Climate Change:
From Impacts to Adaptation

Institute for Catastrophic Loss Reduction Workshop
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Paul Gray

Acknowledgements

Ontario

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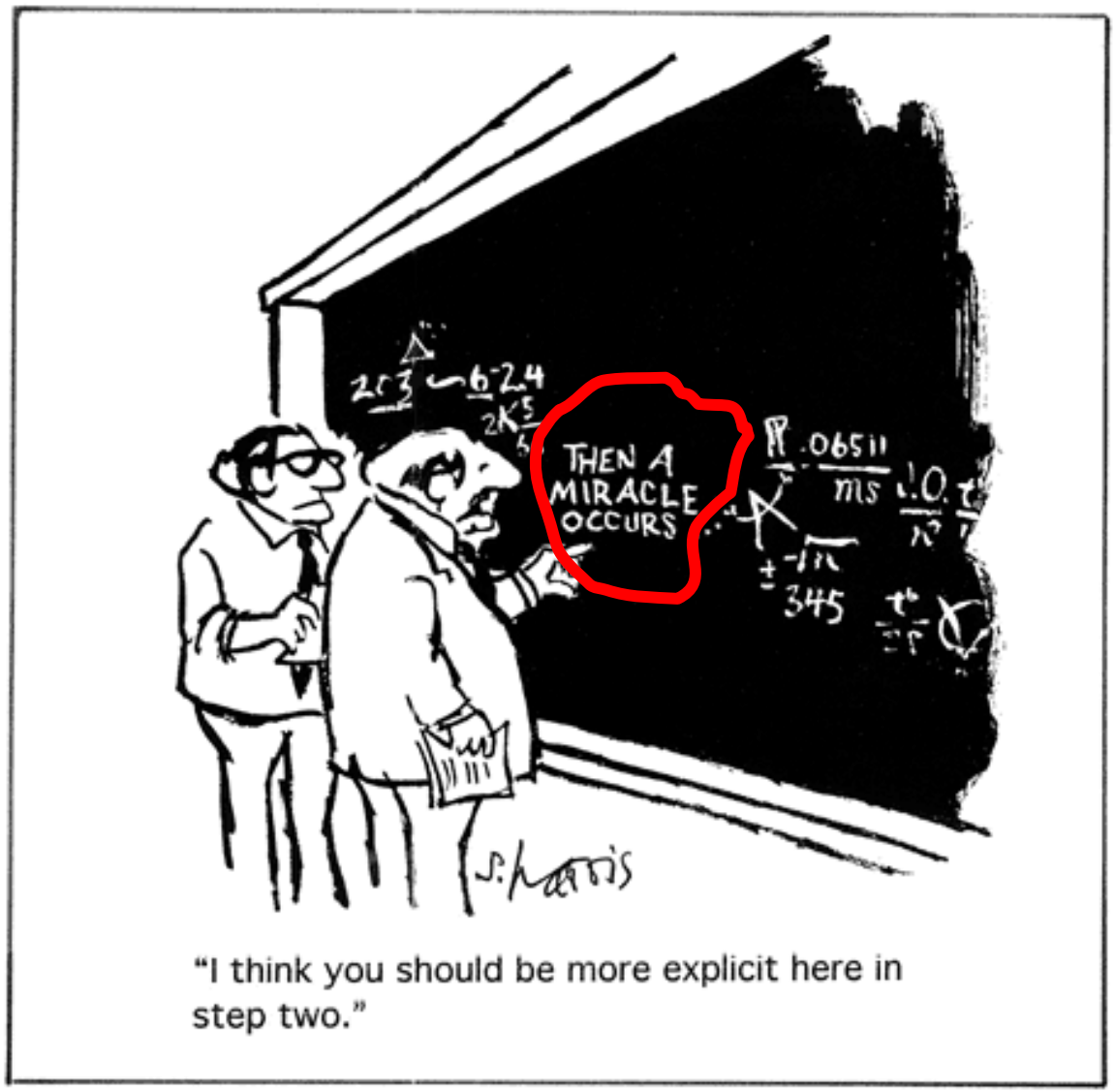
Ogden - Incorporating Climate Change Adaptation Considerations into Forest Management and Planning in the Boreal Forest

Ogden/Edwards - Draft of Guidebook for Forest Management Practitioners

Gleeson et al. – A Practitioner's Guide

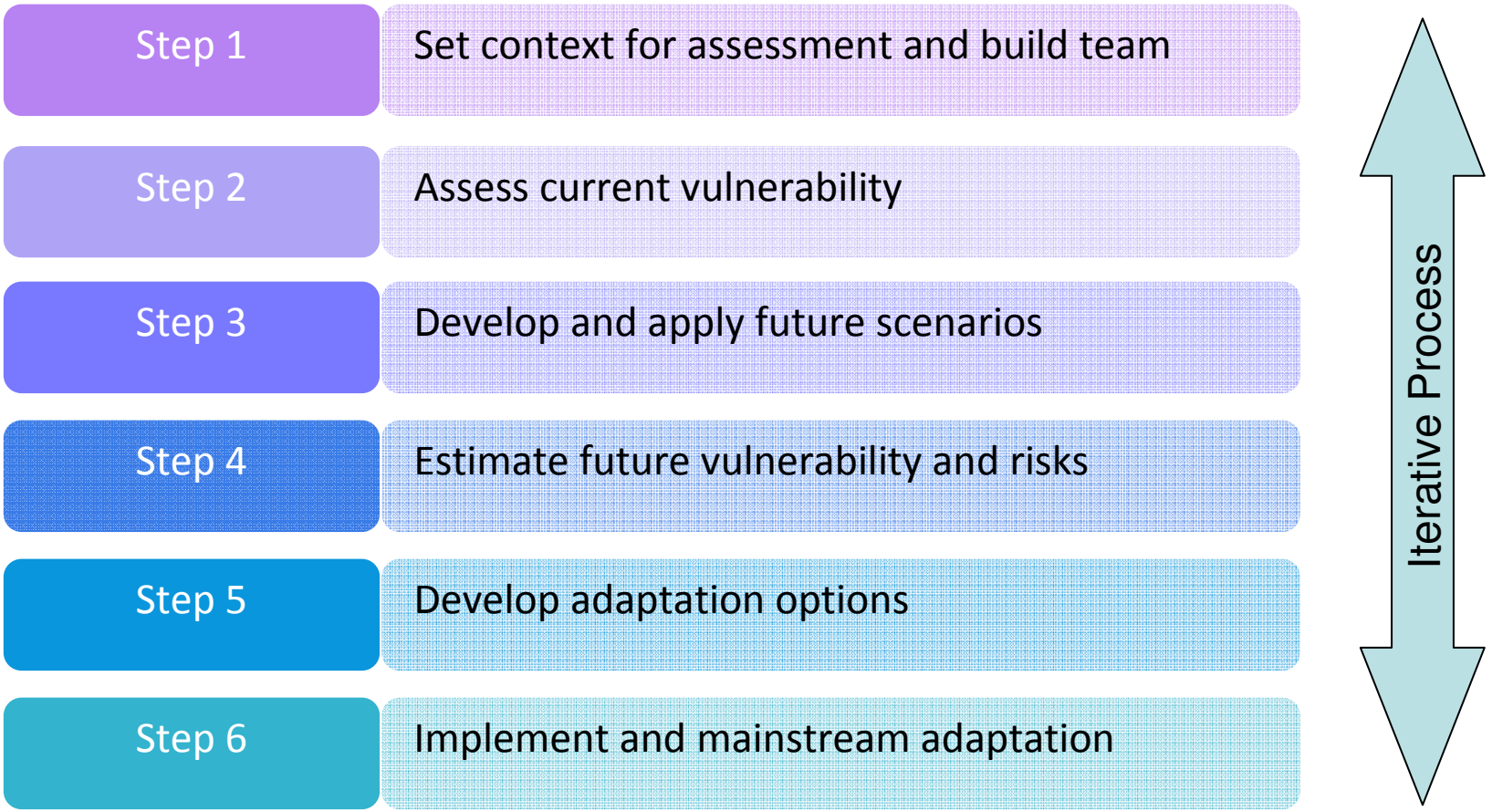
[Source: D. Etkin]

Towards an Adaptive Approach to Managing for Climate Change



"I think you should be more explicit here in step two."

An Adaptation Framework & Process

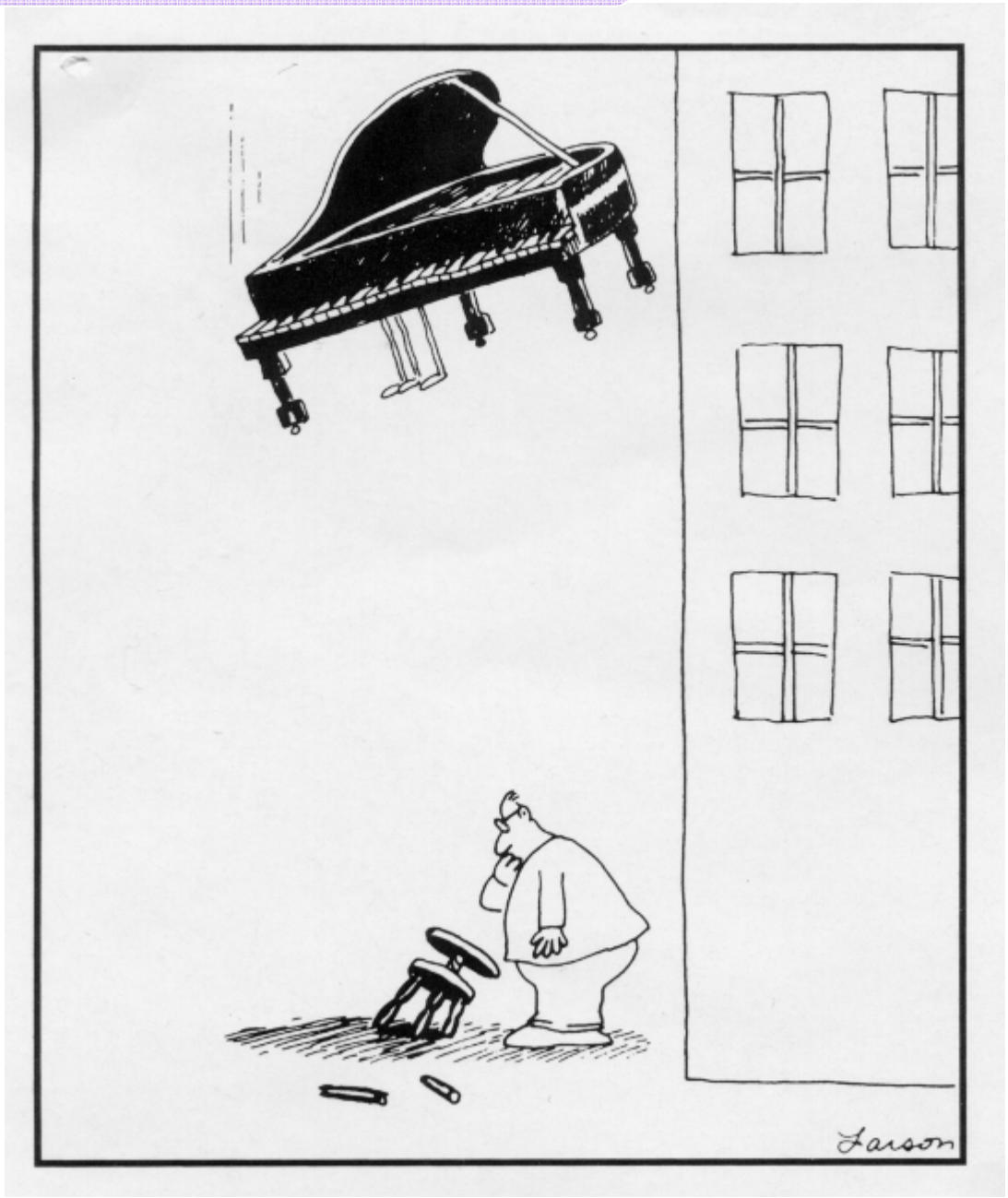


Managing for climate change is about asking the right questions

- **Impact (Disaster) Relief**

+

- **Impact (Disaster) Prevention**



Step 1 Set context for assessment and build team

At what level?

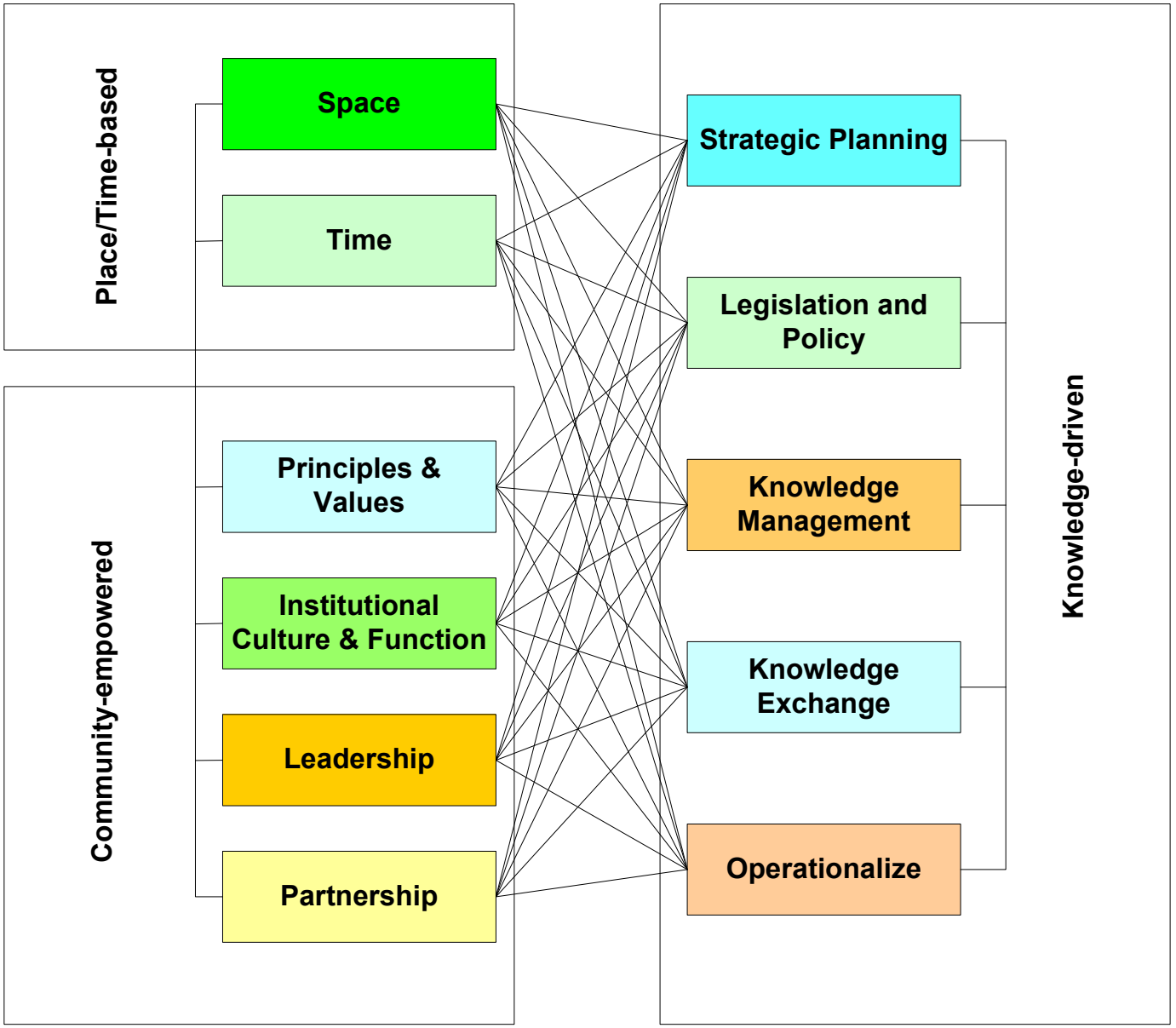
- Local assessments
  - Watershed
  - Municipality
  - Forest management unit etc.
- Regional-level assessments
  - Eco-district or Eco-region

Focused on what?

- Ecological and socio-economic themes of interest to resource managers, communities and policy-makers
  - Hydrology
  - Forests
  - Wetlands
  - Invasive species
  - Tourism
  - Aquatic habitat etc.
- Indicators within each theme may help to focus the analysis

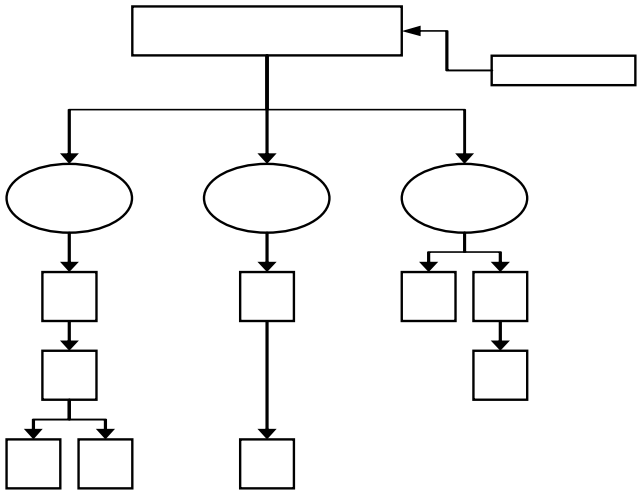
Step 1

Are we capable of implementing an adaptive approach?

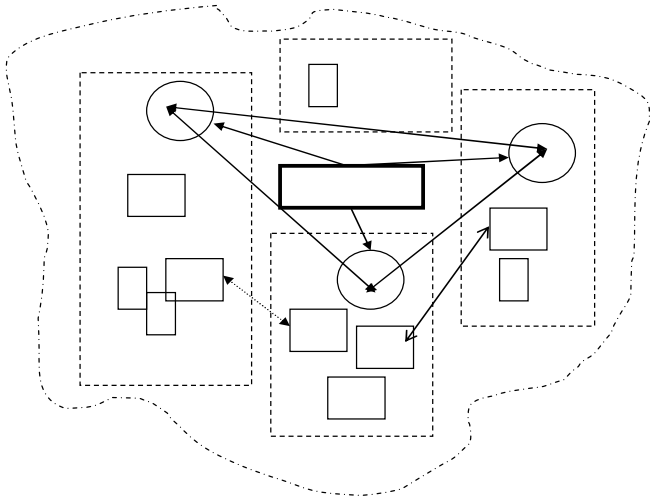


Step 1

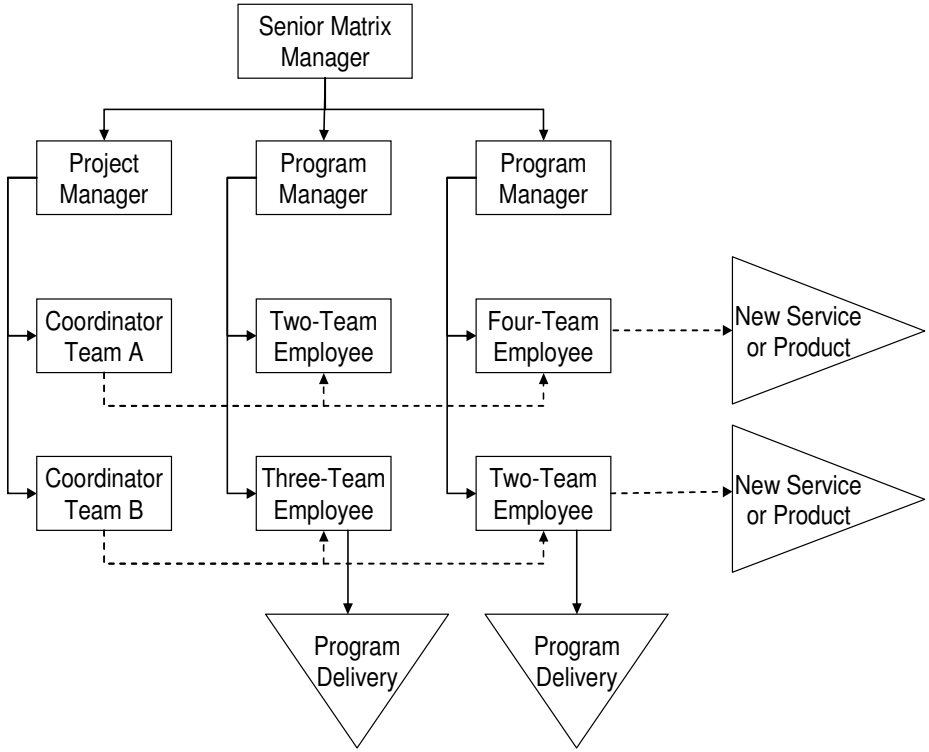
Are we capable of implementing an adaptive approach – will our corporate structure facilitate adaptation?



Monocentric Structure
Classical Bureaucracy



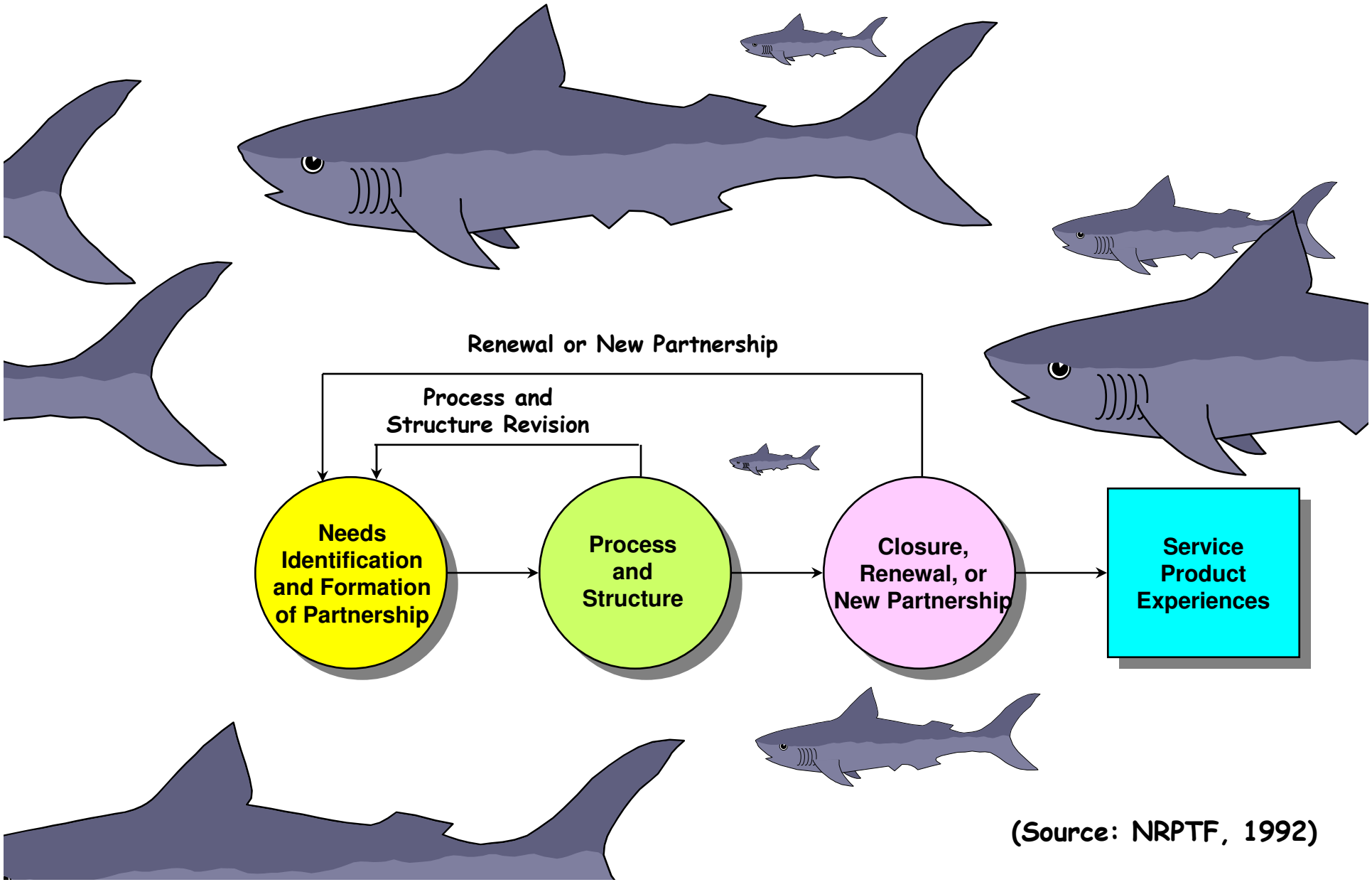
Polycentric Structure
Loosely Structured



Matrix Structure

Step 1

Are we capable of implementing an adaptive approach – Do we have the right partners?



(Source: NRPTF, 1992)

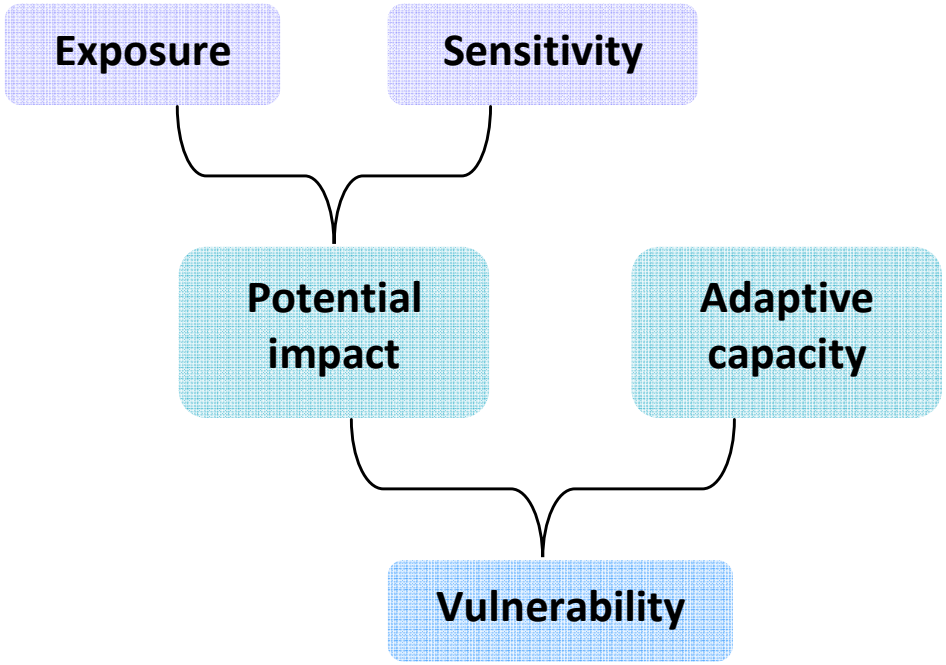
Step 1

Are we capable of implementing an adaptive approach – Are we communicating about the right things effectively?

Step 2 Assess current vulnerability

"Vulnerability to climate change is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes."

IPCC, 2007. Fourth Assessment Report: Impacts, Adaptation and Vulnerability.



Step 2 Describe current vulnerability – develop descriptions (past climate + bio/socio/economic responses)

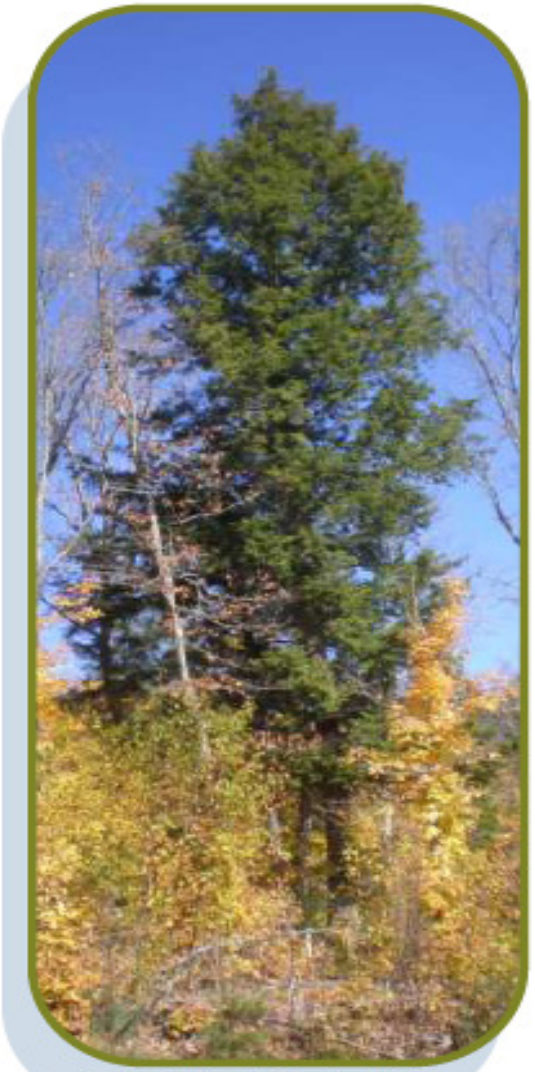
Eastern Hemlock

<u>Exposure:</u>
More extreme weather events like drought and heat waves

<u>Sensitivity:</u>
Requires cool, moist sites and is sensitive to hot, dry conditions

Less snow cover means greater exposure in winter = greater risk of being eaten by deer

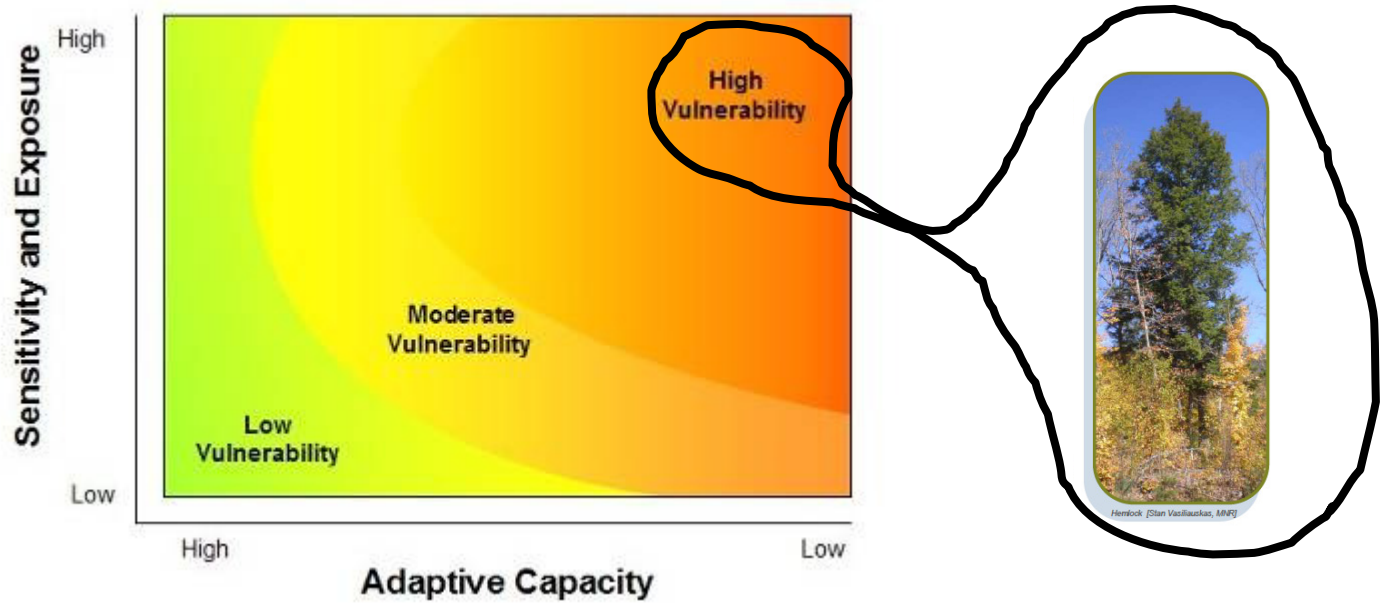
<u>Adaptive Capacity:</u>
Slow seedling growth rate = less adapted to heat and drought that limit growth, cause mortality, and reduce competiveness



Hemlock [Stan Vasiliauskas, MNR]

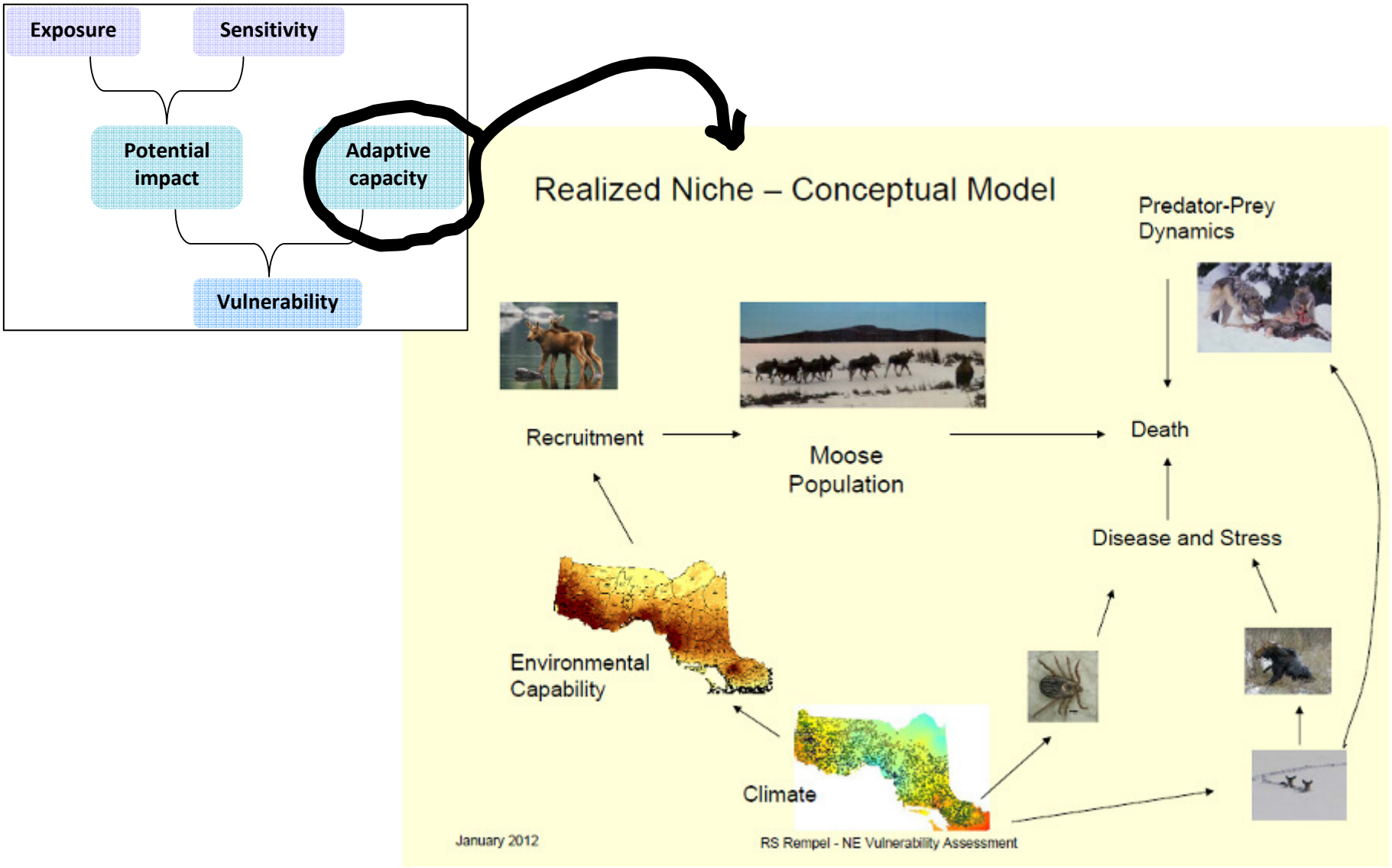
Step 2 Assign vulnerability ranking

- Using results of analysis, identify and describe future vulnerabilities
  - Rank each indicator's future vulnerability High, Medium, or Low using information about sensitivity, exposure and adaptive capacity



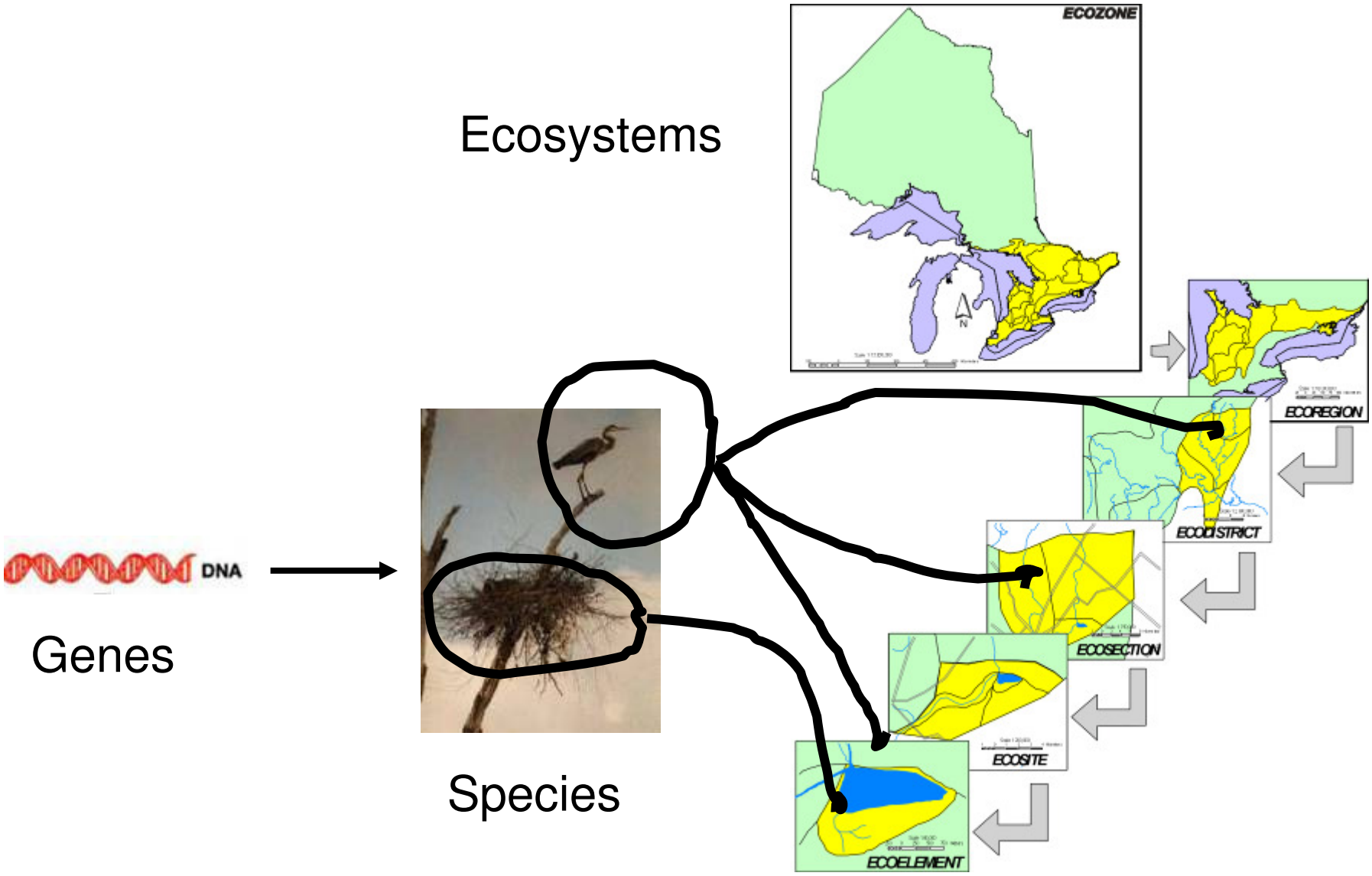
(adapted from Alberta Sustainable Resource Development, 2010)

Step 2 Assess current vulnerability



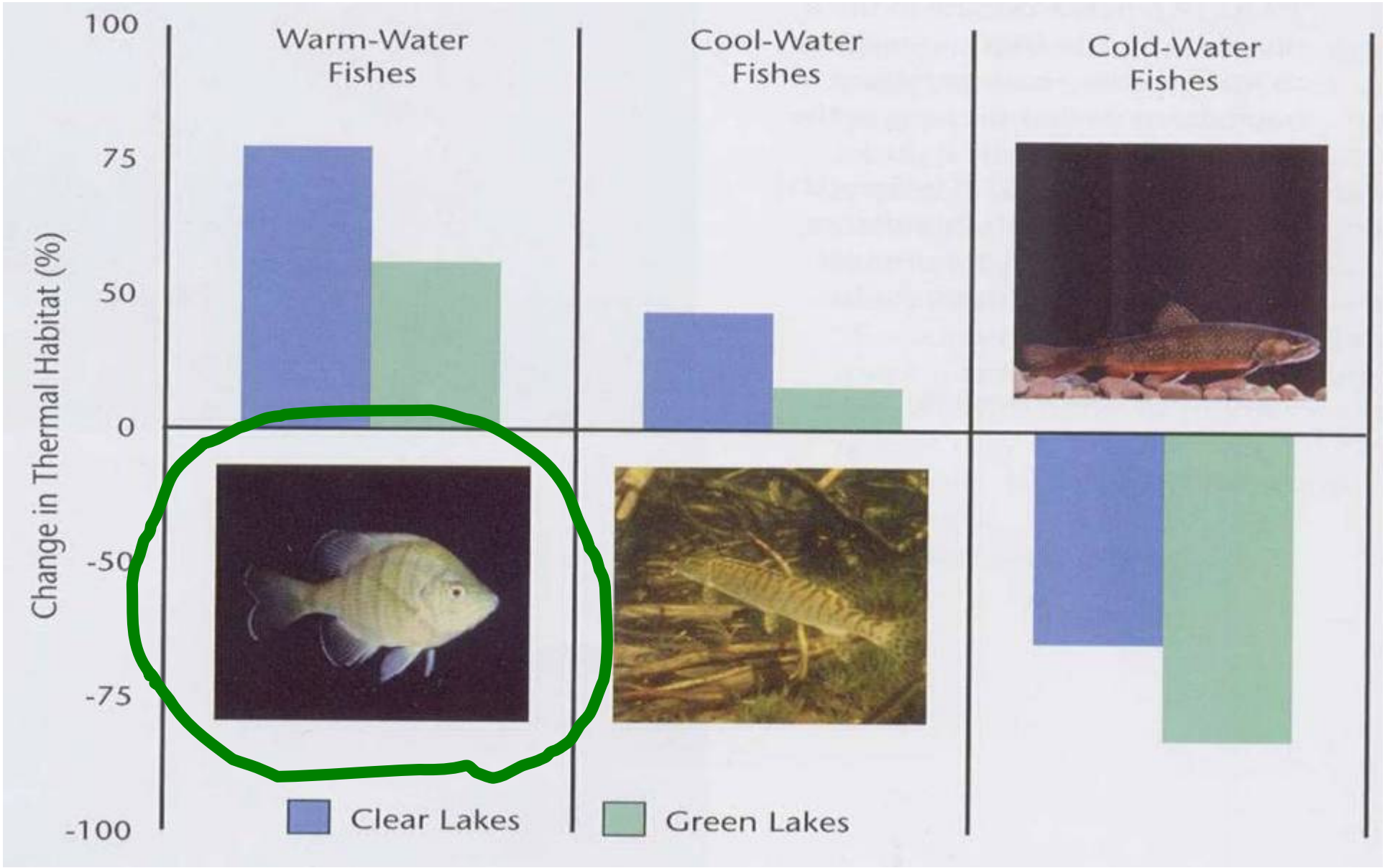
[Rob Rempel 2012]

Step 2 Assess current vulnerability of ecological values



(Source: Gray and Davidson 2000)

Step 2 Assess current vulnerability of ecological values – there are winners and losers

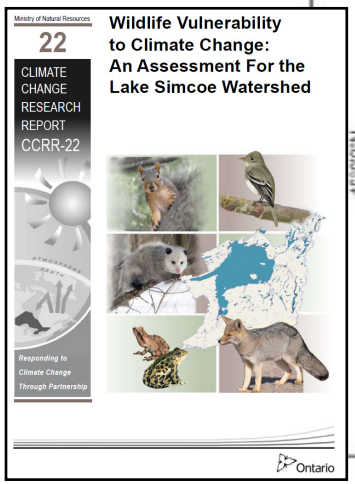


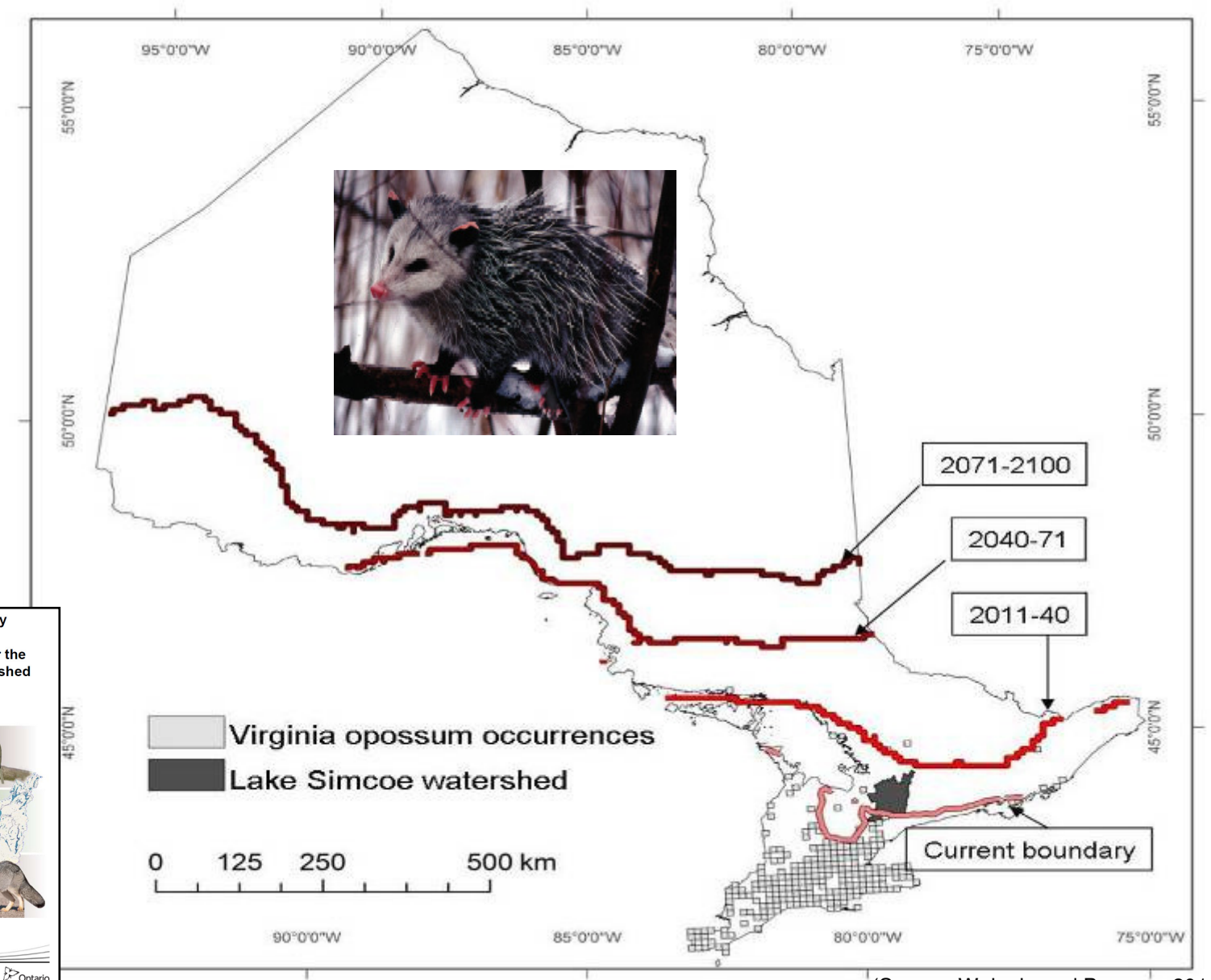
Step 2

Assess current vulnerability of ecological values – there are winners and losers

[Aaron Walpole]

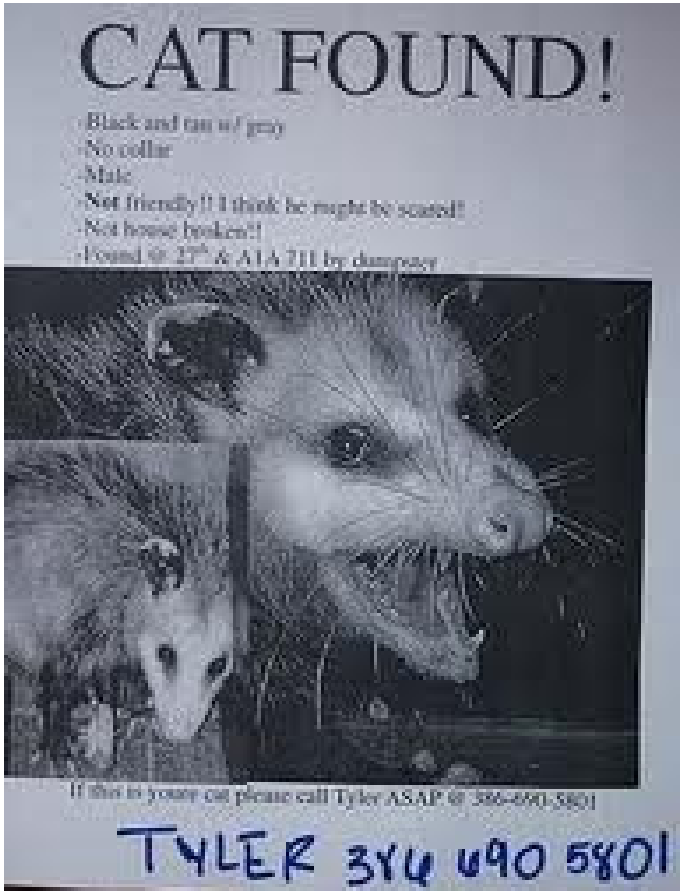
[Jeff Bowman]





(Source: Walpole and Bowman 2011)

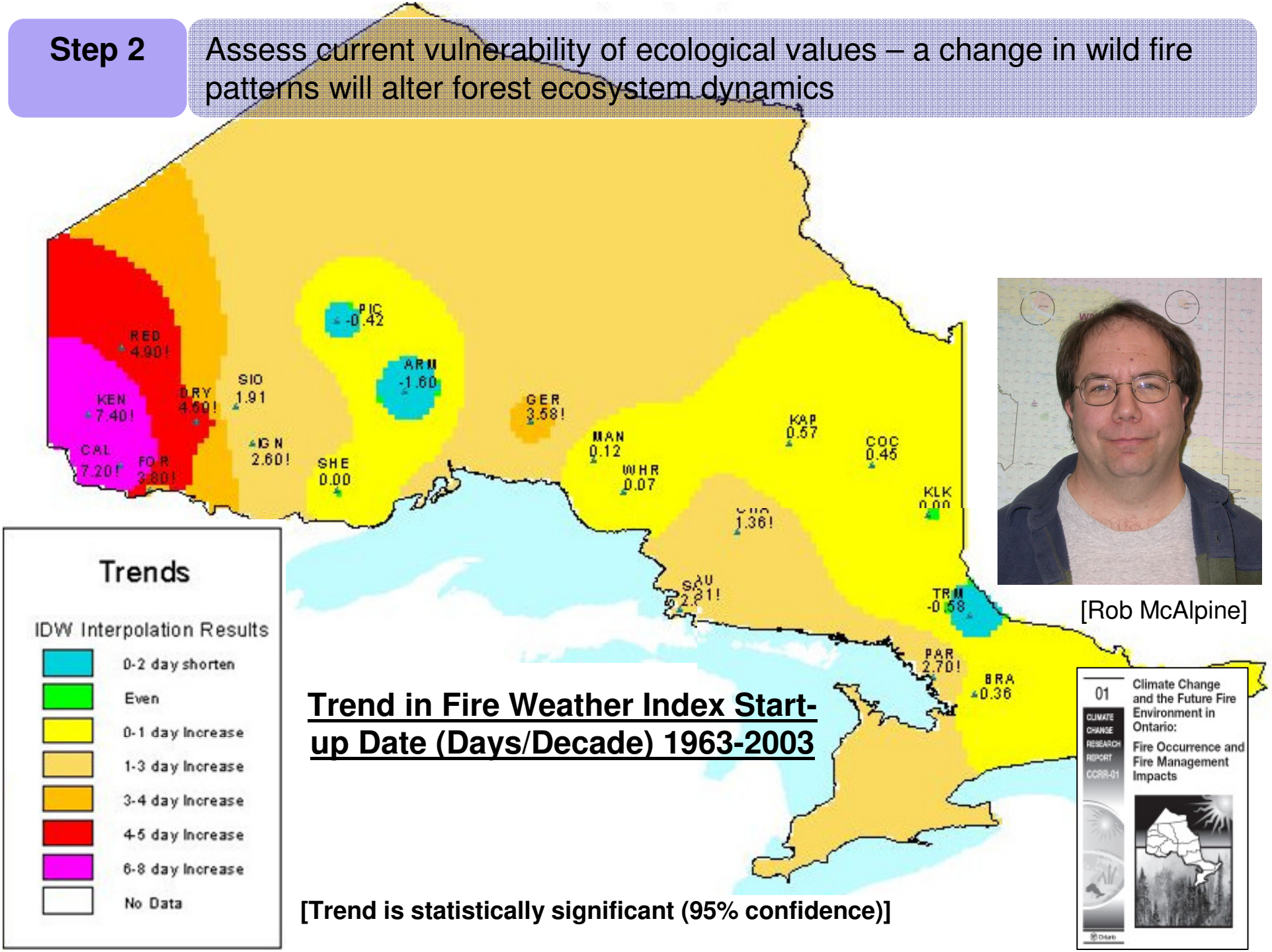
Step 2 Assess current vulnerability of ecological values – there are winners and losers



(Source: Walpole and Bowman, 2011)

Step 2

Assess current vulnerability of ecological values – a change in wild fire patterns will alter forest ecosystem dynamics



Trend in Fire Weather Index Start-up Date (Days/Decade) 1963-2003

[Trend is statistically significant (95% confidence)]

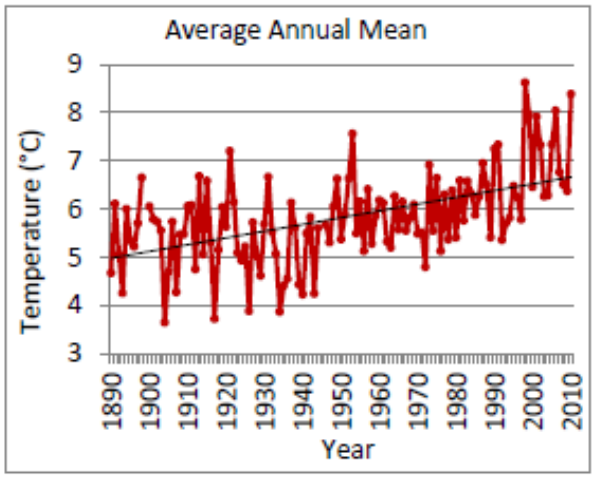
[Rob McAlpine]

Step 2 Assess current vulnerability

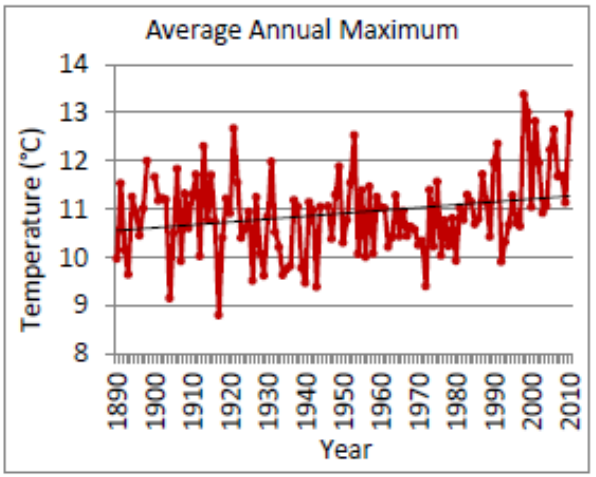
- Understanding the relationship of social, economic, and ecological indicators to climate provides a basis to assess vulnerability to climate change.

- Important to look at observed climatic trends in the area to understand changes that have occurred to date
  - Using information from local weather stations (e.g. temperature and precipitation trends)

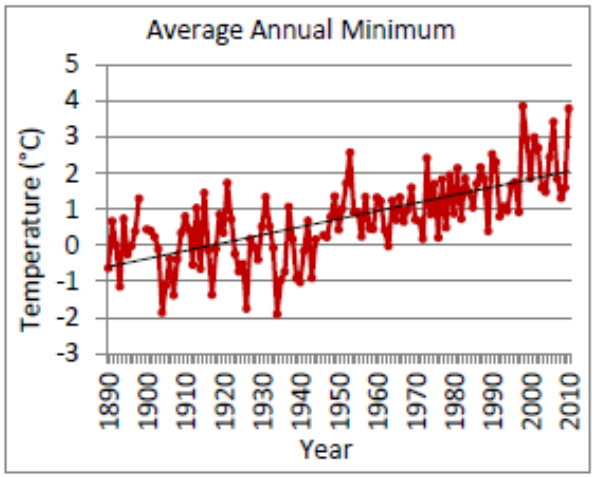
Ottawa, Ontario



Increase of 1.7°C

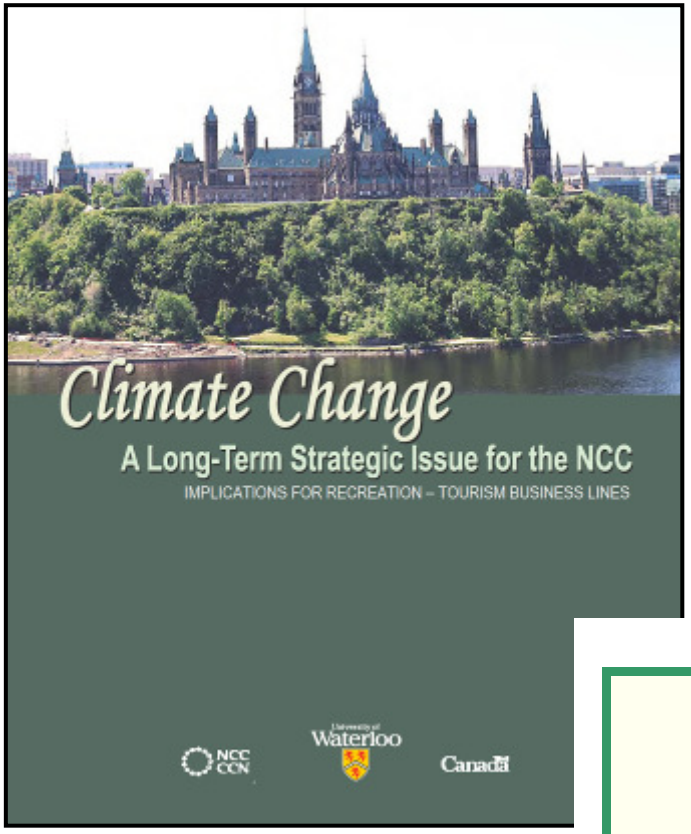


Increase of 0.8°C



Increase of 1.7°C

Step 2 Assess current vulnerability



[Dan Scott]

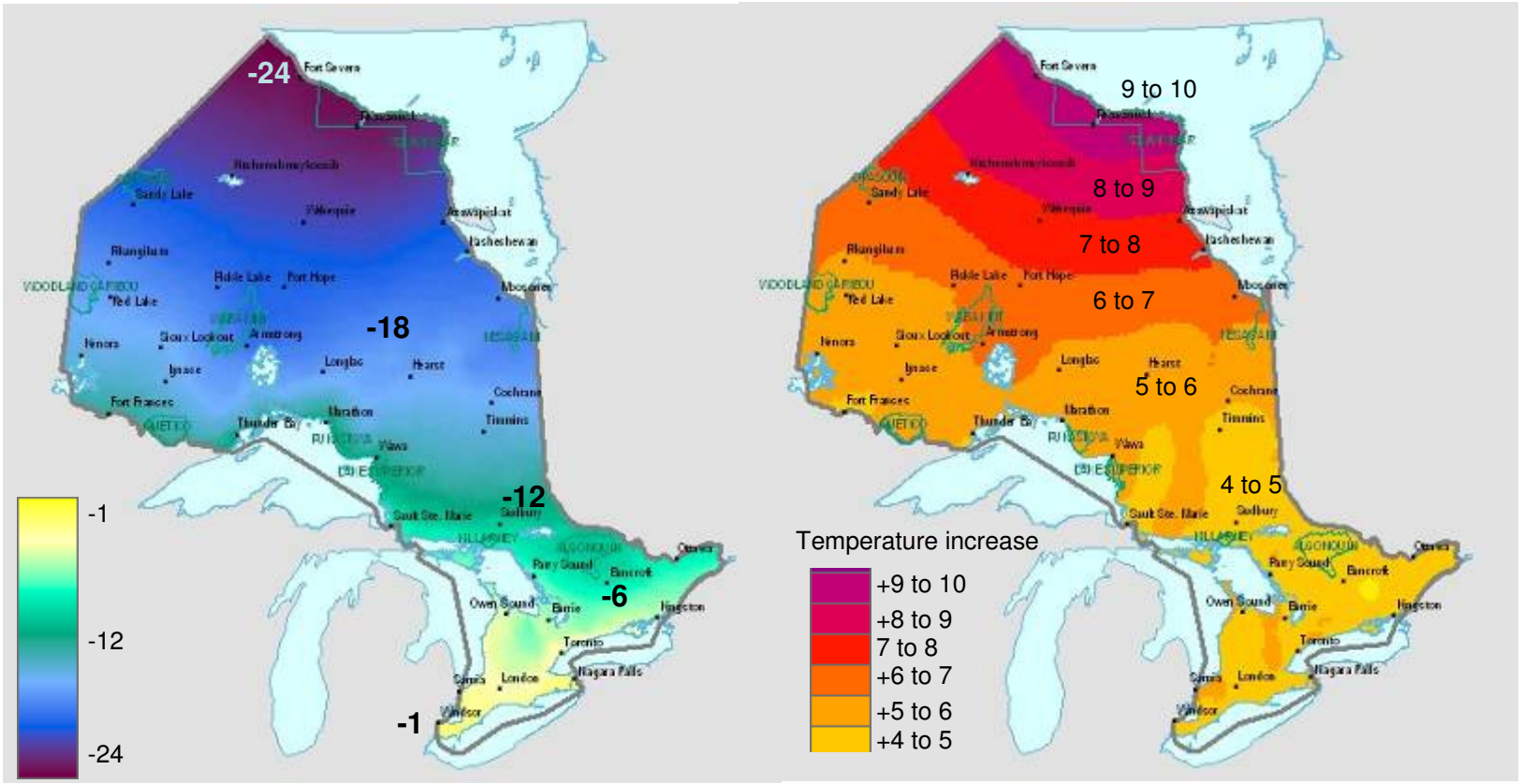
Box 1: Negative impact of weather and climate during the winter of 2001/02

- The Rideau Canal Skateway did not open until February 3
- The Rideau Canal Skateway was closed to skaters on the final weekend of Winterlude
- Only 196,000 people skated on the canal during Winterlude, 50% fewer than in previous years
- The skating season was only 34 days

Step 3 Develop and apply future scenarios

Temperature 1971-2000

Change by 2071-2100



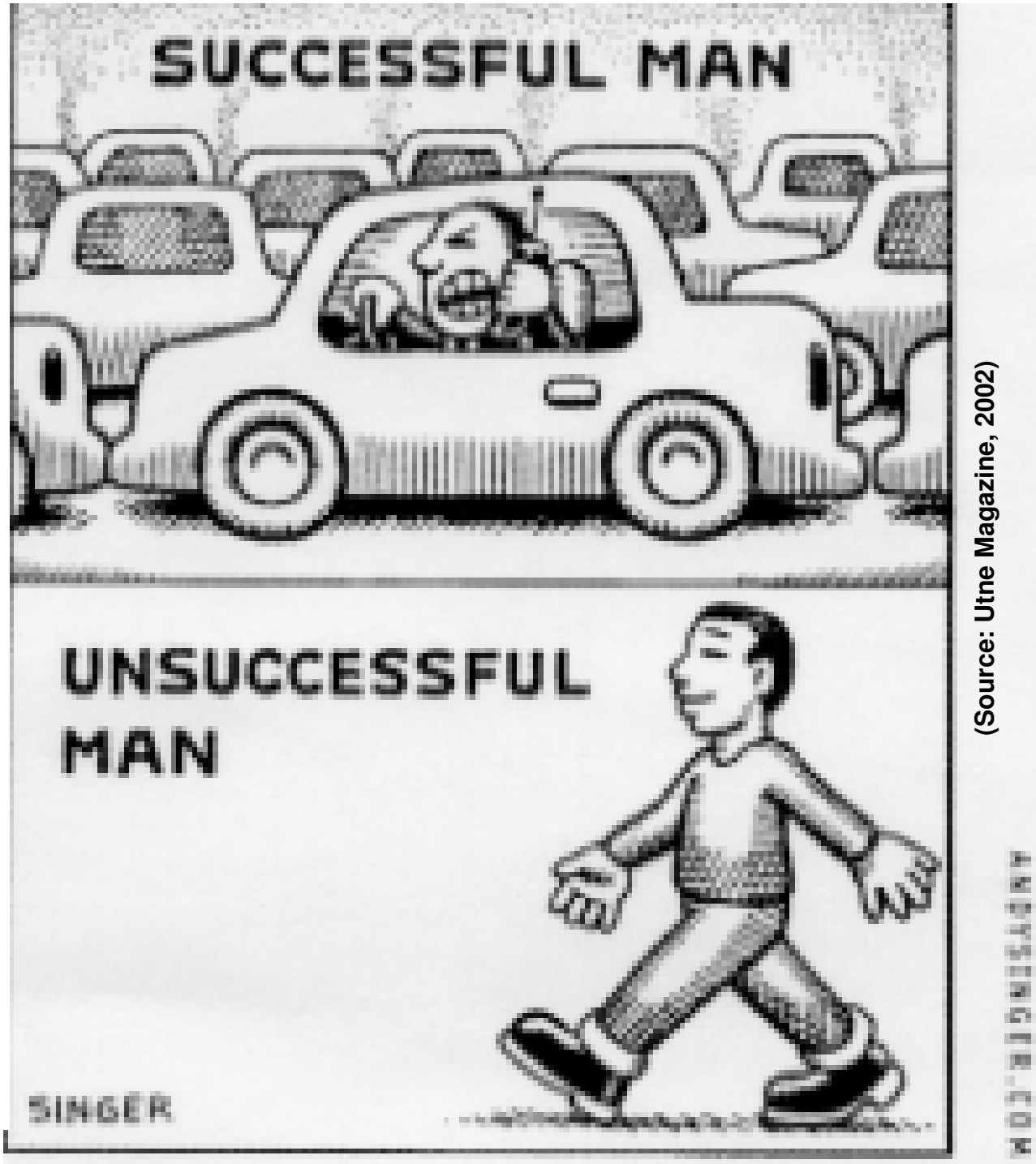
Average Winter Temperature [CGCM2 Model, A2 Scenario]

Map browser accessible on MNR Website

(Source: Colombo et al. 2007)

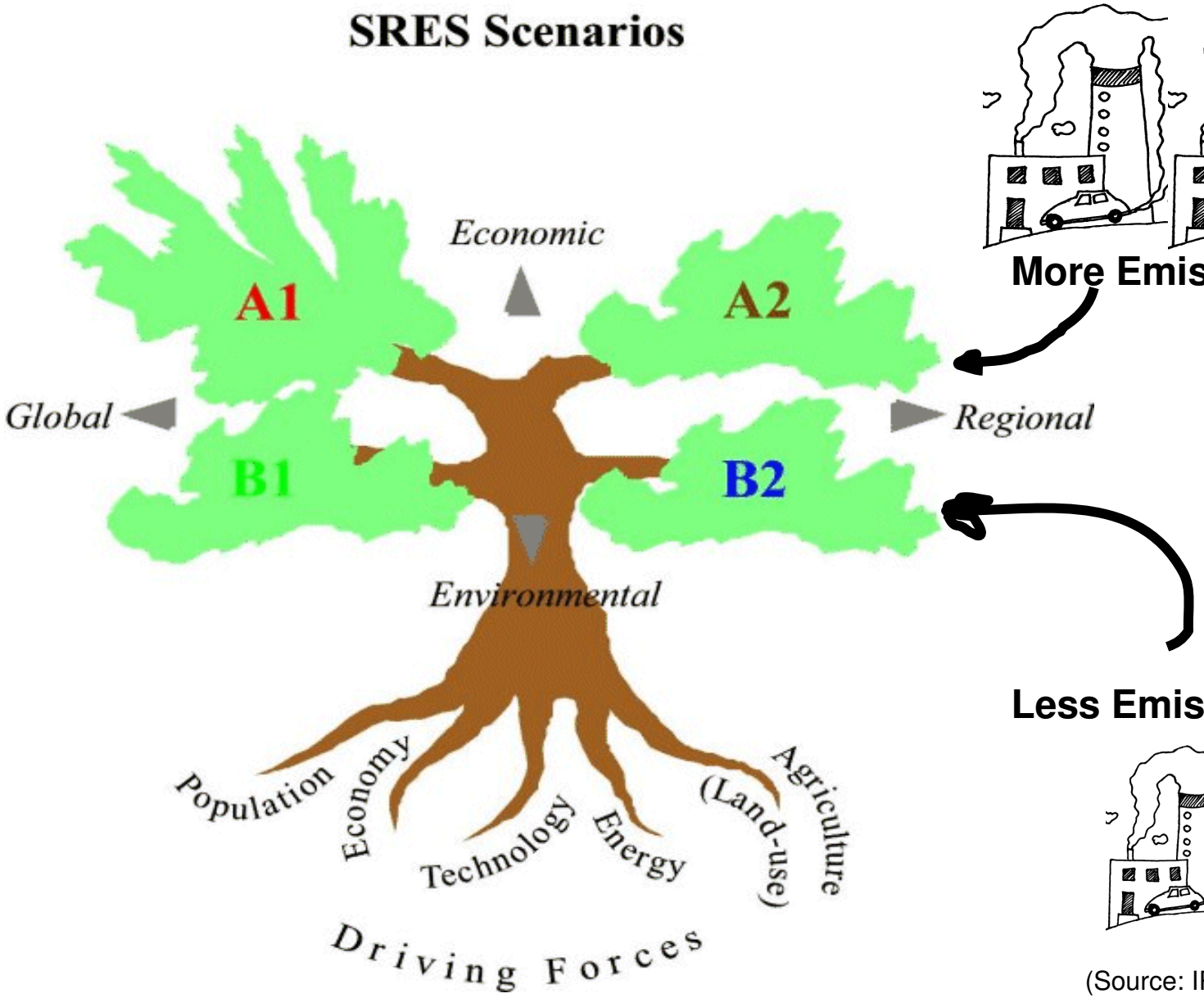
We don't really know how people will behave during the next 100 years

~2-6°C



(Source: Utne Magazine, 2002)

Step 3 Develop and apply <u>future</u> scenarios – there are 40 scenarios to choose from



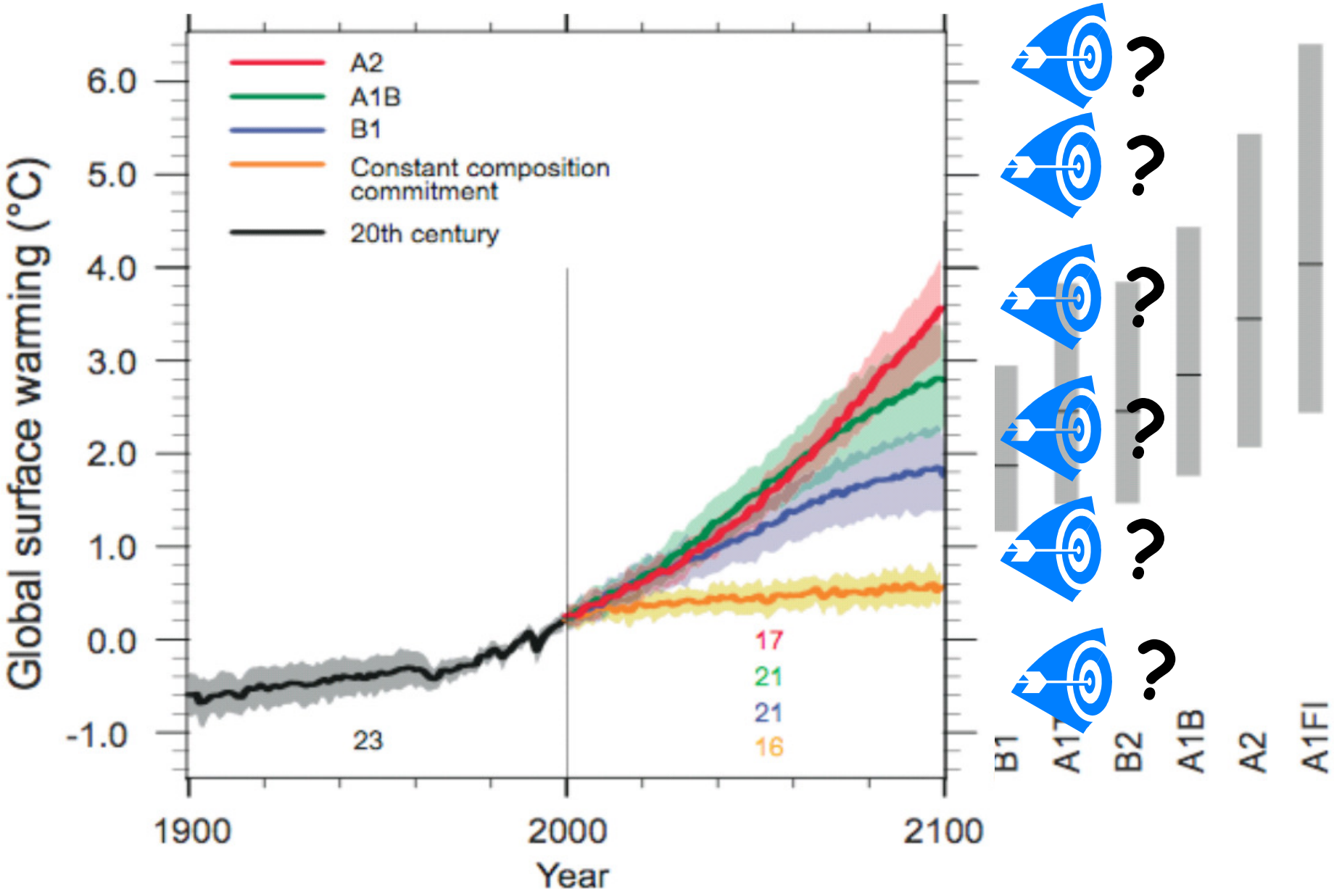
More Emissions

Less Emissions

(Source: IPCC, 2001)

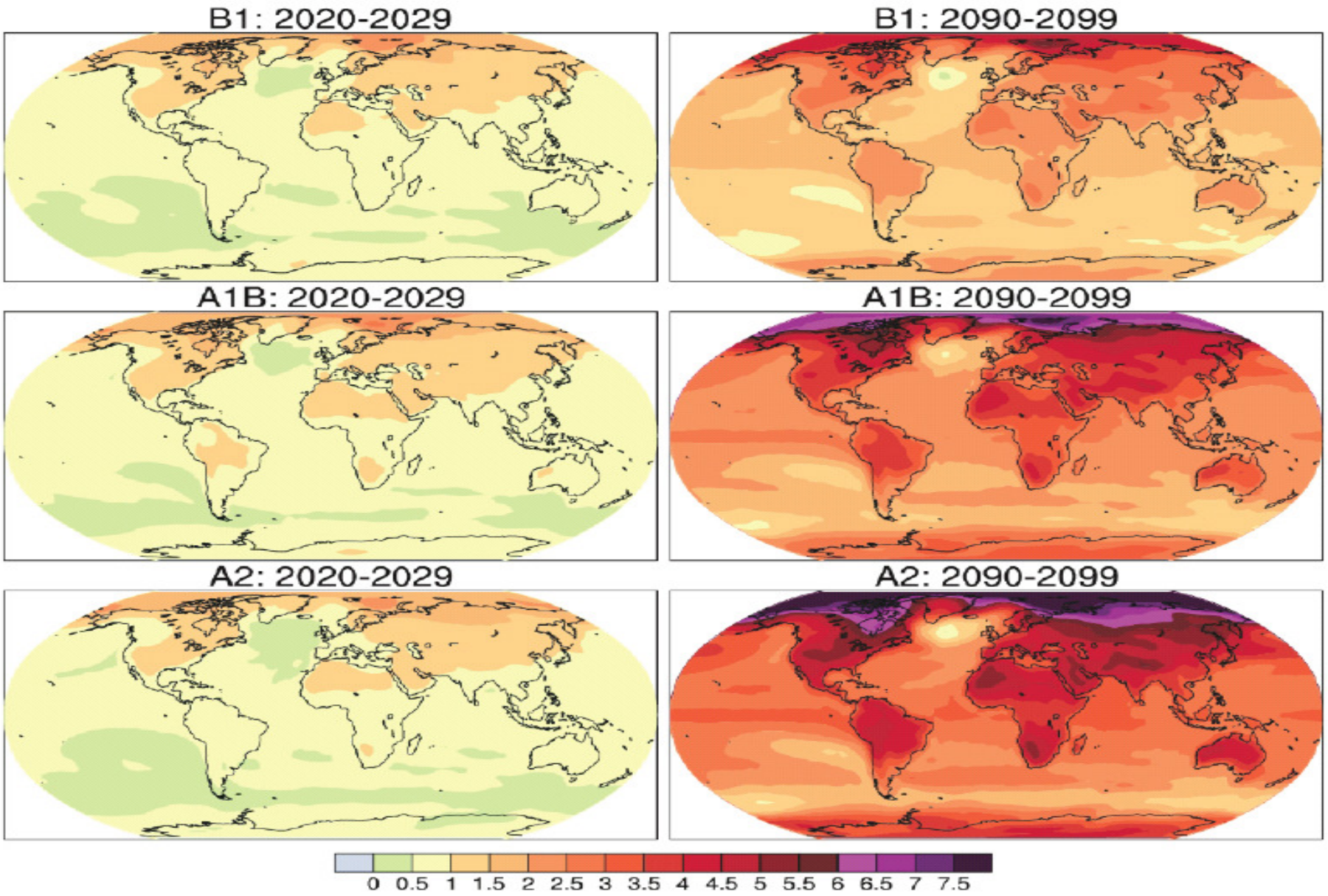
Step 3

Develop and apply future scenarios – multi-model global averages of warming (relative to 1980-1999) for selected scenarios

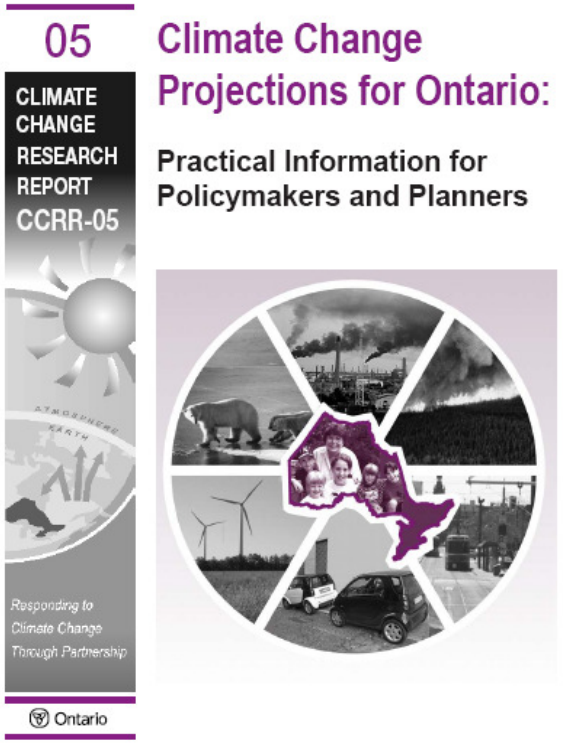


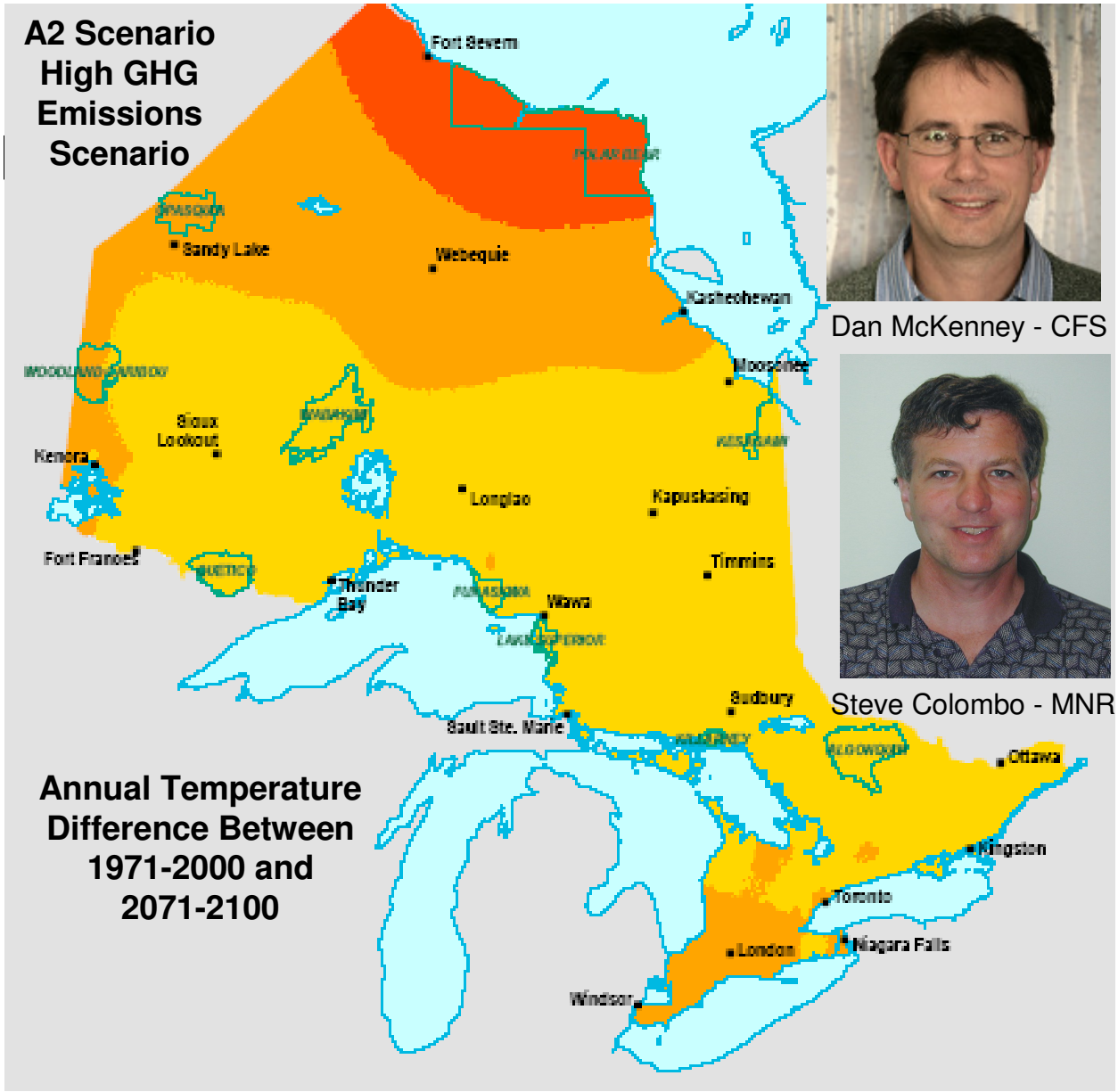
Step 3

Develop and apply future scenarios – general climate model projections of surface temperatures



Step 3 Develop and apply future scenarios





Dan McKenney - CFS

Steve Colombo - MNR

(Source: Colombo et al. 2007)

Step 3 Develop and apply future scenarios – climate models

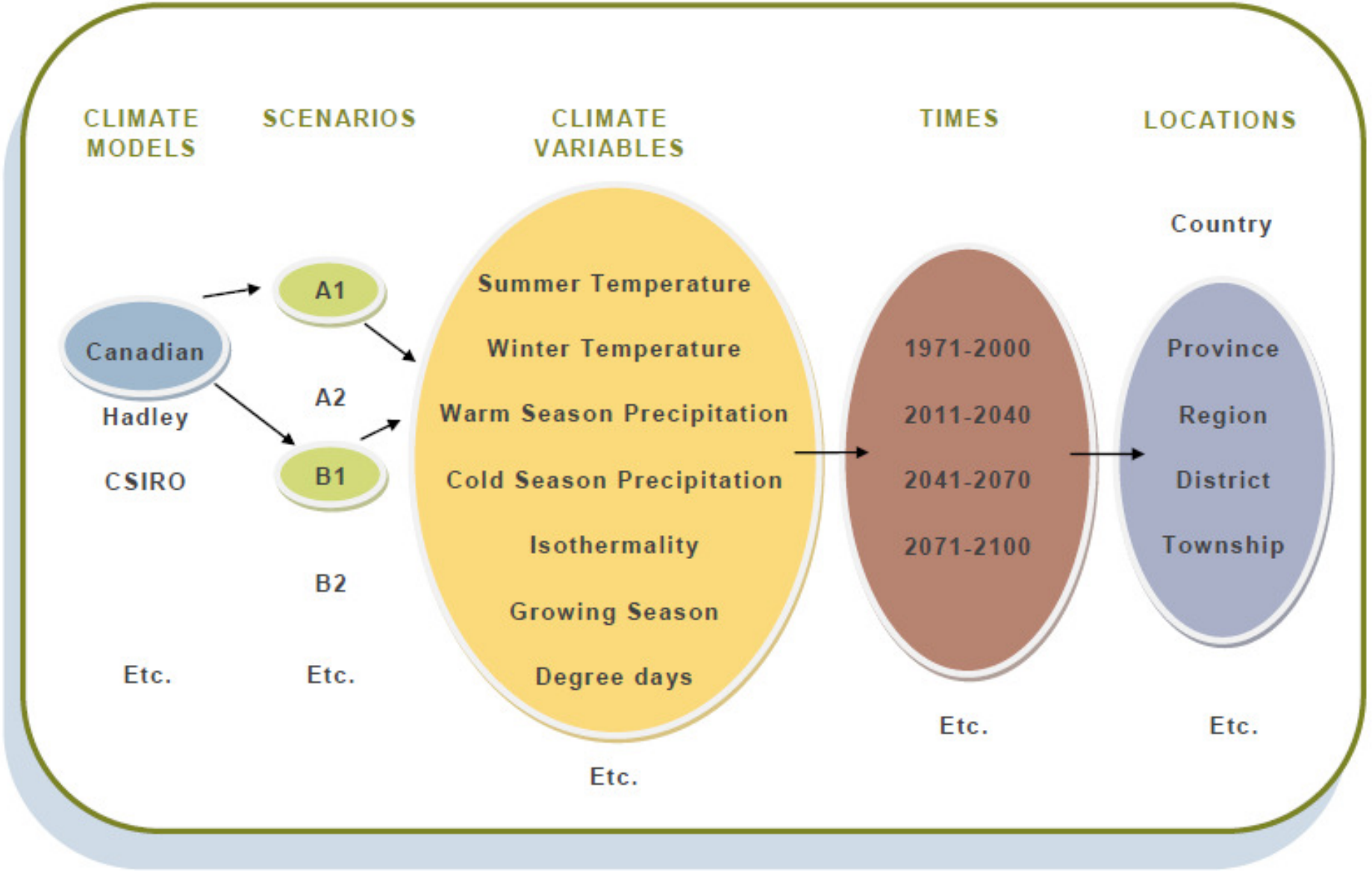
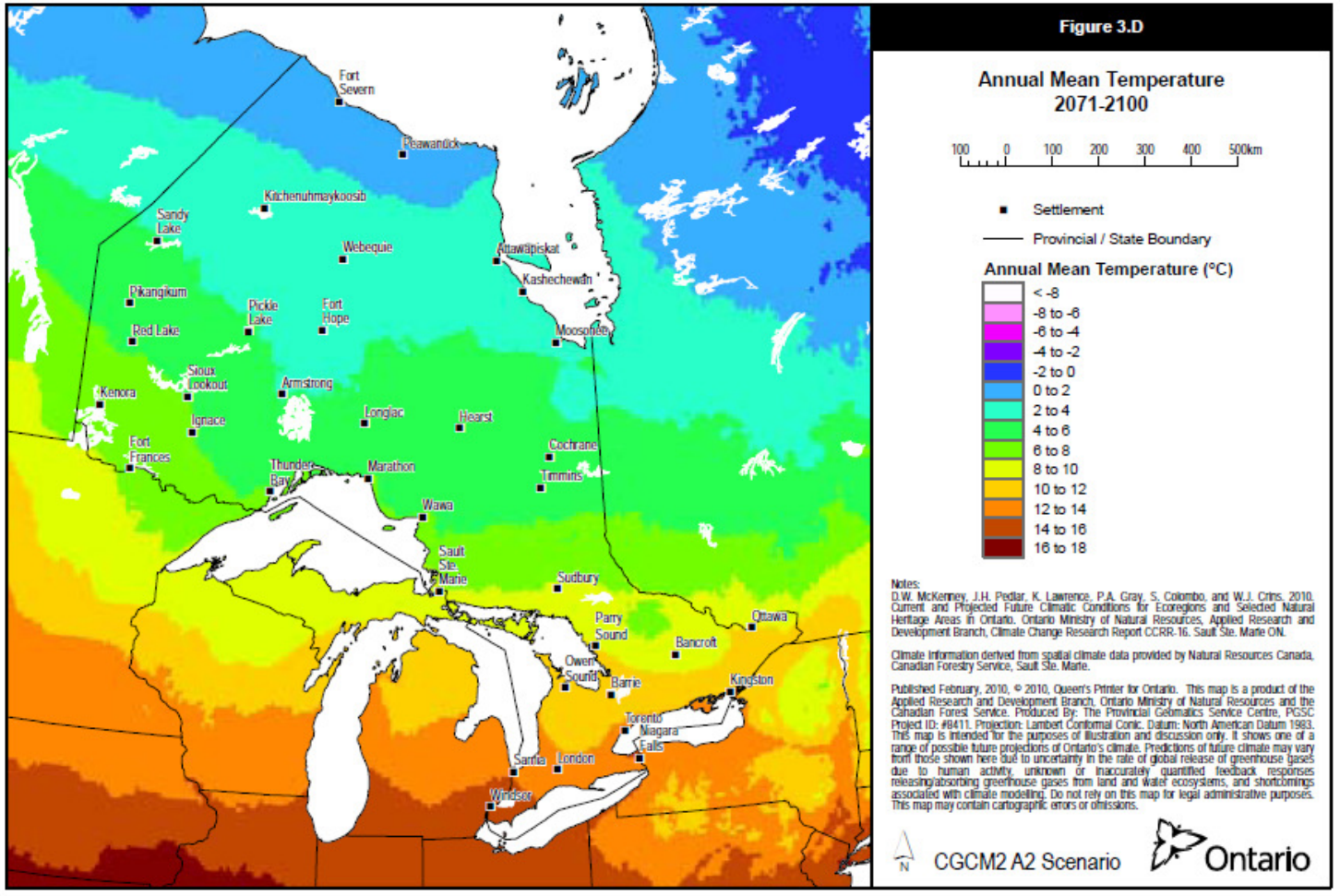


Figure 3. Examples of climate presentation options available to practitioners (Source: Colombo et al., 2007).

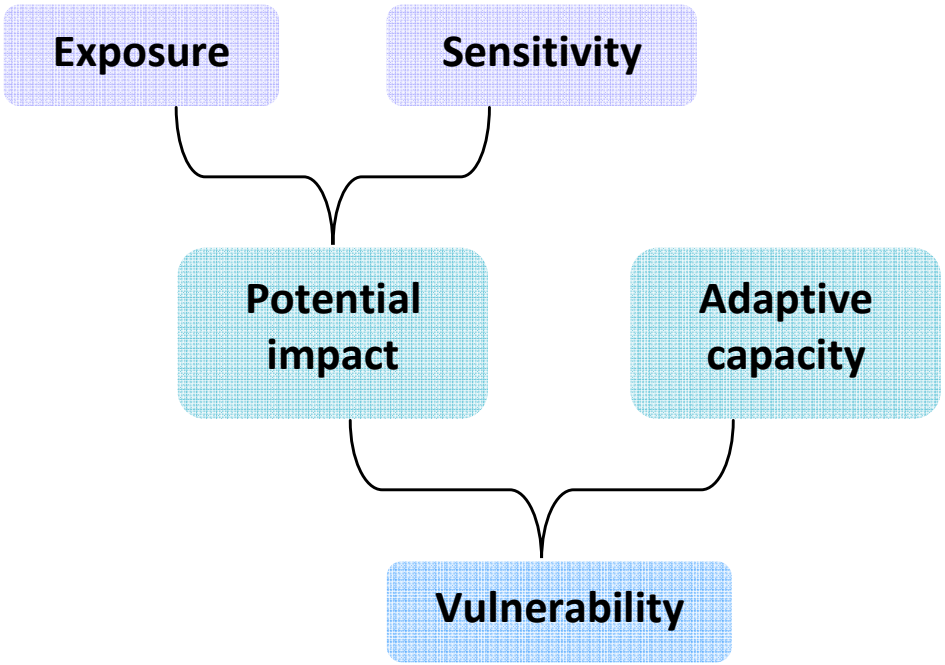
Step 3 Develop and map projections of <u>future</u> climates



Step 4 Create statements about future vulnerability and risks

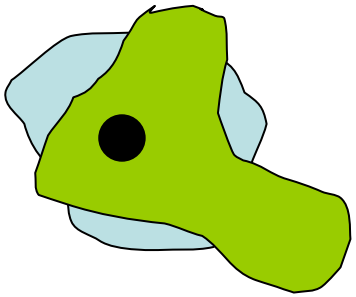
"Vulnerability to climate change is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes."

IPCC, 2007. Fourth Assessment Report: Impacts, Adaptation and Vulnerability.

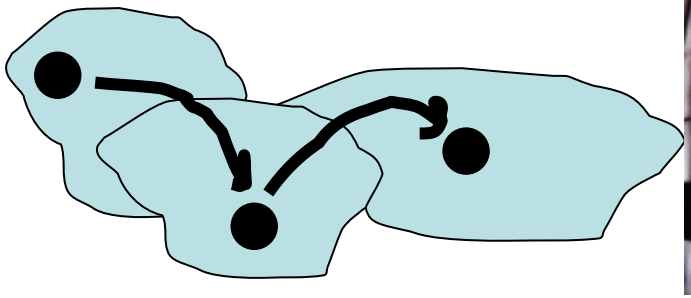


Step 4 Estimate future vulnerability – develop future scenarios (climate models + bio/socio/economic models) to identify winners and losers

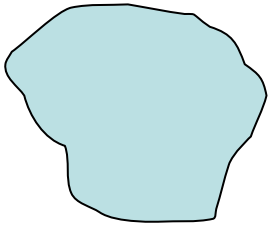
Adaptation/Micro-evolution



Home Range Change/Migration



Extirpation/Extinction



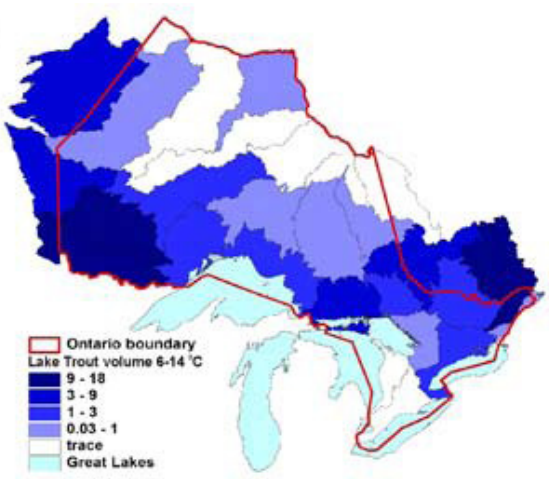
Step 4 Estimate future vulnerability – develop future scenarios (climate models + bio/socio/economic models) to identify vulnerability

Regional Differences in Current and Future Amounts of Lake Trout Habitat Among Ontario's Secondary Watersheds [CGCM2 – A2 Scenario]

Model Parameters

- Water temperature
- Lake depth
- Lake shape

A.

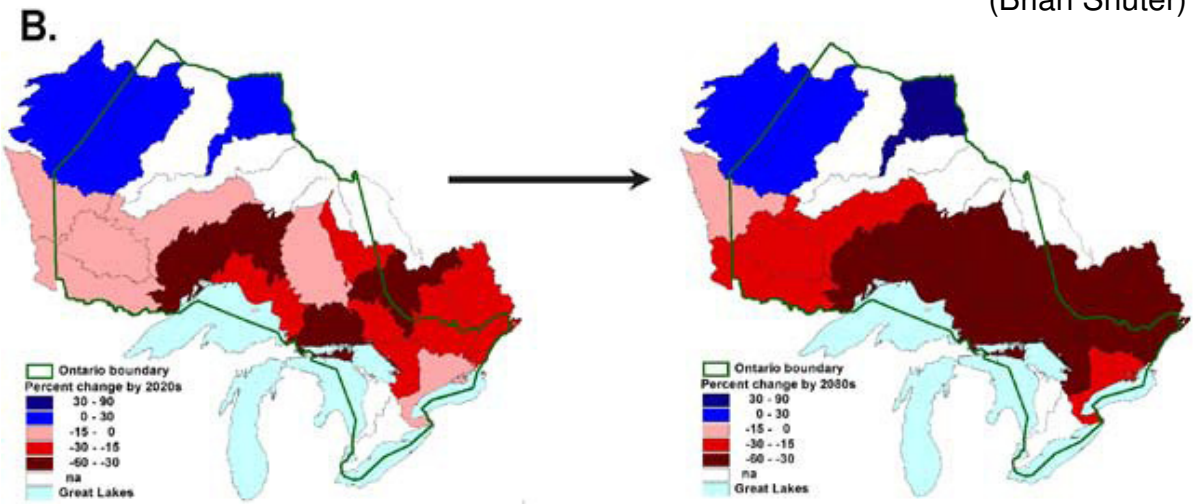


(Brian Shuter)

Model Results

- Habitat ⬇ by 30% by 2100
- ⬇(60%) in south offset by modest ⬆ (30%) in north

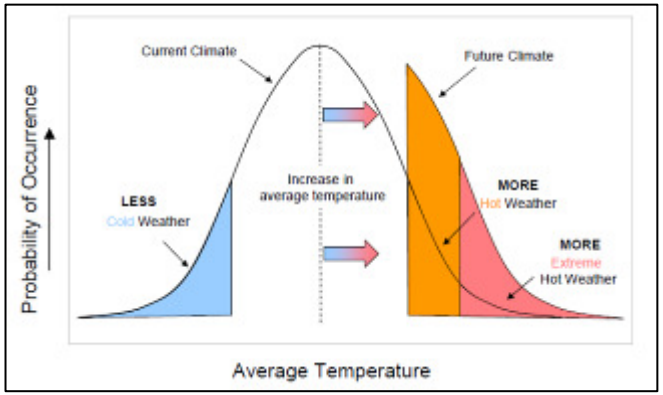
B.

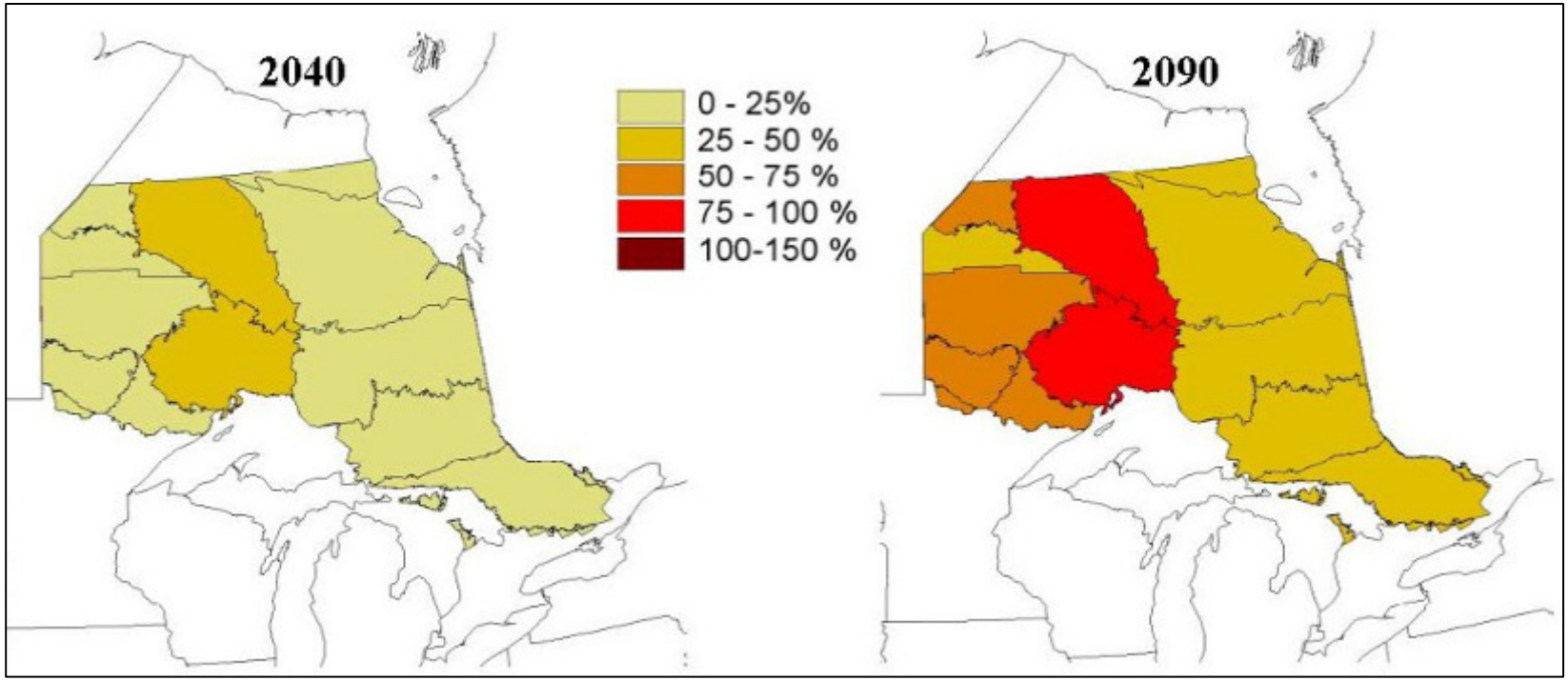


[Minns et al. 2009]

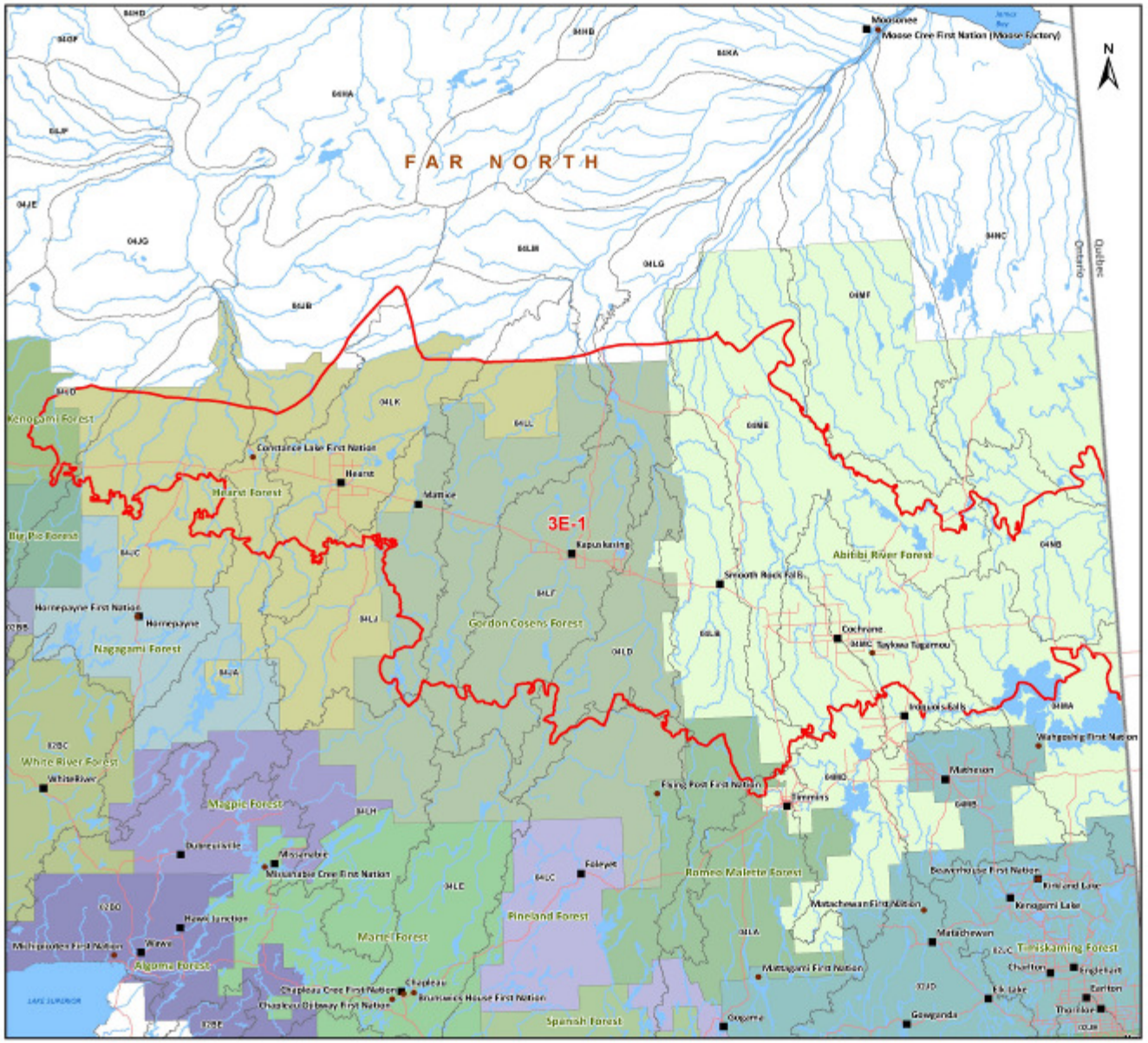
Step 4

Estimate <u>future</u> vulnerability – develop future scenarios (climate models + bio/socio/economic models) to identify hazards (percentage increase in total number of fires)





Climate Change Vulnerability Assessment and Adaptation Options for the Northeast Clay Belt



LEGEND

- First NationCommunity
- Community
- Provincial Boundary
- Road
- Far North Boundary
- River
- EcoDistrict
- Watershed
- Lake

20 10 0 20 40 60
Kilometres

Notes:

This map should not be relied on as a precise indicator of routes or locations, nor as a guide to navigation. The Ontario Ministry of Natural Resources (OMNR) shall not be liable in any way for the use of, or reliance upon, this map or any information on this map.

MNR Lambert Conformal Conic
North American Datum 1983

Sources:
NRVIS 2010-2011
Far North Branch

September 12, 2011
Version 1.3

TGSC

Ontario

Step 4

Projections of future vulnerability in the Clay Belt – socio-economic values

Figure 1. Projected changes to snowmobile season length for Ecodistrict 3E-1 for A1 and B2 climate change scenarios, east and west regions of ecodistrict and three time frames (snowmobile season defined by days with projected snow cover > 30 cm)

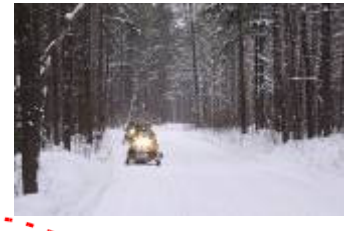


Figure 1.

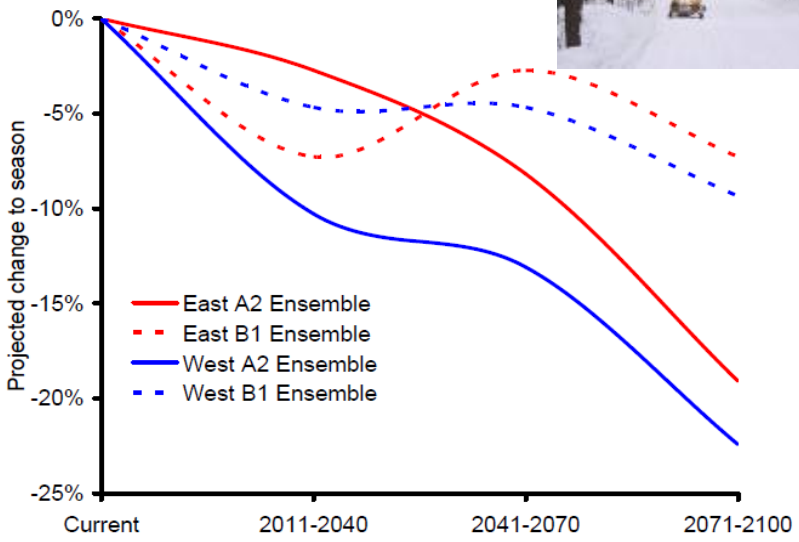
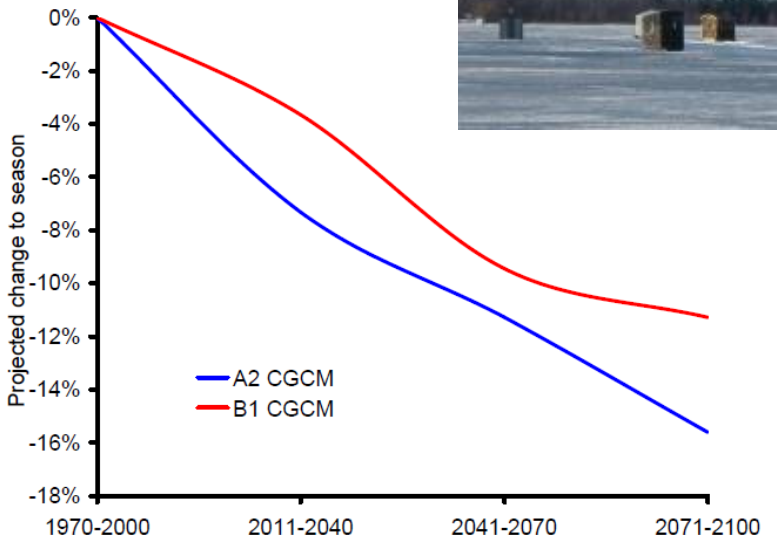


Figure 2. Projected changes to ice fishing season for Ecodistrict 3E-1 for A1 and B2 climate change scenarios and three time frames

Figure 2.



After: Shuter and Minns, in prep)

Len Hunt

Table 1. Current and medium-term future (2041-2070) climate change vulnerabilities for snowmobiling, ice fishing, and nature-based tourism in Ecodistrict 3E-1.

Indicator	Rating (sensitivity and exposure to climate)		Rating (adaptive capacity)	
	Current	Mid-term (2041-2070)	Current	Mid-term (2041-2070)
snowmobiling	Medium	Medium	Medium	Medium
ice fishing	Medium	Medium	Medium	Medium
nature-based tourism	Medium	Medium	Low	Medium

Step 4 Projections of future vulnerability in the Clay Belt in 2050

Vulnerability Assessment Results

Environmental Theme	Impacts
Aquatic Habitat	Smallmouth bass distribution may increase in lakes while Walleye productivity may increase in some lakes and decrease in others.
Forest Blowdown	Increases in potential incidences of severe forest blowdown, as well as building and infrastructure damage due to wind.
Forest Fire	The fire season length is projected to increase by roughly 11 days by 2041 but total number of fires (includes human caused fires and lightning caused fires) is decreasing minimally.
Forest productivity and composition	Ecodistrict 3E-1 will become more favourable climatically to Great Lakes – St Lawrence forest tree species
Hydrology	Soils in the western portion of Ecodistrict 3E-1 will be extremely dry in summers by 2100





Step 4 Projections of future vulnerability in the Clay Belt in 2050

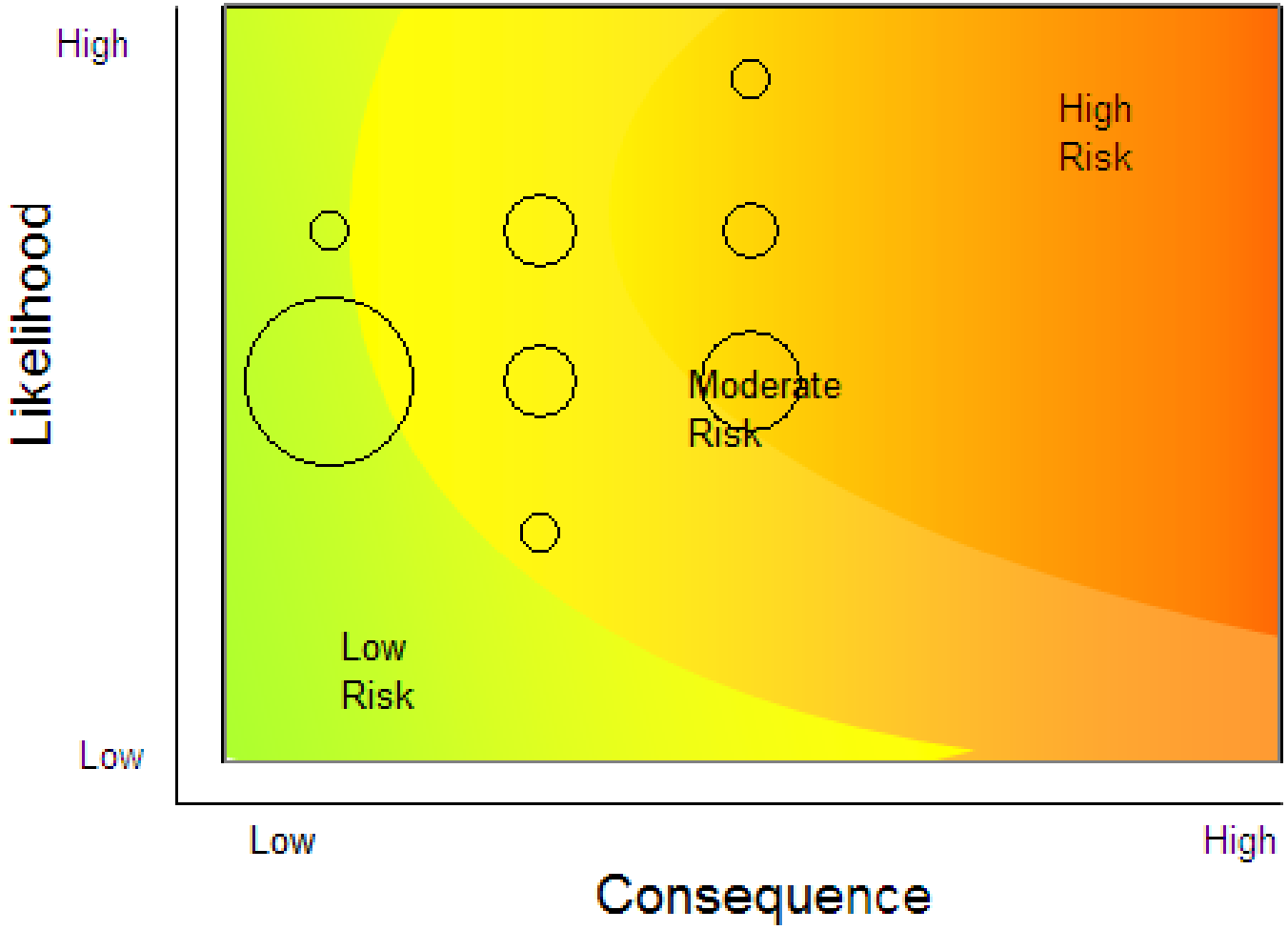
Vulnerability Assessment Results

Environmental Theme	Impacts
Peatlands	Increase bog and decreased fen areas leading to enhanced carbon dioxide sequestration because of higher tree/shrub growth.
Paludification	Interaction of climate change on fire severity and paludification may result in less paludified forests which could result in increased productivity of the forests.
Socio-economics	Walleye's increased productivity may increase revenues at remote tourism establishments. But, snowmobiling and ice fishing season could decrease.
Wildlife	Moose not highly vulnerable to climate change in 3E-1, but if moose density increases this could increase risk for caribou due to likely higher associated wolf densities.
	Sensitivity to wetland availability, spring snow cover, and loss of forest habitat will affect waterfowl.
	Introduction of southern competitors and pathogens as well as increased extinction risk of cold-adapted species.




Step 4 Create risk statements for assets in the Clay Belt in 2050

- Consider the consequences and likelihood of the vulnerabilities from different risk perspectives (financial, safety, operational etc.)



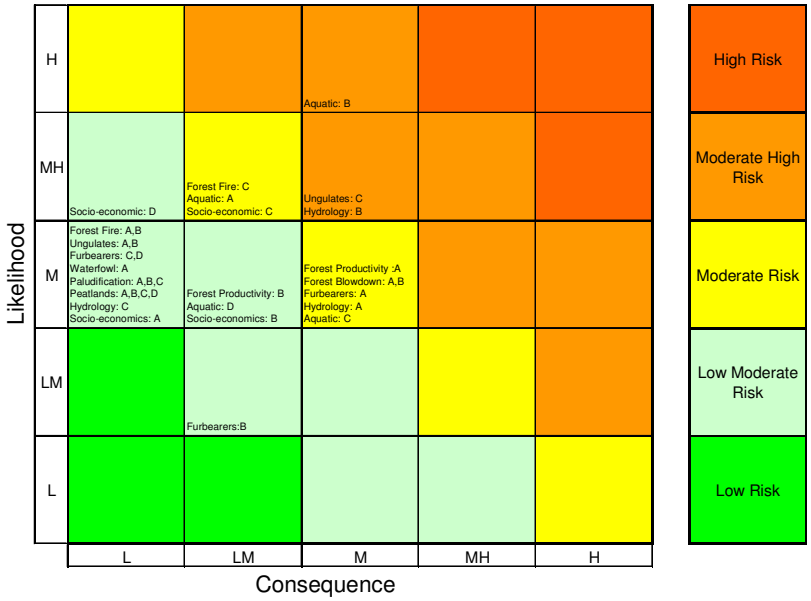
Step 4 Create risk statements for the Clay Belt in 2050

- The purpose of the exercise was to highlight vulnerabilities that should be given priority when creating adaptation options.
- Participants were asked to rank each impact/vulnerability statement in each theme in terms of potential social, economic, and/or environmental consequence.
- Core project team members assigned a likelihood of impact occurrence within the next 40-50 years.
- Consequence and likelihood results were combined to create a risk ranking for natural and socio-economic assets.

Step 4 Create risk statements for assets in the Clay Belt in 2050 – start with consequence rankings and then assign likelihood

Environmental Theme	Impact	Consequence (Low, Moderate, High)		
		Social Factors (Health & Safety, Livelihood, Cultural)	Economic Factors (Property Damage, Financial Impact)	Environmental Factors (Air, Water, Land, Ecosystems)
Forest Productivity and Composition	Ecodistrict 3E-1 will become more favourable climatically to GLSL forest tree species			
	Growth of boreal tree species in 3E1 will improve over the next 30-60 years as the climate becomes warmer and wetter, some species being favored more than others			
Forest Fire	Overall the total number of fires (includes human caused fires and lightning caused fires) is decreasing minimally			
	The decline in Phase 3+ days in the late summer period may reflect a decline in the overall fire hazard in northeastern Ontario			
	The fire season length is projected to increase by roughly 11 days by 2041			

Step 4 Create risk statements for the Clay Belt in 2050



Decrease in number of fires

Possible decline in the overall fire hazard

Moose not highly vulnerable to CC

Moose density increases then stabilizes

Selection for earlier breeding by many species

Enhanced asynchrony in ecological systems

Moderate impact on waterfowl

Less paludified forests possible

Increased productivity of forests

Increased bog and decreased fen areas

Coldwater fish species could be extirpated from some streams

Earlier spring stream peak flow

Increase in moose density and associated wolf populations could increase risk to caribou

Claybelt will be more favourable to Great Lakes St. Lawrence forest tree species

Incidences of severe forest blowdown

Incidences of building and infrastructure damage

Introduction of southern competitors and pathogens

Soils in western area will be extremely dry by 2100

Smallmouth bass distribution may increase

Species dependant on open paludified habitat could be negatively affected

Enhanced shrub and tree growth

Reduced methane emissions

Enhanced carbon dioxide sequestration

Later fall stream-flow peak

Coolwater walleye productivity increase will increase remote tourism revenues

Step 5 Develop adaptation options

- Climate change adaptation actions help reduce or eliminate vulnerabilities and risks

- Adaptation options come in all forms, shapes, sizes and can:
  - Reduce threats
  - Enhance resilience
  - Engage people
  - Improve knowledge

- Recommended to involve partners, stakeholders, public and organizations that will implement the actions in an evaluation of:
  - Implementation costs
  - Technical and institutional feasibility
  - Likely benefits
  - Social acceptability
  - Ecological suitability etc.

Scoping Adaptation Options

Evaluating Adaptation Options for the Clay Belt Region of Ontario

About the surveys:

There are six thematic areas included in the evaluation of potential adaptation options for the Clay Belt region: aquatics, forests, wildlife, socio-economics, paludification & peatlands and 'cross-cutting' measures.

For each theme, the survey ranks the level of priority of implementing adaptation actions. This is based on feasibility and effectiveness of the adaptation measures.

Clay Belt Eco-district 3E-1
Northeastern Ontario

Complete the surveys:

Before you start the survey, please read the Summary of Climate Change Vulnerabilities and Risks in the Clay Belt Region. You may also wish to review the Clay Belt Climate Change Adaptation Options Portfolio, which forms the basis of the survey's ranking process.

Please complete the survey for the 'cross-cutting' theme.

Complete one other theme based on your experience and interest and if you have additional time, please complete each of the themes. Each survey should take approximately 20 minutes to complete.

When you complete the survey, the information will automatically be sent to the Clay Belt Climate Change project team. You will be entered into a draw to win a GPS navigation unit for completing the survey.

Access the surveys:

Cross-cutting

Aquatics

Forests

Socio-economics

Wildlife

Paludification & Peatlands

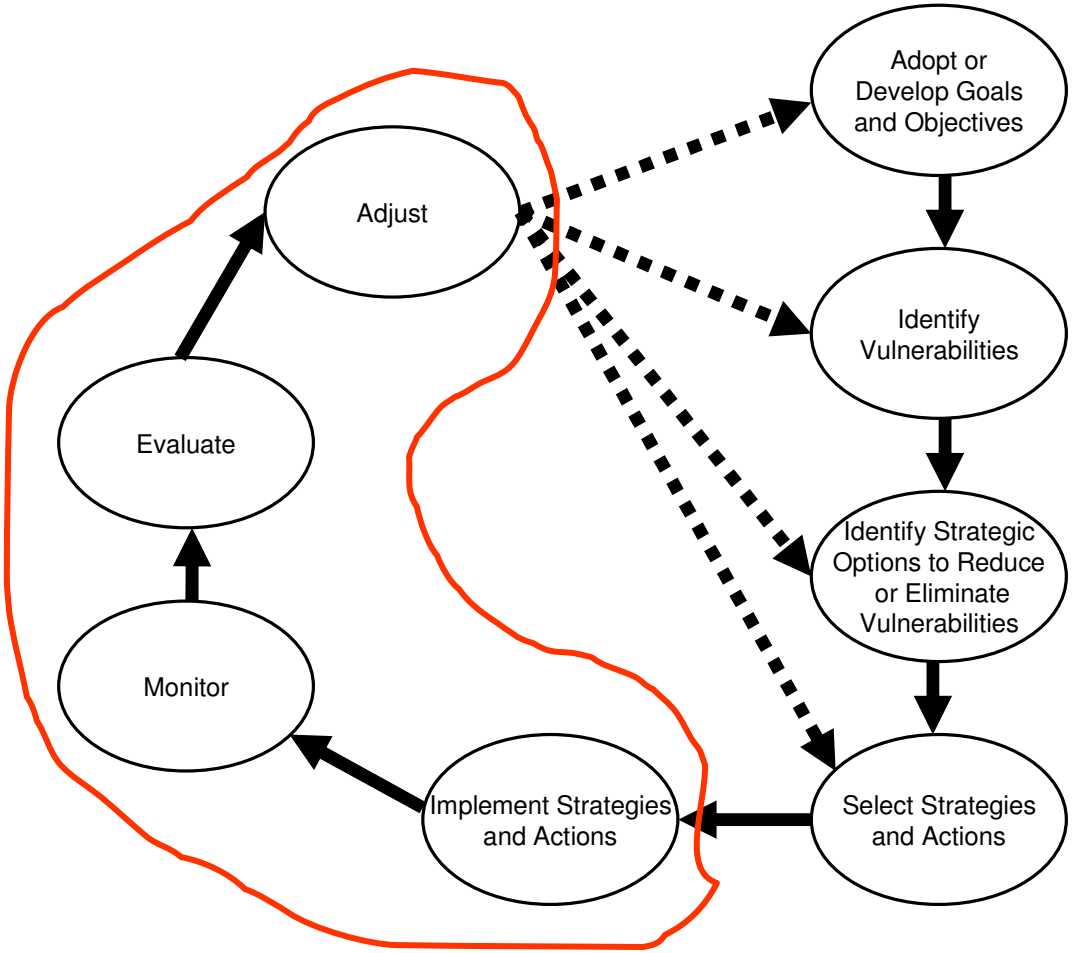
Summary of Recommended Adaptation Options for the Clay Belt Ecodistrict (3E-1)

Survey Theme	Rank	Recommended Adaptation Options
Crosscutting	1	Identify indicator species to monitor response (e.g., abundance, distribution, health) to climate change impacts over time
	2	Evaluate current monitoring network for tracking the impacts of climate change on natural resources and ecosystems and address identified gaps in monitoring
	3	Integrate principles of adaptive management and an ecosystem-based approach into [illegible] plans (e.g., forest management plans, fisheries management plans)
Aquatics	1	Develop protection measures for ground water areas and eskers with[illegible]
	2	Conduct research on how climate affects aquatic ecosyste[illegible]ing fish comm[illegible] dynamics
	3	Monitor range expansion of aquatic invasive sp[illegible]
Forests	1	Apply silvicultural techniques that ma[illegible] age stan[illegible] and mixes of species
	2	Educate forest manageme[illegible] on climate change science and adaptation tools and techniques they can u[illegible]
	3	Increas[illegible] inve[illegible]tory and monitoring including growth and yield, insects, disease, and si[illegible]veness
Socio-economic	1	[illegible]p emergency preparedness strategies that help communities prepare for increased flooding, drought, and other impacts from extreme weather events
	2	Diversify local forest-based economies (e.g., value added products, non-timber forest products, tourism, agriculture)
	3	Understand environmental goods and services provided by healthy ecosystems
Wildlife	1	Understand impacts of climate change on wildlife species, their habitat, invasives, and food web effects
	2	Understand species biology, particularly traits such as vagility (how a species can move and spread), genetic variability and biotic interactions
	3	Improve monitoring to detect, prevent, and respond to new pests and wildlife diseases
Peatlands and Paludification	1	Require identification of the type of paludified forest to help characterize the landscape in forest management planning
	2	Integrate paludification issues into existing silvicultural guides and other best practices
	3	Educate practitioners and forest managers on the function and role peatlands play in global carbon cycles

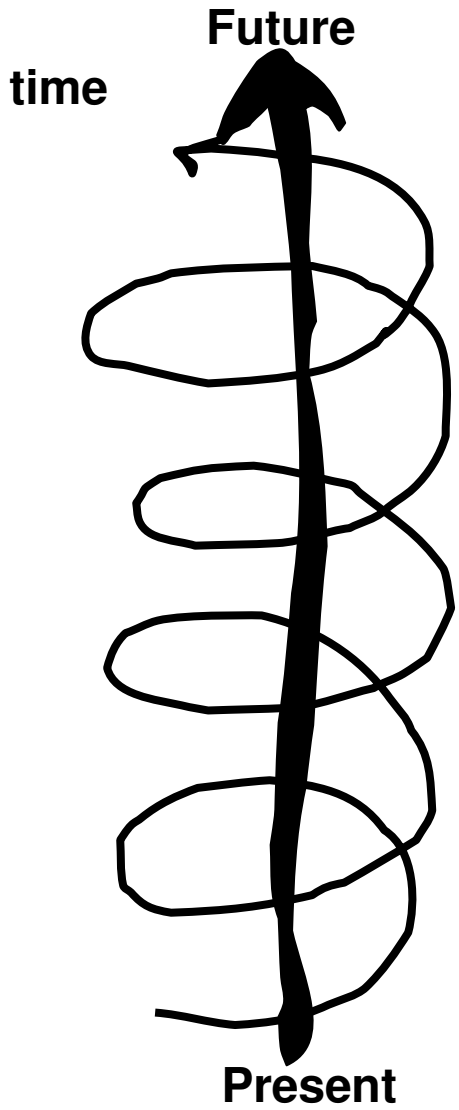
Develop protection measures for ground water areas and eskers within the Clay Belt

Step 6 Implement and mainstream adaptation

Implementation of climate change adaptation plans and strategies will require an adaptive management approach



Step 6 Implement and mainstream adaptation and use monitoring to detect change and gauge management success



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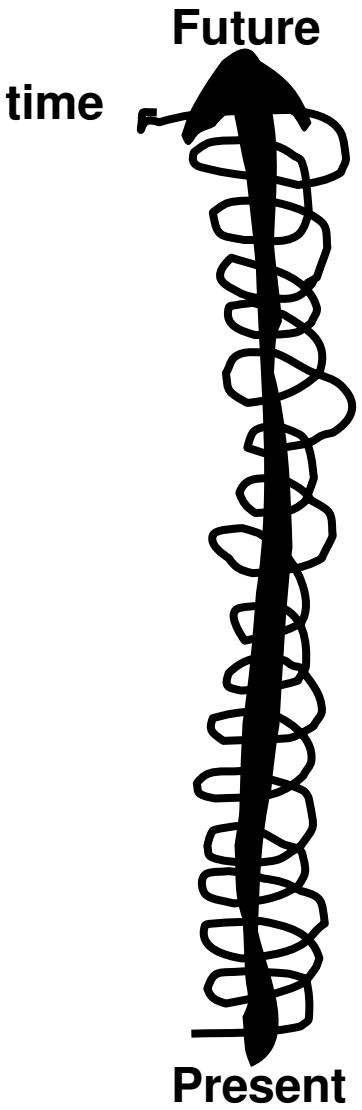
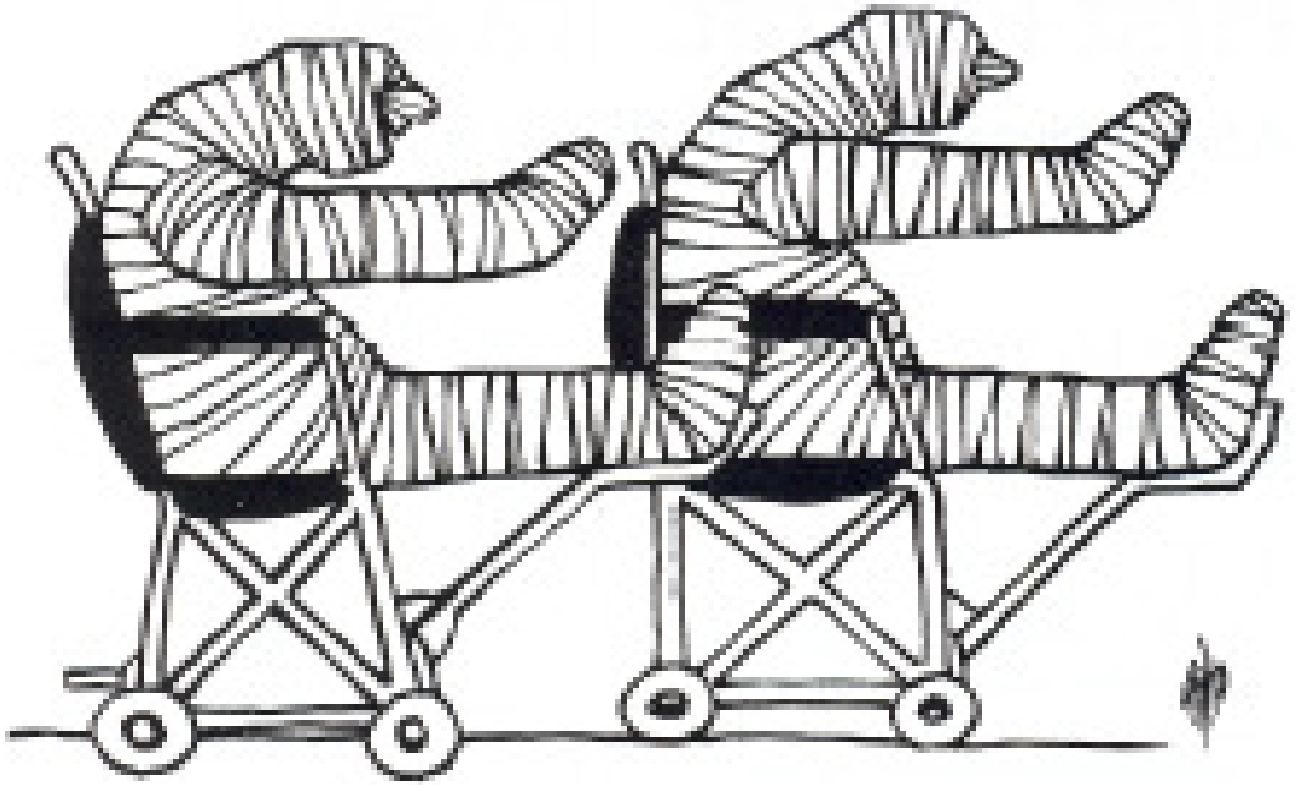


or

Step 6 Implement and mainstream adaptation including the capacity to learn and adjust in mid-course



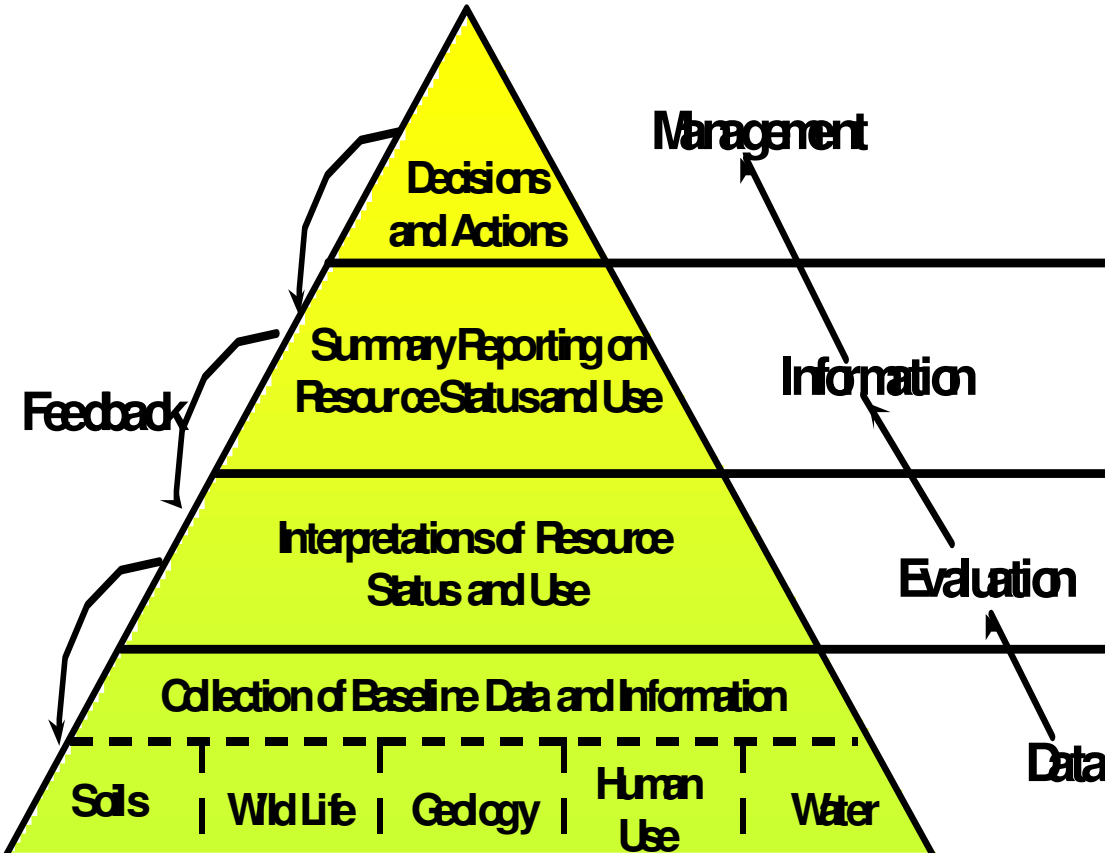
"Want to go halves on another toboggan?"

"You live and learn. Or you don't live long."

(Source: Robert Heinlein)

Step 6 Implement and mainstream adaptation and ensure management information systems work

1. **Monitor habitat e.g. water temperatures**
2. **Monitor species**



Great Lakes too cold for Asian grass carp? For how long?

Steps 1-6 Some emerging axioms?

1. **It is risky to make medium and long-term decisions that assume a stable climate.**

2. **Every species and every ecosystem will respond to climate change in a unique way.**

3. **New and potentially increased threats to human health and well-being.**

4. **The concept/ideal/target of sustainability will require re-evaluation.**

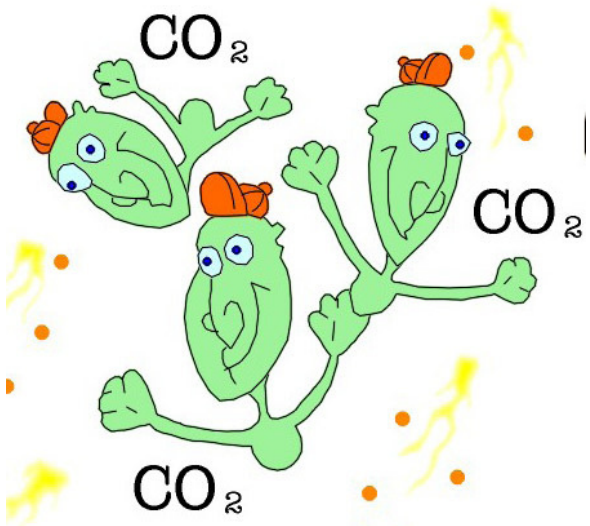
5. **Making decisions about natural assets in climates that have not arrived yet may require new robust governance tools and techniques.**

6. **A commitment to civic duty and participation is important.**

7. **Every town and city and every industry will be confronted with a unique set of climate-induced impacts and associated management issues, and will need to plan for a range impacts with a range of solutions and adaptation strategies.**

(Source: Gray et al, 2011)

The End



(Source: P.C. Gray)