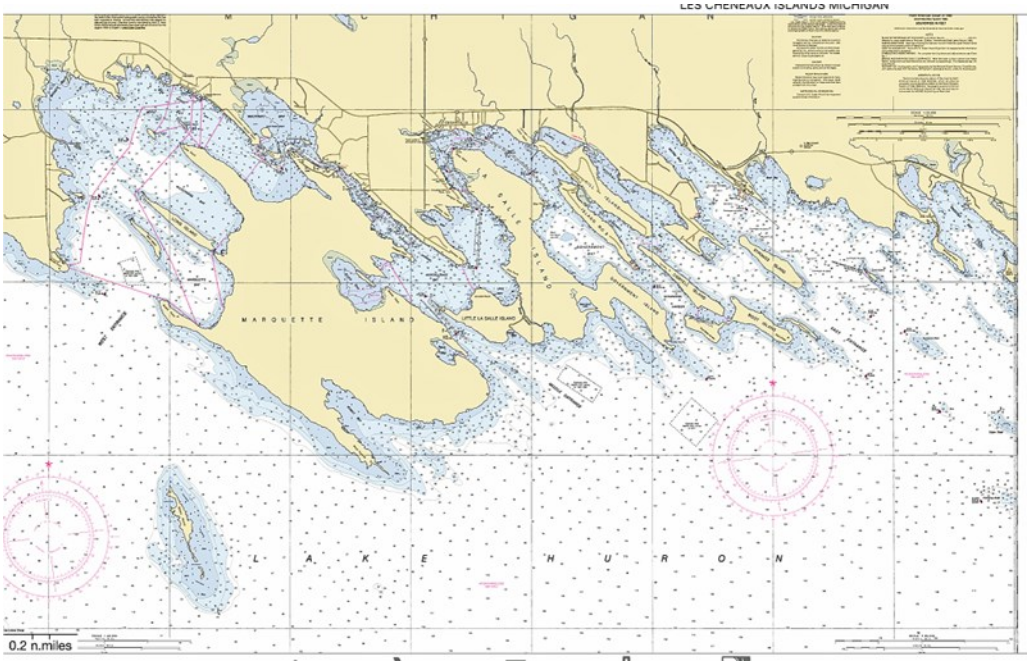


An Abridged Approach to Water Quality Sampling in the Les Cheneaux Islands

Les Cheneaux Watershed Council

R A Smith

December 2024

An Abridged Approach to Water Quality Sampling in the Les Cheneaux Islands.

ABSTRACT

Ensuring recreational water quality is a critical requirement for the tourist-based economy of the Les Cheneaux Islands. The Les Cheneaux Watershed Council has monitored nutrient levels and algal biomass in island channels during the past 22 years. This report summarizes data from an abridged monitoring method which provides a valid trophic assessment yet reduces time and effort to assign the water quality status of local waters. Results of the abridged procedure compare favorably with historic patterns of total phosphorus and chlorophyll-a concentrations. Based on findings herein, the amended water quality monitoring protocol can be recommended for continued use.

INTRODUCTION

Phosphorus and chlorophyll-a are used as primary water quality indicators for the Les Cheneaux Islands. Quantified levels of total phosphorus (TP) and chlorophyll-a (Chl-a) were assigned trophic values according to the Carlson Trophic State Index (1,2), a globally recognized measure of water quality. Trophic state refers to the ability of a water body to support aquatic life. The concept of trophic status is based on changes in nutrient levels (measured by total phosphorus) which influence changes in algal biomass (measured by chlorophyll-a) which, in turn, influence changes in lake clarity (measured by Secchi disk transparency). The Carlson Trophic State Index is a convenient way to quantify this relationship (3).

METHODS AND MATERIALS

Water samples were collected by a Superior Analytics (Lake Superior State University) technical team from a boat provided by Les Cheneaux Islands Association. Five collection sites were selected from multiple sites that have been historically monitored by the Les Cheneaux Watershed Council. Samples were collected on 11 Jul 2024 and subsequently analyzed for TP and for Chl-a using standard methods. Sample sites and raw data are presented in App A and App B.

RESULTS & DISCUSSION

Concentrations of TP and Chl-a have been monitored as Les Cheneaux water quality indicators for the past 22 years (2). Levels of both variables have been consistently rated as oligotrophic, a desirable low-nutrient range, during this period (Fig. 1).

Values recorded for these variables in 2024 are shown in Figs. 2 and 3 where quantified TP and Chl-a ratings were all within the oligotrophic or lower mesotrophic range. Historic seasonal mean values for ten different collection sites were also plotted for both variables in the same figures. The TP and Chl-a concentrations for 2024 water samples compared closely to the historic seasonal means.

Trophic ratings for individual collection sites have remained consistent over the years of monitoring (2). In 2024 it was decided to reduce the number of monthly collection events during a five month period to a single collection in July and to reduce the number of normally sampled collection sites to five (App A, Fig 4). Using historic data, July was selected as the single collection month to best capture maximum TP and Chl-a concentrations. Reducing the number of collections and the resulting assay effort has allowed time and cost savings to be allocated to other water-centric studies while continuing to monitor TP and Chl-A to obtain a valid trophic assessment of Les Cheneaux waters.

Although TP concentration varied among collection sites in 2024 as well as the previous three years, all TP values fell within the oligotrophic-to-lower mesotrophic range (Fig. 1, Fig. 2, App C). When compared to data from the previous three years the 2024 TP was highest at sites TS5 and TS6 during all four years except 2024 (App C). In 2024, except for TS4, TP levels at all other sites were similar.

A similar pattern was observed for Chl-a concentrations with TS5 and TS6 which exhibited higher Chl-a levels *vs* TS2 and TS9 sites which showed the lowest values during the past four years (Fig. 3, App D). The Chl-a upward excursion at TS6 in 2024 is likely due to the collection time coinciding with an algal bloom.

The 2022 Chl-a levels at all other sites were lower than during the other three years shown in App D. An exception was TS9 at which Chl-a concentrations are normally minimal. While several factors can influence algal growth and, therefore Chl-a values, one likely explanation is the uniformly lower water temperatures recorded for July of the 2022 season (App E). Lower water temperatures reduce algal metabolism which is reflected by lower Chl-a values. Mean seasonal temperatures for all collection sites were lower for 2022 as shown in App E.

The relationship of TP, Chl-a and temperature at all collection sites is shown in App F. Whereas varied temperature during the four years influenced Chl-a concentrations, there was no obvious effect on TP nor would such an effect be expected.

SUMMARY

Reduced sampling frequency and reduced number of collection sites has provided data in the same trophic range as historic findings for TP and for Chl-a. Reduced time and effort of this abridged approach to water quality monitoring allows research efforts to be allocated to new aquatic studies.

LITERATURE CITED

(1) Carlson, RE, 1977. A trophic state index for lakes. Limnology and Oceanography 22(2):361-369.
(2) Smith, RA. 2024. Les Cheneaux Islands Water Quality Report:2023. 10 Feb 2024.
(3) USEPA. 2006. www.epa.gov/bioiweb1/aquatic/carlson.html.

Acknowledgment: Thanks to LCIA representatives Mark Engle, Jim Keighley and Paul Tabor for discussions about project objectives and experimental design. Thanks to Jim Keighley for transporting the Superior Analytics team to the water collection sites.

Fig. 1. Historic trophic values for Total phos and Chl-a (µg/L, ppb) monitored at 10 sites. Solid red line indicates the range in Total phos and Chl-a recorded. Broken vertical red line indicates the historical mean values for both variables. Broken horizontal red line indicates the Oligotrophic range. <PP SLIDE FOR 2024 TSIDAT 10 DEC 24>

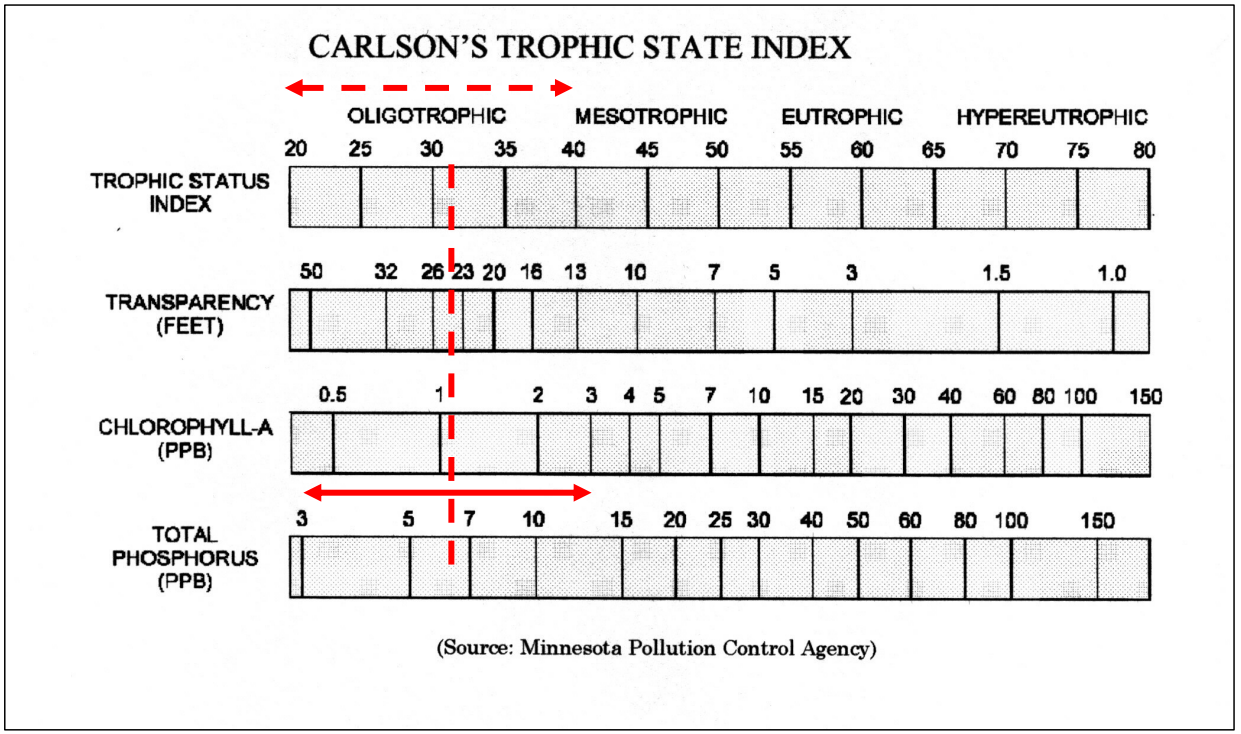


Fig. 1. Chl-a levels (µg/L, ppb) from Jul 2024 collection depicted by green dots. Orange dots represent historic seasonal means for each of the same collection sites. Green vertical bar indicates historic Chl-a means for all 10 collection sites < PP slides for 2024 TSIDAT 10 Dec 24 ED2C>

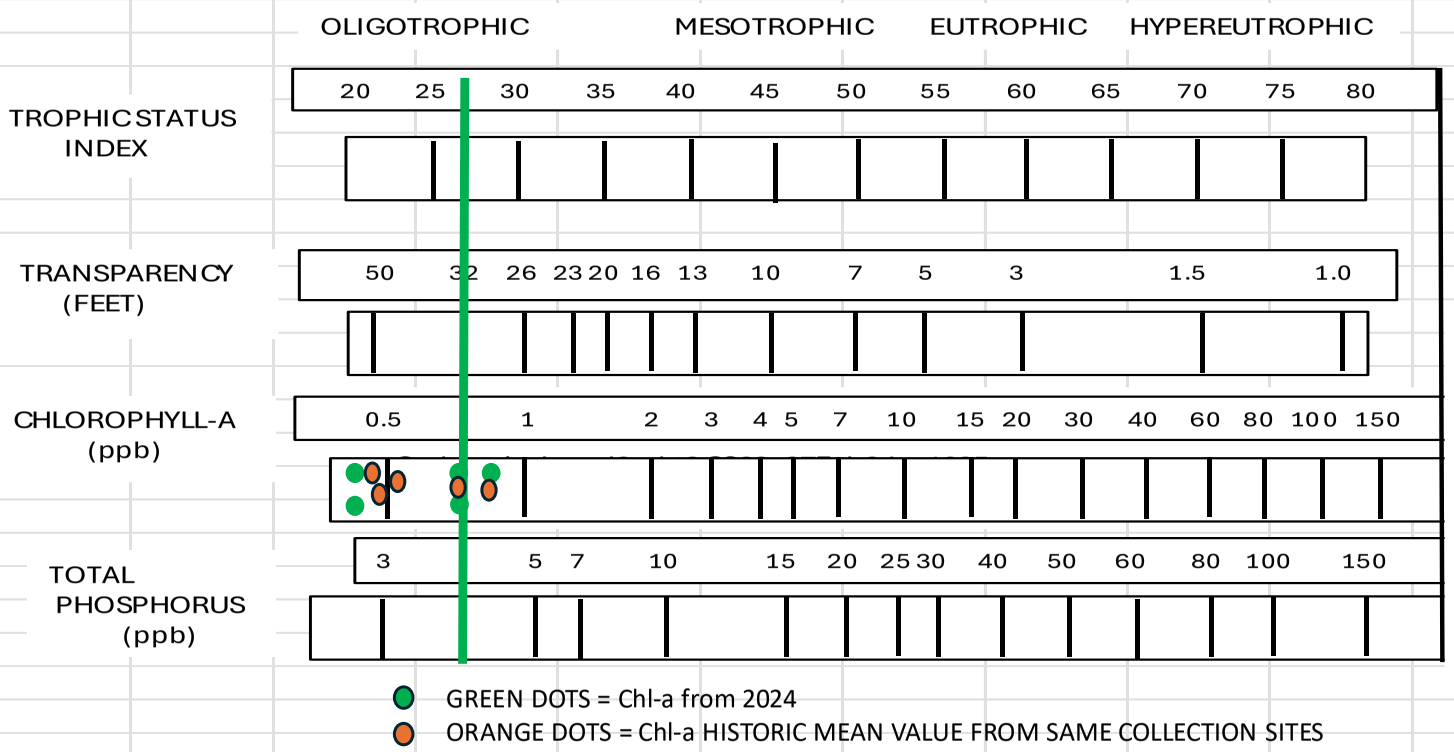
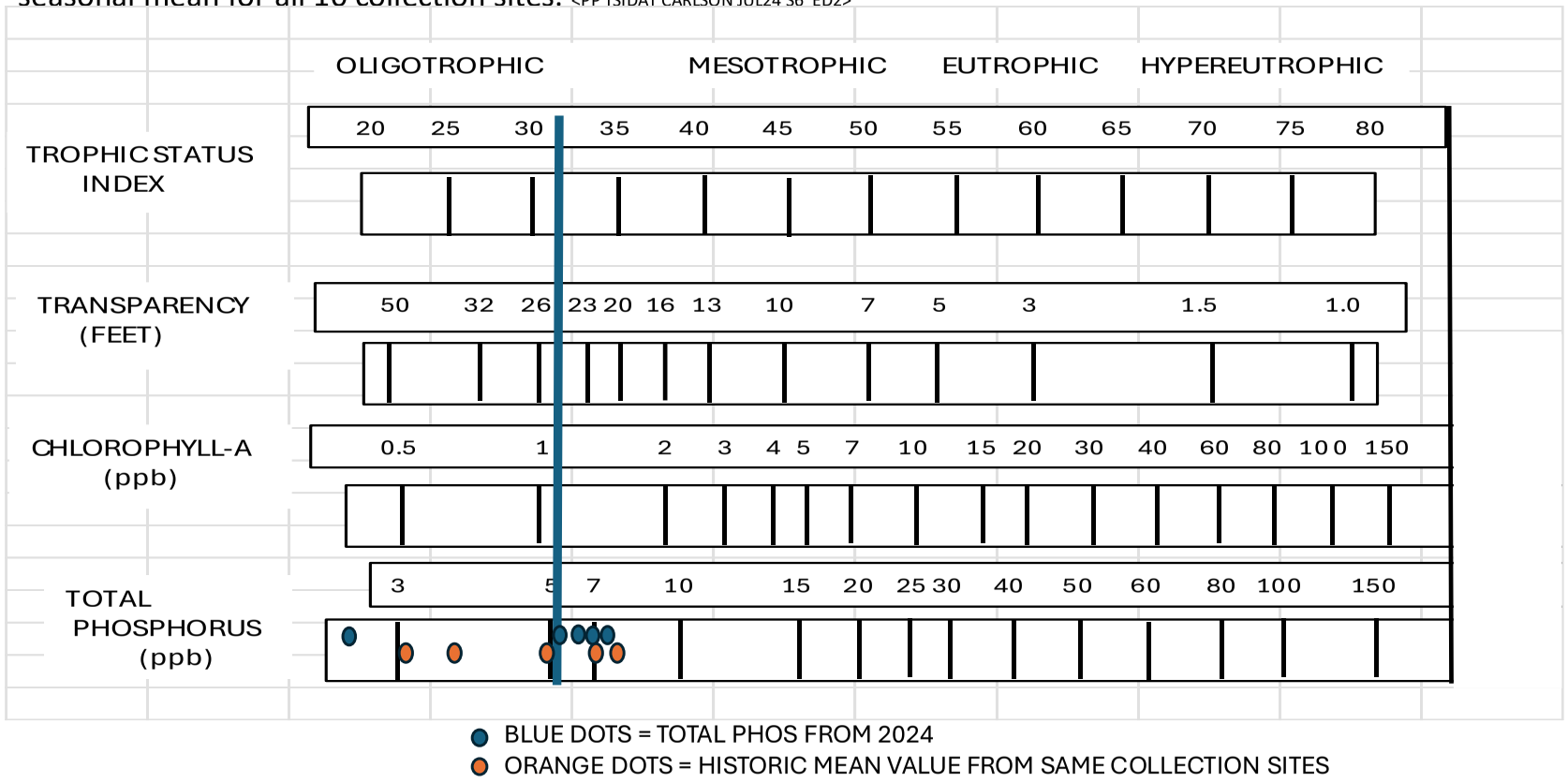
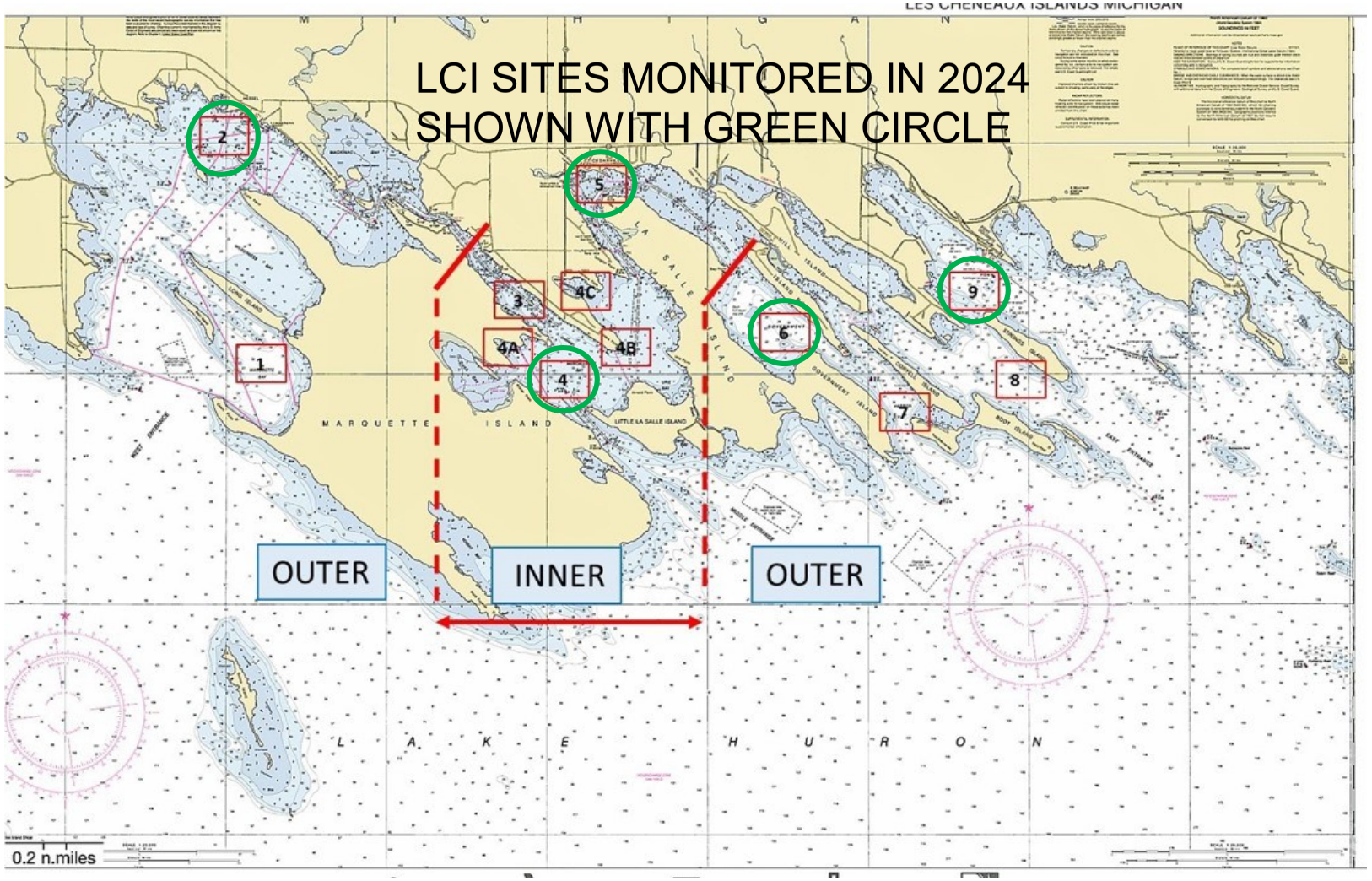


Fig. 2. Total phosphorus levels (µg/L, ppb) from Jul 2024 collection depicted as blue dots. Orange dots represent historic seasonal means for each of the same collection sites. Blue vertical bar is the historical seasonal mean for all 10 collection sites. <PP TSIDAT CARLSON JUL24 S6 ED2>



APPENDIX

APP A
Fig. 4


LCI SITES MONITORED IN 2024
SHOWN WITH GREEN CIRCLE
2
5
3
4C
4A
4B
4
1
9
6
8
7
MARQUETTE ISLAND
LITTLE LA SALLE ISLAND
OUTER
INNER
OUTER
L A K E H U R O N
0.2 n.miles

App B **TSI sample log** <TSI Sample Log 2024 Revised>

7/11/2024	TS-2	TS-4	TS-5	TS-6	TS-9
Latitude	N 46 00.013	N 45 58.101	N 45 59.699	N 45 58.396	N 45 58.599
Longitude	W 84 25.565	W 84 21.831	W 84 21.375	W 84 19.054	W 84 16.784
Depth	16	13	6	28	17
TIME	9:18	9:54	10:18	10:42	11:05
Sky condiftions	Clear	Clear	Clear	Clear	Clear
Wind Speed	0	0	0	1-2 mph	2 mph
& Direction					
Water Temp (F)	68	71	73	70	65
PHOS SAMP					
TAKEN					
SECCI					
Reading (ft)	16	13	6	26	12
CHL-A SAMP					
VOL FILTRD					

Sample sites and frequncy revised for 2024 reflecting learnings from past 20+ years of data and to reduce costs:

One sampling per year - mid-July (data history shows this as the peak)
TS2 location chosen because it is near public beach & a high summer public usage area
TS5 location chosen because it is near sewer system discharge & a high summer public usage area
TS9 location chosen because it is near the quarry docks & commercial shipping usage
TS4 & 6 location chosen because they are in high summer public usage areas

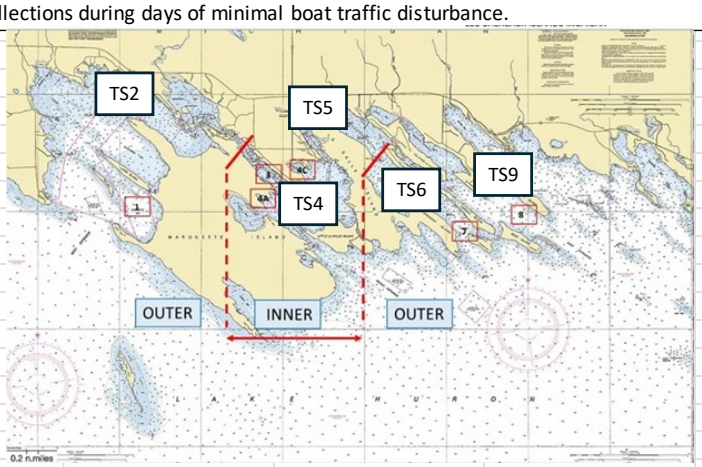
Samplers: Jim Keighley (LCIA), Bob Smith (LCIA), Nick Tilley (LSSU), and Ashley Render (LSSU)

Sampling Plan: LSSU to analyze for Total Phosphous, Chlorophyll-A, and PFAS/PFAS
5 sampling sites (TS2, 4, 5, 6, 9)
3 samples for TP, 3 samples for C and 3 samples for PFAS taken at each of the 5 sampling sites
Total number of samples = 45

1. Making an accurate Secchi disk reading requires fairly calm water. Try to schedule collections when the wind speed is lessthan 5-7 mph. Make reading from the shaded side of the boat.

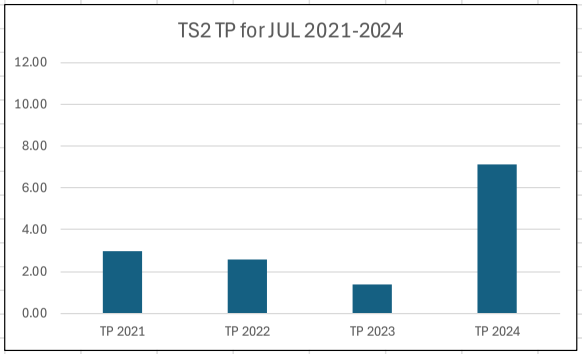
2. Visit collection sites close to the same time during each collection event. Depending on the species, many phytoplankton are diurnal, which results in their moving from the top to the bottom of the water column between day and night. Fluctuation in sampling differences can be minimized by sampling specific stations close to the same time during each sampling event.

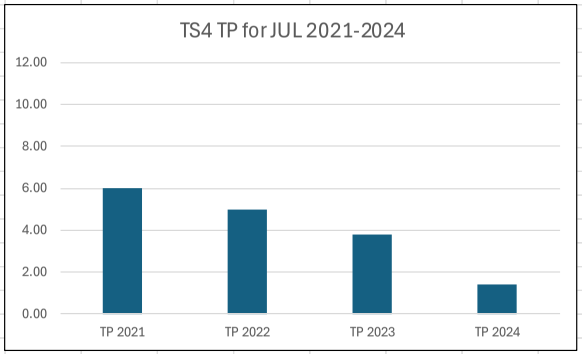
3. Time collections during days of minimal boat traffic disturbance.

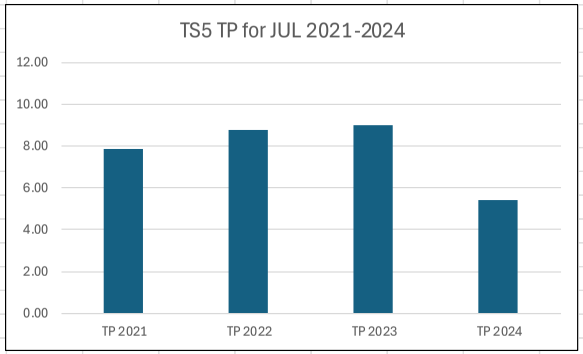


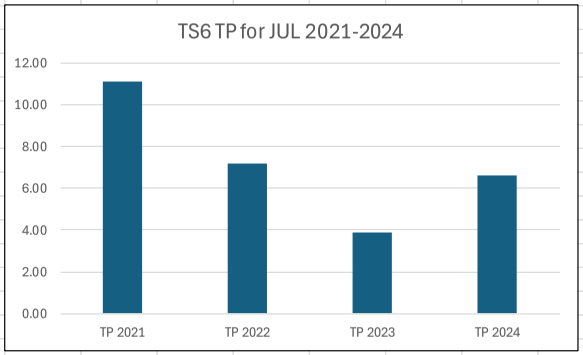
APP. C Relative Total Phosphorus concentration (µ/L , ppb) recorded in Jul 2024 vs Jul values for previous three years.

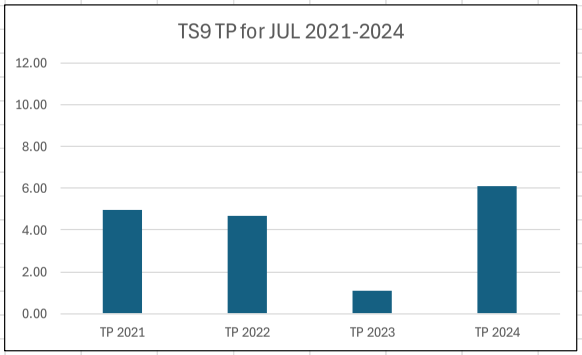
MULTI YR TSIDAT 6 DEC 24 ALL ON COMMON SCALE SHT1 DA90 / SHT2 F10







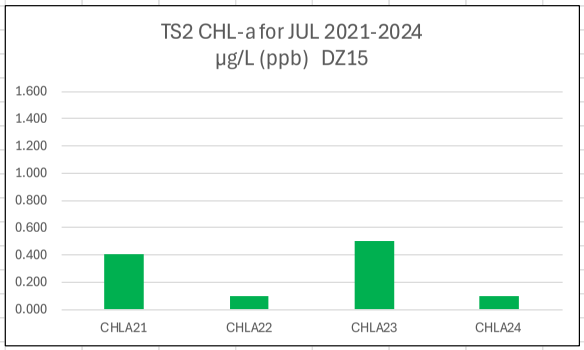


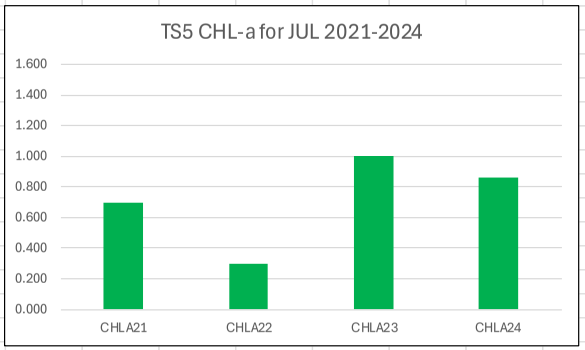


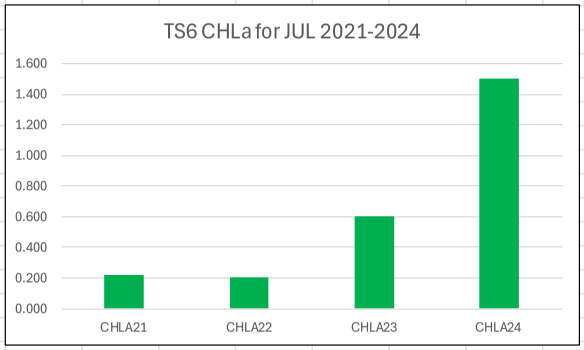
Observations:
1) TP availability during the 4 yr period was highest at TS5 & TS6, lowest at TS 2.
2) Although TP varied among sample sites and years, the TP concentration remained in the oligographic classification (Fig. 1) Shows relative trophic differences among sites. (e.g.) more oligotrophic sites had lowest TP at TS2 & TS9 vs higher TP overall at TS5 & TS6.

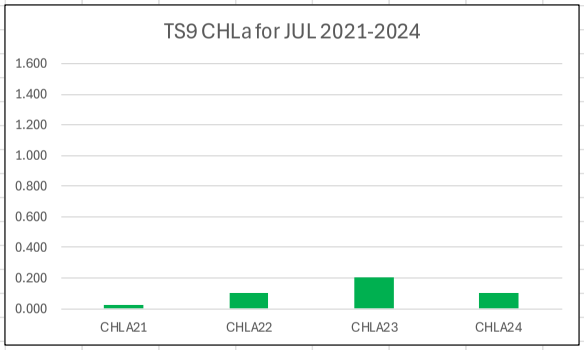
APP. D Relative Chlorophyll-a concentration (µg/L, ppb) recorded in Jul 2024 vs Jul values for previous three years.

MULTI YR TSIDAT 6 DEC24 CHL-a COMMON SCALE SHT1 FM15 / SHT2 AG11

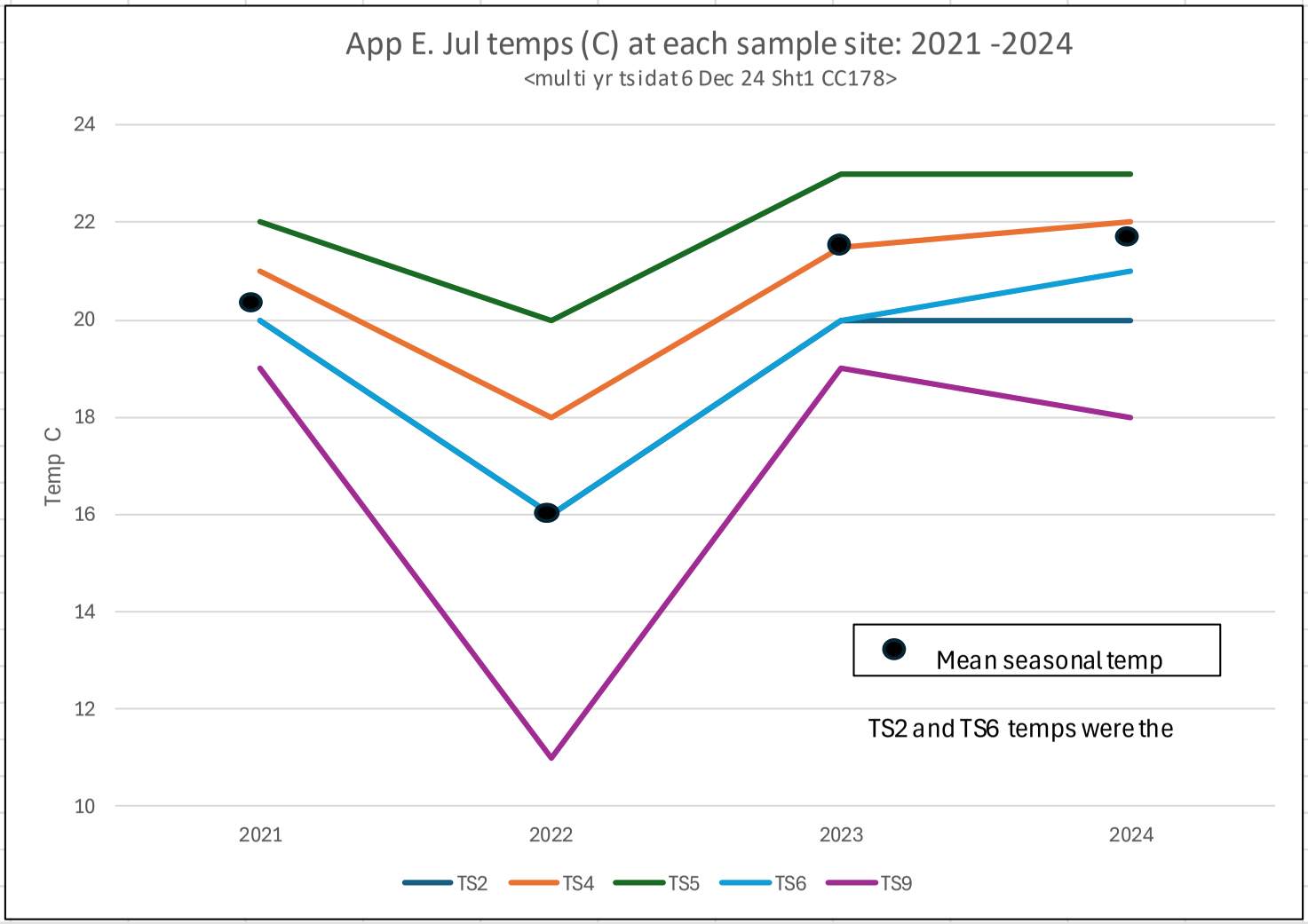








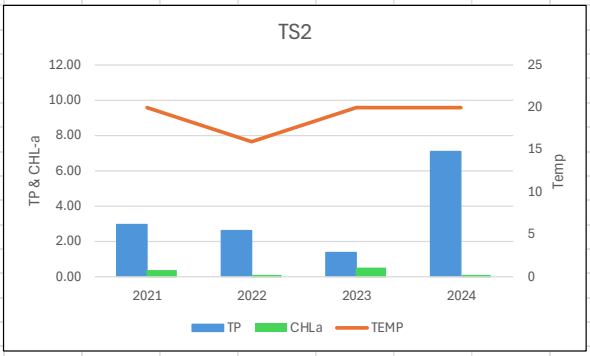
Observations:
1) As expected, collections with lowest Chl-a concentrations, TS2 & TS9, also had lowest yr - yr TP levels.
2) Chl-a excursion at TS6 in 2024 was likely during a phytoplankton bloom.

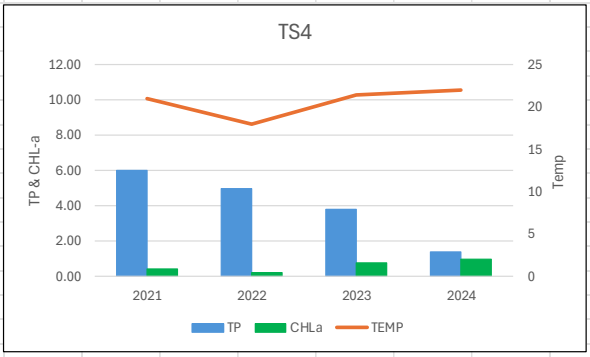

App E. Jul temps (C) at each sample site: 2021 -2024
<multi yr tsidat 6 Dec 24 Sht1 CC178>
Temp C
24
22
20
18
16
14
12
10
2021
2022
2023
2024
Mean seasonal temp
TS2 and TS6 temps were the
TS2
TS4
TS5
TS6
TS9

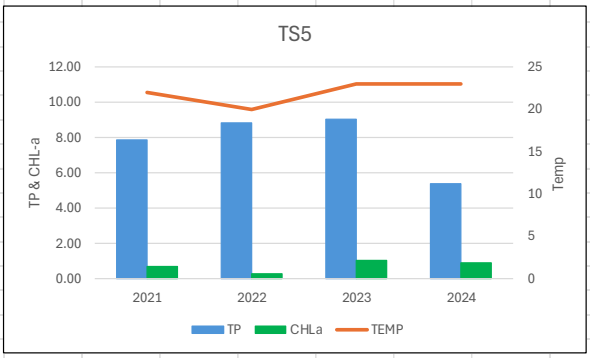
App F. Comparison of TSIDAT over 4 yr using modified monitor schedule in 2024.

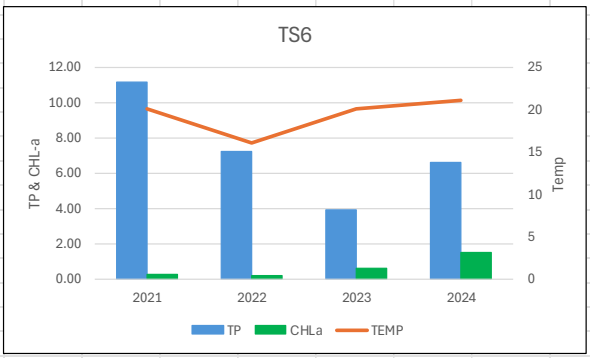
TP and Chl-a reported as µg/L (ppb) and Temperature as ºC

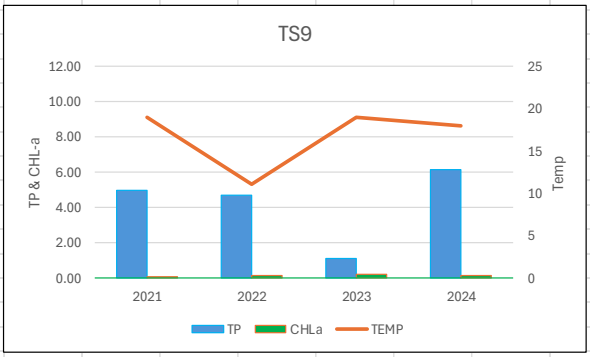
<MULTI YR TSID 6 DEC24 (VERSION 1)
SHT1 JD 40>











E N D