Coastal Sediment Quality

Contaminated sediments can pose an immediate threat to benthic organisms and an eventual threat to entire coastal ecosystems. Sediments can be resuspended by anthropogenic activities, storms, or other natural events; as a result, organisms in the water column can be exposed to contaminants, which may accumulate through the food web and eventually pose health risks to humans (U.S. EPA, 2021).

There are several ways to measure sediment quality. Sediments can be assessed in terms of their toxicity to specific organisms in bioassays, or in terms of the levels of contaminants that are present. Sediment quality also can be inferred by assessing the condition of benthic communities, which largely reflect the quality of the sediments in which they live (although other stressors may be reflected as well). To generate a more complete picture of sediment quality, scientists frequently use several of these measures together.

This indicator presents data on sediment toxicity and contaminant levels. The data are from probabilistic surveys conducted as part of EPA's National Coastal Condition Assessment (NCCA) and presented in EPA's 2015 National Coastal Condition Assessment report (U.S. EPA, 2021). The surveys were designed to provide a national picture of sediment quality by sampling sites in coastal waters throughout the contiguous United States. Each site was sampled during the summer months. Comparable data were collected three times: 2005–2006, 2010, and 2015. Data are sufficient to show differences in sediment condition over time for four regions: Northeast Coast, Southeast Coast, Gulf Coast, and West Coast.

Sediment toxicity (Exhibit 1) is typically determined using bioassays that expose test organisms to sediments and evaluate their effects on the organisms' survival. For this indicator, toxicity was determined using a 10-day static test on the benthic amphipod *Leptocheirus plumulosus*, which is commonly used as a screening tool to identify sediments that pose sufficient concern to warrant further study. Sediment toxicity was classified as good, fair, or poor depending on the resulting survival rate (U.S. EPA, 2020).

Contaminant concentrations (Exhibit 2) do not directly reflect toxicity because toxicity also depends on contaminants' bioavailability, which is controlled by pH, particle size and type, organic content, and other factors (e.g., mercury vs. methylmercury). Contaminant concentrations are a useful screening tool for toxicity, however, when compared with concentrations known to cause particular effects on benthic life. For this indicator, sediment samples were homogenized and analyzed for nearly 100 contaminants, including metals (including mercury), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and organochlorine pesticides. The observed concentrations were then compared with Sediment Quality Guidelines (SQGs) derived from toxicity tests involving benthic organisms (Long et al., 1995). SQGs were available for 37 contaminants. Good, fair, or poor ratings are based on the extent to which contaminants are present at concentrations above SQGs.

Benthic community condition also can be a useful indication of sediment quality, particularly in terms of chronic or community effects that would not be captured in an acute exposure bioassay. The NCCA evaluated coastal sites for several aspects of benthic community condition, and these results are presented as a separate ROE indicator (Coastal Benthic Communities).

What the Data Show

More than 12 percent of the West Coast area was rated "poor" for sediment in 2015 based on the toxicity screening assay (Exhibit 1). The percent of coastal area rated "poor" for sediments along the West Coast peaked at 32 percent in 2010 but was much lower in all other years sampled. At the other end of the spectrum, 84 percent of area along the Southeast Coast was classified as "good" in 2015.

In terms of the sediment contaminants index, most regions saw the vast majority of their coastal area score "good" (Exhibit 2). The sediment contaminants index was rated as "good" in more than 95 percent of Gulf Coast and Southeast Coast area. The area rated "good" increased over time along the Gulf, Northeast, and Southeast coasts.

Limitations

- Comparable data have not been collected over the same timeframes in Alaska, Hawaii, or U.S. territories.
- Sample collection is limited to an index period during the summer. It is not likely that contaminant levels vary from season to season, however.
- The *Leptocheirus* bioassay is a single-organism screening tool, and the SQGs are general screening guidelines based largely on toxicity data from *Leptocheirus*. Thus, these measures do not necessarily reflect the extent to which sediments may be toxic to the full range of biota (including microbes and plants) that inhabit a particular sampling location.
- The *Leptocheirus* bioassay tests only for short-term, not long-term, exposure. Both screening tests characterize sediments in terms of their effects on benthic organism mortality. This indicator does not capture other effects of sediment contaminants on benthic organisms, such as disease, stress, and reproductive effects.
- This indicator cannot be compared quantitatively with indicators that use other types of contaminant guidelines. For example, the Pesticides in Streams indicator uses thresholds intended to be protective of aquatic life with a margin of safety, instead of thresholds shown to cause biological effects (e.g., ERMs). The ERM approach also is not directly comparable with other sediment contaminant approaches, such as EPA's equilibrium partitioning (EqP) benchmarks.

Data Sources

This indicator is based on an analysis published in EPA's 2015 National Coastal Condition Assessment (U.S. EPA, 2021). These data are available on EPA's website at https://www.epa.gov/national-aquatic-resource-surveys/data-national-aquatic-resource-surveys.

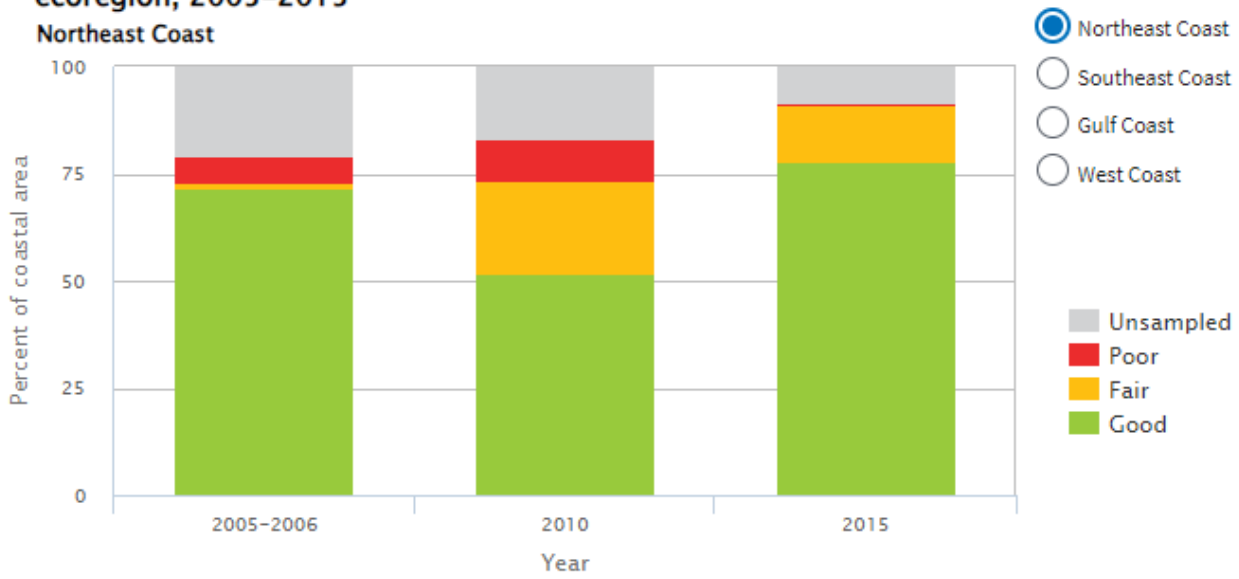
References

Long, E.R., D.D. MacDonald, L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environ. Manage. 19:81-97.

U.S. EPA (United States Environmental Protection Agency). 2021. National Coastal Condition Assessment 2015 report. EPA-841-R-21-001. https://www.epa.gov/national-aquatic-resource-surveys/national-coastal-condition-assessment-2015-report.

U.S. EPA. 2020. National Coastal Condition Assessment 2015 technical support document. EPA-841-R-20-002. https://www.epa.gov/national-aquatic-resource-surveys/national-coastal-condition-assessment-2015-technical-support.

Exhibit 1. Sediment toxicity in coastal waters of the contiguous U.S. by ecoregion, 2005–2015



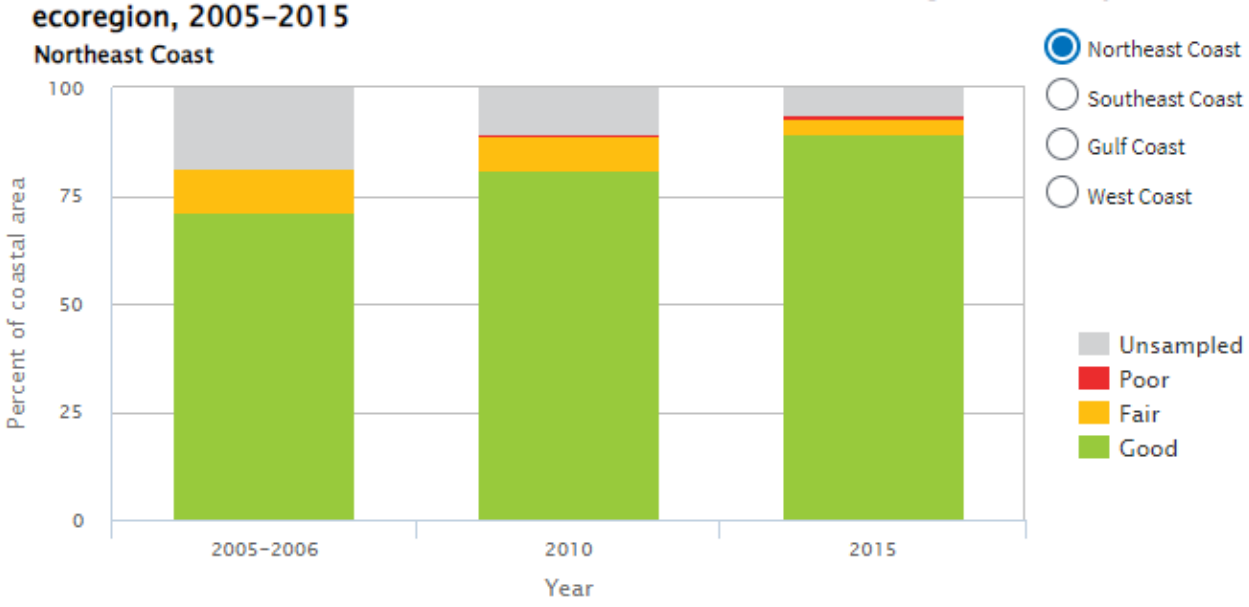
See text for definitions of categories.

Analysis shows that the increase in the fair category and decrease in the poor category in Northeast coastal waters are statistically significant. For more information about uncertainty variability, and statistical analysis, view the technical documentation for this indicator.

Data source: U.S. EPA, 2021

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

Exhibit 2. Sediment contamination in coastal waters of the contiguous U.S. by ecoregion, 2005–2015



See text for definitions of categories.

Analysis shows that the increase in the good category and decrease in the fair category in Northeast coastal waters are statistically significant. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

Data source: U.S. EPA, 2021

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