Nitrogen and Phosphorus in Wadeable Streams

Nitrogen and phosphorus are essential elements in aquatic ecosystems. Both nutrients are used by plants and algae for growth (U.S. EPA, 2005). Excess nutrients, however, can lead to increased algal production, and excess nutrients in streams can also affect lakes, larger rivers, and coastal waters downstream. In addition to being visually unappealing, excess algal growth can contribute to the loss of oxygen needed by fish and other animals, which in turn can lead to altered biological assemblages. Sources of excess nutrients include municipal sewage and septic tank drainfields, agricultural runoff, excess fertilizer application, and atmospheric deposition of nitrogen (Herlihy et al., 1998).

This indicator measures total phosphorus and total nitrogen based on data collected for EPAs 2008-2009 National Rivers and Streams Assessment (NRSA) and EPAs earlier Wadeable Streams Assessment (WSA). Wadeable streamsstreams, creeks, and small rivers that are shallow enough to be sampled using methods that involve wading into the waterrepresent a vital linkage between land and water. They typically include waters classified as 1st through 4th order in the Strahler Stream Order classification system (Strahler, 1952). The WSA and NRSA are based on a probabilistic design, so the results from representative sample sites can be used to make a statistically valid statement about nitrogen and phosphorus concentrations in all of the nations wadeable streams.

Sites were sampled in two periods, 2000-2004 and 2008-2009. Crews sampled 1,297 randomized wadeable stream sites during the first period and 1,169 during the second period across the United States using standardized methods. At each site, a water sample was collected at mid-depth in the stream and analyzed following standard laboratory protocols (U.S. EPA, 2013b).

Because naturally occurring nutrient levels vary from one geographic area to another, streams were divided into nine broad ecoregions (U.S. EPA, 2013a), which were defined by the WSA and NRSA based on groupings of EPA Level III ecoregions (Omernik, 1987; U.S. EPA, 2015). In each ecoregion, a set of relatively undisturbed sites was sampled to determine the range of nutrient concentrations that would be considered low. Next, observed nitrogen and phosphorus concentrations from all sites were compared to the distribution of concentrations among the ecoregions reference sites. If the observed result was above the 95th percentile of the ecoregions reference distribution, the concentration was labeled high. This threshold was used because it offers a high degree of confidence that the observed condition is statistically different from the condition of the reference streams. Concentrations below the 75th percentile of the reference range were labeled low, indicating a high probability that the site is similar to the relatively undisturbed reference sites. Concentrations falling between the 75th and 95th percentiles were labeled moderate.

This indicator is similar to the Nitrogen and Phosphorus in Streams in Agricultural Watersheds indicator, but it covers all wadeable streams regardless of land use, whereas the agricultural streams indicator focuses on a particular land use where activities can pose a risk of nutrient-rich runoff and is focused on a specific set of sites.

What the Data Show

Nationwide, 51.2 percent of wadeable stream miles had low total nitrogen concentrations in 2008-2009, up from 46.6 percent in 2000-2004. High nitrogen concentrations were found in 28.8 percent of stream miles in 2008-2009, down from 31.6 percent in 2000-2004 (Exhibit 1). However, these changes over time were not statistically significant. In contrast, low concentrations of phosphorus were found in 35.9 percent of stream miles in 2008-2009, down from 52.8 percent in 2000-2004. High phosphorus concentrations were found in 44.2 percent of stream miles in 2008-2009, up from 31.1 percent in 2000-2004 (Exhibit 2). Both of these national-scale changes in phosphorus concentrations were statistically significant.

The concentrations associated with the regional thresholds vary because of natural differences among the ecoregions. The Northern Plains had the highest percentage (75 percent) of wadeable stream miles with low total nitrogen concentration and the second-highest percentage (63 percent) of stream miles with low phosphorous concentrations in 2008-2009. The Temperate Plains had the highest proportion (70 percent) of stream miles with low phosphorus concentrations in 2008-2009. In contrast, 41 percent and 70 percent of wadeable stream miles had high total nitrogen and phosphorus concentrations, respectively, in the Northern Appalachians ecoregion in 2008-2009.

Limitations

- Samples were taken one time from each sampling location during the index period (April-November) in 2000-2004 and 2008-2009. Although the probability sampling design results in an unbiased estimate for total nitrogen and phosphorus concentrations in wadeable streams during the study period, concentrations may be different during other seasons.
- This indicator provides an assessment of change between two points in time. Some of these changes are statistically significant, and some are not. Detecting long-term trends will require more years of data.
- Not all forms of nitrogen and phosphorus are equally bioavailable, and the ratio of nitrogen to phosphorus can affect the biomass and type of species of algae in streams. The forms of nitrogen and phosphorus and the nitrogen:phosphorus ratios may vary somewhat between the regional reference sites and the WSA and NRSA streams.

Data Sources

The results shown in this indicator come from EPAs 2013 NRSA (U.S. EPA, 2013a), which includes 2008-2009 data as well as revised estimates of 2000-2004 conditions that were originally published in EPAs 2006 WSA (U.S. EPA, 2006). Data from individual stream sites can be obtained from https://www.epa.gov/national-aquatic-resource-surveys/nrsa.

References

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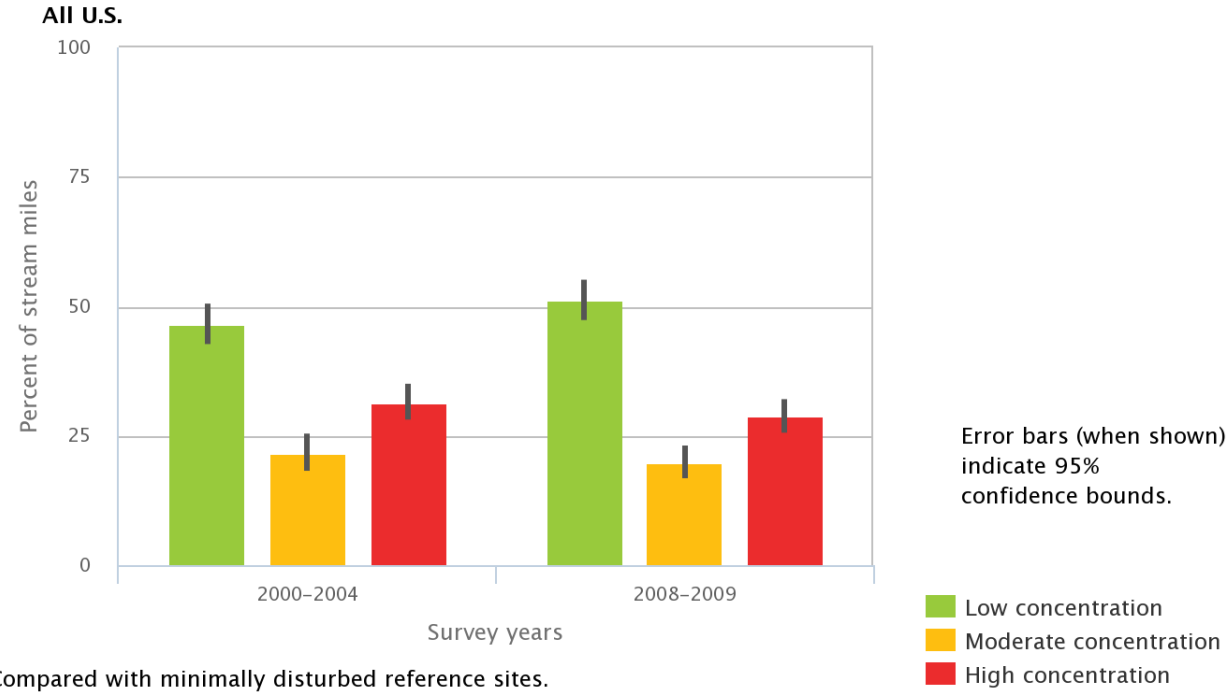
Exhibit 1. Nitrogen in wadeable streams of the contiguous U.S., 2000–2009



Compared with minimally disturbed reference sites.

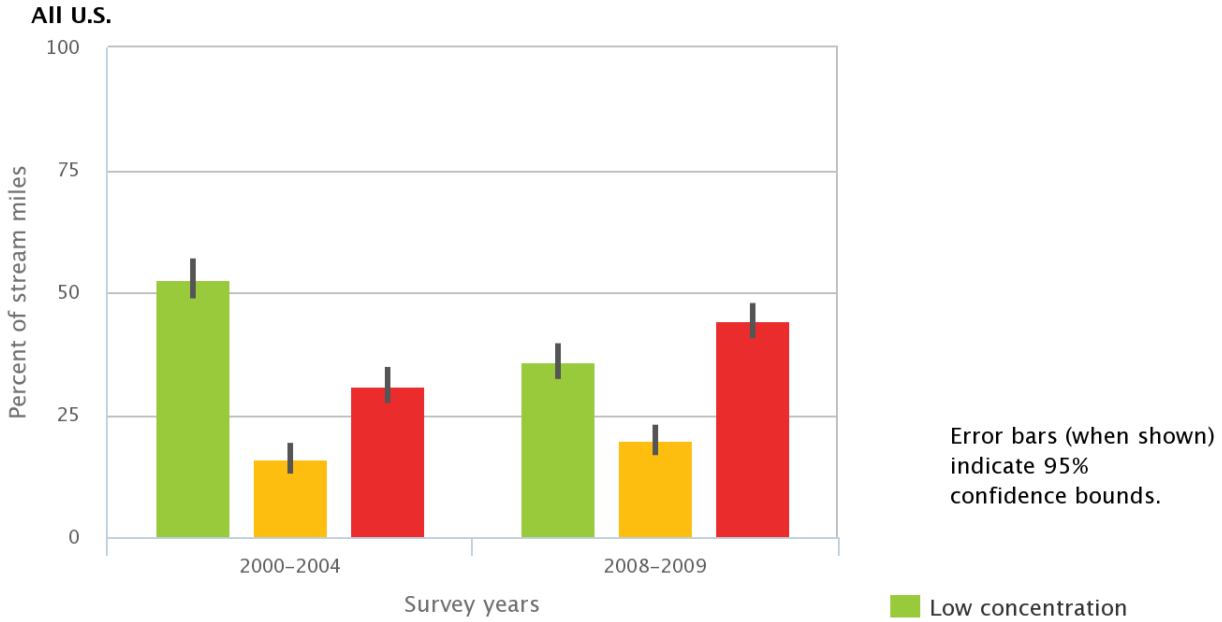
See text for definitions of the categories shown in the figure.

Analysis shows that none of the changes between time periods is statistically significant. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

Data source: U.S. EPA, 2013a

Visit http://www.epa.gov/roe to see the full exhibit.

Exhibit 2. Phosphorus in wadeable streams of the contiguous U.S., 2000–2009



Compared with minimally disturbed reference sites.

See text for definitions of the categories shown in the figure.

Analysis shows that the changes between time periods for low and high concentrations are statistically significant. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

Data source: U.S. EPA, 2013a

Visit http://www.epa.gov/roe to see the full exhibit.