Water Quality Monitoring Findings

Clearwater Valley Watershed

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Clearwater Valley Watershed Restoration Plan

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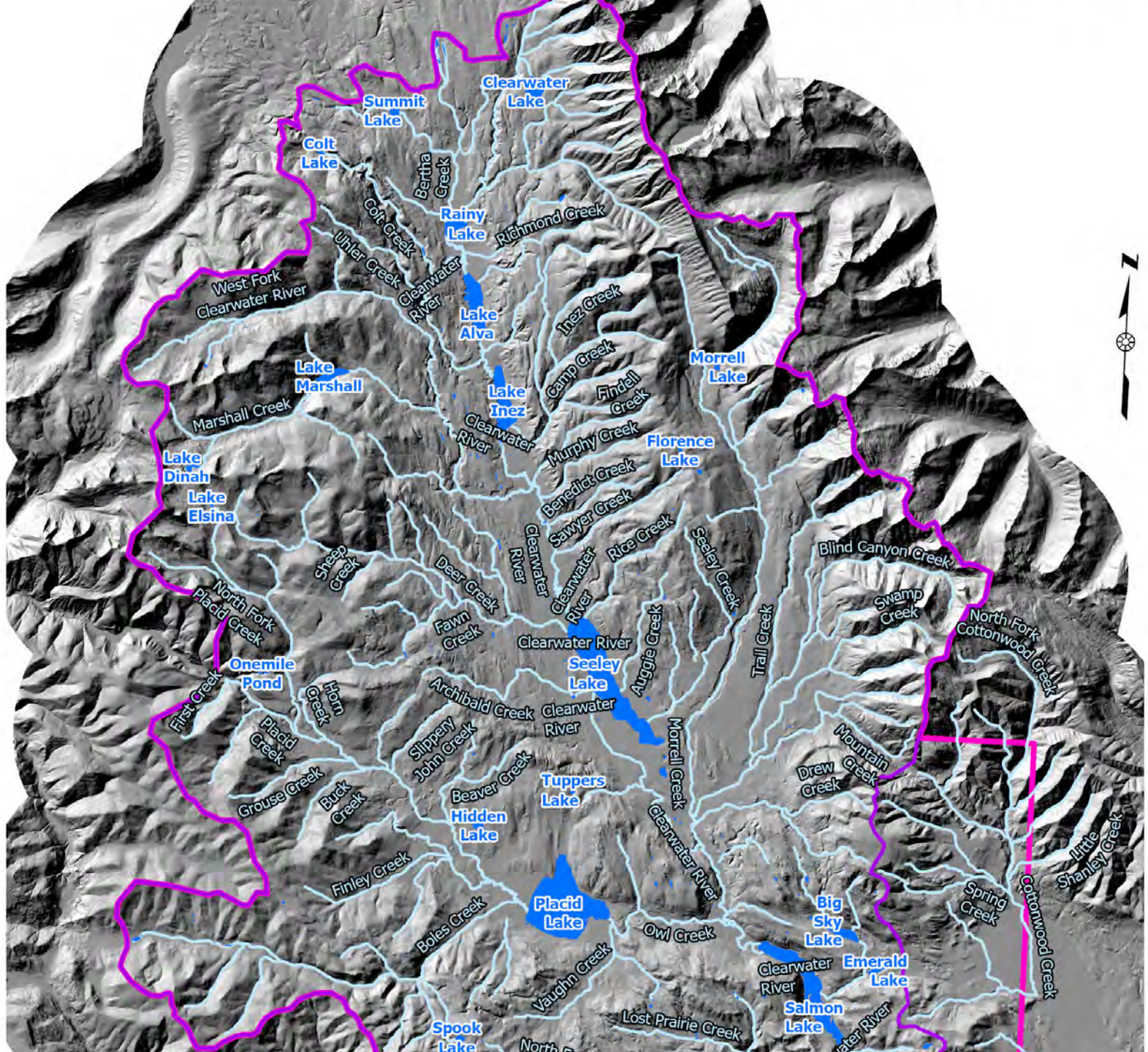
- Bruce Reiman and Joanne Wallenburn
- Caryn Miske, Emily McQuirt, Alicia Dixon, Amanda Zelnis, and Haylie Brown
- Vicki Watson and Hannah Adkins
- Numerous volunteers

CRC Water Quality Monitoring

- 2009- Secchi disk readings for lake clarity
- Dissolved oxygen (DO) and temperature profiles added for Seeley and Salmon and other lakes for some years
- Stream sampling from 2013-2020 (turbidity, nitrogen, phosphorus)
- Lake nutrients, DO and *E. coli* sampling 2021-2023 in lakes
- Reports on the CRC website www.crcmt.org


Clearwater Lake
Summit Lake
Colt Lake
Bertha Creek
Colt Creek
Rainy Lake
Richmond Creek
Uhler Creek
West Fork Clearwater River
Clearwater River
Lake Alva
Inez Creek
Camp Creek
Morrell Lake
Lake Marshall
Findell Creek
Lake Inez
Marshall Creek
Clearwater River
Murphy Creek
Florence Lake
Lake Dinah
Benedict Creek
Lake Elsina
Sawyer Creek
Clearwater River
Rice Creek
Seeley Creek
Blind Canyon Creek
Sheep Creek
Deer Creek
Clearwater River
Swamp Creek
North Fork Placid Creek
Fawn Creek
Clearwater River
Auggie Creek
Trail Creek
North Fork Cottonwood Creek
Onemile Pond
Seeley Lake
Horn Creek
Archibald Creek
Clearwater River
First Creek
Placid Creek
Slippery John Creek
Morrell Creek
Mountain Creek
Drew Creek
Grouse Creek
Buck Creek
Beaver Creek
Tuppers Lake
Hidden Lake
Clearwater River
Little Shanley Creek
Finley Creek
Spring Creek
Cottonwood Creek
Placid Lake
Big Sky Lake
Boles Creek
Owl Creek
Emerald Lake
Vaughn Creek
Clearwater River
Salmon Lake
Lost Prairie Creek
Spook Lake
N

Watershed network

- All of the water (streams, lakes, groundwater) in the Valley interconnected
- Streams
  - All streams carry sediments and nutrients
  - Terrain, vegetation, fire, have an influence
  - Increased sediments and nutrients caused by roads, stream and lakeside vegetation management, septic leachate, and other impacts
- Lakes
  - Stream inputs
  - Groundwater inputs
  - Lakeshore conditions

Threats to Water Quality or Aquatic Ecosystems

- Nutrient and/or pollutant input
  - Septic leachate
  - Road network
  - Stream/lakeside management
- Algal blooms
- Dewatering
- Dams/movement barriers
- Climate change
- Aquatic invasive species

- State of Montana water quality standards
- What was measured?
  - Lakes
  - Streams
- Groundwater information
- What does it mean?
- Paths forward
- Questions and Discussion

DEQ classification of Clearwater Valley lakes

- B-1 classification (Administrative Rules of Montana (ARMs) Chapter: 17.30.600)

17.30.623 B-1 CLASSIFICATION STANDARDS

(1) Waters classified B-1 are to be maintained suitable for drinking, culinary, and food processing purposes, after conventional treatment; bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

- Standards on:
  - E. coli
  - Dissolved oxygen (DO)
  - pH= 6.5 – 8.5
  - Turbidity: not to exceed 5 NTU above background

B-1 classification water quality standards: E. coli

Table 1. Montana's *E. coli* Criteria

Use Classification	Beneficial Use	Applicable Time	Criteria (cfu/100ml or mpn/100ml)	
			Geometric Mean (may not exceed)	Statistical Threshold Value (10% may not exceed)
A-1 and A-closed	Drinking water	year-round	32	64
	Primary contact recreation	April 1 - October 31	126	252
	Secondary contact recreation	November 1 - March 31	630	1260
B, C, and I	Primary contact recreation	April 1 - October 31	126	252
	Secondary contact recreation	November 1 - March 31	630	1260
D, E, F, G	Secondary contact recreation	Year-round	630	1260

Based on collecting "minimum of five samples obtained during separate 24-hour periods during any consecutive 30-day period"

Makarowski, Kathryn. 2020. *Escherichia coli* (*E. coli*) Assessment Method for State Surface Waters. Helena, MT: Montana Department of Environmental Quality. Document WQDWQPBWQA-01, Version 1.0.

B-1 classification water quality standards: DO

(15) Freshwater aquatic life standards for dissolved oxygen in milligrams per liter are as follows:

	Standards for Waters Classified A-1, B-1, B-2, C-1, and C-2		Standards for Waters Classified B-3, C-3, and I	
	Early Life Stages[1,2]	Other Life Stages	Early Life Stages[2]	Other Life Stages
30 Day Mean	N/A[3]	6.5	N/A[3]	5.5
7 Day Mean	9.5 (6.5)	N/A[3]	6.0	N/A[3]
7 Day Mean Minimum	N/A[3]	5.0	N/A[3]	4.0
1 Day Minimum[4]	8.0 (5.0)	4.0	5.0	3.0

[1] These are water column concentrations recommended to achieve the required inter-gravel dissolved oxygen concentrations shown in parentheses. For species that have early life stages exposed directly to the water column, the figures in parentheses apply.

[2] Includes all embryonic and larval stages and all juvenile forms of fish to 30 days following hatching.

[3] N/A (Not Applicable).

[4] All minima should be considered as instantaneous concentrations to be achieved at all times.

Suggested citation: Montana DEQ, Water Quality Division, Water Quality Planning Bureau, Water Quality Standards and Modeling Section. 2019. DEQ-7 Montana Numeric Water Quality Standards. Helena, MT: Montana Dept. of Environmental Quality.

Lakes

Required Parameters for Assessment

Response Variable Parameters	Causal Parameters	Model Inputs
Chlorophyll a (Chla)	Total Nitrogen (TN)	Dissolved Organic Carbon (DOC)
Secchi Depth (SD)	Total Phosphorus (TP)	Temperature Profile*
Dissolved oxygen (mg/l)		

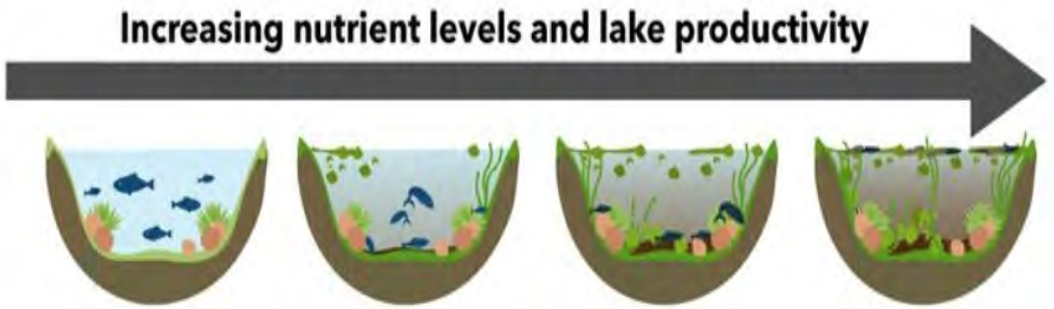
* Temperature profile is only required for aquatic life beneficial use assessment.

Figure 2. A Secchi disk.

Trophic Status

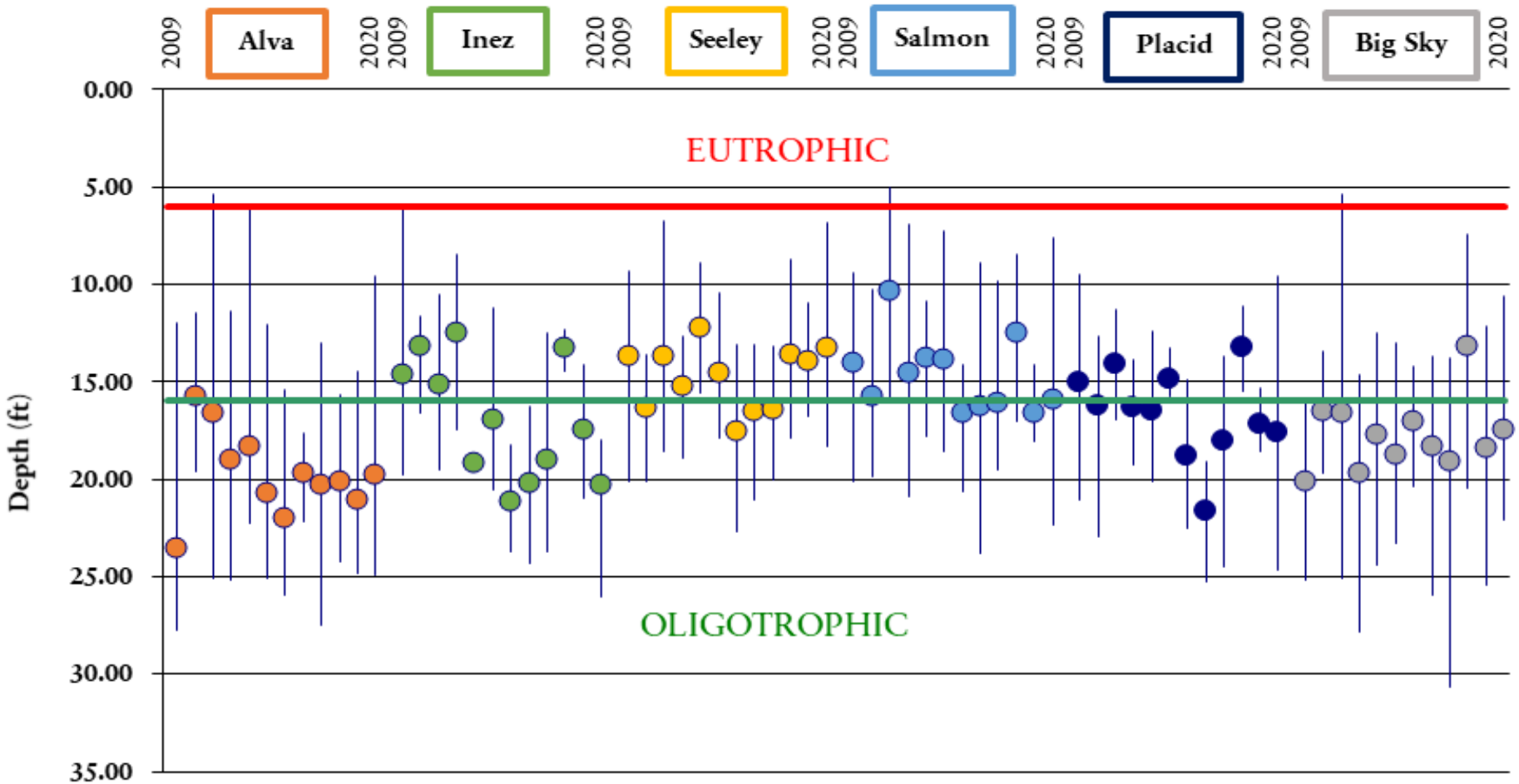
Table 7.2.—General characteristics of oligotrophic and eutrophic lakes (After Rast and Lee 1987)

Variable	Oligotrophic	Eutrophic
Plant Production	Low	High
No. of Algal Species	Many	Few
Characteristic Algae	—	Blue-greens
Aquatic Rooted Plants	Sparse	Abundant
Hypolimnion Oxygen	Present	Absent
Characteristic Fish	Deep-dwelling, coldwater fish such as trout, salmon, and cisco	Surface-dwelling, warmwater fish such as pike, perch, and bass; also bottom-dwelling fish such as catfish and carp
Water Quality for Domestic and Industrial Use	Good	Poor

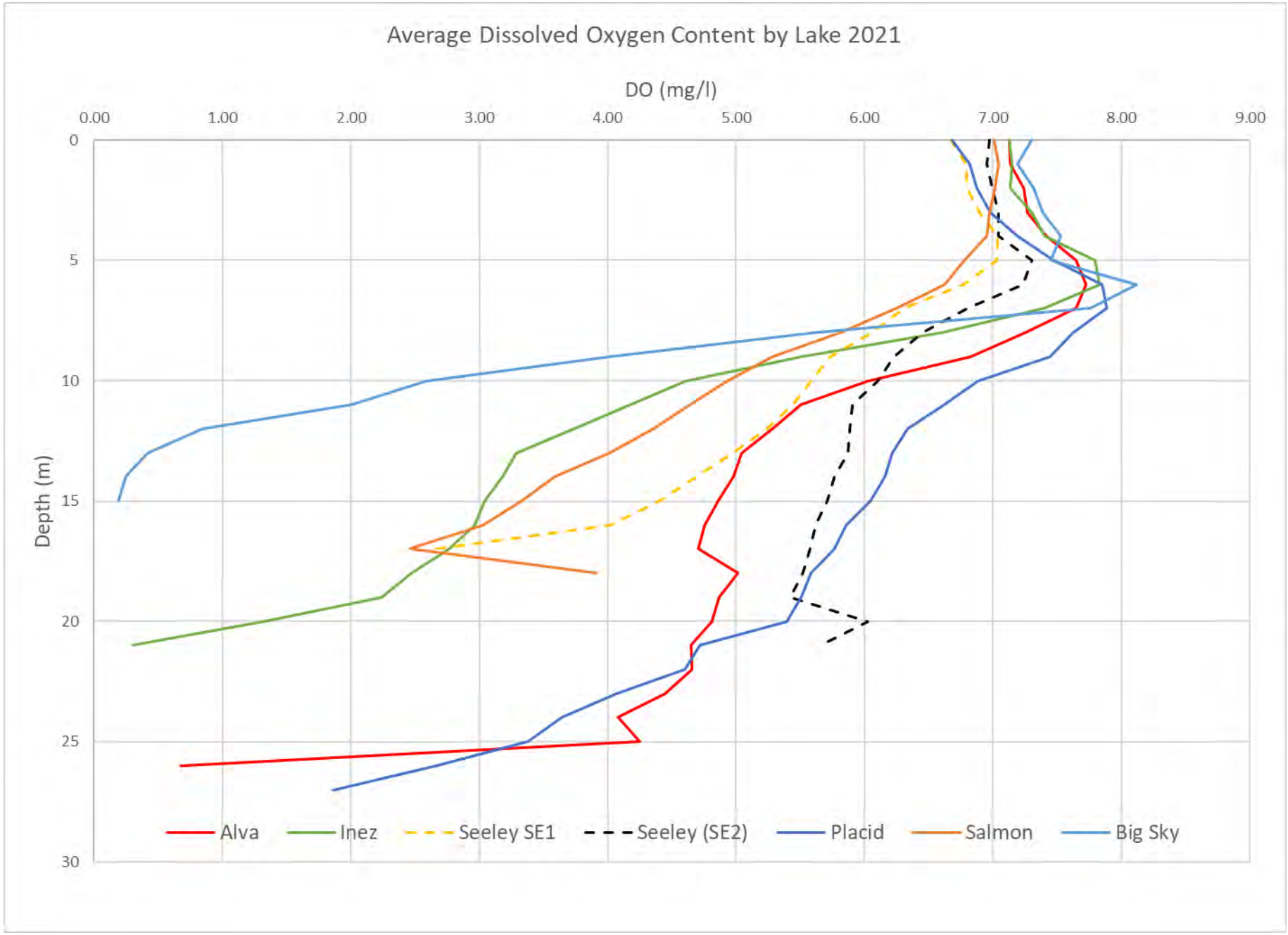


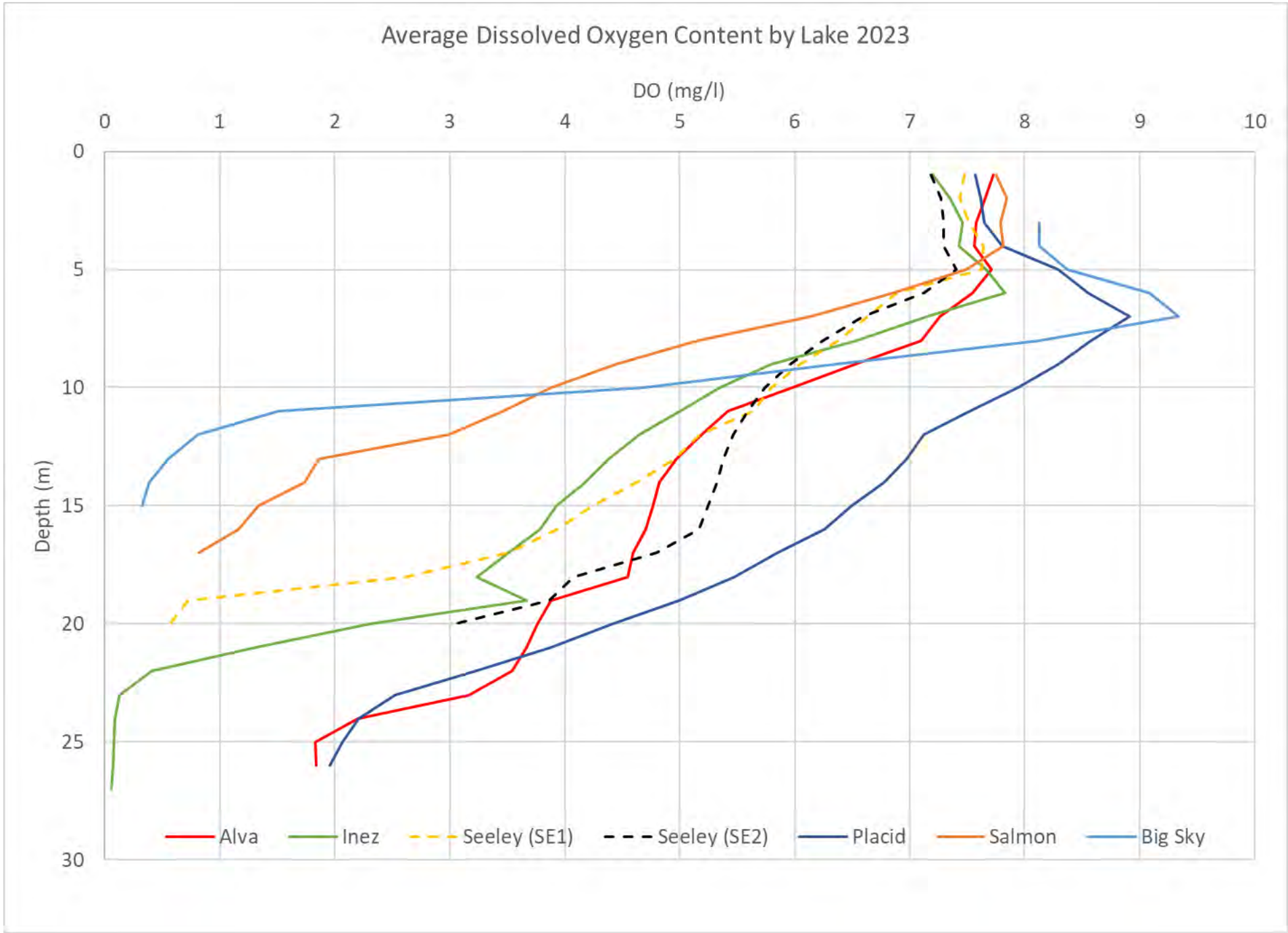
Trophic Status	Oligotrophy	Mesotrophy	Eutrophy	Hypereutrophy
Secchi depth (m)	>5	1.6 - 5	0.7 - 1.6	<0.7
Chlorophyll A(µg/L)	<2	2 - 10	10 - 30	>30
Total phosphorus (µg/L)	<10	10 - 30	30 - 60	>60

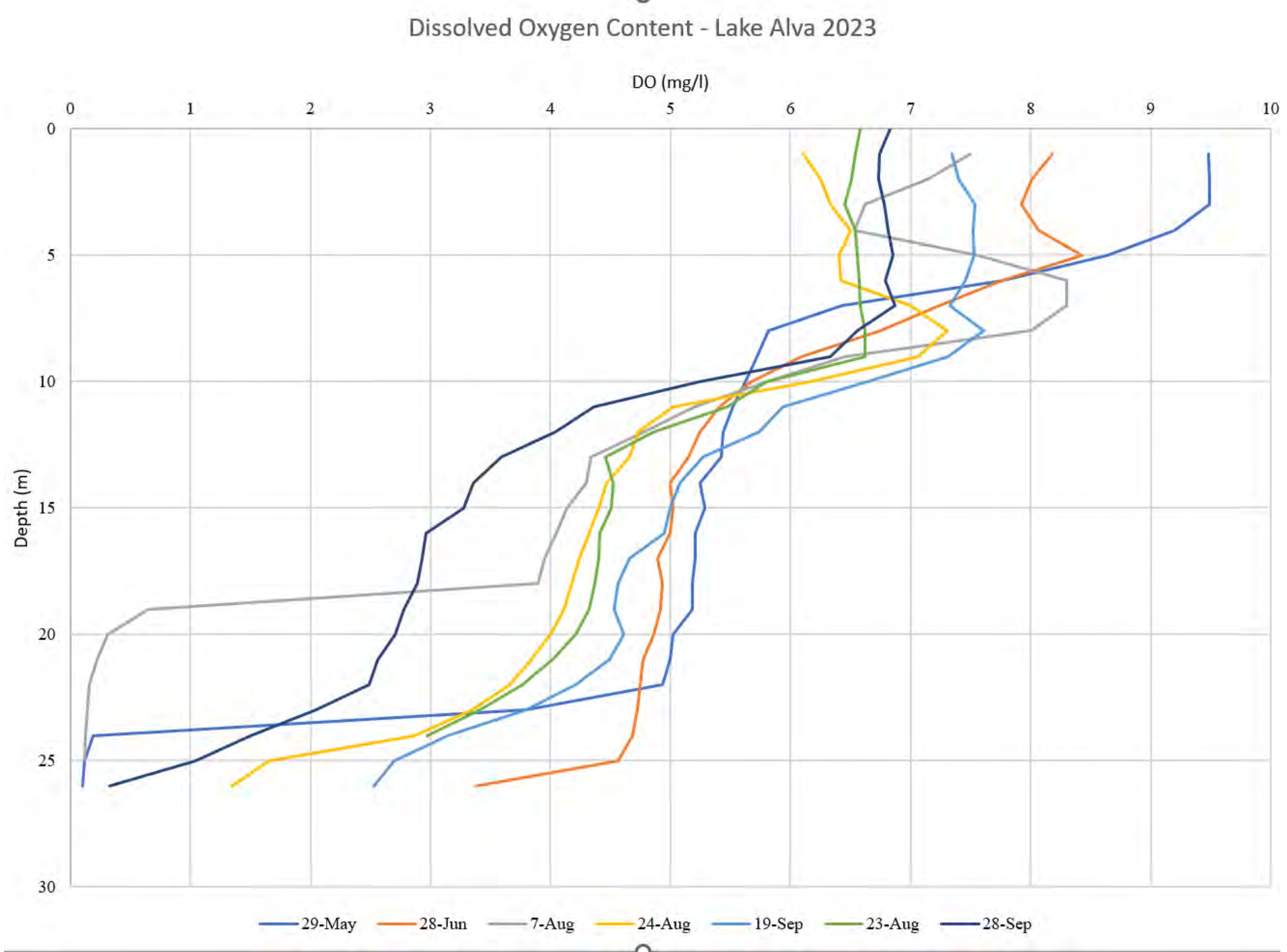
Secchi depth

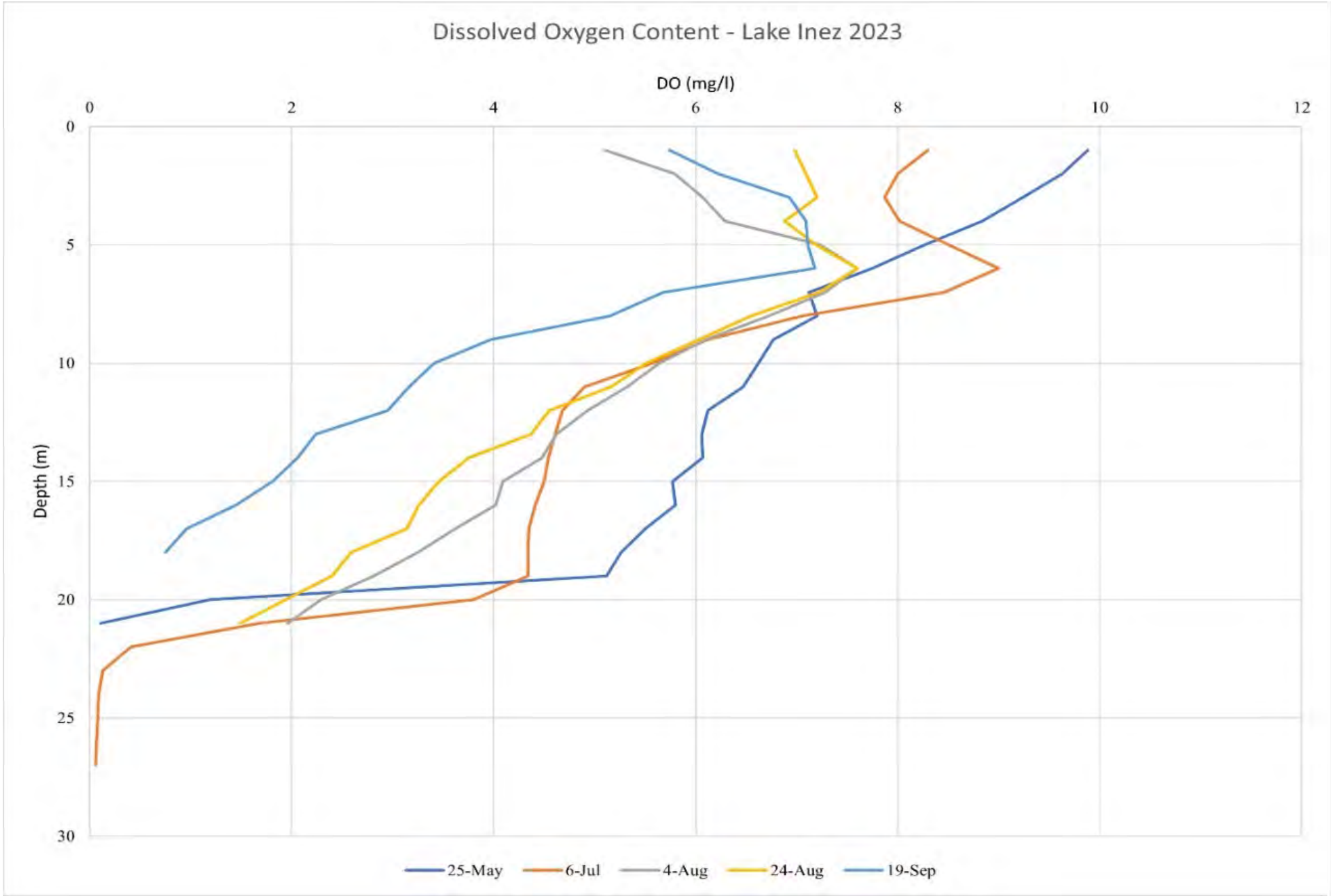


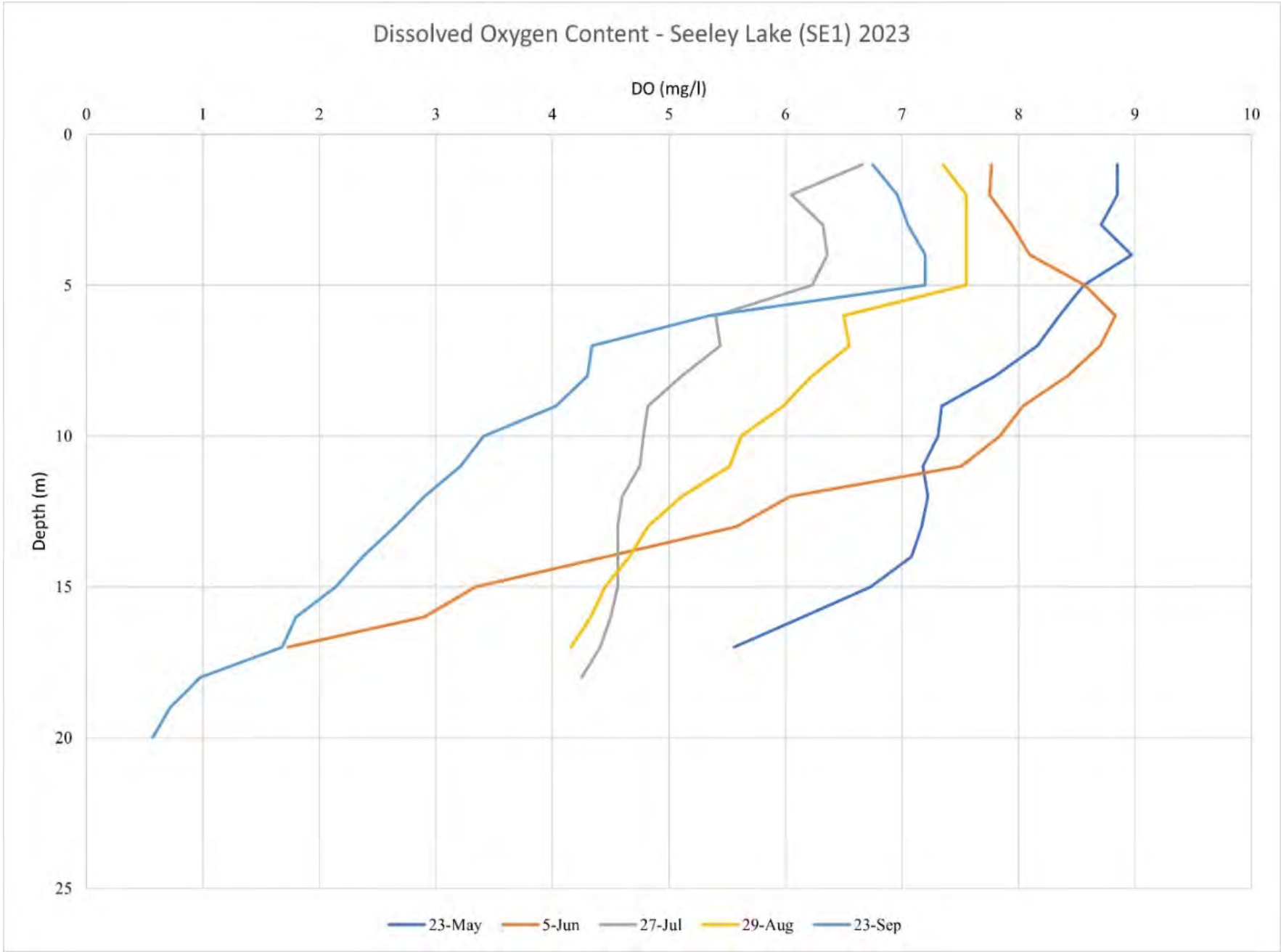
Dissolved Oxygen

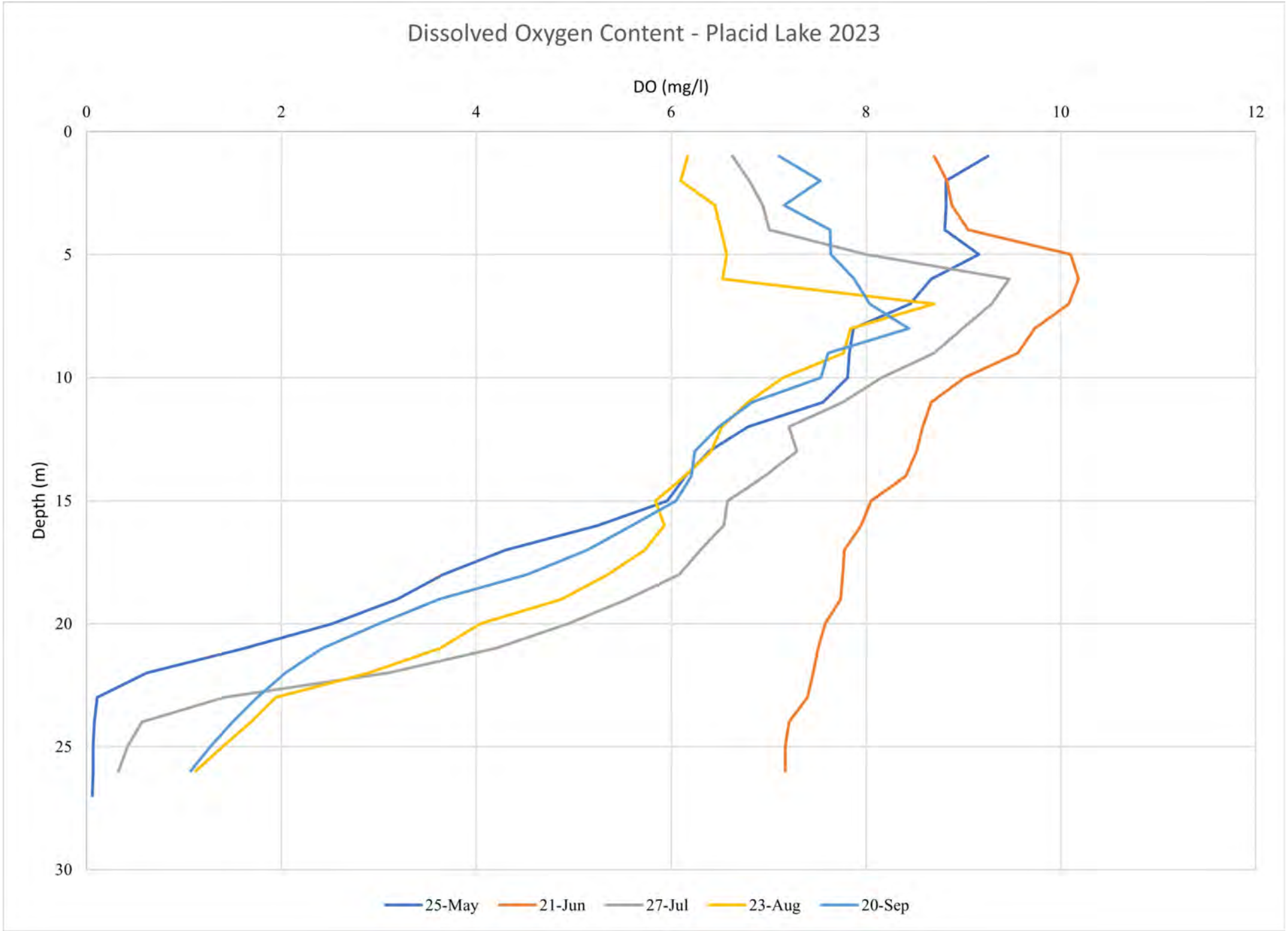


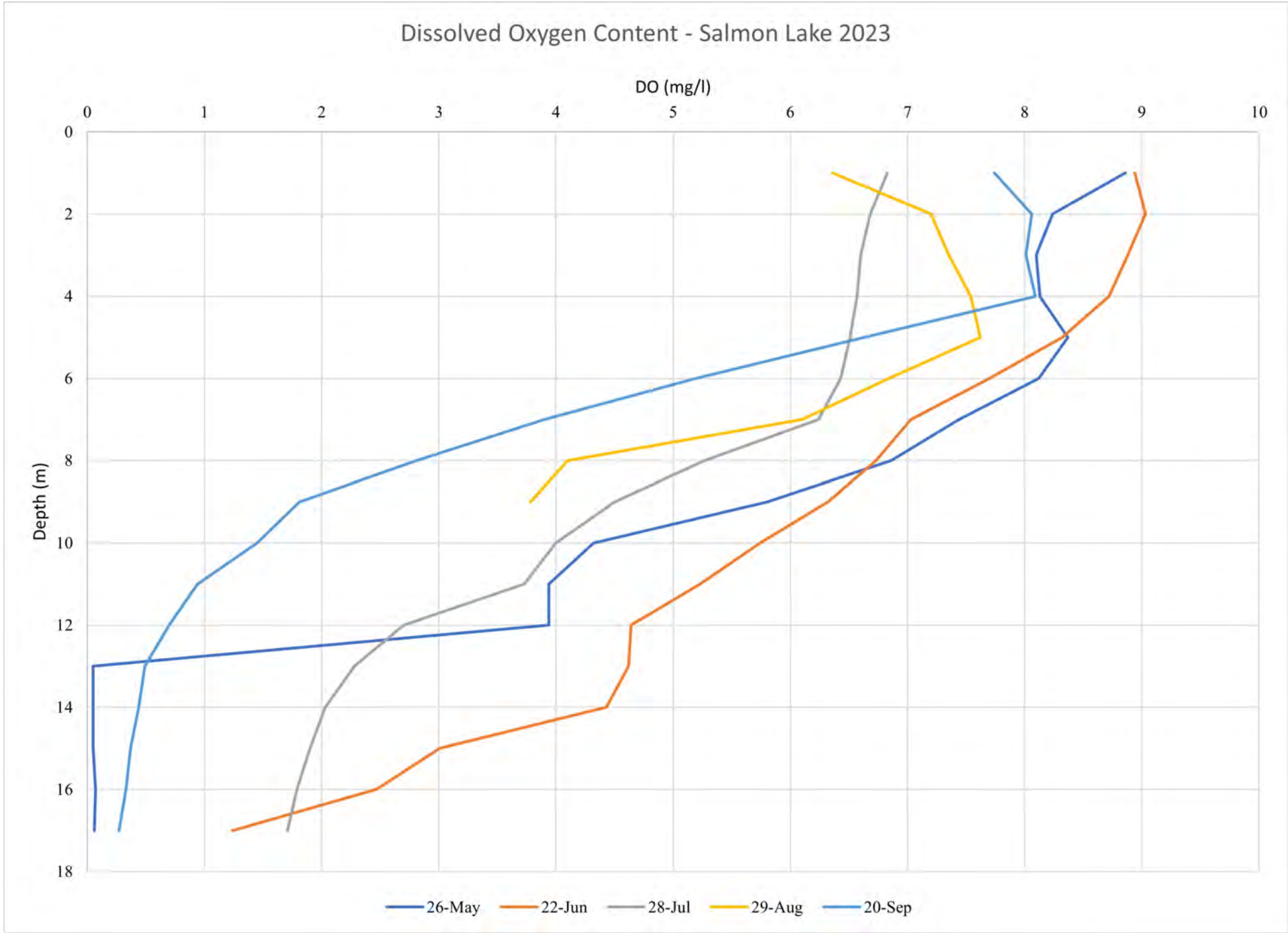

Average Dissolved Oxygen Content by Lake 2023
DO (mg/l)
0
1
2
3
4
5
6
7
8
9
10
Depth (m)
0
5
10
15
20
25
30
Alva
Inez
Seeley (SE1)
Seeley (SE2)
Placid
Salmon
Big Sky

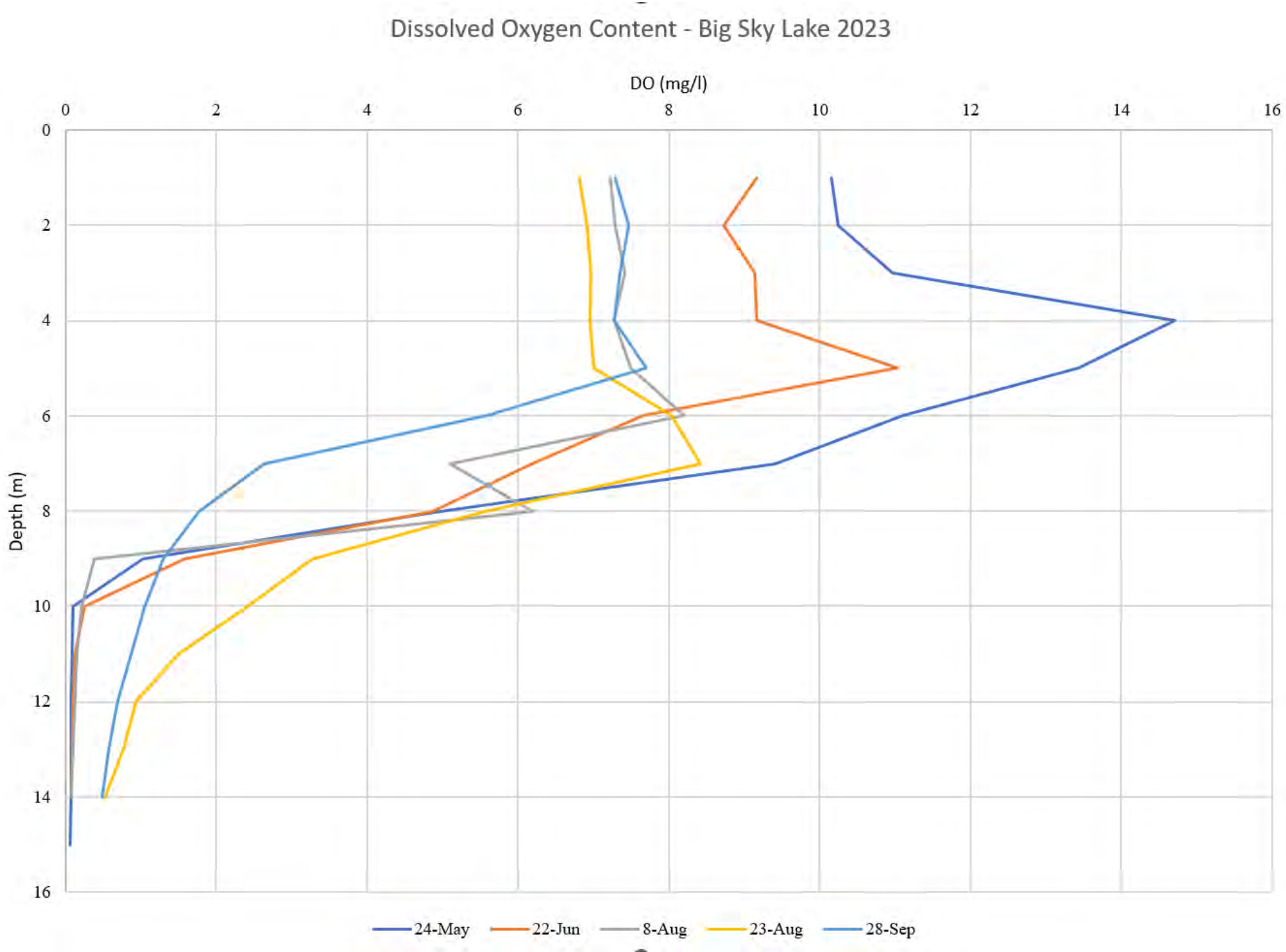

Dissolved Oxygen Content - Lake Alva 2023
DO (mg/l)
0
1
2
3
4
5
6
7
8
9
10
Depth (m)
0
5
10
15
20
25
30
29-May
28-Jun
7-Aug
24-Aug
19-Sep
23-Aug
28-Sep

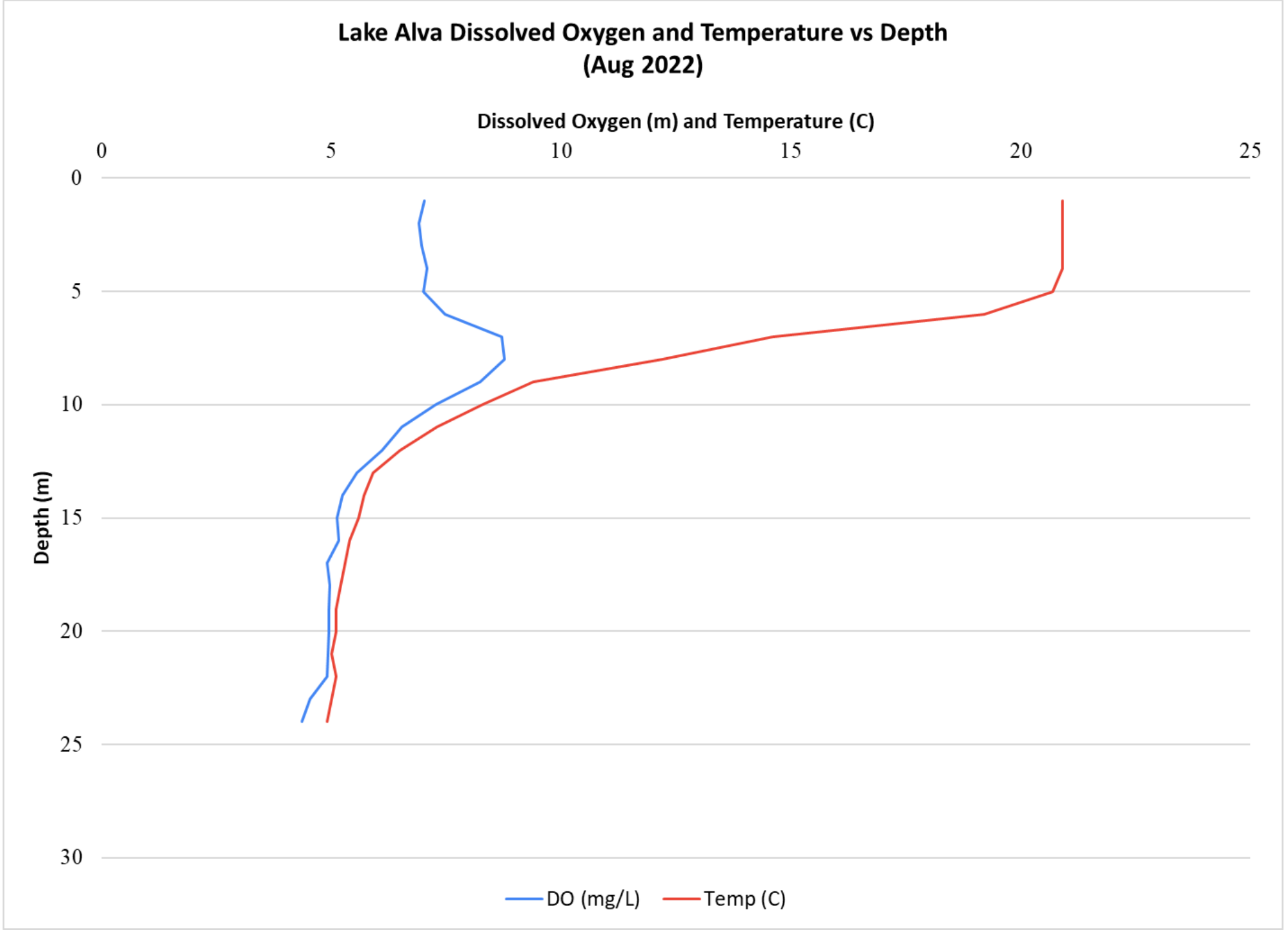

Dissolved Oxygen Content - Lake Inez 2023
DO (mg/l)
0
2
4
6
8
10
12
Depth (m)
0
5
10
15
20
25
30
25-May
6-Jul
4-Aug
24-Aug
19-Sep

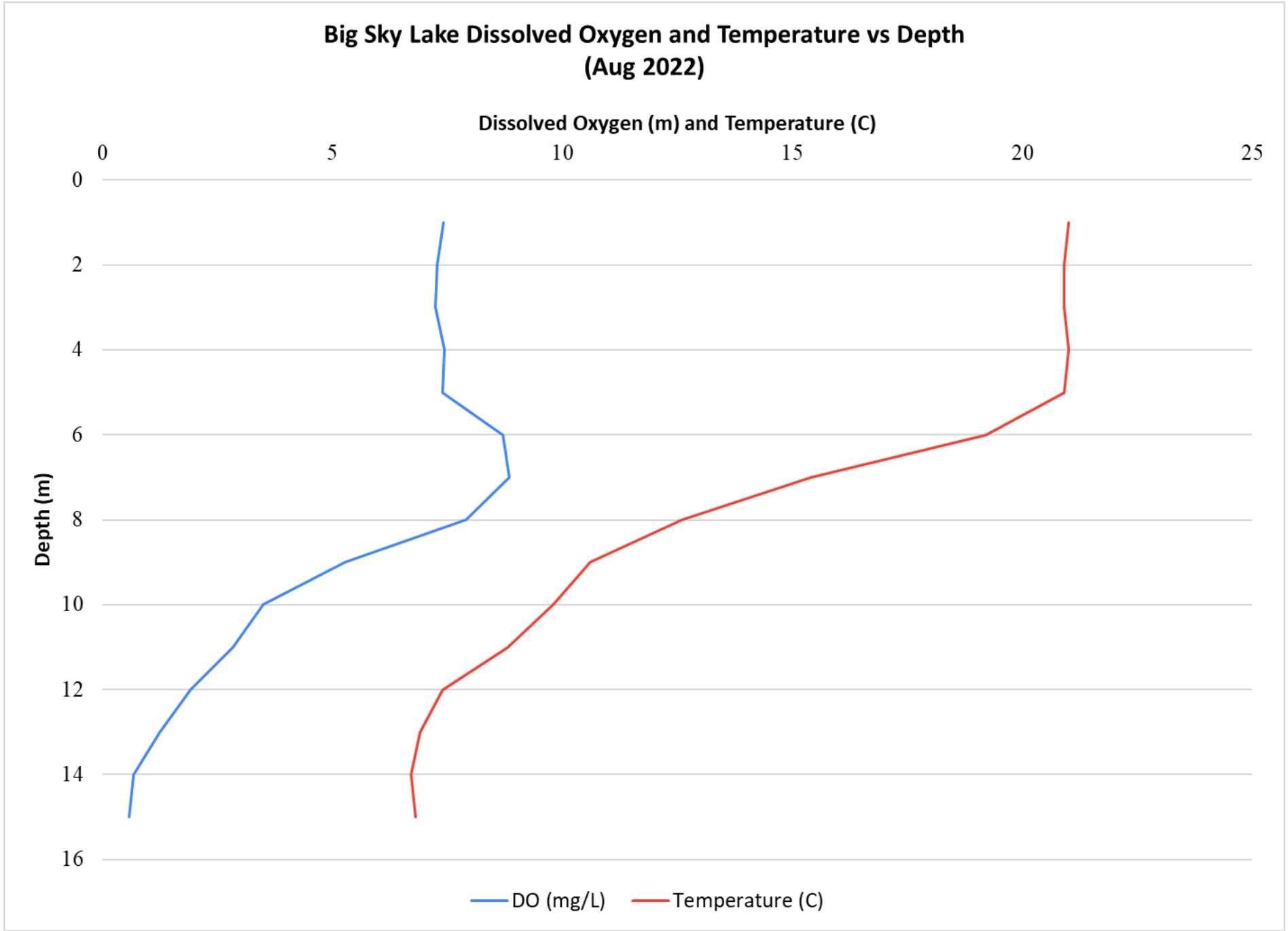

Dissolved Oxygen Content - Seeley Lake (SE1) 2023
DO (mg/l)
0
1
2
3
4
5
6
7
8
9
10
Depth (m)
0
5
10
15
20
25
23-May
5-Jun
27-Jul
29-Aug
23-Sep


Dissolved Oxygen Content - Placid Lake 2023
DO (mg/l)
0
2
4
6
8
10
12
Depth (m)
0
5
10
15
20
25
30
25-May
21-Jun
27-Jul
23-Aug
20-Sep


Dissolved Oxygen Content - Salmon Lake 2023
DO (mg/l)
0
1
2
3
4
5
6
7
8
9
10
Depth (m)
0
2
4
6
8
10
12
14
16
18
26-May
22-Jun
28-Jul
29-Aug
20-Sep

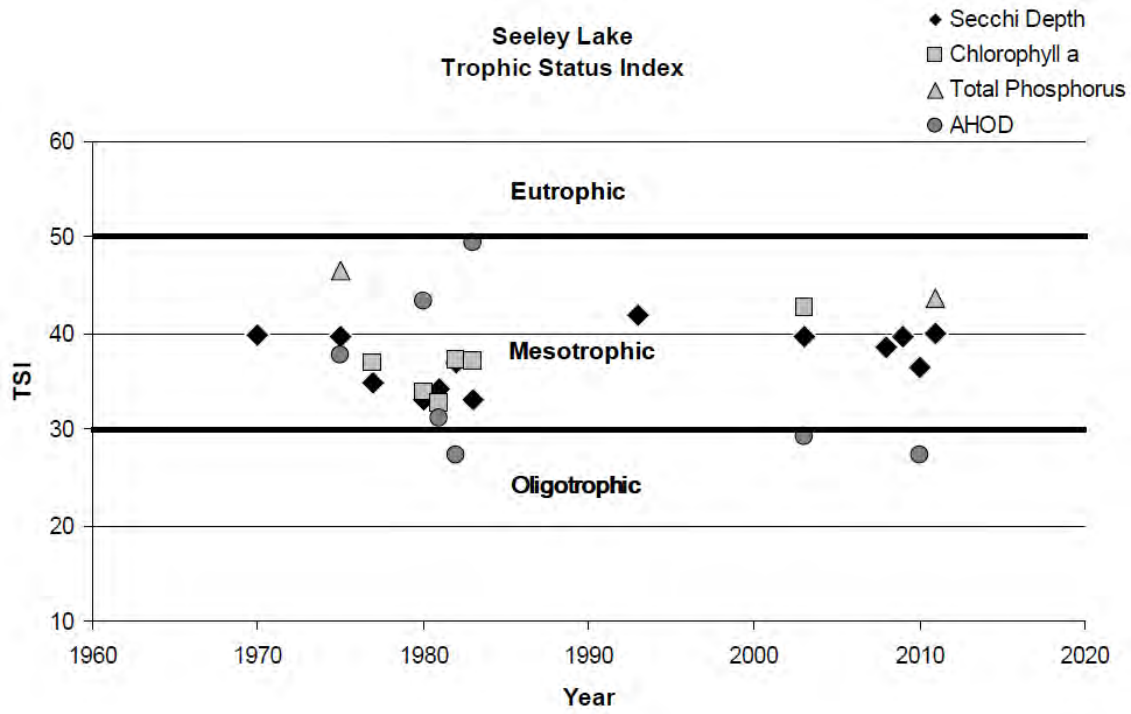

Dissolved Oxygen Content - Big Sky Lake 2023
DO (mg/l)
0
2
4
6
8
10
12
14
16
Depth (m)
24-May
22-Jun
8-Aug
23-Aug
28-Sep

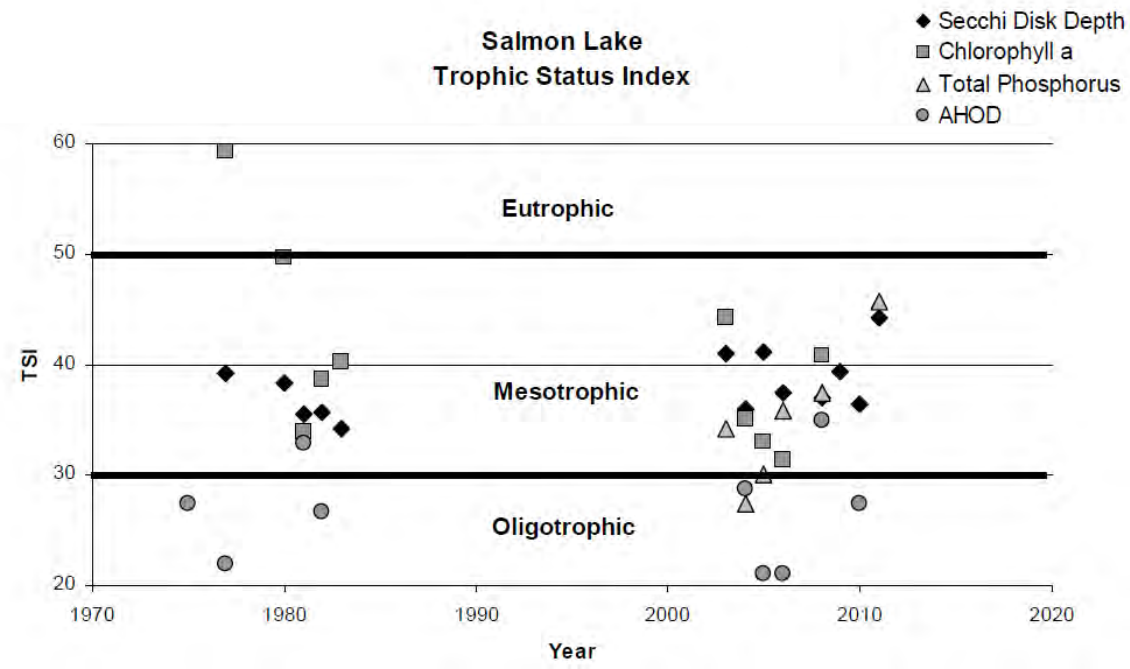

Lake Alva Dissolved Oxygen and Temperature vs Depth
(Aug 2022)
Dissolved Oxygen (m) and Temperature (C)
0
5
10
15
20
25
Depth (m)
0
5
10
15
20
25
30
DO (mg/L)
Temp (C)


Big Sky Lake Dissolved Oxygen and Temperature vs Depth
(Aug 2022)
Dissolved Oxygen (m) and Temperature (C)
0
5
10
15
20
25
Depth (m)
0
2
4
6
8
10
12
14
16
DO (mg/L)
Temperature (C)

Lake Health Summary

- Exhibiting characteristics of both oligotrophic and eutrophic lakes
  - Mesotrophic
- It matters where you sample
- Different parts of the lake have different productivity (ability to support aquatic life)
  - Deep versus near-shore

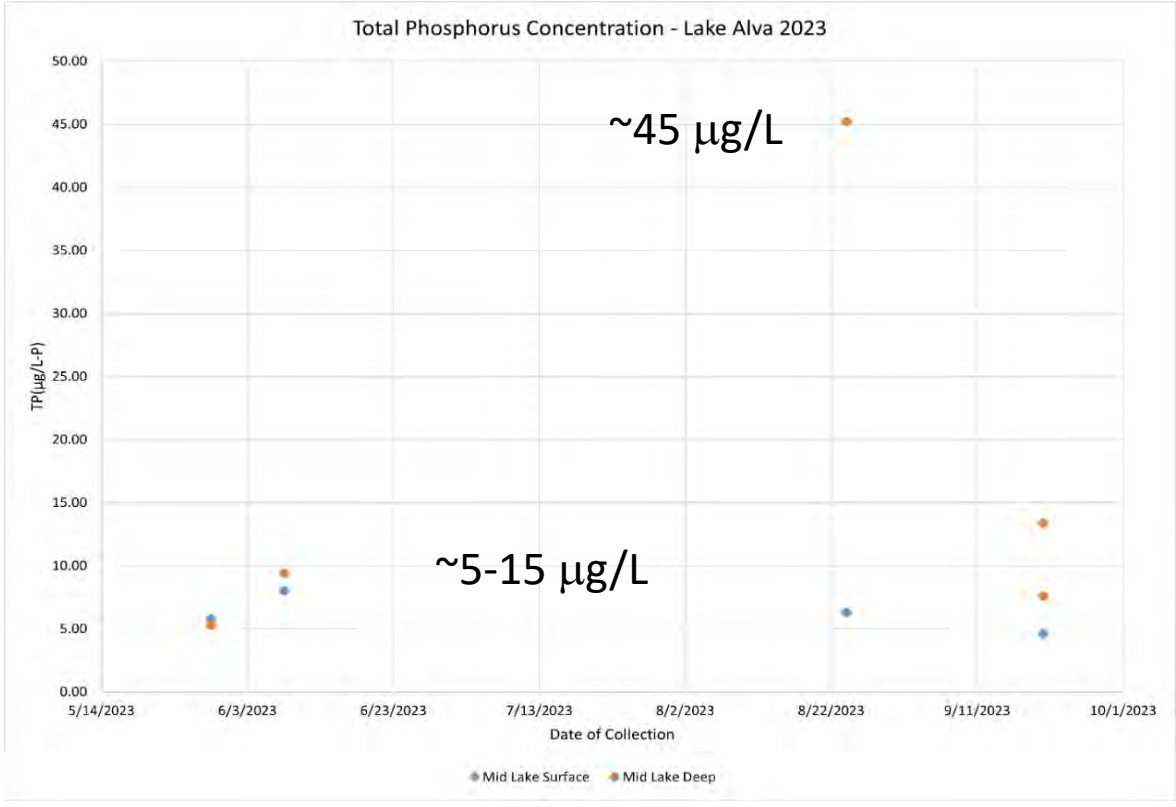




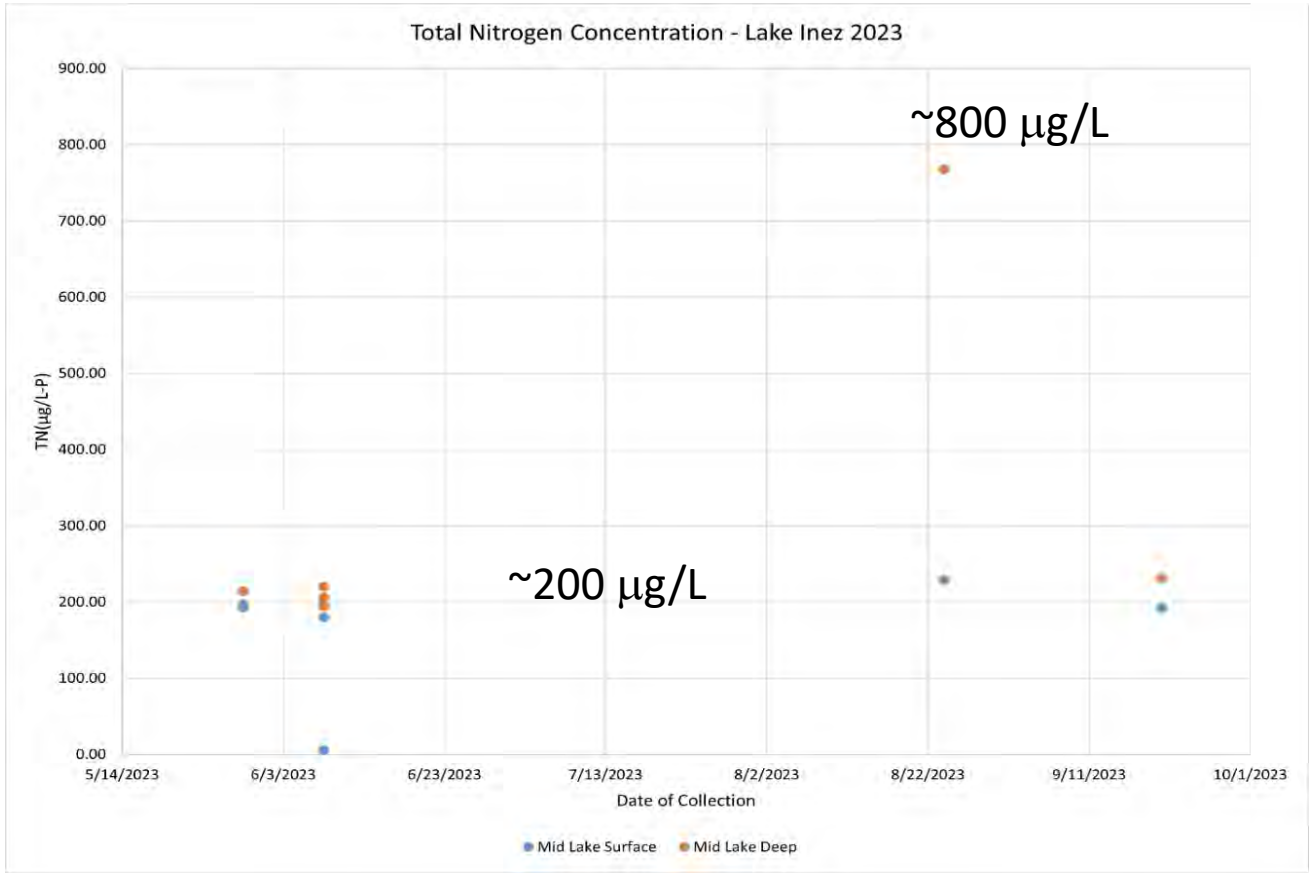
Watson (2012)

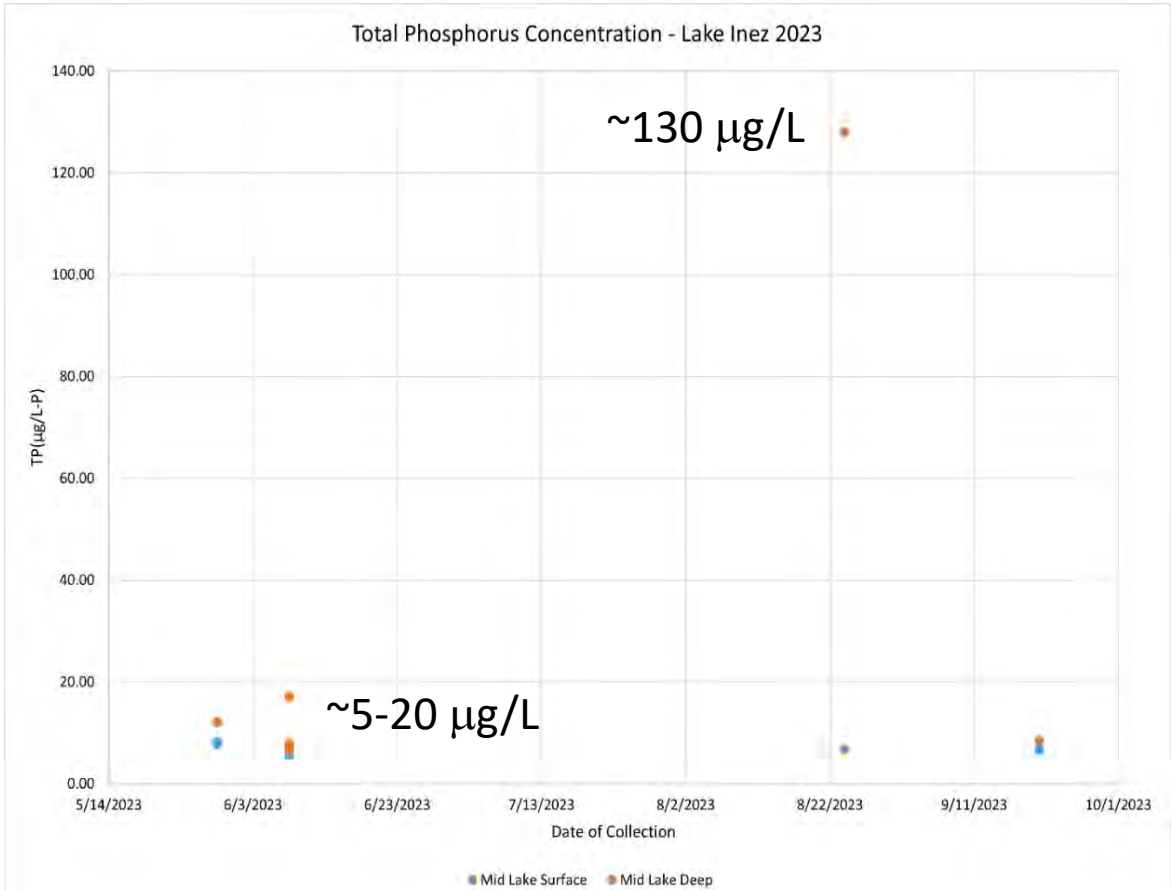
Nutrients
Nitrogen and Phosphorus

Lake Alva (2023): Total Nitrogen and Total Phosphorus

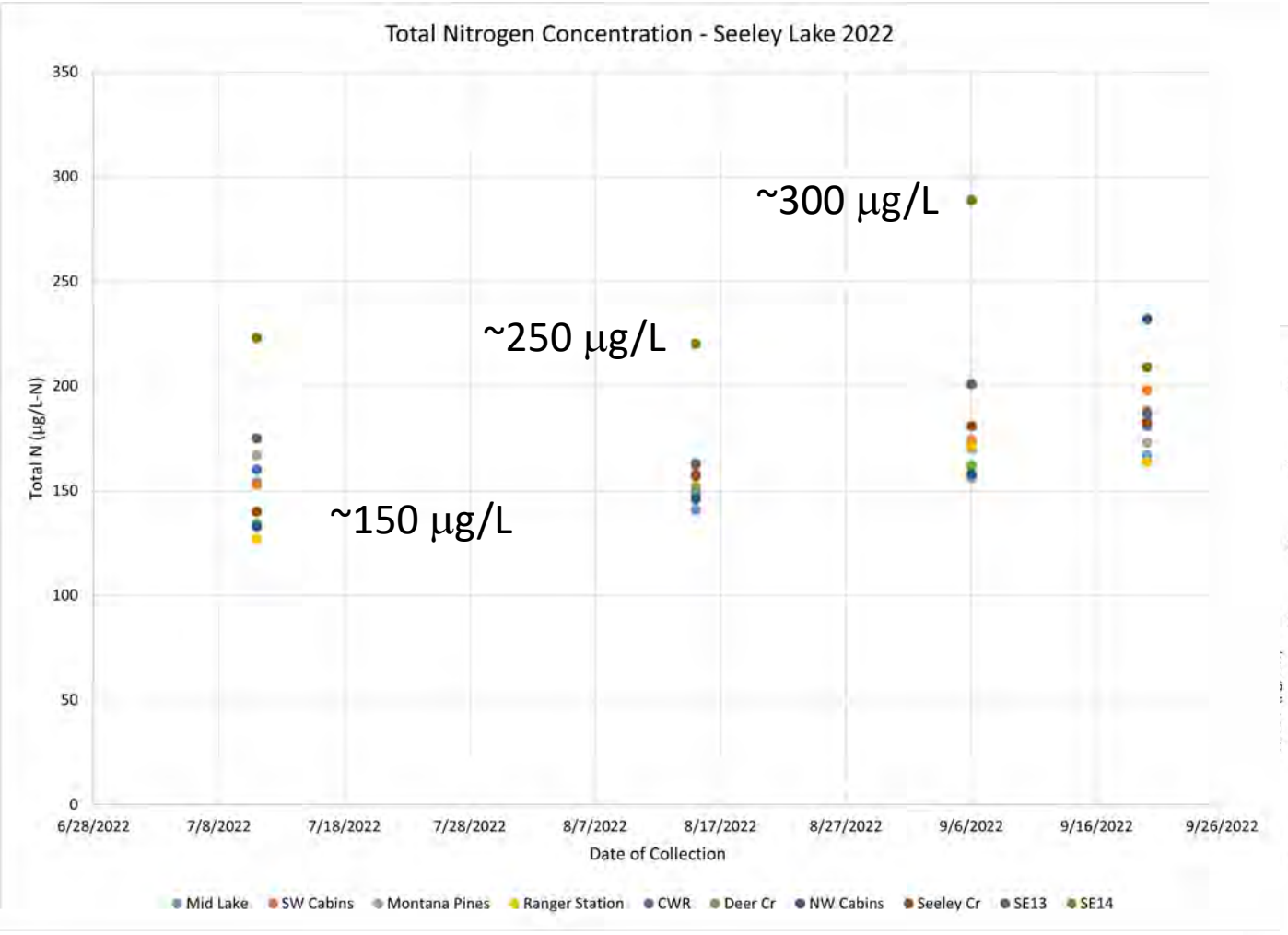


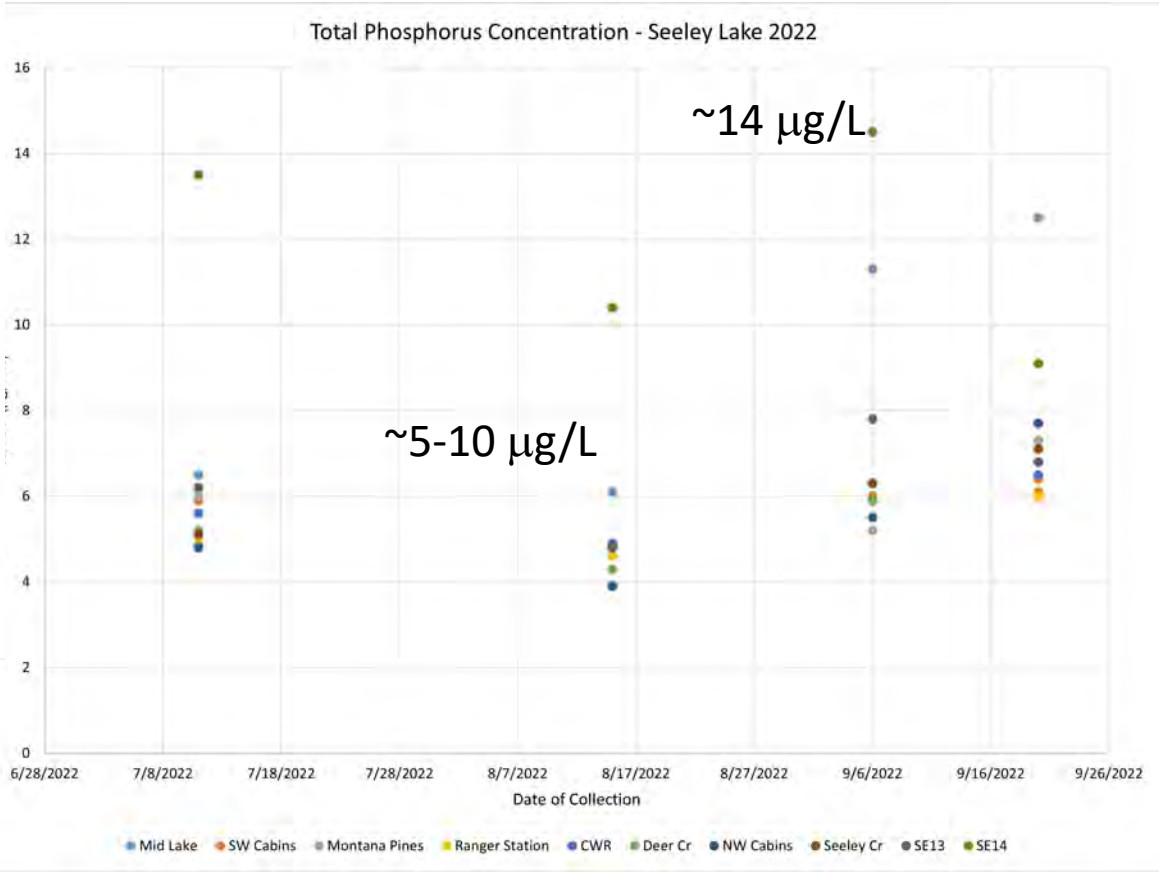
Lake Inez (2023): Total Nitrogen and Total Phosphorus



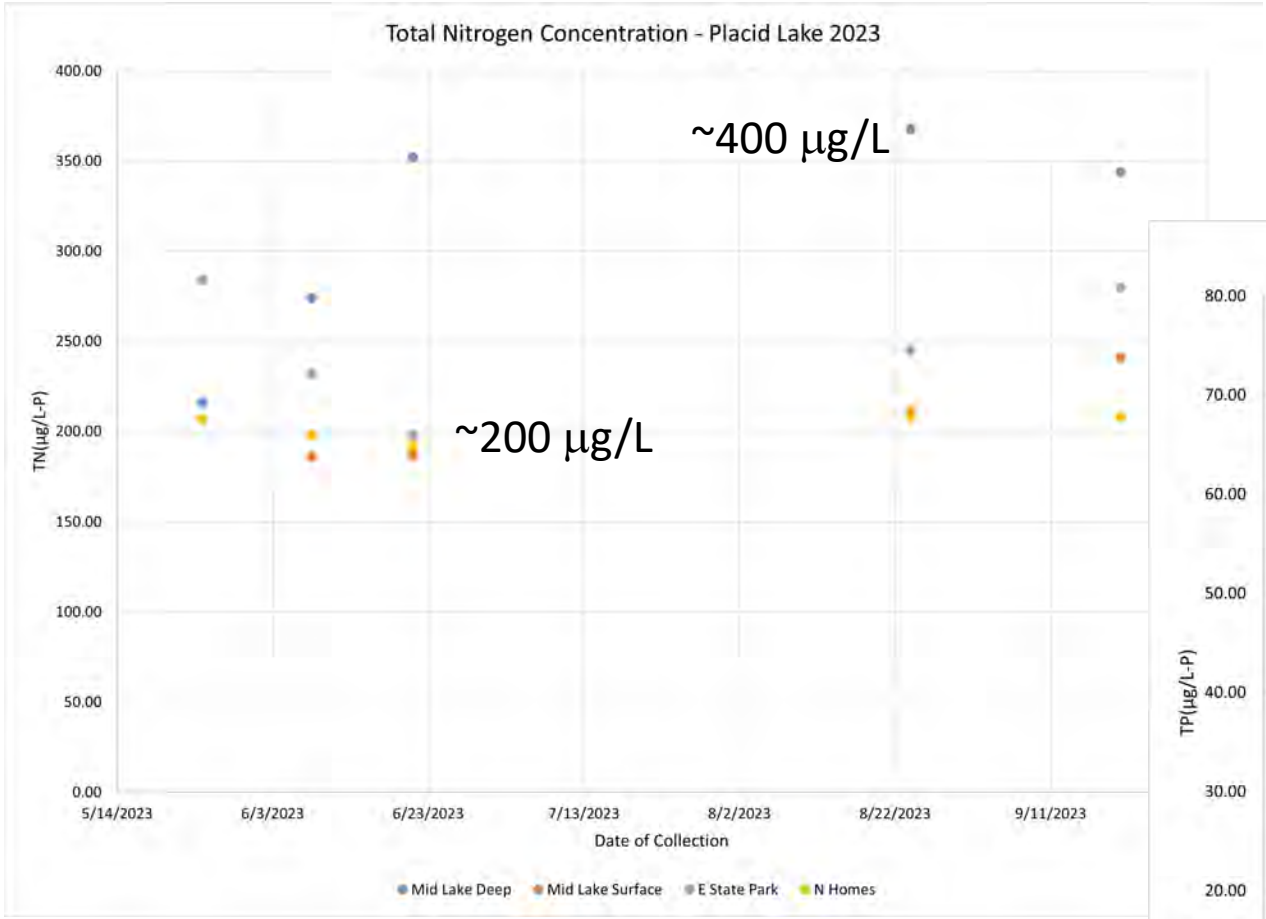


Seeley Lake (2022): Total Nitrogen and Total Phosphorus



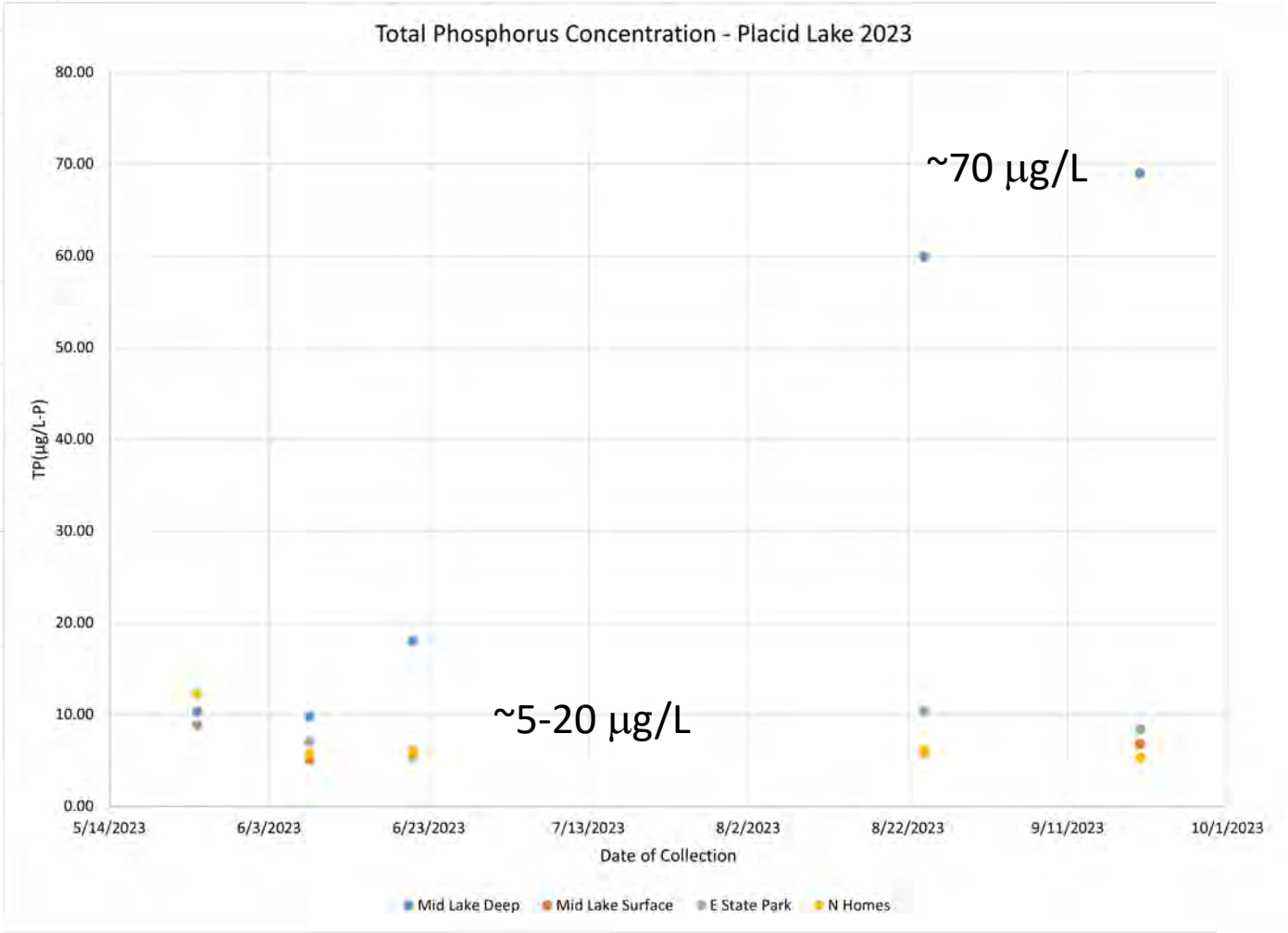


Placid Lake (2023): Total Nitrogen and Total Phosphorus



~400 µg/L

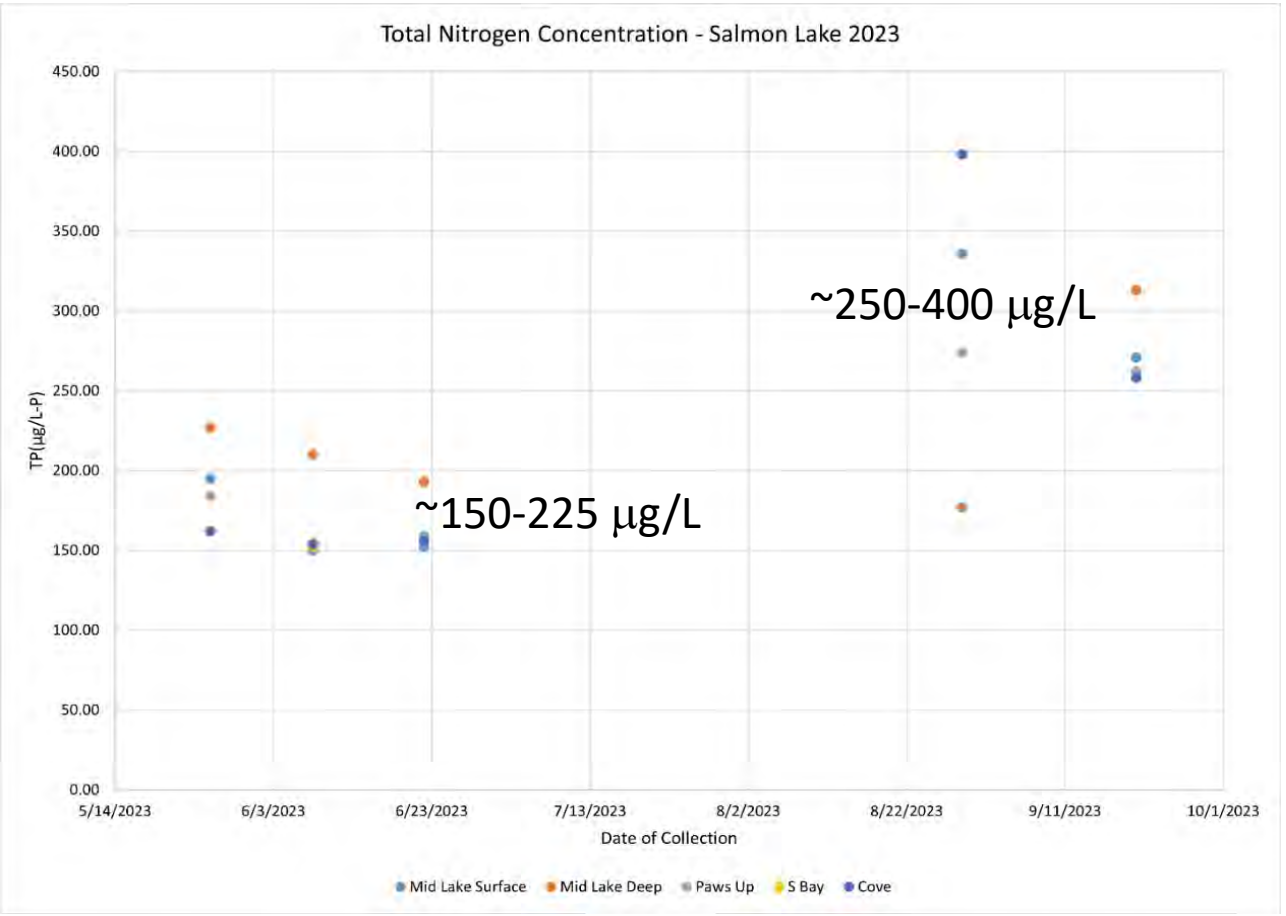
~200 µg/L

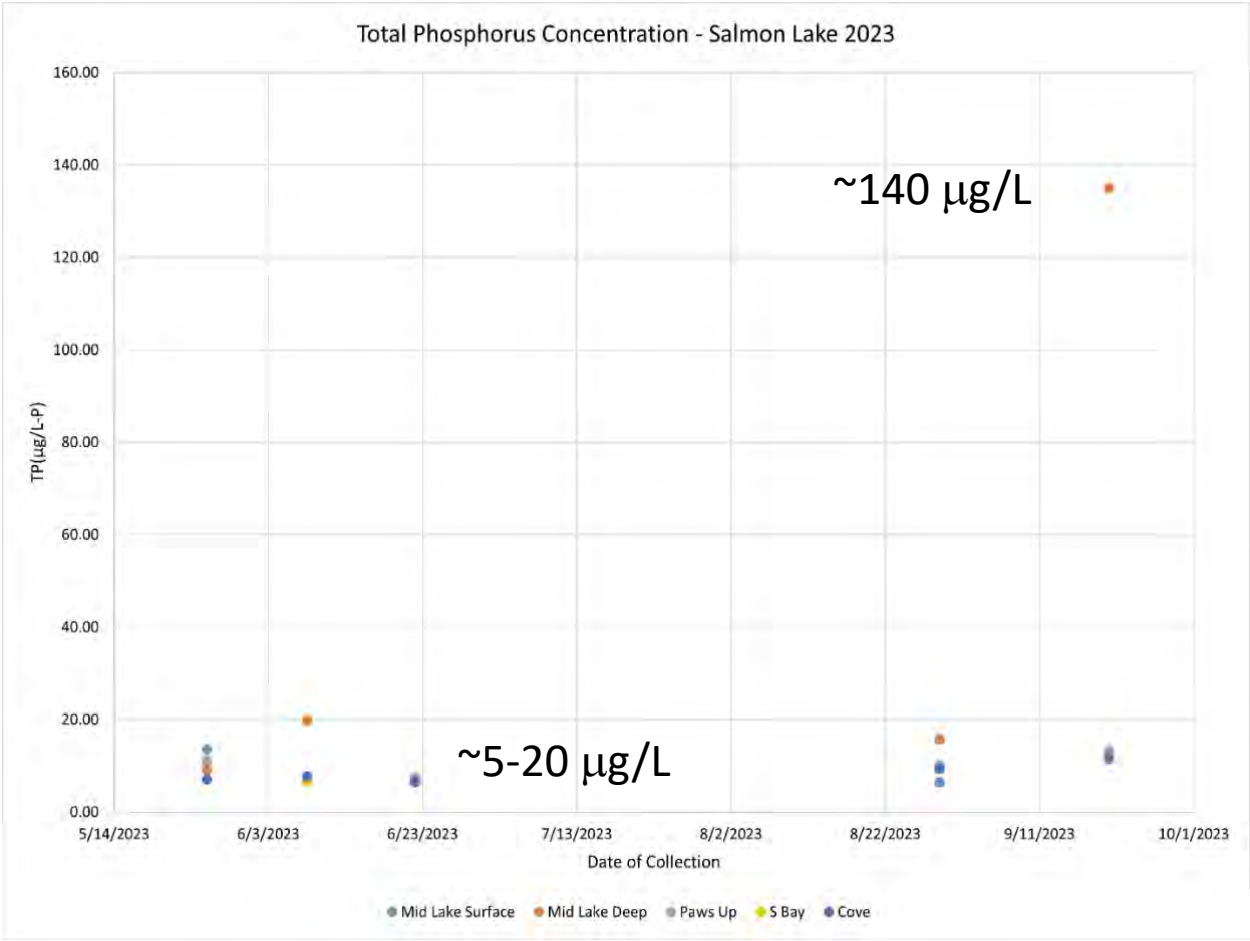


~70 µg/L

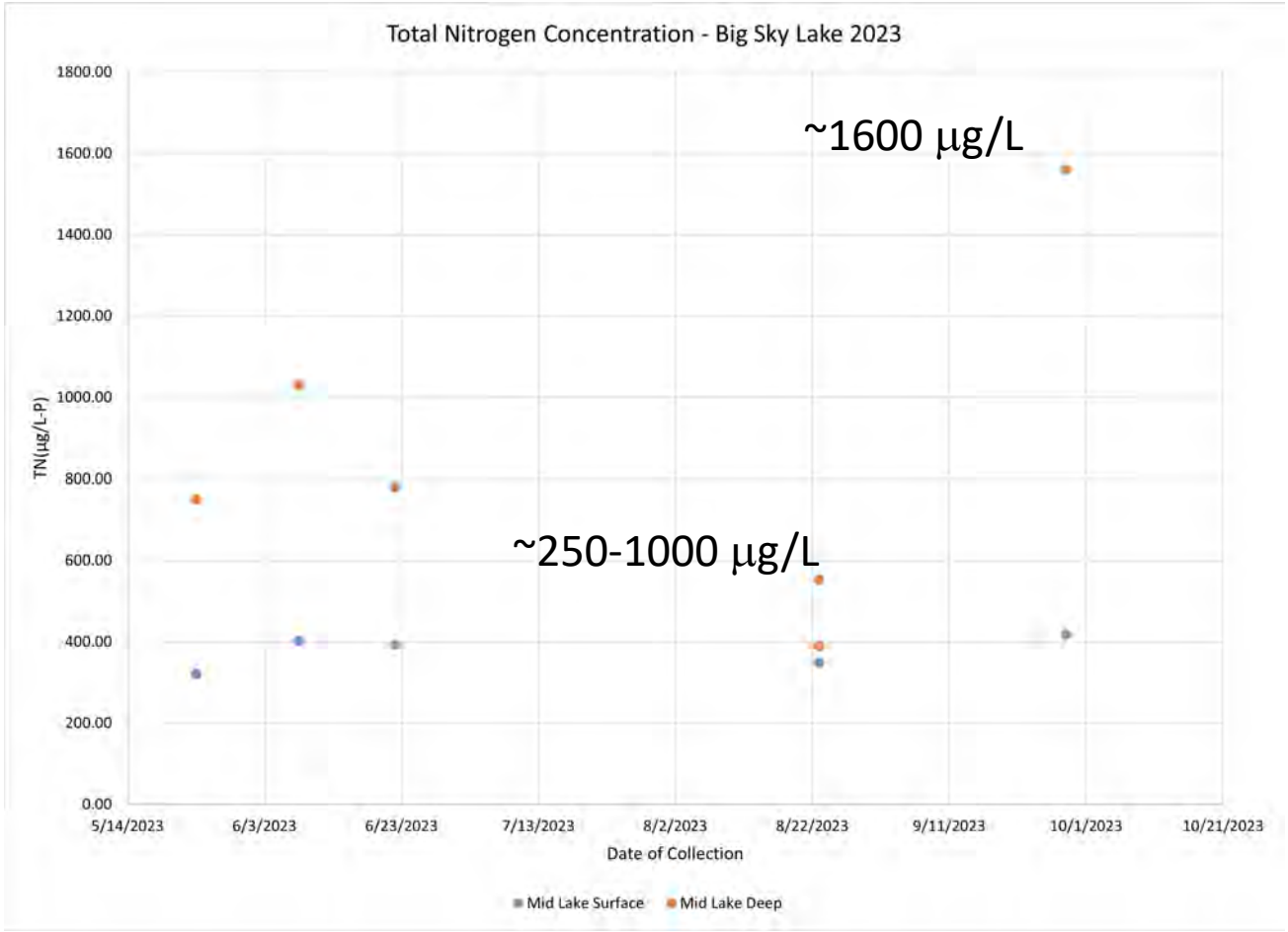
~5-20 µg/L

Salmon Lake (2023): Total Nitrogen and Total Phosphorus



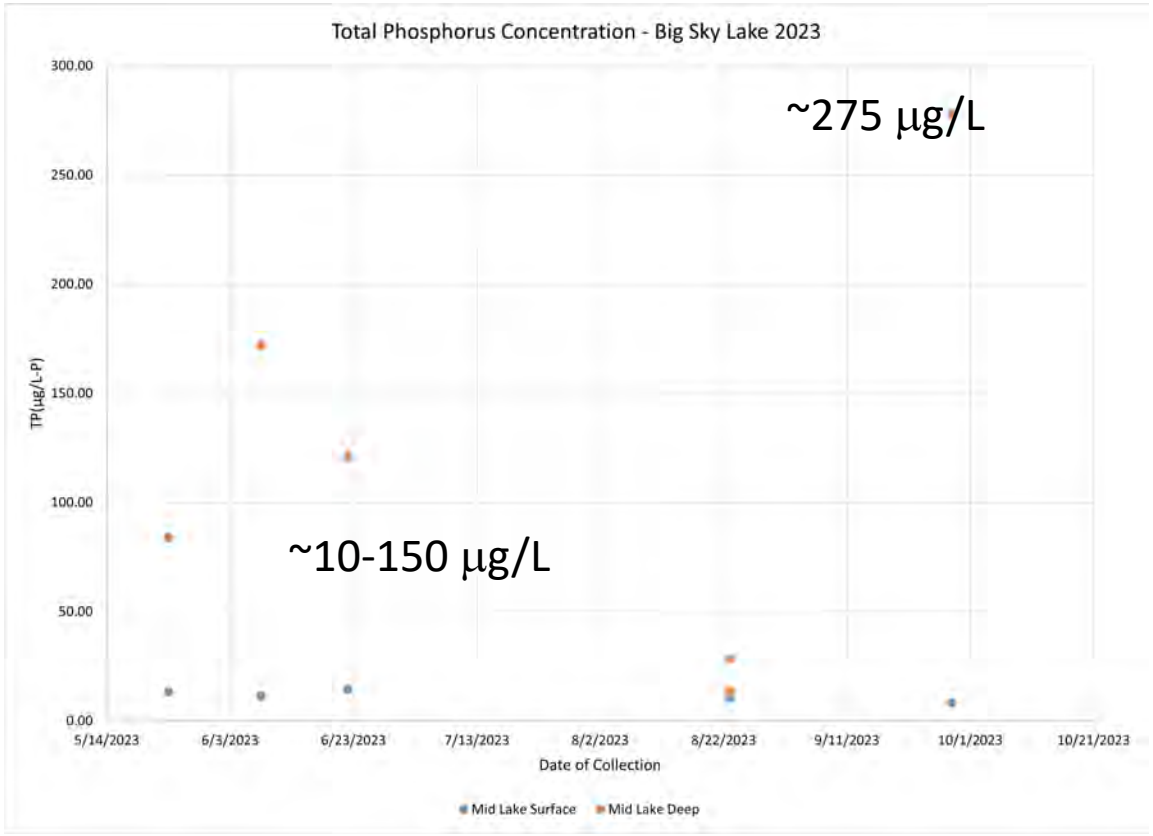


Big Sky Lake (2023): Total Nitrogen and Total Phosphorus



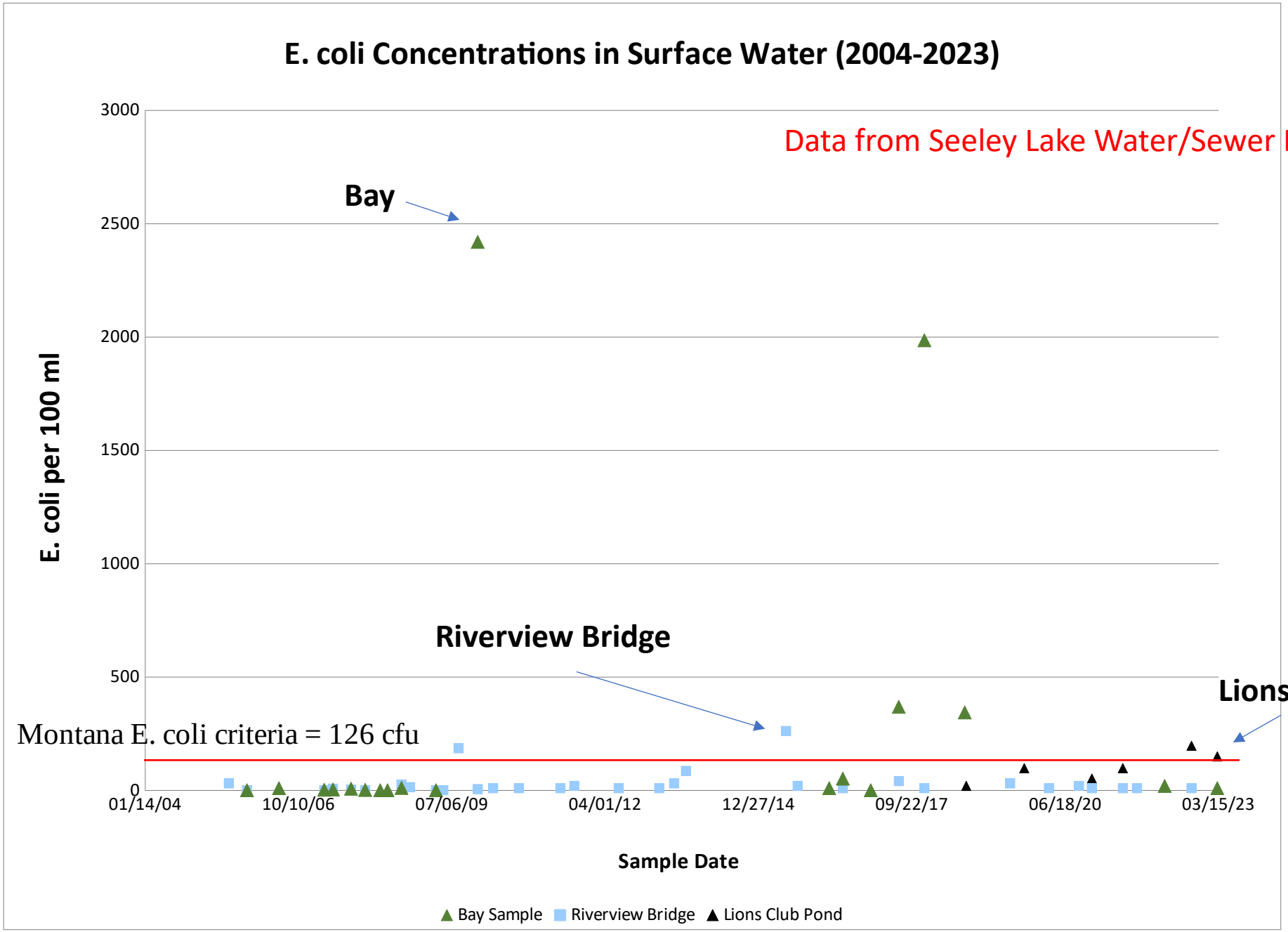
~1600 µg/L

~250-1000 µg/L



~275 µg/L

~10-150 µg/L

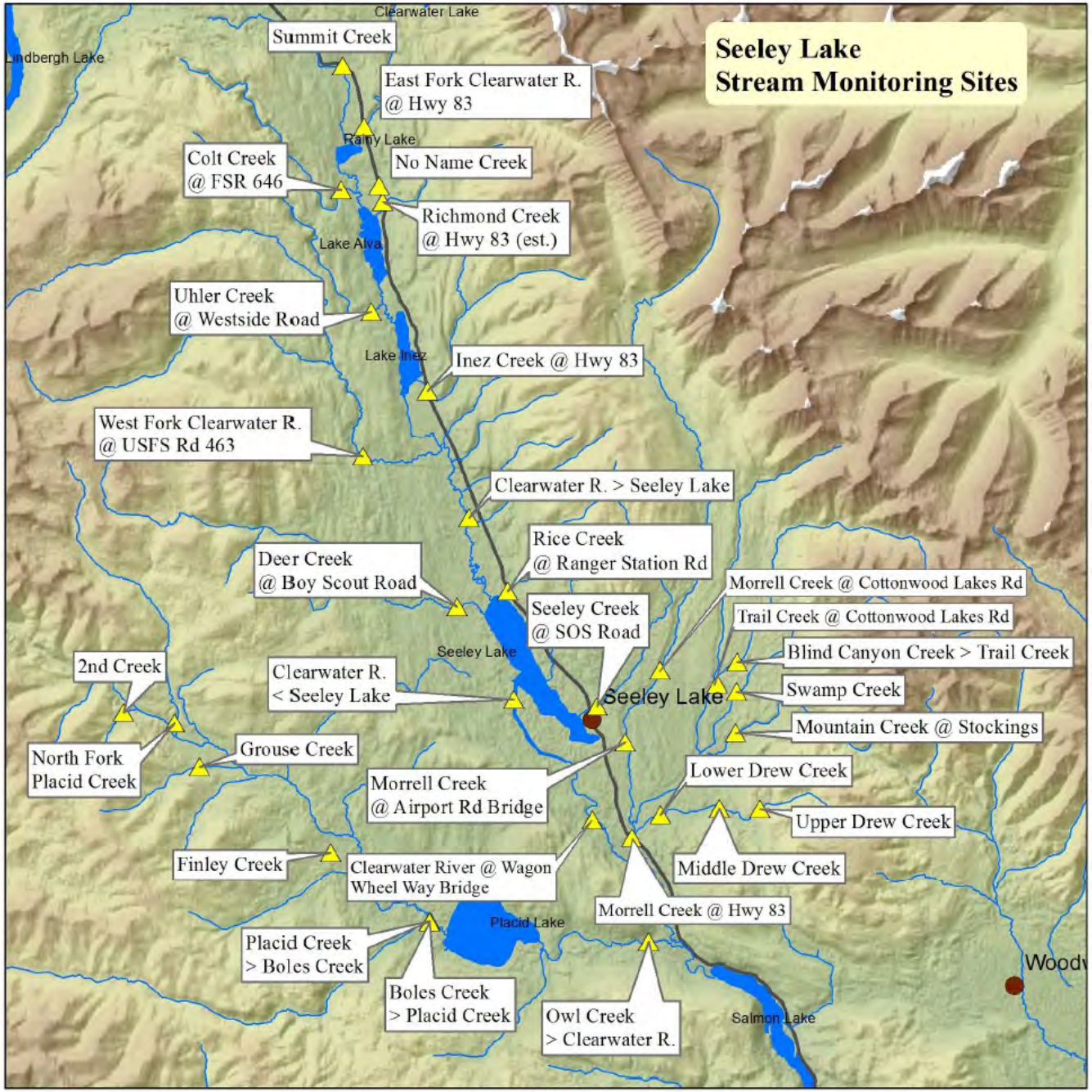

E. coli Concentrations in Surface Water (2004-2023)
Data from Seeley Lake Water/Sewer District
Bay
Riverview Bridge
Lions Club Pond
Montana E. coli criteria = 126 cfu
E. coli per 100 ml
3000
2500
2000
1500
1000
500
0
01/14/04
10/10/06
07/06/09
04/01/12
12/27/14
09/22/17
06/18/20
03/15/23
Sample Date
Bay Sample
Riverview Bridge
Lions Club Pond

2023 CRC *E coli* sampling

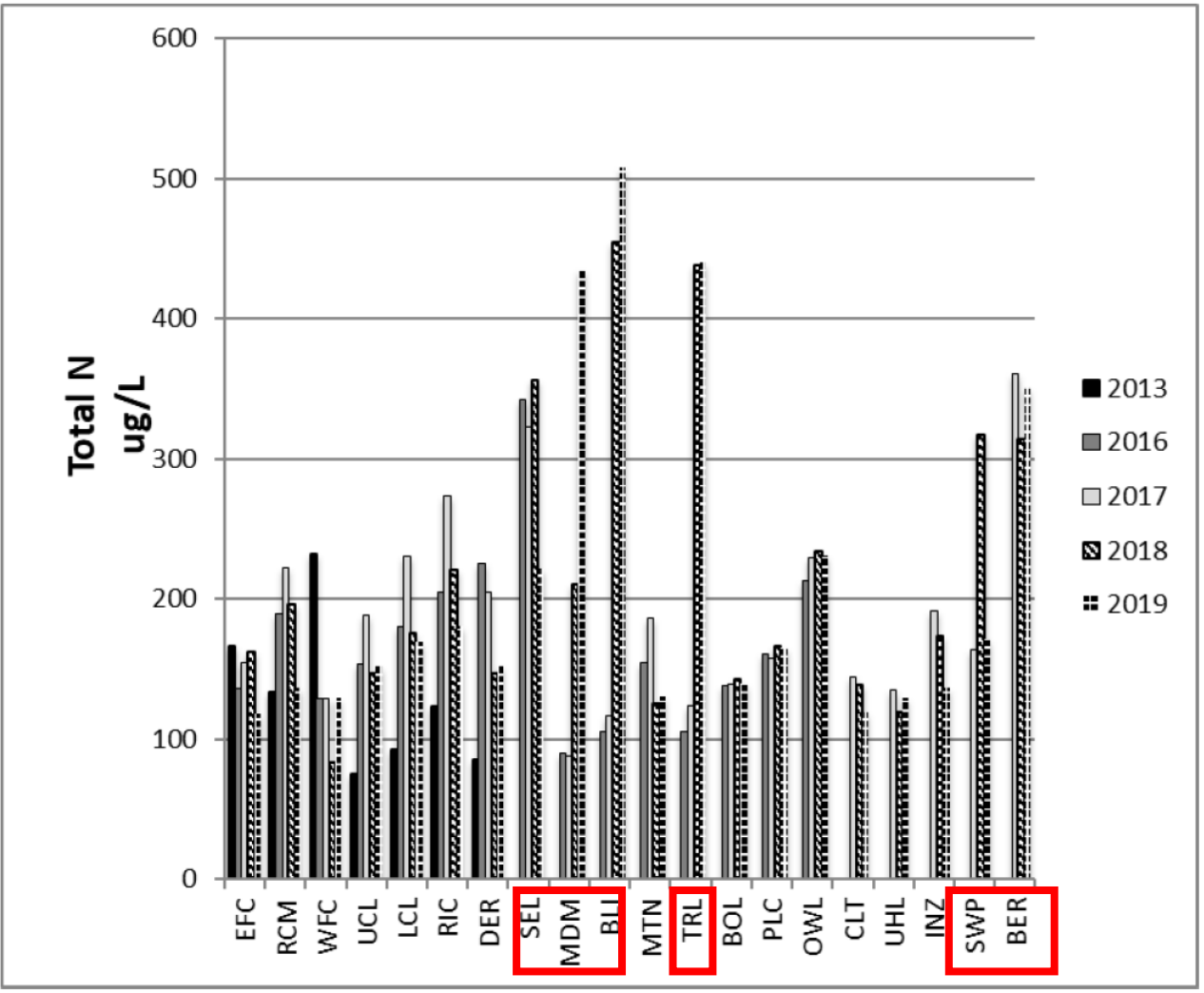
Placid Outlet	6/27/2023	7:22			0
Seeley Lindy's	6/27/2023	7:49			0
Seeley Riverview	6/27/2023	7:37			13
Salmon Outlet	6/27/2023	8:38			2
Big Sky Caretaker	6/27/2023	7:47			8
Seeley (Lindy's)(Dupe)	6/27/2023	7:46			0
Lindy's Dock	8/2/2023	11:21			7
Placid Bridge	8/2/2023	10:56			5
Salmon Lake	8/2/2023	9:57			17
Blank	8/2/2023	11:24			0
Riverview Bridge	8/2/2023	11:09			128
Bigsky Lake	8/2/2023	10:20			72

Where are the nu

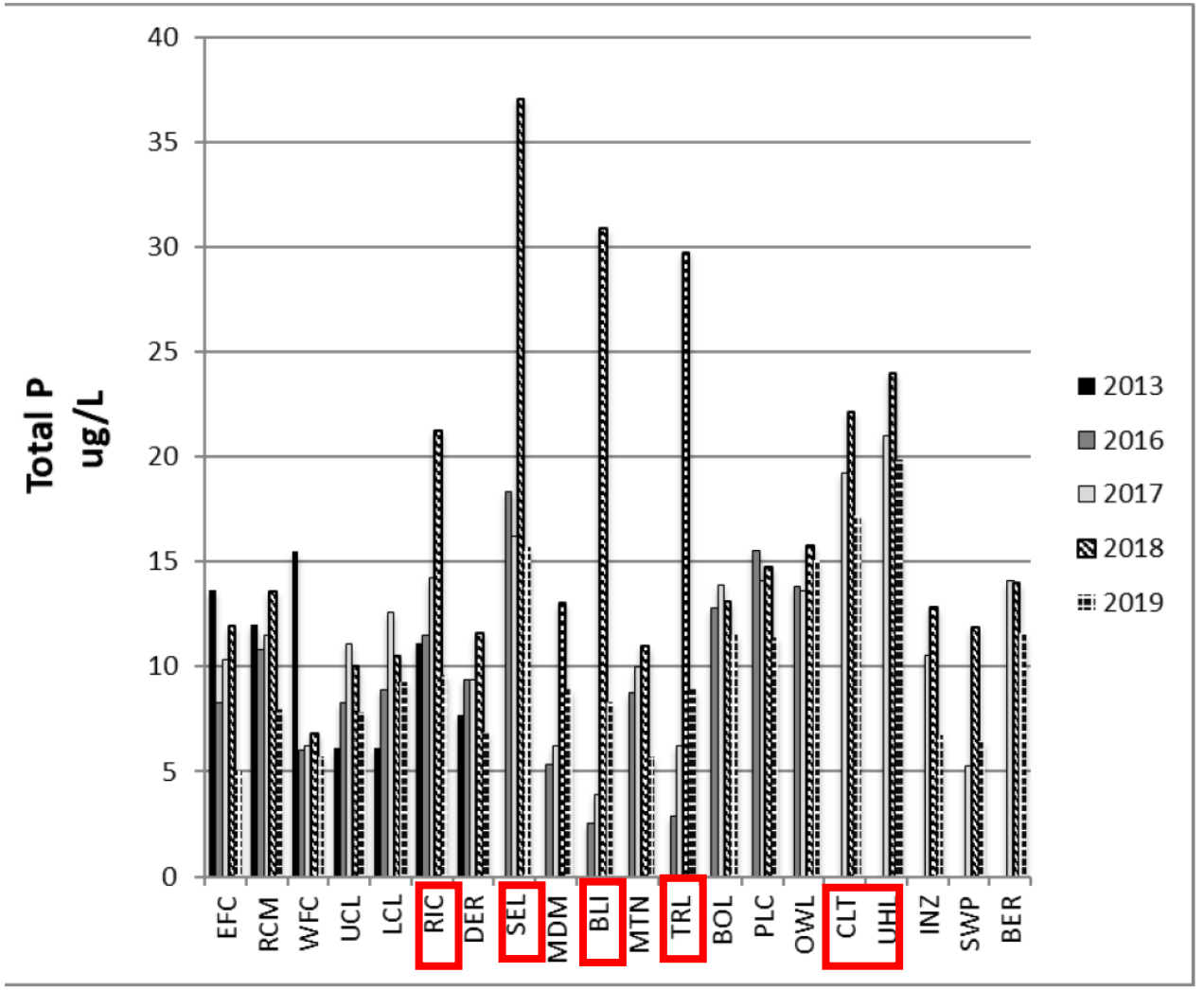
- Streams
  - 15 streams were sampled for TN and TP (2013, 2016-2020)



Nitrogen and Phosphorus Concentrations

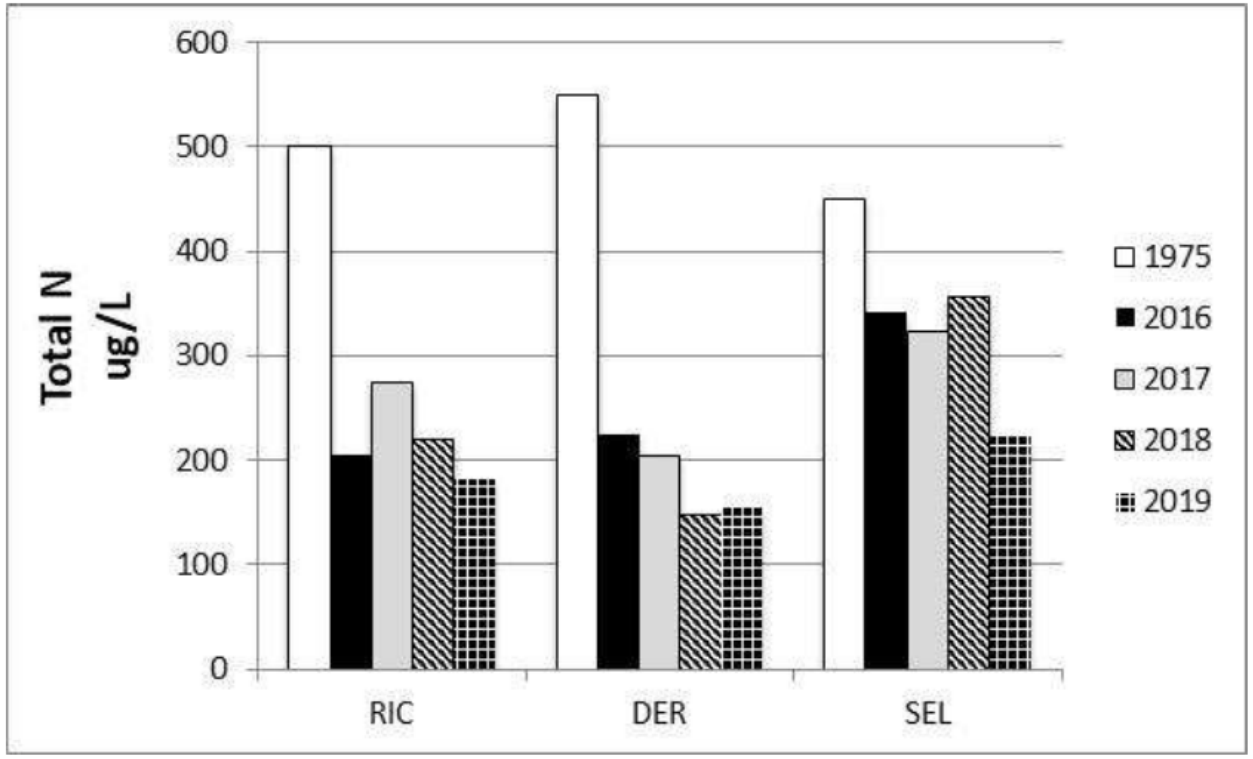


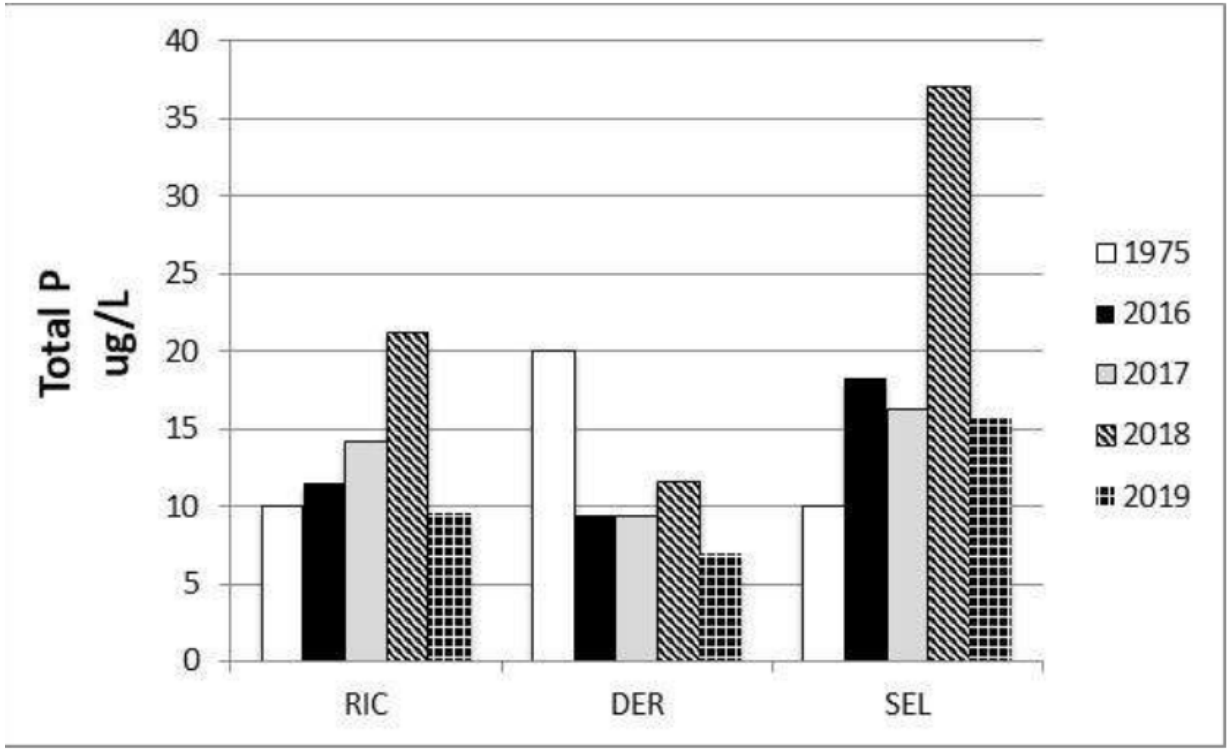
Seeley Cr, Morrell Cr, Trail Cr, Swamp Cr, Blind Canyon, Bertha Cr

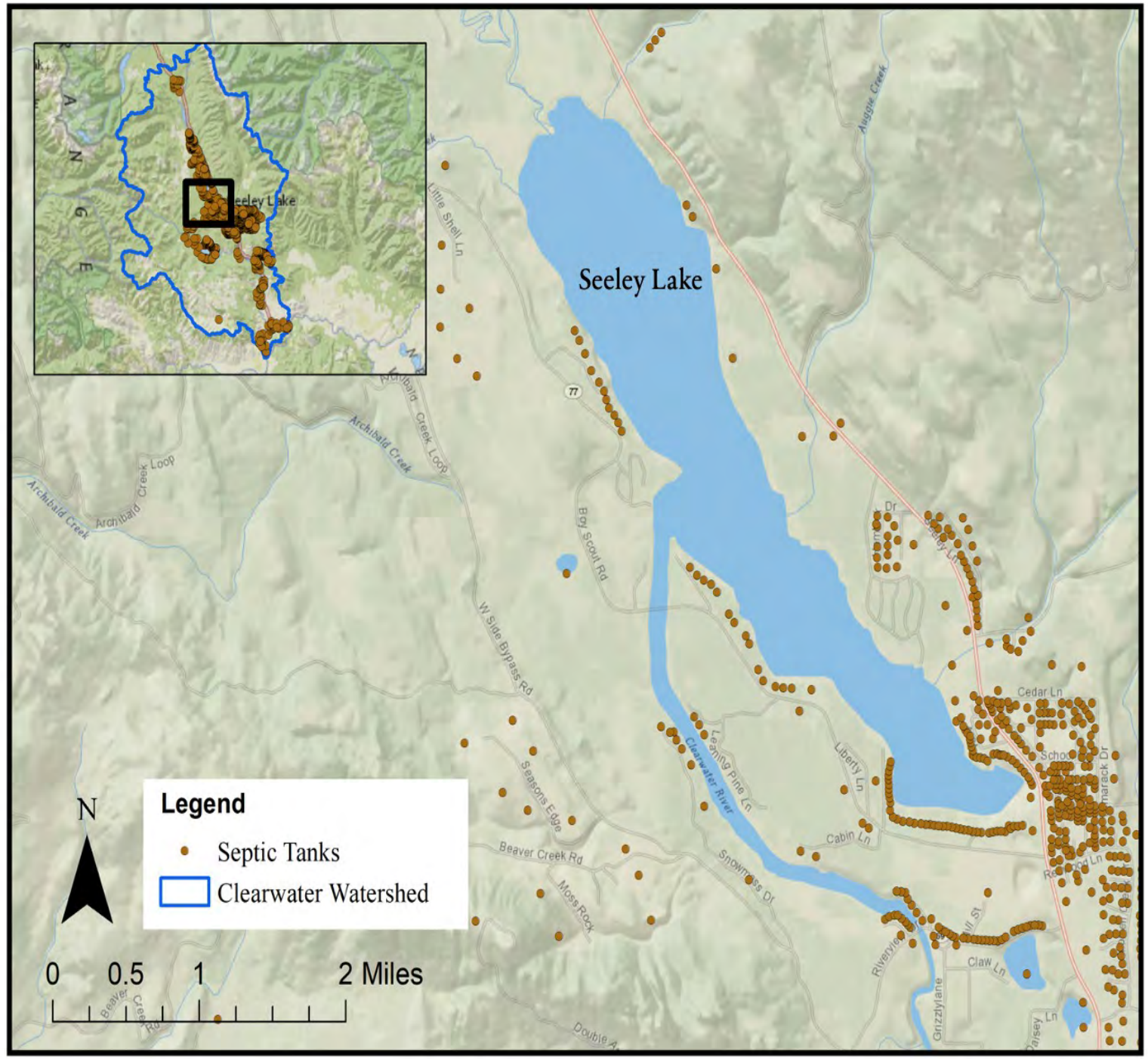


Seeley Cr, Trail Cr, Blind Canyon, Colt Cr, Rice Cr, Uhler Cr

Rice, Deer and Seeley Creeks (1975-2019)






Seeley Lake
Legend
Septic Tanks
Clearwater Watershed
N
0 0.5 1 2 Miles
Archibald Creek Loop
Archibald Creek
Boy Scout Rd
W Side Bypass Rd
Beaver Creek Rd
Moss Rock
Seasons Edge
Clearwater River
Leaning Pine Ln
Liberty Ln
Cabin Ln
Snowmass Dr
Cedar Ln
Claw Ln
Grizzlylane
Little Shell Ln
Augger Creek
Double A

Groundwater

- Nitrate occurs naturally in groundwater
  - Background concentrations: 0.6 -1 mg/L (MBMG, 1999)
- Nitrate is also found in septic effluent

Table 4. Typical Septic Tank Effluent Characteristics

	Range	Mean
Total phosphate (PO4 as P) mg/l	6.25-30	11.6
Nitrate as N mg/l	0-0.1	0.026
Chloride mg/l	37-101	53

Source: Peavy, H. S., Brawner, C. E., Stark, P. E., 1980, The effects of non-sewered subdivisions on ground-water quality: Dept of Civil Engineering and Engineering Mechanics, Montana State Univ. (for the Water Quality Bureau, MT Dept. of Health & Environmental Science), 80-623175.

Previous Work

Seeley Lake Water District
Public Water Supply
PWSID # MT0000327

SOURCE WATER DELINEATION AND ASSESSMENT REPORT

Date of Report: **20 December 2002**

Montana Bureau of Mines and Geology
Open-File Report

Ground-Water Evaluation
Seeley Lake, Montana

by

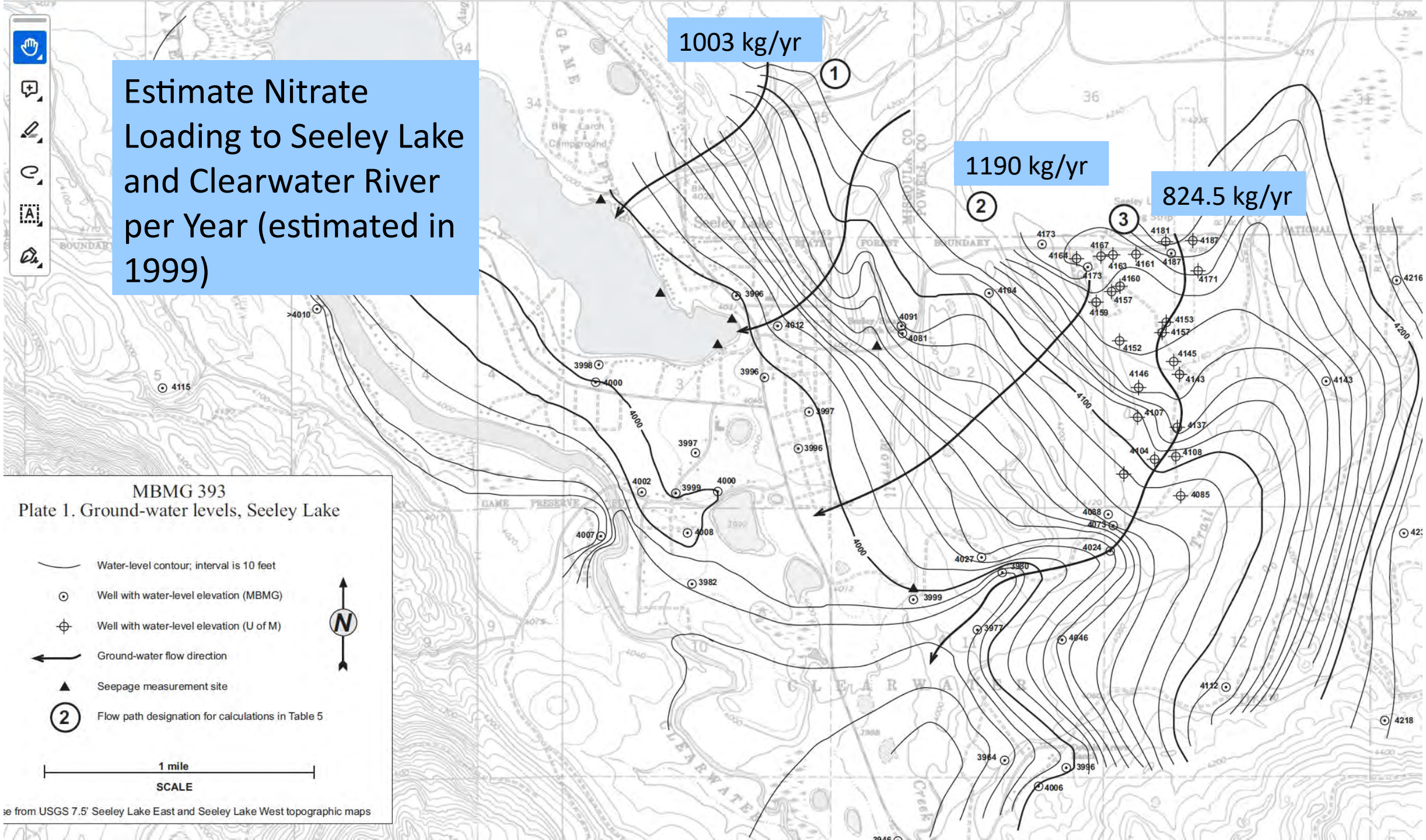
Peter M. Norbeck

and

Catherine McDonald

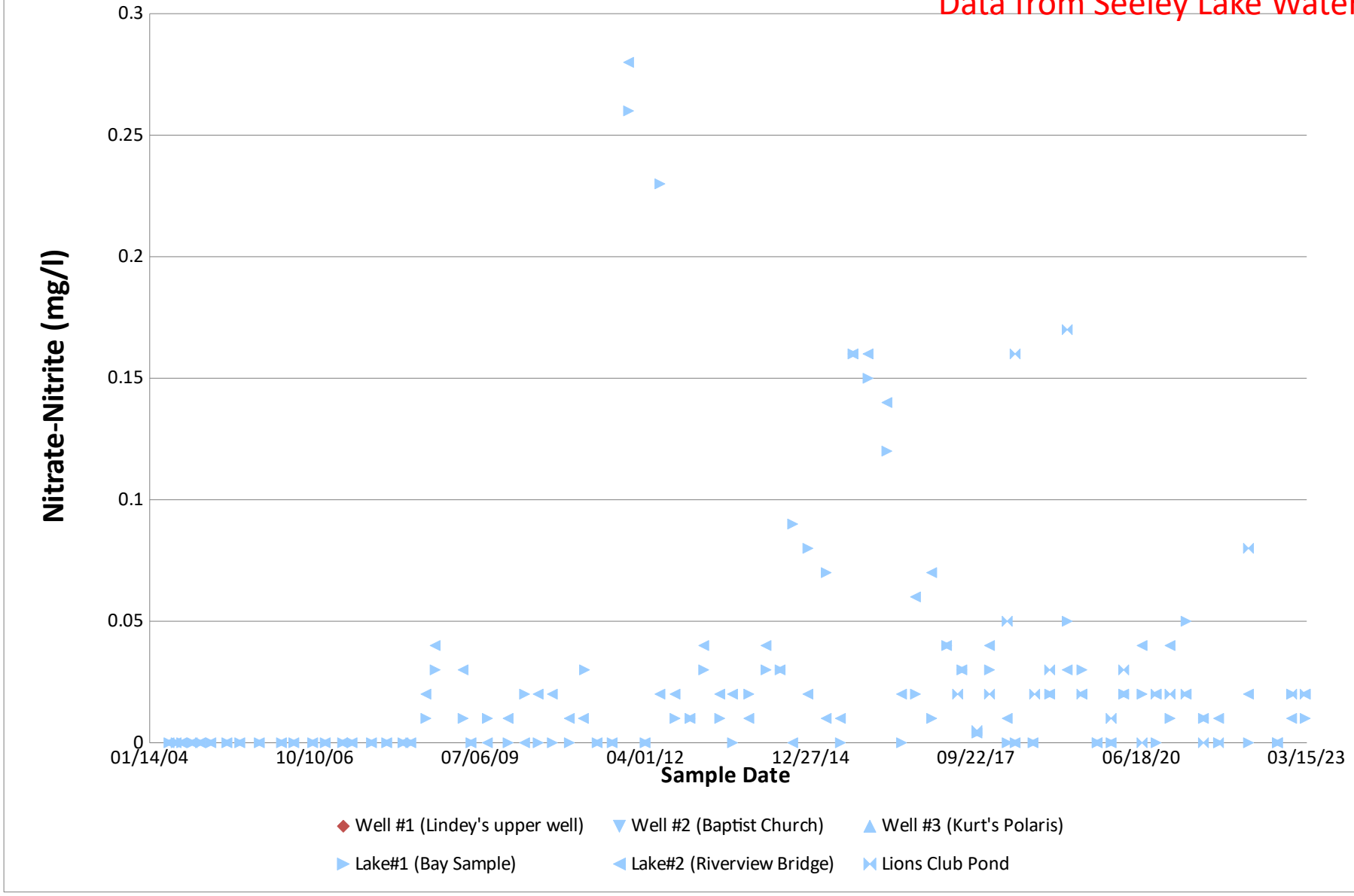
Norbeck, P.M., and McDonald, C., 1999, Ground-water evaluation, Seeley Lake, Montana: Montana Bureau of Mines and Geology Open-File Report 393, 81 p.

Estimate Nitrate Loading to Seeley Lake and Clearwater River per Year (estimated in 1999)



Nitrate-Nitrite Concentrations (2004-2023)

Data from Seeley Lake Water/Sewer District




Proposed Monitoring Wells
MW1
MW2
MW3
MW4
MW5
MW6
MW7
MW8
MW9
MW10
MW11
MW12
MW13
MW14
Seeley Lake
Seeley Creek
Morrell Creek Rd
MT Highway 83
Cedar Ln
Willow Dr
Spruce Dr
Tamarack Dr
Elm Dr
Pine Dr
B St
School Ln
Larch Ln
Locust Ln
Airport Rd
Rieker Rd
Boy Scout Rd
Cabin Ln
Clearwater River
W Riverside Dr
Juniper Dr
Morrell Creek Dr
Black Bear Dr
0 250 500 1,000 1,500 2,000 2,500 3,000 Feet
N
S
E
W
NO.
DESCRIPTION
DATE
DRAFT
REVIEW
NOTES
PROPOSED MONITORING WELLS
SEELEY LAKE, MT MISSOULA COUNTY
FIGURE 1
JOB#: SEELEYLAKESMW21
DATE:9/29/2022
Water & Environmental TECHNOLOGIES

1999

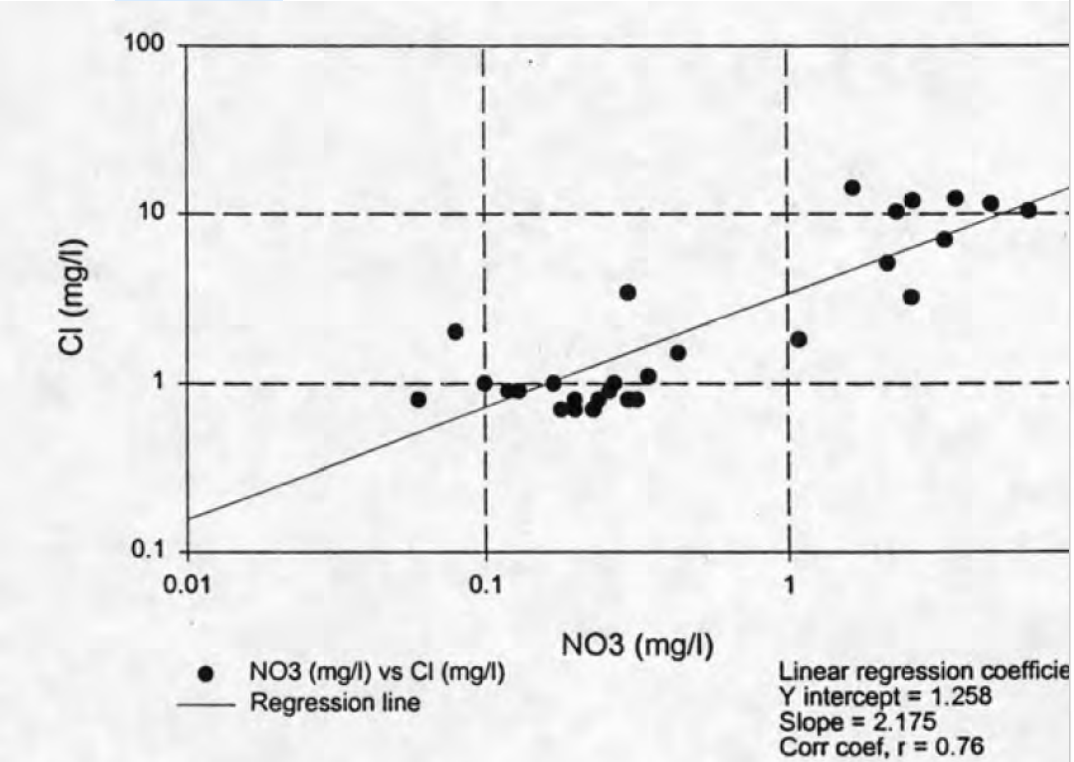
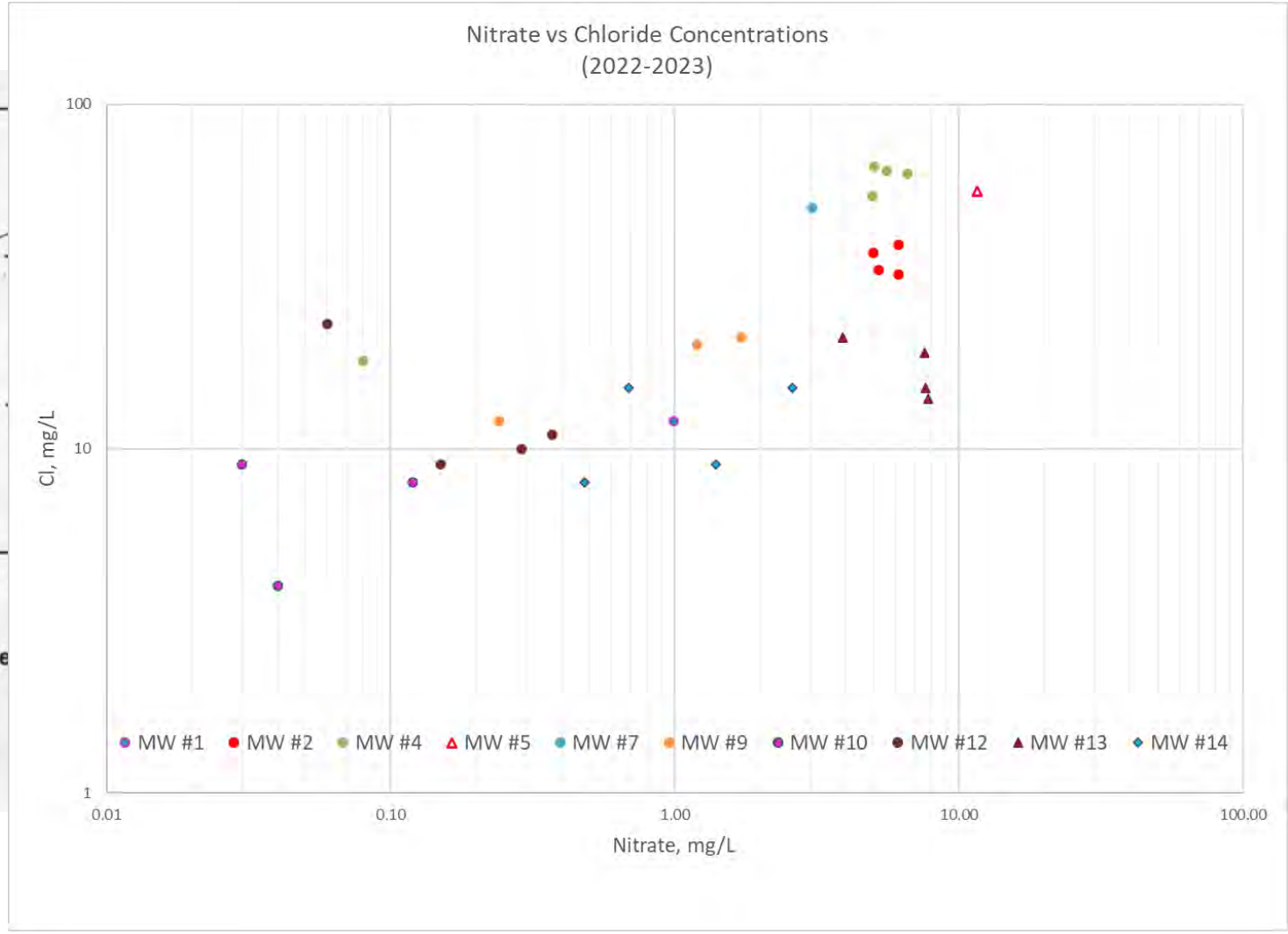
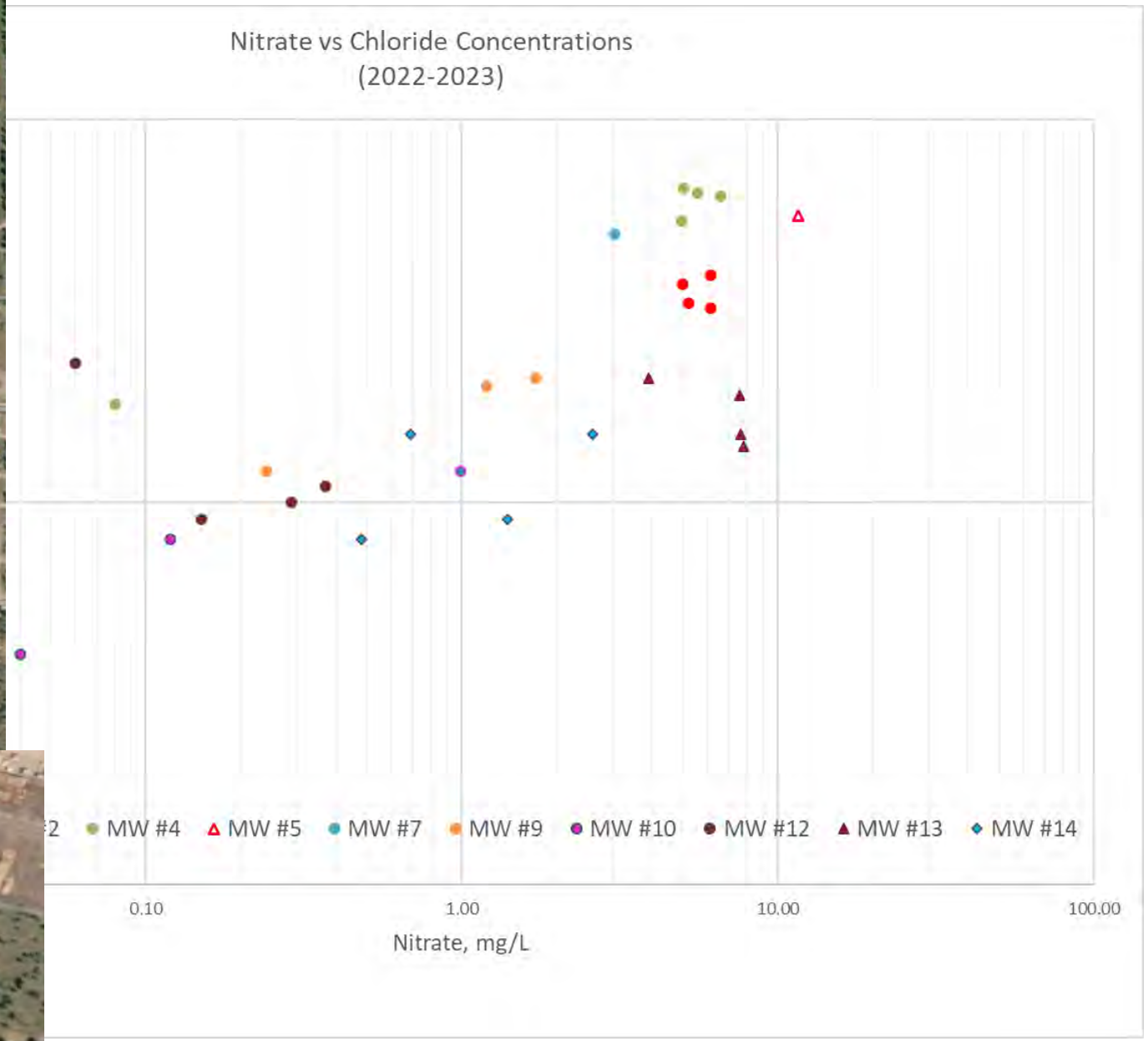


Figure 11. Nitrate vs chloride, Seeley Lake ground water.



Data from Seeley Lake Water/Sewer District


Seeley Lake
MW2
Pine Dr
Elm Dr
B St
MW1
Willow Dr
Spruce Dr
Tamarack Dr
MW4
School Ln
MW3
Larch Ln
Pine Dr
Locust Ln
MW5
Spruce Dr
Tamarack Dr
MW6
MW9
Boy Scout
MW7
Pine Dr
MW8
Juniper Dr
MW13
Riv
W Riverside Dr
MW14


Nitrate vs Chloride Concentrations
(2022-2023)
MW #4
MW #5
MW #7
MW #9
MW #10
MW #12
MW #13
MW #14
0.10
1.00
10.00
100.00
Nitrate, mg/L

Clearwater Valley Watershed Health Summary

- Sampled lake locations generally oligotrophic but some trends toward mesotrophic
- Near shore locations may be different
- Depths (and areas) of the lakes suitable for salmonids (high DO, lower temps) may be getting smaller as lakes warm and DO declines through the summer
- Nutrient concentrations in lakes are greater than either Whitefish Lake or Flathead Lake
- Streams have been significant contributors of nutrients
- The signature of septic effluent is exhibited in monitoring data
- Groundwater is likely to discharge to lakes and streams
- Nutrient loading to the Clearwater River and lakes increases in the downstream direction

Health Summary 2

- Big Sky Lake has high nutrient levels, but to date no indications of algal blooms.
- Deer Creek, Marshall Creek and Owl Creek carry significant discharge and have a significant influence on nutrient levels in the overall system.

Path Forward

- Lake and stream monitoring
  - Lake turnover till fall cooling at strategic locations
  - Streams of concern- Seeley Creek, Rice Creek, Deer Creek, Morrell Creek- above town and below town.
  - Riverview Bridge
- Nutrient budget
  - What comes in from major stream contributors or other sources, what is happening in each lake and what goes downstream to the next lake

Path Forward 2

- Advanced sampling methods (synthetic eDNA, whitening agents, etc.) for potential groundwater/septic leachate into surface waters-
  - Seeley Lake South Bay
  - Morrell Creek in town
  - Riverview Bridge
  - Big Sky Lake
  - Placid Lake outlet bay
  - Salmon Lake
- Continue AIS monitoring and prevention measures

Improve outlying road system

ID	NAME	Length M	Sediment/yr
66029		87.579	313.56
4337	SPOOK LAKE	69.224	367.84
4343	FINMOR	88.047	349.17
4343	FINMOR	63.929	464.04
720	RICE RIDGE	37.721	433.38
9974-2	BEAVER - FINLEY CREEK	86.151	314.16
4362	CAMP CREEK	93.677	555.91
2192	ARCHIBALD LOOP	70.517	320.10
9974-2	BEAVER - FINLEY CREEK	64.495	347.82

Path Forward 3

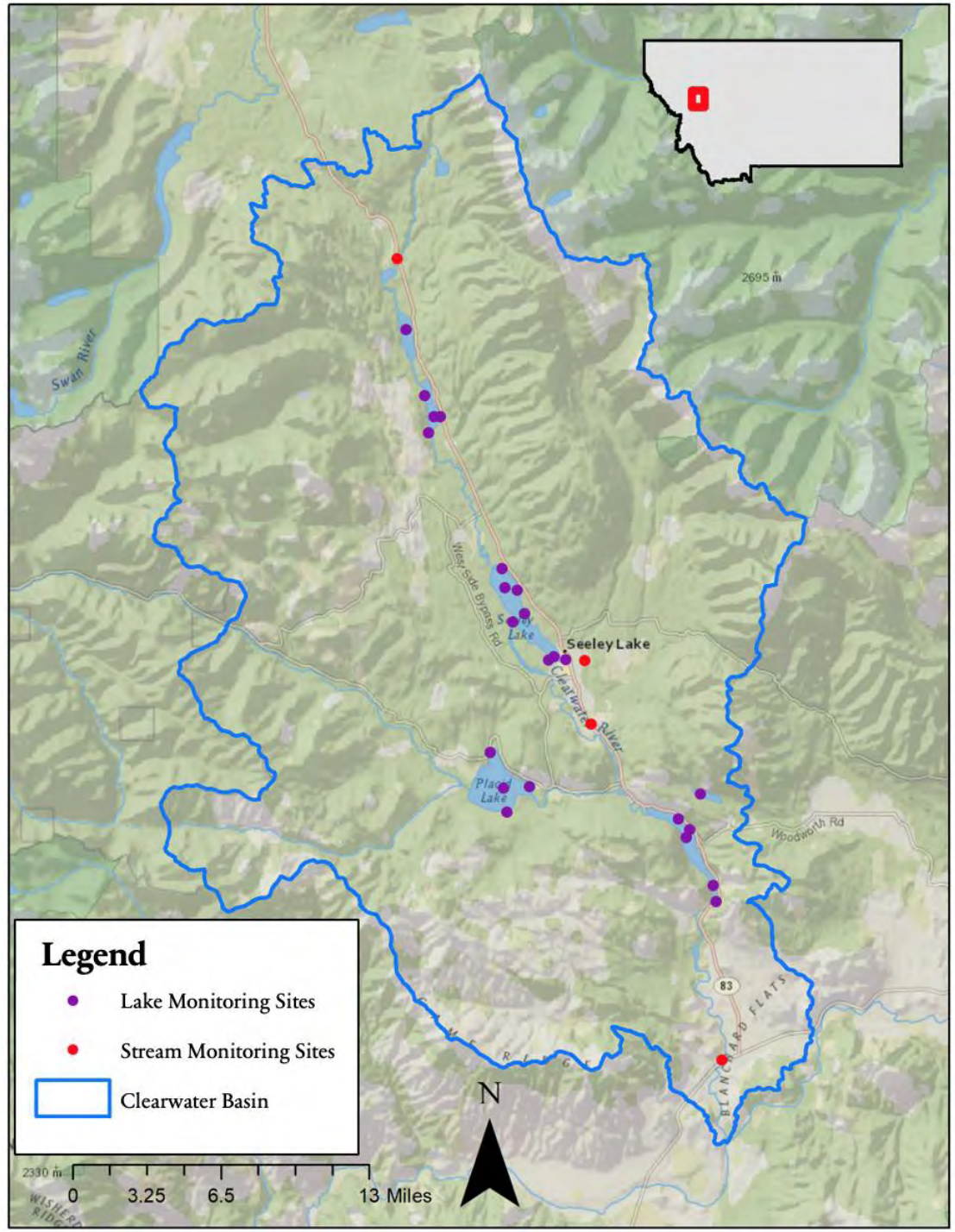
- Address groundwater contamination beneath town
- Identify other sources of contamination to surface waters

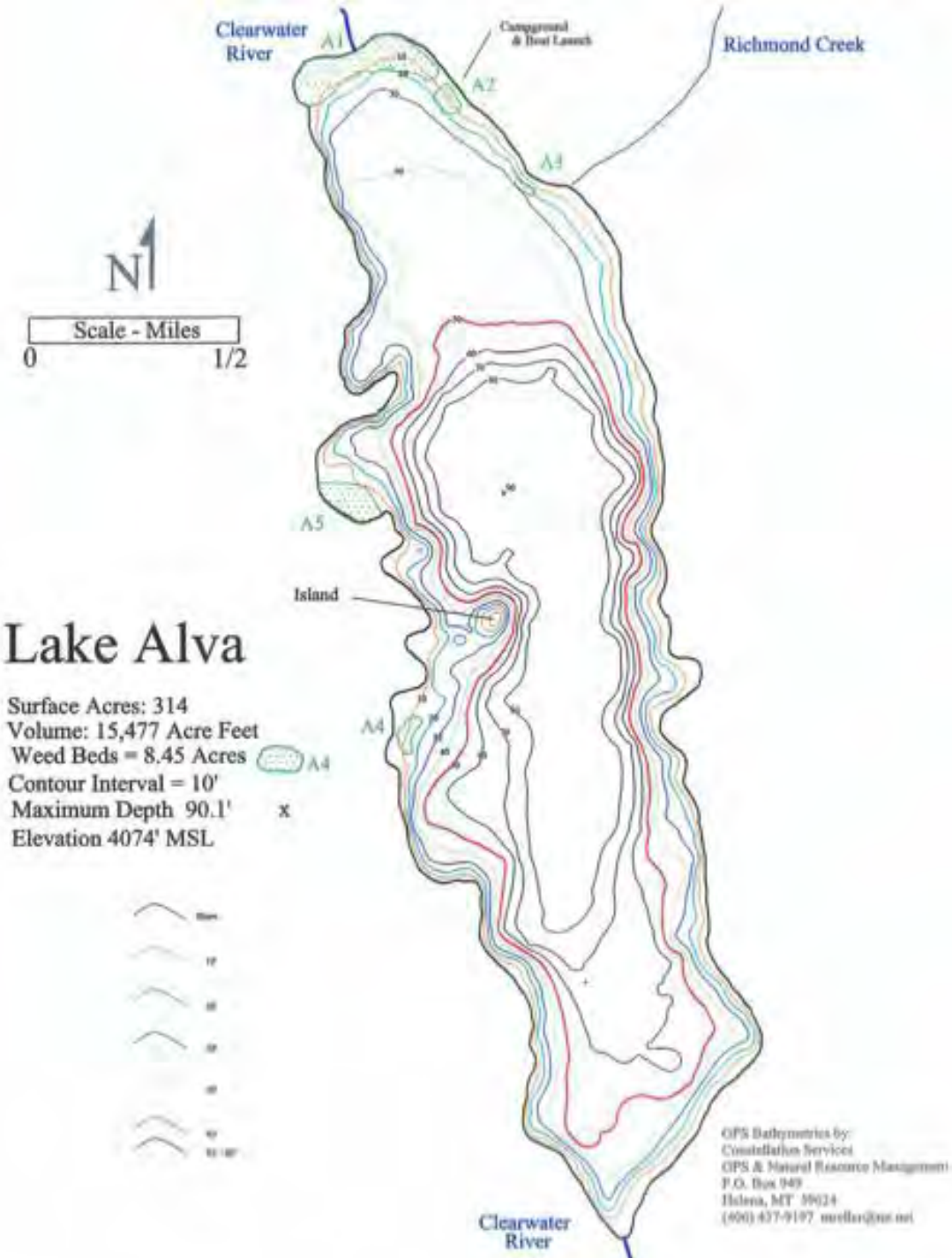
CRC role

- Continue monitoring and focus it on key locations/concerns
- Coordinate locally- Water District, Sewer Board
- Assist and help coordinate with other agencies for additional work
  - Missoula County- Water quality and AIS monitoring
  - USGS- targeted monitoring using new techniques (e.g., synthetic eDNA)
  - DEQ- impairment determinations
- Coordinate with interested lake groups
- Continue outreach and information exchange

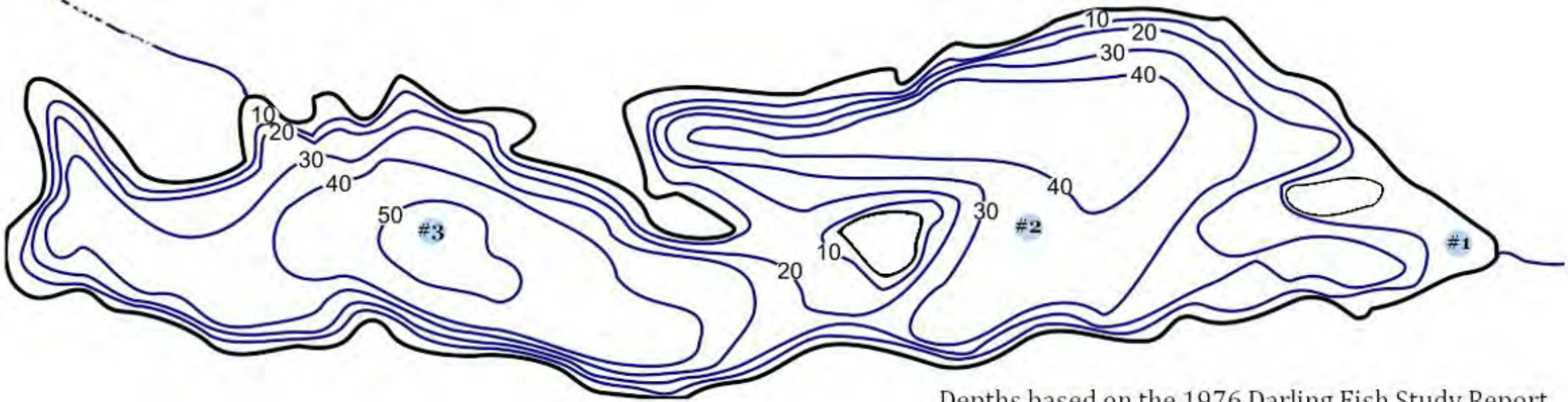
Questions and Discussion

Photo by Joann Wallenburn


Legend
Lake Monitoring Sites
Stream Monitoring Sites
Clearwater Basin
N
0
3.25
6.5
13 Miles
Seeley Lake
Swan River
Clearwater River
West Side Bypass Rd
Woodworth Rd
BLANCHARD FLATS
2695 m
2330 m
83


Clearwater River
A1
Campground & Boat Launch
Richmond Creek
A2
A3
N
Scale - Miles
0
1/2
A5
Island
Lake Alva
Surface Acres: 314
Volume: 15,477 Acre Feet
Weed Beds = 8.45 Acres
A4
Contour Interval = 10'
Maximum Depth 90.1'
Elevation 4074' MSL
GPS Bathymetrics by:
Constellation Services
GPS & Natural Resource Management
P.O. Box 949
Helena, MT 59624
(406) 437-9197
Clearwater River

Big Sky Lake



Depths based on the 1976 Darling Fish Study Report
Digitally set up by J. Harrits Sept. 2020