2023 Maidstone Lake & Tributary Water Quality Monitoring Results: Lay Monitoring Program and LaRosa Partnership Program

Mark Mitchell, Limnologist

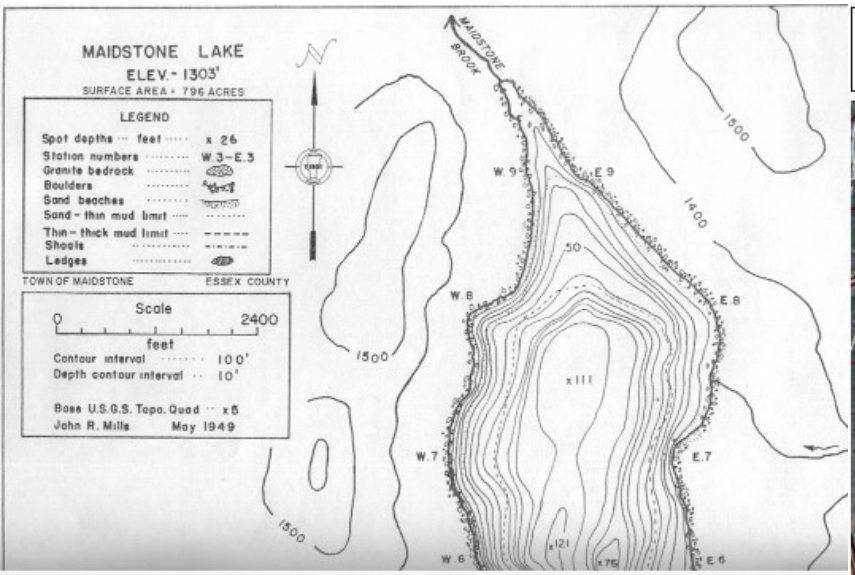
Lake Monitoring and Community Outreach Coordinator

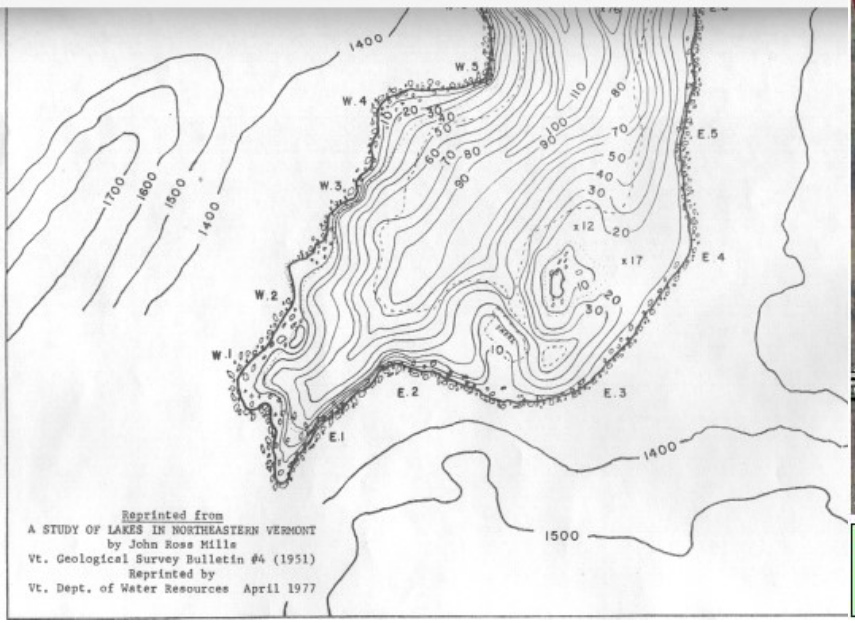
UVM Lake Champlain Sea Grant and VT DEC Lakes & Ponds Program

Lay Monitoring Program (LMP) 2023 Lake Sampling Overview

- Biweekly from June through August (total of 6 samples for summer mean):
  - *Basic Sampling:* Measure Secchi disk transparency depth (clarity)
  - *Supplemental Sampling:* Collect epilimnetic and hypolimnetic water samples that are lab tested for total phosphorus (nutrient) concentration and chlorophyll-a (algae) concentration
  - Pilot caffeine sampling (wastewater)
  - Complete a lake sampling webform (and report cyanobacteria conditions)

https://dec.vermont.gov/watershed/lakes-ponds/monitor/lay-monitoring





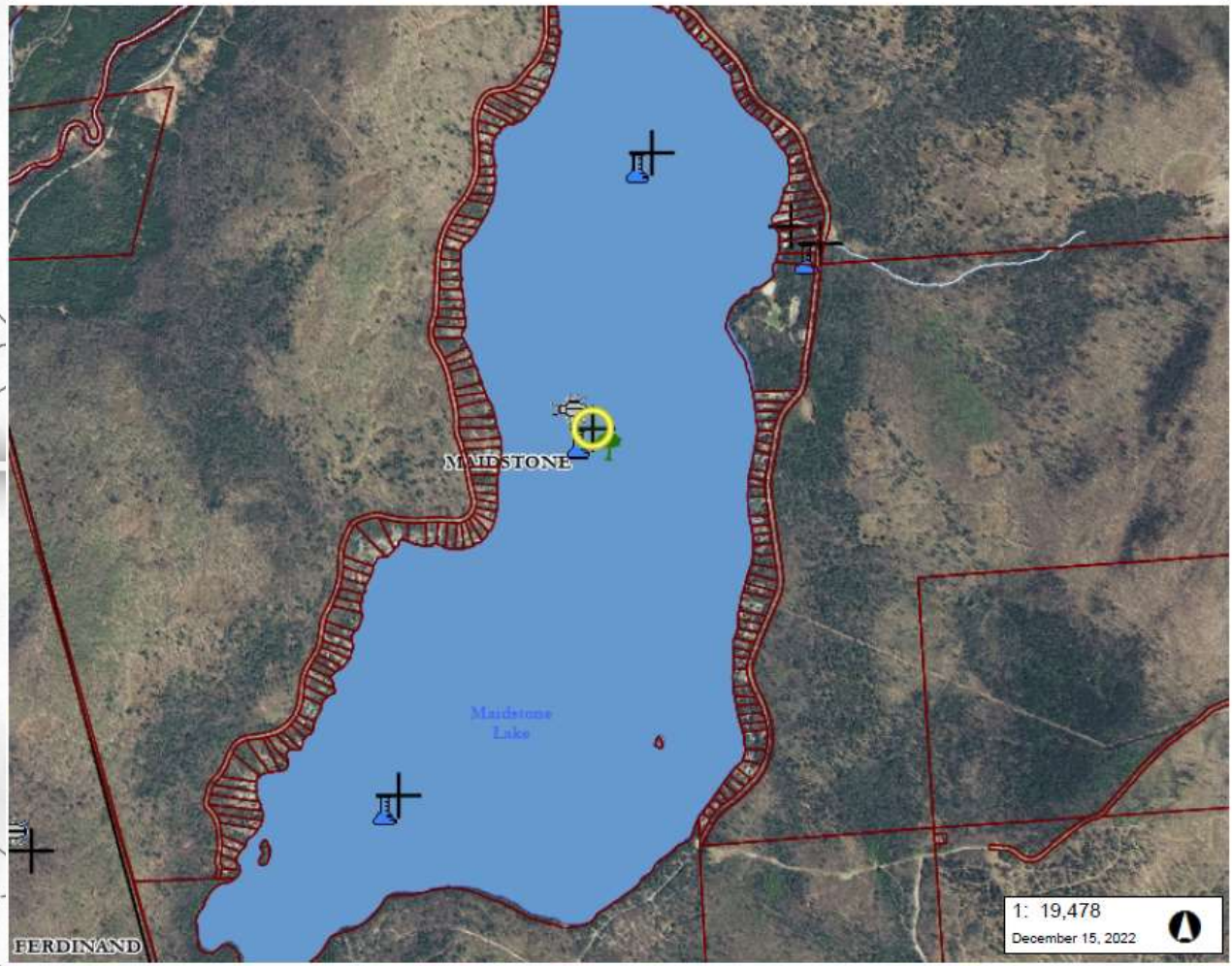
Reprinted from
A STUDY OF LAKES IN NORTHEASTERN VERMONT
by John Ross Mills
Vt. Geological Survey Bulletin #4 (1951)
Reprinted by
Vt. Dept. of Water Resources April 1977

VERMONT

Maidstone Lake Monitoring Station #1

Vermont Agency of Natural Resources

vermont.gov



990.0 0 495.00 990.0 Meters

WGS_1984_Web_Mercator_Auxiliary_Sphere 1" = 1623 Ft. 1cm = 195 Meters

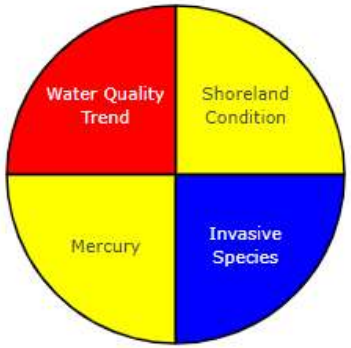
THIS MAP IS NOT TO BE USED FOR NAVIGATION

Vermont Lake Score Card

Maidstone Lake

https://dec.vermont.gov/watershed/lakes-ponds/data-maps/scorecard

Scores | Water Quality Data | Lake Information



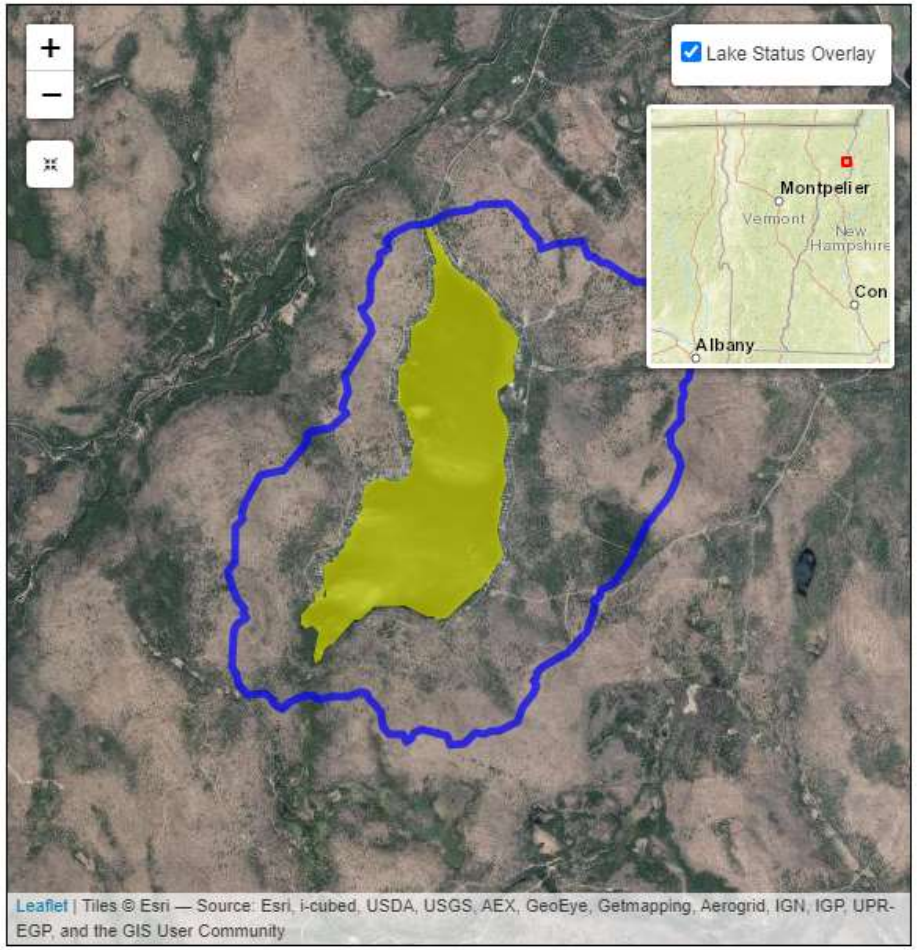
Watershed:	Minimally Disturbed
WQ Standards:	Stressed

Details

Stressed – pH

Color Scoring System
- Good Conditions
- Fair Conditions
- Poor Conditions
- Insufficient Data

Learn How Lakes Are Scored



Vermont Lake Score Card
Maidstone Lake

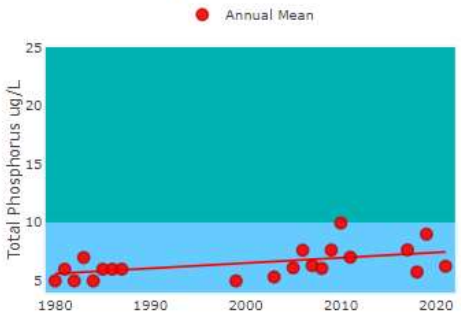
Scores | **Water Quality Data** | Lake Information

Plots

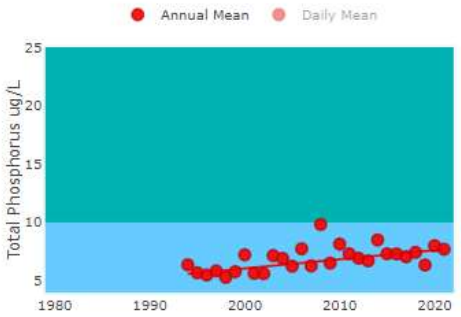
Trophic condition thresholds are indicated by shading:
■ Hypereutrophic ■ Eutrophic ■ Mesotrophic ■ Oligotrophic

Click on "Daily Mean" or "Annual Mean" to toggle on or off the data layer.

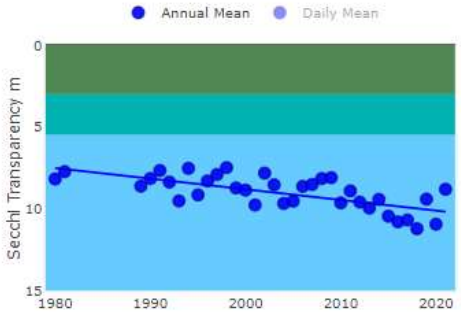
Spring Phosphorus
Trend: Highly Significantly Increasing (p-value=0.0023)



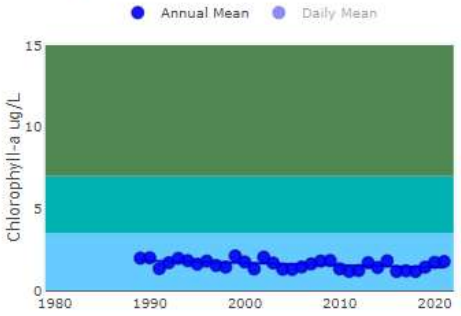
Summer Phosphorus
Trend: Highly Significantly Increasing (p-value=9e-04)



Summer Secchi
Trend: Highly Significantly Increasing (p-value=1e-04)



Summer Chlorophyll-a
Trend: Significantly Decreasing (p-value=0.0132)



Vermont Lake Score Card
Maidstone Lake

Scores | **Water Quality Data** | Lake Information

Plots

Trophic condition thresholds are indicated by shading:
■ Hypereutrophic ■ Eutrophic ■ Mesotrophic ■ Oligotrophic

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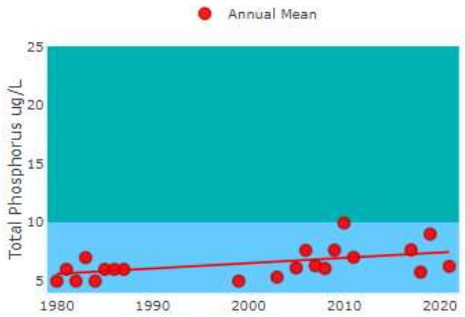
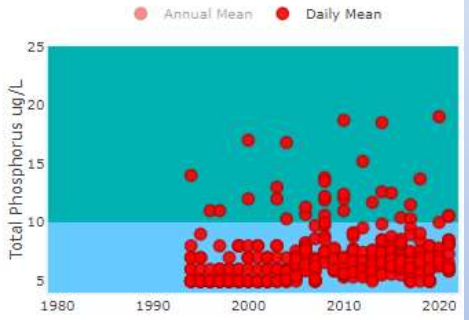
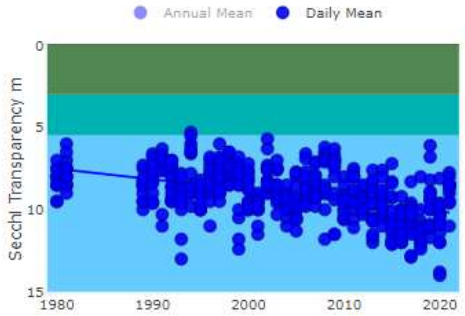
Trend: Highly Significantly Increasing (p-value=0.0023)



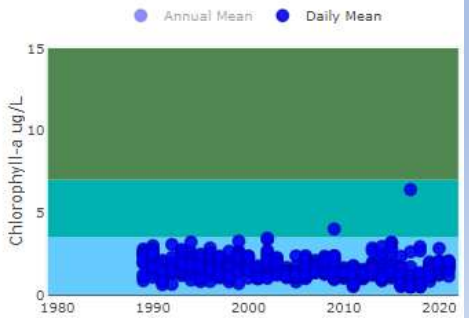
Summer Phosphorus
Trend: Highly Significantly Increasing (p-value=9e-04)

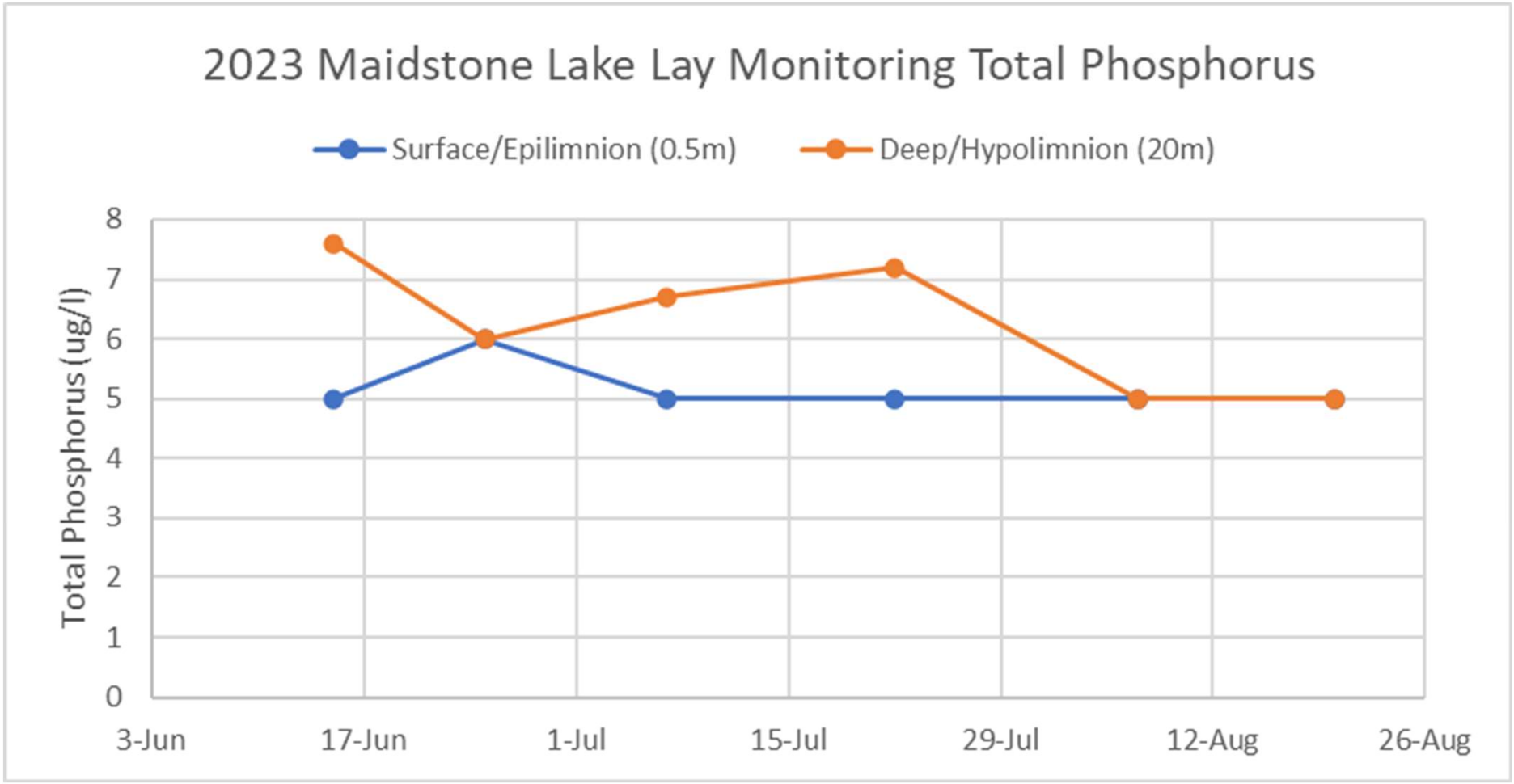


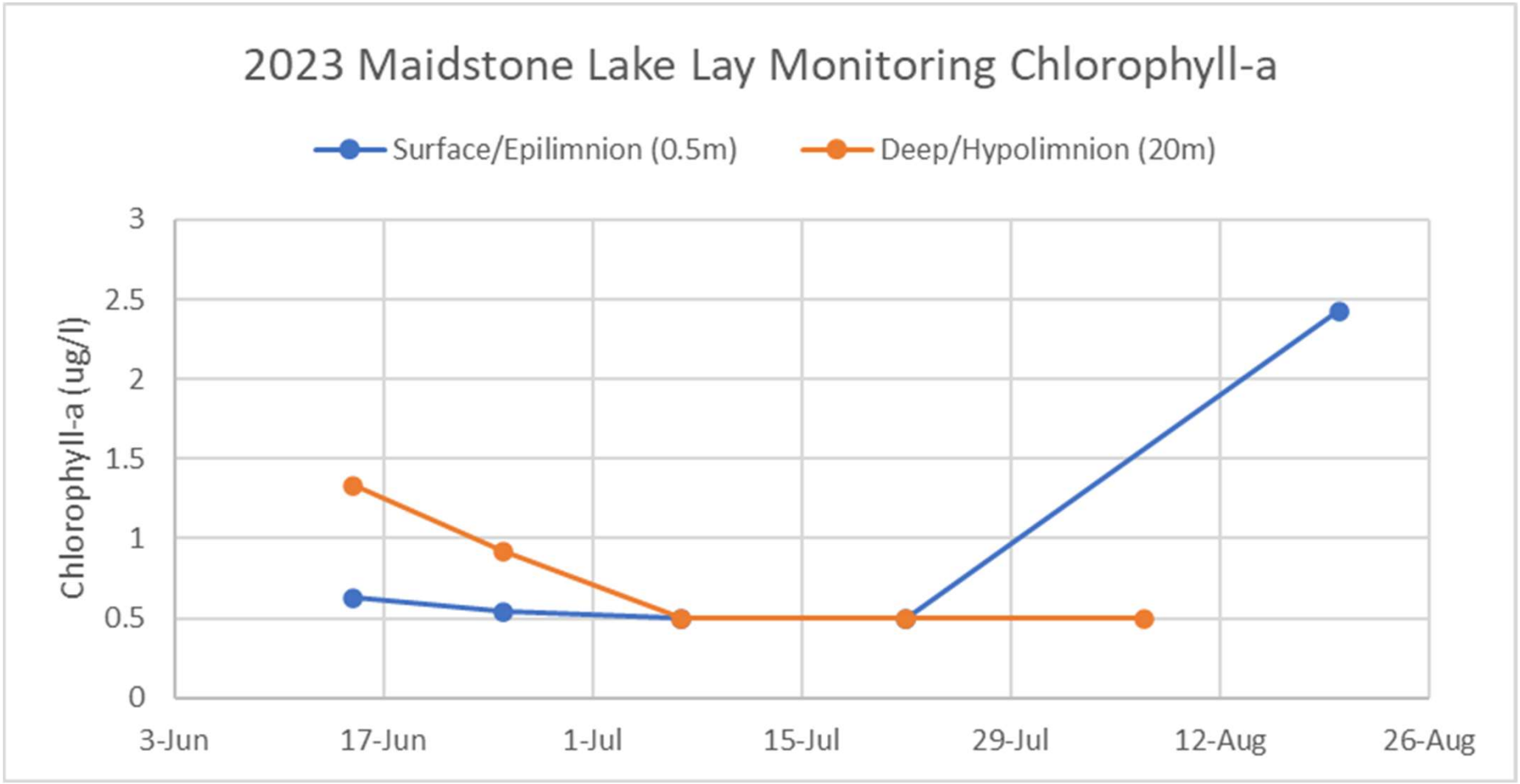
Summer Secchi
Trend: Highly Significantly Increasing (p-value=1e-04)

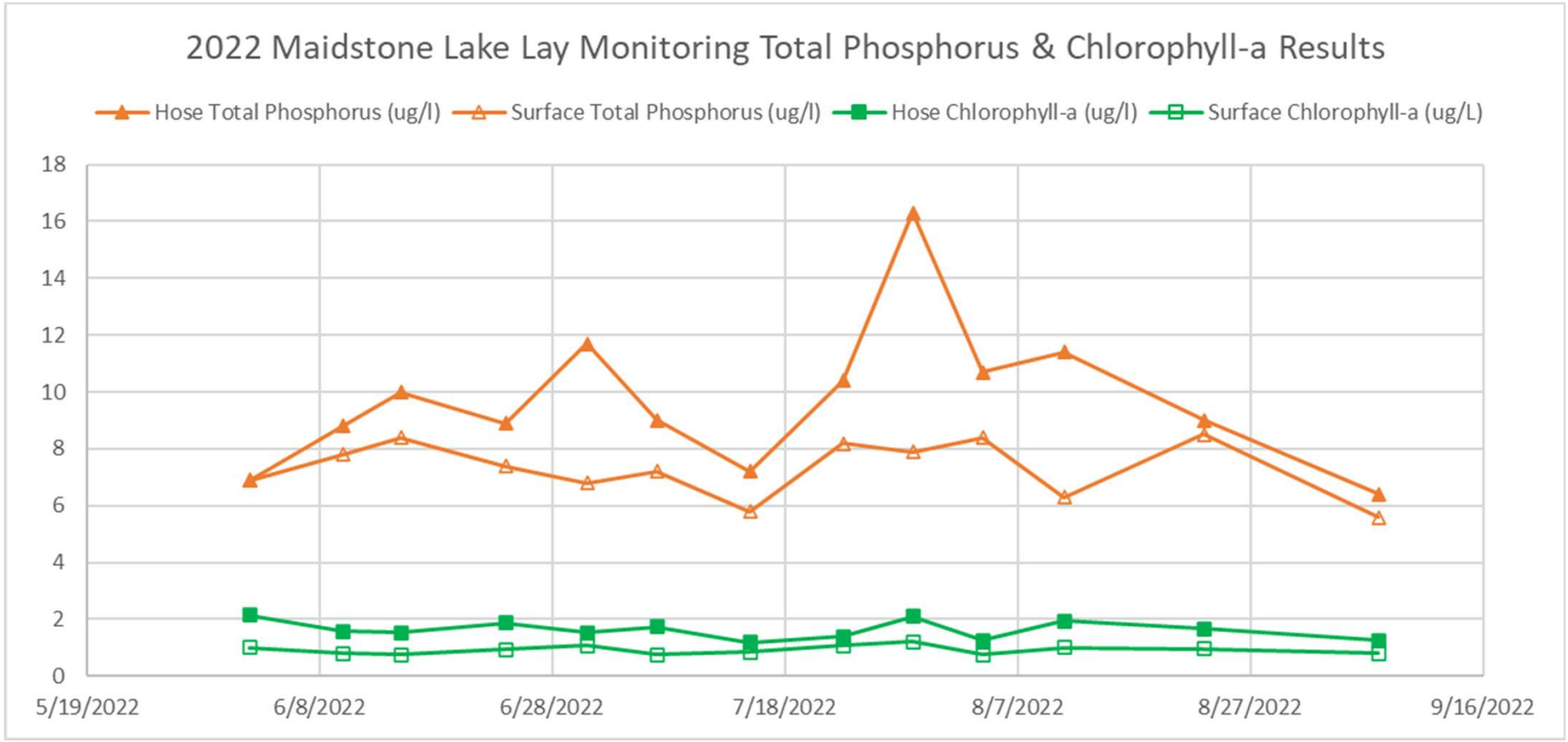


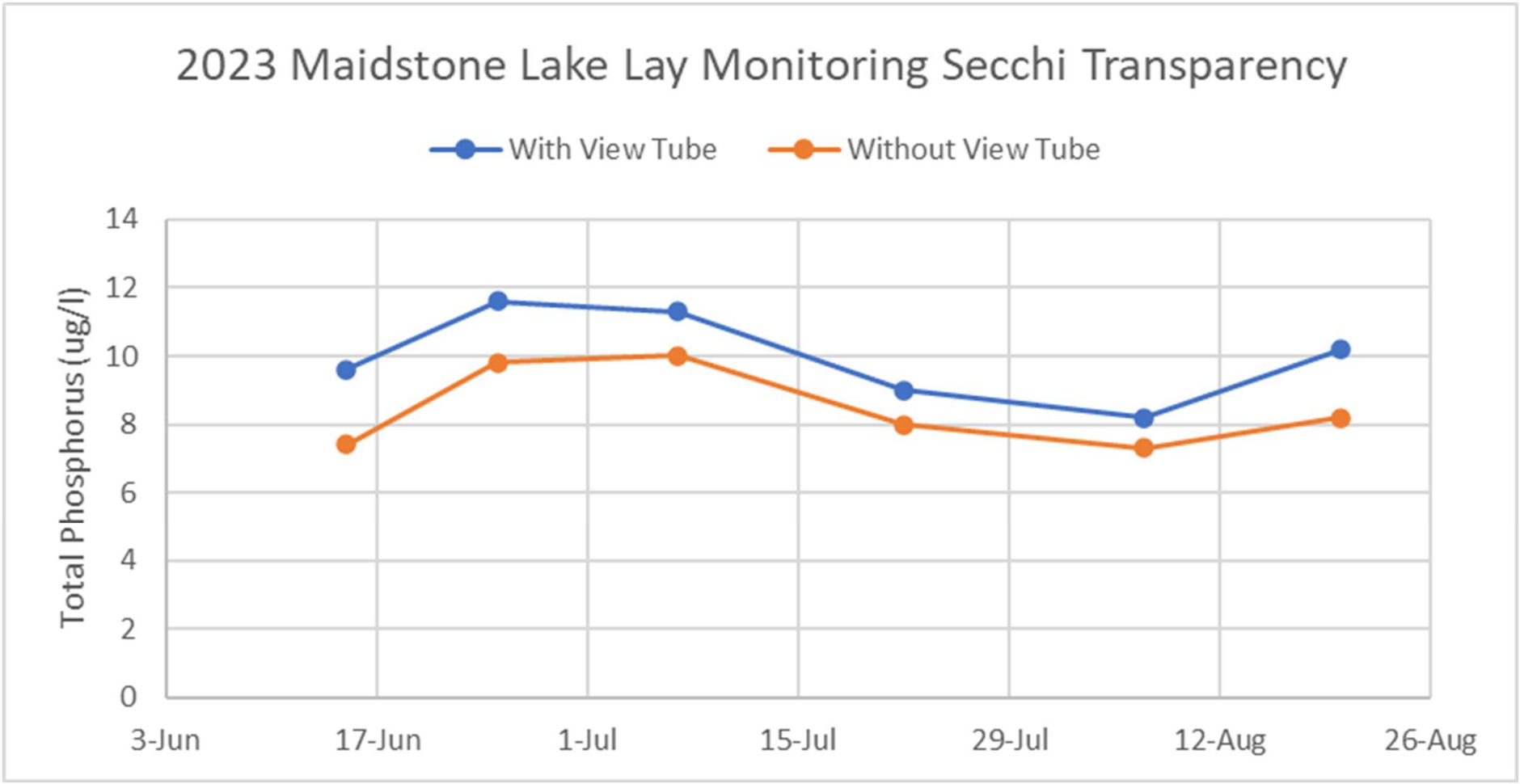
Summer Chlorophyll-a
Trend: Significantly Decreasing (p-value=0.0132)

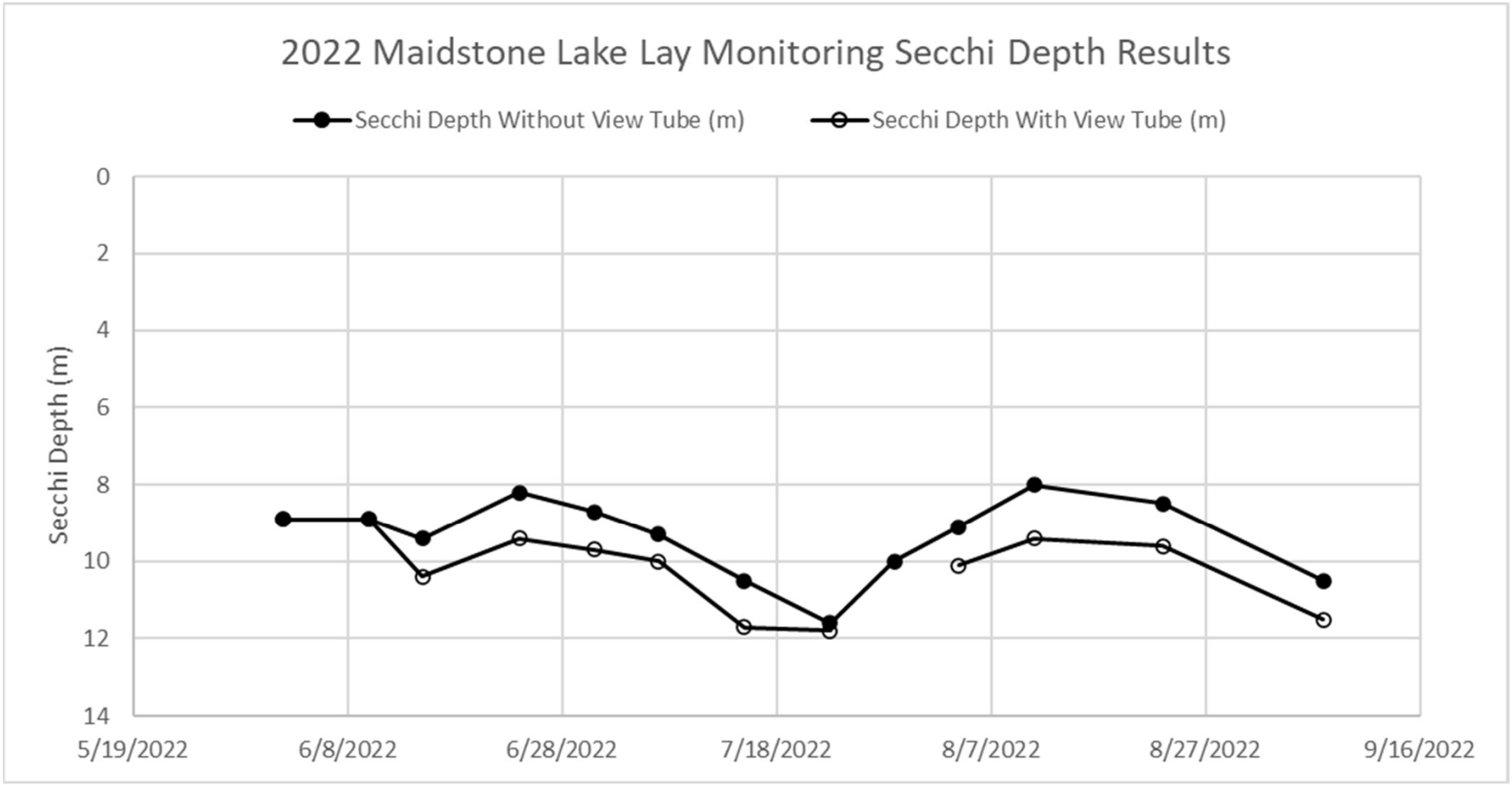


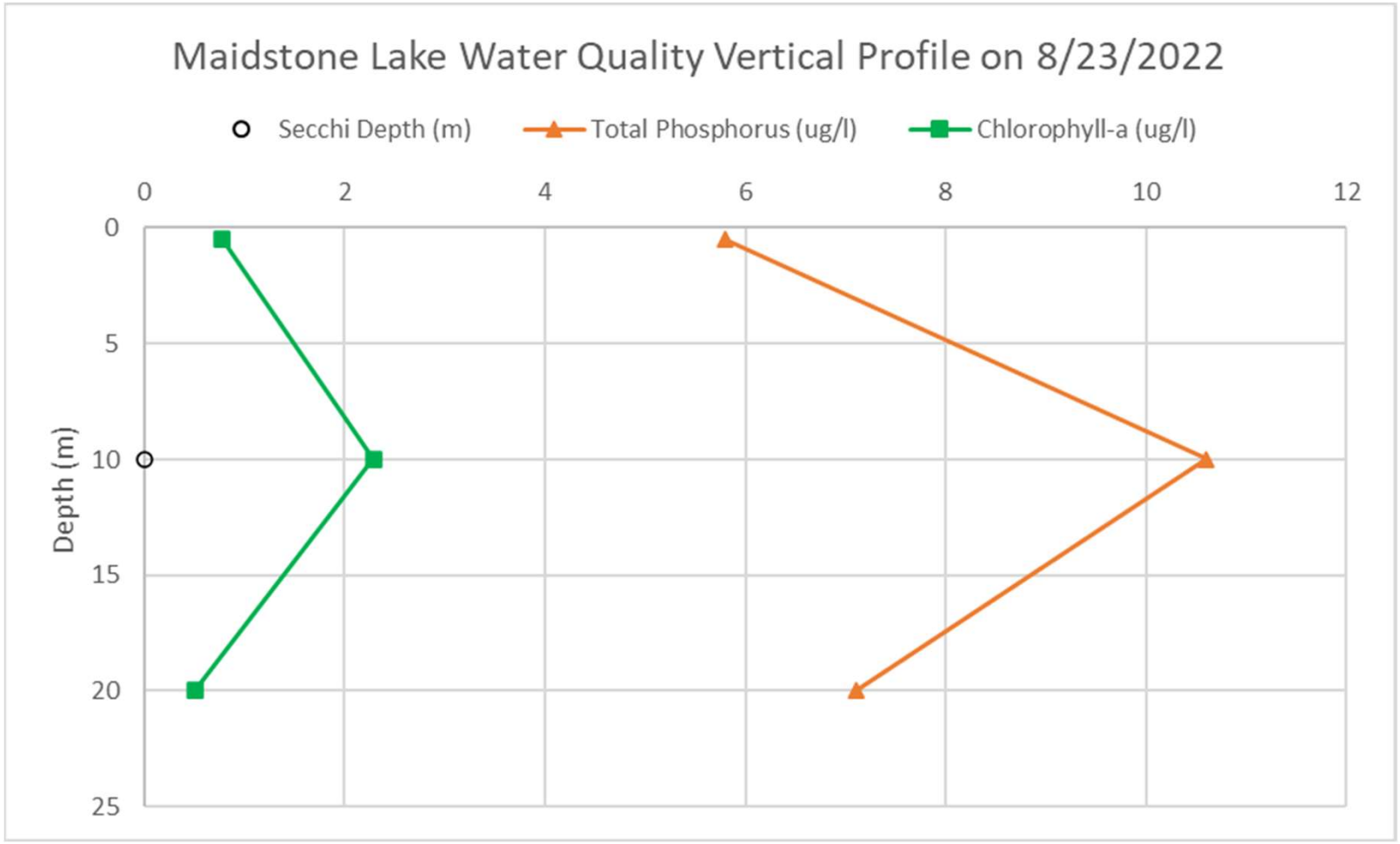

2023 Maidstone Lake Lay Monitoring Total Phosphorus
Surface/Epilimnion (0.5m)
Deep/Hypolimnion (20m)
Total Phosphorus (ug/l)
8
7
6
5
4
3
2
1
0
3-Jun
17-Jun
1-Jul
15-Jul
29-Jul
12-Aug
26-Aug


2023 Maidstone Lake Lay Monitoring Chlorophyll-a
Surface/Epilimnion (0.5m)
Deep/Hypolimnion (20m)
Chlorophyll-a (ug/l)
3
2.5
2
1.5
1
0.5
0
3-Jun
17-Jun
1-Jul
15-Jul
29-Jul
12-Aug
26-Aug


2022 Maidstone Lake Lay Monitoring Total Phosphorus & Chlorophyll-a Results
Hose Total Phosphorus (ug/l)
Surface Total Phosphorus (ug/l)
Hose Chlorophyll-a (ug/l)
Surface Chlorophyll-a (ug/L)
18
16
14
12
10
8
6
4
2
0
5/19/2022
6/8/2022
6/28/2022
7/18/2022
8/7/2022
8/27/2022
9/16/2022


2023 Maidstone Lake Lay Monitoring Secchi Transparency
With View Tube
Without View Tube
Total Phosphorus (ug/l)
14
12
10
8
6
4
2
0
3-Jun
17-Jun
1-Jul
15-Jul
29-Jul
12-Aug
26-Aug


2022 Maidstone Lake Lay Monitoring Secchi Depth Results
Secchi Depth Without View Tube (m)
Secchi Depth With View Tube (m)
Secchi Depth (m)
0
2
4
6
8
10
12
14
5/19/2022
6/8/2022
6/28/2022
7/18/2022
8/7/2022
8/27/2022
9/16/2022


Maidstone Lake Water Quality Vertical Profile on 8/23/2022
Secchi Depth (m)
Total Phosphorus (ug/l)
Chlorophyll-a (ug/l)
0
2
4
6
8
10
12
Depth (m)
0
5
10
15
20
25

Sampling Date	Hose Sample Depth (m)	Hose Total Phosphorus (ug/l)	Surface Total Phosphorus (ug/l)	Hose Chlorophyll-a (ug/l)	Surface Chlorophyll-a (ug/L)	Secchi Depth Without View Tube (m)	Secchi Depth With View Tube (m)
6/2/2022	18	6.9	6.9	2.14	1.01	8.9	8.9
6/10/2022	17.8	8.8	7.8	1.57	0.8	8.9	8.9
6/15/2022	20	10	8.4	1.54	0.75	9.4	10.4
6/24/2022	20	8.9	7.4	1.88	0.93	8.2	9.4
7/1/2022	20	11.7	6.8	1.52	1.08	8.7	9.7
7/7/2022	20	9	7.2	1.73	0.76	9.3	10
7/15/2022	20	7.2	5.8	1.19	0.85	10.5	11.7
7/23/2022	20	10.4	8.2	1.39	1.08	11.6	11.8
7/29/2022	20	16.3	7.9	2.09	1.22	10	
8/4/2022	20	10.7	8.4	1.26	0.75	9.1	10.1
8/11/2022	20	11.4	6.3	1.95	1	8	9.4
8/23/2022	20	9	8.5	1.67	0.95	8.5	9.6
9/7/2022	20	6.4	5.6	1.26	0.79	10.5	11.5
Mean	**19.7**	**9.7**	**7.3**	**1.6**	**0.9**	**9.4**	**10.1**
VT Class A1 Standards	**Photosynthetic Zone**	**12**	**12**	**2.6**	**2.6**	**5**	**5**

MAIDSTONE LAKE

Annual Data (Station 1)

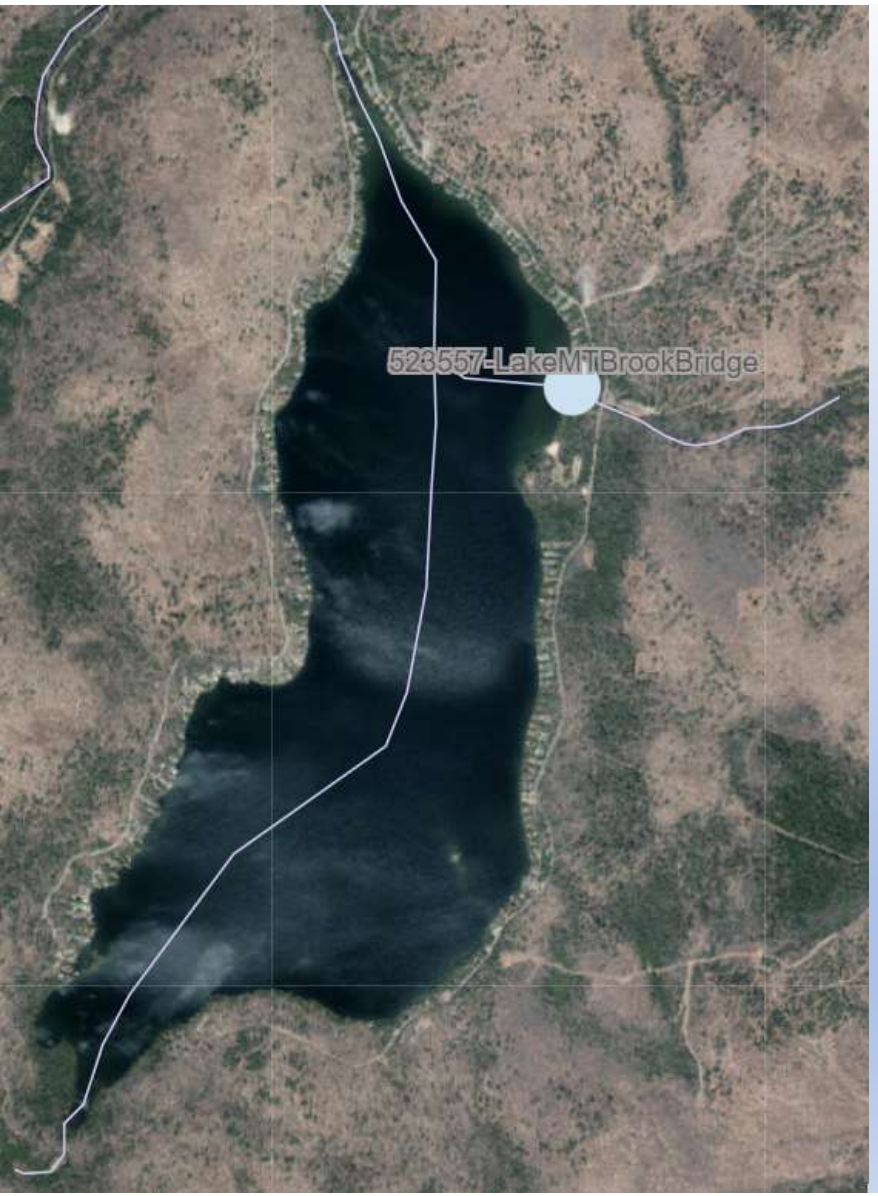
Year	Days Sampled	Secchi (m)	Secchi View Tube (m)	Chloro-a (µg/l)	Summer TP (µg/l)	Spring TP (µg/l)
1979	17	7.3				6.0
1980	14	8.2				4.0
1981	13	7.7				6.0
1982						4.0
1983						7.0
1984						5.0
1985						6.0
1986						6.0
1987						6.0
1989	11	8.6		2.0		
1990	14	8.2		2.0		
1991	13	7.7		1.3		
1992	13	8.4		1.7		
1993	14	9.5		2.0		
1994	13	7.5		1.8	6.2	
1995	13	9.2		1.6	5.6	
1996	14	8.3		1.8	4.6	
1997	14	7.9		1.5	5.4	
1998	13	7.5		1.4	4.9	
1999	14	8.7		2.1	5.5	4.3
2000	13	8.9		1.7	7.2	
*VT Standard**		*2.6*		*7.0*	*18.0*	

** VT Water Quality Standards Nutrient Criteria for Class B2 Lakes > 20 acres.*

Annual Data (Station 1)

Year	Days Sampled	Secchi (m)	Secchi View Tube (m)	Chloro-a (µg/l)	Summer TP (µg/l)	Spring TP (µg/l)
2001	14	9.8		1.3	5.4	
2002	14	7.8		2.0	5.6	
2003	12	8.5		1.7	7.2	5.3
2004	12	9.7		1.3	6.9	
2005	14	9.5		1.3	6.3	6.1
2006	13	8.6		1.4	7.7	7.6
2007	13	8.5		1.6	6.3	6.3
2008	13	8.2		1.8	9.8	6.1
2009	13	8.1		1.8	6.5	7.6
2010	14	9.6		1.3	8.2	10.0
2011	14	8.9		1.2	7.3	7.0
2012	14	9.6		1.2	6.9	
2013	15	10.0		1.7	6.7	
2014	15	9.4		1.4	8.5	
2015	16	10.5		1.8	7.3	
2016	14	10.8		1.2	7.3	
2017	15	10.7		1.2	7.1	7.7
2018	15	11.2		1.2	7.4	5.8
2019	14	9.4		1.4	6.4	9.0
2020	14	10.9		1.7	8.0	
2021	13	8.8		1.8	7.7	6.3
*VT Standard**		*2.6*		*7.0*	*18.0*	

** VT Water Quality Standards Nutrient Criteria for Class B2 Lakes > 20 acres.*



LaRosa Partnership Program (LPP) Tributary Sampling Overview

- LPP first sampled in 2022 ~biweekly from April to August + storm events
- 523557-LakeMTBrookBridge
  - Major tributary to Maidstone Lake

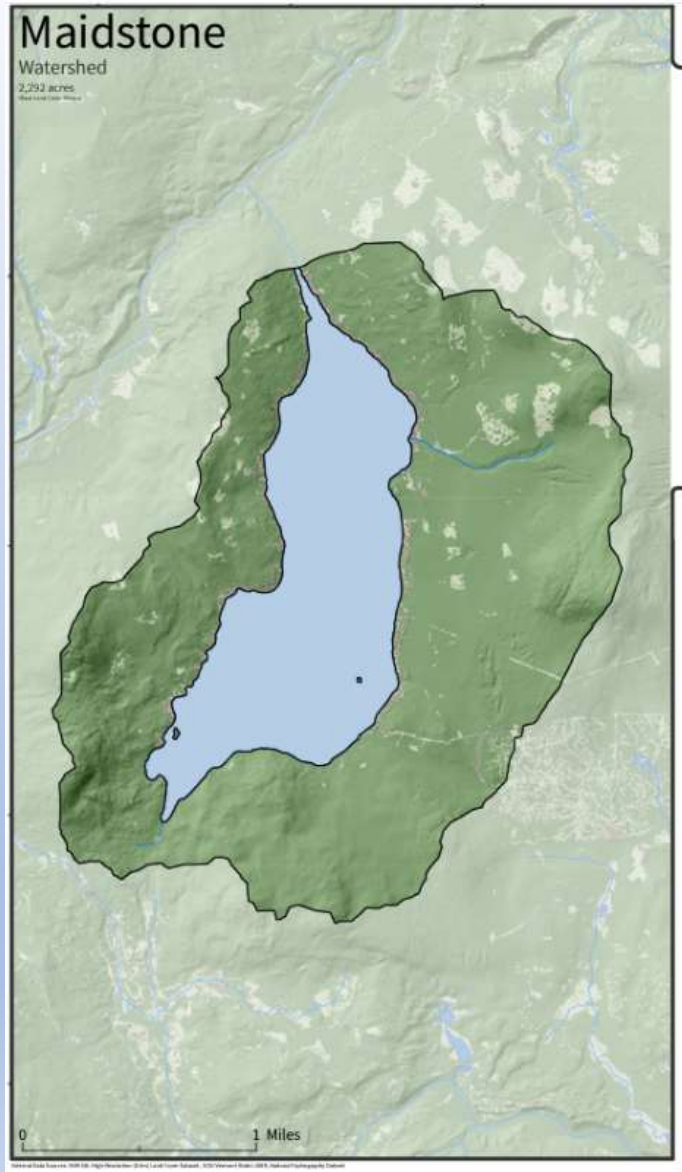
LPP Sample Parameters Overview

Total Phosphorus

- *Impacts*
  - Feeds plants, algae and cyanobacteria
  - Aquatic Biota, Aesthetics, Recreation Uses
- *Human Sources*
  - Runoff from roads, lawns, agriculture, logging
  - Malfunctioning septic systems
- *Vermont Water Quality Standards Nutrient Criteria for Aquatic Biota Use (+ Biological Criteria)*
  - Not to be exceeded at low median monthly flow (baseflow) during June through October
  - 12 ug/L for small high gradient streams (SHG)
  - 15 ug/L for medium high gradient streams (MHG)
  - 27 ug/L for warm-water medium gradient streams and rivers (WWMG)

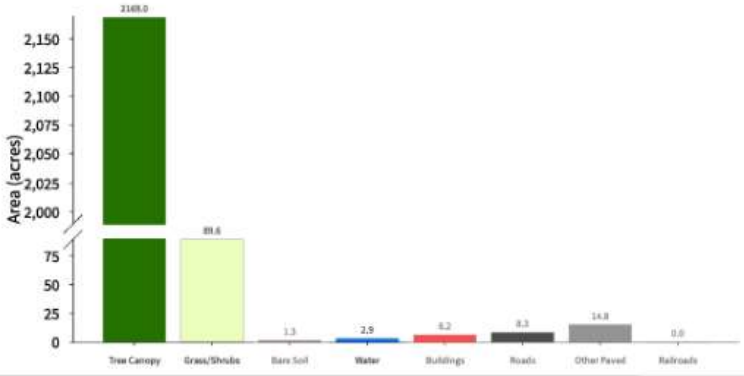
Total Nitrogen

- *Impacts*
  - Feeds plants, algae and cyanobacteria
  - Aquatic Biota, Aesthetics, Recreation Uses
- *Human Sources*
  - Runoff from roads, lawns, agriculture, logging
  - Malfunctioning septic systems
- *Vermont Water Quality Standards*
  - Not to exceed 5.0 mg/l as NO3-N at flows exceeding low median monthly flows, in Class B(1) and B(2) waters.
  - Not to exceed 2.0 mg/l as NO3-N at flows exceeding low median monthly flows, in Class A(1) and A(2) waters at or below 2,500 feet elev.



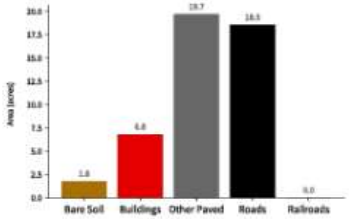
High-Resolution Land Cover Summary

Base Land Cover (Top-Down*)



Supplemental Land Cover

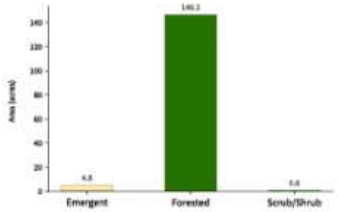
Impervious Surfaces (46.79 acres - 2 % of total)
(Bottom-Up**)



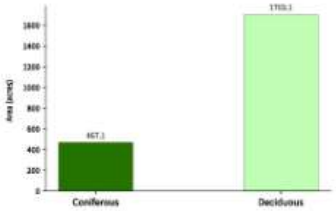
Agriculture (0 acres - 0 % of total)

No Agricultural Land Cover Mapped in this Area

Wetlands (151.71 acres - 6.6 % of total)



Tree Canopy (2,170.18 acres - 94.7 % of total)



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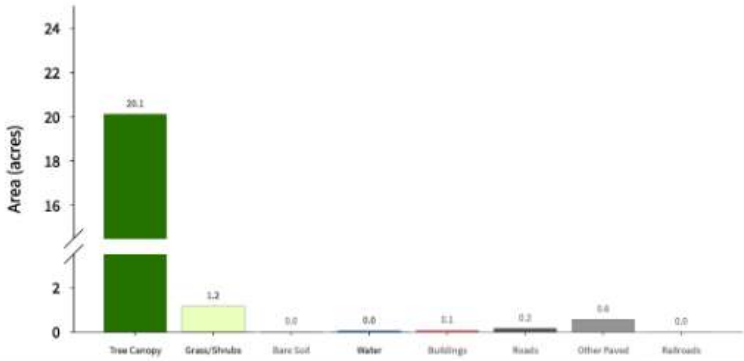
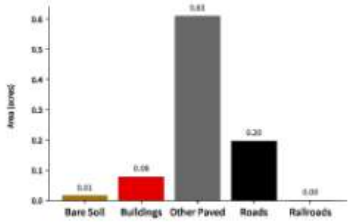


Supplemental Land Cover

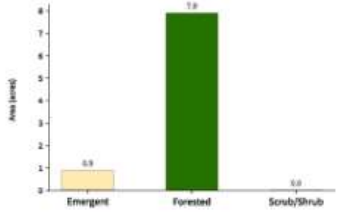
Impervious Surfaces (0.9 acres - 4.1 % of total)
(Bottom-Up**)



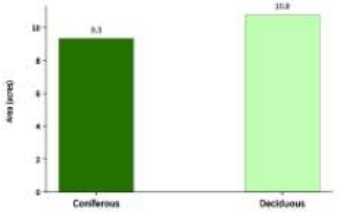
Agriculture (0 acres - 0 % of total)

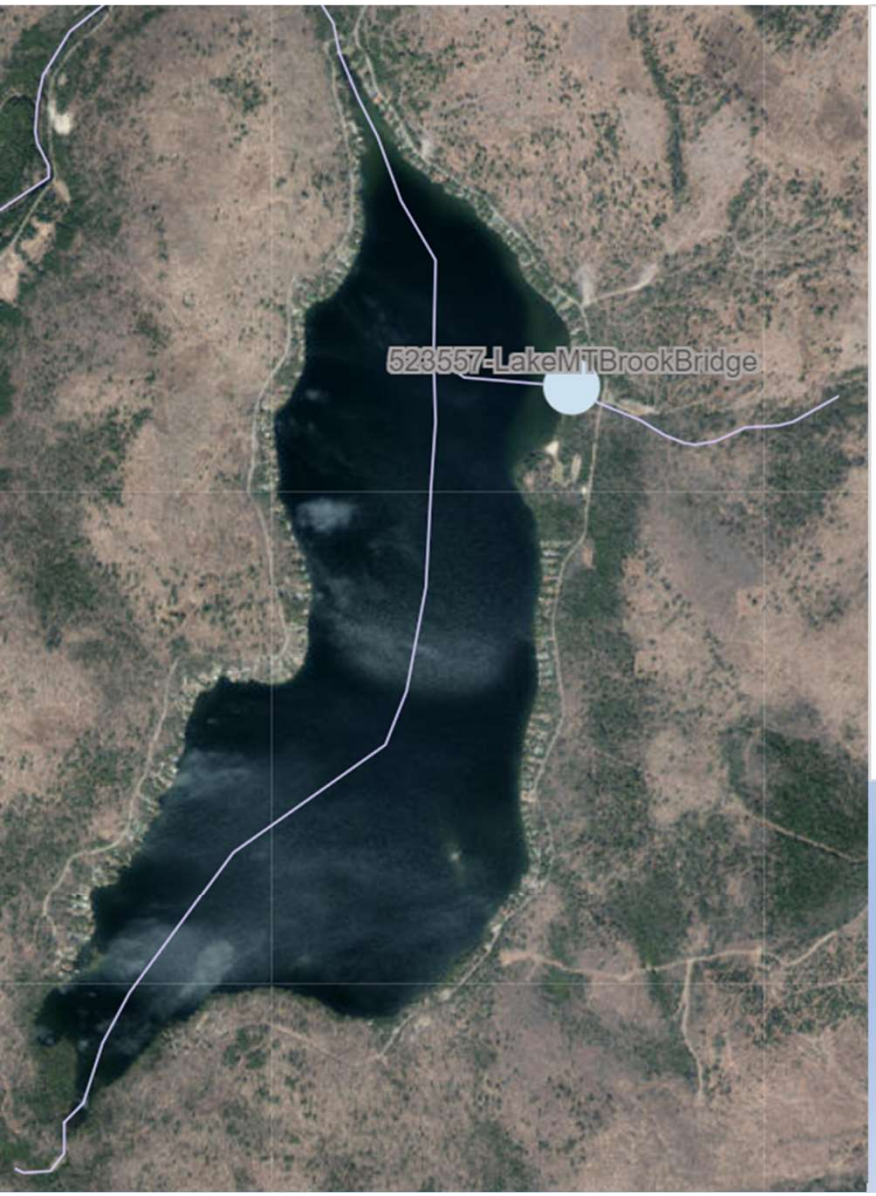
No Agricultural Land Cover Mapped in this Area

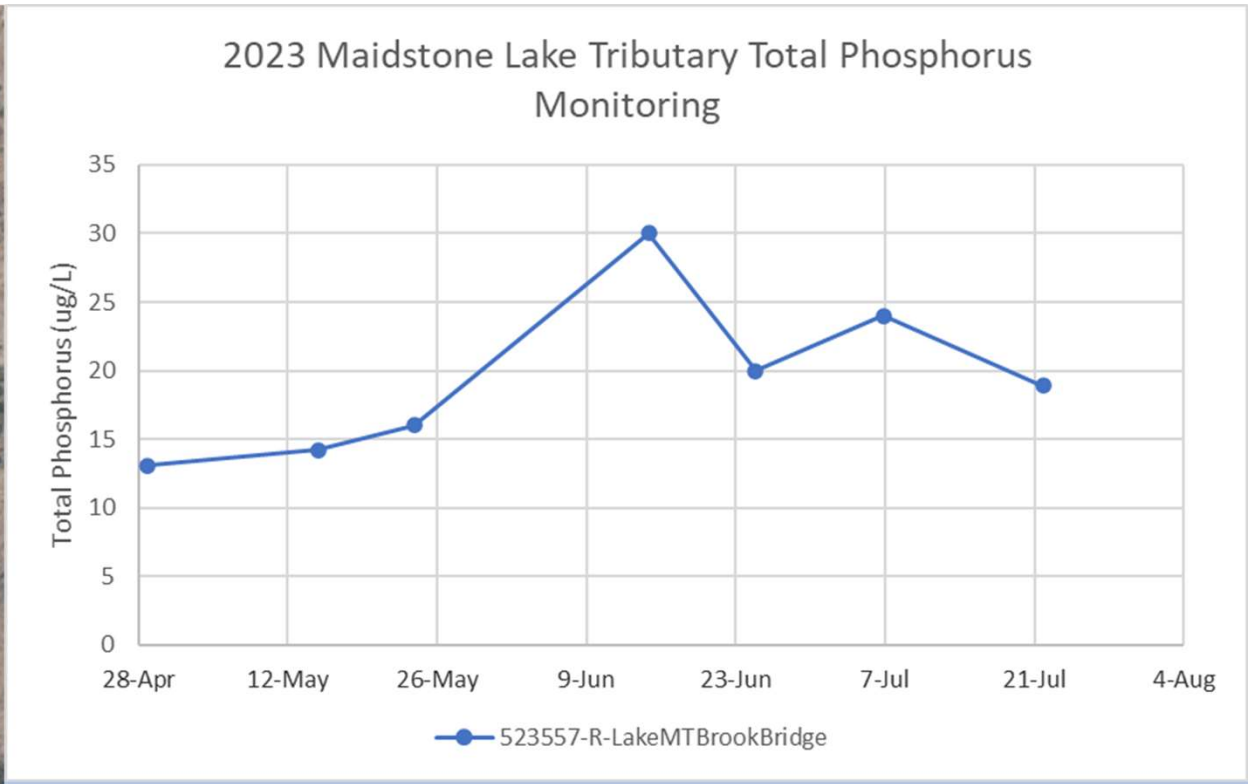
Wetlands (8.78 acres - 39.9 % of total)

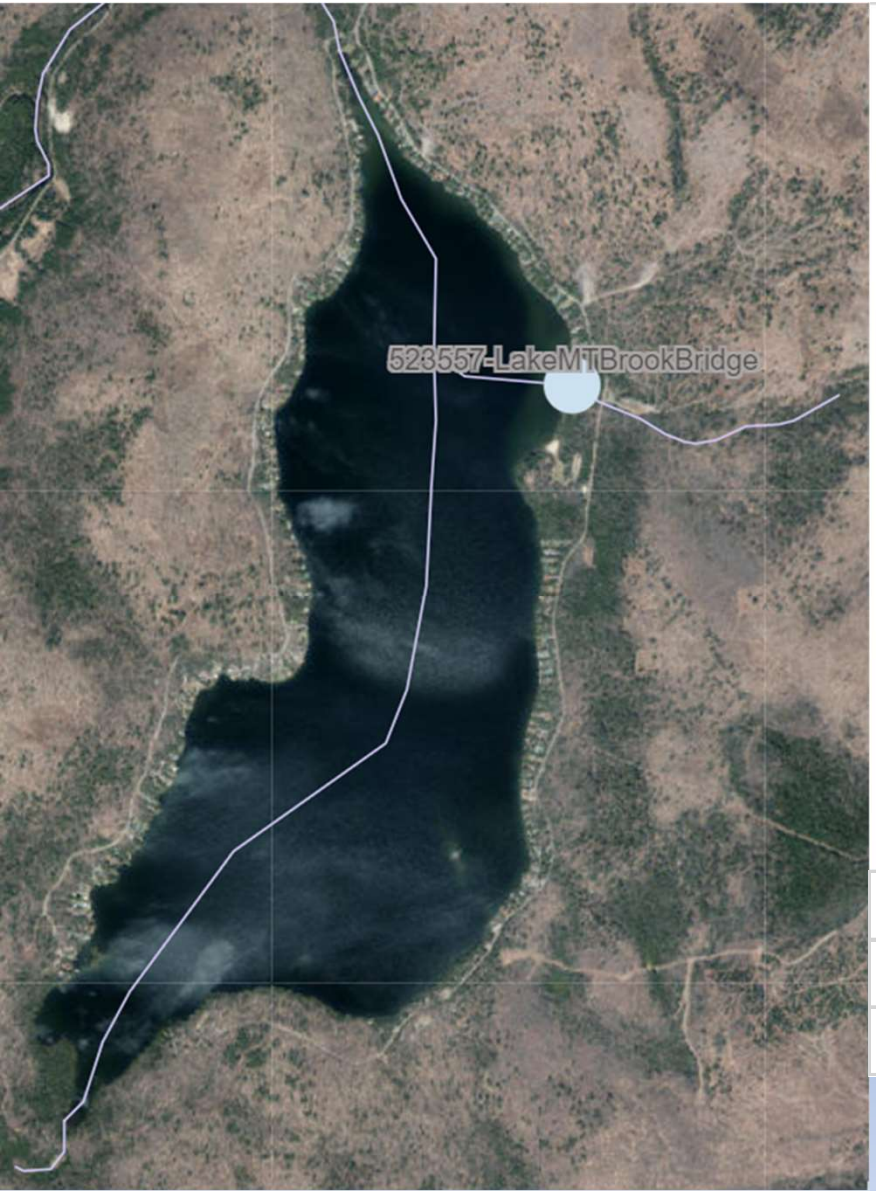


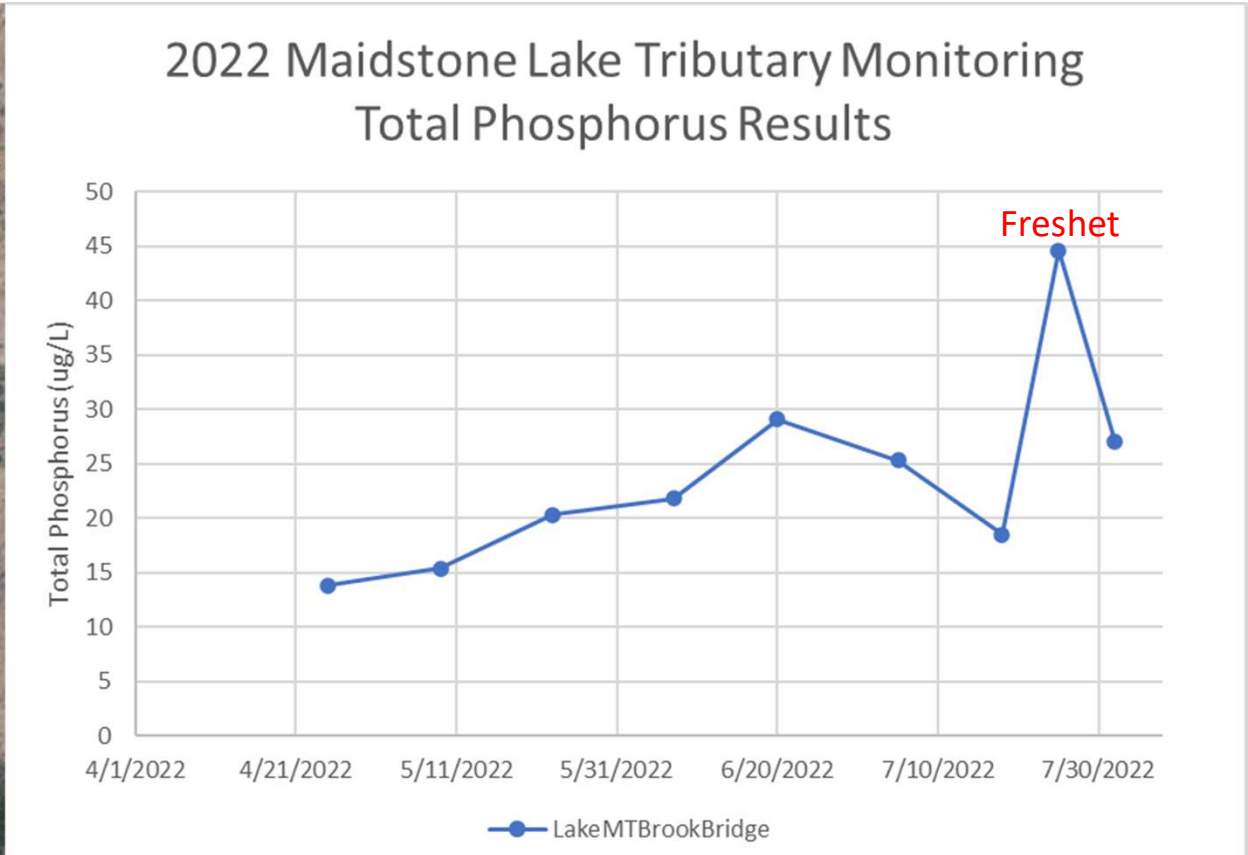
Tree Canopy (20.12 acres - 91.5 % of total)



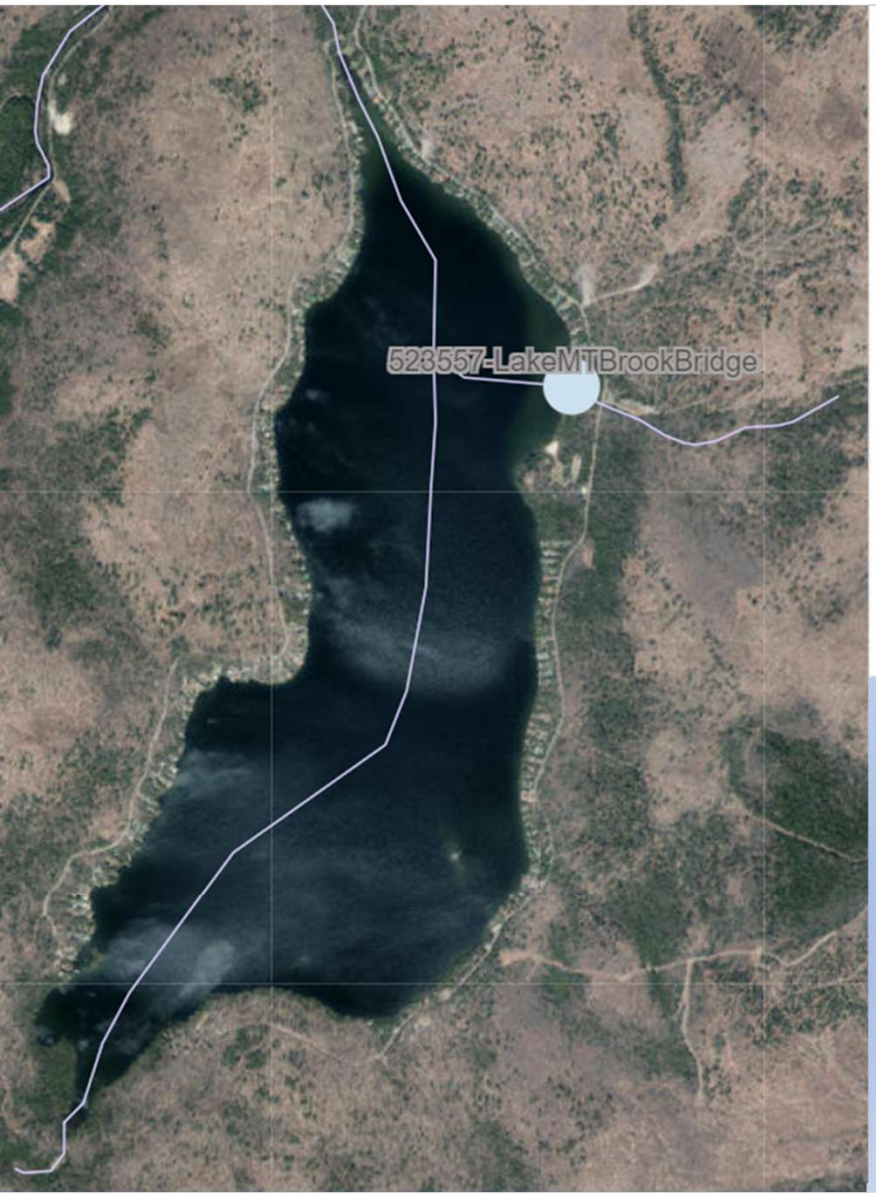

523557-LakeMTBrookBridge

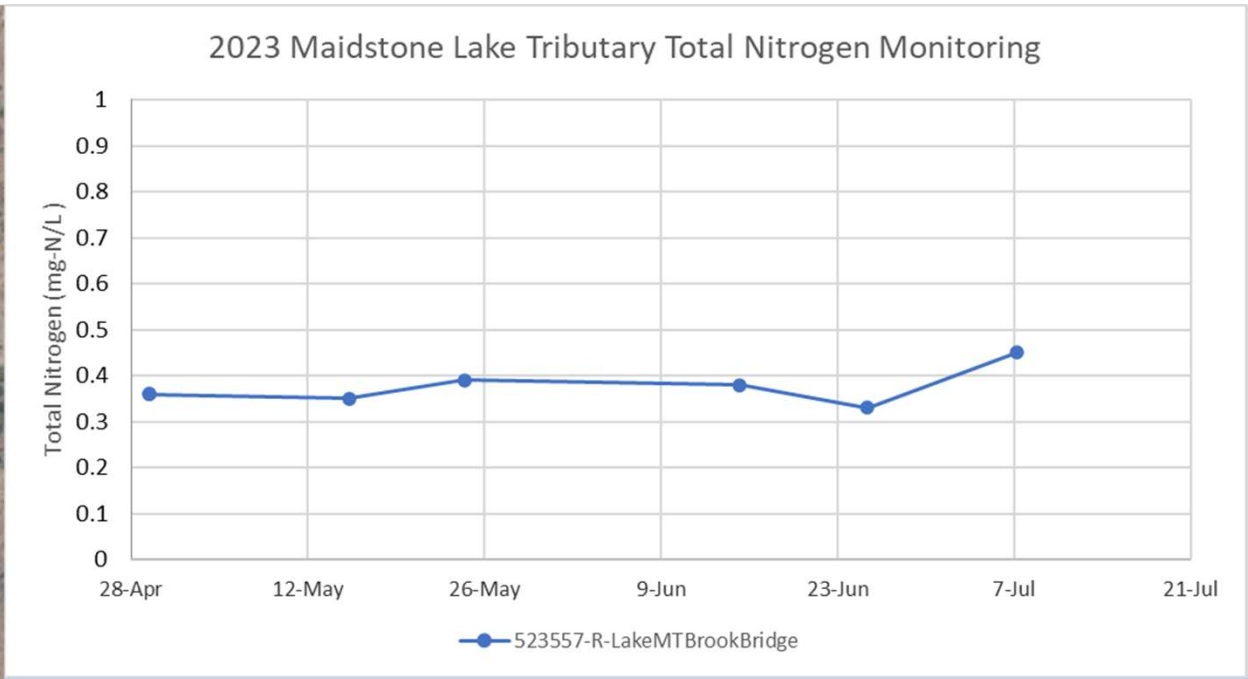

2023 Maidstone Lake Tributary Total Phosphorus Monitoring
Total Phosphorus (ug/L)
35
30
25
20
15
10
5
0
28-Apr
12-May
26-May
9-Jun
23-Jun
7-Jul
21-Jul
4-Aug
523557-R-LakeMTBrookBridge

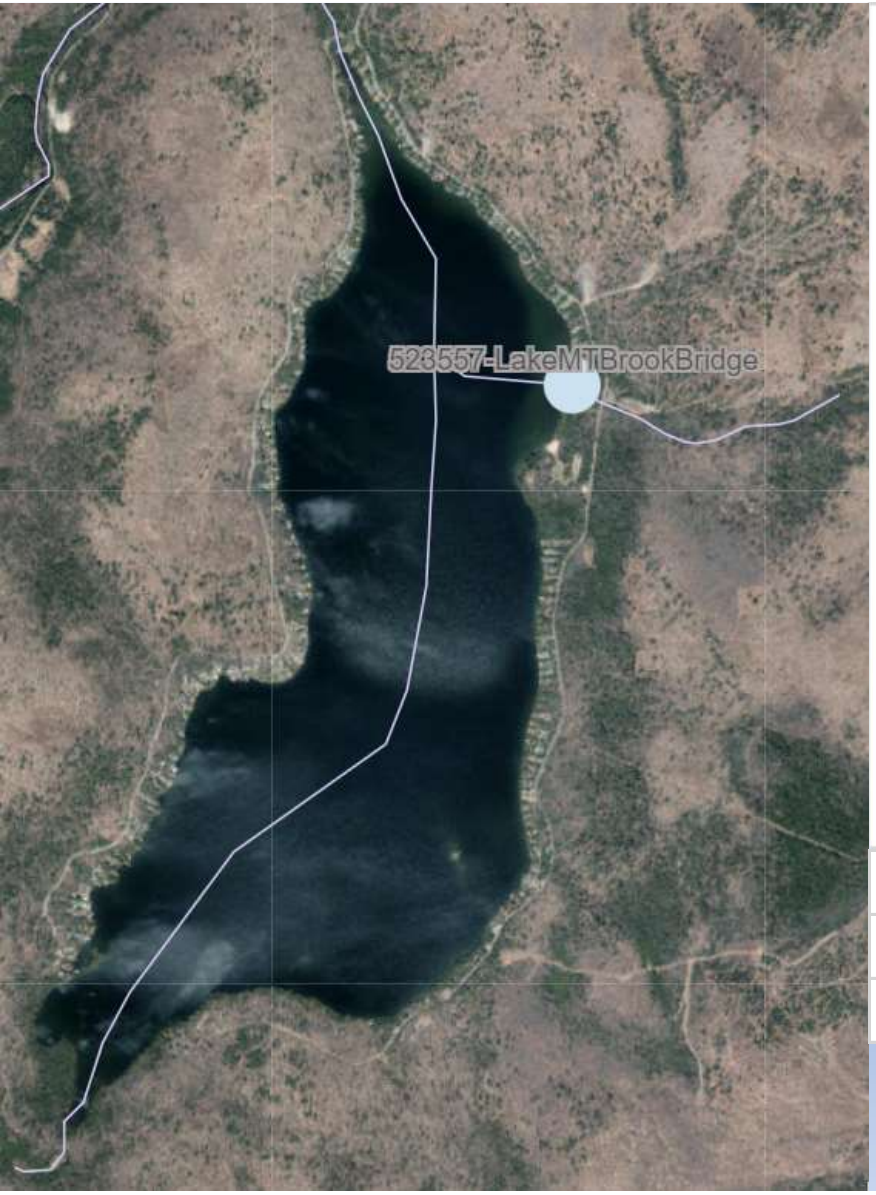


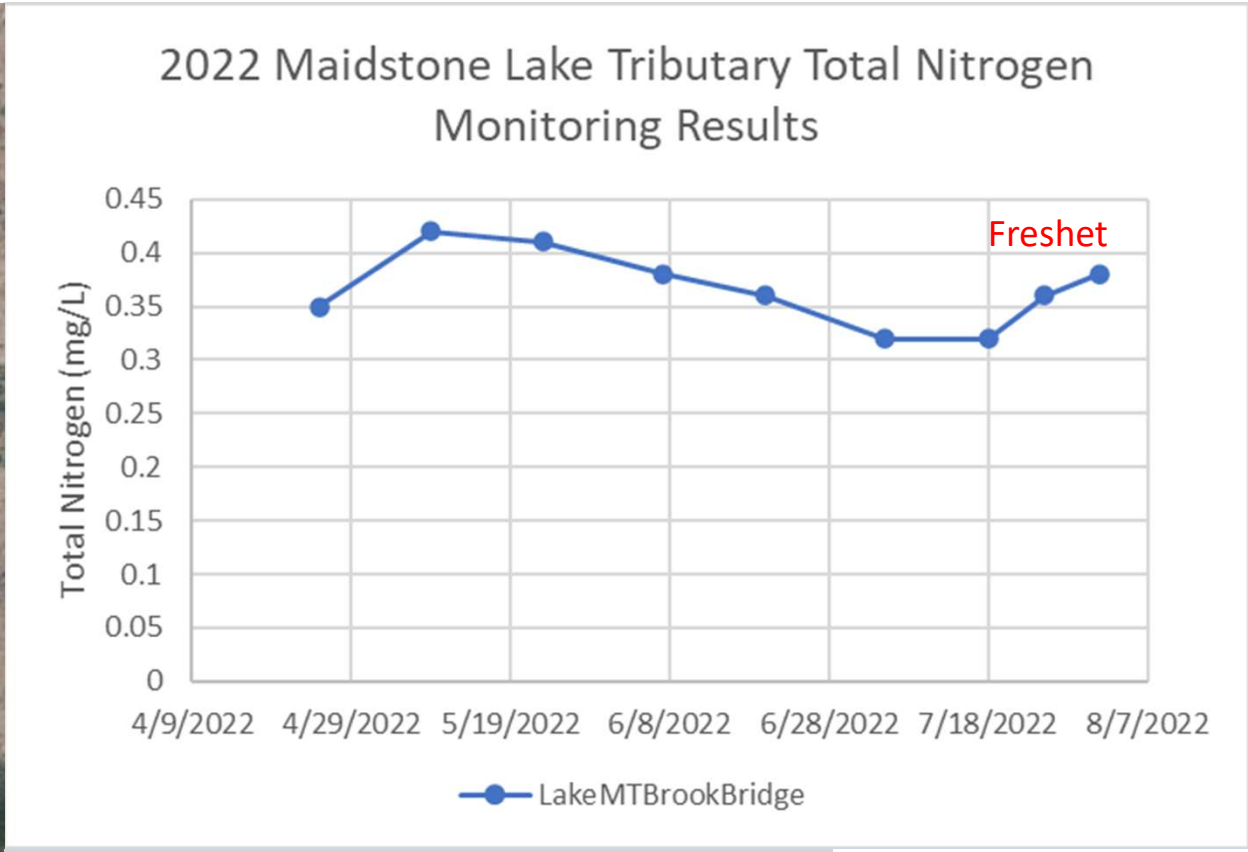


Mean Total Phophorus	**(ug/L)**	**24.0**
Minimum Total Phosphorus	**(ug/L)**	13.8
Maximum Total Phosphorus	**(ug/L)**	44.6


523557-LakeMTBrookBridge

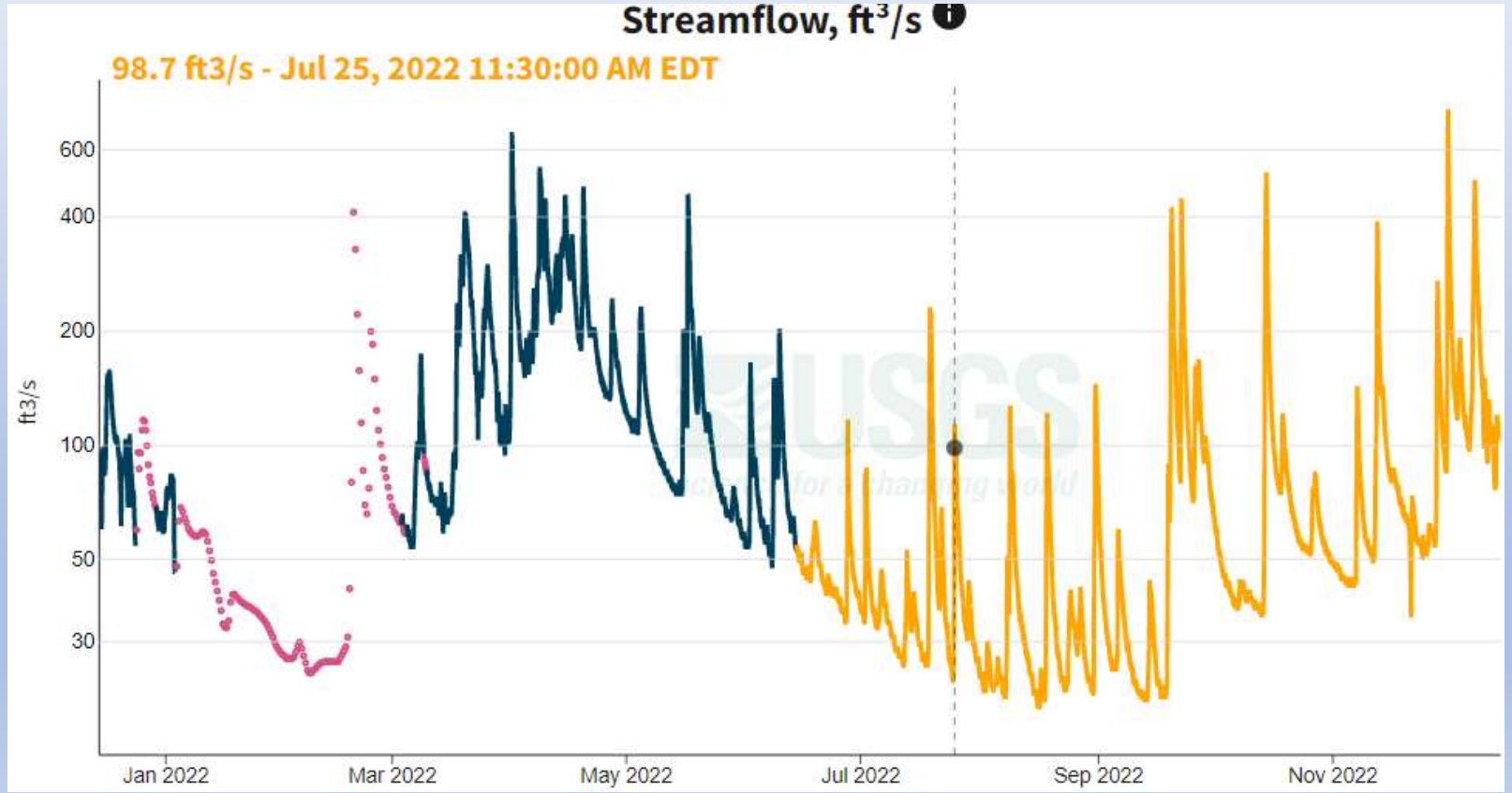

2023 Maidstone Lake Tributary Total Nitrogen Monitoring
Total Nitrogen (mg-N/L)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
28-Apr
12-May
26-May
9-Jun
23-Jun
7-Jul
21-Jul
523557-R-LakeMTBrookBridge





Mean Total Nitrogen	**(ug/L)**	**0.37**
Minimum Total Nitrogen	**(ug/L)**	**0.32**
Maximum Total Nitrogen	**(ug/L)**	**0.42**

USGS Streamflow – E. Branch of Passumpic R.



2023 Monitoring Summary & 2024 Next Steps

https://lamotte.com/horizontal-water-sampler-1087

- Lay Monitoring Program (LMP)
  - 2023 Summary: Lake looks good with similar epilimnetic and hypolimnetic concentrations and slight dip in clarity after July rains.
  - 2024 Next Steps: LMP volunteer continues collecting biweekly epilimnetic (0.5 m) and hypolimnetic (20 m) samples. Caffeine testing will also continue at a lower lab reporting limit (≤0.1 ug/L). LMP staff collects duplicate samples, vertical profile data, and additional metalimnetic (~10 m) sample during annual visit.
- LaRosa Partnership Program (LPP)
  - 2023 Summary: LakeMTBrookBridge had increasing TP
  - 2024 Next Steps: LPP volunteer continues collecting biweekly samples June through August and investigate tributary upstream for potential problem areas