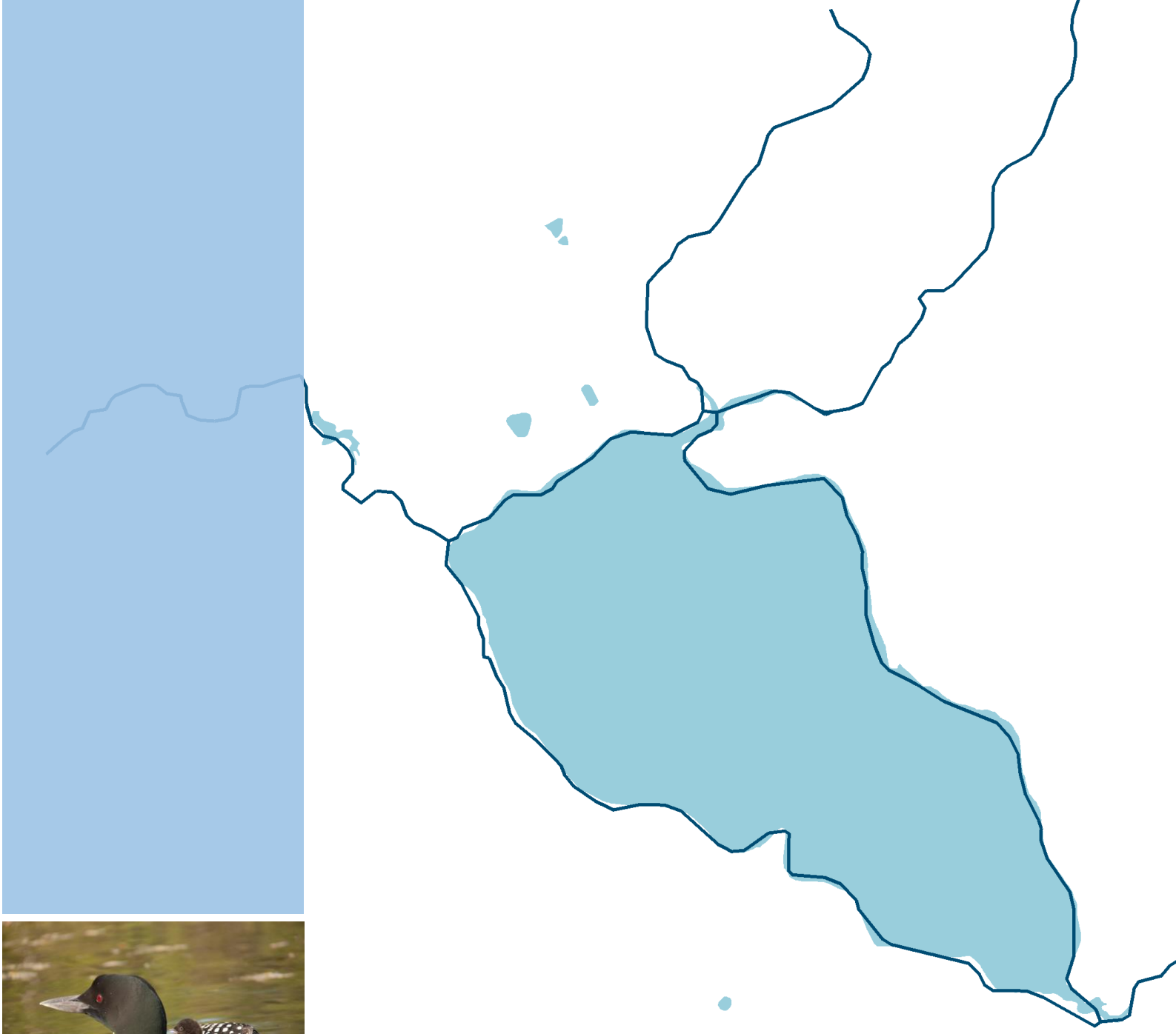


WATCHIC LAKE

2016 WATER QUALITY REPORT

PREPARED BY

FB Environmental Associates
97A Exchange Street, Suite 305
Portland, Maine 04101
Designed by L. Diemer, FBE

SUMMARY AND REPORT TOPICS

TAKE HOME #1

Watchic Lake water quality is overall **VERY GOOD**, but watch out for:

- **LOW OXYGEN**
- **INTERNAL P LOADING**
- **LOW PH**

TAKE HOME #2

Stream water quality entering Watchic Lake is generally **FAIR**, because of:

- **LOW OXYGEN**
- **LOW PH**
- **ELEVATED NUTRIENTS**

LAKE RISK FACTORS

While water quality is good today, Watchic Lake remains at risk over the long term. Ever increasing **human activities** within the watershed can increase the amount and transport of harmful pollutants and dangerous foreign materials into the lake and its streams. **Catastrophic events** such as mega-storms put roads, drainages, and septic systems at risk of introducing toxic runoff. Property owners and other stakeholders must continue to work to address these risks, in order to avoid algal blooms, excessive plant growth, and uncontrolled shoreline erosion.

TOP RECOMMENDATIONS | MINIMIZE POLLUTED RUNOFF

☑ **ADDRESS AND MAINTAIN TOP IDENTIFED RUNOFF RISK AREAS** which currently include:

1. Kiwanis Club Beach Area and Access
2. Watchic Rd 21
3. Hi-Vu Drive northern end (2016)
4. Watchic Rd 19
5. Watchic Terrace
6. Dorothy Drive boat ramp (2016)

☑ **MINIMIZE POLLUTION** by eliminating use of fertilizers, herbicides, and pesticides, recycling and disposing of hazardous materials properly, composting yard waste, picking up pet waste, and maintaining septic systems.

☑ **REDUCE STORMWATER RUNOFF** by vegetating bare soil, maintaining or enhancing buffers, diverting runoff to vegetation for infiltration, and minimizing lawn and parking areas.

☑ **DEVELOP A WATERSHED MANAGEMENT PLAN** that records and summarizes water quality conditions, sets a water quality goal, plans for catastrophic events, and details next steps for improvements.

Watchic Lake Association

HELP PROTECT THE LAKE

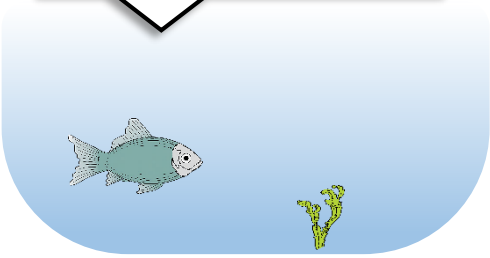
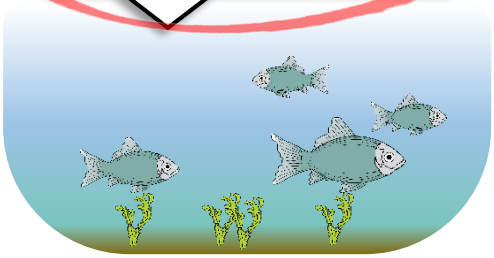
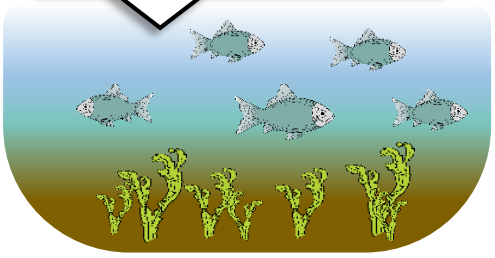
LEARN MORE AT HTTP://WATCHICLAKE.ORG/

WATER QUALITY PRIMER

LEARN MORE ABOUT LAKE HEALTH

Lake productivity changes naturally over time. The **DEGREE OF LAKE PRODUCTIVITY** is determined by multiple factors, including water clarity, phosphorus, chlorophyll-a, plant growth, and dissolved oxygen in bottom waters.

WATCHIC LAKE

OLIGOTROPHIC	MESOTROPHIC	EUTROPHIC
		
Deep Water Clarity	Reduced Water Clarity	Shallow Water Clarity
Low Phosphorus	Moderate Phosphorus	High Phosphorus
Low Chlorophyll-a	Moderate Chlorophyll-a	High Chlorophyll-a
Minimal Plant Growth	Moderate Plant Growth	Abundant Plant Growth
High Oxygen Throughout Entire Water Column	Occasional Oxygen Depletion in Bottom Waters	Frequent Oxygen Depletion in Bottom Waters

NATURAL VS. HUMAN EUTROPHICATION

Lakes naturally age or become more productive over thousands of years. In recent geologic time, humans have enhanced the rate of nutrient enrichment and lake productivity, speeding up this natural process to tens or hundreds of years.

Excess phosphorus enters the lake in eroding sediment, groundwater (e.g. aging septic systems), or stormwater runoff, which contains fertilizers, detergents, or other phosphorus-based products.

Decomposition of excess algae and plant material depletes oxygen in the lake, leading to fish kills. Low oxygen in bottom waters can also release phosphorus back into the water column.

INTERNAL P LOADING

DEFINITIONS

WATER CLARITY is 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. Water clarity is used as an indirect measure of algal productivity.

PHOSPHORUS is a key nutrient that stimulates algal blooms and excessive plant growth, particularly for invasive species.

CHLOROPHYLL-A is a measurement of the green pigment found in plants, and is used as an estimate of algal biomass.

COLOR measures the influence of suspended and dissolved particles in water from weathered geologic material, vegetation cover, and land use activity. Colored lakes (>25 PCU) can have reduced water clarity and increased phosphorus concentrations.

DISSOLVED OXYGEN is a measure of the amount of oxygen dissolved in water. Low oxygen can kill or stress organisms and release phosphorus from bottom sediments.

Algal blooms and uncontrolled sediment erosion along the shoreline can decrease water clarity, which can reduce shoreline property values.

WATER QUALITY PRIMER

LEARN MORE ABOUT LAKE HEALTH

DEFINITIONS

pH is a 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; outside of this range, the reproductive and metabolic functions of most species become compromised.

TOTAL ALKALINITY is a measure of the capacity of water to neutralize acids and 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.

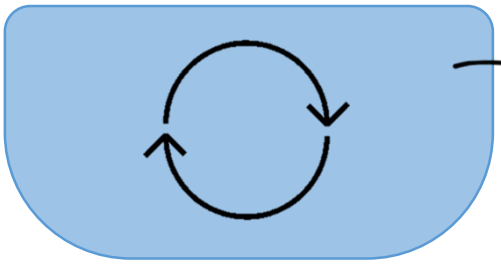
E.COLI is an indicator of harmful pathogens from fecal contamination that can derive from a number of mammalian sources, including human, canine, and wildlife.

WATERSHED is the drainage area or basin in which all land and water drain or flow toward a central collector, such as a stream, river, or lake.

WATER DENSITY

The density of water varies with temperature and is most dense at 4°C; this unique property allows ice at 0°C (freezing point) to be less dense than liquid water, and thus, ice floats above the water surface. Without this property, lakes in winter would freeze from the bottom-up, killing all aquatic life.

SPRING TURNOVER

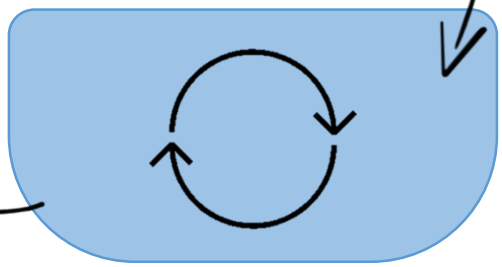


Winter ice melts, exposing surface waters to wind action. A little wind will completely mix the lake, bringing oxygen to the bottom and nutrients to the top.

SUMMER STRATIFICATION

Summer air temperatures warm the surface of the lake, creating 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.

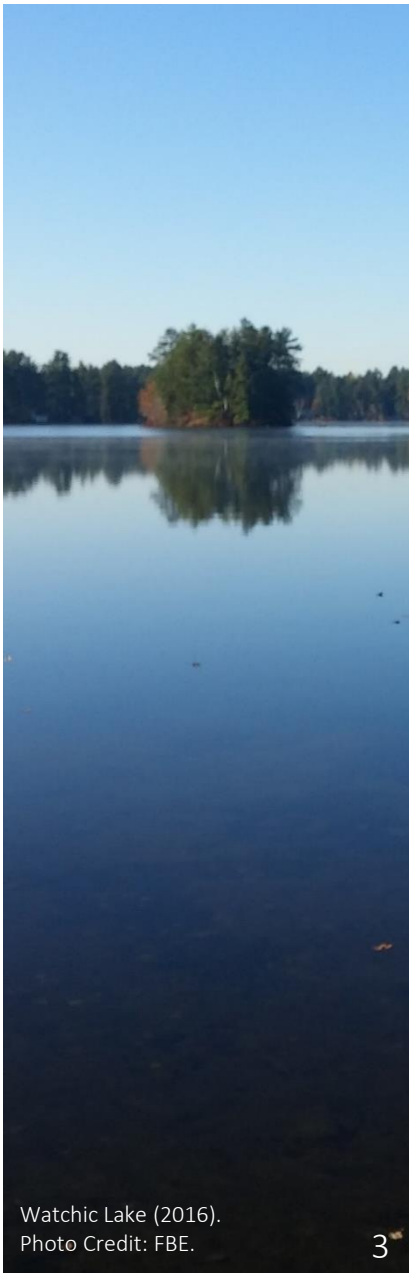
FALL TURNOVER



Fall air temperatures cool the surface of the lake, causing its density to increase; the heavier water sinks, forcing the 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.

WINTER STRATIFICATION

A layer of ice forms at the lake surface, protecting waters below from frigid temperatures and storms. Cold winters with significant snowpack can block sunlight and limit photosynthesis that would otherwise replenish the lake with oxygen throughout the winter. This can result in fish kills.



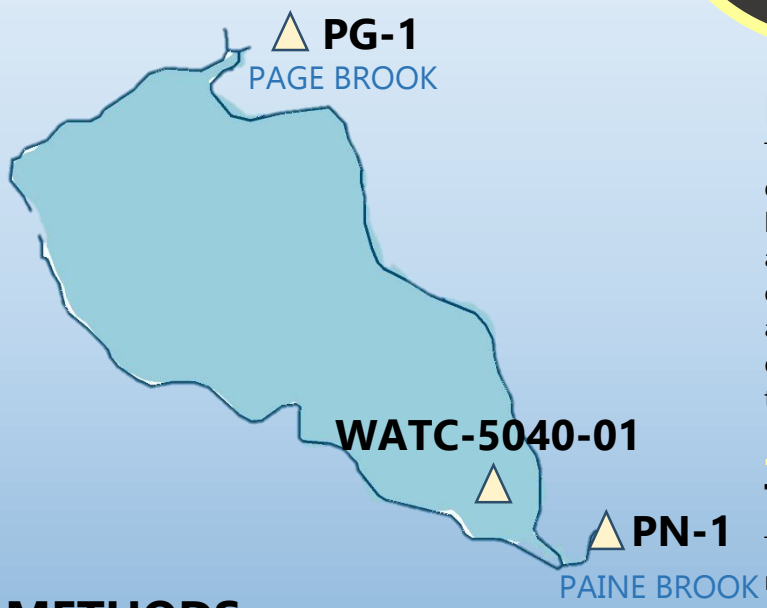
Watchic Lake (2016).
Photo Credit: FBE.

WATCHIC LAKE REPORT

METHODOLOGY

PARAMETERS MEASURED

Secchi Disk Transparency (Water Clarity), Dissolved Organic Carbon (DOC), Total Dissolved Nitrogen (TDN), Total Phosphorus (TP), Dissolved Oxygen (DO), Chlorophyll-a (Chl-a), Temperature, Alkalinity, Color, *E.coli,* pH

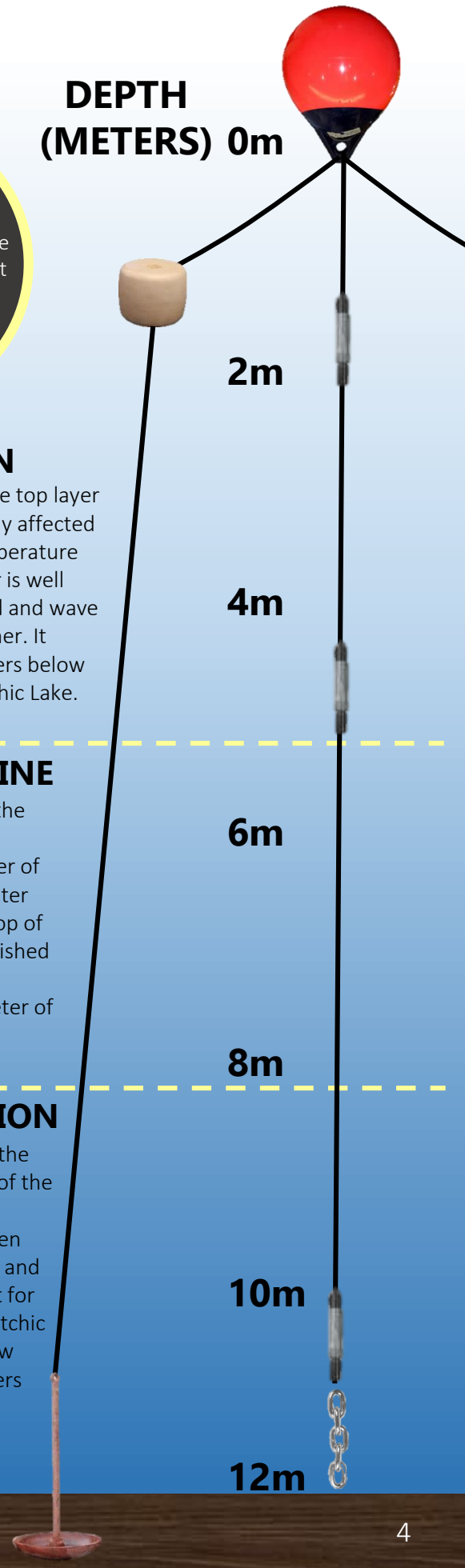


METHODS

FBE, with assistance from WLA, collected DO/temp profiles, Secchi disk readings, and epilimnetic core samples from the deep spot (WATC-5040-01) of Watchic Lake, as well as surface grabs from two tributaries, Page (PG-1) and Paine (PN-1) Brooks, on four sampling dates throughout the summer. Sampling was conducted in accordance with standard methods and procedures for lake monitoring established by the Maine DEP, USEPA, and Maine VLMP. Samples were analyzed at HETL in Augusta, ME and UNH WQAL in Durham, NH.

FBE also deployed three Onset HOBO dissolved oxygen loggers at the deep spot (WATC-5040-01) from May-October. The loggers were placed at 2, 5, and 11 meters below the surface. These depths equate to critical layers in the water column, which becomes thermally stratified in summer. The loggers were cleaned and downloaded during each sampling event. Logger data presented in the report shows interpolated data for the entire water column using R statistical program.

Dissolved oxygen and temperature profiles are collected to determine where the epilimnion (or upper part of the thermocline) occurs and at what depth a core should be taken.



EPILIMNION

The epilimnion is the top layer of lake water 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.

THERMOCLINE

The thermocline is 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.

HYPOLIMNION

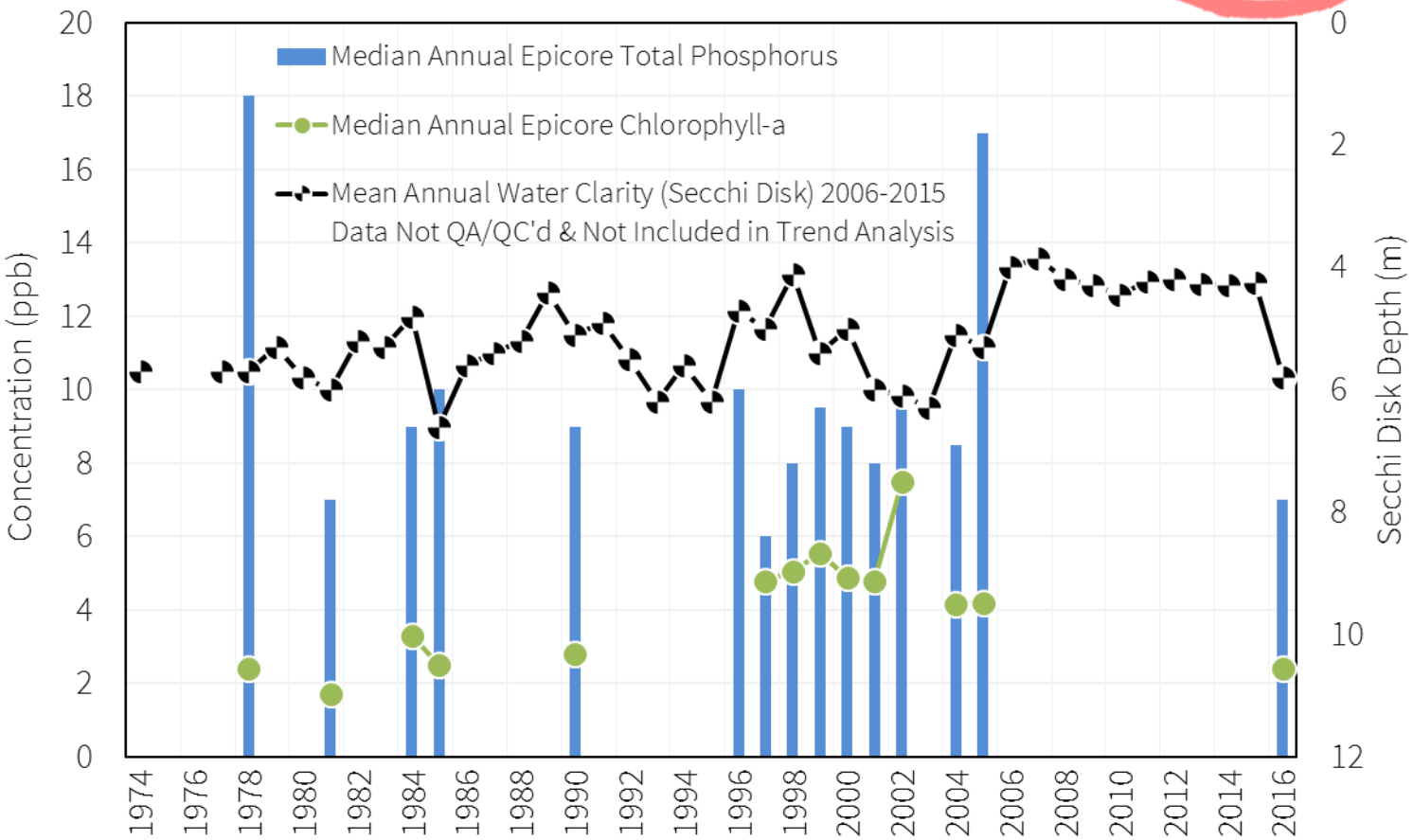
The hypolimnion is the bottom-most layer of the lake. It experiences periods of low oxygen during stratification and is devoid of sunlight for photosynthesis. Watchic Lake experiences low oxygen from 7 meters to the bottom at 12 meters.

TROPHIC STATE INDICATORS

WATCHIC LAKE RESULTS

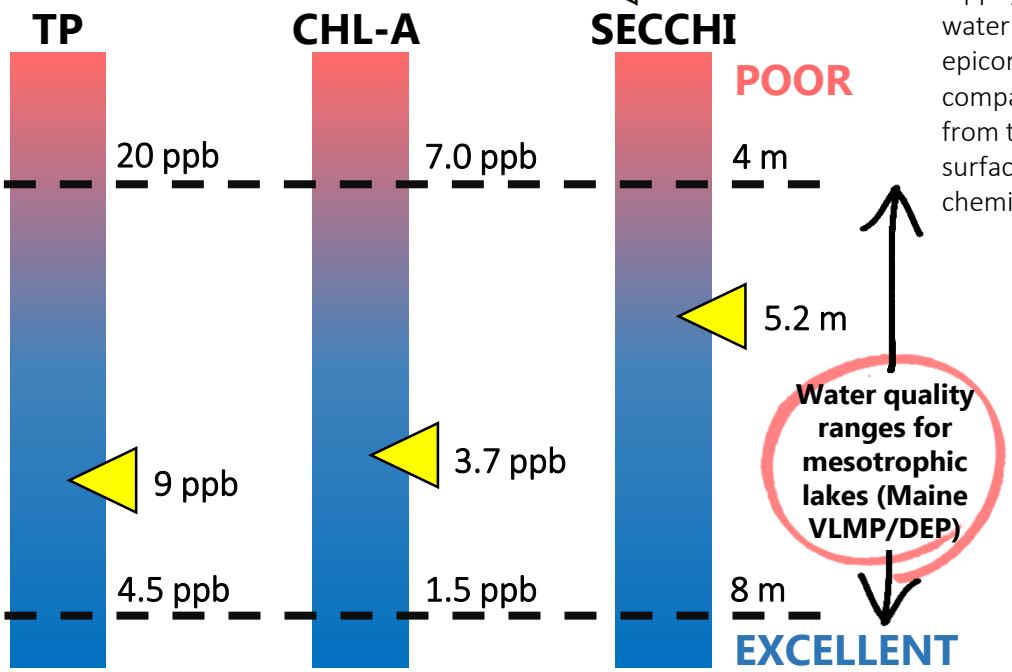
Water clarity, total phosphorus, and chlorophyll-a are **TROPHIC STATE INDICATORS**, or indicators of biological productivity in lake ecosystems. The combination of these parameters helps determine the extent and effect of **EUTROPHICATION** in lakes, such as Watchic Lake, and helps signal changes in lake water quality over time.

Mann-Kendall trend tests were performed on all parameters with more than 10 years of data. No statistically significant improving or degrading trends were found.



WATCHIC LAKE CURRENT CONDITION

ALL DATA (1974-2016), SEASONAL (May 24-Sept 15). ◀ = WATCHIC MEDIAN



MISSING YEARS: WLA collected surface grab samples of TP from 2006-2015 (median = 8 ppb). The newly re-established baseline water quality monitoring program collects epicore samples of TP and Chl-a to accurately compare to historical data. Samples collected from the entire epilimnion (not just the surface) better represent biological and chemical conditions in Watchic Lake.

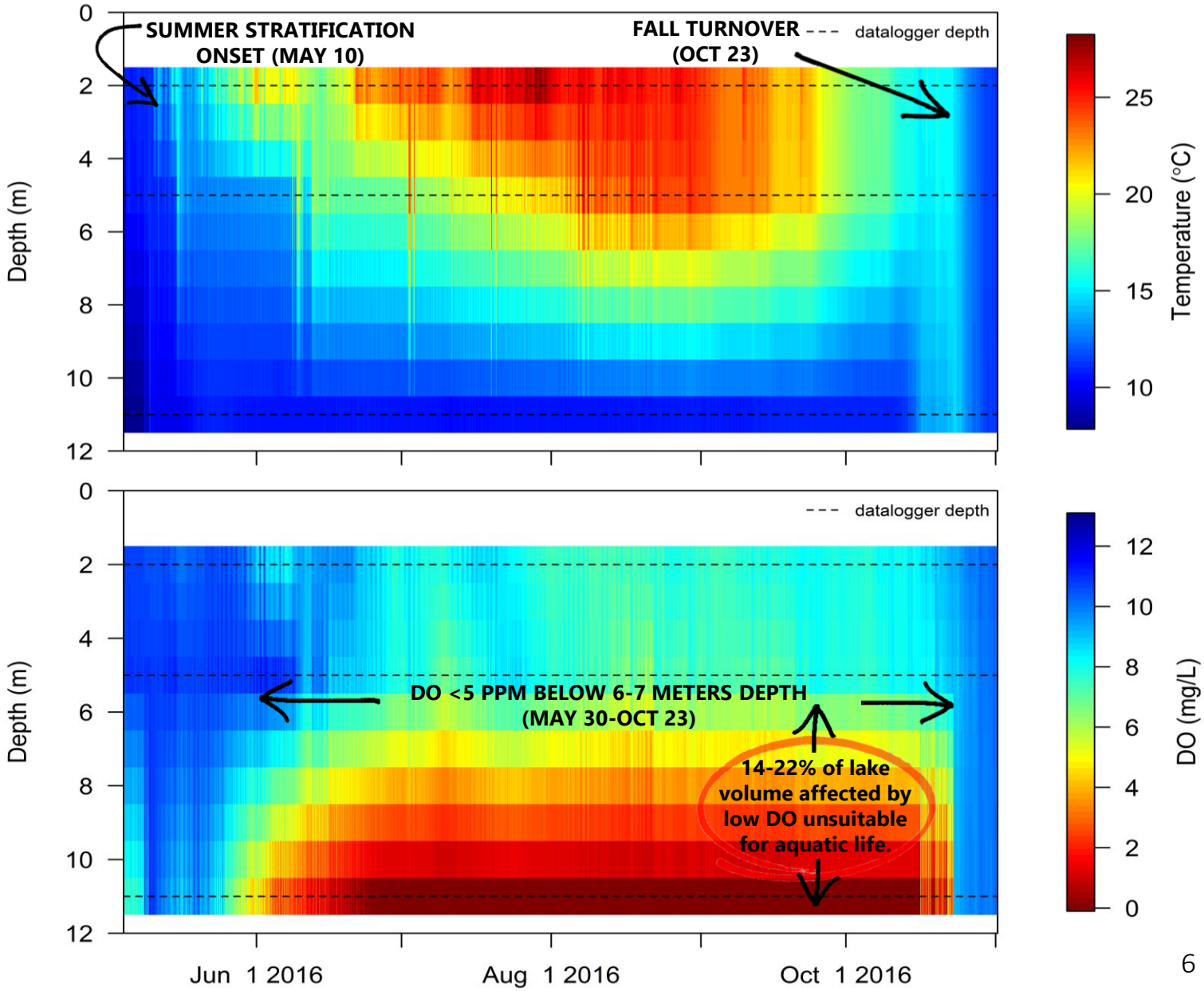
OVERALL, WATER QUALITY IS VERY GOOD FOR WATCHIC LAKE.

DISSOLVED OXYGEN & TEMPERATURE

WATCHIC LAKE RESULTS

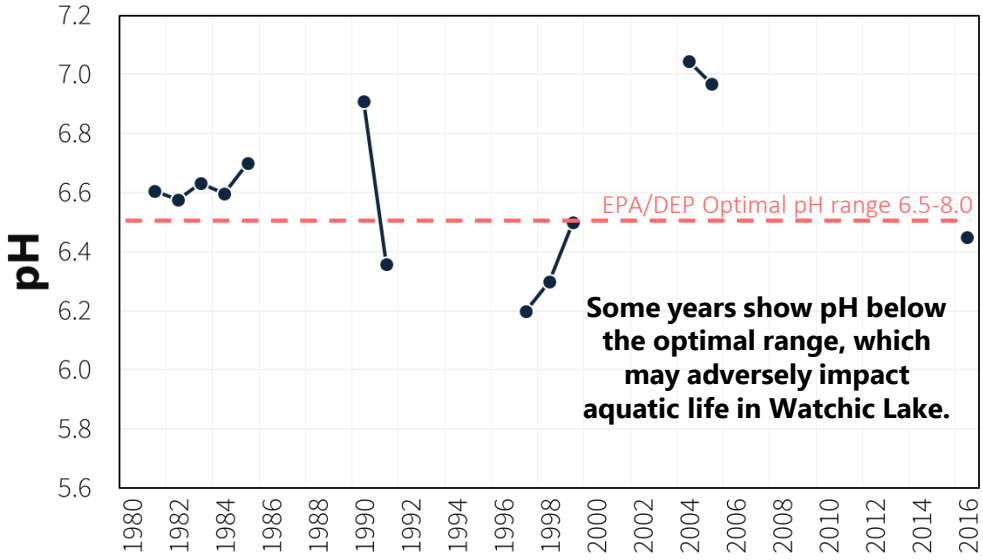
The figures below show water temperature (top figure) and dissolved oxygen (bottom figure) throughout the water column (surface at 0 meters to bottom at 12 meters) at the deep spot in Watchic Lake (WATC-5040-01) from May to October 2016. Water temperature and dissolved oxygen were monitored continuously every 30 minutes using loggers deployed at 2, 5, and 11 meters below the surface (denoted by the dashed lines). Ice-out was particularly early this year, so the loggers were deployed after spring turnover, but we were able to pinpoint the onset of summer stratification (May 10) and fall turnover (Oct 23), as well as see the duration and extent of low oxygen throughout the summer (low oxygen occurred below 6-7 meters depth from May 30-Oct 23, affecting 14-22% of lake volume).

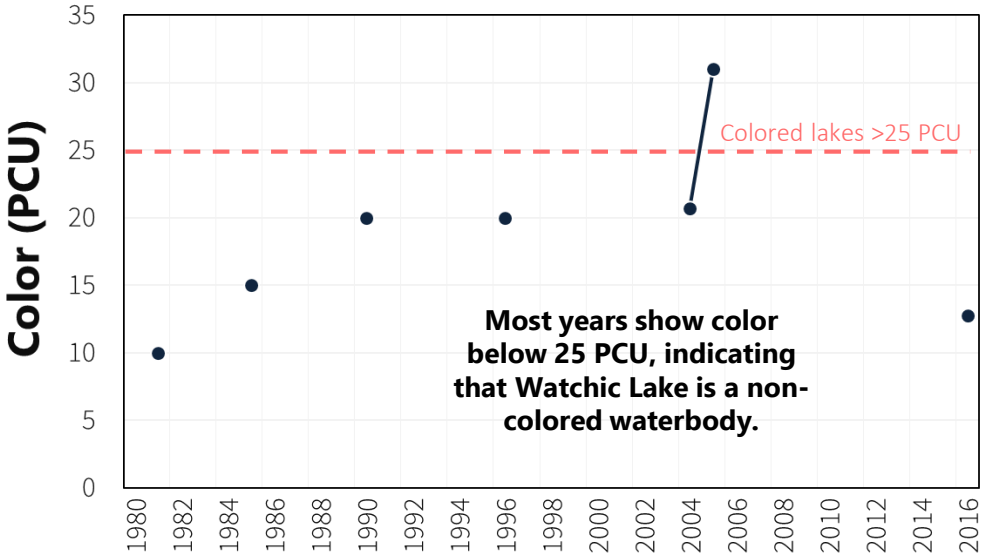
WHY DOES IT MATTER? It is important to track temperature and oxygen throughout the water column because both greatly affect the amount of suitable habitat for aquatic life in the lake. A barrier of low oxygen (< 5 ppm) prevents fish from seeking refuge in cooler, bottom waters when surface waters heat up in summer. You can see in the figures below that warmer waters extend down to 6-7 meters below the surface from August-September; this area overlaps with low oxygen waters that extend from the bottom up to 6-7 meters below the surface during the same time. While thermal stratification and depletion of oxygen in bottom waters is a natural phenomenon, it is important to keep tracking these parameters to make sure the extent and duration of low oxygen does not change drastically as a result of human disturbance. Additionally, low oxygen at the bottom sediment-water interface causes a chemical reaction that releases phosphorus back into the water column to serve as food for algae, which can degrade water quality in Watchic Lake.

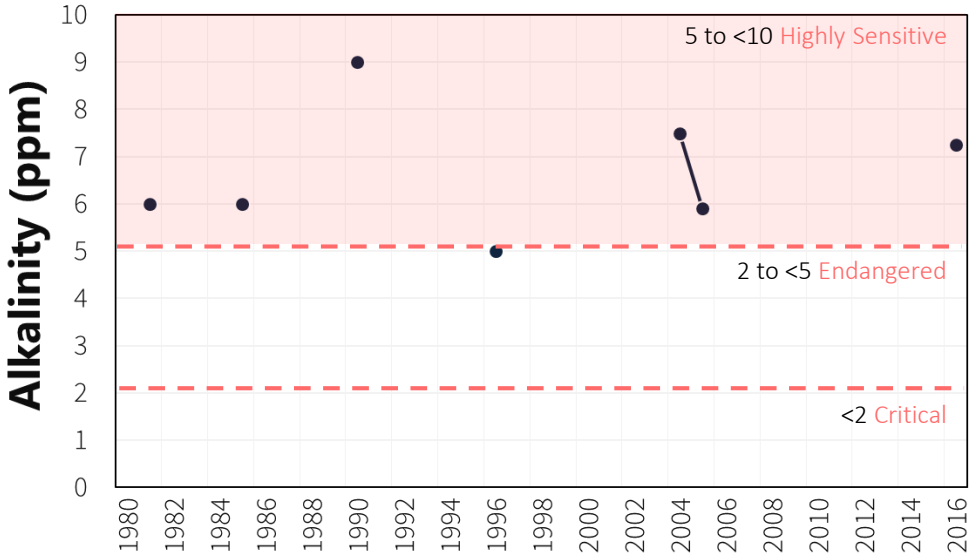


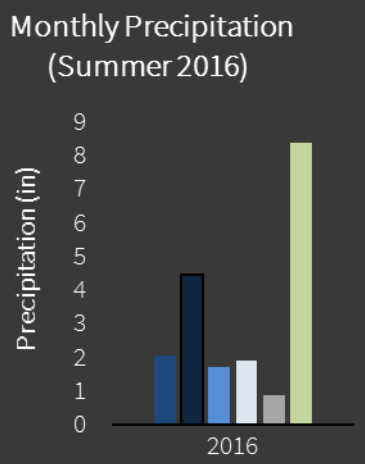
CHEMICAL PARAMETERS

WATCHIC LAKE RESULTS









May	2.04
June	4.43
July	1.7
August	1.9
September	0.86
October	8.36

Data obtained from NOAA NCDC Portland Jetport weather station.

Abnormally dry summer conditions (as experienced in 2016) reduce the amount of runoff (containing sediment and nutrients) entering the lake from the watershed, resulting in improved water quality (deeper Secchi readings, lower phosphorus, and lower chlorophyll-a).

Typical of granite-dominated landscapes in NH and ME, alkalinity in Watchic Lake is classified as **HIGHLY SENSITIVE**. This means that the lake is more susceptible to changes in pH. Since these levels are natural, no action is needed until there is a discernable degrading trend.

Mann-Kendall trend tests were performed on all parameters with more than 10 years of data. No statistically significant improving or degrading trends were found.

STREAM WATER QUALITY

- Both streams have issues with **LOW OXYGEN** and **LOW PH**, both of which can inhibit the growth and reproductive health of fish and other aquatic species.
- **ELEVATED NUTRIENTS** (phosphorus and nitrogen) show typical human-impacted levels for semi-rural watersheds in New England.
- See Recommendations for ways to improve water quality.

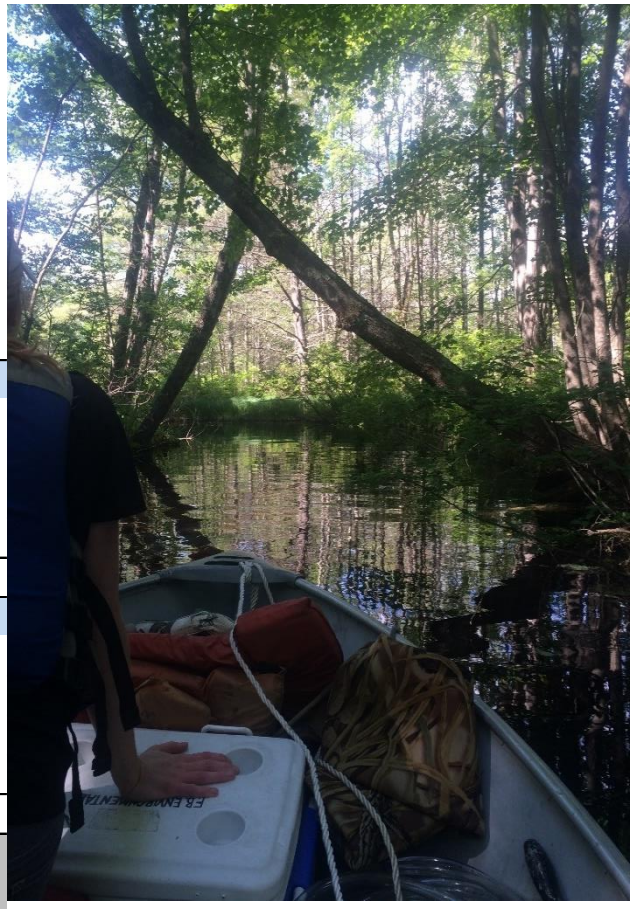
Date	Site Code	Temp (°C)	DO (mg/L)	DO Sat. (%)	pH
Paine Brook					
6/14/2016	PN-1	11.3	8.6	79	5.6
7/21/2016	PN-1	15.7	6.3	64	5.6
8/24/2016	PN-1	15.2	5.9	58	5.8
9/20/2016	PN-1	16.2	5.2	53	5.7
2016 Average		**14.6**	**6.5**	**64**	**5.7**
Page Brook					
6/14/2016	PG-1	11.5	6.9	64	5.2
7/21/2016	PG-1	18.4	5.2	56	5.6
8/24/2016	PG-1	18.8	5.8	62	5.7
9/20/2016	PG-1	18.8	4.4	50	5.7
2016 Average		**16.9**	**5.6**	**58**	**5.5**
State Criteria/EPA Guidelines for Class B Freshwater Streams in Ecoregion VIII		£ 24	³ 7.0	³ 75	£ 8.0; ³ 6.5

Date	Site Code	E. coli (per 100 ml)	TP (ppb)	DOC (ppm)	TDN (ppm)
Paine Brook					
6/14/2016	PN-1	76	19	4.5	0.46
7/21/2016	PN-1	34	20	1.9	0.37
8/24/2016	PN-1	60	17	2.7	0.25
9/20/2016	PN-1	537	18	1.4	0.31
2016 Average		**96**	**19**	**2.6**	**0.35**
Page Brook					
6/14/2016	PG-1	62	32	6.1	0.28
7/21/2016	PG-1	21	39	6.3	0.34
8/24/2016	PG-1	16	31	5.2	0.24
9/20/2016	PG-1	6	26	4.1	0.23
2016 Average		**19**	**32**	**5.4**	**0.27**
State Criteria/EPA Guidelines for Class B Freshwater Streams in Ecoregion VIII		£ 64 (geo) / 236 (single) col/100mL	£ 10	NA	£ 0.38

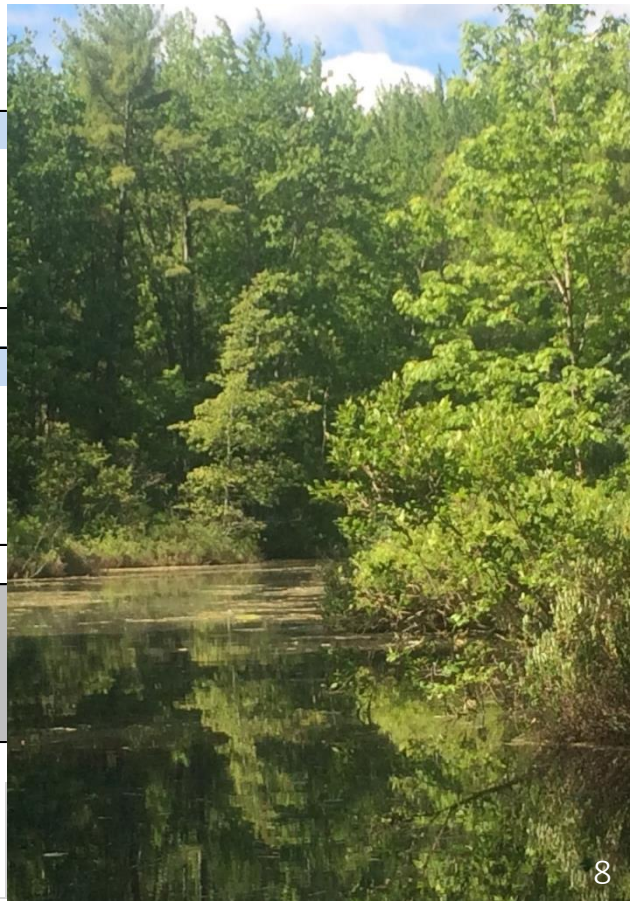
Red text indicates results below good water quality guidelines

DO = dissolved oxygen; DO Sat. = dissolved oxygen saturation; TP = total phosphorus; DOC = dissolved organic carbon; TDN = total dissolved nitrogen

PAGE BROOK (PG-1)



PAINE BROOK (PN-1)



WATCHIC LAKE WATER QUALITY SUMMARY

WATCHIC LAKE

⊕ Trophic state indicators (total phosphorus, chlorophyll-a, and water clarity) show that water quality in Watchic Lake is overall very good.

⊗ Low oxygen (< 5 ppm) in the summer months is making 14-22% of lake volume unsuitable habitat for aquatic life. This oxygen depletion is caused by the decomposition of organic matter (i.e., dead algae and plant matter) that has settled on the lake bottom. Low oxygen can cause a chemical reaction that releases phosphorus back into the water column to fuel more algal growth (thus generating a positive feedback to eutrophication). While it is difficult to remedy what has already been done, the best way to combat future worsening of oxygen depletion in Watchic Lake is to limit the amount of nutrient input to the lake and streams.

⊗ pH in the lake is on the lower, acidic end of the acceptable range for aquatic life, and low alkalinity means that the lake is not well-buffered against environmental factors that may cause significant changes in pH. Since these levels are natural, no action is needed until there is a discernable degrading trend.

STREAMS INTO WATCHIC LAKE

⊕ Both streams exhibited low fecal indicator bacteria (*E.coli*) counts (aside from a single high reading in Paine Brook, which could be from human and/or wildlife sources). Further monitoring is needed.

⊗ Both streams experienced low oxygen and low pH, which can negatively impact the growth and reproductive health of aquatic life. (Note: Paine Brook was generally cooler and had higher oxygen concentrations than Page Brook because cooler water can hold more oxygen.) Low oxygen and low pH can be the result of natural or human sources, but are likely from human sources considering the elevated nutrient levels measured in the streams.

⊗ Nutrients (nitrogen and phosphorus) were elevated in both streams, indicating human pollution from septic systems, fertilizers, surface runoff, etc. Paine Brook showed higher nitrogen, while Page Brook showed higher phosphorus and carbon. An analysis of land use may help determine differences in nutrient sources draining to each stream.

RECOMMENDATIONS FOR WATCHIC LAKE

LAKE USERS | REDUCE RUNOFF

☑ 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 3 inches.

☑ Pump septic system every 3-5 years and keep leachfield clear of trees. Inspect systems >20 years old.

☑ Reduce household chemical and P-based product use.

☑ Wash car and boat in area where runoff is absorbed into the ground.

☑ Become LakeSmart by controlling phosphorus-laden sediment in runoff with best management practices (BMPs).

☑ 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.

EXPAND MONITORING

☑ Continue established 2016 baseline monitoring of the lake and streams. Data will help WLA understand short and long-term variations in lake chemistry and take action to remediate any degrading trends in water quality.

☑ Develop a watershed management plan for the lake that summarizes water quality conditions, sets a water quality goal, and details next steps for improvements.

☑ Consider collecting bottom grab samples of phosphorus in August and September to monitor and quantify the impact of internal P loading as a result of low oxygen conditions.

☑ Consider collecting one profile and epicore sample in February to assess the impact of winter stratification on oxygen and nutrients throughout the water column.

☑ Consider deploying data loggers in the streams to capture continuous water quality information on specific conductivity, dissolved oxygen, temperature, and flow.

WAYS TO PROTECT WATCHIC LAKE

Reduce, divert, and infiltrate surface runoff.

Minimize and define parking areas and pathways.

Stabilize shoreline access points through vegetation or riprap.

Minimize pollutants (e.g., fertilizers, detergents, and other phosphorus-based products.

Maintain shoreline, streamside, and wetland buffers.

Photo credit: FBE, AWWA, SOAK UP the Rain

FOR MORE INFO, VISIT

WATCHICLAKE.ORG

PREPARED BY

FB Environmental Associates
97A Exchange Street, Suite 305
Portland, Maine 04101
Designed by L. Diemer, FBE

2016 WATER QUALITY RESULTS

ATTACHMENT 1

Lake	Date Sampled	Station	Core Depth (m)	Bottom (ft)	pH	Color (PCU)	Chl-a (ppb)	Alk. (ppm)	TP (ppb)	NPOC (ppm)	TDN (ppm)
Watchic Lake											
5040	6/16/2016	1	6	39.6	6.4	17	4.8	7	11.0	4.20	0.18
5040	7/21/2016	1	6	39.4	6.5	14	2.6	7	7.0	4.29	0.25
5040	8/24/2016	1	7	39.8	6.5	10	2.2	7	6.5	4.41	0.17
5040	9/20/2016	1	8	39.5	6.4	10	2.2	8	7.0	4.32	0.20