Electrofishing Estimates of Common Carp in Green Lake

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Project Background

Common carp are a wide-spread invasive species that cause significant changes to aquatic vegetation, water clarity, and native fish abundance (Bajer and Sorenson 2010; 2012). Common carp have been introduced into many aquatic ecosystems throughout the Midwest and recent research at the University of Minnesota has focused on reducing and controlling populations through various management techniques (Bajer et al. 2011; Bajer et al. 2009). Accurate estimation of carp densities is a critical first step in successfully managing and controlling invasive common carp.

Bajer and Sorenson (2012) recently published a study to validate the use of boat electrofishing to estimate common carp abundance in small Minnesota Lakes. Electrofishing is a preferable means of estimating carp abundance because it actively targets large adult carp and requires less effort than traditional mark-recapture techniques. Electrofishing estimates generally matched estimates from mark-recapture techniques and did not require multiple sampling efforts to recapture marked individuals.

At 1,810 acres, Green Lake is the largest lake in the Chisago City area (MNDNR 2011). Green Lake has three main basins: a large central basin and smaller northern and southern basins. A fish survey conducted in 2011 by the Minnesota Department of Natural Resources shows a large diversity of game species and the presence of common carp in Green Lake. Both trap net catches (0.08 fish/net) and gill net catches (0.07 fish/net) were well below the normal range of common carp captured in similar lakes (MNDNR 2011).

Lake Estimates

Green Lake was surveyed on two consecutive weekends in September, 2015. Electrofishing methods followed the methods used by Bajer and Sorenson (2012). In each lake, the electrofishing boat was maneuvered in a zig-zag manner near the inshore zone for 20 minute intervals (Figure 1). This was completed 6-8 times on each day to try and cover a representative amount of shoreline. Catch rates were maximized by targeting preferred carp habitat and actively chasing visible carp. All stunned carp were netted and placed in the boat for counting, measurement, and collection of scales and pectoral fin rays for age analysis. On Sept 19th, all captured carp were tagged and released. On September 26th, all carp were held and removed from the lake.

The boat electrofishing unit used by Saint Mary's University's was similar to that used by Bajer and Sorenson (2012), except that the anodes in the front of the SMU boat were single electrodes that were submersed approximately 30 cm deeper in the water. Electrical control settings were identical to those used in the previous study: pulsed DC, 5-12 amps, 20% duty cycle, and 120-pulse frequency.

A total of 13 common carp were collected on September 19th and 4 carp were collected on September 26th (Table 1). Of interesting note is that carp were only collected in the northern basin and north part of the main basin (Figure 1). No carp were collected or observed in the southern part of the lake. Additionally, none of the carp marked on September 19th were recaptured on September 26th, resulting in the inability to perform a mark-recapture estimate of carp abundance.

The resulting electrofishing catch per unit effort was 3.86 carp per hour, which was within the range of 2.98-64.4 carp per hour reported by Bajer and Sorenson (2012). Densities of

adult carp were estimated from the catch per unit effort regression developed by Bajer and Sorenson (Figure 2). Carp densities from Green Lake (21.2 carp/ha) were similar to those reported in the study for other Minnesota Lakes (13-400 carp/ha), but appear to be on the lower end of reported densities. These results are similar to the MN DNR fisheries survey in 2011, indicating the presence of common carp but below typical catch ranges.

All carp captured were large adults over 640 mm in total length. Similar to the results of Phelps et al. (2007), age estimates from scales were typically within 1-2 years of age estimates from pectoral fin rays, and overall provided a reliable estimate of carp ages. Age range for carp captured was 7-12 years, and did not show any strong year classes (Figure 3). Bajer and Sorenson (2010) found that up to 90-95% of carp populations were comprised of strong year classes in Lake Susan and Lake Riley, MN. However, these year classes were due to high reproductive events in "superabundant" populations, which may not be present under lower and more stable recruitment as evidenced by our captures in Green Lake.

Conclusions

Preliminary estimates of common carp in Green Lake represent a conservative estimate of carp abundance that shows carp densities around 21.2 carp per hectare. Estimates appear to be consistent with previous MN DNR surveys in Green Lake (MNDNR 2011) and other study lakes in Minnesota (Bajer and Sorenson 2012), suggesting a reliable estimate. However, the low number of marked fish and no recaptures prevented validation with mark-recapture techniques. Green Lake was also larger than any other lake previously sampled using this technique. The inability to survey carp in deep water habitat or 100% of the shoreline represents a potential bias

and underestimate of the Green Lake carp population. Repeated surveys or a combination of techniques is recommended for validating initial estimates of carp.

Bajer and Sorenson (2012) concluded that electrofishing could accurately estimate carp numbers at low and moderate densities in small lakes. However, the accuracy of these estimates can be influenced by multiple variables. Bajer and Sorenson identified several potential sources of error in electrofishing estimates that could have affected our study:

1. Carp distribution: Late summer and early fall represent the best time to uniformly sample carp throughout Minnesota lakes. However, daily weather and temperature changes can significantly affect carp distribution in near shore areas and bias sampling results.
2. Non-uniform habitat conditions: Carp tend to concentrate near areas of vegetation and woody structure. We observed that carp were not uniformly distributed around the shoreline, but aggregated in patches. Failure to representatively sample the shoreline habitat (patches with and without carp) can result in biased estimates.
3. Lake size: Lake sizes in the Bajer and Sorenson (2012) study ranged from 81.5-375.6 acres, placing Green Lake (1,810 acres) well outside of the range studied. Larger lakes potentially reduce the efficiency of carp capture and could lead to an underestimate of carp abundance.
4. Migration: Annual and seasonal carp abundance can increase significantly due to immigration from connecting water bodies (Bajer and Sorenson 2009). Any significant migration from connecting water bodies could result is a significant underestimate of the actual population.

This initial estimate is a starting point for determining the management steps needed to minimize ecological damage caused by invasive common carp. Carp densities of ~100 kg/ha have been suggested as a minimal threshold for managing carp densities in Minnesota Lakes (Bajer et al. 2009). Based on estimates of carp density and average adult carp sizes of 6 kg Green Lake has an estimated 127.2 kg/ha, which exceeds this threshold. Consequently, Green Lake could see ecological improvement with active carp removal and long-term management.

Acknowledgments

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Table 1. Summary of electrofishing results from Green Lake.

Date Sampled	Transects Surveyed	Total Effort (min)	Number Adults	CPUE (Carp/hr)	Estimate (Carp/ha)	Estimate (Carp/acre)
9/19/15	8	154	13	5.07		
9/26/15	6	110	4	2.18		
Combined	16	264	17	3.86	21.2	8.6

Table 2. Length, weight, and age data from common carp collected in Green Lake.

Date	Length (mm)	Weight (g)	Age
19-Sep	640	5	7
19-Sep	650	5	7
19-Sep	660	5	7
19-Sep	670	5.5	8
19-Sep	670	5.0	8
19-Sep	680	5.5	8
19-Sep	690	4.25	8
19-Sep	700	6.5	9
19-Sep	700	6.5	9
19-Sep	710	6.5	9
19-Sep	770	5.5	9
19-Sep	775	6	10
19-Sep	800	8.9	12
26-Sep	680	6.25	8
26-Sep	720	6	10
26-Sep	730	6	N/A
26-Sep	815	8.75	12
Mean	709.41	6.01	8.81
SE	13.12	0.31	0.39

Figure 1. Map showing length of shoreline surveyed in Green Lake and number of carp caught in each transect. The September 19th survey is indicated by the orange lines and the September 26th survey is indicated by the blue lines.

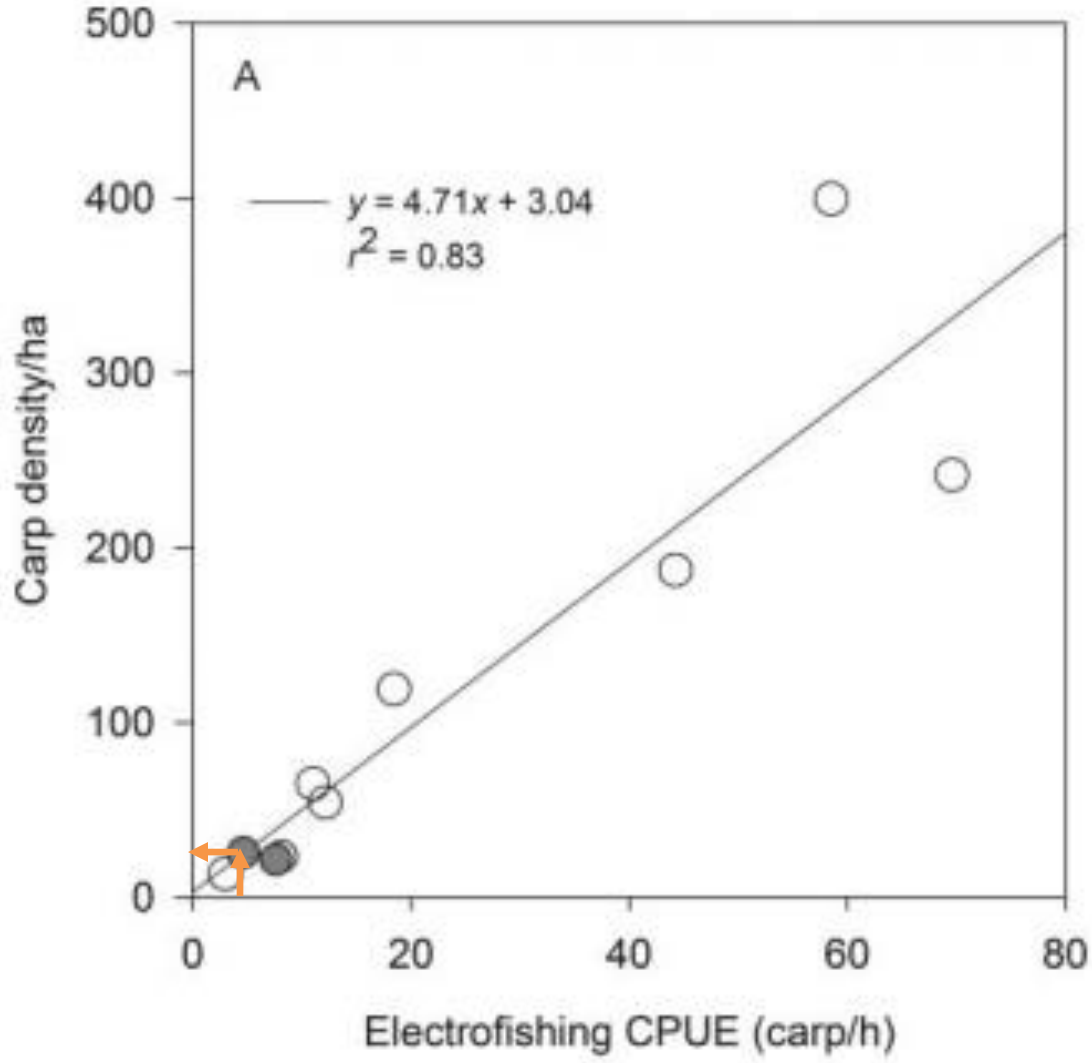

Figure 2. Estimate of common carp density in Green Lake in relation to twelve other Minnesota Lakes. Figure modified from Bajer and Sorenson (2012).

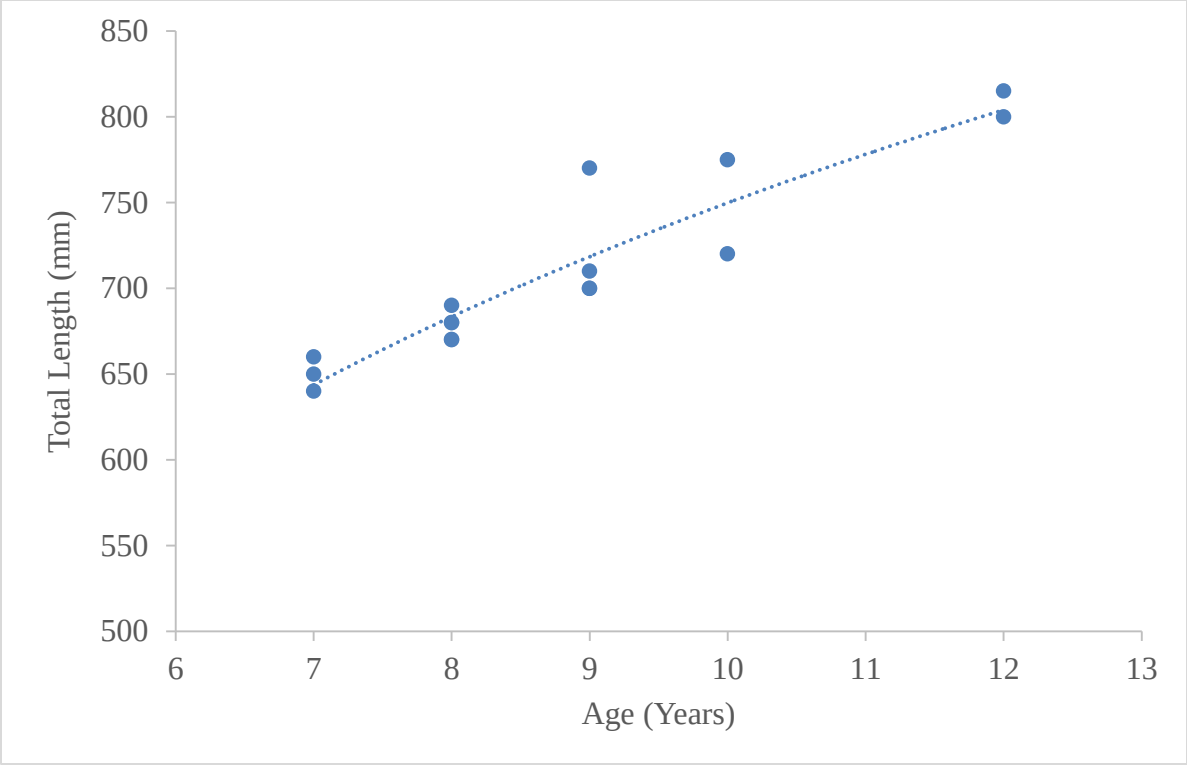

Figure 3. Age and length relationship for common carp captured in Green Lake.