Barren River Lake (BRR) Water Quality Summary

Summary of 2020 Water Quality Results

Barren River Lake had no exceedances of KY's water quality criteria at the tailwater (BRR10000). Total phosphorus and total nitrogen levels at all sample locations exceeded the USEPA nutrient criteria. TSI for all three indices classified the lake as eutrophic or hypereutrophic, indicating a high level of biological activity. Finally, our sampling showed cyanobacteria cell counts over 100,000 cells/mL in only one sample at the time of the sampling event. While cell counts were under 100,000 cells/mL at most sites at the time of sampling, the elevated nutrient levels and eutrophic/hypereutrophic classification indicate there is a high potential for HAB development in the lake.

2020 Activities

In 2020, one sampling event was conducted at Barren River Lake. Field data and chemical samples were collected at 9 sample sites, and only field data was collected at 4 sites (Figure 1). Chlorophyll and phytoplankton were collected at 4 sites, and zooplankton samples were collected at the damsite (BRR20001).

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

Exceedances of KY State Water Quality Criteria

There were two exceedance events of KY state water quality criteria for temperature at the tailwater on January 11 and January 15-17. There were no other exceedances of KY state WQ criteria.

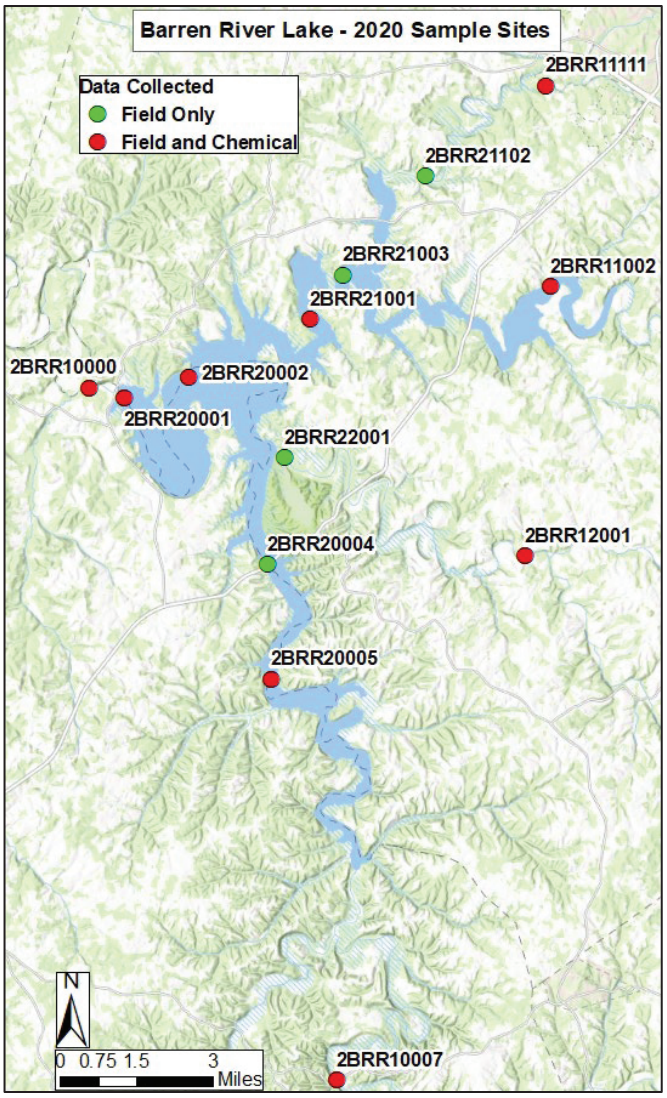

Figure 1. Water quality sampling locations for Barren River Lake in 2020.

Tailwater Temperature and Dissolved Oxygen Conditions

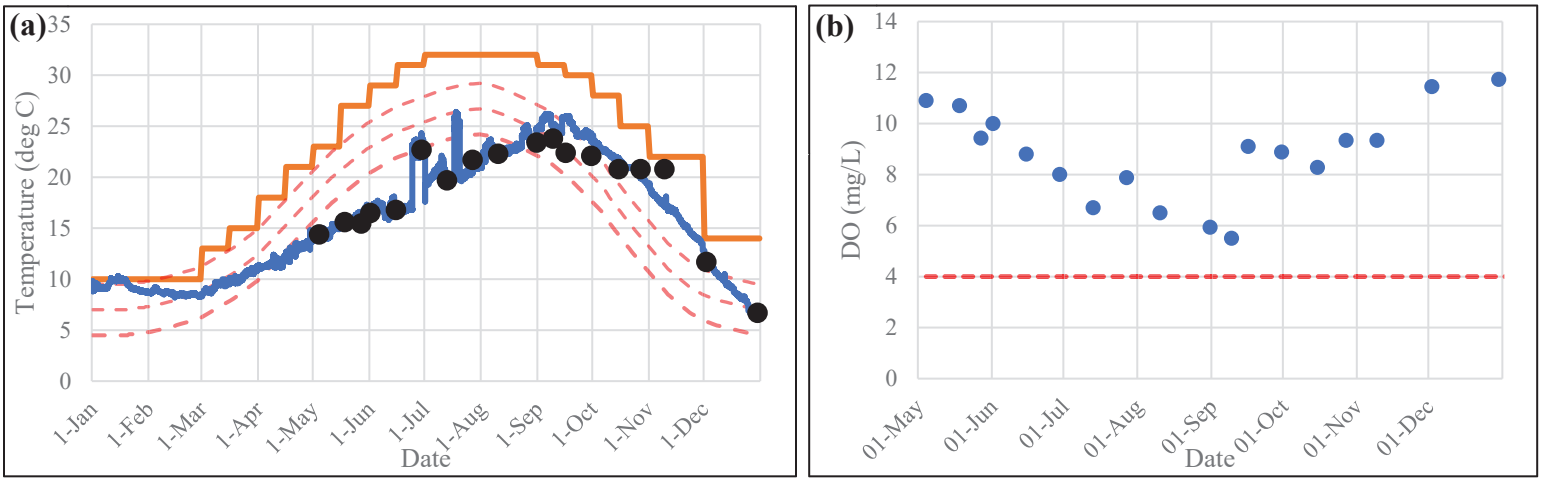

Figure 2. Barren River Lake tailwater temperature and dissolved oxygen data. (a) Tailwater temperature data collected by project staff in 2020 is represented by the black dots. The blue line represents USGS gage data (provisional) from a gage downstream from the project. The temperature guide curve is represented by the dashed red lines, and the orange line represents the KY water quality criteria for temperature. (b) Tailwater DO 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 Barren River Lake (Figure 2a). According to the provisional USGS data, tailwater temperature exceeded the state criteria for temperature on January 11 and January 15-17. During this time, the reservoir was de-stratified; therefore, nothing could be done operationally to prevent these exceedances. Also, tailwater temperatures fell outside the guide curve mid-April through mid-August and mid-October through early December. Maintenance issues with the selective withdrawal gates limited the capacity to operate for temperature; however, repairs have been made and LRL intends to utilize these gates to improve performance of downstream temperature management wherever possible. Tailwater DO levels did not exceed state criteria at any time throughout the year (Figure 2b).

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 and Figure 4). The TP and TN values at each site were 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. One site (BRR11111) exhibits considerably high levels of nutrients compared to the other sites. BRR11111 is just downstream the city of Glasgow and appears to have residential and industrial land-use within its drainage. Further investigation into the nutrient issues at this location is needed.

Total Phosphorus

2020 TP values at Barren River Lake were above the historical medians in all samples (except for BRR11111) and 2020 values were near the top or above the historical distribution for TP values. Also, 2020 TP levels at all sites were above the USEPA recommended nutrient criteria for the respective locations.

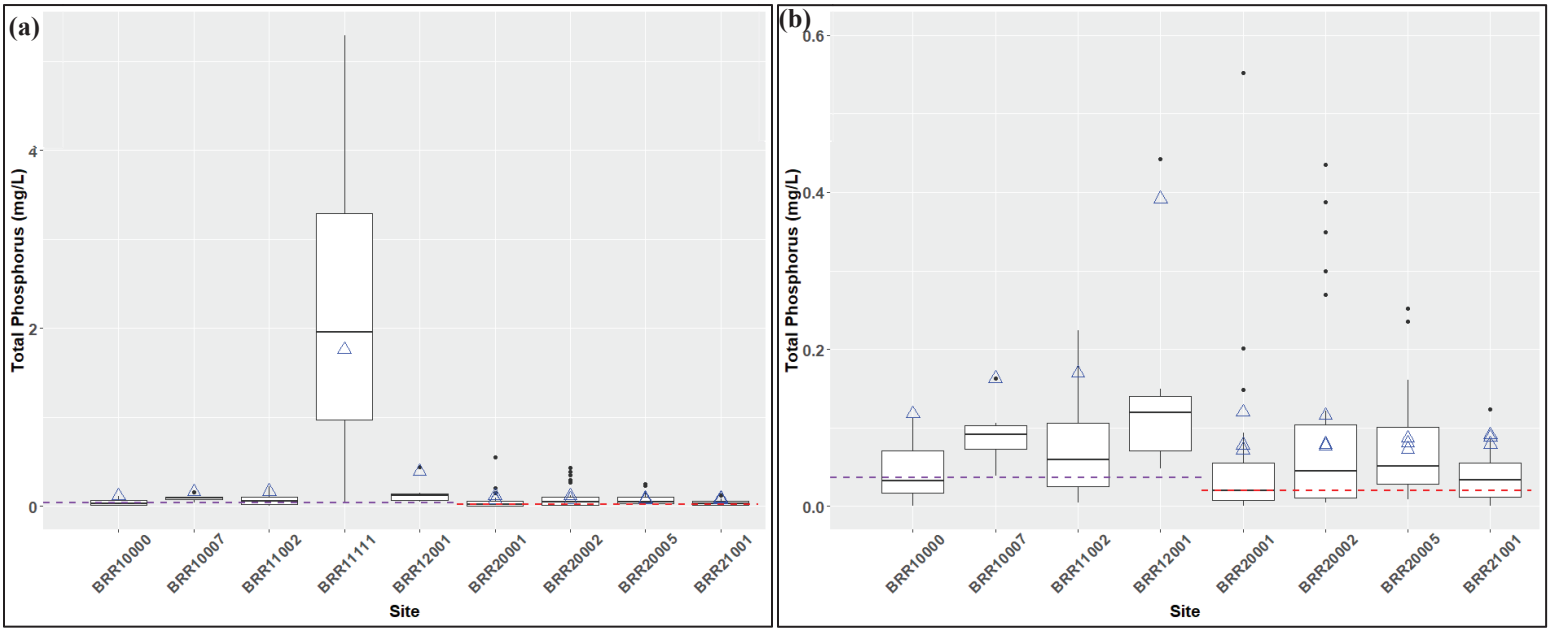

Figure 3. Comparison of 2020 total phosphorus (TP) data to historical samples and nutrient criteria. Boxplots represent data collected in 2012-2019 and blue triangles represent 2020 data. Purple and red dotted lines represent USEPA recommended nutrient criteria for streams and reservoirs, respectively. (a) Comparison of TP data from all BRR sites. (b) Comparison of TP data excluding data from site BRR11111.

Total Nitrogen

2020 TN values at Barren River Lake were above the historical medians in all samples (except for BRR11111) and 2020 values were near the top or above the historical distribution for each location. Also, 2020 TN levels at all locations were above the USEPA recommended nutrient criteria for the respective locations.

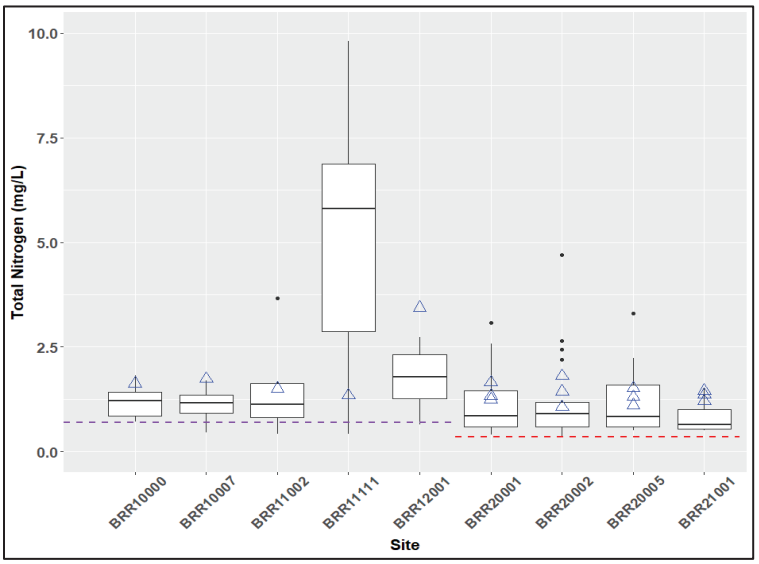

Figure 4. Comparison of 2020 total nitrogen data to historical samples and nutrient criteria. Boxplots represent data collected in 2012-2019 and blue triangles represent 2020 data. Purple and red dotted lines represent USEPA recommended nutrient criteria for streams and reservoirs, respectively. One historical outlier (value = 19.9 mg/L) was excluded to make the plot easier to interpret.

Cyanobacteria Data, HABs, and Trophic State Index

Cyanobacteria Data

12 phytoplankton samples were collected from various depths at 3 sites. Total cyanobacteria cell counts exceeded 100,000 cells/mL (guideline value for moderate health risk from the World Health Organization's Guidelines for Safe Recreational Water Environments [2003]) in 1 out of 12 samples collected. None of these samples exceeded 1,000,000 cells/mL. These results indicate Barren River Lake did not have cell count levels potentially indicative of a HAB for most samples 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 Barren River Lake in 2020.

Trophic State Index

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 Barren River Lake (Table 1). The mean category of all three indices ranged from eutrophic to hypereutrophic, indicating a high to very high level of biological activity.

Table 1. Summary of calculated trophic state indices at Barren River Lake.

	Mean Score (range)	**Mean Category (range, if different)**
TSI(SD)	60 (57-64)	**Eutrophic**
TSI(CHL)	59 (56-64)	**Eutrophic** (Moderately Eutrophic-Eutrophic)
TSI(TP)	67 (67-68)	**Hypereutrophic**