Common Carp & Fish Community Surveys of Shields, Moody, and Bone Lakes within the Comfort Lake-Forest Lake Watershed District



November 28th, 2015

Prepared for:
Emmons & Olivier Resources, Inc.
651 Hale Avenue North
Oakdale, MN 55128

Prepared by:
Dr. Joshua Lallaman
Saint Mary's University of MN
700 Terrace Heights
Winona, MN 55987

EOR water ecology community

Saint Mary's University OF MINNESOTA

Project Background

Common carp are one of the most widely introduced and most damaging invasive species in the world (Bajer and Sorenson 2009; Bajer and Sorenson 2010). Once introduced into a waterbody common carp have the ability to reproduce rapidly and reach very high densities quickly (Bajer et al. 2009). At densities over 100 kg/ha, common carp have been shown to negatively impact water clarity, vegetation cover, and water fowl use in high density lakes (Bajer et al. 2009). However, common carp reproduction is complex and high reproductive events needed to reach densities over 100 kg/ha often requires access to winter kill areas with no egg or larval predators (Bajer and Sorenson 2009).

Bone (MNDNR Public Water # 82005400), Moody (MNDNR Public Water # 13002300), and Shields (MNDNR Public Water # 82016200) Lakes are relatively small waterbodies located in north Washington County and south Chisago County, MN. Recent fish surveys by the Minnesota Department of Natural Resources (MNDNR) reported the presence of common carp *Cyprinus carpio* in Bone and Moody Lakes, but did not detect common carp in Shields Lake (MNDR 2012; MNDNR 2013). The current density and impact of common carp in these systems is not well understood.

The objective of this study was to provide assessments of fish communities and common carp abundance in Bone, Moody, and Shields Lake to assess the potential impact of common carp to the fish communities in these systems. Accurate assessment of common carp densities is a crucial step to enacting and monitoring effective management strategies that control populations below damaging thresholds (Bajer and Sorenson 2010).

Sampling Methods

Overall fish communities were surveyed in all three lakes with trap nets consistent with current MNDNR survey techniques for small lakes. Five trap (fyke) nets with frames measuring 1.2 m by 1.8 m and 12.2-m leads were set in each lake for approximately 24 hours. Each lake was initially sampled from July 27^{th}-30^{th} and sampled again from August 12^{th}-15^{th}, 2015. Fyke nets were spaced evenly around the shoreline to representatively sample fish habitat in each lake (Figure 1).

Seine hauls were attempted in each lake to more effectively sample common carp, as previous research has shown that adult carp avoid trap nets (Clark et al. 1991). However, the soft and unconsolidated lake bottom along with the lack of stable shoreline in Shields and Moody Lakes prevented seining. Seining from the boat was also ineffective due to the inability to launch a large boat with a stable working surface.

Alternatively, Bone Lake was sampled via boat electrofishing to capture and estimate common carp abundance. Bajer and Sorenson (2010) found that boat electrofishing was an effective and reliable method of estimating common carp abundance in small Minnesota Lakes. We followed Bajer and Sorenson's methodology: electrical control settings were set at pulsed DC, 5-12 amps, 20% duty cycle, and 120-pulse frequency. The only notable difference in sampling methodology was in our electrode configuration, we used single anode arrays whereas Bajer and Sorenson used anode arrays of five stainless steel pipes.

Validation for estimates of common carp were attempted via mark-recapture. However, the low catch rates of carp prevented these estimates. Intensive effort with seines or gill nets would likely be needed to capture large numbers of fish sufficient to calculate mark-recapture estimates.

Lake Results & Discussion

Fish Community Overview

Fish communities were similar across all three lakes, a total of 13 fish species were collected, with each individual lake containing between 7-11 fish species (Table 1). Bluegill *Lepomis macrochirus* and black crappie *Poxomis nigromaculatus* were the most abundant species captured comprising 33.29% (Bone), 89.18% (Moody), and 76.55% (Shields) of the total fish biomass (Figure 2). Northern pike *Esox lucius* were the most abundant top carnivore, comprising 8.84% (Bone), 9.79% (Moody), and 8.46% (Shields) of the respective fish biomass. Bone Lake had the most diverse and unique fish assemblage amongst the three lakes, having a greater presence of largemouth bass *Micropterus salmoides*, black bullhead *Ameiurus melas*, and yellow bullhead *Ameiurus natalis* (Figure 2). Bone Lake was also the only lake with walleye *Sander vitreus*, but receives annual stocking of this species.

Catch rates of the four most prevalent game species were also comparable for each lake and similar to previous studies by the MNDNR. Catch rates for black crappie, bluegill, and northern pike were the lowest in Bone Lake but all catch rates fell within the normal range reported for their respective lake type (Figure 3). No other detectable trends or differences in catch rates were noticeable.

Size distribution of game fish within each lake was also similar. Average black crappie lengths were not significantly different and average bluegill lengths were only slightly larger in Moody Lake (Figure 4). Average lengths of largemouth bass and northern pike were significantly larger in Bone Lake, but trap nets are not effective at capturing either of these species, so this comparison is based on a very small sample size. However, it does not appear that the presence of common carp is negatively impacting the size of game fish in Bone Lake.

Relative weights (Wr) were similar between Moody and Shields Lakes, but significantly higher than Bone Lake (Figure 5). Relative weight provides an index of fish condition, which indirectly measures the health or well-being of a fish, with an average Wr = 100 indicating a healthy or typical population (Murphy and Willis 1996). Poor Wr weights can be indicator of poor food or stress due to poor water quality.

Assessment of Common Carp

No common carp were captured in Shields or Moody Lake and a total of two common carp were captured during our fyke net surveys in Bone Lake. Common carp have been shown to avoid trap nets (Clark et al. 1991), so low catches are not necessarily indicative of low abundance in Bone Lake. Electrofishing surveys were able to collect common carp in Bone Lake and provide reasonable data for a population estimate. A total of 11 common carp were captured or observed over 190 minutes of electrofishing, resulting in a Catch Per Unit Effort (CPUE) of 3.47 carp/hr. None of the carp previously marked were recaptured preventing a mark-recapture estimate. However, we were able to use the relationship developed by Bajer and Sorenson (2010) to estimate the common carp density from electrofishing effort at 19.38 carp/ha. The average weight of carp captured was 6.3 kg, resulting in a biomass estimate of 122.1 kg/ha. This is above the suggested threshold published by Bajer et al. (2009), which suggests that biomass above 100 kg/ha can cause significant declines in vegetation and negatively impact waterfowl.

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, in particular lake depth. Electrofishing does not accurately sample fish at depth greater than 5-10 ft, which can lead to an underestimate of overall carp density if carp are not in the shallow near-shore zone. The inability to capture large numbers of carp, made estimating population size with a mark-recapture technique impossible. Without validation from a mark-recapture estimate, our electrofishing data should be viewed as a conservative estimate of carp abundance.

Age estimates were obtained by removing the leading pectoral fin ray and collection of dorsal scales. No fin rays were removed from carp implanted with transmitters, so that their movement would not be affected. However, there was good agreement (within 1 year) for both scale and fin ray analysis, so ages from transmittered fish should be consistent with the other fish sampled. Carp ages ranged from 6-12 years, with an average of 9.1 years (Figure 7). We did notice two peaks in carp ages corresponding with potential high reproduction events in 2007 and 2003. However, no young of the year carp or carp younger than six years of age were captured in our trap nets or during electrofishing, suggesting that carp reproduction in recent years has been limited. High reproduction events of common carp in the Midwest are closely linked with access to frequent winter kill areas that lack egg and larval predators. The installation of fish barriers in 2012 may be working to significantly reduce carp reproduction in Bone Lake.

Impact of Common Carp on Game Species

Many studies have shown a negative impact on native fish communities and in particular game species when common carp are at high densities. Bajer et al. (2009) did not see an effect of common carp on game species abundance, yet they did not study the long-term impact of common carp on the condition of game species. Jackson et al. (2010) found a negative threshold effect on game fish species when common carp were above 2.0 kg per net night. Our results for Bone Lake were 0.875 kg per net night and below this threshold.

Healthy populations of native egg and larval predators, such as bluegill, has been suggested as a mechanism for controlling carp reproduction (Bajer and Sorenson 2010). The healthy presence of bluegill and other game species in Bone and Moody Lakes may be helping to control common carp populations; however, this mechanism has not been well studied in the laboratory or in actual field conditions. Additional research on harvest rates, prey availability, diet, and growth should be conducted before drawing any conclusions on the causes of lower fish catch rates and fish condition in Bone Lake.

Conclusions

Although Bone Lake did have a detectable presence of common carp and slight difference in species abundance and condition, all three lakes were similar in fish community structure and comparable to previous fish sampling by the MNDNR. Common carp typically display a threshold effect on ecosystems, causing severely degraded states above the threshold and minimal ecological damage below the threshold (Jackson et al. 2010). The impacts of moderate common carp densities on ecosystems and game fish is not well documented. Common carp were below the threshold for impacts to game species (2 kg per net night) suggested by Jackson et al. (2010), yet above the threshold for negative impacts to aquatic vegetation (100 kg/ha) suggested by Bajer and Sorenson (2009). Reduction of adult carp populations below the recommended threshold of 100 kg/ha in Bone Lake could however result in increases to native macrophyte abundance and improved water clarity that could result in indirect improvements to the fish community (Schrage and Downing 2005; Bajer et al. 2009).

Use of the transmittered individuals to locate aggregations of carp has been a successful management tool to control common carp in other systems (Bajer et al. 2011). Seining target aggregations of carp in wintertime resulted in up to 80% removal of adult carp from lakes. The five transmitters implanted into carp should allow for effective location and removal of adult carp in Bone Lake.

Acknowledgments

SMU environmental biology students, William Granholm, Crystal Gehring, and Sarah most of the assistance with fish sampling. Thanks to Jason Naber, Emily Schmitz, and Lisa Thibodeau for coordinating sampling efforts and carp disposal. We would like to acknowledge Rick Prahl for his willingness to dispose of the carp. Special thanks to Mike Majeski with Emmons and Olivier Resources, Inc. for contacting and collaborating with Saint Mary's University.

Literature Cited

Bajer, P. G., and P. W. Sorensen. 2012. Using Boat Electrofishing to Estimate the Abundance of Invasive Common Carp in Small Midwestern Lakes. North American Journal of Fisheries Management 32: 817-822.

Bajer, P. G., H. Lim, M. J. Travaline, B. D. Miller, and P. W. Sorensen. 2010. Cognitive aspects of food searching behavior in free-ranging wild common carp. Environmental Biology of Fishes 88:295–300.

Bajer, P. G., and P. W. Sorensen. 2010. Recruitment and abundance of an invasive fish, the common carp, is driven by its propensity to invade and reproduce in basins that experience winter-time hypoxia in interconnected lakes. Biological Invasions 12:1101–1112.

Bajer, P. G., G. Sullivan, and P. W. Sorensen. 2009. Effects of a rapidly increasing population of common carp on vegetative cover and waterfowl in a recently restored Midwestern shallow lake. Hydrobiologia 632:235–245.

Clark, S. W., D. W. Willis, & C. R. Berry. 1991. Indexing of common carp populations in large palustrine wetlands of the northern plains. Wetlands, 11(1), 163-172.

Jackson, Z. J., Quist, M. C., Downing, J. A., & Larscheid, J. G. 2010. Common carp (*Cyprinus carpio*), sport fishes, and water quality: ecological thresholds in agriculturally eutrophic lakes. Lake and Reservoir Management, 26: 14-22.

MNDNR. 2012. Fisheries Lake Surveys: Bone and Moody Lakes. Accessed Nov. 29, 2015:
http://www.dnr.state.mn.us/lakefind/showreport.html?downum=82005400
http://www.dnr.state.mn.us/lakefind/showreport.html?downum=13002300

MNDNR. 2013. Fisheries Lake Surveys: Shields Lakes. Accessed Nov. 29, 2015:
http://www.dnr.state.mn.us/lakefind/showreport.html?downum=82016200

Schrage, L. J., and J. A. Downing. 2005. Pathways of increased water clarity after fish removal from Ventura Marsh; a shallow, eutrophic wetland. Hydrobiologia, 511: 215-231.

Table 1. Species captured across all three study lakes.

	Lake		
	Bone	**Moody**	**Shields**
Black Bullhead	X		
Black Crappie	X	X	X
Bluegill	X	X	X
Bowfin	X		X
Common Carp	X		
Golden Shiner	X	X	
Green Sunfish			X
Largemouth Bass	X	X	X
Northern Pike	X	X	X
Pumpkinseed		X	X
Walleye	X		
Yellow Bullhead	X		X
Yellow Perch	X	X	X

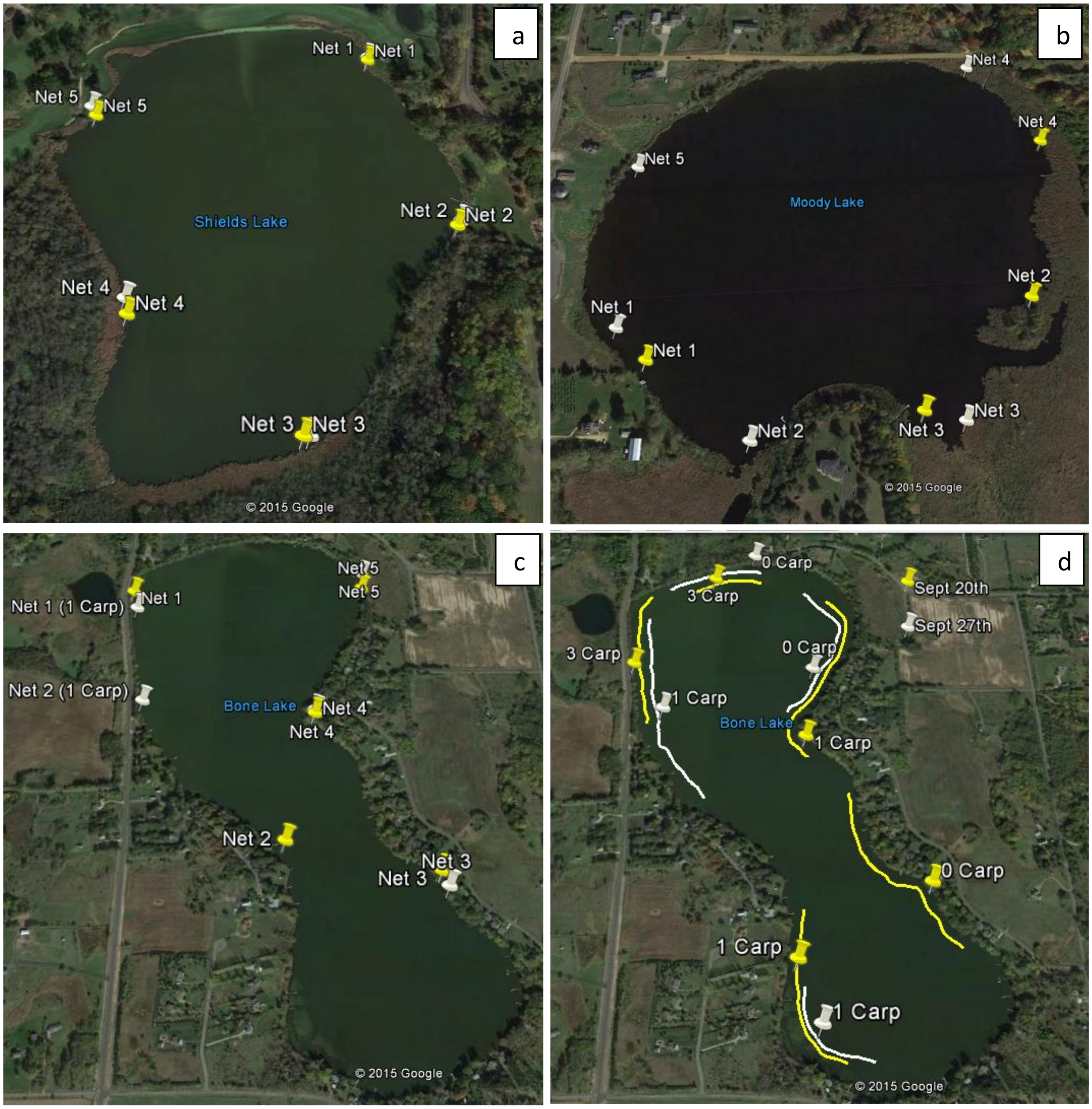

Figure 1. Locations of fyke net sets in all three lakes (a,b,c) and electrofishing effort in Bone Lake (d).

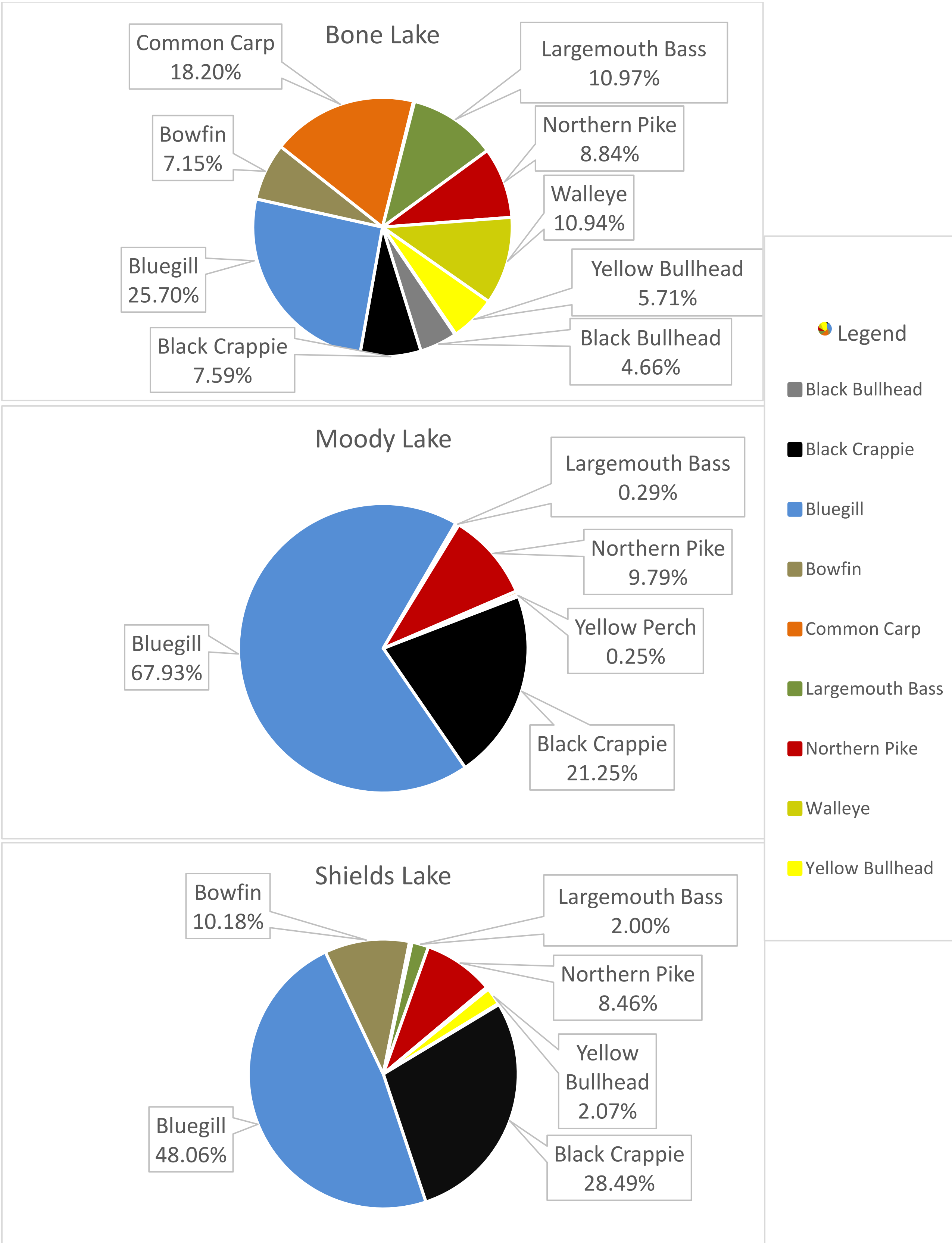

Figure 2. Proportion of fish biomass (percent grams) within each of the three Study Lakes.

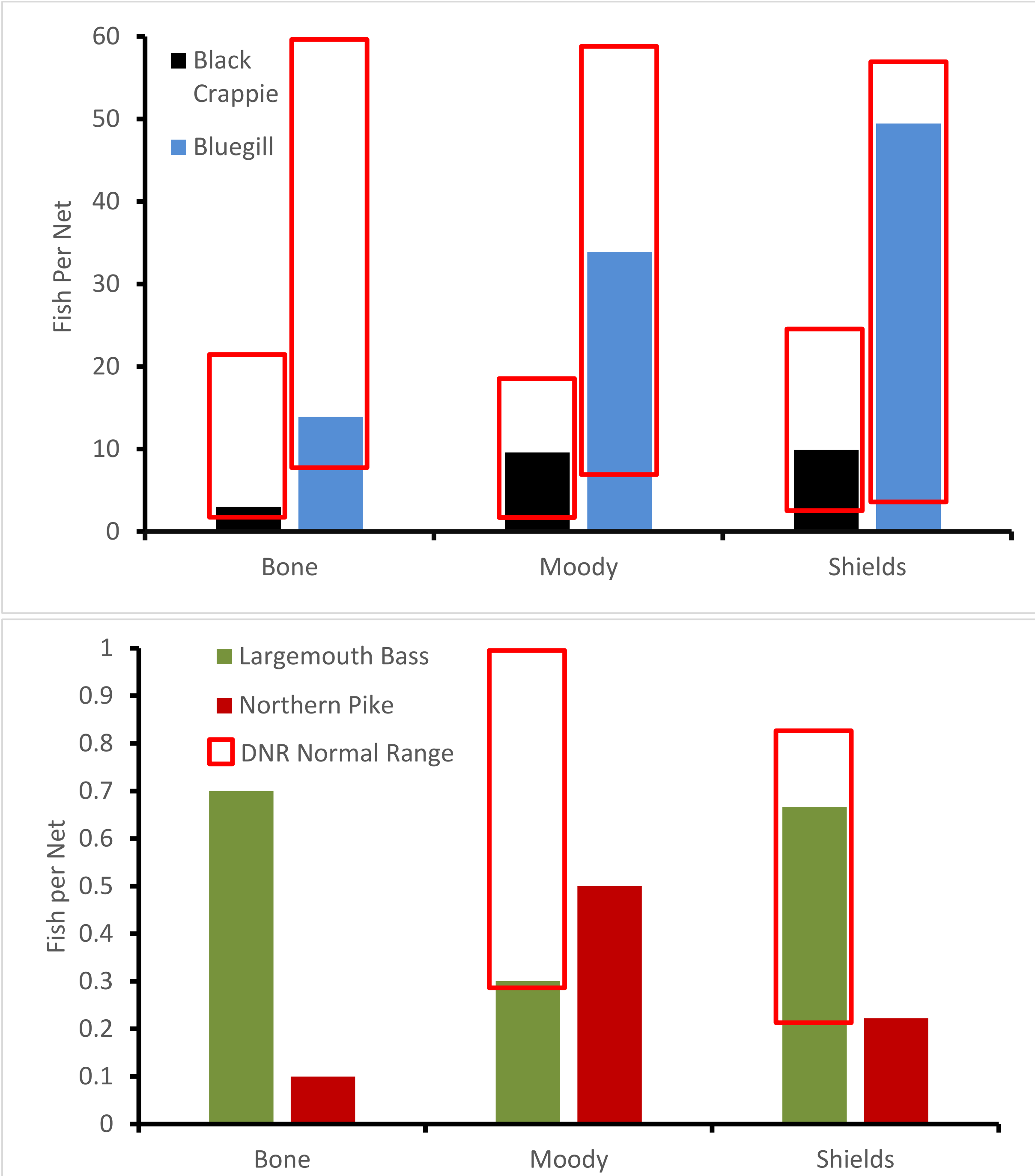

Figure 3. Number of the four most common game fish caught per trap net in all three study lakes. No data was published on largemouth bass in Bone Lake.

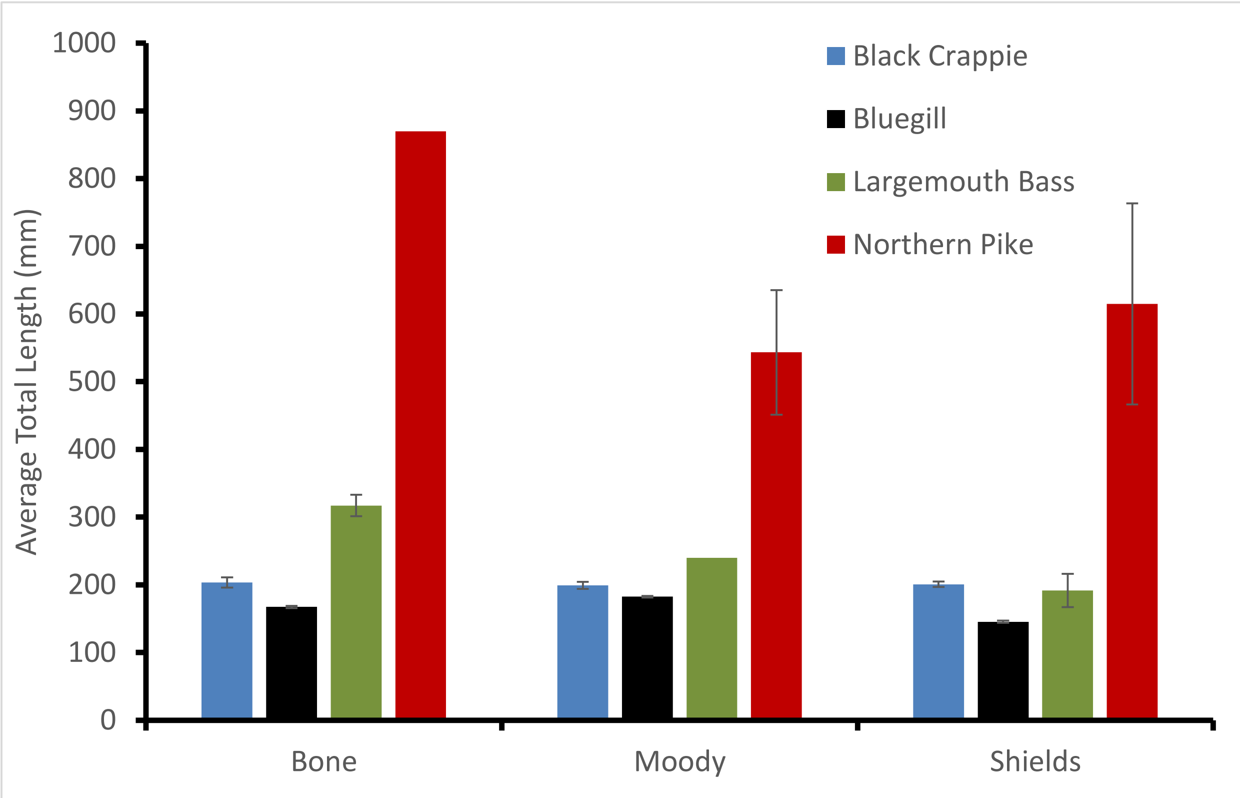

Figure 4. Comparison of average total length for the four most common game species captured. Error bars represent +/- 1 standard error.

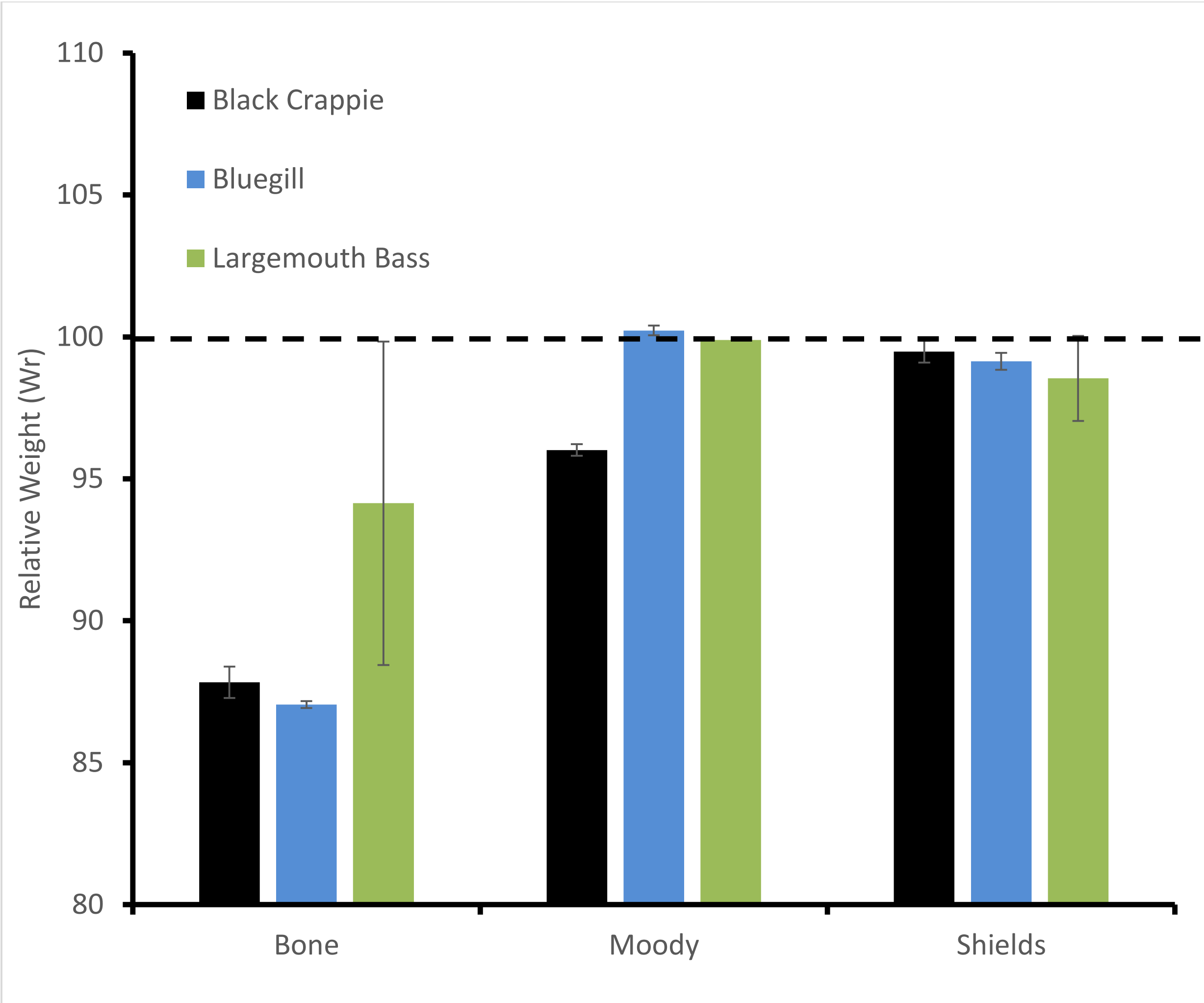

Figure 5. Comparison of average relative weights (Wr) for the three most abundant game species in all three study lakes. A Wr of 100 represents the standard condition of a typical population, error bars represent +/- 1 standard error.

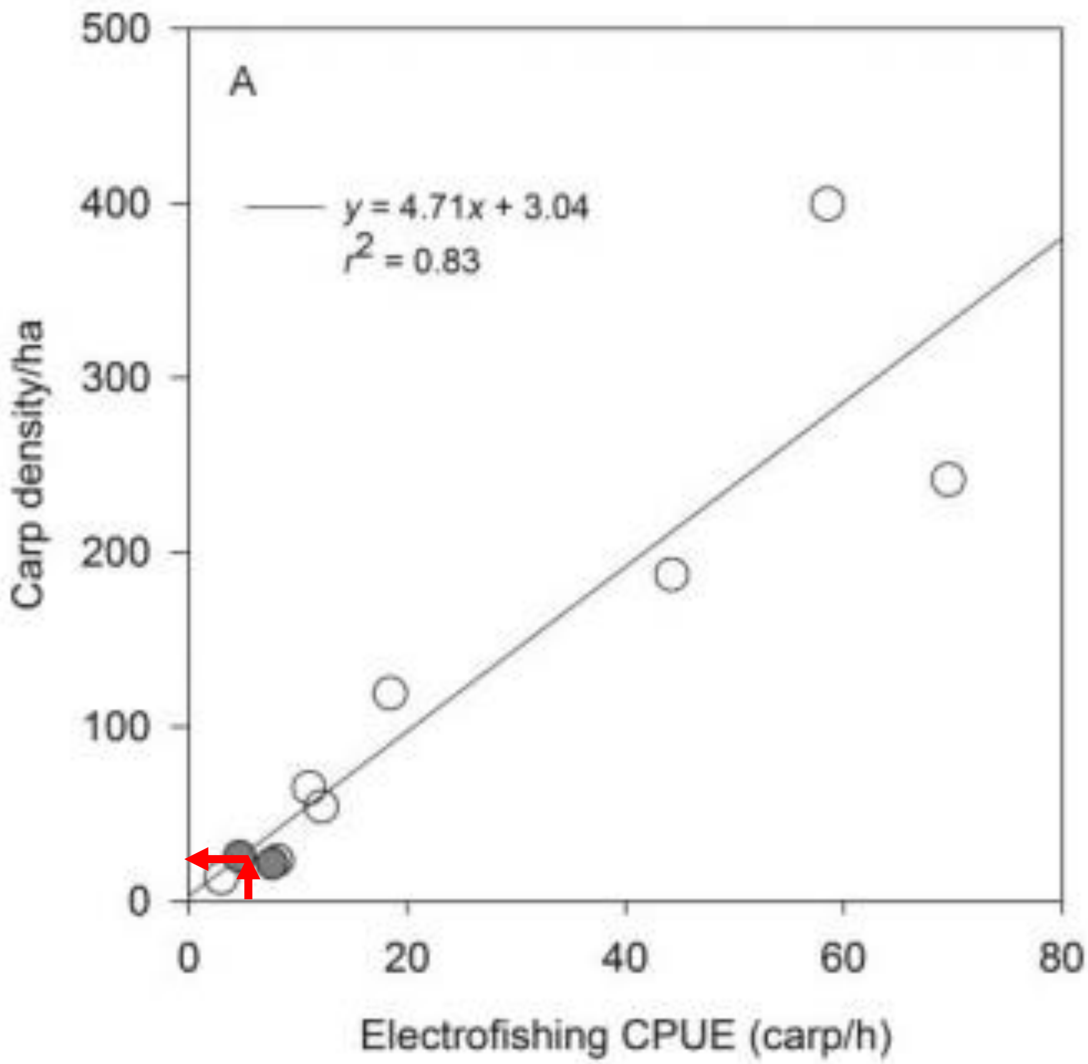

Figure 6. Estimate of common carp density in Bone Lake based on a CPUE of 3.47 carp/hr (red line). Dots are data from eight Minnesota Lakes used to generate the relationship modified from Bajer and Sorenson (2012).

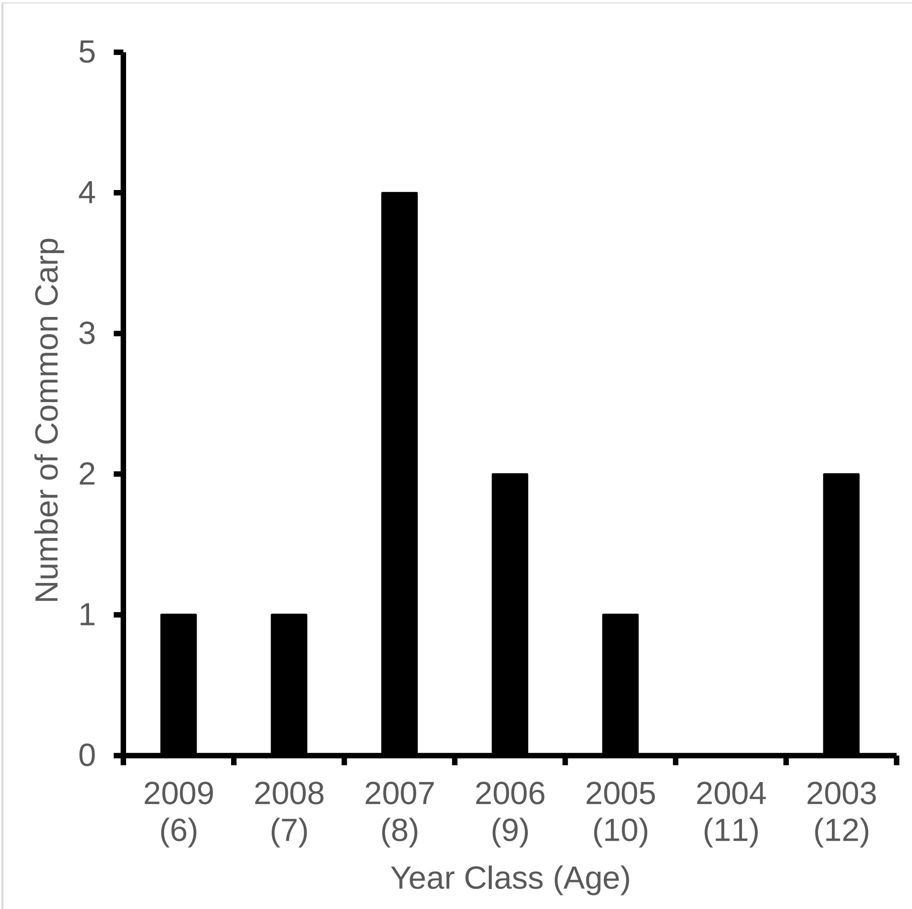

Figure 7. Age distribution of common carp captured in Bone Lake.