Technical and Social Challenges of Climate Change Adaptation for Aquatic Resource Managers

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Clean Water & Climate Adaptation Summit 2010
Climate Change in MN will likely mean large-scale changes in the distribution of fish habitat.

- Significant changes in thermal regimes
  - longer growing seasons
  - loss of coldwater habitat (gains in warm)
- Higher storm frequency -> greater runoff -> increased nutrient loading

Climate Change in MN will likely mean large-scale changes in the distribution of fish habitat.

Predicted Effects Of Global Climate Change On Fishes In Minnesota Lakes

Technical Challenges to Climate Change Adaptation

What we are doing now:

• Assessment of habitat for imperiled species (cisco)
• Comprehensive monitoring (SLICE)
• Intensive statewide assessment (Johnson et al.)
• Climate change downscaling (USGS, NFHPs)
Technical Challenges to Climate Change Adaptation

What we need to start on:

• Assessment of populations and habitat for warm adapted species
• Review of management regimes that may fail
• Developing methods for risk assessment and decision analysis (e.g. SDM)
• Deploy social science tools for engaging stakeholders (e.g. adaptive leadership)
Cisco/Lake Herring
(Coregonus artedi)
Potential cisco refuge lakes
Non-refuge cisco lakes

Coldwater Refuge Lakes
• Deep lakes with good water quality - need extra protection
• Statewide significance
• High priority for shoreland and watershed protection

Coldwater fish oxythermal habitat in Minnesota lakes: Influence of lake productivity, morphometry, and climate
Canadian Journal of Fisheries and Aquatic Sciences
Acoustic tag coverage

- Hydrophone
Sentinel Lakes express range of geomorphological conditions

Aquatic communities are profoundly different across productivity and growing season gradients

Climate change and other watershed stressor may increase productivity and growing season length
Sentinel Lake Selection Criteria

- Ecoregion (4)
  - Stratified
    - H M L
  - Mixed
    - H M L
- Phosphorus

http://www.dnr.state.mn.us/fisheries/slice/index.html
Sustaining Lakes in a Changing Environment (SLICE)

- 24 Sentinel lakes – focal points of cooperative long-term monitoring

- Program purpose is to:
  - Track habitat conditions
  - Species responses to changes in habitat
  - forecast the probability of crossing undesirable thresholds

- Phase 1 (2008-2011):
  - Indicator ID High “signal:noise”
  - Inference into cause-effect

- Strong partnerships – right people doing the right job (PCA, USGS, SNF, Volunteers)
SLICE Phase 1: ID indicator variables with high S/N

Staples et al. 2005
2005 Prediction

\[ P(\text{Indicator} < \text{Benchmark}) = 0.016 \]
Regression; \( p = 0.051 \)

**Benchmark Value**

\[ P(\text{Indicator} < \text{Benchmark}) = 0.256 \]
How Can We Start Adaptation of Fisheries Management Programs?
Duluth Area Fisheries Largemouth Bass Expansion

- **Historical** – 14 lakes had no stocking
- **1970’s** - all stocked, only one in the 70’s
- **1980’s** – all stocked, only one in the 80’s
- **1990’s** – 9 of 13 stocked, only one in the 90’s
- **2000’s** – 11 of 14 stocked, last stocking occurred in 1973

(credit: Nick Frohnauer, MN DNR)
A Trichotomy of Adaptation Responses

• Resistance
• Resilience
• Facilitation

Structured Decision Making

- Trigger
- Problem
- Mandates: Laws, Policies, preferences
- Objectives
- Consider: Uncertainty, & linked decisions
- Alternatives
- SDM Analysis Toolkit
- Decide & Take Action
- Tradeoffs & Optimization
- Consequences
- Values: Preference scales, objective weights & risk attitudes
- Data
- Modeling Toolkit
Structured Decision Making

*Smart Choices: A Practical Guide to Making Better Life Decisions*  
Broadway Books

Structured decision making as a conceptual framework to identify thresholds  
for conservation and management  
Ecological Applications 19:1079-1090
Walleye ? ...... or Bass ? ....... or Both ?
Principles of Adaptive Leadership

1. Resist focusing only on a technical solution for a problem that may have strong social dimensions
2. Get up on the balcony
3. Raise the heat a little bit
4. Prepare to help manage “loss”
Getting Up on the Balcony ............

Give careful consideration to the differences in values of resource managers and their stakeholders.

Management of Native Fish Assemblages?
TURNING UP THE HEAT!

LEVEL OF TENSION

TIME

Don't Intervene

TOO HOT!!
TURNING UP THE HEAT!

LEVEL OF TENSION

TIME

- Don't Intervene
- Turn Up The Heat

TENSION LEVELS:
- TOO HOT!!
- PRODUCTIVE DIALOG
Principles of Adaptive Leadership

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Merging SDM & Adaptive Leadership

Trigger → Problem

Objectives

Alternatives

Consequences

Values: Preference scales, objective weights & risk attitudes

Data

SDM Analysis Toolkit

Decide & Take Action

Tradeoffs & Optimization

Mandates: Laws, Policies, preferences

Consider: Uncertainty, & linked decisions

Modeling Toolkit
SDM will help assess management options:

Preferred by Resource Managers

Preferred by Stakeholders

Adaptive Leadership may help find an acceptable solution.
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Walleye Spawn Earlier

Lake Koronis

$R^2 = 0.137$

$y = 442.80 - 0.168x$


Otter Tail River

$R^2 = 0.388$

$y = 419.29 - 0.158x$


Lake Sallie

$R^2 = 0.048$

$y = 195.50 - 0.042x$

1970 1940 1930 1920 1910 1900 2000

Little Cut Foot Sioux

Pine River

Day of first egg-take (days)

$y = 3550.21 - 1.714x$


Day

of

first

egg-
take

(days)
Can We Merge Two New but Potentially Complementary Tools:

Adaptive Leadership & Structured Decision Making
Principles of Adaptive Leadership

1. Resist focusing only on a technical solution for a problem that may have strong social dimensions
2. Get up on the balcony
3. Raise the heat a little bit
4. Prepare to help manage “loss”
Decisions/Problems:

1. Can walleye stocking be maintained as a viable management strategy in the face of expanding black bass populations in Minnesota?

2. How should basins with natural walleye populations (not stocked) be managed given the expansion of black bass populations in Minnesota?
Potential Objectives for Decision/Problem 1

1. Utilize walleye stocking if high probability of adequate recruitment & adult survival
2. Sustainable, healthy fish populations
3. Acceptable tribal harvest
4. Acceptable recreational opportunities
5. Cost effective and affordable fish management
6. Tourism industry support and benefits from fishery
### Potential Objectives and Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Evaluation</th>
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<tbody>
<tr>
<td>Utilize walleye stocking if high probability of adequate recruitment &amp; adult survival</td>
<td>Year class strength</td>
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<tr>
<td>Sustainable, healthy fish populations</td>
<td>Population management through regulations</td>
</tr>
<tr>
<td>Acceptable tribal harvest</td>
<td>Support</td>
</tr>
<tr>
<td>Acceptable recreational opportunities</td>
<td>Maintain or increase</td>
</tr>
<tr>
<td>Cost effective and affordable fish management</td>
<td>Minimize cost</td>
</tr>
<tr>
<td>Tourism industry support and benefits from fishery</td>
<td>Support</td>
</tr>
</tbody>
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Potential Management Actions

1. Maintain walleye
2. Switch primary spp. to bass
3. Natural system response
Uncertainties/Hypotheses

1. Black bass prey on walleye, resulting in decreased walleye recruitment.

2. Walleye populations decrease due to loss of optimal thermal habitat.

3. Limiting factors for black bass are water temperature and duration of growing season.

4. Pond production of fall walleye fingerlings will continue at current levels.

5. Walleye spring fingerlings will develop into a viable stocking tool.
Certainties

1. Black bass will become the dominant predator in some lakes previously dominated by cool water predators.

2. Black bass in some lakes will result in declines in walleye either through predation or competition.

3. There is spatial uncertainty (i.e. which lakes?)
Scenarios: 5 – 10 Years

1. Walleye dominant species; bass present but not dominant species
2. Dominance fluctuates between walleye and bass
3. Bass dominant species; walleye recruitment declines (or stocking failure)