Assessing Streams in the Chesapeake Bay Watershed to Guide Conservation and Restoration Activities

Sampling by the Chesapeake Bay Partnership across the watershed enables the USGS to assess a variety of important stream characteristics.

Freshwater streams in the Chesapeake Bay watershed are home to numerous aquatic organisms (like fish, amphibians, mussels, and insects) and provide drinking water and recreational opportunities to people living in or visiting the watershed. Land-use changes, such as urban development and increased activities in certain agricultural sectors, have degraded water quality and altered conditions in these streams, thereby affecting their health and function. The U.S. Geological Survey (USGS) is working with Federal, State, and local partners to develop modeled assessments of stream health in freshwater streams and rivers within the Chesapeake Bay watershed. The USGS compiled large datasets for multiple stream health indicators, including instream stressors (salinity, water temperature, physical habitat, and streambank erosion) and living resources (macroinvertebrates and fish communities; fig. 1). These datasets were used by USGS scientists to develop models to predict stream health conditions across the entire region, including areas with little or no monitoring data. Collectively, these stream health assessments provide critical information to natural resource managers who implement restoration and conservation activities in the region.

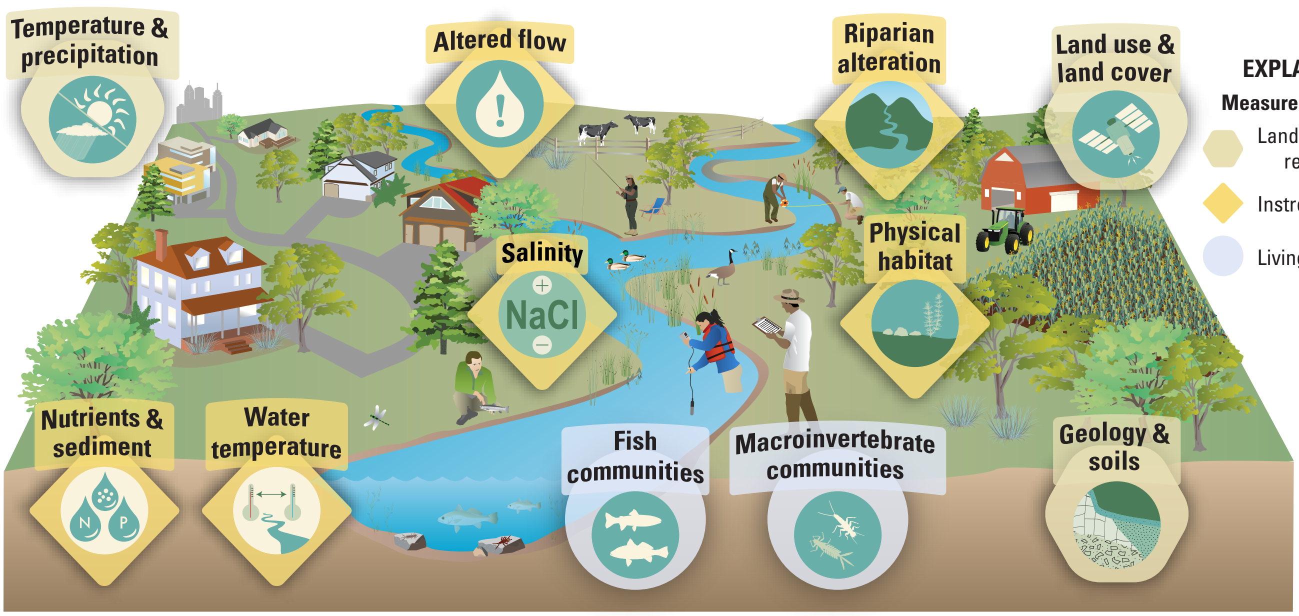


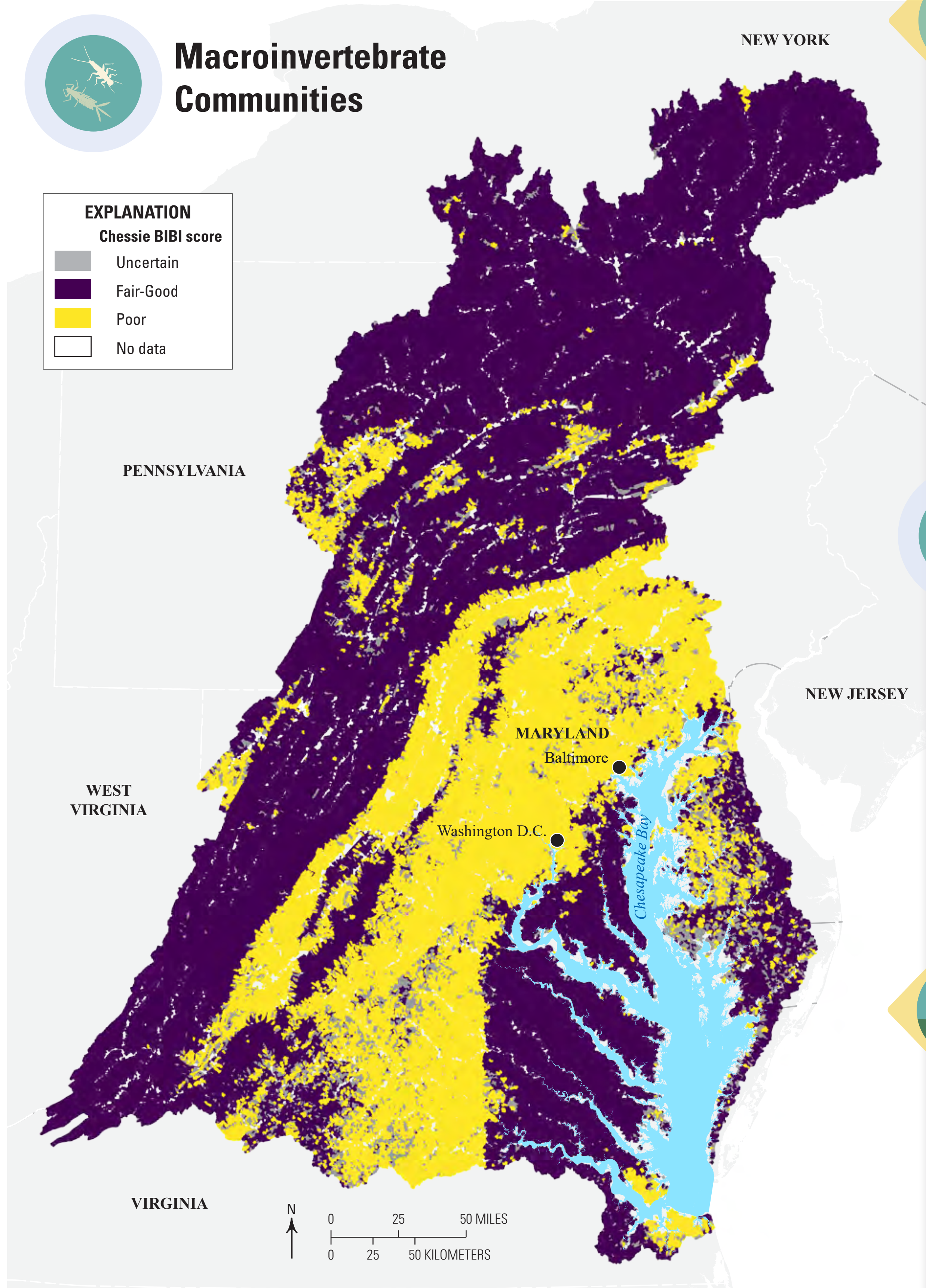
Figure 1. A diagram showing how land-use change, such as development and agriculture, geology, soils and climate patterns can affect conditions for multiple instream stressors, such as nutrients, water temperature, and physical habitat. These stressors can interact with each other and affect living resources. Modified from Noe and others (2024).

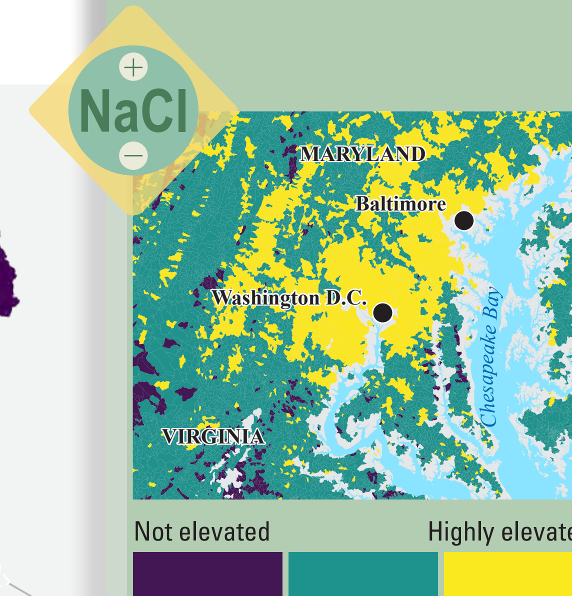
Photographs: (banner) Fletchers Cove in Washington, D.C., by Jenna Valenta, Chesapeake Bay Program. (left) Measuring water quality parameters at Accotink Creek, Virginia, by Rowan Johnson, U.S. Geological Survey. (top) Salvelinus fontinalis *(Mitchill, 1814; brook trout) in Pendleton County, West Virginia, by Steve Droter, Chesapeake Bay Program. (middle) Fish in Susquehanna State Park, Maryland, by Will Parson, Chesapeake Bay Program. (bottom) Water quality monitoring in Loudoun County, Virginia, by Will Parson, Chesapeake Bay Program.*

Stream Health Across the Chesapeake Bay Watershed

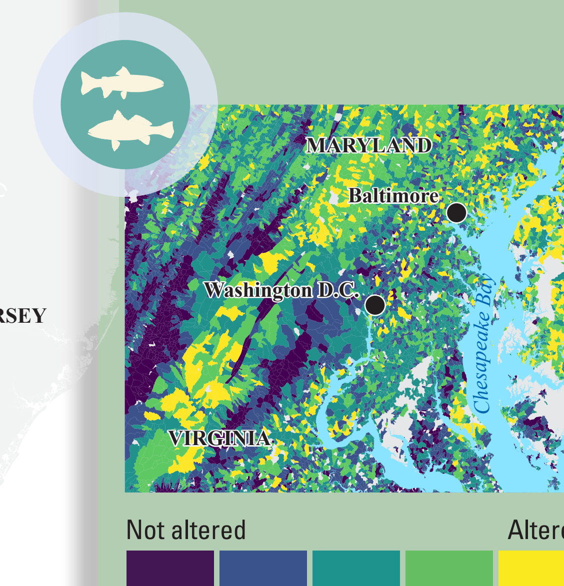
Benthic macroinvertebrates (stoneflies, dragonflies, beetles, and worms) are excellent indicators of stream health because they spend most or all their lives in water, are relatively easy to collect, and differ noticeably in their tolerance to instream stressors. Observations of macroinvertebrate communities across the region are compiled by the Interstate Commission on the Potomac River Basin and used to generate an index of stream health condition called the Chesapeake Basin-wide Index of Biotic Integrity, or “Chessie BIBI.” USGS researchers used the Chessie BIBI observations and a suite of datasets describing land use, geology, soils, and climate to predict Chessie BIBI scores for all small, nontidal streams in the Chesapeake Bay watershed. Certain land uses and land covers, like forest, urban development, and agriculture, were strongly related to the Chessie BIBI. Chessie BIBI scores were then predicted for multiple years. For 2016, predicted Fair-Good stream health conditions (meaning high-quality macroinvertebrate communities) clustered in the northern, western, and southeastern portions of the watershed, and predicted Poor stream health conditions (meaning low-quality macroinvertebrate communities) clustered in the middle portions of the watershed (fig. 2).

Photographs showing (top) sampling of stream macroinvertebrates and (bottom) an individual benthic macroinvertebrate from the sample. Datasets from macroinvertebrate sampling were used to make modeled predictions for unmonitored streams based on relationships with landscape, geology, and climate drivers. Photographs by Brendan Foster, U.S. Geological Survey.

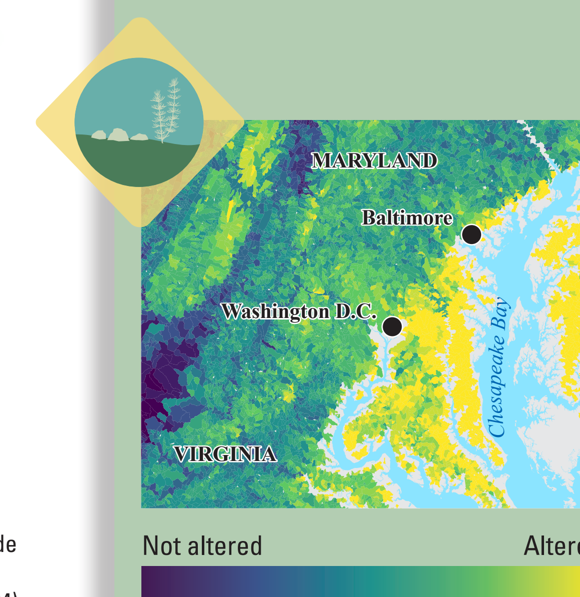




Salinity.—Increases in dissolved ions, like chloride, can elevate salinity levels in freshwater streams, which may harm living resources. USGS researchers used measures of landscape, geology, and climate drivers to predict salinity and departures from background salinity. In urban areas within the area of interest, salinity was elevated compared to natural levels, likely because of winter season road salt applications. Areas that were mostly forested typically had salinity levels around natural levels (fig. 2; Fanelli and others, 2024).



Fish community.—Fish are also used as an indicator of stream health. USGS researchers used fish community data to create an index of alteration with higher scores indicating less altered conditions. Within the area of interest, altered conditions center around the Washington, D.C., metropolitan area, and less- to non-altered conditions are west of Washington, D.C., and southern Eastern Shore of Maryland and Virginia (fig. 2; Maloney and others, 2022b).



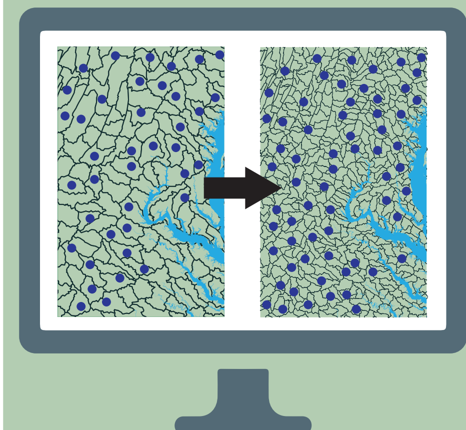
Physical habitat.—Degraded physical instream habitat is a common stressor affecting river ecosystems and thus stream health. USGS researchers used commonly measured rapid instream habitat assessment data to create indices of habitat condition. The area of interest highlights natural changes in stream gradient in the Coastal Plain and alterations around the Washington, D.C., metropolitan area (fig. 2; Cashman and others, 2024).

Figure 2. (left) Map showing the model predictions of stream biological health for 2016 using the Chesapeake Basin-wide Index of Biotic Integrity (Chessie BIBI; Maloney and others, 2022a). (right) Maps showing model predictions of salinity (Fanelli and others, 2024), fish communities (Maloney and others, 2022b), and physical habitat (Cashman and others, 2024) for 2016 for an area of interested centered on the Washington, D.C., metropolitan area.

Future Directions and Applications of USGS Stream Assessments

The USGS is developing models to predict additional instream stressors (nutrients, temperature, streambank erosion, and flow alteration) to develop a more complete suite of stream health assessments. Future models and predictions are planned to be updated to a web-based tool. The USGS plans to continue working with partner organizations to ensure indicators remain relevant to their needs. Stream assessments will be periodically updated when new data are available.

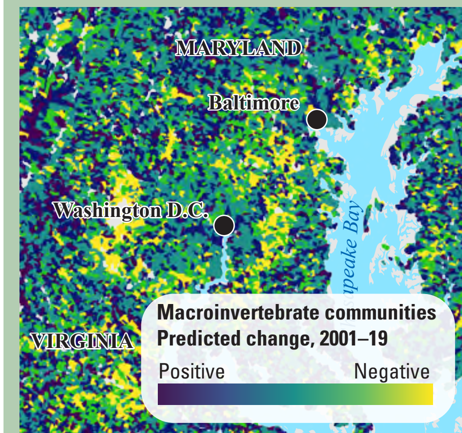
Expanding Analysis and Scale



Polygons represent catchment boundaries at a coarse (left panel) and fine (right panel) map scale, point represent hypothetical sampling locations

The USGS is using a centralized database of high-resolution landscape, geology, and climate datasets (Gressler and others, 2023) for predicting stream health indicators at higher spatial resolutions to better describe living resources and instream stressor conditions. High-resolution predictions will support management and decision making at local scales.

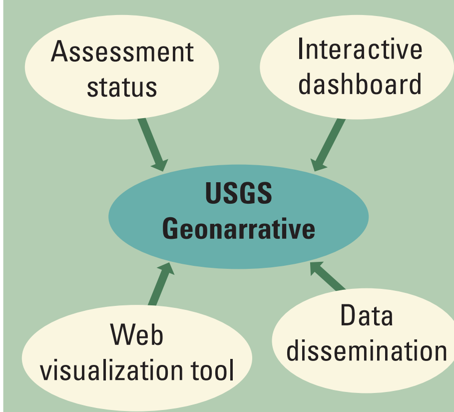
Support Management Decisions



Declining stream health owing to expanding urban development around Washington, D.C.

Predicted changes in stream health can be used to guide restoration or conservation activities. For example, areas with large declines in the Chessie BIBI from 2001 to 2019 (yellow) around the Washington, D.C., metropolitan area could be improved by restoring the reach and surrounding watershed. Areas where the Chessie BIBI has increased (blue) could be further protected by implementing conservation activities in their watersheds.

Delivering Information Using a Web-based Interactive User Tool



The geonarrative is a web-based tool that serves many functions.

The USGS created an interactive web-based tool, called a geonarrative, to display and synthesize assessment results across the watershed (Gordon and others, 2024). This tool allows users to explore indicator information, query and map multiple layers of results, and upload additional data to support decisions regarding restoration and conservation activity implementation.

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Science and Communication and Synthesis Team: Annie Carew, Lili Badri, and Vanessa Vargas-Nguyen of the University of Maryland Center for Environmental Science.
Authors: Kelly O. Maloney, Rosemary M. Fanelli, Matthew J. Cashman, Lindsey J. Boyle, Stephanie E. Gordon, Benjamin P. Gressler, Michelle P. Katoski, Alexander H. Kiser, Marina J. Metes, Gregory B. Noe, Andrew J. Sekellick, Allison Sussman, and John A. Young.

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ISSN 2327-6932 (online)
ISSN 2327-6916 (print)
https://doi.org/10.3133/fs20253056