Research Summary

South Carolina Department of Transportation | Office of Materials and Research

Project Information

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This final report is available online at:

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Effects of Stormwater Runoff from Selected Bridge Decks on Conditions of Water, Sediment, and Biological Quality in Receiving Waters in South Carolina, 2013 to 2018

The downstream bridge span on Lynches River near Effingham, South Carolina, with storm runoff entering the river through downspouts, 2014.

Project

The U.S. Geological Survey, in cooperation with the South Carolina Department of Transportation, investigated the effects of stormwater runoff from bridge decks on stream water quality conditions in South Carolina. The investigation assessed 5 bridges in 3 physiographic provinces in South Carolina (Piedmont, Upper Coastal Plain, and Lower Coast Plain) that had a range of bridge, traffic, and hydrologic characteristics. The five selected South Carolina bridge sites (coincident with U.S. Geological Survey stations) and corresponding highways were Lynches River at Effingham (station 02132000; U.S. Highway 52), North Fork Edisto River at Orangeburg (station 02173500; U.S. Highway 301), Turkey Creek above Huger (station 02172035; South Carolina Highway 41), South Fork Edisto River near Denmark (station 02173000; U.S. Highway 321), and Fishing Creek at Highway 5 below York (station 021473415; South Carolina Highway 5). Bridge decks at the selected sites used open chutes, scuppers, and downspouts to drain stormwater directly into the receiving water at evenly spaced intervals.

Research

Stream water, sediment, and biological samples were collected and analyzed for a variety of constituents to evaluate the stream conditions for this study. Five to six stream samples were collected at transects upstream and downstream from each selected bridge site using the equal-width-increment technique during observable stormwater runoff. Routine samples of the receiving waters were collected 12 to 14 times at the upstream transect during nonstorm conditions.

Samples were analyzed for physical properties, suspended sediment, nutrients, major ions, trace metals, polycyclic aromatic hydrocarbons, and *Escherichia coli*. Bridge-deck sediment and streambed sediment at upstream and downstream transects were collected once at each bridge site and analyzed for metals and semivolatile organic compounds that include polycyclic aromatic hydrocarbons. Benthic macroinvertebrate community surveys were conducted once using Hester-Dendy multiplate artificial substrate samplers deployed at multiple upstream and downstream transects concurrently.

Statistical analysis of the water-quality data determined that stormwater runoff from bridges did not significantly degrade physical properties, nor nutrient, trace-metal, *Escherichia coli*, and suspended-sediment concentrations at the selected sites beyond the variability at the upstream transect (no bridge influence) during the study period. During storm sampling at the bridge sites, water-quality conditions were statistically similar upstream and downstream from each bridge, except for greater turbidity, total nitrogen, and total organic nitrogen plus ammonia concentrations found downstream from the bridge site on Fishing Creek; higher total chromium concentrations detected downstream from the bridge site on Turkey Creek; and increased *Escherichia coli* concentrations found downstream from the bridge site on the North Fork Edisto River. Total recoverable lead, cadmium, and copper concentrations were the only trace metals that periodically exceeded the South Carolina Department of Health and Environmental Control freshwater aquatic-life criteria at some bridge sites (lead, copper, and cadmium in Turkey Creek; cadmium and lead in Fishing Creek; lead in the South Fork Edisto River and Lynches River), but the exceedances occurred more frequently during routine sampling upstream from the bridge sites than during storm sampling at upstream and downstream transects. In general, stormwater runoff from the bridge decks did not seem to be the major source of metal enrichment in receiving waters during the study period. North Fork and South Fork Edisto Rivers and Turkey Creek had only one storm sample that exceeded South Carolina Department of Health and Environmental Control recreational criterion for *Escherichia coli* at both the upstream and downstream locations, while Fishing Creek had more frequent exceedances. Polycyclic aromatic hydrocarbons were detected infrequently in the stream samples.

In general, sediment trace-metal concentrations were below the threshold and probable effect concentration at all bridge sites, except for the chromium concentration (45.1 milligrams per kilogram) detected upstream from the bridge site on Fishing Creek that exceeded the threshold effect concentration of 43.4 milligrams per kilogram. Based on enrichment ratios less than 1.5, bridge-deck runoff did not seem to be affecting trace-metal accumulation in the streambed sediment downstream from the bridge sites, except for lead at the bridge site on the Lynches River and manganese at the bridge site on Fishing Creek.

Individual polycyclic aromatic compound concentrations and the sum of 18 compounds did not exceed any threshold and probable effect concentrations, indicating polycyclic aromatic hydrocarbon concentrations in the streambed sediment at downstream and upstream transects were not likely to affect the health of benthic macroinvertebrate communities. Although the cumulative polycyclic aromatic hydrocarbon concentrations in downstream sediment at the sites on Turkey and Fishing Creeks were well below the threshold effect concentration of 1,610 micrograms per kilogram, the 3- to 100-fold increase in downstream concentrations indicated a strong probability of a bridge-deck runoff source.

Results

Overall, benthic macroinvertebrate community health downstream from the bridge sites did not seem to be affected by bridge-deck runoff based on several multivariate analyses that indicated statistically similar benthic macroinvertebrate communities at upstream and downstream transects. Of the five bridge sites in this study, the site on Turkey Creek seemed to have the least healthy benthic macroinvertebrate communities because of the lowest Ephemeroptera, Plecoptera, and Trichoptera spp. (mayflies, stoneflies, and caddisflies, respectively) taxa, species richness, and diversity; and the highest biotic indices, indicative of poorer ecological health, at upstream and downstream transects. This ecological finding was not unexpected because of seasonal periods of negligible flow when dissolved-oxygen concentrations fell below 4 milligrams per liter during the study period. Of the five bridge sites in this study, the site on the South Fork Edisto River seemed to have healthier benthic macroinvertebrate communities because of the greater mean Ephemeroptera, Plecoptera, and Trichoptera spp. taxa; and lower mean biotic indices at upstream and downstream transects.

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