A Practitioner's Guide to the Biological Condition Gradient: A Framework to Describe Incremental Change in Aquatic Ecosystems[1]

Background

The Biological Condition Gradient (BCG) is a scientific framework that can be used by states, tribes, territories and counties (hereafter referred to as states) to interpret biological responses from the cumulative effects of stressors for all types of water bodies. The BCG was proposed in 2006 as a conceptual framework developed by EPA in partnership with scientists from states, USGS and the academic community. This technical support document describes the steps for developing a quantitative BCG model based on over 10 years of piloting the tool with states in a scientifically defensible manner. This documentation will assist other states in developing a reliable and robust BCG to support their Clean Water Act programs.

Who will use the BCG and for what purpose?

Currently most states are using biological assessment information to support their water quality management programs. The BCG contributes to the EPA biological assessment and criteria toolbox, which includes biological indices, models, and statistical approaches and guidance. The BCG builds upon and complements these approaches to provide a more refined and detailed measure of biological condition and will help states to:

- More precisely define and measure biological condition for specific waters
- Identify and protect high quality waters
- Evaluate potential for improvement in degraded waters and track improvements
- Develop biological criteria
- Clearly communicate the likely impact of water quality management decisions to the public

These applications support CWA programs such as 305(b) assessments and reports, 303(d) listing of impaired waters, and TMDL program implementation. The document describes how to develop a BCG and includes examples of how states are using, or considering using, it to support their programs.

How are BCGs developed?

- There are a series of steps described in the document that utilize available data and local expertise to develop narrative and numeric decision rules to assign different sites with varying biological condition to the 6 levels of the BCG.
- In this process, States convene an expert panel to evaluate biological assessment information and determine how 10 characteristics of an aquatic ecosystem, defined as attributes, change in response to increasing levels of stress, from a natural or undisturbed/minimally disturbed condition to a severely altered condition.
- The 10 attributes address the presence of pollution sensitive or tolerant species, historical or non-native species, as well as organism condition, ecosystem function and connectance.
- Statistical and modeling approaches are then used to establish numeric rules. These rules are tested, refined, and the underlying logic documented so the rules can be applied in the future in a transparent manner without needing to reconvene the expert panel.

[1] EPA document number: EPA 842R1600, can be accessed at: http://www.epa.gov/wqc/biological-assessment-technical-assistance-documents-states-tribes-and-territories

The Biological Condition Gradient: Biological Response to Increasing Levels of Stress

Levels of Biological Condition

Level 1. Natural structural, functional, and taxonomic integrity is preserved.

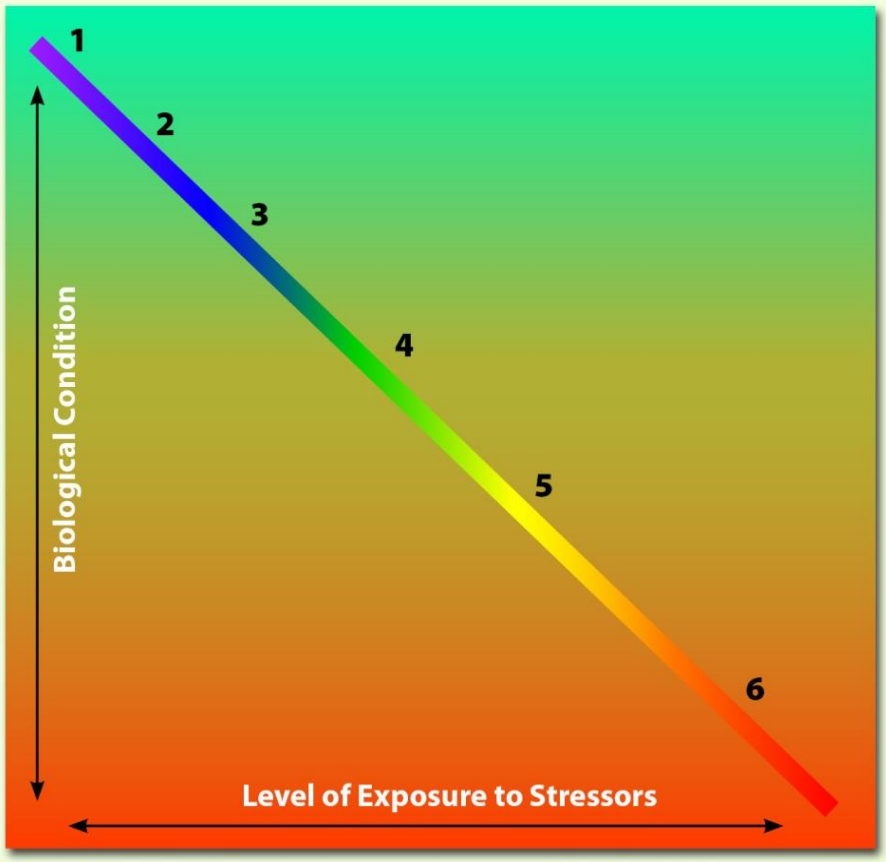
Level 2. Structure & function similar to natural community with some additional taxa & biomass; ecosystem level functions are fully maintained.

Level 3. Evident changes in structure due to loss of some rare native taxa; shifts in relative abundance; ecosystem level functions fully maintained.

Level 4. Moderate changes in structure due to replacement of some sensitive ubiquitous taxa by more tolerant taxa; ecosystem functions largely maintained.

Level 5. Sensitive taxa markedly diminished; conspicuously unbalanced distribution of major taxonomic groups; ecosystem function shows reduced complexity & redundancy.

Level 6. Extreme changes in structure and ecosystem function; wholesale changes in taxonomic composition; extreme alterations from normal densities.



How is this document organized?

- Chapters 1 and 2: Purpose and scientific underpinnings of the BCG
- Chapters 3 and 4: How to quantify the BCG Y axis (the biological levels of condition that span undisturbed to severely altered conditions)
- Chapter 5: How to define the BCG X axis (Generalized Stress Axis)
- Chapter 6: Case studies in streams
- Appendix A: Supporting information on the Generalized Stress Axis
- Appendix B: Ongoing work in large rivers, estuaries, and coral reefs