East Lake Carp Assessment Report

December 2018

A partnership between the Vermillion River Watershed Joint Powers Organization and the City of Lakeville

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Project Purpose

East Lake is located just east of 167th St. and Pilot Knob Road in Lakeville and is on the Environmental Protection Agency's 303d Impaired Waters List. Excess nutrients, namely excess phosphorus, have been found to be the cause of the impairment. Excess nutrients in East Lake originate from both external and internal sources. To date, the Vermillion River Watershed Joint Powers Organization (VRWJPO) and partners have implemented projects to help address both external and internal phosphorus sources, but fishery surveys have shown the presence of common carp (*Cyprinus carpio*) to be significant in East Lake, which may shift the balance of phosphorus sources. Carp feed by rooting in the lake bottom sediments, which stirs up the sediment and releases more nutrients into the water column than would normally be introduced. As a result, the internal nutrient source becomes more of a factor in addressing the water quality impairment. The VRWJPO and City wish to address the internal nutrients source by first performing a survey of the carp population and movement.

The purpose of the East Lake carp assessment project was threefold:

1. Establish and estimate of the carp population and biomass within East Lake to determine if carp management and/or removal are necessary to address carp's impact to water quality.
2. Track carp movements to determine if carp are moving to and using surrounding ponds or the North Creek tributary to the Vermillion River as a carp nursery, which may necessitate the installation of a carp barrier(s).
3. Determine the age of the carp population to determine when carp begin to recruit in East Lake.

East Lake Carp Assessment Report
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Prepared by: Jordan Wein, Aaron Claus and Przemek Bajer
Carp Solutions LLC
www.carpsolutionsmn.com

Summary

This was a one-year project that started on May 1st, 2018. The population of common carp (*Cyprinus carpio*) was estimated using catch per unit effort (CPUE) electrofishing surveys in East Lake. The surveys revealed an estimated population of 1,729 carp and a biomass of 137 kg/ha, which slightly exceeds the general ecological threshold of 100 kg/ha. Twenty adult carp were captured and implanted with radiotransmitters and tracked during the spawning season (May-July) on five different days. While most of the radiotagged carp were consistently found within East Lake, between one and three tagged carp were absent from the lake during each survey (these fish were then located back in the lake during following surveys). The carp that were absent from East Lake were not found in the peripheral ponds adjacent to East Lake, which suggests that they were traveling to and from the North Creek tributary to the Vermillion River (North Creek). East Lake and surrounding connected ponds were surveyed for young of year (YOY) carp. One YOY carp was captured in East Lake, but none were captured in the peripheral ponds, indicating a small level of recruitment in East Lake in 2018.

An ageing analysis revealed that the population was dominated by 3 and 4-year old carp (69% of population), small numbers of YOY (10%) and 2-year old carp (10%) were also present. This suggests that carp recruit within East Lake system on approximately an annual basis, which is frequent, but recruitment strength can vary dramatically among years. Processes that drive carp recruitment (production of young) are currently unknown, but they may be driven by both summer and winter hypoxia. Hypoxia is known to severely reduce populations of bluegill sunfish that have been shown to play an important role in controlling the survival of carp eggs and larvae.

While carp biomass is currently relatively low, it might increase due to rapid growth rate of young carp. A significant 2017/2018 winter kill of large adult carp suggests that high carp biomass can be supported when the lake does not experience significant hypoxia. We were unable to estimate the number or biomass of the carp that perished over the winter since most were too decayed to be measured or counted.

Anecdotally, the carcasses seemed larger than the average size of carp caught during electrofishing transects.

Strategic removal of carp may be desired to reduce the biomass below 100 kg/ha. Additional monitoring to better identify the processes that drive carp recruitment should also be performed. Recommendations for follow-up activities include: dissolved oxygen monitoring to assess the frequency and severity of hypoxia, selective carp removal, expansion of telemetry surveys (or use of Passive Integrated Transponder technology; see management recommendations below) throughout the year, and if warranted, a barrier installed between East Lake and the North Creek.

Activity 1.1. Estimating carp abundance and biomass using boat electrofishing

Rationale and Methods

To conduct an assessment of the carp population, three days of boat electrofishing surveys were conducted in East Lake following protocols developed by Bajer and Sorensen (2012). These surveys were conducted on July 3, August 14, and August 15, 2018. For each survey, the number of captured carp were counted and the mean catch per unit of effort (CPUE; carp/hour) was calculated. The CPUE values were used to generate estimates of carp density and biomass using an equation developed by Bajer and Sorensen (2012). In addition, because electrofishing allows for capturing carp in good physical condition, 20 of the captured carp were also implanted with radiotransmitters and released to facilitate Activity 2.1 (below).

Results

In total, over the three survey days, 78 carp were captured in 180 minutes of boat electrofishing. The overall mean CPUE was 27 carp per hour (Table 1). This catch rate suggested that East Lake was inhabited by approximately 1,729 carp. Their lengths ranged from 153 mm to 650 mm (Figure 1). Using the mean length (438 mm) and weight (1.2 kg or 2.4 lbs), the surveys suggested that the biomass of carp in East Lake was 137.4 kg/ha (Table 2). The management goal for carp in lake ecosystems is 100 kg/ha (Bajer et al. 2009), thus common carp appears to be marginally above this threshold. It should be noted that the lake experienced a significant fish kill, including carp, just prior to the monitoring period (winter 2017/18), presumably from winter hypoxia, thus the biomass was most likely substantially higher in 2017.

Activity 2.1 – Movement to spawning sites: Radiotelemetry

Rationale and Methods

Soon after ice out in 2018, 19 carp and 1 goldfish/carp hybrid were captured with electrofishing gear, anesthetized, implanted with radiotransmitters (Advanced Telemetry Systems Isanti, MN), and released back into East Lake (Table 3). These radiotagged carp were later tracked to determine if and to where the carp were moving to spawn. Telemetry surveys were conducted on five occasions between May 11 and

July 3, 2018. Telemetry was focused on East Lake and the surrounding peripheral ponds.

Results

Of the 20 radiotagged carp, majority (17-19) were found in East Lake during each telemetry survey (Table 3). However, between one and three tagged carp were absent from the lake during each survey (Table 3). This suggests that some carp were moving in and out of the lake throughout the year. Most likely, the carp were moving to and from North Creek because we never located any radiotagged carp in any of the peripheral ponds that surround East Lake. While in East Lake, radiotagged carp were spread throughout the lake with loose aggregations often present at the southwest outlet and the northeast lobe (Fig. 2 and 3).

Activity 2.2: Analysis of carp recruitment (production of young)

Rationale and Methods

Determining recruitment dynamics is often the most critical element of assessing carp management strategies. This activity had two components: 1) ageing analysis to determine **when/how often** young carp recruit into the population in East Lake, and 2) surveys of peripheral ponds as well as East Lake itself to determine from **where** carp recruit (nurseries).

<u>Ageing analysis</u>

A sample of 60 carp from electrofishing surveys were euthanized and kept for ageing analyses using otoliths (inner ear bones). The otoliths were removed, embedded in epoxy, sectioned into 300-micron slices using an isomet saw and examined for age under a microscope.

The results of the ageing analysis show that the population of carp in East Lake appears to be relatively young and dominated by three and four year old individuals. Starting with the dominant cohorts, ~36% of the aged sample were four years old, ~33% were three years old, ~22% were age 6 or older (Fig. 4). The oldest carp was 15. Among the aged fish, we also found a small number of YOY carp (7%) and one age-2 carp (2%) (Figure 4). These results suggest that carp produce young (recruit) on an annual basis, but recruitment strength varies dramatically among years (particularly strong recruitment occurred in 2015 and 2014; three and four year old carp, respectively). These results also show that even if the carp population in East Lake suffers a winterkill, many of the year classes survive and will have a good chance of successfully repopulating the lake.

<u>Surveys of potential carp nurseries</u>

East Lake and eight peripheral ponds were surveyed (Fig. 5). Survey sites were sampled with 3/8”-mesh trap nets, a device known to effectively capture juvenile carp (Bajer et al. 2012). All nets were set overnight and retrieved the next day. The surveys were conducted in late summer when YOY carp were large enough to sample.

Trap nets captured eight different species in East Lake, while between two and six species were captured in the peripheral ponds (Table 4). Only one YOY carp was captured in East Lake (Table 4). The most predominant species caught were bluegill sunfish, black bullhead, and green sunfish (Table 4). Presence of relatively large numbers of bluegills was somewhat surprising given that bluegills are sensitive to hypoxia and East Lake was believed to have experienced a severe hypoxia during the winter of 2017/18. It is possible that bluegills (which appeared to be 1-3 years old) immigrated from North Creek in the spring of 2018, or found a refuge within the lake.

Conclusions

Our surveys suggest that in 2018, East Lake was inhabited by a moderately abundant population of common carp whose biomass (137 kg/ha) slightly exceeded ecological threshold for lakes (100 kg/ha). However, a significant carp winterkill that occurred during the 2017/18 winter suggests that the abundance and biomass of carp were substantially higher in 2017. The ageing analysis shows that this lake is likely susceptible to frequent recruitment events, which means the 2018 population has a good chance to increase quickly. In addition, most of the carp are relatively young and small and their biomass is likely to increase rapidly in future years, unless there is another significant mortality event.

Telemetry showed that some of the radiotagged carp were absent from East Lake during spring months but then returned to the lake. This suggests that carp move in and out of the lake, most likely to and from the North Creek. Trap net surveys did not catch YOY carp in peripheral ponds that are periodically connected to East Lake and only a handful of YOY were captured in East Lake. This sampling effort is insufficient to determine whether East Lake or the peripheral ponds function as carp nurseries. Further, ageing analysis showed that particularly strong year classes occurred in 2015 and 2014 (three and four year old carp, respectively) but processes that drove those recruitment events as well as their location are unknown.

Trap nets also captured high numbers of bluegills in East Lake. These fish were most likely age 1-3 (YOY bluegills rarely exceed 60 mm and most of the collected bluegills were in 80-120 mm range; Tomcko and Pierce 1997). Bluegills have been found to be significant natural predators of carp eggs and larvae, which might explain low carp recruitment in East Lake in 2018. Maintaining stable population of bluegills in East Lake is important to curb carp recruitment. This, however, might require monitoring and preventing winter and summer hypoxia because bluegills are very sensitive to low oxygen concentrations.

Management recommendations

Currently, the carp population is relatively low in East Lake. However, the size of each carp is likely to increase quickly due to rapid growth and recruitment. Additional years of trap netting and electrofishing to determine if the carp population will increase rapidly are recommended. If the results indicate that the population has increased rapidly, then strategic removal to bring the biomass below 100 kg/ha is recommended.

Baited box nets would be a potential option in a location like East Lake due to its depth and bathymetric characteristics (shallow and presence of submerged debris).

Addressing carp recruitment is a higher priority. Promoting the survival of oxygen-sensitive species (like bluegill sunfish) that are predators of carp eggs and larvae would help keep the carp recruitment in check as well as bolster a desirable fishery. Monitoring of dissolved oxygen in East Lake is recommended (most importantly during winter and summer months) to determine if oxygen levels are in fact a driver for carp recruitment. If oxygen levels are found to be prohibitive for oxygen-sensitive species, implementation of an aeration system could be considered. A partnership with the Minnesota Department of Natural Resources (MN DNR) to promote bluegills and other native fish via stocking and aeration is recommended.

In addition, the potential movements of carp between East Lake and North Creek should be monitored further. Of particular interest is the immigration of carp into East Lake, which could negate management efforts. Radio telemetry implemented quarterly during 2019 and 2020 could determine if and how many carp leave the lake throughout the year, not just in the spring. Implanting passive integrated transponder (PIT) tags in carp in East Lake and installing a PIT antenna between the lake and North Creek could also be used to autonomously and continuously track the movements of carp throughout the year. These systems are especially effective at long-term movement patterns of carp between the creek and the lake as the tags last indefinitely (no internal battery). PIT systems can often be operated in remote locations using solar panels and offer a lower cost and higher-resolution alternative to radio telemetry.

If carp are shown to be moving into East Lake from North Creek in significant numbers, a barrier might be considered between the two systems. Considerations with any barrier should include the type of barrier, cost, operation, clogging, and maintenance. Hindering the migrations of native fish should also be considered; this can be addressed by using barriers only during times of carp migrations. Barrier options range from low-cost, semi-permanent physical barriers (Fig. 6), that may require more monitoring for clogging and impedance of fish to more sophisticated electrical barriers that require an external power source but have less issues with clogging.

Preliminary cost estimates for management options:

- Radiotelemetry surveys (Spring 2019 through winter 2020): $2,000
- PVC fish barrier in North Creek: $3,000
- PIT antenna purchase: $5,000
- PIT antenna rental (open water months): $3,600
- PIT antenna design, installation, technical maintenance: $3,000
- Box netting in 2019: $15,000
- Boat electrofishing (needed if using PIT antenna or box netting): $3,200

References

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Bajer PG, Chizinski CJ, Silbernagel JJ, Sorensen PW. (2012). Variation in native micro-predator abundance explains recruitment of a mobile invasive fish, the common carp, in a naturally unstable environment. Biological Invasions. Sep 1;14(9):1919-29.

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Tomcko CM, Pierce RB. 1997. Bluegill growth rates in Minnesota. Minnesota Department of Natural Resources. Investigational Report 458.

Figures and Tables

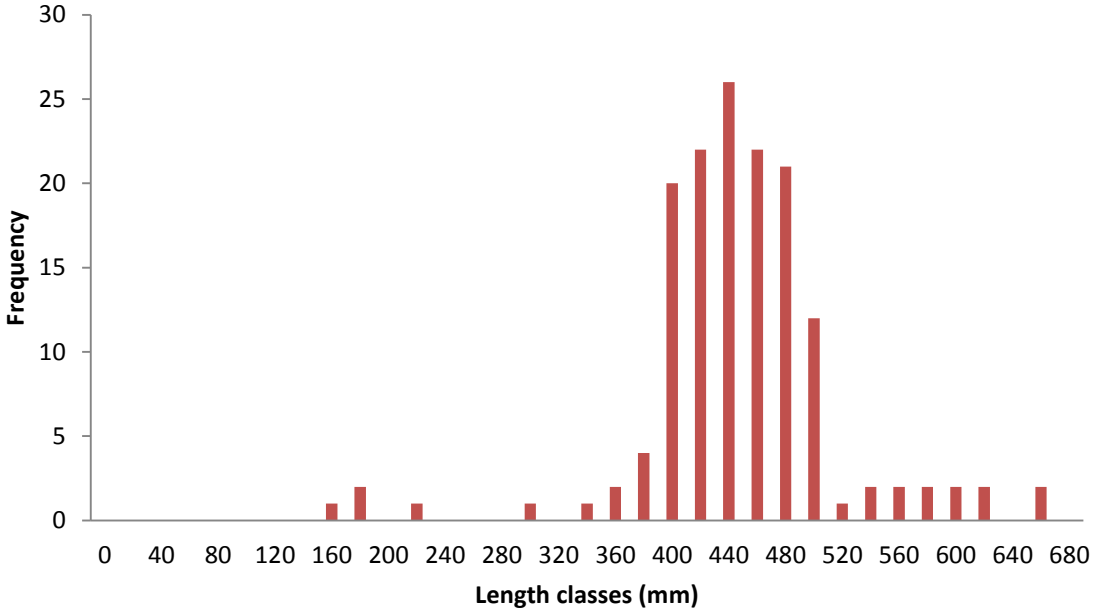

Figure 1: Length histogram of carp caught while conducting boat electrofishing surveys in East Lake on July 3, August 14, and August 15, 2018

Table 1: Electrofishing survey data

Date	Electrofishing time (minutes)	Carp caught	CPUE
7/3/2018	20	9	27
7/3/2018	20	12	36
7/3/2018	20	17	51
8/14/2018	20	8	24
8/14/2018	20	5	15
8/14/2018	20	3	9
8/15/2018	20	13	39
8/15/2018	20	7	21
8/15/2018	20	7	21
Mean CPUE			27

Table 2: Carp population summary

Ave. length	Ave. weight	Lake Area (ha)	Population estimate	Biomass (kg/ha)
438 mm	1.2 kg (2.4 lbs)	15 hectares	1,729	137.4

Table 3: Frequencies of radiotransmitters implanted in East Lake. * denotes a goldfish/carp hybrid that was implanted as well. Radiotagged carp found in East Lake during each telemetry survey (5/11/18 – 7/3/18) are denoted as "+", absent "A".

Length	Frequency	5/11/18	5/24/18	6/13/18	6/21/18	7/3/18
482	148.082	+	+	+	+	+
465	148.261	+	+	A	+	+
456	148.103	+	+	+	+	A
562	148.021	+	+	+	+	+
445	148.122	+	+	+	+	+
420	148.453	A	+	+	+	+
443	148.361	+	+	+	+	+
660	148.341	+	+	+	+	+
553	148.162	+	+	+	+	+
545	148.181	+	+	+	+	+
538	148.060	+	+	+	+	+
517	148.324	+	+	+	A	+
460	148.041	+	+	+	+	+
471	148.433	A	+	+	+	+
422	148.242	A	+	+	+	+
490	148.300	+	+	+	+	+
478	148.423	+	A	+	+	+
465	148.140	+	A	+	+	+
445	148.203	+	+	+	+	+
495	*148.220	+	+	+	A	+

signals

Figure 2: Telemetry maps in May and June 2018. Dots show locations of radiotagged carp. Red circles indicate mortality signals.

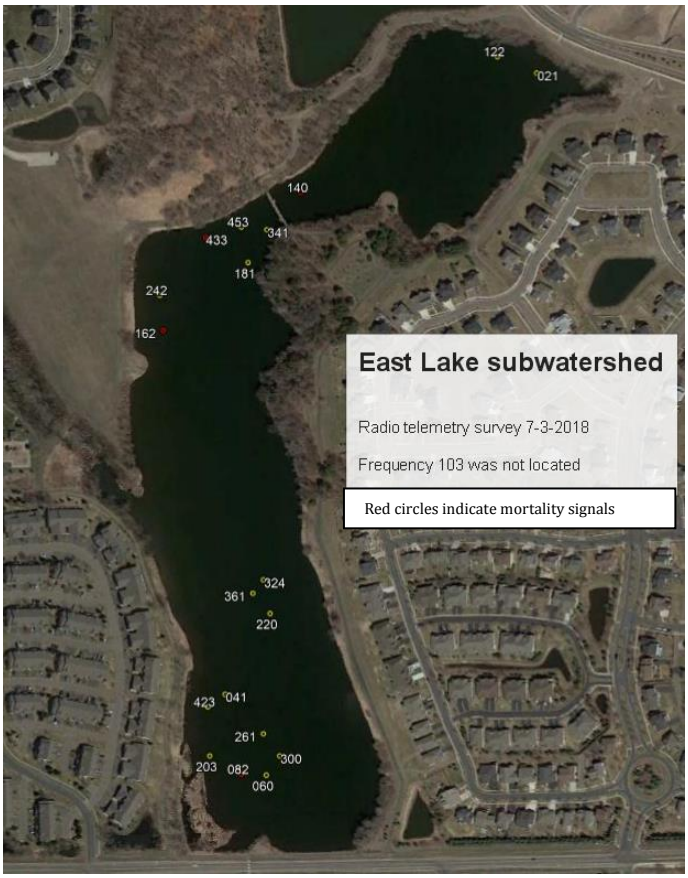

Figure 3: Telemetry map in July 2018. Dots show locations of radiotagged carp. Red circles indicate mortality signals.

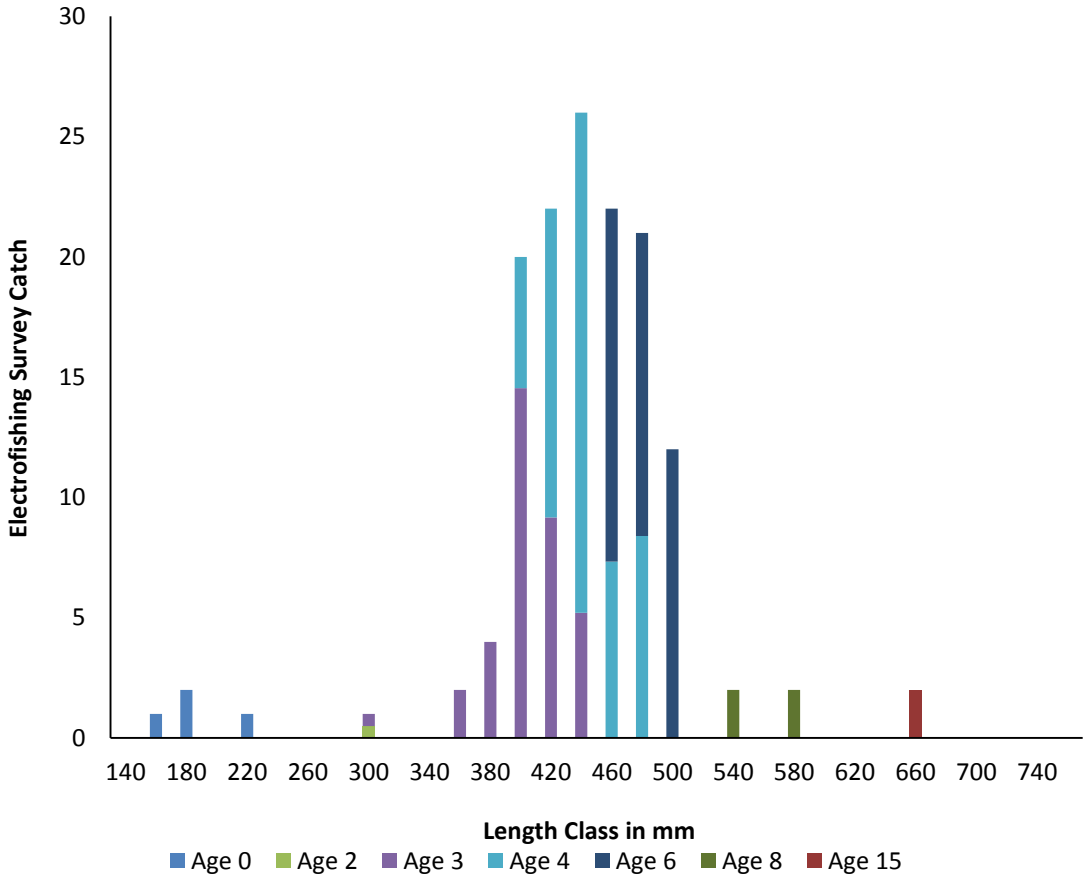

Figure 4: This histogram illustrates results of the ageing analysis in the same length categories of the length structure constructed from electrofishing data.

Table 4: Mean catch per trap net by location.

	EAST LAKE	PERIPHERAL PONDS			
		A	B	C	D
CARP (YOY)	0.2	0.0	0.0	0.0	0.0
CARP ADULT	0.0	0.0	0.0	0.0	0.0
BLUEGILL SUNFISH	151.2	147.5	41.0	17.0	6.2
GREEN SUNFISH	3.0	127.5	0.0	10.7	1.6
BLACK BULLHEAD	44.4	114.5	28.3	21.0	57.6
GOLDFISH	0.0	0.0	0.0	0.0	0.0
BLACK CRAPPIE	0.6	0.0	0.0	0.3	0.0
LARGEMOUTH BASS	0.8	0.0	0.0	0.3	0.2
PUMPKINSEED	2.4	0.0	0.0	2.3	1.0
YELLOW PERCH	6.4	0.0	0.0	0.0	0.0

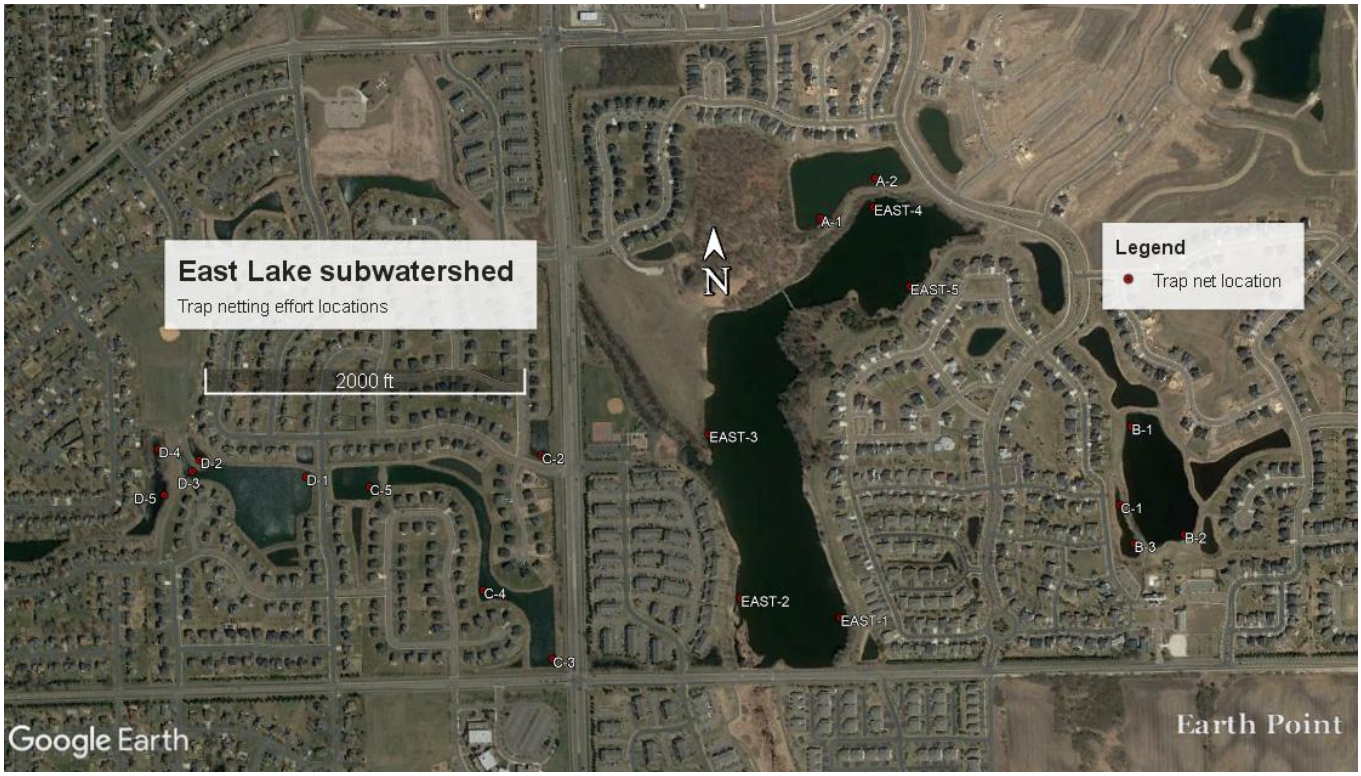

Figure 5: Locations of trap net sets in East Lake subwatershed.

Figure 6: PVC semi-permanent fish barrier example.