Streambed Stability

Streams and rivers 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 2008-2009 National Rivers and Streams Assessment (NRSA). 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). 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 wadeable streams nationwide.

Crews sampled 1,169 randomized sites throughout the U.S. using standardized methods (U.S. EPA, 2013a). Sites were sampled from April to November in 2008 and 2009. 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, 2013b).

Because streambed characteristics vary geographically, streams were divided into nine broad ecoregions (U.S. EPA, 2013a), which were defined by the NRSA based on groupings of EPA Level III ecoregions (Omernik, 1987; U.S. EPA, 2007). 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 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. Any 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. Streams falling between the 5 th and 25th percentiles were classified as "moderately disturbed." Note that the "least disturbed" category may include some 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

Roughly 55 percent of wadeable stream miles are classified as "least disturbed" with respect to streambed condition; that is, their streambed stability is close to or greater than what would be expected at relatively undisturbed sites (Exhibit 1). Conversely, 15 percent of the nation's wadeable streambeds are significantly less stable than regional reference conditions for streambed stability ("most disturbed"), and an additional 30 percent are classified as "moderately disturbed." In six of the nine ecoregions, more than half of wadeable stream miles are classified as "least disturbed." In the Northern Plains, Southern Plains, and Xeric ecoregions, less than half of wadeable stream miles are classified as "least disturbed" and more than one-quarter of wadeable stream miles are classified as "most disturbed."

Limitations

- Samples were taken one time from each sampling location during the index period (summer months of 2008 and 2009). Although the probability sampling design results in unbiased estimates for relative streambed stability in wadeable streams during the study period, RBS values may be different during other seasons and years because of variations in hydrology.
- Although similar data were collected from 2000 to 2004 as part of EPA's Wadeable Streams Survey, these older data used a less precise and less accurate method to measure stream channel slope, and thus it is not appropriate to compare the 2008–2009 data with 2000–2004 data. In addition, the survey design does not allow trends to be calculated within a single sampling period (2008–2009). Thus, this indicator does not show changes over time, and the data shown here will serve as a baseline for future surveys.

Data Sources

Aggregate data for this indicator were provided by EPA's National Rivers and Streams Assessment (U.S. EPA, 2013a). Data from individual stream sites can be obtained from http://water.epa.gov/type/rsl/monitoring/riverssurvey/#tabs-4.

References

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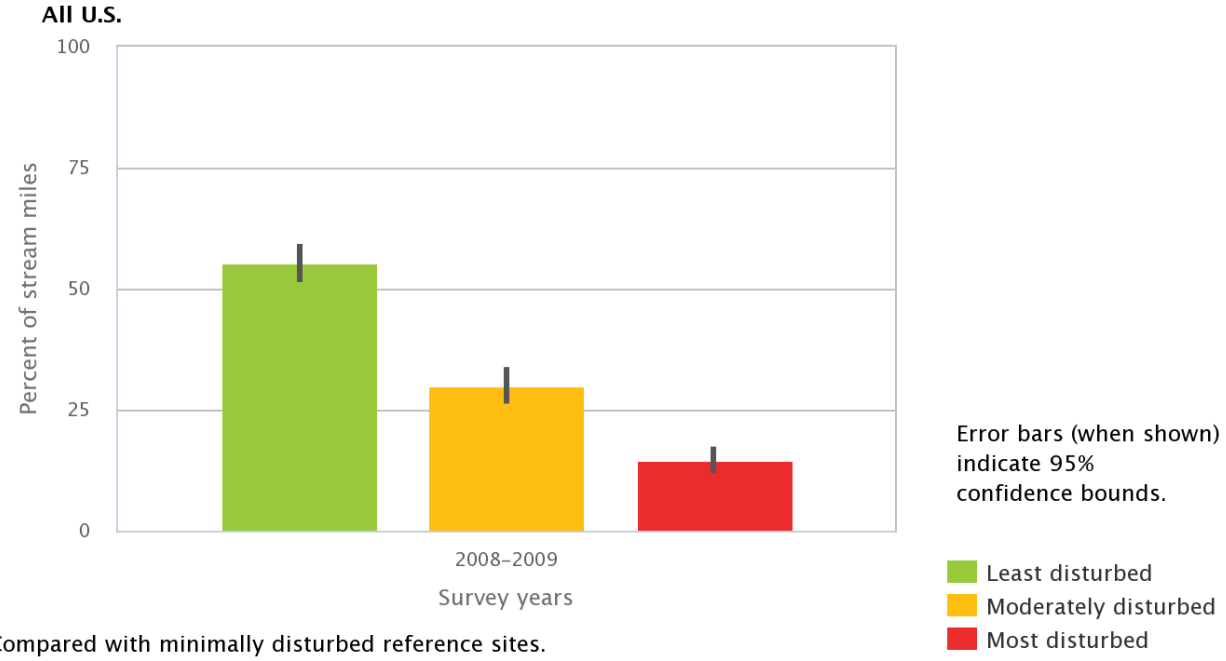
Exhibit 1. Streambed stability in wadeable streams of the contiguous U.S., 2008–2009



Compared with minimally disturbed reference sites.

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

Trend analysis has not been conducted because these data represent a single snapshot in time. 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.