Fecal Coliform Export from Four Coastal North Carolina Areas

D.E. Line, N.M. White, W.W. Kirby-Smith, and J.D. Potts

ABSTRACT

Fecal coliform (FC) bacteria in coastal waters impair the use of these waters for shellfish harvesting and recreation. This study was designed to quantify and compare FC levels and export in two coastal watersheds with different land uses. Continuous monitoring of rainfall and discharge at three sites in the Jumping Run Creek watershed and one site in the Pettiford Creek watershed were conducted during a 4.5-year period. Primary land use in the drainage area of one of the three Jumping Run Creek sites is low density industrial, while the other two are residential. Land use in the Pettiford Creek watershed is managed national forest. Nonstorm or baseflow grab and flow-proportional storm-event samples were collected and analyzed for turbidity, conductivity, suspended sediment, nitrogen, phosphorus, and FC. Geometric mean FC levels for the Jumping Run Creek monitoring sites ranged from 593 to 2096 mpn/100 ml, while the mean level at the Pettiford Creek site was 191 mpn/100 ml. Levels of most other parameters were greater in storm discharge from the Jumping Run Creek sites as compared to Pettiford Creek indicating that pollutant export from a watershed increases with development.

Statistical analysis of the monitoring data suggested that FC levels in stormwater samples consistently increased with storm rainfall, but were not consistently correlated with any other parameter, including TSS. Multivariate analysis indicated that the weekly FC export for each of the four sites was lowest during the December-February quarter. Export was highest during the spring and summer at the Jumping Run Creek sites, while for the Pettiford Creek site, FC export was highest during September-November. The cause of the seasonal variability was unknown but was thought to be associated with human activity in the watersheds.
Key terms: stormwater, fecal coliform, development, monitoring.

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KEY POINTS:

- Fecal indicator bacteria (FIB) are used as a standard to assess the public health risk of the water column to shellfish beds and recreational waters.
- Sources and transport mechanics for FIBs can vary watershed by watershed; ie wildlife to human; surface to ground water to sediment based.
- Movement of / loading rates for bacteria is/ are independent of development density. Need sources + transport mechanisms.
- Monitoring of storm events and quantifying associated pollutant load are the optimal methods for characterizing impacts of stormwater runoff—this is not an easy proposition, which is likely why few data are collected.
- Study encompasses 4.5 years of data collection.
- Compares two sub-watersheds in Jumping Run Creek and one drainage in Pettiford in which the land uses are as follows: Industrial (EMC1); medium density residential (EMC4), managed national forest (PC). The fourth drainage monitored is a combination of the industrial and residential areas (EMC2).
- Automatic monitoring stations were calibrated to collect flow proportional samples for storm events that ranged between 1” to 5’ total rainfall.

Table 1. Characteristics of Areas Draining to Monitoring Sites.

Monitoring Site	Drainage Area	Imperviousness[1]	Residences	Resident Density
	ha	%	no.	no./ha
EMC1	65	10.8	5	0.08
EMC2	142	3.2	100	0.70
EMC4	32	1.3	45	1.41
PC	1130	0	0	0.00

[1] Area of impervious surfaces divided by total area.

Results:

Table 2. Summary Statistics for Storm Samples.

Site/period		Turb	TSS	NH_3-N	NO_3-N	DP	FC
		NTU[1]	mg/L	mg/L	mg/L	mg/L	mpn/100 ml
	MDL[3]	0.1	0.25	0.004	0.001	0.02	18
EMC1							
9/4/99-2/24/04	mean	8.0	21	0.04	0.05	0.05	1271[2]
	st. dev.[4]	11.0	50	0.14	0.06	0.09	4951
	median	5.4	11	0.02	0.03	0.03	1650
	count	87	89	89	89	89	96
	<MDL[3]	0	0	0	0	31	0
EMC2							
9/4/99-2/24/04	mean	6.9	77	0.05	0.05	0.02	1152[2]
	st. dev.[4]	4.4	100	0.12	0.04	0.05	5300
	median	6.0	34	0.02	0.04	0.01	1700
	count	83	83	83	83	83	73
	<MDL[3]	0	0	2	0	72	0
EMC4							
9/4/99-2/24/04	mean	11.0	58	0.12	0.07	0.02	593[2]
	st. dev.[4]	10.1	72	0.10	0.06	0.02	4430
	median	7.0	30	0.10	0.06	0.01	790
	count	71	71	71	71	71	72
	<MDL[3]	0	2	0	3	52	0
PC							
10/29/02-2/24/04	mean	1.5	4	0.05	0.01	0.04	191[2]
	st. dev.[4]	1.2	14	0.17	0.02	0.03	653
	median	1.1	1	0.02	0.00	0.04	220
	count	38	38	36	38	37	38
	<MDL[3]	0	6	1	19	9	1

[1] Nephelometric turbidity units.

[2] Geomean computed for FC at each site

Table 4. Annual Discharge and Pollutant Export from EMC1, EMC2, and EMC4.

Site/Period	Rain mm/ yr	Discharge mm/yr	NO_3-N kg/ha-yr	NH_3-N kg/ha-yr	DP kg/ha-yr	TSS kg/ha-yr	FC million mpn/ha-yr
EMC1 9/5/99-2/24/04	1366	531	0.42	0.29	0.25	70	76,900
EMC2 9/5/99-2/24/04	1366	836	0.57	0.39	0.19	259	193,300
EMC4 9/5/99-2/24/04	1366	1165	0.67	1.42	0.25	235	118,900
PC 10/29/02-2/24/04	1682	874	0.03	0.17	0.26	9	18,100