

Concepts and Application of Multiple and Integrative Indicators to Assess the Effects of Environmental Stressors on the Health of Fish Populations

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Many species of fish, because of their position in the food chain, are integrators of environmental conditions and may reflect, therefore, the health of aquatic ecosystems. In assessing health of fish, stress responses at multiple levels of biological organization can be measured for individual organisms or integrative indices can be used to assess the overall health status or profile of populations and communities. While the primary limitation of individual response measures are they are not integrative in nature and typically do not reflect overall health status, the main advantage is that they have a higher probability of being linked to specific environmental factors (i.e., provide a mechanistic basis of response) responsible for causing specific effects at higher levels of organization. Conversely, integrative indices are reflective of fish health across many levels of biological organization, but cause and effect is more difficult to establish. The bioindicators technique uses responses of key (sentinel) aquatic organisms both as integrators of stress effects and as sensitive response (early-warning) indicators of environmental health. Application of multi-response variables which range from the biochemical to the individual-levels of biological organization can help provide insights into causal mechanisms between environmental stressors and population-level effects and serve as a basis for which the effectiveness of future remedial (environmental clean-up) actions on the health status of aquatic organisms can be evaluated. Short-term sensitive indicators, such as biomolecular and biochemical responses, and longer-term ecologically relevant indicators, such as population and community responses, can both be included in field biomonitoring programs to provide the basis of environmental compliance, regulatory decisions, and aid in the ecological risk assessment process. This multi-response approach can also be used to help evaluate the relative contribution of environmental stressors other than contaminants such as sediment loading, eutrophication, and habitat modification on the health of fish populations.

For further informations see <http://www.esd.ornl.gov/programs/bioindicators/>