New STREAM HEALTH INDICATOR BEING DEVELOPED

The Chesapeake Bay Program and its partners developed an improved stream health indicator that provides a regional assessment of benthic (bottom-dwelling) macroinvertebrate community health. Benthic data collected in different ways by various natural resource agencies were incorporated into a Benthic Index of Biotic Integrity that rates stream health across the entire 64,000 square miles of watershed that drain into Chesapeake Bay. Overall, the analysis showed that out of 3,291 sampling sites in the watershed, 1,632 of the sites had very poor or poor conditions and 1,056 sites had good or excellent conditions.

BOTTOM-DWELLERS ARE AN INDICATOR OF STREAM HEALTH

Bottom-dwellers, also known as benthic macroinvertebrates, are freshwater organisms including snails, mussels, and insects that live in and on the stream and river bottom. They are routinely monitored throughout the Chesapeake Bay watershed by the states and other organizations.

The abundance and diversity of these organisms are good indicators of local stream health because they have more limited movement than fish and they respond quickly to pollutants such as nutrients and sediment and other environmental stressors. The health of bottom-dwellers is threatened by pollutants introduced into streams and rivers by sources such as mining, agriculture, stormwater, fossil fuel combustion, and household and industrial wastewater treatment facilities (Figure 1). These human activities can add nitrogen and phosphorus to the water, which lead to algal blooms and low dissolved oxygen in slow-moving streams. Mining, agriculture, and development also can add fine sediment to streams, which smothers benthic organisms and contributes to low dissolved oxygen. Mining adds toxic chemicals to the water that directly kill these bottom-dwellers.


WV Dept of Env Protection

Bottom-dwellers need streams with shady trees and ample rocks and debris.

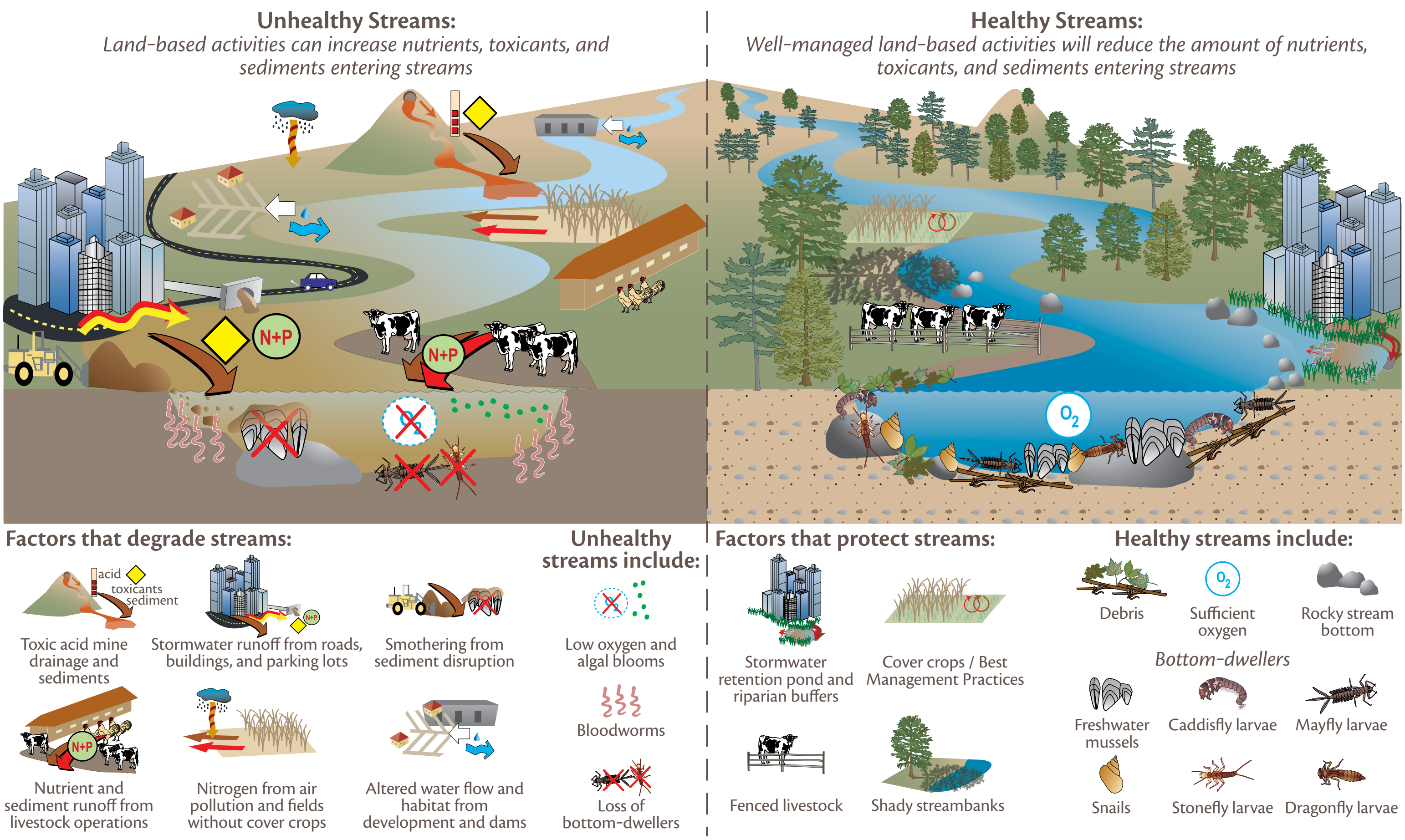


Figure 1: Conceptual diagram illustrating the land-based activities that affect bottom-dwellers and the habitat that they need to survive.

HEALTH INDICATOR FOR CHESAPEAKE BAY STREAMS

Water quality in Chesapeake Bay is linked to the health of the 64,000 square miles of land and associated streams and rivers that comprise its watershed. Land-based activities (e.g., development, agriculture) can add pollution, such as nutrients and sediment, to local streams and rivers, which ultimately flow into Chesapeake Bay.

The new stream health indicator (Benthic Index of Biotic Integrity (BIBI), see back page for methods) illustrates this link between stream health and land-based activities (Figure 2). For example, stream health conditions tend to be very poor to fair in areas that have extreme land disturbance, such as new construction, which results in high levels of pollution, altered water flow, and poor quantity and quality of streamside vegetation. Such unhealthy streams tend to be clustered around large urban areas such as metropolitan Washington, D.C. in the lower Potomac River watershed, and in areas that have land-uses dominated by agriculture (e.g., Eastern Shore of Maryland) and mining (e.g., parts of Pennsylvania and West Virginia). In contrast, stream health conditions tend to be good to excellent in areas with little land disturbance that offer low levels of pollution and natural in-stream and streamside habitat. Such healthy areas tend to be clustered around forested and prairie areas, such as the upper Potomac River watershed. The health of streams is variable throughout the Bay watershed and can vary even within a smaller subwatershed (e.g., the Potomac River watershed). Exceptions to these generalizations linking land-based activities to stream health are expected and are due to complexities within the ecosystem.

Overall, 1,632 of the sites had very poor or poor health conditions and 1,056 sites had good or excellent conditions, out of a total of 3,291 sampling sites. Developing this indicator provides an important tool for managers and watershed groups who are focusing efforts to restore degraded streams and protect the quality of the healthiest ones.

Sediment in streams can smother bottom-dwellers.

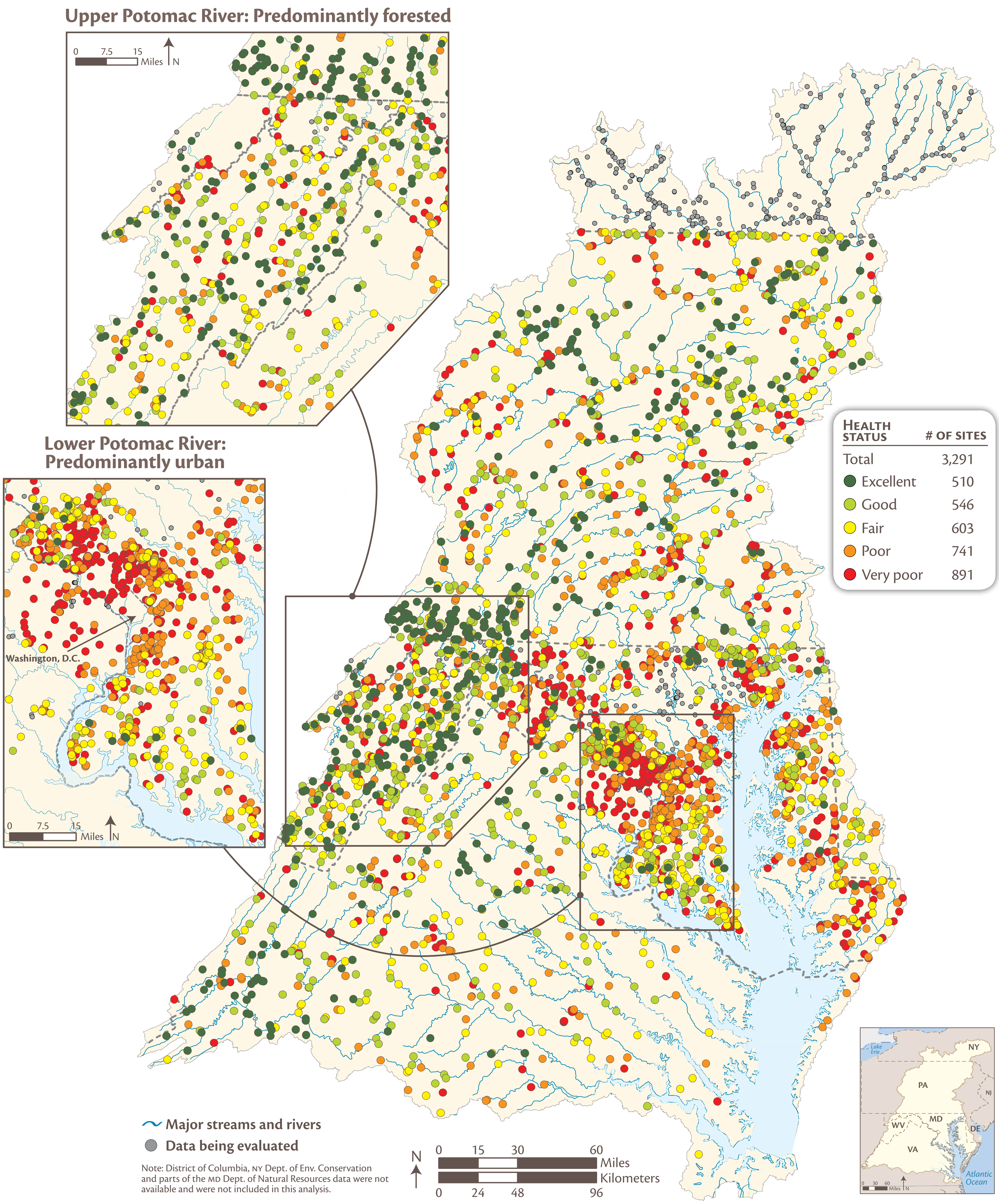
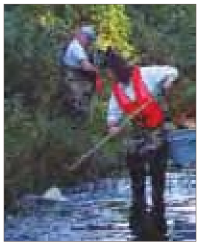


Figure 2: This map of Benthic Index of Biotic Integrity results gives a general picture of local stream health throughout the Chesapeake Bay watershed. The maps of the upper and lower sections of the Potomac River watershed show variation in stream health within one subwatershed. The overall health of streams varies regionally and locally due to multiple factors such as land-use, geology, and climate.

METHODS FOR *NEW* STREAM HEALTH INDICATOR

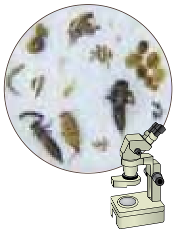
Most monitoring programs in the Chesapeake Bay watershed collect samples of bottom-dwellers (benthic macroinvertebrates) with somewhat similar field methods and calculate a common suite of indicators from the data. However, the programs use state-specific protocols to score and evaluate these indicators in order to identify "impaired" waters for regulatory requirements. The purpose of this new stream health indicator is to evaluate benthic community health in a uniform manner and in the context of the entire Chesapeake Bay watershed. This approach incorporates the data into an overall watershed-wide Benthic IBI that is classified at the scientific family level (Figure 3). This method allows the results to be compared across state boundaries. This indicator is a first step toward a regional benthic community health assessment. Future work will continue to improve upon this indicator by standardizing methodologies, developing ways to combine results from different sampling designs (targeted vs. random samples), and incorporating data that were not available for analysis this year.

8 steps used to determine the health of streams



1. Sampling
Scientists sampled 3,291 different stream sections during different times of the year from 2000–2006.

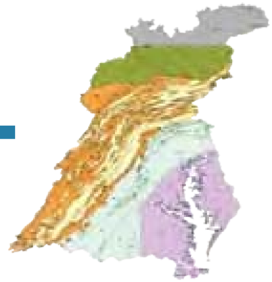
2. Collecting
Numerous bottom-dwellers are collected from a variety of stream habitats over one stream section.



3. Sorting
Scientists sort the samples and count how many and what kind of bottom-dwellers are in each sample.

Results are used by each Bay state to assess impaired status for regulatory purposes. *This is a different method than used for the new indicator.*

Samples are used by the Chesapeake Bay Program to communicate the health of the bay to citizens.



4. Classifying
Samples are classified into one of five eco-regions:

- **Northern Appalachians**
- **Highlands**
- **Valleys**
- **Piedmont**
- **Coastal Plain**
- **Data being evaluated**

5. Setting thresholds
Within each eco-region, threshold values are determined for key metrics based on a comparison to "best sites". Best and worst quality sites were identified from water quality and habitat quality information.

Example of threshold values for each metric

Metric	Thresholds for Piedmont Best	Worst
% Clinger Taxa	76.8	42.4
% Collector Taxa	77.3	53.5
% Dominant Taxa	47.0	27.9
% may-, stone-, & caddisfly taxa	79.1	49.8
Family-level Hilsenhoff Biotic Index (unitless)	4.39	3.16
# of may-, stone-, & caddisfly taxa (count)	7	5

6. Scoring
The basin-wide Benthic Index of Biotic Integrity scores various abundance, diversity, pollution tolerance, and feeding and habit characteristics of each sample with eco-region-specific thresholds, and provides an overall numeric score for each site. For a list of all scored metrics see References.

7. Ranking
Results are grouped into five qualitative categories based on their comparison to thresholds of the best and worst sites on one of two unitless scales.

	N. Appalachians, Highlands, Valleys, Piedmont	Coastal Plain
Excellent	≥27	≥3.86
Good	23–26.9	3.29–3.85
Fair	19–22.9	2.71–3.28
Poor	14–18.9	2.00–2.70
Very poor	<14	≤2.00

8. Mapping
Bottom-dweller community health at each location indicates the general health of the stream.

Figure 3: Eight steps to evaluate the Benthic Index of Biotic Integrity used for the stream health indicator. *Photo credits: DE Dept of Natural Resources and Environmental Control, WV Dept of Environmental Protection.*

Stream health indicator produced by the Chesapeake Bay Program's Non-tidal Water Quality Workgroup:
MD Dept of Nat Res, MD Dept of Env, PA Dept of Env Protection, VA Dept of Env Quality, WV Dept of Env Protection, WV Dept of Agriculture, DE Dept of Nat Res and Env Control, NY Dept of Env Conservation, Prince Georges and Montgomery Counties, MD, Fairfax County, VA, US Forest Service, Chesapeake Research Consortium, Susquehanna River Basin Commission, Interstate Commission on the Potomac River Basin, EPA Region III, US Geological Survey, Chesapeake Bay Program, UM Center for Env Science

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For more information:
www.eco-check.org/reportcard/chesapeake/2008/

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Astin LE (2006) Data synthesis and bioindicator development for nontidal streams in the interstate Potomac River basin, USA. Ecol Ind 6:664-685

Astin LE (2007) Developing biological indicators from diverse data:The Potomac Basin-wide Index of Benthic Integrity (B-IBI). Ecol Ind 7:895-908

Foreman K, Buchanan C, Nagel A (2008) Development of ecosystem health indexes for non-tidal wadeable streams and rivers in the Chesapeake Bay basin. Report to the Cheaspeake Bay Program Non-Tidal Water Quality Wkgrp. 12/05/08

Karr JR (1981) Assessment of biotic integrity using fish communities. Fisheries 6:21-27

Plafkin JL et al. (1989) Rapid bioassessment protocols for use in streams and rivers:Benthic macroinvertebrates and fish. EPA/440/4-98/001. USEPA, Office of Water Regs & Stds, Washington, DC

USEPA (1997) Field and laboratory methods for macroinvertebrate and habitat assessment of low gradient nontidal streams. Mid-Atl Coast Streams Wkgrp, Env Ser Div, Region 3, Wheeling WV, 23pp