Degraded states, novel ecosystems, or reconfigured landscapes

How should we view ecosystem change in a changing world?

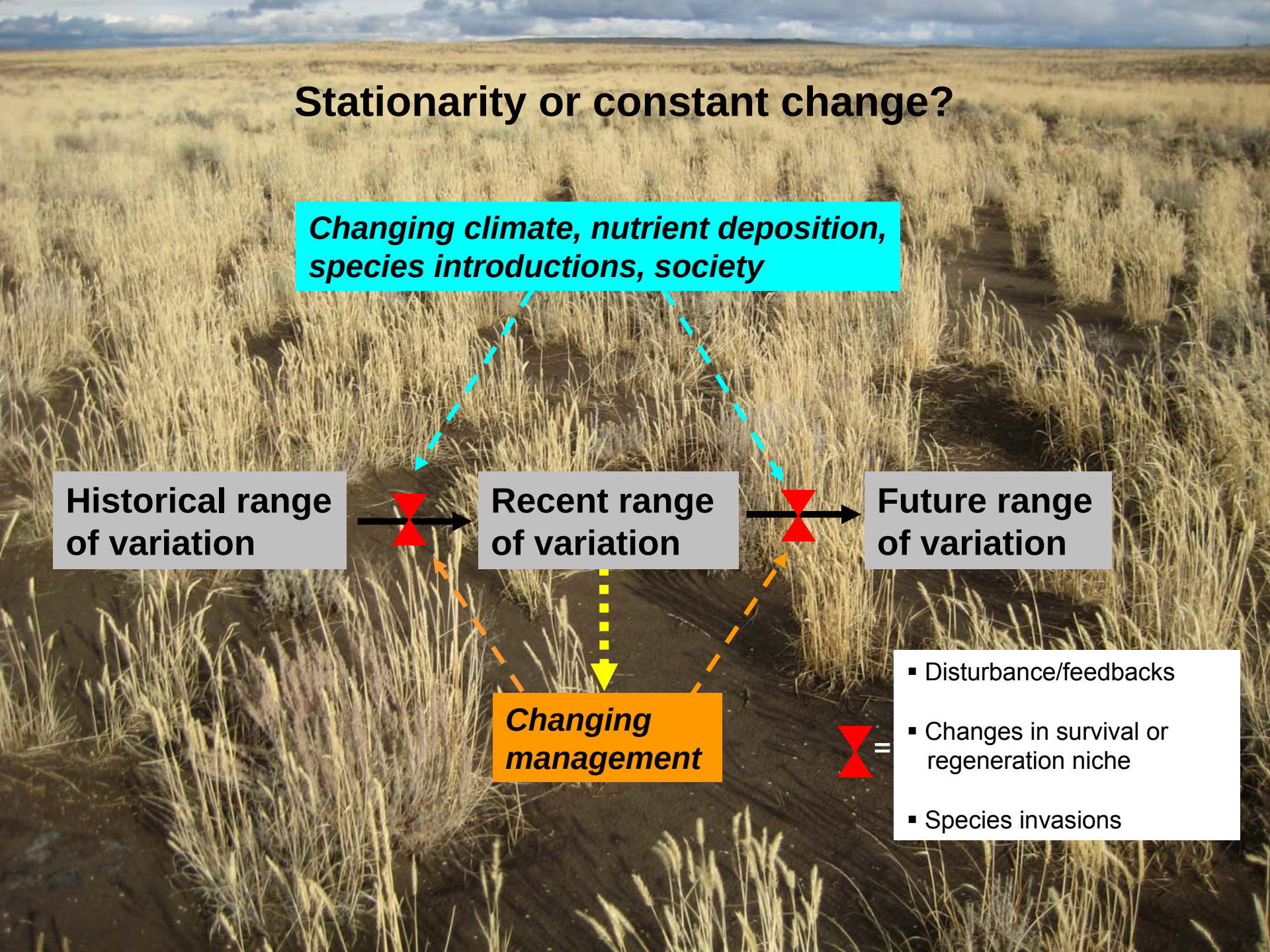
Brandon Bestelmeyer* and Joel Brown†

***USDA-ARS Jornada Experimental Range**
†USDA-NRCS Soil Survey Division

Las Cruces, NM, USA

bbestelm@nmsu.edu

Stationarity or constant change?



Things to think about

1. How do we communicate about changing ecosystems?

► state and transition models vs. alternative regime models

2. How do we gather evidence for the models?

► broader spatial and longer time scales, rare events and communities

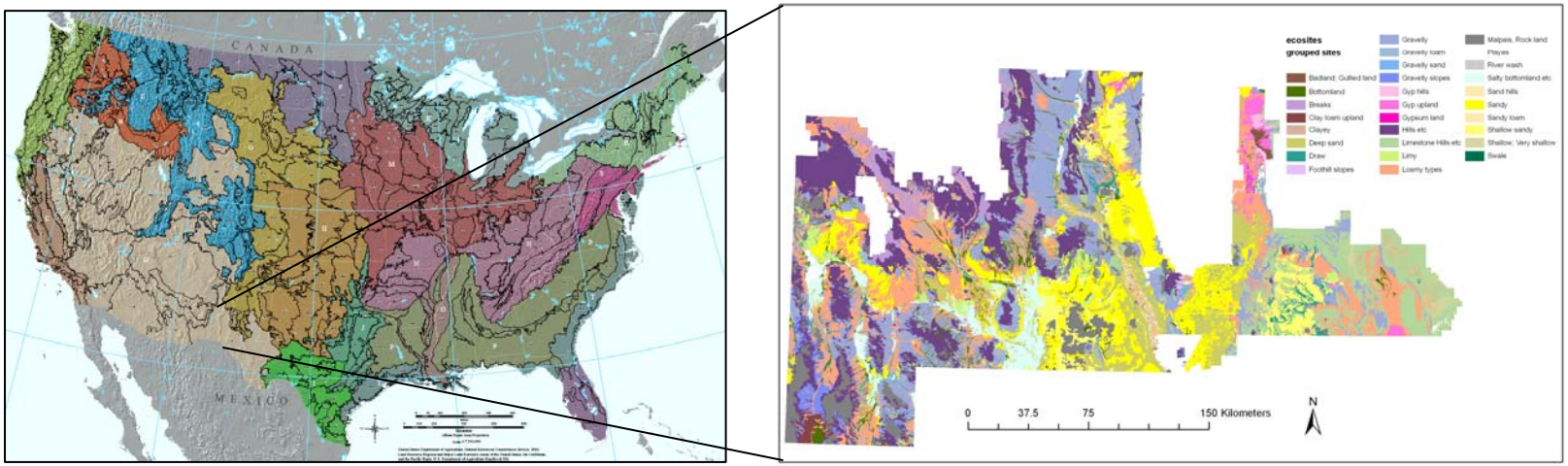
3. How do we react to the models in management settings?

► degradation (try to restore), novel ecosystems (accept or guide inevitable change), or some of both?

Ecological site/state-and-transition model approach

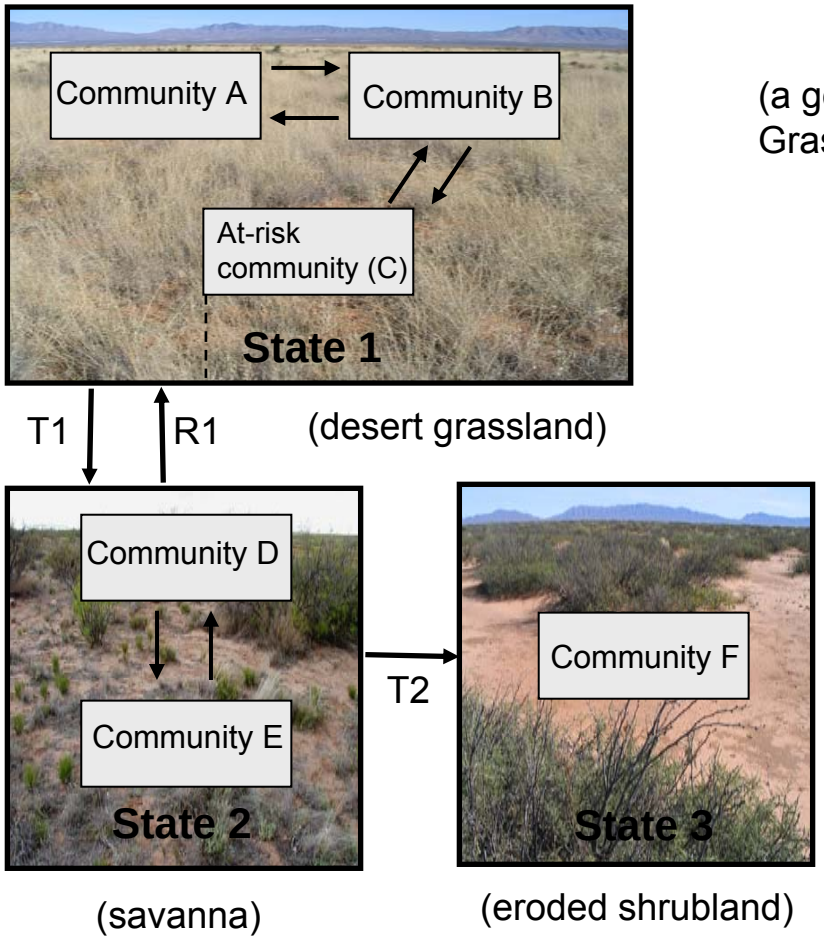
1. Divide the world into climatic/physiographic regions (Major Land Resource Areas [MLRAs] or Ecoregions)

2. Divide MLRAs up into ecological sites based on climate, landform and soils



Ecological site/state-and-transition model approach

3. Specify state-and-transition model for ecological sites



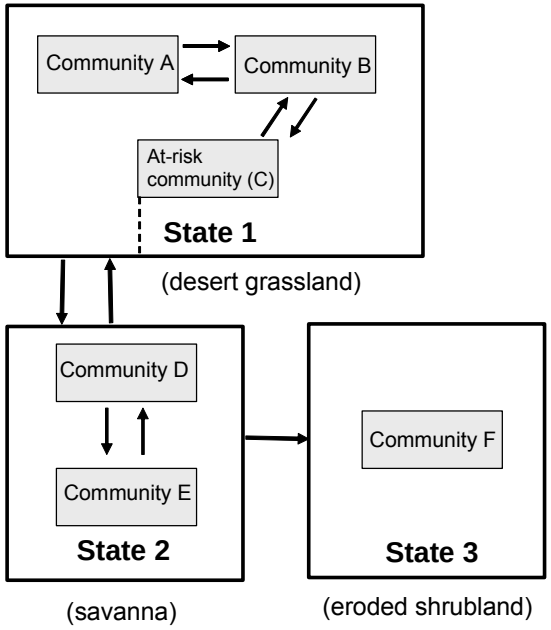
(a generic model for the Chihuahuan Desert Grasslands)

T1, T2—local management drivers; R1—restoration technology

Ecological site/state-and-transition model approach

Historical plant community dynamics

Regime shift



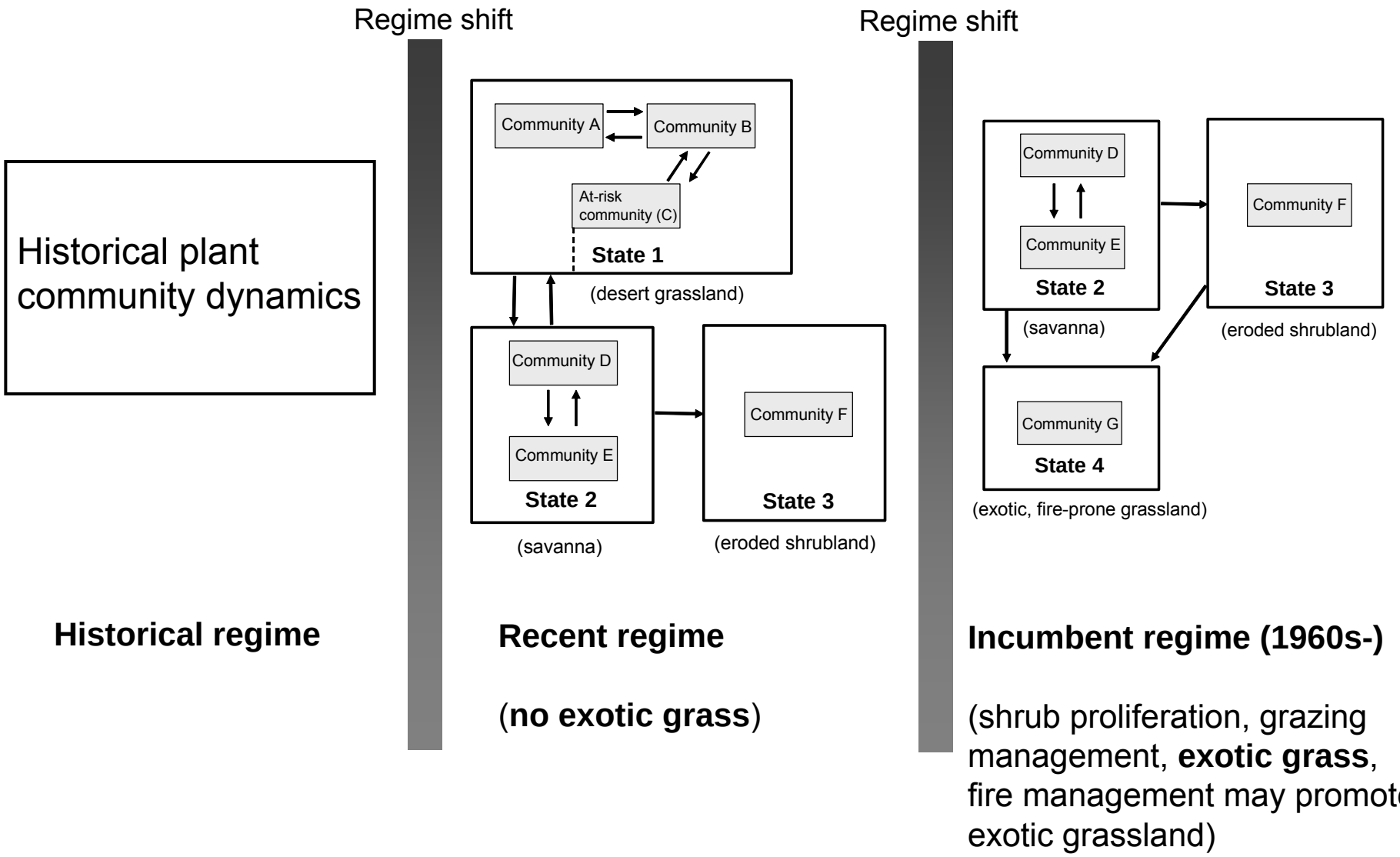
Historical regime (1500ish-1850 AD)

("Little ice age" bioclimatic regime, widespread establishment of grasslands, native grazers, Native American fire management)

Recent regime (1850s-)

(Warmer, drier bioclimatic regime contraction of the regeneration niche of dominant grass, widespread cattle grazing, fire suppression)

Ecological site/state-and-transition model approach



Similar events and management actions have distinct consequences in different regimes

Ecological site/state-and-transition model approach

***Regime* — a suite of co-occurring drivers and conditions, and their feedbacks to management, that characterize a discrete period of time.**

***Regime shift* — sufficient magnitude of change in one or more drivers to alter relationships with other drivers and management.**

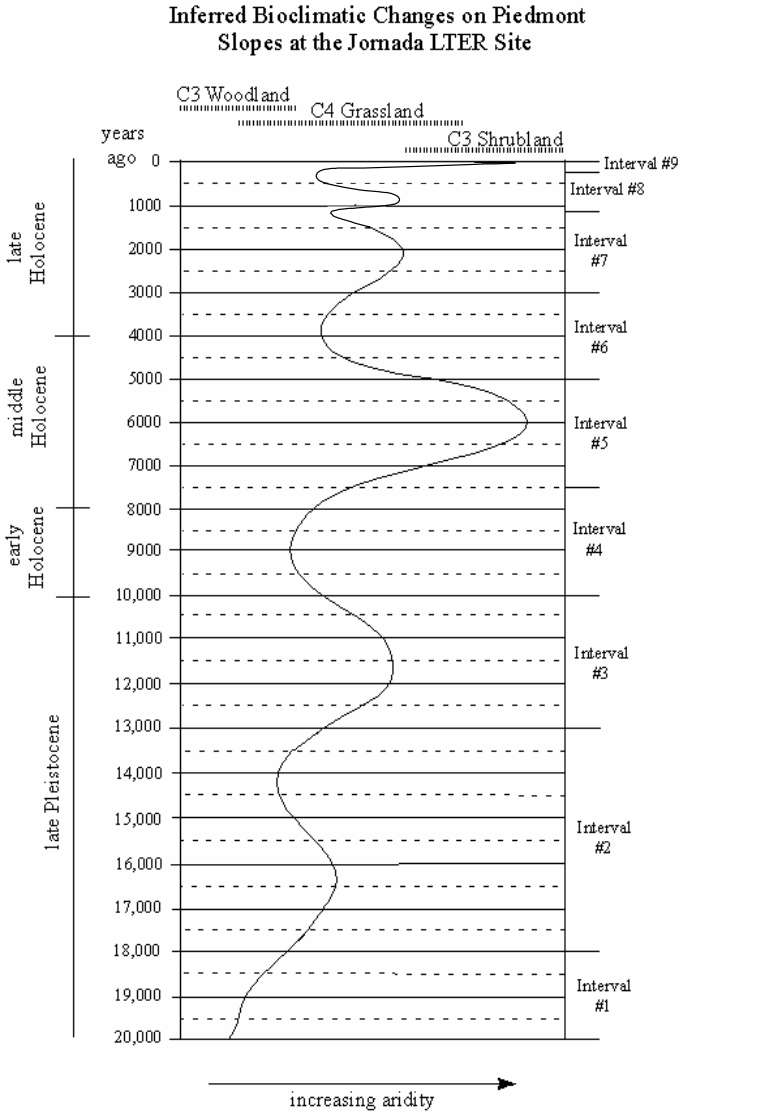
<u>Methodological implications</u>

- **Individual drivers (climate, CO_2, stock management, land tenure, fire) are often changing together**
- **Regime shifts occur at scales larger than those of ecological sites**
- **Historical and broad-scale measurements are at a premium, alongside experiments and monitoring for anticipated change**

Susan Walker et al., 2009, in New Models for Ecosystem Dynamics and Restoration (R. Hobbs and K. Suding, eds, Island Press)

Methods and evidence for “alternative regime” models

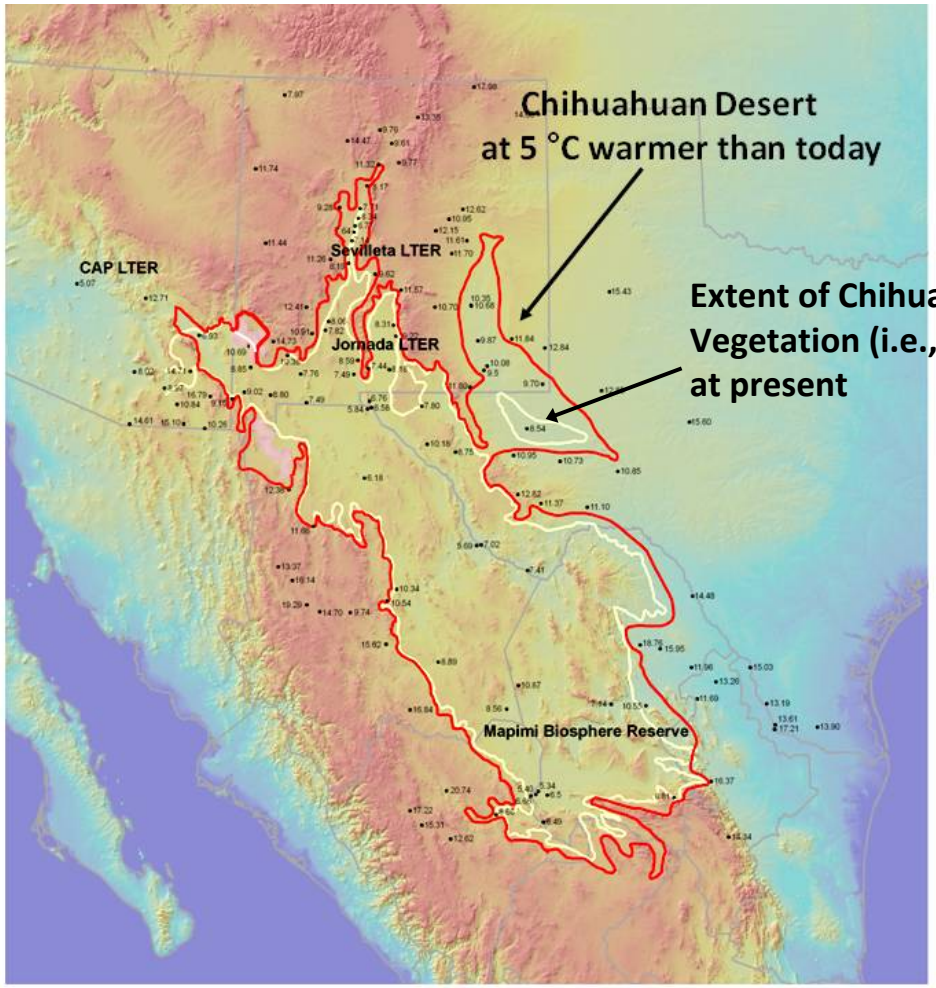
1. Paleoecological/historical reconstructions: past regimes reveal the fluidity of ecosystems and how species respond to a broader range of conditions



BJ Buck and HC Monger 1999

Methods and evidence for “alternative regime” models

2. Bioclimatic envelope models: current relationships between species’ occurrence and climate to project species distribution with altered climate



de Martonne aridity index = ppt (mm)/(temp (deg ˚C) + 10)

S. Ricketts and H.C. Monger,
In prep.

Methods and evidence for “alternative regime” models

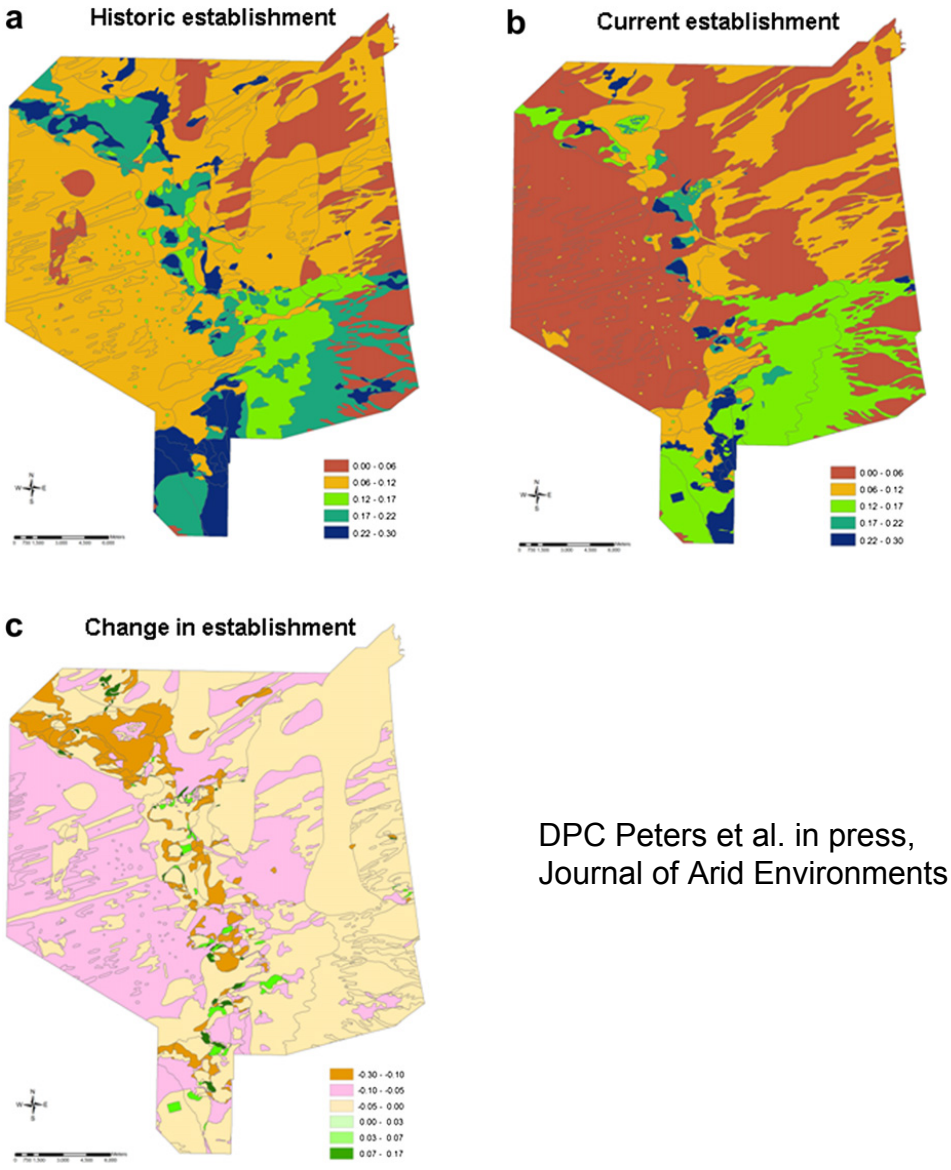
3. Demographic models based on monitoring data/experiments:

What variables (e.g., survival, recruitment) have biggest impact on populations?

How do plant traits influence responses?

How are the affects of climate variation mediated by soils and existing states?

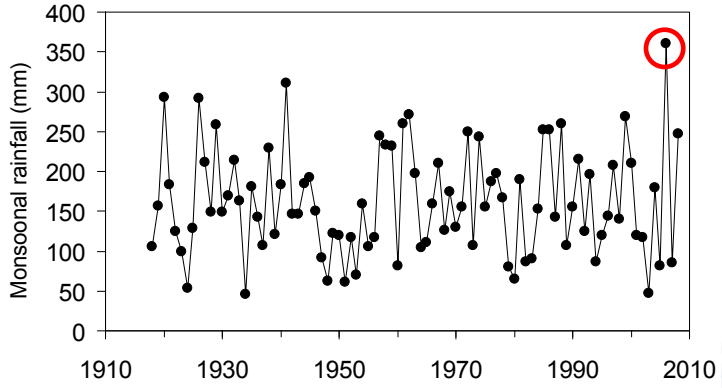
Black grama establishment probabilities vary with soil

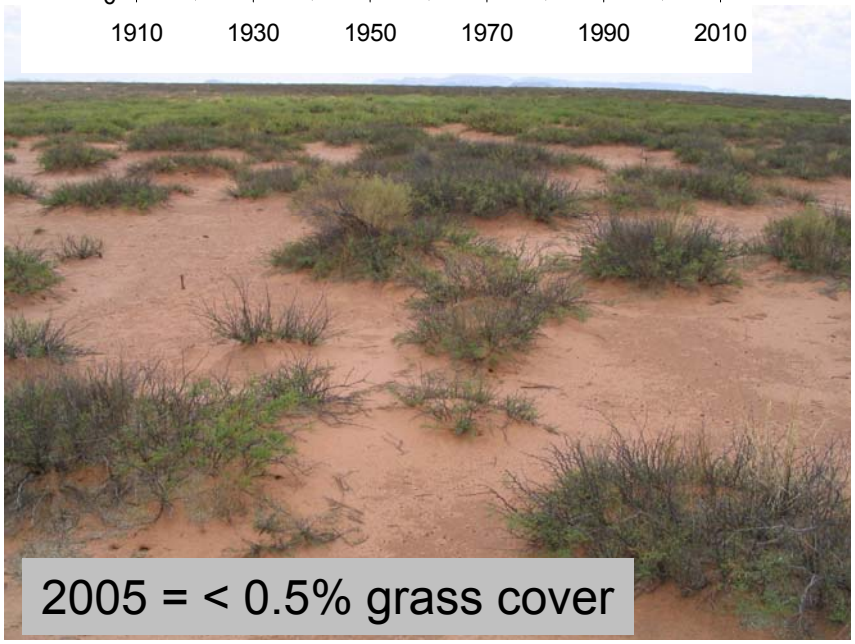


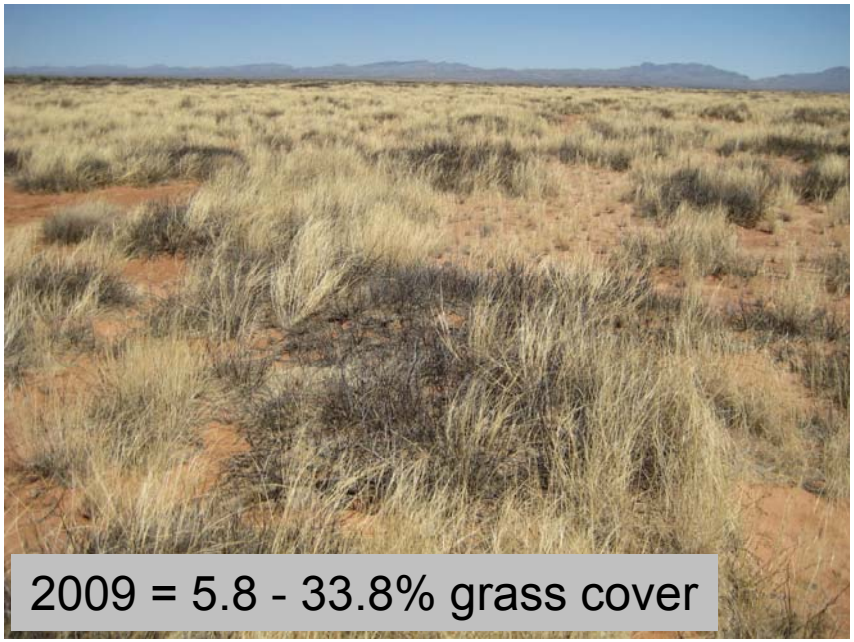
DPC Peters et al. in press, Journal of Arid Environments

Methods and evidence for “alternative regime” models

4. Extensive monitoring networks: what are responses to ongoing climatic events, and how does context influence responses







Methods and evidence for “alternative regime” models

5. Inventory/monitoring for incipient states: what is now rare may become common

A “new” Lehmann’s lovegrass grassland

What are its functions?

Interpretations and management actions given the model

Ecosystem change from HRV is:

Degradation if

- Site function (e.g., ANPP) has been impaired by local drivers
- Attributes and functions of new states are undesirable
- Bioclimatic regime has not changed sufficiently to preclude restoration
- Local restoration thresholds can be overcome with reasonable effort

Management: Manage local drivers, restore toward historical reference

Interpretations and management actions given the model

Ecosystem change from HRV is:

Novel ecosystem if

- Site function (e.g., ANPP) has **not** been impaired and can be sustained
- Some attributes and functions of new states are beneficial
- Bioclimatic regime has changed sufficiently to preclude restoration of other desired functions
- Local restoration thresholds cannot be overcome with reasonable effort, or without introducing substantial risk of even worse ecosystems

Management: Push ecosystem toward composition with maximum benefits and resilience

Interpretations and management actions given the model

Ecosystem change from HRV is:

A hybrid* (reconfigured) landscape if

- Different parts of landscape express historical and novel regimes
- Native plant species move in from adjacent areas
- Desired functions can be preserved, recovered, or fostered in different areas
- Shift in bioclimatic regime is variably "filtered" by soils/landform and historical legacies

Management: For each ecological site and state in a landscape, consider preservation, restoration, or adapting to novel state— but
be aware of risk of spread of exotics into areas managed for HRV

* Hobbs, Higgs, and Harris. 2009. TREE 24: 599-605

Interpretations and management actions given the model

End of "recent" regime

Monitor black grama vegetative reproduction

Seed other grasses in shrublands in high rainfall periods

Watch Lehmann's lovegrass?

…if you can't be with the one you love…, love the one you're with (S. Stills, 1970)