USGS
science for a changing world

NATIONAL WATER-QUALITY ASSESSMENT PROGRAM

Pesticides and Bacteria in an Urban Stream--Gills Creek, Columbia, South Carolina

Significant Findings

- Ten different pesticides were detected in the Gills Creek Basin.
- Samples from 14 of 16 sites had detectable concentrations of at least one pesticide, and 12 sites had at least five pesticides detected.
- Pesticide detection frequency increased as the percentage of urban land use increased.
- Tebuthiuron was detected most frequently (14 sites), followed by diazinon (13 sites), and atrazine (12 sites).
- Diazinon, carbaryl, and dieldrin concentrations exceeded aquatic life standards in some samples.
- Fecal coliform concentrations exceeded 400 colonies per 100 milliliters at 8 of the 16 sites.

Introduction

As part of the U.S. Geological Survey National Water-Quality Assessment Program (NAWQA), water quality in the Santee River Basin and coastal drainages study area (SANT) is being assessed. Gills Creek, an urban stream in Columbia, South Carolina, was studied during a low streamflow period in September 1996. During the study, streamflows were in the lower 30 percent of the 1996 flows in Gills Creek. Samples from 16 sites were collected over 4 days and analyzed for pesticides and fecal coliform bacteria. This fact sheet presents the results of the Gills Creek Basin study.

Where is the Gills Creek Basin?

The Gills Creek Basin is located in metropolitan Columbia, S.C., and drains about 60 square miles. The soils are sandy and have moderately high permeability. The annual mean streamflow at Gills Creek in Columbia (site 1, fig. 1) is about 77 cubic feet per second (Cooney and others, 1997). The annual average precipitation in Columbia is approximately 50 inches per year and is highest during the summer months (South Carolina Department of Natural Resources, 1998).

Gills Creek originates from a spring-fed pond in the northeastern part of the basin and passes through forest and wetlands before reaching urban areas (fig. 1). Vegetation consists of scrub oak, pine, and cactus in the undisturbed areas. Tributaries entering Gills Creek include Rowell Creek, Jackson Creek, Little Jackson Creek, Eightmile Branch, Penn Branch, and Wildcat Creek. Land uses in the tributaries and lower part of the basin include mainly urban and forested areas, with a small percentage of barren and agricultural land. Vegetation, where it occurs in the urbanized areas, consists of tropical lawn grasses and pine trees. The urban landscape consists of residential subdivisions and commercial and shopping areas; golf courses and lake communities are common. The Gills Creek Basin has been experiencing rapid urban development since the late 1960's. The bulk of the residential growth has been single-family houses with less than 1-acre lot sizes.

Pesticides in the Gills Creek Basin

Pesticides are used on a regular basis for agricultural, commercial, and domestic purposes to control insects and selected vegetation. Because of their widespread use, pesticides commonly occur in creeks, streams, and lakes (Larson and others, 1997). Pesticides have several potential pathways to enter surface waters. Pesticides may enter surface waters as a result of direct application of herbicides to streams or streambanks to control weed growth. Atmospheric deposition results from precipitation scouring contaminants from the air and depositing them on the ground or directly into the streams. Nonpoint-source runoff of pesticides occurs when rain washes over the ground surface, carrying contaminants into nearby streams. Pesticides also can soak into the ground and can enter streams in groundwater discharge.

A common "adjusted" method reporting limit (MRL) of 0.01 micrograms per liter (µg/L) was used to compare the detection frequencies of pesticides having different MRL's. Using an adjusted MRL results in a loss of detection information, however, it allows a uniform comparison of the pesticide detection frequencies. Of 47 pesticides analyzed, 10 were detected above the adjusted MRL of 0.01 µg/L. Samples from 14 of the 16 sites had detectable concentrations of at least one pesticide, and 12 sites had at least five pesticides detected.

Gills Creek flowing through a commercial area.

Tebuthiuron was the most commonly detected pesticide (14 sites), followed by diazinon (13 sites), and atrazine (12 sites). Tebuthiuron is an herbicide used to control weeds in non-cropland areas, right-of-ways, and industrial sites. Common trade names for tebuthiuron include Brush, Bullet, Graslan, Herbec, Reclaim, and Spike[1]. Diazinon is an insecticide used to kill cockroaches, silverfish, ants, and fleas in residential areas, and on home gardens and farms to control a variety of other insects. Common trade names for diazinon include Basudin, Dazzel, Gardentox, Kayazol, Knox Out, Nucidol, and Spectracide. Atrazine is an herbicide used to control weeds in cropland and industrial areas. Atrazine use is restricted because of its potential to contaminate ground water. Common trade names for atrazine include Aatrex, Alazine, Farmco Atrazine, Primatol, Simazat, and Zeapos.

Other detected pesticides include carbaryl and dieldrin. Carbaryl is a wide-spectrum insecticide that is used on crops, forests, lawns, poultry, livestock, and pets. Common trade names for carbaryl include Adios, Bugmaster, Crunch, Denapon, Nac, Sevin, and Tornado. Dieldrin is an insecticide that was used widely from 1950 to 1970 to control pests on crops. In 1974, the U.S. Environmental Protection Agency banned all uses of dieldrin except for termite control. In 1987, dieldrin was banned for all uses. Because dieldrin breaks down slowly, low levels are still being detected in the environment. Dieldrin also was detected during a study of shallow ground-water quality in Columbia during summer 1996 (Reuber, 1999).

[1] Use of trade names does not imply endorsement by the U.S. Geological Survey.

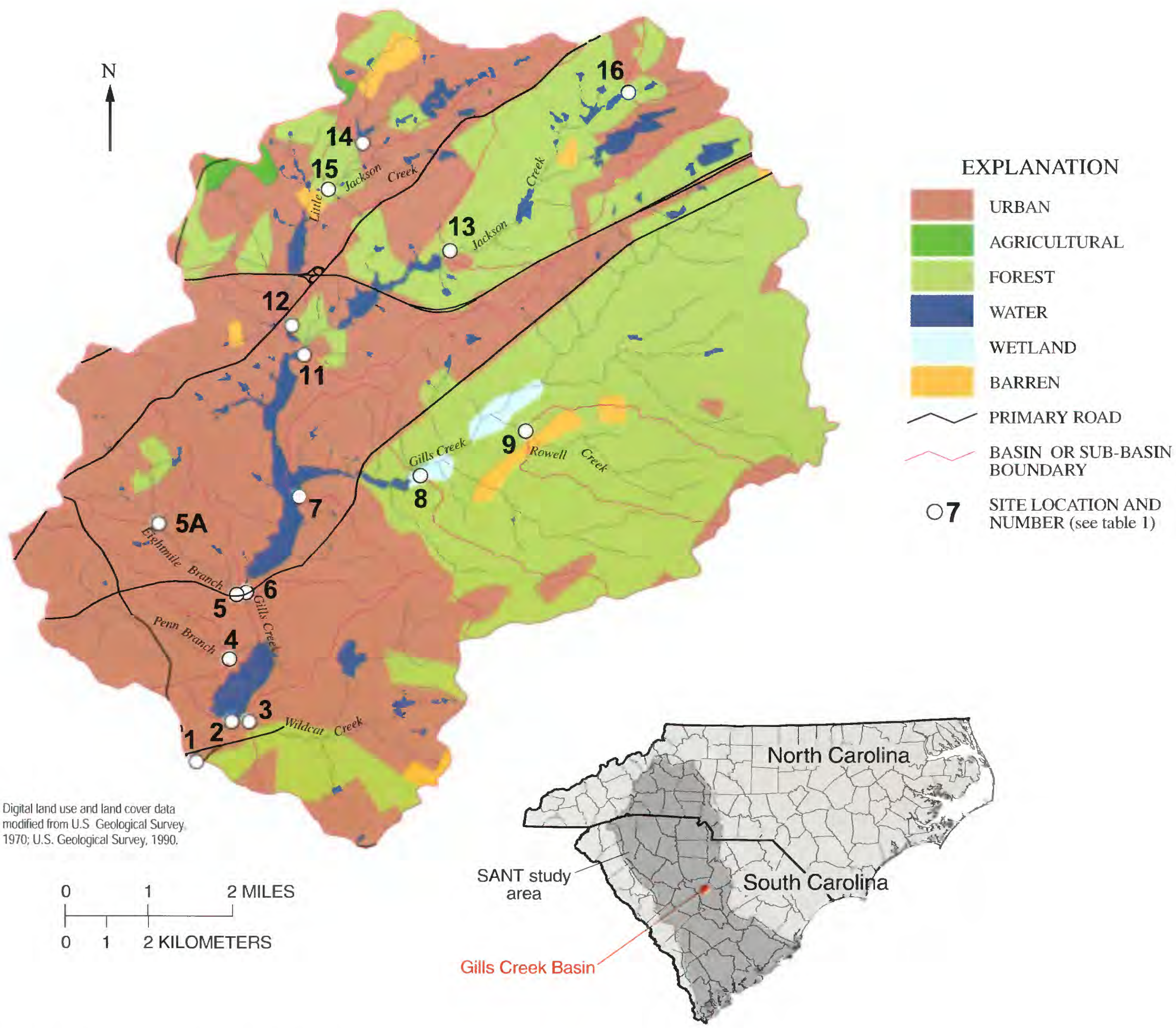

Figure 1. Land use in the Gills Creek Basin.

Table 1. Basin descriptions

Map site number	Site	Drainage area, in square miles	Percent urban land use	Number of pesticides detected
1	Gills Creek at Columbia	59.4	52	7
2	Gills Creek below Lake Katherine	53.4	50	5
3	Wildcat Creek	5.3	68	5
4	Penn Branch	2.9	100	9
5	Eightmile Branch below Trenholm Rd.	3.9	95	7
5A	Eightmile Branch at Covenant Rd.	2.4	92	5
6	Gills Creek below Eightmile Branch	48.2	45	7
7	Gills Creek above Forest Lake	22.4	20	5
8	Gills Creek at Boyden Arbor Rd.	18.6	14	0
9	Rowell Creek at Dixie Rd.	2.5	5	0
11	Jackson Creek above Decker Blvd.	16.1	52	7
12	Little Jackson Creek at Trenholm Rd.	7.0	66	6
13	Jackson Creek at Alpine Rd.	5.2	26	5
14	Trib. to Little Jackson Creek at Rabon	2.5	18	3
15	Little Jackson Creek at Legrande Rd.	3.7	71	4
16	Jackson Creek at Leaning Tree Rd.	0.5	50	5

The number of pesticides detected at a site increased as the percentage of urban land use increased. Penn Branch (100 percent urban) had the most pesticides detected (9), and Gills Creek at Boyden Arbor Road (14 percent urban) and Rowell Creek at Dixie Road (5 percent urban) had no pesticides detected (table 1).

Are the Pesticide Concentrations in the Gills Creek Basin Harmful?

Concentrations of three insecticides exceeded the chronic criteria to protect aquatic life: diazinon, carbaryl, and dieldrin (table 2). Diazinon exceeded the chronic criteria for aquatic life in each of 13 detections; carbaryl exceeded the criteria 8 times in 10 detections; dieldrin exceeded the criteria in each of two detections. At sustained concentrations above the criteria, aquatic life and reproduction may be reduced or impaired. None of the pesticides exceeded their respective U.S. Environmental Protection Agency maximum contaminant level or health advisory level (finished drinking-water standards).

Fecal Coliform Bacteria

High levels of fecal coliform bacteria in streams and lakes may indicate the presence of more serious disease-causing organisms. Cholera, typhoid fever, bacillary dysentery, and infectious hepatitis are some of the well-known waterborne diseases that spread through water contaminated with fecal matter and that affect human and animal health. Eye, ear, nose, and throat infections also can result from contact with contaminated water. High bacteria concentrations can occur in urbanized areas with point-source discharges, landfill leakage, storm drains, runoff of pet waste, overflowing sewer lines, or failing septic systems.

In South Carolina, water-quality standards state that fecal coliform concentrations may not exceed a geometric mean of 200 colonies per 100 milliliters (col/100 mL) from five consecutive samples collected during any 30-day period, and no more than 10 percent of the total samples during any 30-day period can exceed 400 col/100 mL (South Carolina Department of Health and Environmental Control, 1992). Streams or lakes having fecal coliform concentrations greater than 400 col/100 mL are not considered safe for swimming or other direct body-contact activities.

Fecal coliform concentrations ranged from 37 to 1,700 col/100 mL in the Gills Creek Basin. Of the 16 sites, 8 had fecal coliform concentrations greater than 400 col/100 mL (fig. 2). Fecal coliform concentrations were lowest in Gills Creek above Forest Lake, and highest in the downstream section of Jackson Creek and at both Eightmile Branch sites. Because these samples were collected during low streamflow conditions, fecal coliform concentrations may have been lower than they would have been under average or high streamflows. Bacteria concentrations often increase during high streamflows; therefore, care should be taken during recreational use of these streams.

Table 2. Pesticides detected in the Gills Creek Basin, September 1996
[--, not established; concentrations in red italics exceed aquatic life criteria]

Pesticide	Number of detections	Maximum concentration, in micrograms per liter	Aquatic life criteria, in micrograms per liter	Lifetime Health Advisory Level [1], in micrograms per liter	Maximum Contaminant Level [1], in micrograms per liter
Herbicides					
Tebuthiuron	14	0.177	--	500	--
Atrazine	12	0.107	--	[2]3	3
Simazine	11	0.105	[3]10	4	4
Prometon	9	0.178	--	[2]100	--
Insecticides					
Diazinon	13	*0.323*	[3]0.009	0.6	--
Carbaryl	10	*0.139*	[3]0.02	700	--
Malathion	5	0.032	[4]0.1	200	--
Chlorpyrifos	3	0.032	[4]0.041	20	--
Dieldrin	2	*0.011*	[4]0.0019	--	--
Methyl parathion	1	0.012	[4]0.013	--	--

[1] U.S. Environmental Protection Agency, 1996.
[2] Under review.
[3] Freshwater chronic water-quality criteria recommendations from National Academy of Sciences and National Academy of Engineering (1973) modified from Nowell and Resek (1994).
[4] U.S. Environmental Protection Agency, 1997.

Thirteen additional samples were collected and analyzed for fecal coliform bacteria from October 1995 through September 1996 in Gills Creek at Columbia (site 1). Concentrations ranged from less than 20 col/100 mL to just over 1,100 col/100 mL, and only two of the 13 samples exceeded 400 col/100 mL.

—By Terry L. Maluk

Lakeside community in the Gills Creek Basin.

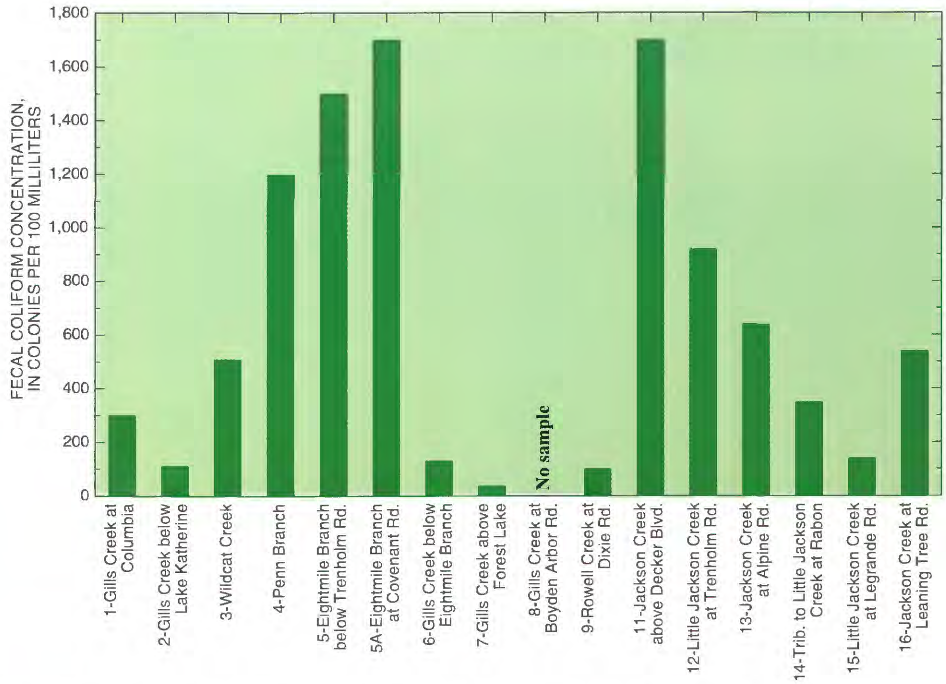

Figure 2. Fecal coliform concentrations at synoptic sites in the Gills Creek Basin.

References

Cooney, T.W., Jones, K.H., Drewes, P.A., Gissendanner, J.W., and Church, B.W., 1997, Water resources data—South Carolina water year 1996: U.S. Geological Survey Water-Data Report SC–96–1, 476 p.

Larson, S.J., Capel, P.D., and Majewski, M.S., 1997, Pesticides in surface waters: Distribution, trends, and governing factors: Chelsea, Mich., Ann Arbor Press, 390 p.

National Academy of Sciences–National Academy of Engineering, 1973, Water-quality criteria, 1972: Washington, D.C., National Academy of Sciences, 594 p.

Nowell, L.H., and Resek, E.A., 1994, Summary of national standards and guidelines for pesticides in water, bed sediment, and aquatic organisms and their applications to water-quality assessments: U.S. Geological Survey Open-File Report 94-44, 115 p.

Reuber, E.J., 1999, Shallow ground-water quality in the coastal plain of Columbia, South Carolina, 1996: U.S. Geological Survey Fact Sheet FS–130–98, 6 p.

South Carolina Department of Health and Environmental Control, 1992, Water classifications and standards (Regulation 61-68): South Carolina Department of Health and Environmental Control, 35 p.

South Carolina Department of Natural Resources, 1998, Climatological normals 1961-1990: accessed June 10, 1998, at URL *http://water.dnr.state.sc.us/climate/sercc/products/normals/381939_30yr_norm.html*

U.S. Environmental Protection Agency, 1996, Drinking water regulations and health advisories: Washington, D.C., Office of Water, EPA 822-B-96-002, 26 p.

_______1997, TSC195 criteria chart: Region IV, Water Management Division, 6 p.

For More Information

Information on technical reports and hydrologic data related to the NAWQA Program can be obtained from:

District Chief
U.S. Geological Survey
720 Gracern Road
Columbia, SC 29210-7651

URL *http://wwwsc.er.usgs.gov*

National Water-Quality Assessment Program

The United States Geological Survey (USGS) is conducting an assessment of water quality in the Santee River Basin and coastal drainages (SANT) study area as part of the National Water-Quality Assessment (NAWQA) Program. The long-term goals of NAWQA are to describe the status of and trends in the quality of a large representative part of the Nation's surface- and ground-water resources and to identify major factors that affect the quality of these resources. A total of 59 hydrologic systems are to be studied that include parts of most major river basins and aquifer systems in the Nation. The assessment activities in the SANT study area began in 1994.