

Article

I&M Water Quality Data Helps Cumberland Gap National Historical Park Address Aging Infrastructure

[Cumberland Gap National Historical Park](#)



Water quality sampling at Station Creek.

NPS / Emma Brinley Buckley

In 2008, scientists from the [Cumberland Piedmont Inventory & Monitoring Network](#) (CUPN) found themselves facing a concerning trend: levels of *E. coli* in one of their water quality monitoring sites at Cumberland Gap National Historical Park were high. Too high.

For the previous two years, staff had been diligently collecting water quality data on the second Tuesday of every month. Water quality is one of the park's "[vital signs](#)," metrics that help scientists take the pulse of the ecosystem as a whole. Along with levels of *E. coli*, the team also measures factors like temperature, pH, specific conductance, and [turbidity](#). But in this case, one measurement consistently drew attention: bacteria levels at the Station Creek monitoring site.

What did this finding mean?

[Escherichia coli](#) (*E. coli*) is a type of bacteria that normally lives in the digestive system of humans and other warm-blooded animals. Most strains are harmless, but some can cause sickness when people consume contaminated food or water or come into contact with other infected people or

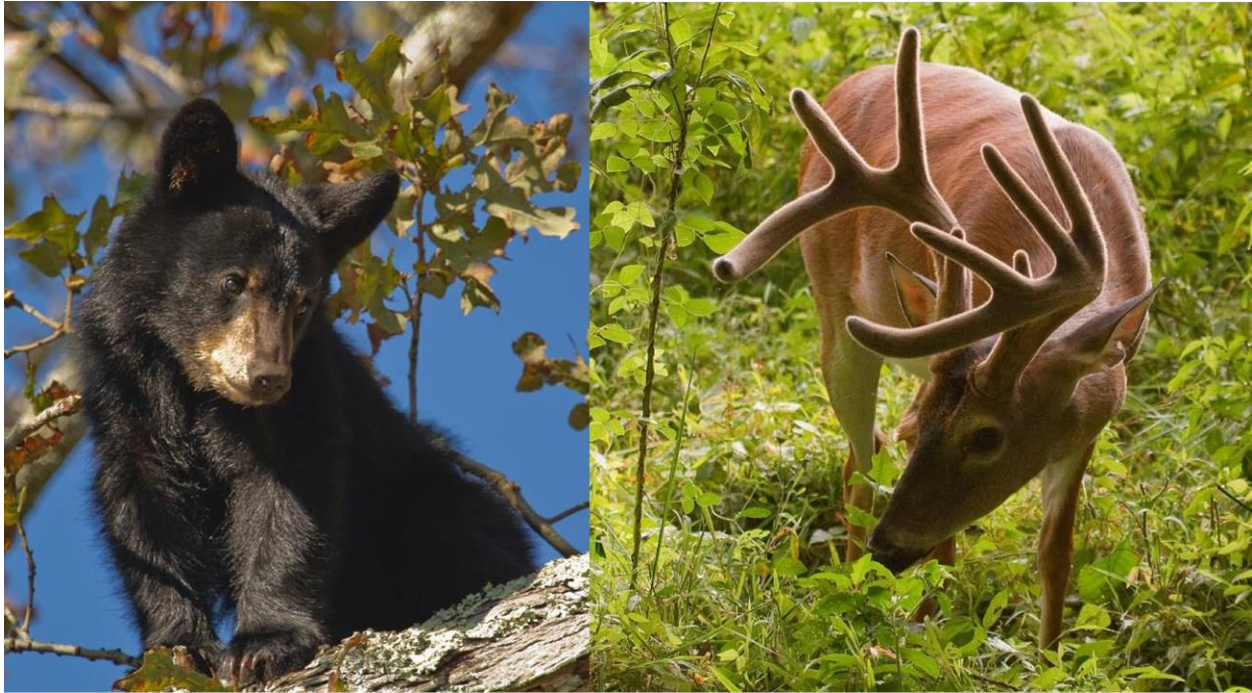
animals. *E. coli* can contaminate waterways when feces comes into contact with the water. Although the Station Creek site was not typically used for swimming or drinking, its location near the park's only developed campground made the high *E. coli* levels cause for concern. Not only were the bacteria levels a potential issue for the park's human visitors, but depending on the source, they could also have dire implications for the aquatic ecosystem. For example, human or animal waste could add excess nutrients to the water, kicking off the process of [eutrophication](#) and making the aquatic habitat unlivable for aquatic plants and animals. For park managers to address the causes of such high levels of *E. coli*, the first step was clear: the team needed to identify the source.

The Investigation

The rough outline of what happened was clear: bodily waste had entered the waterway. But was the source of the waste human, or animal? How had it entered the stream, and where? Like many park streams, Station Creek is typically pristine, with its headwaters in the park. That meant the contamination had come from inside the park. The park is full of potential sources—after all, bears (and deer, horses, raccoons, and possums) do indeed defecate in the woods. On the other hand, human visitors—and the park operations that support them—represented another possible source. To pin down the specifics, the team needed more information. Fortunately, they happened to have two full years of reliable data on hand.

To identify the source of contamination, the team analyzed the environmental patterns surrounding their detection. There were two possible scenarios.

In the first scenario, bacteria end up in the stream after animals defecate in the surrounding environment, with the waste washed into the waterway by rain or snowmelt. This is called [nonpoint source pollution](#): bacteria coming from several different places, rather than one specific location. Higher precipitation may coincide with higher *E. coli* levels, because a wet season offers frequent opportunities for bacteria to enter the stream. When precipitation is low, bacteria levels should be as well, since there is less opportunity for *E. coli* to be transported to the creek.



Possible suspects? Black bears and white-tailed deer are found throughout the park.

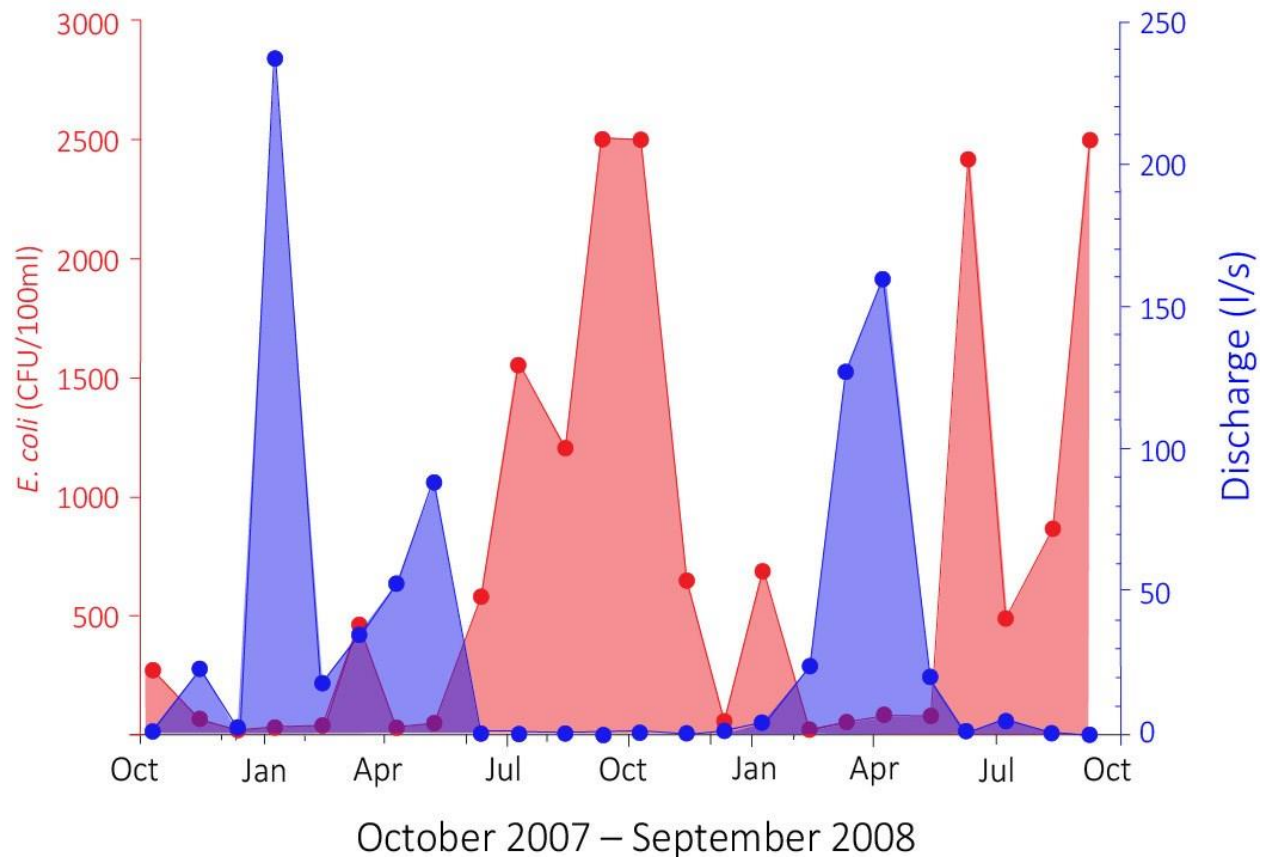
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Alternatively, there is point source pollution, defined by the [EPA](#) as “any single identifiable source of pollution from which pollutants are discharged.” So instead of many small, dispersed *E. coli* sources throughout the watershed, there would be one, much larger source of bacteria being discharged into the water. Because there’s no need for bacteria to catch a ride with rainwater in this case, high precipitation isn’t necessary for high bacteria levels. In fact, more rain would dilute the water and lower *E. coli* levels, leading to the exact opposite of the expected pattern for the first scenario.

Back to the Data

So what did the network's data show? Through the two-year monitoring record, *E. coli* levels rose in late spring, peaked in summer, and trailed off through autumn. Levels were lowest in winter. When the team compared those patterns to patterns of discharge (the volume of water that passes a given point in a given period of time) at Station Creek, they found that discharge was highest in winter and early spring—exactly when *E. coli* was **lowest**. That ruled out wildlife-based nonpoint source pollution (the first scenario). But another pattern did match bacteria levels more closely: visitor use.

Station Creek Monitoring Site



Discharge (blue) and *E. coli* (red) measures at the Station Creek Monitoring Site. Discharge was highest when *E. coli* was lowest, indicating a point source within the park. Adapted from [Meiman 2009](#).

Summer is not only a drier time for the park, but also when the park sees the most visitors. If the source were a systemic issue—for instance, one related to high pressure on the park’s wastewater infrastructure—it would make sense for high visitation to correlate with high bacteria levels. And that was exactly what the team found: one of the highest *E. coli* measurements was a mere two days after Labor Day in 2008. The team turned its eye to the nearby campground, and its septic system—which was already known to park managers to be in need of replacement.

What Next?

While park managers had already been eyeing improvements to the campground facilities, the *E. coli* results added urgency. The Wilderness Road campground, which hosted thousands of visitors every year, was due for an upgrade. When park managers submitted a detailed project proposal outlining the broad revamp of the campground’s wastewater system, CUPN data helped make the case that such measures were necessary. The final project was thorough and ensured that park managers could devote fewer resources to responding to maintenance emergencies as they popped up. Existing sewer lines were replaced with new ones, and septic tank and leach field sizes were reconsidered to prevent issues associated with overburdened systems.



The comfort stations at Wilderness Road campground.

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Since Then

For more than a decade since the wastewater-system renewal at Wilderness Road Campground, CUPN staff have continued monitoring water quality at Station Creek. The results indicate that upgrading the infrastructure has benefited both visitors and park resources. While monitoring does occasionally catch exceedances of bacteria levels or other water quality measures, *E. coli* levels have never been quite as high, as often, as they were before the infrastructure upgrade. And the association between high *E. coli* levels and precipitation—the factor that had helped the team identify the septic system issue in the first place—flipped entirely. After the renewal project, bacteria levels and precipitation moved in tandem, as expected for a nonpoint pollution scenario. Not only had water quality monitoring helped to catch the problem in the first place, but it had also provided the tools to evaluate the solution.

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