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





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How do existing biological indicators respond to climate change?





Categories of Indicators

	Insensitive to Climate Change	Sensitive to Climate Change	Sensitive to Climate Change and Other Stressors
Indicator	Warmwater fish	Fish community composition	Salmon egg to fry survival
Response	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

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





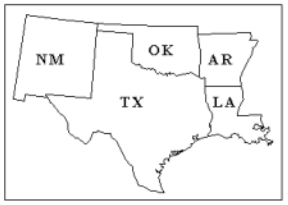

What are the next steps?





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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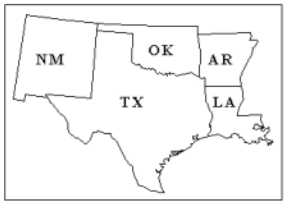

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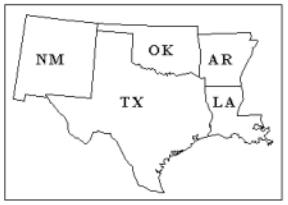
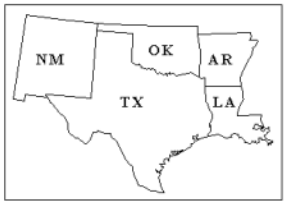


Extending the framework

- 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?