Benthic Macroinvertebrates in Wadeable Streams

Freshwater benthic macroinvertebrate communities are composed primarily of insect larvae, mollusks, and worms. They are an essential link in the aquatic food web, providing food for fish and consuming algae and aquatic vegetation (U.S. EPA, 2006). The presence and distribution of macroinvertebrates in streams can vary across geographic locations based on elevation, stream gradient, and substrate (Barbour et al., 1999). These organisms are sensitive to disturbances in stream chemistry and physical habitat, both in the stream channel and along the riparian zone, and alterations to the physical habitat or water chemistry of the stream can have direct and indirect impacts on their community structure. Because of their relatively long life cycles (approximately 1 year) and limited migration, benthic macroinvertebrates are particularly susceptible to site-specific stressors (Barbour et al., 1999).

This indicator is based on data collected for EPA's 2008-2009 National Rivers and Streams Assessment (NRSA) and EPA's earlier Wadeable Streams Assessment (WSA). Wadeable streams are streams, creeks, and small rivers that are shallow enough to be sampled using methods that involve wading into the water. They typically include waters classified as 1st through 4th order in the Strahler Stream Order classification system (Strahler, 1952). Sites were sampled in two periods, 2000-2004 and 2008-2009. Crews sampled 1,282 wadeable stream sites during the first period and 1,162 during the second period throughout the contiguous U.S. using standardized methods (U.S. EPA, 2013b). Sites were sampled between mid-April and mid-November. At each site, a composite bottom sample was collected from eleven equally spaced transects within the sample reach. The WSA and NRSA are based on a probabilistic design, so results from the sample sites can be used to make statistically valid statements about the percentage of wadeable stream miles that fall above or below reference values for the indicator.

For this analysis, the 48 contiguous states were divided into nine broad ecoregions (U.S. EPA, 2013a), which were defined for the analysis based on groupings of EPA Level III ecoregions (Omernik, 1987; U.S. EPA, 2015). Benthic community condition was determined using a Macroinvertebrate Multimetric Index (MMI), which reduces complex information about community structure into a simple numerical value based on measures of taxonomic richness (number of taxa); taxonomic composition (e.g., insects vs. non-insects); taxonomic diversity; feeding groups (e.g., shredders, scrapers, or predators); habits (e.g., burrowing, clinging, or climbing taxa); and tolerance to stressors. Separate metrics were used for each of these categories in the nine ecoregions, based on their ability to best discriminate among streams. Each metric was scaled against the 5th-95th percentiles for the streams in each region to create an overall MMI, whose value ranges from 0 to 100 (Stoddard et al., 2005).

Once the overall MMI was established, a set of relatively undisturbed sites was selected to determine the range of MMI scores that would be expected among "least disturbed" sites. A separate reference distribution was developed for each ecoregion. Next, the MMI score for every sampled site was compared with the distribution of MMI scores among the ecoregion's reference sites. If a site's MMI score was below the 5th percentile of the regional reference distribution, the site was classified as "most disturbed." This threshold was used because it offers a high degree of confidence that the observed condition is statistically different from the "least disturbed" reference condition. Streams with MMI scores above the 25th percentile of the reference range were labeled "least disturbed," indicating a high probability that they are similar to the relatively undisturbed reference sites. Streams falling between the 5th and 25th percentiles were classified as "moderately disturbed." In addition to national totals, this indicator displays MMI scores for the nine ecoregions.

What the Data Show

Based on the MMI, 20 percent of wadeable stream miles nationwide were classified as "least disturbed" with respect to benthic macroinvertebrate condition in 2008-2009, compared with 27 percent in 2000-2004 (Exhibit 1). Stream miles classified as "most disturbed" accounted for 56 percent of the total in 2008-2009, compared with 44 percent in 2000-2004. These changes over time were statistically significant. In 2008-2009, the Coastal Plains region had the largest proportion (71 percent) of wadeable stream miles classified as "most disturbed." In contrast, the Western Mountains and Xeric regions had the largest percentages (44 and 42 percent, respectively) of wadeable stream miles classified as "least disturbed" in 2008-2009.

Limitations

- Although the probability sampling design results in unbiased estimates for the MMI in wadeable streams during the April-November index period, values may be different during other seasons.
- Reference conditions for the MMI vary from one ecoregion to another in both number and quality, which limits the degree of ecoregional resolution at which this indicator can be calculated.
- 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.

Data Sources

The results shown in this indicator come from EPA's 2008-2009 NRSA (U.S. EPA, 2013a), which includes 2008-2009 data as well as revised estimates of 2000-2004 conditions that were originally published in EPA's 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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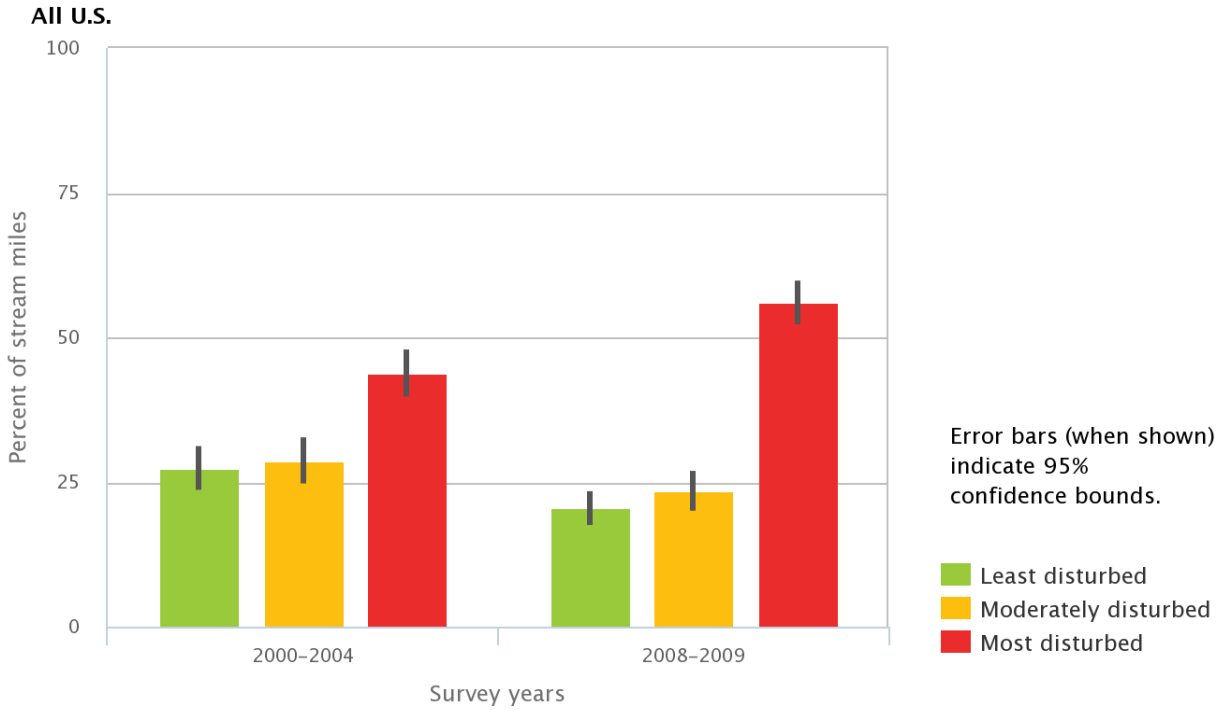
Exhibit 1. Multimetric Index (MMI) for benthic macroinvertebrates in wadeable streams of the contiguous U.S., by region, 2000–2009



Regions based on groupings of EPA Level III ecoregions (Omernik, 1987; U.S. EPA, 2007).

Analysis shows that the changes between time periods for least, moderately, and most disturbed 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 https://www.epa.gov/roe to see the full exhibit.