Data gathering and simulation of climate change impacts in mountainous areas

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The Nature Conservancy 2015 Goal

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
Models project the disappearance of alpine tundra
“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.

“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.”

Models simulate potential alpine habitat contractions but human impacts large
Changes in alpine distribution

Source: Baker et al. 2007

Herbaceous alpine meadows contract as tree line advances and shrubs encroach (grazing, fire ban, climate)

Photos credit: Barry Baker

Baima snow mountain, Yunnan

Larix, Rhododendron and Azalea

ELEVATION

5000m

4000m

73m

144m

212m

CURRENT

COMMIT

B1

A1B
Can we design viable adaptation strategies to address climate change?
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
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
HISTORICAL (1951-2000)

WILDIRES

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.
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

**Habitat heterogeneity**: 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
+2.5°C 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?
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: 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