Electrofishing Estimates of Common Carp in South Center and Linn Lakes

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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.

South Center Lake is an 835-acre lake in Chisago County, MN and managed primarily for walleye and northern pike fishing (MNDNR 2016a). The lake is a popular recreational lake and receives high angler pressure. Fisheries surveys have been conducted every five years from 1985 until 2015. Common carp first appeared in these surveys starting in 2000 but were first detected in a 1995 fisheries survey of North Center Lake, which connects to South Center via a connection under US Highway 8. Although common carp do not appear until the 1990's, they are believed to have entered the lake after a high water period in 1986 (MNDNR 2016a).

Linn Lake is a 136-acre lake located just south of South Center Lake. It is a relatively shallow lake with a maximum depth of 15 feet and does not meet the current water quality standard for recreation due to nutrient impairment (MPCA 2016). The only available MN DNR fisheries data published online was from a 1978 survey. The survey showed high abundance of black and brown bullheads, small northern pike, and bluegill, indicative of a shallow eutrophic lake experiencing frequent winter kill events (MNDR 2016b). No common carp were captured during the 1978 survey, similar to South Center Lake.

Lake Estimates

South Center Lake was surveyed on Saturday October 8th and Linn Lake was surveyed on Saturday October 22nd, 2016. The electrofishing boat was maneuvered in a zig-zag manner near the inshore zone for approximately 20 minute intervals (Figures 1, 2). 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 for age analysis.

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 11 common carp were collected and an additional 10 carp were observed but not netted in South Center Lake (Table 1). Two small carp were collected in Linn Lake and an additional 4 carp were observed. Electrofishing efforts in South Center Lake were typical, we observed numerous fish species becoming stunned and recovering after several seconds. Electrofishing in Linn Lake was very atypical, very few fish became stunned and only then became stunned for less than a second, making capturing fish very difficult. Although we did not measure water quality parameters, the difference of electrofishing efficiency in Linn Lake is likely due to lower electrical conductance in the water (Dean 2016). Consequently, no estimate of common carp density was made for Linn Lake; however, the capture of small carp does suggest that Linn Lake is being used for successful carp reproduction.

The resulting electrofishing catch per unit effort was 8.82 carp per hour for South Center Lake, which was within the range of 2.98-64.4 carp per hour reported by Bajer and Sorenson (2012). The catch per unit effort regression developed by Bajer and Sorenson was then used to estimate an overall carp density of 44.58 carp per hectare (Figure 3), in the middle of the range reported in the study for other Minnesota Lakes (13-400 carp/ha). The MN DNR fisheries survey in 2015 had a catch rate of 0.55 carp per trap net; similarly, this catch rate is in the middle of the normal range of 0.2-1.1 carp per trap net for similar Minnesota Lakes.

The length range of common carp captured in South Center Lake was between 510 and 765 mm (Figure 4). Scales collected from each fish were also used to estimate age (Phelps et al. 2007) and ranged from 5-8 years (Figure 5). 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. Based on our length and age data, 7 of 11 carp captured were 7 year-old carp ranging from 665-

720 mm in total length (Figure 4). These fish indicate a strong reproductive class in 2009, but not enough fish were collected to detect other strong year classes.

The collection of length and age data from the June 2016 Chisago Lakes Carp Festival provides an unique opportunity to compare carp captured via electrofishing versus bow fishing. However, three major differences exist in the data sets: 1) fish captured during the tournament were pooled from both North and South Center Lakes, 2) far fewer fish were captured during electrofishing than from the tournaments, and 3) there was approximately 4 months between the tournament and electrofishing. Despite these limitations, the total length range and frequency distribution for both capture methods was similar (Figure 4). The growth curves for both capture techniques were also similar, although the electrofishing data had a slightly higher growth curve likely due to fish being larger after growing over the summer (Figure 5). The similarity in both data sets suggests that continued monitoring of tournament data can provide important population information for common carp management.

Conclusions

Preliminary estimates of common carp in South Center Lake represent a conservative estimate of carp abundance around a density of 44.58 carp per hectare. Estimates appear to be consistent with previous MN DNR surveys in South Center Lake (MNDNR 2016) and other study lakes in Minnesota (Bajer and Sorenson 2012), suggesting a reliable estimate. However, South Center Lake was larger than any other lake previously sampled using the technique of Bajer and Sorenson (2012). The inability to survey carp in deep water habitat or 100% of the shoreline represents a potential bias and underestimate of the South Center carp population. Repeated surveys or a combination of techniques is recommended for validating initial estimates.

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 around 44.58 fish per hectare and an average adult carp size of 3.9 kg, South Center Lake has an estimated carp density of 173.9 kg/ha, which exceeds this threshold. Consequently, South Center Lake could see ecological improvement with active carp removal and long-term management.

No reliable estimate of common carp was possible for Linn Lake due to poor operation of the electrofisher. However, the capture of two small (age-2) carp does provide evidence that Linn Lake provides suitable reproductive habitat for common carp. Bajer and Sorenson (2009) found that common carp reach higher densities in connected lake systems that provide access to shallow water-bodies that frequently winter kill and lack sufficient numbers of egg and juvenile predators. Although the electrofishing unit was not operating at maximum efficiency, we did observe a large number of small minnows and sunfish being temporarily stunned yet did not observe any large predators in Linn Lake. The shallow, hypereutrophic nature of Linn Lake is similar to winter-kill characteristics suitable for successful carp reproduction in other Minnesota lakes and the observation of small carp supports that this lake is providing at least a minimal amount of successful reproduction. Aside from controlling adult population in South Center Lake, the ability to effectively manage common carp reproduction in Linn Lake is crucial for long-term effective control in both lakes.

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 South Center Lake (835 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.

Acknowledgments

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Table 1. Summary of electrofishing results from Linn and South Center Lake.

Lake	Number of Carp		Time Electrofished	Catch per Unit Effort	Abundance Estimate	Biomass Estimate
	Captured	Observed				
South Center	11	10	2.38 hrs	8.82 carp/hr	44.58 carp/ha	173 kg/ha
Linn	2	4	3.01 hrs	-	-	

Figure 1. Map showing length of shoreline surveyed in South Center Lake, including the number of carp caught or observed in each transect.

Figure 2. Map showing length of shoreline surveyed in Linn Lake, including the number of carp caught or observed in each transect.

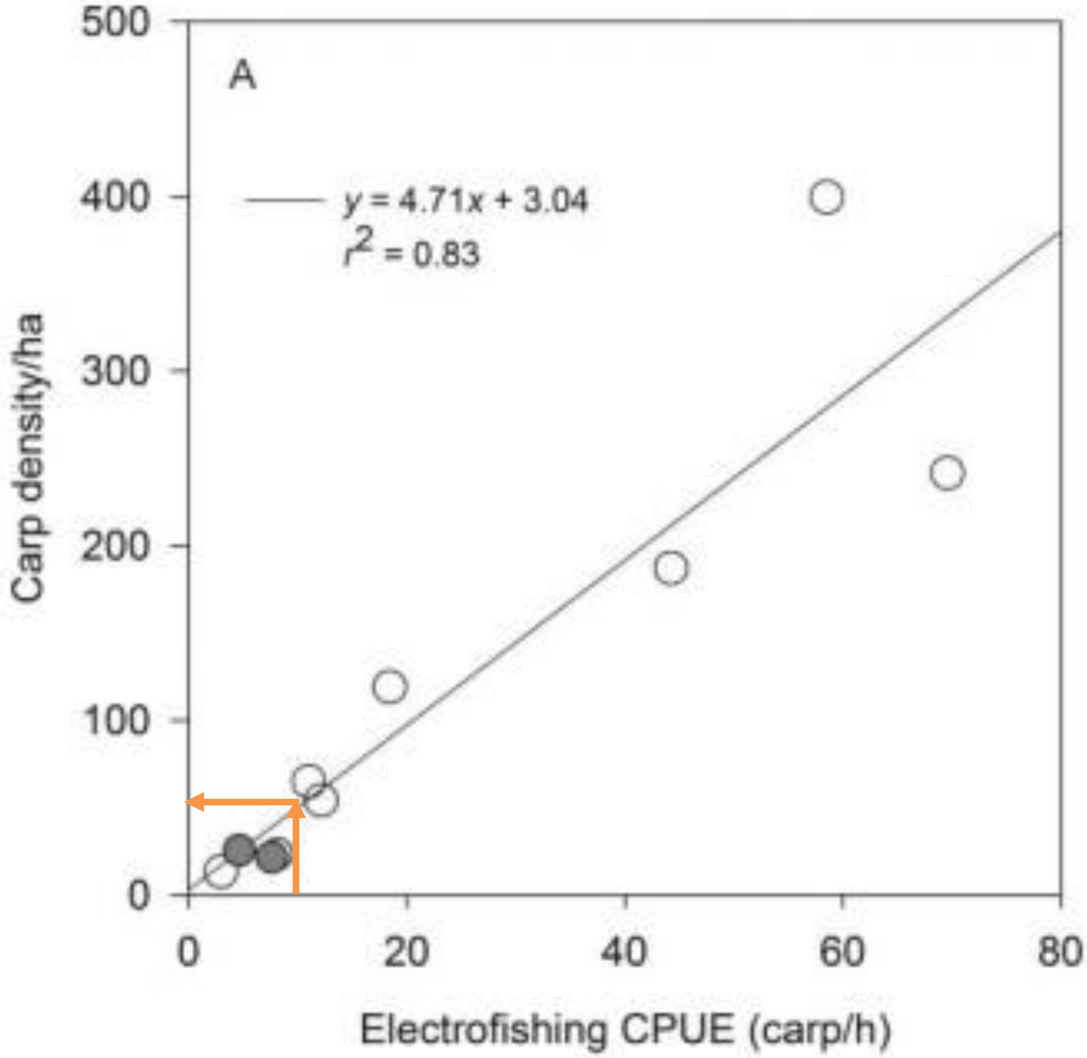

Figure 3. Estimate of common carp density in South Center Lake in relation to twelve other Minnesota Lakes. Figure modified from Bajer and Sorenson (2012).

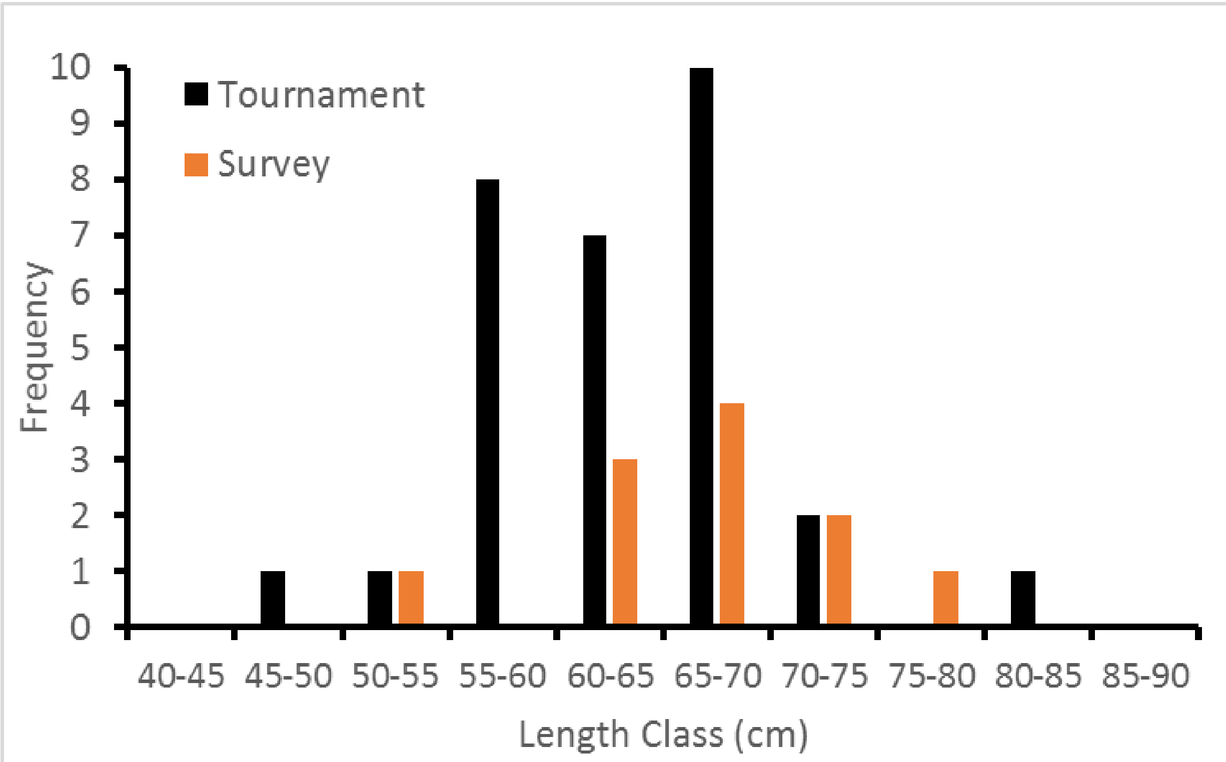

Figure 4. Length frequency distribution for common carp captured in South Center Lake comparing fish collected during the June 2016 Chisago Lakes Carp Tournament (black bars) and October 2016 Electrofishing Survey (orange bars).

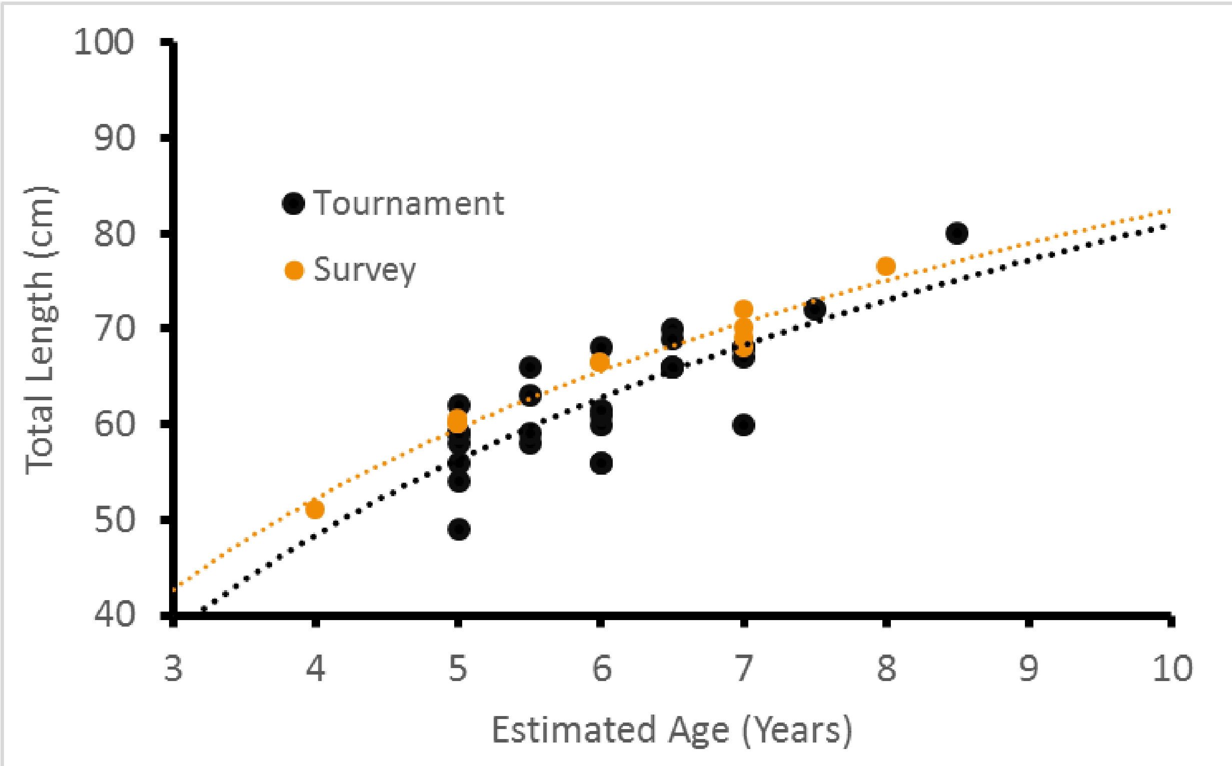

Figure 5. Comparison of growth estimates for common carp collected during the June 2016 Chisago Lakes Carp Tournament (black bars) and October 2016 Electrofishing Survey (orange bars).