# The use of ABM to develop mechanism-based explanations of the dynamics of social-ecological systems

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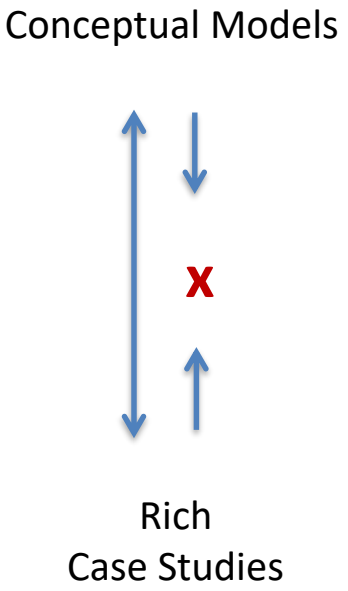
# How agent-based modelling can help us to

- move from description to explanation (from what to how)
- Integrate knowledge from different disciplines
- build understanding that is context sensitive but not context dependent
- develop middle-range theory (i.e. theories that apply to concrete phenomena in a subset of cases)



# Social-ecological Systems

How to capture the interdependence between humans and the ecosystems they affect and depend on?

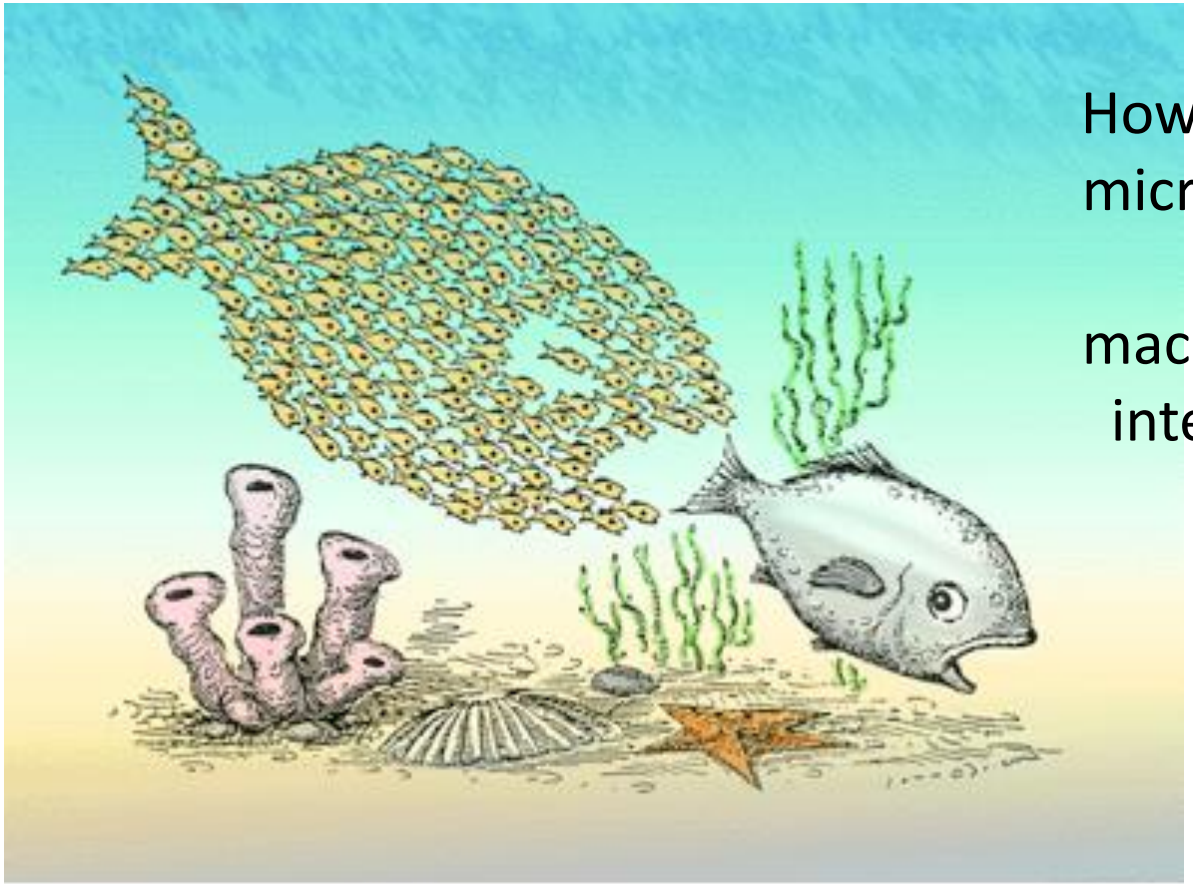
Image: Edward Burtynsky

# are complex adaptive systems

SES phenomena emerge from local social-ecological interactions and adaptations

macro

micro

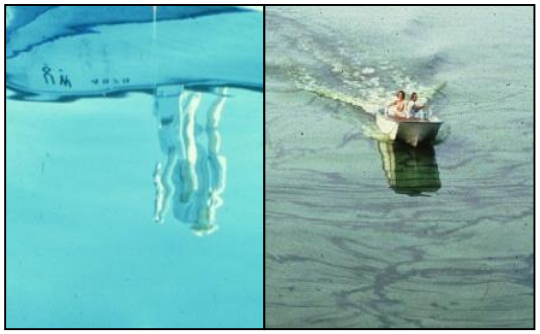


How to analyse micro to macro and macro to micro interactions?

Openabm.org

# Emergent SES phenomena

**Regime shifts**

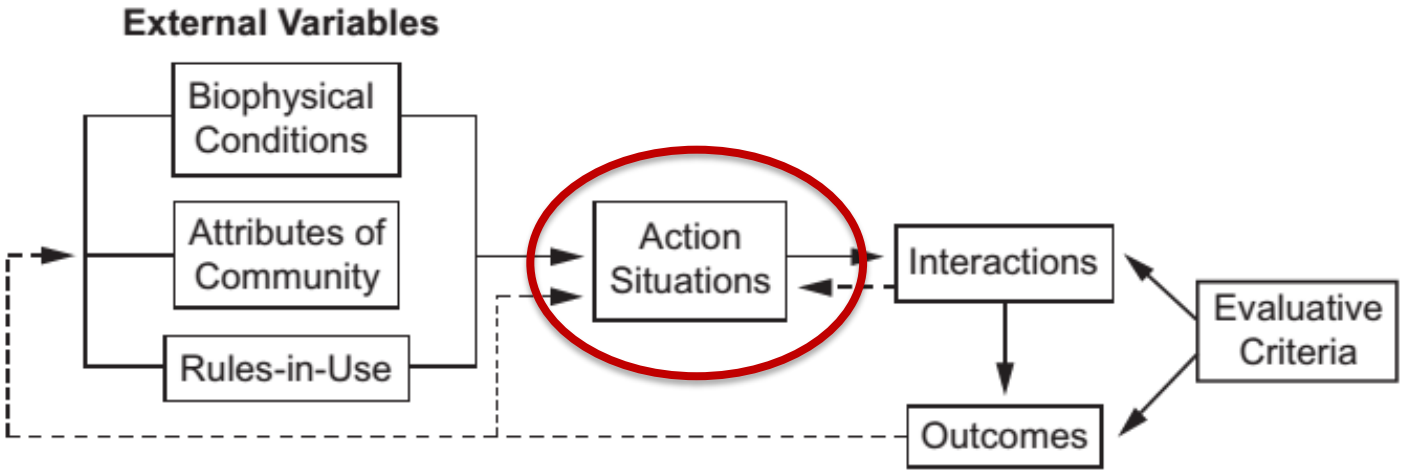


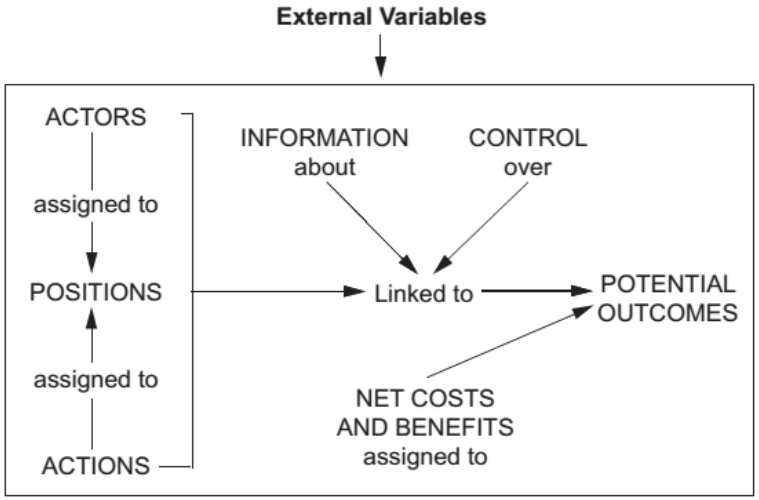
**Common-pool resource governance**

**Traps**

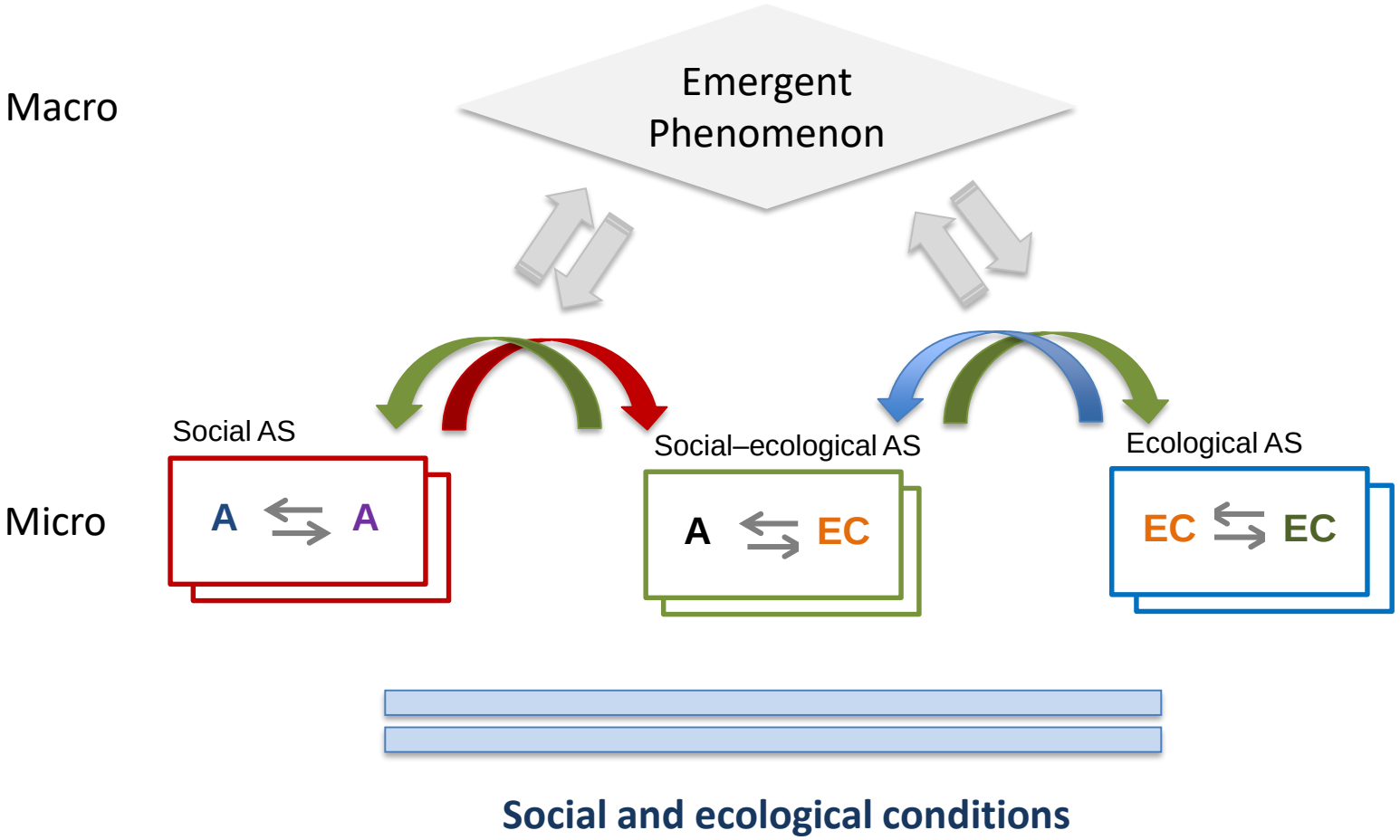
What are key social-ecological interactions?

# The Institutional Analysis and Development Framework (Ostrom 1990)



# An action situation based framework



# Patterns of self-governance in small-scale fisheries

With Emilie Lindkvist (SRC) & Xavier Basurto (Duke University)

# Self-governance of small-scale fisheries

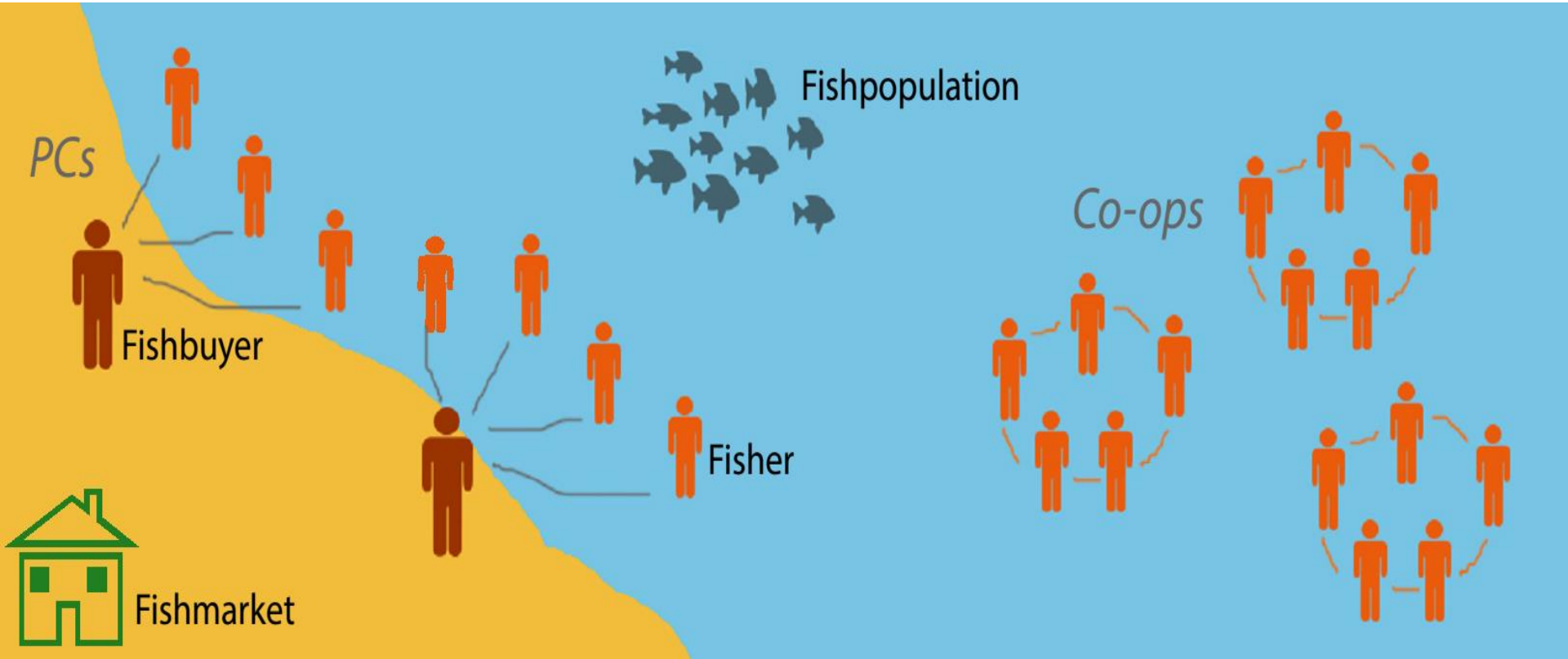
- Small-scale fisheries important for global food production but often neglected by governments as minor policy field
- Cooperative and non-cooperative forms of self governance (Cooperatives (co-ops) and patron-client relationships (PCs))
- PCs increasingly dominant but co-ops more desirable

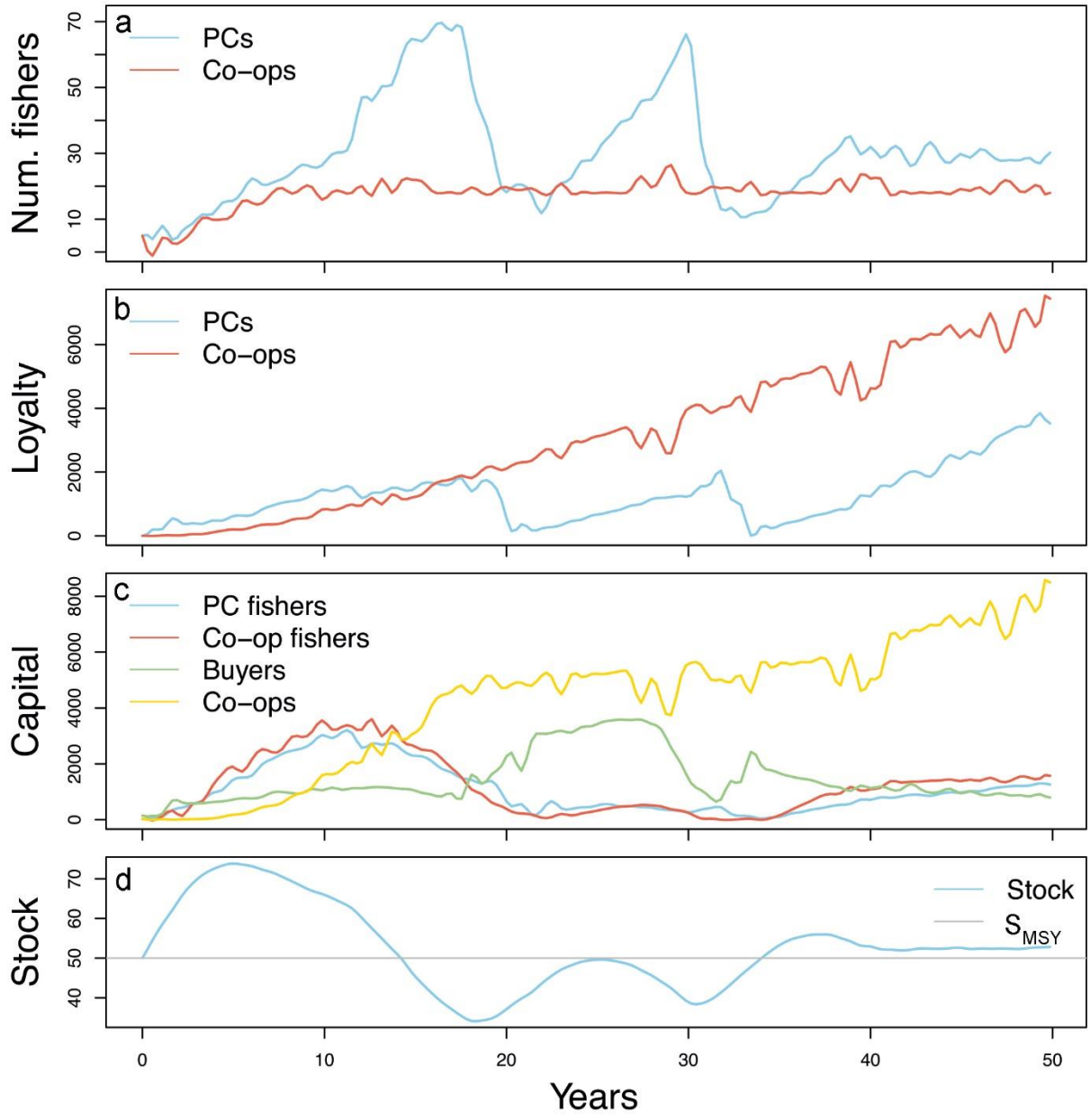
What explains the dominance of PCs and under which conditions are cooperatives more successful?

# Key micro-level interactions

- A-E: fishing; A-A: selecting fishers, lending, returning catch/cheating, exiting; E-E: reproduction
- Cheating as function of reliability and loyalty
- Loyalty changes through social interactions (slower in coops)

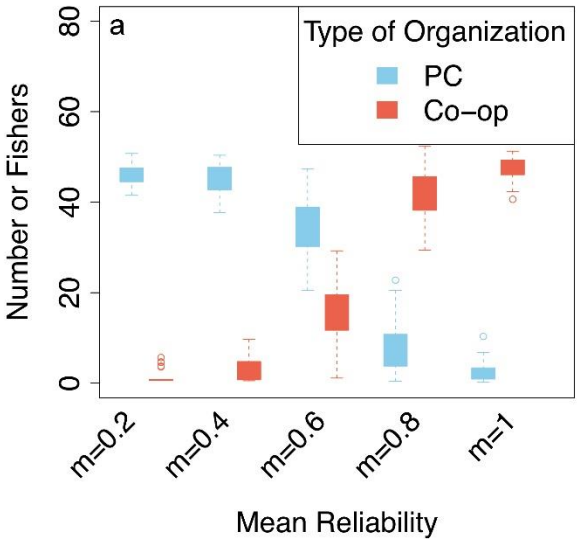
Model based on synthesis of qualitative data, field observations and literature



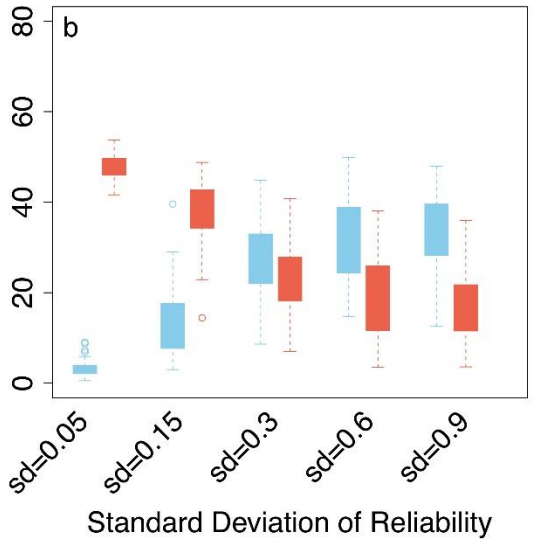

a
PCs
Co−ops
Num. fishers
0
10
30
50
70
b
PCs
Co−ops
Loyalty
0
2000
4000
6000
c
PC fishers
Co−op fishers
Buyers
Co−ops
Capital
0
2000
4000
6000
8000
d
Stock
$S_{MSY}$
Stock
40
50
60
70
0
10
20
30
40
50
Years

# Coops more sensitive to unreliable fishers

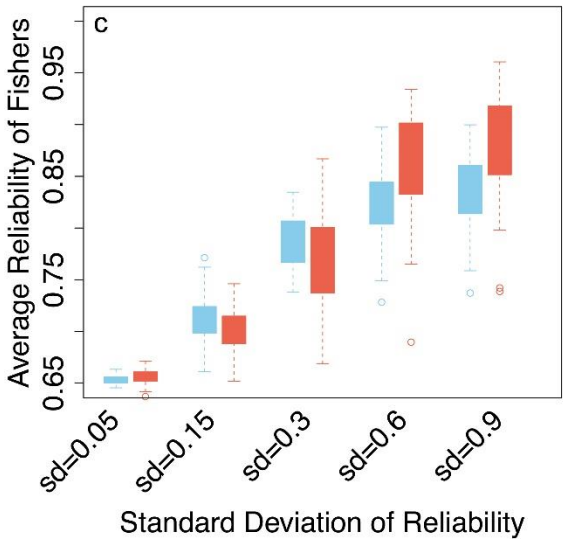
Mean reliability




Variance of reliability




Reliability in organization

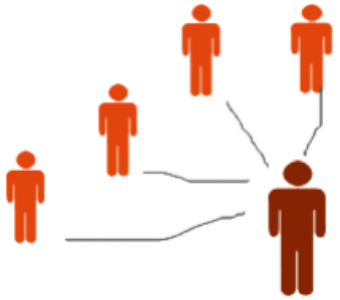


# Coops dominate in homogenous communities with history of working together

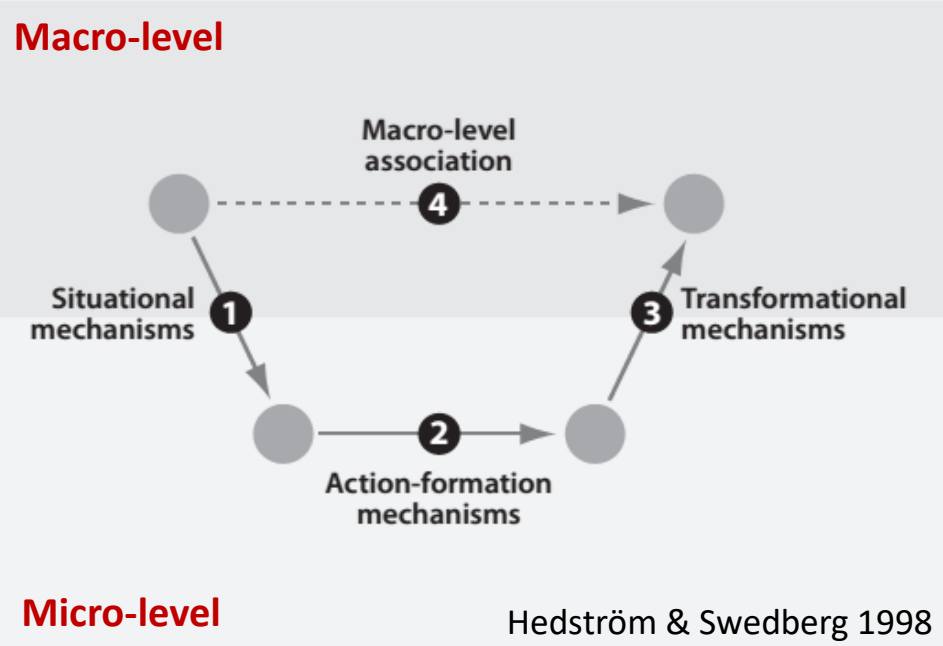

Coops can better cope with seasonal variability

# Micro- to meso- to macro-level interactions affecting the emergence of co-ops and PCs

- Reinforcing feedback between loyalty and cheating (more loyalty -> less cheating -> more loyalty) stabilizes organization
- Establishment dependent on combination of initial group composition, initial loyalty, number of other organzations, state of the fish population
- PCs can better cope with high heterogeneity because of more flexible membership rules
- Coops once established are more robust to fluctuations in fish stock (because of formal membership)

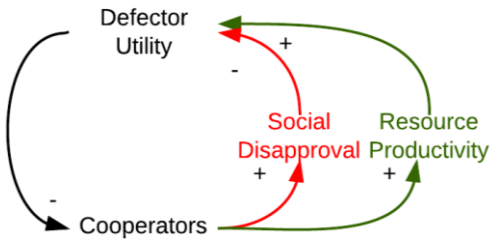


# Mechanism-based explanations



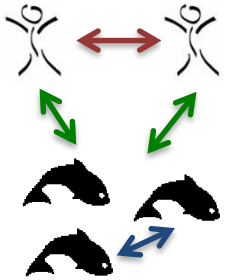

Hedström & Swedberg 1998

A mechanism refers to the entities of a causal process that produces the effect of interest (not necessarily deterministic)

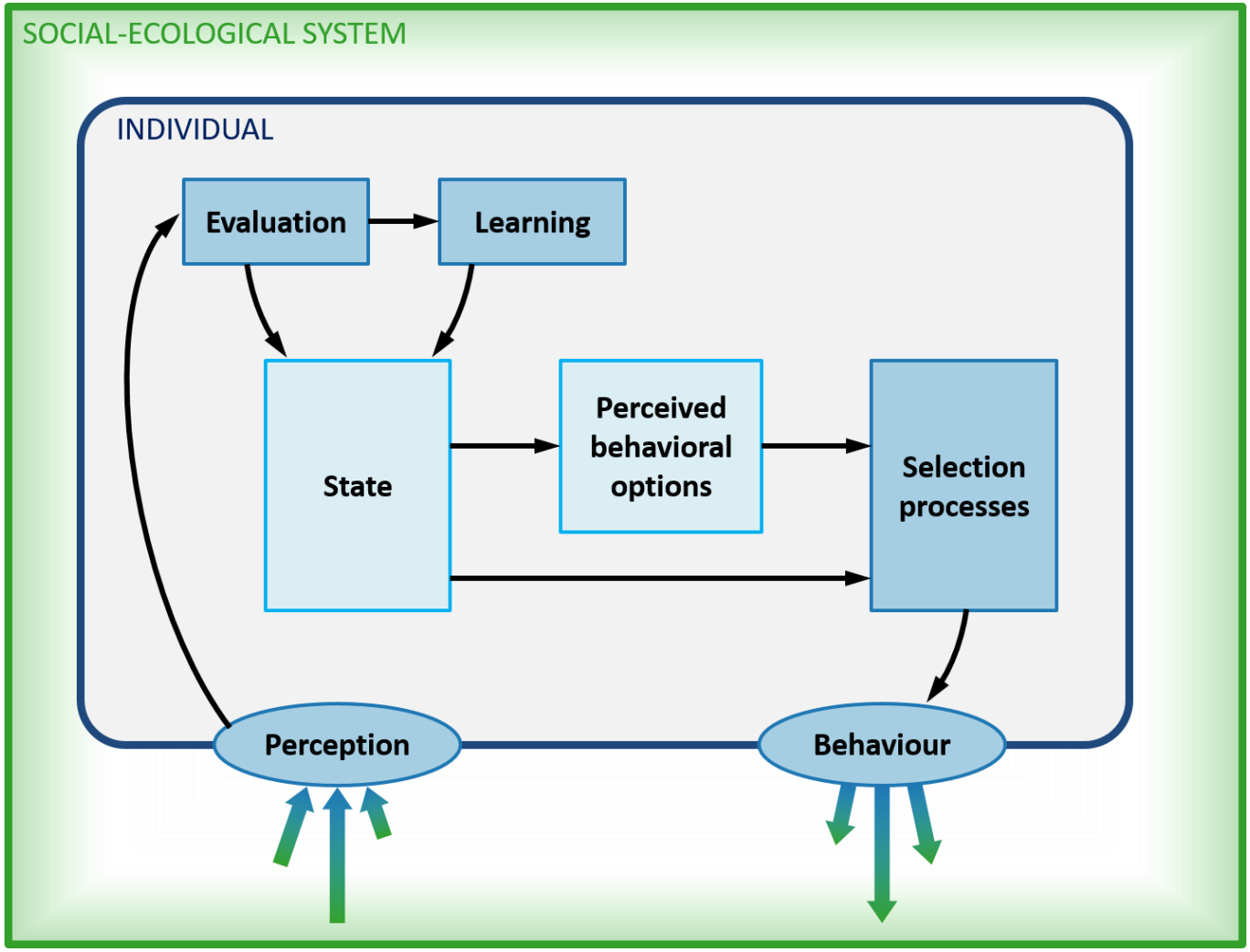



Feedbacks (e.g. social norms, resource degradation)

Micro-level interactions (e.g. patron-client relationships)



# Action-formation mechanisms – The MoHuB framework




Schlüter et al. 2017

# Summary

ABM are useful tool to

- Identify and test mechanisms underlying SES phenomena
- Integrate knowledge across domains in co-development processes
- Identify conditions under which mechanisms hold

But multiple challenges such as

- How to identify mechanisms in the models
- Representing human decision making
- Developing empirical synthesis and hypothesis
- Linking processes across different scales and levels of aggregation

# THANK YOU!

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