

# COMMON CARP POPULATION ESTIMATE, INTER-WATERBODY MOVEMENT, AND MANAGEMENT METHODS FEASIBILITY IN NORMANDALE LAKE

Report for the Nine Mile Creek Watershed District



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## INTRODUCTION

Common Carp are well-known to be a significant driver of poor water quality parameters. While foraging, Carp can resuspend nutrients like phosphorous which would normally be confined to lake sediments. When disturbance occurs from an overabundance of Carp, large amounts of phosphorous is reintroduced to the water column where it becomes available for algae. This in turn promotes algae blooms as well as turbid water conditions. The common parameters that are measured to decide if a water body belongs on the Minnesota Pollution Control Impaired Waters List are total phosphorous (TP), chlorophyll-a (algae abundance), and clarity (measured by secchi). Although Normandale Lake meets state standards for secchi depth and chlorophyll-a and has native vegetation, it does not meet the state standard for total phosphorous. Common Carp can contribute significantly to the internal loading of TP and management of their populations below a threshold of 89 pounds/acre (Bajer et al, 2009) is generally considered to be an inexpensive method of managing internal loading (Bartodziej et al, 2017).

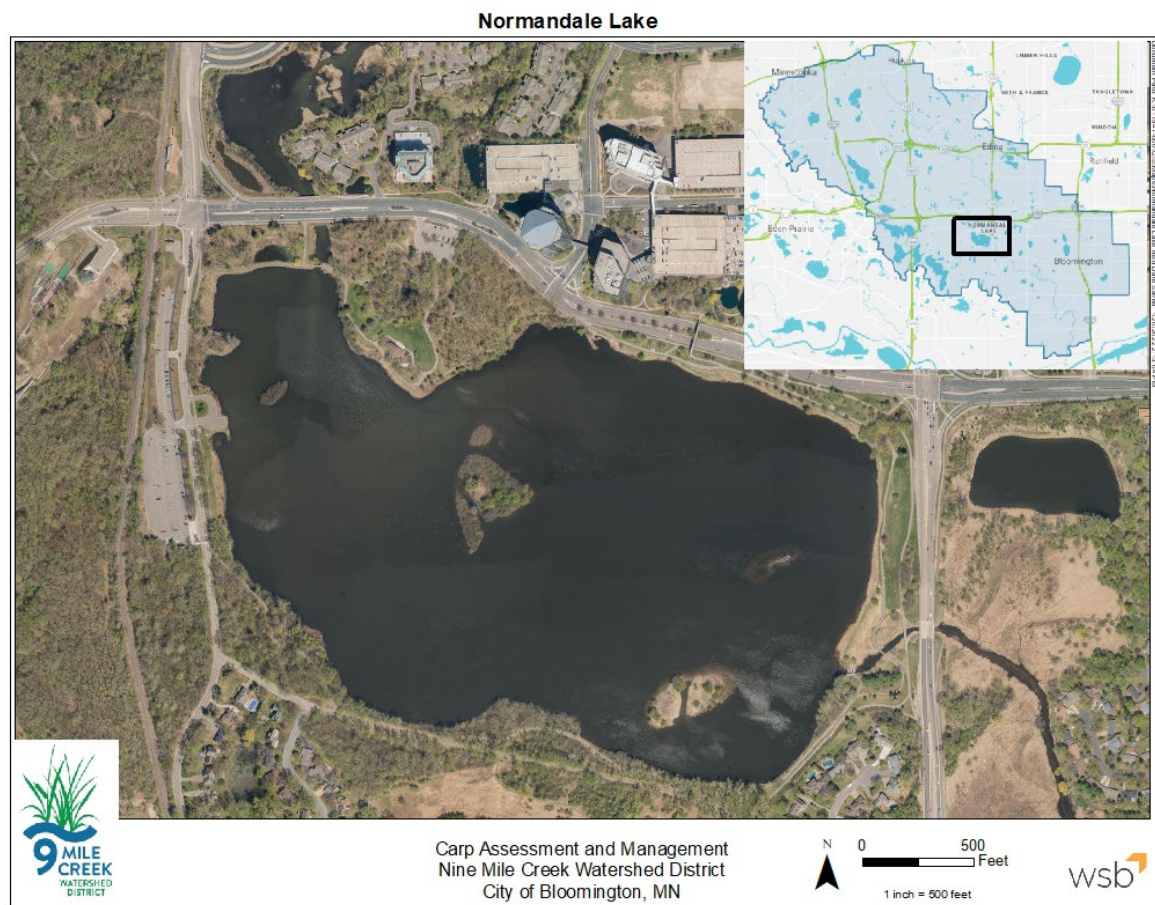


Figure 1: Site map in relationship to Nine Mile Creek Watershed District.

In 2020, surveys completed by Carp Solutions for Nine Mile Creek Watershed District identified Carp in Normandale Lake above the 100 kg/ha (89 pounds/acre) threshold that indicates a need for management. Carp were found in numbers that warranted more rigorous assessment and understanding of inter-lake spatial usage in order to guide future long-term management. To properly assess for Carp population, biomass levels and the presence of young of year (YOY), WSB conducted electrofishing surveys as deemed by protocols in Bajer and Sorensen (2012).

Since it was also important to know the movement capabilities and patterns between water bodies in the Normandale Lake system, WSB utilized passive integrated transponder (PIT) tags and a monitoring station to track movement via antennas at a strategic location on the north side of the lake where previously tagged Carp have been found to pass. Finally, WSB tested removal methods that were felt to be the best available means. These methods included electrofishing, baited box net and float net traps as well as commercial hoop nets.

The following is a detailed report of the field work and data analysis with recommendations for future management.

## TERMS AND DEFINITIONS

**Baited box net:** Relatively large net (20 feet X 40 feet) laying on the bottom of the lake with mesh walls 10 feet tall which can be raised quickly off the bottom of the lake above the water surface to trap all fish inside. Cracked corn is spread in the area of the trap which attracts Goldfish and Carp inside the area where they are trapped when the walls are raised.

**PIT tag:** Passive integrated transponders (technology used in pet chips) that are quickly implanted inside fish and released. When in close proximity (10-18 inches) to a wire that is connected to a computer, the identification number associated with the tag is recorded as well as the exact time it was detected.

**CPUE:** Catch per unit effort is a general term to describe a rate of how many individuals captured during a standardized unit of effort like time, net, or person. When used with electrofishing for fish, this rate can be used to estimate a number of Carp or Goldfish in one acre of a lake.

**CMR:** Capture, mark and recapture estimate is another way to estimate the number of animals in a population. It is typically more accurate but requires more effort and time to complete. It requires at least one effort to give animals a distinguishable/recognizable mark and then at least one effort at a later date to capture more animals and to check how many of the animals had the mark from the first effort and developing a ratio of how many animals were previously captured and how many have not been captured before. The population estimate is more accurate with more marks given initially and more recaptured animals with those marks in follow up efforts.

**Electrofishing:** This is a method that employs controlled electricity directed into the water to temporarily immobilize fish. Systems can be used on a small barge, a backpack carried by an individual, or a motorboat. It is a standardized and effective method of sampling fish.

**Recruitment:** This refers to the process of adding new surviving individuals to a population. For example, a large number of young Goldfish hatch from eggs and survive their first 1-2 years of life would indicate high recruitment. It has been found that there is low or no recruitment of Goldfish and Carp when there are lots of bluegill sunfish of many different sizes.

**YOY:** Young of year refers to a fish that hatched from an egg within the same year that it was found. For example, a goldfish that was caught in August 2021 and was only 2-3 inches long was likely an egg laid in the spring of 2021.



## METHODS

### TASK 1: INSTALLING PIT ANTENNA TO MONITOR CARP MOVEMENT

Passive integrated transponder (PIT) tags are used to identify and track carp. They are a useful because they are inexpensive and easily implanted in Carp of all sizes. PIT tags are a permanent, unique identifier and allow for identification of fish they are implanted in, if they are captured. This is important when accurate understanding of when the fish was initially captured is needed, such as when making a population estimate. PIT tags can be more useful as they are permanent, as compared to the fin clip method, which is not. In addition, PIT tags can be detected as they pass over an antenna that is placed in a passage location like a stream or culvert between lakes. This method was used in Normandale Lake to better understand Carp movement to determine if temporary blocking or strategic removal during times of elevated movement is needed.



*Figure 2: Picture of Normandale inlet PIT antenna monitoring station.*

WSB staff constructed, tested and installed a PIT antenna and self-powered monitoring station on the south side of the 84<sup>th</sup> Street bridge immediately downstream of Josten's Pond. The antenna was 25 feet long and 4 feet tall. These dimensions were determined to be the most effective at detecting the tag type that were implanted in Carp in Normandale Lake due to the increased detection range of 23 mm PIT tags. The antenna was suspended vertically in the water column resting on the bottom of the channel. This created the greatest coverage of the water column and therefore the best chance of detecting the passage of a PIT tagged Carp.

The monitoring station was fitted with a solar panel that charged a deep cycle battery. This setup provided continuous power to the monitoring system. Each time a PIT tagged Carp came within detection proximity of the antenna (approximately 20-24 inches), the passage was time and date stamped, and the

individual's unique tag number was recorded. The station was installed in June 2021 and was uninstalled in early December 2021 to prevent ice dams from damaging the equipment.

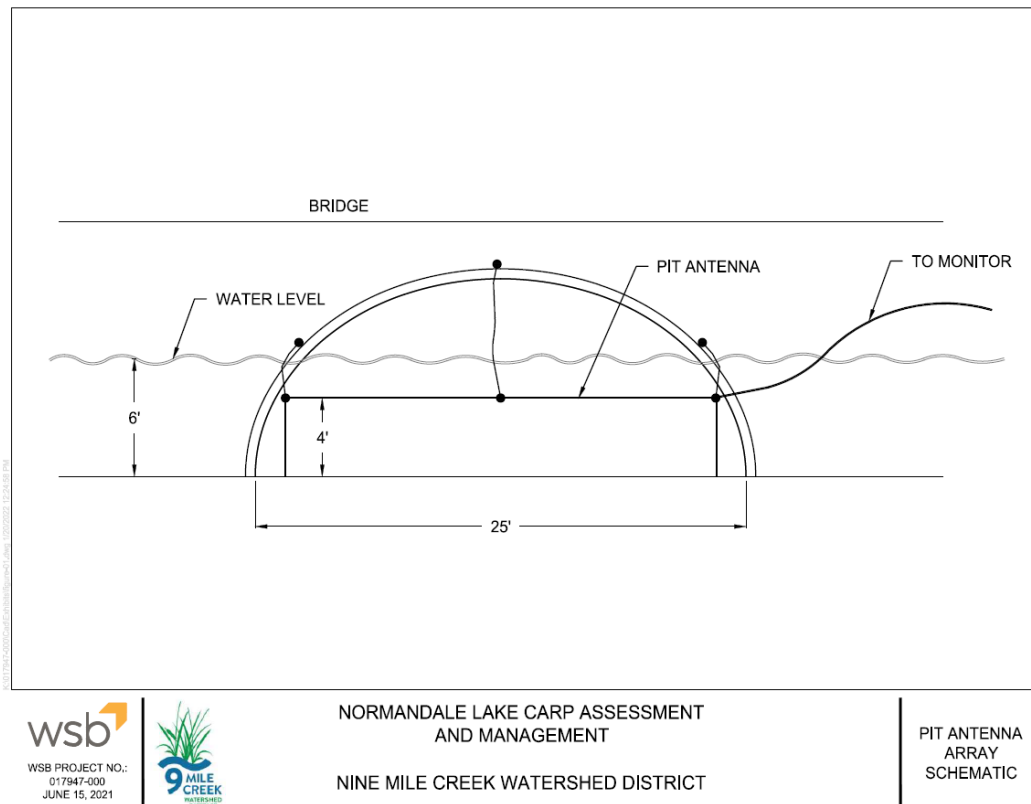


Figure 3: Schematic of PIT antenna installed in bridge at 84th Street.

## TASK 2: ELECTROFISHING SURVEYS FOR CPUE POPULATION ESTIMATE AND PIT TAG IMPLANTATION

Electrofishing surveys are effective at quantifying Carp abundance and biomass density. They can be completed in three days and are relatively accurate with a small effort. In addition, all Carp captured can be measured, weighed and implanted with a PIT tag. Therefore, these surveys were used to complete multiple tasks.

Three days of electrofishing were able to be conducted in 2021. These surveys needed to be timed within 24 hours after significant rainfall events ( $>1/2$  inch of rain over 24 hours, see Figure 3) since lake levels were so low, navigation was impeded enough to skew results of electrofishing surveys. These surveys are best done between the months of June and September while Carp are more evenly distributed around the lake. Our surveys were conducted between June 21<sup>st</sup> and July 15<sup>th</sup>. Each survey included at least three transects of a minimum of 20-minutes in randomized sections of shoreline. We conducted these surveys on days at least one week apart. This is to account for differences in environmental conditions that may bias the catch rate.

Carp captured in the surveys were measured for length, scanned for presence of a PIT tag, and implanted with a PIT tag if it did not already have one before releasing back to the lake.

We used the catch per unit effort (CPUE) model described in Bajer and Sorensen (2012) to quickly determine the Carp density and average size of the Carp. These data and lake acreage were used to develop an overall Carp biomass density and overall biomass (pounds/acre) for the entire lake.



*Figure 4: WSB crew electrofishing on Normandale on left. On right, a large Goldfish was caught during electrofishing.*

### **TASK 3: REMOVAL EFFORTS AND CAPTURE/MARK/RECAPTURE (CMR) POPULATION ESTIMATE**

Due to the desire for an updated, robust effort to estimate the population of Carp and to remove a portion of the population, WSB implemented a plan that improved the population estimate while removing Carp biomass simultaneously. We used baited box nets to remove Carp, a method that has shown consistent success and >98% selectiveness for Common Carp. The accepted amount of Carp biomass (pounds of Carp per acre of lake) considered to be damaging to the lake ecology and water quality is about 89 pounds/acre (Bajer et. al, 2009). During a previous study from 2020 in Normandale, the estimate for Carp biomass was estimated at twice this level (Carp Solutions, 2020) indicating that a reduction in Carp biomass would be required to improve lake ecology. Historical methods of Carp harvest (commercial netting with long nets pulled through the water toward shore) were not going to be possible with the amount of bottom debris, shallow areas, and aquatic vegetation in the lake.

WSB used a combination of baited box nets and an innovative method called a float up net. Both methods train Carp to aggregate at a bait station using cracked corn. Corn is a selective bait and does not attract native fish like Bass, Northern Pike or Bluegill. Therefore, drawing in Carp to a small area can be advantageous to removal efforts.





*Figure 5: Picture of box net with mesh walls raised. Photo from Crystal Lake in Robbinsdale, MN.*

A baited box net trap consists of a 30' X 60' net laying on the bottom of the lake with 10' net walls that can be raised quickly by ropes anchored to shore and raised by hand to trap Carp near the bait. In addition, one trap that consisted of a 100' X 40' net laying on the bottom of the lake with an inflatable tube surrounding the perimeter of the net was used. This tube was quickly inflated using an air pump to raise the outer edge, preventing escape back into the lake. This was known as a float up net. Both the box net trap and the float up net were installed near shore in areas where Carp typically forage during overnight hours. These nets were engaged during multiple times of the day to test the most effective time to trap Carp in Normandale Lake.

A total of six (6) events were attempted between July 29<sup>th</sup> and September 1<sup>st</sup>. This number of events was determined based on two main reasons. First, it is generally understood that as water temperatures cool, Carp tend to forage less and thus are less attracted to a food bait like corn. Second, typically there is a reduction in catch rates when these techniques are used in the same locations several times.

WSB also attempted a method used by commercial fishermen known as hoop netting traps. This style works similarly to fyke trap nets by guiding swimming fish toward traps on either end of a lead line set near shore. By recommendation of fishermen, these traps were set in four (4) locations in the fall when they have historically been most effective. Unfortunately, zero Carp were captured during these attempts.



*Figure 6: An example of a hoop net set near an island in Normandale Lake*



Capture, mark and recapture (CMR) population estimates are generally more reliable than CPUE rapid population estimates but they require more effort and cost. WSB was able to conduct this survey using the electrofishing surveys in Task 2 (electrofishing and PIT tag implantation) as the initial capture and marking period with Task 3 (removal efforts) functioning as the recapture period. The calculation in the most basic form follows this equation:

$$\hat{N} = \frac{Kn}{k}$$

*Figure 7: A Carp recaptured in a box net. Its left pelvic fin that was previously clipped has already begun to regrow.*

Here, N is the total population, n is the total captured in events following the marking event, K is the number of marks given in previous events, and k is the number of recaptured fish that had a fin clip mark or a PIT tag. This formula has been adjusted to more accurately fit different types of populations and different types of marking periods.

In this case, we chose to use the Chapman estimator for mark and recapture population estimates. This small modification is more appropriate for multiple marking and recapture events, which means it's appropriate for our work. The modified formula is as follows:

$$\hat{N}_C = \frac{(K + 1)(n + 1)}{k + 1} - 1$$

# RESULTS

## **TASK 1:     INSTALLING PIT ANTENNA TO MONITOR CARP MOVEMENT**

A total of 200 PIT tags were implanted in Carp in Normandale Lake. Electrofishing surveys were conducted on June 21<sup>st</sup> (26 tags implanted), June 29<sup>th</sup> (78 tags implanted) and July 15<sup>th</sup> (49 tags implanted). The remaining 47 tags were implanted during a box netting effort on August 5<sup>th</sup>. Out of 200 total PIT tags implanted, 16 were detected at some point between initial implants (June 21<sup>st</sup>) and deconstruction of antenna for the winter (December 5<sup>th</sup>). Of those 16, only 3 were from tags implanted during the box netting effort. Overall, the 16 tags accounts for 8% of the total implanted Carp. Average size of PIT tagged Carp was 14.6 inches and the average size of PIT tagged Carp that were detected at the antenna was 17.5 inches. Increases in PIT detections appear to closely follow rainfall events as seen in Figure 3.

### **DISCUSSION:**

The difference in the average size of overall PIT tagged Carp and those that were detected at the antenna may suggest larger Carp seem to be leaving the lake via the outlet more often than smaller Carp. This is understandable since previous work seemed to suggest generally sexually mature Carp are the ones migrating to spawning areas.

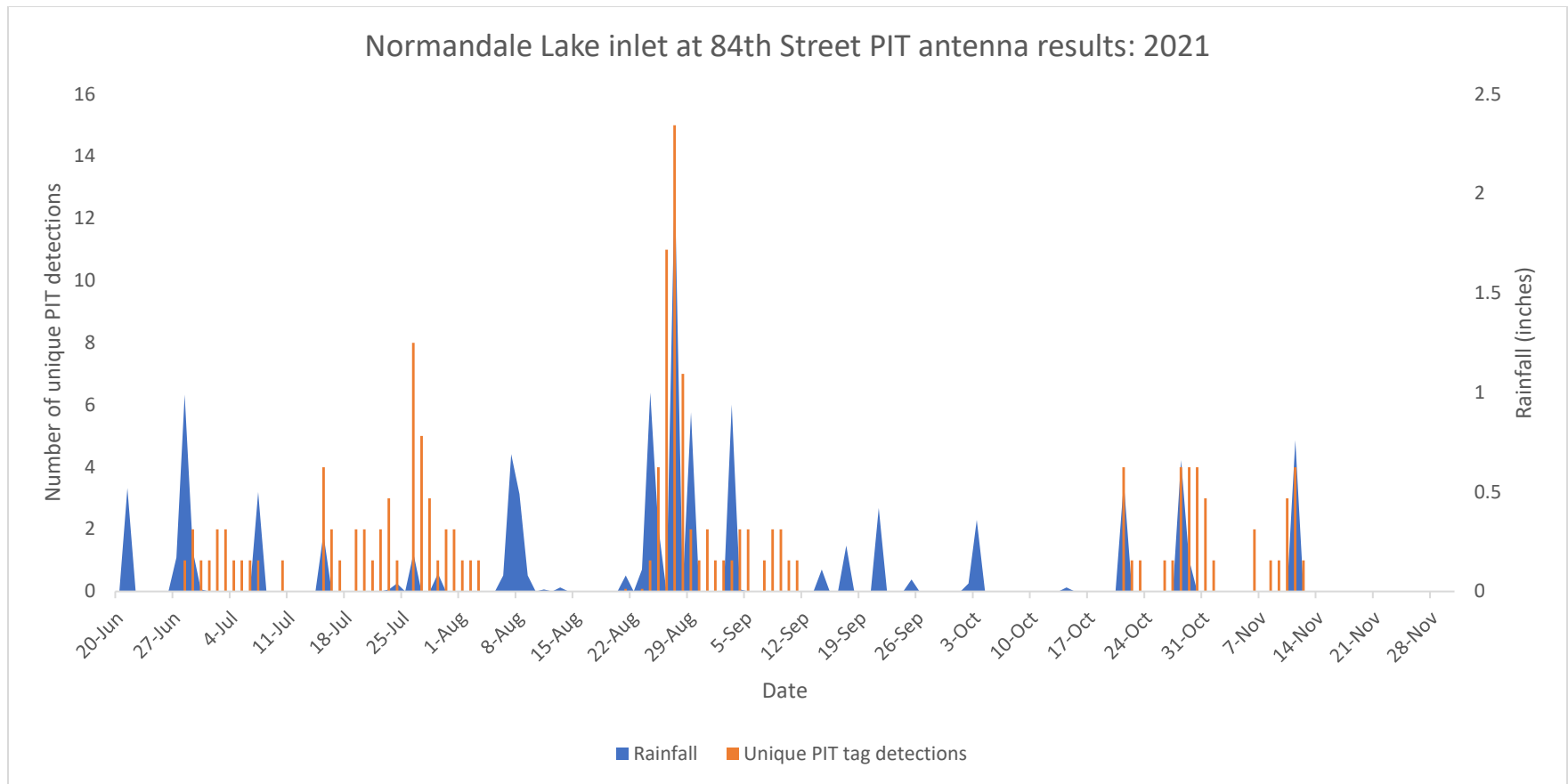


Figure 8: Movement analysis at Normandale inlet using a PIT antenna array. Precipitation data used from CoCoRaHS MN-HN-110 at Edina Lake Park.



## TASK 2: ELECTROFISHING SURVEYS FOR CPUE POPULATION ESTIMATE AND PIT TAG IMPLANTATION

A total of 152 Carp were captured during electrofishing surveys. CPUE values were highest on the 2<sup>nd</sup> day with the lowest being the 1<sup>st</sup> day. Tabulation of results are found in Table 1 below.

Table 1: Summary of electrofishing results for each transect.

Date	Transect	Time (hours)	Catch	CPUE	Population estimate (individuals)
21-Jun	1	0.3	6	18.0	3385
	2	0.3	7	21.0	3930
	3	0.3	8	24.0	4475
	4	0.3	3	9.0	1751
29-Jun	1	0.3	28	84.0	15369
	2	0.3	23	69.0	12646
	3	0.4	27	67.5	12373
15-Jul	1	0.3	8	24.0	4475
	2	0.3	17	51.0	9377
	3	0.3	15	45.0	8288
	4	0.5	10	19.4	3631

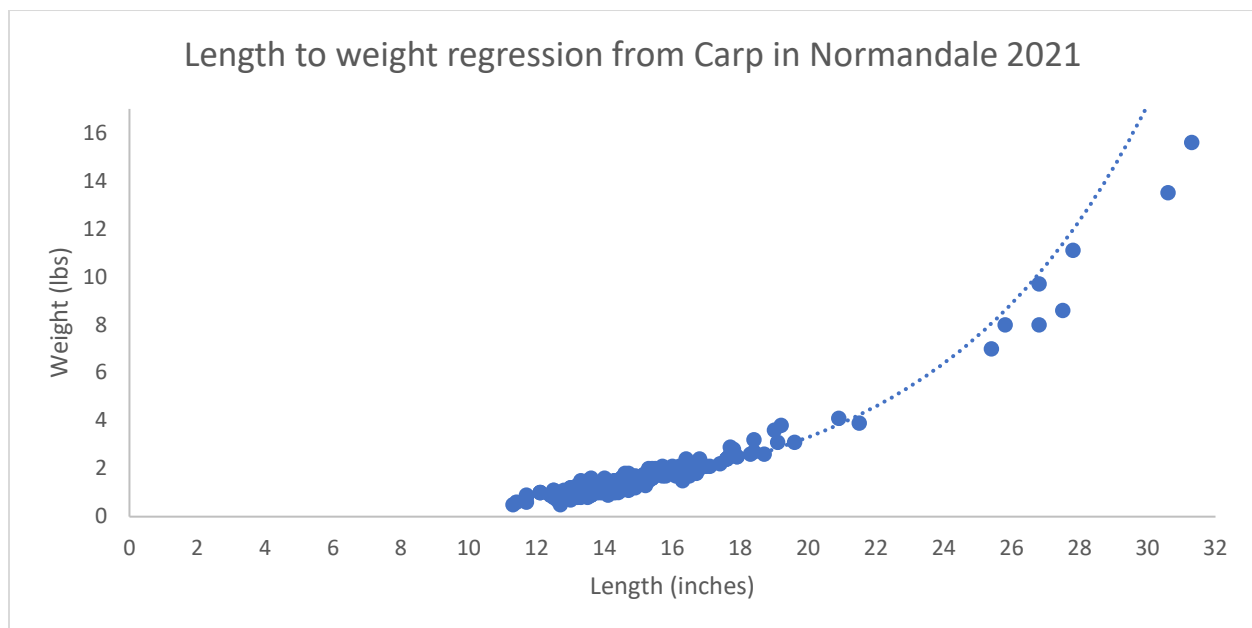


Figure 9: Length to weight relationship for Carp in Normandale Lake

Based on these CPUE results, the estimated number of Carp individuals came to be 7,246  $\pm$  1,811 individuals. Using average weight for the Carp (1.71 pounds), this estimated a biomass of 140 pounds/acre  $\pm$  28 pounds/acre before removal efforts. This is approximately 1.6 times the management threshold for Carp biomass.

## DISCUSSION:

Unfortunately, the drought conditions during months appropriate for electrofishing surveys may have skewed the CPUE results. We were forced to begin the surveys while navigation was not ideal, making it difficult to capture Carp in shallower areas near shore where the method is most accurate. In particular, the first day of surveying resulted in much lower catch rates than the other two days. On the contrary, while lake levels were highest (during the June 29<sup>th</sup> survey), catch rates were much higher. As discussed, this method of rapid population estimation has limitations to its accuracy. Overall, the results of the surveys indicate elevated biomass of Carp, above the threshold of 89 pounds/acres considered to be damaging to the lake ecology and water quality (Bajer et. al, 2009).

## TASK 3: REMOVAL EFFORTS AND CAPTURE/MARK/RECAPTURE (CMR) POPULATION ESTIMATE

A total of 1,498 Carp were captured using the combination of baited box net and float up net traps. Both baited box net and float up net traps were used simultaneously except for August 18<sup>th</sup>. On this day while preparing box net traps for deployment on August 19<sup>th</sup>, a large group of Carp was seen foraging on the bait bag at the float net trap which persuaded us to lift the net immediately to take advantage of the opportunity. This took place around 1:00 PM suggesting that Carp in Normandale Lake may be gathering at bait stations during the day as well. If Carp are visibly foraging in large numbers, the float net trap could easily be raised in the future to take advantage of opportunistic removals. Similarly, the August 5<sup>th</sup> effort occurred during daylight hours. All other efforts were attempted in darkness hours between midnight and 4:00 AM. A total of 17 PIT tagged Carp were captured accounting for approximately 8.5% of the total number of PIT tags (200) in the lake. We determined both daytime and overnight events to be effective since capture rates were similar. Further monitoring of the timing when the most detections of PIT tagged Carp at bait stations should be investigated.

Table 2: Summary of recapture rates for each removal effort. With the exception of 8/18, where only the float net trap was used, 2 baited box net and one float net trap were used.

Date	Total captured (n)	Total marks (K)	Total recaptured (k)	Population estimate
7/29/2021	201	151	0	30703
8/5/2021	124	151	1	9499
8/12/2021	105	200	2	7101
8/18/2021	365	200	4	14712
8/19/2021	205	200	1	20702
9/1/2021	498	200	9	10029

Table 3: Summary of both methods of population and biomass estimation methods results

	CPUE		CMR	
	Population estimate	Biomass estimate (pounds/acre)	Population estimate	Biomass estimate (pounds/acre)
2021 pre-removal	7246 ± 4385	140 ± 29	15458 ± 8116	277 ± 159
Remaining post-removal	5748	111	13958	251

## CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS

The PIT antenna at the Normandale Lake inlet worked well and appeared to detect tagged Carp as predicted. It showed that Carp were moving in many instances when rainfall events occurred which was likely triggered by increase in flow. This is typical of other watersheds especially in the springtime when Carp are migrating to spawning areas. However, this antenna was not installed until after the spring migration period in 2021. Therefore, it is recommended to continue monitoring Carp passage at this location in 2022. The antenna should be installed shortly after the chance of ice-out damage to the antenna has passed, but before the Carp migrations have started. The results of that monitoring will be important to the future discussion of the need for a barrier in this location to prevent Carp from reaching spawning areas. A “bio-acoustic fish fence” may be an option considering the public usage of the lake and recreational trails as well as the difficulty in the continuous maintenance needed for a physical barriers during period of increased flow rates from the inlet. In addition, if a barrier of some kind were to be installed and tested for effectiveness, PIT systems could be used to determine efficacy of the barrier. Additional PIT tags in the system would increase the chance of detecting important movement patterns.

Variability in CPUE during electrofishing surveys was elevated since water level fluctuated drastically and thus the ease of Carp capture similarly fluctuated. The limited early-summer rainfall events resulted in reduced opportunities for electrofishing surveys to be completed. Although ideally these surveys would have been conducted on days with similar water levels that allowed proper motorboat navigation, they needed to be completed before removal efforts commenced. Environmental conditions may have influenced the survey results, but the survey data still provide insights and an opportunity for management decisions.

There was also more than anticipated variability in the population and biomass estimates from the CMR analysis. This began with the reduced catch rate from electrofishing surveys which meant there were fewer opportunities for recapturing PIT tagged (marked) Carp during removal efforts. The final 48 of 200 needed to be implanted during one of the box netting efforts. The accuracy of CMR population estimates can vary greatly with small differences in recapture rate when the number of marked individuals is low. For example, if one more PIT tagged Carp would have been recaptured in each removal event, it would have reduced the variability in the estimate by more than half. Hence, it would be advantageous to continue to mark more Carp in 2022 to help refine the population estimates. This could be done with additional electrofishing surveys which would give an updated population estimate post removal efforts in 2021. If environmental conditions are similar to 2021 making it once again difficult to capture Carp, there would at least be a reference point of CPUE values to compare between 2021 and 2022.

Regardless of variability in both CPUE and CMR methods of population and biomass estimates, both indicate a biomass of Carp in Normandale Lake that is above the ecologically damaging threshold of 89 pounds/acre. Removal efforts and methods are somewhat limited in Normandale Lake due to its bathymetry and abundance of submerged aquatic vegetation. WSB's baited box net and float up net traps were able to draw in aggregations of Carp and trap them effectively considering the conditions that exist in the lake. Depending on estimates, these efforts were able to reduce between 10-21% of the population and biomass. With the variability in estimates, it is difficult to predict the degree of effort remaining to reach goals (likely between 1-3 more equivalent efforts), but more Carp need to be removed from Normandale Lake and carp removal efforts should continue at Normandale Lake.

The baited box net and float net traps were attempted at various times of the day and night. This was in an attempt to gain a better understanding of the most effective time to trap the foraging Carp. Historically, data has shown Carp to be most actively foraging during overnight hours. However, when the float net trap was raised in the afternoon in Normandale, it resulted in the highest catch rate of all the efforts. An addition that can be added to the baited box net and float net systems is PIT tag monitoring at the bait station to guide the timing of the raising of the trap walls. An analysis of the timing of PIT tag detections at the bait site will inform

the decision for trapping the most Carp possible. This supports increasing the number of PIT tags within the Normandale Lake system.

One final observation of concern during the 2021 assessment was the potential presence of Goldfish in Normandale Lake (see Figure 4 above). As Goldfish begin exhibiting more “naturalized” coloration patterns and grow larger, the wild appearance of Goldfish and Common Carp become more similar and difficult to differentiate between the species. If indeed there is an existing Goldfish population mixed with the common Carp in Normandale Lake, this should be documented and monitored for changes in the population dynamics as Carp are being managed. This can be done simply in 2022 during electrofishing and trap net surveys. Any suspected goldfish species could be photographed or collected to be confirmed by the Bell Museum if desired. This CPUE index value can be documented for comparison in following survey years to monitor the population.



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