2022 Water Quality Committee Report

2022 Summary

Based on the findings contained in this report, the water quality of Watchic Lake remains good, and is not substantially changed from data collected over the previous 6 years (2016-2021), or from data back to the 1970's. Specifically, water clarity and total phosphorus levels are consistent with previous years and consistent with other Maine lakes like ours. All data reported here was collected by the Watchic Lake Water Quality Committee and represents over 70 hours of volunteer time with a cost of ~$1500.

The 2021/22 winter was the third in a row where the lake was frozen (ice covered) for less that 100 days. 2022 was a moderate year for rain (23.1 inches from April to October). Spring (May and June) were dry this year (only 2.8 inches of rain combined) compared to the months of April, and July - October each had 3.6-5.0 inches of rain. Despite these changing weather patterns, lake quality as measured by trophic state indicators (water clarity and core total phosphorus and chlorophyl-A levels) was similar to recent years. No major algae issues were reported. We experience long periods of low dissolved oxygen levels at the bottom of the lake again in 2022. At the 11m depth, the dissolved oxygen was below 1mg/L from May-Oct. Such conditions can restrict fish populations and increase algae growth.
Lake residents should continue to be observant with regards to changes in the lake near their property and report any concerns to the Water Quality Committee or WLA Board member.

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Scope of Report

This report summarizes data collected on Watchic Lake and its tributaries from 5-Nov-21 to 22-Oct-22. The data is compared to historical data (mostly 2016-2021, but also older data when appropriate) to look for trends or variations which could suggest a shift in lake water quality or health. The data collected and the analysis is used to direct further monitoring efforts and if necessary, specific actions.

Background and Methodology

This report documents the results of water quality monitoring conducted at Watchic Lake by the WLA Water Quality Committee volunteers in 2021. Monitoring was conducted at the Deep Spot of the Lake (43.736590, -70.604530) and Page Brook (just before the bridge at RT113).

Weather

In 2022, weather data for Watchic Lake was obtained from a personal weather station installed on the lake at Watchic Rd19 (Burnell dock). (https://dashboard.ambientweather.net/devices/public/07ab0e16e084b686213a92cd64264c2e). This station measures outdoor temperature, precipitation, wind direction/speed and other parameters. In addition, air temperature and barometric pressure were collected using an Onset HOBO® barometric pressure logger deployed on the north end of the lake (Watson dock). Data is compared to historical weather data from the Portland Jetport (https://www.wunderground.com/history/monthly/us/me/south-portland/KPWM/date/2019-10). Ice-in and Ice-out dates are taken from the Watchic Lake Dam logbook and from data reported to the Lake Stewards of Maine (resident-reported).

Water sampling/monitoring

Water Quality Committee volunteers (Cathy Watson, and David and Eileen Burnell) received formal training and certification from the Lake Stewards of Maine in the proper techniques for Lake sampling/monitoring. From time to time, other volunteers join to help and learn.
Table 1 lists the dates monitoring was performed and the procedures carried out on each date.

Table 1: 2022 Volunteer Schedule

Date	Volunteer(s)	Secchi	Temp/DO	Meter	Logger reading	Water Samples	Comments
24-Apr-22	Eileen and David Burnell	√		ProSolo			DO meter would not calibrate. No temp/DO readings taken.
6-May-22	Eileen and David Burnell	√	√	ProSolo			
12-May-22	Cathy Watson	√	√	ProODO	√		Removed entire buoy system to QC and reconfigure to Summer configuration. Removed all loggers and took

							readings. Checked meter markings on rope and adjusted as needed. Attached NEW temperature loggers. Replaced sensor caps on DO meters, calibrated and are reattached. The logger at 11m was moved to 8m to catch more data. Will redeployed whole system tomorrow.
13-May-22	Cathy Watson	√	√	ProODO			Redeployed buoy
27-May-22	Cathy Watson and Bob Babcock	√	√	ProODO			Bob Babcock took me out on his bass boat. Used the GPS to set buoy at deep location.
30-May-22	Eileen and David Burnell	√	√	ProSolo			
12-Jun-22	Eileen and David Burnell	√	√	ProSolo			Heavy pollen in water column
15-Jun-22	Cathy Watson and Paul Baptiste	√	√	ProODO	√	√	With Paul Baptiste. Difficulty reading Temp loggers. Only read 9m &10m loggers. Core sample @ 5m. Forgot jug so used rope bucket (well washed) for sample.
2-Jul-22	Cathy Watson	√	√	ProODO			Wind picked up making DO meter readings impossible. Terminated.
11-Jul-22	Eileen and David Burnell	√	√	ProSolo			
19-Jul-22	Cathy Watson and Monica Mahoney	√	√	ProODO	√	√	Wind picked up. No Bottom sample taken. Page Brook sample taken. Monica Mahoney helped.
31-Jul-22	Eileen and David Burnell	√	√	ProSolo			
11-Aug-22	Cathy Watson	√	√	ProODO	√	√	Page Brook sample taken
13-Aug-22	Eileen and David Burnell	√	√	ProSolo			
27-Aug-22	Eileen and David Burnell	√	√	ProSolo			
12-Sep-22	Eileen and David Burnell	√	√	ProSolo			
21-Sep-22	Cathy Watson	√	√	ProODO	√	√	All except 10m Temp logger read. Rob Brisk helped
6-Oct-22	Eileen and David Burnell	√	√	ProSolo			
19-Oct-22	Eileen and David Burnell	√	√	ProSolo			
22-Oct-22	Cathy Watson	√	√	ProODO			10m Temp logger didn't read again. Reconfigured buoy to winter configuration. Replace 10m temp logger with UA1 logger

During the summer months, lake monitors uploaded real-time Secchi disk readings to the Lake Stewards of Maine website (https://www.lakestewardsofmaine.org/near-real-time-lake-data/).

This work represents over 70 hours of volunteer time and a budget of approximately $1500.

Lake Monitoring at Deep Spot - WLA Buoy

WLA Water Quality volunteers maintained a series of Onset HOBO® continuous logging devices at the WLA Buoy at the Deep Spot of the lake (43.736590, -70.604530). The winter buoy consisted of 7 Onset HOBO® UA-002 and 1 Onset HOBO® UA-001 temperature loggers at 1-meter intervals starting at 2 meters from the bottom of the lake (Figure 3). The winter buoy was deployed on 5-Nov-2021 and remained in place over the 2021/2022 winter. The winter buoy was removed on 12-May-22, the temperature loggers were reconfigured to the summer buoy, the DO loggers were added back, and whole system was redeployed 13-May-22 (Figure 3). The loggers were cleaned and downloaded during each monthly sampling event thereafter. On 22-Oct-2022, the summer buoy was pulled from the water. All U26 temperature/dissolved oxygen loggers were removed from the line and the temperature loggers were moved to the winter buoy design. The 10m temperature logger had persistent issues downloading so it was replaced with a UA-001-64 logger (serial# 21183777) for the winter (Figure 3). A replacement

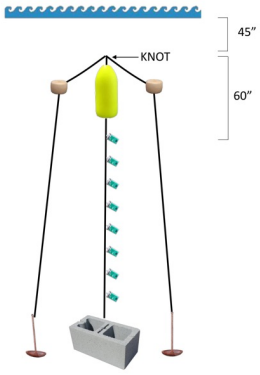
logger was requested from the manufacturer. All loggers are set to read every 15 minutes while deployed.

Figure 3: Buoy and HOBO® Logger configurations

Winter Buoy

Meters from	Serial Number	Logger
11		
10		
9	20160224	Temp
8	20160222	Temp
7	20160225	Temp
6	21883777	Temp*
5	20160221	Temp
4	20160226	Temp
3	20160227	Temp
2	20160228	Temp
1		

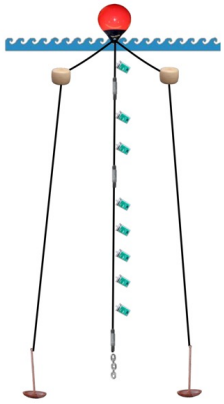
Temp = UA-002 temperature logger
Tenp* = UA-001 temperature logger



Summer Buoy

Meters from Top	Serial Number	Logger
-1	21372956	Temp
-2	10932891	Temp/DO
-3	21372957	Temp
-4	21372958	Temp
-5	10932892	Temp/DO
-6	21372959	Temp
-7	21372960	Temp
-8	10932893	Temp/OD
-9	21372961	Temp
-10	21372962	Temp
-11	21372963	Temp

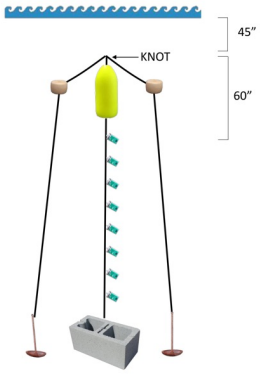
Temp = UA-002 temperature logger



Winter Buoy

Meters from Bottom	Serial Number	Logger
11		
10		
9	21372963	Temp
8	21372957	Temp
7	21372958	Temp
6	21372956	Temp
5	21372959	Temp
4	21372960	Temp*
3	21883777	Temp
2	21372961	Temp
1		

Temp = UA-002 temperature logger
Tenp* = UA-001 temperature logger



WLA volunteers collected manual temperature and dissolved oxygen profiles (using YSI DO meters) and Secchi disk transparency readings bi-weekly from April – October 2022 (Table 1).

In addition to the above measurements, integrated epilimnetic cores (a column of water taken from the surface of the lake, through the epilimnion (biologically active area) to the upper part of the thermocline (where the water temperature changes rapidly) were extracted monthly during the 2022 season (see Table 1 for dates). The thermocline was determined based on the Secchi disk, temperature and dissolved oxygen readings on the day of sampling. These core samples represent an average of lake water quality and were analyzed for trophic state indicators (total phosphorus and chlorophyll-a) and chemical parameters (total alkalinity, pH, and color). In addition to the core sample, grab samples from the bottom of the lake were taken using a Kemmerer Bottle (1.2 L PVC, Silicone) sampler on the same dates (Table 1 above). Immediately after sampling, all samples were driven to the Health and Environmental Testing Laboratory (HETL) in Augusta, ME for analyses.

Page Brook Monitoring

Page Brook was monitored at the sampling station just downstream from the Route 113 bridge near the Outpost Restaurant. This sampling station is located far enough upstream from the brook's outlet to the lake in order to minimize the impact of any mixing with lake water. The brook was monitored for dissolved oxygen and temperature and total phosphorus (analyzed at HETL) as indicated in Table 1 above.

Results

Weather

Weather has a major effect on the water quality of a lake. A summary of the weather conditions from Jan-2022 to Oct-2022 is given below.

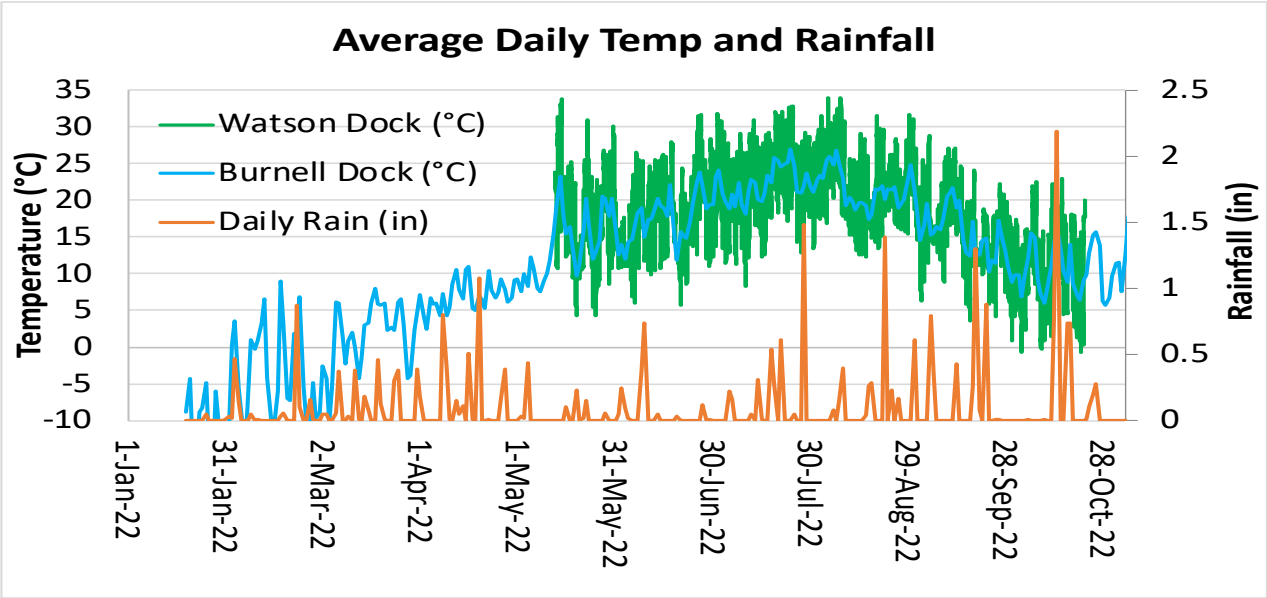
Ice-in and Ice-out time can affect water quality by increasing/decreasing the growing season for algae in the lake. Data available is shown in Table 2. This year's early ice-out (28-Mar-22) coupled with a late ice-in date (21-Dec-21), made the 2021/22 winter the third year in a row where Watchic Lake was frozen for less than 100 days.

Table 2: Ice-in/Ice-Out Dates

YEAR	ICE-OUT	ICE-IN	Ice-free Days	Frozen days
2008	20-Apr-08	Not Recorded		
2009	10-Apr-09	Not Recorded		
2010	9-Mar-10	Not Recorded		
2011	17-Apr-11	Not Recorded		
2012	19-Mar-12	Not Recorded		
2013	10-Apr-13	Not Recorded		
2014	16-Apr-14	Not Recorded		
2015	12-Apr-15	Not Recorded		
2016	13-Mar-16	Not Recorded		
2017	15-Apr-17	15-Dec-17	244	
2018	22-Apr-18	13-Dec-18	235	128
2019	16-Apr-19	17-Dec-19	245	124
2020	23-Mar-20	31-Dec-20	283	97
2021	27-Mar-21	21-Dec-21	268	86
2022	28-Mar-22	28-Dec-22	275	98

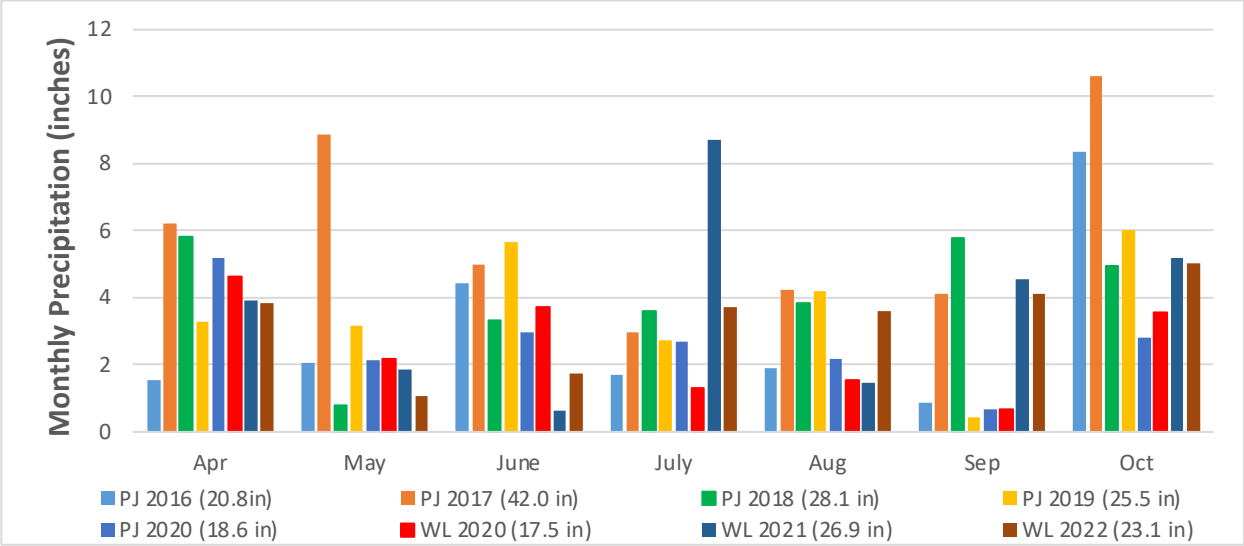
The average daily air temperature and precipitation recorded at the local weather station (Burnell dock) and the temperature from the HOBO logger (Watson dock) are shown in Figure 4. Temperatures in both locations on the lake were very similar.

Figure 4: Average Daily Air Temperature and Precipitation



The total monthly precipitation recorded is presented in Figure 5. 2022 was a moderate year for rain (23.1 inches from April to October). Spring (May and June) were dry this year (with only 2.8 inches of rain combined). In contrast, July - October each had 3.6-5.0 inches.

Figure 5: Monthly Precipitation at Watchic Lake



PJ=Portland Jetport; WL=Watchic Lake (Burnell Dock)

Water Sampling - Lake

Temperature and Dissolved Oxygen

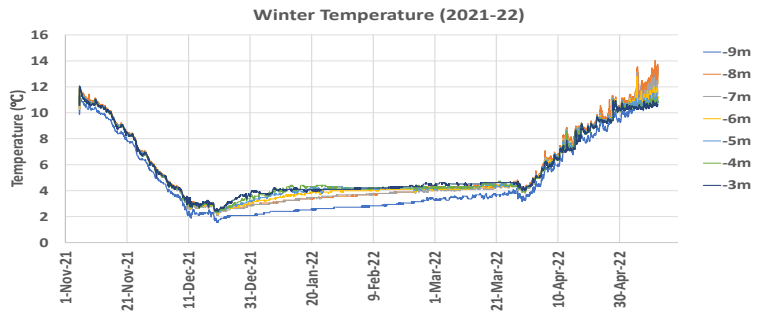
Figure 6A shows the water temperature at 1-meter intervals during the Winter (5-Nov-2021 to 12-May-2022) at the Deep Spot of Watchic Lake. Depths are measured 2m from the bottom of the lake upwards, with higher numbers representing locations closer to the surface of the lake (*e.g.*, 8m). Fall turnover (when the lake mixes top to bottom), occurred on ~27-Oct-21, eliminating the lake's temperature and DO stratification. Water temperatures continued to

drop through 21-Dec-21 to 3°C. Ice-in was 21-Dec-21. Water temperatures remained below 5°C until late March, then the water began to warm. Ice-out was 28-Mar-22 and the lake started to warm up through April, stratifying briefly in mid-April. Spring turnover occurred ~3-May-22.

Figure 6Bi show the water temperature at 1-meter intervals during the Summer buoy configuration with collection from 13-May-2022 to 22-Oct-2022. In this configuration, depths are measured from the top of the lake downward, with larger negative numbers representing locations closer to the bottom of the lake (e.g. -11m). Consistent with past years, the temperature at the bottom of the lake remained constant at ~10°C while the top warmed up during the season. Lower depths continued to warm into September. Fall turnover did not appear to be complete by 22-Oct-22. Data collected bi-weekly using the YSI meters (Figures 6Bii) are consistent with those from the continuous loggers (Figures 6Bi).

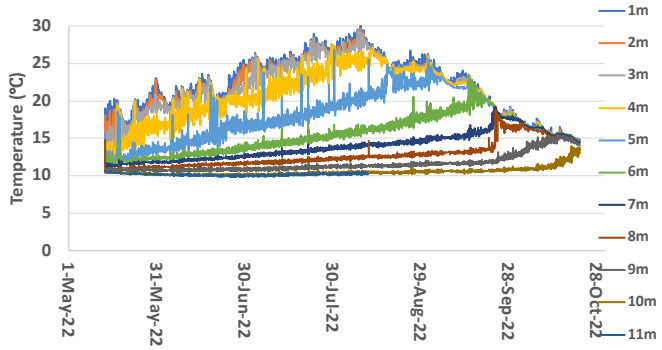
Figure 6: Water Temperature

A: Winter – HBO Loggers 5-Nov-2021 to 12-May-2022 (distance from bottom)

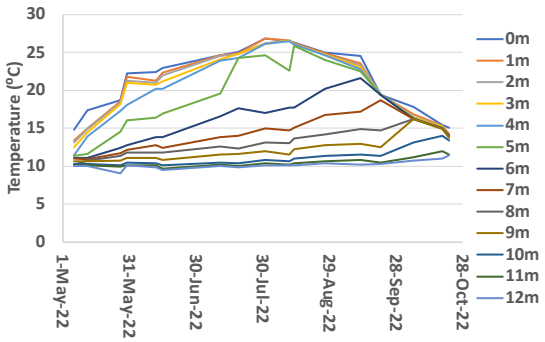


B: Summer – May-2022 to Oct-2022

i: Logger Summer Water Temperatures



Ii: YSI meter Summer Water Temperatures

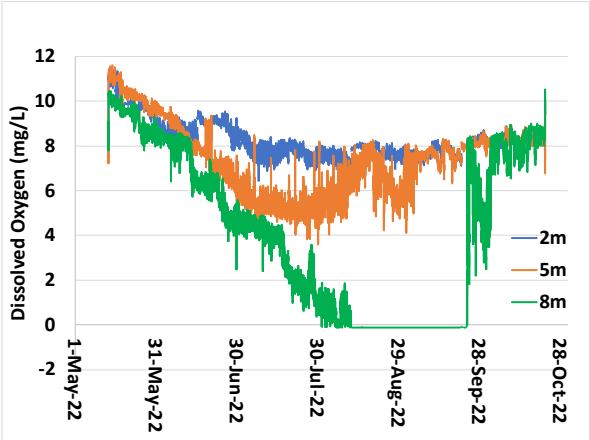


The dissolved oxygen (DO) pattern observed this 2022 season is similar to those seen in recent years. For the most part, oxygen levels are high, and fairly uniform throughout the water column on 6-May, however thereafter DO measured at 12m immediately dropped below 1ppm and remained there throughout the season (Figure 8B). As the season progressed, the deeper water systematically became oxygen depleted (as evidenced by the declining slopes of the curves). By mid-July, depths of ≥10m are below 2mg/L of oxygen. This depletion extends to ≥9m by the 31-Jul and to ≥7m by 29-Aug. The lack of oxygen at the bottom of the lake is known

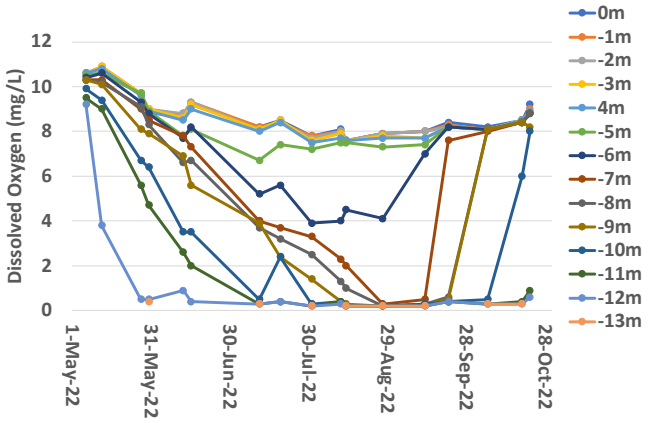
to restrict fish species that require colder water to survive, and may also cause phosphorus bound at the bottom of the lake to be released into the water column. This phosphorus can fuel further algae growth.

Figure 8: Dissolved Oxygen

A : HOBO© Loggers



B : YSI meters



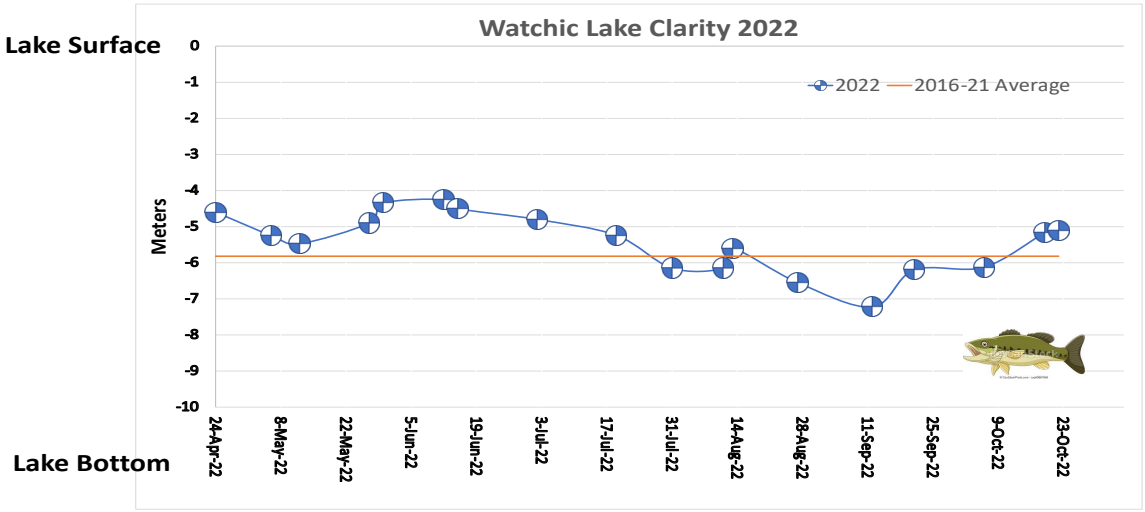
Trophic State indicators

Trophic state indicators (water clarity, total phosphorus, and chlorophyll-a) reflect the biological productivity (*e.g.*, algae growth) of lakes.

Water Clarity

Water clarity (how far you can see down into the water) is measured using a Secchi disk. Figure 9 shows the readings this year and the historical average for the years 2016-2021. The DEP Mesotrophic Water Clarity Acceptable Range is -4 to -8m. The average of all Secchi disk readings for 2022 was -5.4m, which is slightly lower than the 2016-2021 average (-5.8m).

Figure 9: Watchic Lake Secchi Disk Readings



Phosphorus and Chlorophyll-A

Phosphorus in the key nutrient for algae growth in lakes, while chlorophyll-A is a direct measurement of the amount of plant material, mostly algae, in the water.

To sample the most productive part of the lake (relative to algae growth), an epicore sample (a column of water collected from the surface through the epilimnion (usually about 5-6m down in Watchic Lake) was obtained each month at the deepest spot of the lake (WLA buoy). The results represent the average biological and chemical conditions in Watchic Lake.

The 2022 total phosphorus (TP) and chlorophyll-A (Chl-A) results are presented in Table 4. An unusual TP reading was obtained on 15-Jul-22. Averages are calculated with and without this value. Average TP values for 2022 are similar to those obtained in 2016-21 (Table 5). Chl-A was slightly lower than the average, but individual values are within the min/max values recorded between 2016-2021.

Table 4: 2022 Water sampling results

Station	Date Sampled	Core Depth (m)	Bottom (ft)	pH	Color (PCU)	Chl-a (ppb)	Alk. (ppm)	TP (ppb)
WATC-5040-01	15-Jun-22	5.0	41.0	6.3	22.0	3.0	7.0	15.0#
WATC-5040-01	19-Jul-22	5.0	41.0	6.2	15.0	3.0	7.0	8.0
WATC-5040-01	11-Aug-22	5.0	41.0	6.5	13.0	2.0	7.0	7.0
WATC-5040-01	21-Sep-22	6.0	40.0	6.5	12.0	2.0	8.0	6.0
Annual Mean		5.3	40.8	6.4	15.5	2.5	7.3	9.0#
Annual Mean#								7.0
Annual Median		5	41	6.4	14	2.5	7	7.5#
Annual Median#								7.0

***** ppb-parts per billion, ppm-parts per million, PCU-platinum-cobalt units
#Value of 15ppb is aberrant, without that data point, annual mean and median would be 7.0 and 7.0, respectively.

Table 5: Average Water sampling results for 2016-2021

Year	Core Depth (m)	pH	Color (PCU)	Chl-A (ppb)	Alk (ppm)	Total Phos (ppb)
2016	6.8	6.5	12.8	2.9	7.3	7.9
2017	5.8	6.5	22.1	4.1	6.8	8.1
2018	5.3	6.8	14.6	3.3	7.0	7.3
2019	5.2	7.0	21.0	3.8	6.5	7.5
2020*	5.8	7.0	14.8	3.3	6.9	5.4
2021	5	6.8	18.1	3.6	6.8	7.1
2022#	5.3	6.4	15.5	2.5	7.3	7.0
Average 2016-22	5.8	6.7	17.1	3.5	6.9	7.2

Max 2016-22	8	7.1	26.5	6.2	8	15#
Min 2016-22	5	5.9	10	1.8	6	3

*** no Jun/Jul sample, Aug-Sep only; # Average TP value without 15ppb used.**
ppb-parts per billion, ppm-parts per million, PCU-platinum-cobalt units

In addition to the epicore samples, a sample was obtained from the bottom of the lake and analyzed for total phosphorus (TP, Table 6). Results suggest that there is considerably more total phosphorus at the bottom of the lake than at the top (thermocline). There are historical bottom grab TP results dating back to 1978, with the most comprehensive data coming between 1998-2001. From 1998-2001, most samples were obtained from a 10m depth and had an average TP value of 18.3ppb and a range of 7-31ppb. We have settled on a sample depth of 11.5m based on consultation with Scott Williams from Lakes Stewards of Maine (LSM). The average bottom grab TP this year was 16.4 ppb (less than values in recent years).

Table 6: 2022 Bottom Grab Total Phosphorus Samples

Station	Date Sampled	Depth (m)	TP (ppb)
WATC-5040-01	12-Aug-19	13	63
WATC-5040-01	25-Sep-19*	12.5	30
WATC-5040-01	25-Sep-19*	12.5	30
WATC-5040-01	10-Aug-20	12.5	94
WATC-5040-01	3-Sep-20*	11	26
WATC-5040-01	3-Sep-20*	11	33
WATC-5040-01	29-Sep-20	12	45
WATC-5040-01	18-Jun-21	11.5	25
WATC-5040-01	16-Jul-21	11.5	28
WATC-5040-01	17-Aug-21	11.5	36
WATC-5040-01	17-Sep-21	11.5	39
WATC-5040-01	19-Jul-22	11.5	12
WATC-5040-01	11-Aug-22	11.5	17
WATC-5040-01	21-Sep-22	11.5	20

*** duplicates**
ppb-parts per billion

Chemical Parameters

In addition to TP and Chl-A, pH, alkalinity and color were measured in the monthly core water samples (Table 5 above). All 3 parameters were fairly constant throughout the sampling time period (Jun-Sep), and similar to historic value.

Water Sampling - Tributaries

Temperature, dissolved oxygen and total phosphorus were measured in Page Brook in July, August and September. The results are shown in Table 7. Results are similar to historic values.

Table 7: 2022 Monitoring of Page Brook

Station	Date Sampled	Temp (°C)	DO (ppm)	TP (ppb)
Page Brook-01	19-Jul-22	20.6	4.4	48
Page Brook-01	11-Aug-22	19.1	5.3	48
Page Brook-01	19-Sep-22	13.3	7.0	20
Yearly Averages	2016	16.9	5.6	32.0
	2017	17.0	6.0	29.1
	2018	17.0	5.5	26.3
	2019	16.0	4.7	36.5
	2020	19.0	4.4	57.8
	2021	16.7	6.0	27.3
	2022	17.7	5.6	38.7
Average 2016-22		17.2	5.5	34.6
Max 2016-22		22	7.3	100
Min 2016-22		11.5	3.8	15

Conclusions and Recommendations

Based on monitoring performed by the Watchic Lake Water Quality Volunteers in 2022, the water quality of Watchic Lake remains good and is not substantially changed from data collected over the previous 6 years (2016-2021).

While water quality is good today, Watchic Lake remains at risk over the long term. For example, low oxygen levels at the lower depths of the lake again this summer, and the high total phosphorus levels from the bottom of the lake are of concern. The biggest risks to the lake are nutrients from storm run-off and invasive plants. Homeowners must continue to be diligent to protect the lake by stopping storm run-off entering the lake through their property and always remove plant and other organic material from boats and fishing gear.

Recommendations for Continued Water Monitoring

Based on observations this year and historical data from 2016-2021, the following efforts should be continued and/or intensified:

Observation	Recommendation
Loss of oxygen in the lower depths	Continue bottom grab TP sampling
	Consider TP grab samples at various depths
Logger Maintenance	Replace faulty 10m Temperature logger
YSI meters give similar data to Loggers	Consider not replacing loggers in future. Also, delay in deploying loggers would not substantially change interpretation of Lake Quality Data
Quick identification of potential problems is needed. Residents know their area best	Encourage lake residents to be observant and report anomalies to Water Quality Committee or Board member

General Recommendations for Lake Users to maintain and improve Water Quality

- Become LakeSmart by controlling phosphorus-laden sediment in runoff with best management practices (BMPs).
- Avoid using fertilizers, herbicides, and pesticides within 150 feet of lake, ponds, and streams.
- Leave duff and grass clippings; minimize lawn area and cut grass to no less than 3 inches.
- Pump septic system every 3-5 years and keep leach field clear of trees. Inspect systems more than 20 years old. Maine Law requires septic inspection upon sale of property.
- Reduce household chemical and phosphorus-based product use.
- Wash car and boat in area where runoff is absorbed into the ground.
- Use oil-absorbing pillow or 'bilge snakes' to prevent pollutants from entering the lake via inboard motors.
- Store gas and oil in approved secondary containers and dispose at local repair shops. Clean fluid leaks with cat litter.
- Remove fishing line from water and use lead-free lures.
- Dispose of pet waste in trash or toilet.

Recommendations for Lake Users to avoid the spread of Invasive Plants and other Species

Follow the CLEAN, DRAIN, DRY procedures to prevent the spread of Invasive Species

- **Clean** off visible aquatic plants, animals, and mud from all equipment before leaving a body of water.
- Rinse equipment, boat hulls (with high pressure, when possible), interior compartments and flush motor. Use hot water (120°F) when possible.
- **Drain** motor, bilge, livewell, and other water containing devices before leaving water access.
- **Dry** everything for at least 5 days OR wipe with a towel to dry before reuse.
- **Dispose** of any unwanted bait, worms and fish parts in the TRASH.
- If CLEAN, DRAIN, DRY was not done prior to leaving a body of water, ensure that it is done BEFORE entering a new body of water. Be sure to perform the CLEAN and DRAIN activities well away from any body of water.

GLOSSARY OF KEY TERMS

Chlorophyll-a (Chl-A): A measurement of the green pigment found in plants, including microscopic plants like algae. It is used as an estimate of algae biomass; higher Chl-A equates to greater concentration of algae in the lake.

Color: A measure of the influence of suspended and dissolved particles in water from weathered geologic material, vegetation cover, and land use activity. Colored lakes (>25 platinum-cobalt units -PCU) can have reduced water clarity and increased phosphorus concentrations.

Dissolved Oxygen (DO): The concentration of oxygen dissolved in water. Adequate oxygen is critical to the healthy metabolism of many creatures that reside in the water. DO levels in lake water are influenced by a number of factors, including water temperature, amount of algae and other plants in the water, and the amount of nutrients and organic matter that flow into the waterbody from the watershed. DO concentrations may change dramatically with lake depth. Oxygen is produced in the top portion of a lake (where sunlight drives photosynthesis), and oxygen is consumed near the bottom of a lake (where organic matter accumulates and decomposes).

Epilimnion: The top layer of lake water that is directly affected by seasonal air temperature and wind. This layer is well oxygenated by wind and wave action during summer. It extends to 5-7 meters below the surface in Watchic Lake.

Escherichia coli (E. coli): An indicator of harmful pathogens from fecal contamination that can derive from a number of mammalian sources, including human, canine, and wildlife.

Eutrophication: Process by which lakes become more productive over time. Lakes with high productivity have high levels of phosphorus and chlorophyll-a, low water clarity, and abundant biomass with significant accumulation of organic matter on lake bottom. Eutrophic lakes are susceptible to algae blooms and severe oxygen depletion in the hypolimnion. Lakes naturally become more productive or "age" over thousands of years. In recent geologic time, however, humans have enhanced the rate of enrichment and lake productivity, speeding up this natural process to tens or hundreds of years.

Fall Turnover: The process of complete lake mixing when cooling surface waters become denser and sink, forcing lighter, less-dense water to the surface. This process is critical for the natural exchange of oxygen and nutrients between surface and bottom layers in the lake.

Hypolimnion: The bottom-most layer of the lake. It experiences periods of low oxygen during stratification and is devoid of sunlight for photosynthesis. Watchic Lake experiences low oxygen in summer from 7 meters to the bottom at 12 meters.

Integrated Epilimnetic Core: A water sample that is taken with a long tube to determine average nutrient concentration from the lake surface to the top of the thermocline.

pH: The standard measure of the acidity or alkalinity of a solution on a scale of 0-14. Most aquatic species require a pH between 6.5 and 8. As the pH of a lake declines, particularly below 6, the reproductive capacity of fish populations can be greatly impacted as the availability of nutrients and metals changes. pH is influenced by bedrock, acid rain or snow deposition, wastewater discharge, and natural carbon dioxide fluctuations.

Secchi Disk Transparency (SDT) or Water Clarity: A vertical measure of water transparency (ability of light to penetrate water) obtained by lowering a black and white disk into the water until it is no longer visible. Measuring water clarity is one of the most useful ways to show whether a lake is changing from year to year. Changes in water clarity may be due to increased or decreased algae growth or the amount of dissolved or particulate materials in a lake, resulting from human disturbance or other impacts.

Spring Turnover: The process of complete lake mixing following ice-out when surface waters are exposed to wind action, bringing oxygen to the bottom and nutrients to the top of the water column.

Summer Stratification: The development of a thermal barrier that separates warm surface waters from dense, cool bottom waters. Without oxygen replenishment from the surface, bottom-dwelling organisms rapidly consume oxygen throughout the summer and early fall.

Thermocline: The markedly cooler, dynamic middle layer of rapidly changing water temperature. The top of this layer is distinguished by at least a degree Celsius drop per meter of depth.

Total Alkalinity: A measure of the buffering capacity of a lake (*i.e.*, the capacity of water to neutralize acids). The buffering capacity or the concentration of bicarbonate, carbonate, and hydroxide ions in water, is largely determined by the geology of soils and rocks surrounding the lake. Total alkalinity above 20 ppm buffers against drastic changes in pH that could impact aquatic plants and animals.

Total Phosphorus (TP): The total concentration of phosphorus found in water, including organic and inorganic forms. Phosphorus is one of the limiting nutrients needed for plant growth; as phosphorus increases, the amount of algae generally increases. Humans can add excess phosphorus to a lake through stormwater runoff, lawn or garden fertilizers, and leaky or poorly-maintained septic systems.

Trophic State Indicators: Are indicators of biological productivity in lake ecosystems, including water clarity, total phosphorus, and chlorophyll-a. The combination of these parameters helps determine the extent and effect of eutrophication in lakes, and helps signal changes in lake water quality over time.

Watershed: An area of land that drains water to the outlet of a stream, river, or lake.

Winter Stratification: The development of a physical ice barrier and snowpack layer that limit the exchange of oxygen and nutrients between surface and bottom waters. A layer of ice forms at the lake surface, protecting waters below from frigid temperatures and wind storms. Cold winters with significant snowpack can block sunlight and limit photosynthesis that would otherwise replenish the lake