

# Emerging challenges and converging responses:

Challenges and opportunities for  
conservation in an era of global change

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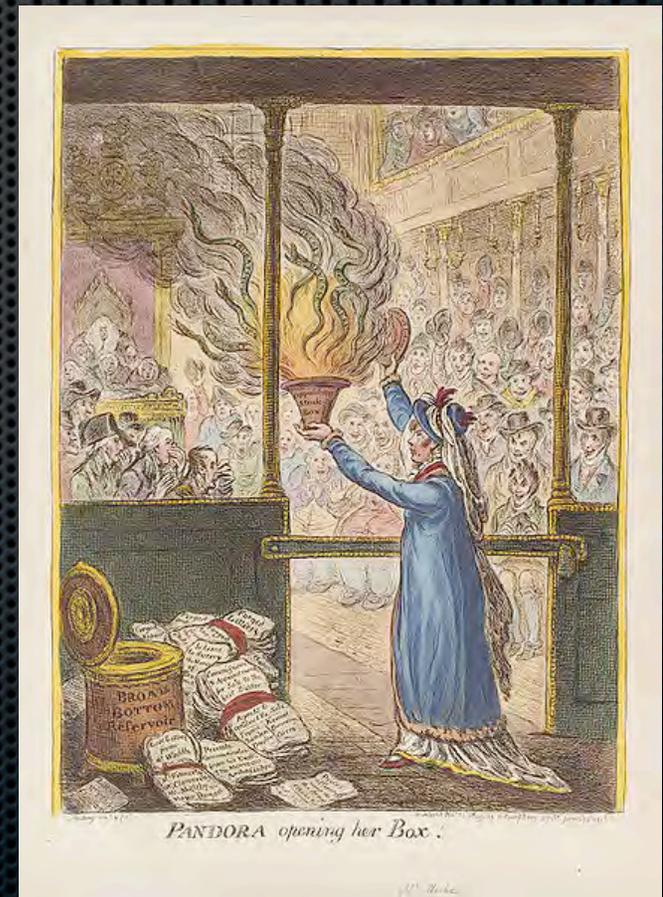


# Outline

- ✦ Very brief introduction to two aspects of global change
- ✦ Emerging challenges: patterns and causes of species endangerment in Canada
- ✦ Emerging challenges: climate change
- ✦ Converging responses:
  1. Engage Canadians in an ongoing **conservation conversation**.
  2. Add proactive conservation initiatives to the agenda.

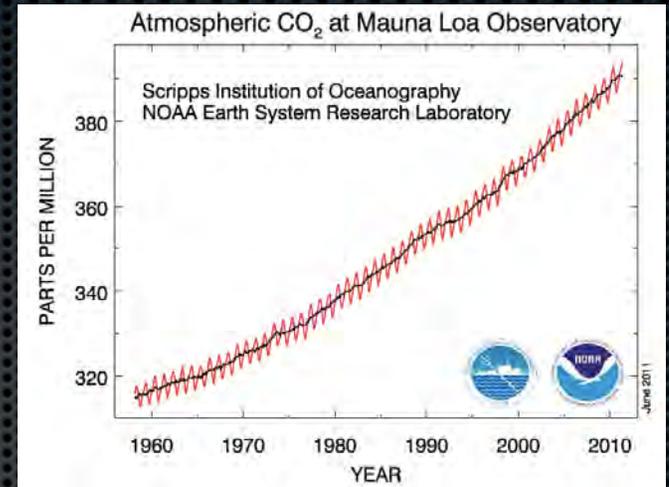
# Changing climate

- Greenhouse gas emissions, especially carbon dioxide from fossil fuel combustion, have altered global and regional climate in the past century.
- Continued human-caused greenhouse gas emissions will cause progressively larger climate changes, with wide-ranging secondary consequences.
- For example, when global temperatures were 2 °C warmer (couple million years BP), sea level was 25 m higher.



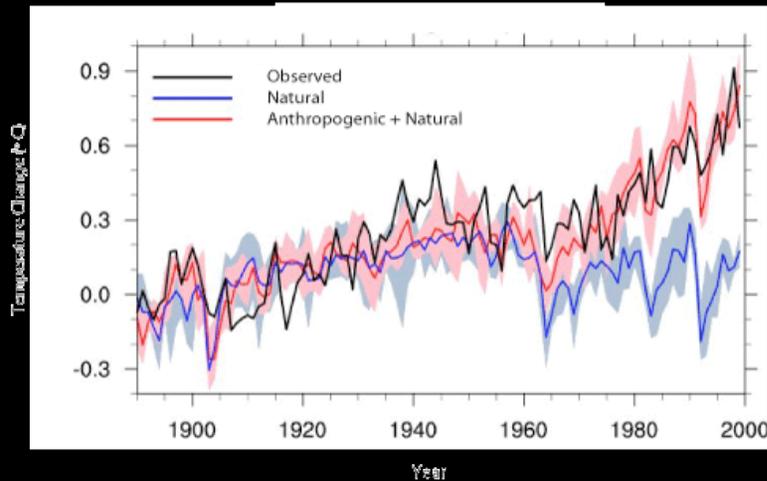
# How do we know?

## 1. Initial observations



Comparison of **Modeled and Observed** Temperature

1980 - 2000

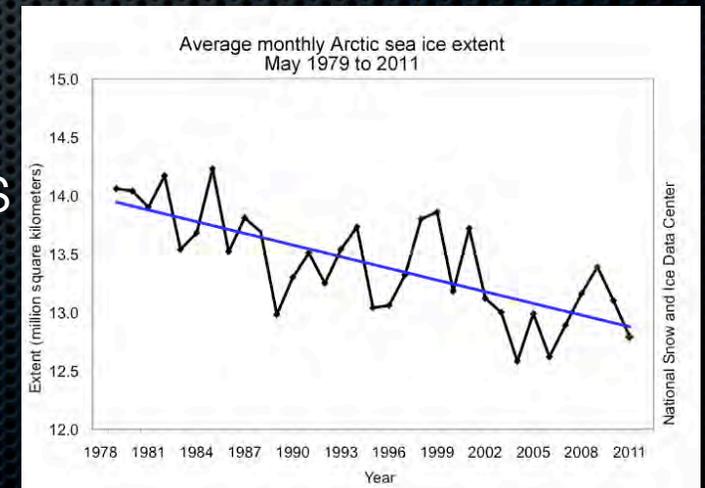


Graph Source: Meehl, G.A., W.M. Washington, C.M. Ammann, J.M. Arblaster, T.W. L'Ecuyer, and C. Tebaldi, 2004.

## 2. Subsequent model development and testing

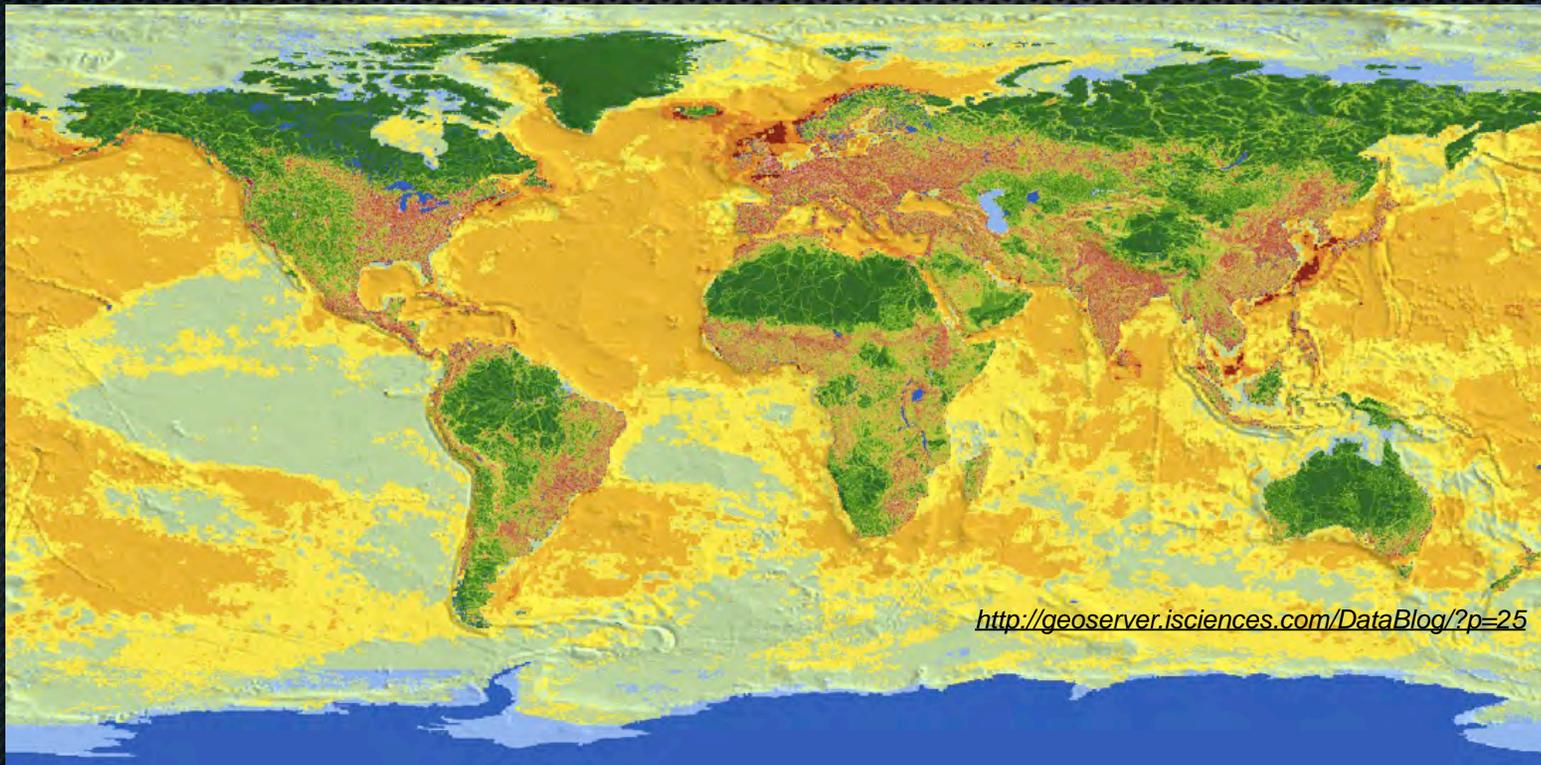
## 3. Secondary predictions that are consistent

Each dataset is TEMPORAL: A vital lesson for global change biology and macroecology

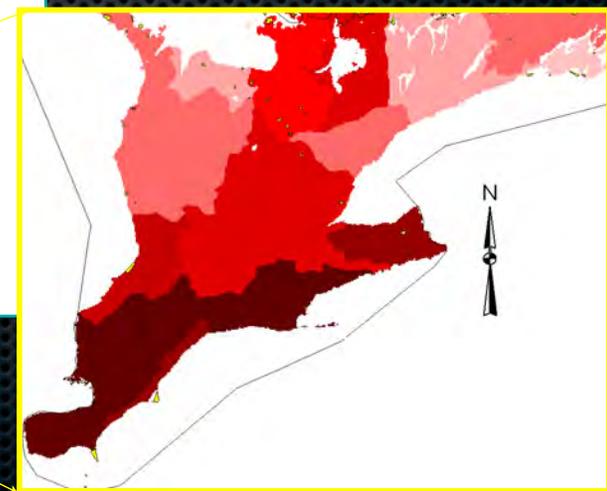
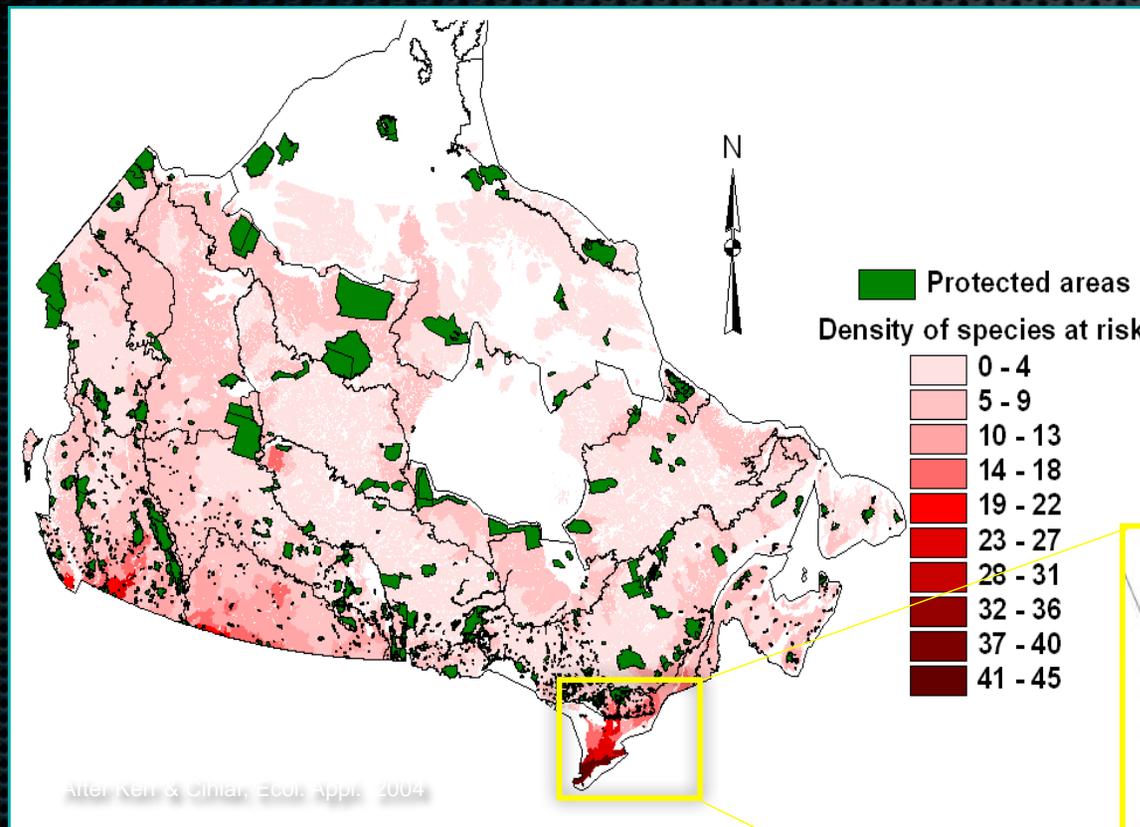


# Human impacts on habitat

- Habitat loss is globally pervasive and a leading cause of extinction. There are few wilderness areas left.
- Anthropocene: reshaping global energy and material cycling to serve human needs. Our footprints are deep.

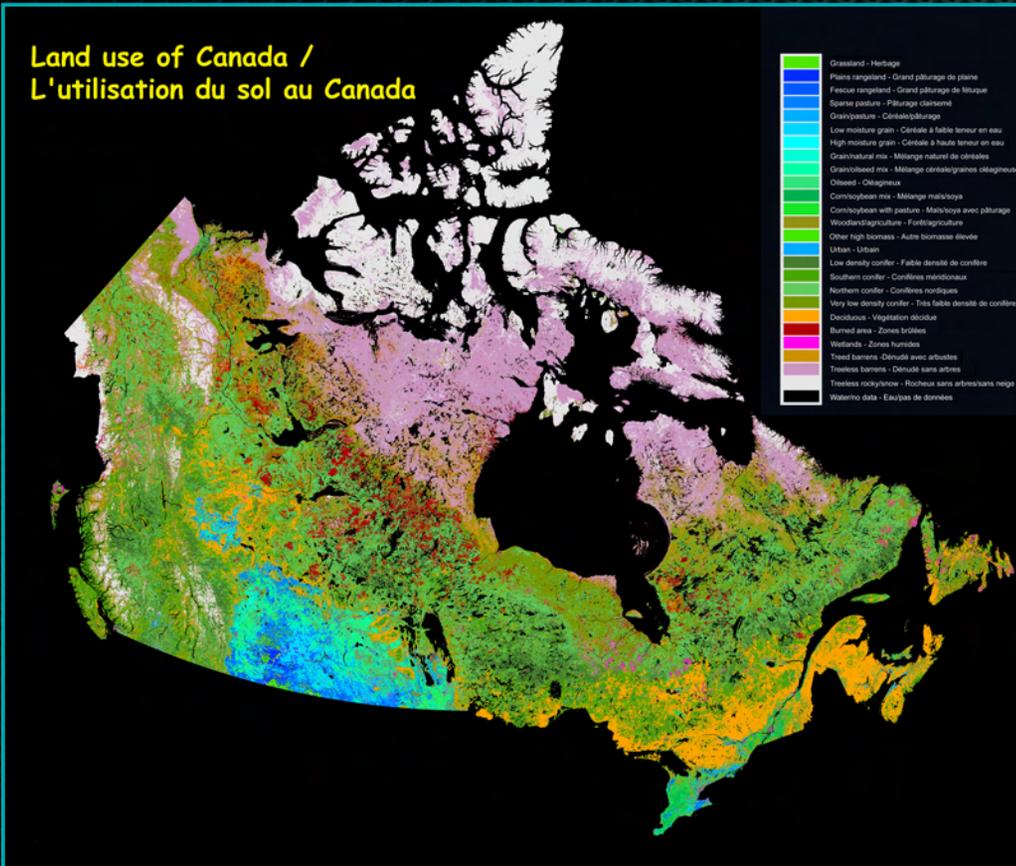


# Consequences of habitat loss?



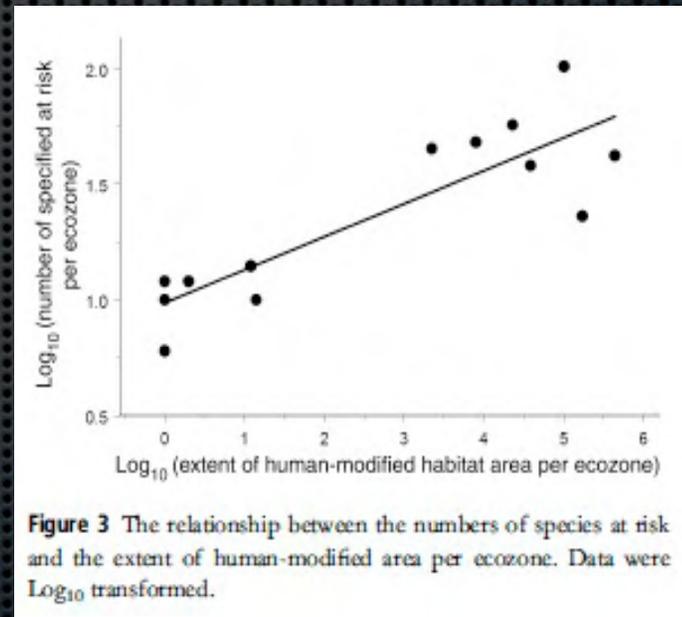
Kerr & Cihlar 2004

# Causes of species endangerment



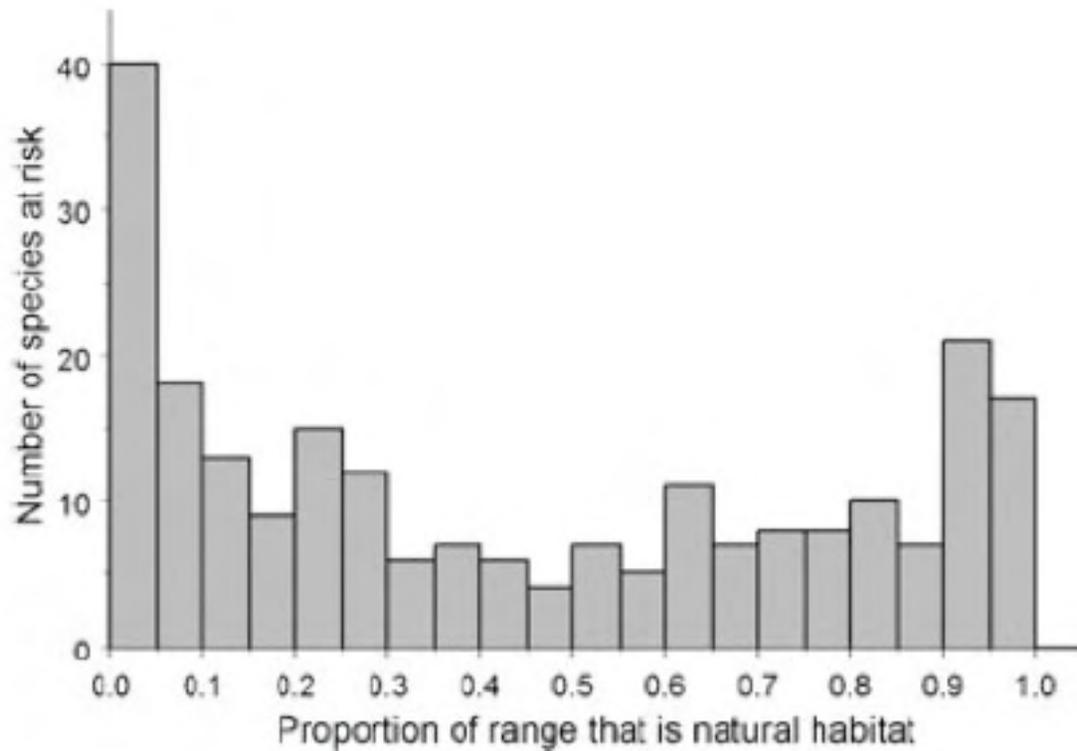
Agricultural land uses relate strongly to rates of species endangerment.

Kerr & Cihlar 2003



Kerr & Deguise 2004

# Is there enough habitat for species at risk to recover?



**Figure 4** A histogram showing the numbers of species at risk (total = 243) relative to proportion of remaining natural habitat within their total ranges.

Many terrestrial species (n = 243) have little remaining habitat, based on satellite-based land use/land cover data for Canada.

(Kerr & Deguise 2004 Ecol. Lett.)

Recovery potential:  
there is almost no  
habitat left for many  
species.

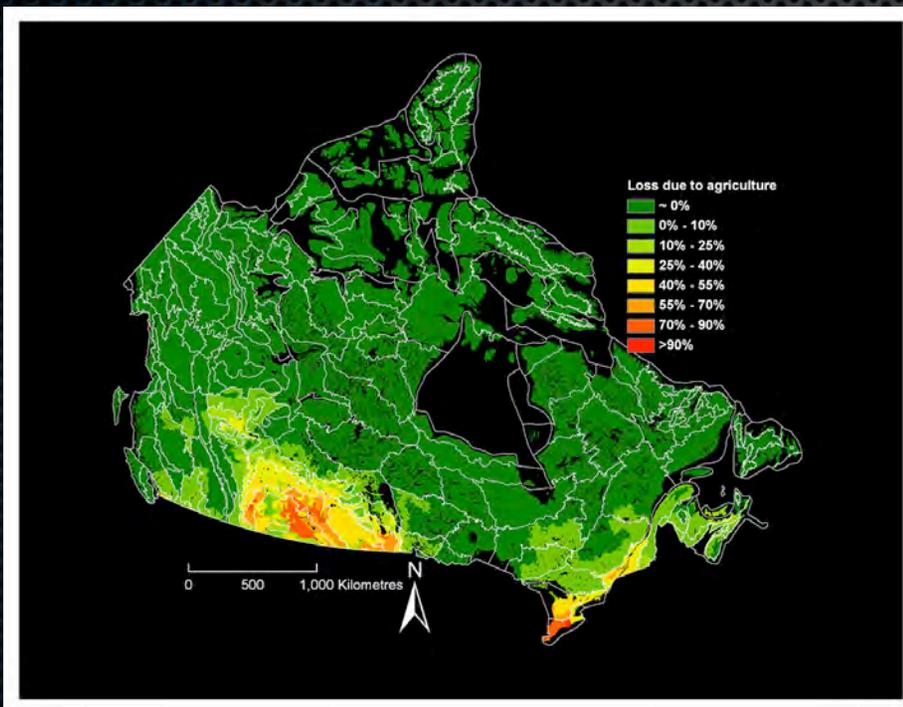
# Can we restore habitat to permit species at risk recovery?

- If habitat losses reflect urbanization, restoration will be more challenging and frequently impractical.
- Venter et al. (2006) argue that habitat loss to urban areas is the most significant cause of species endangerment.

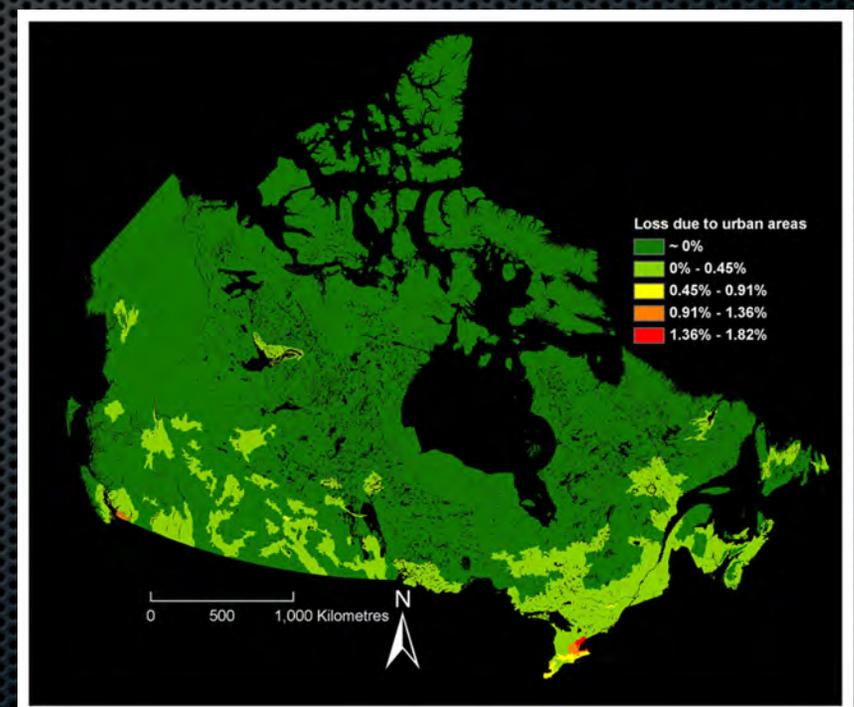
- Agricultural land uses are vastly more extensive than urban areas ...

... ***but***

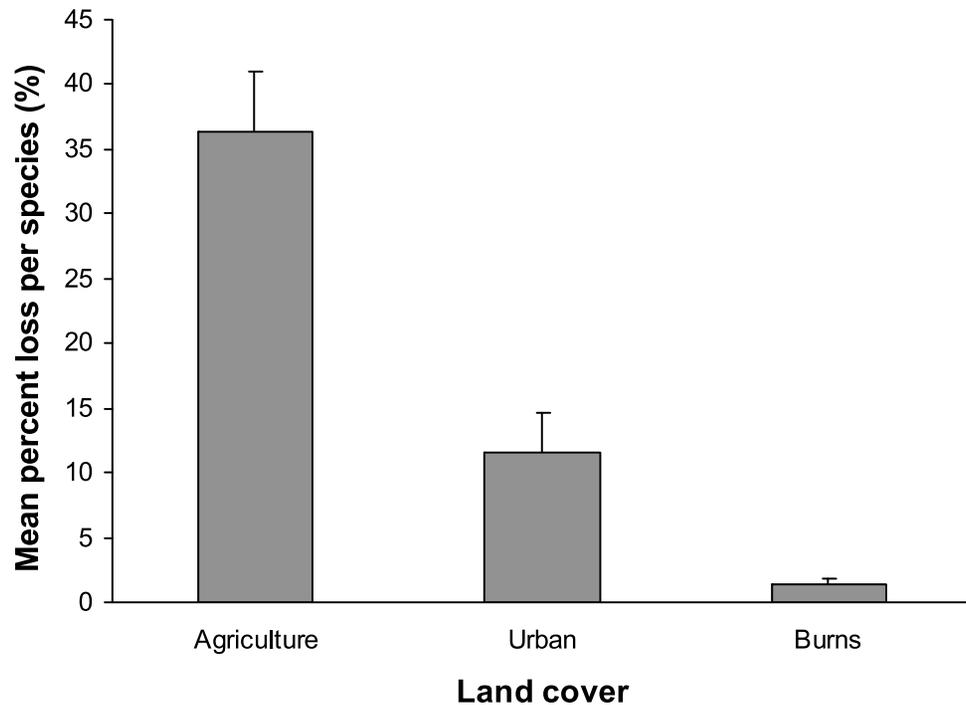
... urban areas are concentrated in Canada's biodiversity hotspots.



% intersection of agriculture with SAR range



% intersection of urban with SAR range



- Although the footprint of agriculture is relatively enormous, because most urban areas are carved out of biodiversity hotspots, the impact of urban areas is disproportionate...

... but agriculture has a much larger impact than urban areas.

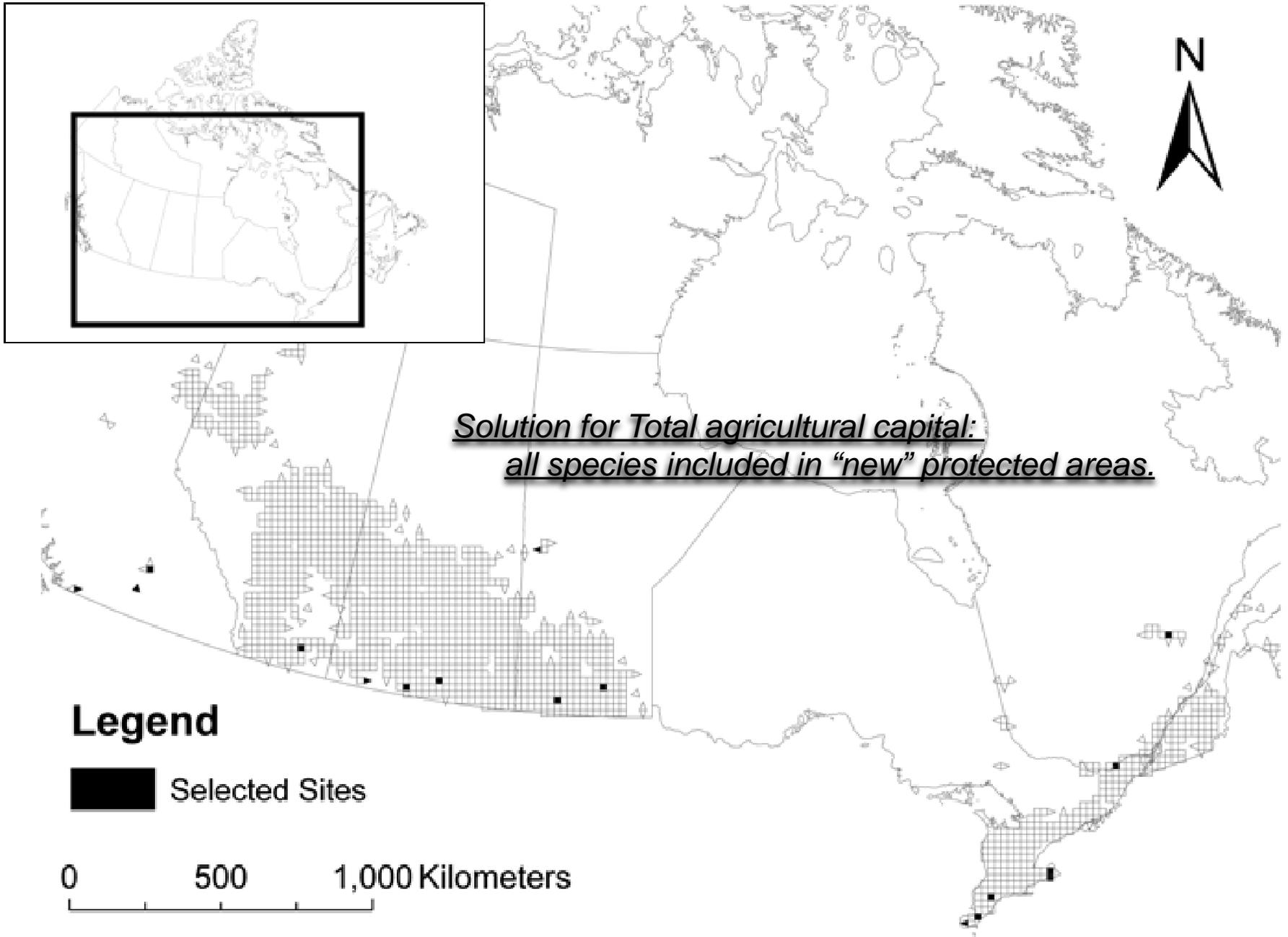
Restoring habitat in agricultural areas: the **first** frontier for species at risk recovery.

HOW:

Determine economic value of agricultural lands based on total agricultural capital or total agricultural income.

Determine conservation value by counting numbers of SAR that were historically present in each “planning unit” across Canada.

Maximize conservation benefits while minimizing economic costs.

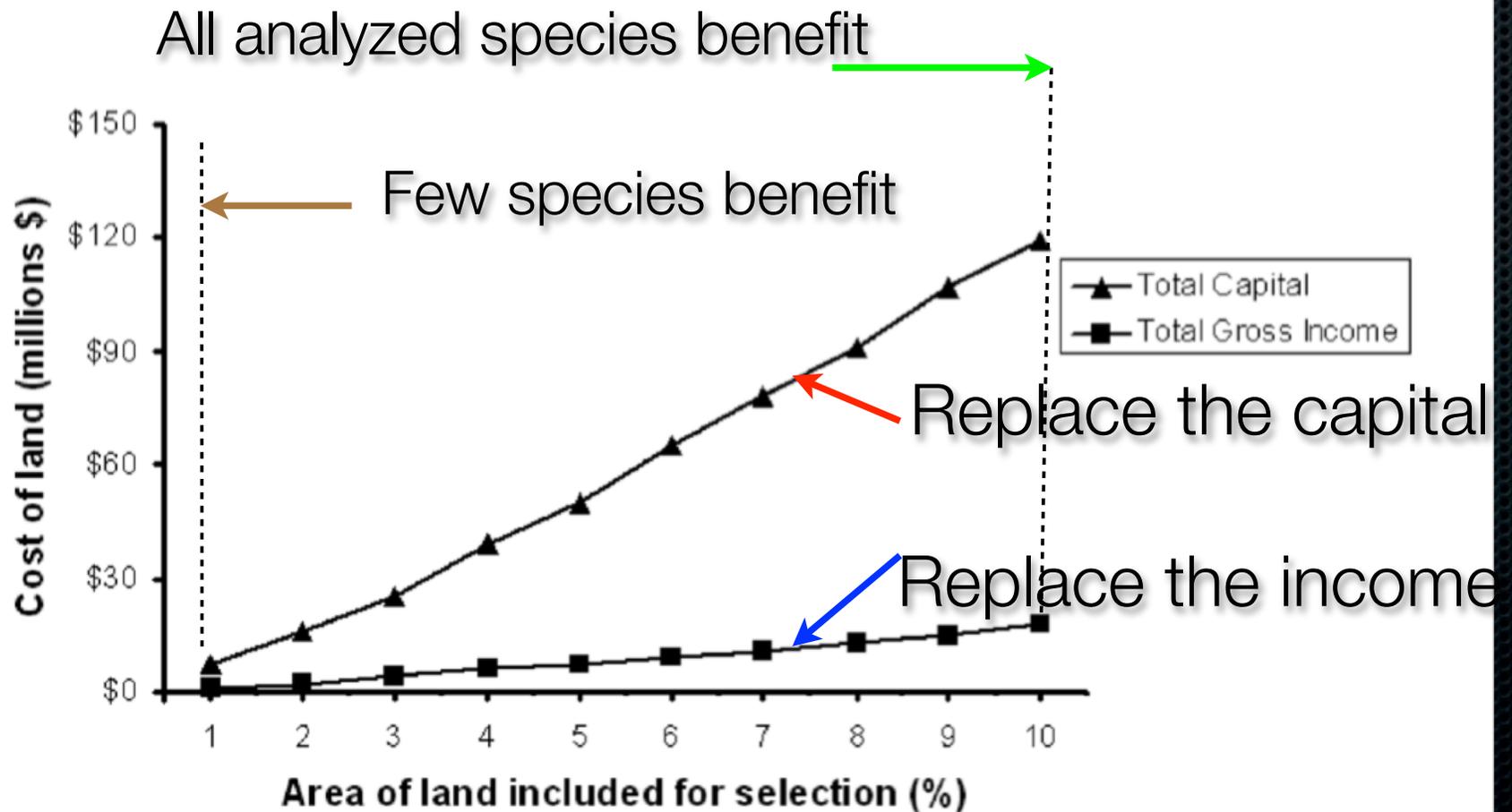


Solution for Total agricultural capital:  
all species included in "new" protected areas.

### Legend

Selected Sites

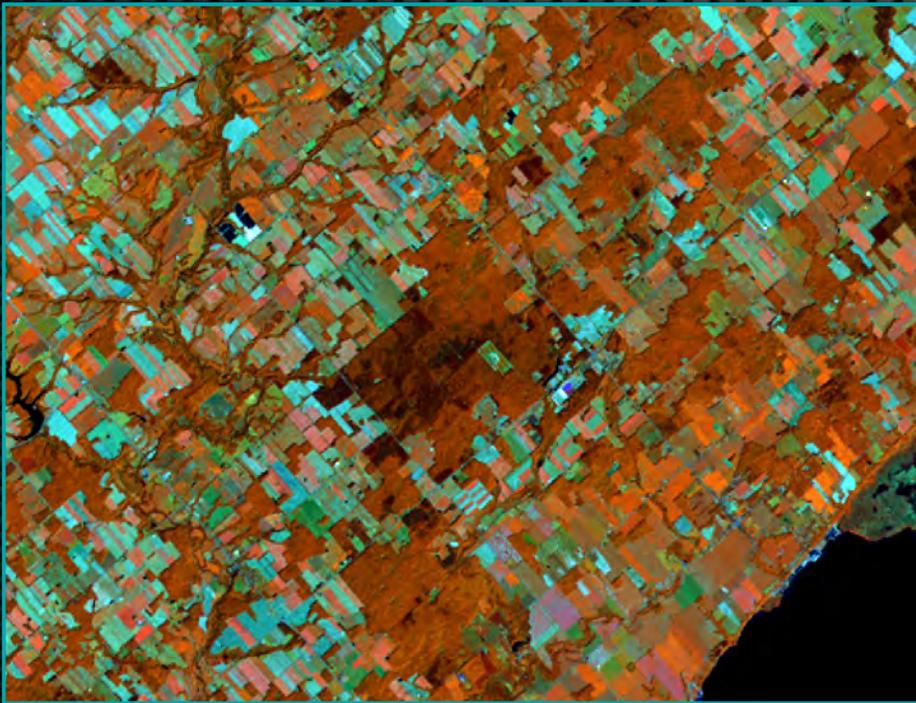
0 500 1,000 Kilometers



- Targeting the least profitable agri-lands for restoration permits larger benefits per \$.

# The impact of the habitat loss challenge:

1. Many species have virtually no remaining habitat
2. Agricultural land conversions are vastly more extensive than urban areas.
3. We can accomplish a lot with relatively small expense and effort. We don't need a societal revolution to make a huge impact on the habitat loss challenge.



Landsat imagery for the best remaining area in Carolinian Canada

# Emerging challenges: Climate change

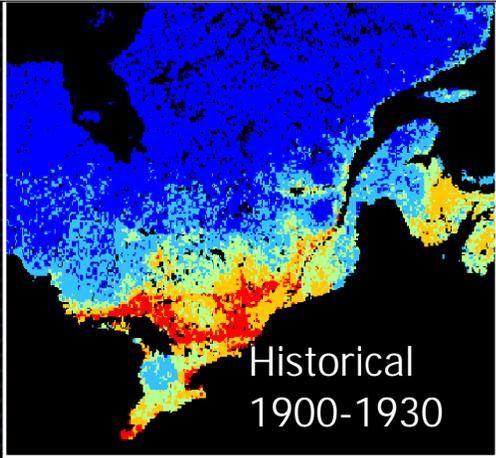


African Monarch, Pilanesberg,  
South Africa

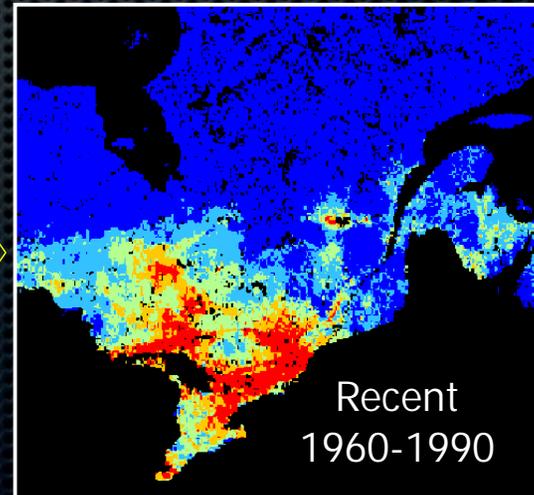
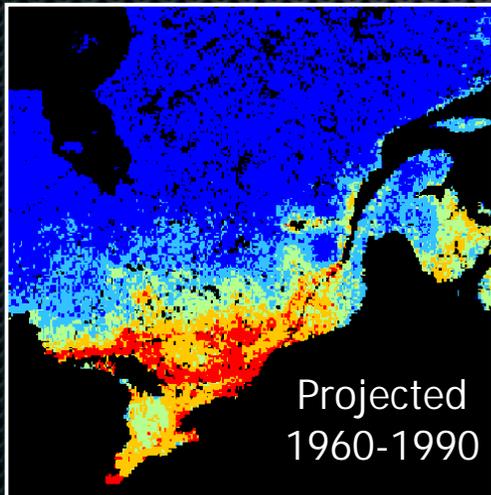
Climate  
affects  
everything.



Responses are  
**complex.**



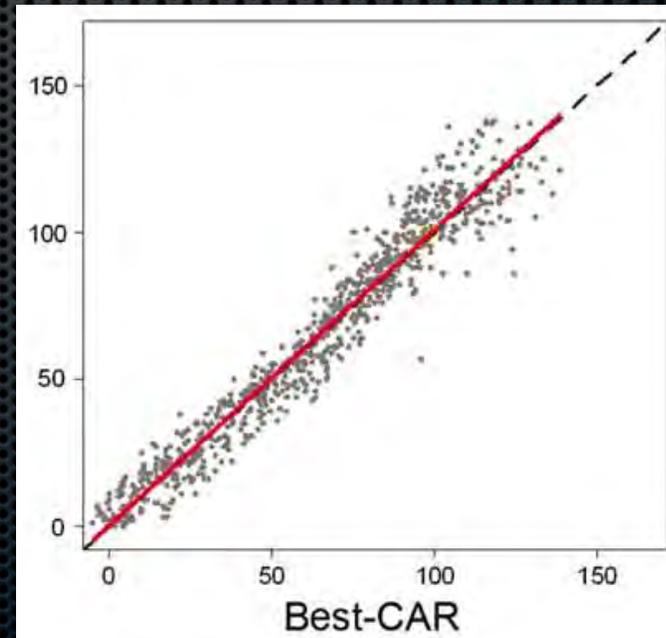
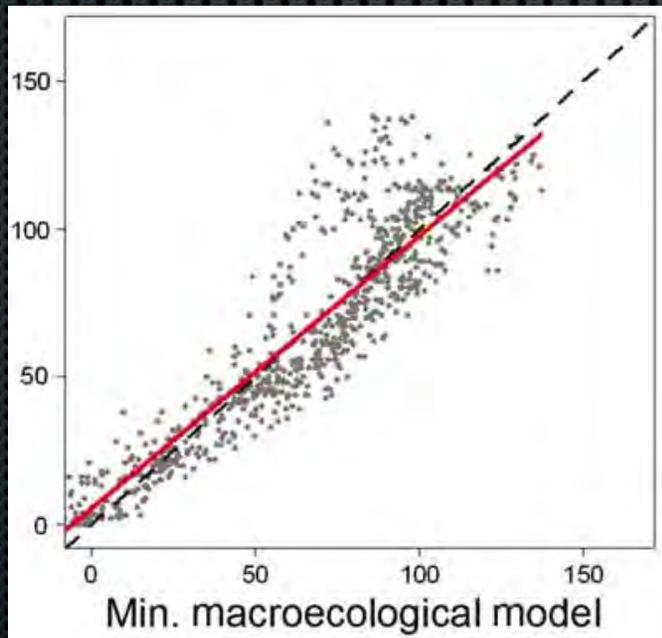
Long term monitoring in a scientific framework provides the basis to predict climate change impacts on species.  
No monitoring = no foresight.



Kharouba et al. 2009. Ecology.  
Kerr et al. 2007. Science.

# Predicting species' responses to climate change

- During the 20th century, the ranges of species have shifted predictably given **observed climate change**.
- Under some circumstances, these shifts are predictable.



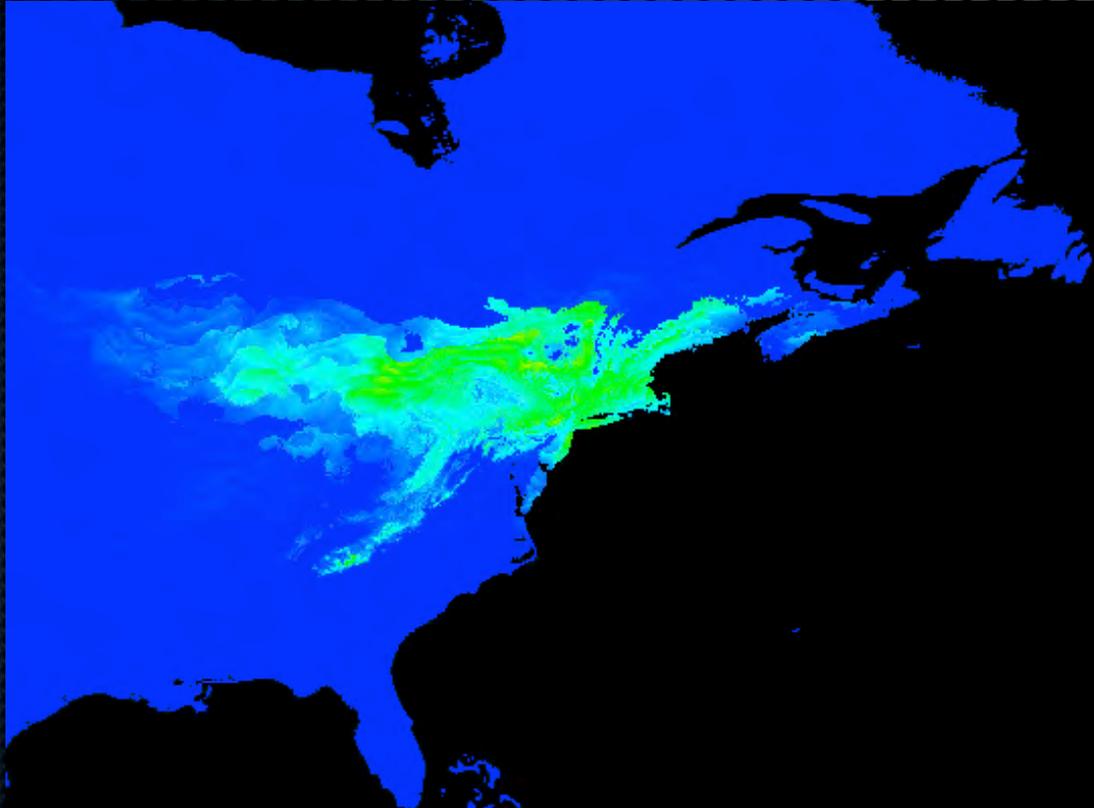
Algar et al.  
2009,  
Ecography.

# Predicting species' responses to climate change

- ✦ For some species groups, geographical responses to climate change have been rapid and have unfolded predictably.
- ✦ Many species are challenged by the **rate** and **magnitude** of climate change. Where will these species go?
- ✦ Climate change is not a gradual shift in mean conditions. It includes violent mood swings that may impose risks for biodiversity.

# Environmental variation

Has recent climate change contributed to the near-extinction of the bumblebee, *Bombus affinis*?



Estimated range of *Bombus affinis* prior to directional, human-caused climate change.

The species was one of the most abundant bumblebees throughout its ~2 million sq. km range.



Photo by Joanna James-Heinz

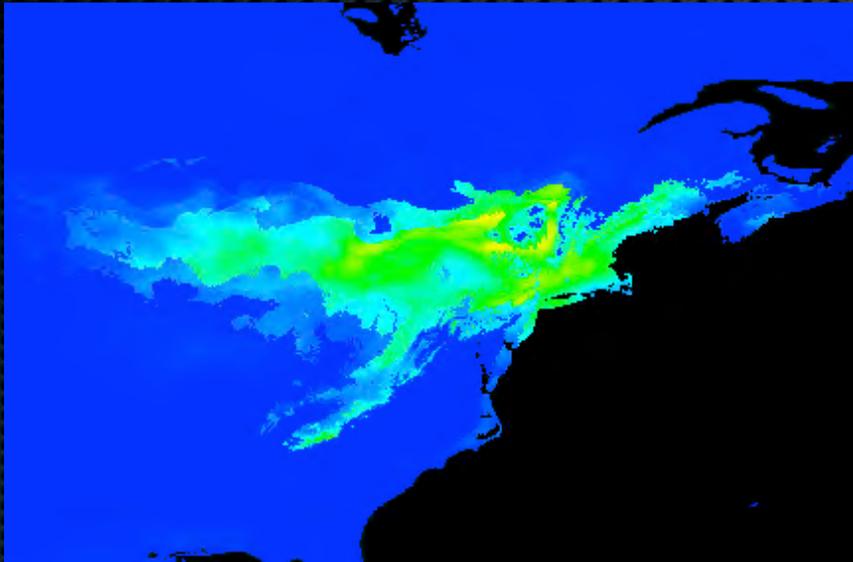
Kerr et al. in prep.

We built an historical model of environmental factors limiting this species' distribution in eastern North America and tested the model against 45 years of subsequent observations.

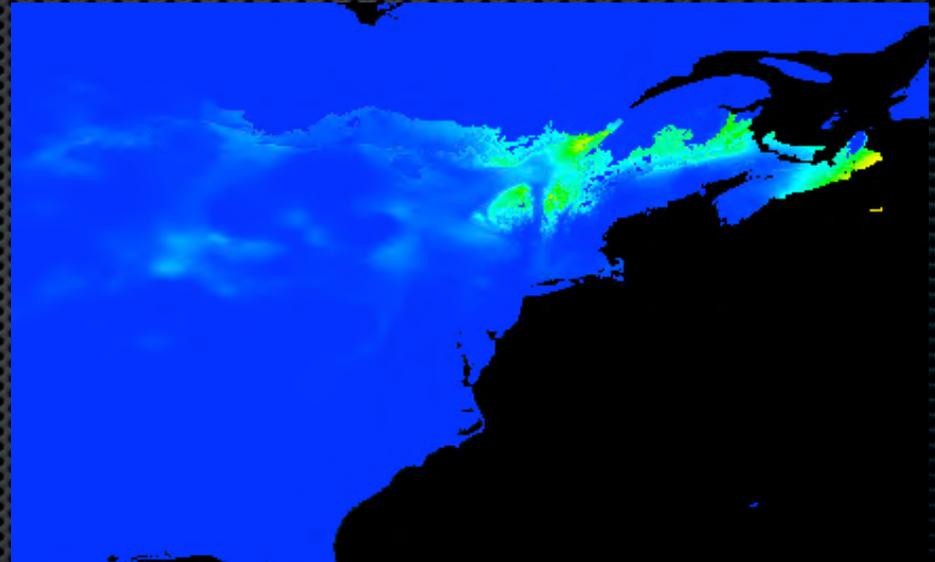
Although climate is changing, the most important limitations on this species' distribution do not show such trends.

There is no observed trend in pesticide use, habitat loss, or bee disease that accounts for known population declines.

Interannual variability of projected habitat suitability is very high: these are the environmental conditions species experience.

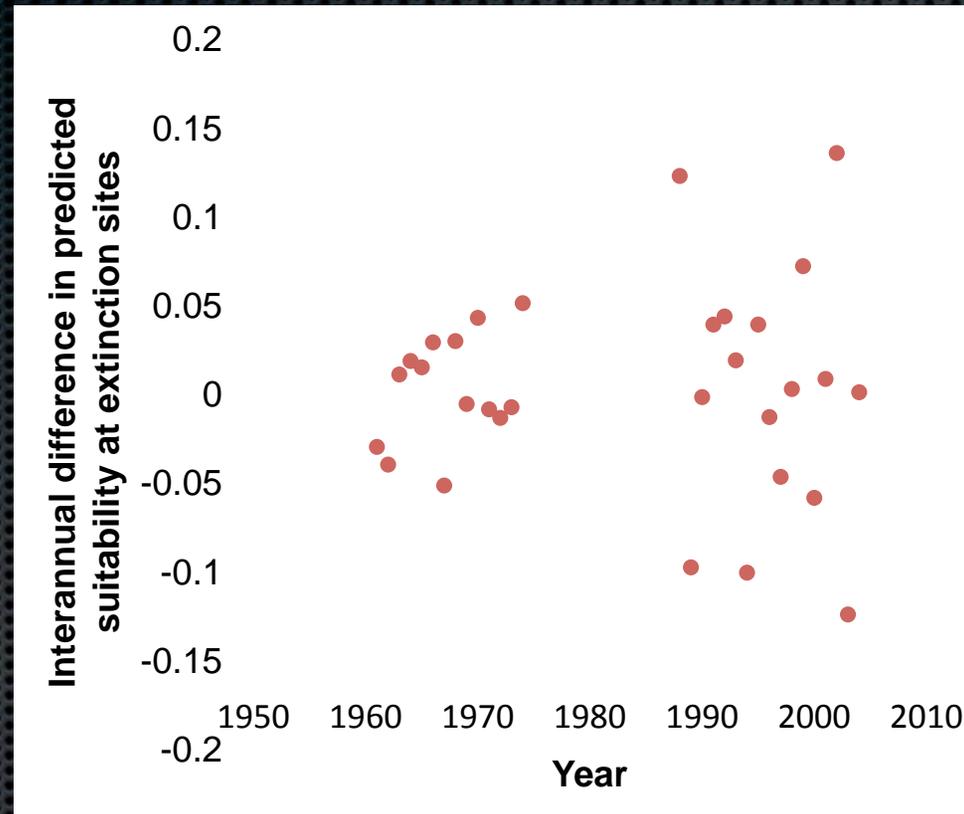


1931-1960 predicted suitability:  
prior to much human-caused  
climate change



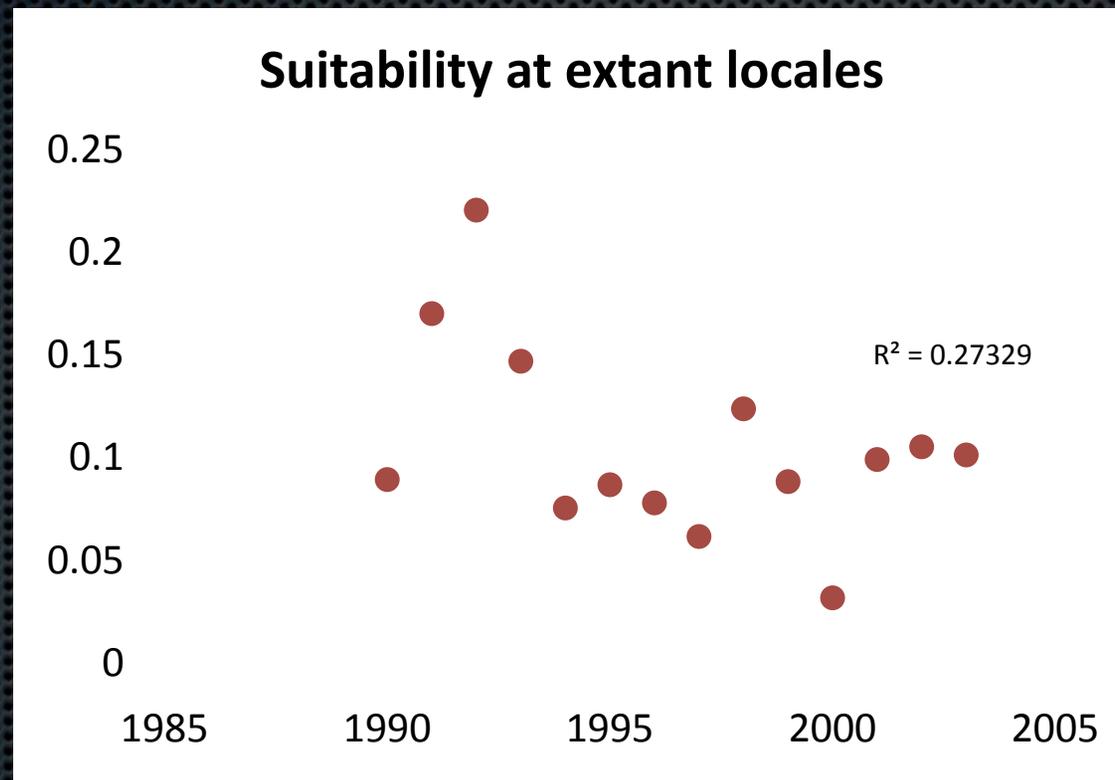
1998 predicted suitability. This is the  
second hottest year since the  
beginning of instrumental records.  
Areas that were historical occupied  
are nearly entirely unsuitable.

Resurveys indicate widespread population extinction.  
Interannual variation in suitability increased at extinction sites.



Interannual variance in predicted suitability increased ( $F=6.01$ ,  $p<0.001$ ,  $n = 117$ ) in areas where *Bombus affinis* is extinct. There is NO trend in the long term mean suitability at extinction sites.

A few *affinis* populations persist. Climatic variability has not changed in these areas. These areas show a gradual shift away from conditions that have been historically suitable:



# Environmental variation

- ✦ Could climatological “mood swings” be to blame for bringing this common pollinator to the brink of extinction?
- ✦ Are those “mood swings” beginning to affect other species?

# Converging responses

- ✦ Governments in Canada are acting to dismember environmental monitoring programs and long term monitoring sites.
- ✦ Canada is losing the ability to measure whether problems are getting worse or better.
- ✦ *Ignoring real-world trends is not going to cause real-world trends to ignore you.*

# Converging responses: filling the engagement gap

- ✦ What if citizen scientists could fill part of the data gap left by federal purges of scientific and environmental capacity?
- ✦ People conserve what they care about and they care about species they see.... and people then join the conservation conversation.

# eButterfly.ca

## a new way to see how butterflies are affected by different aspects of environmental change



OTTAWA CITIZEN

### Researcher seeking to apply 'citizen science' to butterflies

Website created to record sightings by THE SPARK OTTAWA CITIZEN

STORY'S TOUGH

Click here for the big picture before reading the article in your neighborhood and across the country.

thestar.com

### 'Tidal wave of butterflies' hits Eastern Canada

Published On Wed Apr 18 2012

THE STANDARD

### Waves of butterflies inundate city

Local News

By The Press, The Ottawa Citizen

OTTAWA — These clouds of red admiral butterflies may soon be doing more than just filling the air.

A wave of brightly-colored butterflies was hard to miss, fluttering throughout the city Monday as it seemed to be the target of a massive migration in the province's history.

"This year we saw an unprecedentedly early and unprecedentedly large migration for red admiral butterflies," said Jeremy Kerr, an associate professor of biology at the University of Ottawa.

The red admiral—*Vanessa atalanta*—is identified by its striking dark brown, red and black wing pattern.

CBC Ottawa

### April 2012 Archives

Monday April 30, 2012

#### Monday's show - links & info

To help biologist Jeremy Kerr keep track of butterflies in Ottawa, check out the EButterfly web site

OTTAWA CITIZEN

### Sudden cold weather spells doom for butterfly invasion

By The Press, The Ottawa Citizen

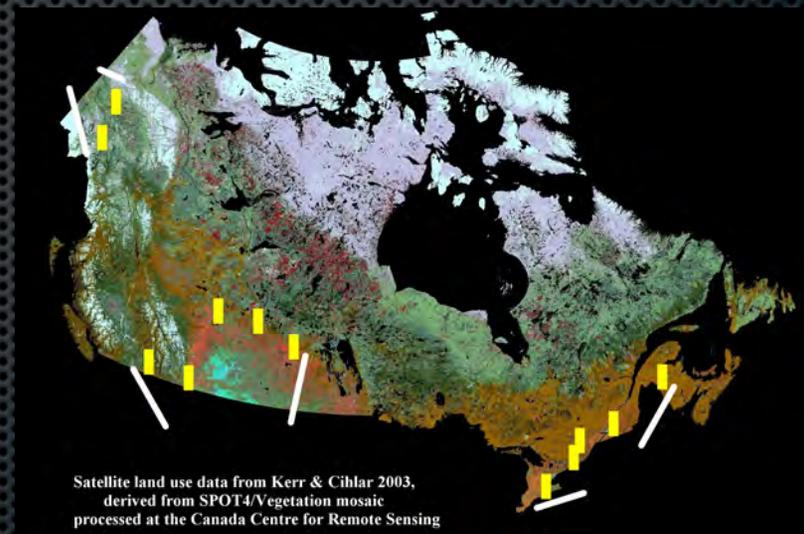
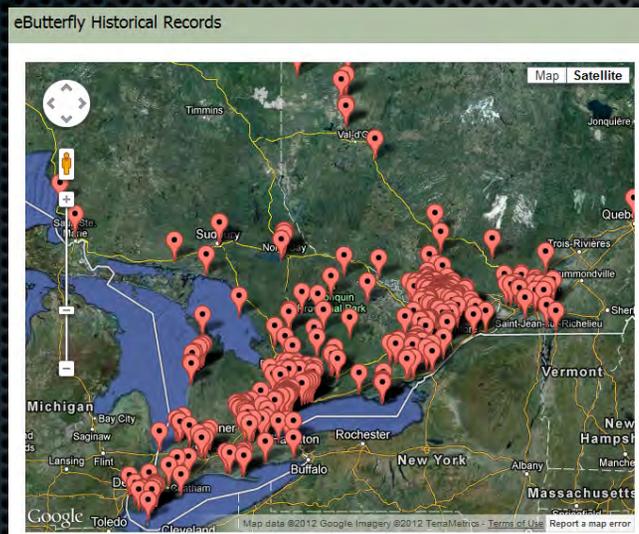
thestar.com

### Species migrating north at two and three times faster' than reported

Published On Fri Aug 19 2011

# Converging responses: engagement

- ✦ Can keep track of which species you have seen, where you saw them, and map each one.



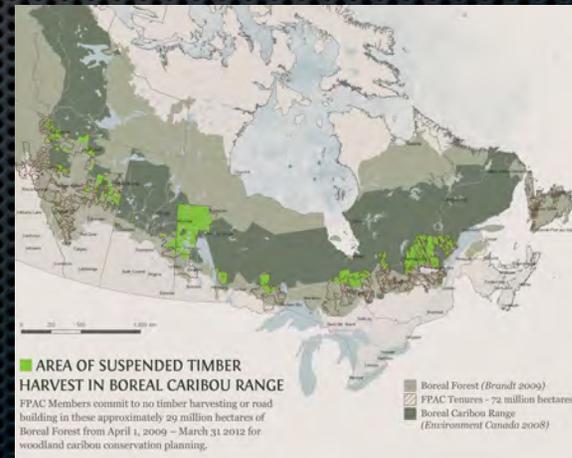
- ✦ And observations from an engaged public are providing insights into the effects of climatic “mood swings”.

# Converging responses: proactive conservation

- Habitat loss and climate change have major impacts on conservation.
- Changing the focus to “get ahead of the curve” on conservation?

# Converging responses: proactive conservation

- Major conservation agreement, May 18, 2010, between ENGOs and the Forest Product Association of Canada. <http://www.interboreal.org>
- Government was excluded from this agreement: a corrosive effect of obvious ideological agendas is that governments lose authority.



# Conclusions

- Emerging threats of habitat loss and climate change have increasing impacts on biodiversity conservation prospects.
- Converging responses address more than one challenge at a time
  - engaging in respectful conservation conversations through education and citizen science
  - Proactive conservation as an addition to conservation strategies.

# Acknowledgments

- ✦ First Nation whose traditional lands we are on.
- ✦ Jim Rusak, Judi Brouse, and the organizers of the 2012 Muskoka Summit on Biodiversity Loss.
- ✦ To the many members of my research group and collaborators around the world: Max Larrivee, Shawn Leroux, Heather Kharouba, Adam Algar, especially.
- ✦ Discovery Grant support through NSERC.