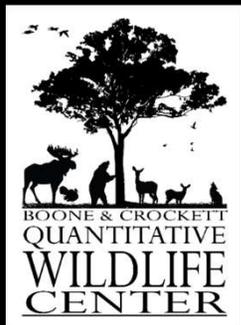




Complex System Dysfunction

Planning for Oak, but not Burning for Oak



Christopher Hoving
Michigan DNR and Michigan State University

Webinar for the Northern Lake States JFSC
November 21, 2019



Outline

- Natural process
- Social process
- Social-ecological system
- Complexity
- Southern Michigan example



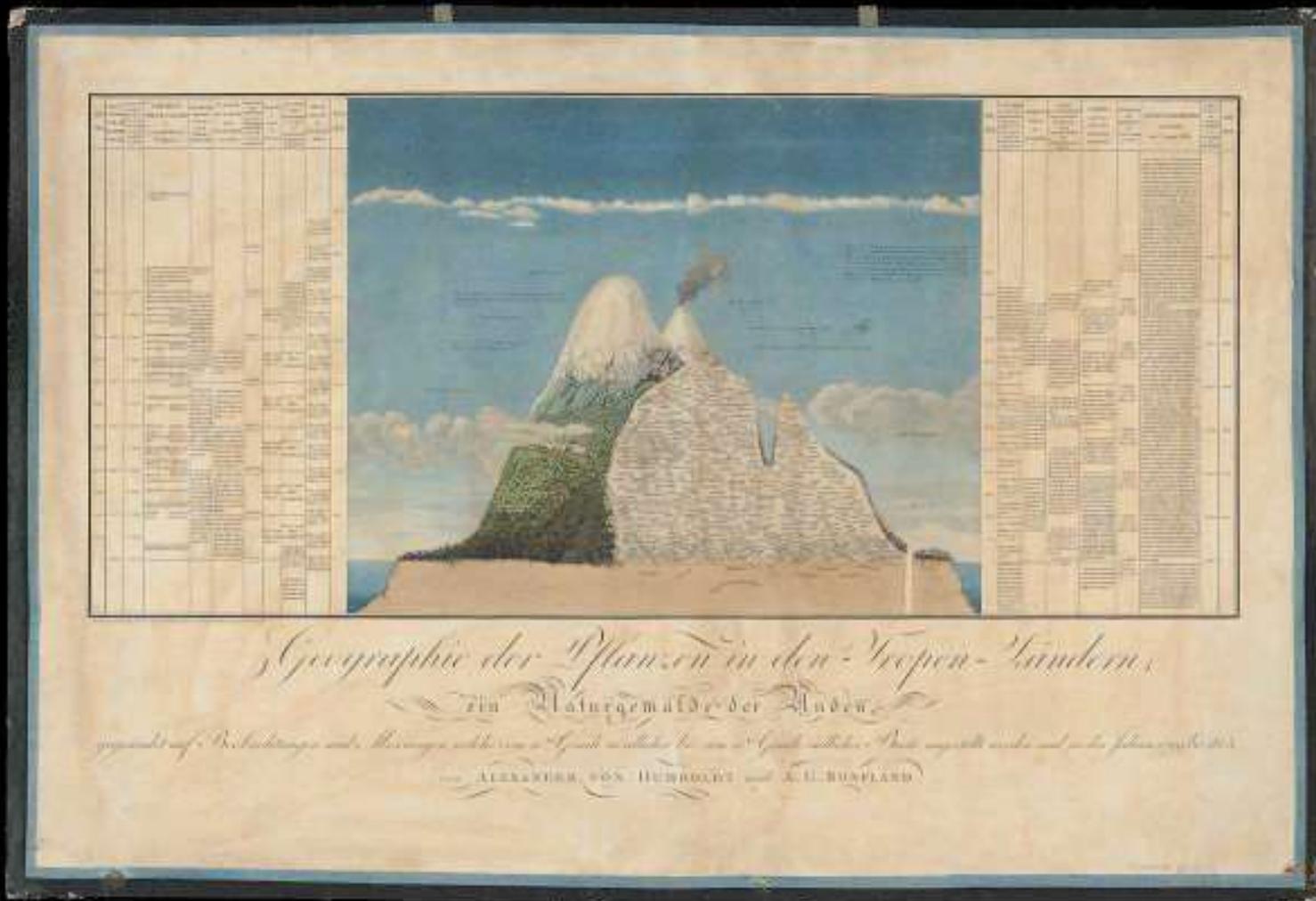
Natural Process

Social Process

Social-ecological
Systems

Complexity

Southern Michigan
Example



Humboldt 1802

Natural Process

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Southern Michigan
Example

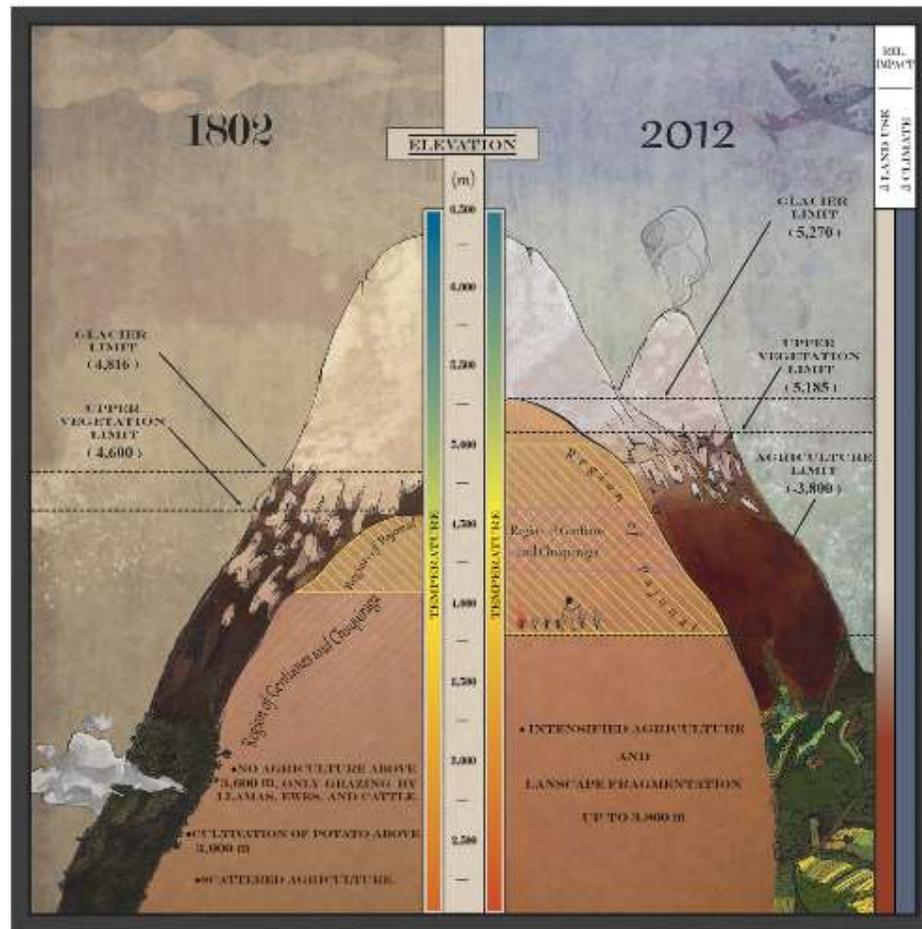


Fig. 3. An update of Humboldt's Tableau. Shown is a summary of major changes in overall vegetation limit, average glacier limit, and shifts in topmost vegetation regions on Chimborazo from 1802 to 2012. The major drivers of change, climate, and land use change are represented by the bars to the right: a constant impact of climate change—in particular, increased temperature—the stronger relative impact of land use at the lower sites, mainly through intensified agriculture, and the effect of grass harvesting and local burning. Illustration of glaciers is approximate.

Morueta-Holme, N., K. Engemann, P. Sandoval-Acuna, J.D. Jonas, R.M. Segnitz, J. Svenning. 2015. Strong upslope shifts in Chimborazo's vegetation over two centuries since Humboldt. PNAS 112: 12741-12745

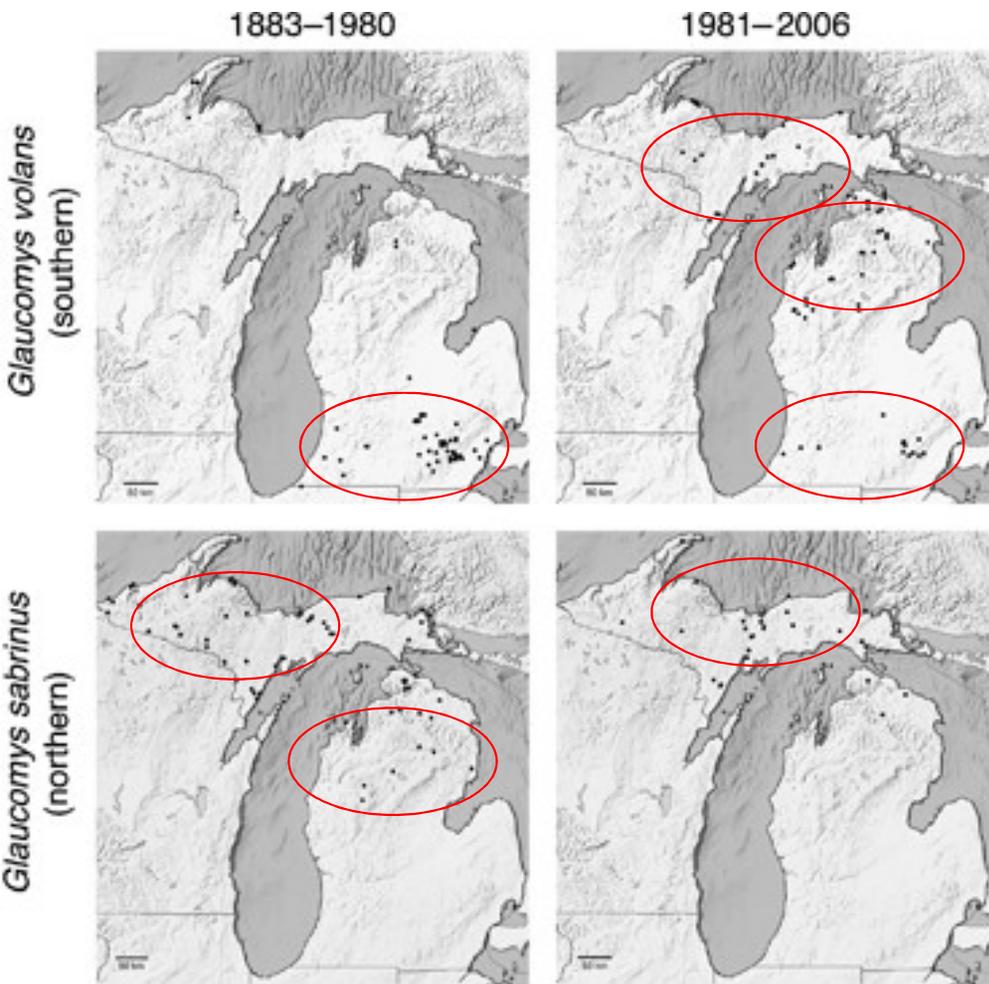
Natural Process

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This Photo by Unknown Author is licensed under [CC BY-SA-NC](https://creativecommons.org/licenses/by-sa/nc/4.0/)

Meyers et al. 2009. Climate-induced changes in the small mammal communities of the Northern Great Lakes Region. *Global Change Biology*, Volume: 15, Issue: 6, Pages: 1434-1454, DOI: (10.1111/j.1365-2486.2009.01846.x)

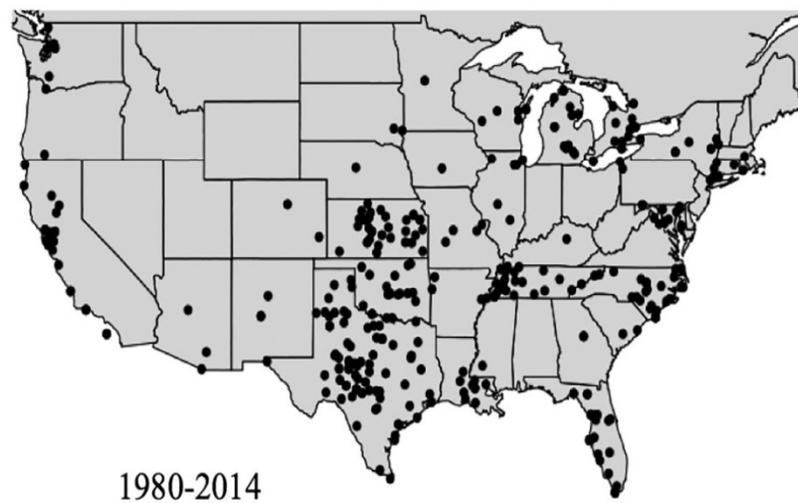
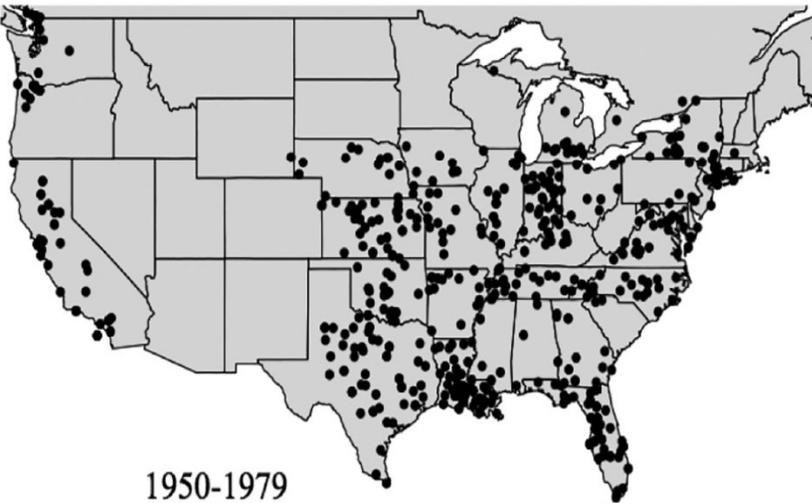
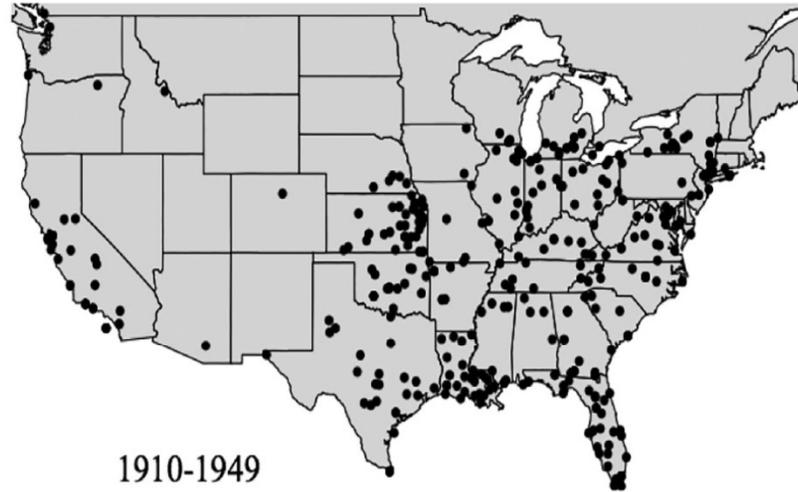
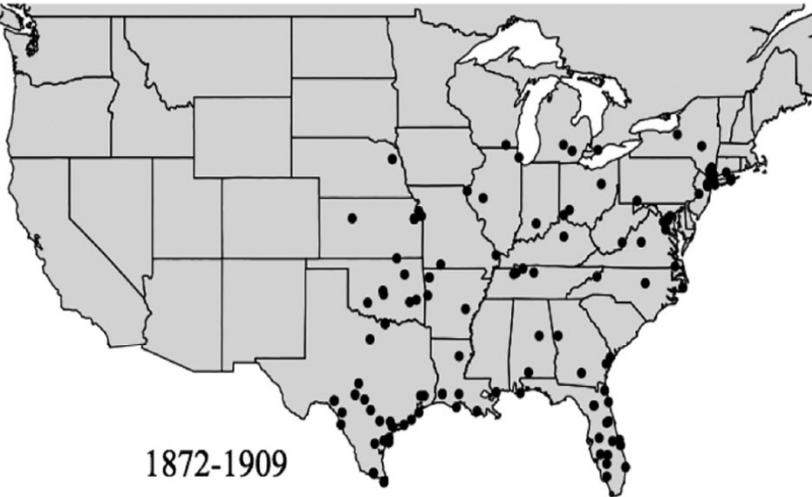
Natural Process

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Systems

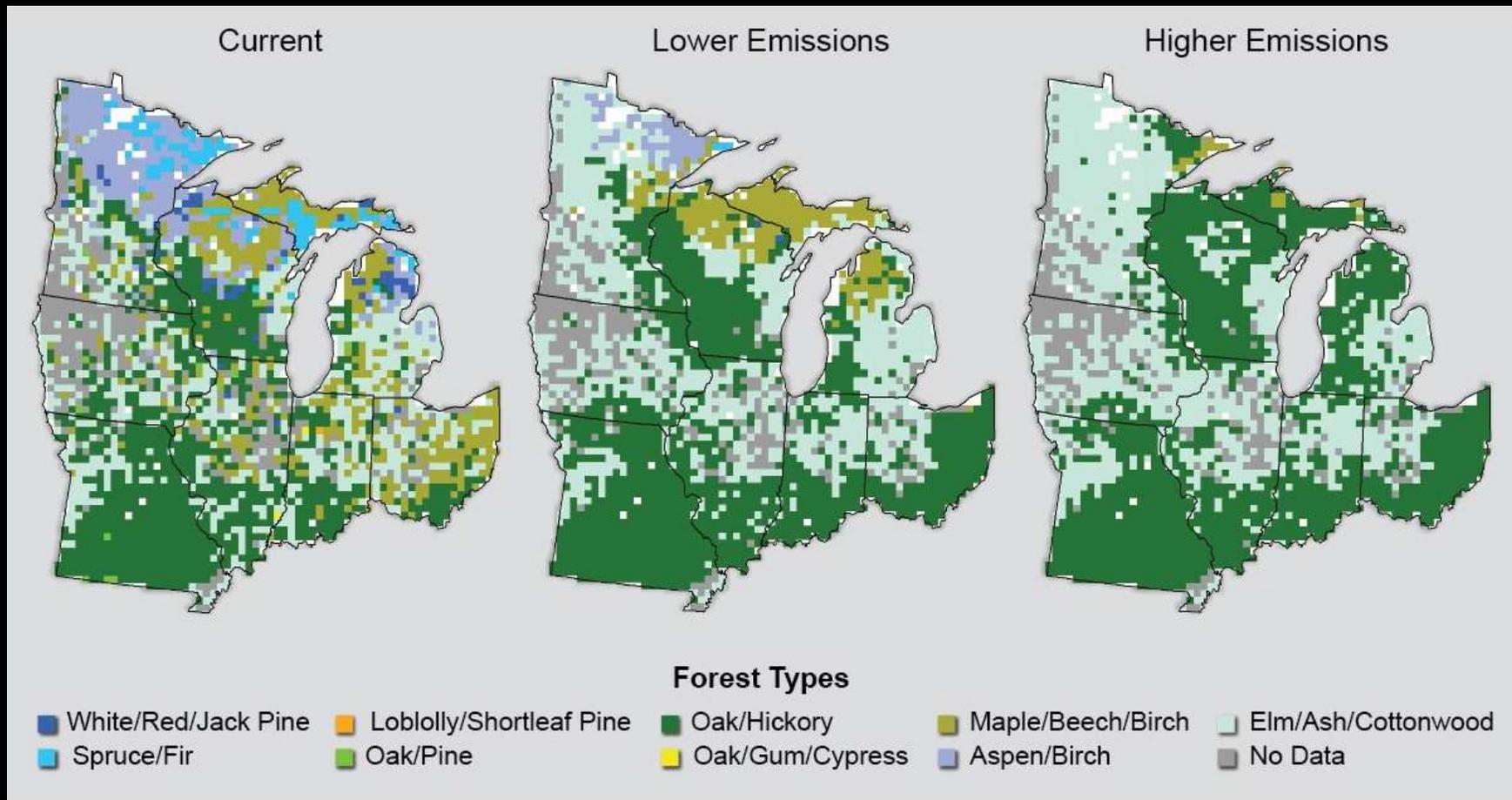
Complexity

Southern Michigan
Example



Walsh and Tucker. 2018.
 Contemporary range expansion of
 the Virginia opossum (*Didelphis
 virginiana*) impacted by humans and
 snow cover. *Can. J. Zool.* 96: 107-115

Natural Process	Social Process	Social-ecological Systems	Complexity	Southern Michigan Example
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Prasad et al. 2007-ongoing

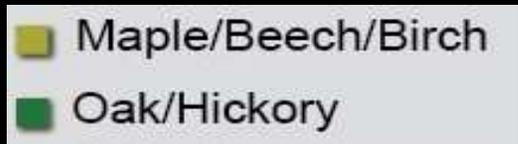
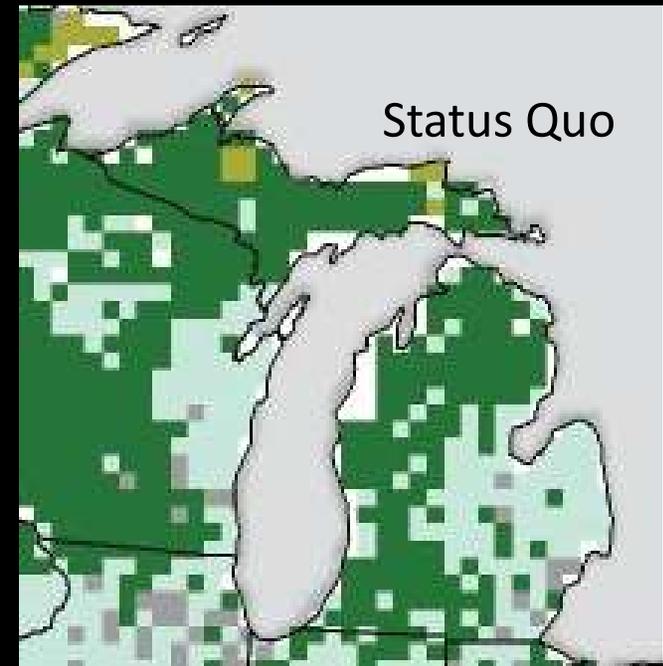
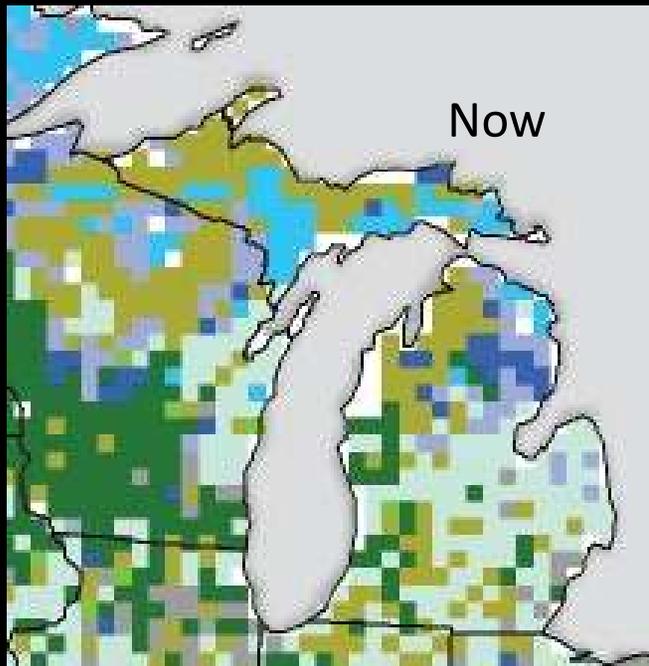
Natural Process

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Southern Michigan
Example



Prasad et al. 2007-ongoing

Natural Process	Social Process	Social-ecological Systems	Complexity	Southern Michigan Example
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Natural Process

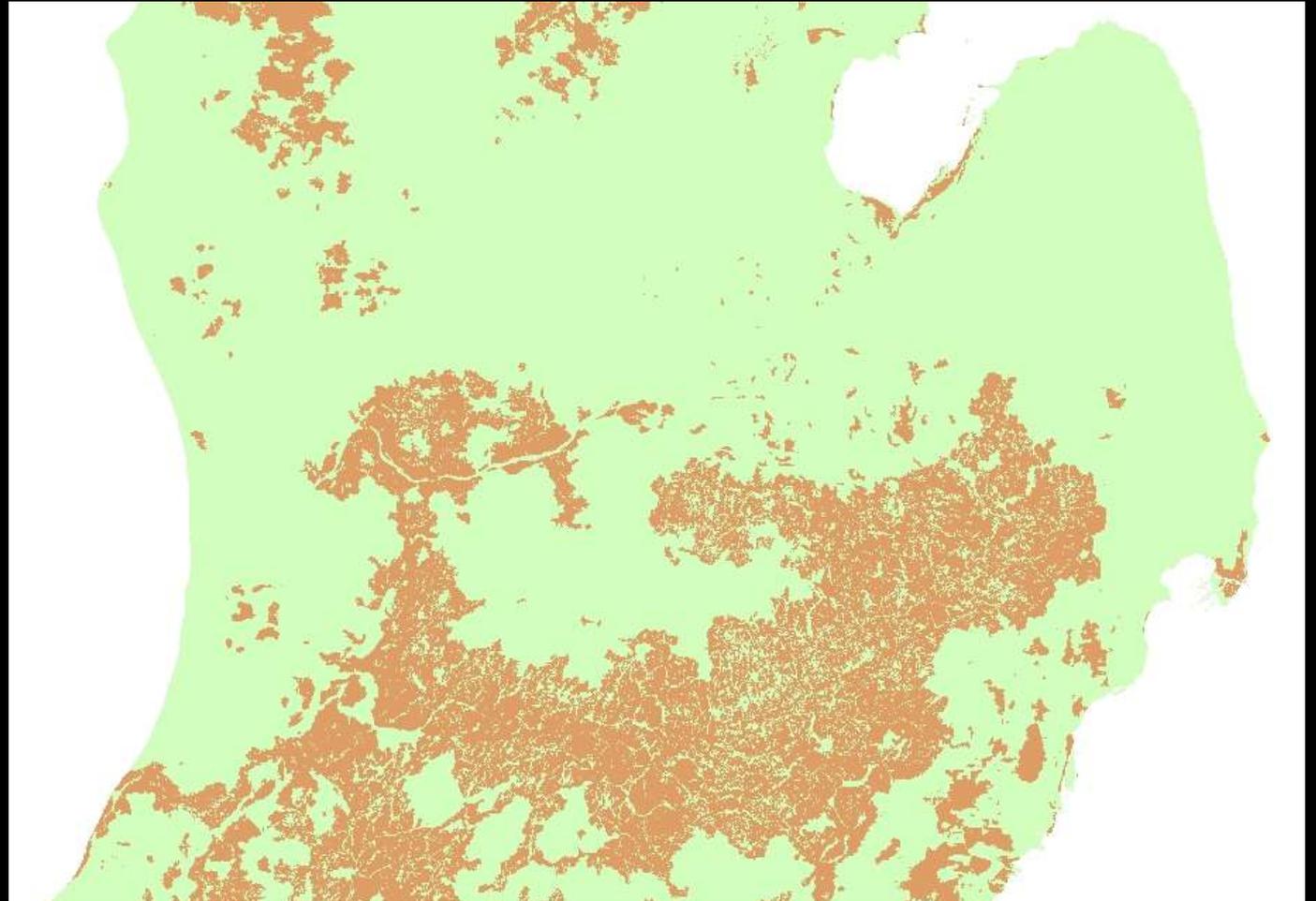
Social Process

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Southern Michigan
Example

Pre- settlement Map of Michigan



Natural Process

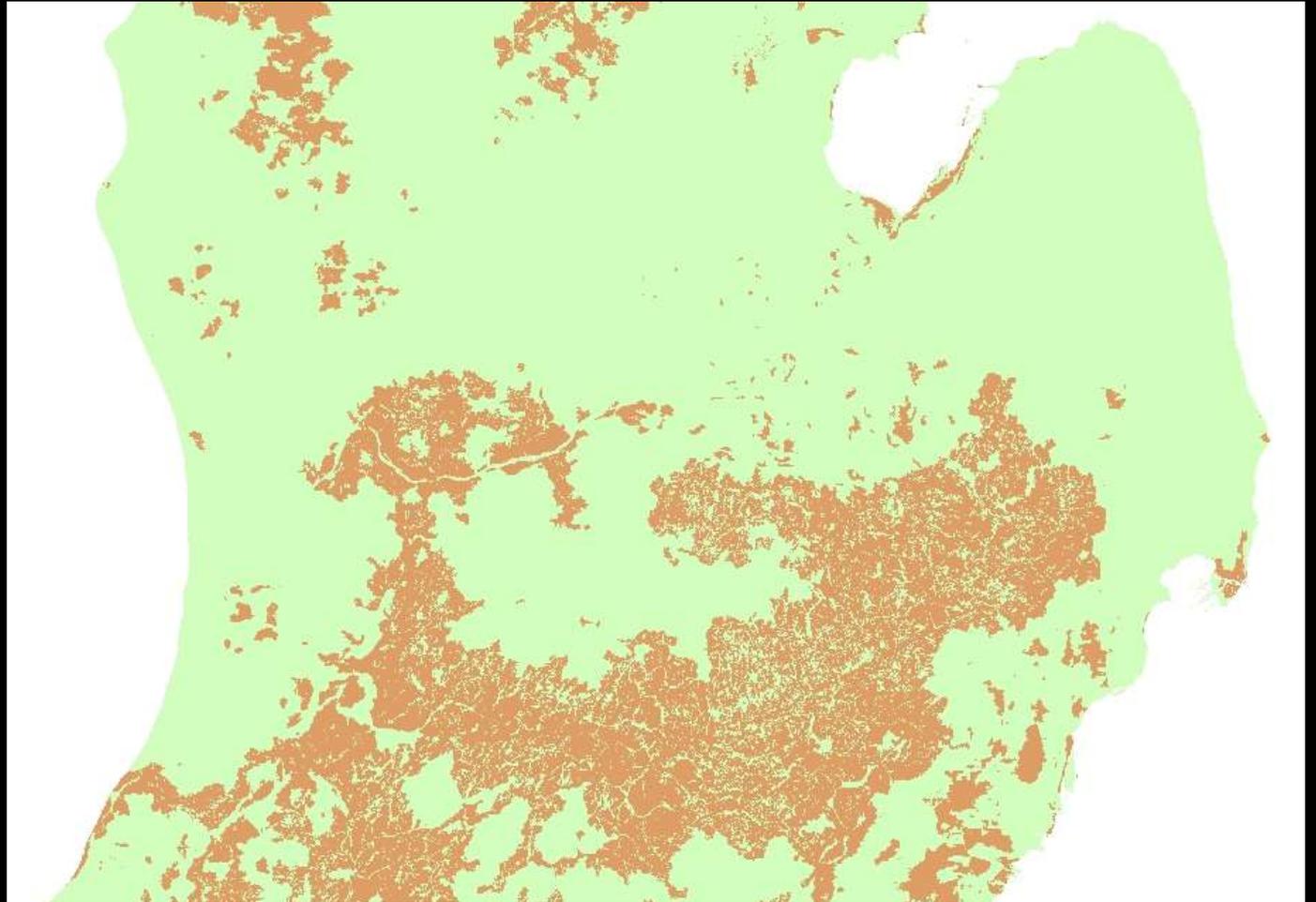
Social Process

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Example

Post- apocalyptic Map of Michigan



Natural Process

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Example

Fire in Southern Michigan

- Rapid increase after settlement
- Slash and burn conversion to farmland
- Rapid decrease after WWII
 - Smokey the Bear
 - 10:00 a.m. policy



Natural Process

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Southern Michigan
Example

Michigan Oak Systems are Social-ecological

- Few ignitions from lightning
- Trends reflect disturbance more than climate
- More social than ecological
 - Suppression swamps climate change
 - Trend toward cool adapted species
 - For now...



Abrams and Nowacki 2019

Natural Process

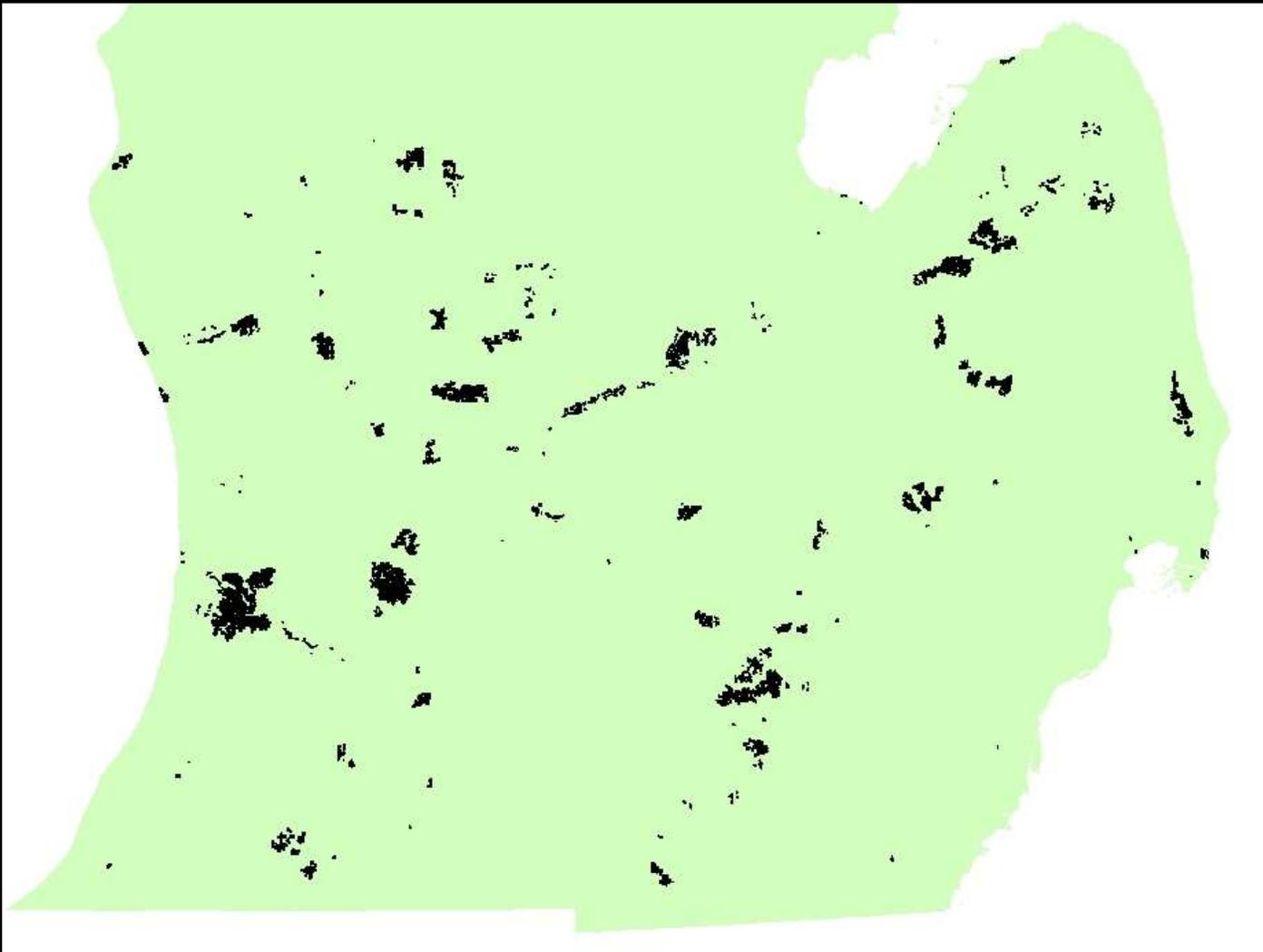
Social Process

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Southern Michigan
Example

Michigan State Game Areas and State Parks



Mesophication is a social-ecological phenomenon



Natural Process

Social Process

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Complexity

Southern Michigan
Example

Complex adaptive systems

- Individuals interacting via simple rules
- Multiple scale or organizational level
- Learning, adapting, evolving
- Self-organizing



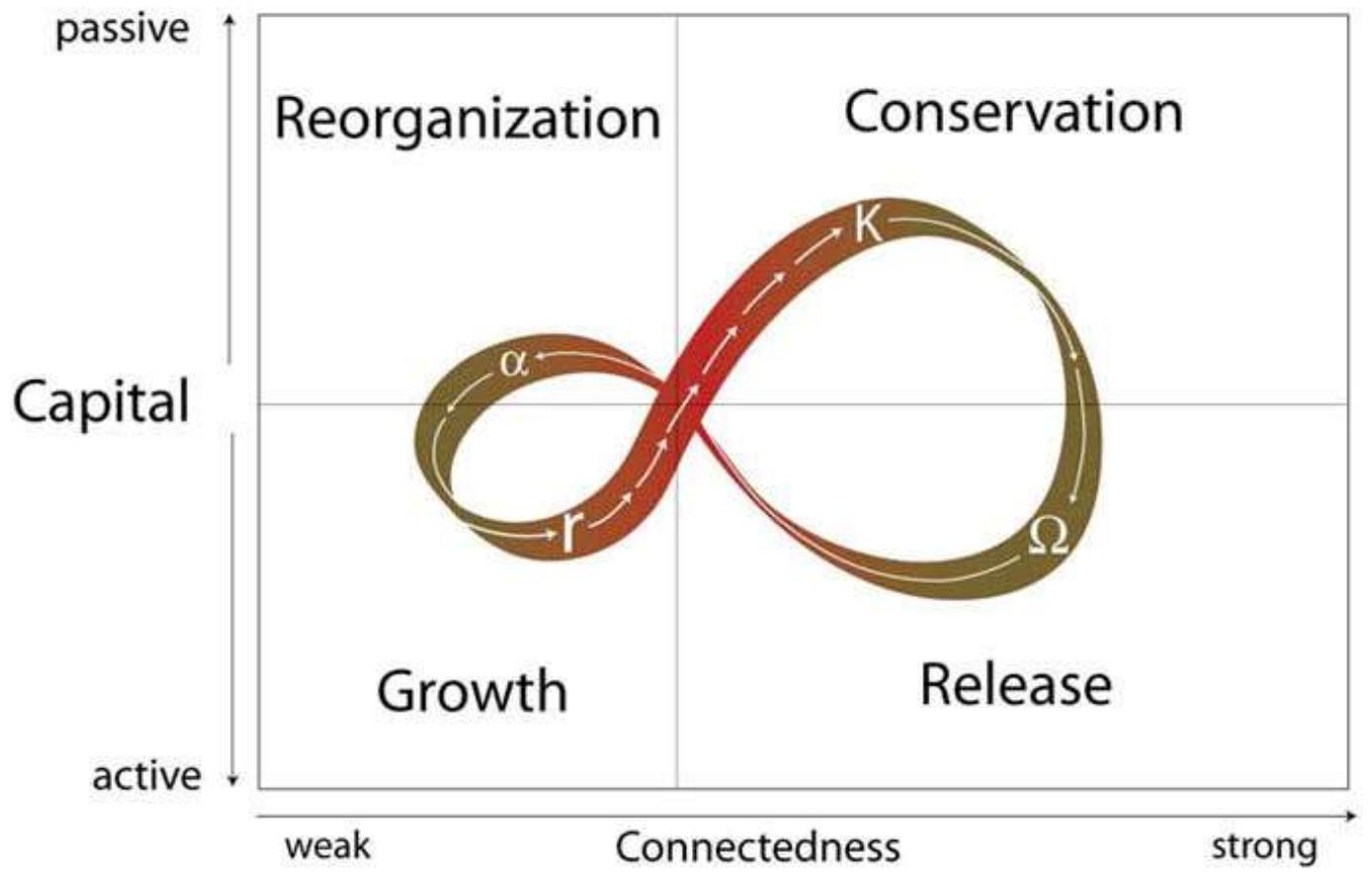
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Example



From Holling CS. 1986. Resilience of ecosystems: local surprise and global change. In: Clark WC, Munn RE, Eds. Sustainable development of the biosphere. Cambridge: Cambridge University Press. p. 292–317.

Natural Process

Social Process

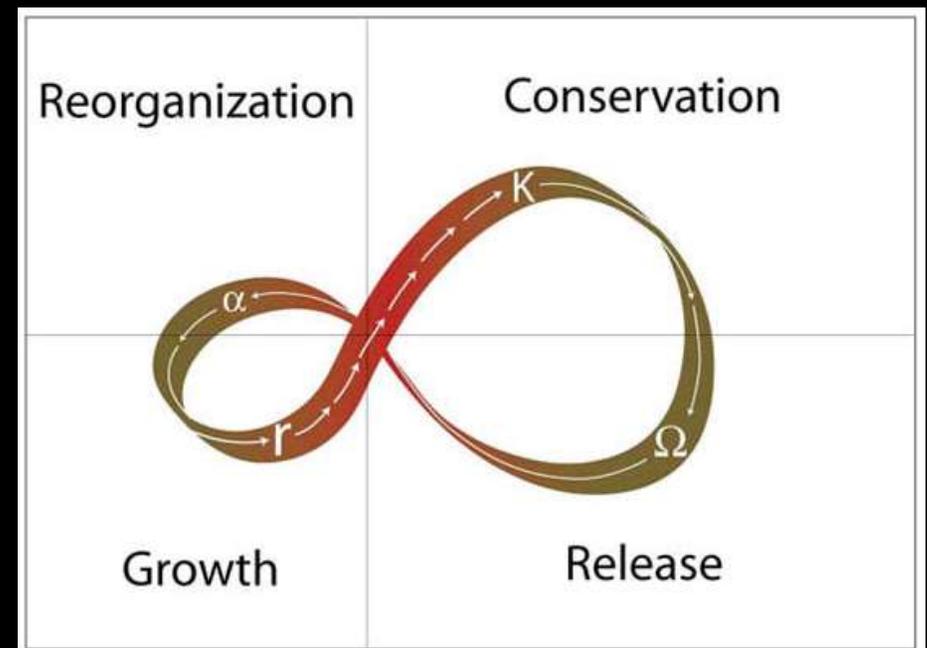
Social-ecological
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Complexity

Southern Michigan
Example

Caution: Simple Solutions Simplify Complexity

- Complex systems fluctuate in
 - diversity
 - uncertainty
- Healthy systems net gain
- Humans have bias
 - Simple solutions
 - Less diversity
 - Less uncertainty



Natural Process

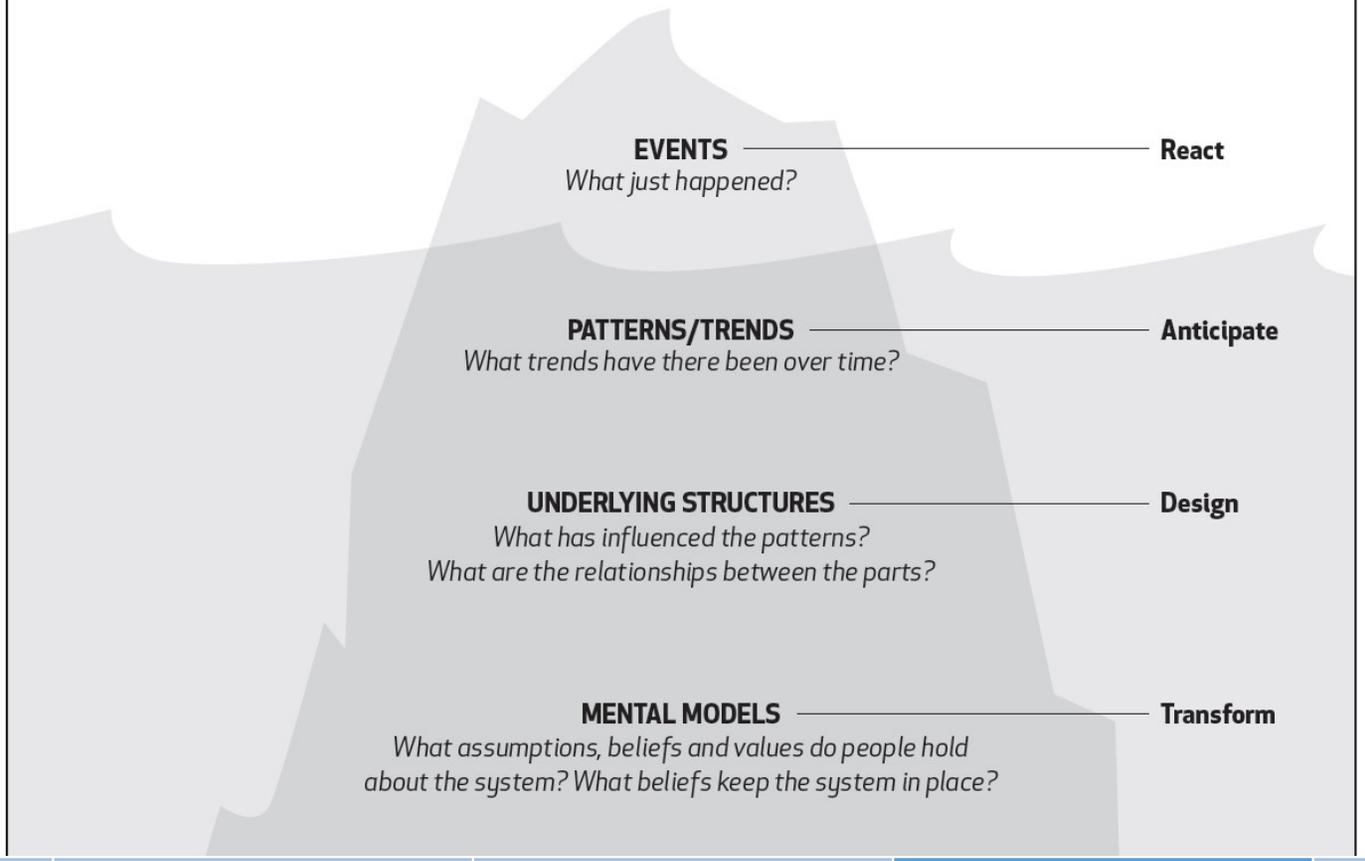
Social Process

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Example

THE ICEBERG
A Tool for Guiding Systemic Thinking



Based on
Meadows 2008

Natural Process	Social Process	Social-ecological Systems	Complexity	Southern Michigan Example
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Complex Social-ecological System Management in Practice

- What is the social system for prescribed fire?
 - On state land
 - In southern Michigan
- What are the mental models?
- Why are plans not changing behavior?



Natural Process

Social Process

Social-ecological
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Southern Michigan
Example

Objectives

- Document rules of social behavior
 - state agency staff
 - regarding oak regeneration and prescribed fire
- Document variation in social behavior
 - among individual land managers
 - among DNR divisions



Natural Process

Social Process

Social-ecological
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Southern Michigan
Example

Methods

- Semi-structured interviews
 - Social science tool
 - 1 hour, recorded and transcribed
 - Qualitative analysis
- Example interview questions
 - Walk me through the process to burn a given area?
 - Is fire suppression a real problem in your area?
 - What are the main barriers to burning in your area?



Knoot et al. 2009 Journal of Forestry 107: 260-267

Natural Process

Social Process

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Southern Michigan
Example

Themes	Interviewees	References
Variation among regions	9	54
Wildness or naturalness	9	38
Variation among Wildlife, Parks, and Forest Divisions	9	35
Factors limiting increased prescribed fire use	9	32
Processes	9	30
Gaming the system	8	31
Priorities	7	23
Oak regeneration	7	17
Goals and goal setting	6	37

Natural Process	Social Process	Social-ecological Systems	Complexity	Southern Michigan Example
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Theme: Procedural fairness

“...just trying to make sure that none of the regions gets left out in the cold. This is a game. It's nothing but a game... and the regions play it for whatever they think they can get away with.”

Natural Process

Social Process

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Example

Theme: Procedural fairness

“I think that depends on the person. So like personally when I do that, I am very honest and follow it to a T... I can't say I have personally done this, but at times there may be a tendency to not propose a burn if you determine that it's not going to rank well. Or try really hard when you propose it to get it to rank well.”

Natural Process

Social Process

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Southern Michigan
Example

Priority Setting

- Land managers propose burns
- Proposals are scored
- List of priorities
- SW Region consistently dominates top 2/3 of list
- “Gaming of the system” by SW Region staff was widely discussed
 - 8 of 10 interviewees
 - 31 references

Criteria	Score
Leadership, research project, or grant deliverable	800
Habitat for threatened or endangered species	200
Restoration of c.1800 land cover for featured species	150
Control competing, exotic, and/or invasive vegetation	100
Department or Wildlife Division initiative	100
Part of a planned management sequence	100
Burn size: > 200, 199-100, 99-20, 19 or less acres	75 / 50/ 25 / 10
Forest management	25
Wetland management	25
Grassland management	25
Other objectives	25

Natural Process

Social Process

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Example

Theme: Procedural Fairness

- Erodes trust in process
- Erodes support for the prescribed fire program
- Motivation and demotivation
 - Successful burn proposals motivate more participation
 - Lack of success demotivates



Natural Process

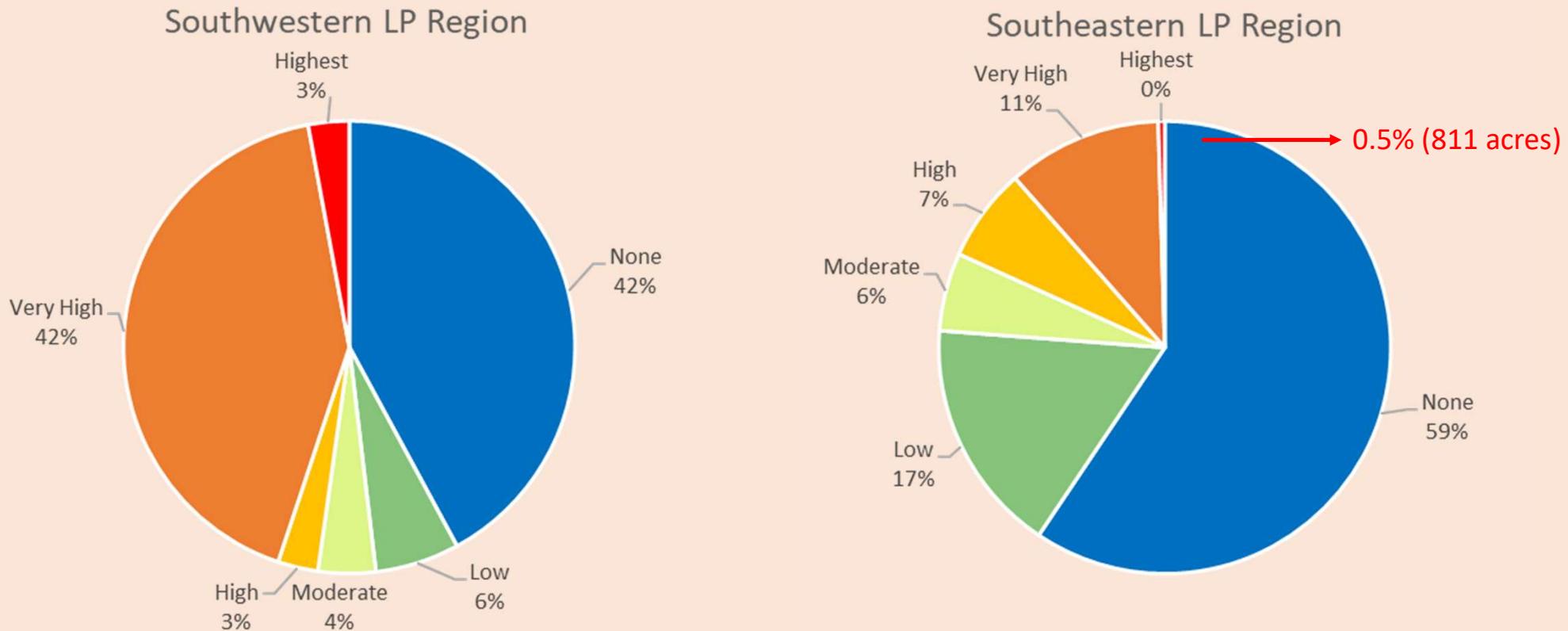
Social Process

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Example

Proportion of Total Acreage by Fire Needs Score



From **Prescribed Fire Needs Assessment for State Lands in Southern Michigan** by Cohen et al. Michigan Natural Features Inventory

Natural Process

Social Process

Social-ecological
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Southern Michigan
Example

Next Steps

- Agent based models
- Quantitative simulation “in silico”
- Social system
 - Motivation
 - Cooperation
 - Regularity and frequency
- Effects on biodiversity



Take home messages

- Land management agencies are human organizations
- Social and ecological science is needed
- Social system dysfunction is usually counterintuitive
- Complexity is healthy



Natural Process

Social Process

Social-ecological
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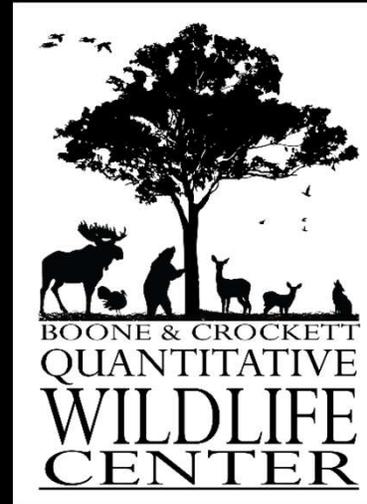
Complexity

Southern Michigan
Example

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