National Biological Indicators

The Biological Indicators graphs show how the biological status of algal, invertebrate, and fish communities of stream sites within a Study Unit compare with the results from a total of 140 sites across the Nation (fig. 1). Biological indicators are shown separately for sites in watersheds categorized as having undeveloped (reference, rangeland, forest), agricultural, urban, or mixed land uses. Communities of algae, invertebrates (insects, worms, and clams), and fish respond at different spatial and temporal scales, and with varying degrees of tolerance, to water-quality degradation, and provide a record of water-quality and stream conditions that water-chemistry indicators may not reveal. Degradation can result from a variety of factors that modify habitat or other environmental features such as land use, water chemistry, and flow.

Figure 1. Map showing locations of 140 sites across the Nation where data on biological status (algae, invertebrates, and fish) were collected.

Definition and derivation of indicators:

The three biological indicators were derived from algae, invertebrate, and fish community data collected during High-Intensity Phase sampling for Study Units that began in 1994. These data were from 140 sites where samples for all three community types were collected. For sites where data were available from multiple reaches and/or multiple years, a median value was used. Because these sites were selected to represent specific land uses—or to integrate the effects of multiple land uses in large watersheds—the principal context for comparing biological status was comparisons among land-use categories. Therefore, variability among land uses was evaluated for a large number of community metrics (15 for algae, 107 for invertebrates; 18 for fish). Indices

chosen were those that were best able to distinguish among sites from different land uses. These indices are defined below; more information on how the indices were derived can be found by clicking on the heading for each index.

Algal Status: The Algal Status Index focuses on the changes in percentage of certain algae in response to increasing siltation. This index is the relative abundance of the diatoms *Navicula*, *Nitzschia*, *Cylindrotheca*, and *Surirella* in a diatom count. Many of these diatoms are able to move through silt particles, are associated with fine sediments, and are considered more tolerant of sedimentation than other diatoms. In addition to being indicative of silty substrates, the siltation index often appears to correlate relatively well with higher nutrient concentrations in some regions. Nationally this indicator has a tendency to be higher in agricultural sites and lower in undeveloped sites.

Invertebrate Status: The Invertebrate Community Status Index is the average of 11 invertebrate community metrics that summarize changes in richness, tolerance, trophic conditions, and dominance associated with water-quality degradation. The indicator increases in value with water-quality degradation. Nationally this indicator is higher at sites located in agricultural, urban, and mixed land use compared to sites located in undeveloped (rangeland/forest/reference) land use.

Fish Status: The Fish Community Degradation Index is the sum of scores for four fish metrics (percent tolerant, omnivorous, non-native individuals, and percent individuals with external anomalies) that change (increase) in association with water-quality degradation. "Tolerant" was defined as those fish that are reported to thrive in degraded habitat or water chemistry. The introduced fish metrics can reflect the biological severity of invading fishes resulting in native species replacement due to environmental stress. However, the interpretation of introduced fish metrics can also be confounded by the human introduction of fish species. Omnivores are considered to be trophic generalists consuming multiple food types. External anomalies are restricted to deformities, eroded fins, lesions, and tumors (DELT anomalies). The four metrics generally increase with increasing environmental degradation.

Interpreting metrics and indices:

The primary utility of providing a national set of metrics and indices is to allow Study-Unit results to be placed in a national context. National rankings of metrics and indices need to be interpreted in relation to local knowledge about site characteristics. Disparities between national rankings and local understanding may yield insight into factors affecting biological conditions; for example, a site known locally to have a good community may still receive a low (degraded) national ranking if local conditions are naturally harsh. When examining NAWQA

data in a national context, the reader should keep the following cautionary notes in mind:

1. Results refer to the population of NAWQA Program sampling sites, which were selected to represent specific environmental and land-use conditions. Therefore, it is NOT statistically valid to generalize results to the world at large.
2. The indices cannot be used as community condition indices; that is, they cannot be used to say a site is "good" or "bad." The components of the Invertebrate Status Index, for example, have been selected in a manner similar to that used in the development of condition indices for biocriteria. However, these indices have not been calibrated because the information required for calibration (reference sites, sites with known degrees of impairment, regional adjustments in metrics, scoring criteria) is not available nationally. The biological status indices provide an appropriate means for understanding how sites rank relative to one another within the NAWQA Program. When possible, the applicability (or inapplicability) of the indices should be examined in the context of locally available information on site condition.
3. The amount of national-scale analyses that were available for Study Units to use in interpreting results for the Summary Reports was limited (latitude, longitude, elevation, drainage size, ecoregion, land use, annual discharge, and flow-weighted nutrient concentrations) and restricted to basin-level data, with no analyses yet for pesticides or VOCs. This greatly limited the ability of the national analyses to address biological responses to local land use, habitat degradation, or water chemistry.
4. The biological status indices were selected according to their ability to distinguish differences among broad land-use classifications. The sites constituting the network (140) were not sufficient in number or distribution to permit examination of differences associated with combinations of ecoregion and land use, or ecoregion, land use, and stream size—all of which are natural factors that are known to affect biological communities.

How these indicators compare nationally among land uses:

Sites were ranked for each biological indicator and grouped into three categories of sites based on percentile distributions: lowest 25 percent (<25th percentile), middle 50 percent (25th to 75th percentile range), and highest 25 percent (>75th percentile). The percentages of sites in each of the percentile categories were then compared among land uses for each of the biological indicators to examine how well the biological indicators distinguished the effects of land use nationwide (fig. 2). In general, for the algal and invertebrate biological indicators, the undeveloped sites had the highest percentage of sites in the lowest percentile class (less degraded sites) compared to all other land-use categories. In contrast, agricultural, urban, and mixed land uses had higher percentages of sites in the highest percentile class (degraded sites) compared to the

undeveloped sites for all biological indicators. Agricultural sites had the highest percentage of sites in the middle and highest percentile class for the algal and fish indicators.

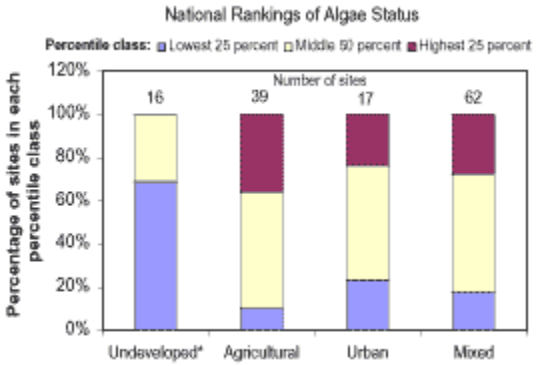
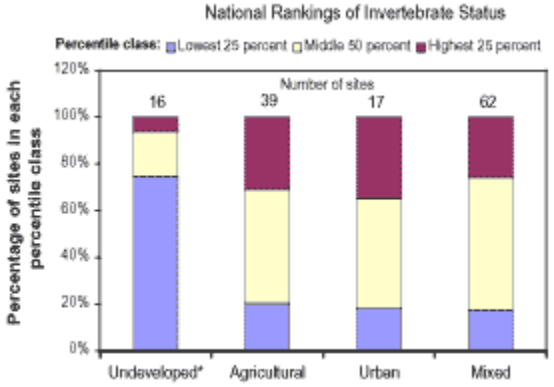
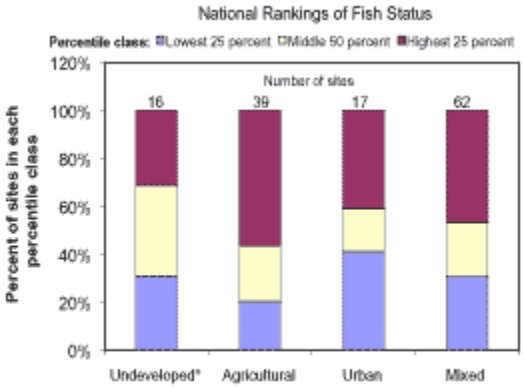


Figure 2. Comparison of national rankings of sites for biological indicator. *Undeveloped = Rangeland or Forest land uses. Mixed land use represents integrator sites.





Interpretation of biological status in a national context:

Three national figures (Algal Status Indicator, Invertebrate Status Indicator, and Fish Status Indicator) display the ranges of values for the 140-site network (bar), the 25th and 75th percentile value for the biological indicator (lines), and the Study-Unit site scores in relation to the national rankings. These figures are located in the Appendix of each Study-Unit report.

Study-Unit-specific findings:

Study-Unit reports may contain a combination of narrative and graphics or pictures to put significant Study-Unit conditions into a larger, national context. To clarify whether local conditions are typical at a national scale, chemical or physical findings are discussed in relation to biological status as represented by the values/ranks of the indicators. Study Units may also have included any other indicator or interpretive approach (for example, the Index of Biotic Integrity) that is available or has utility for resolving differences among sites at the scale of the Study Unit.