# Status of the *Montastraea annularis* species complex in the face of increasing local human stress and climate change: Lessons learned and recommendations

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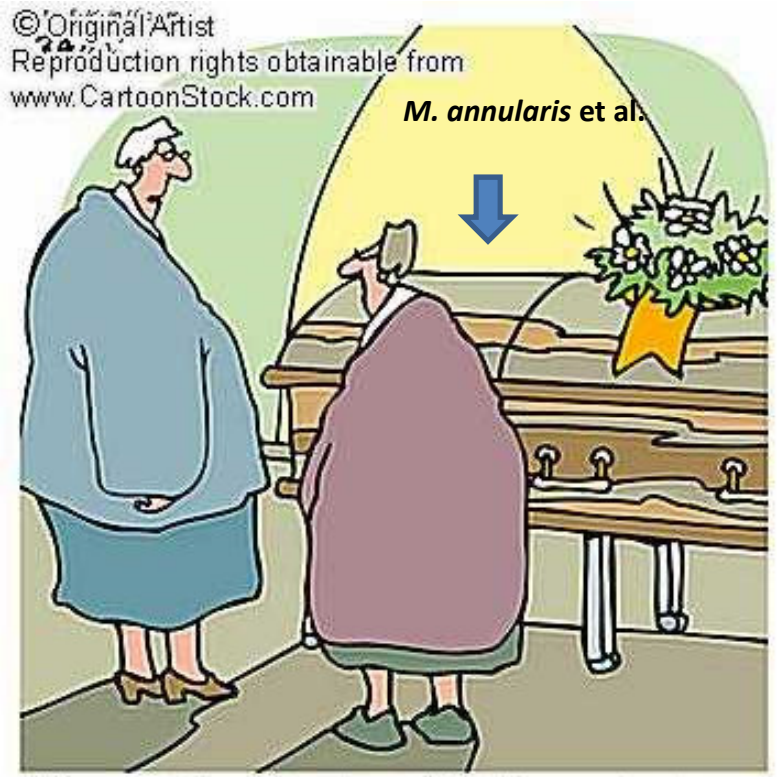
# Objectives

- Summarize what is the actual condition of the *M. annularis* species complex in several representative coral reefs in PR.
- Discuss several case studies regarding combined local anthropogenic impacts and climate change (i.e., sea surface warming).
- Identify some research gaps, needs, and suggest some management actions.



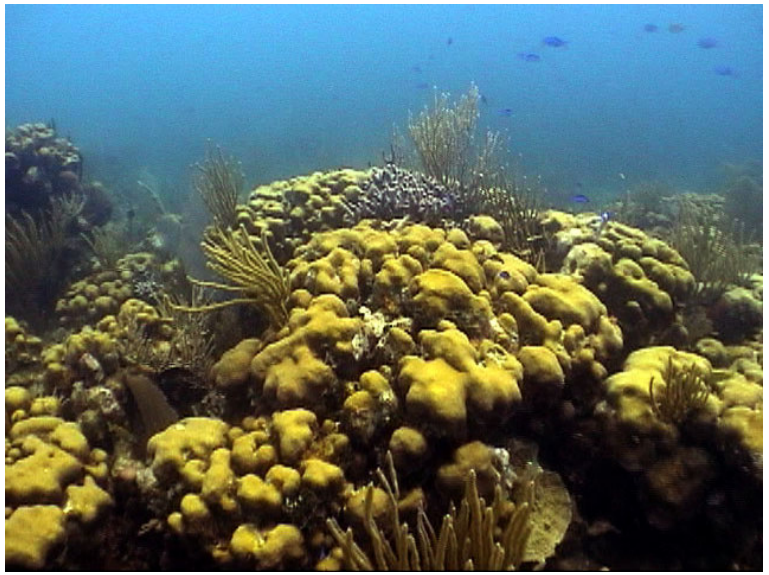

http://www.cartoonstock.com/directory/d/dying.asp

# Facts

- Unprecedented coral mortality event in the Caribbean at least in the last 220,000 years (Pandolfi & Jackson, 2006).

- Time scales necessary for coral reef recovery from any type of disturbance will increase with increasing spatial scales of impacts.

- Current spatial magnitude of coral mortality will require radical actions and decisions, both in land and sea. Large-reef building corals will require a recovery time scale out of our context.



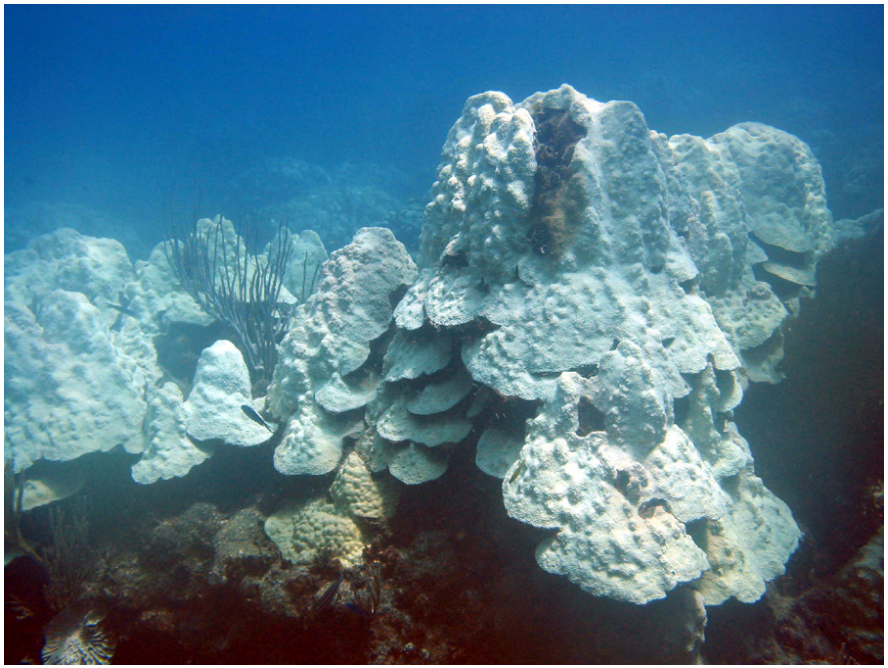
# *"Montastraea annularis"*

- Species complex:
  - *M. annularis.*
  - *M. faveolata.*
  - *M. franksi.*
- Wide bathymetric distribution (>60 m), principal reef-builder in the Atlantic.
- Simultaneous hermaphrodites.
- Annual reproductive cycles.
- Extremely low sexual recruitment rates.
- High recruit mortality rates.

*M. faveolata*

# *"Montastraea annularis"*

- Annual skeletal growth rate <1 cm.
- Highly susceptible to different diseases and/or syndromes.
- Inability to recover lost tissue following disease/syndrome impacts.
- Susceptible to prolonged exposure (>8-15 DHWs) to high SSTs.
- Susceptible to chronic water quality degradation (i.e., transparency, sedimentation, eutrophication).



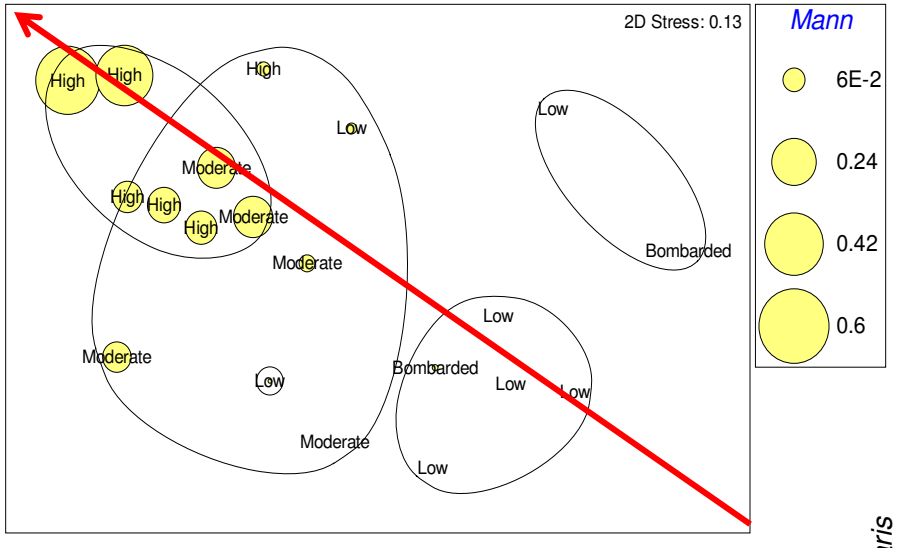
Bleached *M. faveolata*

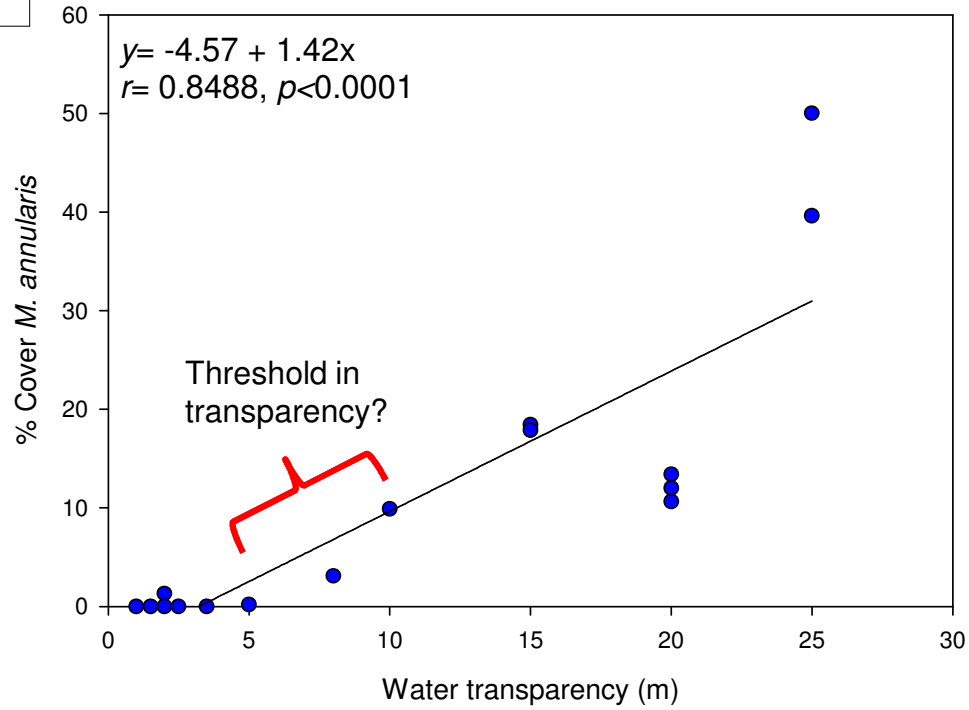
# *"Montastraea annularis"*

- Susceptible to a wide diversity of competitors (i.e., sponges, encrusting tunicates, algae, cyanobacteria).
- Deepwater (>30 m) colonies appear to be in better shape than those from shallower reefs.
- All surveyed shallow-water reefs (<20 m) show at least a moderate degree of population declines.

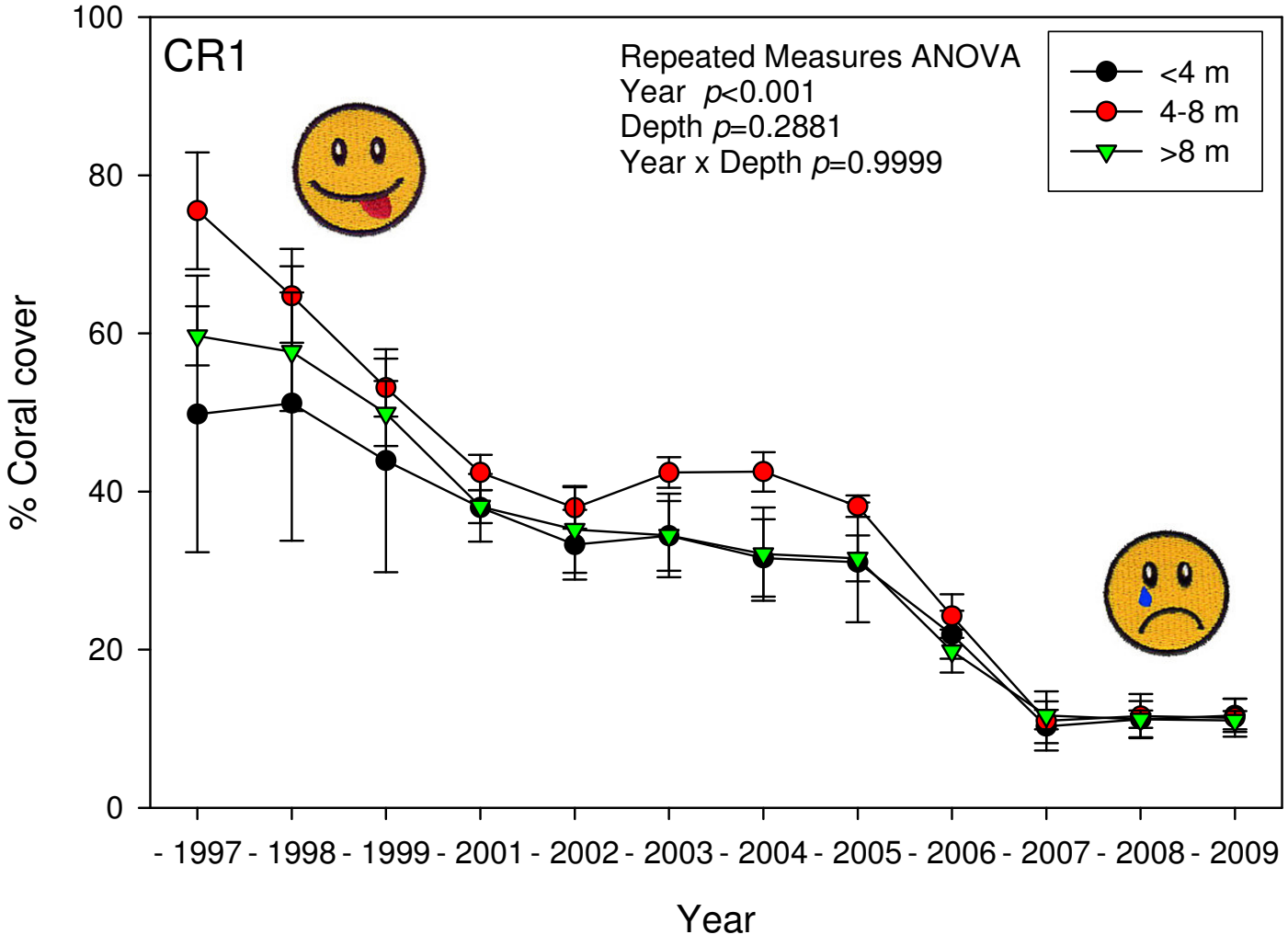
*M. annularis*

# Increasing *M. annularis* abundance with increasing water transparency

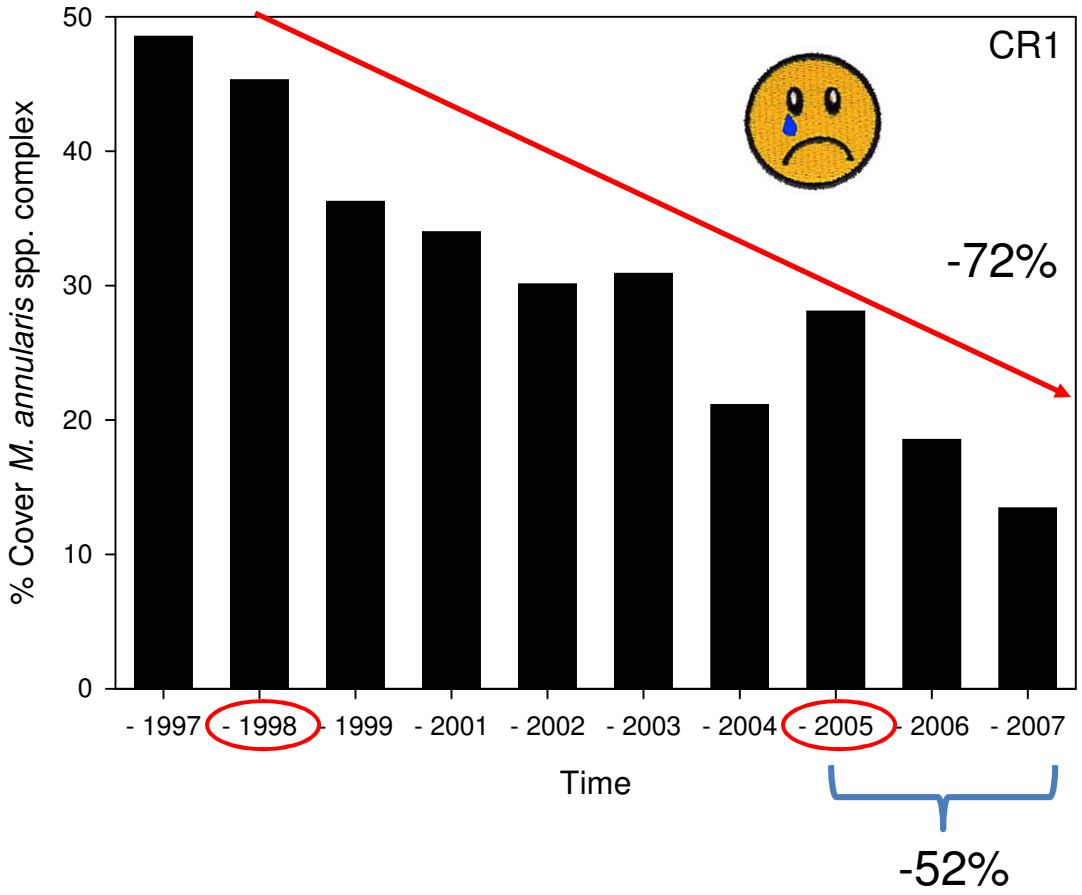


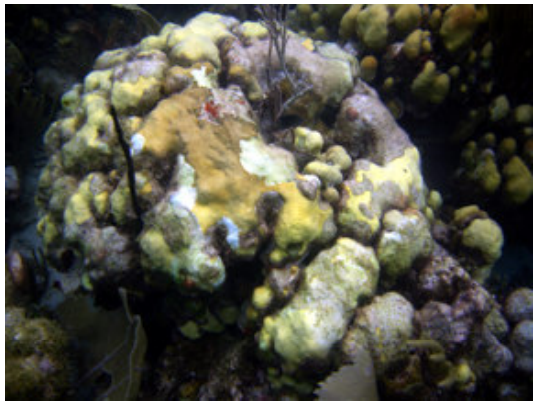



# But significant coral reef decline within 1997-2009

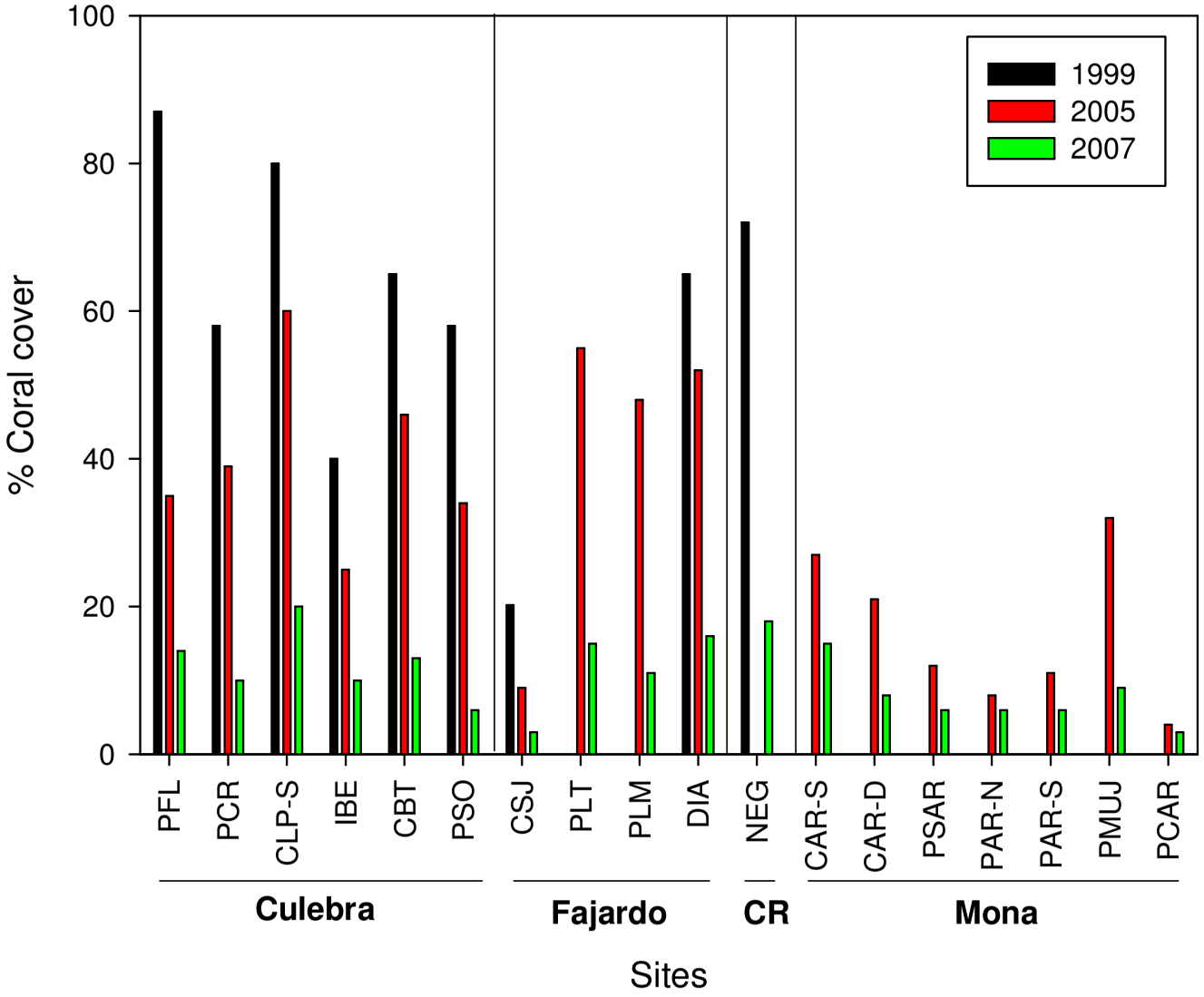


# Collapsing population of *Montastraea annularis*

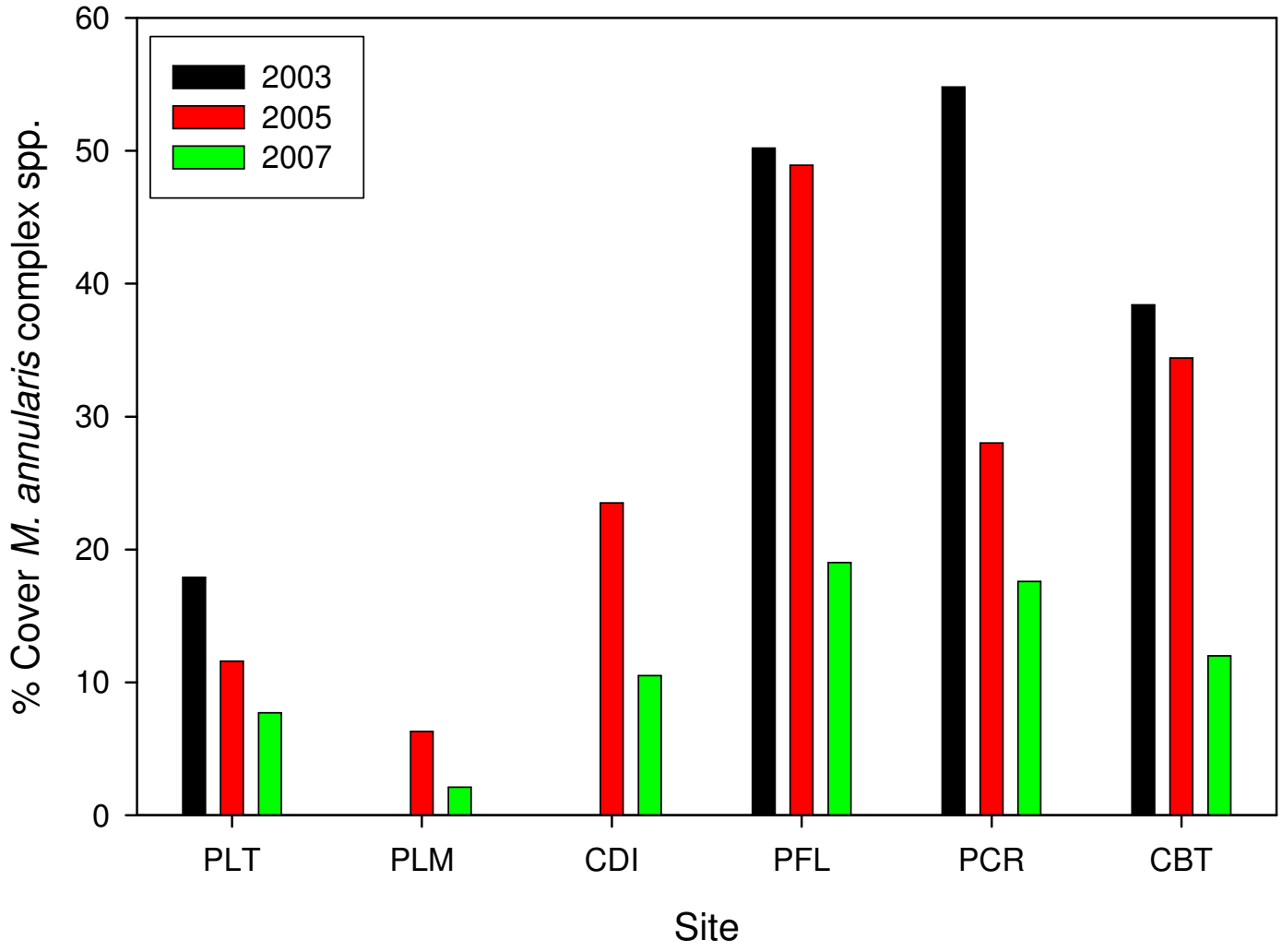


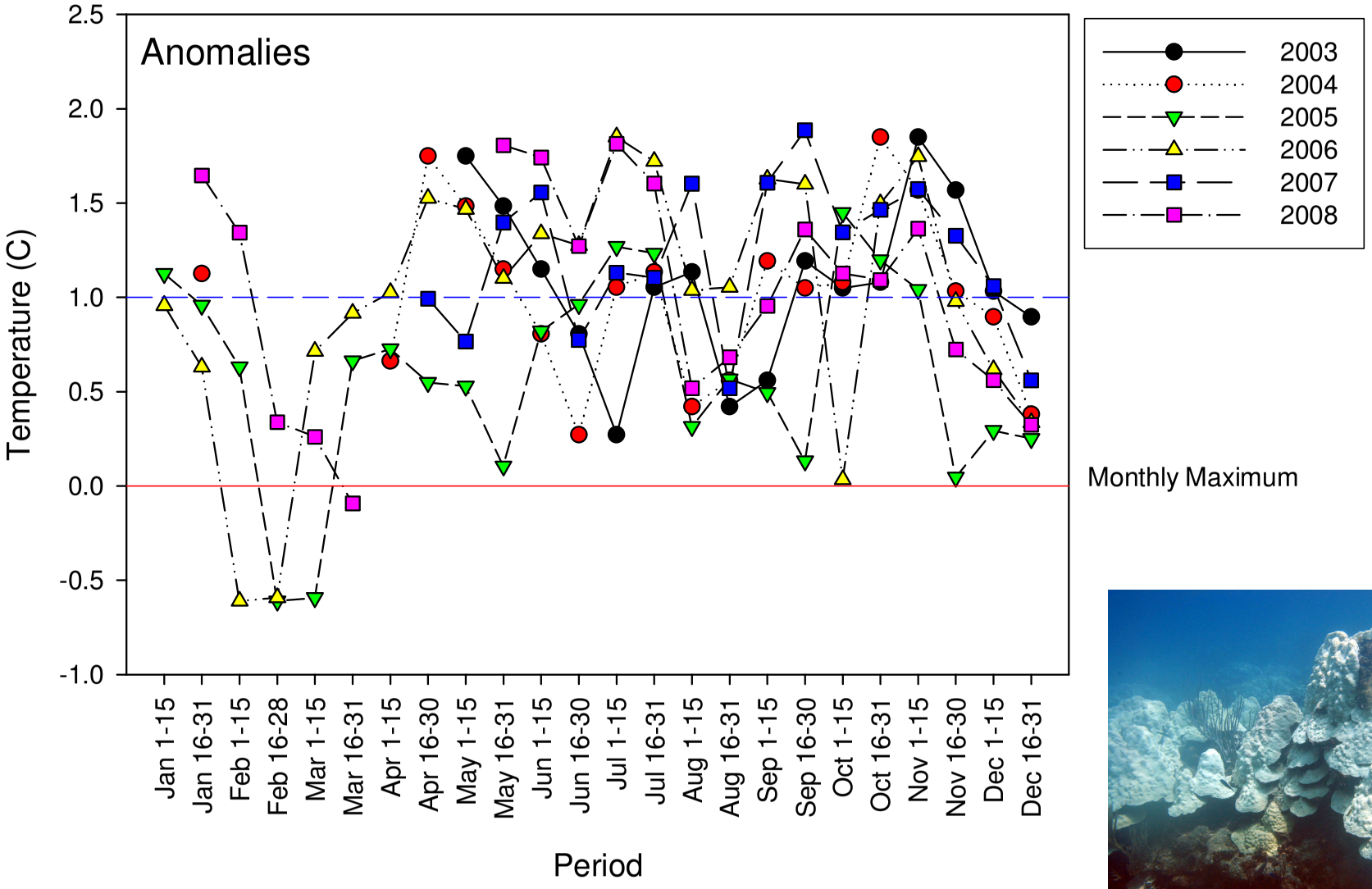
# Other examples from PR

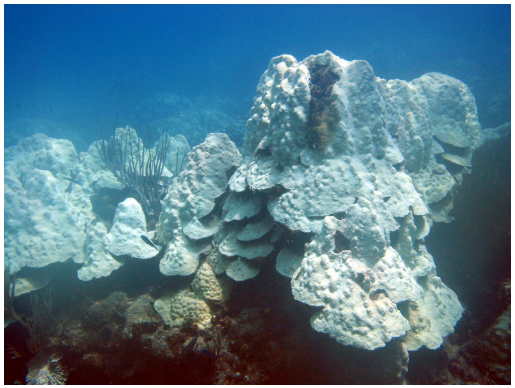


# Eastern PR coast: *M. annularis* species complex population collapse?



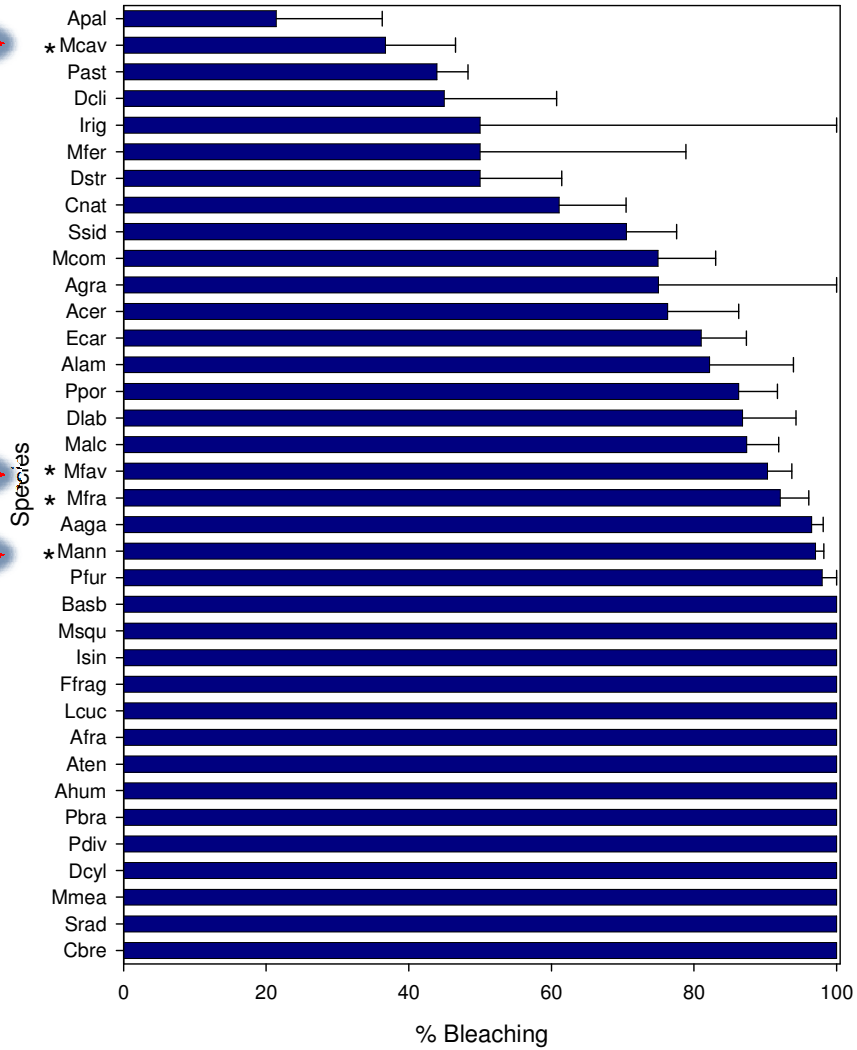
# Year-round thermal anomalies (2003-2008)



# Mass bleaching impacted *M. annularis* complex

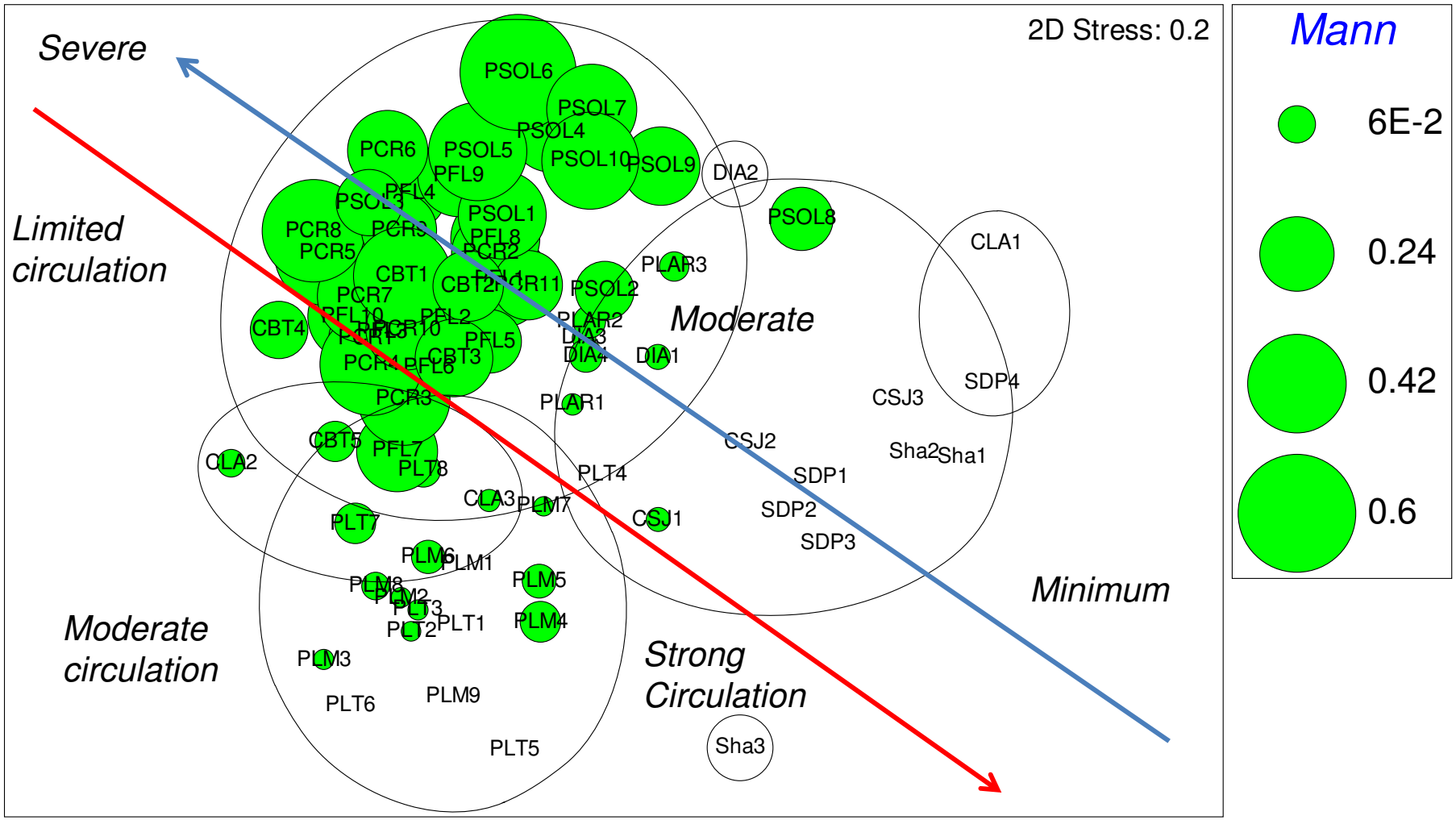
- *Montastraea* spp. impacts:
  - *M.annularis* 97.1%
  - *M. faveolata* 90.4%
  - *M. franksi* 92.1%
  - *M. cavernosa* 36.7%



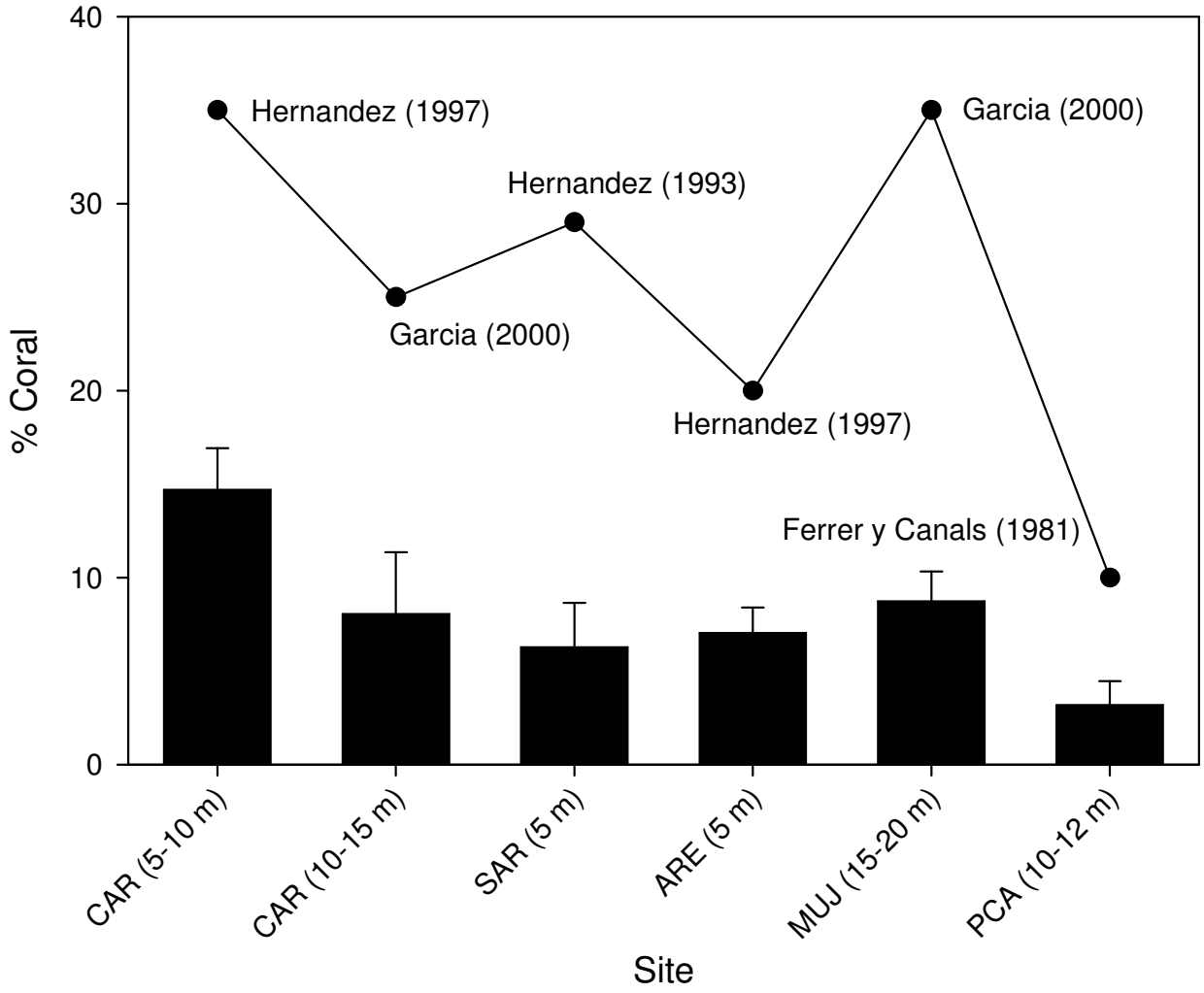

Hernández-Delgado et al., unpub. data

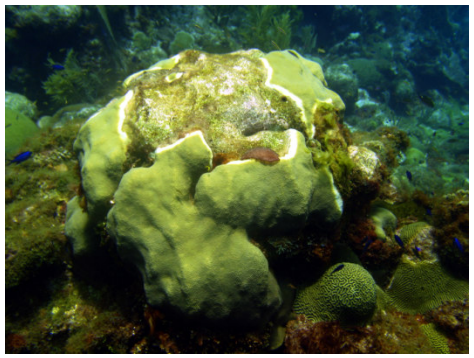
# Community structure and oceanographic patterns influenced bleaching severity

## *Montastraea annularis*

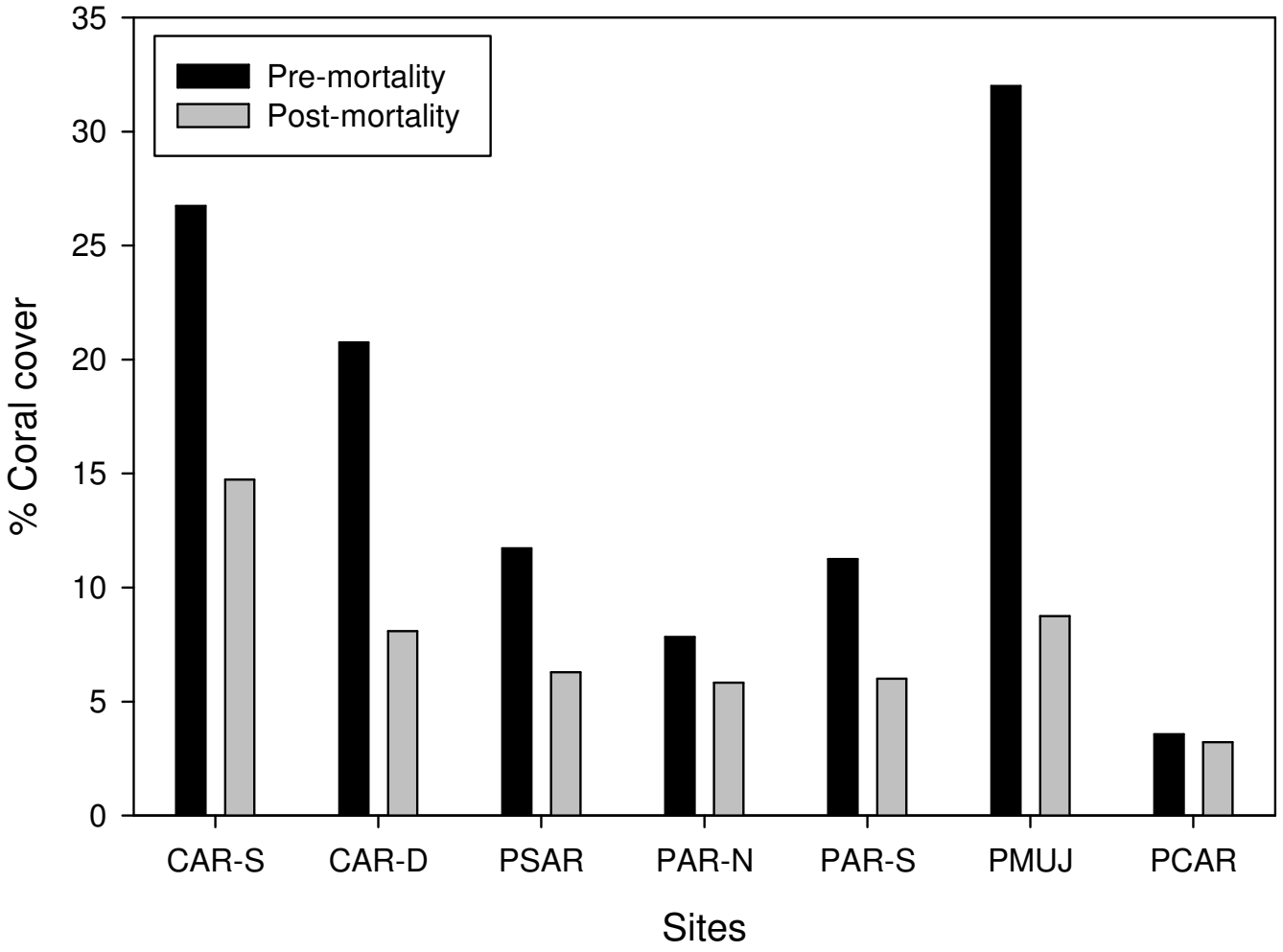


# Mona Island's coral reefs are also collapsing



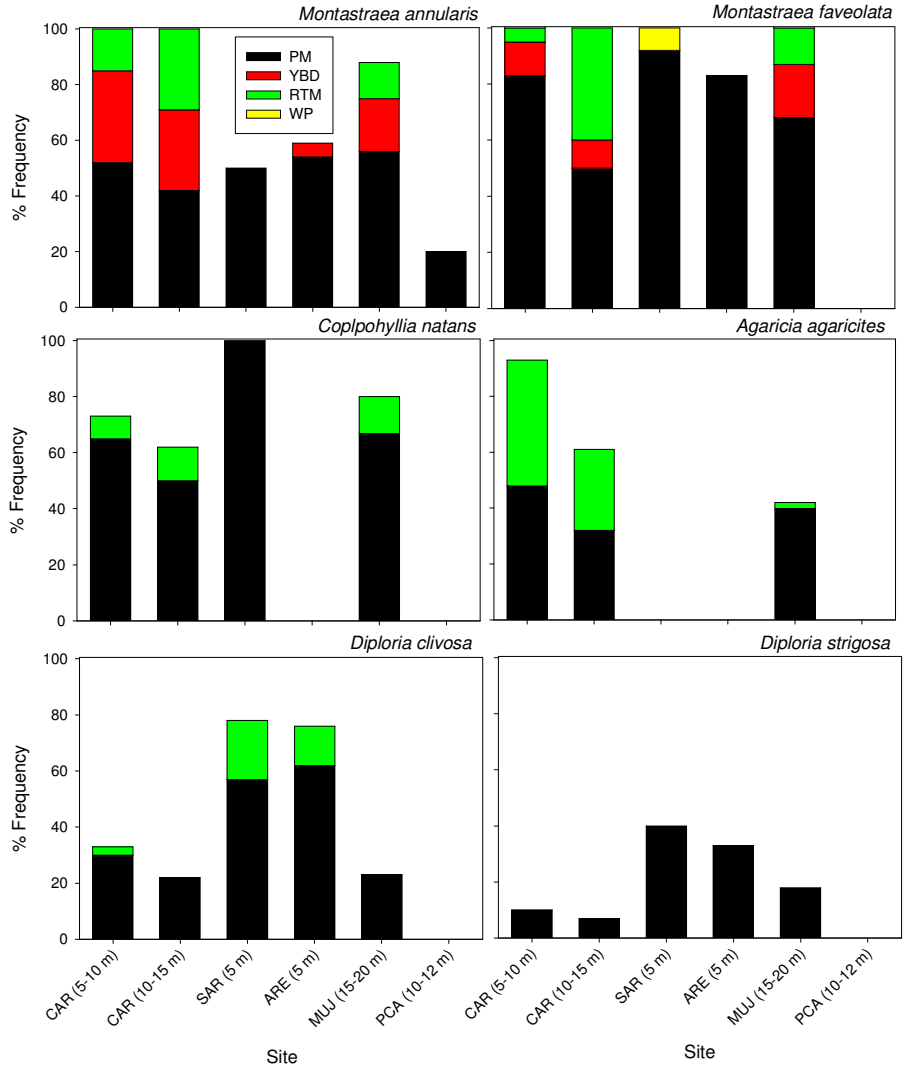



# Abrupt decline in % living tissue cover

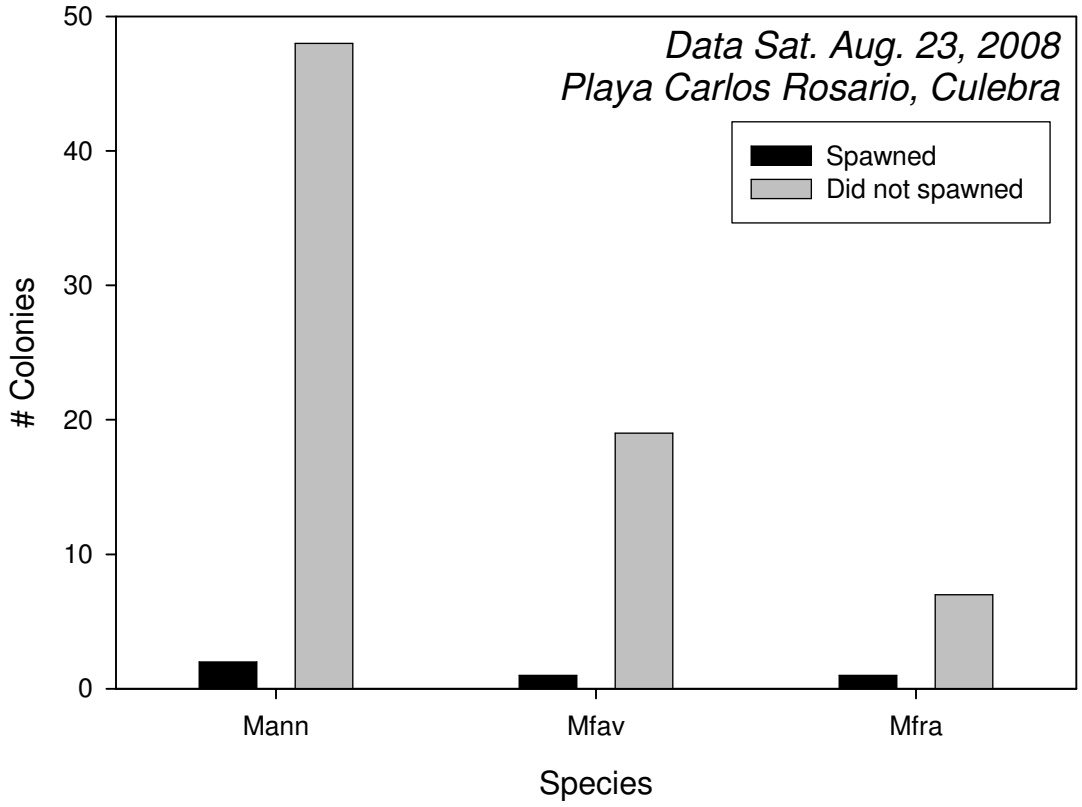


# Major reef-building species undergoing significant mortality

- Most large reef builders have recently died or have suffered significant partial mortality.
- High prevalence of YBD and other syndromes.



# Less than 5% of shallow-water colonies spawned (only isolated polyps spawned in those colonies who did)



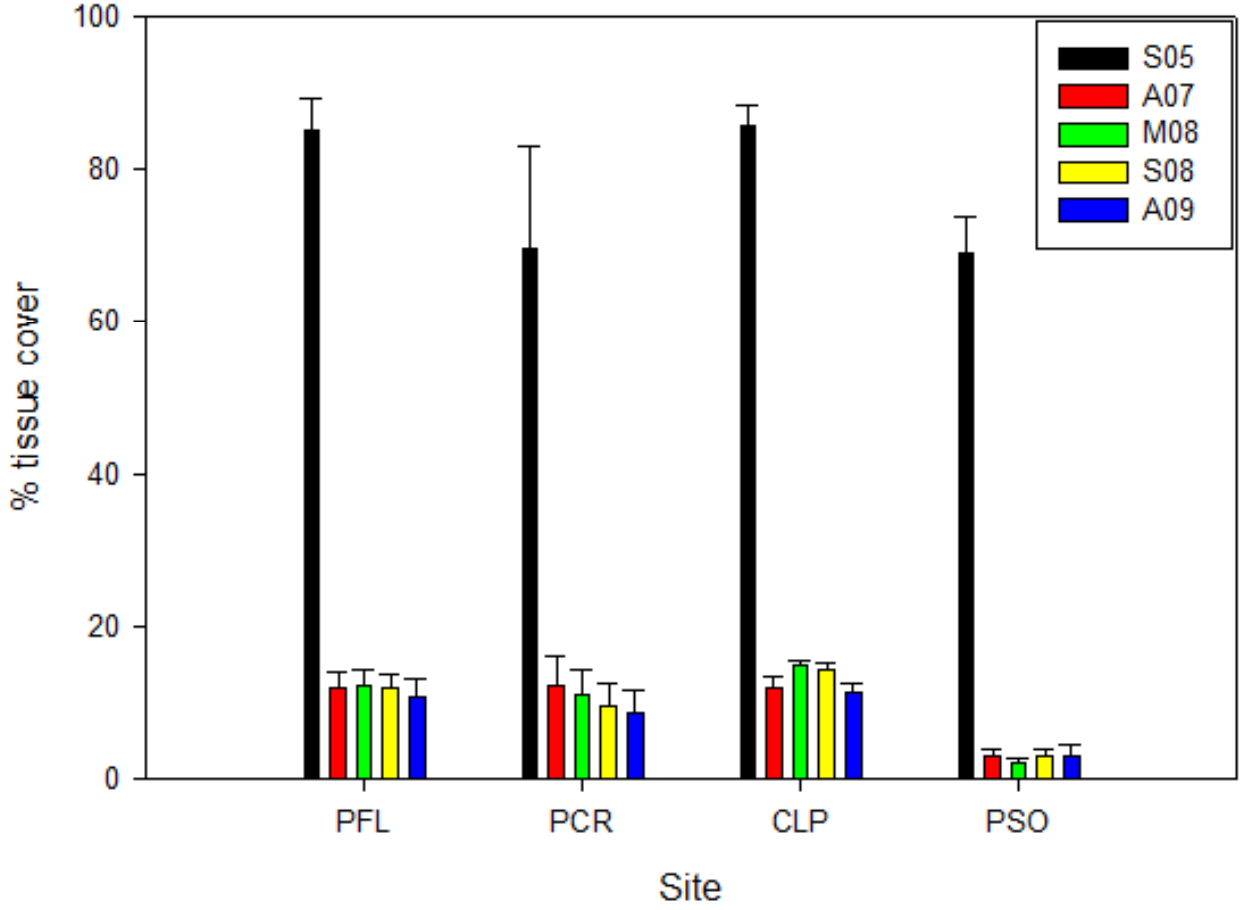

- Annual monitoring of shallow water **mass spawning**.
  - 2006: Total collapse.
  - 2007: Total collapse.
  - 2008-09: Nearly total collapse.

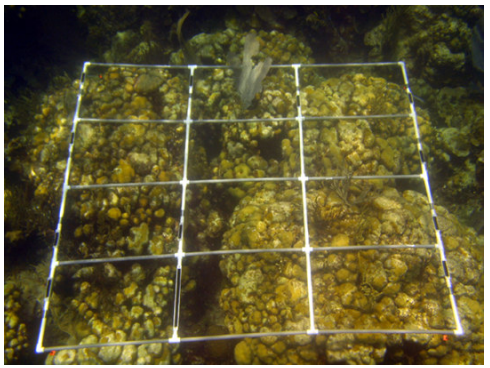
# Are deep water reefs the coral spawning (=genetic) refuges of the future?

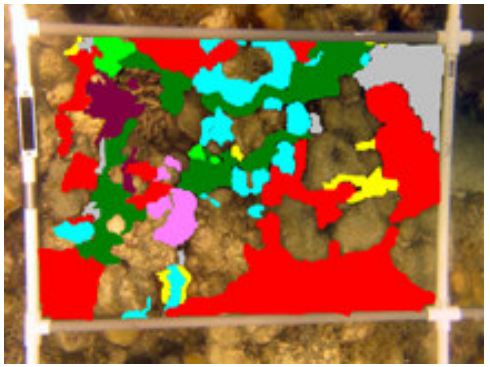
Wednesday August 27, 2008 (Culebra)
(10 nights after full moon)

Source: R. Kingsley, M. Mercado

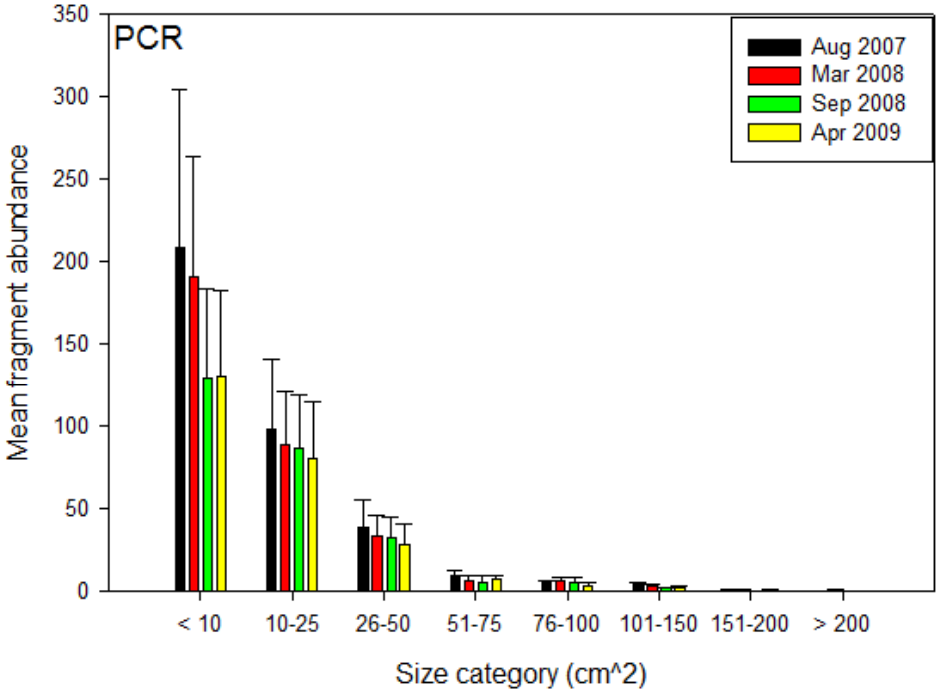
# Dramatic loss in % living tissue cover per colony between 2005 and 2009

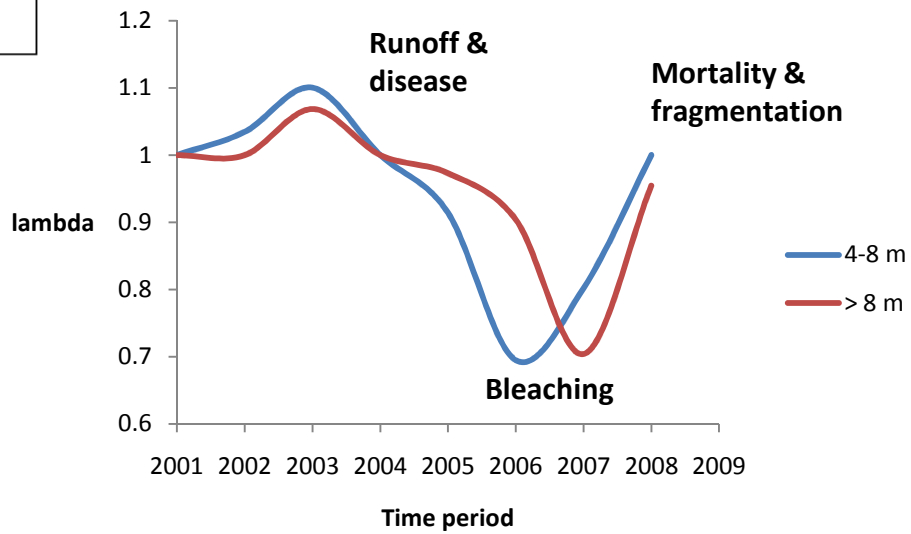


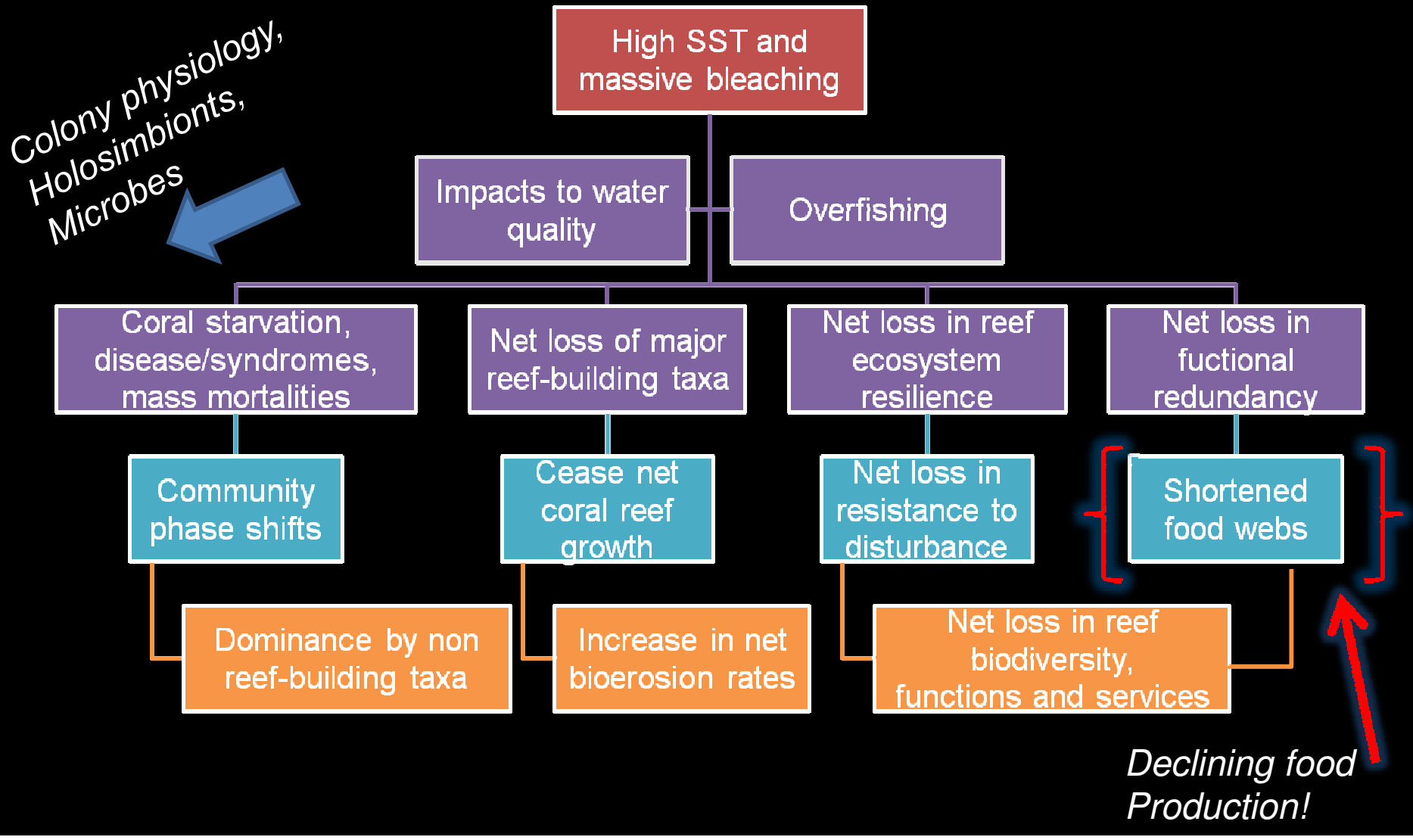


# Significant mortality in smaller size categories



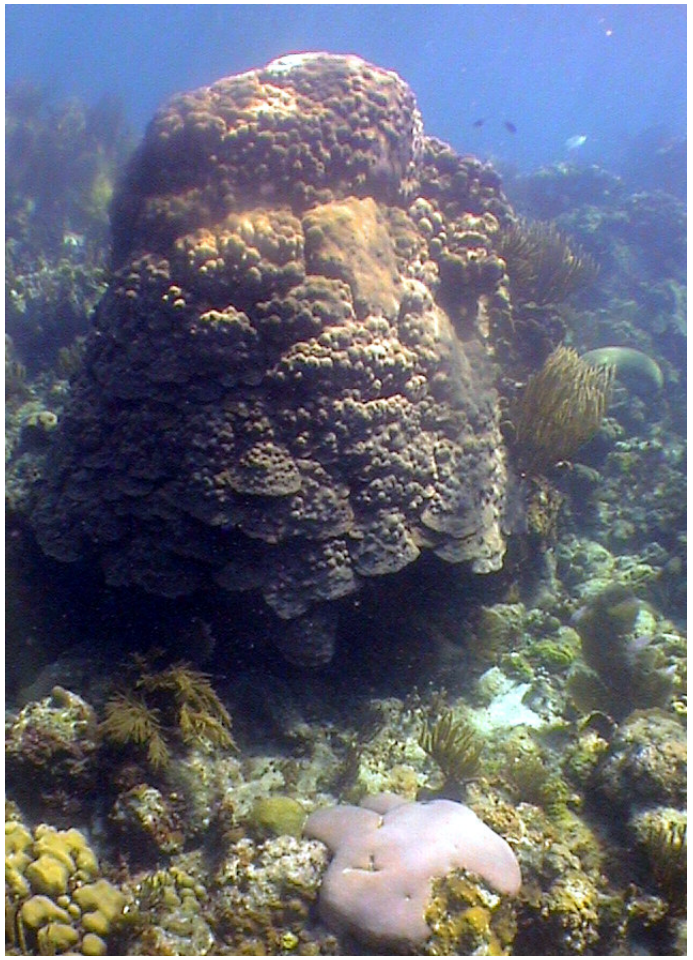



# Long-term consequences of climate change and other human insults in coral reef functional roles



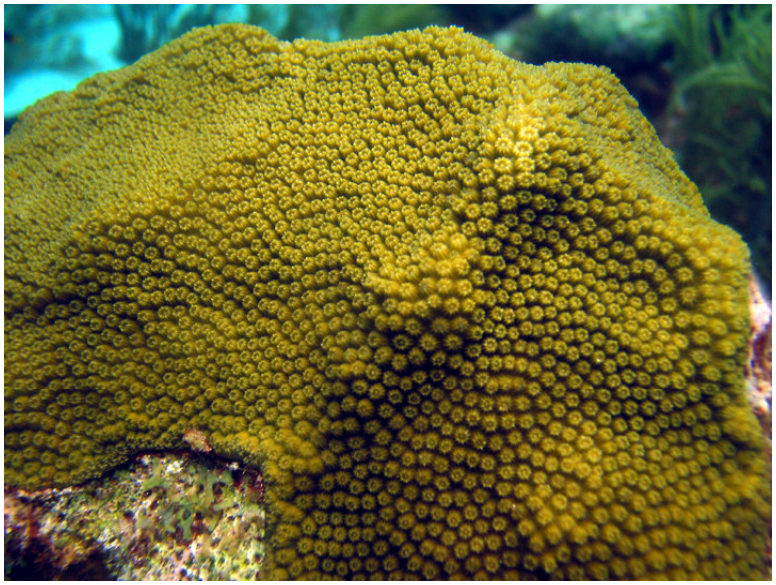
# Update 31-year old Coral Reef Inventory

- **Revisit** original sites.
- **Also** include:
  - Adjacent islands and keys.
  - Shelf-edge reefs.
  - Mesophotic reefs.
- Develop a **GIS-based model** regarding spatial distribution and actual conditions of coral colonies.



# Go back to *Montastraea* Biology 101

- Study **basic biology** of coral physiological fragments:
  - Survival rates*.
  - Growth rates*.
  - Tissue regeneration*.
  - Competition effects*.
  - Gametogenesis*.
  - Reproduction*.
  - Population genetics.
  - Impacts of environmental gradients.
  - Geographic and bathimetric distribution.
  - Microbiology.

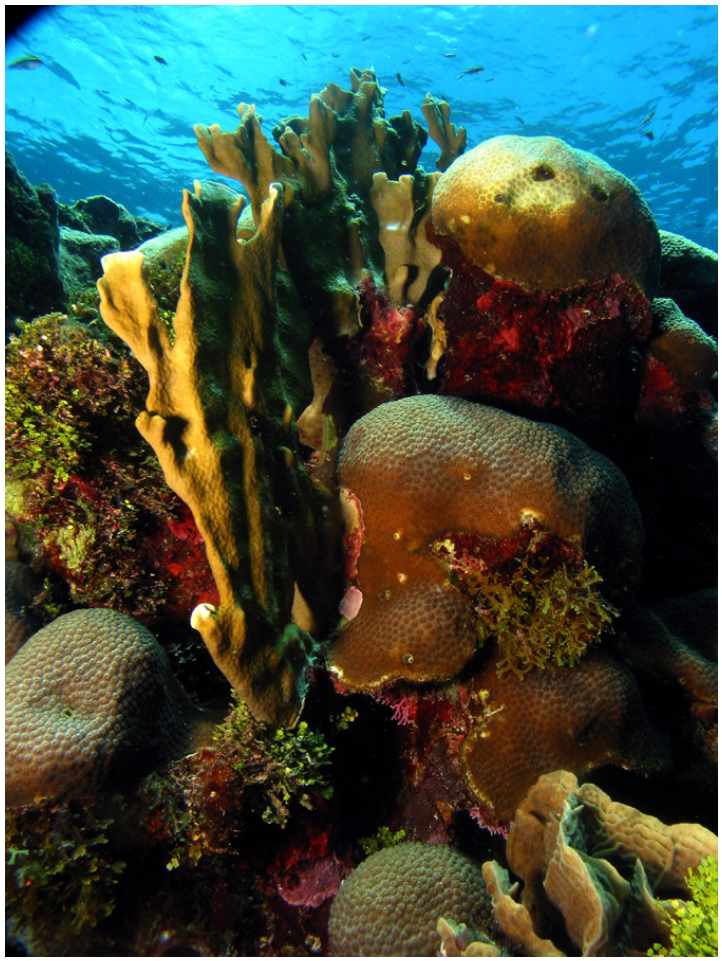


# Population collapse? Hyerarchical approach: From regional to coral colony scale

- Develop a protocol to monitor individual tagged **coral colonies**.
- Modification of existing long-term ecological monitoring programs to address **water quality** issues.
- Develop "**early warning** signals".
- Sediment-water **toxicity** assessments.

# Applied research

- Develop studies regarding **bioerosion** rates under different environmental conditions.
- Document coral **recruitment** rates.
- Expand existing experiments regarding **larval culture** and **reintroduction** of coral spat to natural reefs.



# The past is still the key to the present!

- Develop large scale sclerochronological studies to:
  - Address historical rates of ecological change across **large spatial scales**.
  - Determine historical patterns of change in coral reefs across **anthropogenic gradients**.
  - Discriminate between historical trends of **localized human impacts** and **climate change**.

# Acknowledgements

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