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Reference: 2023 Common Carp Electrofishing Survey for Lakes Winona-Agnes-Henry in Support of Public Waters Work Permit Requirement for Carp Barrier

Introduction

Common Carp (*Cyprinus carpio*) are one of the most widely distributed invasive species in North America and can cause ecological and water quality problems in shallow lakes (Chumchal et al. 2005, Bajer et al. 2009). During foraging carp disturb the substrate and uproot aquatic vegetation causing increases in turbidity and nutrients. On April 13, 2021, a carp barrier was installed between Lake Winona and Lake Agnes to prevent more carp from entering Lake Winona from downstream. The Minnesota Department of Natural Resources (DNR) Public Waters Work Permit (Permit Number 2020-2857) for the carp barrier includes a requirement that carp electrofishing surveys be conducted in 2022, 2023, 2026 and 2027 according to the methodology described in Bajer and Sorensen (2012) and report the catch per unit effort (CPUE) estimates, population/biomass estimates, and length-frequency distributions for each survey conducted. Prior to the installation of the carp barrier, carp population surveys were conducted in 2019 on Lakes Winona, Agnes and Henry to establish pre-management baseline population estimates. This memo describes the carp surveys conducted in 2023 as required by Public Waters Work Permit.

Field Methods

Carp were surveyed on September 21st, October 10th, and October 24th, 2023, using an electrofishing boat delivering 15-20 amps of pulsed direct current (25% Duty Cycle, 64Hz Rate) with an industry standard control box (ETS, Madison WI). Three transects along the shoreline of Lake Winona and three transects combined on Lakes Agnes and Henry were completed during each survey events (see Attachment 1 for maps of transects). Lake Agnes and Lake Henry are considered one waterbody for the purposes of this project given the extent of their hydrological connectivity. Maps showing transect locations are shown in the Appendix attached to this memo. Each transect consisted of 20 minutes of electrofishing 'on time' when electrical current was being delivered while driving slowly along the shoreline. One netter positioned at the front of the boat netted all stunned carp, and fish were held in livewell tanks and allowed to recover until the transect was complete. All carp were measured, weighed, and released. Surveys were completed under Minnesota DNR Fisheries Research permit number 35581.

Reference: 2023 Common Carp Electrofishing Survey

Carp Population Estimates

A total of 133 carp were sampled in Lake Winona during all three surveys in 2023. The average length of carp was 23.1 inches (587 mm) and ranged from 14 to 28 inches (350-704 mm) (Figure 1). The average size of carp in Lake Winona was similar in 2023 to that of surveys from 2019-2022.

Two population estimates (PE) were generated for the 2023 Lake Winona surveys due to variations in CPUE between the first survey and the second and third surveys. CPUE dropped significantly between the first and second survey in Lake Winona. At this time, it is possible that carp were beginning to move to their deeper winter habitat reducing catchability. New research suggests that temperature variations, even within the summer or fall seasons, can affect common carp catchability (Simonson et al. 2022). One PE was calculated for the September survey alone and one PE was calculated for all three 2023 surveys combined (Table 1). The CPUE and subsequent PE for the survey conducted in September of 2023 is similar to those calculated in 2019, 2021, and 2022, whereas the PE calculated from all three 2023 surveys is lower.

Carp density was calculated using the linear regression equation developed by Bajer and Sorensen (2012).

$$\text{Carp density per hectare} = 4.71 * \text{CPUE} + 3.04$$

The CPUE and the resulting PE was lower during the September 2023 survey than the 2022 survey estimates but higher than in 2019 and 2021. The PE for September 2023 was 38,889 carp (982 lbs/acre). Combining all three 2023 surveys resulted in a PE of 18,288 (490 lbs/acre), which is a much lower estimate than we've seen in past years.

Reference: 2023 Common Carp Electrofishing Survey

Table 1. Lake Winona Common Carp Survey Results

	2019	2021	2022	9/21/23	10/10/23	10/24/23	2023 all surveys
Number of Transects	11	3	3	3	3	3	9
Electrofishing Time (hr)	3.67	1.0	1.0	1.0	1.0	1.0	3
Number of individuals sampled	326	88	103	95	24	14	133
Average Length of Common Carp (mm)	596	593	589	581	596	614	587
Average Length of Common Carp (in)	23.5	23.4	23.2	22.9	23.4	24.2	23.1
Average Weight of Common Carp (kg)	2.7	2.9	2.7	2.4	2.9	3.1	2.6
Average Weight of Common Carp (lbs)	6.0	6.3	5.9	5.4	6.3	6.9	5.7
Average Catch Per Unit Effort (carp/hr)	88.9	88.0	103.0	95.0	24.0	14.0	44.3
Estimated Density (carp/ha)	421.92	417.52	488.17	450.49	-	-	211.85
Estimated Density (carp/acre)	171	169	198	182	-	-	86
Estimated Population Size (abundance)	36,412	36,043	42,141	38,889	-	-	18,288
Estimated Biomass (kg)	99,094	103,465	112,729	95,002	-	-	47,403
Estimated Biomass (lbs)	218,466	228,140	248,567	209,479	-	-	104,524
Average Biomass Density (lbs/acre)	1024	1070	1165	982	-	-	490
Average Biomass Density (kg/ha)	1,148.3	1198.5	1305.9	1100.5	-	-	549.1

Reference: 2023 Common Carp Electrofishing Survey

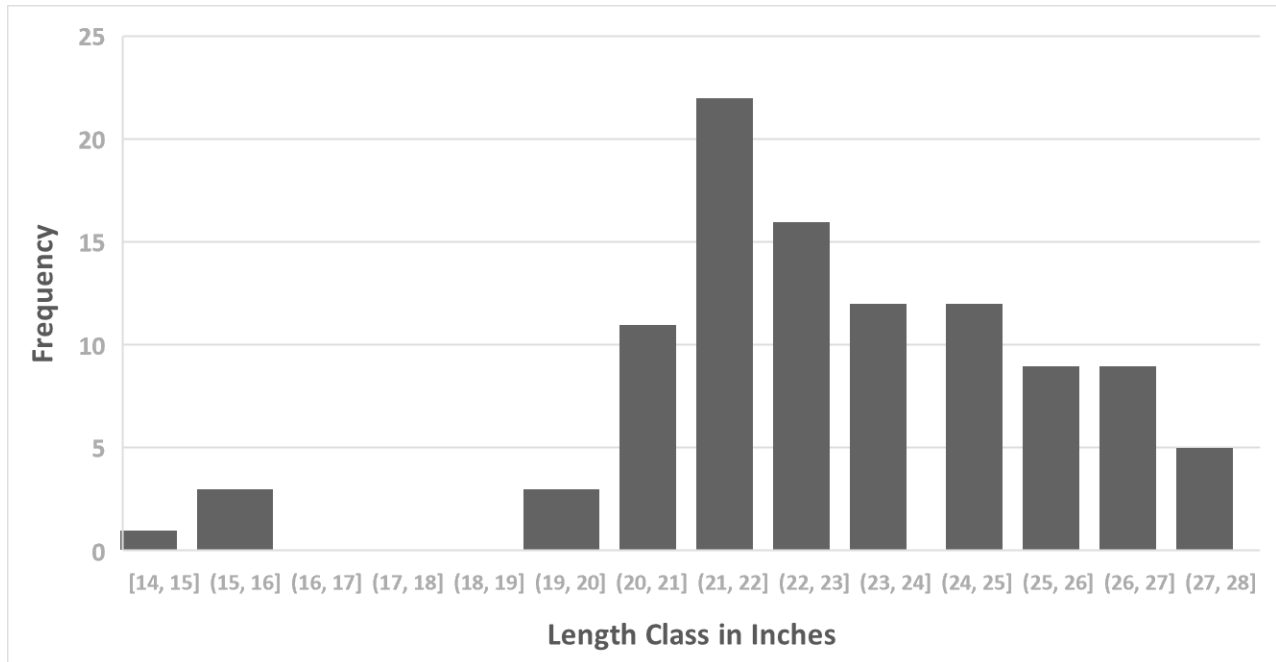


Figure 1. Lake Winona Common Carp Length Frequency 2023

Seven carp were sampled in Lakes Agnes and Henry during all three surveys in 2023. The average length of carp was 25.2 inches (639 mm) and ranged from 7.9 to 29.1 inches (201 to 739 mm) (Figure 2). Unlike the Lake Winona surveys, CPUE remained constant between the first and second surveys and increased during the third survey for Lakes Agnes and Henry; however, due to the low catch rate this increase was only one fish. CPUE was less than the 2022 survey resulting in a PE of 405 carp and biomass density of 94 lbs/acre (105.3 kg/ha). Over the past few surveys, the carp PE has steadily decreased in Lakes Agnes and Henry.

Reference: 2023 Common Carp Electrofishing Survey

Table 2. Lakes Henry and Agnes Common Carp Survey Results

	2019	2022	2023
Number of Transects	9	3	9
Electrofishing Time (hr)	3.00	1.0	3.0
Average Length of Common Carp (mm)	651	683	639
Average Length of Common Carp (in)	25.6	26.9	25.2
Average Weight of Common Carp (kg)	3.92	6.97	5.2
Average Weight of Common Carp (lbs)	8.65	15.37	11.5
Average Catch Per Unit Effort (carp/hr)	49.7	5.0	2.3
Estimated Density (carp/ha)	960.9	26.59	14.03
Estimated Density (carp/acre)	96	11	6
Estimated Population Size (abundance)	27,771	3,121	405
Estimated Biomass (kg)	108,963	21,756	3,038
Estimated Biomass (lbs)	240,224	47,971	6,699
Average Biomass Density (lbs/acre)	830	165	94
Average Biomass Density (kg/ha)	3,770.3	185.4	105.3



Figure 2. Lakes Agnes and Henry Common Carp Length Frequency 2023

Reference: 2023 Common Carp Electrofishing Survey

Conclusion

Carp CPUE population estimates have been conducted in 2019, 2021, 2022, and 2023 in Lake Winona. Between the 2021 and 2022 survey 4,918 carp were removed, between the 2022 and 2023 surveys an additional 1,611 carp were removed. The population estimates derived from these surveys have varied and at times, despite removal efforts and natural mortality, increased. Overall, the CPUE from 2019 – 2022 and September 2023 averages 93.7+/- 13.9 fish/hour. CPUE has varied by only 15 individual fish captured among the 2019 – September 2023 surveys, however, this variability of 15 individual fish has led to population estimates that differ by 6,098 fish.

Two population estimates were calculated from the 2023 data with a large difference between the two estimates. As mentioned above, we calculated two different population estimates because the survey results appear to be influenced by temperature differences following the September survey. The difference in CPUE rates between the three surveys is likely due to the movement of carp from their summer/fall littoral zone habitat to deeper winter habitat. Even though Lake Winona is shallow, carp will migrate from shallow, shoreline areas to the deeper zones during low temperatures Simonson et al. (2022) also concluded that carp CPUE changes with water temperature even within summer or fall seasons. The population estimate developed from the September 2023 survey is similar to previous estimates and for this reason we believe this estimate to be more accurate of the two estimates. However, even if the smaller estimate of 18,288 carp (490 lbs/ac) is underestimating actual carp density in Lake Winona, this is still a substantial density of carp and would require over 8 times the number of fish that were removed in October 2022 to reach the adaptive lake management goal of 133 lbs/acre. Additionally, the density estimate of the lower PE is 549 kg/ha which is still well above what is considered 'high' density (>200kg/ha) for common carp. If we focus on just the September 2023 estimate of 38,889 carp (982 lbs/ac), over 33,000 carp, more than 20 times the number removed in October 2022, would still need to be removed to reach the adaptive lake management goal.

In late May 2022, carp were observed migrating around the carp barrier due to extremely high-water levels that permitted passage over the rip-rap alongside the structure. DNR notified Alexandria Lakes Area Sanitary District of the migration in November 2023. Analysis of the water level data showed that water levels were approximately 0.2 ft below the as-built berm height. Stantec resurveyed the elevation of the constructed berm and found that it was 0.25-0.5 ft lower than the permitted berm elevation. In consultation with the DNR, it was determined that the remedy would be to add Class I and II riprap to the top of the berm to fill in the low void areas and increase the berm elevation to the permitted elevation. Additional riprap was added in May 2023 and no additional observations of carp migrating around the barrier have been reported. Details of our analysis can be found in Stantec's technical memo dated May 23, 2023, "Hydraulic Evaluation of Carp Migration Around Barrier During High-water Levels" (Stantec 2023). The number of carp that were able to migrate into or out of Lake Winona during the high-water levels is unknown. Given the high density of carp that persists in Lake Winona, this migration event likely had very little influence on the overall population density in Lake Winona.

The method used to calculate the PE by using boat electrofishing CPUE was developed by Bajer and Sorenson (2012) in shallow midwestern lakes similar to Lake Winona. They concluded a linear relationship existed between CPUE and carp densities. The current method of calculating PE has relied on this research; however, the data collected over the past few years in Lake Winona suggests that the carp population in Lake Winona may not be following this linear relationship. In 2022 new research was

Reference: 2023 Common Carp Electrofishing Survey

published that examined the use of boat electrofishing CPUE as a common carp population estimator among populations with different densities. Simonson et al. (2022) found common carp populations may exhibit hyperstability where catch rates remain high even as populations decline. They found that at high population densities (>200 kg/ha) catch rates change slowly and the relationship between CPUE and PE is not linear. At high densities CPUE is not expected to change unless the population density changes substantially. The current population of carp in Lake Winona is likely high and detecting changes in the carp population may be difficult until a much lower population size is achieved. This state of hyperstability may explain the similar CPUE rates that at times have increased between 2019-2023 despite natural mortality and removal efforts.

We believe that the common carp population within Lake Winona is still well above the adaptive lake management goal of 133 lbs/acre and well above what is considered 'high' density (>200kg/ha) for common carp. Due to the fluctuating population estimates derived from boat electrofishing CPUE and new research on the relationship between boat electrofishing CPUE and PE for common carp we believe that a substantial decrease in population would be needed in order to detect a change in population.

The two removal events that have occurred in Lake Winona were executed using commercial seining techniques. During each event, the seine kept getting snagged on large woody debris in the lake which likely allowed some carp to pass beneath the seine when pulling it in. The use of commercial seining will not likely result in substantially more carp removed than the last survey event due to the complexity of the lakebed. Box-netting using bait has shown to remove large numbers of carp, which could be an option for Lake Winona in the future.

In 2023 a commercial harvester identified a new invasive crayfish in Lake Winona, the signal crayfish (*Pacifastacus leniusculus*). At this time, it is unknown if there is a reproducing population of signal crayfish in the lake. This invasive crayfish has been shown to affect water quality through changes in the lake food web which might reduce predation on some algal groups (Scordo et al. 2023). The implications on water quality of the interaction of non-native common carp and invasive signal crayfish in Lake Winona are unknown and difficult to predict. The presence of this new invasive species may complicate the water quality issues in Lake Winona and reaching the carp biomass goal may not lead to a shift in water quality improvements with the signal crayfish present.

In Lakes Agnes and Henry, the average biomass density decreased again since the last survey, 94 lb/acre compared to previous surveys in 2019 of 830 lbs/acre and 2021 of 165 lbs/acre. At this time, it is unclear why the estimated population density has dropped dramatically for these lakes. It may be that a small change in population lead to a drastic decrease in CPUE as predicted by Simonson et al. (2022) for a carp population exhibiting hyperstability.

Reference: 2023 Common Carp Electrofishing Survey

References

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