Benthic Imaging of Coral Reefs in Optically-Deep Waters

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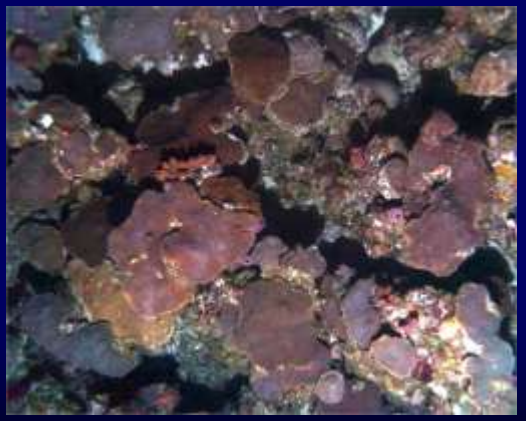
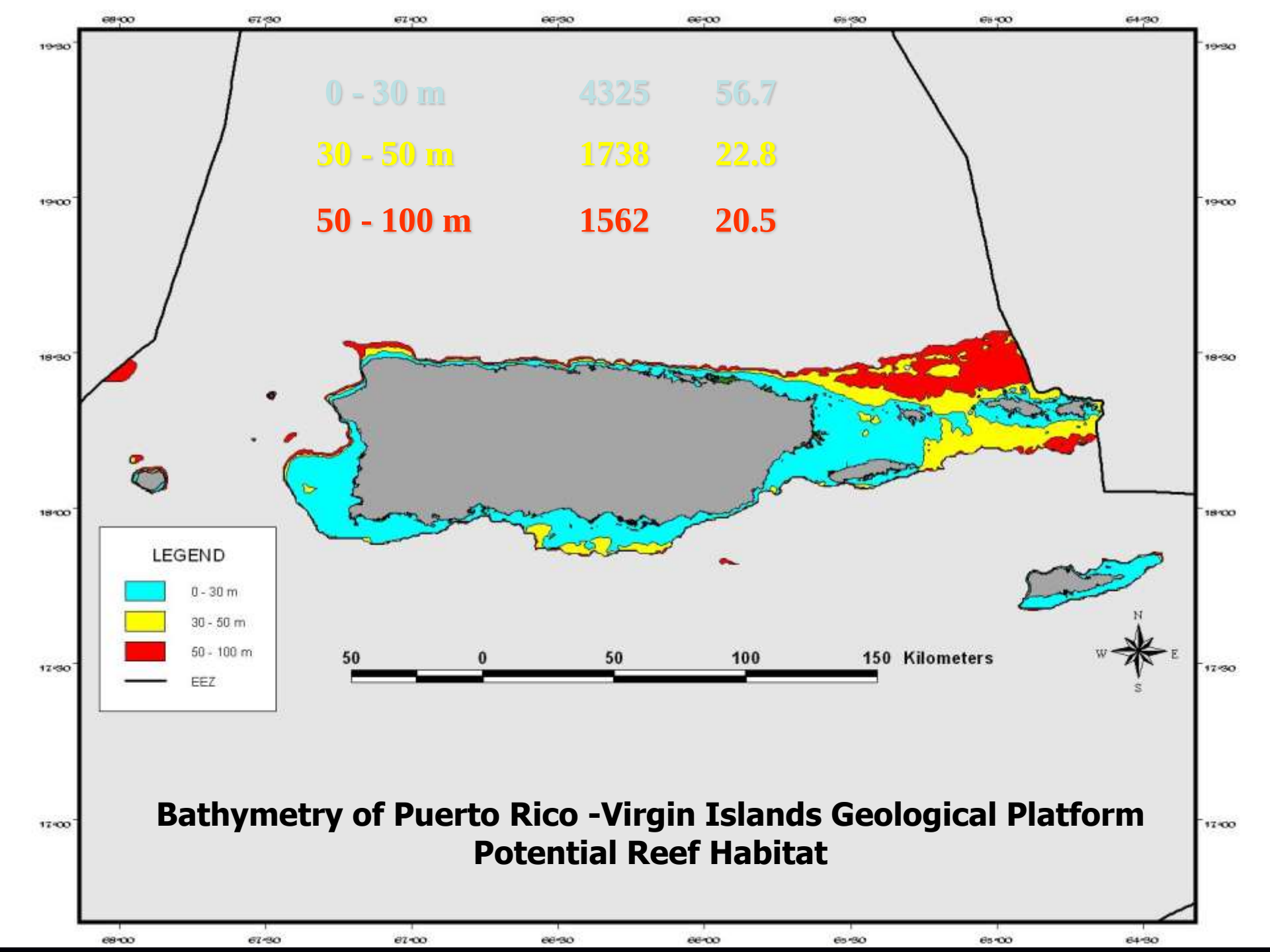


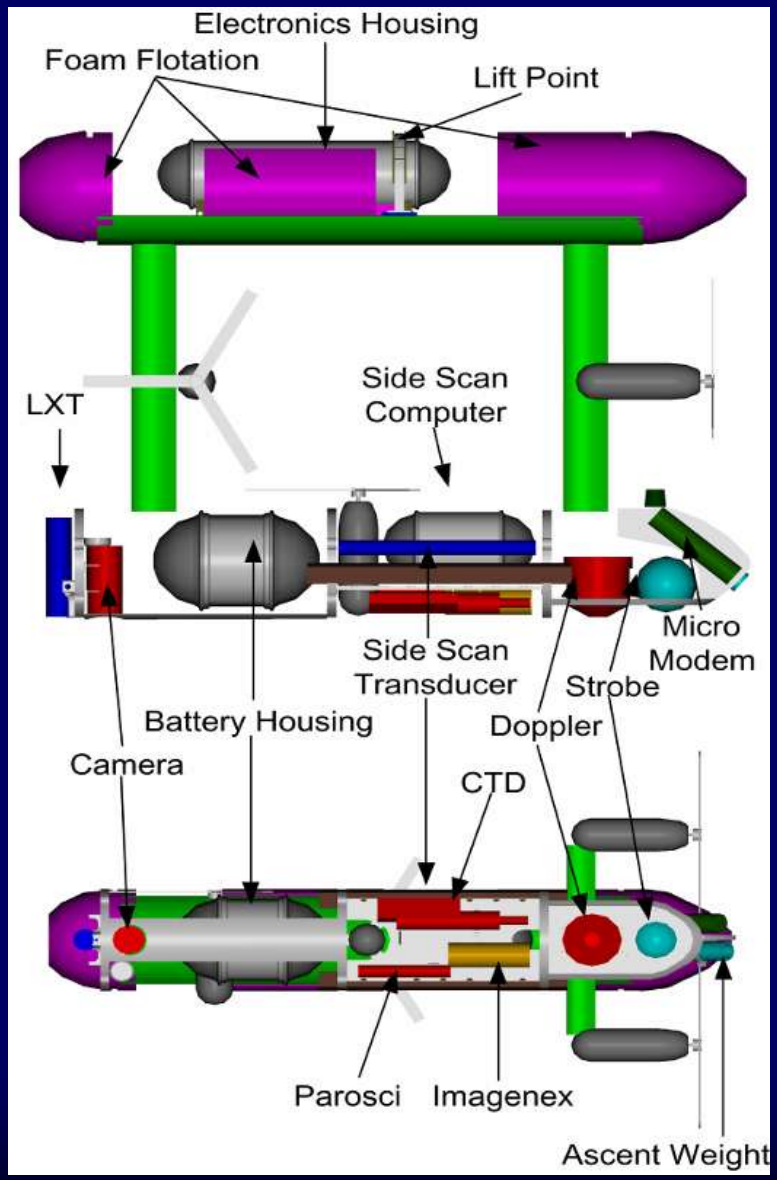
Imaging the Deep Coral Reefs With AUVs

- Effective airborne or satellite remote sensing of coral reefs is limited to shallow, optically clear water.
- AUVs can be configured to carry a wide variety of imaging sensors and other instruments such as side-scan sonars, multi-beam and pencil beam sonars, chemical sensors, video plankton recorders, etc.
- The Seabed AUV can be programmed to maintain a constant distance from the bottom and conduct large scale mapping missions.

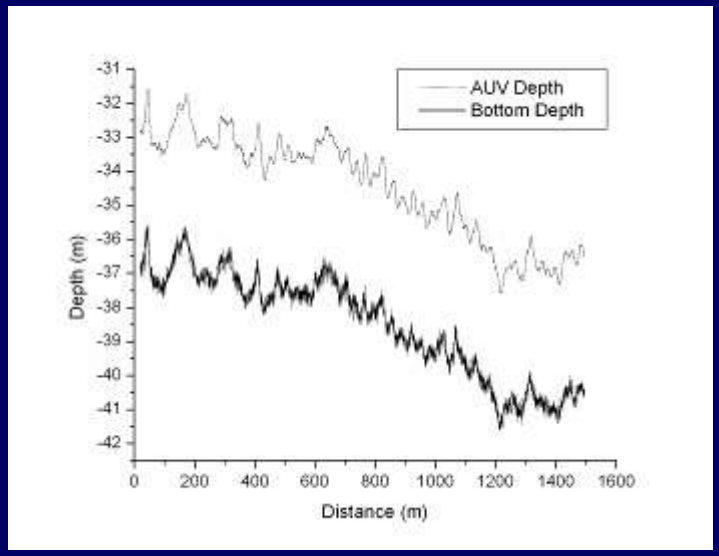


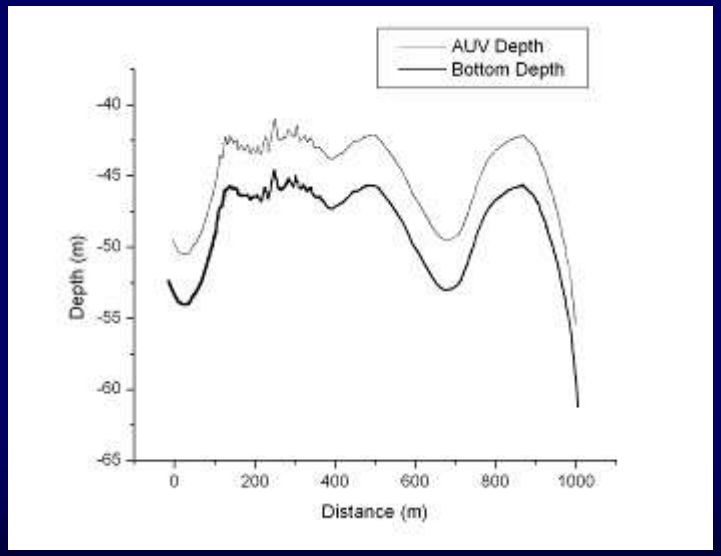
Bathymetry of Puerto Rico -Virgin Islands Geological Platform
Potential Reef Habitat

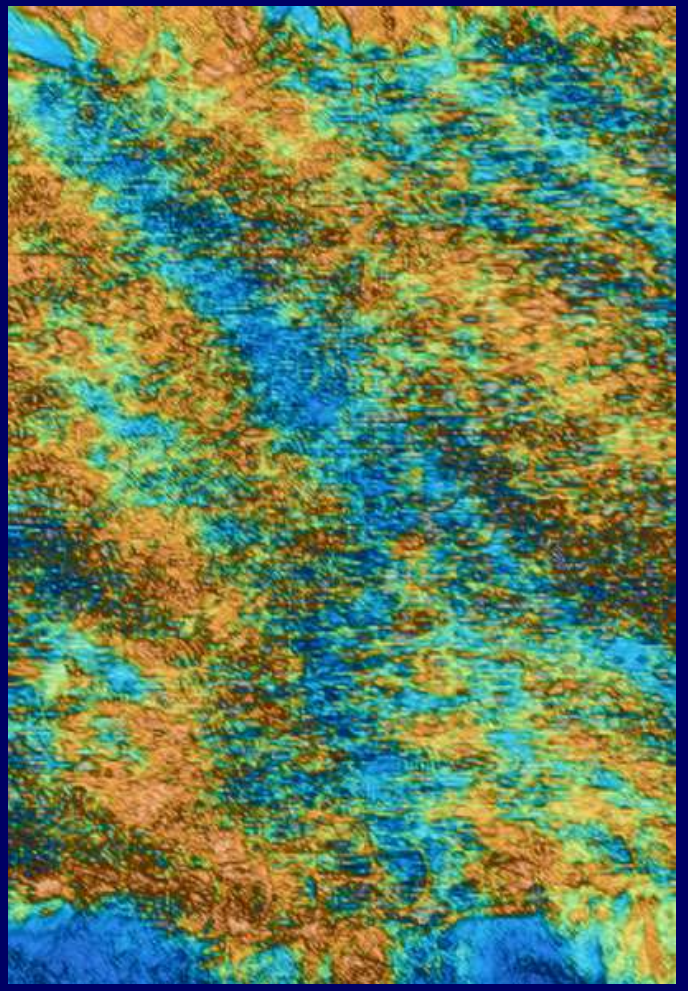
Seabed AUV Operations and Sensors



Seabed altitude and Acoustic Imaging





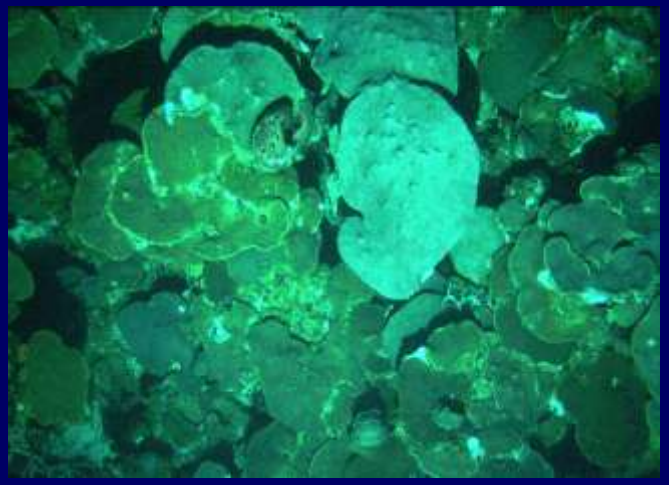


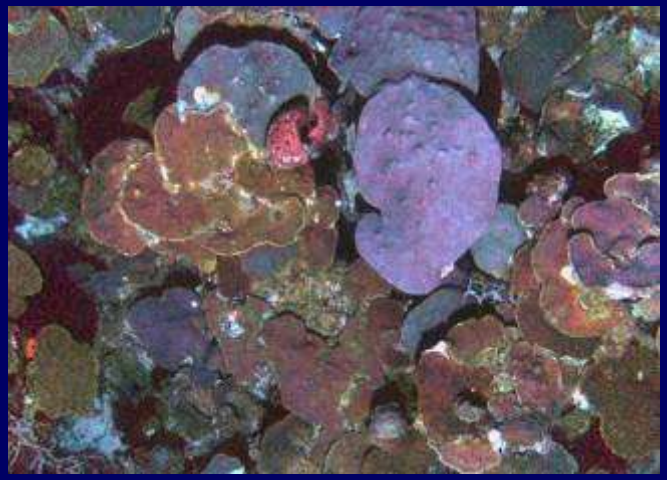
Multi-beam image, SW Puerto Rico

Seabed Optical Imaging

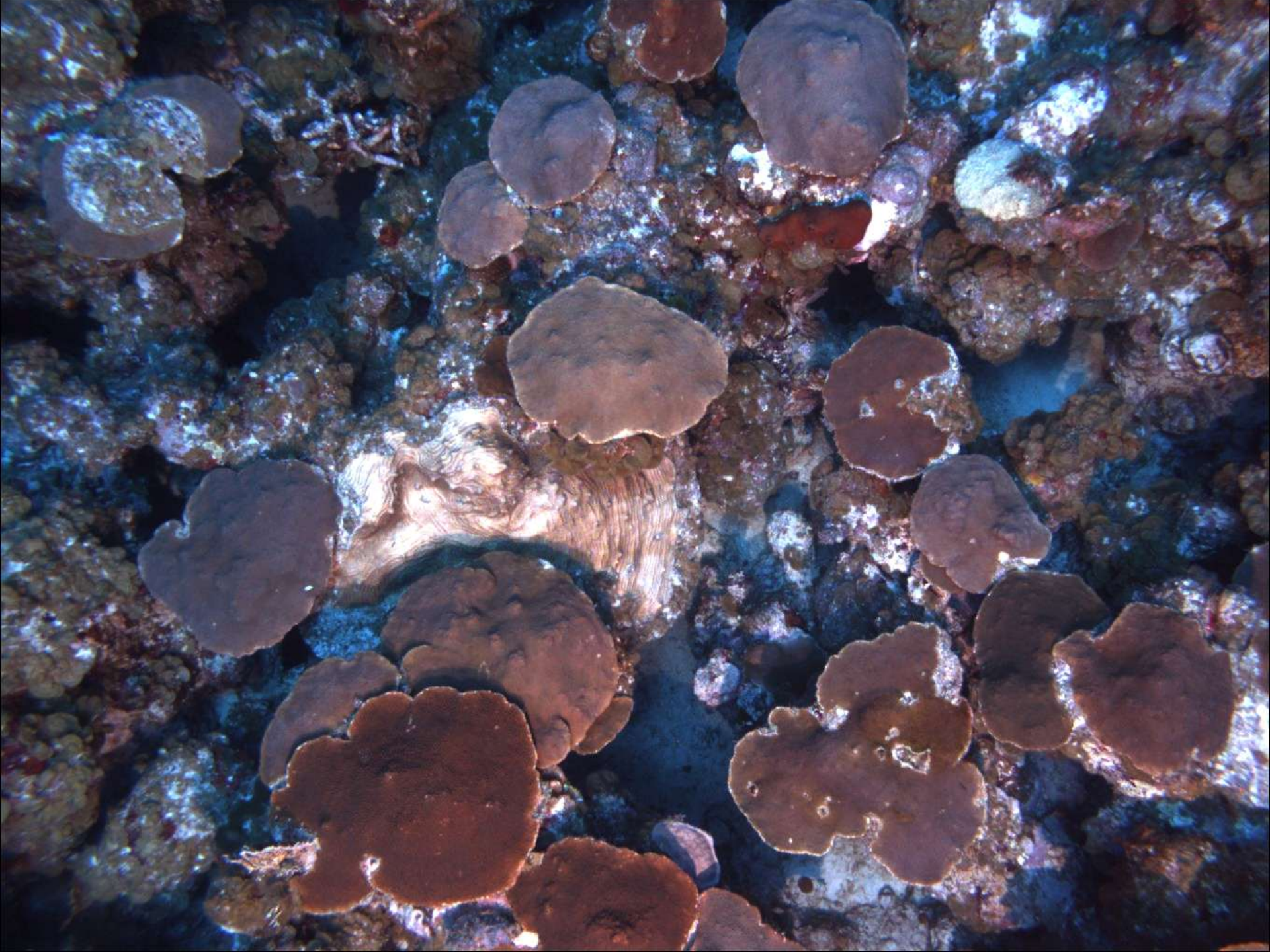
Two Prosilica GC-1380C CCD cameras with 1360 x 1024 resolution
12 bit dynamic range (0 - 4,095 grey levels)
From an altitude of 3 m, the images are 3.12 m wide by 2.3 m long, covering an area of 7.17 m^2
Spatial resolutions of 2.2 mm per pixel
A 150 Ws strobe provides the only source of illumination
Two cameras can be used, a downward looking camera and a forward facing camera
Over 100,000 images of mesophotic reefs in the Puerto Rico Shelf

Color Compensation of Underwater Imagery

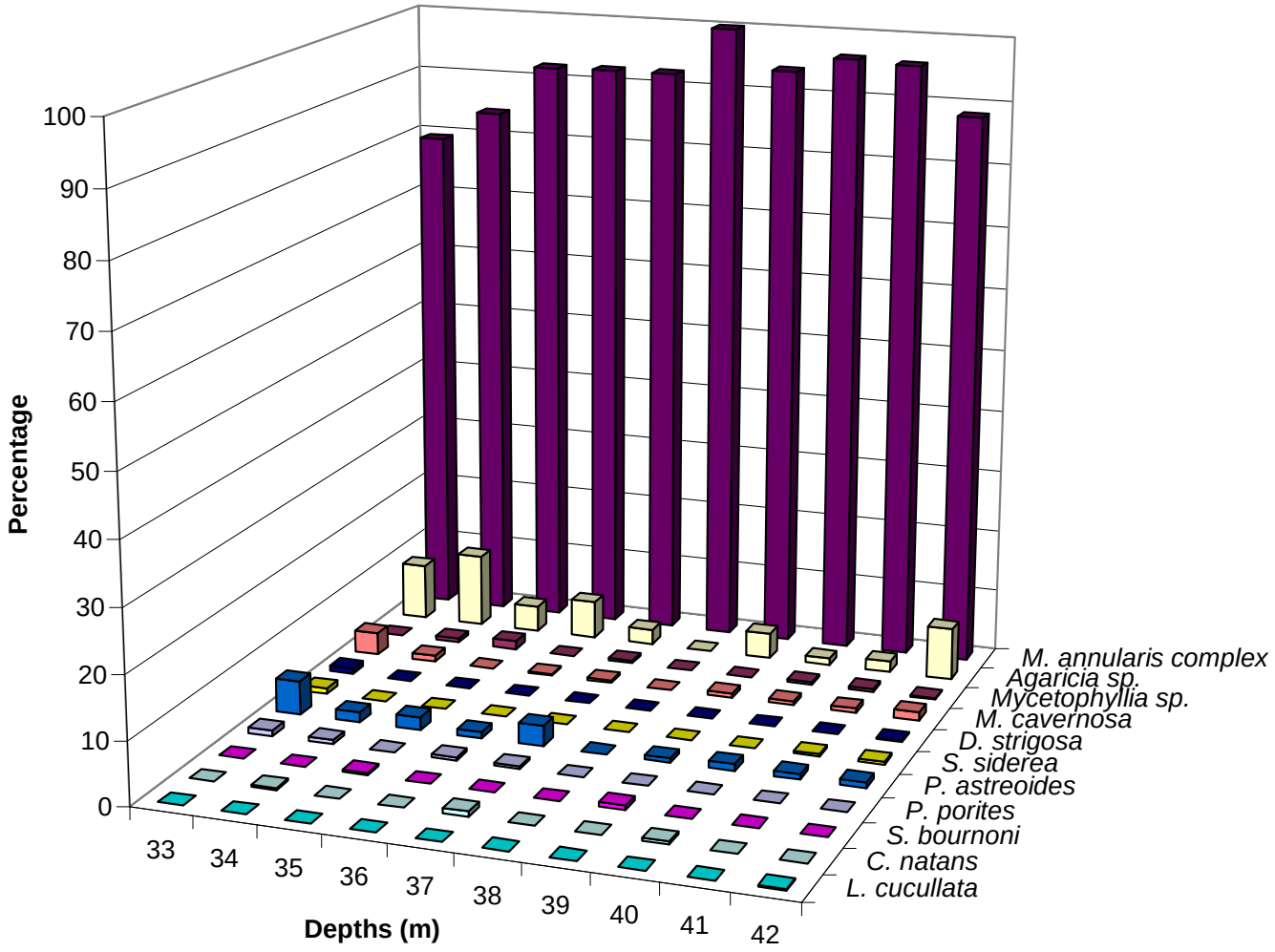




- U/W Imagery characterized by low contrast and low color fidelity
- Nonlinear attenuation of the visible spectrum in seawater
- U/W images tend to be saturated in the blue-green region



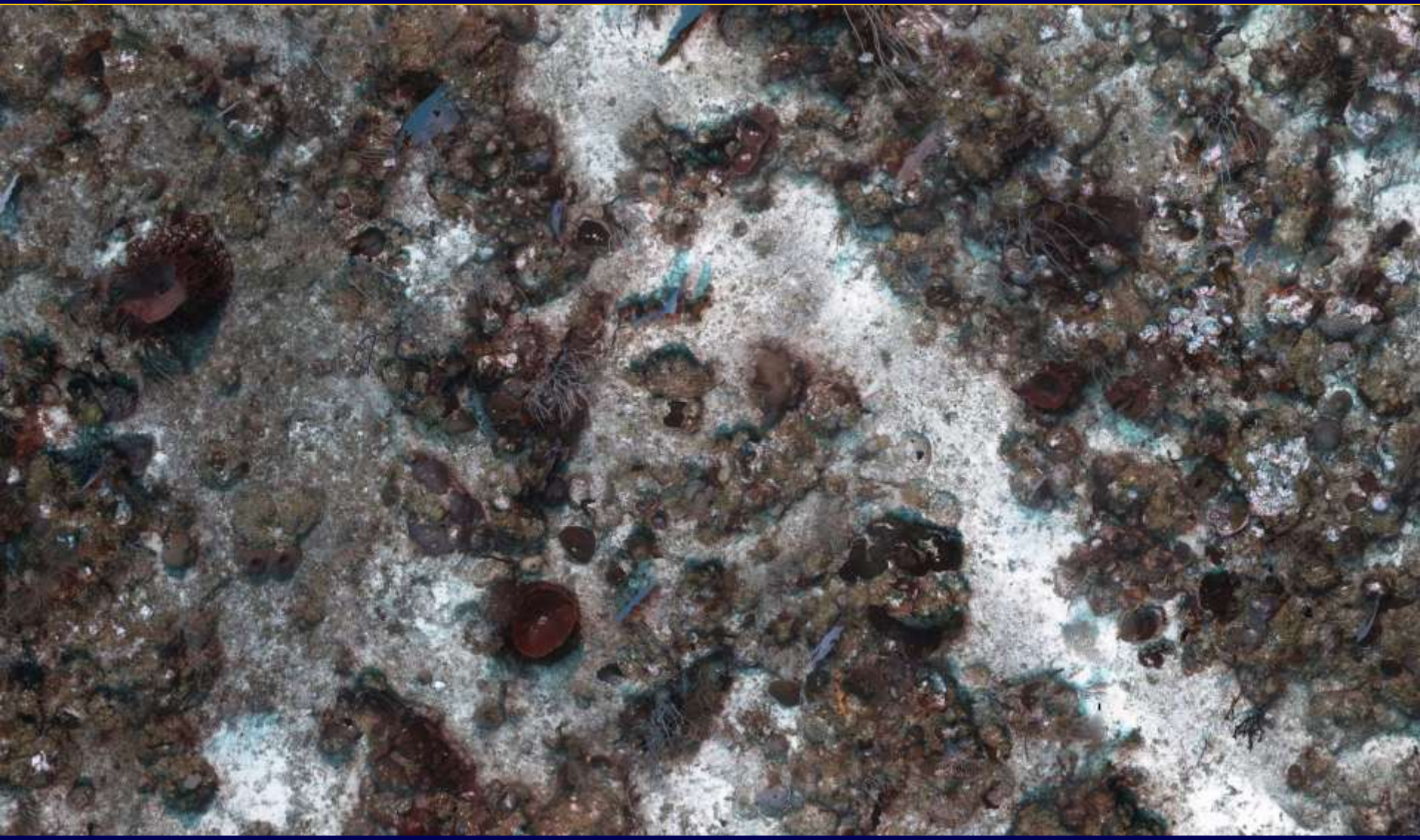
Quantitative Coral Cover Data by Species



One-dimensional mosaic

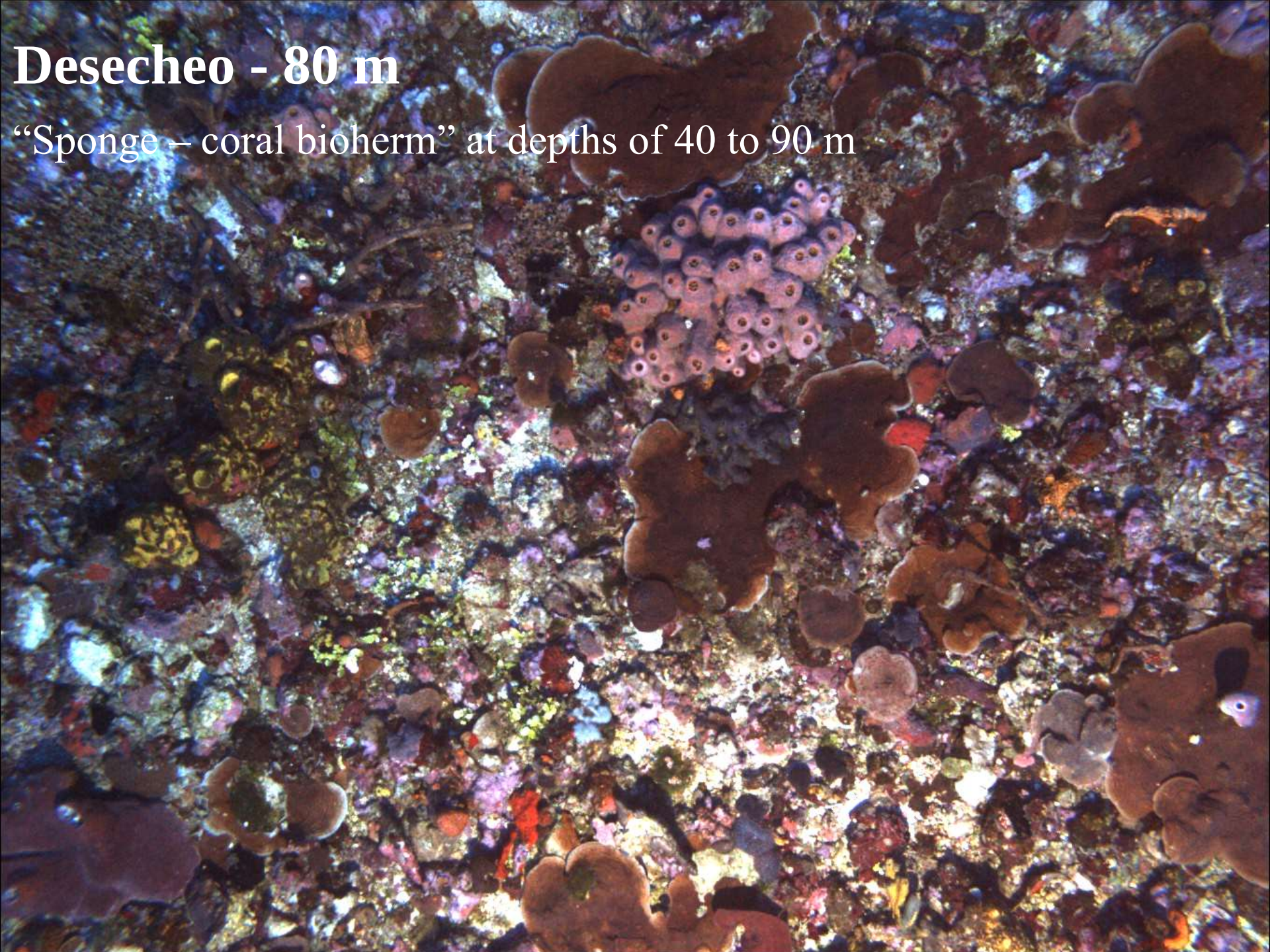
Seven images were used from a depth of 35 m measuring approximately 6.3 m long and covering an area of about 20 m^2

Two-dimensional mosaic

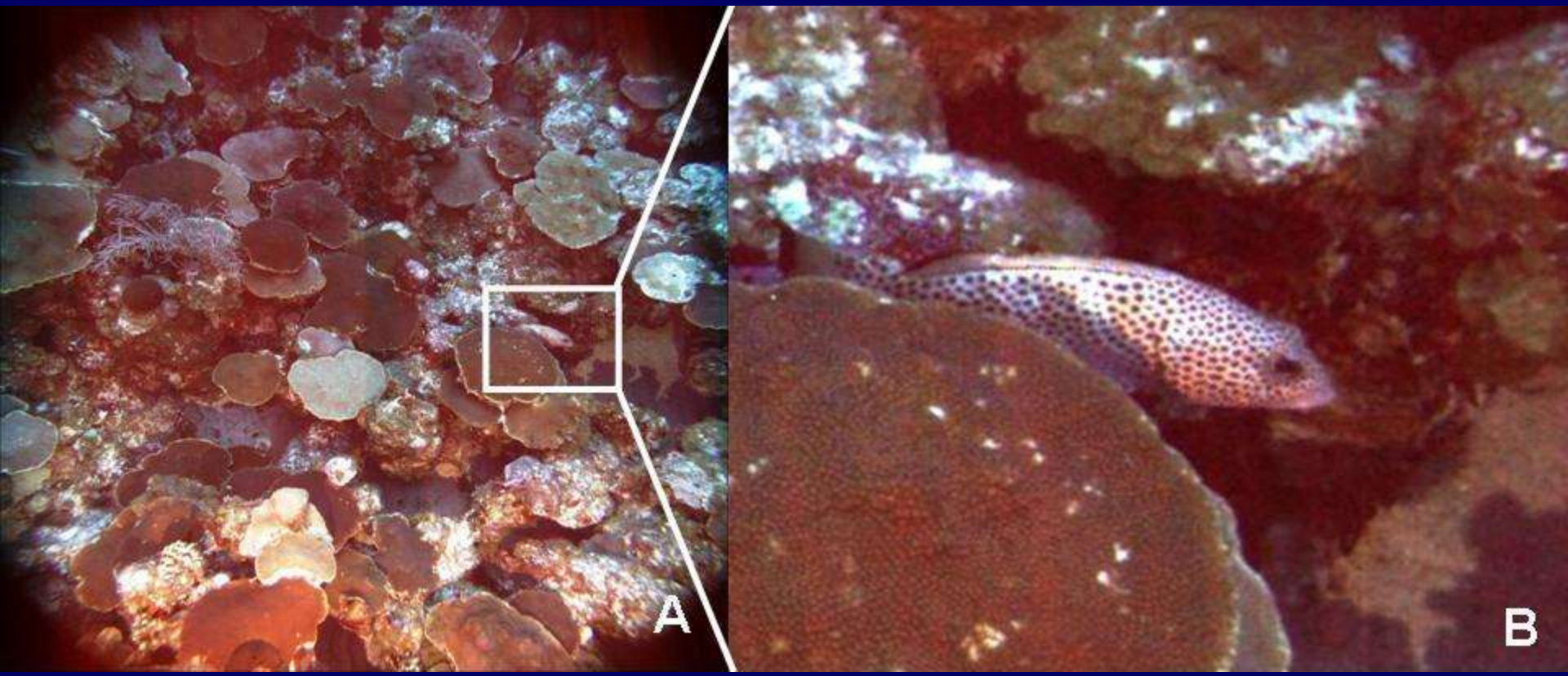


Desecheo - 80 m

"Sponge – coral bioherm" at depths of 40 to 90 m



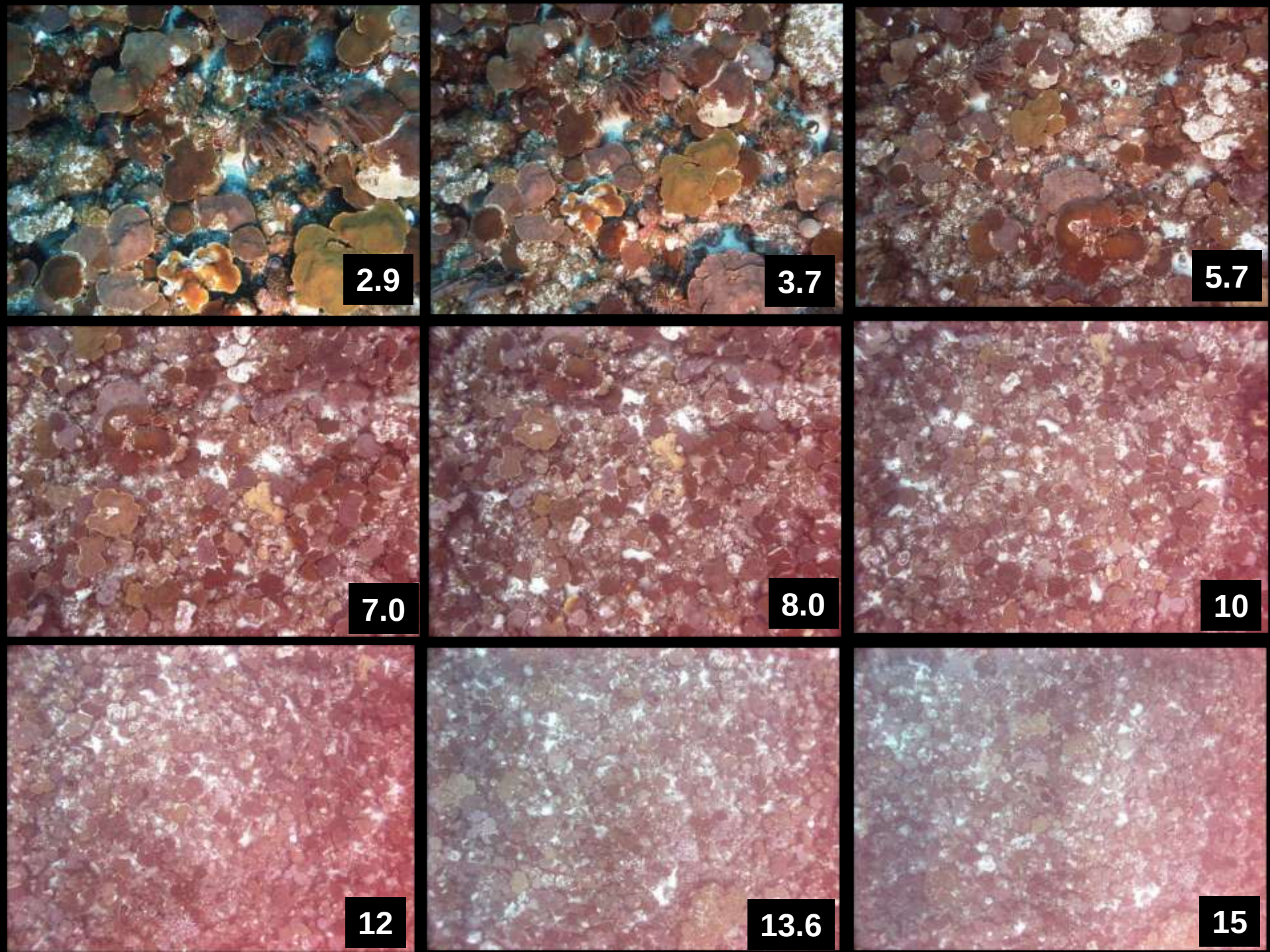
Forward-looking Camera



Forward-looking camera image showing a red hind grouper (*E. guttatus*) (A) and enlargement of the fish (B)

274 m

Forward – Looking Camera - 216 m Depth


2.9
3.7
5.7
7.0
8.0
10
12
13.6
15

Area Covered vs. AUV Altitude

- From a 3 m altitude the area covered by a typical, 1 km AUV transect is approximately 3,120 m^2
- At 15 m altitude the area covered by each image is 178 m^2
- A one km transect at this altitude will cover an area of approximately 10,700 m^2 (assuming 40% overlap)
- Landscape-level analysis of coral bleaching and mortality can be obtained from altitudes of 5-10 m, depending on the level of detail required, while covering an area of 52 and 104 m^2, respectively, per image.

Acknowledgements

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