2016 Lake Monitoring Summary - Big Sandy Area Lakes Watershed

Eleven lakes in the Big Sandy Area Lakes Watershed were monitored through local partners in 2016. Six were monitored through the EPA Section 319 Grant received by the Big Sandy Area Lakes Watershed Management Project. Three were monitored through a MPCA Surface Water Assessment Grant. Two were monitored with support of the Aitkin County Water Planning Task Force. A map showing the location of the sampled lakes can be found in Appendix 1 of this report. Monthly samples were taken for Total Phosphorus, Chlorophyll a, and Secchi Disk Transparency. Six sites were also sampled for Sulfate and Calcium in an effort to gather background data on these parameters.

The main nutrient of concern is phosphorus. Phosphorus enrichment of a water body can result in a variety of negative impacts, such as excessive plant growth, algae blooms, and lowering of oxygen levels. Chlorophyll a (Chl-a) was also measured. Chlorophyll a is the main pigment in algae. The concentration of this pigment is used to estimate the quantity of algae found in the lake. Algae is a normal component of water bodies, however high concentrations can result in low levels of dissolved oxygen and reduced recreation suitability. Secchi disk readings measure the depth of light penetration into the water. This parameter often has a direct correlation to the levels of phosphorus and chlorophyll a found in the water body.

The average 2016 Total Phosphorus (TP), Chlorophyll a (Chl-a), and Secchi Transparency levels for each of the monitored lakes are shown below, as is the expected Eco-Region Range. Values that fell outside the expected range are shown in the shaded boxes.

Parameter	TP (ug/L)	Chl-a (ug/L)	Secchi (m)	Secchi (ft.)
Big Sandy Lake, Bellhorn Bay	26	7	**1.0**	**3.3**
Big Sandy Lake, Main Basin	**37**	**12**	**1.0**	**3.6**
Big Sandy Lake, Websters Bay	**42**	7	**1.0**	**3.2**
Blackface Lake	22	<4	**2.1**	**6.8**
Eagle Lake	25	8		
Island Lake (Aitkin County)	**30**	7	**1.4**	**4.6**
Island Lake, North (Carlton County)	**29**	9		
Island Lake, South (Carlton County)	**31**	**11**		
Loon Lake	16	5	**2.0**	**6.7**
Minnewawa, Main Basin	**36**	**23**	**1.6**	**5.2**
Minnewawa, North Arm	**130**	**25**	**1.4**	**4.7**
Prairie Lake (St. Louis County)	**33**	**16**		
Savanna Lake	**35**	**20**	**1.2**	**3.9**
Shumway Lake	20	<4	2.4	7.7
Eco-Region Range	**14-27**	**<10**	**2.4 – 4.6**	**8-15**

Collected data was used to calculate Trophic Status Index values. Carlson's Trophic State Index (TSI) is a common method of characterizing a lake's overall health. "Trophic Status" refers to the level of productivity in a lake, as measured by phosphorus and algae content, and the depth of light penetration. In general, the lower the TSI Value, the better the health of the lake. TSI's are calculated for Phosphorus, Chlorophyll a, and Secchi Transparency. These three numbers are then averaged to result in an overall TSI value for each lake. A graphic of this information is found in Appendix 2.

	2016 TSI Phosphorus	2016 TSI Chlorophyll a	2016 TSI Secchi Clarity	2016 Overall TSI
Big Sandy Lake, Bellhorn Bay	51	50	60	54
Big Sandy Lake, Main Basin	56	55	59	57
Big Sandy Lake, Websters Bay	58	50	60	56
Blackface Lake	49	44	50	48
Eagle Lake	51	51		51
Island Lake (Aitkin County)	53	50	55	53
Island Lake, North (Carlton County)	53	52		53
Island Lake, South (Carlton County)	54	54		54
Loon Lake	44	46	48	46
Minnewawa, Main Basin	56	61	53	57
Minnewawa, North Arm	74	62	55	64
Prairie Lake (St. Louis County)	55	58		57
Savanna Lake	55	60	57	57
Shumway Lake	47	44	48	46

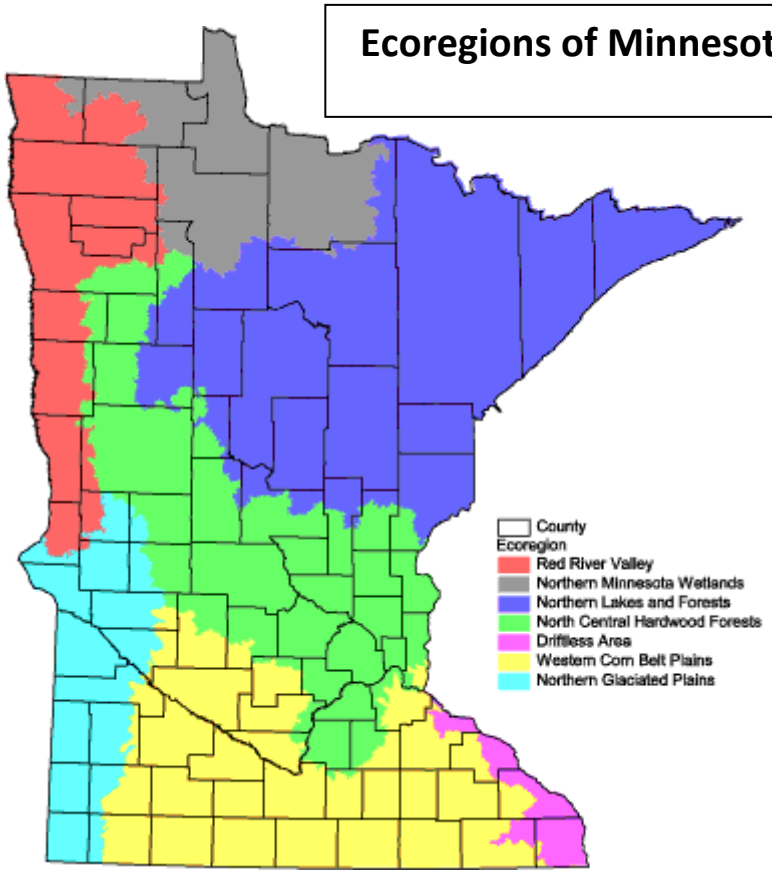
A TSI between 40 and 50 places Blackface, Loon and Shumway Lakes in the mesotrophic range – the moderate ranking of water quality. This is about where we would expect these lakes to fall, and is normal for this area of Minnesota.

A TSI between 50 and 65 places Big Sandy, Eagle, Island(Aitkin Co. and Carlton Co.), Minnewawa, Prairie, Savanna Lakes at the lower boundary of classical eutrophy. Euthophic lakes exhibit decreased transparency, aquatic vegetation problems, and support only warm water fisheries.

Discussion:

The lakes monitored for this study are located in the Northern Lakes and Forest (NLF) Ecoregion of the state. Ecoregions are grouped together based on soils, landforms, potential natural vegetation, and land use. Comparing a lake's water quality to that of reference lakes in the same ecoregion provides one basis for characterizing the condition of the lake.

The Northern Lakes and Forests Ecoregion is heavily forested and comprised of steep, rolling hills interspersed with pockets of wetlands, bogs, lakes and ponds. Lakes are typically deep and clear, with good gamefish populations. These lakes are very sensitive to damage from atmospheric deposition of pollutants, storm water runoff from logging operations, urban and shoreland development, mining, inadequate wastewater treatment, and failing septic systems. Agriculture is somewhat limited by the hilly terrain and lack of nutrients in the soil, though there are some beef and dairy cattle farms.



Shaded boxes in the table on page 2 indicate which lakes / parameters did not fall within the expected eco-region range. Several results were out of this range. Please recall that the majority of the sampling was done on lakes listed as impaired by the Minnesota Pollution Control Agency. These lakes were already determined to have water quality troubles. Monitoring was done to track any changes (positive or negative) to water quality.

The secchi transparency readings were slightly lower than expected. This is attributed to the tannic acid / bog stain of the water of many lakes within the Big Sandy Area Lakes Watershed. It is normal for lakes in our area to have lower transparency due to the tea stain resulting from the wetlands in the watershed.

Seasonal variations should be taken into consideration. 2016 was an extremely wet year, with several heavy rainfall events. It should be noted that this has the potential to add nutrients to a lake through storm water runoff. High water levels can also cause increased soil erosion at the shoreline. Waves reaching higher on the landscape can result in soil washing into the lake. Soil particles carry additional nutrients into the lake too.

Several of the lakes will be monitored again in 2017. This second year of data will help to remove any variability due to weather conditions, and will double the amount of data available for evaluating each lake. This will provide a more complete look at the health of each water body.

SULFATE:

Sulfate is a natural chemical commonly found in surface and ground water. It can be found at varying concentrations in discharges from permitted facilities such as mining operations, municipal wastewater treatment plants, and industrial facilities. In some areas, permitted facility discharges are elevated because groundwater high in sulfate is used for drinking water or industrial needs. The primary factor controlling natural concentrations of sulfate in surface water is the surface geology of Minnesota. For example, glaciation left relatively high -sulfur soils across southwestern Minnesota, which contribute sulfate to lakes and streams. Past studies have shown that wild rice is primarily found in waters with relatively low sulfate concentrations.

Sulfate levels were monitored at the following sites: Big Sandy Lake – Main Bay, Eagle Lake, Island Lake (Carlton County) – North and South, Minnewawa – Main Basin, and Prairie Lake. Monitoring was conducted in an effort to gather baseline data and create a record of historic sulfate levels. Average results for the sampled lakes are given below.

Lake Name	Sulfate mg/L
Big Sandy Lake – Main Bay	1.2
Eagle Lake	< 3
Island Lake (Carlton Co.) North	< 3
Island Lake (Carlton Co.) South	< 3
Minnewawa Lake – Main Basin	1.2
Prairie Lake	< 3

CALCIUM

Calcium levels were monitored at the following sites: Big Sandy Lake – Main Bay, Eagle Lake, Island Lake (Carlton County) – North and South, Minnewawa – Main Basin, and Prairie Lake. Monitoring was conducted in an effort to measure the suitability for zebra mussel infestation. Calcium is an essential nutrient for the formation of zebra mussel shells. Average calcium levels for each lake are shown in the table below:

Lake Name	Calcium mg/L
Big Sandy Lake – Main Bay	11.7
Eagle Lake	14.9
Island Lake (Carlton Co.) North	17.7
Island Lake (Carlton Co.) South	15.3
Minnewawa Lake – Main Basin	10.9
Prairie Lake	11.7

The table below was prepared by RMB Environmental Laboratories and shows the risk for zebra mussel infestation based on several parameters, including calcium. According to this ranking, all lakes with the exception of Island Lake North are placed in the Low Risk category. Island Lake North falls into the Moderate Risk category. Please note that this is just a general ranking of risk, based on only one water quality parameter.

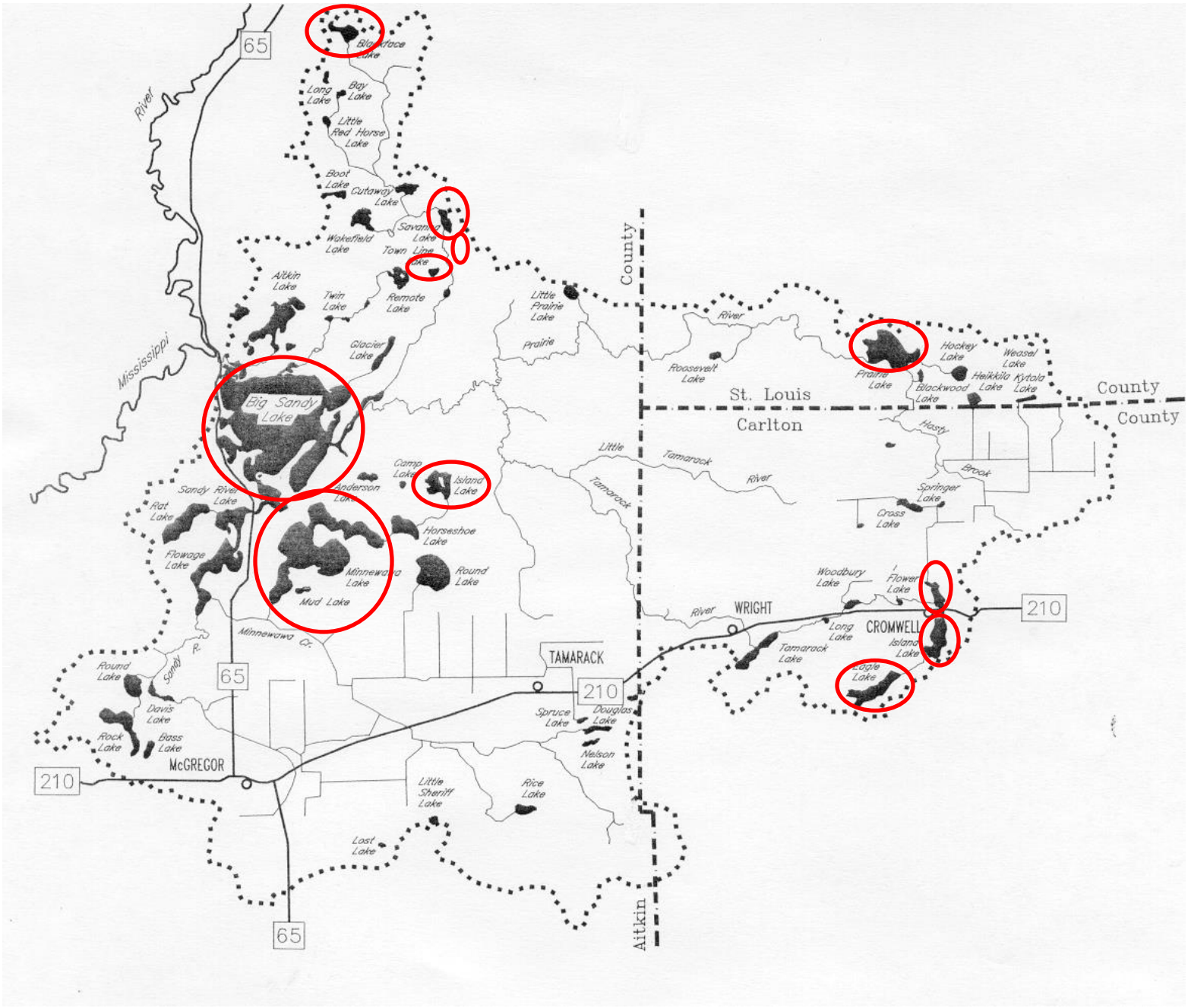
	Risk		
Parameter	**Low Little Potential for Larval Development**	**Moderate (survivable, but will not flourish)**	**High (favorable for optimal growth)**
Calcium (mg/l)	8-15	15-30	>30
pH	7.0-7.8 or 9.0-9.5	7.8-8.2 or 8.8-9.0	8.2-8.8
Hardness (mg/L)	30-35	55-100	100-280
Alkalinity (mg/L)	30-55	55-100	100-280
Specific Conductance (umhos)	30-60	60-110	>110
Secchi depth (m)	1-2 or 6-8	4-6	2-4
Chlorophyll a (ug/L)	2.0-2.5 or 20-25	8-20	2.5-8
Total Phosphorus	5-10 or 35-50	10-25	25-35

Water quality data that was collected through this effort was submitted to the Minnesota Pollution Control Agency for storage in their EQuIS database. It can be viewed on their website (www.pca.state.mn.us) or accessed through the Minnesota DNR Lakefinder site (www.dnr.state.mn.us). A copy of the raw data can also be obtained by calling the Aitkin County SWCD at (218) 927-6565.

Thanks to the many volunteers who donated their time and energy to collect this data.

Larry Antonsen, Lake Minnewawa
Dick Beatty, Big Sandy Lake
Gary Fischer, Eagle Lake
Ken Hallberg, Prairie Lake
Dianne Knoben, Island Lake (Aitkin County)
Mark Miller, Island Lake (Aitkin County)
John Pilney, Big Sandy Lake
Ed Pung, Island Lake South (Carlton County)
Dennis Tennison, Blackface Lake
Norbert Wollack, Island Lake North (Carlton County)

Appendix 1. Lake Sampling Locations 2016



Appendix 2. Carlson's Trophic State Index, based on a scale of 0 – 100. (Carlson 1977)

TSI < 30 Classical Oligotrophy: Clear water, oxygen throughout the year in the hypolimnion, salmonid fisheries in deep lakes.

TSI 30 - 40 Deeper lakes still exhibit classical oligotrophy, but some shallower lakes will become anoxic in the hypolimnion during the summer.

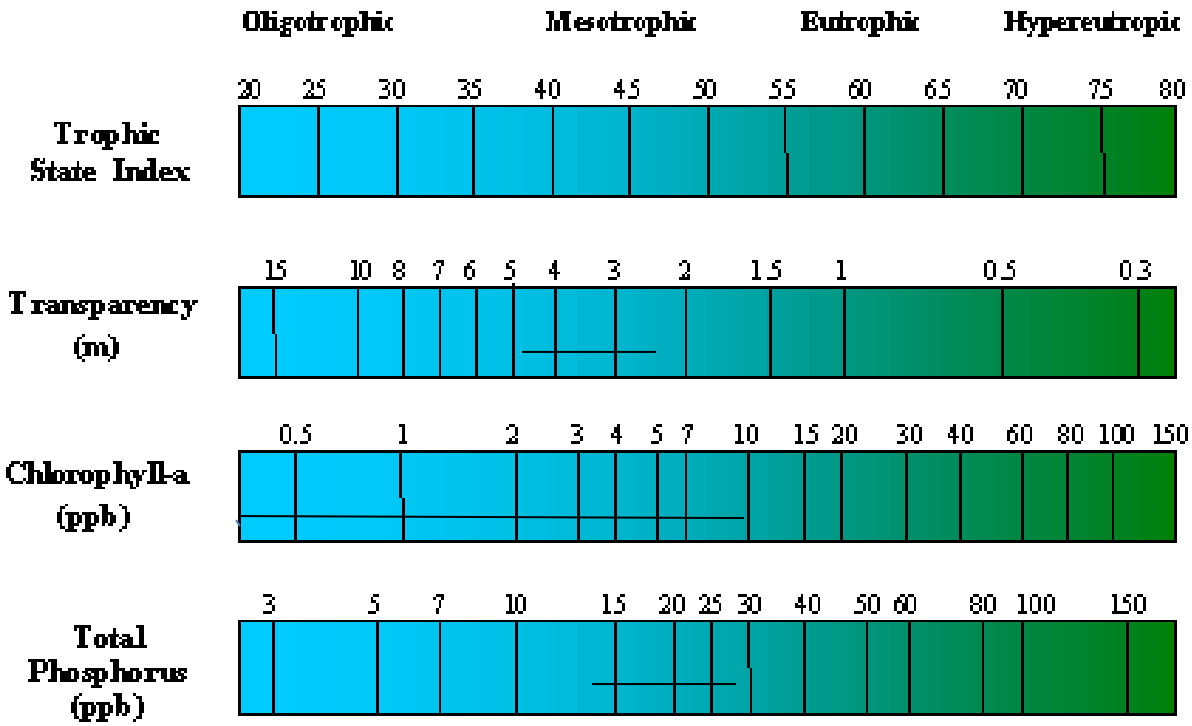
TSI 40 - 50 Water moderately clear, but increasing probability of anoxia in hypolimnion during summer.

TSI 50 - 60 Lower boundary of classical eutrophy: Decreased transparency, anoxic hypolimnia during the summer, macrophyte problems evident, warm-water fisheries only.

TSI 60 - 70 Dominance of bluegreen algae, algal scums probable, extensive macrophyte problems.

TSI 70 - 80 Heavy algal blooms possible throughout the summer, dense macrophyte beds, but extent limited by light penetration. Often would be classified as hypereutrophic.

TSI > 80 Algal scums, summer fish kills, few macrophytes, dominance of rough fish.



Northern Lakes and Forests Expected Ecoregion Range _____