Detection of catastrophic thresholds: perspectives, definitions, and methods

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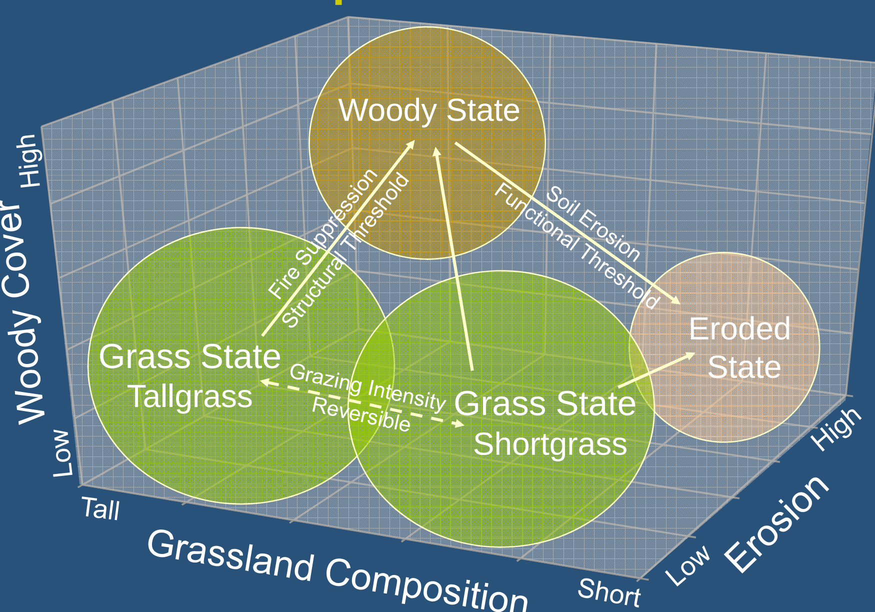
Summary Objectives

- Why is this symposium important?
- What is the symposium contribution?
- How is this symposium relevant to society?

Non-equilibrium Ecology Timeline

- 1973. C.S. Holling. Resilience and stability of ecological systems. Ann. Rev. Ecol. Syst. 4:1-23
- 1984. J.A. Wiens. On understanding a non-equilibrium world… In: Ecological Communities, Princeton Univ. Press
- 1987. D.L. DeAngelis and J.C Waterhouse. Equilibrium and nonequilibrium concepts in ecological models. Ecol. Monogr. 57:1-21
- 1995. J. Wu and O.L. Loucks. From balance of nature to hierarchical patch dynamics… Quart. Rev. Biol. 70:439-466.
- ≥ 2000. Numerous authors. Regime shifts, thresholds and self-organization of ecological systems.

Catastrophic Thresholds



Briske et al. 2005

Equilibrium versus Non-equilibrium Ecosystems

	Equilibrium Systems	Non-equilibrium Systems
Abiotic Patterns	Abiotic conditions relatively constant	Stochastic / variable conditions
Plant-Herbivore Interactions	Tight coupling of interactions	Weak coupling of interactions
Population Patterns	Populations track carrying capacity	Carrying capacity too dynamic for close population tracking
Ecosystem Attributes	Limited spatial extent	Spatially extensive
	Self-controlled systems	Externalities critical to system dynamics

Wiens 1984; Ellis and Swift 1988

Current Interpretation of the Non-equilibrium Ecology

- Equilibrium attributes may not represent a fundamental property of ecosystems, but they may emerge as a characteristic of increasing spatial scale (DeAngelis & Waterhouse 1987).
- Confirms Wiens' (1984) interpretation that ecosystems are distributed along a continuum of equilibrium to non-equilibrium behaviors.

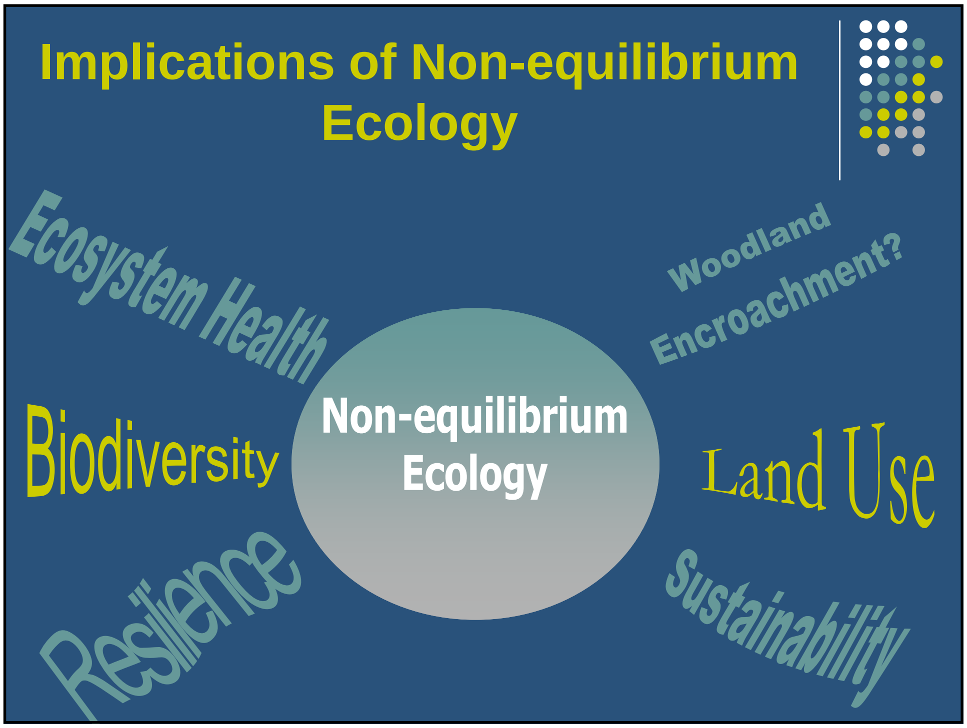
Symposium Contributions

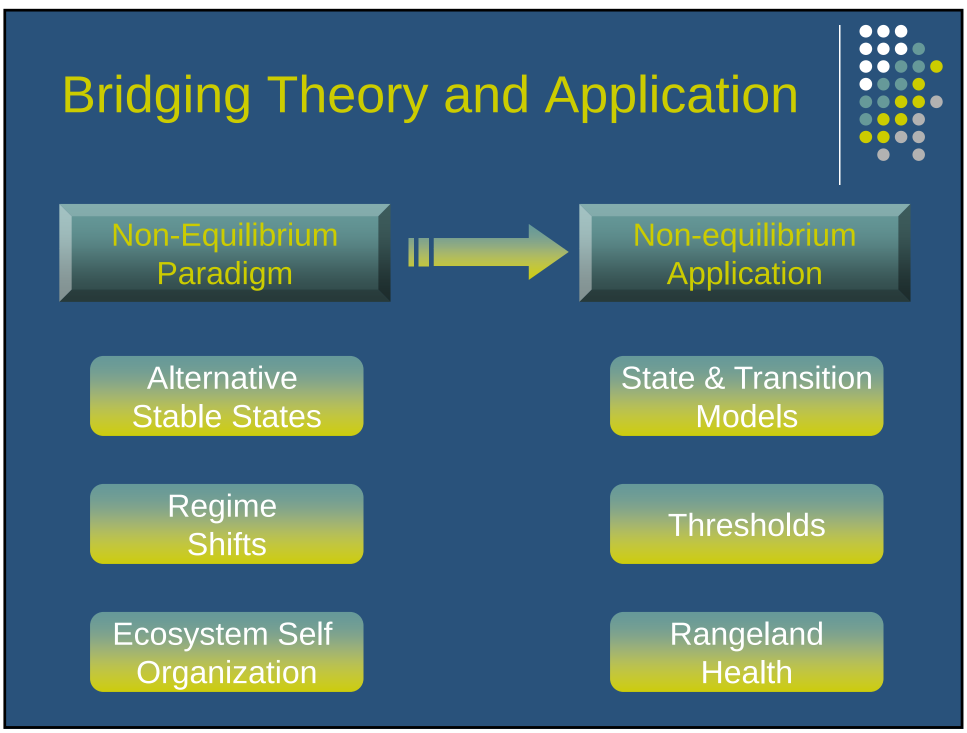
- Protocols to interpret and apply resilience
  - i.e., parallel theme of this symposium.
- Catastrophic thresholds or regime shifts define limits of ecosystem resilience
  - e.g., discontinuity, criticality, bifurcation points.
- Ecological mechanisms of system self-organization
  - e.g., cross-scale structure, structural variability, coupled biophysical landscape dynamics.

Symposium Contributions

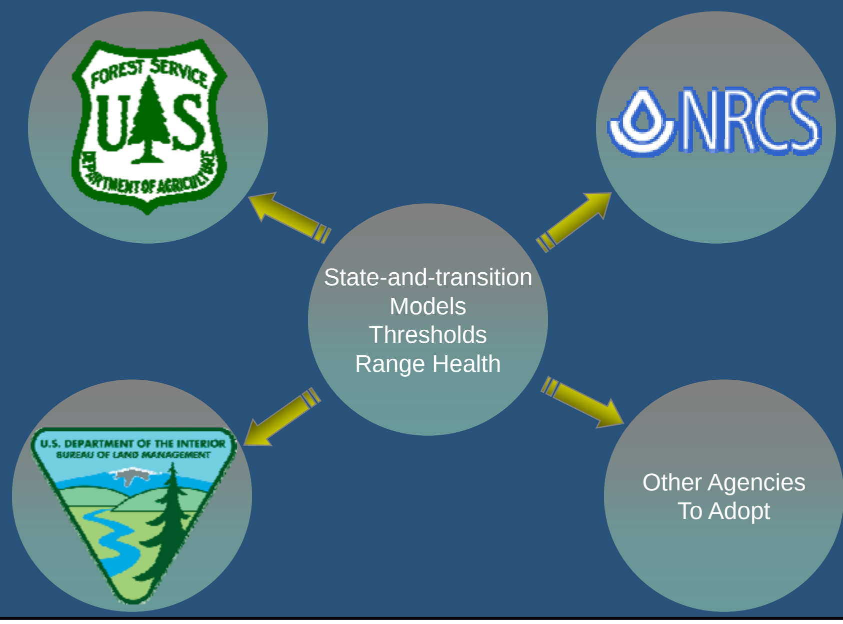
- Scale defines non-equilibrial systems
  - e.g., non-linear scaling laws, cross-scale structure.
- Procedures required to evaluate scale
  - e.g., time scale analysis, characteristic length scales.
- Application of non-equilibrial ecology

  e.g., population ecology, rangeland stewardship, West Nile virus, social-ecological systems


Implications of Non-equilibrium Ecology
Ecosystem Health
Woodland Encroachment?
Biodiversity
Non-equilibrium Ecology
Land Use
Resilience
Sustainability


Bridging Theory and Application
Non-Equilibrium Paradigm
Non-equilibrium Application
Alternative Stable States
State & Transition Models
Regime Shifts
Thresholds
Ecosystem Self Organization
Rangeland Health

Application of Non-equilibrium Ecology



Symposium Postscript: How do we proceed from here?

- Catastrophic thresholds and alternative states have been demonstrated; scale is strongly implicated.
- Process contributing to these dynamics remain inconclusive; greater linkage to existing knowledge would demystify non-equilibrium dynamics.
- Procedures required to effectively apply non-equilibrium ecology, including thresholds.
- A more comprehensive non-equilibrium framework emphasizing scale required for major advancement.