Status of Puertorrican Coral Reefs

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Presentation Overview

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)
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
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.
Desecheo 20m

Monitoring Years

% Cover


Colpophyllia natans
Porites porites
Orbicella annularis

Tourmaline 10m

Monitoring Years

% Cover


Porites porites
Madracis auretenra
Orbicella annularis
Relationships between light attenuation coefficient (Kd 490) and:

a) live coral loss

\[ r^2 = 0.36; \ p < 0.01 \]

b) live coral recovery

\[ r^2 = 0.22; \ p < 0.004 \]
Kd490 vs. Chla, All Waters, R², 2013, Aqua MODIS, 1km*1km

\[ R^2 = 0.95834 \]
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.
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
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 refugee for many overfished large demersal cr fishes

Main habitat of ESA ‘s *Orcicella 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

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Area (km²)</th>
<th>Area (Hectares)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhodolith Reef</td>
<td>8.56</td>
<td>856.2</td>
<td>57.9</td>
</tr>
<tr>
<td>Bank Coral Reef</td>
<td>3.68</td>
<td>368.2</td>
<td>24.9</td>
</tr>
<tr>
<td>Colonized Pavement</td>
<td>1.08</td>
<td>108.3</td>
<td>7.3</td>
</tr>
<tr>
<td>Patch Coral Reef</td>
<td>0.80</td>
<td>79.9</td>
<td>5.4</td>
</tr>
<tr>
<td>Colonized Pavement with Sand Channels</td>
<td>0.34</td>
<td>33.9</td>
<td>2.3</td>
</tr>
<tr>
<td>Uncolonized Pavement with Sand Channels</td>
<td>0.16</td>
<td>16.5</td>
<td>1.1</td>
</tr>
<tr>
<td>Scattered Coral/ Rock in Algal Rhodoliths</td>
<td>0.15</td>
<td>15.4</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td><strong>14.78</strong></td>
<td><strong>1478.4</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

[Diagram showing benthic habitat classifications and areal coverage]
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
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 °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.

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

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...