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

S. Murawski, C. Lembke, S. Grasty, A. Ilich,

The “Elbow”
West Florida Shelf
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)

**Primary Target Species**
- Red Snapper
- Vermilion Snapper
- Red Grouper
- Gag Grouper
- Sea turtles

**Secondary Target Species**
- Other snappers
- Other groupers
- Various reef fishes

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

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
Raw multibeam data is corrected for:

- Vessel motion
- Sound velocity
- Tide
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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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- C-BASS Towed Video Array
- Array of Environmental Sensors (CTD, FL, Optics, Vemco)
- EK-60 Multibeam Sonar
- Benthic & Water column

- Tow Point
- Vemco Receiver
- Onboard Computing, Power, & Comms
- Fluorometer
- Altimeter
- DIDSON Sensor
- HD Camera
- 6 cameras, Sensors
C-SCAMP by the Numbers

- 2,519 km: Length of Transects Imaged with C-BASS from 2016-2019
- 2,350 sq-km: Pre-C-SCAMP of bathymetry added to WFS mapping efforts
- 327 Hours: C-BASS Video Collected from 2016-2019
- 20 Presentations: Oral & Poster-based at a variety of conferences
- Unmapped: (94.5%) At high-resolution (<10x10 m)
Continental Shelf Characterization, Assessment and Mapping Project
Multibeam Bathymetry & Backscatter

Multibeam provides two primary pieces of information:

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

Multibeam provides two primary pieces of information:

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

Multibeam provides two primary pieces of information:

2. **Backscatter** (intensity) = What is it?
Layering the two map products is a step in more fully characterizing the seafloor.
Multibeam Bathymetry & Backscatter

Layering the two map products is a step in more fully characterizing the seafloor.
Seafloor features identified with acoustics:

- Ridges
- Slopes and troughs
- Transient bedforms
- Grouper holes
Multibeam Bathymetry & Backscatter

Seafloor features identified with acoustics:
- Ridges
- Slopes and troughs
- Transient bedforms
- Grouper holes
- Pipelines
- Shipwrecks
M/V Holstein

Sunk in 1992

Supposedly an Amberjack haven...
“Unknown” Shipwreck

Likely 19\textsuperscript{th} Century

Possibly carried concrete which solidified after sinking

Project Scientist: Matthew Hommeyer (mhommeyer@usf.edu)
“Unknown” Shipwreck

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GoM Pipeline Infrastructure

Primarily the GSPL; several others in central & western GoM as part of the “Great Red Snapper Count”
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Project Scientist: Matthew Hommeyer (mhommeyer@usf.edu)
Cultural Resources via Multibeam Sonar (∆ & sometimes C-BASS!)
GoM Pipeline Infrastructure

Primarily the GSPL; several others in central & western GoM as part of the “Great Red Snapper Count”
Cultural Resources via Multibeam Sonar

M/V Holstein
Sunk in 1992
Supposedly an Amberjack haven…

Project Scientist: Matthew Hommeyer (mhommeyer@usf.edu)
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)
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”
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 451:243-254 · June 2011 with 471 Reads
DOI: 10.3354/meps09167
Cite this publication

Carrie Wall
University of Colorado Boulder

Brian T. Donahue
University of South Florida

David F. Naar
University of South Florida

David Allen Mann
Loggerhead Instruments

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)
Steamboat Lumps MPA

Overall, found that hole density increased and of the observed with approx. 95 holes of the observed with CBASS, approx. 84% had at least 1 Lionfish.
In total, **79 sea turtles** were observed over 97 transects (380 h of video) which covered approximately 2,700 km of seafloor.

Sea Turtle Observations

Research Scientist: Dr. Heather Broadbent (hbroadbent@usf.edu)
In total, 79 sea turtles were observed over 97 transects (380 h of video) which covered approximately 2,700 km of seafloor.

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The Elbow GSPL
Madison - Swanson MPA
Steamboat Lumps MPA
FL Middle Grounds HAPC

Loggerheads Galore
Pairing Acoustic & Visual Fish Data

PhD Candidate: Edmund Hughes (ehughes@usf.edu)
Improving Reef Fish Sampling with FWRI-FIM

**S-BRUV**
- Baited
- MaxN Metric
- No Lights
- Stationary
- Sidsescan for habitat

**C-BASS**
- Unbaited
- Density Metric
- Lighted
- Mobile
- MBES/Video for habitat

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

fish = Fish 😊

garbage = small, zoomed in ROIs
Outreach

@CSCAMPscience

Social Media

C-SCAMP Videos

Fish & Habitat Guides

8-page Overview Booklet

Mini Fish Profile Booklets

Infographics

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

www.marine.usf.edu/scamp
High Resolution Multibeam

*WFS publicly available multibeam bathymetry at ~10m resolution or finer
What is Habitat?

Coastal and Marine Ecological Classification Standard

**Structure: Settings and Components**

- **Water Column Component**
  - Structure and Characteristics of the Water Column

- **Geoform Component**
  - Geomorphological Character of the Coast or Seafloor

- **Substrate Component**
  - Character and Composition of Surface and Near-Surface Substrates

- **Biotic Component**
  - Assemblages of Benthic or Suspended/Floating Biota

**Biotope**

Combination of abiotic habitat and associated species

(Federal Geographic Data Committee, 2012)
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(Federal Geographic Data Committee, 2012)
Habitat Scheme: Substrate

Substrate
CMECS Component

Sand
CMECS Substrate Group

Rock Substrate
CMECS Substrate Class
Habitat Scheme: Substrate

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- Low Relief
- Moderate Relief
- High Relief
Habitat Scheme: Biotic

Biotic
CMECS Component

Benthic/Attached Biota
CMECS Biotic Setting
Habitat Scheme: Biotic

Biotic
CMECS Component

Benthic/Attached Biota
CMECS Biotic Setting

Bare

Attached Fauna
CMECS: Biotic Group
Overall Procedure

Towed Underwater Video

Habitat-Specific Fish Densities

Multibeam Sonar

Total Abundance Estimates

Habitat Map
Supervised Classification Process

Bathymetry

Backscatter
Supervised Classification Process

Bathymetry

Backscatter
Supervised Classification Process

Calculate Derivative Features

- Bathymetry
- Backscatter
- Terrain Attribute
- Texture Metric
Supervised Classification Process

Calculate Derivative Features

- Habitat 1
- Habitat 2
- Bathymetry
- Backscatter
- Terrain Attribute
- Texture Metric
Supervised Classification Process

Thematic Habitat Map

Predict

Habitat
- Habitat 1
- Habitat 2
High Resolution Multibeam

Gulf of Mexico

West Florida Shelf
Habitat observations collected every 15 s

Habitat observations collapsed to rock and sand

Filtering and QA/QC

80% training

20% testing

Training Set

$N_{\text{rock}} = 1,309$

$N_{\text{sand}} = 12,205$

Groundtruth Habitat
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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### All Fishes

- **Density (no. of individuals / km²)**

### Amberjacks

- **Density (no. of individuals / km²)**

### Gray Snapper

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- **Density (no. of individuals / km²)**
Fish Abundance Estimates

- All Fishes
- Amberjacks
- Gray Snapper
- Lionfishes
- Porgies
- Red Grouper

Habitat:
- Total
- Sand
- Low Relief
- Moderate - High Relief
Unified West Florida Shelf Substrate Map

11,000 km² classified

West Florida Shelf

Gulf of Mexico

Rock
Sand
Some Next Steps, GoM Habitat Mapping

✓ Extend high-resolution mapping in the Eastern GoM to an additional ~15,000 km² 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....
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✓ 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)
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- 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