Responding to and managing for climate change is about asking the right questions

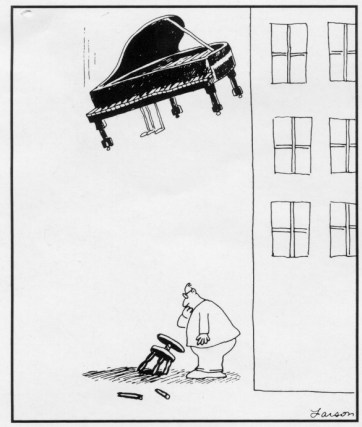
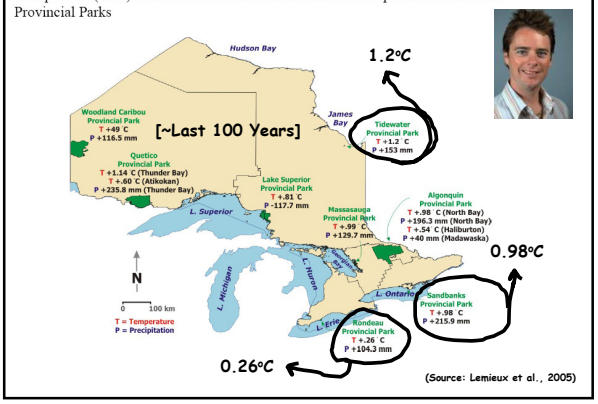
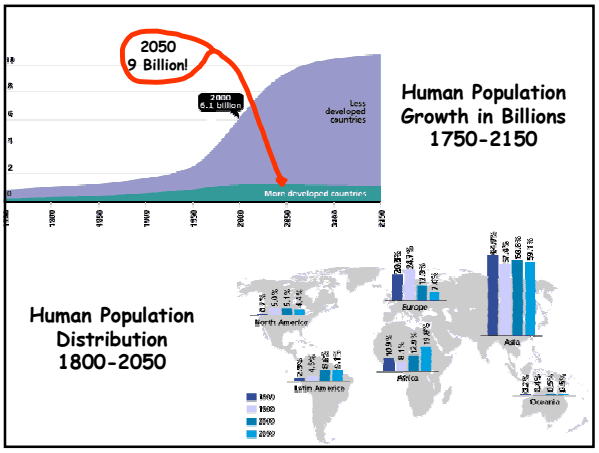
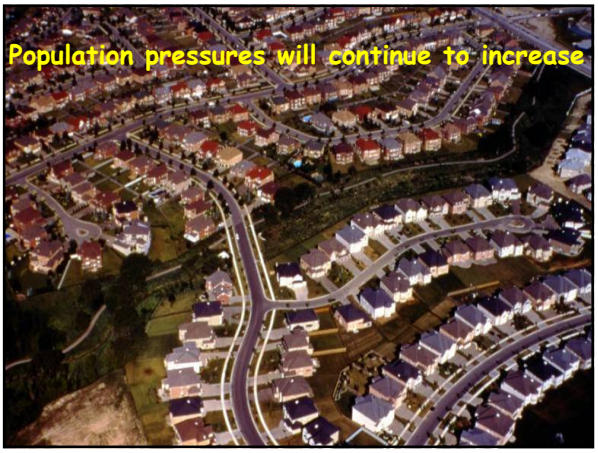


Figure 5: Summary Map of Mean Annual Temperature (MAT) and Total Annual Precipitation (TAP) Trends over the Historical Records for Representative Ontario Provincial Parks

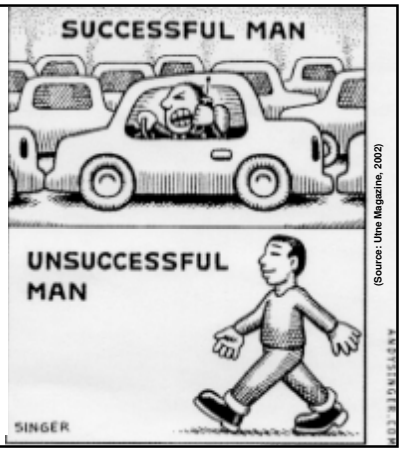


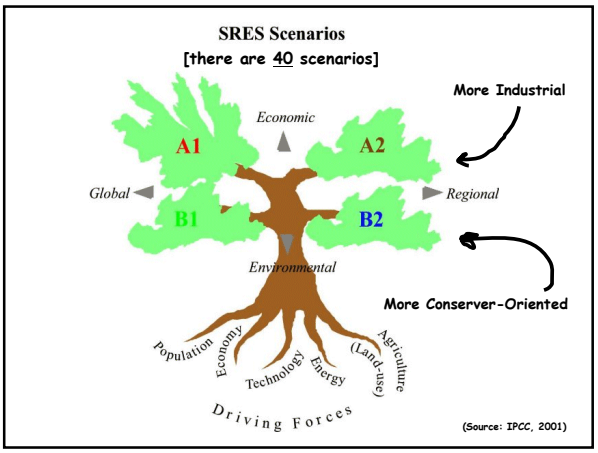


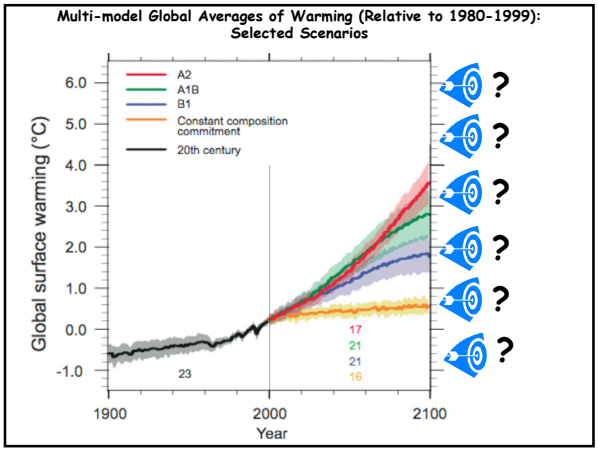


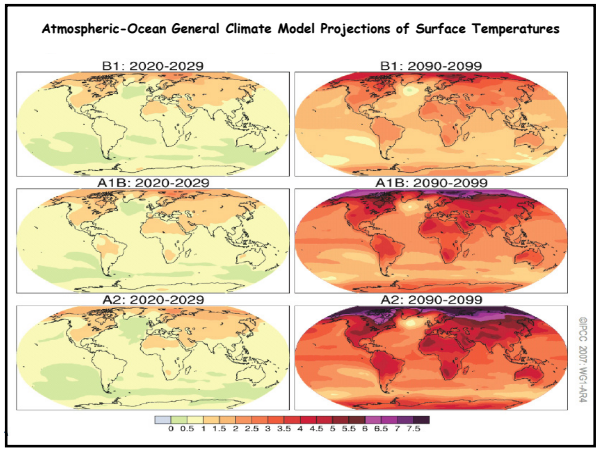
We don't really know how people will behave during the next 100 years

~2-6°C

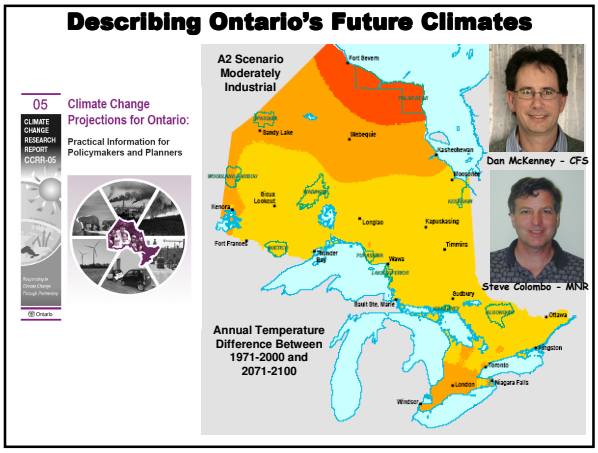




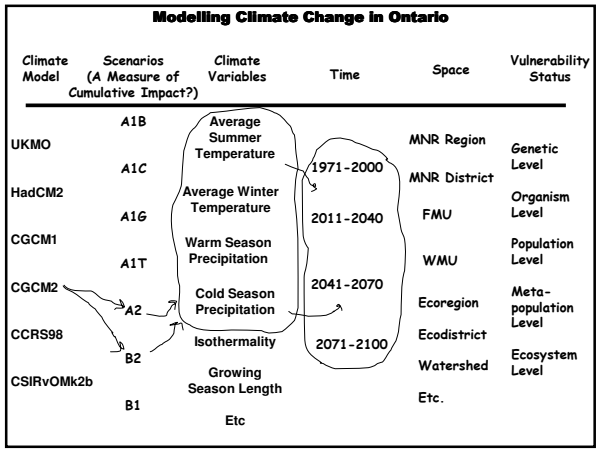




Describing Ontario's Future Climates

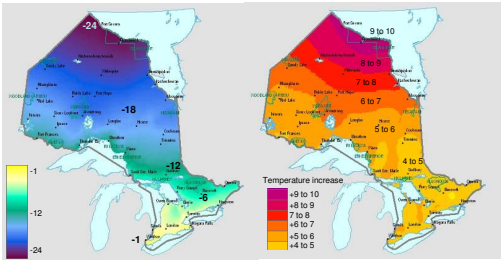


Modelling Climate Change in Ontario

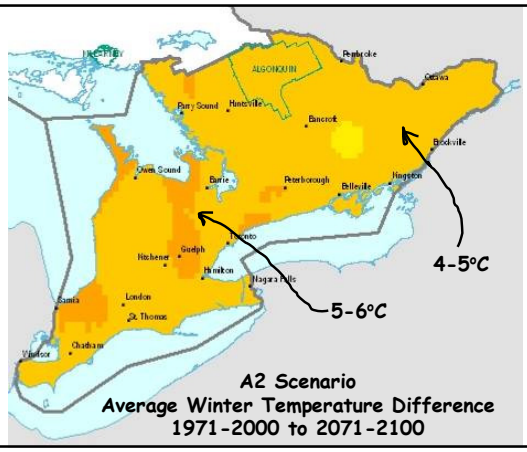


Winter temperature

Temperature 1971-2000 | Change by 2071-2100



Average winter temperature, CGCM2, A2 scenario



Some Emerging Axioms?

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

Some Emerging Axioms?

1. Can't assume a stable climate:

Changing temperature and precipitation patterns:
- Reduced access to water
- Heat stress
- Disease and parasites

Extreme event periodicity:
- Floods
- Blowdowns
- Fire
- Drought
- Bugs (Mountain Pine Beetle)

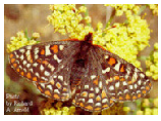
→ Species Distribution and abundance
Species growth and yield
Human health
Human safety
Economic impacts
Cultural impacts

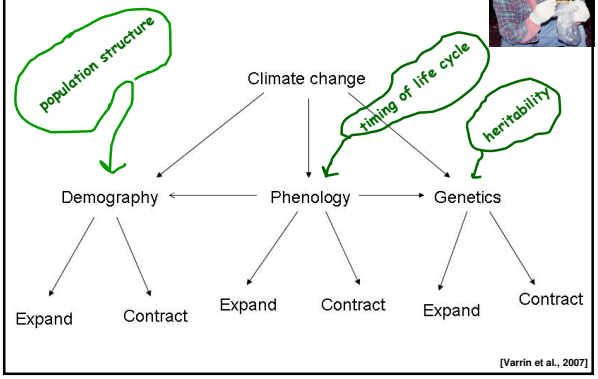
Organism Response to Rapid Climate Change: [Adapt, Move, or Die]

Adaptation/Micro-evolution

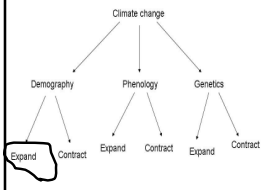
Home Range Change/ Migration

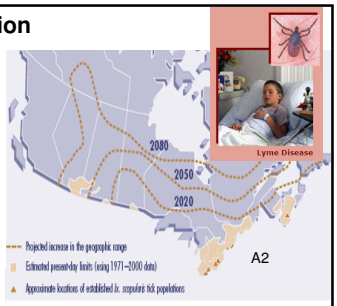
Extirpation/Extinction





Demography – expansion
Black-legged tick





Known and potential effects

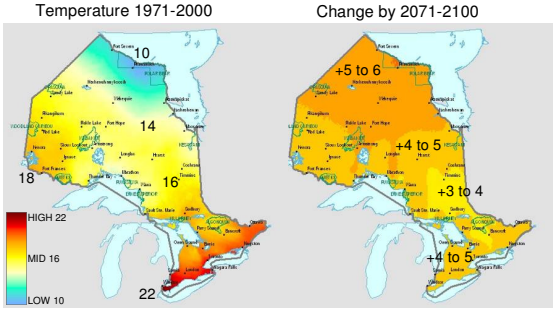
Ixodes scapularis is the vector for the causative agent of Lyme Disease in humans

Increased adult survivorship in winter leads to range expansion at northern boundary

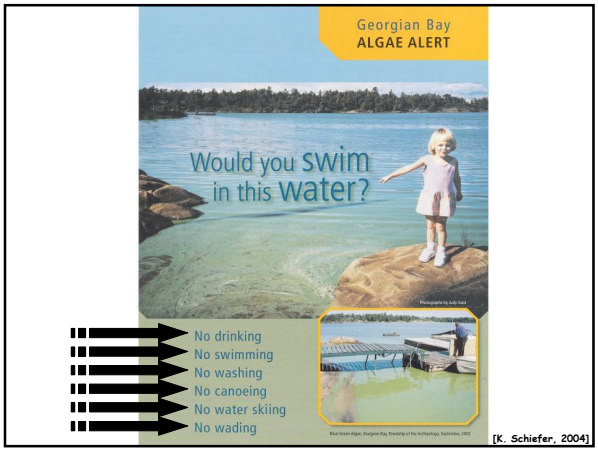
Adapted from Ogden et al. 2006 Internat. J. Parasitol. 36: 63-70.

Summer temperature

Temperature 1971-2000 | Change by 2071-2100



Average summer temperature, CGCM2, A2 scenario

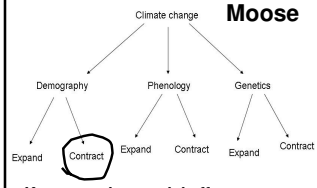


[K. Schiefer, 2004]

Some Emerging Axioms?

1. It is risky to make medium and long-term decisions that assume a stable climate.
2. Human health will be an issue.

Demography – contraction
Moose



Known and potential effects

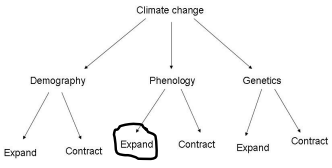
Possible declines in southern parts of range as precipitation (in parts of the range) and temperature increase

In areas with marked increases in snowfall, increased pressure from wolf predation may occur which may further facilitate moose declines

As deer invade moose range, potential for an increased incidence of *P. tenuis* and liver fluke infection in moose and increased mortality

[Varrin et al., 2007]

Phenology – expansion
Eastern bluebird



Known and potential effects

Eastern Bluebird is now migrating and breeding earlier due to warmer winters (Butler 2003, Torti and Dunn 2005)

May even begin to over-winter in some areas of Ontario where average January temperature does not fall below -6.7°C

Potential to expand number of broods produced in one breeding season, leading to range expansion

[Varrin et al., 2007]

Relative risks of climate change associated with certain traits of species in Ontario……..

Trait	Direction of trait	Relative risk
Geographic range size	Large	Low
	Small	High
Genetic variability	High	Low
	Low	High
Vagility	High	Low
	Low	High
Location of range boundaries	SBO*	High
	NBO**	Low

*SBO = southern range boundary occurs in Ontario
**NBO = northern range boundary occurs in Ontario

[Varrin et al., 2007]

With ~ a 1°C increase…….

Of 175 terrestrial vertebrate species studied in relation to Ontario and climate change:

- **10 show evidence of contraction**
- **62 show evidence of expansion**
- **103 show no change**

Varrin et al. (2007)

Can you "roll up" single species effects?.....

Mammal species richness = 1.96 (annual temperature) + 38.1 + error

Energy models predict that biodiversity in Ontario should increase with climate warming

[Kerr and Packer. 1998. Environmental Monitoring and Assessment, 49: 263-270]

Biodiversity and Ecodiversity

Ecosystems

Genes

Species

Energy models do not account for "biotic interactions"…..

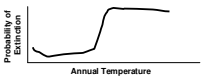
Synergy

Asynchrony

+?

Asymmetry

Thresholds



[Varrin et al., 2007]

So what does this all mean?

Energy Model: ↑ Temperature = ↑ Biodiversity

But…….

biotic interactions are complex, and may often lead to extinctions, creating a deficit of species compared to energy models

Whether or not there is a reduction…..

the configuration of Ontario's ecosystems and the constituents of its biodiversity will change

[Varrin et al., 2007]

Some Emerging Axioms?

1. It is risky to make medium and long-term decisions that assume a stable climate.
2. Human health will be an issue.
3. Every species and every ecosystem will respond to climate change in a unique way.

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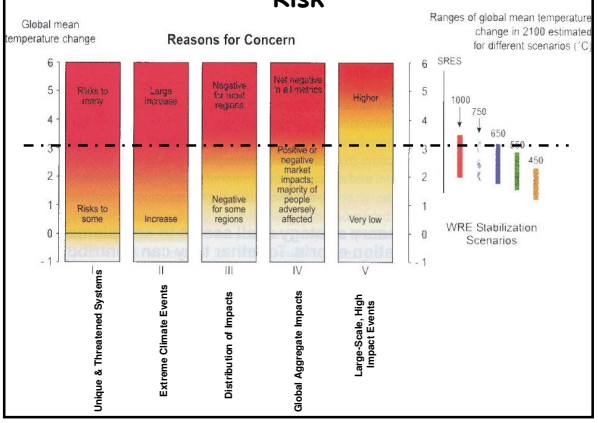
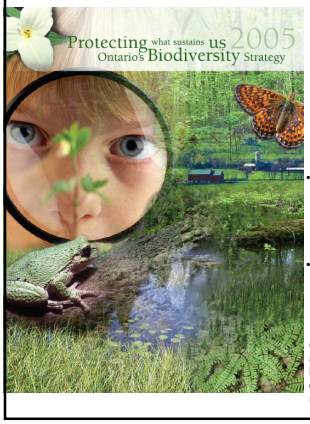
Risk





Goals

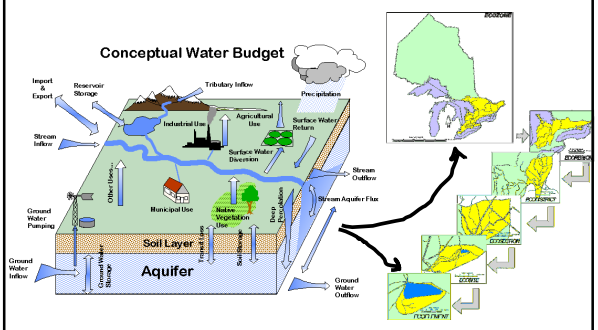
1. Protect the genetic, species, and ecosystem diversity of Ontario.
2. Use and develop the biological assets of Ontario sustainably, and capture benefits from such use for Ontarians

Principles

- All Canadians depend on biodiversity and have a responsibility to contribute to biodiversity conservation and to use biological resources in a sustainable manner.
- An ecological approach to resource management is central to conserving biodiversity and using our biological resources in a sustainable manner.

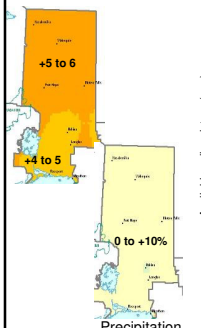
(The province needs to…) enhance the current risk assessment capability in Ontario so that …risks to biodiversity from climate change can be better evaluated, and priorities for contingency plans and response teams identified.

Hydrological Cycle

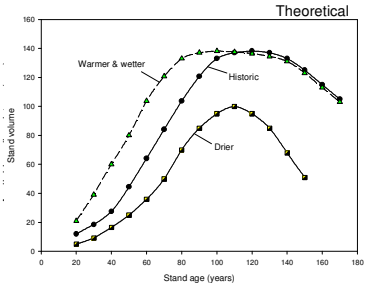


Changes in Soil Moisture May be Crucial

Nipigon temperature 2071-2100



Precipitation 2071-2100



Nipigon Forest, A2 greenhouse gas scenario
Canadian GCM

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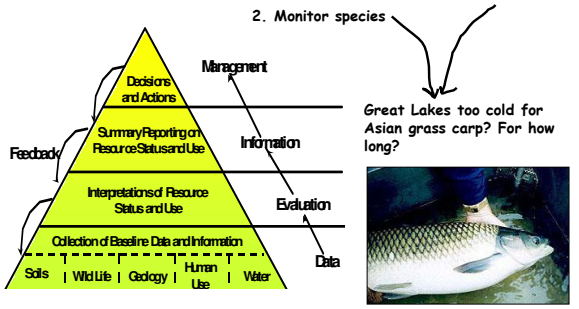
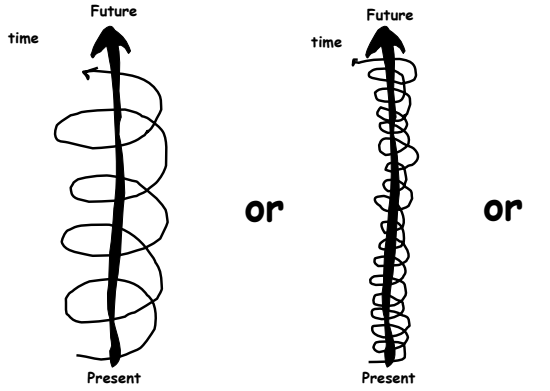
5. The concept/ideal/target of sustainability will change.

Q: Do existing approaches to data and information management meet our needs?

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



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



Q: Commitment to biological, physical, and socio-economic monitoring?

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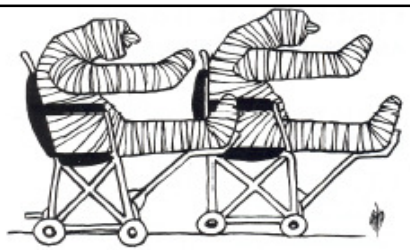
5. The concept/ideal/target of sustainability will change.
6. A robust monitoring and assessment program is critical to adaptive management.



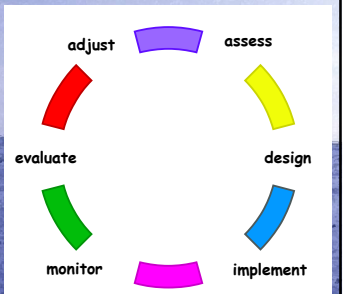
"Want to go halves on another toboggan?"

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

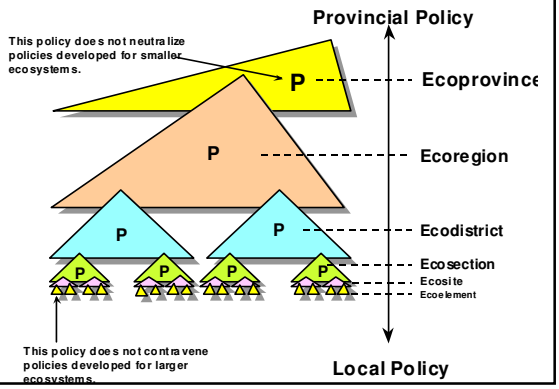
(Source: Robert Heinlein)

Responding to Climate Change

- Understand
- Mitigate
- Adapt



Integrated Policy/Plan Development



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5. The concept/ideal/target of sustainability will change.
6. A robust monitoring and assessment program is critical to adaptive management.
7. New governance tools and techniques – adaptive management using a robust public-government partnership.

It's about civics…..

the rights and duties of citizenship

(Gordon Nelson, University of Waterloo)

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5. The concept/ideal/target of sustainability will change.
6. A robust monitoring and assessment program is critical to adaptive management.
7. New governance tools and techniques – adaptive management using a robust public-government partnership.
8. A commitment to civic duty and participation is critical.

Some Questions confronting all sectors of society…..

Do we need to evaluate our collective interpretation of, use of, and commitment to sustainability in plans, policies, manuals, and guidelines?

Do we need to re-evaluate our current approaches to monitoring and assessment?

Should we explore options for new governance tools and techniques – adaptive management using a robust public-government partnership?

How do we instill a commitment to civic duty and participation?

[Source: D. Etkin]

The End