Scientific basis for biointegrity goals: Reference concepts and the Biological Condition Gradient

Webinar for Stakeholder Advisory Group
September 17, 2018
What is a “biointegrity goal”? 

• A “goal” is an ecological state of a stream that corresponds to sufficient support for ALU. Examples:
  • Largely natural
  • Similar to reference
  • No more than a minor loss of diversity

• We can derive numbers and thresholds for biointegrity indices that correspond to these goals
  • Goals may be used to set narrative or numeric objectives

• Depending on needs and context, we can set different goals for different streams
  • WB staff do not intend to set different objectives for constrained streams, but may use other approaches for setting appropriate goals.
Principles and assumptions

• Bioassessment indices are a direct way to measure support for several aquatic life uses (CLD, WRM, SPWN, and others)
• Multiple measures provide more comprehensive evidence of ALU support
• CSCI and ASCIs are the standard way to measure biointegrity in most California wadeable streams
  • Additional and alternative measures may be appropriate in certain circumstances
Goals for biointegrity policy... and beyond

• Biointegrity goals needed for biological objectives, assessing management effectiveness, and other activities

• But also needed for setting biostimulatory targets!
Two approaches to setting goals for biointegrity

1. Reference variability (percentile of reference)

2. Expert opinion (Biological Condition Gradient, BCG)
Two approaches to setting goals for biointegrity

1. Reference variability (percentile of reference)
   • WB staff prefers this approach for setting goals

2. Expert opinion (Biological Condition Gradient, BCG)
   • WB staff want to use the BCG to communicate and interpret scores
Mean: 1.0

30th percentile: 0.92

10th percentile: 0.79

1st percentile: 0.63

Likely intact

Likely altered

Very likely altered

Poss. altered

Scores at reference sites
BCG approach

Standard narratives of condition-classes, adapted to California by panel of experts

Still reference based, but relies on expert opinion rather than statistical calculation of deviation from reference
BCG approach

Standard narratives of condition-classes, adapted to California by panel of experts

<table>
<thead>
<tr>
<th>Bin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Natural or native condition</td>
</tr>
<tr>
<td>2</td>
<td>Minimal alteration in structure or function</td>
</tr>
<tr>
<td>3</td>
<td>Evident changes in structure, minimal loss of function</td>
</tr>
<tr>
<td>4</td>
<td>Moderate changes in structure, minor loss of function</td>
</tr>
<tr>
<td>5</td>
<td>Moderate changes in structure and function</td>
</tr>
<tr>
<td>6</td>
<td>Severe changes in structure and major loss of function</td>
</tr>
</tbody>
</table>

Still reference based, but relies on expert opinion rather than statistical calculation of deviation from reference
Process for developing a BCG model

• Assemble panels of expert ecologists (2 panels for bugs, algae)
• Ask panels to adapt national definitions to California
  • Describe biological characteristics of each “bin”
  • Ascribe tolerance values to taxa
• Create a dataset of 250 sites across the state, representing different ecoregions and exposures to stress
• Panels assign sites to bins
• Crosswalk bins to observed index scores (probability-odds models)
• Identify scores associated with high likelihood of bin membership
Large statewide development data set

Panels reviewed mostly the same sites (80%)
BCG: Models crosswalk to ranges of index scores

- Reference scores:
  - 1.2
  - 1.0
  - 0.8
  - 0.6
  - 0.4
  - 0.2

- BCG ranges:
  - Likely intact
  - Possibly altered
  - Likely altered
  - Very likely altered
  - Minimally altered structure and function
  - Evident changes to structure and function
  - Moderate changes to structure
  - Moderate loss of function
  - Severe loss of function

- CSCI scores:
  - 1.03
  - 0.83
  - 0.63

- Graph showing the distribution of experts' scores for BCG and CSCI.
1. Moderate changes to structure
2. Minimally altered structure and function
3. Evident changes to structure and function
4. Moderate changes to structure
5. Moderate loss of function
6. Severe loss of function

Likely intact
Possibly altered
Likely altered
Very likely altered

1.4
1.2
1.0
0.8
0.6
0.4
0.2
Reference BCG

Likely intact
Possibly altered
Likely altered
Very likely altered

1.31
1.03
0.92
0.83
0.63
0.33
0.2
Reference BCG

2. Minimally altered structure and function
3. Evident changes to structure and function
4. Moderate changes to structure
5. Moderate loss of function

0.95
0.80
0.63
0.54
0.2
Reference BCG
2. Minimally altered structure and function

3. Evident changes to structure and function

4. Moderate changes to structure

5. Moderate loss of function

6. Severe loss of function
Scores associated with goals

<table>
<thead>
<tr>
<th>Goal</th>
<th>CSCI</th>
<th>ASCI-D</th>
<th>ASCI-S</th>
<th>ASCI-H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ref-30</td>
<td>0.92</td>
<td>0.92</td>
<td>0.93</td>
<td>0.93</td>
</tr>
<tr>
<td>Ref-10</td>
<td>0.79</td>
<td>0.80</td>
<td>0.82</td>
<td>0.83</td>
</tr>
<tr>
<td>Ref-01</td>
<td>0.63</td>
<td>0.63</td>
<td>0.68</td>
<td>0.70</td>
</tr>
<tr>
<td>BCG2</td>
<td>1.025</td>
<td>1.310</td>
<td>1.360</td>
<td>1.230</td>
</tr>
<tr>
<td>BCG3</td>
<td>0.825</td>
<td>0.950</td>
<td>0.860</td>
<td>0.970</td>
</tr>
<tr>
<td>BCG4</td>
<td>0.625</td>
<td>0.540</td>
<td>0.360</td>
<td>0.670</td>
</tr>
<tr>
<td>BCG5</td>
<td>0.325</td>
<td>NA</td>
<td>NA</td>
<td>0.300</td>
</tr>
</tbody>
</table>

BCG2: Numbers are *really high*
BCG5: Couldn’t even model scores for ASCI-D, ASCI-S
BCG3 to BCG4: A very wide interval ASCI-D, ASCI-S (~0.4 to 0.5 points) vs. others (0.3 points)
Both approaches have been used (or evaluated) for bio/nutrient criteria in other states

- Ref proposed for Reg 9’s bio-objectives, Category 1 listings

- MN, FL use BCG3 for most streams, BCG4 for modified uses.
Choices for biostimulatory, biointegrity policies

It’s necessary to select a goal for many applications of biointegrity indices. Different goals may be appropriate for different purposes.

- WB staff wants to use reference approach to setting goals, but use BCG to help interpret and communicate meaning of index scores.
- Ref-10 has widespread use already.
Current status

• Expert panel has completed data review.
• CSCI model complete. ASCI models being re-tweaked for final version of indices.
• Report/journal article distributed to advisory groups for review by the end of September
Probability-odds model

CSCI

Hybrid ASCI