U.S. Geological Survey (USGS) Science Summary—Vegetation traps nutrients and sediment in the flood plain of an urban stream in the Chesapeake Bay watershed

(Released March 2016)

Issue

Urbanization in the Chesapeake Bay watershed has increased stream discharge, the frequency of flood-plain inundation, and the transport of nutrients (such as nitrogen and phosphorus) and sediment to streams and, ultimately, to the bay. Understanding the effects of the abundance, composition, and location of vegetation on flood-plain functions such as nutrient cycling and sediment trapping can aid in the development of effective best management practices that help improve the quality of water entering the bay.

Results of new USGS research

Results of new USGS research published in the journal “River Systems” (Rybicki and others, 2015) show that:

- In the Difficult Run watershed in Virginia, the vegetative demand for nutrients outpaced the supply (fig. 1). Over an annual cycle, the nutrients trapped in the flood plain were retained in the soil or taken up by plants; flood-plain vegetation incorporated nearly all of the soil production of inorganic nutrients into plant biomass.
- Cycling of nutrients in vegetation varied with vegetation abundance, species composition, and location.
- Sediment trapping increased with herbaceous plant cover and lower tree canopy density which, in turn, was associated with the presence of a more water-tolerant tree community in the downstream part of the watershed.
- Plant nutrient uptake and sediment trapping were greatest where the flood plain is widest, the gradient is lowest, and the connection between the stream and flood plain is greatest.

Implications for ecosystem management include:

- Nitrogen and phosphorus are likely recycled after leaf senescence in the autumn and immobilized for a long period in the flood plain. Flood-plain connection and naturalization of vegetation are best management practices that could contribute to long-term retention of nitrogen and phosphorus before these nutrients can be transported downstream to the bay.
- Natural vegetation is a potential long-term sink for nutrients and sediment in highly urbanized flood plains in the Piedmont region. A vegetated flood plain can serve as an effective nutrient and sediment trap to mitigate the effects of urbanization on watershed hydrology.
- Abundant natural herbaceous vegetation in the forested and hydrologically connected part of the flood plain is important for sediment trapping (fig. 2). Therefore, conservation and restoration of vegetated flood plains and their connectivity to the stream may help improve water quality.

Source of information

The findings in this Science Summary are reported in the article below, which should be used as the reference for this information:

For more information about this science summary contact Nancy Rybicki at nrybicki@usgs.gov .
For additional information about USGS Chesapeake Bay studies visit http://chesapeake.usgs.gov/.

Rybicki, N.B., Noe, G.B., Hupp, C.R., and Robinson, M.E., 2015, Vegetation composition, nutrient, and sediment dynamics along a floodplain landscape: River Systems, v. 21, no. 2–3, p. 109–123, accessed March 18, 2016, at http://dx.doi.org/10.1127/rs/2015/0097. [Also available at https://profile.usgs.gov/myscience/upload_folder/ci2015Dec1408514246588Rybicki%20etal%202015%20floodplain%20veg.pdf.]

Additional information about nutrient and sediment trapping on flood plains in the Chesapeake Bay watershed can be found at:

Hupp, C.R., Noe, G.B., Schenk, E.R., and Benthem, A.J., 2013, Recent and historic sediment dynamics along Difficult Run, a suburban Virginia Piedmont stream: Geomorphology, v. 180–181, p. 156–169, accessed March 18, 2016, at http://dx.doi.org/10.1016/j.geomorph.2012.10.007. [Also available at http://www.sciencedirect.com/science/article/pii/S0169555X12004606.]

Noe, G.B., Hupp, C.R., and Rybicki, N.B., 2013, Hydrogeomorphology influences soil nitrogen and phosphorus mineralization in floodplain wetlands: Ecosystems, v. 16, p. 75–94, accessed March 18, 2016, at http://dx.doi.org/10.1007/s10021-012-9597-0. [Also available at https://profile.usgs.gov/myscience/upload_folder/ci2013Jan2910424446588Noe%20etal%202013%20floodplain%20mineralization%20Ecosystems.pdf.]

Noe, G.B., Hupp, C.R., Schenk, E.R., and Rybicki, N.B., 2013, Sediment and nutrient trapping in the floodplain of Difficult Run, Virginia, and the implications for the restoration of Chesapeake Bay: U.S. Geological Survey, accessed March 18, 2016, at http://chesapeake.usgs.gov/sciencesummary-sedimentnutrienttrapping.html. [Also available at http://chesapeake.usgs.gov/documents/ss-sedimentnutrienttrapping.pdf.]

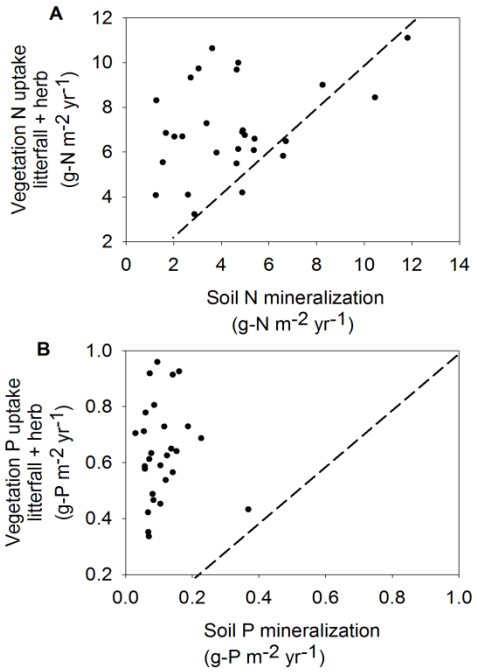

Figure 1. Nutrient uptake by vegetation (tree litterfall and herbaceous production) as a function of inorganic nutrient production (mineralization) in soil for (A) nitrogen and (B) phosphorus. (From Rybicki and others, 2015, fig. 5; N, nitrogen; P, phosp phosphorus; herb, herbaceous production; g-N m^{-2} yr^{-1}, grams of nitrogen per square meter per year; g-P m^{-2} yr^{-1}, grams of phosphorus per square meter per year; dashed line indicates 1:1 relation)

Figure 2. Sediment trapping, both mineral and organic, in vegetation on the hydrologically connected part of the naturally vegetated flood plain of Difficult Run, Virginia, 2008. Photograph by Lauren McPhillips, U.S. Geological Survey.