State and transition models as management tools: past, present, and future

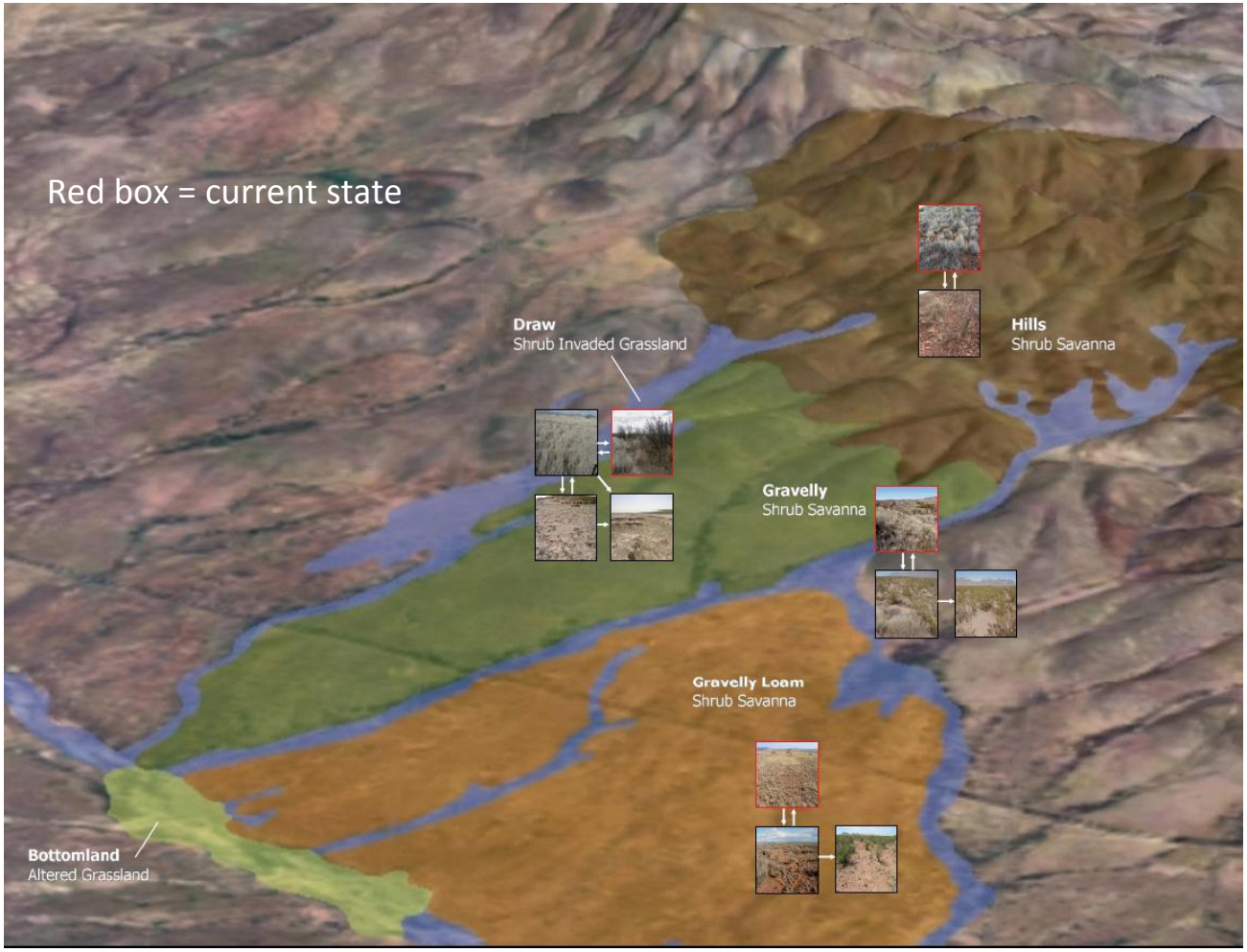
Brandon T. Bestelmeyer

USDA-ARS Jornada Experimental Range

Las Cruces, NM, USA

bbestelm@nmsu.edu

How will heterogeneous landscapes respond to management and natural drivers?



Factors influencing ecosystem responses

- **Climo-edaphic setting (ecological site, “potential vegetation”)**
- **Current assemblage of plants/animals and dynamic soil properties (ecological state)**
- **Ecological mechanisms (competitive release, plant-soil feedbacks, etc.)**

Why are these details important?

Brush management + prescribed grazing: common mental model

Key ecological mechanism*: release of perennial grasses from competition for soil resources*

Why are these details important?

Brush management + prescribed grazing: site-specific realities

Historical soil degradation

Presence of another competitor

Limited climatic and soil potential

The range site model Dyksterhuis 1958 (Ecological Principles in Range Evaluation, Botanical Review 24: 253-272)

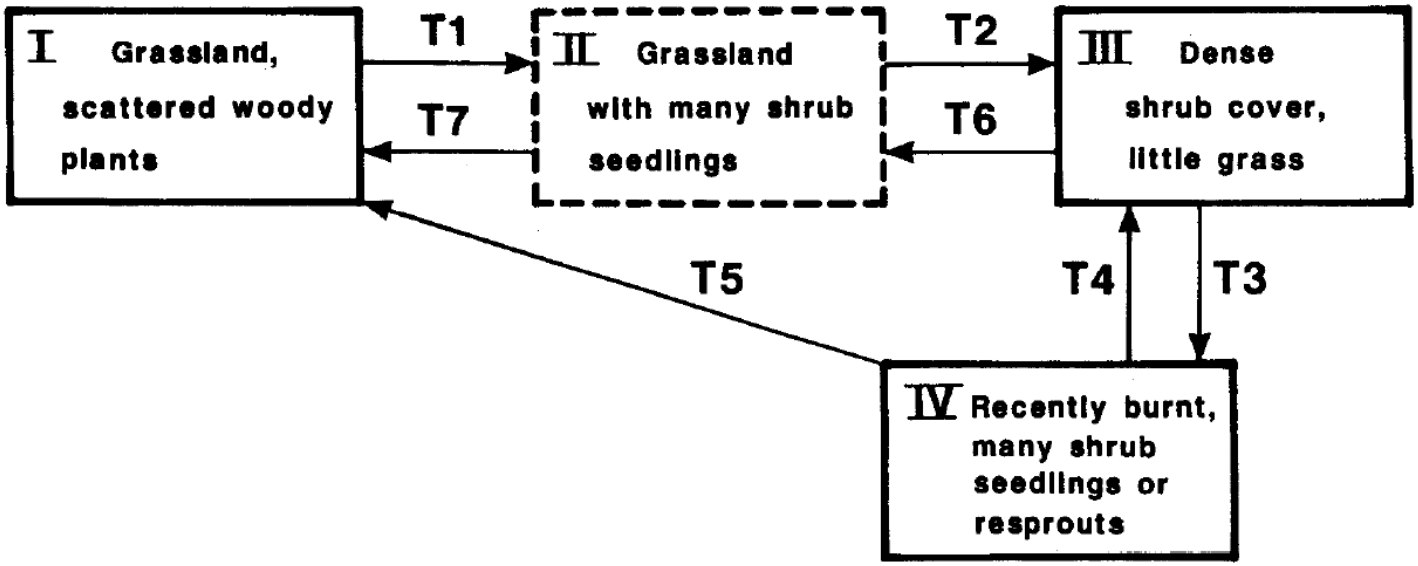
"The physical environment…supports many measurably different plant communities in apparent stability with local site conditions"

"When grazing…is superimposed by thousands of owners with tens of thousands of pastures grazed in various ways, the climax pattern tends to be obscured and there is an overall increase in number of plant communities"

"Secondary succession, if permitted by rest from overgrazing or grazing practices that favor climax dominants, obliterates fenceline contrasts and reduces the number of plant communities"

- Plant and soil data can be used to predict vegetation change

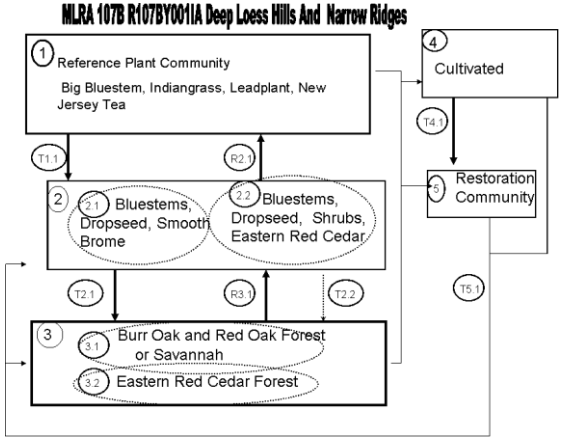
The state and transition model Westoby et al., 1989



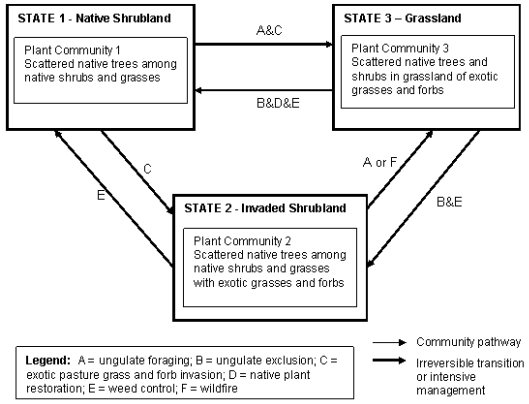
- Discrete plant communities (states) for organizing information
- Detailed mechanisms, including possibility for persistent transitions (thresholds)
- No clear linkage to climo-edaphic variations (except as brief narratives)

State and transition models linked to ecological sites

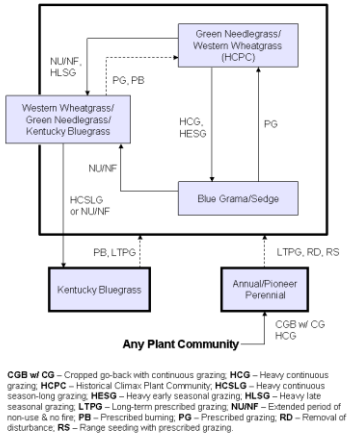
George et al. 1992; National Research Council 1994; SRM 1995



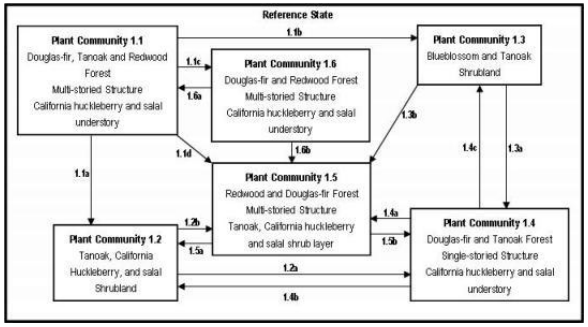
Loess Hills, Iowa



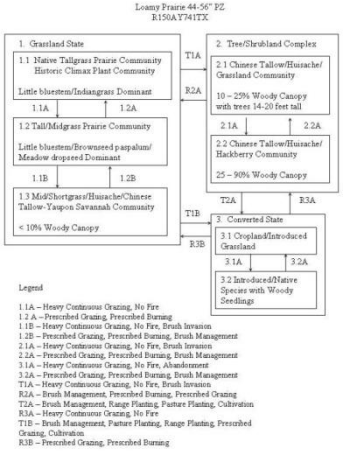
Pahoehoe shrubland, Hawaii



Northern mixed grass prairie, North Dakota



Redwood forest, California

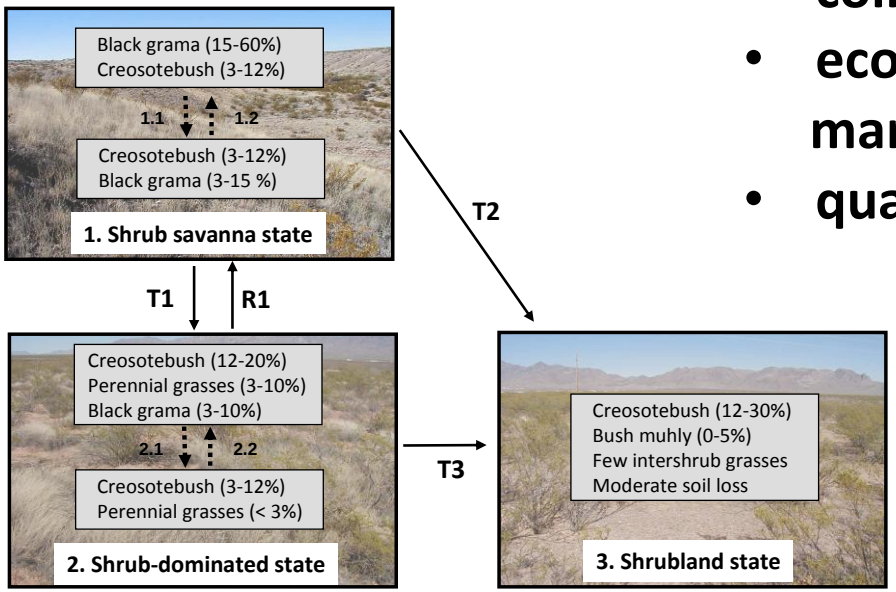


Gulf Coast prairie, Texas, Louisiana

- STMs as a basis for assessment; risk of losing future options
- Expansion of use, linkage to conservation practices

The “3G” state-and-transition models

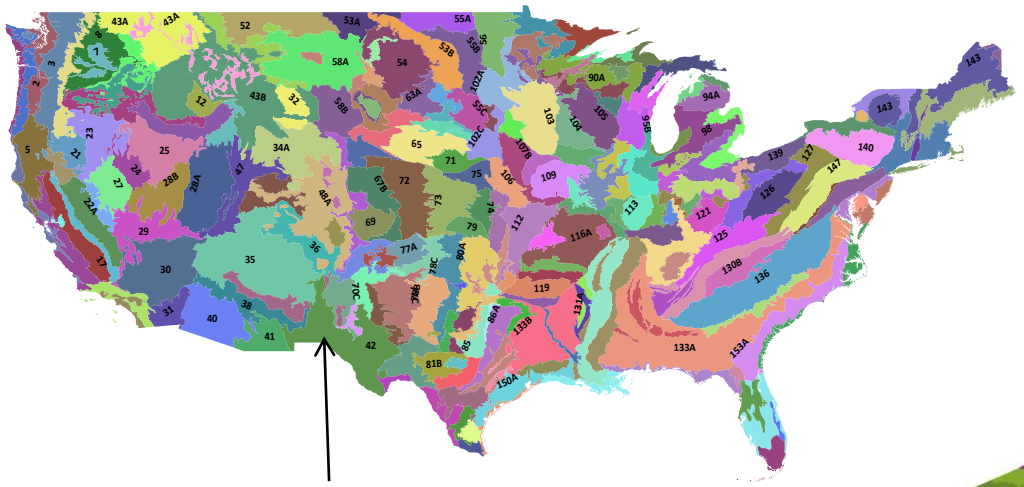
Stringham et al., 2001→Interagency Ecological Site Handbook for Rangelands 2012



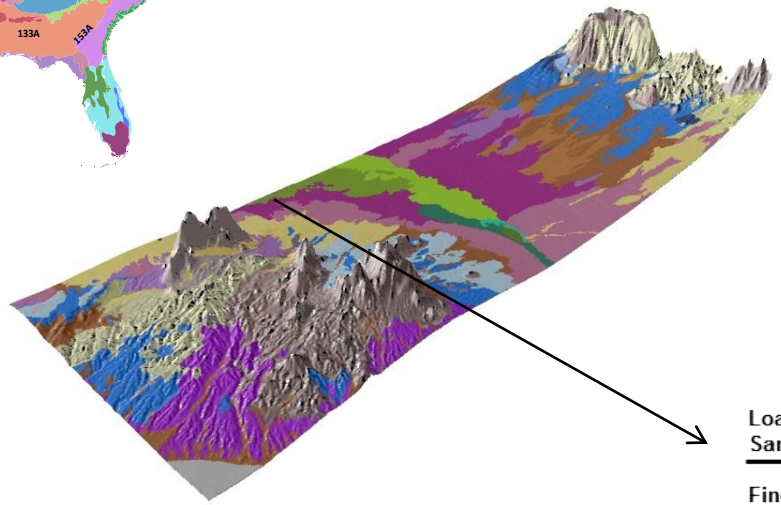
Emphasis on:

- **standardized structure**
- **consistent logic**
- **collaborative creation**
- **ecological processes underlying management responses**
- **quantification and prediction**

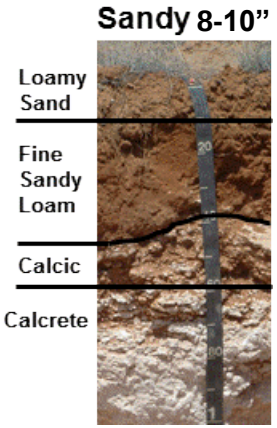
How STM development and use works



Major Land Resource Area

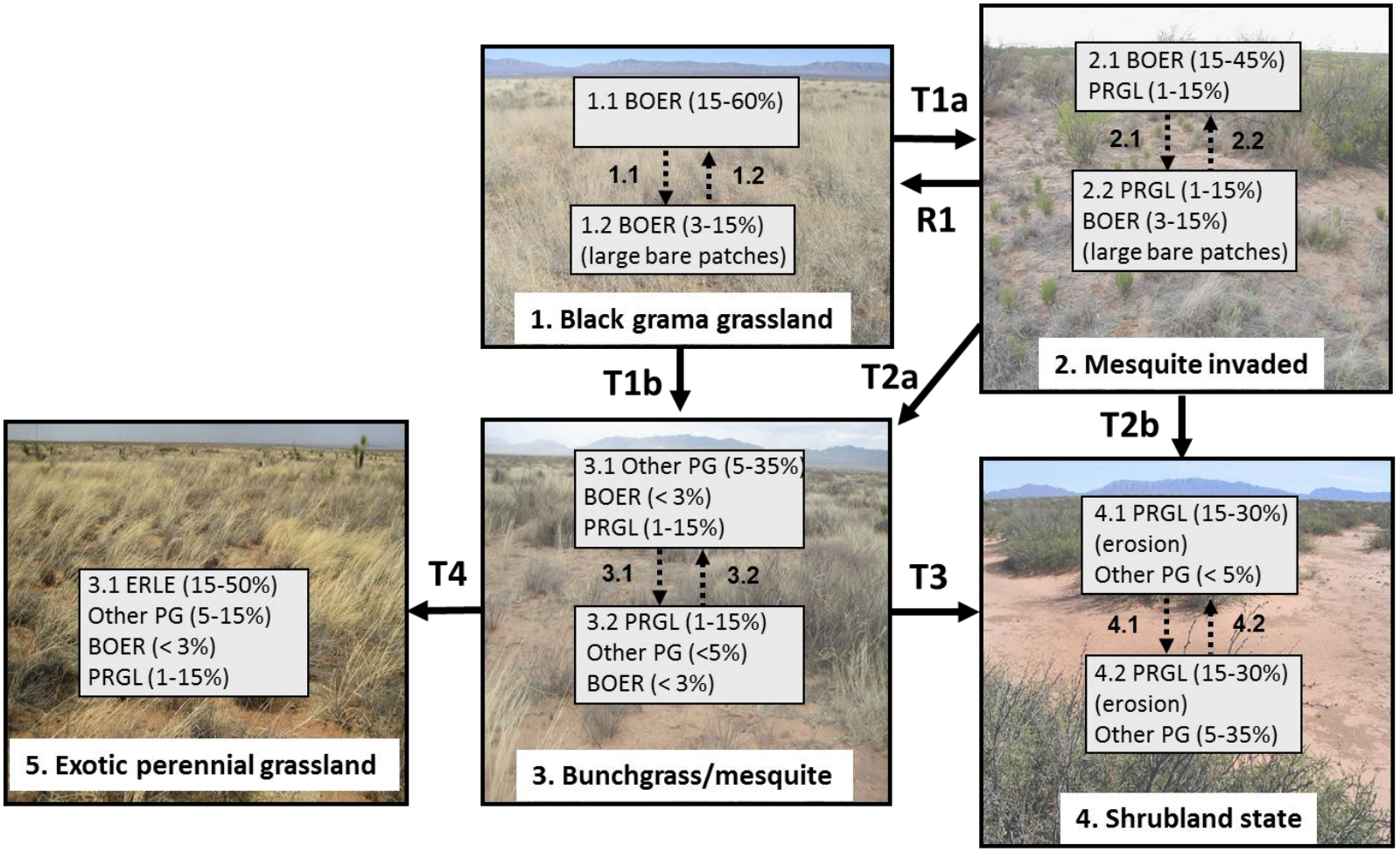


Soil landscape/soil mapping:
Landscape position, elevation, slope/aspect, precipitation zone



Soil profile and climate
→Ecological site

State-and-transition model



T1a. Mesquite establishment facilitated by seed transport by cattle, bare patches > 50 cm, and relatively wet springs
R1. Shrub removal via herbicide or fire followed by black grama recovery to > 15%
T1b, T2a. Black grama is reduced below ca. 3% cover by heavy grazing in drought
T2b, T3. At perennial grass cover < 5%, wind and storm events, trigger deep, spreading soil erosion
T4. Invasion by Lehmann's lovegrass, dominance increased by fire

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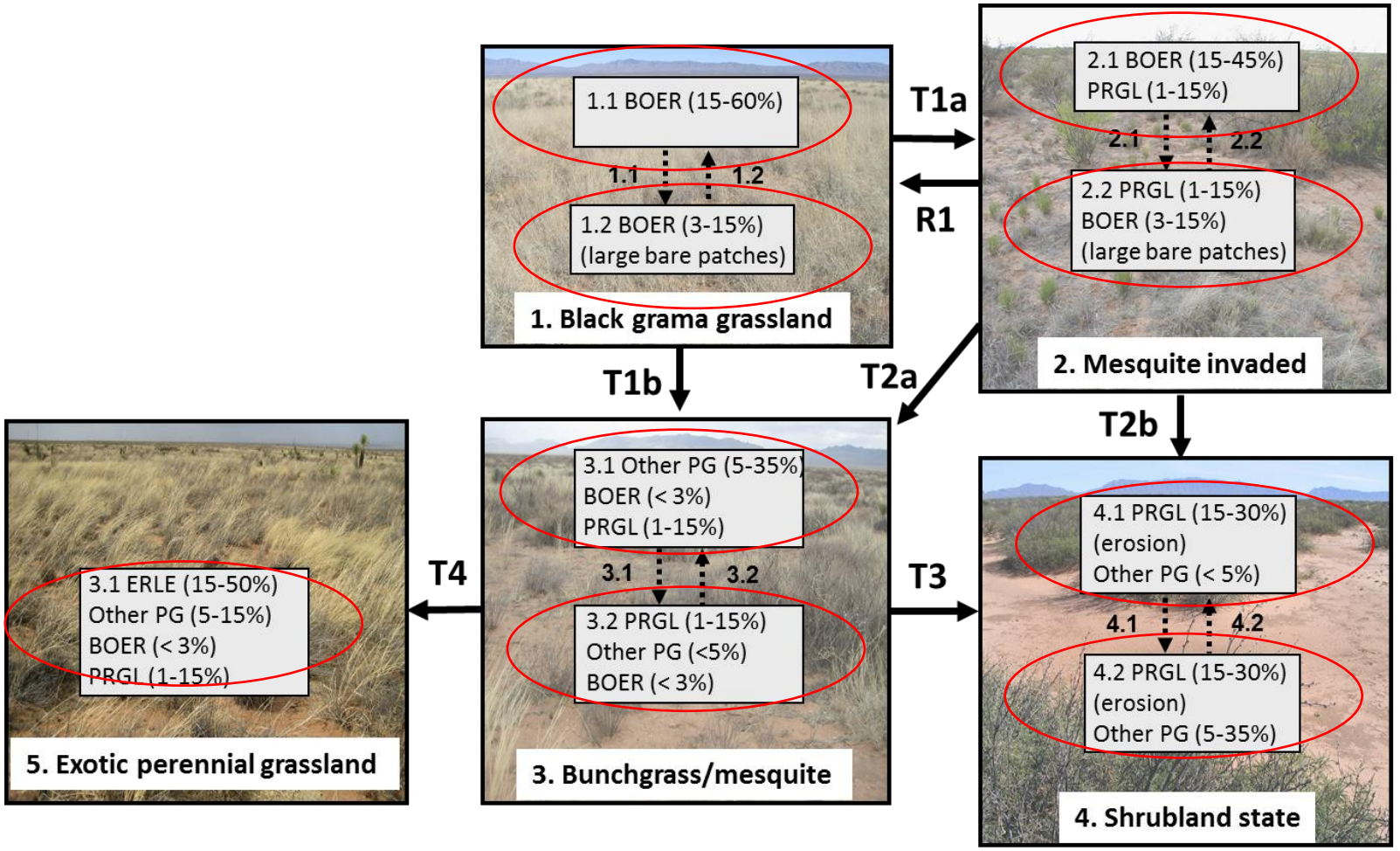

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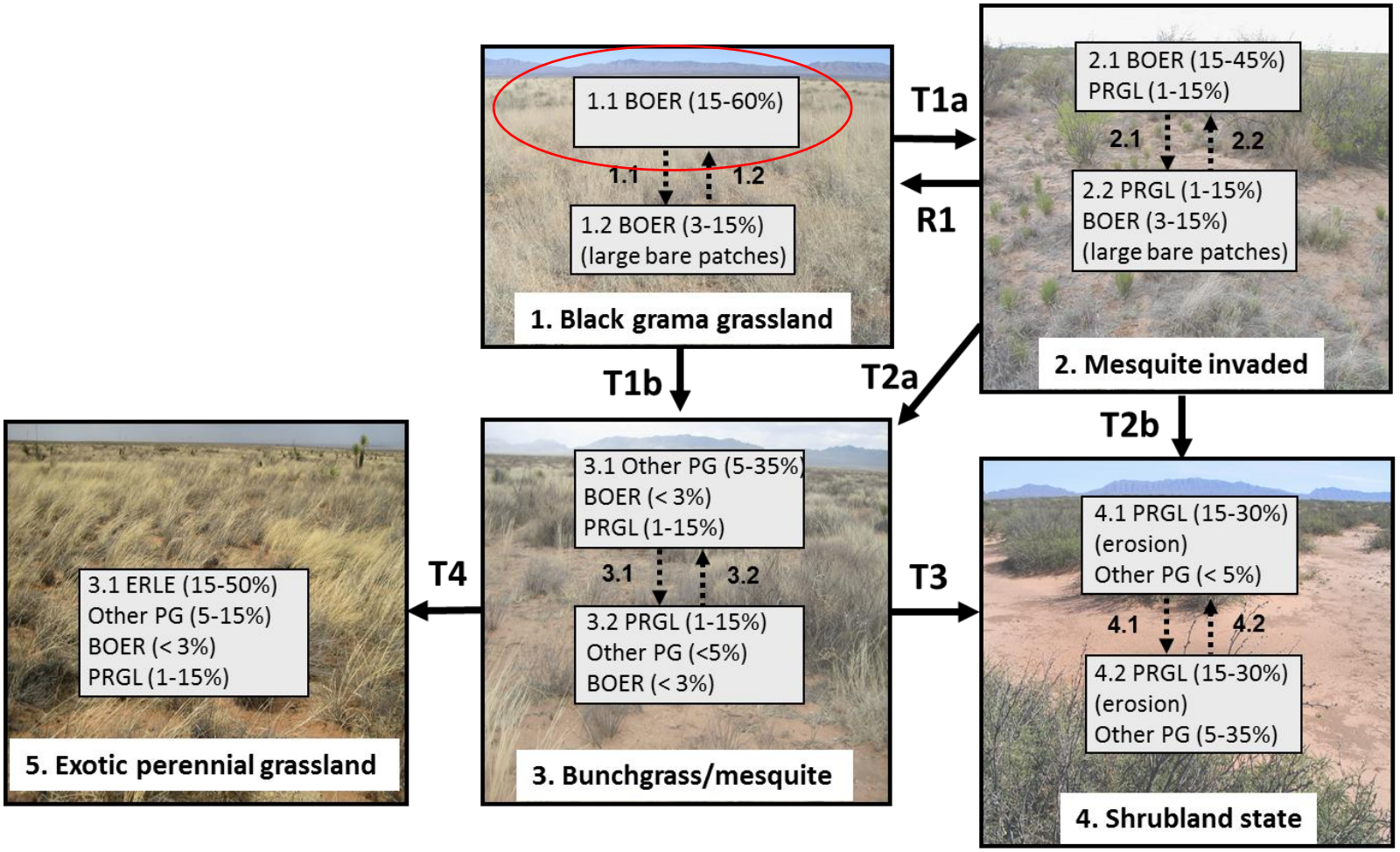

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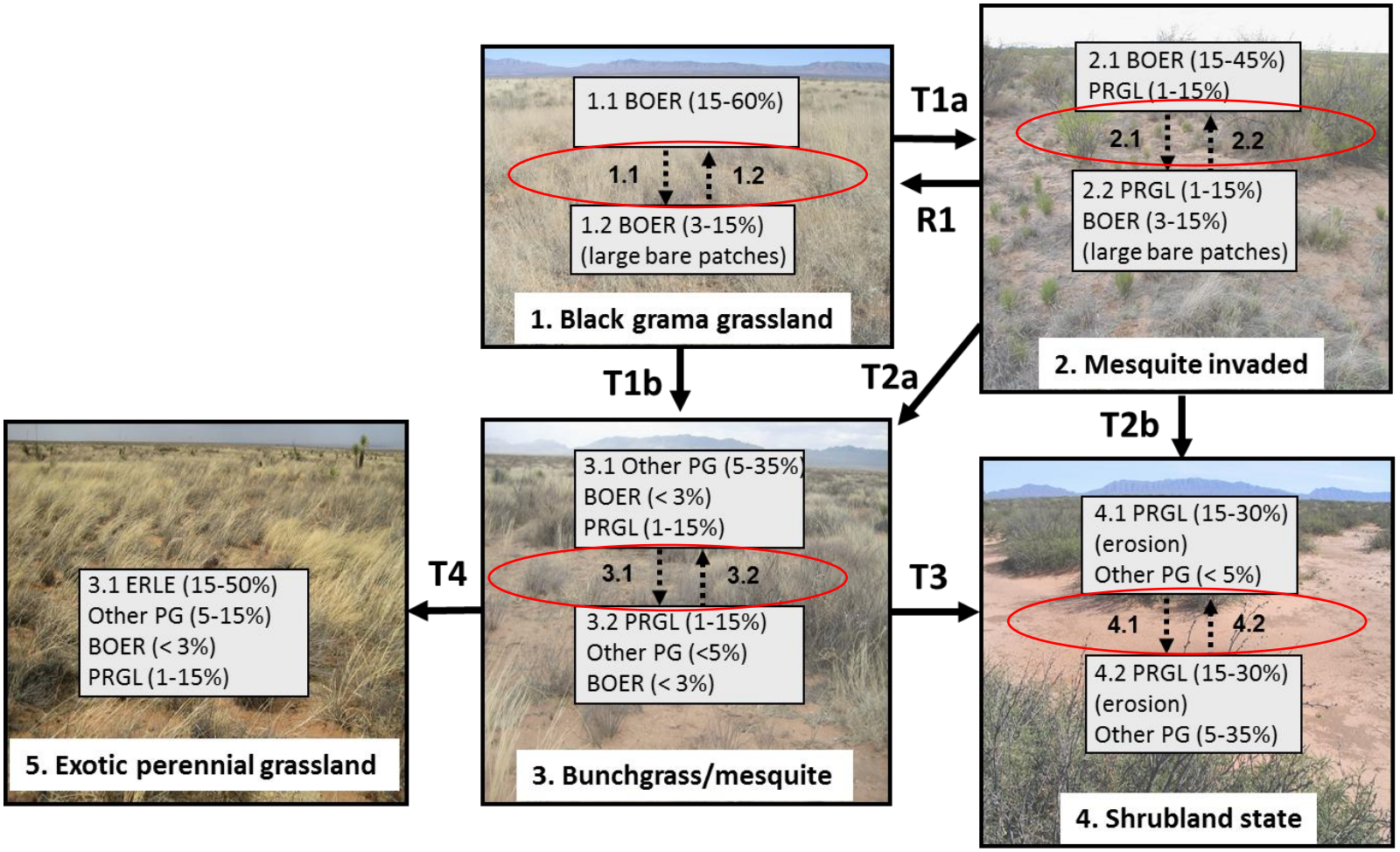

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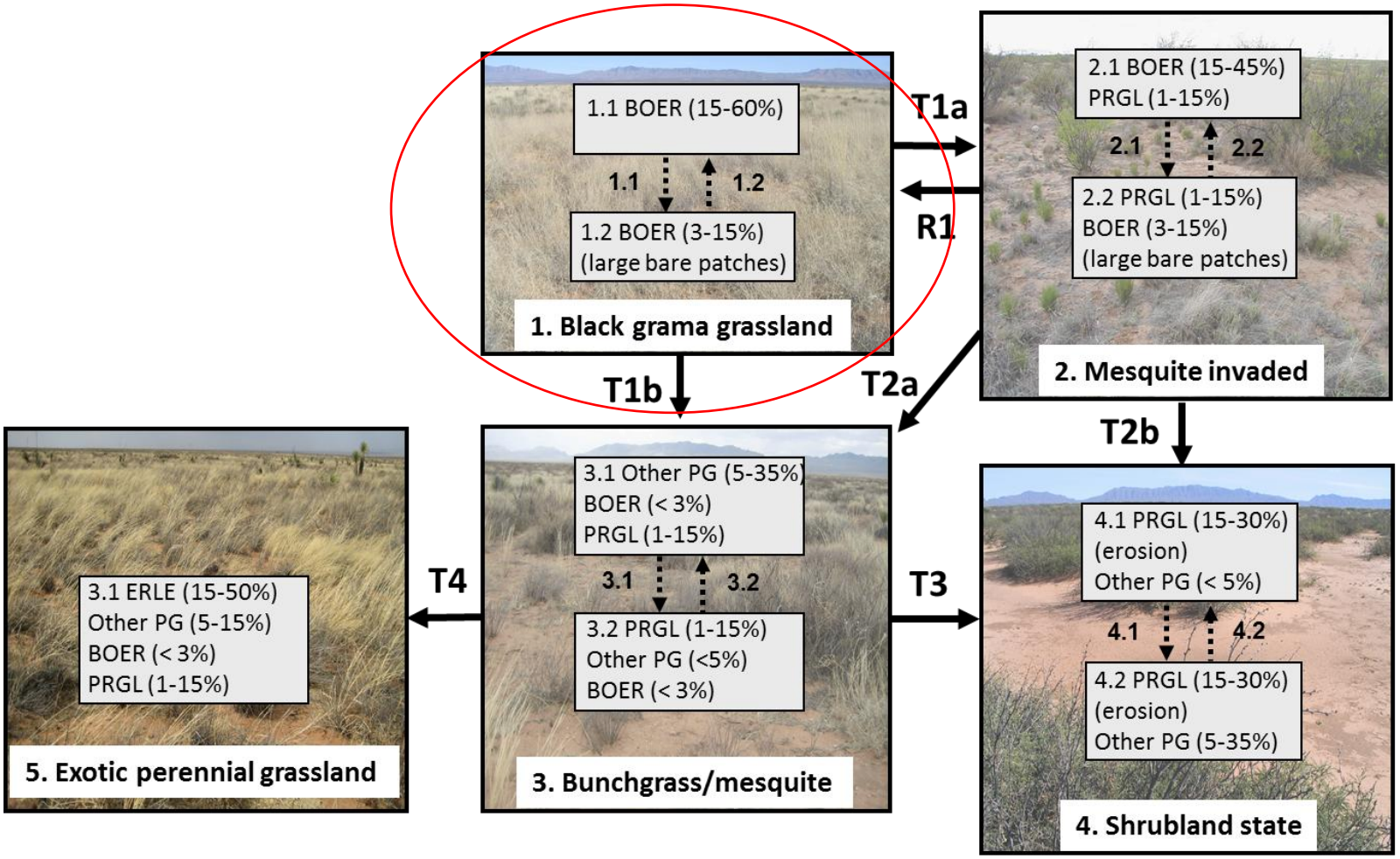

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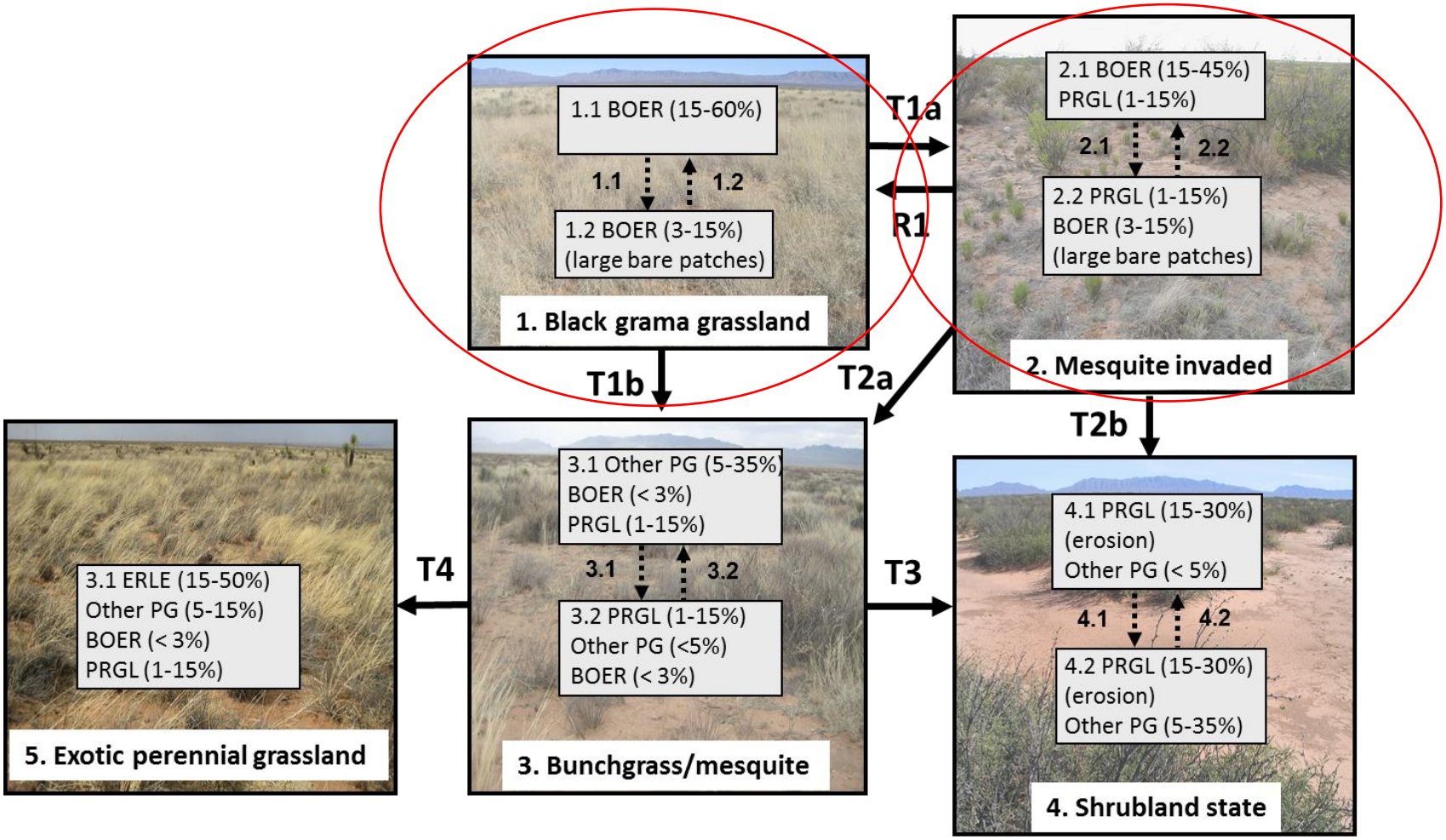

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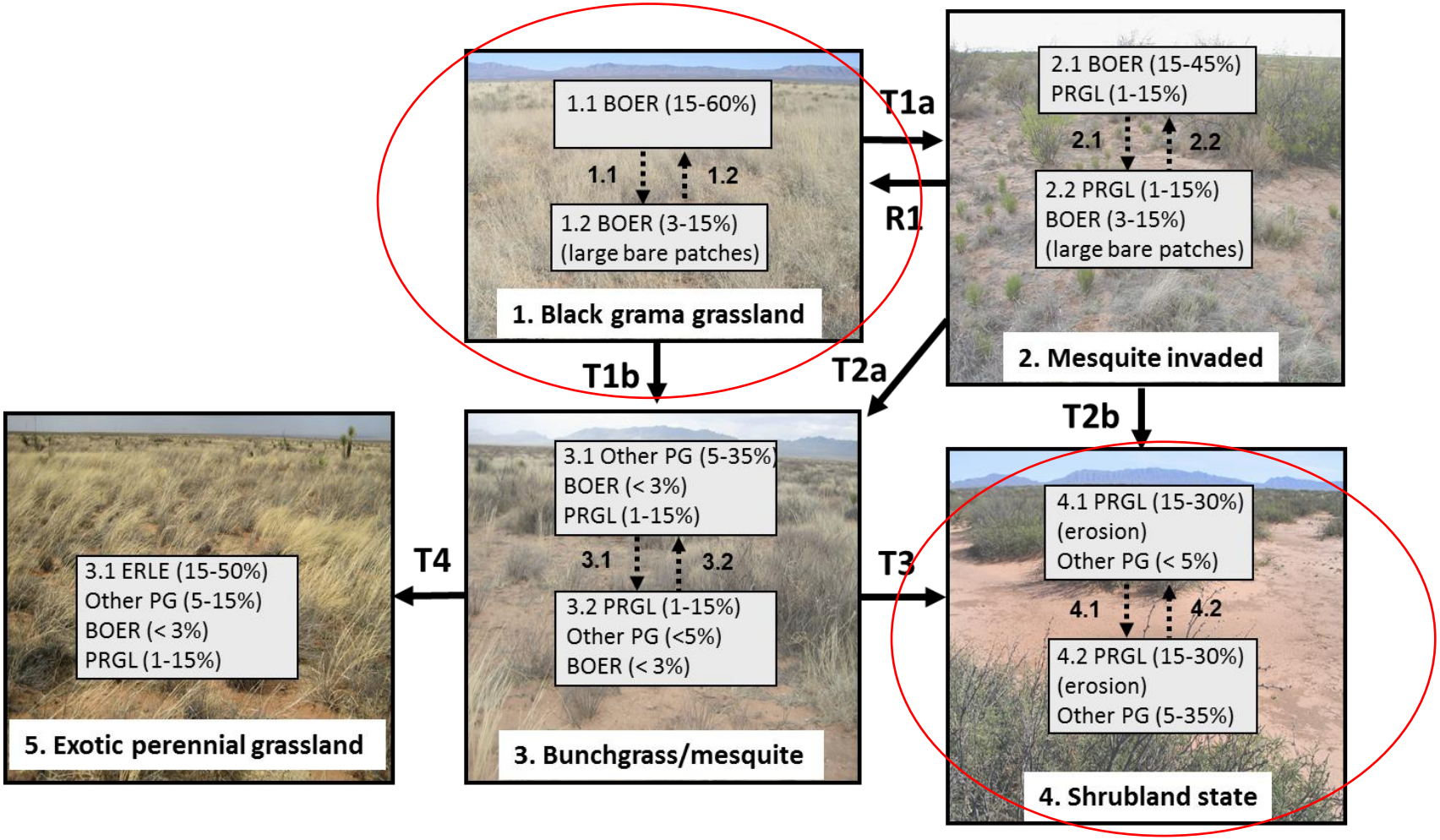

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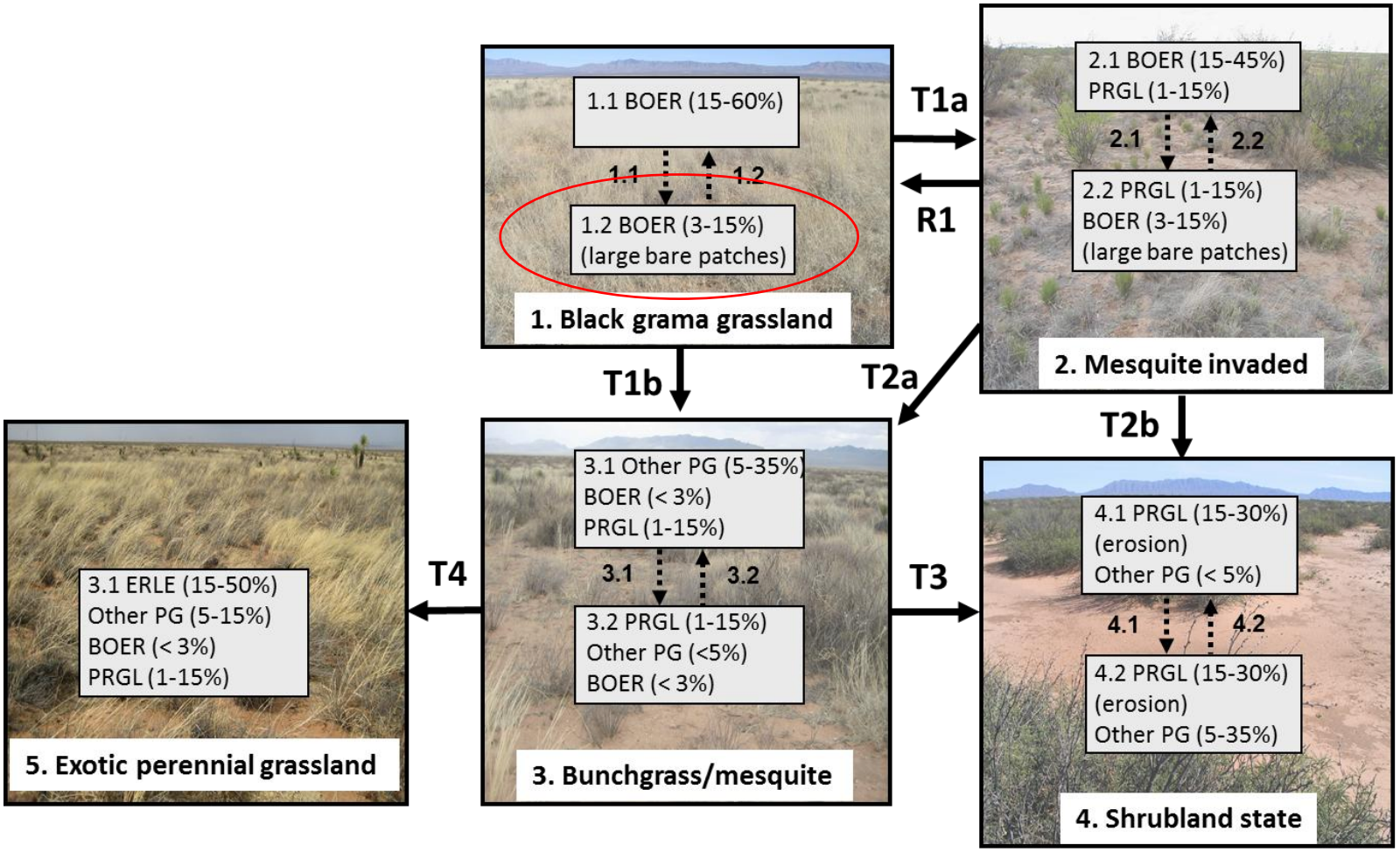

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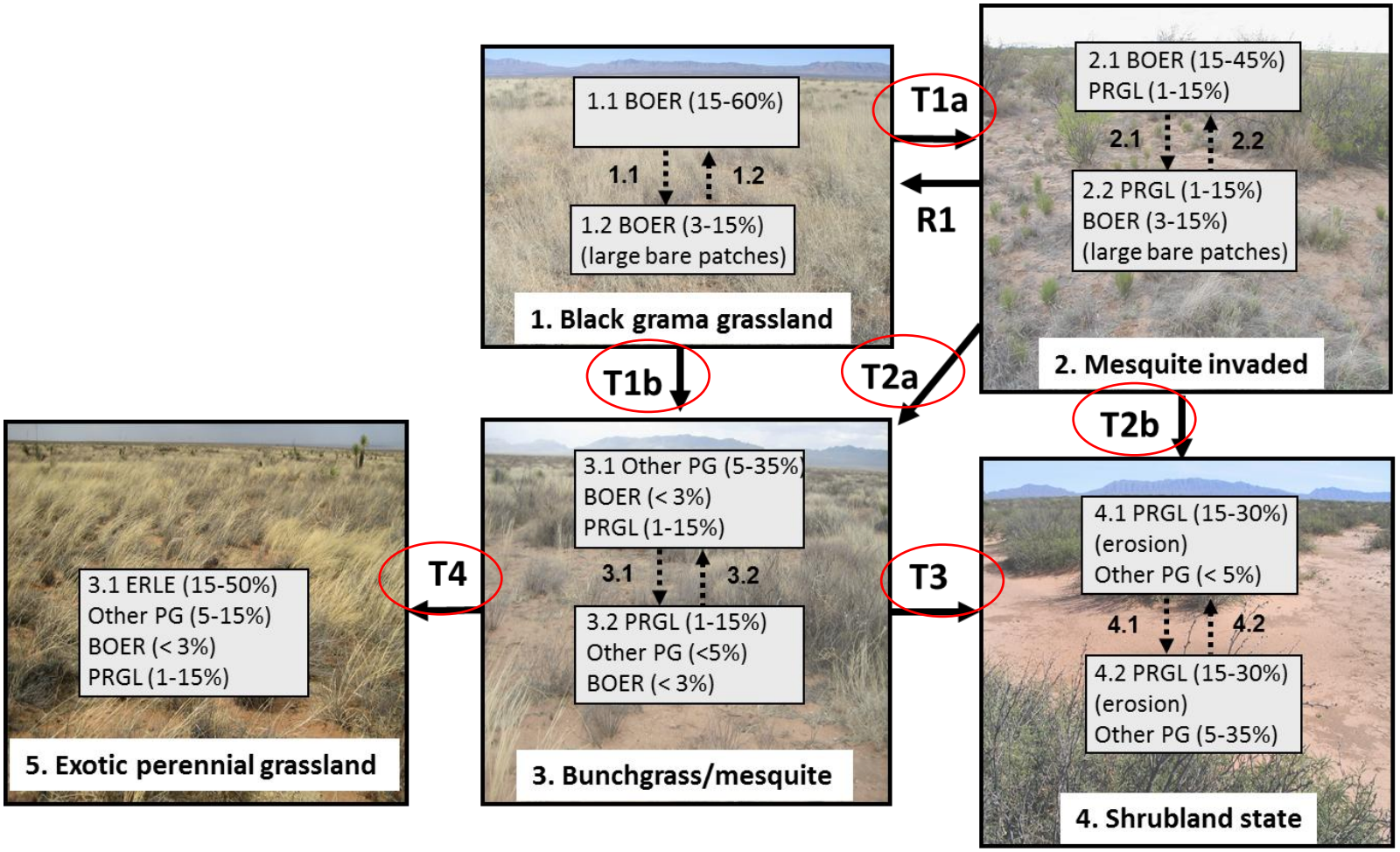

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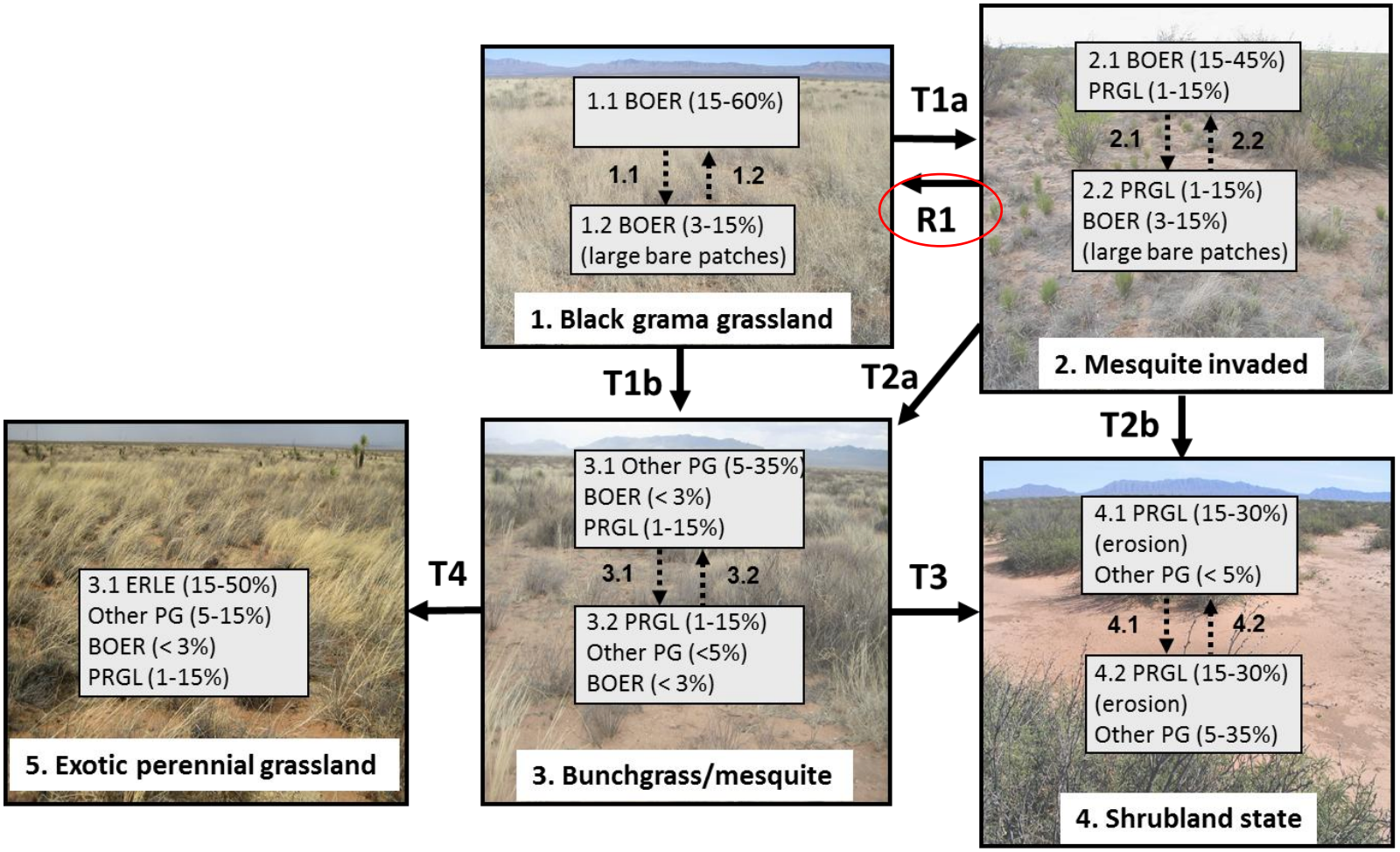

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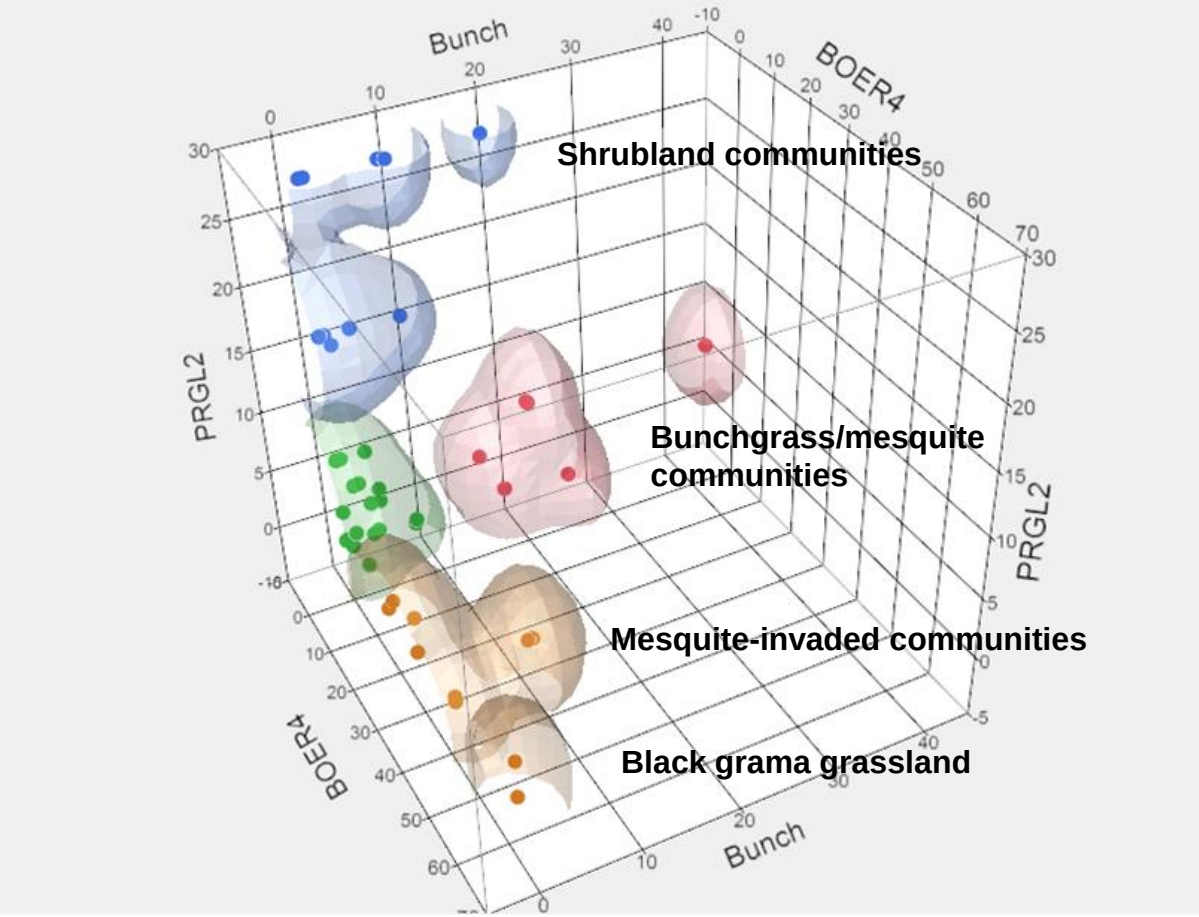
Models supported by a variety of information types



Plant community data from similar soil profiles support concepts and values for phases and states

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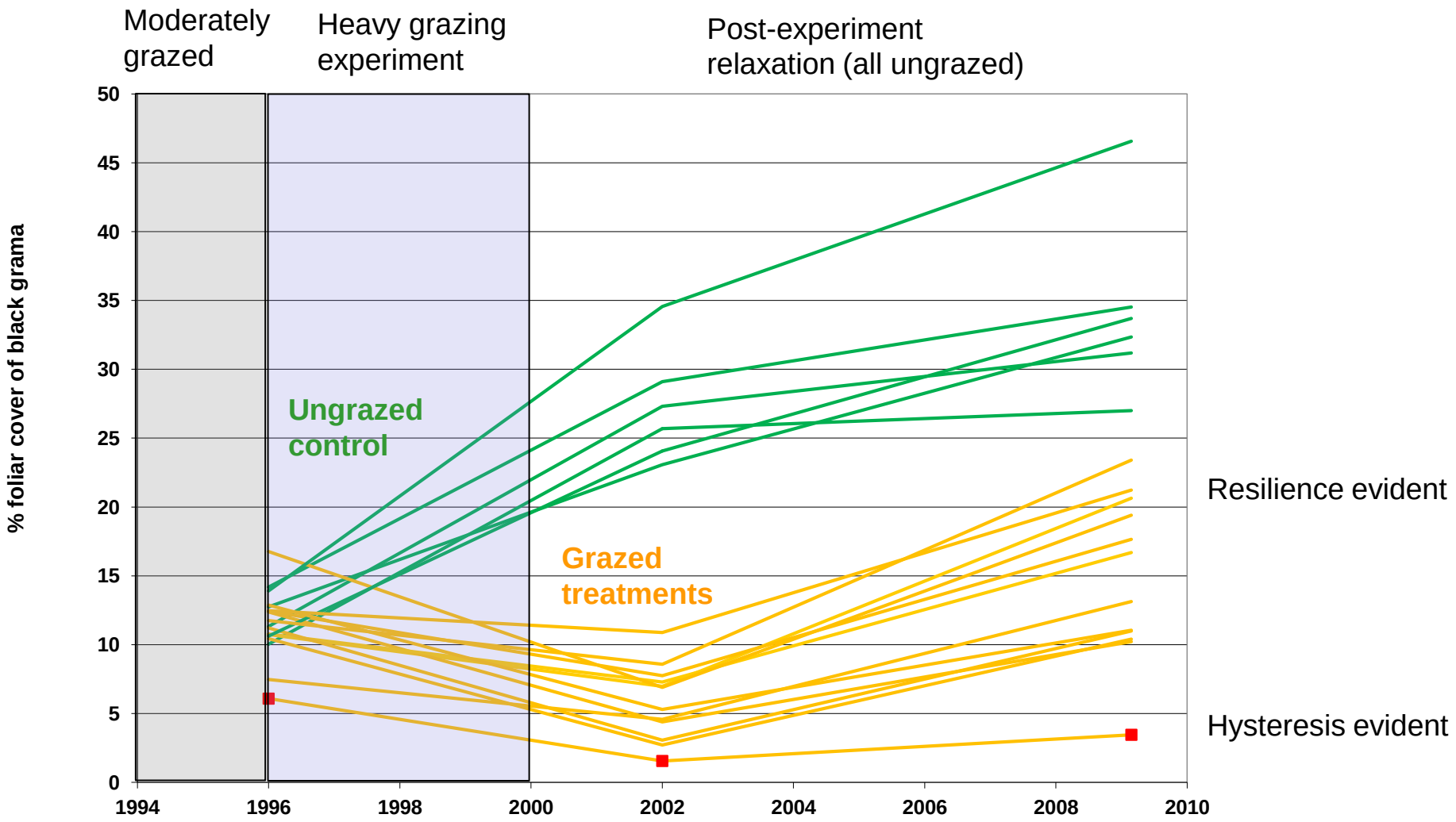

Black grama low cover value in at-risk phase drawn from experiment

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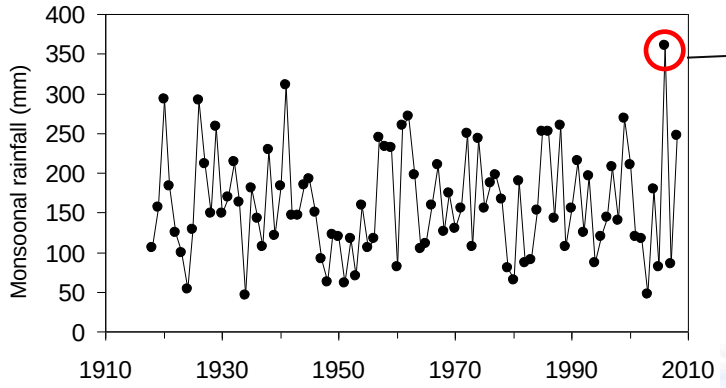
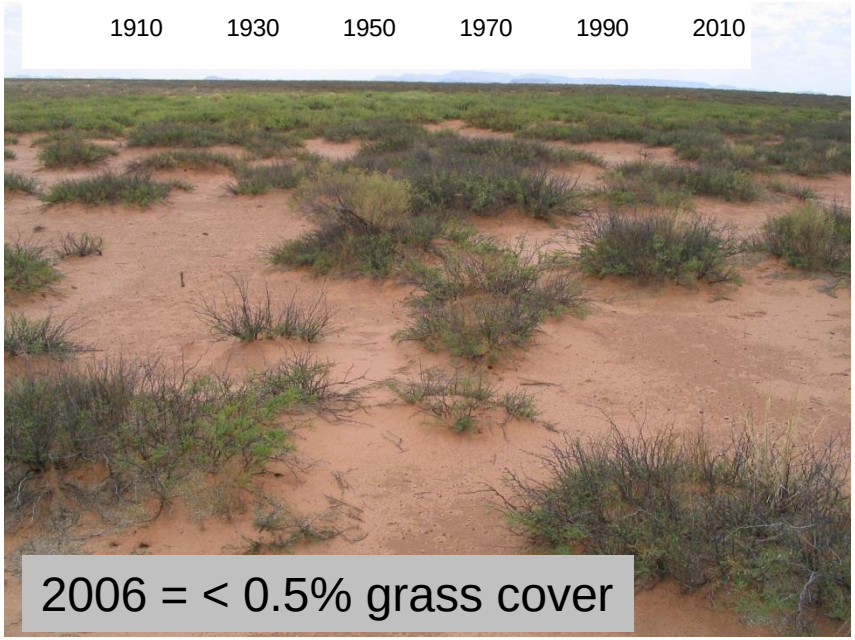
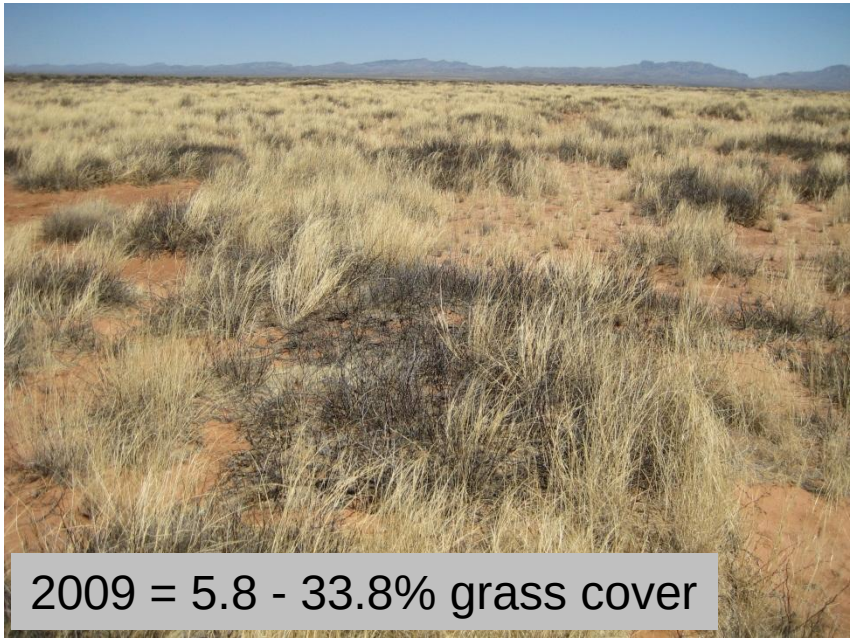


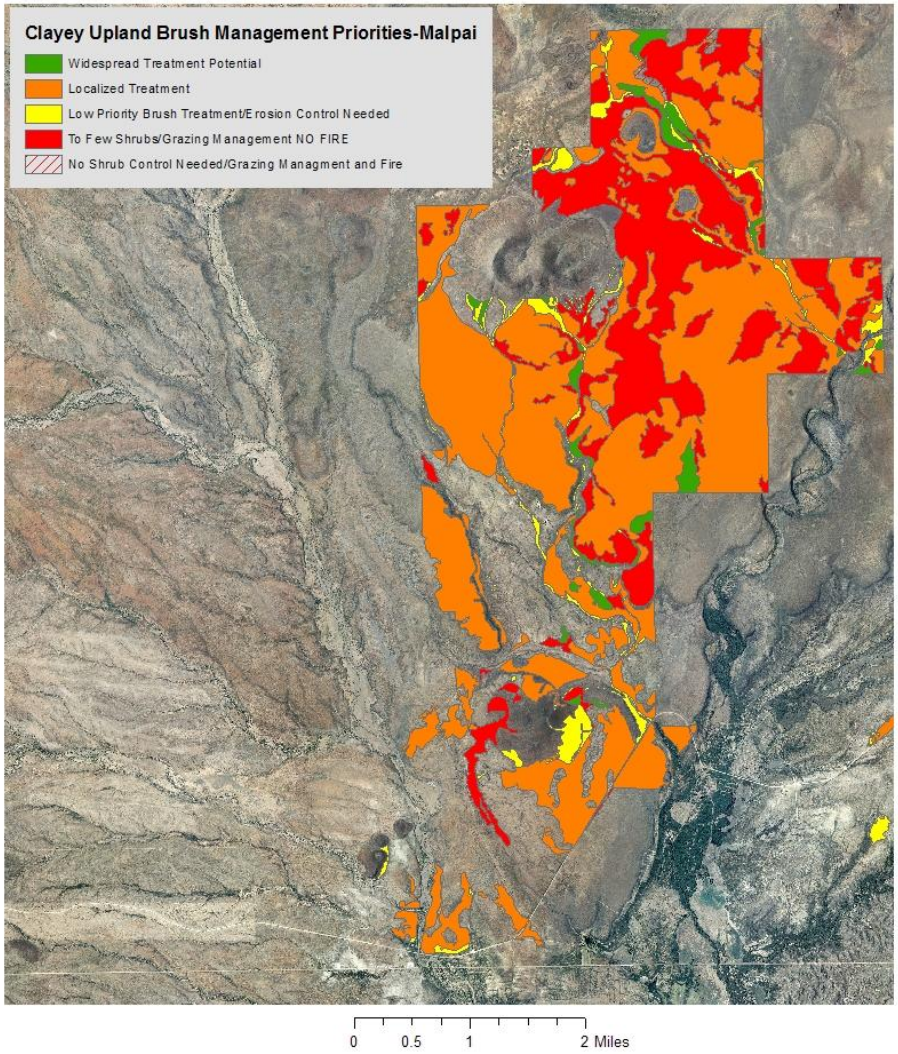
2006 El Nino-related rainfall





A new, desirable community phase in shrubland state from El Nino event

Using STMs at the landscape scale



Maps of ecological states can be reclassified to management needs based on STM

Get involved to improve STMs

- **Inventory (see** http://jornada.nmsu.edu/esd**)**
- **Controlled experiments to test STM mechanisms**
- **Management experiments to test restoration or community pathways**
- **Use your iPhone or android phone to find STMs for your area of interest (SoilWeb application)**