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Memorandum

From: Hans Holmberg and Ben Crary
Date: February 12, 2019
Project: LCO
To: Gary Pulford, COLA
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CC:

SUBJECT: **WisCALM Assessment Update for Lac Courte Oreilles, Data through 2018**

Background

The WisCALM assessment for Lac Courte Oreilles (LCO) was updated using data through 2018. The Wisconsin Department of Natural Resources (DNR) does not conduct an official WisCALM assessment in 2019; therefore, this assessment is for information purposes only. The assessment should be updated again using data through 2019 for the DNR's next scheduled WisCALM update in 2020.

LCO is classified as a two-story fishery lake with both Fish and Aquatic Life (FAL) and recreational (REC) use designations, and 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 Lac Courte Oreilles

Criteria for two-story fishery lake	Threshold	Relevant Sampling Locations
FAL TP	≥15 µg/L	LCO1, LCO2, LCO2B, LCO3, LCO4, LCO5, LCO6
REC TP	≥15 µg/L	
FAL chlorophyll a	≥10 µg/L	
REC chlorophyll a	≥5% of days with ≥20 µg/L	

Musky Bay, while hydrologically connected to the main basins of LCO, is classified by the DNR as a shallow lake with both Fish and Aquatic Life (FAL) and recreational (REC) use designations, and 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 Lac Courte Oreilles

Criteria for shallow lakes	Threshold	Relevant Sampling Locations
FAL TP	≥40 µg/L	MB1
REC TP	≥40 µg/L	
FAL chlorophyll a	≥27 µg/L	
REC chlorophyll a	≥30% of days with ≥20 µg/L	

The lake and its major basins and bays are shown in Figure 1.

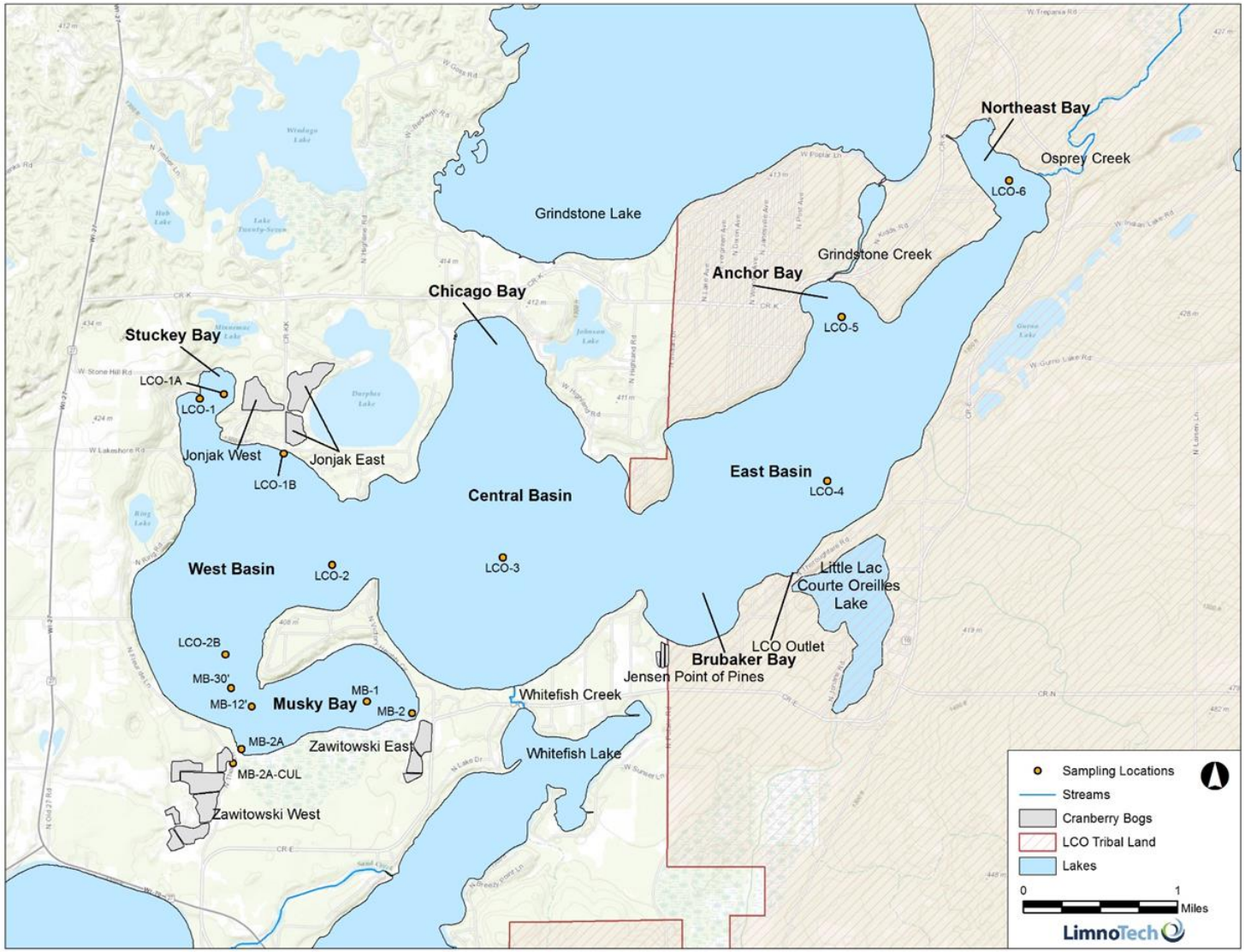

Figure 1: LCO map showing major basins and bays, sampling stations, and cranberry bog locations.

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 2014 and 2018, 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: Lac Courte Oreilles Sampling Characteristics (2014-2018)

Location Name	Station Code	Sampling frequency	# of TP samples[1]	# of Chl a samples[2]	# of Qualifying Years
Musky Bay	MB1	weekly-biweekly	61	32	5
Stuckey Bay	LCO1	weekly-biweekly	44	22	5
West Basin near Musky Bay	LCO2B	weekly-biweekly	41	21	5
West Basin	LCO2	weekly-biweekly	41	21	5
Central Basin	LCO3	weekly-biweekly	41	21	5
East Basin	LCO4	weekly-biweekly	41	21	5
Anchor Bay	LCO5	weekly-biweekly	40	21	5
Northeast Bay	LCO6	weekly-biweekly	40	21	5
		Total	349	180	-

[1] samples only counted over allowable range of June 1st – September 15th
[2] samples only counted over the allowable range of July 15th – September 15th

TP Assessment

Fish and Aquatic Life and Recreational Usage

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 90% 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.

These criteria have not been not been exceeded at any monitored location within Lac Courte Oreilles (Figure 3 and Table 4). Note, however, that average concentrations at MB 1 (Musky Bay), LCO 2 (West Basin) and LCO 6 (Northeast Bay) all exceed the 15 µg/L threshold.

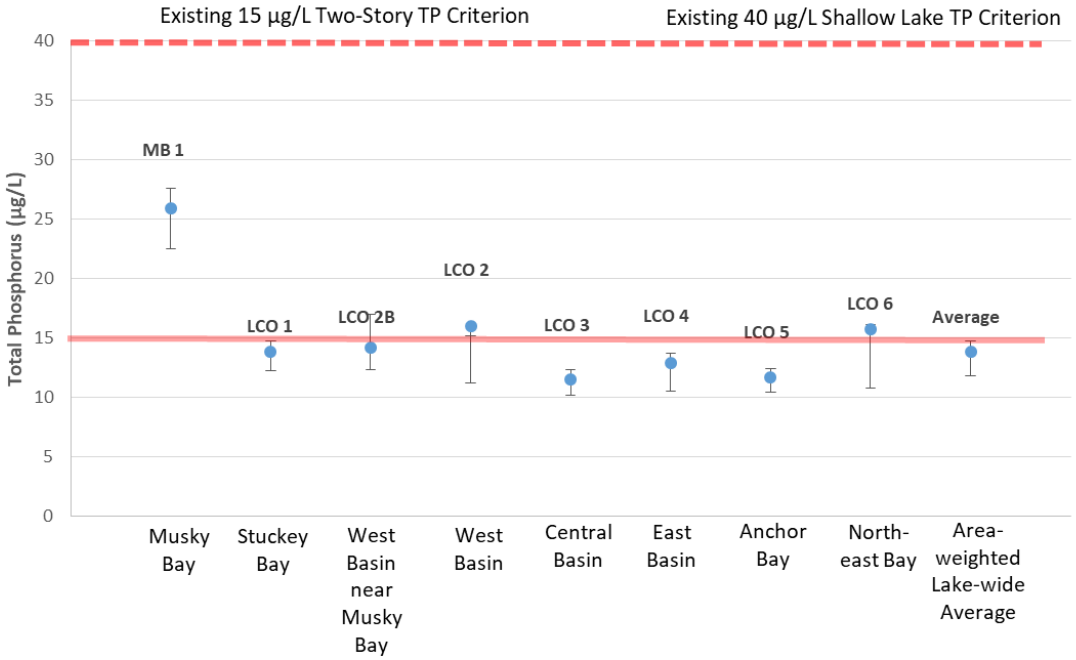

Figure 3: Mean TP concentrations in Lac Courte Oreilles, 2014-2018. Error bars represent 90% confidence interval of grand mean.

Table 4: Mean TP concentrations in Lac Courte Oreilles, 2014-2018 and 90% confidence interval of grand mean.

	2014-2018 Monthly Average Total Phosphorus (µg/L)								
	Musky Bay	Stuckey Bay	West Basin near Musky Bay	West Basin	Central Basin	East Basin	Anchor Bay	Northeast Bay	Area-weighted Lake-wide
Metric	MB 1	LCO 1	LCO 2B	LCO 2	LCO 3	LCO 4	LCO 5	LCO 6	Average
Average	25.9	13.8	14.2	16.0	11.5	12.9	11.7	15.7	13.8
Upper 90%	27.6	14.8	17.0	15.1	12.3	13.7	12.4	16.1	14.8
Lower 90%	22.5	12.2	12.3	11.2	10.1	10.5	10.5	10.8	11.8

Concentrations in 2018 were relatively high compared to the rest of the assessment period (Figure 4). In 5 of 6 sampling locations (excluding MB 1), average concentrations were within 1 µg/L of the two-story fishery rec season concentration standard. Despite the higher concentrations in 2018, the mean concentrations for this 5-year assessment period (2014-2018) were less than the previous period (2013-2017). This is because there were exceptionally high concentrations of TP measured in 2013 that are not included in this assessment period.

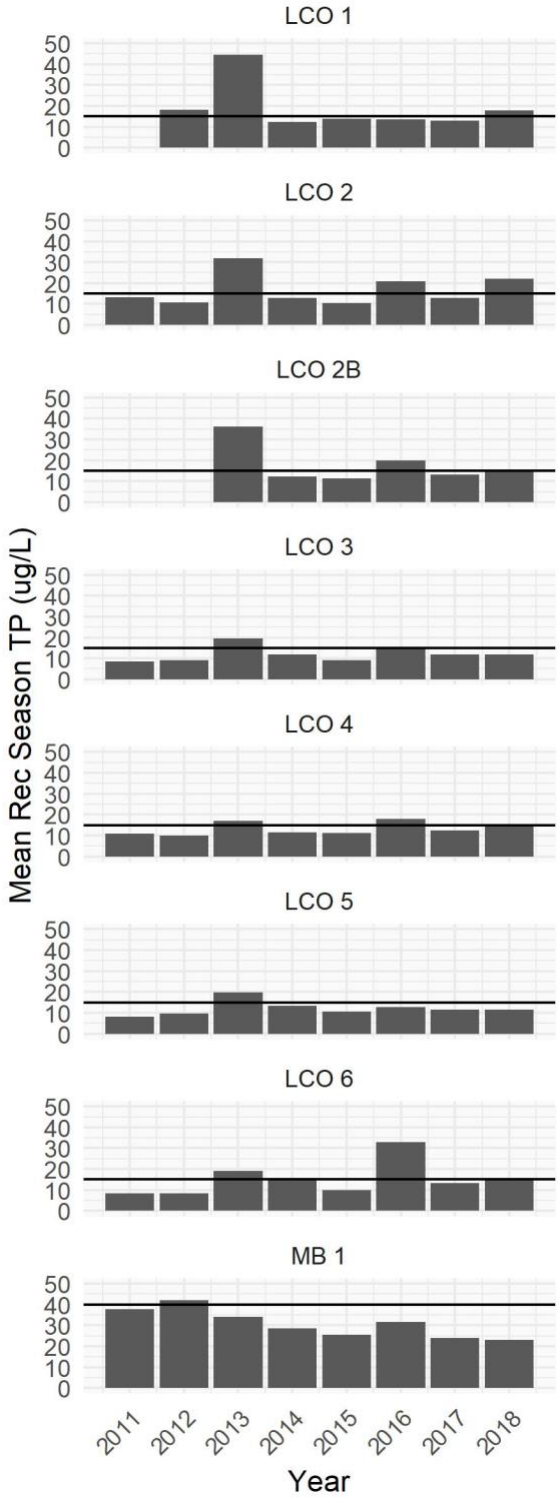

Figure 4: Annual TP concentrations over the assessment period. Applicable standards are shown in black lines.

Chlorophyll *a* Assessment

Fish and Aquatic Life

The chlorophyll a impairment threshold for two-story fishery lakes in Wisconsin is 10 µg/L for the FAL use designations. Similarly, the impairment threshold for shallow lakes is 27 µg/L. WisCALM states that if the lower bound of the 90% 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 at all sampling locations clearly meet the criteria of 10 µg/L and 27 µg/L (Figure 5).

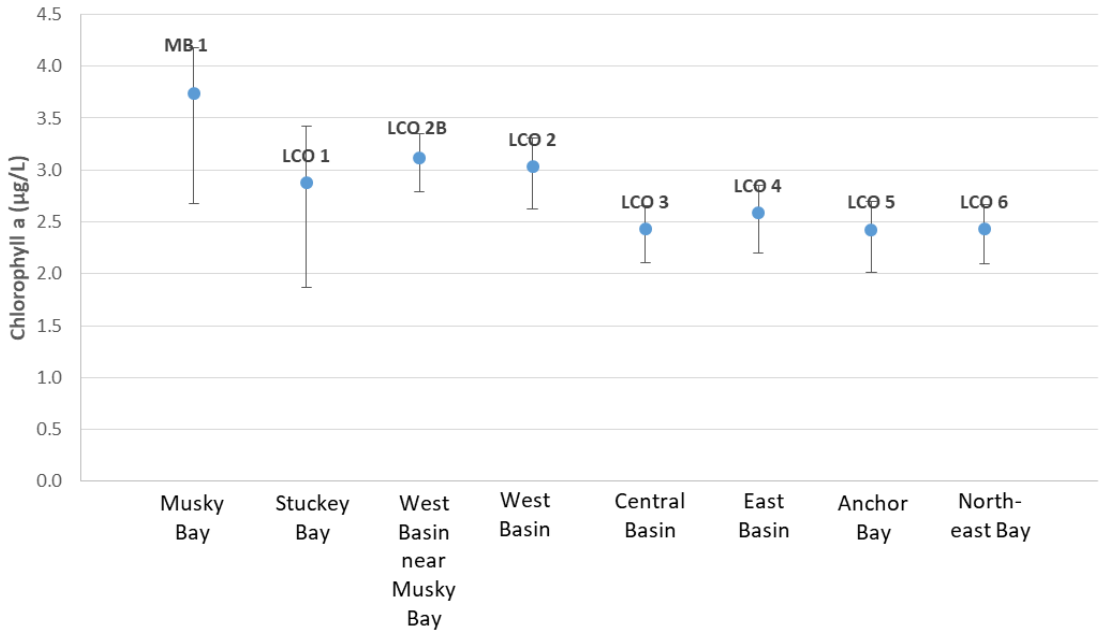

Figure 5: Mean chlorophyll a concentrations in Lac Courte Oreilles. Error bars represent 90% confidence interval of grand mean.

Recreational Usage

The chlorophyll a impairment threshold for two-story fishery lakes in Wisconsin is 5% of days with "nuisance algal blooms." The impairment threshold for shallow lakes is 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 criteria, the waterbody is impaired.

During this assessment period (2014-2018), 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 DO and temperature are needed for assessing support of the two-story fishery.

TDO5

TDO5 is one means of assessing the available cold-water habitat and is defined as a vertical measurement of the water temperature (T) at which the dissolved oxygen (DO) concentration is 5.0 mg/L. An appropriate maximum temperature to support the cisco and lake whitefish in LCO is 66°F. An evaluation of available temperature and dissolved oxygen profile data at the main basin sampling stations in LCO was conducted to determine the maximum TDO5 each year. The results are presented in Table 5. The analysis illustrates that LCO did not maintain a TDO5 of 66°F or less during any year of this assessment at LCO 2 (West Basin) and LCO 3 (Central Basin), and in 4 of 5 years at LCO 4 (East Basin). This assessment confirms that LCO is not protective of cold-water species due to DO impairments.

Table 5: TDO5 at main basin stations

Year	Station and Max TDO (°F)		
	LCO2	LCO3	LCO4
2014	67.2	67.0	64.0
2015	68.5	67.3	67.4
2016	73.5	73.5	73.6
2017	67.7	67.4	67.4
2018	69.3	67.7	67.6

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. Specially, the critical habitat, or the minimum habitat quantity over the course of a year, was quantified for the years 2014-2018. 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. This metric is consistent with the recent rules in development by DNR for protection of two-story cold-water fisheries with cisco and lake whitefish. The public participation process for these rules is expected to begin in spring of 2019 ahead of promulgation. Available temperature and DO profiles were assessed at the three sampling locations in the main basins: LCO 2 in the West Basin; LCO 3 in the Central Basin; and LCO 4 in the East Basin (Figure 1). The results are presented in Table 6.

Table 6: Critical habitat quantity available to cold-water species at 66° F and 6 mg/L dissolved oxygen.

Location		Minimum Habitat Band (m)				
		2014	2015	2016	2017	2018
West Basin	LCO2	0	0	0	0	0
Central Basin	LCO3	0	0	0	0	0

East Basin	LCO4	0	0	0	0	0

Conclusions

The update of the WisCALM assessment for LCO, using data for the most recent five years (2104-2018), confirms 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 beneficial use.

While TP and Chl-a do not exceed WisCALM thresholds for impairment using the existing water quality criteria DNR applies to LCO, TP concentrations were elevated in 2018 and average TP concentrations in LCO exceed criteria in some portions of the lake.

This update demonstrates the following:

- 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; and
- A site-specific TP criterion protective of the two-story cold-water fishery in LCO is needed.