WATER QUALITY STUDIES OF BEAVER CREEK AND TURKEY CREEK

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Abstract. Within the area served by the Middle Flint Regional Development Center at least 19 streams were placed on the 303(b)/303(d) list for 2002. A commonly violated criterion has been fecal coliform numbers. Both Beaver and Turkey Creeks were listed as impaired for fecal coliform counts. In response to the listing of the streams and to facilitate development of Total Maximum Daily Loads (TMDL), fecal coliform studies were undertaken on impaired segments of Turkey Creek and Beaver Creek, tributaries of the Flint River. Samples, collected from 3 locations in Beaver Creek and 4 locations in Turkey Creek for a four month period during the summer of 2002, were tested for fecal coliforms using the membrane filter technique. Data were collected for air temperature, water temperature, pH, dissolved oxygen, conductivity, and rainfall. For both creeks, these parameters were largely stable during the study period. Rainfall was sporadic and limited. Within Beaver Creek, 2 of the 3 sampling locations generally met State and Federal requirements for fecal coliforms. Within Turkey Creek, all 4 sampling locations generally exceeded State and Federal requirements for fecal coliforms. Possible sources of fecal coliforms include agriculture and the large, diverse wildlife population.. Further testing, based on targeted sampling, will be necessary to determine the exact sources of the fecal coliforms.

INTRODUCTION

Fecal coliform bacteria, present in the intestines and feces of warm-blooded animals, are categorized as bacteria able to produce gas from lactose when grown in appropriate culture media at 44.5 °C. These organisms are detected and enumerated as indicators of the degree of waste contamination and the sanitary quality of water. They are the principal indicators of suitability of water for domestic, industrial, and other uses. Methods of detection and enumeration include the multiple-tube dilution method and the membrane filtration technique. Complete information concerning water quality must be based on bacteriological results as well as sanitary conditions surrounding the sample source. (1)

State and Federal requirements for fecal coliforms limits are based on the intended use of the water. For waters used in recreational activities such as swimming and wading, the fecal coliform counts must have a geometric mean under 400 colonies per 100 mL for samples collected from November through April when human contact with the water is less likely. For samples collected from May through October, when human contact is more likely, the geometric mean must be less than 200 colonies per 100 mL. (2)

METHODS

Sample Locations

Beaver Creek flows through a rural area of Macon County, Georgia. Samples were collected from 3 locations within the Beaver Creek watershed including Site 1 at Georgia Highway 49; Site 2 within private property used as a game preserve; and Site 3 at Winchester Road (Macon County Highway 38) at the southern end of the game preserve. These sites were selected to include up-stream, middle, and down-stream sites within the impaired segment of Beaver Creek. Flow in Beaver Creek was from Site 1 through Site 2 through Site 3 with a minimal flow at the up-stream end of the segment.

Turkey Creek flows through rural areas of Dooly County, Georgia, which were planted in cotton, soybeans, and peanuts; used for grazing cattle; or used for poultry production. Samples were collected from 4 locations within the Turkey Creek watershed including Site 4 at the CSX Railroad trestle; Site 5 at Godwin Bridge Road; Site 6 on Pennahatchee Creek at Templeton Road; and Site 7 at Georgia Highway 230. The sites were selected

to include up-stream, middle, and down-stream sites of the impaired segment of Turkey Creek and to include Pennahatchee Creek, a tributary of Turkey Creek which carries effluent from the Vienna, Georgia, sewage treatment plant. The flow in Turkey Creek was from Site 4 through Site 5 through Site 7. Pennahatchee Creek flows into Turkey Creek upstream of Georgia Highway 230.

Both Beaver Creek and Turkey Creek watersheds support large diverse wildlife populations. Deer, fox, bobcats, feral pigs, rabbits, ducks, geese, quail, and blue herons were seen within the areas. Footprints from armadillos, raccoons, and opossums were very common.

Collection Methods

The study was undertaken in compliance with the procedures required by the Georgia Department of Natural Resources, Environmental Protection Division in Title 40 CFR 136 which was updated in 1999 and downloaded from the web in January 2001 (2) and Standard Methods (1). Samples were collected 4 times per month, with at least 48 hours between collections, over a 4 month period. Samples, collected in sterile bottles with lids that did not have liners, were taken in mid-stream at mid-depth by a grab technique then immediately placed on ice for transport.

All samples were processed on the same days they were collected, immediately upon return to the laboratory. The processing of the samples utilized the approved membrane filtration technique with 3 portions (10.0, 1.0, and 0.1 mL) filtered for each water sample. These portions were selected to provide colony counts within the desired range of 20 to 80 colonies per filter while utilizing portions that would flow through the filters without clogging. To evenly disperse the bacterial cells over the membranes all portions were mixed with 50.0 mL of sterile buffer prior to filtration. Two controls were run with each set of samples by filtering 50.0 mL of sterile buffer. Filters were incubated for 24 ± 2 hours in a 44.5^o C circulating water bath. Blue colonies, indicative of fecal coliforms, were counted with the aid of a Quebec colony counter. The characteristic blue color of fecal coliforms was verified by filtering buffer inoculated with a diluted <u>Escherichia coli</u> culture obtained from Presque Isle Cultures in Presque Isle, PA. The fecal coliform counts were used to calculate geometric means. Other data collected included air temperature (^{o}C), water temperature (^{o}C) , dissolved oxygen (mg/L; YSI Model 515 Oxygen Meter) , pH (pH Testr2), and conductivity

(µMHOS, YSI Model 33 S-C-T Meter). Rainfall data were collected from 5 available regional sources. Data from the 2 sources closest to the sampling locations sources were reported.

RESULTS

Data collected are presented in Tables 1 through 6. In keeping with State and Federal requirements, data for fecal coliforms are presented as geometric means in Tables 1 and 2. Tables 3 and 5 present monthly averages for air temperature, water temperature, dissolved oxygen, pH, and conductivity. Tables 4 and 6 present daily rainfalls.

DISCUSSION

As indicated in Table 1, Beaver Creek had variable fecal coliform counts ranging from 23/100 mL (Site 2, June) through 577/100 mL (Site 1, August). Site 1 routinely exceed the limitations with 201/100 ml as the lowest geometric mean. Site 2 consistently met limitations with 142/100 mL as the highest geometric mean. Site 3 met the limitations for 3 of the 4 months with the 295/100

Table 1. **Beaver Creek Geometric Means Fecal Coliforms /100 mL**

Month	Site 1	Site 2	Site 3
May	**201**	43	69
June	**347**	23	85
July	**265**	48	**295**
August	**577**	142	198

Table 2. **Turkey Creek Geometric Means Fecal Coliforms/100 mL**

Month	Site 4	Site 5	Site 6	Site 7
May	**205**	**220**	**407**	134
June	**232**	147	**449**	123
July	**232**	189	**672**	**272**
August	**278**	**307**	**314**	**291**

Table 3. Average Physical Data for Beaver Creek

Month		Site 1	Site 2	Site 3
May	Air (°C)	16.90	17.05	17.08
	Water (°C)	21.03	24.13	21.93
	DO (mg/L)	4.9	6.45	7.30
	pH	7.55	7.48	7.55
	Con(μMHOS)	65.00	61.50	48.25
June	Air	22.30	23.28	21.85
	Water	25.13	28.45	26.48
	DO	4.77	6.51	6.43
	pH	7.38	7.38	7.38
	Cond	75.5	69.25	54.75
July	Air	24.48	24.28	22.93
	Water	25.48	28.18	27.03
	DO	4.43	7.05	6.80
	pH	7.18	7.38	7.38
	Cond	95.25	73.25	55.50
August	Air	25.60	26.85	25.63
	Water	27.05	29.00	27.48
	DO	3.78	7.25	7.48
	pH	7.85	7.85	8.03
	Cond	112.50	77.50	55.00

Table 5. Average Physical Data for Turkey Creek

Month		Site 4	Site 5	Site 6	Site 7
May	Air (°C)	20.05	21.98	23.10	25.48
	Water(°C)	18.50	18.90	16.50	20.33
	DO(mg/L)	6.88	7.60	8.05	6.95
	pH	7.73	7.65	7.63	7.53
	Cond	110.0	91.75	193.8	139.5
June	Air	24.35	25.10	28.48	26.80
	Water	22.25	22.53	23.85	24.00
	DO	6.53	7.30	7.83	4.70
	pH	7.60	7.50	7.60	6.26
	Cond	128.5	103.8	210.0	132.0
July	Air	24.50	25.68	26.03	27.40
	Water	22.05	23.53	24.38	24.83
	DO	7.40	7.70	7.88	6.85
	pH	7.48	7.40	7.48	7.4
	Cond	116.6	102.3	214.8	137.5
Aug	Air	26.03	26.88	29.48	28.50
	Water	22.68	23.73	25.33	25.55
	DO	7.58	7.45	7.00	5.80
	pH	8.03	8.10	7.98	7.90
	Cond	111.0	94.25	240.5	132.8

Table 4. Daily Rainfall for Beaver Creek
(Flint River Nursery, Byromville, GA)

May	4/0.01*	13/0.86	17/0.06	18/0.20	
June	3/0.04	6/045	7/0.09	14/0.58	21/0.13
	22/1.03	23/0.06	26/0.39	27/0.01	28/0.41
	30/0.01				
July	6/0.48	8/0.02	12/0.41	13/0.98	21/1.33
	22/0.53	23/0.06	27/0.43	28/0.01	29/0.74
August	14/0.54	15/0.01	18/0.06	19/0.27	20/0.12
	21/0.03	22/0.04	25/0.18	27/0.71	30/2.02

* day/rainfall amount(inches)

Table 6. Daily Rainfall for Turkey Creek
(Georgia Forestry Commission, Ogelthorpe, GA)

May	1/0.09*	13/0.05	18/1.10	30/0.05	
June	4/0.13	6/0.02	9/0.66	18/0.63	25/0.03
	27/0.02				
July	1/0.05	3/0.25	4/0.21	6/0.68	11/0.05
	15/0.63	23/0.05	26/0.23	29/0.03	30/0.27
August	1/0.03	14/0.20	19/0.43	20/0.02	23/0.05
	26/0.23	27/0.19			

*day/rainfall amount(inches)

mL in July being the only count exceeding the limitations. Site 1 was a shallow marshy area frequented by wildlife and bordered by a poultry production facility. Site 1 was selected to meet the requirements of the TMDL being developed for Beaver Creek. It was a poor area for sampling since flow was minimal, at best, and was further decreased by debris partially blocking the culvert which directed water into the area. Flow was not visible in the area during the sampling period. Site 2 was a small lake located within a game preserve. Although the level varied, flow was visible throughout the summer. Site 3 was a rapidly running creek located adjacent to the game preserve. Creek levels varied greatly during the summer but flow was always present. As indicated in Table 3, Beaver Creek had very consistent physical parameters including low dissolved oxygen levels at Site 1. The remaining parameters measured did not vary greatly within Beaver Creek. As indicated in Table 4, rainfall was sporadic and low.

No correlations were found bewteen fecal coliform counts, physical data, and rainfall. Further sampling will be required to determine the source(s) of fecal coliforms in Beaver Creek. Counts may have been a result of the wildlife population but the animals are present at all sampling stations and only Site 1 had a consistent fecal coliform problem. Runoff from the poultry facility could contribute to the high fecal coliform counts at Site 1 since the site is adjacent to the facility. The impact of runoff is questionable since the individual elevated fecal coliform counts were not preceded by rainfalls in the area..

As indicated in Table 2, Turkey Creek also had variable fecal coliform counts ranging from 123/100 mL (Site 7, June) to 672/100 mL (Site 6, July). Site 4 exceeded limitations each month with 232/100 mL as the lowest geometric mean. Site 5 exceeded limitations 3 out of 4 months with 147/100 mL as the lowest geometric mean.. Site 6 exceeded limitations each month with 314/100 mL as the lowest geometric mean. Site 7 exceeded limitation 2 out of 4 months with 123/100 mL as the lowest geometric mean. Several factors may have contributed to the fecal coliform problems in Turkey Creek. All the sites were located in flowing areas of the Creek but the flows varied greatly throughout the summer and varied from site to site. All the sites were readily accessible to wildlife. All the sites were surrounded by agricultural lands with Site 6 and Site 7 located adjacent to cattle pastures but runoff as a source of the fecal coliforms is questionable since the elevated counts were not preceded by rainfalls. Only Pennahtchee Creek (Site 6) received effluents from a sewage treatment plant which could not have resulted in the elevated fecal coliforms found throughout the Creek. Pennahatchee Creek site was favored by raccoons for eating mussels. As indicated in Table 5, Turkey Creek had consistent physical parameters. As indicated in Table 6, rainfall was sporadic and low.

No correlations were found between fecal coliforms, physical data, and rainfall. Further sampling will be required to locate the fecal coliform source(s) for Turkey Creek.

RECOMMENDATIONS

The source or sources of fecal coliforms in Beaver Creek and Turkey Creek can not be determined based on the data collected. Wildlife are a potential major source but agricultural run-off and a sewage treatment plant are possible contributors. More extensive targeted sampling is recommended. Differentiation of the species of bacteria present could also contribute information on the source.

LITERATURE CITED

(1) Greenberg, AE, LS Clescent, and AD Eaton (eds). 1992. *Standard Methods for the Examination of Water and Wastewater,* 18th edition. Pages 9-54through 9-73..
(2) Environmental Protection Agency 40 CFR 136. Pages 1-24.