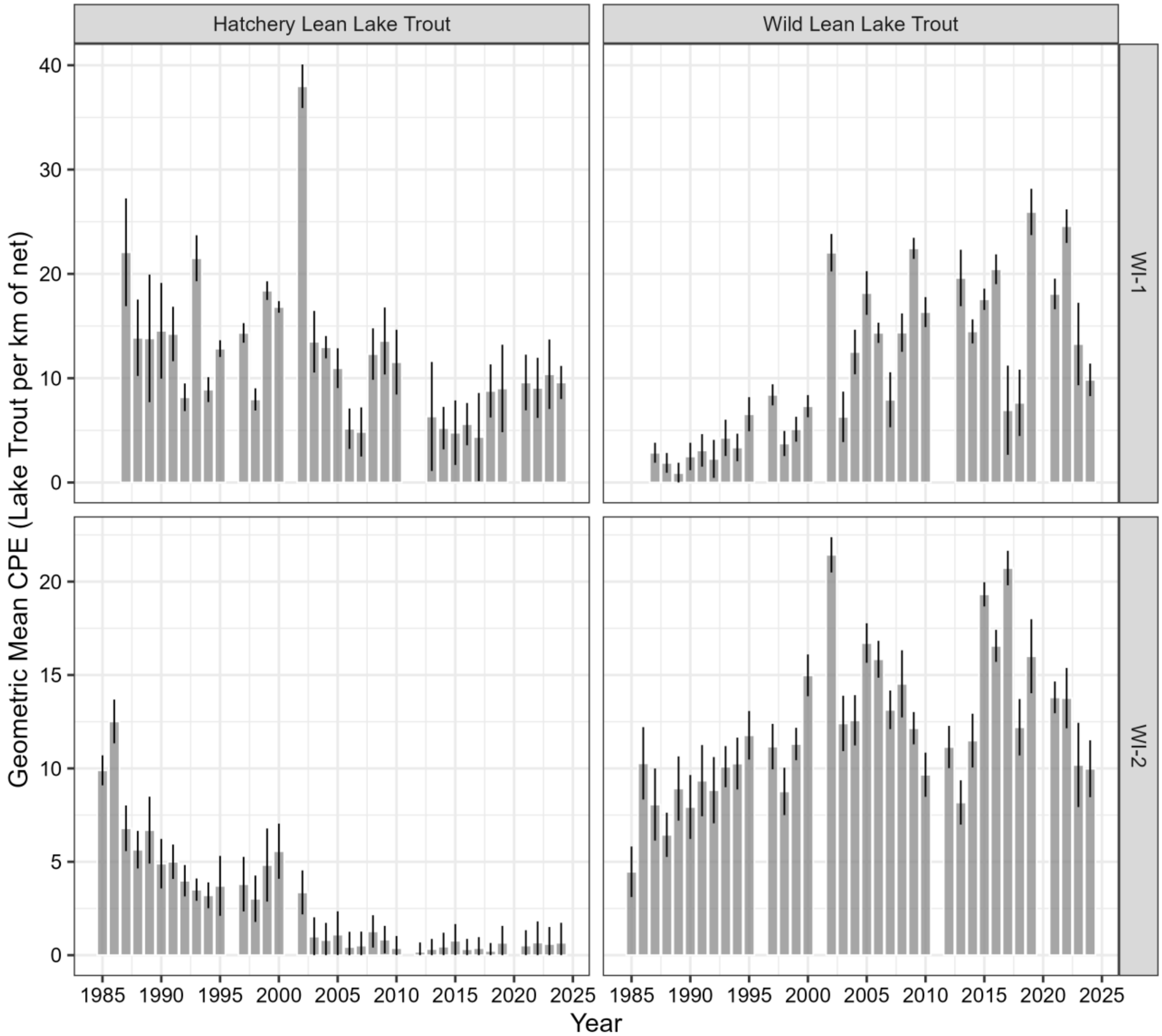

Figure 3. Spring survey geometric mean CPE (+/- one standard deviation) of hatchery-origin (left) and wild (right) lean lake trout in WI-1 (top) and WI-2 (bottom) waters of Lake Superior from 1985 to 2024. CPE is total catch per kilometer of gill net and is standardized for set duration using the LSTC saturation equation (Hansen et al. 1998).

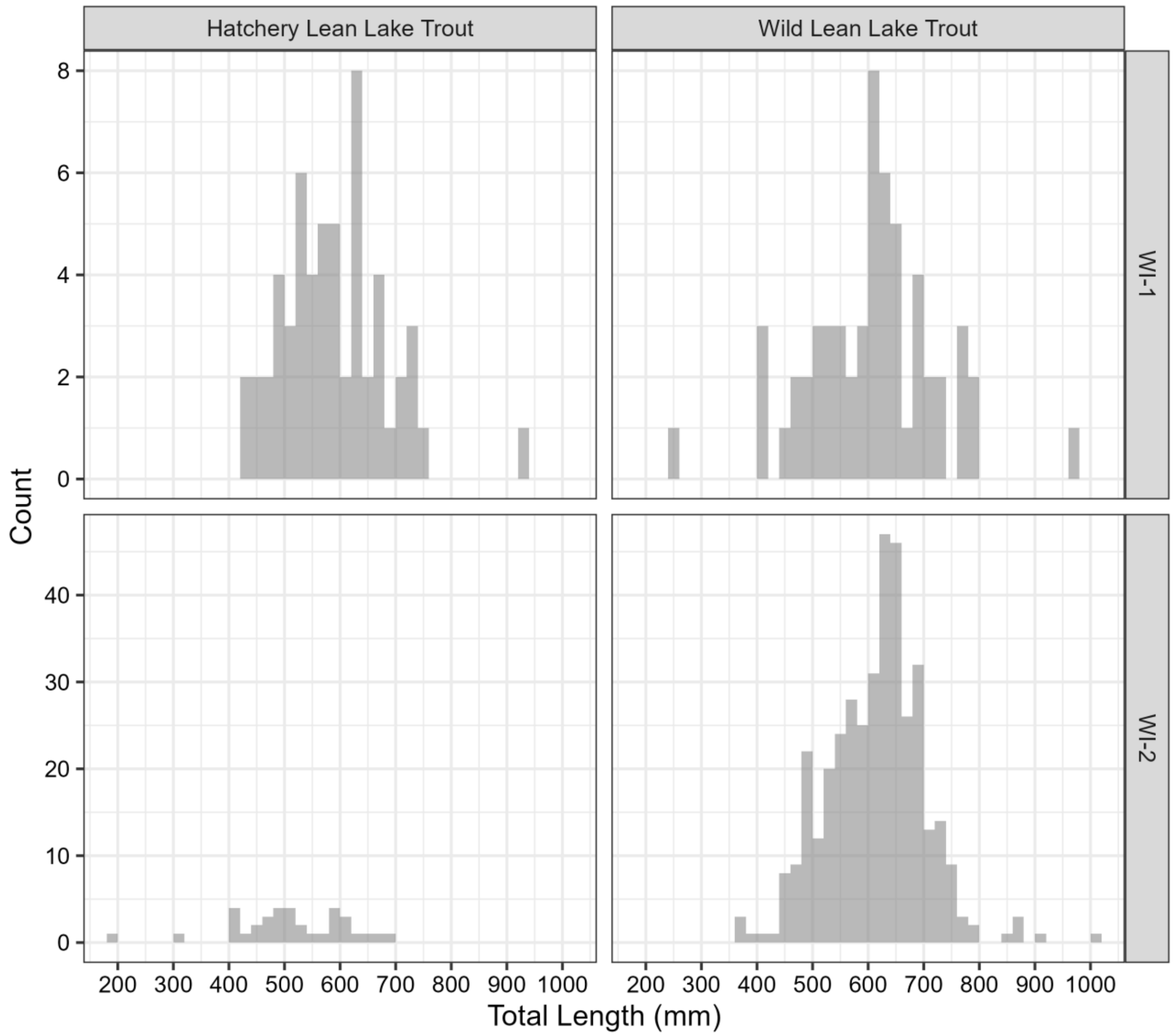

Figure 4. Length frequency histograms of hatchery-origin (left) and wild (right) lean lake trout in WI-1 (top) and WI-2 (bottom) waters of Lake Superior during the 2024 spring survey.

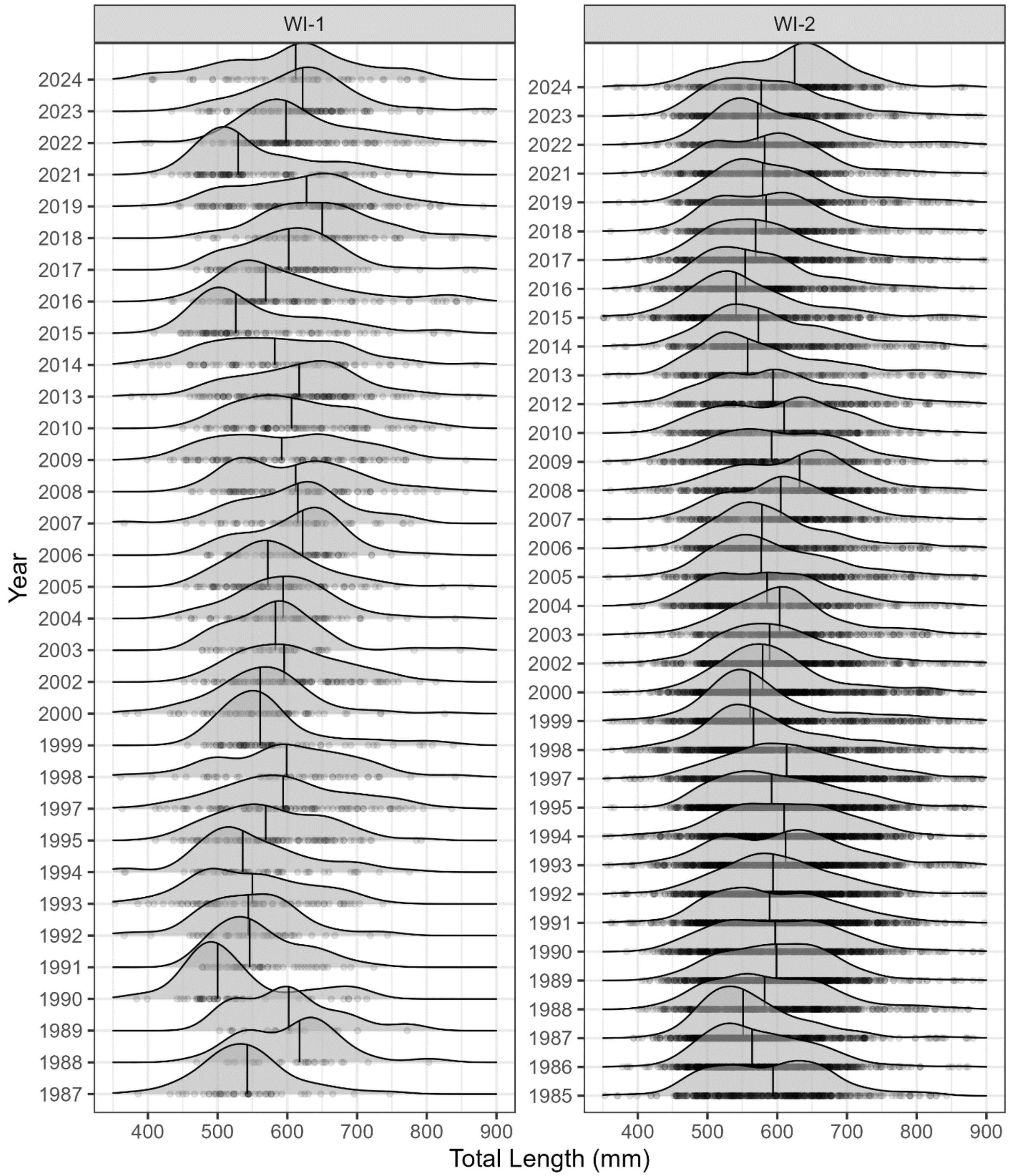

Figure 5. Time series of wild lean lake trout length frequencies in WI-1 (left) and WI-2 (right) waters of Lake Superior from 1985 to 2024. Vertical lines represent the median total length sampled each year.

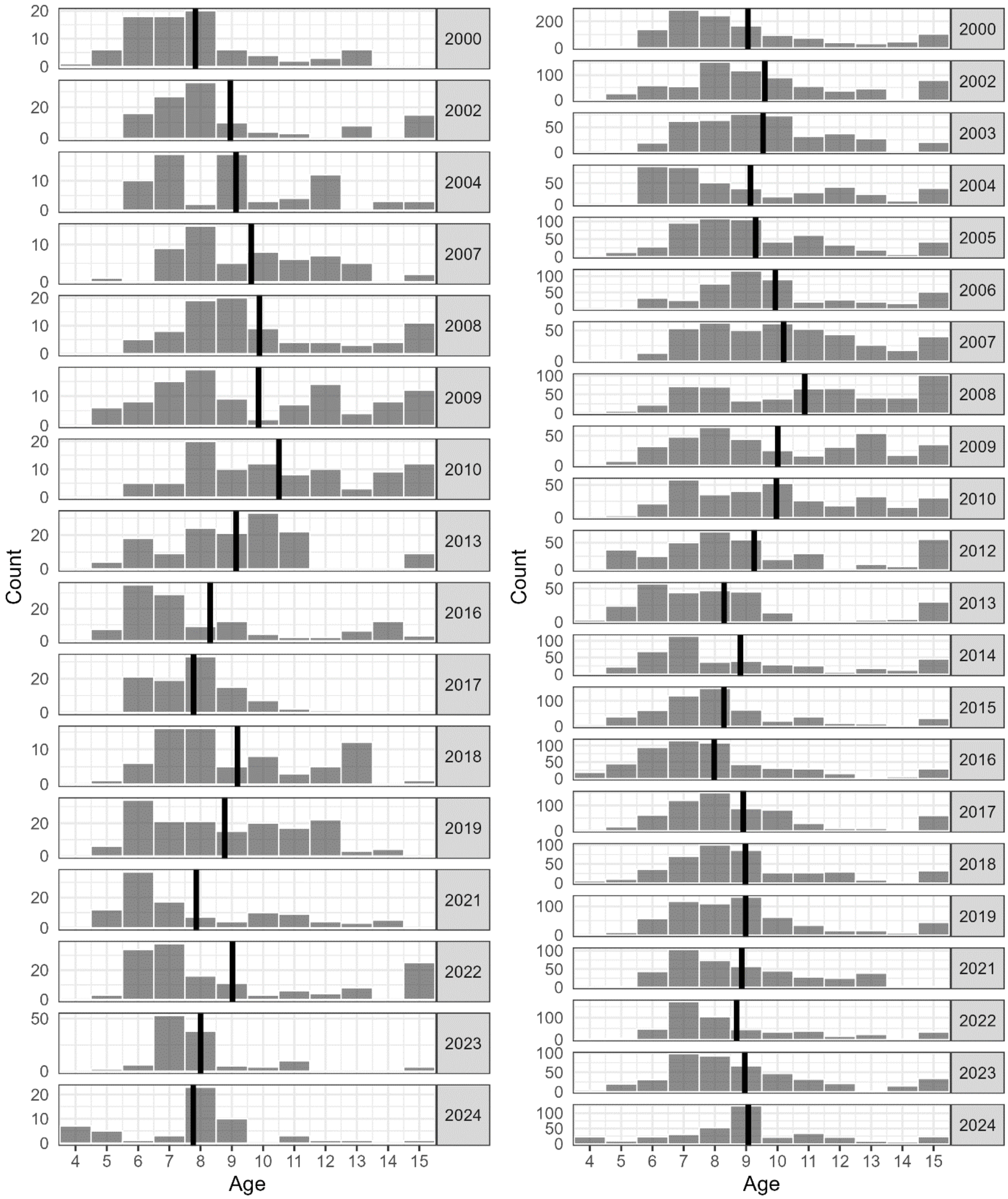

Figure 6. Time series of wild lean lake trout age frequencies in WI-1 (left) and WI-2 (right) waters of Lake Superior from 2000 to 2024. Age 15 represents a combined group of all ages 15 and up (i.e., 15+).

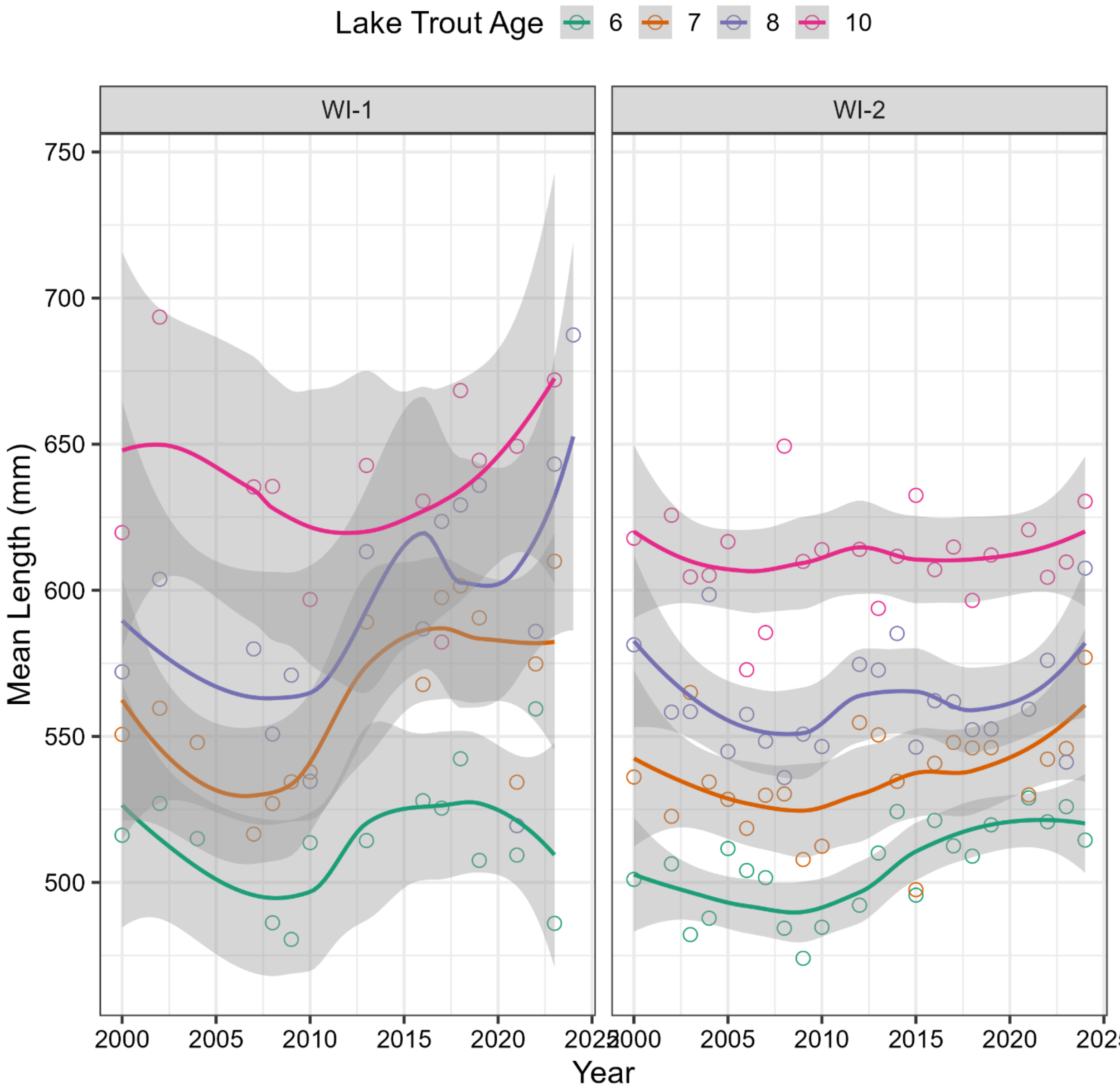

Figure 7. Mean length of age-6 (green), age-7 (orange), age-8 (purple) and age-9 (pink) wild lean lake trout in WI-1 (left) and WI-2 (right) waters of Lake Superior from 2000 to 2024.

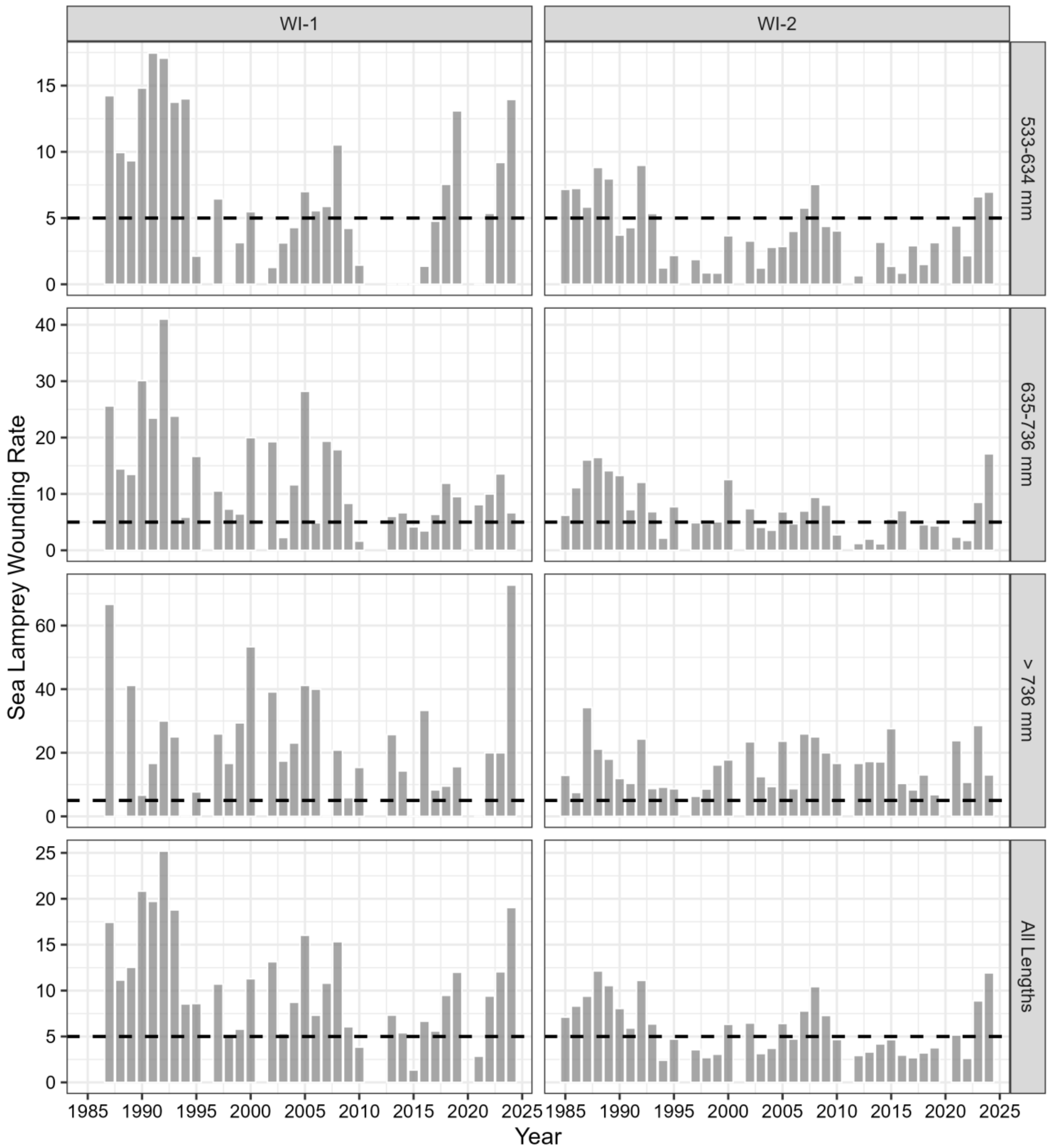

Figure 8. Sea lamprey wounding rates of wild lean lake trout in WI-1 (left) and WI-2 (right) waters of Lake Superior from 1985 to 2024. Wounding rates are represented as the number of A-1 through A-3 type wounds per 100 fish (King 1980; Eshenroder and Koonce 1984). Wounding rates are grouped by total length (LSTC Protocol), and the wounding rate for all fish combined (≥ 533 mm) 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.

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