

Evaluation of Fecal Coliform Concentrations Along Selected Reaches of the Upper Smith River

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Executive Summary

The purpose of this study was to evaluate fecal coliform contributions from recreational floaters during the 2002 floating season on the Smith River. The Smith River is classified as a B-1 water by the State of Montana. The state's fecal coliform standard for B-1 waters states: "During periods when the daily maximum water temperature is greater than 60°F, the geometric mean number of organisms in the fecal coliform group must not exceed 200 CFU/100 milliliters, nor are 10% of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters" (ARM 17.30.623 (2)(a)).

Two groups of study sites were selected along the Smith River float area. The first group was composed of three sites that were sampled in direct compliance with Montana's requirements for fecal coliforms. One site was upstream of the floater launch point at Camp Baker, another just downstream of Camp Baker at the confluence between the Smith River and Sheep Creek, and the third was established approximately sixty miles downstream at the take out point near Eden Bridge. The second group was composed of fifteen additional boatcamp sites that were distributed throughout the approximately 60-mile river reach. The purpose of these samples was to characterize the changes or trends in coliform concentrations throughout this section of the river.

Overall, fecal coliform concentrations were well below the B-1 standard. The highest geometric mean was calculated at the control site upstream of Camp Baker (96 cfu/100ml), and the lowest was at Eden Bridge (66 cfu/100ml). The boatcamp sampling sites demonstrated no clear trend in overall fecal coliform concentrations, thus indicating low impact from the floaters. The highest concentration was found during June (106 cfu/100ml), and the lowest concentration was found during September (2 cfu/100 ml). The Environmental Laboratory of the Montana Department of Public Health and Human Services determined the percentage of the coliform *Escherichia coli* out of the entire fecal coliform concentration for each site. *E. coli* were found to make up 90-100% of total fecal coliform concentrations. It is difficult to determine the source of fecal coliform concentrations because these microbes are common in all warm-blooded animals (i.e. humans, livestock, wildlife, etc). However, this study demonstrates that recreational floaters do not cause a measurable increase of coliform bacteria to the Smith River.

Introduction

This report provides a summary of bacteriological data collected on the Smith River during summer 2002. The study was completed as a collaboration between the Montana Department of Fish, Wildlife and Parks (MT FWP) and the Montana Department of Environmental Quality (MT DEQ). This study was initiated to evaluate the effect recreational floaters, and any latrines used by the floaters, may have on fecal coliform concentrations in the Smith River. To achieve this goal, a Before-After-Control-Impact design was used. This design evaluates changes in a measured parameter by sampling before, during and after a change to a system. In this study, the measured parameter was the abundance of fecal coliform bacteria; the change was the presence or absence of recreational floaters; and the system was a segment of the Smith River.

The main channel is formed by the confluence of the North and South Forks of the Smith River approximately 4 miles southwest of White Sulphur Springs, MT. The mainstem continues 41 miles to a canyon where it confluences with a major tributary, Sheep Creek. The river then continues through a variety of topographies that include conifer-grasslands and limestone cliffs. The mainstem ends where it joins the Missouri River near Ulm, MT, approximately 83 miles downstream of Camp Baker (Bukantis 1996; Figure 1).

River sites evaluated in this survey begin just above Camp Baker and end at Eden Bridge (Figure 1). Camp Baker is the established launch point for floating the river and Eden Bridge is the take-out point approximately sixty miles downstream. Boatcamps are spread throughout the floating area. Citizen complaints concerned with possible fecal coliform contributions from floaters to the Smith River were the impetus for the survey. This survey of fecal coliform levels was undertaken in 2002 in order to address these concerns.

Fecal coliforms enter water bodies following exposure to warm-blooded animals (USEPA 1986). These exposures occur in two forms. The first is through direct contact of animals wading in the water. All warm-blooded animals have resident external coliform flora living on their entire bodies. All other exposure routes result from direct exposure from animal feces. While coliform bacteria in small amounts are not dangerous, they can be used as an indicator of more lethal bacteria (USEPA 1986).

The Smith River is classified as a B-1 water by the State of Montana (ARM 17.30.623). This designation means these waterbodies should be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fish and associated aquatic life, waterfowl and furbearers; and as a water supply for agricultural and industrial uses.

There is a numeric fecal coliform standard in place for B-1 waters. ARM 17.30.623 (2)(a) states: "During periods when the daily maximum water temperature is greater than 60°F, the geometric mean number of organisms in the fecal coliform group must not exceed 200 colony-forming units (CFU) per 100 milliliters, nor are 10% of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters." This protocol allows MT DEQ to make its determination of whether or not standards have been violated. Further, the geometric mean referred to above is to be based on a minimum of five samples each collected at least one day apart, but within a 30-day period (ARM 17.30.620(2)). One fact to keep in mind is that the temperature requirement

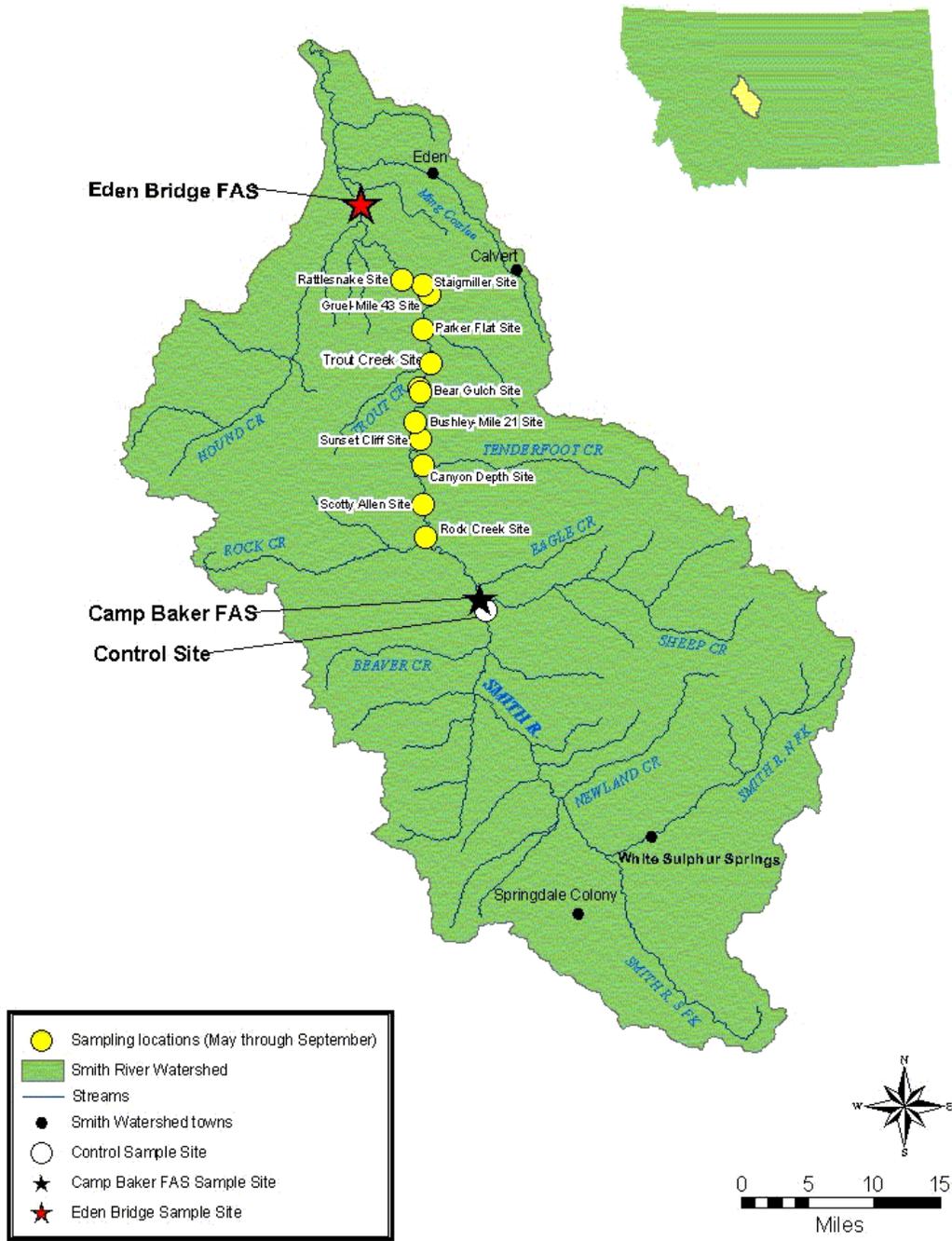


Figure 1. Fecal coliform sample sites on the Smith River, 2002

written in the standard was meant as a reference point for when state waters are most likely to be used for swimming, wading, etc. Fecal coliforms can survive at temperatures lower than 60°F, although changes in water temperature can influence how quickly the microbes propagate.

Methods

Sample sites

Sites within the study reach were selected based upon their proximity to established boatcamps along the river. The study area begins at Camp Baker (river mile 82.7) and ends at Eden Bridge (river mile 19.5). A site was established just upstream of the floating launch point (spatial Control). All samples were collected on site during the permitted floating season that begins April 1 and ends October 31.

Samples were collected from a total of 18 sites; however, only three sites were sampled using the standard technique for fecal coliform analysis (APHA 1998). These sites were: a control area above the Camp Baker launch site, a site just below the Camp Baker launch site downstream of the confluence with Sheep Creek, and the site at the end of the run, at Eden Bridge (Figure 1). These sites all had road access and samples could be returned to the Environmental Laboratory of the Montana Department of Public Health and Human Services within six hours of sampling, as required by Standard Methods (APHA 1998), and were used to determine if the Smith River was meeting the state's fecal coliform standard. The sites were sampled 5 times over a thirty-day time period from July 16, 2002 to August 15, 2002 (Table 1).

Where road access was impossible, sample sites were accessed via canoe. These 15 sites were all between the launch point at Camp Baker and the exit point at Eden Bridge (Figure 1). These sites were sampled three times each during summer 2002. The data from these sites did not meet the sampling criteria necessary for determining compliance with the state's fecal coliform standard because the delayed-incubation technique was used, and only three samples were collected per site.

Bacterial Analysis

Fecal coliform analysis followed two procedures depending upon how much time elapsed between sampling from the river and the analysis in the laboratory. If samples could be returned to the Environmental Lab within six hours, a standard filtration and incubation technique was used. This procedure involved placing the grab samples on ice and returning the samples to the Environmental Lab as soon as possible. The samples were then filtered through a 45- μ m membrane filter, placed in the appropriate media (M-FC), and incubated for 24 hours (APHA 1998). This procedure was used where the river could be accessed by road.

The second procedure was used in areas of the river where road access was impossible. A delayed incubation bacteria analysis was used to determine fecal coliform concentrations in these areas (Britton and Greeson 1987). This technique involved immediately filtering the sample through a 45- μ m filter, and then placing the filter in a special medium (M-ST) that prevents excessive growth. The filters were returned to the Environmental Lab within 72 hours, transferred to a growth medium (M-FC), incubated for 24 hours and then counted directly (APHA 1998).

E. coli counts in this survey were confirmed as an extra step in both processes. After completion of fecal coliform analyses, the membrane filters were placed in another

specialized media (EC-MUG) for twenty-four hours (APHA 1998). *E. coli* is only one species of fecal coliform bacteria (USEPA 1986). Therefore, this step determines the amount of *E. coli* colonies present out of the total number of fecal coliform colonies in each sample.

Fecal Standard for the Smith River

Zar (1999) defines the calculation of the geometric mean as: the *n*th root of the product of the *n* data.

$$\sqrt[n]{\prod_{i=1}^n X_i}$$

Another way to view this equation is:

$$\sqrt[n]{X_1 \cdot X_2 \cdot X_3 \cdot X_4 \cdot \dots \cdot X_n}$$

In the case of Montana standards, five samples were collected within 30 days during the Smith River 2002 summer float season. These data were used to calculate the geometric mean. Because time and temperature variations of some data were outside of the requirements of Montana’s fecal standard, only data collected between July 16, 2002 and August 15, 2002 were selected for this calculation.

Results

Calculated Geometric Mean for Fecal Coliforms in the Smith River

Table 1 contains data collected using the standard-incubation technique that met all conditions to meet the standard for B-1 waters (ARM 17.30.620(2)(a)). Figure 2 shows the calculated geometric means for the three sites sampled over a thirty-day period using the standard technique. Control samples taken above the Camp Baker Control launch site had the highest overall geometric mean of 96 cfu/100 ml. Camp Baker downstream of the Sheep Creek confluence was lower with a geometric mean of 75 cfu/100 ml. The lowest geometric mean of 66 cfu/100 ml was calculated for the Eden Bridge site.

Table 1. Data Used in the Smith River to Determine Compliance with the State's Fecal Coliform Standard.

Site	07/16/02	07/23/02	07/30/02	08/06/02	08/15/02
Camp Baker Control Upstream of Public Launch Point	264	118	108	70	34
Camp Baker Downstream of Public Launch Point	278	168	58	56	16
Eden Bridge (>60 miles Downstream)	66	144	32	96	40

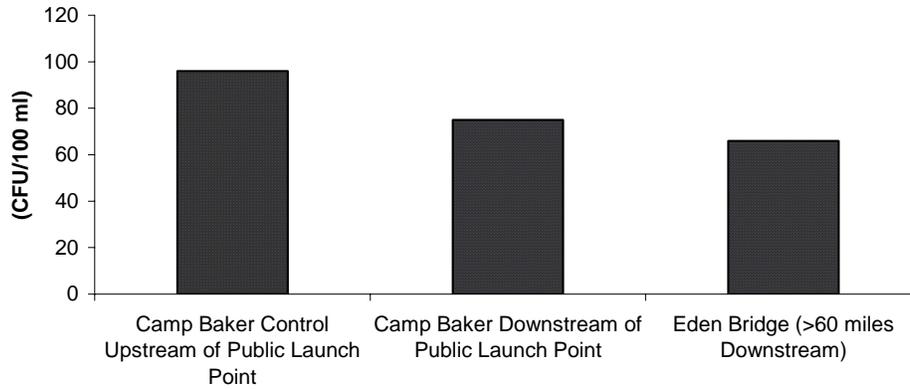


Figure 2. Geometric Mean of Fecal Coliforms measured in the Smith River July 15, 2002 - August 15, 2002. Samples were collected and analyzed in accordance with ARM 17.30.620 (2) and APHA (1998).

Spatial Trends in Fecal Coliform Levels Using the Delayed-Incubation Technique

There were large differences between the first sampling event on May 15, 2002 and the last September 11, 2002 (Figure 3). In general, sampling events earlier in the season yielded higher fecal coliform concentrations. Peak counts were found from all sites on June 20, 2002 averaging 38 cfu/100 ml ± 9 (1 SE). Average fecal coliform concentrations decreased from all sites until August 15, 2002 at 9 cfu/100 ml ± 9 (1 SE). Concentrations were found to increase after the August sampling, to an average of 13 cfu/100 ml ± 9 (1 SE) during the September sampling.

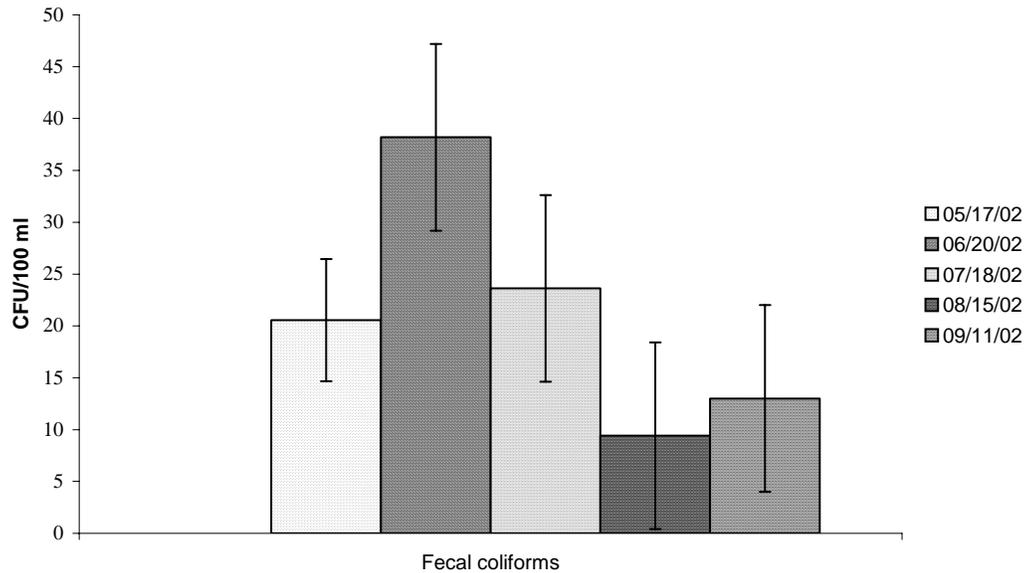


Figure 3. Overall temporal changes of mean fecal coliform concentrations from sites where only the delayed-incubation technique was used in the Smith River. Error bars are one standard error of the mean.

Figure 4 demonstrates differences between the three sites where the standard technique was used throughout the summer. Note that no samples were collected here in June. The largest difference was found during the July 16 sampling. The highest concentrations were found at the Camp Baker Control and Camp Baker sites where

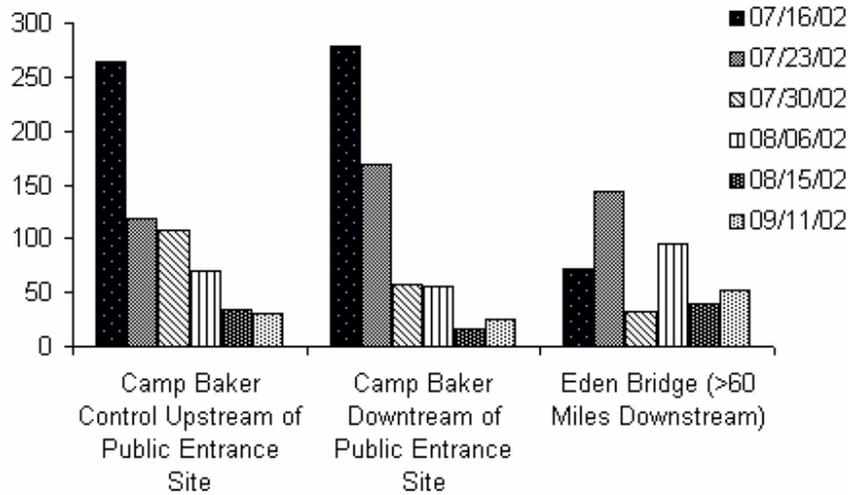


Figure 4. Fecal coliform concentrations from sites along the Smith River throughout the summer 2003.

concentrations were 264 and 278 cfu/100 ml, respectively. Because these concentrations are used as part of the geometric mean that is compared to the B-1 standard, they are not violations by themselves. The Eden Bridge sample from the same date was 72 cfu/100 ml. Overall, fecal coliform concentrations continued to drop the rest of the summer and are very similar by September, when measured levels were 30, 26 and 52 cfu/100 ml, respectively.

Average differences between areas of the Smith River upstream and downstream of areas where floaters enter the river are shown in Figure 5. The purpose of this chart is twofold. First, to demonstrate average differences between fecal coliform counts upstream to downstream. Second, to show differences between the standard and delayed-incubation techniques (APHA 1998) used in the survey. Concentrations of fecal coliforms were typically 50-60% lower from delayed samples than those collected and analyzed using the standard technique.

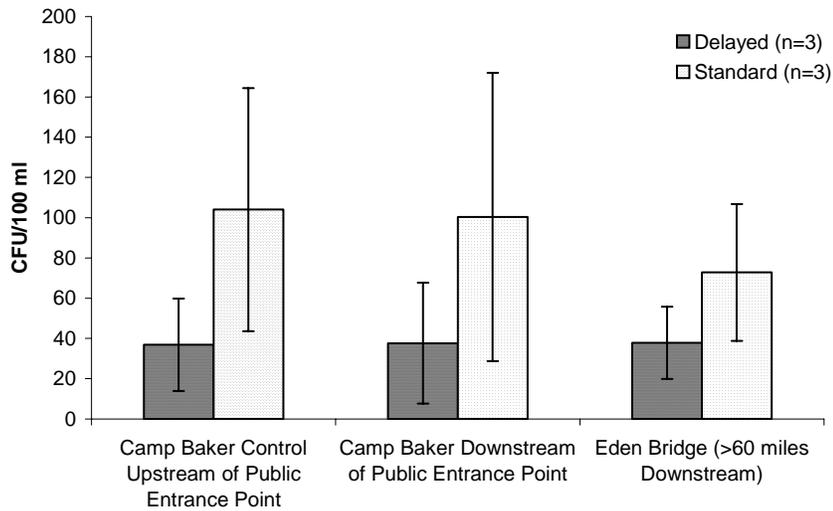


Figure 5. Comparison of results generated by the Delayed-Incubation and Standard Techniques. Error bars are one standard error of the mean.

Figures 6-10 demonstrate monthly differences in fecal coliform concentrations for sites analyzed with the delayed-incubation technique. Concentrations of fecal coliforms (Y-axis) decrease (with few exceptions) for each sample the further downstream traveled from the Camp Baker launch site. These graphs also demonstrate low fecal coliform concentrations throughout the float area. The highest concentration was measured in June 2002 (106 cfu/100 ml) and the lowest was measured September of 2002 (2 cfu/100 ml).

Earlier coliform evaluations were found in the LEGACY STORET database (USEPA 2003; Figure 11). Montana DEQ monitored two Smith River sites in the mid 1970's for fecal coliforms, and these averaged 96 cfu/100 ml. Starting in the early 1970's the USGS monitored one site on the Smith River near Fort Logan, MT below Eagle Creek, and documented a three-year increase in fecal coliforms that peaked in 1995 averaging 162 cfu/100 ml.

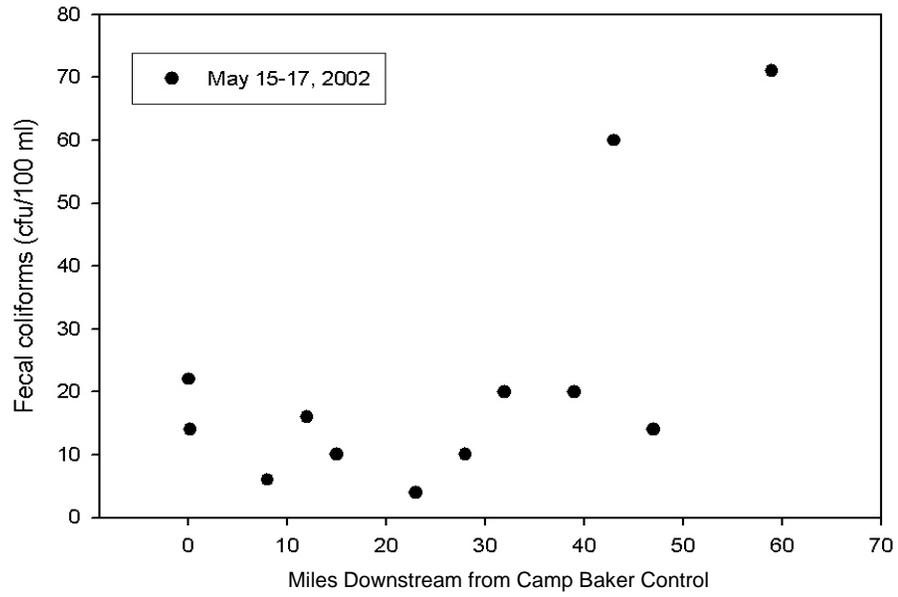


Figure 6. Results from canoe sites sampled using the Delayed-Incubation Technique for May 2002

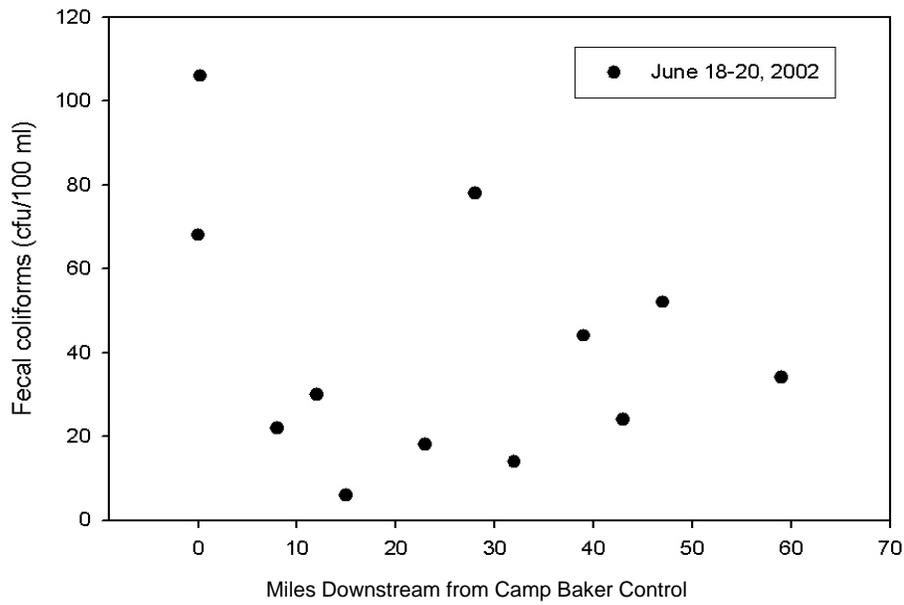


Figure 7. Results from canoe sites sampled using the Delayed-Incubation Technique for June 2002

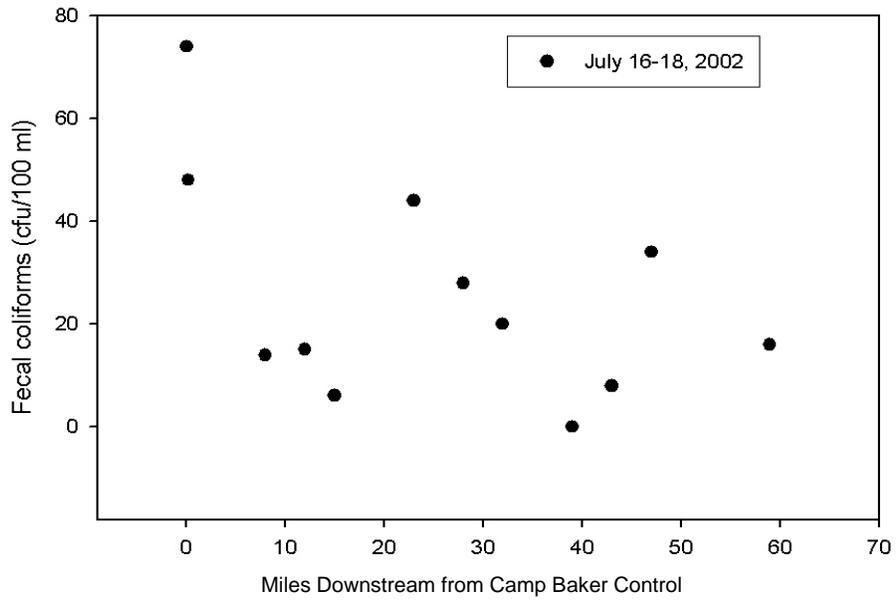


Figure 8. Results from canoe sites sampled using the Delayed-Incubation Technique for July 2002

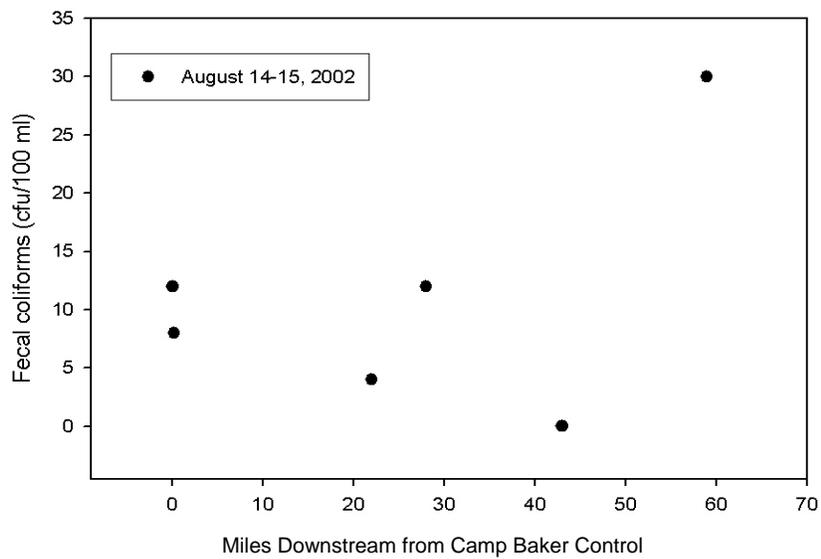


Figure 9. Results from canoe sites sampled using the Delayed-Incubation Technique for August 2002

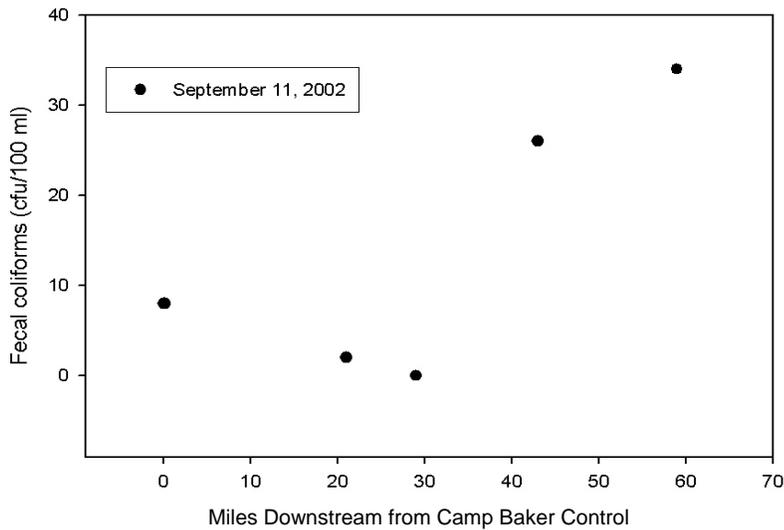


Figure 10. Results from canoe sites sampled using the Delayed-Incubation Technique for September 2002

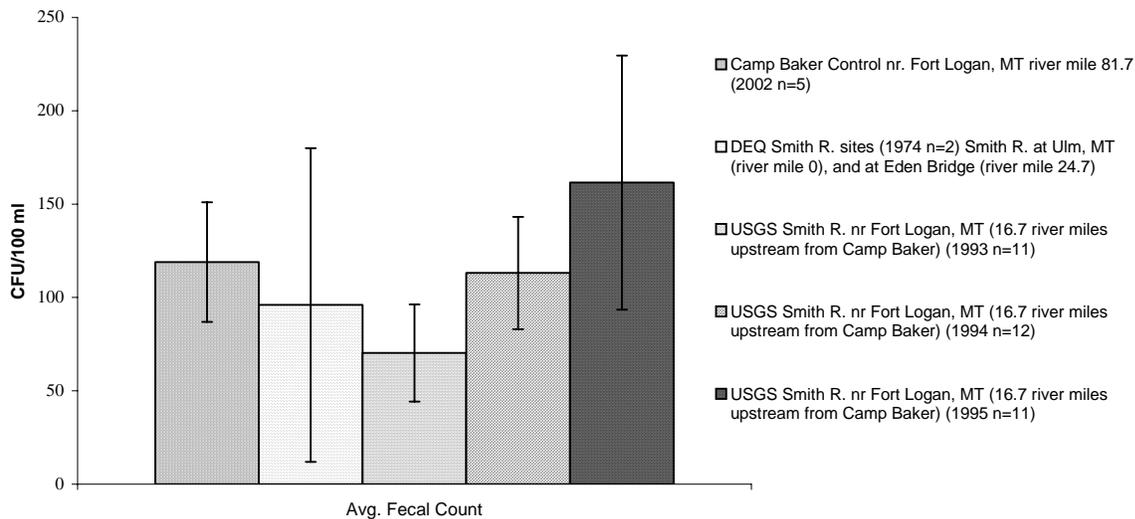


Figure 11. Historical Smith River coliform data, and data from this study. Error Bars are one standard error of the mean. River mile measurements were taken from DNRC 1979.

Discussion and Conclusions

Smith River Fecal Standard

While the fecal coliform data collected in this project are variable, none of the data are above the state's standard of a geometric mean for five samples, which is 200 cfu/100ml (Figure 2). Further, none of the samples exceed 400 cfu/100 ml, which can potentially be a violation of water quality standards (ARM 17.30.623 (2)(a)). Data that were collected at the three standard-technique sites before and after July 15, 2002 to

August 15, 2002 were not included in the calculation of the geometric mean. There are two reasons for this. First, they did not meet the strict thirty-day time period required for calculating the geometric mean. Second, the standard calls for a minimum temperature of 60°F. The data that were collected based upon those specifications, however, clearly demonstrate the low fecal coliform levels found in the Smith River.

Spatial differences in Fecal Coliforms Concentrations from Established Boatcamps

The data demonstrate highest levels of fecal coliforms upstream of the area where the floaters enter the river, at Camp Baker. The Camp Baker Control site just upstream of the established floating launch site was consistently higher in fecal coliform counts throughout the summer than was the site downstream of Camp Baker or Eden Bridge (Figures 2, 4). While this number is below the state standard for the river, it shows that floaters are not causing fecal coliform concentrations to increase in the river. This fact was also reinforced by the consistent and downward trend in coliform concentrations all the way to Eden Bridge, where the floaters typically leave the Smith River. It is difficult to say with any certainty why this trend occurs throughout the Smith River.

Differences in Time within the Index Period

Previous studies have noted changes in coliform concentrations in streams and rivers dependent upon differences in temperature, flow regime, amount of access by warm-blooded animals, and overall water quality (Geldreich et al. 1955, McFeters and Stuart 1972, Bukantis 1995). All of those factors can influence fecal coliform concentrations in a water body. Data in Figures 3 and 4 show the changes in average fecal coliform concentrations through time in the Smith River. There was a definite peak in fecal coliform activity during June and may reflect contributions due to runoff from upland areas. Sites sampled using the standard technique demonstrate a decrease in fecal coliform levels through time. It is difficult to attribute any change in fecal coliform levels to any particular factor with the information provided in this survey. Because all fecal concentrations were low overall, they are more than likely a reflection of instream natural levels. These levels include contributions from any warm-blooded animal that uses the Smith River.

Delayed Incubation vs. Standard Techniques

Differences within sites where both techniques were used were quite clear (Figure 5). Samples evaluated using the standard technique were consistently higher than those evaluated with the delayed-incubation technique. This demonstrates an inherent weakness of the delayed-incubation technique. Initial survivability of bacteria is apparently decreased significantly with the delayed-incubation technique, despite an early study conducted by Geldreich et al. (1955) that touted good comparability of results obtained from the delayed-incubation technique to the standard technique. This may in part be due to the procedures used in that study. Geldreich used fermentation tubes filled with media to culture bacteria compared to membrane filters used for culturing organisms in this survey. Chen and Hickey (1986) determined that the membrane filter technique is a more effective method because it prevents overgrowth of fewer bacterial colonies, rather than an inflation of actual numbers present.

Figure 5 points out another important trend. Differences between sampling sites up and downstream from boatcamps used by floaters are minimal and not significant. Between sites, results from the standard technique varied from 104 cfu/100 ml to 73 cfu/100 ml from Camp Baker to Eden Bridge, respectively. Delayed-incubation results

varied from 37 to 38 cfu/100 ml from Camp Baker Control to Eden Bridge, respectively. Both techniques demonstrate that there was essentially a negligible difference between upstream and downstream sites located at individual boatcamp sites.

Escherichia coli presence in the Smith River

E. coli counts were measured to confirm the presence of warm-blooded animals in the river. This was completed by the Environmental Lab as a verification step not only for the presence of *E. coli*, but to calculate the percentage *E. coli* made up of total fecal coliforms in the river. *E. coli* was found to be the dominant fecal coliform, making up to 90 – 100% of the total fecal coliform counts. One exception was found at site “Gruel-Mile 43” (Appendix A). There, *E. coli* only made up forty percent of the total fecal coliforms from the September 11, 2002 sample. Possible reasons that the level changed at that point in time include water quality changes, or possible decreases in temperature that limit coliform growth (McFeters and Stuart 1972). *E. coli* has been listed by USEPA as a more accurate indicator of harmful microorganisms that cause intestinal illness passed from warm-blooded animals than are fecal coliforms (USEPA 2002). This distinction is important for this study because such a high percentage of measured fecal coliforms were in fact verified as *E. coli*. The overall decrease in fecal coliform (*E. coli*) concentrations throughout the floating area demonstrates the very negligible effect floater contributions have on the stream (Figures 6-10). This study also demonstrates that fecal coliform concentrations have changed little over the thirty-year period during which samplings have occurred (Figure 6). This study’s results were, in fact, about midrange for the Smith River’s measured fecal coliform concentrations. Future bacteriological analyses of the river should focus on *E. coli* as an indicator of harmful microorganisms.

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Appendix A. Complete dataset of bacteria sampled on the Smith River summer 2002

Site Name	Technique	Date Collected	Latitude (DMS)	Longitude (DMS)	Temp	Volume Sampled	Volume Filtered (ml)	Time Collected	Fecal			Fraction		E. Coli. cfu/100 ml
									Fecal Count	cfu per 100 ml	cfu Transferred to E.Coli.	cfu Verified as E.Coli.	Verified as E.Coli.	
Anderson Mile 28	Delayed	08/14/02	46.80377	111.18317	62	250	50	12:10	6	12	4	4	1	12
Anderson Mile 29	Delayed	09/10/02	47.09829	111.28418	62	250	50	12:30	0	0	0	1	0	0
Bear Gulch	Delayed	05/16/02	47.03147	111.28049	46	250	51	9:20	5	10	4	4	1	10
Bear Gulch	Delayed	06/19/02	47.03147	111.28049	50	51	51	10:30	40	78	10	10	1	78
Bear Gulch	Delayed	07/17/02	47.03147	111.28049	64	50	50	8:15	14	28	10	10	1	28
Blank Control	Delayed	05/16/02	46.80398	111.18188	50	250	50	17:00	0	0	0	0	1	0
Blank Control	Delayed	06/18/02	46.80398	111.18188	50	50	50	8:05	0	0	0	0	0	0
Blank Control	Delayed	07/16/02	46.80398	111.18188	68	52	52	8:20	0	0	0	0	1	0
Blank Control	Delayed	08/14/02	46.80398	111.18188	70	250	51	10:15	0	0	0	0	1	0
Bushley-Mile 21	Delayed	09/10/02	47.14685	111.28728	62	250	50	14:50	1	2	1	1	1	2
Bushley-Mile 22	Delayed	08/14/02	46.87085	111.2712	70	250	52	14:45	2	4	2	2	1	4
Camp Baker	Delayed	05/15/02	46.80377	111.18317	48	250	50	8:30	7	14	5	5	1	14
Camp Baker	Delayed	06/18/02	46.80377	111.18317	58	50	50	8:25	53	106	10	10	1	106
Camp Baker	Standard	07/16/02	46.80377	111.18317	71.6	50	50	7:33	139	278	10	10	1	278
Camp Baker	Delayed	07/16/02	46.80377	111.18317	66	52	52	7:50	25	48	10	10	1	48
Camp Baker	Standard	07/23/02	46.80377	111.18317	68	50	50	10:40	84	168	10	10	1	168
Camp Baker	Standard	07/30/02	46.80377	111.18317	70.7	50	50	10:55	29	58	10	10	1	58
Camp Baker	Standard	08/06/02	46.80377	111.18317	66.2	50	50	11:20	28	56	10	10	1	56
Camp Baker	Standard	08/15/02	46.80377	111.18317	61.7	50	50	11:15	8	16	10	10	1	16
Camp Baker	Delayed	08/15/02	46.94943	111.27884	58	250	50	11:20	4	8	4	4	1	8
Camp Baker	Standard	09/11/02	46.80377	111.18317	57.2	50	50	11:25	13	26	10	10	1	26
Camp Baker Control	Delayed	05/15/02	46.80387	111.18117	48	250	50	8:13	11	22	6	6	1	22
Camp Baker Control	Delayed	06/18/02	46.80387	111.18117	58	50	50	8:12	34	68	10	10	1	68
Camp Baker Control	Standard	07/16/02	46.80387	111.18117	71.6	50	50	7:33	132	264	10	10	1	264
Camp Baker Control	Delayed	07/16/02	46.80387	111.18117	66	50	50	8:10	37	74	10	10	1	74
Camp Baker Control	Standard	07/23/02	46.80387	111.18117	68	50	50	10:30	59	118	10	10	1	118
Camp Baker Control	Standard	07/30/02	46.80387	111.18117	70.7	50	50	10:59	54	108	10	10	1	108
Camp Baker Control	Standard	08/06/02	46.80387	111.18117	66.2	50	50	11:30	35	70	10	10	1	70
Camp Baker Control	Standard	08/15/02	46.80387	111.18117	61.7	50	50	11:30	17	34	10	10	1	34
Camp Baker Control	Delayed	08/15/02	46.99647	111.29251	60	250	50	11:30	6	12	6	6	1	12
Camp Baker Control	Standard	09/11/02	46.80387	111.18117	57.2	50	50	11:30	15	30	10	10	1	30
Camp Baker Control	Delayed	09/11/02	46.99647	111.29251	60	250	50	11:30	4	8	4	4	1	8
Camp Baker Mile 0	Delayed	09/11/02	47.23573	111.3886	56	250	50	11:20	4	8	4	4	1	8
Canyon Depth	Delayed	05/15/02	46.94943	111.27884	50	250	51	14:40	5	10	5	5	1	10
Canyon Depth	Delayed	06/18/02	46.94943	111.27884	56	50	50	15:29	3	6	3	3	1	6
Canyon Depth	Delayed	07/16/02	46.94943	111.27884	73	50	50	14:30	3	6	3	3	1	6
Crow's Foot*	Delayed	05/16/02	47.06028	111.26984	48	250	50	10:30	10	20	6	6	1	20
Crow's Foot*	Delayed	06/19/02	47.06028	111.26984	51	50	50	11:50	7	14	7	7	1	14
Crow's Foot*	Delayed	07/17/02	47.06028	111.26984	64	50	50	10:00	10	20	10	10	1	20
Eden Bridge	Delayed	05/17/02	47.23573	111.3886	50	250	49	10:45	35	71	10	10	1	71
Eden Bridge	Delayed	06/20/02	47.23573	111.3886	54	50	50	11:30	17	34	10	10	1	34
Eden Bridge	Delayed	07/18/02	47.23573	111.3886	72	50	50	11:45	8	16	4	4	1	16
Eden Bridge	Standard	07/18/02	47.23573	111.3886	72	50	50	11:45	8	72	4	4	1	72
Eden Bridge	Standard	07/23/02	47.23573	111.3886	68	50	50	8:15	72	144	10	10	1	144
Eden Bridge	Standard	07/30/02	47.23573	111.3886	70.7	50	50	9:20	16	32	10	9	0.9	29
Eden Bridge	Standard	08/06/02	47.23573	111.3886	66.2	50	50	9:05	48	96	10	10	1	96
Eden Bridge	Standard	08/15/02	47.23573	111.3886	61.7	50	50	9:30	20	40	10	10	1	40
Eden Bridge	Delayed	08/15/02	46.90696	111.2761	56	250	50	9:20	15	30	10	10	1	30
Eden Bridge	Standard	09/11/02	47.23573	111.3886	57.2	50	50	9:35	26	52	10	10	1	52
Eden Bridge	Delayed	09/11/02	47.03147	111.28049	56	250	50	9:30	0	0	0	0	1	0
Eden Bridge Mile 59	Delayed	09/11/02	47.15144	111.31928	56	250	50	9:30	17	34	10	10	1	34
Gruel-Mile 43	Delayed	08/14/02	46.80387	111.18117	60	250	51	10:10	0	0	0	0	0	0
Gruel-Mile 43	Delayed	09/10/02	47.06028	111.26984	54	250	50	10:45	13	26	10	4	0.4	10
Parker Flat	Delayed	05/16/02	47.09829	111.28418	50	250	51	12:20	10	20	7	7	1	20
Parker Flat	Delayed	06/19/02	47.09829	111.28418	52	50	50	14:24	22	44	7	7	1	44
Parker Flat	Delayed	07/17/02	47.09829	111.28418	72	52	52	13:00	0	0	0	0	1	0
Rattlesnake	Delayed	05/16/02	47.15144	111.31928	54	250	50	17:00	7	14	4	4	1	14
Rattlesnake	Delayed	06/20/02	47.15144	111.31928	50	50	50	7:59	26	52	10	10	1	52
Rattlesnake	Delayed	07/18/02	47.15144	111.31928	66	50	50	8:00	17	34	10	10	1	34
Rock Creek	Delayed	05/15/02	46.87085	111.2712	47	250	50	11:40	3	6	3	3	1	6
Rock Creek	Delayed	06/18/02	46.87085	111.2712	57	50	50	11:45	11	22	6	6	1	22
Rock Creek	Delayed	07/16/02	46.87085	111.2712	70	50	50	11:30	7	14	6	6	1	14
Scotty Allen*	Delayed	05/15/02	46.90696	111.2761	50	250	50	12:50	8	16	6	6	1	16
Scotty Allen*	Delayed	06/18/02	46.90696	111.2761	59	50	50	13:29	15	30	6	6	1	30
Scotty Allen*	Delayed	07/16/02	46.90696	111.2761	72	52	52	12:40	8	15	7	7	1	15
Staigmillers*	Delayed	05/16/02	47.14685	111.28728	52	250	48	15:00	29	60	10	10	1	60
Staigmillers*	Delayed	06/19/02	47.14685	111.28728	56	50	50	16:46	12	24	7	7	1	24
Staigmillers*	Delayed	07/17/02	47.14685	111.28728	76	52	52	15:50	4	8	4	4	1	8
Sunset Cliff	Delayed	05/15/02	46.99647	111.29251	50	250	49	17:00	2	4	2	2	1	4
Sunset Cliff	Delayed	06/18/02	46.99647	111.29251	57	50	50	17:52	9	18	6	5	0.83	15
Sunset Cliff	Delayed	07/16/02	46.99647	111.29251	72	50	50	16:40	22	44	2	2	1.00	44