2009 Kezar Lake Water Quality Report

A REPORT ON THE WATER QUALITY OF KEZAR LAKE, 2 KEZAR LAKE TRIBUTARIES, AND 6 KLWA PONDS

November 2009

FB Environmental Associates, Inc.
97A Exchange Street, Suite 305
Portland, Maine 04101


Stoneham
Stow
Lovell
Stow
Fryeburg
Upper Bay
Middle Bay
Lower Bay
Gouin Rd
Joe McKeen Rd
Slide Inn Rd
Rattlesnake Island Rd
Birch Island
N End Ln
W Stoneham Rd
Bradley Pond Rd
Garcelon Ln
Cattail Dr
5
Horseshoe Pond Rd
Palmer Ln
Wessebago Rd
Peterson Camp Rd
Daffodil Ln
Heald Pond Rd
Slab City Rd
Westways Rd
Mine RdFoxboro Rd
Quite A Rd
Vinton Rd
Sabattus Rd
Clark Dr
Dragon Fly Rd
Stearns Rd
Tripp Rd
Arnington Rd
Hoss Hill Rd
New Rd
Wiley Rd
Tracey Ln
Fox Cove Rd
Ferris Rd
Nuthatch Rd
Timber Island Rd
Dallinger Rd
Sabattus Trail Rd
Kinipic Cir
Hedgehog Rd
Main St
S Barbour Rd
W Lovell Rd
Sattke Dr
Pleasant Point Rd
Eastman Hill Rd
Kelley Ln
Island Rd
5
Pit Rd
Widden Rd
Stone Ln
Swain Rd
N Lower Bay Rd
Shoestring Rd
Meadow Rd
Union Hill Rd
Loon Av
Old Stage Rd
Conifer Rd
Mountain View Pines Rd
Kezar Lake Rd
Allen Rd
Old Waterford Rd
Merrill Rd
Hartman Rd
Shave Hill Rd
Harbor Rd
Sampling Locations
Kezar Lake
Lovell, Maine
N
0
0.5
1 Miles
FB
environmental

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A report on the water quality of Kezar Lake, 2 Kezar lake tributaries, and 6 KLWA Ponds

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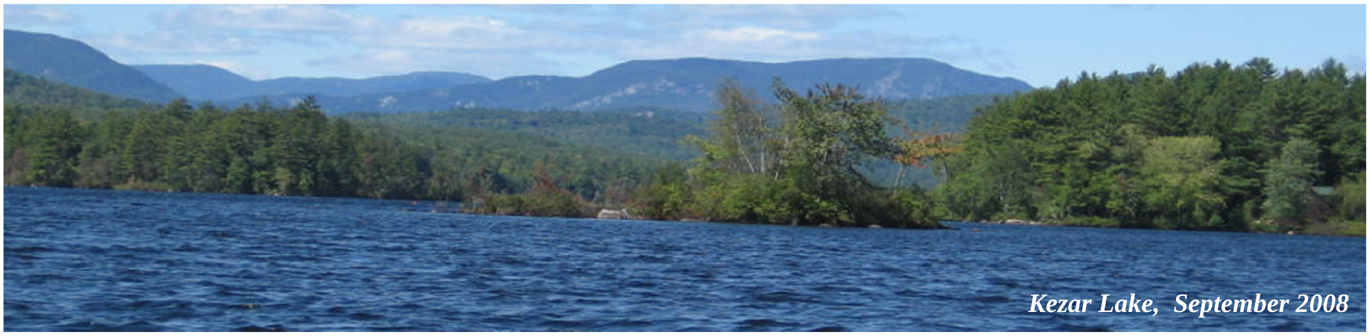


Kezar Lake, September 2008

FIGURES AND TABLES

1. Background and Historical Information

Kezar Lake Facts

- **Watershed:** Saco River
- **Surrounding Towns:** Lovell, Stow
- **County:** Oxford
- **Watershed Area:** 35,732 acres (56 mi^2)
- **Mean Depth:** 34 feet
- **Max Depth:** 155 feet
- **Surface Area:** 2,510 acres (3 mi^2)
- **Watershed Group:** Kezar Lake Watershed Association

Kezar Lake (Midas #0097) is a 2,510-acre non-colored waterbody located in Lovell in Oxford County, Maine. The lake stretches 9 miles from north to south, covering 2,510 acres (3 square miles) and has a maximum depth of 155 feet and a mean depth of 34 feet. Kezar Lake is located within the larger Saco River **watershed**.

Covering 35,732 acres (56 square miles) in the southwestern Maine towns of Lovell, Stoneham, and Stow, the Kezar Lake watershed, located in the foothills of the White Mountains, encompasses nine smaller ponds and numerous streams. These waterbodies are home to a variety of fish including landlocked salmon, large and small-mouth bass, lake trout, white perch, pickerel, and smelt. Kezar lake itself is a mixed warm- and cold-water fishery.

Upper Bay

Water quality monitoring data for the Kezar Lake upper basin (Station 1) has been collected since 1970. Since this time, 27 years of basic chemical information has been collected, in addition to 35 years of **Secchi disk transparencies (SDT)**. The water quality of the Kezar Lake upper basin is considered to be excellent, based on measures of SDT, **total phosphorus (TP)**, and **chlorophyll-a (Chl-a)**. The potential for nuisance algae blooms in the upper basin is very low.

Key Terms

- **Secchi disk transparency (SDT):** a vertical measure of the transparency of water (ability of light to penetrate water) obtained by lowering a black and white disk into the water until it is no longer visible.
- **Watershed** is a drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.
- **Total Phosphorus (TP)**: one of the major nutrients needed for plant growth. It is naturally present in small amounts and limits the plant growth in lakes. Generally, as phosphorus increases, the amount of algae also increases. TP refers to the total concentration of phosphorus found in the water including organic and inorganic forms.

The Kezar Lake upper basin is non-colored (average color 21 SPU) with an average SDT of 7m (22.0 ft). The range of water column TP for the upper basin is 4 to 12 parts per billion (ppb) with an average of 8 ppb, while Chl-a ranges from 2 to 2.6 ppb with an average of 2.3 ppb. Recent **dissolved oxygen (DO)** profiles show little to no DO depletion in deep areas of the upper basin.

A clear lake with small algal populations results in deep Secchi disk readings and low levels of chlorophyll-a and TP.

Middle Bay

Water quality monitoring data for the Kezar Lake middle basin (Station 2) has been collected since 1976. Since this period, 7 years of basic chemical information has been collected, in addition to 31 years of Secchi disk transparencies (SDT). In summary, the water quality of the Kezar Lake middle basin is considered to be excellent, based on measures of SDT and total phosphorus (TP). The potential for nuisance algae blooms in the middle basin is low.

The Kezar Lake middle basin has an average SDT of 6.9 m (22.6 ft). The range of water column TP for Kezar Lake is 3-6 parts per billion (ppb) with an average of 5 ppb, compared to the Maine average of 12 ppb. Recent dissolved oxygen (DO) profiles show no DO depletion in deep areas of the middle basin.

Lower Bay

Water quality monitoring data for the Kezar Lake lower basin (Station 3) has been collected since 1976. During this period, 23 years of basic chemical information was collected, in addition to 30 years of Secchi disk transparencies (SDT). In summary, the water quality of the Kezar Lake lower basin is considered to be below average, based on measures of SDT, total phosphorus (TP), and chlorophyll-a (Chl-a). The potential for nuisance algae blooms in the lower basin is moderate.

The Kezar Lake lower basin is non-colored (average color 16 SPU) with an average SDT of 3.4 m (11.2 ft). The range of water column TP for the lower basin is 6 to 10 parts per billion (ppb) with an average of 8 ppb, while Chl-a ranges from 2.1 to 2.8 ppb with an average of 2.3 ppb. Recent dissolved oxygen (DO) profiles show indeterminate DO depletion in deep areas of the lower basin. The potential for TP to leave the bottom sediments and become available to algae in the water column is also indeterminate. Oxygen levels below 5 parts per million stress certain cold water fish, and a persistent loss of oxygen may eliminate or reduce habitat for sensitive cold water species.

References

PEARL - The Source for Environmental Information in Maine. (n.d.). http://www.pearl.maine.edu/data.htm

Maine VLMP. (2001). Maine Volunteer Lake Monitoring Program. Water Quality Summary: Kezar Lake, Lovell, Midas 0097. Maine DEP, Augusta Maine.

Key Terms

- **Chlorophyll-a :** a measurement of the green pigment found in all plants including microscopic plants such as algae. It is used as an estimate of algal biomass; the higher the Chl-a number, the higher the amount of algae in the lake.
- **Dissolved Oxygen** is the concentration of oxygen that is dissolved in the water. DO is critical to the healthy metabolism of many creatures that reside in the water.

2. Water Quality Monitoring – Methods and Parameters

In 2009 FB Environmental monitored the water quality of Kezar Lake, six ponds in the Kezar Lake watershed, and two tributaries to Kezar Lake. Sampling sites and dates are shown below:

Date	Sampling Sites
22-Jun-09	Kezar Lake, Kezar Lake tributaries (2), Kezar Lake Watershed Ponds (5)
17-Aug-09	Kezar Lake, Kezar Lake Watershed Ponds (6)
15-Sep-09	Kezar Lake, Kezar Lake tributaries (2)

2009 Kezar Lake Sampling

The upper, middle, and lower basins of Kezar Lake were individually assessed during each sampling event. Sampling was conducted in accordance with standard methods and procedures for lake monitoring established by the Maine Department of Environmental Protection, the US EPA, and the Maine Volunteer Lake Monitoring Program. All lab samples were analyzed at the Health and Environmental Testing Lab (HETL) in Augusta. The following parameters were measured:

Trophic state indicators: "Trophic state" indicators, or indicators of biological productivity in the lake ecosystem, help to determine the extent of and effects of eutrophication in lakes. The upper basin of Kezar Lake is classified as unproductive, and the middle and lower basins are moderately productive. Unproductive lakes have below average TP and Chl-a, and Secchi disk transparencies of >7 m. Moderately productive lakes have average TP and Chl-a, and Secchi disk transparencies of 4-7 m. The "trophic state" indicators measured in Kezar Lake include:

- Secchi disk transparency (water clarity)
- total phosphorus (TP)
- chlorophyll-a (Chl-a)

Dissolved oxygen: In addition to the above parameters, the concentration of oxygen dissolved in the water and the water temperature were also measured. Dissolved oxygen (DO) levels in lake water are influenced by a number of factors, including water temperature, the concentration of algae and other plants in the water, and the amount of nutrients and organic matter that flow into the water body from the watershed. Oxygen is needed by virtually all fish, algae and macrophytes, and for many chemical reactions that are important to lake functioning.

Dissolved oxygen concentrations may change dramatically with lake depth. Oxygen is produced in the top portion of a lake (where sunlight drives photosynthesis), and oxygen consumption is greatest near the bottom of a lake (where organic matter accumulates and decomposes). In stratified lakes, such as Kezar Lake, this difference may be dramatic - with high oxygen near the top and close to none near the bottom. As mentioned earlier, some species of fish are particularly sensitive to any loss of oxygen.

Additional parameters: Indicators of lake water quality measured in addition to trophic state and dissolved oxygen data include:

- natural color
- total alkalinity

An "integrated epilimnetic core" method was used to collect samples at the "deep hole" of each of Kezar Lakes three basins. With this method, a core of water is collected from the water surface to the upper part of the thermocline. Sampling results reflect the "average" concentration for each of the measured parameters.

2009 Kezar Lake Tributary Monitoring

Monitoring inflowing streams for potential problems is also important for protecting the Kezar Lake Watershed. Great Brook and Boulder Brook were selected because they are important tributaries to Kezar Lake. Great Brook drains into the north part of the upper basin, and the Boulder Brook outlet is between the middle and upper basins on the East side of Kezar Lake. Sampling was conducted on June 22 and September 15 at the outlet of Great Brook and the route 5 crossing of Boulder Brook. Parameters measured included dissolved oxygen, temperature, total phosphorus, and *E. coli* bacteria. *E. coli* bacteria is an indicatior of the presence of fecal contamination in the watershed. By itself *E. coli* is generally not a threat to human health but can be associated with disease-causing organisms. The sources of this contamination could be from point sources such as wastewater treatment plants discharges and/or stormwater overflows. The bacteria could also originate from polluted runoff sources such as pet waste, livestock contamination and/or failing septic systems, or from nonhuman-associated sources such as wildlife.

2009 Kezar Lake Watershed Pond Sampling

On June 22 and August 17 monitoring was conducted at the deepest parts of Bradley, Cushman, Farrington, Heald, and Trout Ponds. Horseshoe Pond was sampled on both dates but DO measurements were only taken in August. The parameters measured were the same as those described above for Kezar Lake. Several of the six ponds are connected, and they all drain into Kezar Lake. Determining baseline water quality conditions can identify potential problems which could pose a threat to the water quality of Kezar Lake Watershed.

Horseshoe Pond, August 2009

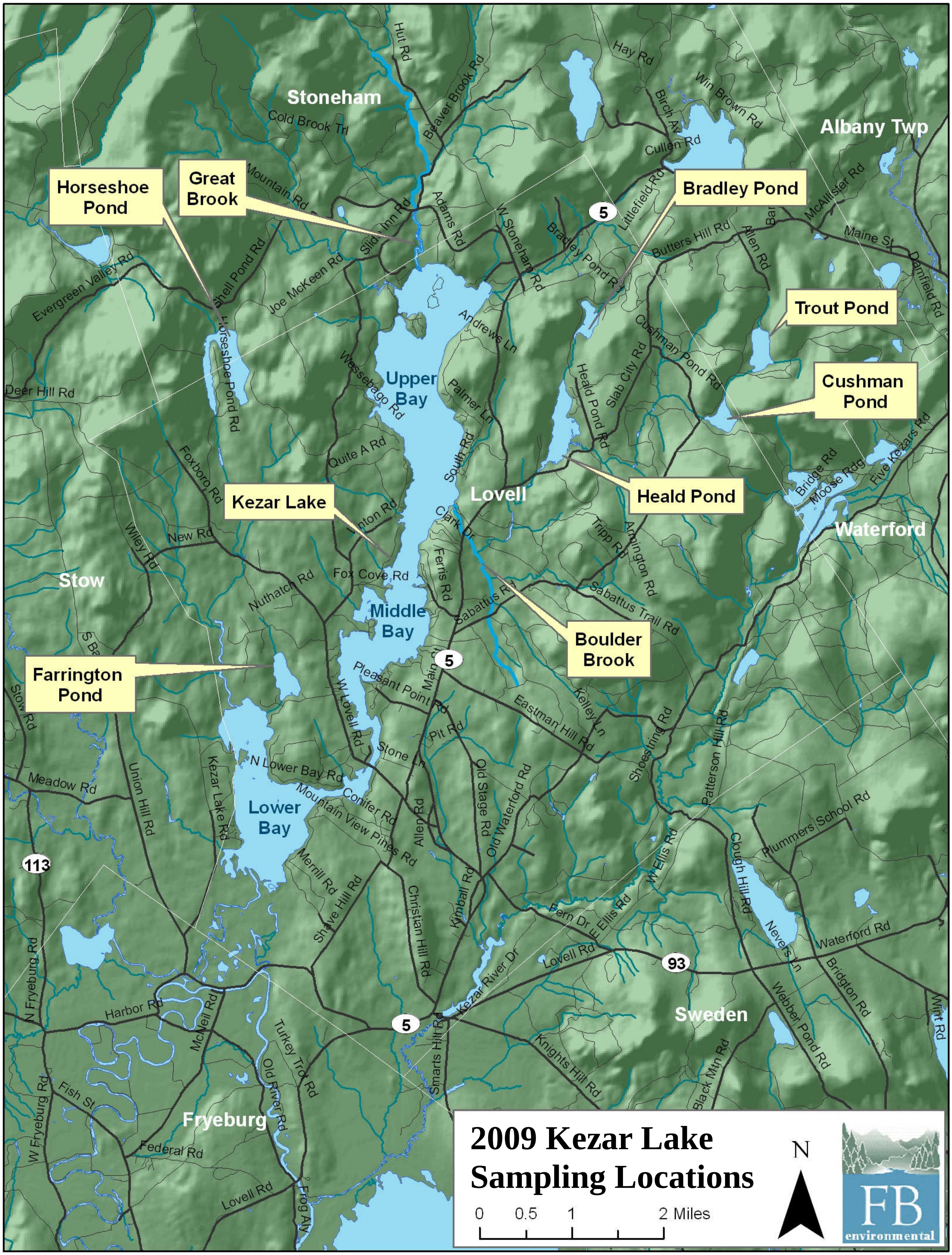


Figure 2.1: *Kezar Lake 2009 sampling locations*

3. Kezar Lake Water Quality Monitoring Results

3.1 Water Clarity

Measuring Secchi disk transparency is one of the most useful ways of showing if a lake is changing from year to year. Changes in transparency may be due to increased or decreased algal growth, or the amount of dissolved or particulate materials in a lake. Such changes could be the result of human disturbance or other impacts to the lake watershed area. Factors that affect transparency include algae, water color, and sediment. Since algae is usually the most abundant factor, measuring transparency can be a way to measure the algal population.

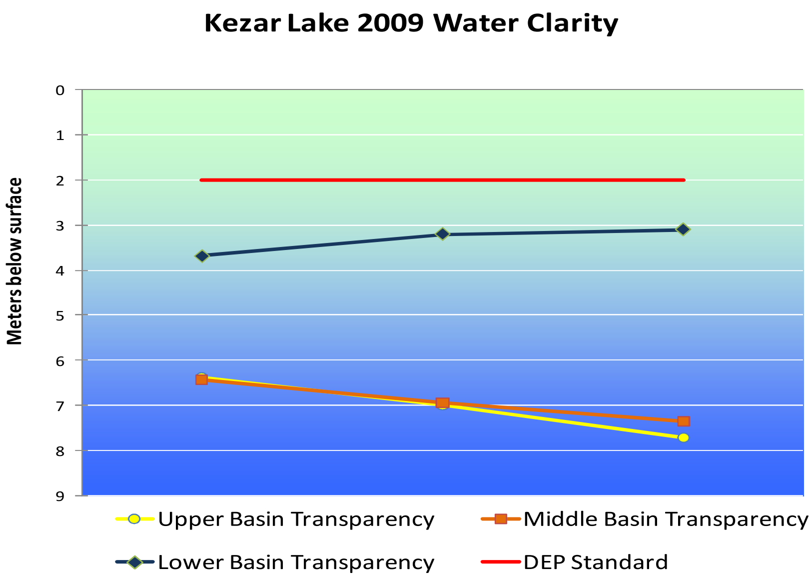


Figure 3.1: Water clarity in the upper and middle basins of Kezar Lake was well below the Maine DEP standard of 2 meters. The shallow nature of the south basin limits water clarity – the Secchi disk reaches the bottom of the basin before it disappears from view.

Transparency values in Maine vary from 0.4 m to 20 m, with the average being 4.8 m. Generally, a transparency of 2 m or less indicates a water quality problem and possible algae bloom conditions.

In 2009, average Secchi disk transparency for the upper, middle, and lower basins of Kezar Lake were 7, 6.9, and 3.3 m, respectively (Figure 3.1). Water clarity is likely underestimated in the lower basin because the Secchi disk touches bottom before disappearing from view. The 2009 average Secchi disk transparency for the upper basin is 0.7 m less clear than historical results and the average depth found during the 2008 sampling period. However, Secchi disk measurements in all three basins have been fairly consistent throughout the years (Figure 3.2).

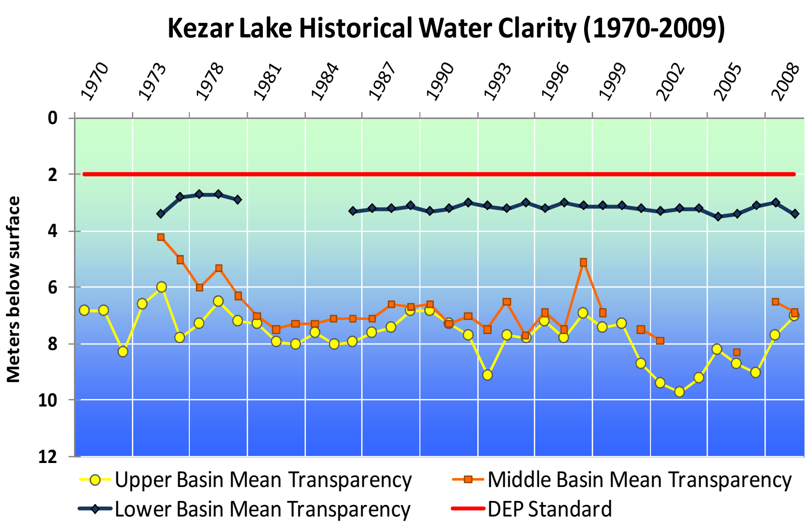


Figure 3.2: The 2009 average water clarity for the upper basin of Kezar Lake is 0.7 below the historical average for the lake (1970-2007). Secchi disk readings have been fairly consistent over the years.

In Maine, average Secchi disk readings are related to algal productivity using the following guidelines:

- *4 meters or less = Productive*
- *4-7 meters = Moderately Productive*
- *7 meters or greater = Non-productive*

According to these guidelines, the upper basin of Kezar Lake is in between non-productive and moderately productive and the middle basin is barely moderately productive. If the lower basin was deep enough, it would likely fall into the moderately productive range. Short-term changes in transparency such as the 0.7m difference between the 2008 and 2009 readings in the upper basin may be due, in part, to weather influences such as high winds or increased rainfall. Heavy rainfall and high winds can reduce water clarity by increasing the amount of particles—particularly sand, silt, and clay sediments—suspended in water. Heavy rainfall increases stormwater runoff and carries soil and sediments from land into the lake. Sustained rainfall and colder temperatures throughout the season can cause clarity measures to evenly decline. The turbulent energy generated by wind and wave action can act to homogenize the lake at near surface depths, erode unvegetated shorelines, and re-suspend sediments in shallow areas of the lake. Long term changes in transparency, on the other hand, may be due to increased development or changes in land use in the lake watershed.

3.2 Dissolved Oxygen

Dissolved oxygen (DO) is the measure of the amount of oxygen dissolved in the water. All living organisms, except for certain types of bacteria, need oxygen to survive. Too little oxygen severely reduces the diversity and population of aquatic communities. Therefore, the amount of DO in the water is very important to aquatic life. A common problem in Maine lakes is the depletion of oxygen in the deepest part of the lake in the summer months. This occurs when thermal stratification prevents the oxygenated surface water from mixing with water deep in the lake. As a result, oxygen in deeper areas can become depleted. DO levels below 5ppm can stress some species of cold water fish, and over time reduce habitat for sensitive cold water

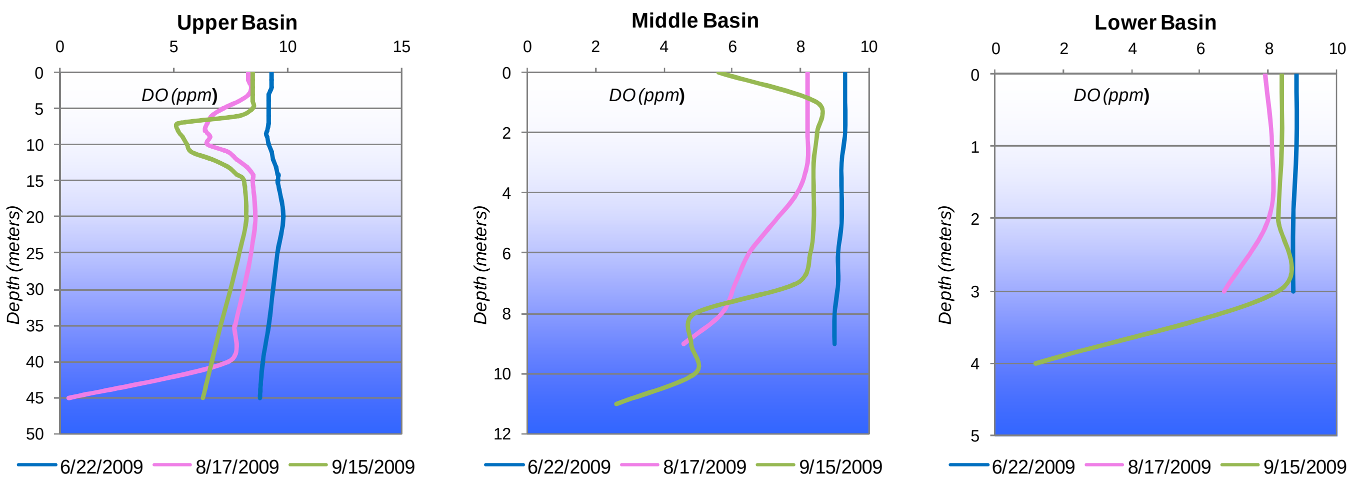


Figure 3.3: *Kezar Lake 2009 dissolved oxygen measurements show high DO concentrations throughout the lake.*

species. Kezar Lake does experience some DO depletion in all three basins (Figure 3.3). The greatest depletion was in the middle basin during the August and September sampling dates. In August and September 2009, the DO concentration in the middle basin were <5 ppm at a depth of 9m and 8m, respectively. Overall, Kezar Lake has adequate DO for aquatic life. The DO depletion observed in the bottom 5 m of the upper and middle basins is only a minor concern due to proximity to the bottom..

3.3 Total Phosphorus

Total phosphorus (TP) is one of the major nutrients needed for plant growth. It is generally present in small amounts and limits the plant growth in lakes. As phosphorus increases, the amount of algae also increases. If the amount of algae increases enough, an algal bloom will be visible. Humans can add phosphorous to a lake through stormwater runoff, lawn or garden fertilizers, and leaky and poorly maintained septic tanks. In Maine lakes, TP varies from 1 ppb to 110 ppb with the average being 12 ppb.

Table 3.1: Kezar Lake total P

Total Phosphorus (ppb)		
6/22/2009	Upper	12
	Middle	5
	Lower	10
8/17/2009	Upper	8
	Middle	6
	Lower	6
9/15/2009	Upper	4
	Middle	3
	Lower	7
2009 Average (Kezar Lake)	Upper	8
	Middle	5
	Lower	8
Average for Maine Lakes		12

In 2009, TP averaged 8, 5, and 8 ppb, at the upper, middle, and lower basins, respectively (Table 3.1). This is a slight decrease from the past two years and is closer to the historical average of 6 for the upper basin. The upper basin saw a continuous decrease in TP throughout the sampling season while the middle and lower basins remained relatively constant. The TP concentrations in the lower basin were similar to the past two years, and in line with the historical average of 8.5 ppb. All of the TP concentrations measured in 2009 were below or equal to the Maine average of 12 ppb.

3.4 Color

Color is measured by comparing a sample of the lake water to Standard Platinum Units (SPU). Colored lakes (>25 SPU) can have reduced transparency readings and increased phosphorus values. However, this does not necessarily mean such lakes are more productive. Color can interfere with test results. As such, chlorophyll-a (Chl -a) is the best indicator of productivity in colored lakes. In Maine lakes, color varies from 0 to 250, with the average being 28 SPU (VLMP). Color was 21, 13, and 16 SPU, respectively, in the upper, middle, and lower basins of Kezar Lake in 2009 (Table 3.2). This is greater than the historical averages of 12 and 15 SPU for the upper and lower basins of the lake by 9 and 1 SPU, respectively. The color in the upper basin also is 6 SPU greater than found in 2008.

Table 3.2: Kezar Lake color

Color (SPU)		
6/22/2009	Upper	12
	Middle	11
	Lower	13
8/17/2009	Upper	39
	Middle	14
	Lower	17
9/15/2009	Upper	13
	Middle	13
	Lower	18
2009 Average (Kezar Lake)	Upper	21
	Middle	13
	Lower	16
Average for Maine Lakes		28

Table 3.3: Kezar Lake chlorophyll-a

Chlorophyll-a (ppb)		
6/22/2009	Upper	2.3
	Middle	2.1
	Lower	2.8
8/17/2009	Upper	2.6
	Middle	2.4
	Lower	2.0
9/15/2009	Upper	2
	Middle	1.8
	Lower	2.1
2009 Average (Kezar Lake)	Upper	2.3
	Middle	2.1
	Lower	2.3
Average for Maine Lakes		5.3

3.5 Chlorophyll-a

Chlorophyll-a (Chl-a) is a measurement of the green pigment found in all plants including microscopic plants such as algae. It is used as an estimate of algal biomass, the higher the Chl-a number the higher the amount of algae in the lake. Chl-a in Maine lakes ranges from 1.1 ppb to 51.5 ppb, with an average value of 5.3 ppb. In 2008, Chl-a averaged 2.3, 2.1, and 2.3 ppb in the upper, middle, and lower basins, respectively (Table 3.3). These values varied little during the three sampling events, and are similar to results from the previous two years. In addition, the Chl-a concentrations are less than half the Maine average of 5.3 ppb.

3.6 Alkalinity

Alkalinity is a measure of the buffering capacity of a lake, or the capacity of water to neutralize acids. It is a measure primarily of naturally available bicarbonate, carbonate, and hydroxide ions in the water, which is mostly determined by the geology of the soils and rocks surrounding the lake. Alkalinity is important to aquatic life because it buffers against changes in pH that could have drastic effects on animals and plants. Kezar Lake has low alkalinity; the upper and middle basins averaged 3 mg/L and the lower was 4 mg/L (Table 3.4). This is a decline from the previous two years when alkalinity ranged from 4.7 to 5.3 mg/L in the upper and lower basins, and is below the Maine average of 11.9. Due to the low alkalinity, Kezar Lake is susceptible to changes in pH.

Table 3.4: Kezar Lake alkalinity

Alkalinity (ppm)		
6/22/2009	Upper	3
	Middle	3
	Lower	4
8/17/2009	Upper	4
	Middle	3
	Lower	4
9/15/2009	Upper	3
	Middle	4
	Lower	4
2009 Average (Kezar Lake)	Upper	3
	Middle	3
	Lower	4
Average for Maine Lakes		11.9

3.7 Summary

Kezar lake remains one of Maine's cleanest and clearest lakes, with above average water quality and clarity compared to most lakes in Maine. Historically, Kezar Lake's total phosphorus and chlorophyll-a averages have been well below the statewide averages. Similarly, the long term average SDT for the lake's upper basin is 7.7 meters, compared to an average of 4.8 meters for most Maine lakes. Water clarity in the middle and lower basins is also consistently below (better than) the state average.

Based on measures of Secchi disk transparency, total phosphorus (TP) and chlorophyll-a (Chl-a), Kezar Lake water quality declined slightly in 2009, compared to 2008 and 2007 measurements (Table 3.6). However, 2009 water quality was in-line with the historical averages for the lake.

In 2009, water clarity in the north basin of the lake was 0.7m below the historical average of 7.7 meters, but was 2.1 and 0.7 meters less than the 2007 and 2008 averages, respectively. Similarly, water clarity in the middle basin improved compared to 2008 measurements by 0.4 meters. As mentioned previously, it is difficult to compare Secchi measurements in the lower basin from year to year, since the Secchi disk hits the lake bottom. As such, TP and Chl-a are better water quality measure for the lower basin.

2009 TP measurements in the upper basin were lower than last year but still higher than 2007 and the historical average for the basin. No considerable change in TP levels was noted in the lower basin in 2009. 2009 chlorophyll-a measurements in both the upper and lower basins of the lake showed little changes from the previous two years, and were comparable to historical averages. The upper basin Chl-a level has increased steadily since 2006 toward the historical average of 2.8 ppb. Historical TP and Chl-a measurements were not available for the middle basin.

A decline in water clarity and an increase in TP levels in 2009 may be attributed to much higher precipitation than in 2007 and 2008 (Table 3.5). During the months of June through September, Lovell, Maine received over 37 inches of rain. This is nearly 5 inches more than during the same period in 2007 and 2008 combined.

While the water quality of Kezar Lake is generally excellent, the lake is sensitive to change. In 2005, the lake was added to Maine's list of Priority Waterbodies. Continuing to monitor all three basins of the lake, as well as the small ponds that drain to Kezar, will help us better understand long- and short-term trends and maintain Kezar Lake's water quality into the future.

Table 3.5: *Summer month precipitation averages, 2007-2009 in inches (Source: Weather Underground)*

	2007	2008	2009
June	3.14	7.26	12.15
July	2.53	4.7	14.54
August	1.7	5.74	10.26
September	2.6	5.45	0.29
Totals	**9.97**	**23.15**	**37.24**

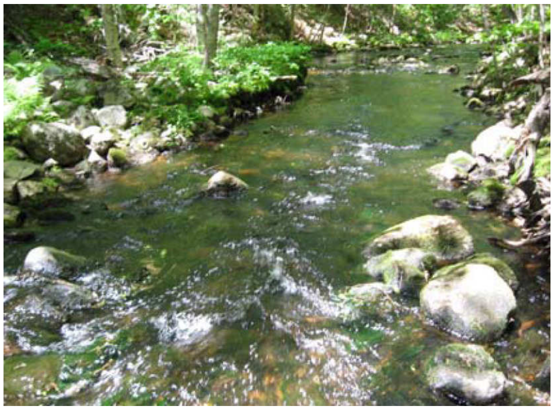
Table 3.6: *Kezar Lake historical and recent water quality averages*

Year	Basin	SDT (meters)	TP (ppb)	Chl-a (ppb)	pH	Alkalinity (mg/L)	Color (SPU)
2009 Average (Kezar Lake)	**Upper**	7.0	8	2.3	-	3	21
	Middle	6.9	5	2.1	-	3	13
	Lower	3.3	8	2.3	-	4	16
2008 Average (Kezar Lake)	**Upper**	7.7	10	2.2	6.5	3	15
	Middle	6.5	22.5	2.4	6.6	3	15
	Lower	3.0	8.5	2.6	6.5	3	19
2007 Average (Kezar Lake)	**Upper**	9.1	4	1.8	-	4.7	11
	Middle	-	-	-	-	-	-
	Lower	3.1	8	2.5	-	-	-
2006 Average (Kezar Lake)	**Upper**	8.7	5	1.9	6.8	4.8	-
	Middle	-	-	-	-	-	-
	Lower	3.4	8	2.3	-	5.3	-
Historical Average (Kezar Lake)*	**Upper**	7.7		2.8	6.6	4.7	12
	Middle	-	6 7	-	6.5	-	-
	Lower	3.1	9	2.4	6.6	4.8	15
Maine Average		4.8	12	5.3	6.8	11.9	28

** The historical average includes all ME DEP and VLMP certified data through 2006. Surveying was not conducted every year, and for many years only SDT data is available.*

4. Kezar Lake Tributary Sampling Results

4.1 Water Quality Results



Great Brook

Boulder Brook

In 2009, the water quality of two Kezar Lake tributaries, Boulder Brook and Great Brook, was monitored under both wet and dry conditions. Great Brook is located on the Northwest end of Kezar Lake off of West Stoneham Road. Boulder Brook drains a wetland and travels under Rte 5 just north of Center Lovell. The stream travels through the Boulder Brook Club and outlets into Kezar Lake at the swimming area.

Boulder Brook water quality was measured on 2 dates at the outlet (2 samples). Great Brook was also monitored on 2 dates at the crossing of West Stoneham Road (2 samples total). Results indicate good water quality in both streams during wet and dry sampling events.

In both streams, **dissolved oxygen (DO)** was well above the 7 ppm threshold required by most aquatic species for survival and growth. The average DO for Great Brook was 10.0 ppm, the Boulder Brook outlet had an average of 9.3 ppm.

E. coli results for both streams were below the Maine DEP standard of 194 colonies per 100 milliliters. In September 2009, Boulder Brook tested 105 colonies/100 mL which is very high compared to background results from past sampling. Other sampling events in both streams produce results between 10 and 20 col/100 mL. Further testing is needed to confirm the high sample.

Total phosphorus (TP) is the most important nutrient to monitor in freshwater ecosystems. As described in the previous section, when TP concentrations increase, algal abundance also increases. TP results for the tributaries ranged from 5 to 16 ppm. These concentrations are within an acceptable range, and do not pose a threat to Kezar Lake.

In 2009 precipitation was continuously high throughout the summer months which can act to increase DO and phosphorus but lower pH and turbidity as more runoff reaches the stream.

The differences between Great Brook and Boulder Brook 2009 water quality monitoring results are minor. Great Brook was slightly colder and had a higher DO concentration. TP concentration was equal for both streams at 13 ppb in June but were more polarized in August. *E. coli* was four times more abundant in Boulder Brook but still below (better than) Maine standards.

Table 4.1: *Boulder Brook 2009 water quality monitoring results*

Date	Temp. (C)	DO (mg/L)	TP (mg/L)	E. coli (col/100m
6/22/2009	18.2	9.11	13	17
9/15/2009	17.3	9.56	16	105
AVERAGE	**17.75**	**9.335**	**14.5**	**61**

Table 4.2: *Great Brook 2009 water quality monitoring results*

Date	Temp. (C)	DO (mg/L)	TP (mg/L)	E. coli (col/100mL)
6/22/2009	14.5	10.47	13	17
9/15/2009	14.6	9.6	5	12
AVERAGE	**14.55**	**10.035**	**9**	**14.5**

5. KLWA Ponds Water Quality Results

In 2009, FB Environmental conducted baseline sampling for six ponds that drain directly, or indirectly into Kezar Lake. Bradley, Cushman, Farrington, Heald, and Horseshoe Ponds were monitored during the months of June and August. June is the beginning of the "warm" season in Maine lakes, and August is generally the time when Maine lakes are the most biologically productive, and when indications of stress and water quality degradation are generally most evident.

Based on 2009 monitoring data, water quality is generally good in the 6 ponds. According to 2009 sampling results (Table 5.1, p.14), all of the six KLWA ponds sampled had an average water clarity below (better than) both the Maine DEP standard of 2 meters and the Maine average of 4.8 meters. As with Kezar Lake, some signs of decreasing water quality were noted. Again, some of these concerns may be the result of heavier rainfall during the 2009 sampling season, compared to the previous 2 years. In 2009, total Phosphorus (TP) averages in Farrington and Heald Ponds both decreased from high 2008 levels. Last year TP concentrations in Farrington Pond more than doubled (compared to 2007) and reached possible algal bloom conditions. The TP levels have dropped considerably in 2009 as shown by further testing. All ponds are consistently lower than the state average for alkalinity making the watershed highly susceptible to changes in pH. Water clarity in all ponds decreased slightly from 2008 to 2009 following the trend seen the year previous. Water sampling results during this sampling season were highly variable most likely due to 37.24 inches of rain falling during the sampling period (Table 3.5). Variations in water quality from year to year are common. By continuing to collect baseline data for the KLWA ponds, we can gain a better understanding of water quality trends in the Kezar lake watershed.

5.1 Bradley Pond

Bradley Pond is an undeveloped, 35-acre waterbody with a maximum depth of 30 feet, an average depth of 10 feet, and a watershed area of 0.49 square miles. Water from Bradley Pond drains into Heald Pond, and then runs through Boulder Brook into Kezar Lake. The water quality of Bradley Pond is above the Maine average for all parameters except for alkalinity, as are all Kezar Pond watershed ponds. In 2007 thru 2009, alkalinity was found to be 4 mg/L, which is below the Maine average of 12. This indicates that Bradley Pond is susceptible to changes in pH. However, the pH is currently within a normal range. In August 2009, dissolved oxygen (DO) in Bradley Pond dropped dramatically below 3 meters depth (Figure 5.1, p.14) which is an improvement over 2008 data. DO remains above 5 mg/L during the June sampling date. Overall, the water quality of Bradley Pond has declined slightly when compared to 2008 data. Secchi disk transparency decreased from 5.5 to 4.7 m and, Chl-a increased from 3.9 to 4.1 ppb.

5.2 Cushman Pond

Cushman Pond is notable because of a well marked milfoil infestation site. Cushman has a surface area of 37 acres, an average depth of 15 feet, a maximum depth of 21 feet, and a watershed area of 0.50 square miles. Like Bradley, Cushman drains into Heald Pond, which drains into Kezar Lake through Boulder Brook. In 2009, minimal DO depletion was observed in August at the bottom of the deepest area of the pond (Figure 5.2, p.14). This finding is consistent with recent and historical late summer DO profiles. The water quality of Cushman Pond has changed little since 2007. The most notable changes were a slight increase in TP from 4 to 10 ppb which is opposite of the trend seen last year. Alkalinity also increased opposite to last year. Alkalinity declined from 6 mg/L to 4 mg/L over the past three years but has now risen to 5.0 mg/L. The alkalinity of Cushman Pond, like all water bodies in the Kezar Lake watershed, is below average.

5.3 Farrington Pond

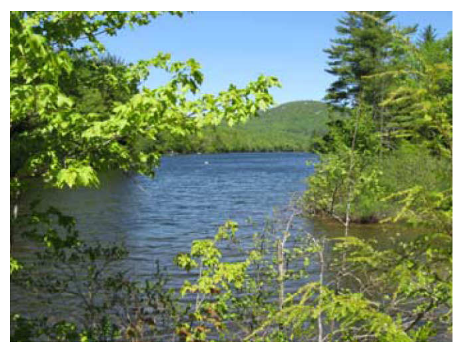
Farrington Pond drains directly into the lower basin of Kezar Lake. It has a surface area of 57 acres, a maximum depth of 15 feet, an average depth of 5 feet, and a watershed area of 0.53 square miles. The TP concentrations in Farrington Pond dropped from 39 ppb in 2008 to 13.5 ppb in 2009 which is much closer to 2007 levels. This result confirms the suspected lab error of 39 ppb seen in 2008. Surprisingly, Chl-a, which is a measure of algal abundance, declined from 8.6 ppb in 2007 to 6.4 ppb in 2008 and further to 6.1 ppb in 2009. Alkalinity, color, and Secchi disk transparency were similar to recent and historical readings. DO depletion is not an issue for this pond, primarily because of the pond's shallow depth (Figure 5.3, p.15).

5.4 Heald Pond

Heald Pond drains through Kezar Lake into Boulder Brook. It has a surface area of 101.3 acres, a maximum depth of 19 feet, and a watershed area of 4.24 square miles. DO concentrations are dangerously low below 3 meters (9.8 feet) in the summer months (Figure 5.4, p.15). TP concentrations decreased from 12 ppb in 2008 to 11.5 in 2009, an increase since 2007 of 3.5 ppb. Any increase in TP is of interest but these results are within the historical range of 8-16 ppb. Alkalinity declined from 6 mg/L in 2007 to 4 mg/L in 2008 but rose in 2009 to 5.0 mg/L. DO depletion was minimal in this shallow pond.

5.5 Horseshoe Pond

Horseshoe Pond drains into Moose Pond, which in turn drains into Kezar Lake. This pond has a surface area of 136 acres, a depth of 12 feet, a maximum depth of 40 feet, and a watershed area of 1.64 square miles. Due to volunteer efforts, there is more historical data for this pond than any other small pond in the Kezar Lake Watershed. The water quality of Horseshoe Pond has changed little since last year, and is in line with historical results as well. Chl-A and TP have increased by 0.9 ppb and 0.5 ppb, respectively, but are not a major issue. However, DO depletion is an issue for this pond. In August the DO concentration was below 5 ppm in the bottom 6 meters of this ~12-meter deep pond (Figure 5.5, p.15). Data was not available for the sampling date in June due to an onsite equipment failure.



5.6 Trout Pond

Water from Trout Pond travels through Cushman Pond, Heald Pond, and Boulder Brook before reaching Kezar Lake. A secluded summer camp is the only development on this pond. Trout Pond's surface area is unknown, but it is slightly larger than Cushman Pond. Based on FB Environmental depth measurements, the maximum depth of the pond

is 73 feet. However, a camp employee stated that it may be as deep as 87 feet. Trout Pond has the best water quality of all the small ponds in the Kezar Lake Watershed. In 2009 water clarity increased over the previous year to 7.23 m but is still not as clear as observed at 8.45 m in 2006. However, both TP and Chl-a results showed a slight increase over 2008 data. In 2009, severe DO depletion was observed below 10 m in the summer months.

Table 5.1: *KLWA Ponds 2009 water quality monitoring results*

Pond	SDT (m)	TP (ppb)	Chl-a (ppb)	Alkalinity (mg/L)	Color (PCU)
Bradley	4.69	9.5	4.1	4.0	23.5
Cushman	5.16	10.0	2.6	5.0	11.0
Farrington	4.78	13.5	6.1	4.0	17.5
Heald	4.06	11.5	3.0	5.0	38.0
Horseshoe	6.83	6.5	3.1	3.0	11.0
Trout	7.23	4.0	1.8	3.0	9.5
Maine Average	***4.8***	***12***	***5.3***	***11.9***	***28***

(B) = bottom

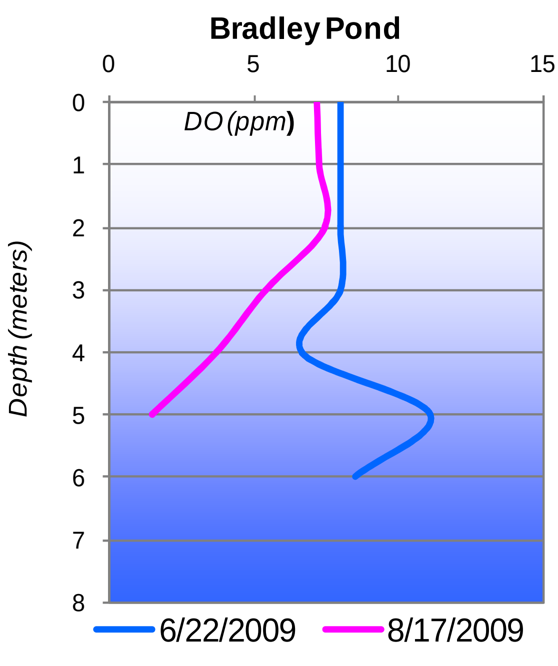


Figure 5.1: *Bradley Pond 2009 DO profile*

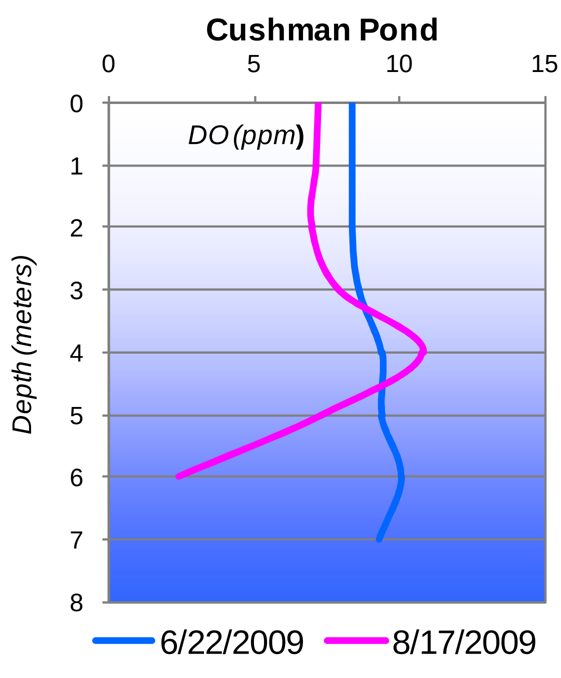


Figure 5.2: *Cushman Pond 2009 DO profile*

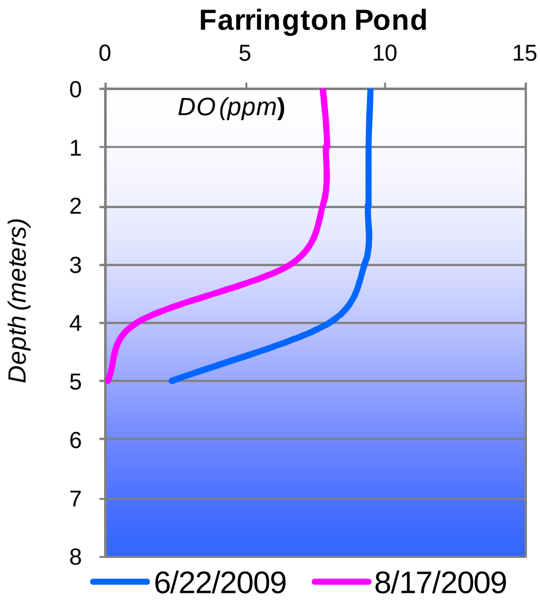


Figure 5.3: *Farrington Pond 2009 DO profile*

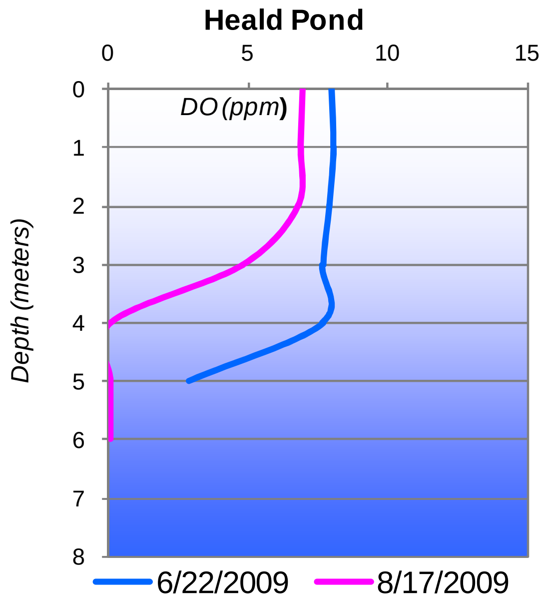


Figure 5.4: *Heald Pond 2009 DO profile*

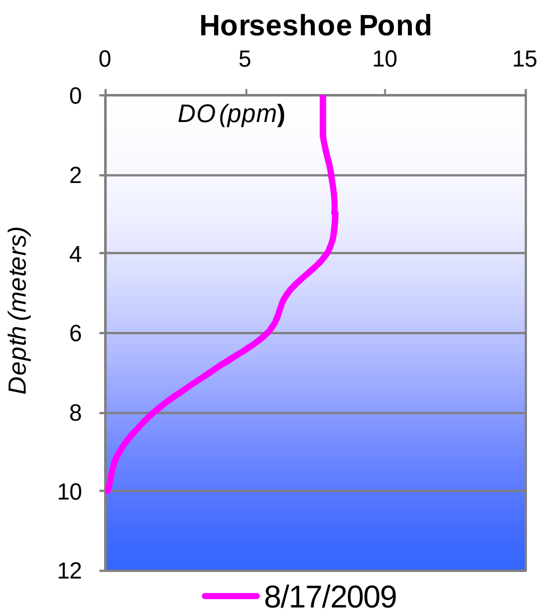


Figure 5.5: *Horseshoe Pond 2009 DO profile*

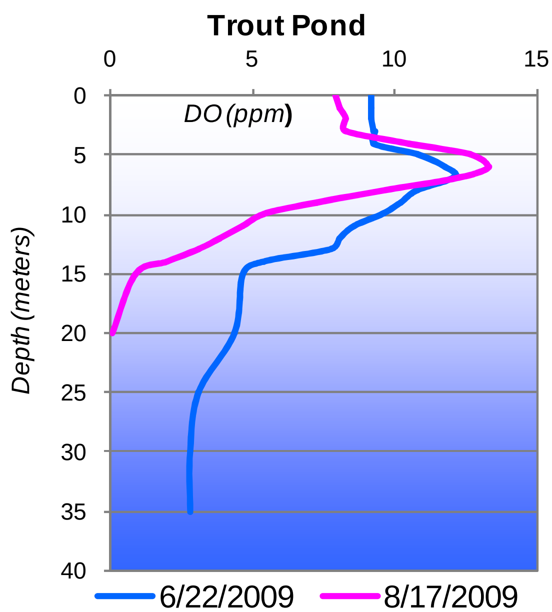


Figure 5.6: *Trout Pond 2009 DO profile*

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2009 KEZAR LAKE SAMPLING PHOTOS