Water Quality Perspectives on Lake Sylvia

State of Lake Sylvia in 2021

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Summary

- Overall the water quality in both basins of Lake Sylvia was good and meeting its use attainability classification. Water quality parameters continue to be better than the reference lakes within the Northcentral Hardwood Forest (NHF) ecoregion.
- Transparency averages do fluctuate from year to year, but have remained good over the past 40 years. Current water clarity is considered good to very good.
- Average summer time total phosphorous levels have remained below State Standards and reference lake values since 2005.
- Phosphorous from lake sediments is the most significant driver of phosphorous levels within each basin. Loading from upstream lakes and falling septic systems were considered low contributors.
- The range of chlorophyll a-levels in both basins is near the oligotrophic level. Both basins are below the range for the reference lakes and well below the State Standard.
- The average summertime TSI (Trophic State Index) for the East Basin was 32.2 and that of the West Basin was 30.0, and represents a trophic state that is between Oligotrophic and Mesotrophic.
- Fish consumption advisory is still in effect for both basins based on mercury levels in tested species, but the data is very old. No new sampling is planned at this time.
- No other water quality parameters were collected by the Lake Sylvia Citizen Monitoring Group or Minnesota Pollution Control Agency in 2021.

Introduction

The water quality of Lake Sylvia has been monitored in some form since at least 1972. The majority of measurements have been done by our lake volunteers. The Minnesota Pollution Control Agency (MPCA) and Minnesota Department of Natural Resources (MDNR) have also contributed to the data base. Water quality parameters monitored have been chosen to determine how the water in the lake meets its designated uses per Minnesota WQ Standards, 7050.0222, the Northcentral Hardwood Forest Ecoregion (NHFE) reference lakes and whether the water quality is improving or diminishing. For more background information see the 2015 report (Mischuk, 2015).

General Water Quality

As in past reports, the assessment of the water quality for Lake Sylvia will be by basins. Lake Sylvia has two distinct basins, East and West, and the data collected over the years has been segregated by basin in the MPCA and MDNR data bases, so the data will continue to be kept separate.

Trophic Status

The trophic state of a lake is often used to assess its water quality. Lakes can be divided into three general trophic categories oligotrophic, mesotrophic, and eutrophic. These categories reflect a lake's nutrient and clarity levels.

Oligotrophic lakes are generally clear, deep and free of weeds and algae blooms. Although they are beautiful, they are low in nutrients and they do not support a diverse biological community. Eutrophic lakes are high in nutrients and support a large biological biomass. They are usually either weedy or subject to frequent algae blooms, or both. Mesotrophic lakes lie in between oligotrophic and eutrophic states.

Carlson's Trophic State Index (TSI) is often used as the basis for estimating the trophic status of a lake. Carlson's TSI is based on the interrelationships of Secchi transparency, total phosphorus (TP), and chlorophyll-a (Chl-a) measurements.

Secchi Transparency

Secchi transparency (clarity) is an indicator of water quality related to chemical and physical properties of a lake. Transparency is measured with a standard Secchi disk. Water clarity has two main components: true color (material dissolved in the water) and turbidity (material suspended in the water such as algae and silt). Measurements of transparency have been collected and recorded on Lake Sylvia since 1974, and represent the one parameter with the most data points, 1256 in the East Basin and 1551 in the West Basin. Measurements have been collected from several stations within each basin, principally from May through September of each year, the primary growing season for aquatic plants. Transparency has generally been very good in both basins over the past 47 years. The most dramatic change occurring after 1986, when transparency increased in both basins by an average of 7feet (Figures 1 and 2).

On average, water clarity in the East Basin in 2021 was 25 feet, and ranged from 22 to 30 feet. The average was 5 feet above the 2020 measurements. The West Basin average for 2021 was 26 feet and ranged from 21 to 32 feet. The average was nearly 4 feet above that measured in 2021.

Figure 1. Average Secchi disk measurements from 1977 thru 2021.

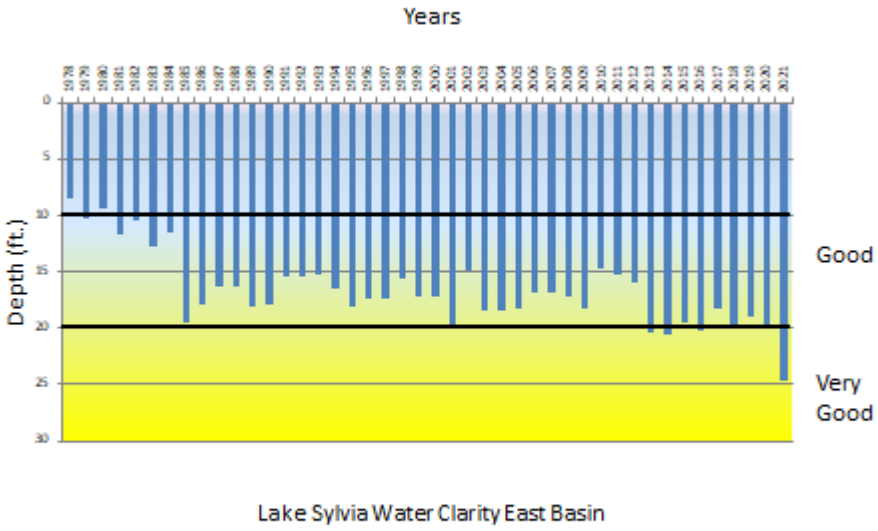
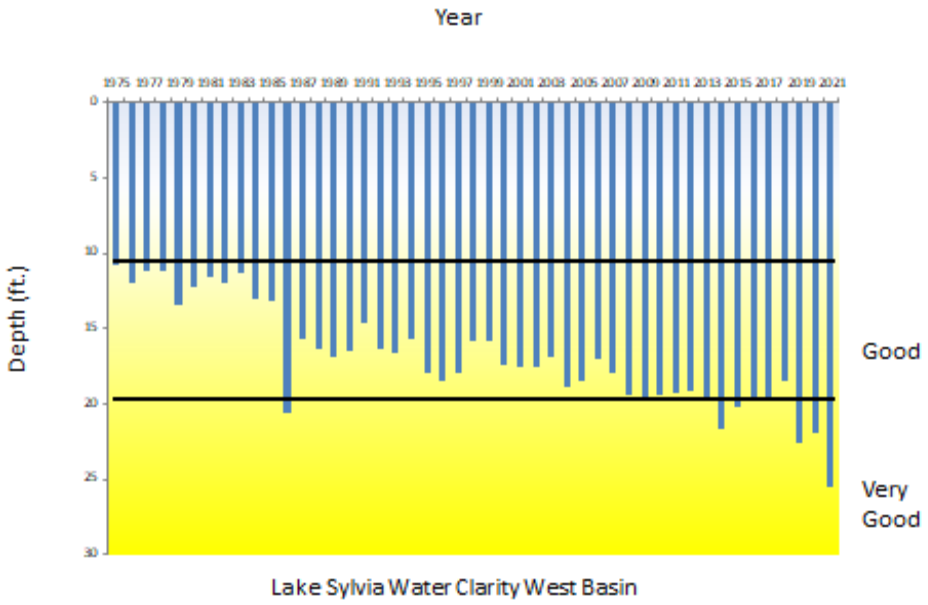


Figure 2. Average Secchi disk measurements from 1974 thru 2021.



Lake Sylvia data was also compared to the ecoregion reference lakes summer mean values (Table 1).

Table 1. Lake Sylvia water quality parameters compared to Ecoregion and Minnesota Water Quality

Parameter	East Basin Lake Sylvia	West Basin Lake Sylvia	Northcentral Hardwood Forest [1]	Minnesota WQ Standard 7050.0222 NHF Ecoregion
Total Phosphorus (ug/l)	7.8[2]	5.7[2]	23-50	40 ug/l
Chlorophyll a (ug/l)	1.6[3]	1.5[3]	5-22	14 ug/l
Secchi Disk (ft.)	25[4]	26[4]	4.9-10.5	Not<1.4 m (4.6 ft.)
Total Kjeldahi Nitrogren[5] (mg/l)	0.8	0.73	< 0.60-1.2	
Ntrite + Ntrate-N (mg/l)	0.02	0.025	<0.01	
Alkalanity (mg/l)	160	160	75-150	

Color (Pt-Co Units)	8	7	10-20	
pH (s.u.)	8.6	8.6	8.6-8.8	6.5-9.0
Chloride (mg/l)	7	6	4-10	250 mg/l (3C std)
Total Suspended Solids (mg/l)	2	2	2-6	
Total Suspended Inorganic Solids (mg/l)	N/D	N/D	1-2	
Turbidity (NTU)	2	1	1-2	
Conductivity (mmhos/	287	284	300-400	
TN:TP ration	0.08:1	< 0.01:1	25:1-35-1	
Mercury, total in water (ng/l)				6.9
Mercury[6], total in fish tissue mg/kg				0.2
Average Mercury concentration in skin -on fillet, mg/kg (ppm)				
Bluegill sunfish	0.12	0.1		
Largemouth bass	0.46	N/D		
Northern pike	0.41	0.44		
Walleye	0.4	0.39		

[1] Ecoregion reference lake data collected between 1985 and 1988. N/D – No data
[2] Average values for 2021.
[3] Average Values for 2021.
[4] Average Secchi depth 2021.
[5] Most of these water quality parameters have not been monitored since 2009.
[6] Mercury in fish tissue has not been monitored by the MDNR since 1992.

Reference lakes within the NHF ecoregion were chosen to be representative of that ecoregion and minimally impacted by human influences (e.g., no point source wastewater discharges, no large urban areas in the watershed, etc.). The summer average Secchi transparency readings for the NHF ecoregion range from 4.9 to 10.5 feet (Table 1).

The clarity of Lake Sylvia has been much greater than the reference lakes. In addition, Lake Sylvia water clarity exceeds the standards for use attainable category 2Bd under section 7050 of the Minnesota Water Quality Standards (Table 1).

Total Phosphorous

Phosphorous promotes aquatic plant growth. It is the key nutrient affecting the amount of algae and weed growth within a lake. A study done by the Crow River Organization of Water, completed in 2016, looked at water quality impairments due to excess phosphorous loading within the North Fork of the Crow River watershed (CROW, 2016). This assessment included both East and West Lake Sylvia. The study looked at both external and internal sources of total phosphorous to the two lake basins. The results from the study indicated that internal loading of phosphorous from lake sediments is the most significant driver for phosphorous levels within each basin. Loading from upstream lakes and failing septic systems were low contributors to phosphorous loading in both basins. In addition, due to the morphology of both basins (large size, deep, small watersheds, long residence time) they seem to be resistant to watershed loading. Because of the size and depth of each basin, phosphorous release from sediments seems to be confined to hypolimnetic (bottom) water. In addition, thermal stratification limits the amount of biologically available phosphorous to algae during the summer months. This is reflected in the low total phosphorous values obtained from surface water sampling during the summer months.

In general a concentration of 20ug/l of total phosphorous should not be exceeded in the water column to minimize algal blooms. Figures 3 and 4 display box plots showing the distribution of total phosphorous data for the years in which data were available.

Box plots are a nonparametric tool for conveying the distribution of data sets and variation changes between different groups without the assumptions of parametric statistics. The boxes represent the middle 50% of the data points. Generally, where the group boxes overlap, there is no difference in data sets.

In general the total phosphorous levels have remained in a rather steady state over the past 18 years. Average summer time total phosphorous levels have remained below State Standards and reference lake values since 2005 (Figures 3 and 4, Table 1). There are gaps in the data prior to 2005, and the data is more variable, therefore information for this parameter needs to be viewed with caution.

Figure 3. Average summer total phosphorous measurements for the East Basin of Lake Sylvia.

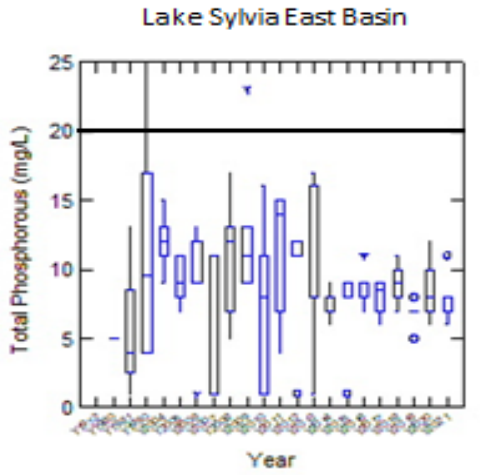
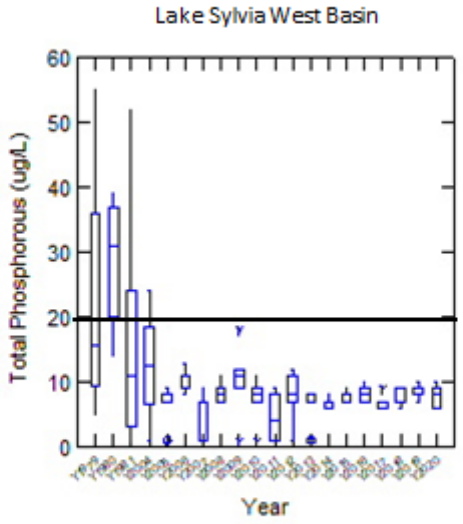


Figure 4. Average summer total phosphorous measurements for the West Basin of Lake Sylvia.



Chlorophyll-a

The green pigment found in algae is necessary for photosynthesis. The amount present in lake water depends on the amount of algae and is used as an indicator of water quality. Chlorophyll-a values greater than 11ug/l generally equate to a eutrophic condition, while values less than 2ug/l indicate an oligotrophic condition (Figures 5 and 6). In general chlorophyll-a value in both basins are near or in the oligotrophic region. Both basins are below the range for the reference lakes and well below the State Standard. As with the total phosphorous information, there are data gaps prior to 2004 and therefore the information needs to be viewed with caution.

Figure 5. Average summer chlorophyll a-measurements for the East Basin of Lake Sylvia.

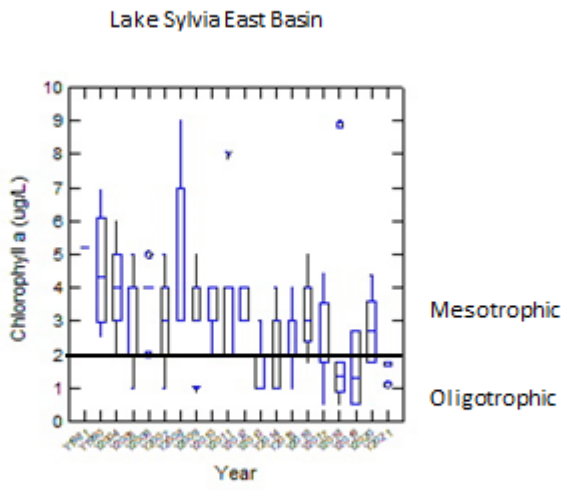
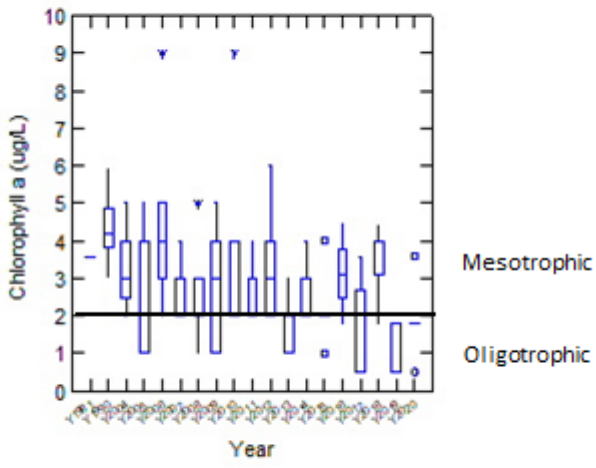


Figure 6. Average summer chlorophyll a-measurements for the West Basin of Lake Sylvia.



Carlson Index

Carlson's Trophic State Index (TSI) is used as the basis for estimating the trophic status of lakes in Minnesota. The index is based on the interrelationship of total phosphorous (TP), chlorophyll-a, and Secchi transparency measurements. Figures 7 and 8 display this relationship.

Figure 7. TSI for the East Basin of Lake Sylvia. The Average TSI value for 2021 was 32.2.

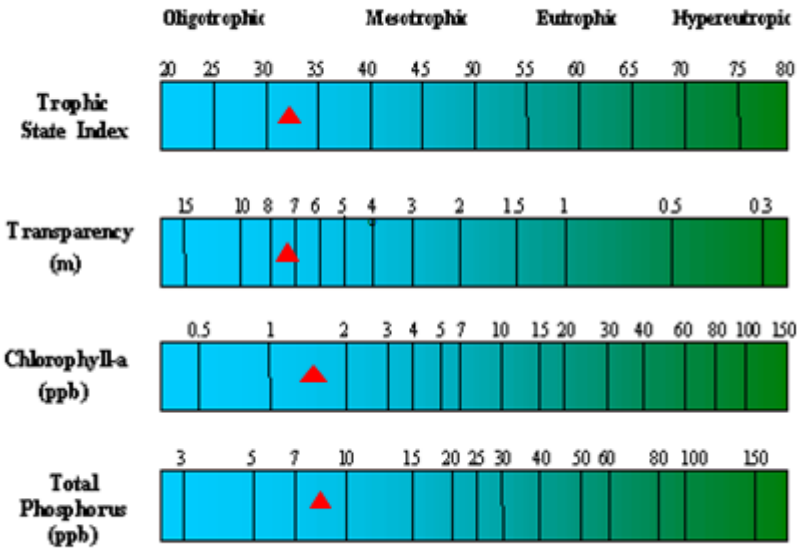
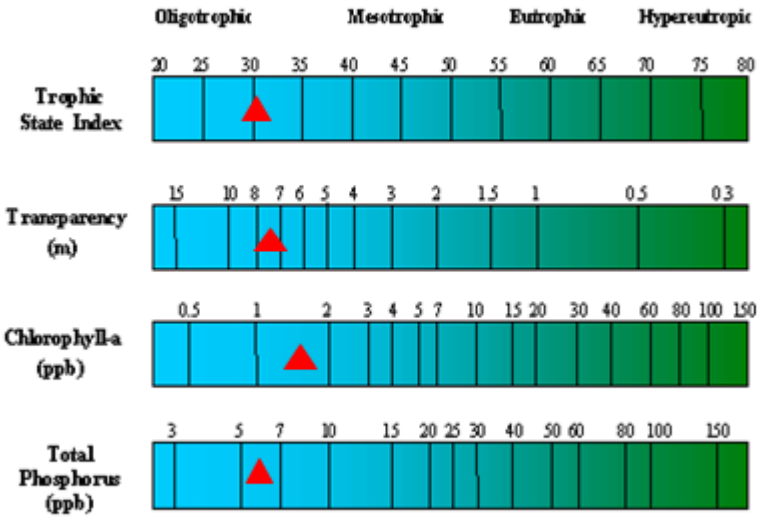


Figure 8. TSI for the West Basin of Lake Sylvia. The Average TSI value for 2020 was 30.0.



The average summertime TSI for the primary sampling site in the East Basin in 2021 was 32.2 and was below the 15 year average of 37.2 (RMB database only). The West Basin had and average summertime TSI of 30.0 in 2021 which was substantially below the 14 year average of 35.6 (RMB database only). The 2021 TSI values represent a trophic state that is Oligotrophic to Mesotrophic.

Mercury

Both basins of Lake Sylvia are still under a fish consumption advisory for mercury. The data upon which this advisory was initiated was collected in 1992. Table 1 presents the tissue concentration data along with the permissible standard. There has been no fish tissue collected for this contaminant analysis since 1992.

References

Mischuk, M. 2015. Water Quality Perspectives on Lake Sylvia State of Lake Sylvia in 2015.

Crow River Organization of Water. 2016. North Fork Crow Protection Lakes Watershed Assessment. WENCK File #2366-09.