Cave Run Lake (CRR) Water Quality Summary

Summary of 2020 Water Quality Results

Cave Run Lake had eight exceedance events of KY's water quality criteria for temperature at the tailwater (CRR10000) in 2020. Total phosphorus levels at all sample locations exceeded the USEPA nutrient criteria, while only one total nitrogen sample exceeded USEPA criteria. TSI for the three indices classified the lake as mesotrophic or eutrophic, indicating varying levels of biological activity potential. Finally, our sampling showed there were no samples with cyanobacteria cell counts over 100,000 cells/mL at the time of the sampling event. The elevated nutrient levels and eutrophic TSI classification indicate there is a potential for HAB development in the lake.

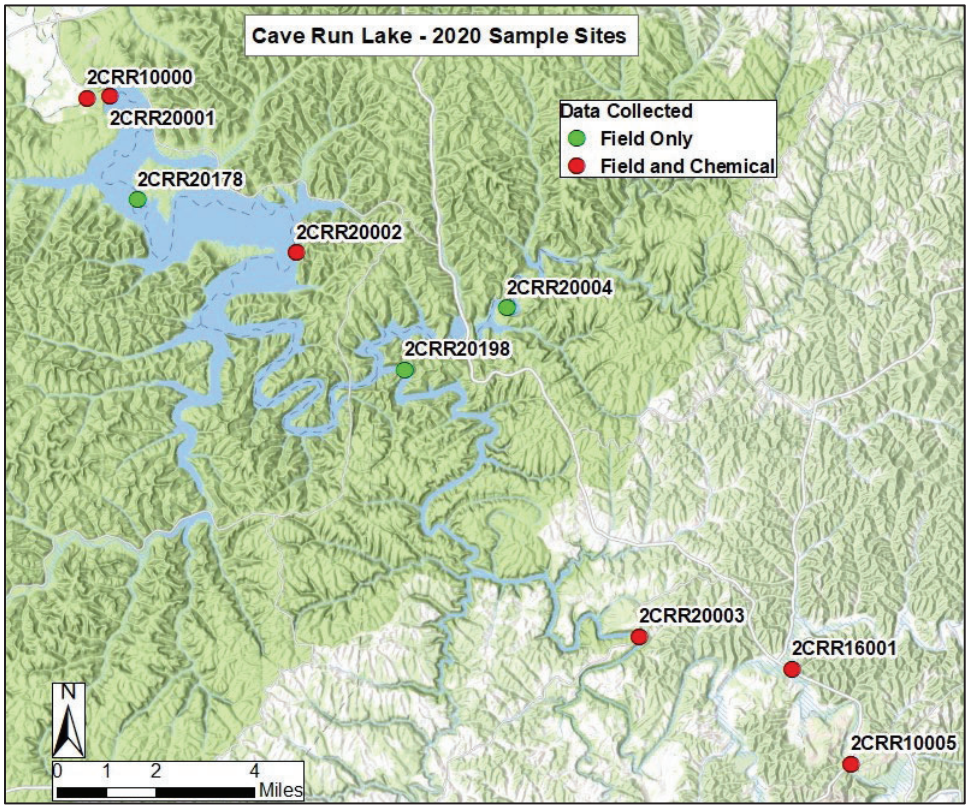

Figure 1. Water quality sampling locations for Cave Run Lake in 2020.

2020 Activities

In 2020, one sampling event was conducted at Cave Run Lake. Field data and chemical samples were collected at six sample locations, and field data was collected at 3 sample location (Figure 1). Chlorophyll and phytoplankton were collected at two sites, and zooplankton samples were collected at the damsite (CRR20001).

Additionally, temperature and dissolved oxygen (DO) profiles were collected by the project staff at the damsite and tailwater approximately every two weeks from late May through late November.

Exceedances of KY State Water Quality Criteria

There were eight exceedance events of KY state water quality criteria for temperature at the tailwater in 2020 based on provisional USGS gage data. There were no other exceedances of KY state WQ criteria.

Tailwater Temperature and DO Conditions

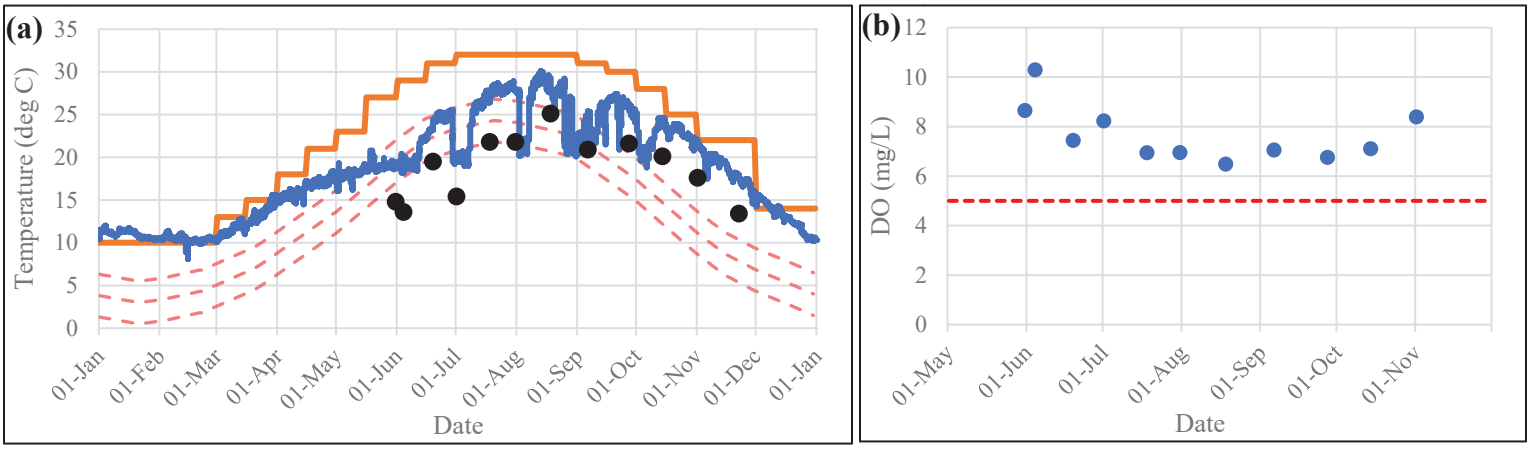

Figure 2. Cave Run Lake tailwater temperature and DO data. (a) Tailwater temperature data collected by project staff in 2020 is represented by the black dots. The blue line represents USGS gage data (provisional) from a gage downstream from the project. The temperature guide curve is represented by the dashed red lines, and the orange line represents the KY water quality criteria for temperature. (b) Tailwater dissolved oxygen data collected in 2020 is represented by the blue dots. The KY water quality criteria for DO is represented by the dashed red line.

Tailwater data was compared to KY state water quality criteria for temperature and to the Louisville District's temperature guide curve for Cave Run Lake (Figure 2a). According to the provisional USGS data, tailwater temperature exceeded the state criteria for temperature on multiple occasions: January 1-February 29, March 28, March 29-30, March 31, December 1-8, December 9, December 11, and December 12-13. These events totaled to 76 days (or 20% of the year) where for some or all of the day, the tailwater did not meet state temperature criteria. During this time, the reservoir was de-stratified; therefore, nothing could be done operationally to prevent these exceedances. In addition, tailwater temperatures fell outside the guide curve January through early May and most of the time from mid-July through the end of the year. The WQ Program will use these findings to inform future operational decisions to improve performance of downstream temperature management wherever possible. Tailwater dissolved oxygen levels (Figure 2b) did not exceed state criteria at any time throughout the year.

Nutrient Analyses

Nutrient data, including total nitrogen (TN) and total phosphorus (TP) data, were collected at all sample sites in 2020. The 2020 TP and TN values were compared to historical data from 2012 through 2019 (Figure 3). The TP and TN values at each site were also compared to their respective USEPA recommended criteria. Nutrient levels are an area of concern because elevated nutrients can lead to high biological activity, especially with respect to HABs.

Total Phosphorus

2020 TP values at all sites were higher than historical medians and were near or above the top of the distribution of historical values for each location. Also, 2020 TP levels at all sites were above the USEPA recommended nutrient criteria for the respective locations.

Total Nitrogen

2020 TN values at all sites were near or below the historical medians and were at or below the distribution of historical values for each location. Only one 2020 TN value exceeded the USEPA recommended nutrient criteria.

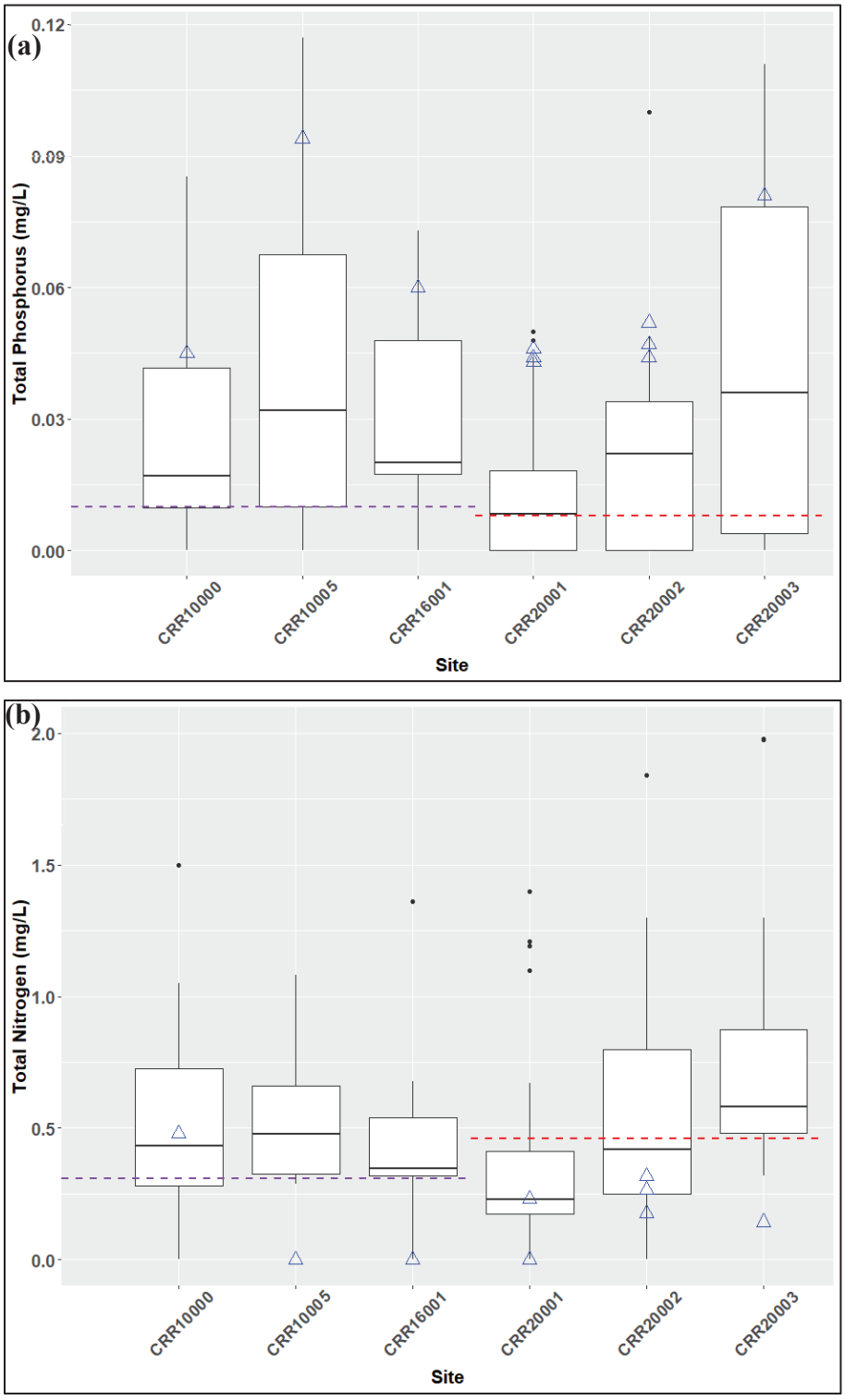

Figure 3. Comparison of 2020 Cave Run Lake nutrient data to historical samples and nutrient criteria. Boxplots represent data collected in 2012-2019 and blue triangles represent 2020 data. Purple and red dotted lines represent USEPA recommended nutrient criteria for streams and reservoirs, respectively. (a) Comparison of total phosphorus data. (b) Comparison of total nitrogen data. Two outliers (values range from 2.39 to 6.3 mg/L) were excluded to make plot easier to interpret.

Cyanobacteria Data, HABs, and Trophic State Index

Cyanobacteria Data

8 phytoplankton samples were collected from various depths at 2 sites. Total cyanobacteria cell counts did not exceed 100,000 cells/mL (guideline value for moderate health risk from the World Health Organization's Guidelines for Safe Recreational Water Environments [2003]) at Cave Run Lake. These results indicate Cave Run Lake did not have cell count levels potentially indicative of a HAB at the time of sampling.

Harmful Algal Bloom (HAB) Response

The KY Division of Water (KDOW) is the lead agency for HAB response in Kentucky. KDOW did not issue any advisories for HABs at Cave Run Lake in 2020.

TSI

The trophic state indices for Secchi depth [TSI(SD)], chlorophyll-a [TSI(CHL)], and total phosphorus [TSI(TP)] were calculated for six reservoir sites at Cave Run Lake (Table 1). The mean categories of all three indices ranged from mesotrophic to eutrophic, indicating moderate to high levels of biological activity potential.

Table 1. Summary of calculated trophic state indices at Cave Run Lake.

	Mean Score (range)	**Mean Category (Range)**
TSI(SD)	60 (47-73)	**Eutrophic** (Mesotrophic-Hypereutrophic)
TSI(CHL)	39 (31-46)	**Mesotrophic** (Oligotrophic-Mesotrophic)
TSI(TP)	62 (58-68)	**Eutrophic** (Eutrophic-Hypereutrophic)