Transforming Range Curriculum in the 21st Century

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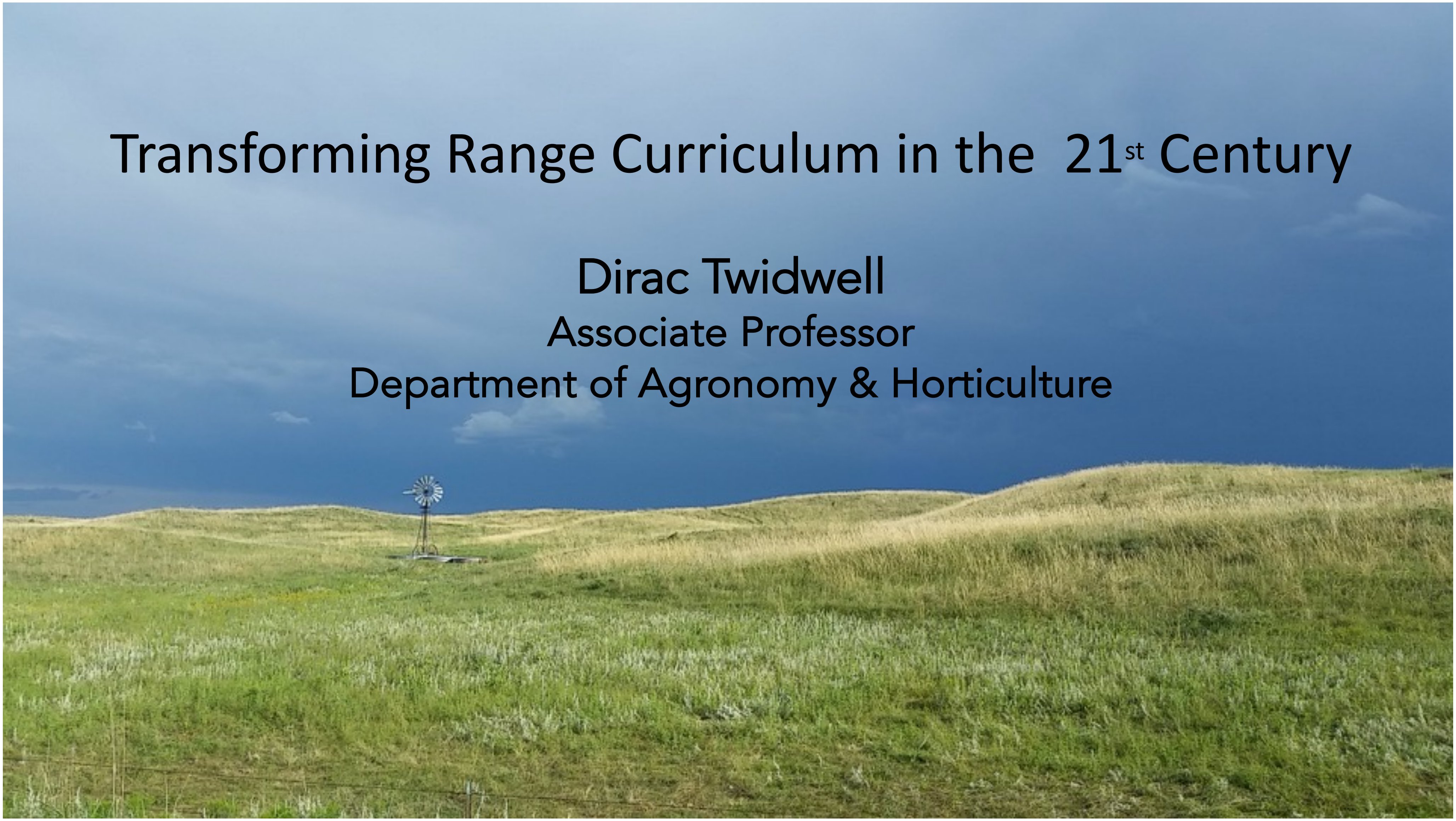
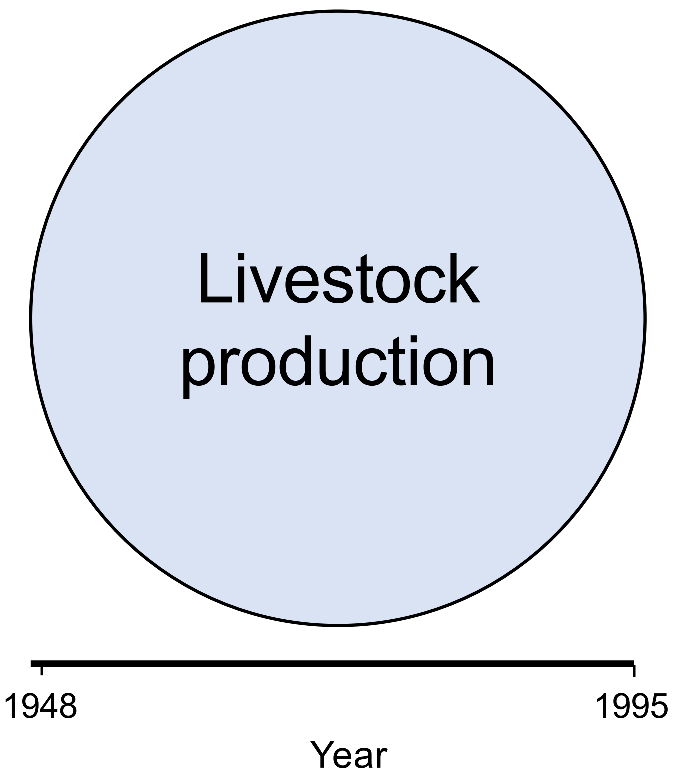


The rangeland discipline has experienced a rapid shift in what is expected from range scientists



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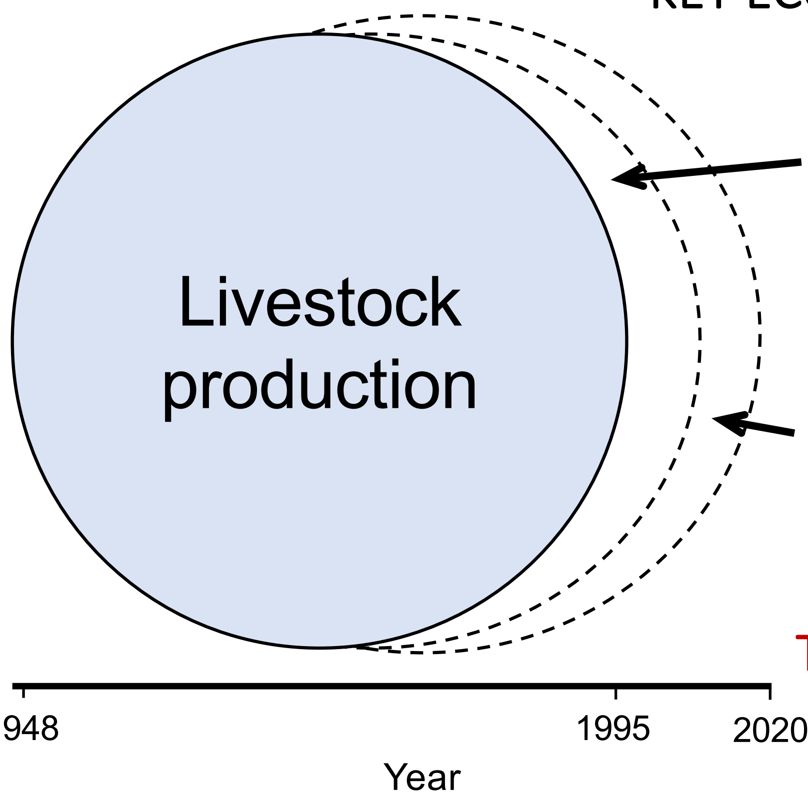


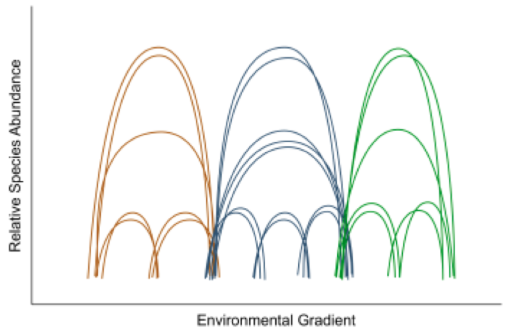
KEY ECOSYSTEM SERVICE EXAMPLES

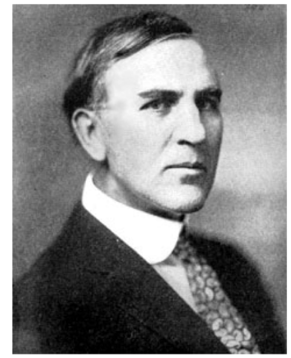
- Conservation of biodiversity & rare/endangered species
- Carbon sequestration
- Water quality/quantity

- Disaster mitigation
- Energy
- Aesthetic value
- Ecotourism & recreation
- Human health

This disciplinary shift is expected for all FEWS disciplines

Classical Ecological Theory



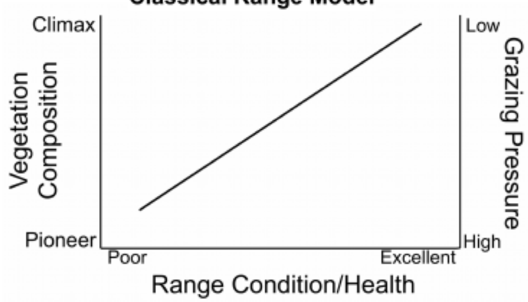


Central Concepts

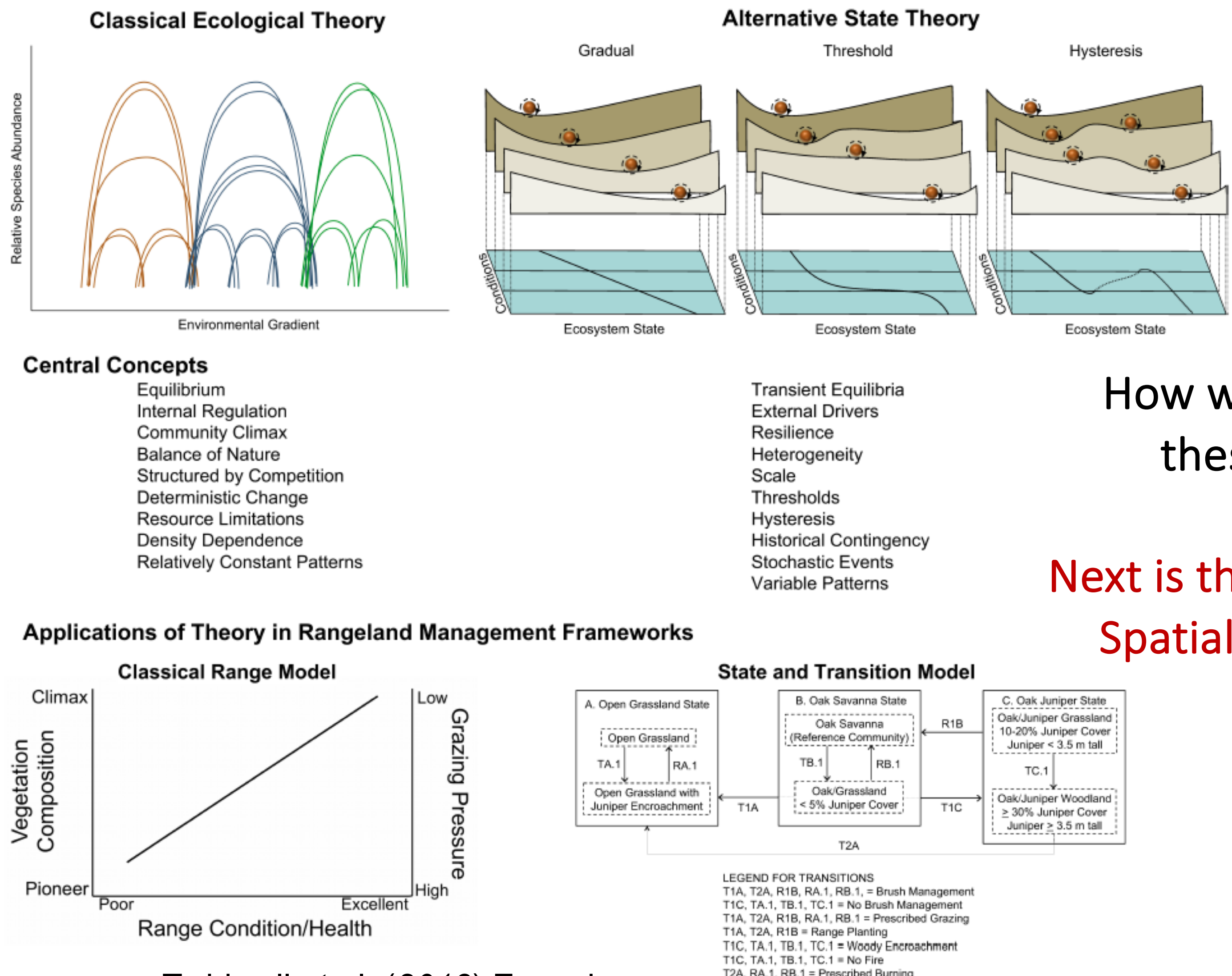
- Equilibrium
- Internal Regulation
- Community Climax
- Balance of Nature
- Structured by Competition
- Deterministic Change
- Resource Limitations
- Density Dependence
- Relatively Constant Patterns

Applications of Theory in Rangeland Management Frameworks

Classical Range Model



Twidwell et al. (*2013*) Ecosphere

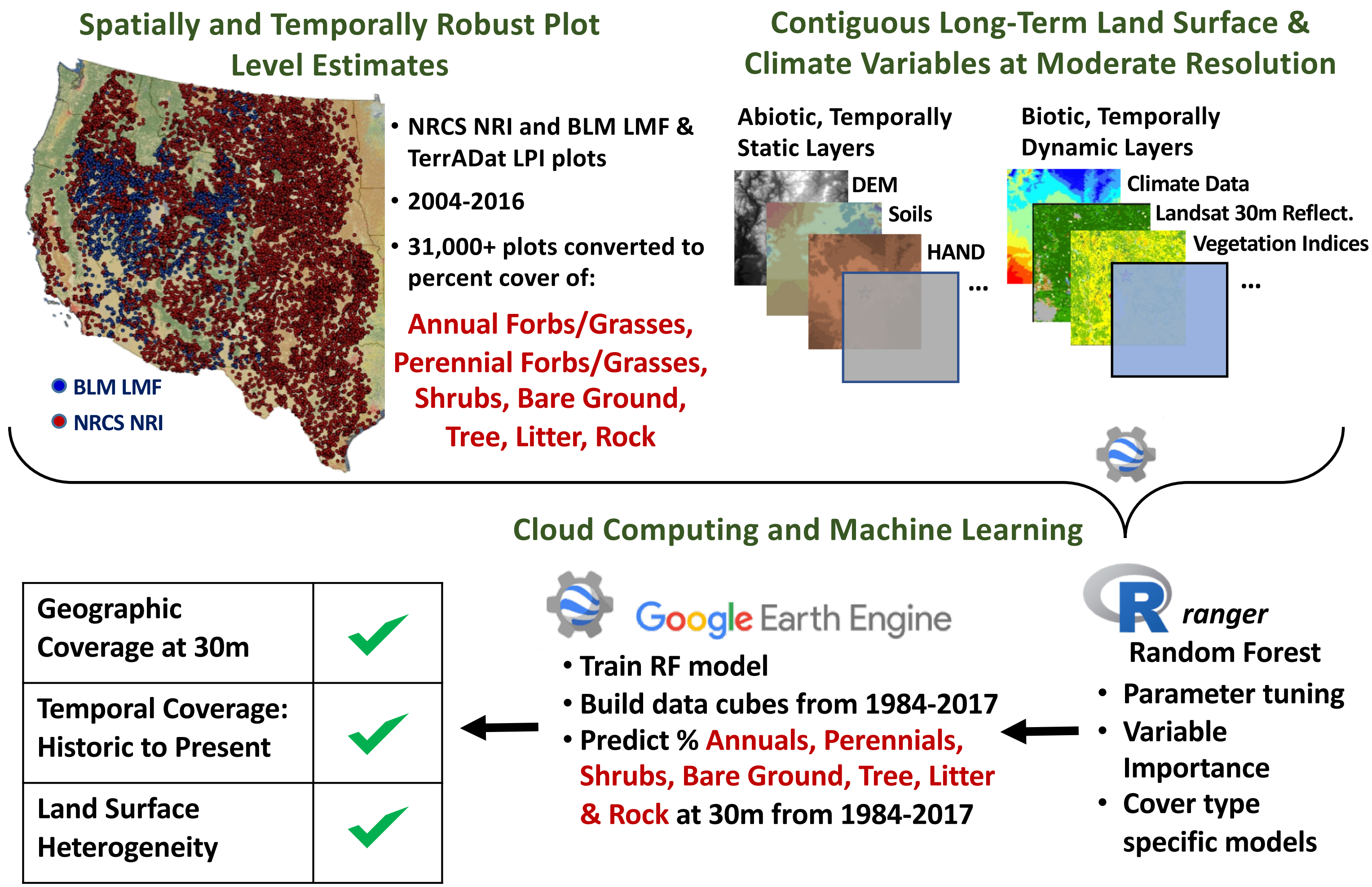


Twidwell et al. (*2013*) Ecosphere

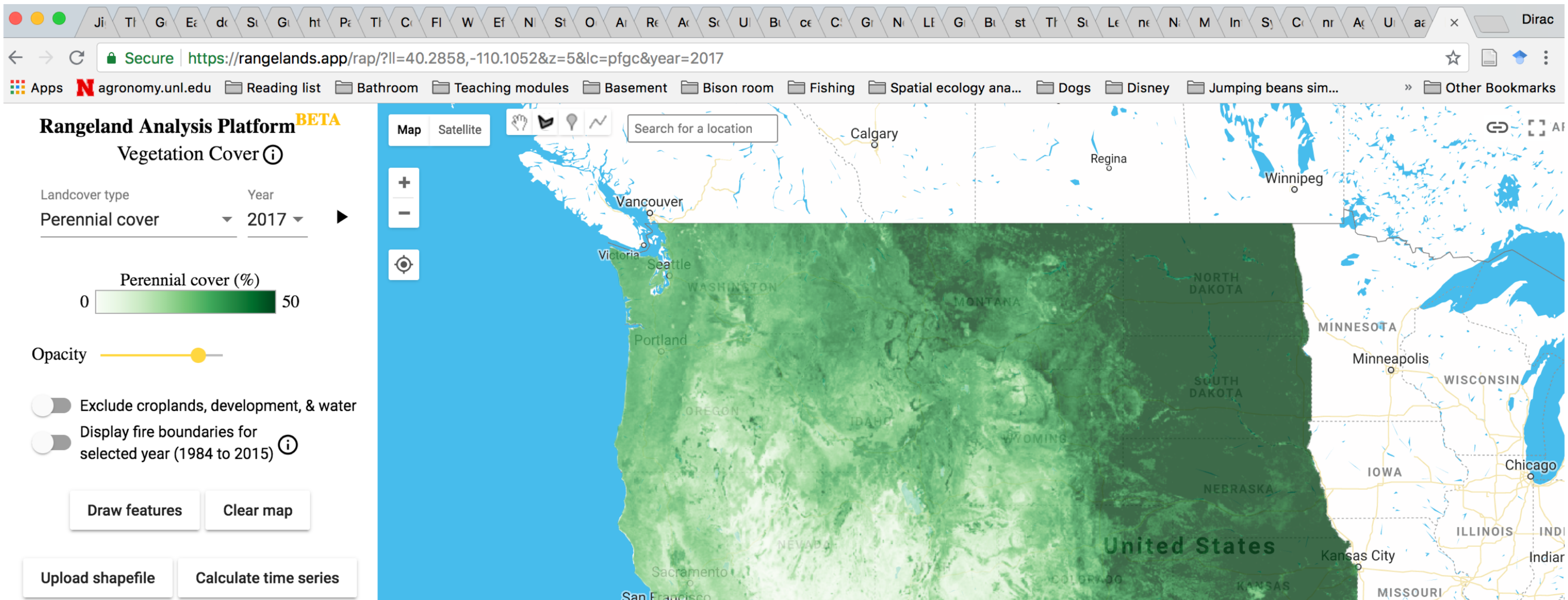
How well do we teach these concepts?

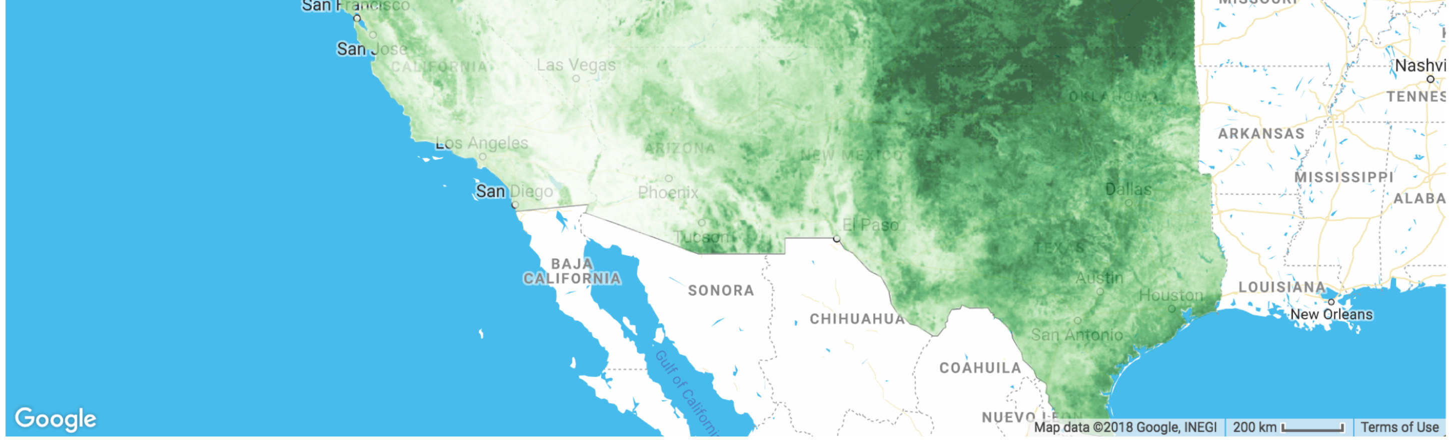
Next is the transition to the Spatial Informatics Age

Rangeland Analysis Platform



Jones et al. (*in press*) Ecosphere



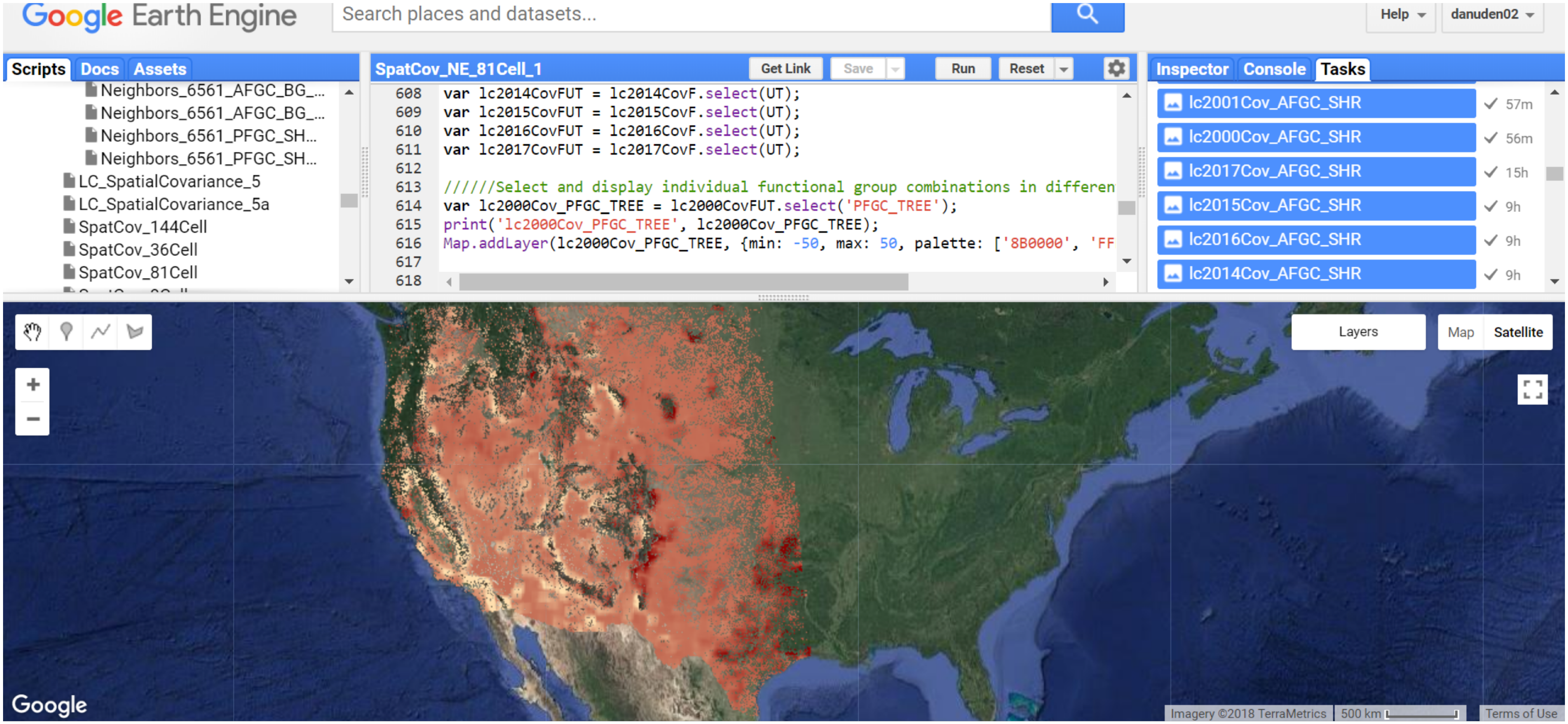


Provides a pathway for new and more objective decision-support tools in rangelands that emphasize change detection in real-time.

"Track your own land"

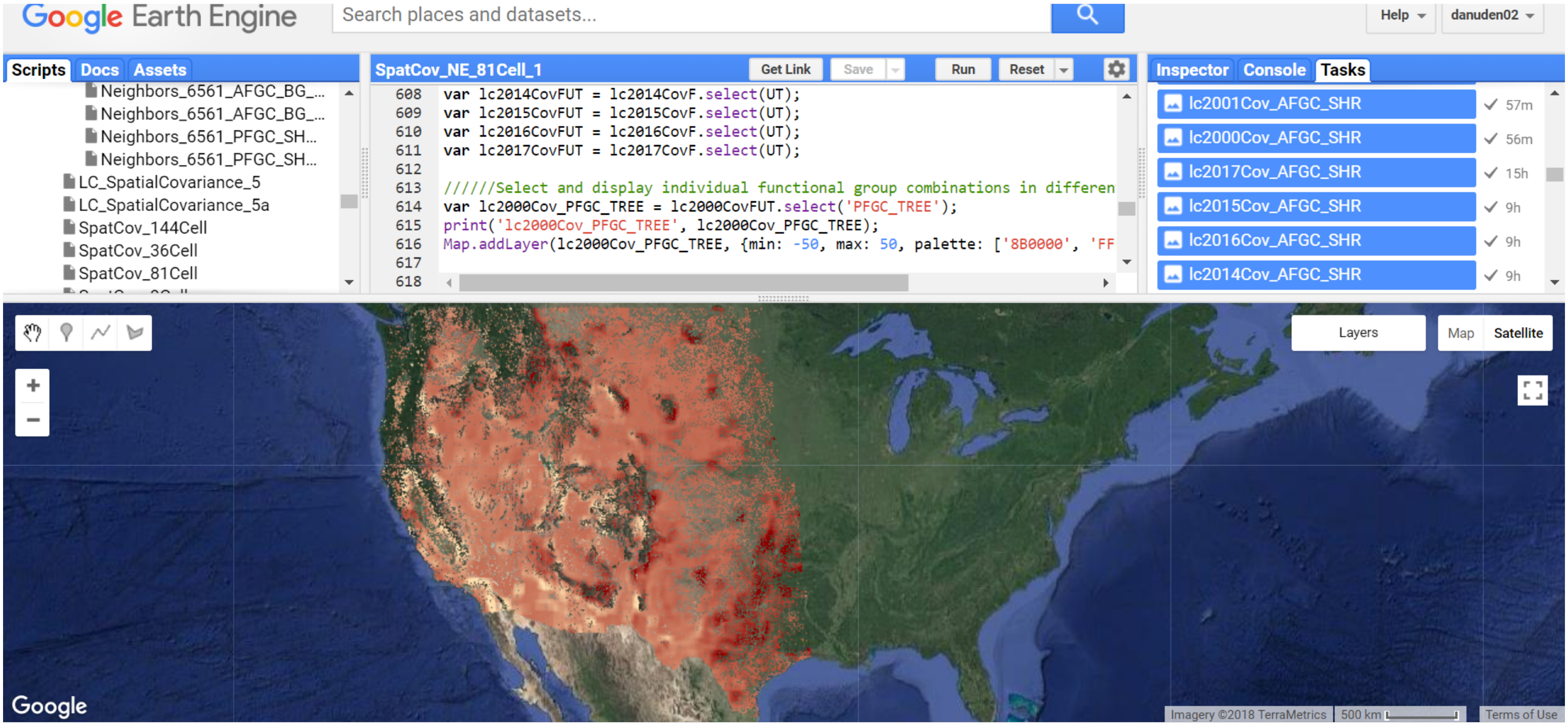
Quantifying the spatial order of state transitions

Trends in Grass-perennial exclusion relationships (2000)



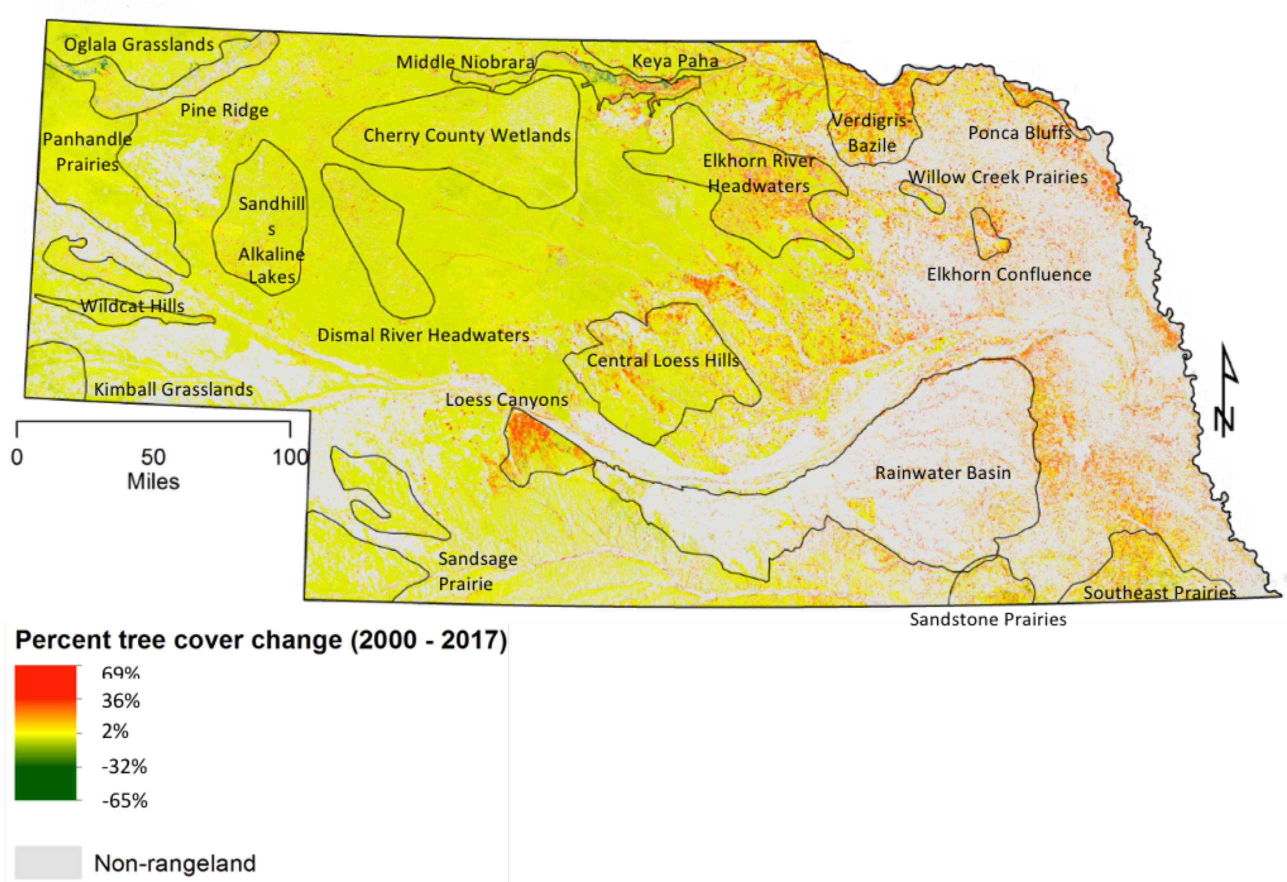
Quantifying the spatial order of state transitions

Trends in Grass-perennial exclusion relationships (2017)

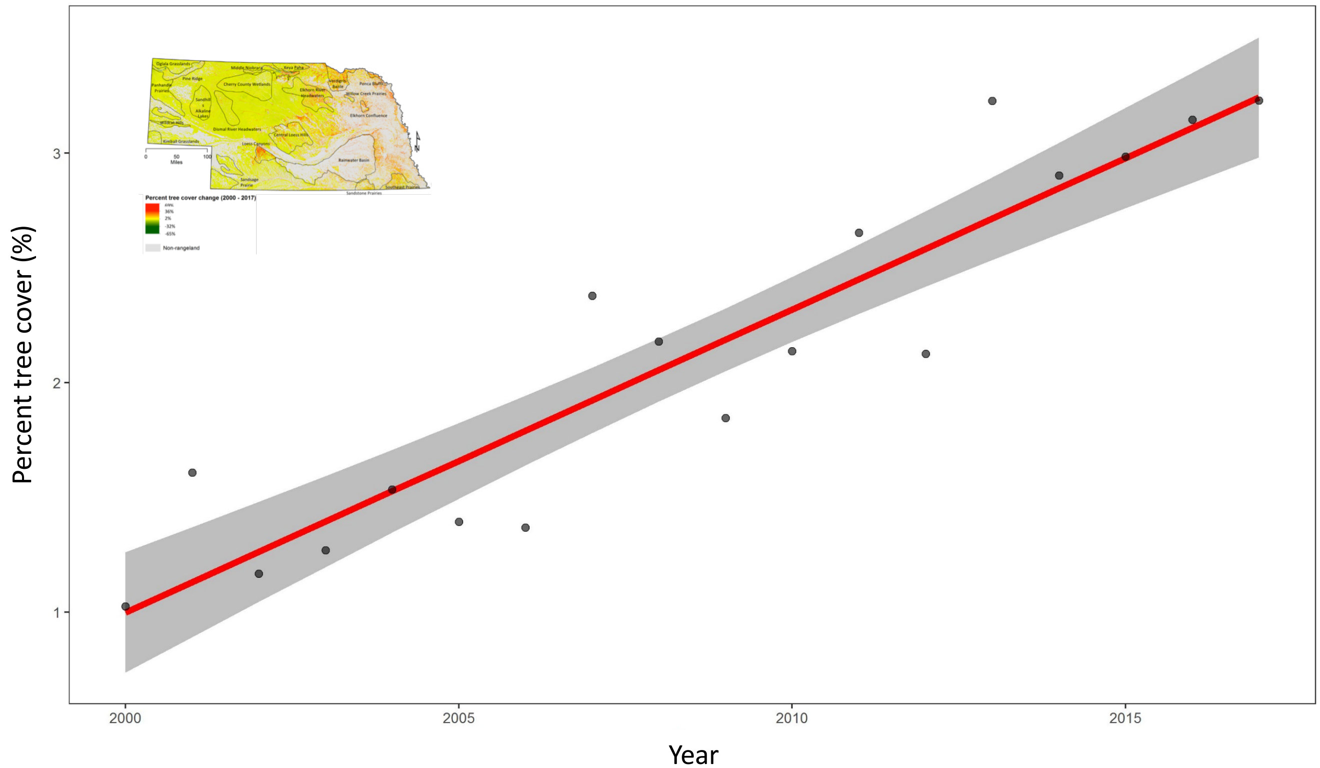


Monitoring change in regional conservation planning programs

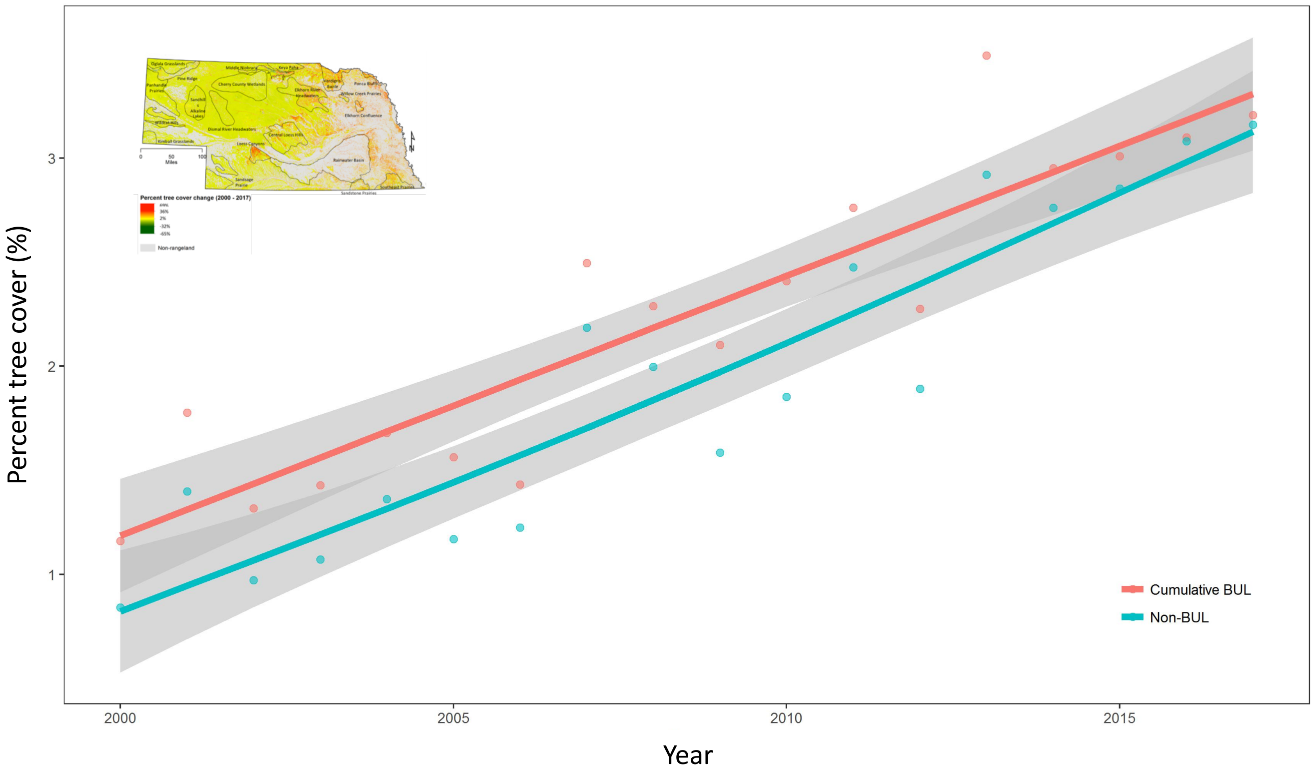
Nebraska's Natural Legacy Project (Biologically Unique Landscapes)



Statewide Trend (2000 – 2017) is consistent with a regional indicator of unsustainable management occurring on localized lands

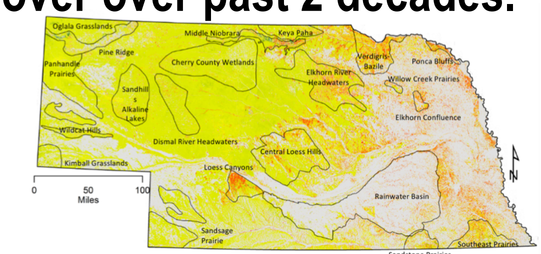


The rate of transitions is similar when comparing lands in BULs versus those not in BULs

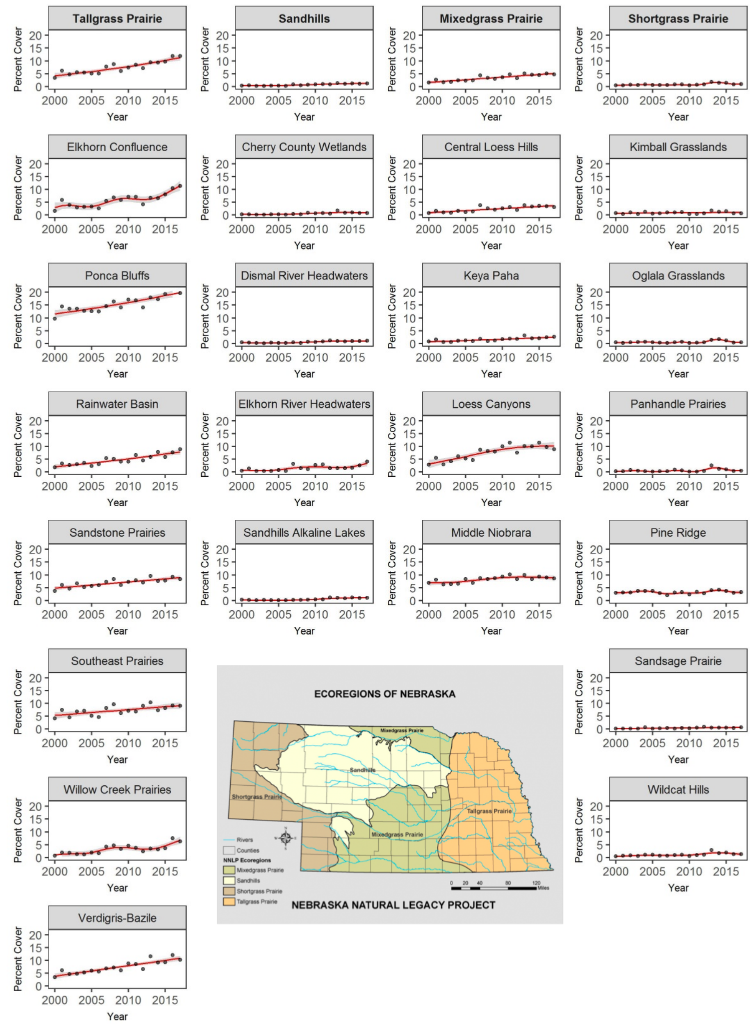


Summary of BUL Assessment (2000-2017)

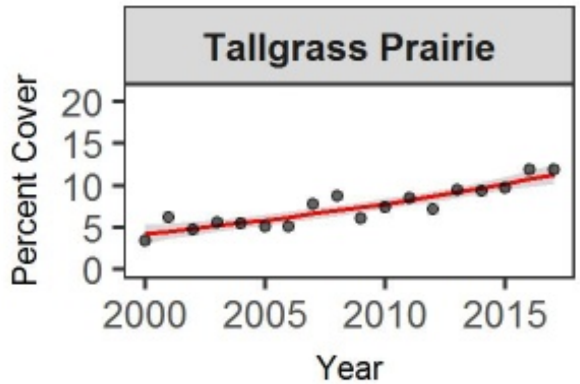
- All BULs in the tallgrass prairie zone are transitioning to tree dominance.
- All BULs in the mixedgrass prairie zone have increased in tree cover since 2000.
- All Sandhills BULs have increased in tree cover (at early stages of woody transitions).
- BULs in the shortgrass prairie zone are currently the most stable.
- **No BUL showed declines in tree cover over past 2 decades.**

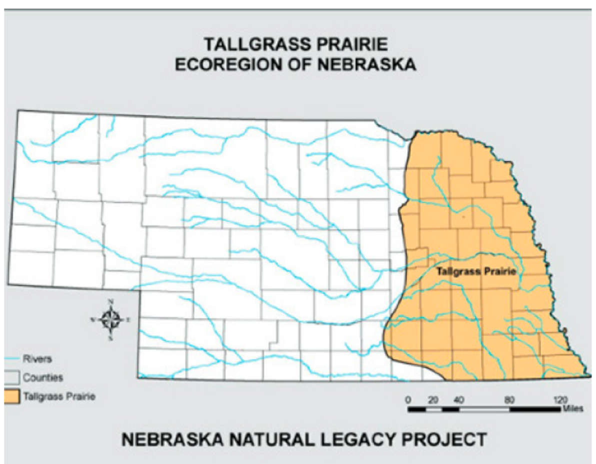


Percent tree cover change (2000 - 2017)

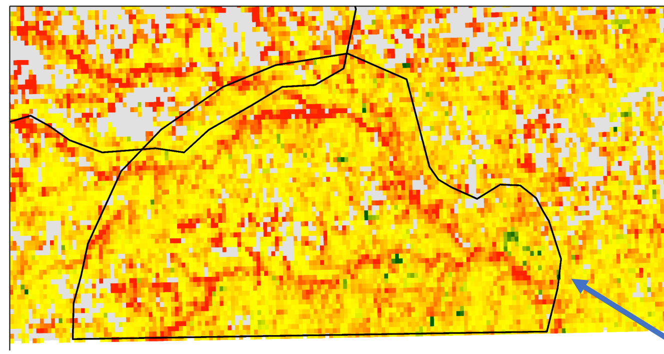


Tree dominance has tripled across tallgrass prairie BULs since 2000

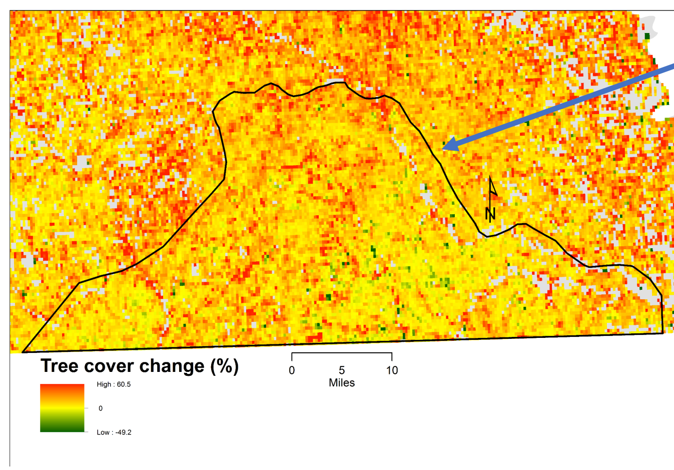


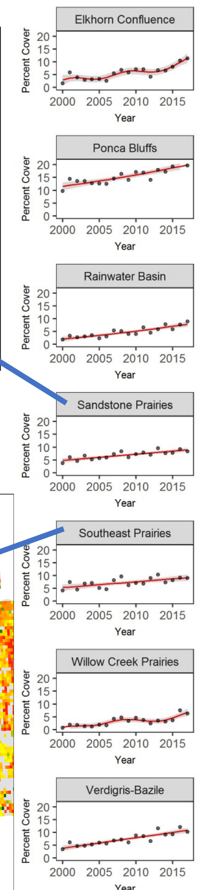


Sandstone Prairies



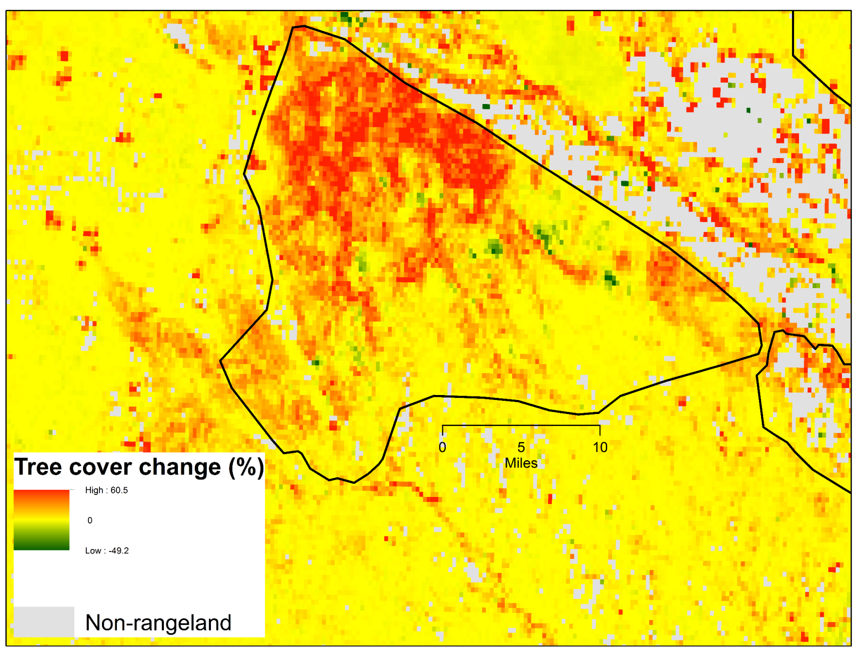
Southeast Prairies

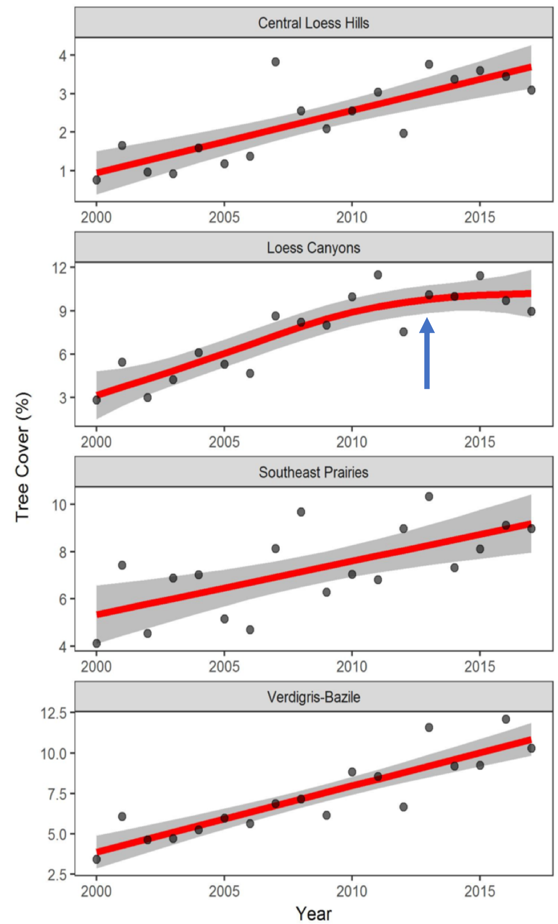




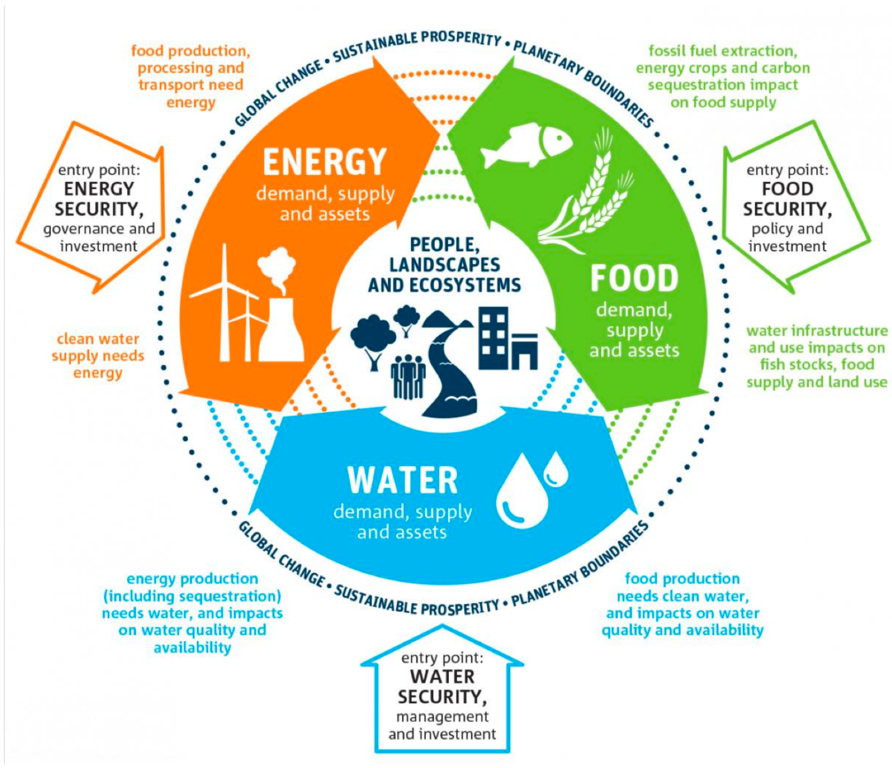
Comparison of BULs with major investments spent on Eastern redcedar

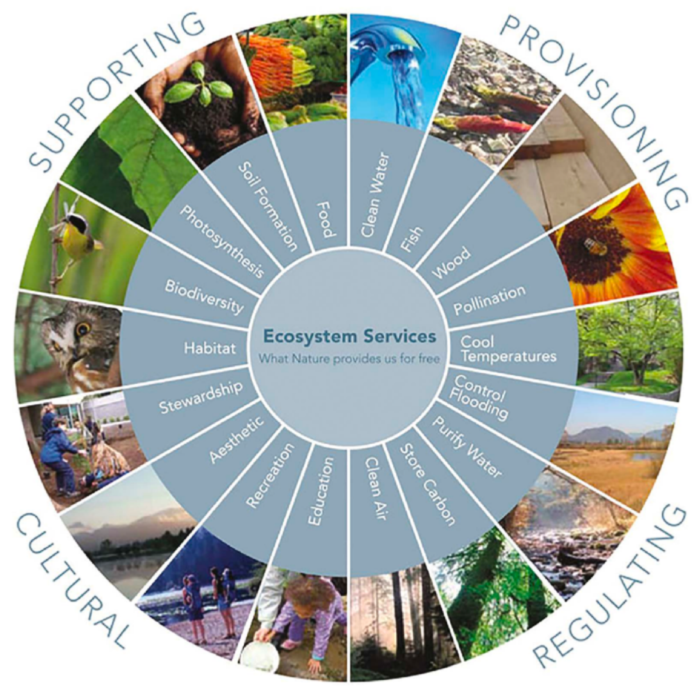
While the Loess Canyons BUL has increased in woody dominance (since 2000), it is the only region known in the entire Great Plains to have stabilized (since 2013) after undergoing high levels of transitions to juniper dominance.





The challenge in the rangeland discipline is shared across all production-oriented disciplines

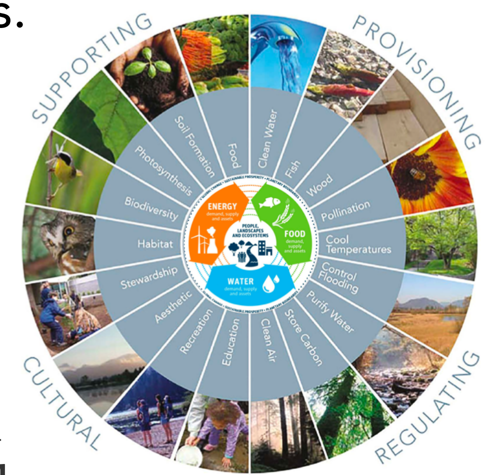




https://www.unl.edu/nc-few/food-energy-water-nexus

Image from Millennium Ecosystem Service Assessment

Disciplines at the Nexus of Food – Energy – Water are embedded within the biosphere, a Complex Adaptive System that provides a diverse array of Ecosystem Services that benefit humanity. The days are over where these disciplines had the luxury to prioritize one service at the expense of multiple others.



2018 Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES) Scientific Assessment

- 100 experts from 45 countries
- 3-year assessment on the state of Earth's life support system
- Calls for new pathways for dealing with the increasing human exploitation of the natural environment and impacts observed globally

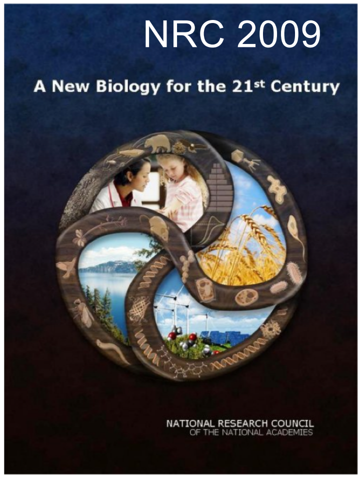
75% of Earth's Land Areas Are Degraded

A new report warns that environmental damage threatens the well-being of 3.2 billion people. Yet solutions are within reach.

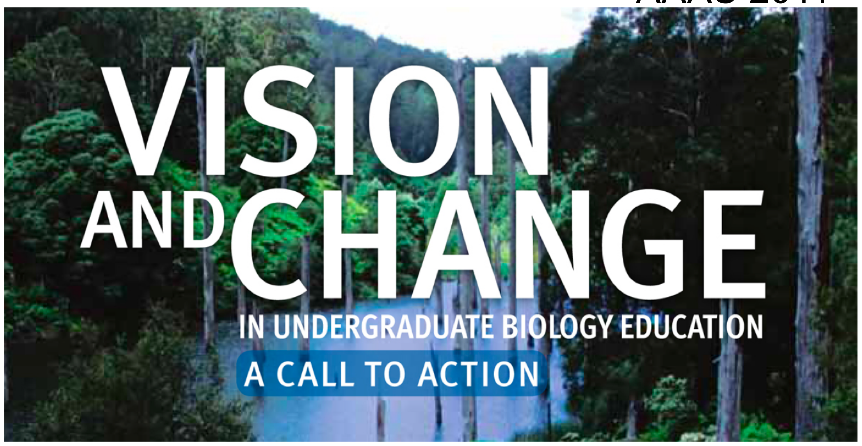
ipbes
Science and Policy for People and Nature

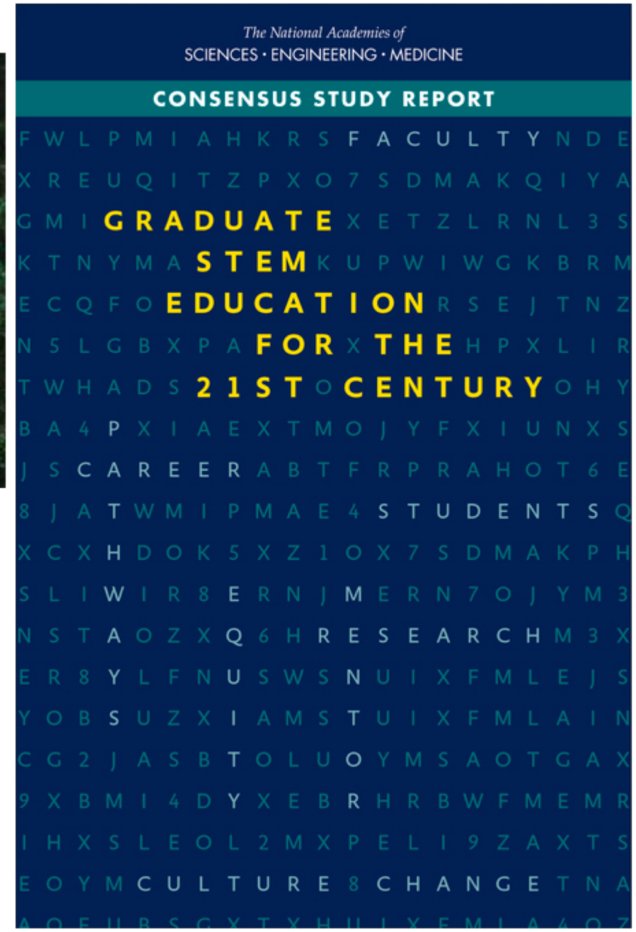
How quickly can science, teaching, and extension adapt to these changing expectations?

NRC 2009



AAAS 2011





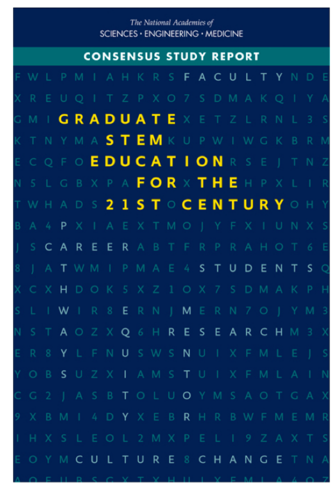
National Academies 2018

<u>Core Competencies for All Students</u>

1) Ability to apply process of science
2) Ability to use quantitative reasoning
3) Ability to use modeling and simulation
4) Ability to tap into the interdisciplinary nature of science
5) Ability to communicate and collaborate with other disciplines
6) Ability to understand the relationship between science and society

CORE COMPETENCIES FOR ALL STEM MASTER'S DEGREE PROGRAMS

1. Disciplinary and interdisciplinary knowledge: Master's students should develop core disciplinary knowledge and the ability to work between disciplines.
2. Professional competencies: Master's students should develop abilities defined by a given profession.
3. Foundational and transferrable skills: Master's students should develop skills that transcend disciplines and are applicable in any context, such as communications, leadership, and working in teams.
4. Research: Master's students should develop the ability to apply the scientific method, understand the application of statistical analysis, gain experience in conducting research and other field studies, learn about and understand the importance of research responsibility and integrity, and engage in work-based learning and research in a systematic manner.



CORE COMPETENCIES FOR ALL STEM PH.D. DEGREE PROGRAMS

1. Develop Scientific and Technological Literacy and Conduct Original Research

a. Develop deep specialized expertise in at least one STEM discipline.
b. Acquire sufficient transdisciplinary literacy to suggest multiple conceptual and methodological approaches to a complex problem.
c. Identify an important problem and articulate an original research question.
d. Design a research strategy, including relevant quantitative, analytical, or theoretical approaches, to explore components of the problem and begin to address the question.
e. Evaluate outcomes of each experiment or study component and select which outcomes to pursue and how to do so through an iterative process.
f. Adopt rigorous standards of investigation and acquire mastery of the quantitative, analytical, technical, and technological skills required to conduct successful research in the field of study.
g. Learn and apply professional norms and practices of the scientific or engineering enterprise, the ethical responsibilities of scientists and engineers within the profession and in relationship to the rest of society, as well as ethical standards which will lead to principled character and conduct.

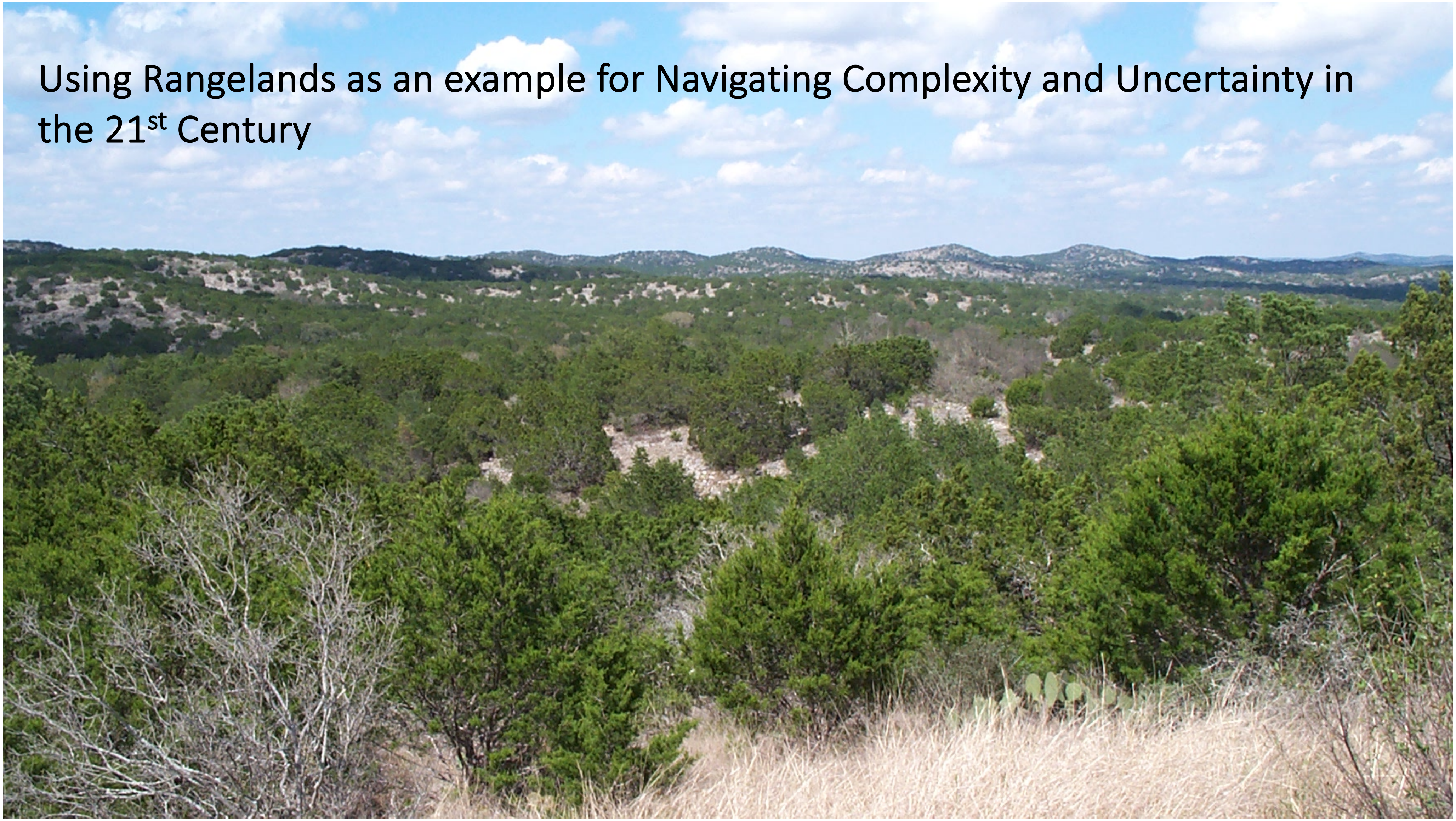
CORE COMPETENCIES FOR ALL STEM PH.D. DEGREE PROGRAMS

2. Develop Leadership, Communication, and Professional Competencies

a. Develop the ability to work in collaborative and team settings involving colleagues with expertise in other disciplines and from diverse cultural and disciplinary backgrounds.

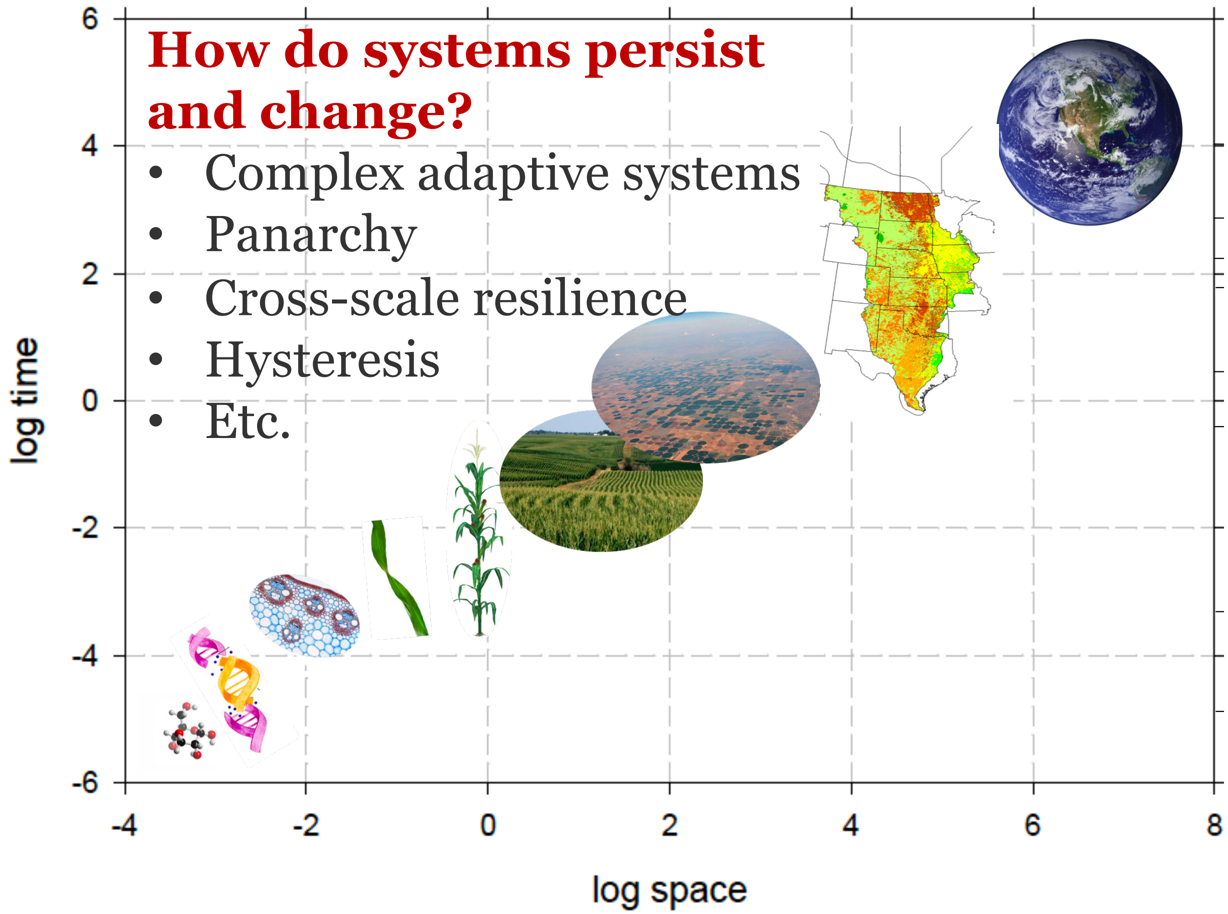
b. Acquire the capacity to communicate, both orally and in written form, the significance and impact of a study or a body of work to all STEM professionals, other sectors that may utilize the results, and the public at large.

c. Develop professional competencies, such as interpersonal communication, budgeting, project management, or pedagogical skills that are needed to plan and implement research projects.


Using Rangelands as an example for Navigating Complexity and Uncertainty in the 21st Century

I. What should every student know?

Embrace frameworks proven to help groups navigate complex systems and rapid social-ecological change



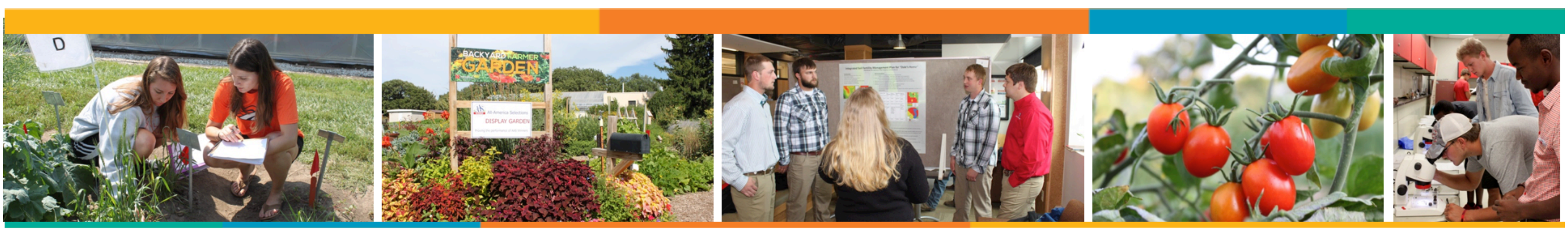
Traditional Silo Approach emphasizes a single domain of scale for professional expertise

- Range, Wildlife, Forestry, Agronomy, Soils
- Biotechnology, Plant Breeding, Molecular Biology

The “Best Practices” Lesson Plan
Great Plains Ecosystems 440/840
(30 minute exercise)

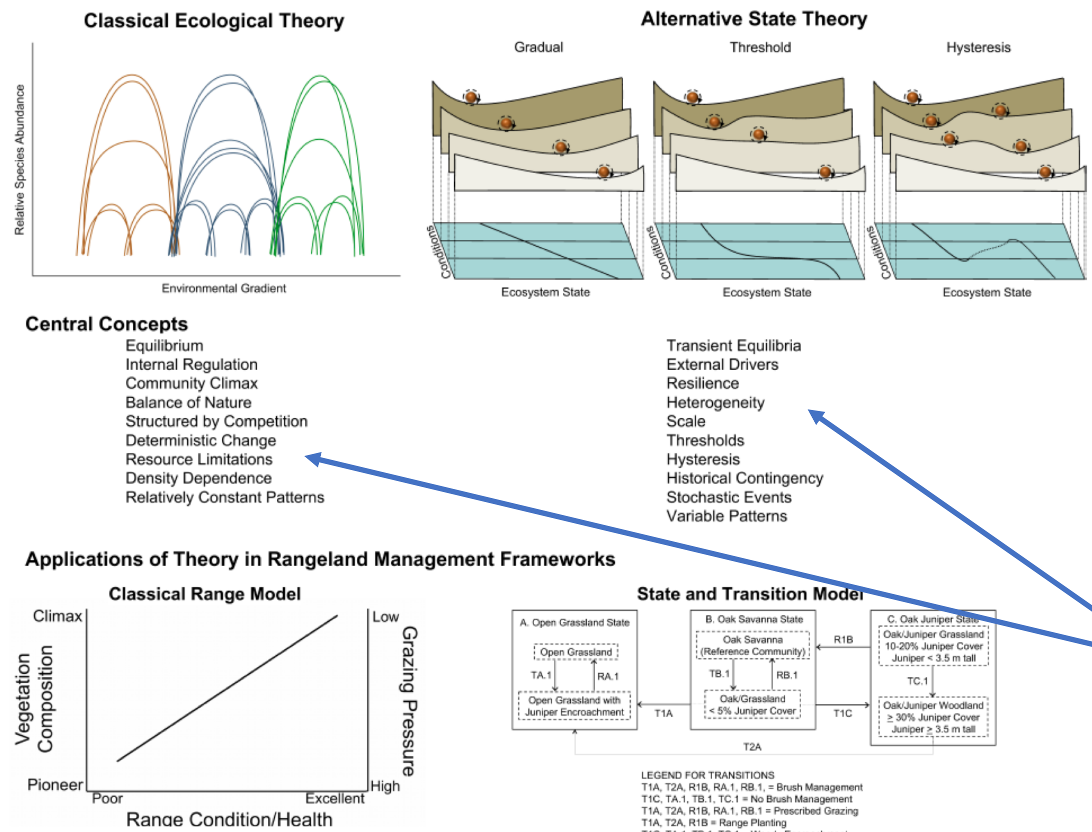
Steps:

1. Students identify a target resource or commodity (soil, crops, water, beef, wildlife)
2. Students self-organize into similarly identified resource targets
3. Groups identify best practices
4. Groups identify threats
5. Assess mismatch between threats and best practices within their group
6. Present/Synthesize group’s plan of action
7. Discuss the epiphany that emerges…



II. Focus on foundational concepts, competencies, and proficiencies

Allow courses to emerge from those discussions to escape the rigidity trap of past course offerings



Twidwell et al. (*2013*) Ecosphere

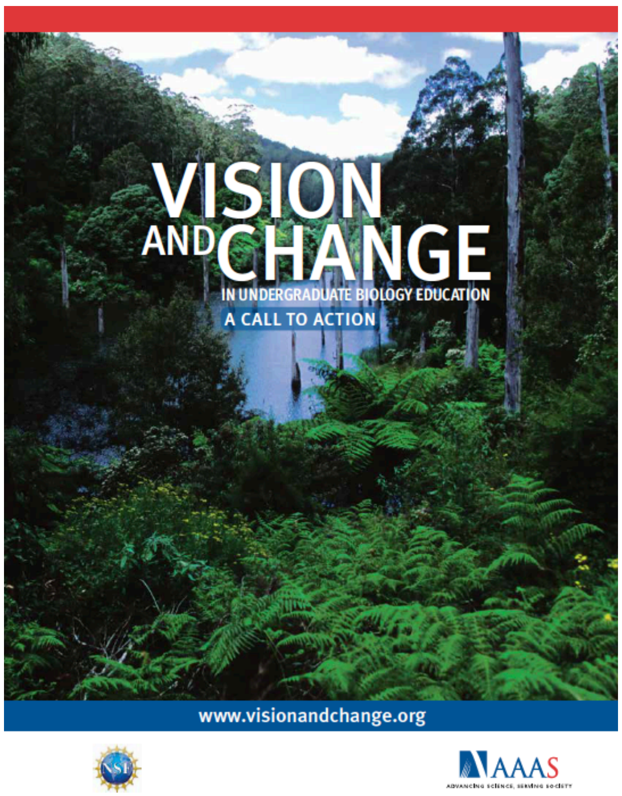
How well do we teach these concepts?

Next is the transition to the Spatial Informatics Age

<u>And either set of Central Concepts can be applied to Systems Thinking!</u>

III. Address perception mismatch between employers & students

Design courses that engage students and employers on novel real-world problems



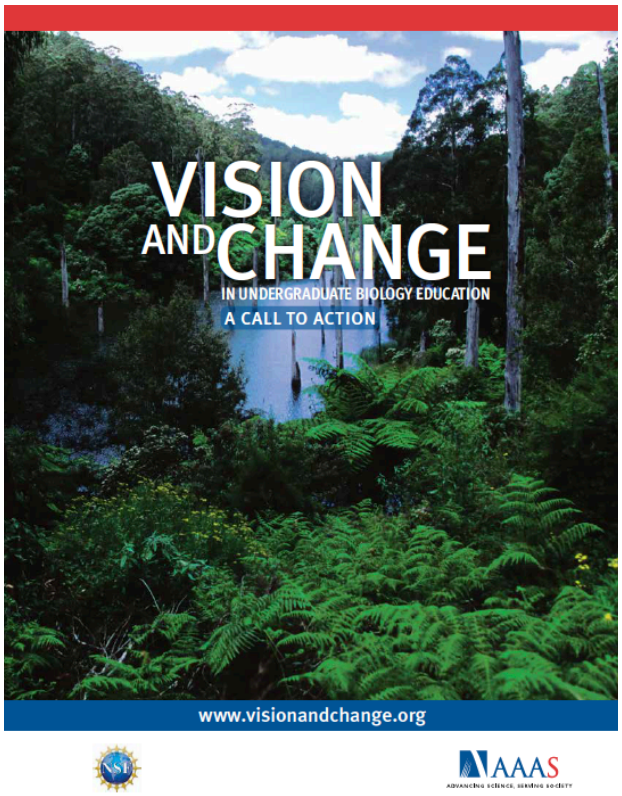
Source: Job Outlook 2018

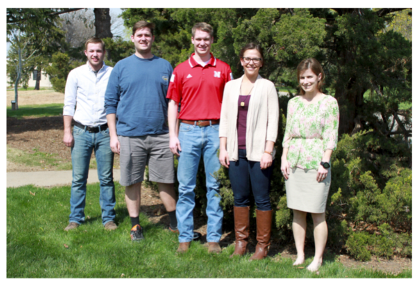
COMPETENCY	% OF EMPLOYERS THAT RATED RECENT GRADS PROFICIENT	% OF STUDENTS WHO CONSIDERED THEMSELVES PROFICIENT**
Professionalism/Work Ethic	**42.5%**	**89.4%**
Oral/Written Communications	**41.6%**	**79.4%**
Critical Thinking/ Problem Solving	**55.8%**	**79.9%**
Teamwork/Collaboration	77.0%	85.1%
Leadership	**33.0%**	**70.5%**
Digital Technology	65.8%	59.9%
Global/Intercultural Fluency	20.7%	34.9%

Develop Disciplinary Abilities ❯ **Demonstrate Technical & Experimental Ability** ❯ **Competency in Real Applications**

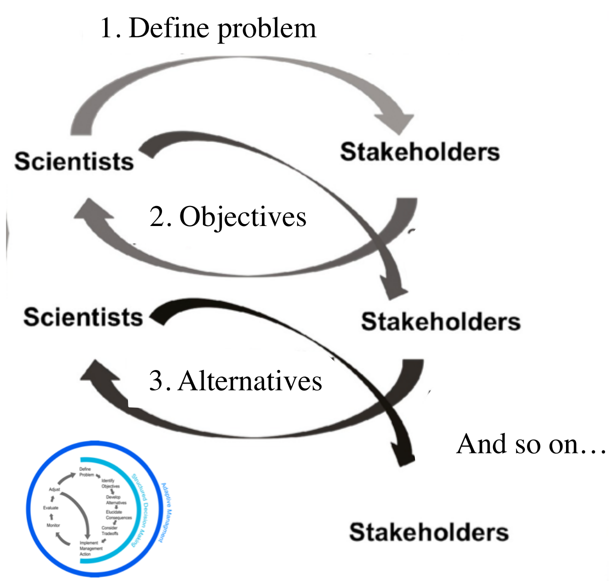
Student-led Community of Practice on Novel and Real Problems

Loess Canyons Rangeland Alliance



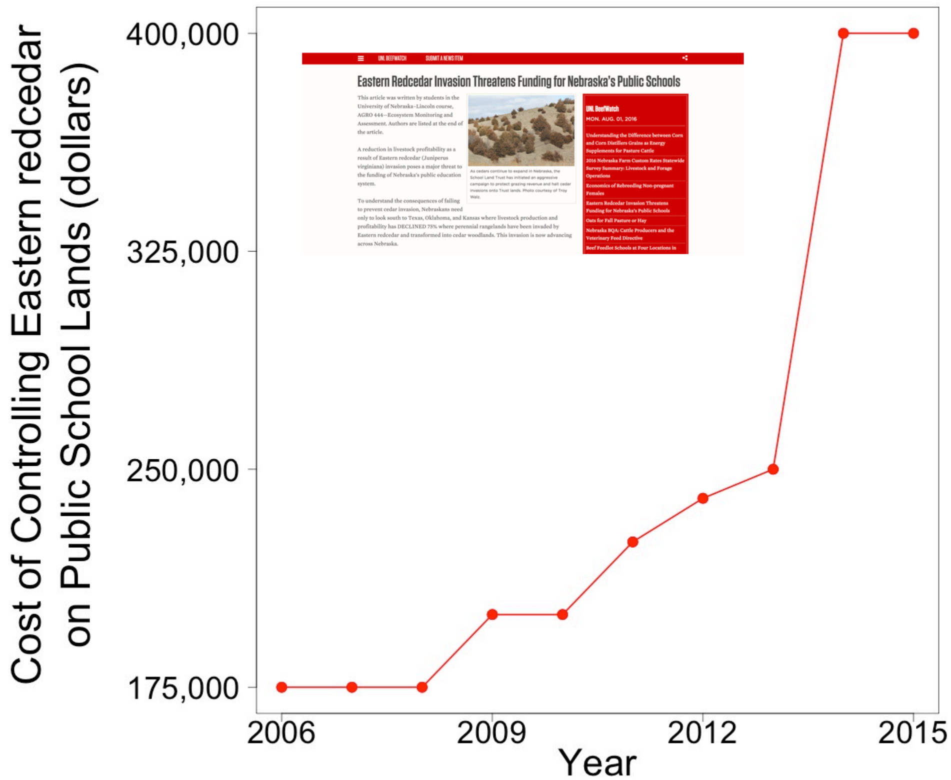


Mutual Learning as a Community of Practice (Translational Ecology)

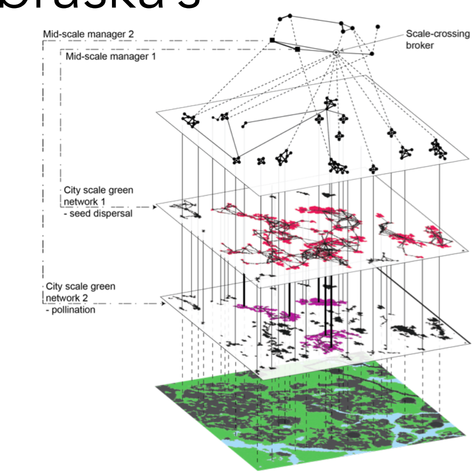


Sandhills Task Force
"Where People and Land are One"

Student-team extension: 4th most visited UNL Beefwatch article, 2017



Tapping into complex social-ecological networks shows Eastern redcedar invasion is reducing $ available for Nebraska's public schools



Lally et al. 2016 *UNL BeefWatch*

IV. Update knowledge required for positions to excel and meet the broader sustainability mission of the profession

EVALUATION FACTORS – RANGELAND MANAGEMENT SPECIALIST – GS-454-09

1. Knowledge Required by the Position FLD 1-6 950 points

Knowledge of the principles, methods, and techniques of rangeland management and related sciences including agronomy, hydrology, biology, and engineering practices sufficient to: 1) **develop conservation plans employing conventional and established criteria and techniques**; and 2) draft complete tentative **plans for management and improvement of specific ranches or range allotments**, including analyzing field data, preparing maps, recommending grazing practices and land treatments in light of inventory findings and management goals, adjusting stocking rates and seasons of use, and considering related land and resource uses. Knowledge of soil properties and characteristics sufficient to interpret land use potential and deficiencies and advise landowners or operators of sound erosion control and plant management techniques. Knowledge of agency soil and water conservation programs, eligibility for landowner participation, and payment provision for individuals and formal conservation organizations upon successful application of conservation measures

Contrast with descriptions for Soil Con., Agronomy, Forestry… does the sum of training beget sustainability of this integrated system?

Are students better prepared to navigate complexity and deal with large and abrupt transitions anticipated in the future?

Information rich but Knowledge poor? Are important drivers of change missing? Specialization at the expense of Integration?

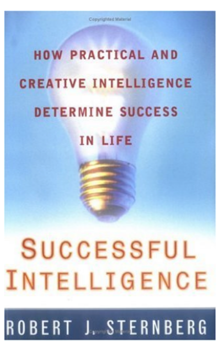
Rangeland courses needed for Rangeland Management Specialist

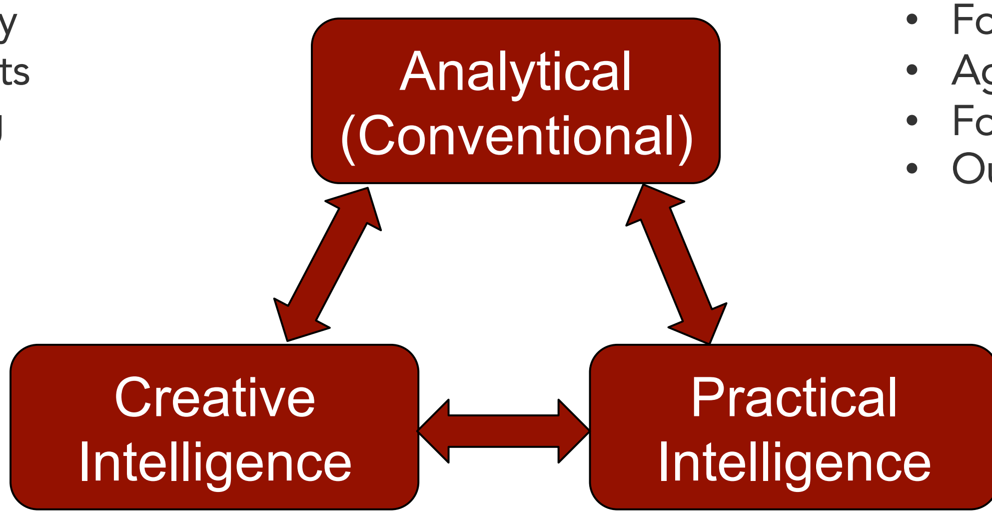
- *Example borrowed from Range Science Education Council*

Range Management Courses
- Principles of Range Management
- Range Plants
- Rangeland Ecology
- Rangeland Inventory
- Range Improvements
- Rangeland Planning

Plant, Soil, Animal Courses
- Plant science
- Animal Science
- Soil Science

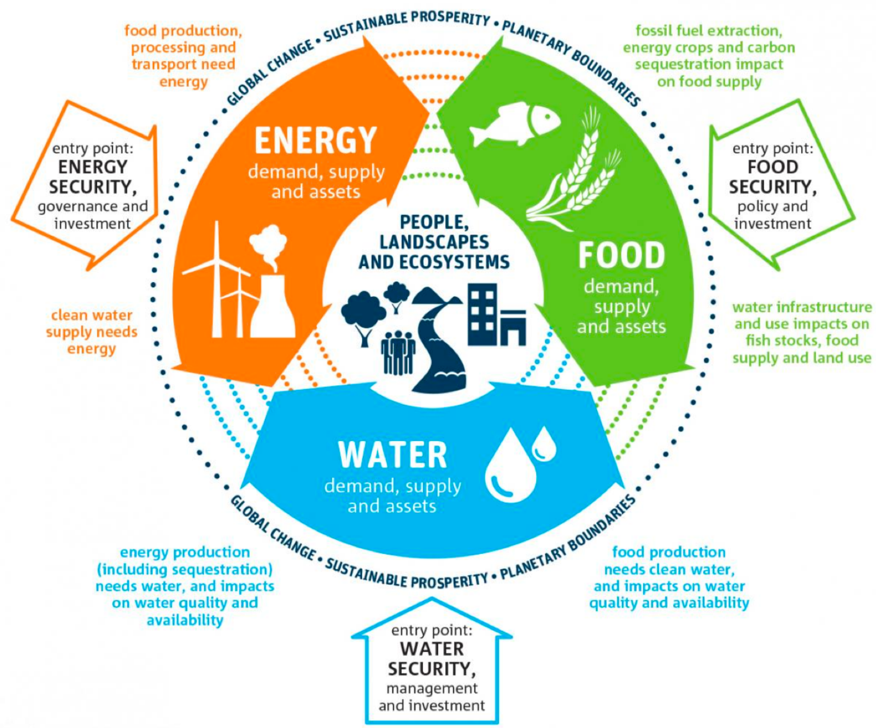
Resource Management Courses
- Wildlife management
- Watershed management
- Agricultural Economics
- Forestry
- Agronomy
- Forages
- Outdoor recreation





V. Embrace the complexity of the world today and thrive with the opportunity

On the need for interdisciplinarity



https://www.unl.edu/nc-few/food-energy-water-nexus

Viewed often as a solution for excessive specialization and disciplinary isolation.

Often gives rise to new disciplines that establish because of success in addressing important questions or problems in the space between traditional disciplines.

One consequence of the emergence of new discipline(s) is that, without theoretical foundations, programs and student training can become further fragmented and narrowed.

- Agribusiness
- Agricultural Economics
- Agricultural Education
- Agricultural and Environ. Sciences Comm.
- Grassland Ecology & Management
- Grazing Livestock Systems
- Horticulture
- Hospitality, Restaurant & Tourism Mnt.

Do the sum of the parts lead to more sustainable pathways for this complex adaptive system?

- Environmental Restoration Science
- Environmental Studies
- Fisheries & Wildlife
- Food Science & Technology
- Food Technology for Companion Animals
- Forensic Science
- Plant Biology
- PGA Golf Management
- Turfgrass & Landscape Management
- Veterinary Science
- Veterinary Technology
- Water Science

SUMMARY

1. Rangelands, like many other specializations in the life sciences, are undergoing rapid theoretical, technological, and also real socio-environmental change.
2. Over the past couple decades, the discipline has attempted to undergo a rapid philosophical shift from a single, production oriented goal (livestock/forage production) toward a more integrative discipline focusing on multiple, critical ecosystem services (food, water, energy, life support, natural disaster avoidance).
3. Meeting this integrative disciplinary focus will require major restructuring of programs that both embrace broader, more integrative theory while leveraging its history of disciplinary success.
   - Embrace frameworks proven to help groups navigate complex systems and change
   - Escape rigidity trap of past course offerings and emphasize foundational concepts, competencies, and proficiencies
   - Move toward Real-world, novel problem solving or innovation over “Experiences”
   - Update knowledge required for professional excellence
   - Make interdisciplinary and deep knowledge a specialized pursuit

Rangelands and other applied life science disciplines (e.g. FEWS) cannot wait until graduate school to build this workforce.

- Increases the science – policy – practice gap
- Prioritizes specializations over integration
- Limits marketability of students
- Lowers preparedness of incoming graduate students
- Creates false sense of how complex adaptive systems work
- Limits potential for discipline to address complex problems important to society
- Reduces ability of citizens and the workforce to keep pace with theoretical and technological advancements and innovation