Using Biological Monitoring To Detect Climate Change Effects: A Classification of Bioindicators

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Abstract:

Bioassessment programs use bioindicators to measure ecosystem condition, generally focusing on changes caused by land alteration or pollution. Climate change, however, will shift the baseline condition at all sites, including impaired and non-impaired. Climate change and variability will increasingly affect aquatic ecosystems through changes in water temperature, hydrological cycles, and degree days; these changes will occur in addition to other existing stressors. Therefore, managers in bioassessment programs that use a reference condition approach to determine impairment will need to be able to distinguish climate change effects from others. We reviewed available literature on climate change effects on aquatic ecosystems and developed a framework that categorizes indicators according to their responsiveness to climatic changes versus other stressors. The most responsive bioindicators may be used to detect effects of climate change, particularly when monitoring data are compared across impaired and non-impaired sites, while the least responsive may be used to identify other stressors. We distinguish five classes of responsive bioindicators: (1) phenology, (2) number of reproductive periods, (3) climate-sensitive life stage, (4) thermal tolerance, and (5) hydrological tolerance. We used these classes to categorize indicators for phytoplankton, macroinvertebrates, fish, and plants. For example, changes in emergence dates of mayflies might indicate climate change effects, if they occurred across a range of conditions in a given region. Therefore, understanding issues that are important to discuss as programs begin to adapt to long-term climatic changes include: biological response of indicators to climate change effects, availability of novel indicators to detect effects, ability of current monitoring to detect climate-driven changes, and likelihood that current monitoring will continue to detect impairment.

Keywords: climate change, bioindicators, bioassessment, aquatic ecosystems