

# **Fish Community Surveys of Sand Lake and Long Lake Washington County, MN**



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## **Project Background**

Sand Lake (MNDNR Public Water #00820067) and Long Lake (MNDNR Public Water #00820030) are relatively small, shallow lakes located in northeast Washington County, MN. These lakes currently meet the Minnesota Pollution Control Agency (MPCA) water quality standards for shallow water lakes. However, both of these lakes are considered high priority for management in the Carnelian-Marine St. Croix Watershed District as shallow lakes are particularly susceptible to degradation caused by excess phosphorus loading within the watershed (EOR 2013). Both lakes are currently under an adaptive management plan to maintain or improve the existing water quality and biologic communities (EOR 2013).

Strong scientific evidence supports a direct relationship between the concentration of abiotic nutrients and biological productivity. Although nutrient concentration does not account for 100% of the variability in aquatic communities, suggesting that top-down control through biological interaction (e.g. fish predation) can also have a significant effect on shaping aquatic communities (Shapiro 1980; Carpenter et al. 1985). Increasing the abundance of top predators can result in a trophic cascade that reduces abundance of planktivorous fish, increasing large zooplankton abundance, ultimately reducing phytoplankton and algae, and increasing water clarity.

The objective of this study was to supplement ongoing physical, chemical, and biological monitoring in Sand and Long Lakes with an up-to-date assessment of fish communities within these lakes. The Sand and Long Lake Diagnostic Study and Implementation Plan drafted by Emmons and Olivier Resources, Inc. (EOR 2013) calls for monitoring of the fish communities at 5-yr intervals to assess the effectiveness of water quality improvements in both watersheds. Adaptive management and monitoring of the biological communities can ensure that improved

water quality standards are having a positive impact on the biologic community in these high-priority shallow water environments.

## **Sampling Methods**

Fish were surveyed in both lakes with a combination of trap nets and seines, consistent with current MNDNR survey techniques for small lakes. Five trap nets with frames measuring 1.2 m by 1.8 m and 12.2-m leads were set in each lake for 24 hours. Trap nets were spaced evenly around the shoreline to representatively sample fish habitat in each lake (Figures 1 & 2). An additional 5 seine hauls were conducted in each lake to collect a more representative sample of fish species in the near shore zone. The seine was 100 m x 1.5 m with a modified bag end to collect fish. The seine was extended to its maximum length parallel to the shoreline at a wadable depth of approximately 1.3 m.

Sand Lake was surveyed on August 11-12<sup>th</sup> and Long Lake was surveyed on August 14<sup>th</sup>-15<sup>th</sup>, 2014. All captured fish were identified, enumerated, measured for total length to the nearest mm, and measured for weight to the nearest tenth of a gram. All fish were released unharmed after measurement. Condition estimates of fish were calculated from length and weight data using the relative weight ( $W_r$ ) metric developed by Wedge and Anderson (1978). Fish in good condition ( $W_r \approx 100$ ) are considered to be a healthy weight for a given length, suggesting an appropriate balance with their prey (Flickinger et al. 1999).

The potential impact of human activity on the biological community within each lake was estimated from an Index of Biotic Integrity (IBI). IBIs are a unit-less, multi-metric approach that addresses species specific responses to agricultural and urban disturbances. Both species richness and species biomass data from trap nets were scored using index criteria developed by

Drake and Pereira (2002) for small inland lakes in Central Minnesota. In general, IBI scores are positively correlated with species richness, number of intolerant species, and increasing insectivore biomass but are negatively correlated to the number and biomass of tolerant and omnivorous species.

## **Lake Results**

In each lake, fish were successfully captured in 4 out of 5 trap nets. One net in each lake did not have any fish present but did capture 1-2 adult snapping turtles. Five seine hauls were completed in Sand Lake and successfully captured many young-of-the-year bluegill, largemouth bass, and black crappie. Several seine hauls were attempted in Long Lake, but the extremely soft lake bottom and abundant near shore vegetation impeded seining efforts resulting in no fish captured. Subsequent community analysis will focus solely on the fish captured in trap nets.

### *Sand Lake*

A total of 37 fish representing 5 species (Black Crappie, Bluegill, Largemouth Bass, Northern Pike, and Walleye) were captured in Sand Lake. Bluegill was the predominant forage species and represented 40.5% of the total catch by number (Figure 3a). Top carnivores included black crappie, largemouth bass, northern pike, and walleye, representing 59.5% of the total catch. Species richness was noticeably different from the previous survey due to the absence of top carnivores and higher abundance of bluegills in the 1992 data (Table 1a). The average weight of fish captured was very close to the “normal range” for surrounding lakes as defined by the MNDNR (Table 1b). Condition was within the target range (100 +/- 15 relative weight units)

for all five species, indicating that the overall fish community is well balanced and not over or under-populated (Figure 5).

### *Long Lake*

A total of 92 fish representing 6 species were captured in Long Lake. Bluegill and green sunfish were the predominant forage species and represented 43.5% of the total catch by number (Figure 3b). Top carnivores included black crappie, largemouth bass, northern pike, but only represented 27.2% of the total catch due to the presence of omnivorous black bullhead comprising 29.3% of the catch. Species richness was similar to the previous survey conducted by the MNDNR, yet again largemouth bass were noticeably absent and bluegill captures were higher in the 1993 samples (Table 1a). Average weights were at the low end or below the normal range for similar area lakes (Table 1b). Mean condition was within the target range of relative weight (100 +/- 15 units) for both bluegill and black crappie, indicating these species are in balance with their prey (Figure 5). However, mean condition for both largemouth bass and northern pike was below the recommended threshold value of 85, suggesting the top carnivores in Long Lake are too few and too small for their respective prey.

### *Index of Biotic Integrity*

Overall index scores were low compared to the total possible IBI score of 110 (Table 2). IBI scores below 60 are similar to other Minnesota Lakes that have been severely impacted by agricultural and urban eutrophication (Drake and Valley 2005). Sand Lake did score higher (IBI = 46.99) than Long Lake (IBI = 39.04), indicating better habitat quality and a slightly healthier fish community in Sand Lake. The difference of IBI scores between lakes can largely be

attributed to the presence of black bullhead in Long Lake, which is a tolerant omnivorous species that thrives in disturbed environments (Scott and Crossman 1973).

## **Conclusions**

Sand and Long Lakes have typical fish communities found in many shallow Minnesota Lakes. Sand Lake has a high proportion of top carnivores that help to reduce forage fishes that prey on zooplankton, which can help stabilize algal predation and biomass. Black crappie and bluegill were in good condition in both lakes, suggesting a good prey base for insectivores/planktivores. Largemouth bass and northern pike in Sand Lake were in good condition, but had significantly poorer condition in Long Lake. Overall community balance in Long Lake appears to be suffering from a lack of larger predators possibly as a result of frequent winter kill.

Sand and Long Lakes were last surveyed by the Minnesota DNR in 1992 and 1993, respectively (MNDNR 2014). Previous catch data had a notable lack of top carnivores, particularly largemouth bass. Bluegill catch rates were also approximately 14-20 times higher in the previous survey, likely related to the lack of predation by largemouth bass and low number of other top predators. This increase in top predators and decrease in insectivores/planktivores show a shift in the biological community that is consistent with decreased phosphorous loading, increased algal predation, and improved water quality (Carpenter 1985).

IBI scores for each lake provide an estimate of biological integrity within each lake and serve as a baseline for future comparisons and benchmarks for biological improvement. Sand and Long Lake had low IBI scores that were similar to other Minnesota Lakes severely impacted by urban and agricultural eutrophication. However, this study represents a conservative estimate

of biologic integrity and caution should be used when comparing these values to other Minnesota lakes. Drake and Pereira (2002) developed their IBI using trap nets, seines, gill nets, and electrofishing to effectively sample all species present in both near-shore and off-shore zones. Failure to sample off-shore zone with gill-nets and the near-shore zone with electrofishing could have under-sampled species richness or missed relatively rare intolerant species. Additionally the IBI was specifically developed for small lakes in Central Minnesota, yet the smallest lake studied by Drake and Pereira was 46 ha, 2.5X larger than Sand Lake and 1.6X larger than Long Lake. Fish richness exhibits a strong relationship with lake size (Magnuson et al. 1988), consequently lower IBI scores would be expected in these smaller lakes, reducing the comparability to other studies.

## **Recommendations**

Sand Lake should maintain the current management strategies (i.e. walleye stocking, winter aeration) that favor the high proportion of top carnivores, which control invertivores/planktivores and subsequently increase zooplankton grazing of algae. Mean condition for all fish species in Sand Lake was considered good, but the condition of stocked walleye was at the lower range of what is typically considered healthy or balanced. Additional studies of walleye survival, growth, and condition could lead to strategies for improving the walleye population and overall fish community in Sand Lake.

Long Lake could potentially benefit from an increase in the number and size of large predators to balance planktivore populations and increase zooplankton grazing of algae. When combined with nutrient controls, biological manipulation to improve water clarity has been successfully accomplished through stocking of piscivorous species like walleye and northern

pike (Lathrop et al. 2002), winter aeration to reduce winter kill (Moss 1990), or whole lake fish removal (Hanson and Butler 2011). Water quality in Long Lake has a potential for improved community balance with more intensive fish management.

### **Acknowledgments**

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Table 1a. Number of fish captured per trap net in Sand and Long Lake, MN. Data from 1993 survey and normal range data taken from the MNDNR Fisheries Survey database.

Species	Sand Lake		Long Lake		Normal Range
	1992 Survey	2014 Survey	1993 Survey	2014 Survey	
Bluegill	64.4	3.0	17.6	1.2	7.5 - 62.5
Black Crappie	-	0.2	0.7	1.0	1.8 - 21.2
Northern Pike	-	0.2	0.7	2.2	N/A
Largemouth Bass	-	3.6	-	1.8	0.2 - 0.7
Walleye	-	0.2	-	-	0.3 - 1.2
Black Bullhead	-	-	75.9	5.4	0.7 - 25.7
Green Sunfish	-	-	17.3	6.8	0.2 - 1.3
Yellow Perch	-	-	2.0	-	0.3 - 1.7
Golden Shiner	0.2	-	0.7	-	0.2 - 0.8

Table 1b. Average fish weight for species collected using trap nets in Sand and Long Lake. Data from 1993 survey and normal range data taken from the MNDNR Fisheries Survey database.

Species	Sand Lake		Long Lake		Normal Range
	1992 Survey	2014 Survey	1993 Survey	2014 Survey	
Bluegill	0.15	0.09	0.11	0.11	0.1 - 0.3
Black Crappie	-	0.79	0.07	0.15	0.2 - 0.3
Northern Pike	-	8.8	1.91	0.28	N/A
Largemouth Bass	-	0.38	-	0.06	0.2 - 0.9
Walleye	-	1.1	-	-	0.8 - 2.8
Black Bullhead	-	-	-	0.14	0.3 - 0.6
Green Sunfish	-	-	-	0.13	0.1 - 0.2
Yellow Perch	-	-	0.08	-	0.1 - 0.2
Golden Shiner	0.1	-	0.07	-	0.1 - 0.1

Table 2. List of 11 Index of Biotic Integrity metrics calculated for Sand and Long Lake trap net data.

<b>Metric</b>	<b>Scoring Multiplier</b>	<b>Sand Lake</b>	<b>Long Lake</b>
<u>Species Richness</u>			
Native	0.40	2	2.4
Intolerant	2.00	0	0
Tolerant	10-3.33	10	6.67
Insectivore	0.77	0.77	1.54
Omnivore	12-2	10	8
Cyprinid	2.00	0	0
Small Benthic	2.50	0	0
Vegetation	1.67	1.67	1.67
<u>Trap-net Composition</u>			
Insectivore Biomass	12.35	2.55	6.32
Omnivore Biomass	10-16.39	10.00	7.05
Tolerant Biomass	10-25.64	10.00	5.39
<b>Total IBI Score</b>	<b>110</b>	<b>46.99</b>	<b>39.04</b>



Figure 1. Map locations of the five trap net set (blue dots) and five seine hauld (blue stars) in Sand Lake, MN



Figure 2. Map locations of the five trap net sets (blue dots) and 5 seine hauls (blue stars) in Long Lake, MN.

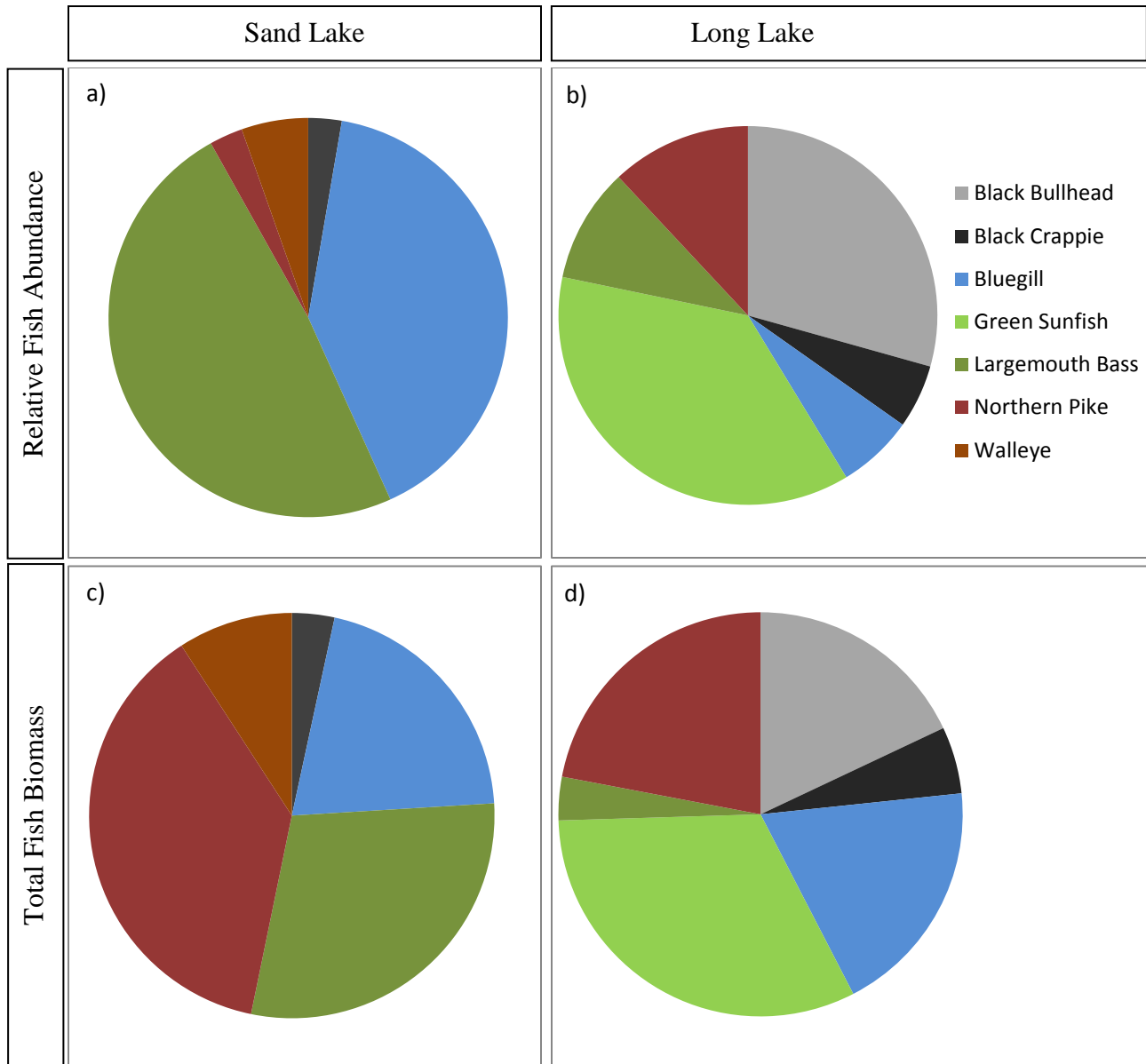


Figure 3. Relative fish abundance captured from five trap nets in Sand Lake a) and Long Lake b). Total species biomass captured using trap nets Sand Lake c) and Long Lake d).

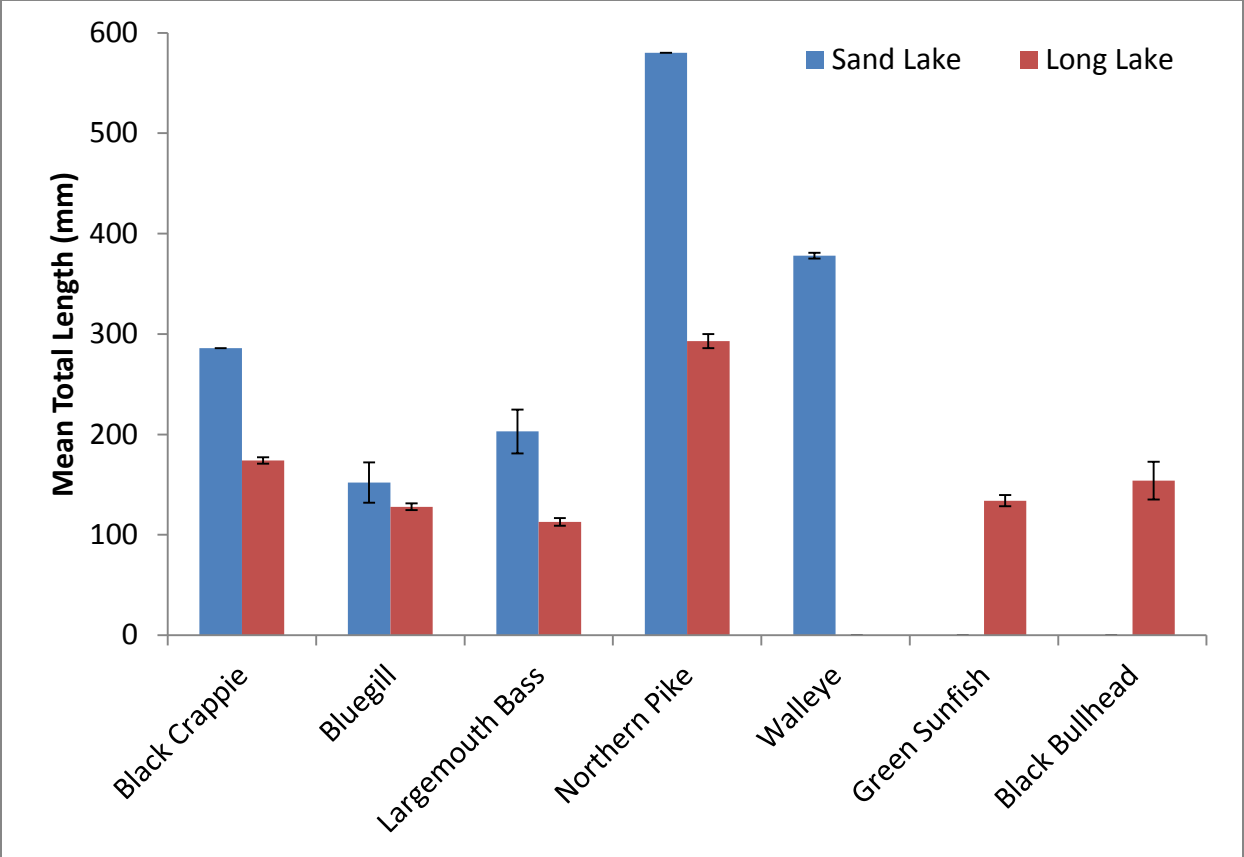


Figure 4. Mean total length (mm) of fish captured in Sand Lake (blue) and Long Lake (red). Error bars represent +/-1 standard error.

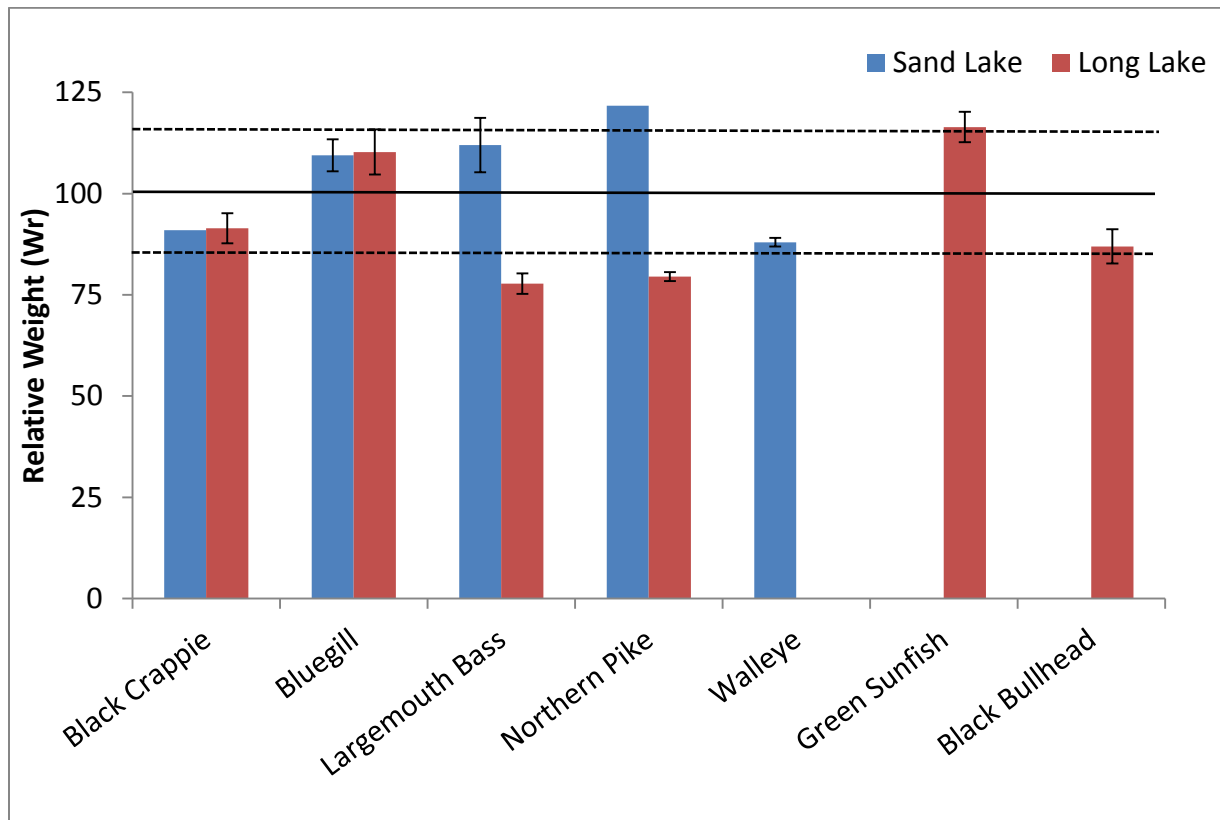


Figure 5. Fish condition as measured by mean relative weight (Wr) for fish species captured in Sand Lake (blue) and Long Lake (red). Values close to 100 (solid line) represent fish in good condition or in balance with their prey. Values below 85 (lower dashed line) represent fish in poor condition, likely due to overabundance. Error bars represent +/-1 standard error.