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SRM Symposium

Conceptual Advances That Have Transformed The Rangeland Profession During The Past 25 Years

Organizer: David D. Briske, Texas A&M University

Society for Range Management

Rangelands & Wildlife
The Society for Range Management

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Symposium Objectives

Document major conceptual advances in range science.

- Why did advances arise at this particular time?
- What are their implications to the profession?
- What lessons were learned to guide future change?

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Edited Rangeland Volume

Rangeland Systems: Processes, Management and Challenges

- Conceptual advances is the major theme
- 17 Chapters; 60 Authors; 10 Countries
- Springer Environmental Stewardship Series
- David Briske, Editor
- Publication end 2016

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Topics and Speakers

- 8:00 am Conceptual Advances Overview; **David Briske**
- 8:20 am Ecohydrology, **Brad Wilcox**
- 8:40 am Provision of Ecosystem Services, **Kris Havstad**
- 9:00 am State transition models, **Brandon Bestelmeyer**
- 9:20 am Livestock Production Systems, **Justin Derner**
- 9:40 am Invasive Plants, **Tom Monaco - Cancelled**
- 10:00 am Break

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Topics and Speakers

- 10:20 am Collaborative adaptive management, **Craig Allen**
- 10:40 am Heterogeneity & range management, **Sam Fuhlendorf**
- 11:00 am Monitoring Protocols, **Jason Karl**
- 11:20 am Rangelands in Developing Nations, **Layne Coppock**
- 11:40 am Open Discussion

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20th Century Range Science

- ‘Range Problem’ recognized – 1900
- Assessment w/ Clementsian succession – 1917
  - ✓ Proposed by Arthur Sampson ‘Father Range Management’
  - ✓ ‘Plant Succession’ published by F.E. Clements – 1916
  - ✓ E.J. Dyksterhuis quantified procedure – 1949
- 50 years of conceptual stability followed
  - ✓ Consistency of Range Management texts; 1943, 55 & 75

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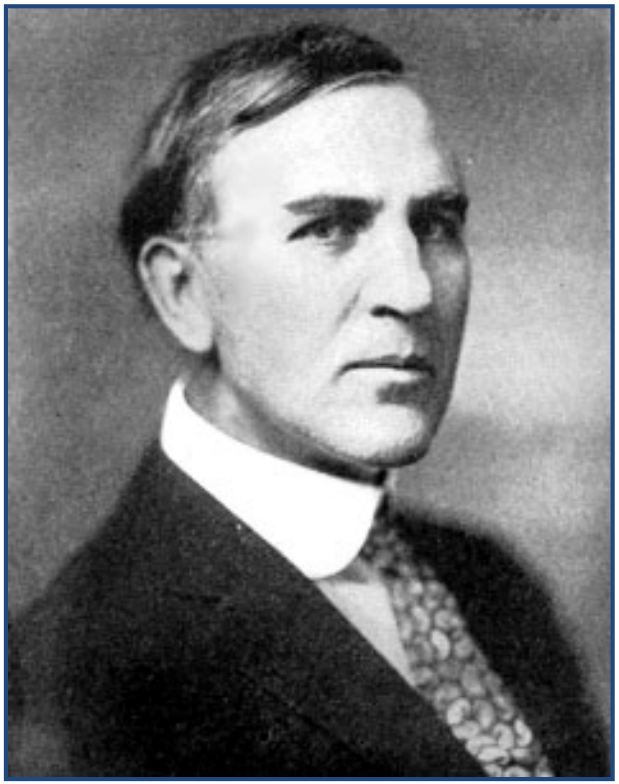
Initial Conceptual Advance?

Fredric E. Clements
1874 - 1945



Arthur W. Sampson
1884 - 1967

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What Disrupted Conceptual Stability?

- Rapid change began in late 1980's.
- Important events occurred both internal and external to the rangeland profession.
- Events comprised both scientific and socio-political developments.
- Multiple, interrelated events transformed the rangeland profession within 2 decades.

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Woody Plant Encroachment

Juniper

Major land cover change past 150 yrs
Altered fire regimes important cause

Mesquite

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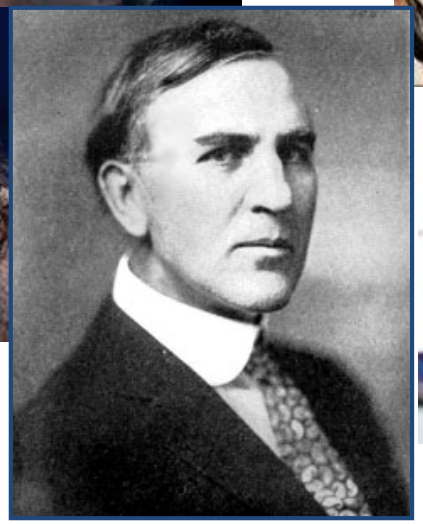
Clements Intellectually Pummeled



Fredric E. Clements

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Internal Events

- Criticism of rangeland assessment on basis of Clementsian succession in 70's and 80's.
  - ✓ Recognition of woody plant encroachment
  - ✓ Non-linear, non-reversible vegetation dynamics
  - ✓ Inconsistent with the linear range model
- STM framework introduced in 1989.
- NRC Rangeland Health Report political motivation 1994.
- NRCS adopted STM framework in late 1990's.
- Introduction of new scientific and multidisciplinary perspectives with generational turnover.

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External Events

- Introduction of resilience theory (Holling 1973)
  - ✓ Replaced stability w/ ‘dynamic, but resilient’ perspective
  - ✓ System integrity maintained while undergoing change
- Shift in research funding altered research direction
  - ✓ Focused, disciplinary projects funded by experiment stations replaced by interdisciplinary research funded by federal programs.
- University curriculum modified
  - ✓ Range science integrated into multidisciplinary programs
  - ✓ Increased scope, academic capacity, and relevance

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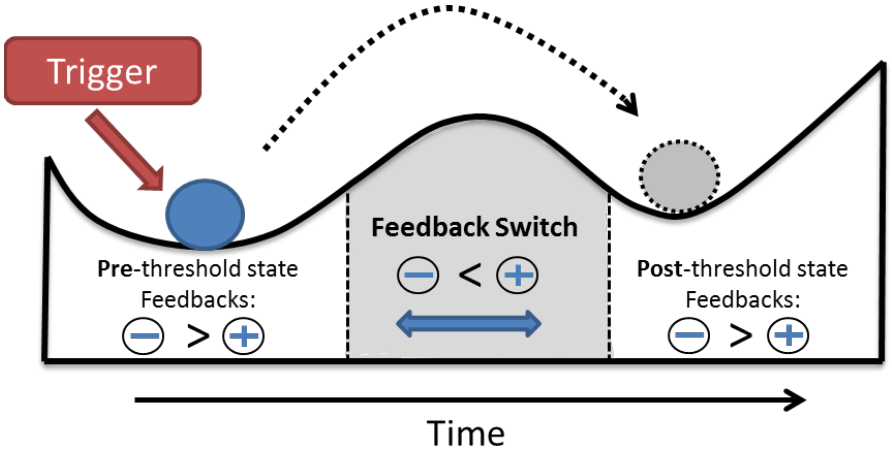
Non-equilibrium Ecology and Resilience

David D. Briske, Texas A&M University

Andrew W. Illius, University of Edinburgh, Scotland

J. Marty Anderies, Arizona State University



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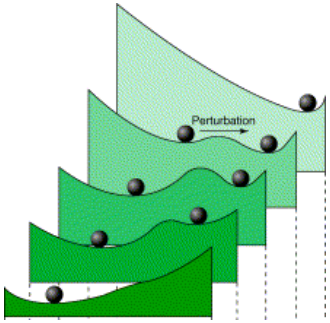
Non-equilibrium Ecology

- Rangelands characterized by extreme climatic and spatial variability, and event-driven nonlinearities.
- Models are needed to accommodate environmental variability and nonlinear vegetation dynamics.
  - ✓ Non-equilibrium persistent model (NEP)
  - ✓ State-and-Transition model (STM)



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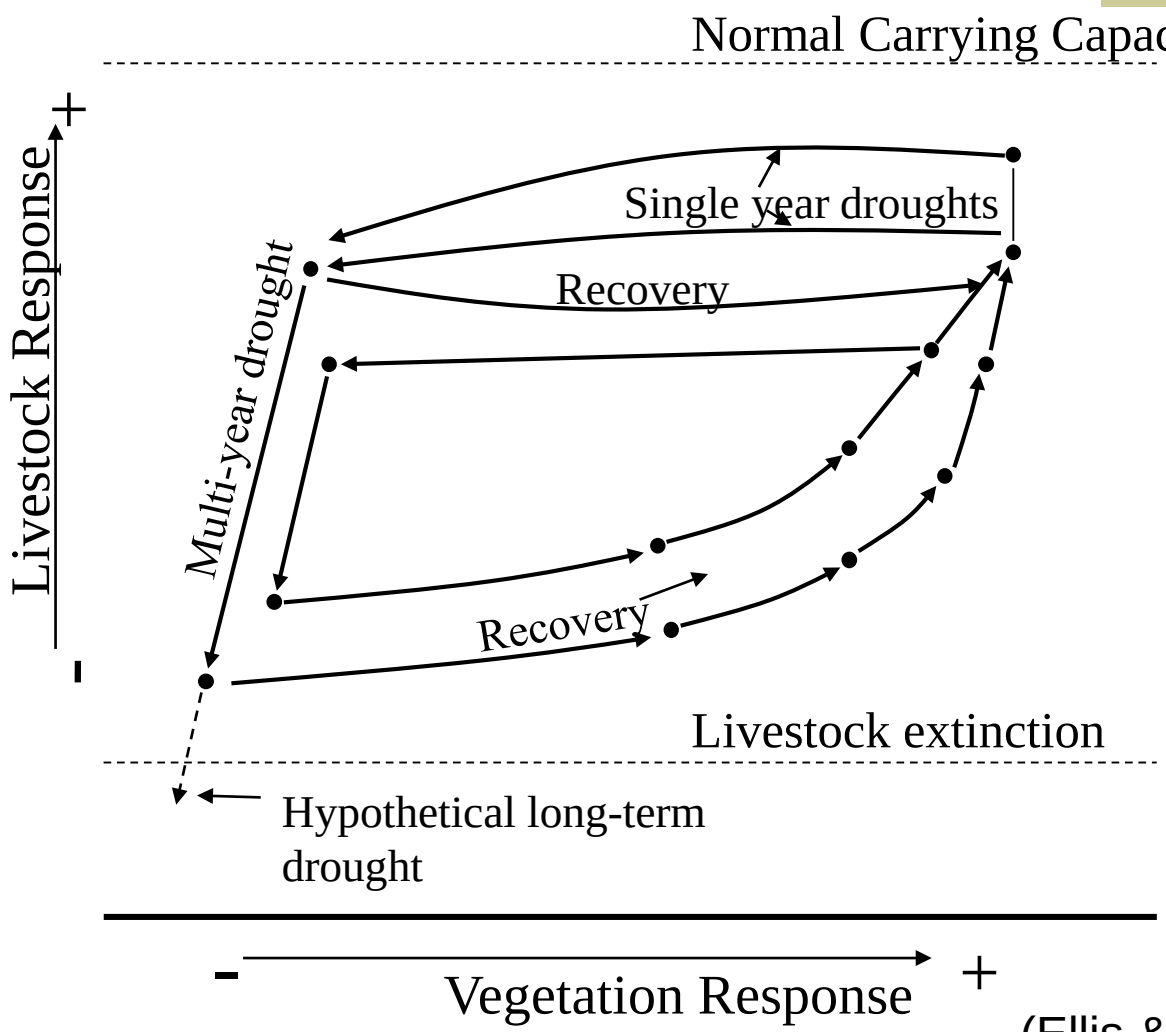
Non-equilibrium Persistent Model



(Ellis & Swift 1988)

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‘New’ Rangeland Ecology

Non-equilibrium models welcomed as an alternative to traditional equilibrial concepts. They rejected:

- Density-dependent regulation of plant production by livestock
- Concepts of carrying capacity and stocking rate
- Ability of grazing animals to adversely impact rangeland resources.

Behnke, Scoones & Kerven 1993

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Equilibrial Key Resource Areas

- Reassessment indicated NEP model did not consider heterogeneity of resource use by herbivores.
- Animal numbers are **coupled** to a small subset of ‘key’ resources that are accessible in the dry season.
- Key resource areas are critical for determining animal survival in response to drought.
- Animals are largely **uncoupled** from abundant wet season forage resources.

Illius & O’Connor 2000
Hempson et al. 2015

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Non-equilibrium and STMs

- ‘Opportunistic management for rangelands **not** at equilibrium’ – Westoby, Walker & Noy-Meir 1989.
- Emerged from dissatisfaction of equilibrium concepts
- Intent to catalog alternative states and transitions; as opposed to a ‘permanent’ equilibrium.
- STMs linked to ecological resilience in 2008.

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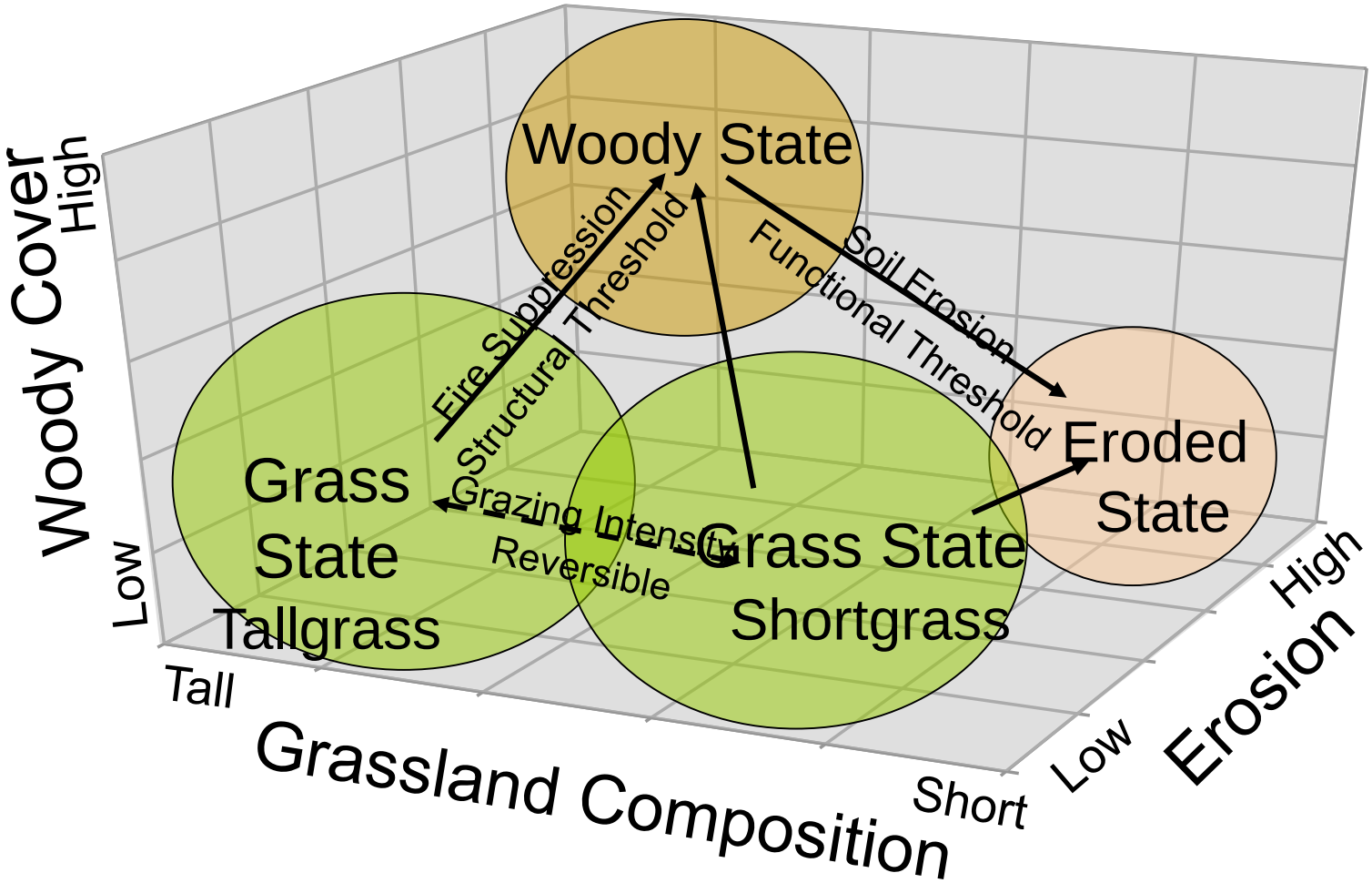
Resilience is an Equilibrial Concept

- Individual states are organized around a single equilibrium point or basin of attraction.
- Thresholds represent boundaries between alternative equilibrium points and stable states.
- Non-equilibrium ecology has largely been replaced by ecological resilience - a multi-equilibrial concept.
- Identify slow variables and feedbacks controlling the dynamics of structural variables within systems.

Petraitis 2013

Multiple Equilibrium Concept



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Return Toward Equilibrium Ecology

- Qualification of equilibrial ecology required, rather than replacement by non-equilibrium ecology.
- Multi-equilibrium has largely replaced the non-equilibrium interpretation.
- This interpretation represents a more logical and manageable explanation of rangeland dynamics.