P.G. Hunt, Soil Scientist, and K.C. Stone, Agricultural Engineer, USDA-ARS, P.O. Box 3039, Florence, SC 29502-3039. Phone: (803) 669-5203. FAX: (803) 669-6970.

F.J. Humenik, Professor, and J.M. Rice, Extension Specialist, North Carolina State University, P.O. Box 7625, Raleigh, NC 27611-7625. Phone: (919) 515-6767. FAX: (919) 515-6772.

M.G. Cook, Professor Emeritus, North Carolina State University, P.O. Box 7619, Raleigh, NC 27611-7619. Phone: (919) 515–2655. FAX: (919) 515-2167.

Summary

A USDA Water Quality Demonstration Project was initiated in 1990 on the Herrings Marsh Run (HMR) watershed in Duplin County, North Carolina. Stream sampling stations were established in the watershed to evaluate the influences of agricultural practices on stream water quality. Stream water from subwatershed 2 was consistently lower in quality (Nitrate-N consistently > 5 ppm). The mass flow of ammonia-N and nitrate-N from this subwatershed was 64 and 89%, respectively, of the mass flow from the entire HMR watershed; but the tributary supplied only 28% of the water flow from the HMR watershed. Soluble phosphorus was low (< 0.20 ppm) throughout the HMR watershed. There was more dense swine and crop production in subwatershed 2 than in the remainder of the watershed, and the riparian buffer zones in subwatershed 2 were not as prevalent or as large as in other parts of the HMR watershed. In spring 1993, an 8-acre wetland was established immediately upstream of the sampling station at subwatershed 2. Nitrate-N levels in water entering the wetland remained consistent with pre-impoundment-concentrations (approximately 5 to 7 ppm). Nitrate-N levels in water exiting the wetland were < 1.0 ppm during the warmer months. These initial results indicate the importance of effective nutrient management and various landscape features in maintaining good stream water quality.

Project Description

The 5,000-acre demonstration watershed, Herrings Marsh Run (HMR), is located in the Cape Fear River Basin in Duplin County, North Carolina (Stone et al., 1995). The initial phase of the project evaluated the effect of existing agricultural management practices on stream and groundwater quality within the watershed. The second phase of the project evaluated the impact of management and landscape modifications on water quality.

The HMR has intensive crop and animal production, shallow groundwaters that are used for drinking water, and close connections of shallow groundwaters, streams, and sensitive environmental areas. The major agricultural crops on the watershed include corn, soybean, tobacco, wheat, and vegetables. Although swine and poultry operations produce sufficient quantities of waste to supply 62% of the nitrogen and 96% of the phosphorus necessary for good crop production, 90% of the nutrients applied to cropland are supplied by commercial fertilizers.

A nitrogen and phosphorus mass balance was calculated using results of farm surveys. Stream water sampling stations were established within the watershed in cooperation with the U.S. Geological Survey during 1990 (Fig. 1) (Stone et al., 1995). Water samples were analyzed according to EPA methods. Subwatershed outlets are indicated in Fig 1 at the diamond-shaped samplers 1-4. The stream from subwatershed 2 flowed through a wetland that existed in the bottom of an old pond with a breached dam. Beavers built a dam across the old breach in April 1993. The beaver dam was modified for water routing, and the dam sidewalls were reinforced to enhance their stability. The expanded wetland area upstream of station 2 was about 8 acres when the water level at the dam was approximately 10 feet above the bottom of the stream bed.

Results

Stone et al. (1995) estimated that the excess nitrogen applied to crops as animal waste and fertilizers was 76, 49, 23, and 34 lb/ac/yr for subwatershed 2, subwatershed 3, subwatershed 4, and the total watershed, respectively. Phosphorus excesses were estimated to be 51, 13, 4, and 18 lb/ac/yr in subwatershed 2, subwatershed 3, subwatershed 4, and the total watershed, respectively.

The geometric means (antilog of the mean of the log of the data) of nitrate-N concentrations in stream water from subwatershed 2, the HMR from subwatershed 3, subwatershed 4, and the HMR watershed outlet at station 1 were 5.4, 1.2, 1.3 and 2.0 ppm, respectively, from Sept. 1991 to June 1993 (Stone et al., 1995). Ammonia concentrations had the same relationship as nitrate-N in the HMR, but they were much smaller than nitrate-N concentrations. The most significant ammonia-N problem was at sampling station 2. An overloaded lagoon was discharging swine wastewater that flowed downhill to the stream about half a mile above sampler 2. This discharge caused elevated ammonia-N in the stream. Construction of an expanded lagoon and land application of excess wastewater have eliminated the high ammonia-N problem. The streamflow from the upstream stations was less than one-third the 5.2 ft^3/s of the HMR watershed outlet (station 1). Thus, the low nitrate-N concentration of subwatershed 3 and 4 produced mass fluxes of nitrogen that were > 9 lb/day. On the other hand, the nitrogen flux from subwatershed 2 was nearly as large as that from the watershed outlet, 46 and 53 lb/day, respectively. Other research has shown that four of the five farms with high nitrate-N in the groundwater (> 10 ppm) were in the subwatershed 2.

Soluble–P concentrations in the streams were generally < 0.2 ppm, and the mass flux differences among the streams resulting from the small concentration differences were of little environmental significance.

Prior to the establishment of the 8-acre, in-stream wetland, the mean nitrate concentration from subwatershed 2 at sampler 2 was about 5.5 ppm. After the wetland was established, the concentration of nitrate-N in the water entering the wetland upstream of sampler 2 remained about the same as the pre-wetland concentrations, but the concentration of nitrate-N in the stream leaving the wetland at station 2 was 1 ppm or less in the warmer months. However, the wetland was less effective in nitrogen removal during the cooler months. This seasonal effect was probably due to the effect of less plant growth and slower denitrification in the cooler months. Ammonia-N and soluble-P were not altered greatly. They were generally less than 0.4 and 0.2 ppm, respectively, before and after flow through the wetland.

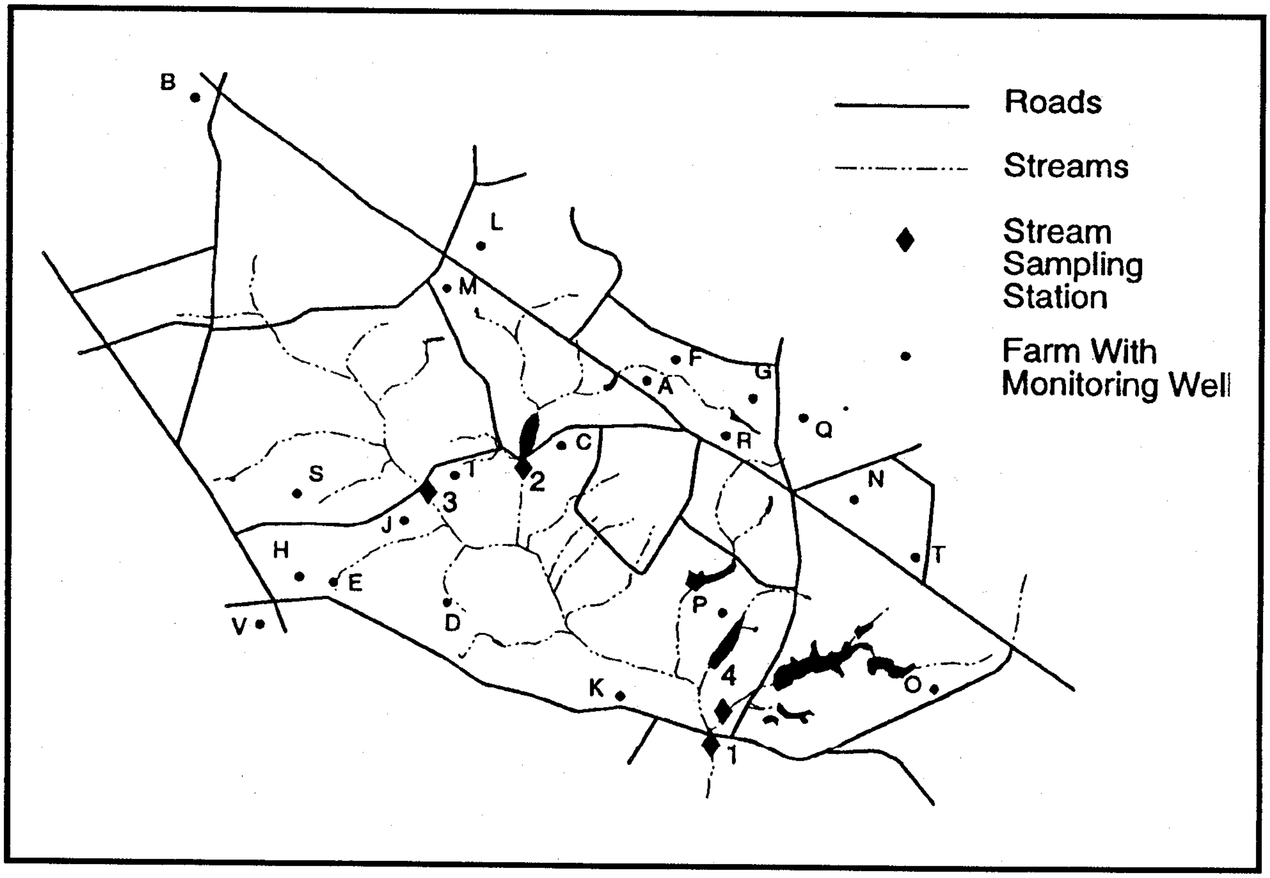

Figure 1. Location of stream sampling stations and farms with groundwater monitoring wells on Herrings Marsh Run watershed.

Technology Transfer

These results can be used by action agencies, farmers, and agricultural industry to understand the value BMPs and wetland landscape features in the protection of stream water quality. This information is being transferred in scientific journals, scientific meetings, special topic workshops, public meetings, field days, and media presentations. Portions of the study are supported by a USDA hydrologic unit project, USGS cooperative research, and the USEPA landscape features function project CR822270.

During this year, five papers, four talks and one poster exclusively directed to project results were given. Highlights from last year include: 28 Duplin County meetings with 1,400 people attending; a presentation on "Almanac," the weekly statewide television program of the University of NC and presentations at 47 statewide meetings with 3,740 people attending; magazine articles in *Progressive Farmer* and *Carolina Farmer* and three presentations at regional conferences with 13 states and 230 people; on a national level, 4 mini-tours were conducted for SCS and presentations were made at 6 meetings with 1,200 people; and a tour of the project site was conducted for a Canadian environmental group and three papers were delivered to 1,900 people in three countries.

Project results are already resulting in preservation of many natural wetlands, especially those constructed by beavers in eastern North Carolina; and the results are serving as a basis for constructing in-stream wetlands for water quality protection.

Public Affairs

Barker, J. C., et al. 1994. Waste management for poultry producers–developing a plan to comply with state regulations. N.C. Poultry Federation.

Hunt, P.G., et al. 1995. Impact of animal waste on water quality in an eastern Coastal Plain watershed. In Animal Waste and the Land-Water Interaction, AWRC Interdisciplinary Conference. Fayetteville, AR, July 1995. In press.

Parsons, J.T., et al. 1994. The feasibility and efficacy of portable poultry mortality composters. N.C. Poultry Federation.

Zublena, J.P., et al. 1994. Evaluation of poultry by-products as nitrogen sources for corn. Southeast Poultry Science Society, and the N.C. Corn, Soybean, and Small Grain Growers Annual Meeting.

References

Stone, K.C., P.G. Hunt, S.W. Coffey, and T.A. Matheny. 1995. Water quality status of a USDA water quality demonstration project in the eastern Coastal Plain. J. Soil and Water Cons. (in press).

Stone, K.C., P.G. Hunt, J.M. Novak, and T.A. Matheny. 1994. Impact of BMP's on stream and ground water quality in a USDA demonstration watershed in the eastern Coastal Plain. pp. 280-286. In Campbell, K.L., W.D. Graham and A.B. Bottcher (eds.) Proc. of the Second Environmentally Sound Agriculture Conference. ASAE, St. Joseph, MI.