Thriving Mesophotic Coral Ecosystems in the U.S. Caribbean: Form, function, and management implications

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Deep Coral Reef Ecosystems Studies (Deep CRES)

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What are Mesophotic Coral Ecosystems (MCEs)?

- **Characterized by the presence of light-dependent corals and associated communities**
- **Typically found at depths ranging from 30-40 m and extending to 100+ m in tropical and subtropical regions**
- **The dominant communities providing structural habitat in the mesophotic zone are comprised of coral, sponge and algal species**

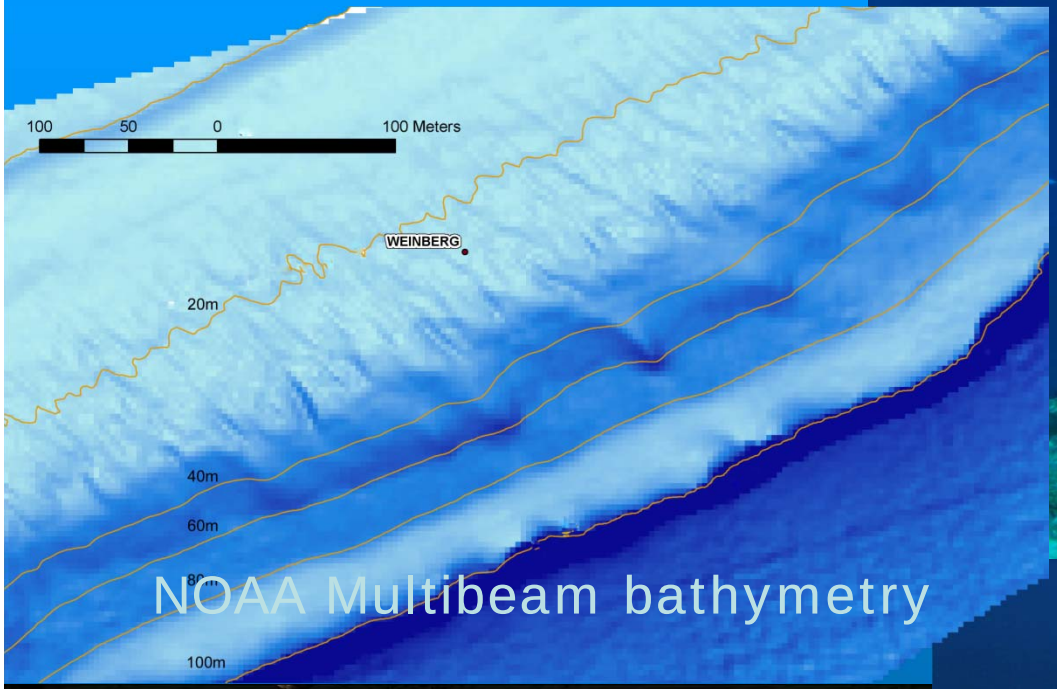
Mesophotic Coral Ecosystems

- **Why important?**
  - **Often unique flora and fauna**
  - **Potentially large areal extant rivaling that of shallow reef systems**
  - **Further removed from terrestrial and anthropogenic influences than shallower environments and may serve as refugia for corals and other species during times of environmental stress**

Objectives

- Characterization of the community composition and structure, including how these are limited by biological and geostructural factors
- The connectivity between deep and shallow reefs.
- The vulnerability of deep reefs to anthropogenic stress
- Slope - 50-100 m
- Targeted 50 & 70 m
- → US Caribbean
- Spatial connectivity

Methodology



NOAA Multibeam bathymetry

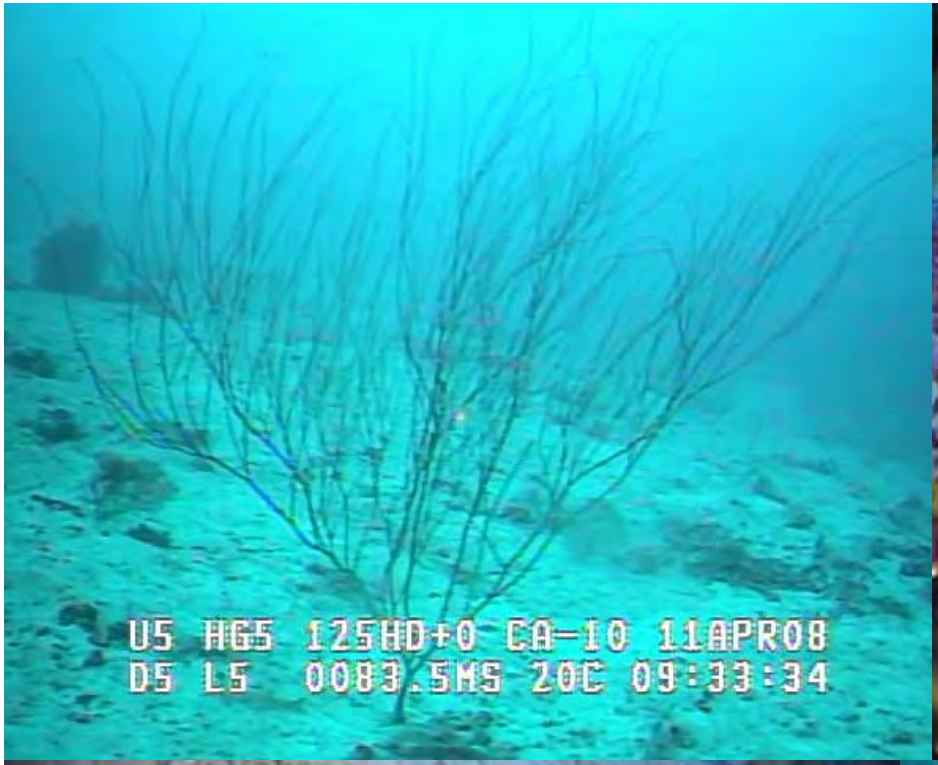
Seabotix LBV 200 ROV

Small boat access

Mixed-gas rebreather diving

NEKTON RORQUAL

SPREE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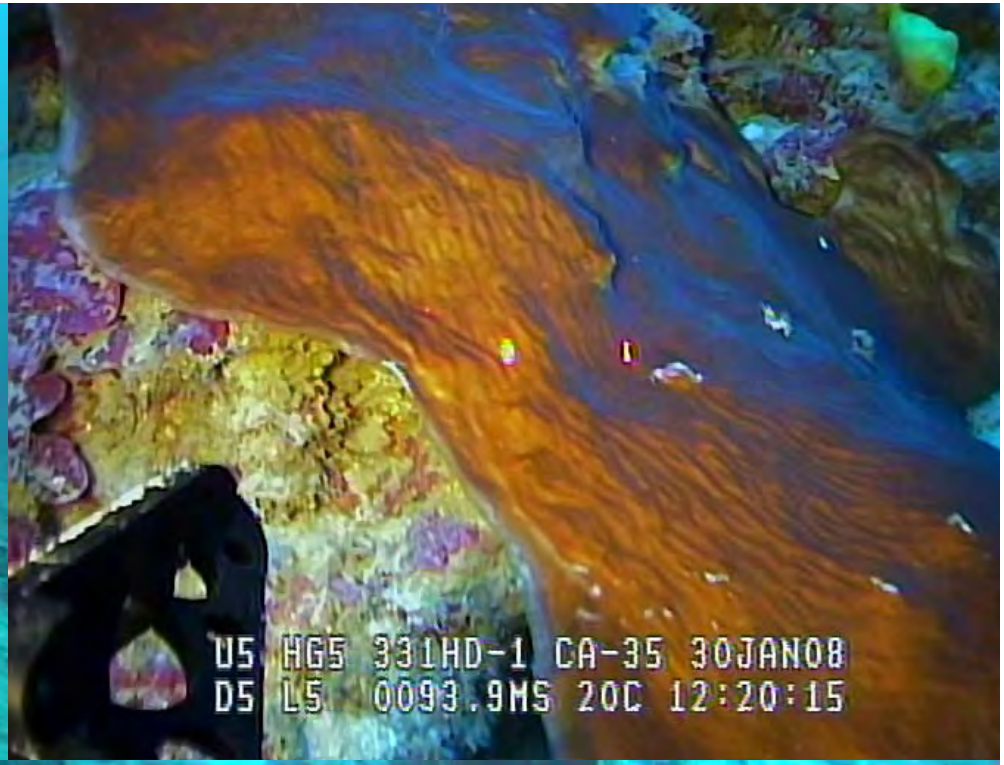
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U5 HG5 097HD+1 CA+05 16JAN10
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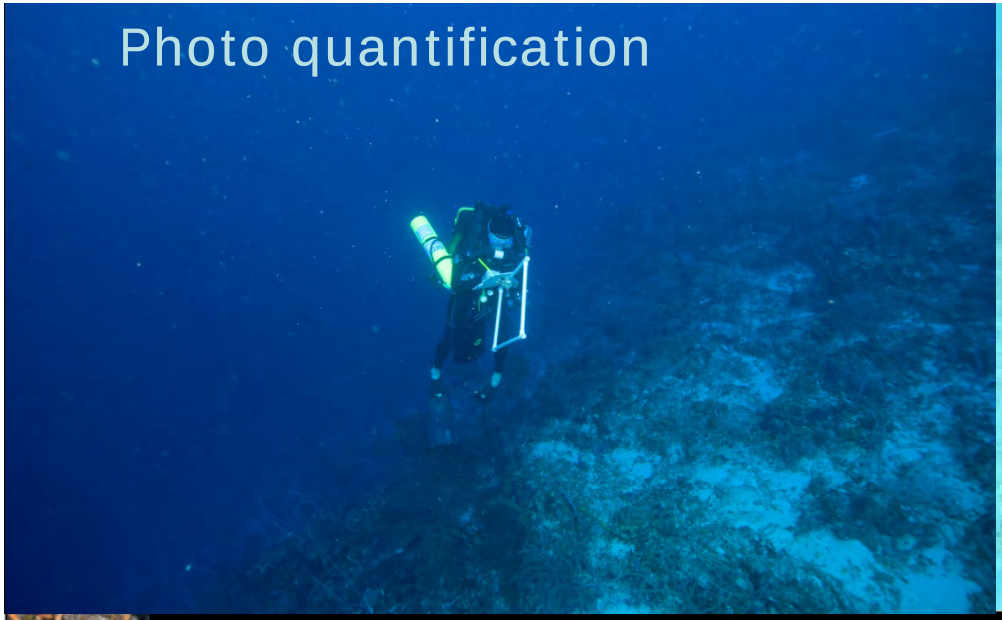
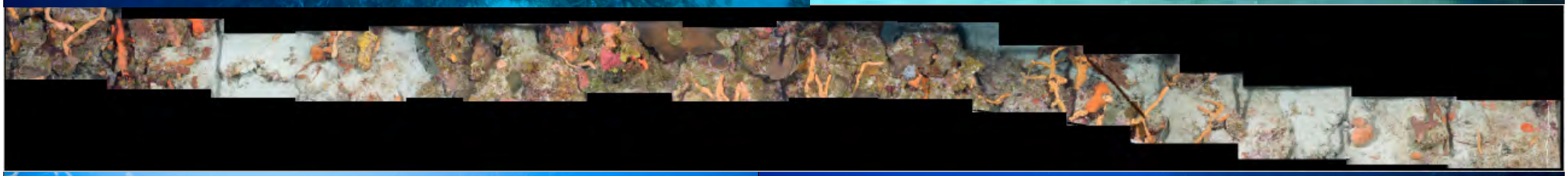


Photo quantification

Fish counts



Geomorphology

Collections

Photo-quadrat at 250’/76 m

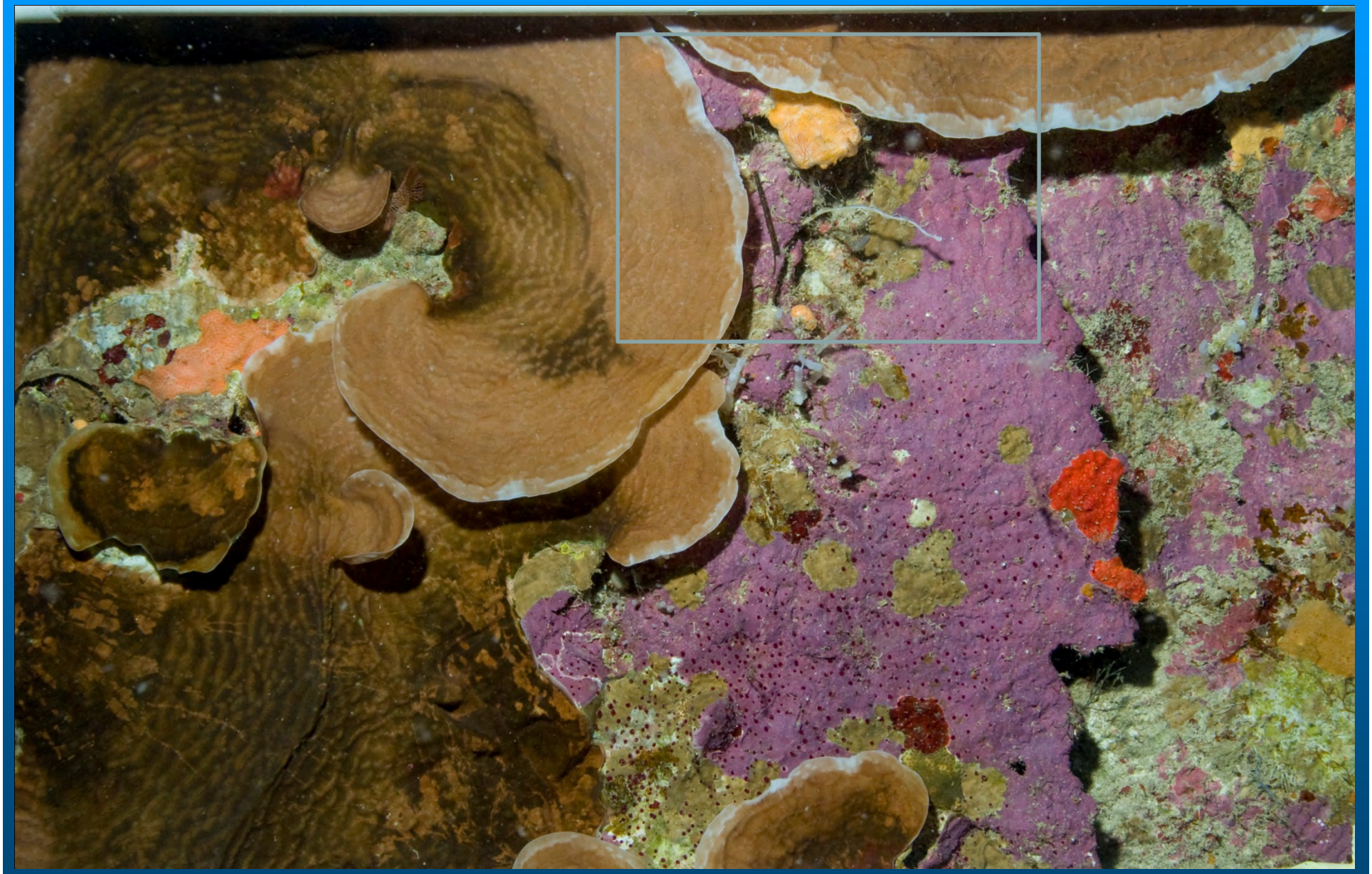
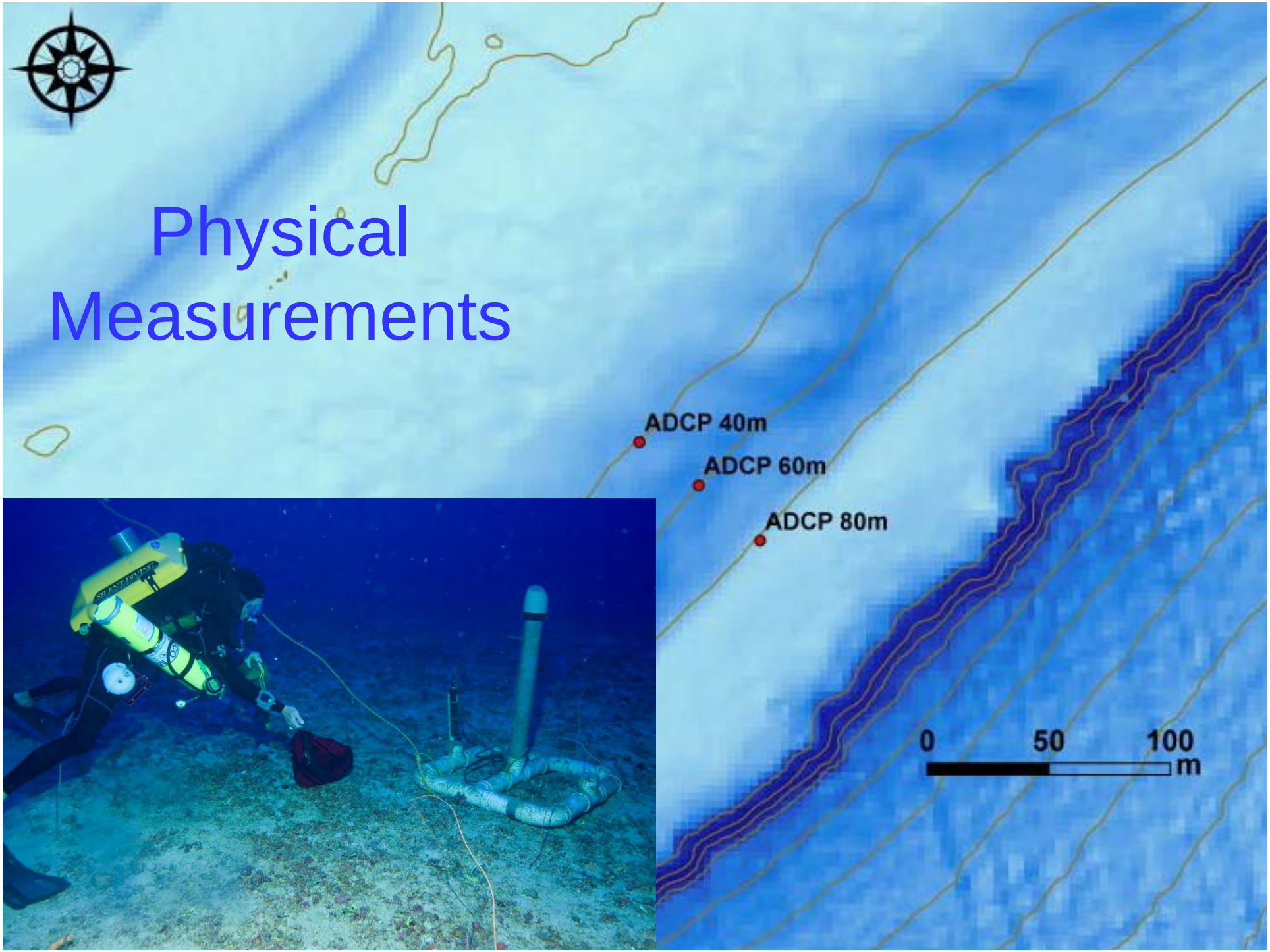
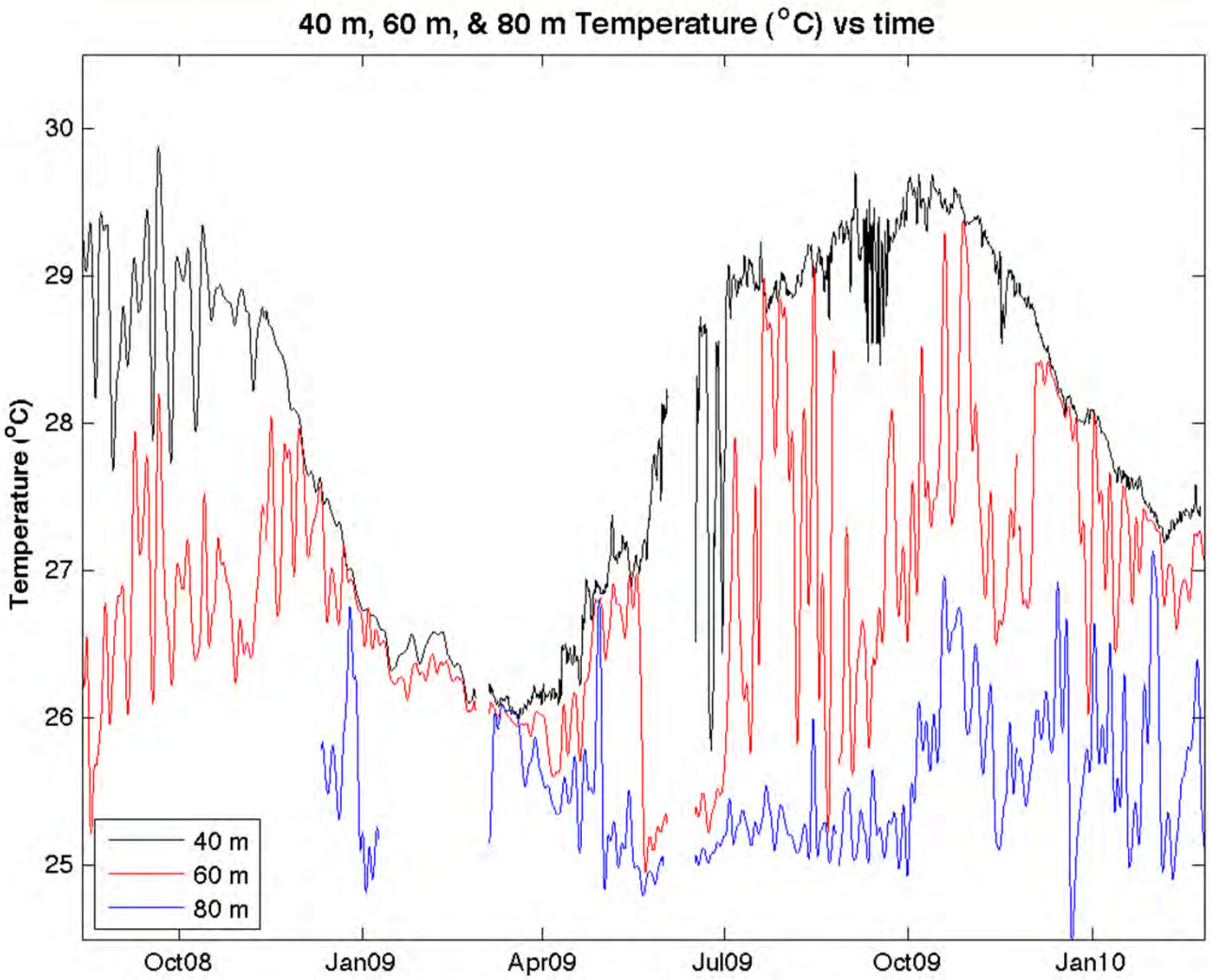


Photo-quadrat at 250’/76 m

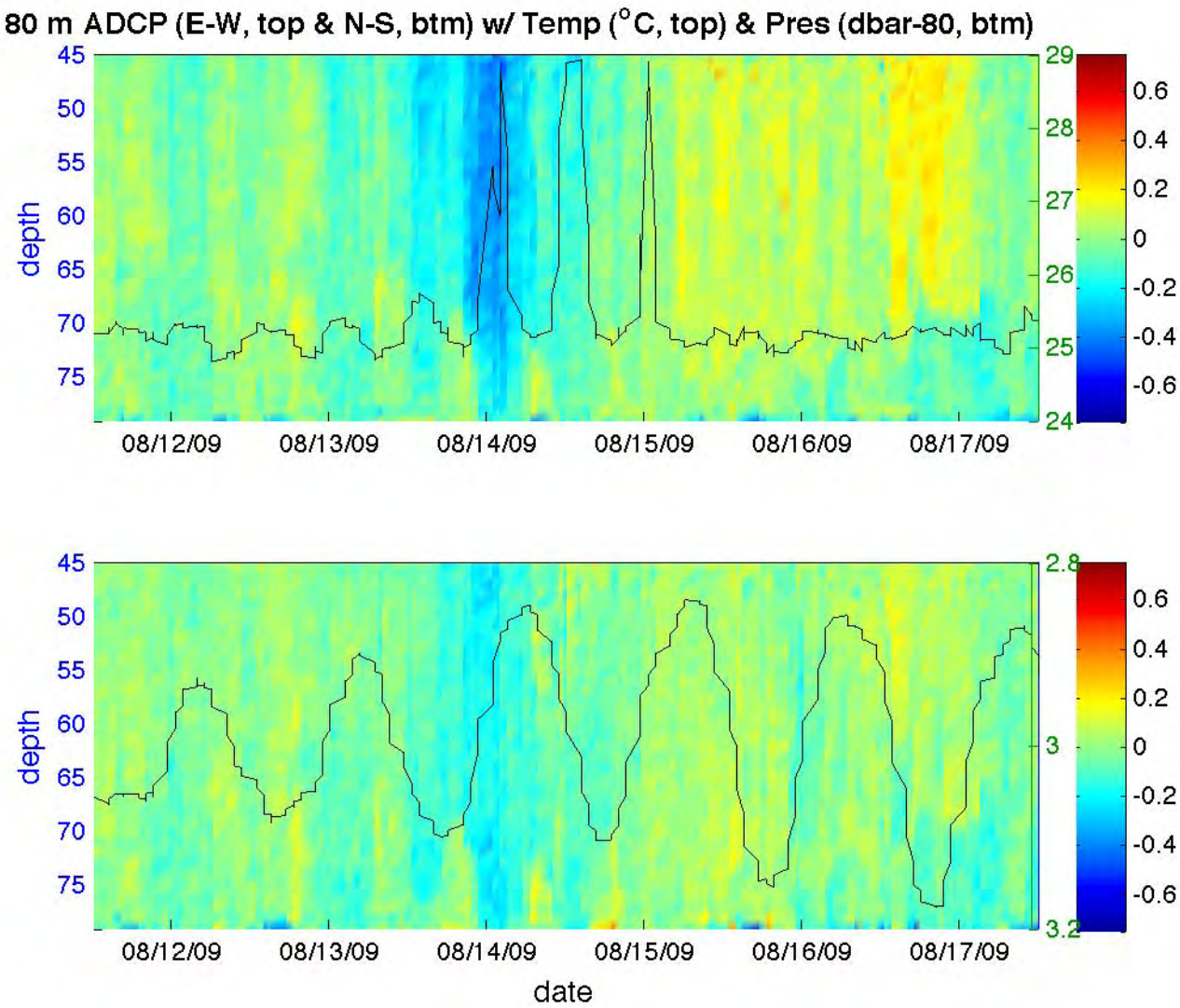
Physical Measurements



Variable Environment

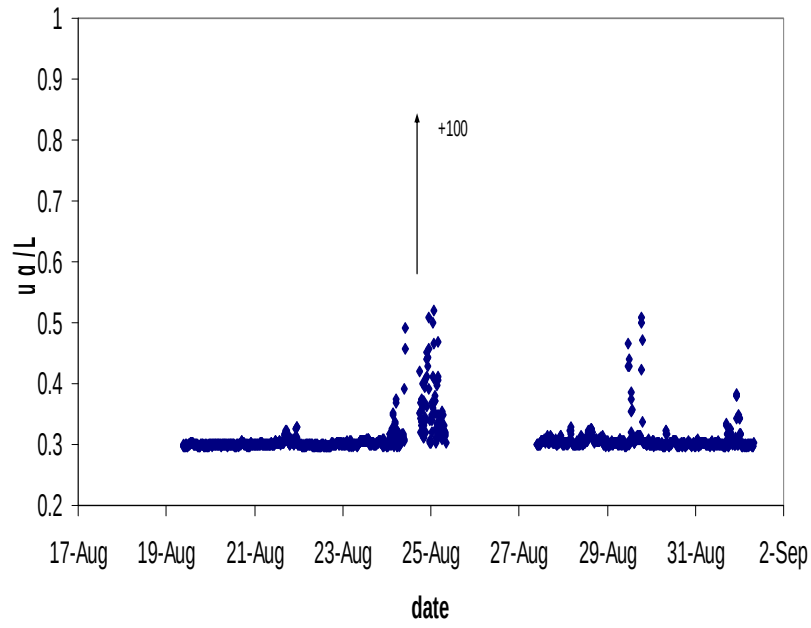


Short-term spikes and current reversals



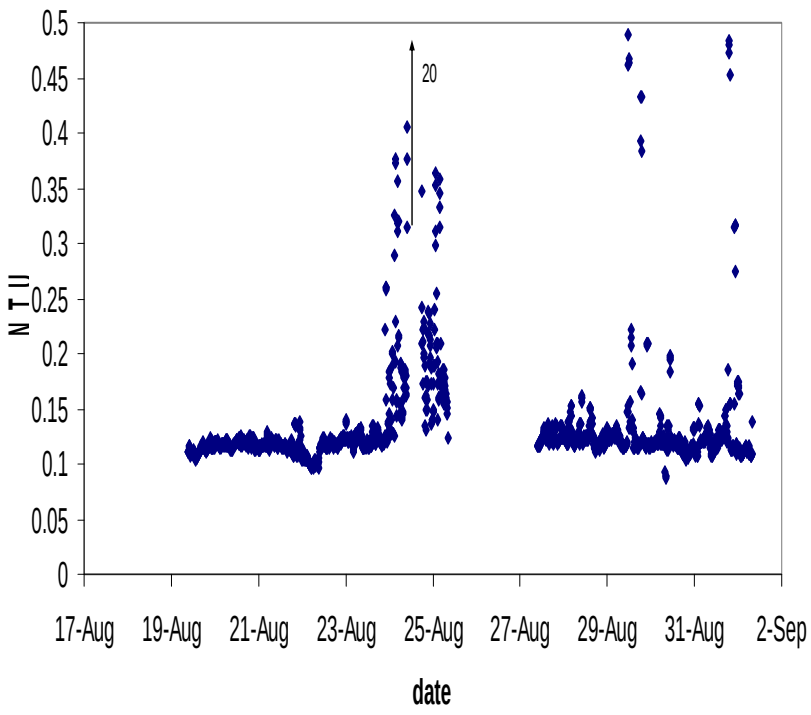
Sporadic Spikes in Chlorophyll and Turbidity

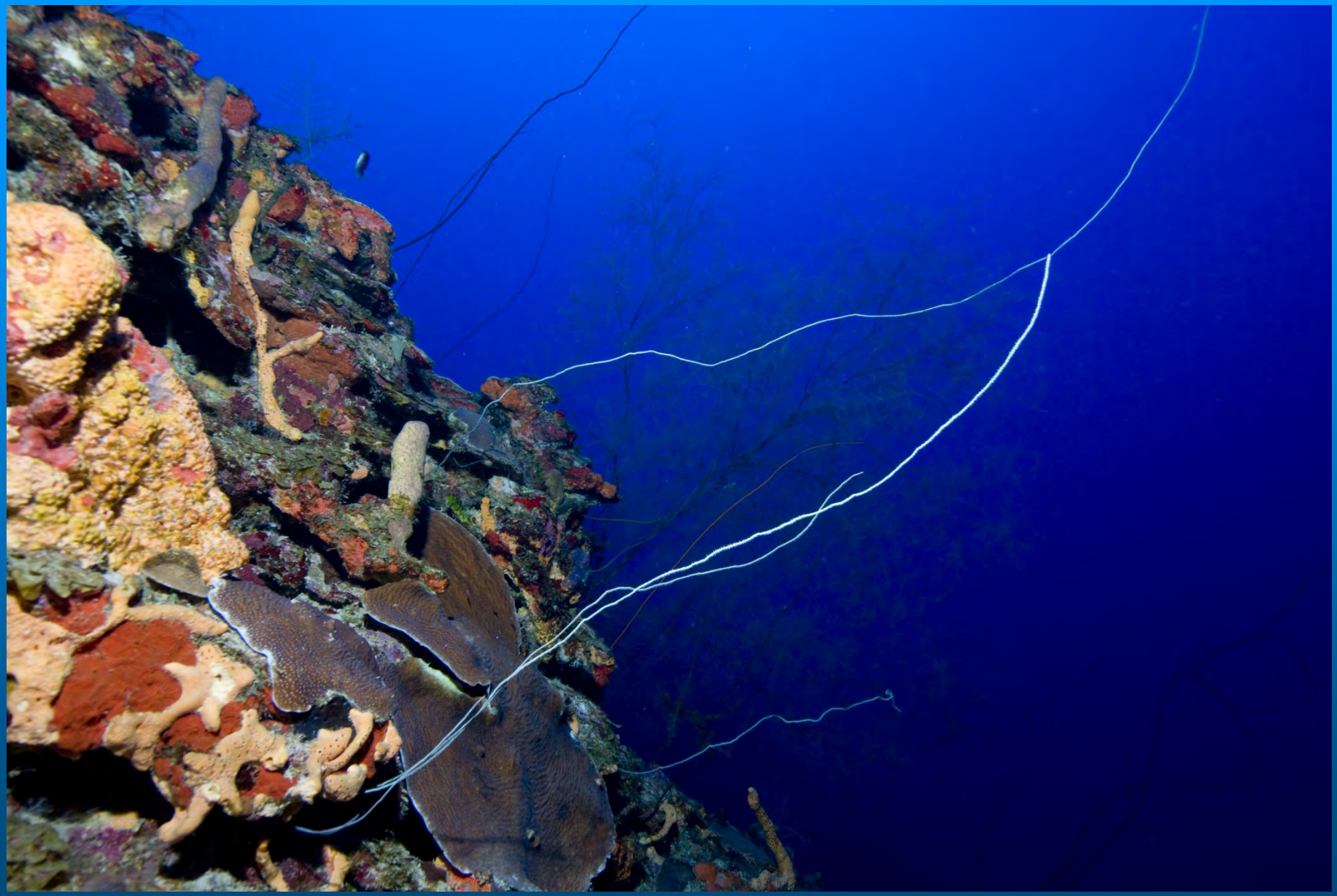
Chla



Aug 09

Turb





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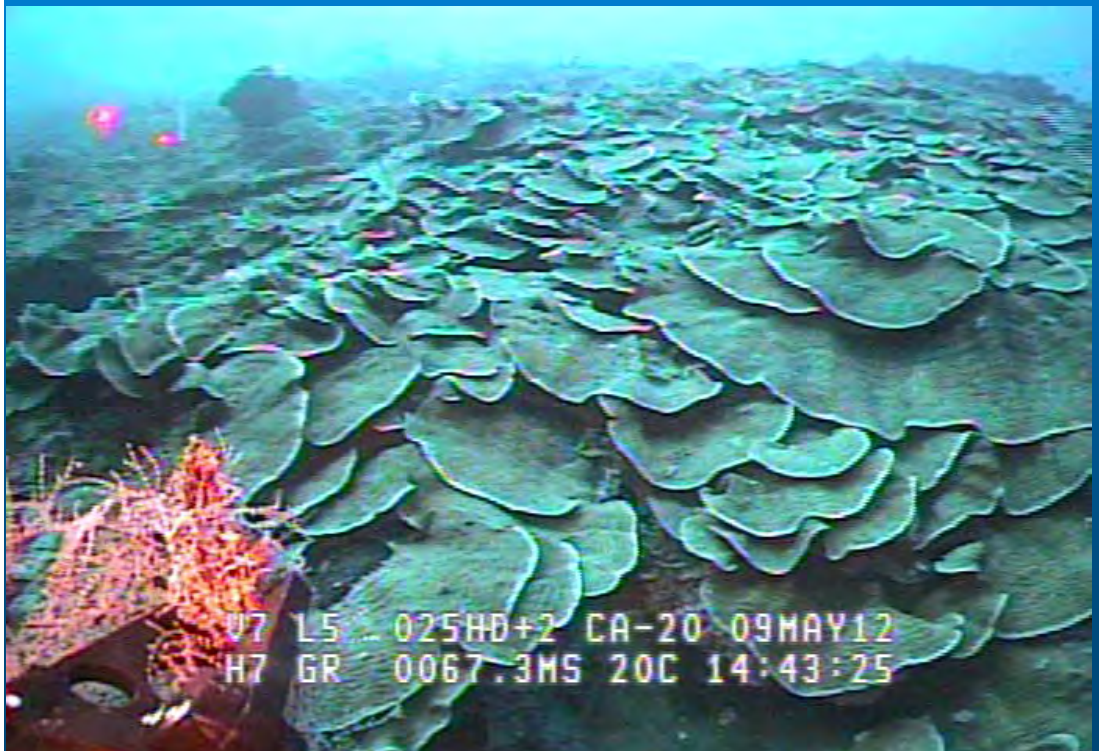
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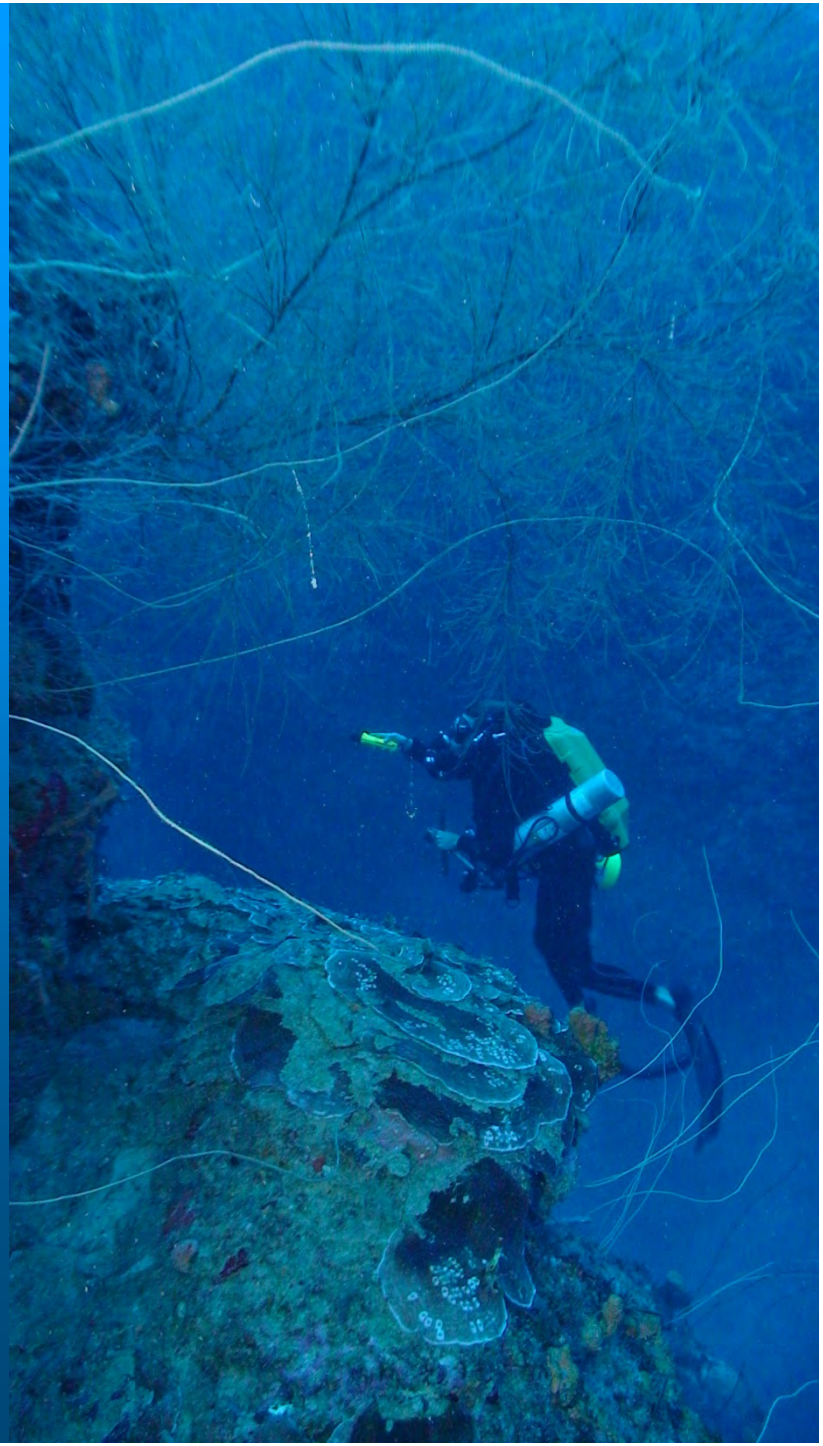
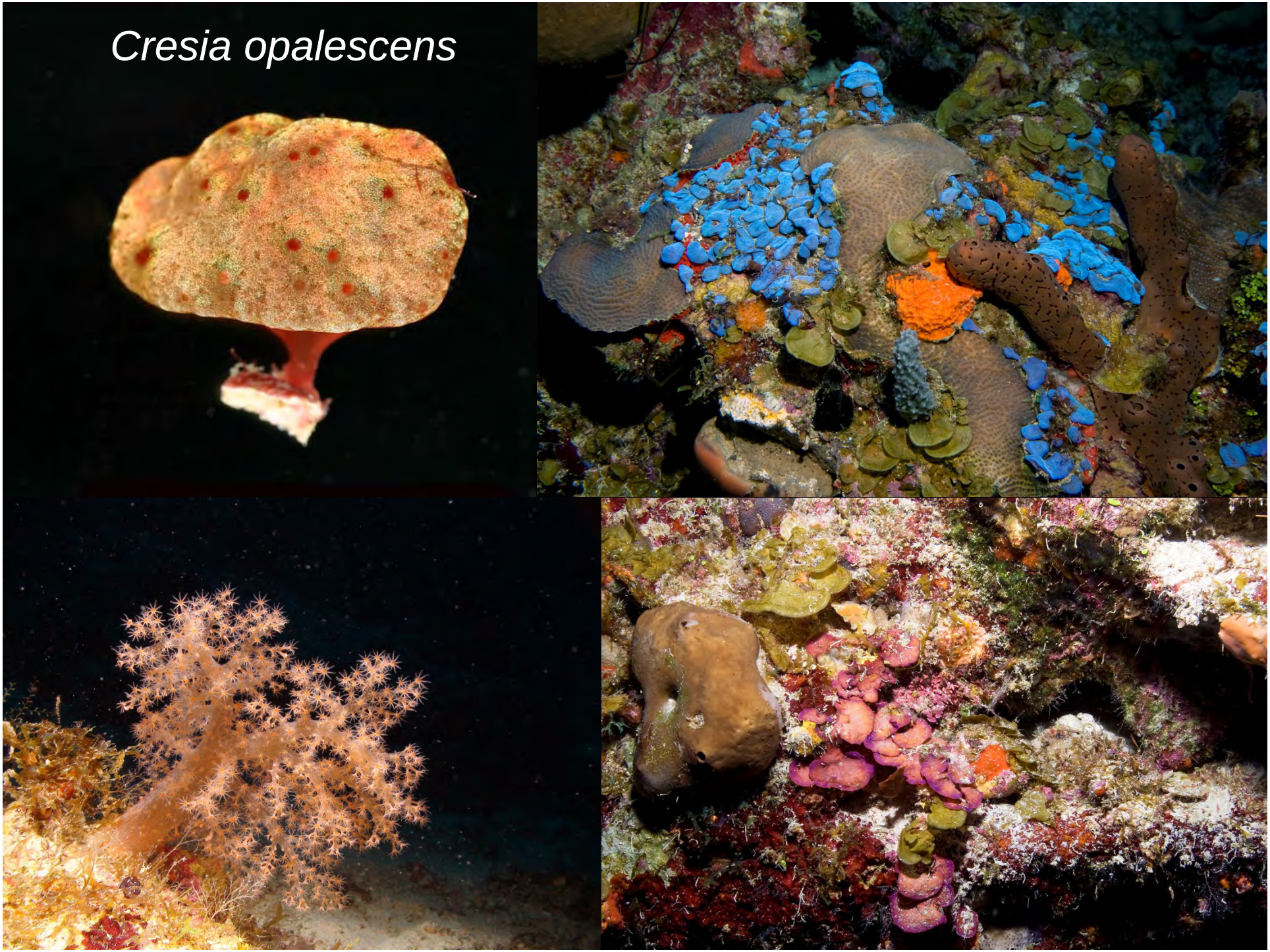
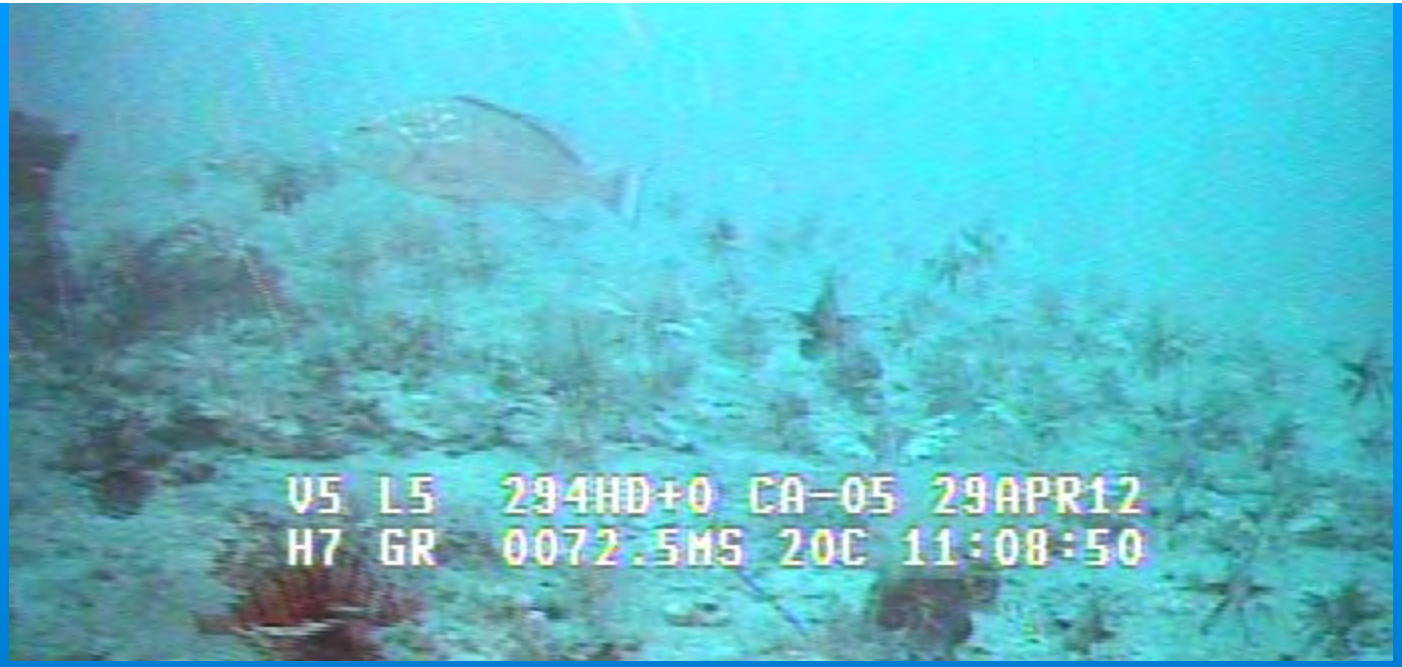


Cresia opalescens

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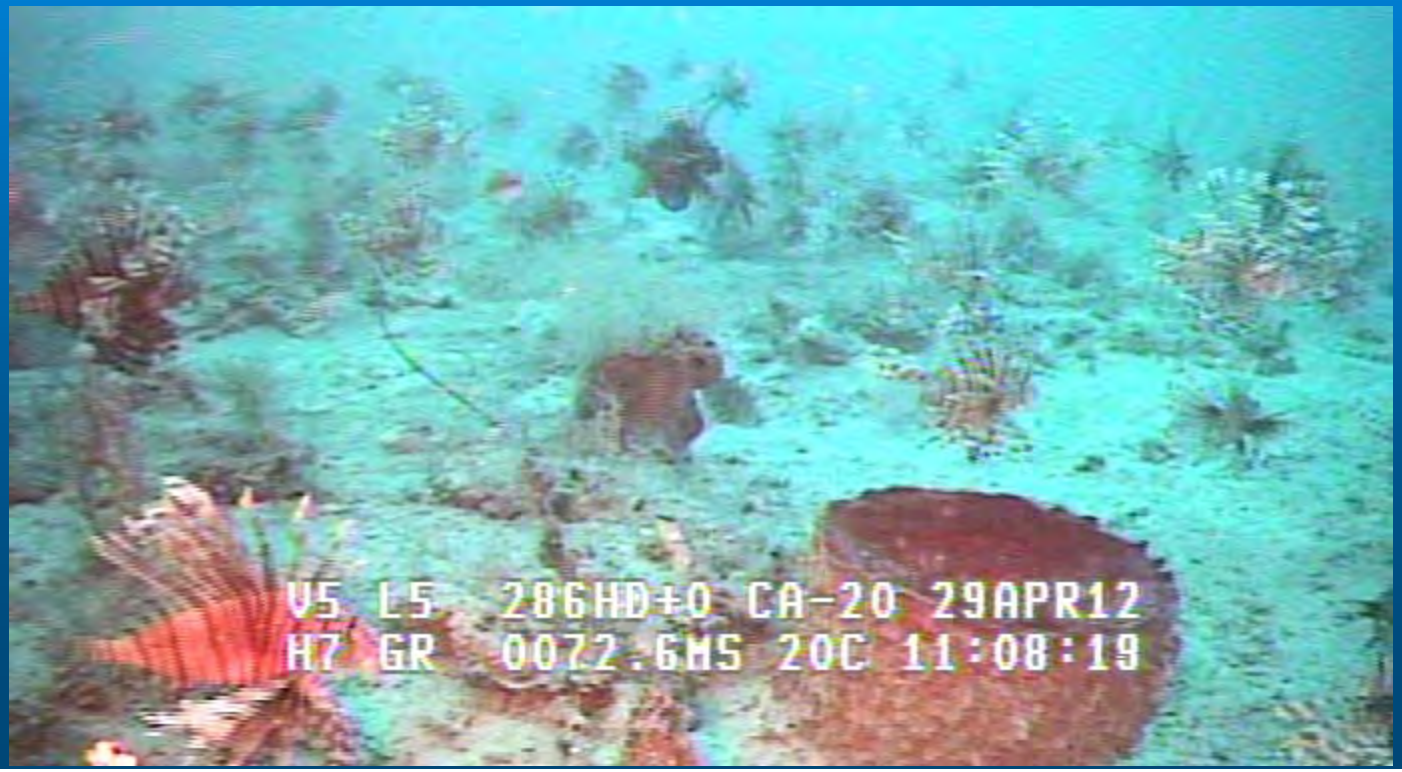
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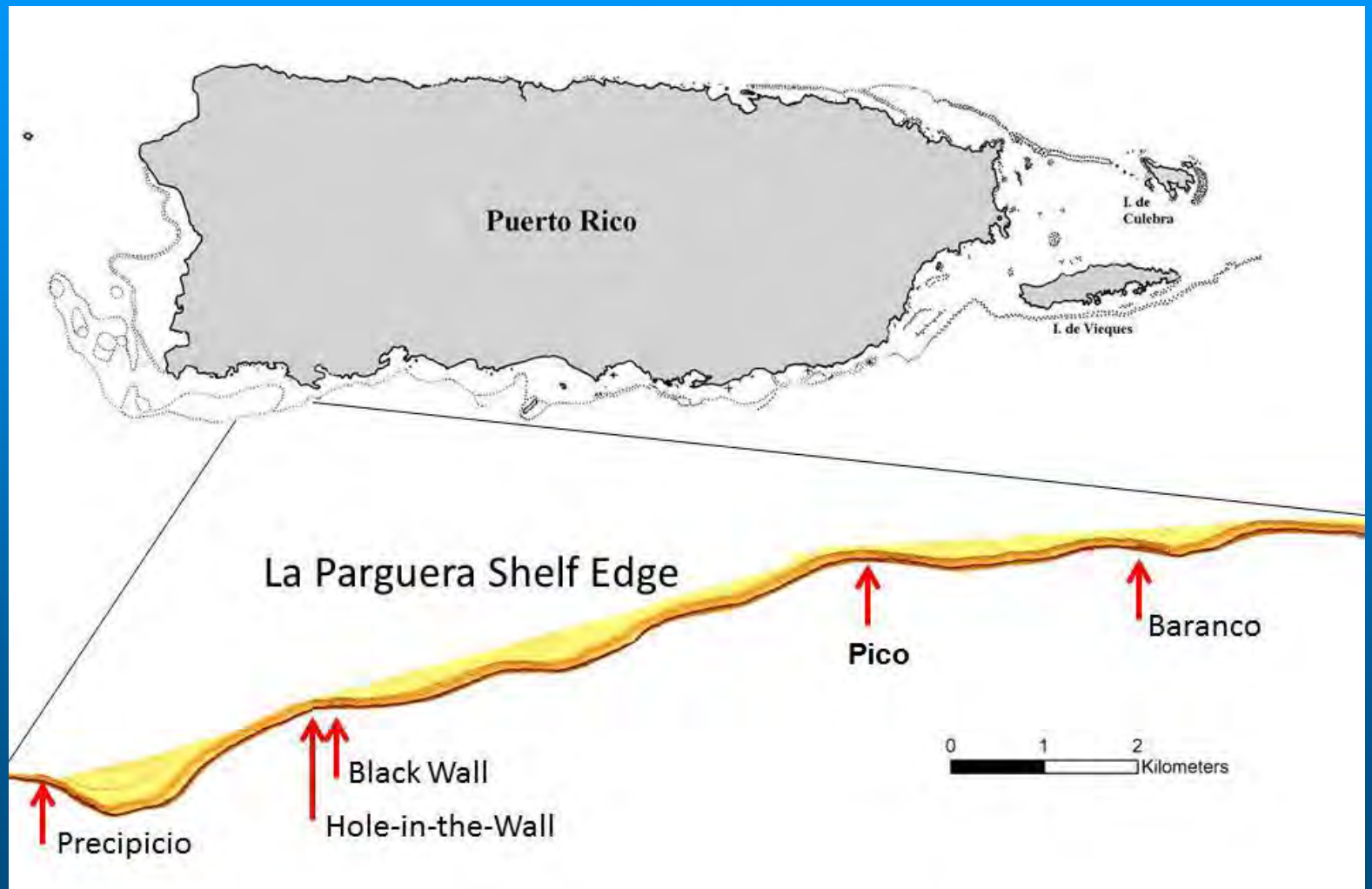
Sampling Sites

Deep CRES and MCE Cruises (2010-2013)

- “Well developed” MCEs Observed

Large-scale Geomorphology Affects MCE Distribution



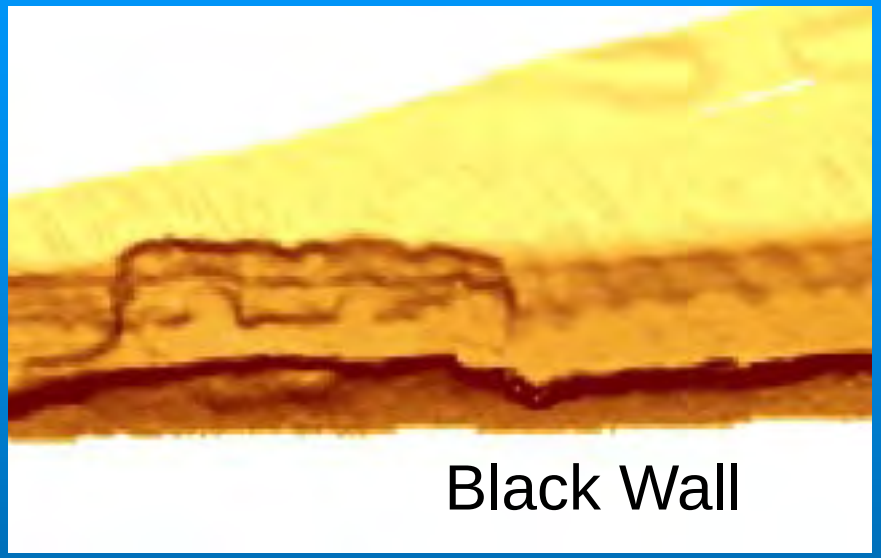
SW Sides - Greater MCE Development

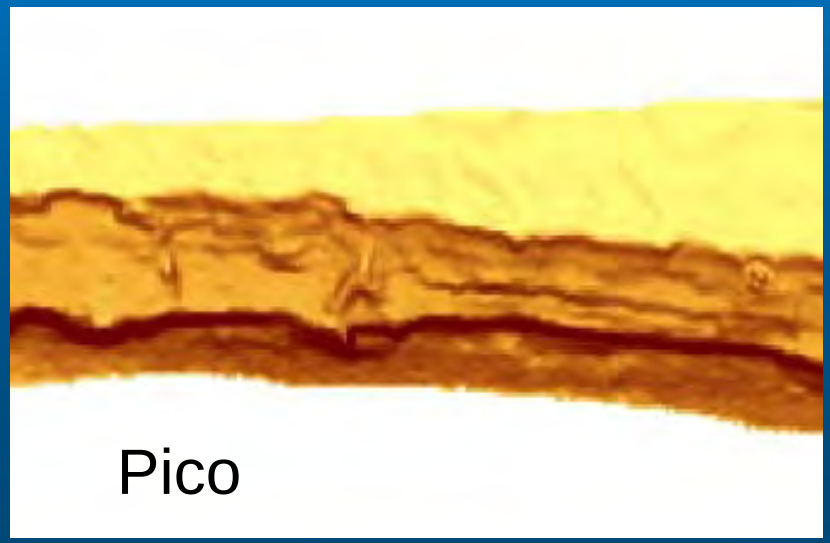
Southwest facing slopes have greater rugosity and higher gradient

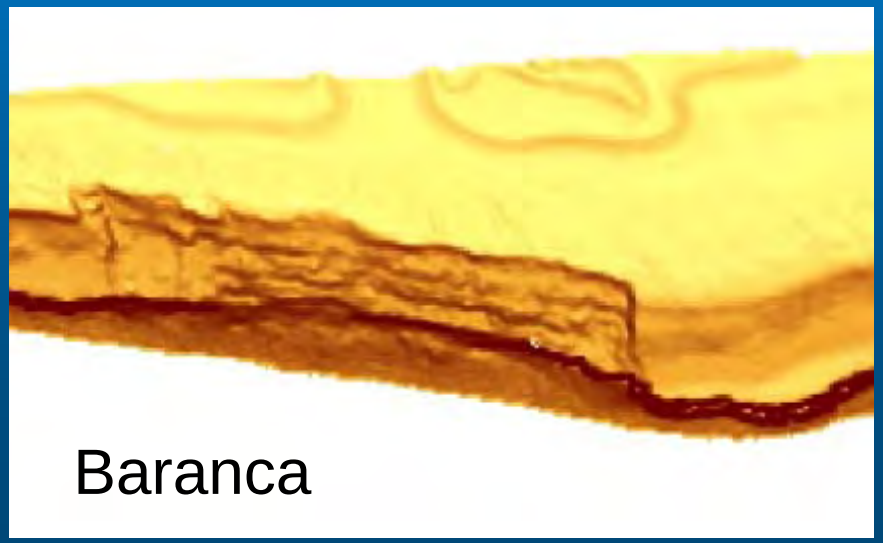
SW Facing Slope

SE Facing Slope

Meso-Scale Geomorphology Affects MCE Development



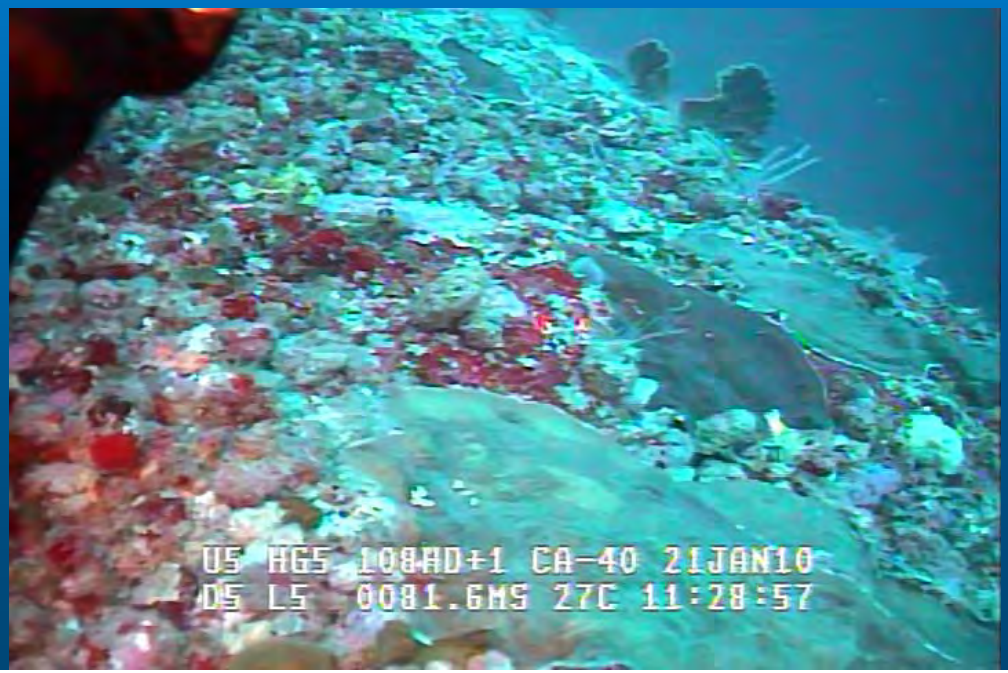


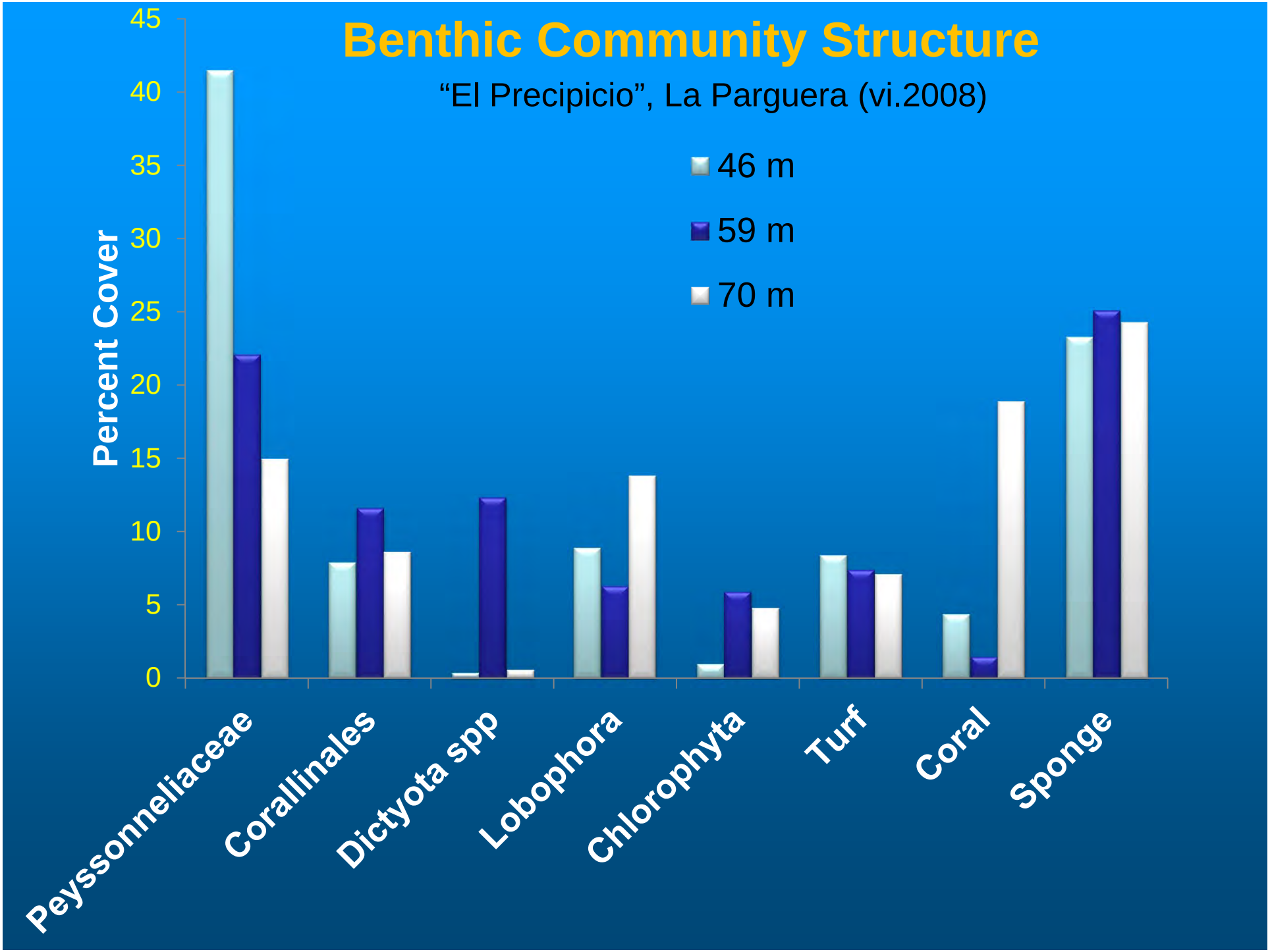


Small-scale Geomorphology Affects MCE Development

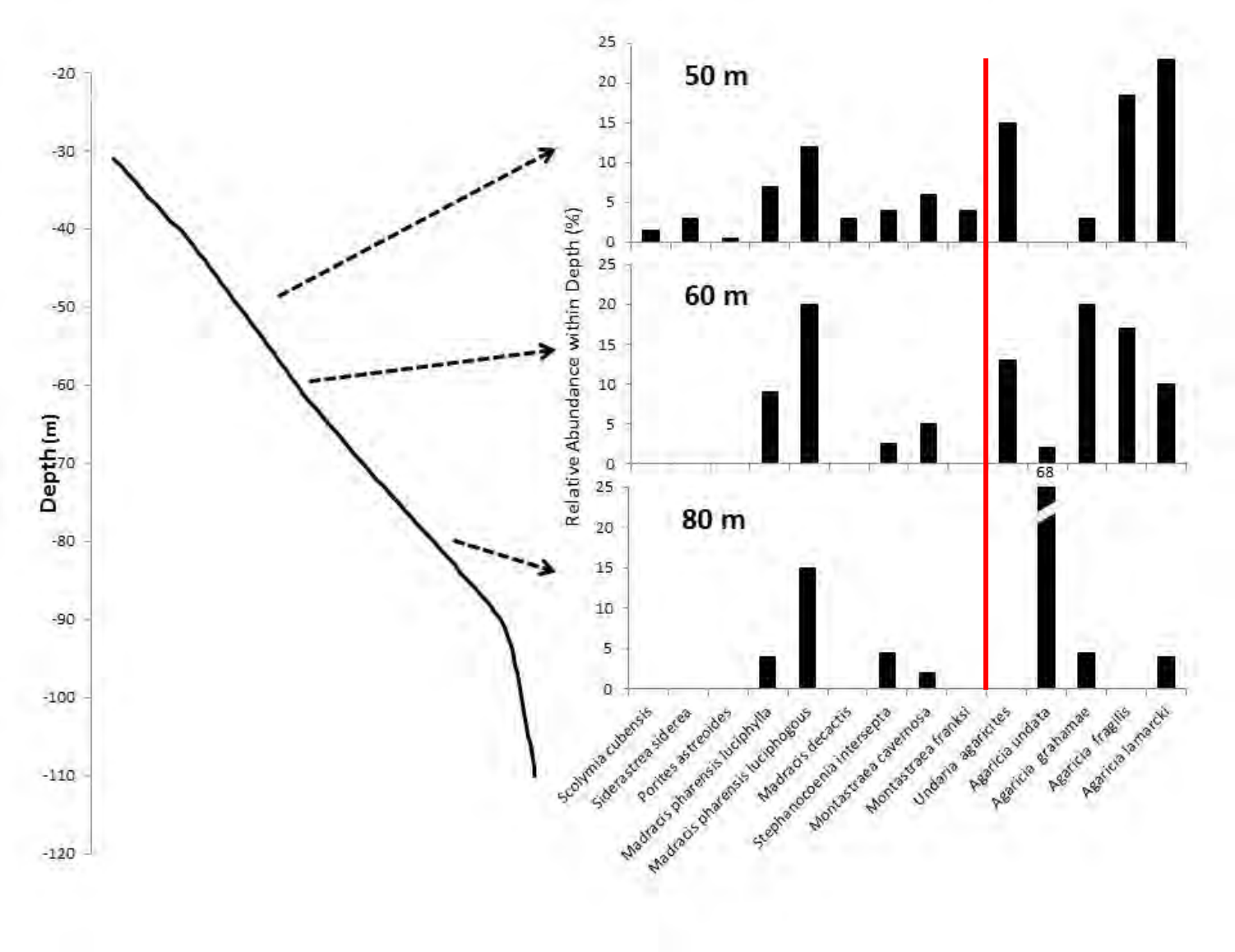
Channeling of Bedload Transport

Changes in Slope

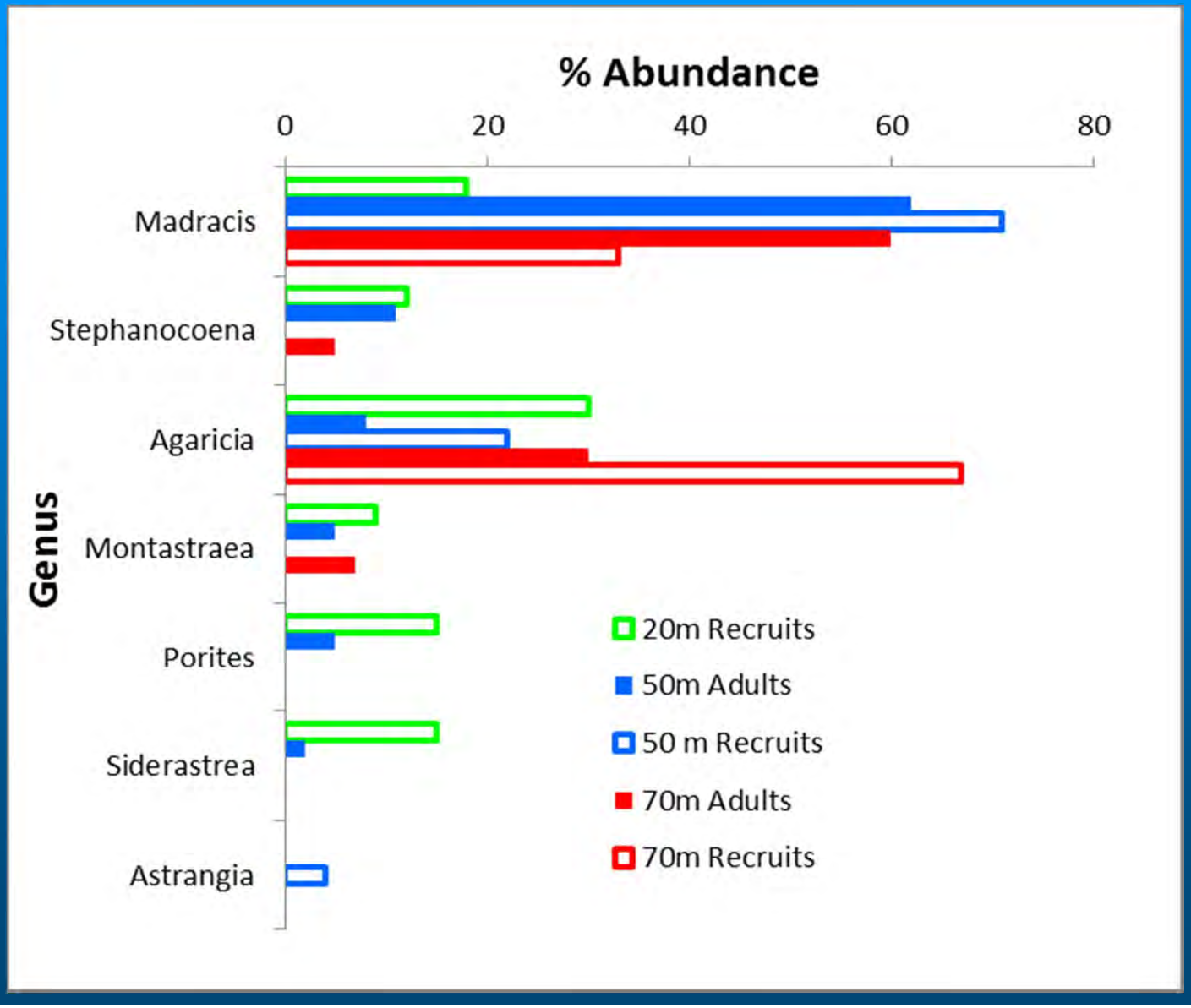



Benthic Community Structure
"El Precipicio", La Parguera (vi.2008)
46 m
59 m
70 m
Percent Cover
45
40
35
30
25
20
15
10
5
0
Peyssonneliaceae
Corallinales
Dictyota spp
Lobophora
Chlorophyta
Turf
Coral
Sponge

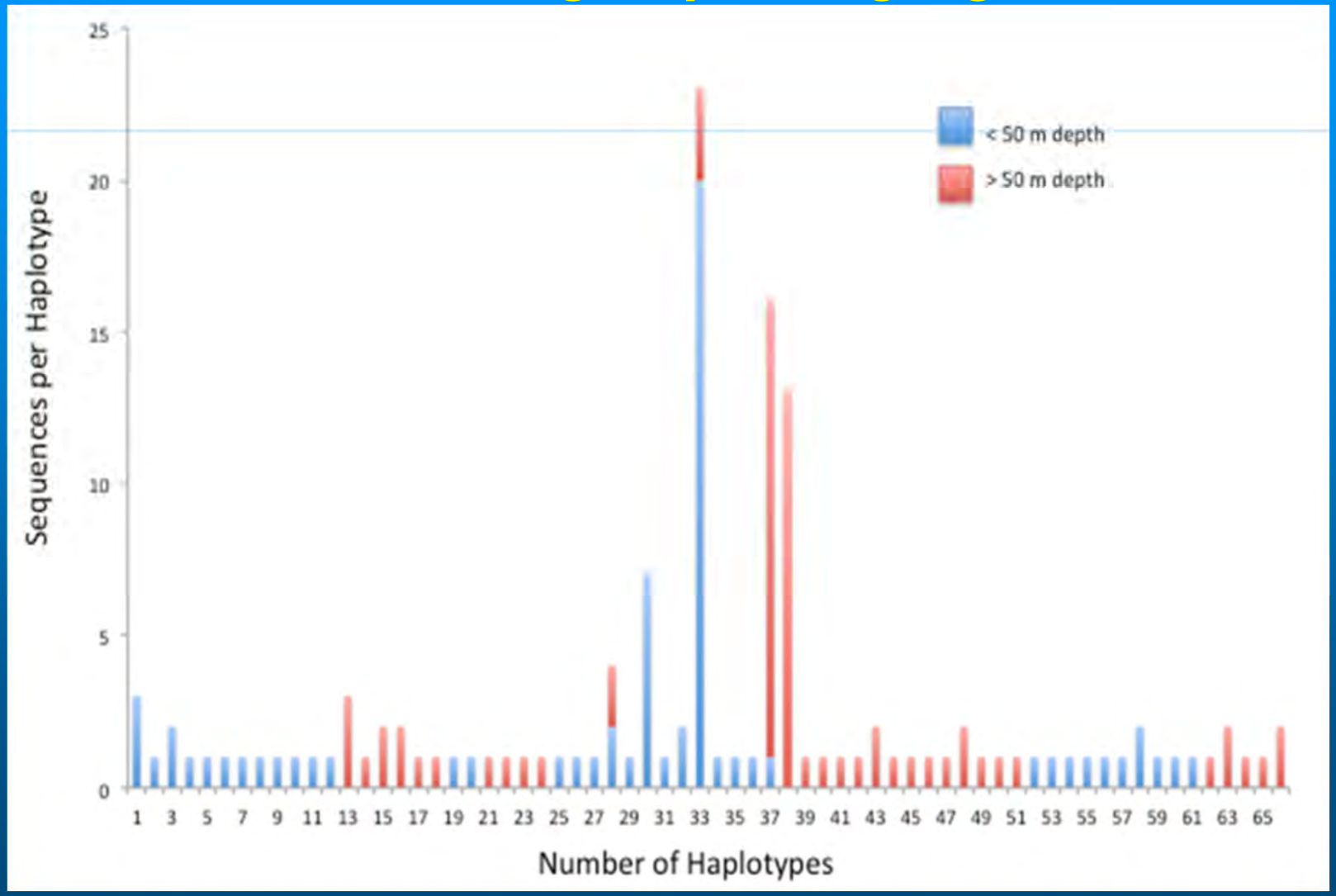
Number of Coral Species and Species Composition Changes with Depth



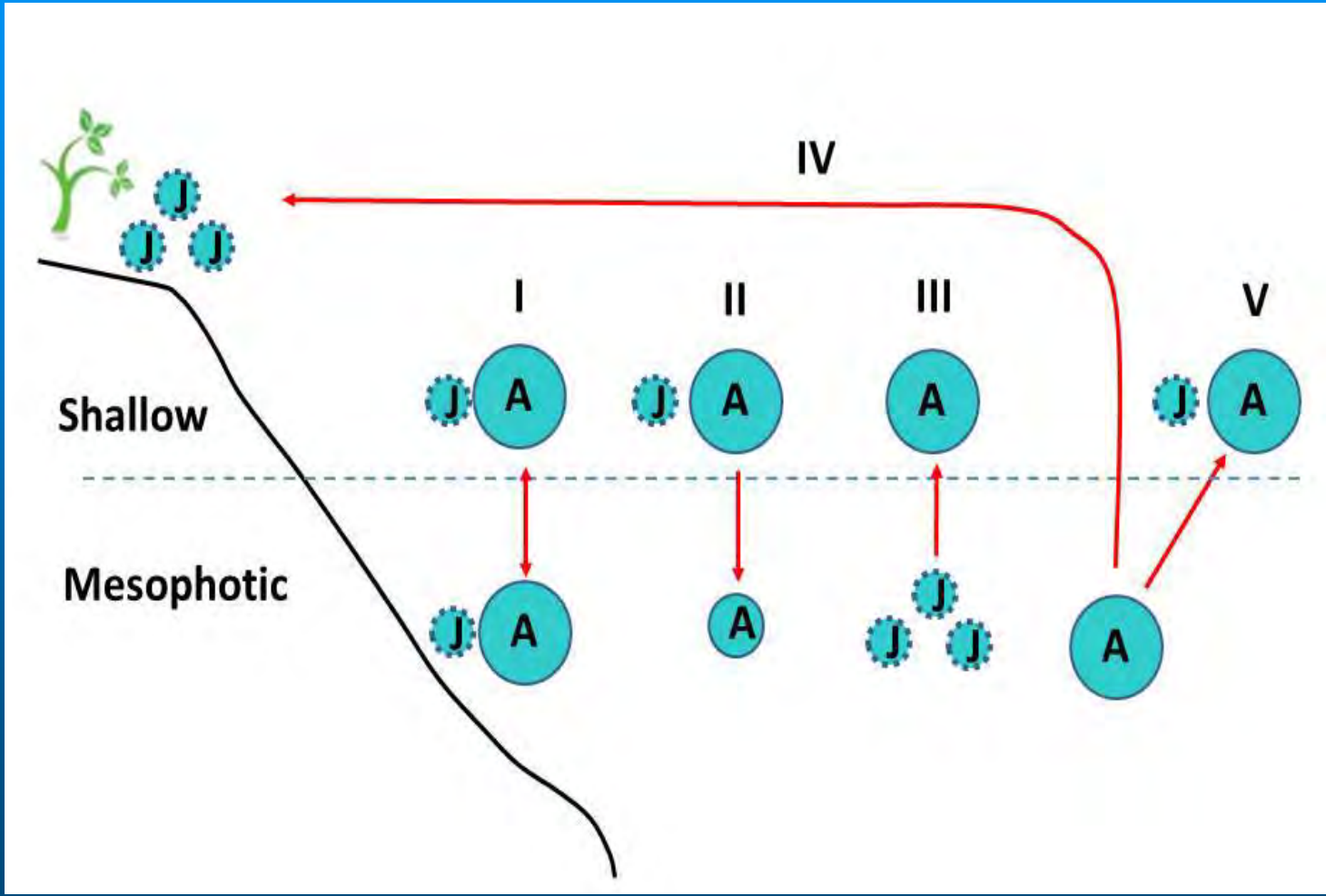
Coral Distribution with Depth Follows Recruitment Patterns



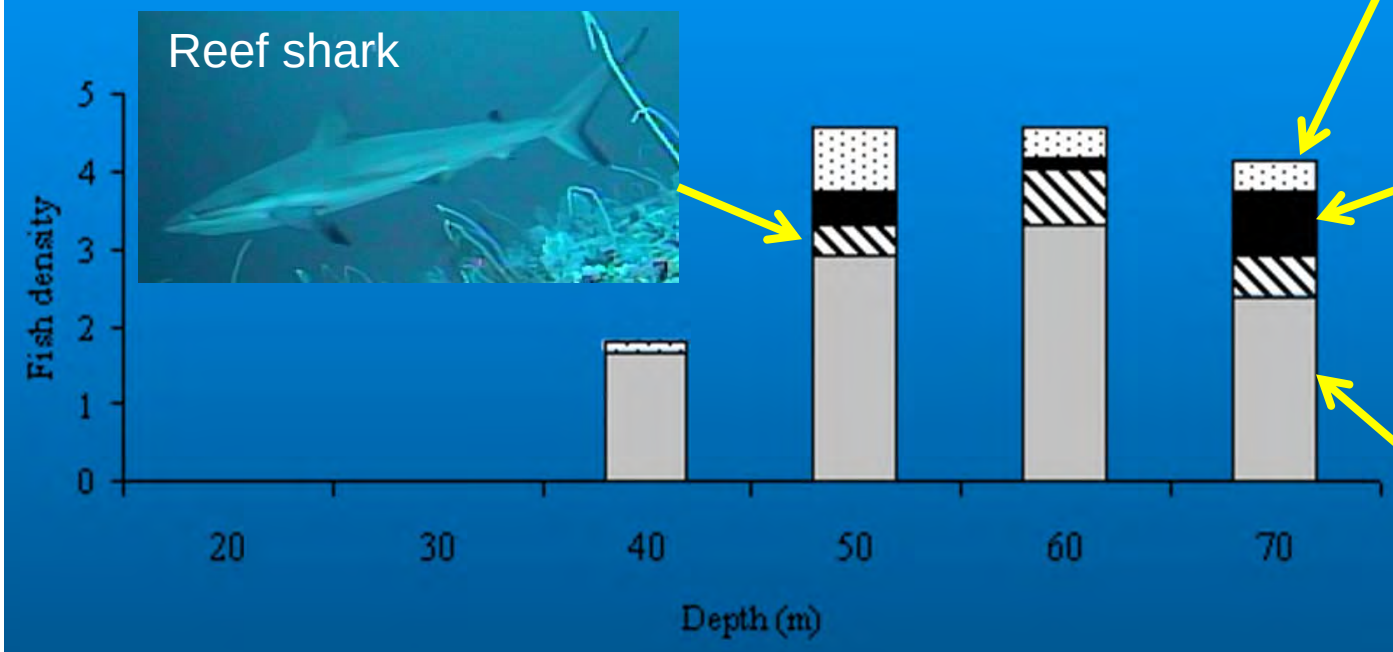
Genetic composition of zooxanthellae shows strong depth segregation



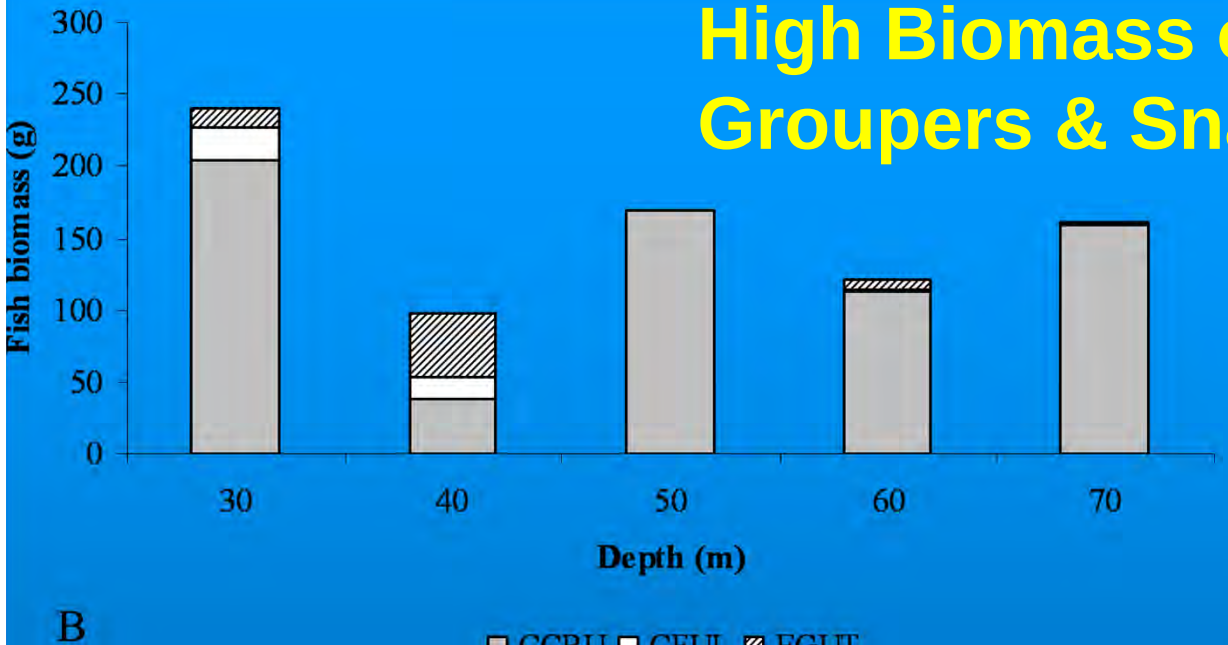
Mesophotic fishes show strong connectivity and interdependence with shallow reef systems



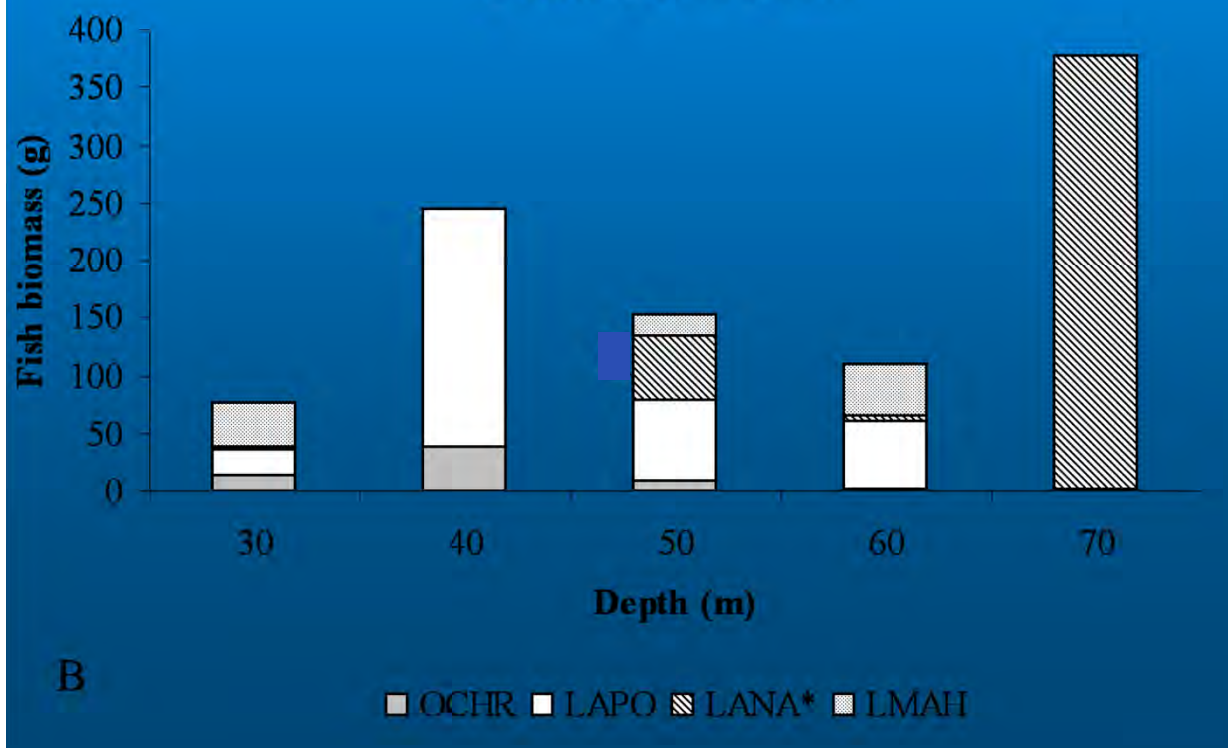
Abundance of large bodied predators increases with depth



High Biomass of Medium-bodied Groupers & Snappers in MCEs

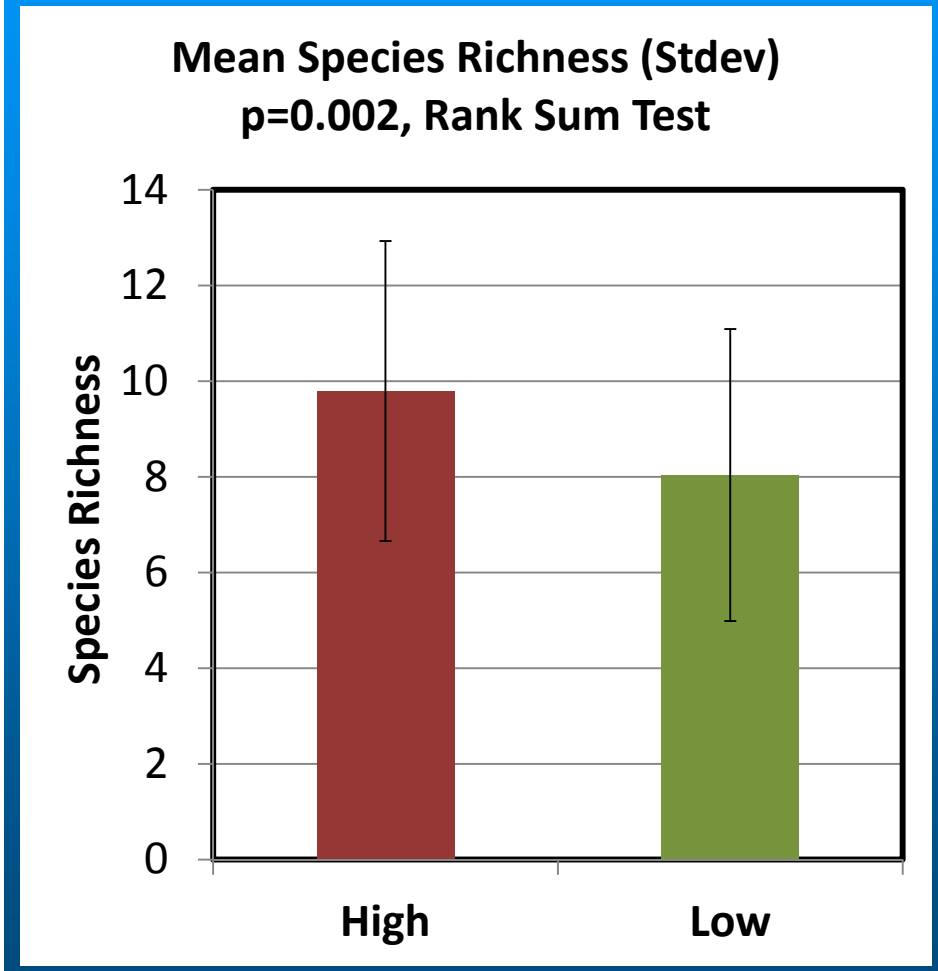


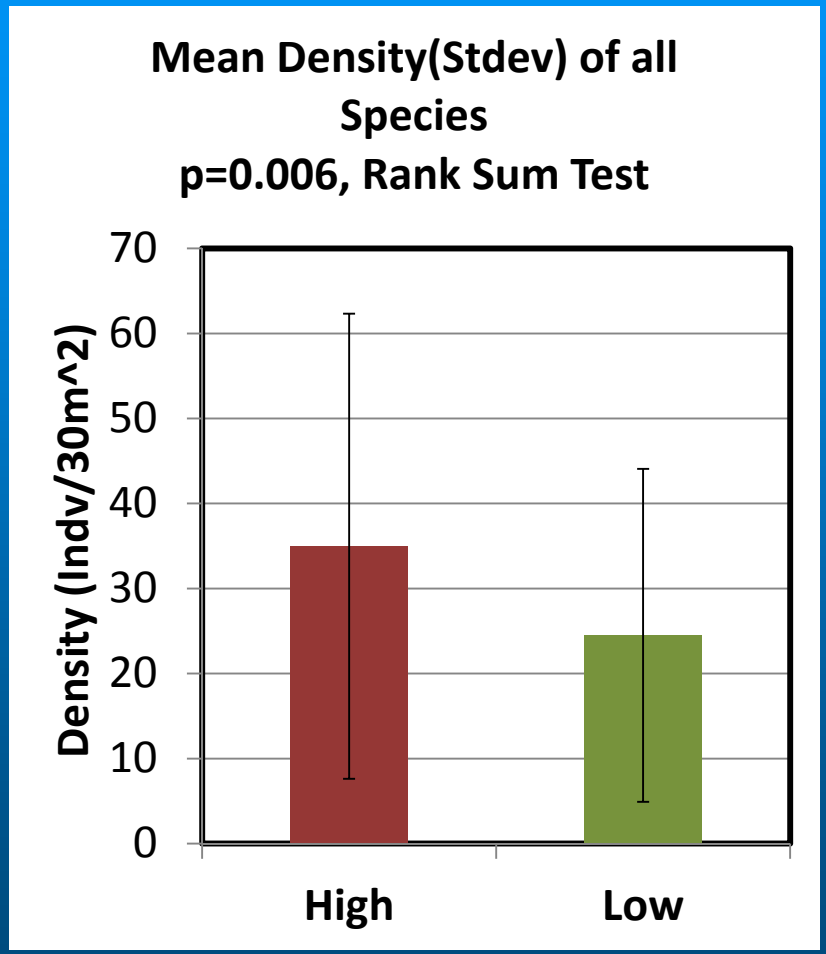
Grasby
Coney
Red Hind



Yellowtail Snapper
Schoolmaster
Mutton Snapper
Mahogany Snapper

Spatial Variation
Rugosity & Slope



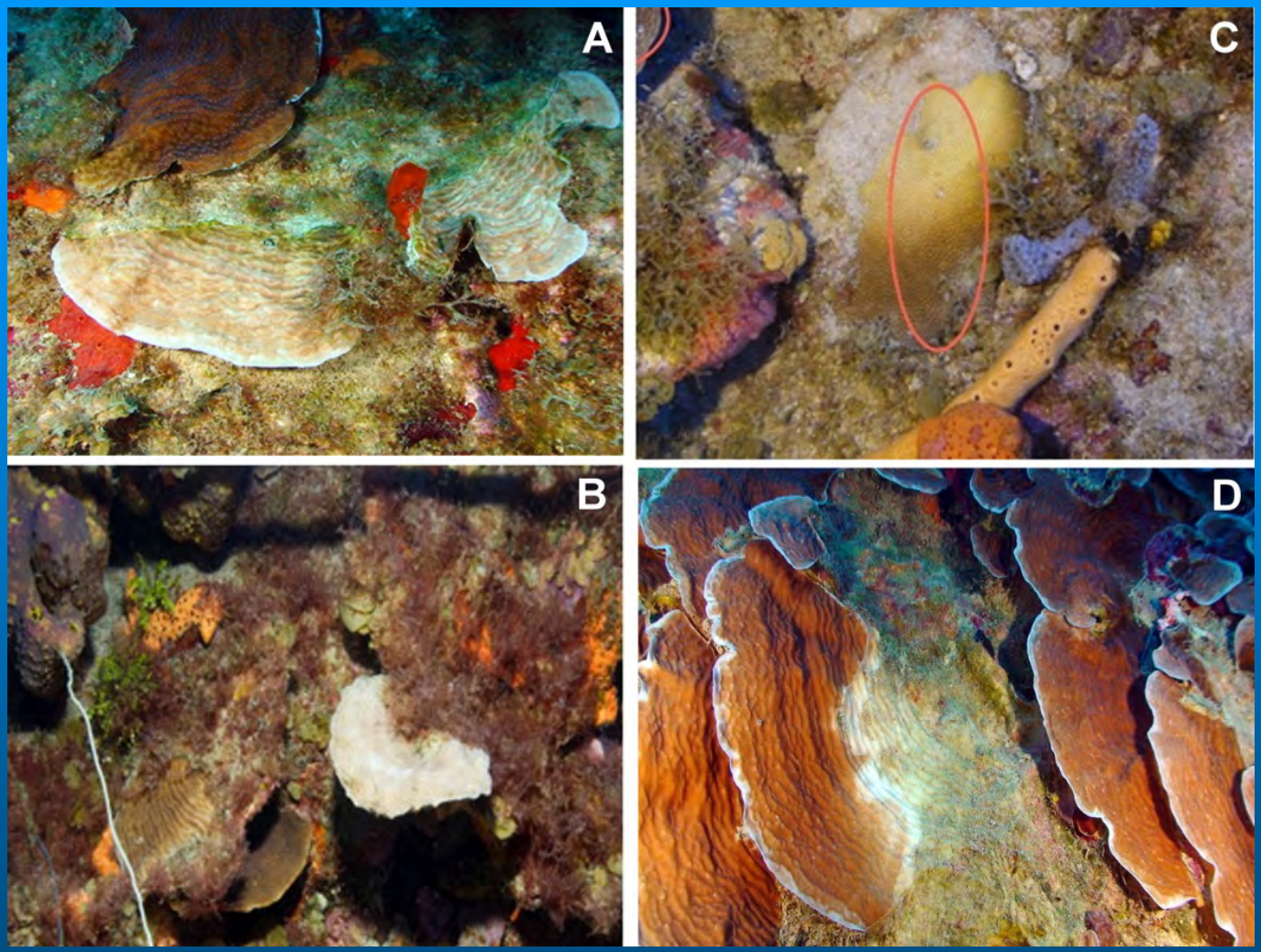


Stability of MCEs – Changes over 1 Year

Hole in the Wall 70 m

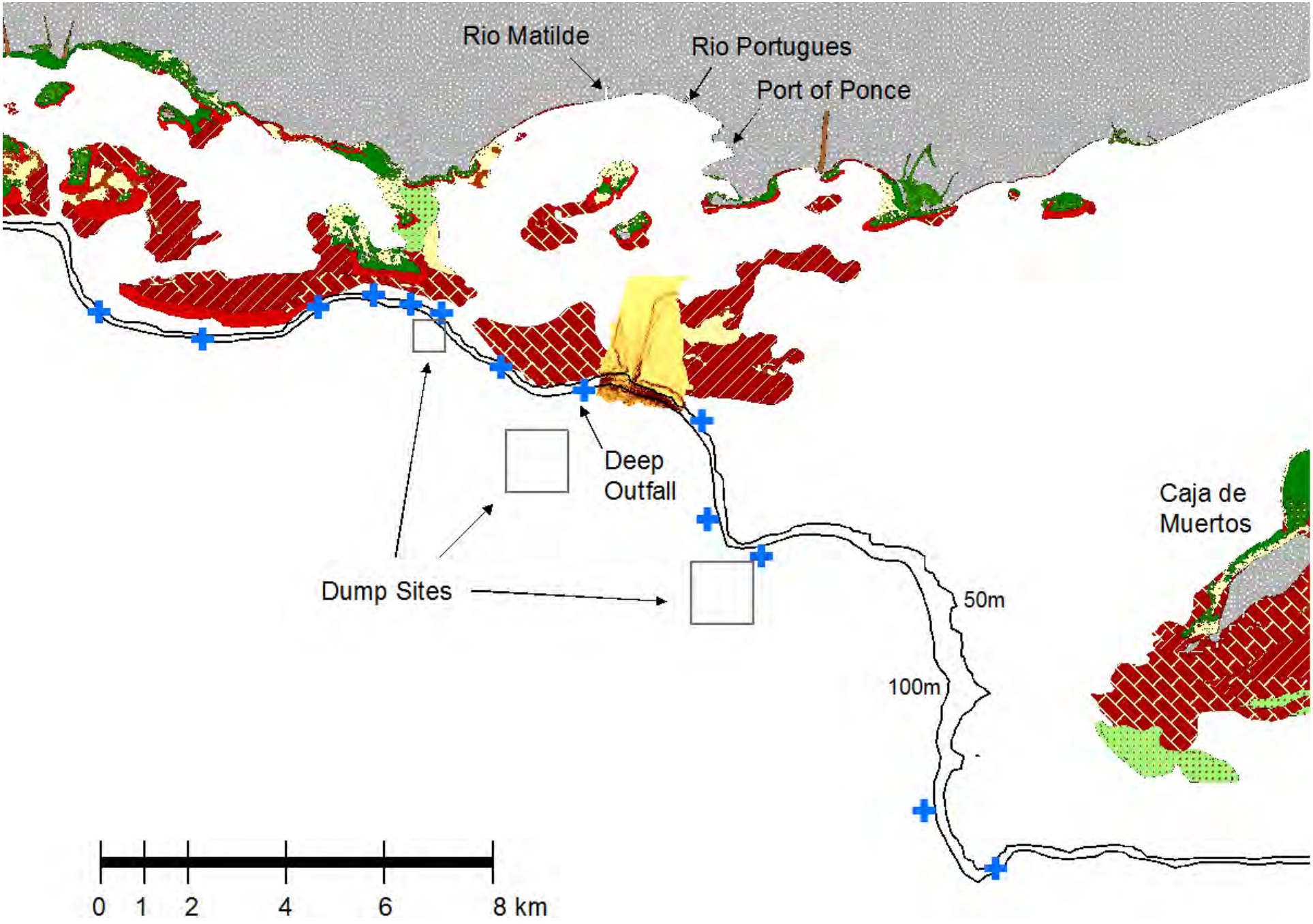
Bleached and diseased colony of *A. lamarcki*, 60m

Bleached colony of *U. humilis*, 50m



Bleached colony of *S. intersepta*, 50 m

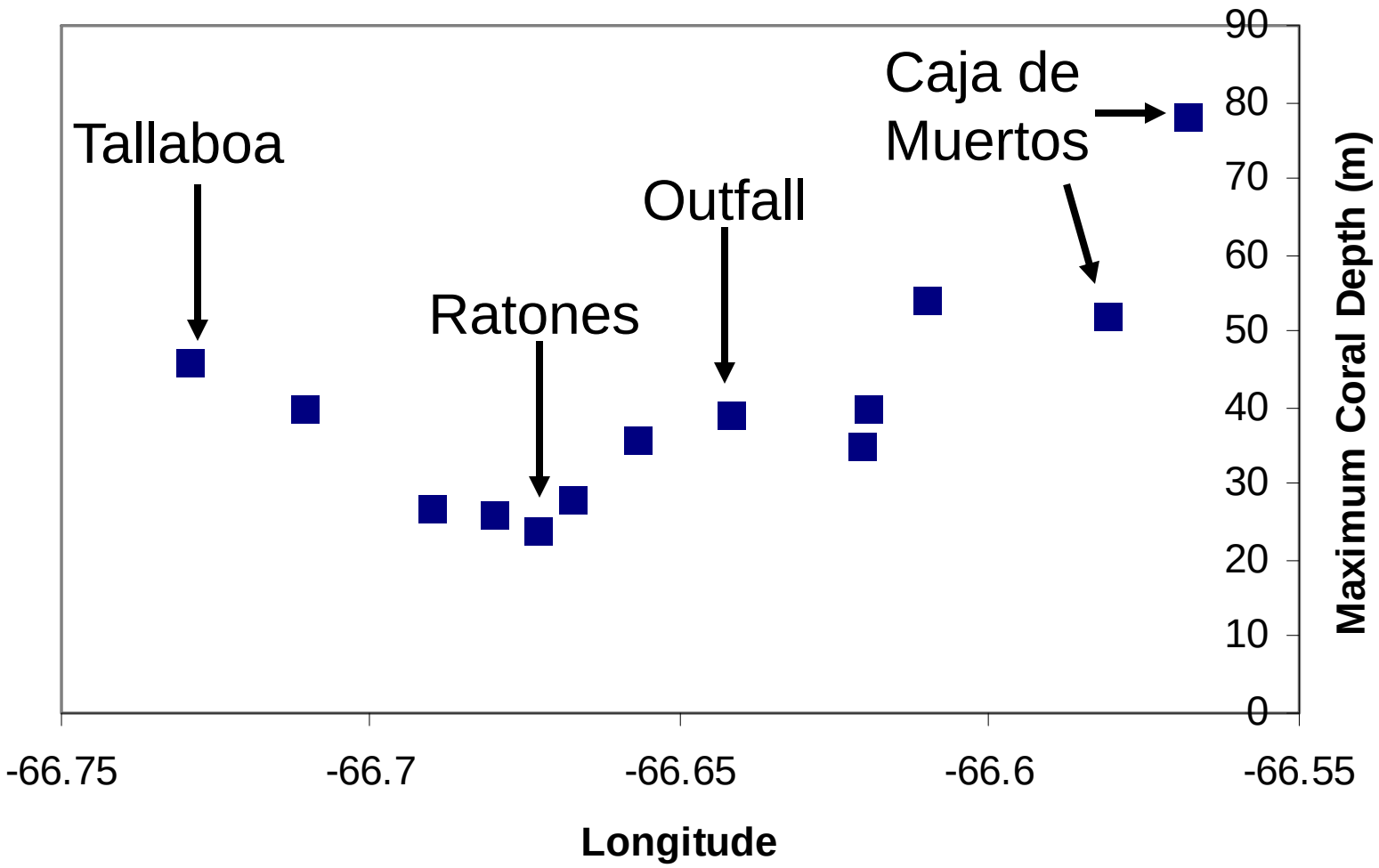
***A. undata* with white syndrome and recent tissue mortality , 70 m**


Rio Matilde
Rio Portugues
Port of Ponce
Deep
Outfall
Caja de
Muertos
Dump Sites
50m
100m
0 1 2 4 6 8 km

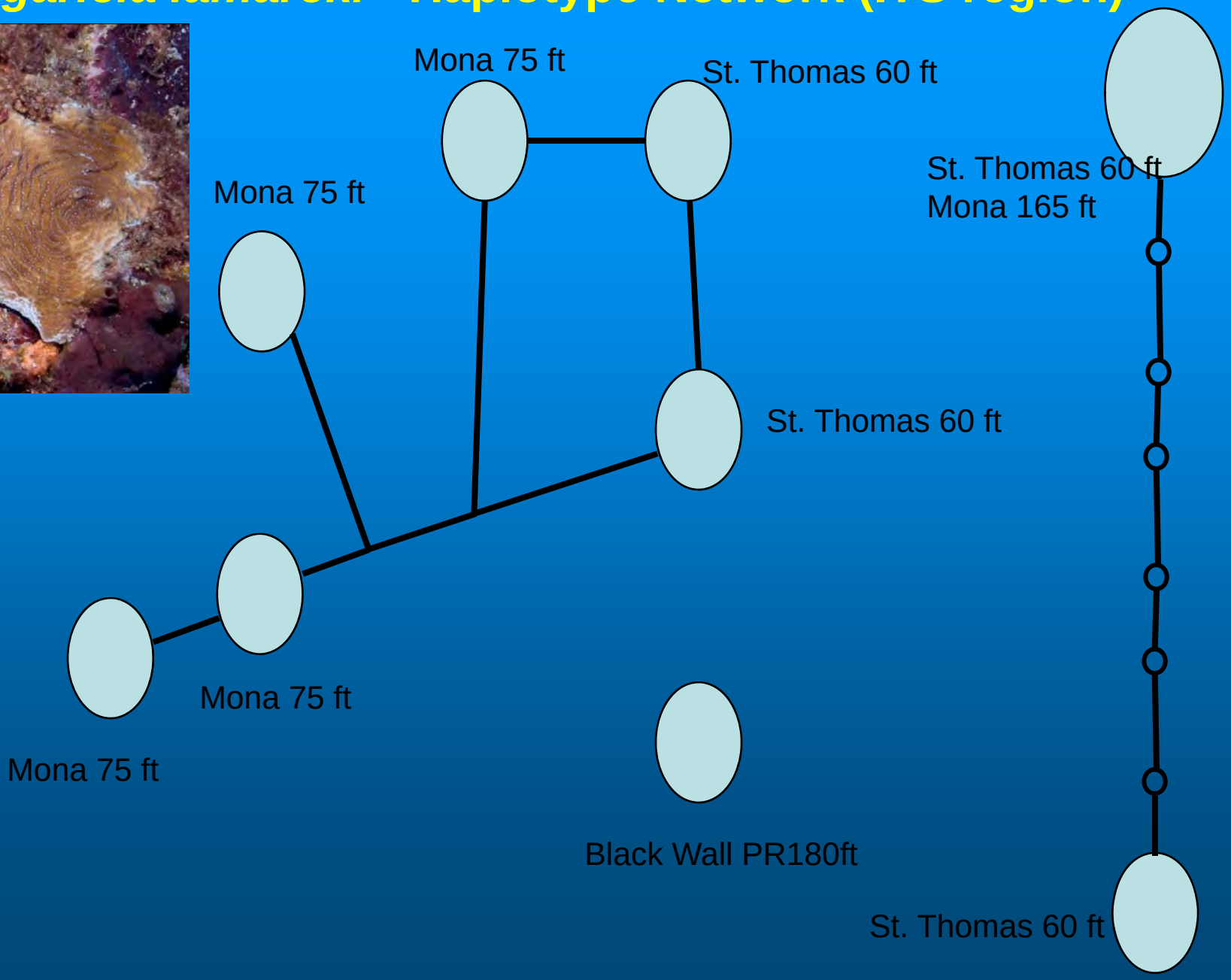
Ratones

Heavy Siltation

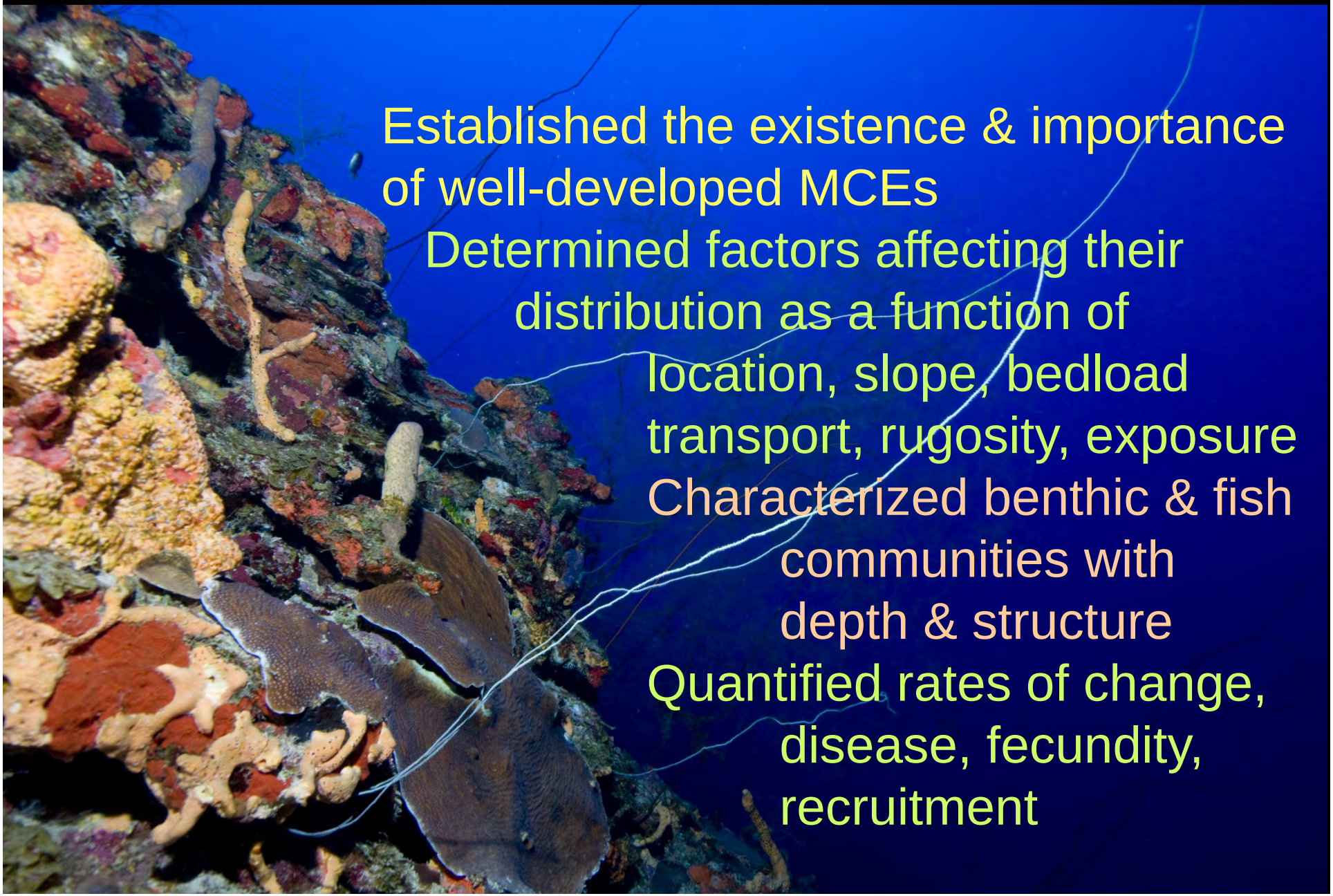
Maximum Depth of Corals



Agaricia lamarcki - Haplotype Network (ITS region)



Summary



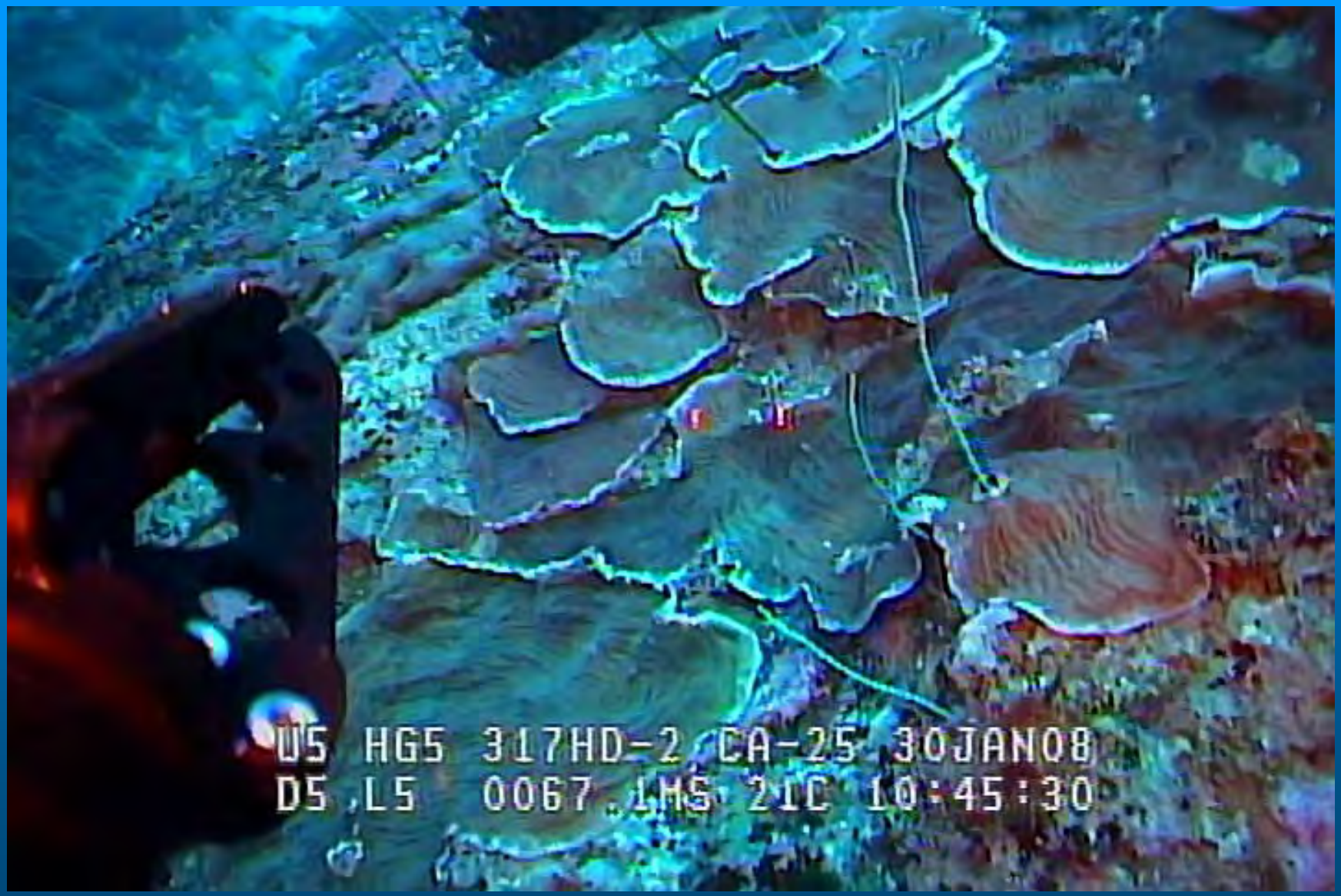
Established the existence & importance of well-developed MCEs

Determined factors affecting their distribution as a function of location, slope, bedload transport, rugosity, exposure

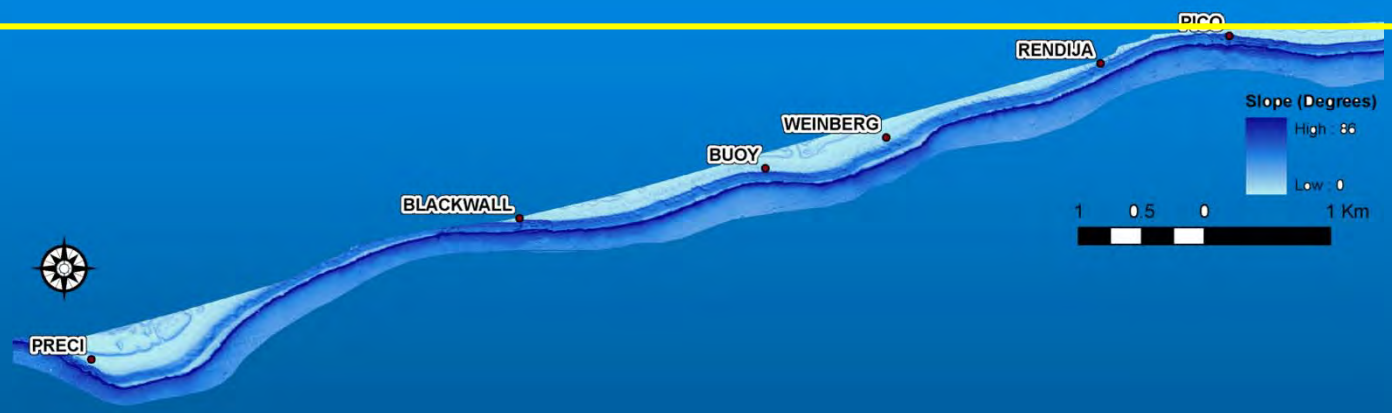
Characterized benthic & fish communities with depth & structure

Quantified rates of change, disease, fecundity, recruitment

New Knowledge and Management Significance

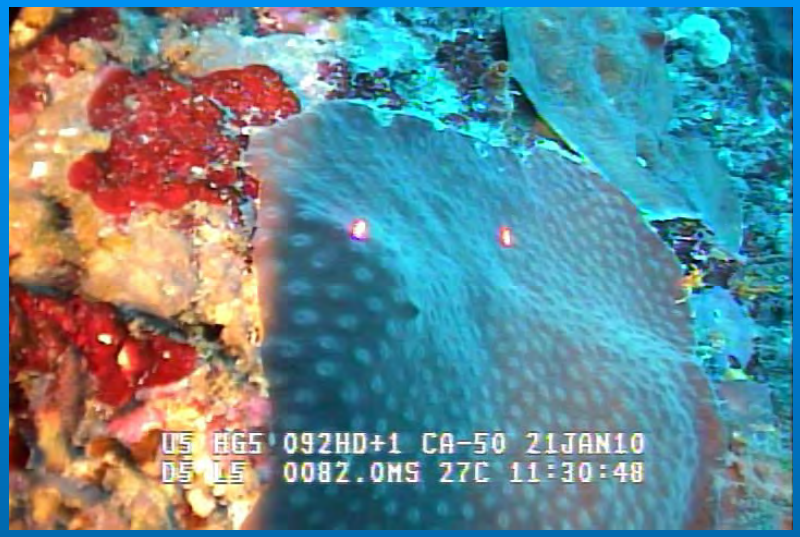


MCEs are more abundant on southwest facing slopes, which tend to be steep and irregular. In areas subject to sediment delivery from the shelf edge, MCEs are concentrated on topographic highs. Suggests that MCE distributions are predictable.



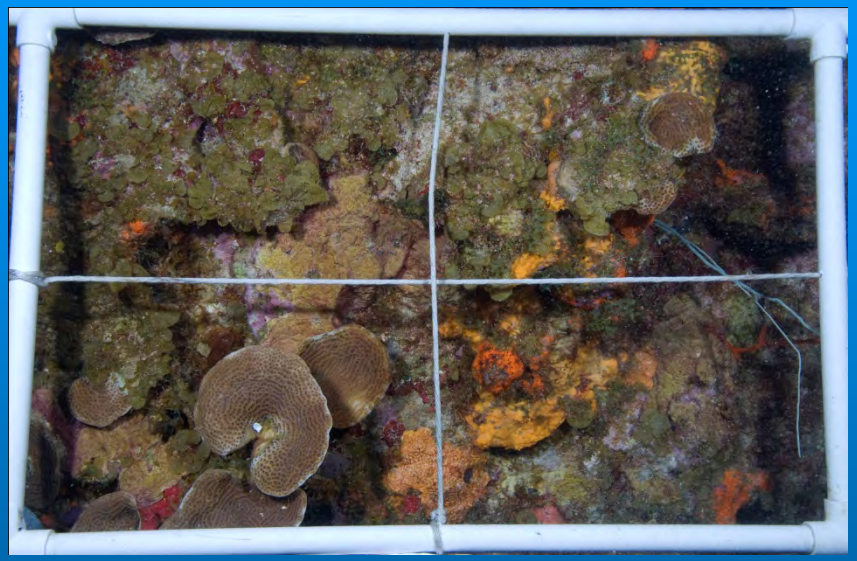
This information will help focus future management and research efforts on areas with higher potential to contain these ecosystems and in the development of marine spatial plans.

Documented coral abundances and distributions within MCEs, e.g., *Agaricia lamarcki* and *Montastraea* spp.



Agaricia lamarcki and *Montastraea* spp. were proposed to be listed under the Endangered Species Act. Such information is invaluable in determining the true status of these species and their respective essential habitat.

MCEs are areas of high biodiversity, potentially including many new species. Several new species of algae and invertebrates have already been documented.



Special attention should be given to protecting MCEs for their biodiversity legacy and potential for new and novel bioactive compounds. Requirements for impact evaluations under the current laws should include MCEs.

Many commercial fishes documented in MCEs were once common in shallower reefs (such as Nassau and black groupers, cubera and dog snappers). Now rarely seen because of historical fishing pressure.

Observations suggest that MCEs are serving as refugia for heavily exploited species. Conservation is warranted. Spatial or species protection could be used for conservation. Spatial protection avoids decompression impacts.

Documented connectivity between shallow and deep coral ecosystems. Many commercial species commonly seen in MCEs (snappers, barracuda) are known to be dependent on shallow nursery areas.

For some species, MCE populations are dependent on management effectiveness in conserving the extent and health of nearshore habitats. This also suggests that management consider the spatial scale of this connectivity in activities such as spatial planning and MPA design.

Fish abundance and diversity, especially for larger species, is greater over more rugose topography.

Areas of well developed benthic MCEs are likely to have a greater species richness and standing stock of fishes. These areas could be focus for spatial protection for biodiversity and fishery conservation.

MCEs serve as habitat for species of concern, particularly hawksbill turtles and reef sharks.

Protection should be given to MCEs that serve as habitat for the conservation of these species.

The presences of sharks and large snappers and groupers suggests that MCEs have a more intact trophic structure that in shallow areas.

Intact trophic systems may be contributing to the health of MCEs relative to shallow areas. Additionally, this suggests that with protection, MCE fish communities should recover more rapidly that shallow communities.

Documented the establishment of invasive lionfish within MCEs.

Lionfish are invasive and voracious predators that can significantly alter ecosystem trophodynamics and fisheries production. MCE populations show eradication is unachievable. Management should focus on controlling impact.

To date, a low incidence of disease or bleaching among corals within MCEs has been observed.

Corals within MCEs may be buffered from some stresses observed in shallow areas, offering the prospect for greater survival and MCEs as potential coral refugia to provide spawning stock to seed shallow areas.

There is a shift in benthic community composition occurring at ~45-50 m, with MCEs below this depth no longer strongly reflecting the shallow coral communities.

MCEs at these depths generally will not act as refugia for shallow benthic invertebrate species.

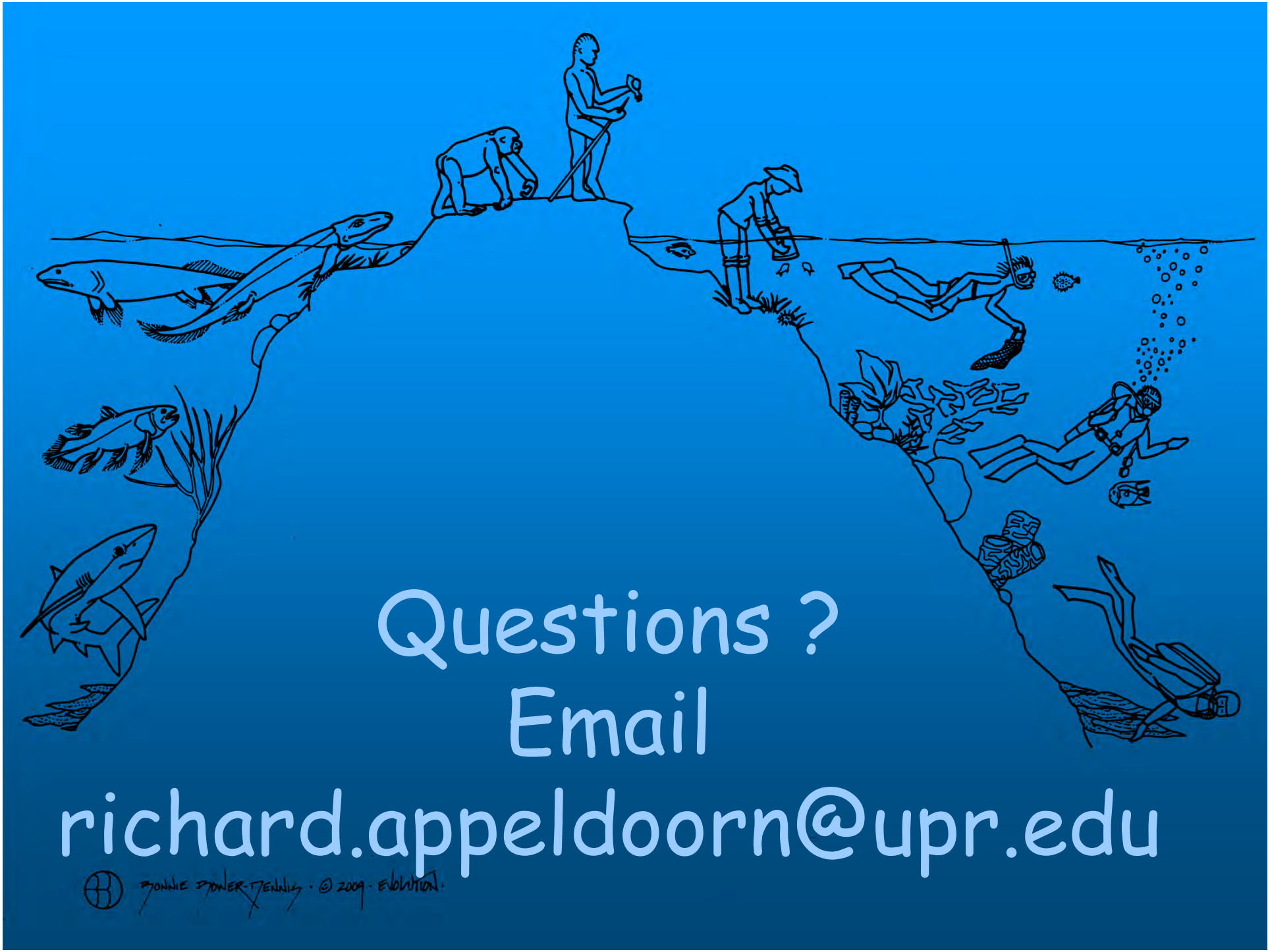
Heavy sedimentation rates severely impact MCE development, with coral abundance and maximum depth increasing with distance from the source(s).

MCEs can be threatened by LBSP, especially those increasing turbidity and sedimentation. Projects potentially increasing the latter should assess impacts to MCEs. Areas under the impact of high sedimentation (e.g. associated with rivers) would not be expected to have MCE communities.

Recruitment to new substrate (deep outfall tube and surge backfill) at Ponce shows no MCE corals, but an abundance of sea whips (Antipatharians). Coral recruitment rates off La Parguera are comparable with shallow reefs.

Conditions at Ponce are preventing coral recruitment, suggesting that MCEs are fragile ecosystems.

This study would not be possible without a sustained effort and adequate resources


Questions ?
Email
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