# Resilience what is it?

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Resilient Environment: Resilient communities,
ECO conference, 1-3 July 2011

## Coastal ecosystems are the melting pot where terrestrial and marine influences interact –our most multi-use ecosystems

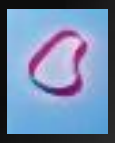
# What are the threats?

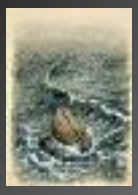
- Land management (especially sedimentation, urbanisation, non-point source contaminant runoff, sewage, rubbish, changes in freshwater flows)
- Coastal reclamation, changes to hydrodynamics, maintenance dredging
- Mining (sand, gravel, mineral nodules, diamonds, oil, gas etc.)
- Fishing (especially trawling and dredging)
- Incidents (e.g., oil spills)
- Power generation
- Invasive species
- Eutrophication
- Climate change
- ……

And what are the responses?

# Many definitions in ecology and environmental science

- The potential for recovery from disturbance, sometimes called engineering resilience
- A variable that represents the movement of an ecosystem within and between different states, also called ecological resilience
- The capacity of an ecosystem to adapt or transform, useful from a resource management perspective
- The ability of an ecosystem to maintain its identity in the face of both internal and external forces, this represents an insurance against potentially adverse changes in the delivery of ecosystem goods and services
- Confused? Always be clear you understand Resilience of "what" for "what"





Thrush, S.F., Hewitt , J.E., Dayton, P.K., Coco, G., Lohrer, A.M., Norkko, A., Norkko, J., Chiantore, M. (2009) Forecasting the limits of resilience: integrating empirical research with theory. *Proceedings of the Royal Society B-Biological Sciences, **276, 3209-3217.***

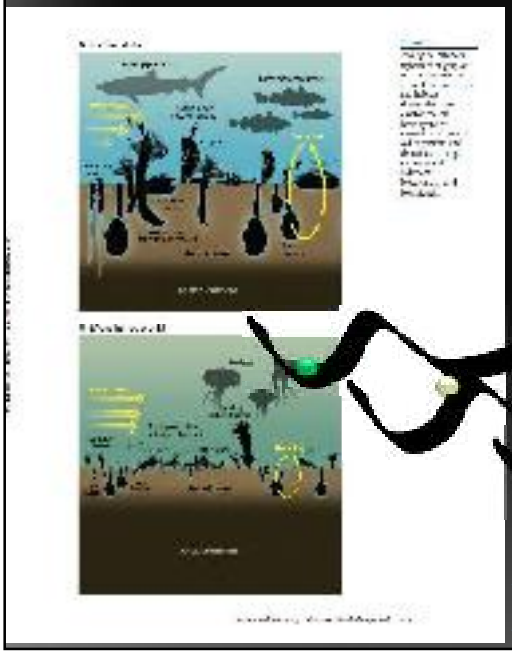
## A way of thinking and problem solving


Increasingly, cracks are appearing in the capacity of communities, ecosystems, and landscapes to provide the goods and services that sustain our planet's well-being. The response from most quarters has been for "more of the same" that created the situation in the first place: more control, more intensification, and greater efficiency.

"Resilience thinking" offers a different way of understanding the world and a new approach to managing resources….

http://www.resalliance.org

## An ecologists perspective



The ball and basin analogy:

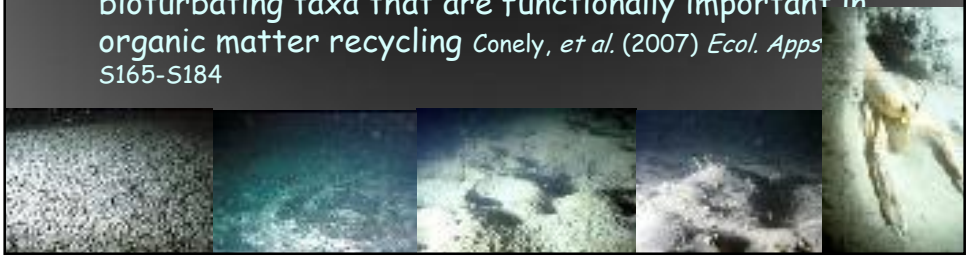
Resilience recognises that ecosystem are dynamic and that profound changes can occur in both directions

Loss of resilience can occur due to environmental forcing or Ecosystem dynamics or a combination of the two

Thrush, S.F., Dayton, P.K. (2010) What can ecology contribute to ecosystem-based management? *Annual Review of Marine Science*, **2, 419-441.**

# When small changes matter

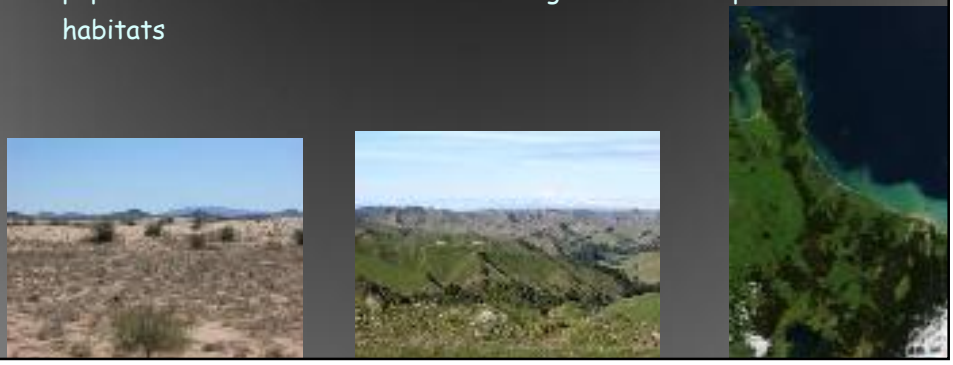
- Loss of resilience frequently implies escalating degradative ecological change as alterations in the disturbance regime feedback onto local and regional changes in ecological communities Folke, *et al.* (2004) *A. Rev. Ecol. Syst.* 35, 557-581
- For example, eutrophication-induced hypoxia and anoxia has reduced the role of deep-burrowing, and bioturbating taxa that are functionally important in organic matter recycling Conely, *et al.* (2007) *Ecol. Apps* S165-S184



# But what of the dynamical consequences of chronic disturbance?

## Do cumulative effects occur on the coast?

Habitat loss, fragmentation, and homogenization of natural communities alter the patterns of connectivity, potentially isolating populations and communities and limiting them to suboptimal habitats



# Connectivity in Marine Ecosystems?

- Limits to dispersal and decreased connectivity are important constraints on the resilience of benthic communities
- This influences the potential for recovery both in disturbed areas and across seafloor

# Results

- Our field experiment emphasizes the importance of ecological and physical connectivity.
- Disturbance and recovery interact
- Cumulative effects are a real threat to estuarine ecology
- Think about RMA processes
- Think about thresholds vs gradual degradative change

Thrush, S.F., *et al.* (

# Regime shifts

(thresholds, step-trends, criticality, phase shifts, rapid transitions or tipping points)

- Increasingly reported in marine ecosystems as a result of anthropogenic stress, climatic/oceanographic change or the interaction of the two.
- Evidence is accumulating that interactions between the intrinsic ecological dynamics and chronic, cumulative, or multiple stressor effects can lead to regime shifts.

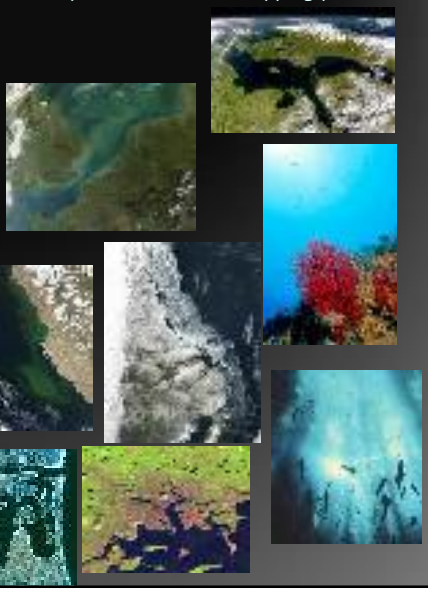
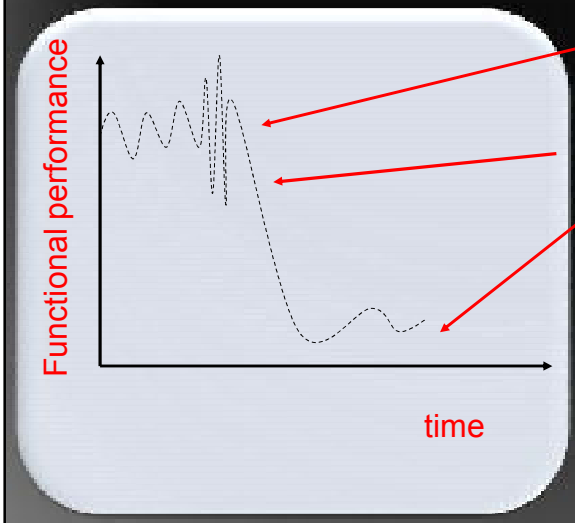


Photo credits: Visible earth; Paul Dayton, Rod Budd

# The implications are significant!




Shifts in environmental characteristics or resource quality/quantity, intrinsic dynamics

Snap feedbacks

Unfortunate consequences:

Loss of function

Homogenisation of communities and ecosystems

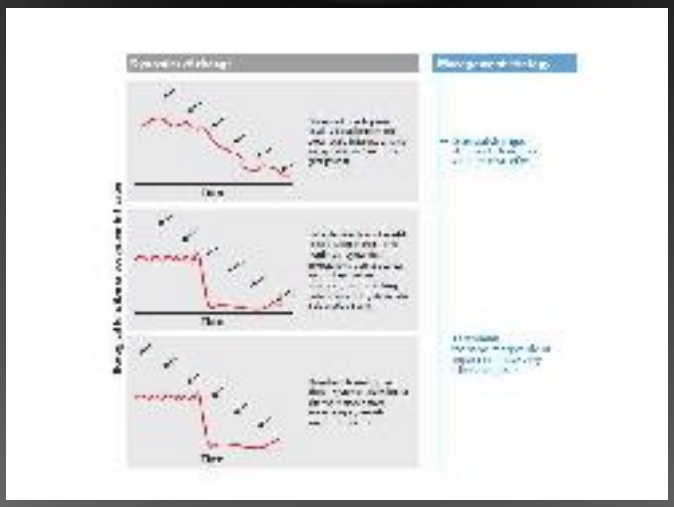
Loss in food web complexity

Loss of biogenic habitat structure,

Decreases in the size of organisms

Slow recovery to previous state

## The potential for threshold responses should profoundly influence management



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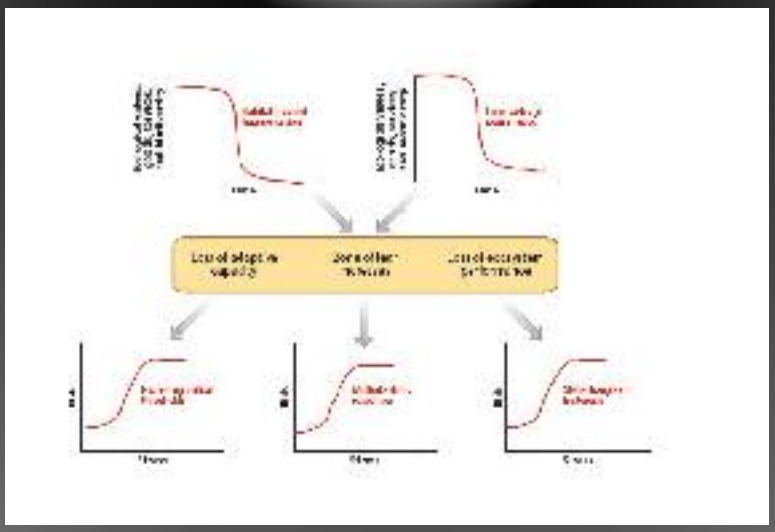
## Cumulative and interactive effects radically shift risk profiles



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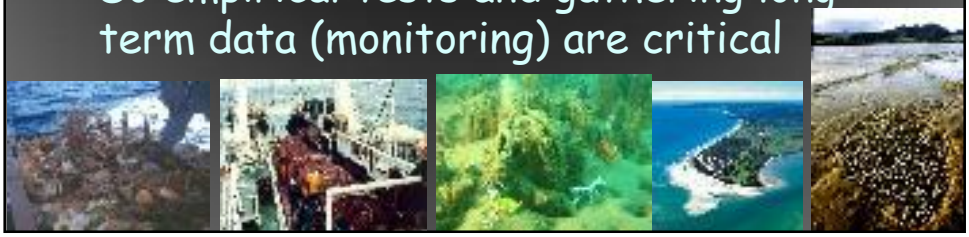
## Expect surprises

- We now understand ecological systems enough to know that it is not only our ignorance that leads to surprises
- It is also a feature of the way ecosystems can function
- So empirical tests and gathering long-term data (monitoring) are critical



## Ecosystem-based management and resilient systems

- Maintaining adaptive capacity
- Restoring biodiversity
- Considering all nature's un-priced services
- Enhancing multi-functionality
- Integrating management strategies