2023 Echo Lake Water Quality Monitoring Results: Lay Monitoring Program and LaRosa Partnership Program

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VT Department of Environmental Conservation, UVM Lake Champlain Sea Grant

VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WATERSHED MANAGEMENT DIVISION
LAKES & PONDS PROGRAM

VERMONT LAY MONITORING PROGRAM •1979•

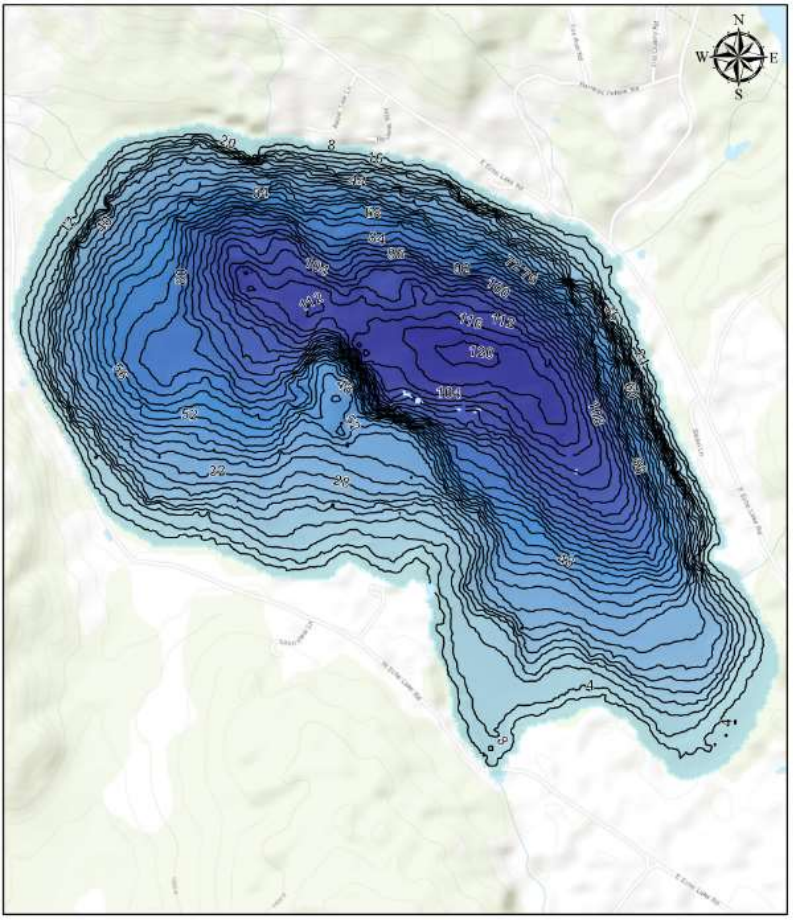
Sea Grant
Lake Champlain

Lay Monitoring Program (LMP) 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 water samples with hose at twice Secchi depth 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

Echo Lake, Charleston, VT



Legend

Depth (ft.)

High : 0

Low : 121

Depth Contour (4 ft.)

0 0.125 0.25 0.5 Miles

VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WATERSHED MANAGEMENT DIVISION
LAKES & PONDS PROGRAM

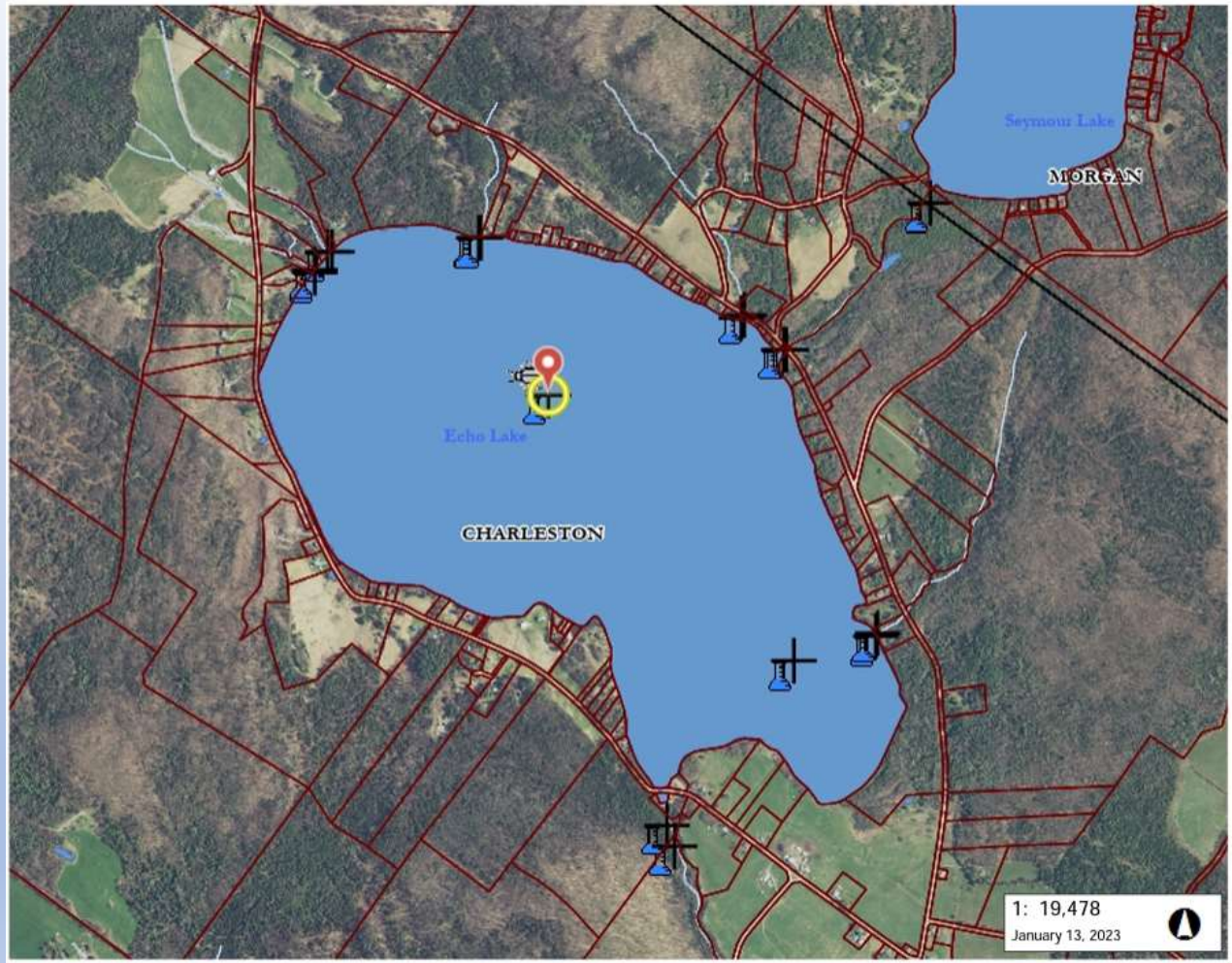
Source Data Collected: 9/20/2018

VERMONT

Echo Lake (Charleston) 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

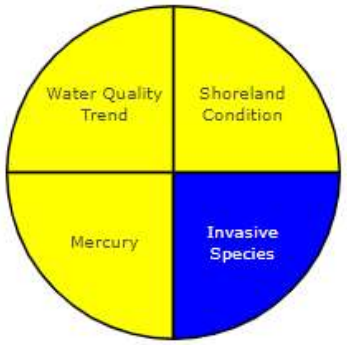
THIS MAP IS NOT TO BE USED FOR NAVIGATION

Vermont Lake Score Card

Echo Lake

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

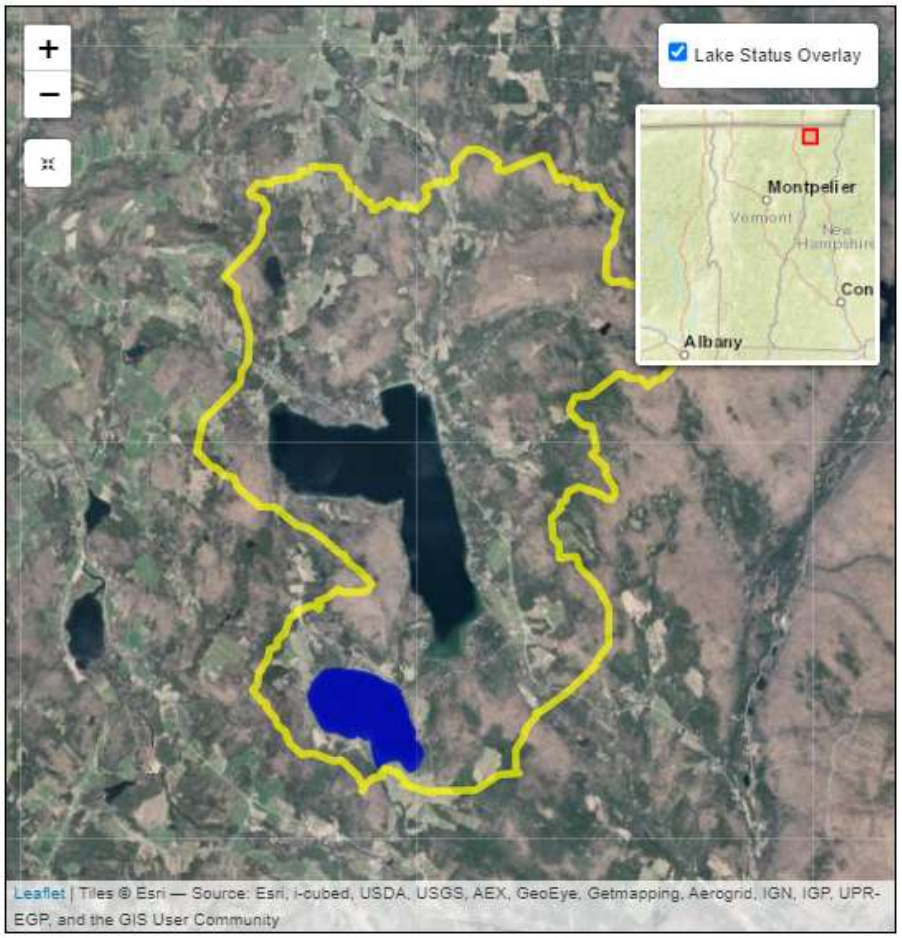
Scores | Water Quality Data | Lake Information



Watershed:	Moderately Disturbed
WQ Standards:	Meets Standards

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

Learn How Lakes Are Scored



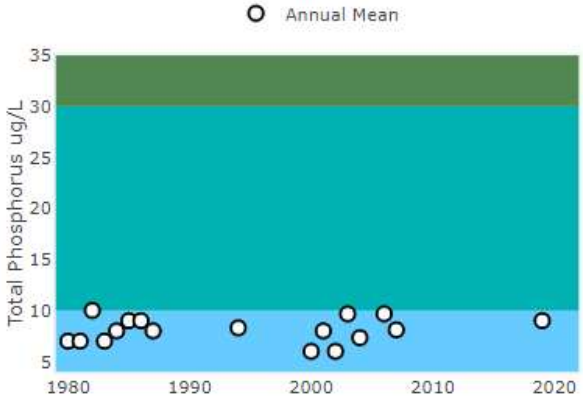
■ Hypereutrophic ■ Eutrophic ■ Mesotrophic ■ Oligotrophic

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

ECHO LAKE (CHARLESTON) SCORE CARD WATER QUALITY ANNUAL MEANS

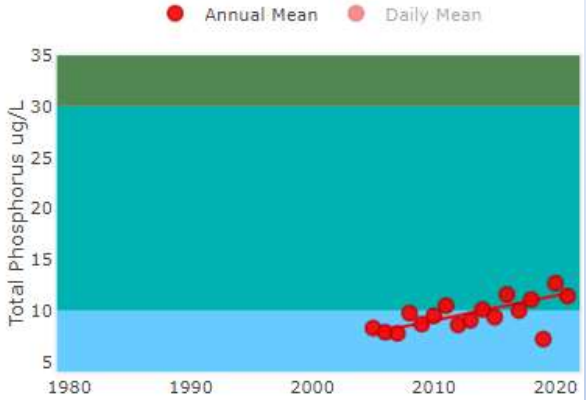
Spring Phosphorus

Trend: Stable (p-value=0.3599)



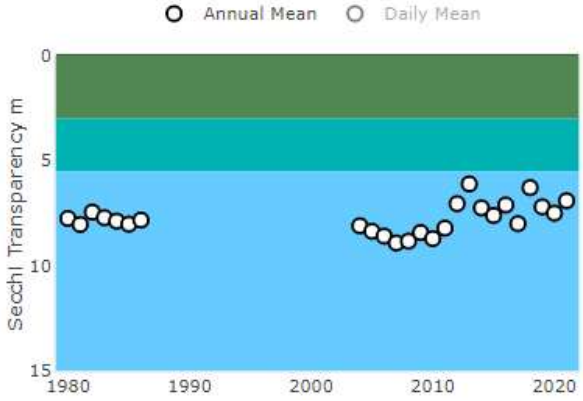
Summer Phosphorus

Trend: Highly Significantly Increasing (p-value=0.0037)



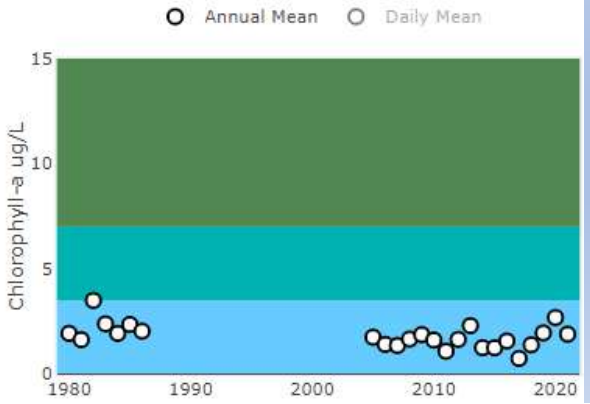
Summer Secchi

Trend: Stable (p-value=0.2512)



Summer Chlorophyll-a

Trend: Stable (p-value=0.1955)



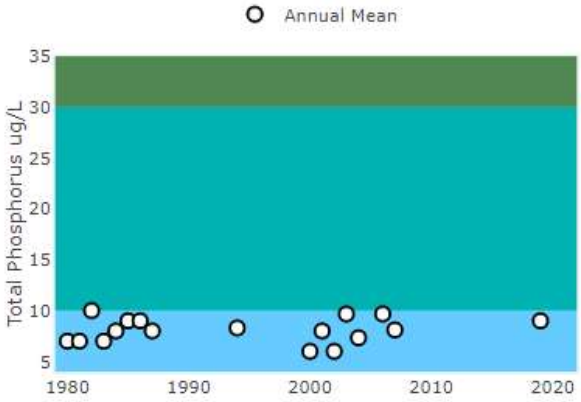
■ Hypereutrophic ■ Eutrophic ■ Mesotrophic ■ Oligotrophic

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

ECHO LAKE (CHARLESTON) SCORE CARD WATER QUALITY ANNUAL RANGE

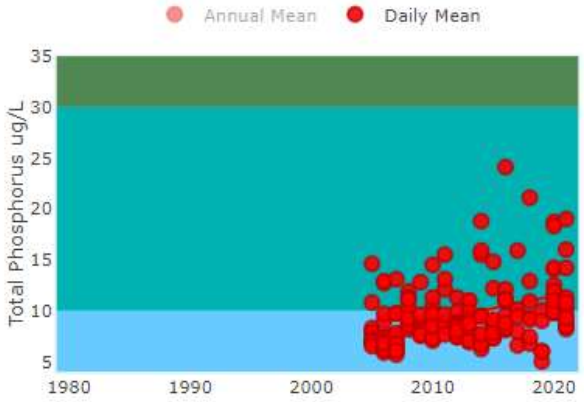
Spring Phosphorus

Trend: Stable (p-value=0.3599)



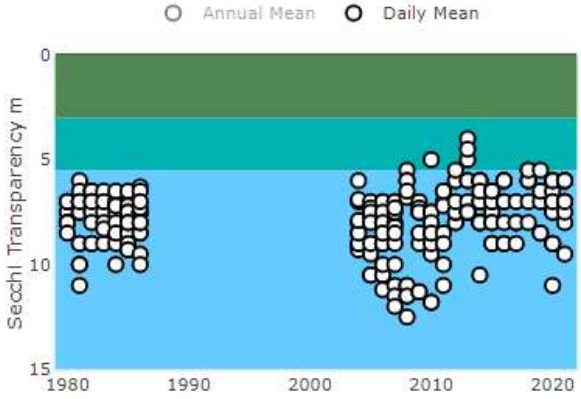
Summer Phosphorus

Trend: Highly Significantly Increasing (p-value=0.0037)



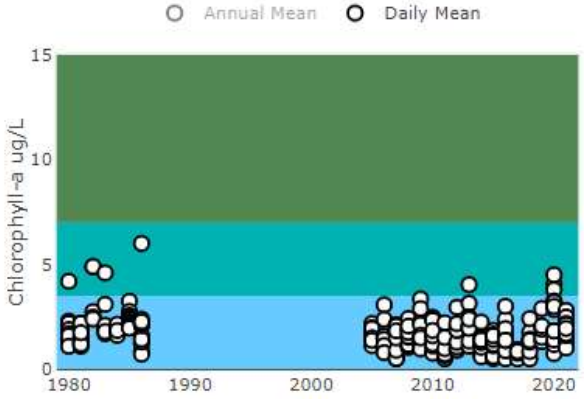
Summer Secchi

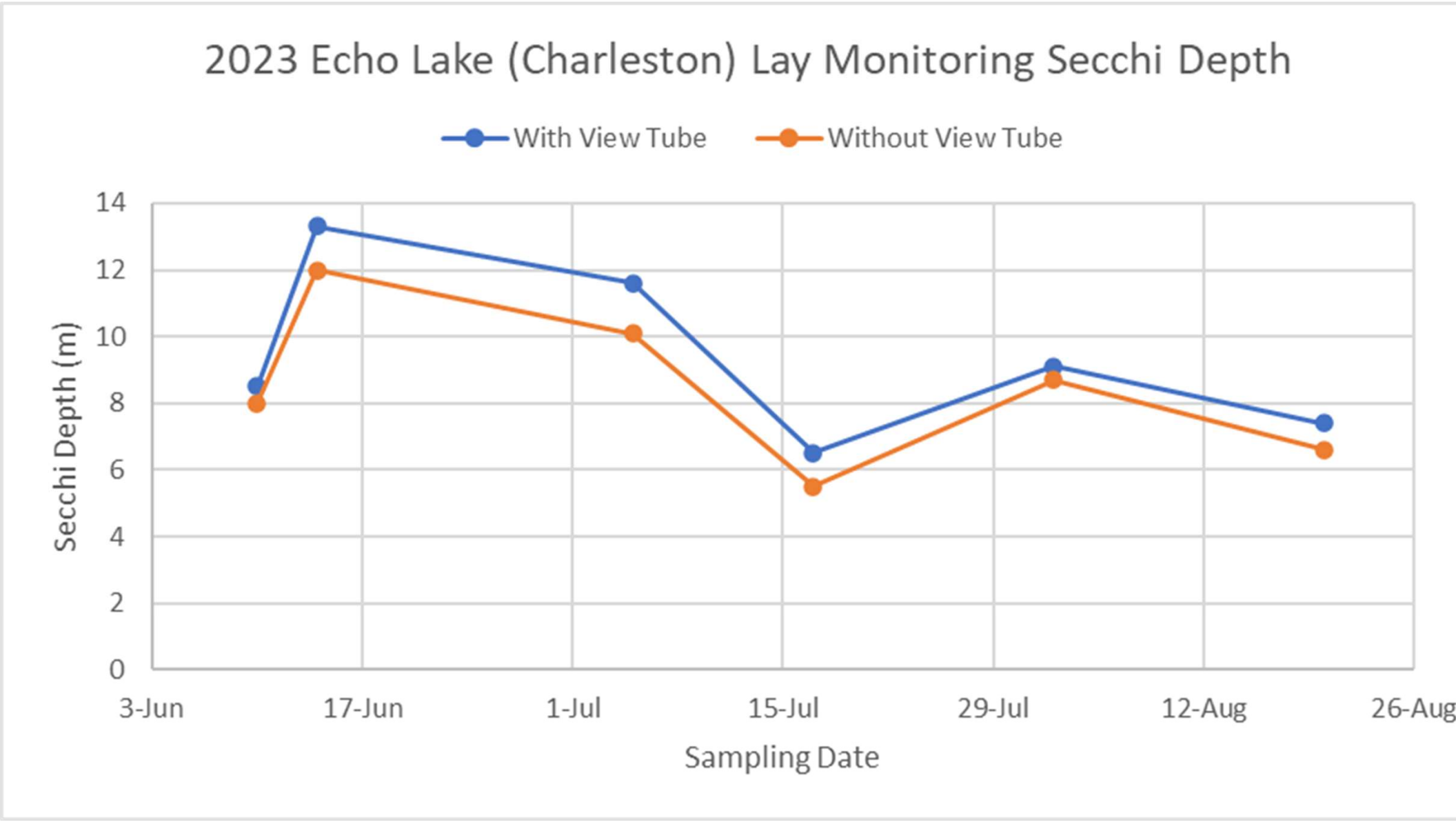
Trend: Stable (p-value=0.2512)

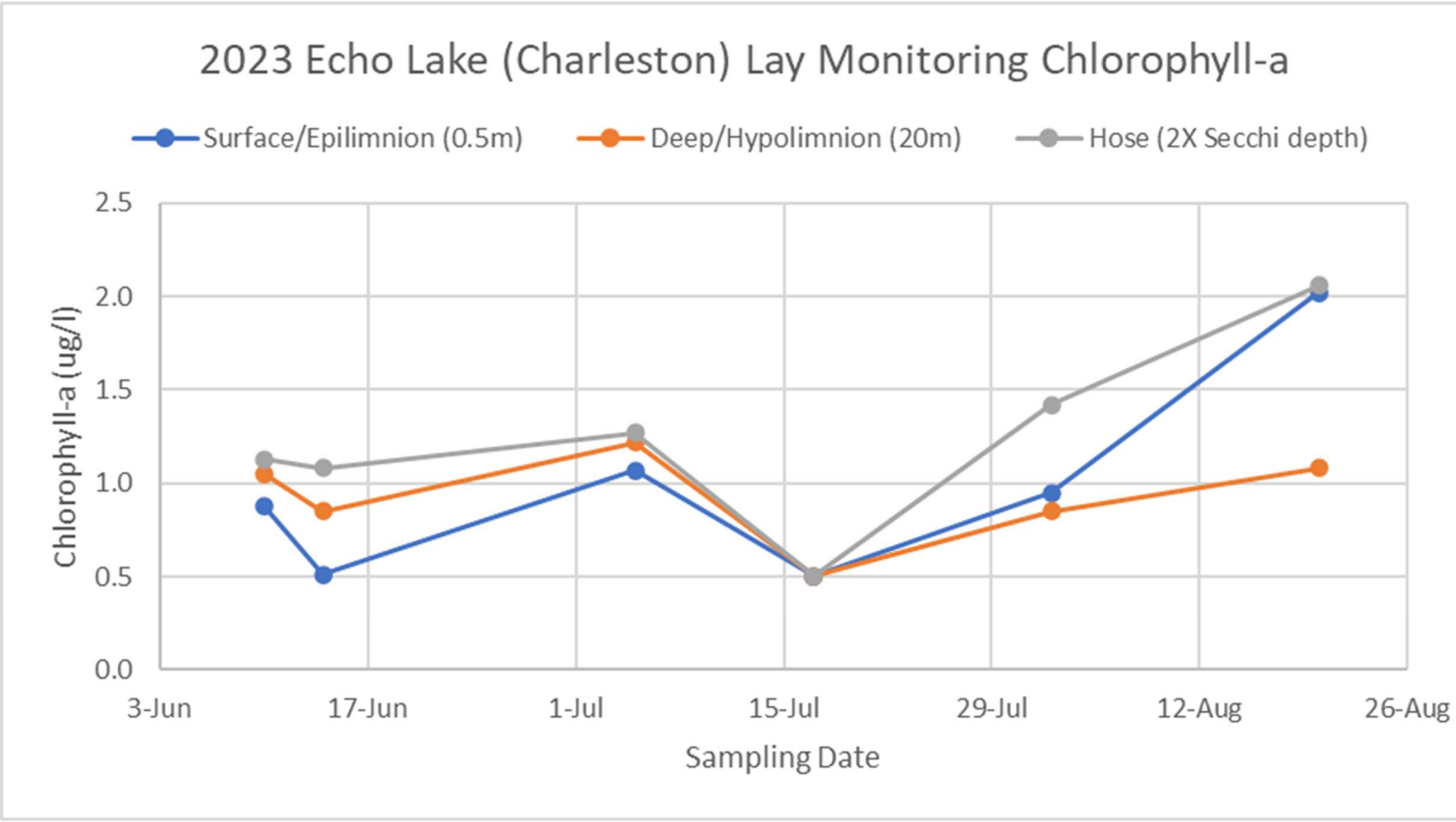


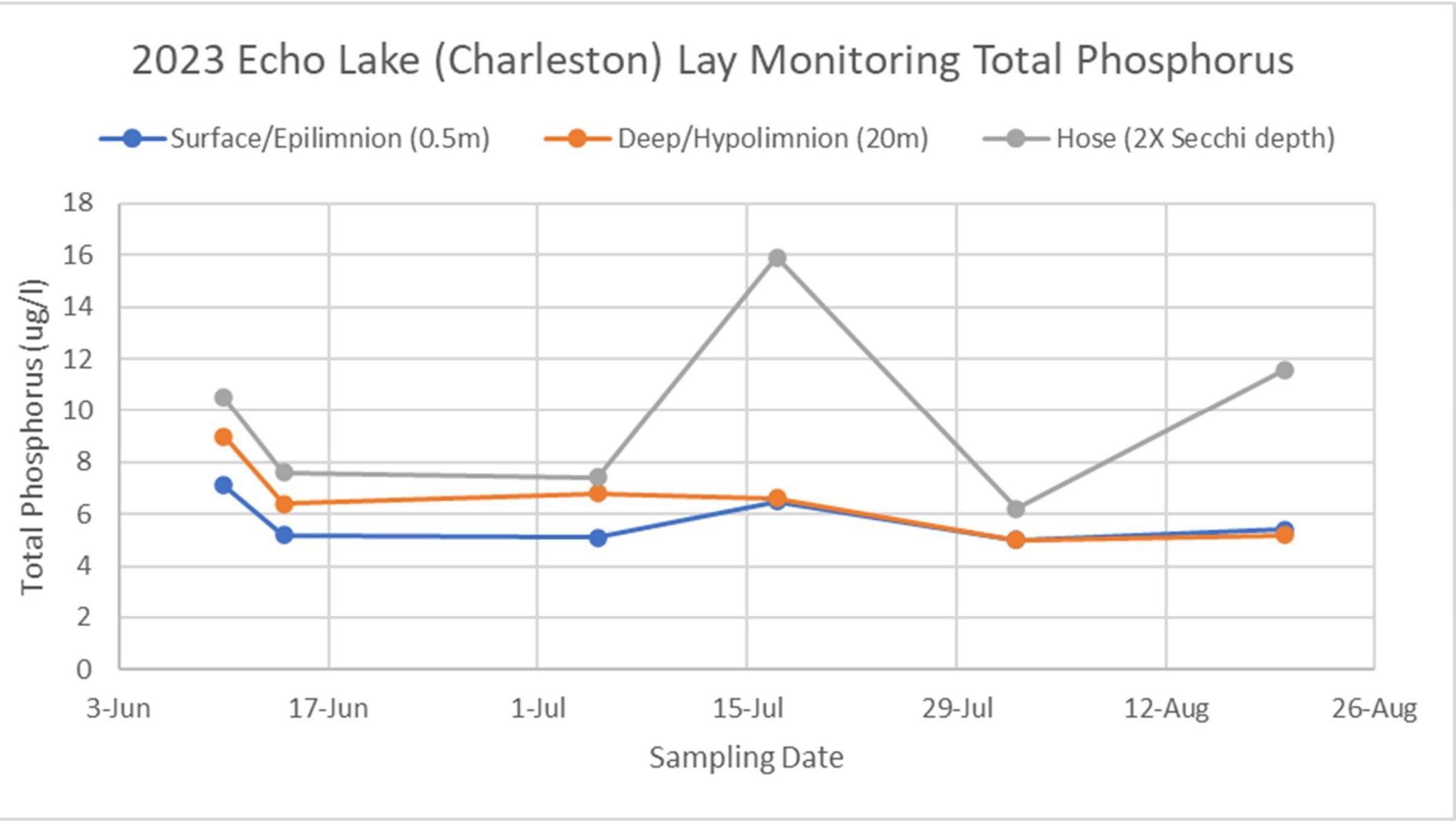
Summer Chlorophyll-a

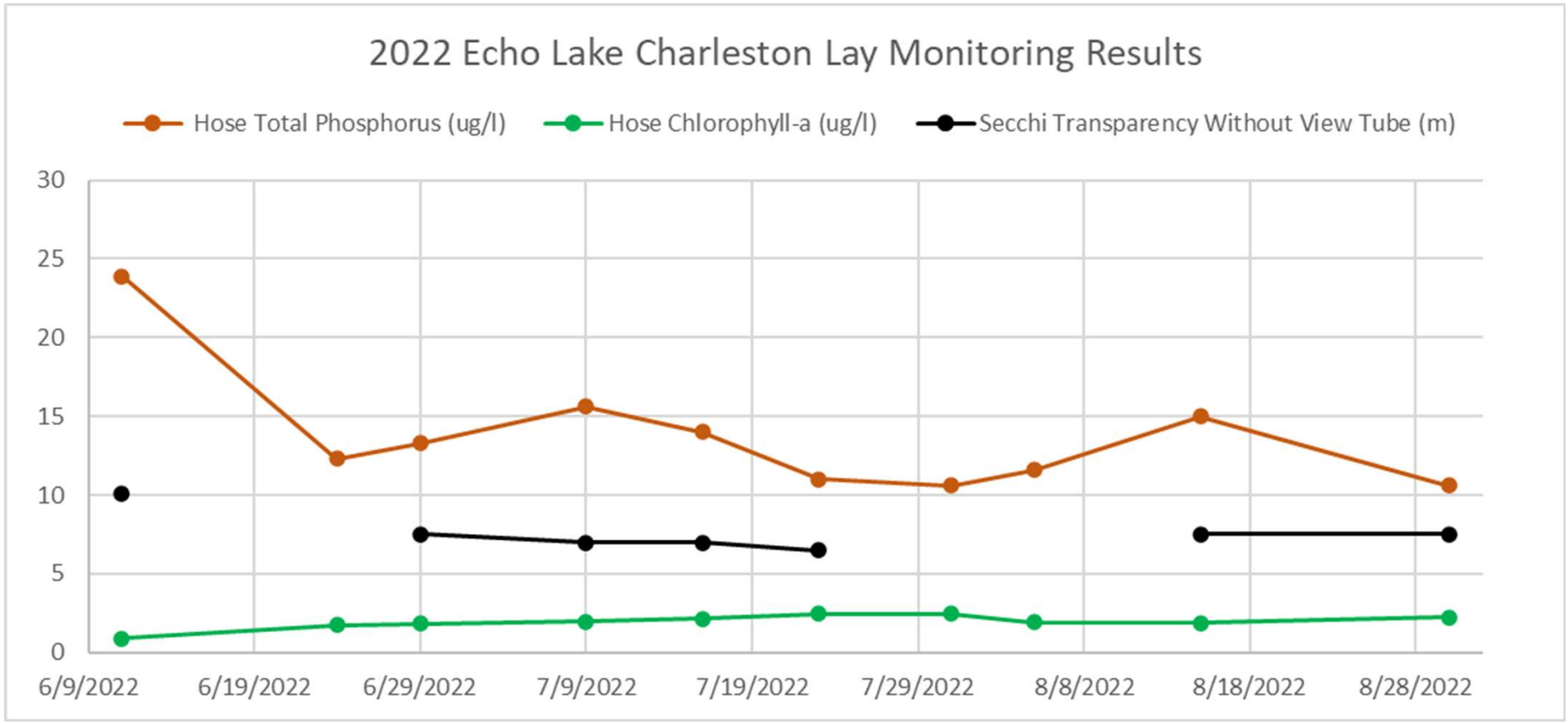
Trend: Stable (p-value=0.1955)



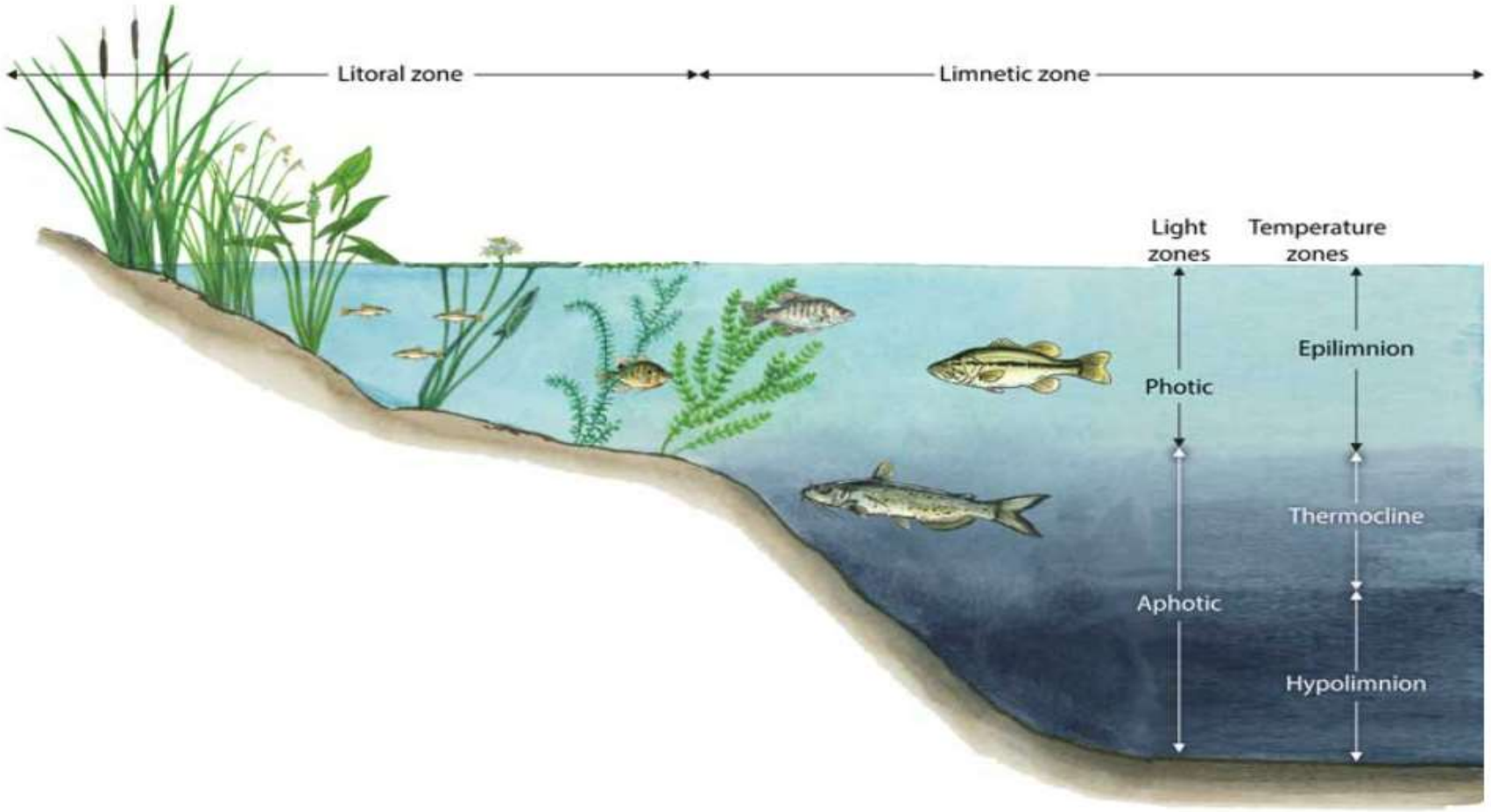

2023 Echo Lake (Charleston) Lay Monitoring Secchi Depth
With View Tube
Without View Tube
Secchi Depth (m)
14
12
10
8
6
4
2
0
3-Jun
17-Jun
1-Jul
15-Jul
29-Jul
12-Aug
26-Aug
Sampling Date


2023 Echo Lake (Charleston) Lay Monitoring Chlorophyll-a
Surface/Epilimnion (0.5m)
Deep/Hypolimnion (20m)
Hose (2X Secchi depth)
Chlorophyll-a (ug/l)
2.5
2.0
1.5
1.0
0.5
0.0
3-Jun
17-Jun
1-Jul
15-Jul
29-Jul
12-Aug
26-Aug
Sampling Date


2023 Echo Lake (Charleston) Lay Monitoring Total Phosphorus
Surface/Epilimnion (0.5m)
Deep/Hypolimnion (20m)
Hose (2X Secchi depth)
Total Phosphorus (ug/l)
18
16
14
12
10
8
6
4
2
0
3-Jun
17-Jun
1-Jul
15-Jul
29-Jul
12-Aug
26-Aug
Sampling Date


2022 Echo Lake Charleston Lay Monitoring Results
Hose Total Phosphorus (ug/l)
Hose Chlorophyll-a (ug/l)
Secchi Transparency Without View Tube (m)
30
25
20
15
10
5
0
6/9/2022
6/19/2022
6/29/2022
7/9/2022
7/19/2022
7/29/2022
8/8/2022
8/18/2022
8/28/2022

From Lake Champlain Long-Term Monitoring Protocol:
During stratified conditions, two samples will be obtained, representing the epilimnion and hypolimnion, respectively.
https://dec.vermont.gov/sites/dec/files/wsm/docs/20200605%20LTM%205yr%20QAPP-Workplan.pdf

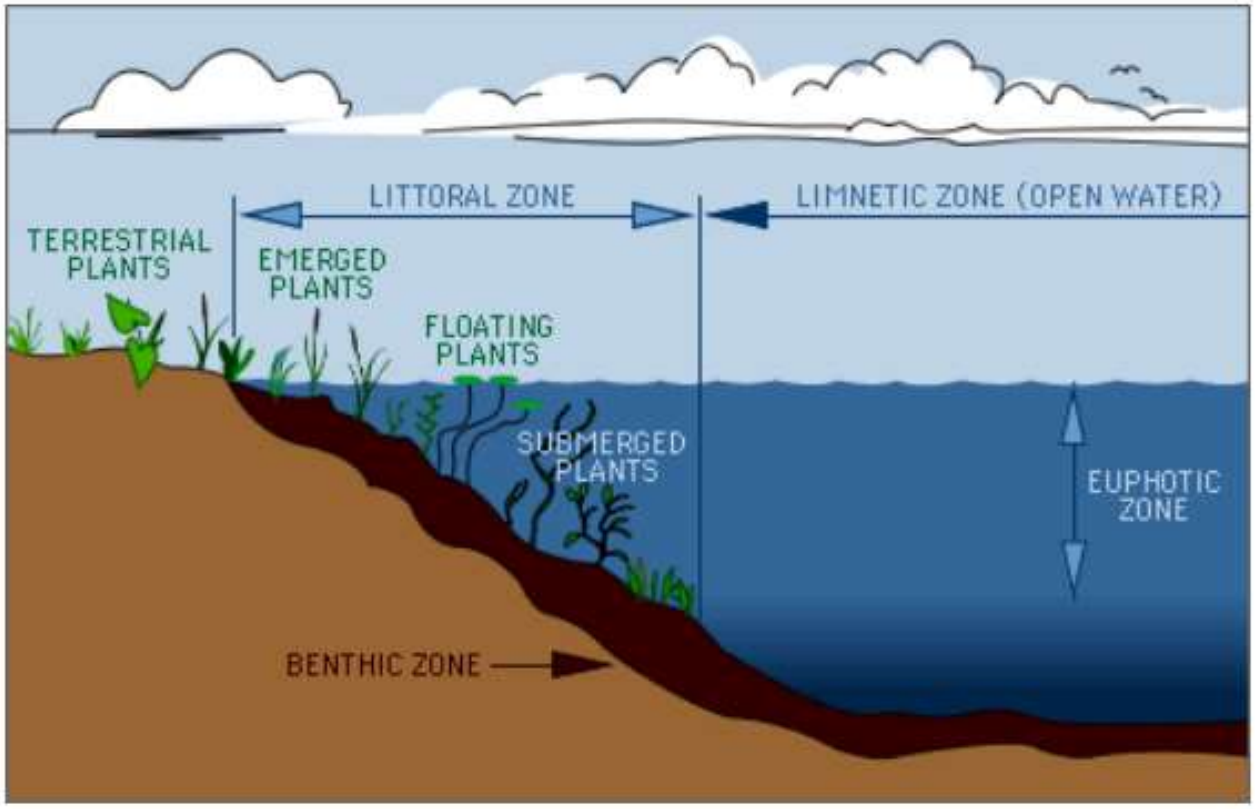


(Image courtesy of Kasco Marine)

https://kascomarine.com/blog/pond-lake-zone-identification/

Lake Zones

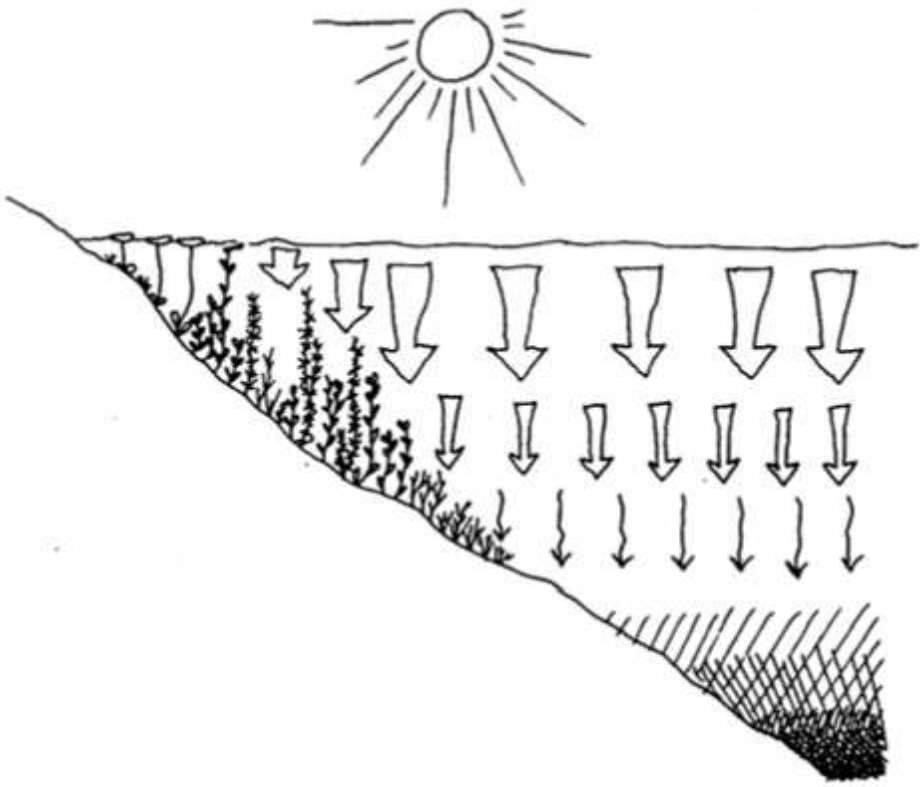
A typical lake has distinct zones of biological communities linked to the physical structure of the lake (Figure 10). The **littoral** zone is the near shore area where sunlight penetrates all the way to the sediment and allows aquatic plants (**macrophytes**) to grow. Light levels of about 1% or less of surface values usually define this depth. The 1% light level also defines the **euphotic zone** of the lake, which is the layer from the surface down to the depth where light levels become too low for **photosynthesizers**. In most lakes, the sunlit euphotic zone occurs within the **epilimnion**.



http://waterontheweb.org/under/lakeecology/10_biological_lakezones.html

4. *Light*

Plants need light to grow. Many lakes have deep water areas where rooted plants can't get enough light to survive. The maximum depth at which plants grow in a lake depends on the water clarity. In Vermont lakes, plants can generally be found growing out to water depths of 25 feet.



https://dec.vermont.gov/sites/dec/files/wsm/lakes/ans/docs/Lake%20and%20Pond%20Plants%20Booklet.pdf

Sampling Date	Hose Sample Depth (m)	Hose Total Phosphorus (ug/l)	Hose Chlorophyll-a (ug/l)	Secchi Transparency Without View Tube (m)
6/11/2022	20	23.9	0.89	10.1
6/24/2022		12.3	1.73	
6/29/2022	15	13.3	1.82	7.5
7/9/2022	14	15.6	1.98	7
7/16/2022	14	14	2.14	7
7/23/2022	13	11	2.45	6.5
7/31/2022		10.6	2.46	
8/5/2022		11.6	1.92	
8/15/2022	15	15	1.88	7.5
8/30/2022	15	10.6	2.24	7.5
2022 Mean	**15.1**	**13.8**	**1.95**	**7.6**
A1 Criteria	**Euphotic Zone**	**12**	**2.6**	**5**

ECHO 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	7.2				3.0
1980	13	7.8		1.9		7.0
1981	14	8.0		1.6		7.0
1982	10	7.5				10.0
1983	8			2.4		7.0
1984	9	7.9		1.9		8.0
1985	15	8.0		2.3		9.0
1986	14	7.8		2.0		9.0
1987						8.0
1994						8.3
2000						6.0
*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						7.3
2002						6.0
2003						9.7
2004	12	8.1				7.3
2005	11	8.4		1.7	8.3	
2006	13	8.6		1.4	7.9	9.7
2007	12	8.9		1.3	7.8	8.1
2008	10	8.8		1.7	9.7	
2009	10	8.4		1.9	8.7	
2010	10	8.7		1.6	9.5	
2011	8	8.2			10.5	
2012	10	7.1		1.6	8.6	
2013	9	6.1		2.3	9.0	
2014	12	7.3		1.2	10.1	
2015	9	7.6		1.2	9.3	
2016	9	7.1		1.6	11.6	
2017	5					
2018	7					
2019	5					9.0
2020	13	7.5		2.7	12.7	
2021	11	7.0		1.9	11.4	
2022	10			2.0	13.8	
*VT Standard**		*2.6*		*7.0*	*18.0*	

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

LaRosa Partnership Program Tributary Sampling Overview

- Tributaries first sampled in 2021 ~biweekly (8X) May/June to July/August + ~2 storm events
- 523168-R-Echo Inlet
  - Perrenial stream-Measure potential nutrients entering the lake to determine if they are contributing to rising P levels.
- 523170-R-Bennett-BFarmRd
  - Perrenial stream-Possible euthropication from upstream hay fields and road runoff that may contribute to rising P levels in lake.
- 523171-R-Dickey-EchLRd
  - Perrenial stream-Possible euthropication from erosion and road runoff that may contribute to rising P levels in lake.
- 523172-R-Winape-BPebbleRd
  - Intermittent stream- Possible euthropication from upstream housing development that may contribute to rising P levels in the lake.
- 523554-EEchoLakeRd
  - Perennial stream-possible eutrophication from road runoff
- 523640-WEchoLakeRd
  - 100ft downstream from lake side of road

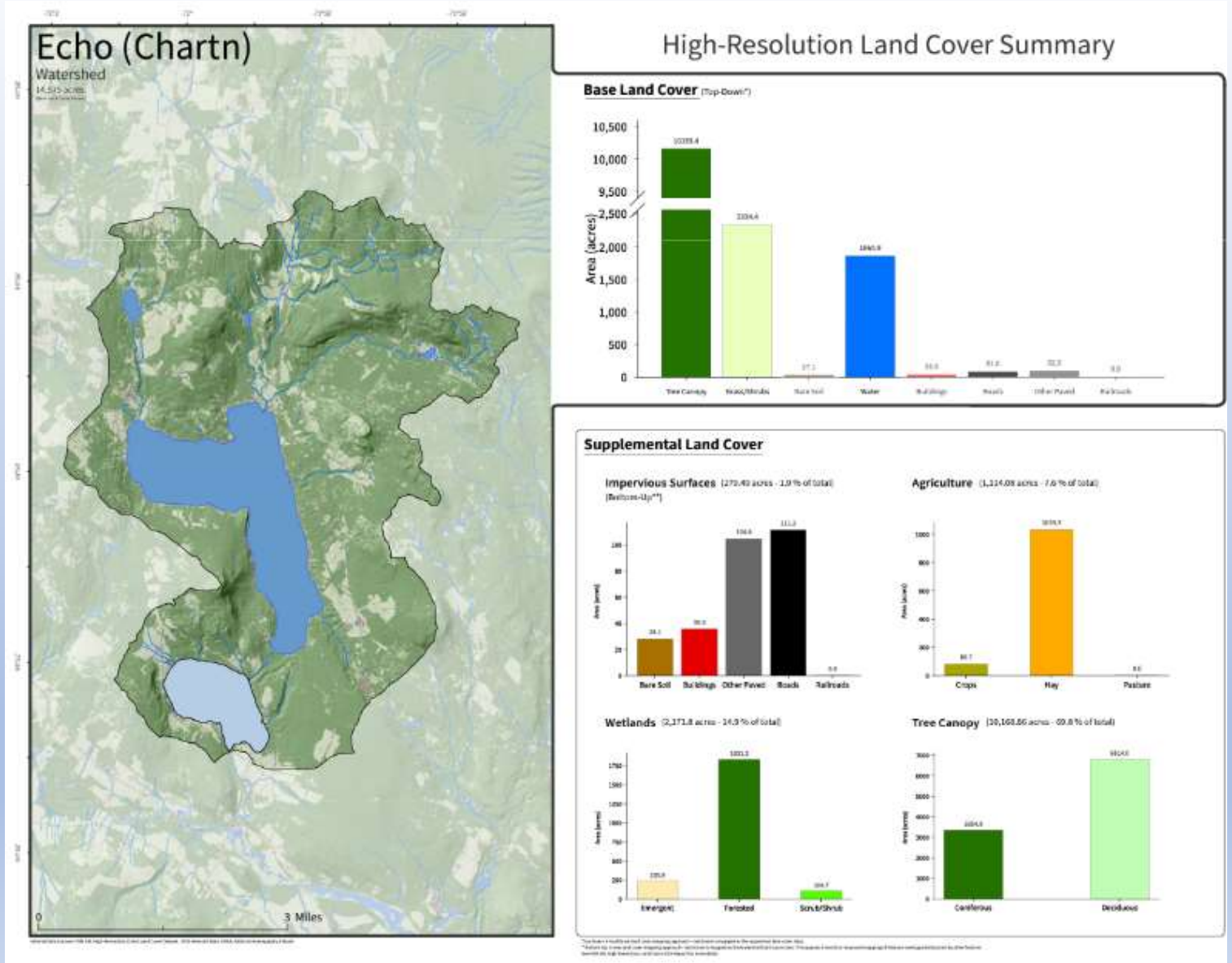
LPP Sample Parameters Overview

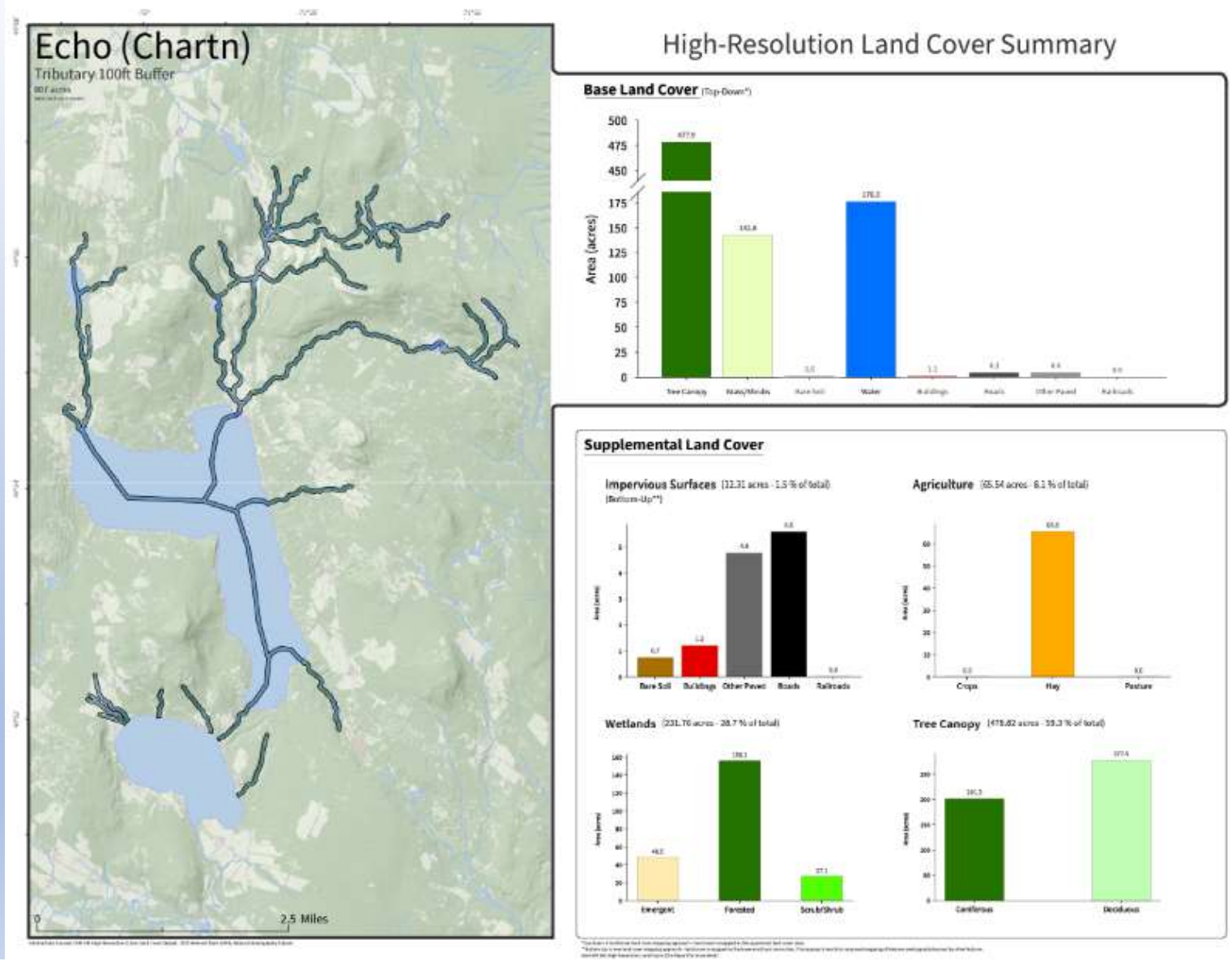
Total Phosphorus

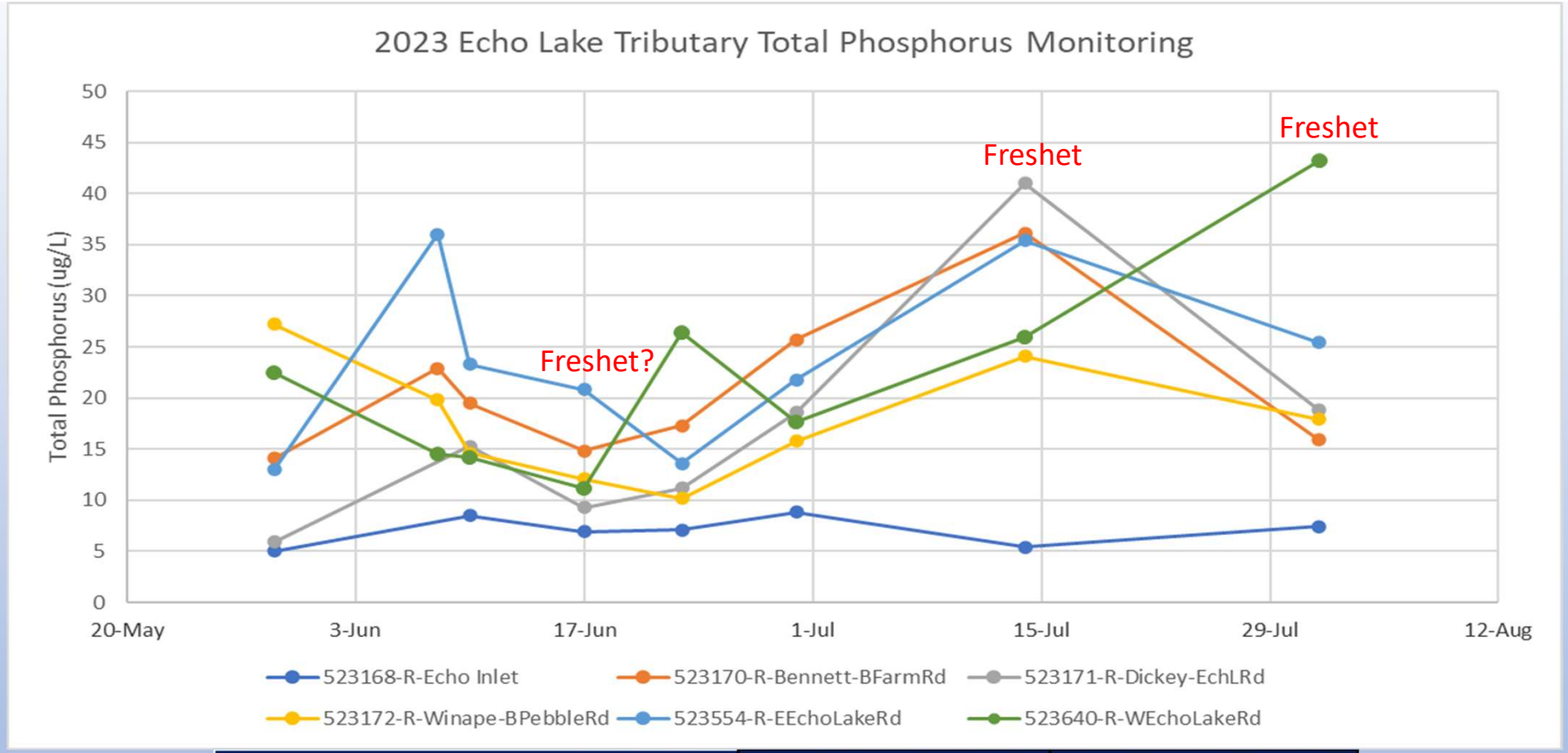
- *Impacts*
  - Feeds plants, algae and cyanobacteria
  - Aquatic Biota, Aesthetics, Recreation Uses
- *Human Sources*
  - Runoff from roads, lawns, agriculture, logging
  - Malfunctioning septic systems
- *Vermont Water Quality Standards Nutrient Criteria for Aquatic Biota Use (+ Biological Criteria)*
  - 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

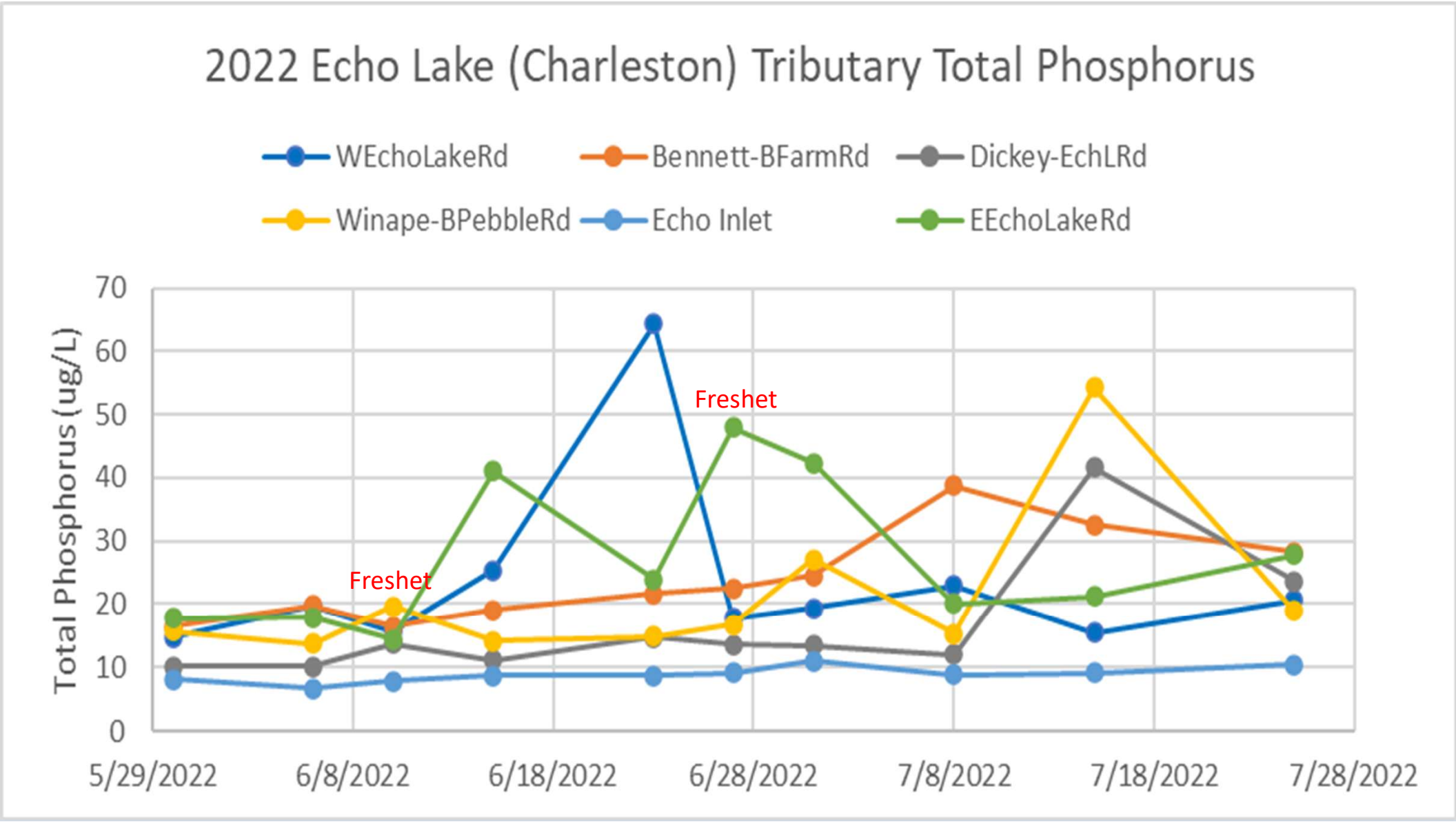
- *Impacts*
  - Feeds plants, algae and cyanobacteria
  - Aquatic Biota, Aesthetics, Recreation Uses
- *Human Sources*
  - Runoff from roads, lawns, agriculture, logging
  - Malfunctioning septic systems
- *Vermont Water Quality Standards*
  - Not to exceed 5.0 mg/l as NO3-N at flows exceeding low median 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.

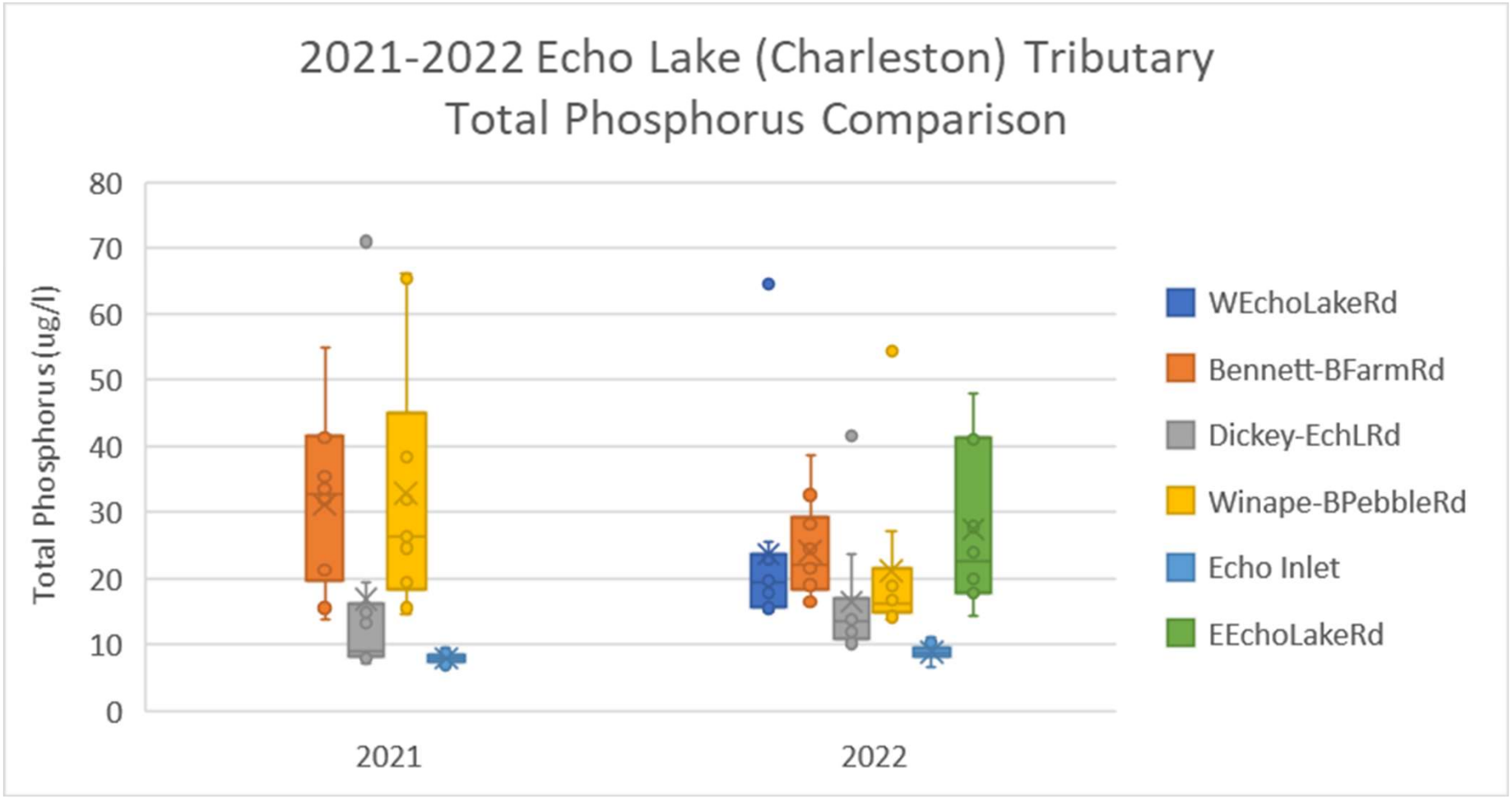

Echo (Chartn)
Watershed
0
3 Miles
High-Resolution Land Cover Summary
Base Land Cover (Top-Down*)
Area (acres)
10,500
10,000
9,500
2,500
2,000
1,500
1,000
500
0
Supplemental Land Cover
Impervious Surfaces
Bare Soil
Buildings
Other Paved
Roads
Railroads
Agriculture
Crops
Hay
Pasture
Wetlands
Emergent
Forested
Scrub/Shrub
Tree Canopy
Coniferous
Deciduous

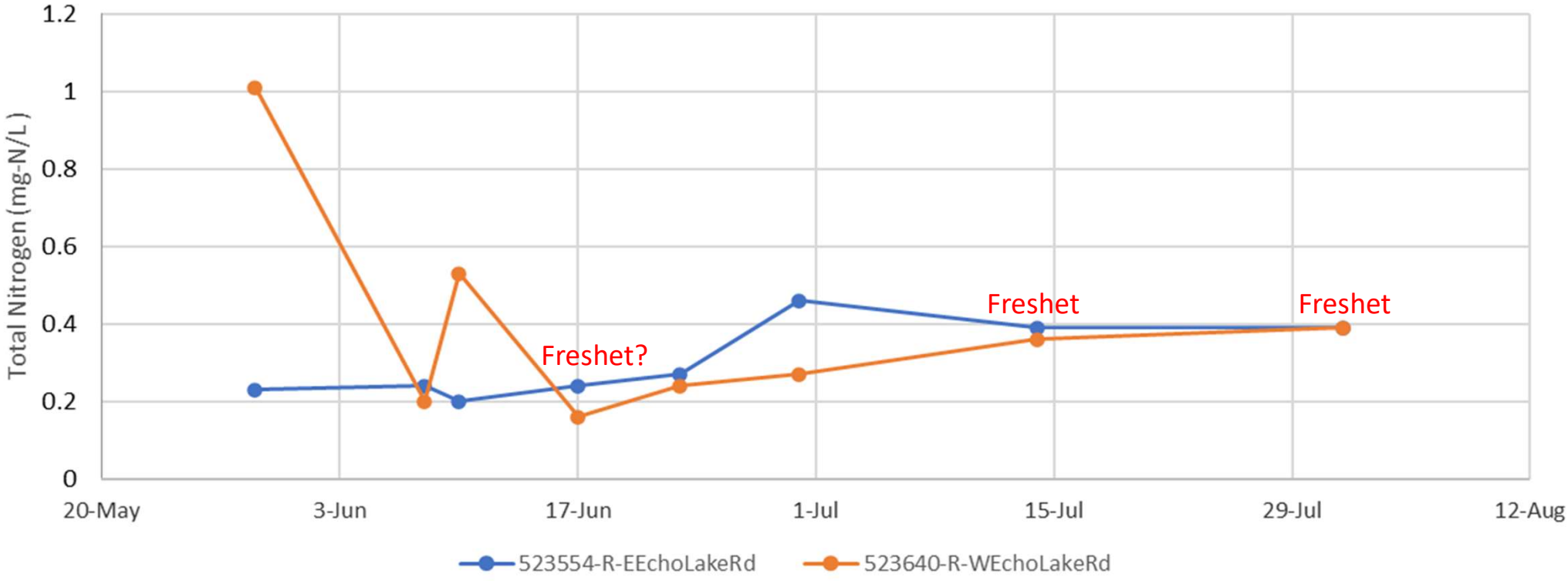

Echo (Chartn)
Tributary 100ft Buffer
2.5 Miles
High-Resolution Land Cover Summary
Base Land Cover (Top-Down*)
Area (acres)
500
475
450
175
150
125
100
75
50
25
0
Supplemental Land Cover
Impervious Surfaces (11.31 acres - 1.5 % of total)
(Bottom-Up**)
Bare Soil
Buildings
Other Paved
Roads
Railroads
Agriculture (65.54 acres - 8.1 % of total)
Crops
Hay
Pasture
Wetlands (231.76 acres - 28.7 % of total)
Emergent
Forested
Scrub/Shrub
Tree Canopy (478.82 acres - 59.3 % of total)
Coniferous
Deciduous



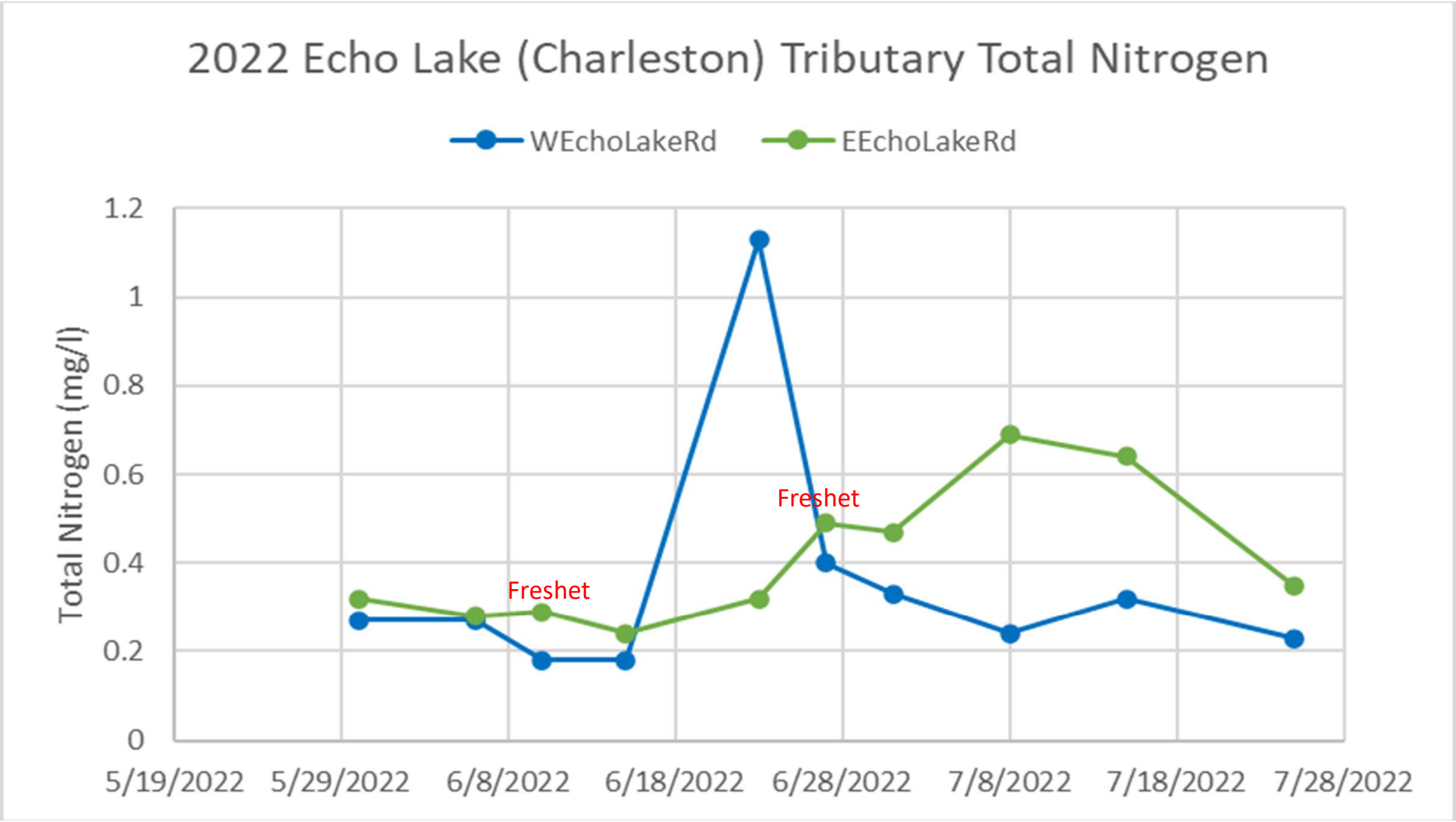
Site	LocID	# Sam	Mean TN	Max TN	Min TN	Mean TP	Max TP	Min TP
523170-R-Bennett-BFarmRd	523170	8				20.8	36.1	14.1
523171-R-Dickey-EchLRd	523171	7				17.2	41.0	5.9
523172-R-Winape-BPebbleRd	523172	8				17.7	27.2	10.2
523168-R-Echo Inlet	523168	7				7.0	8.8	5.0
523640-R-WEchoLakeRd	523640	8	0.40	1.01	0.16	22.0	43.2	11.2
523554-R-EEchoLakeRd	523554	8	0.30	0.46	0.20	23.7	36.0	13.0

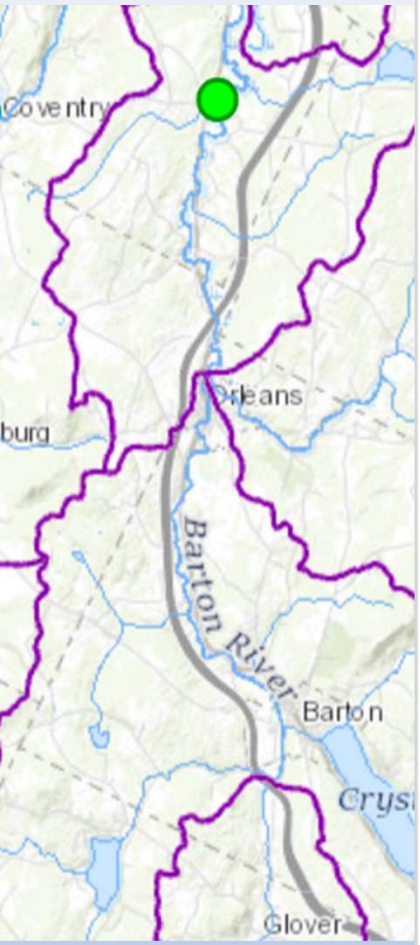

2022 Echo Lake (Charleston) Tributary Total Phosphorus
WEchoLakeRd
Bennett-BFarmRd
Dickey-EchLRd
Winape-BPebbleRd
Echo Inlet
EEchoLakeRd
Total Phosphorus (ug/L)
70
60
50
40
30
20
10
0
Freshet
Freshet
5/29/2022
6/8/2022
6/18/2022
6/28/2022
7/8/2022
7/18/2022
7/28/2022

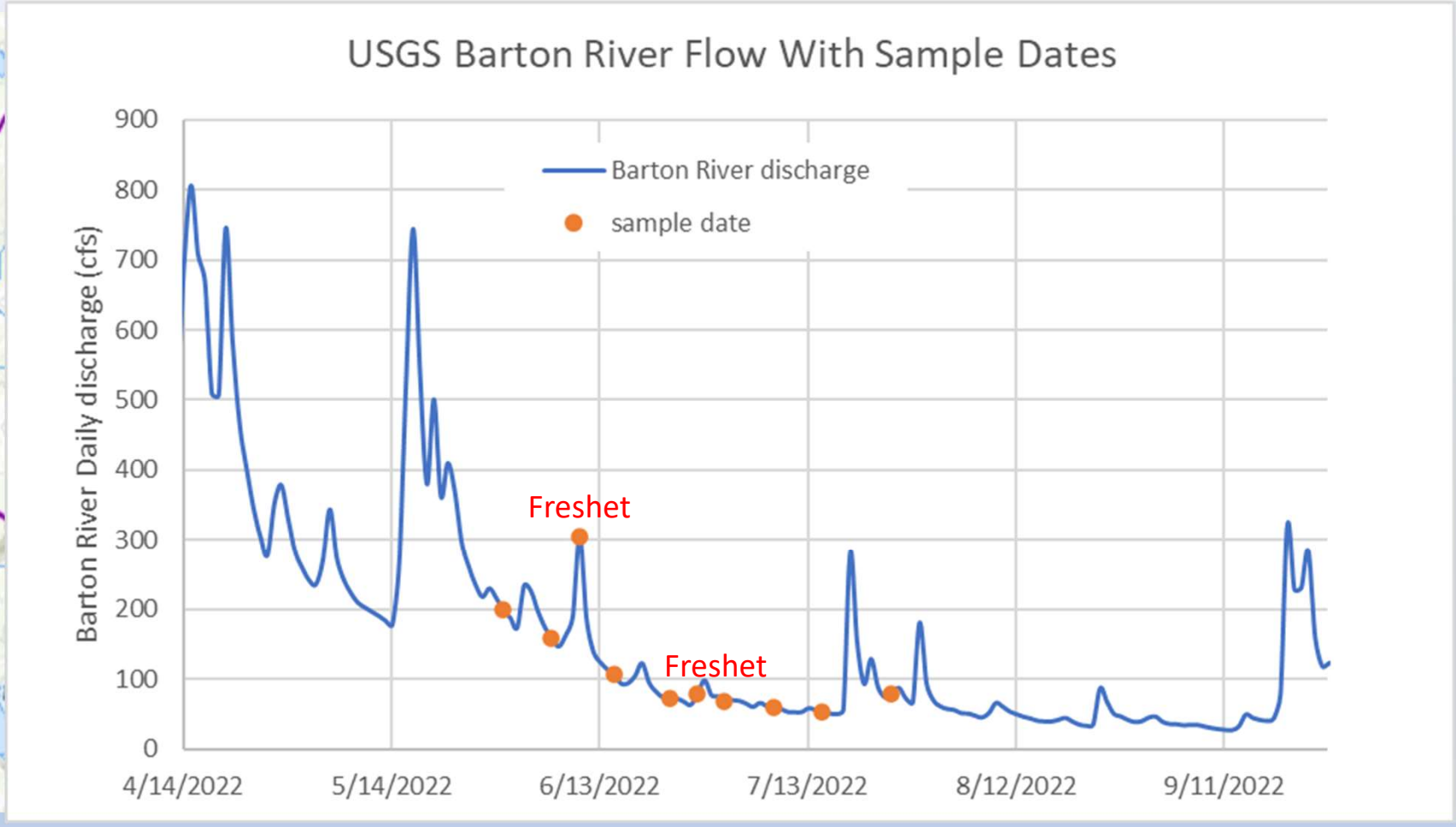

2021-2022 Echo Lake (Charleston) Tributary
Total Phosphorus Comparison
Total Phosphorus (ug/l)
80
70
60
50
40
30
20
10
0
2021
2022
WEchoLakeRd
Bennett-BFarmRd
Dickey-EchLRd
Winape-BPebbleRd
Echo Inlet
EEchoLakeRd



Site	LocID	# Sam	Mean TN	Max TN	Min TN	Mean TP	Max TP	Min TP
523170-R-Bennett-BFarmRd	523170	8				20.8	36.1	14.1
523171-R-Dickey-EchLRd	523171	7				17.2	41.0	5.9
523172-R-Winape-BPebbleRd	523172	8				17.7	27.2	10.2
523168-R-Echo Inlet	523168	7				7.0	8.8	5.0
523640-R-WEchoLakeRd	523640	8	0.40	1.01	0.16	22.0	43.2	11.2
523554-R-EEchoLakeRd	523554	8	0.30	0.46	0.20	23.7	36.0	13.0


2022 Echo Lake (Charleston) Tributary Total Nitrogen
WEchoLakeRd
EEchoLakeRd
Total Nitrogen (mg/l)
1.2
1
0.8
0.6
0.4
0.2
0
Freshet
Freshet
5/19/2022
5/29/2022
6/8/2022
6/18/2022
6/28/2022
7/8/2022
7/18/2022
7/28/2022


Orleans
Barton River
Barton
Glover


USGS Barton River Flow With Sample Dates
Barton River Daily discharge (cfs)
900
800
700
600
500
400
300
200
100
0
4/14/2022
5/14/2022
6/13/2022
7/13/2022
8/12/2022
9/11/2022
Barton River discharge
sample date
Freshet
Freshet

2023 Monitoring Summary & 2024 Next Steps

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

- Lay Monitoring Program (LMP)
  - 2023 Summary: Very high Secchi depths decreased by ~5 m after July 10th floods but recovered in early August back to clarity seen in early June. Chlorophyll-a was very low and then increased slightly in August similarly with all three sampling methods (eplimnetic, hypolimnetic, and depth-integrated hose). Total phosphorus was very low with all three sampling methods except for the hose after July 10th floods and in late August, possibly due to sediment trapped in the metalimnion. All summer means qualify for A1 reclassification. All caffeine results except one (hose) were below the lab reporting limit (0.5 ug/L).
  - 2024 Next Steps: LMP volunteer continues collecting biweekly epilimnetic (0.5 m) and hypolimnetic (20 m) samples, while replacing hose sampling with metalimnetic (10 m) sampling. Caffeine testing will also continue at a lower lab reporting limit (≤0.1 ug/L). LMP staff collects vertical profile data during annual visit.
- LaRosa Partnership Program (LPP)
  - 2023 Summary: All sites except Echo Inlet (from Seymour) had at least one high total phosphorus result, especially after July 10th floods. Only WEchoLakeRd had one high total nitrogen result in late May.
  - 2024 Next Steps: LPP volunteer continues collecting biweekly samples at all sites, except now on the LMP schedule of June through August. Look upstream for possible sources to inform LWAP.