Linking the science of ecological transformation to RAD decisions

SCIENCE FOR ECOLOGICAL TRANSFORMATION ON FEDERAL LANDS (SET)

FOSTER ECOLOGICAL & SOCIAL SCIENCE – NEW OR SYNTHESIZED – FOCUSED ON ECOLOGICAL TRANSFORMATION to help navigate ecological transformation.

SUPPORT ECOLOGICAL TRANSFORMATION-CONSCIOUS NATURAL RESOURCE MANAGEMENT

- CHARACTERIZE PROBABILITIES OF ECOLOGICAL TRANSFORMATION to inform vulnerability assessments.
- PROVIDE SCENARIOS OF PLAUSIBLE ECOLOGICAL FUTURES to inform review/revision of goals and objectives.
- DETERMINE POTENTIAL EFFICACY of resisting or directing ecological transformation, to help identify possible adaptation options.
- ASSESS PLAUSIBLE ECOLOGICAL FUTURES and the potential outcomes of possible adaptation options in the context of social values, socio-economics, and agency missions, values, and goals.
FedNET Transformation-conscious Climate Smart Conservation Cycle

1. Define planning purpose and scope
2. Assess climate impacts and vulnerabilities
3. Review/revise conservation goals and objectives
4. Identify possible adaptation actions
5. Evaluate and select adaptation actions
6. Implement priority adaptation actions
7. Track action effectiveness and ecological response

- Characterize probabilities of ecological transformation
- Provide plausible scenarios of ecological futures
- Assess technical ability to direct or resist ecological transformation
- Monitor social & ecological response
- Support social, political, & economic assessment of alternative futures and choice of goals & actions

Social Science
Natural Science
Linking the science of ecological transformation to RAD decisions

Synthesizing paleo-transformations to map today’s transformation risk
Shelley Crausbay, Conservation Science Partners

Early Warnings of Ecosystem Transitions
Steve Carpenter, University of Wisconsin-Madison

Anticipating and managing 21st century transformations in dryland ecosystems
John Bradford, USGS Southwest Biological Science Center

State-and-transition models as tools to navigate social-ecological transformation
Brandon Bestelmeyer, USDA Agricultural Resource Service

Panel-audience discussion: Linking science on ecological transformation to RAD decisions
Robin O’Malley, North Central Climate Adaptation Science Center
Synthesizing paleo-transformations to map today’s transformation risk

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Ecological transformation

Carpenter & Folke 2006

Reorganization of a system from one ~ unchanging state to another

The new, distinct state is persistent

Characterized by a broad change in species assemblage

Cascades to ecosystem function, provision of services, and ability to support species of concern

Millar & Stephenson 2015 Science
Why paleorecords?

Rich context of individual records

Deep data is now big data

Characterize the probabilities of transformation (step 2)
Similar rates of climate change

Change per 100 years
Last Glacial = 1-2.5 °C
Younger Dryas = 10 °C

Change per 100 years
1900 – 2000 = 0.85 °C
2000 – 2100 = 1-4 °C
Ecological archives of transformation
Pacific Northwest

Crausbay et al. 2017 Ecology
Pacific Northwest

Vegetation zones
Fires during times of high climate velocity = ecological transformation
Fires during times of low climate velocity = ecological resilience
Ecological transformation can occur **rapidly** with a **single fire** but only with high rates of climate change
Hawaiʻi

Maui

Paleorecords bracket forest line
Response Variable: Forest vs. shrubland

Predictor Variables:
- El Niño frequency
- Moisture availability (deuterium isotopes)
- Temperature
- Fire

Crausby et al. in prep
Drivers of forestline dynamics

Crausbay et al. in prep
Ecological transformation can occur rapidly with a change in the drought regime.
Coring site at upper limit of cloud forest taxa in the Dominican Republic on Hispaniola.
Dominican Republic

Response Variables:
Cloud forest habitat
Pine forest habitat

Predictor Variables:

Fire

ITCZ position (moisture)

El Niño frequency

Crausby et al. 2015; Journal of Ecology
Cloud forest taxa more abundant when ITCZ is northward and rainfall is greater.

Cloud forest taxa

r^2 = 0.63
P < 0.001

Dominican Republic

Crausbay et al. 2015; Journal of Ecology
Ecological transformation can occur **slowly** with a **long trend in rainfall**
Surface temperature change relative to 22 kyr BP

CCSM3 TraCE-21000
bigger = older
500 to 50,000 years old
What caused past ecological transformations?

Identify moments of transformation

I. What determines the occurrence of past ecological transformations

   I. Vegetation type before transition
   II. Wildfire occurrence
   III. Rate of climate change
   IV. Geodiversity

Vegetation type

Fire

Rate of climate change

Geodiversity
What caused past ecological transformations?

Identify moments of transformation

Vegetation type

Fire

Rate of climate change

Geodiversity

Scale paleoecological models ‘up’ to the contemporary landscape

Map transformation risk
Characterize probabilities of ecological transformation.
Characterize probabilities of transformation

Basic, empirical understanding of ecological transformation

Where on the landscape is ecological transformation more or less likely to happen?

Spatial information helps us plan for adaptation options that are more equitable
Pull data from Neotoma & GCD

Develop new age models (‘bacon’)

Identify moments of transformation (‘rioja’)
  - cluster analysis
  - broken-stick

Identify wildfire occurrence (CharAnalysis)

Calculate rates of climate change (PaleoView)

Match to landscape characteristics (ERGo)

Model determinants of transformation
$$p = P(Y = 1 \mid \text{veg, fire, climate, geodiversity})$$