2023 Hess Lake Carp Management Report
March 19, 2024
Prepared for: Progressive AE
Attn.: Tony Groves

Prepared by:
Carp Solutions LLC
www.carpsolutionsmn.com

Background

During the fall of 2023, Carp Solutions continued its work with Progressive AE on common carp management in Hess Lake. Boat electrofishing was used to collect 50 carp for aging and to implant radio tags in 20 carp in order to track their movements during the winter of 2023-2024. Two outings were conducted to track the locations of radio tagged carp, one in late fall of 2023 and another in March 2024.

Methods and Results

Boat electrofishing was conducted on October 10 and 11 to collect carp for aging. The purpose of aging was to determine reproductive history for the Hess Lake population. Each survey consisted of one to two transects, consisting of approximately twenty minutes of effective electrofishing time. During these surveys, an electric current was passed through the water, which stunned fish that would then float to the surface where the carp were collected using dip nets. Collected carp were measured for length and weight, scanned for previously implanted PIT tags from the previous year, and euthanized. In total, 57 carp were collected in this manner. While we only planned to age 50 of the collected carp, several extra otoliths were collected to ensure that at least 50 were able to be aged. The average length of these carp was 22.4 inches and the average weight was 5.5 pounds. After euthanizing the carp, their otoliths were removed and embedded in epoxy before they were sectioned using a jewelers saw. These sections were then read under a microscope to count the annuli of the otolith and determine their age.

Further boat electrofishing was done on the following days on October 12 and 13 to collect carp in order to implant them with radio tags. The method of carp collection was the same as for the aging surveys, however, once collected, only the length was measured before the carp were surgically implanted with a radio tag for future radio telemetry tracking. These carp were then placed back into the lake and released at the

boat launch. A total of 22 carp were collected, 20 of which were implanted with radio tags. The average length of these carp was 22.5 inches. The two remaining carp were too small (around 17 inches) for implants and were released after their lengths and weights were measured.

Carp proved remarkably easy to catch with boat electrofishing, especially during the last two days after local aggregation sites were found (Table 1). The lengths of all 79 carp collected during this work ranged from 17-27 inches with an overall average of 22.4 inches (Figure 1). The 59 carp weighed, including the 57 carp collected for aging and the two carp that were released because they were too small to implant radio tags, had an average weight of 5.1 lbs (Figure 2). A length-weight regression was calculated using the lengths and weights of the 59 carp (Figure 3) and can be used to estimate the weights of carp using their lengths.

The ages of 50 of the collected carp were determined from their otoliths. Ages ranged from 10-29, with an average of 23.2 (Figure 4). There was no significant correlation between the determined ages and lengths (linear fit r-squared=0.24). Of particular note, no juvenile (under 4 year old) carp were found. Of the 50 aged carp, 32 (64%) were 24 or 25 years old, born in 1998-1999.

The radio frequencies and corresponding lengths of the carp implanted with radio tags is shown in Table 2. A radio telemetry survey was conducted on November 13, 2023. The water temperature was 6 °C (43 °F). All 20 radio tagged carp were located, although two were only heard from a distance in the beginning of the day and then not located more precisely at short range later in the day (Figure 5). No apparent aggregation of carp was located on November 13, 2023. All but two of the carp were in shallow areas near the shoreline. The remaining two carp were located slightly offshore, roughly 160 and 450 feet from the nearest shoreline. However, neither of these carp were in the same area. The majority (65%) of carp were located closer to where they were released (the boat launch) compared to where they were caught around the lake. A post ice-out radiotelemetry survey was carried out on March 7, 2024. The water temperature was the same as the fall survey, 6 °C (43 °F). All 20 carp were precisely located. In contrast to the fall survey, an aggregation of 11 radio tagged carp was located in the southeast area of the lake off of the mouth of Wheeler Drain (Figures 6 and 7). On average, carp were closer to the release location than catch location during the fall survey but closer to their original catch location than the release location in the spring (Table 3). On average, individual carp locations were 1.0 miles apart between the two radio telemetry surveys.

Table 1: Hess Lake electrofishing data for adult carp by date. CPUE stands for Catch Per Unit Effort, in units of carp per hour of shock time. Note that only two small carp were weighed on 10/13, so the average weight is only of those two small carp, not for the seven measured that day.

Date	Transects	Carp caught	Time shocking (min)	CPUE	Average length (inches)	Average measured weight (lbs)
10/10/2023	2	30	41	43.83	22.4	5.1
10/11/2023	2	27	44	36.68	22.9	5.2
10/12/2023	2	14	11	73.68	22.9	NA
10/13/2023	1	7	5	82.89	20.0	2.6*
Average	1.75	20	25	46.02	22.4	5.1
Total	7	78	102			

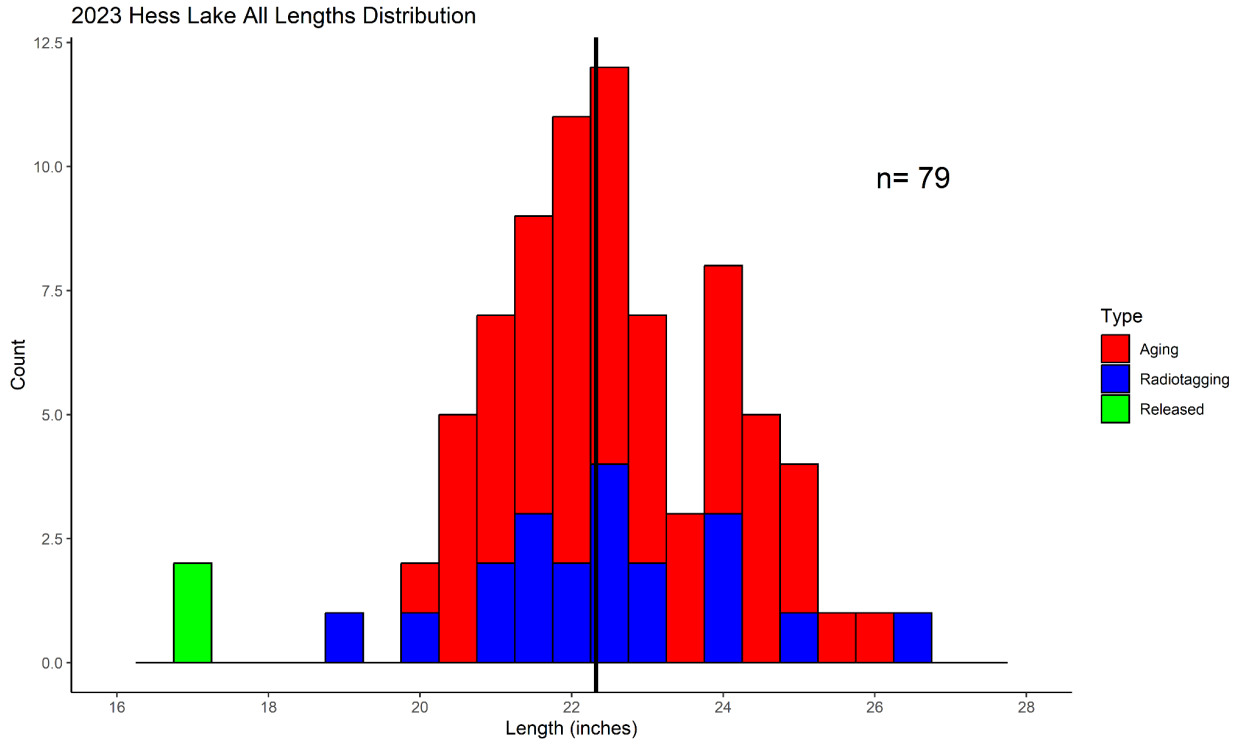

Figure 1: Length distributions from all carp (n=79) collected during Hess Lake electrofishing in 2023. The black line indicates median length.

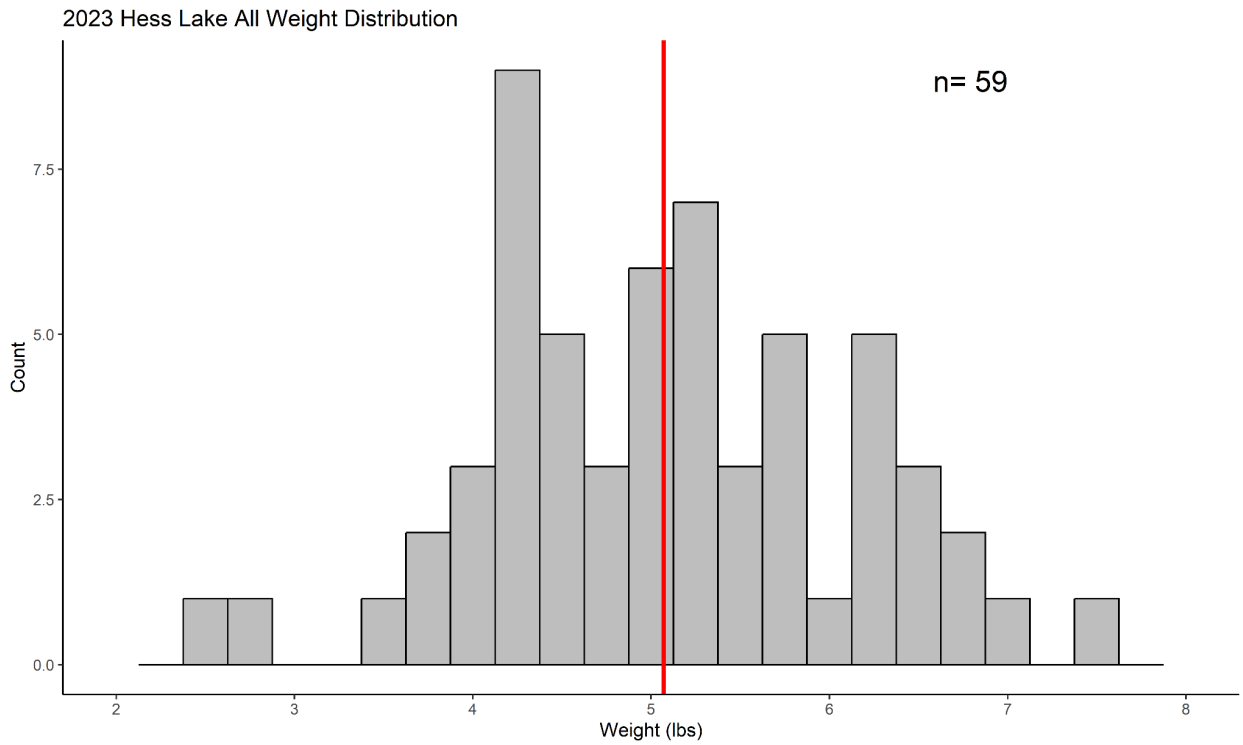

Figure 2: Weight distribution for all carp (n=59) weighed during Hess Lake electrofishing in 2023. The red line indicates median weight.

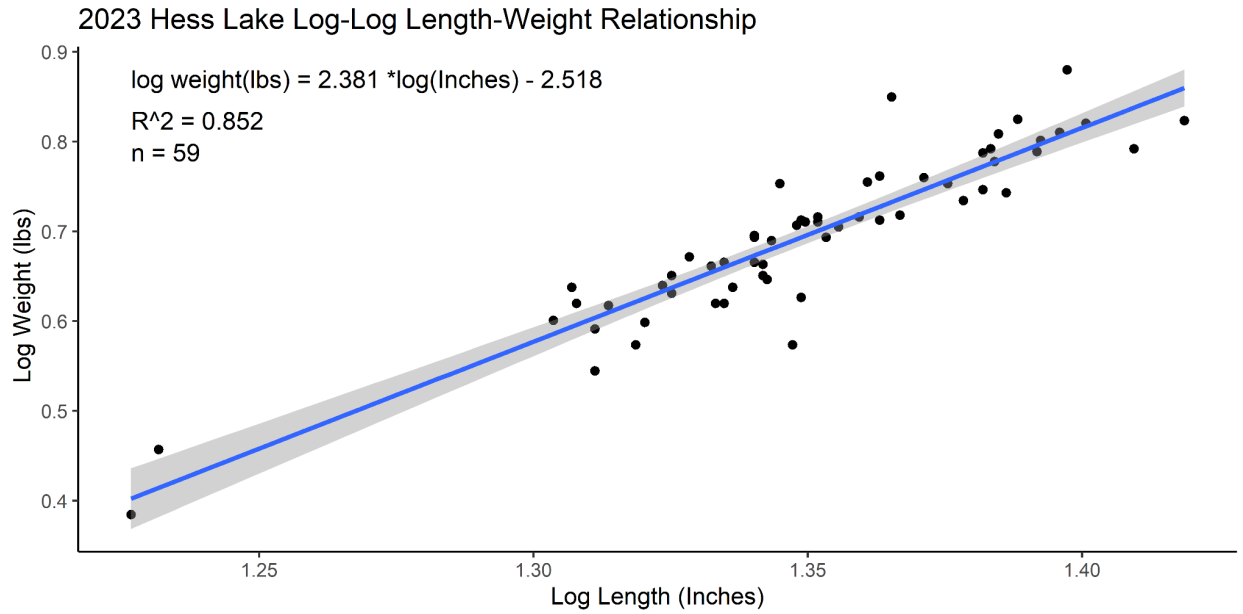

Figure 3: Log-transformed length-weight scatterplot for the carp collected for aging in Hess Lake. The equation can be used to estimate carp weights from this lake using the equation: weight (lbs)=$10^{-3.253}$ x inches$^{2.988}$

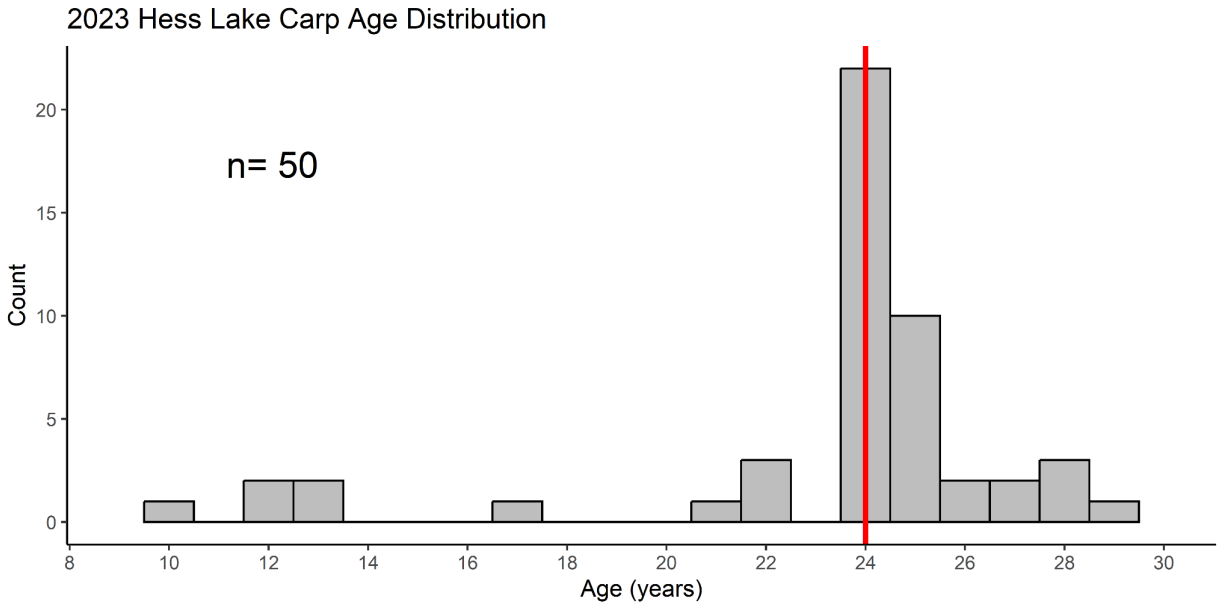

Figure 4: Age distribution of carp captured from Hess Lake. The red line represents the median age (24).

Table 2: Data for the carp implanted with radio tags in Hess Lake.

Date	Radio Tag ID	Length (inches)
10/12/2023	148.211	22.4
10/12/2023	148.133	21.5
10/12/2023	148.090	26.7
10/12/2023	148.250	22.1
10/12/2023	148.652	24.2
10/12/2023	148.622	21.7
10/12/2023	148.172	22.6
10/12/2023	148.575	24.9
10/12/2023	148.332	20.9
10/12/2023	148.112	22.4
10/12/2023	148.011	24.0
10/12/2023	148.352	24.0
10/12/2023	148.293	20.0
10/12/2023	148.233	23.1
10/12/2023	148.053	22.9
10/13/2023	148.311	19.1
10/13/2023	148.030	22.1
10/13/2023	148.192	22.7
10/13/2023	148.153	21.5
10/13/2023	148.072	20.8

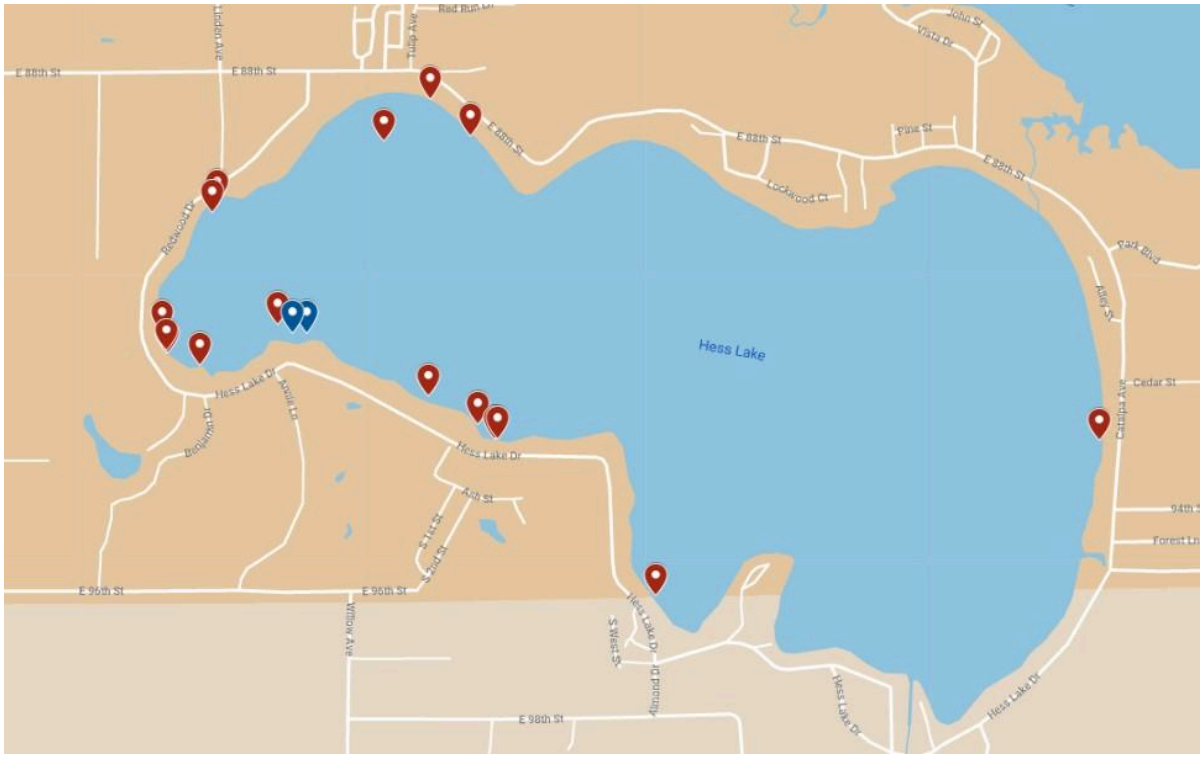

Figure 5: Locations of radio tagged carp located on November 13, 2023 in Hess Lake. Red pins represent exact locations while blue pins indicate approximate locations when the exact location could not be determined.

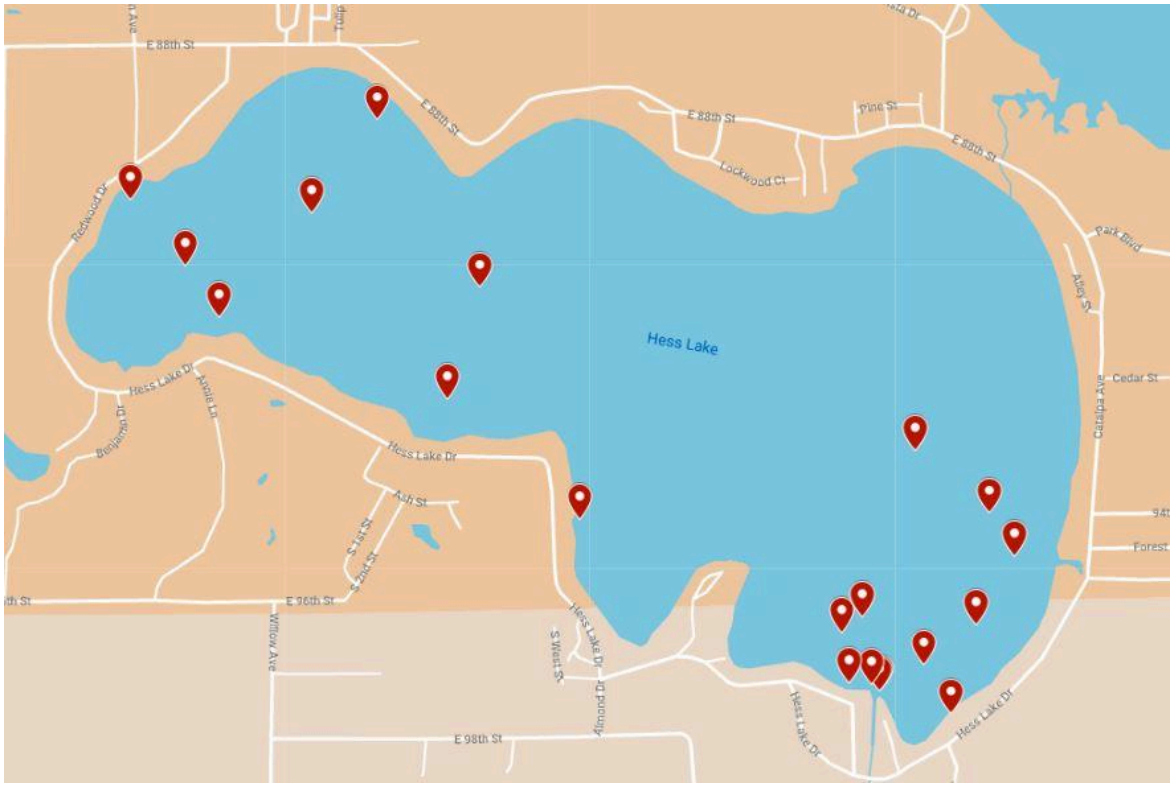

Figure 6: Locations of radio tagged carp located on March 7, 2024 in Hess Lake.

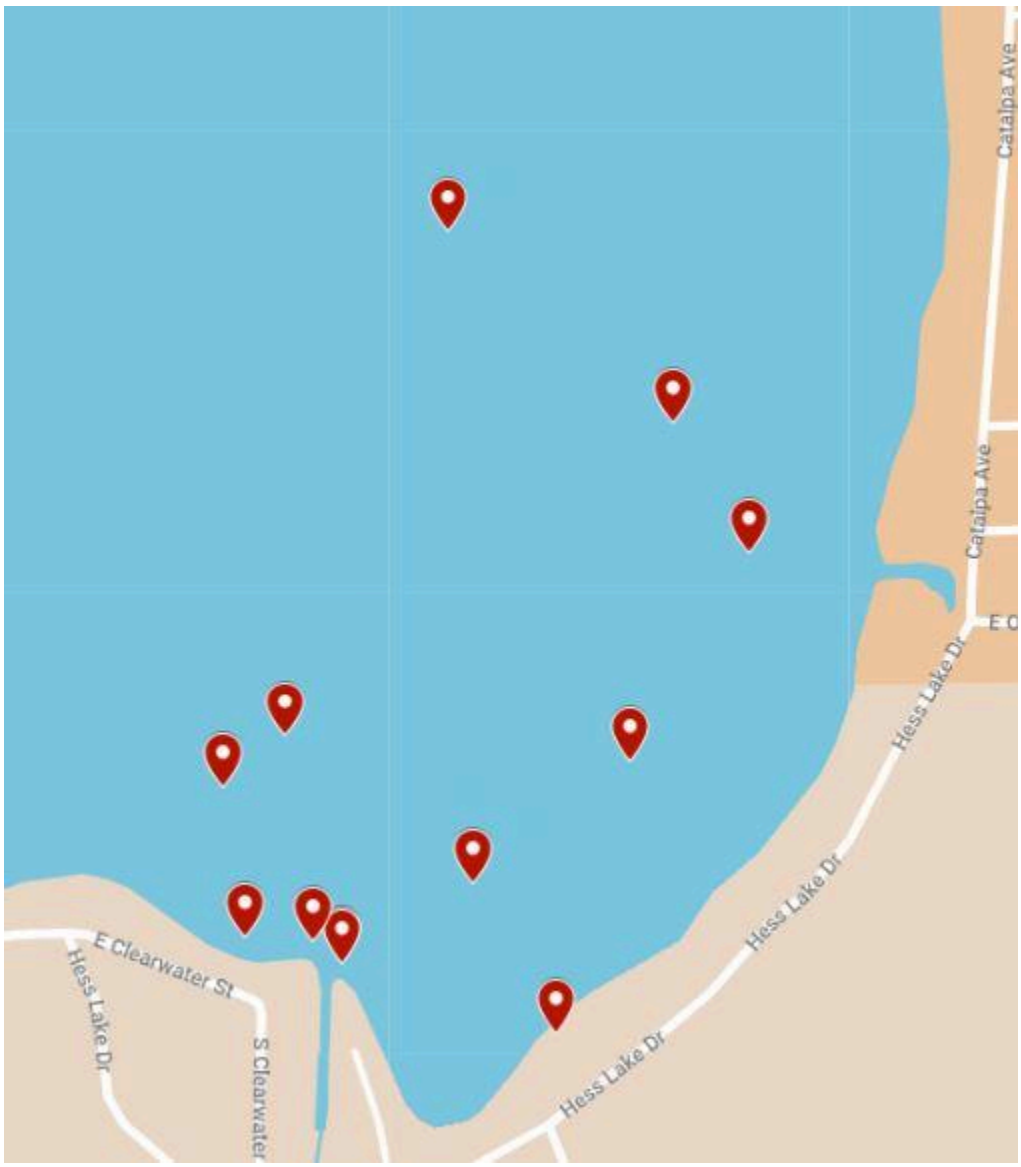

Figure 7: Close up of the southeast corner of the lake with the locations of radio tagged carp located on March 7, 2024.

Table 3: Distances carp moved from where they were caught, released (boat launch), and the distance they moved between surveys.

	Distance from catch site			Distance from release site			Distance between surveys
Tag ID	11/13/2023	3/7/2024		11/13/2023	3/7/2024		
148.011	1.6	0.3		0.4	1.4		1.3
148.030	0.1	0.8		0.7	1.5		0.8
148.053	0.7	0.5		0.6	0.4		0.3
148.072	0.1	0.2		0.7	1.0		0.3
148.090	1.2	1.1		0.7	0.5		0.3
148.112	1.8	0.2		0.5	1.6		1.7
148.133	1.8	0.3		0.5	1.6		1.7
148.153	0.4	0.9		1.1	1.6		1.6
148.172	1.3	0.5		0.6	1.6		1.1
148.192	0.8	0.1		0.3	0.7		0.7
148.211	1.6	0.4		0.4	1.7		1.5
148.233	0.1	0.1		0.1	0.2		0.1
148.250	1.8	0.5		0.5	1.6		1.5
148.293	0.1	0.3		0.2	0.3		0.3
148.311	0.1	0.6		0.7	0.3		0.5
148.332	1.8	0.5		0.5	1.5		1.6
148.352	0.1	0.5		0.3	0.3		0.5
148.575	1.6	0.1		0.4	1.6		1.5
148.622	1.8	0.4		0.5	1.5		1.5
148.652	0.2	0.1		1.6	1.5		0.2
Average	1.0	0.4		0.6	1.1		1.0

Discussion

Because the electrofishing done in 2023 was not randomly distributed around the lake like in 2022, data from it should not be used for estimating the abundance of carp population. In order to efficiently capture as many carp as quickly as possible from different areas of the lake, likely areas were targeted multiple times, increasing catch rates. This is especially noticeable on the last two days, when catch rates nearly doubled as only areas that had carp in them the previous two days were targeted. Overall, this resulted in the catch-per-unit-effort (CPUE) being over twice as high in 2023 (46.0 carp/hr) as in 2022 (21.9 carp/hr). Due to this non-random electrofishing, the

data should not be used to calculate population or biomass density estimates. Thus, the best estimate for carp remains the estimate from 2022 of approximately 32,500 carp and a biomass density around 250 kg/ha. Roughly 20,000 carp will need to be removed to get below the ecologically damaging threshold of 100 kg/ha; this estimate should be updated and verified using mark-recapture methods once cap removal begins.

Comparing the lengths of carp collected in 2022 and 2023 shows a number of important differences. The average length of carp in 2023 (22.4 inches) was significantly different than in 2022 (21.4 inches) (Figure 8) (Welch Two Sample t-test, p=0.00032). Of particular note, a class of carp in the 13-17 inch range was caught in 2022, but only two carp around 17 inches were caught in 2023 when carp were being caught for radio tagging. This may indicate the presence of additional year classes younger than those aged in 2023. It would be beneficial to age a sample of carp this size or smaller during any future removals to see if there has been any recruitment since 2013, the youngest year class in the aging sample.

The radiotelemetry surveys showed that carp did aggregate to some degree. In November of 2023, the carp were found distributed around the lake (no obvious aggregation), mostly in the western half of the lake where they were released a month earlier. Only two were offshore and neither were close to each other. Importantly, the carp were significantly closer (0.6 miles) to where they were released than where they were caught. By contrast, in the spring of 2024, the carp showed a strong preference for the southeast corner of the lake, especially near Wheeler Drain. This aggregation could potentially be targeted with a seine, although it is not known if the area is seineable (i.e potential obstacles on the bottom) and if the aggregation is stable enough over time to allow seining. Additionally, the aggregation off of the Wheeler Drain area and two nearby small inlets suggests that there may be carp aggregating in these areas to attempt to spawn. Even though it is extremely unlikely that any carp could make it up the sheet piling dropoff, it is possible that carp aggregate in the canal between the check dam and the main body of Hess Lake. This could potentially offer an opportunity to block the canal off and capture them. Although the small inlets on the southern half of the western shore do not connect to any major water bodies, they do provide clear access to small very shallow ponds. It is possible that small numbers of carp move up them and attempt to spawn in the ponds. It would be worthwhile to investigate these inlets to ensure that carp cannot spawn there. Due to their small size, this could be done by a volunteer frequently checking and/or a remote camera.

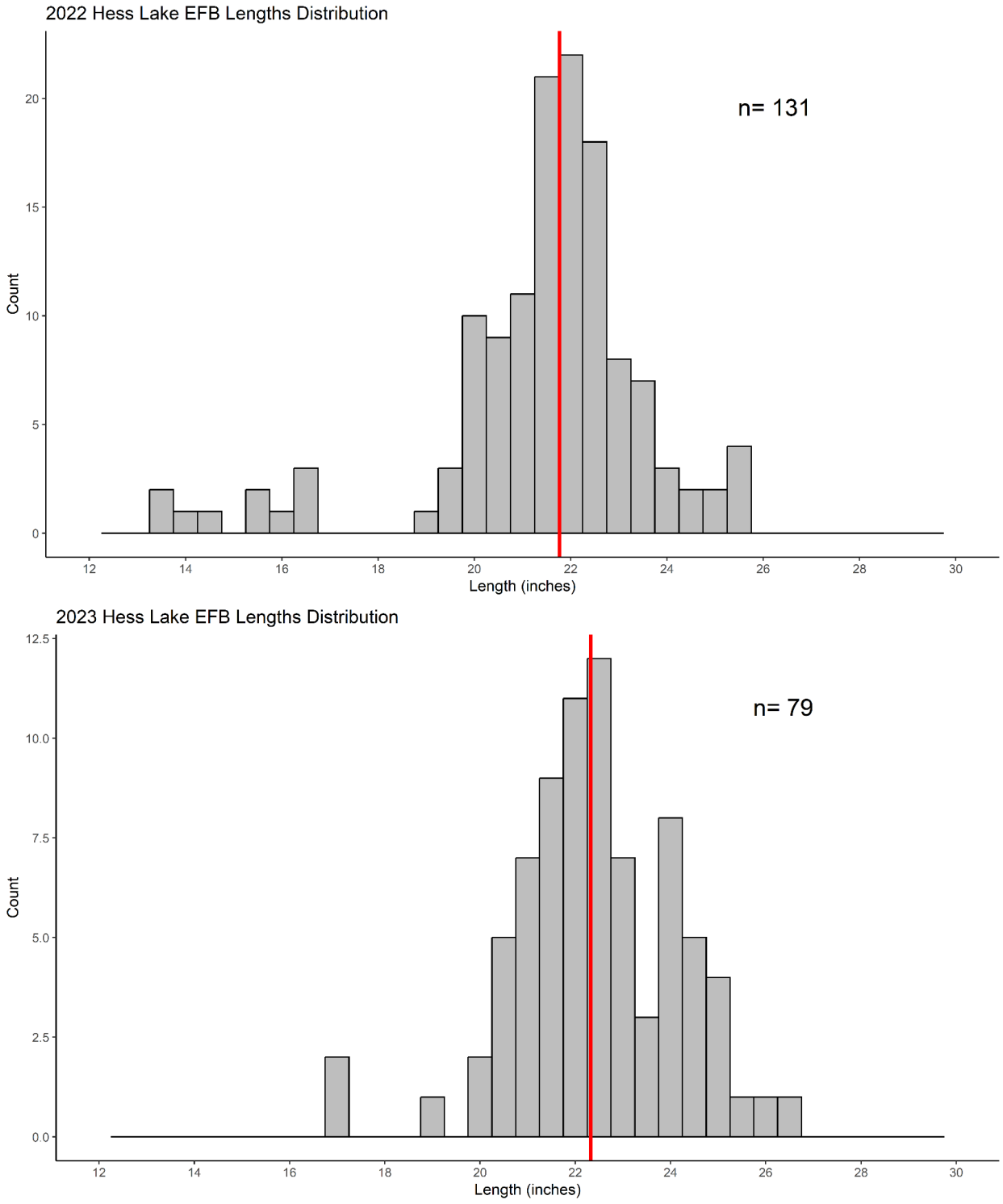

Figure 8: Comparison of lengths collected from 2022 (n=131) and 2023 (n=79).

Management Recommendations

In order to remove the approximately 20,000 carp needed to get below the 100 kg/ha threshold, significant efforts will be needed. Four main efforts have been used in other water bodies to remove carp on this scale, two of which Carp Solutions has tested in some fashion on Hess Lake.

The first and most drastic option is rotenone, a naturally occurring piscicide that indiscriminately kills all fish, not just carp. Rotenone has been used at a whole-lake level to restore lakes dominated by carp (Schrage and Downing 2004). However, rotenone treatment is very expensive and not always successful. Rotenone applications are often difficult because any inlet streams, underwater seepage area, springs, etc., can serve as refugia where carp can survive the treatment. Water drawdowns are often used in conjunction with rotenone applications to reduce the treated area, but drawdowns appear not to be practical in Hess Lake. Often, an incomplete carp kill occurs as a result of rotenone application, allowing carp population to quickly repopulate in a post-rotenone lake ecosystem that is void of native fish. In successful applications, the entire native fish community needs to be reset following stocking. Rotenone applications can also have major issues with permitting and acquiring sufficient quantities of the chemical due to environmental and health concerns. Overall, rotenone treatment does not appear to be feasible in Hess Lake.

The second option is removals of carp during their spring migrations into lake inlets or outlets. This is a technique that Carp Solutions has deployed with great success in systems in Minnesota, both on large and small scale. Under the right circumstances, technologies using seasonal barriers and guidance systems and conveyors can be used to efficiently remove carp with minimal physical labor. However, this technique requires significant carp migrations through an area that provides convenient access for equipment and personnel. During a site visit in July 2023, the inlets and the outlet of Hess Lake were inspected. Most of the inlets would be inaccessible to carp except during exceptionally high water and flows. The main inlet to the lake, Wheeler Drain, has two dams that are four feet or taller which carp would not be able to get over. The second largest inlet, Alger Drain, may be accessible to carp under relatively high water and flow conditions in a particularly wet spring. The outlet stream to Brooks Lake should be accessible to carp in most conditions. However, the migrations (or aggregations of carp that attempt to migrate but are not able to) of carp at these locations has not been investigated. Carp Solutions recommends a barrier in the outlet stream to Brooks Lake to prevent any future immigration of carp from Brooks Lake or the Muskegon River.

Beyond these major inlets and the outlets, some smaller inlets were observed during later work that may be of management interest. During the electrofishing surveys in October, workers from JNR Waterfront Services mentioned that they had seen what they thought were small carp in an inlet stream on the southwest end of the lake. Boat

electrofishing at the mouth of that did not reveal any carp there. In the spring radiotelemetry survey after tagged carp were found in the vicinity, this inlet and another nearby inlet were examined from shore. Although these inlets are small and only lead to small, very shallow wetlands, it is possible that carp could be moving into them to spawn. Potential nursery sites that are small in size should not be neglected as carp populations inhabiting entire chains of lakes are often supported by peripheral small nurseries (e.g. stormwater ponds; Sorensen and Bajer 2021).

In order to ascertain whether carp are using any of these streams as spawning migration routes, two techniques utilizing the tags that have already been implanted in carp could be used. First, radio telemetry surveys like those conducted in the winter could be conducted to look for carp that are moving or have moved out of Hess Lake itself. These surveys would be conducted around the peak of the spawning season in late May to early June. This method does not require any sensors or equipment to be installed and provides accurate locations of carp in any areas searched, but only provides as much temporal detail as surveys conducted. Also, the relatively small sample size of carp (20) tagged in Hess Lake likely will not provide an accurate percentage of the carp that take that route. The other method, PIT antennas, requires the temporary installation of PIT systems on the streams and only provides information on tagged carp moving over that particular spot. However, PIT antennas can be installed and left to provide constant monitoring of that site without additional labor. With 129 PIT tags implanted in 2022 and only one removed to date, the sample size would allow for a far more accurate estimate of the percentage of carp moving through that stream. An additional and far cheaper method could be used if barriers are installed. A cheap remote access security camera could be installed on the lake side of the barrier to visually monitor for carp aggregations. This does not rely on implanted tags, but also does not provide any numerical estimates of carp movement, just a general idea of the size of aggregations. Carp Solutions often employs such cameras in addition to the other methods especially to assist with removal efforts. At the least, visual inspections of these potential routes for carp in late May and early June should be conducted to ensure that carp are not using them. It is of paramount importance that carp are prevented from recruiting as much as possible.

If significant spawning migrations are found, removals of these migrations during spring could be conducted to reduce the carp population. However, infrastructure changes to facilitate mechanized removals would likely be needed to capture enough carp to affect the overall population. The advantage of migration removals is that they accompany the blocking of migrations of carp necessary for sustainable long-term carp management. During long-term carp management, they also maintain their efficiency as carp populations are significantly decreased and approach the ecological damaging threshold of 100 kg/ha. So, if significant migrations are found, they should be blocked as part of long term carp management, and could provide for effective removals .

A third removal option is coldwater seining, which the radiotelemetry surveys were planned to test the feasibility of. Common carp tend to aggregate in large groups as water temperatures fall below 10°C (Bajer et al. 2011). These aggregations can be targeted by open water seines in the late fall or early spring or if ice conditions allow, on the ice in the late winter. This method utilizes the “Judas fish” technique, where some carp are implanted with a radiotelemetry tag. These carp can then be tracked to observe their behavior, especially when they aggregate heavily. The aggregations located in this way can then be netted with a seine net. However, seining may be of limited use if obstacles (large rocks, submerged trees, uneven bottom, etc.) are present in areas where carp aggregate as these obstacles can snag the net. The 20 tags implanted into carp in October 2023 were planned to test the feasibility of this method by seeing if the carp in Hess Lake aggregate during cold water periods. The tags have a 3-5 year battery life, meaning that if aggregations are observed, the currently implanted tags could be used to guide this removal. Unlike the fall radiotelemetry survey, the spring survey showed aggregations of carp. Thus, coldwater seining may be a feasible removal option. Currently, it is unclear if the carp only aggregate in the spring or at other times of the year. Also, before actually deploying seine nets, the area to be seined needs to be scanned with side imaging sonar to verify that there are no underwater snags that would catch the net and rip it, or lift it above the bottom allowing carp to escape. Larger obstacles within the seine area would need to be removed. Finally, it is not known how mobile the carp aggregation might be in the lake (i.e. whether the carp will aggregate in the same or different area in different years), thus frequent tracking would need to be conducted in anticipation of seining.

The final method of carp removal is box netting. Carp Solutions has successfully used box netting to decrease carp biomass densities in water bodies ranging from small ponds to 1500 acre reservoirs. Carp Solutions tried a small pilot box netting project with two pulls of three box nets in 2022, capturing and removing 396 carp. This catch was below expectations, largely due to two reasons: 1) before the first round of removals bait consumption was minimal, suggesting that the carp were simply not trained to aggregate at the bait, 2) this was ameliorated for the second pull, where bait consumption increased to 50 lbs/day (all provided bait was consumed) and multiple tagged carp were detected at the bait, however, carp largely stopped visiting the bait 24h before the second pull. Overall, we believe that catches in box nets could be much improved, had the crew stayed on site and had more time to monitor the behavior of carp and pull the nets when carp presence at the bait was high. Key advantages of box netting over other management techniques are: 1) ease of coordination; because box netting can be used any time between June and October, rapid crew mobilization is not necessary as is the case for cold water seining or spring removal during spawning run, both of which are transient, 2) it is not influenced by obstacles on the bottom and does not require lake bottom clean up, 3) can engage local residents to reduce the cost, 4)

can be scaled up (many nets) or down (few nets) as needed, 5) finally, box netting can be largely automated and remotely monitored to reduce cost, for example, automated feeders, which were not available in 2022 are available now.

Based on data from other systems, we believe that catches in box nets could be substantially improved over those documented in 2022. To achieve that in 2024 we propose: extending the baiting period with minimum cost using remotely-controlled feeders, using larger nets than in 2022, providing a crew of 2 on site for four days before expected net pull, using an additional PIT system for tracking carp aggregations and pulling the nets only if carp activity is high. For 2024 we recommend …… 4 nets x 3 times… Data from this effort (updated mark-recapture estimate, mean catch per net) would allow for developing and implementing carp management beyond 2024.

In order to remove carp at the scale required for Hess Lake, six to ten box nets, half of which would have PIT antennas, would have to be pulled up to six times a year for probably three years. Continued implantation of PIT tags for mark-recapture estimates and information about carp feeding activity would also be needed. Before going to a full scale removal, Carp Solutions recommends a 40-50% scale test project with three box nets pulled three times. Along with that, more PIT tagging with boat electrofishing would be needed to increase the number of tagged carp in the system and provide an updated and accurate population estimate before removal. An estimate for this project was provided with this report. Ideally, this test project would be done in the summer of 2024 so that large scale removals could begin in 2025. Carp Solutions has also used box netting in combination with spring removals and cold water seining, so if these other methods prove feasible, box netting could be used at a smaller scale to assist in the reduction of carp biomass.

In summary, there are three possible options for carp removal in Hess Lake. Removal of spawning aggregations might be possible in a few locations, but the nature of the inlets suggests that this would likely not be as effective as other water bodies where it is commonly done. The final radiotelemetry survey in the spring suggests that coldwater seining could be effective in Hess Lake. Finally, box netting has been tried, and should be an effective method at a large enough scale. Importantly, the long-term success of these depends on preventing reproduction and migration of new carp into Hess Lake, which involves blocking the outlet to Brooks Lake.

Citations

Bajer, P. G., C. J. Chizinski, and P. W. Sorensen (2011). Using the Judas Technique to Locate and Remove Wintertime Aggregations of Invasive Common Carp. Fisheries Management and Ecology 18: 497–505.

Bonneau, J. L., and D. L. Scarnecchia (2001). Tests of a rotenone-impregnated bait for controlling common carp. Journal of the Iowa Academy of Science 108(1):6-7.

Schrage, L. J., and Downing, J. A. (2004). Pathways of increased water clarity after fish removal from Ventura Marsh; a shallow, eutrophic wetland. Hydrobiologia 511, 215–231.