



E. coli Investigation 2018

Cache County, UT

Rich County, UT

Bear Lake County, ID

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Yellowstone to Uintas Connection

PO Box 280

Mendon, Utah 84325

Introduction

The Little Bear River Watershed encompasses 182,000 acres in Northern Utah. The area includes much of Cache Valley as well as a large portion of the Bear River Range to the East and the Wellsville Range to the West. The land within this watershed is comprised of state, federal, and private property with uses such as recreation, agriculture, and urban development. 88% of the land is privately owned within the watershed¹.

Grazing cattle in the Little Bear River Watershed is common on federal, state, and private land. This study examines *Escherichia coli* (E. coli) concentrations at eight points within the Little Bear River Watershed. E. coli can be used as a water quality indicator of fecal contamination from warm bodied animals. Contact with these bacteria can cause sickness in humans including fever, nausea, and even death². States have taken precautions to avoid E. coli outbreaks by defining recreation water bodies and setting standards for E. coli concentrations. The sampling location identifications for this study include Millville Canyon – Millville Creek, North Rich – Saddle Creek, and Paris Canyon – Paris Creek (Fig. 1). The creeks that run through Millville Canyon and the North Rich allotment are classified as 2B (secondary) Contact Recreation water bodies under Utah Administrative Code R317-2³. Paris Creek, in Paris Canyon is classified as a cold-water fishery for Salmonid Spawning and for Primary Contact Recreation⁴.

Secondary contact recreation refers to activities in which arms and legs may come in contact with water, but the human body is not entirely submerged. Activities such as fishing and canoeing are considered secondary contact recreation. These activities are deemed to have reduced exposure to water and the bacteria within them.

Water Quality Standards

In Utah, the 2B Contact Recreation criteria for E. coli includes maximum geometric mean sample criteria of two hundred and six (206) E. coli organisms per one hundred (100) ml. This is based on a minimum of five (5) samples taken every three (3) to seven (7) days over a thirty (30) day period. The single sample maximum is six hundred and sixty-eight (668) E. coli organisms per one hundred (100) ml⁵.

For water quality assessment purposes, up to 10% of representative samples may exceed the 668 per 100 ml criterion (for 1C and 2B waters) and 409 per 100 ml (for 2A [primary] waters). For small datasets, where exceedances of these criteria are observed, follow-up ambient monitoring should be conducted to better characterize water quality.

These numbers can be compared to Idaho's water quality standards which limit the geometric mean of both primary and secondary contact recreation waters to one hundred twenty-six (126)

¹Utah Department of Environmental Quality. 2006. Little Bear River Watershed TMDL. https://deg.utah.gov/ProgramsServices/programs/water/watersheds/docs/2006/09Sep/Little_Bear_River_TMDL.pdf

² Center for Disease Control and Prevention. 2015. E. coli. <https://www.cdc.gov/ecoli/general/index.html>

³ Utah Administrative Code. 2017. Standards of Quality of Waters for the State, Classification of Waters of The State. R317-2-13. <https://rules.utah.gov/publicat/code/r317/r317-002.htm>

⁴ Idaho Administrative Code, Department of Environmental Quality, IDAPA 58.01.02 Water Quality Standards

⁵ Utah Administrative Code. 2017. Standards of Quality of Waters for the State, Numeric Criteria. R317-2-14. <https://rules.utah.gov/publicat/code/r317/r317-002.htm>

and the single sample for secondary contact recreation to five hundred seventy-six (576)⁶. While Utah's water quality standards have improved since the revision of rule R317-2 (the previous maximum E. coli criteria was nine hundred forty (940) for 2B water),⁷ they are still higher than Idaho standards.

Idaho's Primary Contact Recreation criteria for E. coli includes geometric mean single sample criteria:

Waters designated for primary or secondary contact recreation are not to contain E. coli bacteria in concentrations exceeding a geometric mean of one hundred twenty-six (126) E. coli organisms per one hundred (100) ml based on a minimum of five (5) samples taken every three (3) to seven (7) days over a thirty (30) day period.³

For waters designated as primary contact recreation, a single sample maximum of four hundred six (406) E. coli organisms per one hundred (100) ml.

Though the EPA does not give a recommendation for E. coli levels in secondary contact recreation water bodies, they do give two recommendations for primary contact recreation areas (Table1). These recommendations are based on illness rates derived from the National Epidemiological and Environmental Assessment of Recreational Water (NEEAR) definition of gastrointestinal illness⁸. Both recommendations by the EPA are within one unit of Utah's primary recreation standards (Table 2). However, both standards still leave >3% chance of sickness for primary recreation users. This means that Utah standards still leave primary contact users at risk, especially if they are participating in primary contact recreation on a designated secondary contact recreation stream.

EPA Recommendation for Primary Contact Recreation			
Estimated Illness Rate (NGI): 36 per 1,000 primary contact recreators		Estimated Illness Rate (NGI): 32 per 1,000 primary contact recreators	
GM (cfu/100 ml)	STV (cfu/100 ml)	GM (cfu/100 ml)	STV (cfu/100 ml)
126	410	100	320

Table 1: EPA recommendations for primary contact recreation E. coli standards based on estimated illness rate. Standards are provided as geometric mean (GM) and statistical threshold value (STV) for estimated illness rates of 3.6% and 3.2%. Statistics are per 100 ml samples of water and refer to the colony forming units (cfu) of E. coli.

⁶ Idaho Administrative Code. 2000. Rules of the Department of Environmental Quality, IDAPA 58.01.02, "Water Quality Standards." <https://adminrules.idaho.gov/rules/current/58/0102.pdf>

⁷https://deq.utah.gov/ProgramsServices/programs/water/standards/docs/2008/07Jul/20080715_Triennial_Review_2008_June_20_2008_WQB.pdf

⁸ EPA. 2012. 2012 Recreational Water Quality Criteria. <https://www.epa.gov/sites/production/files/2015-10/documents/rec-factsheet-2012.pdf>

Utah E. coli Water Quality Standards			
Primary Contact Recreation (2A)		Secondary Contact Recreation (2B)	
GM (cfu/100 ml)	STV (cfu/100 ml)	GM (cfu/100 ml)	STV (cfu/100 ml)
126	409	206	668

Table 2: Utah's E. coli water quality standards for primary and secondary contact recreation water bodies. Standards are provided as geometric mean (GM) and statistical threshold value (STV). These values are represented at colony forming units (cfu) of E. coli per 100 ml of water.

Idaho E. coli Water Quality Standards			
Primary Contact Recreation (2A)		Secondary Contact Recreation (2B)	
GM (#/100 ml)	STV (#/100 ml)	GM (#/100 ml)	STV (#/100 ml)
126	406	126	576

Table 3: Idaho's E. coli water quality standards for primary and secondary contact recreation water bodies. Standards are provided as geometric mean (GM) and statistical threshold value (STV). These values are represented at colony forming units (cfu) of E. coli per 100 ml of water.

E. coli Impacts from Cattle, Recreation and Wildlife

E. coli are typical of fecal bacteria found in the digestive tracts of animals and humans and are used as indicators of fecal contamination. Their presence may also be indicative of contamination by other bacteria or protozoans that can cause illness resulting in: diarrhea; nausea; vomiting; eye, ear, nose and throat infections; even death such as that experienced in the Milwaukee cryptosporidium outbreak in 1993.⁹

Cattle have been shown to produce 5.4 billion fecal coliform and 31 billion fecal streptococcus bacteria in their feces per day. Since cattle spend a significant portion of their time in or near streams, lakes and wetland areas and average 12 defecations per day, they can contribute significant numbers of these organisms to surface waters.¹⁰

Recent research in areas used by cattle, recreationists, pack animals or wildlife is pertinent to this effort. Research conducted in wilderness areas in the Sierra Nevada mountains included areas of high use by backpackers, high use by pack animals and cattle grazed watersheds. Fifteen areas used by backpackers yielded only one site containing E. coli and this site was significantly lower than those used by cattle or pack animals.¹¹ Five years of data collection from these sites found similar results, concluding, *"Surface water from watersheds below cattle areas and those used by pack animals is at high risk for containing coliform organisms. Water from Wild, Day Hike, or Backpack sites poses far less risk for contamination by coliforms"*.¹²

The costs of nutrients and bacteria from cattle grazing in the Sierra Nevada were characterized as, *"summer cattle grazing on federal lands affects the overall water quality yield from this essential watershed as cattle manure is washed into the lakes and streams or directly deposited into these*

⁹ Rock C, B Rivera. 2014. Water quality, e. coli and your health. University of Arizona College of Agriculture and Life Sciences. AZ1624.

¹⁰ Howard G, Johnson S, Ponce S. 1983. Cattle grazing impact on surface water quality in a Colorado front range stream. J. Soil and Water Conservation. March-April 1983:124-128.

¹¹ Derlet R, Carlson J. 2006. Coliform bacteria in Sierra Nevada wilderness lakes and streams: What is the impact of backpackers, pack animals, and cattle? Wilderness and Environmental Medicine 17:15-20.

¹² Derlet R, Ger K, Richards J, Carlson J. 2008. Risk factors for Coliform bacteria in backcountry lakes and streams in the Sierra Nevada mountains: a 5-year study. Wilderness and Environmental Medicine 19:82- 90.

bodies of water. This organic pollution introduces harmful microorganisms and also provides nutrients such as nitrogen and phosphorus which increase algae growth causing eutrophication of otherwise naturally oligotrophic mountain lakes and streams. Disinfection and filtration of this water by municipal water districts after it flows downstream will become increasingly costly. This will be compounded by increasing surface water temperatures and the potential for toxins release by cyanobacteria blooms.”¹³

Another study in the Sierra Nevada mountains sampled for coliform bacteria in one ungrazed site and four sites grazed by cattle. Before cattle entered the area, all sites were below criteria for coliforms and *E. coli*. After cattle entered the area, the ungrazed site remained low, while the grazed sites rapidly increased above criteria and remained there until after cattle left the area, then quickly declined.¹⁴

In a study of the effect of high precipitation years on benthic algae and coliform bacteria in areas grazed by cattle, areas used predominantly by pack animals, recreation areas used only by humans and remote wildlife areas in the Sierra Nevada mountains, mean benthic algae coverage was 29.5% in cattle grazed areas compared to 8.5% in pack animal areas, 3.7% in human use areas and 1.8% in wildlife only areas. *E. coli* attached to the benthic algae was 90% at cattle grazed sites, 23% at pack animal sites, 0% at human and wildlife sites. *E. coli* was detected suspended in water at concentrations greater than 100 colony forming units/100 ml at 70% of cattle grazed sites and none at pack animal, human or wildlife sites.¹⁵

While this study focused on *E. coli* impacts, it is worth noting that livestock have many additional negative effects on stream systems. They impair water quality and quantity by increasing nutrients and sediment. They alter channel morphology through hoof shear causing channel widening and reducing depth. They alter hydrology by destroying bank stabilizing vegetation, increase water temperature by loss of stream shading vegetation and cause loss of fish and wildlife populations as a result of these habitat changes.^{16,17}

Sample Location Background Information

The North Rich sample point lies within the North Rich Cattle Allotment in the Wasatch Cache National Forest. Its northern boundary is US Highway 89 and its southern boundary is the Saddle Creek Allotment. Most streams within the North Rich Allotment, including the North Rich sample location, flow into Saddle Creek and eventually into the Blacksmith Fork River. The 2017 North Rich Cattle Allotment Annual Operating Instructions (AOI) authorizes 1260 cow/calf pairs for 80 days between June 16th and Sept 11th or 830 cow/calf pairs for 87 days between June 16th and Sept

¹³ Derlet R, Goldman C, Connor M. 2010. Reducing the impact of summer cattle grazing on water quality in the Sierra Nevada Mountains of California: a proposal. *J. of Water and Health*:08.2:326-333.

¹⁴ Myers L, Kane D. 2011. The impact of summer cattle grazing on surface water quality in high elevation mountain meadows. *Water Qual. Expo. Health* 3:51–62.

¹⁵ Derlet R, Richards J, Goldman C. 2012. Does above-normal precipitation reduce the Impact of mountain cattle grazing on watershed algae and bacteria? *Water Qual Expo Health* (4):105–112.

¹⁶ Belsky A, Matzke A, Uselman S. 1999. Survey of livestock influences on stream and riparian ecosystems in the western United States. *J. Soil and Water Cons.* 54(1):419-431.

¹⁷ This section “*E. coli* Impacts From Cattle, Recreation and Wildlife” was taken directly from: Western Watersheds Project and Yellowstone to Uintas Connection. 2017. *E. coli* Investigation, Summer, 2016, Paris Creek, Bear Lake County, Idaho.

30thth.¹⁸ In the 2004 assessment, only 7.3% of the capable rangeland within the North Rich allotment was determined to be “satisfactory” while 41.2% was “unsatisfactory.”¹⁹

The Millville Canyon sample location is within the Millville Cattle Allotment and the Millville Wildlife Management Area. The 2017 Millville Canyon AOI authorizes 88 cow/calf pairs to graze from July 1st to October 4th.²⁰ The canyon is only accessible by ATV or non-motorized transportation. During summer, people recreate along the stream.

The Paris Canyon site is located on KM Ranch property, near Paris, Idaho. Upstream of the site is both private and Forest Service land. The creek flows from its spring headwaters through the National Forest Campground and Riparian Area and then enters private land. The Paris Creek Riparian Area on the Forest was closed to livestock grazing in a 2005 Decision by the Montpelier Ranger District. This closure was to allow Paris Creek to recover from its livestock-degraded state to desired conditions. In the Fall of 2016, the Forest Service reconstructed the stream in this reach to support the native Bonneville cutthroat trout. After leaving the Forest, Paris Creek flows through private land in Paris Canyon until it reaches KM Ranch. It then flows through the town of Paris, and eventually enters the Bear River. During the summer, people live, camp and recreate along the stream.

Methods

Because these bacteria do not normally reproduce in water, *E. coli*/fecal coliform can be used as an indicator of pollution from warm-blooded animal wastes, and to evaluate associated beneficial use impairments, primarily recreational use impairments. Samples are taken from a well-mixed portion of the stream using sterile 100ml Whirl-Pak® bags to collect the sample and contain the sample from the site and during transport in coolers kept to $\leq 4^{\circ}\text{C}$ until the sample is processed through the Colilert® system. Sterile protective gloves were used for collecting each sample to prevent the samplers from contaminating the samples. Samples then must be sealed and placed in an incubator within six hours. Samples were transported to the Yellowstone to Uintas Connection Field Office for processing. Once at the office, an ampoule of Colilert® reagent was added to each sample and mixed well, then the sample was poured into a 97 cell Quanti-Tray® and sealed using an Idexx Quanti-Tray® Sealer Model 2X.²¹ Once sealed, the sample tray was placed in an incubator held at 37 C for 24 hours. After 24 hours, each tray was inspected for the yellow color that indicates fecal coliform presence, then read under a Spectrolite EA-160 ultraviolet lamp for *E. coli* delineation. The resulting counts for the two sets of cells are read against a chart of *E. coli* most probable numbers/100 ml for comparison to criteria. The method is EPA SM 9223B. During each sample trip, one blank and one duplicate sample were collected for quality control purposes. Initial samples (prior to August 23, 2016) were taken to the Bear River Health Laboratory in Logan, Utah for analysis.²²

¹⁸ Logan Ranger District. 2017. Annual Operating Instructions, North Rich Cattle Allotment.

¹⁹ USDA Forest Service. 2004. North Rich Allotment Final Environmental Impact Statement. Range 3-22. Table 3.3.

²⁰ Logan Ranger District. 2017. Annual Operating Instructions. Millville Cattle Allotment.

²¹ http://www.idexx.com/view/xhtml/en_us/water/products/quantitr-tray.jsf

²² This section, “Methods,” was taken directly from: Western Watersheds Project and Yellowstone to Uintas Connection. 2017. *E. coli* Investigation, Summer, 2016, Paris Creek, Bear Lake County, Idaho.

E. Coli Sampling Locations 2018			
Location	Description	Latitude	Longitude
1	Paris Canyon	42.20711111	-111.4738889
2	North Rich Allotment	41.763813	-111.474835
3	Millville Canyon	41.6652139	-111.802222

Table 4: E. coli sampling locations

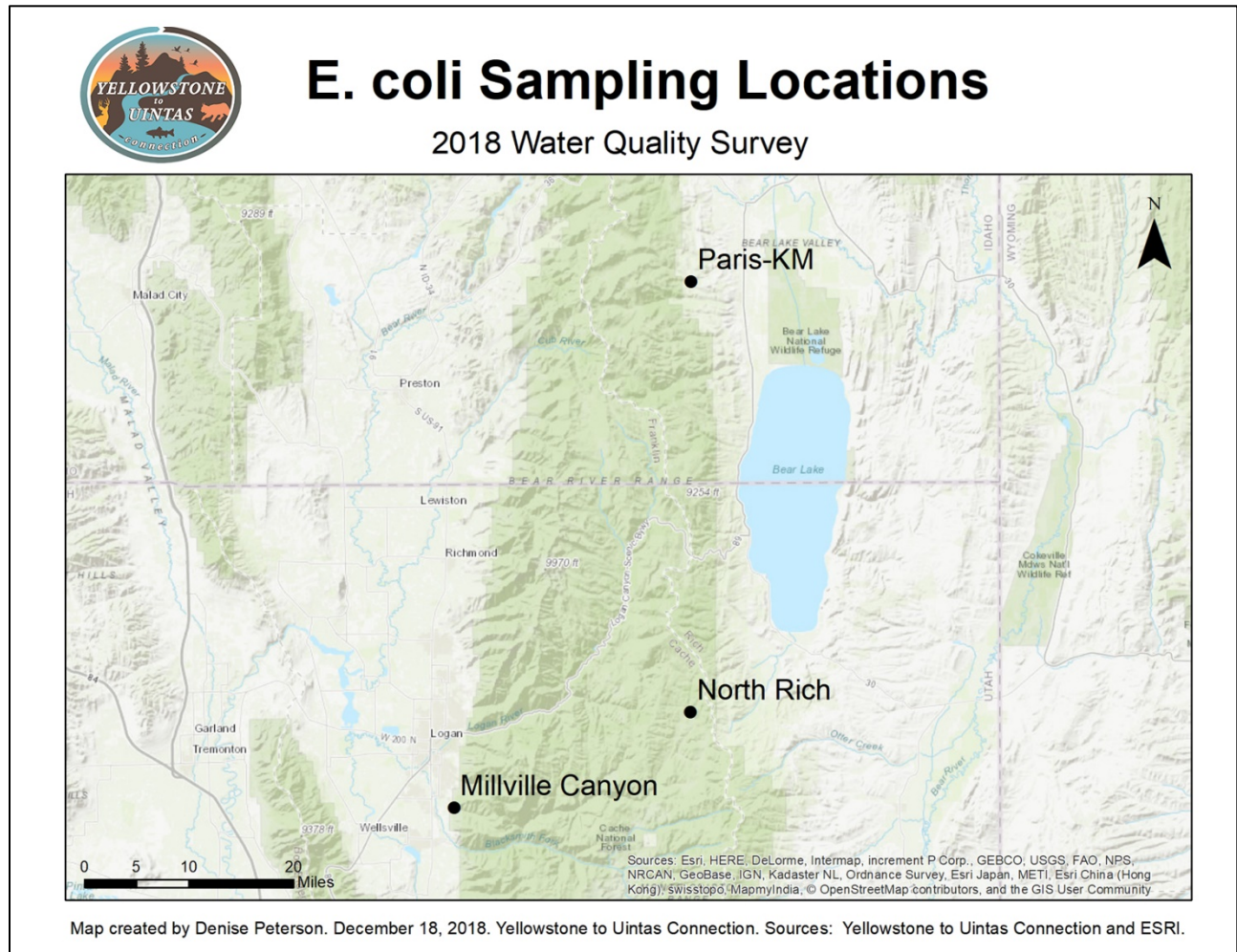


Figure 1 Map of Sample Locations

Results

Cattle were observed near the North Rich, Millville Canyon, and Paris Canyon sample locations during the study. The following (Fig. 2-4 and Table 4 & 5) describe the sample results.

The North Rich location was sampled seven times. Both single sample and geometric mean criteria were exceeded during this sample period. The E. coli samples ranged from 76.3/100 ml to greater than 24161.6/100 ml. The geometric mean for all six samples was 819/100 ml (Fig. 10). The single

sample criterion was exceeded on September 15th and September 11th with E. coli values of >2,419.6²³ and 1119.9, respectively (Fig.2).

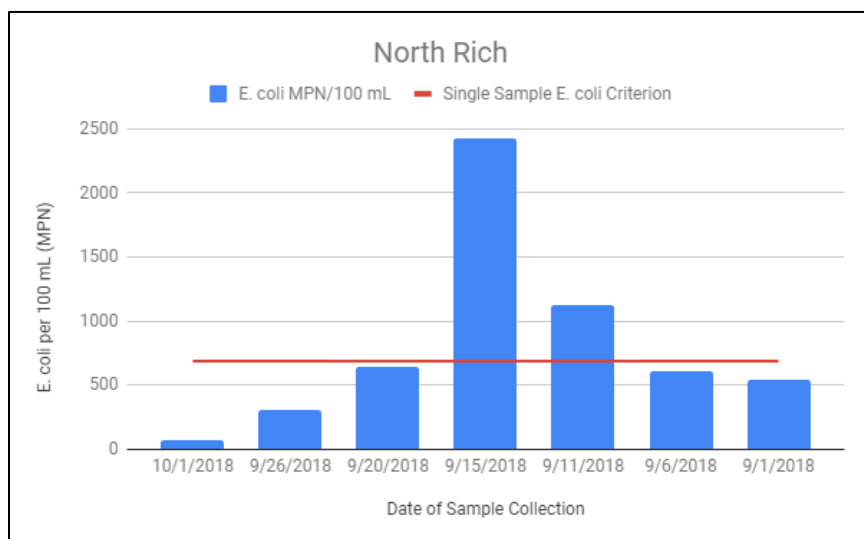


Figure 2: North Rich E. coli sampling results. Single sample E. coli criterion is based on Utah water quality standards for Secondary Contact Recreation water bodies

The Millville Canyon location was sampled seven times between September 1st and October 1st. The single sample criterion was exceeded on September 1st, 6th, 11th, and October 1st. The values associated with these dates were 980.4/100 ml, 980.4/100 ml, 770.1/100 ml, 686.7/100 ml, and 1732.9, respectively. The E. coli geometric mean criterion was also exceeded for this sample period with a geometric mean of 840.4/100 ml (Fig. 3).

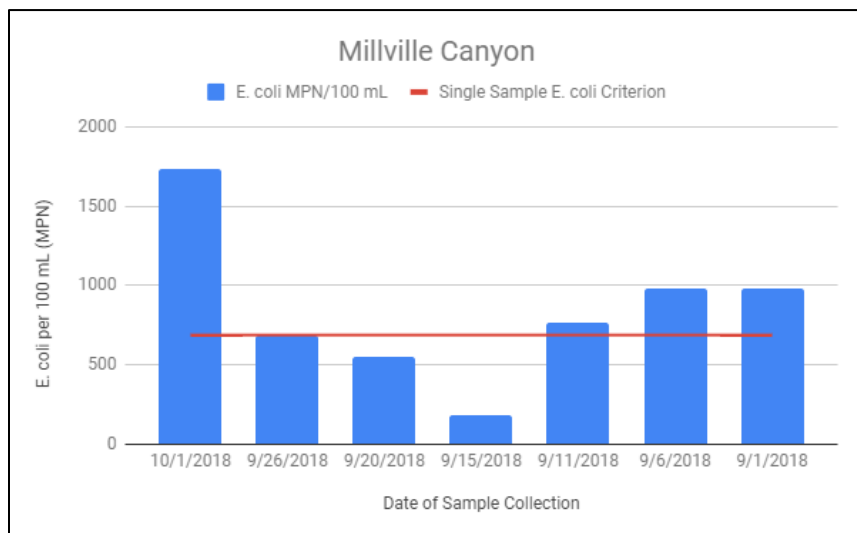


Figure 3: Millville Canyon E. coli sample results. Single sample E. coli criterion is based on Utah water quality standards for Secondary Contact Recreation water bodies.

²³ This number reflects the maximum count possible using the IDEXX Quanti-Tray®/2000 MPN Table. All cells tested positive for E. coli.

The Paris Canyon location at KM Ranch was sampled seven times between September 1st and October 1st. E. coli samples results ranged from 410.6/100 ml to >2419.6/100 ml. Six of the seven samples exceeded Idaho's state standards for single E. coli samples (406 cfu/100ml). These exceedances occurred on September 1st, 6th, 11th, 20th, and 26th with measurements of 1119.9/100 ml, 1203.3/100 ml, 1732.9/100 ml, > 2149.9/100 ml, and 2149.9/100 ml, respectively. The E. coli geometric mean criterion was also exceeded for this sample period with a geometric mean of 1403.3/100 ml (Fig. 4). The GM criterion for primary contact recreation water bodies in Idaho is 126 cfu/100ml).

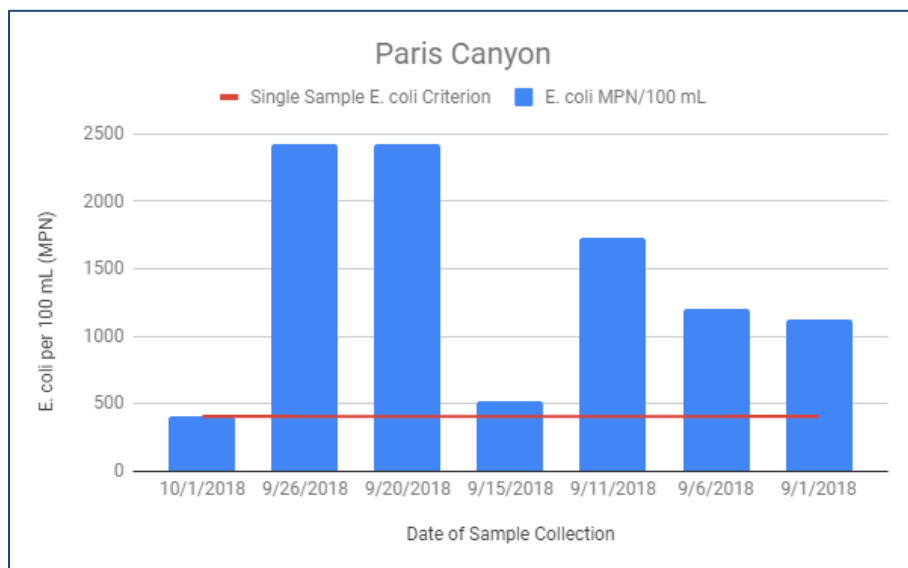


Figure 4: Paris Canyon E. coli sample results. Single sample E. coli criterion is based on Idaho water quality standards for Primary Contact Recreation water bodies.

Coliform Single Sample Results			
Site Name	Collection Date	Total Coliforms/100 mL	E. coli/100 mL
Millville	10/1/2018	>2419.6	1732.9
Millville	9/26/2018	1986.3	686.7
Millville	9/20/2018	1986.3	547.5
Millville	9/15/2018	>2419.6	185
Millville	9/11/2018	>2419.6	770.1
Millville	9/6/2018	>2419.6	980.4
Millville	9/1/2018	>2419.6	980.4
North Rich	10/1/2018	410.6	76.3
North Rich	9/26/2018	816.4	307.6
North Rich	9/20/2018	1119.9	648.8
North Rich	9/15/2018	>2419.6	>2419.6

North Rich	9/11/2018	2419.6	1119.9
North Rich	9/6/2018	1413.6	613.1
North Rich	9/1/2018	1203.3	547.5
Paris-KM	10/1/2018	770.1	410.6
Paris-KM	9/26/2018	>2419.6	2419.6
Paris-KM	9/20/2018	>2419.6	>2419.6
Paris-KM	9/15/2018	1203.3	517.2
Paris-KM	9/11/2018	>2419.6	1732.9
Paris-KM	9/6/2018	1413.6	1203.3
Paris-KM	9/1/2018	2419.6	1119.9

Table 5: E. coli sample results. Red indicates exceedance of single sample criterion. Orange indicates values that exceed geometric mean standards. Green indicates samples that meet E. coli standards

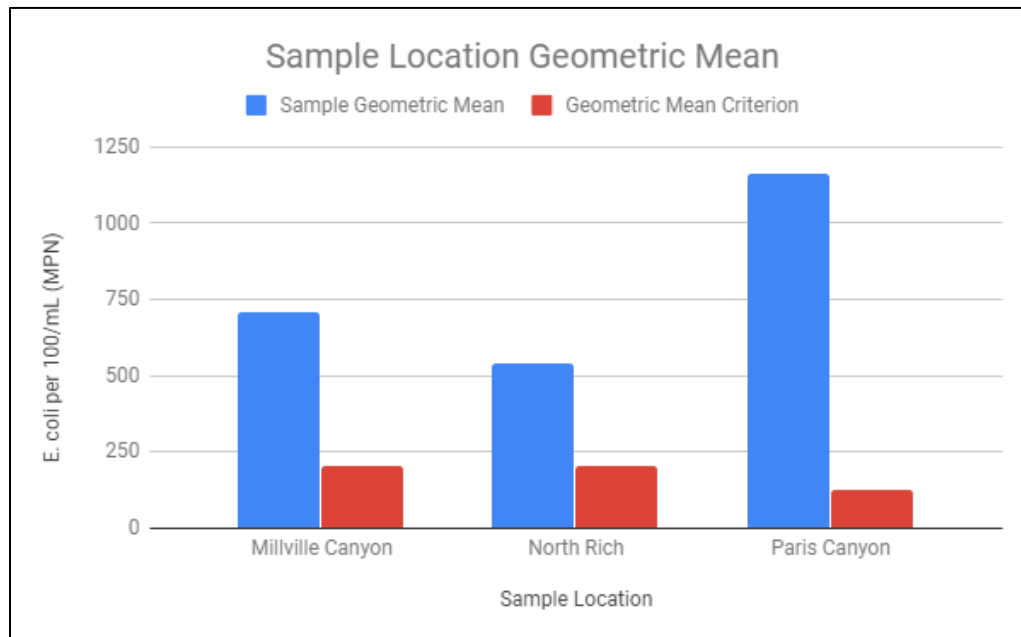


Figure 5: Geometric mean of each sample site in comparison to the E. coli geometric mean standards.

Geometric Mean (GM) at Sample Locations		
Sample Location	GM of Samples	GM Standards
Millville Canyon	708.0506148	206.00
North Rich	542.6181064	206.00
Paris Canyon	1164.467374	126.00

Table 3: Geometric mean (GM) of E. coli sample results as compared to the geometric mean standards at each location. Red indicates an exceedance of GM standards. Each sample location was in violation of state E. coli GM standards.

Conclusions

Monitoring conducted in the Fall of 2018 within the Bear River Watershed has demonstrated that cattle grazing on the Uinta-Wasatch-Cache and Caribou-Targhee National Forest cattle allotments are causing an exceedance of Utah and Idaho E. coli standards (Fig. 5). Each of the Utah samples were taken on a creek listed as a class 2B Contact Recreation stream in the Utah Administrative Code (Rule R317-2. Standards of Quality for Waters of the State). In accordance with this classification, the criteria were violated at both Millville Canyon and North Rich sample sites during the 2018 sample period. The Paris Canyon site is located along Paris Creek, which is designated as a Primary Contact Recreation water body. In accordance with this classification, the state water quality standards were violated at the Paris Canyon sample site during the 2018 sample period. The Utah sample sites were sampled and reported as violating state water quality standards during the summer 2017 E. coli investigation conducted by Yellowstone to Uintas Connection. Paris Creek samples collected in 2016 also showed exceedances of E. coli criteria. A report was submitted to Idaho Department of Environmental Quality for 2016.