Lake Carmi Walleye Management
District 4

Vermont Fish and Wildlife Department
Annual Report

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Summary

A fall nighttime electrofishing survey was conducted on Lake Carmi to monitor the Walleye population and fish community. The catch rate, size, and age structure of Walleye were analyzed and the length distribution of Yellow Perch was compared to historical distributions. Alewife were sampled using a floating micro-mesh gillnet to assess relative abundance and length distribution.

Introduction

Lake Carmi in Franklin County, Vermont has a robust, self-sustaining Walleye *Sander vitreus* population that supports a popular fishery. From 1996 through 2004, the Walleye fishery was regulated with an open season from the first Saturday in May through March 15th; a minimum total length of 381 mm (15 inches) with a 432 to 508 mm (17 to 20 inches) protected slot; and a creel limit of five fish per day. These regulations were designed to allow harvest of the abundant smaller Walleyes while protecting the majority of the spawning stock and allow more Walleyes to reach quality sizes. In 2005, the protected slot was reduced to 432 to 483 mm (17-19 inches) while the creel limit remained at five per day, but with only one Walleye greater than 483 mm (19 inches). The change was made with the goal to allow further growth of the segment of quality-sized Walleyes in the population.

In 2018, Lake Carmi was the first lake in Vermont to be designated a "lake in crisis" by the Agency of Natural Resources following many years of large cyanobacteria blooms. This designation provided a mechanism to set in motion a state response plan that included the installation of a whole-lake aeration system in 2019 (Lake Carmi Crisis Response Plan 2018). The system was designed to prevent anoxic conditions at the water-sediment interface thereby preventing phosphorus bound in the sediment from being released into the water column. Although startup of the aeration system is delayed as late into the spring as possible, it is

unknown whether the altered water currents will affect the recruitment success of Walleye or other spring spawning fish species.

In December 2017, Alewife *Alosa pseudoharengus* were confirmed in Lake Carmi following a large die-off of approximately 3,000 fish (Good 2018). Multiple size classes were present indicating the population was likely present for many years and reproducing. However, Alewife had not previously been detected during annual fall nighttime boat electroshocking Walleye surveys and have only been sporadically detected during these surveys in subsequent years, resulting in a lack of information about the population. Floating micro-mesh gillnets were set during one sampling event in 2020 and many Alewife were captured across multiple age classes (Simard 2021). Subsequently, in late-November and early-December 2020, another large Alewife die-off was reported (Simard 2021).

The objectives of this study are 1) to evaluate the Lake Carmi Walleye population response to the current harvest regulation, whole-lake aeration system, and establishment of Alewife, 2) to assess trends in the Lake Carmi fish community with a specific focus on Yellow Perch *Perca flavescens* due to its popularity among anglers, and 3) sample for Alewife to establish basic information about the population in Lake Carmi.

Methods

A shoreline boat electrofishing fish community survey using pulsed DC current was conducted on the nights of October 17th and 18th, 2022. All eight standardized and georeferenced shoreline transects were surveyed (Table 1, Figure 1). Walleye, Largemouth Bass *Micropterus salmoides,* Smallmouth Bass *Micropterus dolomieu*, Northern Pike *Esox lucius*, and Black Crappie *Pomoxis nigromaculatus* were targeted during all transects. A sample of all other species were collected during the first 15 minutes of electroshocking on transects 3 and 6.

All fish collected were measured for total length (TL) and released. All game fish species noted above were weighed prior to being released. Based on past sampling, Walleye less than 254 mm (10 inches) were assumed to be age-0. The second dorsal spine was removed from all Walleye greater than 254 mm in length for age estimation. Additionally, the second dorsal spine was also removed from all larger (generally >254 mm) Yellow Perch to assess the precision and feasibility of using this structure to estimate the age of the species. While otoliths are typically used for estimating the age of Yellow Perch within the Vermont Fish and Wildlife Department (e.g., Pientka 2022), the use of fin spines has also been evaluated and are commonly used by other agencies (e.g., Isermann et al. 2018) and could be easily incorporated into the workflow already being used for Walleye.

Walleye and Yellow Perch spines were cleaned in bleach, mounted in epoxy resin, and cross sectioned into typically five sections using an Isomet saw (1.605 mm thick). All five sections were mounted onto a single glass slide using Cytoseal 280 and then labeled with the sample information. Mineral oil was placed on each cross section before examining with a compound microscope. Two readers independently examined each slide to estimate the age of the fish in whole year increments. If there was disagreement between the two age estimates, a third reader would examine the slide. If two of the three readers agreed, that age estimate was

recorded. If there was not 2/3 consensus but the three estimates were consecutive (e.g., 6 yrs, 7 yrs, 8yrs) the mean value was recorded as the consensus age. Ages were not recorded for samples with more disparate age estimates among the three readers.

Catch per Unit Effort (CPUE) expressed as number of fish caught per hour was calculated for all Walleye collected, as well as for subsets of those estimated to be age-0, those estimated to be age-1, those between 381 mm and 432 mm (15 in – 17 in, the harvestable size below the current slot limit), and for those over 483 mm (19 in, the harvestable size above the current slot limit). The CPUE of other sportfish targeted during the first round of sampling was also calculated.

The length distribution of Yellow Perch collected was compared with values from perch collected during sampling at the same stations (3 and 6) since 2011. The percent agreement between Reader 1 and Reader 2 was calculated. Age-bias plots similar to those suggested by Campana et al. (1995) were used to show the differences in mean age estimates of Reader 1 and Reader 2 relative to the consensus age. The mean coefficient of variation (CV = [SD / mean] *100) (Isermann et al. 2018) was also calculated between readers 1 and 2 relative to the consensus age.

A floating micro-mesh gillnet was deployed in the northeast portion of Lake Carmi to sample for Alewife during both sample events. The net measures 6 m deep by 21 m in length with seven panels of mesh sizes including 6.24, 8, 10, 12, 15, 18, and 25 mm. Nets were set in approximately 7 m of water prior to starting electrofishing sampling on both October 17 and October 18 and retrieved after electrofishing was completed. Fish were picked from the nets within one day of retrieval and the total length of all collected fish was measured. Catch-per-unit effort was calculated as the number of Alewife caught per 4-hour net set.

Results

A total of 315 Walleye were collected in 3.61 hours of electrofishing (Tables 1 and 2). Water temperature averaged 13.6°C across the two sampling days (Table 1). Walleye lengths ranged from 170 – 597 mm (6.7 – 23.5 in). Ages were estimated for 313 of the collected Walleye. The catch was dominated by young-of-year Walleye with total lengths between 170 mm to 236 mm composing 55.9% of the total catch (Figures 2, 3). Walleye from 12 other age classes ranging from age-1 to age-14 were also captured (Figure 3). Total Walleye CPUE was 87.26 Walleye per hour (Table 2, Figure 4), the highest level observed since 2006. CPUE of Walleye over 483 mm (19 in) was 14.1 Walleye per hour (Table 2), the highest level observed since routine sampling began in 1996 (Figure 5).

A total of 275 Yellow Perch were collected during the first 15 minutes of sampling at stations 3 and 6 with lengths ranging from 52 - 327 mm with approximately 66% of the fish collected less than 175 mm (Figure 6). The length range of captured Yellow Perch was relatively similar to previously sampled years (Figure 7). Spines were taken from 66 Yellow Perch with lengths ranging from 246 mm – 327 mm (Figure 8). A consensus age was reached for 64 of these fish with age estimates ranging from 3 to 8 years (Figure 8). There was only a 28.8% agreement between age estimates for Reader 1 and 2. Reader 1's age estimates were

biased low relative to the consensus age across near all ages while Reader 2's estimates was typically closer to the consensus age with a lower CV (Figure 9).

A total of 155 Smallmouth Bass, 38 Largemouth Bass, 28 Northern Pike, and 4 Black Crappie were collected (Table 3). Other species captured included Golden Shiner *Notemigonus crysoleucas*, White Sucker *Catostomus commersonii,* Brown Bullhead *Ameiurus nebulosus*, Rock Bass *Ambloplites rupestris*, Pumpkinseed *Lepomis gibbosus*, Banded Killifish *Fundulus diaphanus*, Emerald Shiner *Notropis atherinoides*, Blacknose Shiner *Notropis heterolepis,* and an unidentified Cyprinid.

The floating micro-mesh gillnets were set for a total of 10.88 hours. A total of 19 Golden Shiner and one Black Crappie were captured. No Alewife were captured in the nets for a CPUE of 0.00 Alewife per four-hour gillnet set.

Discussion

Walleye catch rates on Lake Carmi in the fall of 2022 were very high with the overall catch rate again the highest observed since 2006 and the catch rate of Walleye above the slot limit the highest observed since annual fall shoreline electrofishing began in 1996. High catch rates appear to be transferring to the fishery as well with many anglers anecdotally reporting high-quality fishing over the past year, especially for larger fish above the slot limit. These reports and data indicate that the slot limit as currently implemented has been effective at achieving its purpose of allowing more Walleye to reach a quality size. Given the reduced limit for Walleye over 483 mm (19 in), these large fish should remain abundant and be observed in sampling events over the next several years. However, anglers continued to comment that it has been challenging to fill a bag limit as very few legal-sized fish below the slot limit are being caught. Our data supports these comments as relatively few 381-432 mm (15-17 in) Walleye were observed during this survey. However, many fish were caught in the age-1 year class that were just below the legal length limit and should begin to recruit into the fishery in 2023.

A robust age-0 year class of Walleye was again observed in 2022 following the strong year class from 2021. Robust year classes of Walleye typically only occur every two or three years as a variety of environmental factors are required to allow larval fish to survive. Similarly, strong Walleye year classes were observed in Chittenden Reservoir in 2021 and 2022 (Good 2023) suggesting spring conditions may have been ideal for Walleye throughout the region. Additionally, the lack of Alewife in the floating micro-mesh gillnets suggests the population has not recovered in Lake Carmi following the die-off observed in December, 2020 allowing Walleye young-of-year to have higher survival rates. In Saginaw Bay, Lake Huron, Alewife abundance is the dominant factor predicting production of wild age-0 Walleye with low Alewife abundance a prerequisite for a strong Walleye year class (Fielder et al. 2007). Floating micromesh gillnets should continue to be used to monitor trends in Alewife populations as they rebound from this last die-off to better understand the relationship between Walleye recruitment success and Alewife abundance in Lake Carmi.

The whole-lake aeration system in Lake Carmi was activated on May 10, 2022, more than a week earlier than when the system was activated in 2021 again due to a warm spring that quickly

increased water temperatures and decreased oxygen levels within the lower portion of the water column. However, despite this early activation, a robust Walleye year class still recruited to the population. It is likely that the timing of Walleye spawning, which is also water temperature dependent, also responded similarly and occurred earlier in the spring, possibly limiting any effects of the early activation of the aeration system. While these two years do not alone prove the aeration system does not have an impact on Walleye recruitment success, it does seem to indicate that the water quality metrics at which the system is activated and were agreed to by VFWD and the Department of Environmental Conservation may be appropriate to not harm larval Walleye as they hatch and develop.

The maximum length of Yellow Perch observed during sampling increased relative to the previous two years and is around the maximum length observed over the previous 10 years. The current sampling methodology only provides a general overview of the population and alone is unable to provide details on what changes may be occurring within the population. However, incorporating age information into future surveys could provide additional information about growth and length-at-age and allow population changes to be better monitored over time. While the percent agreement between readers 1 and 2 was quite low, a consensus age was still reached for nearly all the spines collected. A clear bias was present between the two readers. Given the extensive prior experience readers had estimating ages using Walleye spines, additional discussion and training did not occur prior to reading Yellow Perch spines. While the structures were very similar, certain differences likely lead to the observed bias. Reviewing these differences in the future prior to reading would likely increase the agreement and precision of the two readers. If these issues were addressed, these results suggest dorsal spines should be used for age estimation if a more detailed Yellow Perch assessment is desired, especially given fish do not have to be sacrificed and the structure can be incorporated into the same workflow used for Walleye.

Conclusions

The Lake Carmi Walleye population continues to provide a high-quality fishery for anglers with abundant large fish. Catch-rates of Walleye above the slot-limit (483 mm) were again the highest observed since annual fall shoreline electrofishing began in 1996. A strong age-0 year class was again present for the second consecutive year. Few legal-length Walleye below the protected slow (381-432 mm) were observed during sampling, but the 2021 year-class should begin to recruit into fishery within the coming year. Sampling with a micro-mesh floating gillnet did not capture any Alewife indicating the Alewife population likely remains at a very low abundance following the die-off observed in late 2020 allowing another strong year class to survive. Dorsal spines appear to be an appropriate structure to use to estimate the age of Yellow Perch in Lake Carmi. A consistent bias was observed between readers across ages, but additional discussion and training would likely reduce these differences during future use.

Recommendations

1. Continue monitoring the Lake Carmi Walleye population to track trends over time, especially in response to the fluctuation in Alewife populations and the continued use of the whole-lake aeration system.

2. Continue to sample Alewife in Lake Carmi using floating micro-mesh gillnets to track the relative abundance and size distribution of the species over time.
3. Continue collecting a subset of all species at stations 3 and 6 while sampling for Walleye to monitor the overall fish community in Lake Carmi, especially Yellow Perch. Utilize dorsal spines for Yellow Perch age estimation if a more detailed assessment is desired.

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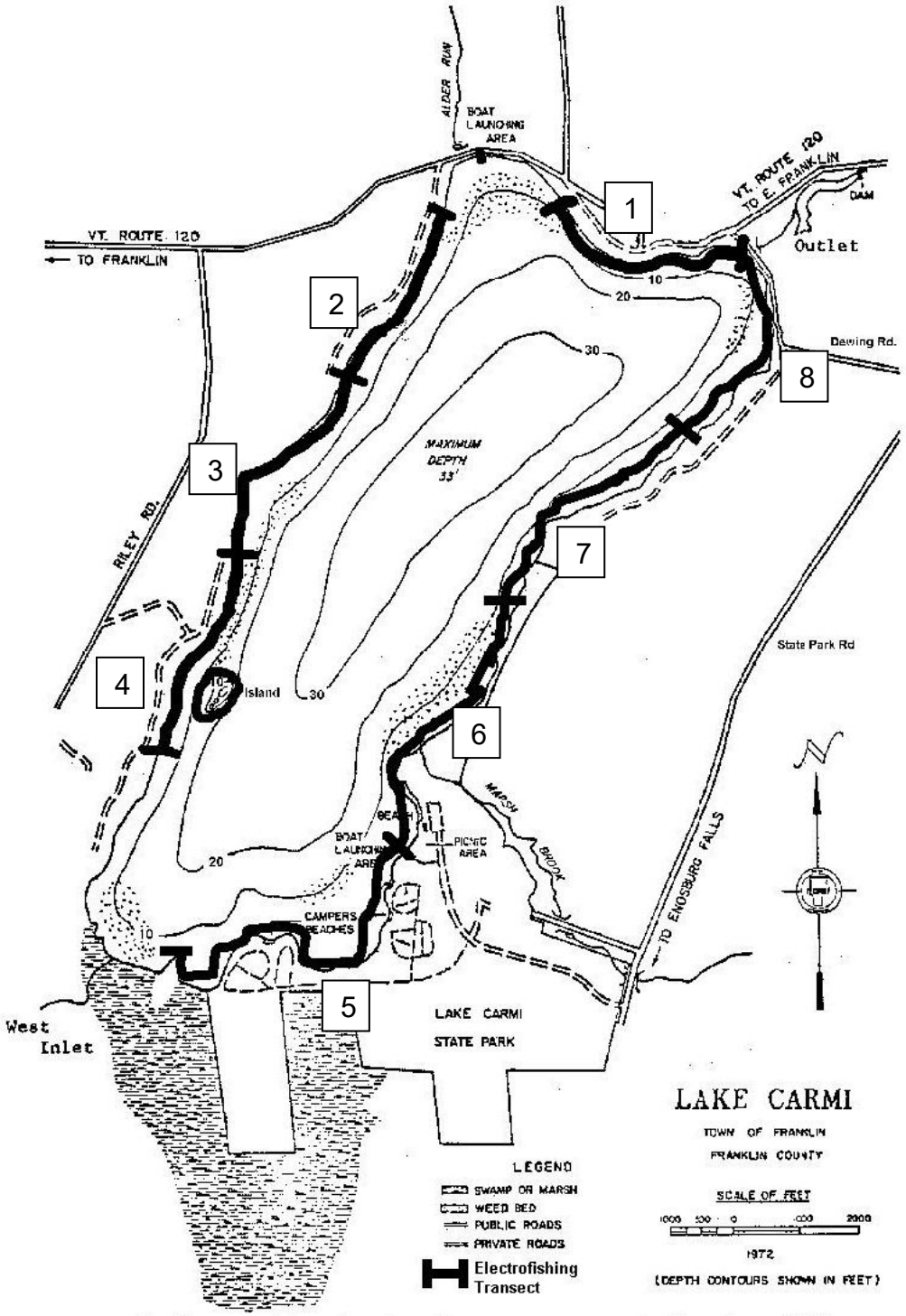

Figure 1. Locations of eight shoreline electrofishing transects on Lake Carmi typically sampled during the fall surveys.

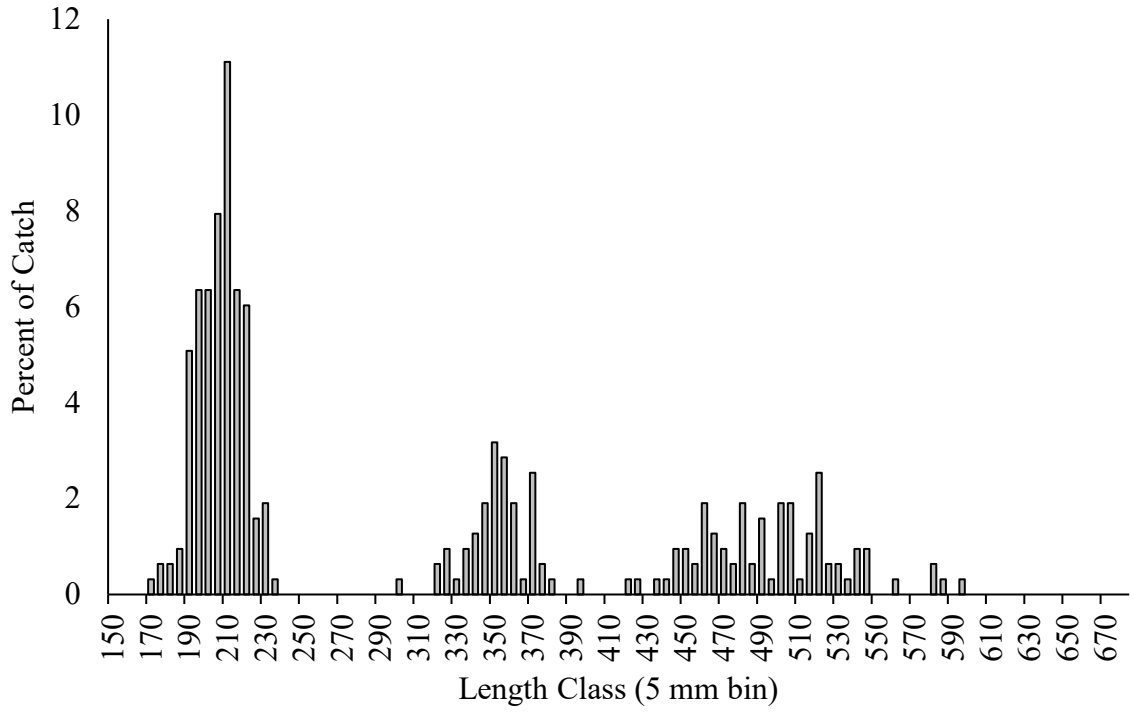

Figure 2. Relative length-frequency of Walleye captured during fall nighttime boat electroshocking on Lake Carmi on October 17 and October 18, 2022.

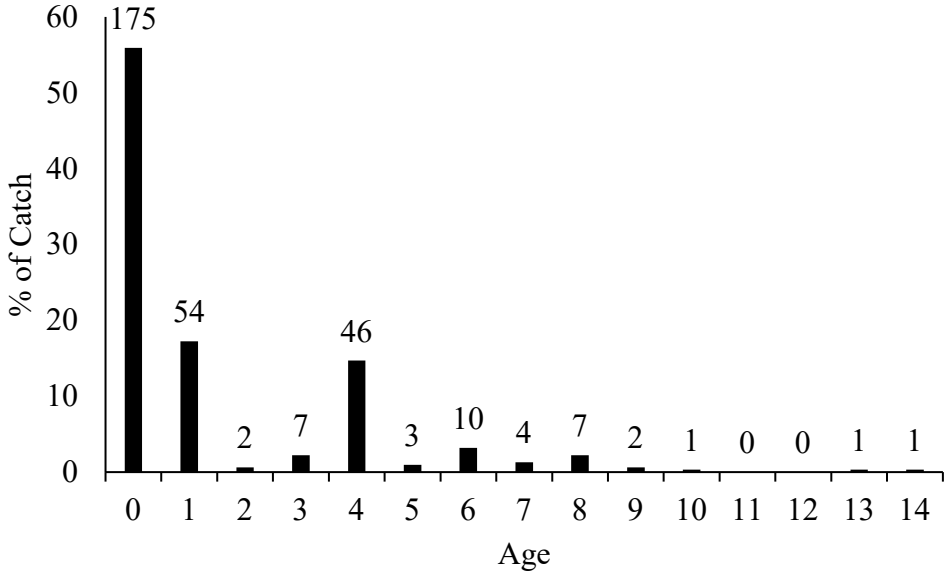

Figure 3. Relative age-frequency distribution of Walleye captured during fall nighttime boat electroshocking on Lake Carmi on October 17 and 18, 2022. Numbers above each bar indicate the count of Walleye within the given age bin. Walleye less than 254 mm were assumed to be age-0 based on length and were not aged with spines.

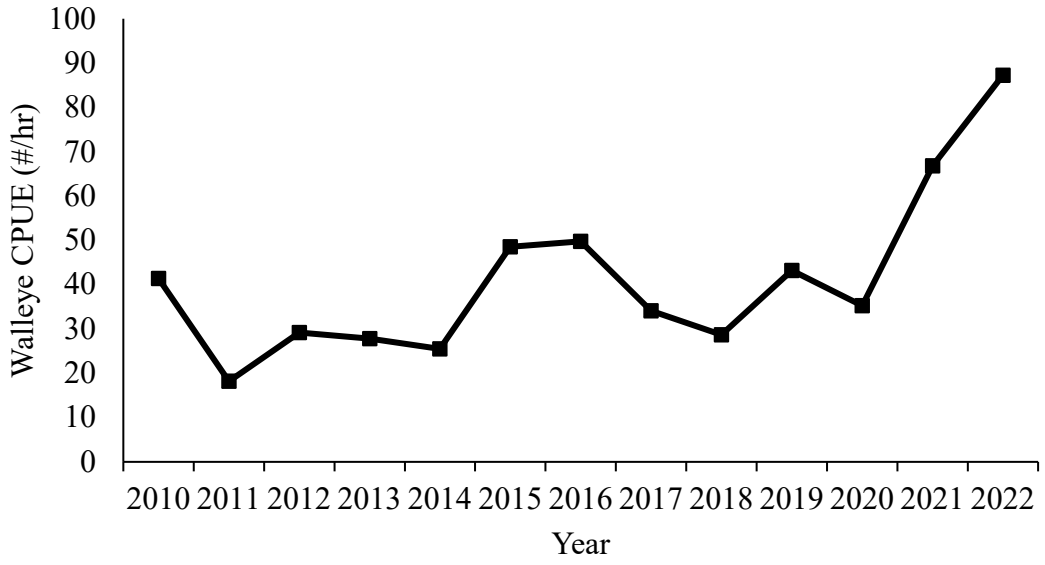

Figure 4. CPUE (number/hour) of Walleye collected during fall nighttime boat electroshocking on Lake Carmi from 2010 to 2022.

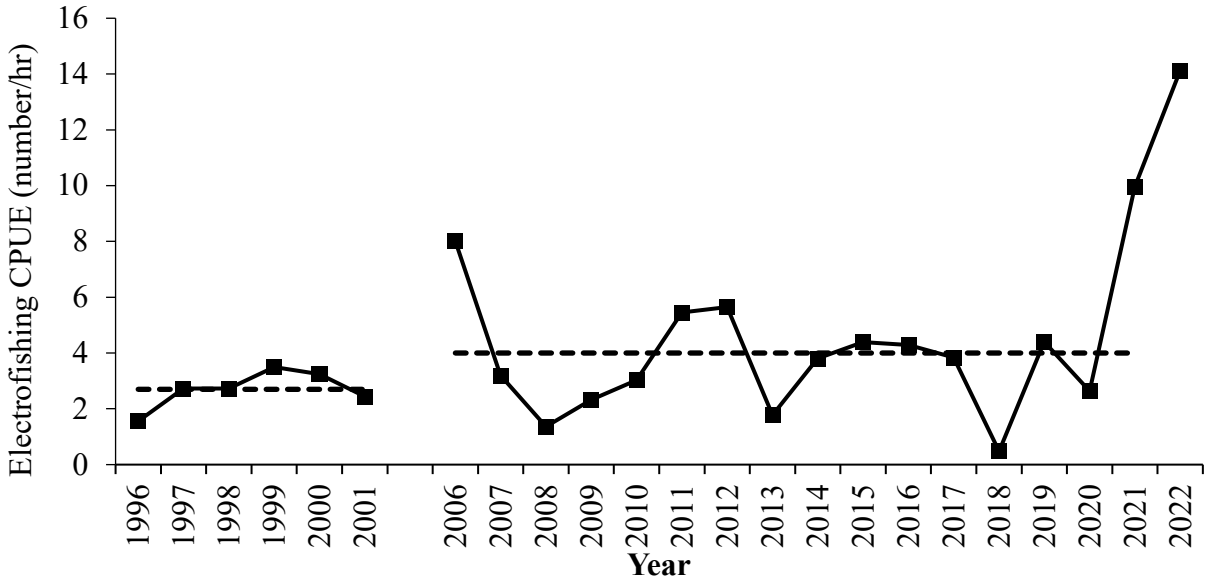

Figure 5. CPUE (number/hour) of Walleye over 483 mm (19 in) captured by fall nighttime boat electroshocking on Lake Carmi over time. Values are shown relative to the average CPUE calculated for the period before and after the Walleye slot limit was adjusted in 2005.

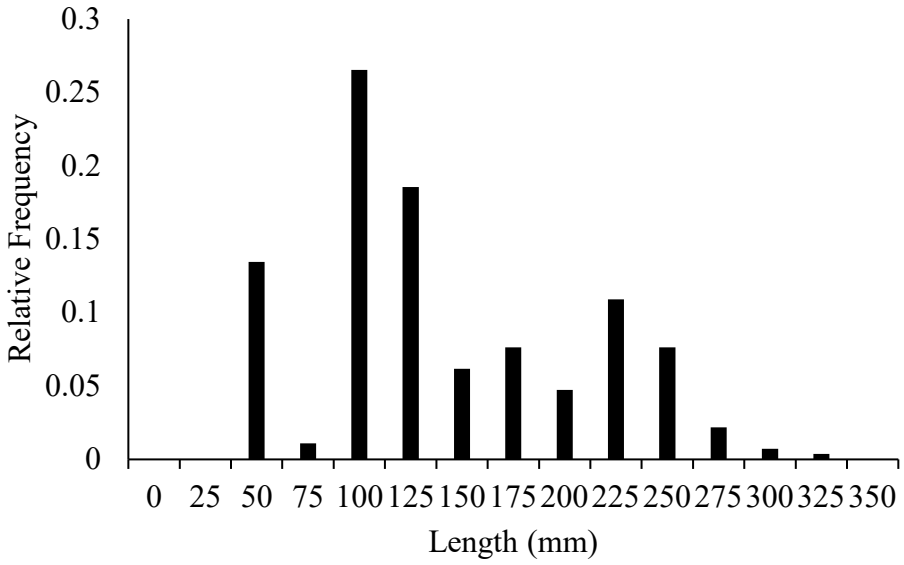

Figure 6. Relative length-frequency of yellow perch (n = 275) collected during the first 15 minutes of nighttime boat electroshocking in stations 3 and 6 on Lake Carmi, October 17 and 18, 2022.

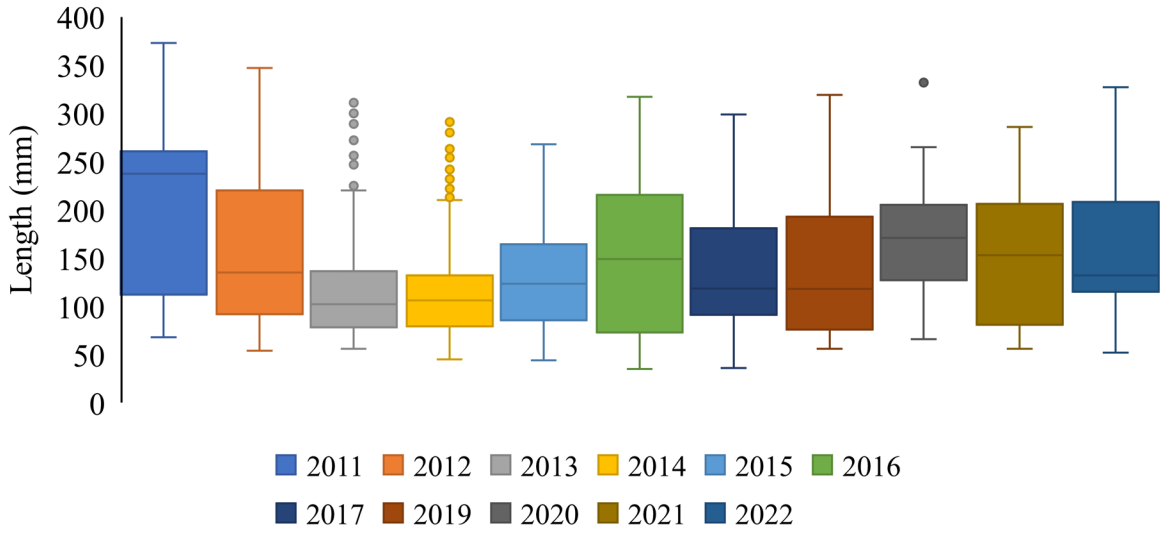

Figure 7. Total length distribution of Yellow Perch collected during fall nighttime boat electroshocking on Lake Carmi at stations 3 and 6 over time. Station 6 was not sampled in 2012.

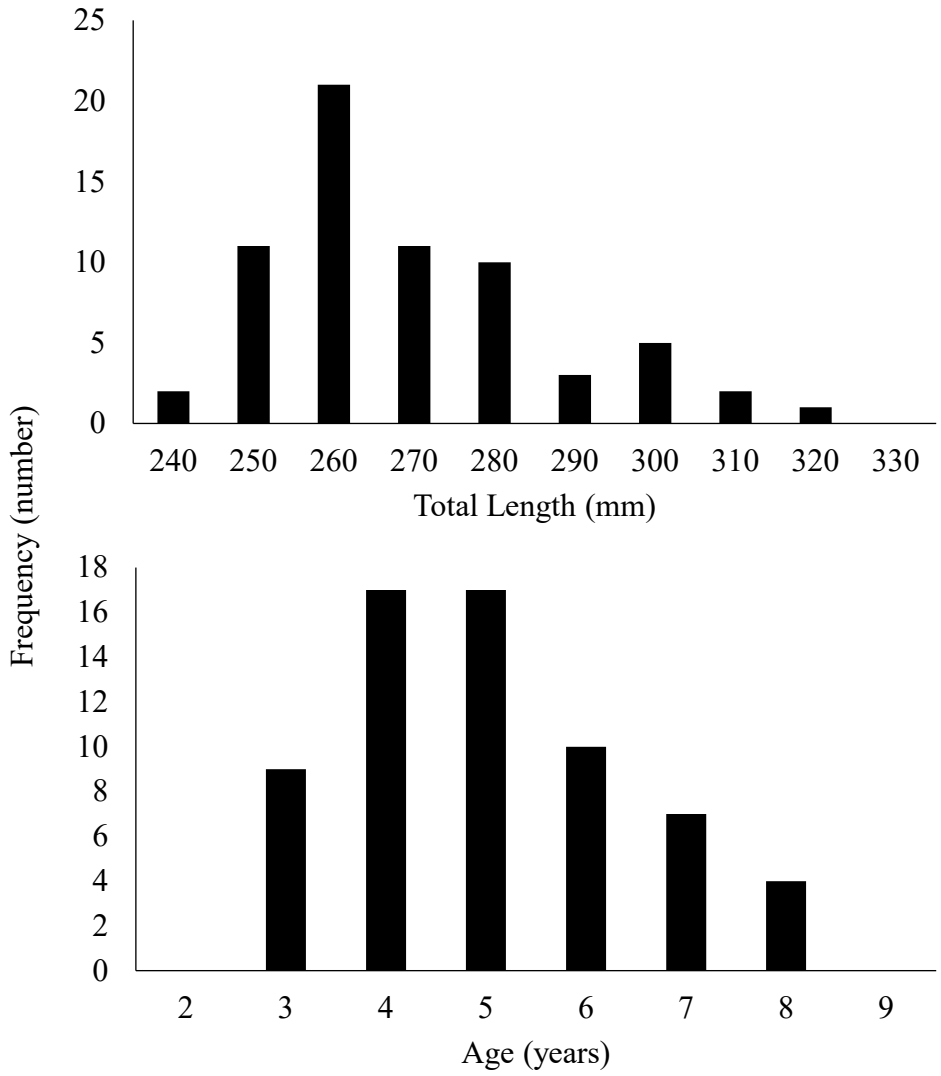

Figure 8. Total length (mm) and age frequencies based on consensus age based on sectioned dorsal spines of Yellow Perch collected in Lake Carmi, 2022.

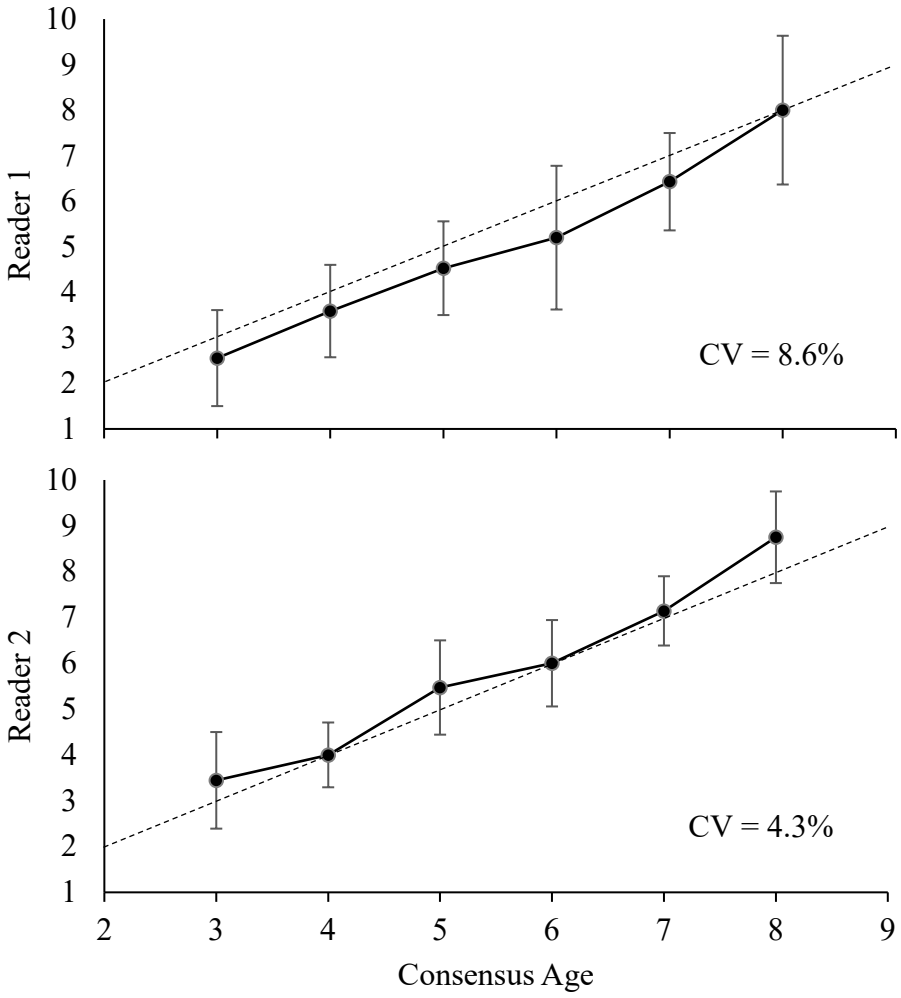

Figure 9. Mean age estimates and mean coefficient of variation (CV) for Reader 1 and Reader 2 in relation to the consensus age derived for sectioned dorsal spine age estimates for Walleye from Lake Carmi, 2022. Error bars represent the 95% confidence intervals while dashed lines represent 1:1 relationships between ages.

Table 1. Lake Carmi nighttime boat electroshocking transects surveyed in 2022. Transect numbers refer to Figure 1. A representative subset of all species encountered were collected for the first 15 minutes of sampling on transects marked with an asterisk (*).

Date	Transects Surveyed	Species Targeted	Mean Water Temp (°C)	Hours Sampled
17-Oct-2022	5, 6*, 7, 8	WAL, LMB, SMB, NRP, BLC	13.6	1.97
18-Oct-2022	1, 2, 3*, 4	WAL, LMB, SMB, NRP, BLC	13.5	1.64
			13.6	*3.61*

Note: WAL=Walleye, LMB=Largemouth Bass, SMB=Smallmouth Bass, NRP=Northern Pike, BLC=Black Crappie

Table 2. Number and CPUE (number per hour) of Walleye in various size and age classes captured during 3.61 hours of nighttime boat electroshocking on Lake Carmi, October 17 and 18, 2022.

Age or Size Range	N	CPUE
All	315	87.26
~Age 0	175	48.48
~Age 1	54	14.96
381-432 mm (15-17 in)	4	1.11
>= 483 mm (19 in)	51	14.13

Table 3. Number and CPUE of other sportfish targeted during 3.61 hours of nighttime boat electroshocking on Lake Carmi, October 17 and 18, 2022.

Species	Number	CPUE (#/hr)
Smallmouth Bass	155	42.9
Largemouth Bass	38	10.5
Northern Pike	28	7.8
Black Crappie	4	1.1