Investigating Variations in Coral Reef Morphology using Photomosaics and Percent Coverage Statistical Analysis

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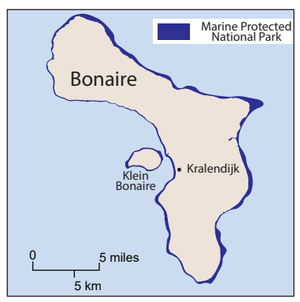
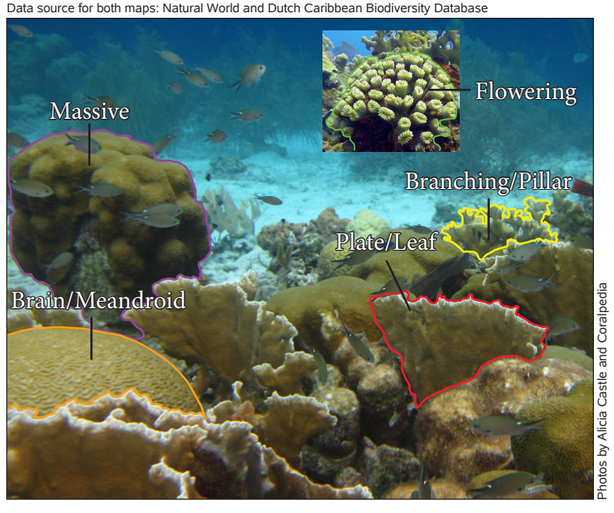
Coral reefs serve as an important component to the marine ecosystems functionality and composition. However, coral cover in the Caribbean reefs continues to decline due to climate changes. A section of corals was studied on the leeward side of Bonaire, Netherland Antilles, in the southern Caribbean. The island is surrounded by a Marine Protected National Park, making it an ideal place to study coral reef health and change. Corals are adapted to thrive in a limited range of environmental conditions, where small changes in the oceans structure can lead to wide-scale loss of organisms. The research investigates five categories of coral reef morphology: massive, brain/meandroid, flowering, plating/leafing, and branching/pillar. Each type of coral morphology is adapted to survive in a specific range, where its physical characteristics demonstrate how each type of coral competes with each other for survival.

Bonaire is located in the southern Caribbean Sea 50 miles north of Venezuela. Bonaire is one of the multiple islands encompassing the Dutch Netherland Antilles.



A Marine Protected National Park surrounds Bonaire, enforcing strict fishing regulations and encouraging conservation work to improve and maintain the coral reefs health.

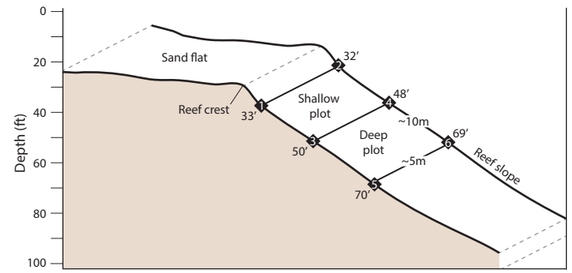
Data source for both maps: Natural World and Dutch Caribbean Biodiversity Database



Photos by Alicia Castle and Coralpedia

Methodology

Data Collection



Two subplots, one shallow and one deep, were measured out along the reef slope. The boundaries of each subplot are marked with a rebar pin (numbers 1-6) where pins at equal depth have a width of roughly 5m and the length along the slope between pins is roughly 10m.

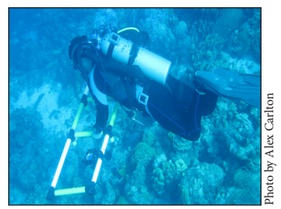
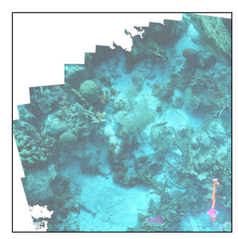


Photo by Alex Carlton

A scuba diver swims over a subplot in a "lawnmower" pattern to capture overlapping imagery. Two cameras in underwater housing units attached to a PVC rig. Images are captured in one second intervals and a subplot takes roughly 15 to 20 minutes to collect all of the imagery. A single subplot results in roughly 2,000 images in total.

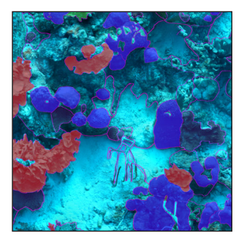
Stitching

Each sub plot collects around 2,000 images that are then brought back to the lab to be combined. A software looks at each photo to compare and connect the similar features in the photos. This process creates the large-scale image, called a photomosaic, with rough edges where the photography ends in connection with one another.



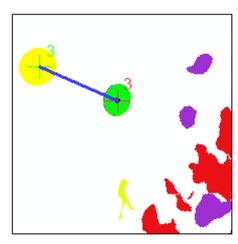
Photoshop

The photomosaic is placed into Photoshop, where each benthic organism and section is traced. Once the areas are traced within a sub plot, they are filled with a color corresponding to the type of coral reef morphology that area takes up. The photomosaic is compared with the raw images to help identify corals that are uncertain when only observed in the photomosaic.

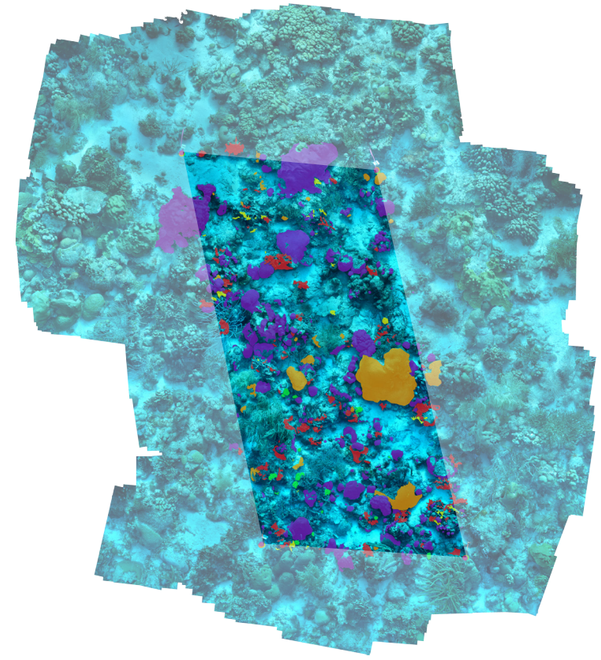


QGIS

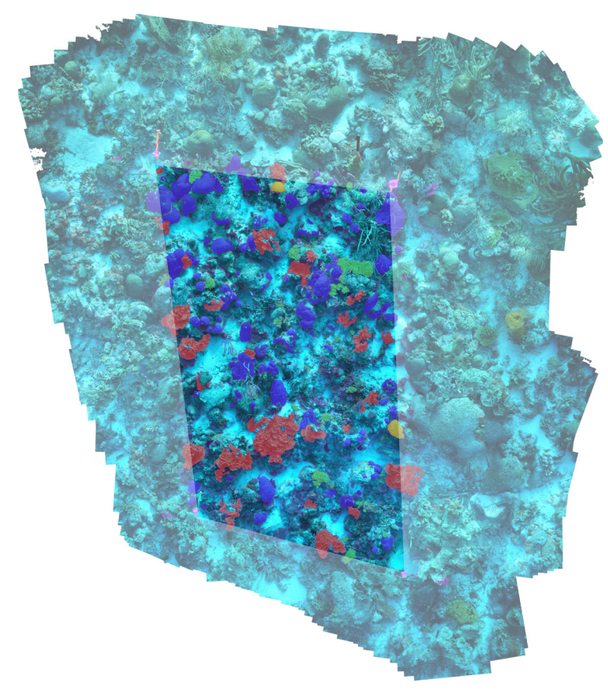
After tracing and filling, each coral morphology layer is extracted and placed into ArcMap. The image is georeferenced with GPS coordinates of the pins that make up each subplot. The data is converted into vector data and clipped to have only the area of corals that will within the plot. Then the areas are simplified before finally calculating the area of each polygon/coral.



Shallow Plot

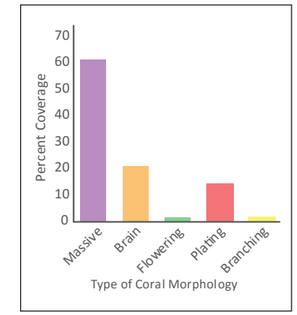


Deep Plot



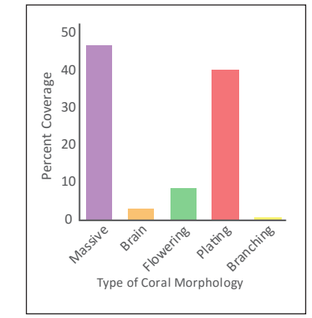
Results

Shallow plot



The coral cover shows that 61% is from massive corals, 21% is from brain corals, 1.5% is from flowering corals, 14% is from plating corals, and 2% is from branching corals. The total area of coral coverage within the shallow subplot is 10.504m2. Thus, based on a subplot size of 43.766m2, the stony coral coverage compared to other benthic organisms is 24%.

Deep plot



The coral cover shows that 46% is from massive corals, 4.3% is from brain corals, 9% is from flowering corals, 40% is from plating corals, and 0.4% is from branching corals. The total area of coral coverage within the shallow subplot is 9.257m2. Thus, based on a subplot size of 36.251m2, the stony coral coverage compared to other benthic organisms is 25%.

Discussion

The results show that massive coral are the dominant morphology in both the shallow and deep plot based on percent coverage and area size. Surprisingly the data showed that flowering species was only present from below 40 feet, indicated that this species may prefer darker areas. Plating corals significantly increase in coral area coverage in the deep plot, matching with the idea of these corals using increased surface area to absorb more light for zooxanthellae. Branching corals were minimally found within either plot, which may indicate that this coral morphology is not viable for a reef slope and could be declining in numbers. Additionally, brain corals had a higher area coverage in the shallow plot, indicating that this morphology possibly doesn't have a high enough surface area to tolerate deeper depths.

Acknowledgements

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