A Framework for Categorizing Biological Indicators According to their Sensitivity to Climate Change

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Key Messages

Biological indicators may be affected by climate change

Categorizing indicators according to climate sensitivity is one step in controlling for or detecting climate change effects
Outline

• A very brief overview of biocriteria
• How climate change affects biological indicators
• Categories of indicators
• Indicator classes
• Implementation of framework
Biocriteria

- Targets define desired biological condition of waterbody
  - Assess ecosystem health
  - Element of water quality standards

- EPA biocriteria guidance documents exist for:
  - Rivers & Streams, Lakes, Wetlands, Estuaries & Coastal Areas

- Biocriteria guidance is under development for:
  - Coral Reefs
State Biocriteria Program Goals

- Stressor identification
- Monitor BMP effectiveness
- TMDL assessment & monitoring
- Status & trends in water quality & condition
  - Baselines
  - Water quality standards
- Aquatic life uses determination
Climate Change & Biocriteria Programs

- Additional stressor on ecosystem
- Affects both reference & non-reference sites
- Current indicators may be confounded by climate change effects on ecosystems
- Biocriteria program management goals
  - Difficult to establish goal if baseline is changing
  - Or goals may be impossible to meet

Overview - Climate Change Effects - Categories of Indicators - Indicator Classes - Implementation of Framework
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How do existing biological indicators respond to climate change?
# Categories of Indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Insensitive to Climate Change</th>
<th>Sensitive to Climate Change</th>
<th>Sensitive to Climate Change and Other Stressors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicator</td>
<td>Warmwater fish</td>
<td>Fish community composition</td>
<td>Salmon egg to fry survival</td>
</tr>
<tr>
<td>Response</td>
<td>No change in majority of range</td>
<td>Cold- and coolwater fish species decline, warmwater fish species increase</td>
<td>Decreased survival due to increased turbidity from sediment input due to increased precipitation and/or land use change</td>
</tr>
</tbody>
</table>
What Defines Climate-Insensitive?

- Ecological events not cued to temperature
- Species is tolerant of broad temperature range
- Tolerant of wide range of hydrologic conditions
  - High flows or low flows
  - High variability in flow
  - Variation in salinity
What Defines Climate-Sensitive?

- Ecological events cued to temperature
- Species exists in narrow temperature range
- Intolerant of certain hydrologic conditions
  - High flows or low flows
  - Saltwater intrusion
Climate-Sensitive Indicator Classes

- Phenology (timing of emergence, reproduction, flowering, etc.)
- Number of reproductive periods
- Vulnerable life stage to climate variable
- Thermal tolerance
- Hydrological tolerance
Examples of Sensitive Indicators

Phenology

• Earlier emergence of stoneflies and mayflies with warmer temperatures
• Earlier trout spawning in warmer water
Examples of Sensitive Indicators

Longer growing season leads to an increase in the number of reproductive periods

- Increase in algal productivity
- Additional reproductive periods of amphipod species
Examples of Sensitive Indicators

Life stage vulnerable to climate variable

• Decrease in salmon egg to fry survival from increased turbidity from erosion
Examples of Sensitive Indicators

Thermal tolerance

• Increase in peak abundance of thermophilic copepod species
• Shift from cold- and coolwater to warmwater fish species
Examples of Sensitive Indicators

Hydrological tolerance

• Decline of drought intolerant mussel spp.
• Decrease in autumn spawning salmonid species
• Decrease in salt intolerant wetland plants
What are the next steps?
Using the Framework

• Evaluate and understand how current indicators respond to climate change

• Evaluate novel indicators to detect climate change

• Determine how indicator responses affect a Biological Condition Gradient and biocriteria in standards
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Extending the framework

- Alter design of sampling and monitoring programs (Case Study 1)

- Monitor reference and non-reference sites for similar changes (Case Study 2)
Thank You!

Questions?