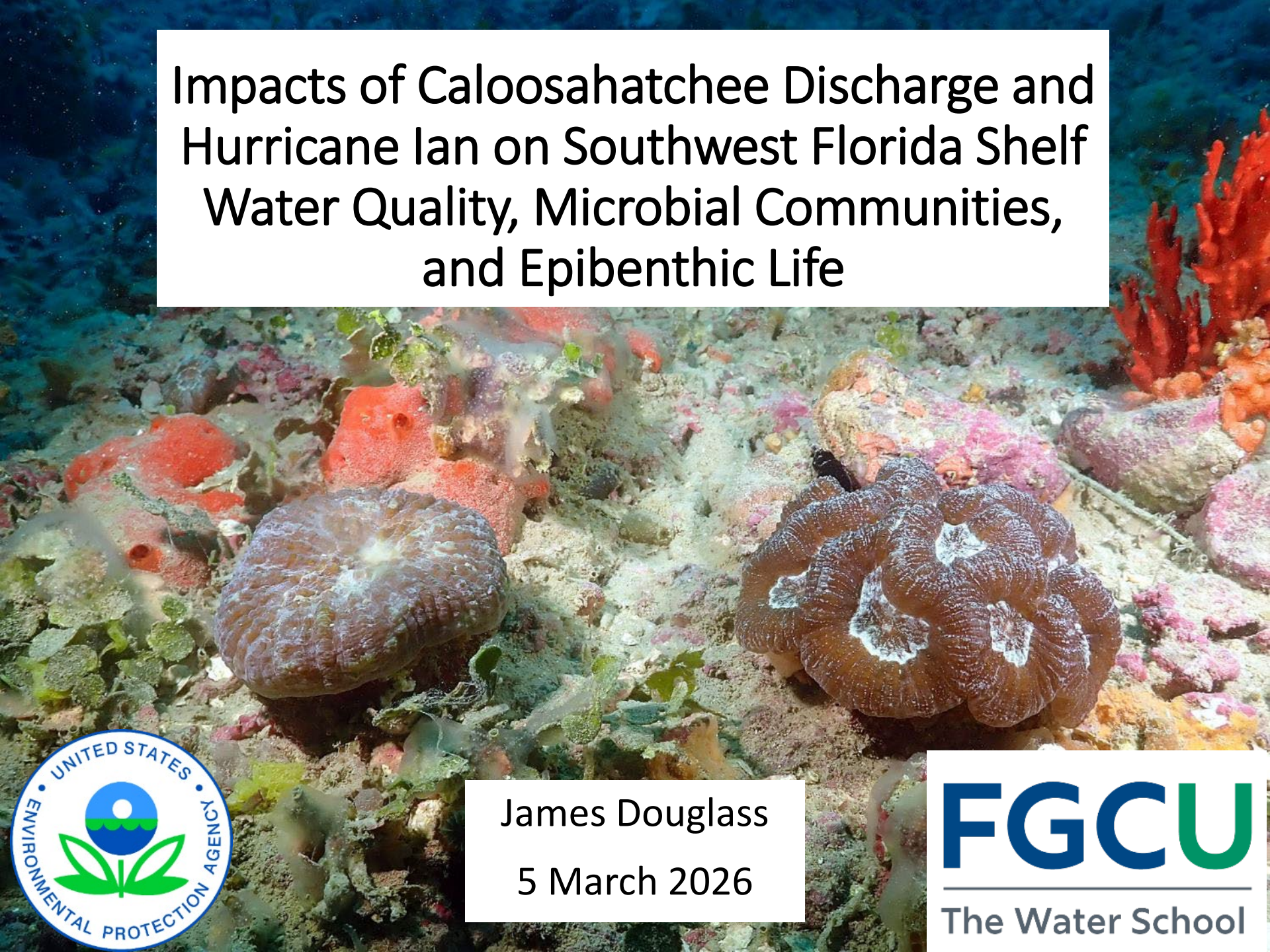
# Impacts of Caloosahatchee Discharge and Hurricane Ian on Southwest Florida Shelf Water Quality, Microbial Communities, and Epibenthic Life



James Douglass

5 March 2026

FGCU
The Water School

# Funding Support

- EPA South Florida- 2021-2024
  - PIs: Douglass, Adhikari, Urakawa, Parsons, Bartleson
- NSF Rapid- 2022-2023
  - PI: Adhikari
  - Hurricane Ian response
- FIO ship time- 2022-2023

# Research Team: PIs

- Epibenthic Community Composition → Me and my students
- Water Quality & Nutrient Sources → Puspa Adhikari

- Microbial Community Composition → Hidetoshi Urakawa

- Benthic-Pelagic Coupling →

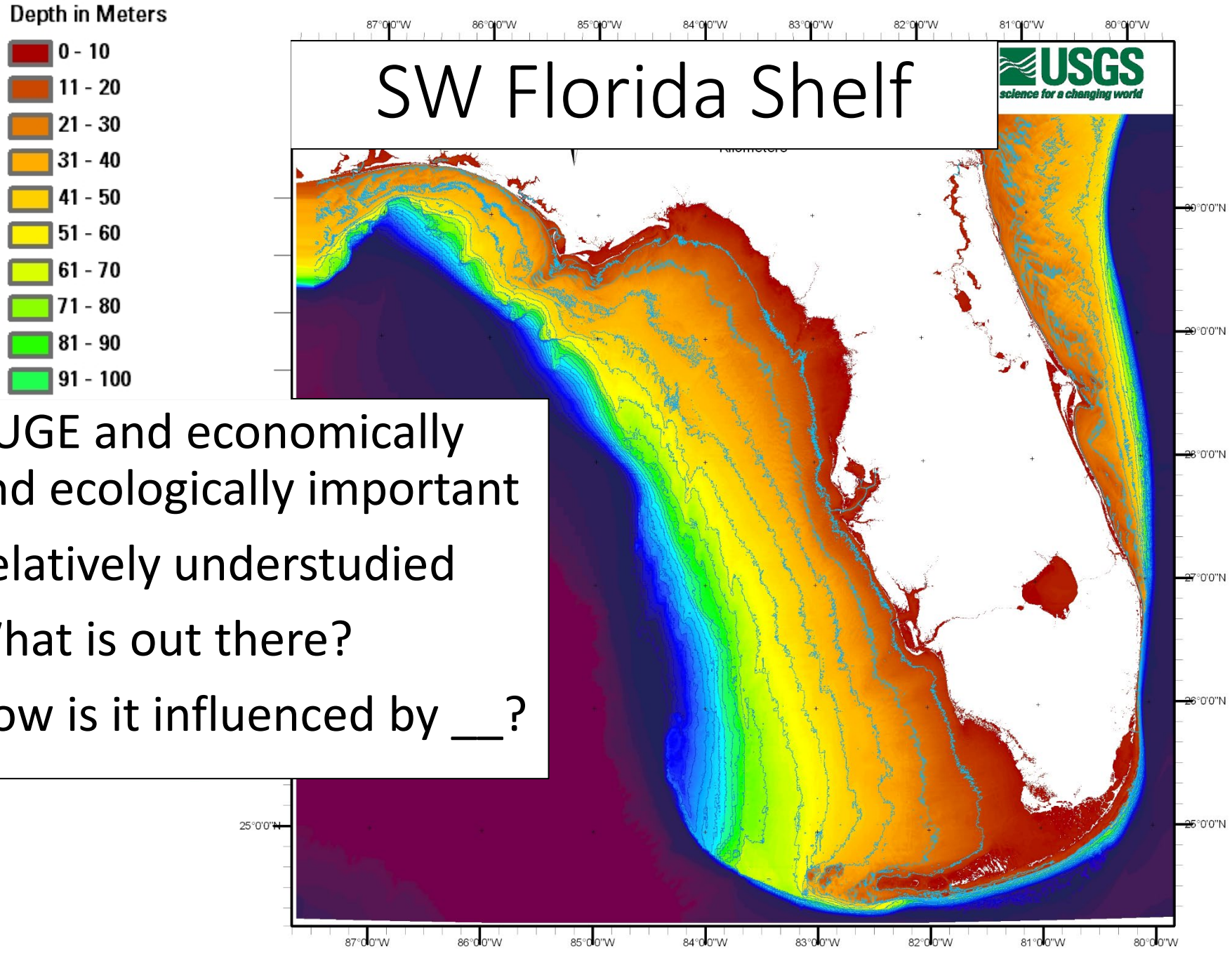
Mike Parsons

Rick Bartleson (SCCF)

# Research Team: Grad Students

- Matthew “Cole” Tillman – MS Env Science 2024
  - **Thesis**: *Effects of substrate type, depth, hurricanes, and proximity to the Caloosahatchee River plume on epibenthic community structure on the Southwest Florida Shelf*
  - **Publication**: Coasts 5(2): 16 https://doi.org/10.3390/coasts5020016
- Trevor Tubbs – MS Env Science 2025
  - **Thesis**: *Seasonal and spatial microbial community dynamics among microbial habitats on the Southwest Florida continental shelf*
  - **Publication**: Coasts 5(4): 47. https://doi.org/10.3390/coasts5040047
- Robert “Marlin” Smith – MS Env Science 2025
  - **Thesis**: *Characterizing Water Chemistry on the Southwest Florida Shelf: A Study of Spatial, Temporal, and Disturbance-Driven Variation*

# SW Florida Shelf




- HUGE and economically and ecologically important
- Relatively understudied
- What is out there?
- How is it influenced by __?

# SW Florida Shelf Substrates & Ecosystem Types

*Phillips et al. (1990) Benthic Biological Studies of the Southwest Florida Shelf. Amer. Zool. 30:65-75*

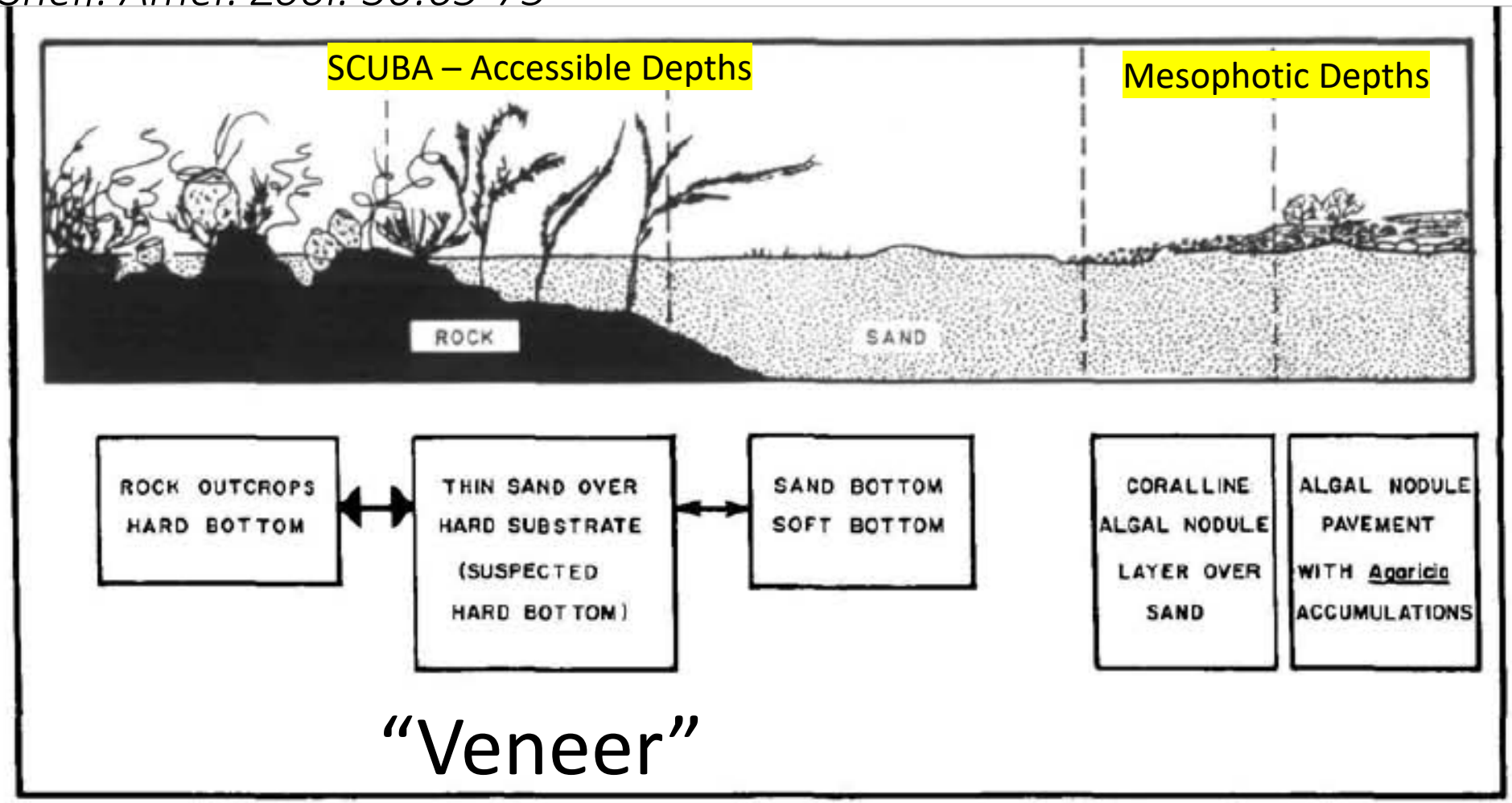
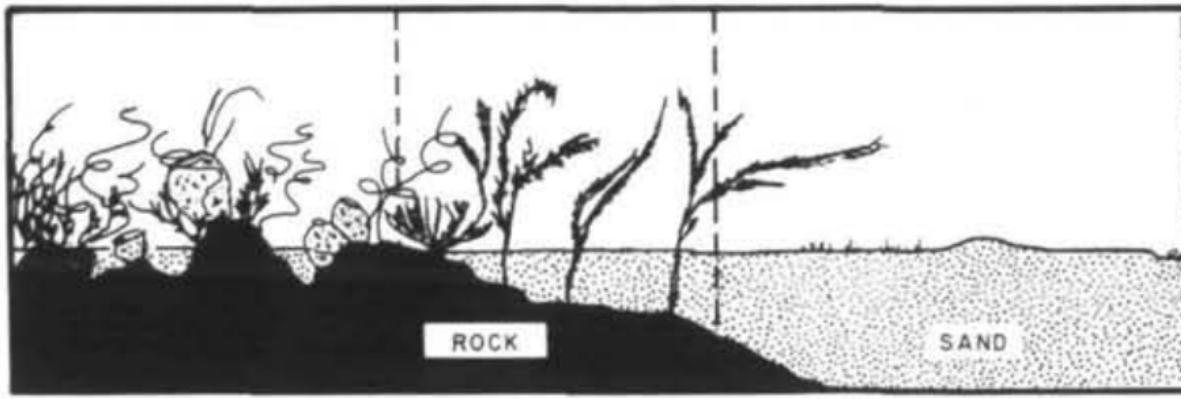
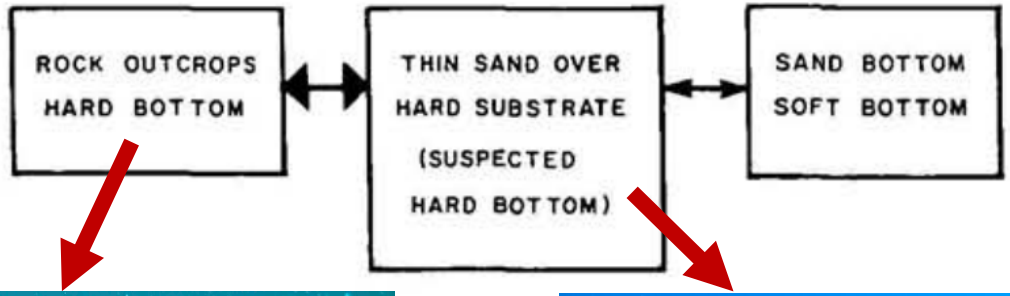
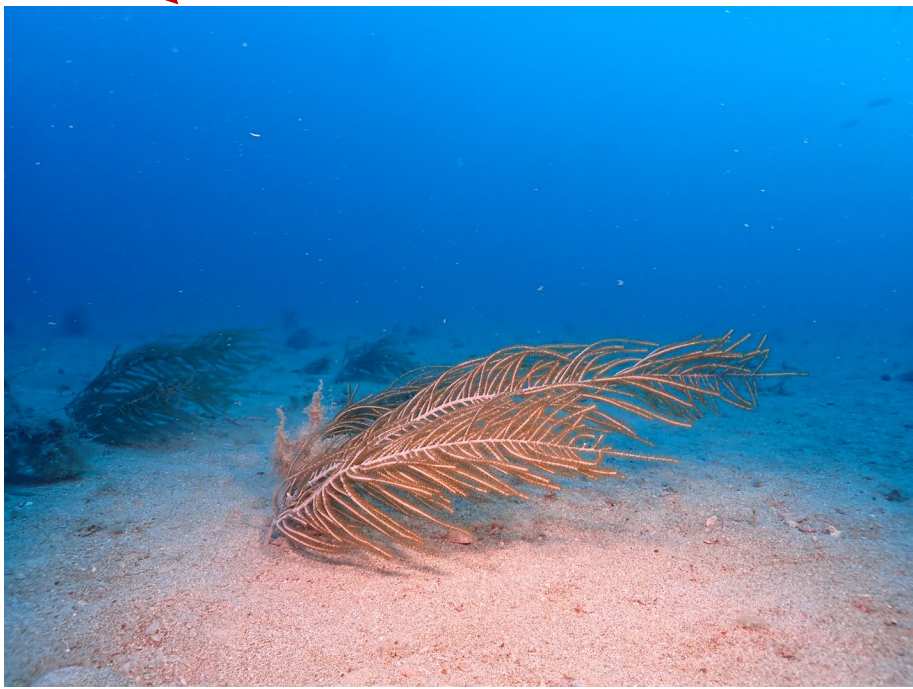
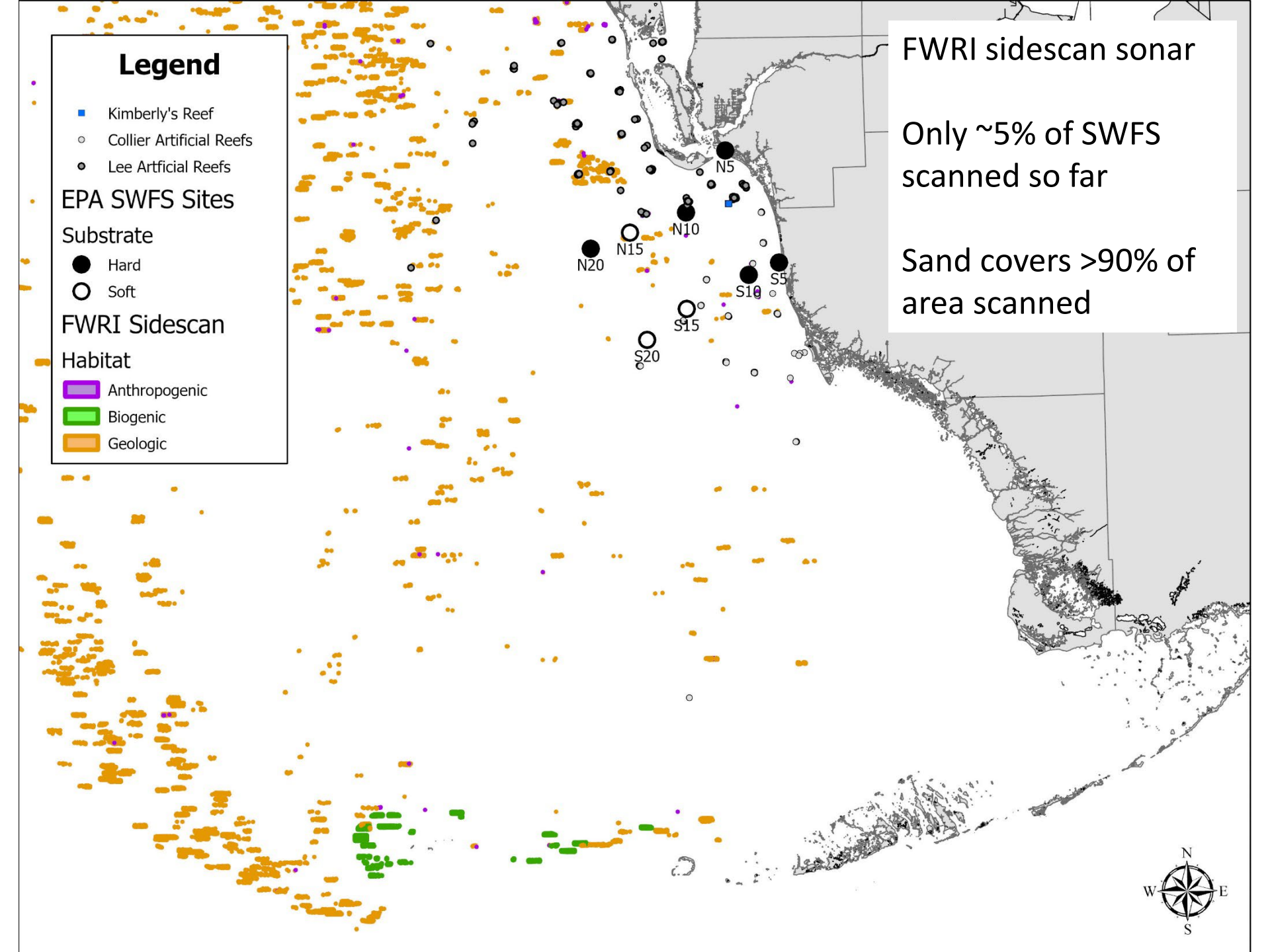



FIG. 3. Schematic illustration of visually recognized substratum types. This combination of substratum types does not necessarily occur together at one location, or along a shelf cross-section.


ROCK
SAND

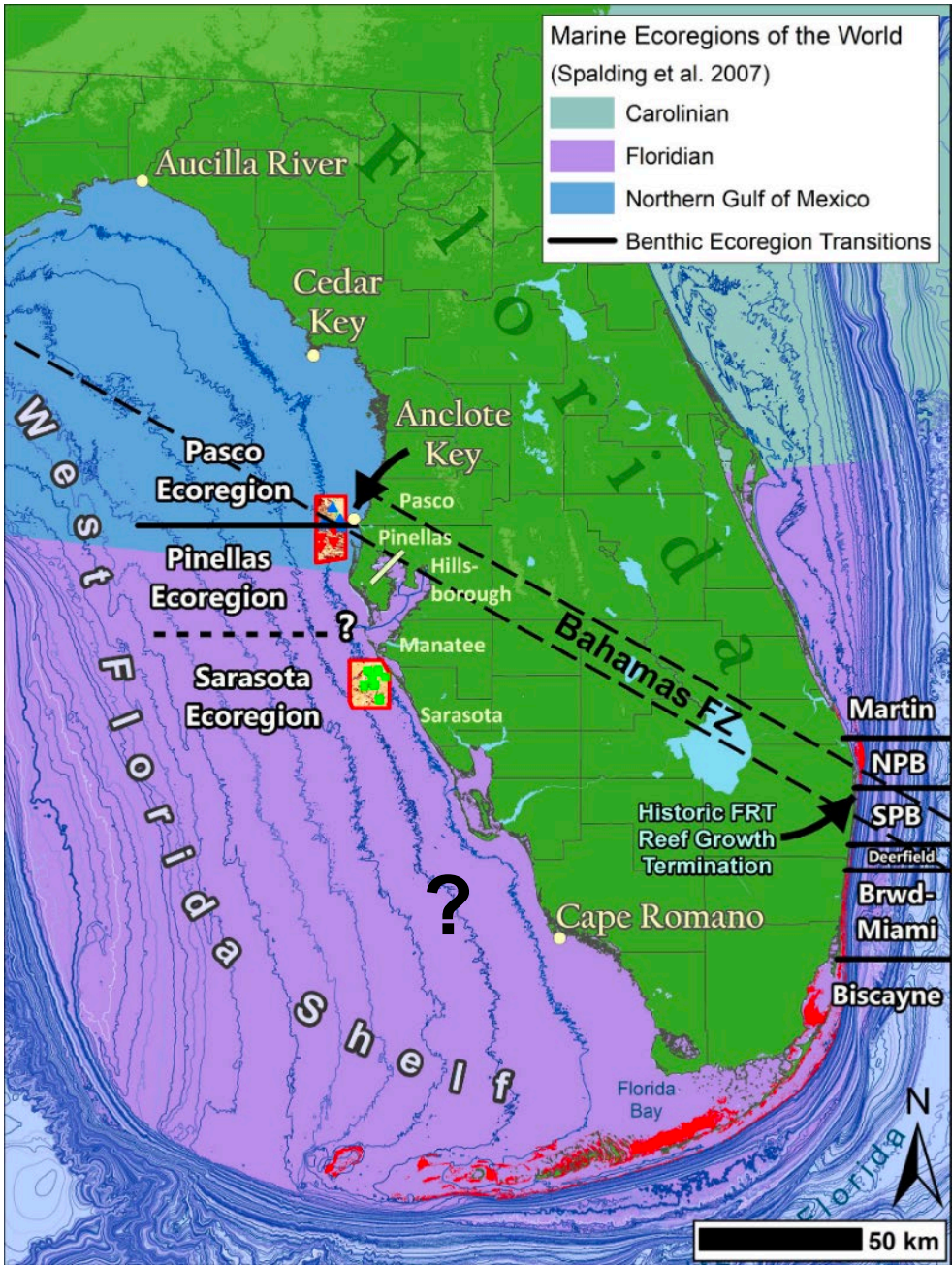

ROCK OUTCROPS
HARD BOTTOM
THIN SAND OVER
HARD SUBSTRATE
(SUSPECTED
HARD BOTTOM)
SAND BOTTOM
SOFT BOTTOM




Legend
Kimberly's Reef
Collier Artificial Reefs
Lee Artficial Reefs
EPA SWFS Sites
Substrate
Hard
Soft
FWRI Sidescan
Habitat
Anthropogenic
Biogenic
Geologic
N5
N10
N15
N20
S5
S10
S15
S20
FWRI sidescan sonar
Only ~5% of SWFS scanned so far
Sand covers >90% of area scanned
N
W
E
S

# West FL Shelf Biogeography

- Ecoregion boundaries between Pasco and Sarasota counties
- Changes from Sarasota to Florida Keys not as well known
- Caloosahatchee River impacts likely significant




(Spalding et al. 2007, Walker et al. 2020)

# Caloosahatchee River “Plume”

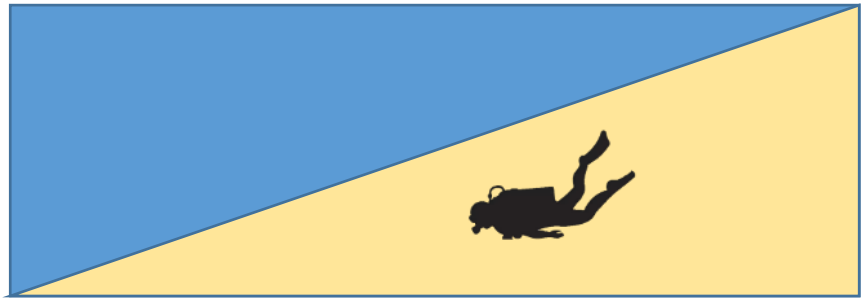

Photo taken 3 November 2020 by Ralph Arwood

# Our Study Design Considerations

## Caloosahatchee Plume

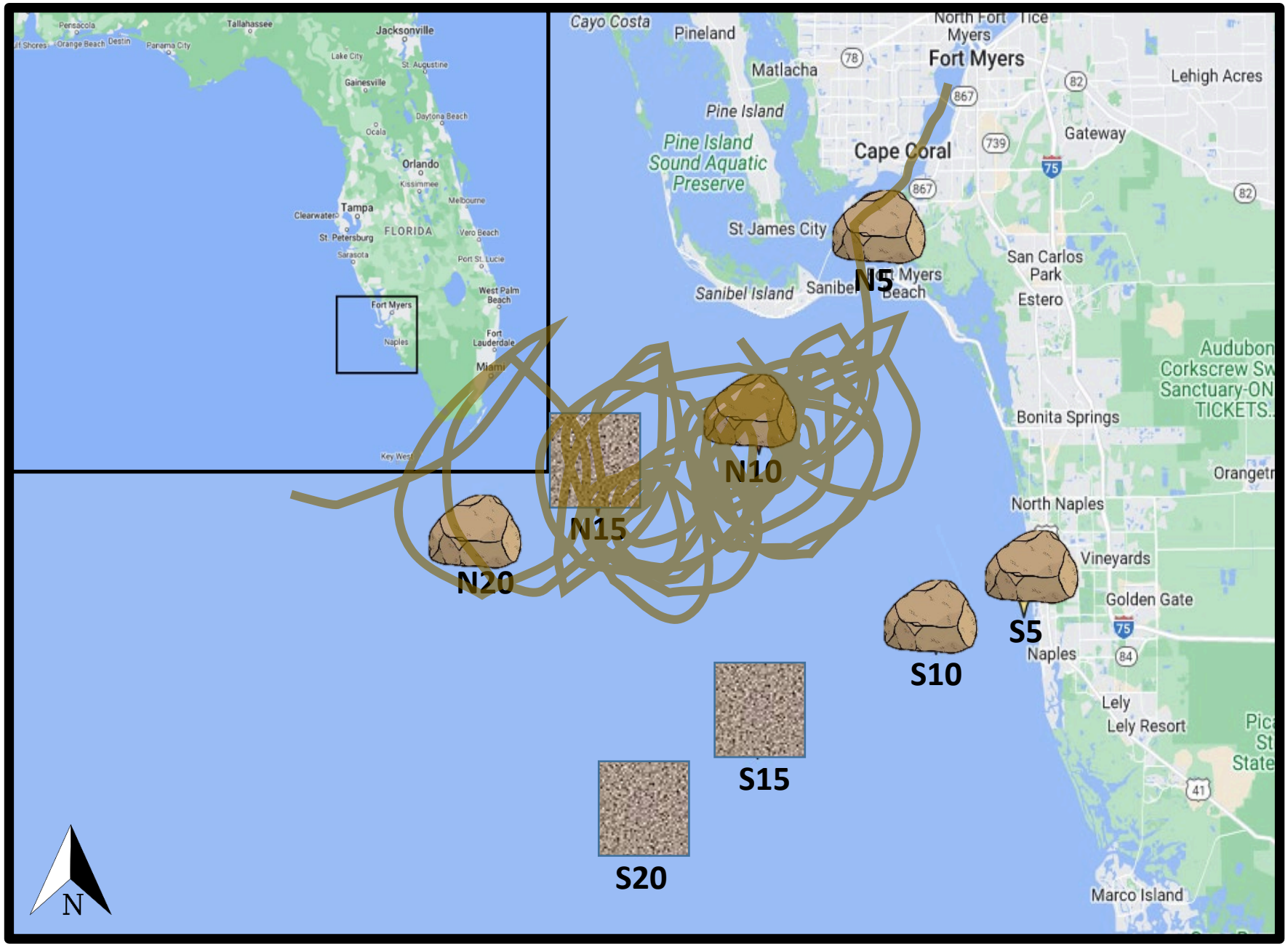
## Substrate Types


## Depth (5-20 m)



+Seasonal changes
+Disturbance effects if something happens

# Final Site Selection



# Sampling Timeline

- Bimonthly sampling for a year, began in June 2022
  - Round 1- June – July 2022
  - Round 2- Aug – Sep 2022
  - Round 3- Oct – Nov 2022 **(POST HURRICANE IAN)**
  - Round 4- Dec 2022 – Jan 2023
  - Round 5- Feb – Mar 2023
  - Round 6- Apr – June 2023
  - Round 7- July – Aug 2023

FGCU Vessels

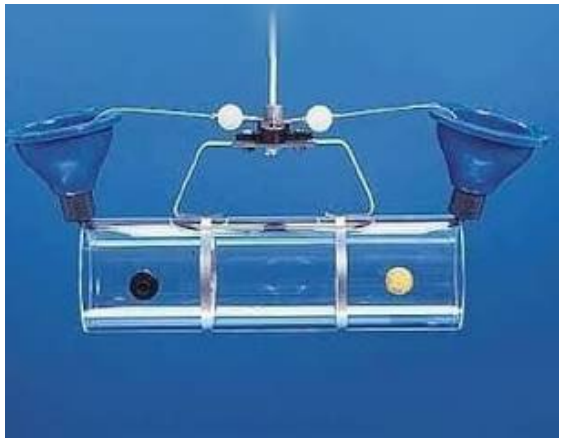
FIO Vessel

# Collecting Water Quality Data

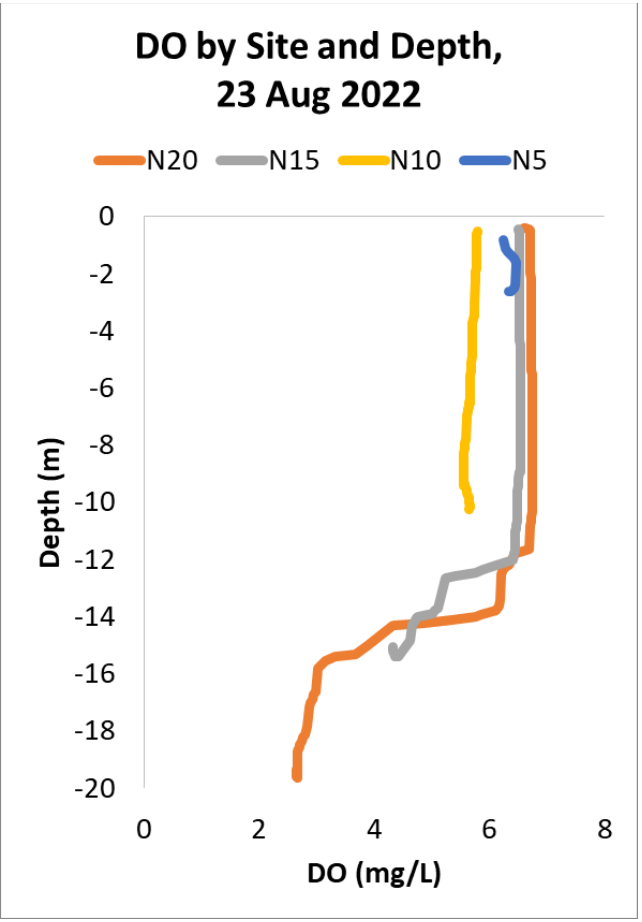
- Trevor Tubbs and Marlin Smith

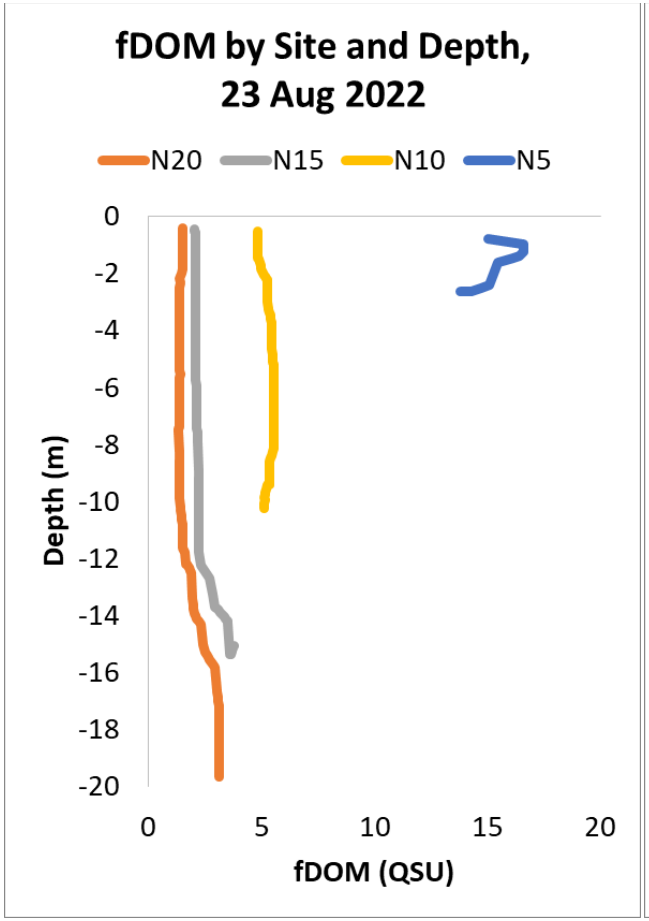
# Collecting Water Quality Data

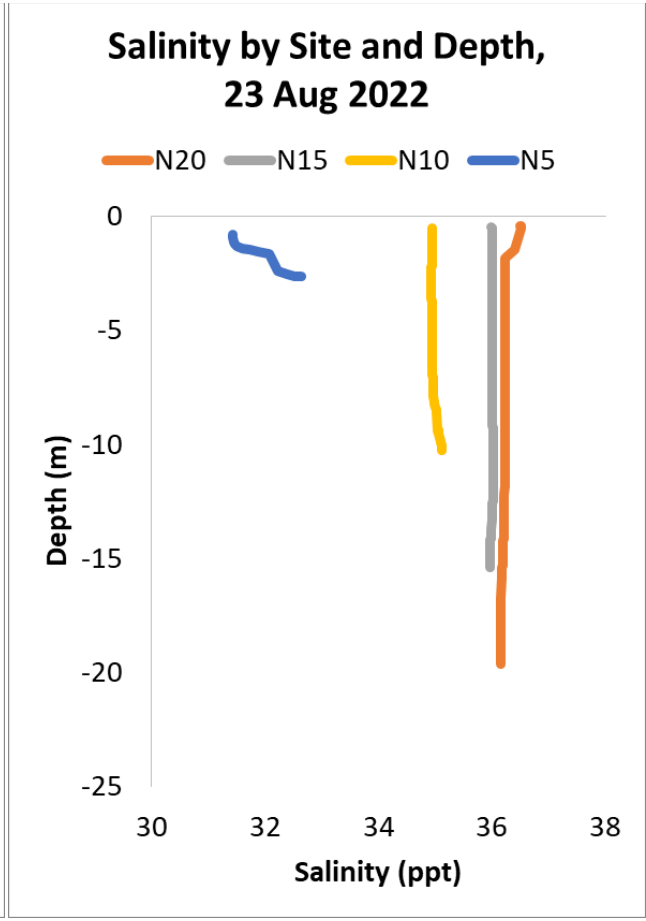
- Vertical water column profiles collected using a YSI EXO II multiparameter sonde
  - Salinity, DO, turbidity, etc.
- Grab samples of water collected at surface, middle depth, and near bottom with Van Dorn sampler
  - Chlorophyll *a*, nutrients, fDOM, DIC, etc.
- Bulk water samples for Radium

# Example water column profiles




Inshore-offshore gradients as expected, low DO in bottom water of deeper sites

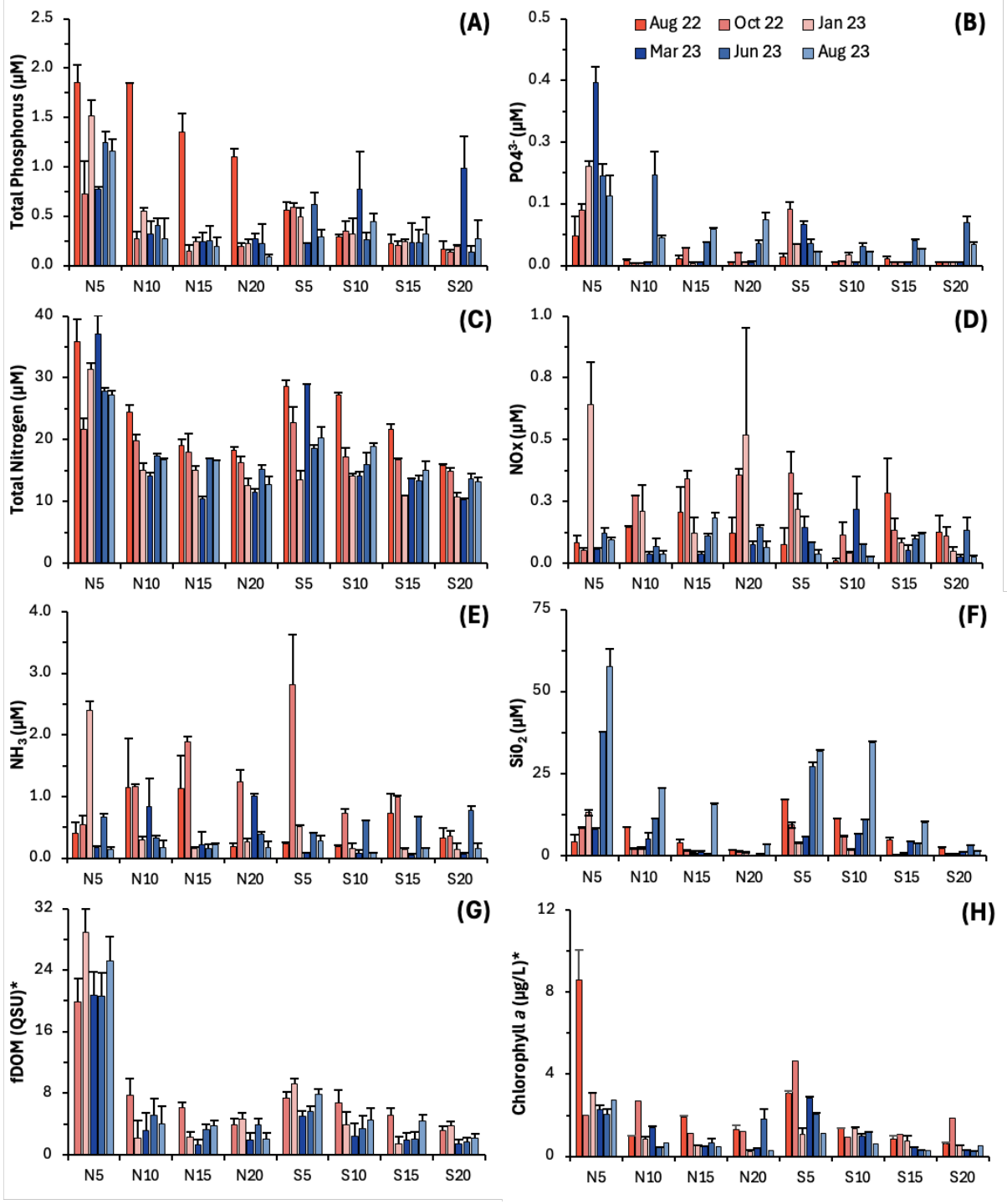

N20 July 2022 – Pretty Clear


N20 August 2022 – Green, low DO at bottom

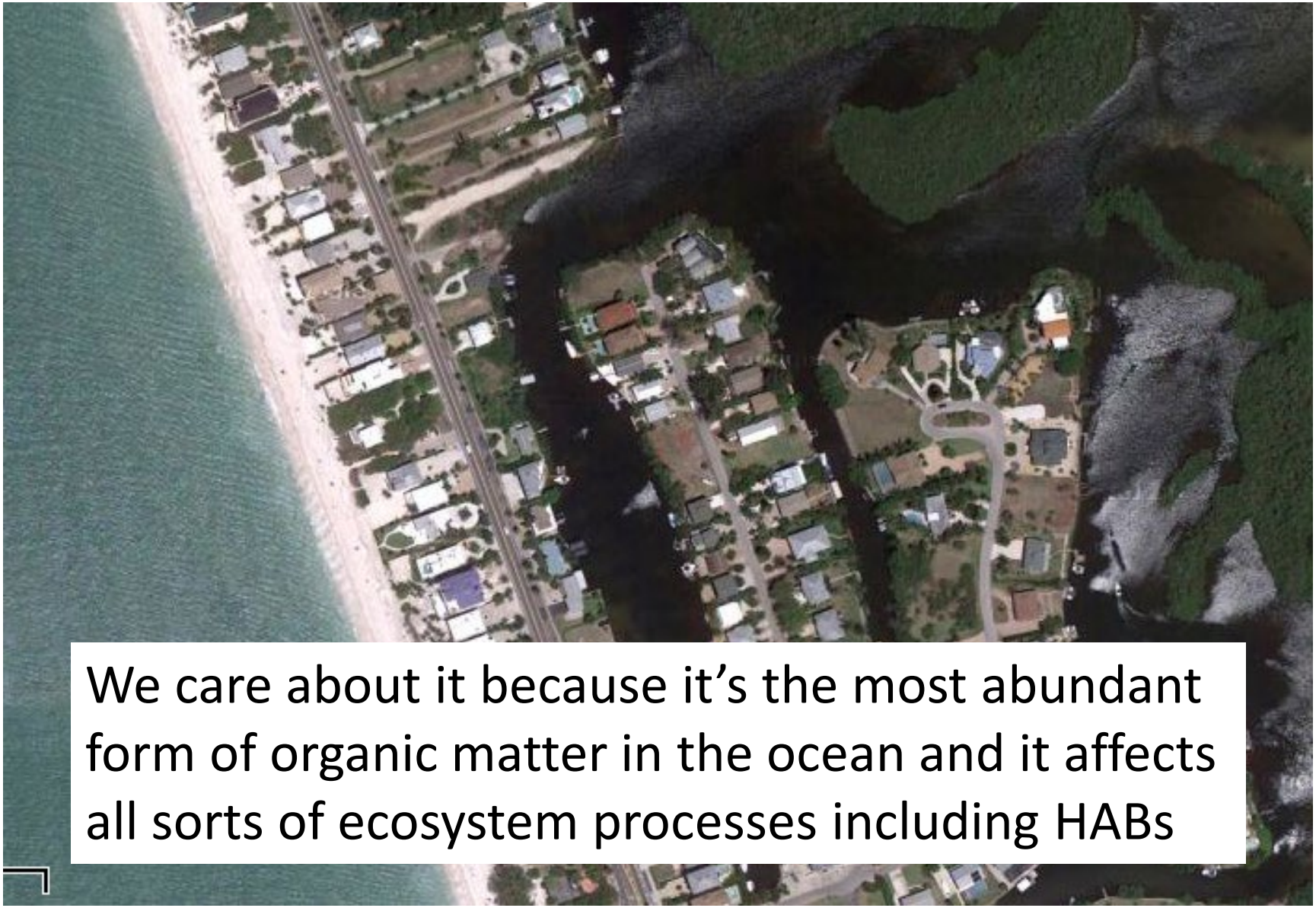
# N20 October 2022 – Dark, turbid, tannic… but more DO

# Water Quality Patterns

- Nutrients, Chlorophyll, and DOM generally decreased with distance from shore and from Caloosahatchee

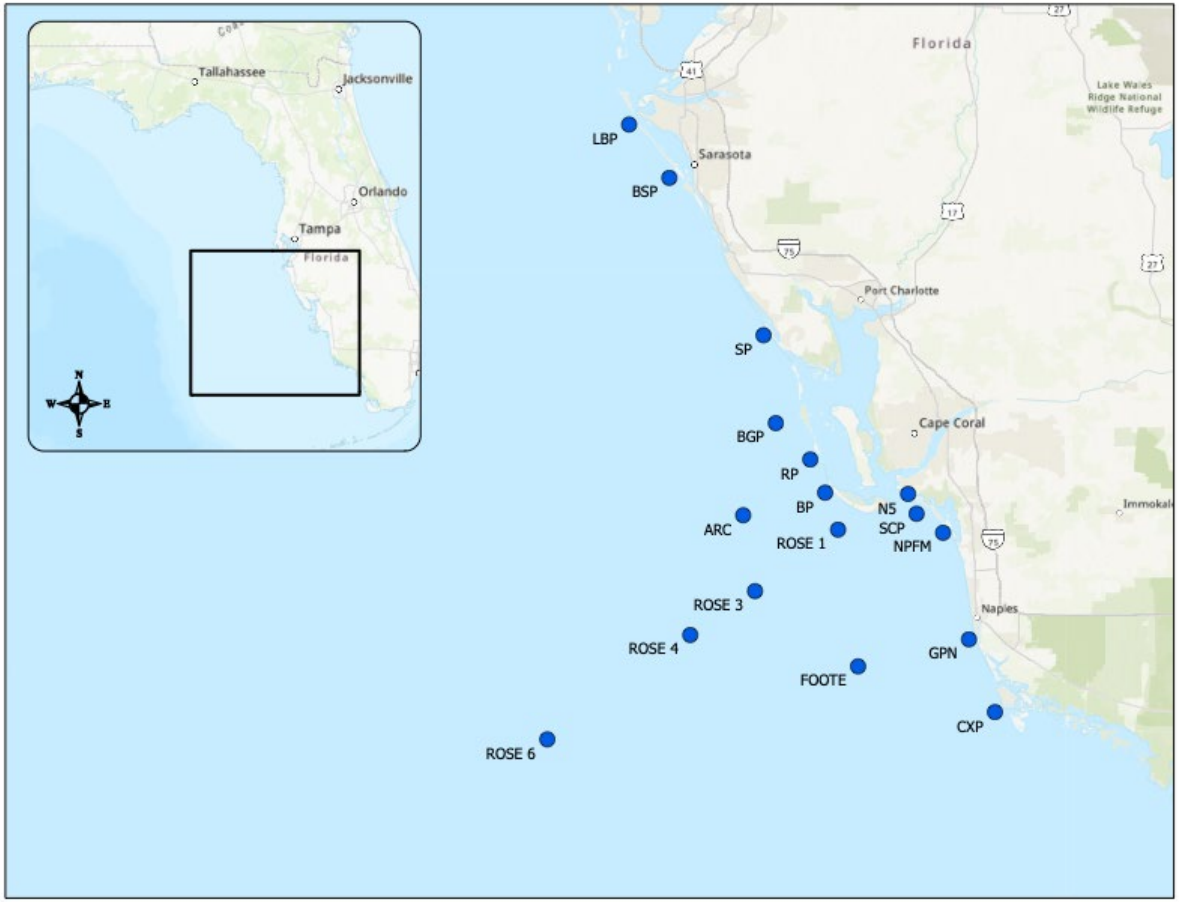


# DOM: Dissolved Organic Matter

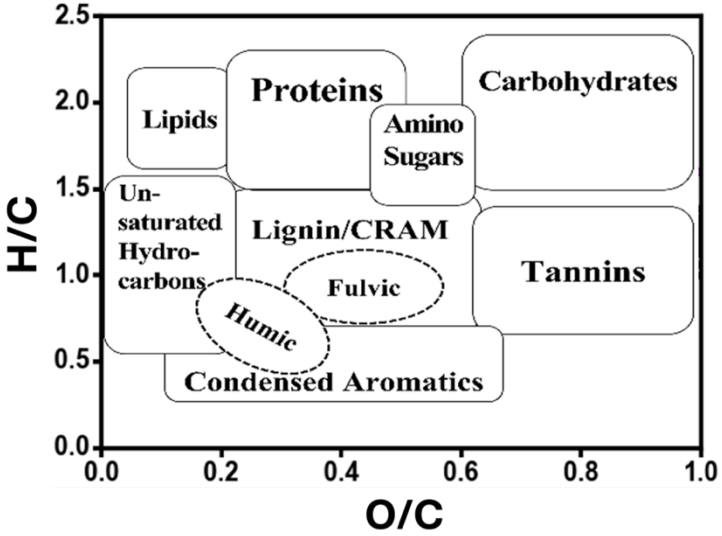


We care about it because it's the most abundant form of organic matter in the ocean and it affects all sorts of ecosystem processes including HABs

# Adhikari & Smith's DOM Study

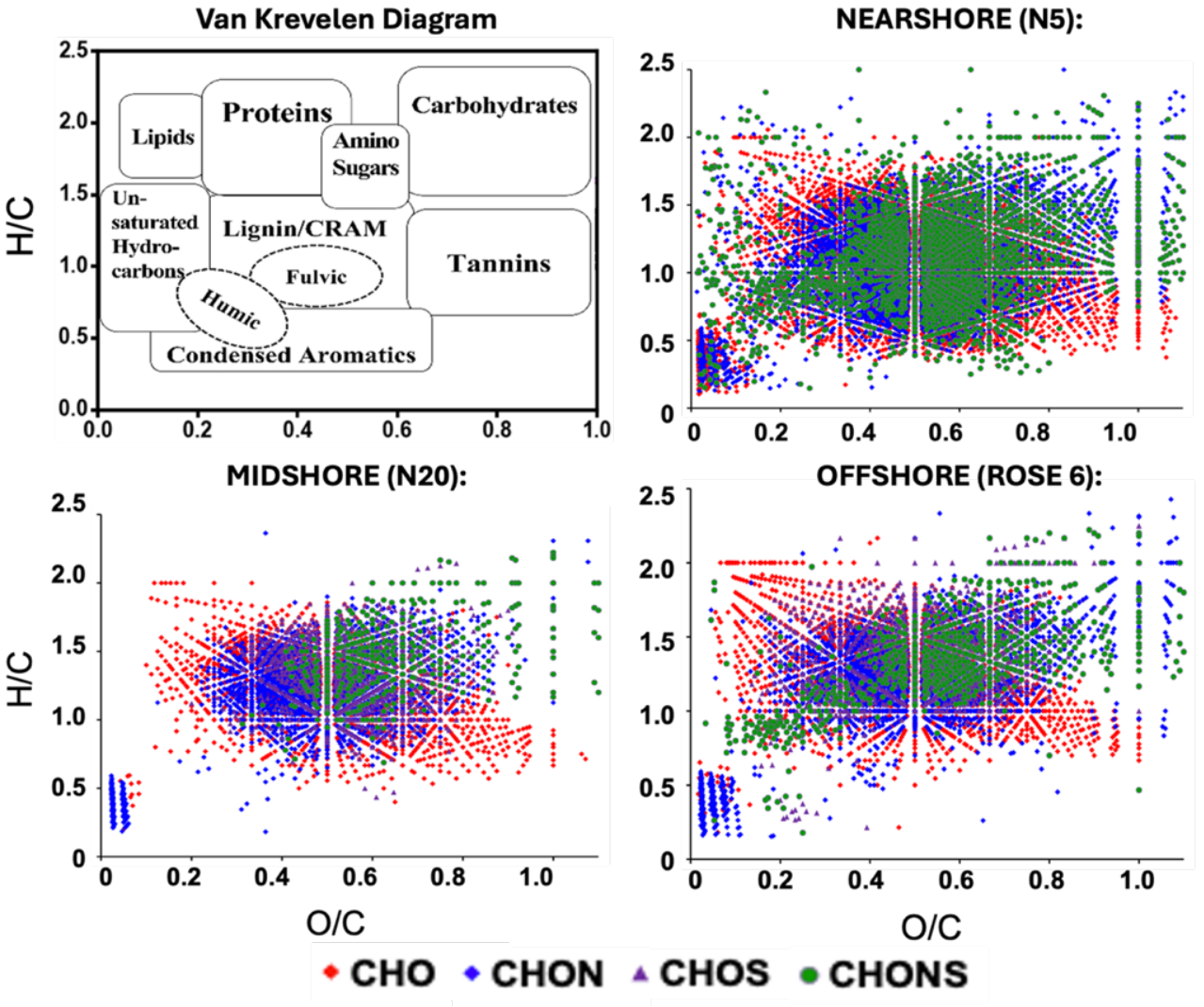



- Samples analyzed in super powerful mass spectrometer in Tallahassee to characterize the different molecular components of the DOM




Van Krevelen diagram showing the distribution of different biomolecular classes based on their hydrogen to carbon (H/C) and oxygen to carbon (O/C) molar ratios.

- More terrestrial allochthonous material near shore
- More autochthonous / reprocessed material offshore

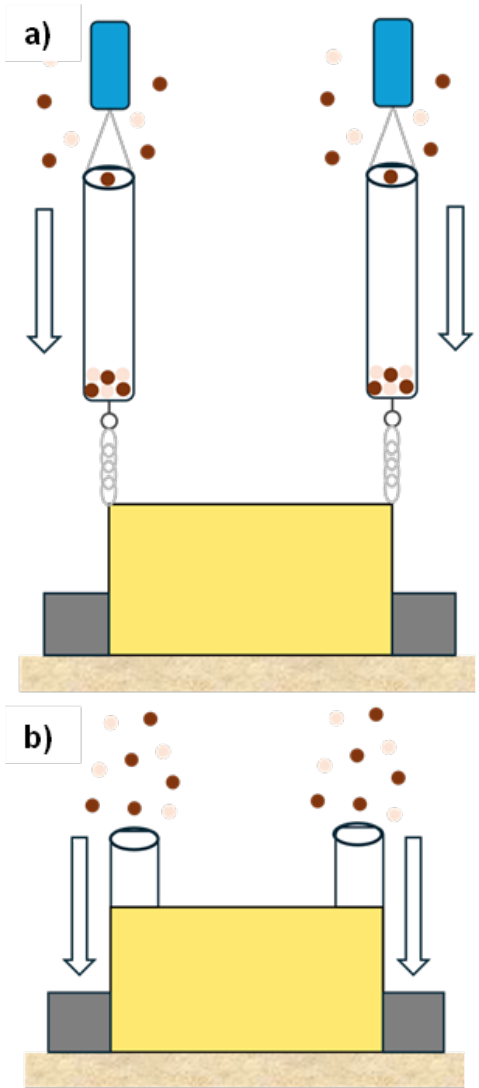


# Water Quality Summary

- Strong inshore-offshore gradients in nutrients, chlorophyll, and DOM
- Nearshore near Caloosahatchee worse than nearshore near Naples
- Chronic WQ stresses punctuated by acute disturbance impacts (e.g., bloom and storm events)
- Submarine groundwater discharge is patchy but important nutrient source to nearshore shelf

# Microbial Data Collection

- Water Column Microbes (WC)
  - Surface and Bottom
- Particle-Attached Microbes (PA)
  - Sediment traps (a & b)
- Sediment Microbes (SED)
  - Scooped by divers or taken from Shipek Grab
  - Sediment characteristics also assessed
- 16s rRNA amplicon sequencing
  - Data in the form of “amplicon sequence variants” (ASV)

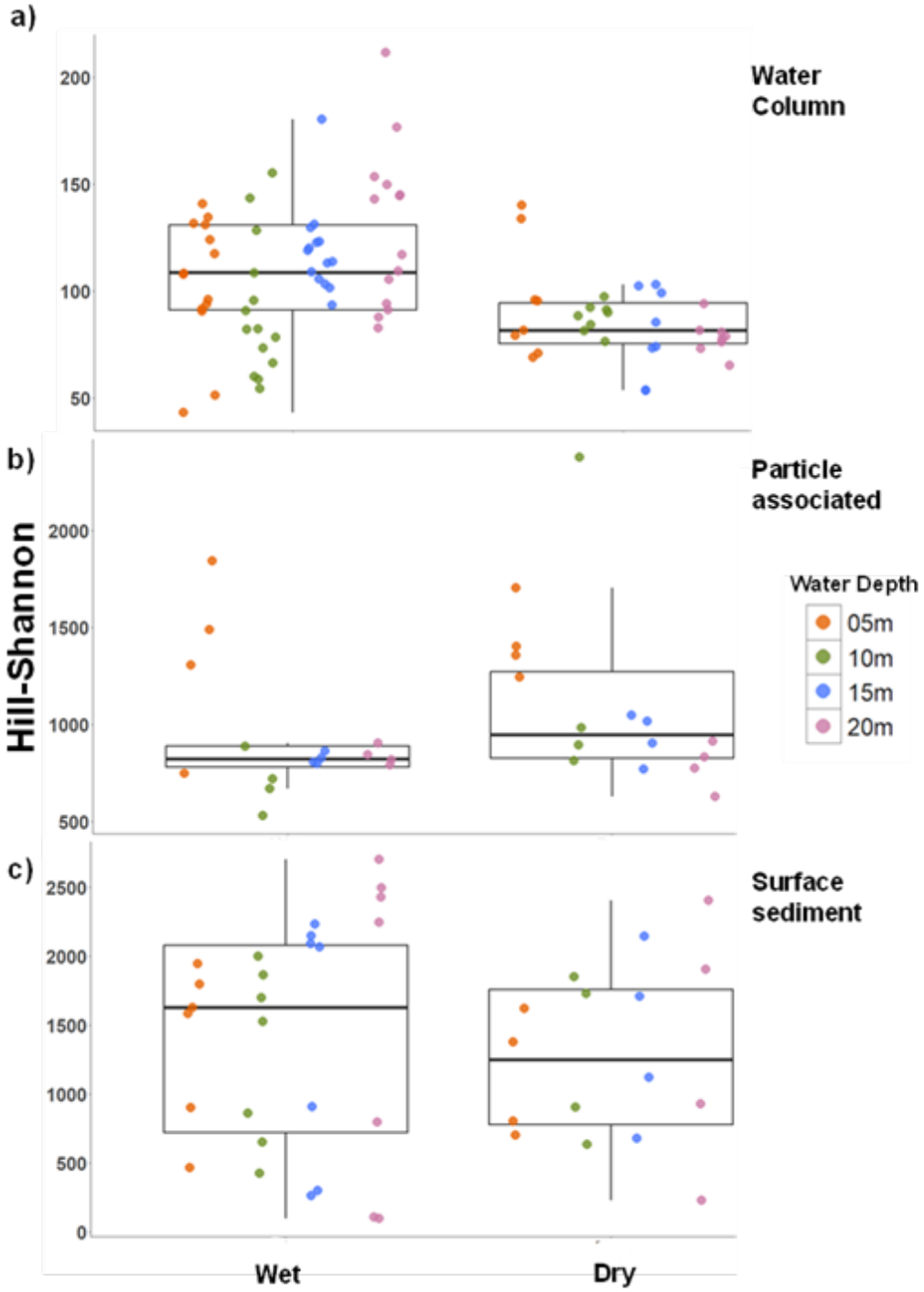


# Microbial Data Analyses

- Diversity
- Species (ASV) composition
- Taxonomic / functional composition
- Multivariate comparisons among sites, seasons, sample types, etc.

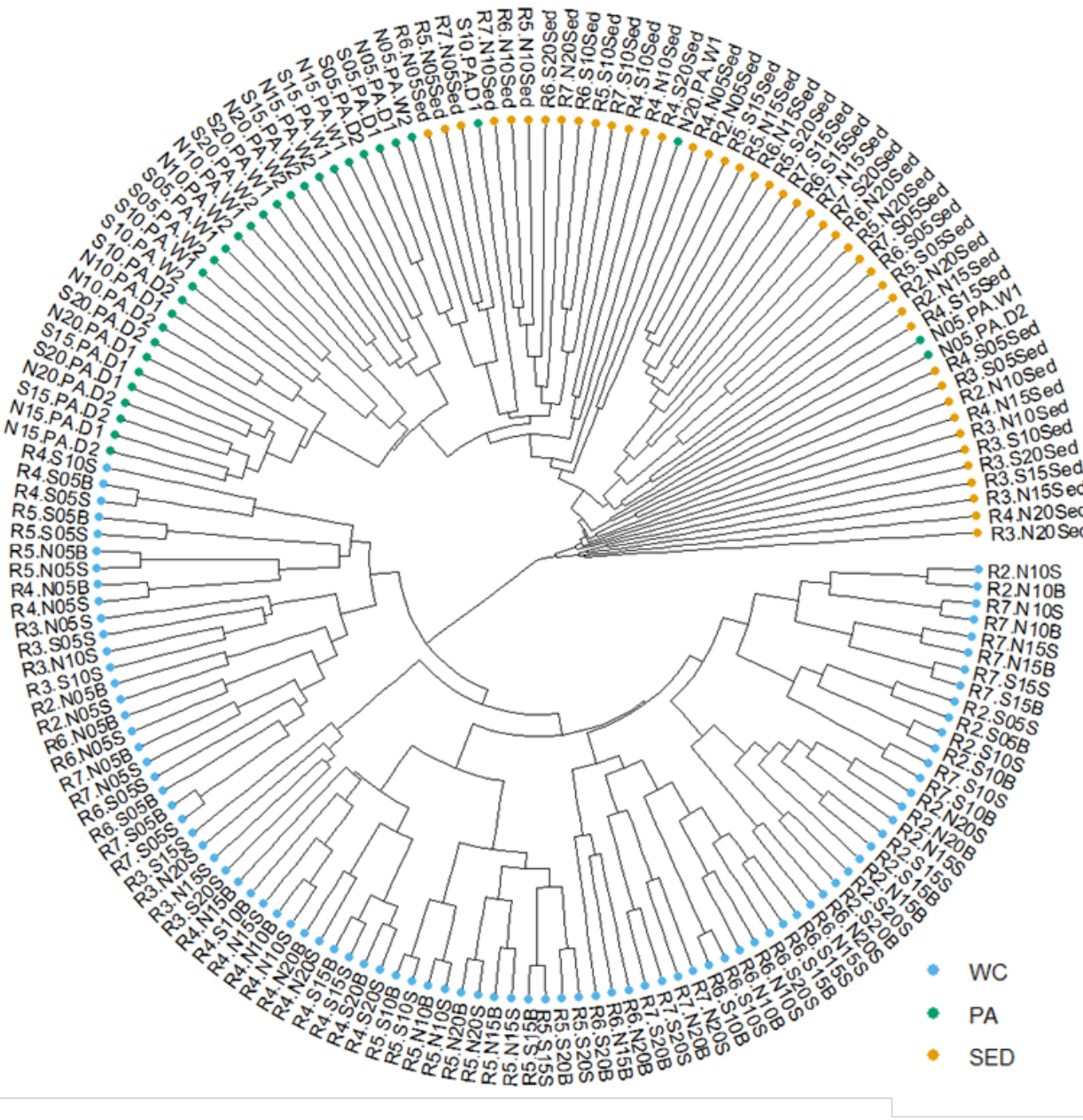
# Microbial Diversity

- Water column microbes more diverse offshore and in wet season
- Particle-associated microbes most diverse inshore and in dry season
- Sediment microbial communities 10x more diverse than water column ones



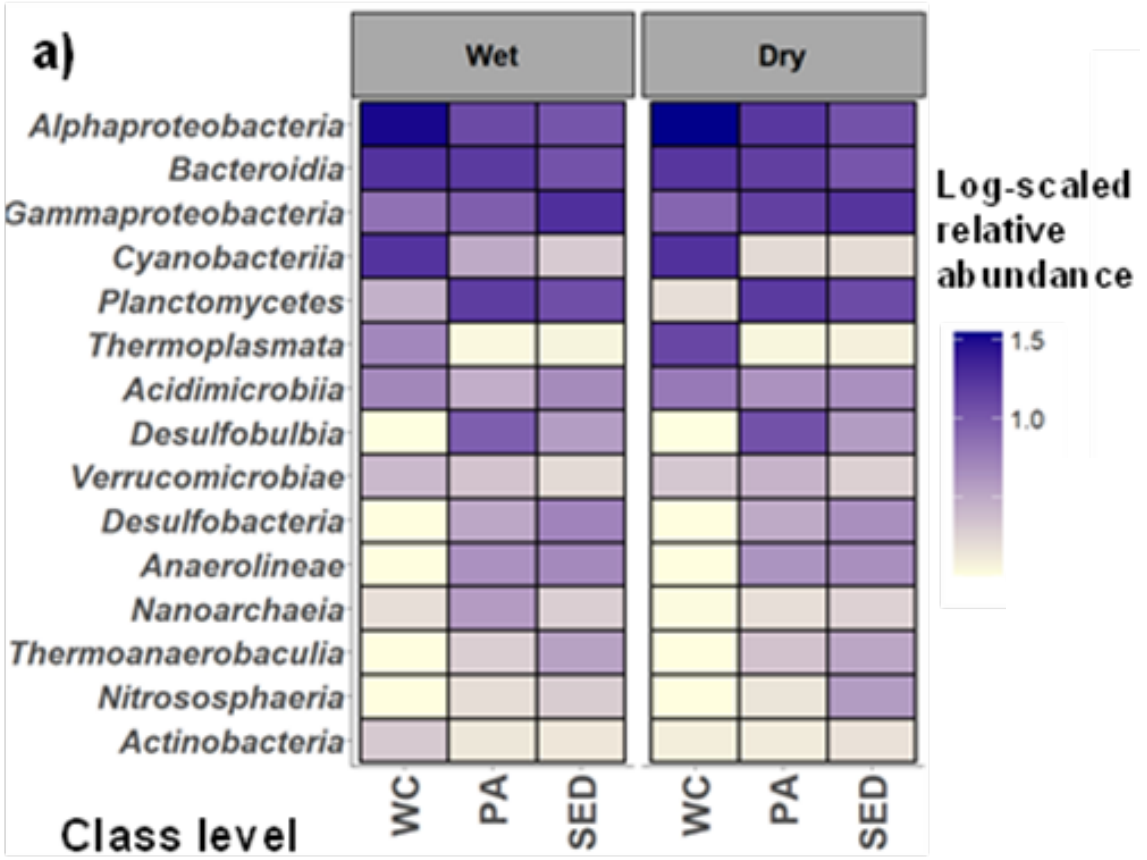
# Microbial Community Composition

- Sediment (SED) and particle-associated (PA) microbial communities more similar to each other than either was to water column (WC) communities



# Class level microbial patterns

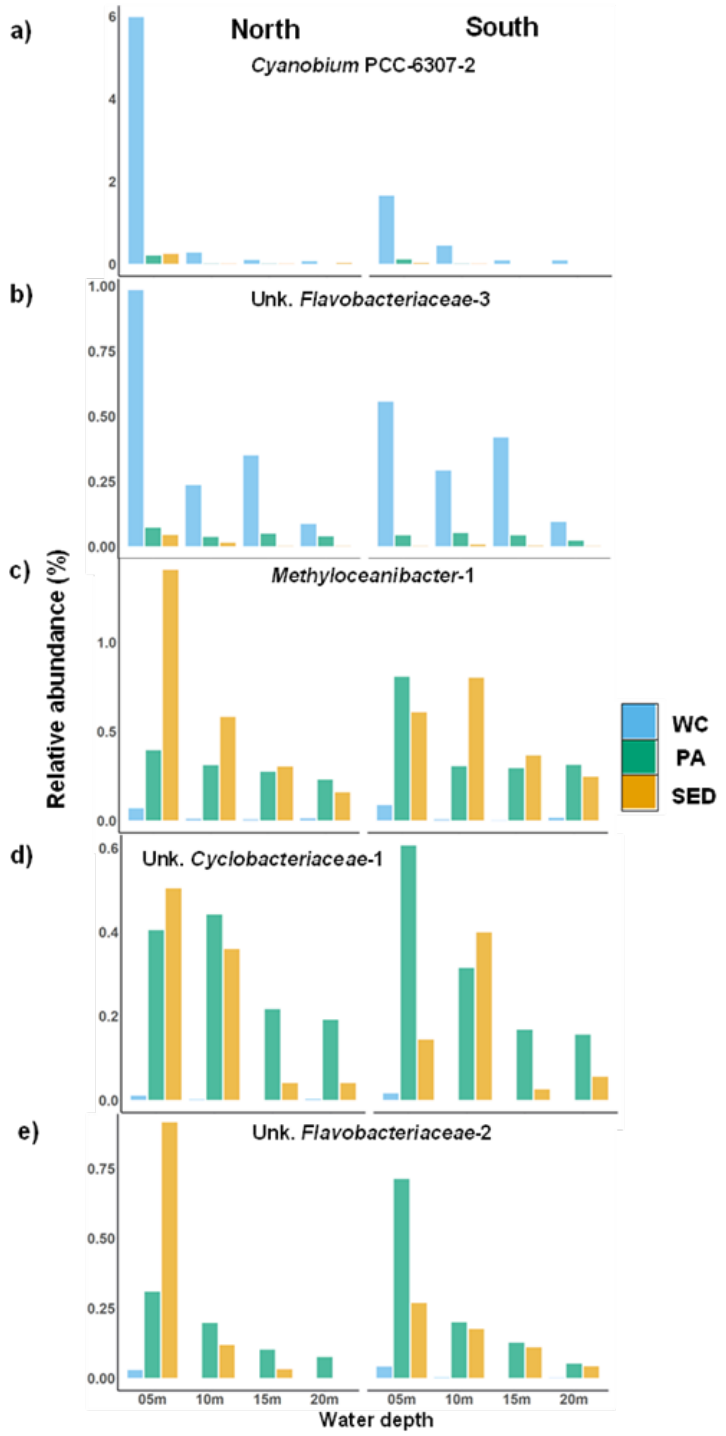
- Water column dominated by *Cyanobacteriia*, *Thermoplasmata*, and *Actinobacteria*
- Sediment and particle-associated dominated by *Planctomycetes*, sulfate-reducing bacteria (SRB) (*Desulfobulbia* and *Desulfobacteria*), and ammonia-oxidizing archaea (AOA) *Nitrososphaeria*



# Microbial Indicator Taxa

- Certain microbes could be good indicators of freshwater influence

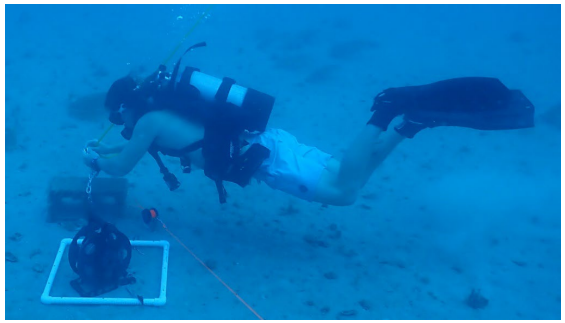
- Other microbes, specialists in processing algal-derived carbohydrates, respond to fluxes of algal organic matter



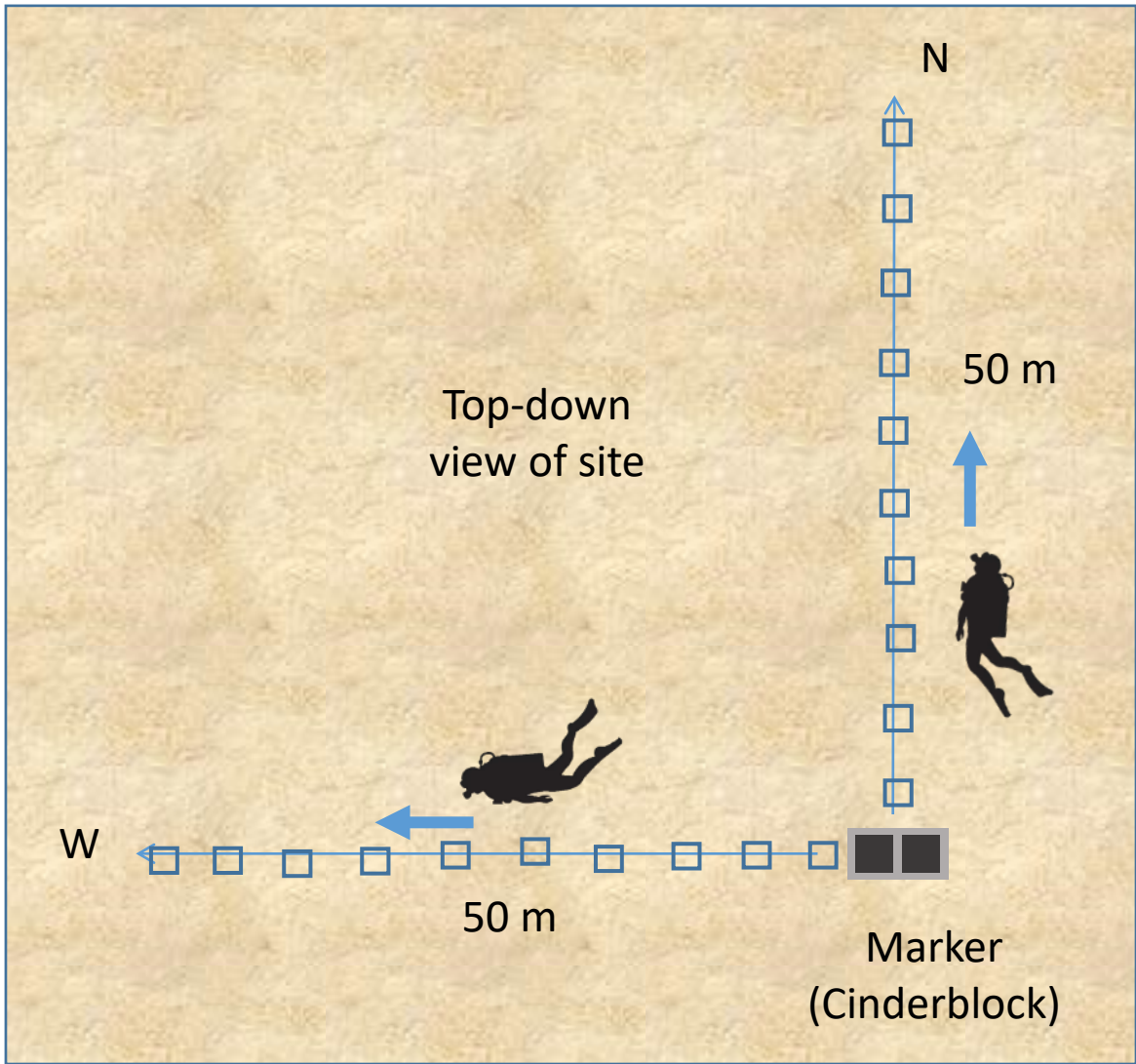
# Microbial Communities Summary

- Inshore-offshore zonation and seasonal changes
- Terrestrial/Freshwater/Estuarine indicator taxa associated with Caloosahatchee plume
- Similar microbial communities in sediments and sinking particles, indicating resuspension
- Influx of decaying algal material drives wet season microbial changes

# Collecting Macrobenthic Community Data



- 2x 50 m transects
- 10 photos of 50x50 cm quadrat, every 5 meters along transect
- Video on swim back to marker



# Benthic Cover Categorization: Hierarchical

- Abiotic Major Categories
  - Hard Bottom
  - Shell Hash
  - Sand/Mud
- Biotic Major Categories
  - Fleshy macroalgae
  - Calcareous Green Algae (CGA)
  - Seagrass
  - Sponge
  - Soft Coral
  - Stony Coral
  - Other Invertebrates

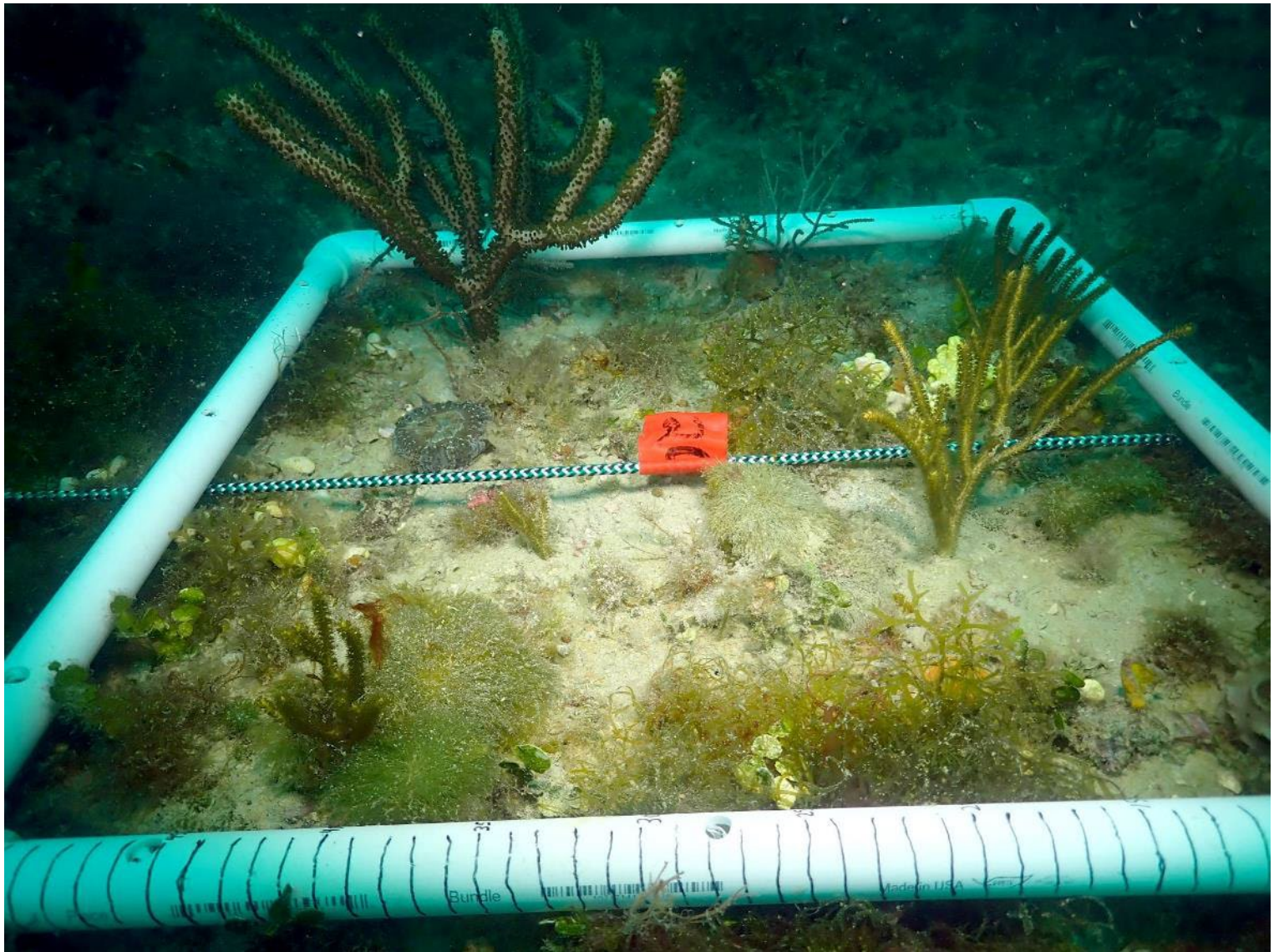
Subdivided to genus/species level in photographs

# Quadrat Photo Analysis

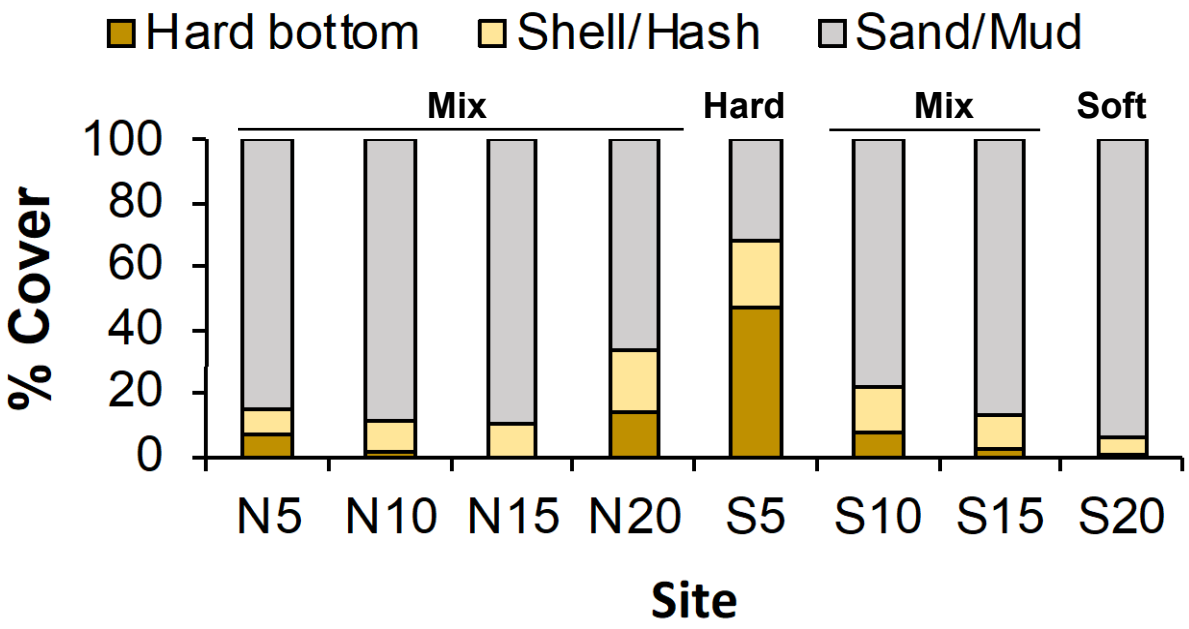
- Coral Point Count software (CPCe)
- 100 points per photo
- ID to Genus/Species where possible


Kohler and Gill 2006

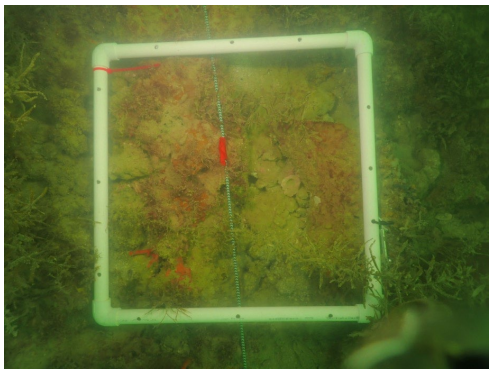
# Side-profile pictures used to help with species identification



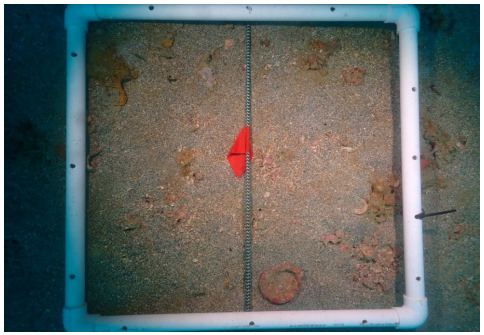
# Substrate Categorization



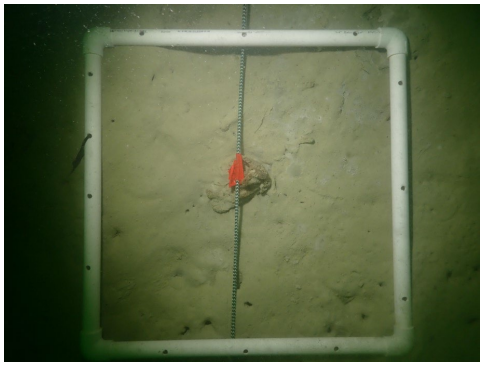

Hard: > 50% Hard bottom (HB) and Shell/Hash (S/H)



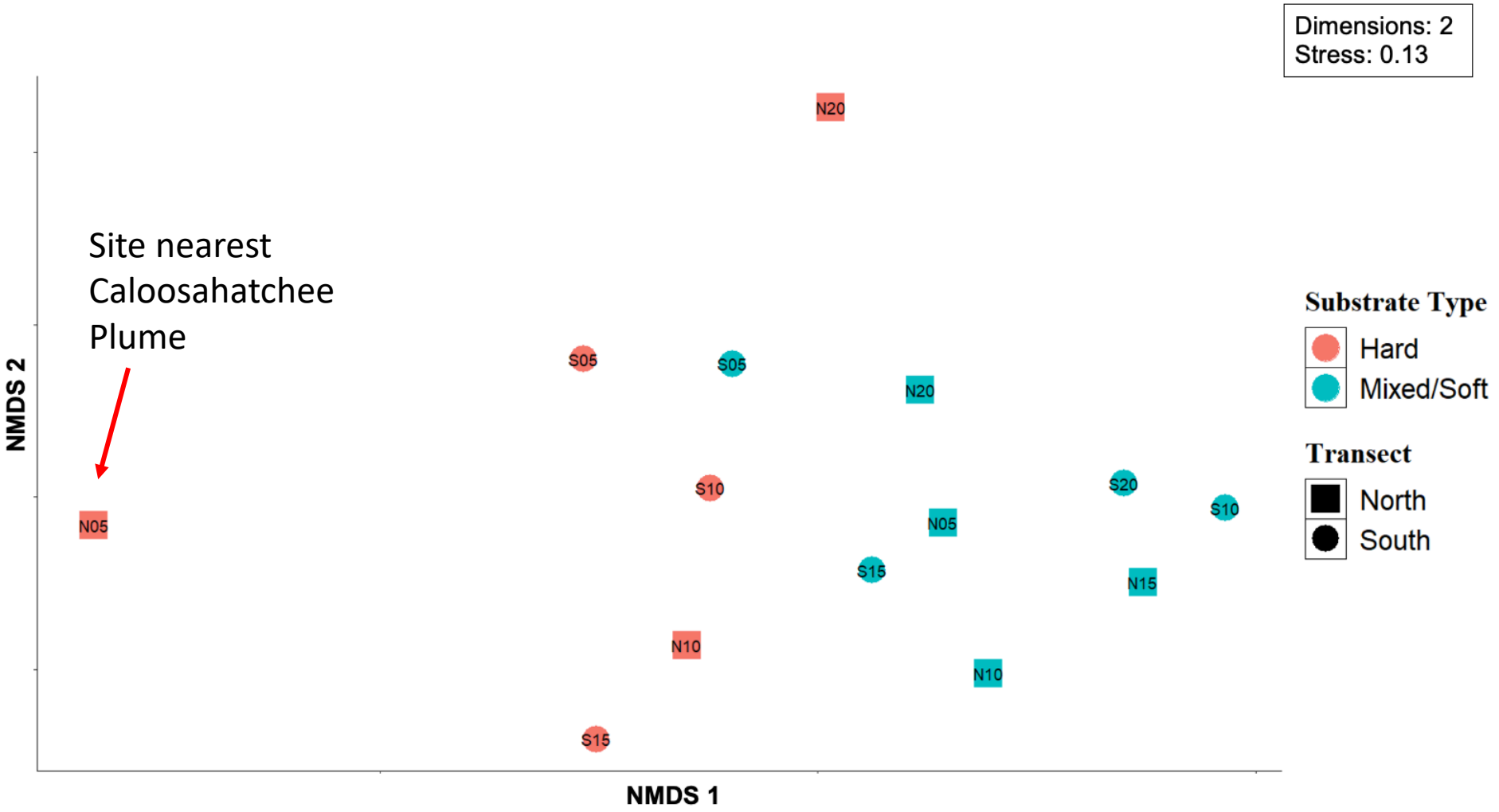
Mixed: ≤ 50% HB and S/H, ≥10% HB and S/H

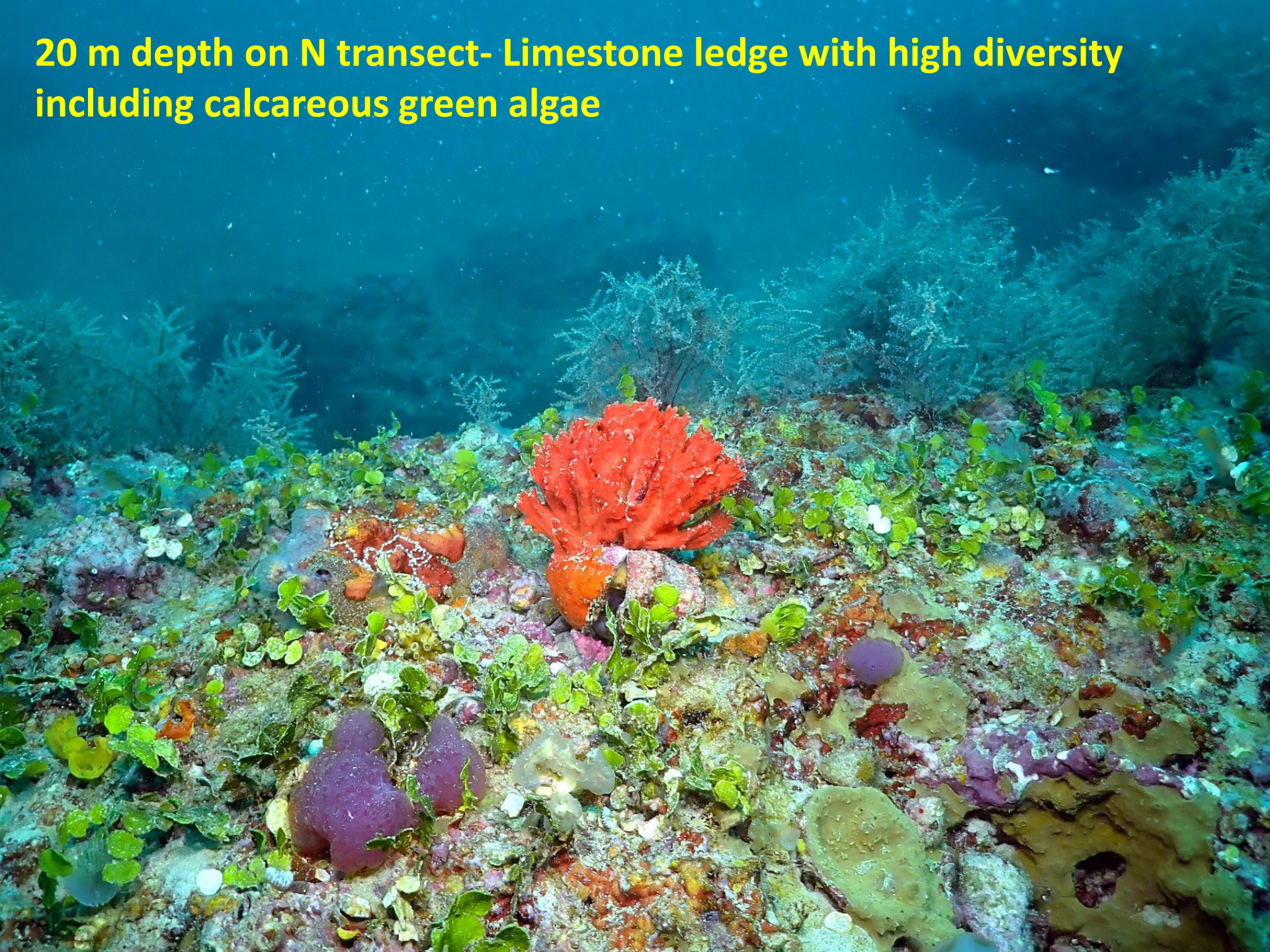


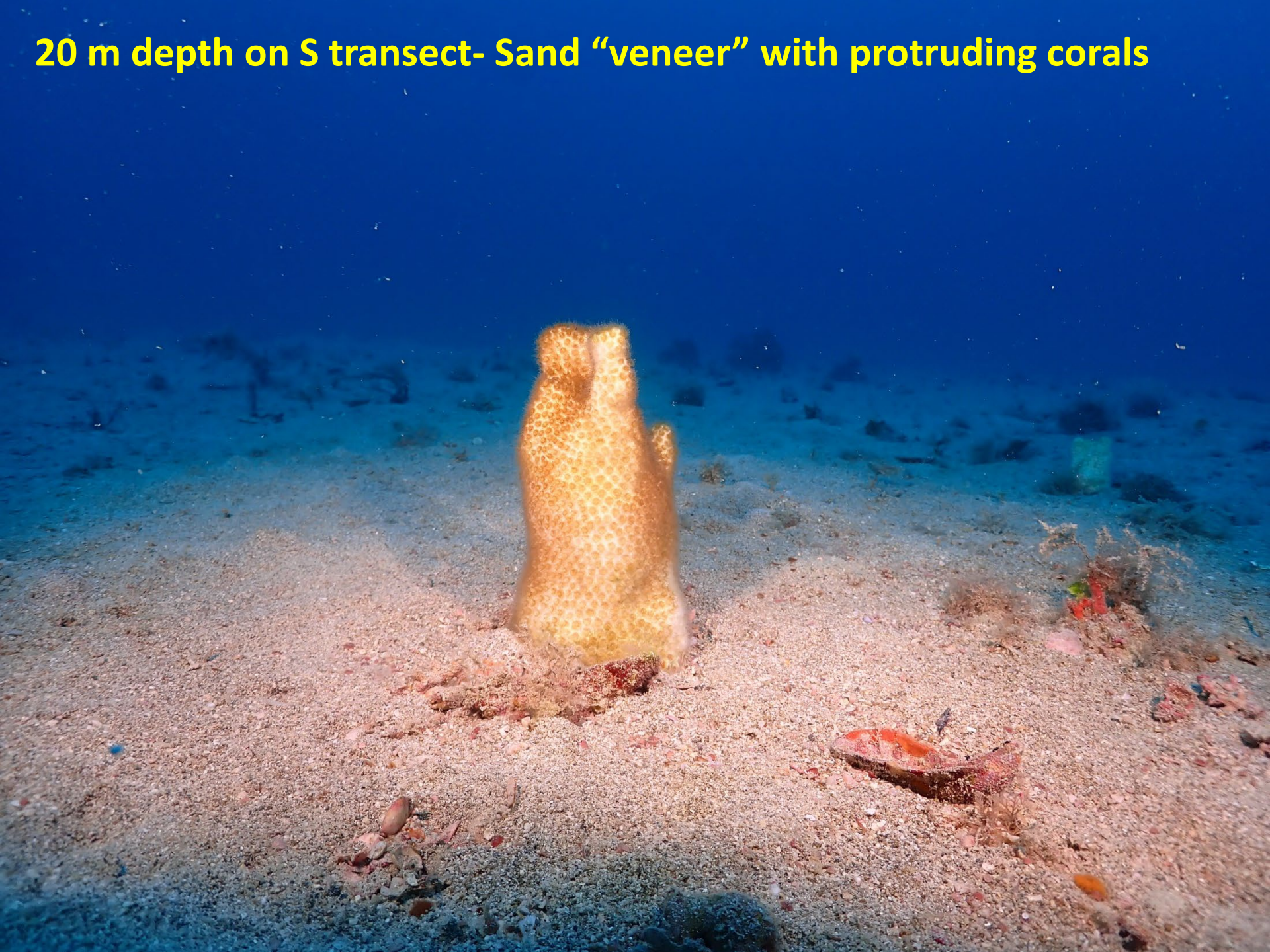
Soft: < 10% HB and S/H

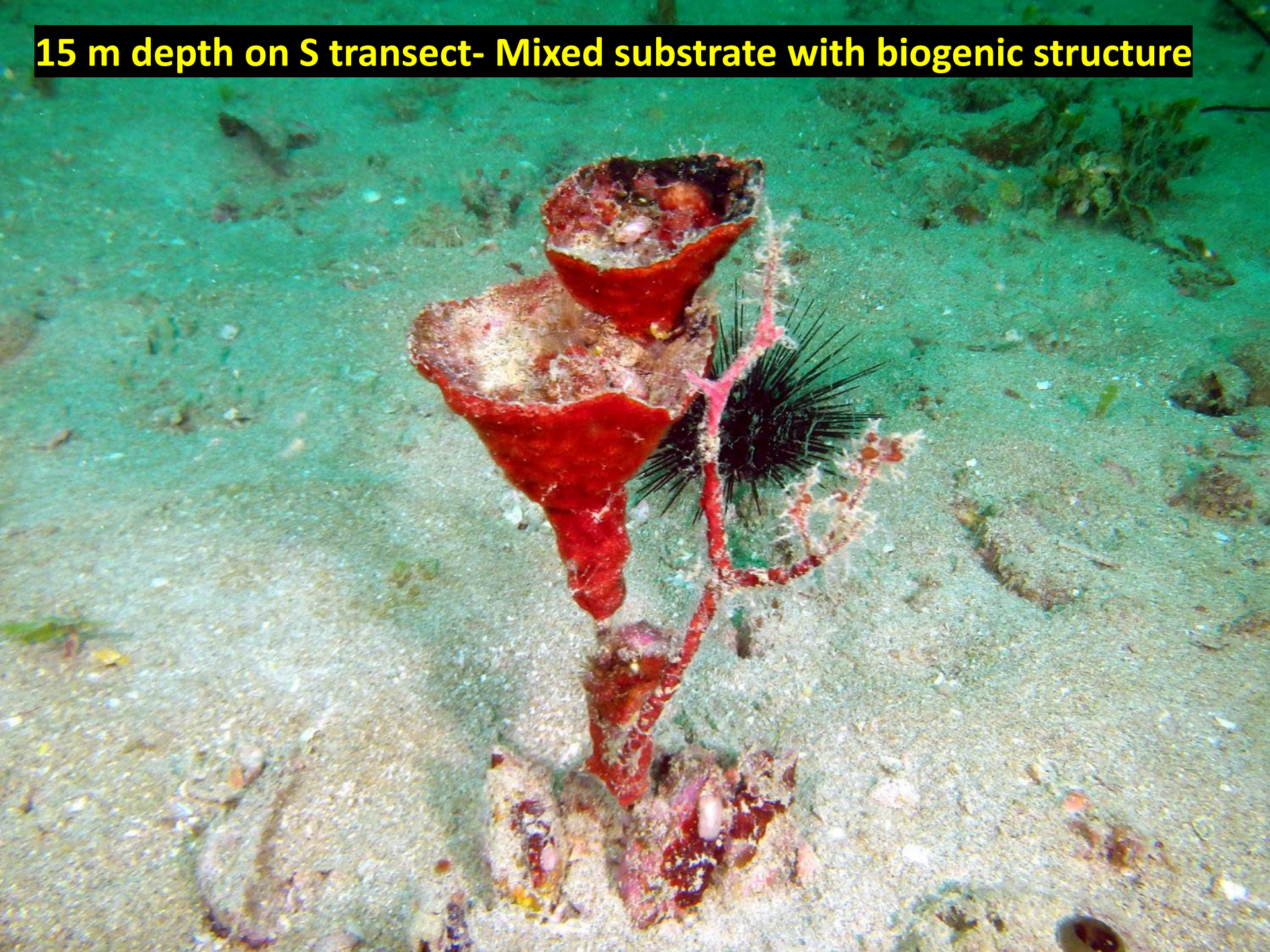


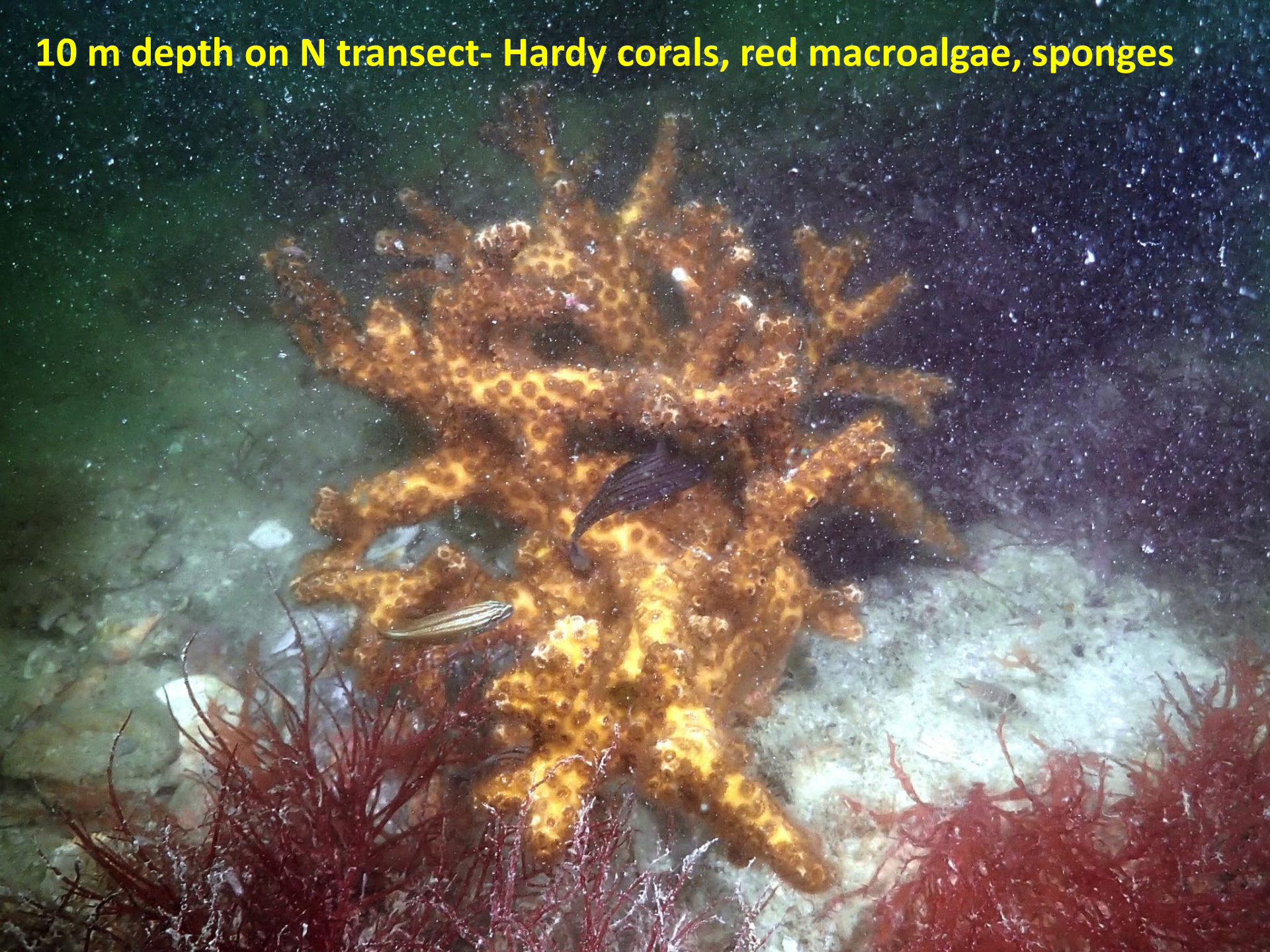
# Substrate type, depth, and proximity to Caloosahatchee all influenced epibenthic species composition




20 m depth on N transect- Limestone ledge with high diversity including calcareous green algae


20 m depth on S transect- Sand “veneer” with protruding corals


15 m depth on S transect- Mixed substrate with biogenic structure

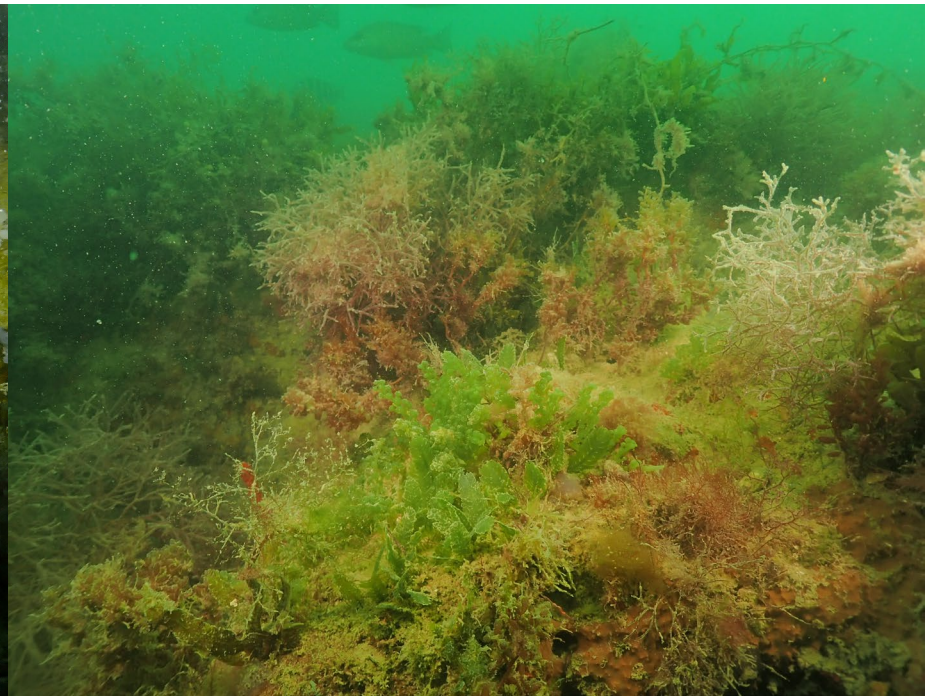

10 m depth on N transect- Hardy corals, red macroalgae, sponges

5 m depth on S transect

# Nearshore hard-bottom differences suggest Caloosahatchee plume influence

- Caloosahatchee (N5)
- Less diverse, lots of cyanobacteria

- Naples (S5)
- More diverse, lots of *Sargassum filipendula*



Negative effects of eutrophication on benthic *Sargassum* - Peres et al. 2023

# Species indicative of good WQ

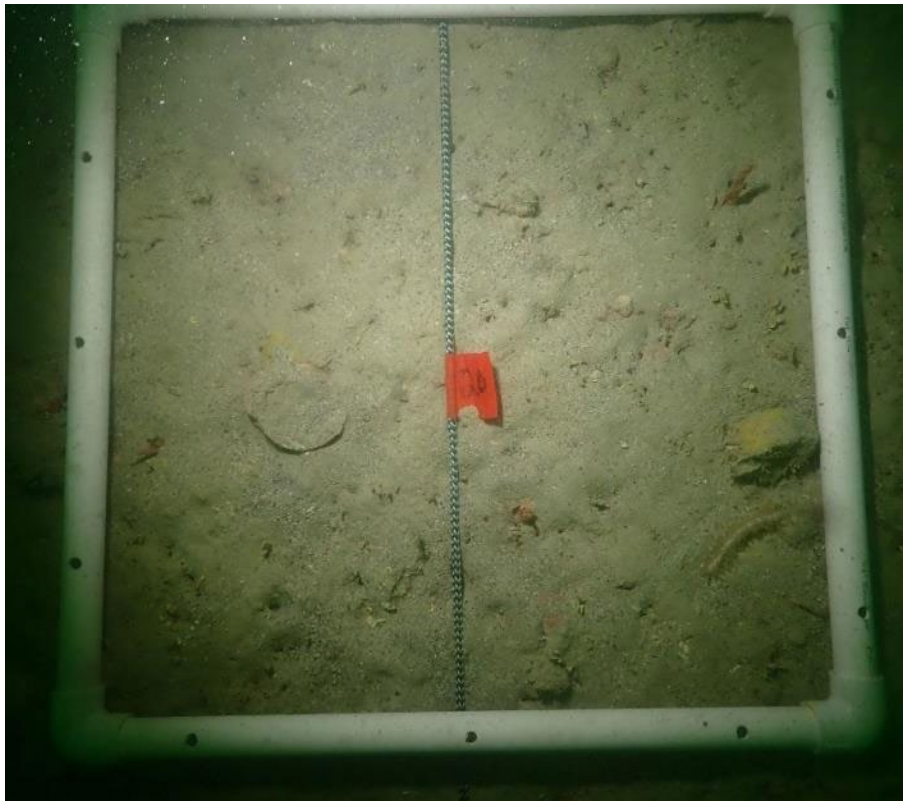
| Group | Only found offshore / away from Caloosahatchee | Found everywhere we looked on the shelf |
|---|---|---|
| Hard Corals | *Stephanocoenia intersepta, Scolymia lacera, Isophyllia sinuosa* | *Solenastrea hyades, S. bournoni, Oculina sp., Cladocora arbuscula, Siderastrea* sp., *Phyllangia americana* |
| Soft Corals | *Antillogorgia, Pterogorgia, Muricea, Eunicea* | *Leptogorgia* |
| Macroalgae | *Halimeda* sp., *Rhipocephalus phoenix, Penicillus pyriformis* | *Caulerpa* spp., *Dictyota* spp., *Halymenia, Botryocladia*, Corallinales |
| Fish | Scaridae, Pomacanthidae, Pomacentridae | Lutjanidae, Haemulidae, Serranidae |

# Hurricane Ian Impacts

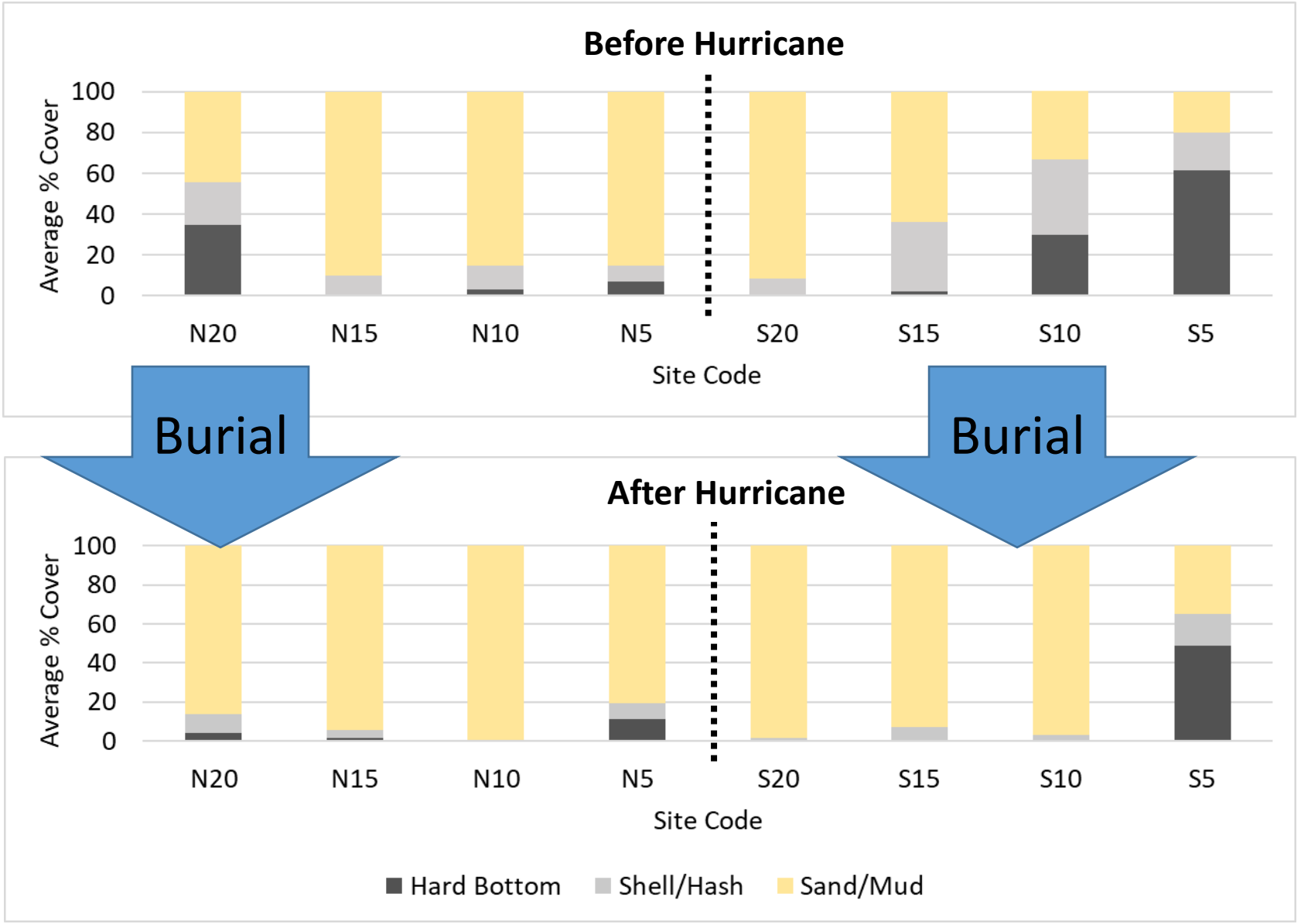

# Hurricane Ian Impacts – Site N20

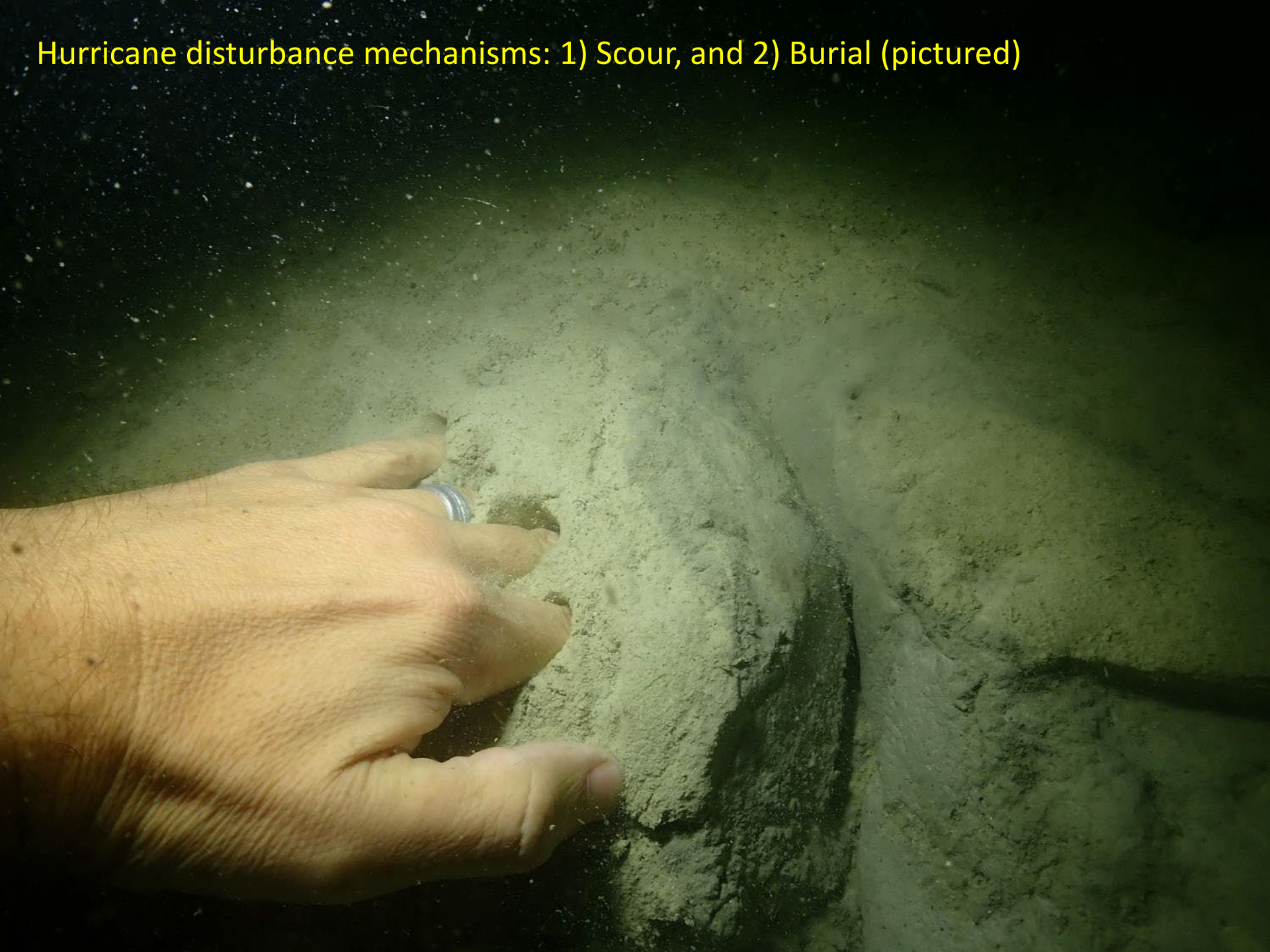
7-15-2022

10-22-2022



# Findings: Substrate



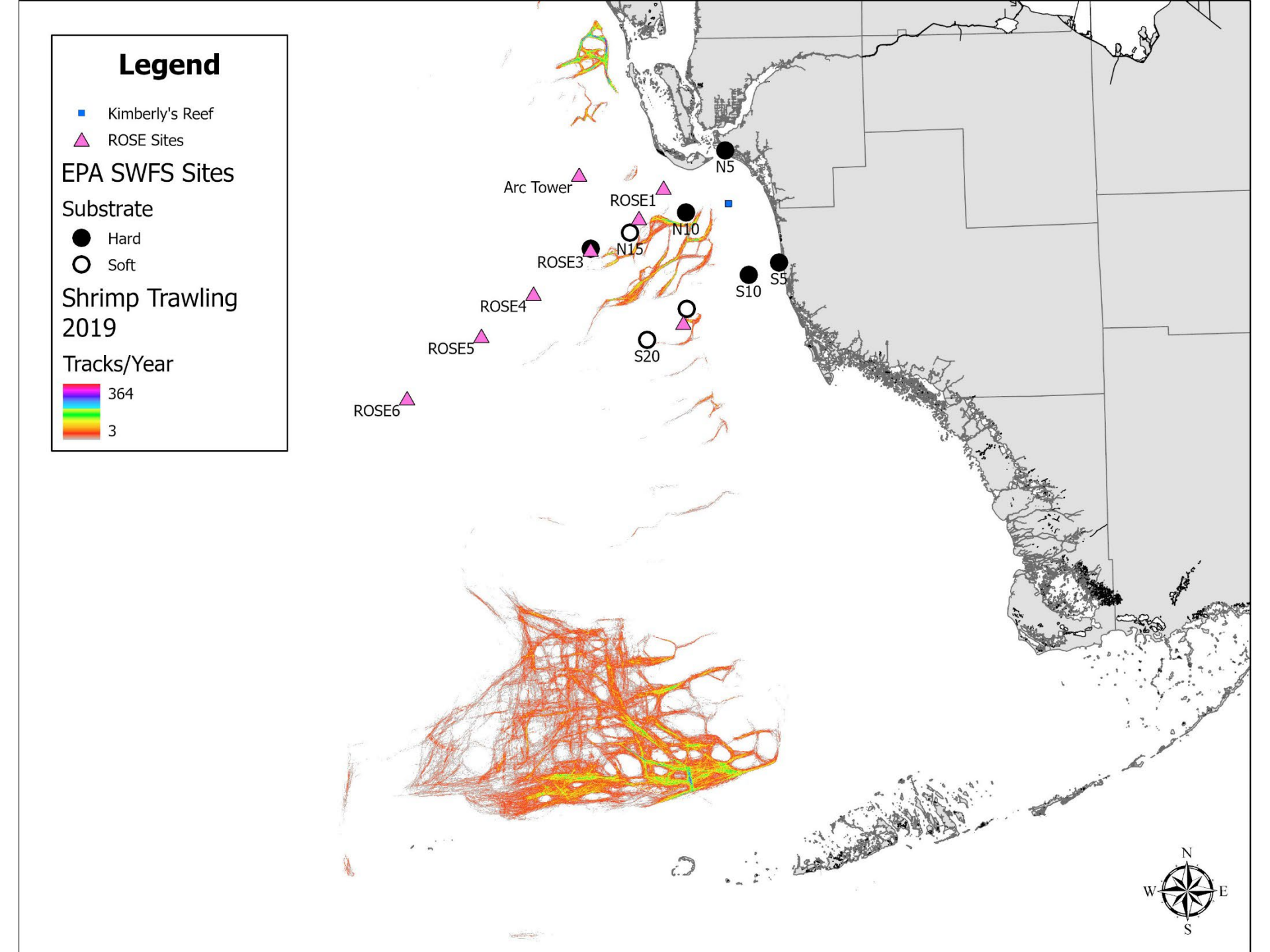

Hurricane disturbance mechanisms: 1) Scour, and 2) Burial (pictured)

# Epibenthic Communities Summary

- Presence of hard substrate profoundly important for structuring communities
- Habitat-forming species *especially* important where geologic hard substrates scarce
- Distance from shore and Caloosahatchee affect species composition and diversity
- Hurricane impacts mediated by sediment processes; time to full recovery unclear

# Future

- More mapping and species range delineation, especially for corals
  - Is SW Florida shelf a potential refuge habitat for some of the species declining in the FKNMS?
- Artificial reef vs. natural hard bottom comparisons
- Genetic-assisted assessment of eukaryotic biodiversity on the shelf
- Evaluate trawling impacts


Legend
Kimberly's Reef
ROSE Sites
EPA SWFS Sites
Substrate
Hard
Soft
Shrimp Trawling 2019
Tracks/Year
364
3
N5
Arc Tower
ROSE1
N10
N15
ROSE3
S5
S10
ROSE4
ROSE5
S20
ROSE6
N
W
E
S