

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
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- 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?



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Categories of Indicators

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

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



M.Wenger, USFWS

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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



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Examples of Sensitive Indicators

Phenology

- Earlier emergence of stoneflies and mayflies with warmer temperatures
- Earlier trout spawning in warmer water



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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?



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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



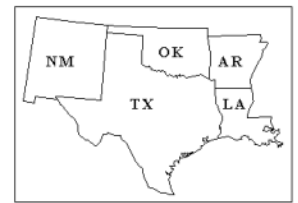
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Extending the framework

- Alter design of sampling and monitoring programs (Case Study 1)
- Monitor reference and non-reference sites for similar changes (Case Study 2)



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Thank You!

Questions?

