

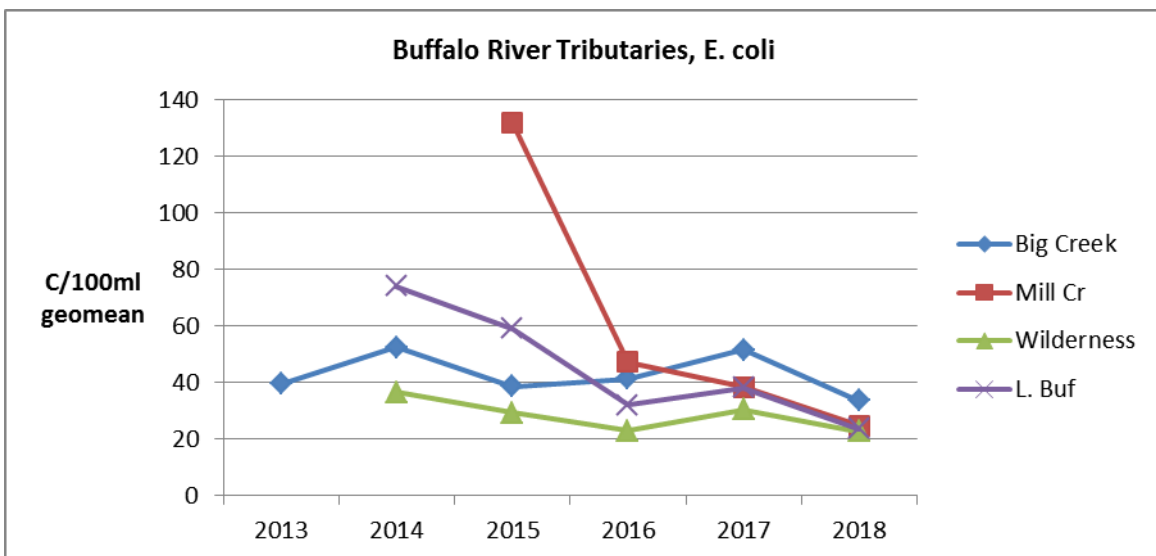
Big Creek E. coli Project 2013-2019 (BNR data – Shawn Hodges)

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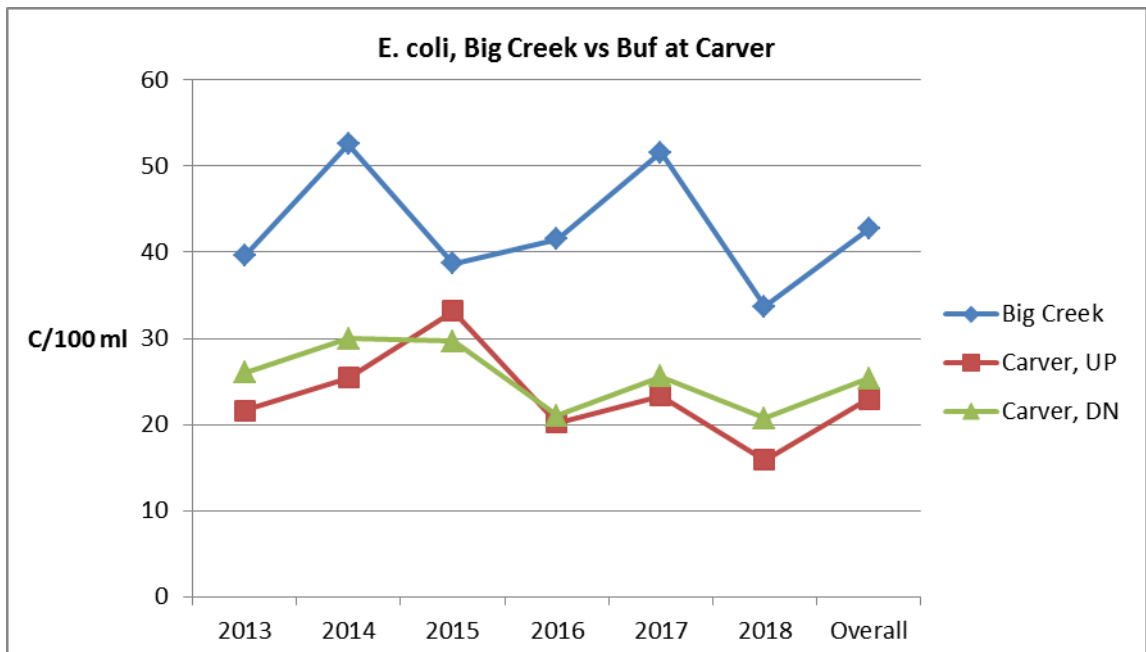
Intro: The sources of E. coli in the Buffalo River watershed are similar to other rural watersheds. Most E. coli are not harmful and the statistically determined 3% infection rate (rashes, red eyes, ...) corresponds roughly to a geomean levels above 100 (EPA). The data in this study supports the conclusion that water users (canoe/kayak/campers) are not likely a primary cause of high E. coli since they don't frequent the tributaries. Often geomeans are computed for 3-5 moving average, rather than the yearly data below.

1. This graph compares the E. coli levels in Big Creek at Carver to other major tributaries upstream from Carver.

Notice: The levels of E. coli in Mill Creek were extremely high in 2015, apparently attributable to a malfunctioning waste water system. A stream with a geomean over 100 (approximately) is considered to be impaired – this was true for Mill Creek from 4/15/15 until 12/15/15, and then sporadically afterward. This graph may partially justify the BBRAC decision not to include Big Creek for study. Although the wilderness readings might be considered a baseline since there is little upstream agriculture, there are some persistent high readings during low flow, indicating possible wildlife contamination. While other tributaries have shown a decrease in time, the levels from Big Creek seem stable over time.



2. This graph shows that E. coli levels in Big Creek at Carver are much higher than either upstream or downstream from the confluence. Except for 2015, the Big Creek levels are twice as high as upstream. Tributary streams typically have higher E. coli levels than the main stem (e.g. compare Mill Creek/Little Buffalo to Hasty). But despite the sudden injection of high E. coli water into the main stem Buffalo at Carver, the levels measured downstream are only 10% higher cumulatively and occasionally lower (2015) [which causes consternation among Buffalo River critics]. There are at least three possible explanations for this effect:
- i) The discharge of Big Creek is about 25% of the upstream discharge on the main stem at Carver. A standard mixing model for stream flow would imply that an increase by about 20% (this is generally the case, see data).
 - ii) When two streams merge, thorough mixing of waters may take several miles, but the sampling downstream at Carver is immediately downstream from the confluence and from the north side (by wading as far as safety allows) whereas Big Creek enters from the south. Thus there might be systematic sampling errors of necessity, i.e. the mixing area is inaccessible.
 - iii) E. coli sampling methodology has a relatively high standard deviation, so that even successive samples can differ significantly.



3. Most E. coli are not harmful and the statistically determined 3% infection rate corresponds roughly to geomean levels above 100. The levels of E. coli allowed in the Buffalo watershed vary with time of year and statistical method (geomean vs grab samples).

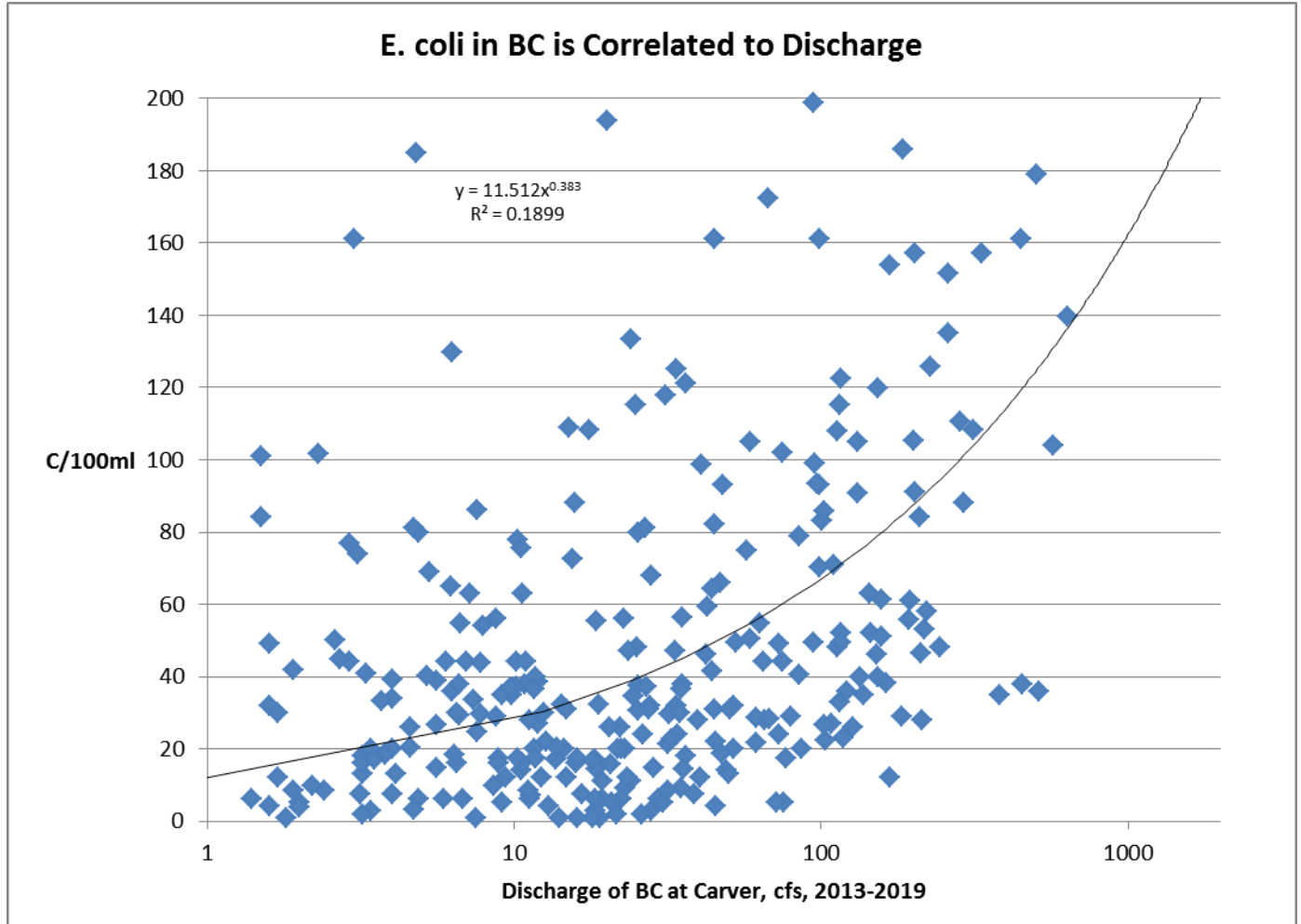
Yearly Geomean, C/100ml

Mm	22.3 Wilderness	28.3 Ponca	52.3 Mill Cr	55.9 L. Buf	59.3 Hasty	63.1 Carver, UP	63.2 Big Creek	63.3 Carver, DN
2013						21.6	39.6	26
2014	36.6			74.1		25.4	52.6	30
2015	29.3		131.8	59.1		33.2	38.7	29.7
2016	23		47.2	32		20.2	41.5	21
2017	30.5		38.4	38.3		23.3	51.6	25.6
2018	22.7	37	24.9	23.73	12.3	15.9	33.7	20.7
Overall	26.84	37	49.98	38.6	10.5	22.98	42.7	25.35
n =	245	37	224	246	69	274	274	274

% Grab Samples over C/100ml

mm	22.3 Wilderness	28.3 Ponca	52.3 Mill Cr	55.9 L. Buf	59.3 Hasty	63.1 Carver, UP	63.2 Big Creek	63.3 Carver, DN
2013						6%	13%	10%
2014	21			29		20	30	21
2015	13		53	23		15	25	13
2016	18		18	10		5	25	7
2017	15		25	25		18	33	18
2018	17	8	19	7	7	10	17	8
Overall	16	8	29	17	7	16	28	16
n =	245	37	224	246	69	274	274	274

4. Although E. coli is clearly related to discharge, $R^2 = 0.19$, there are plenty of other variables involved – rainfall intensity, farming practices, temperatures, wildlife, Some of the E. coli levels get extremely high, second graph, even at modest discharge levels (< 100 cfs). 28% of the samples from Big Creek at Carver were above 100 C/100ml.



E. coli in BC is Correlated to Discharge

