About the Harvey Lake Watershed, 2019

Our watershed land area includes approximately 1,500 acres (by comparison, Northwood Lake's watershed is 15,384 acres, and Jenness Pond's is 1,837 acres). Our flushing rate is 2.7, which means the volume of water in the lake (1.3 million cubic meters) changes over 2.7 times per year. By comparison, Northwood Lake's flushing rate is 3.9 for its volume of 8.5 million cubic meters of water, and Jenness Pond's is 1.6 for its volume of 2.5 million cubic meters of water. The size of each lake: Harvey, 105 acres; Northwood, 687 acres; and Jenness, 232 acres. Pleasant Lake, which has a better trophic classification than the previous three lakes, is 493 acres in a watershed land area of 2,240 acres, with a flushing rate of 0.4 for its water volume of 14 million cubic meters. This lake is much deeper than the three others (7 – 20 meters) as opposed to Harvey Lake (3 – 6 meters); Northwood Lake (also 3 to 6 meters) and Jenness Pond (2.7 to 8.5 meters).

	Lake size (acres)	Watershed size (acres)	Water volume (meters^3) / Flushing rate	Mean Depth
Harvey Lake	105	1,500	1.3 million / 2.7	3 m
Northwood Lake	687	15,384	8.5 million / 3.9	3 m
Jenness Pond	232	1,837	2.5 million / 1.6	2.7 m
Pleasant Lake	493	2,240	14.0 million / 0.4	7 m

Our latest results are in line with what we have been witnessing for many years at Harvey Lake. We are a high-phosphorous lake in comparison to other New Hampshire lakes (The state median for phosphorous is 12 ug/L.) Harvey Lake consistently shows results much higher at the inlet than at the outlet. The June 2019 results show a phosphorous content of 37.9 ug/L at the inlet on Harmony Road and a phosphorous content of 25.0 ug/L at the outlet on Harvey Lake Road. In the lake itself, the phosphorous content ranges from 18 to 25 ug/L in the upper layer. The most recent reading on June 23 was 22.1 ug/L. The lake uses phosphorous (considered the "limiting nutrient") as a food source for plant life and algae blooms. Seeing lower readings where the water exits the lake indicates the lake is utilizing this phosphorous and may explain why some years we see an abundance of algae blooms and bladderwort. We have also flirted with cyanobacteria blooms (Last year's wasn't high enough to trigger a state advisory.) Because our lake originates from a wetland – basically a marsh – we will probably always have high phosphorous readings due to decomposing vegetative matter, animal activity, and runoff.

Water Quality Test Results, 1990 - 2019

Date	Chl.-A	Transparency	Phos/inlet	Phos/dam	Phos/deep (EPI)	Dis. Oxy.	Color	ANC	Conductivity	Turbidity
7/10/1990	9.76 ug/L	1.8 m	44 ug/L	32 ug/L	20 ug/L	0.0				
8/31/2005			41 ug/L	26 ug/L	28 ug/L					
2006										
9/24/2007			35 ug/L	25 ug/L	18 ug/L					
8/11/2009			29 ug/L	22 ug/L	24 ug/L					
8/11/2011			50 ug/L	68 ug/L	15 ug/L					
8/15/2013			27.5 ug/L	21.2 ug/L	16.3 ug/L					
8/16/2016	8.6 ug/L		61.8 ug/L	19.0 ug/L	11.6 ug/L					
7/23/2017	7.98 ug/L	1.55 m	87.9 ug/L	20.2 ug/L	19.3 ug/L					
2017 ave.	7.98	1.45-2.58	65	19	20		125	6.2	126.6-142.6	.66 – 3.66
6/10/2018		1.5 m	29.4 ug/L	23.3 ug/L	18.5 ug/L			6.2	135.3-222	
7/15/2018		1.68 m	51.4 ug/L	36.1 ug/L	17.0 ug/L		90	6.1	150.8-197.3	
8/14/2018	9.51	1.27 m	27.2 ug/L	23.8 ug/L	20.9 ug/L		150	6.7	135.3-157.6	
6/23/2019	2.16	1.75 m	37.9 ug/L	25.0 ug/L	22.1 ug/L	na	100	7	116.9 – 139.9	.51 – 1.85
8/1/2019										

Note:

State median for phosphorous is 12 ug/L for N.H. lakes.

A 2006 report noted chlorophyll-A levels at Harvey Lake are higher than the state median of 4.58 mg/$m^{3.}$ Our Chl-A results were called “slightly bad” in a 2016 report.

What the numbers mean

Chlorophyll-A: The median summer chlorophyll-a concentration for New Hampshire’s lakes and ponds is 4.58 mg/m3. Chlorophyll-a concentration measured in the water gives an estimation of the algal concentration or lake productivity. A high chlorophyll-a level indicates that an algal bloom may be occurring. Historical data (from a 2006 report) show that Harvey Lake’s chlorophyll-a reading is much greater than the state median and the similar lake median. Our concentrations the past few years have been in the area of 5.24 to 9.51. This latest reading in

June was 2.16. Chlorophyll-a concentration has significantly increased (meaning worsened) on average by approximately 7.9 percent per year during the sampling period 1995 to 2006.

Transparency: Volunteer monitors use a Secchi disk to measure how far a person can see into the water. Transparency, a measure of water clarity, can be affected by the amount of algae and sediment in the water, as well as the natural color of the water. The median summer transparency for New Hampshire's lakes and ponds is 3.2 meters. Overall, the statistical analysis of the historical data shows that the non-viewscope transparency has significantly decreased (meaning worsened) on average by approximately 4.1 percent per year during the sampling period 1995 to 2006.

Phosphorous: The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 12 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L. Overall, the statistical analysis of the historical data shows that the phosphorus concentration in the epilimnion (upper layer) and the hypolimnion (lower layer) has not significantly changed since monitoring began. Specifically, the epilimnetic phosphorus concentration has fluctuated between approximately 10.5 and 36 ug/L, and the hypolimnetic phosphorus concentration has fluctuated between approximately 15 and 52 ug/L since 1995.

Dissolved Oxygen: The presence of dissolved oxygen is vital to fish and amphibians in the water column and also to bottom-dwelling organisms. As stratified lakes age, and as the summer progresses, oxygen typically becomes depleted in the hypolimnion by the process of decomposition. In Harvey Lake, the dissolved oxygen concentration is much lower in the hypolimnion (lower layer) than in the epilimnion (upper layer) at the deep spot.

Chloride: The chloride ion (Cl-) is found naturally in some surface waters and groundwaters and in high concentrations in seawater. Research has shown that elevated chloride levels can be toxic to freshwater aquatic life. In order to protect freshwater aquatic life in New Hampshire, the state has adopted acute and chronic chloride criteria of 860 and 230 mg/L respectively. The chloride content in New Hampshire lakes is naturally low, generally less than 2 mg/L in surface waters located in remote areas away from habitation. Higher values are generally associated with salted highways and, to a lesser extent, with septic inputs. Our chloride readings have ranged from 21 to 30 mg/L, which is much less than the state acute and chronic chloride criteria. However, these concentrations are greater than what we would normally expect to measure in undisturbed New Hampshire surface waters.

Acid Neutralizing Capacity: Buffering capacity (ANC) describes the ability of a solution to resist changes in pH by neutralizing the acidic input. The median ANC value for New Hampshire's lakes and ponds is 4.9 mg/L, which indicates that many lakes and ponds in the state are at least "moderately vulnerable" to acidic inputs. The mean acid neutralizing capacity (ANC) of the epilimnion (upper layer) has been in the area of 4.3 to 7.0 mg/L. In addition, this indicates that the lake is moderately vulnerable to acidic inputs.

Ph (Acidity): pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 6.0 typically limits the growth and reproduction of fish. A pH between 6.0 and 7.0 is ideal for fish. At Harvey Lake, our

pH level have been measured over the years at the deep spot from 6.07 in the hypolimnion to 6.41 in the epilimnion, which means that the water is slightly acidic.

Conductivity: Conductivity is the numerical expression of the ability of water to carry an electric current, which is determined by the number of negatively charged ions from metals, salts, and minerals in the water column. The median conductivity value for New Hampshire's lakes and ponds is 40.0 uMhos/cm, and values above 100 indicate human disturbance. Conductivity has fluctuated in Harvey Lake and the inlet tributaries since monitoring began, but has generally been much greater than the state median. Typically, elevated conductivity levels indicate the influence of pollutant sources associated with human activities. The lake's proximity to Route 4 could be a factor (road salt). Our levels have ranged from 103.9 to 139.9, that highest reading in June of this year at the outlet.

Turbidity: The lake bottom is covered by a thick organic layer of sediment which is easily disturbed. When the lake bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. At Harvey Lake, the hypolimnetic turbidity has been elevated on several sampling events and has been at least slightly elevated on many sampling events during previous years. Our readings have been 0.51 to 0.60 at the upper layer of the deep spot and 1.85 to 4.18 at the inlet. The median for N.H. lakes is 1.0.

Rainfall is a major factor for our lake

An unusually large amount of rainfall in some years and resulting high groundwater and surface water levels during some springs and early summers causes the wetland systems in the area of the watershed to release phosphorus-enriched water into the tributaries, and ultimately into the lake. High amounts of rainfall can affect all our lake's numbers, with high volume leading to increased flushing, which can affect the amount of phosphorous leaving the lake, along with higher turbidity readings, conductivity, and transparency. Erosion and runoff, which can be minimized, affect our numbers. In years when we get very little rainfall, especially in summer, the water sits in the lake longer and can lead to elevated phosphorous numbers.

Concord, New Hampshire averages 40.69 inches of rain per year (U.S. average is 38 inches of rain per year) and averages 61 inches of snow per year. According to the website USClimateData.com, from January through August, Concord has had 28.02 inches of rain, which is about 8 inches less than average for the period. From May through August, our rainfall has been 13.83 inches. Average for this period is 14.29 inches.

What could happen?

One of the best descriptions of what could happen to a lake if natural and manmade forces create too much phosphorous in a lake was provided in a fact sheet from the state Department of Environmental Services:

Because a lake is a settling basin for a watershed, eventually everything on land higher than the lake and located around it ends up in the lake. Lake aging, or eutrophication, is a natural process that happens over thousands of years. The lake eventually fills in. This process can be accelerated by manmade processes.

As the lake fills, it becomes more shallow. A shallower lake has less water volume. Less water volume means less water to dilute incoming contaminants. Phosphorous instead of existing in unattached form, which usually exits the lake in diluted form, instead attaches itself to the increasing sand particles. More phosphorous increases plant growth - algae and possibly invasive plants as well as native plants. A shallower lake bed allows more sunlight to penetrate to the bottom, allowing the littoral zone (the area where plants can grow) to expand and produce more vegetation which when it dies, rots and adds more sediment to the lake. A shallower lake bed means less water, which will heat up faster in summer, and warmer water means less dissolved oxygen. Fish and animal life need that dissolved oxygen to survive. Fish also prefer stony lake beds for reproduction, and increased sand and sediment reduces that stony lake bed.

As you can see, a lake is a fragile ecosystem. A cascading effect is created by the gradual introduction of contaminants such as sand, fertilizers, and other sources of phosphorous.

Cyanobacteria

Cyanobacteria are normally present in freshwater lakes, usually in amounts that are not considered a problem. A small amount of the cyanobacterium Anabaena has been observed in annual water sampling at Harvey Lake and has not been considered a cause for concern. It is when these single-cell organisms expand and bloom that problems occur. The mechanism that causes a bloom is not completely understood, but high phosphorous levels and warm water temperatures are thought likely determinants of a bloom.

Last summer, cyanobacteria blooms were prevalent on many New Hampshire lakes. Harvey Lake had a surface scum along the shore – approximately 50 feet of shoreline - directly behind Coe Brown Academy on Sunday, July 1, 2018. The state DES biologist took a sample and the low concentration of cyanobacteria (Microcystis, Woronichinia and Anabaena) did not require posting an advisory. The state issues an advisory once the level of cyanobacteria reaches 70,000 cells/ml. That bloom was about 7,000 cells/ml.

Harvey Lake did have an advisory issued for a cyanobacteria bloom, last on June 8, 2009. It was reported on the western shore, not far from the boat ramp.

This summer, I have been keeping a close eye on the area behind Coe Brown and the Congregational Church for signs of a bloom, but so far have seen nothing suspicious.

We have a high amount of pondweed in the lake this year, especially in those two locations, and our water quality coordinator, Jennifer Boulanger, sent in a suspicious specimen to the exotic species coordinator in July, taken in the area of the inlet, but that turned out to be filamentous green algae, a common, native algae.

Late last summer, we had a high amount of bladderwort, also a native species.

If you do see a suspicious film and it looks like a cyanobacteria bloom, the state has a hotline: (603) 848-8094. If you can take a photo, that would be helpful, along with a specific location where seen. Email that info to beaches@des.nh.gov.

E. coli testing

We have tested intermittently for e coli (fecal bacteria) for several years. State standards for Class B waters (which includes Harvey Lake) specify no more than 406 e. coli counts/100nL in any one sample, and for designated beach areas (we are NOT part of the beach inspection program) the more stringent standard of 88 counts/100 mL applies. Over these amounts triggers a warning that is posted at the beach area (only in state-inspected beaches, not us).

We test only at the beach/boat ramp for e coli. Some results in the record over the years:

8/31/2005: 140 cts/100 mL; at the inlet: 270 cts/100 mL

8/8/2016 at the beach: 360 cts/100mL

6/11/2018 at the beach: 19.9 MPN/100mL

7/30/2018 at the beach: 770.1 MPN/100mL

8/14/2018 at the beach: 24.1 MPN/100mL

Other than the July 2018 reading, we have been in compliance for Class B waters when we test. The July reading could be an aberration due to the fact that it was a busy, hot day when we tested. No ducks were noted in the area, but several people, including children, were swimming, and boaters were putting in watercraft.

Our most recent test on June 23, 2019 showed a result of 110.6 MPN/100 mL. State standards for Class B waters (which includes Harvey Lake) specify no more than 406 e. coli counts/100mL in any one sample, and for designated beach areas (we are NOT part of the beach inspection program) the more stringent standard of 88 counts/100 mL applies. Over these amounts triggers a warning that is posted at the beach area (only at state-inspected beaches, not us).

E. coli tests are very specific: Any number of factors, from ducks, to children, to leaking septic systems, can affect the results.

While our June result of 110.6 MPN/100 mL is not alarming, it is concerning. If this were a state beach inspection area, the state would do another test and if the second result were over 88 MPN/100mL, would issue an advisory.

We conducted another testing on Aug. 1, but as of this date (Aug. 20) we have not received the results. If we become part of the state beach inspection program, we will have more immediate access to the test results. Right now, it takes up to two weeks for us to get the notification.

(I last asked for our inclusion in the program in 2007, but the budget was already created and selectmen indicated they could find money to pay for this, but there was no follow-up.)

To participate in the state's Beach Inspection Program, we need to ask selectmen for permission, perhaps (at the direction of our members) ask for money in next year's budget to participate, and then contact the state Beach Inspection Program to ask for our lake's inclusion in the program.