Chetek Lakes Sediment Study

Chetek Chain of Lakes

Barron County, Wisconsin

CHLPA-172996 | December 1, 2023

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December 1, 2023

RE: Chetek Chain of Lakes
Chetek Lakes Sediment Study
Barron County, Wisconsin
SEH No. CHLPA-172996

Mr. Jamey Lideen, President
Chetek Lakes Protection Association
PO Box 916
Chetek, WI 54728

Dear Mr. Lideen:

Please find enclosed the Chetek Lakes Sediment Study for the Chetek Chain of Lakes in Barron County, Wisconsin. This report presents the results of the field survey performed in June 2023, sediment volume estimates, and nutrient content of sediment based on laboratory analysis.

Thank you for the opportunity to provide services to the Chetek Lakes Protection Association. Short Elliott Hendrickson Inc. (SEH®) is pleased to provide you with this information for your records and review. If you have any questions, please contact me directly at 715-210-5879 or via e-mail at rcance@sehinc.com.

Sincerely,

Renee Cance

Renee Cance, PWS, CFM
Sr Scientist

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Chetek Lakes Sediment Study

Chetek Chain of Lakes
Barron County, Wisconsin

Prepared for:
Jamey Lideen, President
Chetek Lakes Protection Association
PO Box 916
Chetek, WI 54728

Prepared by:
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Chetek Lakes Sediment Study

Chetek Chain of Lakes

Prepared for the Chetek Lakes Protection Association

1 Summary of Findings

Sediment depths varied across the Chetek Chain of Lakes, based on 31 sample locations. Across the entire Chain of Lakes, observed sediment depths ranged from 0.0 feet (no sediment found at the sample point) to 4.3 feet. Within the Chetek Chain of Lakes, the total estimated volume of sediment is 10,175,301 cubic yards. On a per-lake basis, Prairie Lake had a significantly higher amount of sediment (5,418,017 cubic yards) than the rest of the lakes in the chain. Lake Chetek had the least amount of sediment, estimated to be 462,701 cubic yards.

Across the Chain of Lakes, 60 sediment samples were collected and analyzed for nutrient content. Sediment within Lake Chetek has the highest average **Phosphorus (P_2O_5)** concentrations within the Chain, with an average available phosphorus content of 7.24 lbs/1,000 gallons if applied as a liquid application method, such as spreading spoil material on agricultural fields. Prairie Lake had the lowest average level of phosphorus (1.96 lbs/1,000 gallons), while phosphorus concentrations in Ojaski, Pokegama, and Tenmile Lakes were all relatively consistent.

In general, the average concentrations of **Total Nitrogen (TKN)** did not widely vary between the lakes. The amount of total nitrogen found to be in the sediments ranged from 0.11% to 0.22%, as averages per lake. Sediments with Tenmile Lake were found to have the highest concentration of total nitrogen, with Lake Chetek having the lowest concentrations.

Iron (Fe) concentrations were discovered to be the highest in Lake Chetek. With a lake average of 26,431 ppm, the iron concentrations in Lake Chetek were 2 to 3.5 times higher than in any other lake in the Chain. The rest of the lakes in the Chain exhibited iron concentrations that averaged from 7,430 ppm to 12,137 ppm.

2 Purpose of Study

The purpose of this study is to collect data pertaining to the quantity and composition of lake sediment within the Chetek Chain of Lakes and apply this data towards future water quality improvement projects. The Chetek Lakes Protection Association (CLPA) was awarded a Wisconsin Department of Natural Resources (WDNR) Surface Water Grant in 2023 to assist in funding this study. The study was coordinated with the Barron County Conservation District (BCCD) was heavily involved with the development of the study and also contributed funding towards the project.

The objective of this study is to estimate the volume of sediment within the Chetek Chain of Lakes, identify patterns of varying sediment accumulation, and determine the current nutrient content of the lake sediment. To accomplish these objectives, at 31 locations within the Chain the

depth of sediment was measured, sediment samples were collected, and laboratory analysis of sediment samples were completed.

It is anticipated that this study will lay the foundation for future studies towards identifying appropriate projects to promote water quality improvement in the Chain. This will likely include prioritization of hydraulic dredging locations, feasibility of applying sediment/spoil material onto agricultural fields, and other actions or improvement options that may be realized by the data results.

This study will complement the work of the 2011 Internal Phosphorous Loading and Sediment Phosphorous Fractination Analysis for the Chetek Chain of Lakes [1], which explored how iron-bound phosphorus in sediment diffuses to the water column under both aerobic and anaerobic conditions. To correlate with the 2011 study, the sediment samples collected in 2023 were analyzed for iron content.

3 Project Location and Description

The project site is located in Barron County, Wisconsin and described as follows:

Table 1 – Public Land Survey System Location of Project Site

Municipality	Township	Range	Sections
Town of Stanley	34N	11W	27, 34, 35
Town of Prairie Lake	33N	11W	1, 2, 3, 11, 12, 13, 24
Town of Chetek	33N	10W	6, 7, 8, 17, 18, 19, 20, 21, 27, 28, 29, 32, 33
City of Chetek	33N	10W	19, 29, 30
	33N	11W	24
Town of Dovre	32N	10W	4

The project area is a 3,362-acre lake chain that is generally located east of USH 53 and south of USH 8, as shown on **Figure 1**.

The Chetek Chain of Lakes consists of Prairie Lake (1,408 acres), Ojaski Lake (332 acres), Pokegama Lake (433 acres), Lake Chetek (923 acres), and Tenmile Lake (266 acres).

The five lakes on the Chetek Chain are interconnected and receive inflows from four perennial streams and 10 intermittent streams. The waterbodies converge into Lake Chetek, which outlets to the Chetek River via a dam that was constructed in 1865.

The Chetek Chain has a 214 square mile watershed made up of five subwatershed basins. Approximately 32% of the watershed is under agricultural land use, of which approximately a third is attributed to cropland with the remaining being utilized for hay production and as pasture. Cropland within the watershed is primarily of sandy outwash soils, which have high infiltration levels and limited potential for runoff. There are very limited options for implementing soil conservation practices that would effectively improve water quality within the Chetek Chain.

[1] William F. James, 2011. Internal Phosphorous Loading and Sediment Phosphorous Fractination Analysis for the Chetek Chain of Lakes. ERDC Eau Galle Aquatic Ecology Laboratory. Spring Valley, Wisconsin.

4 Background

The Chetek Chain of Lakes is a hypereutrophic water system with a long-standing history of high phosphorus levels. Hypereutrophic lakes are typically high in nutrients and experience frequent algae blooms. The CLPA has a letter dated July 1945, that requests the treatment of a northern section of Prairie Lake due to heavy algae growth.

Water quality data most recently published on the WDNR's Citizen Lake Monitoring Network (CLMN) database [2] depicted that the average summer (July-August) phosphorus concentrations in the Chetek Chain ranged from 68 µg/L to 241.5 µg/L. The mean summer phosphorus concentration is 28.0 µg/L for lakes in northwestern Wisconsin [3]. Waterbodies with total phosphorus concentrations that exceed 20 µg/L are likely to experience nuisance algal blooms [4]. Based on the CLMN data, each lake within the Chain has phosphorus concentrations that significantly exceed 20 µg/L, indicating a likelihood for nuisance algal blooms. Summary of the CLMN water quality data is shown in **Table 2**.

Table 2 – Summary of Total Phosphorus Concentrations

Lake	Current Total Phosphorus Concentrations[1]		
	Summer Average[(a)] (µg/L)	Range in Growing Season (µg/L)	Year[(b)]
Prairie	241.5	135-348	2012
Ojaski	197	73-225	2011
Pokegama	106	106[(c)]	2019
Tenmile	232.5	92-288	2011
Chetek	68	72-198	2011

Notes: [a] Summer Months are the months of July through August. [b] Year of most recent CLMN data available. [c] Monitoring occurred one time during the year.

Source: [1]CLMN data.

In 2015 the Chetek Lake Comprehensive Plan (2015 SEH) calculated an annual estimated phosphorus budget of 46,447 pounds, with 8,507 pounds sourced from internal loading.

There are numerous potential phosphorus sources in a lake system, which can include the following:

- Phosphorus is released directly into the water column from lakebed sediment.
- Decomposing plant biomass can contribute thousands of pounds of phosphorus directly into the water column annually.
- Private septic systems surrounding the lake infiltrate phosphorus-laden water into the groundwater.

[2] Citizen Lake Monitoring Network | | Wisconsin DNR.
[3] Lillie, R.A. and J.W. Mason, 1983. Limnological Characteristics of Wisconsin Lakes. Wisconsin Department of Natural Resources Technical Bulletin No. 138. Madison, WI. 116 pp.
[4] Shaw, B., C. Mechenich and L. Klessig, 2004. Understanding Lake Data. University of Wisconsin – Extension Publication G3582. Madison, WI.

- Mowed lawns and impervious surfaces along the shoreline send nutrient-laden stormwater runoff directly to the lake.
- Stormwater with high nutrient content runs off agricultural lands and flows to streams which discharge to the lake system.

5 Survey Methods

Across the Chain of Lakes, 31 samples point locations were selected, focusing on bays and areas anticipated to have higher amounts of sediment accumulation due to limited water flow and shallow water depths. Sample point locations are shown on **Figure 2**. The BCCD was involved with identifying these sample point locations that would best represent the conditions of each lake. The study originally included 30 sample point locations, but due to lack of sediment at two of these locations, an additional sample point was added in order to still collect the desired amount of sediment samples for laboratory analysis.

Field surveyors utilized a sub-meter accuracy Global Positioning System (GPS) unit to navigate to the location of each pre-determined sample point. A 48-inch hand core sediment sampler [5] was used to collect sediment samples. Extension pieces were added to the equipment to reach the desired depths.

At each sample point, the thickness of the sediment layer was determined by 1) measuring the distance (feet) between the water surface and the top of the soft sediment, and 2) measuring the distance (feet) between the water surface and the hard bottom of the lake. Depths of sediment recorded during the field survey are in shown in **Appendix A**.

The original plan was to collect a sediment sample within the top 1 foot of sediment and to collect another sample at 4 feet below the top of sediment. During the field survey it was discovered that there was less than 4 feet of sediment at most of the sample point locations. To account for the shallower than anticipated sediment depths, sediment samples were collected at the top of the sediment and at the bottom of the sediment; if sediment was greater than 4 feet thick then the sample was collected at the 4-foot depth.

Each sediment sample was placed in a pint-sized plastic container, which was provided by AgSource Laboratory. Containers were labeled with the appropriate sample point location number and a letter “A” (A = 1-foot depth) or “B” (B = lower depth).

At the end of each field day, sediment samples were given to a CLPA member and stored in a freezer. Once all sediment collection was complete, a CLPA member transported and delivered the frozen samples to a laboratory for analysis.

6 Data Analysis Methods

6.1 Sediment Volume Analysis

During field data collection, the depth to the top of the sediment and depth to the bottom of the sediment were measured at each of the 31 sample locations. This data was used to calculate the thickness of the sediment layer at these specific locations.

[5] https://wildco.com/wp-content/uploads/2017/04/2424-B-Hand-Corer.pdf

Sediment Depth Layer was created by:

1. The sample locations, along with their associated sediment depths were plotted in GIS.
2. An interpolation tool was used in GIS to create a grid (raster) layer, where each grid cell was assigned an estimated sediment depth value. Estimated depth values were based on the depth values and proximities of nearby sample points (inverse distance weighted interpolation).
3. The grid layer was clipped to the lake boundaries for display purposes and for further analysis.

Next, **Estimated Sediment Volumes** were derived using the follow steps:

1. The grid layer was broken up into five different areas, one for each lake.
2. For each lake, key information was recorded, including the grid cell dimensions (constant for all grid cells), the number of pixels in the dataset, and the mean sediment depth of the grid cell dataset for that specific lake.
3. For each lake, the total estimated sediment was calculated using the following equation: (*grid cell length*) x (*grid cell width*) x (*mean sediment depth*) x (*number of grid cells*)

The spreadsheet calculations used to estimate the total sediment volumes is included in **Appendix B**.

Estimated volume quantities are based on limited data. Across the 3,362-acre Chain of Lakes, data was collected at 31 sample points, which was 3 to 14 points per lake, prorated based on lake size. Many of the sample points were located near the middle part of the waterbody. Sample point data along transects was not collected, which could have provided a more detailed representation of how sediment depths vary across each lake.

6.2 Lab Analysis

The sediment samples were analyzed by AgSource Laboratories [6]. Each of the 60 sediment samples were analyzed for the following nutrients:

Total Nitrogen, TKN	Calcium, Ca	Copper, Cu
Ammonium, NH_4-N	Magnesium, Mg	Soluble Salts, EC
Organic Nitrogen, N	Sodium, Na	pH
Phosphorus, P_2O_5,	Zinc, Zn	Dry Matter
Potassium, K_2O	Manganese, Mn	Moisture Content
Sulfur, S	Iron, Fe	

The sediment samples were processed as liquid manure. If hydraulic dredging is pursued in the future, ideally the spoil material would be spread on agricultural fields, therefore acquiring nutrient values from an agronomic perspective is most applicable for possible future uses. In addition, since this is a preliminary study, processing samples as liquid manure instead of as soil is more cost effective and allowed the CLPA to maximize the number of samples to be processed within the available project budget.

Analysis results data from the laboratory is in **Appendix C**.

[6] https://agsource.com/

7 Results

Sediment Volumes and Depths

Observed sediment depths varied across the Chetek Chain of Lakes. Overall, observed sediment depths ranged from 0.0 feet (no sediment found at the sample point, which occurred at the east end of Lake Chetek) to 4.3 feet (observed in the central part of Prairie Lake). The measured sediment depths were used to interpolate the volume of sediment in each lake. Within the Chetek Chain of Lakes, the total estimated volume of sediment is 10,175,301 cubic yards. On a per-lake basis, Prairie Lake had a significantly higher amount of sediment than the rest of the lakes in the chain, and Lake Chetek had the least.

The Sediment Depth Map (**Figure 3**) shows both the observed sediment depths and interpolated sediment depths across the Chain of Lakes. A summary of the sediment volume and depth statistics that resulted from this study is listed in **Table 3**, below.

Table 3 – Estimated Sediment Volumes and Average Depths

Lake	Total Sediment Volume (cy)	Average Depth of Sediment (ft)[(a)]	Number of Sample Points	Lake Size (ac)
Prairie Lake	5,418,017	2.29	14	1,408
Ojaski Lake	716,260	1.13	3	332
Pokegama Lake	1,307,046	1.80	6	433
Tenmile Lake	2,271,277	0.93	3	266
Lake Chetek	462,701	1.16	5	923
Total	**10,175,301**		**31**	**3,362**

Notes: [a] Average depth is based on the sediment depths collected during this study.

Prairie Lake, spanning roughly 7 miles, is the largest lake in the Chain and was revealed to have the highest volume of sediment. Estimated to contain 5,480,017 cubic yards of sediment, this accounts for more than half of the accumulated sediment in the Chain. Observed sediment depths in Prairie Lake ranged from 0.8 feet to 4.3 feet, with an average depth of 2.29 feet. Based on GIS analysis, over three-fourths of the lake is estimated to have sediment depths between 2.0 and 4.0 feet, as depicted on **Figure 3**.

Ojaski Lake is estimated to have 716,260 cubic yards of sediment. Field data was collected at three sample points in Ojaski Lake, and the depth of sediment was found to be consistent throughout the lake, with observed sediments only ranging from 1.0 feet to 1.3 feet deep, resulting in an average sediment depth of 1.13 feet.

Pokegama Lake is calculated to have 1,307,046 cubic yards of deposited sediment on the lake bottom. Roughly 80% of the lake has an estimated sediment depth in the 1.0 to 2.0 foot range. Sediment appears to lessen the southeast part of the lake, while sediment depths significantly increase at the far southern end of the lake. Across Pokegama Lake sediment depths ranged from 0.4 feet to 3.8 feet, with an average sediment depth of 1.80 feet.

Lake Chetek, which receives flow from each of the surrounding lakes, has lowest estimated volume of sediment at 462,701 cubic yards. Observed sediment depths within Lake Chetek ranged from 0.0 feet (no observed sediment) to 2.9 feet, resulting in an average sediment depth of 1.16 feet. Sediment within Lake Chetek appeared to be less at the far western and eastern portions of the lake, with higher amounts of sediment found to be in the northern portion of the lake near the Pokegama Lake inlet.

Tenmile Lake was found to have the thinnest sediment depths within the Chain, with an average sediment depth of 0.93 feet, derived from observed sediment depths ranging from 0.7 feet to 1.2 feet. Sediment depths appeared to be lesser in the southern and northern portions of the lake. Tenmile Lake is estimated to have 2,271,277 cubic yards of sediment.

Nutrient Content of Sediment

Across the Chain of Lakes, 60 sediment samples were collected and analyzed. Laboratory analysis provided dozens of nutrient content quantities for each sediment sample. A trimmed-down version of this data is presented in **Appendix C**; the full set of laboratory results will be provided to the CLPA as a separate document. Focusing on nutrients that are most relevant to this lake system, the hypereutrophic nature of the waterbodies, and future potential water quality improvement projects, **Table 4**, below, is a summary of select nutrient content quantities found in sediments on a per-lake basis.

Table 4 – Average Nutrient Content of Sediment in Each Lake

Lake	Ave. Depth of Sediment (ft)	Dry Matter (%)	P_2O_5 (lbs/1000gal) Liquid Application	Total N, TKN (%) As Received	Total N, TKN (lbs/1000gal) Liquid Application	Fe (ppm) Dry basis	pH As Received
Prairie	2.29	13.81	1.96	0.16	13.61	9,580	6.17
Ojaski	1.13	35.54	3.40	0.17	14.12	12,137	6.30
Pokegama	1.80	27.94	3.29	0.17	13.79	7,430	5.83
Tenmile	0.93	22.10	3.10	0.22	18.21	11,260	6.40
Chetek	1.16	36.71	7.24	0.11	9.25	26,431	6.48

Sediment within Lake Chetek has the highest average **Phosphorus** concentrations within the Chain, while also being the lake with the lowest estimated volume of sediment. Sediment from Lake Chetek is anticipated to have an average phosphorus (P_2O_5) content of 7.24 lbs/1,000 gals if applied as a liquid application method, such as spreading spoil material on agricultural fields. Inversely, Prairie Lake had the lowest average levels of phosphorus, at 1.96 lbs/1,000 gals if applied as a liquid application method, which was unexpected as this lake has the thickest observed sediment amounts and has the largest estimated volume of sediment. Phosphorus concentrations in Ojaski, Pokegama, and Tenmile Lakes were all relatively consistent.

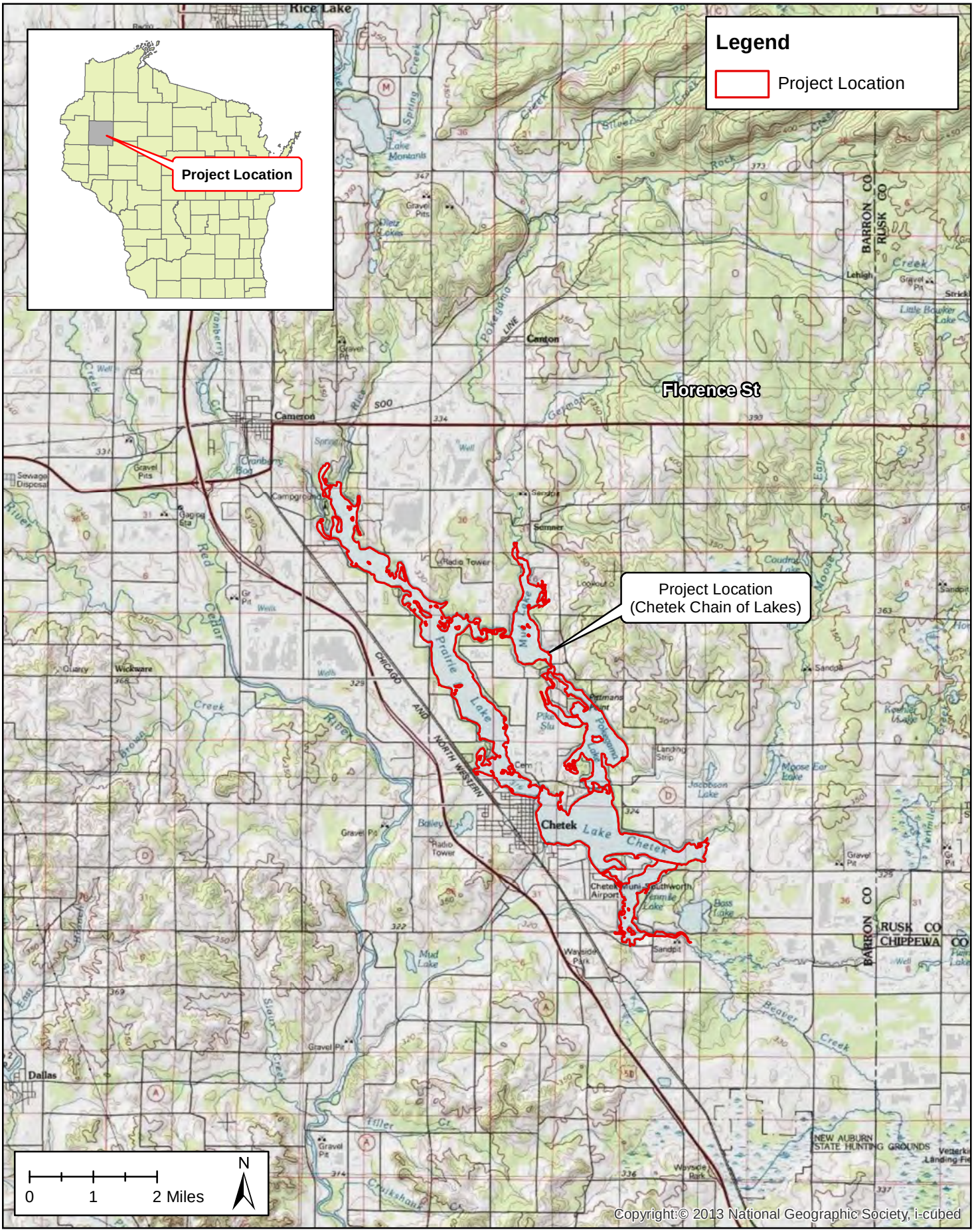
Total Nitrogen (TKN) is expressed as the combination of organic nitrogen (N) and inorganic ammonium (NH_4-N). All three of these forms of nitrogen were analyzed for and listed on the laboratory results spreadsheet in **Appendix C**. In general, the average concentrations of total nitrogen did not widely vary between the lakes. In the condition that the samples were received by the laboratory, the amount of total nitrogen found to be in the sediments ranged from 0.11% to 0.22%, which are averages per lake. The estimated available total nitrogen content, if applied by

liquid application method, has a lake average range of 9.25 lbs/1,000 gallons to 18.21 lbs/1,000 gallons. On average, Tenmile Lake was found to have the highest concentration of total nitrogen, with Lake Chetek having the lowest concentrations.

Iron (Fe) concentrations were discovered to be the highest in Lake Chetek. With a lake average of 26,431 ppm, the iron concentrations in Lake Chetek were 2 to 3.5 times higher than in any other lake in the Chain. The rest of the lakes in the Chain exhibited iron concentrations that averaged from 7,430 ppm to 12,137 ppm. When testing for iron, the sediment samples were analyzed after being dried.

In most of the lakes, sediment samples have **pH levels** that consistently average in the low to mid 6's (6.17 to 6.48). Pokegama Lake is the outlier, with an average of only 5.83. Of the 12 samples collected in Pokegama Lake, seven of them exhibited pH levels of less than 6.0; actual measurements ranged from 5.1 to 5.9. When determining the pH levels, the sediment samples were processes as they were received, meaning that no other preparation/alteration (i.e., drying, diluting, etc.) to samples were taken.

Figures



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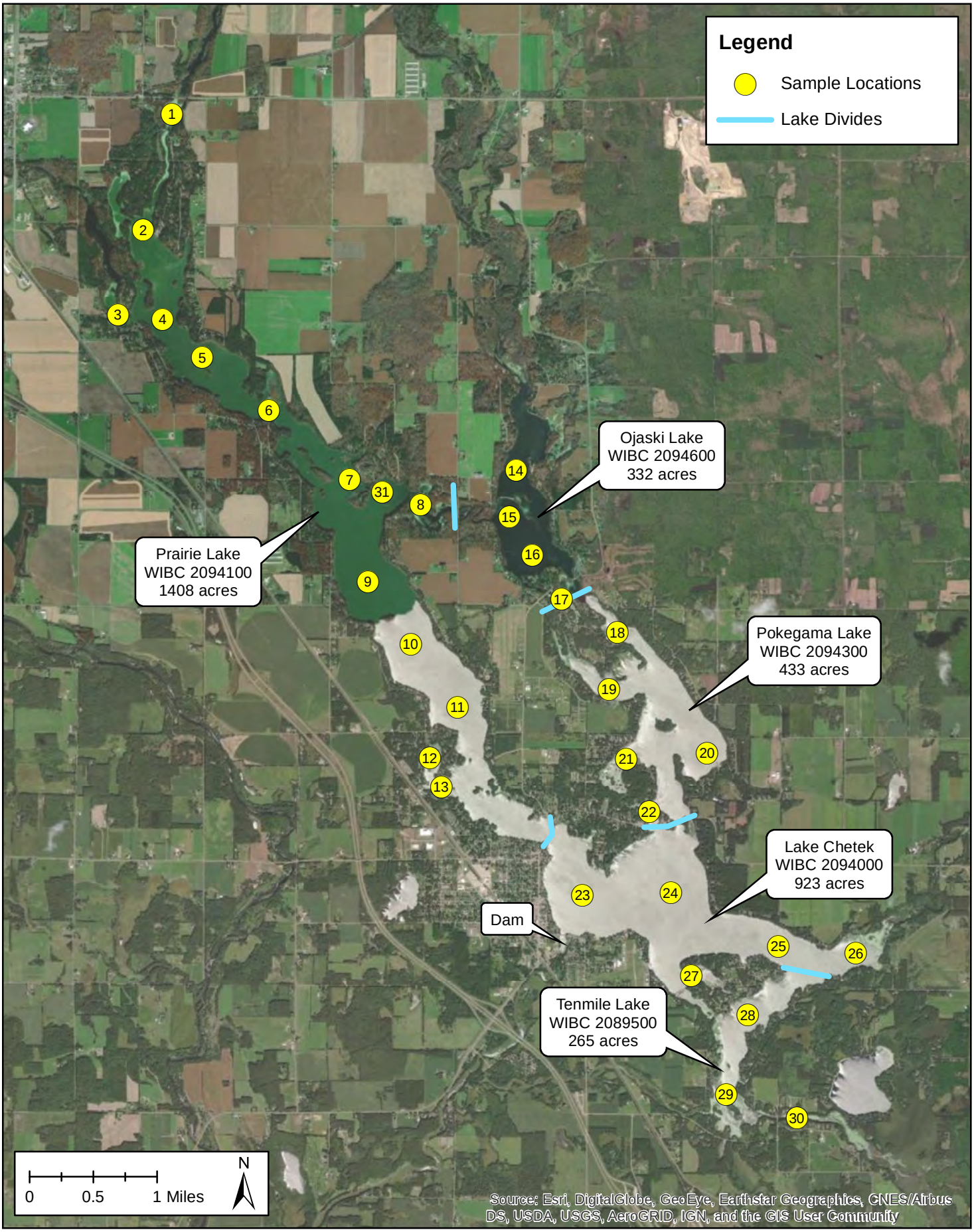
Project: CHLPA 172996
Print Date: 7/11/2023
Map by: mfalk
Projection: WISCRS, Barron County (ft)
Source: Barron County, USGS
Aerial Year: 2017

Project Location Map
Chetek Lakes Sediment Study
Barron County, WI

Figure 1



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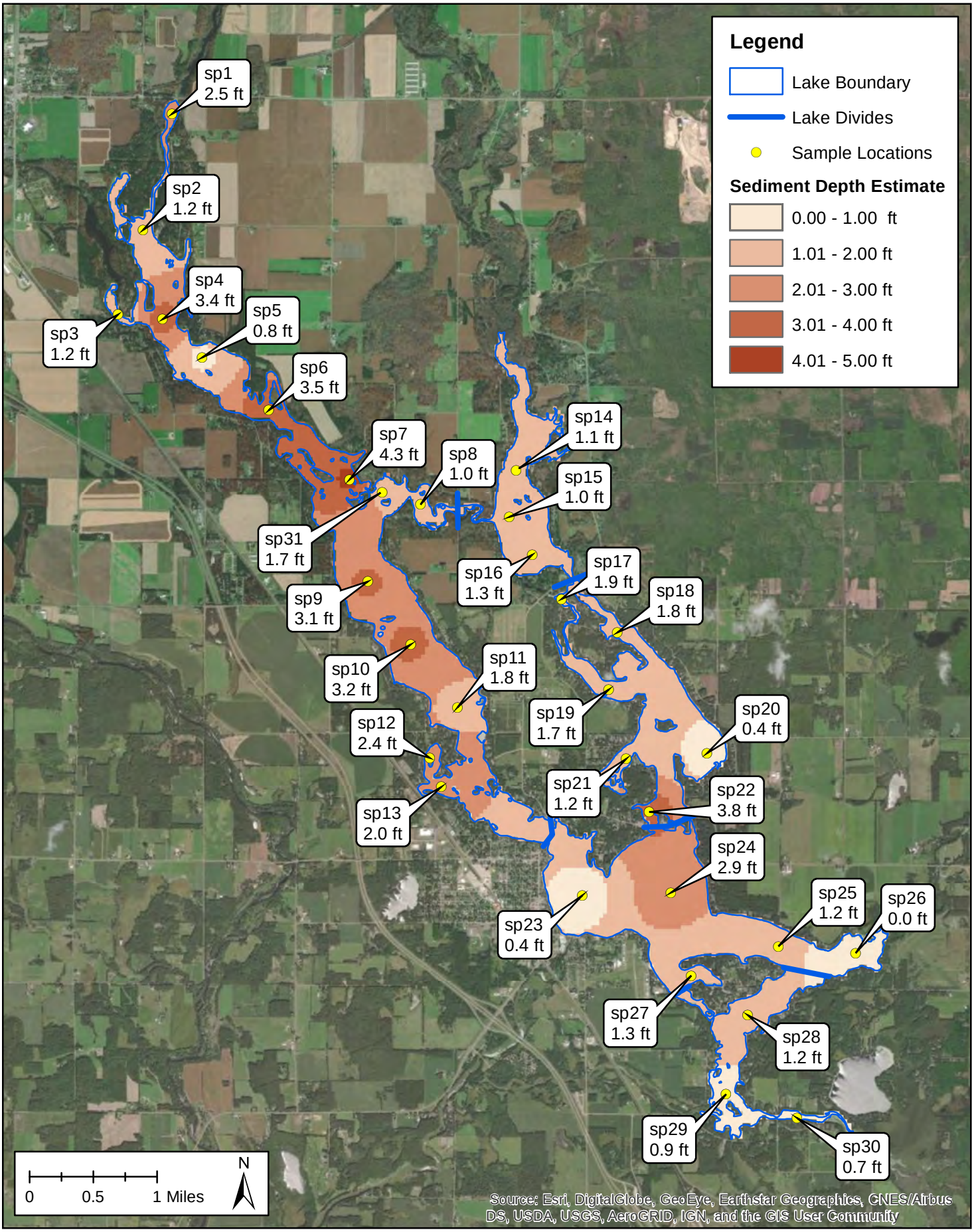
Map by: mfalk
Projection: WISCRS, Barron County (ft)
Source: Barron County
Aerial Year: 2017

Sample Locations

Chetek Lakes Sediment Study
Barron County, WI

Figure 2



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Project: CHLPA 172996
Print Date: 8/1/2023
Map by: mfalk
Projection: WISCRS, Barron County (ft)
Source: Barron County
Aerial Year: 2017

Sediment Depth Map

Chetek Lakes Sediment Study
Barron County, WI

Figure 3

Appendix A

Sediment Sampling Data Log

Field Data Form
Chetek Lakes Sediment Study

Sample Point	Sediment Sample Label	Depth below sediment	Depth to top of sediment (feet)*	Depth to lake bed/ hard bottom (feet)*	Sample Date	Sediment Depth *calculated* (feet)
1	1A 1B	1 ft 4 ft	*4.3*	*6.8*	*6.6.2023*	2.50
2	2A 2B	1 ft 4 ft	*9.0*	*10.2*	*6.6.2023*	1.20
3	3A 3B	1 ft 4 ft	*7.9*	*9.1*	*6.6.2023*	1.20
4	4A 4B	1 ft 4 ft	*13.9*	*17.3*	*6.6.2023*	3.40
5	5A 5B	1 ft 4 ft	*13.7*	*14.5*	*6.6.2023*	0.80
6	6A 6B	1 ft 4 ft	*13.1*	*16.6*	*6.6.2023*	3.50
7	7A 7B	1 ft 4 ft	*8.7*	*13.0*	*6.6.2023*	4.30
8	8A 8B	1 ft 4 ft	*6.1*	*7.1*	*6.6.2023*	1.00
9	9A 9B	1 ft 4 ft	*16.8*	*19.9*	*6.6.2023*	3.10
10	10A 10B	1 ft 4 ft	*14.6*	*17.8*	*6.6.2023*	3.20
11	11A 11B	1 ft 4 ft	*12.0*	*13.8*	*6.6.2023*	1.80
12	12A 12B	1 ft 4 ft	*5.5*	*7.9*	*6.6.2023*	2.40
13	13A 13B	1 ft 4 ft	*7.3*	*9.3*	*6.6.2023*	2.00
14	14A 14B	1 ft 4 ft	*5.7*	*6.8*	*6.6.2023*	1.10
15	15A 15B	1 ft 4 ft	*7.9*	*8.9*	*6.6.2023*	1.00

*tenth of a foot *tenth of a foot

Field Data Form
Chetek Lakes Sediment Study

Sample Point	Sediment Sample Label	Depth below sediment	Depth to top of sediment (feet)*	Depth to lake bed/ hard bottom (feet)*	Sample Date	Sediment Depth *calculated* (feet)
16	16A	1 ft	*8.9*	*10.2*	*6.6.2023*	1.30
	16B	4 ft				
17	17A	1 ft	*4.3*	*6.2*	*6.6.2023*	1.90
	17B	4 ft				
18	18A	1 ft	*8.9*	*10.7*	*6.7.2023*	1.80
	18B	4 ft				
19	19A	1 ft	*9.2*	*10.9*	*6.7.2023*	1.70
	19B	4 ft				
20	20A	1 ft	*13.0*	*13.4*	*6.7.2023*	0.40
	20B	4 ft				
21	21A	1 ft	*5.5*	*6.7*	*6.7.2023*	1.20
	21B	4 ft				
22	22A	1 ft	*14.3*	*18.1*	*6.7.2023*	3.80
	22B	4 ft				
23	23A	1 ft	*11.0*	*11.4*	*6.6.2023*	0.40
	23B	4 ft				
24	24A	1 ft	*19.0*	*21.9*	*6.7.2023*	2.90
	24B	4 ft				
25	25A	1 ft	*9.9*	*11.1*	*6.7.2023*	1.20
	25B	4 ft				
26	26A	1 ft	*5.7*	*5.7*	*6.7.2023*	0.00
	26B**	4 ft				
27	27A	1 ft	*10.0*	*11.3*	*6.7.2023*	1.30
	27B	4 ft				
28	28A	1 ft	*7.8*	*9.0*	*6.7.2023*	1.20
	28B	4 ft				
29	29A	1 ft	*5.0*	*5.9*	*6.7.2023*	0.90
	29B	4 ft				
30	30A	1 ft	*4.1*	*4.8*	*6.7.2023*	0.70
	30B**	4 ft				
31	30A	1 ft	*7.1*	*8.8*	*6.7.2023*	1.70
	30B	4 ft				

*tenth of a foot *tenth of a foot

***Sample not collected; sediment was too thin for multiple samples.*

Appendix B

Sediment Volume Calculations

Sediment Volume Calculations

Chetek Lakes Sediment Study

Lake	Pixel Count	Pixel Area (sf)	Mean Pixel Depth (ft)	Mean Pixel Sediment Volume (cf)	Total Lake Sediment Volume (cf)	Total Lake Sediment Volume (cy)
Prairie	2396	25728.8016	2.373	61,054.45	**146,286,453.11**	**5,418,016.78**
Ojaski (Mud)	569	25728.8016	1.321	33,987.75	**19,339,028.00**	**716,260.30**
Pokegama	853	25728.8016	1.608	41,371.91	**35,290,241.77**	**1,307,045.99**
Chetek	1565	25728.8016	1.523	39,184.96	**61,324,469.98**	**2,271,276.67**
Ten Mile	462	25728.8016	1.051	27,040.97	**12,492,928.36**	**462,701.05**

Sum: **10,175,300.79**

Appendix C

Sediment Samples Lab Results

Sediment Samples Laboratory Results

AgSource Laboratories

Sample Date	Sample ID	Sample Depth (ft)	Actual Sample Depth (ft)	Lake	Dry Matter As Recieved (%)	Moisture Content As Recieved (%)	Total N, TKN As Recieved (%)	pH As Received	Soluable Salts/ Electrical Conductivity As Recieved (mmhos/cm)	Total N, TKN Liquid App. (lbs/1000 gal)	NH_4-N Liquid App. (lbs/1000 gal)	Organic N Liquid App. (lbs/1000 gal)	P_2O_5 Liquid App. (lbs/1000 gal)	K_2O Liquid App. (lbs/1000 gal)	S Liquid App. (lbs/1000 gal)	Ca Dry Basis (%)	Cu Dry Basis (ppm)	Fe Dry Basis (ppm)	Mg Dry Basis (%)	Mn Dry Basis (ppm)	Na Dry Basis (%)	Zn Dry Basis (ppm)
6/13/2023	1A	1	1	Prairie Lake	14.89	85.11	0.13	6.30	3.95	10.50	1.17	9.30	10.50	2.10	3.00	0.36	21.71	27713.2	0.26	2369.0	0.03	89.68
6/13/2023	1B	4	2.5	Prairie Lake	19.60	80.40	0.12	6.40	1.98	10.41	1.75	8.70	5.20	0.80	2.10	0.33	9.08	11972.7	0.12	999.4	0.02	44.18
6/13/2023	2A	1	1	Prairie Lake	15.82	84.18	0.21	6.20	2.73	17.16	2.42	14.70	1.80	1.10	3.30	0.52	21.21	11576.5	0.20	438.2	0.02	73.02
6/13/2023	2B	4	1.2	Prairie Lake	15.98	84.02	0.21	6.20	2.93	17.83	1.25	16.60	2.10	1.00	2.70	0.61	19.27	13322.9	0.19	687.5	0.02	56.05
6/13/2023	3A	1	1	Prairie Lake	10.49	89.51	0.17	6.30	3.23	14.08	0.92	13.20	1.20	0.50	3.50	0.56	16.03	6384.1	0.16	88.4	0.02	74.33
6/13/2023	3B	4	1.2	Prairie Lake	7.81	92.19	0.13	6.00	1.92	11.00	0.92	10.10	0.60	0.20	2.10	0.85	12.86	4774.9	0.14	41.1	0.02	13.76
6/13/2023	4A	1	1	Prairie Lake	6.95	93.05	0.13	6.20	3.64	11.25	1.42	9.80	0.90	0.40	2.80	0.61	22.60	9201.6	0.17	280.4	0.03	59.73
6/13/2023	4B	4	3.4	Prairie Lake	10.71	89.29	0.16	6.30	3.15	13.66	1.08	12.60	0.80	0.30	2.40	0.44	9.17	4647.1	0.09	271.0	0.02	17.28
6/13/2023	5A	1	0.8	Prairie Lake	4.21	95.79	0.02	6.50	1.97	1.33	1.5	--	0.6	0.3	1.5	0.60	23.14	11520.7	0.19	555.7	0.03	65.44
6/13/2023	5B	4	0.8	Prairie Lake	9.50	90.50	0.14	6.40	3.74	11.58	1.67	9.90	4.20	0.50	2.40	0.46	17.91	15930.2	0.14	1707.0	0.02	49.50
6/13/2023	6A	1	1	Prairie Lake	5.49	94.51	0.10	6.40	3.18	8.41	1.33	7.10	0.90	0.40	2.80	0.61	44.26	11389.4	0.23	232.3	0.03	94.49
6/13/2023	6B	4	3.5	Prairie Lake	8.73	91.27	0.17	6.30	3.42	13.91	1.75	12.20	0.80	0.40	2.80	0.50	17.97	7655.9	0.15	443.4	0.02	39.34
6/13/2023	7A	1	1	Prairie Lake	4.54	95.46	0.08	6.20	1.50	6.58	0.67	5.90	0.50	0.20	2.40	0.68	21.50	10813.7	0.14	196.1	0.02	54.83
6/13/2023	7B	4	4.3	Prairie Lake	6.33	93.67	0.12	6.20	6.21	10.08	1.50	8.60	0.40	0.10	6.60	0.50	5.26	15434.6	0.10	108.5	0.02	19.56
6/14/2023	8A	1	1	Prairie Lake	16.32	83.68	0.19	5.90	2.17	16.08	0.50	15.60	2.20	1.50	4.90	0.41	16.94	7829.0	0.14	115.5	0.02	60.61
6/14/2023	8B	4	1	Prairie Lake	30.29	69.71	0.28	5.40	6.15	23.49	0.42	23.10	2.90	1.50	2.30	0.20	9.66	2625.0	0.07	53.1	0.02	23.99
6/14/2023	9A	1	1	Prairie Lake	5.21	94.79	0.13	6.60	3.58	10.50	0.42	10.10	0.90	0.40	2.60	0.63	31.89	12617.9	0.19	183.1	0.02	68.09
6/14/2023	9B	4	3.1	Prairie Lake	6.15	93.85	0.19	6.50	4.91	15.50	0.83	14.70	0.60	0.40	2.80	0.52	13.96	7852.6	0.14	162.8	0.02	28.05
6/14/2023	10A	1	1	Prairie Lake	4.65	95.35	0.13	6.40	4.49	10.91	0.42	10.50	1.20	0.60	2.60	0.71	50.78	21756.8	0.26	268.4	0.02	104.42
6/14/2023	10B	4	3.2	Prairie Lake	6.28	93.72	0.18	6.40	2.11	14.75	0.50	14.20	0.70	0.60	4.70	0.54	25.35	16830.3	0.23	276.8	0.02	40.84
6/14/2023	11A	1	1	Prairie Lake	6.49	93.51	0.17	6.40	6.41	14.25	0.33	13.90	0.70	0.30	3.80	0.81	9.53	5691.3	0.17	131.3	0.02	21.35
6/14/2023	11B	4	1.8	Prairie Lake	58.02	41.98	0.12	6.20	7.89	9.83	0.50	9.30	3.30	1.70	1.90	0.17	3.98	2596.1	0.08	33.4	0.01	7.95
6/14/2023	12A	1	1	Prairie Lake	10.68	89.32	0.18	5.90	1.80	15.25	0.58	14.70	1.20	0.30	2.00	0.63	12.44	2525.5	0.11	107.3	0.02	17.44
6/14/2023	12B	4	2.4	Prairie Lake	9.77	90.23	0.18	5.20	1.17	14.58	0.58	14.00	1.10	0.40	2.00	0.42	15.29	1723.4	0.09	39.7	0.02	18.67
6/14/2023	13A	1	1	Prairie Lake	19.21	80.79	0.19	6.00	1.66	16.25	0.58	15.70	2.60	1.20	4.00	0.48	35.77	7210.2	0.12	127.2	0.01	37.76
6/14/2023	13B	4	2	Prairie Lake	6.66	93.34	0.15	6.50	1.56	12.91	0.01	12.90	0.60	0.40	4.70	0.59	15.35	8382.8	0.22	65.1	0.02	30.60
6/19/2023	31A	1	1	Prairie Lake	39.26	60.74	0.38	6.00	4.89	31.74	1.58	30.20	4.50	1.60	2.60	0.53	12.69	3615.9	0.13	96.9	0.01	12.91
6/19/2023	31B	4	1.7	Prairie Lake	26.69	73.31	0.21	5.40	8.70	17.16	0.75	16.40	2.00	1.10	2.70	0.34	18.92	4656.4	0.17	65.9	0.01	19.98
6/14/2023	14A	1	1	Ojaski Lake	26.57	73.43	0.13	6.60	2.44	10.91	0.75	10.20	2.50	2.10	2.40	0.34	16.84	13077.4	0.25	182.9	0.01	61.93
6/14/2023	14B	4	1.1	Ojaski Lake	55.76	44.24	0.06	6.50	2.23	4.83	0.75	4.10	5.30	3.90	2.30	0.24	15.31	12240.2	0.23	167.3	0.02	65.76
6/15/2023	15A	1	1	Ojaski Lake	47.60	52.40	0.25	6.30	6.59	20.49	1.50	19.00	3.60	4.30	2.40	0.36	18.98	13425.8	0.24	126.8	0.01	46.10
6/15/2023	15B	4	1	Ojaski Lake	48.07	51.93	0.16	6.20	2.02	13.58	1.42	12.20	5.50	3.80	1.20	0.29	15.68	15681.7	0.26	123.2	0.01	83.48
6/15/2023	16A	1	1	Ojaski Lake	13.24	86.76	0.26	6.20	2.96	21.74	1.75	20.00	2.00	0.80	3.10	1.04	20.64	10942.6	0.20	247.5	0.01	143.81
6/15/2023	16B	4	1.3	Ojaski Lake	9.99	90.01	0.16	6.00	1.93	13.16	1.17	12.00	1.50	0.40	2.00	1.07	17.40	7446.7	0.18	86.2	0.01	16.08
6/15/2023	17A	1	1	Pokegama Lake	5.93	94.07	0.13	5.50	1.72	10.91	1.33	9.60	1.10	0.50	3.20	0.49	25.11	9720.7	0.14	146.6	0.03	69.04
6/15/2023	17B	4	1.9	Pokegama Lake	9.05	90.95	0.21	5.10	7.36	17.50	1.17	16.30	1.20	0.80	1.40	0.32	10.02	1491.5	0.04	18.4	0.03	9.17
6/15/2023	18A	1	1	Pokegama Lake	39.64	60.36	0.26	5.90	1.01	21.58	2.08	19.50	12.10	2.80	2.30	0.29	22.05	10754.4	0.15	72.5	0.02	31.09
6/15/2023	18B	4	1.8	Pokegama Lake	40.82	59.18	0.24	5.80	9.58	20.41	1.92	18.50	7.80	4.10	2.00	0.20	25.51	8348.9	0.14	30.9	0.02	19.69
6/15/2023	19A	1	1	Pokegama Lake	18.29	81.71	0.36	5.50	5.80	29.82	1.42	28.40	2.80	0.70	3.50	0.68	15.36	4017.3	0.10	68.4	0.02	30.84
6/15/2023	19B	4	1.7	Pokegama Lake	18.38	81.62	0.28	5.40	8.25	23.16	0.92	22.20	2.80	0.70	3.70	0.69	22.35	4773.1	0.13	85.0	0.03	35.32
6/15/2023	20A	1	0.4	Pokegama Lake	10.51	89.49	0.13	6.20	1.96	10.41	0.75	9.70	1.40	1.60	2.30	0.49	67.68	12775.5	0.32	99.3	0.02	101.13
6/15/2023	20B	4	0.4	Pokegama Lake	29.04	70.96	0.12	6.10	6.46	9.91	1.17	8.70	2.20	2.00	1.50	0.28	22.50	5452.1	0.17	39.1	0.01	41.56
6/15/2023	21A	1	1	Pokegama Lake	19.30	80.70	0.12	5.50	2.93	9.66	0.75	8.90	1.10	1.00	2.70	0.20	20.07	6392.2	0.11	48.1	0.01	26.20
6/15/2023	21B	4	1.2	Pokegama Lake	71.84	28.16	0.03	6.20	4.82	2.83	0.42	2.40	4.10	2.90	1.20	0.16	4.57	4732.4	0.11	39.4	0.01	19.20
6/19/2023	22A	1	1	Pokegama Lake	6.45	93.55	0.08	6.40	2.93	6.41	0.17	6.20	1.60	0.90	2.30	0.50	114.13	18262.8	0.30	207.4	0.02	114.38
6/19/2023	22B	4	3.8	Pokegama Lake	66.04	33.96	0.03	6.40	1.27	2.92	0.08	2.80	1.30	1.30	1.10	0.13	3.17	2444.2	0.07	25.7	0.01	10.79
6/19/2023	23A	1	0.4	Lake Chetek	53.00	47.00	0.13	6.50	1.40	11.25	0.50	10.70	9.10	1.60	2.20	0.32	9.00	40505.7	0.13	353.8	0.01	15.95
6/19/2023	23B	4	0.4	Lake Chetek	71.30	28.70	0.05	6.70	8.51	4.58	0.08	4.50	5.40	1.40	1.20	0.17	4.17	14715.5	0.10	113.6	0.01	16.62
6/19/2023	24A	1	1	Lake Chetek	10.80	89.20	0.15	6.50	1.59	12.58	0.58	12.00	7.40	0.90	2.00	0.73	25.34	56978.4	0.31	795.6	0.01	96.81
6/19/2023	24B	4	2.9	Lake Chetek	13.12	86.88	0.15	6.50	2.35	12.50	0.58	11.90	8.00	1.10	2.30	0.68	27.35	49484.1	0.30	751.0	0.02	102.72
6/19/2023	25A	1	1	Lake Chetek	40.72	59.28	0.10	6.70	1.76	8.08	0.50	7.60	9.30	1.60	2.40	0.35	9.75	21393.9	0.19	753.5	0.02	38.18
6/19/2023	25B	4	1.2	Lake Chetek	57.21	42.79	0.02	7.00	3.62	1.75	0.08	1.70	19.70	1.10	0.50	0.20	3.78	27325.1	0.12	1665.3	0.01	20.06
6/19/2023	26A	1	0	Lake Chetek	65.36	34.64	0.06	6.20	4.71	5.08	0.08	5.00	3.70	1.30	0.50	0.14	8.35	6468.0	0.12	78.0	0.01	17.34
6/19/2023	27A	1	1	Lake Chetek	10.89	89.11	0.16	6.00	1.31	13.00	0.50	12.50	1.50	0.80	3.20	0.76	36.72	13546.2	0.23	222.0	0.02	69.70
6/19/2023	27B	4	1.3	Lake Chetek	7.99	92.01	0.17	6.20	8.17	14.41	0.08	14.30	1.10	0.20	1.40	1.40	13.81	7459.4	0.18	192.2	0.01	9.45
6/19/2023	28A	1	1	Tenmile Lake	12.46	87.54	0.24	6.40	1.06	20.33	0.50	19.80	3.60	0.40	3.90	1.07	24.82	18588.2	0.17	447.5	0.02	61.98
6/19/2023	28B	4	1.2	Tenmile Lake	31.88	68.12	0.17	6.10	7.35	14.16	0.17	14.00	1.20	0.30	2.10	0.30	6.65	3273.1	0.09	88.7	0.01	13.19
6/19/2023	29A	1	0.9	Tenmile Lake	14.08	85.92	0.34	6.10	9.45	28.41	0.75	27.70	3.50	0.30	3.20	0.78	20.28	9155.2	0.13	342.7	0.01	12.67
6/19/2023	29B	4	0.9	Tenmile Lake	11.13	88.87	0.23	6.30	2.09	19.33	0.58	18.70	4.90	0.30	3.60	0.86	16.65	22182.9	0.14	1244.2	0.02	52.37
6/19/2023	30A	1	0.7	Tenmile Lake	40.96	59.04	0.11	7.10	1.75	8.83	0.08	8.80	2.30	0.80	3.10	0.33	6.68	3098.4	0.11	57.1	0.01	19.41

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