

Benthic Macroinvertebrates in Rivers and 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 rivers and 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 river or 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 National Rivers and Streams Assessment (NRSA), a survey conducted throughout the contiguous U.S. approximately every five years. Crews sampled nearly 2,000 stream sites during spring and summer in each survey period using standardized methods (U.S. EPA, 2016b, 2020b). At each site, a composite bottom sample was collected from 11 equally spaced transects within the sample reach. The NRSA is based on a probabilistic design, so results from the sample sites can be used to make statistically valid statements about the percentage of 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, 2020a), which were defined based on groupings of EPA Level III ecoregions (Omernik, 1987; U.S. EPA, 2012). 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., 2008).

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. Rivers and 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. Rivers and 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, 30 percent of river and stream miles nationwide were classified as "least disturbed" with respect to benthic macroinvertebrate condition in the most recent survey (2013-2014)—about the same as in 2008-2009 (Exhibit 1). River and stream miles classified as "most disturbed" accounted for 44 percent of the total in 2013-2014, compared with 45 percent in 2008-2009.

In 2013-2014, the Coastal Plains region had the largest proportion (64 percent) of river and stream miles classified as "most disturbed" (Exhibit 1). In contrast, the Northern Plains and Western Mountains regions had the largest percentages of river and stream miles classified as "least disturbed" in 2013-2014 (50 and 51 percent, respectively).

Limitations

- Although the probability sampling design results in unbiased estimates for the MMI in streams during the

spring/summer sampling period, values may be different during other seasons. Consistent use of the index period for sampling enables comparisons of population-wide changes over time.

- The 2008-2009 NRSA was the first to sample rivers and streams of all sizes. Thus, 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 2013-2014 NRSA (U.S. EPA, 2020a), which includes 2013-2014 data as well as revised estimates of 2008-2009 conditions that were originally published in EPA's 2008-2009 NRSA (U.S. EPA, 2016a). Data from individual stream sites can be obtained from <https://www.epa.gov/national-aquatic-resource-surveys/data-national-aquatic-resource-surveys>.

References

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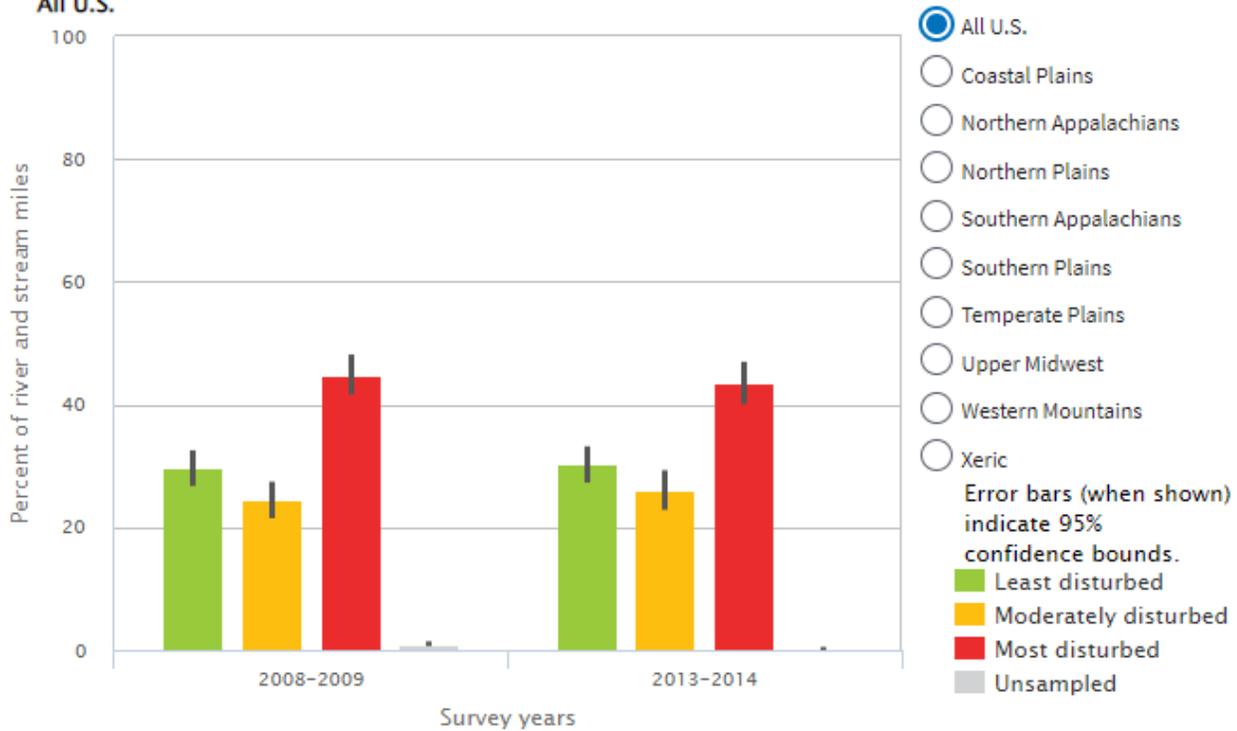
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Exhibit 1. Multimetric Index (MMI) for benthic macroinvertebrates in rivers and streams of the contiguous U.S., by region, 2008–2014

All U.S.



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

Analysis shows that these trends are not statistically significant. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

Data source: U.S. EPA, 2020a

Visit <https://www.epa.gov/roe> to see the full exhibit.