2023

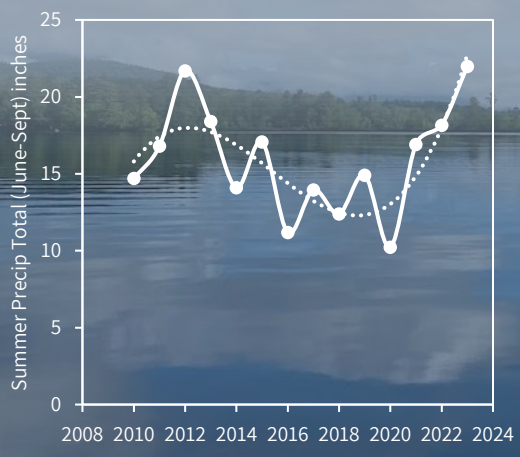
KEZAR LAKE
WATER QUALITY REPORT

A REPORT ON THE WATER QUALITY OF KEZAR LAKE, NINE STREAMS, AND SIX WATERSHED PONDS

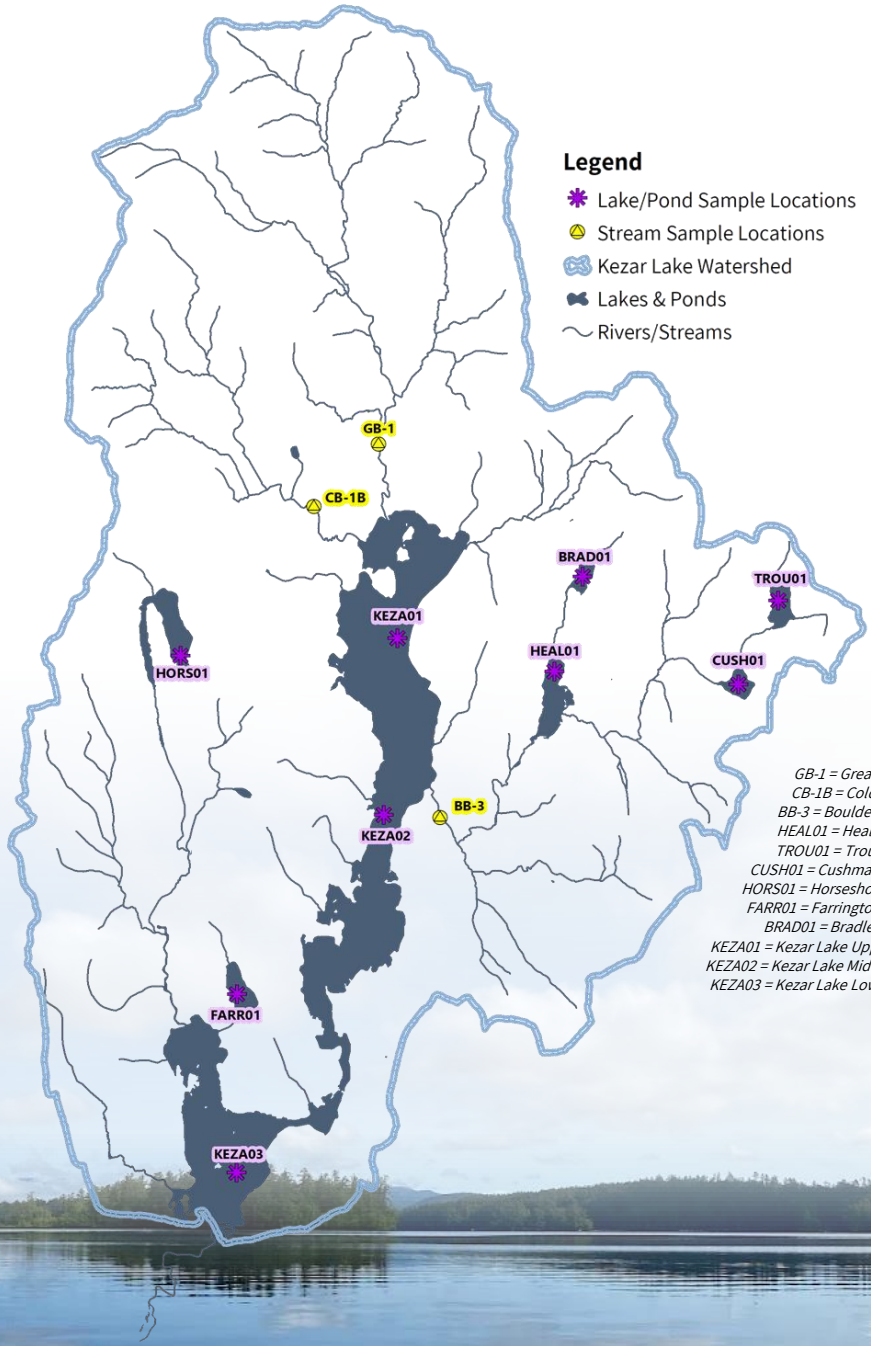
Kezar Lake remains one of Maine's cleanest and clearest lakes, with above average water quality and clarity.

Historically and in the current monitoring year, Kezar Lake's trophic state indicators (water clarity, total phosphorus, and chlorophyll-a) have been better than statewide averages. Water clarity is improving in all three basins and chlorophyll-a is improving in the upper basin. The water columns of all three basins of Kezar Lake were well-oxygenated, which helped coldwater fish species survive the warmest months of the year. However, total phosphorus and chlorophyll-a in 2023 at the three basins were worse than historic averages. Some other concerning water quality conditions were observed at the ponds, including higher-than-normal total phosphorus, chlorophyll-a, and color for most of the ponds, as well as shallower-than-normal water clarity at Bradley Pond, Heald Pond, and Horseshoe Pond. Refer to the KLWA website for long-term data and trends.

While the water quality of Kezar Lake and its tributaries and ponds is generally excellent, these waterbodies are sensitive to change. Continuing to monitor Kezar Lake, the three streams, and six ponds will help KLWA better understand long and short-term trends in water quality and maintain the high quality of the water in the Kezar Lake watershed for future generations.



Summers were becoming drier but have steadily become wetter since 2020. Summer 2023 was the wettest year on record in the last 14 years. Data from Fryeburg Weather Station (KIZG).



LAKE & PONDS **SAMPLING**

For lake and pond deep spot monitoring, FBE, with the help of KLWA volunteers, collected temperature and dissolved oxygen profiles, Secchi disk transparency readings (or water clarity), and integrated epilimnetic core samples in June and August (and September for Kezar Lake's three basins). Core samples were analyzed for total phosphorus, chlorophyll-a, and chemical parameters (total alkalinity, pH, and color). Sampling was conducted in accordance with standard methods and procedures for lake monitoring established by the Maine Department of Environmental Protection (Maine DEP), the US Environmental Protection Agency (USEPA), and Lake Stewards of Maine (formerly VLMP). Laboratory samples were analyzed at the Health and Environmental Testing Lab (HETL) in Augusta, ME. In 2023, water quality was generally excellent in the lake and ponds and better than the average water quality of Maine lakes, with some exceptions. The record wet conditions caused higher-than-normal color and chlorophyll-a at most sites and higher-than-normal total phosphorus and shallower-than-normal water clarity at a few sites. Refer to the KLWA website for long-term data and trends.

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

Waterbody	Water Clarity (m)		Total Phosphorus (ppb)		Chlorophyll-a (ppb)	
	Historical[b]	Recent 2023[c]	Historical[b]	Recent 2023[c]	Historical[b]	Recent 2023[c]
Kezar Lake - Upper Bay	7.8	7.1	5.0	8.0	2.0	2.0
Kezar Lake - Middle Bay	7.4	7.5	5.0	7.0	2.0	3.0
Kezar Lake - Lower Bay*	3.2	3.5	9.0	8.0	2.3	3.0
Bradley	5.1	4.3	9.0	10.0	4.0	5.3
Cushman	5.5	5.4	7.0	6.0	2.3	3.5
Farrington*	4.4	5.1	14.0	13.0	5.8	6.0
Heald	4.6	3.5	10.0	14.0	4.0	4.5
Horseshoe	6.8	6.2	7.0	6.5	3.3	4.5
Trout	7.3	6.8	5.0	5.5	1.8	1.0
Maine Lakes[a]	4.8		12.0		5.4	

Waterbody	pH		Alkalinity (ppm)		Color (PCU)	
	Historical[b]	Recent 2023[c]	Historical[b]	Recent 2023[c]	Historical[b]	Recent 2023[c]
Kezar Lake - Upper Bay	6.7	6.7	4.0	4.0	10.0	22.0
Kezar Lake - Middle Bay	6.6	6.8	4.0	4.0	10.0	24.0
Kezar Lake - Lower Bay*	6.7	6.7	4.0	4.0	13.0	27.0
Bradley	6.4	6.5	4.0	4.0	23.0	34.0
Cushman	6.7	6.5	5.0	5.0	11.0	15.5
Farrington*	6.7	6.7	4.0	4.0	17.0	20.5
Heald	6.7	6.6	5.0	5.0	24.0	51.0
Horseshoe	6.7	6.6	3.0	3.0	10.0	17.0
Trout	6.6	6.6	4.0	3.5	9.0	15.5
Maine Lakes[a]	6.8		11.8		28.0	

** Water clarity limited by lake depth - Secchi disk hits bottom*

[a] Median values calculated from the Lake Stewards of Maine, 2019, Distribution of Lake Water Quality Data. Includes datapoints through 2018. https://www.lakestewardsofmaine.org/distribution-of-water-quality-data.

[b] Median historical values calculated by FBE from all data obtained by the MEDEP through 2018; duplicate values/days were averaged; only epicore samples were used in the analyses; includes FBE-collected-only data for 2019-23

[c] Median values calculated by FBE from 2023 data

Red cells indicate median values from 2023 showing worse water quality compared to the historic median

Dark blue cells indicate median values from 2023 showing better water quality when compared to the historic median

Light blue cells indicate median values from 2023 showing no change from or within one standard deviation of the historic median

MONITORING **BUOYS**

METHODS

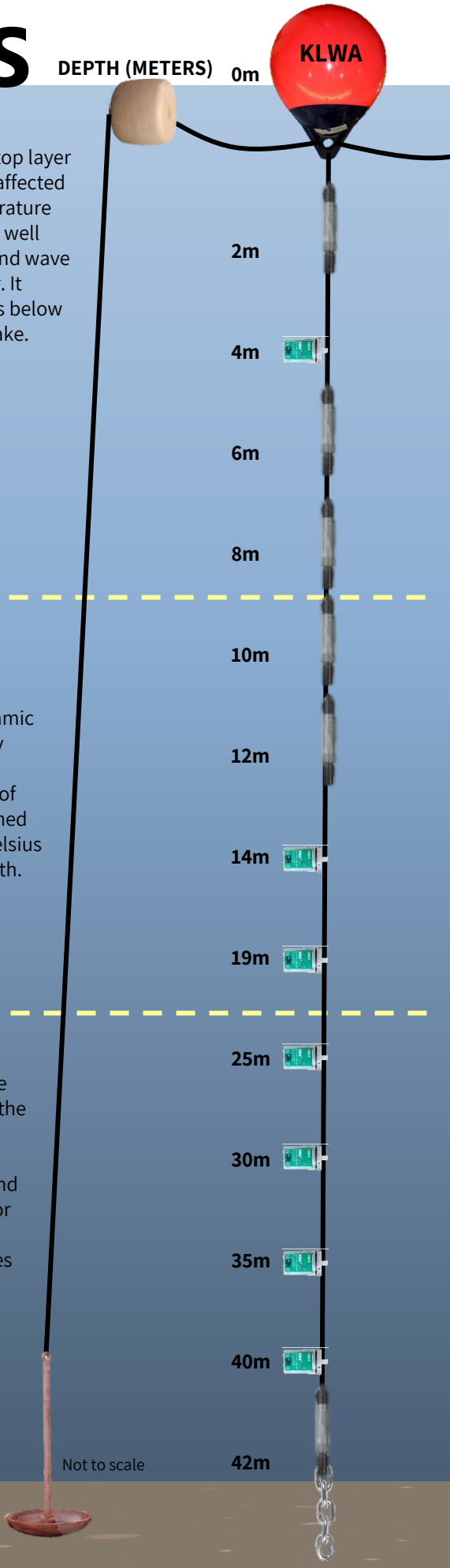
FBE and KLWA deployed a buoy with six Onset HOBO® U-26 dissolved oxygen and temperature loggers at 2, 6, 8, 10, 12, and 42 meters below the surface at the upper basin (all recording at 30-minute intervals from May to November). These depths equate to critical layers in the water column, which becomes thermally stratified in summer at the upper basin.

Onset HOBO® temperature pendants were also deployed at 4, 14, 19, 25, 30, 35, and 40 meters below the surface at the upper basin, recording temperature at 15-minute intervals continuously year-round (pendants were left over winter at 2, 4, 6, 10, 19, 30, and 40 meters below the surface at the upper basin).

The loggers were cleaned and downloaded during each sampling event. Logger data presented here shows data for the entire water column using R statistical software. These data will serve as a baseline for future comparisons of water quality to assess long-term changes in temperature and dissolved oxygen. Until more data are collected over the next few years to begin to account for interannual variability, no major conclusions or analyses can be made on this limited dataset aside from general patterns.

WHY DOES IT MATTER?

It is important to track temperature and oxygen throughout the water column because both greatly affect the amount of suitable habitat for aquatic life in the lake. A barrier of low oxygen (< 5 ppm) prevents fish from seeking refuge in cooler, bottom waters when surface waters heat up in summer. While thermal stratification and depletion of oxygen in bottom waters is a natural phenomenon, it is important to keep tracking these parameters to make sure the extent and duration of low oxygen does not change drastically as a result of human disturbance and climate change. Additionally, low oxygen at the bottom sediment-water interface can cause a chemical reaction that releases phosphorus back into the water column to serve as food for algae, which can degrade water quality.



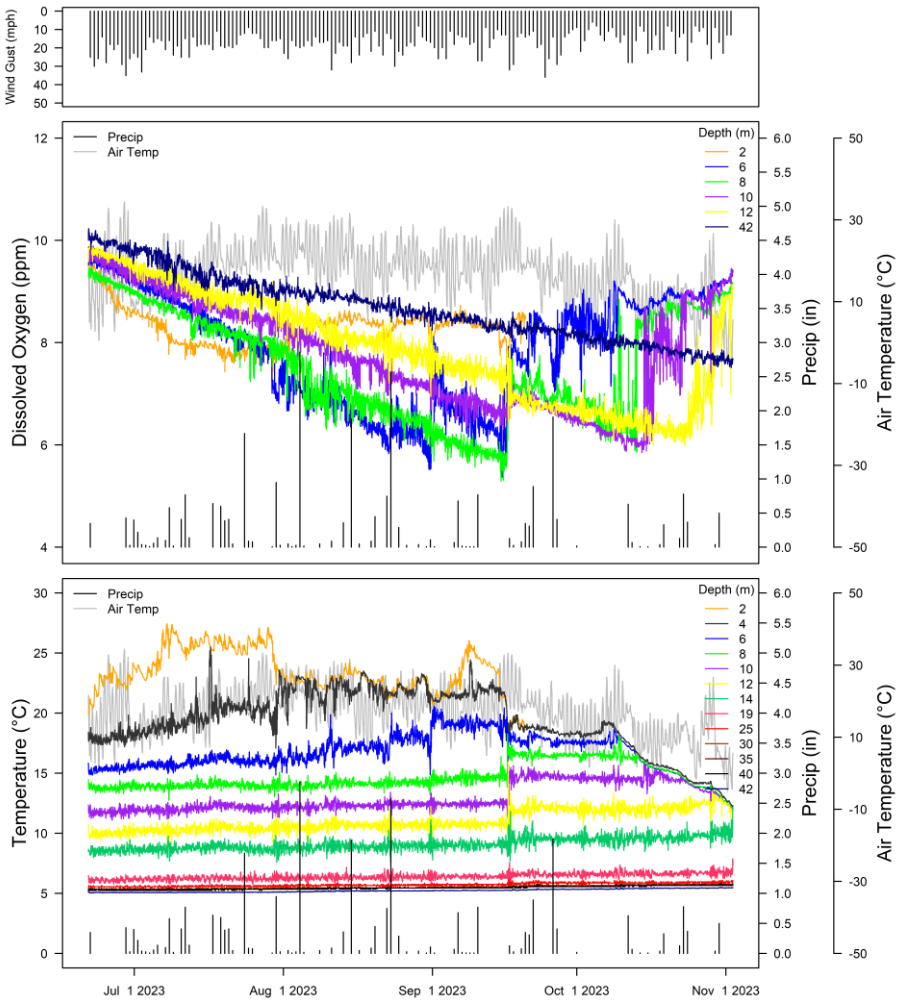
EPILIMNION
The epilimnion is the top layer of lake water directly affected by seasonal air temperature and wind. This layer is well oxygenated by wind and wave action during summer. It extends to 8-10 meters below the surface in Kezar Lake.

METALIMNION
The metalimnion or thermocline is the markedly cooler, dynamic middle layer of rapidly changing water temperature. The top of this layer is distinguished by at least a degree Celsius drop per meter of depth.

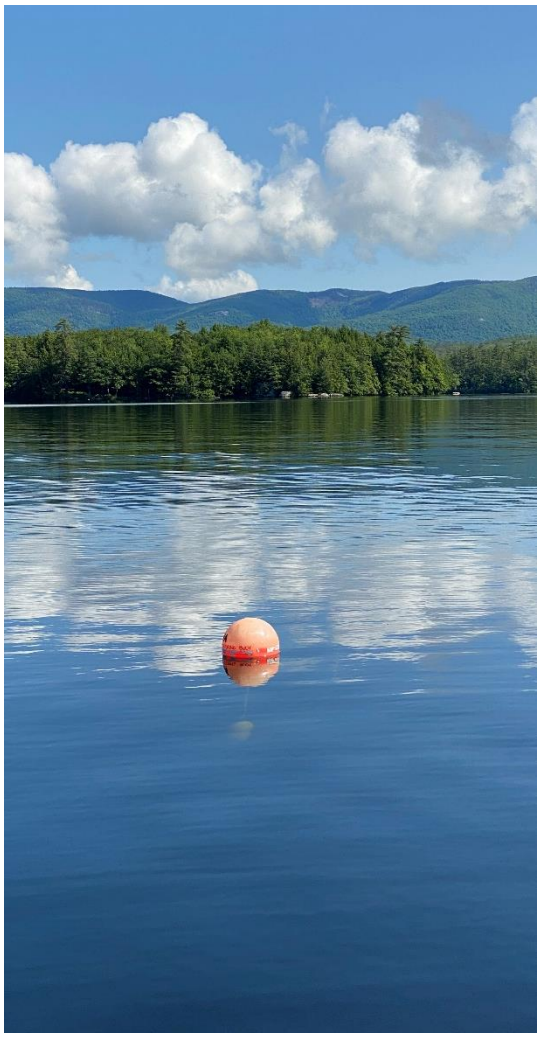
HYPOLIMNION
The hypolimnion is the bottom-most layer of the lake. It experiences periods of low oxygen during stratification and is devoid of sunlight for photosynthesis. Kezar Lake rarely experiences low oxygen even at 45 meters.

UPPER BAY **BUOY**

Historically, Kezar Lake has experienced some DO depletion in the upper and middle basins in summer. In 2023, DO depletion (<5 ppm) at lake bottom was not evident at the upper and middle basins. In April and December following turnover events (not shown), the upper basin experienced relatively uniform temperature from the surface to the lake bottom. Following spring turnover, the water column began to stratify with warm surface waters reaching a maximum of 27.5°C at 2 meters depth on 7/7/23. Overall, water temperature was cooler and dissolved oxygen was lower in the upper portion of the water column in 2023 compared to previous years, likely due to the wetter season creating highly turbid water that inhibited growth. The upper basin had not yet experienced complete fall turnover when the loggers were removed on 11/2/23, as only the upper 12 meters had been mixed at that point. Year-round temperature data at the upper basin showed that fall turnover occurred on 12/1/22 and spring turnover occurred on 4/13/23 following ice-out (data not shown). Formation of the metalimnion (thermocline) began between 6 and 12 meters below the surface at the upper and middle basins.



Daily maximum wind gust (top) and sub-hourly dissolved oxygen (middle) and water temperature (bottom) readings taken every 30 minutes during the summer at various depths at the deep spot of Kezar Lake's upper basin. Logger malfunction so no data at 2 meters after 9/20/23. Precipitation, air temperature, and wind gust data were obtained from NOAA NCEI QCLCD Fryeburg Eastern Slopes Regional Airport (54772/IZG).



TRIBUTARY **MONITORING**

For tributary monitoring, three sites (Great, Boulder, and Cold Brooks) were sampled in June and September for temperature, dissolved oxygen, pH, *E. coli*, and total phosphorus (results in table below).

Water temperatures fell below 24°C, which is excellent for coldwater fish species.

Dissolved oxygen readings in the brooks for 2023 averaged above 7 ppm, which is the Maine DEP criterion for Class A streams and the minimum concentration required by sensitive aquatic species for survival and growth. Note that dissolved oxygen is lowest before 8 am; mid-day sampling usually represents best-case conditions.

pH in the brooks was not significantly different than historical averages.

E. coli measured in 2023 was below the Maine DEP instantaneous criterion of 236 col/100mL and the geometric mean of 64 col/100mL for all three brooks. *E. coli* in Cold Brook was higher-than-normal compared to the historic average, which may be attributed to the record wet season.

Total phosphorus in the brooks has remained relatively stable over time, with greater variability historically in Boulder Brook.

Refer to the KLWA website for long-term data and trends.


Great Brook


Boulder Brook


Cold Brook

Waterbody	Temp (°C)		DO (mg/L)		pH		E. coli (col/100mL)		TP (ppb)	
	Historical[b]	Recent 2023[c]	Historical[b]	Recent 2023[c]	Historical[b]	Recent 2023[c]	Historical[b]	Recent 2023[c]	Historical[b]	Recent 2023[c]
Great Brook (GB-1)	15.0	15.0	9.3	9.9	6.4	6.6	21	15	6	7
Boulder Brook (BB-3)	18.2	19.2	7.9	7.9	6.3	6.0	26	21	18	14
Cold Brook (CB-1B)	16.1	16.1	9.6	9.9	6.6	6.6	16	30	12	11

[b] *Median historical values calculated by FBE from all data obtained by the MEDEP through 2018; duplicate values/days were averaged; only epicore samples were used in the analyses; includes FBE-collected-only data for 2019-23*

[c] *Median values calculated by FBE from 2023 data*

Red cells indicate median values from 2023 showing worse water quality compared to the historic median

Dark blue cells indicate median values from 2023 showing better water quality when compared to the historic median

Light blue cells indicate median values from 2023 showing no change from or within one standard deviation of the historic median



Kezar Lake
WATERSHED ASSOCIATION

Special thanks to Heinrich Wurm and Steve Lewis (KLWA Water Quality Committee), Terri Mulks (Camp Susan Curtis - Trout Pond), Chris Brink (Kezar Lake), the Taylor Family (Farrington Pond), Mrs. Sundstrom (Heald Pond), and the Emond Family (Horseshoe Pond) for providing access, time, and/or equipment for the 2023 water quality monitoring season.

PREPARED BY:
FB Environmental Associates
97A Exchange Street, Suite 305
Portland, Maine 04101