

Resilience

Prof. Garry Peterson
Stockholm Resilience Centre
Stockholm University

Why resilience?

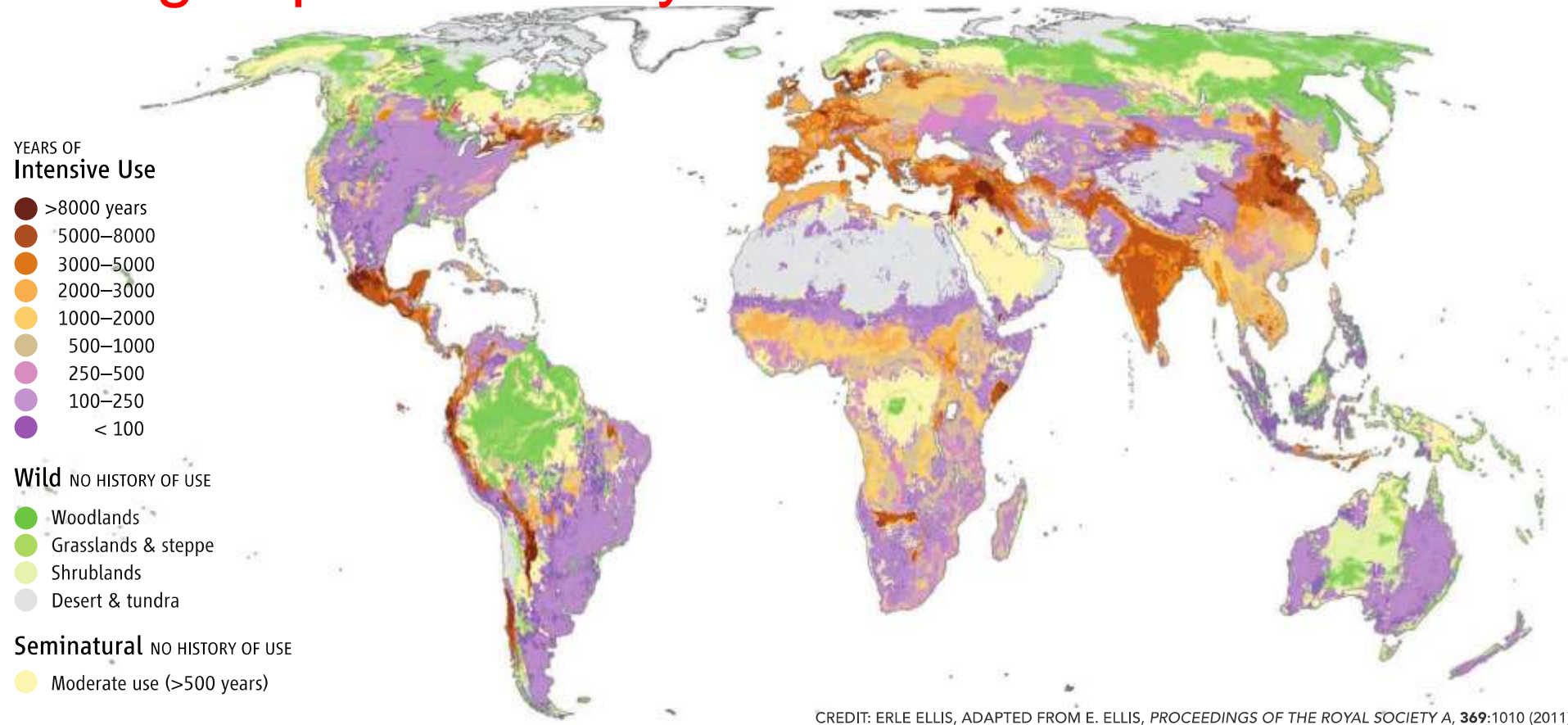
What is resilience?

Operationalizing resilience

Resilience & Sustainability

Anthropocene

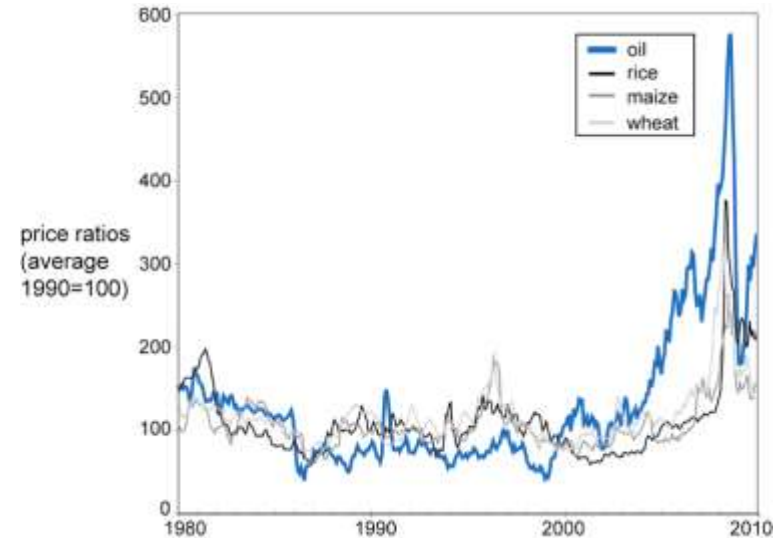
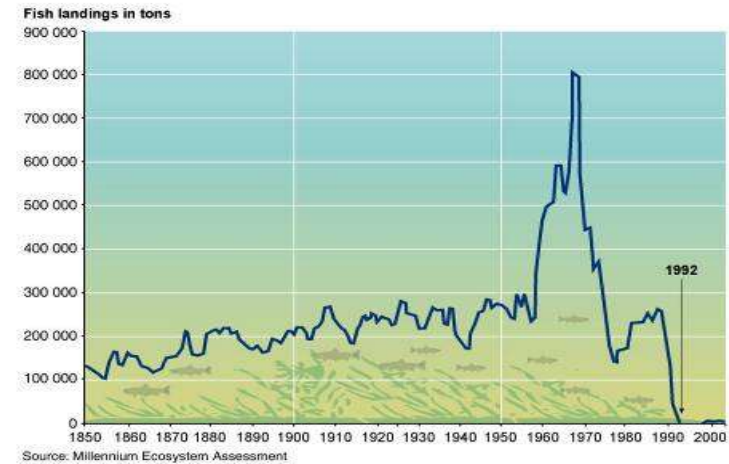
humanity no longer impact or disturbance but an integral part of ecosystem function



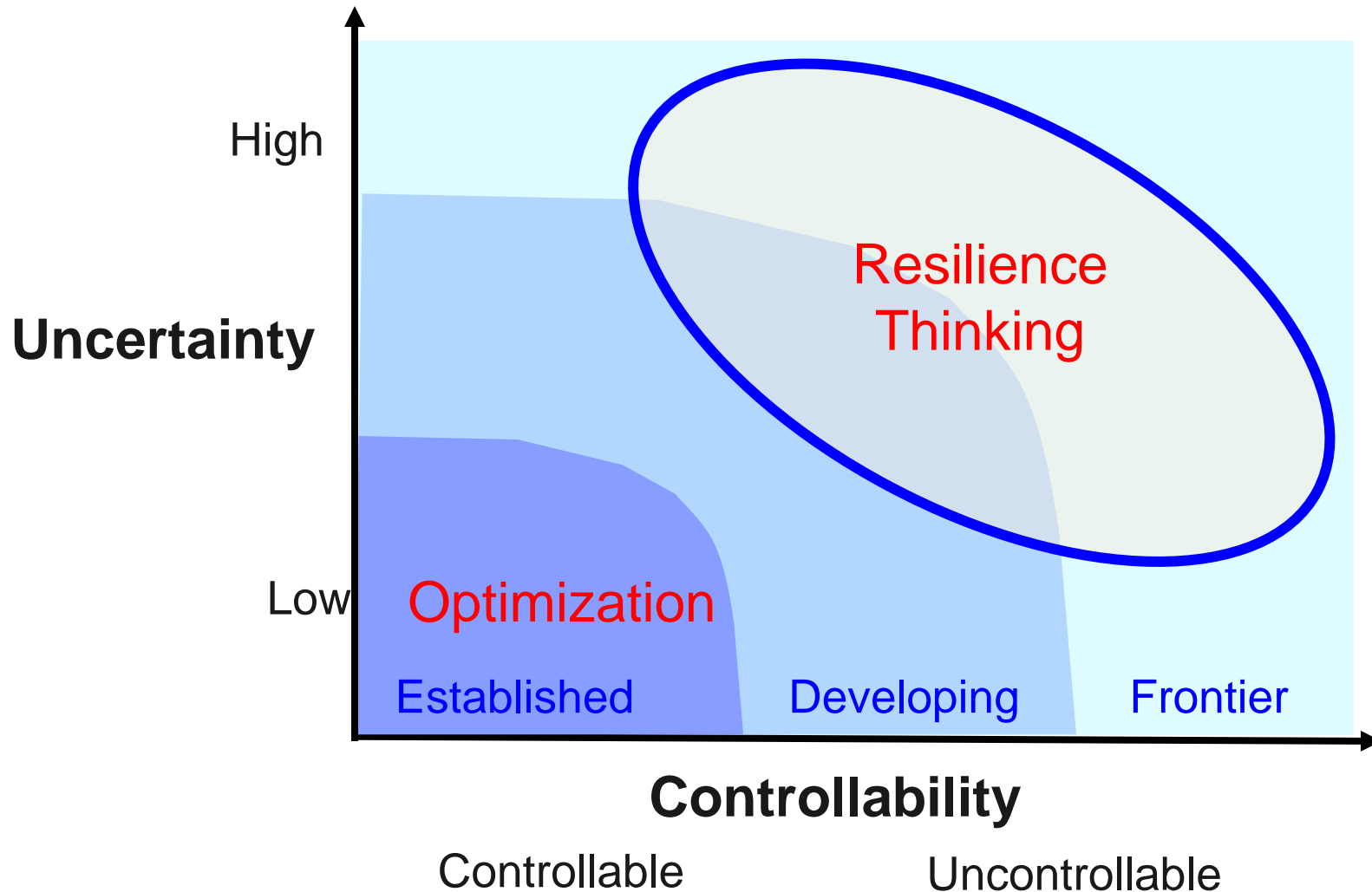
how do these social-ecological systems work?

Ecological Change in 20th Century produced surprises

- 🌍 Pests and pathogens rapidly evolved resistance to biocides
- 🌍 Toxins biomagnified in food chains
- 🌍 Emergence of disease facilitated by modifying ecosystems (e.g. irrigation)
- 🌍 Removing top predators decreased resilience & reliability of many ecosystem services



Approaches to sustainability based largely on assumptions of linear, isolated world





Why resilience?

What is resilience?

Operationalizing resilience

Resilience & Sustainability

“Ecological Resilience”



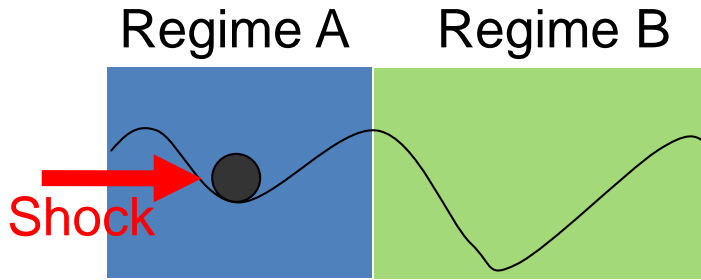
Ecologist C.S. Holling
analysis of insect
outbreaks in 1970s

Systems approach

Extended to many
ecological
management
situations & later to
management more
generally

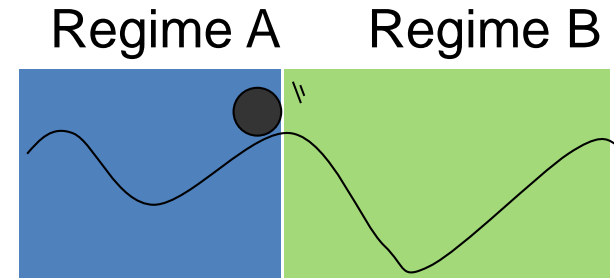
Resilience: Two Faces

Amount of shock system can absorb without reorganizing



Persistence Resilience

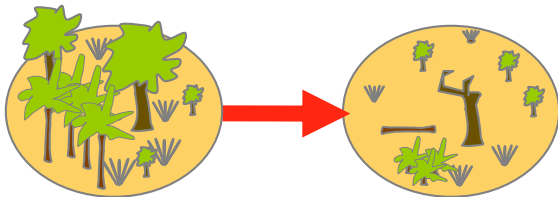
State of System



State of System

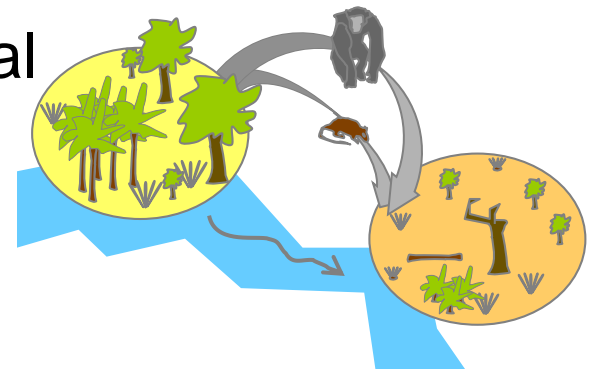
Capacity for self-organization, learning, adaptation

Collapse



Reorganization

Reorganizational Resilience



Development of Resilience

1970s model

ecological
resilience

1980s critique

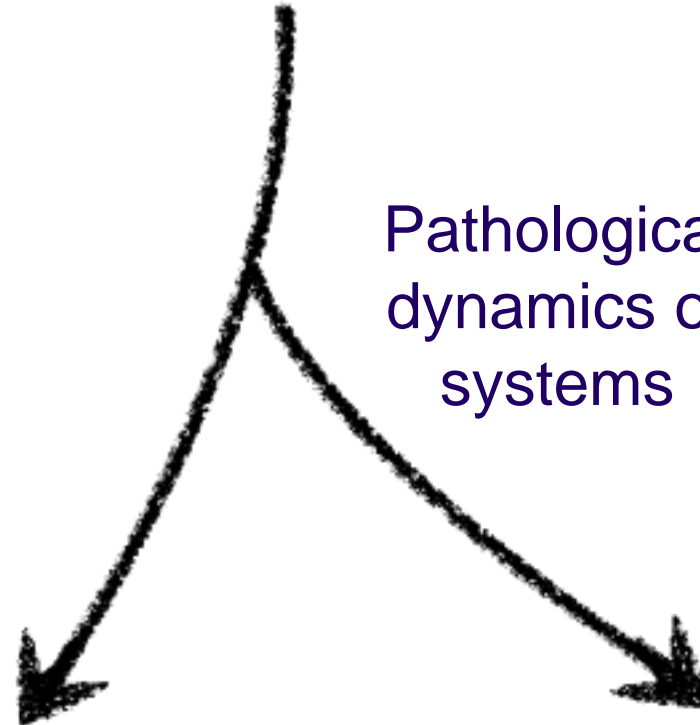
Pathological
dynamics of
systems

1990s empiricism,
diversification

2000s
acceptance
diversification

regime
shifts

transformation



Regime shifts are substantial, persistent, reorganizations in structure and processes

E.g. Coral Reefs



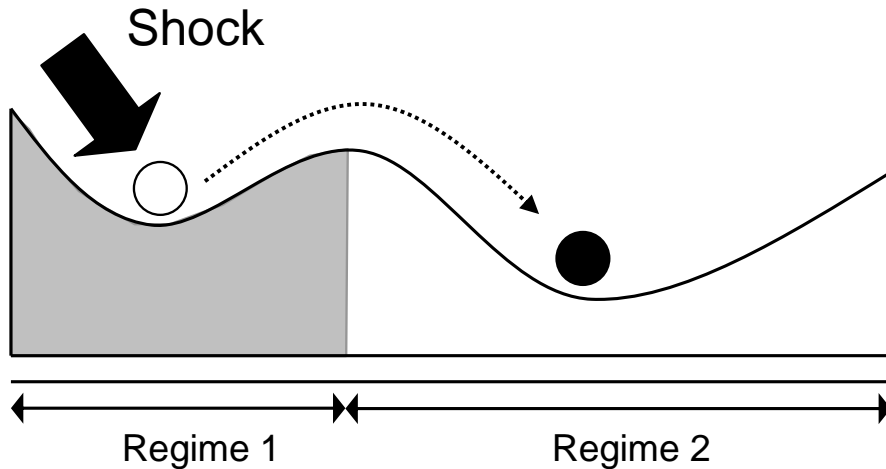
Source: CoralReefInfo

Regime Diverse coral dominated reef

Algae dominated reef

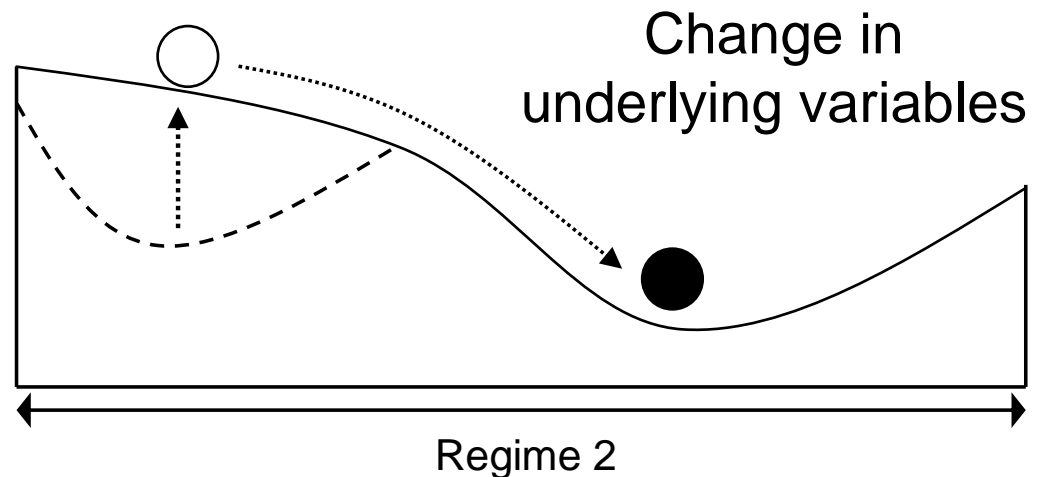
Ecosystem Services Food, Tourism, Storm surge protection Reduced & less valuable food

What causes regime shifts?



"Fast"
Dominant feedbacks are overwhelmed

"Slow"
Dominant feedbacks are slowly eroded



Dynamics of resilience & social-ecological transformation

Holling's pathology of natural resource management - resilience dynamics

1) to increase supply of desired ecosystem services people simplify ecosystem

2) this decreases ability of ecosystem to self-regulate

3) people become increasingly dependent on continued supply of ecosystem services

5) People invest in artificial regulation

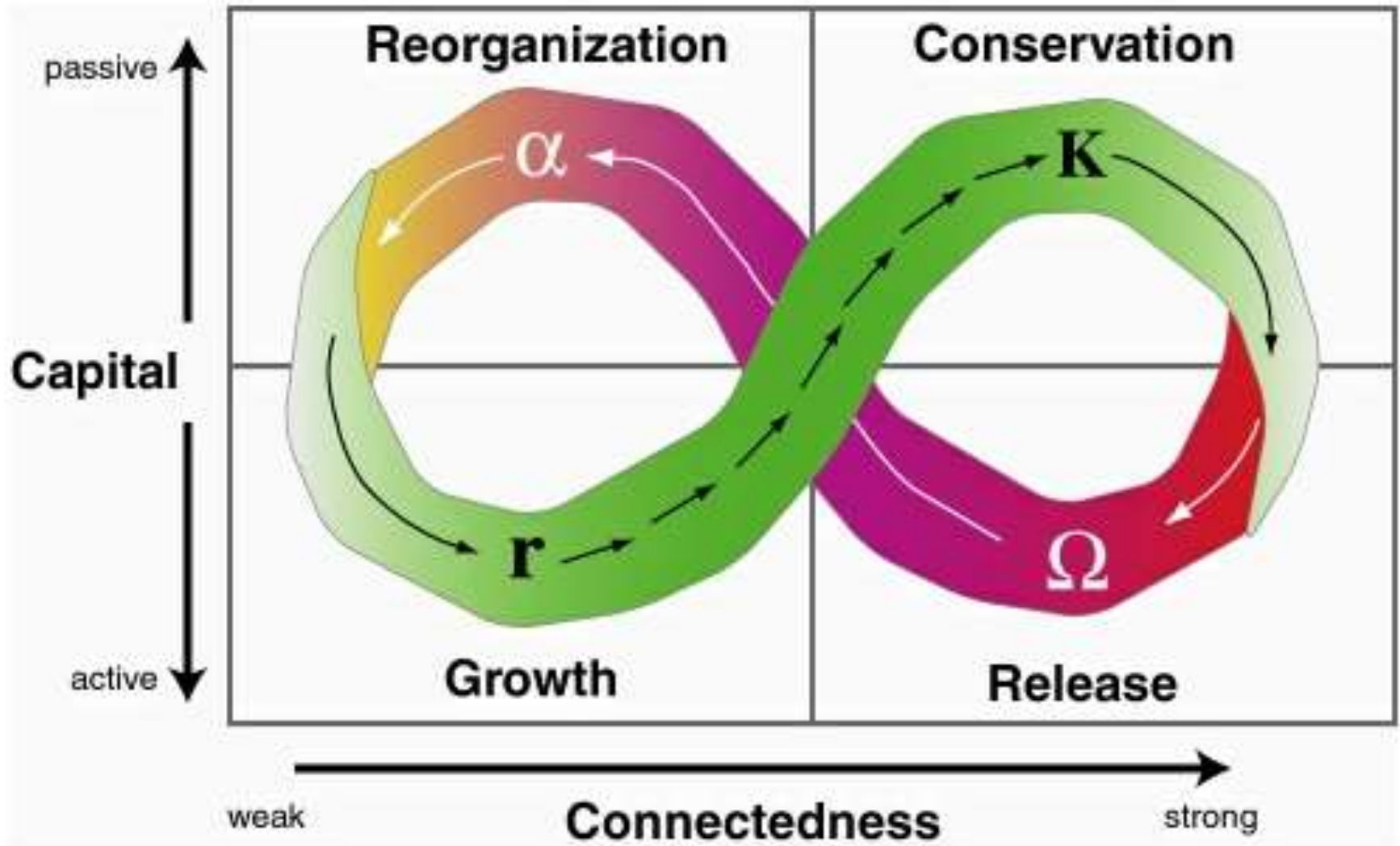
6) Artificial regulation further decreases resilience leading to either

a) a rigidity trap or

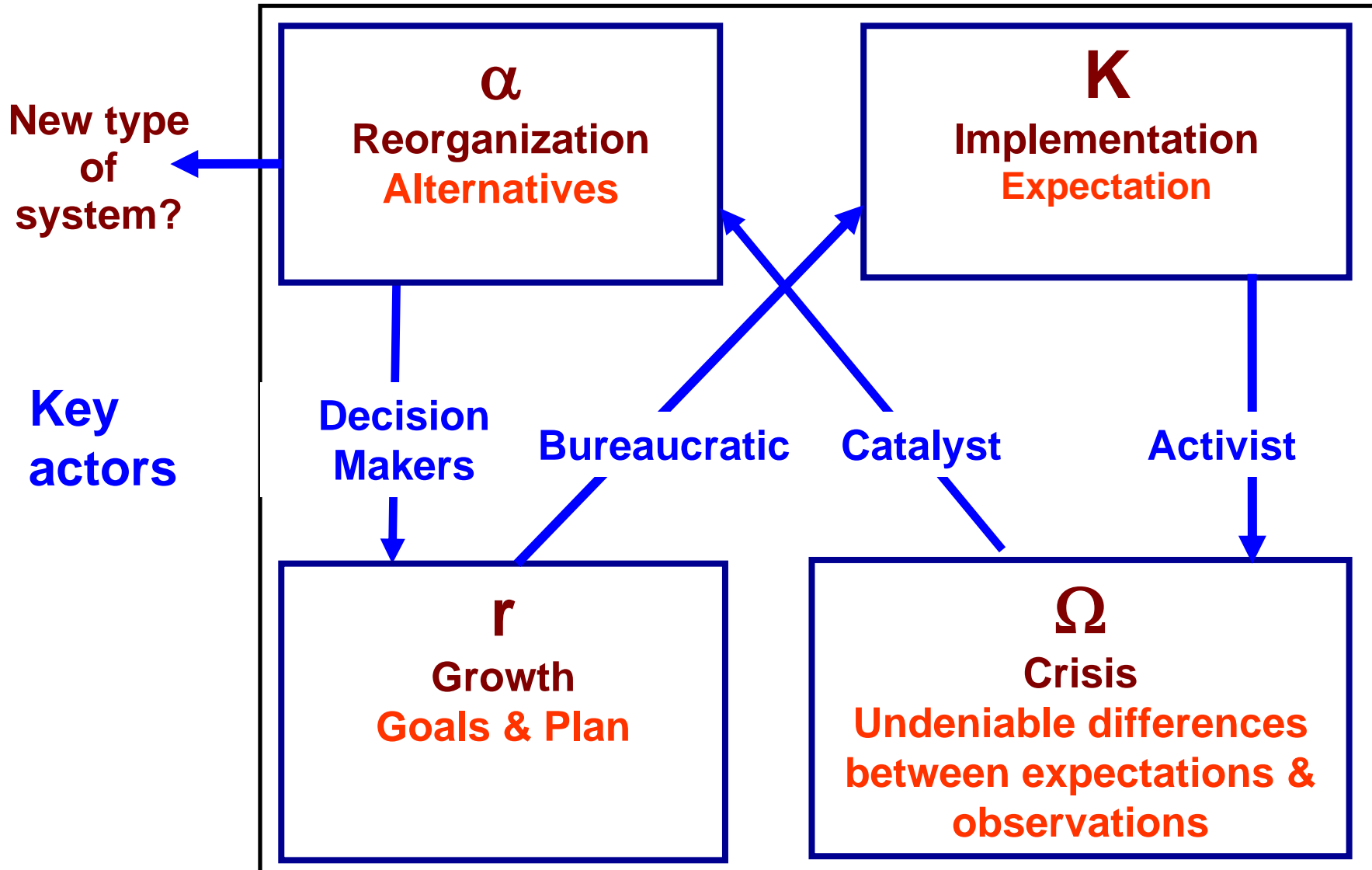
b) crisis & reorganization of SES

(Holling 1986, Holling, Gunderson, & Peterson 2002)

Holling's Adaptive Cycle



Adaptive Cycle & Key Actors



Organization roles identified using Adaptive cycle

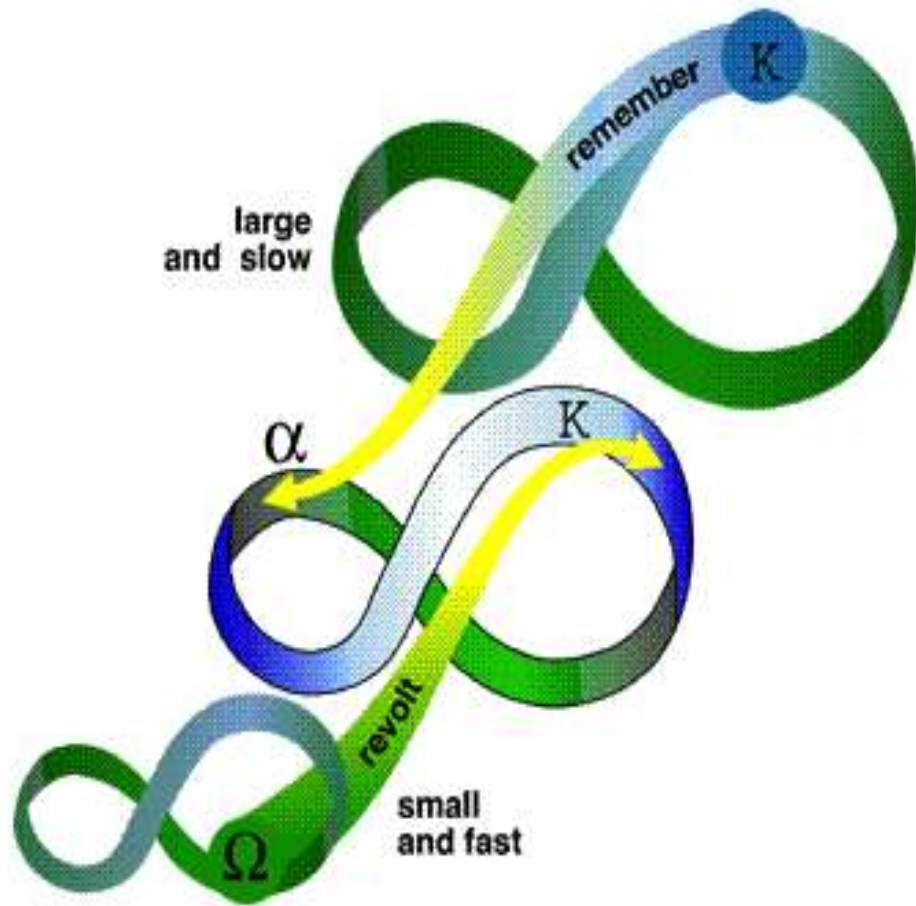
From large scale environmental governance

Phases	r->K	K-> Ω	Ω -> α	-> novel
Key internal actors	Bureaucracy	Loyal heretics	Reformers	Higher level decision body
Problem Network	NGOs	Activists	Epistemic	Visionary leadership
Policy activity	Implementing	Destroying	Framing new options	Resolution & transformation
Strategy	“do more”	“create crisis”	“unlearning yesterday”	“invent tomorrow”
Response to change	Ignore & deny change	Forcing change	Articulate new futures	Compromising & reconciling
Guiding vision	Stability	Survival	Reconstruction	Creating new visions
Role of science	Science supports policy	Science invalidates policy	Science integrates & assesses	Politically expedient science selected

(Gunderson 1995; Holling, Gunderson, Peterson 2002)

Panarchy

Importance of cross-scale feedbacks



Memory - larger scales shape the reorganization of smaller scales after crisis

Transformation - Smaller scales can trigger reorganization or crisis at larger scales, if larger systems are open to change

Diversification of Resilience Concepts



Management

Adaptive
Management

Adaptive
Co-Management

Adaptive
Governance

Social-ecological
innovation

Social-ecological
networks

Theory

Resilience '73

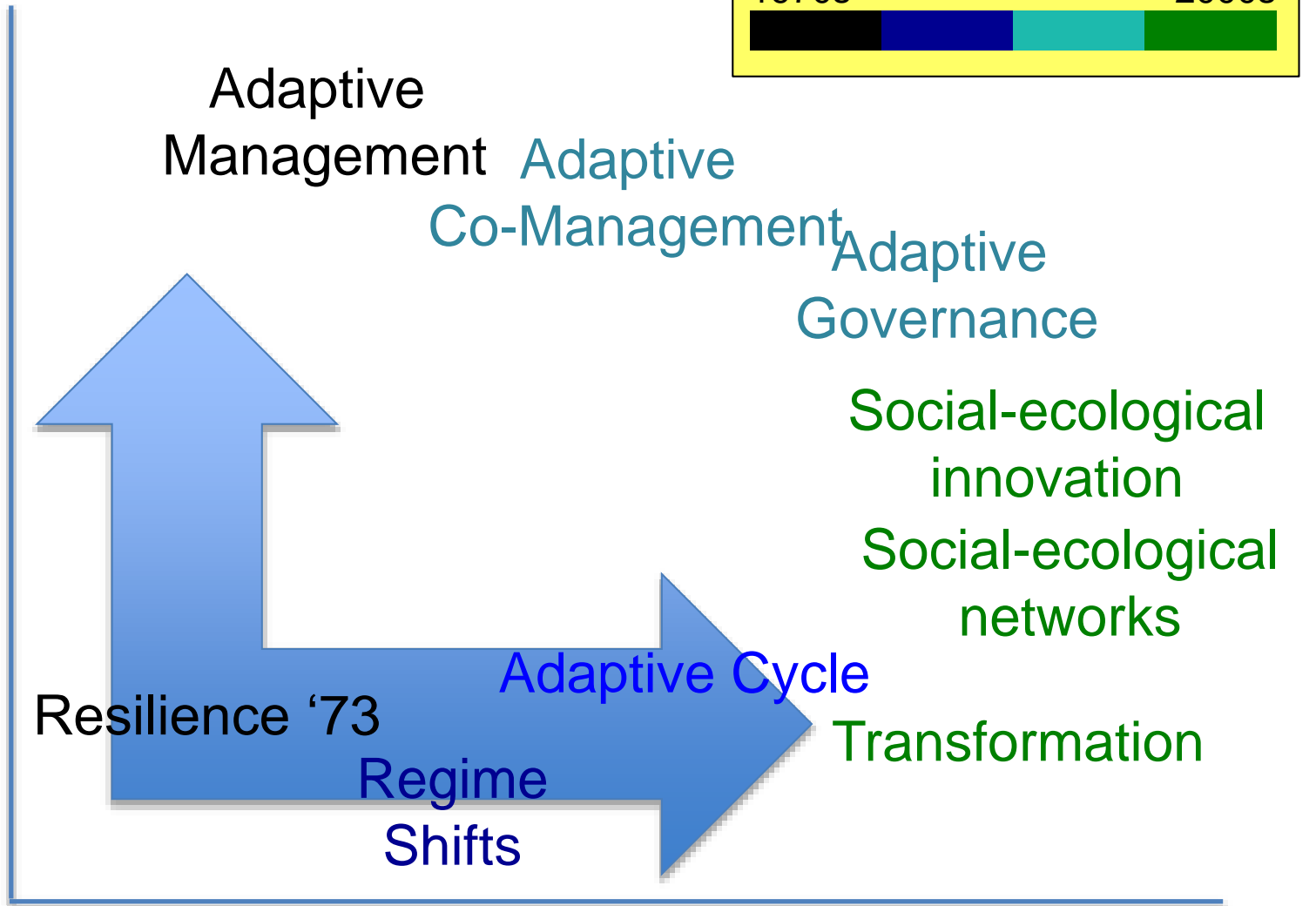
Adaptive Cycle

Regime
Shifts

Transformation

Ecological

Social-ecological



Questions?



Why resilience?

What is resilience?

Operationalizing resilience

Resilience & Sustainability

Why Use Resilience?



Rob Hopkins of Transition Town Movement:

“the concept of resilience is a much more useful idea than that of sustainability. Sustainability implies that we are trying to design a steady-state system with less inputs and less outputs than we have at the moment, which can carry on indefinitely. Whereas actually what we need to be designing for is the ability to withstand shock ... [and] it's about seeing that shock as an opportunity to change.”

“making a community more resilient, if viewed as the opportunity for an economic and social renaissance, for a new culture of enterprise and reskilling, should lead to a healthier and happier community while reducing its vulnerability to risk and uncertainty resilience is reframed as a historic opportunity for a far-reaching rethink”.

“Transition has been framed in terms of building (or rebuilding) resilience in local communities. So far, the movement seems to have successfully used resilience as a motivating framing concept. The lack of specificity used in the framing of resilience has probably contributed to resilience being perceived as an appealing goal by the wide range of citizens who have become involved with the movement”

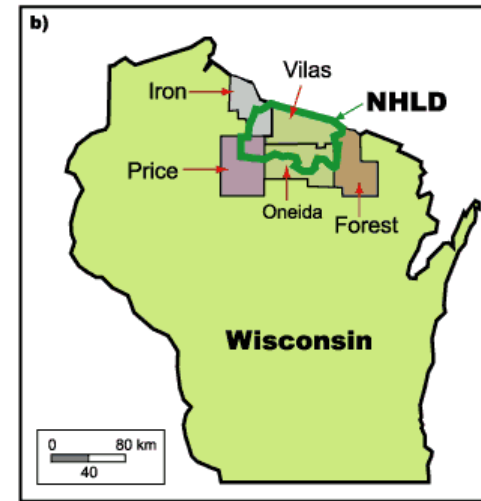
Two examples of Resilience Application

- Vacation area in Northern Wisconsin, USA
- Town of Eskiltuna, Sweden

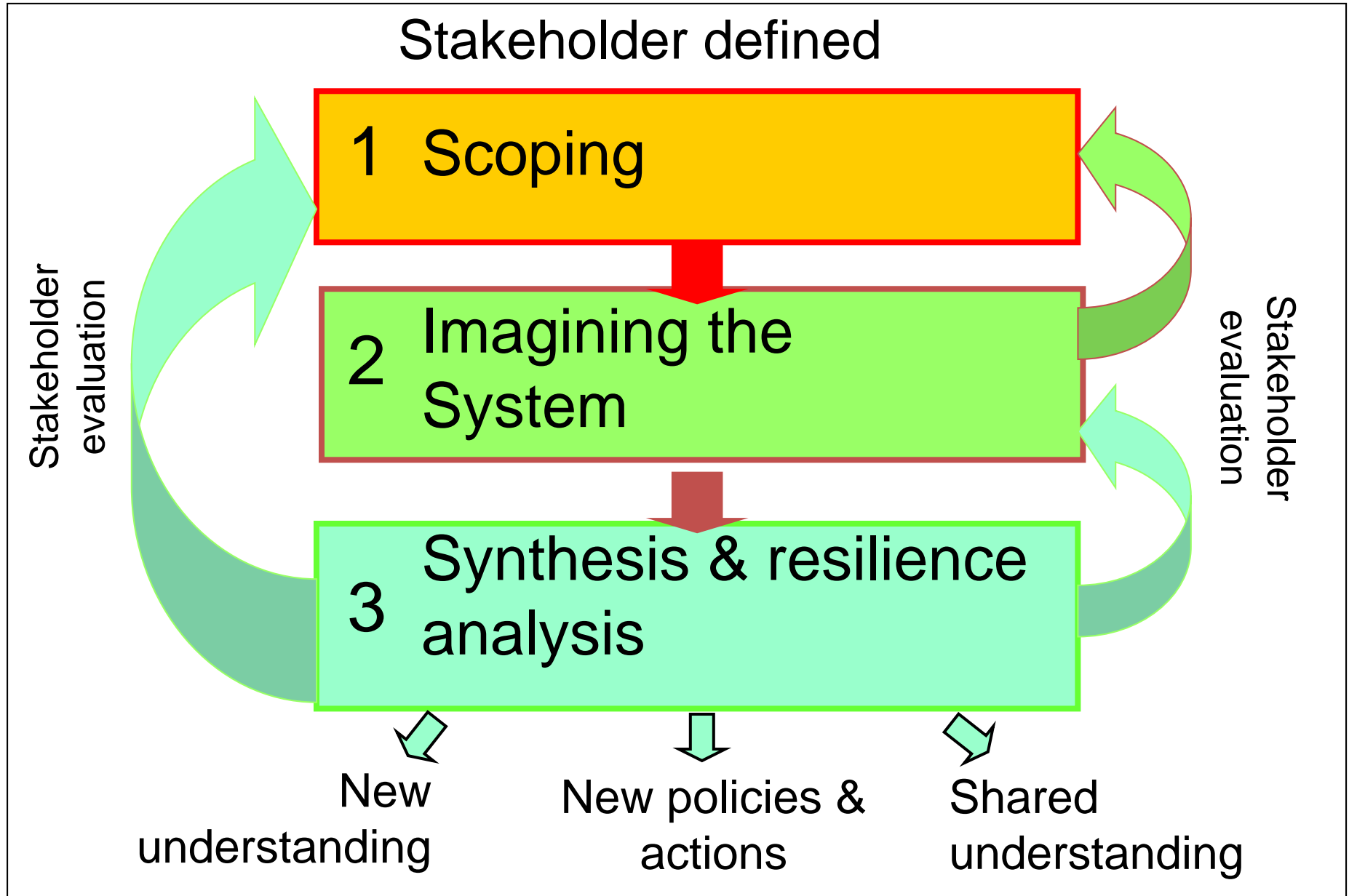
Paradox of Development in Northern Wisconsin

Desire for North Woods Life
Quiet, Independence, Jobs,
Quality Water
& Fish

Destroys North Woods Life



Framework for Assessing Resilience



NHLD Participatory Scenarios

Anaheim North

- **Unintended consequences** of development + myopic lake associations -> regional Balkanization

Northwoods Quilt

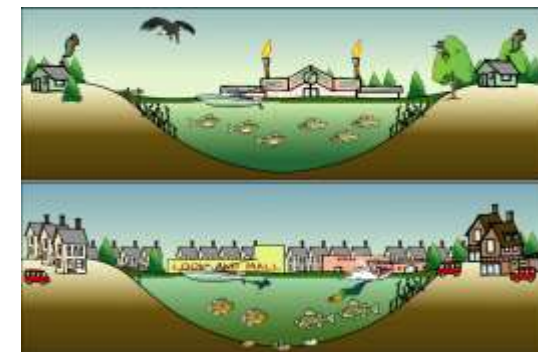
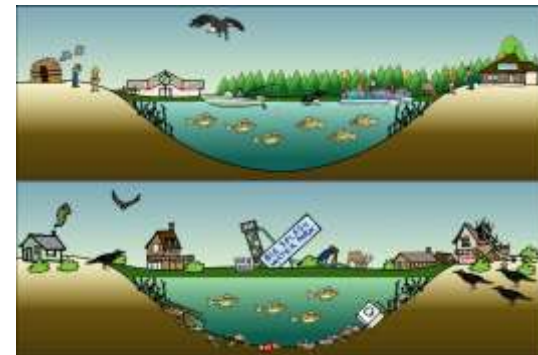
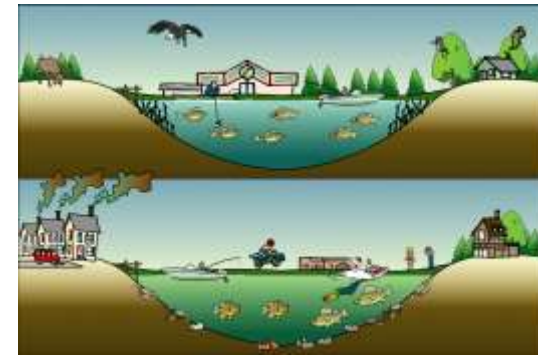
- **Path to Ecological Development** - Lake association power->Diverse lake management-> Lake Heterogeneity

Walleye Commons

- **Tourist Decline** - Ecological Degradation + Social Conflict --> Population decline --> Tribal dominance

Refugee Revolution

- **Settlement Boom** - 2nd homeowners start to stay most of year long --> region becomes work rather than tourism focused



Resilience Assessment & Strategies

Unrecognized Resilience

- Diversity of landscape; People

Unrecognized Adaptive Capacity

- Cooperation between state, lake associations & tribal management
- Scientific ecological understanding

Unrecognized Surprises

- People are providing a new cross-lake ecological connection (fishing, invasive spp., development)
- Migration of people to region

Opportunities

- Build of inter-group connectivity
 - need for bridging organizations & individuals
- Lac du Flambeau tribe potential source of innovation (institutional diversity)
- Creating shared vision of future

(Peterson et al 2003; Peterson 2008)

Urban Resilience Assessment in Eskilstuna, Sweden

Eskilstuna

Preparedness for crises

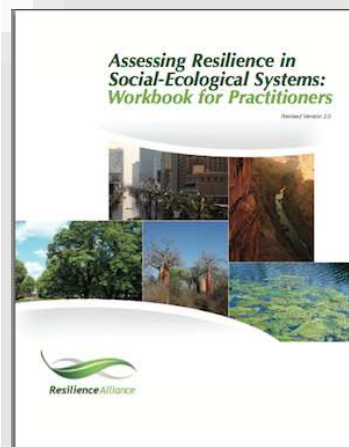
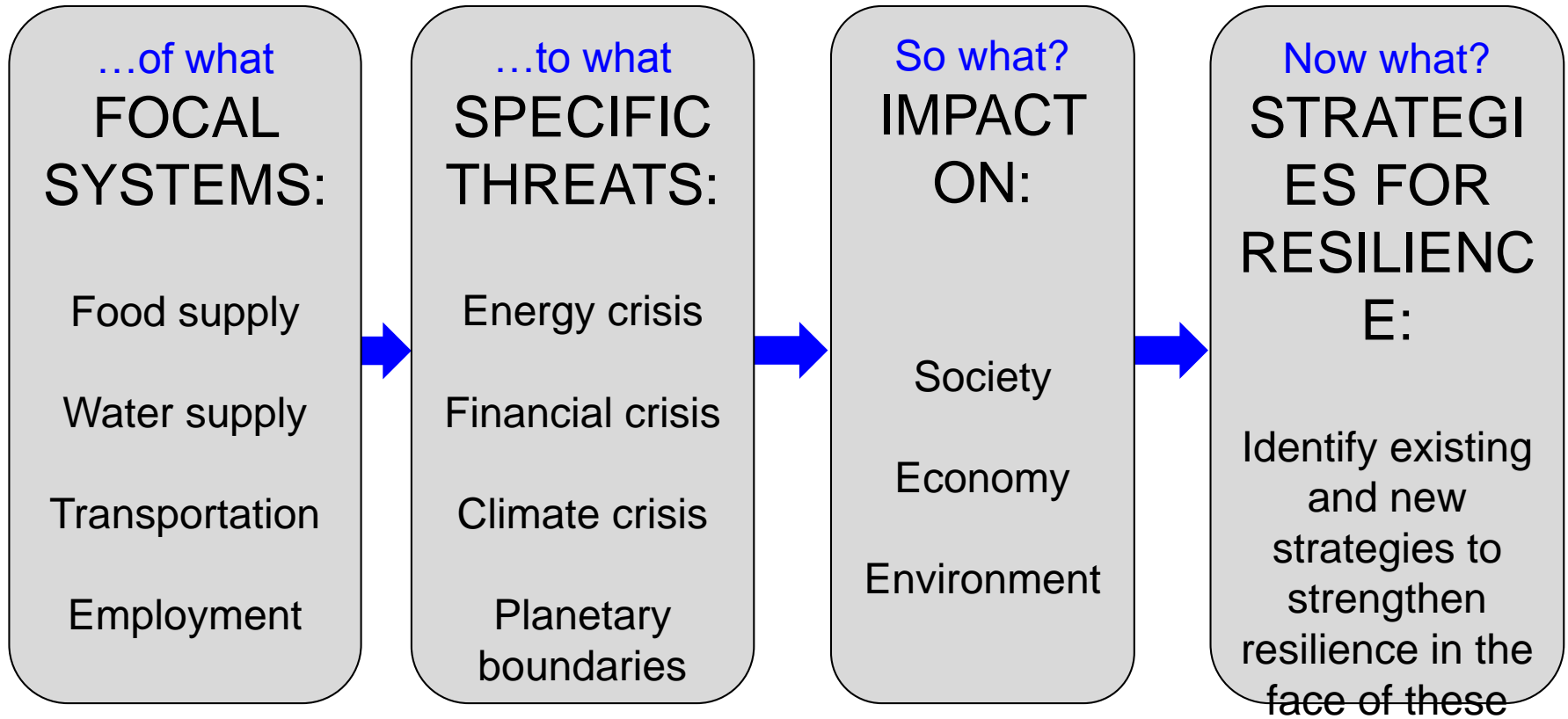
Policy and planning for sustainable development

Assessing Resilience in Social-Ecological Systems: Workbook for Practitioners

Resilience Alliance

Medium sized
Green leader
Shifting economic possibilities

Resilience Assessment Process in Eskiltuna ...



Contributions of Resilience Assessment

LEARNING

Application on their system

Assumptions about the systems we manage

Concepts

Method for analysis

Brings in

- Complex adaptive systems thinking
- Planning for long-term uncertain threats

...strengthen

- Operationalization
- Holistic perspective and sector integration

Process

COMMON SYSTEM UNDERSTANDING

Application on governance?

Historical perspective on changes

Interconnectedness between parts and across scales

System dynamics

...and has a potential to

- Clarify the shared vision
- Provide alternatives to “Business as Usual”



Why resilience?

What is resilience?

Operationalizing resilience

Resilience & Sustainability

Resilience for the Anthropocene



Anthropocene will produce surprise, loss, reorganization and demands transformation

Resilience can act as an 'operating system' or framework for living in the Anthropocene

Resilience focuses on both sustaining what we want to persist

Building the capacity to adapt or transform into something better

Learning & Resilience Need One Another

“Learning provides an alternative for crisis”

-Frances Westley 1995

Resilience is ability to persist despite
surprise

To adapt to surprise you have to be able to
learn

Learning requires being able to have
experiments fail, & that requires resilience

Four Dimensions of Resilience Management

Bridging different knowledge systems for learning

e.g. Build local ecological knowledge

Building Resilience

e.g. Nurturing diversity for reorganization and renewal

Experimental Management

e.g. management integrates monitoring, adaptation and mitigation activities

Navigating larger context

e.g. Building external networks & collaborations – building cross-scale resilience

Resilience Building Strategies

Maintain function

- response diversity provides insurance
- functional diversity maintains functions
- cross-scale diversity provides robust function

Nurture sources of renewal

- Enhance mobile links; support areas;
- cross-scale function; experiments

Manage disturbance

- Allow failure; Produce & maintain legacies; maintain patterns

Slow release (omega)

- Avoid loss of 'capital', maintain legacies

Create alternatives (alpha)

- Create shared vision, wait for windows of opportunity, develop new feedback loops,

Criteria for a “good” anthropocene

- Fair
 - location of birth doesn't dominate life chances
- Prosperous
 - many opportunities to live fulfilling life
- Sustainable
 - civilization strengthens rather than undermines our biospheric life support
- Resilient
 - Able to cope & benefit from surprise

• Fun?

For more information

Garry Peterson homepage
www.stockholmresilience.org/peterson

Stockholm Resilience Centre
www.stockholmresilience.org/

Twitter:
[@resilienceSci](https://twitter.com/resilienceSci)

Resilience Alliance
resalliance.org

Ecology & Society
Ecologysociety.org