



Bacteria Characterization of Big Creek and Buffalo River near Carver

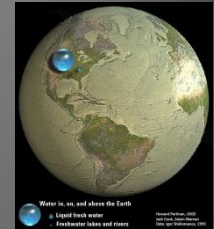
Boone County Library
September 23, 2014

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Presentation Presuppositions

(Acknowledging the Elephant in the Room)



Environmental Science – is the academic field that takes physical, biological, and chemical sciences to study the environment and discover solutions to environmental problems. (Science, Art, Social Sciences/~Politics)

Confined Animal Feeding Operations (CAFO) – most all meat, eggs, and milk products, goal is low cost food, wide variety of production types. 74% of world's poultry, 43% of beef, 68% of eggs (Worldwatch Institute 2006);

Summary - CAFOs provides an important and necessary service to the human community.

National Parks – special places set aside by citizens/their representatives, national public parks an **unique American value, natural wonders and places of profound beauty**, collectively preserved by citizens and entrusted to federal agencies, ultimate **preservation value is generational**, social fabric, and provides economic benefit to local and regional community.

Water Resources – sources of water that are useful or potentially useful (*to humans*). Uses include agriculture, industrial, household, recreational, and environmental activities. The majority of human uses require fresh water. (USGS)

1. Agriculture is essential.
2. Natural environment (water quality for human uses) is essential.
3. Education, understanding, and goodwill can reduce conflict and promotes positive decision making.

Therefore, we have means to reduce conflict between agricultural industry and water resources through a process of education an application of goodwill toward others.



Purpose(s) of Park's Existence

Buffalo National River

- Created by Congress in 1972 by Public Law 92-237.
- Enabling legislation states:



*“That for the **purposes of conserving and interpreting** an area containing unique scenic and scientific features, and preserving as a free-flowing stream an important segment of the Buffalo River in Arkansas **for the benefit and enjoyment of present and future generations**, the Secretary of Interior (hereinafter referred to as the “Secretary”) may establish and administer the Buffalo National River.”*

- Mandate assumes that water quality would be monitored and maintained to a standard that is “enjoyable” during recreation and is safe for direct contact.

Park's Recreation Use and Importance

Recreation Patterns and Type

- Activities: canoeing, camping, caving, picnicking, hiking, swimming, sight-seeing, hunting, fishing, etc. (NPS data)
- Peak river use for water based recreation **April through August**
- **30% of river receives the majority** of canoe traffic, upper and middle river
- Recreational river impacts: trash, boat launch area maintenance, gravel bar camping, etc. **2014 might be record high for river uses.**
- **Note:** the majority of bacteria enter river system from tributaries during **non-base** flow conditions, most water based recreation occur during base-flow conditions or post flood.



Economic Benefit to Local Communities from National Park Visitation and Payroll, 2010 (Stynes, D. J., 2011. Michigan State University)

Buffalo National River

- Recreation visits – 1,545,599
- Overnight stays – 114,898
- Visitor Spending – All \$47,169,000 and Non-local **\$41,554,000**
- Impacts of Non-Local Visitor Spending
 - #Jobs – **594**



History of Water Quality Program

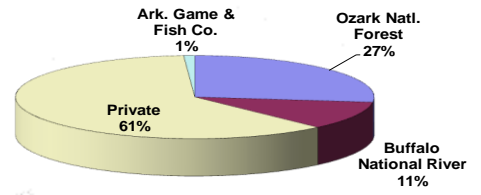
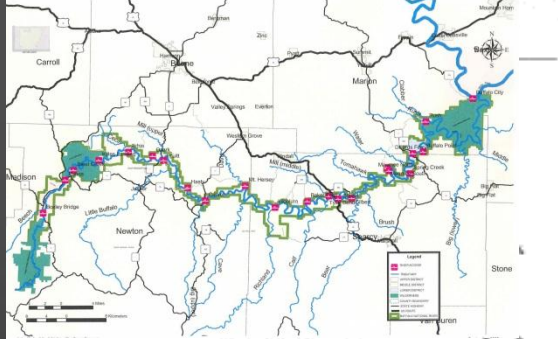


- Monitoring plan was implemented in **1985** and continues today.
- **20 tributaries, 3 springs, and 9 river sites** are monitored **quarterly**.
- BNR **cooperatively** works with Arkansas Department of Environmental Quality (ADEQ) and shares data with ADEQ (data available to public).
- ADEQ implements the U.S. Clean Water Act for Arkansas (Regulation #2).
- **BNR does not have jurisdiction outside park boundaries** accept for *federally* funded water projects that may diminish park's primary water resources.
- Selected parameters monitored by BNR are based upon ADEQ Regulation #2 standards.
- Initial Goal for WQ program was environmental status and condition, i.e. is the river ecosystem health, near natural, etc.
- Added ***Escherichia coli (E. coli)*** in 2009 as requested by ADEQ

Buffalo National River

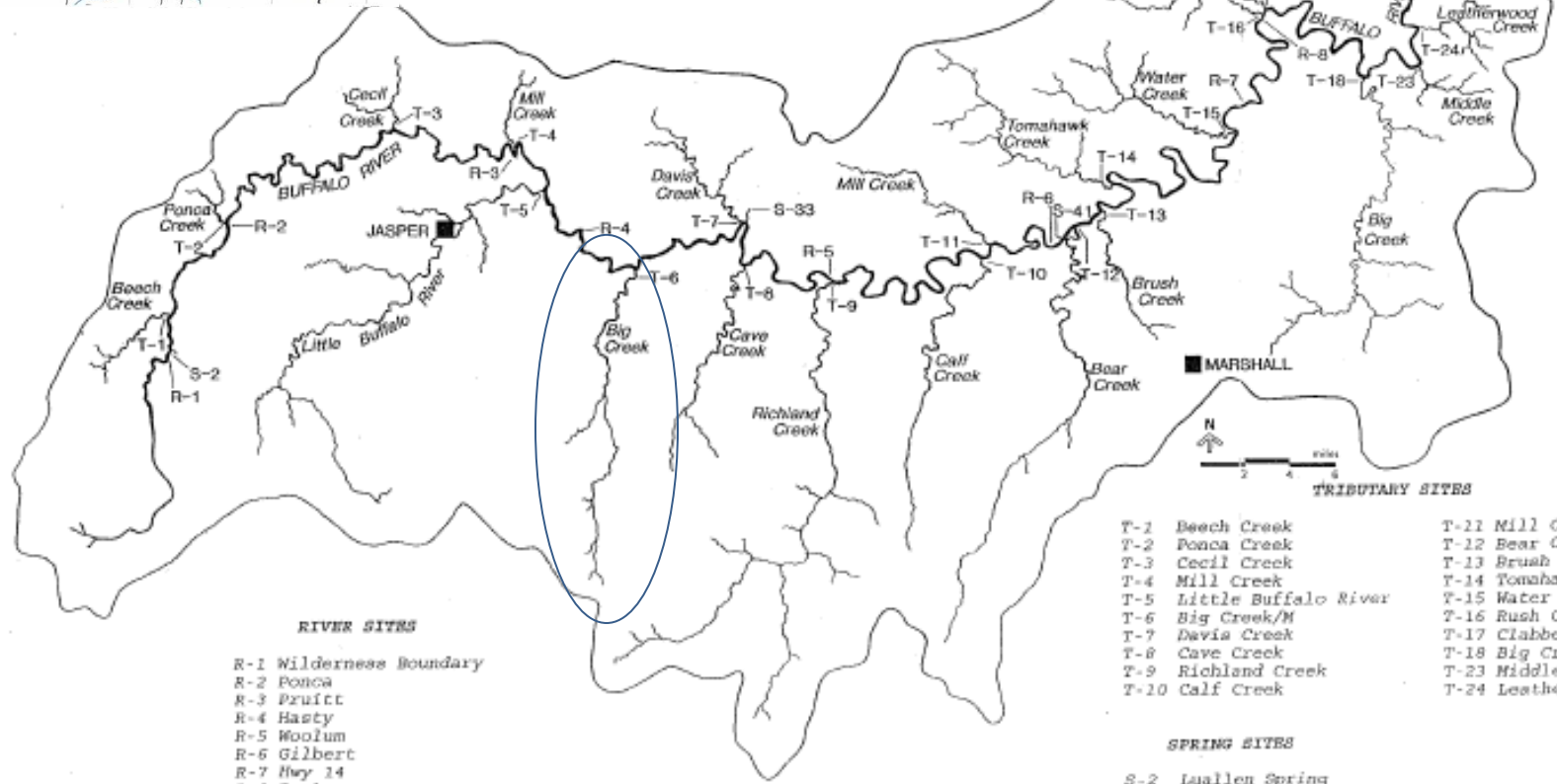


Buffalo National River Area Map



HARRISON

YELLVILLE



RIVER SITES

- R-1 Wilderness Boundary
- R-2 Ponca
- R-3 Pruitt
- R-4 Hasty
- R-5 Woolum
- R-6 Gilbert
- R-7 Hwy 14
- R-8 Rush
- R-9 Mouth

TRIBUTARY SITES

- | | |
|--------------------------|------------------------|
| T-1 Beech Creek | T-21 Mill Creek/M |
| T-2 Ponca Creek | T-22 Bear Creek |
| T-3 Cecil Creek | T-23 Brush Creek |
| T-4 Mill Creek | T-24 Tomhawk Creek |
| T-5 Little Buffalo River | T-15 Water Creek |
| T-6 Big Creek/M | T-16 Rush Creek |
| T-7 Davis Creek | T-17 Clabber Creek |
| T-8 Cave Creek | T-18 Big Creek/L |
| T-9 Richland Creek | T-23 Middle Creek |
| T-10 Calf Creek | T-24 Leatherwood Creek |

SPRING SITES

- S-2 Luallen Spring
- S-33 Mitch Hill Spring
- S-41 Gilbert Spring

MARSHALL



Major Shift Water Quality Program Priorities

Initial Priority

- Initial priority was basically to monitor, assess, and maintain good water quality, assess impacts of watershed development, i.e. *protect the river from the impact of people*.
 - Roads and recreation within the park.
 - Human activities and development within the watershed.
 - Defining what is “**natural**” from what is “**man-caused**”.
 - Answering “does water quality results conform to Reg.#2 standards?”

Additional Priorities and Shift toward **Health and Human Safety for Visitor Use**

- 2009 continuous sewage spill in Mill Creek (T04)
 - Marble Falls Sewer District lift station failed post ice storm
 - ~6,000 gallons/day into upper Mill Creek
 - Dye trace indicated quick deliver of **untreated human** wastes to river
 - First advisory and public warning issued in history of the park
 - Shift priorities to *protect people from poor water quality in the river*.



U of A Ph. D. Researcher

Dual Purpose of WQ Program – *Visitor Safety and Environmental Protection Added Escherichia coli to program.*

Arkansas Surface Water **Bacteria Standards** (Recreation)

Regulation 2.507 Bacteria

- Arkansas Department of Health has responsibility of approving or disapproving surface waters for the suitability of specifically delineated outdoor bathing places for body contact recreation.
- **Primary Contact Waters**
 - May 1 through September 30
 - Escherichia coli geometric mean (*5 samples over 30 days*): **126** colonies/100ml
 - Single-sample maximum: **298** colonies/100ml
- **Secondary Contact Waters**
 - October through April
 - Escherichia coli geometric mean: **630** colonies/100ml
 - Single-sample maximum: **1490** colonies/100ml

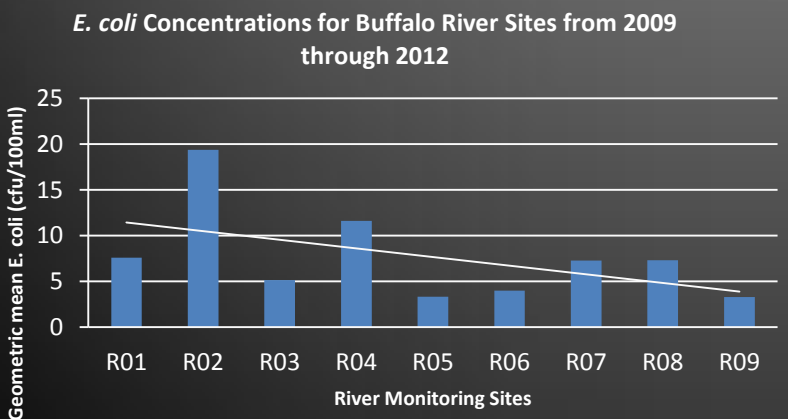


Note: Since water based recreation occurs all year within the park, *BNR assumes the maximum allowable risk for water based recreation to be set at Primary Contact Water levels*; most safe and provides increase vigilance for visitor protection.

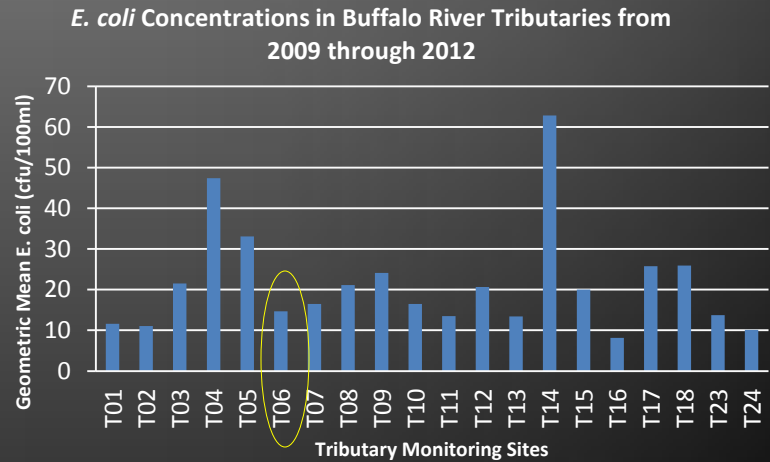


Assessment of Escherichia coli Concentrations in Surface Waters of Buffalo National River, 2009 through 2012 (Usrey, 2013)

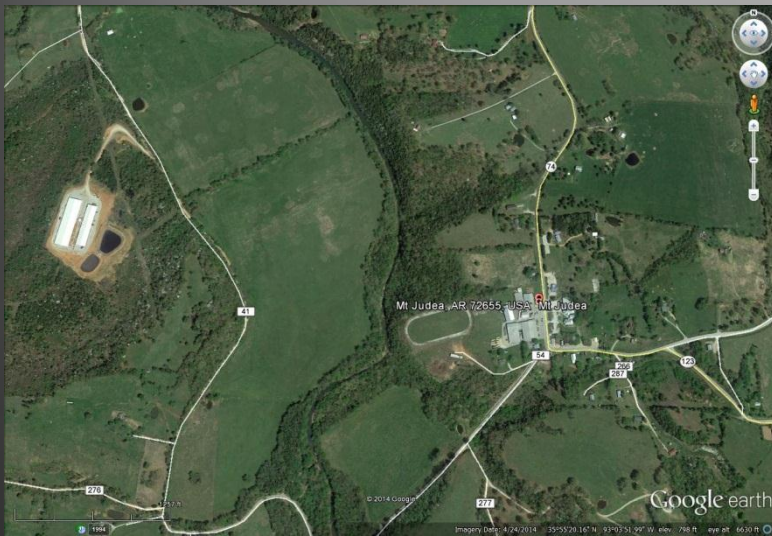
- *E. coli* **quarterly** sampling at all monitoring sites
- Based on Reg.# 2 Bacteria Criteria: **single-sample maximum (298 cfu)**
- *Note:* **base-flow** conditions only
- **1** river site out of 122 samples exceeded standard
- Nearly **½** of tributaries exceeded standard
- One spring exceeded 2 out of 16 samples
- **Conclusion: at base-flow, river sites are typically well below State standards for primary contact and are below acceptable health and human safety standards for recreational contact.**



126 colonies/100ml



Background on Permitted Swine CAFO



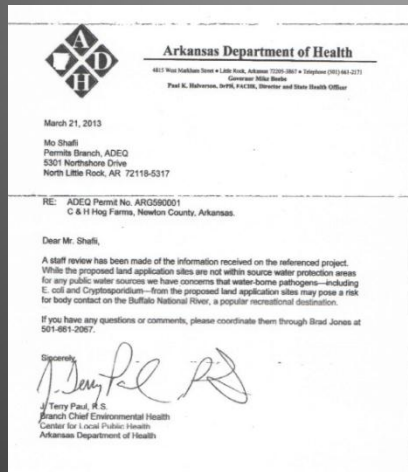
Information from permit application.

- ADEQ issued a Confined Animal Feeding Operation (CAFO) in August of 2012
- Permit for **2000 hog farrowing** operation on Big Creek, Mt. Judea
- Plan estimates up to **6503 hogs** on site
- Annual waste stream estimated at **2,090,181 gallons of manure** annually
- Applied on 630.7 acres, some fields **within floodplain** of Big Creek
- Approximately **5 miles** above BNR
- **No mechanical treatment** of manure (lagoons to field)
- Estimated **seepage rate** of lagoons maximum allowable **5,000 gallons** per day
- Began operation in **2013** with first land application of manure in winter of 2013/2014

So Why is BNR Concerned about this CAFO?

Visitor Health and Human Safety

- **Arkansas Department of Health**, March 2013 states “we have concerns that water-borne pathogens—including E. coli and Cryptosporidium—from the proposed land application sites may pose a risk for body contact on the Buffalo National River, a popular recreational destination.”
- **U.S. Centers for Disease Control (CDC) and Prevention, National Assoc. of Local Boards of Health, Understanding Concentrated Animal Feeding Operations and Their Impacts of Communities** (Hribar, 2010). “over **150 pathogens in manure** that could impact human health.” “Those at higher risk include infants or **young children**, pregnant women, the elderly, and those who are immunosuppressed, HIV positive, or have had chemotherapy.”



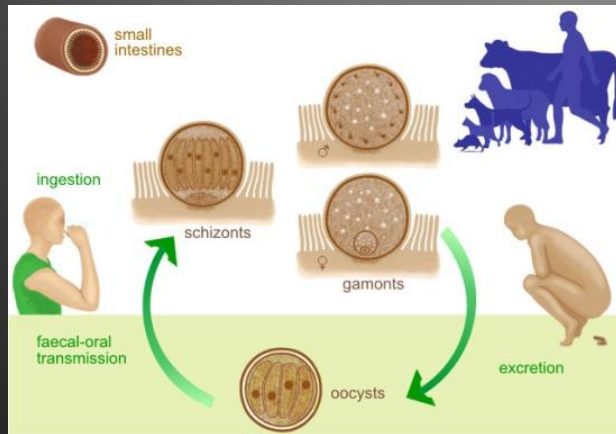
So Why is BNR Concerned about this CAFO?

Cryptosporidium spp.

- Protozoan
- Causes gastrointestinal illness
- Acute short-term infection
- Can become severe and nonresolving in children and immunocomprised
- Human infections can last to 5 weeks

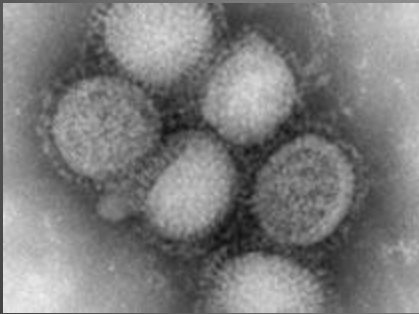
Purdue University, Purdue Extension; CAFOs and Public Health: Pathogens and Manure (ID-356-W).

“Concentrated animal feeding operations (CAFOs) can generate large quantities of manure, most of which is applied to fields as fertilizer.” “Livestock manure can also contain disease causing microorganisms; and **if manure is improperly stored or mishandled**, these **pathogens could pose a health hazard** if they come in **contact with water** or raw foods. As such, there are concerns that the manure generated by **CAFOs could result in infectious disease outbreaks** in surrounding communities.” “Many of the organisms that cause infectious disease in humans, such as Salmonella, E. coli, and **Cryptosporidium can be readily found in livestock manure.**”



<http://parasite.org.au/para-site/cryptosporidium>

So Why is BNR Concerned about this CAFO?



<http://www.cdc.gov/h1n1flu/qa.htm>

National Institute of Environmental Health Science, *Swine CAFOs & Novel H1N1 Flu: Separating Facts from Fears* (Schmidt, 2009).

“As with other complex topics, nearly every significant aspect of CAFO production can be viewed from multiple perspectives. But perhaps this much is clear: the current pandemic (H1N1) shows that **viruses of animal origin can pose a substantial human health threat.**”

CDC Website (<http://www.cdc.gov/h1n1flu/qa.htm>)

Influenza viruses infect the human upper respiratory tract. There has never been a documented case of influenza virus infection **associated with water exposure.**

Recreational water **that has been treated** at CDC recommended disinfectant levels does not likely pose a risk for transmission of influenza viruses. **No research** has been completed on the susceptibility of 2009 H1N1 influenza virus to chlorine and other disinfectants used in swimming pools, spas, water parks, interactive fountains, and other treated recreational venues.

My take: Viruses as a potential health threat from water based recreation appears to lack vector connectivity but no research is available that fully assess health risk. So, I am unsure about this as a visitor safety issue.

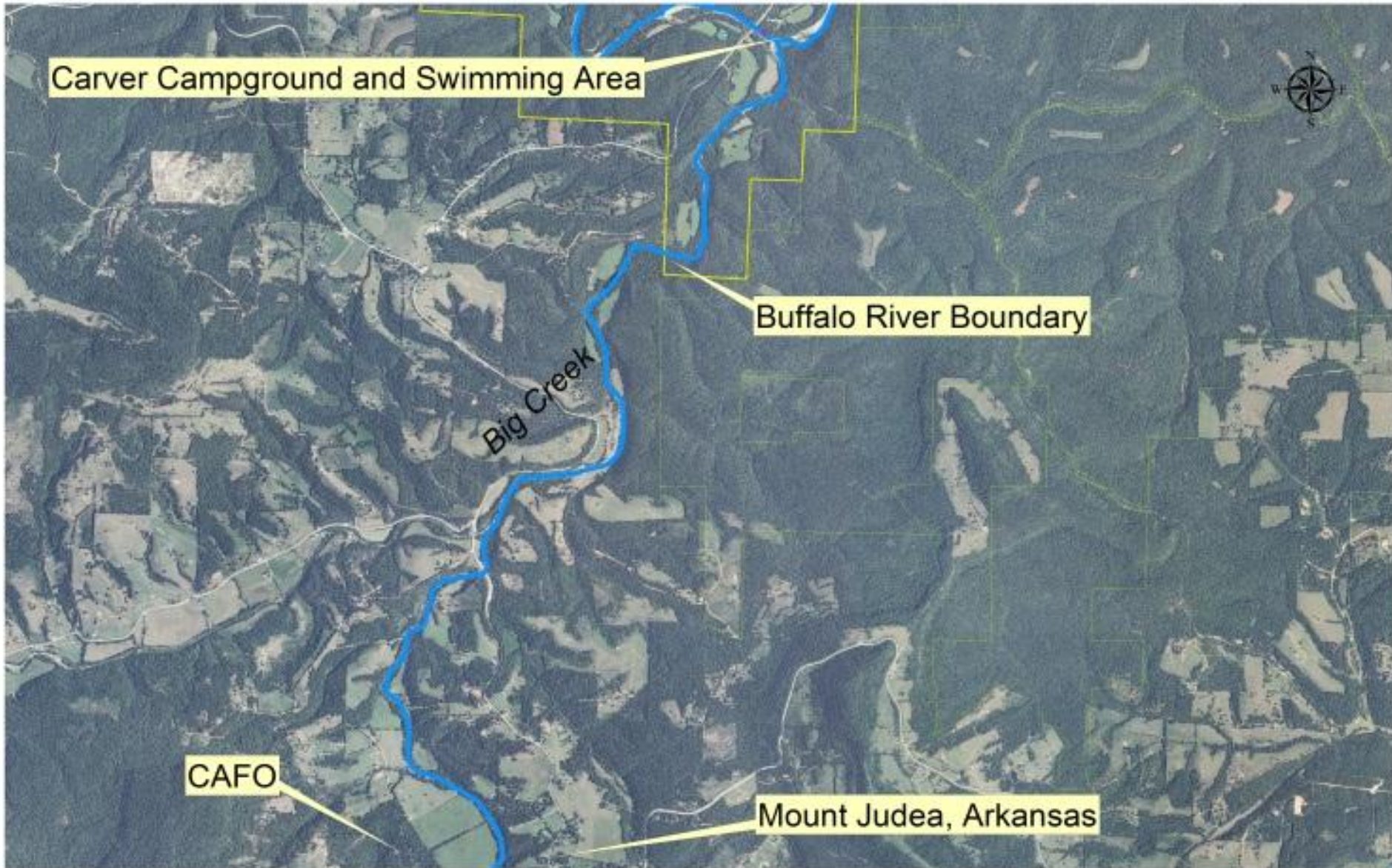


Big Creek Project

- Goal was to characterize *E. coli* concentrations in Big Creek prior to CAFO implementation.
- Project initiated March 2013.
- Sample frequency at 5 samples/30 day period (**all flow conditions**).
- General assessment for water based recreation, based upon ADEQ Regulation #2.
- Regulation 2.507 Bacteria – *E. coli*
 - Primary Contact between May 1 and September 30
 - Geometric mean **126** colonies/100ml
 - Single-sample maximum **298** colonies/100ml
 - For visitor health and human safety, NPS assumes primary contact year round



Big Creek Confluence Area



Buffalo National River



R0414

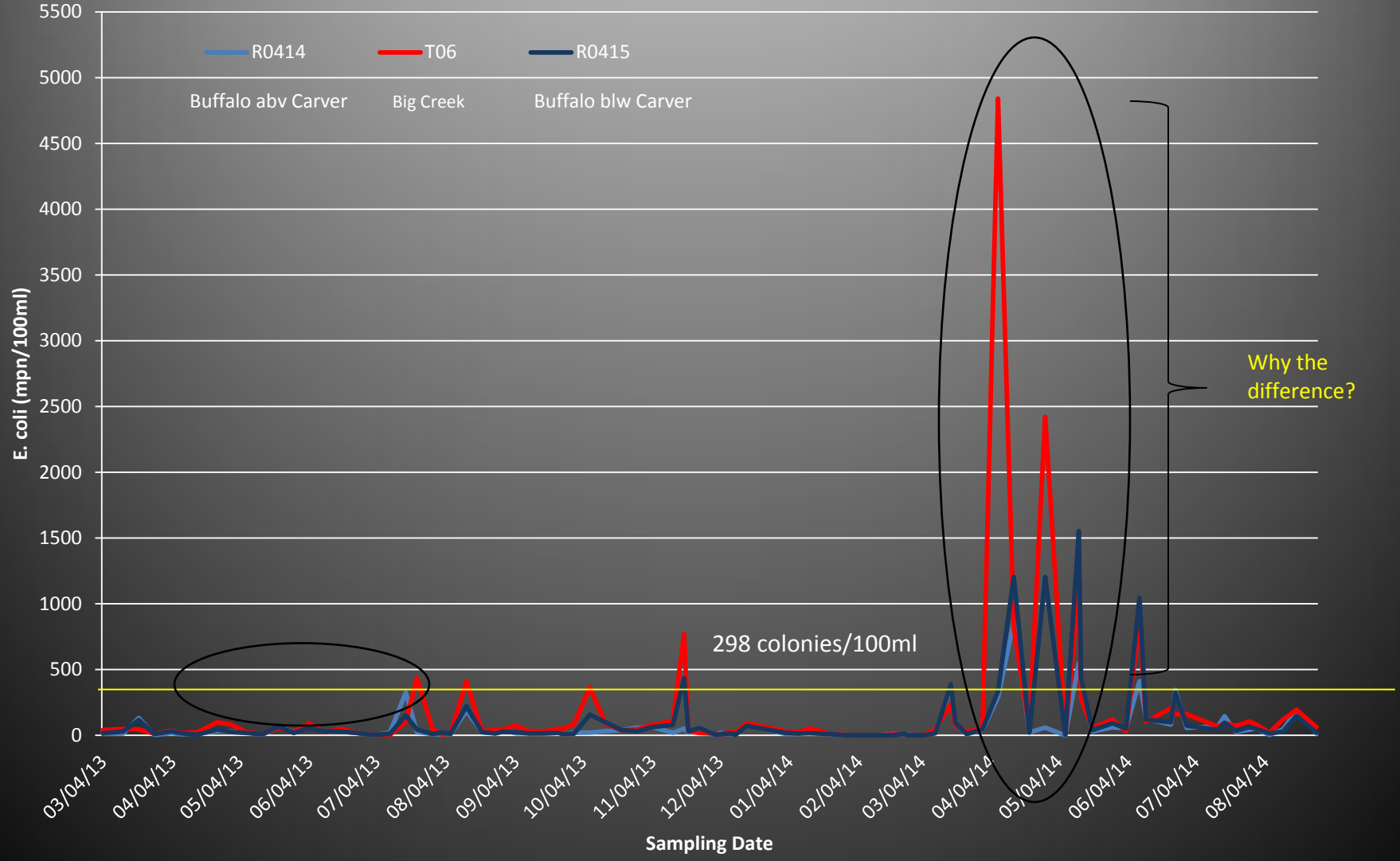
R0415

T06

USGS



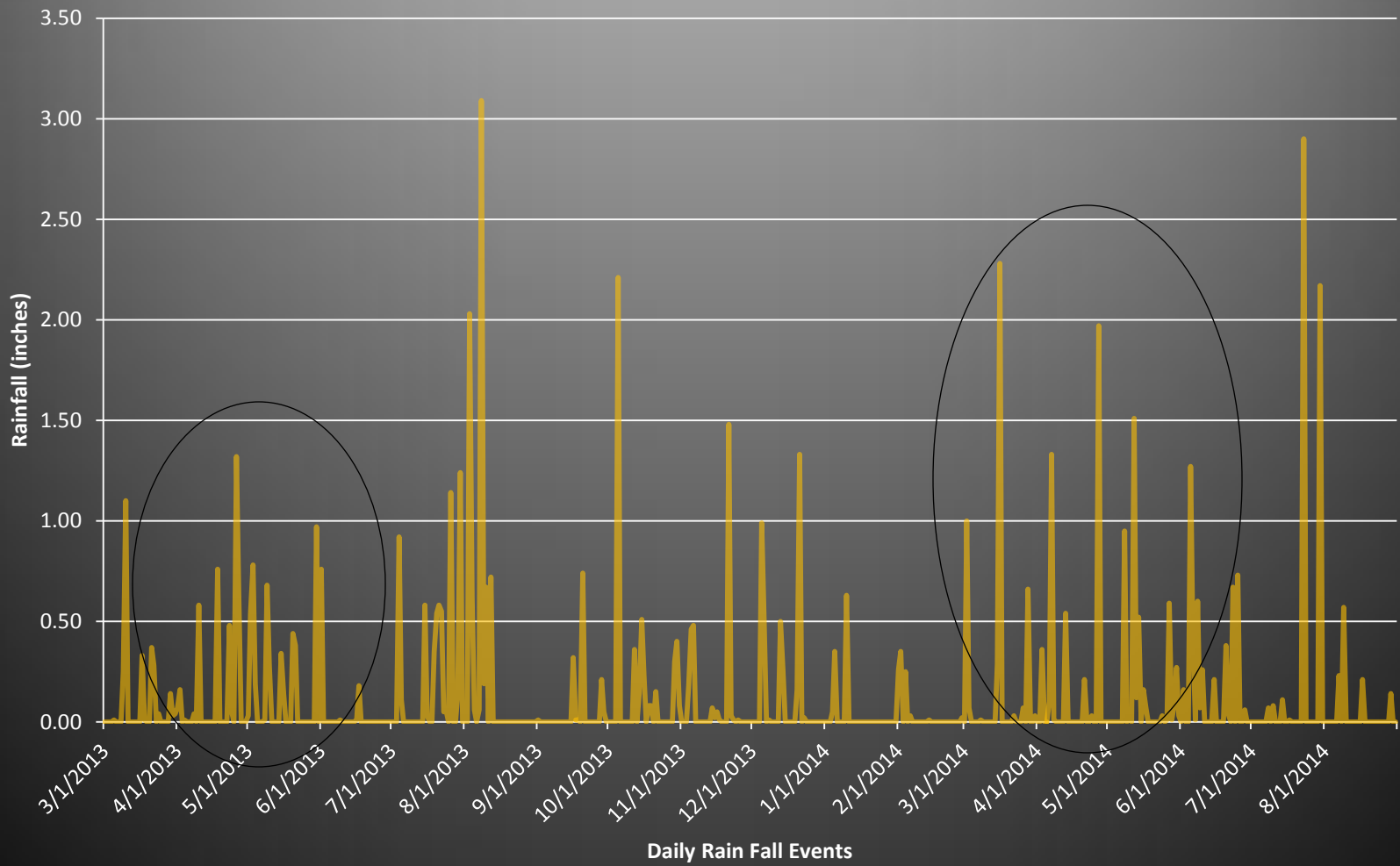
Single Sample Grab for E. coli



Single-sample maximum = 298 colonies/100ml

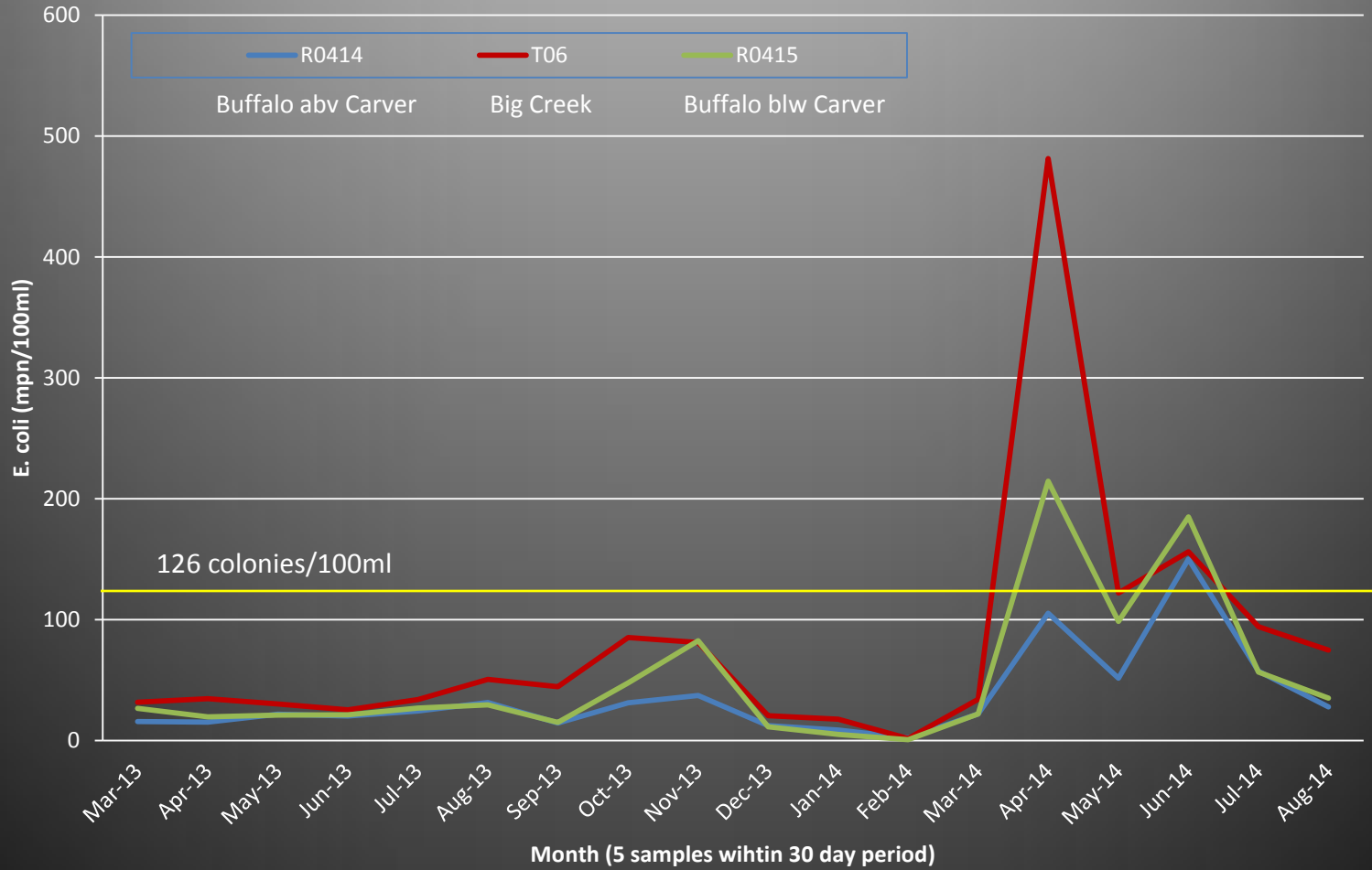


Precipitation Rates for Harrison, Arkansas (Airport) for March 2013 through September 2014





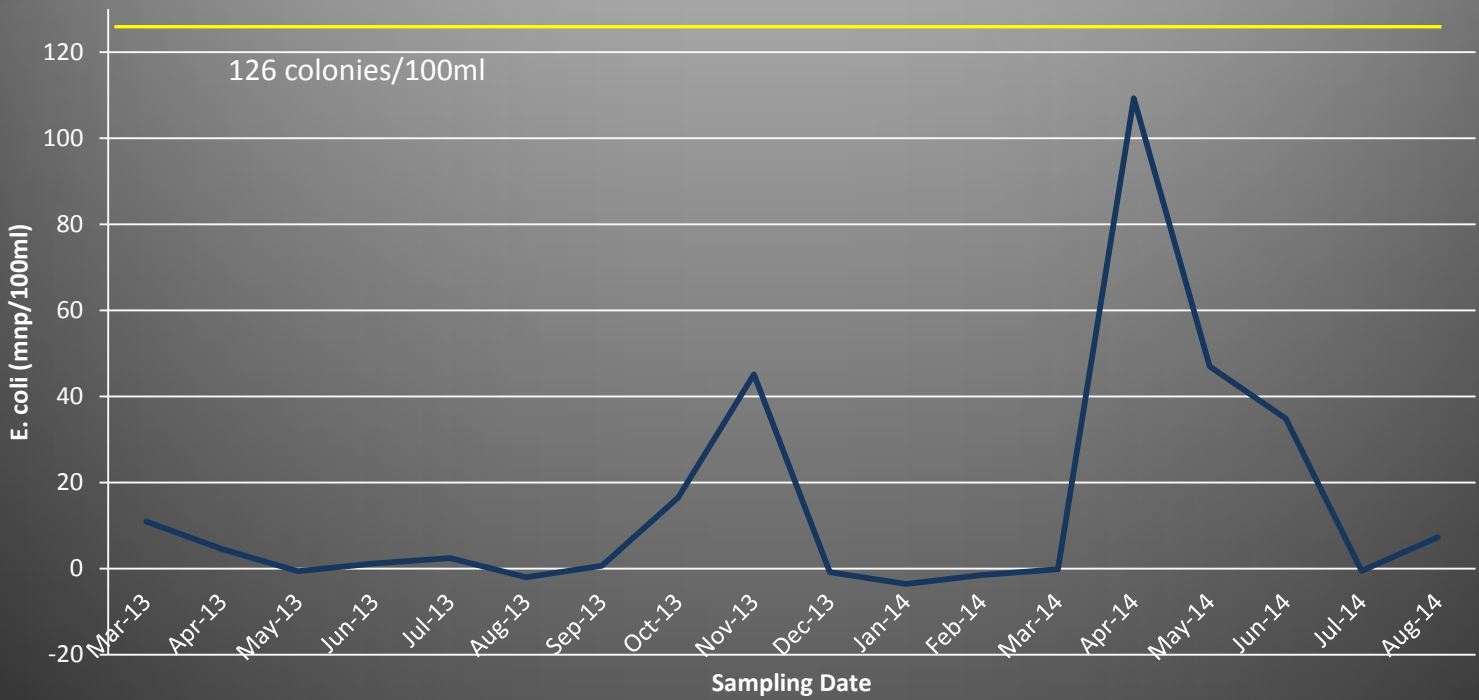
Monthly Geometric Mean of E. coli



Geometric mean = 126 colonies/100ml



Loading Effect (Volumetrically) of Big Creek Upon Buffalo River (Geometric Mean, **Buff below – Buff above**)



Geometric mean 126 colonies/100ml.
Big Creek can elevate Buffalo River into high E. coli conditions.



| Geometric Mean | | | |
|------------------------------------|-------|-----|-------|
| Period - March 2013 to August 2014 | | | |
| | R0414 | T06 | R0415 |
| # Month Exceeds | 1 | 2 | 2 |
| Total # Months | 16 | 16 | 16 |
| Percent Exceeds | 6 | 13 | 13 |

- Hydrograph is not separated into base flow, rising, or falling conditions
- Water based recreation within BNR varies widely, but high water events are specifically targeted by canoe and kayaking visitors
- Big Creek doubles the *E. coli* exposure risk in Buffalo River ; from 6 to 13% of the sample period for a period of 2 months in 2014.





Conclusions (thus far)

Big Creek *E. coli* Project

- Spring 2014 had a dramatic increase in *E. coli* concentrations, and rainfall frequency and amplitude was mobilizing animal wastes from the watershed into the river system.
- Big Creek was above the recreational contact limit for 2 months and its loading effect prolonged high levels in Buffalo River below Carver for an extra month beyond what was observed above Carver.
- For nearly 1 month, Big Creek alone was responsible for loading the Buffalo River, nearly responsible for elevating the river to high *E. coli* concentrations.
- Continued monitoring of Big Creek is justifiable, and project will continue.



Future Direction

- To assess regional conditions relative to Big Creek (T06), BNR will be adding Little Buffalo River (T05) and Buffalo River at Upper Wilderness Boundary (R01) starting in FY2015 (October).
- Dissolved oxygen will be monitored continuously between May through October in T05 and R01 to compare to Big Creek (T06).
- T05 is similar in geology (~karst), size, and human development (minus CAFO). R01 is similar in geology but slightly smaller and represents most natural conditions for Boston Mountain Streams (Wilderness)
- BNR will begin contingency planning (ADEQ and ADH) to respond to potential high *E. coli* concentrations and a public warning system for water based recreation is being planned in FY2015.



Questions?



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