

Coral Reef Ecosystem Studies

Puerto Rico

Terrestrial Sediment Budget in La Parguera, Puerto Rico

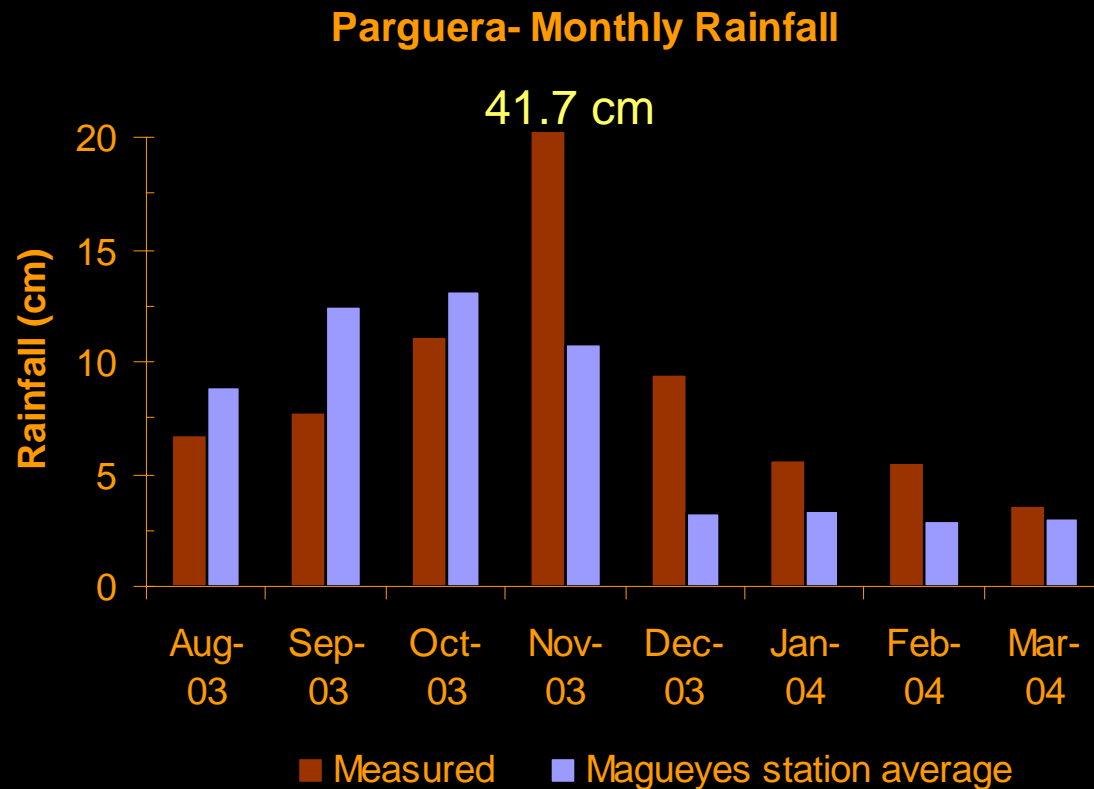
Project Objectives

1. To measure and predict sediment production rates from individual sources of sediment in the La Parguera area.
2. To measure runoff and sediment delivery rates into the marine environment of La Parguera.

Project Component: Rainfall measurements

Method: Tipping bucket raingauge

Preliminary data:



Monthly rainfall lower than average from Aug-Oct 03, but higher than average from Nov 03-Mar 04

Nov 03 rainfall = 3.9 times average precip. recorded at Isla Magueyes

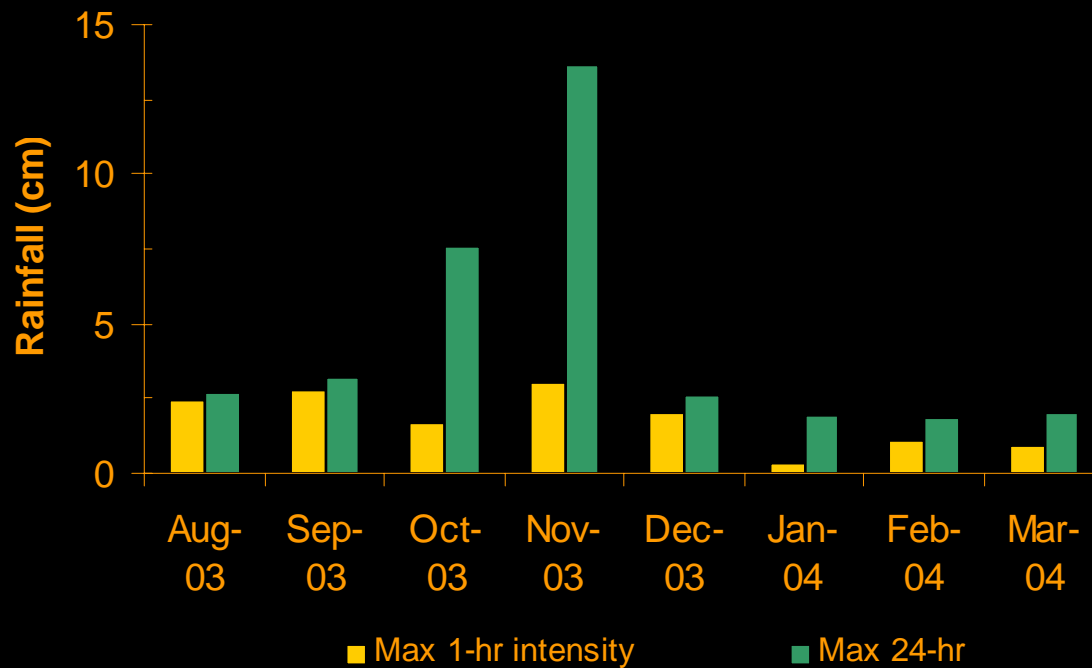
Total rainfall = 91.4 cm or 1.6 times higher than expected from average rainfall

Project Component: Rainfall measurements

Method: Tipping bucket raingauge

Preliminary data:

Parguera-Maximum Rainfall Intensity by Month



Number of individual storms = 123

Maximum 1-hr intensity = 3.05 cm hr⁻¹

Study period characterized by high intensity rainfall with high erosive potential

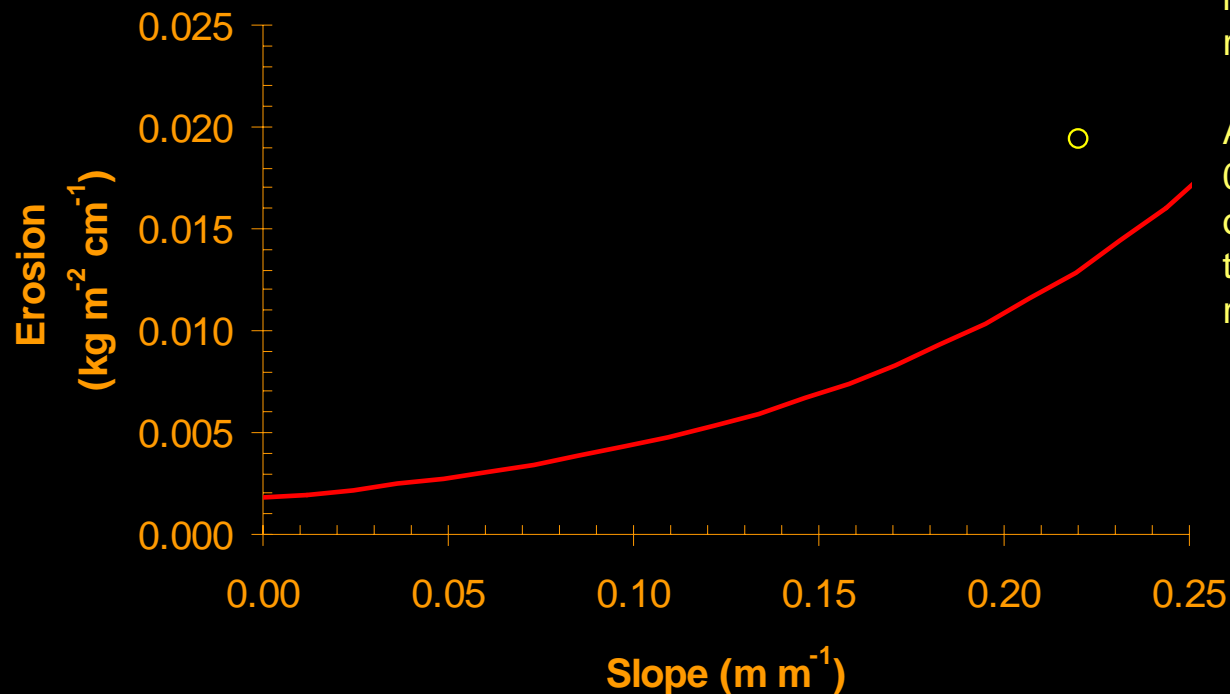
Project Component: Sediment production

Method: 36 sediment traps have been installed by March 2004.

Traps collect sediment from undisturbed hillslopes, unpaved roads, and cutslopes.

Only limited unpaved road sediment production data available at this time.

Road segments- Slope vs. sediment production

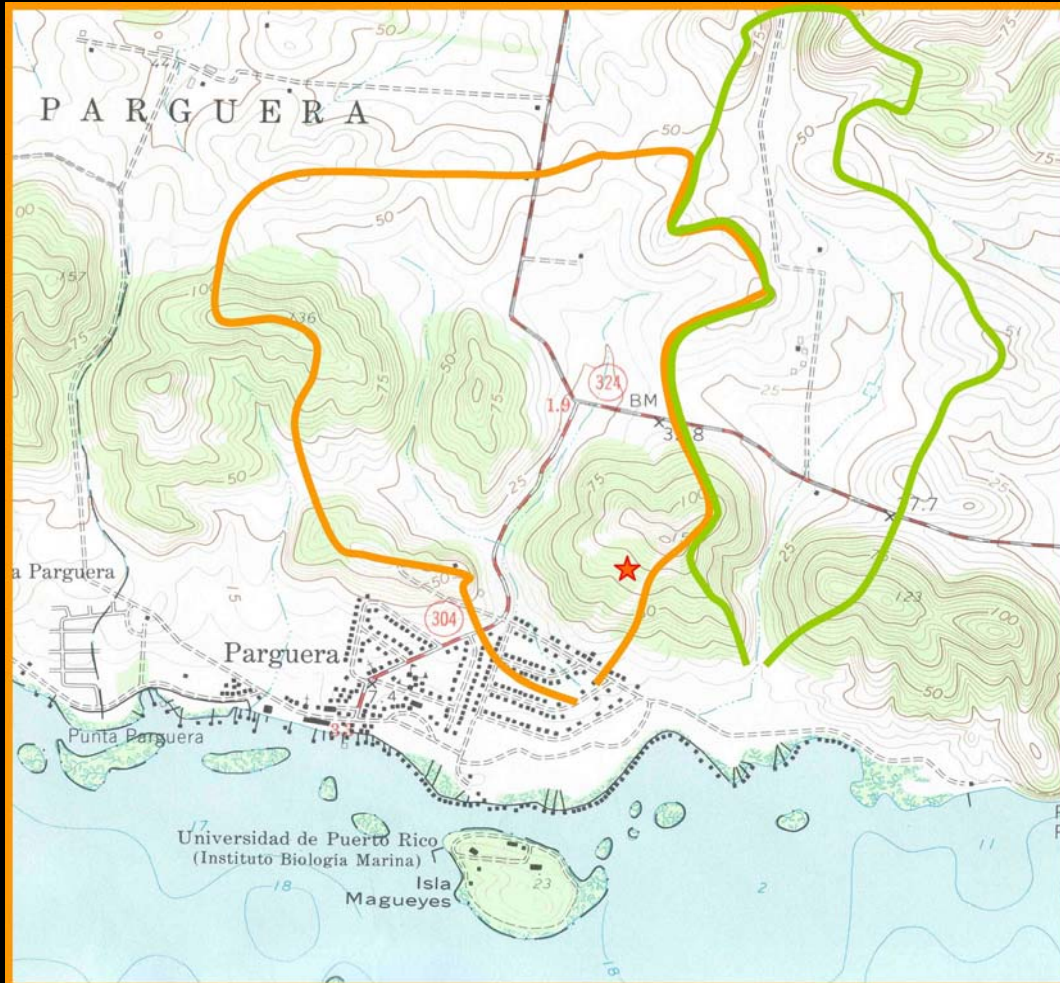


Road sediment production is a function of rainfall and road segment slope.

Average erosion rate is 0.007 kg m⁻² cm⁻¹, which is one-order of magnitude lower than the average measured from roads in St. John.

Project Component: Watershed-scale runoff/sediment yield

Method: Two natural channel stream gauging stations installed October 03



Quebrada Nautico
Watershed

Quebrada Poblado
Watershed

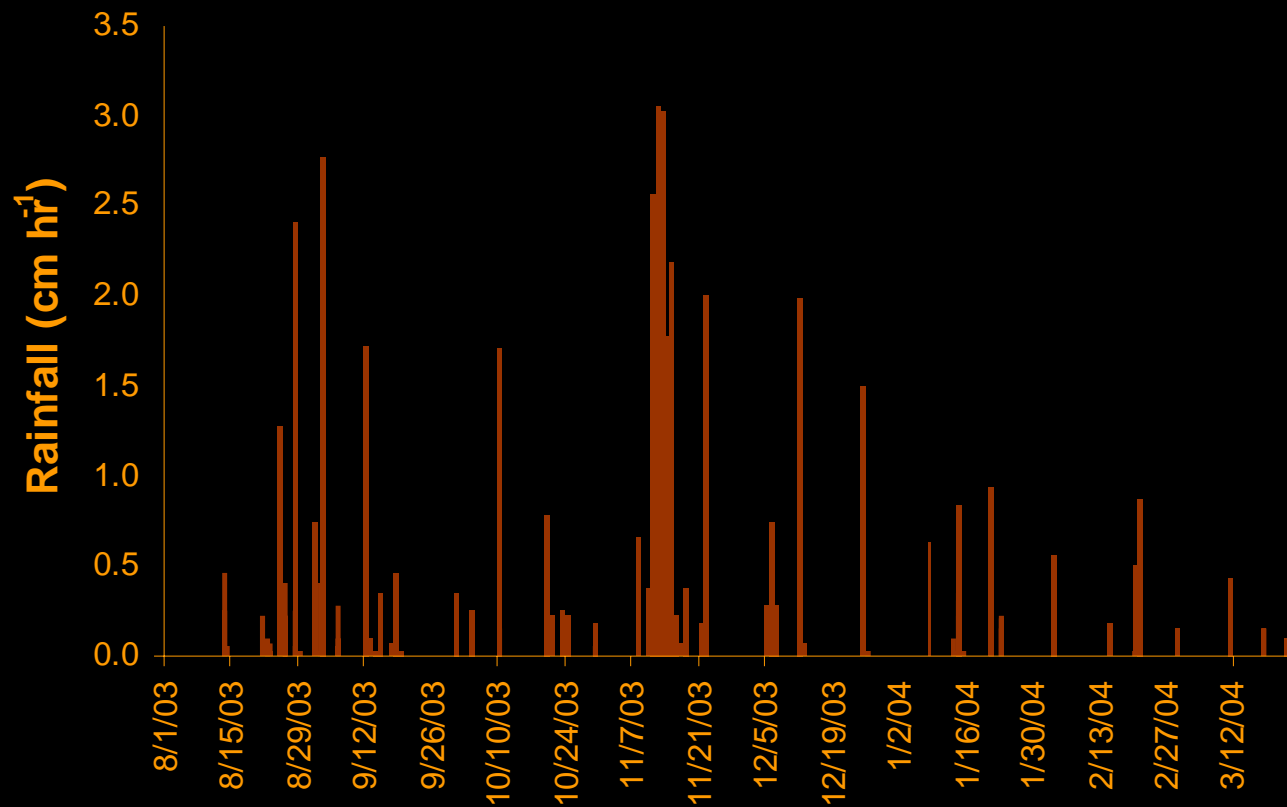
★ Raingauge

No suspended sediment samples
have been collected.

Project Component: Watershed-scale runoff/sediment yield

Method: Two natural channel stream gauging stations installed October 03
Preliminary data:

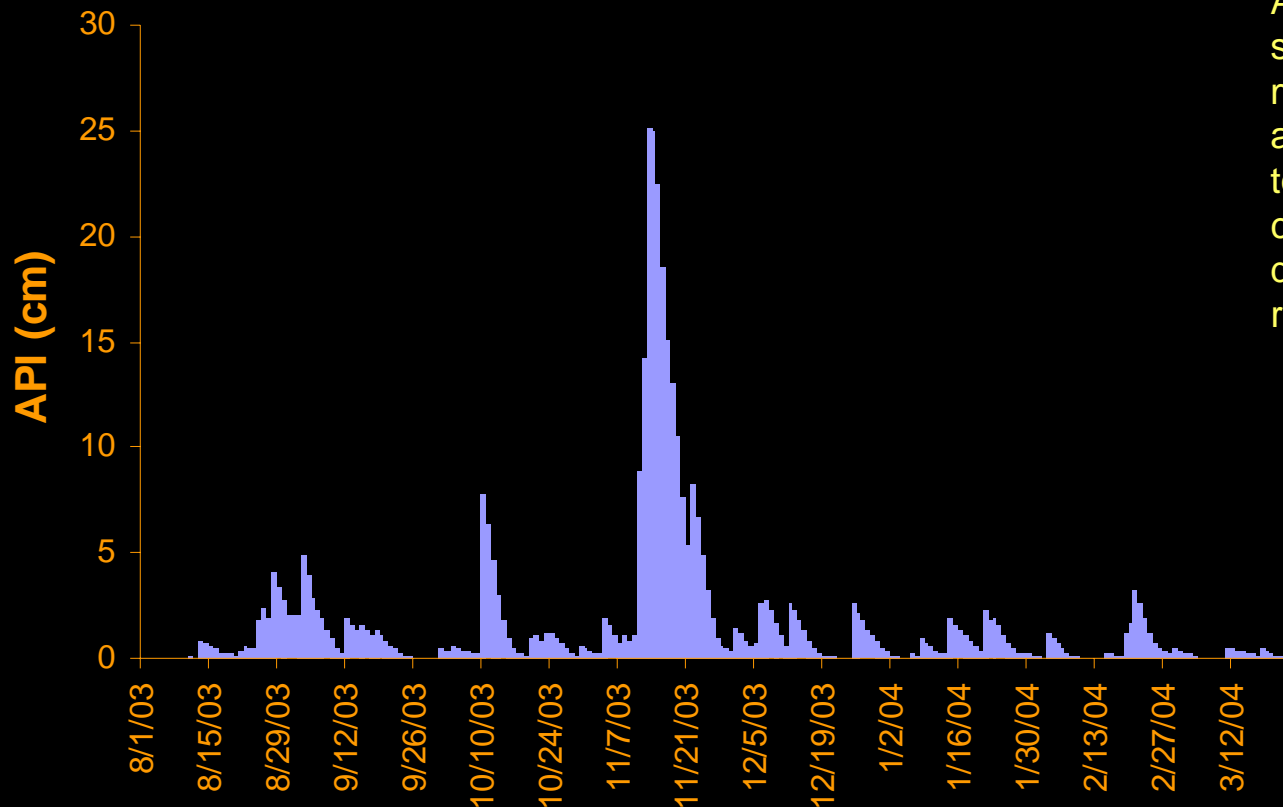
1-hr Rainfall Intensity



Project Component: Watershed-scale runoff/sediment yield

Method: Two natural channel stream gauging stations installed October 03
Preliminary data:

Antecedent Precipitation Index

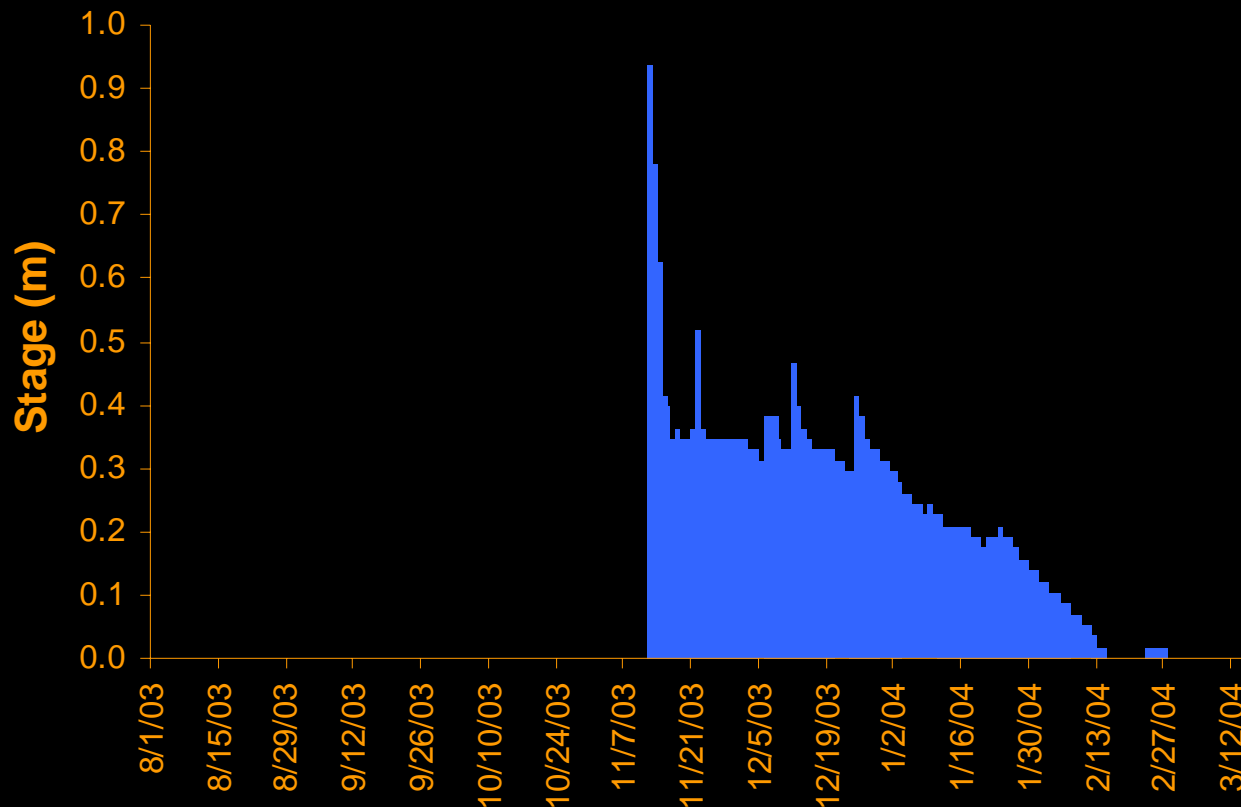


API is used as a surrogate for soil moisture content and is expected to be an important control on the development of runoff.

Project Component: Watershed-scale runoff/sediment yield

Method: Two natural channel stream gauging stations installed October 03
Preliminary data:

Quebrada Nautico Stage (Preliminary)



Calculation of runoff rates is pending the development of the stage-discharge rating curve.

Highest stage recorded 12 Nov 03 during a 6.6 cm rainfall event with an API of 7.1 cm.

Lowest rainfall and API values triggering any significant increase in stage were 2.3 and 0.3 cm, respectively.

Future Work

1. Intensive field work will be conducted from May to August 2004:
 - a) Install additional sediment traps.
 - b) Begin lab analysis of sediment samples collected from sediment traps.
 - c) Install 10m² plots for measuring runoff/sediment yield from both natural and disturbed surfaces.
 - d) Install SS-59 type samplers to collect suspended sediment samples at the two stream gauging stations.
2. Lower intensity field work will be conducted from August 2004 to February 2005.
3. Data analysis and preparation of deliverables from March to June 2005.

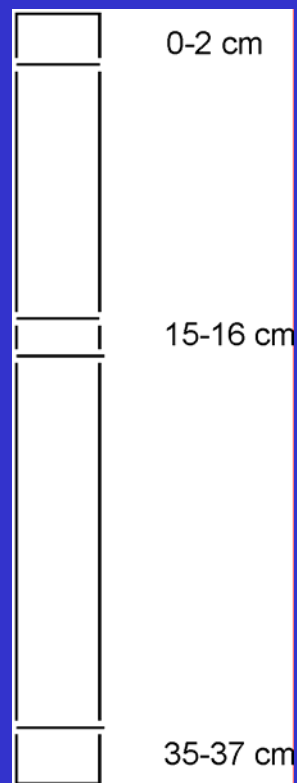


Transport of watershed-based materials

Fatty Acid Analysis of Sediments

- Biological origin of sedimentary organic matter
- Assignment of specific fatty acids as markers for the contribution of particular biota
- Need to know the lipid composition of appropriate organisms
- Some unknown sources are possible !

Sections of the sediment sample analyzed (LP 3)

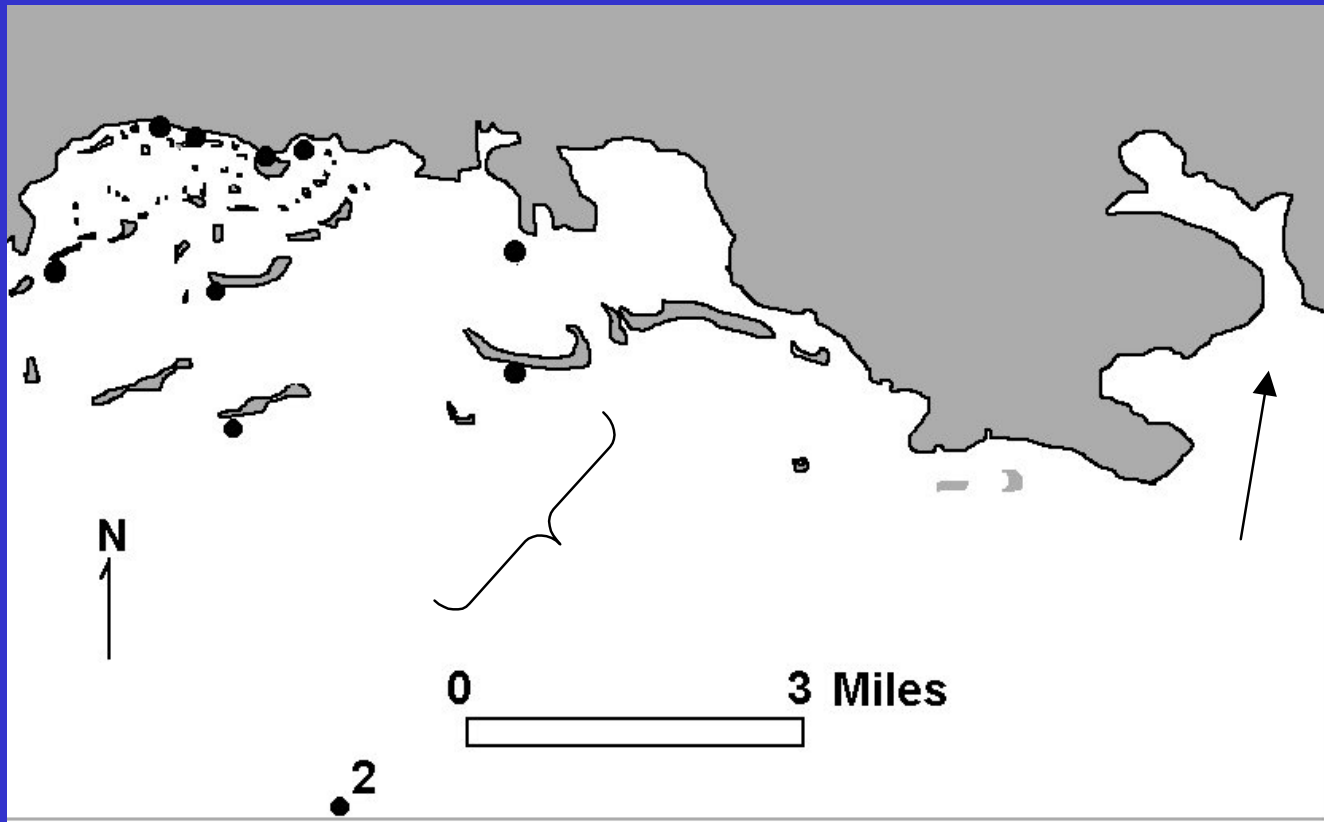


10-11 cm

25-27 cm

Preliminary Conclusions

1. There are a few fatty acids (probably bacterial) that can be used as biomarkers since their origin seems to be very specific.
2. C₁₆-C₁₈ fatty acids predominated at all levels but at the top a bit more (8% vs. 5%) of *iso/anteiso* C₁₅-C₁₇ fatty acids (bacterial) were observed.
3. In the central core C₂₅-C₂₉ fatty acids were observed (not at other levels) which could arise from terrestrial higher plants.
4. The presence of 4-Me-14:0 and 4-Me-16:0 is noteworthy since these acids are not common. Some of these compounds have been detected in phosphatide of marine sediment (2001, China) and there is an earlier mention of some of these in algae (1983). We isolated similar fatty acids from a halophilic bacillus from salt pans in Bulgaria (2001).



Standard stations

1. **Media Luna**
2. **Shelf Edge**
3. Magueyes
4. Romero
5. Varadero
6. **Las Pelotas**
7. Town
8. Club Nautico
9. Isla Matei
10. Enrique

Discrete water sample analysis for:
 salinity, turbidity, temperature, chlorophyll *a*,
 bacterial and unicellular cyanobacterial counts,
 total suspended solids, bacterial production

Semicontinuous monitoring for periods of 2-5 days of:
in vivo chlorophyll *a* fluorescence,
 Turbidity, temperature and salinity

**Water Column
 Transport
 Processes**

Quantification of terrestrial material transport into reefs of La Parguera.

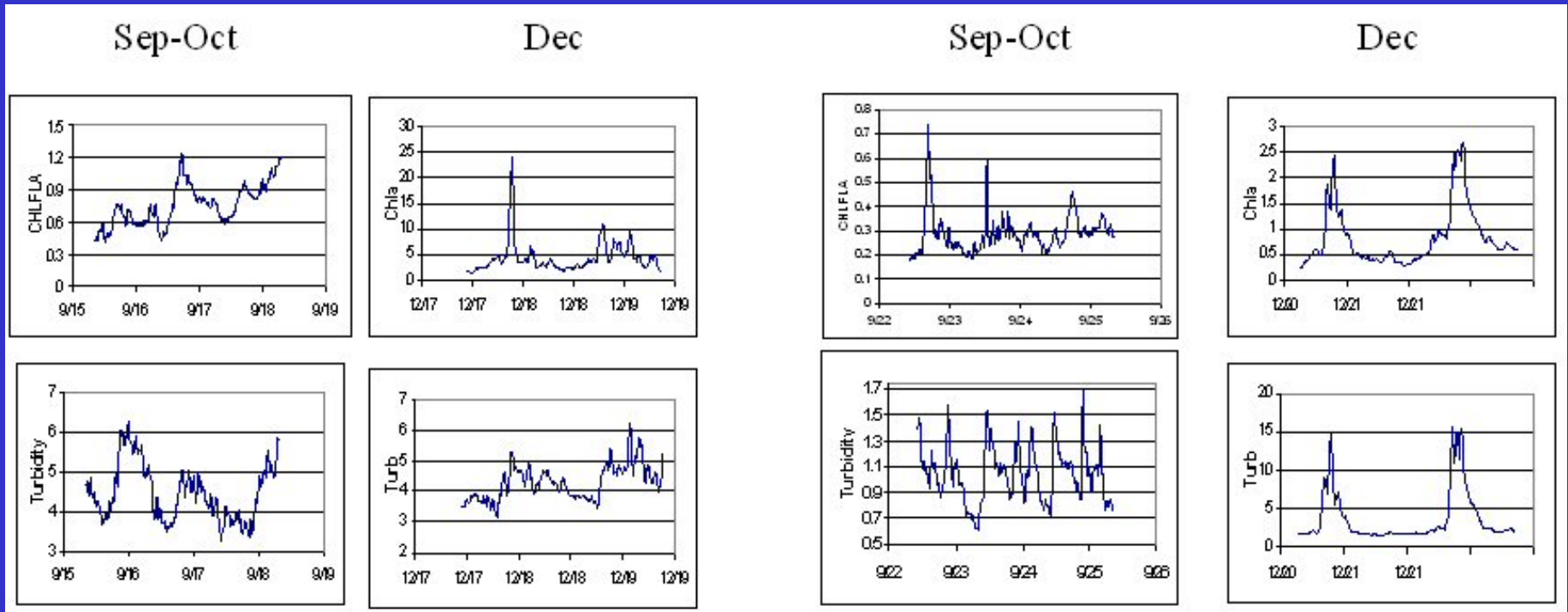
Dissolved organic matter fluorescence as an indicator of inputs of terrestrial matter

Station	Proportion (after/before rains)
Varadero	10.6
Tres Marias	27.3
Playa Rosada	22.2
Club Náutico	10.2
Pelotas	2.8
North Enrique	2.4

Chlorophyll (top) and Turbidity (bottom) time series for coastal stations

Varadero

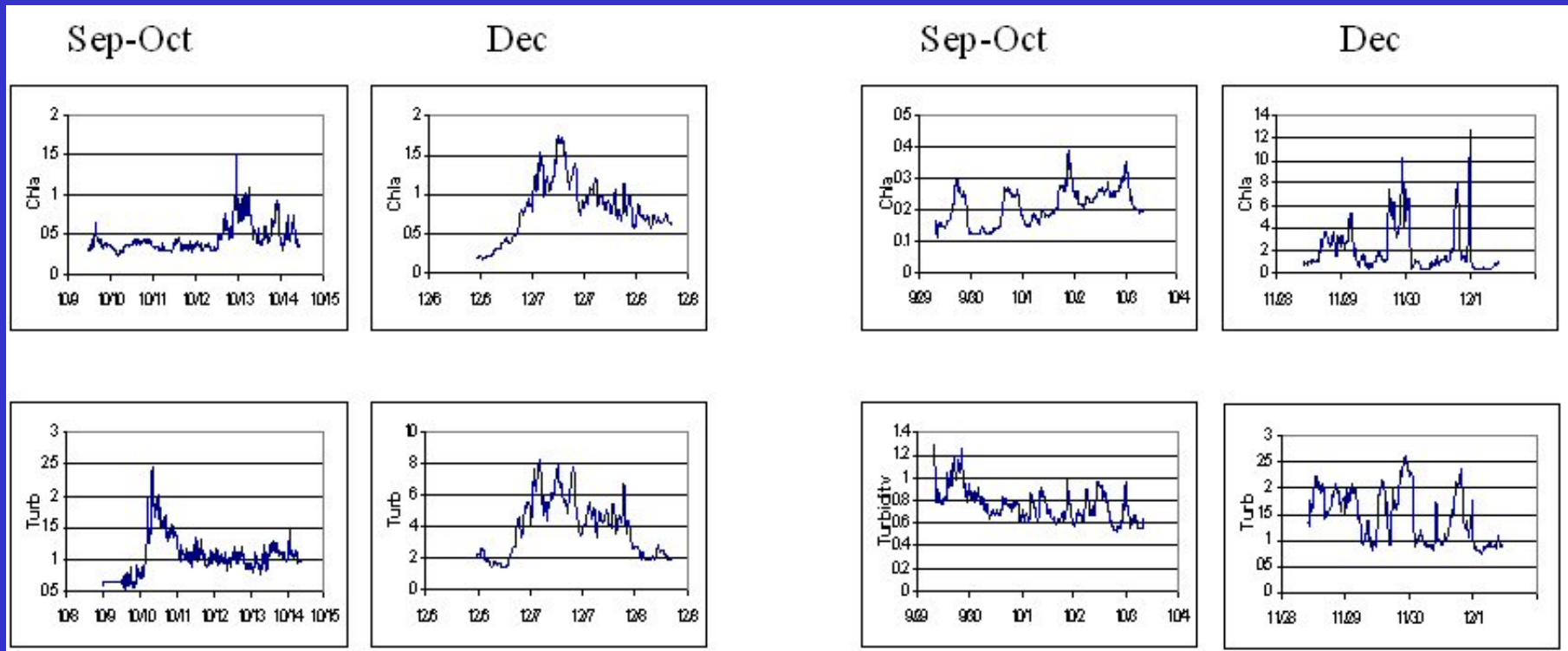
Magueyes



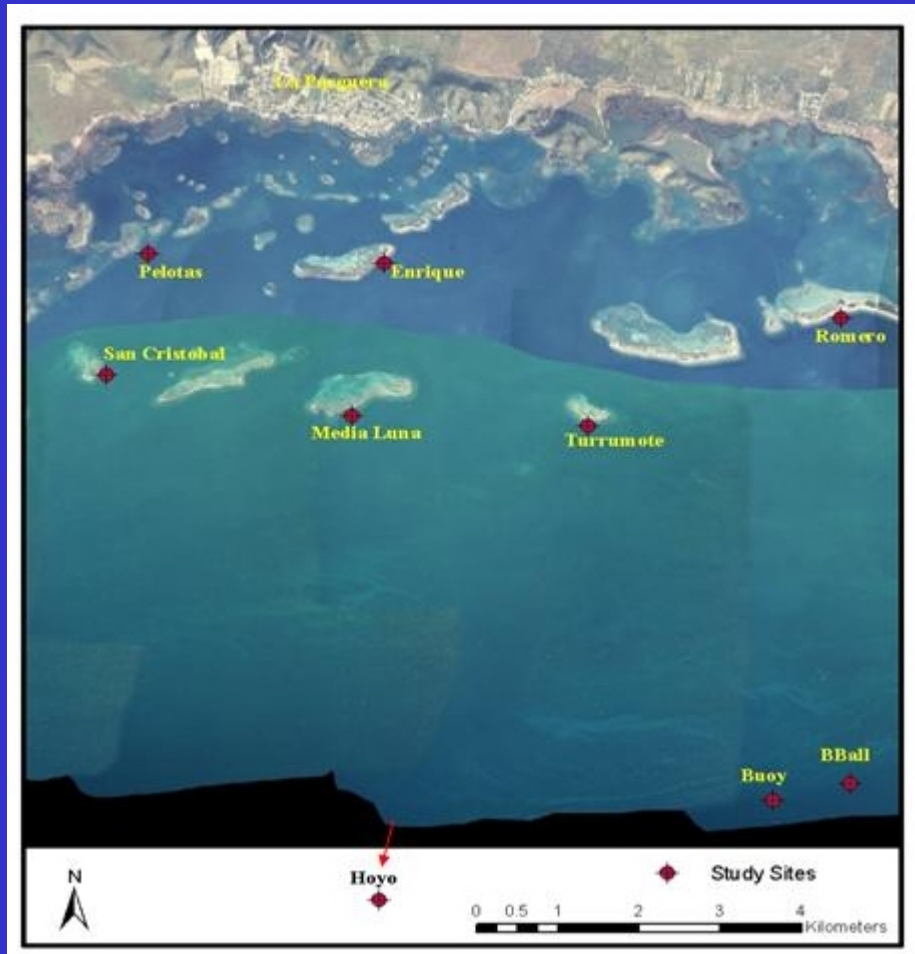
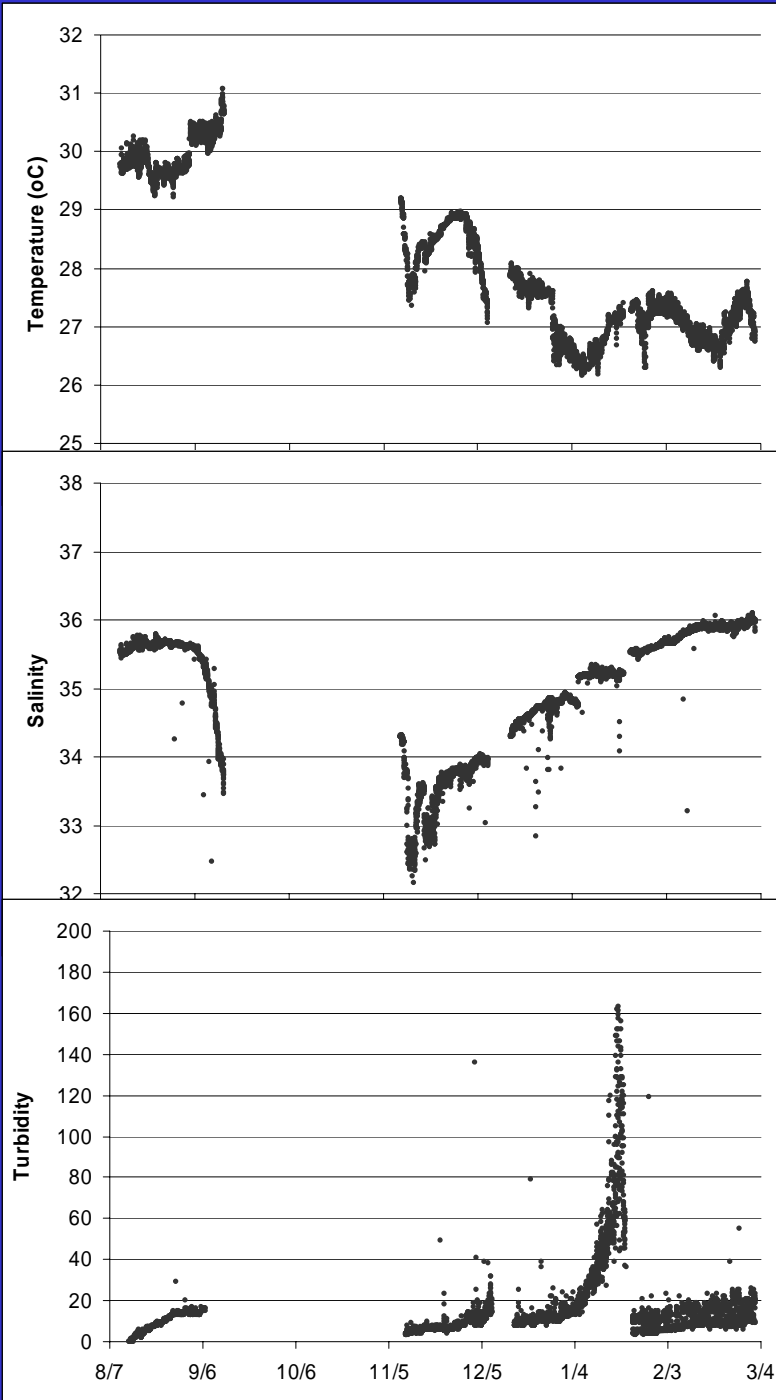
Chlorophyll (top) and Turbidity (bottom) time series in external reef stations

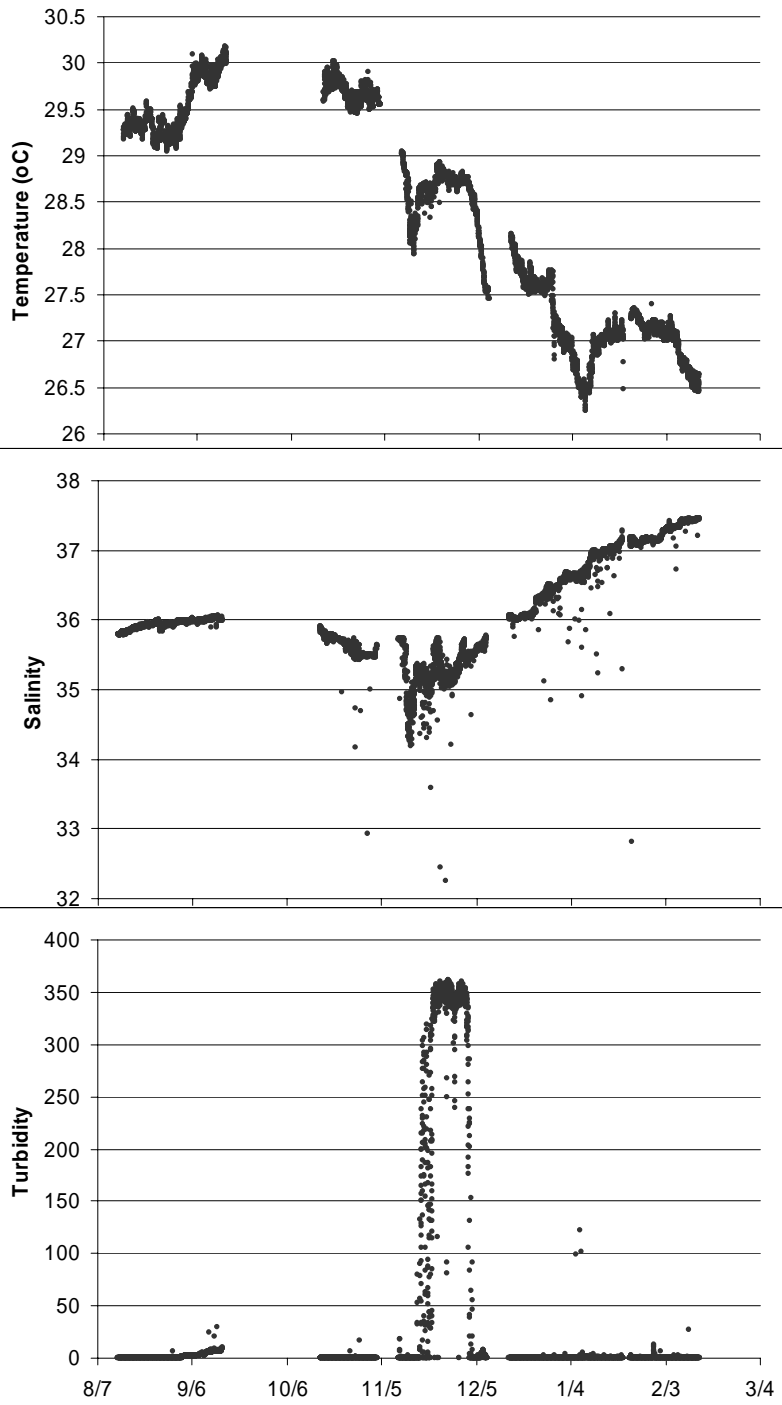
Media Luna

Romero

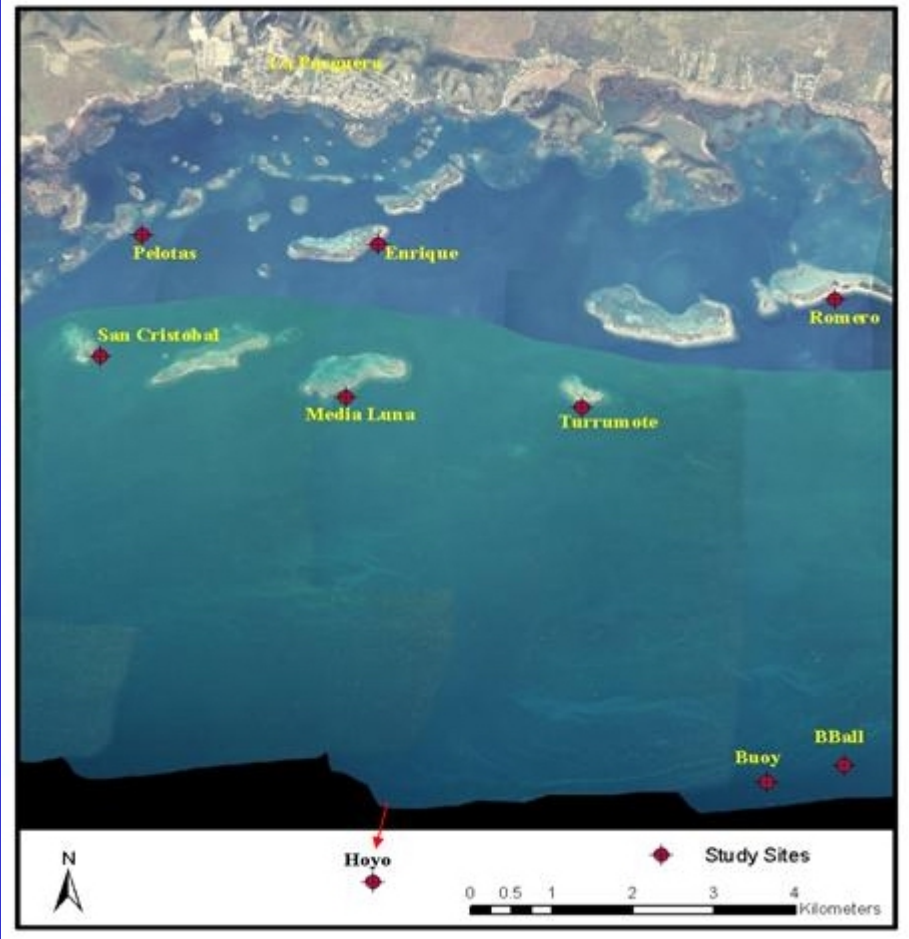


Inshore – Las Pelotas

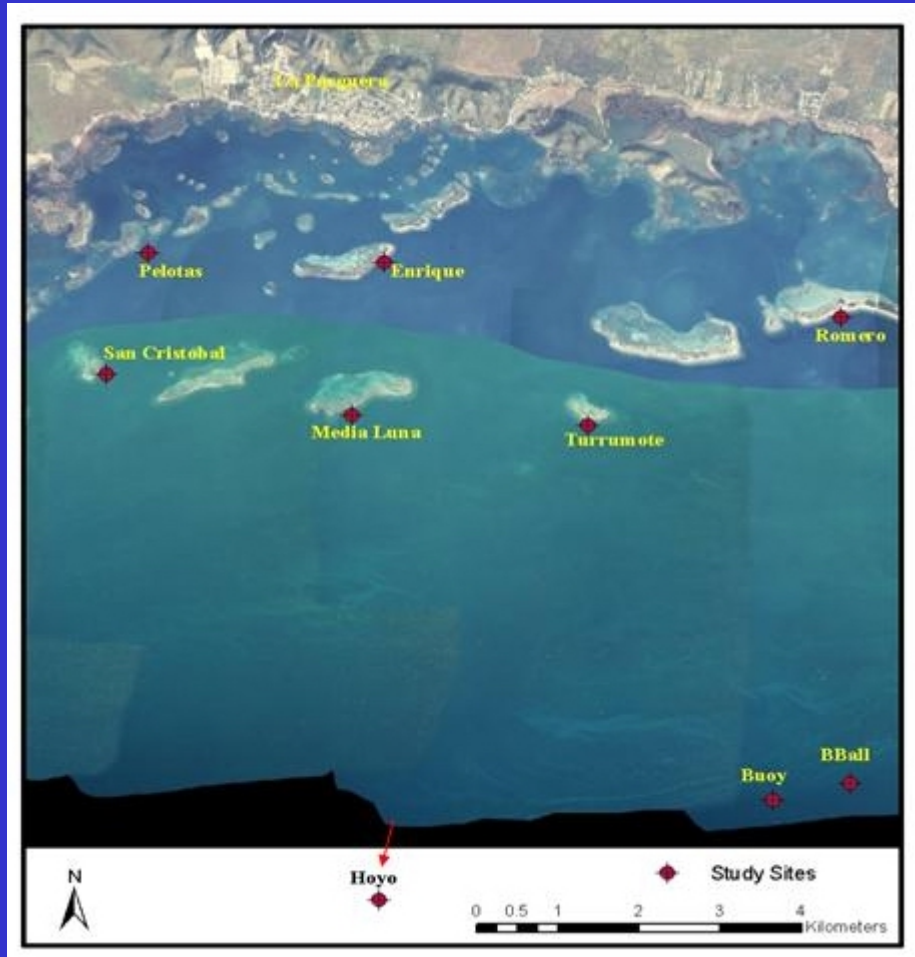
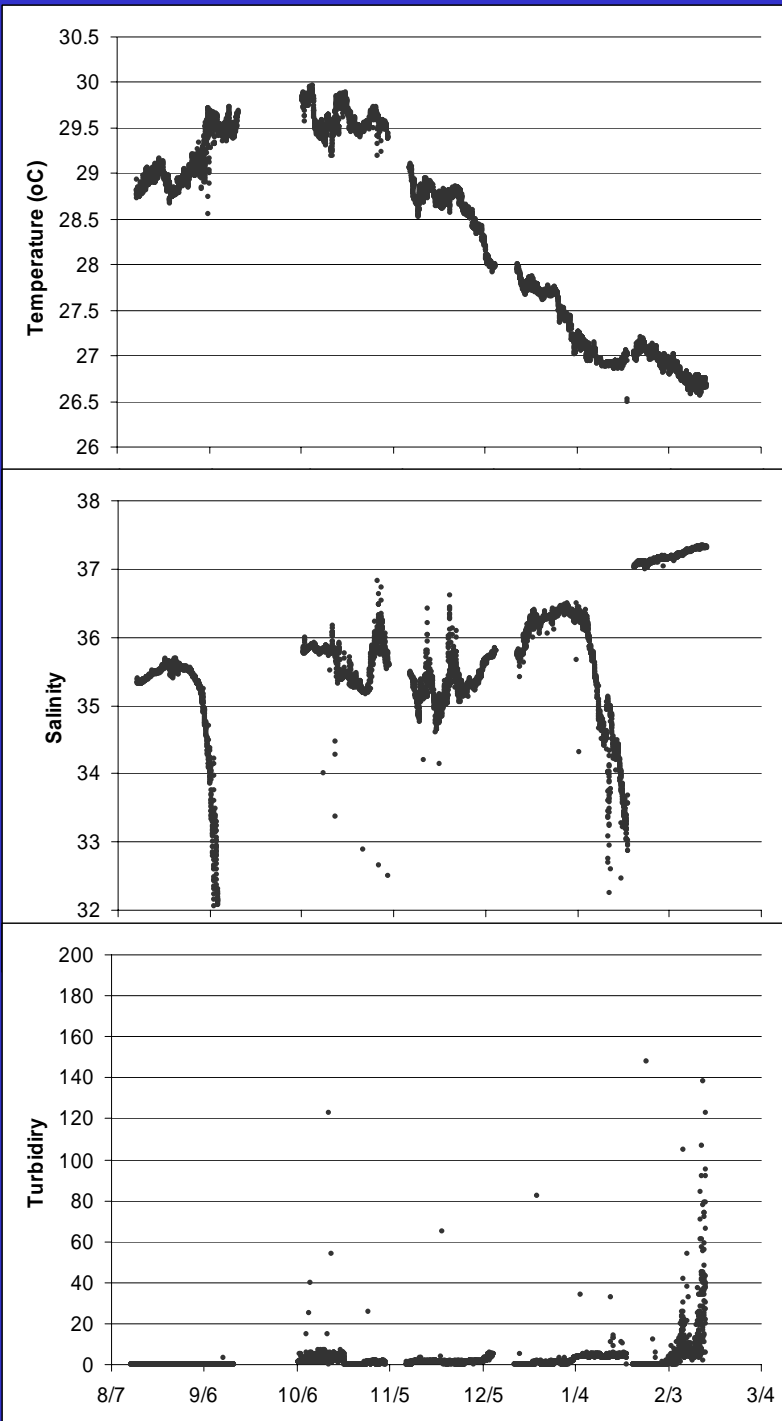




Mid-Shelf – Media Luna

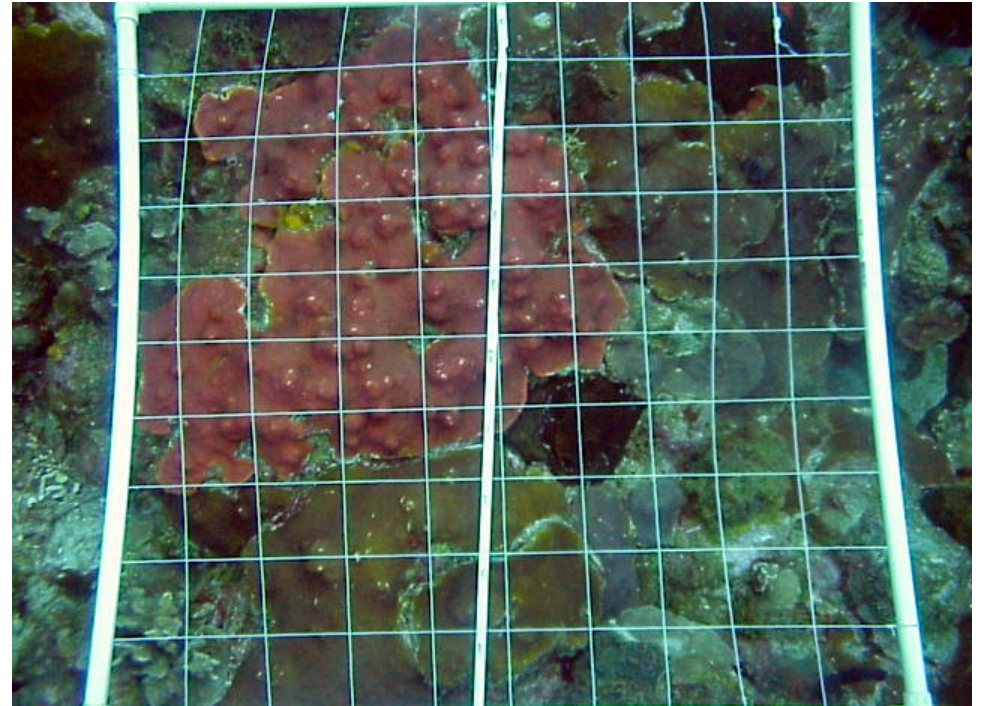
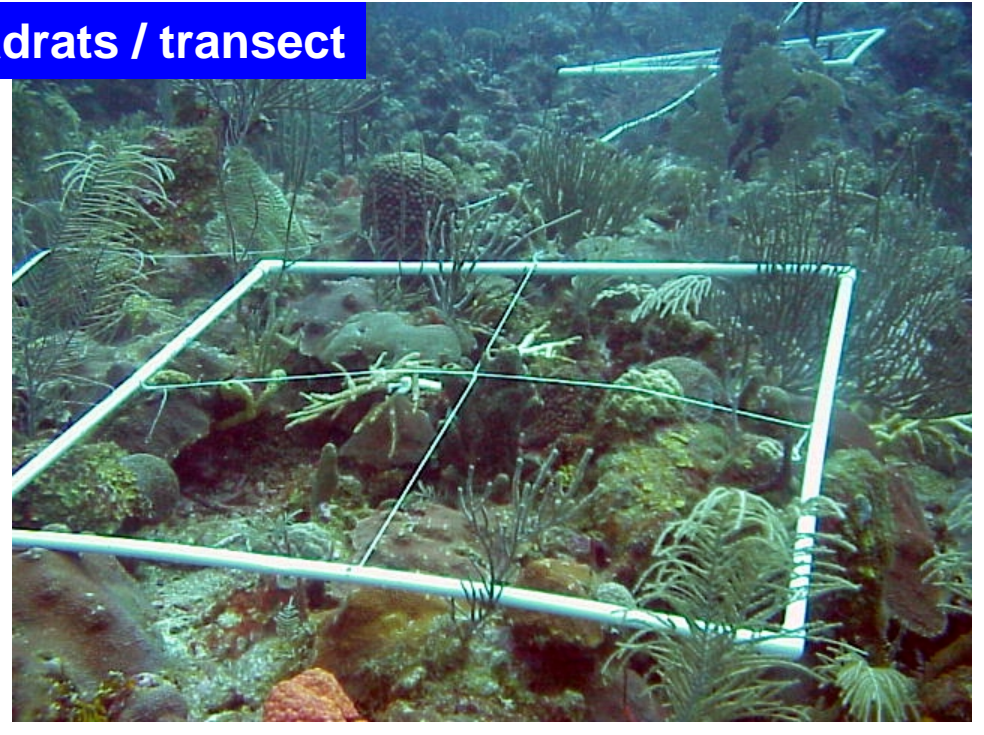
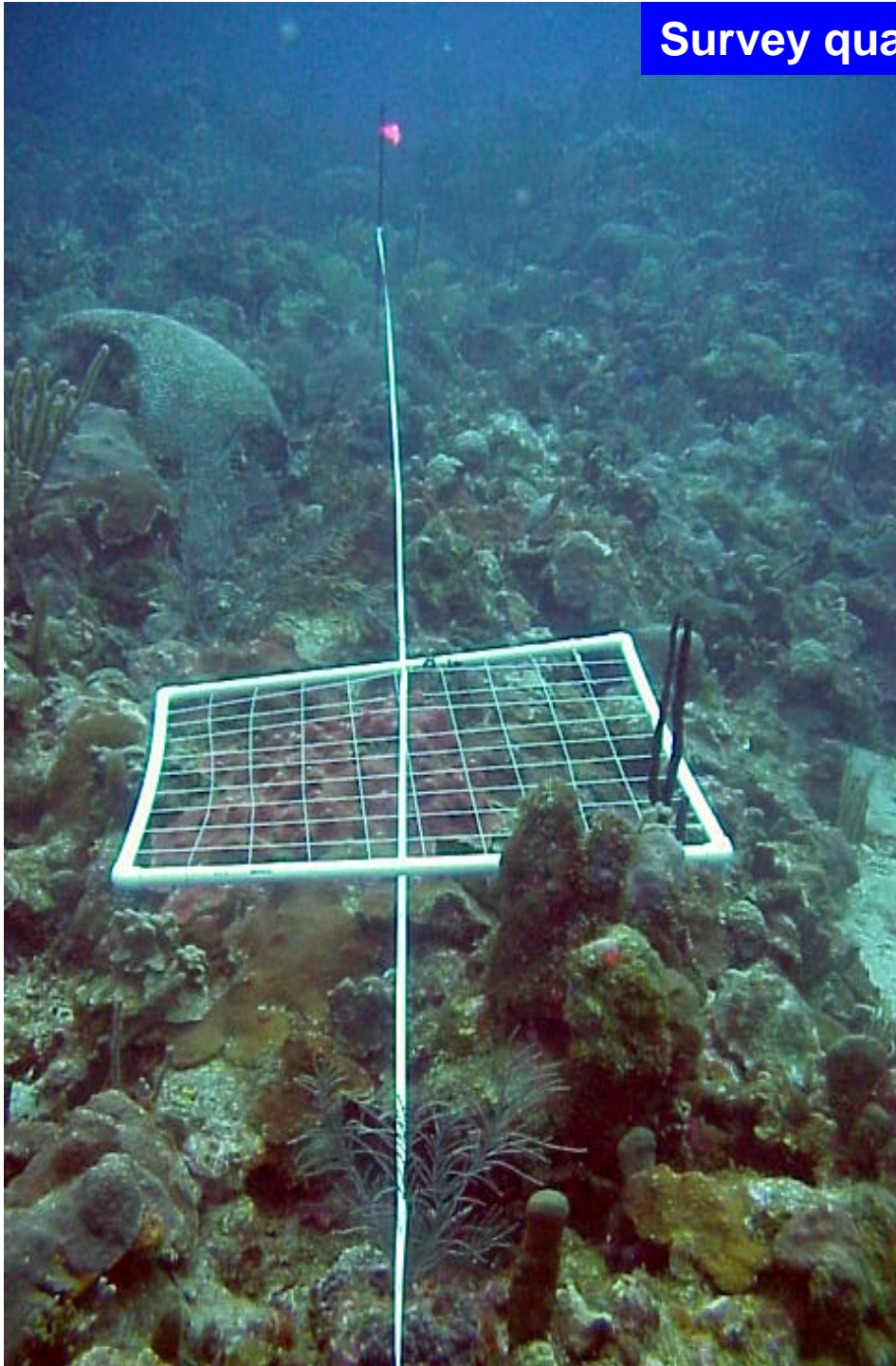


Shelf-edge – BB Court





Survey quadrats / transect



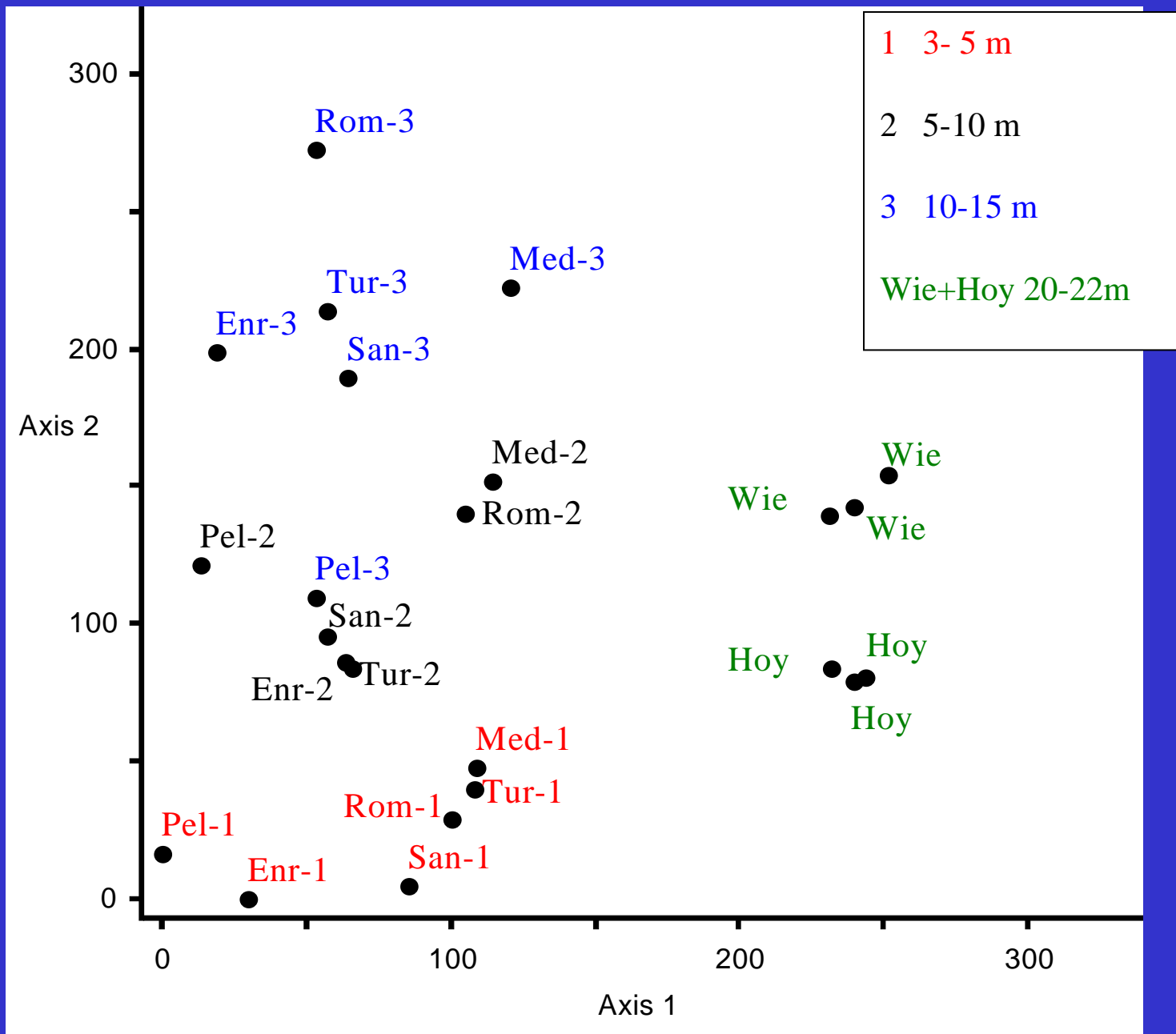
Permanent Transects:

Gorgonian Survey – Status March 2004

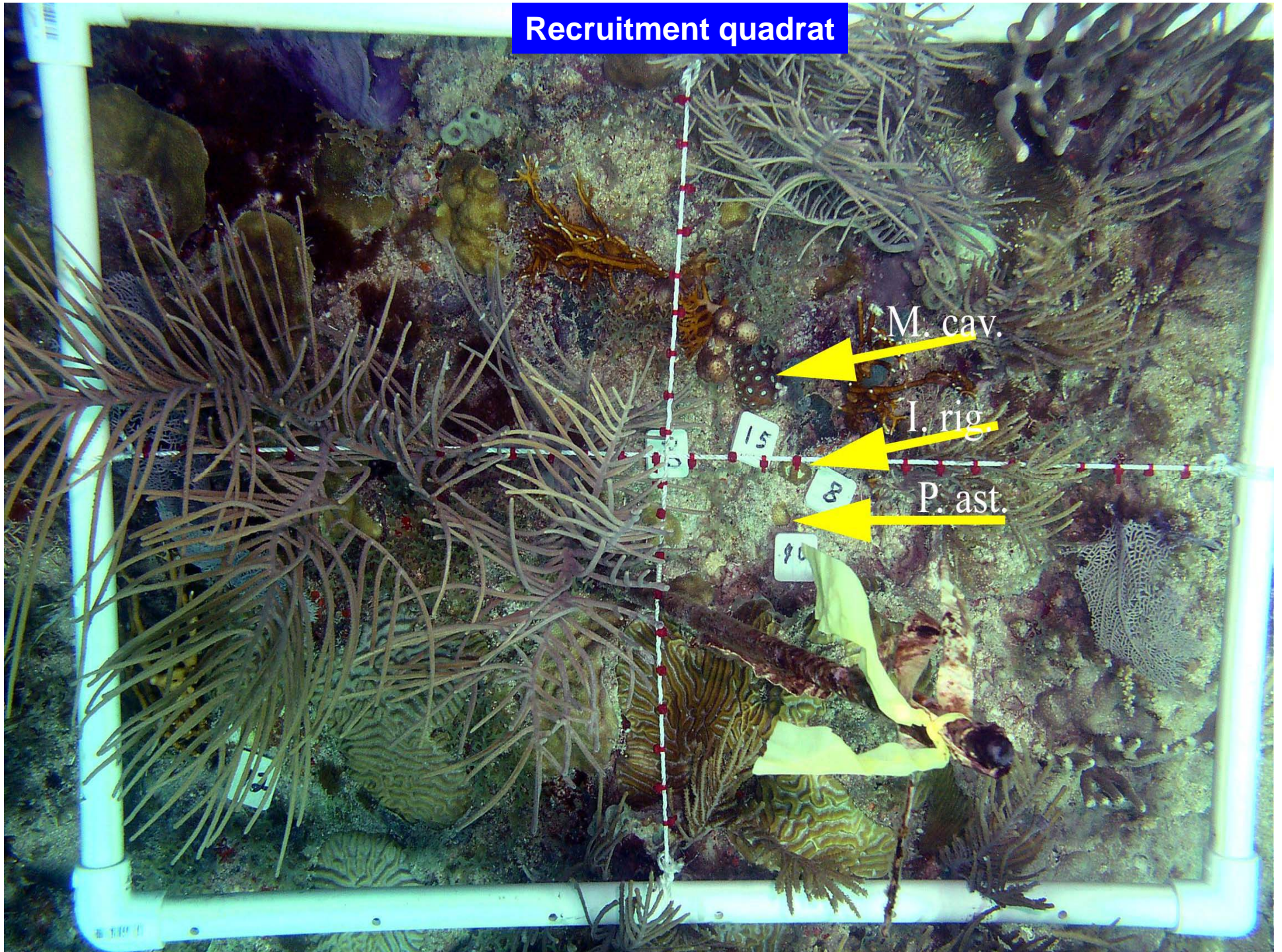
Study sites (24 m ² /site)	% Surveyed
Pelotas	100%
San Cristobal	58.30%
Enrique	100%
Media Luna	100%
El Hoyo	100%
Romero	0%
Turumote	66.70%
Basketball Court	66.7

Permanent Transects: Reef fish surveys

Site	Position	Depth	Species Richness
Romero	Inshore	3-5 m	26
		5-10 m	30
		10-15 m	26
		Overall	48
Enrique	Inshore	3-5 m	33
		5-10 m	17
		10-15 m	27
		Overall	49
Pelotas	Inshore	3-5 m	28
		5-10 m	21
		10-15 m	31
		Overall	47
Turrumote	Middle	3-5 m	24
		5-10 m	31
		10-15 m	45
		Overall	47
Media Luna	Middle	3-5 m	22
		5-10 m	36
		10-15 m	34
		Overall	47
San Cristobal	Middle	3-5 m	31
		5-10 m	20
		10-15 m	29
		Overall	45
Wienberg	Shelf-edge	20-22 m	52
El Hoyo	Shelf-edge	20-22 m	38
Total for all sites combined			86

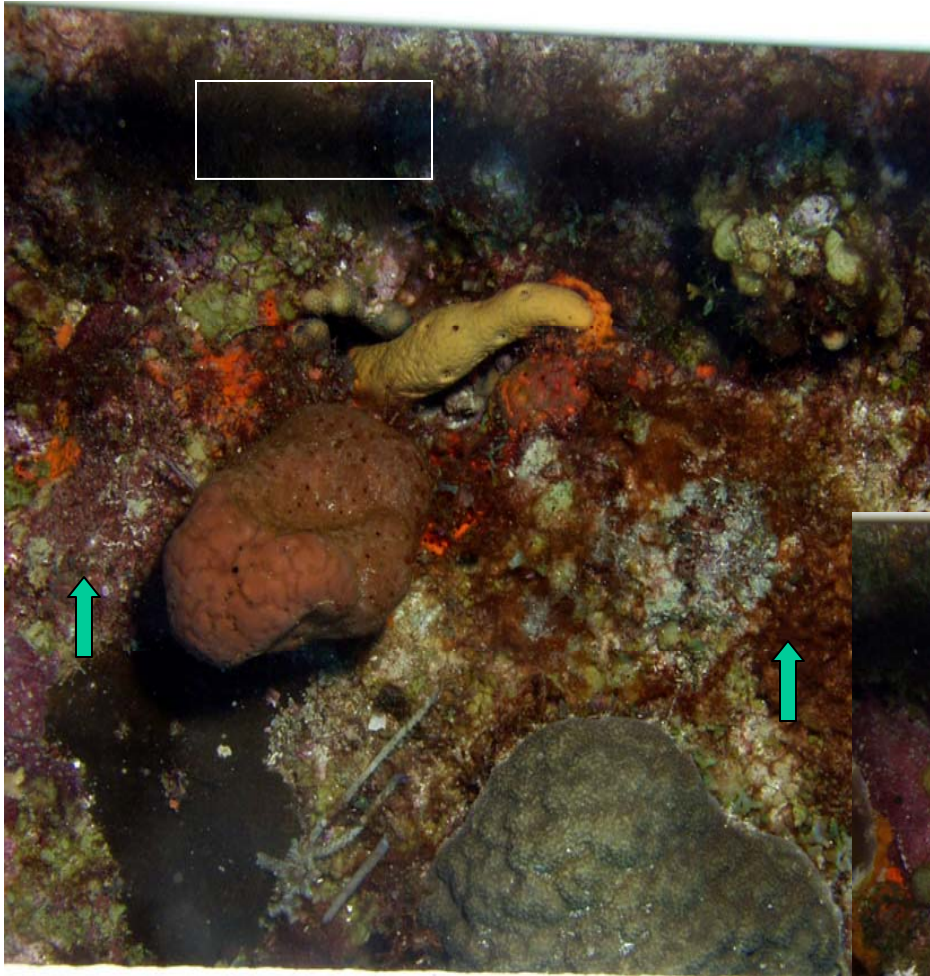


Recruitment quadrat



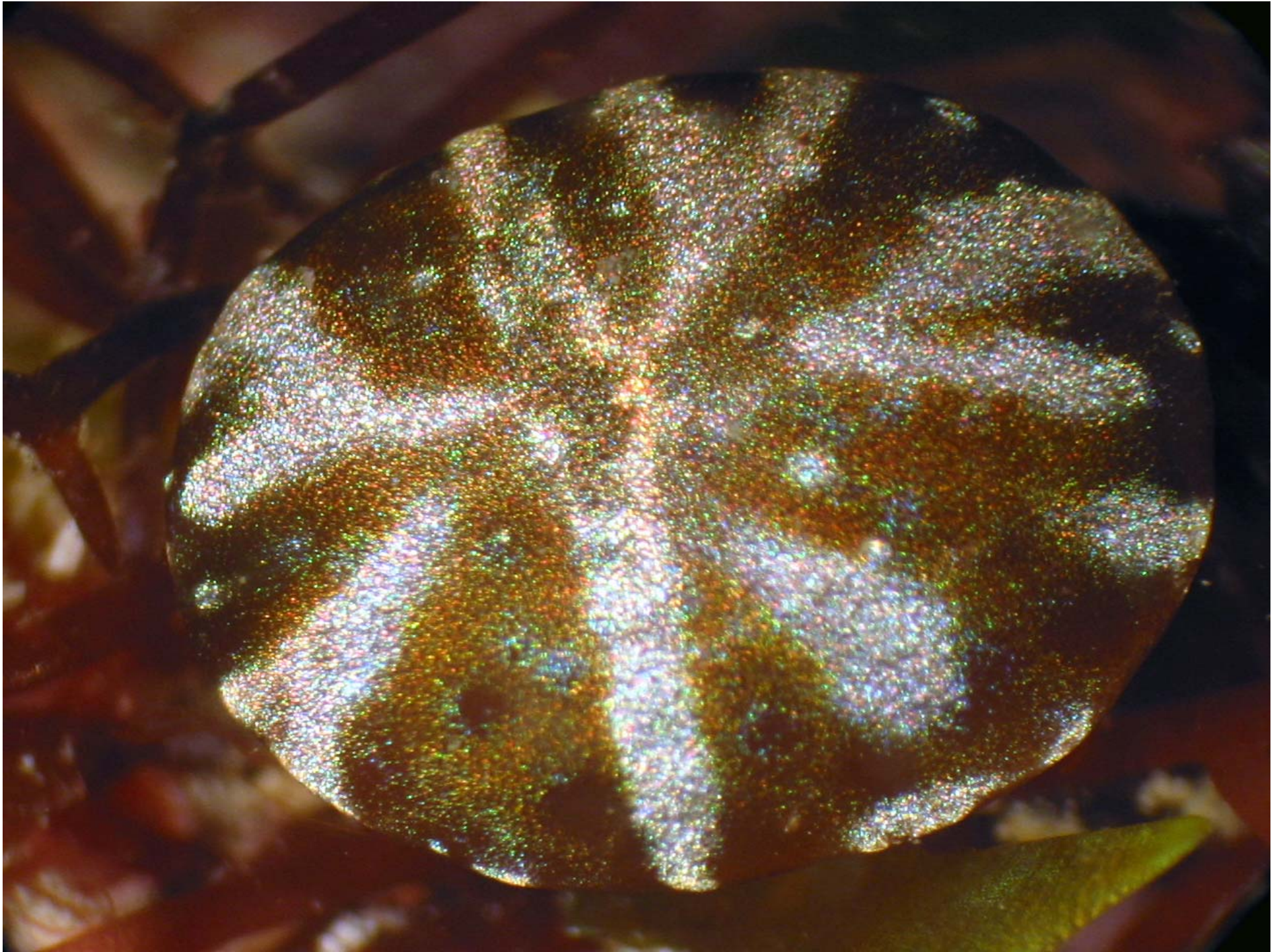
Several juvenile colonies of 8 different species in a ½ m quadrat



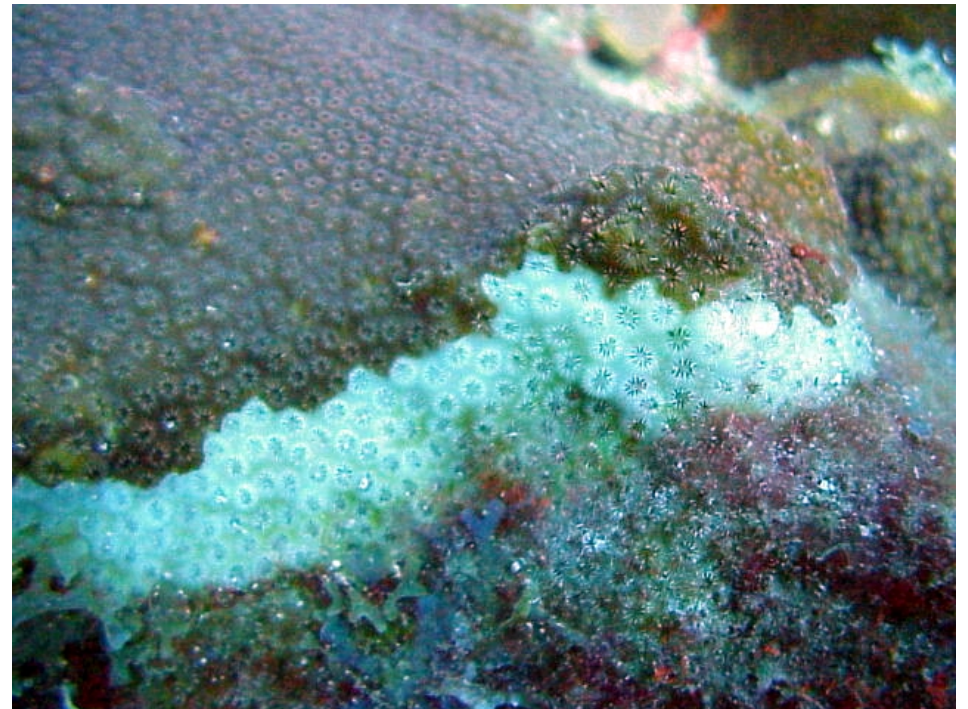
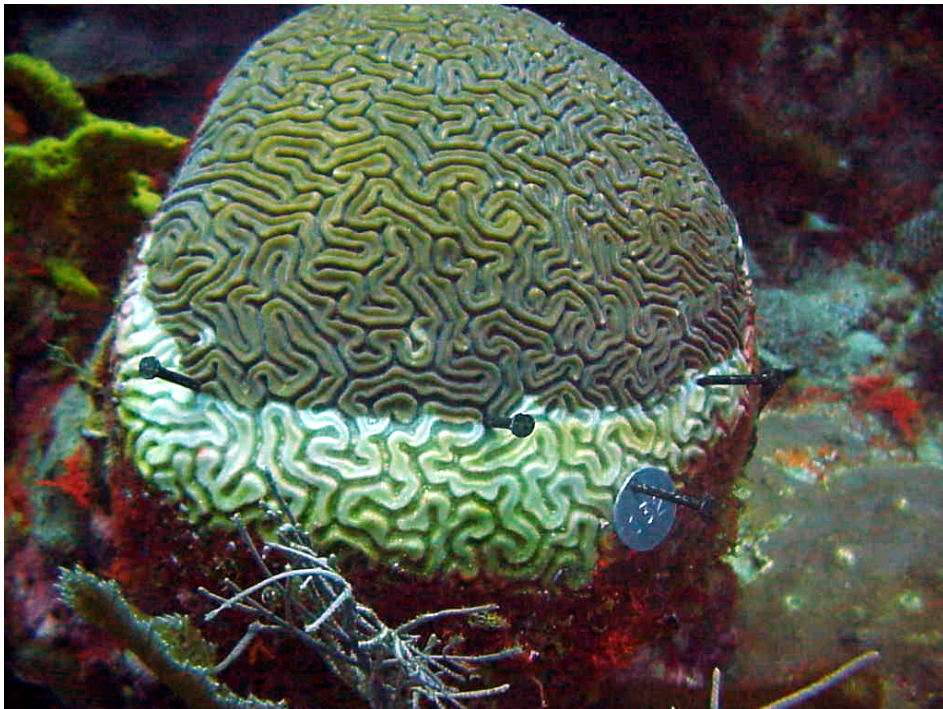


New species of
Peyssonnelia

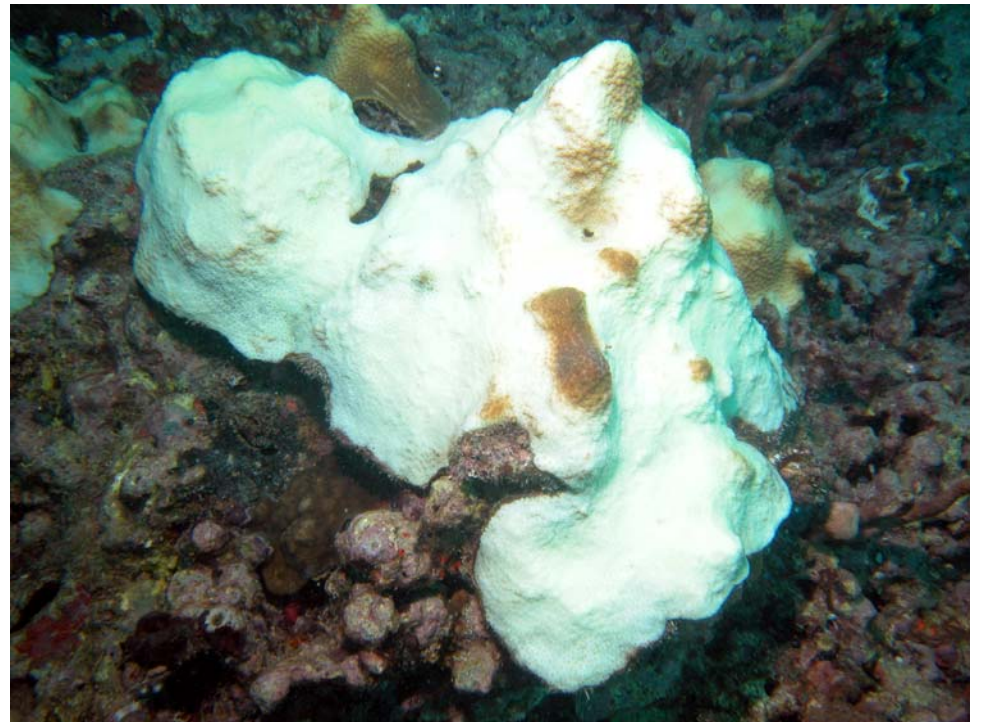




White plague outbreak - 2004



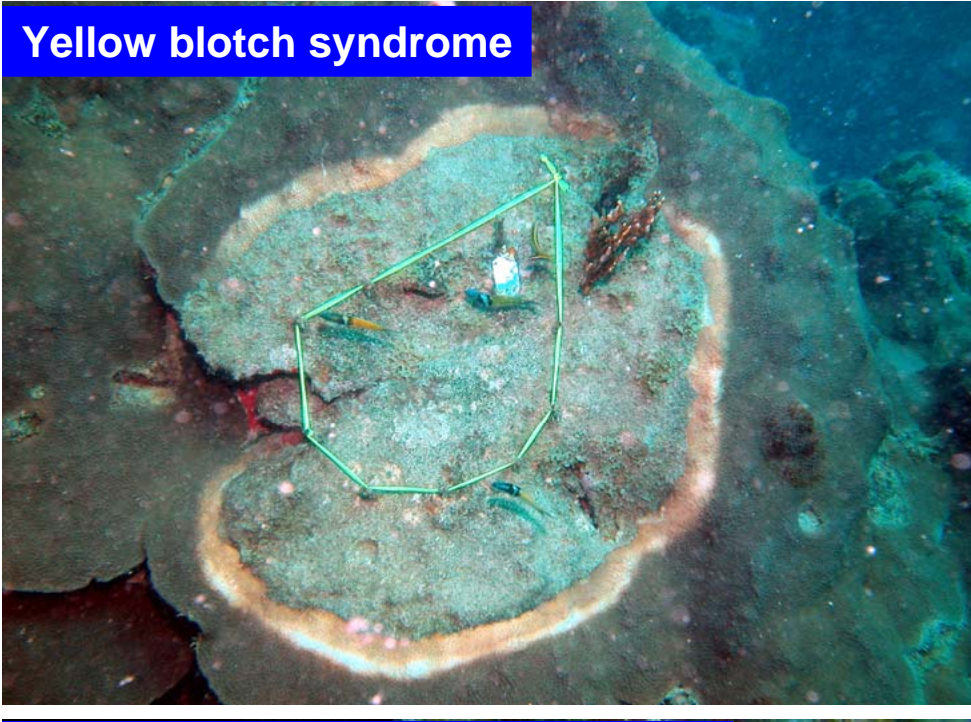
Bleaching - 2004



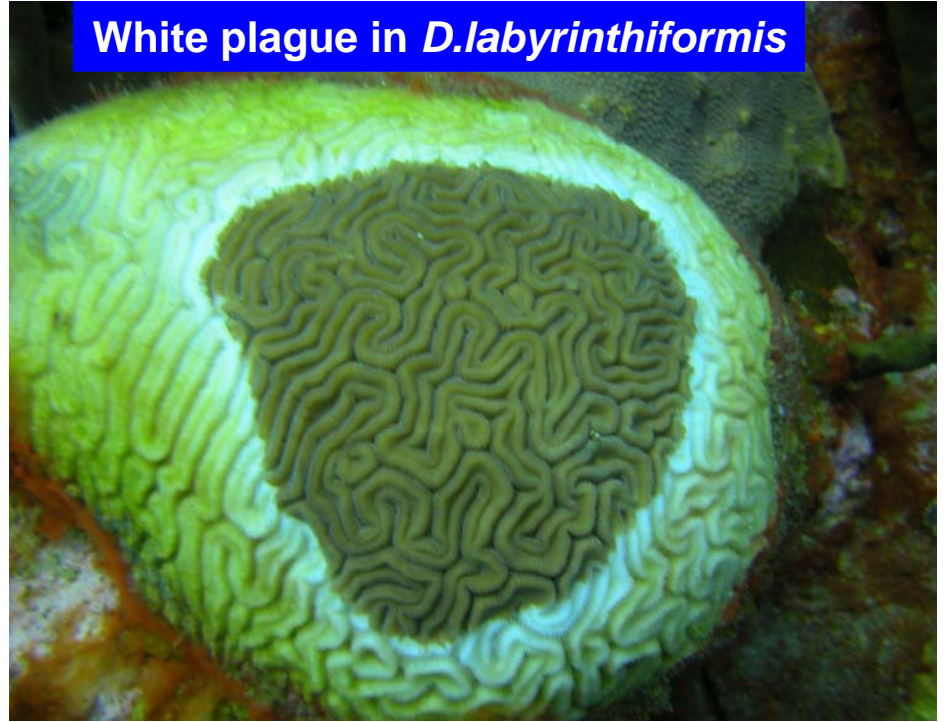
Bleaching - 2004



Yellow blotch syndrome



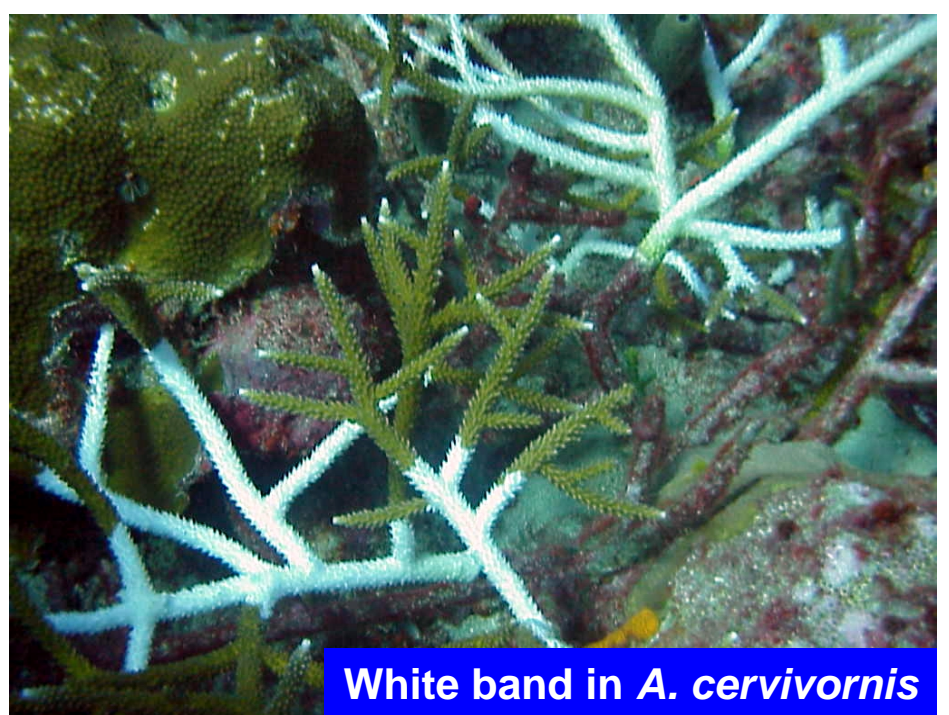
White plague in *D.labyrinthiformis*



White syndrome in crustose algae



White band in *A. cervicornis*

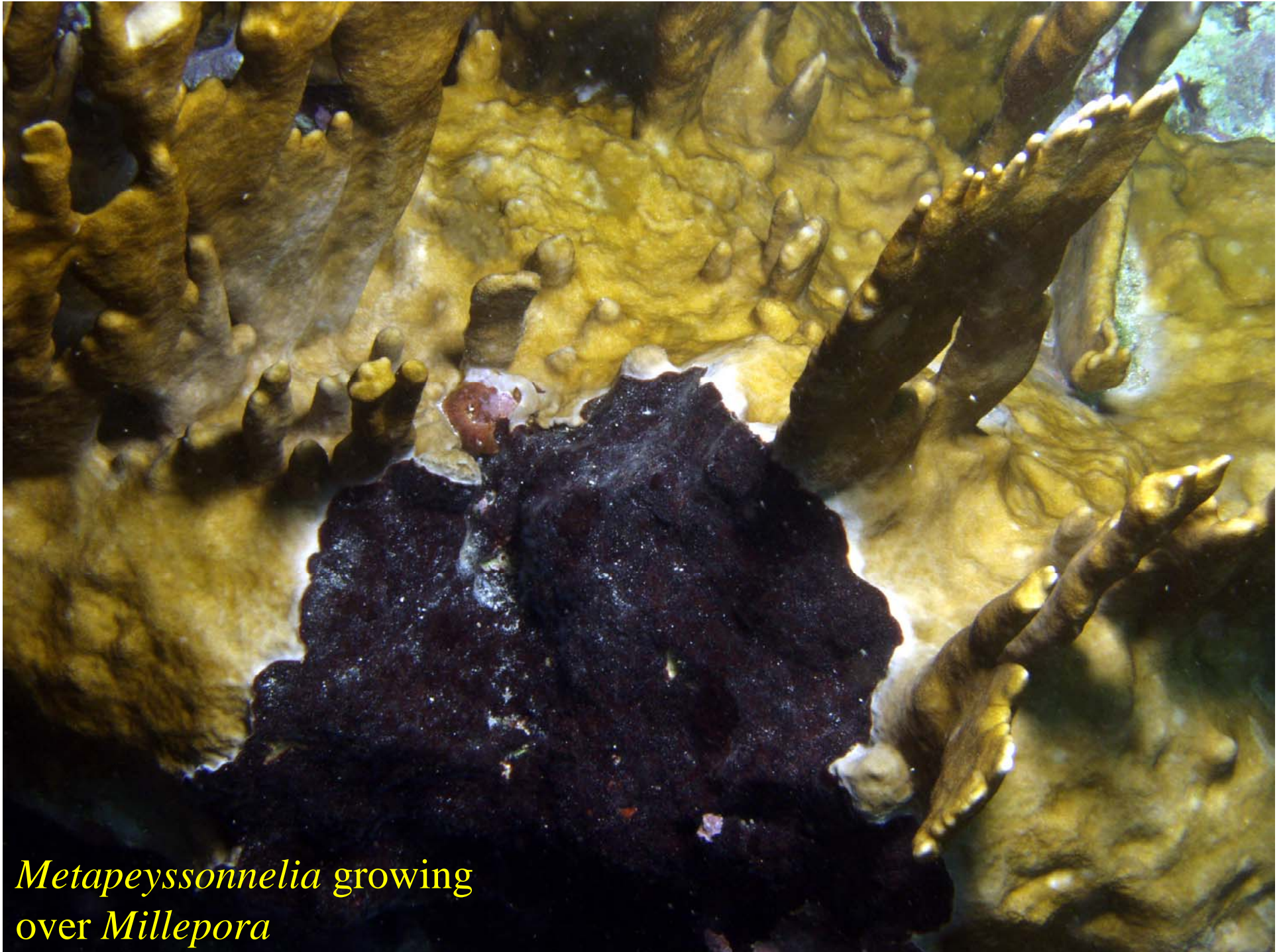


Cyanobacteria (*Schizothrix*) overgrowing *Porites*



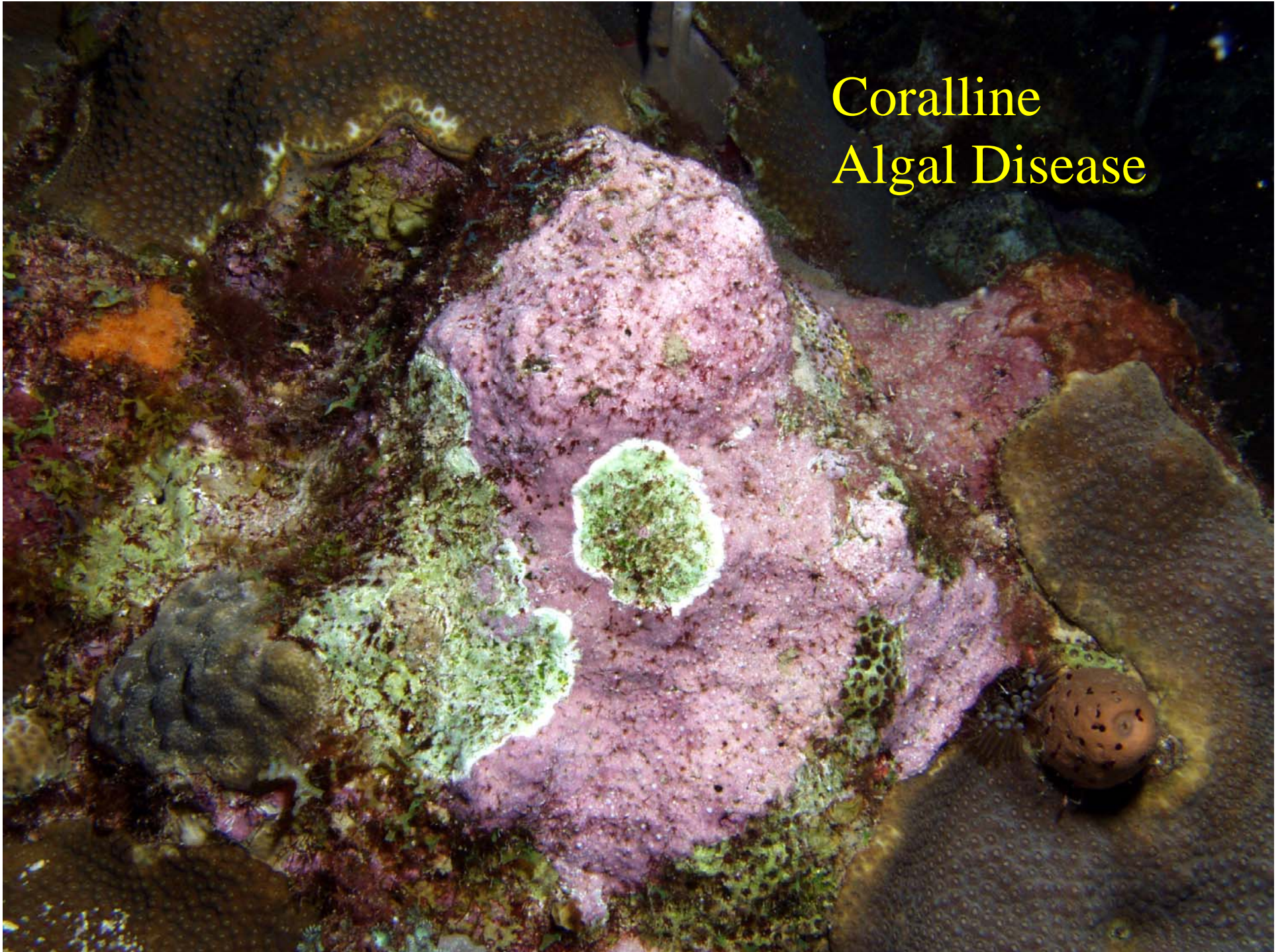


Cyanobacteria
encroaching on corals

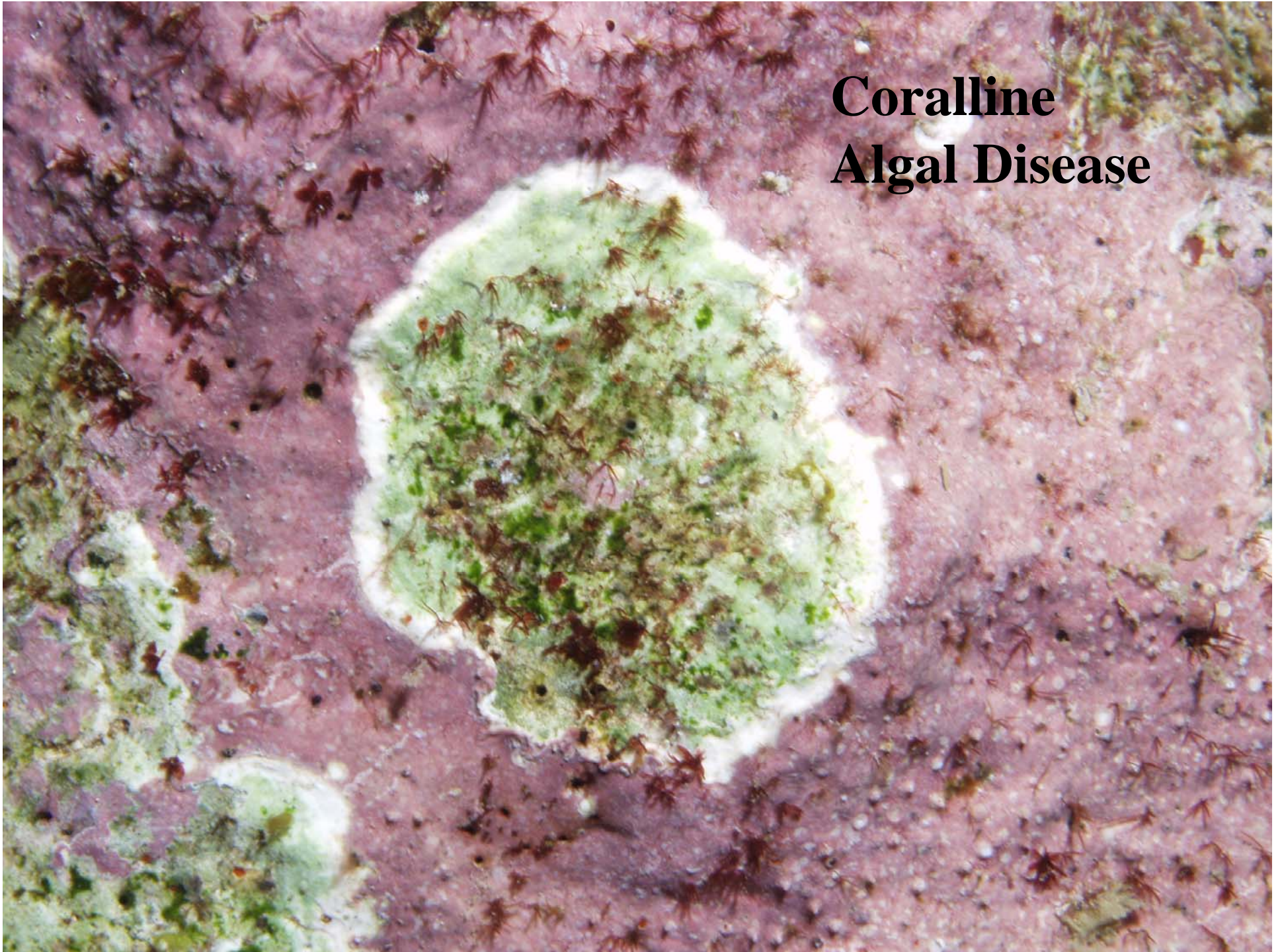


Metapeyssonnella growing
over *Millepora*

Coralline Algal Disease

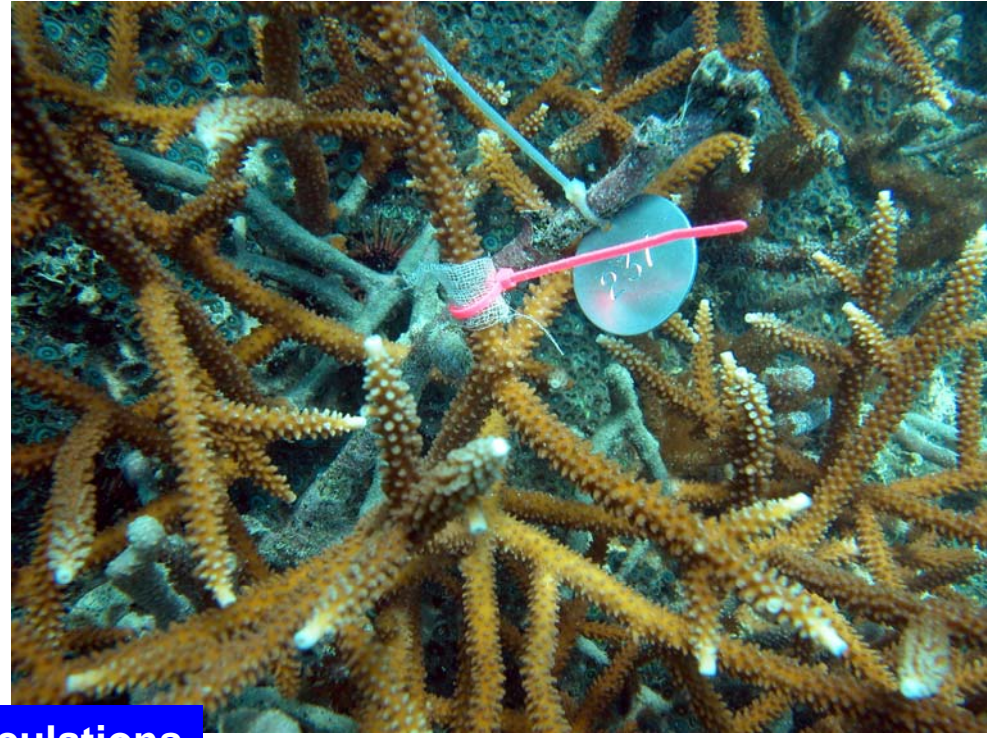


**Coralline
Algal Disease**

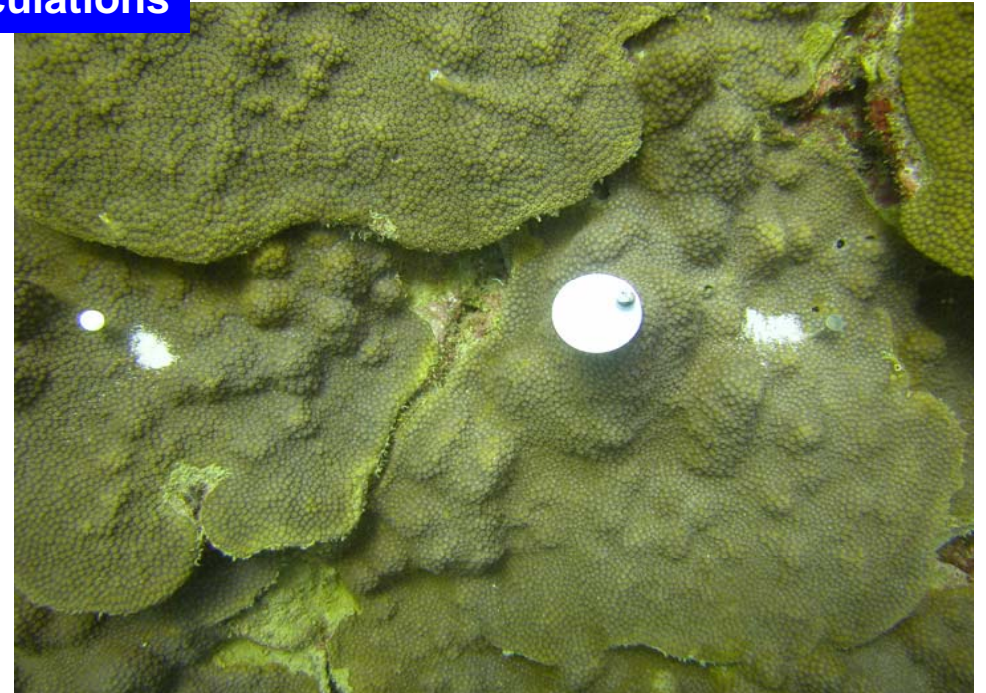




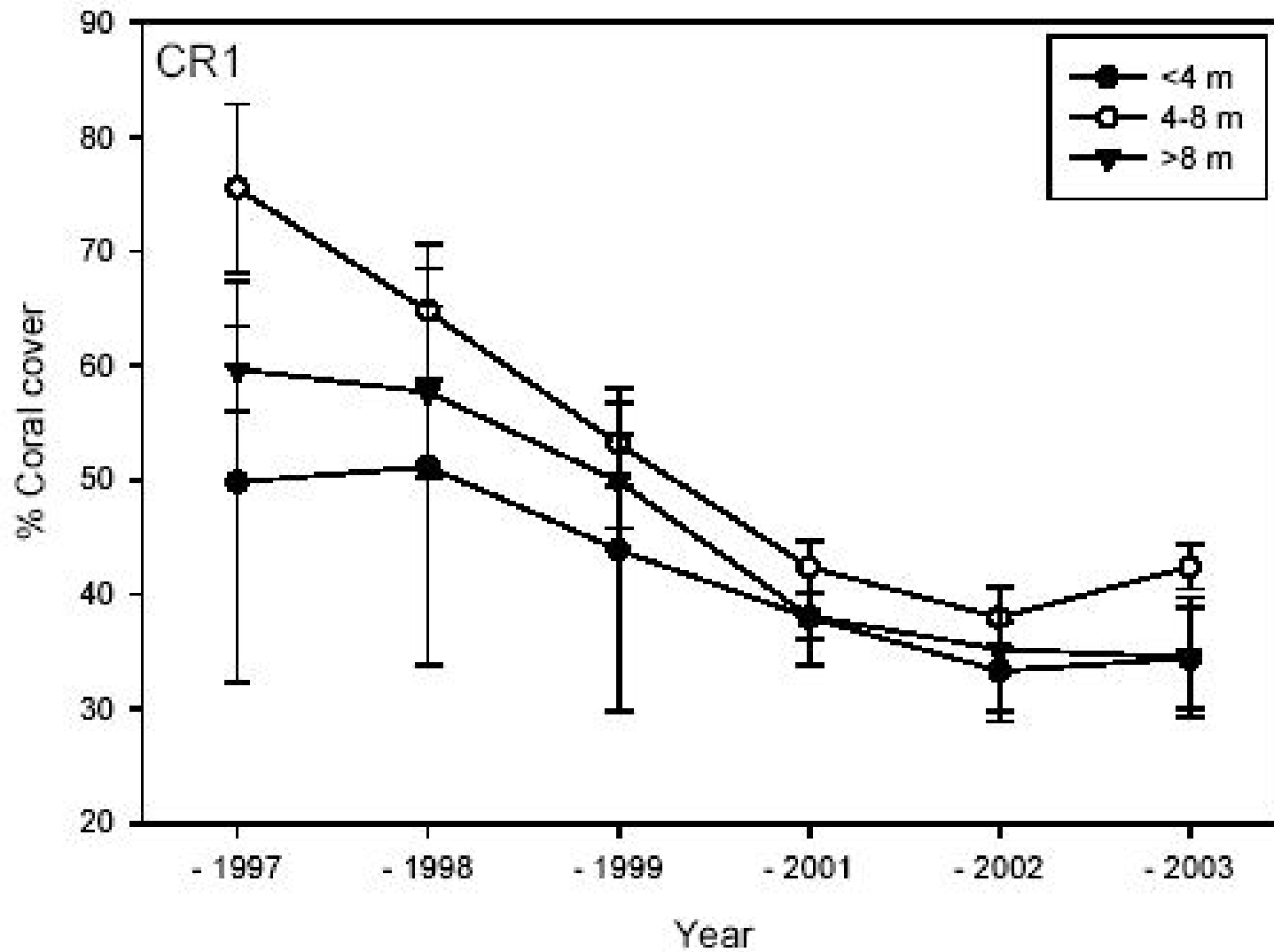
Endolithic Algal
Disease (?)



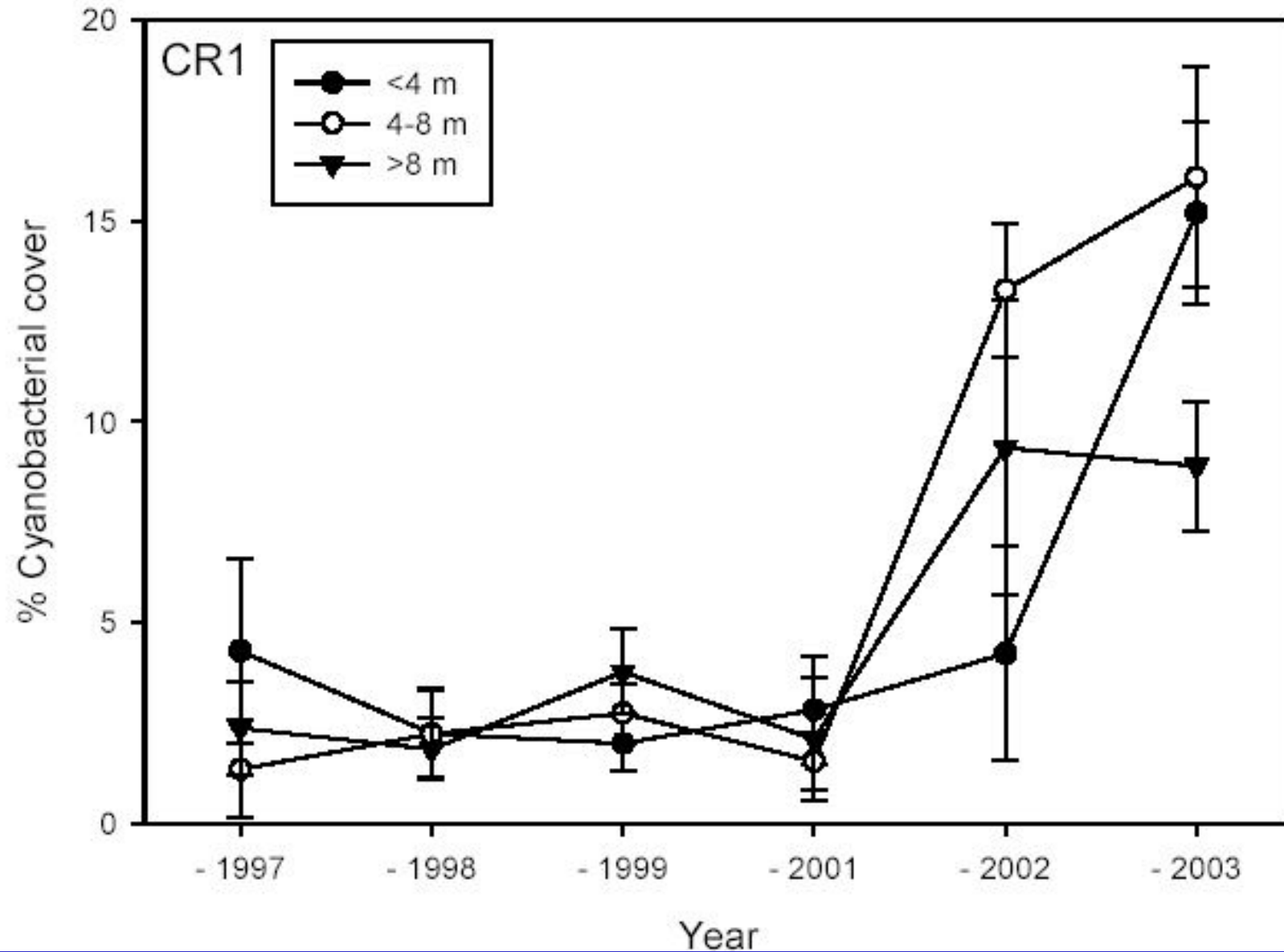
Disease inoculations

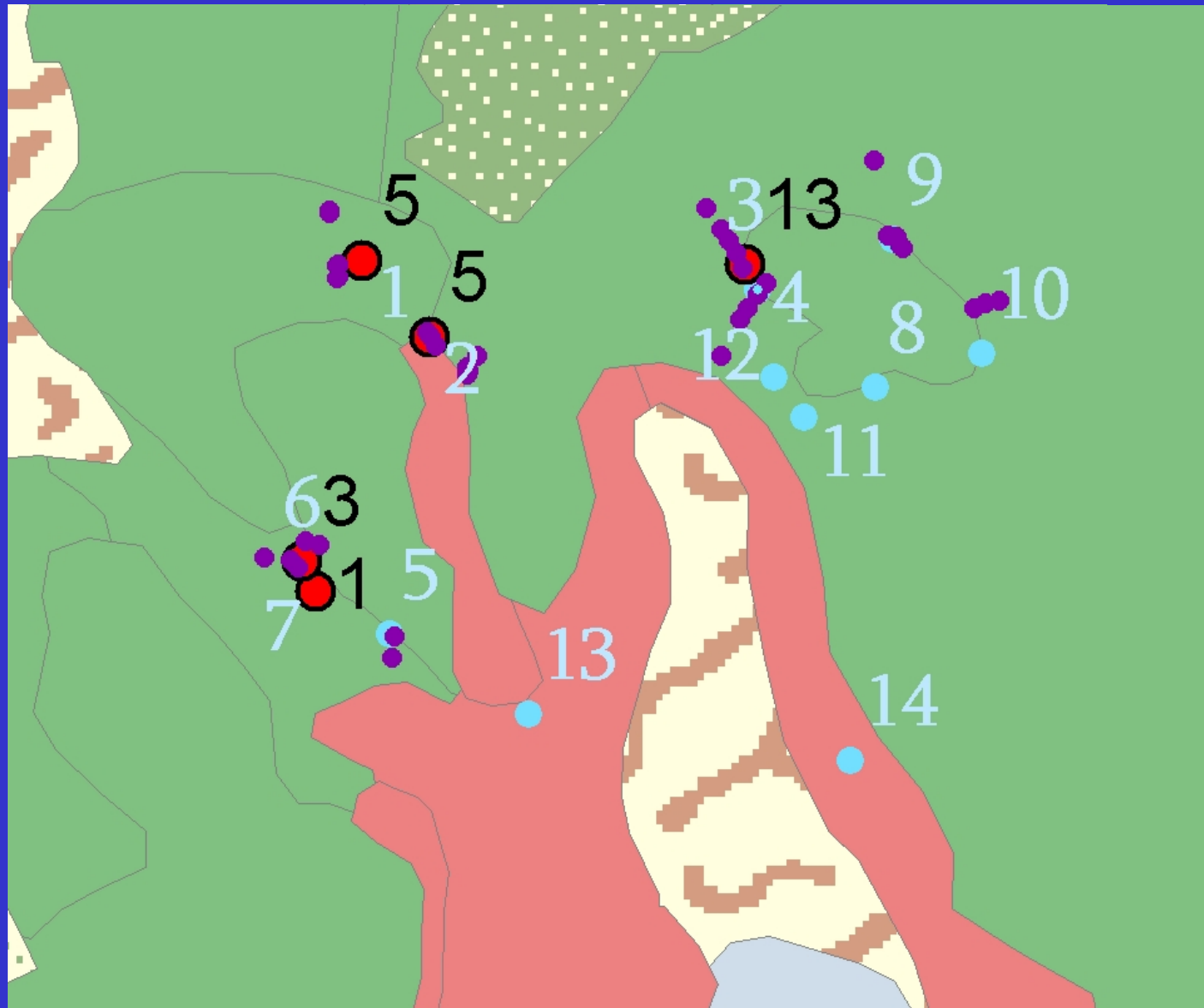


Culebra - % Coral Cover



Culebra - % Cyanobacterial Cover





Movement of Juveniles From School 1 (N=168) Over 4 Months



Counts of tagged fish at each location

CRES Socioeconomic Activities

- Ethnographic work in two regions: Guayama (south coast), and Rincón-La Parguera (northwest and southwest)
- Documentation of La Parguera and Culebra cases
- Linkage between CRES and other data collection initiatives
- In-depth interviews and focus groups



Activities for the Rincón-La Parguera Region

- Design, testing and implementation of two interview formats for species and habitats
- Design and scheduling of focus groups with fishers, scientists and managers
- Selection of key informants for the in-depth interviews

Activities

- Documentation (case study) of La Parguera socioeconomic monitoring using the SOCMON (NOAA).
- Established a linkage for data exchange between CRES and NMFS study on the socioeconomic profile of fishing communities in the western portion of Puerto Rico (David Griffith P.I.), and NOAA's survey of Marine Managed Areas.

Activities in the Guayama area

- Testing of methodologies for systematically documenting fishers' experience-based knowledge of marine ecosystems
- Participant observation of various fishing activities throughout the region
- Informal interviews with fishers
- Data gathering for NMFS fishing community profile, and application of the data gathering instrument in the communities of the south.

Activities

- **Conducted a set of three in-depth interviews with 25 key informants.**
- **Key informant interviews included: perception of environmental change, ecological narratives, identification of species to elicit ecological data, and the identification of critical environmental issues in the region.**
- **A survey (an interview schedule) was design to explore the social distribution of knowledge and of perceptions of environmental continuity and change in a larger sample of fishers in the southern region.**

Integrated sequence of quantitative techniques for the design and assessment of marine reserve plans

Marine reserves in the “plan” should not be overlapping or adjacent.

The model should allow for pre-specifying the number of reserves.

Each reserve must protect a certain proportion of population abundance or biomass for each exploited species of the reef fish stock under consideration.

The model should allow for specifying a target of no more than a certain number of fishing vessels displaced upon implementation.

The total area of coral reef habitat protected by the reserves in a reserve plan must meet a desired target level.

The total area covered by the reserves in a reserve plan must meet a desired target area.

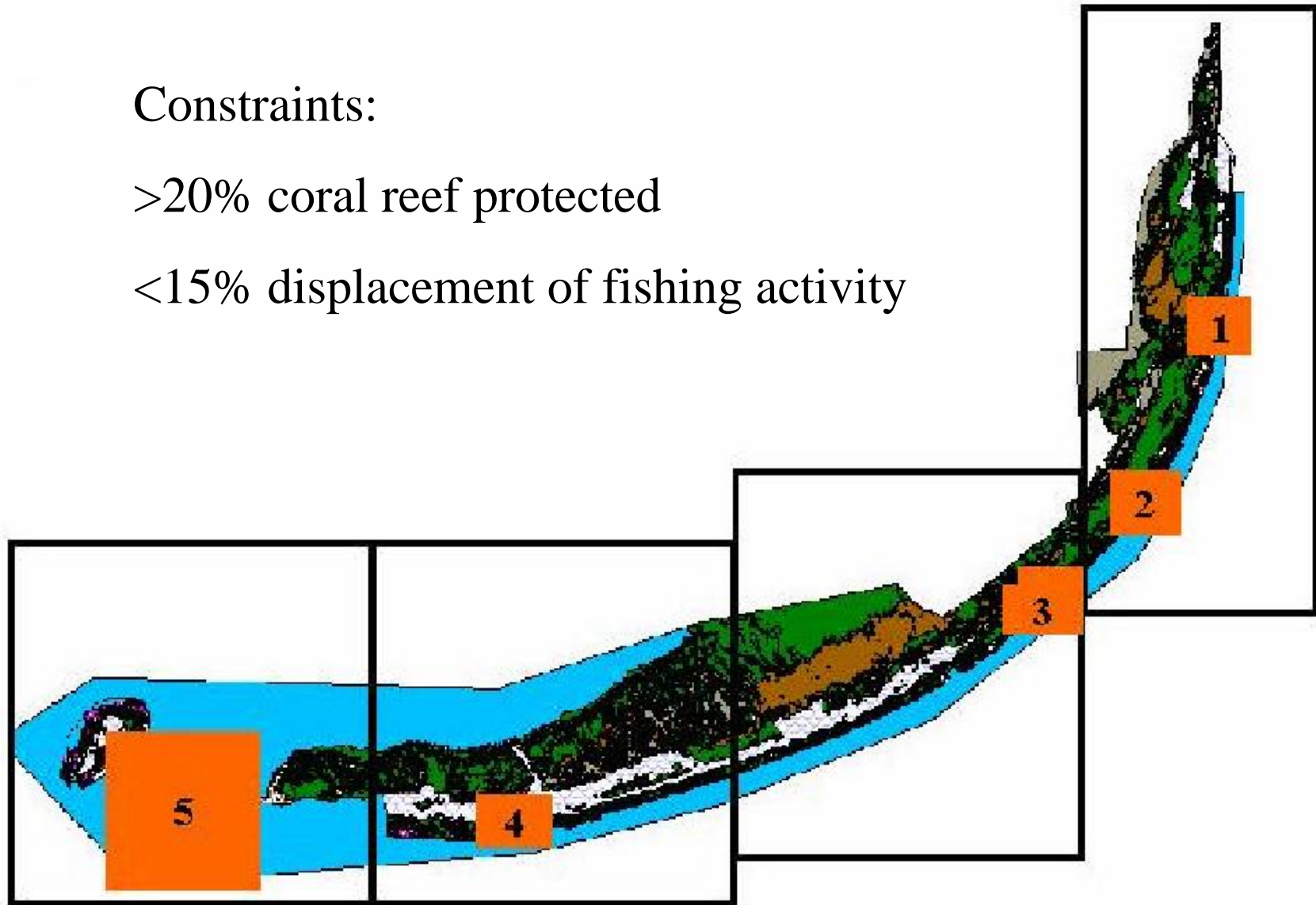
The methodology must be able to distribute reserves throughout various regions of the study area.

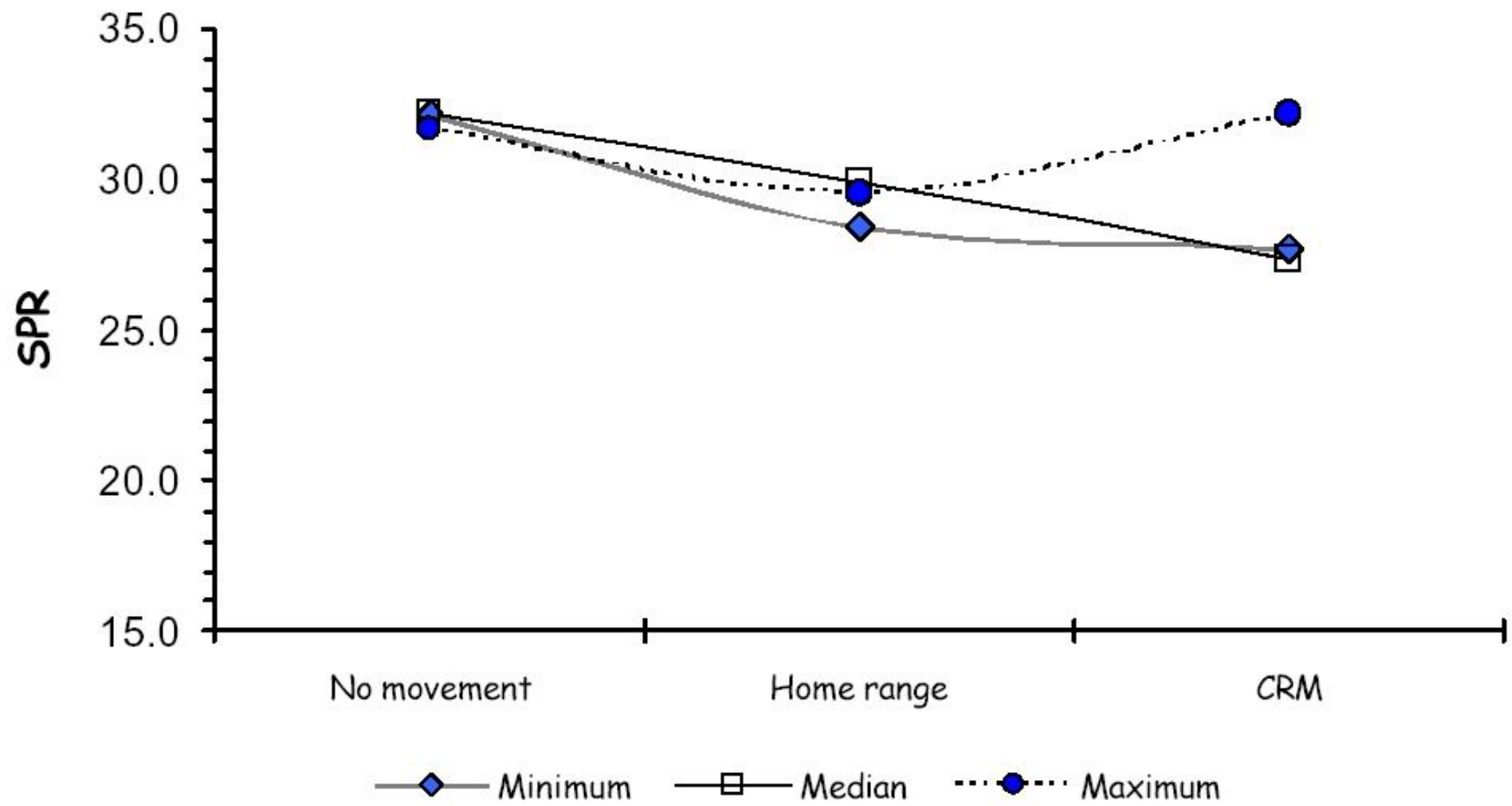
Each reserve should be contiguous, compact and desirably shaped.

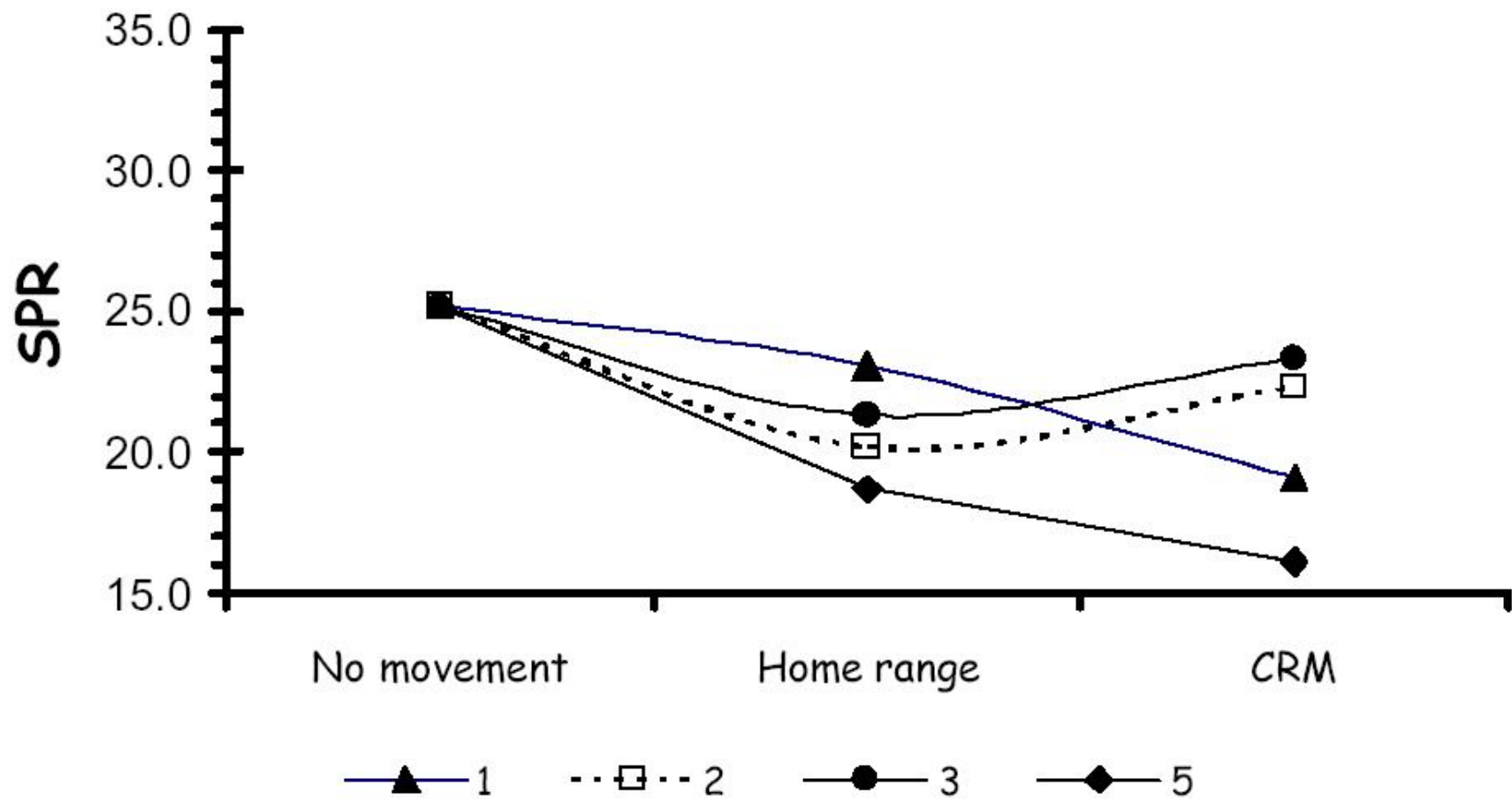
Constraints:

>20% coral reef protected

<15% displacement of fishing activity







Ecopath with Ecosim

- Ecopath

- Static, mass-balanced snapshot of ecosystem resources and their interactions
- Trophically linked biomass pools

	Fishery Catches
+	Predation Mortality
+	Biomass Accumulation
+	Net Migration
+	Other Mortality
<hr/>	
	Production

- Ecosim

- a complex simulation model for evaluating the impacts of different fishing regimes

- Ecospace

- Non-homogeneous spatial behavior
 - Preferred habitats
 - Habitat driven migration
 - Marine reserves/zones

I. Generalized Caribbean (PR-VI) Model

- Diet comp. analysis completed
- Grouping spp. – detailed model
- Incorporating fisheries data
- Next steps: Model balancing and finish documentation

II. La Parguera Model

- Habitat specific conditions: seagrass, reef, mangrove, etc.
- Current and historical data
- Simulate decadal changes to quantify fishing pressures
- Next steps: Modify existing PR-VI model inputs

III. Turrumote Model

- Reef platform-specific conditions
- Flux coupled with La Parguera model (or nested)
- ⇒ Predict outcomes for “no-take” management
- ⇒ Examine: Spp-specific changes and timeframe
- ⇒ CRES data: Model validation over 5 yrs.

Highly-detailed Model

Coastal Sharks

- Tiger Shark
- Lemon Shark

Rays and Skates

- Southern stingray
- Nurse shark

Sea Birds

- Brown pelican
- Brown booby

Dolphins

- Spinner dolphin
- Bottlenose dolphin

Sea Turtles

- Loggerhead
- Hawksbill

Pelagic Piscivores

- Horse-eye jack
- Cero

Benthic Piscivores

- Sand diver
- Green moray eel

Reef-associated Big Groupers

- Tiger grouper
- Yellowfin grouper

Reef-associated Snappers

- Yellowtail snapper
- Mahogany snapper

Reef-associated Jacks and Barracuda

- Bar jack
- Great barracuda

Reef-associated Small Groupers

- Coney
- Graysby

Demersal Planktivores

- Blue chromis
- Creole wrasse

Demersal Coralivores

- Foureye butterflyfish
- Banded butterflyfish

Demersal Sponge-eaters

- Sharpnose puffer
- Queen angelfish

Demersal Herbivores

- Ocean Surgeonfish
- Striped Parrotfish

Demersal Omnivores

- Queen Parrotfish
- Spotted trunkfish

Demersal Invertivore

- Queen triggerfish
- Spanish hogfish

La Parguera Base Map Ecospace

