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Antibiotic Fate and Transport in Three Effluent Dominated Ozark Streams

Leslie D. Bartsch, Brian E. Haggard and Joel M. Galloway

Abstract Text:

Antibiotics enter the environment through direct input from municipal wastewater treatment plant discharges, agricultural effluent discharges, and surface runoff from some sources. As a result, many studies have shown the occurrence of antibiotics and degradation products in streams. This unique study, however, evaluated the uptake [or possible release] of these chemicals on a whole reach basis. This study examined net changes in antibiotic concentrations downstream from a wastewater treatment plant (WWTP) effluent discharge and applied the solute spiraling theory to estimate net uptake length (Snet), net uptake velocitiy (vf–net), and net uptake rate (Unet) of antibiotics at Mud Creek, Spring Creek, and Decatur Branch in northwest Arkansas, USA. Water samples were collected during August and September 2006 and analyzed for multiple antibiotics representing five classes (beta-lactams, macrolides, quinolones, sulfonamides, and tetracyclines). Measurable concentrations of several antibiotic residuals and degradation products (macrolides, quinolones, and sulfonamides) were detected downstream from the effluent discharge at all three stream reaches. Some antibiotics (macrolides, quinolones, and trimethoprim) were significantly retained at Mud Creek and Spring Creek and traveled kilometer-scale distances (Snet, 3.4 to 20.2 km) with low uptake velocities (vnet, 2.9 to 97.1 10-6 m s-1) and rates (Unet .8 to 38.4 10-6 µg m-2 s-1). However, some macrolides and sulfamethoxazole increased in concentration downstream from the effluent discharge at Decatur Branch, suggesting possible release from within the fluvial channel or additional sources of these antibiotics along the stream reach. Antibiotics that are being retained or transformed by in-stream processes (e.g., sorption, uptake and degradation) travel kilometer-scale distances within the fluvial channel at these effluent dominated Ozark streams.

Impact Statement:

Antibiotics are unregulated yet emerging contaminants in aquatic systems. Several studies have confirmed the presence of these chemicals in many streams; however, this unique study moved beyond simple occurrence and evaluated the transport of these chemicals within a stream reach.