

Consequences of the 2006 coral mass mortality following coral bleaching in Puerto Rico: A case study from the CCRI Coral Reef Long-Term Monitoring Program

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Objectives

- Rapid overview of the 2005 bleaching impacts.
- Discuss a case study of the 2006 post-bleaching mass mortality impacts.
- Address possible long-term consequences of recurrent bleaching and mass mortality events.
- Next steps of CCRI Coral Reef Long-Term Ecological Monitoring Project.



2005 mass bleaching event

- 82 Cnidarian taxa:

52 Scleractinians.

4 Hydrocorals.

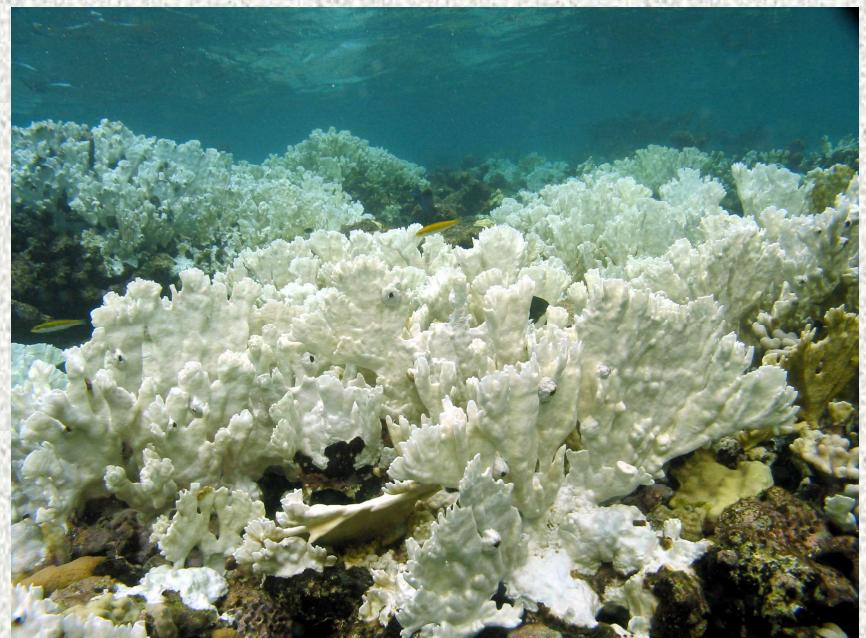
13 Octocorals.

4 Zoanthideans.

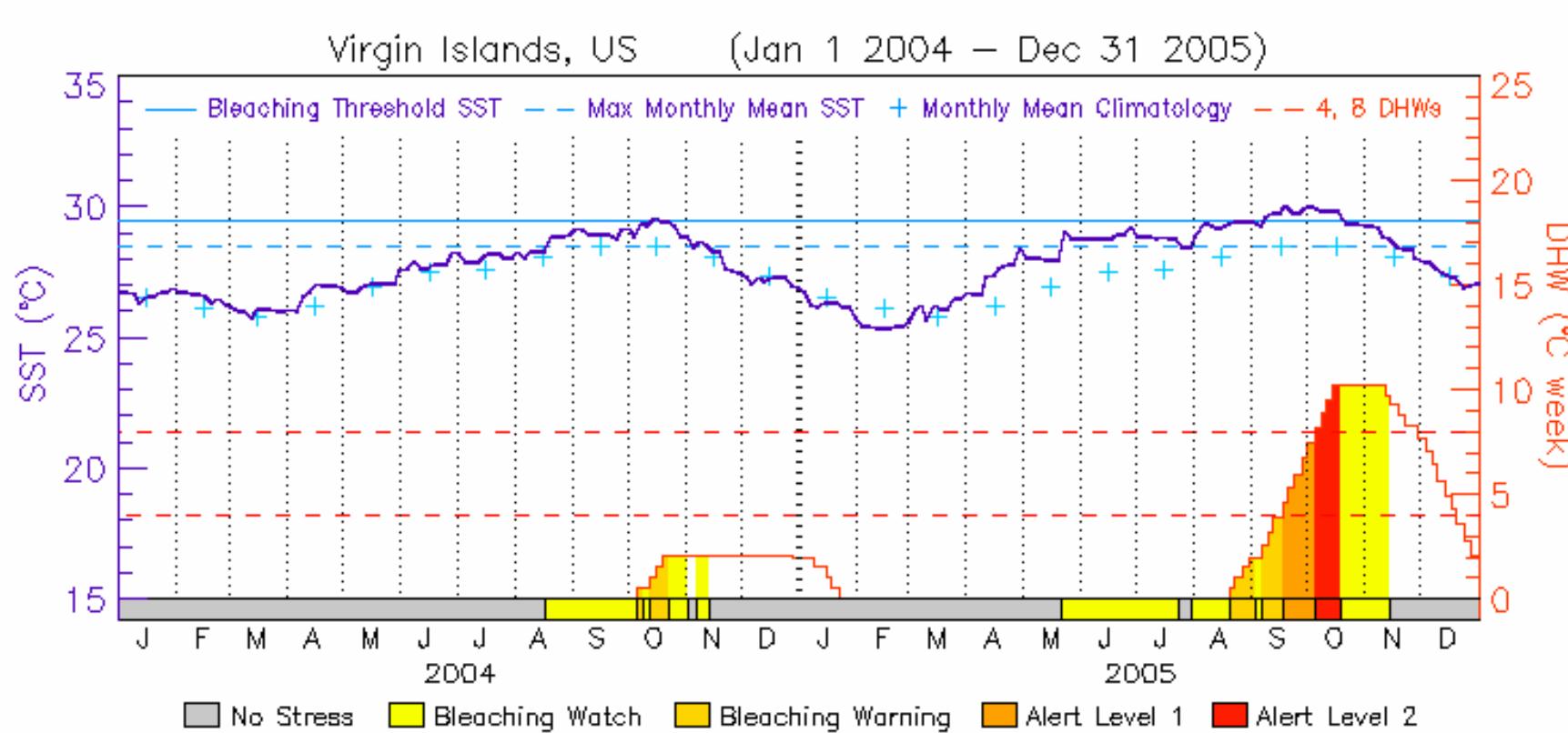
4 Actiniarians.

3 Corallimorpharians

2 Scyphozoans.

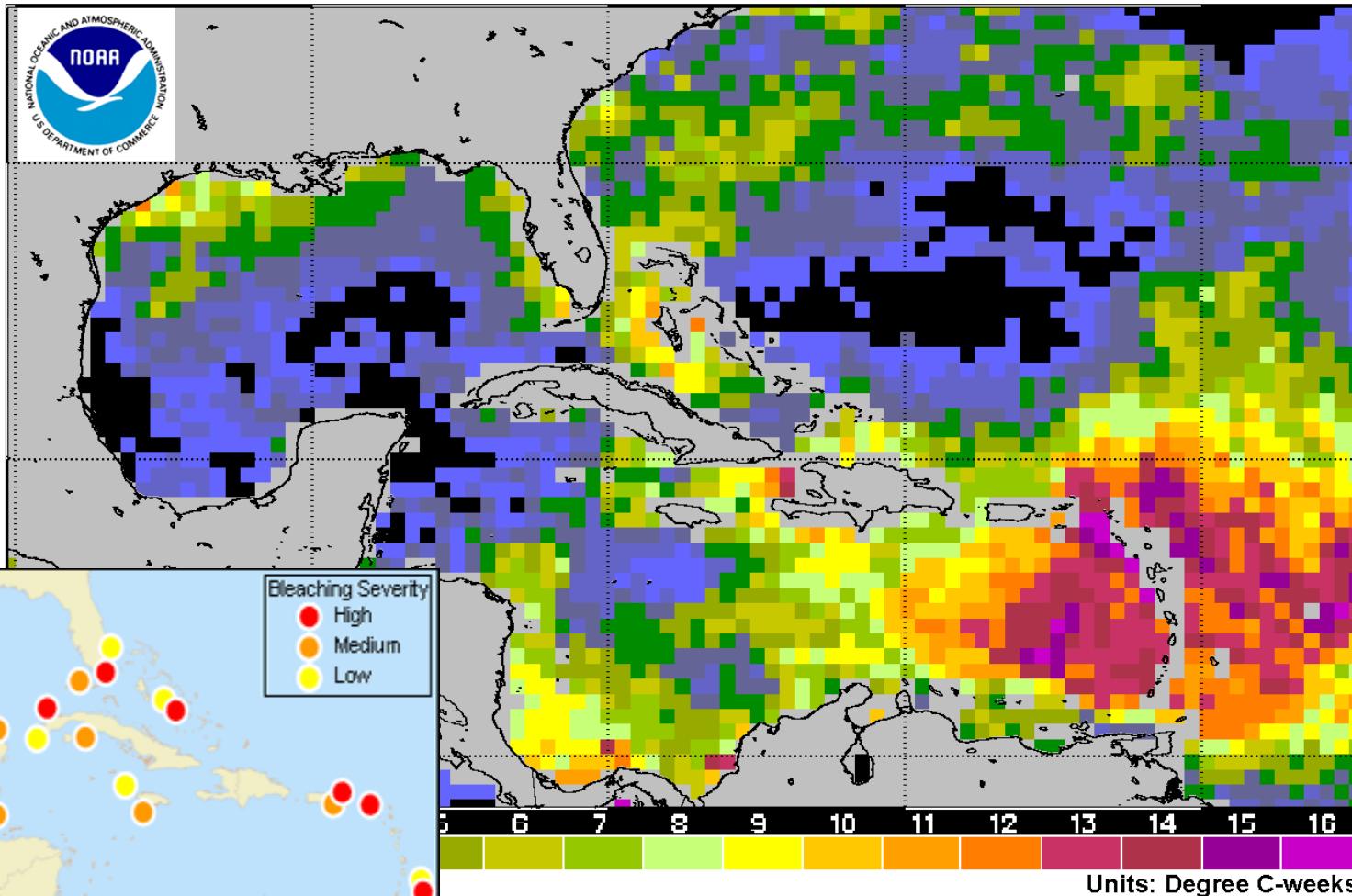


USVI 2005 CREWS buoy data



Prolonged warming and doldrums during 2005

2005 Annual Composite of Maximum Twice-weekly Degree Heating Weeks



Culebra Island: 14.3 DHWs

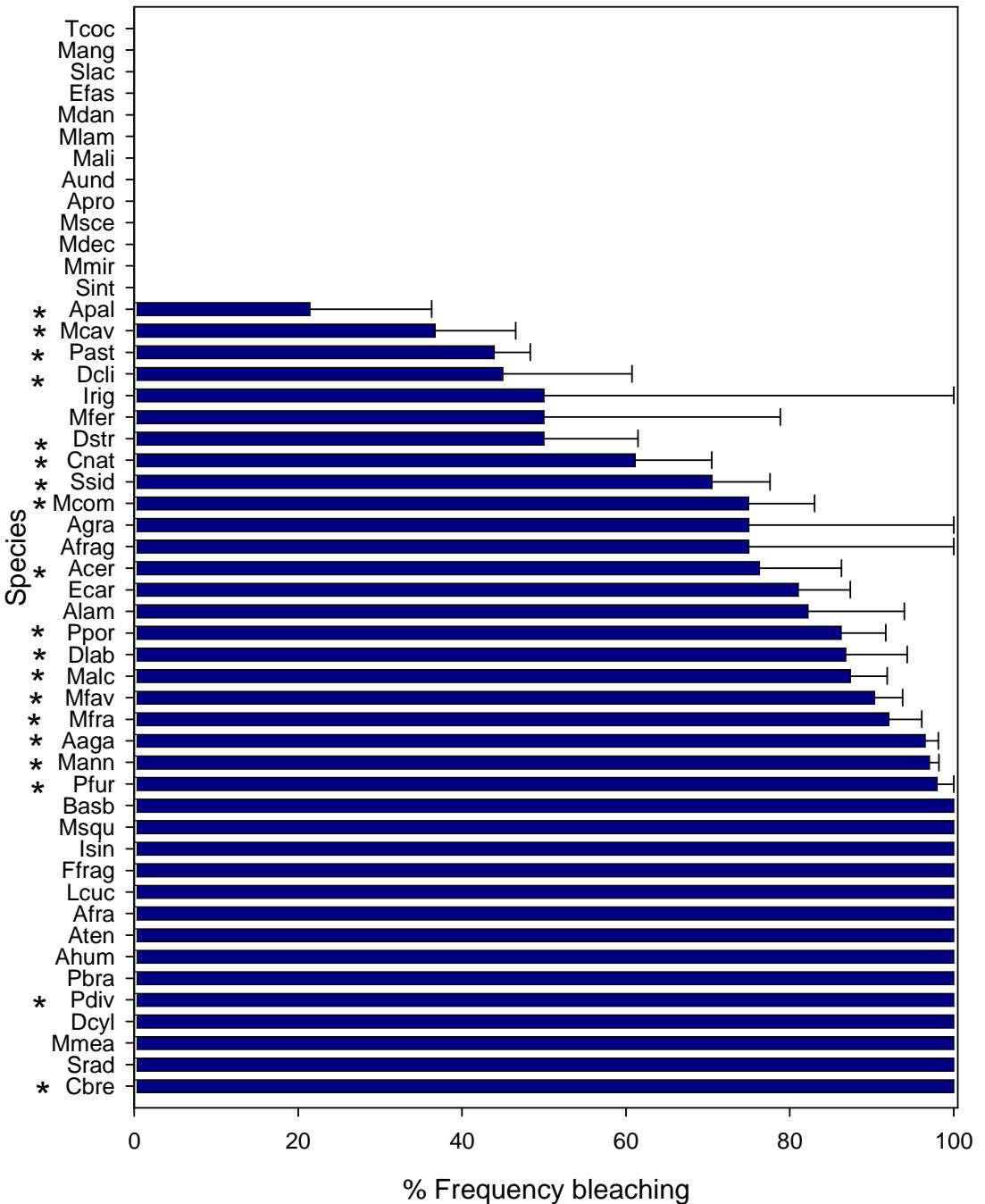
Coral species responses to bleaching

48% (>80% bleaching)

18% (50-80% bleaching)

8% (20-50% bleaching)

26% (not bleached in transects)



2005 mass bleaching event

- Up to 97% bleached colonies.
- Impacts variable depending on local ocean circulation patterns.
- Prolonged species-specific effects (up to 11 months).
- Bleaching followed by disease/syndrome and mortality.

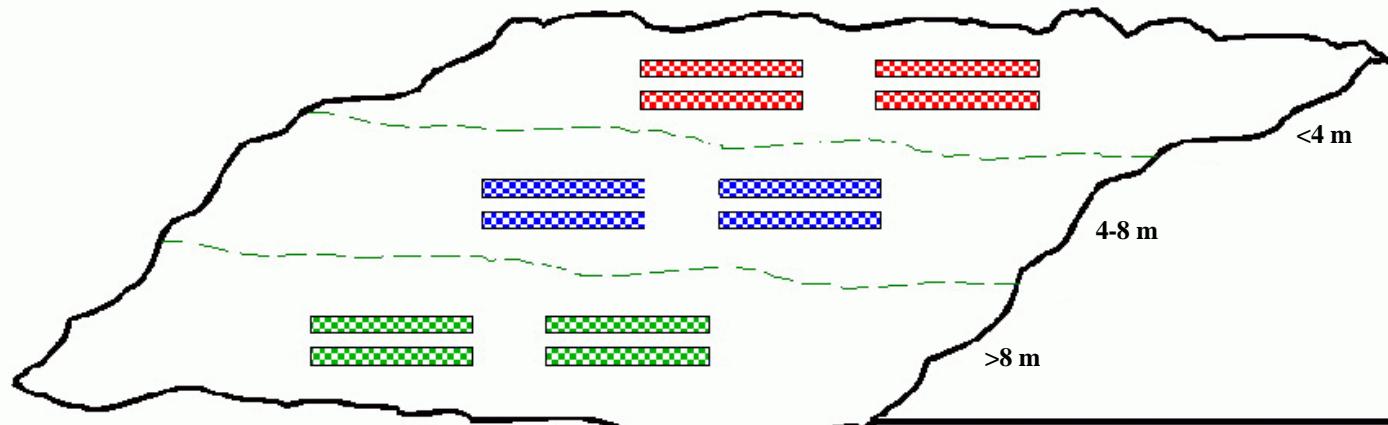


What were the “reefscape” consequences of bleaching and the subsequent post-bleaching mortality event?

- Species/specific responses?
- Reef parameter responses?
 - % cover.
 - H'n.
 - J'n.
- Community structure?

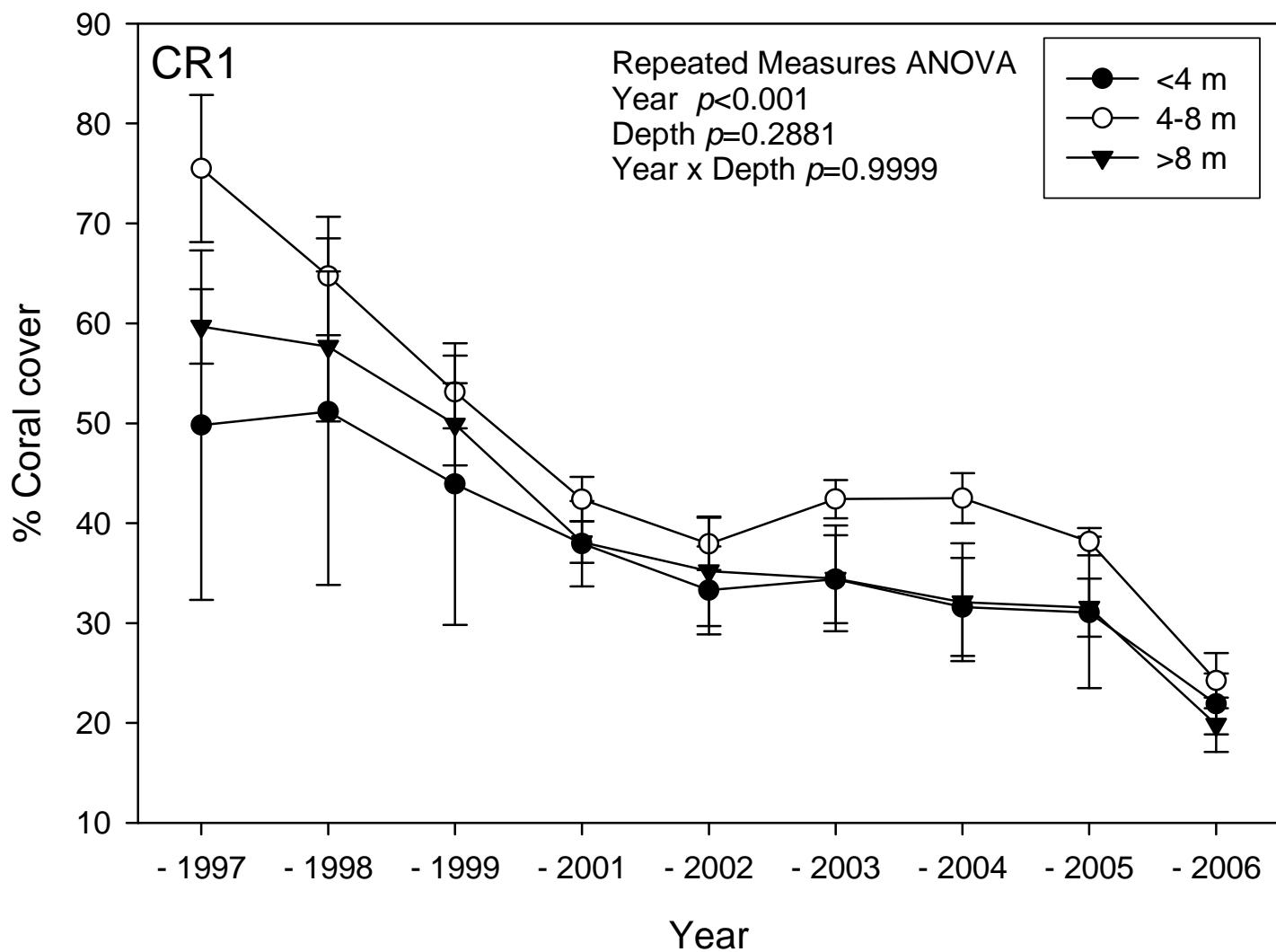


Benthic sampling

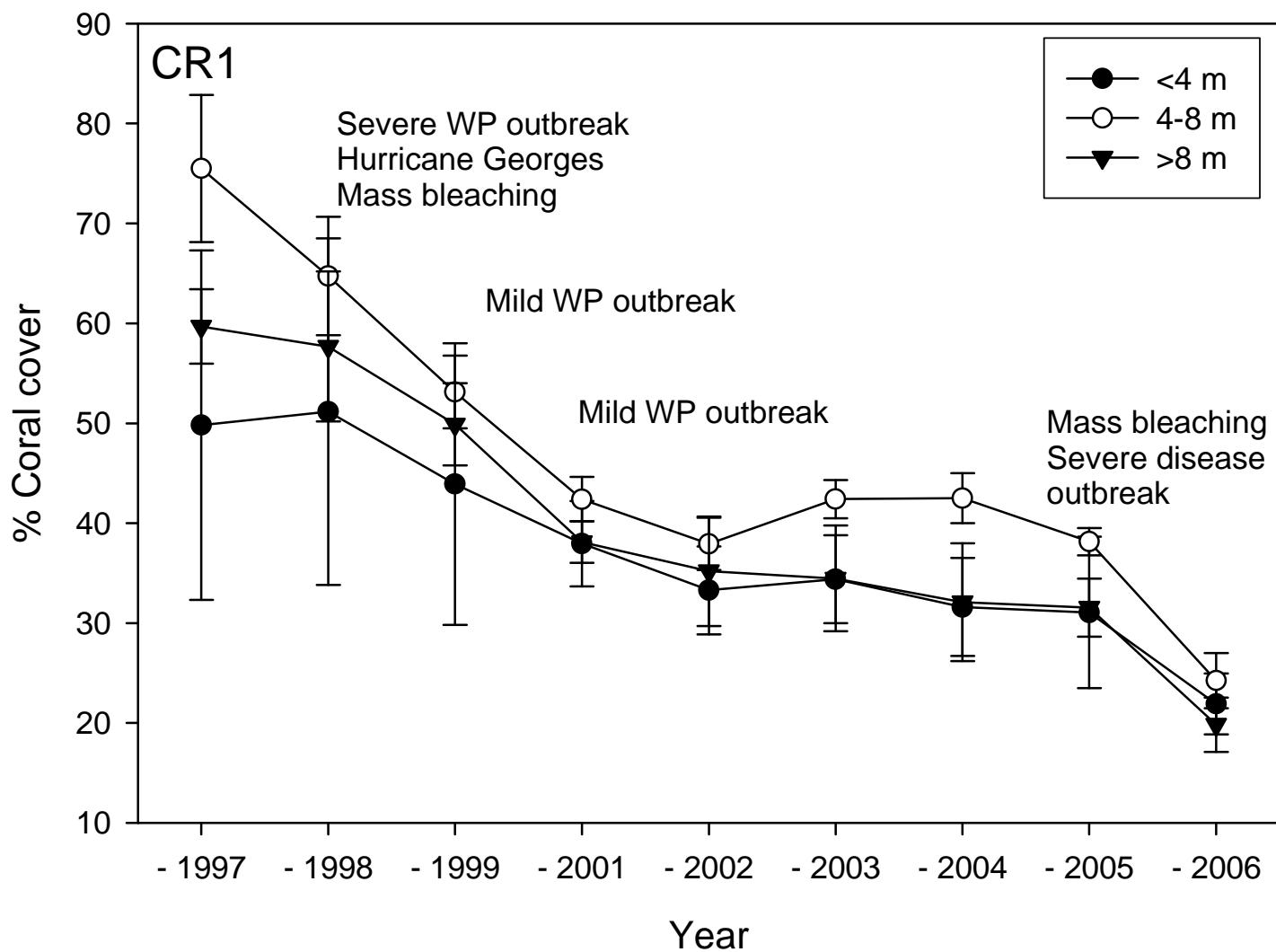


Permanent line intercept transects (10 m) + digital photography.
2-way Repeated Measures ANOVA
Time (1997, 1998, 1999, 2001, 2002, 2003, 2004, 2005, 2006)
Depth (<4m; 4-8 m; >8 m)

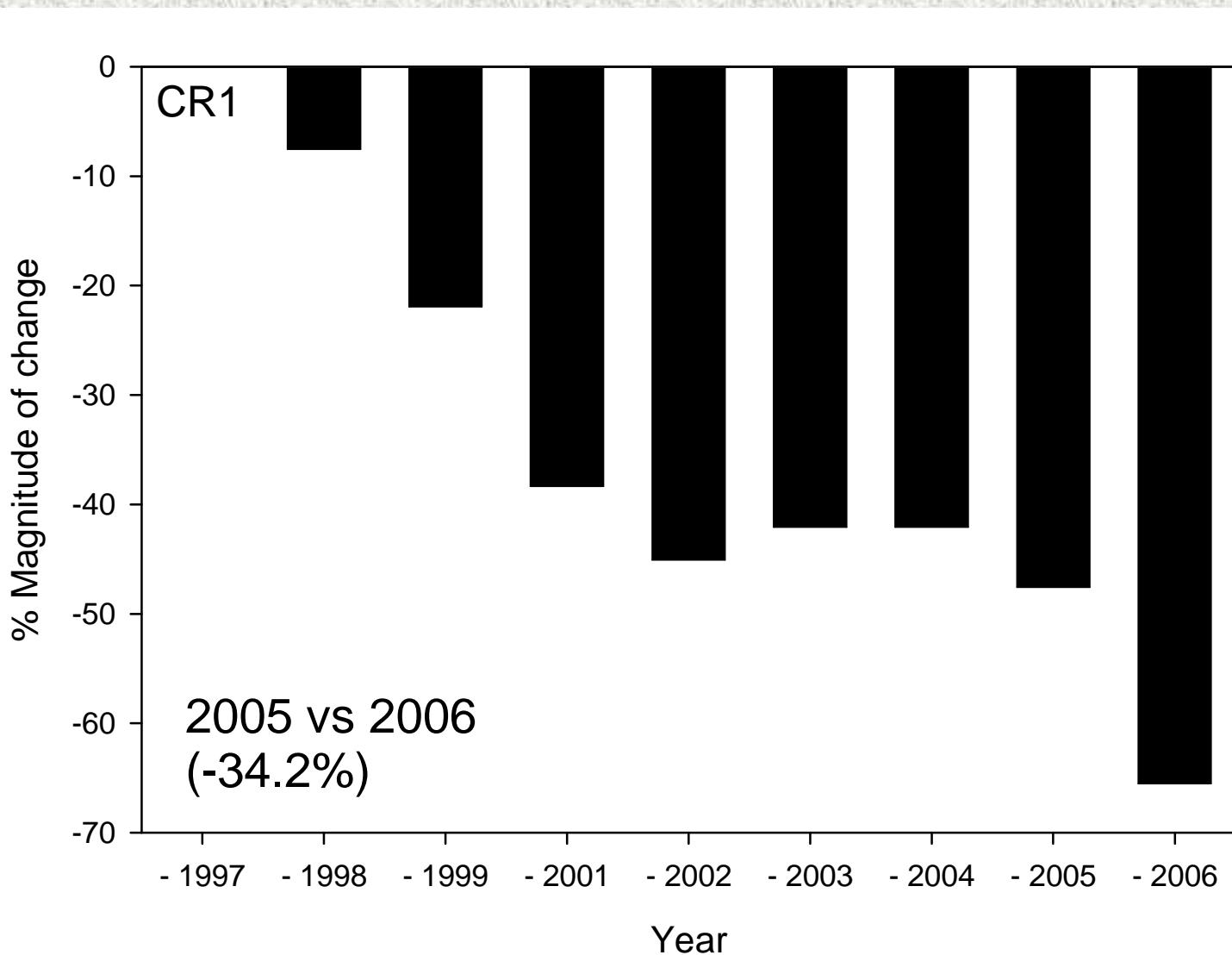
% Coral



% Coral



Magnitude of change % Coral



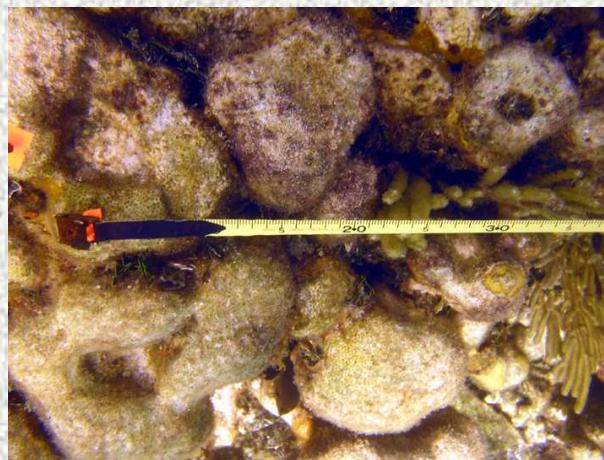
Montastraea annularis



June 27, 2005

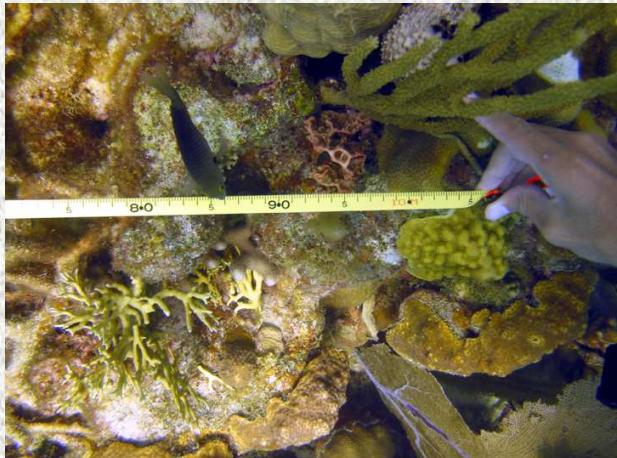


September 25, 2005



July 26, 2006

Several species lost



June 26, 2005



September 24, 2005

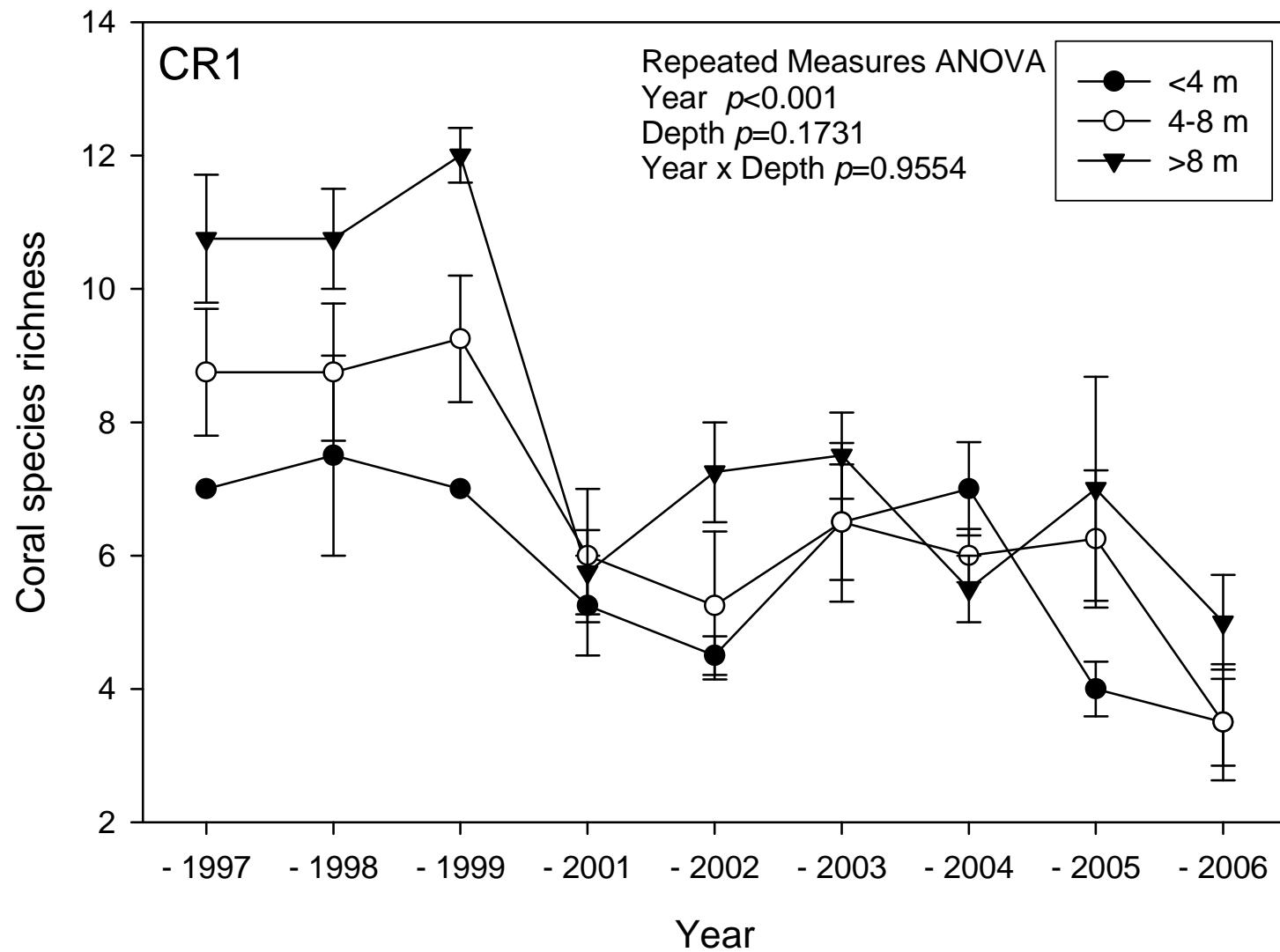


April 22, 2006

Species lost:

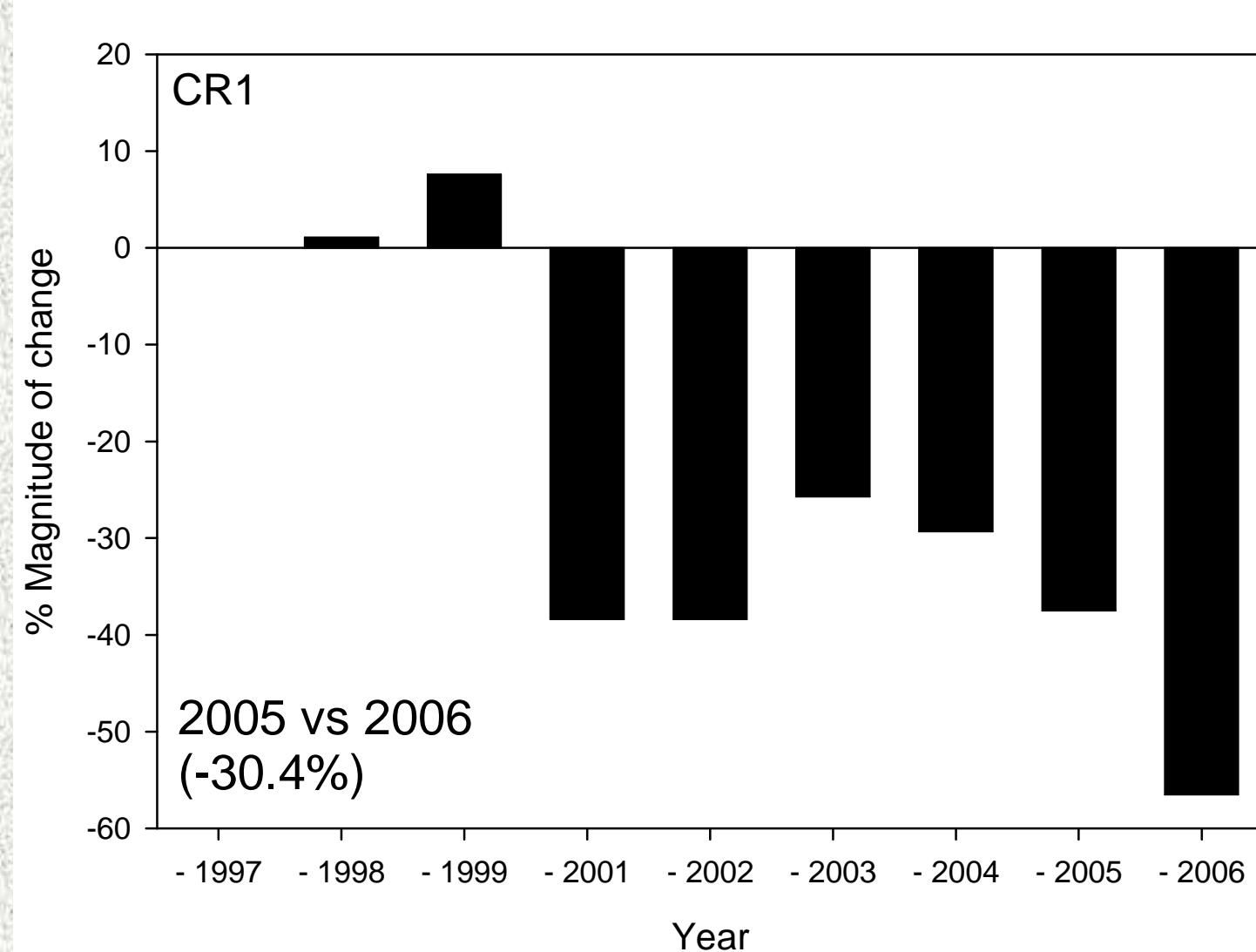
Agaricia agaricites
Millepora alcicornis
Millepora squarrosa

Species richness

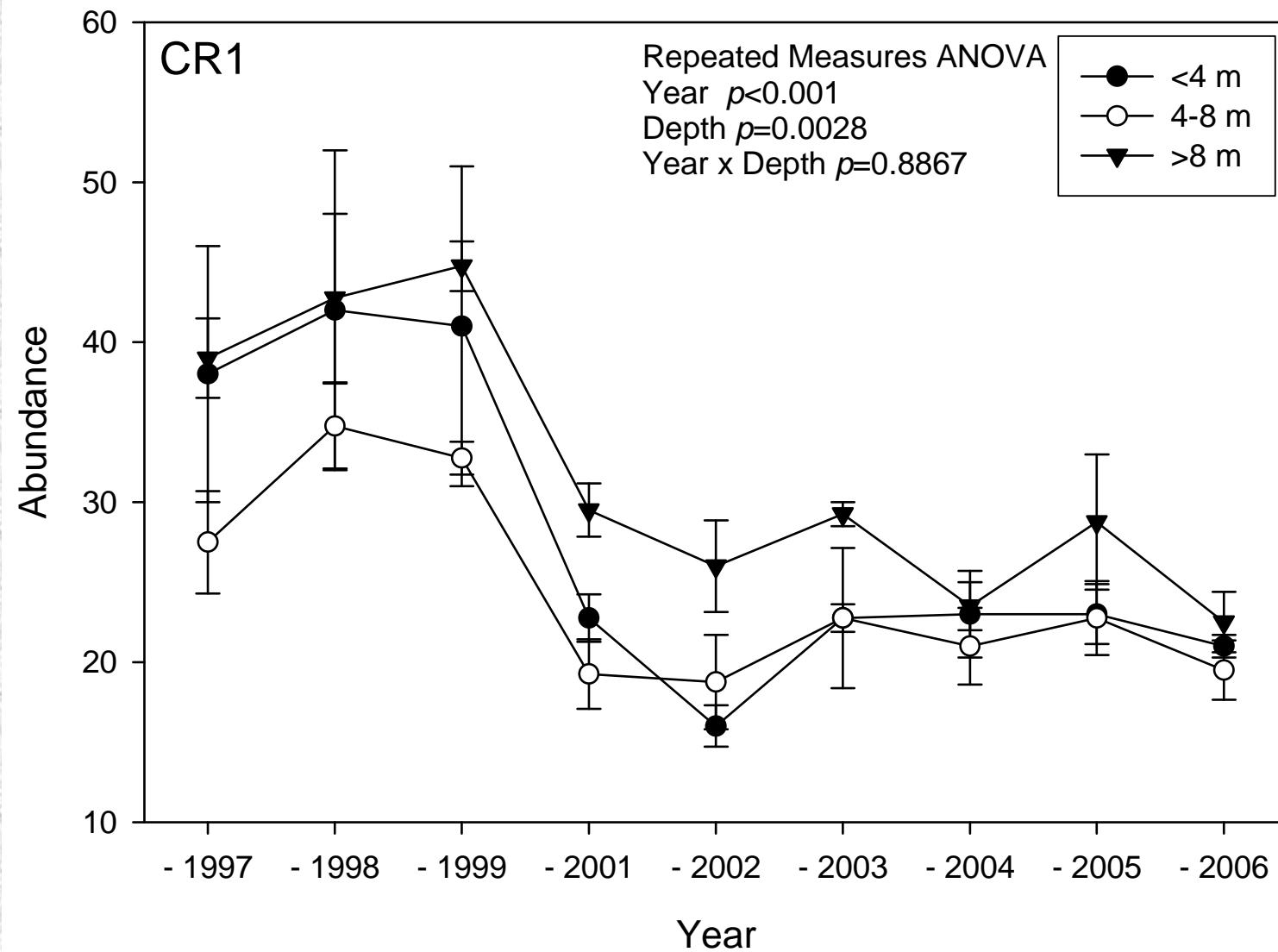


Magnitude of change

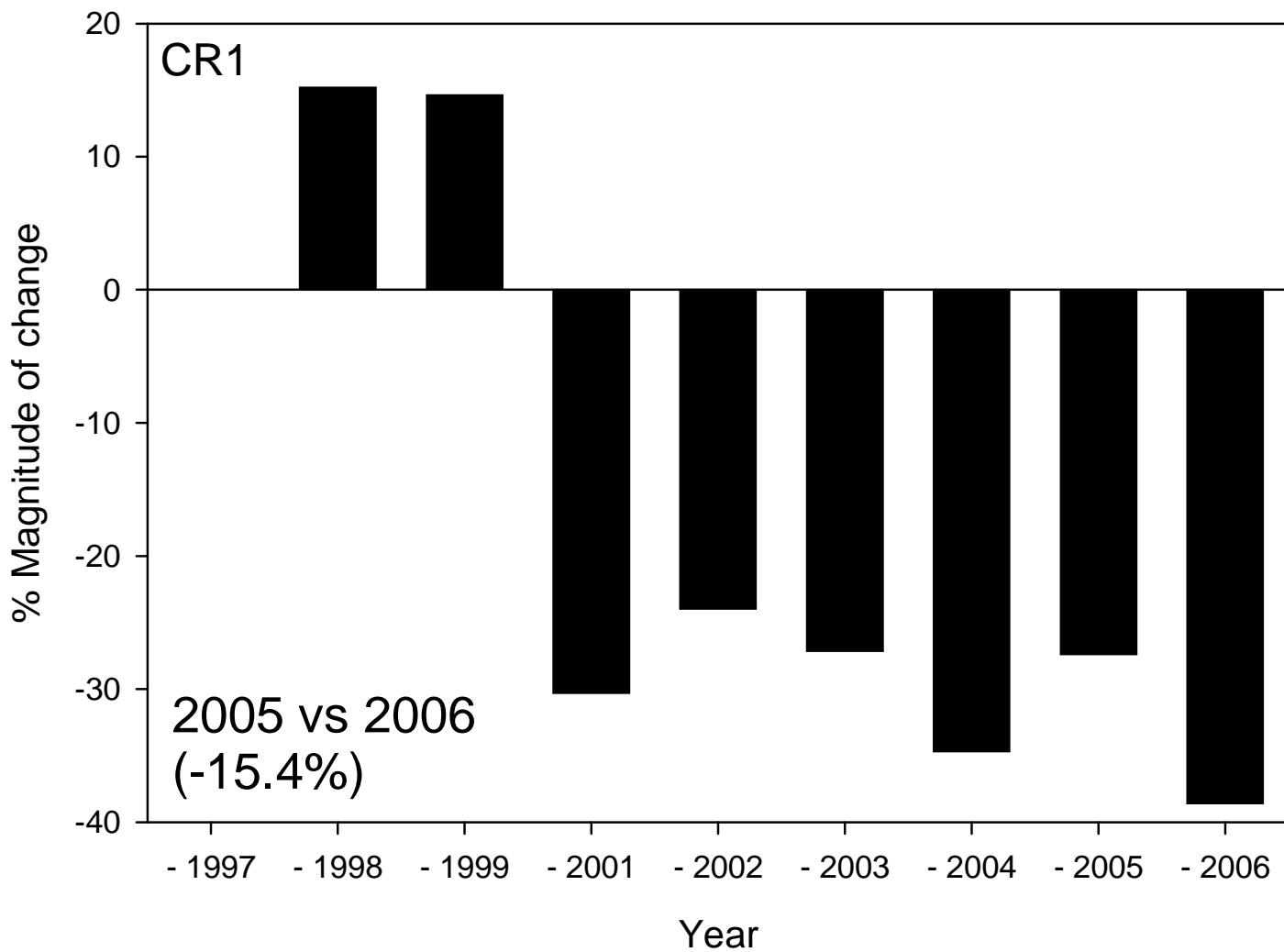
Species richness



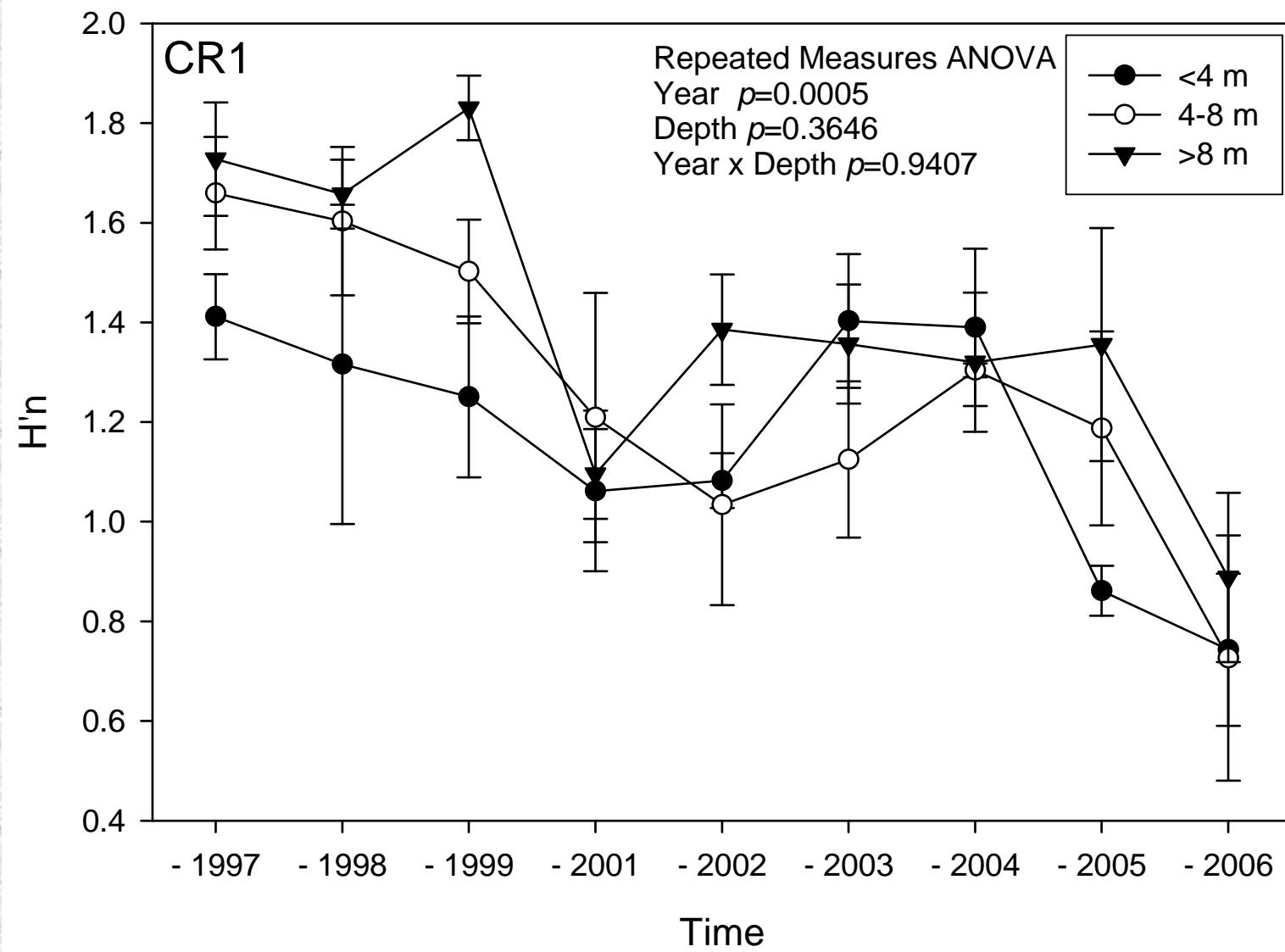
Colony abundance



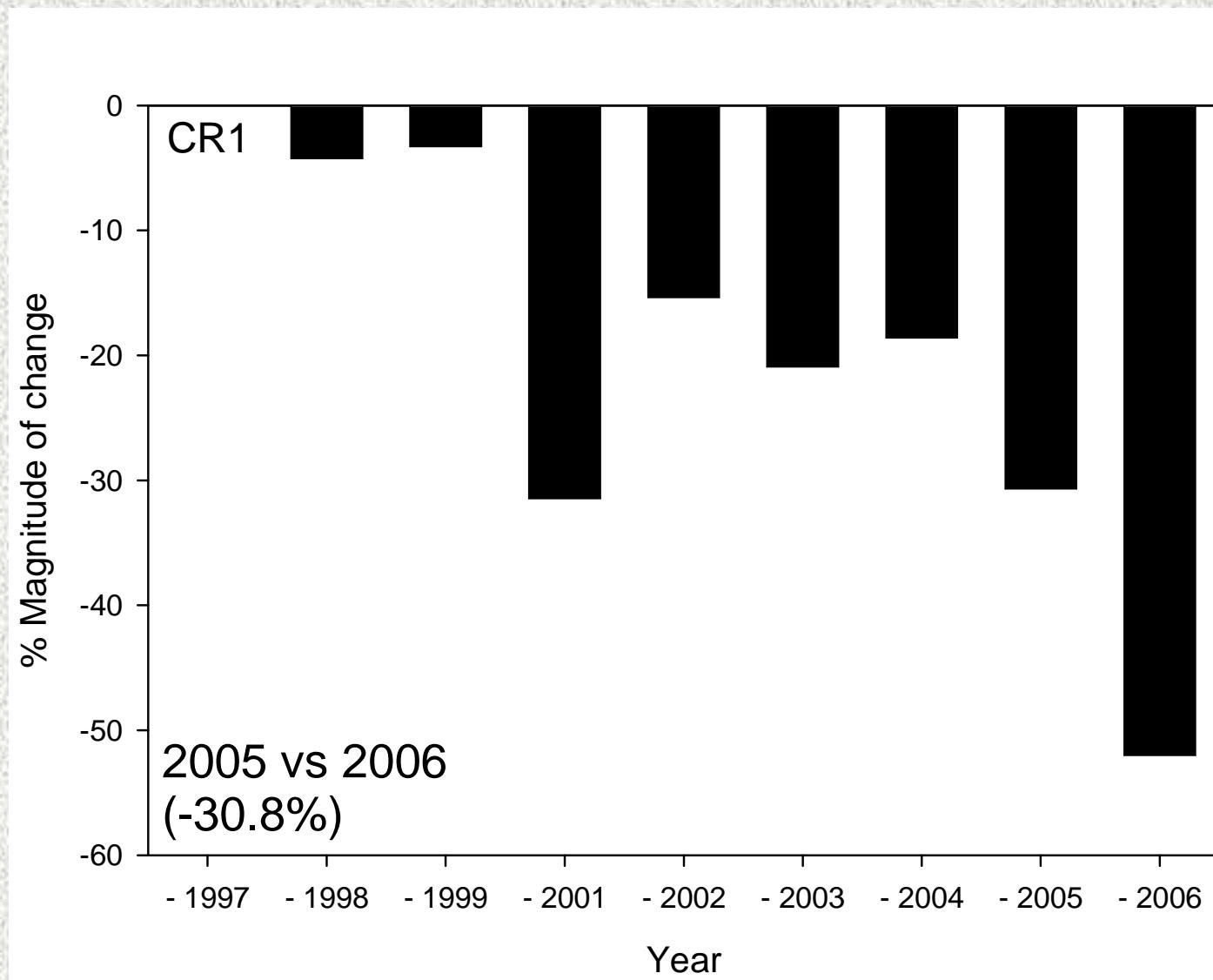
Magnitude of change Colony abundance



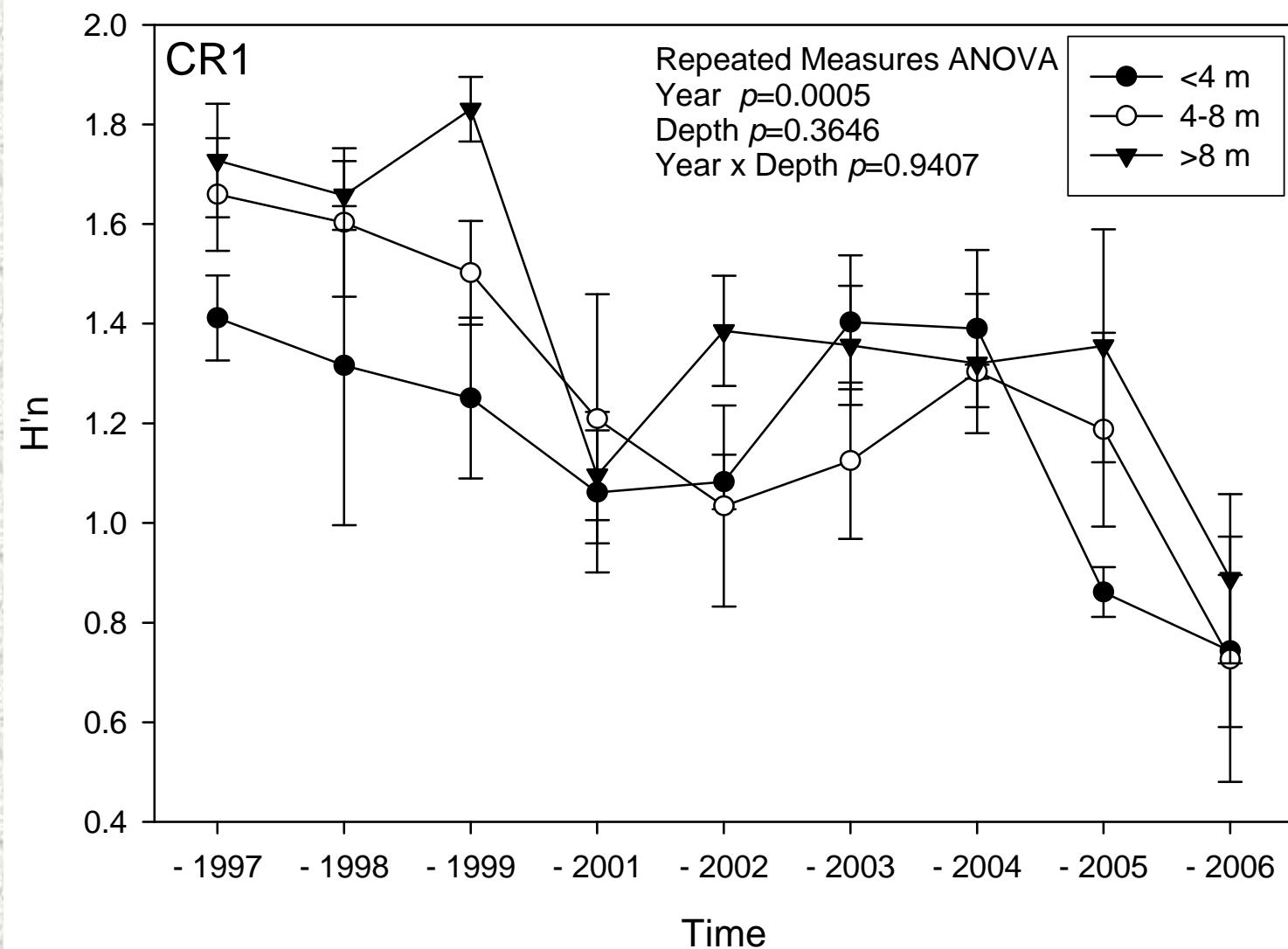
H'n



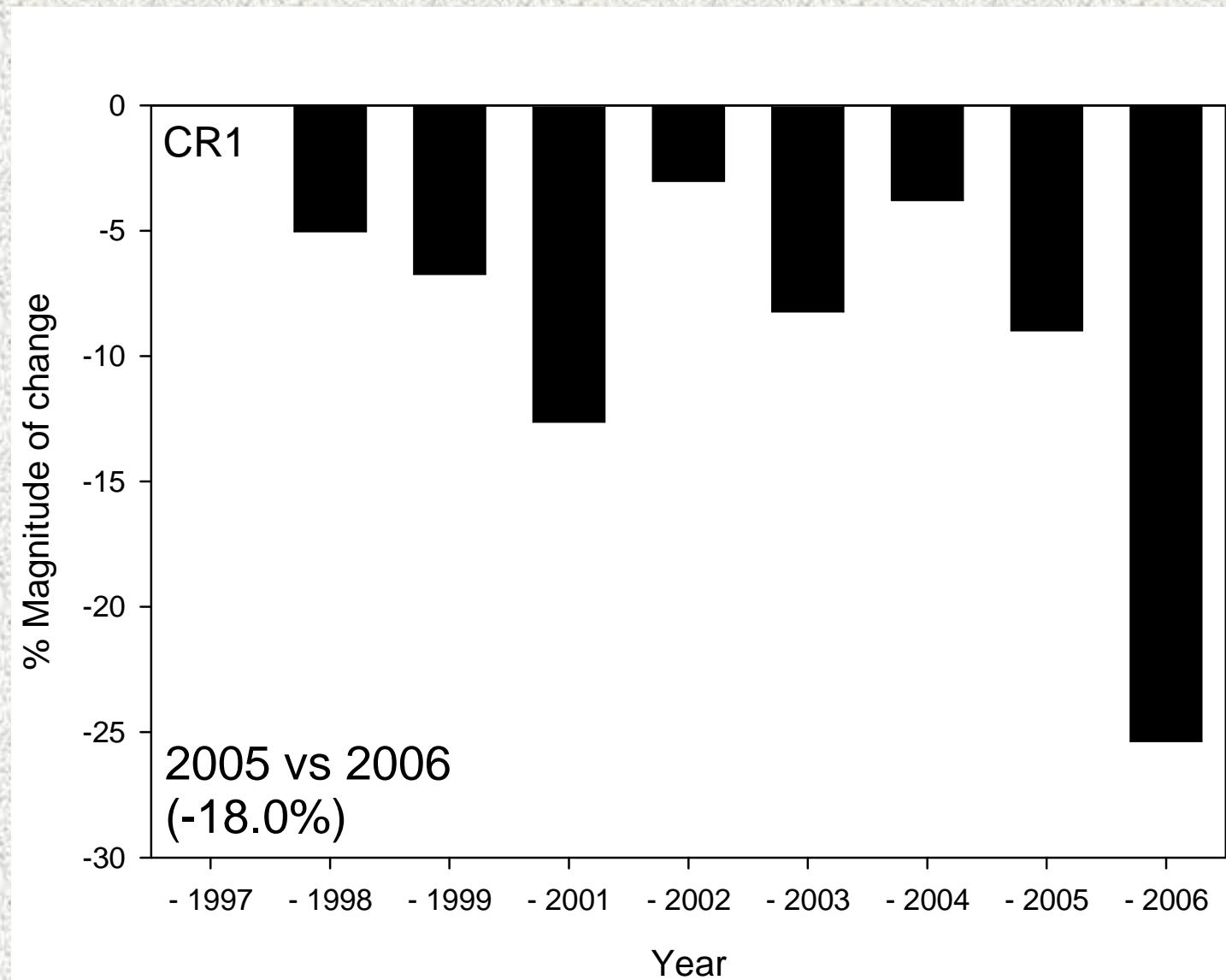
Magnitude of change H'n



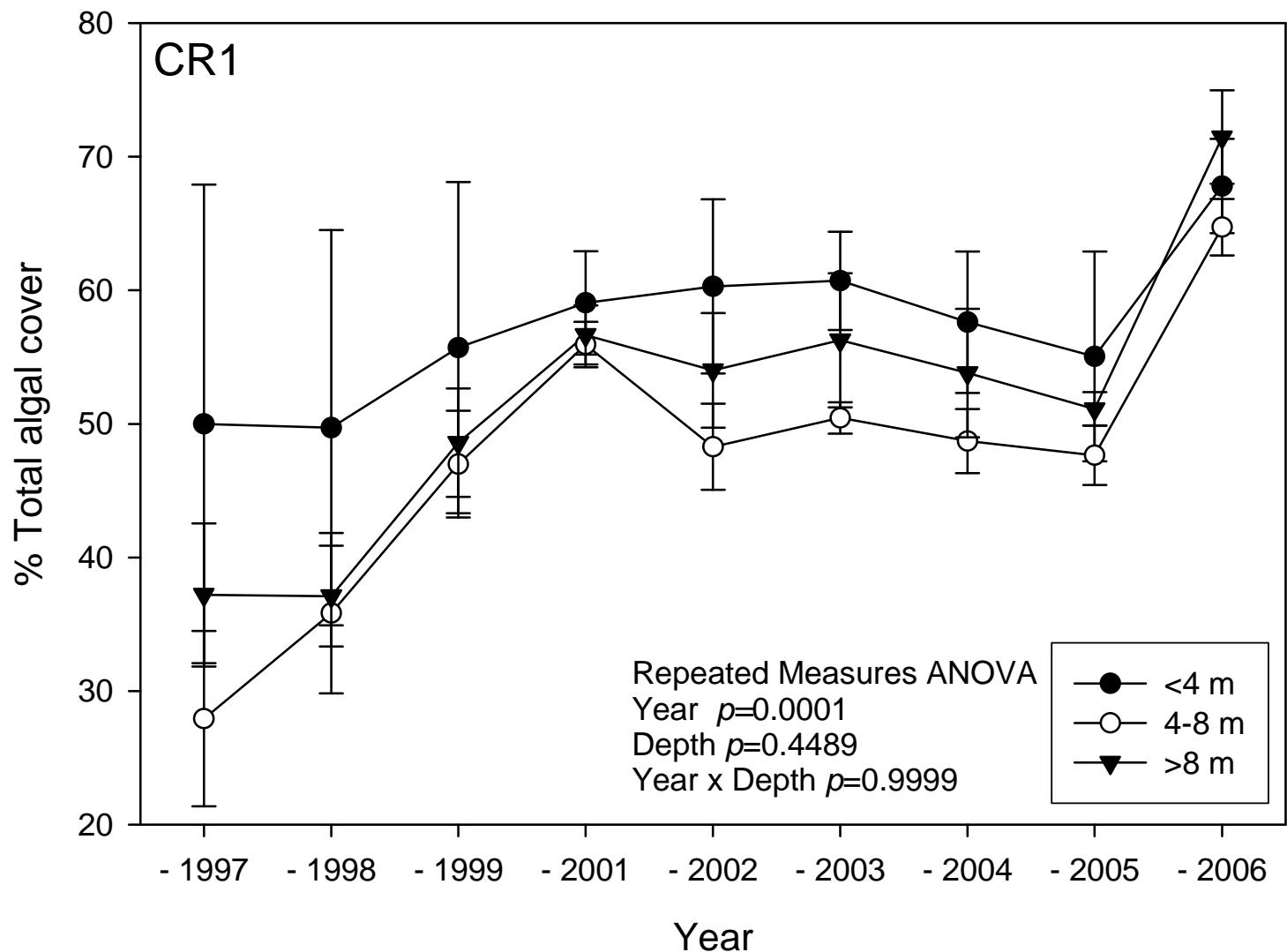
J'n



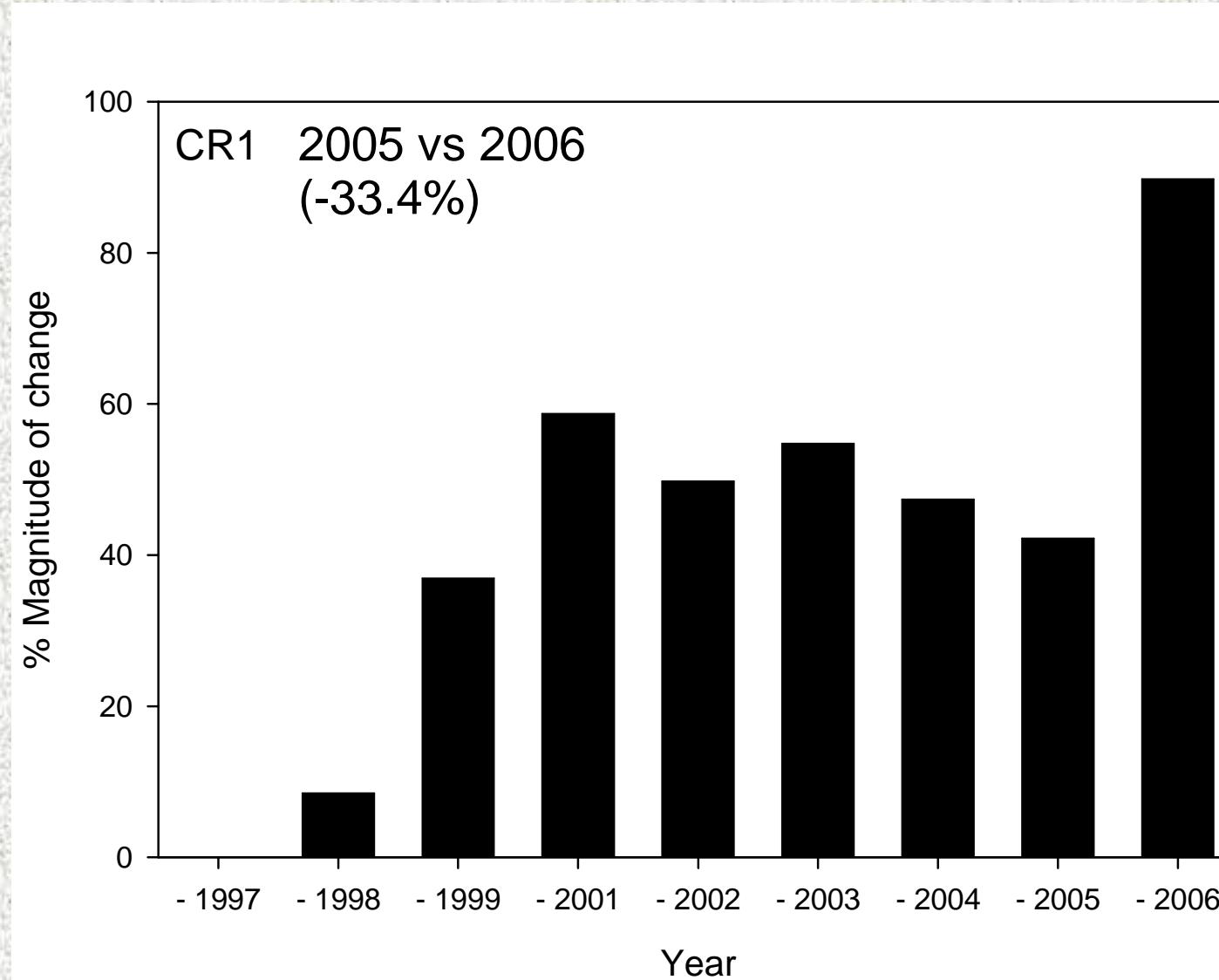
Magnitude of change J'n



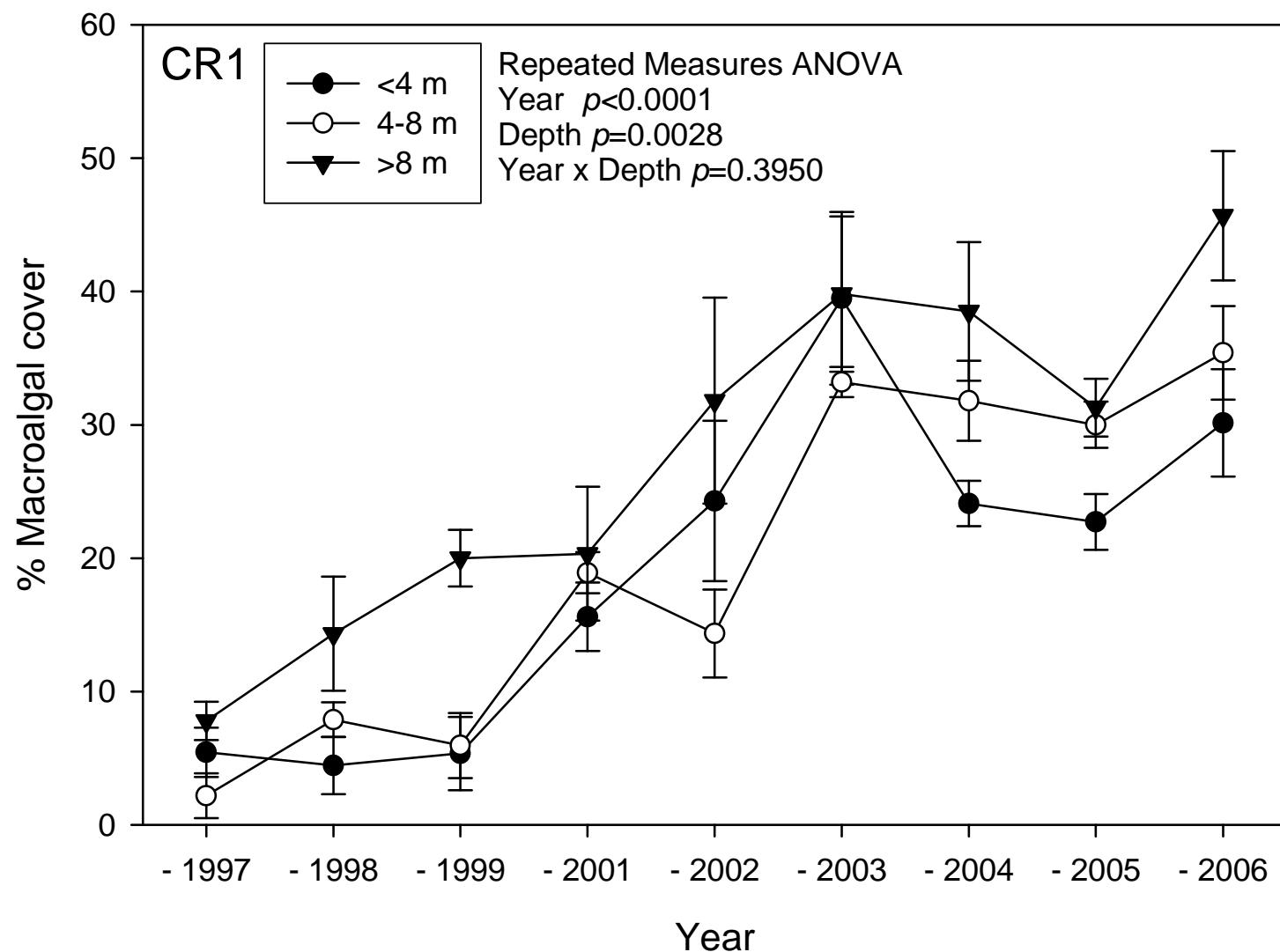
% Total algae



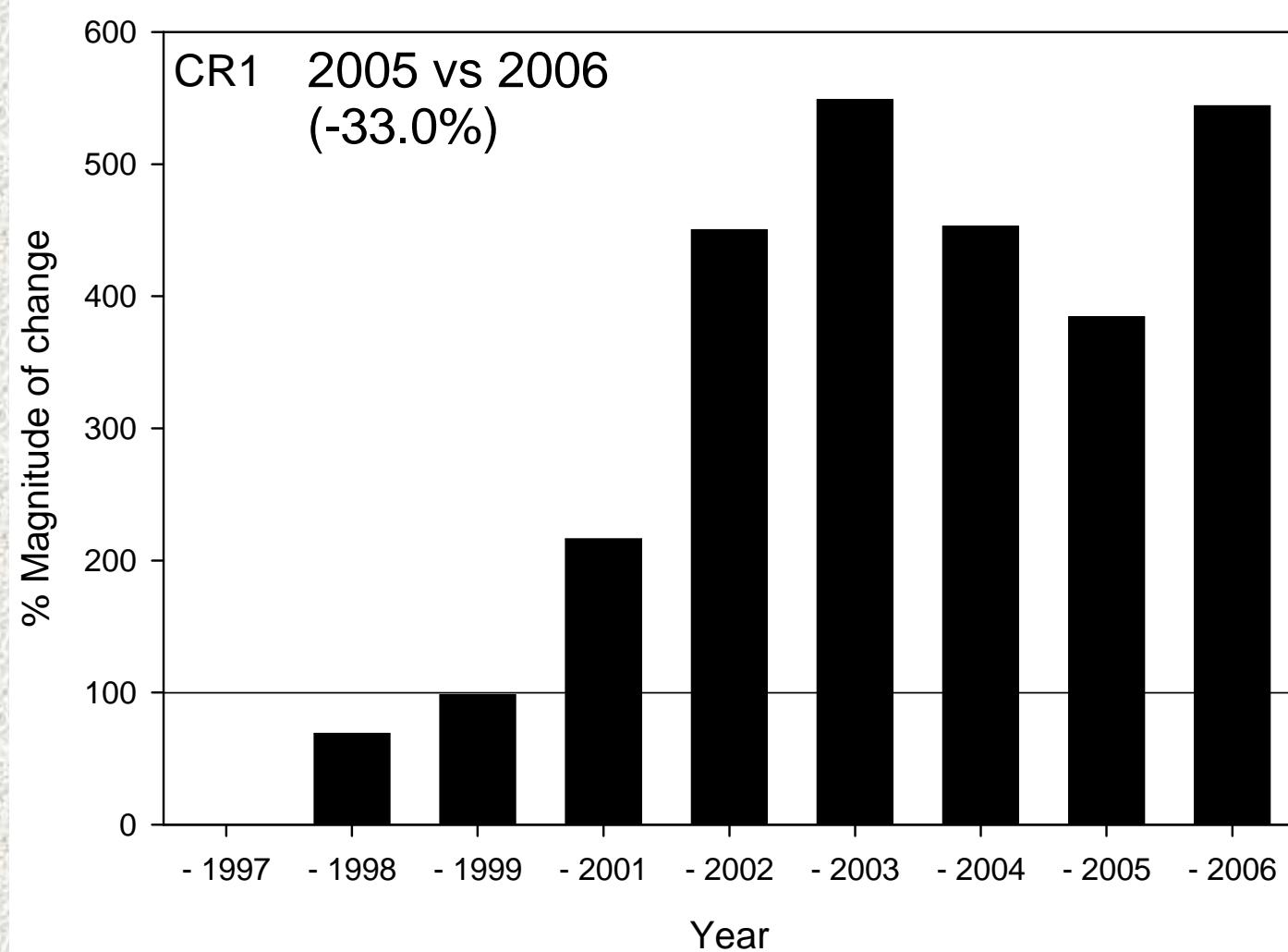
Magnitude of change % Total algae



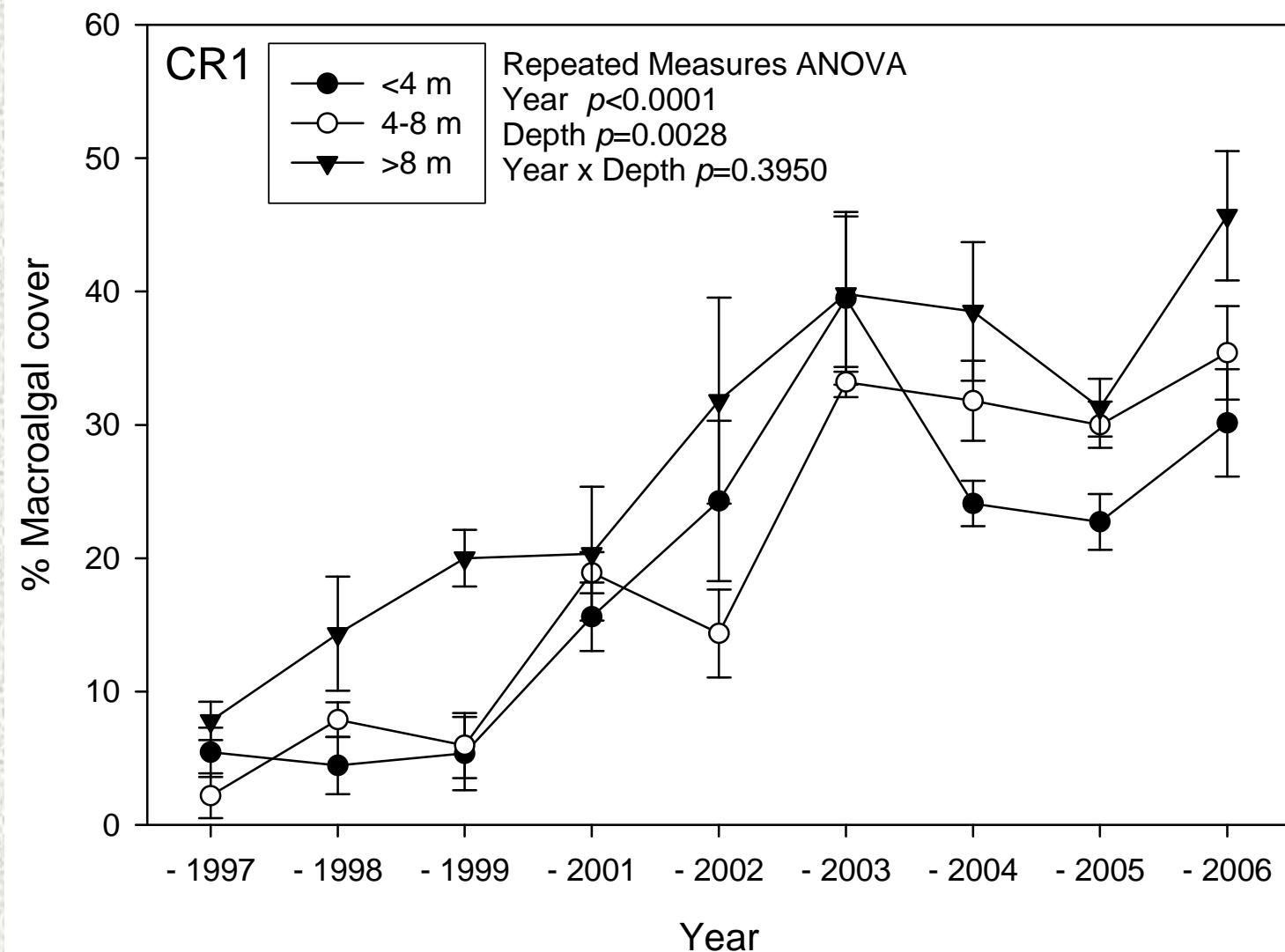
% Macroalgae



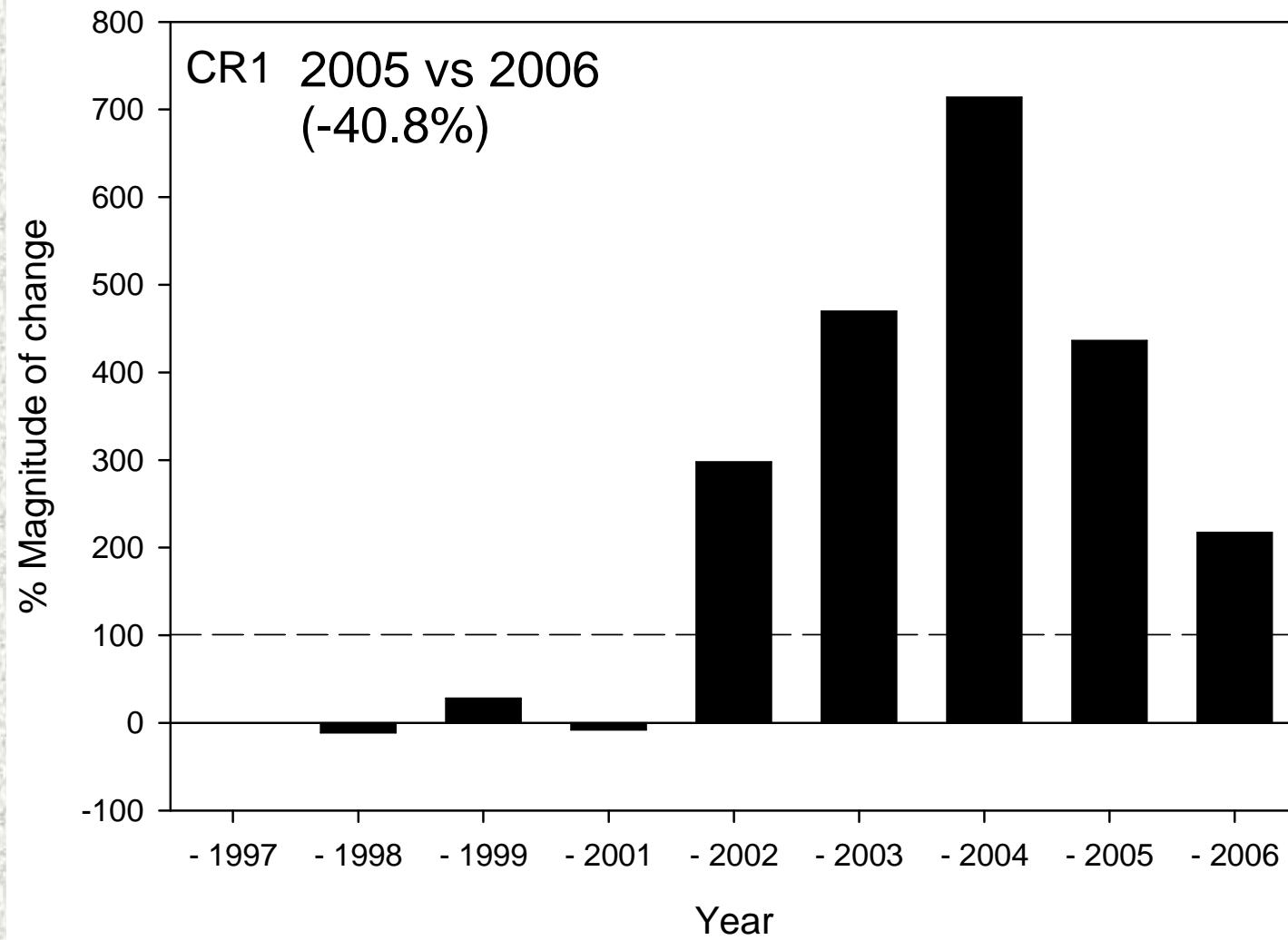
Magnitude of change % Macroalgae



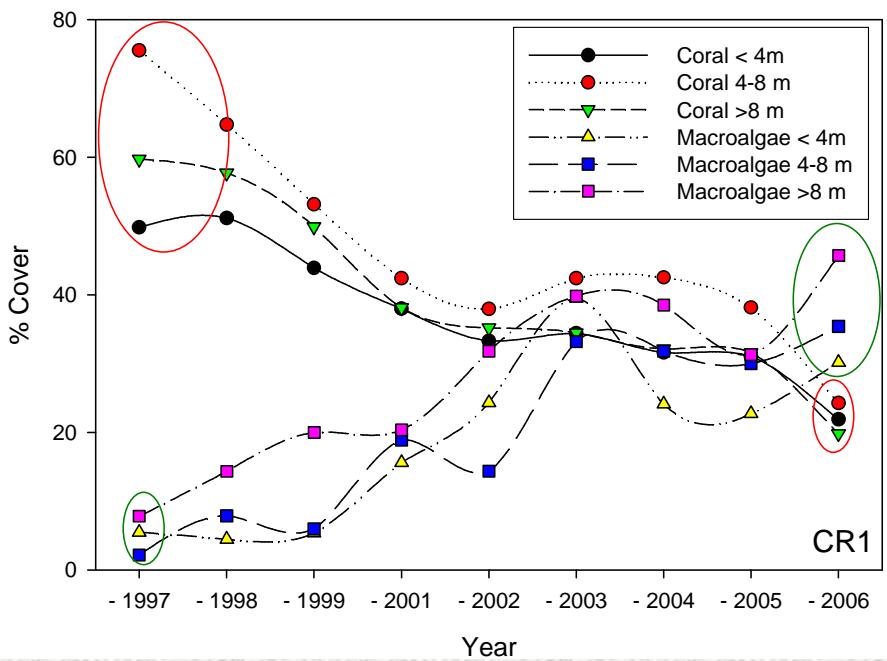
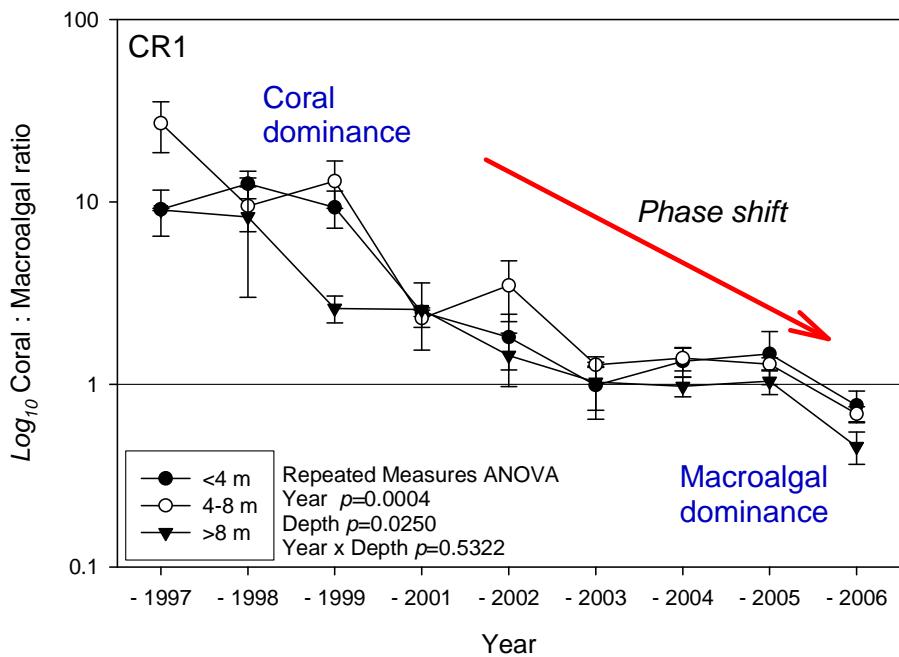
% Cyanobacteria



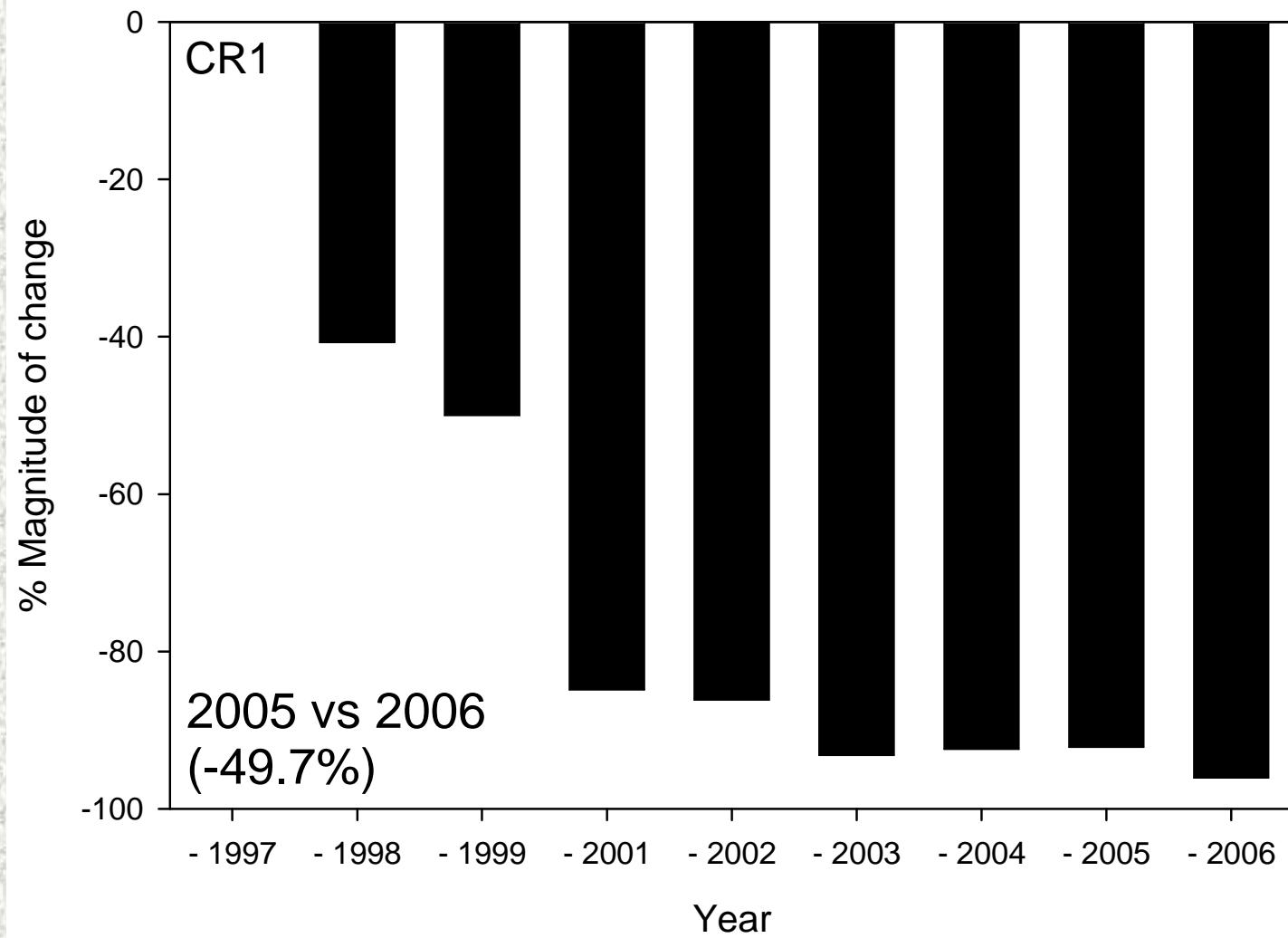
Magnitude of change % Cyanobacteria



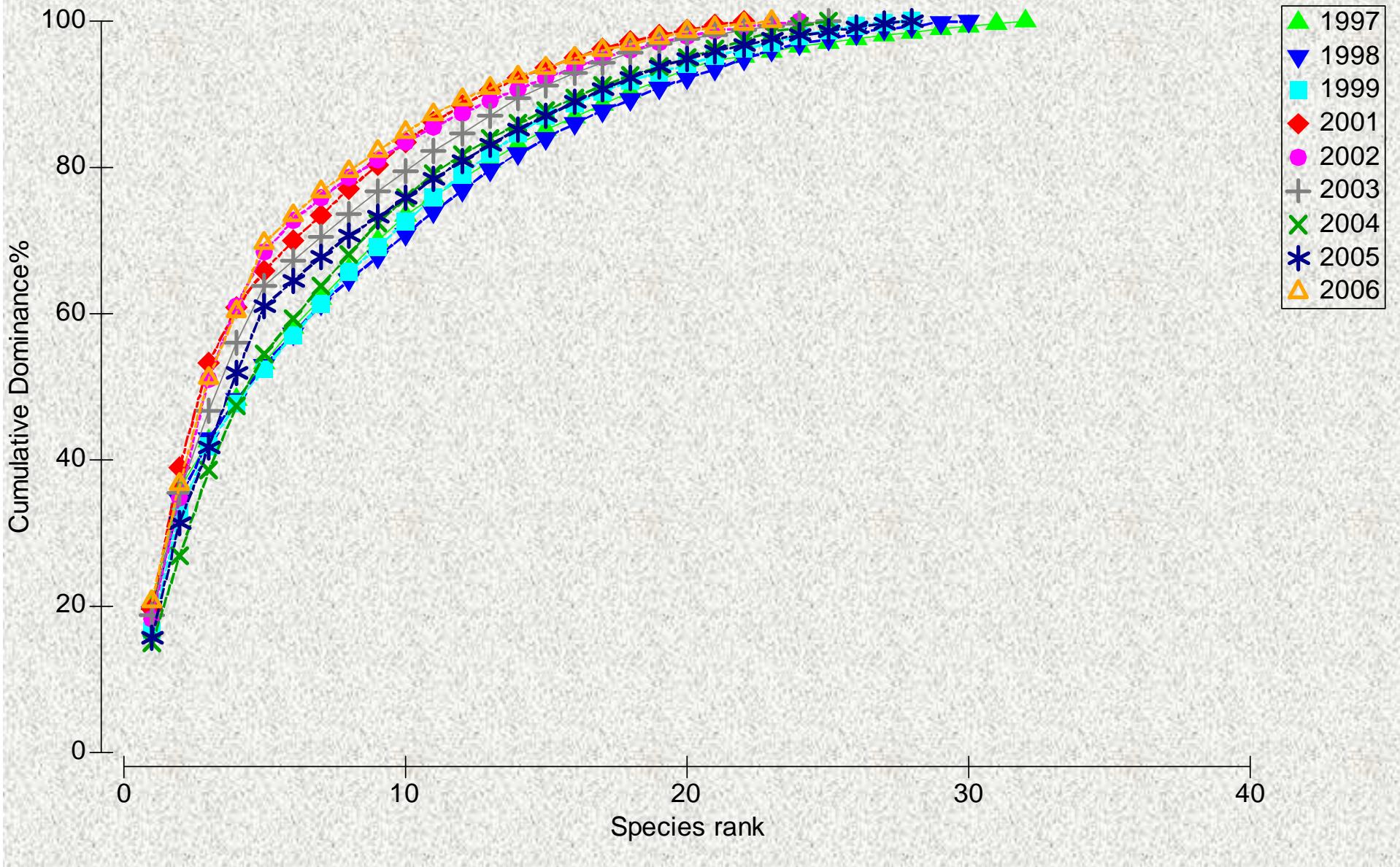
Coral:Macroalgal ratio



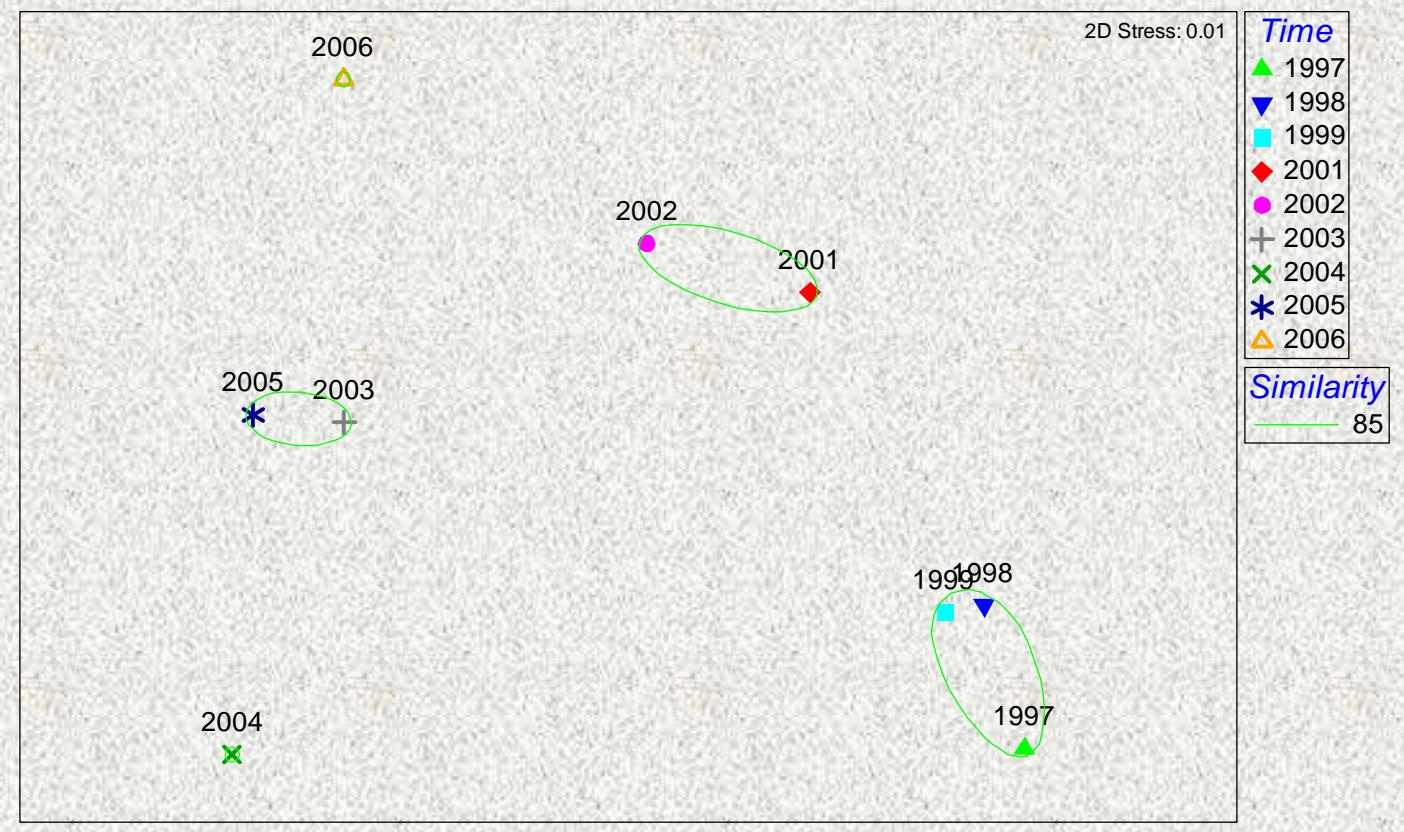
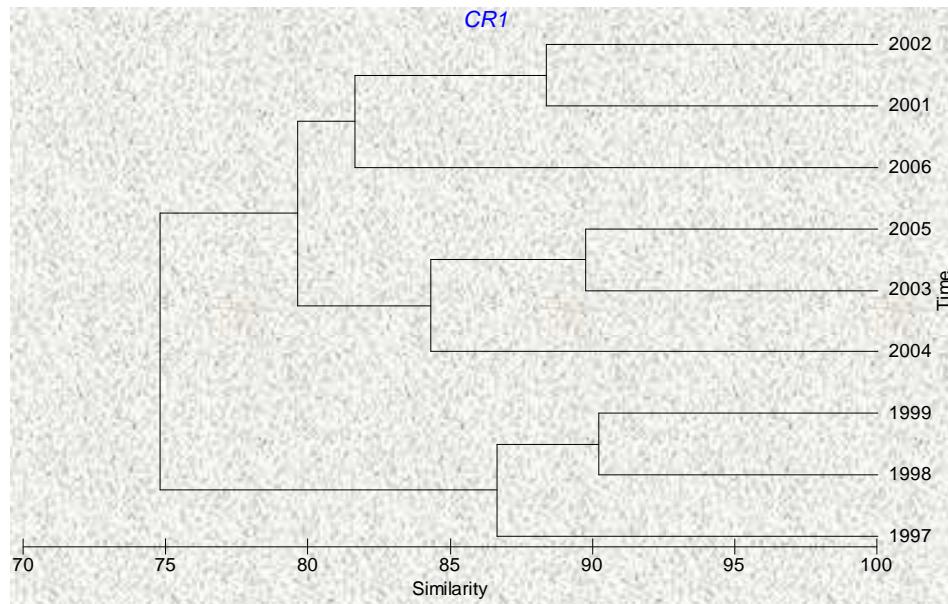
Magnitude of change Coral:Macroalgal ratio



Cummulative dominance curve



Temporal patterns in community structure



2002

Coral dominance



2006

Alarming partial colony mortality rates

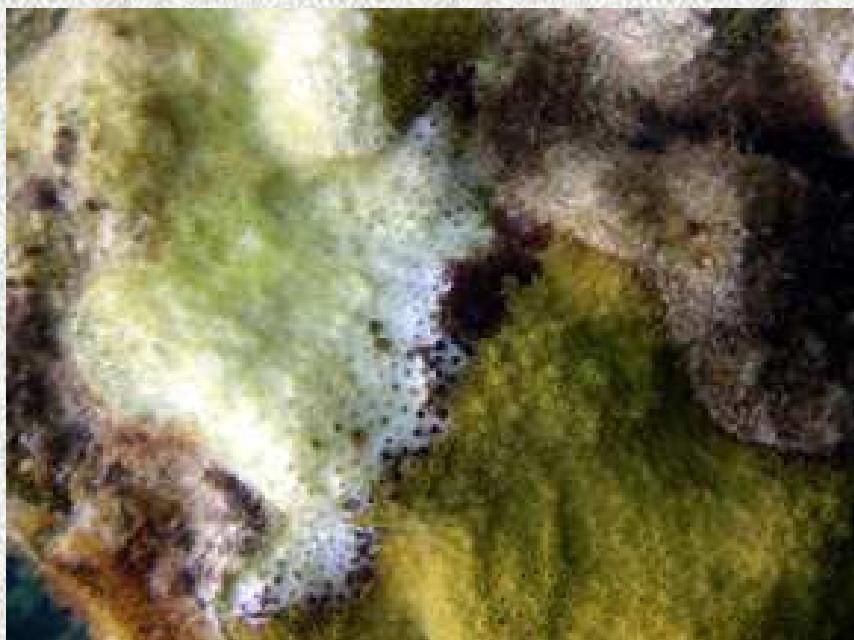


Diploria labyrinthiformis



Siderastrea siderea

2006
Recurrent “disease”/syndrome events
within short temporal scales



Montastraea faveolata



Siderastrea siderea

2006

Rapid phase shift towards algal dominance



Cyanobacteria



Algal turfs

2006

Rapid phase shift towards algal dominance



Red filamentous algae



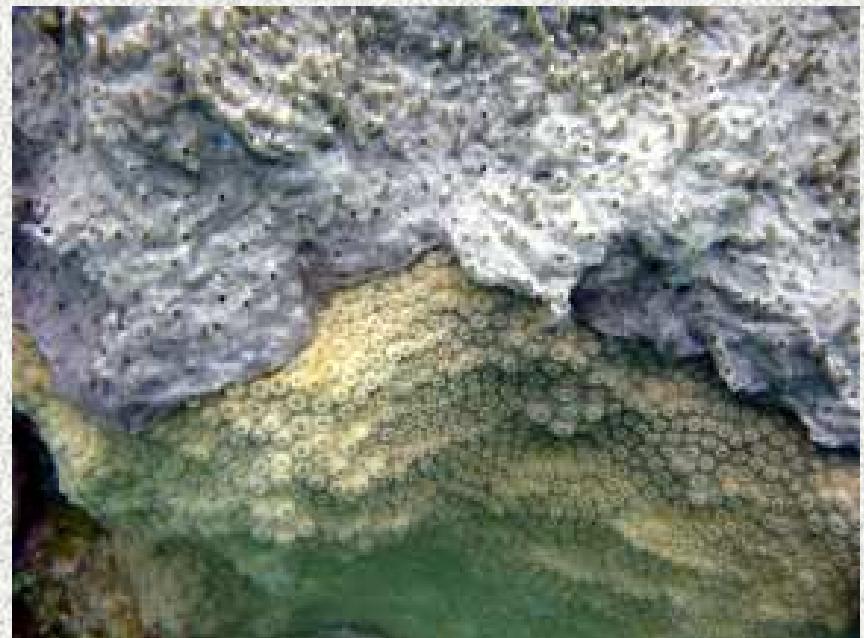
Lobophora variegata

2006

Outcompetition by aggressive reef critters



Trididemnum solidum



Sponges

2006

Mass mortality of large reef-building species

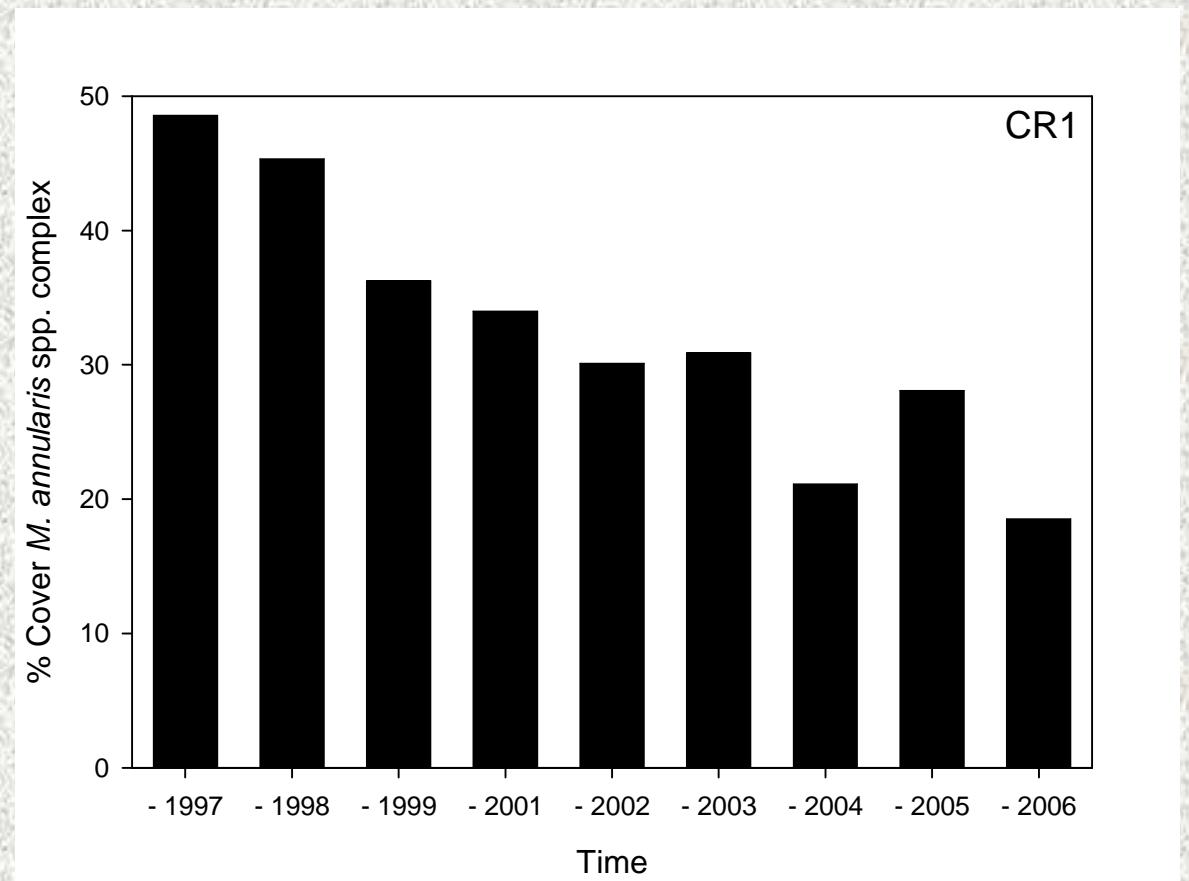


Montastraea annularis



Montastraea faveolata

Montastraea annularis species complex



2006

Poorly documented mass mortality of octocorals



Pseudoplexaura spp.



Pseudopterogorgia bipinnata

2006

Population collapse or extirpation of highly susceptible coral species complexes



Agaricia spp.



Millepora spp.

2006

Population collapse or extirpation of highly susceptible coral species complexes



Mycetophyllia spp.



Acropora cervicornis

Conclusion

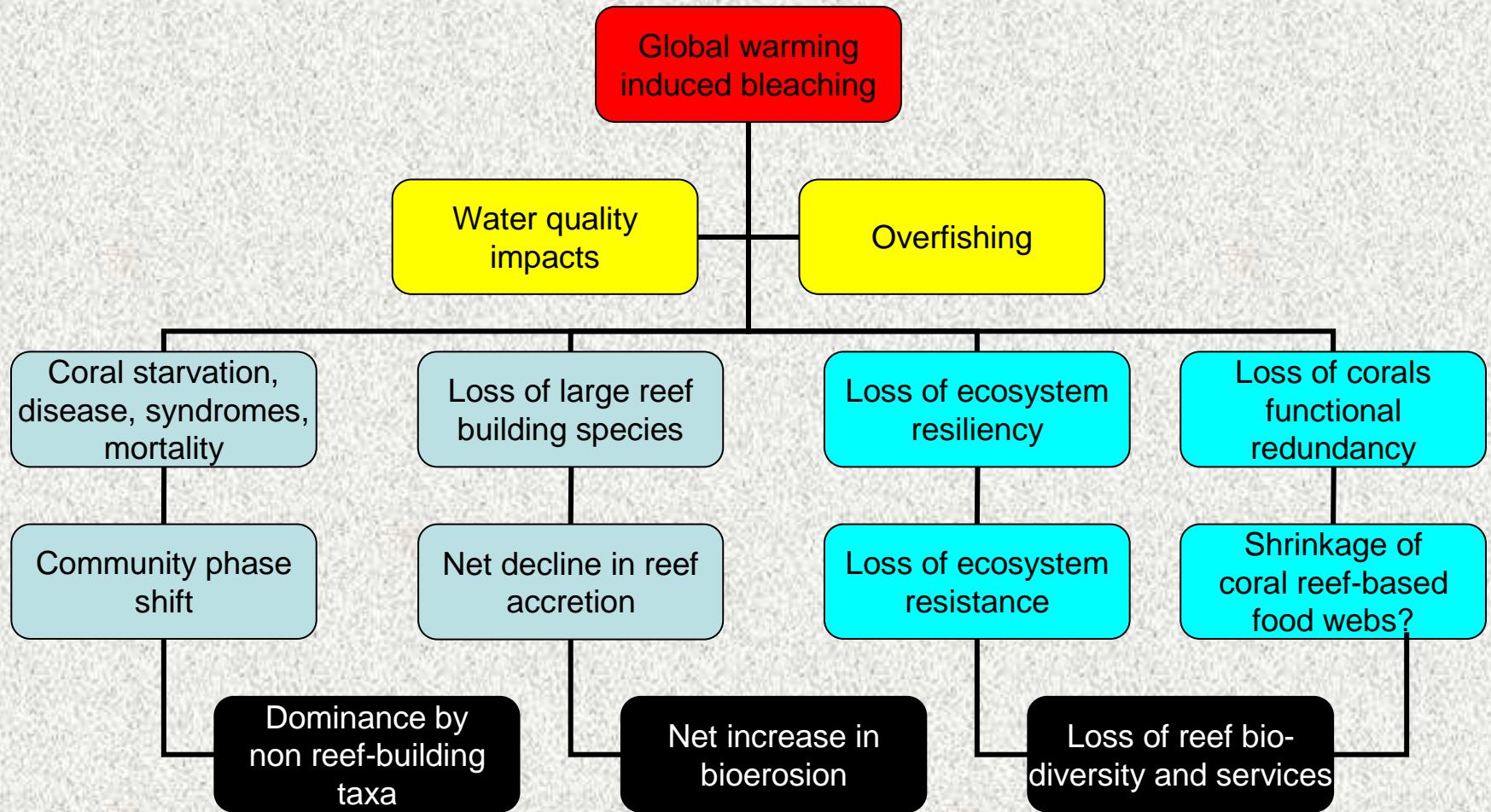
- There has been a mass mortality event through a wide geographic area.
- Major decline in coral cover, species richness, colony abundance, H'n, and J'n.
- Major loss of large reef-builders.
- Local extirpation of many coral species.

Mortality effects at the “reefscape” level

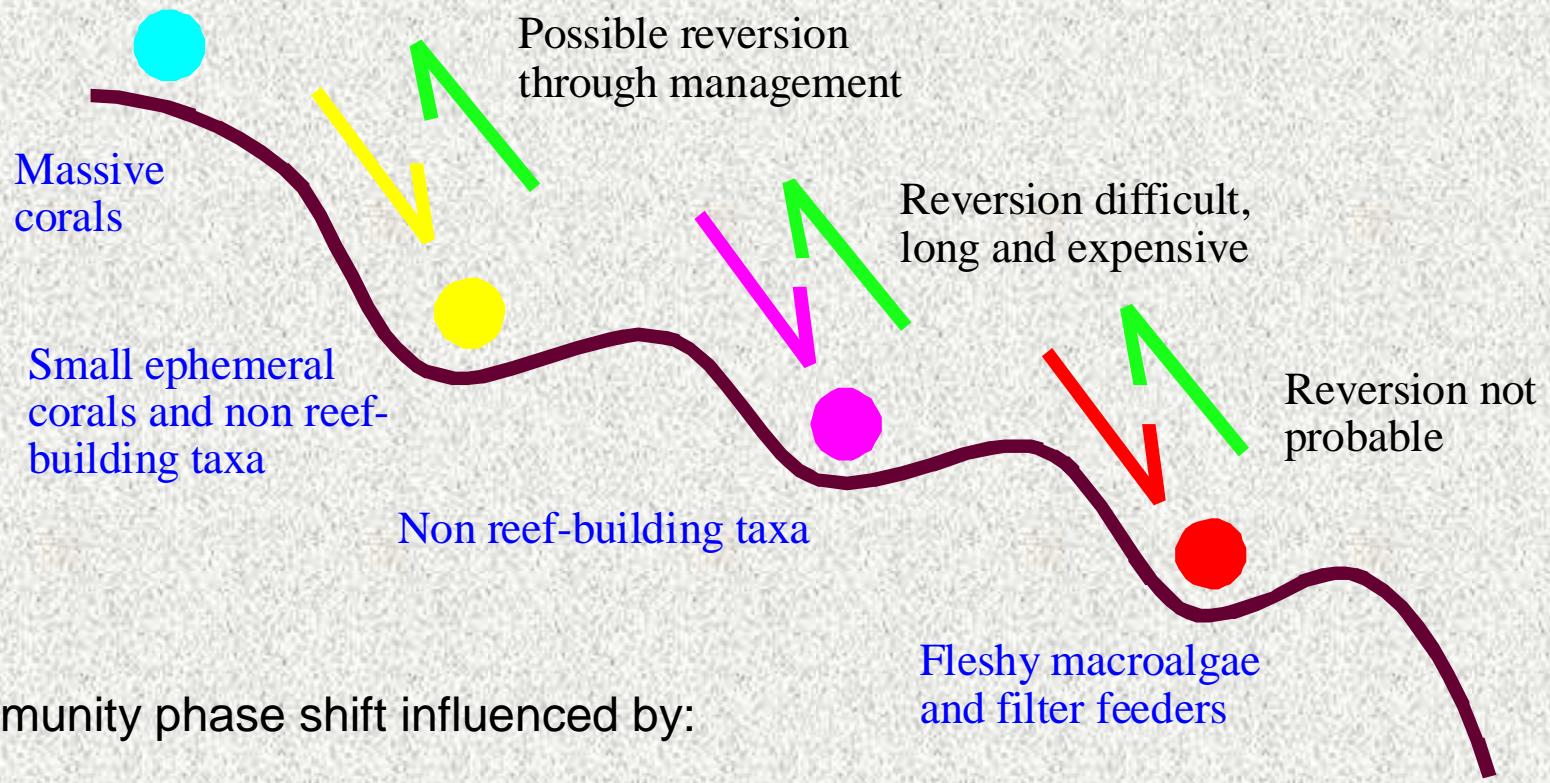


- Loss of microhabitat connectivity (small spatial scales).
- Loss of habitat for cleaning gobies (loss of reef cleaning stations).
- Increasing pressure from corallivores on remnant colonies.
- Decline in corals reproductive output.
- Allee effect for some species.

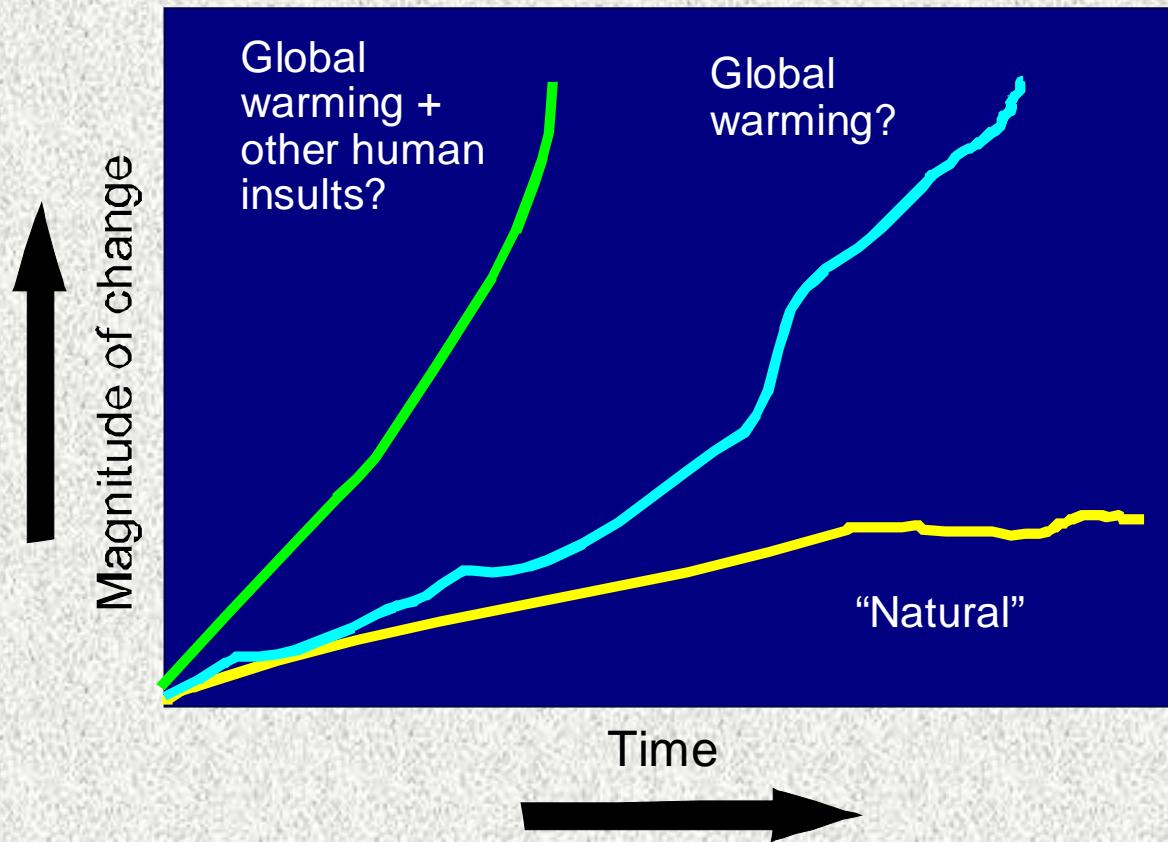
Long-term consequences?



Long-term consequences?

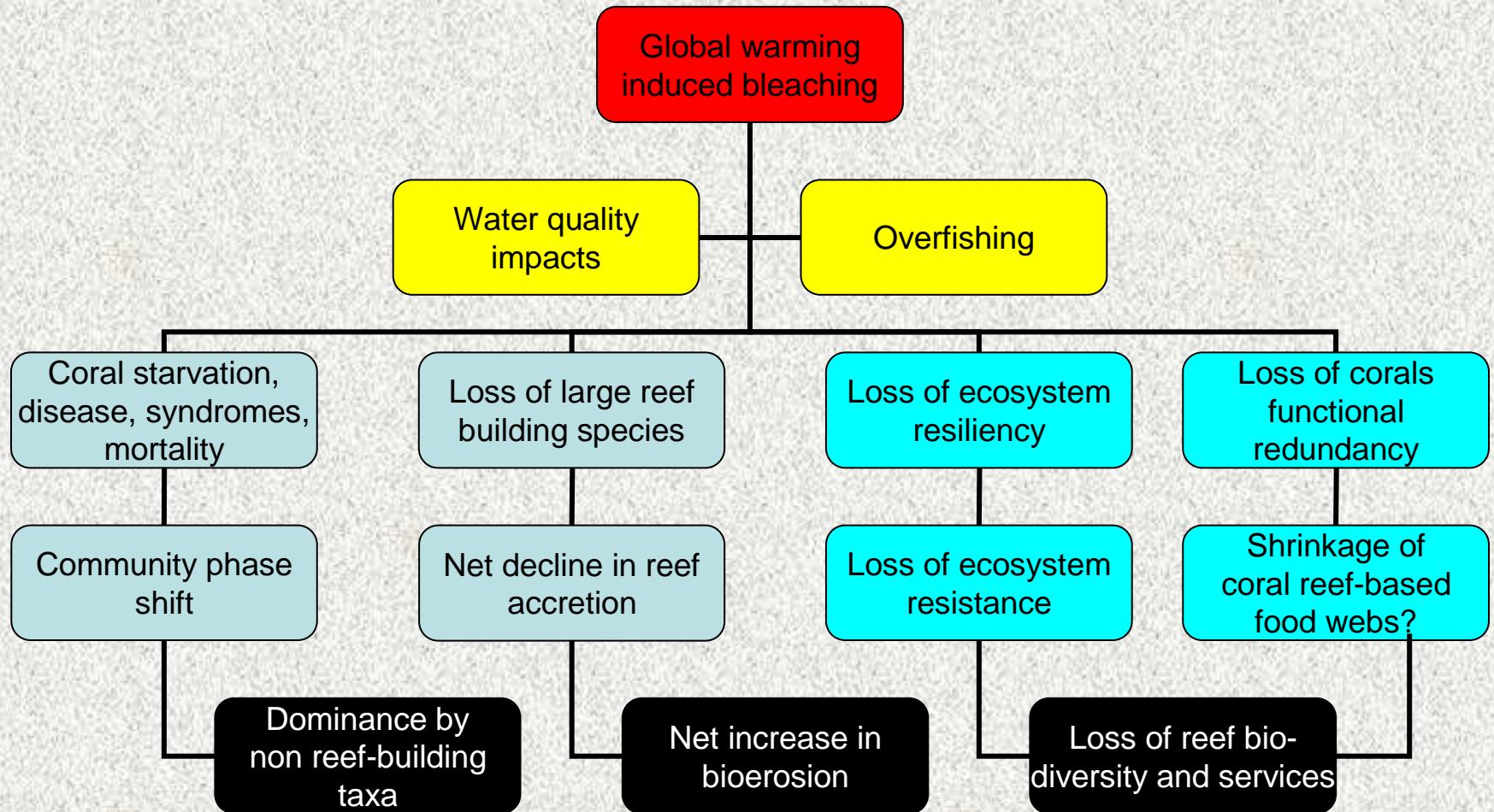


Long-term consequences?



Corals and other reef species can not cope with rapid ecological change.

Long-term consequences?



Thanks!



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