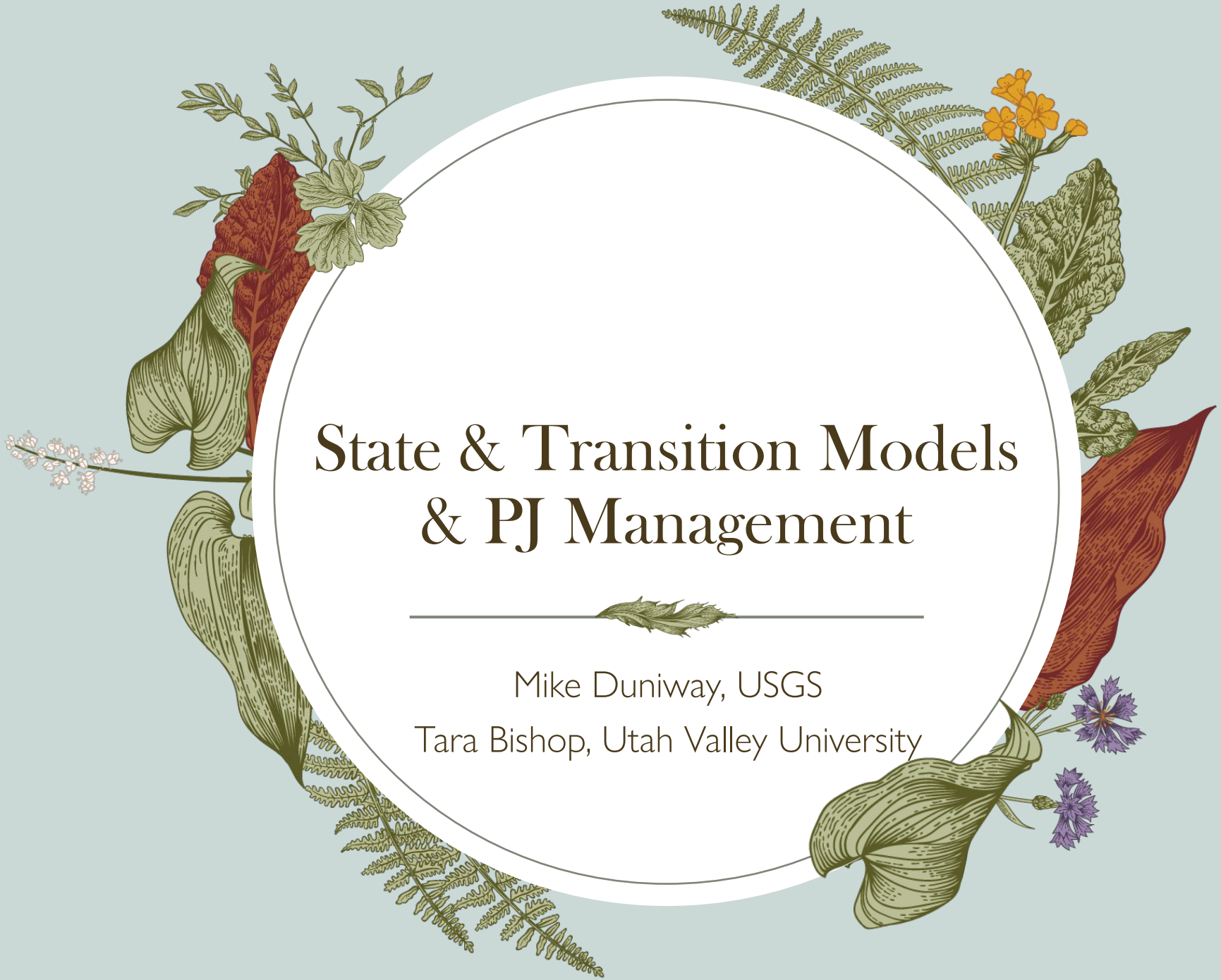
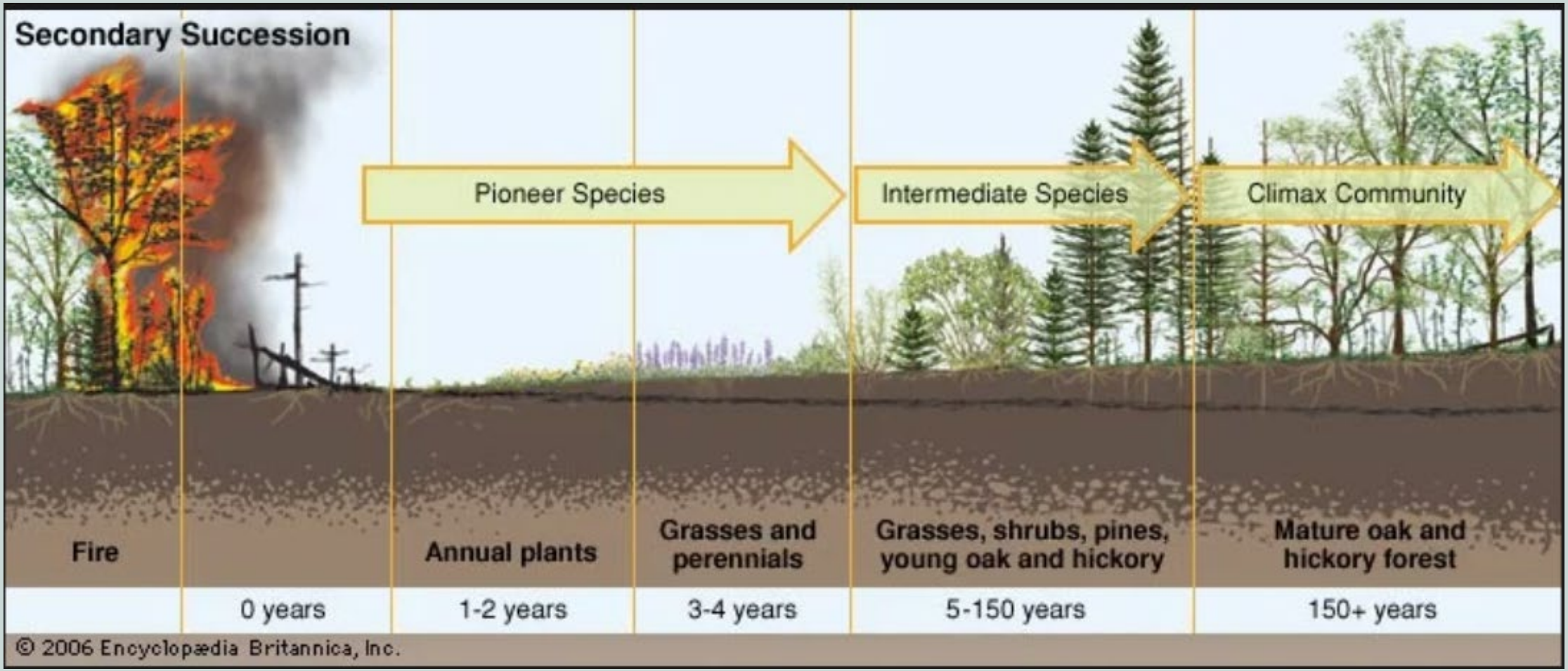


State & Transition Models & PJ Management

Mike Duniway, USGS

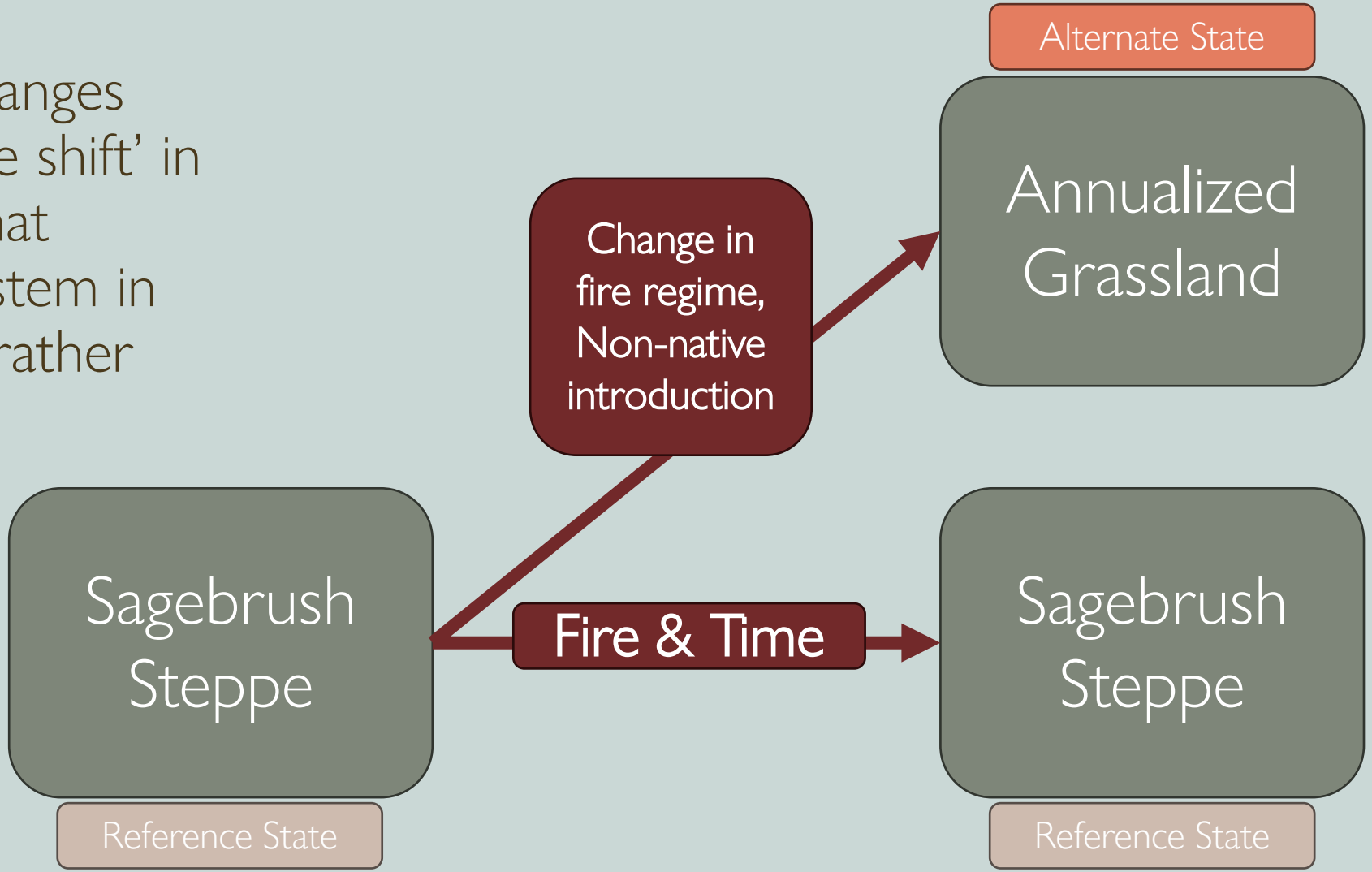
Tara Bishop, Utah Valley University

Succession is a linear process



Alternate State Theory – Ecosystems aren't always linear

- Disturbances or changes may cause a 'regime shift' in critical processes that maintains an ecosystem in an 'alternate' state rather than returning to a 'reference' state



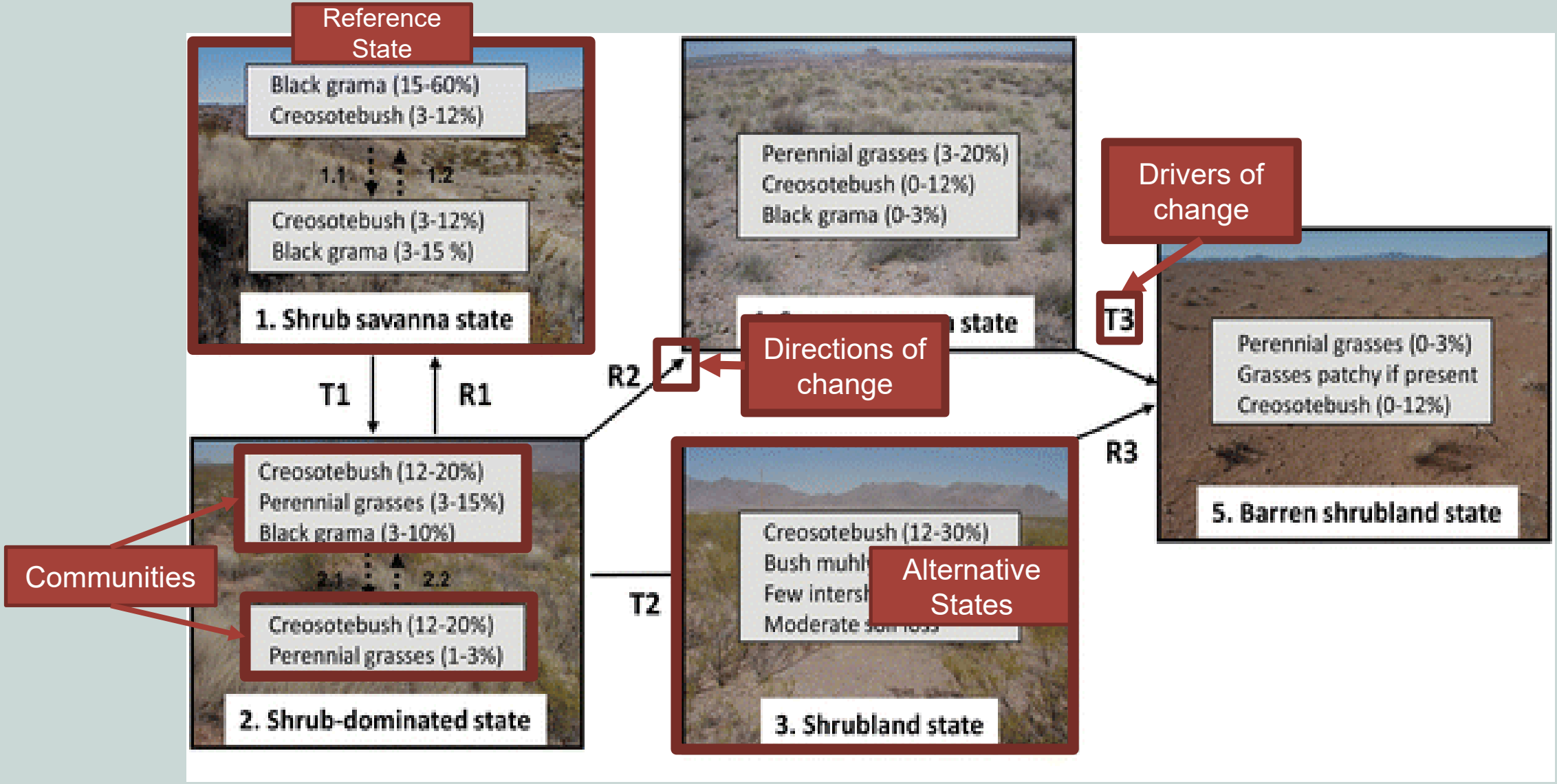
STM

STM define it's 'land potential'

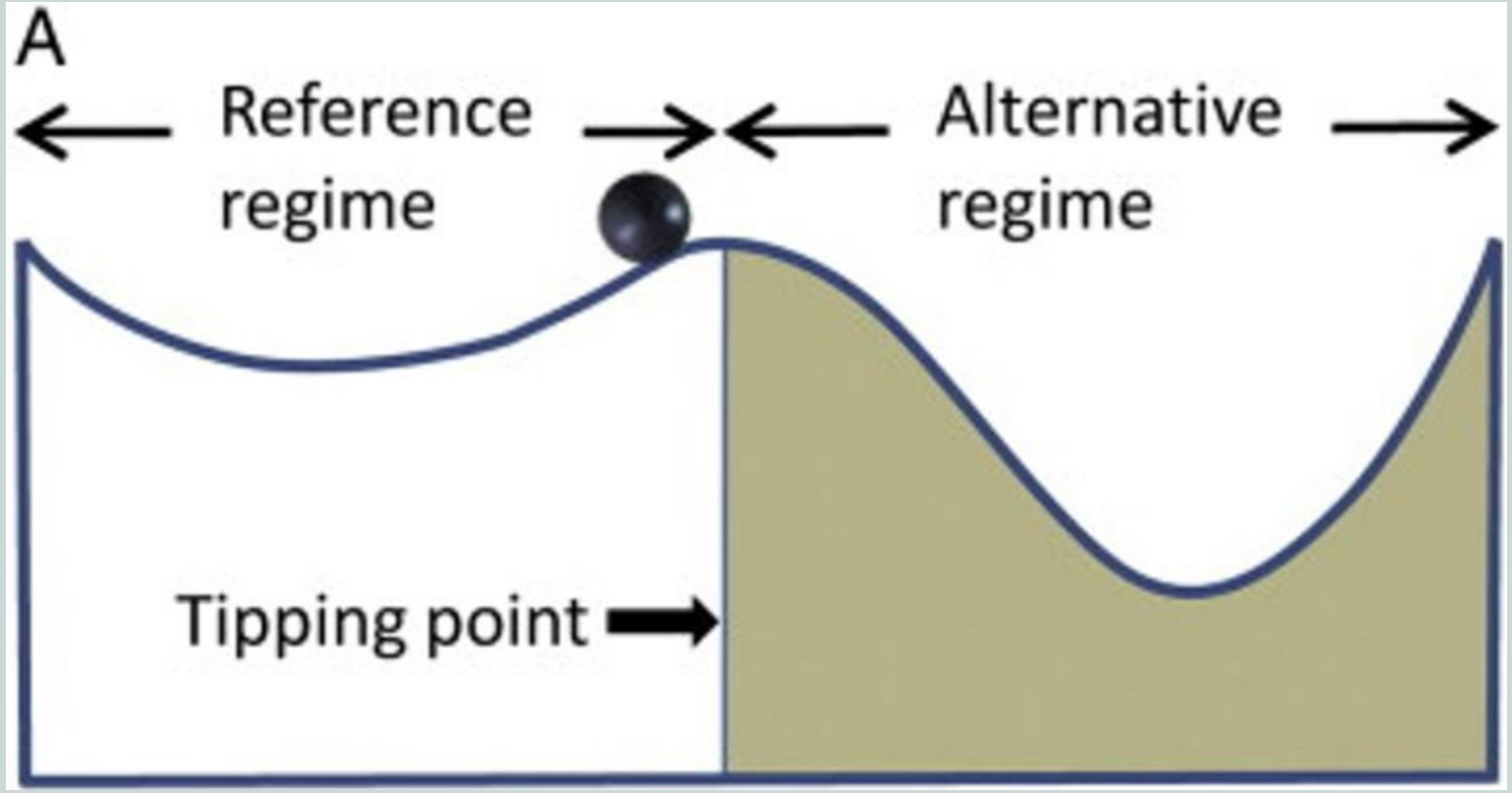
State and Transition Model

Describe changes in plant communities and associated dynamic soil properties that can occur due to change drivers (natural or anthropogenic)

State and Transition Model (STM)



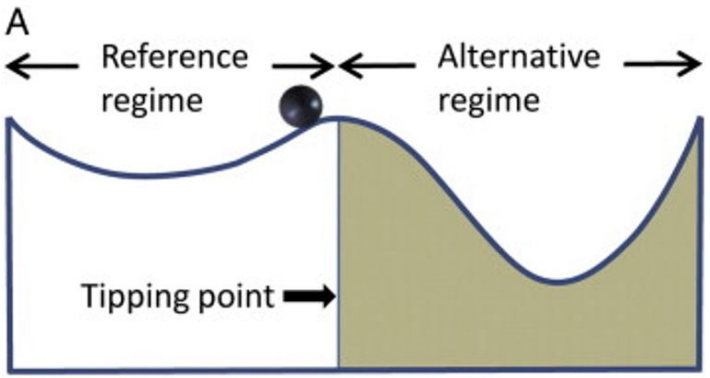
State and Transition Model (STM)

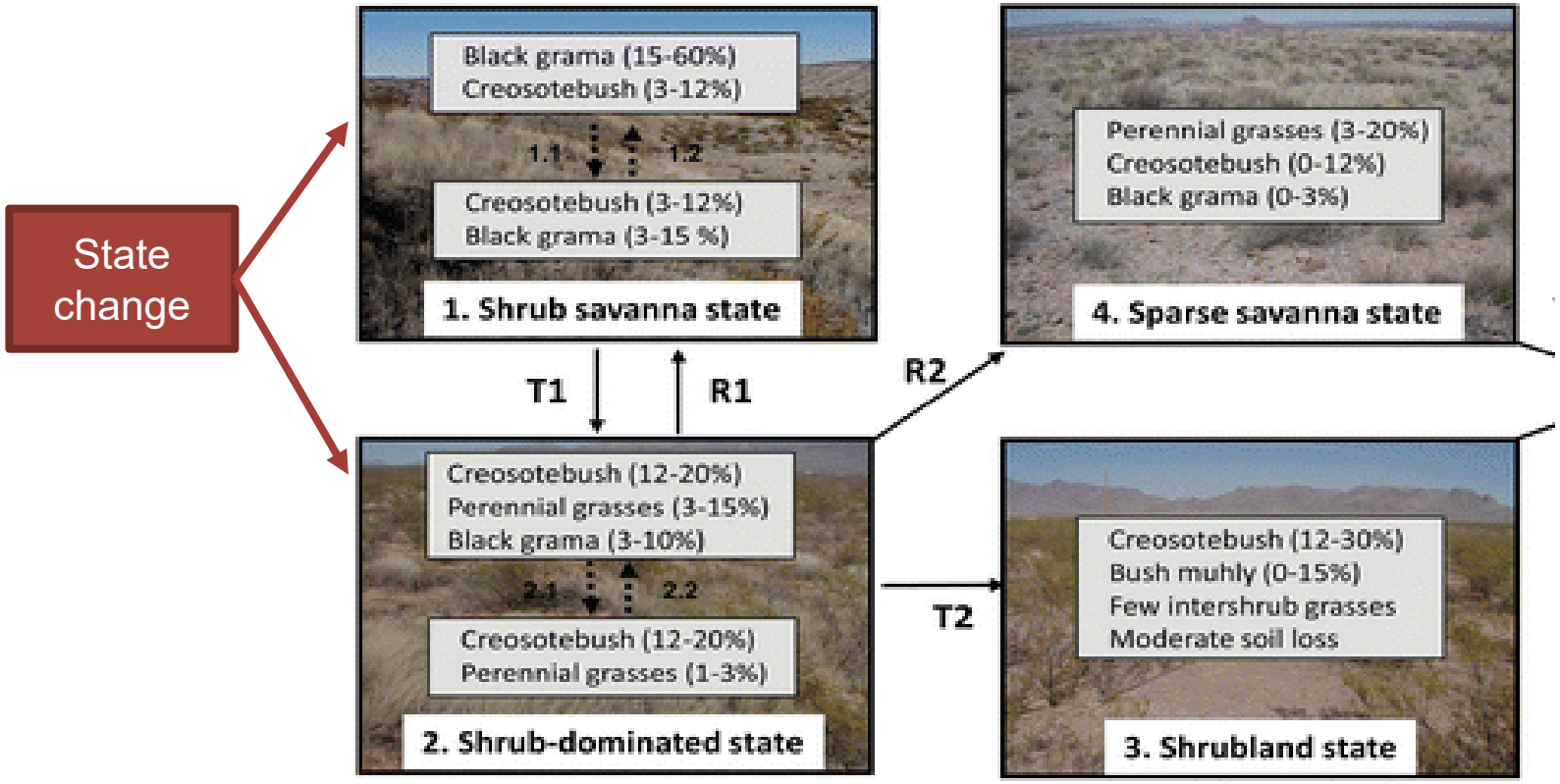


Bestelmeyer 2015 *Rangelands*

State and Transition Models (STMs)

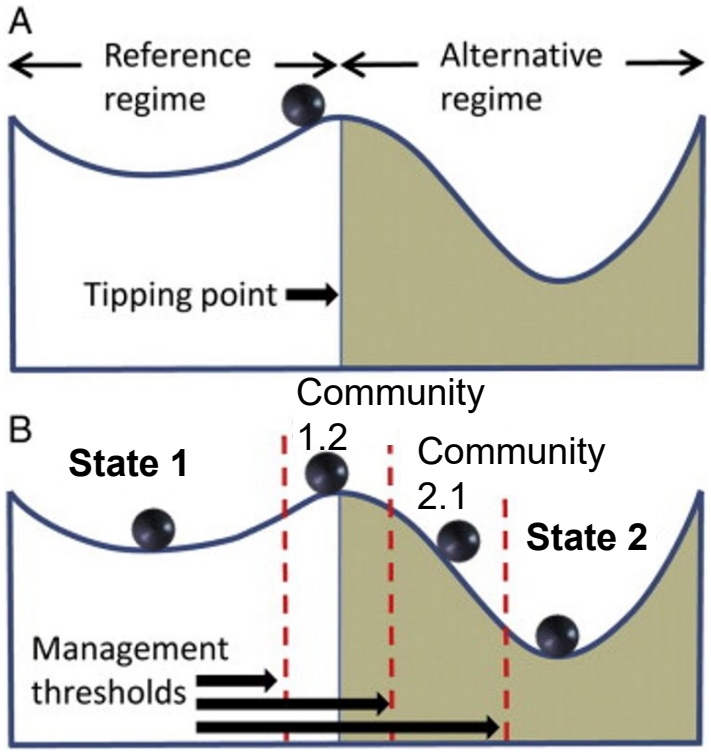
Difference between a community pathway and a state transition

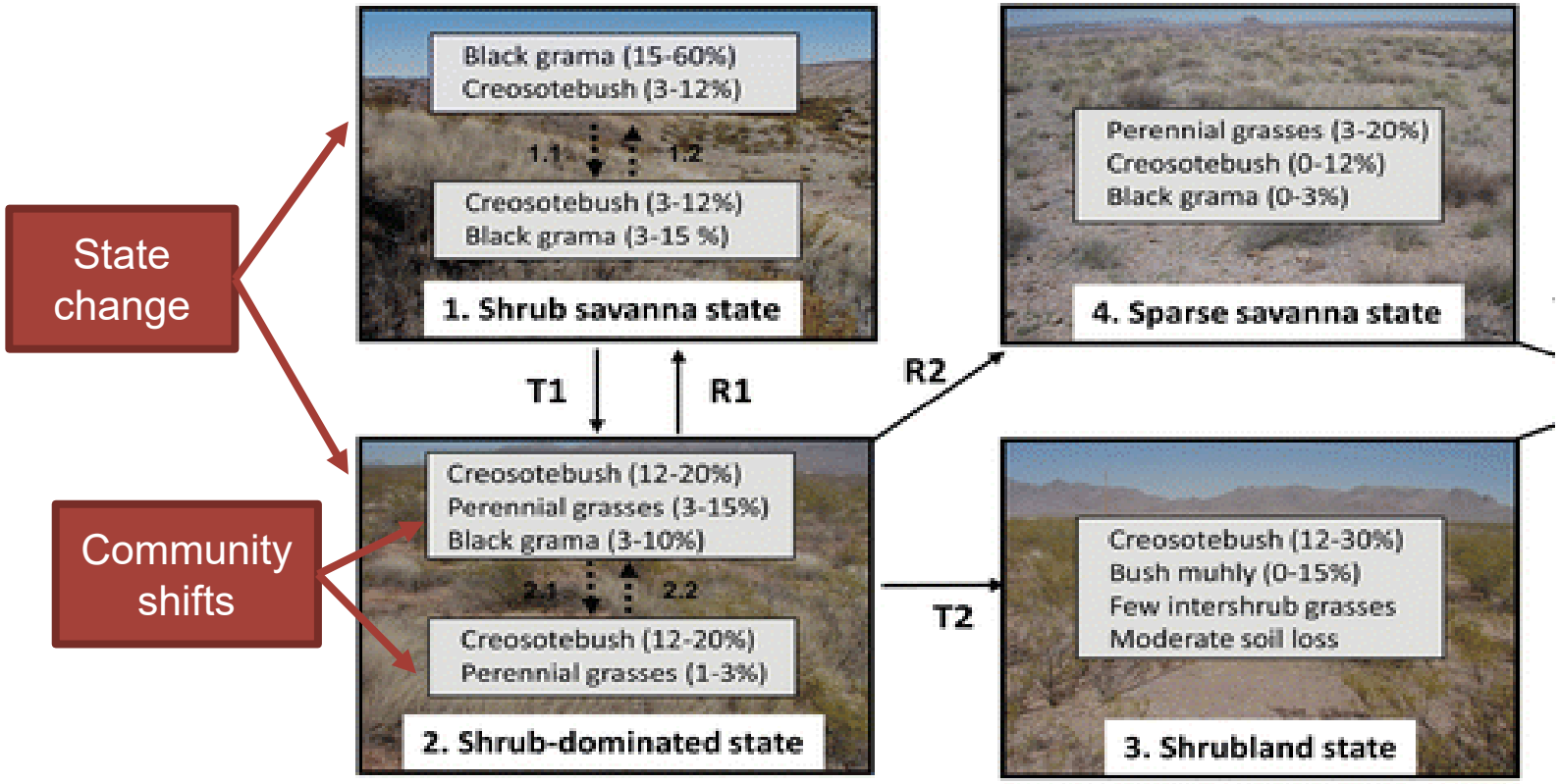




State and Transition Models (STMs)

Difference between a community pathway and a state transition



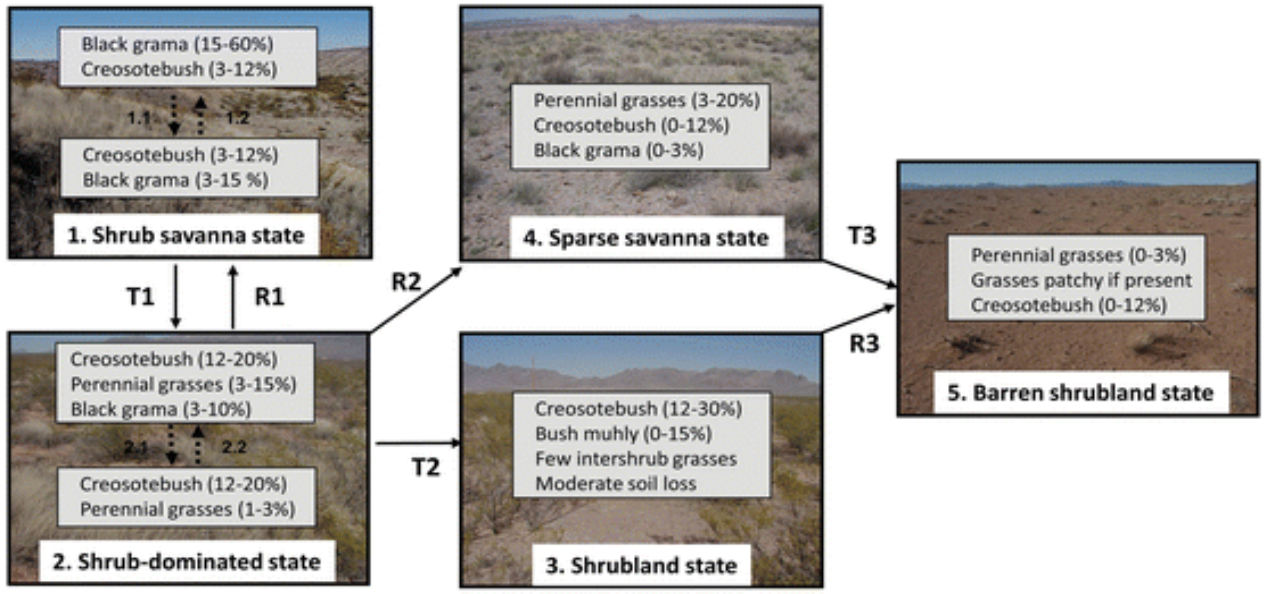


State and Transition Models (STMs)

Typical drivers of transitions

- Grazing – reduced or overgrazing
- Fire/lack of fire
- Drought
- Seeding/restoration
- Soil erosion

Drivers of change

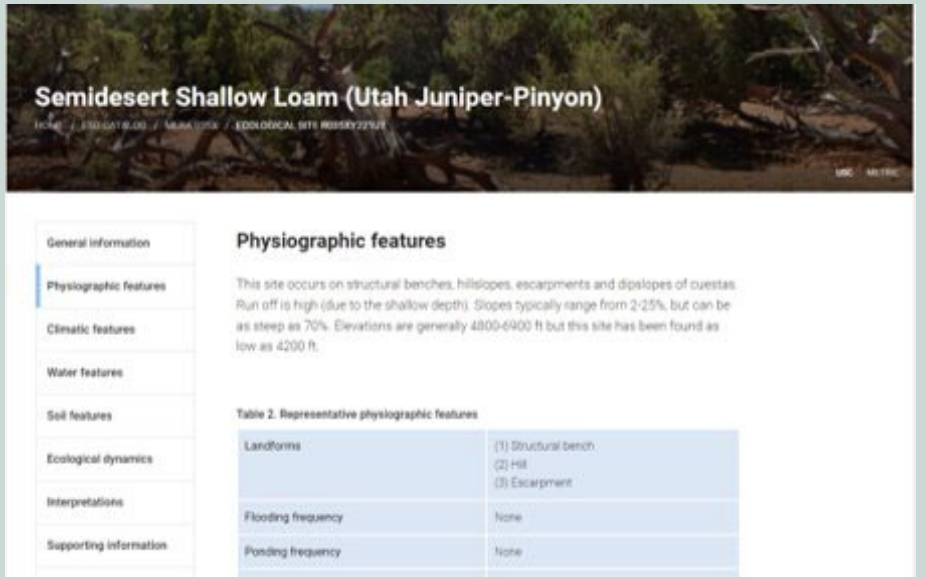


T1. Continuous heavy grazing, thinning and patchy loss of black grama, lack of fire, shrub proliferation, patchy erosion.
R1. Shrub control associated with grazing deferment or prescribed grazing and climate permitting black grama recovery
R2. Shrub control after grass is sparse or erosion advanced, or followed by poorly planned grazing
T2. Loss of remaining interspace grasses, gradual loss of soil organic matter, infill of shrubs, and soil erosion
R3. Shrub control when soil loss or other constraints preclude grass establishment
T3. Poorly planned grazing that causes collapse of grass population

STMs and Decision Making Tools

Ecological Sites

- Delineate based on land potential
- An ecological site defined by abiotic characteristics:
    - Soil
    - Climate
    - Landform information



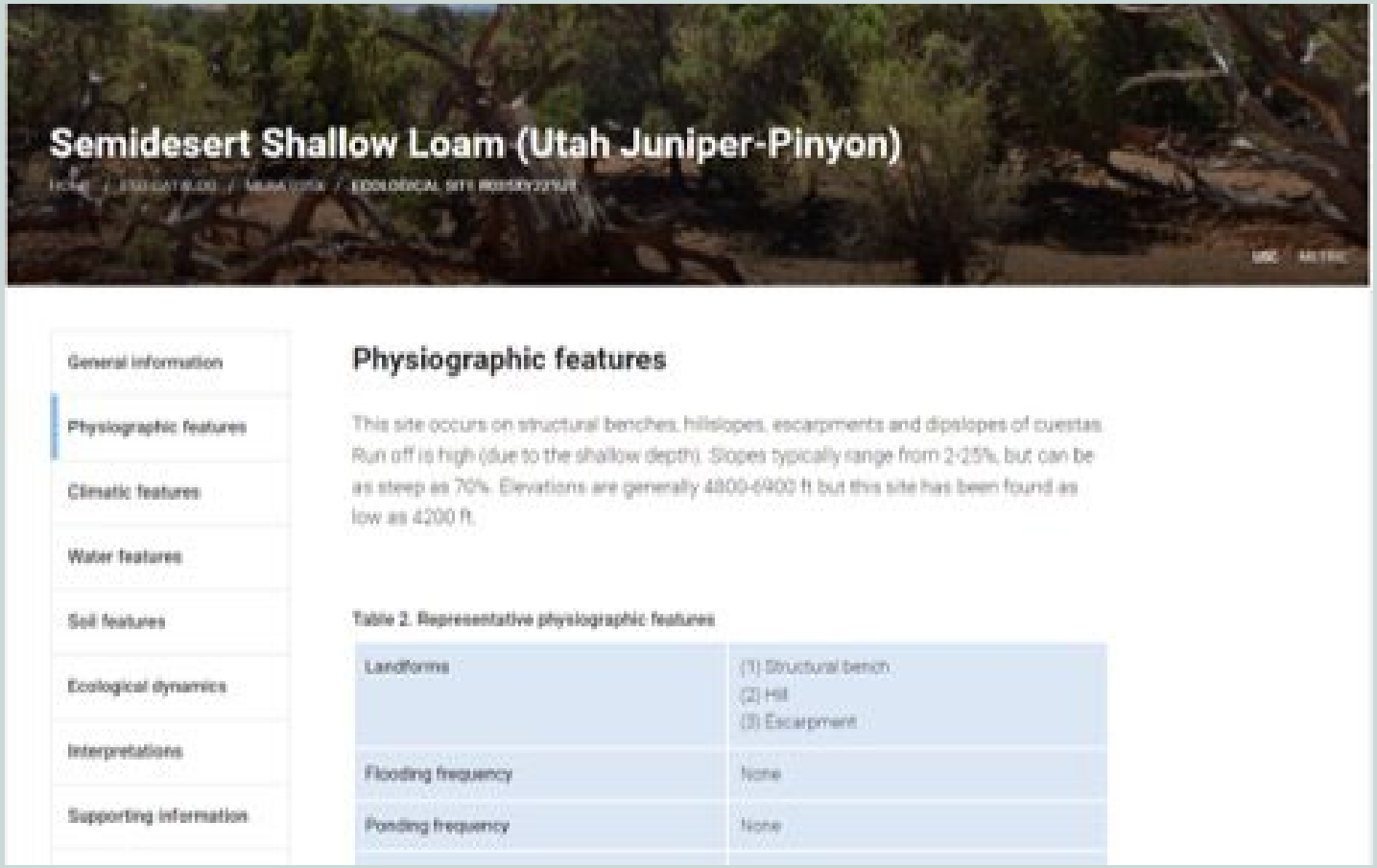
Ecological Sites Descriptions

- Database: EDIT

https://edit.jornada.nmsu.edu/catalogs/esd

EDIT is organized by **Major Land Resource Area**

MLRA 035X
Colorado Plateau



Ecological Site Descriptions (ESD)

Site Characteristics

- Physiographic
- Climate
- Soil
- Water

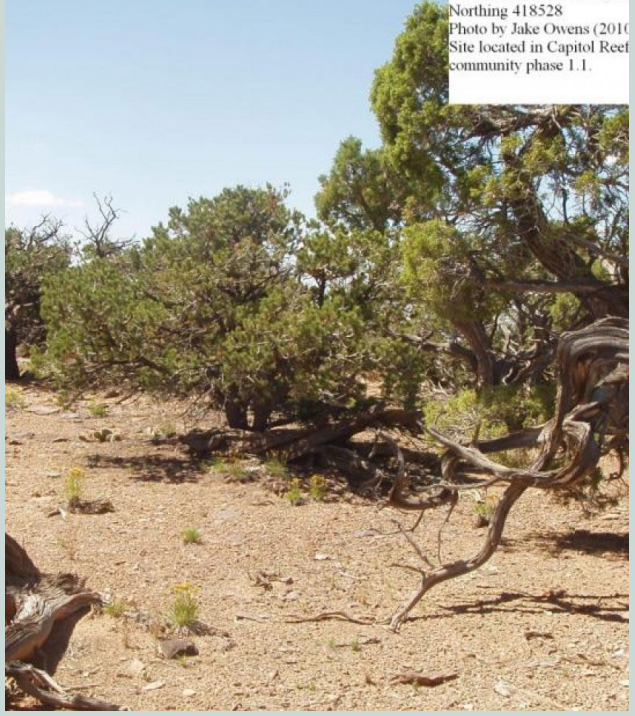
Plant communities

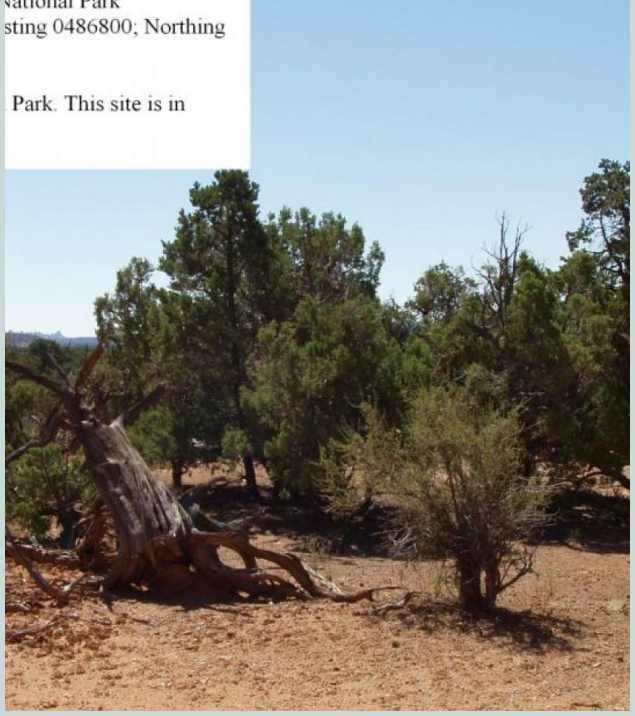
- Plant species
- Vegetation states
- Ecological Dynamics
- Plant composition

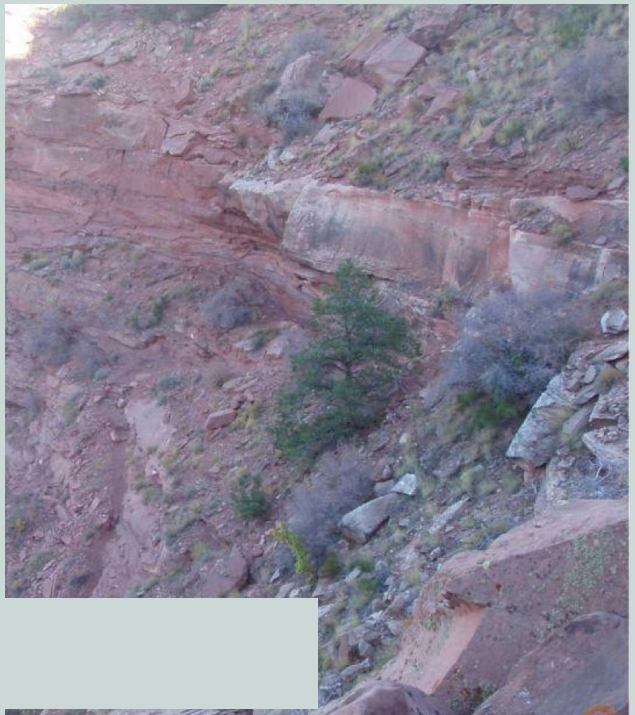
Site Interpretations & Supporting Information

- Management alternatives for the site and its related resources
- Relevant literature, information and data sources

STM related to ESD describes it's 'land potential'







‘Reference’ states of PJ on CP

Semidesert Shallow Hardpan (Utah Juniper-Pinyon)

Dominant Plant species

Juniperus osteosperma

Pinus edulis

Artemisia tridentata subsp. Wyomingensis

Bouteloua gracilis

Pleuraphis jamesii

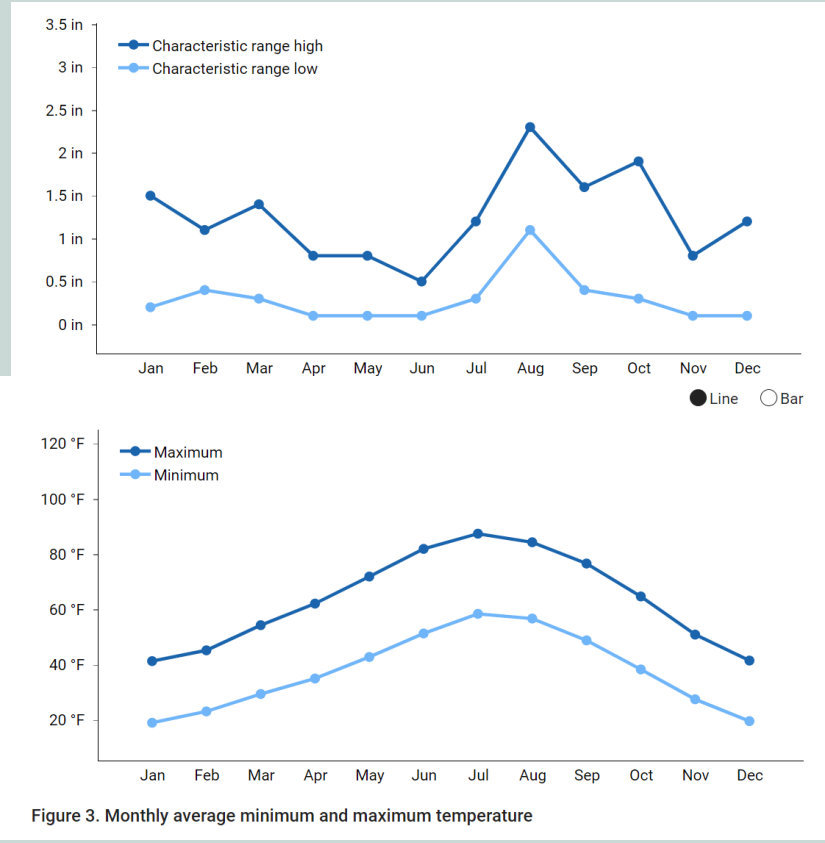
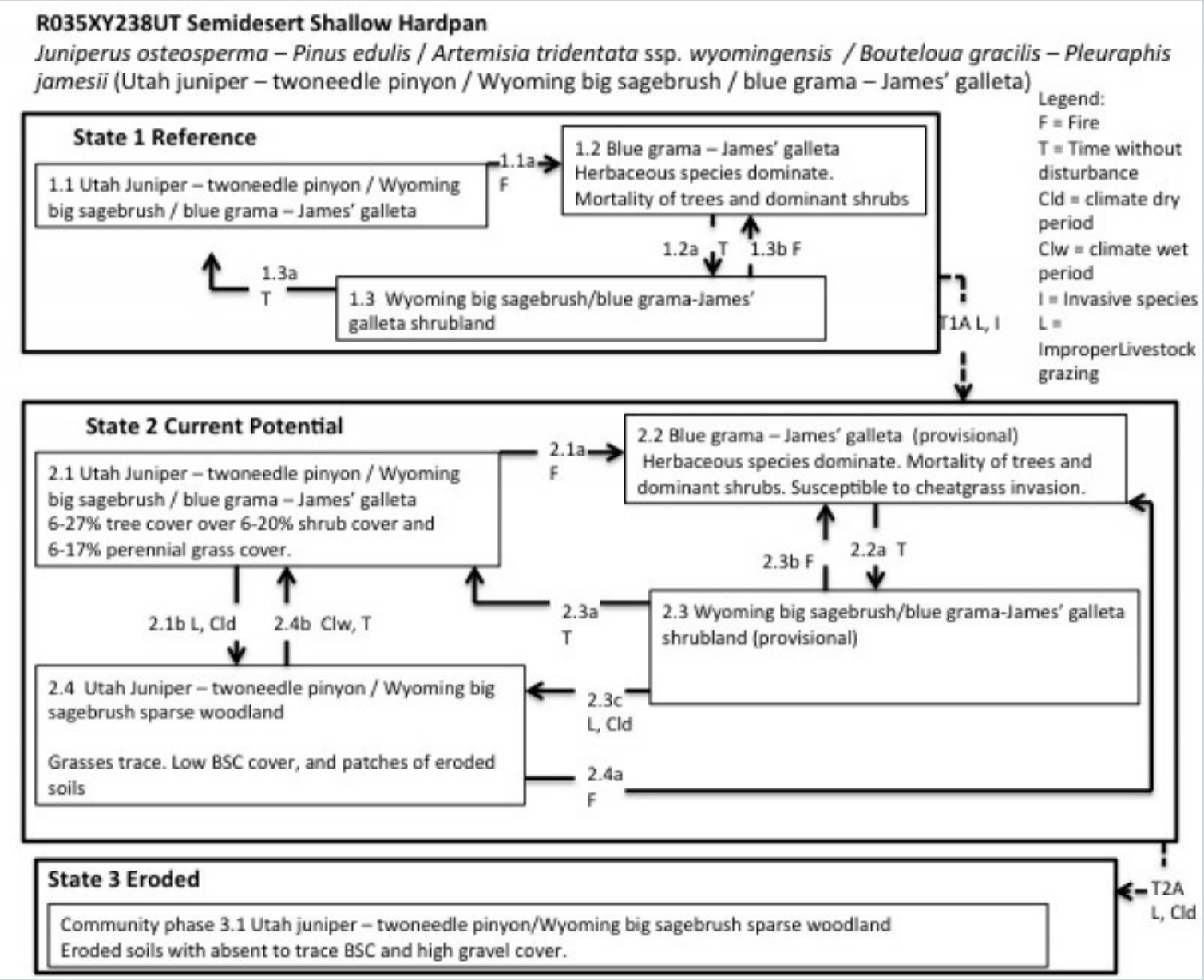


Figure 3. Monthly average minimum and maximum temperature

Semidesert Shallow Hardpan (Utah Juniper-Pinyon) - STM



Legend:

F = Fire

T = Time without disturbance

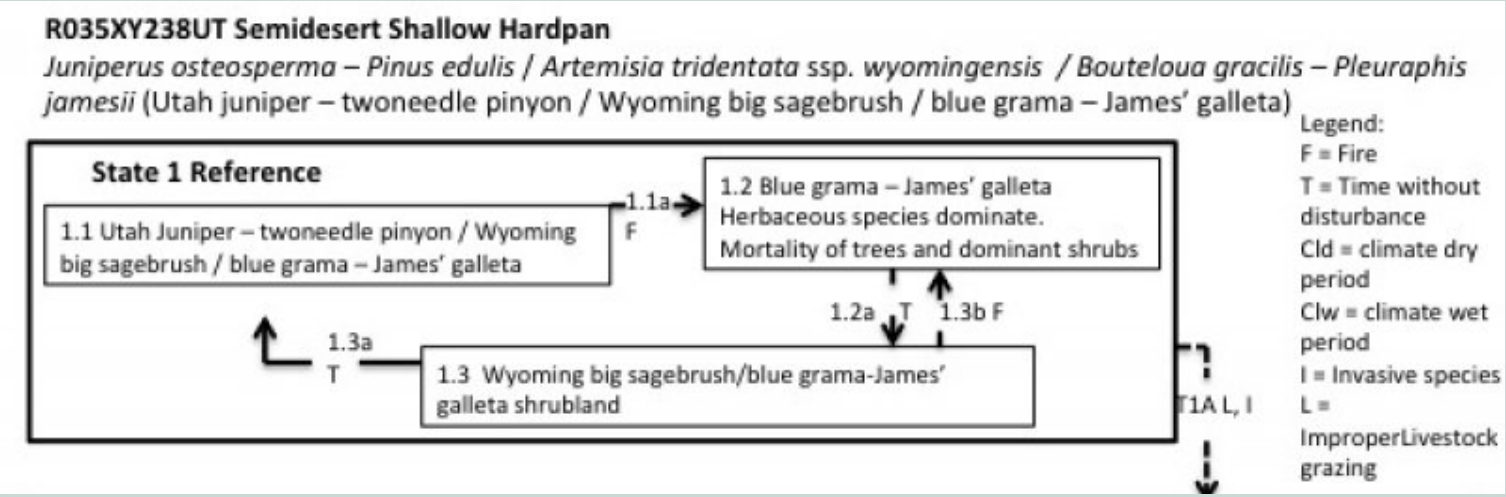
Cld = climate dry period

Clw = climate wet period

I = Invasive species

L = Improper Livestock Grazing

Semidesert Shallow Hardpan (Utah Juniper-Pinyon)



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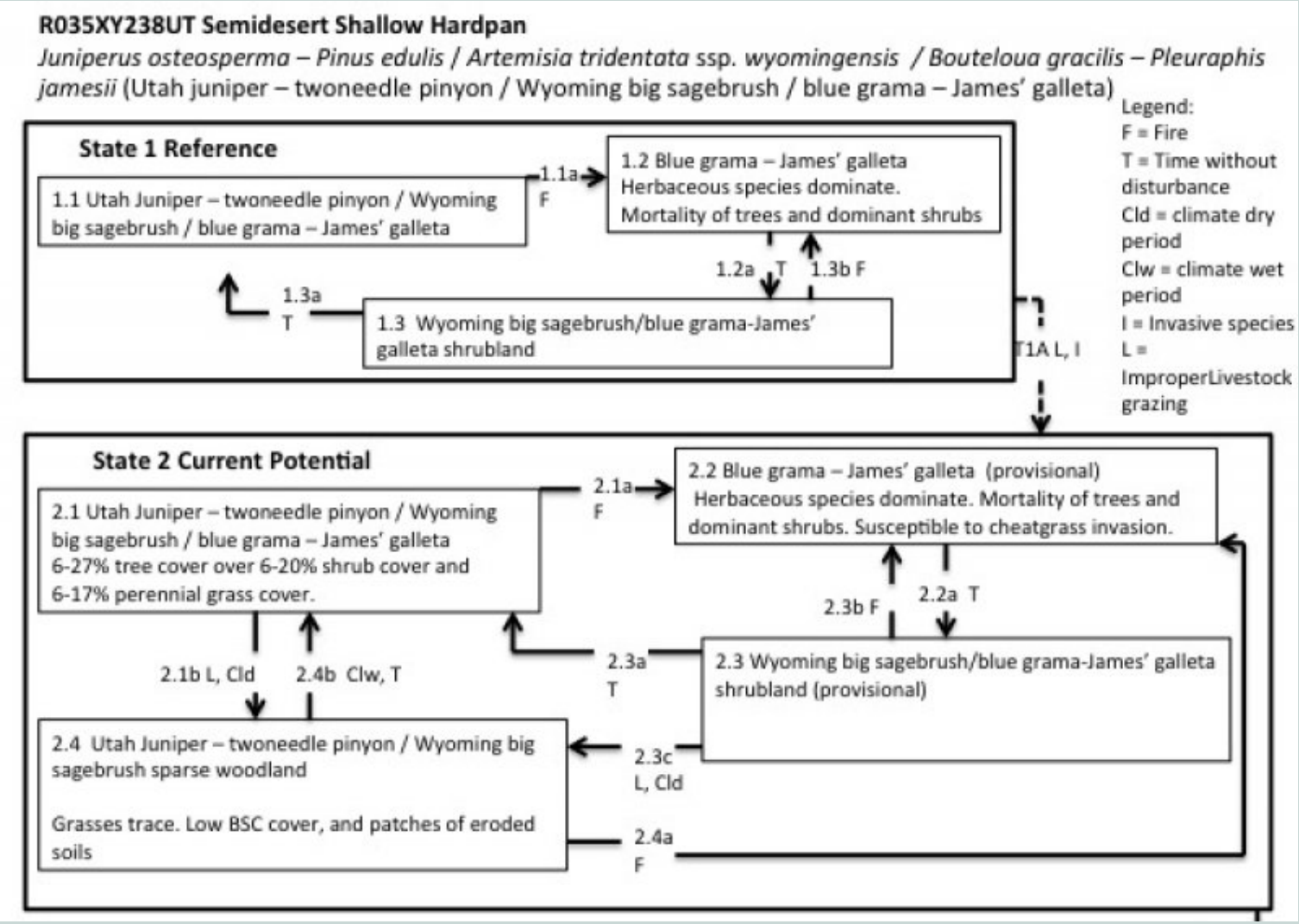

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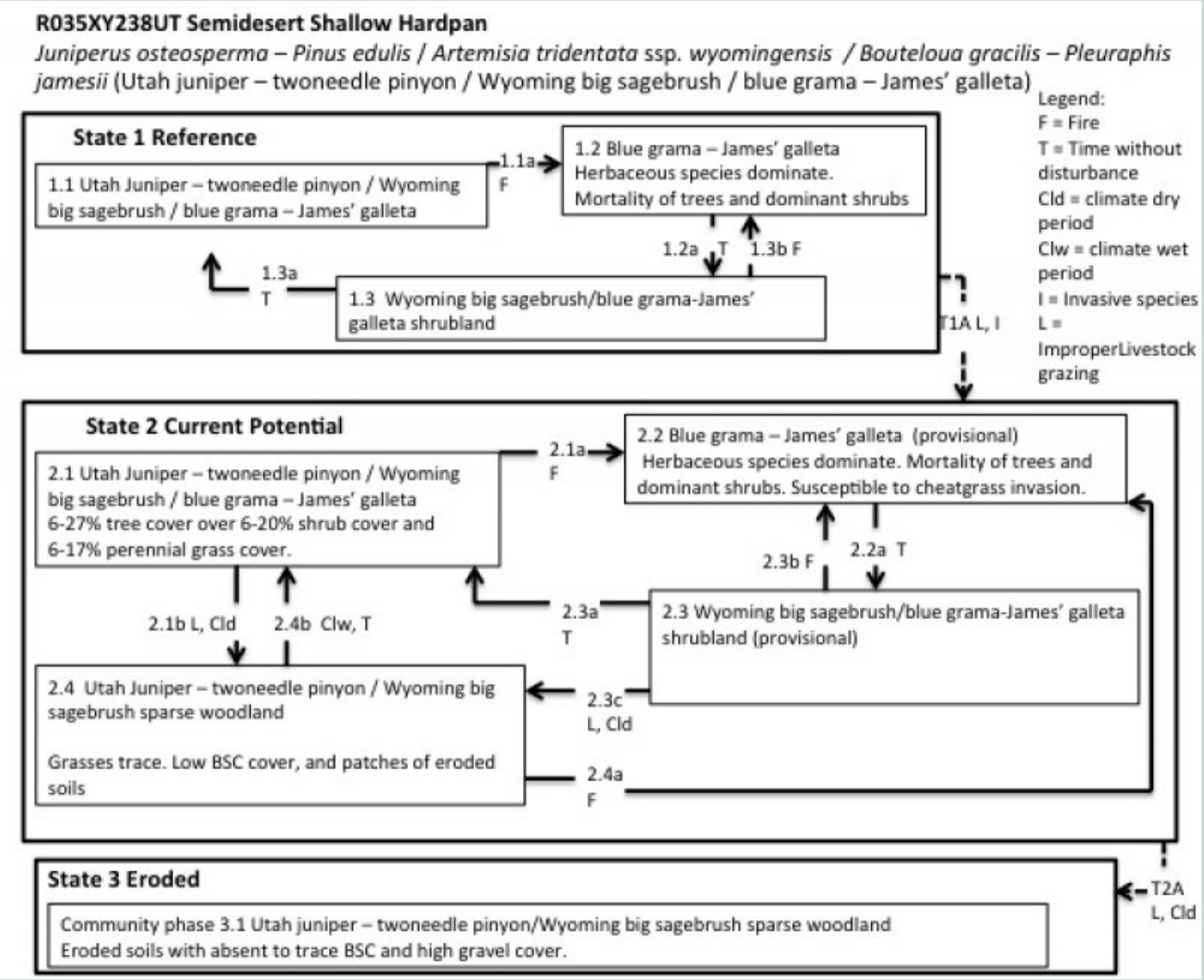

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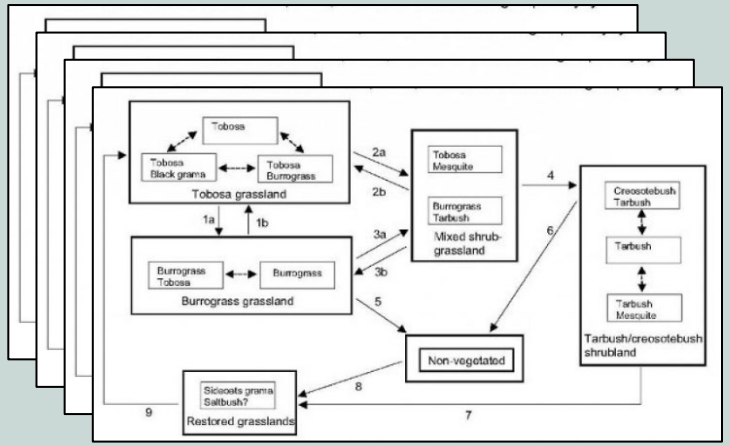
Building STMs Utilizing Ecological Site Groups to meet management goals

- Ecological Site Descriptions (ESDs)

✓	**Ecological context**
✗	**Landscape scale**
✗	**Data driven**
✗	**Spatially explicit**
✗	**Updatable**

Over 800 Ecological Sites (and ESDs)

35 Ecological Site **Groups** (ESGs)

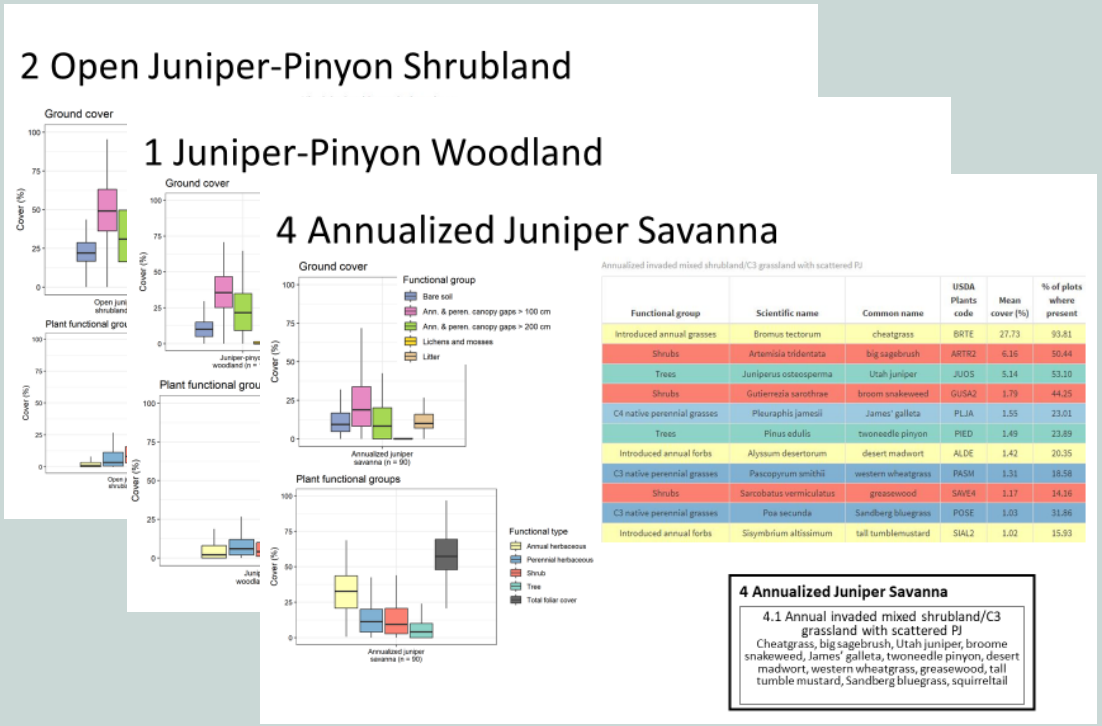


Sandy and Loamy ESG

(Nauman et al., 2022)

Collaborative Framework

- Using workshops to determine:
  - Supplement research & data with expert knowledge
  - Ensure STM is meeting management needs
  - Identify important knowledge gaps



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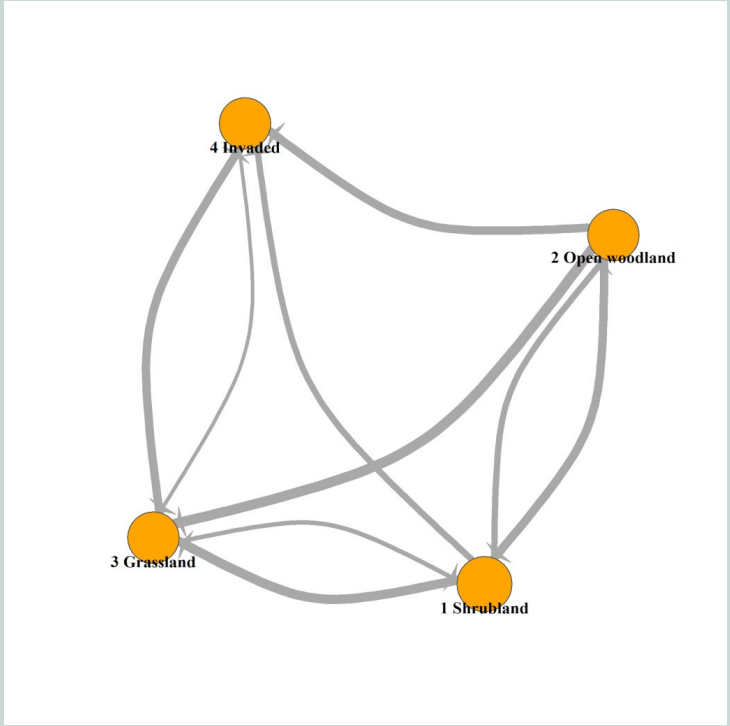
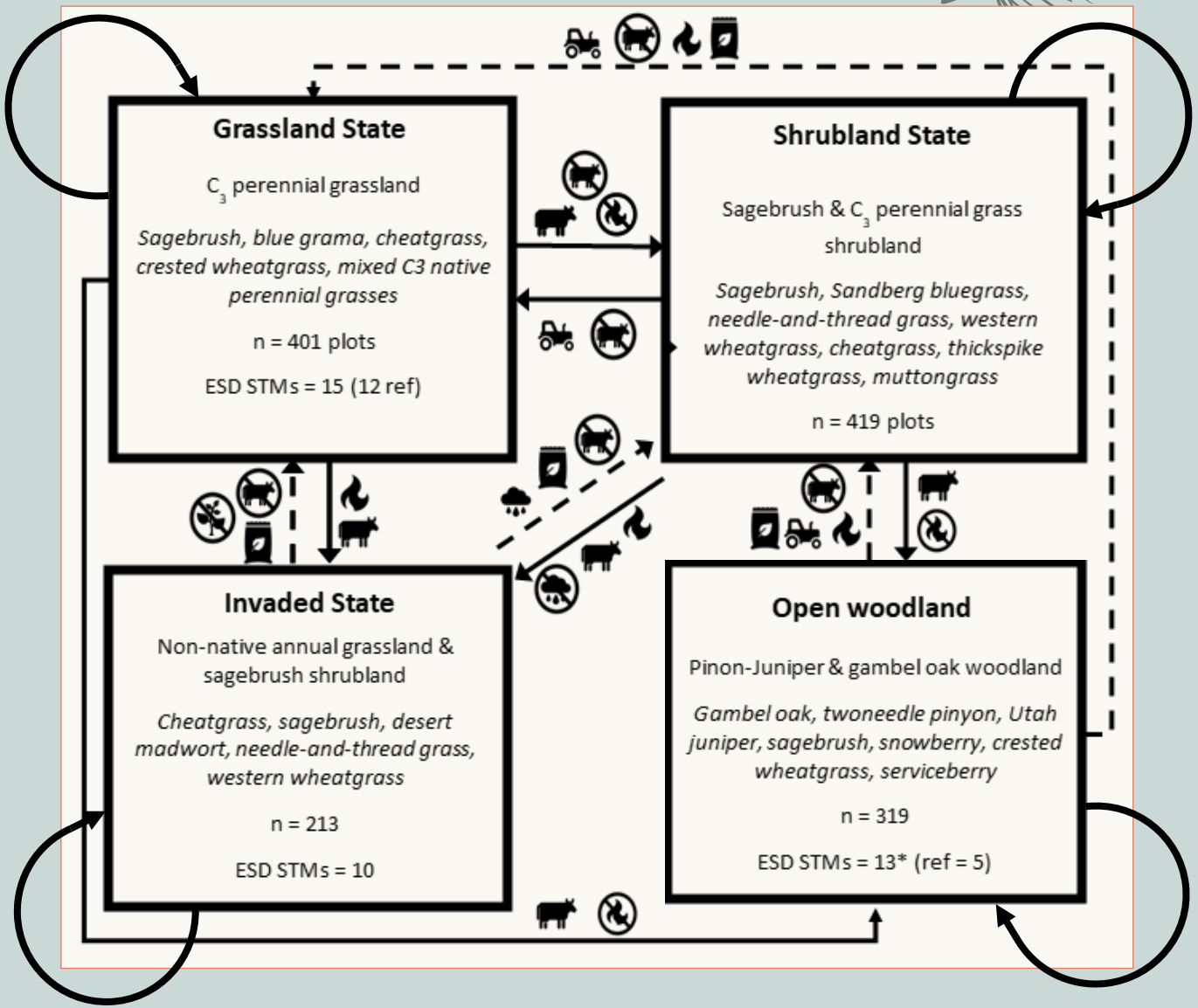


Collaborative Framework



Applying STMs in Changing Climate

Consensus built manager response framework

Resist

- working to maintain or restore ecosystem composition, structure, processes, or function based on historical *or acceptable* current conditions

Accept

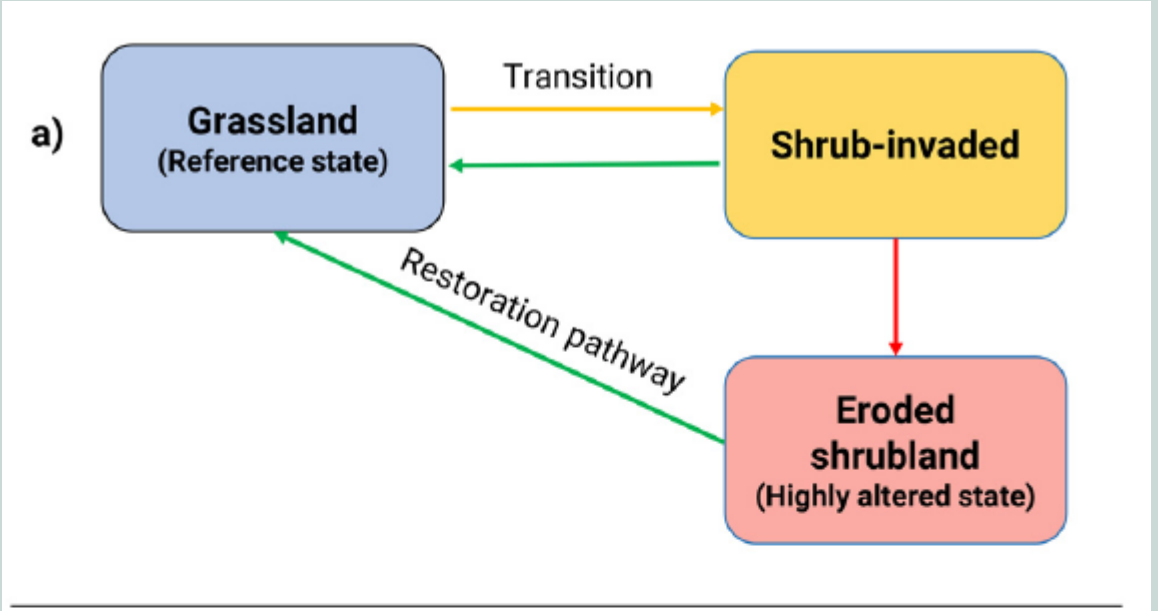
- Allowing ecosystem composition, structure, processes, or function to change autonomously

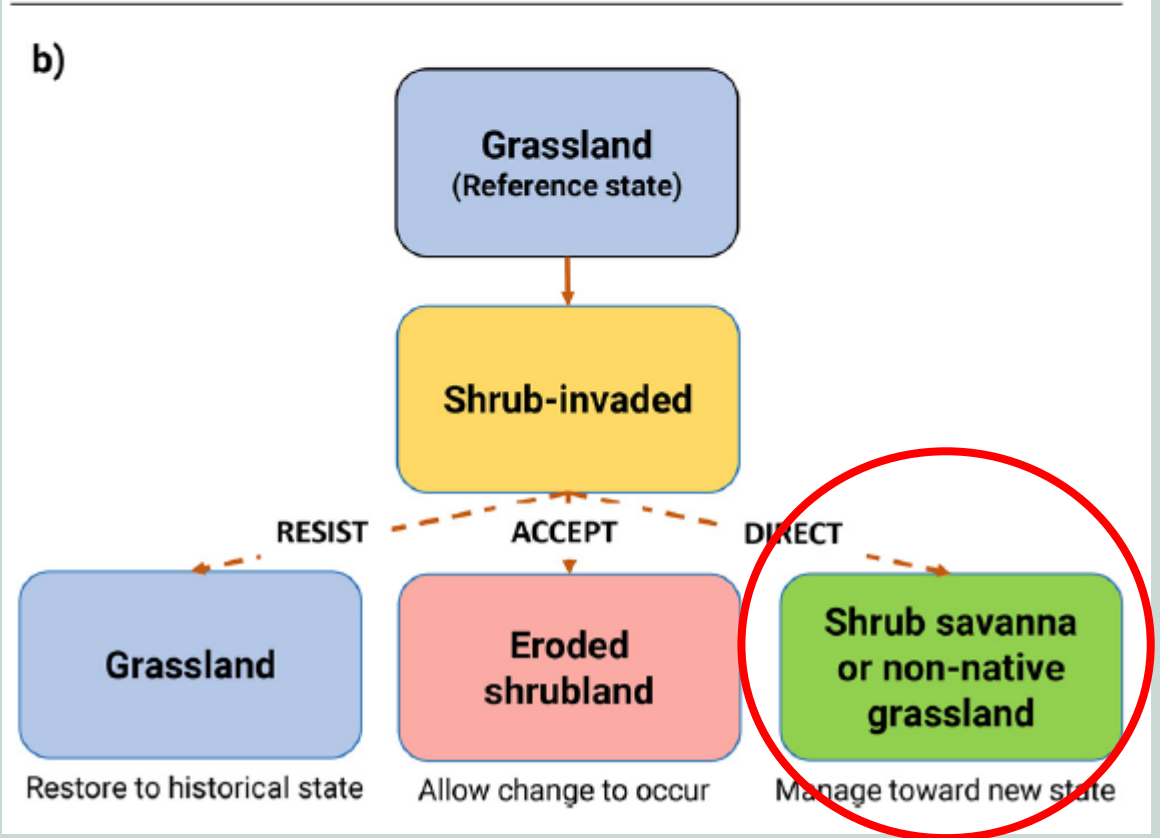
Direct

- Actively shaping change in ecosystem composition, structure, processes, or function toward preferred new conditions

STM & RAD decisions

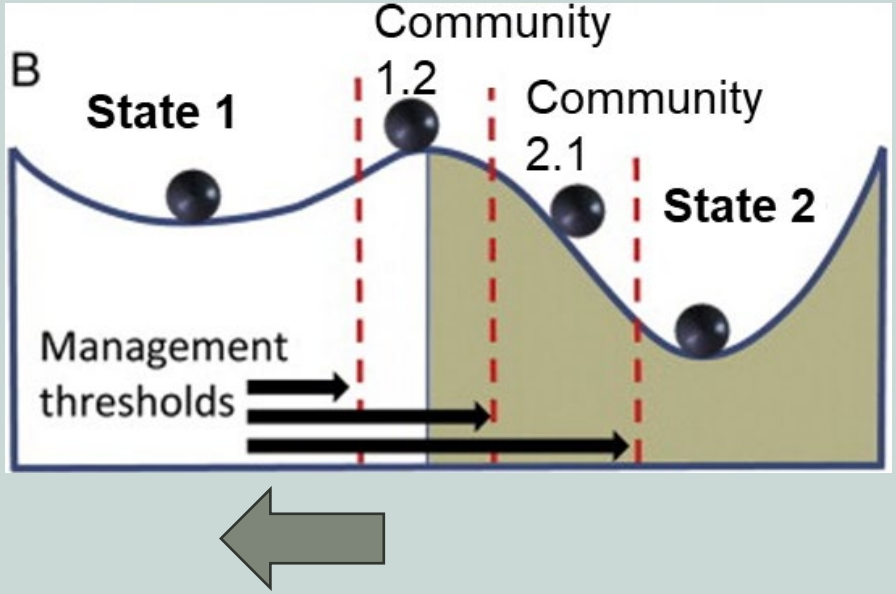
https://edit.jornada.nmsu.edu/catalogs/esd/041X/R041XC308AZ
Lehmann lovegrass Community





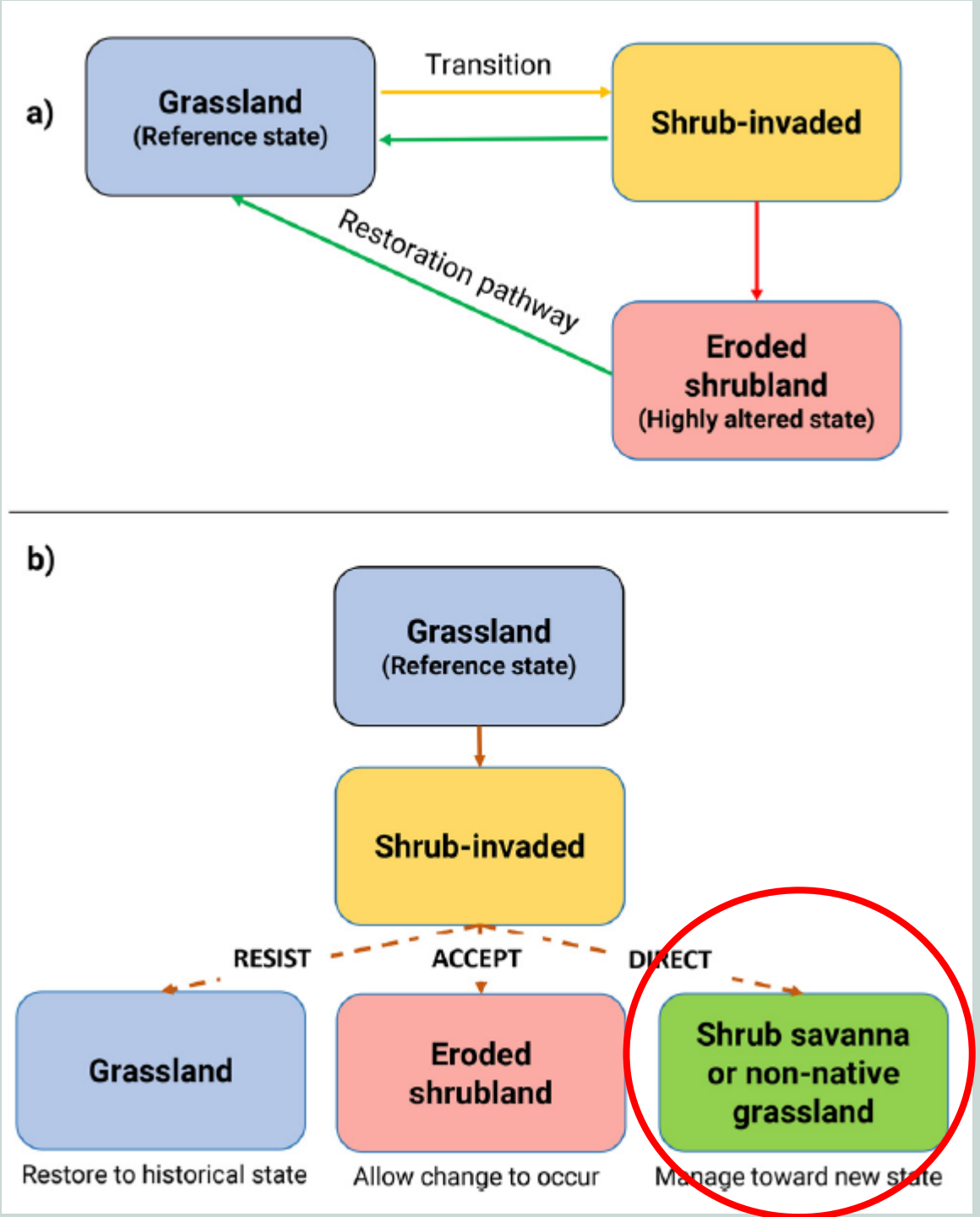
Bestelmeyer et al. 2023, Managing an arid ranch in the 21st century: New technologies for novel ecosystems: Rangelands, v. 45, no. 4, p. 60-67.

STM & RAD decisions



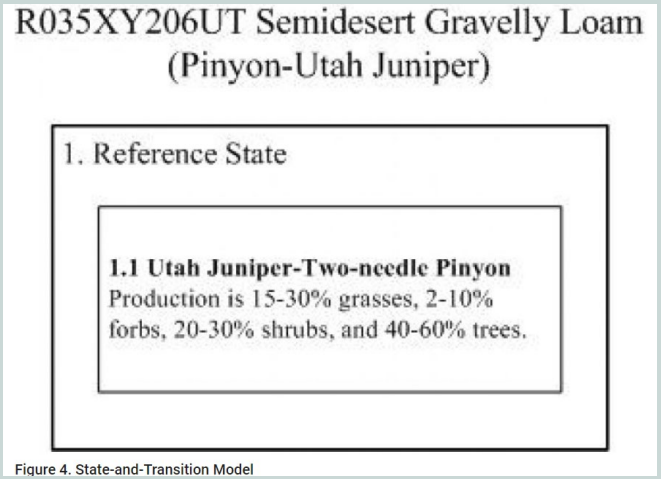
- Resist can also be managing for state resilience
  - Some approaches in menus are examples of this (e.g., reduce fuel loads)

Bestelmeyer et al. 2023, Managing an arid ranch in the 21st century: New technologies for novel ecosystems: Rangelands, v. 45, no. 4, p. 60-67.



STM & RAD decisions

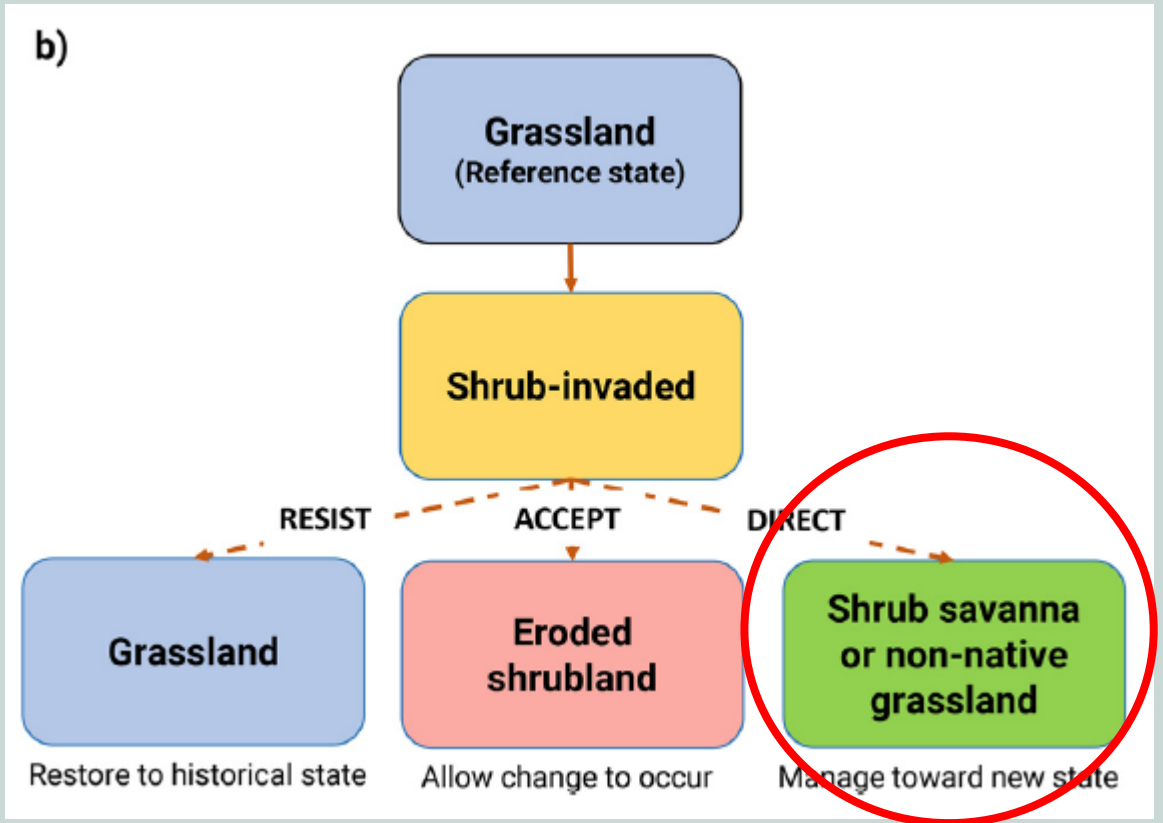
- What is missing from current PJ STMs?
  - On Plateau, most ~one-state models, need more possibilities
    - Including direct options
  - More information on managing for resilience (e.g., drought)


R035XY206UT Semidesert Gravelly Loam
(Pinyon-Utah Juniper)

1. Reference State

1.1 Utah Juniper-Two-needle Pinyon
Production is 15-30% grasses, 2-10% forbs, 20-30% shrubs, and 40-60% trees.

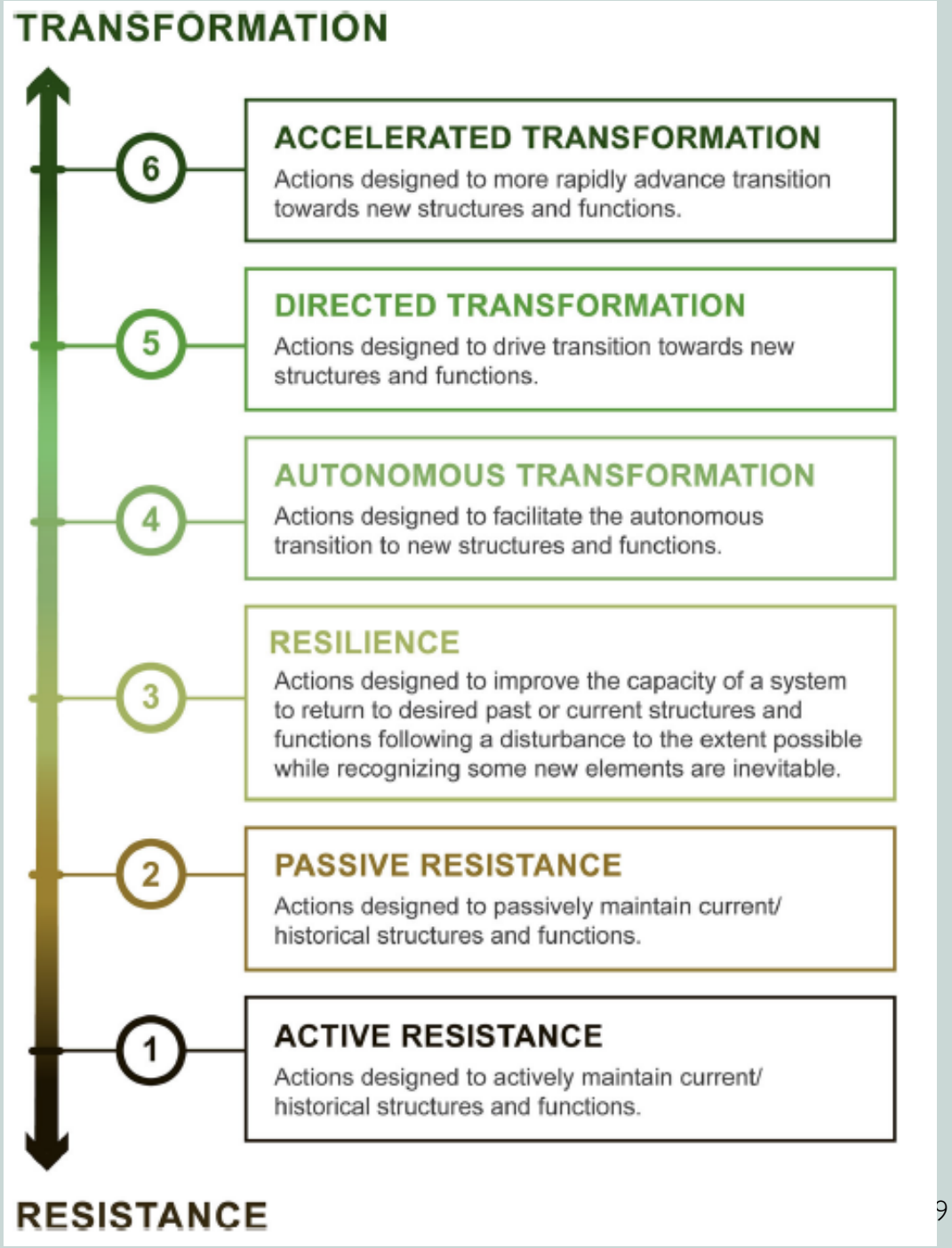
Figure 4. State-and-Transition Model



Bestelmeyer et al. 2023, Managing an arid ranch in the 21st century: New technologies for novel ecosystems: Rangelands, v. 45, no. 4, p. 60-67.

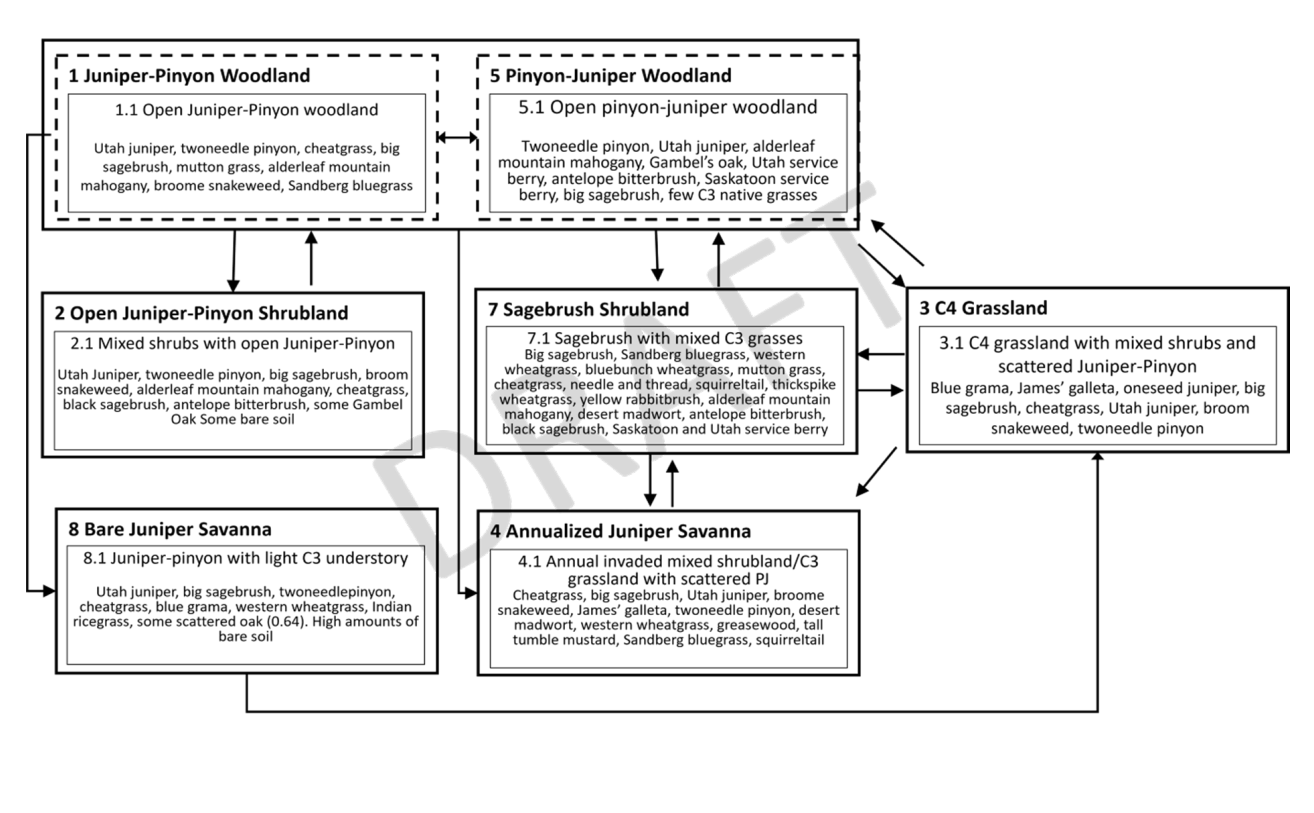
R-R-T (resistance-resilience-transformation)

- "main difference between the two is that the RAD framework emphasizes .. **actions** .. [RRT] proposes a combination of **actions and outcomes**."
- Further breaks down RAD into more options, different language
  - Continuous integer scale
  - Explicit about resilience (only implied in RAD)
  - More details on 'Direct' (transformations)
- No real 'Accept'



Peterson St-Laurent, et al. 2021, R–R–T (resistance–resilience–transformation) typology reveals differential conservation approaches across ecosystems and time: Communications Biology, v. 4, no. 1, p. 39.

STMs and Pinyon & Juniper Management Menu



Strategy 2. Foster and preserve biodiversity to enhance ecosystem functionality and improve adaptability to climate change.

Approach 2A. Prioritize sites for conservation where future climate will be favorable for the long-term sustainability of PJ woodlands.

Approach 2B. Maintain and restore soil and microbial community health to support the establishment of native understories and enhance overall ecosystem functions such as nutrient cycling, water retention, and resistance to environmental stresses.

Approach 2C. Use natural and artificial microsites that reduce soil loss, enhance soil moisture, moderate temperatures, shield seedlings from wind, and maintain elevated humidity levels to improve restoration project outcomes.

Approach 2D. Use pinyon, juniper, and native understory species genotypes for assisted colonization that are better adapted to future climate scenarios and altered fire regimes.

Approach 2E. Identify and control highly competitive non-native plants that threaten species diversity and habitat heterogeneity.

Strategy 3. Conserve ecotones in and around PJ woodlands by employing PJ management actions that account for the unique habitat requirements of many wildlife species and the projected impacts of climate change.

Approach 3A. Maintain and enhance connectivity between similar habitat types.

Approach 3B. As PJ woodland ranges evolve with changing climate, establish and enhance wildlife refuges and corridors to transition at-risk species into habitats that are more favorable under new climatic conditions.

Approach 3C. Diversify wildlife habitats and resources within and adjacent to woodlands.

Transitions → Inform Management Approaches

States = Strategies for maintaining services and processes

Thank you!

More info here: https://www.usgs.gov/centers/southwest-biological-science-center/science/new-tools-modern-land-management-decisions

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