C-SCAMP

UNIVERSITY OF SOUTH FLORIDA
College of MARINE SCIENCE

Continental Shelf Characterization, Assessment and Mapping Project

Project Overview

In the Gulf of Mexico, the West Florida Continental Shelf (WFS) is home to several species of economically important reef fish, including snappers and groupers. Florida's fishing industries support nearly 80,000 jobs and contribute $6 billion in gross domestic product to the state's economy each year. Surprisingly, despite its economic importance, only about 3% of the WFS had been mapped at high resolution when this project began in 2015.

The Continental Shelf Characterization, Assessment, and Mapping Project (C-SCAMP) has provided baseline data to help inform offshore development and improve fisheries management by contributing an additional 2,250 square kilometers of high resolution benthic habitat maps in five defined high priority regions along the WFS: the Madison-Swanson MPA (Marine Protected Area), the Steamboat Lumps MPA, the Elbow, the Gulfstream Natural Gas Pipeline, and the Florida Middle Grounds HAPC (Habitat Area of Particular Concern).

Images: The C-BASS on the deck of the *R/V Weatherbird II* (above, left), retrieval of the C-BASS (top, right), image of a Red Grouper captured on C-BASS footage (middle, right), The *R/V Weatherbird II* (bottom, right).

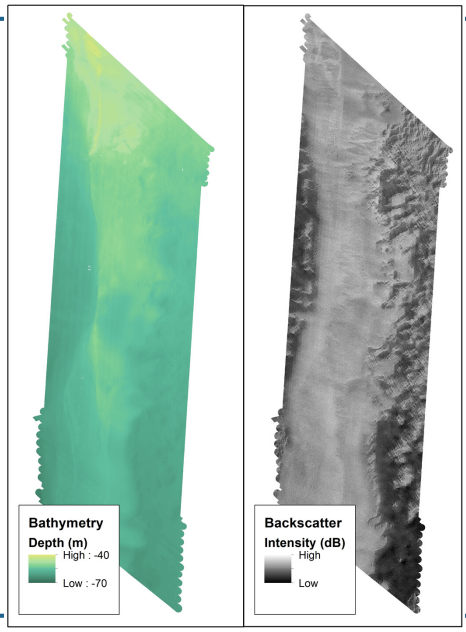
Funding and collaboration

In January 2015, the University of South Florida, College of Marine Science received a grant of $4.4 million from the National Fish and Wildlife Foundation (NFWF) to conduct seafloor mapping, benthic habitat characterization and fish assessments on the West Florida Shelf (WFS) in the Gulf of Mexico. This project is in partnership with the Florida Fish and Wildlife Research Institute and the Florida Institute of Oceanography.

Seafloor Mapping Using Multibeam Sonar

Accurate bathymetric maps are important for many reasons - from the development of nautical charts used by mariners, to assessing the effects of climate change by measuring beach erosion and sea level rise. For projects like C-SCAMP, bathymetric maps were the basis for developing **benthic** habitat maps. This can then allow scientists to define the parameters within which marine species live, feed and breed and ultimately better inform management strategies and decisions.

To develop bathymetric maps of the WFS, C-SCAMP used a high resolution **multibeam** echosounder aboard several of the Florida Institute of Oceanography's vessels; *R/V Bellows*, *R/V Weatherbird II* and *R/V WT Hogarth*. Multibeam sonar determines seafloor depth by emitting sound waves and measuring how long it takes for them to come back to a receiver after bouncing off the seafloor. This facilitates the collection of two essential mapping elements for describing the seafloor: **bathymetry** and **backscatter.**



Bathymetry

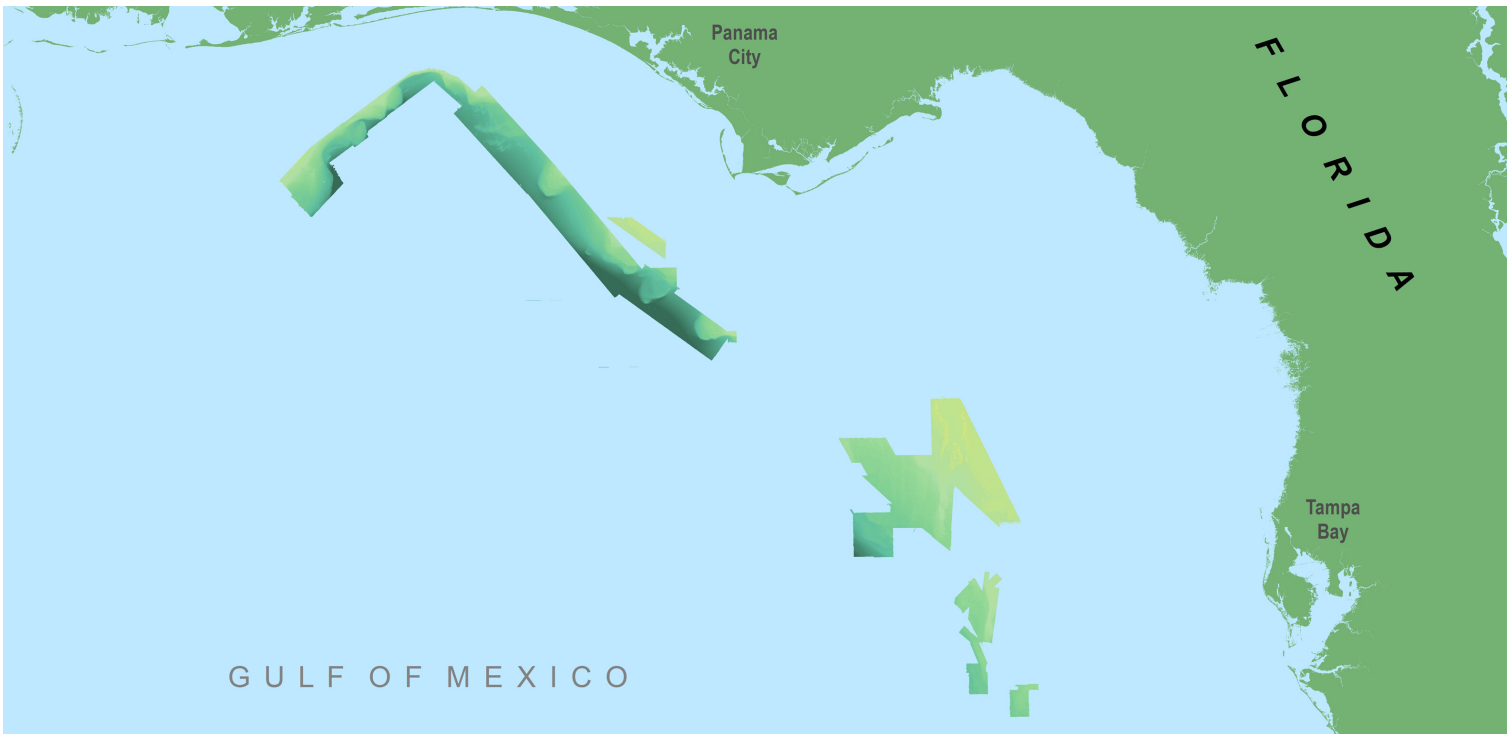
Bathymetry refers to the depth of the seafloor and is similar to **topographic** maps on land.

Backscatter

Backscatter is calculated based on how loud the returning soundwaves are, which provides an indication of what comprises the bottom. For example, a weak return can indicate the presence of soft bottom such as mud, while a strong return could indicate hard bottom such as rock.

Left: examples of bathymetry (left) and backscatter (right) maps collected by this project. Below: Existing, large-scale bathymetry (10x10m resolution or less) currently available for the north and central WFS.

- **Benthic** - Relating to or occurring at the seafloor.
- **Multibeam** - Systems that emit a wide swath of many sound beams towards the ocean bottom and seafloor depth is determined based on return time of these sound beams as they bounce off the seafloor.
- **Topography**- The configuration of a surface including relief and position of natural and manmade features.

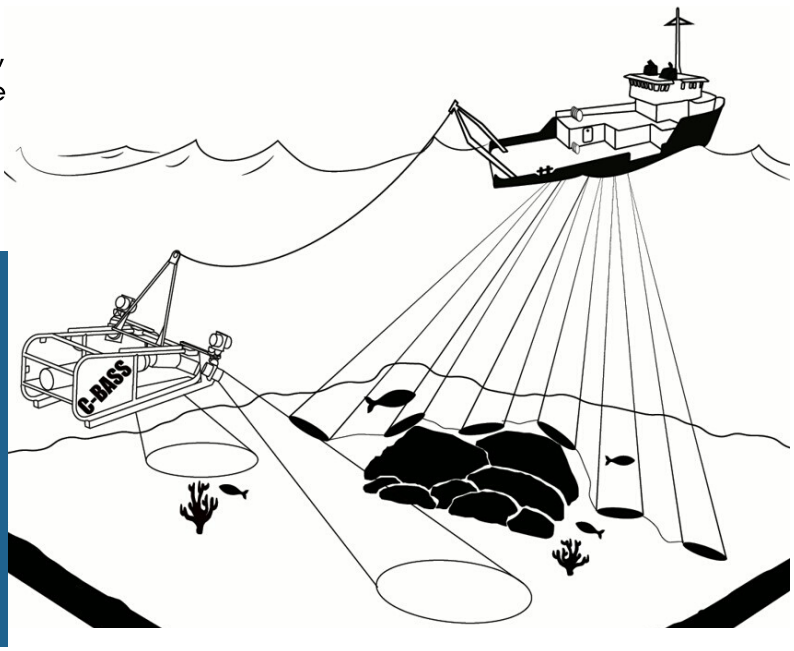


C-BASS: The Camera-Based Assessment Survey System

Above: Deploying the C-BASS off the deck of the *R/V Weatherbird II* (left) Images of the C-BASS (right).

While the multibeam echosounder provides information on the seafloor shape, depth and texture. The development of **habitat** maps requires an understanding of the actual geologic and biologic elements being detected by the echosounder.This requires **groundtruthing**, or "putting eyes" on the seafloor to determine exactly what is present. To do this, C-SCAMP used an underwater towed vehicle called the C-BASS (Camera-Based Assessment Survey System) equipped with six video cameras that gives near-180 degree visual coverage. The C-BASS is towed and lowered via a cable off the stern of a vessel where it then samples at 2 - 4 m above the seafloor. The system is also equipped with a suite of scientific and performance sensors allowing for continuous measurements of turbidity, chlorophyll, temperature, salinity, depth, altitude, and attitude as the system is towed.

An onboard computer is used to monitor all cameras and sensors. All data are stored on the tow body while sensor data and limited video are sent to the operator at the surface. Video collected by the system is then used to characterize the seafloor type as well as enumerate fish. Visually groundtruthing bathymetric data using C-BASS footage allows C-SCAMP biologists to not only define habitat type, but also to assess habitat quality, an important consideration when effectively managing marine resources. Over the course of this project, the C-SCAMP team has collected over 300 hours of video and baseline data along over 2,500km of transects.



Right: Schematic of the C-BASS being towed behind the R/V Weatherbird II.

Habitat- The environment in which an organism lives, including abiotic (i.e. temperature, substrate) and biotic (prey, predators) factors.

Groundtruthing- Information provided by direct observation as opposed to data gathered through inference via remote sensing.

Estimating Fish Abundance and Species Composition

Towed camera systems are particularly useful when surveying fish species that are found in areas difficult to survey using traditional sampling gear, such as trawls and long lines. Additionally, traditional sampling measures can be invasive and harmful to the habitat where they are being used. The C-BASS provides a non-invasive alternative for surveying fish species across stratified habitat types.

Below: Southern Stingray (top, left), school of amberjack (top, middle), Red Grouper (top, right), Gray Snapper on the Gulfstream Natural Gas Pipeline (bottom).

The C-SCAMP team has collected hundreds of hours of footage from transects along the WFS that were analyzed for species specific abundance. By analyzing these videos, C-SCAMP biologists have a visual census of almost all economically important species including Red Snapper, Red Grouper, Gag, Scamp, and amberjacks.

The scientists with C-SCAMP are continuing to develop an autorecognition computer software in partnership with SRI International that will automatically and efficiently identify fish, and possibly even characterize benthic habitat.






Above: C-BASS footage of seaturtles along the Gulfstream Natural Gas Pipeline.

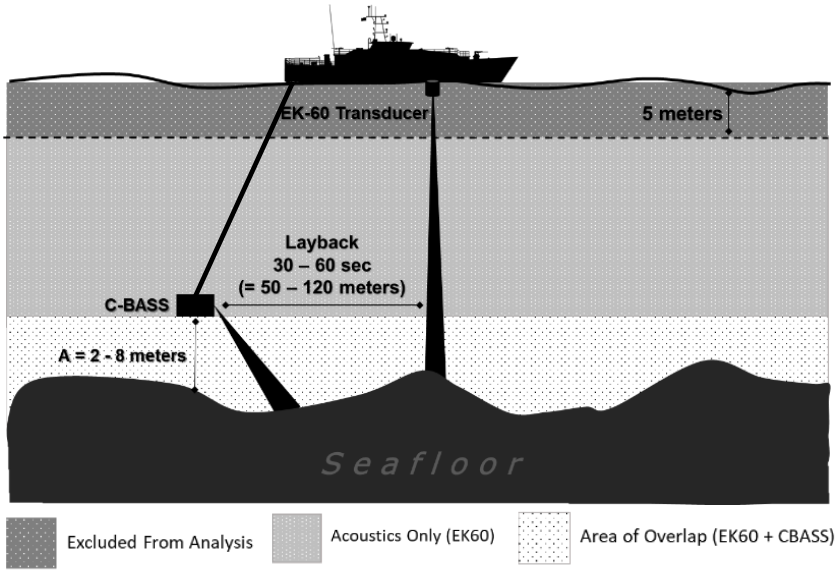
Assessing Sea Turtle Populations with C-BASS

Using footage collected with their towed camera system, C-SCAMP scientists have also been able to survey marine habitats that are important for the reproduction, foraging and migration of endangered or threatened sea turtle species in the Gulf of Mexico. This project collected *in-situ* data on 80 individual sea turtles between 2014 to 2019, most of which were Loggerheads but also included Green and Kemp's Ridley sea turtles. This information is beneficial for the conservation and management of these threatened and endangered species by better understanding their populations and habitat use throughout the WFS.

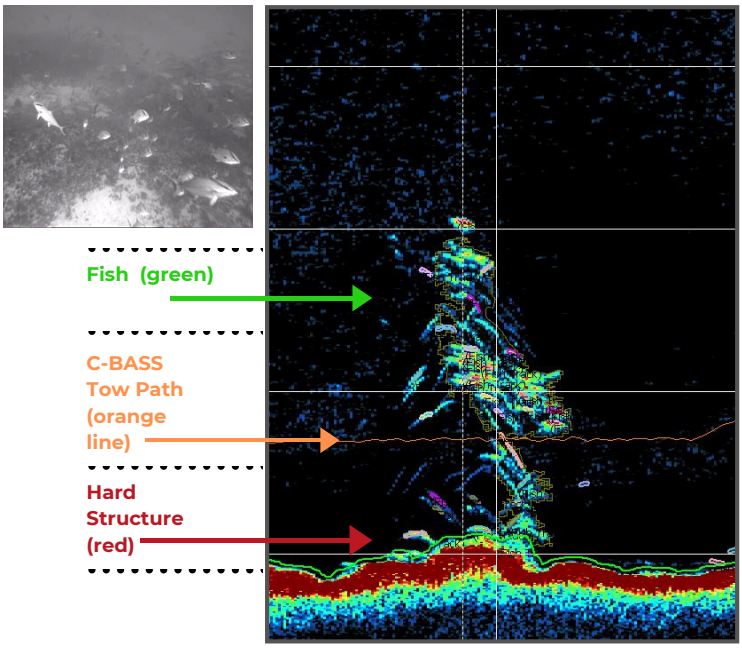
Estimating reef fish densities using an EK60 Echosounder

Anytime the C-BASS is being towed, a fisheries echosounder was used to concurrently collect data for analyzing fish biomass throughout the water column. As fisheries management transitions from a single stock management approach to an ecosystem-based approach, acoustics has emerged as one of the most promising tools in supplementing the data needed for this paradigm shift.

The C-SCAMP project used a hull mounted split beam **echosounder** (Simrad EK60). Similar to a traditional fish finder you may find on a recreational boat, the echosounder emits acoustic pings and the sound reflected back from fish and other organisms in the water column is collected and measured. When a series of ping returns are placed sequentially side by side, it is called an **echogram**.



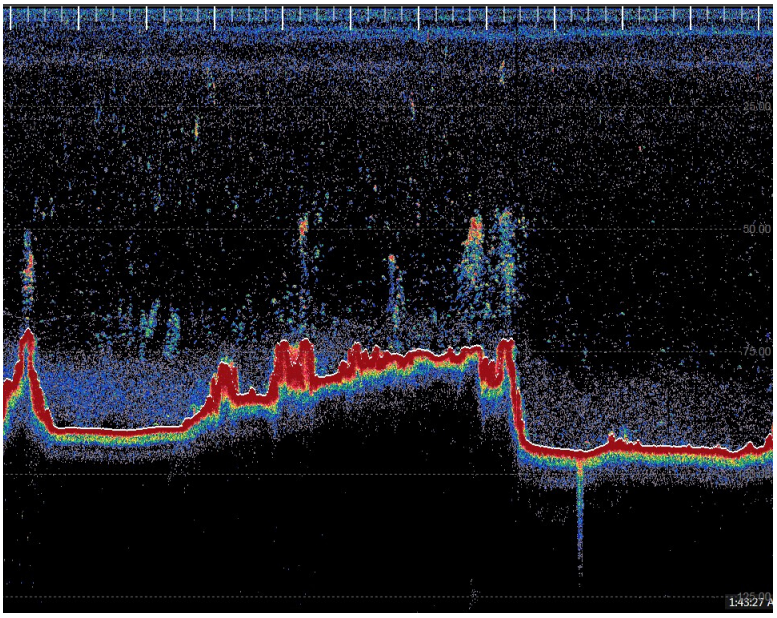
Above: A schematic showing the hull-mounted EK60 echosounder in relation to the towed C-BASS system.



Above: Image of an amberjack school captured by C-BASS (left) and corresponding echogram (right).

From these echograms, proxies for fish biomass can be calculated allowing for abundance estimates of reef fish species which are then compared to the data collected with the C-BASS. The use of acoustics is advantageous for its ability to cover large areas quickly and to look at fish in an area more comprehensively. For the C-SCAMP project, the use of the echosounder was also able to supplement C-BASS video data from the portion of the water column above where the C-BASS was towed, particularly when large fish schools were observed. Similarly, acoustic data were supplemented by species data collected with the C-BASS.

Acoustic data collected with the echosounder were both comparative and additive to data collected with the C-BASS and showed there is great potential to better estimate reef fish abundance in the Gulf of Mexico by combining data from these two technologies.



Right: An echogram depicting pinnacle features in the Alabama Alps region in the northern Gulf of Mexico. Overlying fish schools are visible above several of the pinnacles.

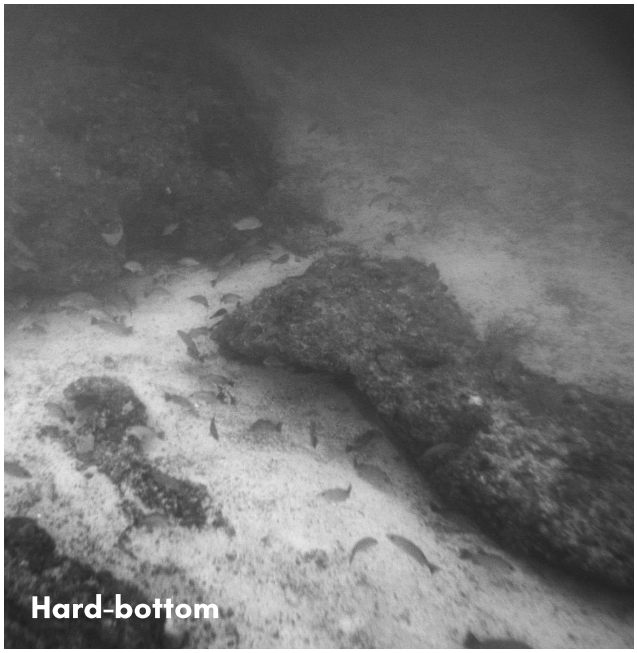
Echosounder- A device that uses sound to detect fish and other organisms in the water column.

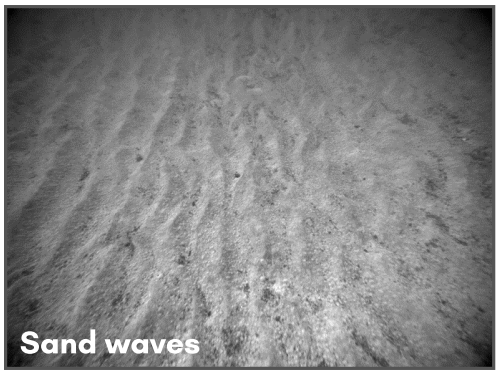
Echogram - A data product used to view the series of ping returns collected by a water column sonar.

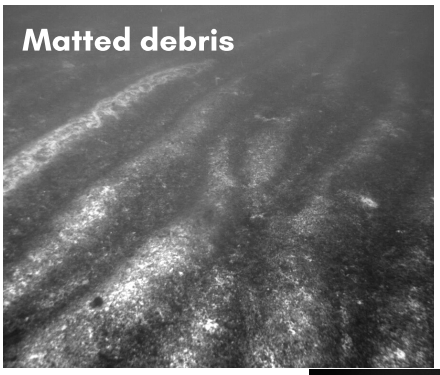
Benthic Habitat Characterization and Maps

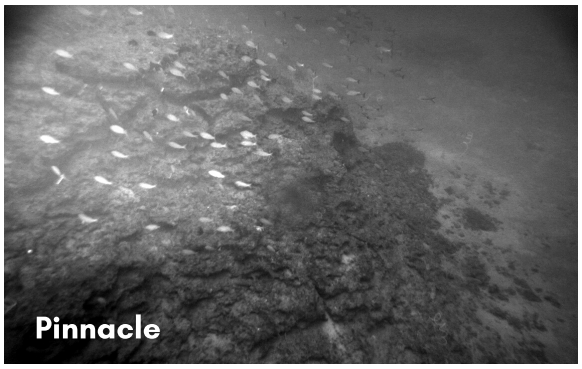
Characterizing benthic habitat requires a description of both the biotic (living) and abiotic (non-living) components of an area. Abiotic factors can include the geomorphology, substrate type, water temperature and salinity while biotic factors include the organisms living in, on, and around the physical structures.

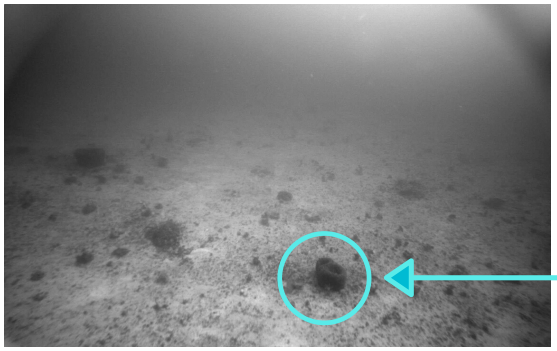
Multibeam sonars can efficiently cover large swaths of seafloor, providing scientists with information about the depth, shape, and general characteristics of the benthic environment. These data alone however do not constitute benthic habitat. To develop a more comprehensive understanding of seafloor habitats C-SCAMP scientists tow an underwater camera near the seafloor to see exactly what the seafloor looks like and what types of organisms are living there.

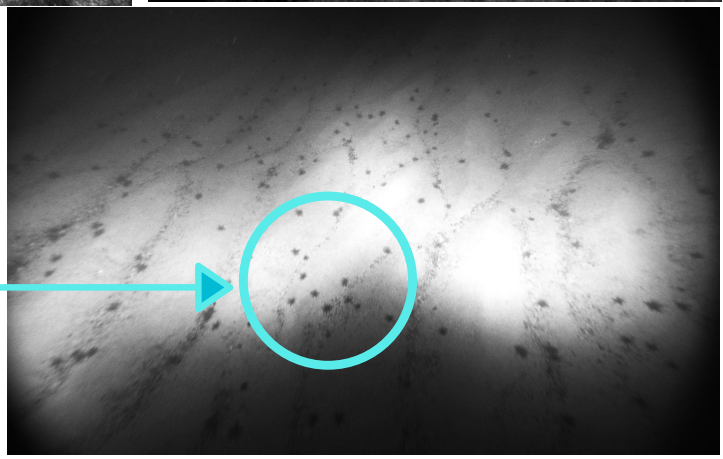


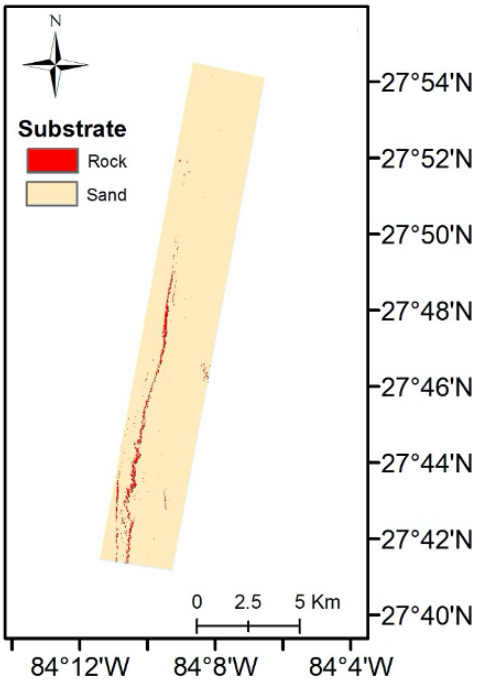












This video alone provides an invaluable and detailed accounting of the range of benthic habitats, their condition, and the organisms that utilize these habitats. Scientists can also examine the habitat preferences of different organisms. By combining the data from these two technologies, more broad-scale descriptors of benthic habitat such as substrate can be extrapolated to the entire multibeam survey using statistical models that relate the substrate seen in the video to the acoustic signature from the multibeam data. Habitat maps combined with an understanding of habitat preferences of ecologically and economically important species can be useful for designating Marine Protected Areas (MPAs), designing surveys for monitoring fish stocks, and can be used to estimate the abundance of demersal reef fish.

Left: Substrate map of an area of the West Florida Shelf known as "The Elbow".

Whats Next? a note from c-scamp's principal investigator

As we wrap up the project *Restoring Fish and Sea Turtle Habitat on the West Florida Continental Shelf: Benthic Habitat Mapping, Characterization and Assessment*, funded by the National Fish and Wildlife Foundation, it is appropriate to consider what has been accomplished and the "next steps" in bathymetric and habitat mapping in the Eastern Gulf of Mexico and beyond. Using the assets of the University of South Florida's College of Marine Science, and especially the staff of the Ocean Technology Group, C-SCAMP was able to go from a research and "proof of concept" stage to a fully integrated mapping program that has vastly expanded our knowledge of essential habitats on the West Florida Continental Shelf. Doing so would not have been possible without the strategic partnerships forged with our collaborating institutions including the Florida Fish and Wildlife Research Institute, the National Oceanic and Atmospheric Administration (including the National Ocean Service, the National Marine Fisheries Service and the National Centers for Environmental Information), the Florida Institute of Oceanography and our talented and insightful external steering committee.

While much has been accomplished in developing operational end-to-end approaches to bathymetric mapping and fusing these data with *in situ* habitat surveys, much remains to be done. Large swaths of the continental shelf of the eastern Gulf of Mexico have yet to be comprehensively mapped. We estimate that about 15,000 km^2 of the over 200,000 km^2 of the west Florida shelf contain hard-bottom habitat features of critical importance to fisheries and protected species. These data are required for ecosystem management agencies to effectively do their jobs in protecting and enhancing critical habitats sustaining the region's valuable resources. Our project has established a strategy for prospecting for these habitats based on the geology of the shelf. Working with relevant agencies, the C-SCAMP program will seek to identify funding opportunities and additional strategic partnerships with government, academic and private entities to continue comprehensive mapping activities initiated under this program.

The need to comprehensively map the bathymetric and habitat resources of the United States Exclusive Economic Zone (EEZ) has long been recognized as a scientific and management gap that has been recently emphasized by federal government Executive Order:

"To improve our Nation's understanding of our vast ocean resources and to advance the economic, security, and environmental interests of the United States, it is the policy of the United States to support the conservation, management, and balanced use of America's oceans by exploring, mapping, and characterizing the U.S. EEZ" (The White House, November, 2019).

We will strive to help make this vision a reality.

Dr.Steven Murawski, Principal Investigator, C-SCAMP

Find us online at www.marine.usf.edu/scamp

Our findings, reports, and publications are available on this site in the form of ***map downloads, videos, and an interactive GIS portal***. We also provide educational outreach materials on benthic habitat identification and an identification guide for the reef fishes of offshore West Florida.

@CSCAMPscience C-SCAMP Videos

Published Works

Accepted

Broadbent, H.A., Grasty, S.E., Hardy, R., Lamont, M.M., Hart, K.M., Lembke, C., Brizzolara, J.L., and Murawski, S. "West Florida Shelf Pipeline Serves as Sea Turtle Benthic Habitat Based on in Situ Towed Camera Observations." *Aquatic Biology*, vol. 29, 2019, pp. 17–31., doi:10.3354/ab00722.

Brizzolara, J.L., Grasty, S.E., Ilich, A.R., Gray, J.W., Naar, D.F., & Murawski, S.A. "Characterizing Benthic Habitats in Two Marine Protected Areas on the West Florida Shelf." *Seafloor Geomorphology as Benthic Habitat*, 2020, pp. 605–618., doi:10.1016/b978-0-12-814960-7.00036-1.

Grasty, S. "How Many Fish Are Really in the Sea? Investigating Fisheries Management Concepts by Estimating Reef Fish Abundance Using Trawl and Underwater Video Data." *The Science Teacher*. April/May 2020 Issue. pp. 18 - 25. The National Science Teaching Association.

Grasty, S. E., Wall, C. C., Gray, J. W., Brizzolara, J., & Murawski, S. "Temporal Persistence of Red Grouper (*Epinephelus morio)* Holes and Analysis of Associated Fish Assemblages from Towed Camera Data in the Steamboat Lumps Marine Protected Area." *Transactions of the American Fisheries Society*, vol. 148, no. 3, Feb. 2019, pp. 652–660., doi:10.1002/tafs.10154.

Lembke, C., Mann, D., Taylor, C., Silverman, A., Gray, J., and Hughes, E. "Utilizing Gliders and Acoustics to Identify Fish Habitat Hotspots: A Case Study." 2018. *OCEANS 2018 Marine Technology Society/IEEE Oceanic Engineering Society Conference*. Charleston, SC. 8pp. doi:10.1109/oceans.2018.8604916.

Lembke, C., Grasty, S., Silverman, A., Broadbent, H., Butcher, S., and Murawski, S. "The Camera-Based Assessment Survey System (C-BASS): A Towed Camera Platform for Reef Fish Abundance Surveys and Benthic Habitat Characterization in the Gulf of Mexico." Continental Shelf Research, vol. 151, 2017, pp. 62–71., doi:10.1016/j.csr.2017.10.010.

Silverman, A., Lembke, C., Butcher, S., Lindemuth, M., and Murawski, S. "Enabling a Platform for Habitat and Marine Assessment with Real Time Monitoring and Synchronous Databasing." 2018. *OCEANS 2018 Marine Technology Society/IEEE Oceanic Engineering Society Conference*. Charleston, SC. 6pp.doi:10.1109/oceans.2018.8604912.

Other Publications

"Just Call Us the Fish Paparazzi." by Sarah Grasty. Ocean Currents Blog. Ocean Conservancy. 18 August 2017 <https://oceanconservancy.org/blog/2017/08/18/just-call-us-fish-paparazzi/>

"What's Underneath it All?" by Sarah E. Grasty. *Guy Harvey Magazine*. Fall 2018 Issue. pgs 64 - 69.

Planned *

Hughes, E., Grasty, S., Murawski, S. and Naar, D. "An Acoustic "Look" at Reef Fish Density Estimates from Video: How do Estimates from Two Different Technologies Compare?"

Ilich, A., Brizzolara J., Grasty S., Gray J., Hommeyer M., Lembke C., Locker S., Silverman A., Switzer T., Vivlamore A., and Murawski S. "Integrating Towed Underwater Video and Multibeam Acoustics for Marine Benthic Habitat Mapping and Fish Population Estimation"

*Submitted December 2019

Master's Theses Supported by the Project

Brizzolara, Jennifer L., "Characterizing Benthic Habitats Using Multibeam Sonar and Towed Underwater Video in Two Marine Protected Areas on the West Florida Shelf, USA" (2017). *Graduate Theses and Dissertations*. https://scholarcommons.usf.edu/etd/6806.

Gray, John Willis, "The Stability of Sand Waves in a Tidally-Influenced Shipping Channel, Tampa Bay, Florida" (2018). *Graduate Theses and Dissertations*. https://scholarcommons.usf.edu/etd/7157.

Ilich, Alexander Ross, "Integrating Towed Underwater Video with Multibeam Acoustics for Mapping Benthic Habitat and Assessing Reef Fish Communities on the West Florida Shelf " (2018). *Graduate Theses and Dissertations*. https://scholarcommons.usf.edu/etd/7525.

Stewart, Lewis, "Investigation of Sediment Ridges Using Bathymetry and Backscatter near Clearwater, Florida" (2017). *Graduate Theses and Dissertations*. https://scholarcommons.usf.edu/etd/7091.

C-SCAMP Team

Principal Investigator: **Dr. Steven Murawski**
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Electrical Engineer and Software Developer: **Alex Silverman**
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Fisheries Acoustics/EK60 Scientist/PhD Candidate: **Eddie Hughes**
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Research Scientist: **Dr. Heather Broadbent**
PhD Student: **Alex Ilich**
Technicians: **Abigail Vivlamore & Rachel Crabtree**

Alumni: **John Gray, Jennifer Brizzolara and Dr. Gerardo Toro-Farmer**