State-and-transition Models:
Current Status and Future Direction

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Professional Reinvention

Rangeland Health?

Woodland Encroachment?

Ecological Scale

Rangeland Profession

Multiple States

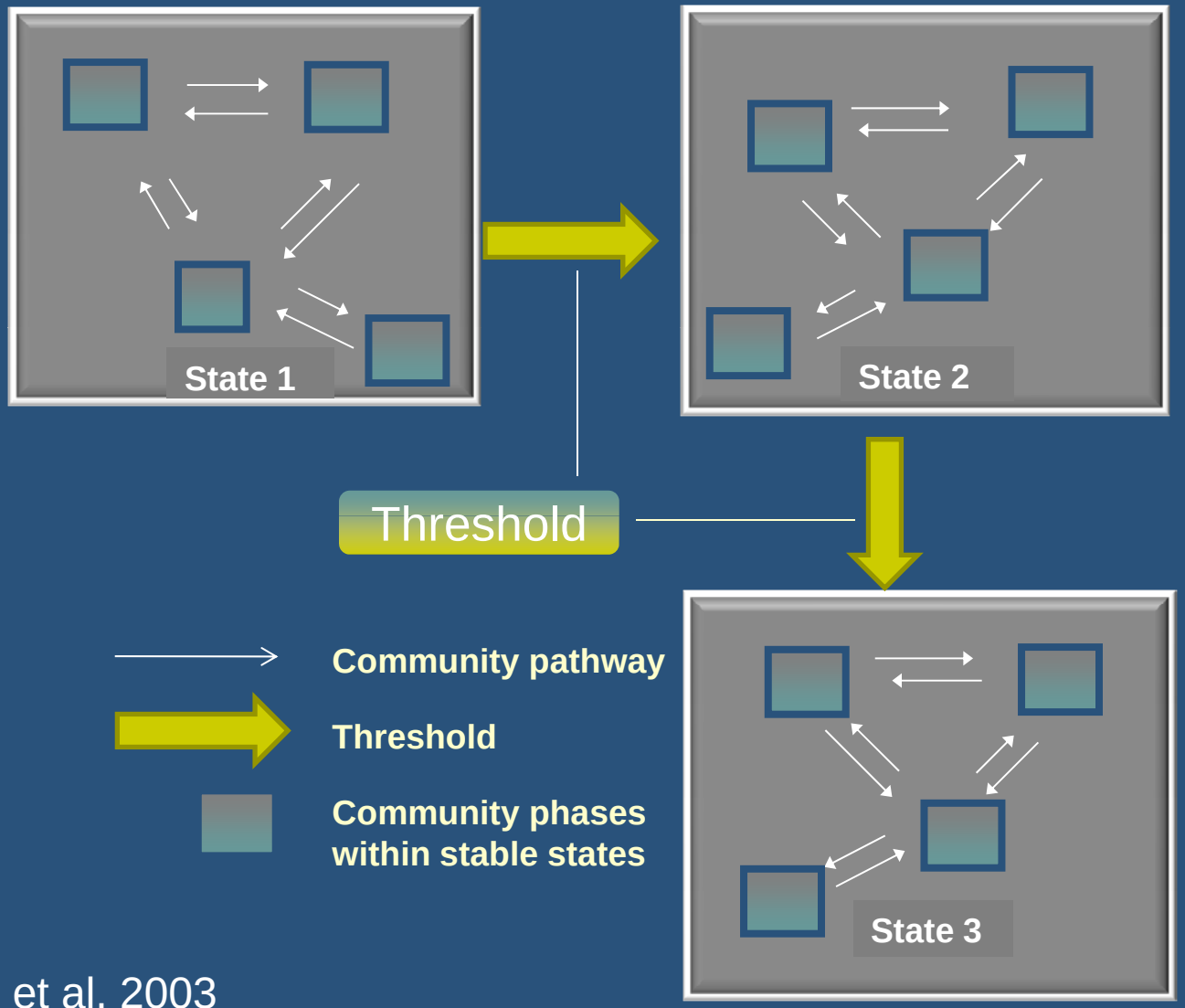
Range Condition?

Threshold Application?

SRM

Society for Range Management

State-and-transition Model Framework



Stringham et al. 2003

Presentation Objectives

- Explore linkage between STMs and resilience
- Assess the current effectiveness of STMs
- Investigate role of empirical data in STMs
- Comment on the future direction of STMs



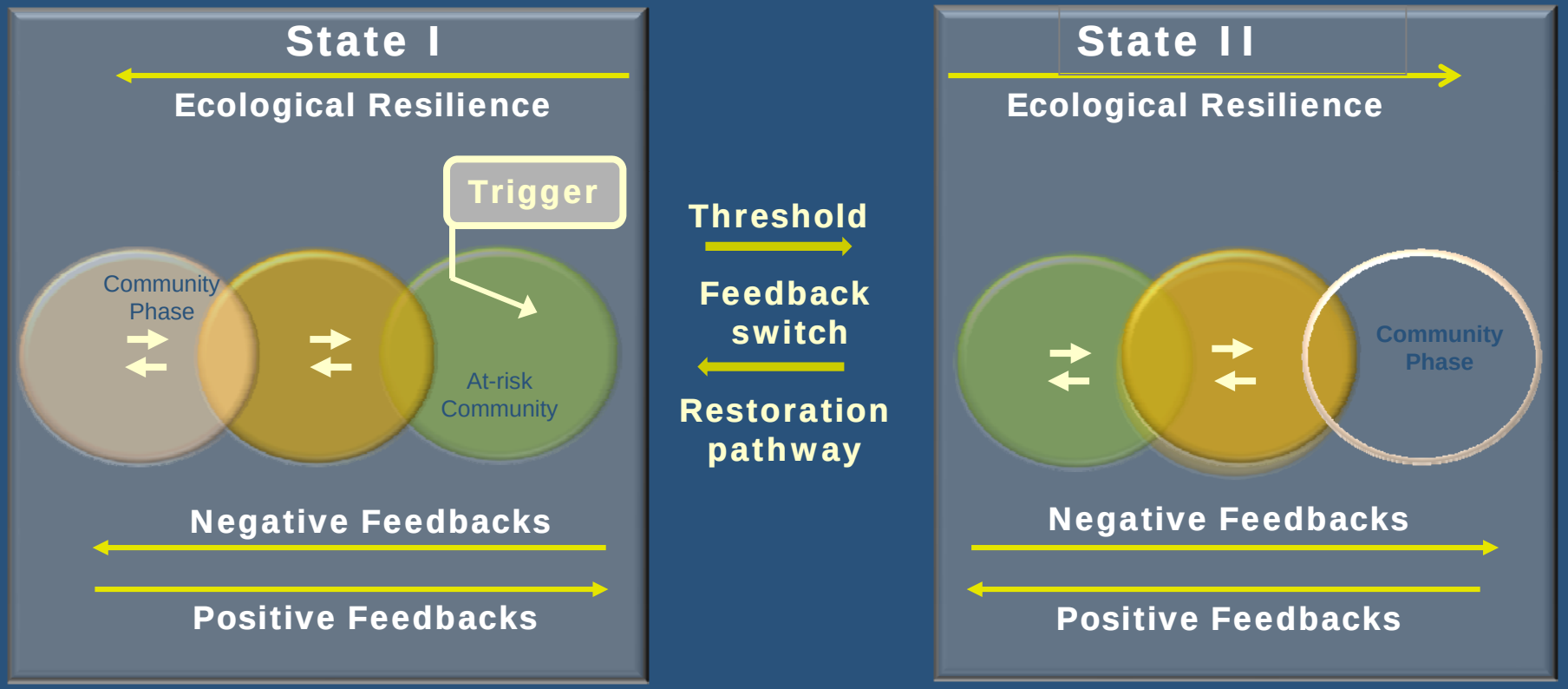
Thresholds vs Resilience

Thresholds

Resilience

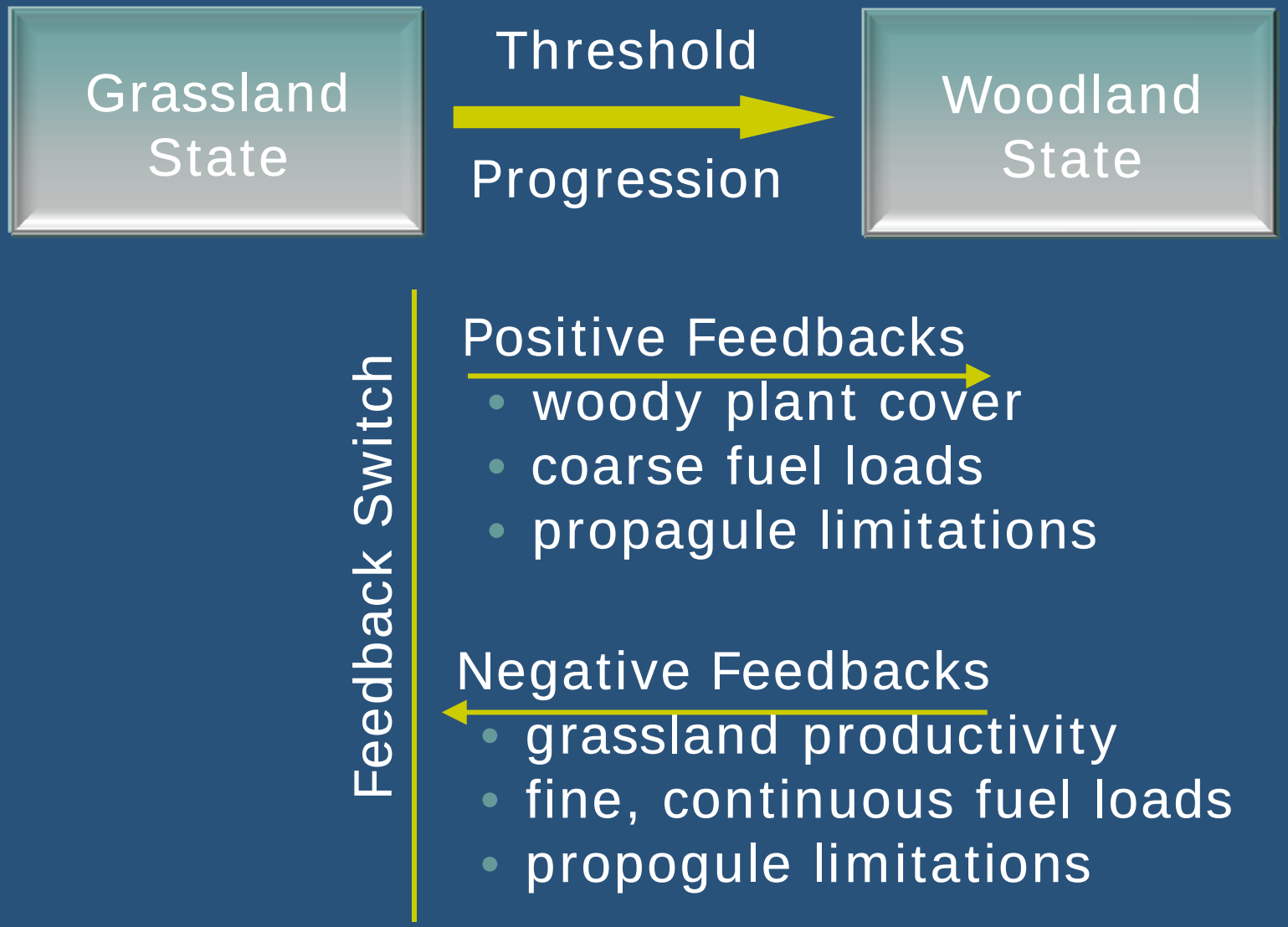
Resilience – degree of modification that an ecosystem can absorb prior to transform to an alternative state.
Threshold – resilience limit of an ecosystem.

Resilience-based Management

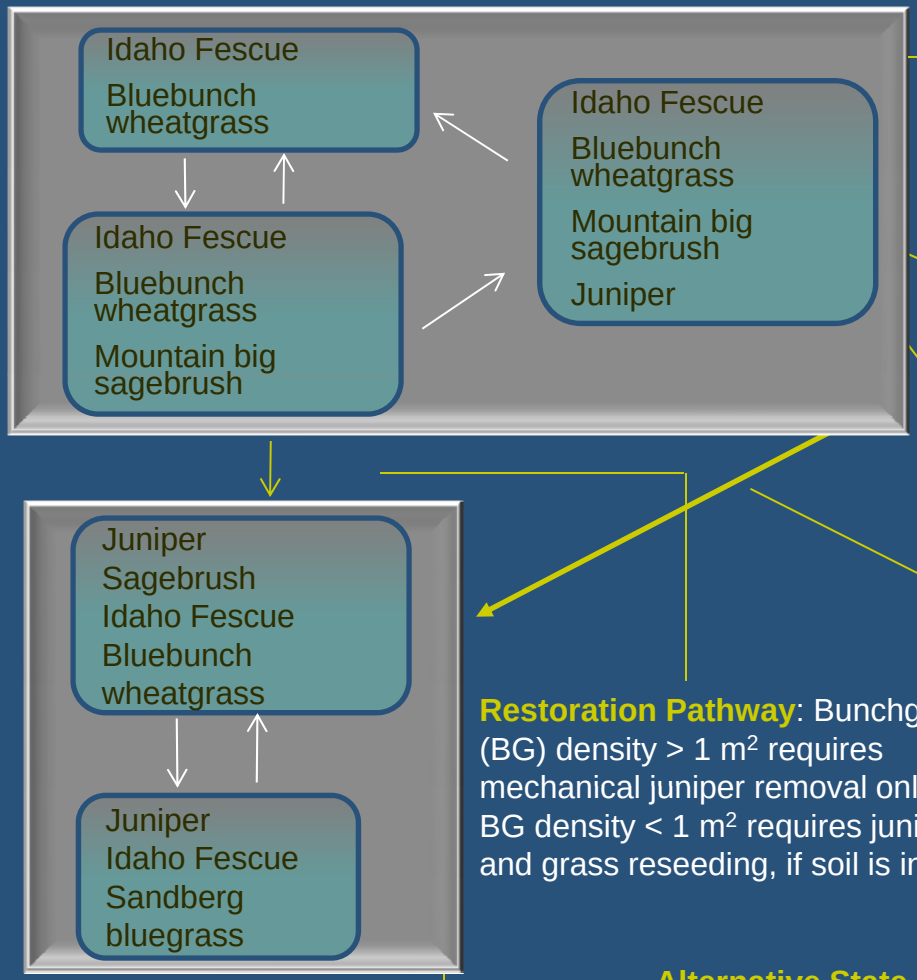


Modified from Briske et al. 2008

Positive and Negative Feedbacks



Mountain Clay Ecological Site, Oregon



Reference State
Indicators: High perennial grass cover, dispersed sagebrush cover, minimal juniper and bare soil.
Feedbacks: Herbaceous cover retains water on site and provides fuel to support a fire return interval of less than 50 years.

At-risk Community Phase: Herbaceous cover reduced, sagebrush decadence, juniper visible and bare soil patches increasing, potential fire frequency reduced.

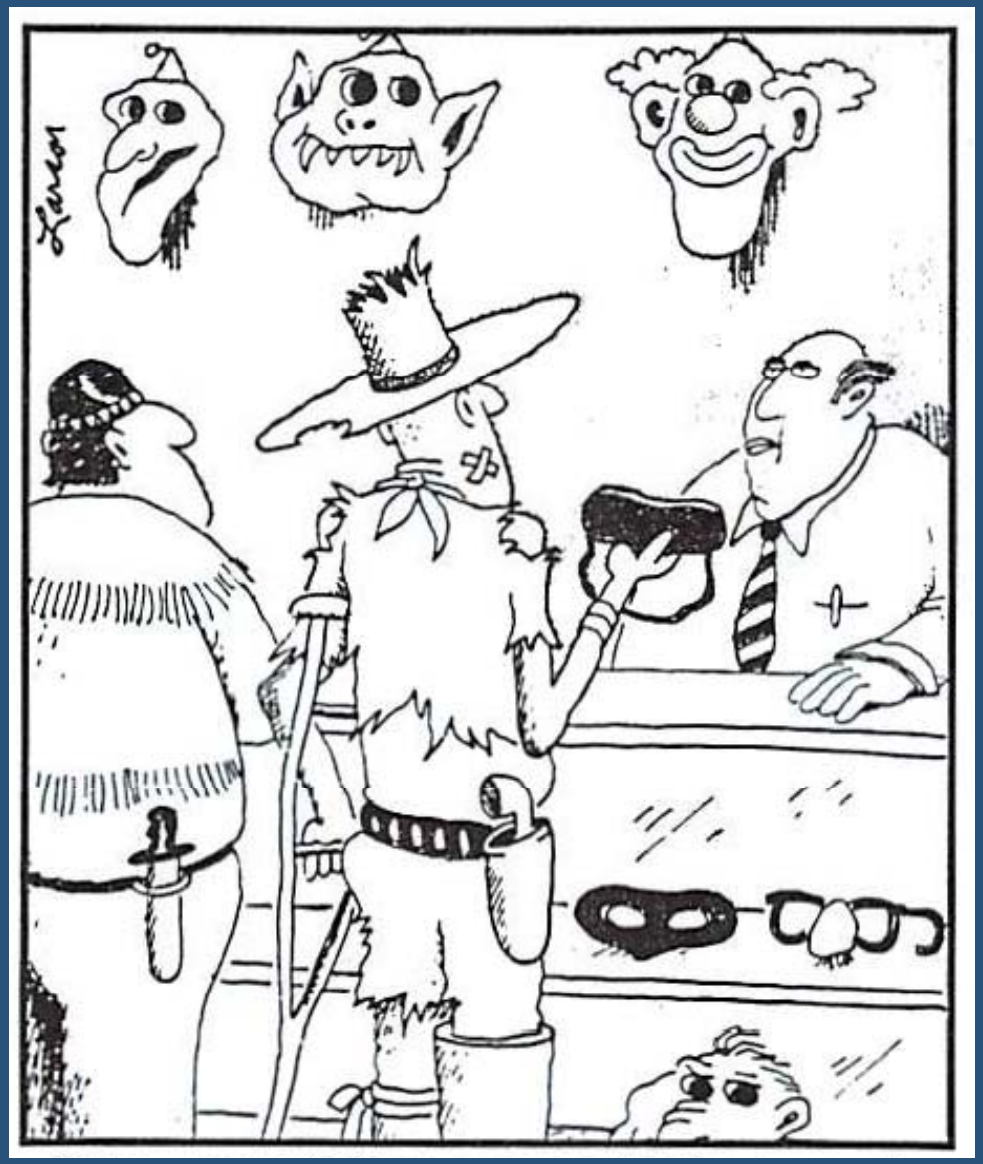
Trigger: Drought and intensive grazing promote juniper establishment through reduced fire frequency.

Threshold: Juniper attains a height and density that reduces fine fuel load and fire-induced tree mortality. Large, inter-connected bare soil patches occur with redistribution of nutrients/soil beneath juniper canopies.

Restoration Pathway: Bunchgrass (BG) density > 1 m^2 requires mechanical juniper removal only;
BG density < 1 m^2 requires juniper removal and grass reseeding, if soil is intact.

Alternative State
Indicators: Mature juniper dominant, Idaho fescue only beneath juniper canopies, large interconnected bare soil patches, sagebrush decadence..
Feedbacks: Juniper dominates resource use, water and wind redistribute soil and nutrients beneath juniper, minimal grass and sagebrush establishment .

Effectiveness of STMs

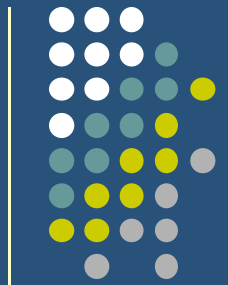


Say, aren't here supposed to be holes in this mask!

How Effective are STMs?

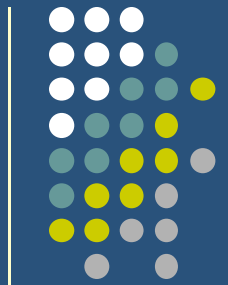
- Survey 47 rangeland professionals
  - 26 Agency Managers
  - 21 Research Scientists
- Purposes of STMs
- Model Strengths
- Model Weaknesses
- Construction and Review

STM Purposes



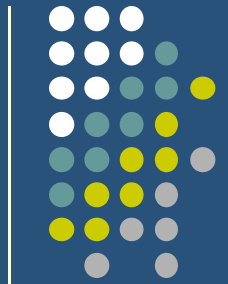
- Guide management (87%)
  - Managers 92%; Researchers 81%
- Describe ecological dynamics (70%)
  - Managers 65%; Researchers 76%
- Identify testable hypotheses (40%)
  - Managers 12%; Researcher 76%
- Communications tool (38%)
  - Managers 35%; Researchers 43%

STM Strengths



- Improve decision making (87%)
  - Managers 92%; Researchers 81%
- Describe system dynamics (70%)
  - Managers 65%; Researchers 76%
- Improve communication (38%)
  - Managers 35%; Researchers 43%
- Identify relevant questions (34%)
  - Managers 19%; Researchers 52%

STM Weaknesses



- Insufficient information (43%)
  - Managers 30%; Researchers 57%
- Models overly complex (26%)
  - Managers 38%; Researchers 10%
- Lack of time and resources (21%)
  - Managers 27%; Researchers 14%
- Potential misrepresentation (17%)
  - Managers 8%; Researchers 29%

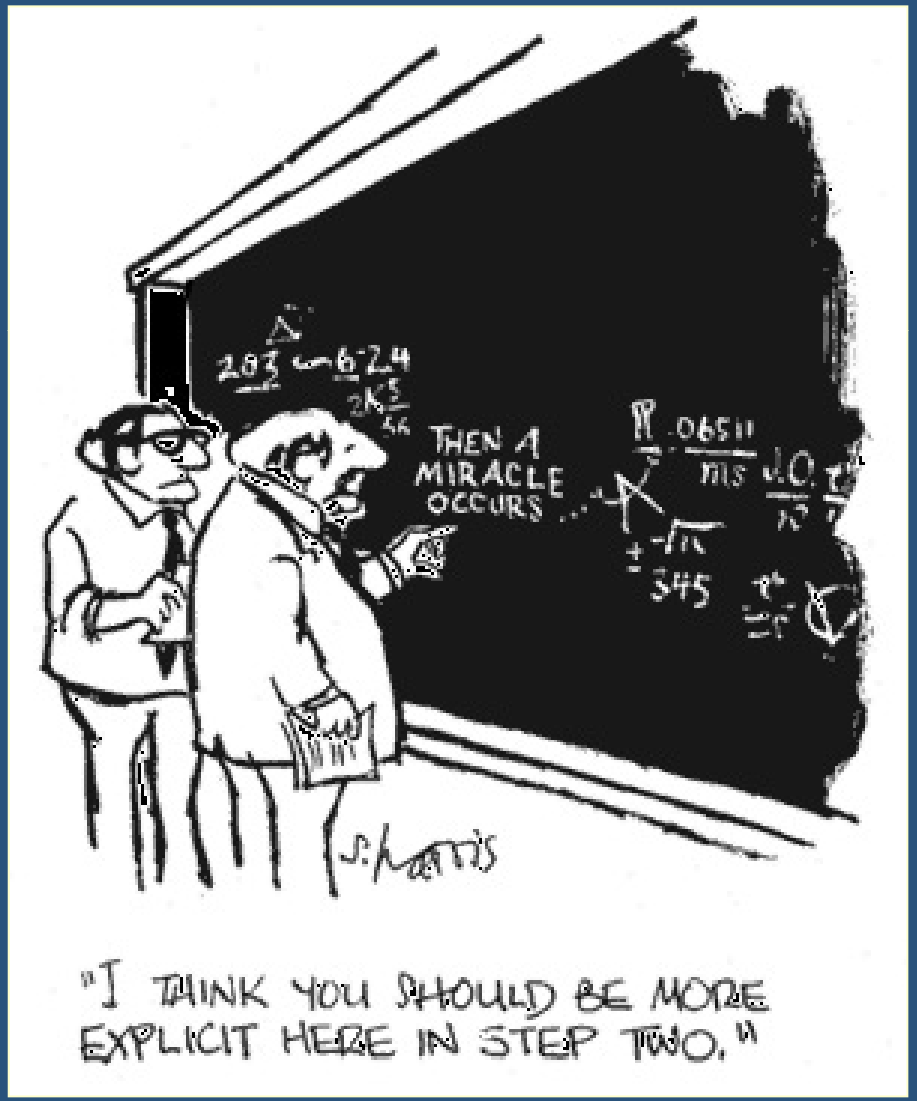
Construction & Review

- Expert knowledge critical (43%)
  - Managers 47%; Researchers 37%
- Minimal empirical knowledge (43%)
  - Managers 34%; Researchers 61%
- Model inconsistency (26%)
  - Managers 34%; Researchers 13%
- Mechanisms for validation (87%)
  - Managers 87%; Researchers 88%

Areas of STM Refinement

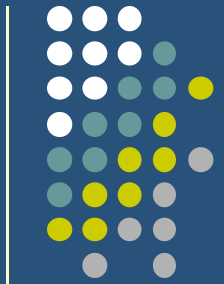
- Management vs ecological drivers
- Role of expert vs empirical knowledge
- Criteria to define thresholds
- Appropriate model complexity
- Model review and revision

Value of Empirical Data



"Then a miracle occurs" !!

Attributes Idaho Data Sets



- Idaho National Lab
- Plant density
- 34 m^2 plots
- Sampled 10 times
- 1950 – 2006
- N = 340 samples
- Species = 55
- MAP = 220 mm
- Idaho Falls ID

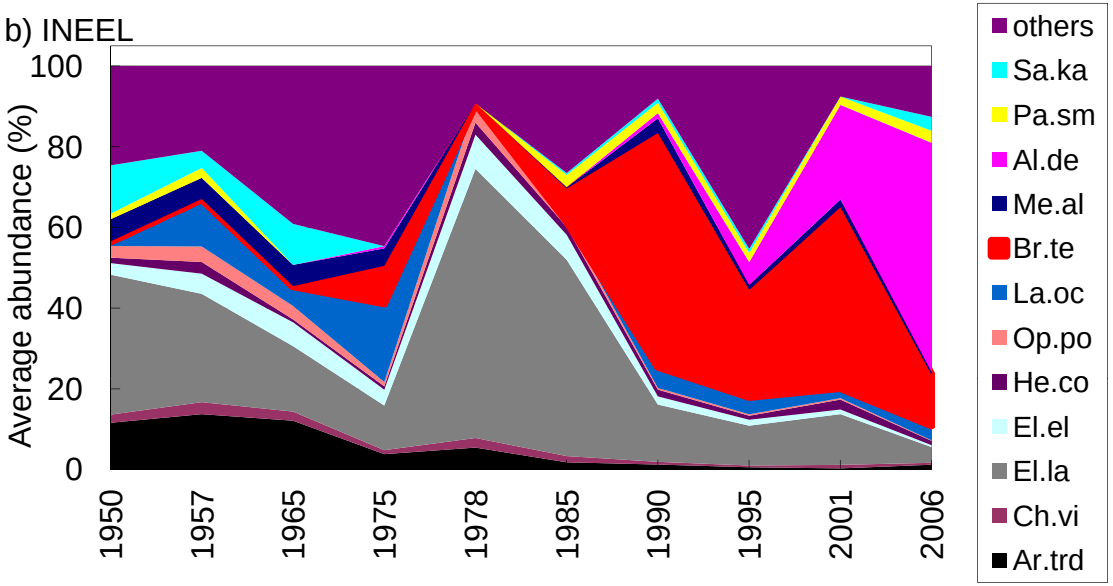
- US Sheep Station
- Plant density
- 15-26 m^2 plots
- Sampled 23 times
- 1930 – 1957
- N = 545 samples
- Species = 54
- MAP = 300 mm
- Dubois ID

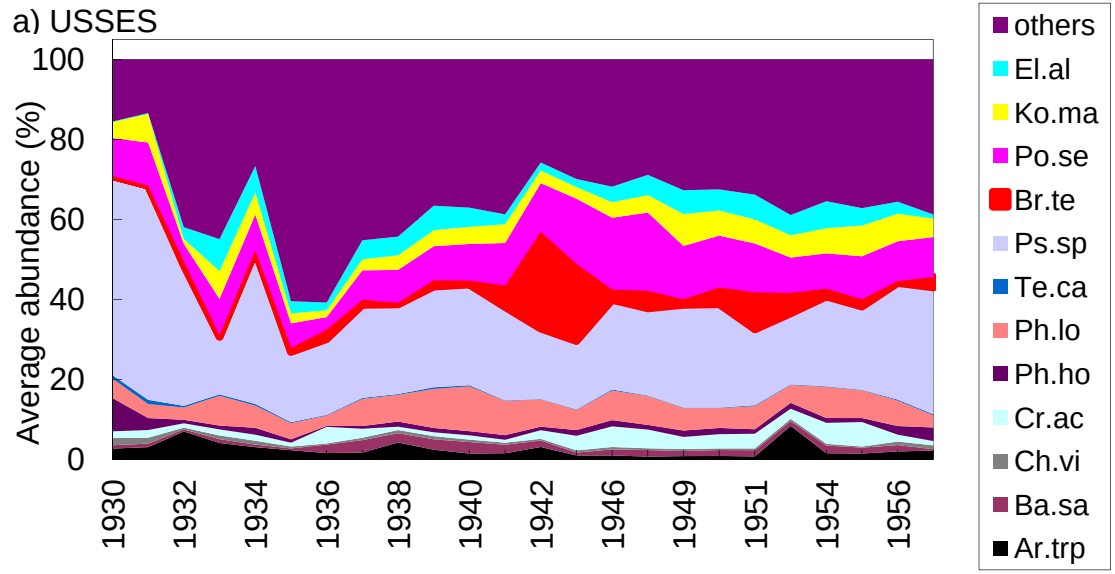
Data Analysis

Dr Sumanta Bagchi

- Identify communities with cluster analysis
- Verify community membership against species dissimilarity
  - BIC-parsimony, ANOSIM, SIMPER
- Record community transitions in time
- Categorize transition frequency and attributes

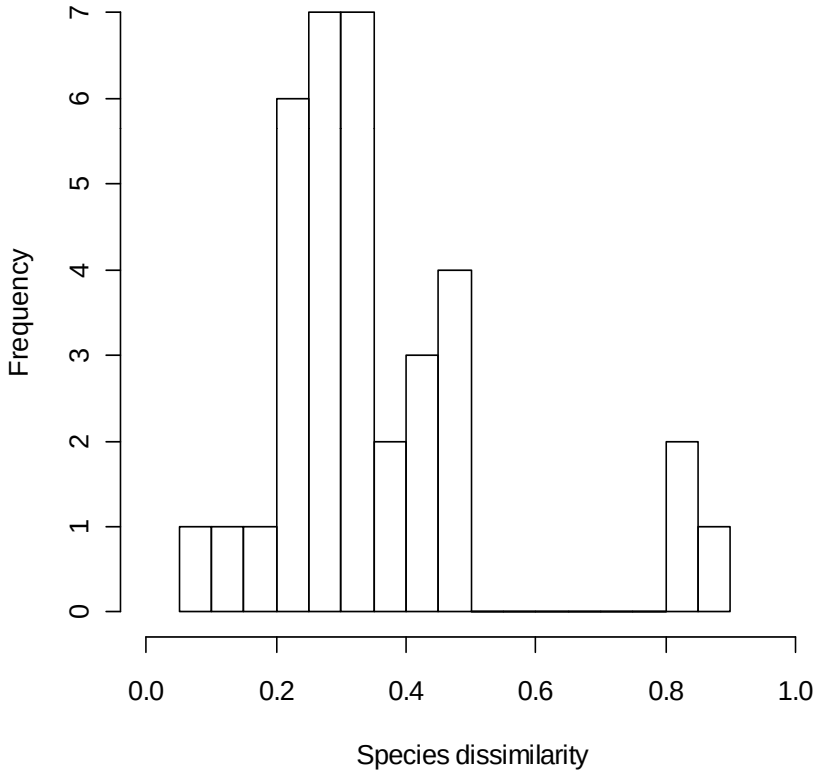
Species Composition



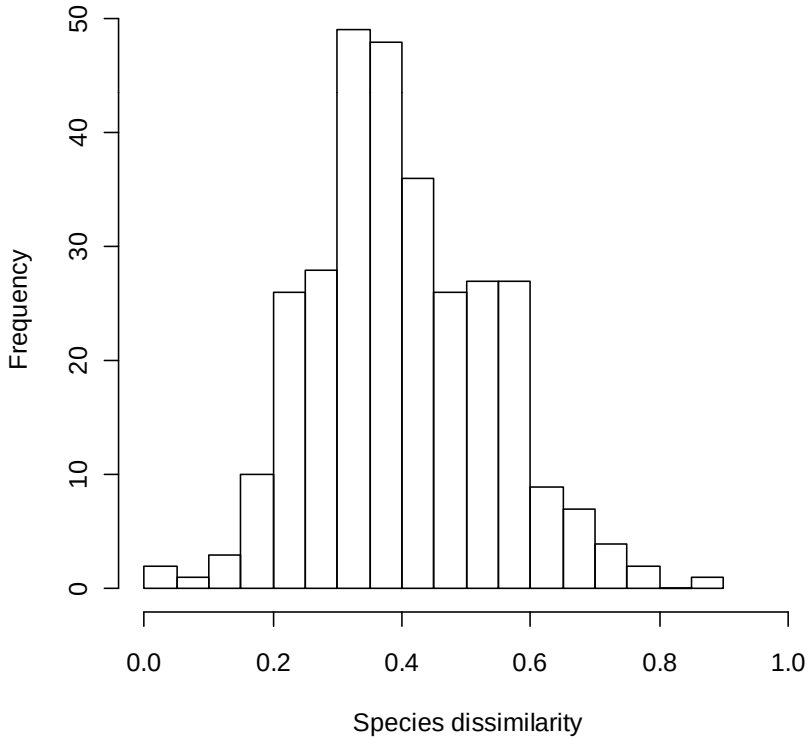


Transition Dissimilarity

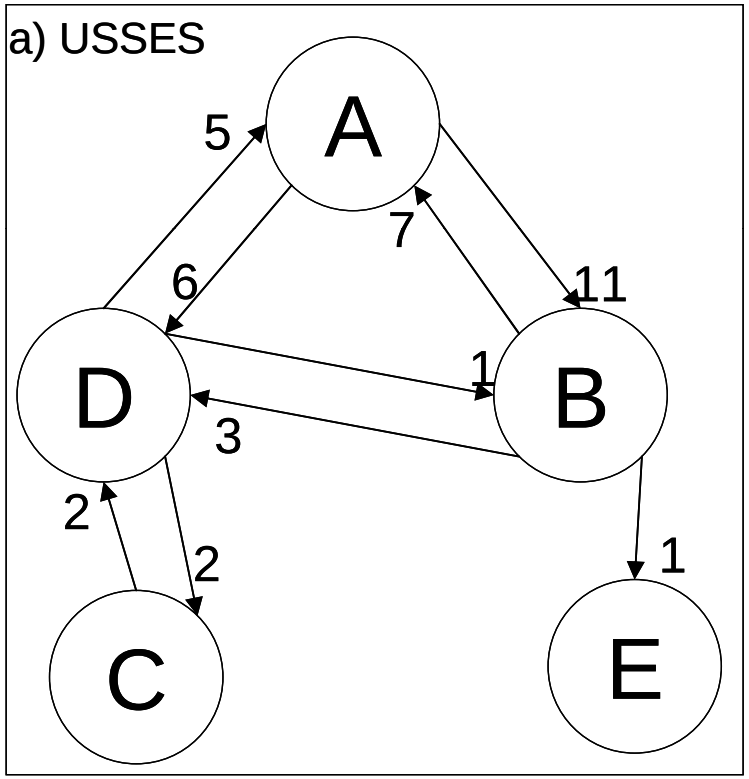
US Sheep Station

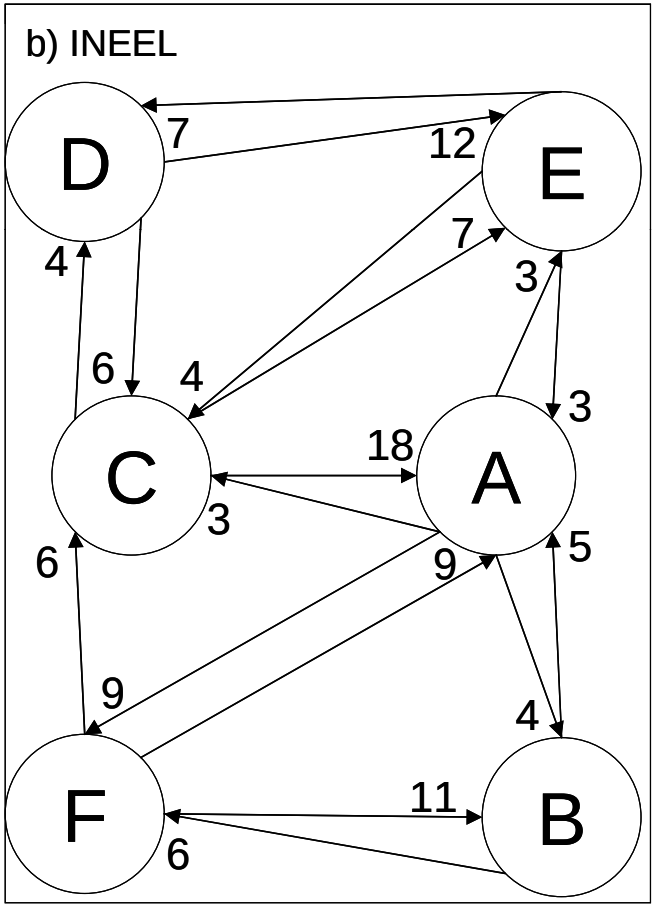


Idaho National Lab

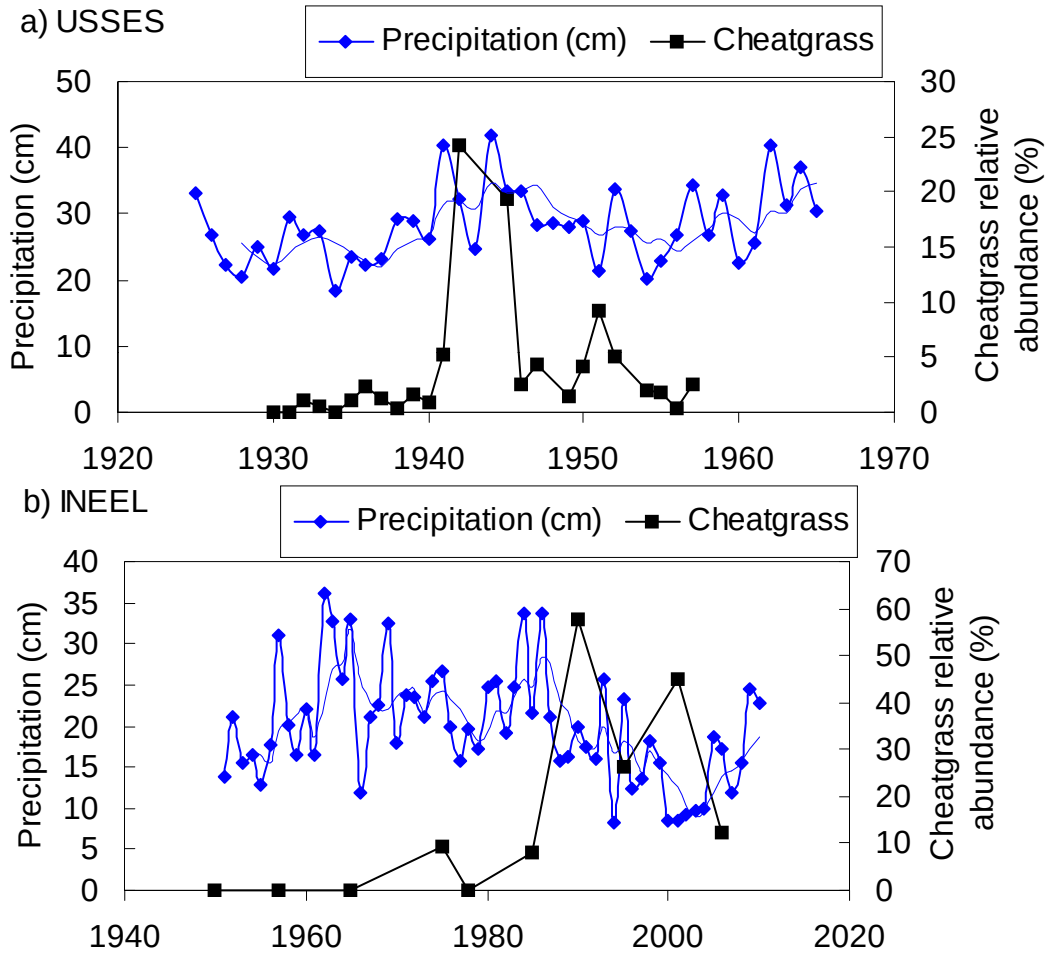


Empirical STMs

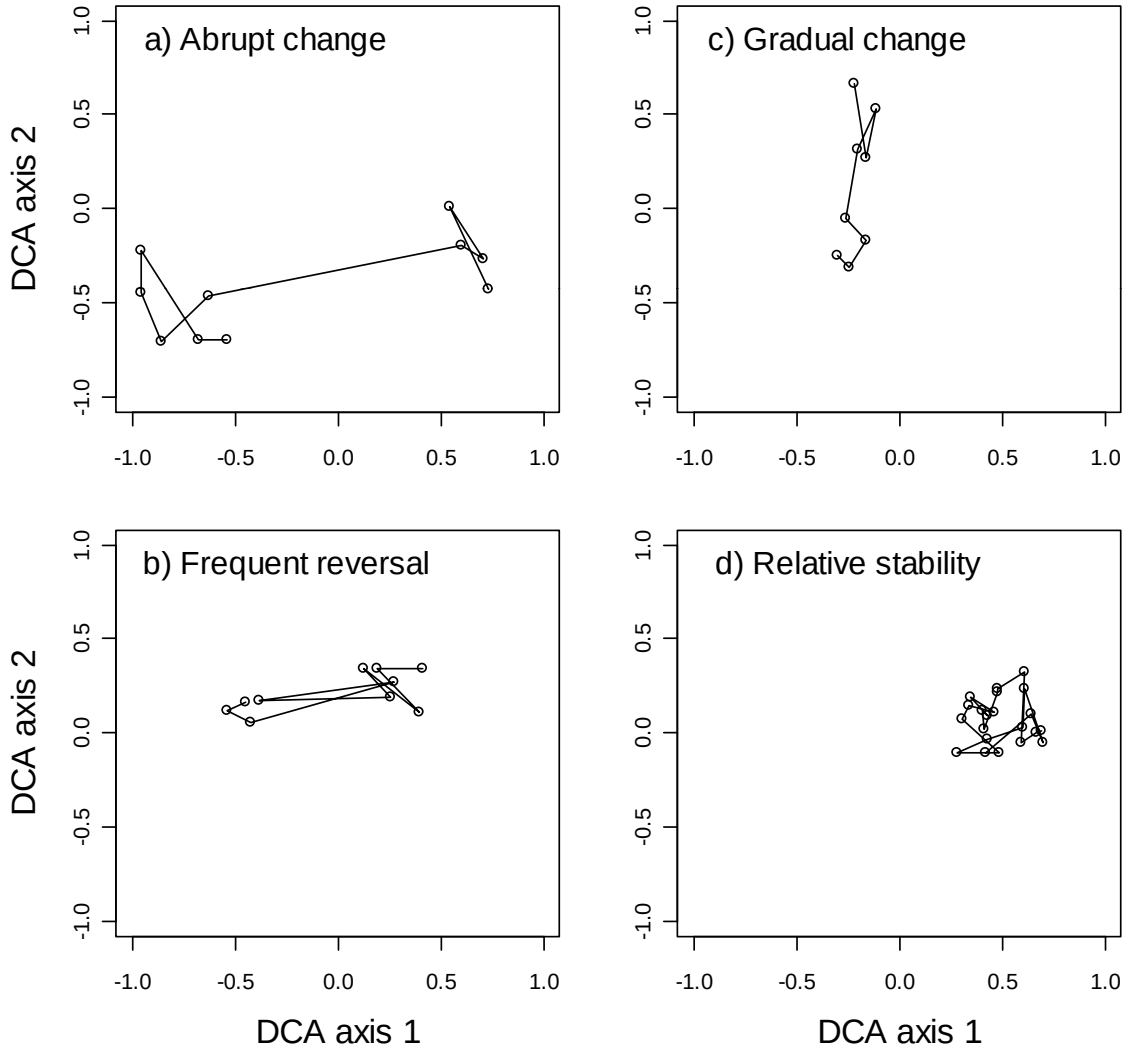




Community Transitions



Temporal Dynamics



Summary Idaho Data Sets

- Transitions occurred in a 10 yr window
  - Associated with **increasing** cheatgrass density
- Transitions decreased at maximum density
  - Alternative stable state formed
- Cheatgrass is a ‘biotic trigger’
  - Interaction with precipitation patterns
- Feedbacks rapid and unrelated to fire
  - Likely induced by plant-soil processes
- Similar patterns occurred at both sites

Value of Empirical Data?

- Empirical data can support STMs:
  - Describe community transitions
  - Identify temporal scales
  - Assess feedback mechanisms
  - Refine resilience hypotheses
- Vegetation records insufficient:
  - Adaptive management best approach
  - Monitor management outcomes
  - Consider autogenic & climatic processes

Future of STMs

- Strong, consistent support among stakeholders
- Continue resilience-based foundation
- Adaptive management supported w/ monitoring
- Science-management partnerships