

Status of Puertorrican Coral Reefs

An underwater photograph of a coral reef. The scene is dominated by large, flat, light-colored coral structures, possibly table corals, which are densely packed and cover most of the seabed. The water is a deep, clear blue, and the lighting is somewhat dim, suggesting an underwater environment. The coral appears to be in various stages of growth or health, with some showing signs of bleaching or damage.

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Coral Reef Task Force Meeting

Fajardo, PR
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Presentation Overview

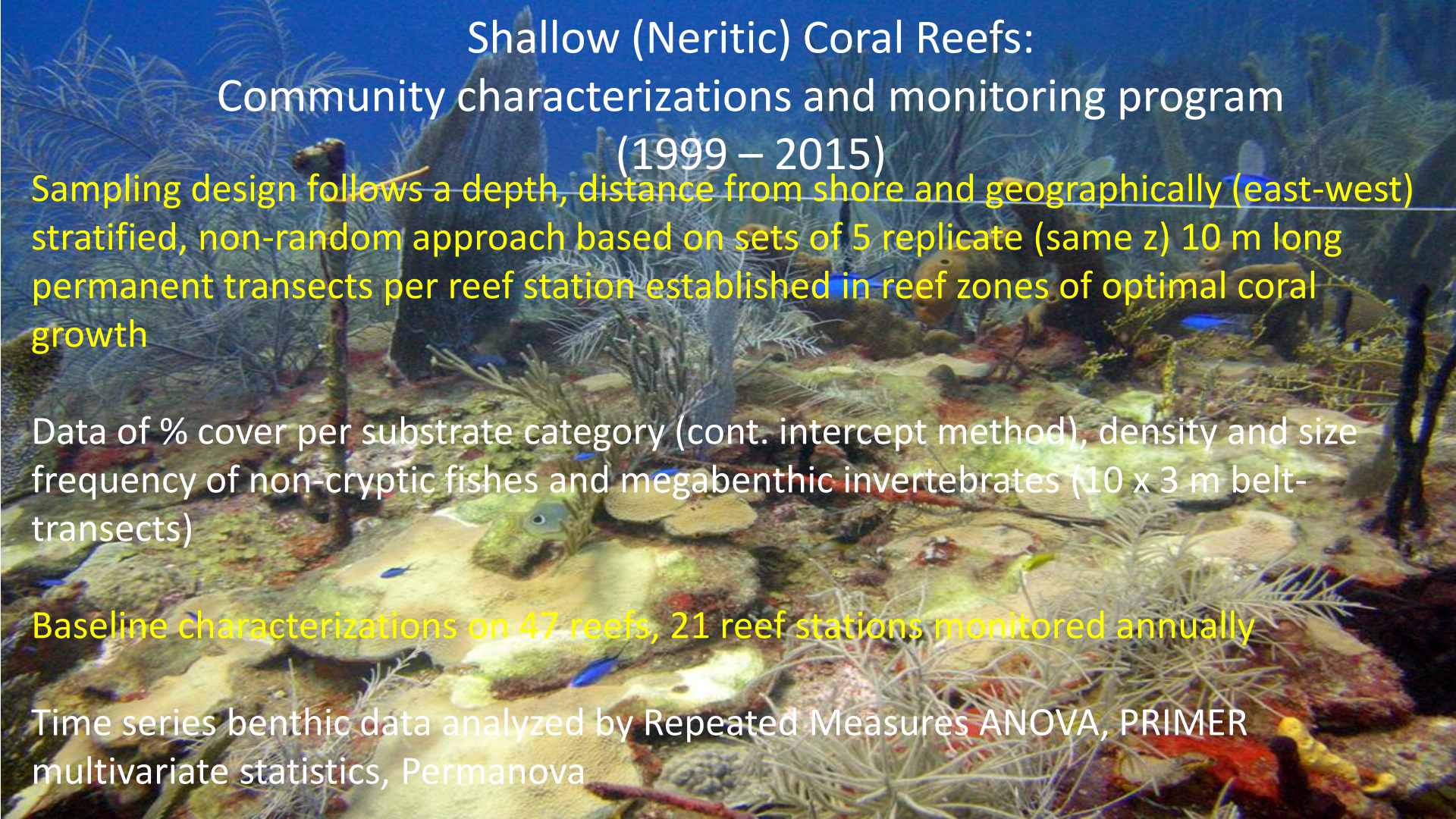
An underwater photograph of a coral reef. The background is a clear, blue-green water. In the center, there is a prominent, vertical, columnar coral structure, possibly a species of sea fan or similar. The surrounding reef is composed of various other coral species, including branching and table corals, creating a complex and textured environment. The lighting is natural, coming from above, which creates a gradient of light from the surface down to the reef.

Status of shallow (neritic) coral reefs from Natural Reserves in PR – inferences from the monitoring program (1999 – 2015)

Research synthesis on mesophotic coral reefs

Recent exploration and characterization of deep, cold, aphotic coral reefs

Management perspectives & priorities (2 cents)



Shallow (Neritic) Coral Reefs: Community characterizations and monitoring program (1999 – 2015)

Sampling design follows a depth, distance from shore and geographically (east-west) stratified, non-random approach based on sets of 5 replicate (same z) 10 m long permanent transects per reef station established in reef zones of optimal coral growth

Data of % cover per substrate category (cont. intercept method), density and size frequency of non-cryptic fishes and megabenthic invertebrates (10 x 3 m belt-transects)

Baseline characterizations on 47 reefs, 21 reef stations monitored annually

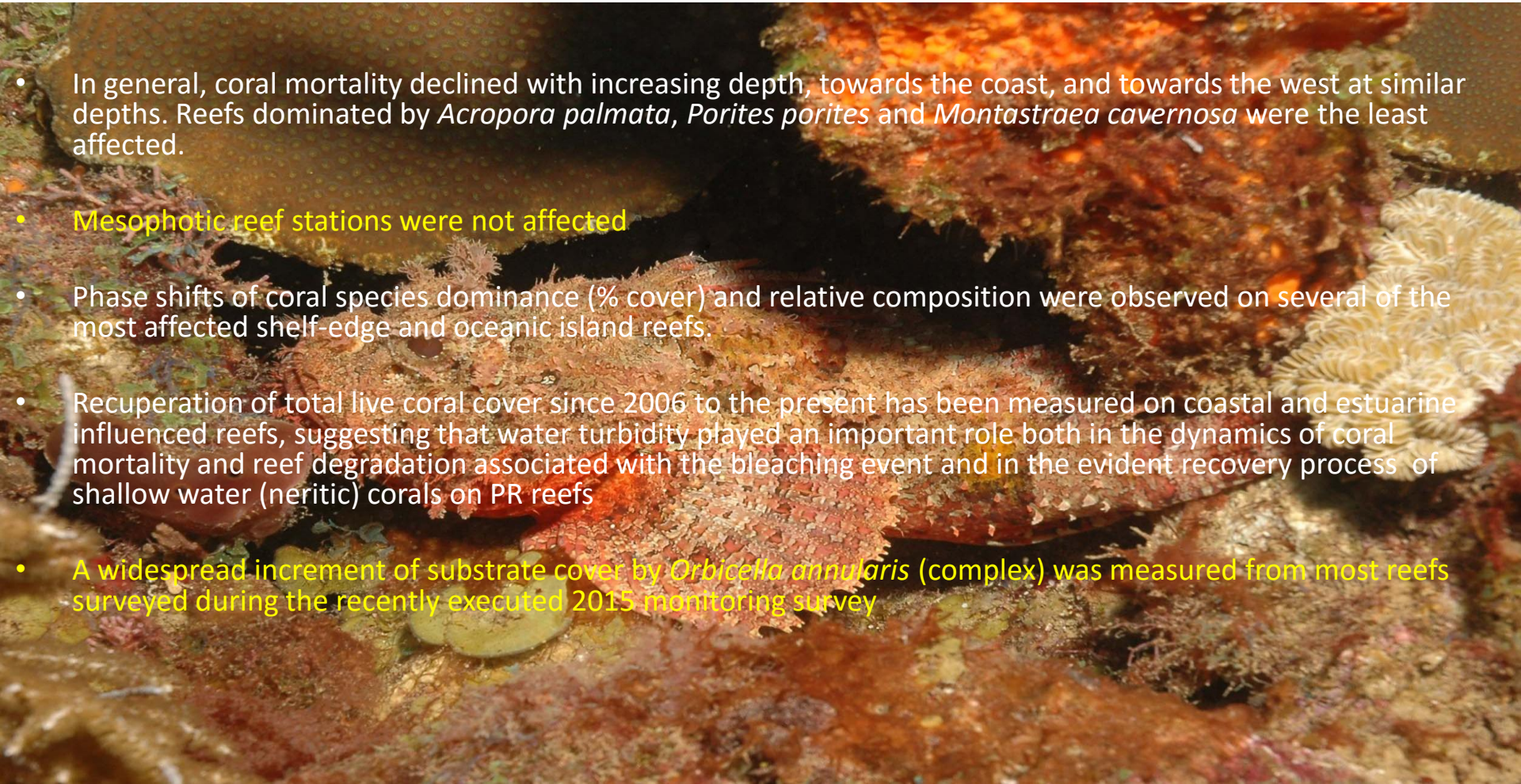
Time series benthic data analyzed by Repeated Measures ANOVA, PRIMER multivariate statistics, Permanova

Inferences from the monitoring program:

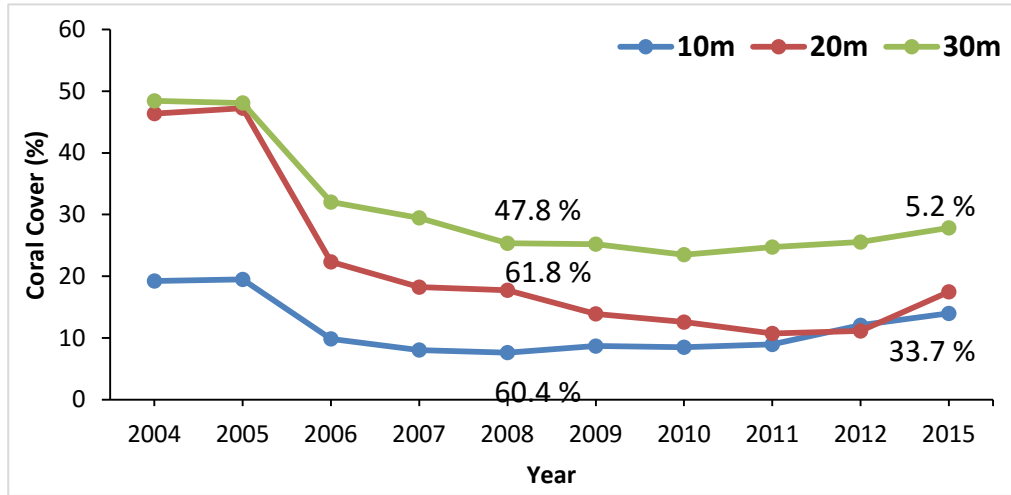
- Coral reefs located at the outer shelf (Derrumbadero, La Boya - LP, Media Luna and Turrumote – LP), oceanic islands (Desecheo, Mona) and east coast islands (Cord de Fajardo, Vieques) presented the highest % of live coral cover during the baseline surveys (> 40 % live coral cover)
- Live coral cover remained stable at most reefs during the monitoring program until 2006, when a variable decline was measured on the majority of the reef stations surveyed after a severe regional coral bleaching event affected reef systems of Puerto Rico and the U. S. Virgin Islands during late 2005.
- The decline of (total) coral cover was largely driven by mortality of

Inferences from the monitoring program: (cont)

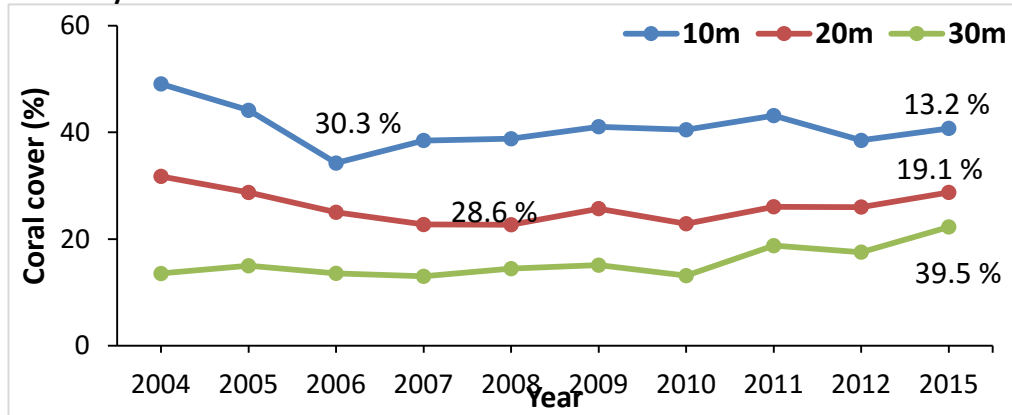
- In general, coral mortality declined with increasing depth, towards the coast, and towards the west at similar depths. Reefs dominated by *Acropora palmata*, *Porites porites* and *Montastraea cavernosa* were the least affected.
- Mesophotic reef stations were not affected
- Phase shifts of coral species dominance (% cover) and relative composition were observed on several of the most affected shelf-edge and oceanic island reefs.
- Recuperation of total live coral cover since 2006 to the present has been measured on coastal and estuarine influenced reefs, suggesting that water turbidity played an important role both in the dynamics of coral mortality and reef degradation associated with the bleaching event and in the evident recovery process of shallow water (neritic) corals on PR reefs
- A widespread increment of substrate cover by *Orbicella annularis* (complex) was measured from most reefs surveyed during the recently executed 2015 monitoring survey

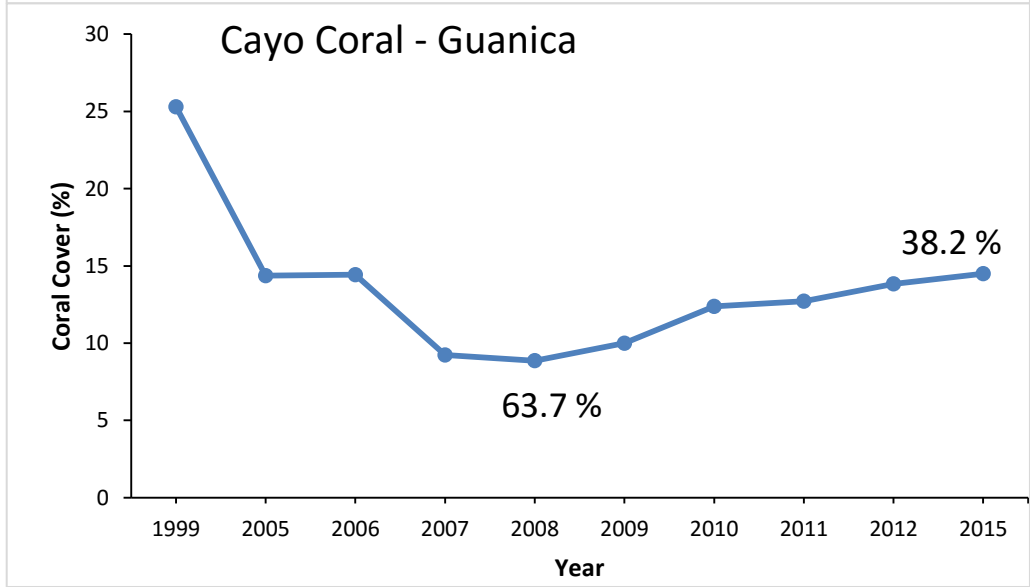
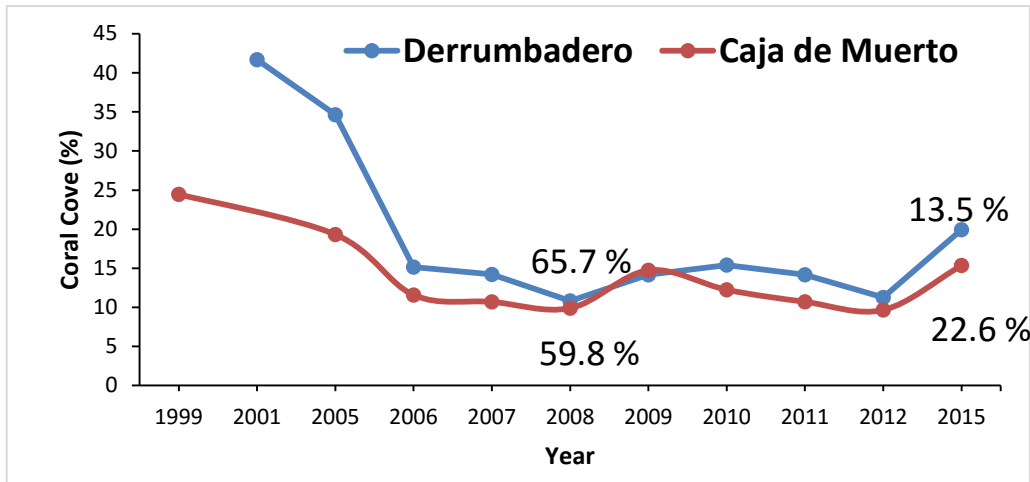


Isla Desecheo



Tourmaline – Mayaguez Bay

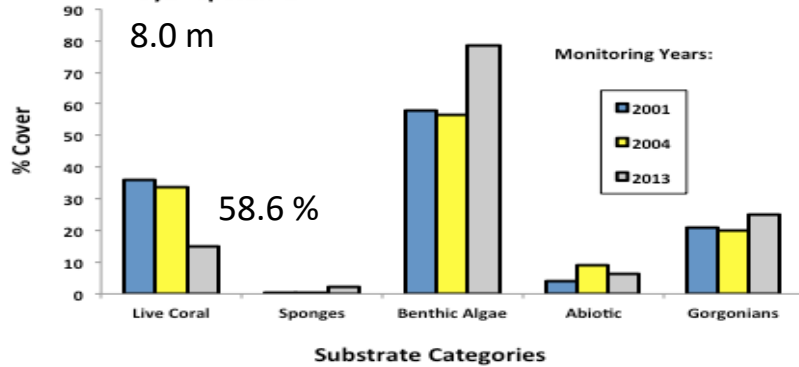




Vieques

Boya Esperanza

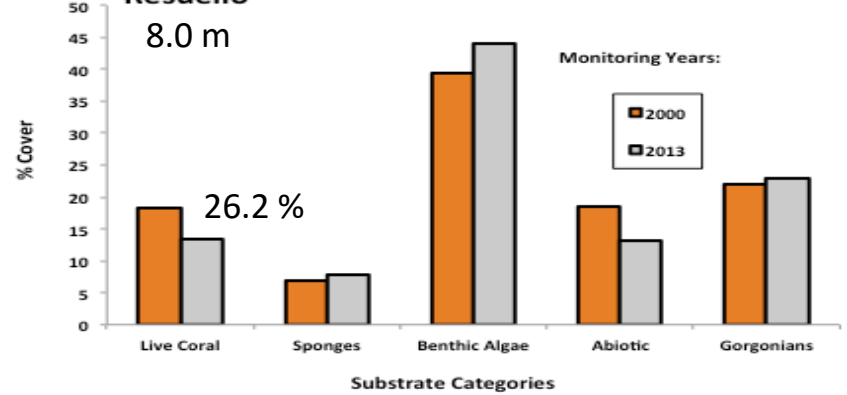
8.0 m



Cabo Rojo

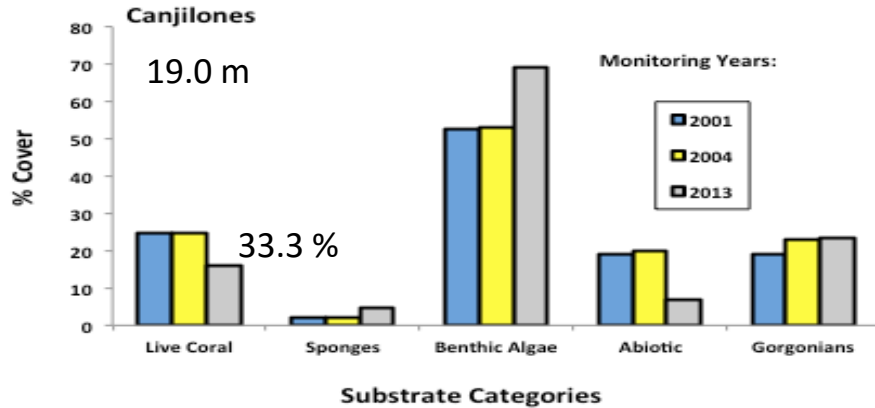
Resuello

8.0 m



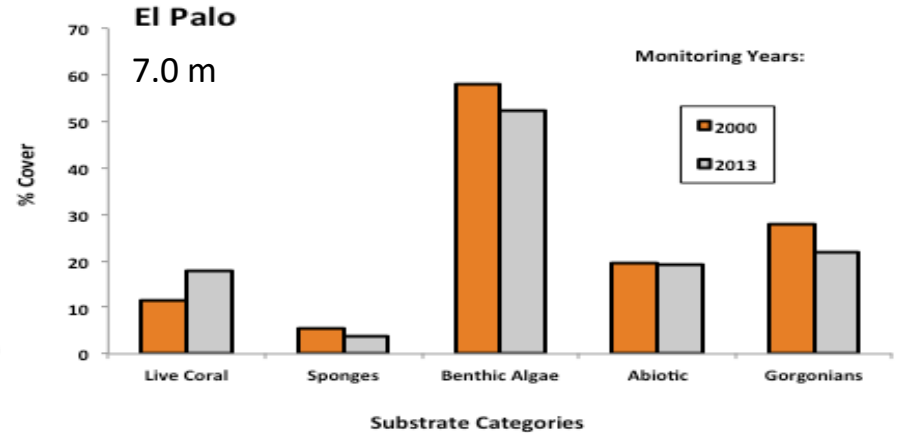
Canjilones

19.0 m

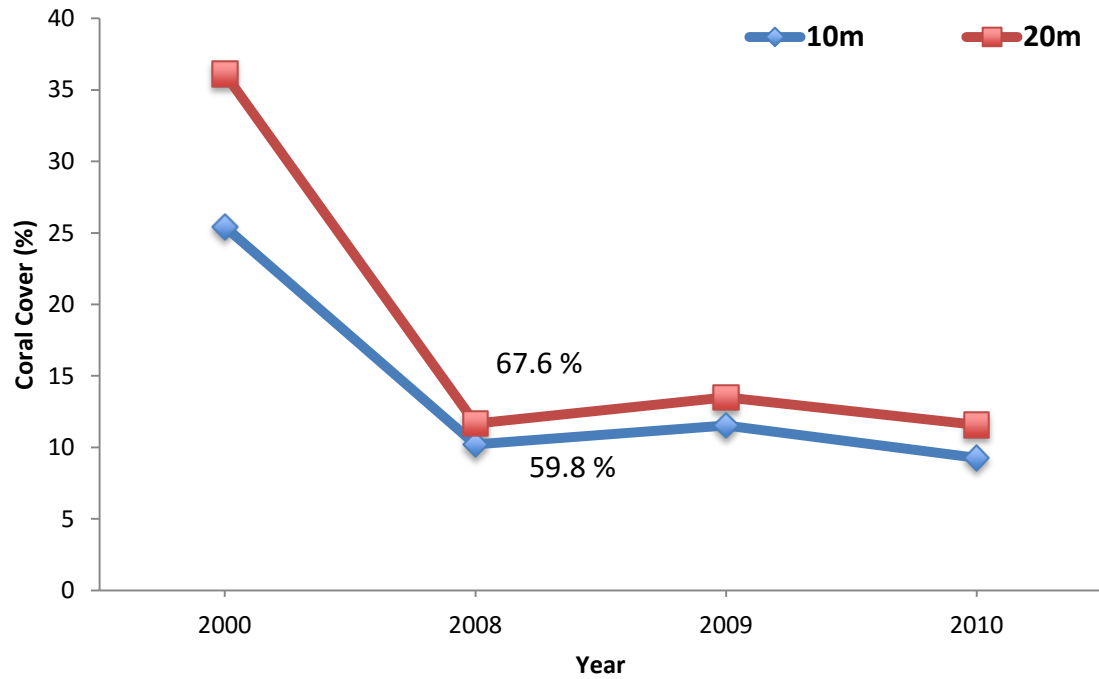


El Palo

7.0 m



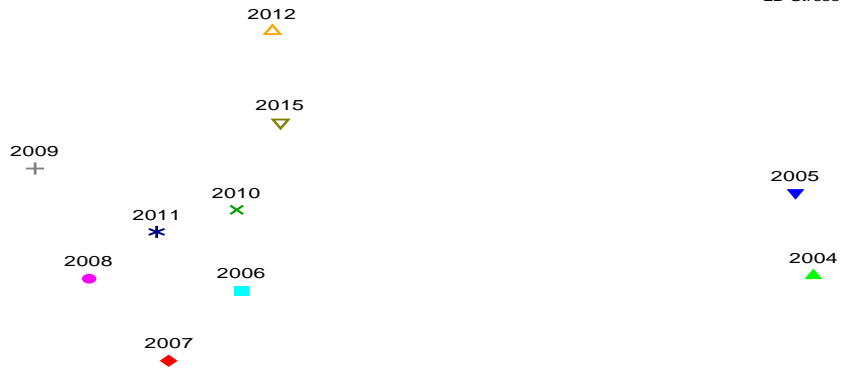
Isla Mona



Isla Desecheo – 15 m

Resemblance: S17 Bray Curtis similarity

2D Stress: 0.03



Isla Desecheo – 30 m

Resemblance: S17 Bray Curtis similarity

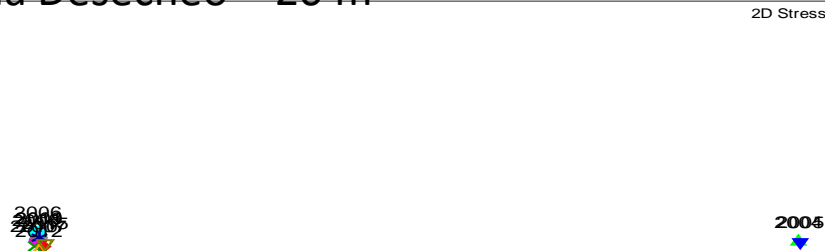
2D Stress: 0.01



Isla Desecheo – 20 m

Resemblance: S17 Bray Curtis similarity

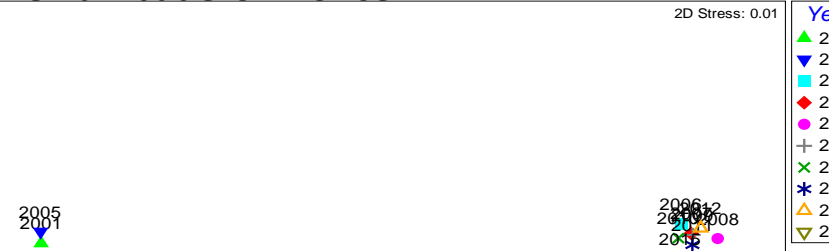
2D Stress: 0.01



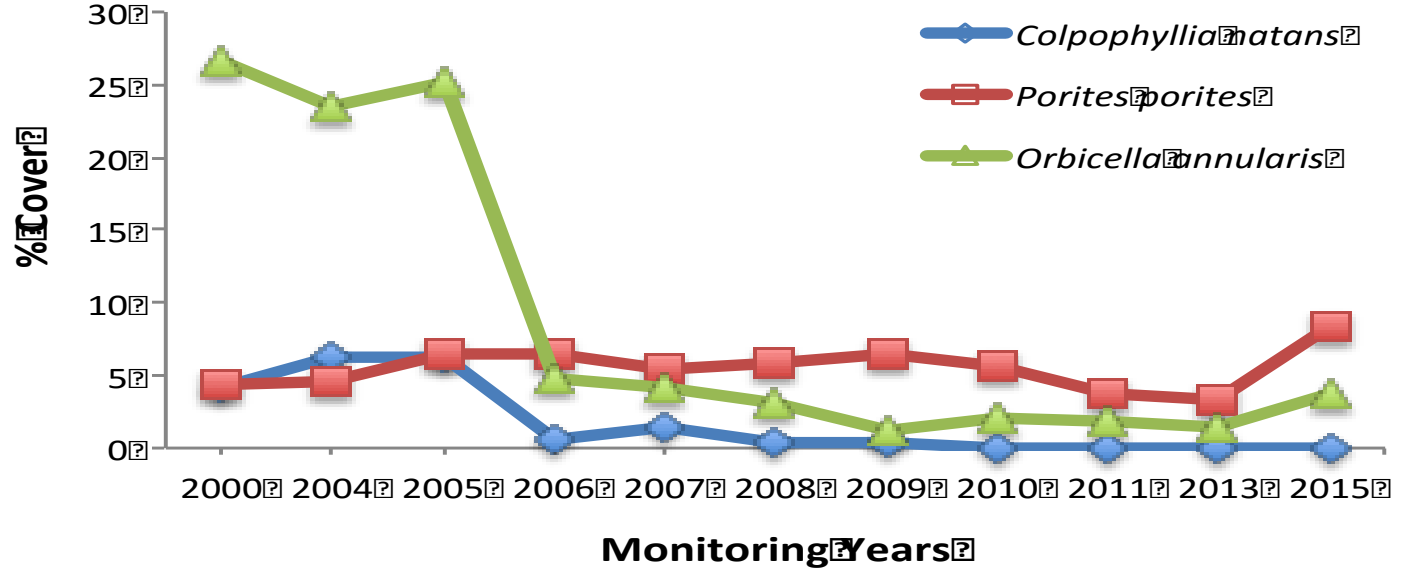
Derrumbadero - Ponce

Resemblance: S17 Bray Curtis similarity

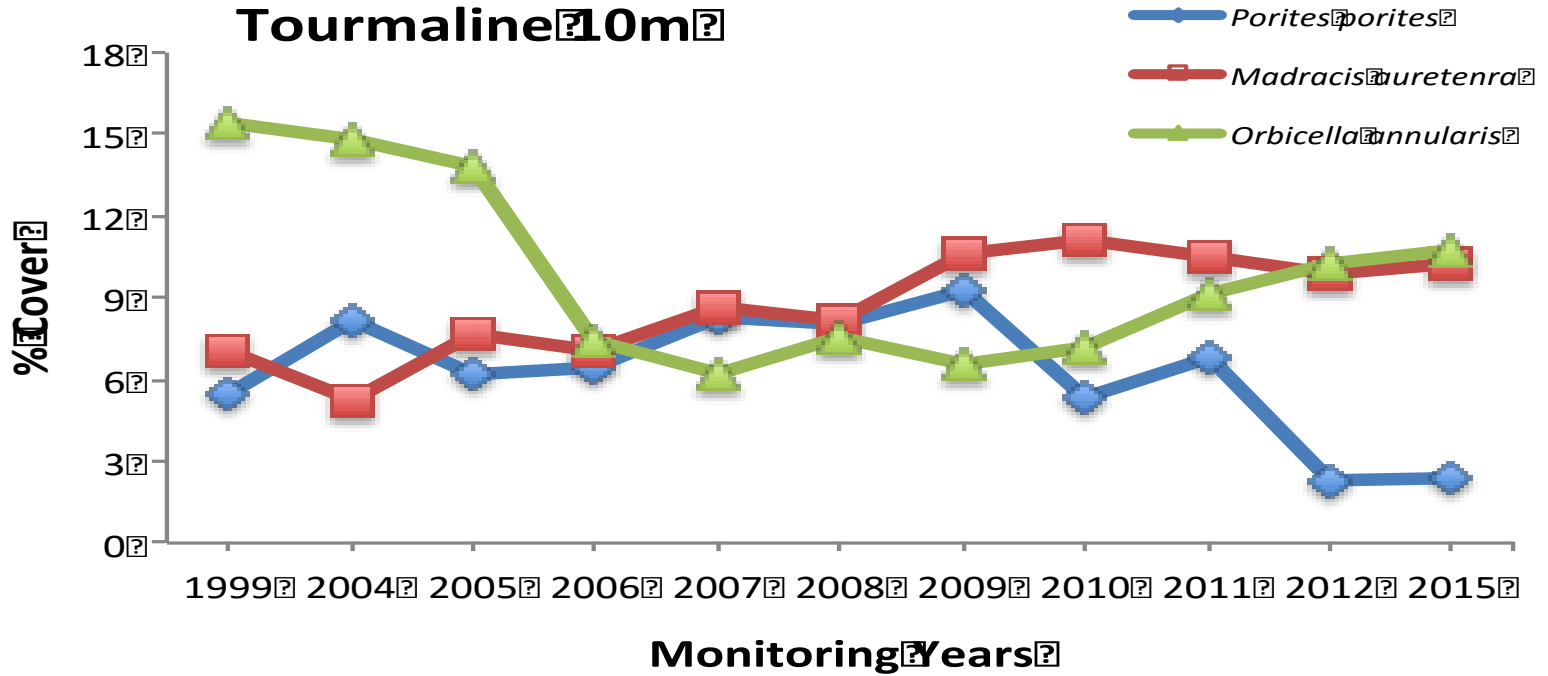
2D Stress: 0.01



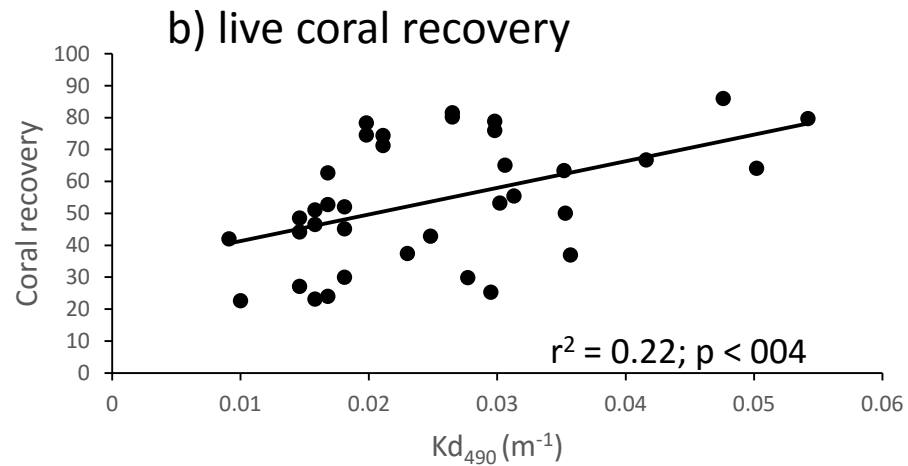
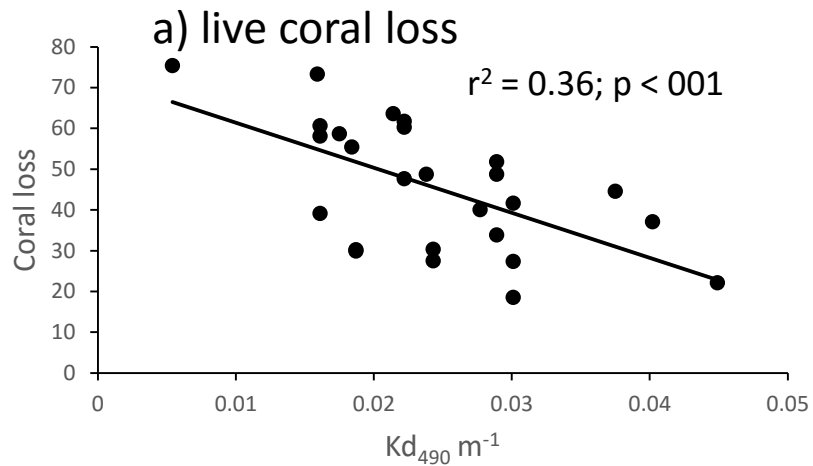
Desecheo 20m



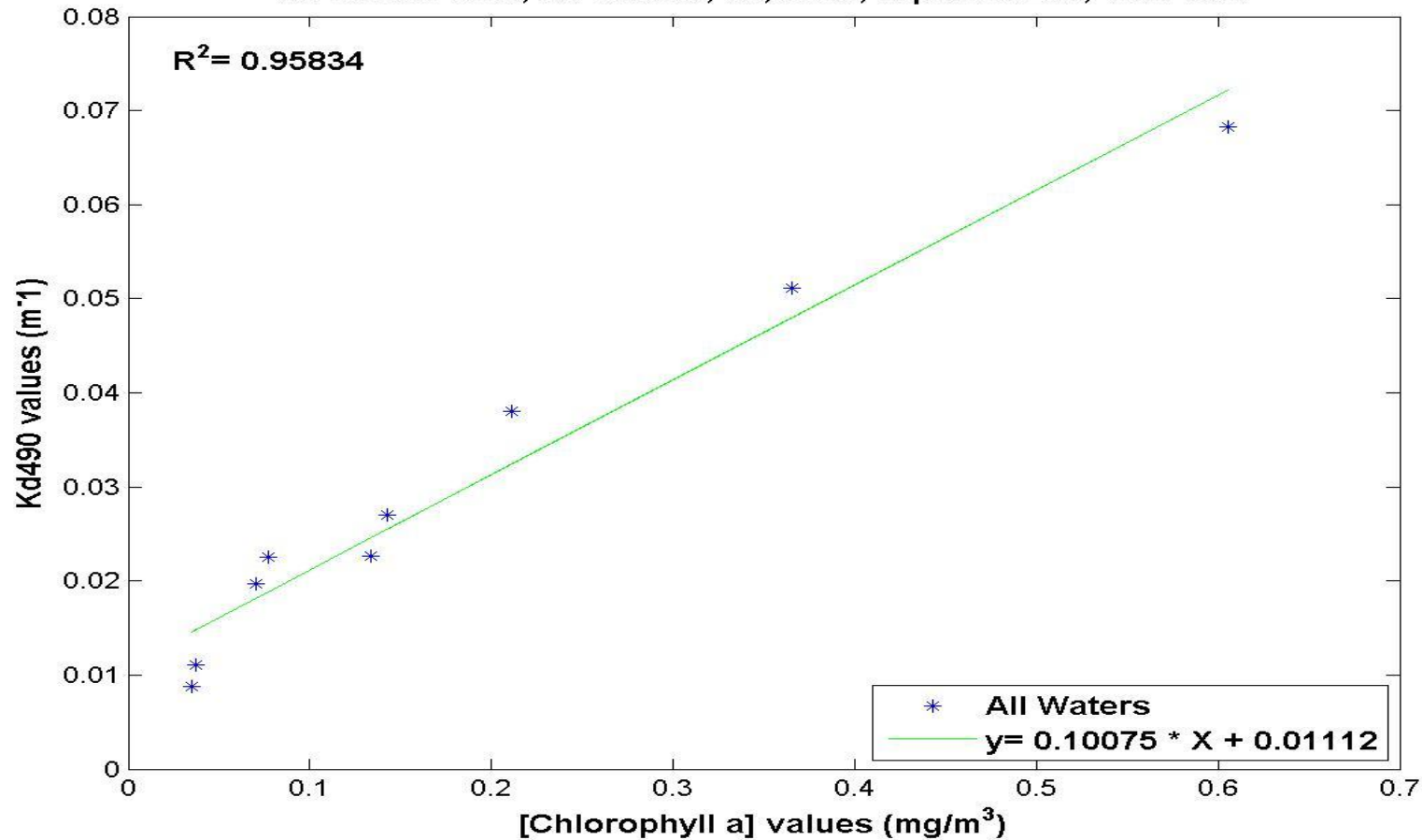
Tourmaline 10m



Relationships between light attenuation coefficient (Kd 490) and:



Kd490 vs. Chla, All Waters, R², 2013, Aqua MODIS, 1km*1km



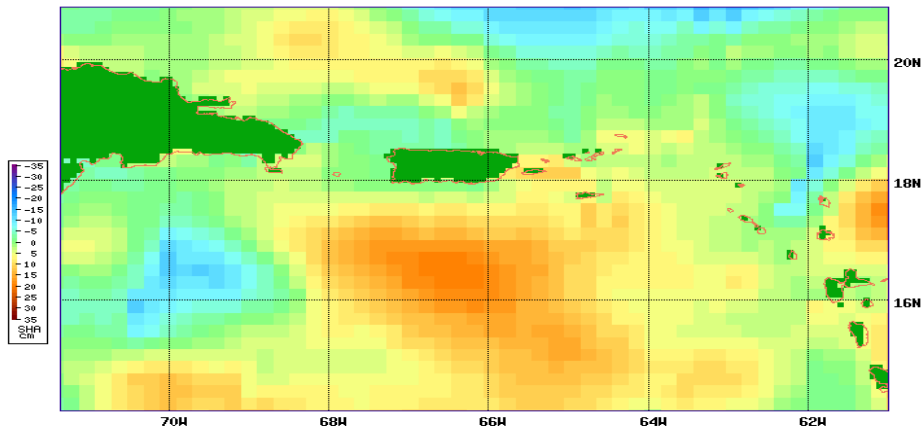
CORAL BLEACHING:

Passage of an anti-cyclonic eddy coincident with the 2005 coral bleaching event.

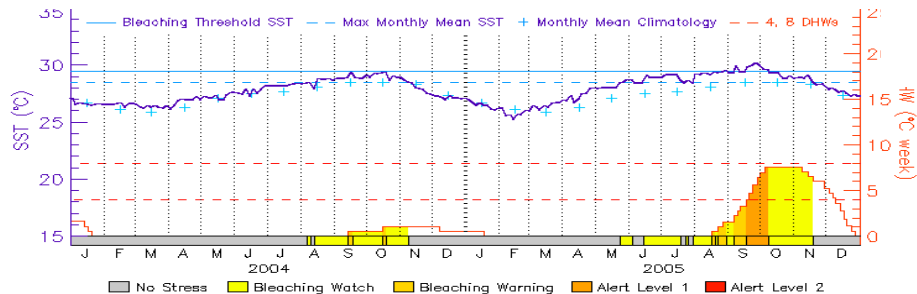
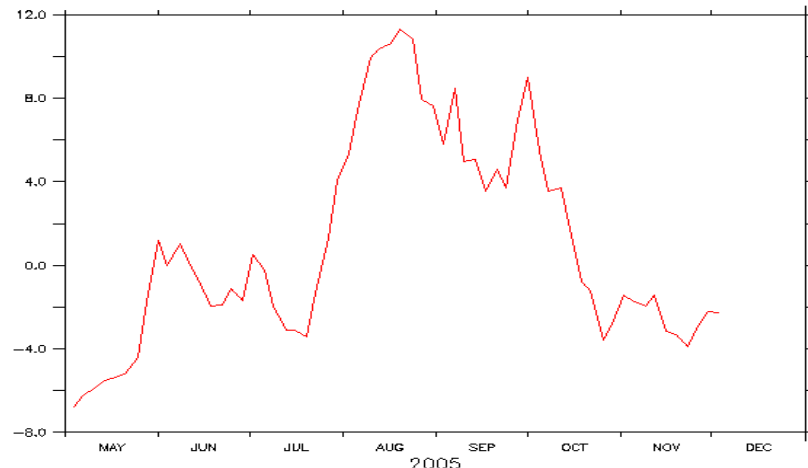
Increased heat content and UV radiation associated with anti-cyclonic eddies can exacerbate coral bleaching

AUG-12-2005

CoastWatch NOAA/AOML
Altimeter/GTS Interface



AVISO
LONGITUDE : 69W(-69) to 67W(-67)
LATITUDE : 16N to 18N



2005
test (from Maps of Sea Level Anomalies Merged ave(x=-69.0:-67.0)
ave(y=18.0:18.0)) (cm)

Mesophotic Coral Reefs of PR

- Research sponsored by NOAA Coral Grants the Caribbean Fishery Management Council (CFMC)
- Benthic habitat mapping and biological characterizations
- Density and size frequency of fishes and commercially exploited shellfish
- Digital still and video photo-documentation of benthic habitats and associated communities



Research synthesis - MRE

Associated with shelf-edges and upper insular slopes, deep outer shelf and oceanic island basins, upper seamount ranges

Most research in PR done within the 30 – 50 m depth range; Biological/ BHM surveys within the US EEZ at BDS, ALS, Tourmaline, El Seco – Vieques, Lang Bank and the MCD, St. Thomas, USVI

Spawning aggregation sites for many commercially important coral reef fishes

Foraging habitats of Hawksbill turtles and many HMS that are commercial/recreational targets

Residential habitats and perhaps, the last refuge for many overfished large demersal cr fishes

Main habitat of ESA 's *Orbicella franksi*, black corals (Antipatharia – at least 7 spp), Nassau grouper

Genetic reservoir of shallow water corals and commercially exploited fish & shellfish (Queen conch)

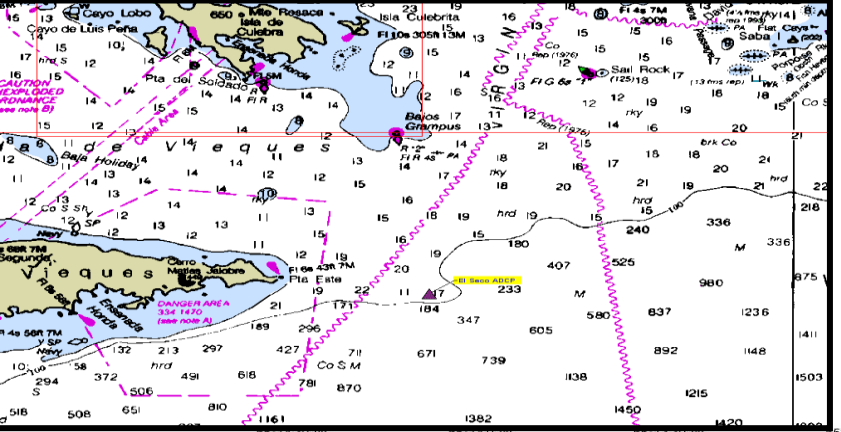


Table 5. Benthic habitat classifications and areal coverage at “El Seco”, southeast Vieques

Habitat Type	Area (km ²)	Area (Hectares)	%
Rhodolith Reef	8.56	856.2	57.9
Bank Coral Reef	3.68	368.2	24.9
Colonized Pavement	1.08	108.3	7.3
Patch Coral Reef	0.80	79.9	5.4
Colonized Pavement with Sand Channels	0.34	33.9	2.3
Uncolonized Pavement with Sand Channels	0.16	16.5	1.1
Scattered Coral/Rock in Algal Rhodoliths	0.15	15.4	1.0
	14.78	1478.4	100

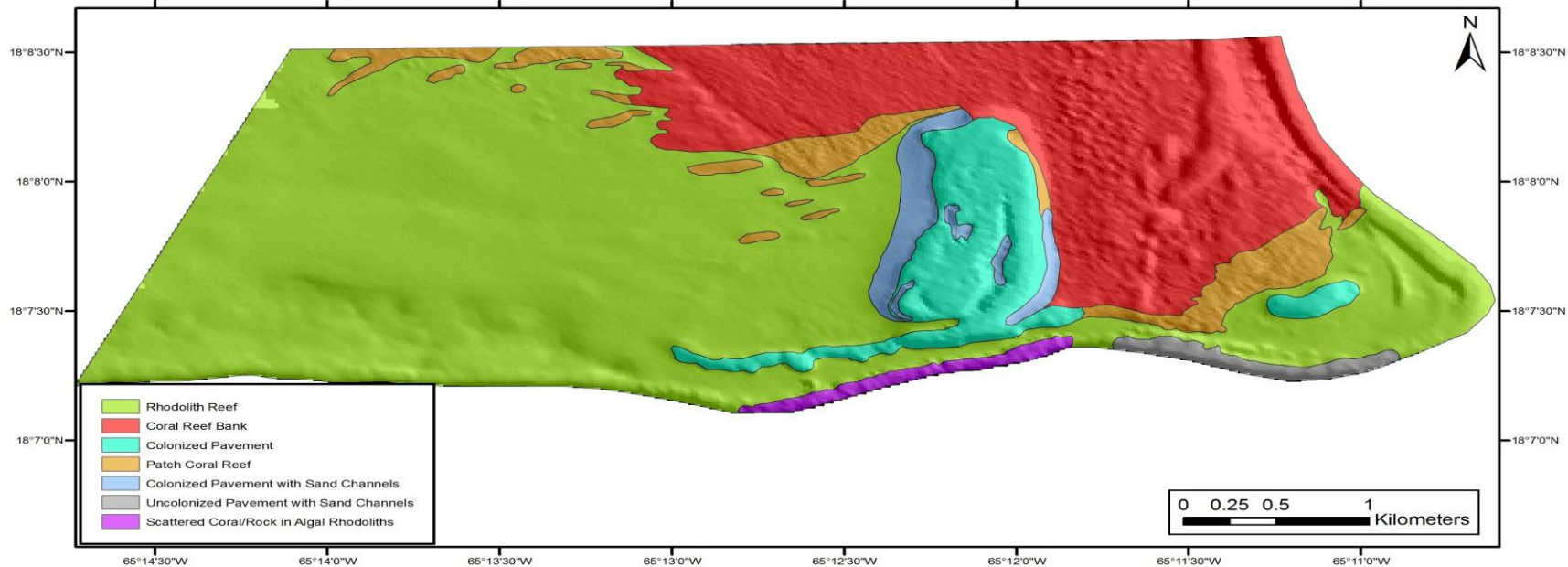
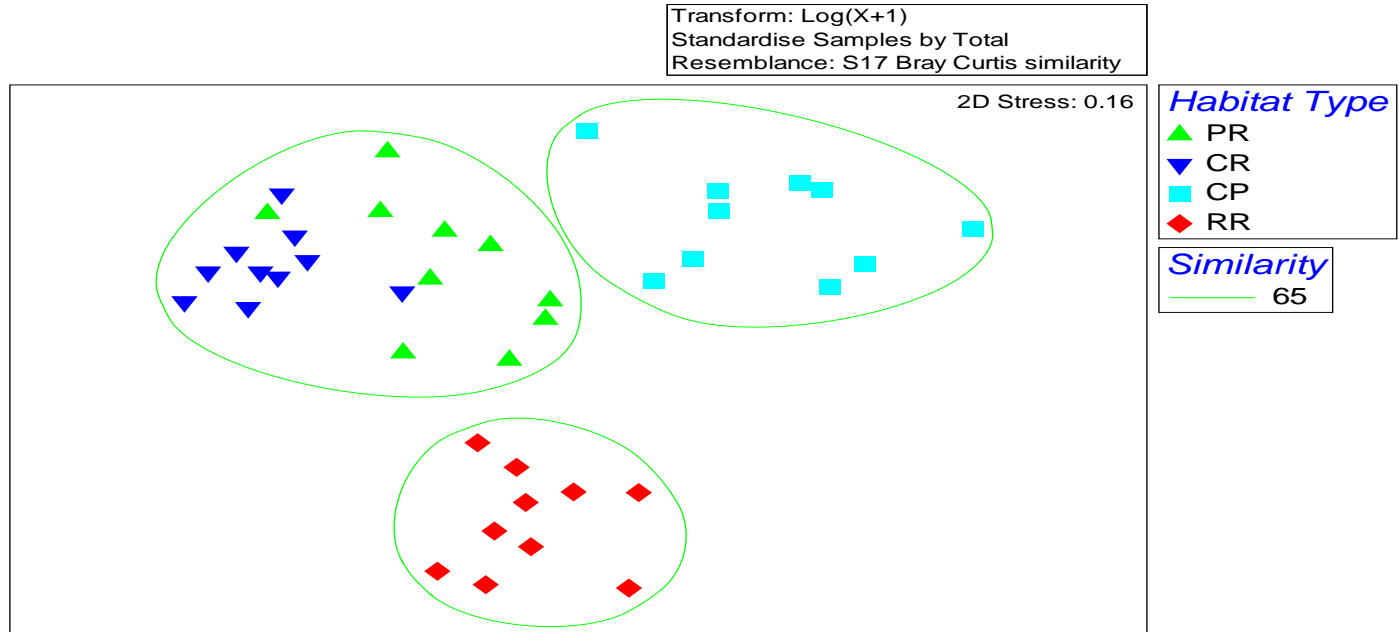
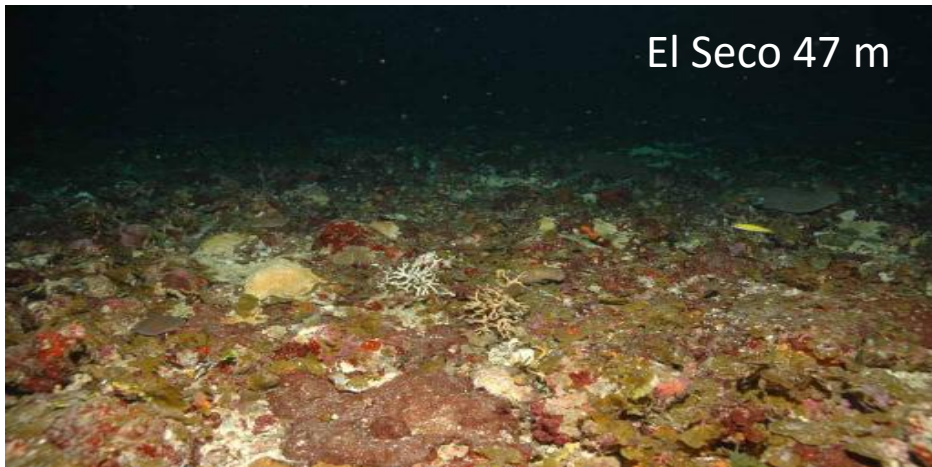
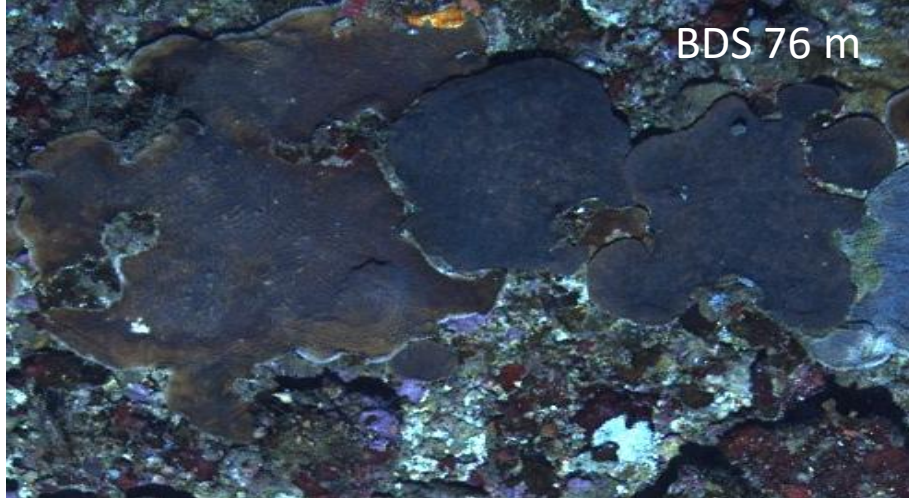
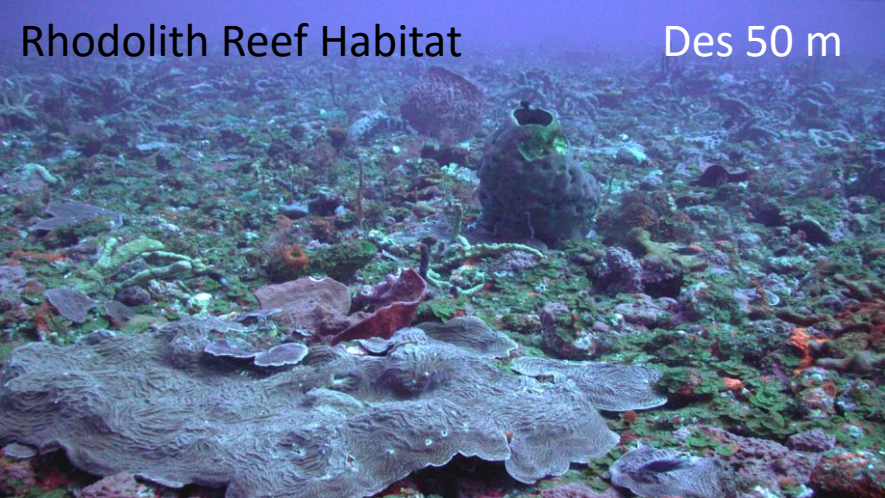


Figure 18. Multidimensional scaling plot of Bray-Curtis similarities between benthic habitats based on the data of percent substrate cover by sessile-benthic categories on photo-transects at El Seco, southeast Vieques. 2010-11



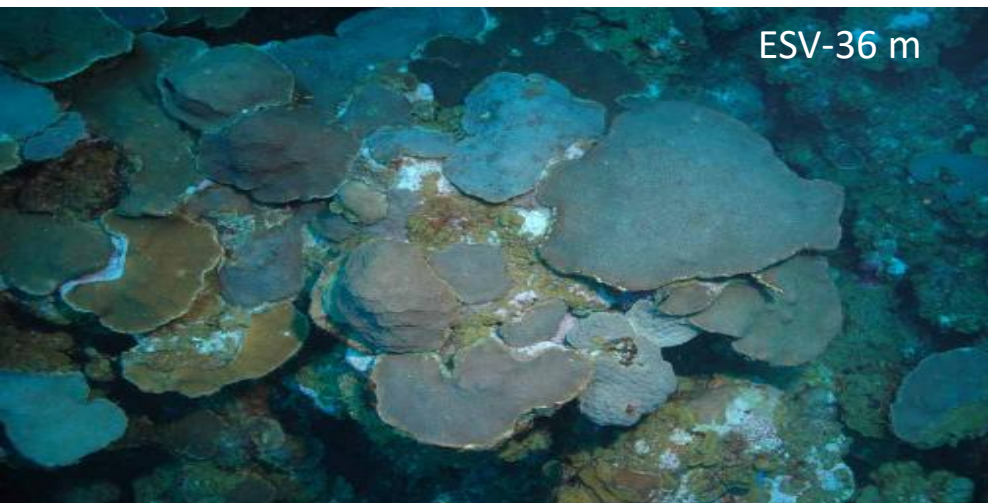


Coral Reef Habitat



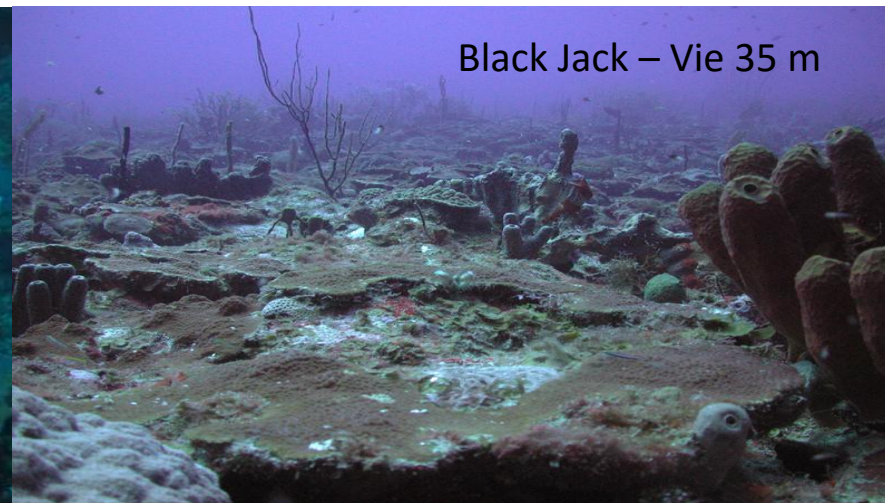
ESV-36 m

Black Jack – Vie 35 m



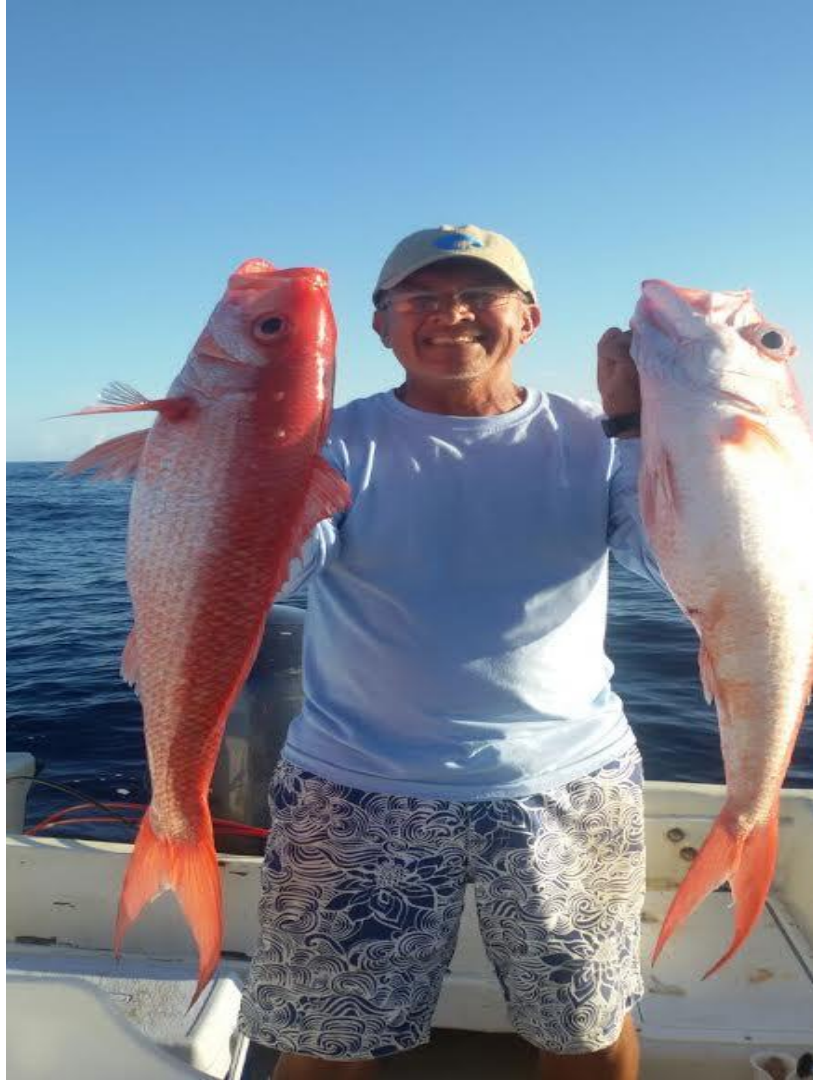
ESV-36 m

Black Jack – Vie 35 m









Aphotic coral reefs of PR

Baseline research initiative sponsored by NOAA Coral Grant to the CFMC.

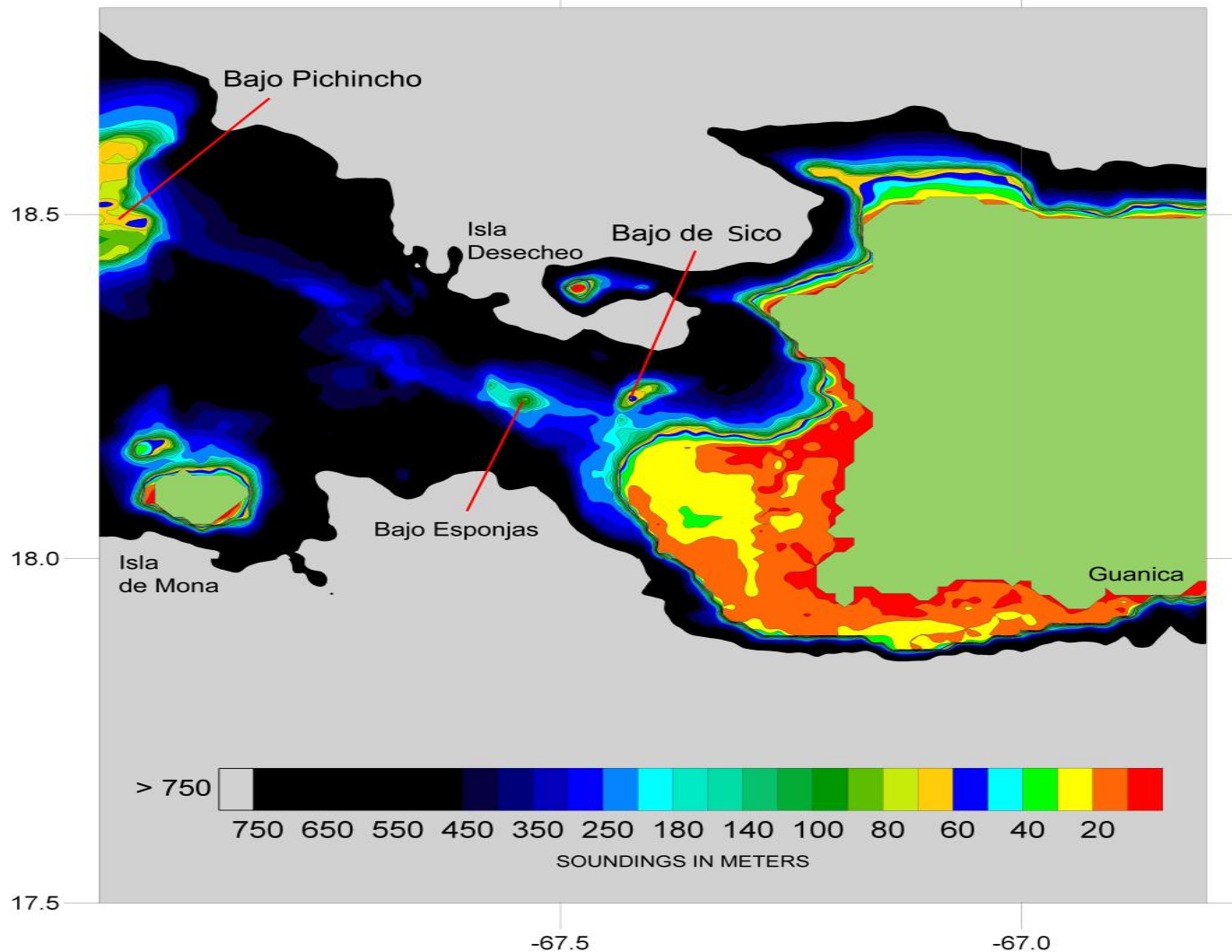
“Characterization of deep reef habitats in fishing grounds of the Queen Snapper (*Etelis oculatus*) in Mona Passage, PR”

First benthic quantitative assessments of aphotic (>200 m depths) reef habitats using SeaBed AUV digital image analyses

Associated with the insular slope, volcanic seamounts and ridges along the southern Puertorrican fault (Mona Passage). Deeper than 150 m, $< 20^{\circ}\text{C}$, no light

Prime habitats of the deep water snapper/grouper assemblage of major relevance for Puertorrican fisheries

Fishing grounds for migratory pelagic fisheries (marlin, mahi-mahi, tunas, mackerel, etc).



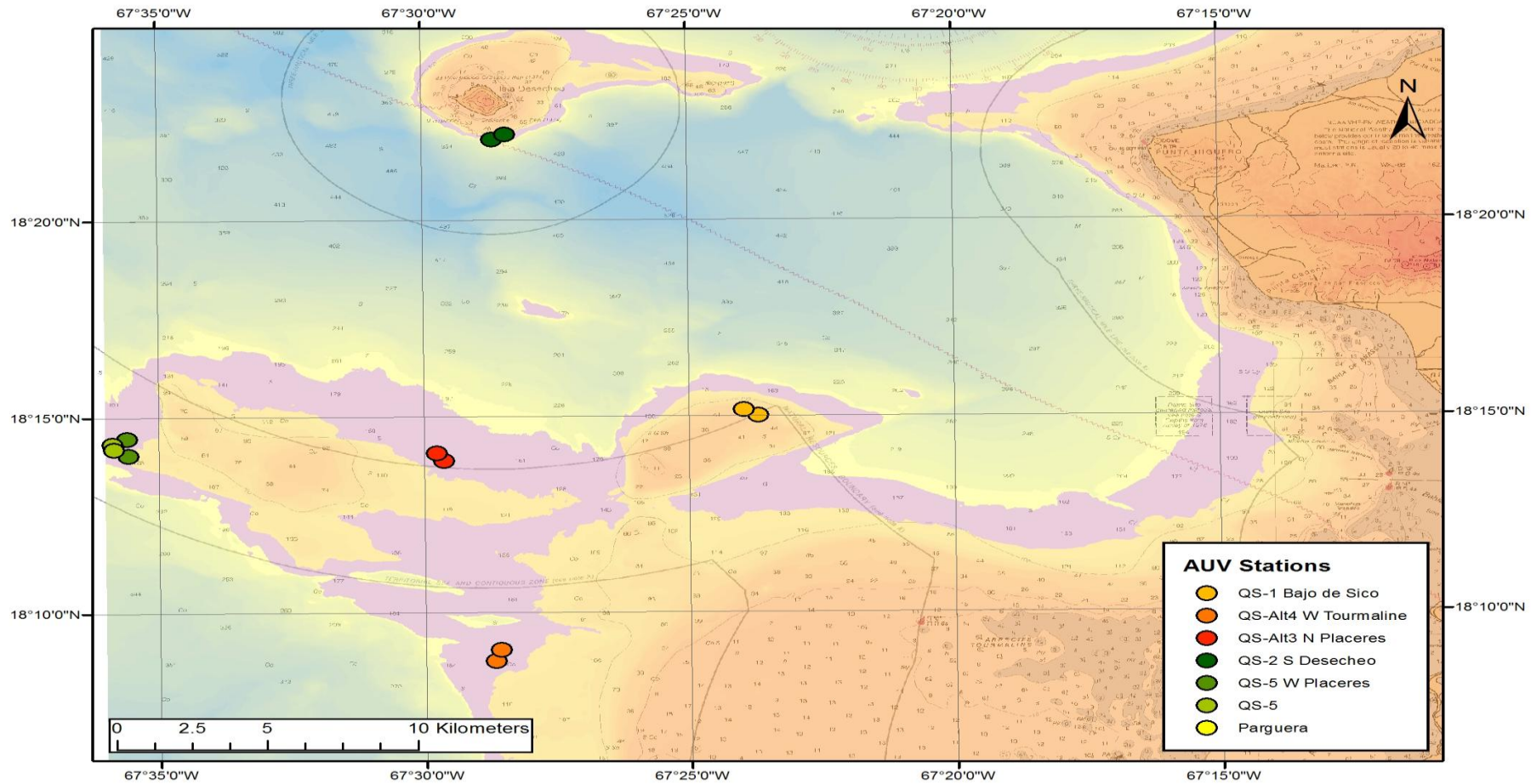


Table 7. QS – 5 (N – S). Placeres W. Percent cover by substrate categories and densities of predominant biota within the transect area photographed by the SeaBed AUV at Bajo Placeres W during Feb 2015. Depth range: 260 – 280 m.

Total photos analyzed: 91		Total Area: 647.9 m²
SUBSTRATE CATEGORY	% Substrate Cover Mean	Density (# col/100m²)
Total Abiotic	64.02	
Total Sponges	5.75	40.4
Ahermatypic Coral		
Unknown	4.74	33.29
<i>Lophelia</i> or <i>Oculina</i>	2.95	20.72
White polyps	1.81	12.71
<i>Enallopsamma profunda</i>	1.53	10.74
<i>Madrepora oculata</i>	0.34	2.39
Bamboo coral	0.1	0.70
Total Ahermatypic Coral	11.47	80.6
Antipatharians		
<i>Bathypathes</i> sp.	2.66	18.68
Unknown	0.62	4.35
Planular black coral	0.05	0.35
Short bushy black coral	0.03	0.21
Tall bushy coral	0.03	0.21
Total Antipatharians	3.38	23.7
Hydrocorals an Octocorals	0.41	2.8

TOTAL CORALS **15.3 % of total area, 42.5 % of hard bottom**

(modified from Garcia-Sais et al., 2015)

Management Perspectives/Priorities

- Aphotic reefs: expand geographical exploration range; perform quantitative assessments of reef substrate cover by photo-transect approaches; specimen collections (priorities: El Pichincho and West Placeres Banks – Mona Passage)
- Mesophotic reefs: (priority) benthic habitat mapping and characterization of the shelf-edge reef system connecting East Vieques and South St. Thomas. Manage as breeding grounds of large demersal fishes and as genetic reservoirs of ESA spp.
- Neritic reefs:
 - Protect ecological system integrity: from plankton to fishermen
 - Integrate management regulations and enforcement efforts with federal agencies
 - Value & protect the large individuals/reef predators, enforce fspa's area seasonal closures – NO EXCUSES !
 - **PR coral reefs are recovering** – value your DNER management contributions to that success
 - broken, don't fix them...





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