

Estimating historic biological integrity in wadeable streams of the Central Plains – a disturbance gradient approach.

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Introduction

Reference (a.k.a. least disturbed, minimally disturbed, etc.) conditions can be used as benchmarks for ecosystem health in the development of bioindicators and biocriteria for aquatic communities (Barbour et al. 1995; Hughes 1995; Barbour et al. 1999; Reynolds et al. 1997; Bailey et al. 2004; Dods and Oakes 2004). How does one determine reference condition when the natural condition of many communities has been altered by human impacts? Historic conditions are indicative of reference condition, but if historic data are missing where does one start?

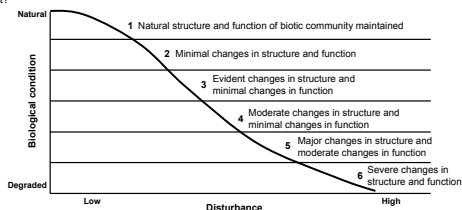


Figure 1. Biological condition gradient conceptual model (modified from Davies and Jackson 2006).

The Central Plains Center for BioAssessment (CPCB) attempted to address this issue through the use of the **Biological Condition Gradients (BCG)**. The BCG model was conceptualized by USEPA as a means of recognizing the continuum of aquatic communities that are structurally and functionally different as a result of anthropogenic disturbances (www.epa.gov/whr/bioassessment). Davies and Jackson (2006). Natural resource managers and scientists can use BCGs to monitor conditions over time. CPCB modified USEPA's concept by creating hypothetical BCGs based on fish and macroinvertebrate metrics as measures of biological integrity. These BCGs quantify the changing biological quality or integrity of an ecoregion through time. **We examine BCG created from historic and extrapolated historic values.**

Data

Table 1. Agencies that supplied the 14 datasets merged to create the USEPA Region 7 macroinvertebrate and fish databases. The final macroinvertebrate database comprises 1151 stream sites of 1 – 19 collection dates each, with over 1,550,000 specimens representing over 1200 taxa from over 1800 sampling events. The final fish database comprises specimen data collected from 1325 stream sites, with 1,480,000 specimens representing over 200 different taxa from 2369 sampling events.

Data source	
Iowa Department of Natural Resources	
Kansas Biological Survey	
Kansas Department of Health and Environment	
Kansas Department of Wildlife and Parks	
Missouri Department of Natural Resources	
Missouri Department of Conservation	
Nebraska Department of Environmental Quality	

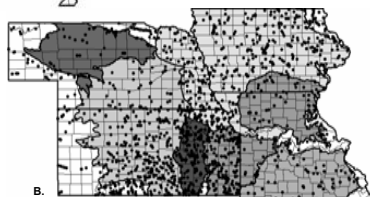
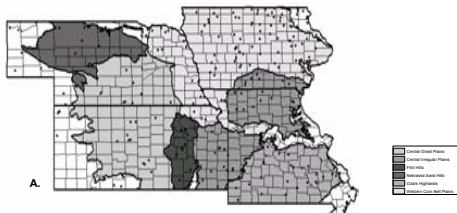


Figure 1. A. Stream sites (dots) in USEPA Region 7 selected as reference by best professional judgment. B. All stream sites (dots) in USEPA Region 7. Omernik Level III ecoregions examined are shaded.

Methods

From the raw macroinvertebrate and fish data we calculated the following indices for which BCGs were created:

Macroinvertebrates

Total Taxa Richness: Count of all taxa.
Proportion EPT: Count of all EPT taxa divided by total taxa richness.
Proportion Ephemeroptera: Count of all Ephemeroptera taxa divided by total taxa richness.
Proportion Trichoptera: Count of all Trichoptera taxa divided by total taxa richness.
Proportion Sensitive: Count of all sensitive taxa divided by total taxa richness (i.e. sensitive, intermediate, tolerant).
Underline: Number of individuals in the most numerous taxon divided by the total number of individuals in the sample.

Fish

Total Taxa Richness: Count of all taxa.
Simonsons D: Measures the probability that two individuals randomly selected from a sample will belong to the same species.
Proportion Sensitive: Count of all sensitive taxa divided by total taxa richness (i.e. sensitive, intermediate, tolerant).

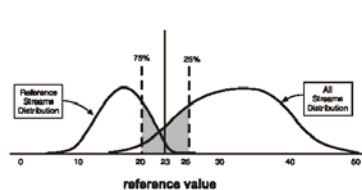


Figure 2. Reference values as selected from a theoretical dataset of streams, proposed by the USEPA Nutrient Criteria Guidance Manual (2000). The reference value is selected from either the 75th percentile of a reference population or the 25th percentile of the total population of streams.

Biological Condition Gradients

BCGs were created by ecoregion, and only for the ecoregions in which reference sites significantly differed ($p < 0.05$) from nonreference sites.

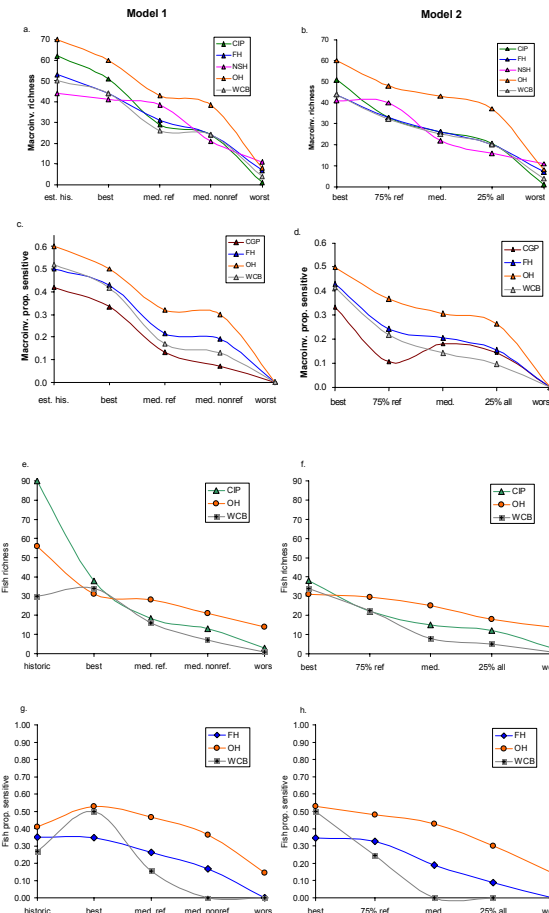
Two models were used to generate the values of the y-axis of the BCGs. Model 2 is based on USEPA (2000) in which the reference value is selected from either the 75th percentile of a reference population or the 25th percentile of the total population of streams (Figure 2). Figure 3 illustrates an actual dataset.

Table 2. Models, abbreviations used in graphs, and the condition they approximate.

abbr.	condition	value
his.	historic	Historic (available only for fish richness)
est. his.	estimated historic	Estimated historic value if true historic data was lacking
best	attainable	Maximum value of all sites
med. ref.	least disturbed	Median of the reference sites
med nonref.	disturbed	Median of the nonreference sites
worst	impaired	Minimum value of all sites
best	historic	Maximum value of all sites
75% ref.	attainable	75th percentile of reference sites
med.	least disturbed	Median of all sites
25% all	disturbed	25th percentile of all sites
worst	impaired	Minimum value of all sites

Results

Below are selected Biological Condition Gradients by ecoregion, based on Model 1 and Model 2. Ecoregion abbreviations used in the BCGs: CGP = Central Great Plains; CIP = Central Irregular Plains; FH = Flint Hills; NSH = Nebraska Sandhills; OH = Ozark Highlands; WCB = Western Combett Plains



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