Interaction Between Surface and Ground Water in the Transport of Nutrients from Animal Wastes in Karst Terrain

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Animal wastes contain nutrients that, if delivered in sufficient quantities, have potential to negatively impact surface and subsurface water quality. The Savoy Experimental Watershed (SEW) was established as a site for long-term studies of animal-waste impacts on surface and subsurface water quality in karst terrain such as the Ozark Highlands. The SEW is a collaborative effort between the University of Arkansas; U.S. Department of Agriculture, Agricultural Research Service; U.S. Geological Survey; and the Arkansas Department of Environmental Quality and involves an interdisciplinary team of scientists. The most intense monitoring activities have been directed at Basin 1 of the SEW, a 147-hectare watershed immediately adjacent to the Illinois River. Surface cover in Basin 1 is divided between forest (60%) and pasture (40%), and the entire watershed is grazed by beef cattle (*Bos taurus*). Poultry litter (bedding material and manure) is applied at varying intervals and amounts to pastures within the basin.

Weirs were installed on two continuously flowing springs (Langle and Copperhead) adjacent to Basin 1 and at the basin outlet to measure flow and water-quality parameters. Over 20 shallow, 5-centimeter diameter monitoring wells have been installed primarily in alluvial areas near the outlet of Basin 1 while 3 deep [>30-meter (m)] wells allow sampling of the shallow aquifer above the regional confining layer. Additional sampling sites including several small springs, a nearby tributary (Clear Creek) and the Illinois River also are monitored for several water-quality parameters including nitrate (NO_3-N), ammonia (NH_3-N), and dissolved reactive phosphorus (DRP).

Nitrate and DRP concentrations in spring baseflow samples are consistently higher for Copperhead Spring as compared to Langle Spring. This trend may be related to higher animal waste applications in the Copperhead Spring recharge basin. Concentrations for NO_3-N and DRP range from 1 to 9 milligrams per liter (mg L^{-1}) and from 0.02 to 0.05 mg L^{-1}, respectively, with the higher NO_3-N observed during low-flow conditions in late summer. Only very low concentrations of NH_3-N have been detected (<0.005 mg L^{-1}). Samples collected during two storm events in February 1999 indicated that NO_3-N concentrations peak at the leading edge of storm hydrographs. Very little organic N or NH_3-N was transported during these events. Nitrate concentrations ranged from 3 to 8 mg L^{-1} for Copperhead Spring and 1.5 to 3.5 mg L^{-1} for Langle Spring, respectively. Phosphorus concentrations were less than 0.055 mg L^{-1} during the storm events with elevated total P levels early in the storm hydrograph. Dye-tracing studies and analyses of runoff data indicate that surface runoff is routinely captured by both springs and that the degree of capture varies with runoff volume.

Results of monitoring activities at the SEW indicate significant transport of NO_3-N in Basin 1 via surface and subsurface flow paths while low concentrations of DRP in spring and runoff water indicate effective retention of P in soil layers. Low concentrations of sediment-bound N and P suggest that erosion is not a significant factor in nutrient transport within this basin. Langle and Copperhead Springs capture surface runoff, a process that effectively bypasses further nutrient retention by surface soil layers.

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