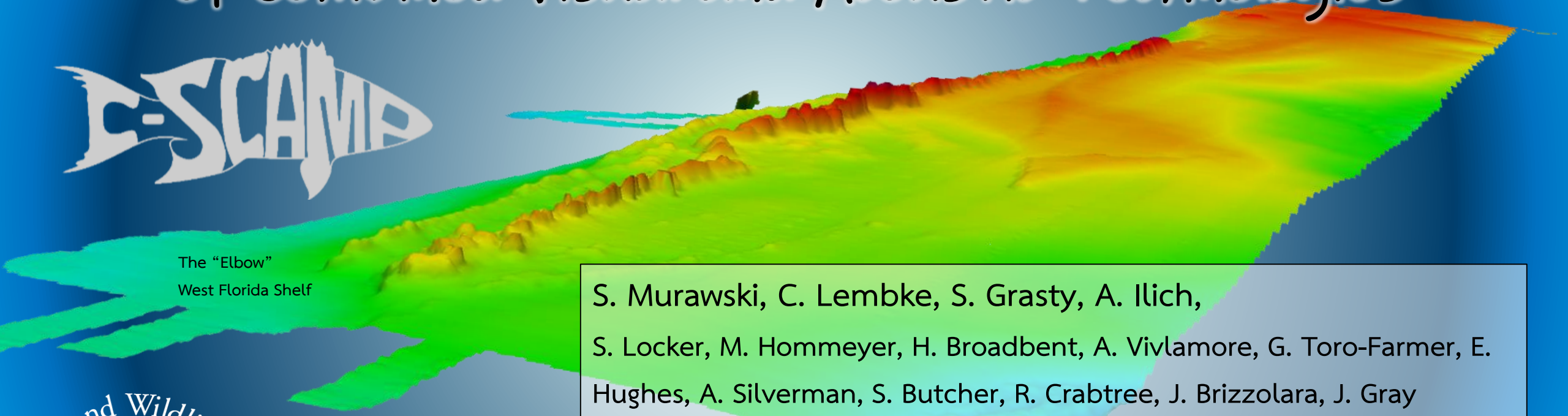
# Establishing Baselines for Benthic Habitat and Fish Populations on the West Florida Shelf via the Power of Combined Visual and Acoustic Technologies



The "Elbow"
West Florida Shelf

S. Murawski, C. Lembke, S. Grasty, A. Ilich,
S. Locker, M. Hommeyer, H. Broadbent, A. Vivlamore, G. Toro-Farmer, E. Hughes, A. Silverman, S. Butcher, R. Crabtree, J. Brizzolara, J. Gray

28 July, 2020

# Scope of the problem and long term goal

Reef fish species occur on the West Florida Shelf on carbonate reefs that cannot be easily quantified with traditional gears (nets, traps, hooks, trawls)

**Long-Term Goal: Design a sampling system to estimate absolute abundance of reef fish populations and habitats**

Primary Target Species

Red Snapper

Vermilion Snapper

Red Grouper

Gag Grouper

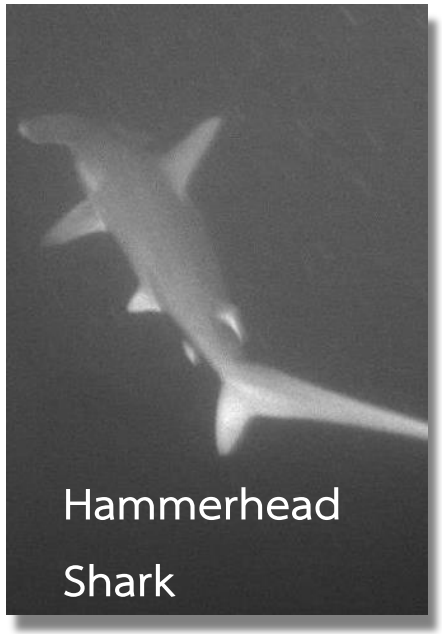
Sea turtles

Secondary Target Species

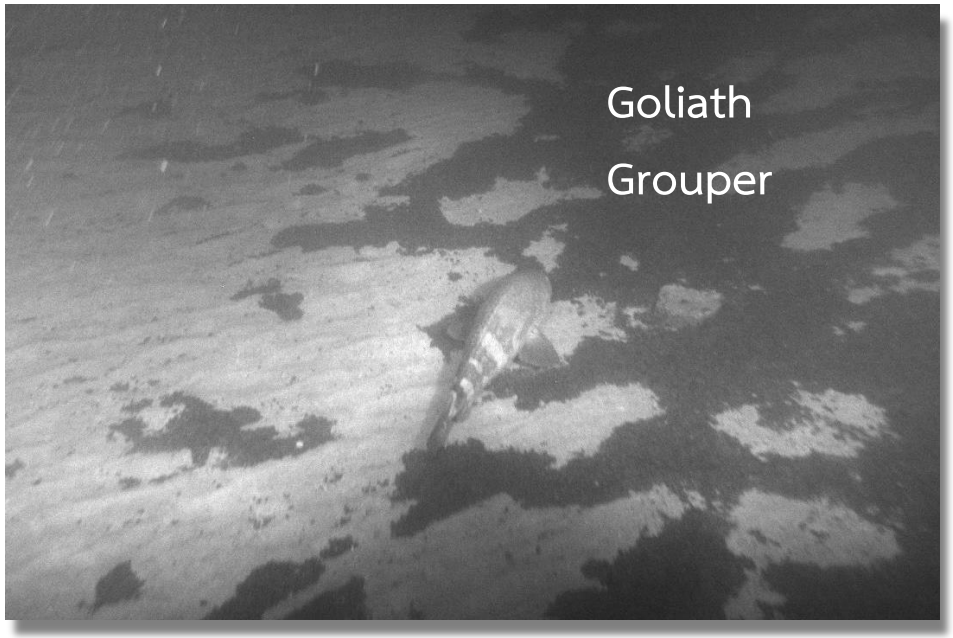
Other snappers

Other groupers

Various reef fishes

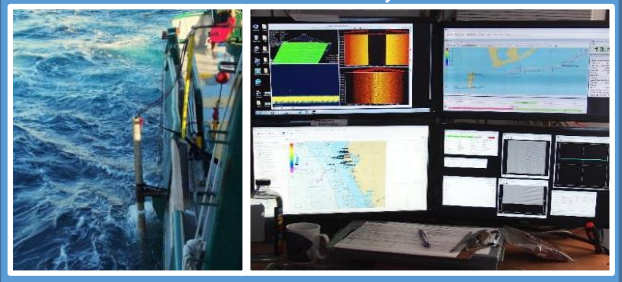





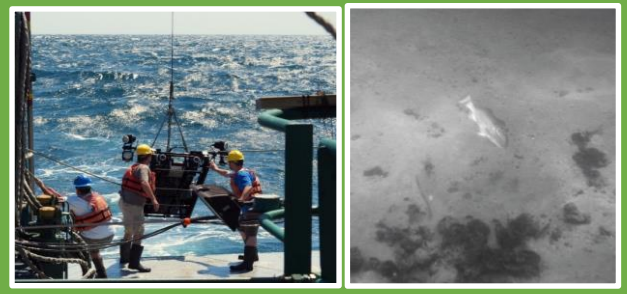



# Project Recipe

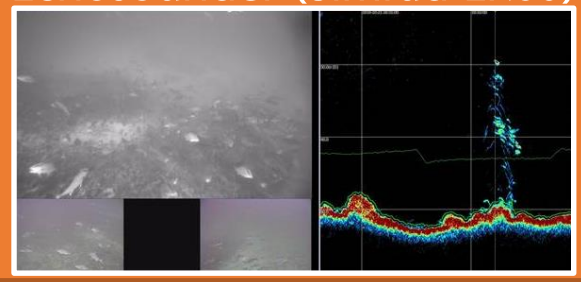
## Multibeam Echosounder (SeaBat 7125, T50)



## Towed Video (C-BASS)



## Split-Beam Fisheries Echosounder (Simrad EK60)



### First Order Analysis

- Bathymetry Analysis
- Backscatter Analysis
- CMECS-based Classification
- Environmental Sensor Data
- Fish and Turtle Analysis
- Biomass Analysis

### Inter Relational Analysis

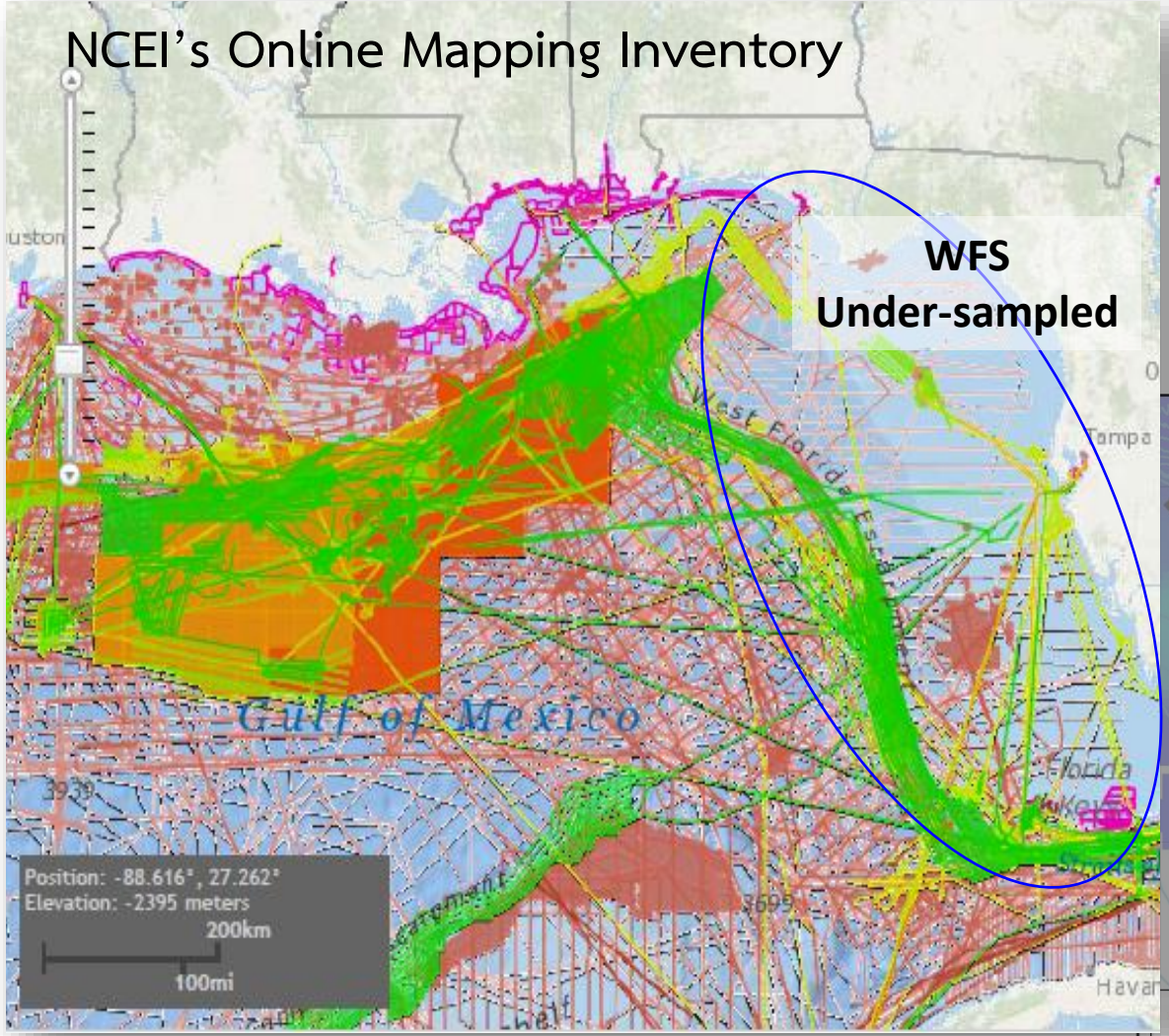
- Map Benthic Habitat Characteristics
- Fish-Habitat Relationships
- Combine Species and Biomass

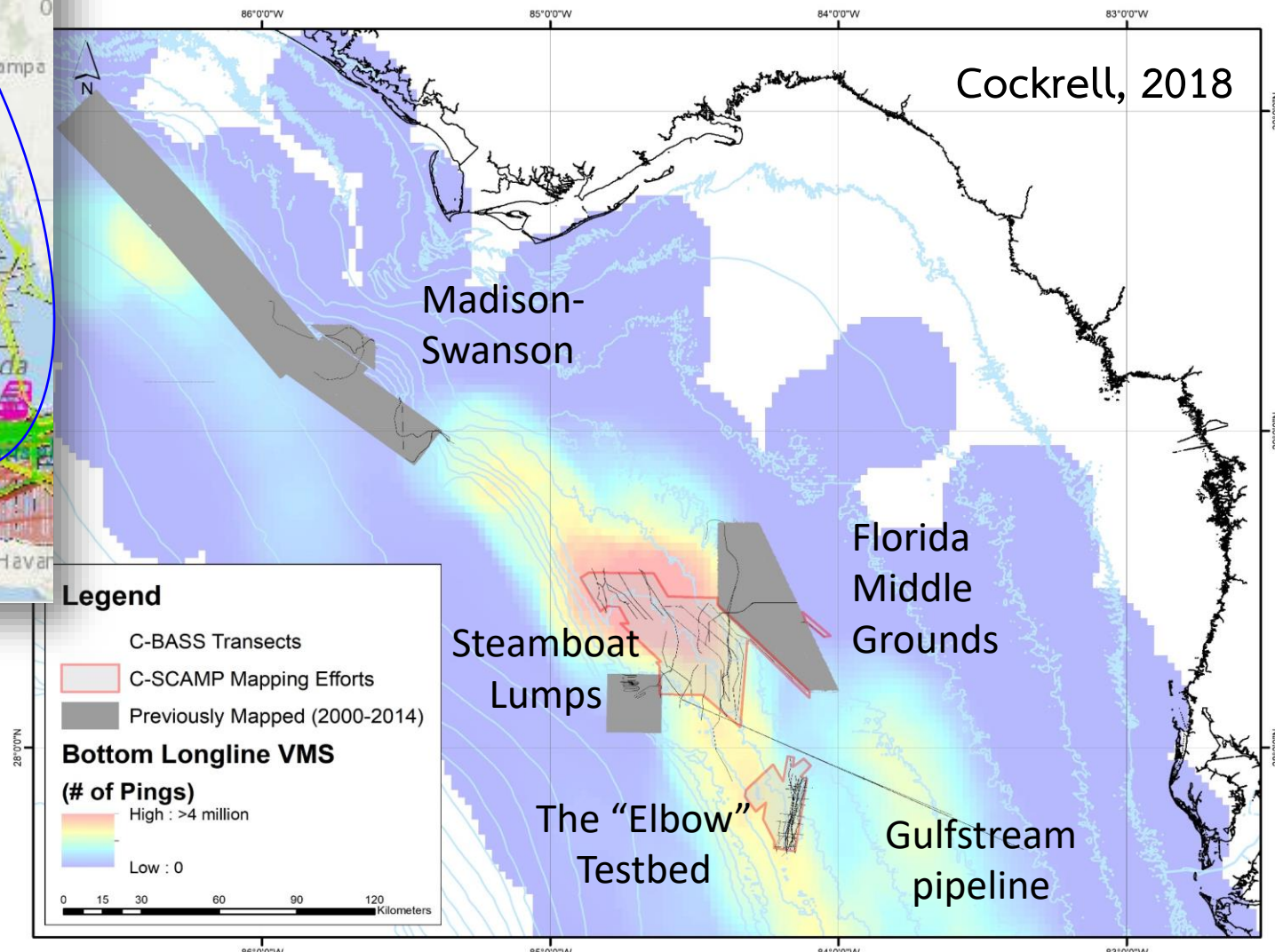
### User Based Products

- Species Habitat Maps
- Stratified Population Estimates

# Where to Map?

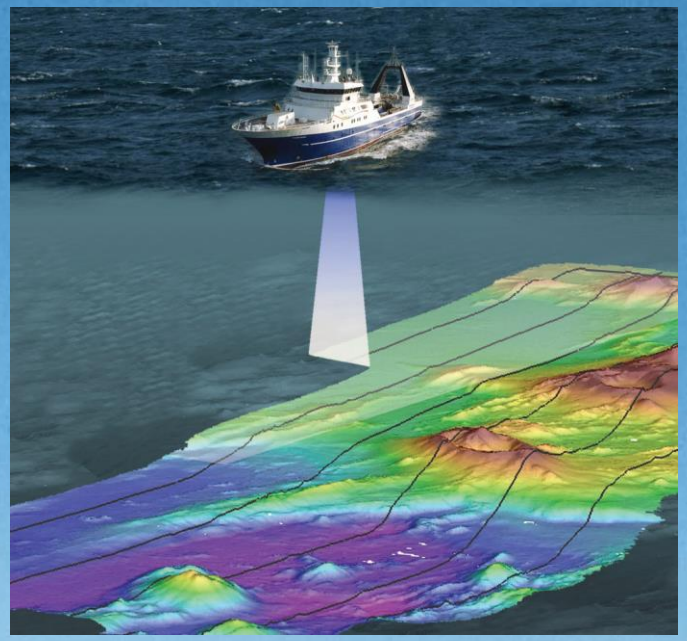
VMS Data from Reef Fish fishery, filtered for fishing activity indicates high-value habitats




Extend from previously mapped areas to understand processes giving rise to hard bottom habitats

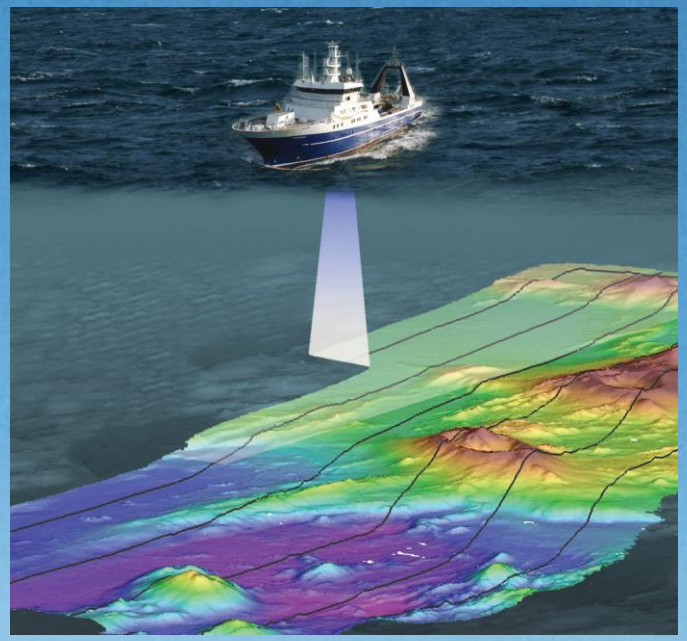
# Multibeam Bathymetry & Backscatter

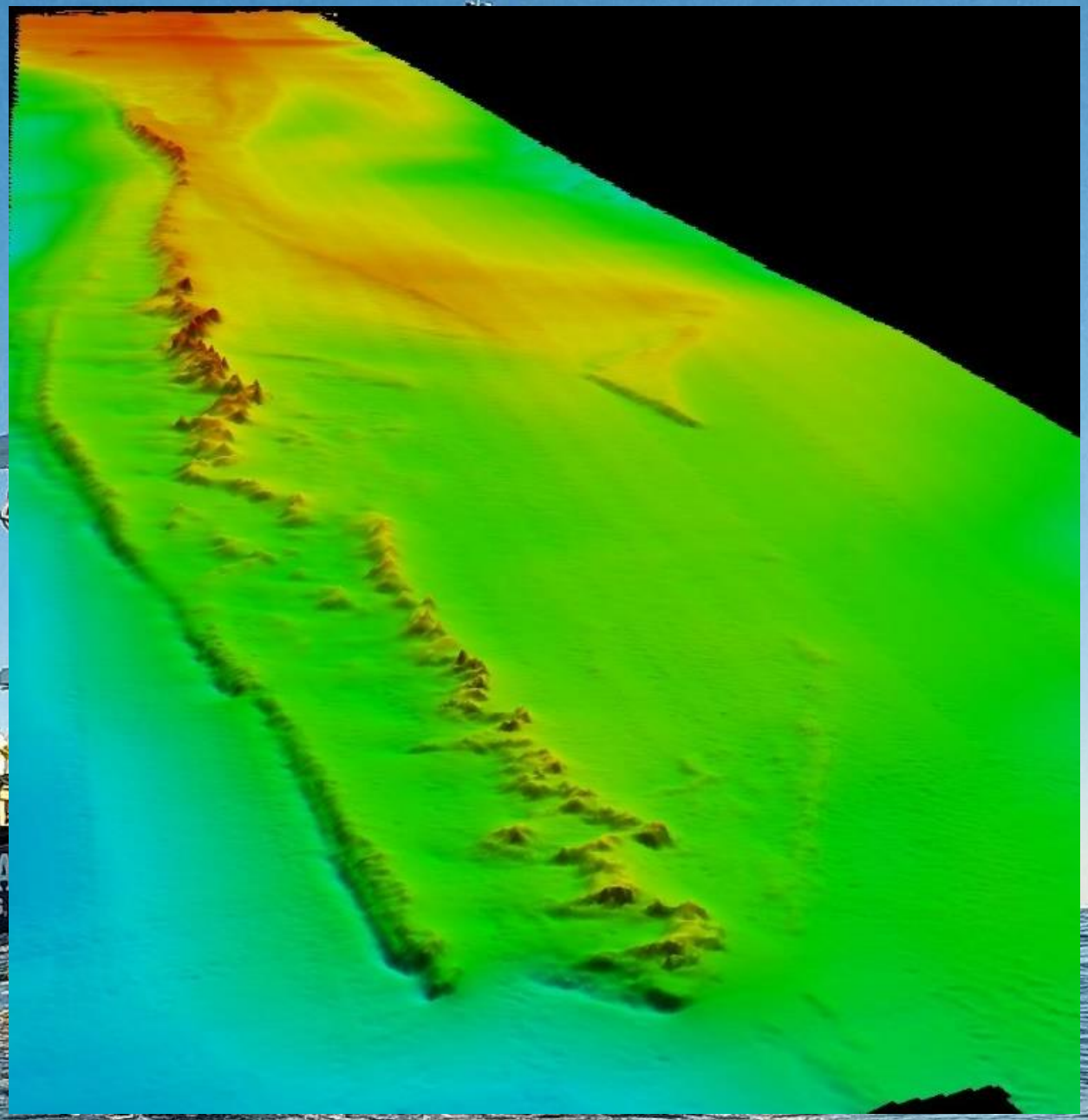


Raw multibeam data is corrected for:

- Vessel motion
- Sound velocity
- Tide

# Multibeam Bathymetry & Backscatter





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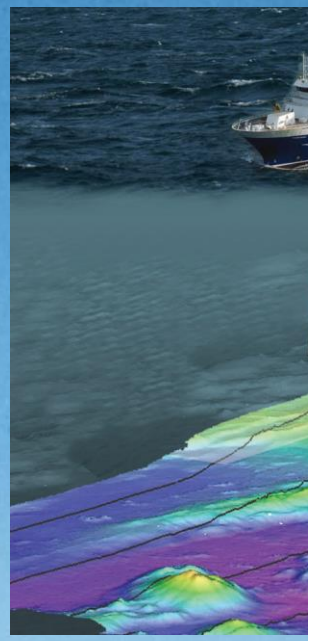

Raw multibeam

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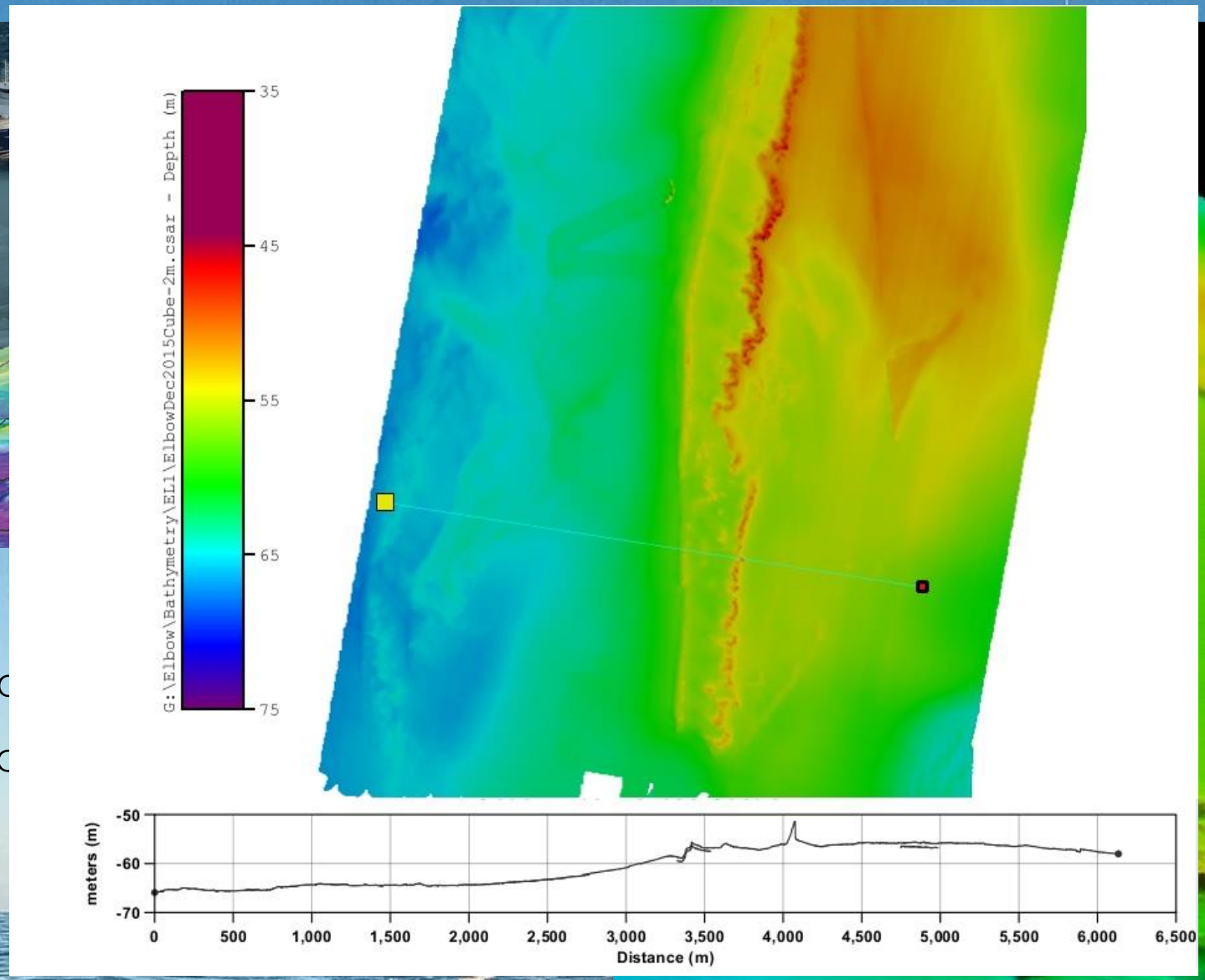
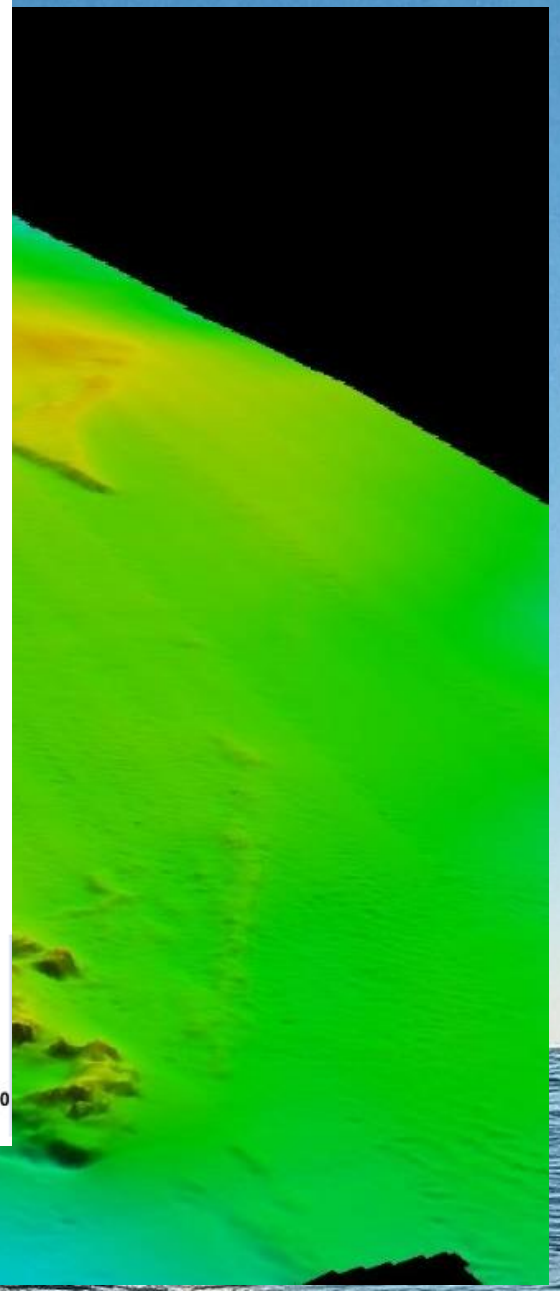
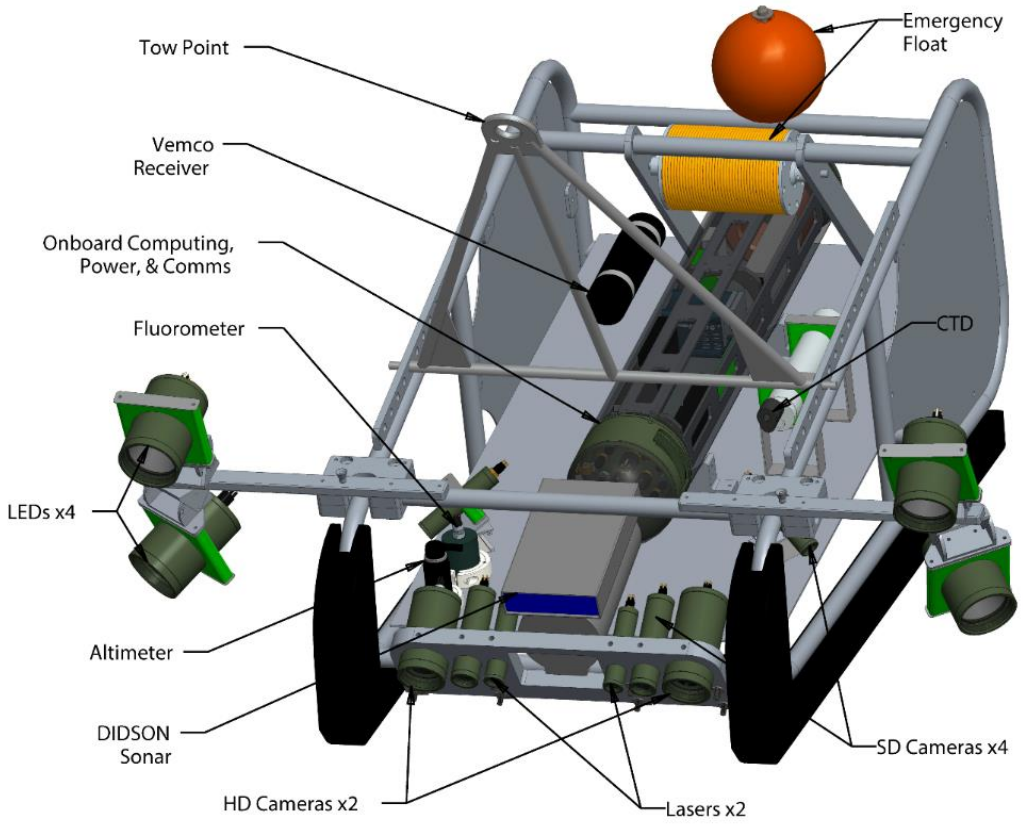


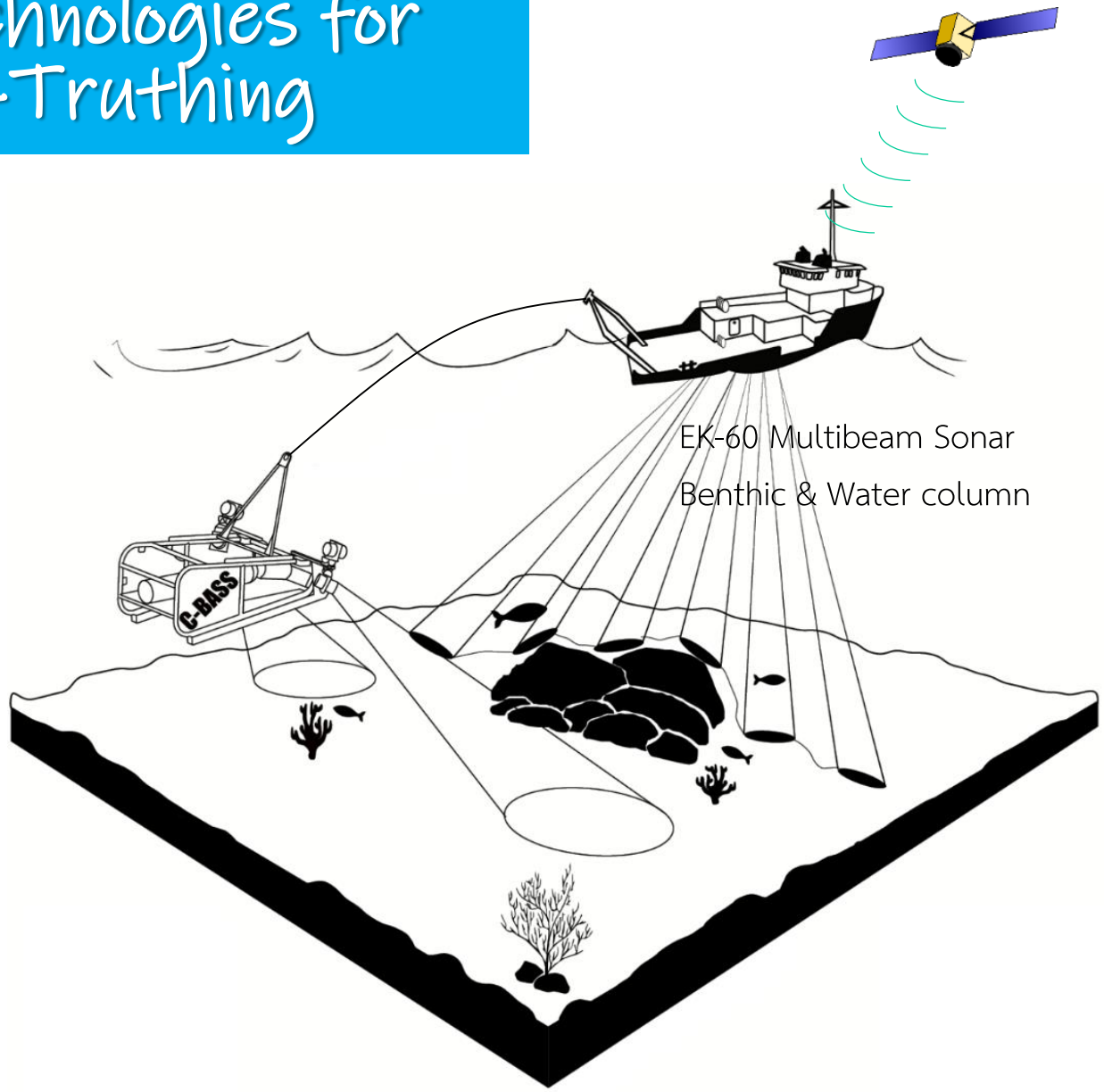



# Leveraging Multiple Technologies for Mapping and Ground-Truthing




C-BASS Towed Video Array

6 cameras, Array of Environmental Sensors (CTD, FL, Optics, Vemco)




EK-60 Multibeam Sonar

Benthic & Water column

# Leveraging Multiple Technologies for Mapping and Ground-Truthing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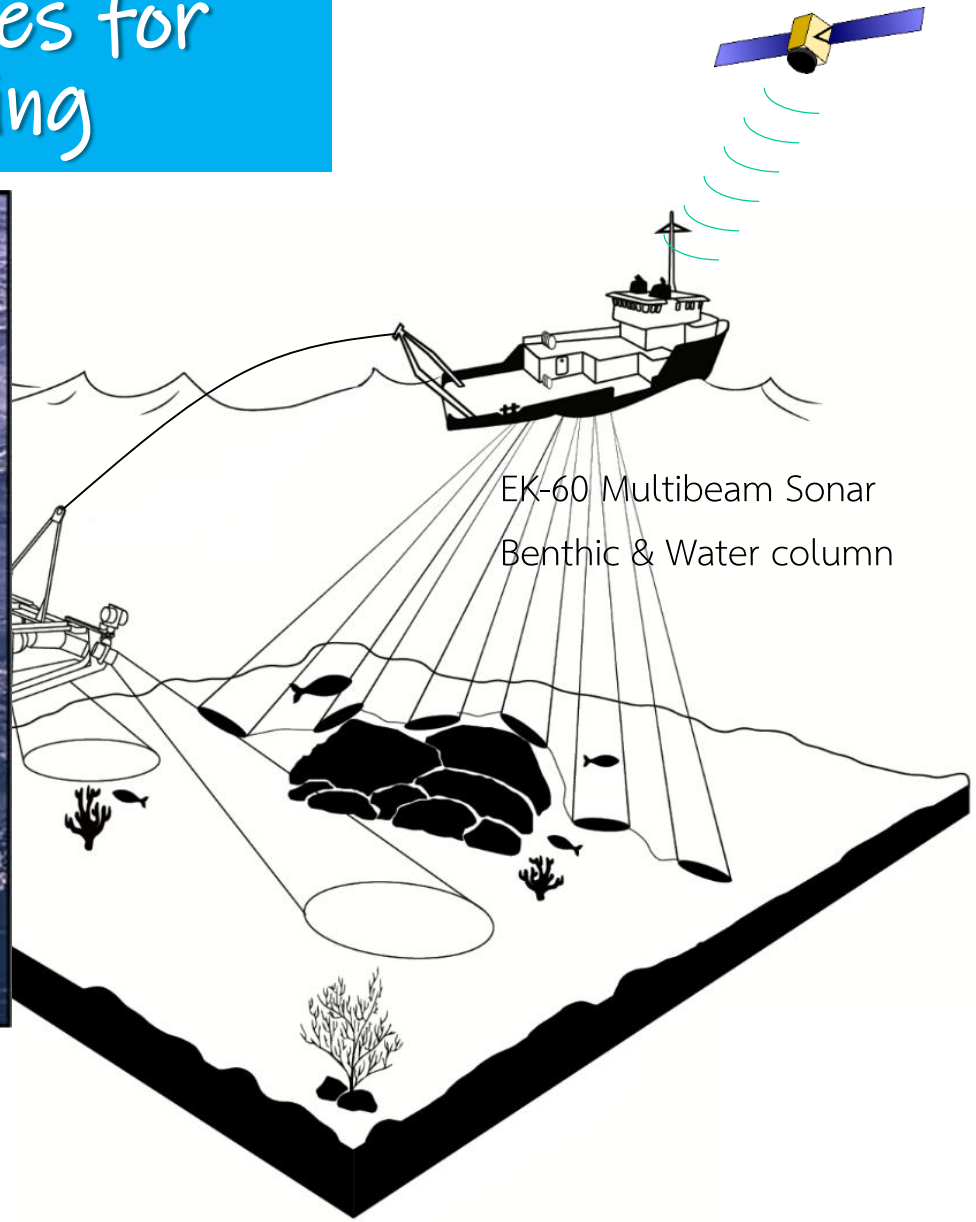
6 cameras, Array of Environmental Sensors (CTD, FL, Optics, Vemco)



EK-60 Multibeam Sonar

Benthic & Water column

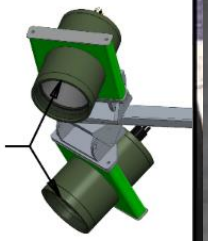
# Leveraging Multiple Technologies for Mapping and Ground-Truthing

Tow Point

Vemco Receiver

Onboard Computing, Power, & Comms

Fluorometer

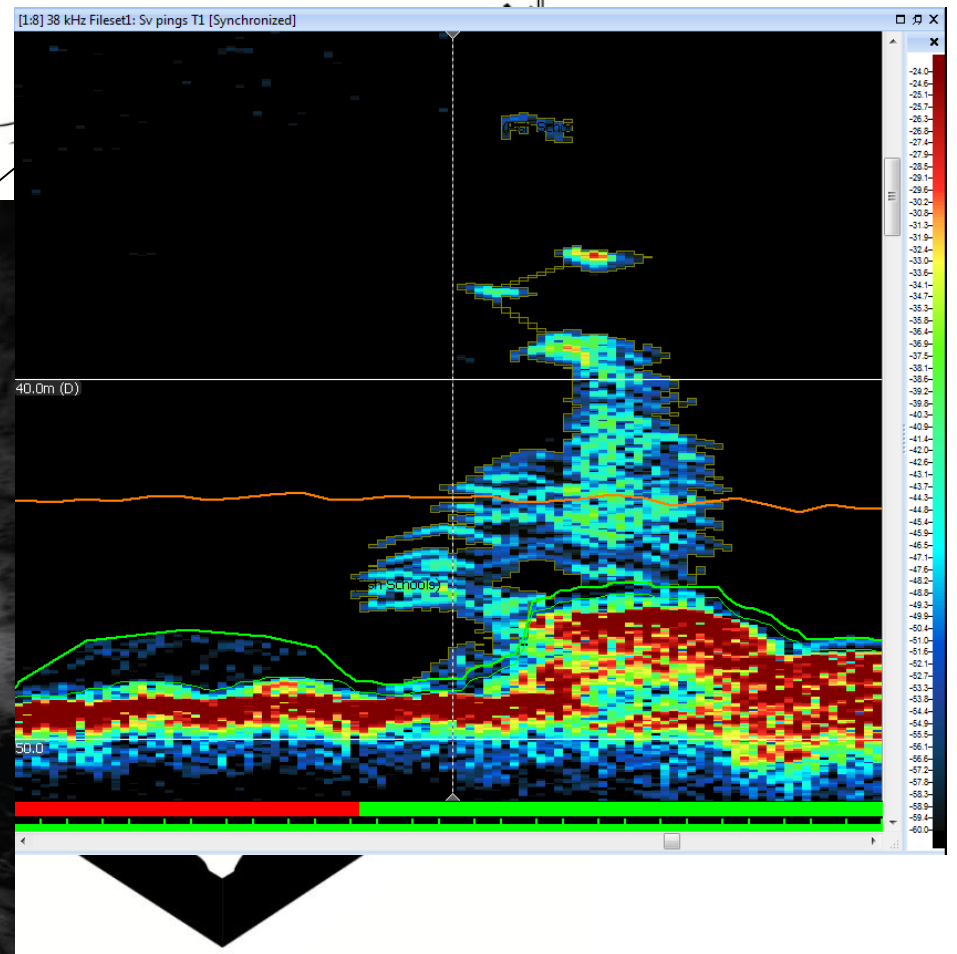


LEDs x4

Altimeter

DIDSON Sonar

HD Ca




C-BASS

6 came

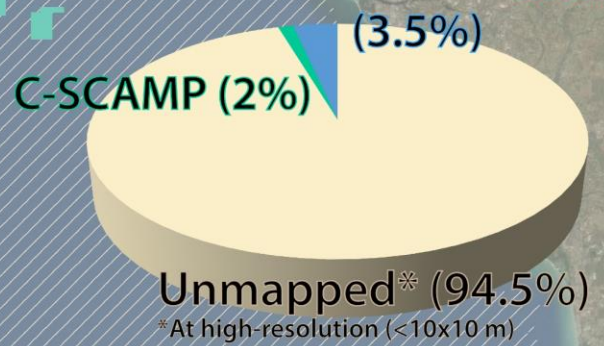
Sensors

# C-SCAMP by the Numbers

## 2, 519 km
Length of Transects
Imaged with C-BASS
from 2016- 2019

## 327 Hours
C-BASS Video Collected
from 2016 - 2019

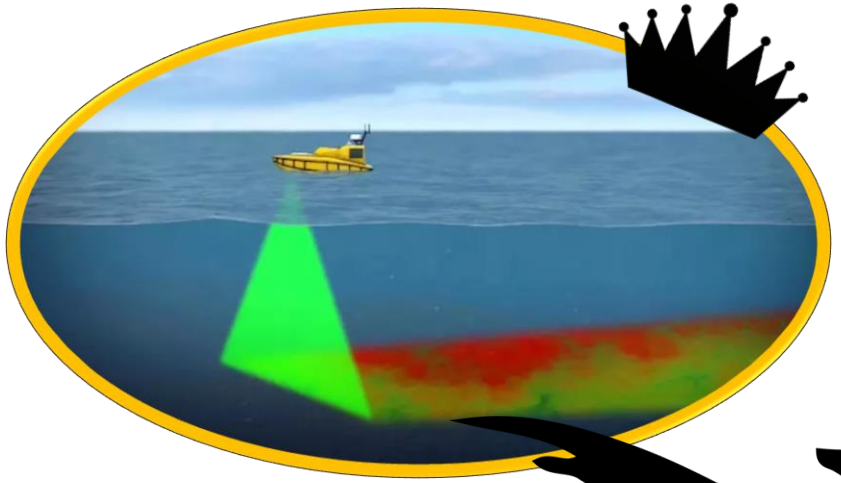
## 2,350 sq-km
of bathymetry added to WFS mapping efforts




## 20 Presentations
Oral & Poster-based at a variety of conferences

## 14 Project Members
With backgrounds in Marine Biology, Geology, Electrical Engineering, Software Development, Mechanical Engineering, GIS, Underwater Acoustics, and Statistics.

## 172 Days
At Sea for Multibeam Bathymetry and C-BASS data collection between 2015 and 2019.



# C-SCAMP

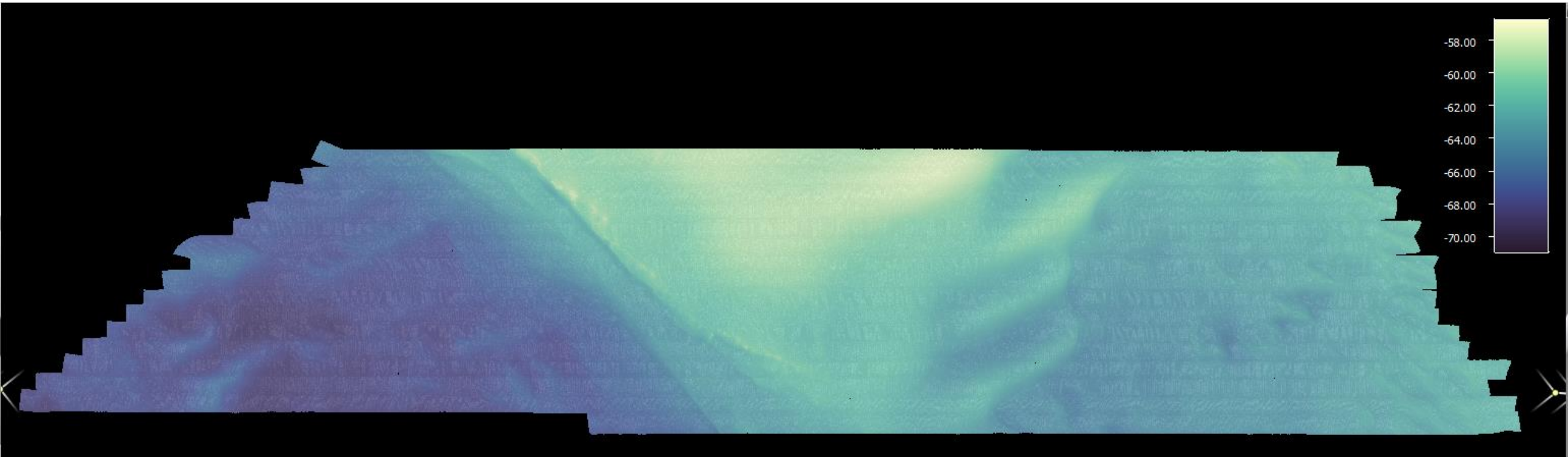
Continental Shelf Characterization, Assessment and Mapping Project

Sub-

# Multibeam Bathymetry & Backscatter

Multibeam provides two primary pieces of information:

1. **Bathymetry** (time) = How deep is it?

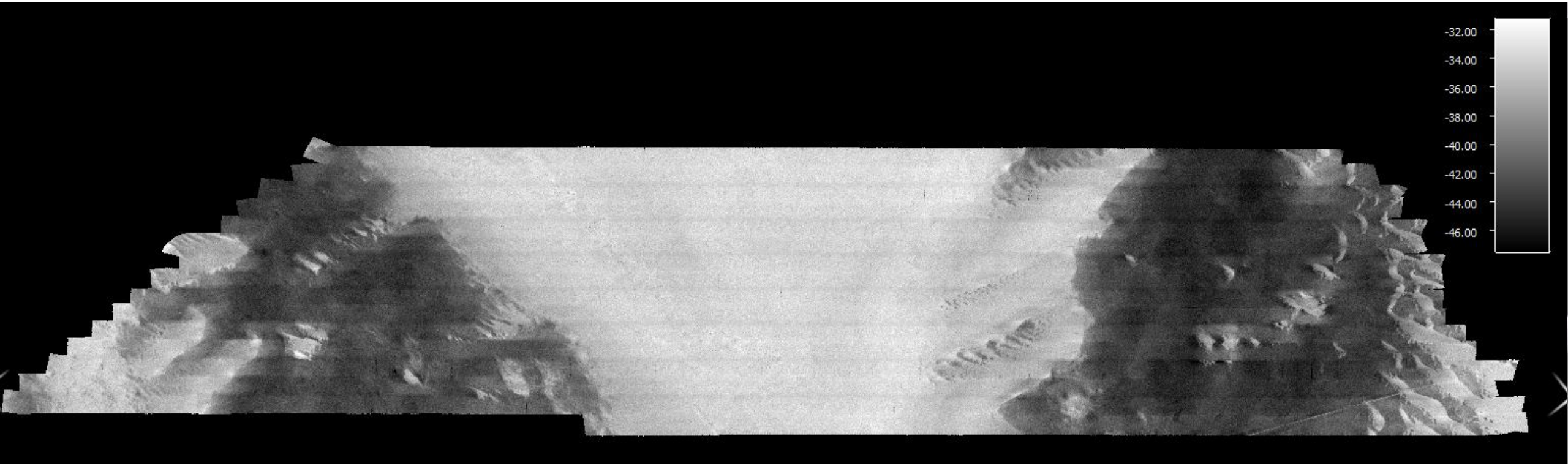



Project Scientist: Matthew Hommeyer (mhommeyer@usf.edu)

# Multibeam Bathymetry & Backscatter

Multibeam provides two primary pieces of information:

2. **Backscatter** (intensity) = What is it?

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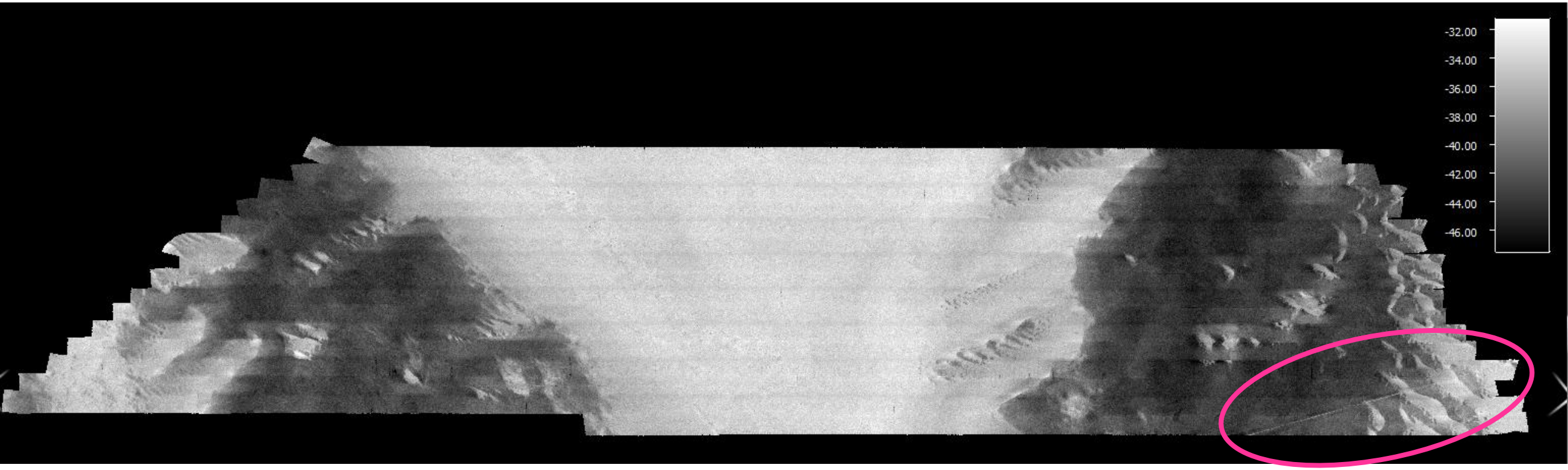


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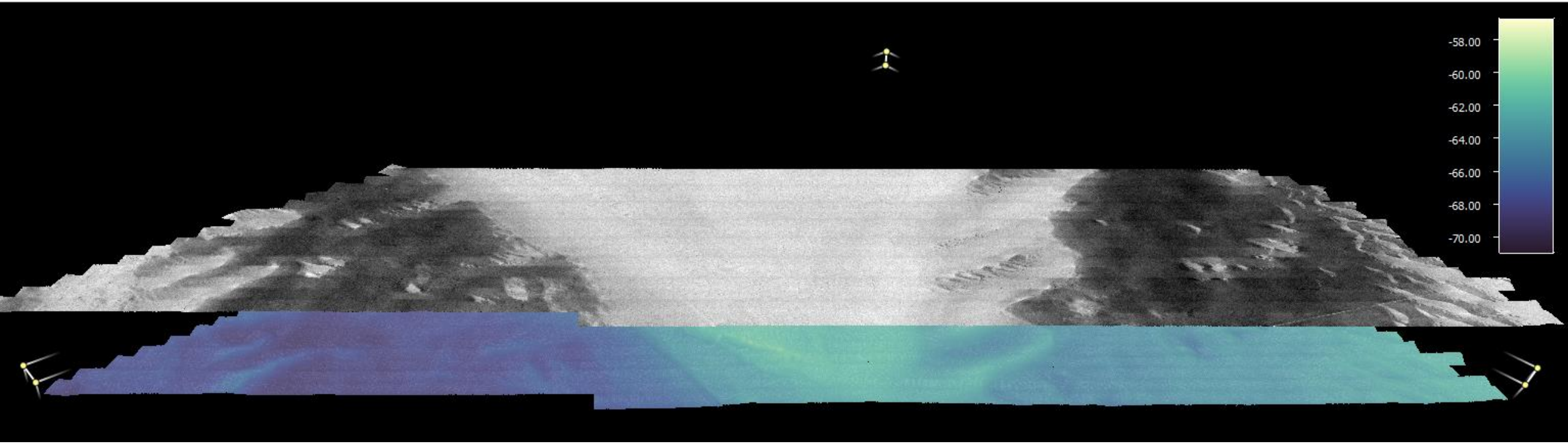
# Multibeam Bathymetry & Backscatter

Layering the two map products is a step in more fully characterizing the seafloor.

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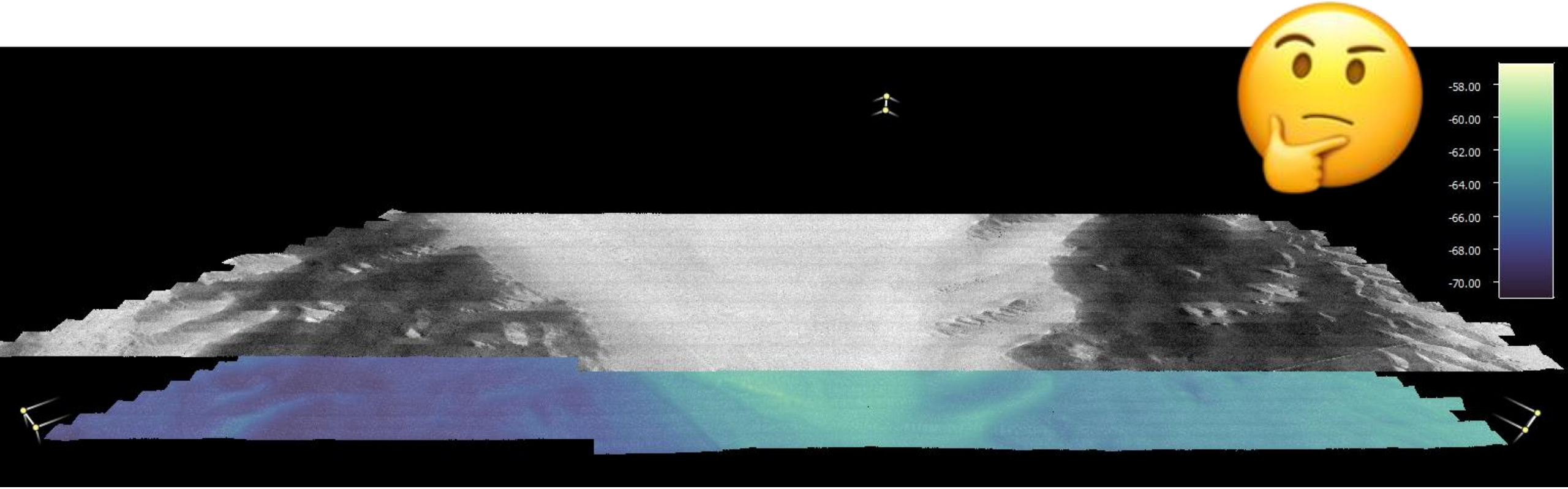


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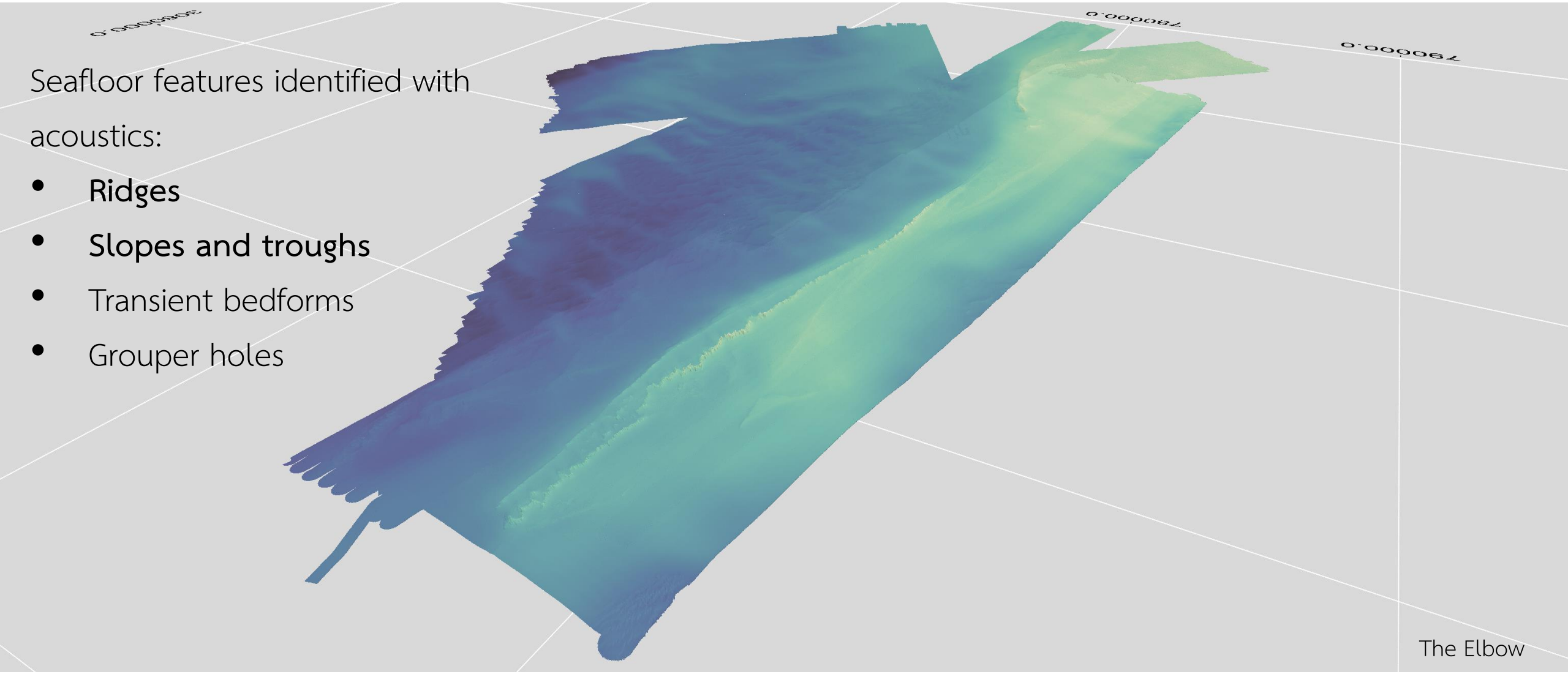
# Multibeam Bathymetry & Backscatter

Seafloor features identified with acoustics:

- **Ridges**
- **Slopes and troughs**
- Transient bedforms
- Grouper holes

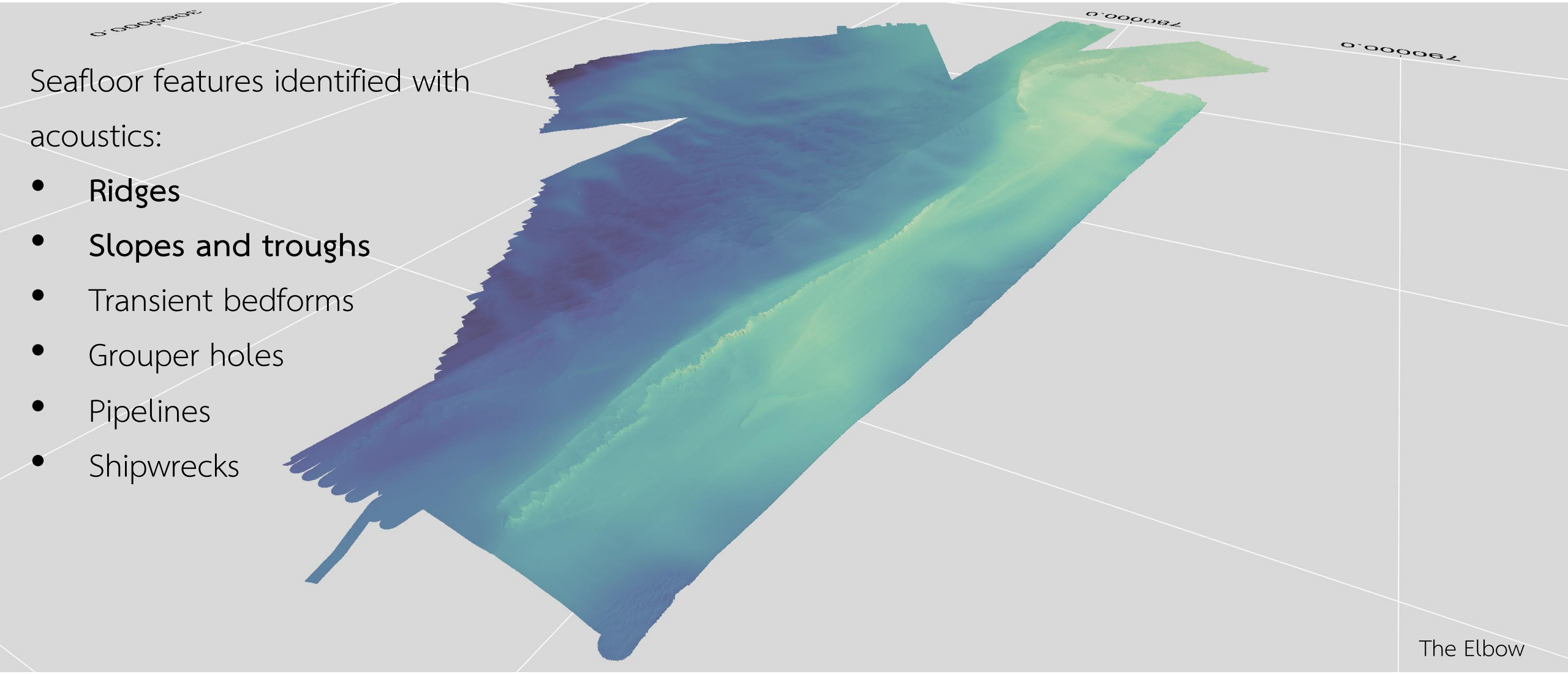



Project Scientist: Matthew Hommeyer (mhommeyer@usf.edu)

# Multibeam Bathymetry & Backscatter

Seafloor features identified with acoustics:

- **Ridges**
- **Slopes and troughs**
- Transient bedforms
- Grouper holes
- Pipelines
- Shipwrecks

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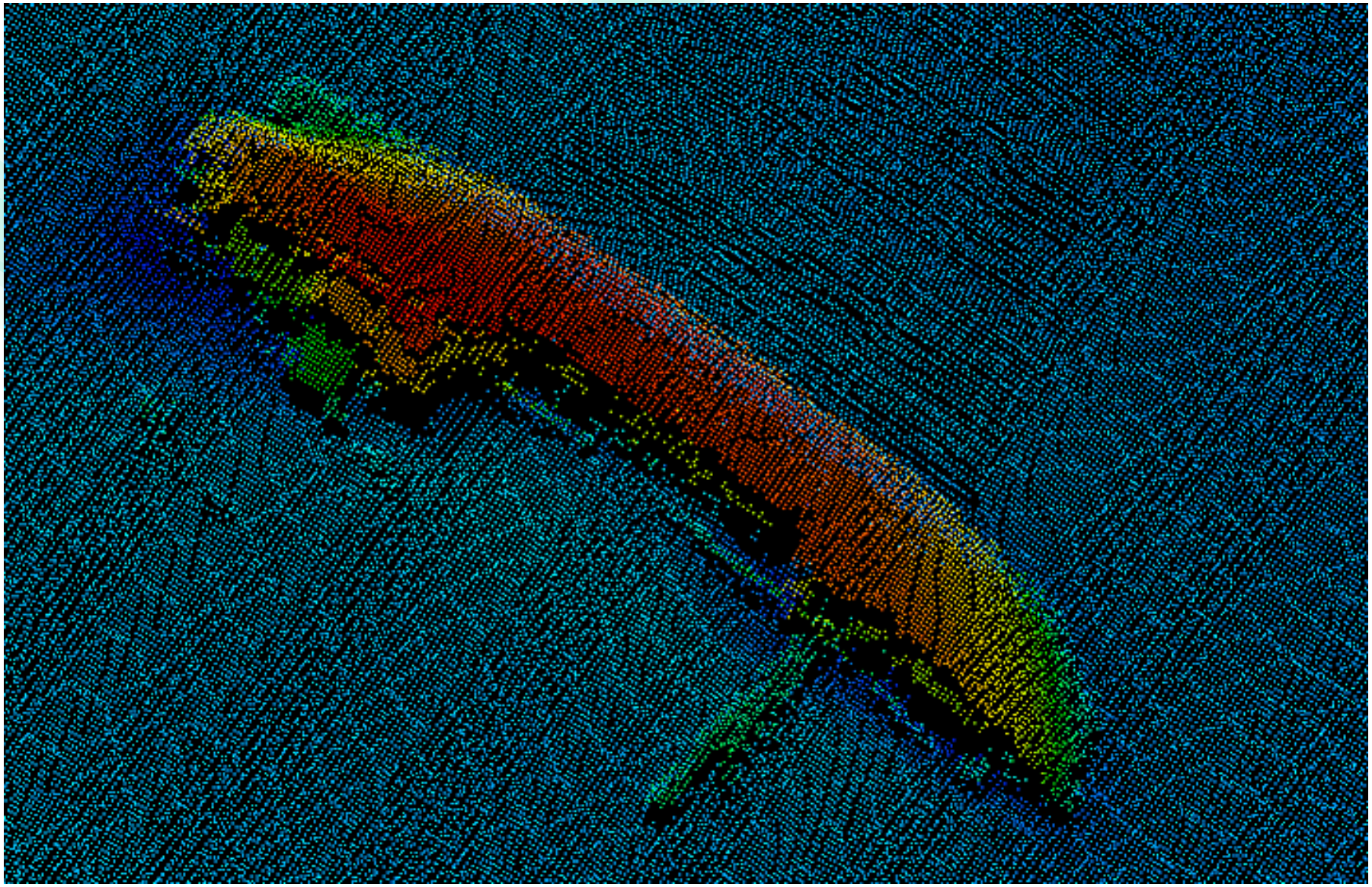
# Cultural Resources via Multibeam Sonar ^(& sometimes C-BASS!)



**M/V Holstein**

Sunk in 1992

Supposedly an Amberjack haven…

Project Scientist: Matthew Hommeyer (mhommeyer@usf.edu)

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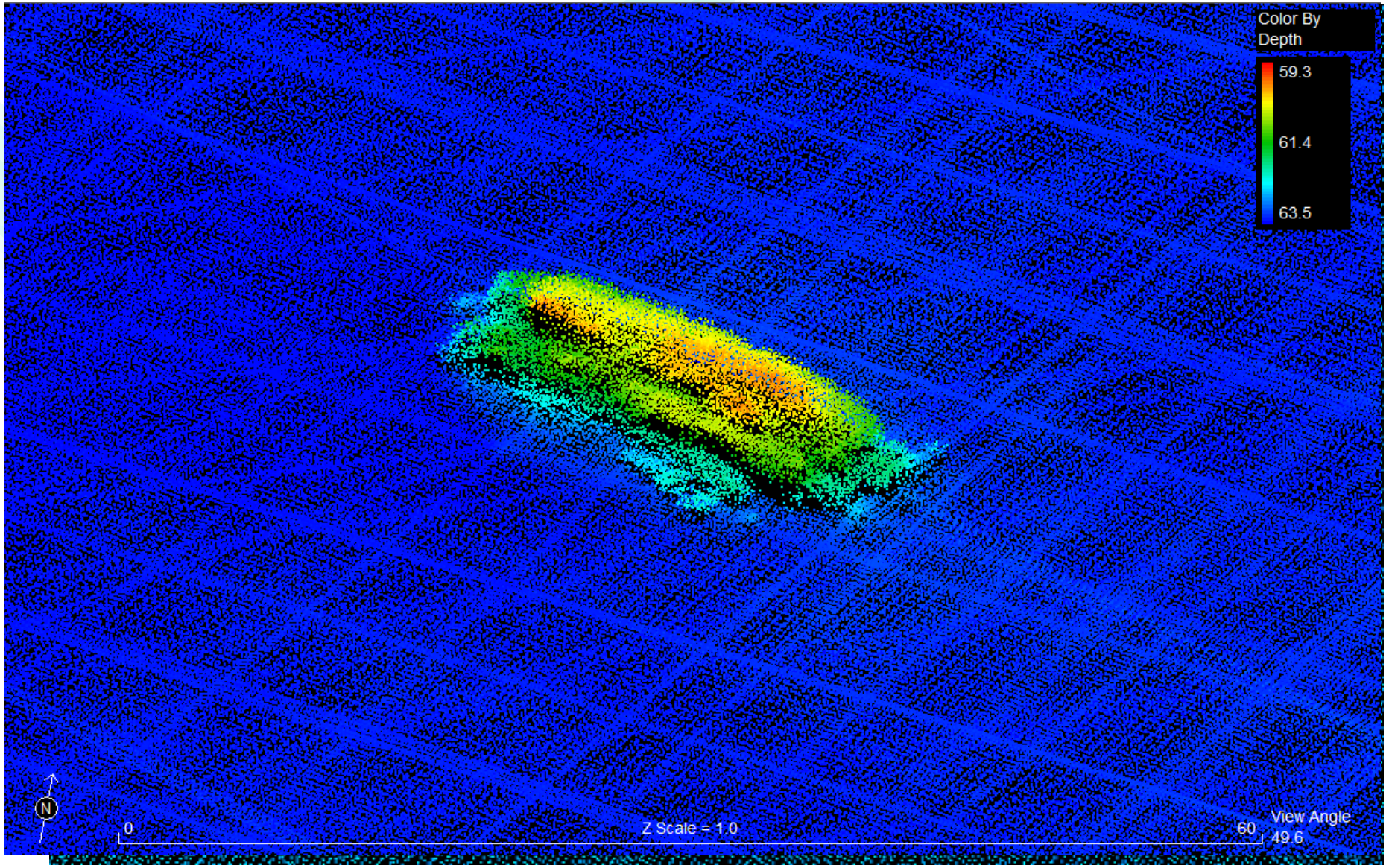


**“Unknown” Shipwreck**

Likely 19th Century

Possibly carried concrete which solidified after sinking

Project Scientist: Matthew Hommeyer (mhommeyer@usf.edu)

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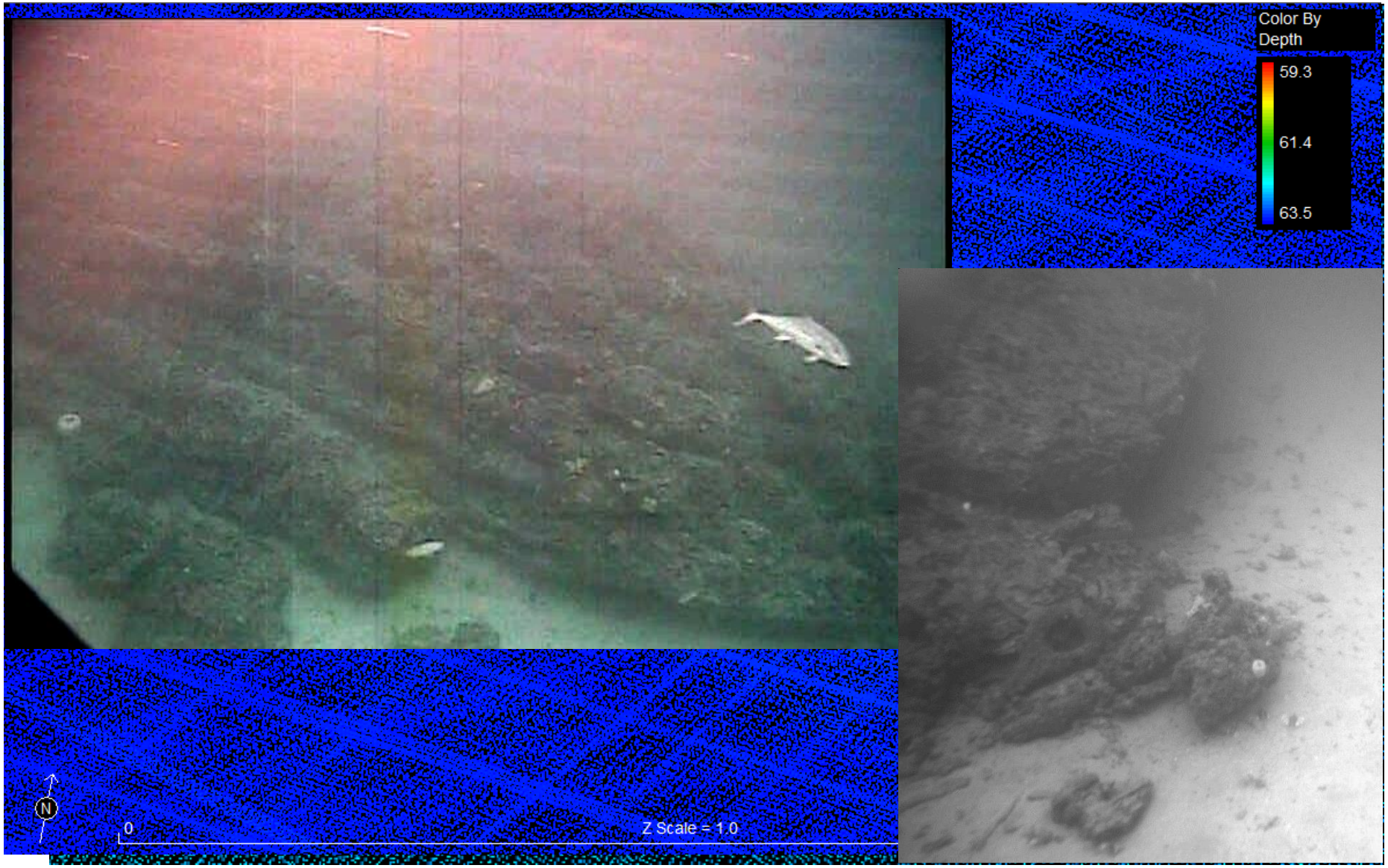


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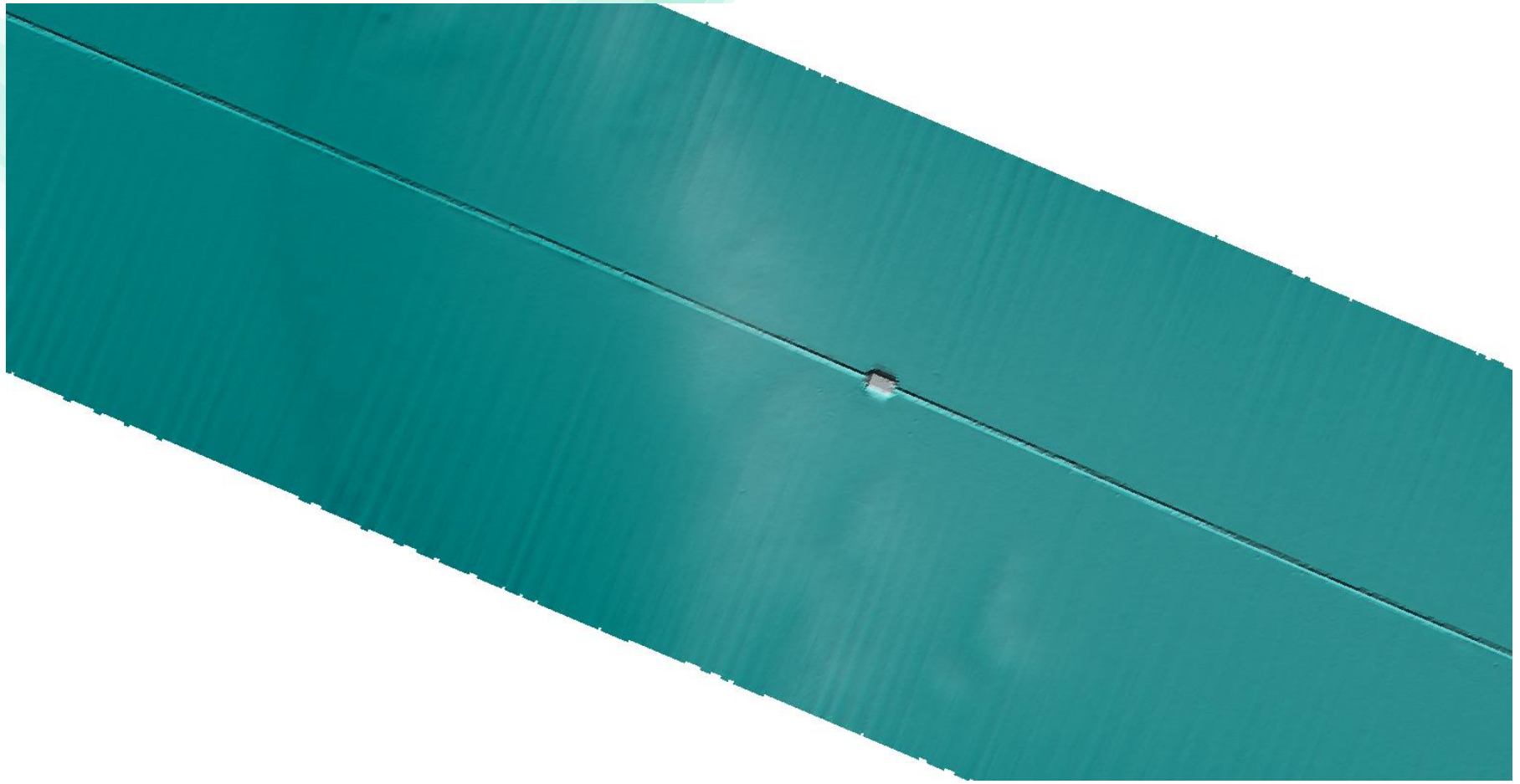

**GoM Pipeline Infrastructure**

Primarily the GSPL; several others in central & western GoM as part of the "Great Red Snapper Count"

Project Scientist: Matthew Hommeyer (mhommeyer@usf.edu)

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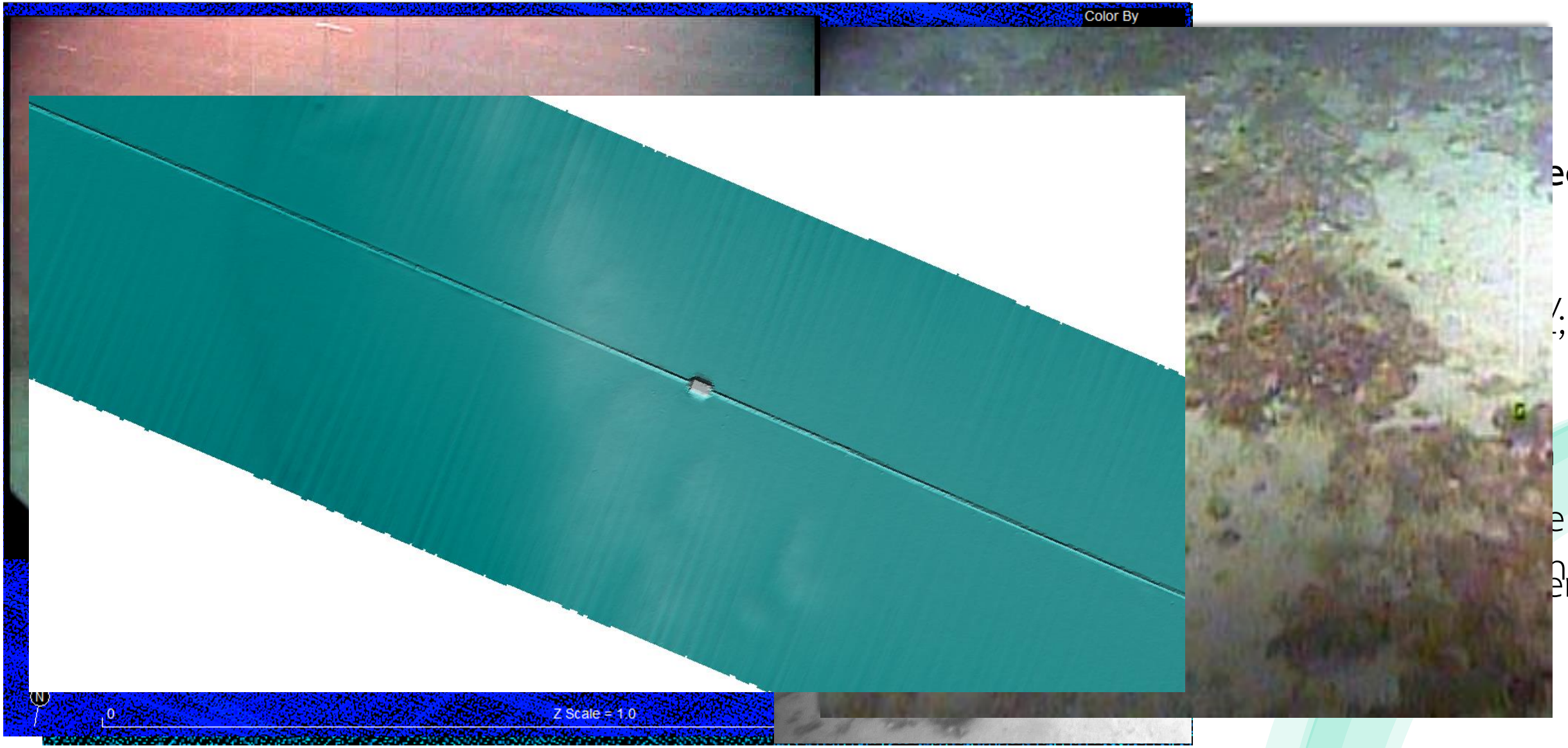


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# Cultural Resources via Multibeam Sonar ^(& sometimes C-BASS!)

Project Scientist: Matthew Hommeyer (mhommeyer@usf.edu)

# Subbottom and Grain Size Analyses

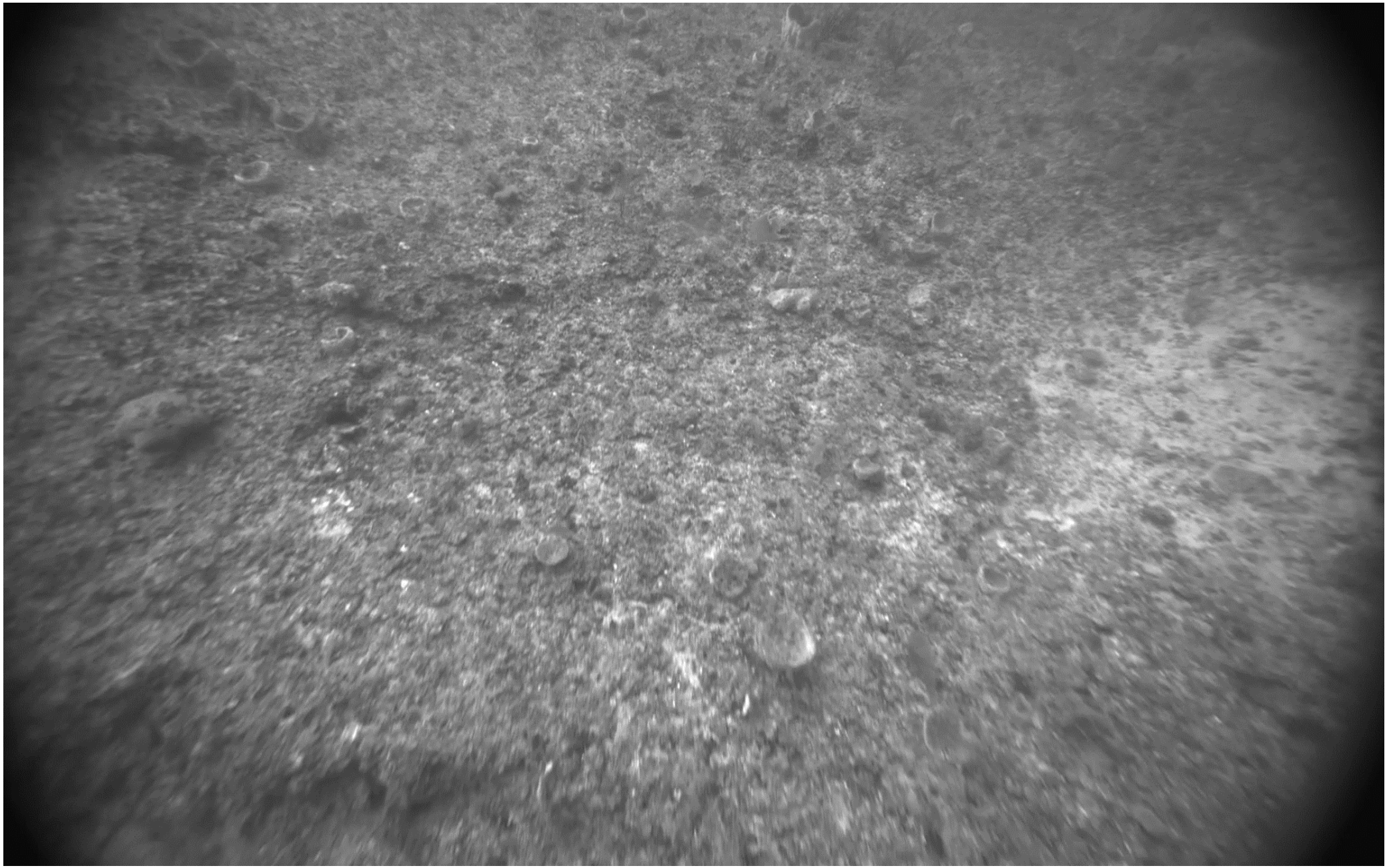

Bubble gun was used to collect 336 km of **seismic-reflection data (white lines)** in August 2018

Bottom **sediment samples (black pins)** were taken using a Shipec grab sampler during 2015 and 2016 cruises; analyzed by Eckerd College

Purpose was to better understand formation of hardbottom features to **scout for new areas**

Project CoPI: Dr. Stanley Locker (stan@usf.edu)

# Exploring Fish "Neighborhoods"



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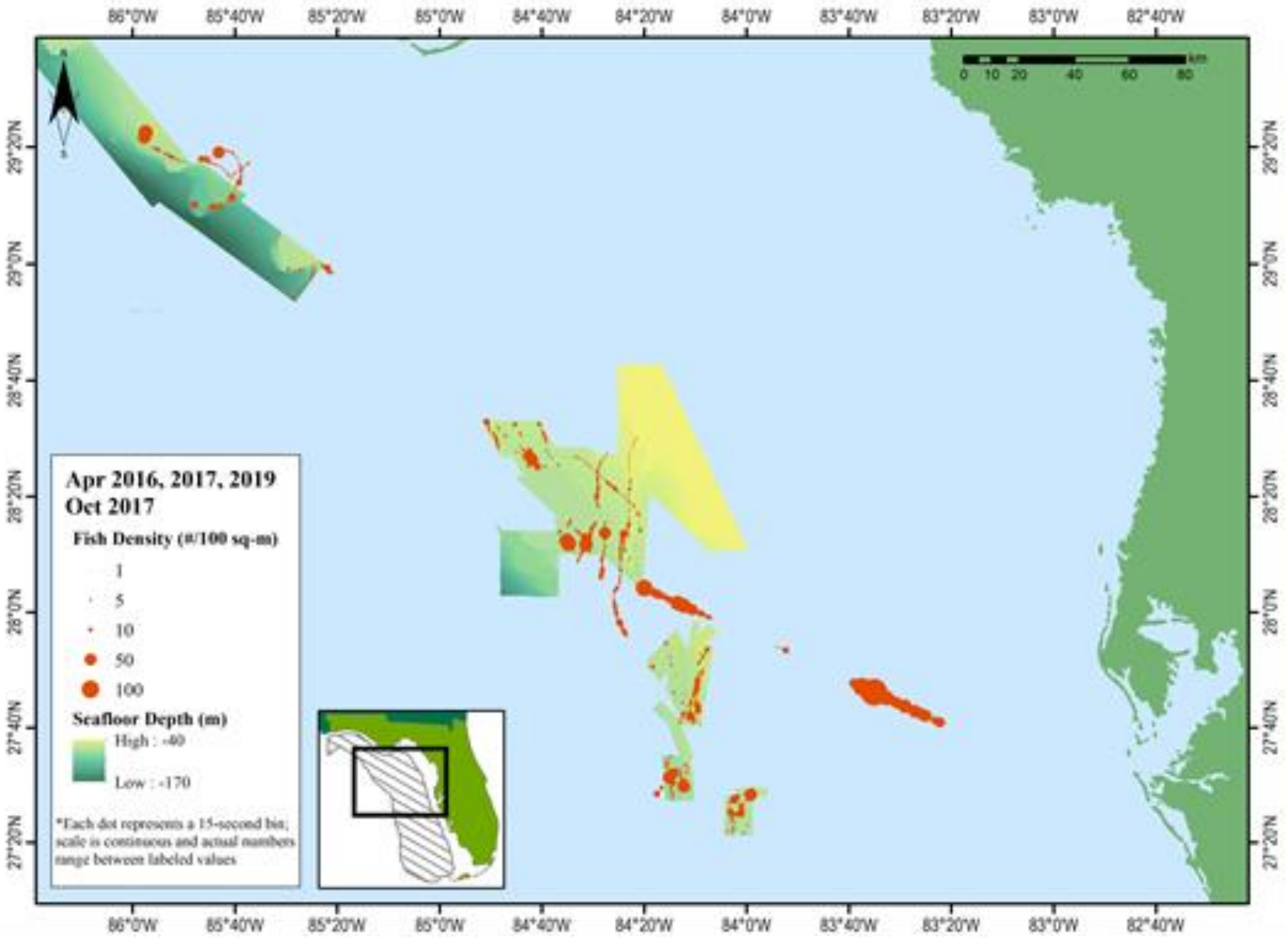



Collected > **325 hours** of **video**

**Imaged >2,500 km** of transect (approx. 25 sq-km)

**124 species** observed

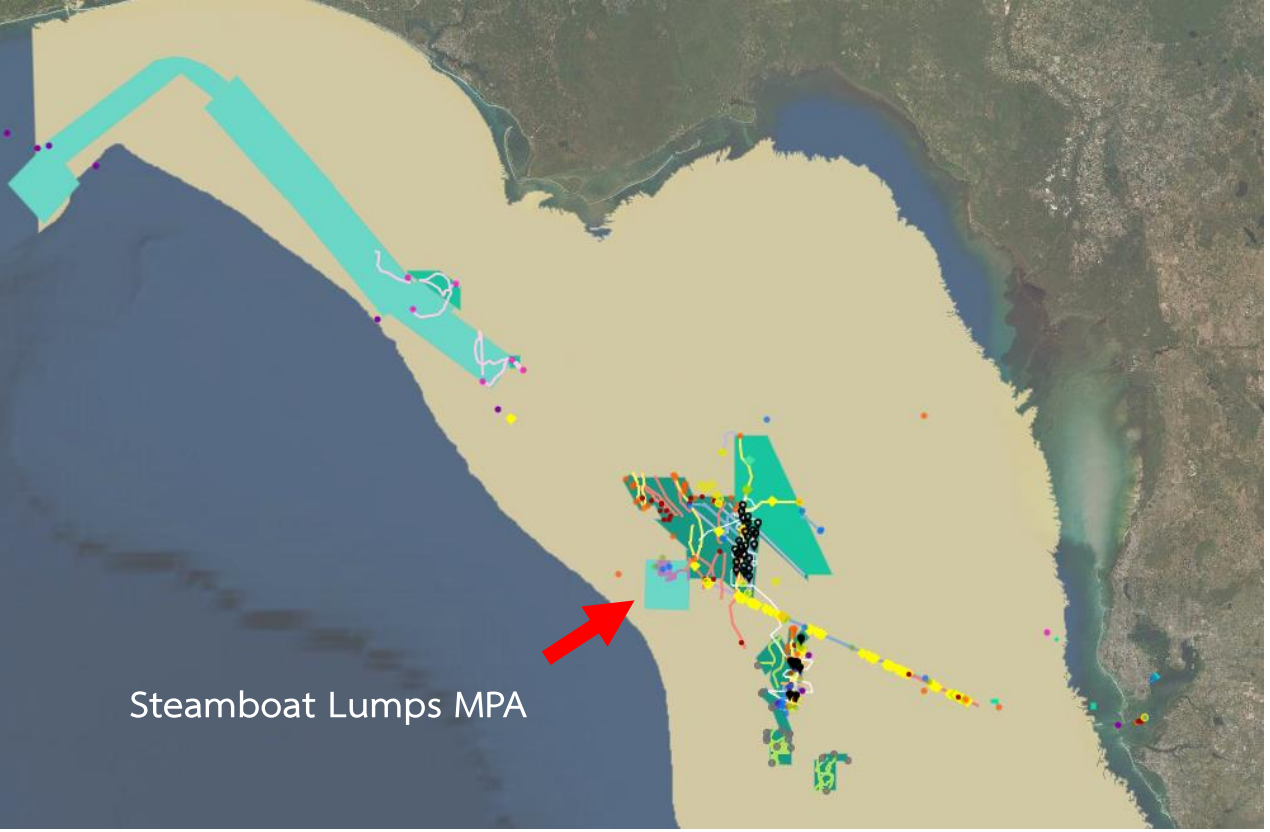
Most **frequently** observed:

- Lionfish
- Gray Snapper (Lujanus griseus)
- Bigeye spp. (Priacanthidae spp.)

**GSPL** had **highest** densities

**Low-relief hardbottom** is extremely **important** on the WFS

# Exploring Fish "Neighborhoods" And Change Over Time




Spatial and temporal variability of red grouper holes within Steamboat Lumps Marine Reserve, Gulf of Mexico

**Article (PDF Available)** *in* Marine Ecology Progress Series 431:243-254 · June 2011 *with* 471 Reads
DOI: 10.3354/meps09167
Cite this publication

**Carrie Wall**
25.37 · University of Colorado Boulder

**Brian T. Donahue**
18.07 · University of South Florida

**David F. Naar**
32.09 · University of South Florida

**David Allen Mann**
38.88 · Loggerhead Instruments

Transactions of the American Fisheries Society

Article | Full Access

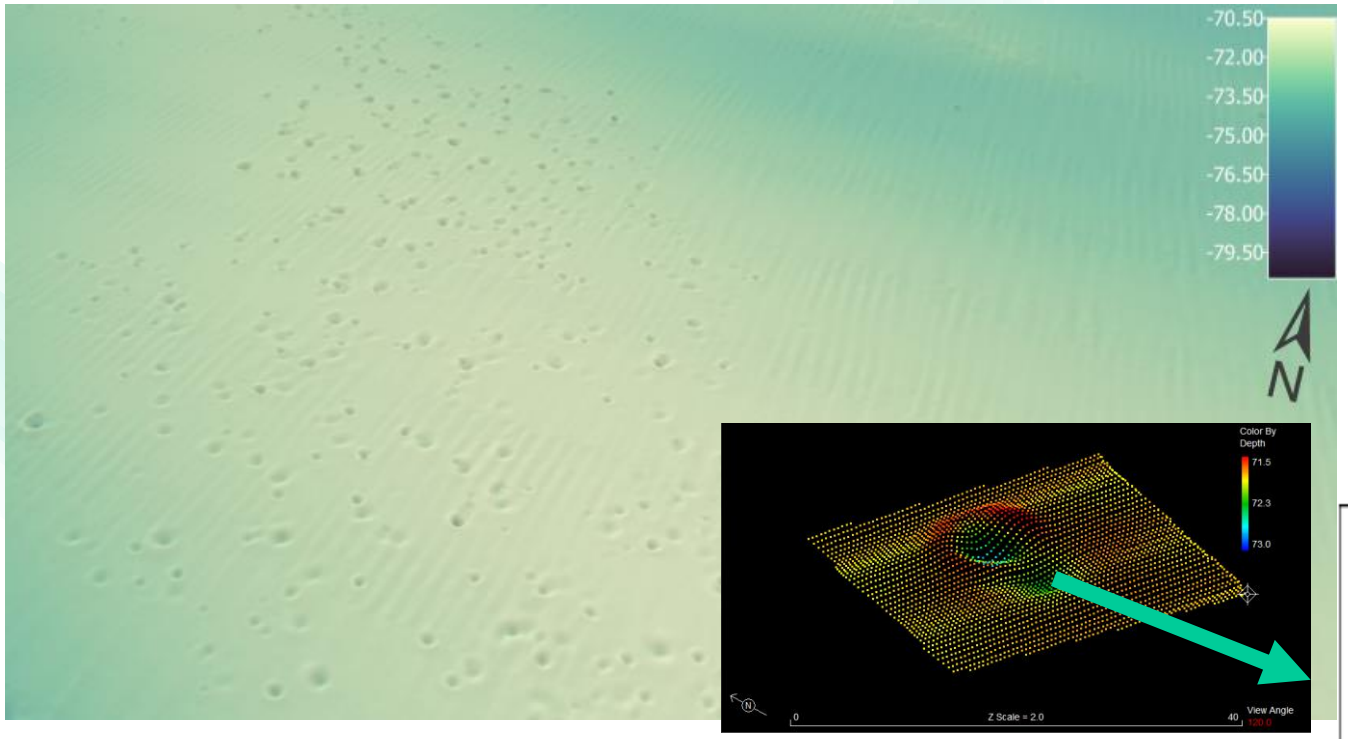
Temporal Persistence of Red Grouper Holes and Analysis of Associated Fish Assemblages from Towed Camera Data in the Steamboat Lumps Marine Protected Area

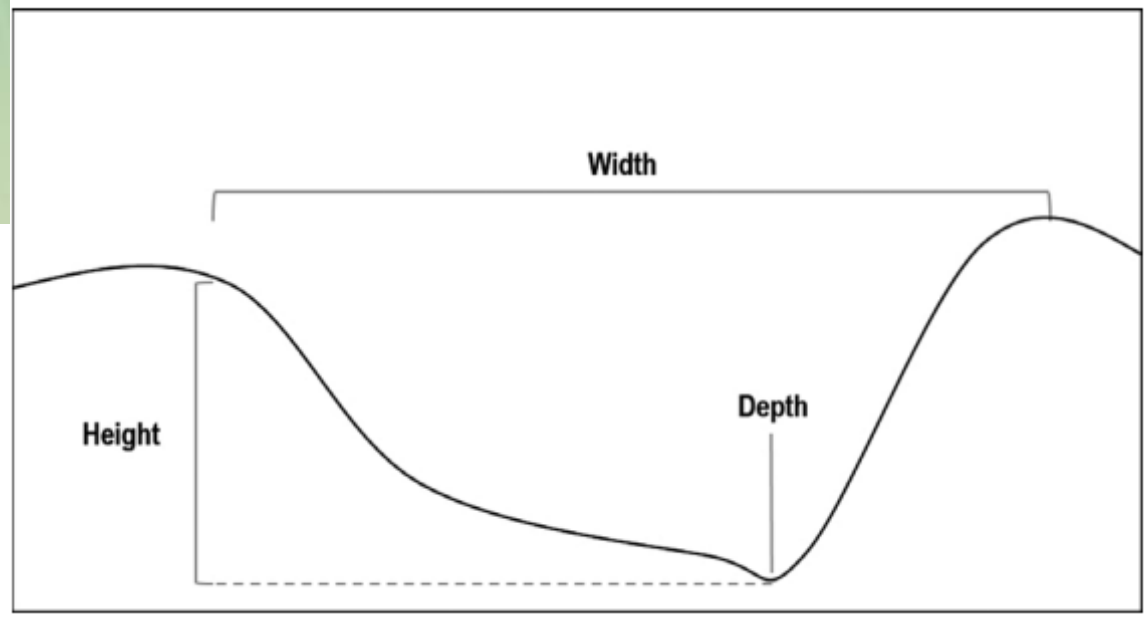
Sarah E. Grasty, Carrie C. Wall, John Willis Gray, Jennifer Brizzolara, Steven Murawski

First published: 19 February 2019 | https://doi.org/10.1002/tafs.10154 | Citations: 1

Project Scientist: Sarah Grasty (grastys@usf.edu)

# Exploring Fish "Neighborhoods" And Change Over Time

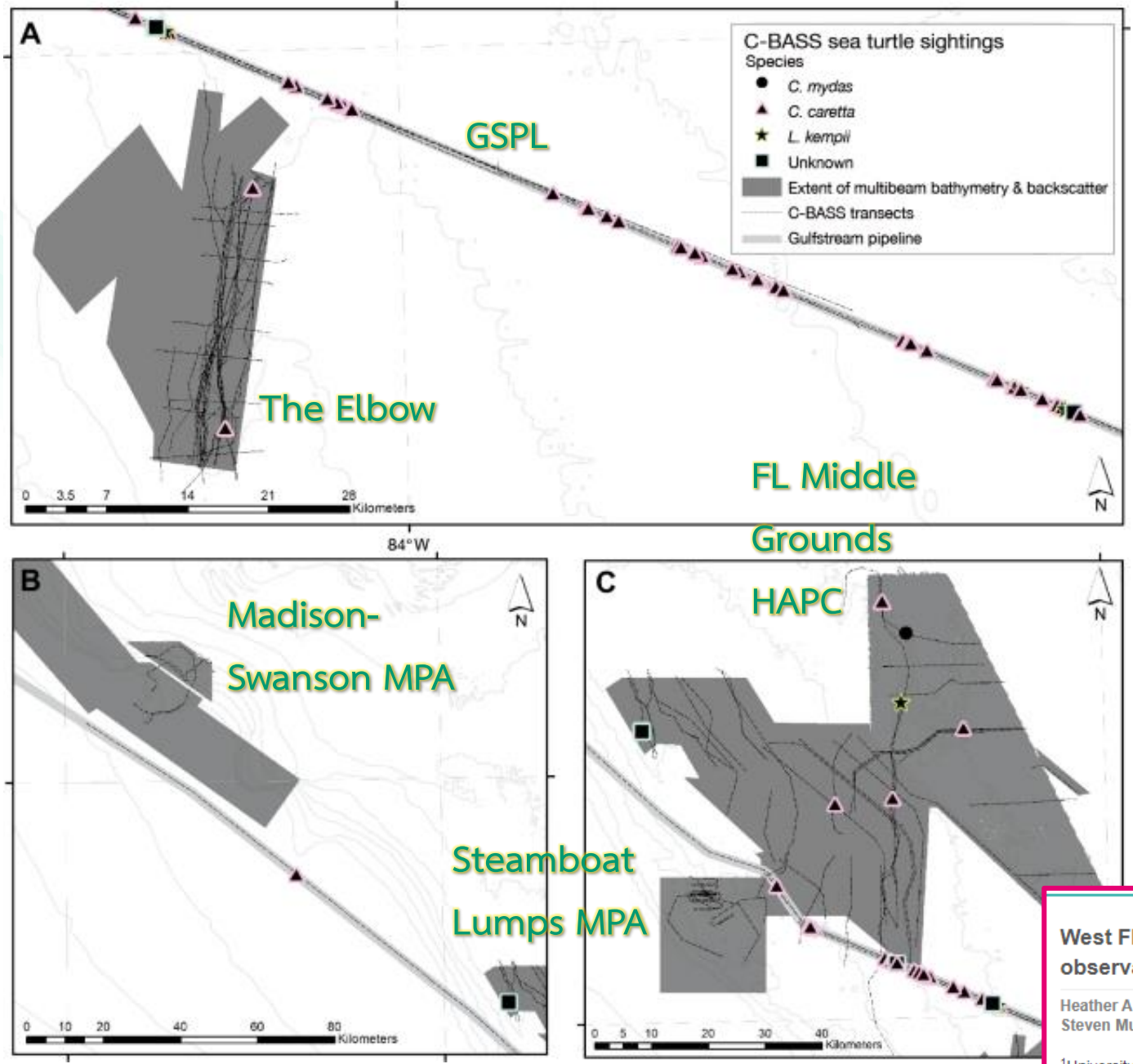



Overall, found that hole **density increased** and of the **95 holes** observed with **CBASS,** approx. **84%** had at least 1 **Lionfish**

Project Scientist: Sarah Grasty (grastys@usf.edu)

# Sea Turtle Observations




In total, **79 sea turtles** were observed over 97 transects (380 h of video) which covered approximately 2,700 km of seafloor

Research Scientist: Dr. Heather Broadbent (hbroadbent@usf.edu)

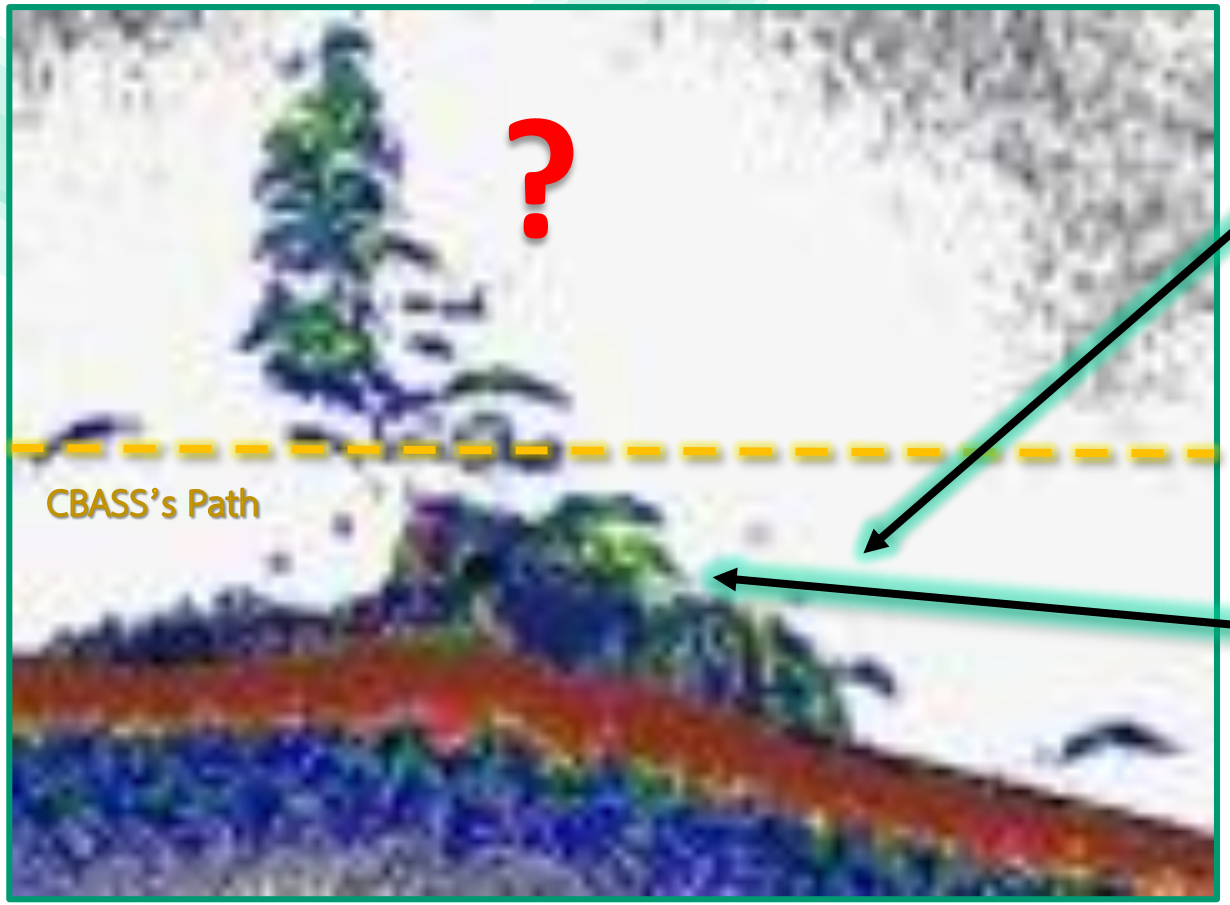
**West Florida Shelf pipeline serves as sea turtle benthic habitat based on *in situ* towed camera observations**


Heather A. Broadbent[1,*], Sarah E. Grasty[1], Robert F. Hardy[2], Margaret M. Lamont[3], Kristen M. Hart[4], Chad Lembke[1], Jennifer L. Brizzolara[1], Steven Murawski[1]

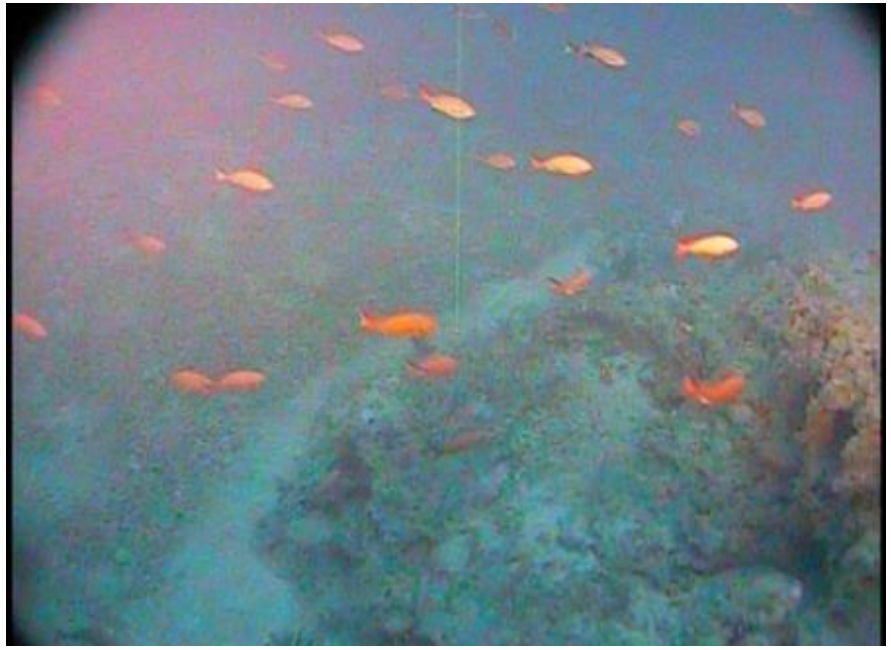
[1]University of South Florida, College of Marine Science, Saint Petersburg, FL 33701, USA
[2] Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Saint Petersburg, FL 33701, USA
[3]US Geological Survey, Wetland and Aquatic Research Center, Gainesville, FL 32653, USA
[4]US Geological Survey, Wetland and Aquatic Research Center, Davie, FL 33314, USA


Loggerheads
Galore

# Pairing Acoustic & Visual Fish Data




EK60 Echogram



PhD Candidate: Edmund Hughes (ehughes@usf.edu)

# Improving Reef Fish Sampling with FWRI-FIM

## S-BRUV

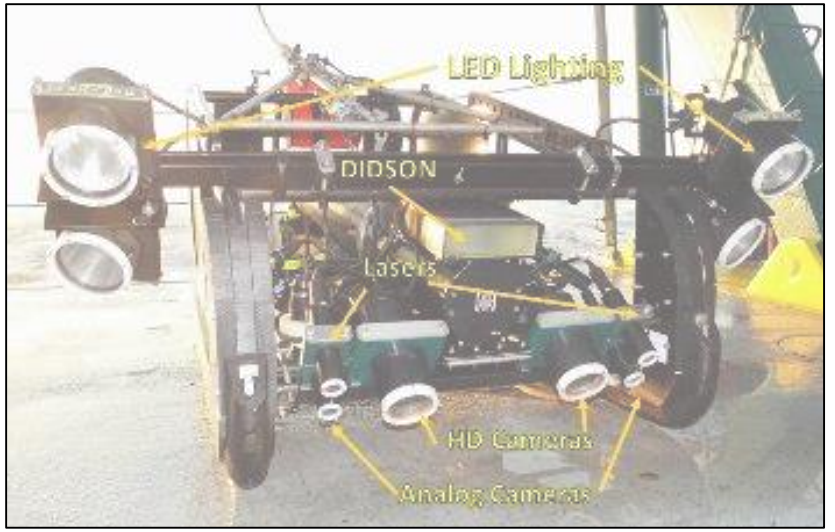
- Baited
- MaxN Metric
- No Lights
- Stationary
- Sidescan for habitat

## Both

- Measurement
- Camera model

## C-BASS

- Unbaited
- Density Metric
- Lighted
- Mobile
- MBES/Video for habitat

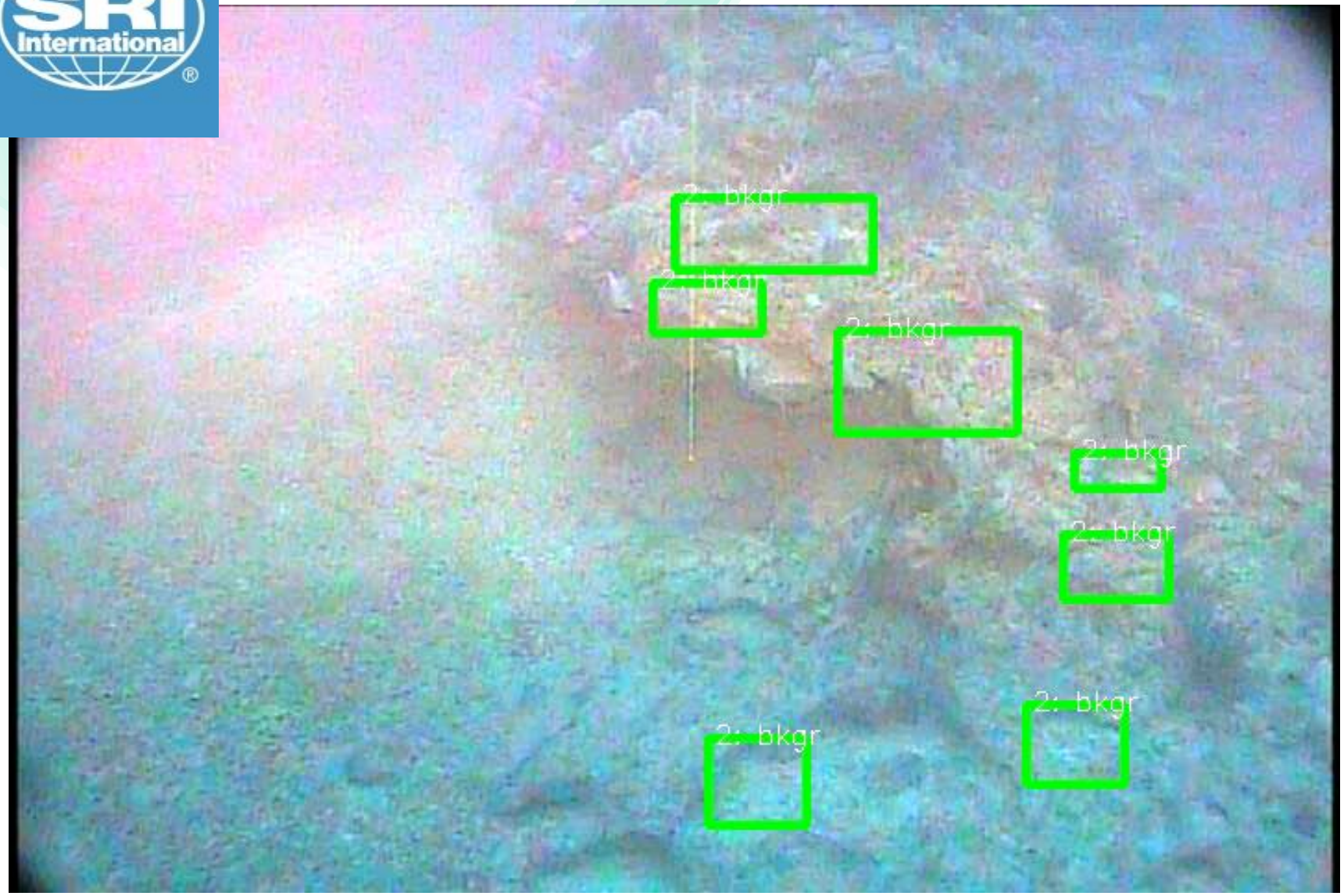



C-BASS

S-BRUV

Collaborators: Dr. Ted Switzer & Sean Keenan (FWRI)

# Fish Autorecognition




bkgr = Background

fish = Fish ☺

garbage = small, zoomed in ROIs

# Outreach

@CSCAMPscience

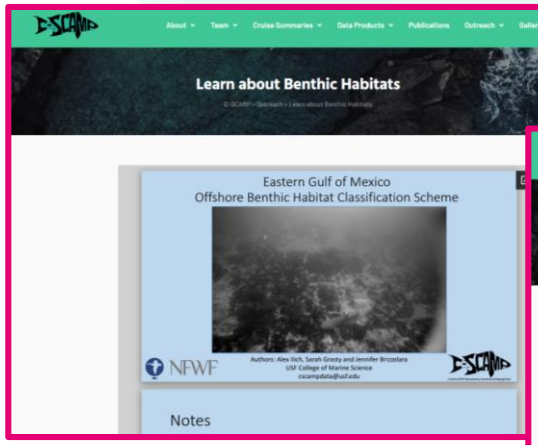
## Social Media

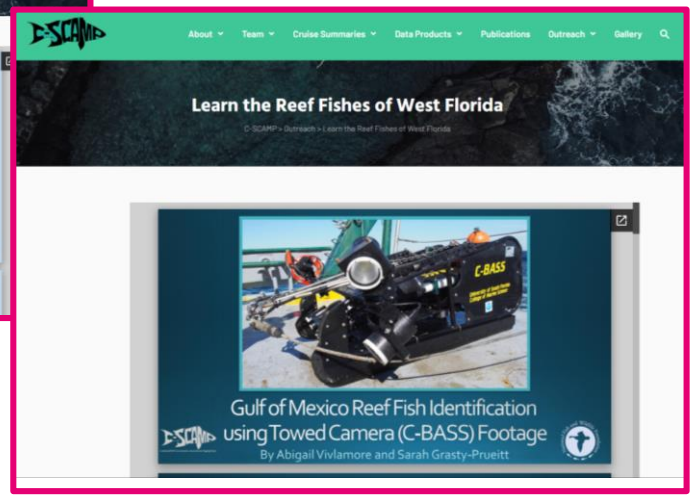
C-SCAMP Videos


## 8-page Overview Booklet

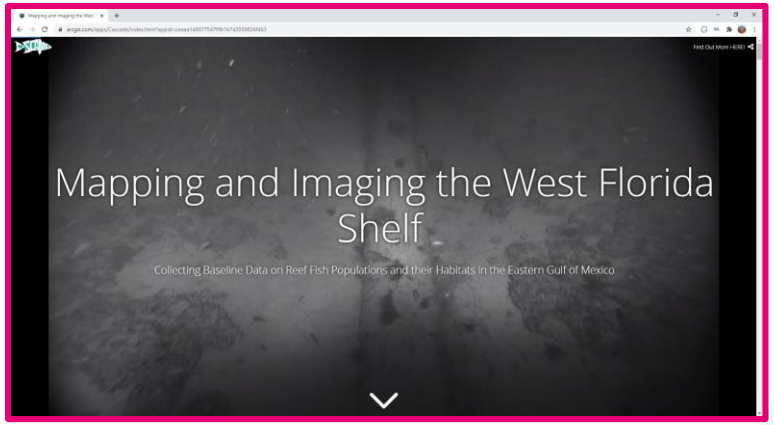

## Mini Fish Profile Booklets


## Infographics




## Fish & Habitat Guides

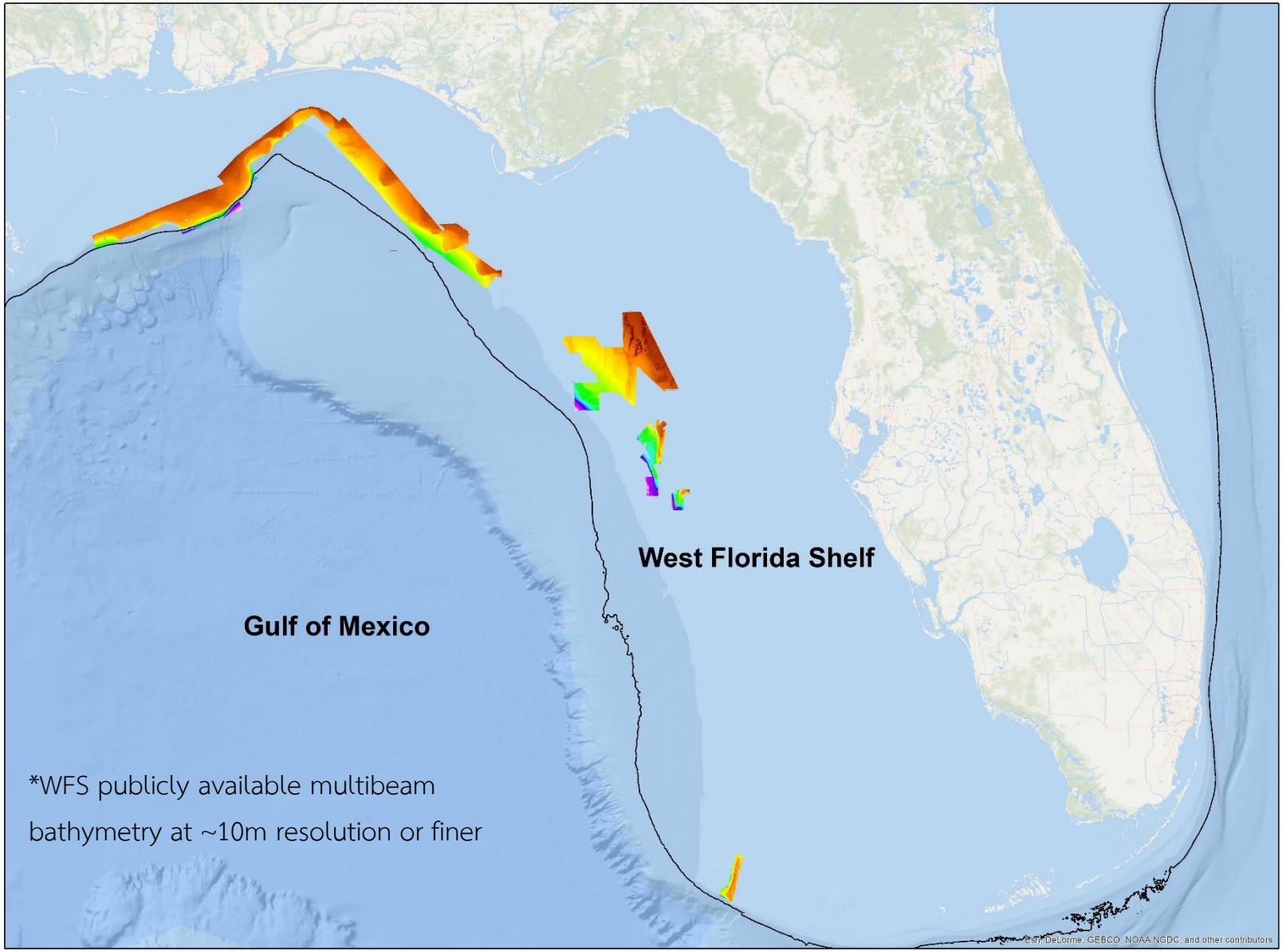



## ArcStory

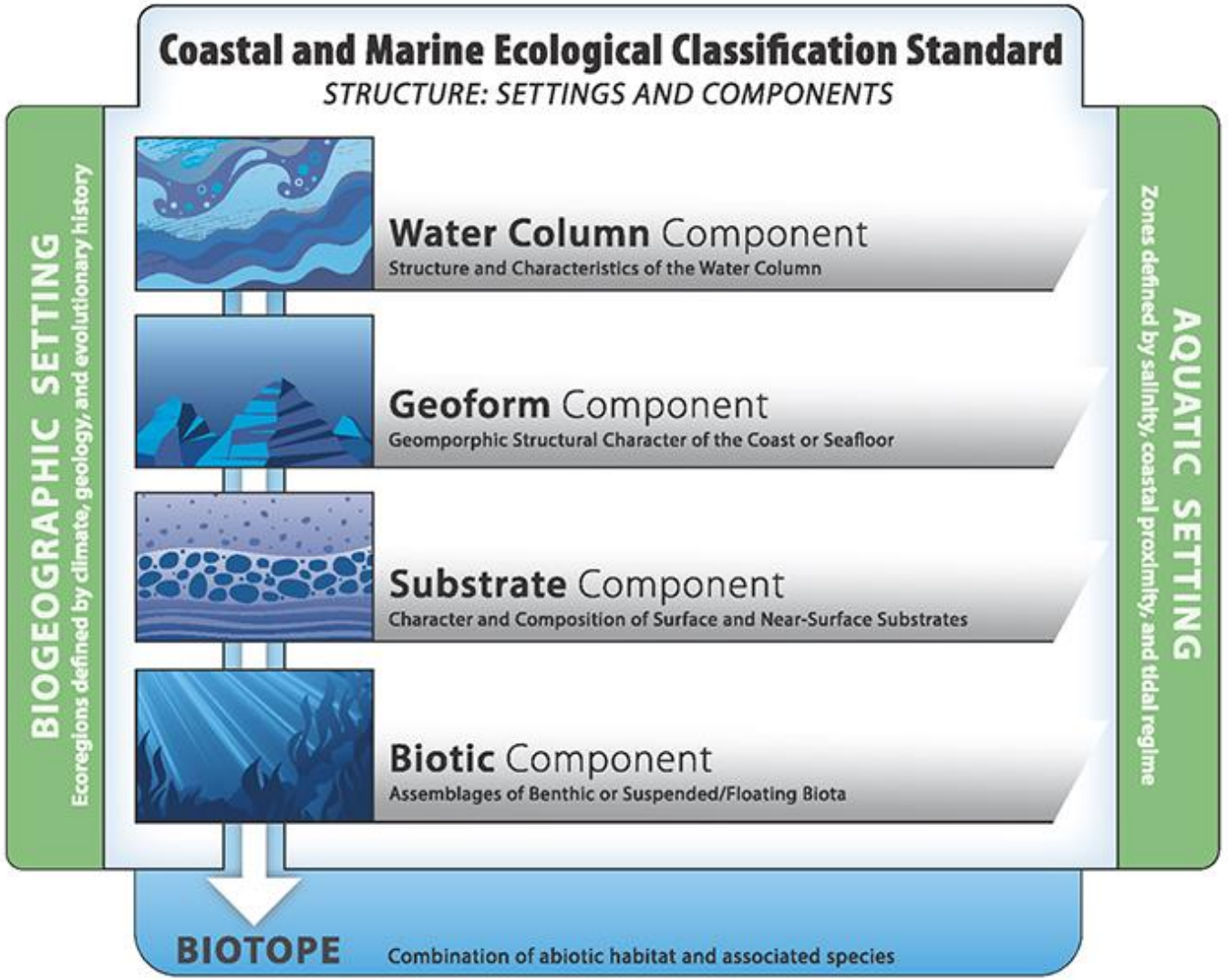
www.marine.usf.edu/scamp

Project Technicians: Abigail Vivlamore (avivlamore@usf.edu) & Rachel Crabtree (rcrabtree@usf.edu)

# High Resolution Multibeam



# What is Habitat?




(Federal Geographic Data Committee, 2012)

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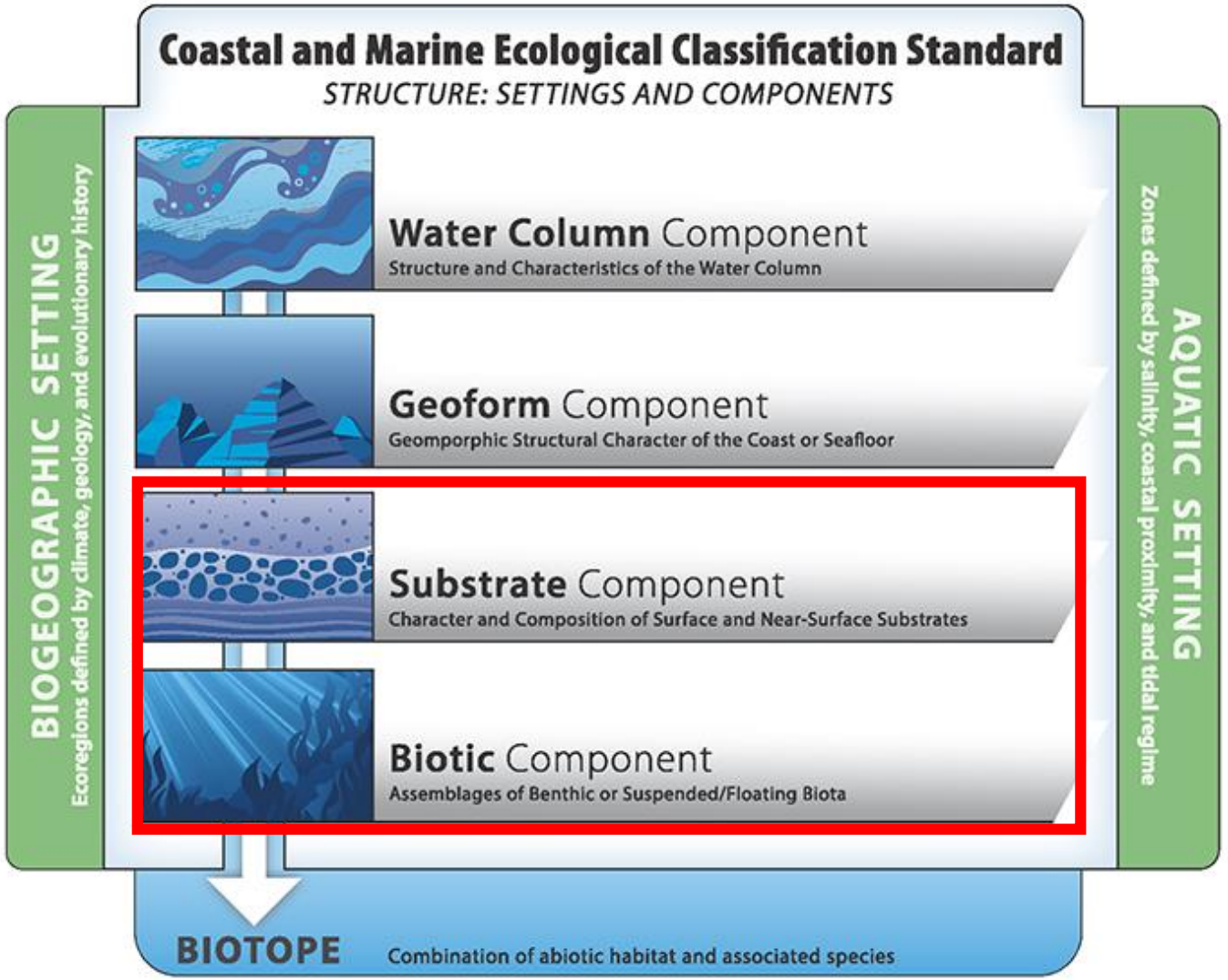



(Federal Geographic Data Committee, 2012)

# Habitat Scheme: Substrate

**Substrate**

**CMECS Component**

# Habitat Scheme: Substrate

**Substrate**

CMECS Component


**Rock Substrate**

CMECS Substrate Class

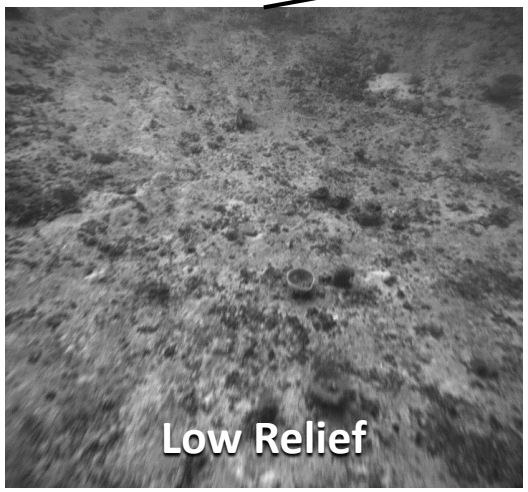
# Habitat Scheme: Substrate

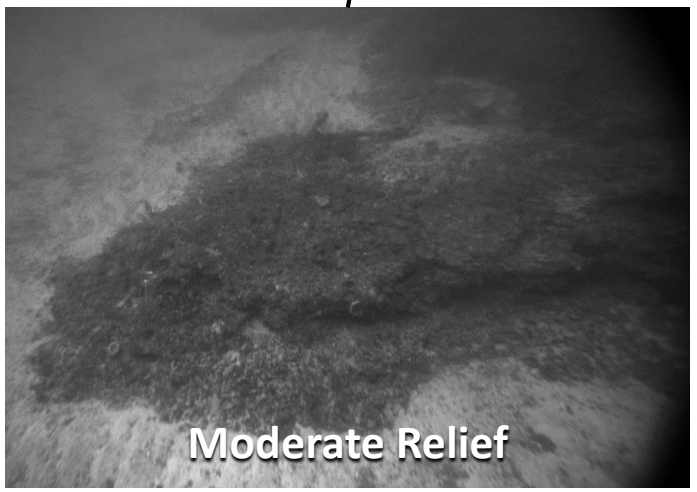
**Substrate**

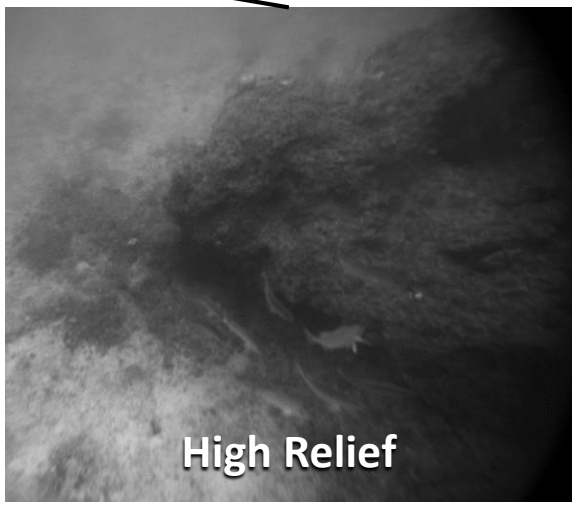
CMECS Component


**Rock Substrate**

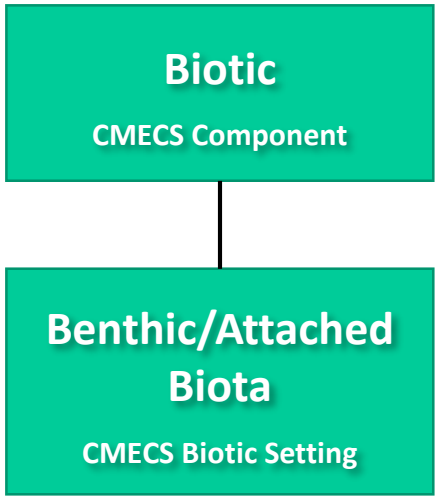
CMECS Substrate Class



# Habitat Scheme: Biotic



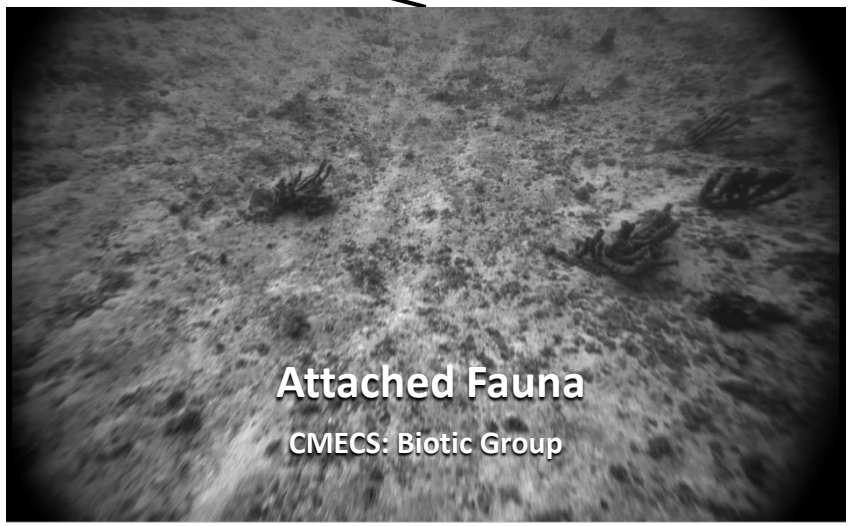
# Habitat Scheme: Biotic

**Biotic**

CMECS Component

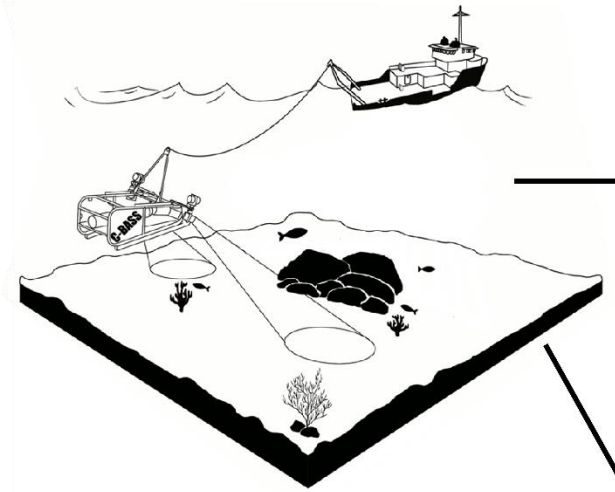
**Benthic/Attached Biota**

CMECS Biotic Setting

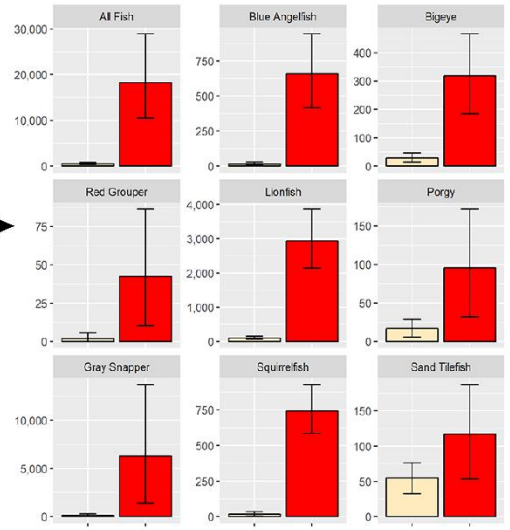



# Overall Procedure

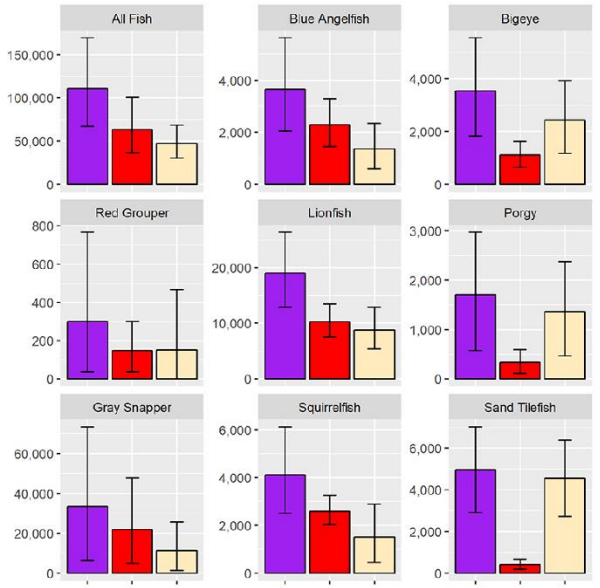
## Towed Underwater Video



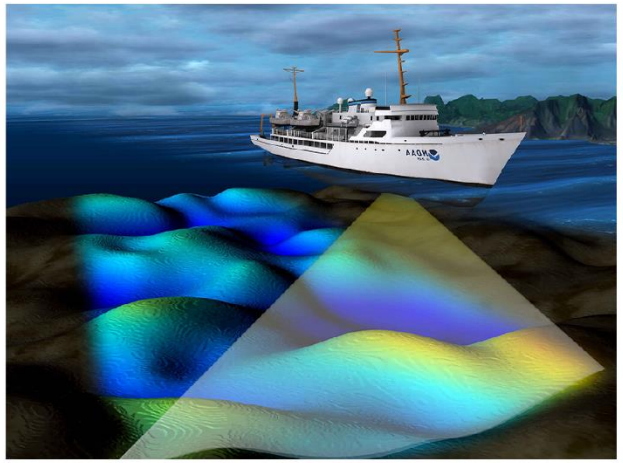

## Habitat-Specific Fish Densities



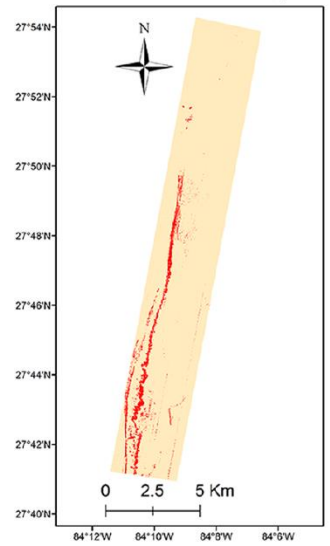

## Total Abundance Estimates



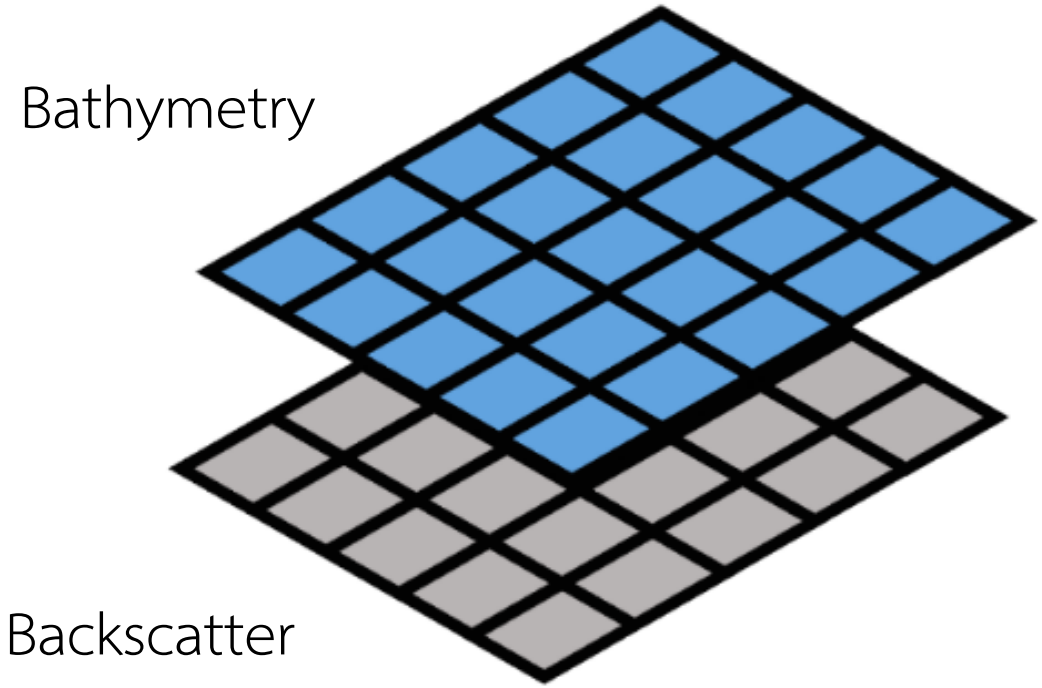

## Multibeam Sonar



## Habitat Map



# Supervised Classification Process



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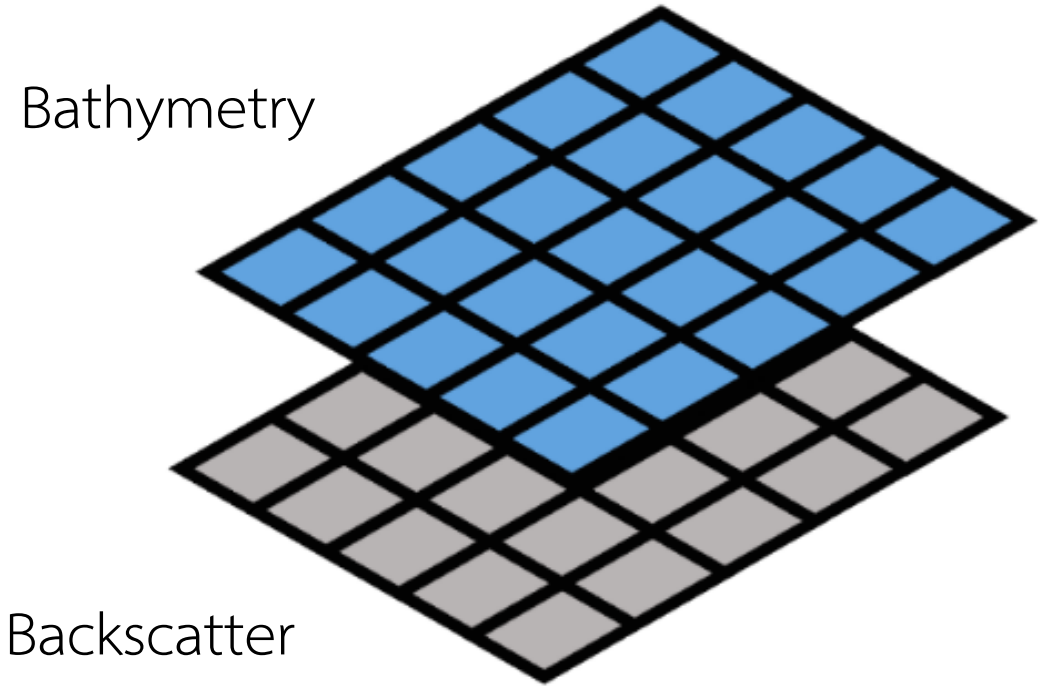

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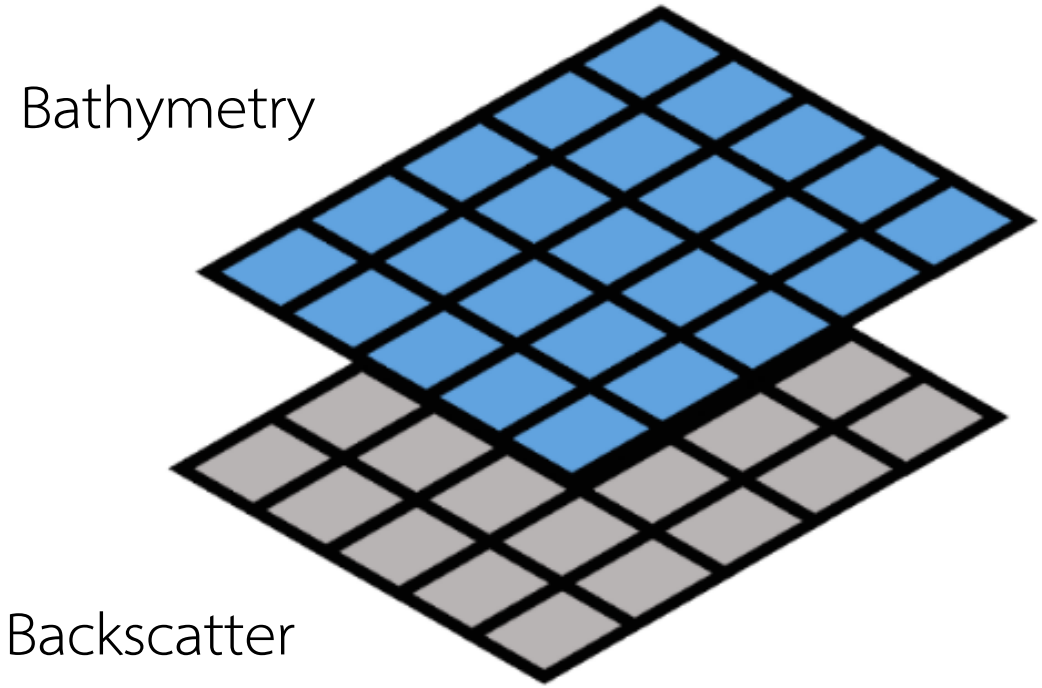

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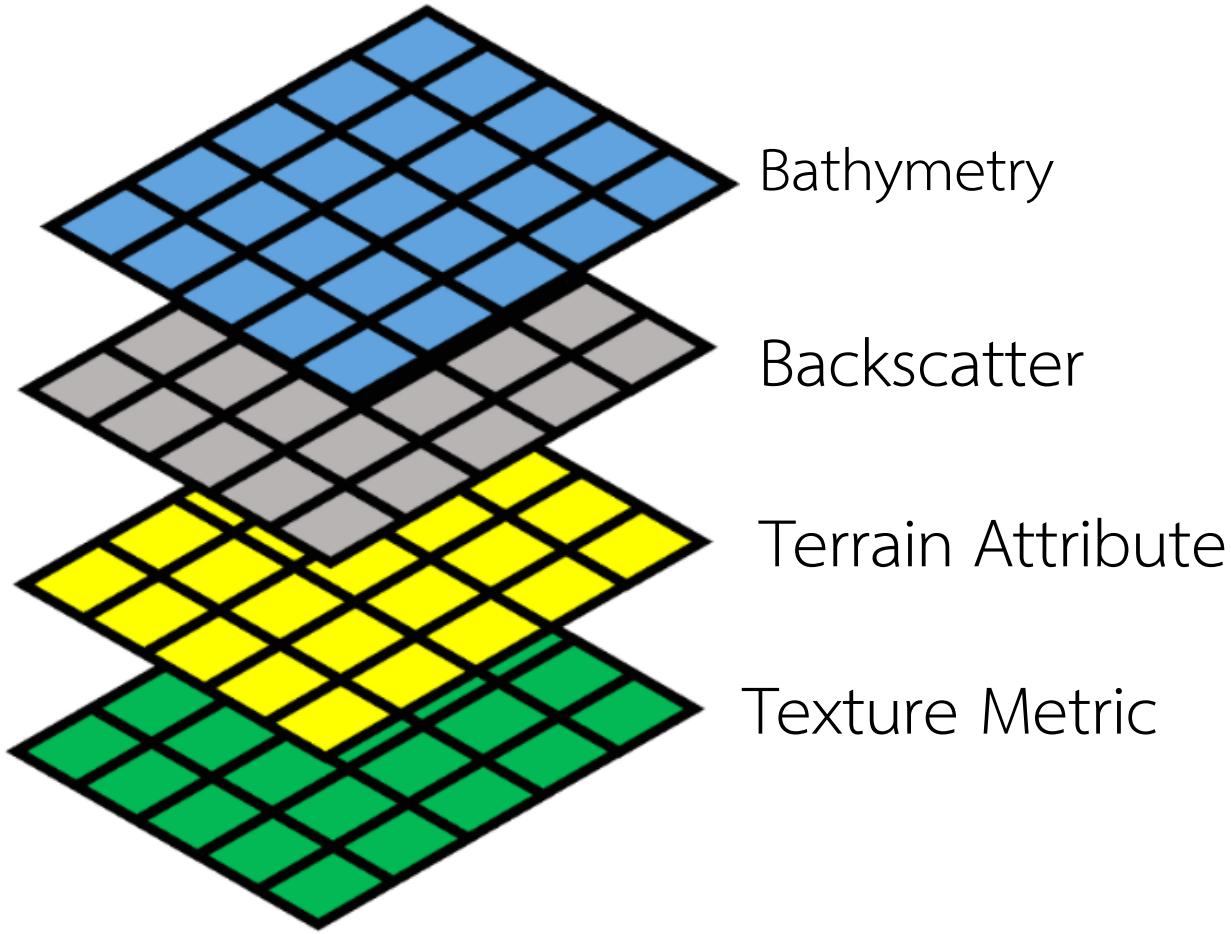
Calculate Derivative Features



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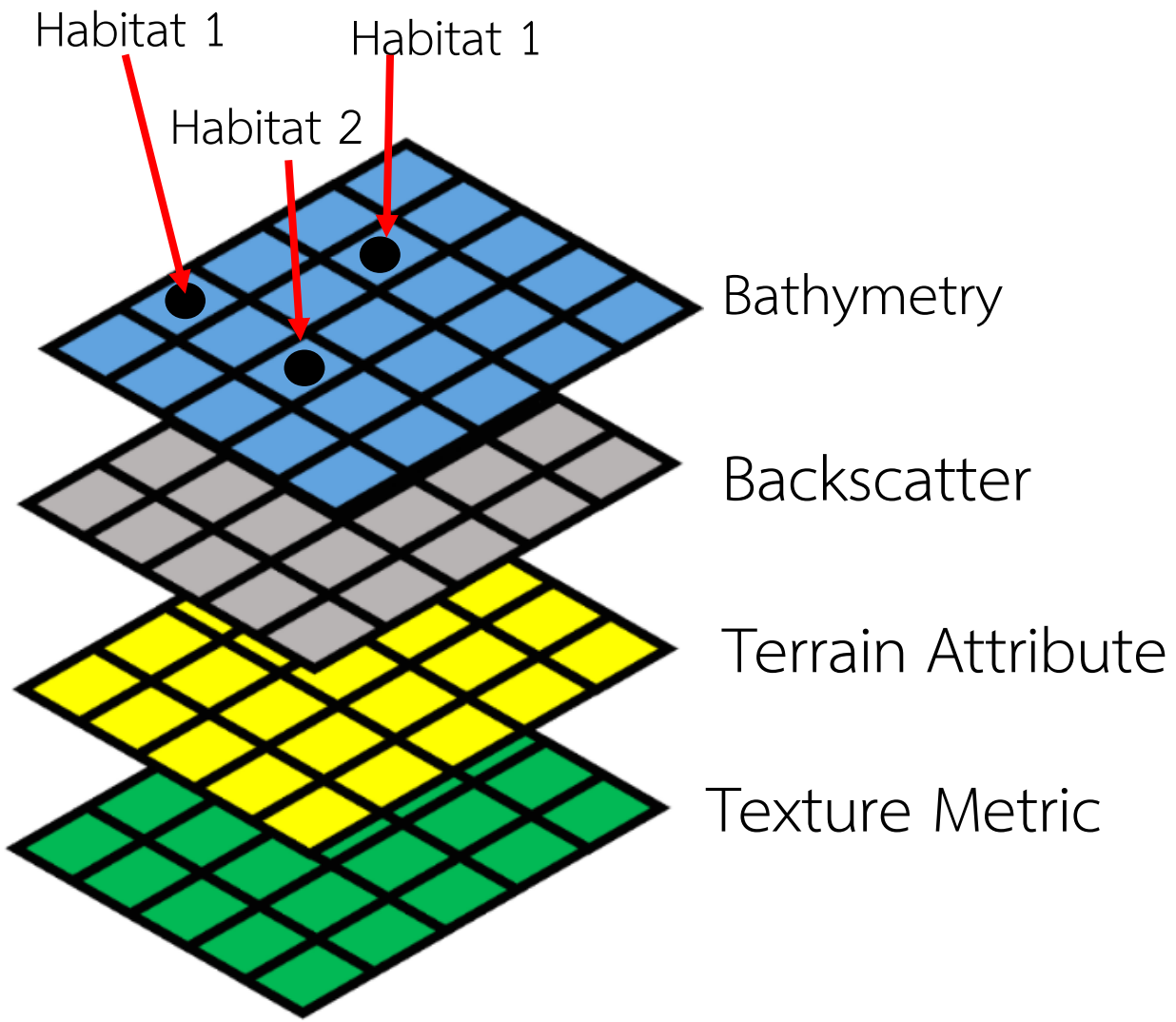
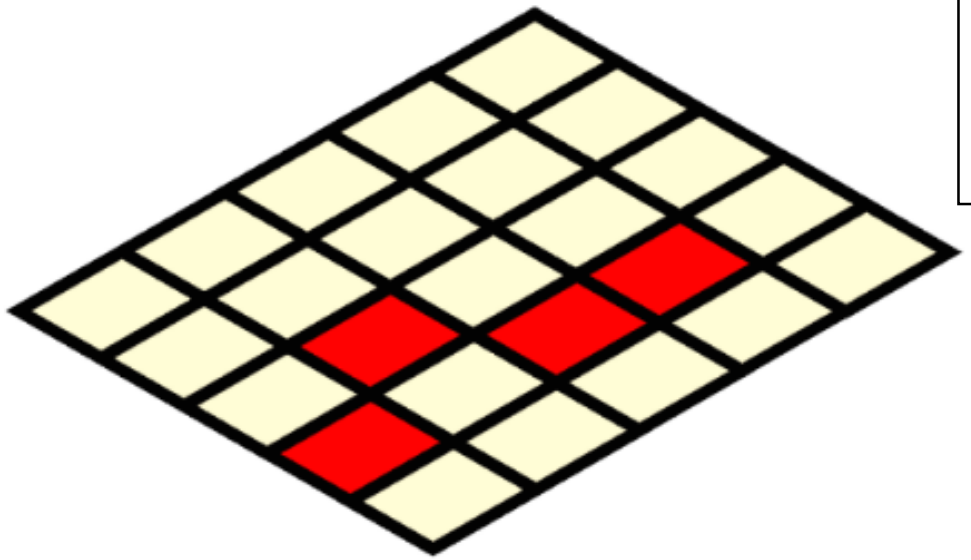


# Supervised Classification Process

Predict

## Thematic Habitat Map

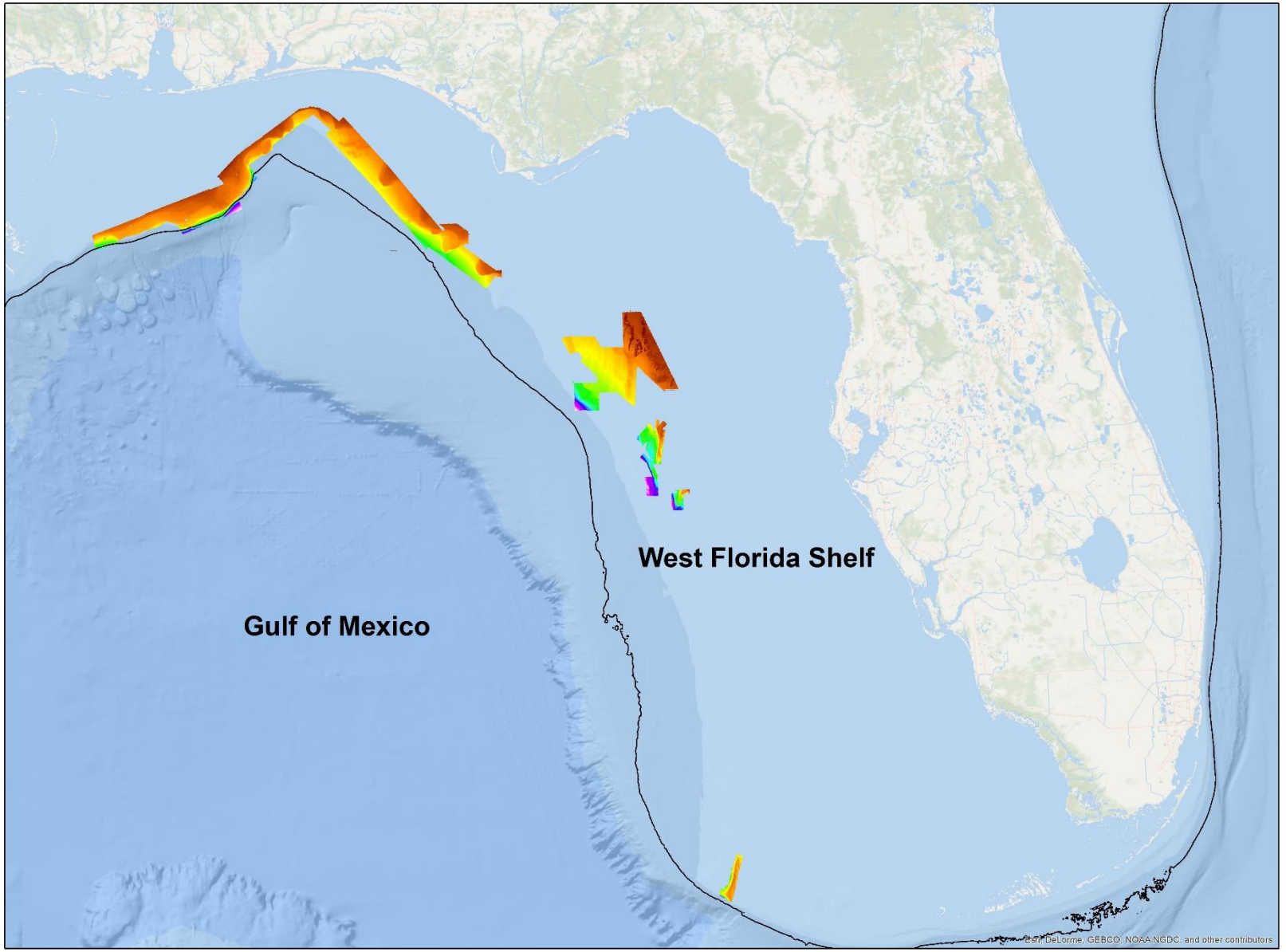


Habitat

Habitat 1

Habitat 2

# High Resolution Multibeam



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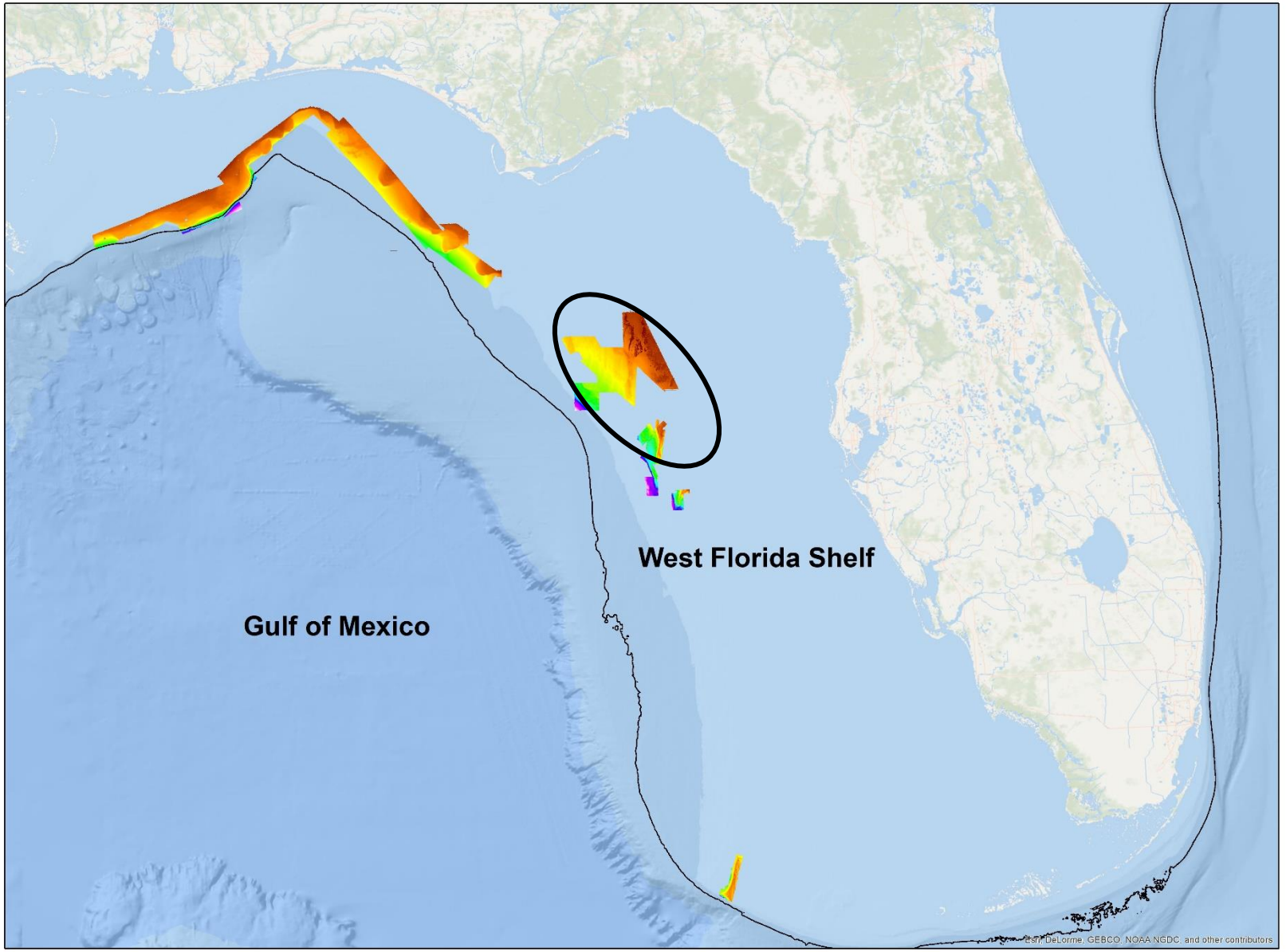
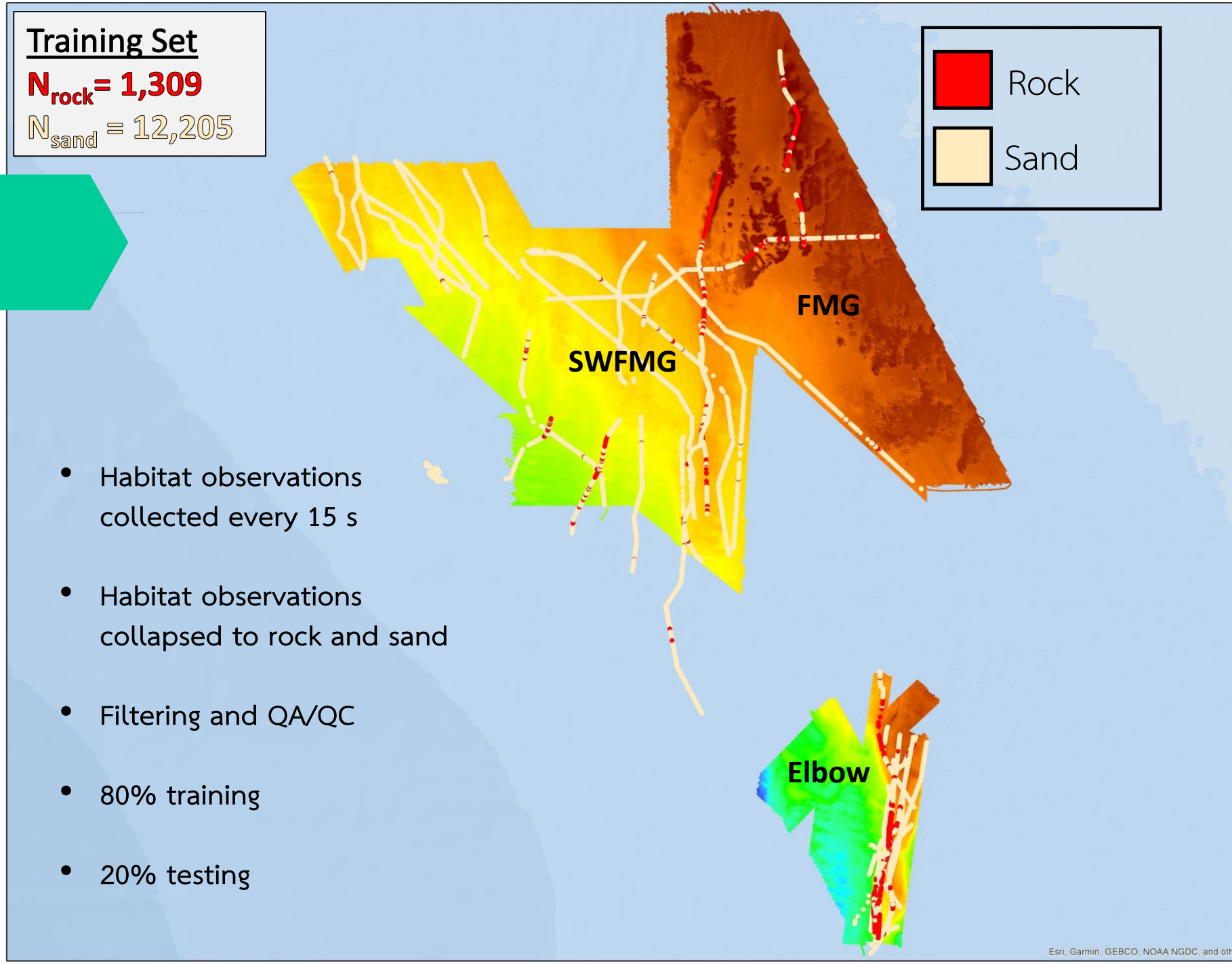


# Groundtruth Habitat

**Training Set**

$N_{rock}$ = 1,309

$N_{sand}$ = 12,205




- Habitat observations collected every 15 s
- Habitat observations collapsed to rock and sand
- Filtering and QA/QC
- 80% training
- 20% testing

# Substrate Maps

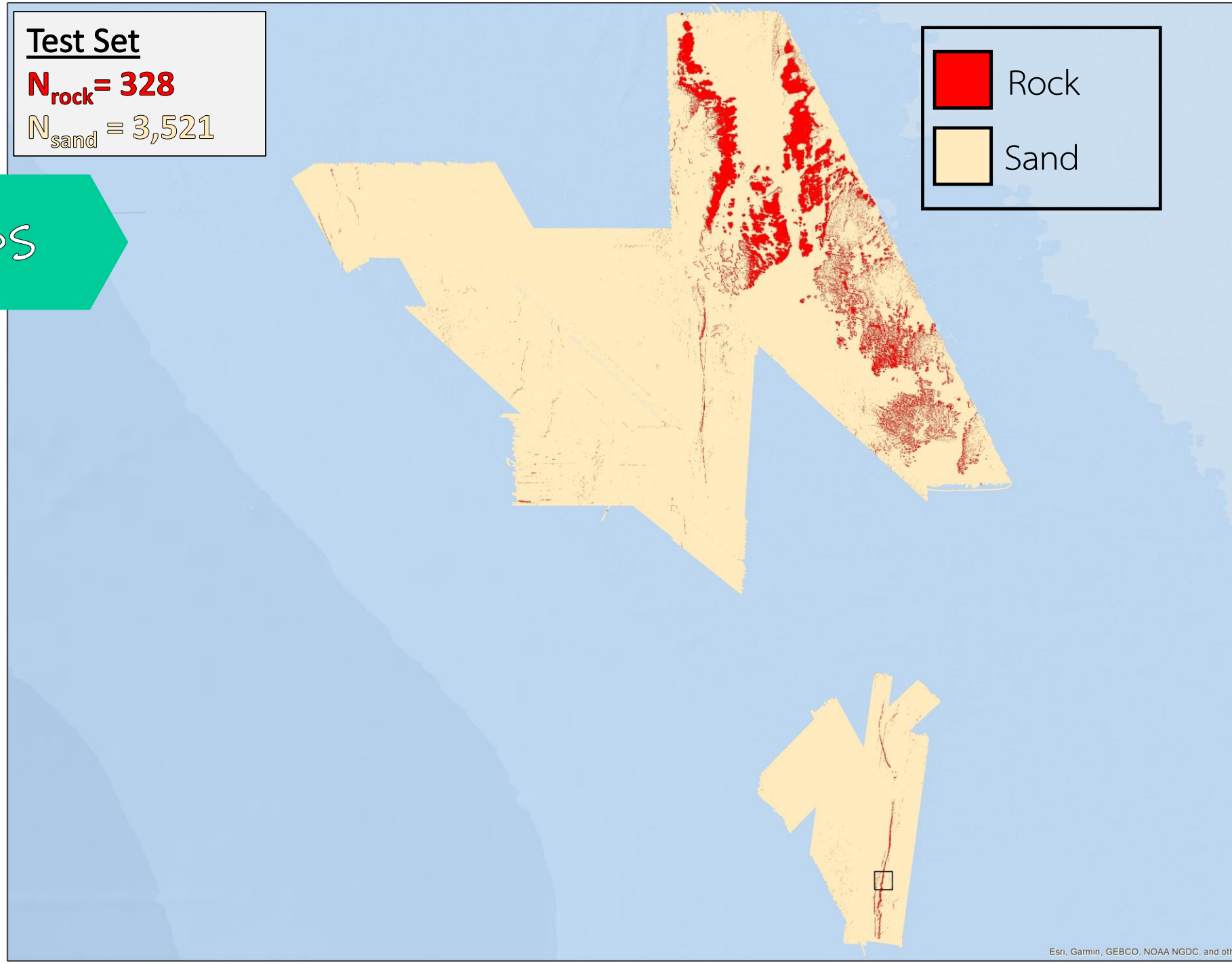
Accuracy = 96%

Kappa = 0.74

**K** > 0.6 indicates “substantial agreement”
(Landis and Koch, 1977)

Why use statistical classifiers?

- Manual delineation can be time consuming
- More objective
- Can be iteratively improved over time



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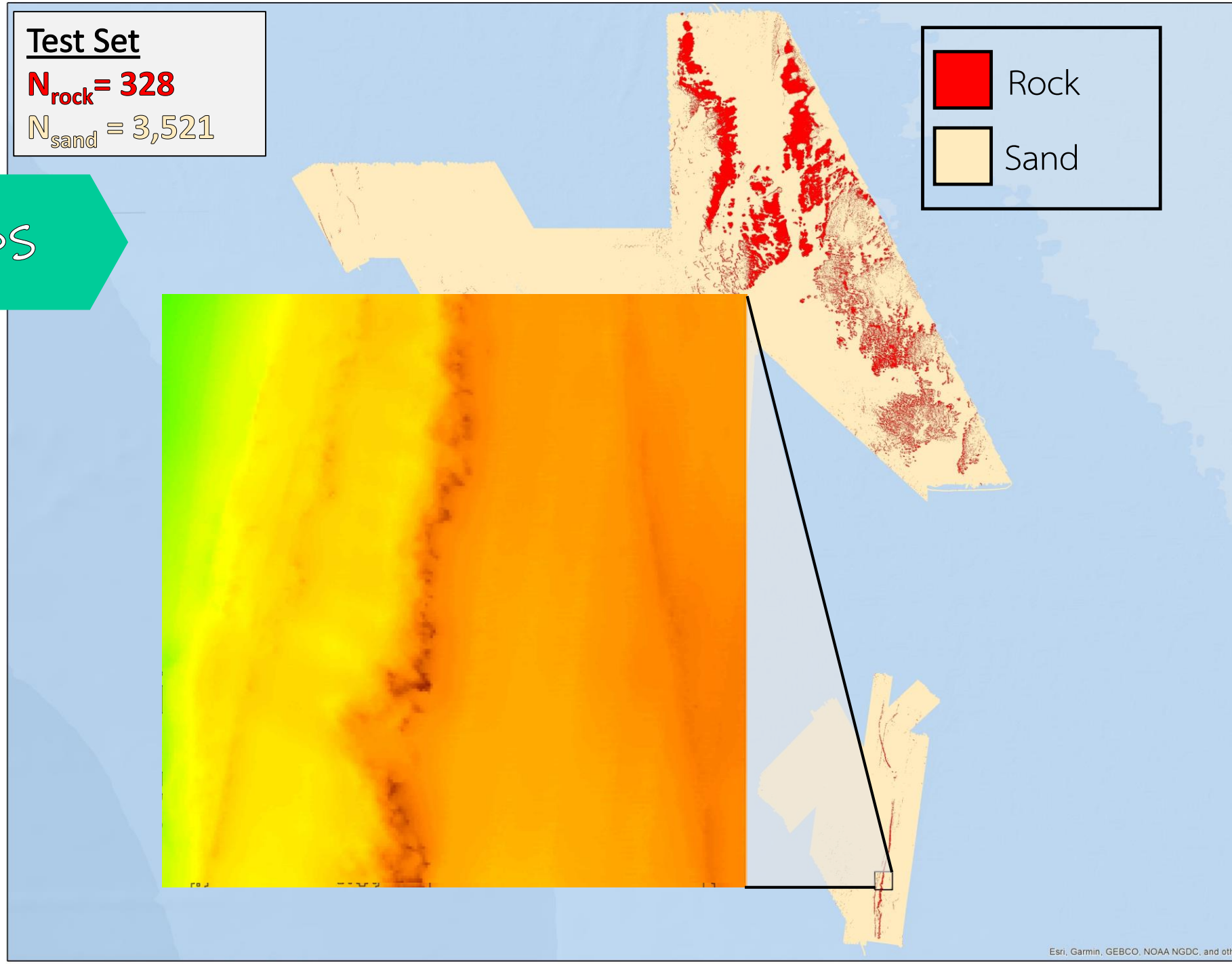

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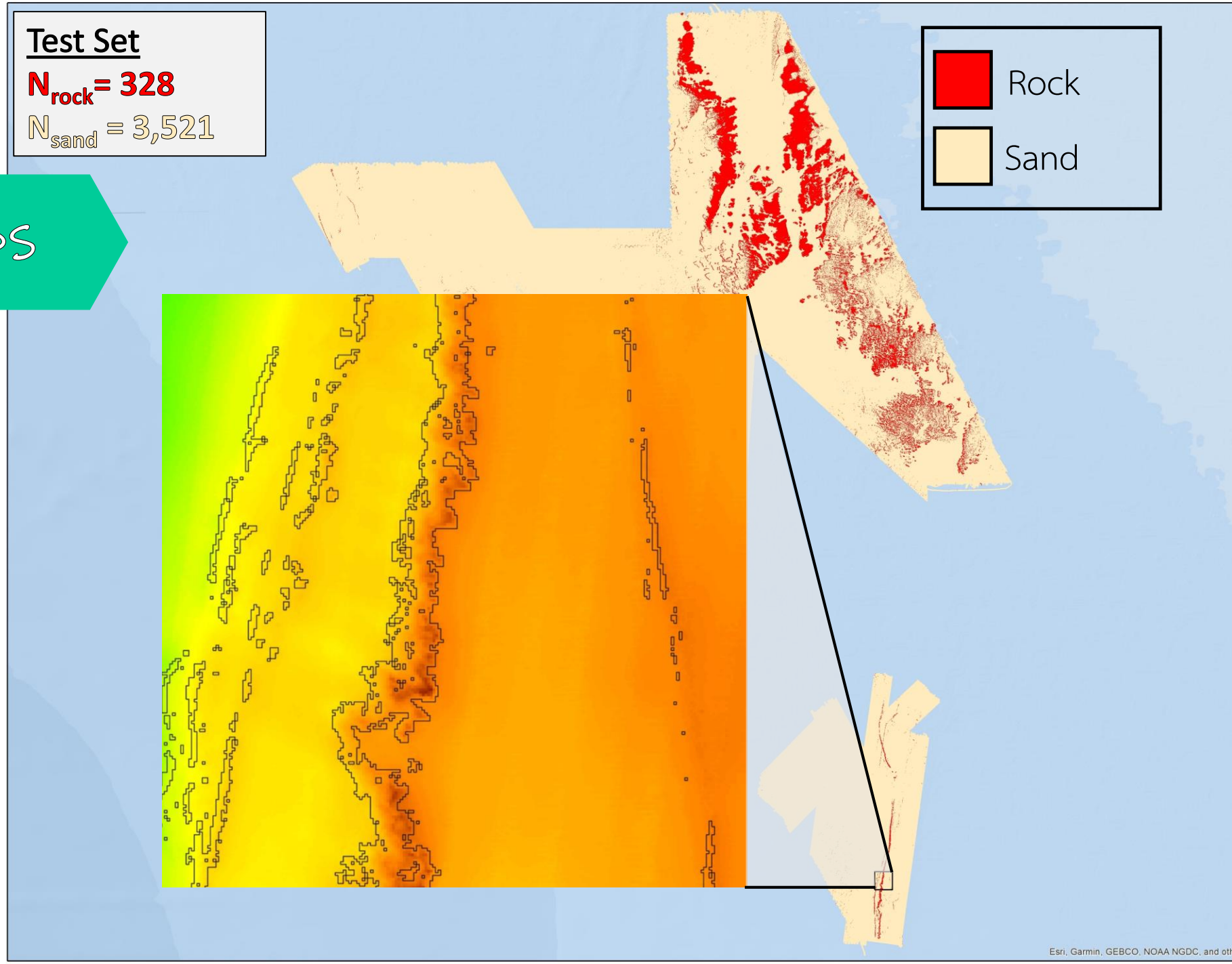
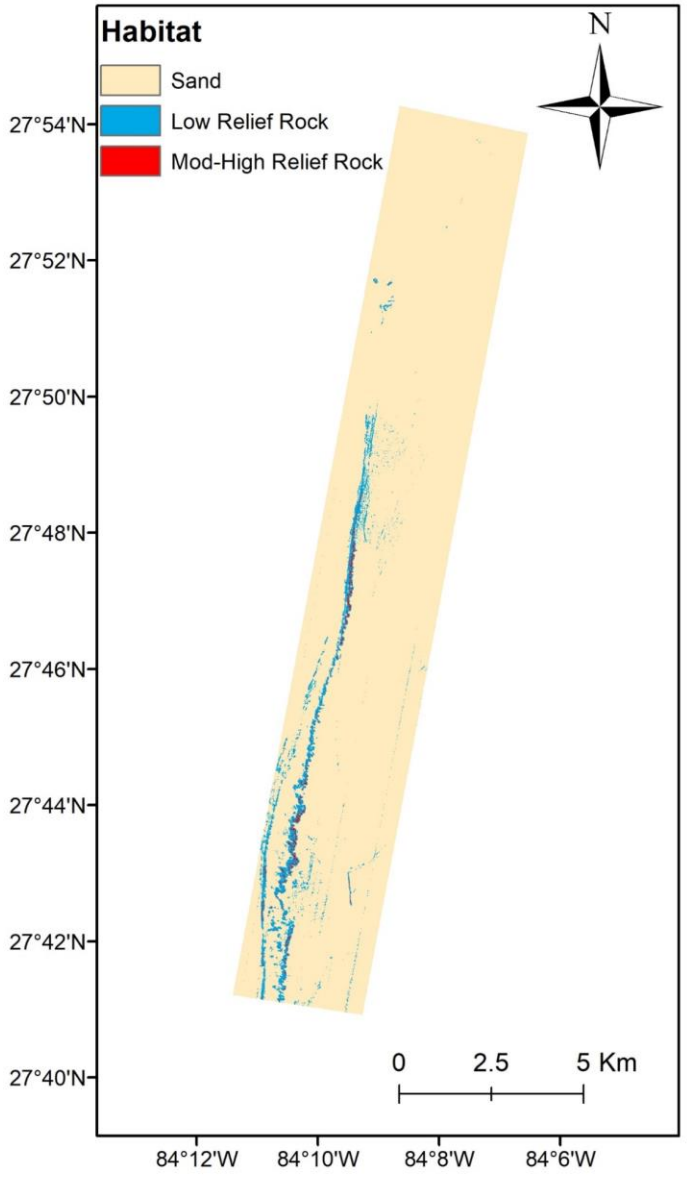
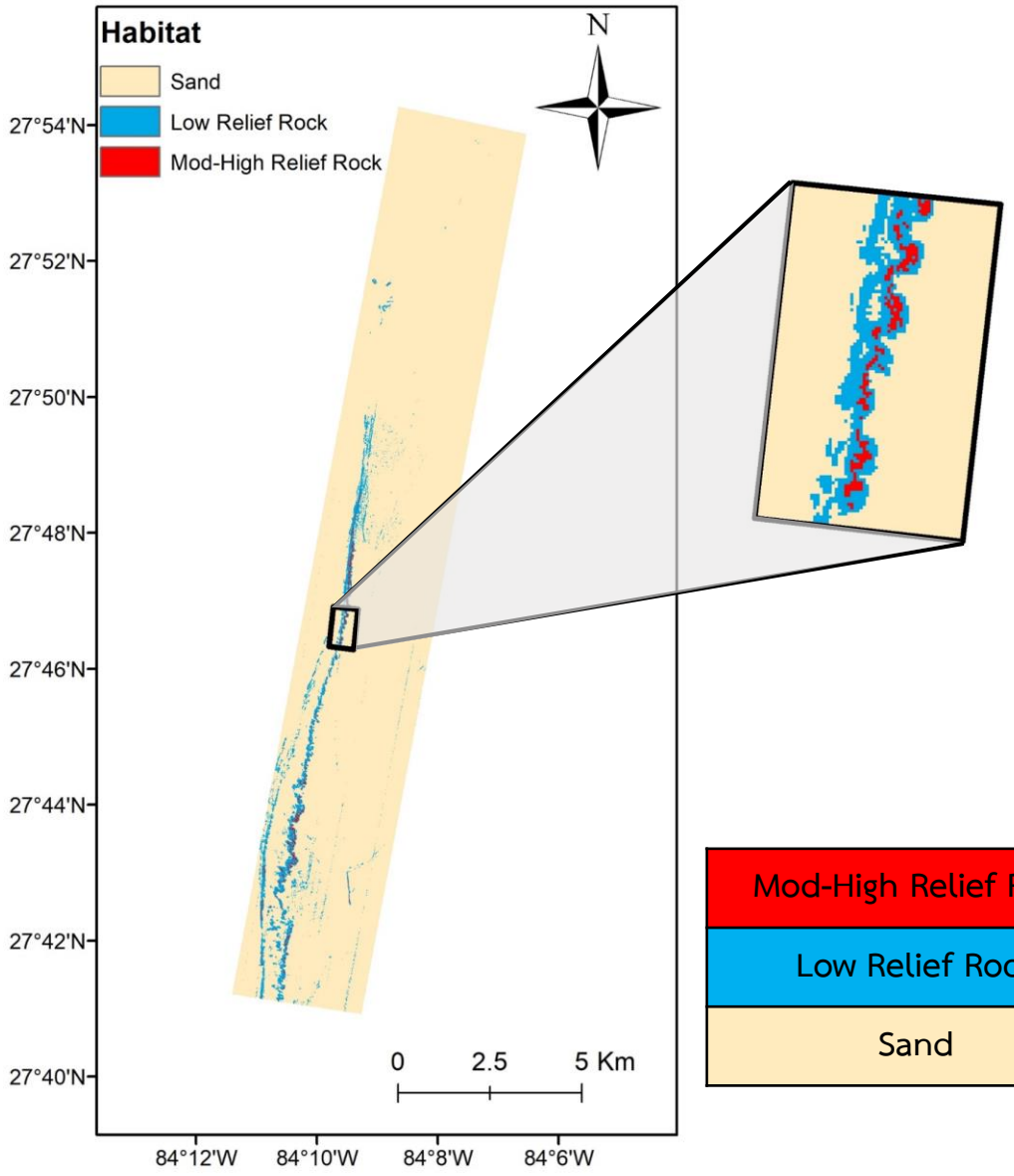


# Fish Abundance Estimates




| | Area ($Km^2$) |
|---|---|
| Mod-High Relief Rock | 0.3 |
| Low Relief Rock | 3.2 |
| Sand | 83.6 |

# Fish Abundance Estimates

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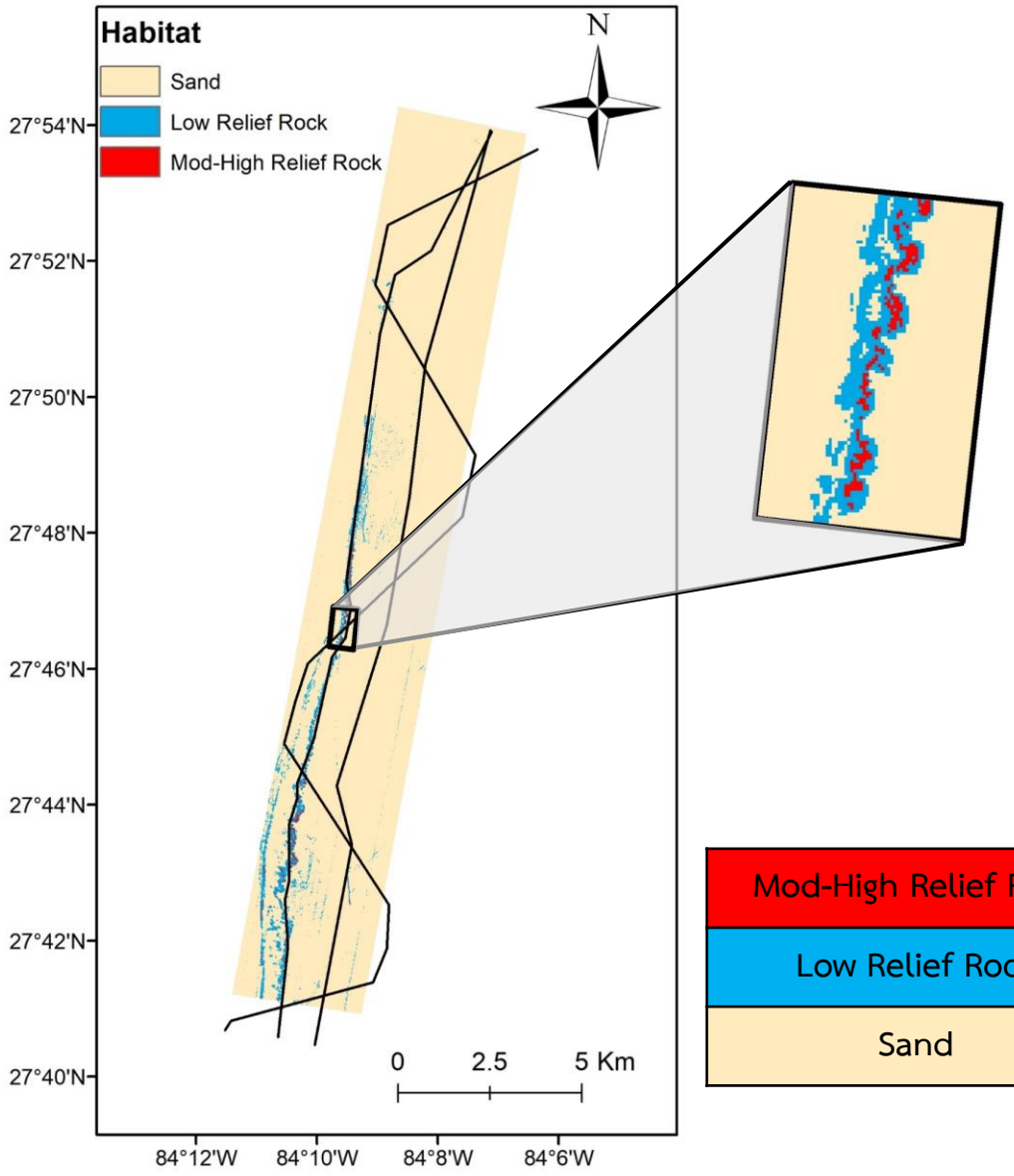


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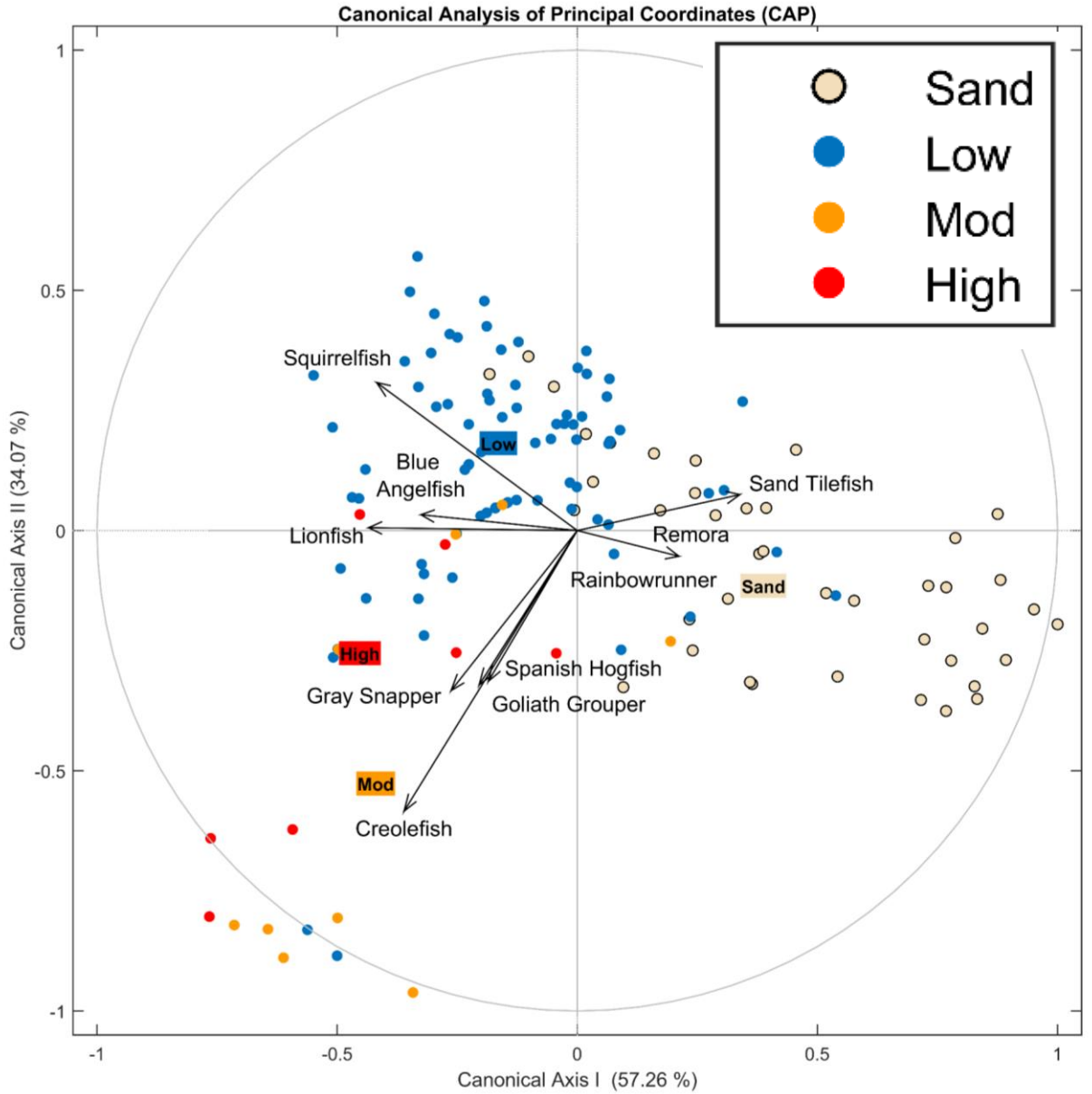

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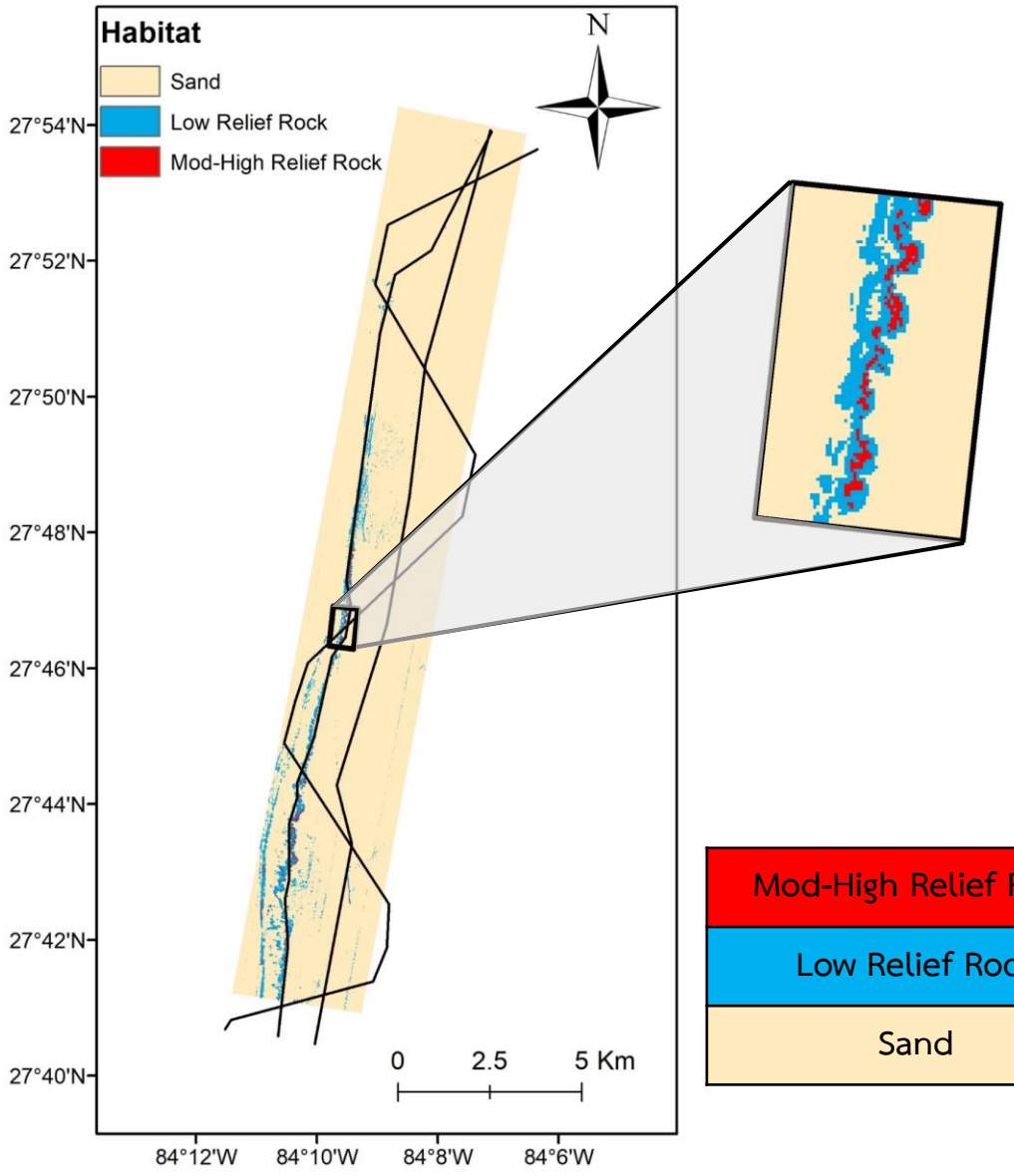


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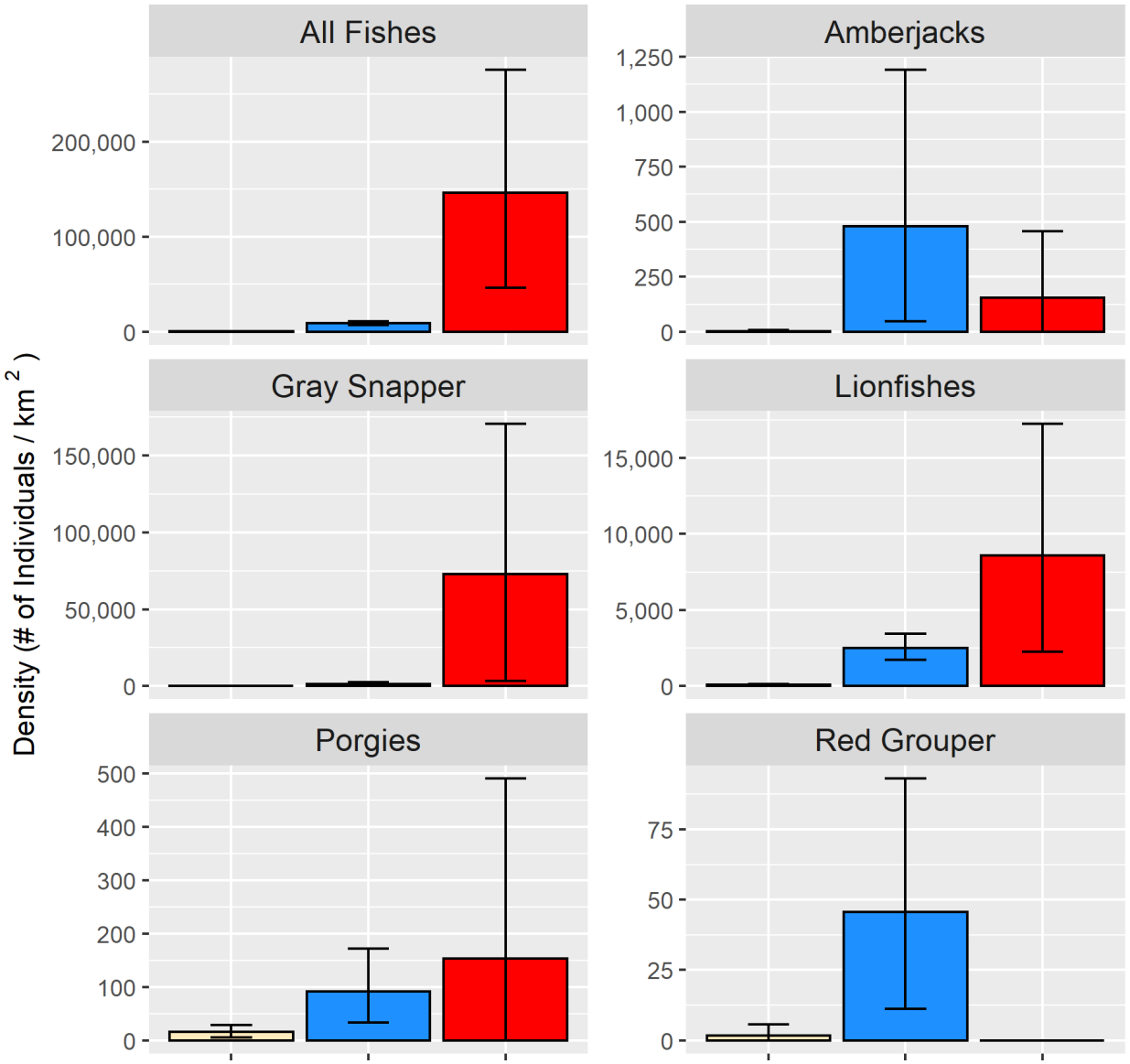

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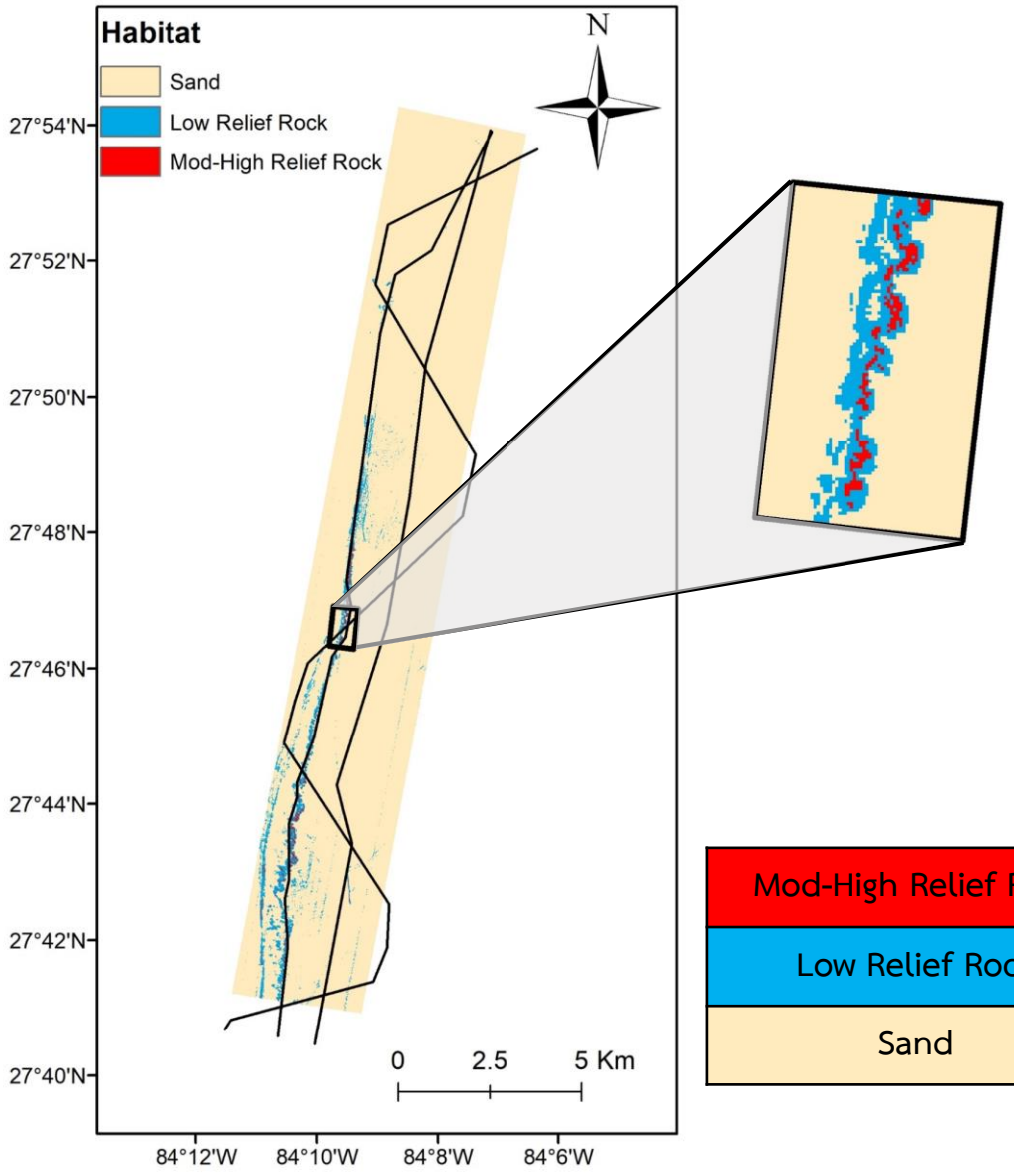


*

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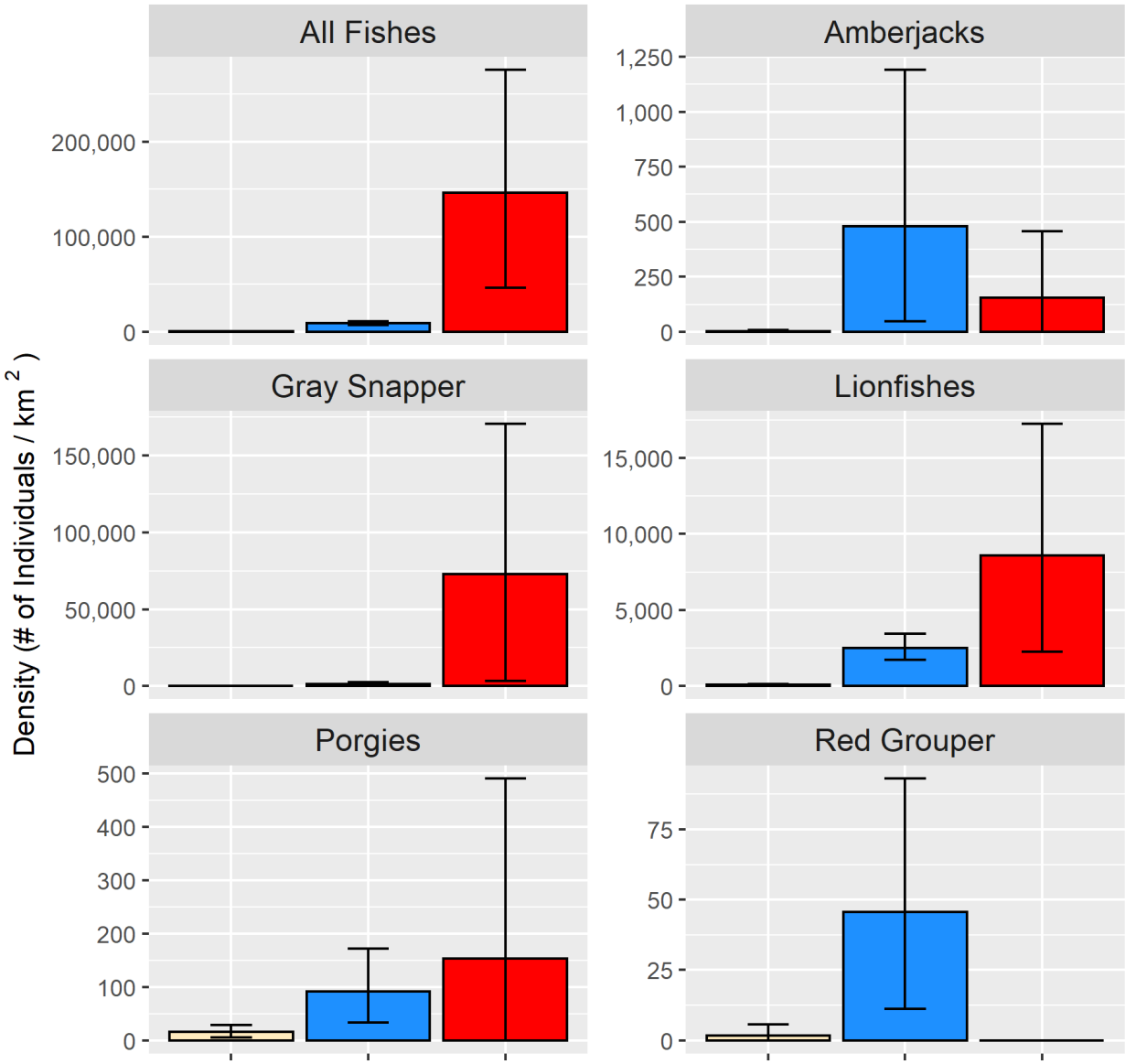

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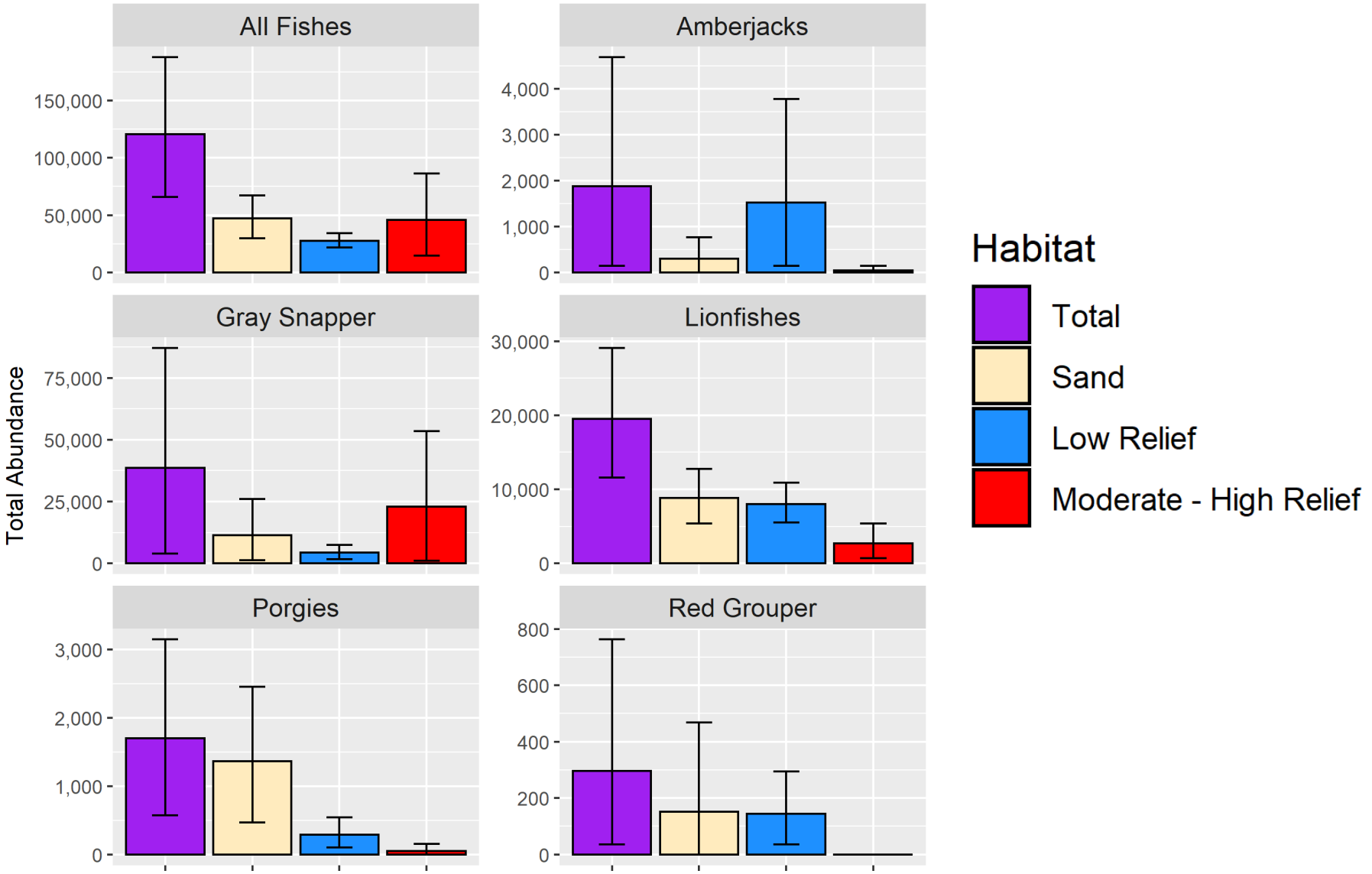
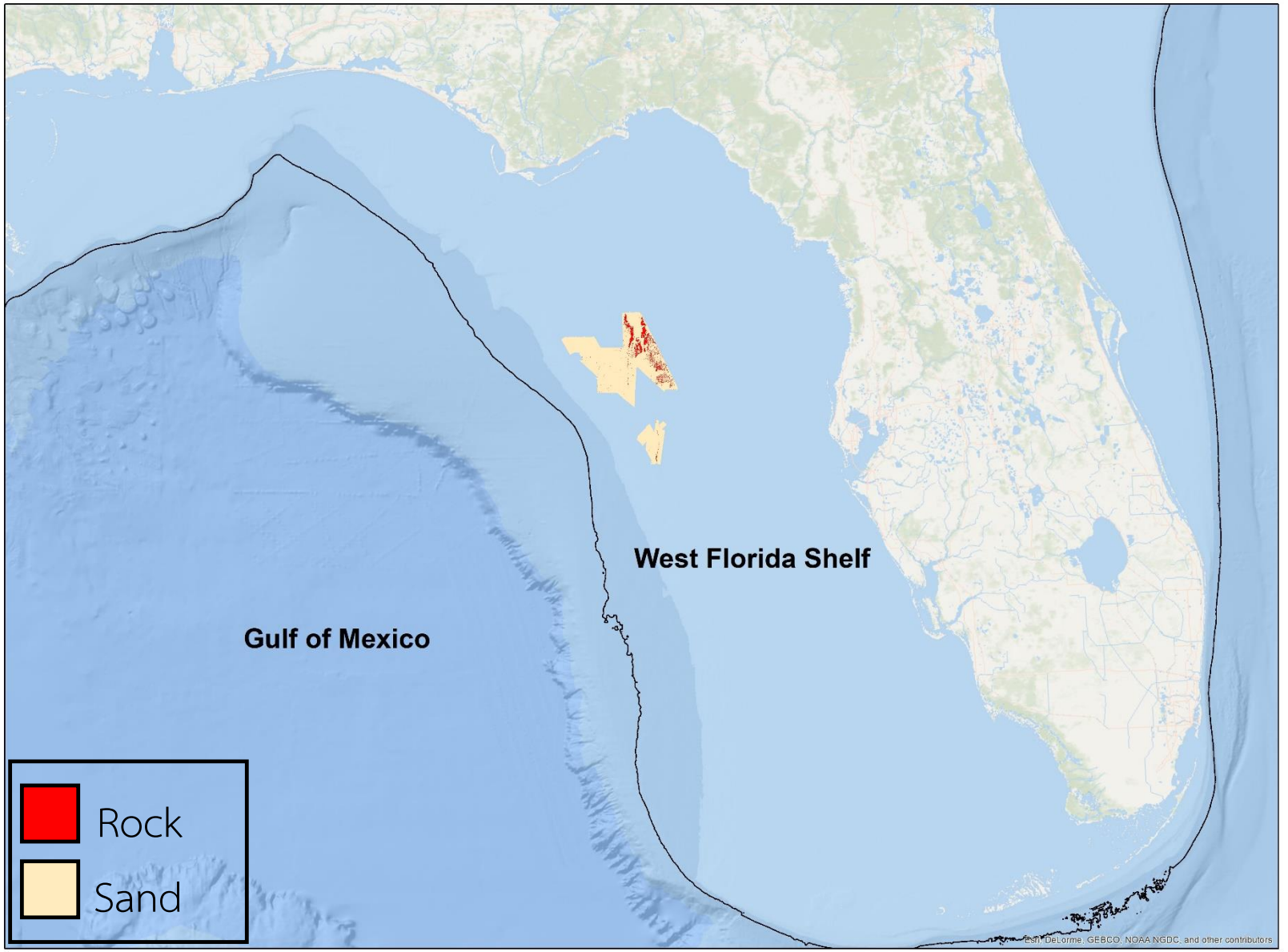


# Unified West Florida Shelf Substrate Map



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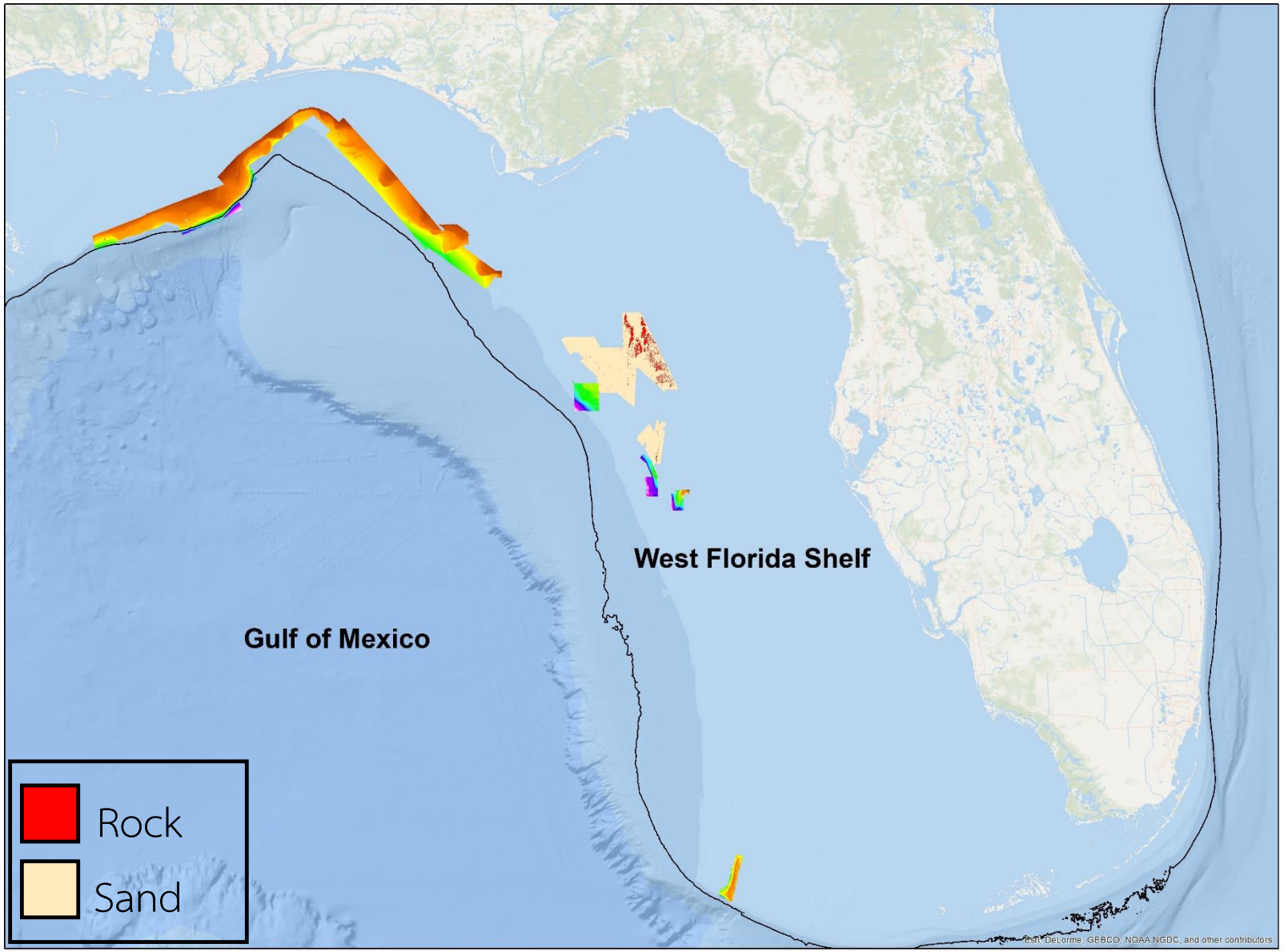

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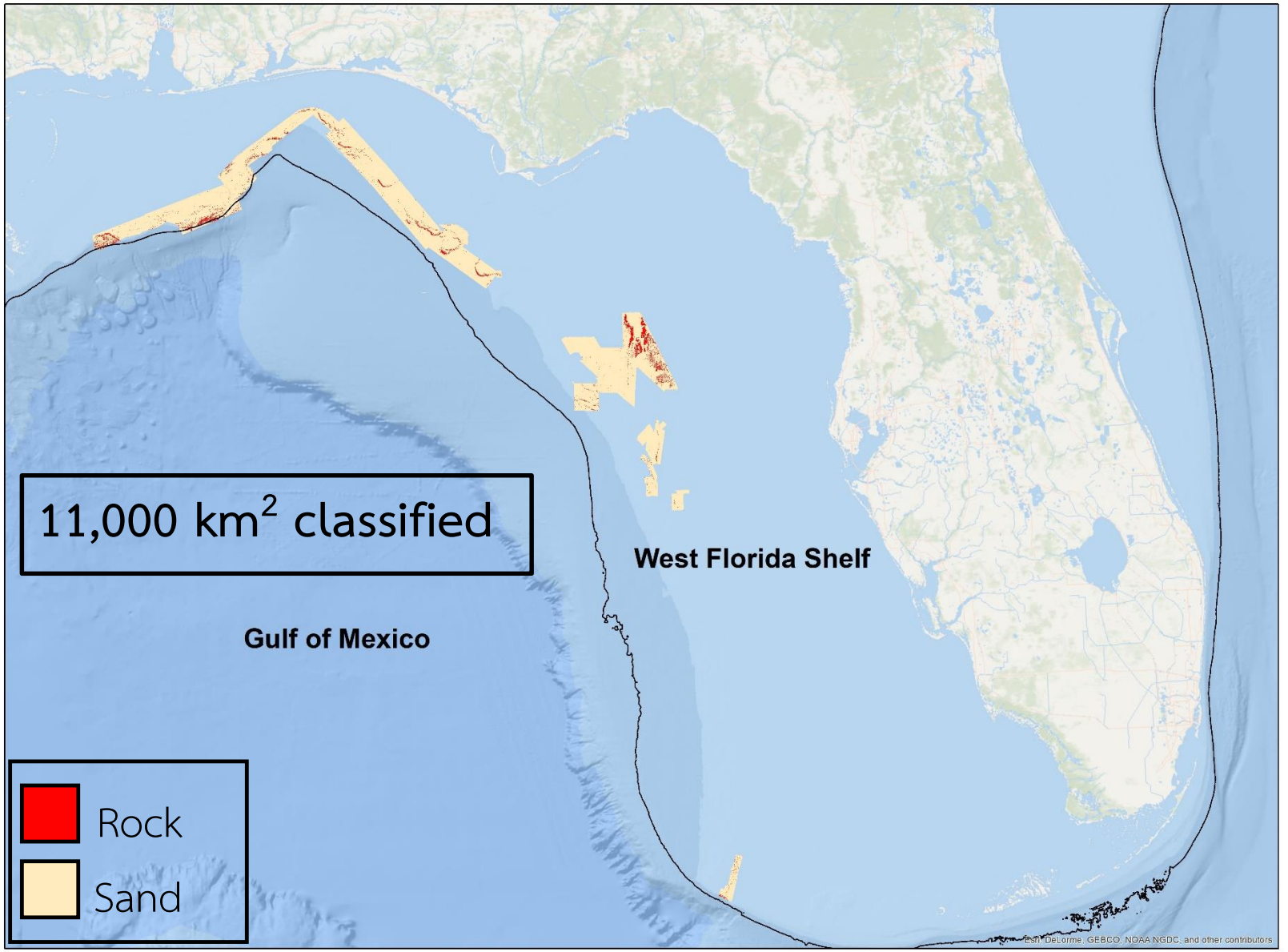
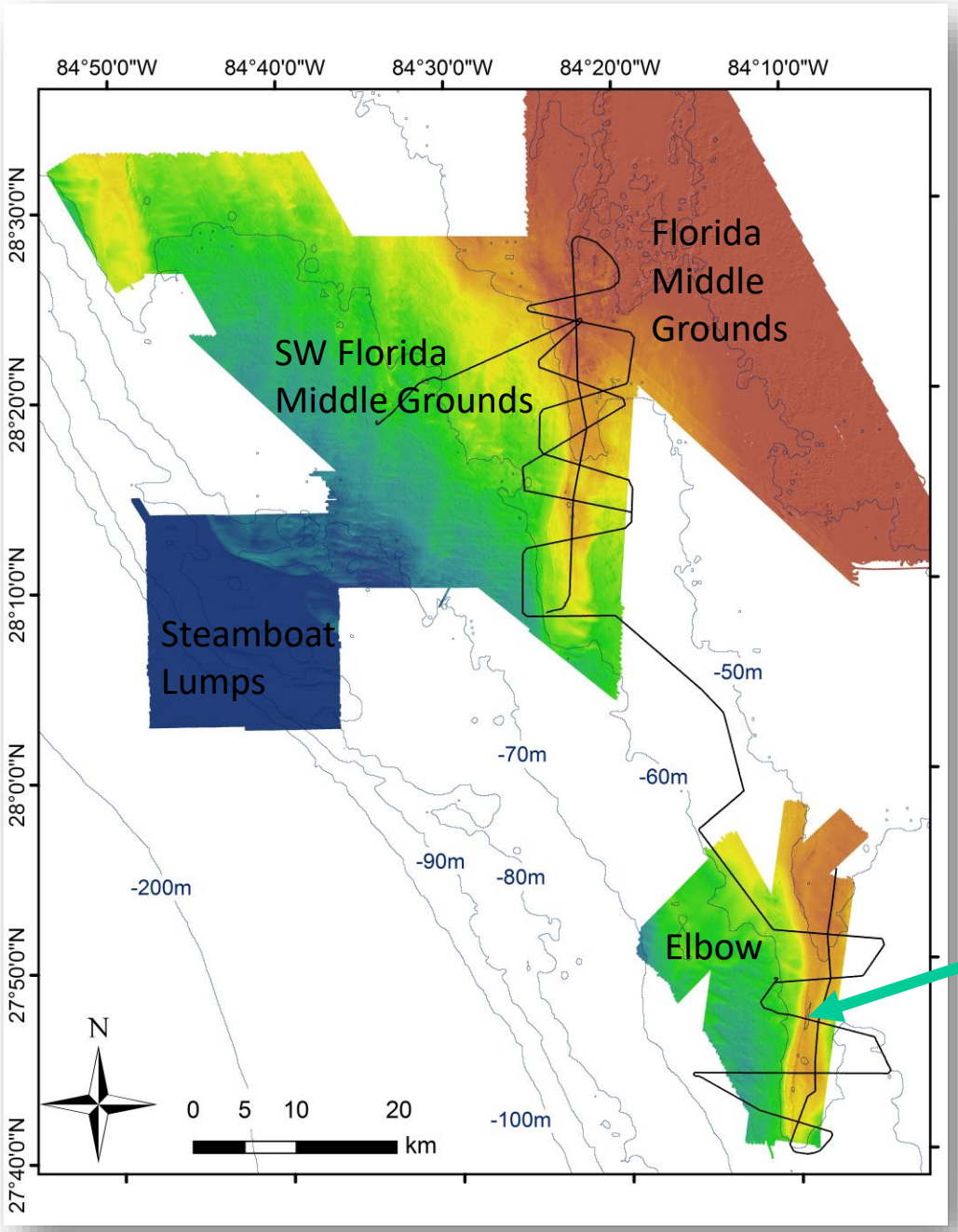
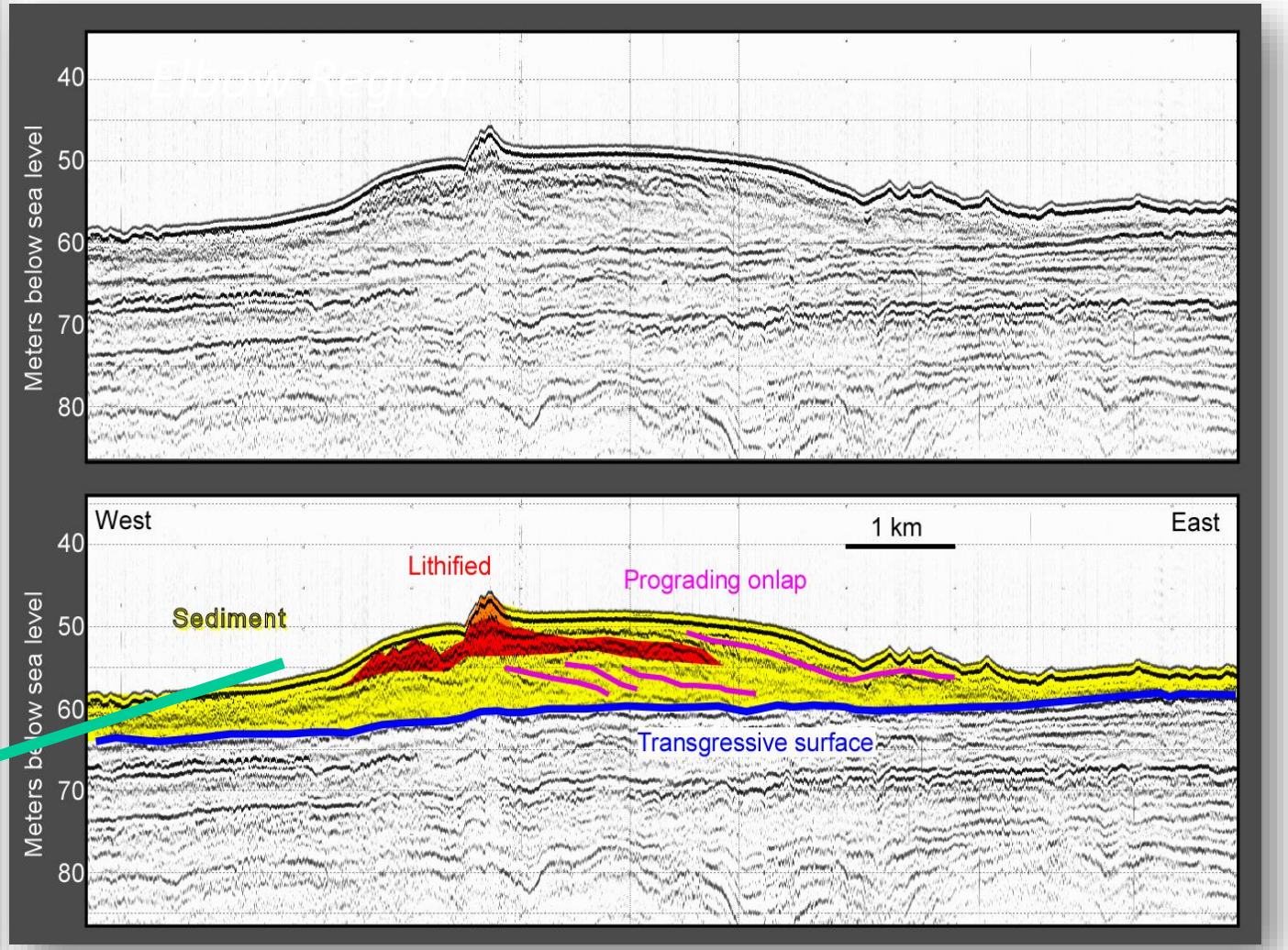


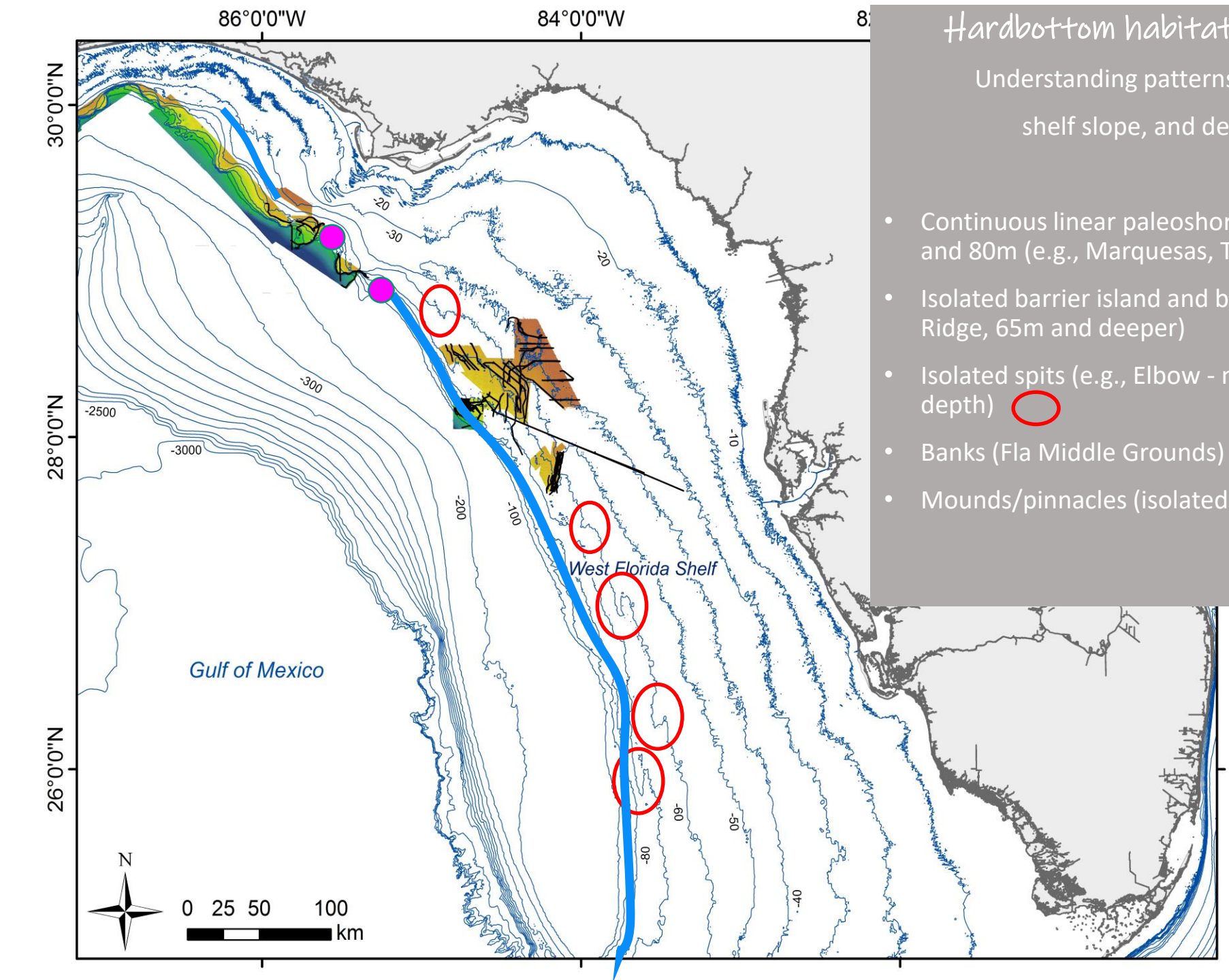
# Some Next Steps, GoM Habitat Mapping


- ✓ **Extend high-resolution mapping in the Eastern GoM to an additional ~15,000 km$^2$ of important offshore reef fish & sea turtle habitat**

# Understanding the Geological Setting of Hard Bottom Habitat: Bubble gun seismic survey






# Hardbottom habitat - A regional perspective

Understanding patterns related to sea-level history, shelf slope, and depositional environment.

- Continuous linear paleoshoreline ridges –water depths of 70m and 80m (e.g., Marquesas, Twin Ridges)
- Isolated barrier island and broad ridge systems (e.g., Pulley Ridge, 65m and deeper)
- Isolated spits (e.g., Elbow - many features in 50-60 m water depth)
- Banks (Fla Middle Grounds)
- Mounds/pinnacles (isolated or large areas)

Interpreting maps for additional habitats of interest....

# Some Next Steps, GoM Habitat Mapping

- ✓ Extend high-resolution mapping in the Eastern GoM to an additional ~15,000 km$^2$ of important offshore reef fish & sea turtle habitat
- ✓ Fully-develop a flexible autoclassification package for species and habitat features (+auto-CMECS?)

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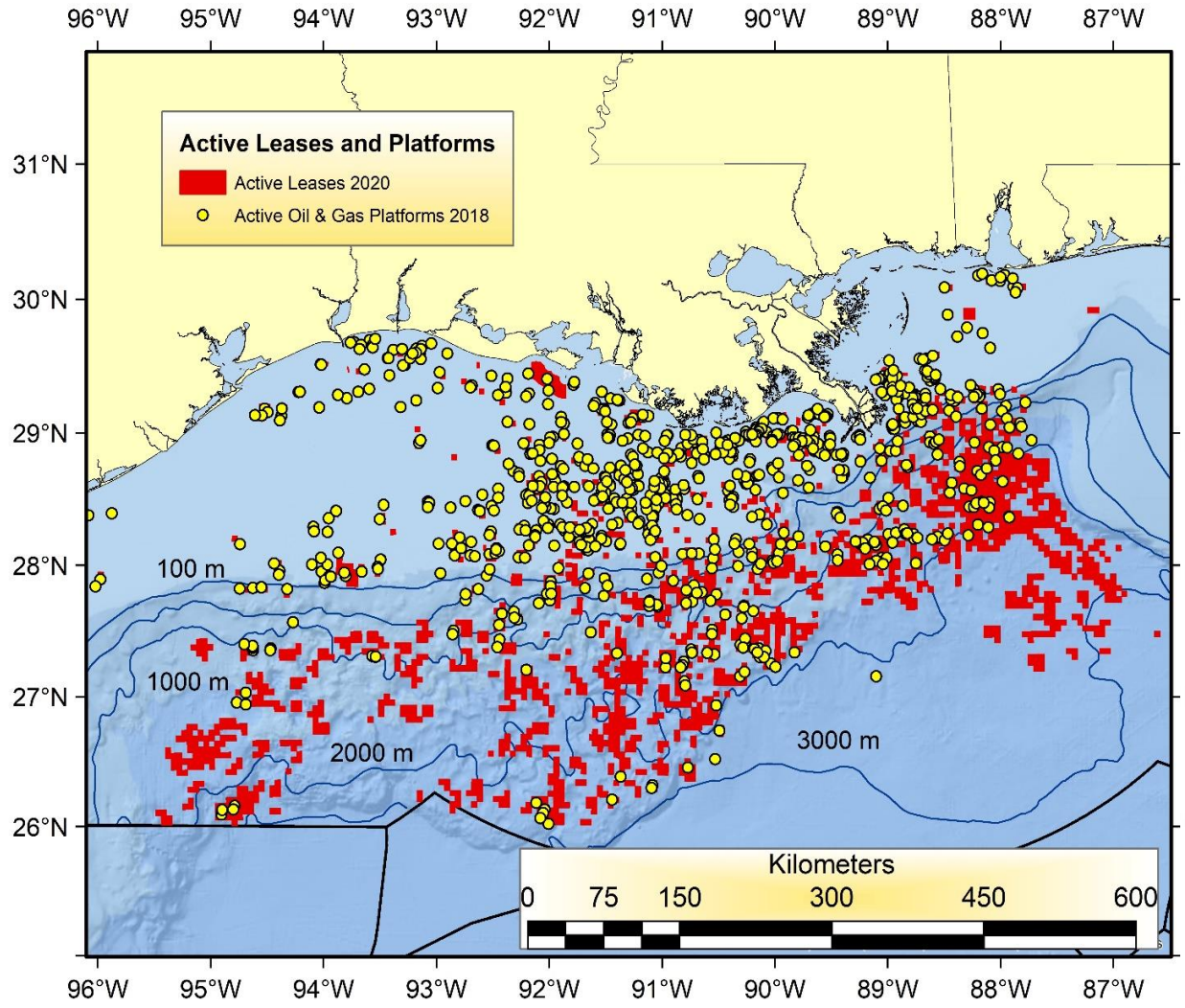
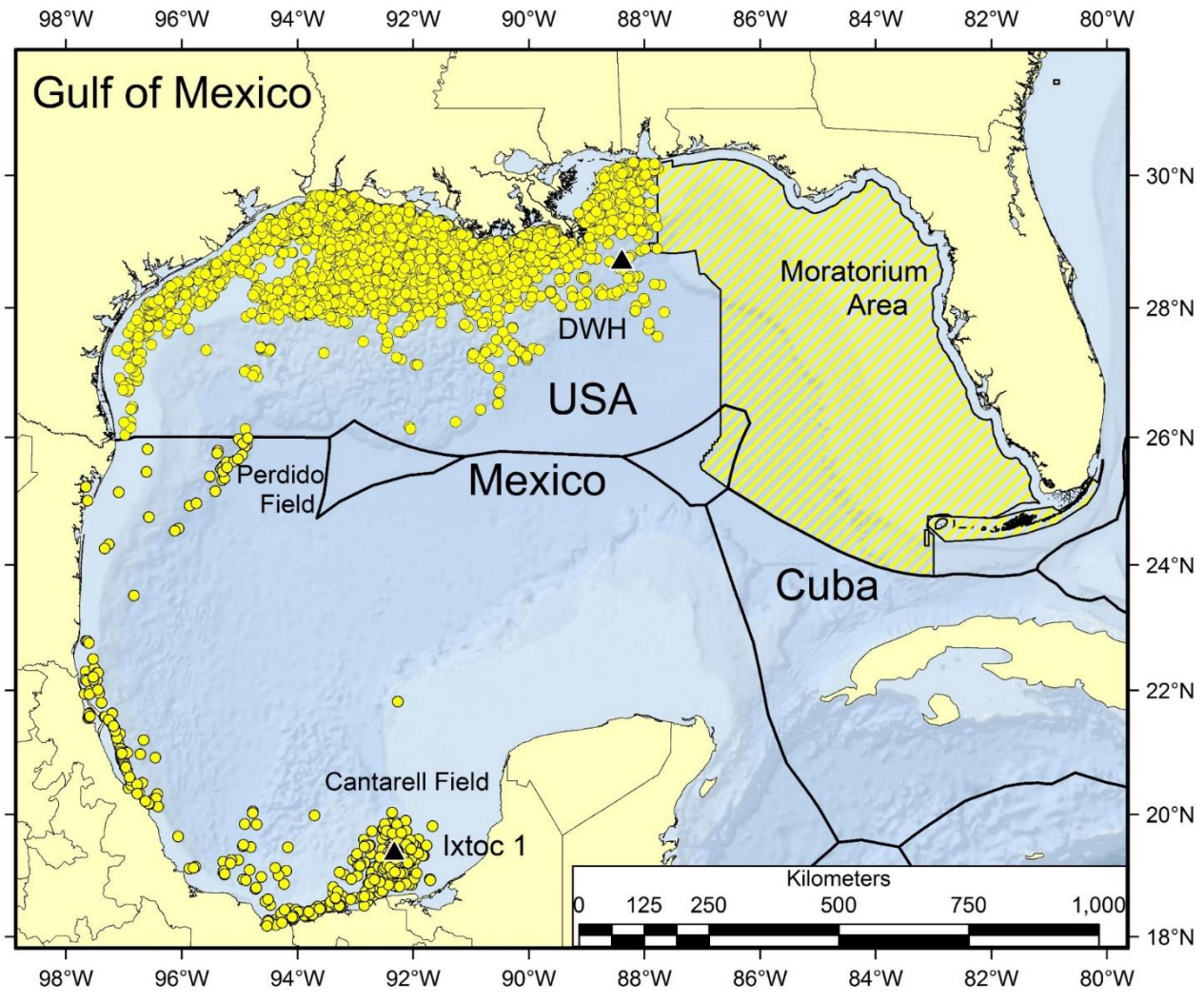
- ✓ Engage in further analyses of these data (interested?), including Cross-calibration studies with NMFS & FWRI camera systems
- ✓ Further engage regulatory agencies in prioritizing and protecting valuable mapped habitats (e.g., GoMFMC meeting September 2020)

# Active Wells & Current leases (2020)




# Moratorium (until 2022)



# Some Next Steps, GoM Habitat Mapping

- ✓ Extend high-resolution mapping in the Eastern GoM to an additional ~15,000 km$^2$ of important offshore reef fish & sea turtle habitat
- ✓ Fully-develop a flexible autoclassification package for species and habitat features (+auto-CMECS?)
- ✓ Archive data collected for efficient discovery (NCEI, FWRI, 'OOses, commercial applications, e.g., Strikeline, Garmin, CMOR)
- ✓ Engage in further analyses of these data (interested?), including Cross-calibration studies with NMFS & FWRI camera systems
- ✓ Further engage regulatory agencies in prioritizing and protecting valuable mapped habitats (e.g., GoMFMC meeting September 2020)
- ✓ Help create an enduring "community of practice" and stable resource base for future mapping efforts (this is important and very timely)

# Questions?

## Thanks to Our Partners & the Project Steering Committee!


**For a list of publications from this project, please visit:**

**http://www.marine.usf.edu/scamp/publications**

**cscampdata@usf.edu**