Ecological Resilience: an African perspective

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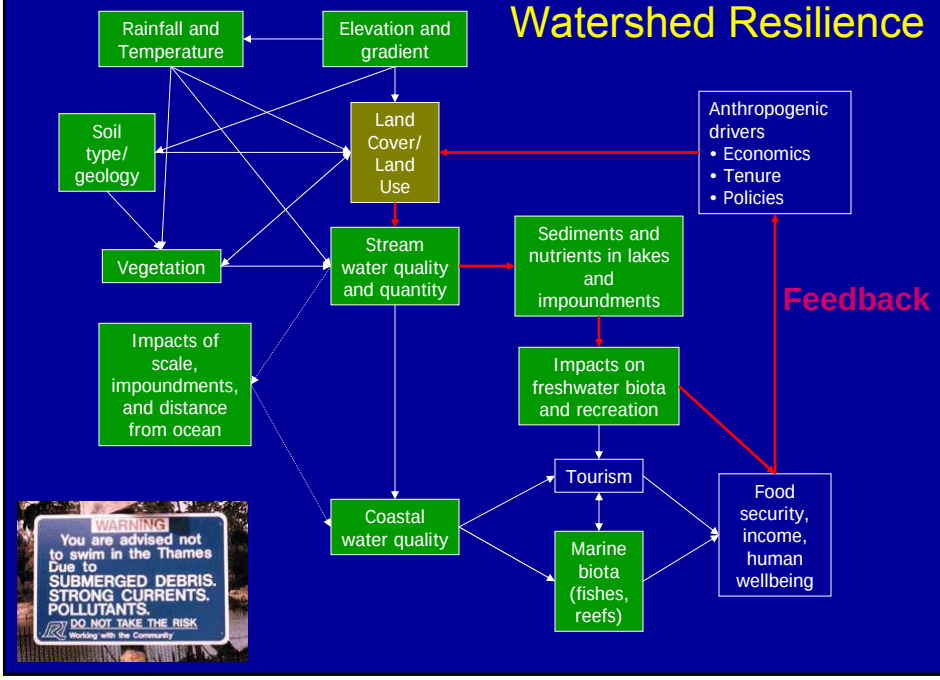
Resilience: Definition

- The amount of change that a system can undergo and still maintain the same controls on function and structure.
- The system's ability to self-organize.
- The degree to which the system is capable of learning and adaptation.

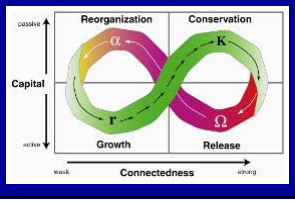
(Carpenter et al. 2001, *Ecosystems 4:765-781)*

Watershed Resilience



Resilience is Integrative

- Interconnections between different systems
- Dynamic change
- Transfer of ideas and metaphors between systems (e.g., adaptive cycle)
- Platform for interdisciplinary research.



Resilience: too abstract?

- Can't be measured directly (?)
- Systems too big or too slow to experiment on
- Many complexities are apparently irreducible
- Contingent on future (unknown) conditions

Resilience: operational or not?

To operationalize resilience, clarity must first be achieved on:

- Scale of analysis, spatial and temporal;
- System components and relationships that are considered "essential";
- "Who decides": actor(s) of interest, including the visions and values of the researcher and the community;
- Specified future perturbations.

Resilience: operationalization

A social-ecological system can be defined as consisting of essential actors, components, and interactions.

System identity consists of maintaining these elements through space and time.

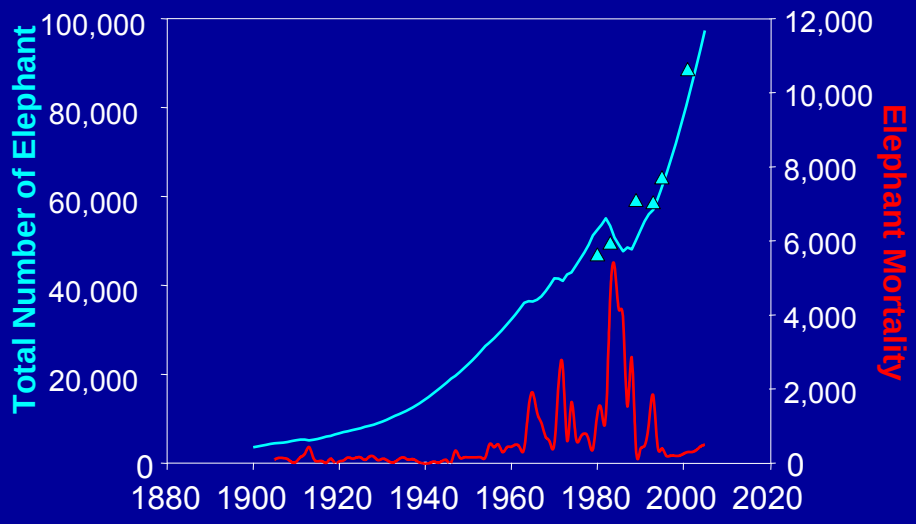
Resilience can thus be redefined as the ability of the system to maintain its identity in the face of internal change and external perturbations.

(Cumming et al., 2005, *Ecosystems* 8: 975-987)

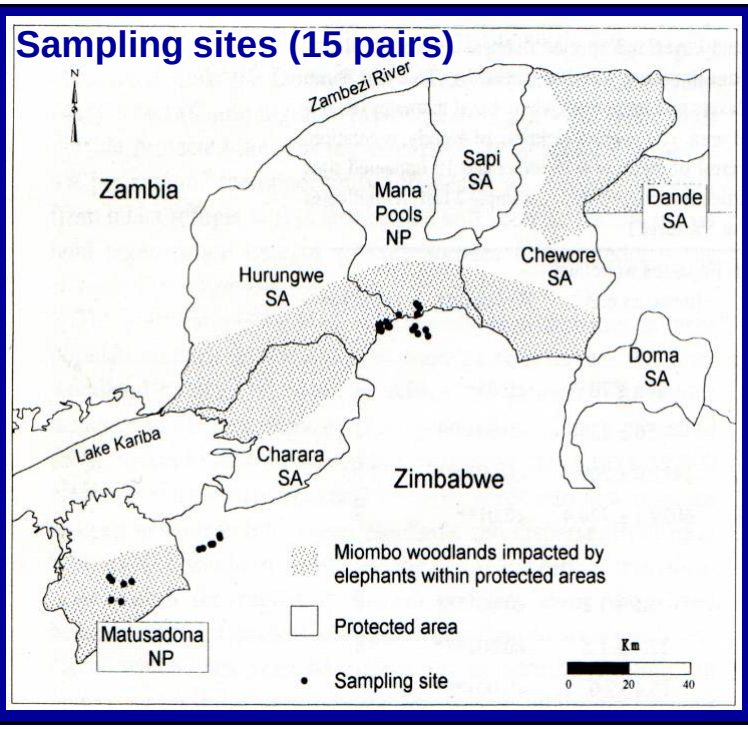
Identity Examples

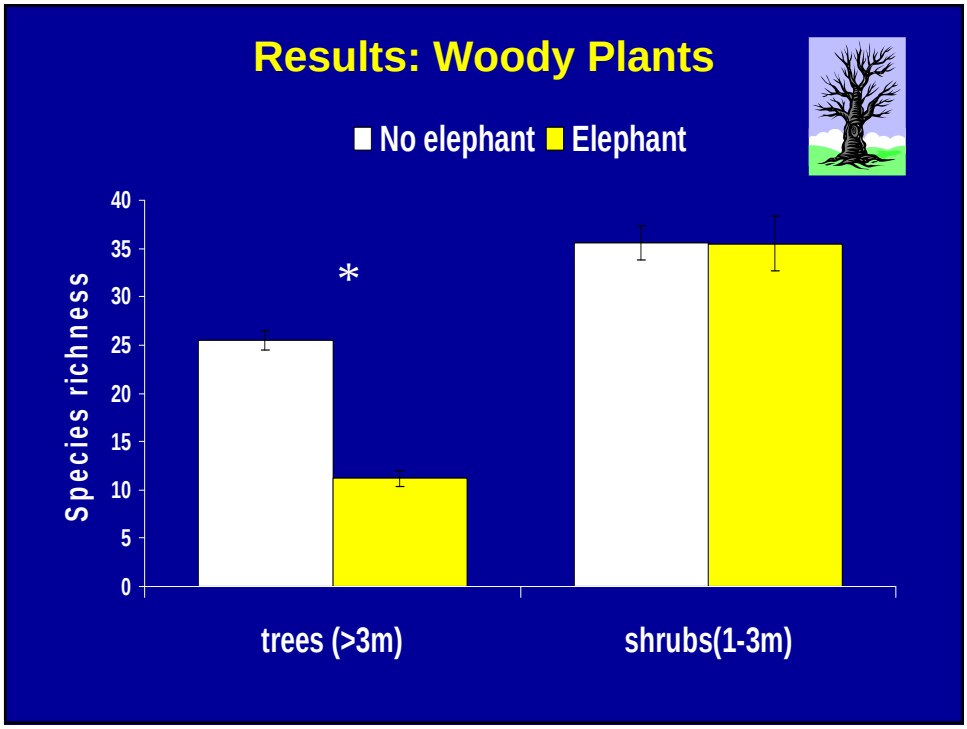
Property	Ecological Example	Zim example	Identity threshold eg
Components (essential)	Habitat amount	% area of Miombo woodland	Loss of more than 30% of area
Relationships (functionally relevant)	Food webs	Pollination, nest cavity excavation	>20% pop decline in sunbirds or barbets
Innovation (sources)	Biodiversity	Species or pop loss	>20% reduction
Continuity	Seed banks, dist legacies	*Acacia* recruitment post fire	Loss of >50% in year class

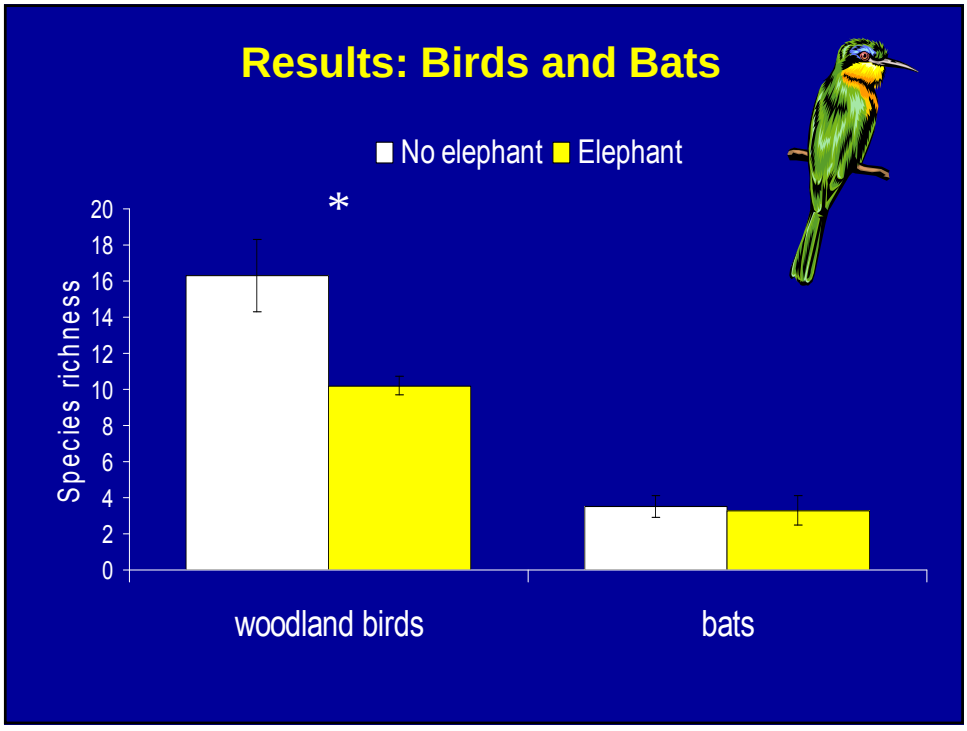
Example: Elephant and their impacts



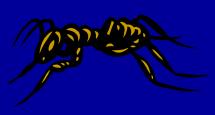
Sampling sites (15 pairs)

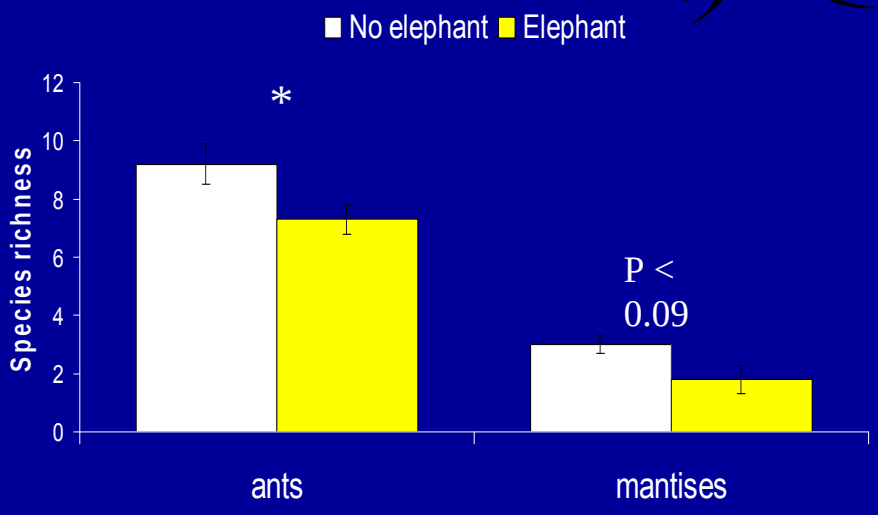



Results: Woody Plants
No elephant
Elephant
Species richness
40
35
30
25
20
15
10
5
0
*
trees (>3m)
shrubs(1-3m)


Results: Birds and Bats
No elephant
Elephant
Species richness
20
18
16
14
12
10
8
6
4
2
0
*
woodland birds
bats

Results: Insects

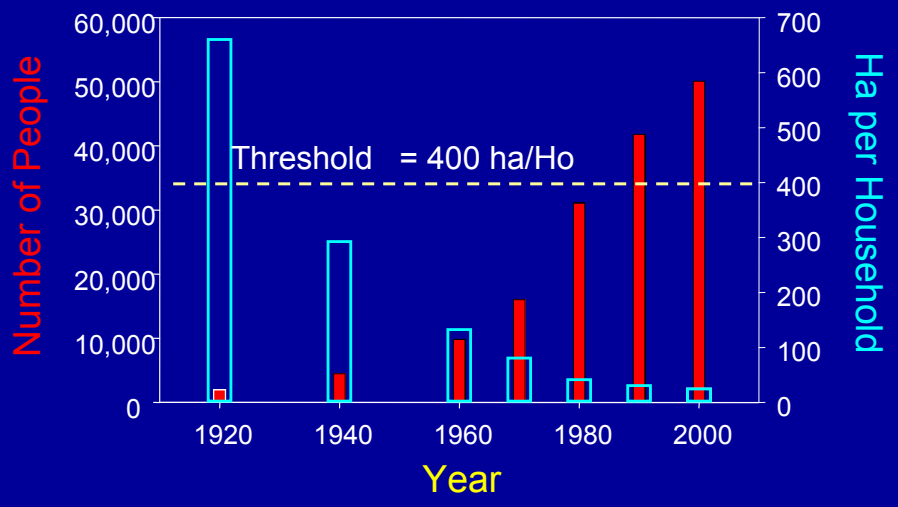




Fenceline Contrasts show:

- High densities of elephants had a negative effect on species richness of trees, ants, and woodland birds.
- Loss of large trees and regime shift to thicket well under way
- Reduction in structural and compositional diversity – clear indicators of decreasing resilience?

Meanwhile…



Matibi II Communal Land, SE Zimbabwe. With minimal external inputs a household requires 20 ha arable land (4ha plot, minimum five year rotation) and c. 400 ha grazing land to support 25 head of cattle and 35 goats.

Capturing Ecological Resilience

Ecological system: key components are species, including full range of ungulates, predators, birds, insects, plants, etc.

Key relationships are structural and trophic

Long-term memory from seed banks, old-growth woodlands and trees, long-lived animals

Regimes driven by herbivory, fire, drought

Enhancing Ecological Resilience

- Higher biodiversity
- Full complement of functional groups
- Natural heterogeneity/patch mosaic
- Maintaining capacity for broad-scale responses (migration, spatial subsidies)
- Maintenance of natural disturbance regime (especially fires and floodplain dynamics)

Capturing Social Resilience

Social system: key components are people, their livelihoods, and their rules, laws, customs, attitudes.

Key relationships include governance, social networks, kinship

Long-term memory from older people, libraries, aerial photographs, etc.

Regimes driven by politics, laws, history

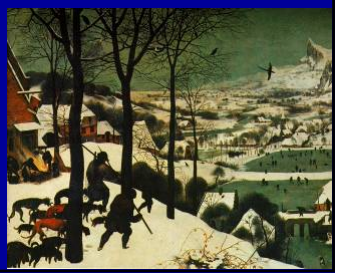
Enhancing Social Resilience

- Increased financial capital
- Diversification of livelihoods
- Increases in trust and community cooperation
- Better education
- Enhancing local response capacity through appropriate institutions and organizations
- Creating appropriate incentives for abiding by laws

Capturing the Social-Ecological System

Social-ecological system: key components are people and other organisms as well as essential maintenance components (e.g., water quality and quantity, soil fertility).

Key relationships link the two systems – e.g., land tenure, land use, management, agriculture, hunting.



Social-Ecological Resilience

Social resilience and ecological resilience may be in conflict.

Focusing on ecosystems can reduce social resilience (e.g., invasions of game farms in Zimbabwe)

Exploiting ecological capital can create financial capital and increase social resilience.

Eventual outcomes depend on tightness (and speed) of feedbacks between ecosystems and people. "Sometimes, trashing the ecosystem is your only option for survival".

Scale-Related Complications

Local system dynamics are greatly complicated by higher-scale processes:

- Interference of central government in local governance
- Attempts by central government to capture capital
- National regulations and (lack of) law enforcement
- Remittances from "external" family members
- Global societal attitudes and external markets
- Aid organizations and NGOs
- CITES (Convention In Trade in Endangered Species) reduces potential profits from elephant safari hunting

Summary

- Resilience theory can be better operationalized through clarifying scale, identity, and key future concerns
- Ecological Resilience ≠ Social Resilience ≠ Social-Ecological Resilience
- Elephant problem: wicked, but adopting a resilience perspective helps describe and understand root causes and system dynamics