

Coral reefs and the history of their degradation

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Overview

- What are coral reefs and Why should we care?
- What's the problem?
- What are the long-term trends?
- Recommendations



What are coral reefs?

- I) Diverse, complex, and productive
< 0.2% of the ocean, 25% diversity
32 of 34 known phyla
- II) Reefs are some of Earth's oldest ecosystems
- III) 3-dimensional structures built totally from the activity of their animal and plant inhabitants
- IV) Live in the warm, clear, shallow waters of tropical oceans



- Corals build the reef
- Form massive 3-D structures
- Accumulate over vast amounts of time

Complexity - interaction



Tropical Coral Reefs

Fringing Reef - Fiji



Great Barrier Reef
- Australia



Atoll – French Polynesia

How Do People Depend on Reefs?

- Assets to local and national economies
 - Fisheries for food, materials for new medicine, tourism and recreation (also aquarium trade, subsistence)
- Barriers to erosion – coastal protection
 - Natural harbors and storm protection



Why Save the Reef's Creatures?

- 1) You care about the people who depend on reefs



Why Save the Reef's Creatures?

- 2) Stability may depend on diversity
So maintain storehouse of diversity
to maintain the ecosystem
(no fish to eat if the ecosystem is gone)



Overview

- What are coral reefs and Why should we care?
- **What's the problem?**
- What are the long-term trends?
- Recommendations



What's the Problem?

- Direct human impacts



- Climate change



Overview

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- **What are the long-term trends?**
- Recommendations



Historical Perspective

- Deep time (thousands to hundreds of thousands ybp)
- Archaeological records (hundreds to thousands of ybp)
- Historical records (last 500 years)
- Modern ecology (last 50-100 years)

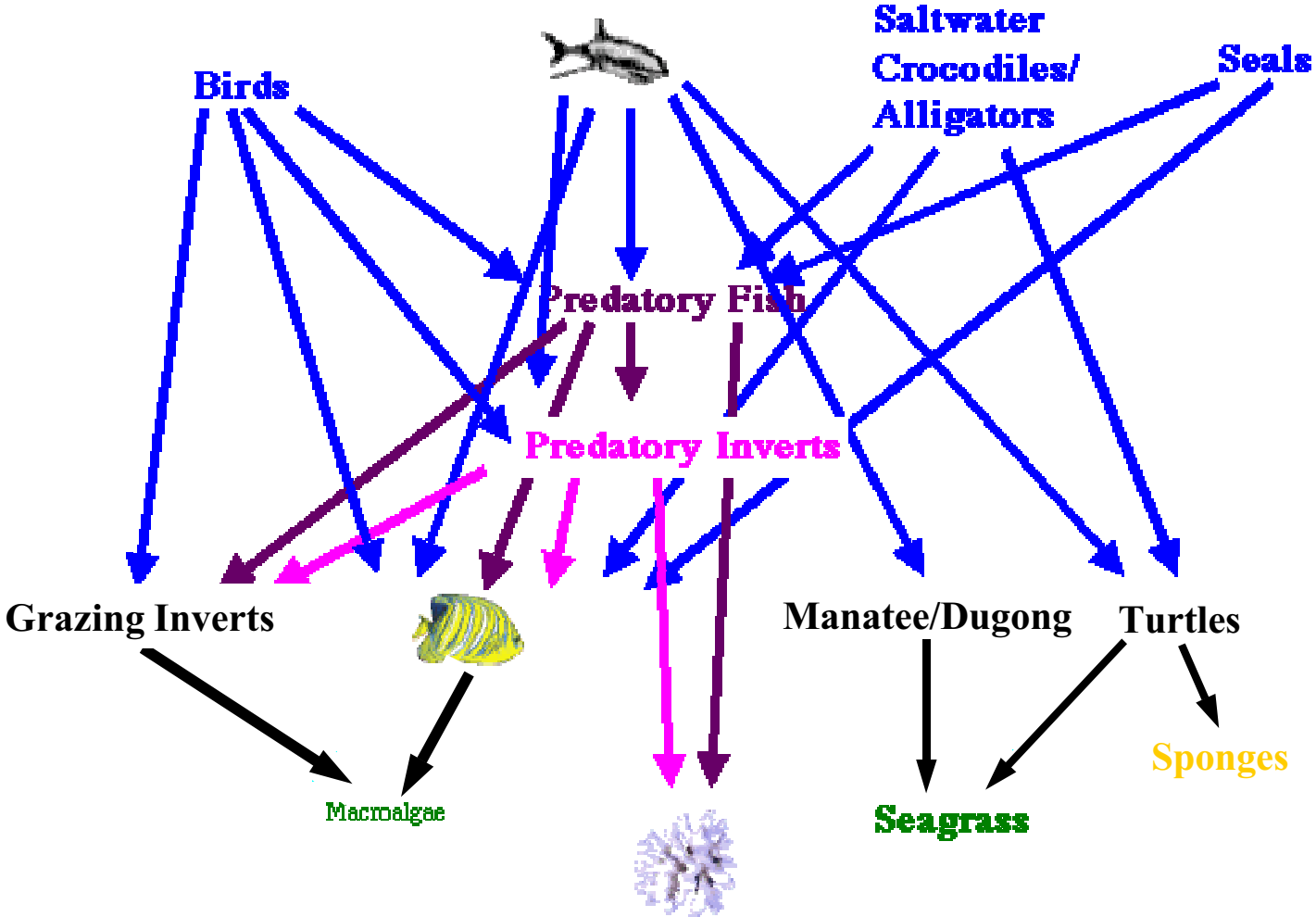




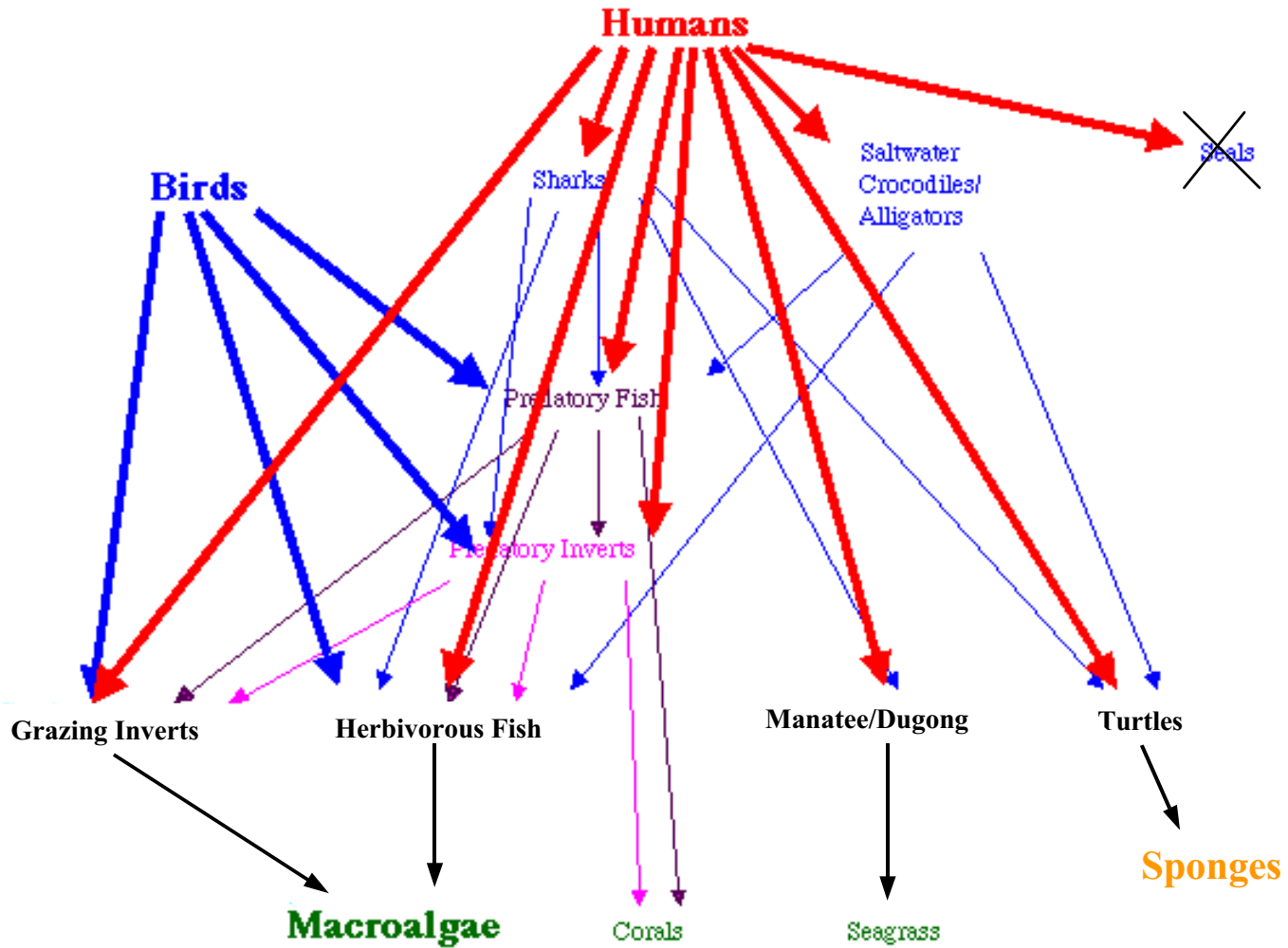
Historical
overfishing
and the Recent
collapse
of coastal
ecosystems

Jackson et al. 2001

Coral Reef Seagrass
Before Human Predation



Coral Reef/Seagrass With Human Predation



Sea Turtles

“...it is affirmed that vessels, which have lost their latitude in hazy weather, have steered entirely by the noise which these creatures make in swimming, to attain the Cayman isles.”

Edward Long, *The History of Jamaica*, 1774



late 1600's

Bermuda Timeline

Turtles:

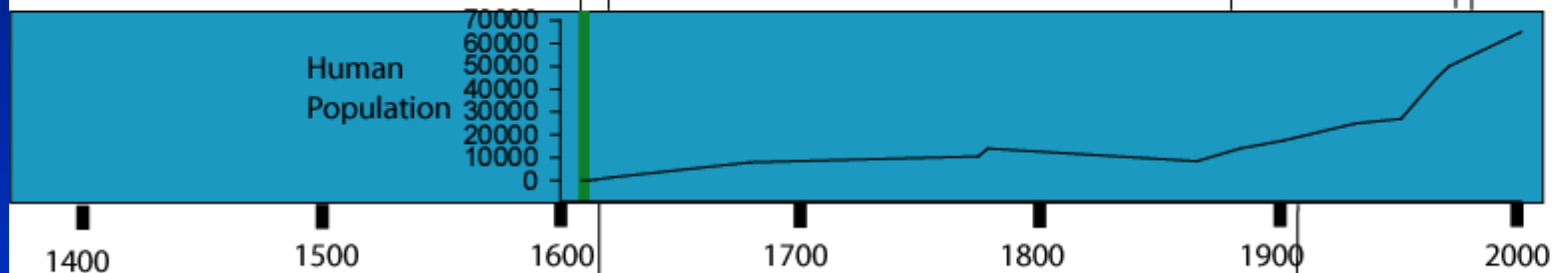
1620
Law prohibits
taking small turtles

1609
Great store
of turtles

1973
Turtle fishery closes

1880
Turtle fishing all but
'passed away'

1980
Turtles are
"endangered species"



Whales:

1615
First whaling industry
of the New World starts

1904
Whales so rare that
they are not even hunted



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How do we quantify loss through time?

- Cultural Periods

- Pre-human to today

- Ecosystem States

- Populations pristine to extinct

- Communities surveyed

- Megafauna

- Architects

Cultural Periods

Pre-human (40,000 bp – 1503)

Hunter-gatherer (20,000 bp – 1824)

Agricultural based (1400 – 1800)

Colonial occupation (1500 – 1850)

Colonial development (up to 1900)

Modern I: 1900-1950

Modern II: 1950-2002



Ecosystem State

Pristine	Detailed historical record of marine resource lacks any evidence of human use or damage. <i>Example: Fossil corals</i>
Abundant/ Common	Human use with no evidence of reduction of marine resource. <i>Example: No reduction in size of fish vertebrae in middens</i>
Depleted/ Uncommon	Human use and evidence of reduced abundance (number, size, biomass, etc.). <i>Example: Shift to smaller sized fish, decrease in abundance, size, or species proportional representation</i>

Ecosystem State (con't)

Rare	Human use and evidence of severe impact. <i>Examples: Truncated geographic range; greatly reduced w/r/t original population size; harvesting of pre-reproductive individuals; CPUE significantly increased; sightings < 1 dive.</i>
Ecologically extinct	So rare that there are few direct observations of its presence...OR...if numbers were zero there would be no further environmental effect. Human observation is newsworthy and a novelty. <i>Examples: Turtles.</i>
Globally extinct	Forever extinct. <i>Example: Caribbean Monk seal</i>

Communities surveyed

I) Megafauna

- Large and small carnivores
- Large and small herbivores



II) Architects

- Corals
- Seagrasses
- Suspension feeders (eg. oysters)

13 Study Sites

Bahamas

Bermuda

Cayman Islands

Jamaica

Inner Great Barrier Reef

Outer Great Barrier Reef

Moreton Bay, AUS

Panama (eastern)

Panama (western)

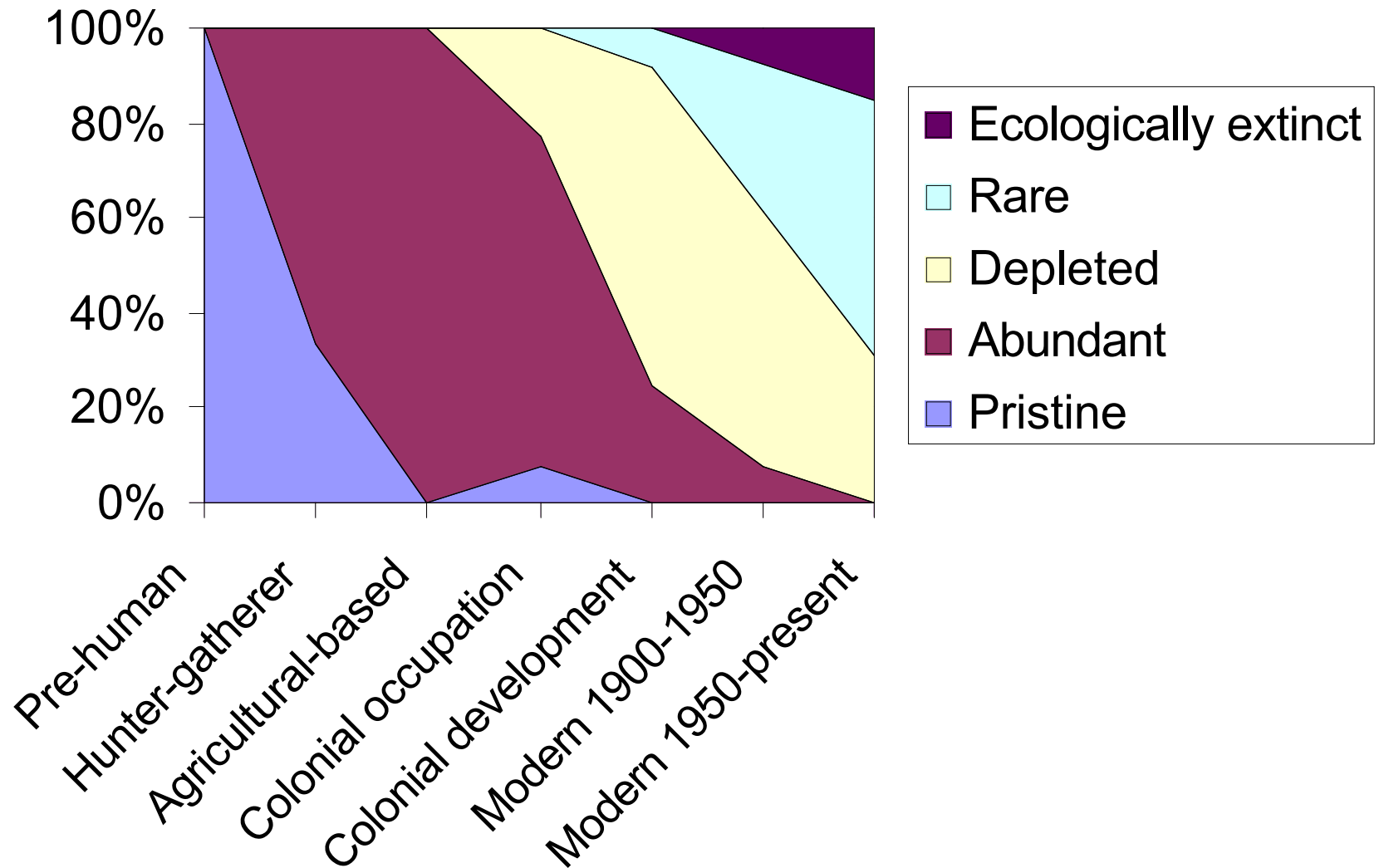
Torres Straits (AUS)

US. Virgin Islands

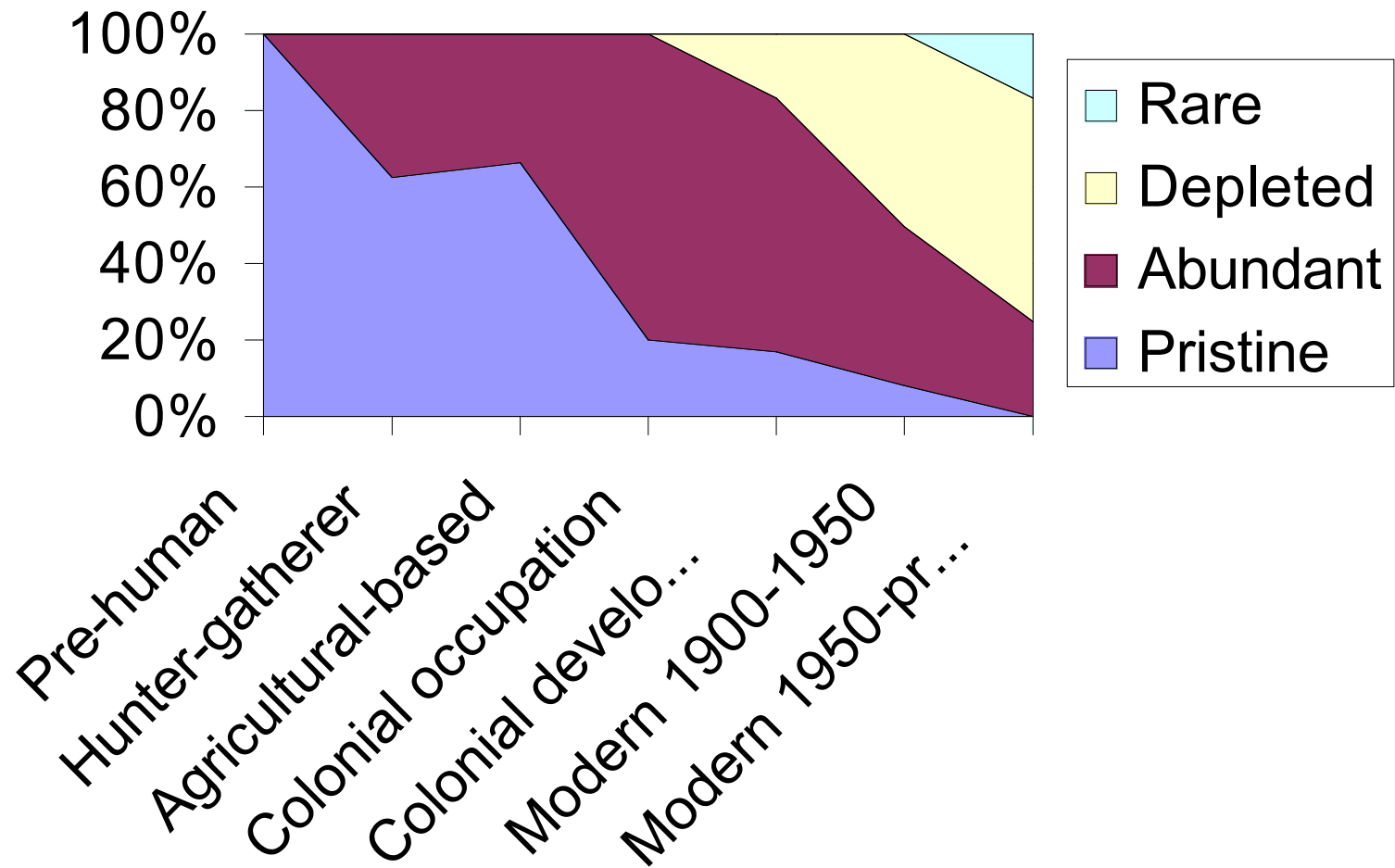
Red Sea (northern)

Red Sea (southern)

Megafauna



Architects - corals



Jamaica - Changes in the Megafauna

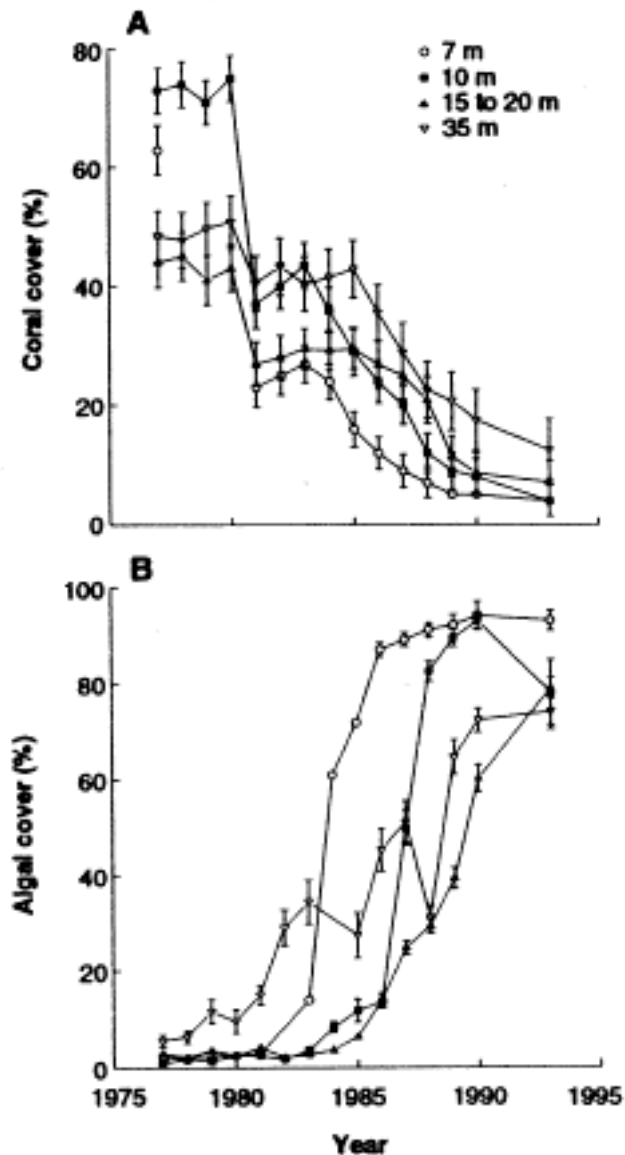
- Over-fishing of herbivorous fish
 - ◆ 1960's: fish > 9 inches rare
- Hurricane Allen 1980
 - ◆ 1980-82: Corals begin recovery

Disease to herbivorous sea urchin

- ◆ 1983: > 98% decline



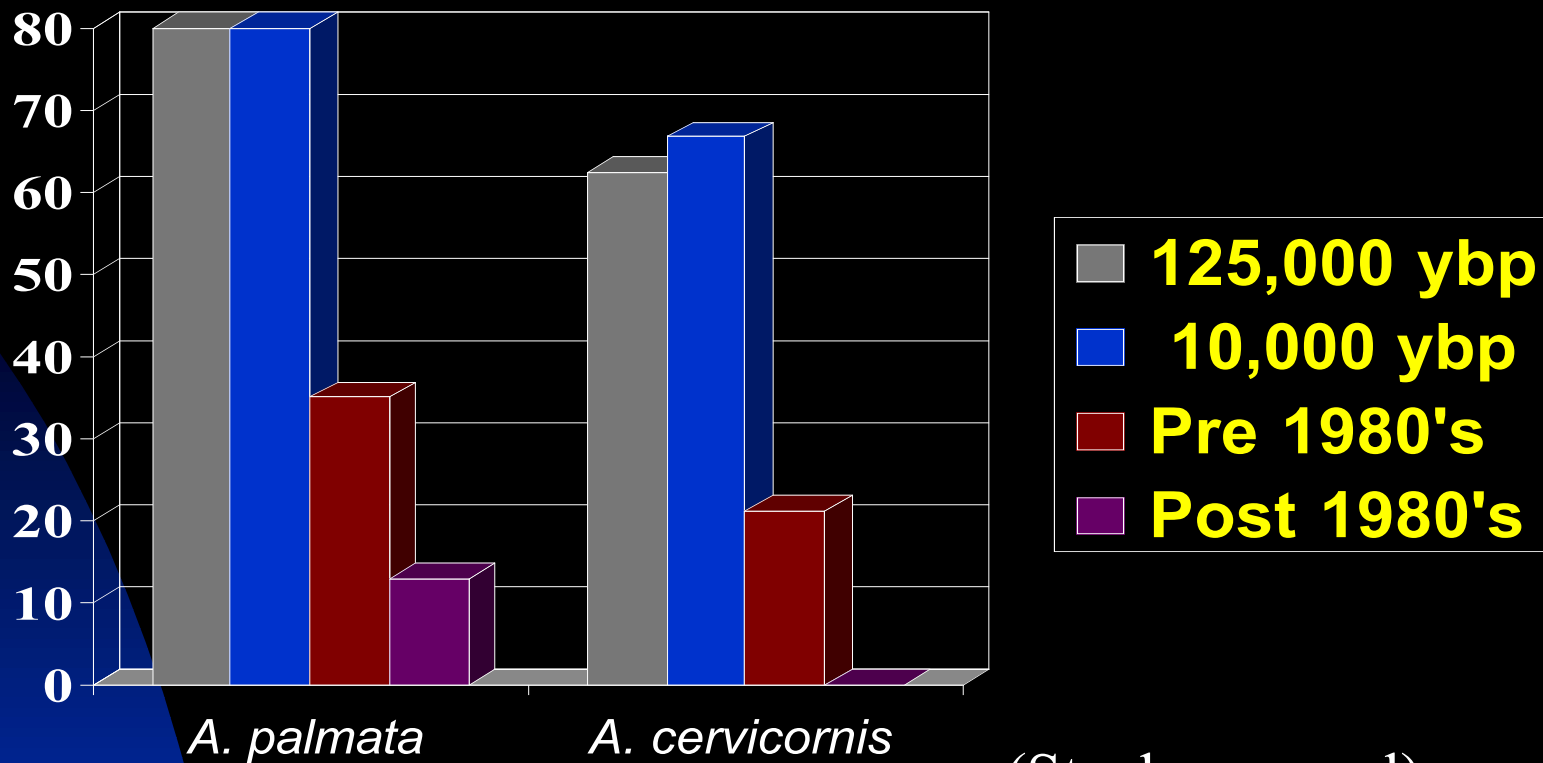
Jamaica - Changes in the Architects



Live Corals

Seaweed

%
Caribbean
sites



(Elkhorn coral)

(Staghorn coral)



Scientific Conclusions

- 1) Clear indications of degradation in coral reefs from earliest human use
- 2) There is a general trajectory of decline in all major ecosystem components of tropical coral reef communities
- 3) The variation among ecological groups means that historical analyses can be used to predict future ecosystem states – allowing managers to anticipate problems

Scientific Conclusions

- 4) History of population sizes of marine organisms must be known before modern population sizes can be properly evaluated and managed

Management Recommendations

I) The Problems:

- Unsustainable present use
- Large-scale
- Loss of marine megafauna

Management Recommendations

II) The Solutions:

- Huge reserves
- Change the *status quo*
- *Reef populations*
- *Management techniques*
- *Compensation, policing, reduction in efficiency of taking, brokering*

