



# Enhancing Condado Lagoon's Fish Habitat with an Artificial 'Taíno' Reef Trail



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## Introduction

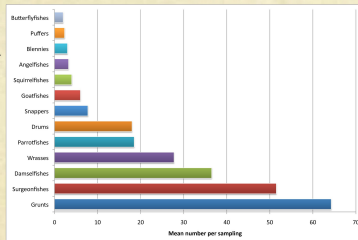
The Condado Lagoon is an important part of the San Juan Bay Estuary as it holds one of the links between the marine waters of the Atlantic Ocean to the North and the estuarine areas to the South. Given the important ecological connective function of this region as well as the popularity the area provides to local tourism enterprises, an artificial reef snorkeling trails was proposed. In addition to providing habitat the trail provides an alternate activity to reduce intensive human impacts on nearby coral reefs. A series of artificial reef modules, 'Taíno' reefs, were deployed to create the Condado Lagoon Taíno Reef Trail. The purpose of this artificial reef is to provide habitat for reef fishes that use the San Juan Bay Estuary system. A monitoring scheme was designed to compare the impact of the artificial reef on the local fish community during one year. Surveys were conducted in the area before deployment and quarterly afterwards. The number of fishes, their size as well as the fish community structure is described for the Trail and compared over time.

## Methodology

The Taíno Reef Trail is located in the northeastern extent of the outlet of the Condado Lagoon to the Atlantic Ocean in San Juan, Puerto Rico (Fig. 1). This small bay is part of the San Juan Bay Estuary that connects various estuarine and marine habitats in the region.

Underwater visual surveys (UVS) were conducted before the Trail was created (Sampling 0), after all modules were deployed (Sampling 1) and quarterly during the following year (Samplings 2 - 4). Fish associated to Taíno Reef modules were quantified with stationary UVS as point counts, in a cylindrical area, that included all fishes above and under each module. Fishes were identified to the lowest possible taxonomic level, enumerated, and the total length (TL) was estimated to the nearest cm. Mean number of fish were calculated per module for each sampling in order to compare their abundance over time.

Figure 2. Fish abundance per family, averaged by sampling.



## Results

### Species Richness

- The most specious family in the trail was the grunts (Haemulidae), with 7 species.
- The second most specious families were damselfishes, parrotfishes, snappers and squirrelfishes.
- The Surgeonfishes, puffers and wrasses were represented with 3 species.

Species List
Scientific Name
<i>Pomacanthus paru</i>
<i>Mullacoetus</i> sp.
<i>Chaetodon capistratus</i>
<i>Chaetodon striatus</i>
<i>Abudefduf saxatilis</i>
<i>Stegastes diencaeus</i>
<i>Stegastes adustus</i>
<i>Stegastes leucostictus</i>
<i>Stegastes partitus</i>
<i>Equetus punctatus</i>
<i>Mulloidichthys martinicus</i>
<i>Pseudupeneus maculatus</i>
<i>Coryphopterus</i> sp.
<i>Anisotremus virginicus</i>
<i>Haemulon aurolineatum</i>
<i>Haemulon carbonarium</i>
<i>Haemulon flavolineatum</i>
<i>Haemulon parra</i>
<i>Haemulon sciurus</i>
<i>Haemulon</i> spp.
<i>Carangoides ruber</i>
<i>Pterois volitans</i>
<i>Sparisoma aurofrenatum</i>
<i>Sparisoma chrysotermum</i>

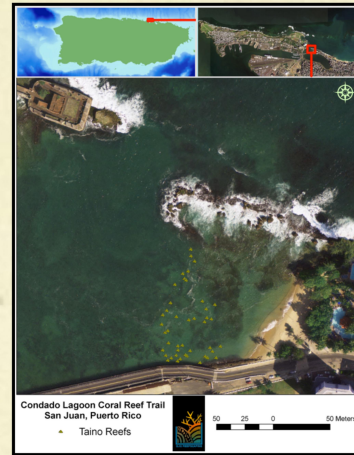


Figure 1. Detail of the Condado Lagoon Taíno Reef Trail, San Juan, Puerto Rico.

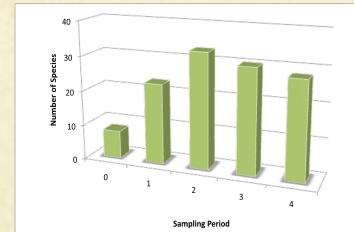
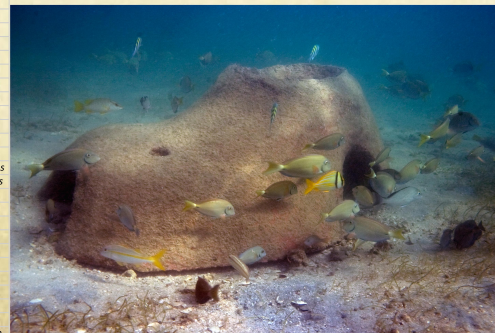


Figure 3. Species richness by sampling period.



Taíno Reef Module full of reef fishes

## Results

### Fish Abundances (Fig. 2)

- The most abundant families were the grunts, surgeonfishes, damselfishes and wrasses.
- The most numerous family, the grunts, had a total of 257 individuals (high abundances of early juvenile stages)
- The next most numerous families were the surgeonfishes, with 213 fish, followed by damselfishes and wrasses with over 100 individuals counted.
- The lowest abundances were observed for trunkfishes, trumpetfishes, jacks, porgies and gobies.
- The marine invasive Lionfish (*Pterois volitans*) was observed during the final stages of the study at two of the modules.

### Temporal Patterns (Fig. 3)

- The number of species triplicated after the deployment of the Taíno Reef modules.
- The greatest number of species was quantified during sampling 2, with a 1.4-fold increase.
- During the first two samplings the fish community was dominated by fish <10 cm TL.
- The size frequency distribution shifted towards larger size classes (Fig. 4).

## Discussion

- Condado Lagoon Taíno Reef Trail has provided essential fish habitat to coral reef species within nearshore habitats of the eastern shore of the entrance area of the lagoon.
- Condado Lagoon Taíno Reef Trail increased and diversified the touristic, recreational and environmental education opportunities.
- The presence of consolidated structures within seagrass near mangroves and other fish nursery habitats provides connectivity with nearby coral reefs. Many species that conduct ontogenetic shifts in habitats from seagrass to shallow coral reefs are occupying the daytime shelter sites provided by the Taíno Reef Trail.
- The number of species and abundances of reef fishes has increased due to the artificial reef modules in seagrass habitat. The mean number of fish that were present before deployment increased 1.5 to 2.4 times in response to the Taíno Reef Trail.

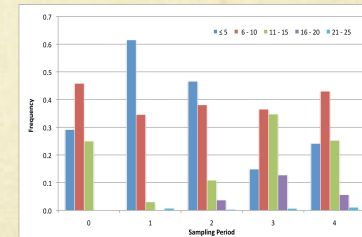


Figure 4. Frequency distribution of fishes by 5-cm total length size classes over the sampling periods including all species.

Species List
<i>Scarus iseri</i>
<i>Sparisoma radians</i>
<i>Sparisoma rubripinne</i>
<i>Calamus penna</i>
<i>Spheroides testudineus</i>
<i>Canthigaster rostrata</i>
<i>Diodon hystrix</i>
<i>Lutjanus analis</i>
<i>Lutjanus griseus</i>
<i>Lutjanus mahogani</i>
<i>Lutjanus synagris</i>
<i>Ocyurus chrysurus</i>
<i>Holocentrus rufus</i>
<i>Holocentrus adsensionis</i>
<i>Holocentrus rufus</i>
<i>Myripristis jacobus</i>
<i>Neomiphon marianus</i>
<i>Sargocentron vexillarius</i>
<i>Acanthurus bahianus</i>
<i>Acanthurus chirurgus</i>
<i>Acanthurus coeruleus</i>
<i>Aulostomus maculatus</i>
<i>Lactophrys triquetus</i>
<i>Halichoeres bivittatus</i>
<i>Halichoeres poeyii</i>
<i>Thalassoma bifasciatum</i>

## Acknowledgements

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<http://web.me.com/hectorruiz/Reefscaping/Welcom.html>