

Memorandum

From: Hans Holmberg and Jon Hilsendager **Date:** June 06, 2023
To: Jim Coors, COLA **Project:** LCO
 Dan Tyrolt, LCOCD **CC:**

SUBJECT: WisCALM Assessment Update for Lac Courte Oreilles, Data through 2022

Background

The surface water quality of Lac Courte Oreilles (LCO) was assessed using the Wisconsin Department of Natural Resources (DNR) Consolidated Assessment and Listing Methodology (WisCALM 2024).

LCO is classified as a two-story fishery lake with both Fish and Aquatic Life (FAL) and recreational (REC) use designations. LCO must not exceed impairment thresholds for total phosphorus (TP) and chlorophyll *a*, as shown in Table 1. Additional biological indicator metrics include macrophyte growth, dissolved oxygen, and cold-water habitat quantity.

Table 1: Two-story fishery criteria and thresholds currently applicable to LCO

Criteria for two-story fishery lake	Threshold	Relevant Sampling Locations
FAL TP	≥15 µg/L	LCO 2, LCO 3, LCO 4
REC TP	≥15 µg/L	
FAL chlorophyll <i>a</i>	≥8 µg/L	
REC chlorophyll <i>a</i>	≥5% of days with ≥20 µg/L	

Musky Bay, while hydrologically connected to the Major Basins of LCO (LCO 2, LCO 3, and LCO 4), is classified by the DNR as a shallow lake with both Fish and Aquatic Life (FAL) and recreational (REC) use designations. Musky Bay must not exceed impairment thresholds for total phosphorus (TP) and chlorophyll *a*, as shown in Table 2.

Table 2: Shallow-lake criteria and thresholds currently applicable to Musky Bay

Criteria for shallow lakes	Threshold	Relevant Sampling Locations
FAL TP	≥40 µg/L	MB 1
REC TP	≥40 µg/L	
FAL chlorophyll <i>a</i>	≥27 µg/L	
REC chlorophyll <i>a</i>	≥30% of days with ≥20 µg/L	

The lake and its Major Basins and bays are shown in Figure 1.

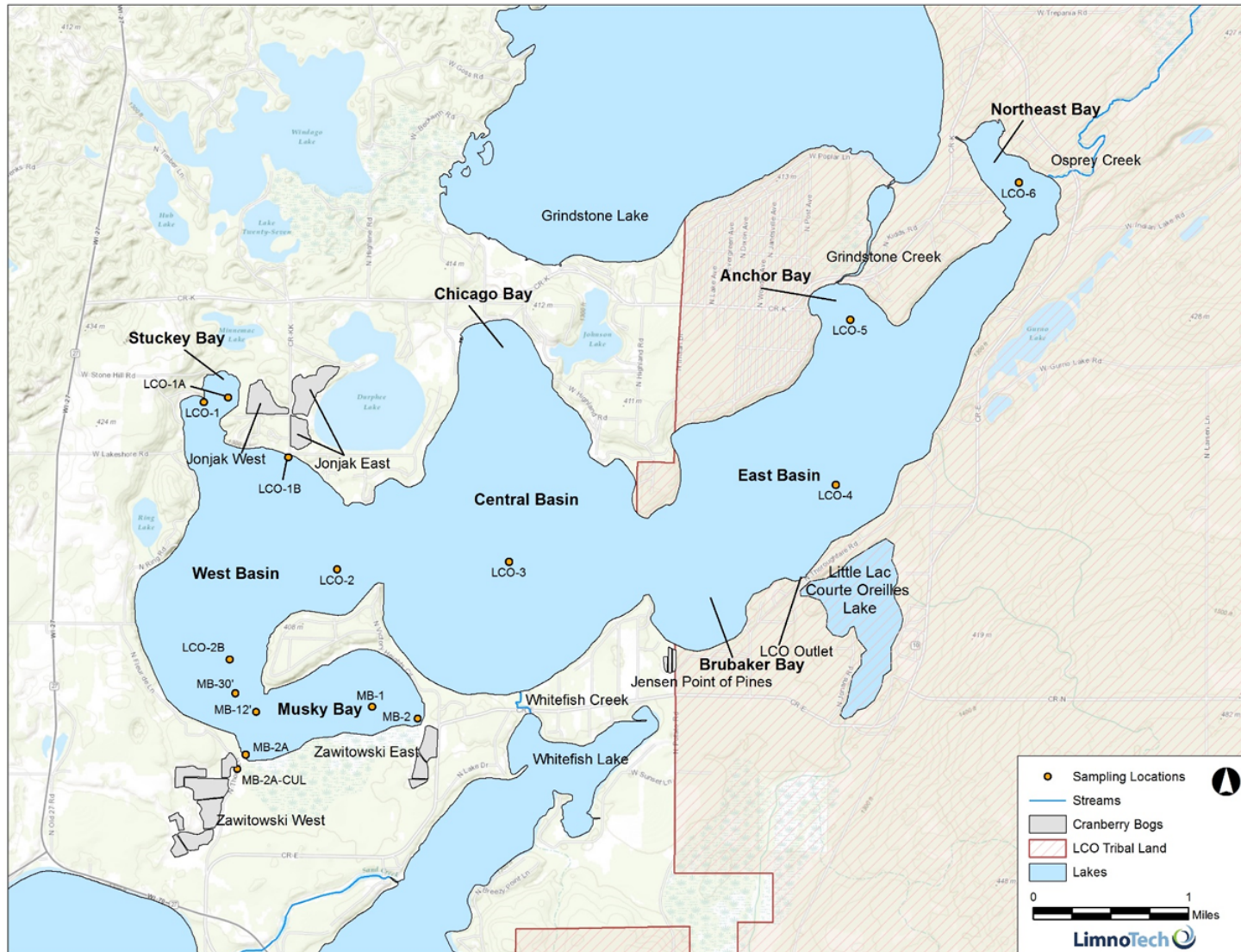


Figure 1: LCO map showing major basins and bays, sampling stations, and cranberry bog locations.

Compiled LCO Data

There are eight LCO locations that are sampled routinely throughout the ice-off season by the LCO Conservation Department (LCOCD). These locations are presented in Table 3 and Figure 1. During the most recent five years, between 2018 and 2022, samples were collected weekly or biweekly at these locations. Analysis of surficial TP and surficial chlorophyll *a* were made on each sample collected.

Table 3: LCO Sampling Characteristics (2018-2022)

Location Name	Station Code	Sampling Frequency	# of TP Samples ¹	# of Chlorophyll <i>a</i> Samples ²	# of Qualifying Years
Musky Bay	MB 1	weekly-biweekly	39	23	5
Stuckey Bay	LCO 1	weekly-biweekly	39	22	5
West Basin near Musky Bay	LCO 2B	weekly-biweekly	40	20	5
West Basin	LCO 2	weekly-biweekly	33	22	5
Central Basin	LCO 3	weekly-biweekly	34	22	5
East Basin	LCO 4	weekly-biweekly	39	22	5
Anchor Bay	LCO 5	weekly-biweekly	38	22	5
Northeast Bay	LCO 6	weekly-biweekly	38	22	5
		Total	300	175	-

¹ samples only counted during assessment period of June 1st – September 15th

² samples only counted during assessment period of July 15th – September 15th

TP Assessment

Fish and Aquatic Life and Recreational Usage

WisCALM assessment: The TP impairment threshold for two-story fishery lakes in Wisconsin is 15 µg/L for the fish and aquatic life (FAL) and recreational (REC) use designations. Similarly, the TP impairment threshold for shallow lakes is 40 µg/L. WisCALM states that if the lower bound of the 80% two-sided confidence interval of the mean concentration between June 1st and September 15th exceeds this threshold, there is an exceedance; and if it exceeds 1.5 times the threshold there is an overwhelming exceedance.

Of the three main basins (LCO 2, LCO 3, and LCO 4), the West Basin (LCO 2) has a 2018-2022 mean of 15.6 µg/L with an upper confidence interval (16.7 µg/L) exceeding the 15 µg/L. However, since the lower confidence interval (14.6 µg/L) does not exceed the 15 µg/L standard, the West Basin is not considered to be “clearly exceeding the standard”. The Central (LCO 3) and East (LCO 4) Basins both have a 2018-2022 mean below 15 µg/L. See Figure 3 for mean concentrations and confidence limits.

Additional analyses: Although WisCALM compares only the deep spots of the three main basins to the criteria, COLA also finds it informative to evaluate the bay concentrations and to calculate an area-weighted lake-wide average that includes both basins and bays. The average TP concentration in Musky Bay over the 2018-2022 period (26.0µg/L) did not exceed the shallow lake TP criterion (40 µg/L). See Figure 3 for mean concentrations and confidence limits for the other individual locations.

The area-weighted lake-wide average during the 2018-2022 period was 14.9 µg/L, a 2.0% decrease as compared to the 2017-2021 period of 15.2 µg/L, a 3.5% increase over the 2016-2020 average of 14.4 µg/L, and a 5% increase over the 2015-2019 average of 14.2 µg/L.

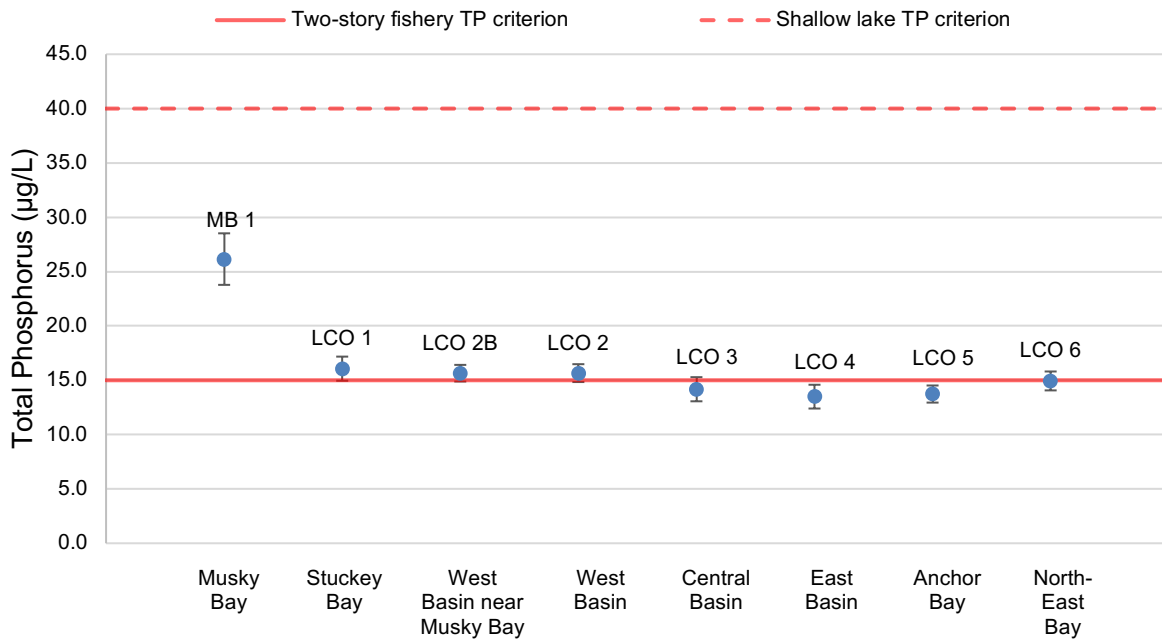


Figure 3: Mean TP concentrations in LCO, 2018-2022 Error bars represent 80% confidence interval of arithmetic mean.

The recreational season mean total phosphorus concentrations for the Major Basins and Musky Bay were analyzed for temporal trends from 2002 to 2022. The Mann-Kendall Test was used to identify statistically significant trends. There was no lake-wide statistically significant trend. Statistically significant temporal trends ($p < 0.05$) were identified at the major basins (increasing TP, $p = 0.02$) and Musky Bay (decreasing TP, $p = 0.006$) using the annual area-weighted average concentration across the recreation season. Averages for this long term trend assessment were computed on the total recreation season dataset whereas the averages presented in the previous sections are summarized first at the monthly level then at the yearly level. Significant trends are shown in Figure 4.

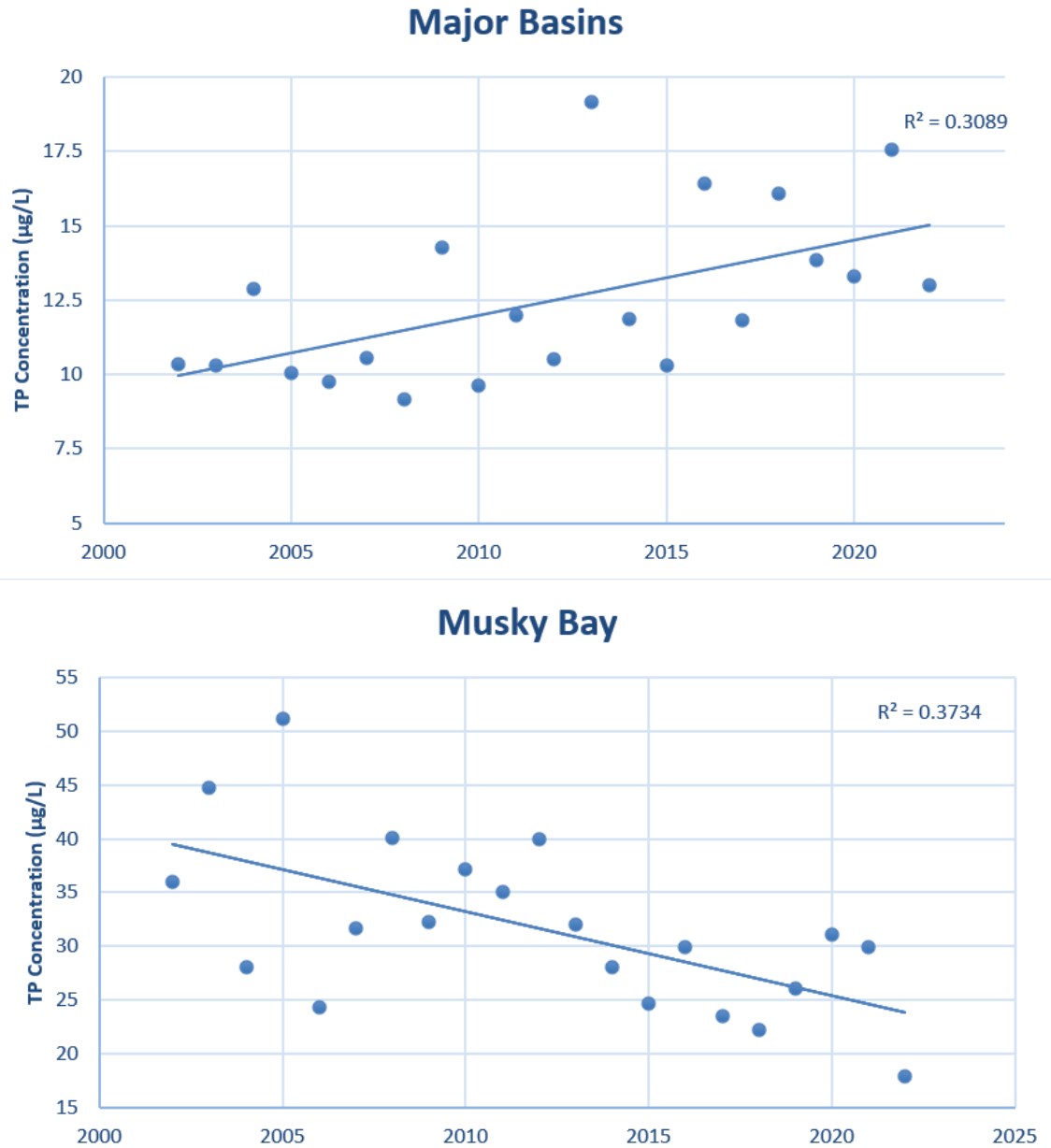


Figure 4. Statistically significant trends in recreational season mean total phosphorus concentration in LCO and Musky Bay.

The area-weighted lake-wide average (including minor basins) total phosphorus concentration in 2022 (13.3 µg/L) was 11% lower than the overall weighted average during the entire 2018-2022 assessment period (14.9 µg/L). The station specific concentrations in CY 2022 are consistently lower when comparing data from the past 3 to 5 years (Figure 5).

Musky Bay average concentrations did not exceed the shallow lake criterion (40 µg/L) in 2022. An increasing trend in Musky Bay total phosphorus concentration was previously observed in the most recent years of data; however, this no longer holds true. Musky Bay total phosphorus concentrations have been decreasing over recent years which is consistent with the long term trend of the lake. All Major Basin sampling locations had average total phosphorus

concentrations below the current two-story fishery criterion (15 µg/L) in 2022 (Figure 5) and are the lowest yearly average levels recorded in the past 5 years.

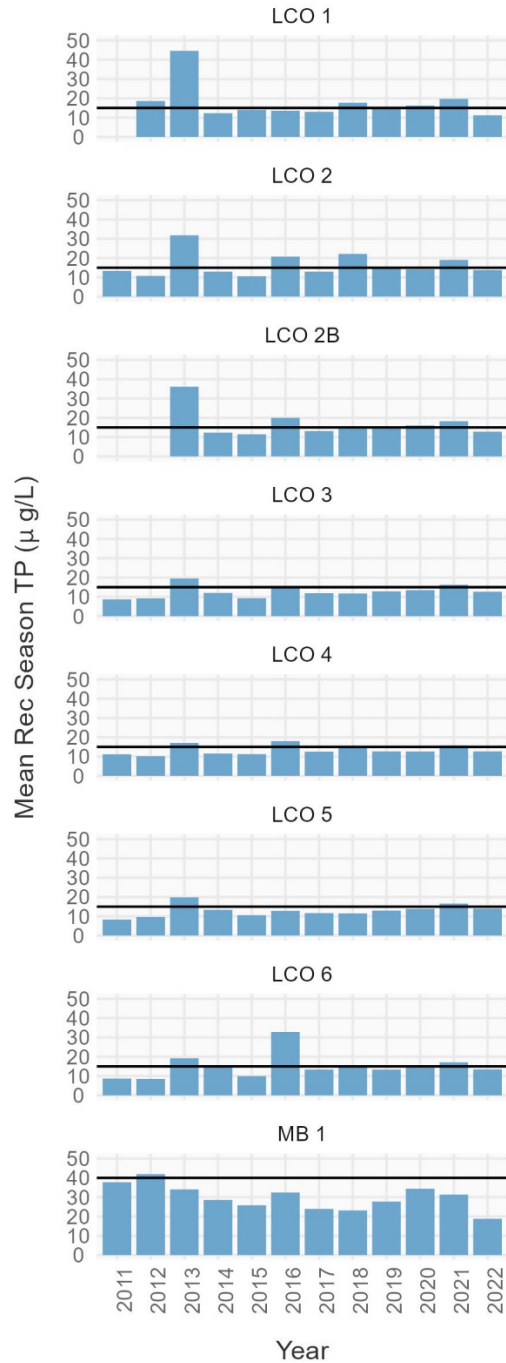


Figure 5: Annual arithmetic average TP concentrations for identification of non-compliance with applicable standards, 2011-2022. Applicable standards are shown in black lines.

Chlorophyll *a* Assessment

Fish and Aquatic Life

The 2024 WisCALM updates the chlorophyll *a* impairment threshold for two-story fishery lakes in Wisconsin to 8 µg/L for the FAL use designations. The impairment threshold for shallow lakes (that is applied to Musky Bay) remains at 27 µg/L. WisCALM states that if the lower bound of the 80% two-sided confidence interval of the mean concentration between July 15th and September 15th exceeds this threshold, there is an impairment.

The available chlorophyll *a* data do not demonstrate an impairment at LCO sampling locations using the WisCALM thresholds for fish and aquatic life use. The concentrations of the three main basins clearly meet the criteria of 8 µg/L, and Musky Bay clearly meets the criterion of 27 µg/L (Figure 6). Other bays sampled also show low chlorophyll *a* concentrations.

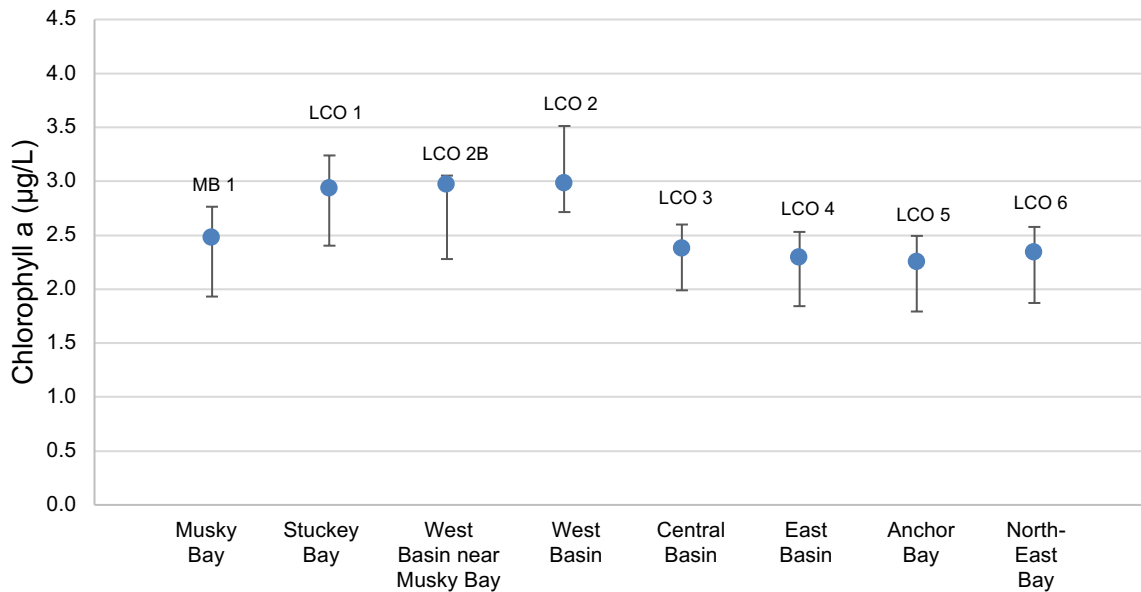


Figure 6: Mean chlorophyll *a* concentrations in LCO, 2018-2022. Error bars represent 80% two-sided confidence interval of the grand mean.

Recreational Usage

The chlorophyll *a* impairment threshold for two-story fishery lakes in Wisconsin is no more than 5% of days with “nuisance algal blooms.” The impairment threshold for shallow lakes (which applies to Musky Bay) is no more than 30% days with “nuisance algal blooms.” WisCALM states that “nuisance algal blooms” are defined as days exceeding 20 µg/L chlorophyll *a* during the period between July 15th and September 15th. If more than 5% of days exceed this criterion, the waterbody is impaired.

During this assessment period (2018-2022), there were no observed chlorophyll *a* concentrations greater than 20 µg/L.

Dissolved Oxygen and Cold-Water Habitat

Cisco, lake whitefish and other cold-water fishes need a band of water that has both cold enough temperatures and high enough oxygen for them to survive. Therefore, measures that represent the presence and overall quantity of suitable habitat by combining both dissolved oxygen (DO) and temperature are needed for assessing support of the two-story fishery.

Habitat Quantity

An assessment of LCO temperature and DO profile data was performed to evaluate the habitat quantity available for cisco and lake whitefish in LCO. The critical habitat, or the minimum habitat quantity over the course of a year, was quantified for the years 2018-2022. Suitable habitat was quantified as the depth being maintained above a DO concentration of 6 mg/L and below a temperature of 66°F to support sustainable cisco and lake whitefish populations in LCO. Available temperature and DO profiles were assessed at the three sampling locations in the Major Basins: LCO 2 in the West Basin; LCO 3 in the Central Basin; and LCO 4 in the East Basin. For the years 2018-2022, a desirable habitat was completely eliminated in each year indicating the absence of a suitable season-long habitat for cold-water species.

Suitable habitat for whitefish was absent from the Major Basins on at least one profiling day in each of the last five years. The duration of stress, or suboptimal habitat, was also assessed at each location. The duration helps quantify the amount of stress that a certain species may face in a given year due to habitat depletion.

It was likely that no suitable habitat for whitefish existed for at least 68-84 days between late June to mid-September (2022) in any of the Major Basins. These durations are assessed as minimums based on the available profiling frequency. Suitable habitat was measured on June 27 in both the East Basin (LCO 4) and West Basin (LCO 2).

Conclusions

The update of the WisCALM assessment for LCO, using data for the most recent five years (2018-2022), continues to confirm impairment of the two-story cold-water fishery habitat for cisco and lake whitefish. The measures of the minimum oxythermal habitat band demonstrate the impairment of this designated use.

TP and chlorophyll *a* do not exceed WisCALM thresholds for impairment using the existing water quality criteria DNR applies to LCO, however a statistically significant increasing trend in total phosphorus concentration was identified at the major basins suggesting a degradation in water quality.

This update demonstrates that conclusions from previous assessments remain the same, as listed below.

- Continued data collection in LCO is critically important;
- Understanding and addressing the drivers of the impaired oxythermal habitat for cisco and lake whitefish is high priority. The habitat for cold-water species has been found to be insufficient (< 1 m) every year since at least 2013;
- The 2024 WisCALM methodology now includes assessment protocols for oxythermal habitat in two-story lakes. A two story fishery must maintain an oxythermal layer of at

least 1m in thickness which meets both dissolved oxygen concentration greater than 6 mg/L and temperature requirements as determined by the cold water species present. With both Cisco and Whitefish present, the upper temperature limit must remain below 66°F.

- Results of TP and Chlorophyll *a* sampling and analysis generally indicate higher levels in the western end of LCO. This includes the West Basin and both Musky Bay and Stuckey Bay. Cranberry bogs discharge to Musky Bay and Stuckey Bay;
- The 2024 WisCALM requires the Lower Confidence Level (LCL) of the TP data to exceed the applicable criterion to list phosphorus as the cause of impairment. The calculation of the LCL for 2018-2022 data indicates that none of LCLs for the major basin monitoring stations exceed the currently applicable criterion of 15 µg/L. In the case of implementation of a site-specific criterion of 10 µg/L TP for LCO, which COLA, the LCO Tribe, and the DNR have proposed, the LCL for LCO 2, LCO 3, and LCO 4 exceed 10 µg/L. Therefore, DNR would list LCO as impaired for TP.
- A site-specific TP criterion protective of the two-story cold-water fishery in LCO is needed.

Consistent with last year's assessment, LimnoTech recommends an updated survey of overall fish community structure in Lac Courte Oreilles take place. Methods could follow DNR fyke and electrofishing protocols, as previously conducted. The goals of the survey should consider characterizing and evaluating:

1. Cold-water community abundance and richness
2. Overall fish community abundance and richness
3. Age distribution of existing cold-water populations
4. Cold-water species movements during periods of oxythermal stress

Routine data collection demonstrates that there are insufficient oxythermal conditions for cold-water species, but little is known about the status of the cold-water species populations. No fish kills have been reported in the past several years, however, there are not enough data to describe how the fish populations are responding to impaired conditions.

The 2012 DNR fyke netting and creel surveys noted a pike fyke net capture rate of 8 per net-night indicating a population "greater than desired".¹ This high population is affirmed by the most recent (2016) fyke netting and creel surveys which reported a pike catch rate of 35 per net-night.² These reports suggest possible food web pressure on the fish community, but community structure assessments have not been reported since 2016. The current status of the fish community is uncertain.

¹ <https://dnr.wi.gov/topic/fishing/documents/north/2012LacCourtOreillesSawyerFykeNet.pdf>

² <https://dnr.wi.gov/topic/fishing/documents/north/SawyerLCOSN12016.pdf>