Florida’s Coral Reefs in a Caribbean Context

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Florida and the Wider Caribbean

• Turnover on Caribbean reefs over the last 30 years
  – What we thought we knew: the story from Discovery Bay, Jamaica.
  – What we think we know now.

• How Florida’s reefs fit (or don’t fit) into Caribbean patterns.
Acropora cervicornis
Montastraea spp.
The narrative from Discovery Bay, Jamaica

Fore Reef

DBML
Decades to centuries of overfishing
Hurricane Allen, September 1980

Charlie Wahle
Disco Bay fore reef: from this (1978)
...to this (the day after, 1980)...

Lynton Land
Diadema mass mortality: 1983–84
...to this (2003).
Restoring herbivory should reverse algal dominance and recover corals.
Cayman Islands: fishing prohibited, so...kill corals and herbivores OR just kill enough corals.
Recent Turnover on Caribbean Reefs

- Coral mortality has been widespread and catastrophic throughout the wider Caribbean.
- Macroalgae dominate some reefs, both fished and unfished...
…but most Caribbean reefs are NOT dominated by macroalgae…

Côté, Precht, Aronson, unpublished data

71 studies
334 sites
1977–2001

Macroalgal Cover > Coral Cover

Macroalgal Cover >50%

Côté, Precht, Aronson, unpublished data
...and Florida's reefs have low coral AND low macroalgal cover

3,668 surveys; 1,967 sites 1971–2006

Recent Turnover on Caribbean Reefs

• Coral mortality has been widespread and catastrophic throughout the wider Caribbean.

• Macroalgae dominate some reefs, both fished and unfished, but…

• …high herbivory and low macroalgal cover on other reefs, including many reefs of the Florida Keys, have not been followed by coral recovery.
Mean Cover of Functional Groups

Pooled video-transect data
3 NTRs and 3 reference sites,
2 depths (7–9 m and 13–18 m), 13 years

Data courtesy Lauren Toth, Florida Tech
Recent Turnover on Caribbean Reefs

• At present the trajectories of corals and algae are decoupled.

• Coral mortality and variations of coral cover around a low mean are independent of algal dynamics.

• Following coral mortality:
  – Low herbivory relative to available space: macroalgal dominance (some reefs).
  – High herbivory relative to available space: dominance by CTB, corals, sponges ascidians, and others (some other reefs).
Recent Turnover on Caribbean Reefs

- Evidence is accumulating that macroalgae suppress coral recruitment and the recovery of coral populations.
- If that surmise is correct, then reduced macroalgal cover could promote coral recovery if coral mortality could be controlled.
- But again, is the Caribbean overrun by macroalgae?
Coral Morbidity and Mortality

• **Regional to Global Scales (some examples)**
  – Rising temperatures
  – Ocean acidification
  – Accelerating sea-level rise
  – Marine diseases

• **Local to Subregional Scales (some examples)**
  – Hurricanes
  – Nutrient loading and other forms of pollution
  – Loss of herbivores
  – ‘Inimical waters’ from Florida Bay (Florida Keys)
    • hot and hypersaline in summer
    • cold and hyposaline in winter
  – Cold sea temperatures (east coast of Florida)
Hypothesis-Testing in Coral-Reef Ecology

[T]he object of investigation is [to ascertain] the proportion of observed variation that may be explained through the use of one or more predictors…, and the proportion that is… ascribed to “chance.”

The first wave: 1970s–1990s
White-Band Disease
Two Meta-Analyses


Gardner et al., *Science*, 2003
Aronson and Precht, *Coral Reefs*, 2006
Two Meta-Analyses


Gardner et al., *Science*, 2003
Aronson and Precht, *Coral Reefs*, 2006
WBD, and to a lesser extent hurricanes, were the principal factors causing mortality of *Acropora* throughout the Caribbean, reducing coral cover substantially on most reefs.
Contribution of White-Band Disease to the Observed Pattern

• Acroporid corals were primary framework builders and ecological dominants on most Caribbean reefs.
• WBD was the primary cause of Acropora mortality.
• Therefore, WBD was a leading cause (or the leading cause) of the decline of coral cover in the Caribbean.
• It was not the only cause: cold-water stress killed acroporids in the Florida Keys in January 1977.
• Subsequent perturbations killed Montastraea spp. and other corals.
100-km scale: Sectors within the reef tract

10-km scale: Reefs within sectors

1-km scale: Sites within reefs

0.1-km scale: Transects within sites
Concordance of Coral Cover
Within Reefs of the Florida Keys

13–19 m depth
10 video transects/site
3 sites per reef

Murdoch and Aronson, *Coral Reefs*, 1999
Variance in Coral Assemblages in the Florida Keys

- low among sites within reefs. Sites are relatively uniform.
- high among reefs within sectors. Hydrographic differences cause variation from reef to reef.
- low among sectors. Any differences are swamped by smaller-scale hydrography.
Overprint of cold-water events on the east coast of Florida
Controls on Floridian Reefs

- Reef assemblages along the Florida Keys are strongly influenced by hydrography (inimical waters flowing through passes increasing variability of coral cover), which overprints Caribbean-wide patterns (loss of *Acropora*; generally low coral cover).

- *Acropora* populations along the east coast of Florida are controlled by their (in)tolerance of cold sea temperatures, which overprints Caribbean-wide patterns.
Significant declines in coral cover were more common in protected than non-protected sites.

Sites with higher coral cover in 1998 experienced greater coral loss.

Decline in coral cover was unrelated to protection.

Data courtesy Lauren Toth, Florida Tech.
Efficacy of MPAs in the Florida Keys

• **Overprint #1**: regional, global
  – coral disease
  – climate change
  – ocean acidification, etc.

• **Overprint #2**: hydrographic, latitudinal
  – Florida Bay water to the Keys
  – Winter temperatures on the east coast
Efficacy of MPAs in the Florida Keys

• So should we just give up on MPAs, MPA networks, and other management and restoration actions?
• Of course we should not give up, because...
Liebig’s Law of the Minimum
From the Polyp to the Planet

• Of course we should not give up...
• …but the rationale cannot be to work on local problems just because they are the tractable ones; that is rear-guard action—the prelude to surrender.
• Local action must be explicitly promoted as a component of management integrated across scales and hierarchical levels.