Science for Managing the Great Barrier Reef

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Changing Paradigms in Marine Science

Scaling-up of ecology – becoming more relevant for management

Fisheries science is becoming more ecological (EBM)

Barriers between ecology, fisheries, and social science are breaking down – e.g. No Take Areas

Talk Outline

- Global threats to coral reefs
- Resilience and phase-shifts of reefs
- No-Take Areas: Tools for managing ecological resilience
- A resilience approach to reef management

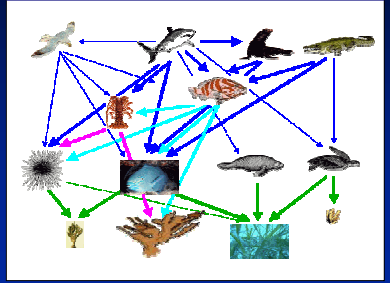
RESILIENCE

- The capacity of a system to absorb insults or disturbances without fundamentally changing into an different configuration or "state"
- The system can be ecological, socio-economic or both (a linked social-ecological system)
- Alternate states may be desirable or undesirable, and so management may seek to bolster or undermine resilience

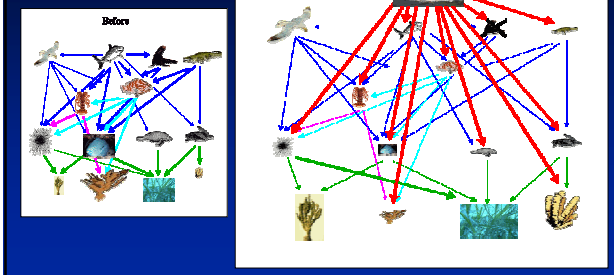
Major threats to Coral Reefs

- Over-harvesting (top-down effects)
- Declining water quality (bottom-up effects)
- Climate change

Coral reef FOODWEB

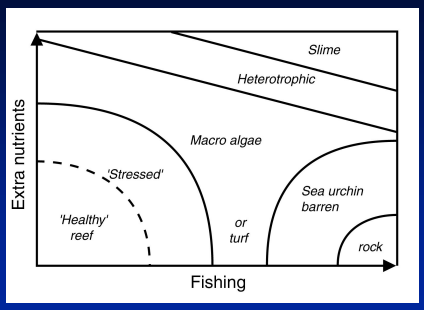


Coral reefs



Phase-shifts on coral reefs

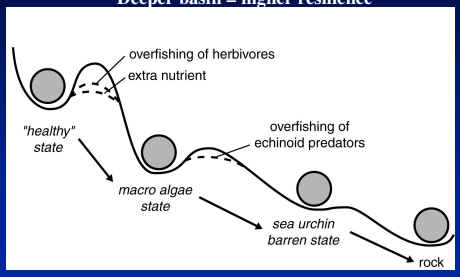
Multiple Drivers, multiple States



Phase-shifts on coral reefs

Basins of Attraction in Stability Landscapes

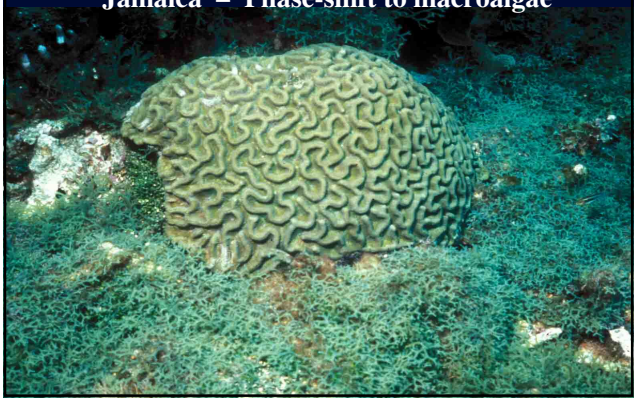
Deeper basin = higher resilience



Jamaica 1979

Jamaica 1980

Jamaica – Phase-shift to macroalgae



…but are gloom-and-doom stories from overseas developing countries relevant for Australian reefs?

- Overseas evidence is flawed or doesn't apply
- Our fisheries are the best managed in the world
- Threats to reefs are exaggerated
- Our reefs are pristine

So, what is the "health" of the GBR?

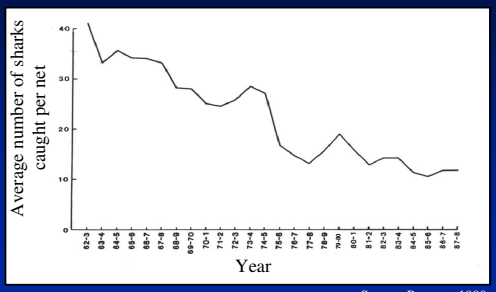
- The Great Barrier Reef is not pristine
- Increased runoff since 1850
- Wild stocks of many species have been substantially reduced:
  - Crocodiles
  - Dugongs
  - Pearl Oysters
  - Sea Cucumbers
  - Sharks
  - Turtles
  - Reef Fishes

Historical evidence of huge dugong herds

"The writer's boat was once anchored in Hervey's Bay… For between three and four hours there was a continuous stream of dugongs passing… liken to the rush of cattle out of a stock-yard after a general muster."

Source: Thorne, 1876

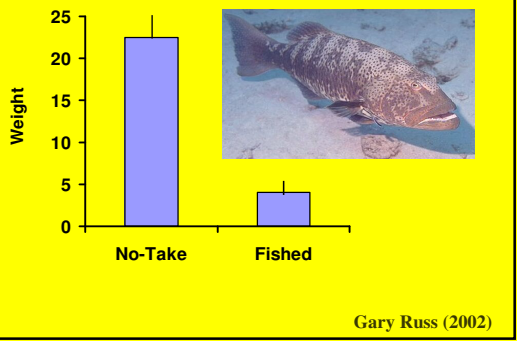
Average number of sharks caught annually per net (1962-1988)



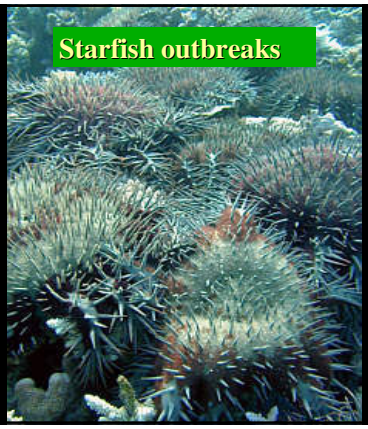
Source: Paterson 1990

FISHING PRESSURE

Coral Trout



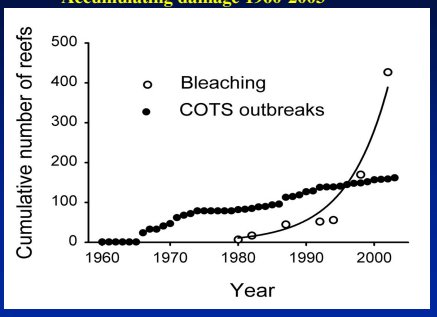
Gary Russ (2002)



Climate-change Impacts: Coral Bleaching

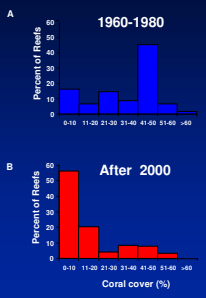
Great Barrier Reef

Accumulating damage 1960-2003

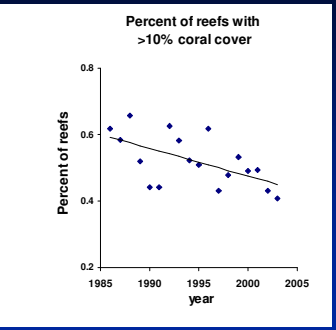


Bellwood, Hughes, Folke & Nystrom, *Nature* 2004

Coral cover on the GBR: 1960's - Present



Coral cover on the GBR: 1986 - Present



AIMS monitoring data

Resilience eroded by loss of top predators, crown-of-thorns starfish, bleaching……a weedier fauna

Summary of GBR:

Megafauna rapidly declining, reefs moderately fished, coral resilience challenged by chronic crown-of-thorns outbreaks and climate change.

High redundancy within functional groups:

High connectivity

Managing Resilience of Coral Reefs

by incorporating the role of human activities

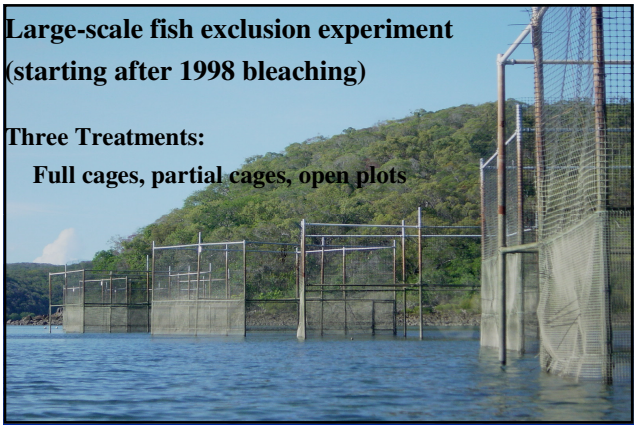
What are the consequences of loss of large fishes from coral reefs?

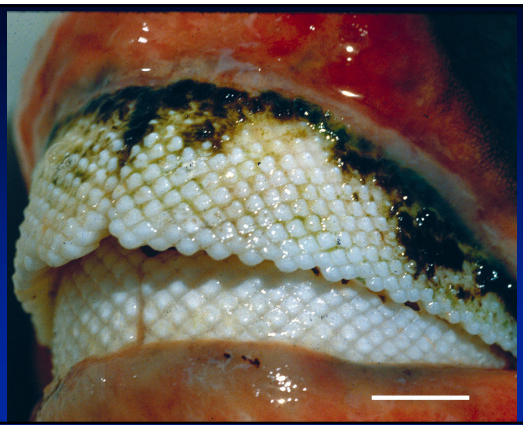
In particular, does overfishing of herbivores reduce reef resilience to climate change?

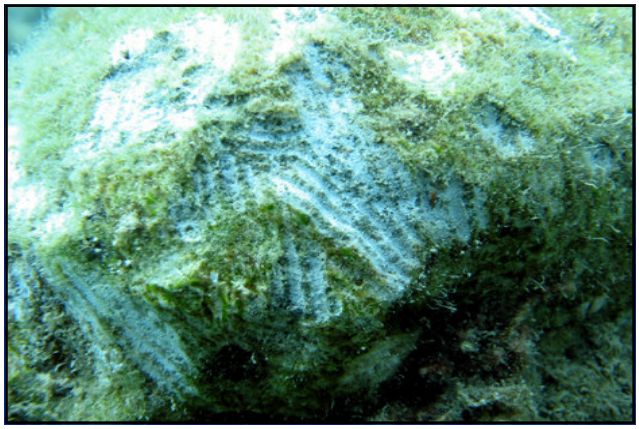
Large-scale fish exclusion experiment (starting after 1998 bleaching)

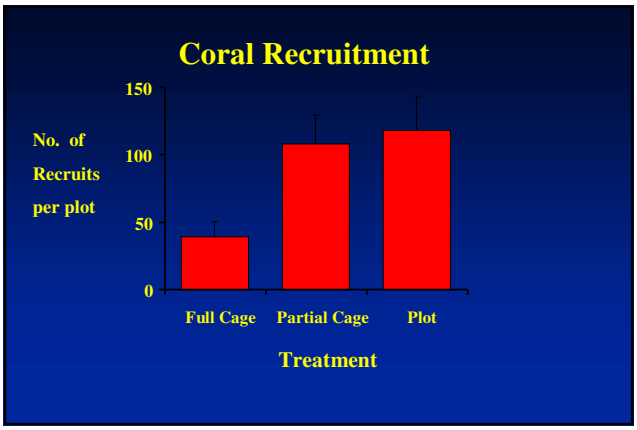
Three Treatments:

Full cages, partial cages, open plots









Loss of fish biodiversity is important!

- Excluding herbivorous fishes increases macroalgae, reduces coral recruitment, impairs *resilience*
- Managing fisheries (and also water-quality) can prevent phase-shifts, help to maintain reef resilience to future climate change.
  (Local, proactive management in response to a global threat)

A Resilience approach to Management

A new framework for Adaptive Governance

- Changing focus from reactive to *proactive* management, *based on maintaining resilience, anticipating* future uncertainty
- Building an understanding of resource and ecosystem *dynamics* - developing new metrics to monitor resilience
- Developing management practices that respond to ecological feedbacks
- Supporting an adaptive governance framework with shared responsibilities, operating at multiple scale.

Hughes et al., TREE 2005

ACKNOWLEDGEMENTS

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