2010 Kezar Lake Water Quality Report

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

December 2010

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

2010 Kezar Lake Water Quality Report

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

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Table of Contents

Kezar Lake, September 2010

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 mi²)
- **Mean Depth:** 34 feet
- **Max Depth:** 155 feet
- **Surface Area:** 2,510 acres (3 mi²)
- **Watershed Group:** Kezar Lake Watershed Association

Kezar Lake (Midas #0097) is a 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, 30 years of basic chemical information has been collected, in addition to 39 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

- **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.
- **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.
- **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 8 SPU) with an average SDT of 7.7m (25.3 ft). The range of water column TP for the upper basin is 4 to 19 parts per billion (ppb) with an average of 9 ppb, while Chl-a ranges from 2 to 2.2 ppb with an average of 2.1 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 6.8 m (22.3 ft). The range of water column TP for Kezar Lake is 2-5 parts per billion (ppb) with an average of 4 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 9 SPU) with an average SDT of 3.1 m (10.2 ft). The range of water column TP for the lower basin is 8 to 14 parts per billion (ppb) with an average of 11 ppb, while Chl-a ranges from 2.1 to 2.8 ppb with an average of 2.4 ppb. Current dissolved oxygen (DO) profiles show little 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 although TP levels have been rising slightly over time. Oxygen levels remained above 7.5 ppm throughout the summer months in 2010.

References

KnowledgeBase - Science & information management for the Gulf of Maine & it's watershed. (2010). <http://www.gulfofmaine.org>

Maine VLMP. (2006). 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 2010 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	Weather	Sampling Sites
28-Jun-10	Wet	Kezar Lake, Kezar Lake tributaries (2), Kezar Lake Watershed Ponds (6)
16-Aug-10	Dry	Kezar Lake, Kezar Lake Watershed Ponds (6)
20-Sep-10	Dry	Kezar Lake, Kezar Lake tributaries (2)
27-Sept-10	Wet	Kezar Lake tributaries (2)

2010 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 unless otherwise noted. 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 and the smaller watershed ponds. 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.

2010 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 28, September 20, and September 27 at the Adams Rd crossing of Great Brook and the outlet of Boulder Brook. Parameters measured included dissolved oxygen, temperature, total phosphorus, and *E. coli* bacteria. *E. coli* bacteria is an indicator 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. Due to a laboratory error while processing the September 20 *E. coli* samples, two separate samples were taken September 27 and processed by Northeast Laboratory Services in Winslow, ME.

2010 Kezar Lake Watershed Pond Sampling

On June 28 and August 16 monitoring was conducted at the deepest parts of Bradley, Cushman, Farrington, Heald, Horseshoe, and Trout Ponds. 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.

Kezar Lake, 2010

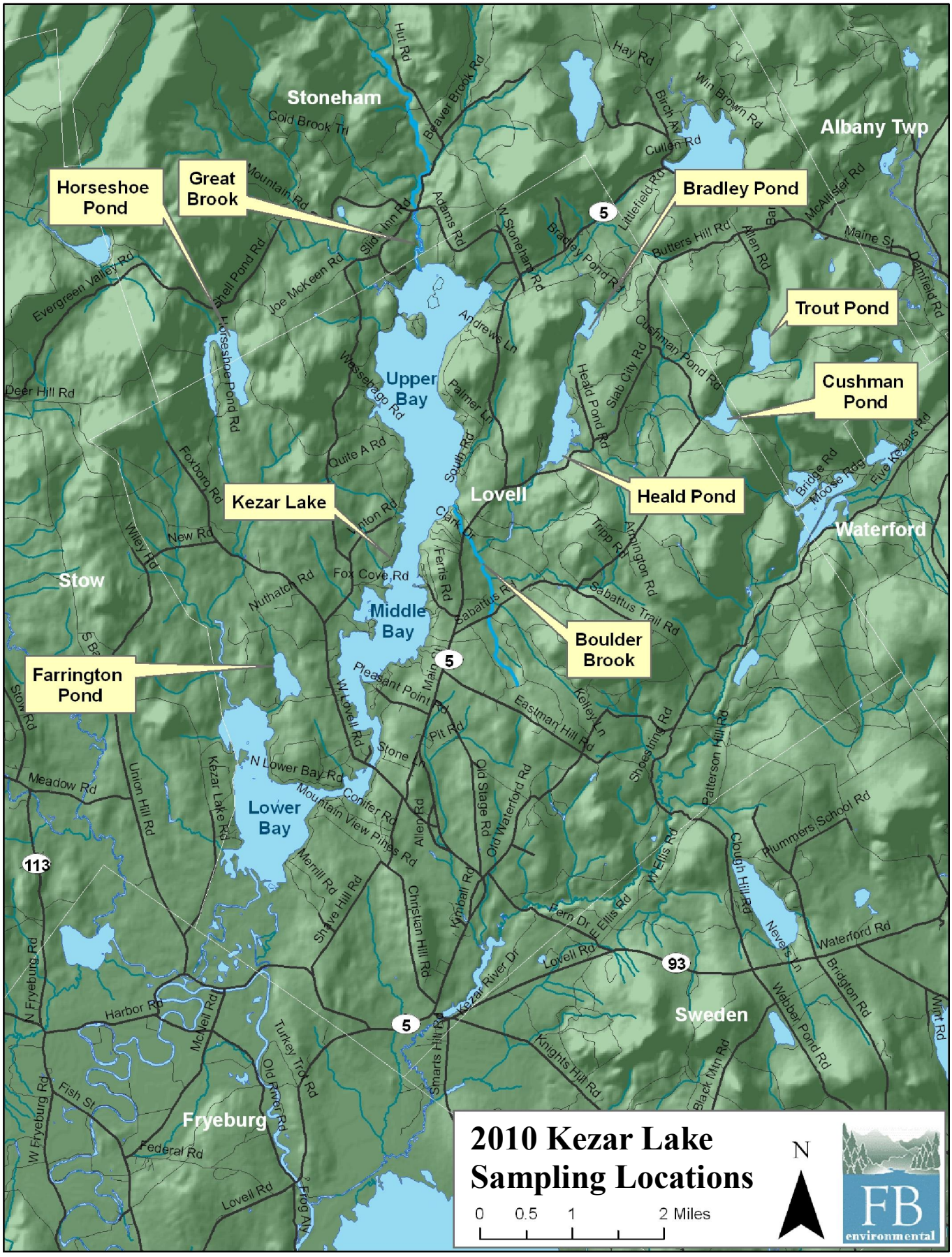

Figure 2.1: *Kezar Lake 2010 sampling locations*

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.

Transparency values in Maine vary from 0.5 m to 15.5 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 2010, average Secchi disk transparency for the upper, middle, and lower basins of Kezar Lake were 8.7, 8.0, and 3.4 m, respectively (Figure 3.1). Water clarity is underestimated in the lower basin because the Secchi disk touches bottom before disappearing from view. Water clarity in the Upper and Middle basins of Kezar Lake improved since 2009 by over a meter. A large gain in clarity such as this may be caused by less rain and/or wind during the season. Historically, the basins have slightly fluctuated in clarity (Figure 3.2) but overall show a consistent trend.

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*

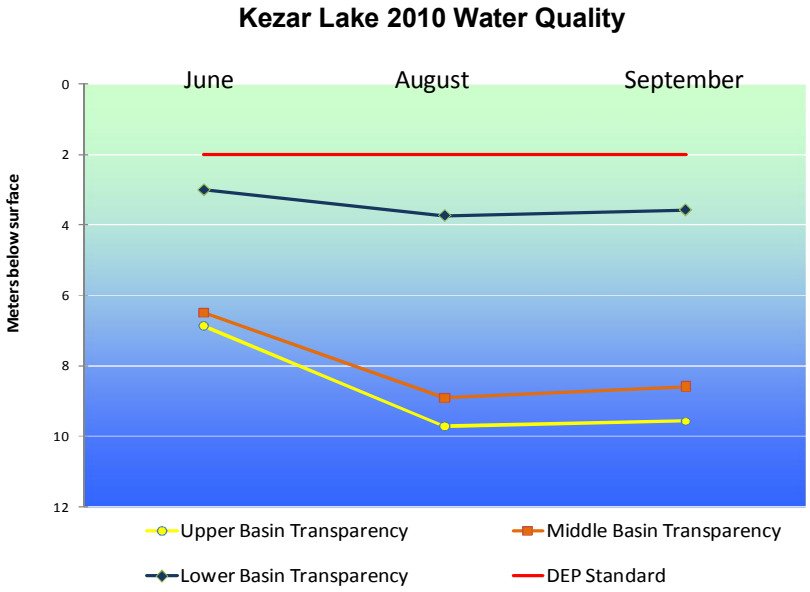

Figure 3.1: *Water clarity in the upper and middle basins of Kezar Lake was much better than the Maine DEP standard of 2 meters. The shallow nature of the south basin limits water clarity – the Secchi disk reaches the bottom of the basin before it disappears from view.*

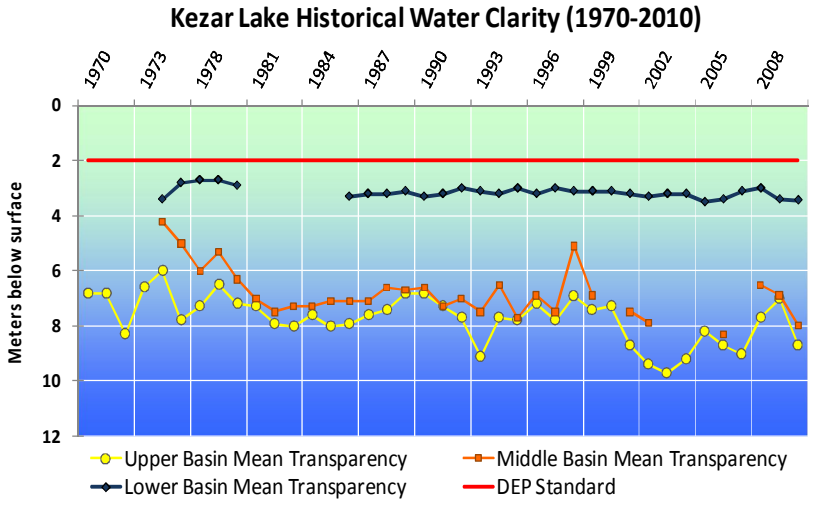

Figure 3.2: *The 2010 average water clarity for the upper basin of Kezar Lake is 1m better than the historical average for the lake (1970-2010). Secchi disk readings have been fairly consistent over the years.*

- *7 meters or greater = Non-productive*

According to these guidelines, the upper basin of Kezar Lake is on the lower end of non-productive and the middle basin is moderately productive. If the lower basin was deep enough, it would likely fall into the moderately productive range.

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 species. Historically, Kezar Lake has experienced some DO depletion in all three basins, however, in 2010 no depletion of DO was seen. Typically during the hottest summer months the DO concentration in the middle basin is <5 ppm, as was seen in 2009. In 2010 the middle basin barely strays below 8 ppm during the August sampling date. The temporary change in DO from 2009 to 2010 may also be influenced by reduced precipitation over the year. Overall, Kezar Lake has adequate DO for aquatic life.

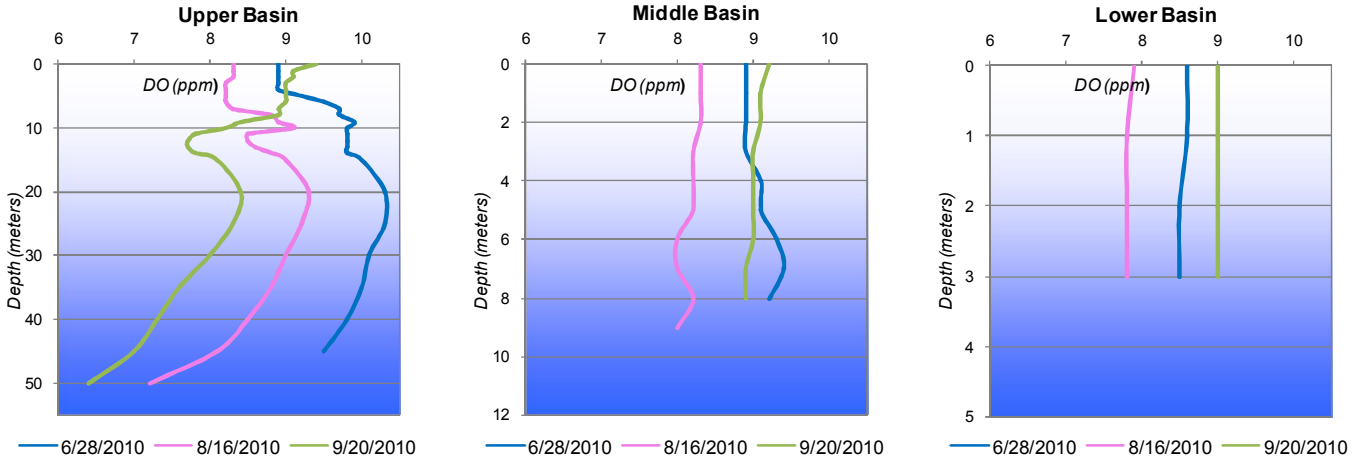

Figure 3.3: *Kezar Lake 2010 dissolved oxygen measurements show high DO concentrations throughout the lake.*

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 158 ppb with the average being 12 ppb.

In 2010, TP averaged 9, 3, and 11 ppb, respectively, at the upper, middle, and lower basins of Kezar Lake (Table 3.1). Overall, these values show an increase since 2009 except in the middle basin, which decreased from an average of 5ppb in 2009. The upper basin average P levels increased by 1ppb. As in 2009, the upper basin TP values

Table 3.1: Kezar Lake total P

Total Phosphorus (ppb)		
6/28/2010	Upper	19
	Middle	3
	Lower	10
8/16/2010	Upper	5
	Middle	2
	Lower	8
9/20/2010	Upper	4
	Middle	5
	Lower	14
2010 Average (Kezar Lake)	Upper	9
	Middle	3
	Lower	11
Average for Maine Lakes		12

decreased as the season progressed. The 2010 TP concentrations in the lower basin during June and September were higher than in the past two years, and greater than the historical average of 8.5 ppb. Individually, the TP concentrations in Kezar Lake are close to the Maine average of 12 ppb, however, the season averages for each basin are below the statewide average.

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 2 to 389, with the average being 28 SPU. Color was 8, 9, and 9 SPU, respectively in the upper, middle, and lower basins of Kezar Lake in 2010 (Table 3.2). These results are much lower than in 2009 and the historical averages of 12 and 15 SPU for the upper and lower basins of the lake, respectively. The 2010 results are also lower than 2008 values.

Table 3.2: Kezar Lake color

Color (SPU)		
6/28/2010	Upper	8
	Middle	10
	Lower	10
8/16/2010	Upper	9
	Middle	8
	Lower	8
9/20/2010	Upper	8
	Middle	8
	Lower	9
2010 Average (Kezar Lake)	Upper	8
	Middle	9
	Lower	9
Average for Maine Lakes		28

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 0.7 ppb to 182 ppb, with an average value of 5.3 ppb. Since 2008, Chl-a levels in the upper and middle basins of Kezar Lake have decreased by 0.2 and 0.3 ppb, respectively. The lower basin has 0.1 ppb more algae than in 2009 and 2008 and is more at risk to algae growth than other areas of the lake because it is so shallow. Overall, these results varied little during the three sampling events and, as expected, the lower basin tested consistently higher. The Chl-a concentrations are still roughly half the Maine average of 5.3 ppb (Table 3.3)..

Table 3.3: Kezar Lake chlorophyll-a

Chlorophyll-a (ppb)		
6/28/2010	Upper	2.2
	Middle	2.0
	Lower	2.8
8/16/2010	Upper	2.0
	Middle	1.7
	Lower	2.1
9/20/2010	Upper	2.1
	Middle	1.7
	Lower	2.2
2010 Average (Kezar Lake)	Upper	2.1
	Middle	1.8
	Lower	2.4
Average for Maine Lakes		5.3

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; all of the basins averaged 4 mg/L over the course of the season (Table 3.4). This is an increase of 1 ppm for the upper and middle basin compared to 2009 values, but 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. The average alkalinity in Maine lakes is 12 ppm. Due to the low alkalinity, Kezar Lake is susceptible to changes in pH.

Table 3.4: Kezar Lake alkalinity

Alkalinity (ppm)		
6/28/2010	Upper	4
	Middle	4
	Lower	4
8/16/2010	Upper	4
	Middle	4
	Lower	4
9/20/2010	Upper	3
	Middle	4
	Lower	4
2010 Average (Kezar Lake)	Upper	4
	Middle	4
	Lower	4
Average for Maine Lakes		12

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 better than the state average.

Based on measures of Secchi disk transparency, total phosphorus (TP) and chlorophyll-a (Chl-a), Kezar Lake water quality increased slightly in 2010, compared to 2009 and 2008 measurements (Table 3.6). Water clarity and Chl-a were better than the historical averages for the lake but TP declined. Further monitoring is needed to assess whether these changes are temporary or suggest a changing trend.

In 2010, water clarity in Kezar Lake showed the greatest improvement since 2009 of all of the monitoring results. In the upper and middle basins the clarity was at least 1 m deeper than the previous year. Short-term changes in transparency such as the 1m difference between the 2009 and 2010 readings in the upper basin may be due, in part, to weather influences such as calm winds or decreased rainfall (Table 3.5). Decreased rainfall and calm winds can increase water clarity by decreasing the amount of particles—particularly sand, silt, and clay sediments—suspended in water. Long term changes in transparency, on the other hand, may be due to increased development or changes in land use in the lake watershed. 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.

Table 3.5: *Summer month precipitation averages, 2008-2010 in inches (Source: Weather Underground)*

	2008	2009	2010
June	7.3	12.2	4.8
July	4.7	14.5	2.5
August	5.7	10.3	3.9
September	5.5	0.3	3.5
Totals	**23.2**	**37.2**	**14.7**

TP measurements have declined since 2008 but historically the results have been lower than they were in 2010. Less rainfall and precipitation over the course of the year can reduce the amount of runoff from the watershed, decreasing suspended solids. Calmer winds also reduce shore erosion potential and lake currents which can agitate bottom soils, releasing TP.

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

Year	Basin	SDT (meters)	TP (ppb)	Chl-a (ppb)	Alkalinity (mg/L)	Color (SPU)
2010 Average (Kezar Lake)	**Upper**	8.7	9	2.1	4	8
	Middle	8.0	3	1.8	4	9
	Lower	3.4	11	2.4	4	9
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	3	15
	Middle	6.5	22.5	2.4	3	15
	Lower	3.0	8.5	2.6	3	19
2007 Average (Kezar Lake)	**Upper**	9.1	4	1.8	4.7	11
	Middle	-	-	-	-	-
	Lower	3.1	8	2.5	-	-
Historical Average (Kezar Lake)*	**Upper**	7.7	6	2.8	4.7	12
	Middle	6.8	7	-	-	-
	Lower	3.1	9	2.4	4.8	15
Maine Average		5.1	12	5.3	12	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.*

In 2010, Chl-a in the upper basin showed little change from the previous two years and the historical average. A historical Chl -a measurement was not available for the middle basin but it has shown consistent improvement since 2007.

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.

4. Kezar Lake Tributary Sampling Results

4.1 Water Quality Results

Great Brook

Boulder Brook

In 2010, 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 was sampled at the outlet to Kezar Lake on the Boulder Brook Club property. Great Brook was sampled upstream of the Adams Rd crossing adjacent to Hut Rd. Water quality parameters were measured each time a grab sample was taken and both brooks were sampled 3 times for *E. coli* and twice for total phosphorus. Dissolve oxygen (DO) than Boulder Brook but both were well above the 7 ppm threshold required by most aquatic species for survival and growth. Great Brook averaged 8.3 ppm and Boulder Brook averaged 9.1 ppm. These values are lower than in 2009, which could be due to weather differences. Boulder Brook was also warmer and averaged 17.4 °C (63.3 °F) compared to 15.8 °C (60.4 °F) of Great Brook.

E. coli results varied for both streams. The first sampling event showed *E. coli* results well above the Maine DEP standard of 194 colonies per 100 mL in both Boulder Brook and Great Brook. Great Brook measured 1,046 colonies/100 mL and Boulder Brook measured 313 colonies/100 mL (Tables 4.1 and 4.2). The highest sampling result in 2009 was 105 col/100 mL and no high counts were noted in 2008. All samples after the June 2010 sampling date were below 20 col/100 mL and below most samples taken in 2009 and 2008. Further sampling is needed to validate the sporadic high values.

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 7 to 75 ppm. Boulder Brook contributed more TP to Kezar Lake with an average of 51.5 ppb. Great Brook is well within the acceptable TP range, averaging 11.5. ppb, and is not a large contributor. Overall, TP in the streams was higher than in 2009 and 2008.

In 2010, precipitation was continuously low throughout the summer months which can decrease DO and phosphorus temporarily. Further sampling is needed in the 2011 season to confirm long-term trends.

The differences between Great Brook and Boulder Brook 2010 water quality monitoring results are minor. Great Brook was slightly colder but Boulder Brook had a higher DO concentration. TP concentration in Boulder Brook averaged more than 4 times higher than Great Brook. As mentioned earlier, *E. coli* far exceeded Maine standards in both streams during the first event but were well below standards in subsequent sampling events.

Table 4.1: *Boulder Brook 2010 water quality monitoring results*

Date	Temp. (C)	DO (ppm)	TP (ppb)	*E. coli* (col/100mL)
6/28/2010	19.2	8.5	28	313
8/16/2010	19.8	8.78	ns	8
9/27/2010	13.3	9.93	75*	16
2010 Average	**17.4**	**9.1**	**51.5**	**112.3**
2009 Average	*17.8*	*9.3*	*14.5*	*61.0*

ns= not sampled

*TP sample was taken on 9/20/2010

Blue indicates wet weather sampling event

Table 4.2: *Great Brook 2010 water quality monitoring results*

Date	Temp. (C)	DO (ppm)	TP (ppm)	*E. coli* (col/100mL)
6/28/2010	16.1	9.43	16	1046
8/16/2010	18.1	7.3	ns	8
9/27/2010	13.1	8.3	7*	7.5
2010 Average	**15.8**	**8.3**	**11.5**	**353.8**
2009 Average	*14.6*	*10.0*	*9.0*	*14.5*

ns= not sampled

*TP sample was taken on 9/20/2010

Blue indicates wet weather sampling event

5. KLWA Ponds Water Quality Results

In 2010, 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 2010 monitoring data, water quality is generally good in the 6 ponds. According to 2010 sampling results (Table 5.1, p.14), all but two of the six KLWA ponds sampled had an average water clarity better than the Maine average of 5.14 meters. All but Farrington, Horseshoe, and Trout ponds showed decreased TP levels since 2009. All ponds are consistently lower than the state average for alkalinity making the watershed highly susceptible to changes in pH. Only Farrington Pond saw a decrease in alkalinity by 2 ppb from 2009 to 2010, the others are consistent over the years. Water clarity in all ponds but Farrington improved in 2010, which is particularly positive when compared to the trend of declining clarity noted over the previous two years. Water sampling results during this sampling season were relatively stable from month to month, most likely due to the lack of rainfall and consistently warmer temperatures. Trout Pond was the most variable pond between the June and August sampling events by far, while Cushman was the most stable. 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. The alkalinity of Bradley Pond has remained at 4 ppm since 2007 which is well below the Maine average of 12 ppm. This indicates that Bradley Pond is susceptible to changes in pH. At 14.5 SPU, Bradley is the second most colored pond in the Kezar Lake watershed showing considerable improvement since 2009 when it tested 23.5 SPU. In August 2010, dissolved oxygen (DO) in Bradley Pond dropped below the aquatic life standard of 5 ppm between 4 and 5 meters depth (Figure 5.1) which is an improvement since 2009 and 2008. DO remains above 5 mg/L during the June sampling date through 6 meters. Overall, the water quality of Bradley Pond has improved when compared to 2009 data and is very similar to 2008 data in all parameters but color. Secchi disk transparency increased from 4.7 to 5.4 m (2008 clarity was 5.5 m) and, Chl-a decreased from 4.1 to 3.9 ppb, matching 2008 results.

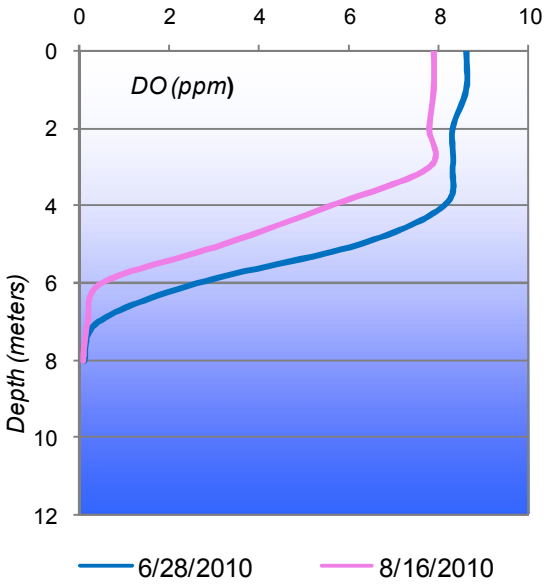

Figure 5.1: *Bradley Pond 2010 DO profile*

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 2010, as in 2009, minimal DO depletion was observed during both sampling events at the bottom of the deepest area of the pond (Figure 5.2). This finding is consistent with recent and historical late summer DO profiles. The water quality of Cushman Pond has changed little since 2007. TP decreased from 2009 value of 10 ppb to 4.5 ppb, which is 0.5 ppb higher than in 2008. Alkalinity has remained stable at 5.0 ppm after fluctuating in past years. The alkalinity of Cushman Pond, like all water bodies in the Kezar Lake watershed, is below average, however, Cushman appears to be the most stable watershed pond through the year.

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. In 2010, the TP concentrations in Farrington Pond remained constant at 2009 levels of 13.5 ppb. Surprisingly, Chl-a, which is a measure of algal abundance, has consistently declined since 2007 and is now at the lowest level of 3.9 ppb, 2.2 ppb lower than 2009. Alkalinity, color, and Secchi disk transparency all decreased slightly compared to 2009 values. DO depletion is not an issue for this pond, primarily because of the pond's shallow depth (Figure 5.3).

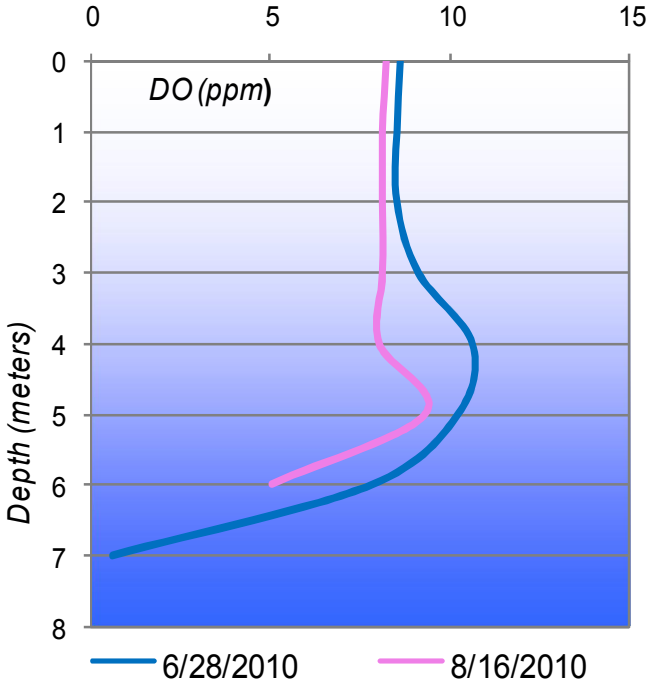

Figure 5.2: *Cushman Pond 2010 DO profile*

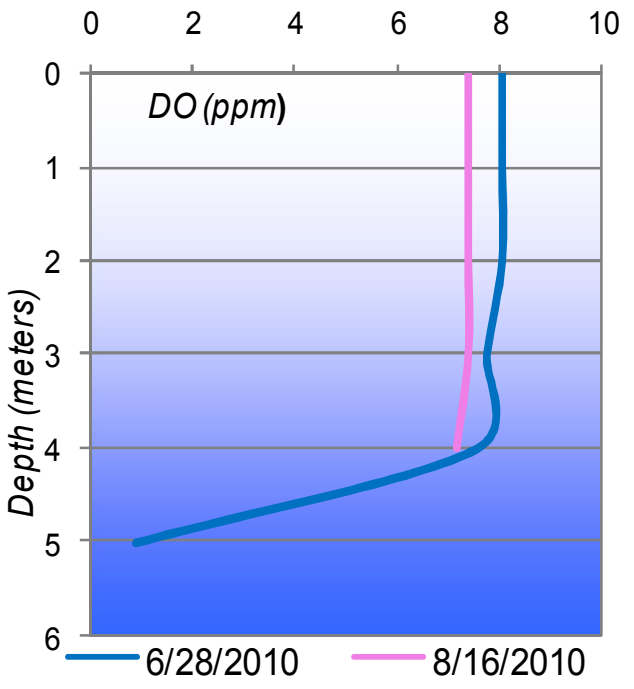

Figure 5.3: *Farrington Pond 2010 DO profile*

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 very low below 4 meters (13.7 feet) in the summer months (Figure 5.4), a meter lower than in 2009. TP concentrations have been declining since 2008 and were at 8.5 ppb in 2010, still higher than a low of 3.5 in 2007. Chl -a was 4.2 ppb in 2010, second highest of the watershed ponds. Heald Pond is at risk for algae blooms if readings continue to increase. Alkalinity remained at 5 ppm making it one of the most resistant ponds in the watershed to changes in pH..

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 over the years, and is in line with historical results as well. Chl-a and TP have continued to increase. 2010 results show an increase since 2009 of 1.3 ppb and 0.5 ppb, respectively. Horseshoe Pond has the highest Chl-a concentration in the six ponds and may be at risk for algae blooms if trends continue. DO depletion is an issue for this pond. During both June and August events the DO concentration was below 5 ppm in the bottom 6 meters of this ~12-meter deep pond (Figure 5.5).

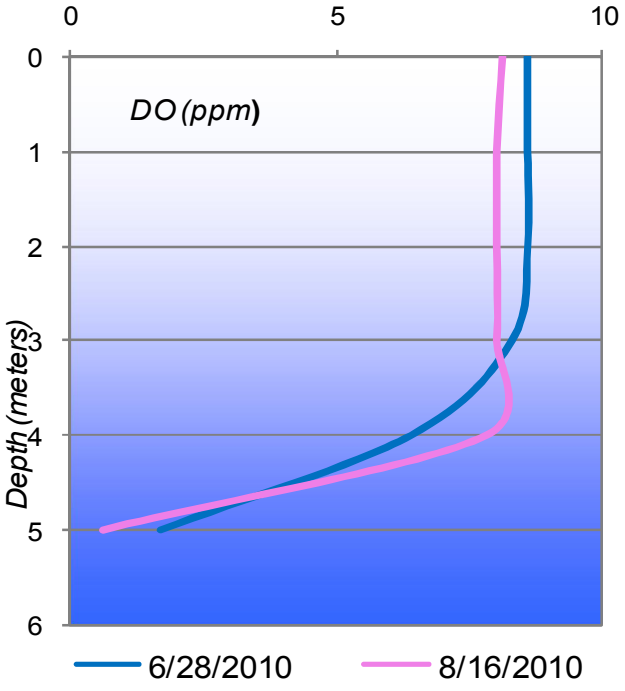

Figure 5.4: *Heald Pond 2010 DO profile*

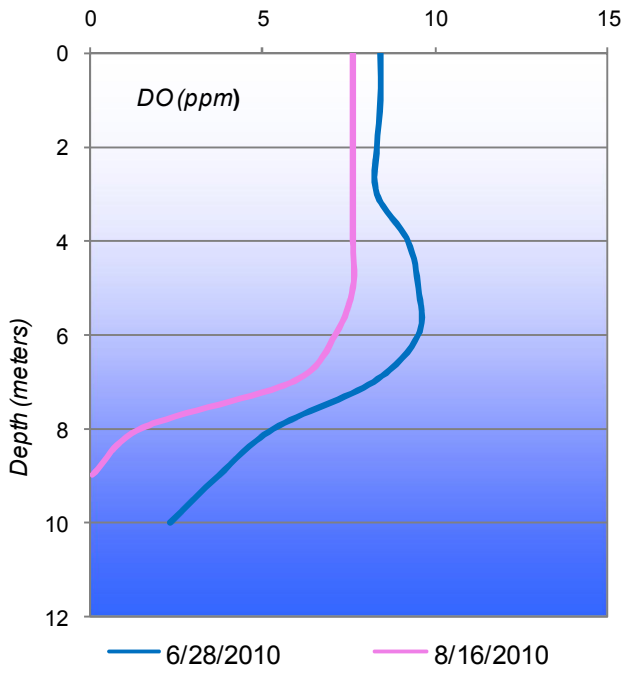

Figure 5.5: *Horseshoe Pond 2010 DO profile*

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. In 2010, water clarity increased 0.9 m to 8.13 m, closer to the best reading of 8.45 m in 2006. Water clarity and alkalinity have both improved but TP, Chl-a and color showed a slight increase over 2009 data. Trout Pond has the best water quality of all the small ponds in the Kezar Lake Watershed. However, variability between sampling events was high. For example, in June 2010 TP and Chl-a were 10 and 1 ppb, respectively. Results from the August event were 3 and 6.7 ppb, respectively. Large differences between sampling events could mean that the lake is very susceptible to external influences such as weather, temperature, and flow. Unlike the water chemistry results, DO was relatively unchanged through the summer months and comparable to 2009 patterns. Severe DO depletion was observed below 13 m in June and 11 m in August, which is a meter lower than 2009.

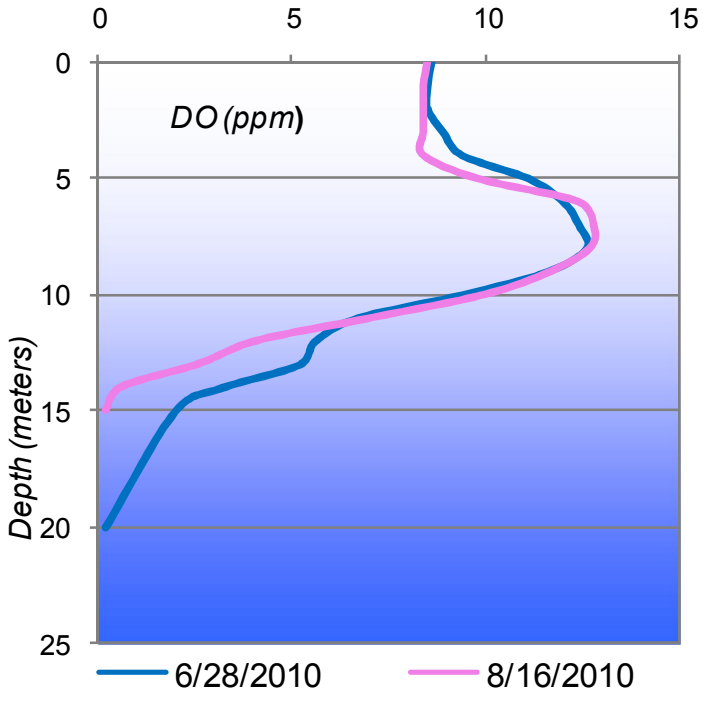

Figure 5.6. Trout Pond 2010 DO profile

Figure 5.6: *Trout Pond 2010 DO profile*

Pond	SDT (m)	TP (ppb)	Chl-a (ppb)	Alkalinity (ppm)	Color (SPU)
Bradley	5.44	7.5	3.9	4.0	14.5
Cushman	5.86	4.5	1.8	5.0	8.0
Farrington	4.55	13.5	3.9	3.0	10.0
Heald	4.88	8.5	4.2	5.0	16.0
Horseshoe	6.82	7.0	4.4	3.0	8.0
Trout	8.13	6.5	3.9	3.5	10.0
Maine Average	***5.14***	***12***	***5.3***	***12***	***28***

Table 5.1: *KLWA Ponds 2010 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***

Table 5.2: *KLWA Ponds 2009 water quality monitoring results*

5. KLWA 2010 Watershed Survey

On June 5, 2010 KLWA, with the help of FB Environmental and Maine DEP, kicked off a watershed survey project as part of a long-term effort to keep Kezar Lake clean for future generations to enjoy. The goal of the first part of the project was to revisit sites with uncontrolled soil erosion and polluted runoff to the lake identified in a 2000 watershed survey. On the day of the survey, a volunteer training workshop was held in order to provide the participants with the background information needed to identify and record soil erosion sites. Following the training, the 20 volunteers and 8 technical leaders were assigned to one of 7 survey sections. Teams of volunteers walked the roads, driveways, residential properties, and other developed areas within the Kezar Lake watershed. Volunteers revisited over 100 "high and medium impact" sites from the watershed survey conducted in 2000. Of the sites visited, 34% (36 sites) were no longer a problem, 34% (36 sites) were still rated high or medium impact, and the remaining sites were low impact (a small percentage could not be located).

FBE and DEP are currently summarizing the watershed survey results. The final report will be distributed to the community. The next steps in this project may include applying for a grant fix problems identified in the survey and/or applying for a grant to expand the survey to the rest of the watershed.

Scenes from the 2010 Watershed Survey training and field assessment.

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