



# Adaptive Management in Upper Great Lakes Study

Meeting of the Great Lakes on  
Aquatic Nuisance Species

April 28, 2010

# Outline of Presentation

- ▶ Addressing future uncertainty
- ▶ Climate change scenarios
- ▶ IUGLS Adaptive Management Process

# Lake Superior Regulation Mandate

- *Review the regulation of Lake Superior outflows and assess the need for changes to address the evolving needs of and conditions affecting the interests of the upper Great Lakes including under climate change.*



# Future Uncertainty

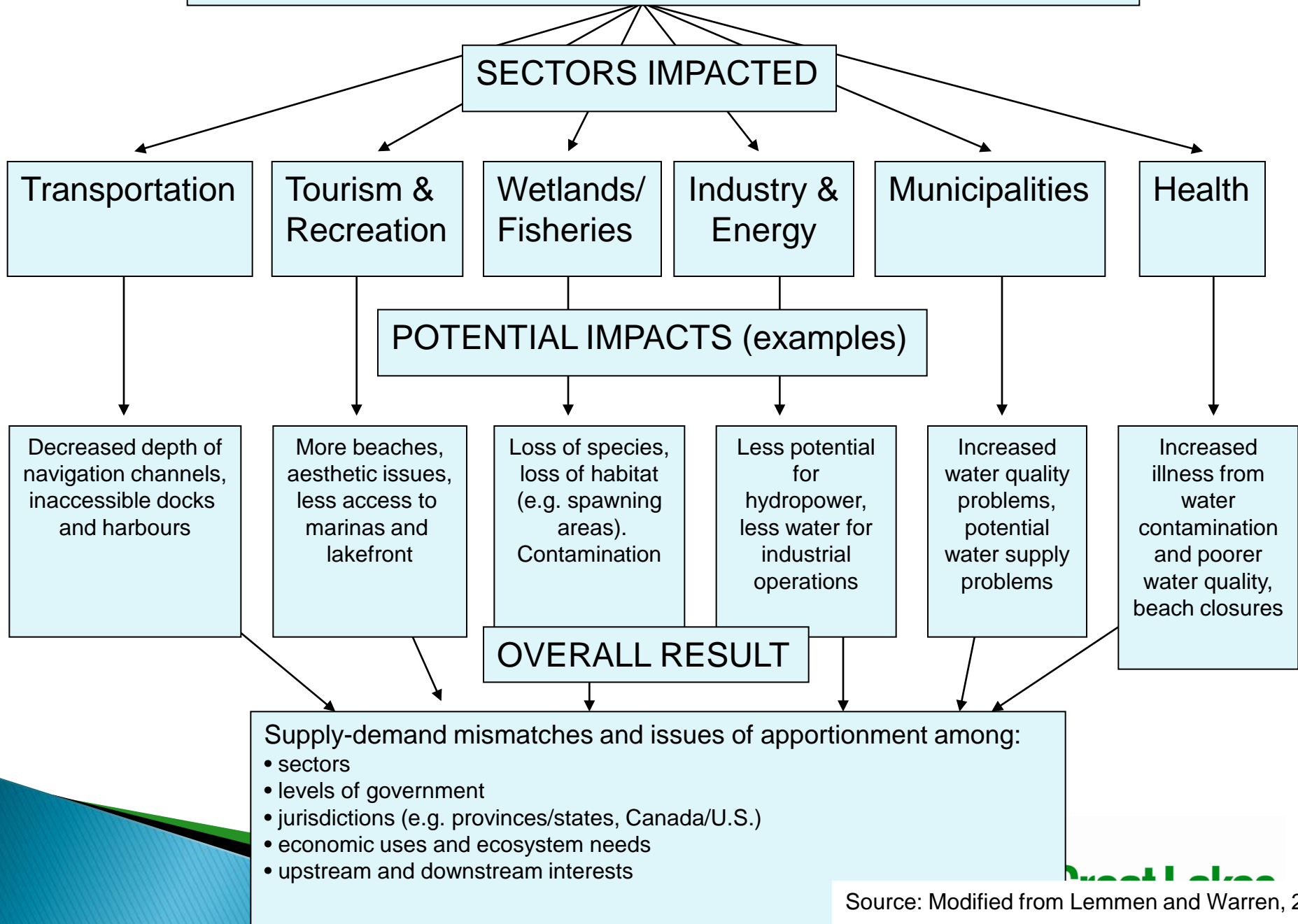
What if...

- ▶ Water levels dropped below historical recorded lows and persisted at low levels for years, even decades?

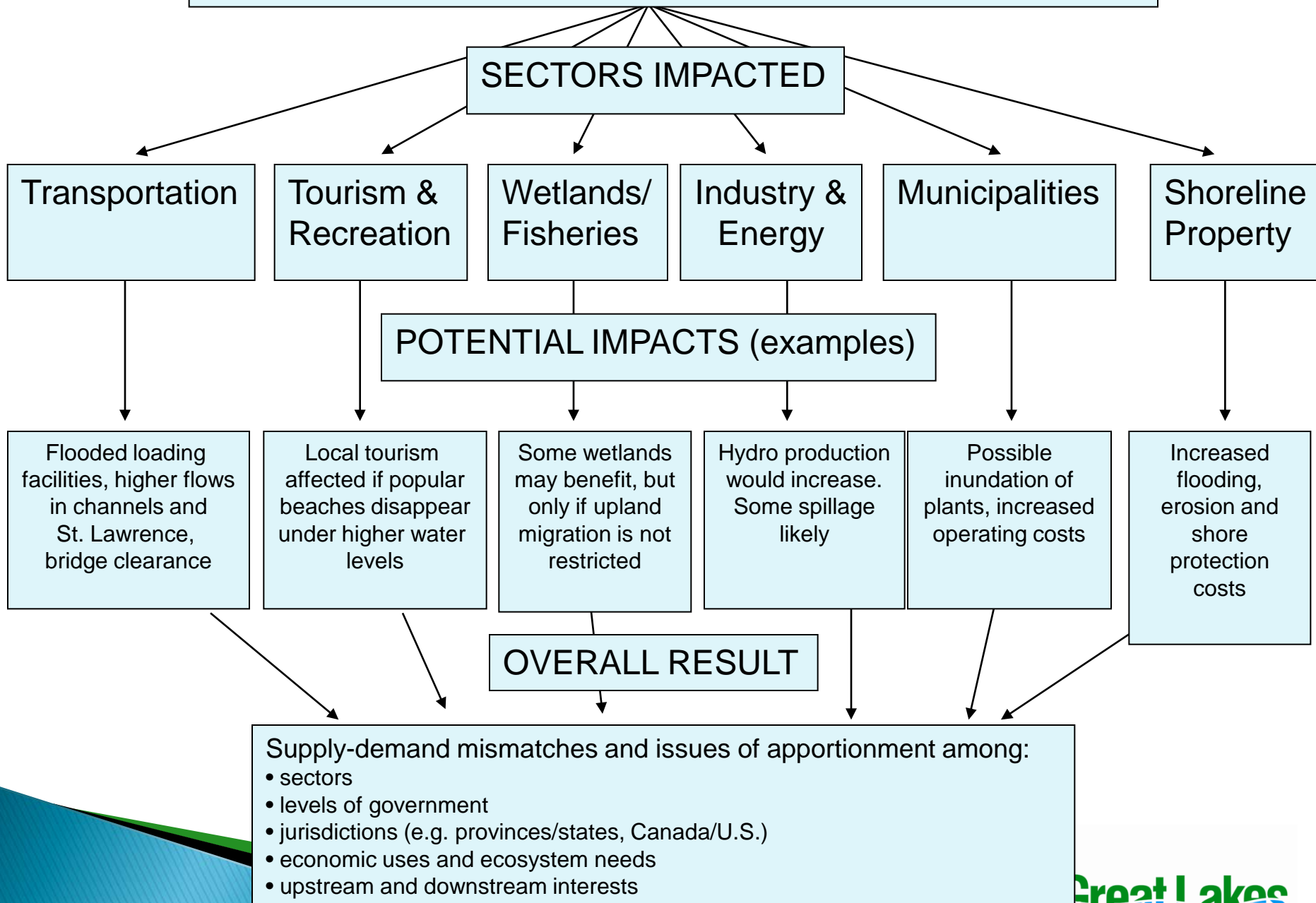
And/Or

- ▶ Water levels rose above recorded levels and persisted at much higher levels for extended periods and this was exacerbated by an increased frequency and severity of storm activity?

# Lower water levels in the Great Lakes – St. Lawrence System



# Higher water levels in the Great Lakes – St. Lawrence System



# Future Uncertainty

Nor do we know how the future climate may influence or be influenced by, the economy, or the cumulative impact with other environmental threats such as Asian Carp

# IUGLS Adaptive Management Approach

- ▶ Attempt to assess key vulnerabilities to extreme water levels (both lows and highs)
- ▶ Then ask, how plausible are these extremes based on all available water supply scenarios (stochastic, climate change, paleo)
- ▶ The idea is to plan for plausible, damaging future scenarios (what are we most concerned about and ill prepared for?)
- ▶ Develop an adaptive management strategy and seek buy-in for a post study, long-term structured, iterative process for decision making aimed at reducing uncertainty through monitoring and modelling and taking actions to minimize risk.

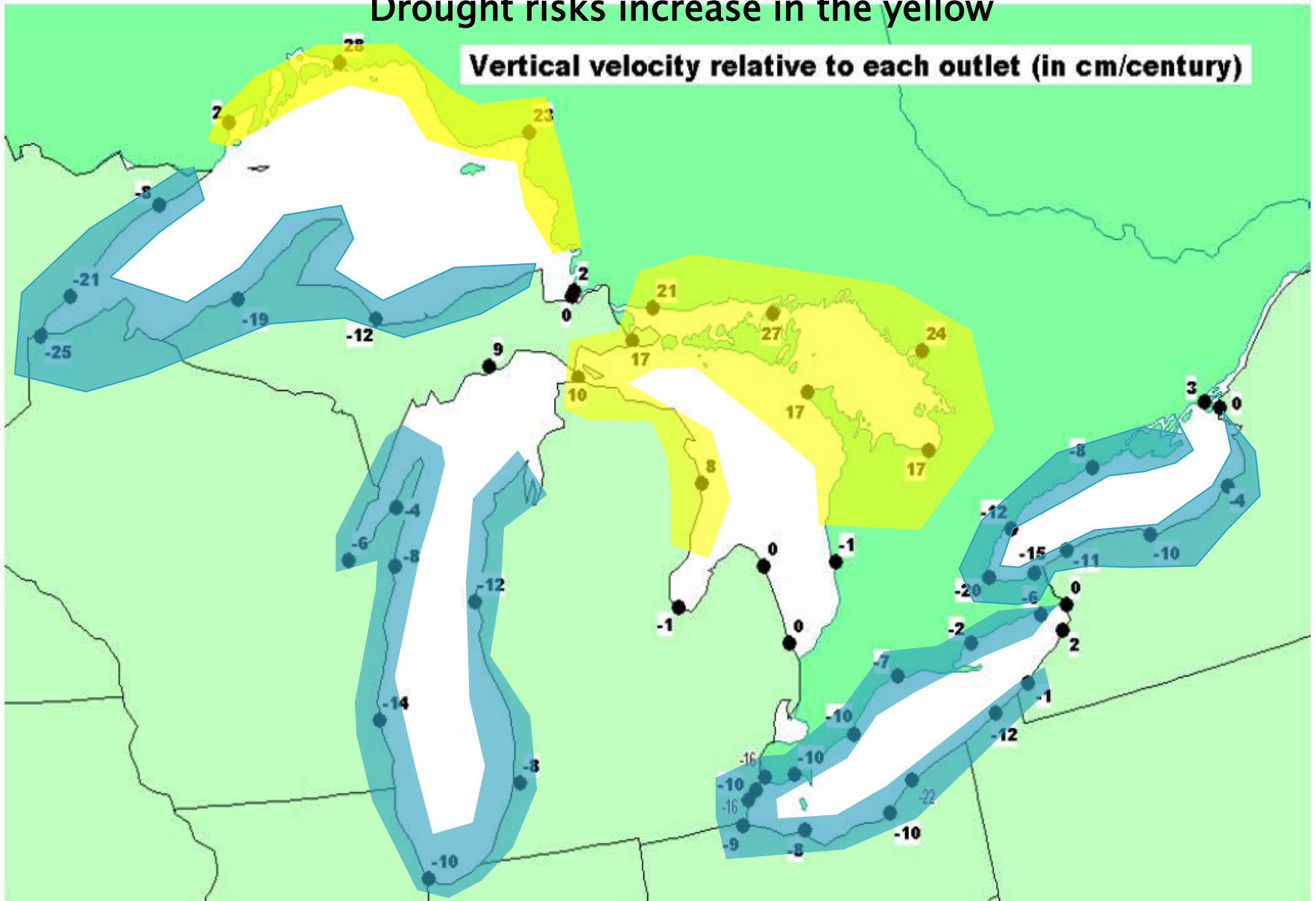
# Understanding vulnerabilities

## Establish Coping Zones:

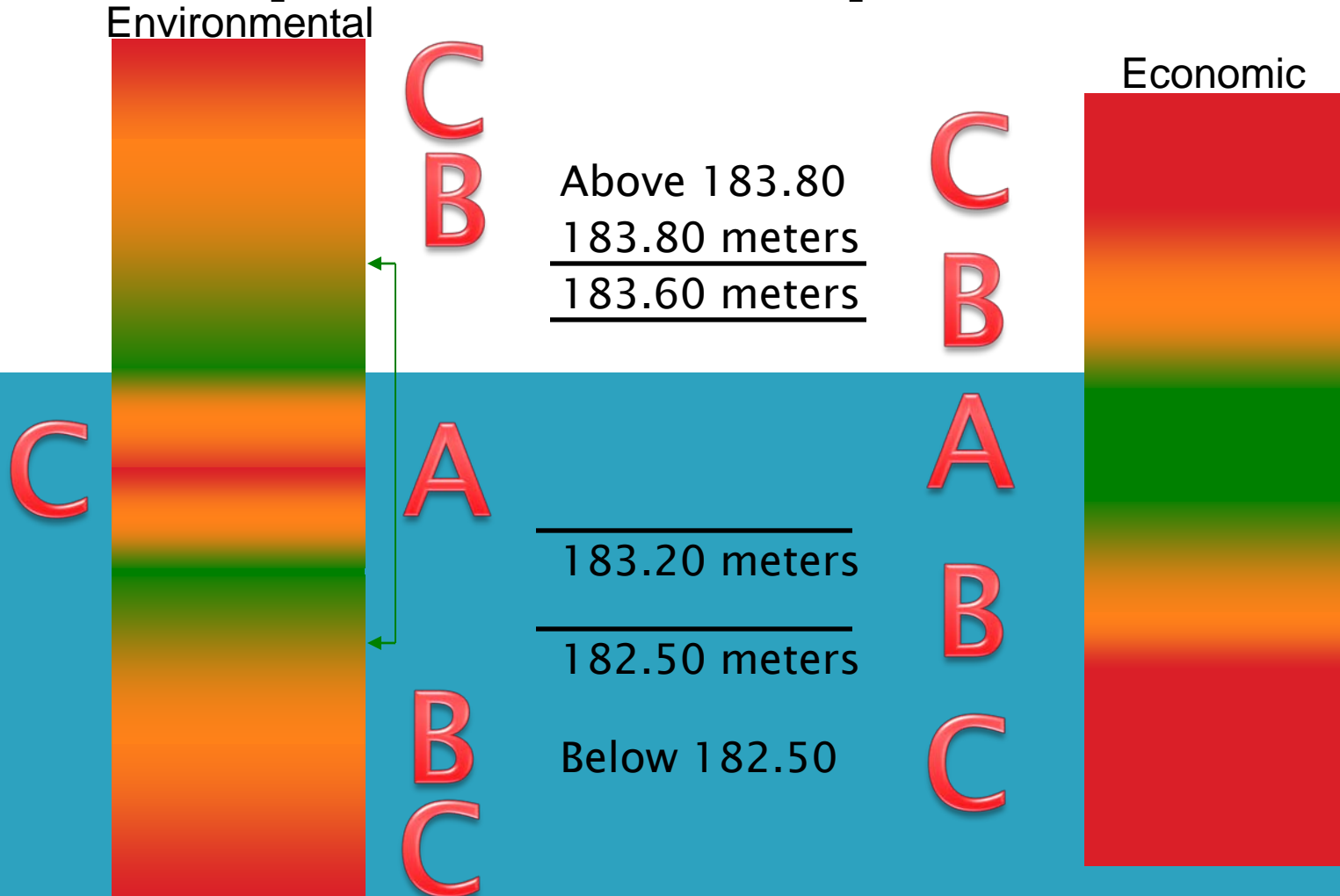
- ▶ A Zone: acceptable – within expectations
- ▶ B Zone: non-trivial costs (or environmental impact), interests will persevere, not irreversible
- ▶ C Zone: significant costs, interest cannot survive (bankruptcies) or serious degradation of ecosystem function, irreversible
  
- ▶ Zones include levels/flows, range, duration, frequency, seasonality, rate of change
- ▶ Will vary by location - focus on key vulnerabilities

# Relative Crustal Movement

Flood risk increases in the blue shaded areas  
Drought risks increase in the yellow



# Example - Lake Superior Zones



# Descriptive Framework of Biological Condition

| Impact Score | Biological Condition   |
|--------------|--|
| 1            | <b>Natural or native condition</b><br>Native structural, functional, and taxonomic integrity is preserved; ecosystem function is preserved within range of natural variability   |
| 2            | <b>Minimal changes in structure of biotic community; minimal changes in ecosystem function</b><br>Virtually all native taxa are maintained with some changes in biomass and/or abundance; ecosystem functions are fully maintained within range of natural variability   |
| 3            | <b>Evident changes in structure of biotic community; minimal changes in ecosystem function</b><br>Some changes in structure due to loss of some rare native taxa; shifts in relative abundance of taxa but sensitive-ubiquitous taxa are common and abundant; ecosystem functions are fully maintained through redundant attributes of the system  |
| 4            | <b>Moderate changes in structure of biotic community; minimal changes ecosystem function</b><br>Moderate changes in structure due to replacement of some sensitive-ubiquitous taxa by more tolerant taxa, but reproducing populations of some sensitive taxa are maintained; overall balanced distribution of all expected major groups; ecosystem functions largely maintained through redundant attributes |
| 5            | <b>Major changes in structure of biotic community; moderate changes in ecosystem function</b><br>Sensitive taxa are markedly diminished; conspicuously unbalanced distribution of major groups from that expected; organism condition shows signs of physiological stress; system function shows reduced complexity and redundancy; increased buildup or export of unused materials                          |
| 6            | <b>Severe changes in structure of biotic community; major loss of ecosystem function</b><br>Extreme changes in structure; wholesale changes in taxonomic composition; extreme alterations from normal densities and distributions; organism conditioning is often poor; ecosystem functions are severely altered   |

Davies and Jackson, (2006); Bain (2007)

# How plausible are catastrophic events?

- ▶ Establish as broad a set of possible futures as we can
  - Update stochastic series from LOSLR
  - Create a stochastic/climate change sequence
  - Consider changes in variability including paleo record
  - Examine relationship between upper atmospheric conditions and ocean indices and climate change.
  - Run as many GCMs and RCMs as are available to generate hundreds of possible NBS sequences.
  - Consider economic and environmental scenarios that might influence future decisions

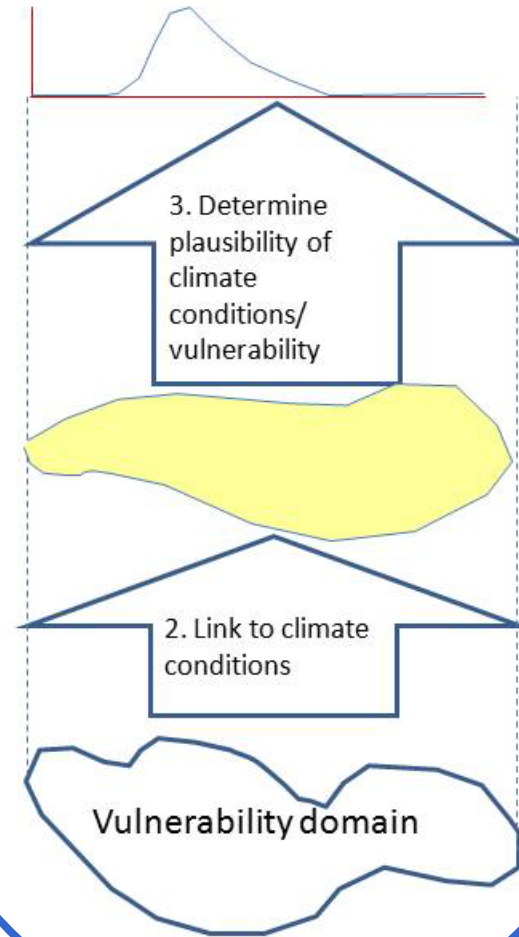
# Decision Scaling Approach

## Traditional Approach



1. Downscale multiple model projections
2. Generate a few water supply series
3. Find whether system is vulnerable for these series.

## Decision Scaling



1. Determine the vulnerability domain
2. Link to climate conditions
3. Determine plausibility of climate conditions/vulnerability

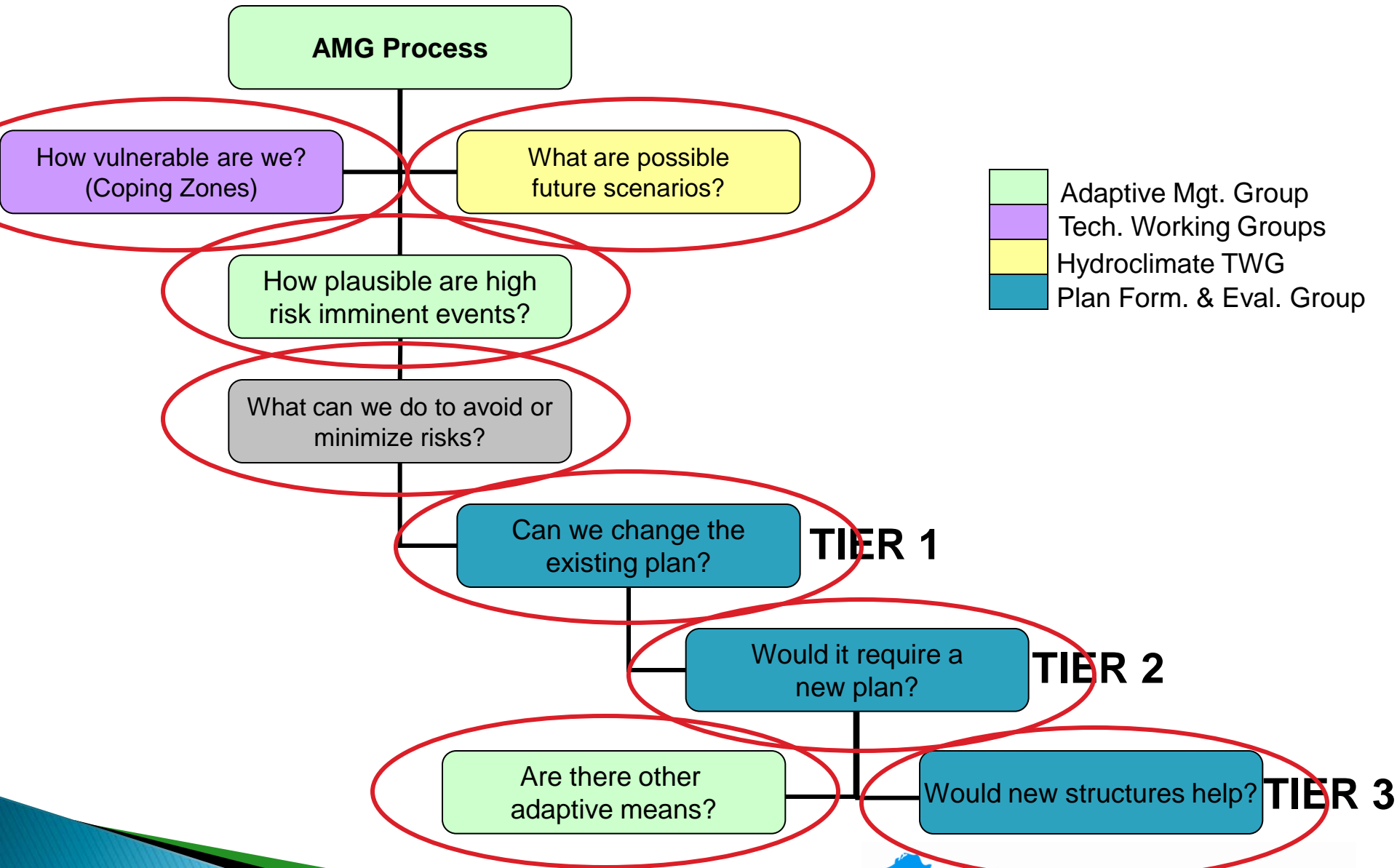
# Risk Evaluation Matrix

|               |                                   |                                  |  |                      |                  |
|---------------|-----------------------------------|----------------------------------|--|----------------------|------------------|
| <b>Zone C</b> | <b>Low</b>                        | <b>Moderate</b>                  | <b>Moderate</b>                          | <b>High</b>          | <b>Extreme</b>   |
| Zone B        | <b>Negligible</b>                 | <b>Moderate</b>                  | <b>Moderate</b>                          | <b>Moderate</b>      | <b>High</b>      |
| Zone A        | <b>Negligible</b>                 | <b>Negligible</b>                | <b>Slight</b>                            | <b>Slight</b>        | <b>Slight</b>    |
|               | No indication scenario will occur | Unlikely but cannot be ruled out | Expected, but extreme or rare or distant | Unusual but expected | Common, imminent |
|               | <i>Not very plausible</i>         | <i>Plausible</i>                 |  |                      |                  |

# Establishing Future Actions

1. **A new near-term Superior regulation plan –**
  - a replacement for the current plan
  - Goals: equitable, environmental & economic
  - flexible, rules can change with water conditions.
2. **Suggested next term Superior regulation plan(s) and an adaptive management plan for refining and implementing a tier 2 plan for the future.** A tier 2 plan addresses a **goal**. The shift to a tier 2 plan would be a leading indicator of change (hydroclimatic, economic, social, environmental) before it's too late for regulation to help.
3. **Beyond regulation of Superior**– the two main possibilities are **multi-lake regulation** and **non-regulation adaptation** such as new coastal zone and floodplain management policies, and new investment strategies by private interests.

*The Study Board can contribute information to the third tier, but actions in this tier require authority outside the IJC.*



- Adaptive Mgt. Group
- Tech. Working Groups
- Hydroclimate TWG
- Plan Form. & Eval. Group

# Knowing when to take action

Establish a decision tree with rules for taking action including:

- ▶ A cause for taking action (e.g. shift in water level regime)
- ▶ A trigger for taking action (an impact or related water level or flow) and issue of false positives
- ▶ The goal of the action
- ▶ Who is responsible for implementing/funding the action
- ▶ Scientific data through monitoring and modelling to determine
  - If triggers are being reached
  - if the action implemented is successful in meeting its goals
- ▶ Institutional process for implementing an action

# Institutional/Governance Analysis

- ▶ For implementing a new plan
- ▶ For building new structures
- ▶ For non-regulation adaptive response

# Institutional/Governance Analysis

Establishes

- ▶ Who's responsible for taking the action?
- ▶ What legal or policy requirements/barriers are there for taking action?
- ▶ What is the process/mechanisms for implementation?
- ▶ What are the funding requirements and who pays?