Developing Great Lakes Bioindicators of Environmental Conditions and Recovery from Degradation with Reference to Watershed -Based Risk of Stress

CIBOROWSKI, J.J.H.,[1] KOVALEKO, K.,[2] HOST, G.E.,[2] HOWE, R.W.,[3] REAVIE, E.,[2] BROWN, T.N.,[2] BRADY, V.,[2] DANZ, N.,[4] NIEMI, G.L.,[2] CAI, M.[2] & JOHNSON, L.B.[2]

[1] Department of Biological Sciences, University of Windsor, Windsor, ON, Canada
[2] Natural Resources Research Institute, University of Minnesota Duluth, Duluth, MN, USA
[3] Department of Natural and Applied Sciences, University of Wisconsin Green Bay, Green Bay, WI, USA
[4] Natural Sciences Department, University of Wisconsin Superior, Superior, WI, USA

Environmental assessment typically entails comparing biological characteristics at a test site to those of sites in the reference condition (the RCA), whose limits are determined empirically by sampling many reference sites. The reference condition is defined by physicochemical characteristics of "best available" sites and associated biota. Test sites are then classified as "equivalent to reference" (biota are not significantly different than a reference) or "nonreference". Applying the RCA is difficult when most of the study region is subject to varying degrees of disturbance. However, even when the Reference Condition is well defined, the relative status of failing test sites (designated "nonreference") is undefined because classification is binary. The complementary "degraded condition" is operationally defined as the set of sites whose physicochemical characteristics are deemed unacceptable by consensus (i.e., the worst sites in the system). Consequently, any test site can be ordinated along a reference-degraded continuum (human disturbance gradient), and the site's relative quality (and associated biota) summarized by its position along the continuum.

We have analysed variation in assemblages of Great Lakes biota across reference-degraded continua at Great Lakes coastal margins to derive taxon-specific bioindicators (assemblages of birds, aquatic vegetation, fishes, aquatic invertebrates and diatoms). Titan threshold analyses of taxon losses or gains often identified two thresholds on the reference-degraded gradient. At one, many sensitive species disappeared, suggesting biodiversity loss; at another, tolerant taxa increasingly dominated. All assemblages were affected at approximately the same threshold, suggesting significant ecosystem functional alteration at these points. Composite indices can be calibrated to identify these critical points as "biological criteria." We propose that the non-degraded/degraded threshold be a suitable operational target to define the boundary between degraded and non-degraded conditions needed to delist Beneficial Use Impairments at Great Lakes Areas of Concern. The reference/non-reference threshold may be a suitable operational target to define the boundary between biodiverse and less biodiverse conditions.