United States Environmental Protection Agency

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BIOLOGICAL ASSESSMENTS:
Key Terms and Concepts

While the world constantly changes, our basic uses for water remain the same: We drink it, we bathe in it, we grow food with it. Our demand on water resources has a direct impact on the health and wellbeing of waterbodies and those species they support. To maintain healthy waterbodies, the Environmental Protection Agency (EPA) and many states and tribes have established regulations and programs to help restore and maintain the health of the nation's waters.

The first step in restoration and maintenance is to evaluate the condition of waterbodies and to understand the relationship between stressors and their impact on aquatic communities. Biological assessments provide information on the condition of the biological community and help document the response of this community to stressors.

What is a Biological Assessment?

A **biological assessment** is an evaluation of the condition of a waterbody by sampling species that spend all or part of their lives in that waterbody. A **biological survey** is conducted to collect a representative sample of the biological community found in the waterbody. For each site sampled specific attributes, known as **biological indicators**, are compared to the conditions expected for that indicator based on **reference sites**.

- ***Biological survey.*** A systematic method for collecting a consistent, reproducible and reliable sample of the aquatic biological community in a waterbody.
- ***Biological indicators.*** The groups of organisms used to assess the condition of an environment. Depending on the type of waterbody being sampled, biological indicators used in biological surveys may include the following:
  - Fish (trout, sunfish, perch, salmon)
  - Benthic macroinvertebrates (insects, snails, crayfish, worms)
  - Periphyton (algae)
  - Amphibians (frogs, salamanders)
  - Macrophytes (aquatic plants)
  - Birds (residential or migratory)

- ***Reference Sites.*** Data collected at reference sites provide a benchmark for assessing the biological condition of surveyed sites. Ideally, reference sites are sites that have not been disturbed by anthropogenic stress. However, the impact of human activities on aquatic systems in the United States is widespread and pervasive. Reference sites, therefore, typically have been influenced to some degree by human activities and may represent our best approximation of natural conditions. Data from reference sites can be used to develop management targets for protection and restoration of aquatic resources.

Metrics: Measuring Biological Conditions

Metrics are quantitative measures of biological indicators, and can provide information on both the present and past effects of anthropogenic stress on aquatic systems. Each metric is given a score, which can be interpreted as a measure of the condition of the sampled site relative to reference sites. Definitions and examples of typical metrics are described in the table below.

METRIC	DEFINITION	EXAMPLE
Total Taxon Richness	The number of different species (or genera or families) counted in a sample collection.	There are 41 different species of benthic macroinvertebrates from 34 different genera, 22 families and 8 different orders observed in one sample. The expected richness in reference sites is 40 or more species. The metric value of the sample (41) is comparable to reference site values.
Relative Richness	The percentage of the number of species in a sample that are either pollution sensitive or pollution tolerant species compared to the total taxon richness.	19.5 percent in a sample of benthic macroinvertebrates are pollution sensitive species. The reference site percentage is 36 percent or higher.
Percent Occurrence of Anomalies	The percent of sampled fish that have visible, external anomalies (e.g. tumors, lesions, abnormalities).	12 percent of a fish sample show external anomalies. Samples from the reference sites show less than 1 percent.

Biological Index. To gain a more comprehensive view of an aquatic community, multiple types of metrics are combined into a biological index. The typical biological index may include information from up to 7 to 12 different metrics.[1] The index of biological integrity (IBI) for fish is an example of a biological index created from metrics. Alternatively, models such as RIVPACS, can be used to compare the observed species (O) at a site to the expected species (E) based on reference sites.[2] The O/E ratio is then used as a measurement of "taxonomic completeness".

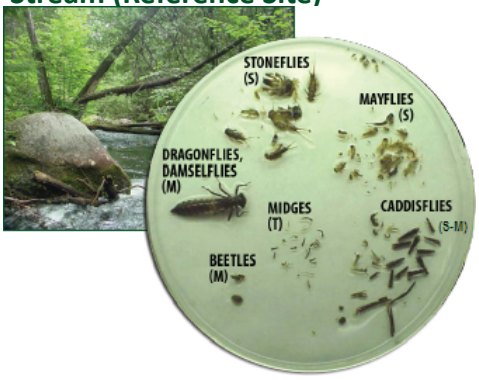
Biological Assessments in the Field: An Example

The following photographs[3] give an example of a biological assessment in Maine. A biological survey has been conducted on each stream to determine their communities' structures. In this case, the benthic macroinvertebrate assemblage is the biological indicator, and metrics such as relative richness have been selected. The condition represented by undisturbed/minimally disturbed streams, or reference sites, is used to assess changes in different metric values from other communities with increasing stress.

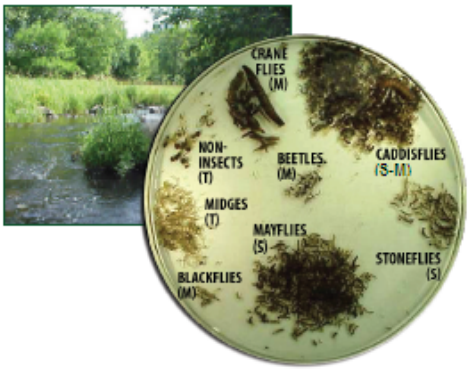
As the level of stress increases in these streams, the aquatic communities' compositions were measurably changed. Species that are sensitive to stress disappeared and more pollution tolerant species were found.

Those species are identified in the following images to indicate their general level of sensitivity to stress and ability to tolerate pollution: Intermediate species: **S**. Moderately tolerant species: **M**. Tolerant species: **T**.

Undisturbed/Minimally Disturbed Stream (Reference Site)



Nutrient Enriched Stream



Drainage from a Shopping Mall Parking Lot

[1] Karr, J.R., K.D. Fausch, P.L. Angermeier, P.R. Yant and I.J. Schlosser. 1986. Assessment of biological integrity in running water: A method and its rationale. Special Publication 5, Illinois Natural History Survey, Champaign, IL.

[2] Wright, J.F. 2000. An introduction to RIVPACS. In Assessing the Biological Quality of Fresh Waters: RIVPACS and Other Techniques. J.F. Wright, D.W. Sutcliffe and M.T. Furse (eds.), pp. 1-24. Freshwater Biological Association, Ambleside, UK.

[3] Photographs used with permission from the Maine Department of Environmental Protection.