Data gathering and simulation of climate change impacts in mountainous areas

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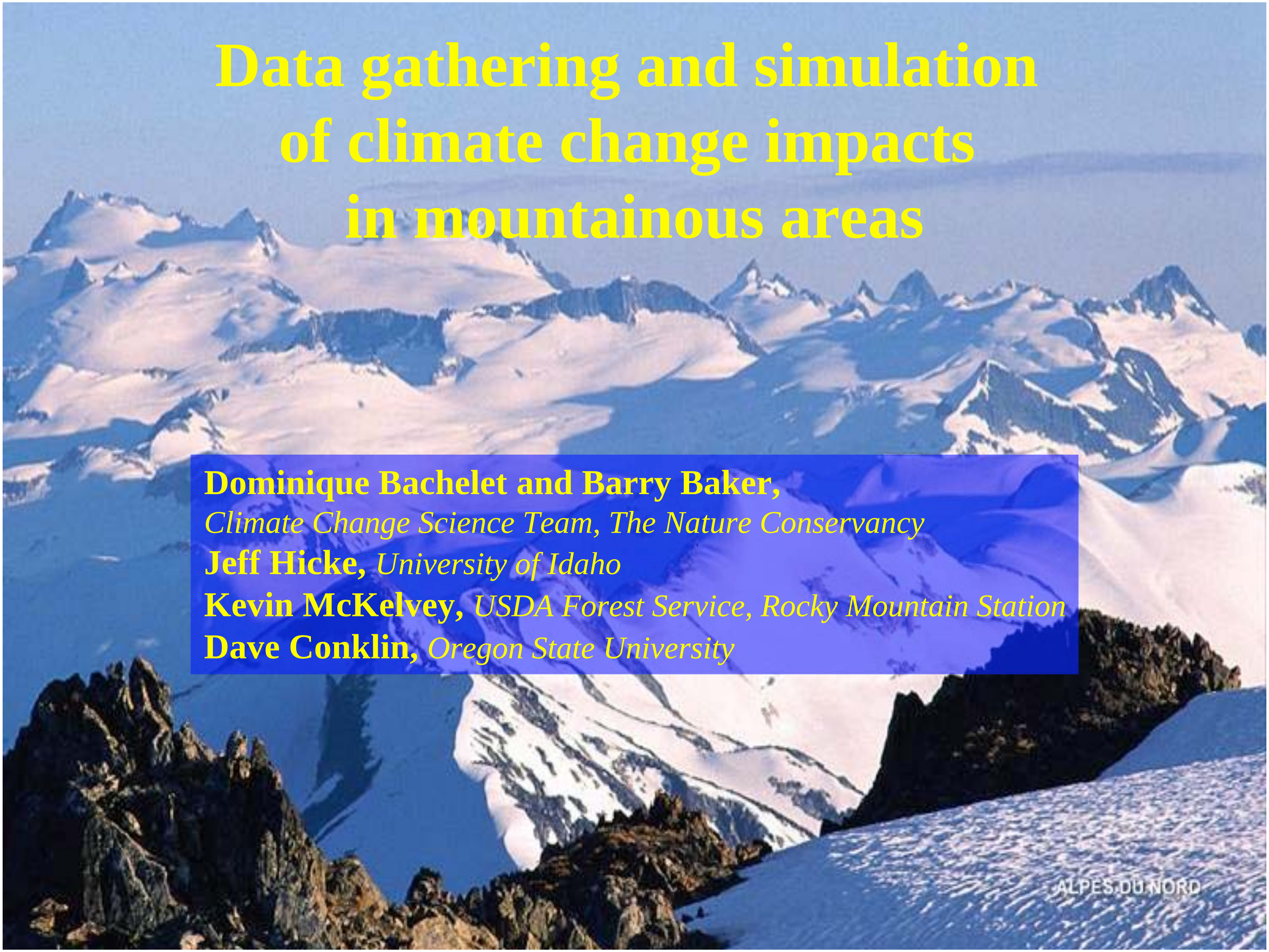

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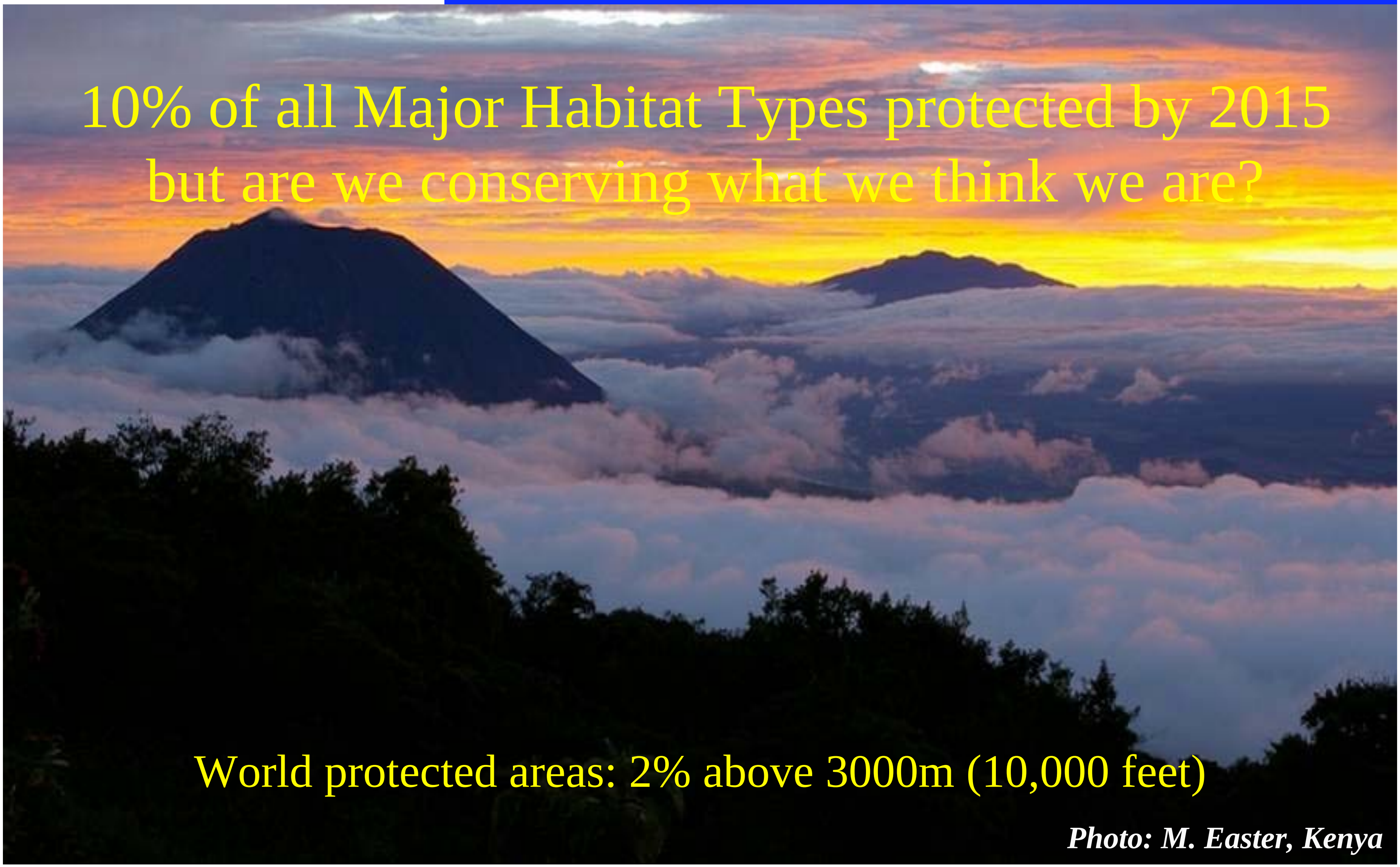


10% of all Major Habitat Types protected by 2015 but are we conserving what we think we are?

World protected areas: 2% above 3000m (10,000 feet)

Photo: M. Easter, Kenya

CLIMATE CHANGE IMPACTS ON THE UNITED STATES

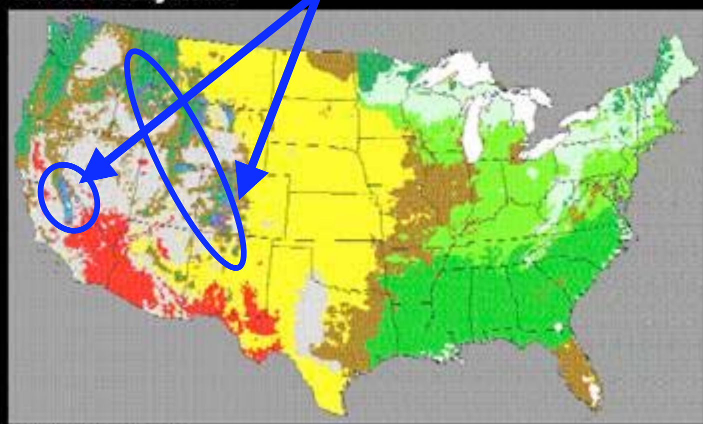
ALPINE TUNDRA disappears

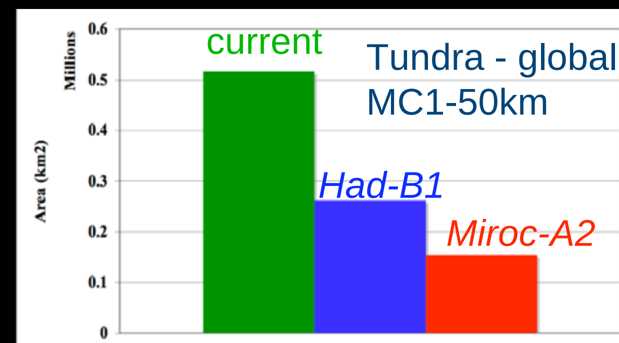
Ecosystem Models

Maps of current and projected potential vegetation distribution for the conterminous US. Potential vegetation means the vegetation that would be there in the absence of human activity. Changes in vegetation distribution by the end of the 21st century are in response to two climate scenarios, the Canadian and the Hadley. Output is from MAPSS (Mapped Atmosphere-Plant-Soil System).

- Tundra
- Taiga / Tundra
- Conifer Forest
- Northeast Mixed Forest
- Temperate Deciduous Forest
- Southeast Mixed Forest
- Tropical Broadleaf Forest
- Savanna / Woodland
- Shrub / Woodland
- Grassland
- Arid Lands

Current Ecosystems





Canadian Model

Hadley Model

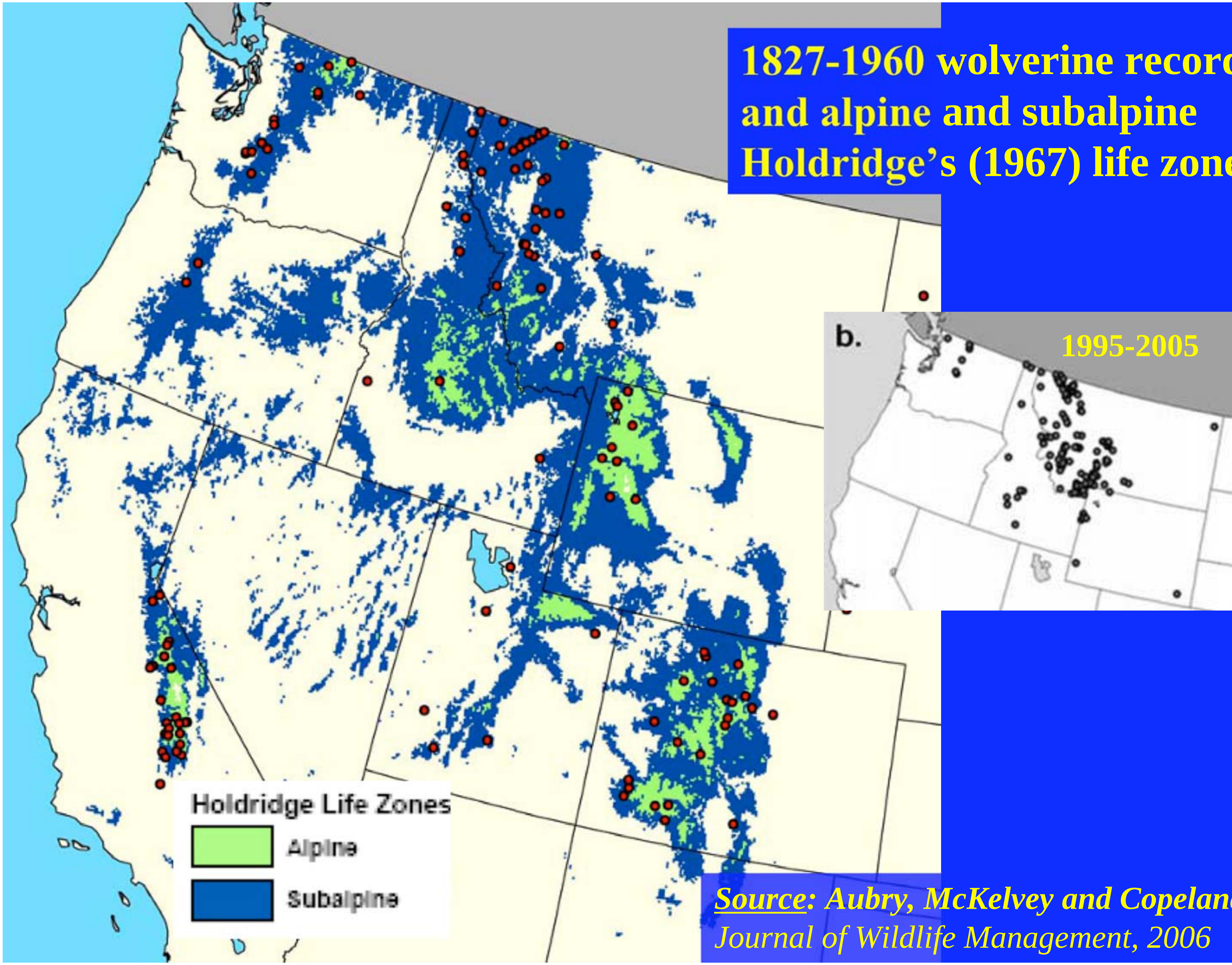
Models project the disappearance of alpine tundra

2000 USGCRP Nat. Ass. Report

“ in the absence of forthright guidance from the scientific community…” Science 2007

Data show multiple stresses
climate stress often hard to tease out

1827-1960 wolverine records and alpine and subalpine Holdridge's (1967) life zones.



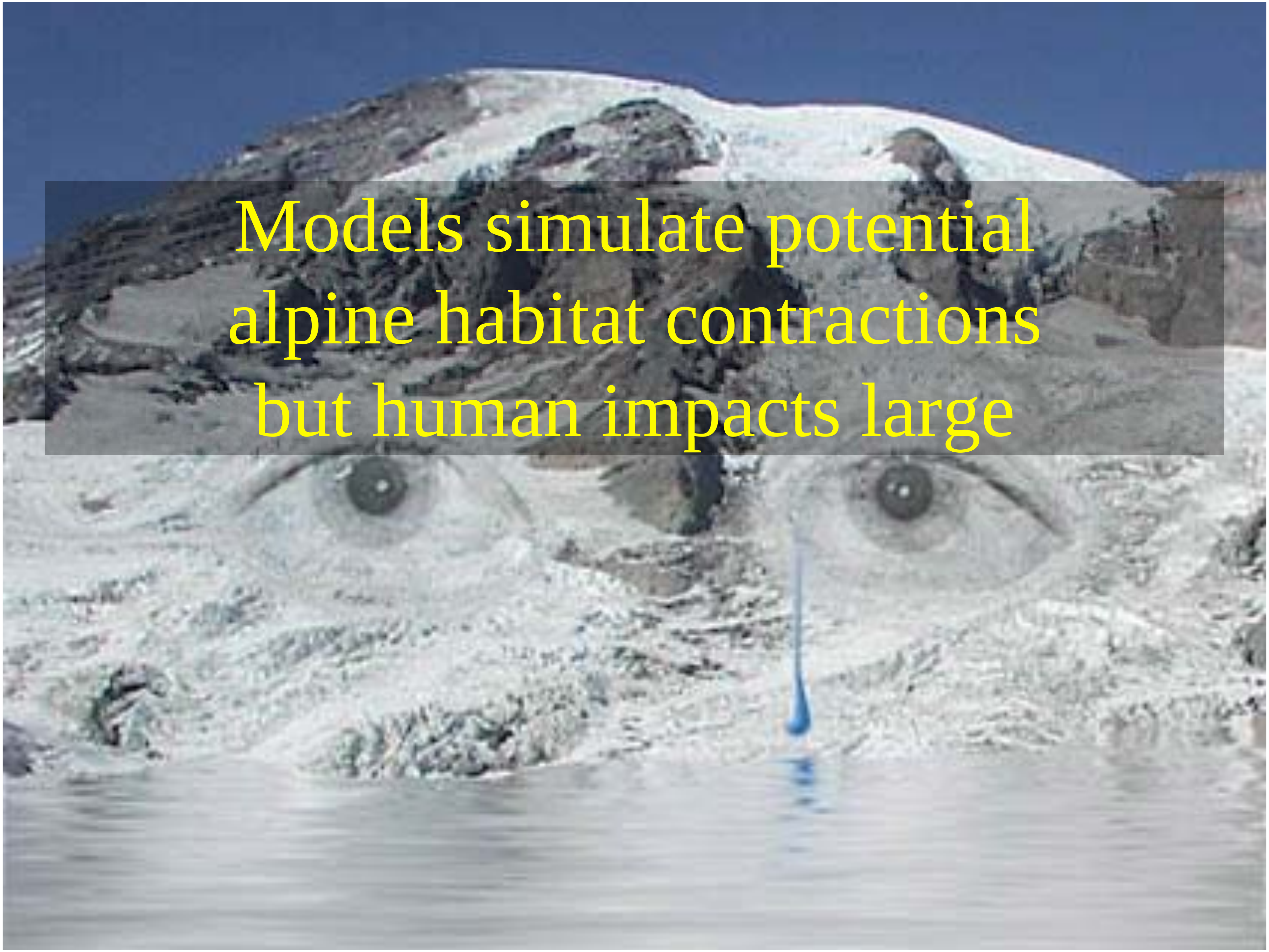
***<u>Source</u>*: Aubry, McKelvey and Copeland**
Journal of Wildlife Management, 2006

Strong relation between wolverine and spring snow cover

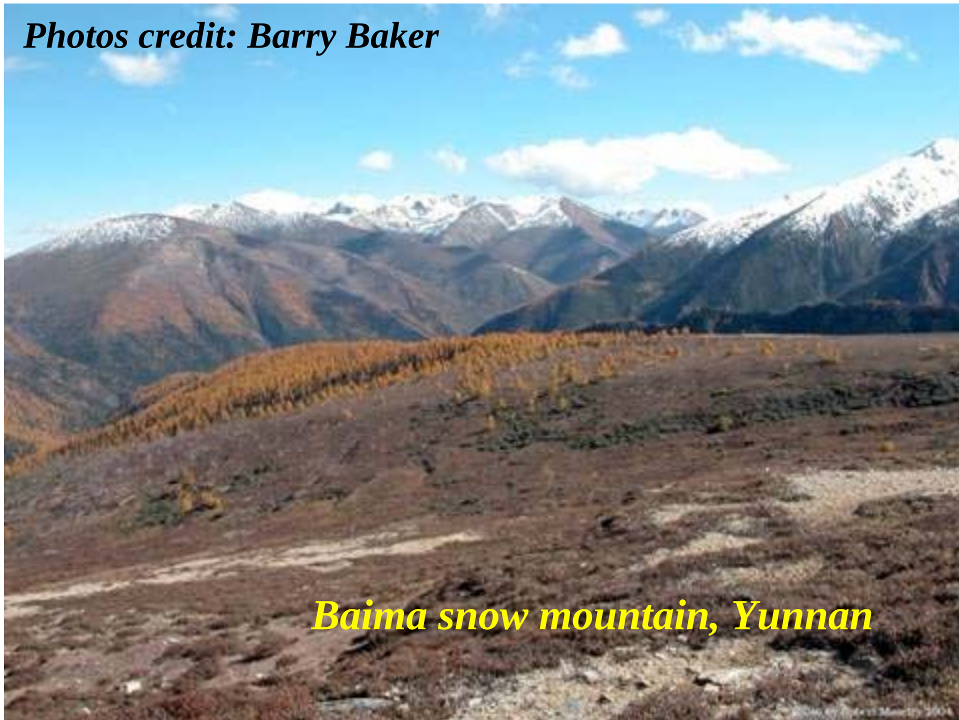
<u>Source</u>*: *Aubry, McKelvey and Copeland - *Journal of Wildlife Management, 2006*

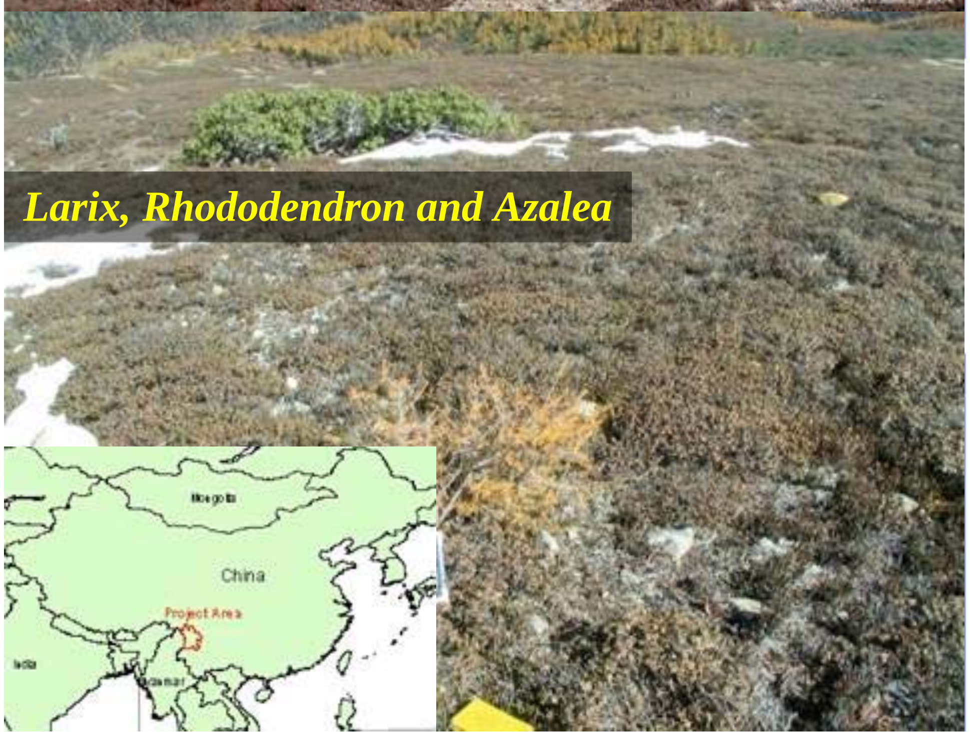
"However, wolverine range changes in the 19th and 20th centuries have been strongly driven by anthropogenic activities and teasing a climate change signature probably is not possible to do with any rigor, especially given these are historical rather than systematically collected data."

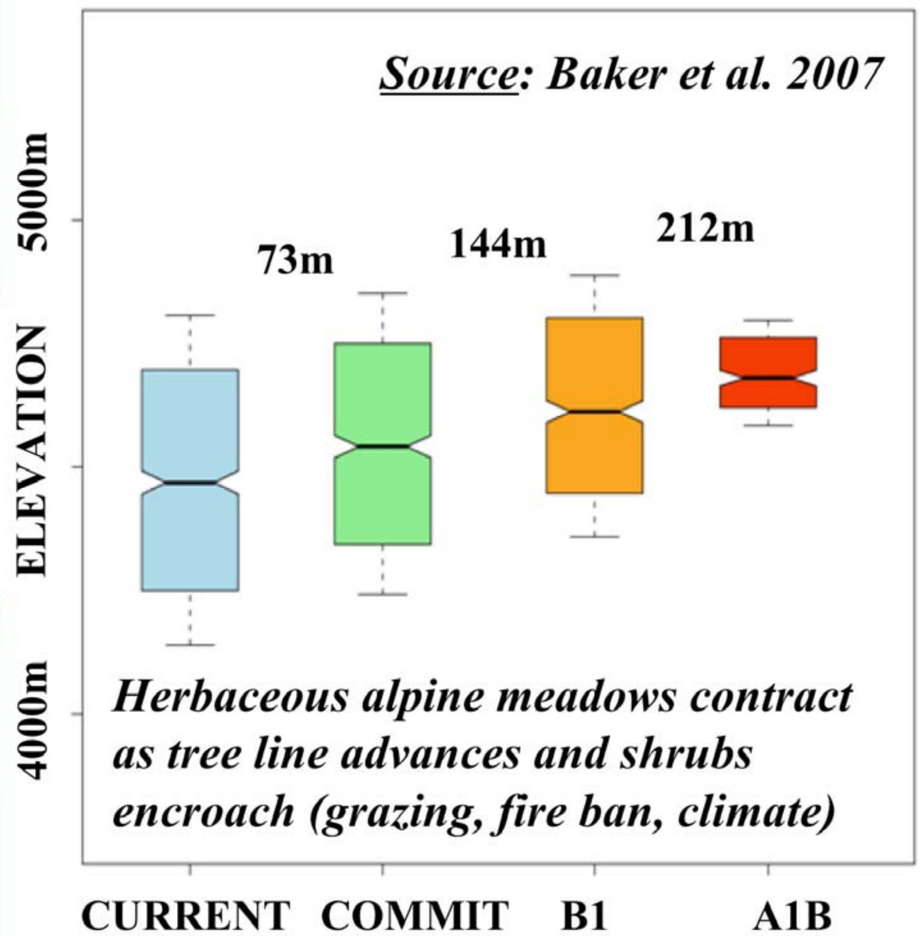
McKelvey, Pers. Comm.


Models simulate potential
alpine habitat contractions
but human impacts large

Changes in alpine distribution







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Can we design viable adaptation strategies to address climate change ?

Loosely adapted from Joyce and Millar 2007 Ecol.App.

1. Reactive Approach: RESISTANCE

"Homeland security approach"- Conservation at all costs

Tarp over glaciers, refrigerated zoos, alpine gardens …

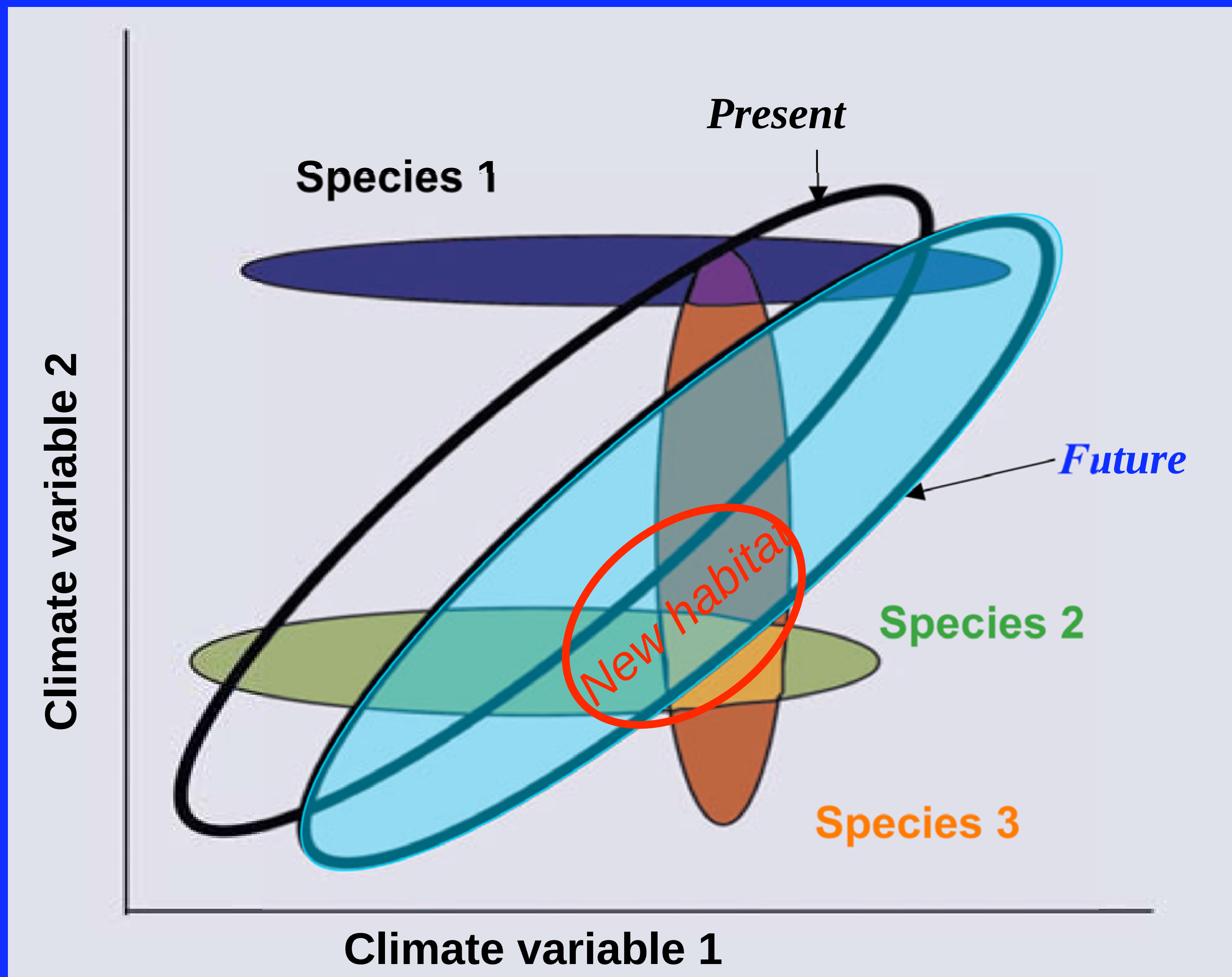
Problems: expensive, short term solution *from Williams and Jackson 2007*

Novel climates, no-analog communities, and ecological surprises

warm

MINIMUM TEMPERATURE

cold



Deep snow SNOW DEPTH *No snow*

2. Facilitative Approach: RESILIENCE

#1 Ass: Healthy systems are more resilient

Describe/Simulate reality: existing vegetation with *human impacts* such as pollution (N deposition, ozone damage), fire suppression/prescription, timber management (rotation length) - *pristine systems do not exist*

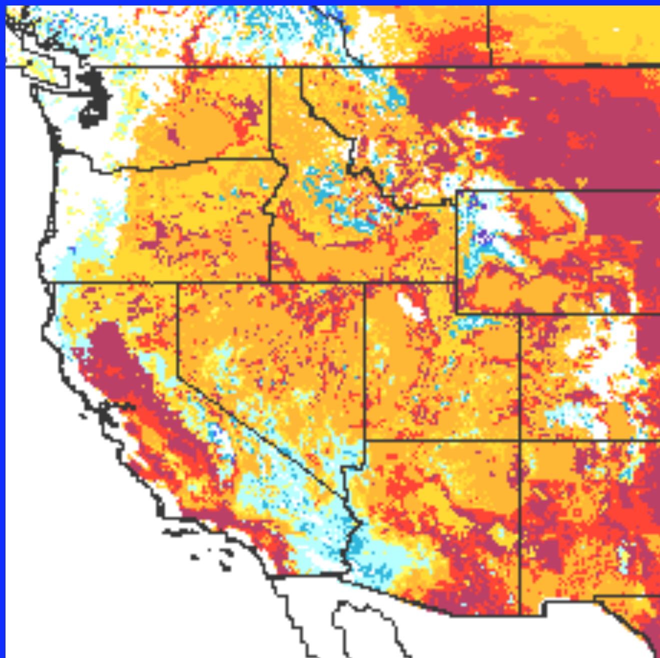
#2 Ass: Marginal areas may have higher resilience than prime habitat because already many other stresses

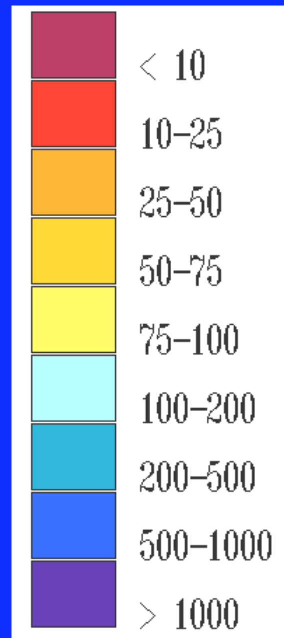
Document/simulate *thresholds* using mechanistic and process-based approach

Problems:

Systems are in transition and new stresses may materialize

WILDIRES



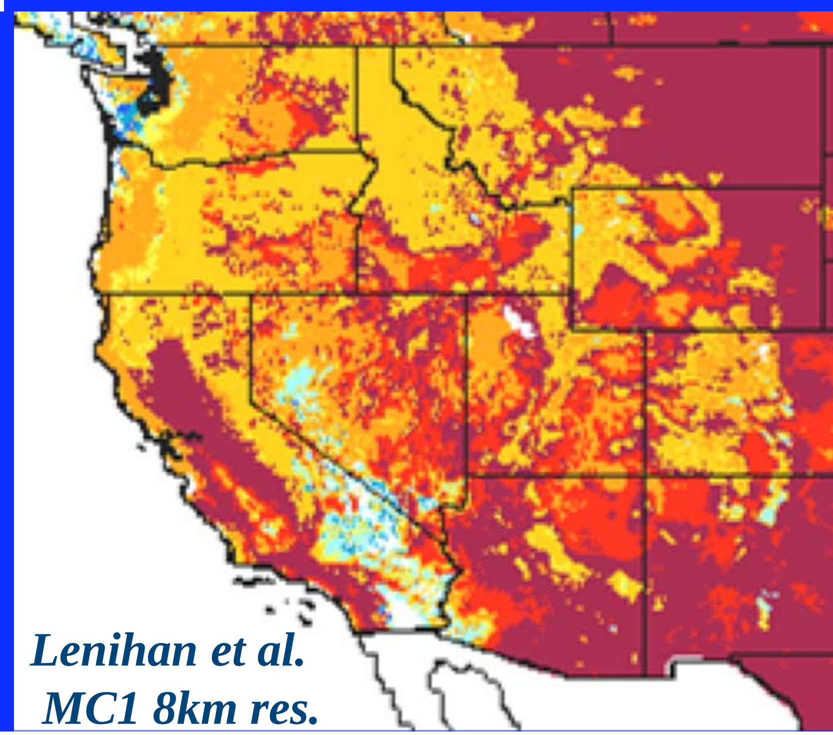


HISTORICAL (1951-2000)

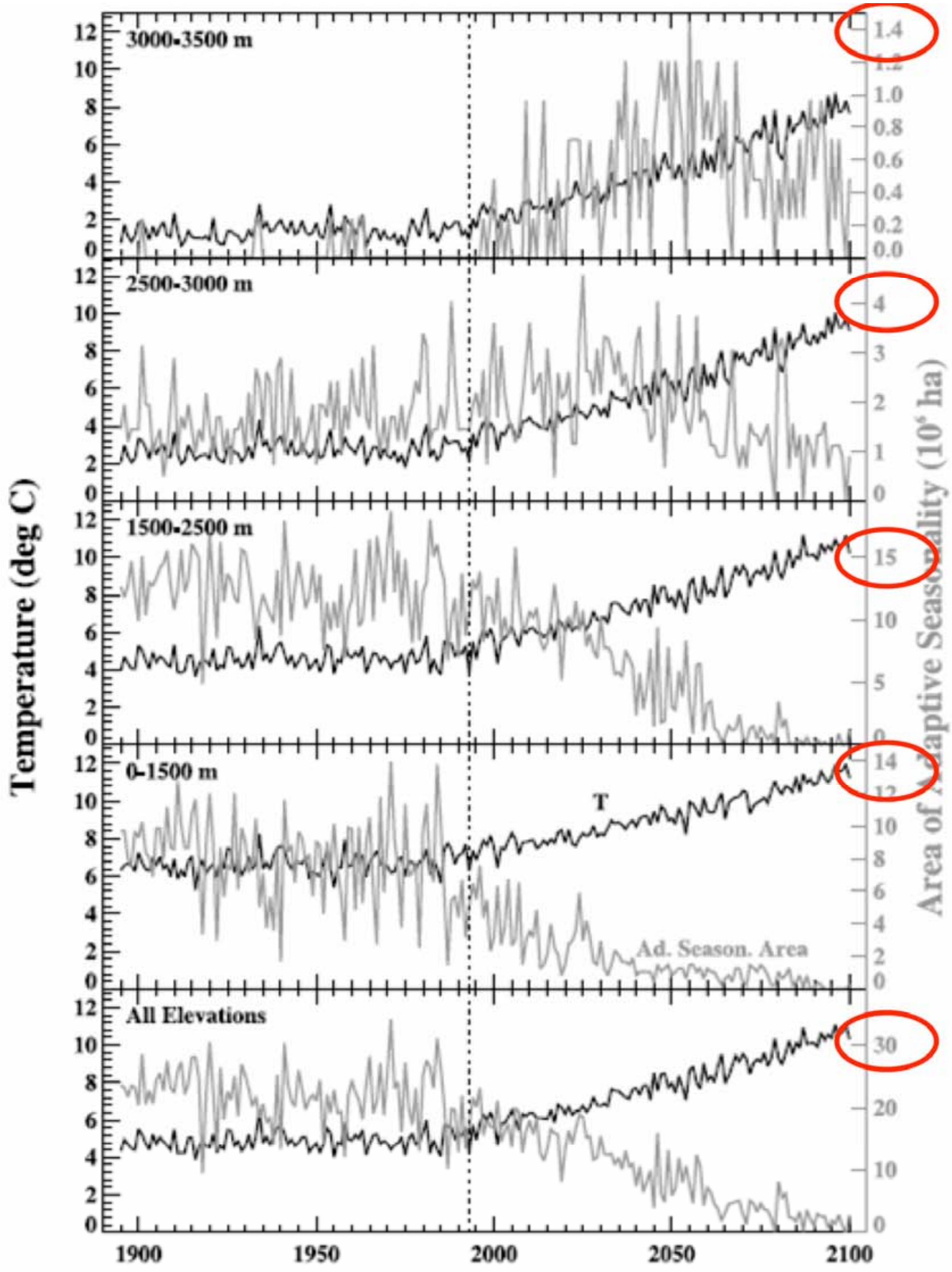
In dry low-elevation forests
fires are limited by fuel
vs
in high elevation moist forests
fires are limited by fuel moisture

ex. HADLEY A2 (2050-2100)

National Geographic



Lenihan et al.
MC1 8km res.



Mean annual T vs adaptive seasonality in the western US

Source: Hicke et al. JGR 2006

Adaptive seasonality corresponds to the synchronous emergence of adult beetles at the appropriate time of season when they can complete their life cycle in one year (univoltine conditions)

Logan and Powell 2001

Projected warming leads to reduced area of adaptive seasonality except at the highest elevations: occurrence of beetle outbreaks in novel environments: high elevation whitebark pines

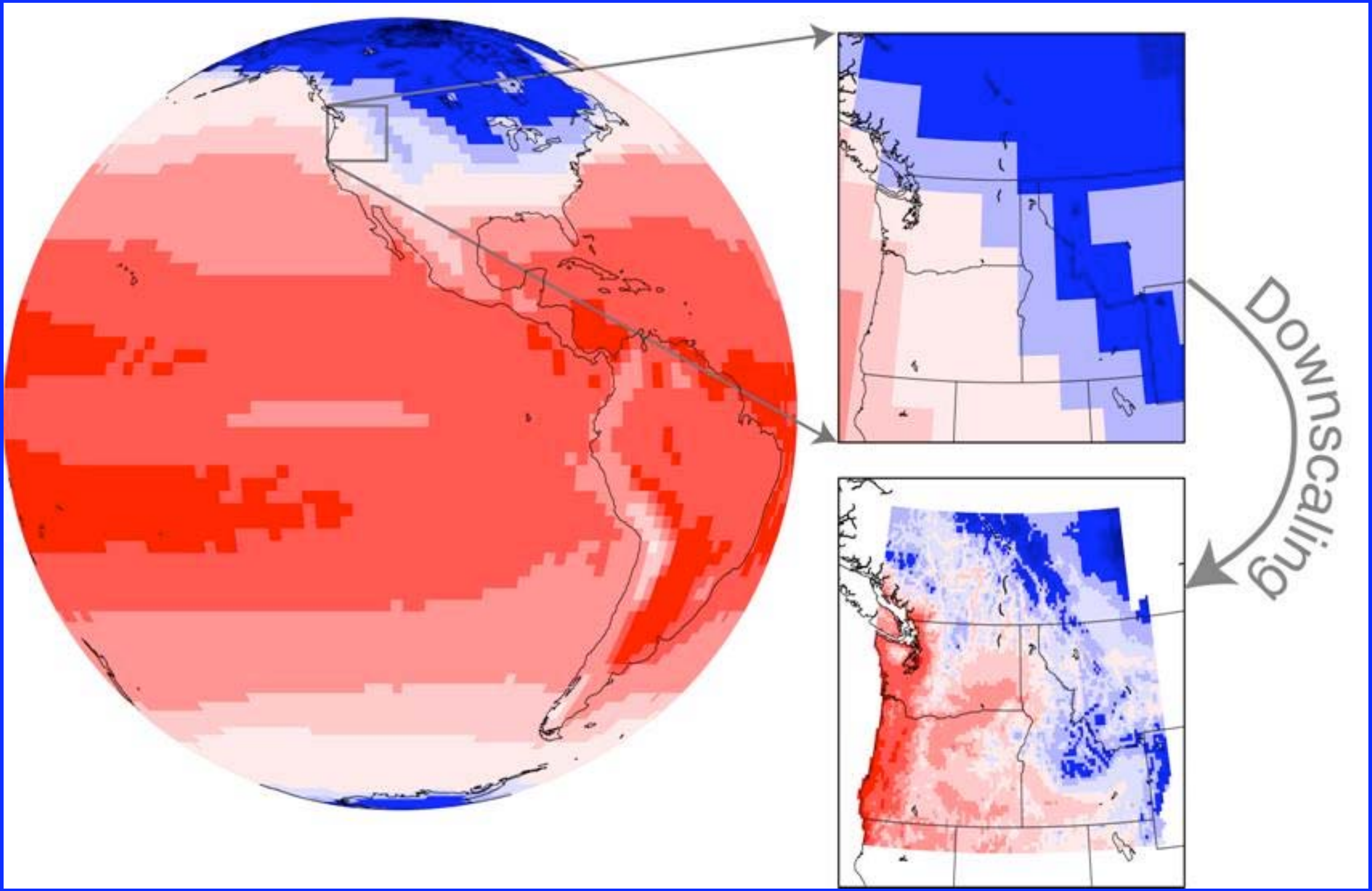
3. Proactive approach: RESPONSE

Various options: “Assisted migration”, Redundancy, Genetic diversity, Buffer zones, Connectivity

<u>Habitat heterogeneity</u>: can models simulate *refugia* so we can protect them?

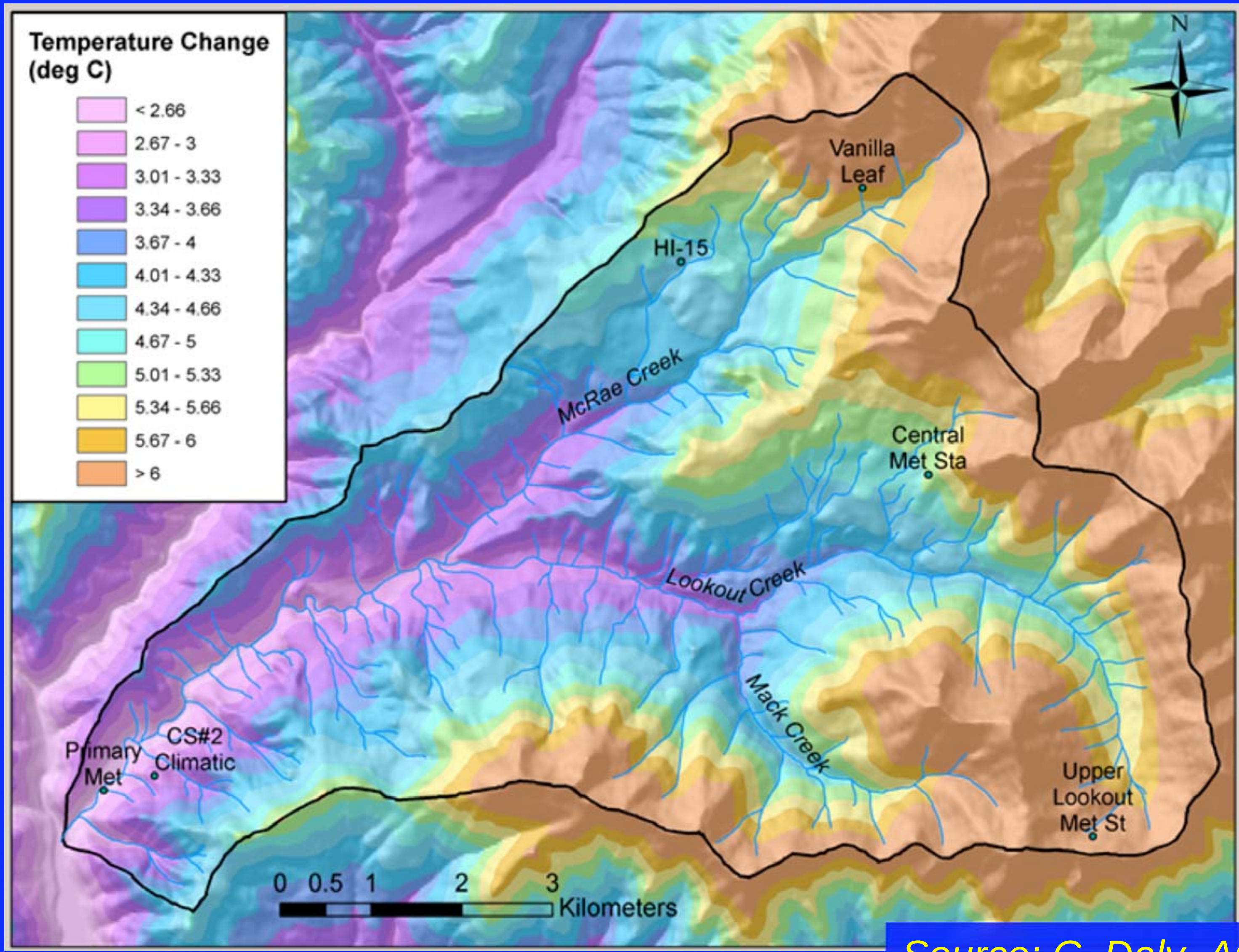
Refugia = areas that escaped ecological changes occurring elsewhere = a suitable habitat for relict species

Global models must be downscaled for regional studies



source: CIG Seattle

Complex topography and implications for climate change Projections - HJ Andrews January Tmax Projected Change +2.5C Regional Change and +10 Anticyclone-Cyclone

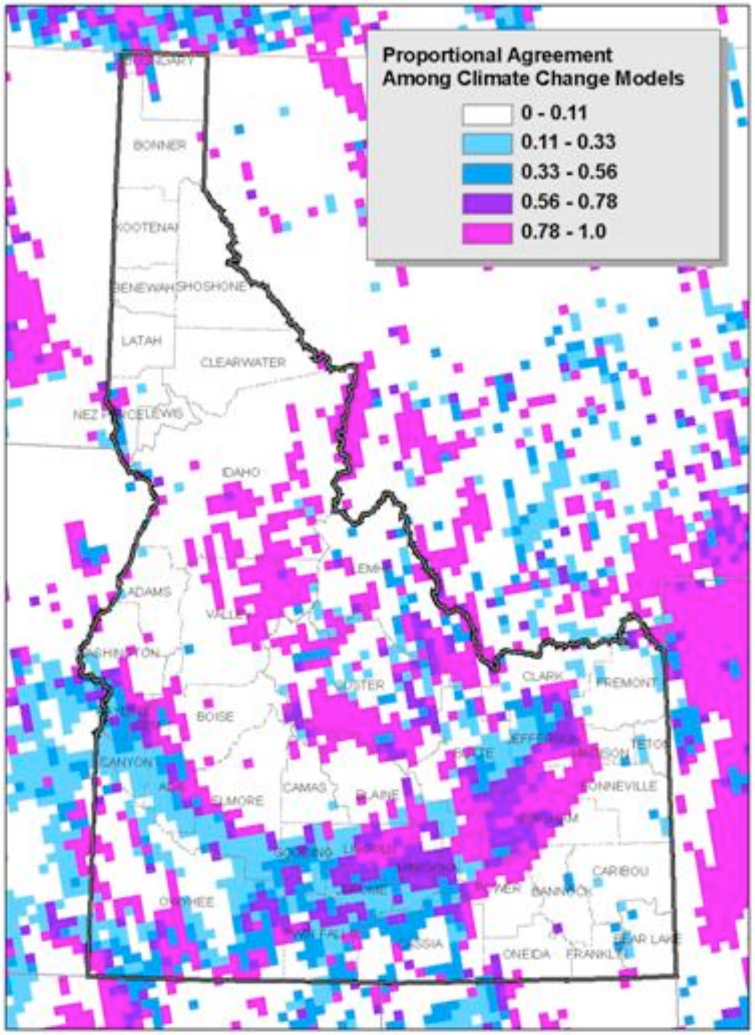


Source: C. Daly, AGU 2007

4. TRIAGE: prioritization because limited funds and human needs

Are models up to the task?

Figure 2. The likelihood that climate change will cause a shift in biome in Idaho for the period 2071-2100 (Gonzalez et al. 2007).



Documenting uncertainties: scenarios, impacts

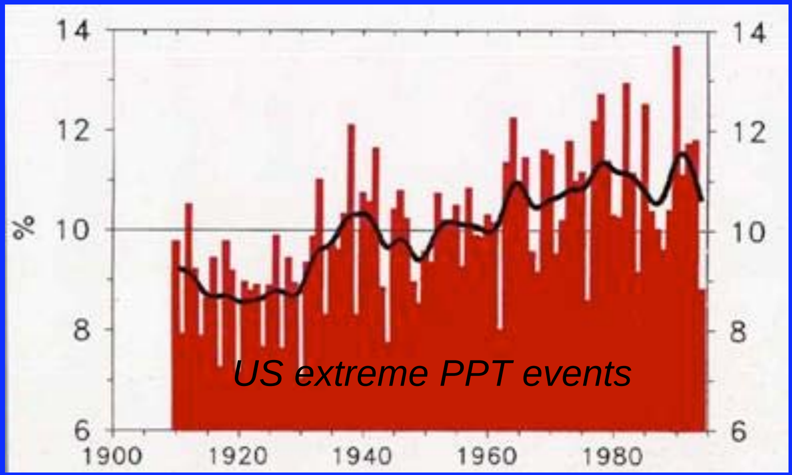
The likelihood that climate change will affect Idaho Conservation area planning and future investments

Source: Eric Stone, TNC Idaho

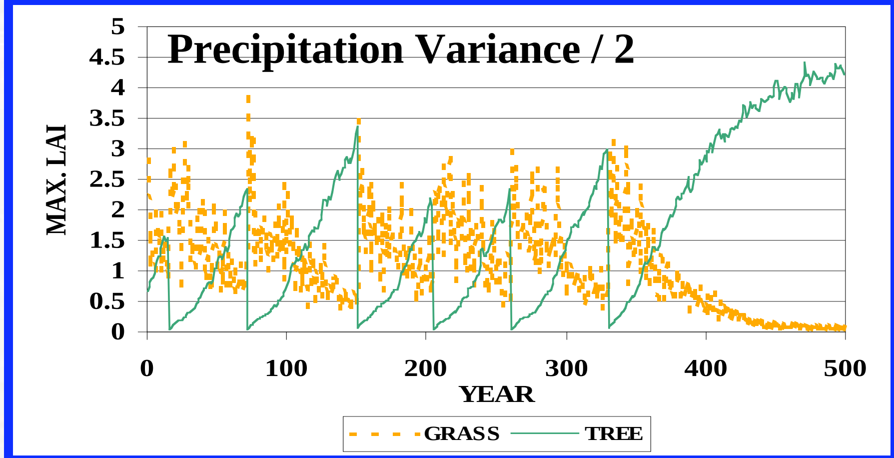
MC1 output
3 GCMs (Had, CSIRO, MIROC)
3 emission scenarios (A2, B1, B2)

5. REALIGN

Use models to look at impacts of extreme events not trends



Source: Karl, et al. 1996.



Source: Bachelet, Ferguson, Mearns, unpublished

CONCLUSIONS

. As the largest private land owner in world, TNC has unique opportunity to monitor change (indicators - green compass)

. TNC CC science team is creating a CC database & a web-based interface to deliver information and link scientific knowledge to field experience (*Zganjar et al., poster GC33A-0947*)

. Observations and model experiments can help develop new strategies: CC learning networks will communicate science, gather field experience, and test new strategy effectiveness

. TNC CC science team creating a modeler's workbench & bring in partners to work with and to train TNC staff

"There are risks and costs to a program of action. But they are far less than the long range risks and costs of comfortable inaction"

John F. Kennedy