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Bioassessment in complex environments: designing an index for consistent meaning in different settings

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ABSTRACT

Regions with great natural environmental complexity present a challenge for attaining 2 key properties of an ideal bioassessment index: 1) index scores anchored to a benchmark of biological expectation that is appropriate for the range of natural environmental conditions at each assessment site, and 2) deviation from the reference benchmark measured equivalently in all settings so that a given index score has the same ecological meaning across the entire region of interest. These properties are particularly important for regulatory applications like biological criteria where errors or inconsistency in estimating site-specific reference condition or deviation from it can lead to management actions with significant financial and resource-protection consequences. We developed an index based on benthic macroinvertebrates for California, USA, a region with great environmental heterogeneity. We evaluated index performance (accuracy, precision, responsiveness, and sensitivity) throughout the region to determine if scores provide equivalent ecological meaning in different settings. Consistent performance across environmental settings was improved by 3 key elements of our approach: 1) use of a large reference data set that represents virtually all of the range of natural gradients in the region, 2) development of predictive models that account for the effects of natural gradients on biological assemblages, and 3) combination of 2 indices of biological condition (a ratio of observed-to-expected taxa [O/E] and a predictive multimetric index [pMMI]) into a single index (the California Stream Condition Index [CSCI]). Evaluation of index performance across broad environmental gradients provides essential information when assessing the suitability of the index for regulatory applications in diverse regions.

Full Text

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