Streambed Stability

Rivers and streams adjust their channel shapes and particle sizes in response to the supply of water and sediments from their drainage areas, and this in turn can affect streambed stability. Lower-than-expected streambed stability is associated with excess sedimentation, which may result from inputs of fine sediments from erosion—including erosion caused by human activities such as agriculture, road building, construction, and grazing (Kaufmann et al., 2009). Unstable streambeds may also be caused by increases in flood magnitude or frequency resulting from hydrologic alterations. Lower-than-expected streambed stability may cause stressful ecological conditions when, for example, excessive amounts of fine, mobile sediments fill in the habitat spaces between stream cobbles and boulders. When coupled with increased stormflows, unstable streambeds may also lead to channel incision and arroyo formation and can negatively affect benthic invertebrate communities and fish spawning (Kaufmann et al., 1999). The opposite condition—an overly stable streambed—is less common, and generally reflects a lack of small sediment particles. Overly stable streambeds can result from reduced sediment supplies or stream flows, or from prolonged conditions of high sediment transport without an increase in sediment supply.

This indicator is based on an index of Relative Bed Stability (RBS), which is one measure of the interplay between sediment supply and transport. RBS is the ratio of the observed mean streambed particle diameter to the "critical diameter," the largest particle size the stream can move as bedload during storm flows. The critical diameter is calculated from field measurements of the size, slope, and other physical characteristics of the stream channel (Kaufmann et al., 2008, 2009). A high RBS score indicates a coarser, more stable bed—i.e., streambed particles are generally much larger than the biggest particle the stream could carry during a storm flow. A low RBS score indicates a relatively unstable streambed, consisting of many fine particles that could be carried away by a storm flow. Expected values of RBS are based on the statistical distribution of values observed at reference sites that are known to be relatively undisturbed. RBS values that are substantially lower than the expected range are considered to be indicators of ecological stress.

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, crews measured substrate particle size, streambed dimensions, gradient, and stream energy dissipators (e.g., pools and woody debris), then used these factors to calculate the RBS (U.S. EPA, 2020b). The NRSA is based on a probabilistic design, so the results from representative sample sites can be used to make a statistically valid statement about streambed stability in rivers and streams nationwide.

Because streambed characteristics vary geographically, streams 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). In each ecoregion, a set of relatively undisturbed reference sites was sampled in order to determine the range of RBS values that would be expected among "least disturbed" streams. Next, the RBS for every site was compared with the distribution of RBS values among the ecoregion's reference sites. If the observed RBS for a sample site was below the 5^{th} 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. Any river or stream with an RBS above the 25^{th} percentile of the reference range was labeled "least disturbed," indicating a high probability that the site is similar to the relatively undisturbed reference sites. Rivers or streams falling between the 5^{th} and 25^{th} percentiles were classified as "moderately disturbed." Note that the "least disturbed" category may include some rivers or streams with higher-than-expected RBS values, which represent overly stable streambeds. Because it is more difficult to determine whether overly stable streambeds are "natural" or result from anthropogenic factors, this indicator only measures the prevalence of

unstable streambeds (i.e., excess sedimentation).

What the Data Show

About 52 percent of river and stream miles are classified as "least disturbed" with respect to streambed condition as of the most recent survey shown (2013-2014). That is, their streambed stability is close to or greater than what would be expected at relatively undisturbed sites (Exhibit 1). Conversely, 22 percent of the nation's streambeds are much less stable than regional reference conditions for streambed stability ("most disturbed"), and an additional 22 percent are classified as "moderately disturbed." Conditions vary by ecoregion, with "most disturbed" streambeds most prevalent in the Temperate Plains and Southern Appalachians and "least disturbed" conditions most prevalent in the Southern Plains and Xeric ecoregions. Approximately one-quarter of the category scores shown in Exhibit 1 changed significantly between 2008-2009 and 2013-2014.

Limitations

- 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.

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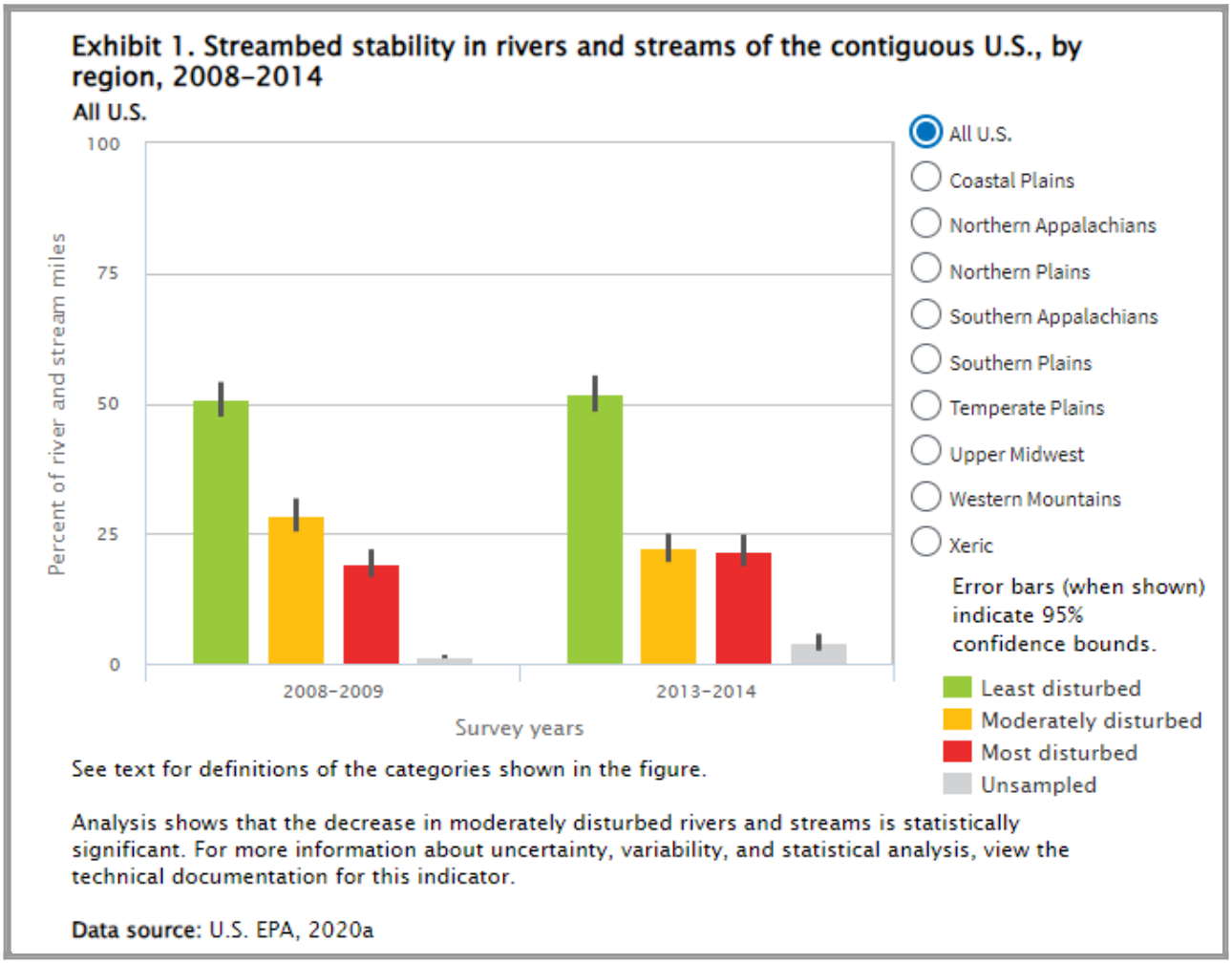

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