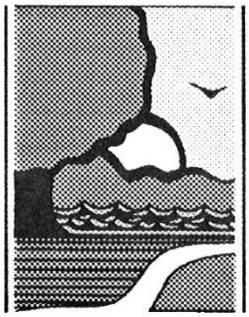

Illinois Department of Natural Resources

Division of Fisheries

Lake Trout Monitoring in Lake Michigan:

2023 Spring and Fall Assessments

William L. Stacy-Duffy

Illinois Department of Natural Resources - Lake Michigan Program

April 24, 2024

This work was funded by Federal Aid in Sport Fish Restoration Funds (F-65-R)

Table of Contents

List of Figures

INTRODUCTION

Lake Trout *Salvelinus namaycush* was the top native predator in Lake Michigan before its decline due to a combination of overfishing and mortality caused by the invasive Sea Lamprey *Petromyzon marinus*, resulting in the extirpation of Lake Trout in Lake Michigan by the 1950s (Wells and McLain 1972; Holey et al. 1995). A Sea Lamprey control program was initiated shortly thereafter and a Lake Trout stocking program, with the goal of rehabilitation, began in 1965 (Wells and McLain 1972).

Lake-wide stocking of Lake Trout continues annually at a combination of nearshore and offshore locations. Stocking locations and harvest restrictions were first formalized in *A Lakewide Management Plan for Lake Trout Rehabilitation in Lake Michigan* (LMLTTC 1985). Primary stocking sites (areas with the best spawning habitat and where high commercial harvests of Lake Trout occurred) were established as well as refuges in the northern and mid-lake regions that were closed to all forms of harvest. In addition, secondary stocking sites were adopted which were deemed to have sub-par habitat but provided for more localized fisheries. In Illinois waters, Julian's Reef was established as a primary stocking site and regulated as a commercial refuge, where sport fishing was allowed but commercial fishing was prohibited (Figure 1). Julian's Reef was first stocked in 1981 and has received annual stocking each year with the exception of five years (Figure 2). Despite these efforts, successful natural reproduction was negligible until recently and thus the Management Plan's goal of establishing a self-sustaining Lake Trout population has been unmet for decades.

Stocking locations and numbers were revised under *A Fisheries Management Implementation Strategy for the Rehabilitation of Lake Trout in Lake Michigan* (Dexter et al. 2011; referred to hereafter as the *Strategy*). Julian's Reef was retained as a First Priority stocking site and 60,000 yearling Lake Trout of Lewis Lake (LLW) strain and 60,000 yearling Lake Trout of Seneca Lake (SLW) strain have been stocked each year since 2011. The *Strategy* has four Evaluation Objectives to monitor progress toward targeted rehabilitation: 1) catch-per-unit-effort (CPUE) of >25 Lake Trout/1000 ft graded-mesh gill nets in spring stock assessments by 2019; 2) CPUE of >50 Lake Trout/1000 ft graded mesh gill nets in spawning surveys by 2019; 3) spawning populations of at least 25% female and which have ten or more age groups older than age-7; and 4) an egg deposition rate of >500 viable eggs/m^2 (eggs with thiamine concentrations of >4 nmol/g). Evaluation Objectives 2-4 are used to assess First Priority stocking sites.

To assess progress toward these Evaluation Objectives in the Illinois waters of Lake Michigan, annual gill net surveys are conducted in the spring at offshore locations near Waukegan, IL and at spawning reefs in

the fall. Gill nets have been used annually to sample spawning Lake Trout at both Waukegan and Julian's reefs since the early 1980s. Patterson et al. (2017) found no significant differences in catch statistics between Julian's Reef and Waukegan Reef during 1999-2014. Thus, Evaluation Objectives 2 and 3 were assessed annually at Julian's Reef, and data from Waukegan Reef was considered particularly in years when no sampling occurred at Julian's Reef.

Considering the similarities between Julian's and Waukegan reefs and an increase in Lake Trout of wild origin, a change in fall Lake Trout sampling site selection was instituted. Beginning in 2017, these priority sites were sampled in alternate years to allow investigation of population parameters at other Illinois reefs where Lake Trout may be spawning. Fall Lake Trout sampling included the "non-priority sites" consisting of North Reef (2017), Wilmette Reef (2018), and Lake Bluff 10-Mile Reef (2019), which were sampled in addition to either Julian's or Waukegan reefs. However, this rotation of priority sites was interrupted in 2020, when COVID-19 restrictions prevented both spring and fall Lake Trout sampling. Both surveys resumed in 2021 and Julian's and Waukegan reefs were sampled during the fall given that neither priority reef had been visited the previous year. Due to vessel maintenance and lake condition issues causing an incomplete sampling of the two sites in 2021 and 2022 respectively, both reefs were sampled again in 2023.

This report covers progress towards Evaluation Objectives 1-3 in Illinois waters; Evaluation Objective 4 is not included in this report since there is currently no quantitative sampling for eggs or juveniles in Illinois waters.

METHODS

Lake Trout were sampled with gill nets during two offshore surveys. Presented data are from surveys conducted in 2004-2023.

Spring and Fall Lake Trout Surveys

Two graded mesh gill nets, each with two 100 ft panels of 2.5" to 6" (½ inch increments) mesh sizes (1600 ft total) were fished overnight (Schneeberger et al. 1998) on 15-18 May, 2023. One net was set at an established site within each of three depth bins (50-100, 100-150, and 150-200 ft) along two transects offshore of Waukegan, IL. A total of six nets were fished during the 2023 spring survey.

Two graded mesh gill nets, each with two 100 ft panels of 4.5" to 6" (½ inch increments) mesh sizes (800 ft total) were fished overnight on three occasions during 18 October-02 November 2023. Four nets

were set at Waukegan Reef but, due to a lack of suitable weather and lake conditions, only two nets were set at Julian's Reef. A total of six nets were fished during the 2023 fall survey.

In both surveys, fish were measured to the nearest 5 mm (maximum total length) and weighed to the nearest 50 grams. In addition, clipped fins, lamprey wounds, sex, and maturity were recorded. Lake Trout with an adipose fin clip, indicating the presence of a coded-wire tag (CWT), had the head removed for tag extraction in the laboratory.

Data Analyses

Lake Trout CPUE was calculated as number of fish per 1000 feet of gill net in both the spring and fall surveys. Because CPUE values are highly dependent on standardized effort, nets that were fished for more than 1 day in duration (since a 2-day set ≠ twice the number of fish of a 1-day set) or with incorrect mesh sizes were removed from CPUE analyses. For this report, all nets from the spring Lake Trout survey in 2003, two nets from the spring Lake Trout survey in 2007, and two nets from the fall spawner survey in 2011 were removed from analysis. Catch data from all net sets was used in the reporting of proportion female, number of age classes, proportion of unmarked fish, and stocking origin (CWT data) since effort and mesh size has less influence on these indices.

RESULTS AND DISCUSSION

Spring Lake Trout Survey

Spring Lake Trout CPUE was 9.5 fish/1000 ft of net in 2023. This was approximately 40% of the target (25 fish/1000 ft), which has only been achieved once in 23 years of spring sampling (Figure 3). Spring CPUE during 2023 was consistent with the generally stable trend in recent years and close to the overall mean CPUE since 2018 (9.7 fish/1000 ft of net). Evaluation Objective 1 of the *Strategy* has not been achieved in Illinois waters.

Thirty-seven Lake Trout (41%) were not fin clipped and presumed to be of wild origin (Figure 4). This represents the highest proportion of wild fish observed in the spring survey to date (the second highest proportion of wild fish occurred in 2022). The percentage of unmarked fish in our spring catches increased after 2010 and has averaged 22% (2011-2023 average) since that time. Forty-three Lake Trout had an adipose fin clip and a coded-wire tag, and all tags were successfully decoded. A majority (33) were stocked on Julian's Reef (5 to 26 years old at capture) and nine were stocked on the Mid-lake Reef Complex (6 to 32 years old at capture). One fish was stocked from shore in Racine in 2014 as a fall-fingerling (9 years old at capture).

The average age of stocked (hatchery-reared) Lake Trout collected in the 2023 spring survey was 9.5 years, which was in between the past two years' averages (8.5 and 10.5 years in 2021 and 2022, respectively), and noticeably higher than the long-term average (7.7 years from 1998-2021). The calculation of average age of stocked Lake Trout only includes ages obtained from CWTs and does not include those with rotational fin clips since only a range of potential ages can be estimated for these fish at this time. Seven Lake Trout were captured with rotational fin clips whereby individual fins or combinations of fins were clipped on a 5-6 year rotation for several decades to identify potential year classes. This practice ended with the 2010 year class implying a minimum age of 13 years for fish with a left ventral fin clip and higher minimum potential ages for other unique clips. Assuming all Lake Trout with rotational fin clips were the minimum possible age to provide a conservative estimate, the average age of stocked Lake Trout would be 10.4 years.

Fall Spawner Survey

Fall Lake Trout CPUE was 60.4 fish/1000 ft of net in 2023. Fall CPUE has exceeded the 50 fish/1000 ft target in all but three years of the fall survey (Figure 5). Consistent CPUEs above the target indicate that Evaluation Objective 2 of the *Strategy* has been achieved in Illinois waters. Like 2021 and 2022, catch per unit effort differed dramatically between Julian's Reef (80.0 fish/1000 ft of net) and Waukegan Reef (50.6 fish/1000 ft of net) in 2023. Several net sets in 2023 encountered higher than usual bottom temperatures (58° - 59° F), something that has occurred multiple times since 2021, likely leading to lower catches and adding variability to the CPUE analysis. It is likely that warmer water caused a delay in the arrival of Lake Trout to their spawning grounds.

Evaluation Objective 3 of the *Strategy* has two components. The first is a goal of at least 25% female Lake Trout at spawning sites. This target has been met in 9 out of 23 years of the fall spawner survey (Figure 6), indicating continued inconsistency in attaining the percent-female target. In 2023, percent-female across both sites was 32%, though only 14% at Julian's Reef (the priority site for the assessment of progress towards evaluation objectives). Over the duration of the fall Lake Trout survey, percentage of sampled fish that were female has been consistently higher at Waukegan Reef (mean = 35%) than at Julian's Reef (mean = 24%). In years where both reefs were sampled, percent-female has been higher at Waukegan Reef 82% of the time (16 out of 19 years). The cause of between-reef variation in percentage of females is currently not known.

The Lake Trout catch at Julian's Reef consisted of eight age groups older than age-7 in 2023 (Figure 7) and ten age groups older than age-7 across both reefs. Since the start of the fall survey, Lake Trout

catches have consisted of 10-14 age classes older than age-7 in 11 of 23 years, indicating inconsistency in meeting the age-class target of Evaluation Objective 3. Currently, coded-wire tags represent the only source of ages for Lake Trout collected from spawning sites in the fall survey; ages from wild Lake Trout or Lake Trout with rotational fin clips are not yet represented within the data being used to evaluate Objective 3 in Illinois waters. Furthermore, no coded-wire tags were given to Lake Trout between 2005-2009, meaning that in the 2023 data the 14-18 year old age classes were not represented. Aging structures have been collected from Lake Trout during previous and current annual assessments and processing of these structures over the next couple years is anticipated. Future inclusion of this data particularly from unclipped, wild Lake Trout should provide a more complete age structure of the existing mixed stock of hatchery-reared and wild Lake Trout.

About 63% of Lake Trout sampled at Waukegan Reef (102 of 162) did not have a fin clip in 2023, while the percentage of non-clipped fish at Julian's Reef was 54% (69 of 128). The presence of unmarked, potentially wild fish has increased substantially in recent years (Figure 8).

In 2023, 44 Lake Trout sampled at Julian's Reef had an adipose fin clip and a coded wire tag. Most (37) of the tagged fish were stocked at Julian's Reef (5 to 13 years old at capture). Of the remaining fish, four were stocked at the Mid-lake Reef Complex (10 to 29 years old at capture), one was stocked from shore in Indiana (9 years old at capture) and one fish was stocked from shore in Wisconsin (8 years old at capture) as a fall fingerling (all others were stocked as yearlings). One tag was lost during the extraction process and not able to be decoded.

At Waukegan Reef, 40 Lake Trout were sampled with an adipose fin clip and coded wire tag. Most (29) were stocked at Julian's Reef (5 to 20 years old at capture), and nine were stocked at the Mid-lake Reef Complex (8 to 19 years old at capture). One fish was stocked from shore as a fall fingerling (all others were stocked as yearlings) at either Kewaunee, WI or New Buffalo, MI (10 years old at capture). Finally, one tag was damaged and could not be read completely, but the two potential tag lots revealed it was either stocked at the Mid-Lake Reef Complex or in the Northern Refuge (34 years old at capture).

The average age of stocked Lake Trout sampled in the 2023 fall survey was 10.4 years, exactly matching the long-term average of 10.4 years (1998-2023 average). The calculation of average age of stocked Lake Trout only includes ages obtained from CWTs and does not include those with rotational fin clips since only a range of potential ages can be estimated for these fish at this time. During the 2023 fall survey, 27 Lake Trout were captured with rotational fin clips whereby individual fins or combinations of fins were

clipped on a 5-6 year rotation for several decades to identify potential year classes. Assuming all Lake Trout with rotational fin clips were the minimum possible age to provide a conservative estimate, the average age of stocked Lake Trout would be 11.6 years.

CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS

Spring Lake Trout survey CPUE was anticipated to be lower than fall CPUE when targets were set because Lake Trout aren't necessarily aggregated in the spring as they are during the fall spawn. Spring CPUE in the Illinois waters of Lake Michigan however have remained below the target in a majority of years sampled, not reaching 25 fish/1000 ft since the mid-2000s. Similarly, the target has been met only briefly at four of the twelve spring sampling sites lake-wide and has not been achieved with any regularity or consistency at any site (LMLTWG 2021).

Recommendations: Continue participation in spring Lake Trout survey and evaluate results toward achieving Evaluation Objective 1 of the Strategy; share results with Lake Trout Working Group of the Lake Michigan Technical Committee.

Lake Trout population parameters for the fall spawner survey have been showing positive signs toward rehabilitation over the last decade. Catch per unit effort, proportion of females present in the spawning population, and number of older age classes have been at or above the targeted levels recently, suggesting movement toward rehabilitation success at some sites (LMLTWG 2021). The increased presence of unmarked fish in recent years indicates successful recruitment to adult life stages, especially in Illinois waters.

Recommendations: Continue participation in fall spawner survey at Julian's and Waukegan Reef with a special focus on presence of unmarked fish in the population as well as Objectives 2 and 3 of the Strategy, and disseminate results of progress toward rehabilitation goals; share results with the Lake Trout Working Group of the Lake Michigan Technical Committee.

Although no new non-priority sites were sampled in 2021-2023, bathymetric surveys have been conducted by the Illinois Natural History Survey at other reefs (e.g. Gumby Reef) along with side-scan sonar surveys used to classify benthic substrate. These surveys will allow IDNR to plan future fall spawner surveys to investigate rehabilitation at other non-stocked reef locations.

Recommendations: Expand the fall spawner survey sampling to other potential Lake Trout spawning reefs in the Illinois waters of Lake Michigan, based on Illinois Natural History Survey mapping project results, *while maintaining an annual assessment of the Evaluation Objectives at either Waukegan or Julian's reefs. Utilize bathymetry and substrate information to target Lake Trout spawning locations on reefs.*

ACKNOWLEDGEMENTS

Special thanks are extended to Steve Robillard for his past efforts on field survey methods, database development and management, and writing support in a previous version of this annual report.

LITERATURE CITED

Bronte, C.R., Holey, M.E., Madenjian, C.P., Jonas, J.L., Claramunt, R.M., McKee, P.C., Toneys, M.L., Ebener, M.P., Breidert, B., Fleischer, G.W., Hess, R., Martell Jr., A.W., and E. Olsen. 2007. Relative abundance, site fidelity, and survival of adult lake trout in Lake Michigan from 1999-2001: Implications for future restoration strategies. North American Journal of Fisheries Management. 27(1): 137-155.

Dexter, J.L., Eggold, B.T., Gorenflo, T.K., Horns, W.H., Robillard, S.R., and S.T. Shipman. 2011. A fisheries management implementation strategy for the rehabilitation of Lake Trout in Lake Michigan. Lake Michigan Technical Committee Document. 12 pp.

Holey, M.E., Rybicki, R.W., Eck, G.W., Brown Jr., E.H., Marsden, E.J., Lavis, D.S., Toneys, M.L., Trudeau, T.N, and R.M. Horrall. 1995. Progress toward lake trout restoration in Lake Michigan. Journal of Great Lakes Research. 21(Supp 1): 128-151.

Lake Michigan Lake Trout Working Group (LMLTWG). 2021 Lake Michigan Lake Trout Working Group Report. Lake Michigan Technical Committee Document. 21pp.

Patterson, K.A., J.A. Stein, and S.R. Robillard. 2016. Progress toward lake trout rehabilitation at a stocked and unstocked reef in Southern Lake Michigan. North American Journal of Fisheries Management 36(6):1405-1415.

McKee, P.C., Toney, M.L., Hansen, M.J., and M.E. Holey. 2004. Performance of two strains of lake trout stocked in the Midlake Refuge of Lake Michigan. North American Journal of Fisheries Management. 24(4): 1101-1111.

Schneeberger, P., Toneys, M., Elliot, R., Jonas, J., Clapp, D., Hess, R., and D. Passino-Reader. 1998. Lakewide assessment plan for Lake Michigan fish communities. Lake Michigan Committee Document. 57 pp.

Wells, L., and A. McLain. 1972. Lake Michigan: Effects of exploitation, introductions, and eutrophication on the salmonid community. Journal of the Fisheries Research Board of Canada. 29: 889-898.

Figure 1. Location of the spring Lake Trout survey sites (white squares) and fall spawning Lake Trout surveys (Open Circles) in the Illinois waters of Lake Michigan in 2023.

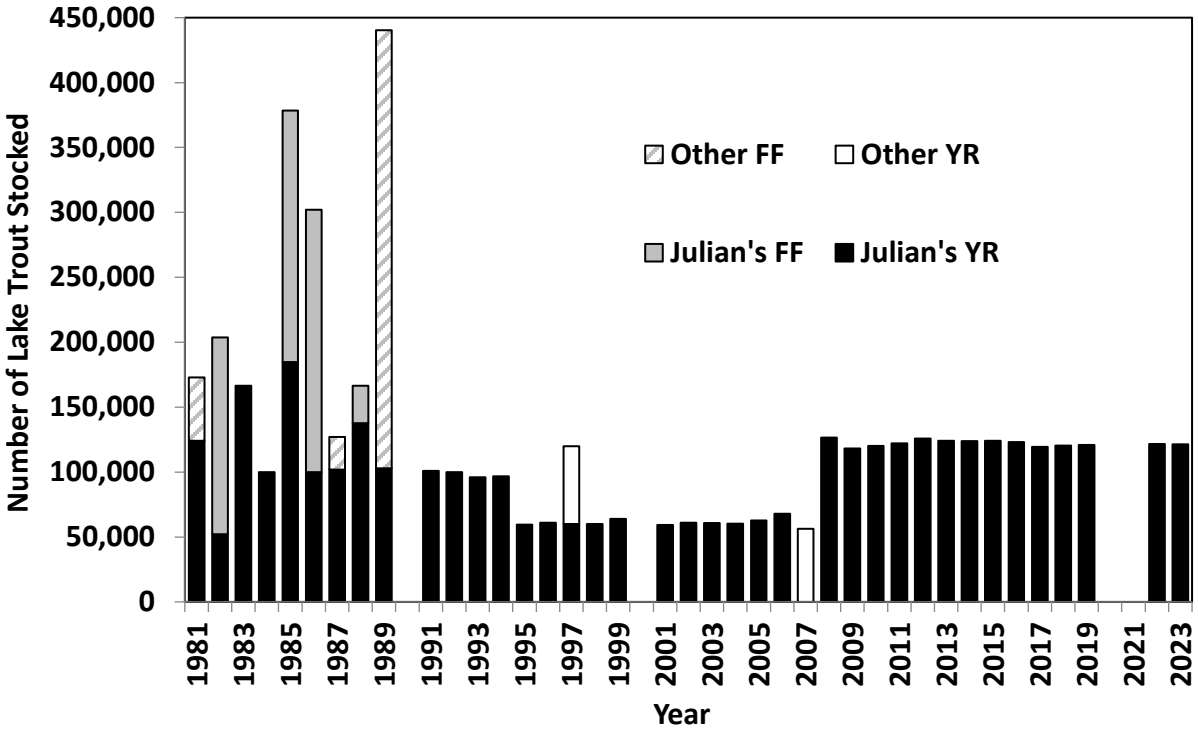

Figure 2. Lake Trout stocking in Illinois waters of Lake Michigan, 1981 to 2023 (FF = fall fingerling, YR = yearling). Due to COVID-19 restrictions, federally reared Lake Trout allocated to Illinois were stocked from shore in Wisconsin during 2020 and 2021.

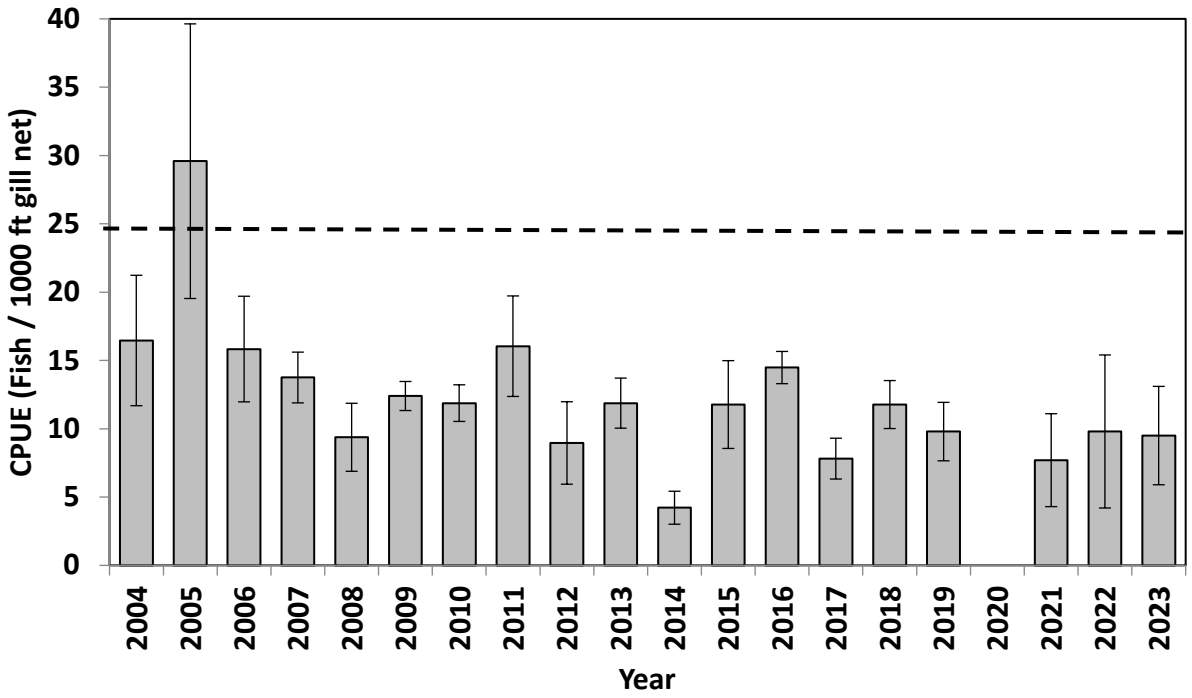

Figure 3. Catch per unit effort (CPUE) of Lake Trout sampled in May 2004-2023. The dotted line represents the CPUE goal (>25 fish/1000 ft of gill net) of Evaluation Objective 1 in A Fisheries Management Implementation Strategy for the Rehabilitation of Lake Trout in Lake Michigan. Due to COVID-19 restrictions no sampling occurred in 2020.

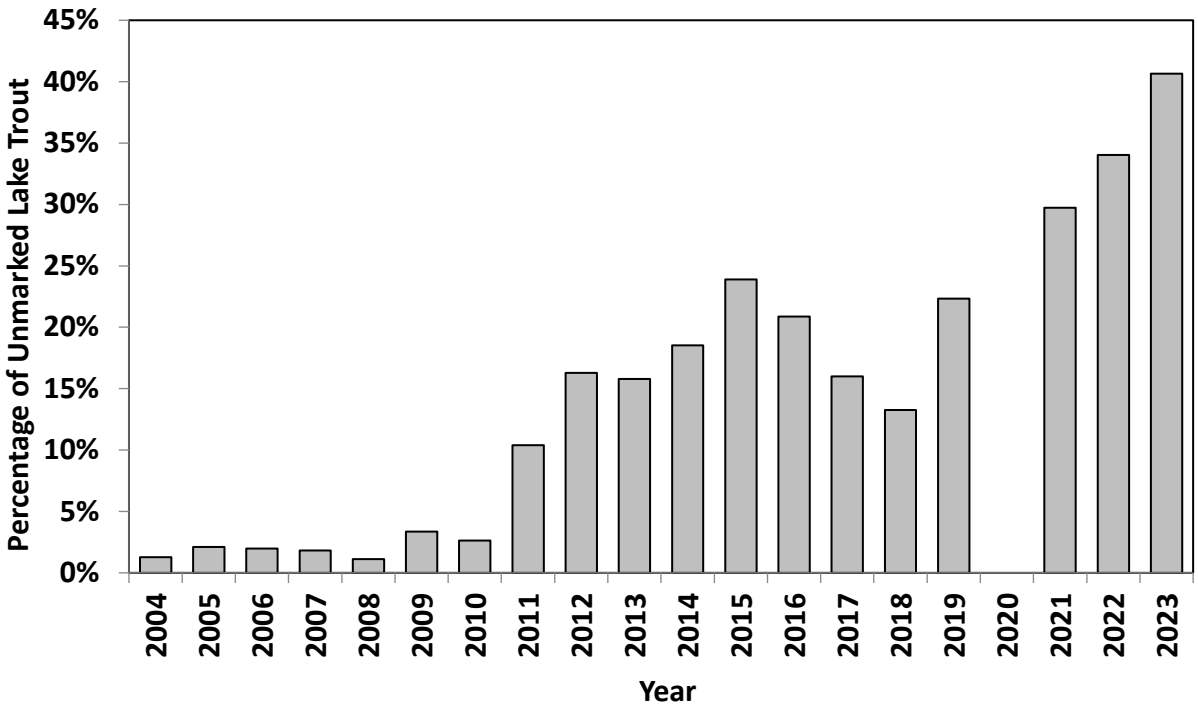

Figure 4. Percentage of unmarked Lake Trout sampled in May 2004-2023 near Waukegan, IL. Due to COVID-19 restrictions no sampling occurred in 2020.

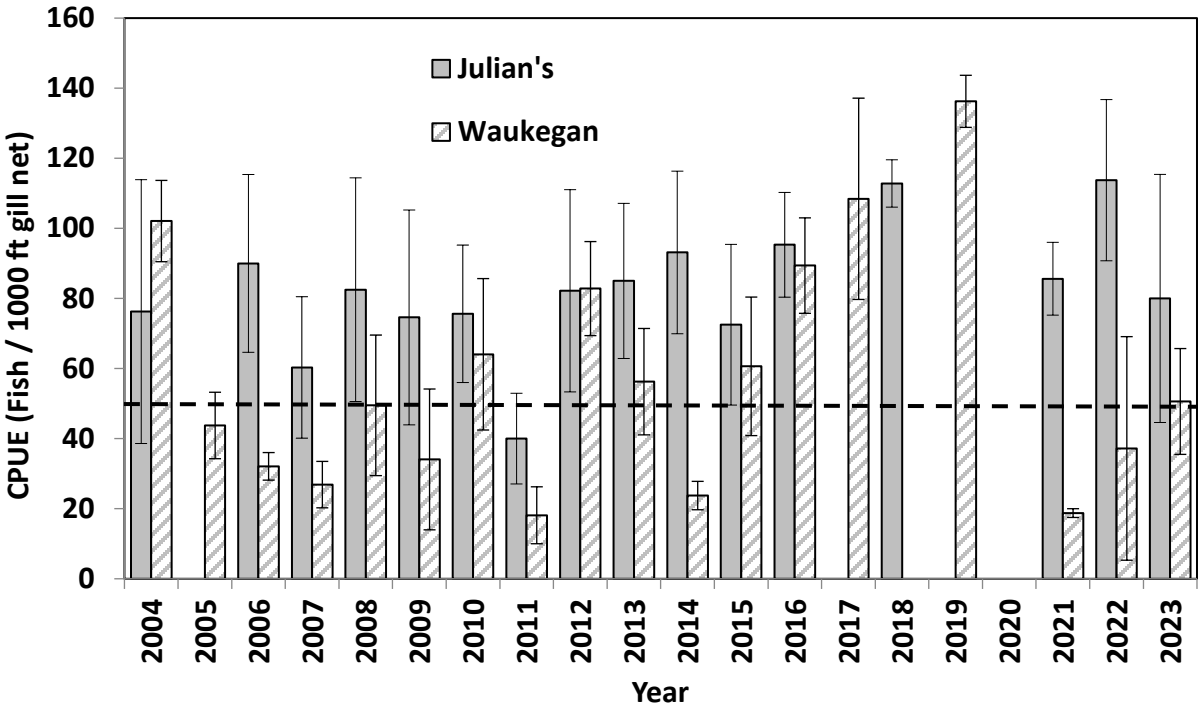

Figure 5. Catch per unit effort (CPUE) of Lake Trout sampled in October and November 2004-2023 at Julian's Reef (sold gray bars) and Waukegan Reef (crosshatched). The dotted line represents the CPUE target (>50 fish/1000 ft of gill net) of Evaluation Objective 2 in A Fisheries Management Implementation Strategy for the Rehabilitation of Lake Trout in Lake Michigan. No sampling occurred in 2020.

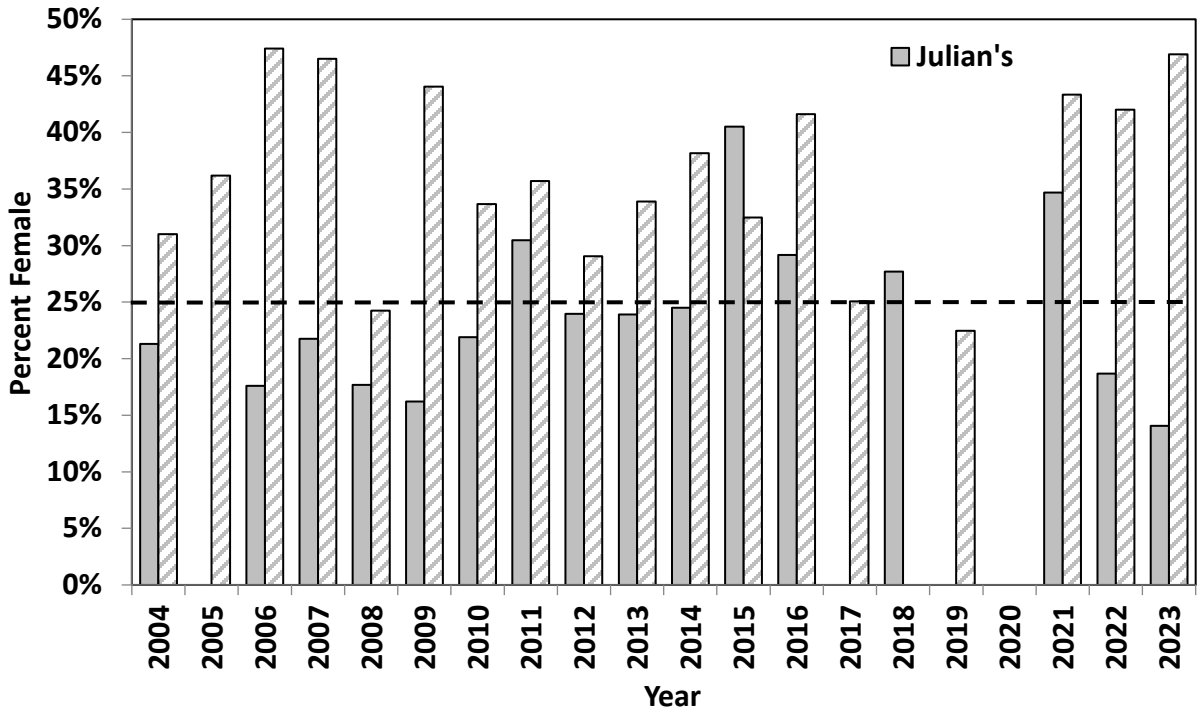

Figure 6. Percent female Lake Trout sampled in October and November 2004-2023 at Julian's Reef (sold gray bars) and Waukegan Reef (crosshatched). The dotted line represents the female proportion target (>25% female for spawning populations) of Evaluation Objective 3 in A Fisheries Management Implementation Strategy for the Rehabilitation of Lake Trout in Lake Michigan. No sampling occurred in 2020.

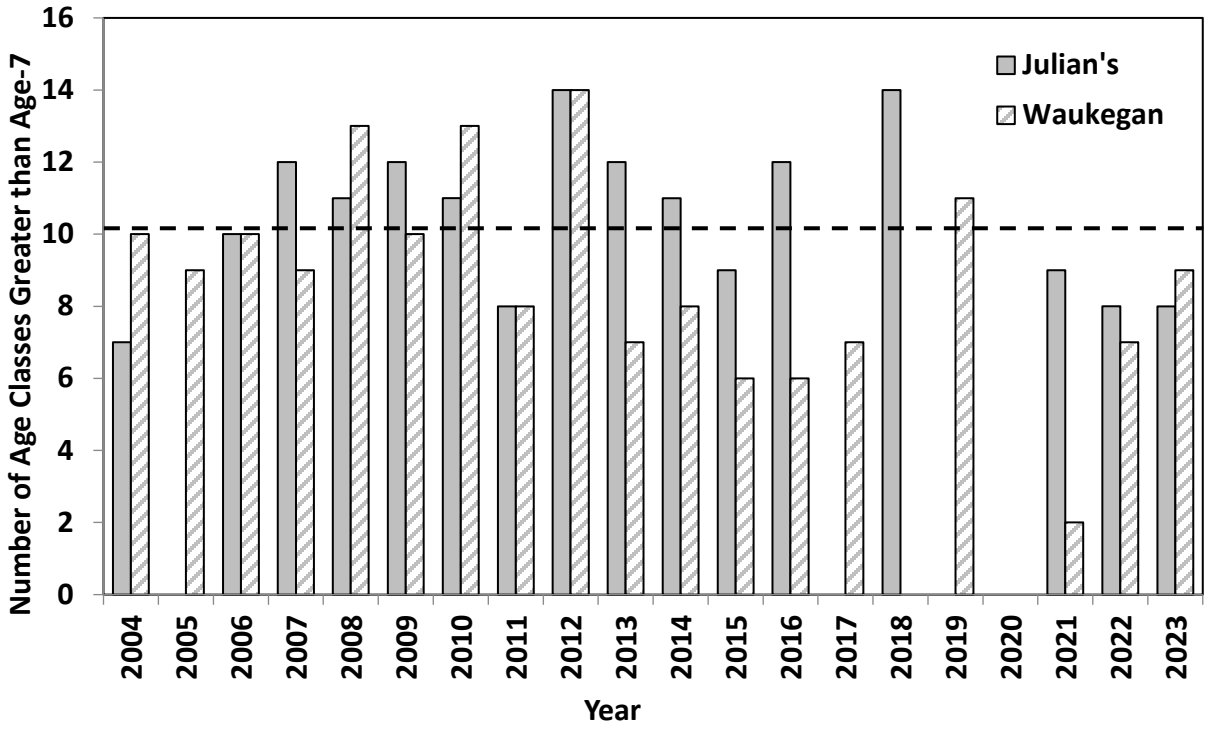

Figure 7. Number of Lake Trout age classes greater than age-7 sampled in October and November 2004-2023 at Julian's Reef (sold gray bars) and Waukegan Reef (crosshatched). The dotted line represents the age class target (≥10 age groups older than age-7 for spawning populations) of Evaluation Objective 3 in A Fisheries Management Implementation Strategy for the Rehabilitation of Lake Trout in Lake Michigan. No sampling occurred in 2020.

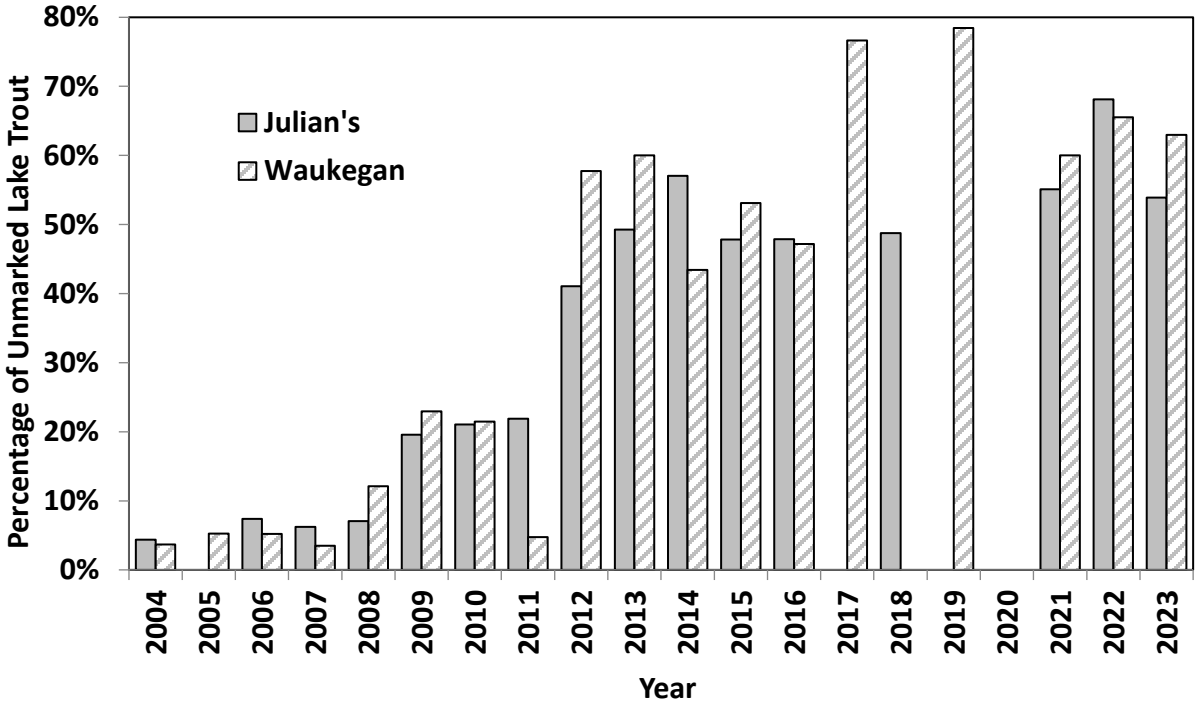

Figure 8. Percent of unmarked Lake Trout sampled in October and November 2004-2023 at Julian's Reef (sold gray bars) and Waukegan Reef (crosshatched). No sampling occurred at Julian's Reef in 2005, 2017, and 2019 or Waukegan Reef in 2018 and neither site was sampled in 2020.