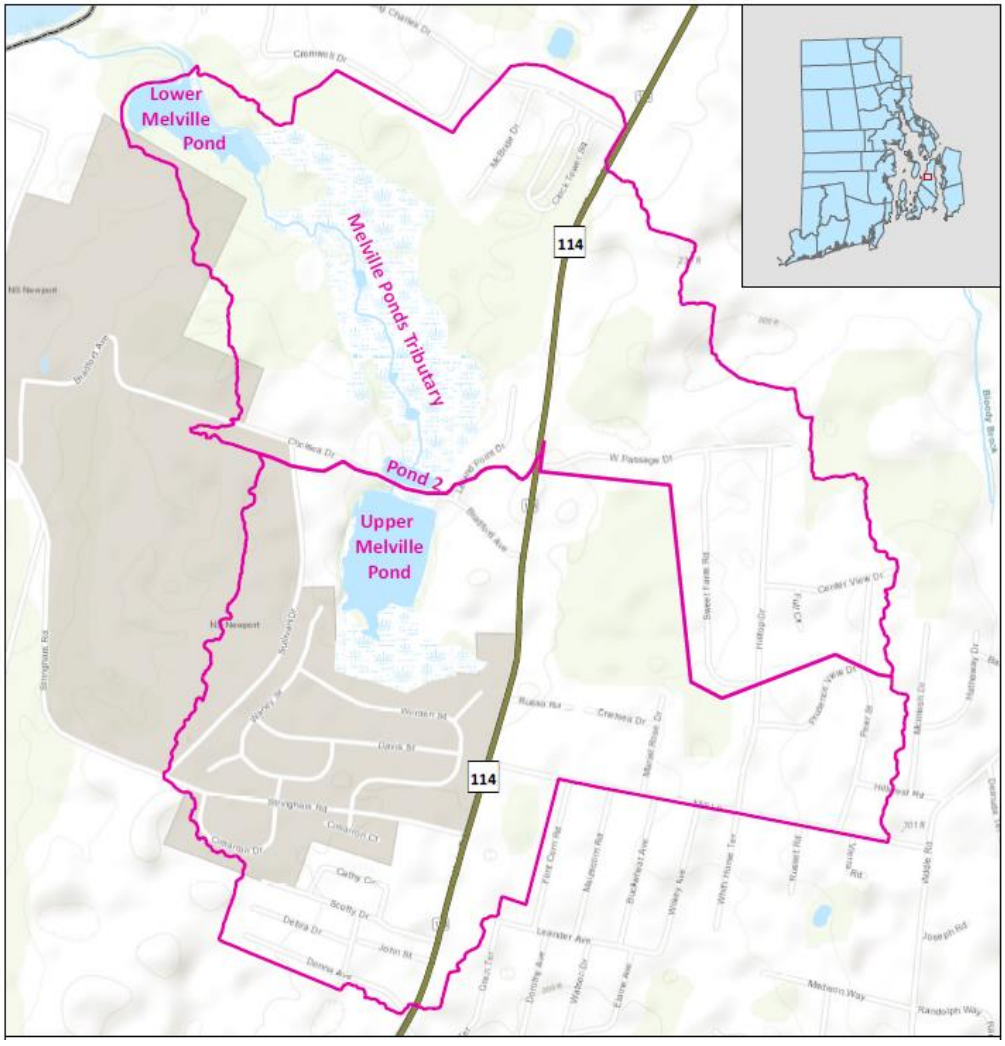
Surface Water Monitoring Summary for Upper and Lower Melville Ponds, Portsmouth, RI (2021-2022)

Data Report
October 2022



STATE OF RHODE ISLAND
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
Office of Water Resources
235 Promenade St.
Providence, RI 02908

OVERVEW

This report presents the quality assured quality controlled (QAQC) data collected by RIDEM's Office of Water Resources in 2021-2022 to support TMDL development in upper and lower Melville Ponds, Portsmouth, RI. The primary purpose of this report is to evaluate the field and analytical data to ensure that it meets the measurement performance criteria specified in the EPA-approved Quality Assurance Project Plan (QAPP) (www.dem.ri.gov/pubs/qapp/qapp-melville-ponds-sampling.pdf). Analysis and interpretation of the field and analytical data as they relate to the pollutants of concern are presented in the TMDL.

Both Upper and Lower Melville Ponds share a single waterbody ID (RI0007029L-01) and both are considered Class A waterbodies (https://rules.sos.ri.gov/regulations/part/250-150-05-1). Designated use goals associated with Class A waters include fish and wildlife habitat, fish consumption, and primary and secondary contact recreation.

Melville Ponds are listed on Category 5 of Rhode Island's 2018-2020 Impaired Waters Report (http://dem.ri.gov/programs/benviron/water/quality/pdf/iwr22.pdf). The designated use of fish and wildlife is not being met in both ponds- the cause/impairment is due to elevated levels of total phosphorus. Fish consumption use is not assessed and at present there is insufficient information to evaluate primary and secondary contact recreation uses. Waterbodies listed on Category 5 of the states Impaired Waters Report require development of a TMDL for each impairment.

The data collected by RIDEM in 2021 will be used to develop total phosphorus TMDL's for Upper and Lower Melville Ponds. Water samples and physical data were collected from both ponds during all surveys. The Rhode Island Department of Health (HEALTH) Laboratories, located in Providence, Rhode Island analyzed samples for total phosphorus (TP), orthophosphate (PO4), nitrite and nitrate nitrogen (NO_2 and NO_3-N), algal-cyanobacteria enumeration and identification, and algal toxins. New England Testing Laboratory in North Providence analyzed samples for total Kjeldahl nitrogen (TKN), and ammonia (NH_3). The University of Rhode Island Watershed Watch (URIWW) laboratory analyzed samples for chlorophyll-a (chlorophyll-a).

A summary of data collected in 2023 to support development of the Melville Ponds Tributary TMDL is provided in Appendix C.

GOALS AND OBJECTIVES OF MONITORING

Prior to RIDEM's 2021 data collection in upper and lower Melville Ponds the only available data for evaluation of water quality conditions in Upper Melville Pond came from a single, mid-pond surface station for the years 1997-2020 and no data exist for Lower Melville Pond. The data collection activities in 2021 were meant to fill these data gaps and provide a full season of bi-weekly data to aid in TMDL development.

The goals of the monitoring/sampling were to: 1. Obtain an additional year of water chemistry and field data that will be used to evaluate the nutrient (mainly P) dynamics of upper and lower Melville Ponds and develop the TMDLs and 2. Collect sufficient water column data to estimate internal loading of phosphorus from sediments.

SAMPLING OVERVIEW

The study design is described in detail in the EPA-approved Quality Assurance Project Plan. Staff from RIDEM collected water chemistry and other physical data in Melville Ponds on a bi-weekly basis from May through October 2021. Surveys were conducted on the dates shown in Table 1. In total, 11 surveys were completed.

Table 1: Melville Ponds 2021 Sampling Dates

May 19	June 17	July 14	Aug 11	Sept 8	Oct 20
June 2	June 29	July 27	Aug 24	Sept 29	

Sampling locations, sampling parameters, and sampling frequency and format are described in detail in the QAPP. Each reservoir was sampled at a single location (utilizing an electronic depth finder and available bathymetric information) at its deepest point (Figure 1). Sampling of both ponds was completed by two staff members in a single day. Water samples collected during the study were analyzed for total phosphorus (TP), ortho-phosphorus (OP), total nitrogen (TN), nitrate (NO_3-NO_2), total Kjeldahl nitrogen (TKN), ammonia (NH_3), and chlorophyll-a. Water clarity was measured using a secchi disc. The collection of temperature, dissolved oxygen, and specific conductance in the water column (in increments of feet), at the deepest point/location of each pond, was completed using a YSI ProPlus or 2030 series sonde.

The total number of water samples collected in each reservoir was dependent upon conditions at the time of sampling (i.e., stratified or non-stratified). Under stratified conditions, samples to be analyzed for TP, OP, TN, TKN, and NH3 were collected from two depths at the sample station. One vertically integrated (2 meter) sample within the epilimnion and one collected using a Van Dorn sampler within the hypolimnion. For non-stratified conditions, samples to be analyzed for TP, OP, TN, TKN, and NH3 were taken with a vertically integrated (2 meter) sampler and chlorophyll-a samples were collected at the surface.

Figure 1. Approximate sampling locations for Upper and Lower Melville Ponds

QUALITY ASSURANCE

FIELD DATA QA/QC

Field sampling and measurement protocols followed those specified in the QAPP for in-situ temperature, dissolved oxygen, and specific conductance using the YSI ProPlus meter, as well as for measurements of clarity (secchi depth). ProPlus meters were calibrated and post-calibrated per manufacturer's instructions and the Standard Operating Procedure (SOP) in the QAPP. Calibration records are kept at the RIDEM Office in Providence. No issues were encountered with calibration, use, or post-calibration of the YSI ProPlus meter that would have affected results and therefore all data were considered acceptable.

ANALYTICAL QA/QC

As specified in the QAPP, analytical services were provided by the State Health Laboratory (SHL), located in Providence, Rhode Island, New England Testing Laboratory (NETL) in North Providence, Rhode Island, and the University of Rhode Island Watershed Watch (URIWW) Laboratory in Kingston, Rhode Island. The total number of samples collected and analyzed in 2021 are listed in Table 2. The analytical methods and laboratory SOPs specific to each analyte are presented in the QAPP. Reporting limits for each analyte are provided in Table 3.

Table 2: Upper and Lower Melville Pond 2021 Sample Summaries

Parameter	Laboratory	Analytical Method/ Laboratory SOP	Upper Melville Pond	Lower Melville Pond	Field Duplicates	Total Number of Samples
Chlorophyll-a	URIWW	LSOP012	11	11	5	27
Ortho-P	SHL	SM 4500 P E	19	20	5	44
Total-P	SHL	SM 4500 P E	21	23	6	50
TKN and NH3	NETL	TKN: EPA 350.1 Rev. 2.0 NH_3: EPA 351.2	21	22	6	49
NO2-NO3	SHL	EPA 353.2	21	22	6	49
TOTAL						**219**

Table 3: Reporting Limits for each analyte

Analyte	Total P (ug/L)	Ortho P (ug/L)	Nitrate (ug/L)	NH3 (ug/L)	TKN (ug/L)	Chlorophyll-a (ug/L)
Reporting Limit	10	20	50	100	100	0.2

Applicable laboratory analytical methods and achievable laboratory limits are provided in the QAPP. Only data meeting the QA/QC criteria set forth in the QAPP were utilized for analysis by RIDEM. Field duplicates from the final datasets were evaluated by RIDEM and those samples not meeting the criteria set in the QAPP were removed from the final datasets. Field duplicate QA/QC was evaluated by RIDEM below. Unless otherwise noted, the relative percent difference (RPD) of >20% was set as the criteria for acceptance of the field duplicate and original sample for all parameters. Field duplicate data, by waterbody, for nutrients and chlorophyll-a are shown in Tables 4 and 5. Values not utilized in the final datasets are noted.

Table 4: Upper and Lower Melville Pond 2021 Nutrient Field Duplicate Results.

Sample Site	Total P (ug/L)	Ortho P (ug/L)	Nitrate (ug/L)	Total NH3 (ug/L)	TKN (ug/L)	TN (ug/L)
Upper Melville - Surface	37	ND	720	ND	500	1220
Field Duplicate - 5/19/2021	37	ND	720	ND	600	1320
RPD	0.0%	N.A.	0.0%	N.A.	18.2%	7.9%
Lower Melville - Surface	20	ND	1300	ND	600	1900
Field Duplicate - 6/17/2021	22	ND	1330	100	600	1930
RPD	9.5%	N.A.	2.3%	N.A.	0.0%	1.6%
Lower Melville - Surface	54	25	800	0	1400	2200
Field Duplicate - 7/14/2021	48	24	890	0	1200	2090
RPD	-11.8%	0.0%	10.7%	N.A.	-15.4%	-5.1%
Lower Melville - Depth	600	N.A.	ND	2400	3000	3000
Field Duplicate - 8/11/2021	800	N.A.	ND	1600	2200	2200
RPD	28.6%	N.A.	N.A.	-40.0%	-30.8%	-30.8%
Upper Melville - Depth	110	ND	720	300	1000	1000
Field Duplicate - 9/8/2021	130	ND	790	300	1100	1100
RPD	16.7%	N.A.	9.3%	0.0%	9.5%	9.5%
Upper Melville - Surface	**39***	24	690	100	700	1390
Field Duplicate - 10/20/2021	28	25	690	100	700	1390
RPD	-32.8%*	4.1%	0.0%	0.0%	0.0%	0.0%

***Considered acceptable for use: 1) depth sample was also 39 ug/L and other parameters were <5% RPD, 2) reported concentration was less than 5 times the reporting limit, 3) water column was fully mixed. ND (non-detect). NA (not analyzed).

Table 5: Upper and Lower Melville Pond 2021 Chlorophyll-a Field Duplicate Results

Chlorophyll-a Sampling Date	Lower Melville (ug/L)	Upper Melville (ug/L)	Field Duplicate	Chlorophyll-a (ug/L)	FD RPD%
5/19/2021	4.7	5.3			
6/2/2021	3.0	9.5*	Upper	6.9	-31.3%
6/17/2021	5.7	9.3			
6/29/2021	5.6	7.0	Lower	5.4	-3.8%
7/14/2021	71.6	13.3			
7/27/2021	7.6	16.9	Upper	16.9	0.0%
8/11/2021	19.0	37.2			
8/24/2021	56.4	27.2	Upper	26.5	-2.6%
9/8/2021	26.8	27.9			
9/29/2021	26.9	34.5	Lower	26.6	-1.1%
10/20/2021	14.1	17.1			
	avg	avg			
	21.9	19.6			

*Datapoint not used to calculate mean annual concentration statistic

WATER QUALITY MONITORING RESULTS

CHLOROPHYLL-A

Chlorophyll-a data for both ponds are presented below in Table 6.

Table 6. Chlorophyll-a Summary for Upper and Lower Melville Pond (2021).

Chlorophyll-a concentrations in ug/l	**Upper Melville Pond**	**Lower Melville Pond**
Date		
5/19/2021	5.3	4.7
6/2/2021	-	3.0
6/17/2021	9.3	5.7
6/29/2021	7.0	5.6
7/14/2021	13.3	71.6
7/27/2021	16.9	7.6
8/11/2021	37.2	19.0
8/24/2021	27.2	56.4
9/8/2021	27.9	26.8
9/29/2021	34.5	26.9
10/20/2021	17.1	14.1

*Upper Melville sample on 6/2/21 was removed due to QA/QC criteria with field duplicate.

NUTRIENT DATA SUMMARY

As stated earlier, the total number of water samples collected for nutrient analysis was dependent upon thermal conditions in the pond at the time of sampling (i.e., stratified or non-stratified). Under stratified conditions, samples analyzed for nutrients were collected from two depths at the sample station: 1) epilimnion using a 2-meter vertically integrated sampler and 2) hypolimnion using a van dorn sampler. For non-stratified conditions, samples analyzed for nutrient-related parameters were collected from just below the surface. The analytical QA/QC criteria for nutrients are listed in the QAPP. In Lower Melville, consistent water column stratification was noted throughout most of the sampling season (5/19/21-10/20/21) and in Upper Melville, the water column was weakly stratified from 6/17/21 to 9/8/21. All nutrient data are presented in tabular format in Appendix A.

PHOSPHORUS DATA SUMMARY

Figures 2-5 display plots of the total phosphorus and ortho-phosphorus data within the surface/epilimnion and hypolimnion of both upper and lower Melville Pond.

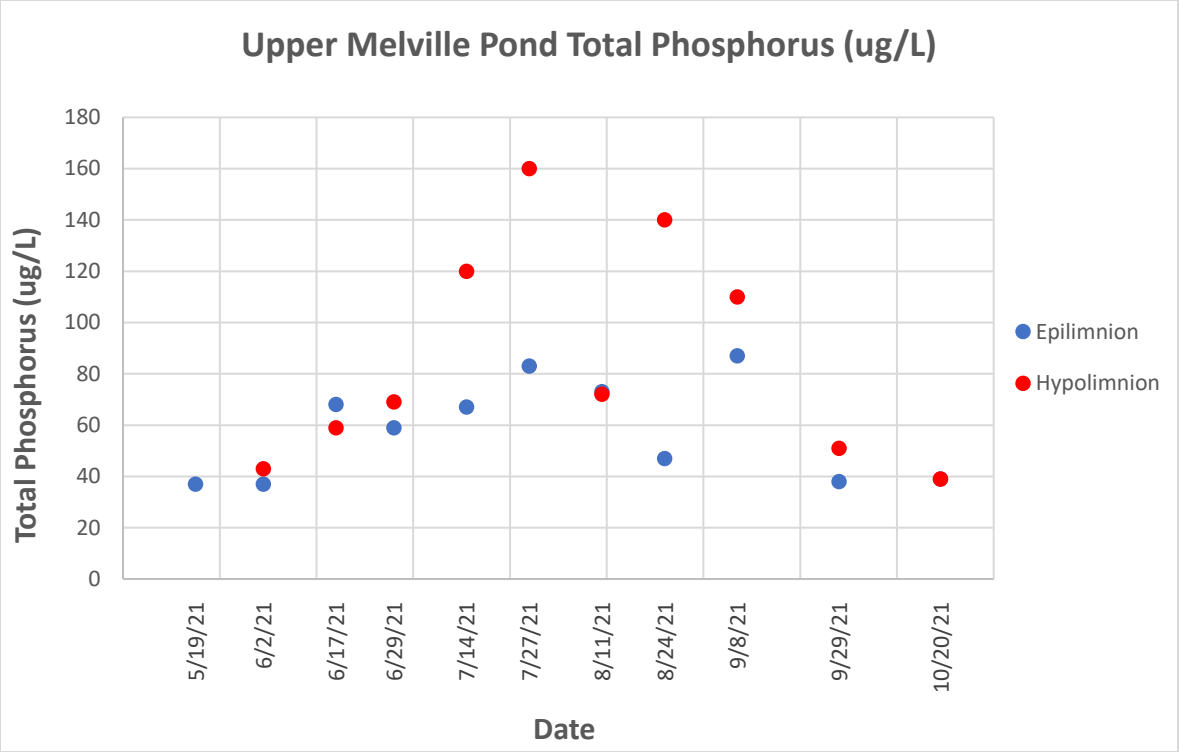


Figure 2. Upper Melville Pond total phosphorus results.

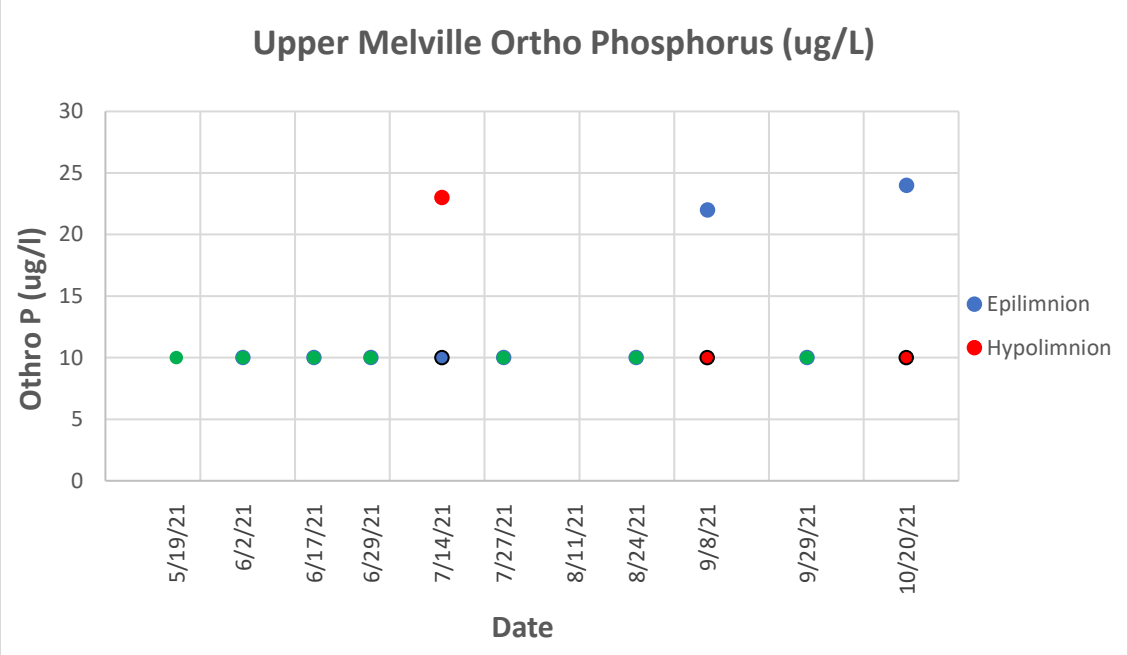


Figure 3. Upper Melville Pond ortho-phosphorus results. 8/11/21 samples were not analyzed. Symbols with black outline indicate sample result was reported as below detection limit. A value of 'half the detection limit' is used for display and averaging purposes. Green symbols indicate that both epilimnion and hypolimnion samples were reported as below the detection limit- these are plotted as half the detection limit.

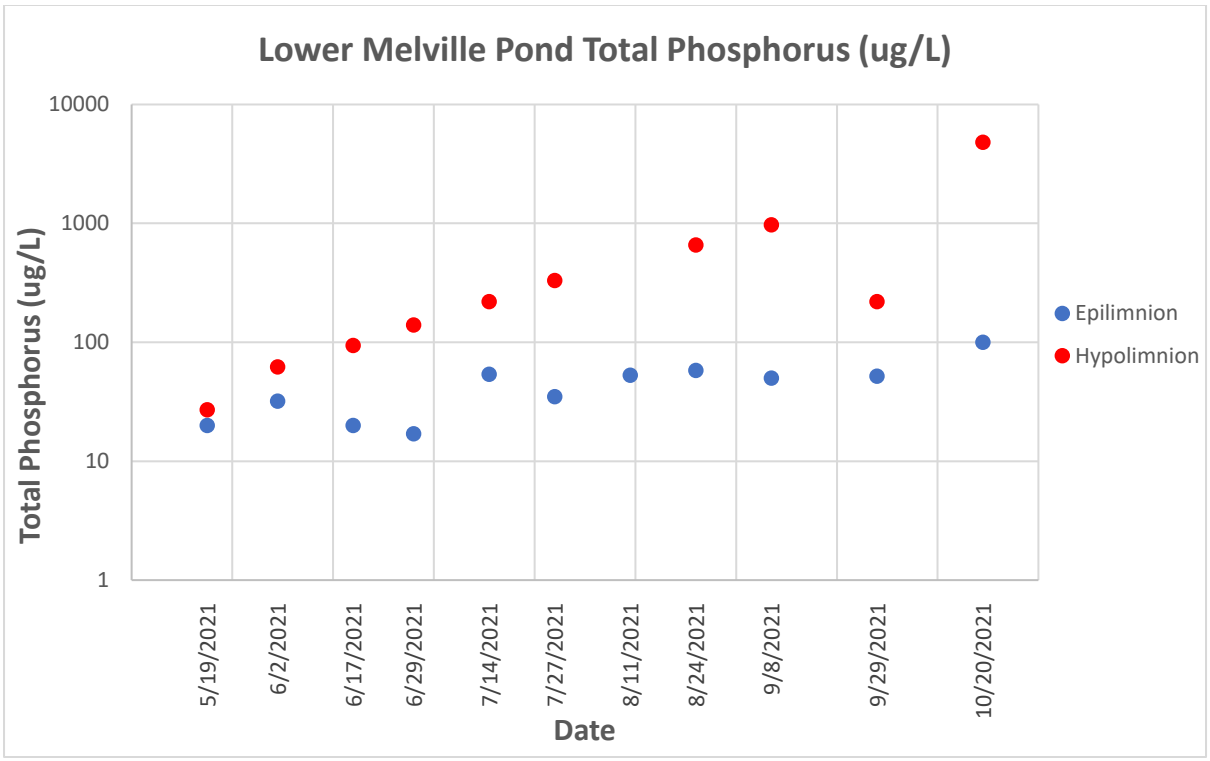


Figure 4. Lower Melville Pond total phosphorus (ug/l) results. Note log scale. Hypolimnetic sample on 8/11/21 did not meet QA-QC criteria.

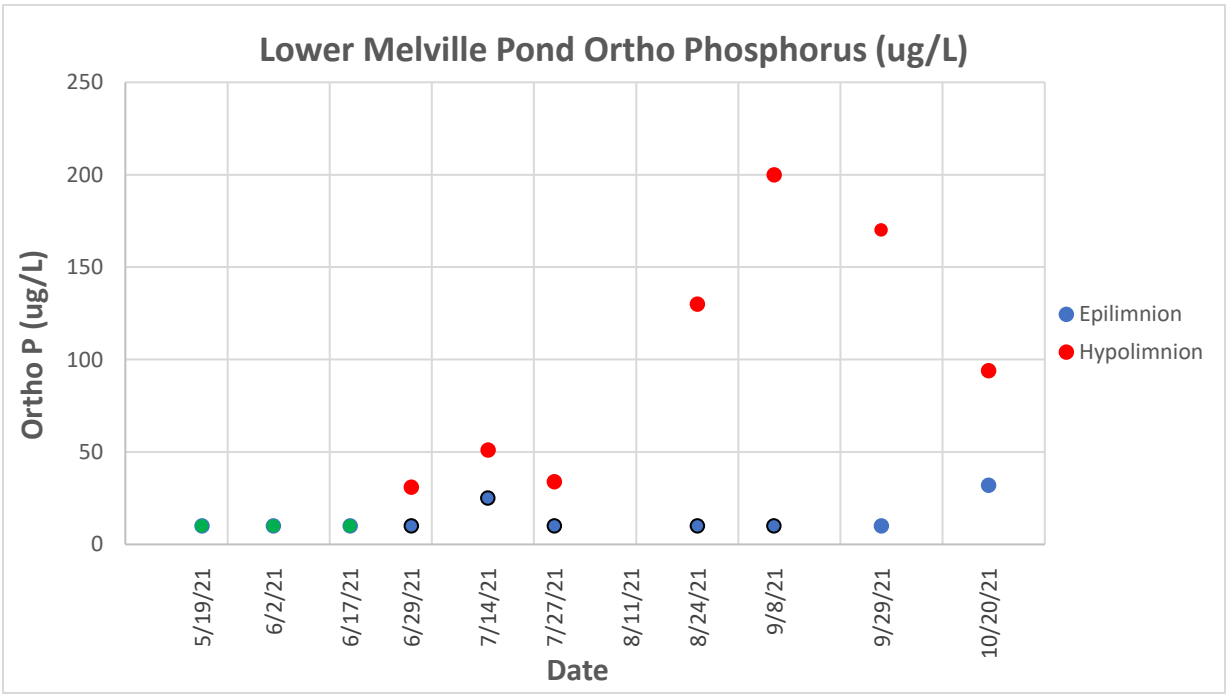


Figure 5. Lower Melville Pond ortho-phosphorus results. Symbols with black outline indicate sample result was reported as below detection limit. A value of 'half the detection limit' is used for display and averaging purposes. 8/11/21 samples not analyzed.

NITROGEN DATA SUMMARY

Figures 6-13 display plots of total nitrogen, nitrate-nitrogen, ammonia-nitrogen, and organic nitrogen data within the surface/epilimnion and hypolimnion of both upper and lower Melville Pond. Total nitrogen was calculated as the sum of total kjeldahl nitrogen and nitrate-nitrite nitrogen.

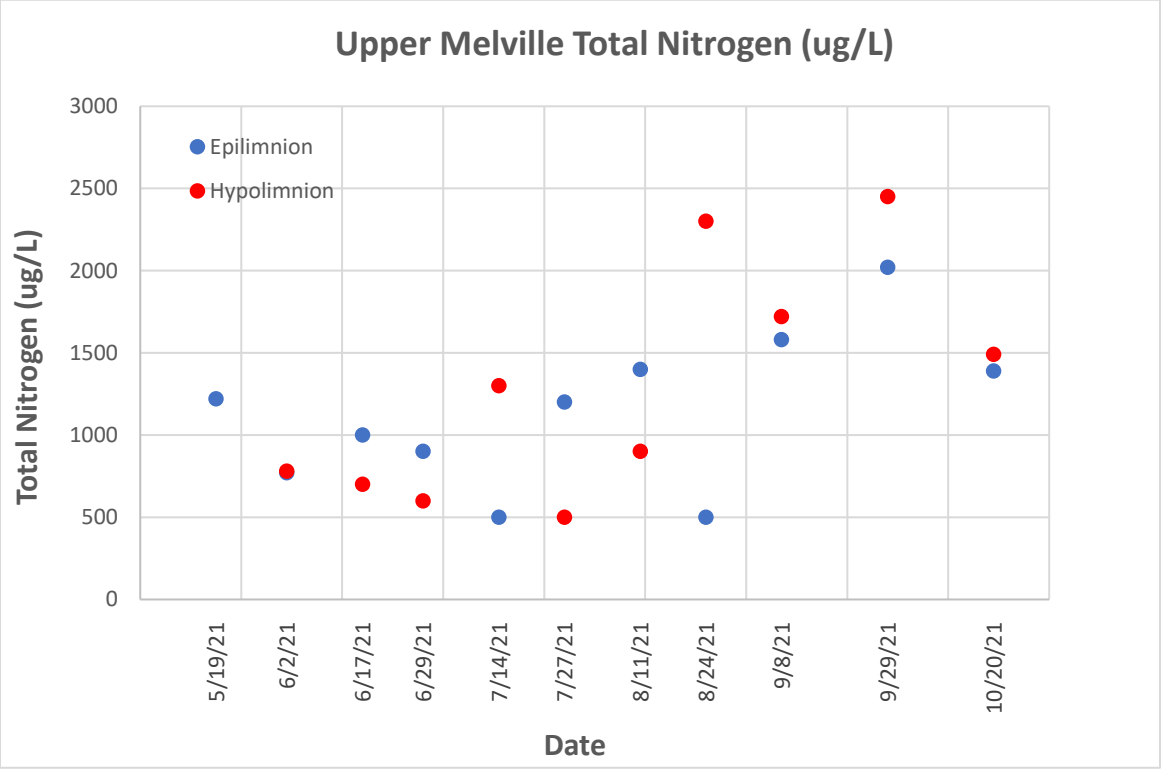


Figure 6. Upper Melville Pond total nitrogen results.

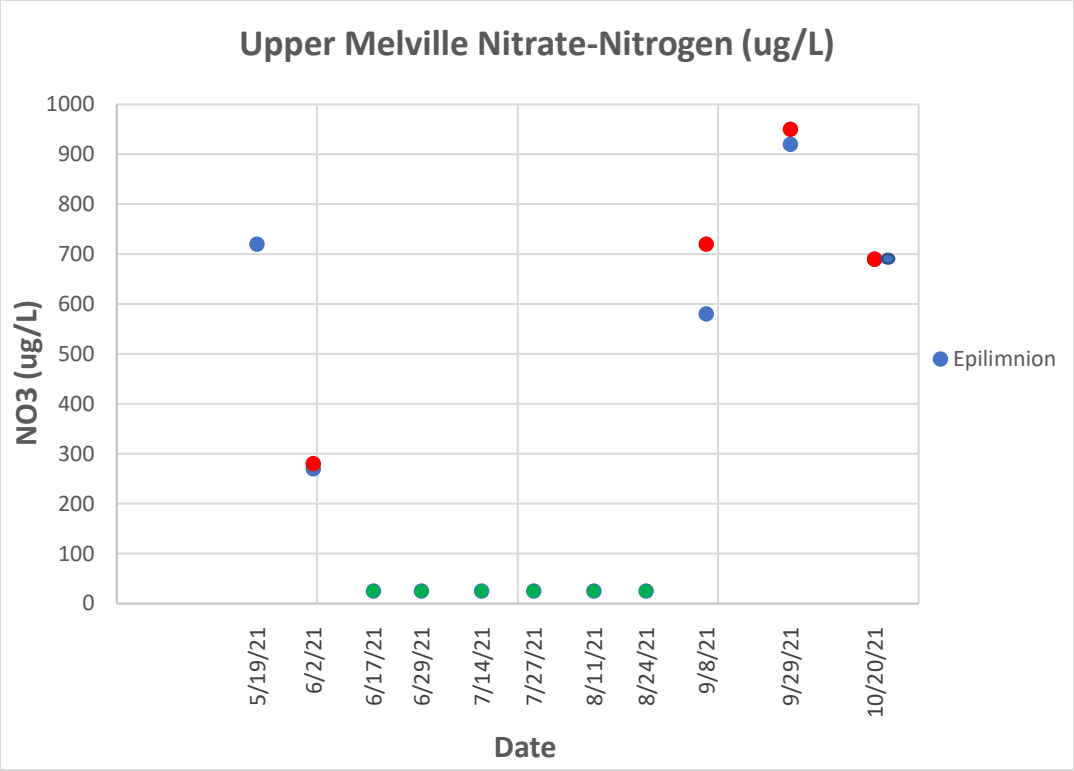


Figure 7. Upper Melville Pond nitrate nitrogen results. Green symbols indicate that both epilimnion and hypolimnion samples were reported as below the detection limit- these are plotted as half the detection limit.

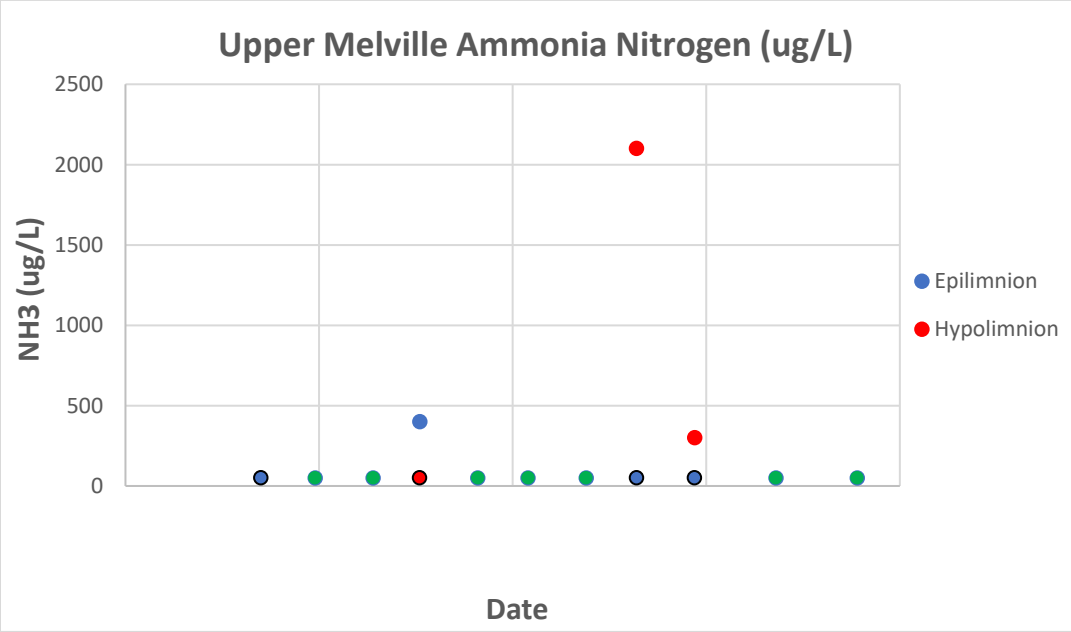


Figure 8. Upper Melville Pond ammonia-nitrogen results. Symbols with black outline indicate sample result was reported as below detection limit. A value of 'half the detection limit' is used for display and averaging purposes. Green symbols indicate that both epilimnion and hypolimnion samples were reported as below the detection limit- these are plotted as half the detection limit.

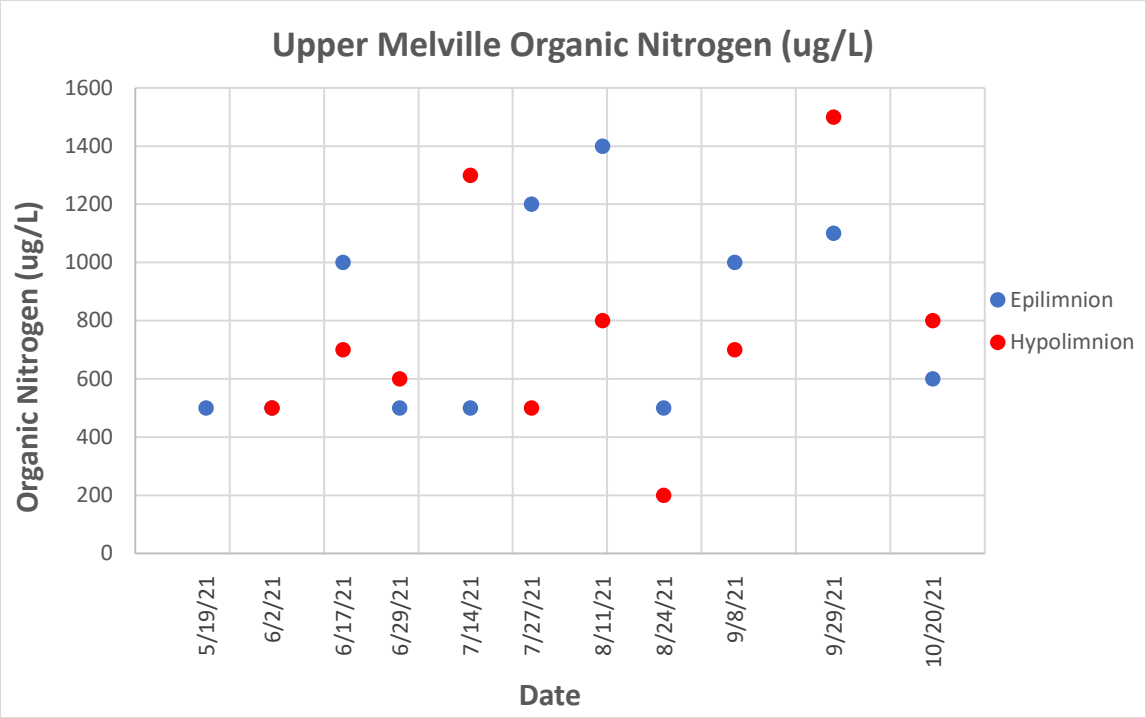


Figure 9. Upper Melville Pond organic nitrogen results.

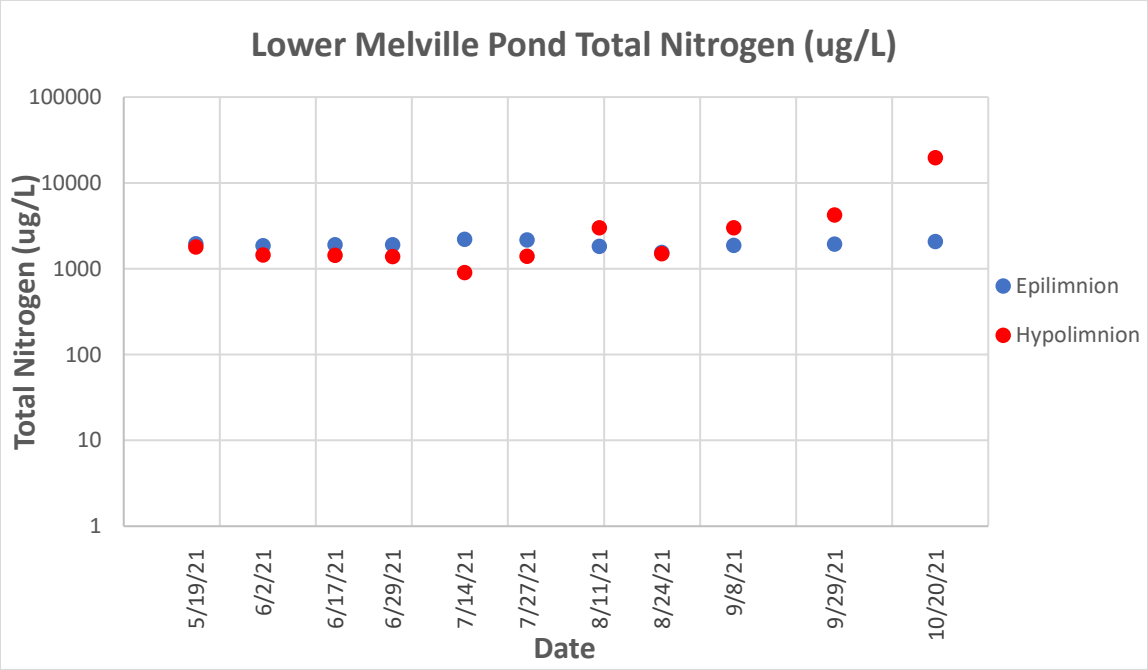


Figure 10. Lower Melville Pond total nitrogen results.

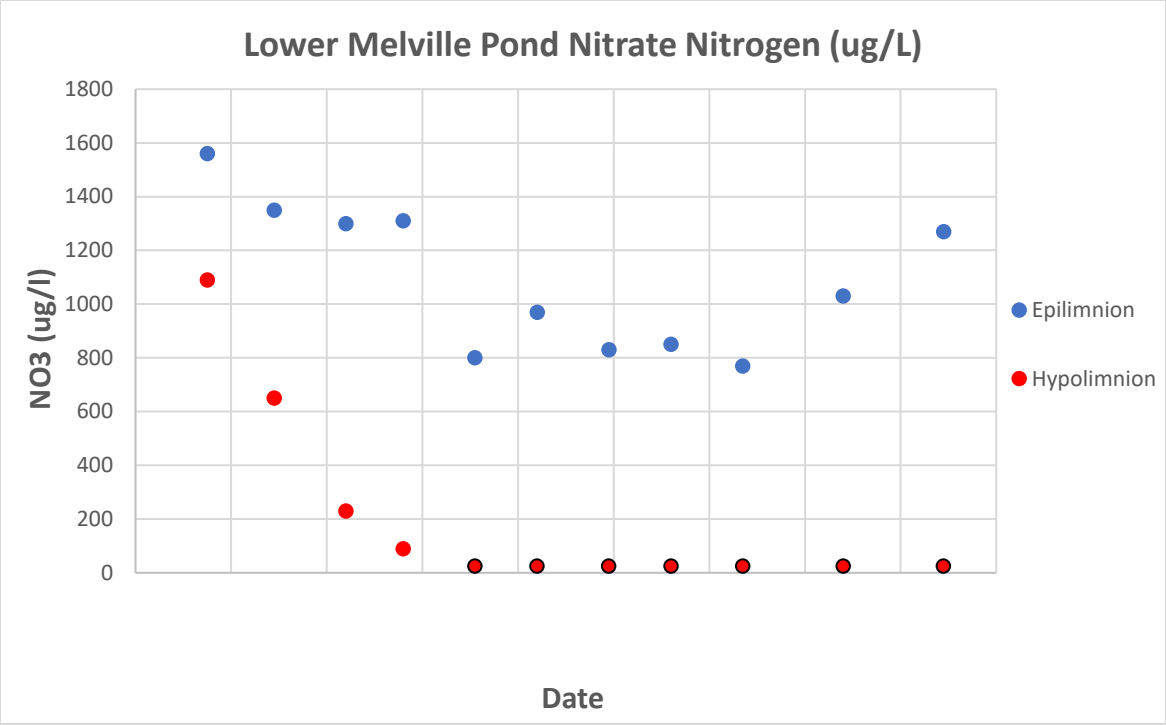


Figure 11. Lower Melville Pond nitrate nitrogen results. Symbols with black outline indicate sample result was reported as below detection limit.

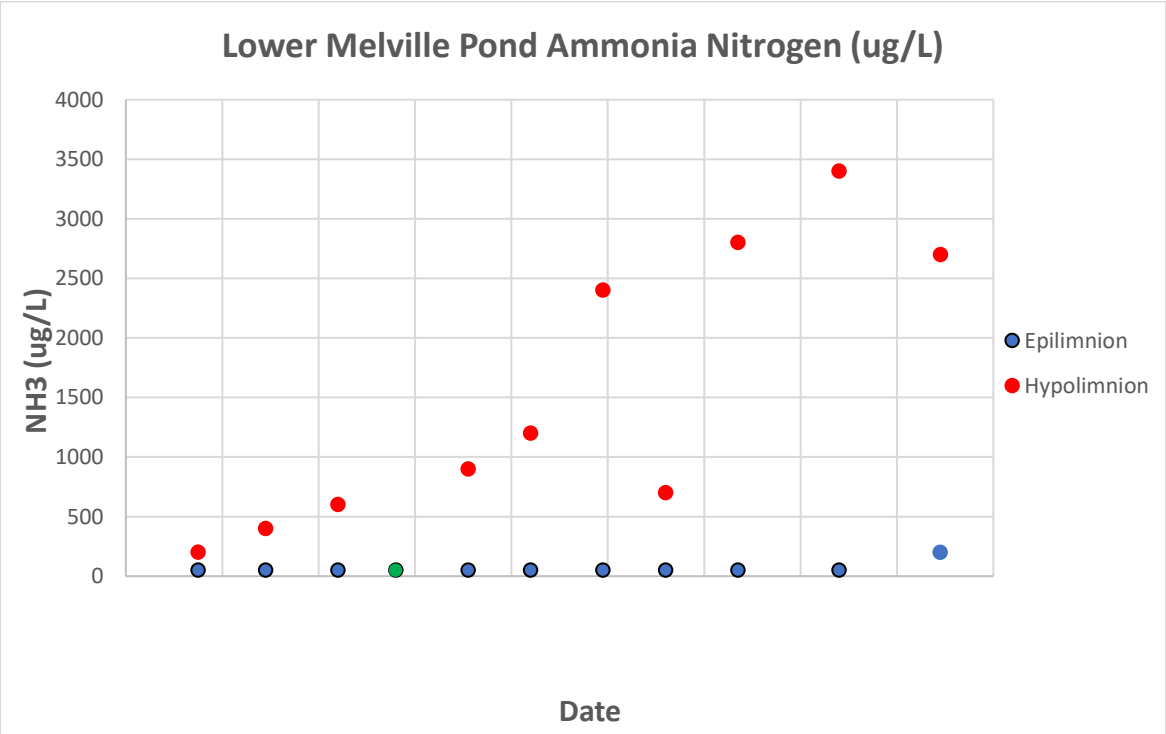


Figure 12. Lower Melville Pond ammonia nitrogen results. Symbols with black outline indicate sample result was reported as below detection limit.

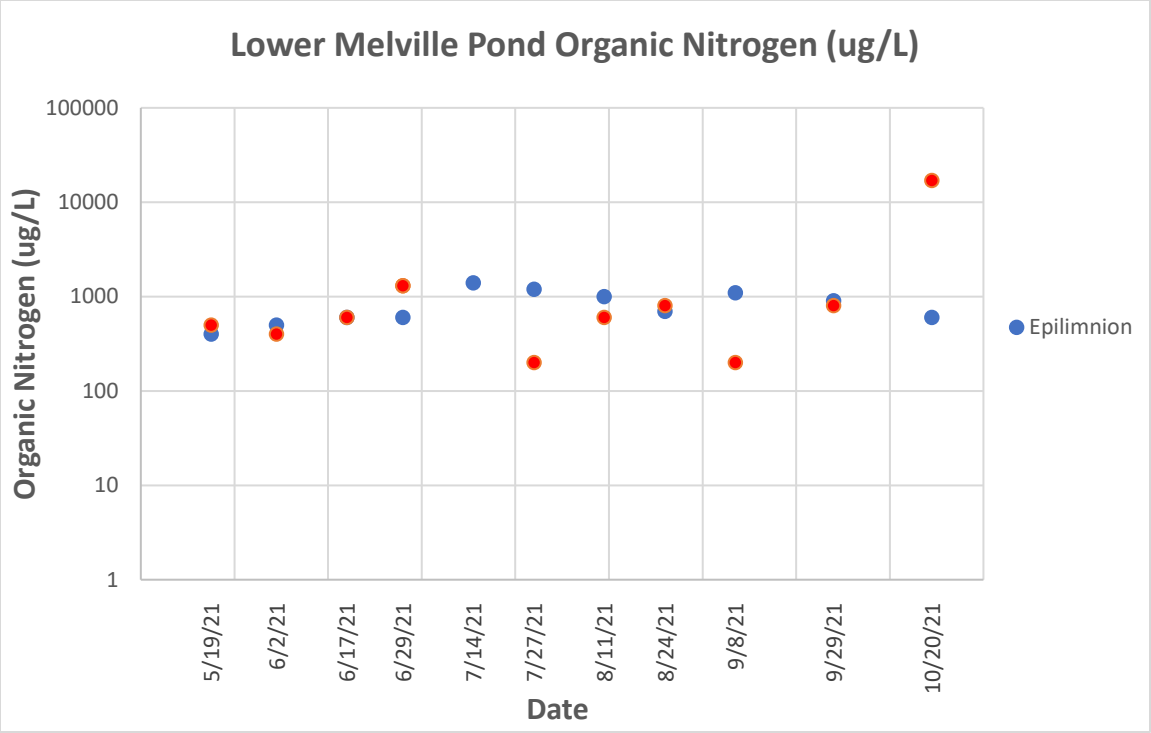


Figure 13. Lower Melville Pond organic nitrogen results.

TEMPERATURE AND DISSOLVED OXYGEN DATA SUMMARY

Figures 14-17 present the temperature and oxygen profiles from each pond during the 2021 sampling season. All YSI data in tabular format and survey specific profiles of dissolved oxygen and temperature are presented in Appendix B.

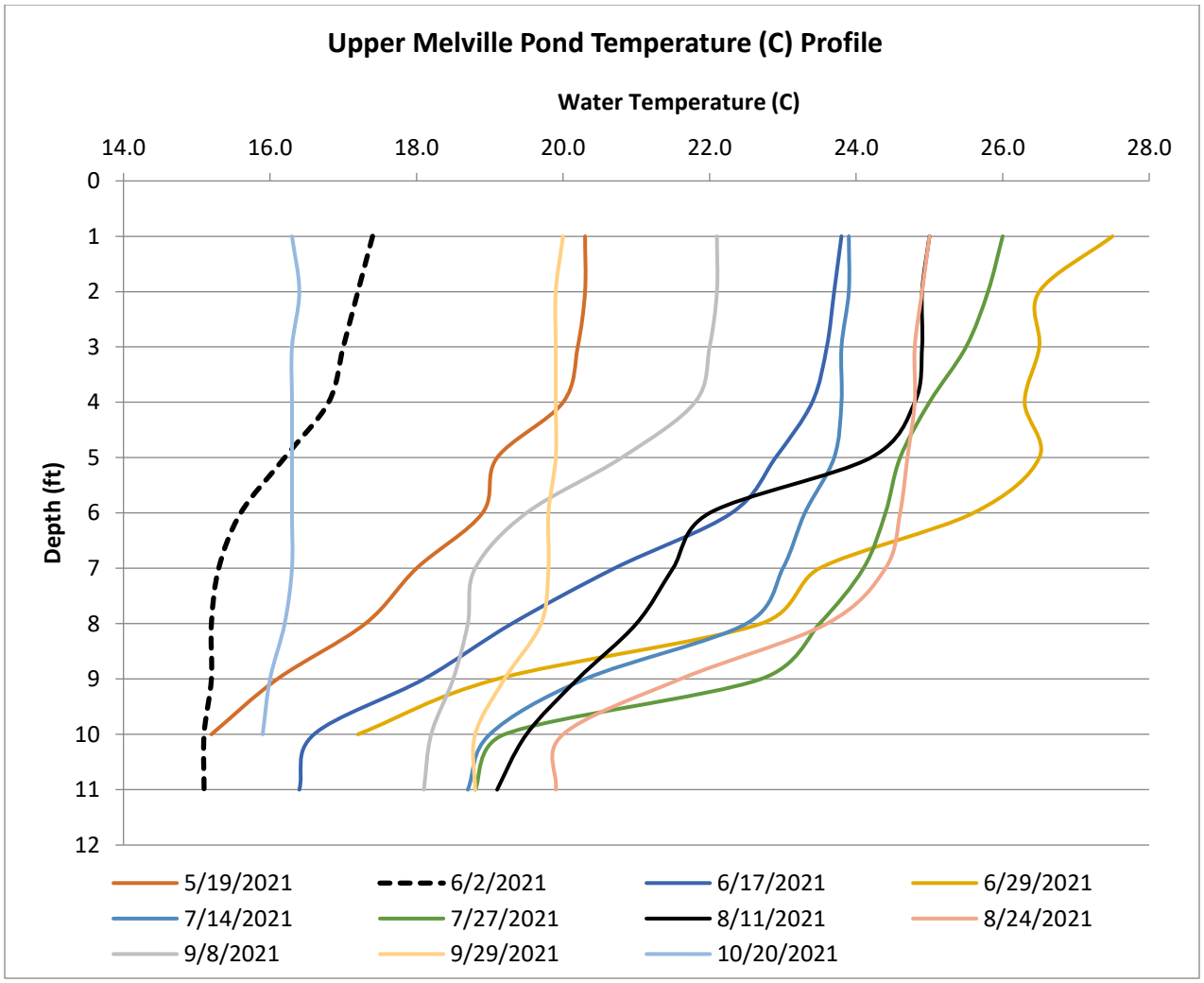


Figure 14. Upper Melville Pond seasonal temperature profiles (2021).

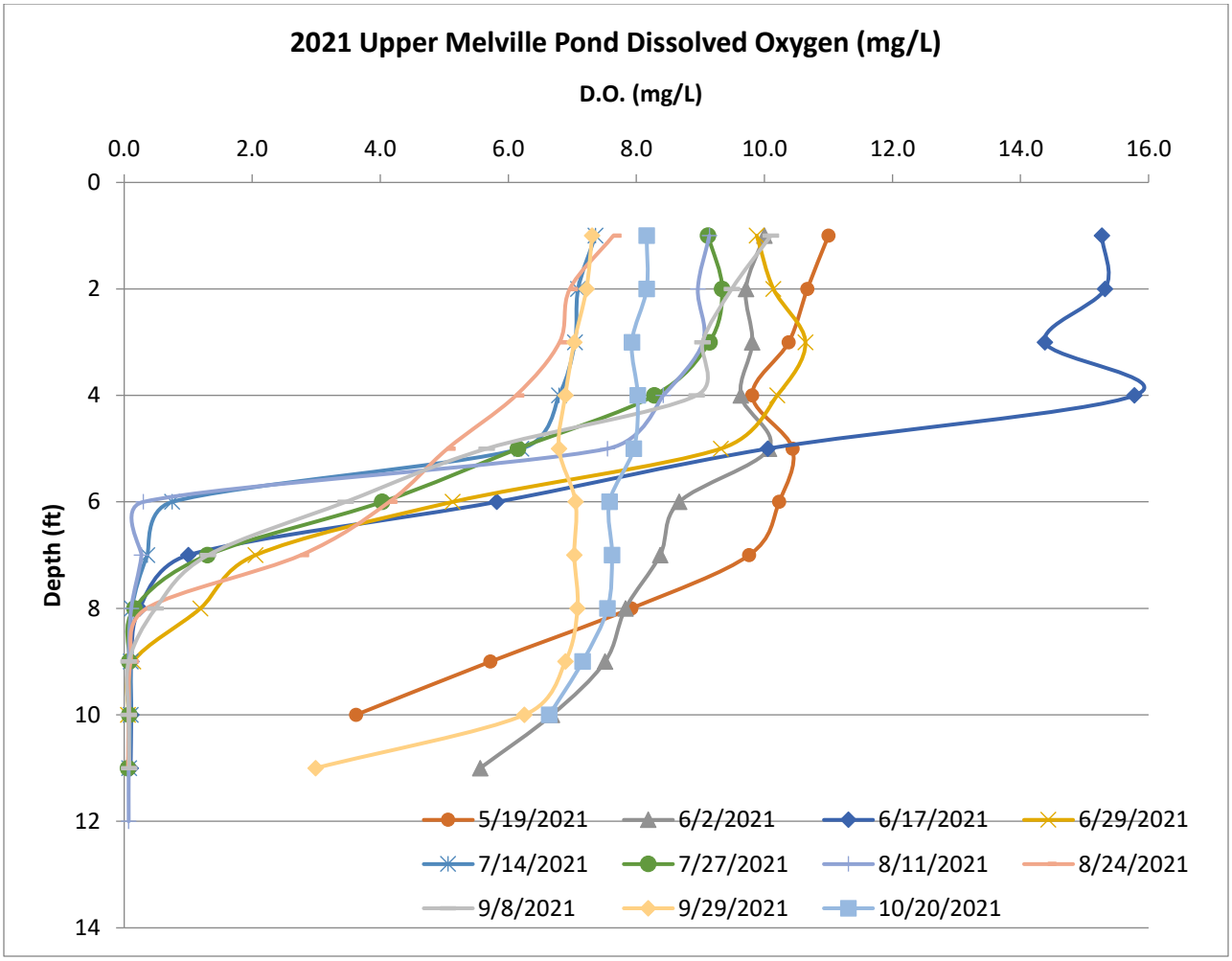


Figure 15. Upper Melville Pond seasonal dissolved oxygen profiles (2021).

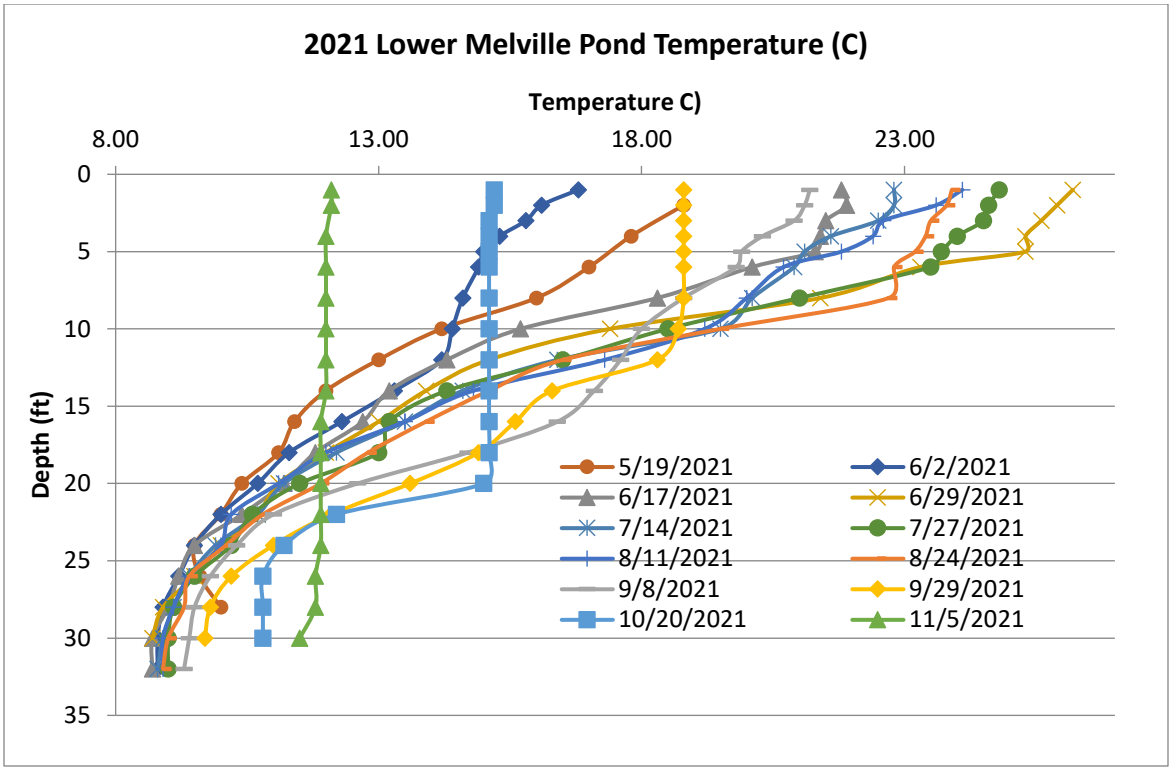


Figure 16. Lower Melville Pond seasonal temperature profiles (2021).

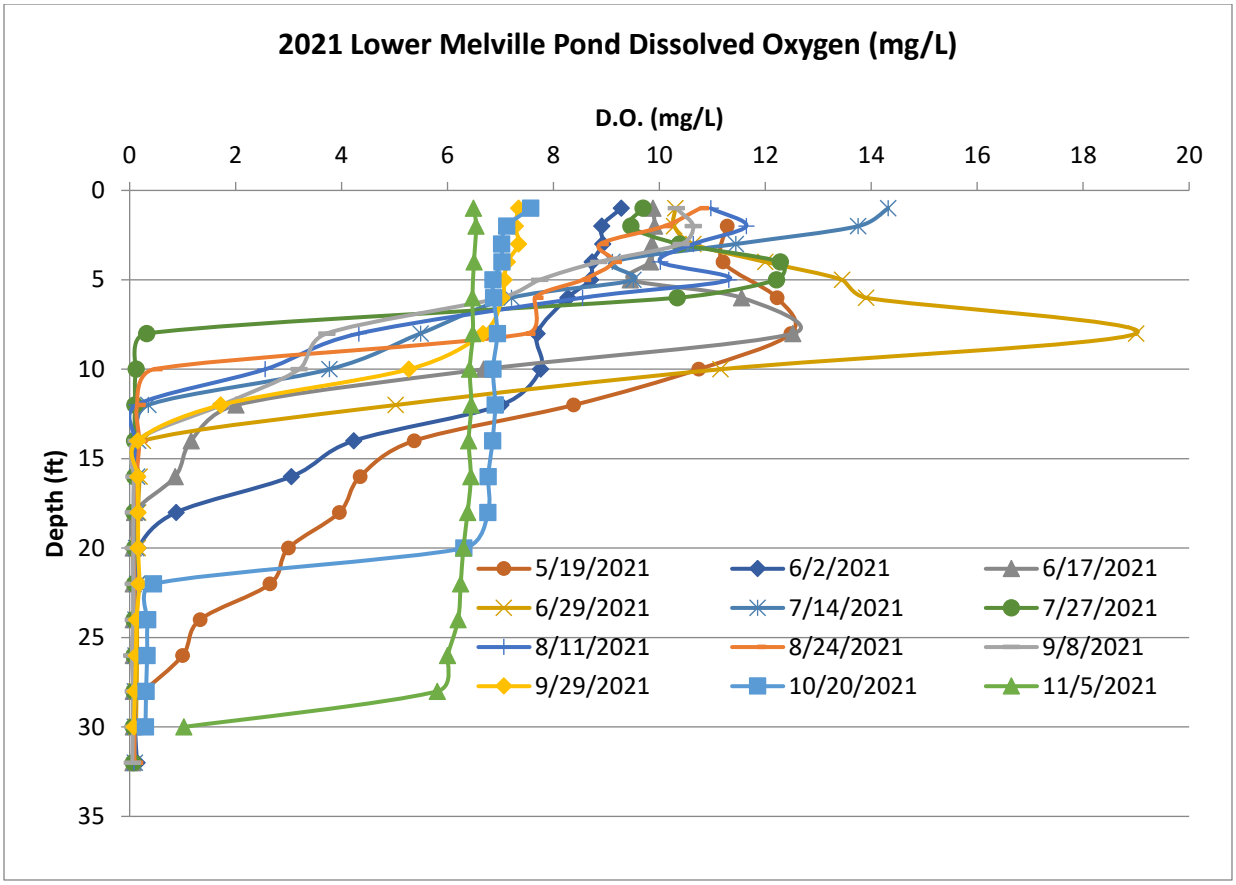


Figure 17. Lower Melville Pond seasonal dissolved oxygen profiles (2021).

APPENDIX A.

NUTRIENT DATA FOR UPPER AND LOWER MELVILLE PONDS

Table 1: Nutrient Summary for the Epilimnion of Lower Melville in 2021

Date	Total P (ug/L)	Ortho P (ug/L)	Nitrate (ug/L)	Total NH3 (ug/L)	TKN (ug/L)	Organic N (ug/L)	TN (ug/L)
5/19/2021	20	10*	1560	50*	400	400	1960
6/2/2021	32	10*	1350	50*	500	500	1850
6/17/2021	20	10*	1300	50*	600	600	1900
6/29/2021	17	10*	1310	50*	600	600	1910
7/14/2021	54	25	800	50*	1400	1400	2200
7/27/2021	35	10*	970	50*	1200	1200	2170
8/11/2021	53	N.A.	830	50*	1000	1000	1830
8/24/2021	58	10*	850	50*	700	700	1550
9/8/2021	50	10*	770	50*	1100	1100	1870
9/29/2021	52	10*	1030	50*	900	900	1930
10/20/2021	100	32	1270	200	800	600	2070

*Non-detect samples (N.D.) were given a value of half the detection limit while not available (N.A.) indicates sample was not analyzed.

Table 2: Nutrient Summary for the Hypolimnion of Lower Melville in 2021

Date	Total P (ug/L)	Ortho P (ug/L)	Nitrate (ug/L)	Total NH3 (ug/L)	TKN (ug/L)	Organic N (ug/L)	TN (ug/L)
5/19/2021	27	10*	1090	200	700	500	1790
6/2/2021	62	10*	650	400	800	400	1450
6/17/2021	94	10*	230	600	1200	600	1430
6/29/2021	140	31	90	50*	1300	1300	1390
7/14/2021	220	51	25*	900	900	N.D.	900
7/27/2021	330	34	25*	1200	1400	200	1400
8/11/2021	600	*N.A.	25*	2400	3000	600	3000
8/24/2021	660	130	25*	700	1500	800	1500
9/8/2021	970	200	25*	2800	3000	200	3000
9/29/2021	220	170	25*	3400	4200	800	4200
10/20/2021	4800	94	25*	2700	19700	17000	19700

*Non-detect samples (N.D.) were given a value of half the detection limit while not available (N.A.) indicates sample was not analyzed.

Table 3: Nutrient Summary for the Epilimnion of Upper Melville in 2021

Date	Total P (ug/L)	Ortho P (ug/L)	Nitrate (ug/L)	Total NH3 (ug/L)	TKN (ug/L)	Organic N (ug/L)	TN (ug/L)
5/19/2021	37	10*	720	50*	500	500	1220
6/2/2021	37	10*	270	50*	500	500	770
6/17/2021	68	10*	25*	50*	1000	1000	1000
6/29/2021	59	10*	25*	400	900	500	900
7/14/2021	67	10*	25*	50*	500	500	500
7/27/2021	83	10*	25*	50*	1200	1200	1200
8/11/2021	73	*N.A.	25*	50*	1400	1400	1400
8/24/2021	47	10*	25*	50*	500	500	500
9/8/2021	87	22	580	50*	1000	1000	1580
9/29/2021	38	10*	920	50*	1100	1100	2020
10/20/2021	39	24	690	100	700	600	1390

*Non-detect samples (N.D.) were given a value of half the detection limit while not available (N.A.) indicates sample was not analyzed.

Table 4: Nutrient Summary for the Hypolimnion of Upper Melville in 2021

Date	Total P (ug/L)	Ortho P (ug/L)	Nitrate (ug/L)	Total NH3 (ug/L)	TKN (ug/L)	Organic N (ug/L)	TN (ug/L)
5/19/2021	N.A.	*N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
6/2/2021	43	10*	280	50*	500	500	780
6/17/2021	59	10*	25*	50*	700	700	700
6/29/2021	69	10*	25*	50*	600	600	600
7/14/2021	120	23	25*	50*	1300	1300	1300
7/27/2021	160	10*	25*	50*	500	500	500
8/11/2021	72	*N.A.	25*	100	900	800	900
8/24/2021	140	10*	25*	2100	2300	200	2300
9/8/2021	110	10*	720	300	1000	700	1720
9/29/2021	51	10*	950	50*	1500	1500	2450
10/20/2021	39	10*	690	50*	800	800	1490

*Non-detect samples (N.D.) were given a value of half the detection limit while not available (N.A.) indicates sample was not analyzed.

APPENDIX B.

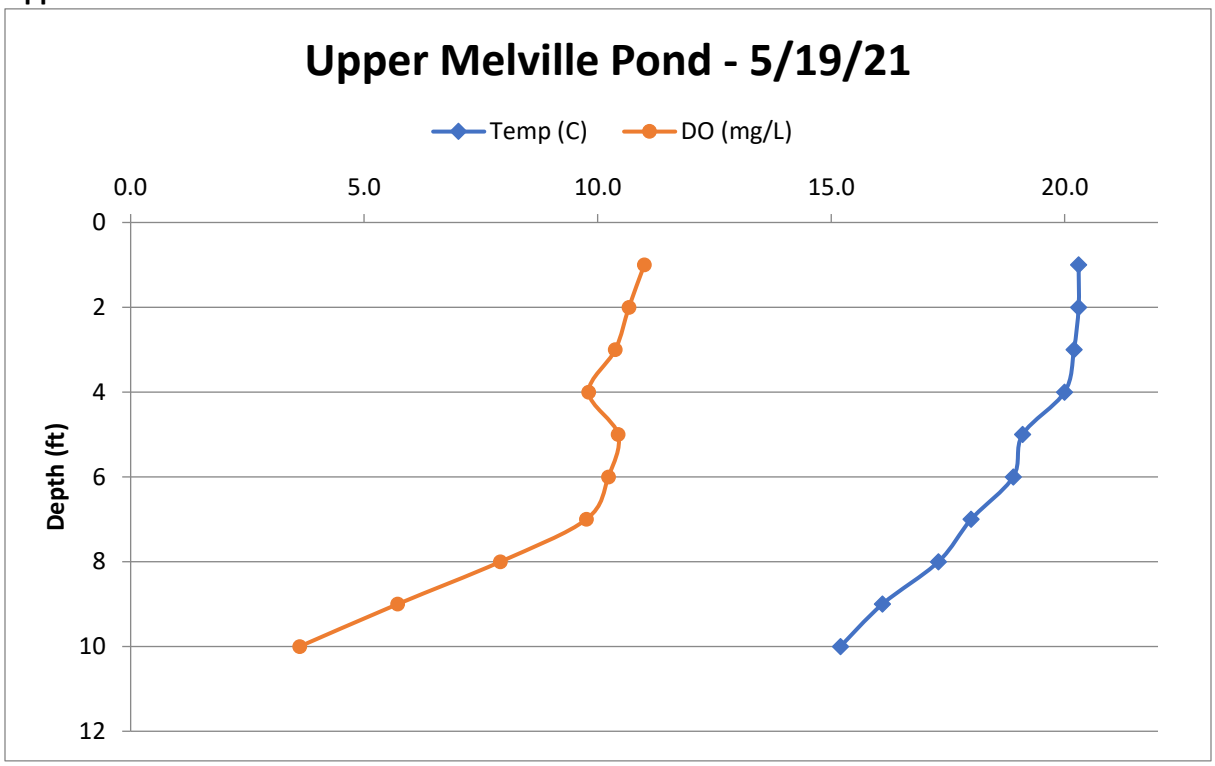
TEMPERATURE AND DISSOLVED OXYGEN PROFILE DATA AND FIGURES

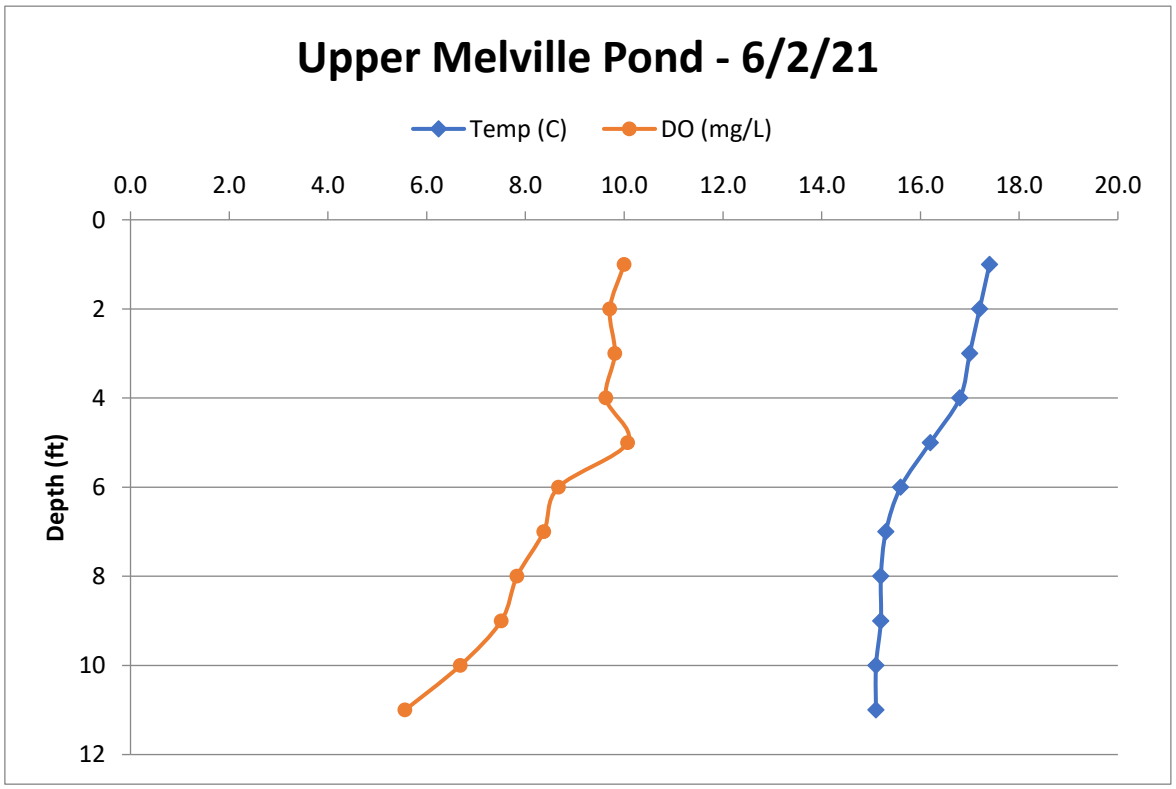
Upper Melville YSI Vertical Profile Data

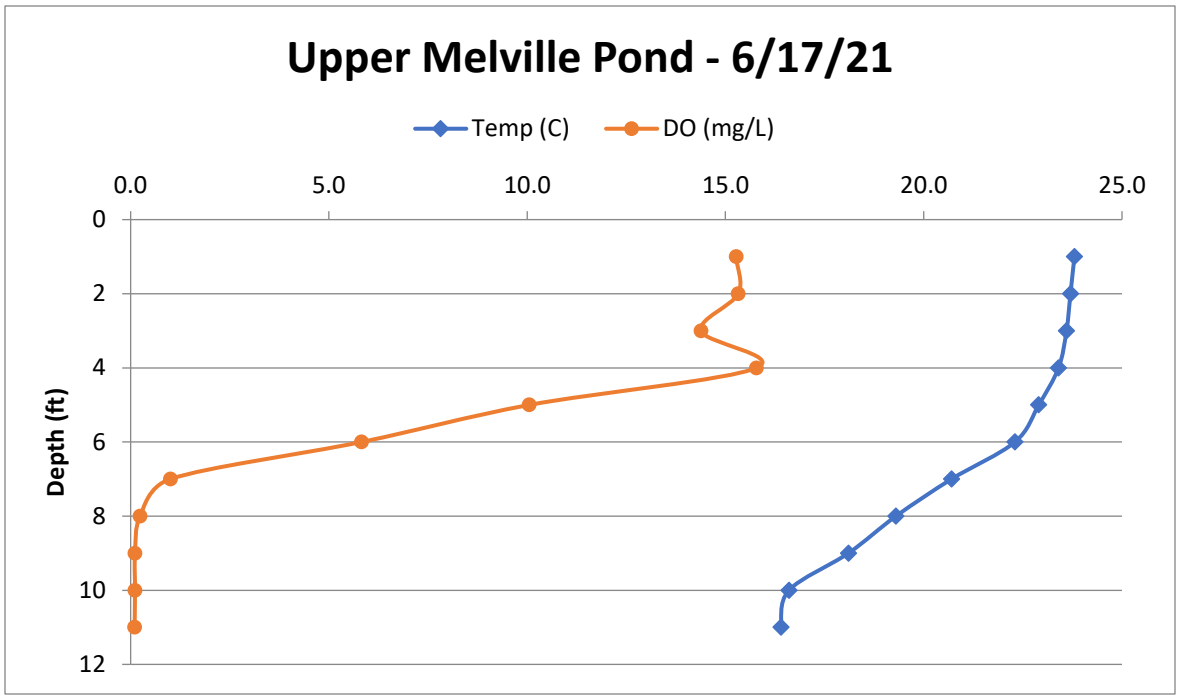
Date	5/19/2021											
Time	10:15am											
Depth (ft)	12	T (C)	20.3	20.3	20.2	20.0	19.1	18.9	18.0	17.3	16.1	15.2
Secchi (ft)	7.0	Depth (ft)	1	2	3	4	5	6	7	8	9	10
Weather	Sunny, 70F	DO (%)	122.3	117.3	112.8	105.4	110.5	108.7	102.6	80.8	60.0	35.4
Pressure(mmHg)	n/a	DO (mg/L)	11.00	10.67	10.38	9.81	10.44	10.23	9.76	7.92	5.72	3.62
Van Dorn (ft)	8	SPC	407	408	408	408	406	406	406	410	416	420
Date	6/2/2021											
Time	10:15am											
Depth (ft)	12	T (C)	17.4	17.2	17.0	16.8	16.2	15.6	15.3	15.2	15.2	15.1	15.1
Secchi (ft)	6.8,7	Depth (ft)	1	2	3	4	5	6	7	8	9	10	11
Weather	Sunny, 70F	DO (%)	103.9	100.8	100.6	99.0	102.0	85.7	80.2	77.4	74.6	66.4	55.3
Pressure(mmHg)	768.7	DO (mg/L)	10.00	9.71	9.81	9.63	10.07	8.67	8.37	7.83	7.51	6.68	5.56
Van Dorn (ft)	8	SPC	372	372	372	371	371	373	373	373	373	374	377
Date	6/17/2021											
Time	10:45am											
Depth (ft)	12	T (C)	23.8	23.7	23.6	23.4	22.9	22.3	20.7	19.3	18.1	16.6	16.4
Secchi (ft)	5.2,5.3	Depth (ft)	1	2	3	4	5	6	7	8	9	10	11
Weather	Sunny, 75F	DO (%)	176.9	177.1	173.4	183.4	116.3	66.0	14.1	2.6	1.2	1.1	0.8
Pressure(mmHg)	764	DO (mg/L)	15.27	15.32	14.38	15.78	10.05	5.82	1.00	0.24	0.11	0.11	0.10
Van Dorn (ft)	9	SPC	381	381	380	382	372	374	376	378	383	401	405
Date	6/29/2021											
Time	10:45am											
Depth (ft)	11	T (C)	27.5	26.5	26.5	26.3	26.5	25.6	23.5	22.7	19.1	17.2	
Secchi (ft)	4.6,4.5	Depth (ft)	1	2	3	4	5	6	7	8	9	10	
Weather	Sunny, 85F	DO (%)	123.3	122.1	130.1	124.9	108.4	62.1	26.0	10.1	2.4	0.8	
Pressure(mmHg)	769.3	DO (mg/L)	9.88	10.14	10.64	10.20	9.32	5.13	2.05	1.19	0.14	0.06	
Van Dorn (ft)	8	SPC	372	372	371	371	368	366	369	375	400	457	
Date	7/14/2021											
Time	10:45am											
Depth (ft)	12	T (C)	23.9	23.9	23.8	23.8	23.7	23.3	23.0	22.5	20.3	19.0	18.7
Secchi (ft)	4.6,4.5	Depth (ft)	1	2	3	4	5	6	7	8	9	10	11
Weather	Cloudy, 70F	DO (%)	89.4	84.6	83.1	78.5	71.7	9.8	2.7	1.6	1.0	1.0	0.9
Pressure(mmHg)	767.2	DO (mg/L)	7.36	7.09	7.04	6.79	6.20	0.75	0.36	0.12	0.10	0.10	0.08
Van Dorn (ft)	8	SPC	323	323	323	323	323	324	326	342	367	402	421
Date	7/27/2021											
Time	10:45am											
Depth (ft)	12	T (C)	26.0	25.8	25.5	25.0	24.6	24.4	24.1	23.5	22.7	19.2	18.8
Secchi (ft)	3.9, 3.7	Depth (ft)	1	2	3	4	5	6	7	8	9	10	11
Weather	Sunny, 80F	DO (%)	112.3	113.9	110.1	99.1	73.8	49.3	15.9	2.0	0.9	0.8	0.7
Pressure(mmHg)	761.4	DO (mg/L)	9.12	9.34	9.14	8.28	6.15	4.03	1.30	0.16	0.08	0.08	0.06
Van Dorn (ft)	9	SPC	331	331	330	329	330	330	331	336	383	451	466

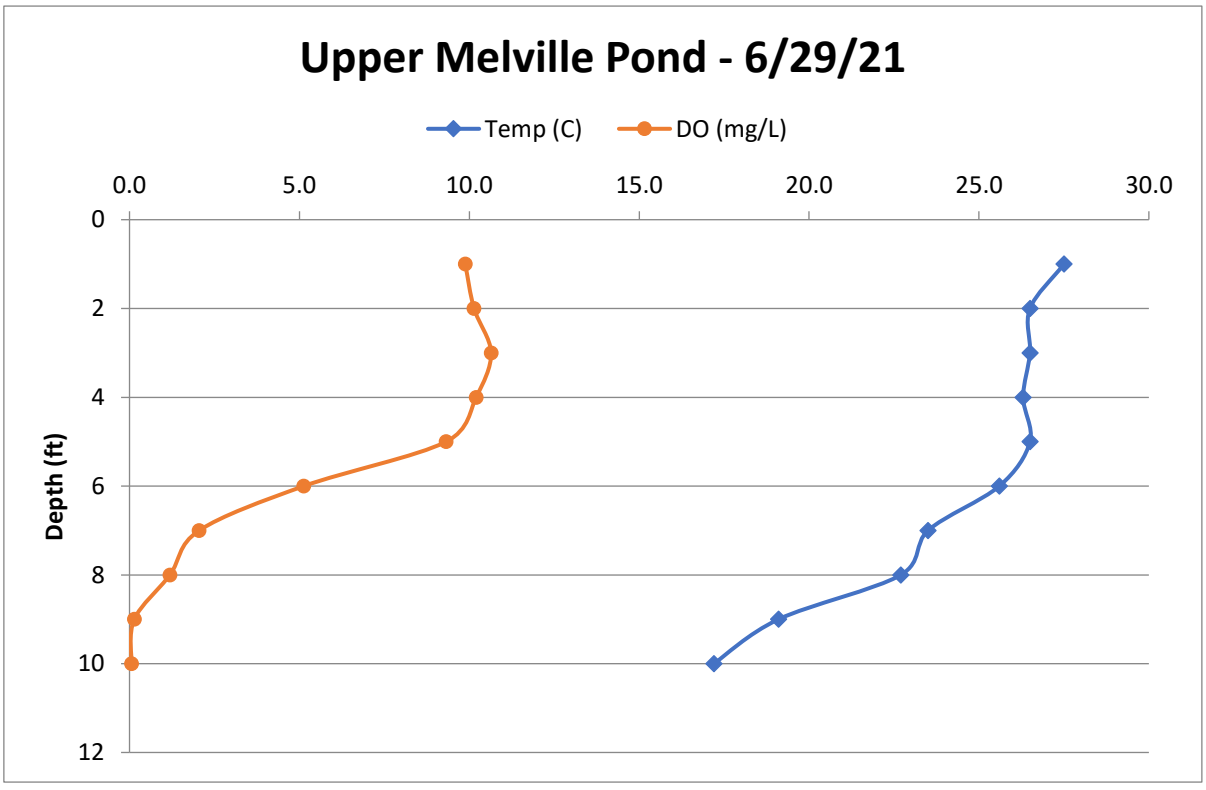
Date	8/11/2021												
Time	10:45am												
Depth (ft)	12	T (C)	25.0	24.9	24.9	24.8	24.2	22.0	21.5	21.0	20.2	19.5	19.1	19.0
Secchi (ft)	2.3, 2.7ft	Depth (ft)	1	2	3	4	5	6	7	8	9	10	11	12
Weather	Sunny, windy 80F	DO (%)	109.0	107.9	104.9	103.0	88.7	3.5	3.2	1.2	0.7	0.8	0.6	0.8
Pressure(mmHg)	763.6	DO (mg/L)	9.14	8.96	9.04	8.42	7.55	0.30	0.27	0.11	0.07	0.08	0.07	0.07
Van Dorn (ft)	9	SPC	288	288	288	288	288	250	231	236	296	348	377	414
Date	8/24/2021												
Time	10:45am												
Depth (ft)	12	T (C)	25.0	24.9	24.8	24.8	24.7	24.6	24.4	23.6	21.6	20.0	19.9	
Secchi (ft)	4.3, 4.1ft	Depth (ft)	1	2	3	4	5	6	7	8	9	10	11	
Weather	Wet Weather 75F	DO (%)	94.7	84.2	80.9	74.7	62.2	52.2	31.8	6.4	1.2	0.8	0.7	
Pressure(mmHg)	760.2	DO (mg/L)	7.64	6.96	6.80	6.12	5.05	4.14	2.76	0.35	0.10	0.07	0.06	
Van Dorn (ft)	9	SPC	275	275	275	275	274	268	269	250	311	357	369	
Date	9/8/2021												
Time	10:45am												
Depth (ft)	12	T (C)	22.1	22.1	22.0	21.8	20.8	19.5	18.8	18.7	18.5	18.2	18.1	
Secchi (ft)	3.9, 4.1ft	Depth (ft)	1	2	3	4	5	6	7	8	9	10	11	
Weather	70F, windy	DO (%)	115.7	107.9	104.7	103.6	68.5	38.6	17.3	4.8	0.9	0.8	0.8	
Pressure(mmHg)	761.4	DO (mg/L)	10.10	9.49	9.03	8.94	5.66	3.46	1.31	0.49	0.07	0.07	0.08	
Van Dorn (ft)	9	SPC	150	150	151	155	152	120	108	114	134	170	179	
Date	9/29/2021												
Time	10:45am												
Depth (ft)	12	T (C)	20.0	19.9	19.9	19.9	19.9	19.8	19.8	19.7	19.2	18.8	18.8	
Secchi (ft)	2.8, 2.7ft	Depth (ft)	1	2	3	4	5	6	7	8	9	10	11	
Weather	65F, very windy	DO (%)	79.2	79.8	76.8	76.0	74.6	78.4	77.1	77.3	76.0	63.8	31.5	
Pressure(mmHg)	761.1	DO (mg/L)	7.31	7.22	7.03	6.89	6.79	7.05	7.03	7.08	6.89	6.25	2.99	
Van Dorn (ft)	9	SPC	245	244	244	244	244	244	244	245	244	249	284	
Date	10/20/2021												
Time	10:45am												
Depth (ft)	11	T (C)	16.3	16.4	16.3	16.3	16.3	16.3	16.3	16.2	16.0	15.9		
Secchi (ft)	5.4, 5.3ft	Depth (ft)	1	2	3	4	5	6	7	8	9	10		
Weather	65F, windy	DO (%)	83.4	84.0	81.4	82.2	81.4	77.3	79.0	77.6	72.0	67.2		
Pressure(mmHg)	760.7	DO (mg/L)	8.16	8.16	7.93	8.02	7.96	7.58	7.62	7.55	7.16	6.64		
Van Dorn (ft)	9	SPC	273	273	272	273	272	273	272	272	274	275		

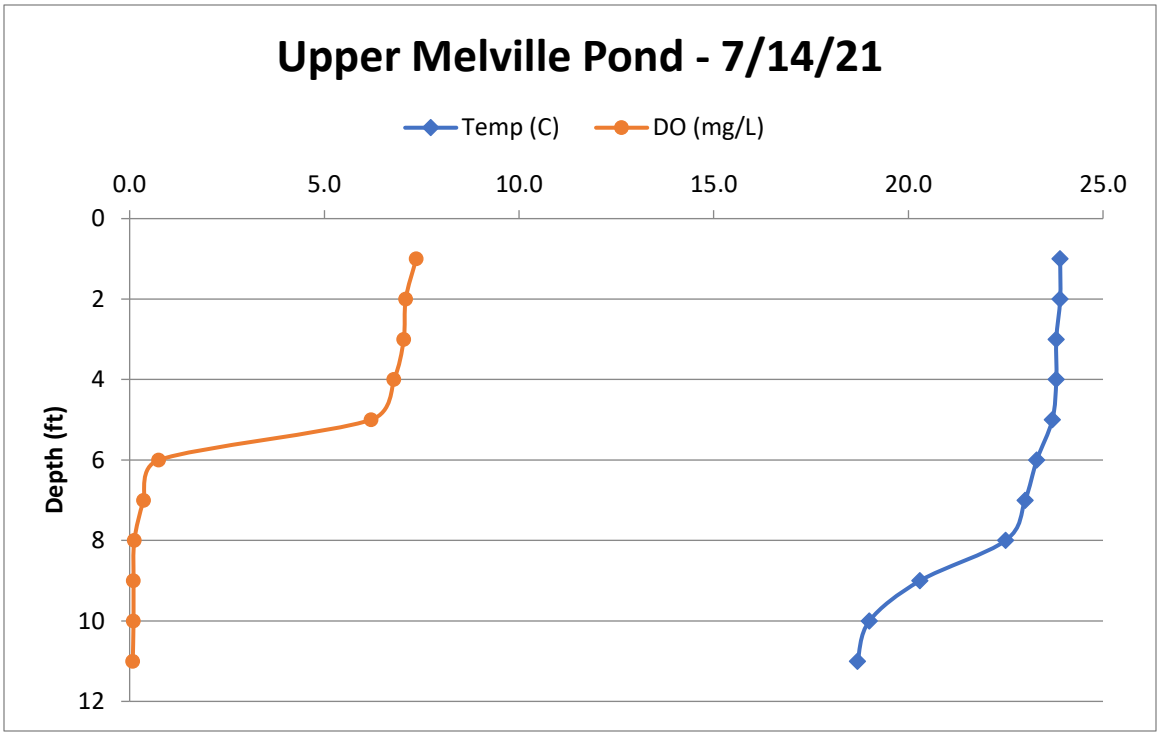
Upper Melville Vertical Profile Charts

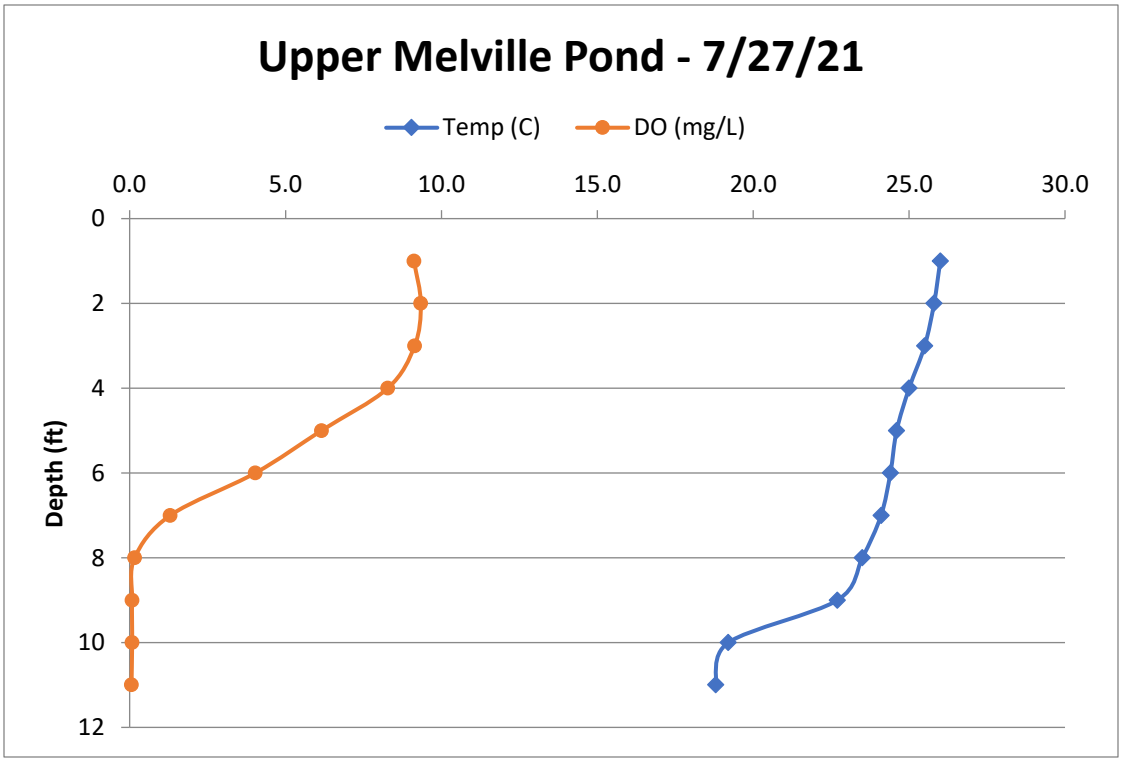


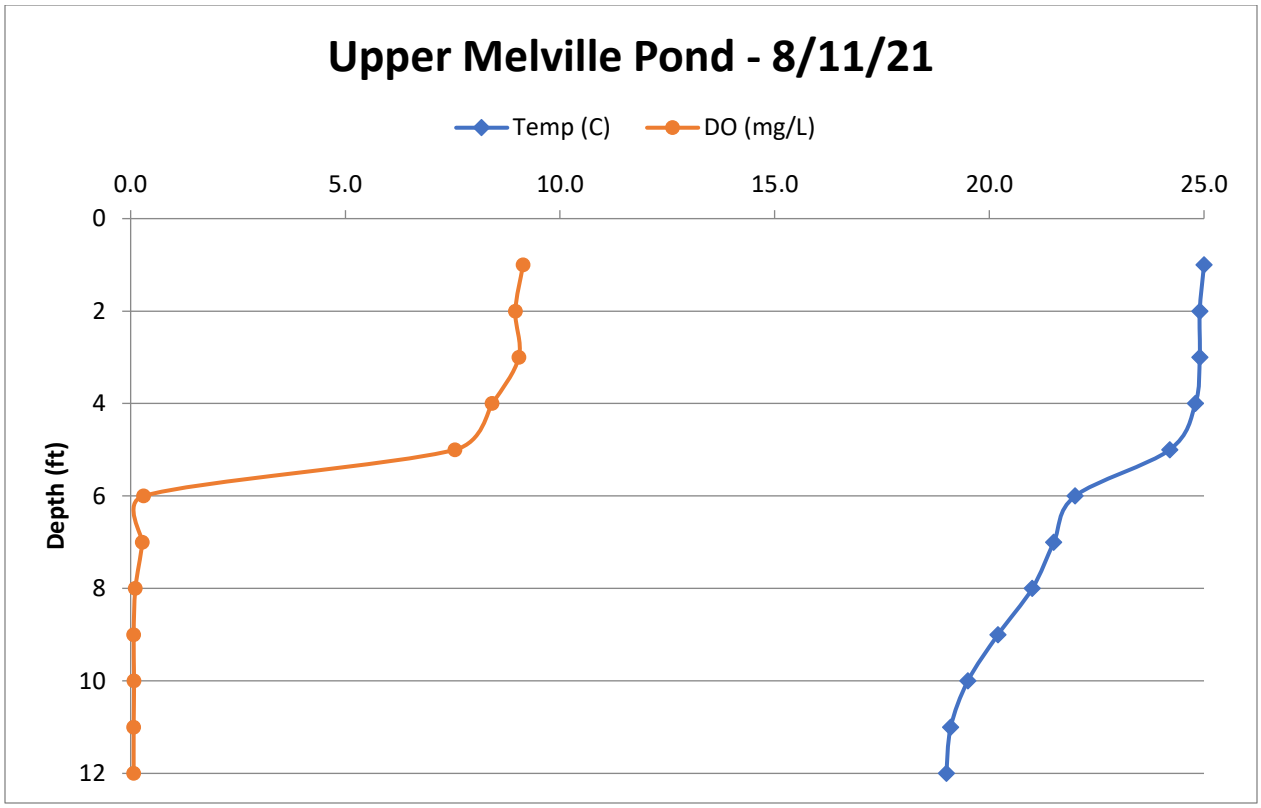


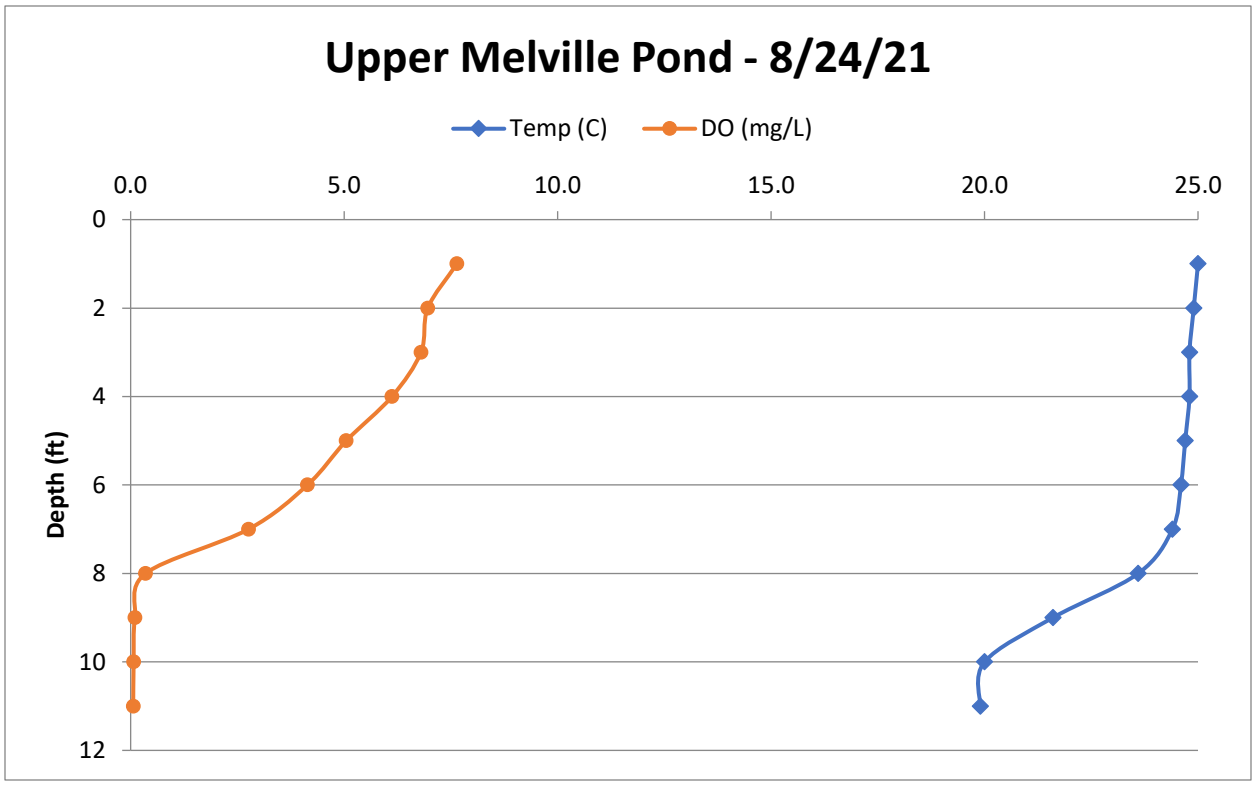

Upper Melville Pond - 6/17/21
Temp (C)
DO (mg/L)
0.0
5.0
10.0
15.0
20.0
25.0
0
2
4
6
8
10
12
Depth (ft)

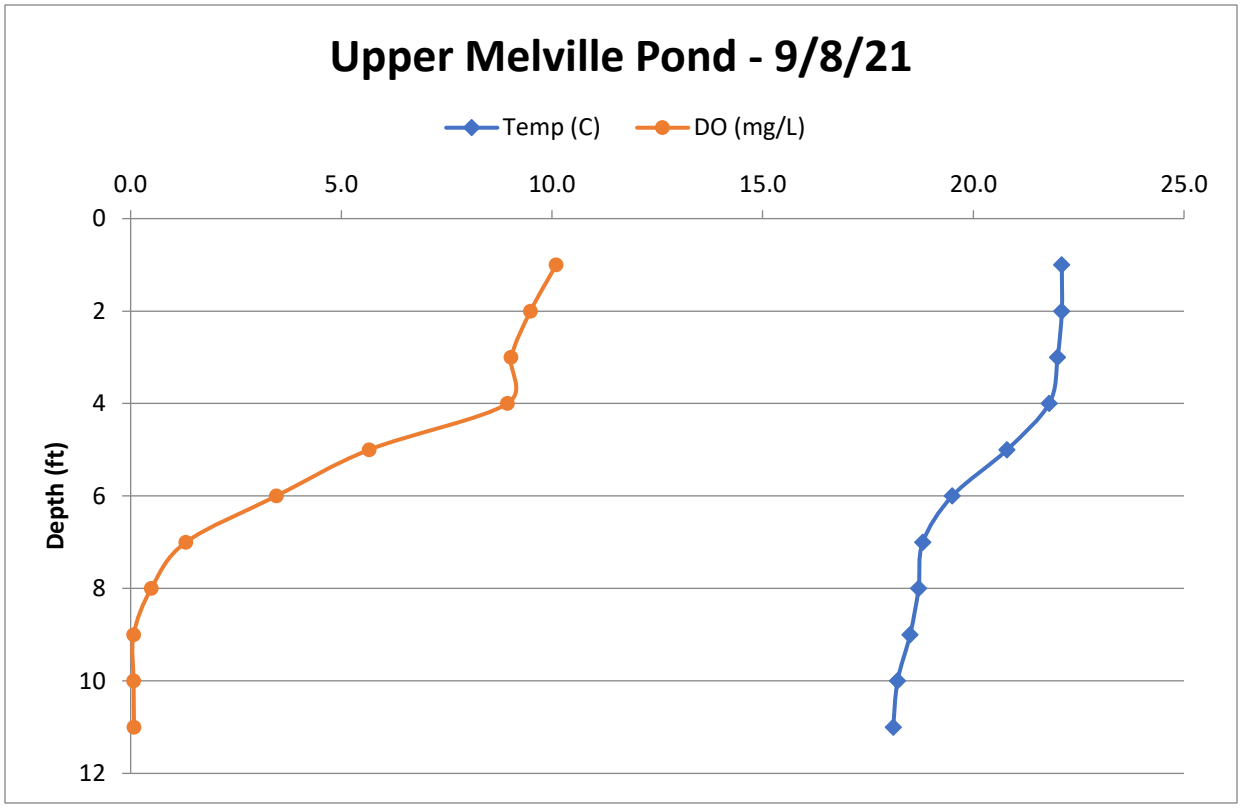

Upper Melville Pond - 6/29/21
Temp (C)
DO (mg/L)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
0
2
4
6
8
10
12
Depth (ft)

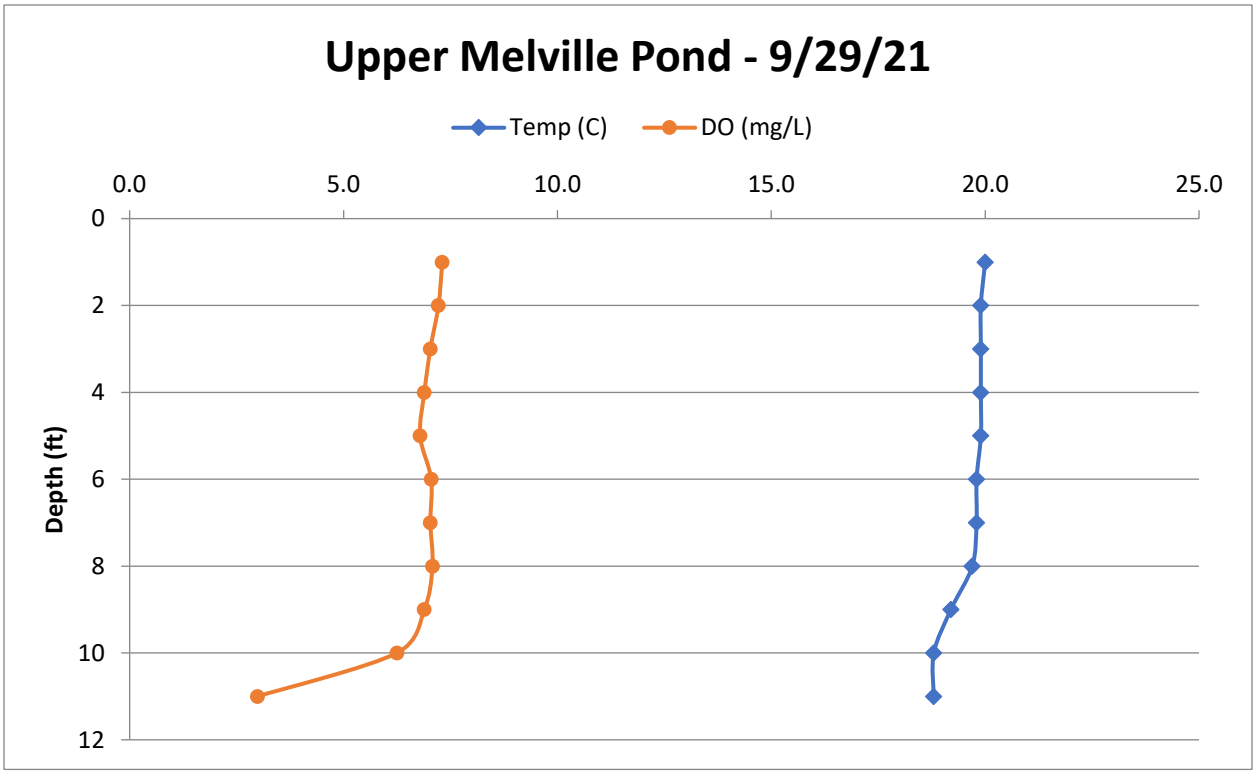

Upper Melville Pond - 7/14/21
Temp (C)
DO (mg/L)
0.0
5.0
10.0
15.0
20.0
25.0
0
2
4
6
8
10
12
Depth (ft)

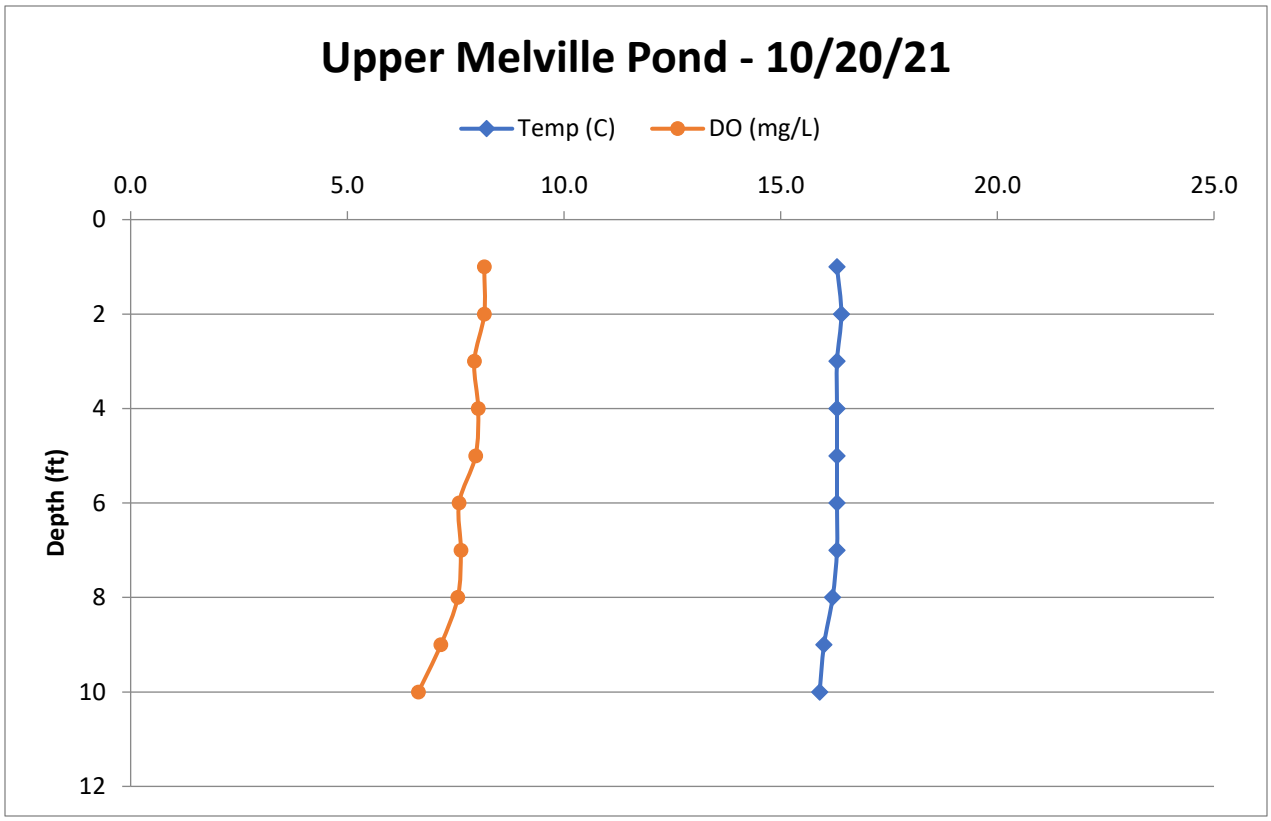

Upper Melville Pond - 7/27/21
Temp (C)
DO (mg/L)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
0
2
4
6
8
10
12
Depth (ft)


Upper Melville Pond - 8/11/21
Temp (C)
DO (mg/L)
0.0
5.0
10.0
15.0
20.0
25.0
Depth (ft)
0
2
4
6
8
10
12


Upper Melville Pond - 8/24/21
Temp (C)
DO (mg/L)
0.0
5.0
10.0
15.0
20.0
25.0
Depth (ft)
0
2
4
6
8
10
12


Upper Melville Pond - 9/8/21
Temp (C)
DO (mg/L)
0.0
5.0
10.0
15.0
20.0
25.0
0
2
4
6
8
10
12
Depth (ft)


Upper Melville Pond - 9/29/21
Temp (C)
DO (mg/L)
0.0
5.0
10.0
15.0
20.0
25.0
0
2
4
6
8
10
12
Depth (ft)

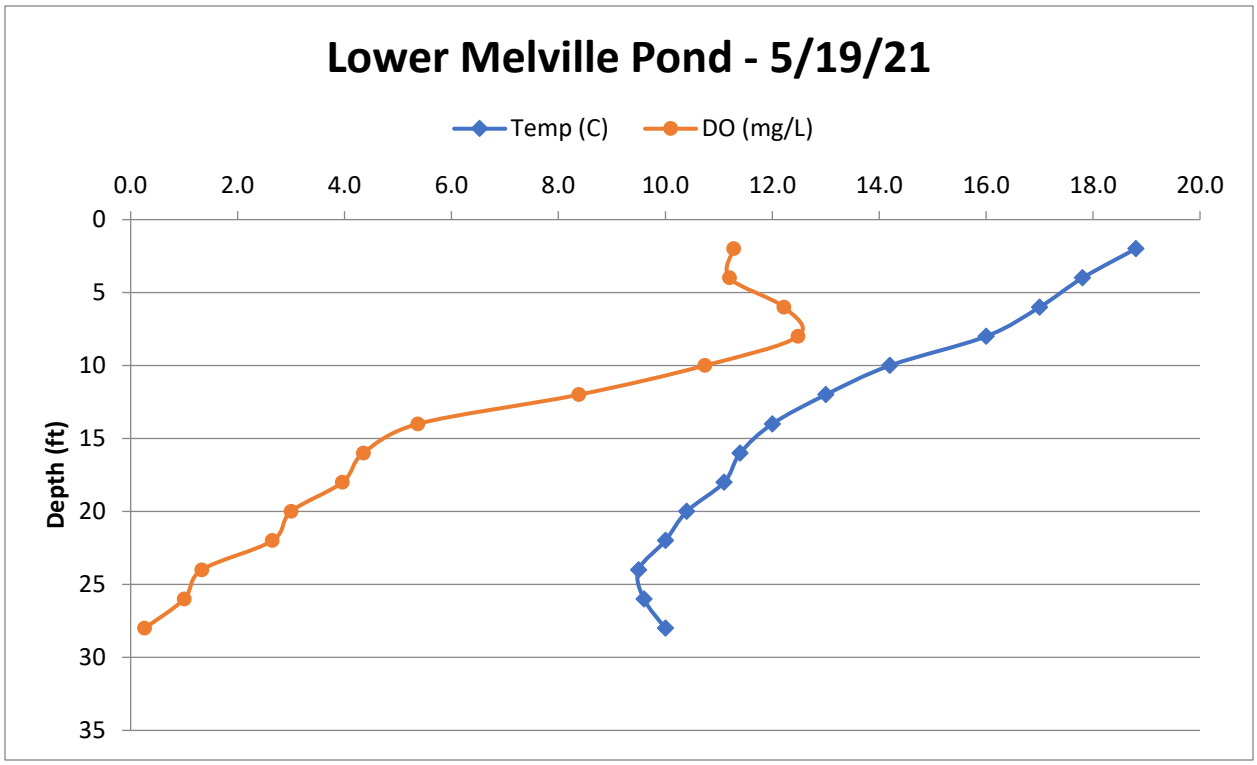

Upper Melville Pond - 10/20/21
Temp (C)
DO (mg/L)
0.0
5.0
10.0
15.0
20.0
25.0
0
2
4
6
8
10
12
Depth (ft)

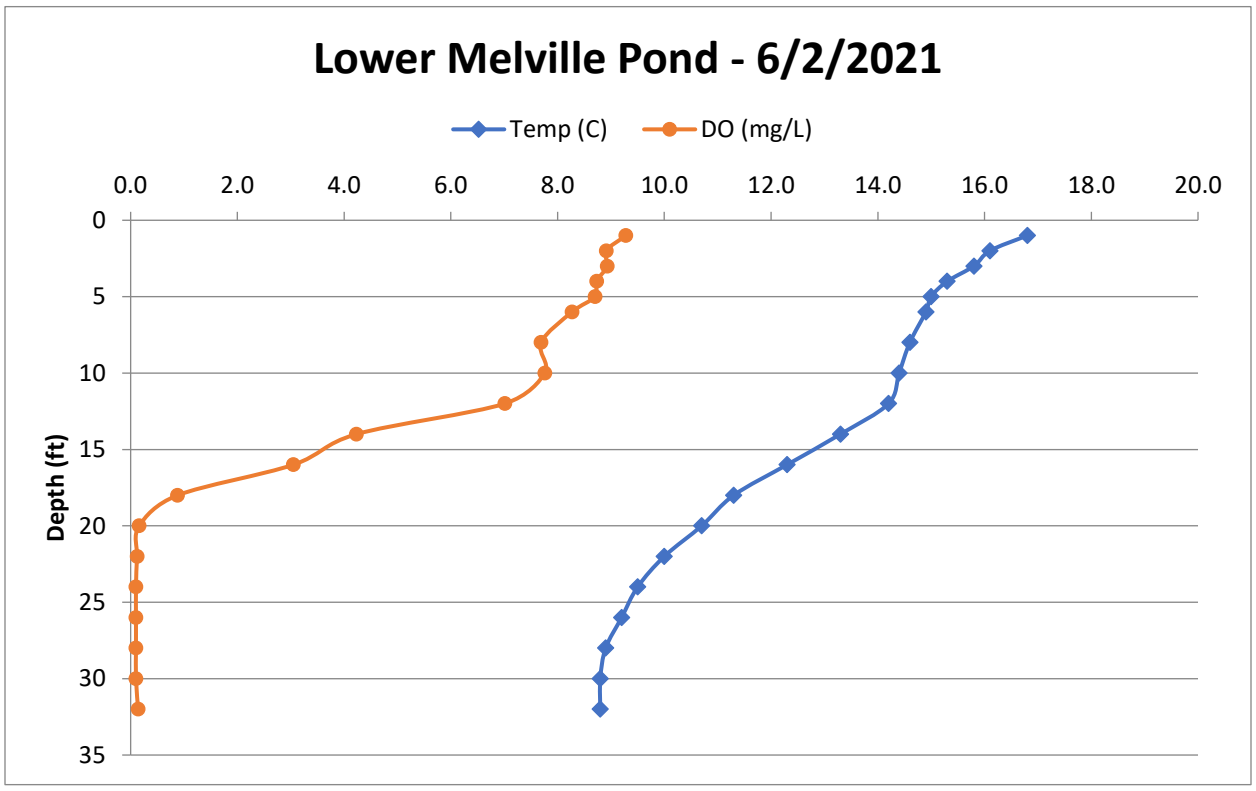
Lower Melville YSI Vertical Profile Data

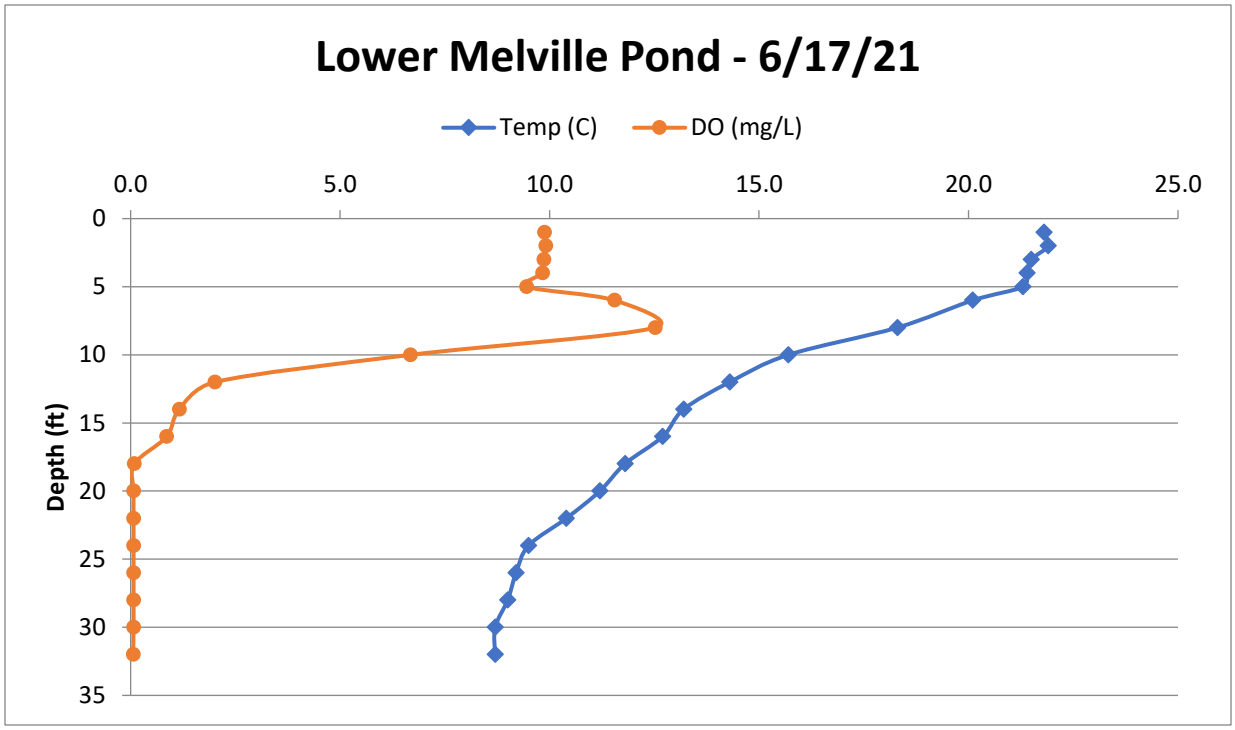
Date	5/19/2021																			
Time	9:30AM																			
Depth (ft)	31	T (C)	18.8	17.8	17.0	16.0	14.2	13.0	12.0	11.4	11.1	10.4	10.0	9.5	9.6	10.0				
Secchi (ft)	8.0	Depth (ft)	2	4	6	8	10	12	14	16	18	20	22	24	26	28				
Weather	Sunny, 70F	DO (%)	122.4	118.8	124.5	124.0	104.1	79.0	50.1	39.8	35.6	27.3	23.7	13.5	9.1	2.4				
Pressure(mmHg)	n/a	DO (mg/L)	11.28	11.20	12.22	12.48	10.74	8.38	5.37	4.35	3.96	3.00	2.65	1.33	1.00	0.26				
Van Dorn (ft)	22	SPC	375	379	376	370	370	378	377	378	382	385	388	391	393	393				
Date	6/2/2021																			
Time	9:30AM																			
Depth (ft)	32	T (C)	16.8	16.1	15.8	15.3	15.0	14.9	14.6	14.4	14.2	13.3	12.3	11.3	10.7	10.0	9.5	9.2	8.9	8.8	8.8
Secchi (ft)	9.3,9	Depth (ft)	1	2	3	4	5	6	8	10	12	14	16	18	20	22	24	26	28	30	32
Weather	Sunny, 70F	DO (%)	93.7	91.3	88.9	86.8	84.1	80.6	74.8	74.6	67.5	40.1	28.1	8.0	1.6	1.0	0.9	0.9	0.9	0.8	1.1
Pressure(mmHg)	769.2	DO (mg/L)	9.28	8.91	8.93	8.73	8.70	8.27	7.69	7.76	7.01	4.23	3.05	0.88	0.16	0.12	0.10	0.10	0.10	0.10	0.14
Van Dorn (ft)	25	SPC	349	348	348	348	347	348	348	347	349	364	364	380	386	389	392	394	398	420	422
Date	6/17/2021																			
Time	9:30AM																			
Depth (ft)	33	T (C)	21.8	21.9	21.5	21.4	21.3	20.1	18.3	15.7	14.3	13.2	12.7	11.8	11.2	10.4	9.5	9.2	9.0	8.7	8.7
Secchi (ft)	9.4,9.2	Depth (ft)	1	2	3	4	5	6	8	10	12	14	16	18	20	22	24	26	28	30	32
Weather	Sunny, 75F	DO (%)	109.7	112.6	109.1	107.9	106.2	126.6	133.9	69.4	20.0	11.0	8.0	0.8	0.7	0.7	0.7	0.7	0.6	0.5	0.5
Pressure(mmHg)	764	DO (mg/L)	9.88	9.91	9.86	9.83	9.45	11.55	12.52	6.68	2.01	1.16	0.86	0.09	0.07	0.07	0.07	0.07	0.07	0.07	0.06
Van Dorn (ft)	26	SPC	363	364	364	363	364	355	350	351	356	355	354	371	383	389	394	396	408	426	427
Date	6/29/2021																			
Time	9:30AM																			
Depth (ft)	33	T (C)	26.2	25.9	25.6	25.3	25.3	23.3	21.4	17.4	15.1	13.9	13.0	12.0	11.1	10.7	10.0	9.5	8.9	8.7	
Secchi (ft)	7.5,7.7	Depth (ft)	1	2	3	4	5	6	8	10	12	14	16	18	20	22	24	26	28	30	
Weather	Sunny, 85F	DO (%)	126.1	126.2	128.7	136.2	158.1	161.0	212.3	112.7	48.3	2.4	1.6	1.2	1.3	1.3	1.2	1.2	1.1	1.0	
Pressure(mmHg)	769.3	DO (mg/L)	10.30	10.28	10.64	12.00	13.45	13.90	19.00	11.15	5.02	0.25	0.19	0.16	0.15	0.15	0.14	0.14	0.13	0.12	
Van Dorn (ft)	26	SPC	365.1	364.1	365.5	364.3	363.7	362.9	357.6	353.1	354.4	352.1	348.8	358.1	384.2	388.5	392.1	402.1	425.3	440.7	
Date	7/14/2021																			
Time	9:30AM																			
Depth (ft)	33	T (C)	22.8	22.8	22.5	21.6	21.1	20.9	20.1	19.5	16.4	14.6	13.5	12.2	11.2	10.7	9.9	9.4	9.1	8.9	8.8
Secchi (ft)	2.2,2.1	Depth (ft)	1	2	3	4	5	6	8	10	12	14	16	18	20	22	24	26	28	30	32
Weather	Cloudy, 70F	DO (%)	168.8	158.6	136.2	104.3	105.6	81.1	58.1	41.1	4.0	1.6	1.5	1.3	1.2	1.1	0.8	1.0	0.9	0.8	0.8
Pressure(mmHg)	770	DO (mg/L)	14.32	13.75	11.44	9.11	9.51	7.21	5.49	3.77	0.35	0.16	0.14	0.14	0.12	0.14	0.11	0.11	0.10	0.10	0.10
Van Dorn (ft)	26	SPC	328.1	328	326.4	328.4	334.7	329.4	337.6	344	355.1	356	352.4	357.9	382.4	388.7	400.4	416	430.9	440.2	452.9
Date	7/27/2021																			
Time	9:30AM																			
Depth (ft)	34	T (C)	24.8	24.6	24.5	24.0	23.7	23.5	21.0	18.5	16.5	14.3	13.2	13.0	11.5	10.6	10.2	9.5	9.1	9.0	9.0
Secchi (ft)	4.8, 4.9	Depth (ft)	1	2	3	4	5	6	8	10	12	14	16	18	20	22	24	26	28	30	32
Weather	Sunny, 80F	DO (%)	118.6	111.1	126.2	148.8	144.5	116.3	4.0	1.2	0.9	0.9	0.8	0.7	0.8	0.8	0.7	0.6	0.6	0.6	0.5
Pressure(mmHg)	763.6	DO (mg/L)	9.69	9.46	10.38	12.28	12.21	10.34	0.32	0.12	0.10	0.09	0.09	0.08	0.09	0.09	0.08	0.08	0.08	0.07	0.07
Van Dorn (ft)	26	SPC	350	350	350	351	349	347	340	348	354	354	362	365	383	395	405	423	438	444	447

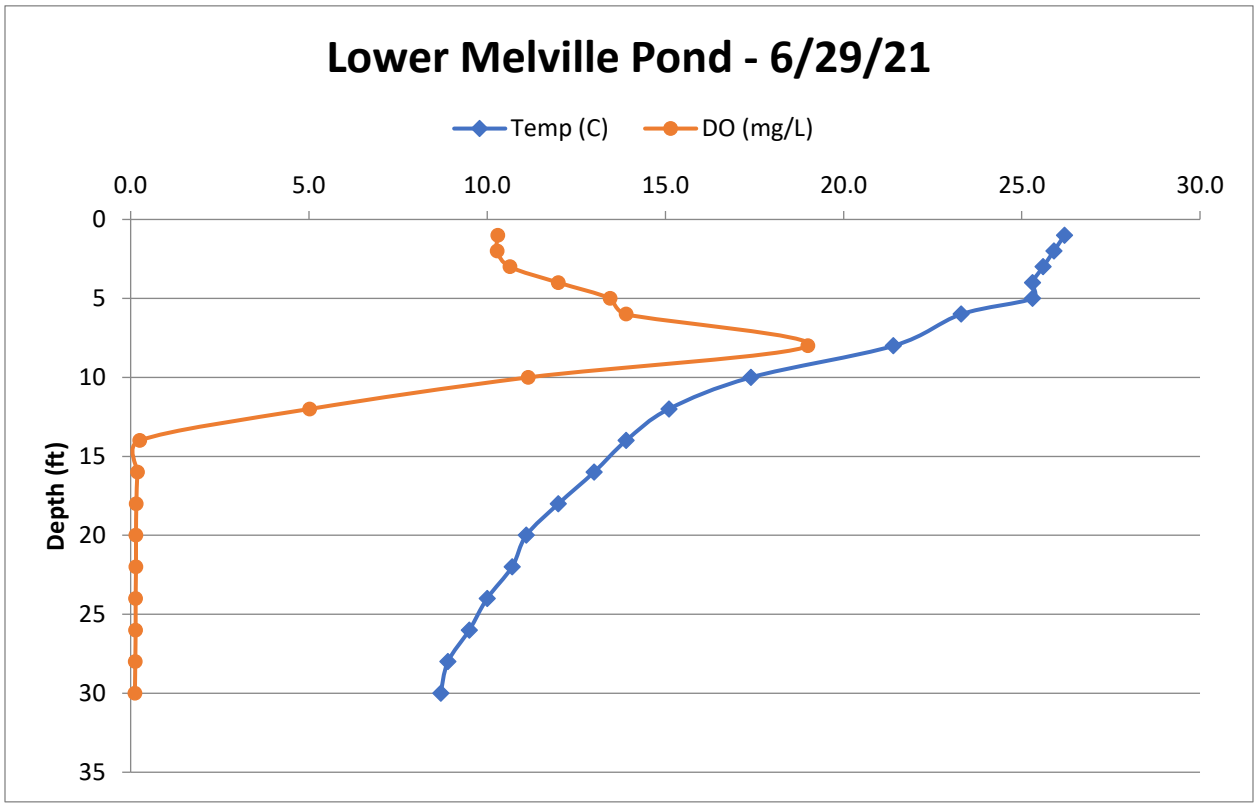
Date	8/11/2021																			
Time	9:30AM																			
Depth (ft)	33	T (C)	24.1	23.6	22.6	22.4	21.8	20.7	20.0	19.2	17.3	14.8	13.5	12.0	11.1	10.2	10.0	9.4	9.1	8.9	8.9
Secchi (ft)	4.0, 4.1	Depth (ft)	1	2	3	4	5	6	8	10	12	14	16	18	20	22	24	26	28	30	32
Weather	Sunny, windy, 80F	DO (%)	126.2	135.3	119.2	116.0	125.0	96.8	46.3	26.7	1.3	1.0	0.8	0.5	0.6	0.8	0.8	0.6	0.9	0.8	0.7
Pressure(mmHg)	766.2	DO (mg/L)	10.97	11.64	10.64	10.02	11.31	8.55	4.33	2.56	0.13	0.11	0.10	0.08	0.07	0.11	0.08	0.05	0.10	0.09	0.08
Van Dorn (ft)	26	SPC	308	310	314	315	301	287	287	297	343	360	365	378	392	406	412	430	446	466	475
Date	8/24/2021																			
Time	9:30AM																			
Depth (ft)	33	T (C)	23.9	23.8	23.5	23.4	23.2	22.8	22.7	19.5	16.5	15.1	13.9	12.8	11.9	10.8	10.1	9.4	9.3	9.0	8.9
Secchi (ft)	2.9, 3.0	Depth (ft)	1	2	3	4	5	6	8	10	12	14	16	18	20	22	24	26	28	30	32
Weather	Wet Weather 75F	DO (%)	127.3	118.1	104.5	107.1	100.7	88.5	87.0	5.7	1.2	1.7	1.1	0.8	0.8	0.6	0.7	0.6	0.7	0.6	0.4
Pressure(mmHg)	761.8	DO (mg/L)	10.77	10.09	8.88	9.13	8.55	7.65	7.50	0.46	0.14	0.18	0.13	0.08	0.07	0.09	0.08	0.09	0.09	0.09	0.09
Van Dorn (ft)	26	SPC	310	309	303	304	295	291	293	309	350	366	370	375	388	400	412	433	445	461	478
Date	9/8/2021																			
Time	9:30AM																			
Depth (ft)	33	T (C)	21.2	21.1	20.9	20.3	19.9	19.8	18.8	18.0	17.6	17.1	16.4	14.7	12.6	11.0	10.3	9.8	9.5	9.4	9.3
Secchi (ft)	5.5, 6.0	Depth (ft)	1	2	3	4	5	6	8	10	12	14	16	18	20	22	24	26	28	30	32
Weather	70F, windy	DO (%)	115.7	119.3	117.3	95.6	83.7	78.8	40.9	33.2	17.5	1.5	0.9	0.7	0.7	0.8	0.6	0.4	0.5	0.5	0.6
Pressure(mmHg)	763.5	DO (mg/L)	10.32	10.64	10.41	8.86	7.74	7.01	3.72	3.20	1.73	0.12	0.08	0.07	0.07	0.07	0.07	0.04	0.07	0.06	0.05
Van Dorn (ft)	26	SPC	191	191	192	201	183	176	154	153	164	196	226	296	379	401	415	434	452	460	467
Date	9/29/2021																			
Time	9:30AM																			
Depth (ft)	31	T (C)	18.8	18.8	18.8	18.8	18.8	18.8	18.8	18.7	18.3	16.3	15.6	14.9	13.6	12.1	11.0	10.2	9.8	9.7	
Secchi (ft)	4.3, 3.7	Depth (ft)	1	2	3	4	5	6	8	10	12	14	16	18	20	22	24	26	28	30	
Weather	65F, very windy	DO (%)	80.4	78.3	76.8	75.8	76.1	74.2	73.3	58.1	19.4	1.7	1.6	1.4	1.5	2.1	1.2	0.9	1.1	0.8	
Pressure(mmHg)	763.7	DO (mg/L)	7.34	7.28	7.34	7.13	7.07	7.03	6.67	5.27	1.72	0.15	0.15	0.16	0.16	0.18	0.13	0.12	0.10	0.08	
Van Dorn (ft)	26	SPC	255	255	255	255	255	255	255	248	227	246	275	304	388	438	462	486	506	509	
Date	10/20/2021																			
Time	9:30AM																			
Depth (ft)	31	T (C)	15.2	15.2	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.0	12.2	11.2	10.8	10.8	10.8	
Secchi (ft)	4.0, 3.9	Depth (ft)	1	2	3	4	5	6	8	10	12	14	16	18	20	22	24	26	28	30	
Weather	65F, windy	DO (%)	77.2	70.7	70.1	70.2	68.7	68.5	68.9	68.2	68.4	68.0	67.2	67.8	64.2	4.7	3.2	2.9	2.8	2.7	
Pressure(mmHg)	763.6	DO (mg/L)	7.57	7.12	7.02	7.03	6.86	6.87	6.94	6.86	6.90	6.85	6.77	6.76	6.31	0.45	0.34	0.33	0.31	0.30	
Van Dorn (ft)	26	SPC	307	307	307	307	307	307	308	308	307	308	308	308	311	435	483	494	497	497	

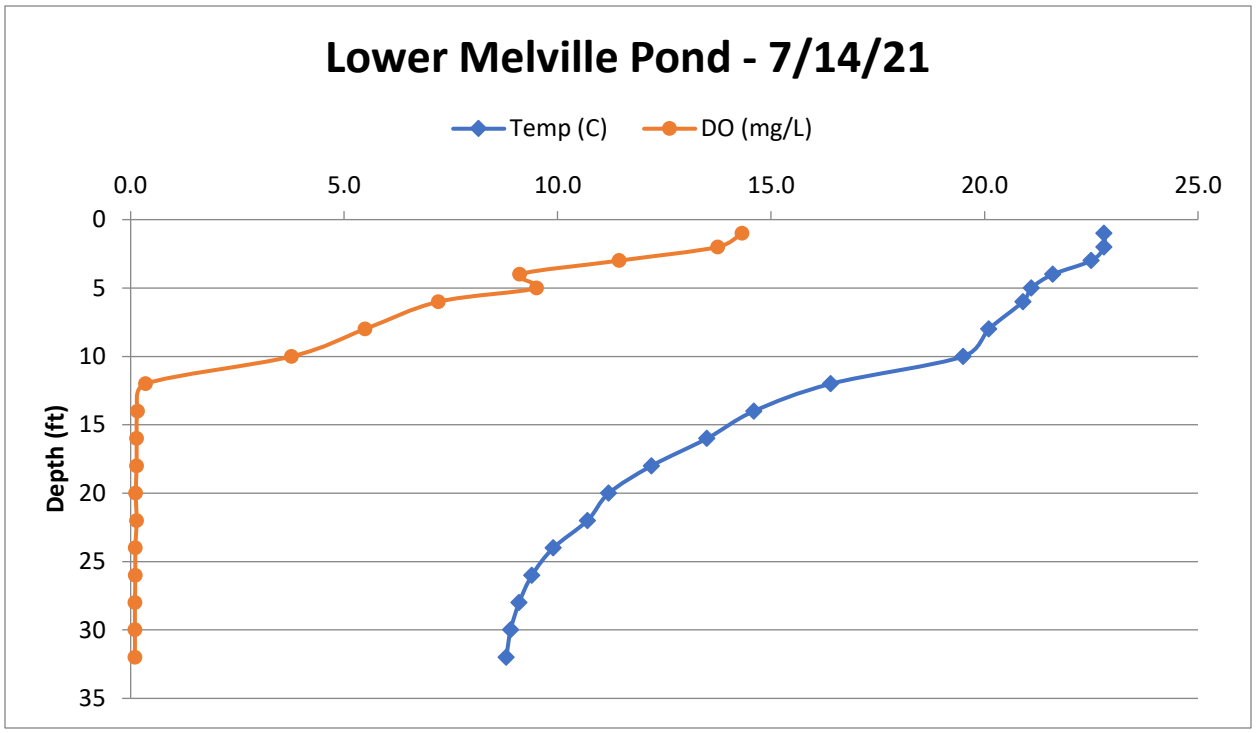
Lower Melville Vertical Profile Charts






Lower Melville Pond - 6/17/21
Temp (C)
DO (mg/L)
0.0
5.0
10.0
15.0
20.0
25.0
0
5
10
15
20
25
30
35
Depth (ft)


Lower Melville Pond - 6/29/21
Temp (C)
DO (mg/L)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
0
5
10
15
20
25
30
35
Depth (ft)


Lower Melville Pond - 7/14/21
Temp (C)
DO (mg/L)
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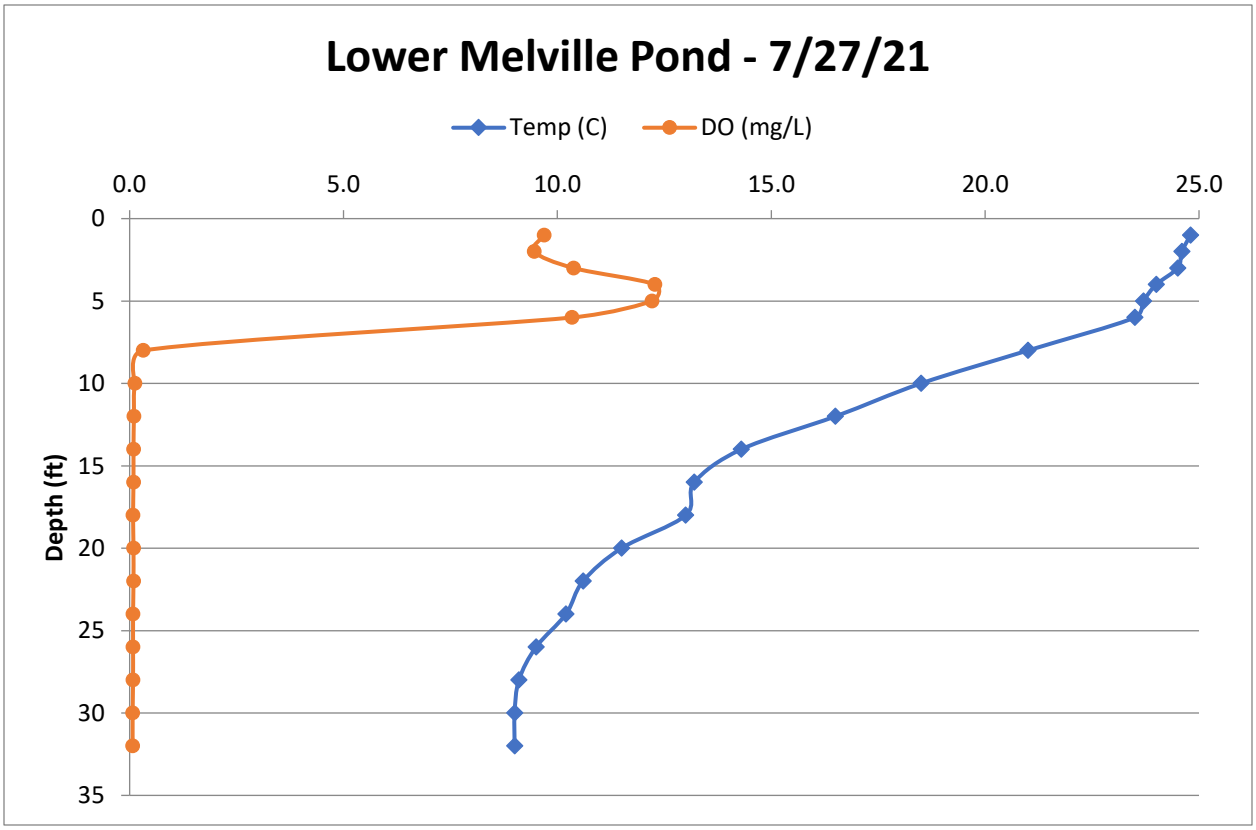
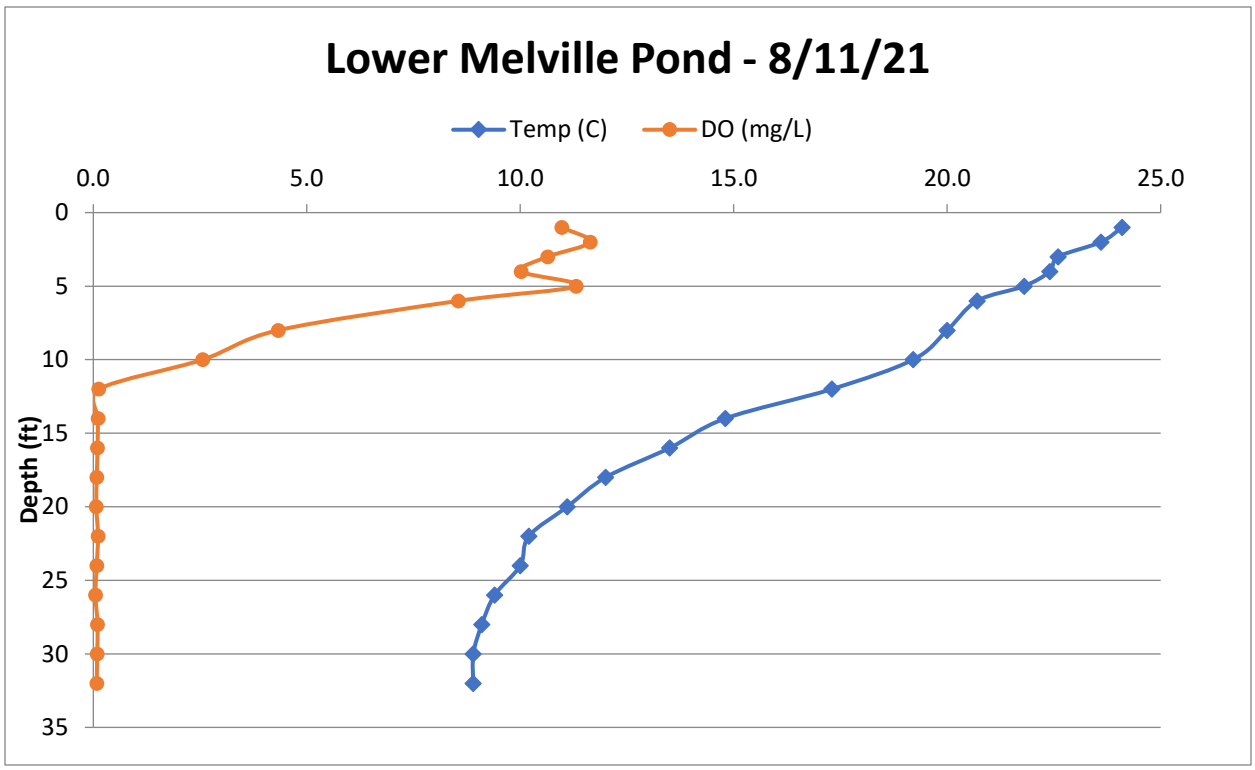
5.0
10.0
15.0
20.0
25.0
0
5
10
15
20
25
30
35
Depth (ft)


Lower Melville Pond - 7/27/21
Temp (C)
DO (mg/L)
0.0
5.0
10.0
15.0
20.0
25.0
0
5
10
15
20
25
30
35
Depth (ft)


Lower Melville Pond - 8/11/21
Temp (C)
DO (mg/L)
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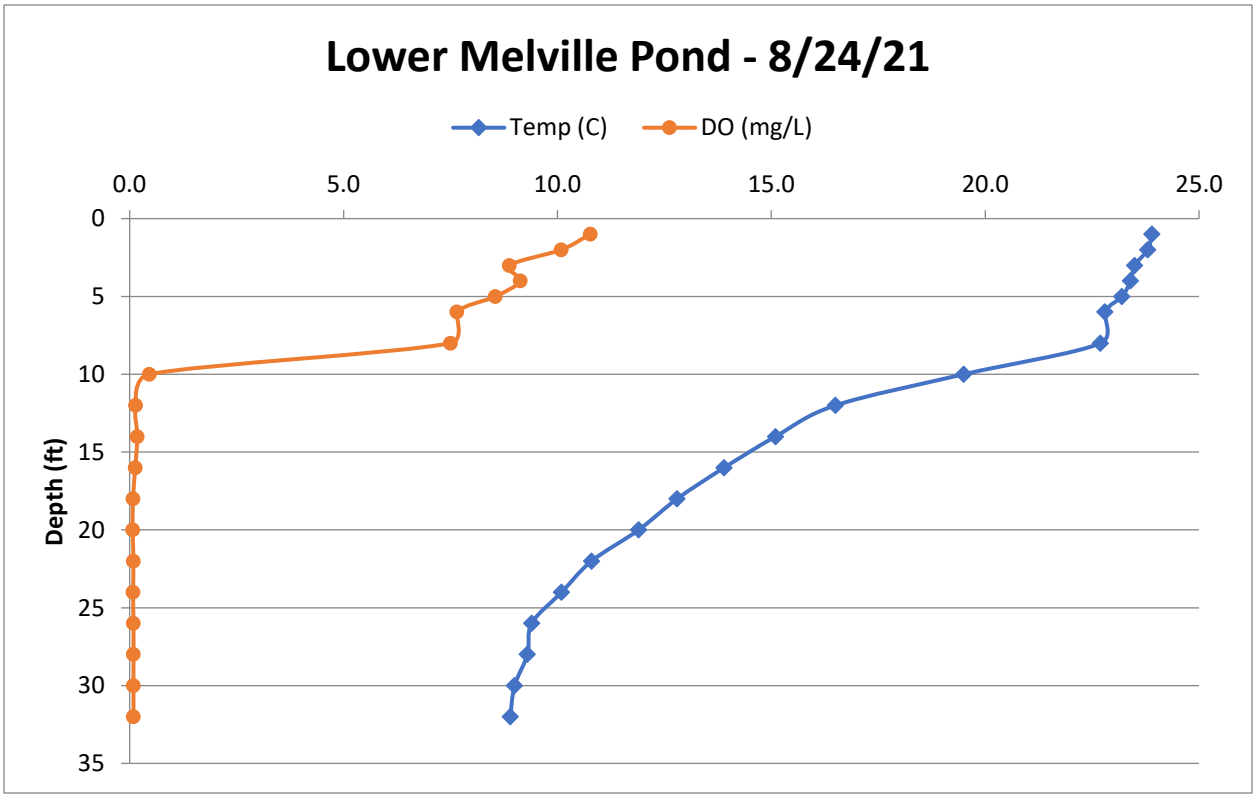
10.0
15.0
20.0
25.0
0
5
10
15
20
25
30
35
Depth (ft)


Lower Melville Pond - 8/24/21
Temp (C)
DO (mg/L)
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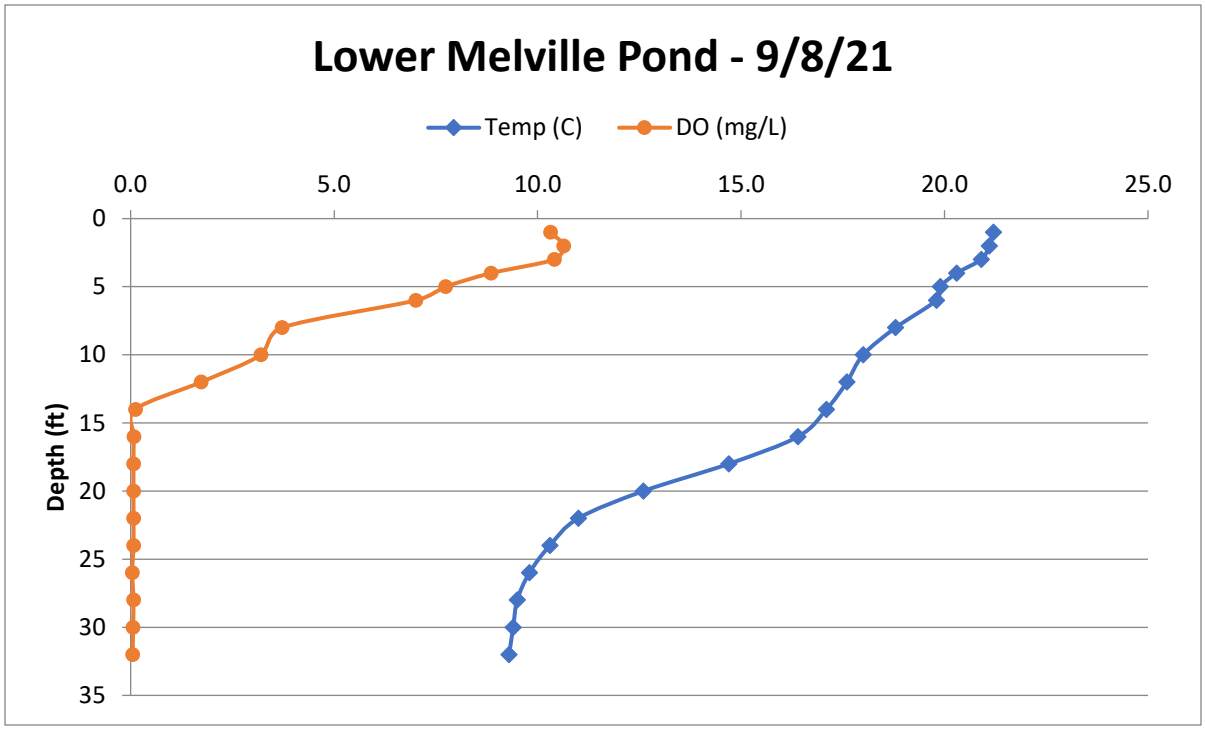
10.0
15.0
20.0
25.0
0
5
10
15
20
25
30
35
Depth (ft)


Lower Melville Pond - 9/8/21
Temp (C)
DO (mg/L)
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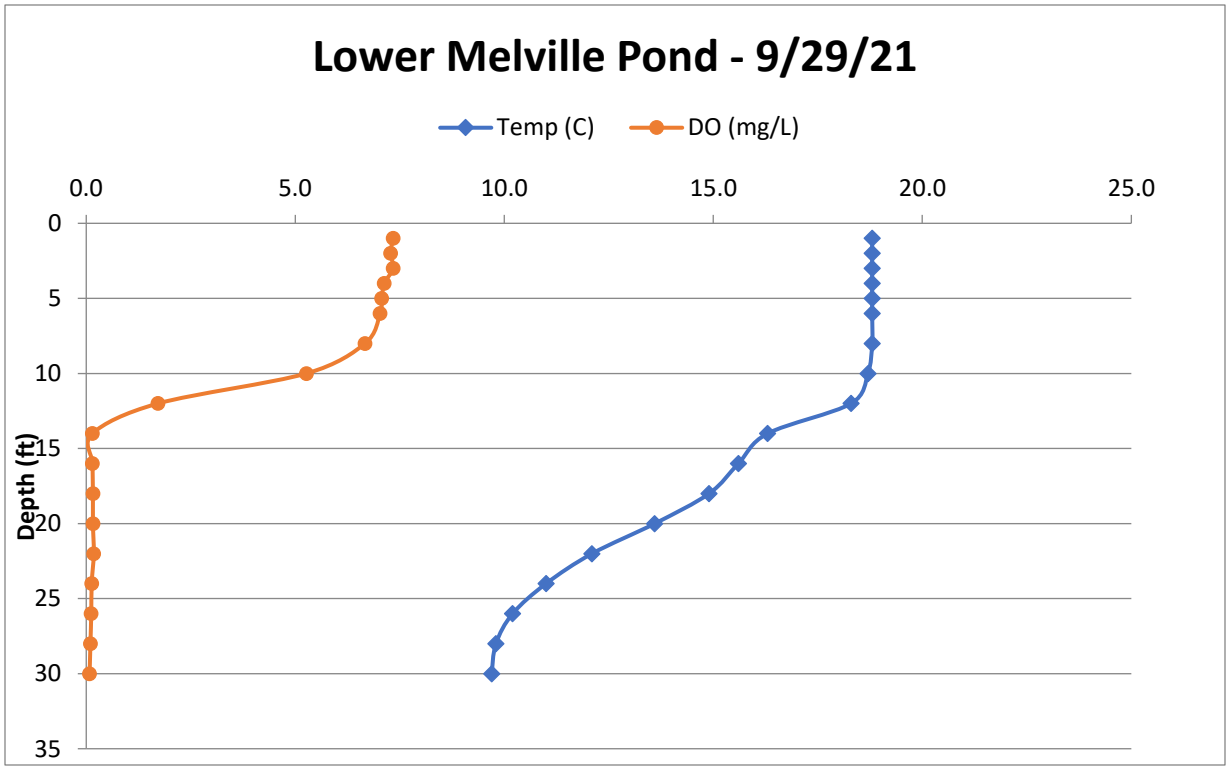
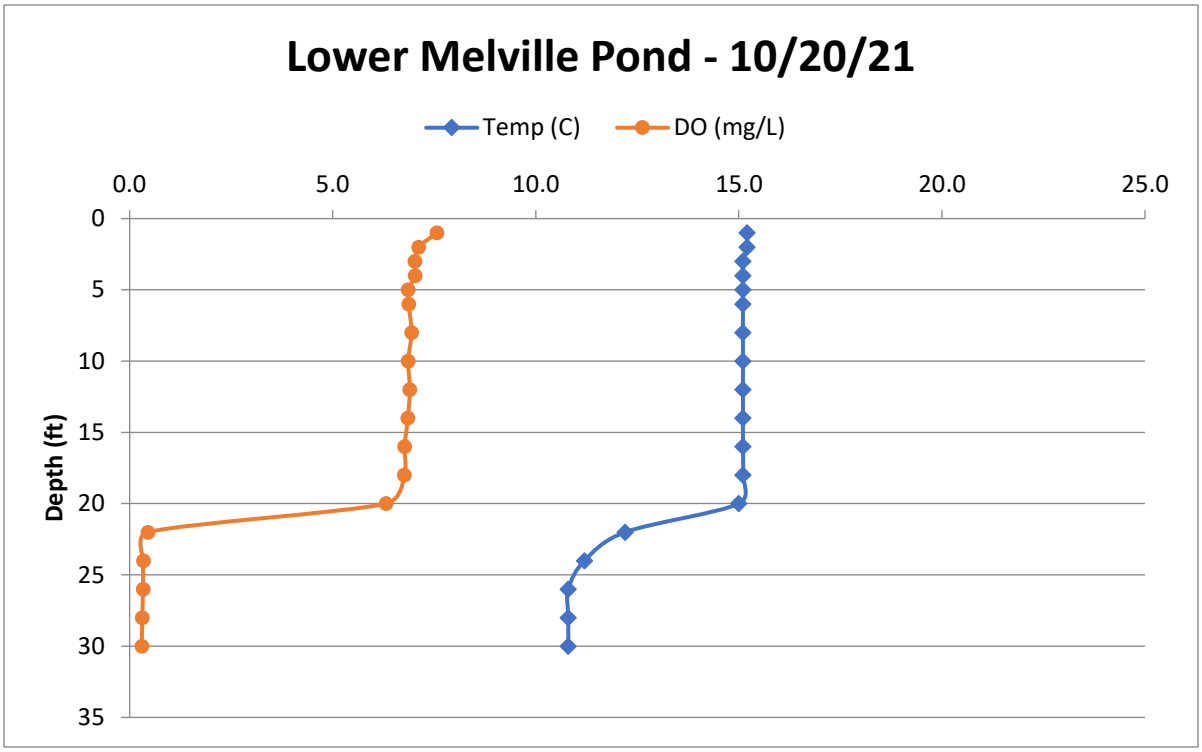
10.0
15.0
20.0
25.0
0
5
10
15
20
25
30
35
Depth (ft)


Lower Melville Pond - 9/29/21
Temp (C)
DO (mg/L)
0.0
5.0
10.0
15.0
20.0
25.0
0
5
10
15
20
25
30
35
Depth (ft)


Lower Melville Pond - 10/20/21
Temp (C)
DO (mg/L)
0.0
5.0
10.0
15.0
20.0
25.0
0
5
10
15
20
25
30
35
Depth (ft)

Appendix C. 2023 SAMPLING DATA SUMMARY.

Additional Data Collection to Support Development of Upper and Lower Melville Pond and Melville Pond Tributary total phosphorus TMDL

The RIDEM Office of Water Resources collected total phosphorus and orthophosphate data from the outlet of Upper Melville Pond and the inlet of Lower Melville Pond in 2023 to support development of the total phosphorus TMDL for Upper and Lower Melville Pond and the Melville Pond Tributary. The purpose of collecting this data was to evaluate the amount of phosphorus attenuation occurring between Upper and Lower Melville Ponds via the Melville Pond Tributary and associated wetlands. The Melville Pond Tributary was added to the 2024 Impaired Waters List based on the collected data and the data was used to develop a TMDL for the Melville Pond Tributary.

The analytical data was evaluated to ensure that it met the measurement of performance criteria specified in the Melville Ponds Outlet and Inlet Sampling Plan.

Sampling Overview

Staff collected samples from the outlet of Upper Melville Pond and the inlet to Lower Melville Pond on a biweekly basis from June through September 2023. A total of 9 surveys were conducted on the dates shown in Table C1. Sample locations are depicted on Figure C1. Samples were collected from the shoreline using a sampling stick. The samples were analyzed for total phosphorus and orthophosphate by the Rhode Island State Health Laboratory. All sampling results are provided in Table C2.

Table C1. Melville Ponds Outlet/Inlet Sampling Dates.

Sampling Dates
6/20/2023
7/6/2023
7/11/2023
*7/20/2023
*8/1/2023
8/15/2023
*8/31/2023
9/12/2023
9/28/2023

*Field Duplicate Collected

Table C1. Water Quality Sampling Results.

	Upper Melville Pond Outlet		Lower Melville Pond Inlet	
Date	Total Phosphorus (ug/L)	Orthophosphate (ug/L)	Total Phosphorus (ug/L)	Orthophosphate (ug/L)
6/20/2023	75	10	33	16
7/6/2023	100	Non-detect*	43	20
7/11/2023	180	Non-detect	50	21
7/20/2023	82	17	50	24
8/1/2023	68	10	39	23
8/15/2023	89	11	66	31
8/31/2023	81	12	37	19
9/12/2023	63	Non-detect	49	21
9/28/2023	59	Non-detect	30	11

*Orthophosphate detection limit was 10 ug/L.

Figure C1. Map of approximate sampling locations of Upper Melville Pond outlet and Lower Melville Pond inlet.

Quality Assurance

Analytical and Laboratory QA/QC

Table C3 provides the analytical method and detection limit for the analyses conducted by the Rhode Island State Health Laboratory. Additional information about laboratory QA/QC procedures is provided in the Melville Ponds QAPP.

Table C2. Analytical method and reporting limit for total phosphorus and orthophosphate analyses.

Parameter	**Analytical Method**	**Reporting Limit**
Total Phosphorus	EPA 365.3	0.010 mg/L
Orthophosphate	SM 4500- P E	0.010 mg/L

Field duplicates were collected during 3 sampling events, as indicated in Table C1. Data not meeting the criteria set in the QAPP addendum was removed from final datasets used in the TMDL. Acceptable field duplicates are those with an RPD less than 20%. Field duplicate data results are provided in Tables C4 and C5.

Table C3. Upper Melville Pond Outlet Field Duplicate Results

Sampling Event	Total Phosphorus (ug/L)	Orthophosphate (ug/L)
7/20/2023	82	17
Field Duplicate	86	13
RPD	4.8%	26.7%
8/31/2023	81	12
Field Duplicate	90	18
RPD	10.5%	40.0%

Table C4. Lower Melville Pond Inlet Field Duplicate Results

Sampling Event	Total Phosphorus (ug/L)	Orthophosphate (ug/L)
8/1/2023	39	23
Field Duplicate	34	22
RPD	13.7%	4.4%
8/31/2023	37	19
Field Duplicate	32	22
RPD	14.5%	14.6%