

## Characterizing benthic macroinvertebrate and algal biological condition gradient models for California wadeable Streams, USA

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### ABSTRACT

The Biological Condition Gradient (BCG) is a conceptual model that describes changes in aquatic communities under increasing levels of anthropogenic stress. The BCG helps decision-makers connect narrative water quality goals (e.g., maintenance of natural structure and function) to quantitative measures of ecological condition by linking index thresholds based on statistical distributions (e.g., percentiles of reference distributions) to expert descriptions of changes in biological condition along disturbance gradients. As a result, the BCG may be more meaningful to managers and the public than indices alone. To develop a BCG model, biological response to stress is divided into 6 levels of condition, represented as changes in biological structure (abundance and diversity of pollution sensitive versus tolerant taxa) and function. We developed benthic macroinvertebrate (BMI) and algal BCG models for California perennial wadeable streams to support interpretation of percentiles of reference-based thresholds for bioassessment indices (i.e., the California Stream Condition Index [CSCI] for BMI and the Algal Stream Condition Index [ASCI] for diatoms and soft-bodied algae). Two panels (one of BMI ecologists and the other of algal ecologists) each calibrated a general BCG model to California wadeable streams by first assigning taxa to specific tolerance and sensitivity attributes, and then independently assigning test samples (264 BMI and 248 algae samples) to BCG Levels 1–6. Consensus on the assignments was developed within each assemblage panel using a modified Delphi method. Panels then developed detailed narratives of changes in BMI and algal taxa that correspond to the 6 BCG levels. Consensus among experts was high, with 81% and 82% expert agreement within 0.5 units of assigned BCG level for BMIs and algae, respectively. According to both BCG models, the 10th percentiles index scores at reference sites corresponded to a BCG Level 3, suggesting that this type of threshold would protect against moderate changes in structure and function while allowing loss of some sensitive taxa. The BCG provides a framework to interpret changes in aquatic biological condition along a gradient of stress. The resulting relationship between index scores and BCG levels and narratives can help decision-makers select thresholds and communicate how these values protect aquatic life use goals.

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