



Discrete Water Quality Monitoring: Water Year 2021

Background

The Obed Wild and Scenic River (OBRI) is a major free-flowing tributary in the upper Tennessee River system. The watershed comprises three major tributaries, Obed River (170 square miles [440.3 square kilometers]), Clear Creek (173 square miles [448.1 square kilometers]), and Daddys Creek (175 square miles [453.2 square kilometers]), in addition to smaller headwater streams. Obed Wild and Scenic River supports one of the most biologically diverse river systems of rare and threatened habitats, and wildlife resources (NPS 2015), including 54 native fish species, 11 freshwater mussels, and numerous other aquatic species. Among these are five imperiled fish species and two freshwater mussel species.

The Obed River is the only Wild and Scenic River in Tennessee. The Wild and Scenic Rivers Act established a policy to preserve rivers in a free-flowing condition, protect their water quality, and promote their outstandingly remarkable values for the benefit and enjoyment of present and future generations (Public Law 90-542). In recognition of their exceptional ecological and recreational significance, streams within the Obed Wild and Scenic River boundary were designated by the State of Tennessee as Outstanding National Resource Waters (ONRW).

Issues of Management Concern

The main issues negatively influencing water resources at Obed Wild and Scenic River are sedimentation, erosion, nutrient inputs, and contamination from land development, mineral extraction, wastewater discharge, agricultural and commercial forestry operations, and drainage from abandoned mines. In addition, water demands and urban development have increasingly affected the ecological and biological integrity of the park.



From left, damselfly larva, darter on a river bottom, and the Obed River in the fall. NPS photos / APHN staff.

Highlights

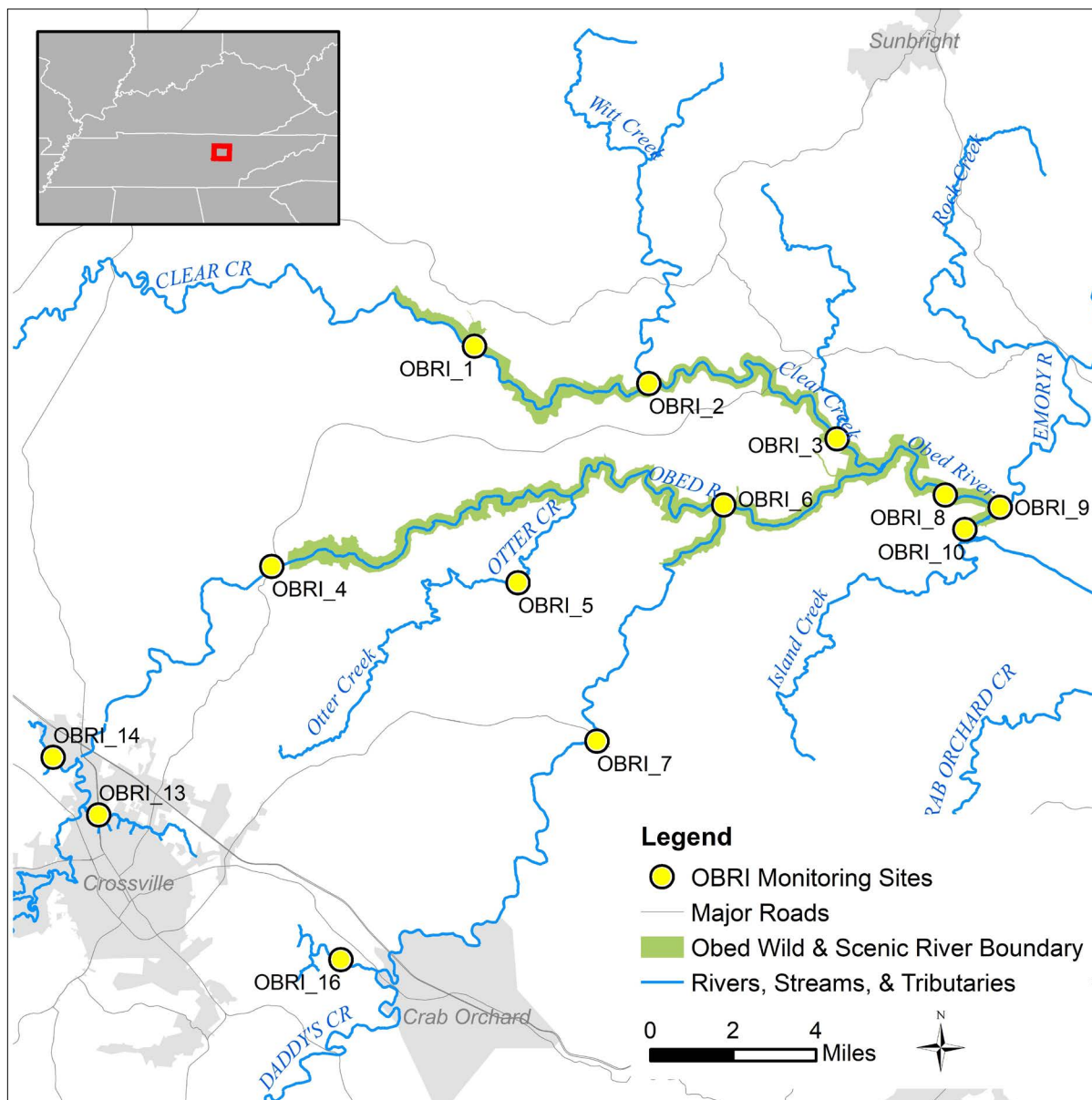
- In water year 2021, all measurements of water temperature, dissolved oxygen, and pH met state standards.
- 32% of samples were above the reference condition of 100 $\mu\text{S}/\text{cm}$ for specific conductance..
- 14% of samples exceeded available reference conditions of 100MPN/100ML for *E. coli*, while 4% exceeded the ONRW criteria.
- 64% of samples exceeded the provisional recommendations for nitrate + nitrite concentrations.

Monitoring and Objectives

The Appalachian Highlands Inventory and Monitoring Network (APHN) monitors water quality at strategic integrator sites to identify water resource conditions. The network monitors core water quality parameters, including:

- Streamflow
- Water Temperature
- Dissolved Oxygen
- pH
- Specific Conductance
- ANC (Acid Neutralizing Capacity)
- *Escherichia coli* (*E. coli*)
- Turbidity
- Metals
- Nutrients
- Major Ions

For detailed methods, see Hughes et al. 2018.



Map of discrete water quality monitoring sites in the Obed Wild and Scenic River (OBRI) watershed.

Table listing monitoring sites with identification numbers (ID), location/stream names (Name), total number of samples collected (2016–2021), and samples collected in water year 2021 (2021).

ID	Name	2016–2021	2021
OBRI_1	Clear Creek at Norris Ford	12	1
OBRI_2	White Creek at Mouth Near Barnett Bridge	12	1
OBRI_3	Clear Creek at Lilly Bridge	41	6
OBRI_4	Obed River at Adams Bridge	41	6
OBRI_5	Otter Creek at Firetower Road	0	0
OBRI_6	Obed River at Obed Junction Upstream Daddys Creek	0	0
OBRI_7	Daddys Creek at Antioch Bridge	39	3
OBRI_8	Obed River at Alley Ford	10	0
OBRI_9	Emory River Upstream of Obed Confluence	10	1
OBRI_10	Emory River at Nemo Bridge above Rock Creek	11	1
OBRI_13	Little Obed River at Crossville	9	1
OBRI_14	Black Drowning Creek near Crossville	1	1
OBRI_16	Byrd Creek at Homestead	4	1

Water Year 2021

Water year 2021 (WY21) ranged from October 2020 to September 2021 but due to changes in personnel, the majority of sampling at Obed Wild and Scenic River took place after April of 2021. Therefore, minimal sampling was conducted from October to April, seasons characteristic of higher flows and lower temperatures in the park. In WY21, monitoring sites paired with USGS gaging stations were sampled three to six times. Otter Creek at Firetower Road (OBRI_05), Obed River at Obed Junction (OBRI_06) and Obed River at Alley Ford (OBRI_08) were not sampled this water year due to time constraints, while the remaining sites were sampled once.

As most of the sampling occurred from May to September, site-specific mean streamflow was slightly lower than the average of prior years (Figure 1; gray boxplots denote quartiles and median line for all available data from 2016–2021, white circle denotes mean from 2016–2021, green triangle is the mean from WY21). In addition, mean water temperature was higher than the average of prior years (Figure 2) and mean dissolved oxygen levels were slightly lower than the mean of prior years (Figure 3).

Streamflow

Streamflow at the time of sampling ranged from a minimum of 0.61 cubic feet per second (cfs) at Little Obed at Crossville (OBRI_13) to a maximum discharge of 314 cfs at Daddys Creek (OBRI_07). Across all sites in WY21, mean streamflow was 57.3 cfs.

Water Temperature

Overall mean temperature at Obed Wild and Scenic River for WY21 was 21.18°C (70.12°F). All samples were below the Tennessee State Water Quality Temperature Exceedance Criteria of 30.5°C (86.9°F). Water temperatures ranged from a minimum of 12.2°C (54.0°F) at Obed River at Adams Bridge (OBRI_04) to a high of 28.53°C (83.35°F) at Clear Creek at Lilly Bridge (OBRI_03). Water temperatures also followed an expected seasonal trend with minimum mean temperatures in April (12.75°C [54.95°F]) and maximum mean temperatures in July (25.4°C [77.7°F]).

Dissolved Oxygen

All samples in WY21 met the Tennessee State Water Quality Dissolved Oxygen Minimum Criteria of 5.0 mg/l. Dissolved oxygen levels ranged from a minimum of 5.48 mg/l at Black Drowning Creek (OBRI_14) to 10.78 mg/l at Obed River at Adams Bridge (OBRI_04). Mean dissolved oxygen across all sites was 8.57 mg/l.

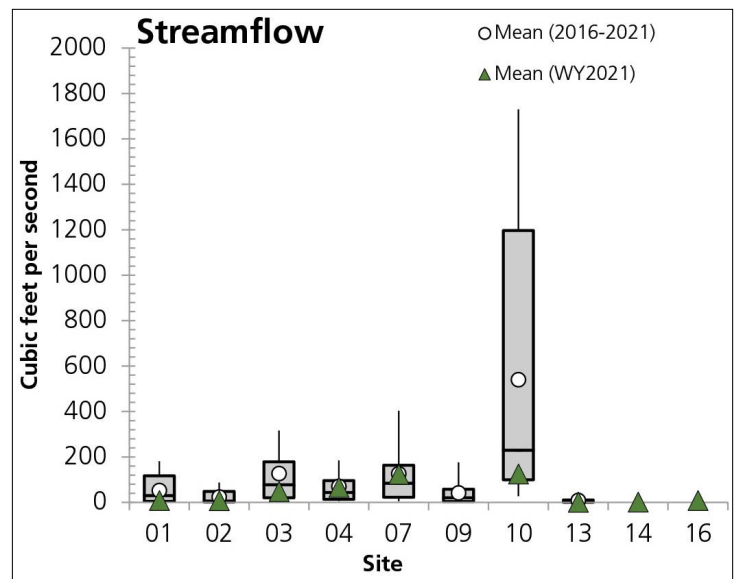


Figure 1. Streamflow at OBRI water-quality monitoring sites.

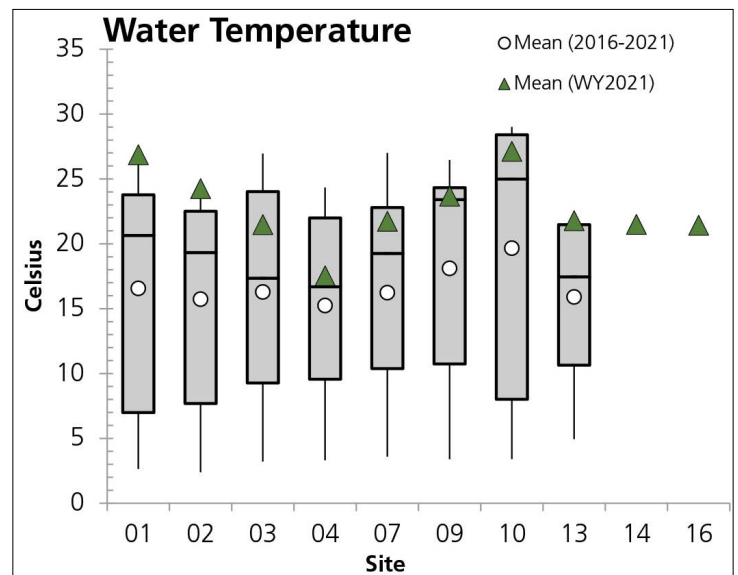


Figure 2. Water temperature at OBRI monitoring sites.

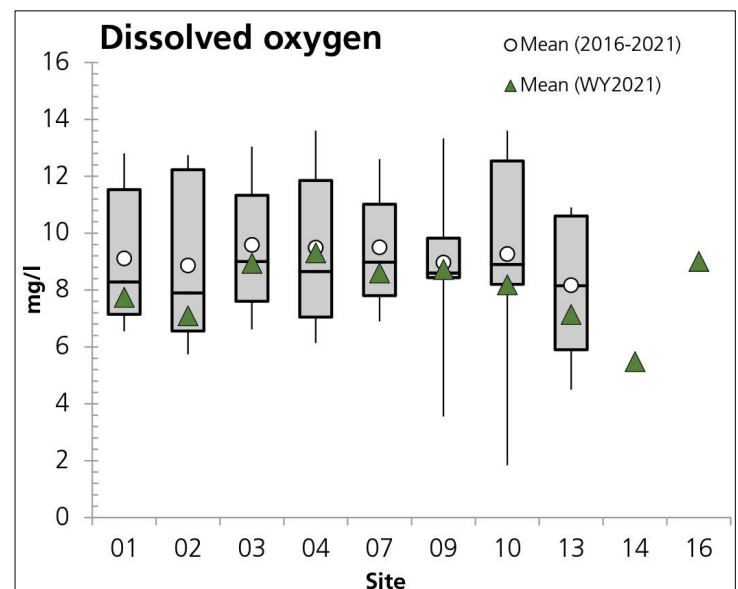


Figure 3. Dissolved oxygen levels at OBRI monitoring sites.

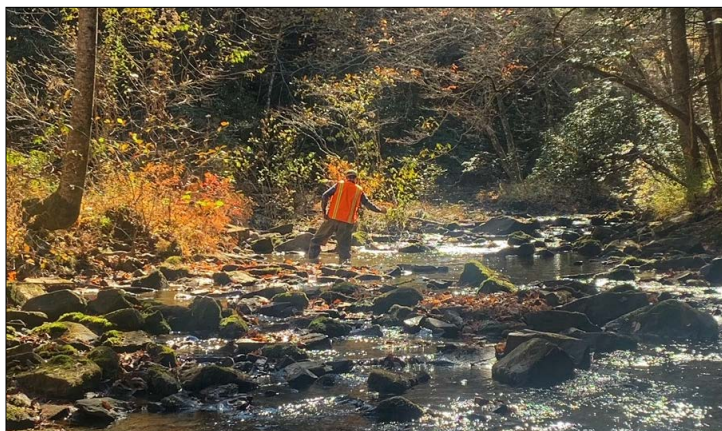
Water Year 2021 (Continued)

pH

The Tennessee State Water Quality pH Criteria specifies pH for Wadeable streams should be between 6.0–9.0 standard units (SU). All pH measurements in WY21 met the state standard. pH ranged from 6.92 SU at Black Drowning Creek (OBRI_14) to 7.92 SU at Daddys Creek (OBRI_07; Figure 4). Mean pH across all sites during WY21 was 7.46 SU.

Specific Conductance

Waterbodies tend to have a relatively constant range of specific conductance (SpC), a measure of the ability of water to pass an electrical current, and changes in conductivity can be indicative of inputs or disturbances. In WY21, SpC ranged from a minimum of 37.6 $\mu\text{S}/\text{cm}$ at Clear Creek (OBRI_03) to a maximum of 241.1 $\mu\text{S}/\text{cm}$ at Little Obed at Crossville (OBRI_13). Mean SpC across all sites was 92.79 $\mu\text{S}/\text{cm}$. As Obed Wild and Scenic River is dominated by conglomerate sandstone, waters within the park are mostly chemically dilute (soft), with low SpC levels, generally below 100 $\mu\text{S}/\text{cm}$. For WY21, 32% (7 out of 22 samples) were above this reference, of which four of the seven were from Obed River at Adams Bridge (OBRI_04). Little Obed at Crossville (OBRI_13) has the highest historic and current mean SpC levels (Figure 5).



Collecting water samples in an OBRI stream. NPS photo / APHN staff.

E. coli

Escherichia coli (*E. coli*) is a bacteria commonly found in the intestinal tracts of warm-blooded animals and is an indicator of sewage or animal-waste contamination. *E. coli* results are reported as the most probable number (MPN), an estimate of the number of organisms present, per 100 ml of water sample. In WY21, *E. coli* ranged from a minimum of 4.1 MPN/100 ml to a maximum of 2419.6 MPN/100 ml at Obed River at Adams Bridge (OBRI_04; Figure 6). Across all sites, mean *E. coli* was 156.4 MPN/100 ml and the median was 24.4 MPN/100 ml. At two sites, Obed River at Adams bridge and Daddys Creek at Antioch Bridge, 14% of samples (3 out of 22) were higher than the available reference condition of 100 MPN/100 ml (Rikard 1986). One sample from Obed River at Adams Bridge exceeded the single sample state water quality standard for ONRW (Outstanding Natural Resource Waters) of 487 MPN/100 ml.

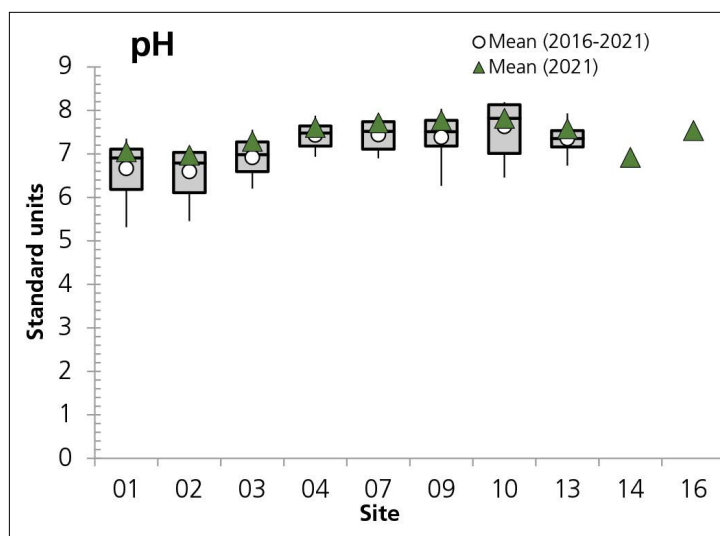


Figure 4. pH boxplots at OBRI monitoring sites.

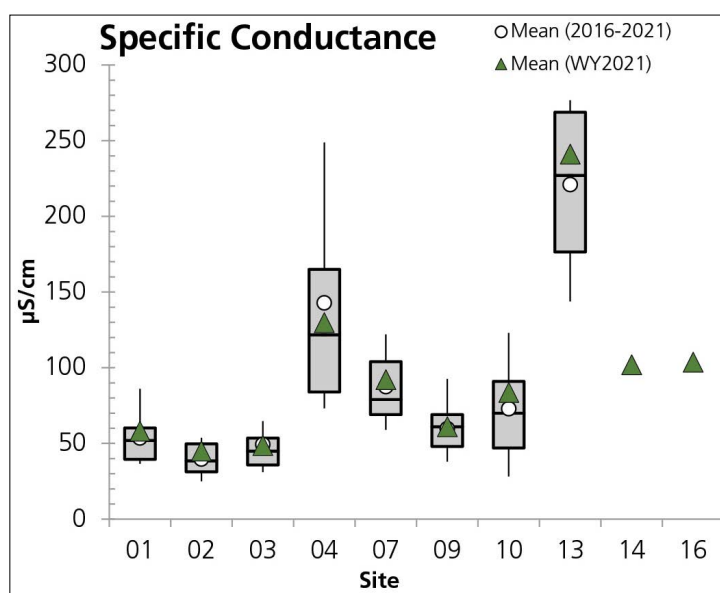


Figure 5. Specific conductance at OBRI monitoring sites.

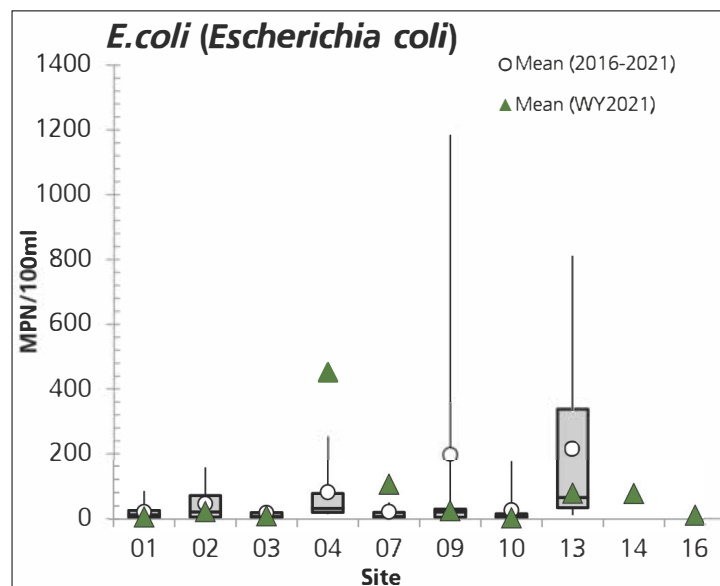


Figure 6. *E. coli* levels at OBRI monitoring sites.

Water Year 2021 (Continued)

Nitrate (NO_3) + Nitrite (NO_2)

Across all sites, mean nitrate + nitrite averaged 0.74 mg/l and ranged from a minimum of 0.04 mg/l at Clear Creek at Lilly Bridge (OBRI_03) to a maximum of 3.56 mg/l at Obed River at Adams Bridge (OBRI_04; Figure 7). In WY21, over 64% of samples (14 out of 22) from seven sites were above the regional recommendation for $\text{NO}_3 + \text{NO}_2$ criteria provisionally set at less than or equal to 0.23 mg/l (TDEC 2001). This included six samples from Obed River at Adams Bridge (OBRI_04) and three samples from Daddys Creek (OBRI_07). Of note, Haag et al (2019) found that streams with nitrate + nitrite concentrations greater than 2 mg/L had low mussel growth.



Hydrology assistant Ross Shipley filtering samples. NPS photo / APHN staff.

Chloride

Mean chloride levels across all OBRI sites in WY21 were 5.14 mg/l and ranged from a minimum of 1.26 mg/l at Emory River upstream of the Obed Confluence (OBRI_09) to a maximum of 13.29 mg/l at Little Obed at Crossville (OBRI_13; Figure 8). The current EPA chronic chloride criteria is 230 mg/l for freshwater organisms; however this threshold is being reevaluated at state levels.

Sulfate

Sulfate ranged from a minimum of 2.16 mg/l at White Creek near Barnett Bridge (OBRI_02) to a maximum of 8.85 mg/l at Emory River upstream of the Obed Confluence (OBRI_09; Figure 9). Across all sites, mean sulfate levels were 4.54 mg/l.



Hydrology assistant Isabel Ahlstrom measuring streamflow.

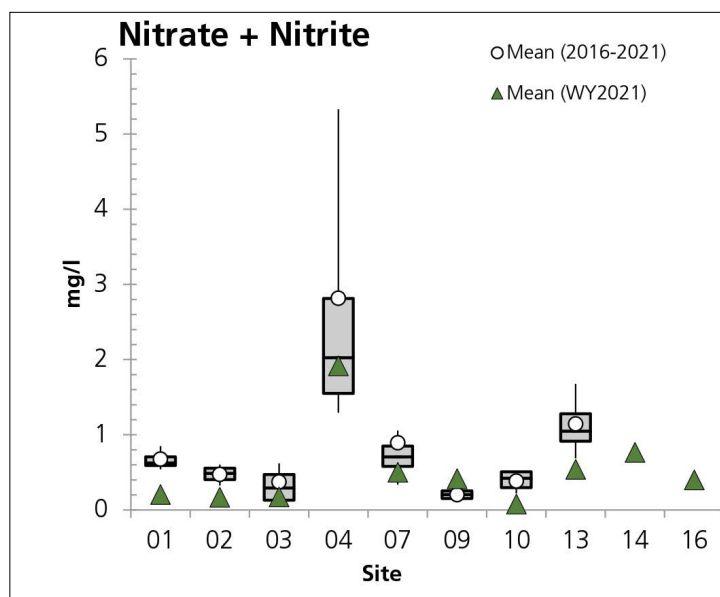


Figure 7. Nitrate + Nitrite at OBRI monitoring sites.

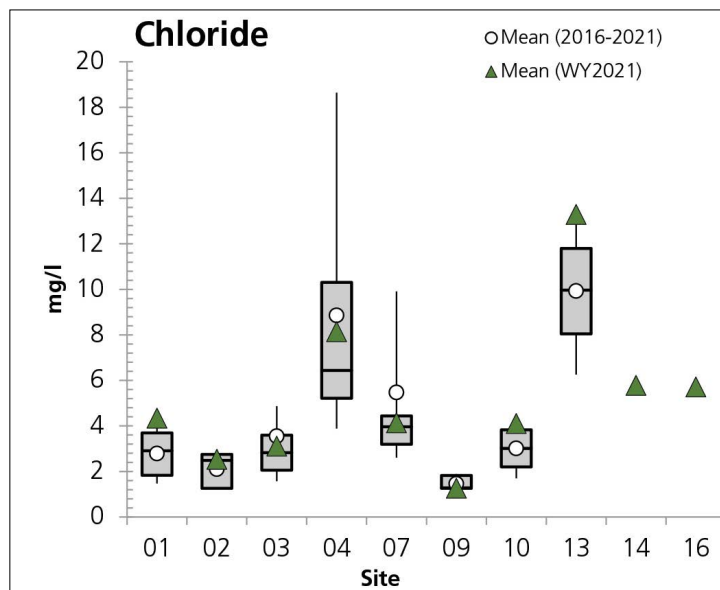


Figure 8. Chloride levels at OBRI monitoring sites.

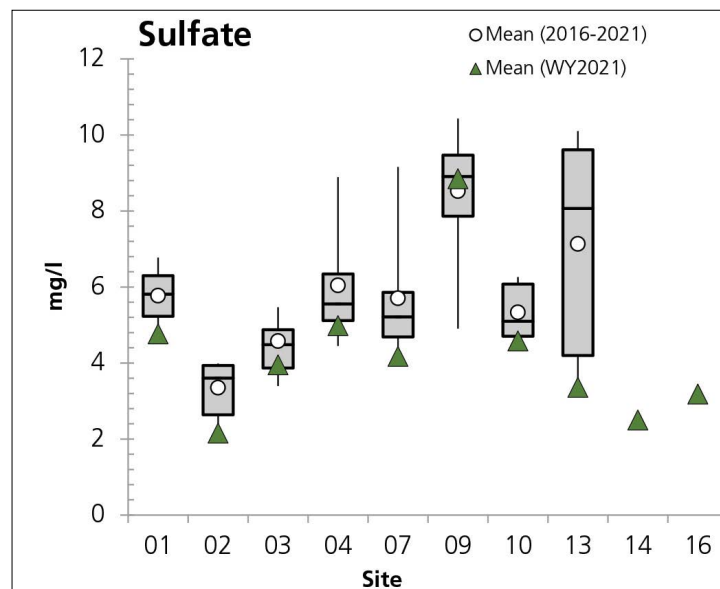


Figure 9. Sulfate levels at OBRI monitoring sites.

Conclusions

There was a range of water quality conditions in the Obed Wild and Scenic River watershed during WY2021. Overall, water quality remained stable and conditions generally aligned with past monitoring years. Clear Creek remained one of the highest quality tributaries at Obed Wild and Scenic River, reflecting near natural reference conditions.

Several river segments and streams remain on the TN 303-d list of impaired waters. From Adams Bridge to the confluence of Daddys Creek at Obed Junction, 15.5 of the 24.5 miles (24.9 to 39.4 kilometers) of the Obed River within the park boundary (63%) are listed as impaired due to phosphorous, nitrogen, and *E. coli* exceedances. These issues stem from riparian grazing, municipal and biosolid discharges, and sanitary sewer overflows. Samples from the Obed River at Adams Bridge (OBRI_04) showed elevated levels of *E. coli*, specific conductance, nitrate + nitrite, and chloride in WY2021. In addition, the entirety of Daddys Creek, including the 2.3 miles (3.7 kilometers) within the park boundary, is listed as impaired due to mercury from atmospheric deposition. Outside of park boundaries but contributing to the Obed River watershed, Little Obed River, Black Drowning Creek, and Byrd Creek are 303(d) listed. Black Drowning Creek and Little Obed River are listed because of elevated *E. coli*, phosphorous, nitrate/nitrite, and sedimentation. Sampling during WY2021 show low levels of dissolved oxygen at Black Drowning Creek (OBRI_14), and elevated specific conductance and chloride levels at Little Obed River (OBRI_13). Concerns at Byrd Creek stem from an upstream dam impacting dissolved oxygen levels. However, measurements at Byrd Creek (OBRI_16) in WY2021 indicated dissolved oxygen levels were within state standards at the time of sampling.

Literature Cited

- Haag, W. R., J. J. Culp, M. A. McGregor, R. Bringolf and J. A. Stoeckel. 2019. Growth and survival of juvenile freshwater mussels in streams: Implications for understanding enigmatic mussel declines. *Freshwater Science*, 38(4), 753–770.
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- Tennessee Department of Environment and Conversation (TDEC) 2020. EPA Approved Lists of Impaired and Threatened Waters for TN. Available at <https://www.tn.gov/environment/program-areas/wr-water-resources/water-quality/water-quality-reports---publications.html> (last accessed August 2022).

Protocol Citation

- Hughes, J., R. Emmott, E. Raskin, and B. Witcher. 2018. Long-term discrete water-quality monitoring at Big South Fork National River and Recreation Area, Blue Ridge Parkway, and Obed Wild and Scenic River: Protocol narrative. Natural Resource Report NPS/APHN/NRR—2018/1840. National Park Service, Fort Collins, Colorado. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2258269> (last accessed August 2022).

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<https://www.nps.gov/im/aphn/index.htm>