Escherichia coli monitoring at Little River Canyon National Preserve

What is *Escherichia coli*?

Escherichia coli (*E. coli*) is a naturally-occurring bacteria found in intestines and feces of warm-blooded animals. While not generally a human pathogen (a substance that causes harm to people), some strains of *E. coli*, 0157:H7 for example, have been linked to illness in contaminated foods. As *E. coli* are associated with pathogens, they are considered an indicator species, and thus used for a measure of water quality.

How does *E. coli* enter the water?

E. coli bacteria enters a stream or river by point source (direct injection at specific points), and non-point source (run-off over a broad area). Point sources include failing septic systems and inadequate waste water treatment facilities. Non-point sources include surface run-off from livestock pastures and wildlife habitat.

While each method of entrainment produces the same result – bacterial contamination of a waterbody – both point and non-point sources have distinct relationships to rainfall events and resultant stream flow condition. Non-point sources are washed from a broad area into a stream during a rainfall event. Point sources enter a stream at a constant rate, regardless of rainfall.

A point source contaminant concentration diminishes at times of high flow as it is diluted. Conversely, at times of low flow it is concentrated. The exact opposite can be expected for a non-point source contaminant; at times of low stream flow, its concentration would be very low as a rainfall event is needed to wash it from the land. At times of high flow (the result of rainfall events) non-point source contamination is high as the land surface is washed of contaminants in the form of run-off.

Sources of *E. coli* within the Little River Canyon Watershed

A watershed is a portion of land that drains to a common point. The watershed of Little River Canyon National Preserve is all land that contributes water to the most downstream point of the preserve, Canyon Mouth. This 127,160 acre watershed contains various land uses that may contribute to the overall bacterial load (Figure 1). These uses include wastewater from a population (US Census 2000) of 7,571 individuals (both rural and small towns alike) and one wastewater treatment facility (Desoto State Park). Non-point contributions include runoff from 21,000 acres of pasture and hay land and its livestock, and the wildlife that are found throughout the watershed, including the 13,798 acres of state and federal park lands. Each may contribute a share to the total bacterial load.

Figure 1. Watershed of Little River Canyon National Preserve.

Results of Water Quality Monitoring

Water quality data are shown in Figure 2. While the park routinely monitors water quality at 11 locations throughout the watershed, for brevity we will examine the results at one station. These data, with gaps between monitoring efforts, were collected over a nine year period at Canyon Mouth. These data display a signature of non-point source delivery of *E. coli* bacteria and turbidity. Turbidity, primarily caused by suspended particles, can be simply described as the clarity of the water; the higher the turbidity, the muddier the water. Increases in flow are met with an increase in *E. coli* and turbidity. This relationship is not apparent in every rainfall event as antecedent condition (for example time since last rainfall), and distribution of the rainfall event (where it rained and how much) produce variance. That is, the less time between run-off producing rainfalls, the less waste is available to wash into the streams.

So, what do these data tell us? We know that *E. coli* and turbidity at Canyon Mouth spike during high flow conditions. These high flow conditions are caused by rainfall events. These rainfall events produce surface run-off. Run-off entrains various contaminants, including *E. coli* and soil particles. The pattern we see is indicative of non-point sources. We also know that as long as there have been animals living within the watershed, there have been *E. coli* in the waters of Little River. What we do not know is the species of animal from which the bacteria originate or natural background concentrations. We also know that at times of high flow the USEPA recommended *E. coli* single-sample maximum value for full body contact was exceeded. It is also unlikely that people were swimming at these times.

It is the intention of this National Park Service water quality monitoring program to construct a database over the next decades in which long-term trends can be detected. Our understanding of this issue is better than it was ten years ago, and it will be far better ten years from now.

For more information regarding natural resources monitoring, please visit our web site:
http://science.nature.nps.gov/im/units/cupn/

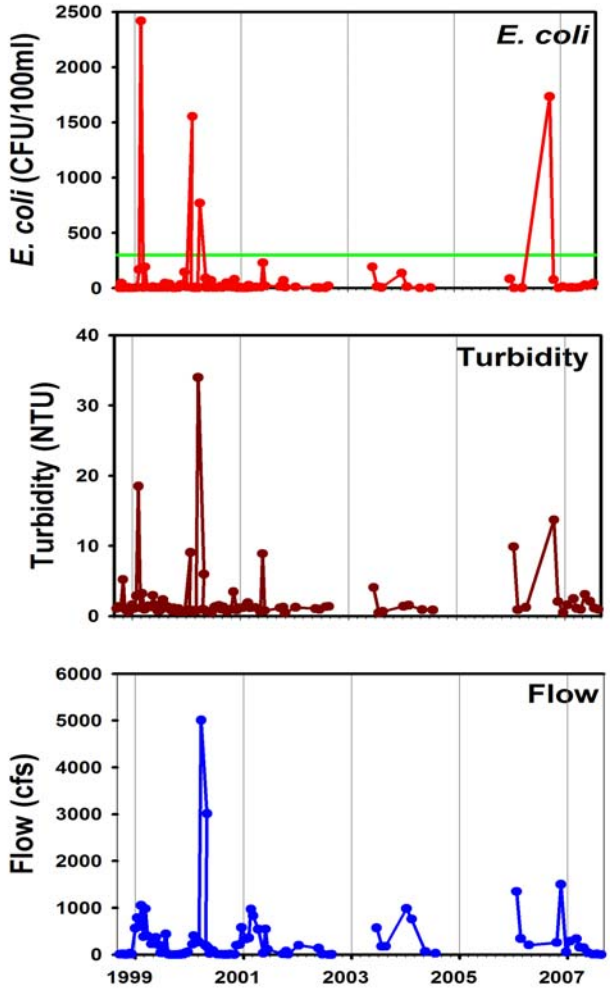

Figure 2. E. coli, turbidity, and flow at Canyon Mouth; CFU/100ml = colony forming units per 100 ml of water; NTU = Nephelometric Turbidity Units; cfs = cubic feet per second. The green line represents the USEPA recommended E. coli single-sample maximum value for full body contact.

Visitors enjoying a summer day at Canyon Mouth, Little River Canyon National Preserve.