Evolutionary Implications for Sustainability Science

A Research Agenda

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Outline

- What I do
- Sustainability Theory
- Evolutionary Insights
- Current Work

What I (try to) Do

- Interdisciplinary Social Science (human ecology)
- Evolution of culture and cooperation (export)
- Field research, ethnography (mixed methods)
- Behavioral experiments
- Simulation modeling
- Application & outreach!

India


Irrigation

Cooperation


Culture Matters

Culture → Cooperation → Outcomes

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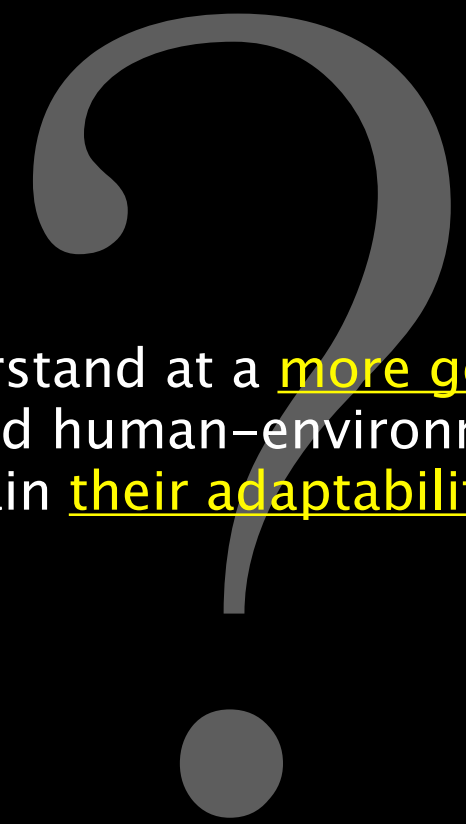
Sustainability Theory



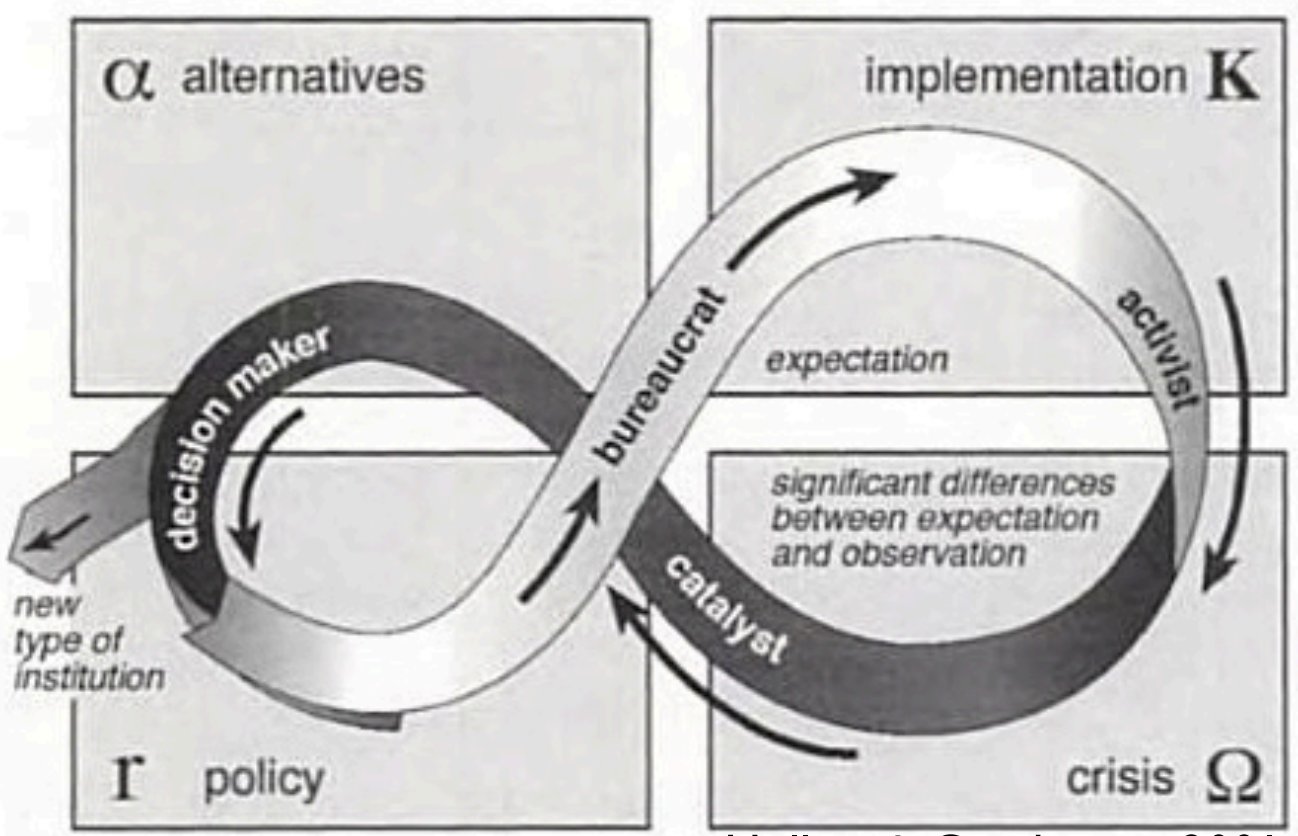
"we need to understand at a more generalizable level which features of coupled human-environment systems enhance and which constrain their adaptability" (Levin & Clark 2010).

Levin, S.A. & Clark, W.C., 2010. Toward a Science of Sustainability. Airlie Center, Warrenton, Virginia: The National Science Foundation

Current frameworks

- Resilience (Folke et al. 2002)
- Vulnerability (Turner et al. 2003)
- Coupled Human-Natural Systems (Liu et al. 2007)
- Social-Ecological Systems (Ostrom 2009)

Panarchy & Adaptive Cycle



Holling & Gunderson, 2001

When do heuristics take the place of testable theory?

Disciplinary Social Science Theory

- → Anthropology
- → Psychology
- → Economics
  - → Gap: Quantitative models of the endogenous processes of cultural & social change.

What Sustainability Theory Needs

→ generalizability	transposable
→ culture & cooperation	endogenous social change
→ predictive capacity	dynamic
→ descriptive	non-normative
→ interdisciplinary	open
→ applicable	interventions

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Evolutionary Implications

1. humans evolve
2. culture evolves
3. cooperation evolves
4. groups evolve

1. humans evolve

- Genetic constraints (drift, bottlenecks, pleiotropism)
- Design constraints (wheels, turbines)
- Vestigial characteristics (appendix)

Credit: Neanderthal Museum (Mettmann, Germany)

Credit: Kennis & Kennis: reconstruction (Photo, Joe McNally)

1. humans evolve

- Risk averse
- Habit bound
- Cognitive limitations
- not perfect optimizers

1. humans evolve

- Penn, D. J. (2003). The evolutionary roots of our environmental problems: Toward a Darwinian ecology. *The Quarterly Review of Biology*, 78(3), 275–301.
- Beddoe, R., Costanza, R., Farley, J., Garza, E., Kent, J., Kubiszewski, I., Woodward, J. (2009). Overcoming systemic roadblocks to sustainability: The evolutionary redesign of worldviews, institutions, and technologies. *PNAS*, 106(8), 2483–2489.
- Ehrlich, P. R. (2009). Cultural evolution and the human predicament. *Trends in Ecology & Evolution*, 24(8), 409–412. doi:10.1016/j.tree.2009.03.015
- Kinzig, A. P., Ehrlich, P. R., Alston, L. J., Arrow, K., Barrett, S., Buchman, T. G., Saari, D. (2013). Social Norms and Global Environmental Challenges: The Complex Interaction of Behaviors, Values, and Policy. *BioScience*, 63(3), 164–175.
- Van Vugt, M., Griskevicius, V., & Schultz, P.W. (2014). Naturally Green: Harnessing Stone Age Psychological Biases to Foster Environmental Behavior. *Social Issues and Policy Review*, 8(1), 1–32.

2. culture evolves

Dawkins, 1976 *The Selfish Gene*

Cavalli-Sforza & Feldman, 1981 *Cultural Transmission and Evolution*

Boyd & Richerson, 1985 *Culture and the Evolutionary Process*

Inuit technology

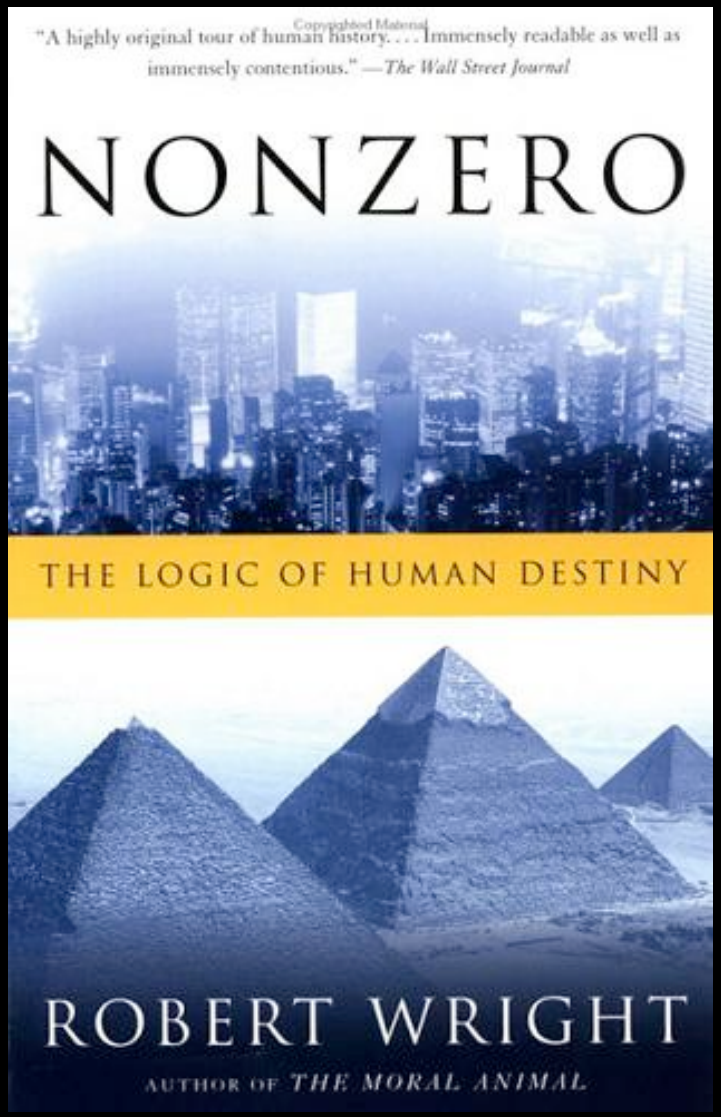
!kung technology

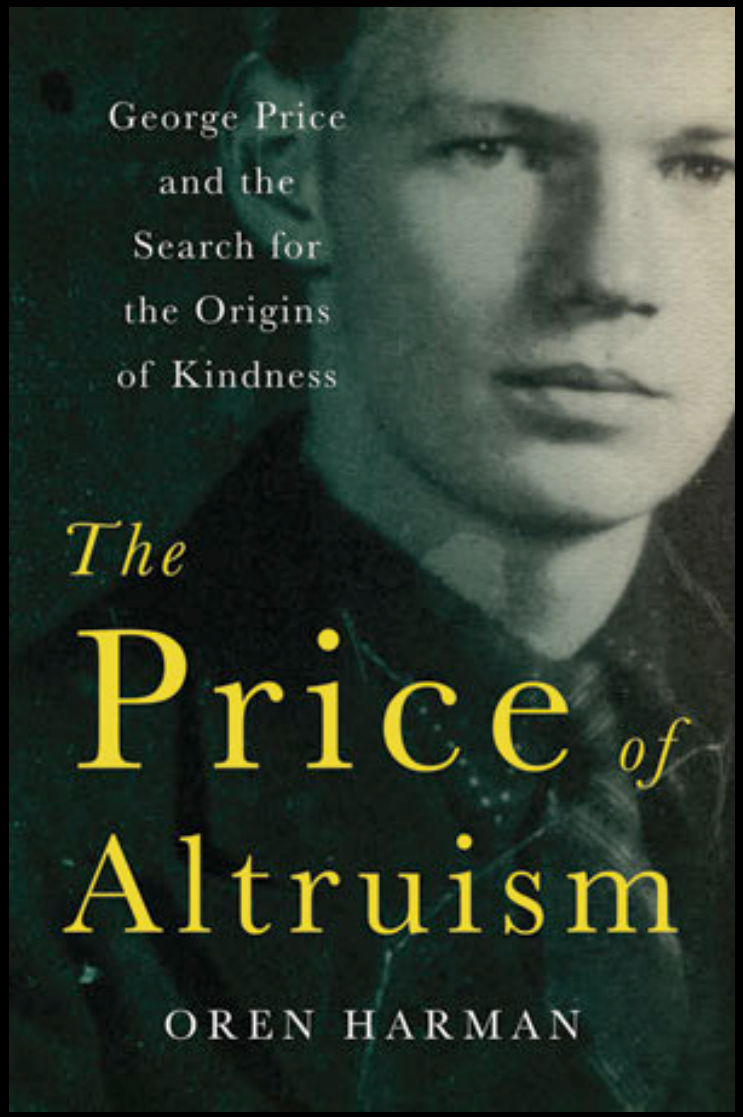

2.99
Save 1.00
2.99
Save 1.00
Whole Wheat
Sweet Onion
3.99
4.29
2.49
Save 1.00
Sesame
Kaiser
FRENCH
SOURDOUGH
GARLIC
Plain
3.99
3.59
4.59
The Perfect Tailgate Food
Franz Outdoor Rolls and
Johnsonville Sausage
OUTDOOR
FRENCH

Tikopia


Rapa Nui

3. cooperation evolves





3. cooperation evolves

Kin Selection

Hamilton, 1963 *The Evolution of Altruistic Behavior*

Reciprocity

Trivers, 1971 *The Evolution of Reciprocal Altruism*

Boyd & Richerson, 1989, *The Evolution of Indirect Reciprocity*

3. cooperation evolves

Group Selection

Wilson, 1975 *A Theory of Group Selection*

Wilson & Sober, 1994. *Reintroducing group selection to the human behavioral sciences.*

Wilson & Wilson, 2007. *Rethinking the Theoretical Foundation of Sociobiology*

3. groups evolve

Human cooperation is group-centric

Apicella, Marlowe, Fowler & Christakis, (2012) Nature 481, 497–501.

Group Selection Works

160% increase in clutch size

Muir, W., 1996. Group selection for adaptation to multiple-hen cages: selection program and direct responses. Journal of Poultry Science 75, 447–458.

Posted to Flickr by USDAgov at http://flickr.com/photos/41284017@N08/6354331371

Molly Hayden, U.S. Army Garrison Grafenwoehr Public Affairs
http://www.army.mil/article/69655/

Institutions Evolve

- Sethi, R., & Somanathan, E. (2000). The evolution of social norms in common property resource use. *American Economic Review*, 86, 766-788.*s*
- Ostrom, E. (2000). Collective action and the evolution of social norms. *Journal of Economic Perspectives*, 14, 137-158.
- Bowles, S., Choi, J.-K., Hopfensitz, A., 2003. The co-evolution of individual behaviours and social institutions. *Journal of Theoretical Biology*, 223, 135–147


34
18
5
50
2

Choi, Bowles, 2007. The coevolution of parochial altruism and war. *Science* 318, 636–640.

The Battle of Agincourt.
http://www.britishbattles.com/100-years-war/agincourt.htm

Public Goods Experiments

- Gürerk, Irlenbusch, & Rockenbach (2006) subjects "voted with their feet" and migrated to punishment institution.
- Puurtinen and Mappes (2009) groups compete, winning group extracts earnings from losing group. Group competition enhanced cooperation.
- Sääksvuori, Mappes, & Puurtinen (2011) punishment produces higher individual and group payoffs during competition, but punishing groups had more equal payoff distribution.
- Tan and Bolle (2007) found that cooperation increased due to competition with and without incentives to win

→Group-competition accelerates cooperation.

Can it drive more sustainable outcomes?

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2. culture evolves
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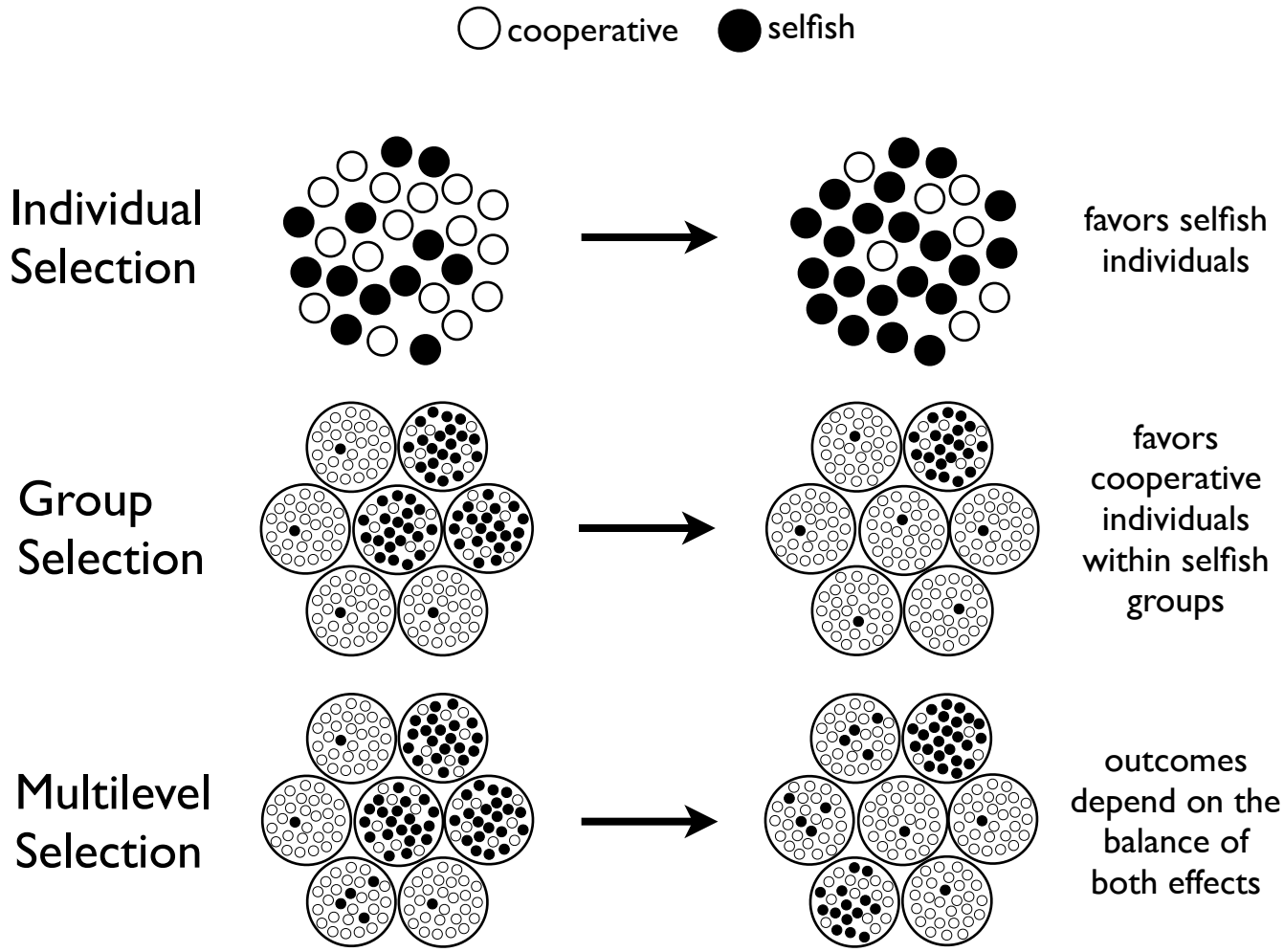
framework?

Multilevel Selection

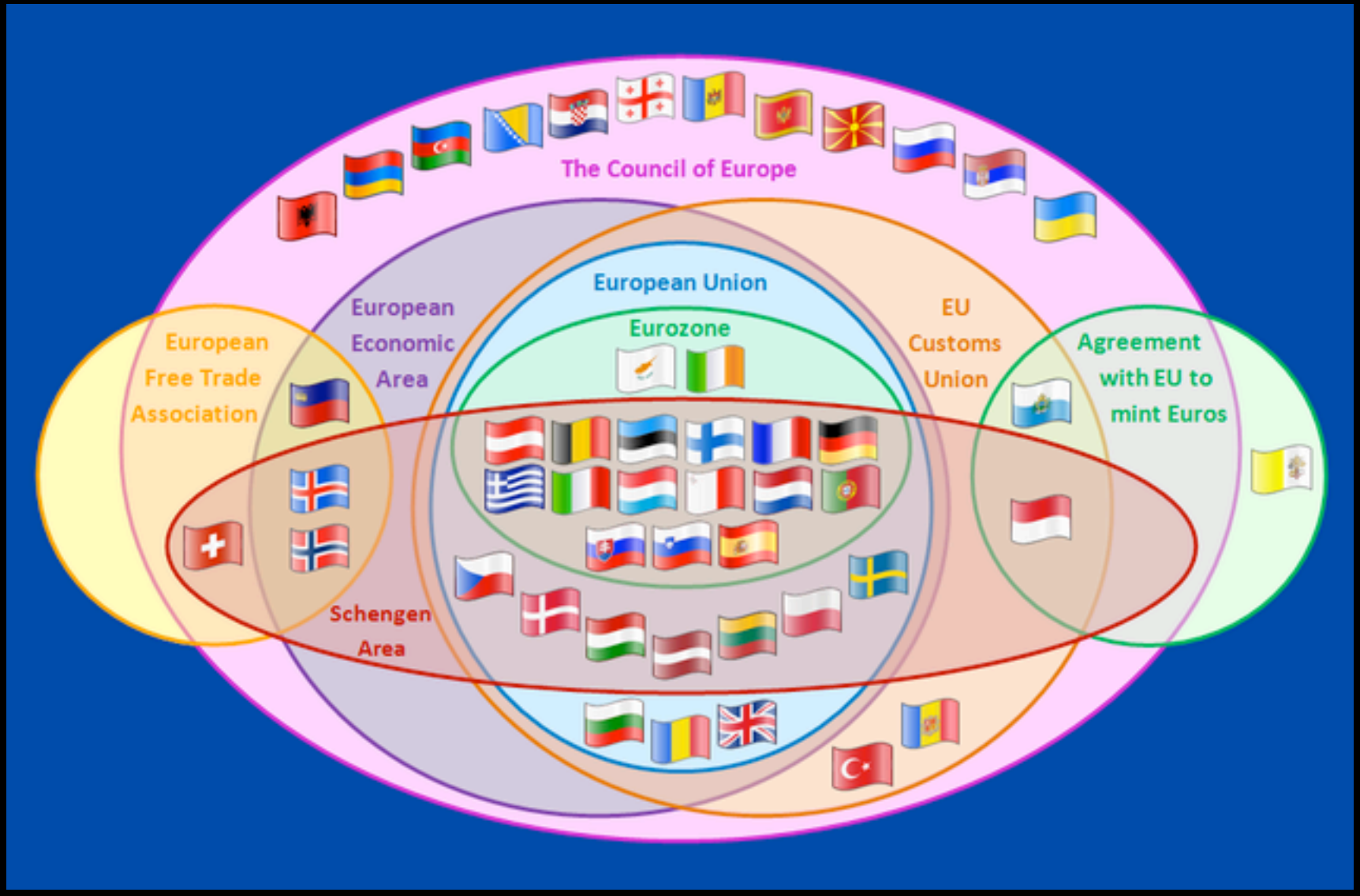


Levels of Selection Often Conflict

Institutions evolve by multilevel selection

- Henrich, J., 2004. Cultural group selection. Co-evolutionary process and large-scale cooperation. *J. Econ. Behav. Organ.* 53, 85–88.
- Traulsen, A., Nowak, M.A., 2006. Evolution of cooperation by multilevel selection. *PNAS* 103, 10952–10955.
- Van den Bergh, J., & Gowdy, J. M. (2009). A group selection perspective on economic behavior, institutions and organizations. *Journal of Economic Behavior and Organization*, 72, 1-20.

So what happens when...



Evolutionary Sustainability Theory

→ culture & cooperation	endogenous social change
→ generalizability	transposable
→ predictive capacity?	dynamic
→ descriptive	non-normative
→ interdisciplinary?	open
→ applicable?	interventions?

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- Evolutionary Sustainability Science
- Current Work

NIMBioS

National Institute for Mathematical and Biological Synthesis

A Cultural Multilevel Selection Framework for Sustainability Analysis

Karolina Safarzynska, Environment and Regional Development, Vienna Univ. of Economics and Business, Austria
Marco Janssen, School of Human Evolution and Social Change, Arizona State Univ.

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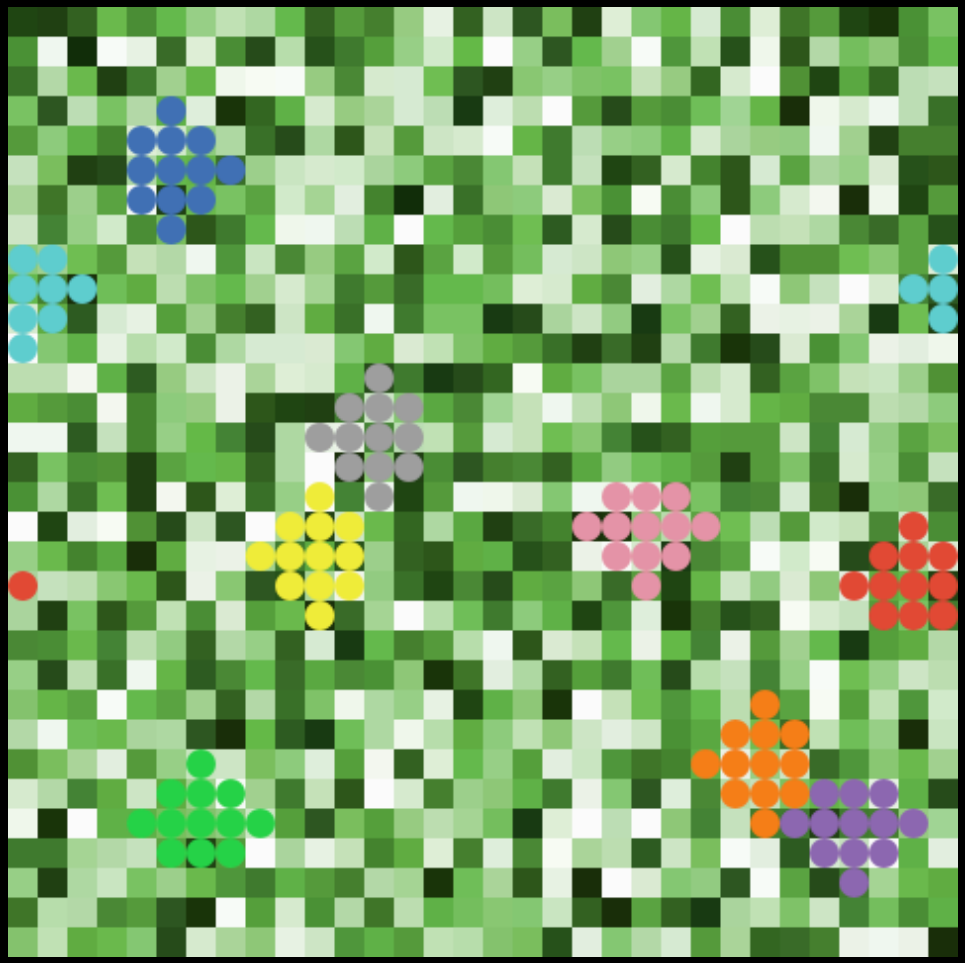
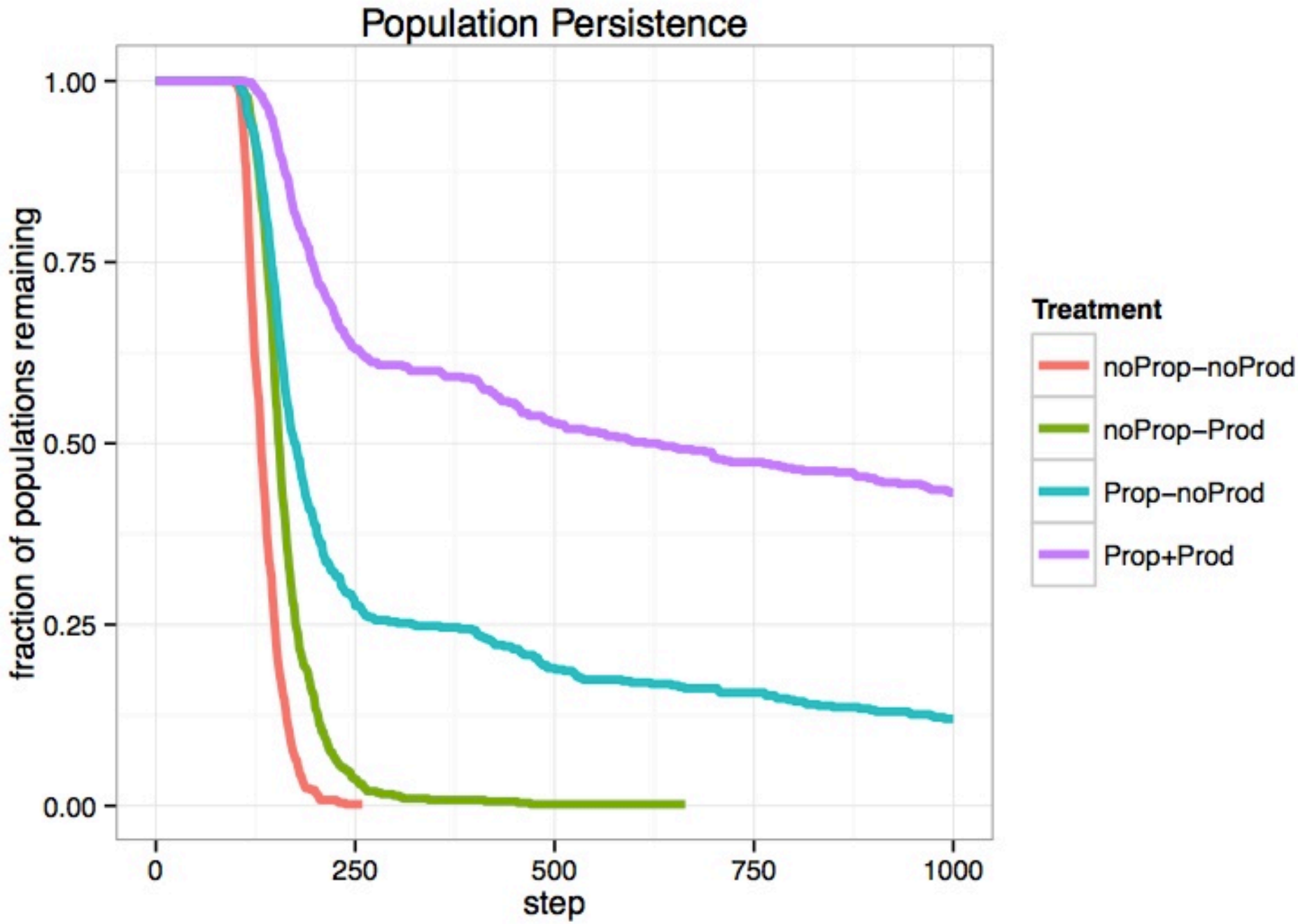
Karthik Panchanathan, Anthropology, Univ. of Missouri
Paul Smaldino, Center for Advanced Modeling, Johns Hopkins Univ.
Matthew Zimmerman, NIMBioS, Univ. of Tennessee, Knoxville
Vicken Hillis, Center for Environmental Policy and Behavior, Univ. of California, Davis

Agent-Based Modeling

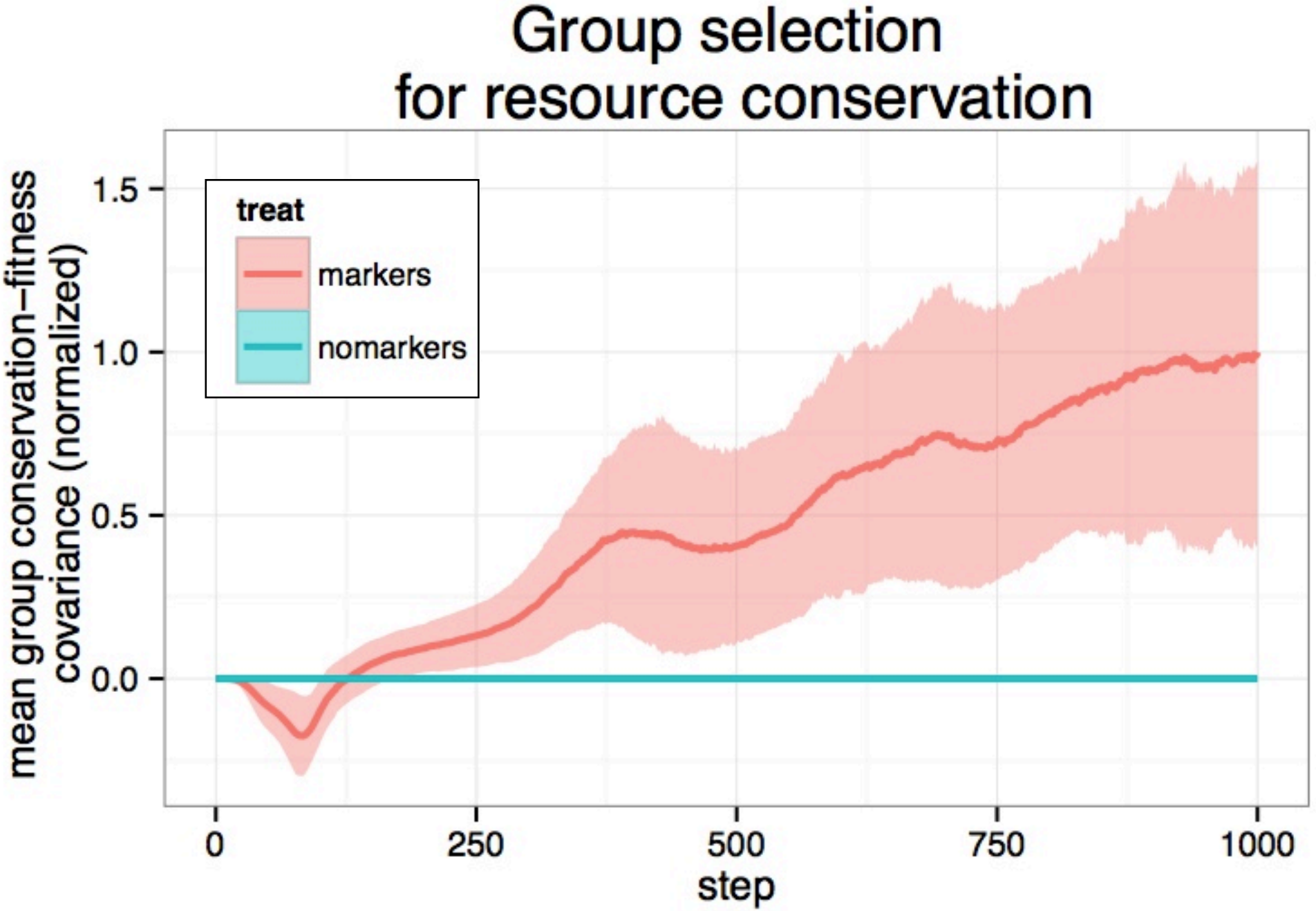


Research Question

- Can cultural group selection accelerate the emergence of institutions of sustainable resource management?



Populations persist when the norms of property and production are allowed to evolve.


Group selection
for resource conservation
mean group conservation–fitness
covariance (normalized)
1.5
1.0
0.5
0.0
treat
markers
nomarkers
0
250
500
750
1000
step

Summary

1. Group level selection can drive the emergence of sustainable institutions (societies)
2. Population persistence varies with institutional adoption (none < production < property < both)

CAREER:
The Evolution of Local Food Organizations

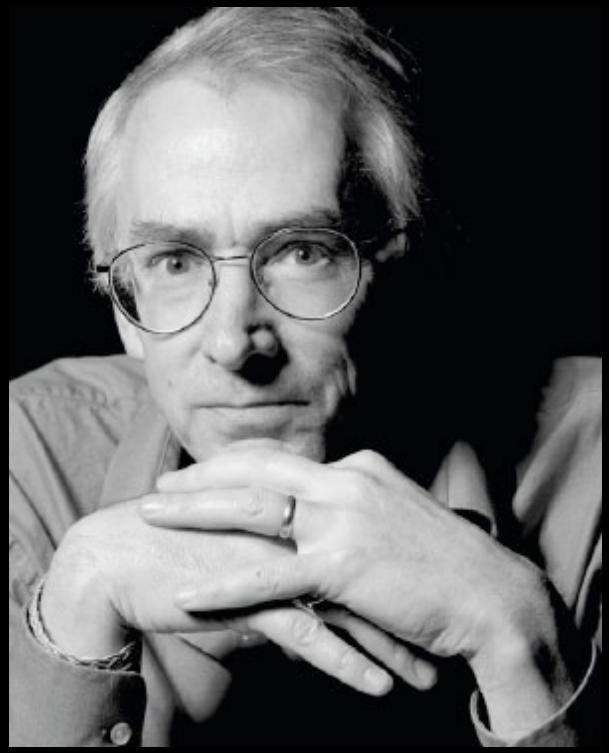
Ostrom's Design Principles

1. Clear social boundaries
2. Fair distribution of costs & benefits
3. Collective-choice
4. Monitoring
5. Graduated sanctions
6. Conflict resolution
7. Self determination
8. Nested governance

Elinor Ostrom

Courtesy of Indiana University.

Ostrom, E. (1990). Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press.



David Sloan Wilson

Binghamton University

PROSOCIAL

designing groups for success


Thank You!
Questions?