



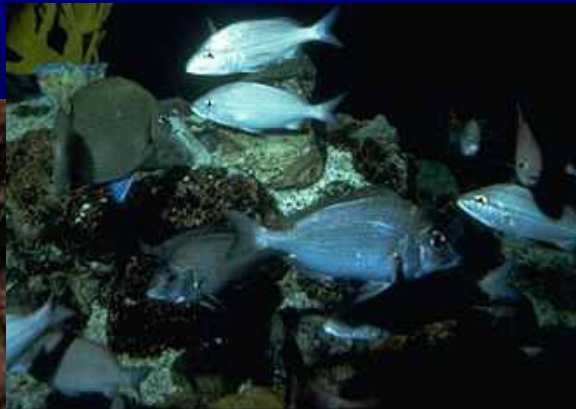
Gray's Reef National Marine Sanctuary



Mapping the Benthic Habitats of Gray's Reef

~ Research and Monitoring Workshop for Ecosystem Management ~

**Kendall, M. S., O.P. Jensen, G. McFall
R. Bohne, D. Field, C. Alexander, and M. E. Monaco**





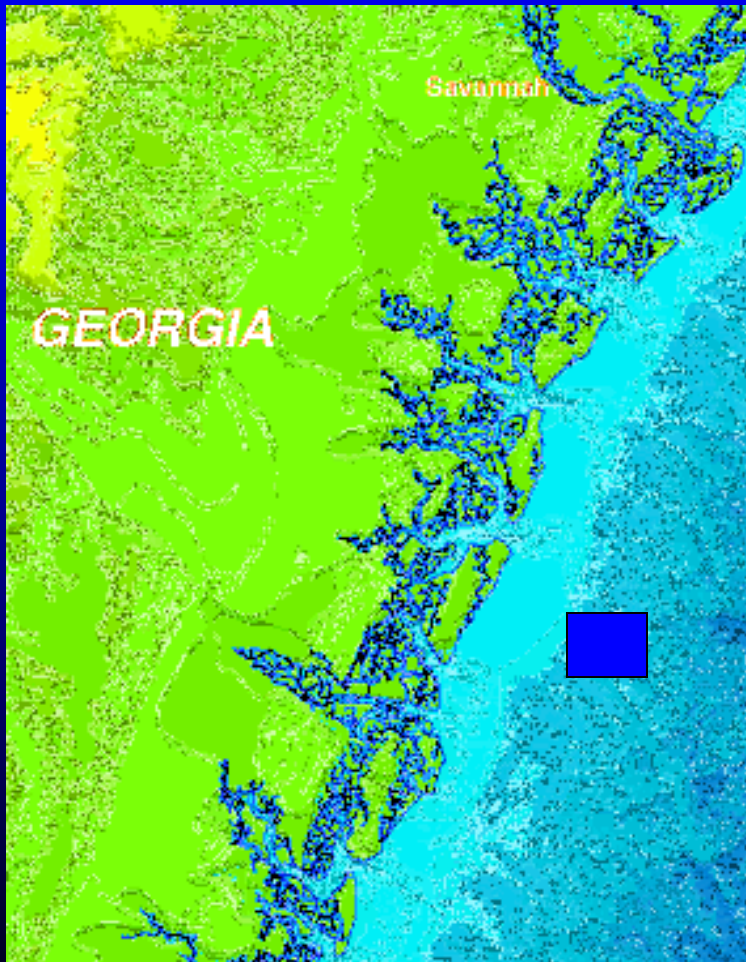
Sanctuary System Goals



- **To support, promote and coordinate scientific research on and monitoring of, the resources of these areas;**
- **To enhance public awareness, understanding, appreciation and wise use of the marine environment;**
- **To facilitate, to the extent compatible with the primary objective of resource protection, all public and private uses of the resources;**
- **To maintain, restore and enhance living resources by providing places for species that depend upon these marine areas to survive and propagate.**



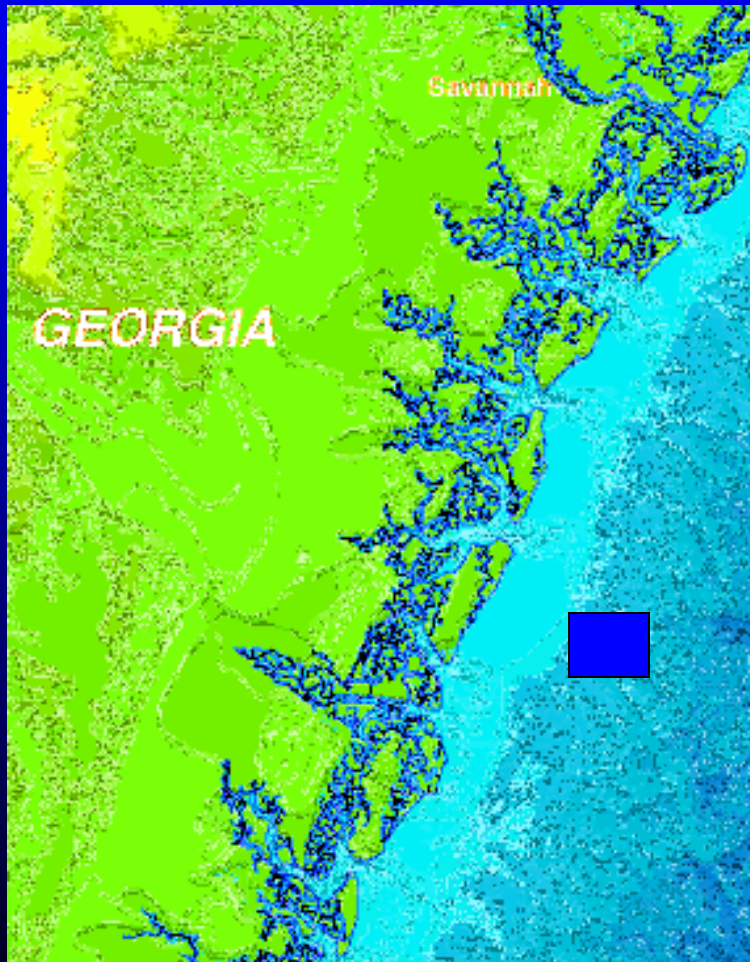
Information on Gray's Reef



- **Designated in 1981**
- **Recognized 1986 as an International Biosphere Reserve**
- **Recently designated as a “Habitat Area of Particular Concern” by the SAFMC**
- **Only natural area protected off the coast of GA**



Information on Gray's Reef



- **Located 17 nm offshore of Sapelo Island in 60-70 FSW**
- **Boundaries encompass 17 nm²**
- **Lies at margin of inner and mid shelf of SAB**
- **Encompasses areas of “live-bottom habitat”**



The Fishes of Gray's Reef



- There are estimated to be over 300 species of marine fish in Georgia's coastal waters
- 163 species have been observed within the sanctuary
- Many species are managed under protection of the SAFCMC
- Species present fill a wide variety of ecological niches





What are the geographic bounds of an “Ecosystem?”



- **Depends on who you ask**
- **The geographic bounds are very different for a Belted Sandfish than for a Great White Shark**
- **The concept of dealing with species or guild specific “ecosystem gradients” is difficult to grasp**



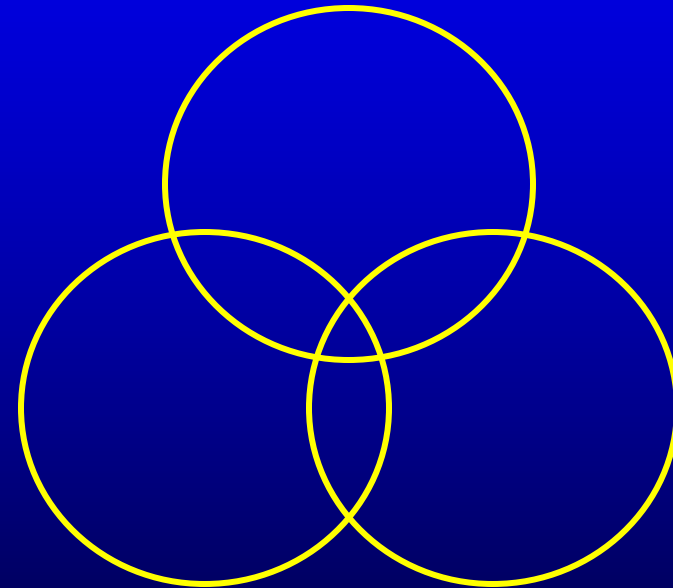


What is “Ecosystem Management?”



- **Depends on who you ask**
- **What management agency, constituent or interest group is involved**
- **“Ecosystem management” also exists along a “continuum” of interests, needs and mandates**

Conservation/ Resource Protection

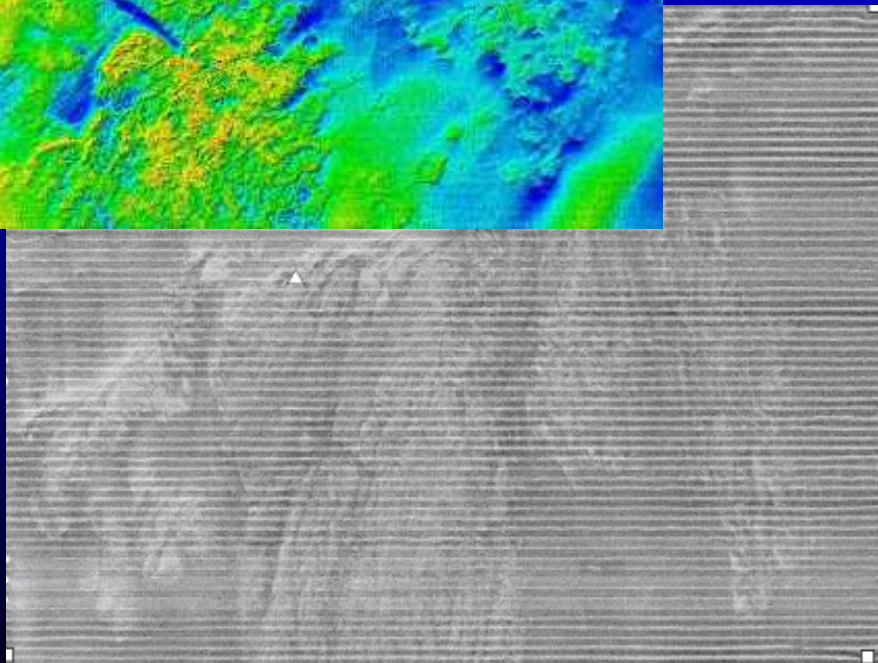
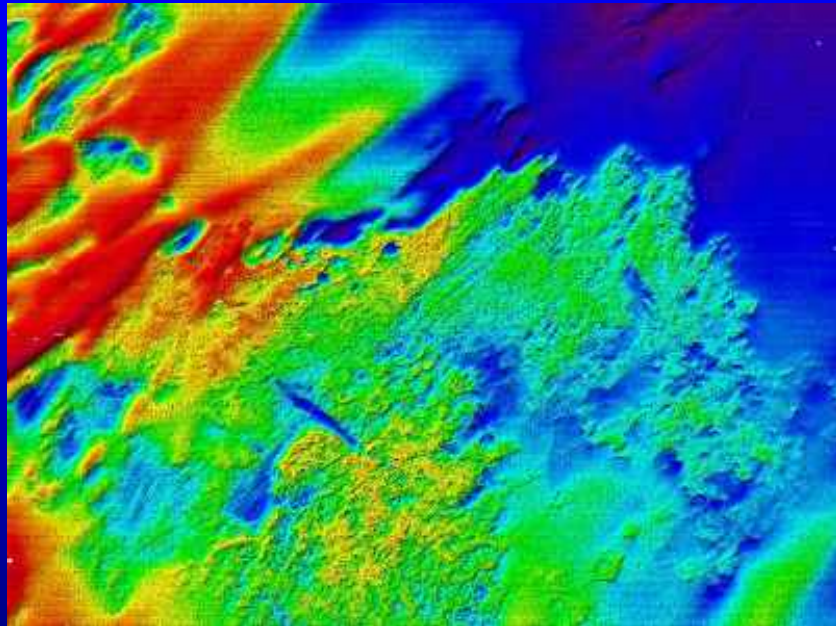


**Fisheries
Management**

**Constituent
Groups**



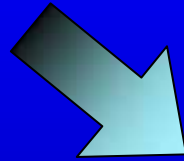
Gray's Reef Habitat Data Collection



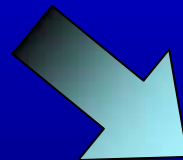
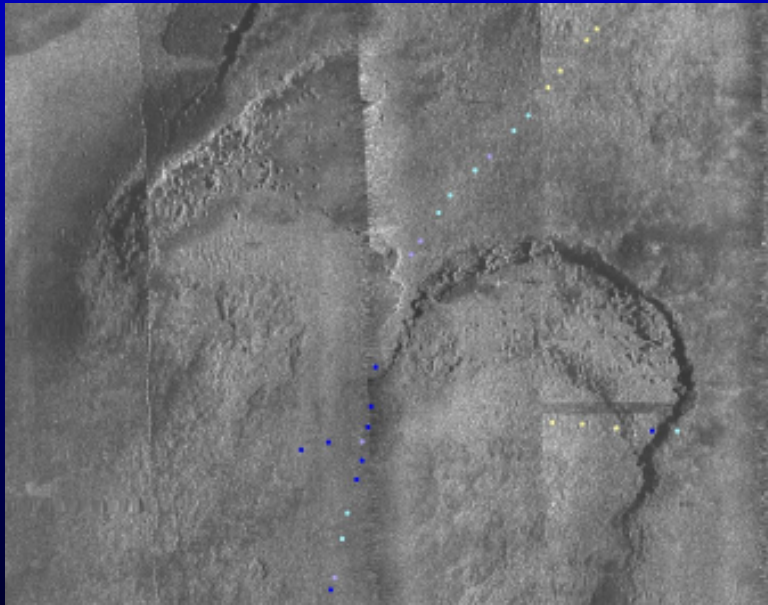
- **In 2001, we obtained high-resolution bathymetry of the bottom formations of the entire sanctuary**
- **We also obtained 100% side scan sonar in both E-W and N-S orientations**

Overview of habitat classification...

Provide brief review of past and current mapping activities



Explain methods for mapping using sonar data



Present draft maps and preliminary results

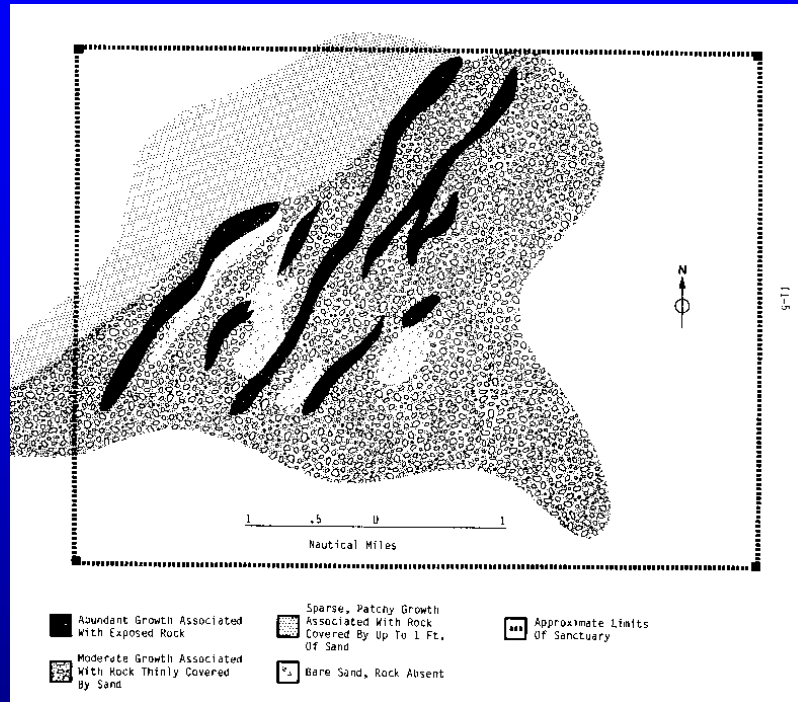


Talk about uses/future plans

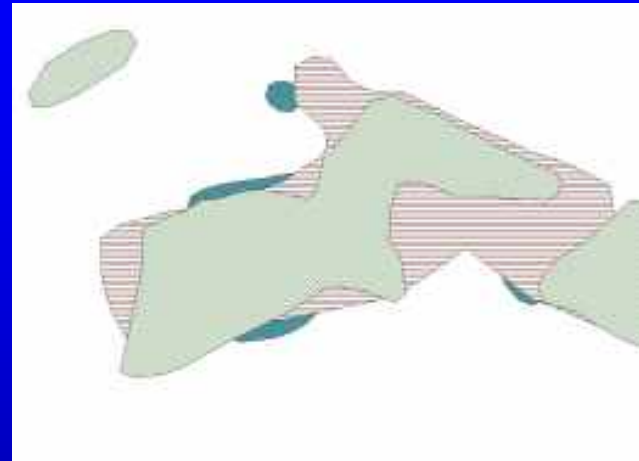


Previous Mapping in GRNMS

Hunt 1974

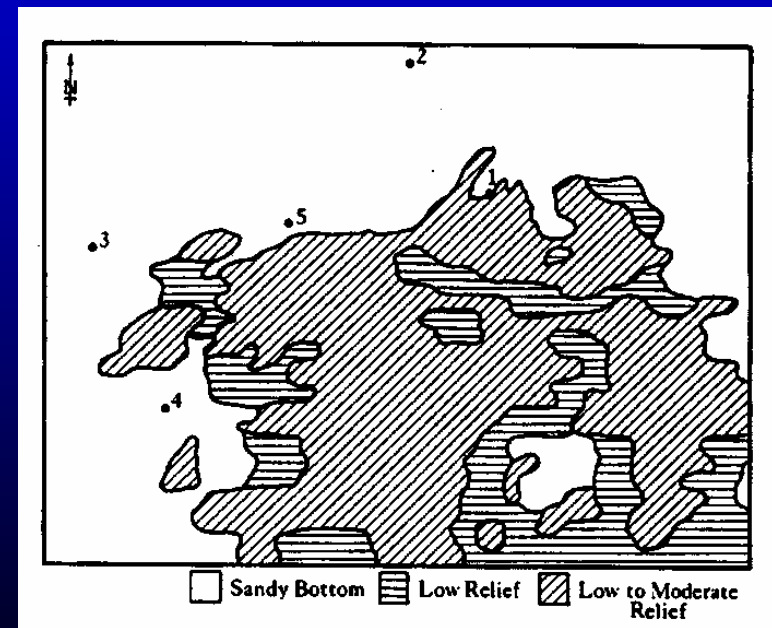


NOAA 1980s ?



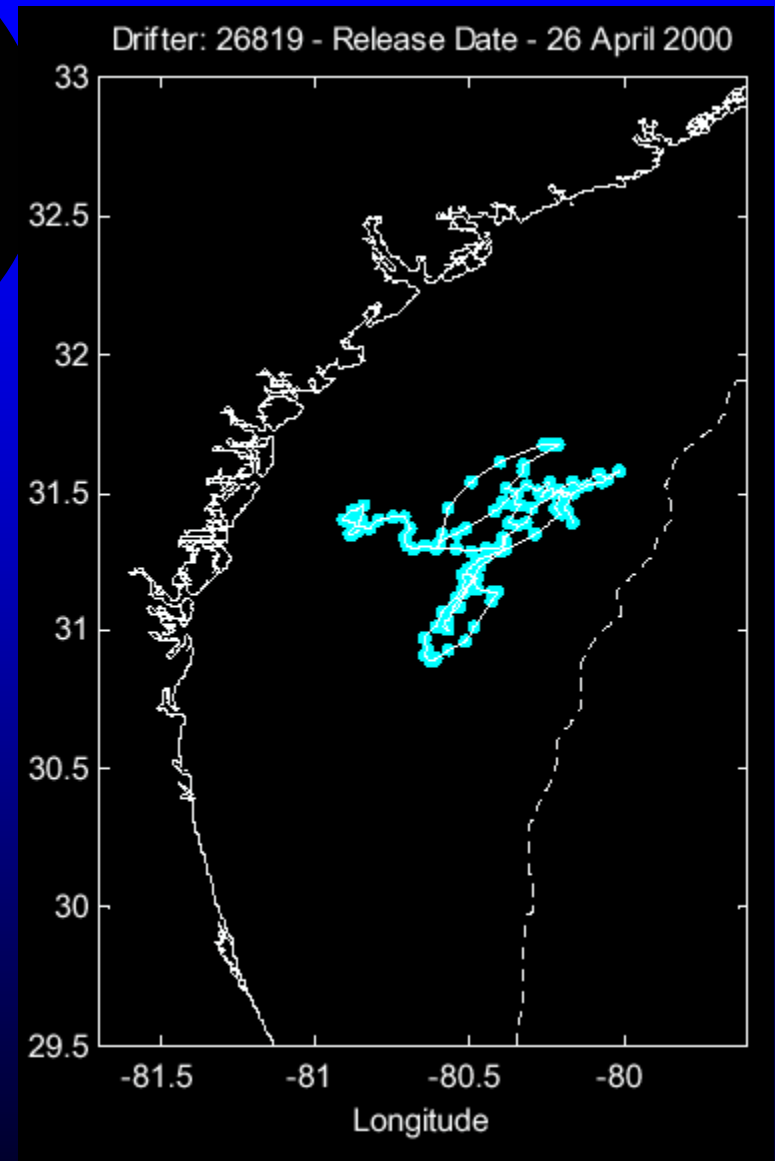
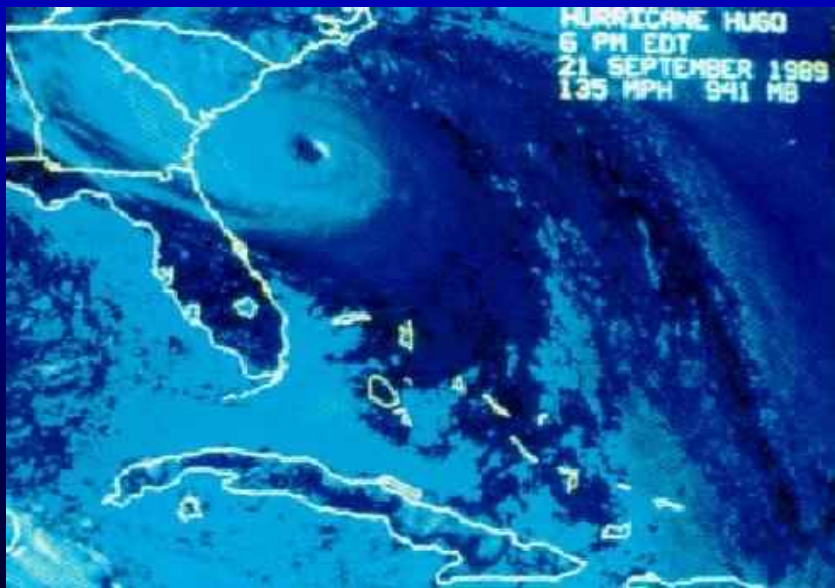
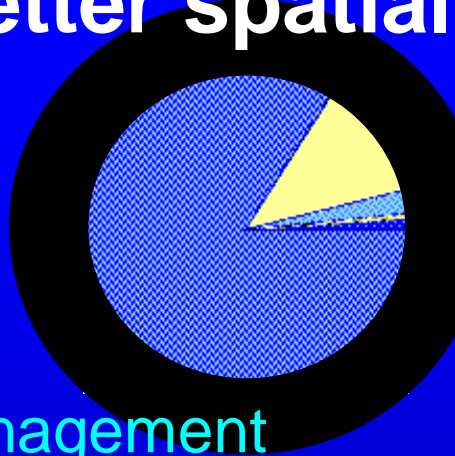
Others?

GA DNR 1980s ?
from Hopkinson et al 1991



The need for better spatial data...

- Baseline inventory
- Change detection
- Spatially explicit management
- “Foundation” for research activities



Improved technology and a new approach...

Using sonar data

Collecting ground truth and
accuracy assessment data

Developing the habitat
classification scheme

Digitizing benthic maps

Measuring
classification accuracy

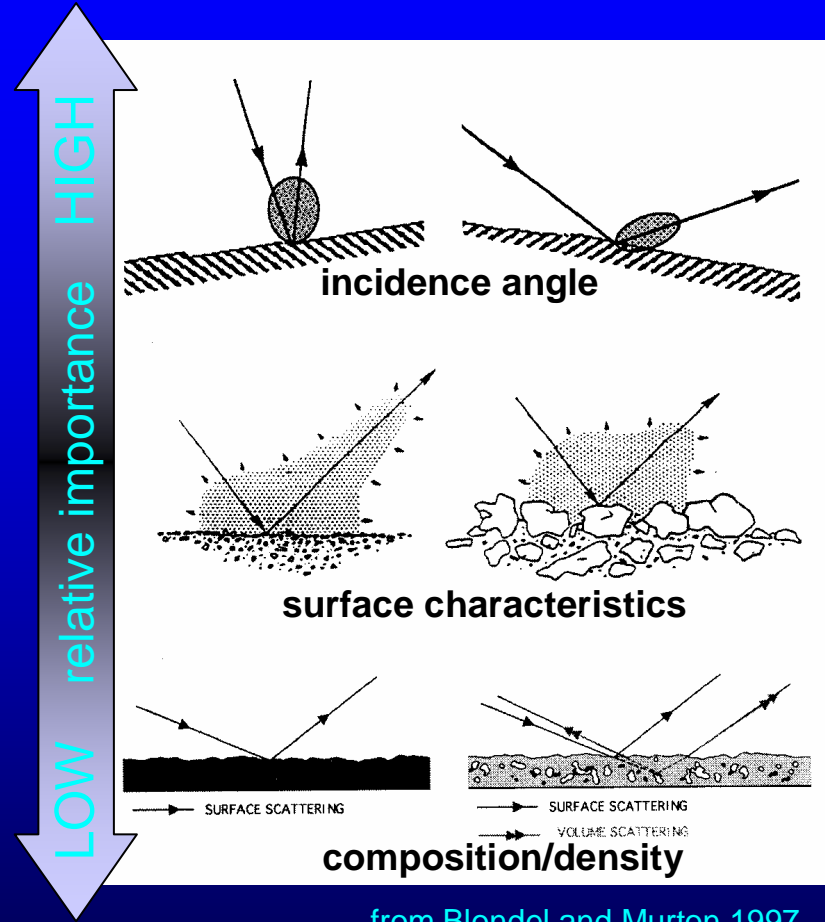
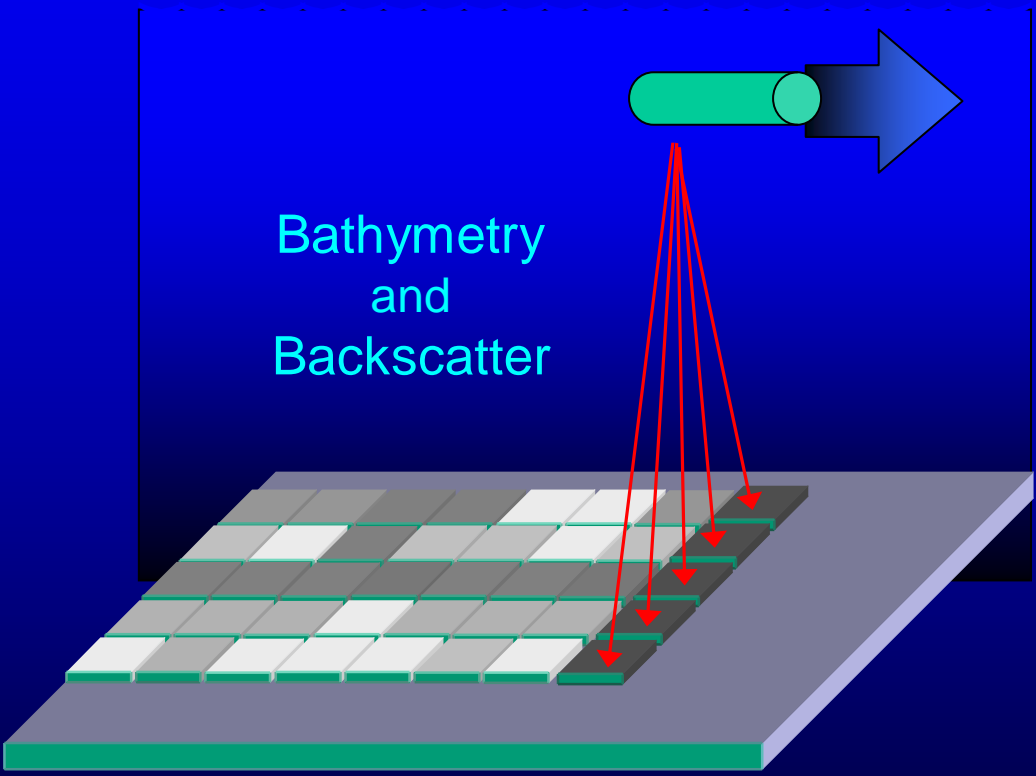


fine-scale benthic maps



Some sonar basics...

Bathymetry
and
Backscatter



from Blondel and Murton 1997



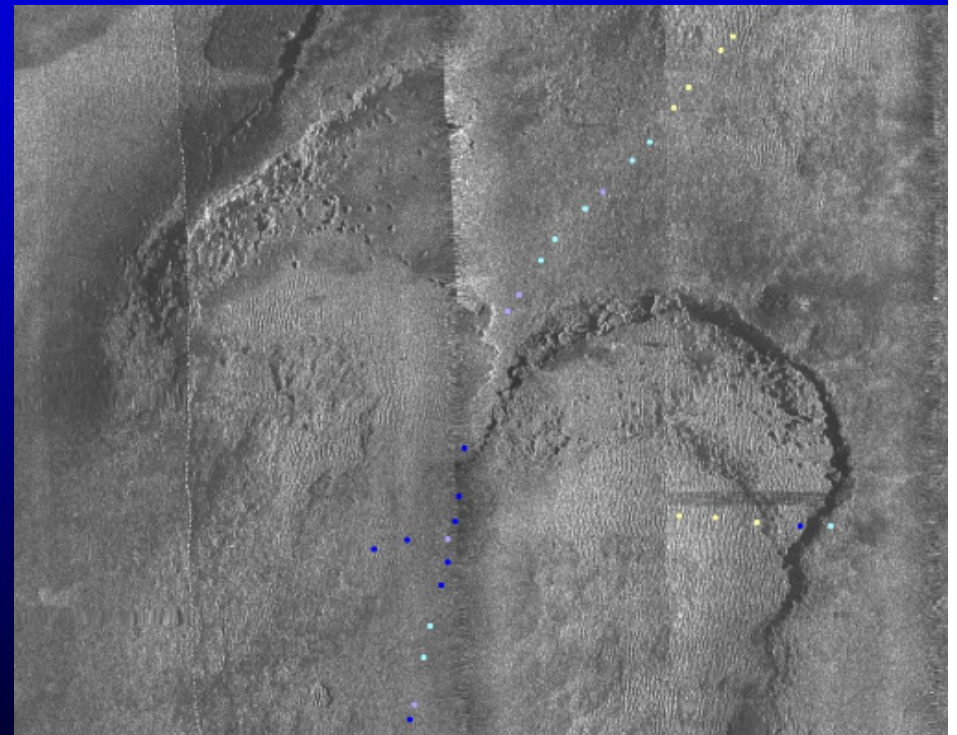
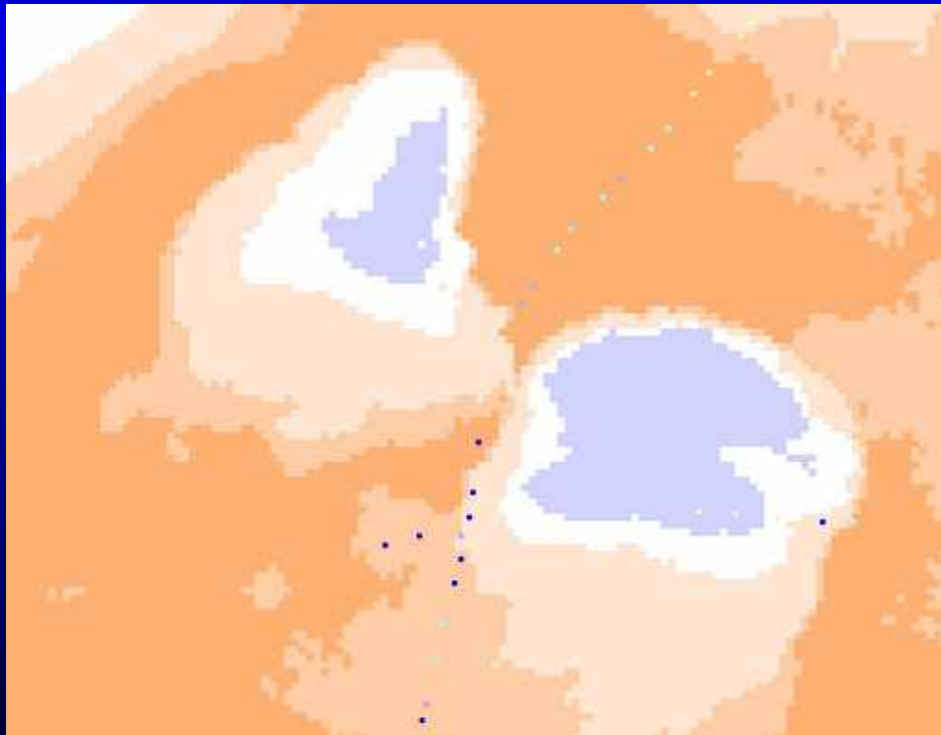
Sonar data for mapping at Gray's Reef NMS

Multibeam Bathymetry

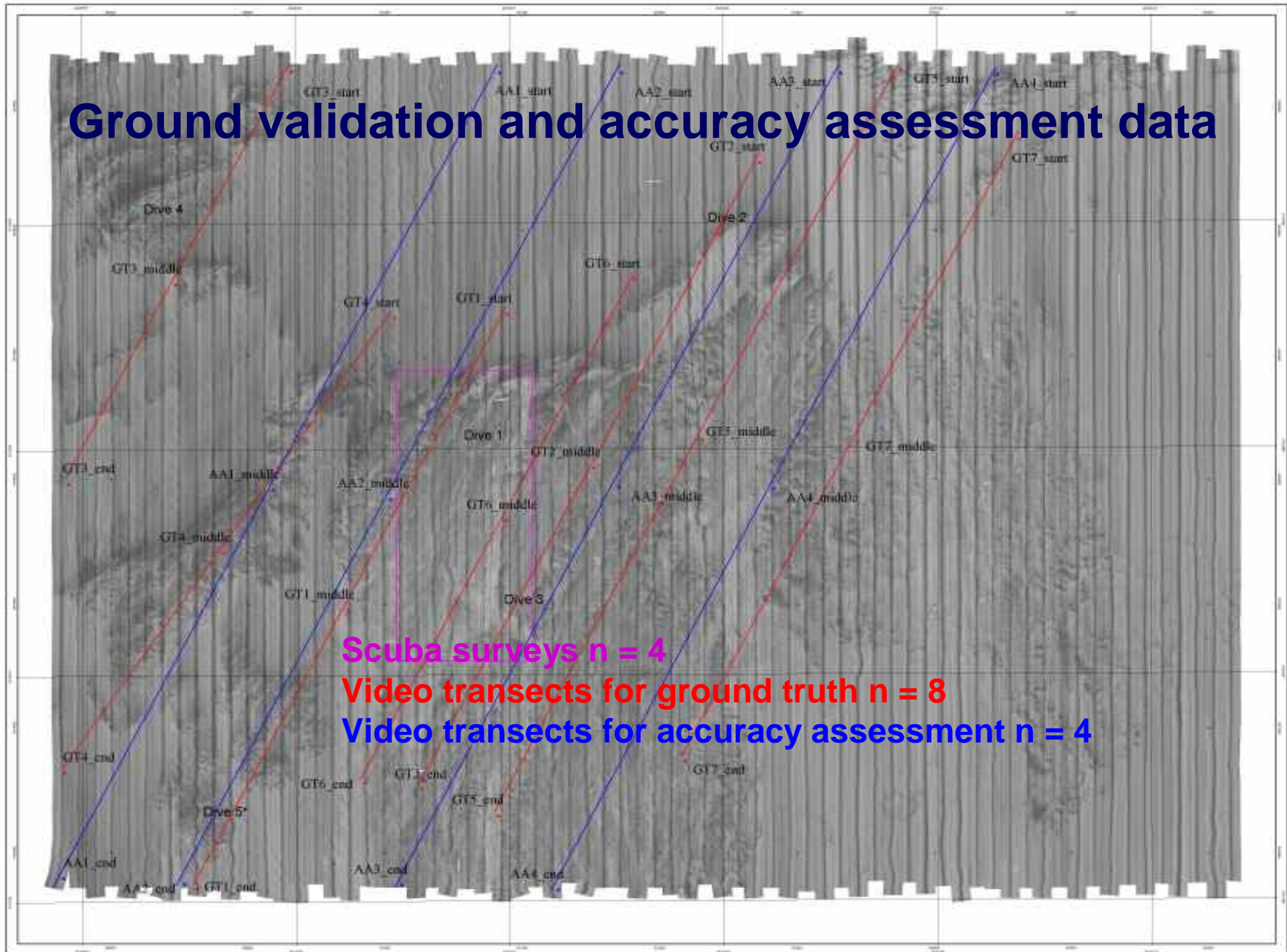
- ~ 2 m pixels
- ~ 85 m swath width
- ~ 40% side lap
- E/W track lines

Sidescan Backscatter

- ~ 0.25 m pixels
- ~150 m swath width
- ~ 10-30% side lap
- N/S and E/W track lines
- Mosaiced by Dr. Clark Alexander, SKIO



Ground validation and accuracy assessment data



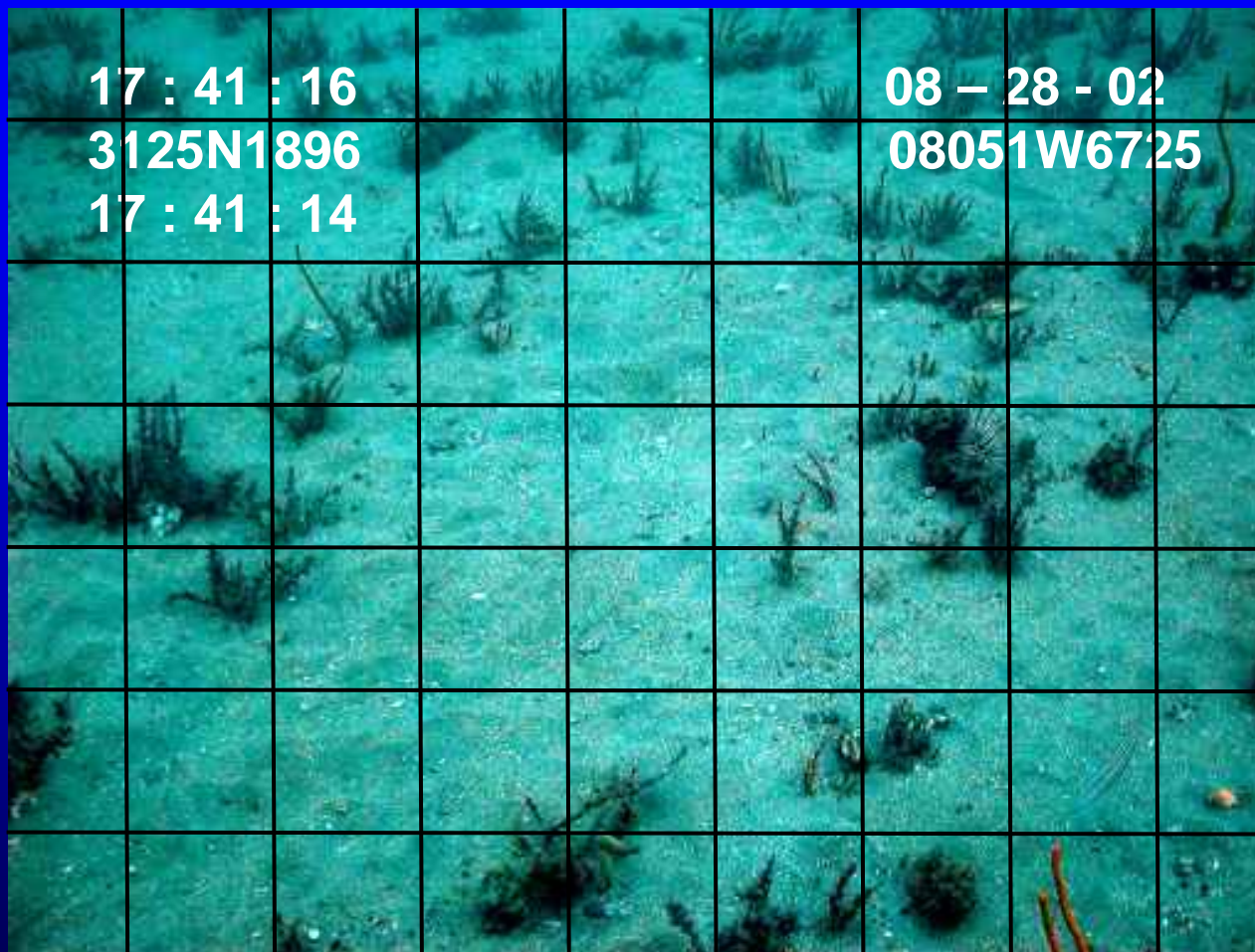
Scuba surveys $n = 4$

Video transects for ground truth $n = 8$

Video transects for accuracy assessment $n = 4$

Ground validation and accuracy assessment data

Minibat Mounted Video: Don Field, NOAA/CCFHR



Ground validation and accuracy assessment data

Minibat Mounted Video

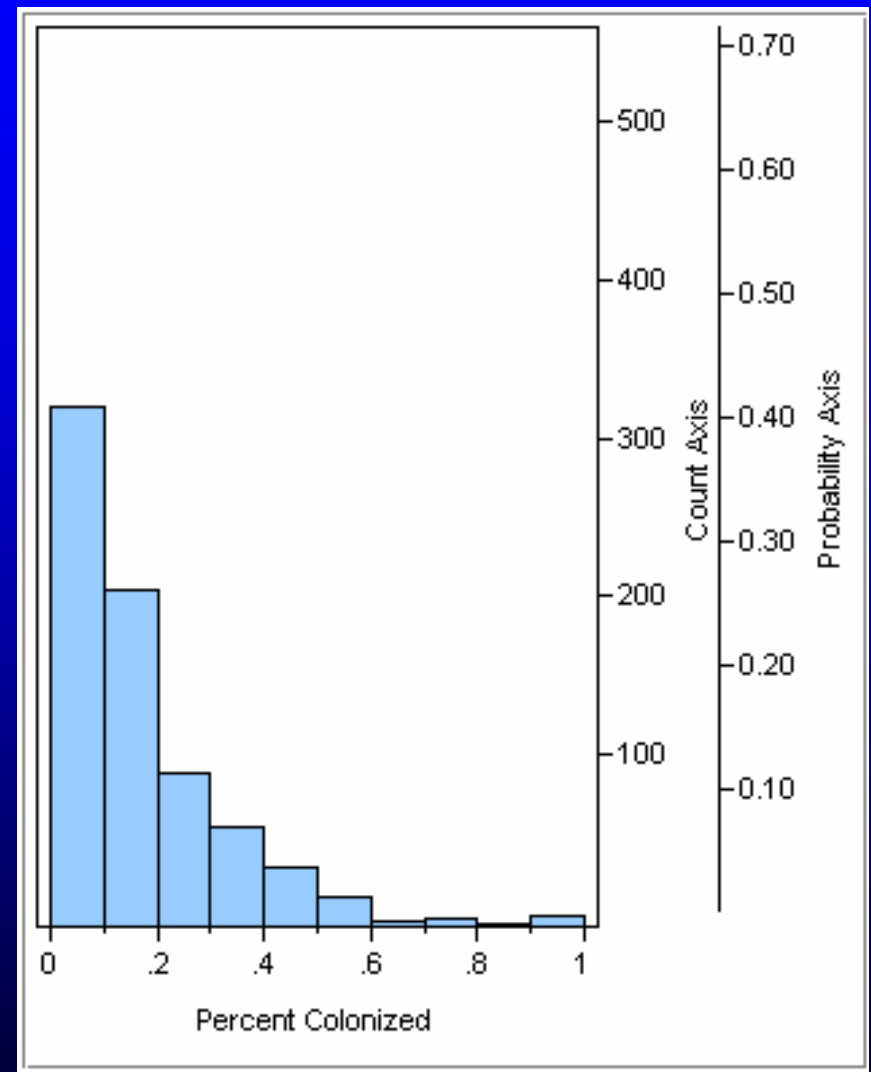
- ~2 m above substrate
- ~5-10 m horizontal accuracy
- 61 linear kilometers

Ground validation (n=8)

- 37 linear kilometers
- non-randomly placed

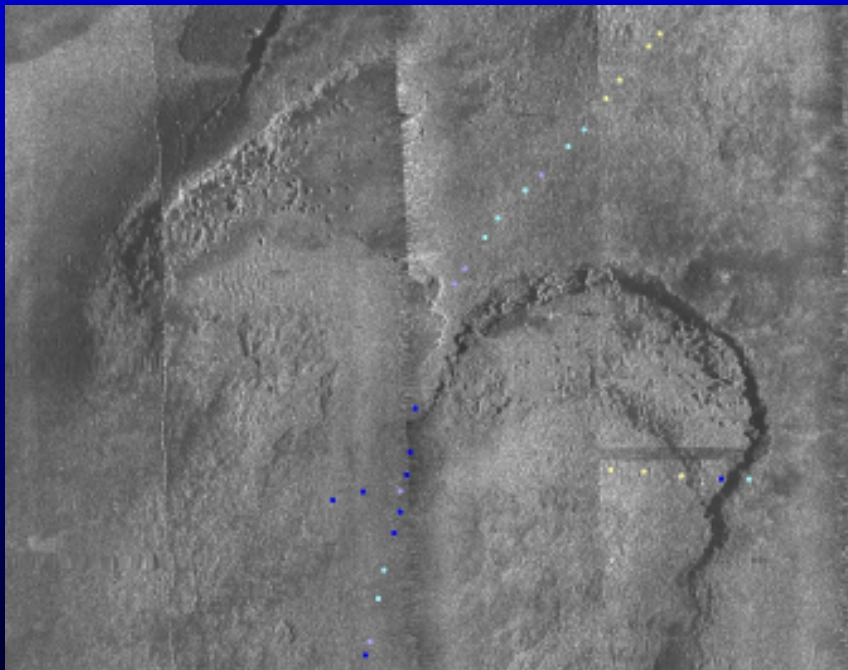
Accuracy assessment (n=4)

- 24 linear kilometers
- random placement
- 1928 geocoded video frames
 - 60% (1146) were bare sand
 - 40% (782) were colonized...



Considerations for Developing the Habitat Classification Scheme:

- Need to support diverse management/research applications
- Limited by quality and resolution of the source data
- Hierarchical to allow collapse/expansion
- Quantitative in density of colonization
- 100 m² minimum mapping unit (MMU)



Unconsolidated Sediments

Flat Sand: Coarse sediment occurring as a stable, flat region. Thickness is variable but may be only a few centimeters overlying flat limestone. Bioturbation is often present from polychaetes, echinoderms, and burrowing fishes and ranges from reworking of surface material to mound building and other excavations.



Unconsolidated Sediments

Rippled Sand: Sediment deposited in sufficient thickness such that regular ridges or waves are formed. The ridges generally run from north to south in this region due to the orientation of tidal currents. Typically, these ridges are 6-10 cm in height from crest to trough and are 40-60 centimeters in length from crest to crest. Troughs are often dominated by coarser material such as shell fragments while crests are primarily composed of sand.



Colonized Hard Bottom

Sparsely Colonized Hard Bottom: Bottom composed of partially exposed limestone substrate that is colonized with a sparse assemblage of sessile benthic organisms such as soft corals, sponges, and tunicates. Between 1 and 59 percent of the bottom area is colonized. A thin veneer of sand 1-2 cm thick may cover much of the bottom but is thin enough to allow sessile benthic organisms to attach to the limestone. Typically, this bottom type covers large contiguous areas of very low relief bottom.



Colonized Hard Bottom

Densely Colonized Hard Bottom:
Bottom composed of exposed limestone substrate that is colonized with a nearly continuous coverage of sessile benthic organisms such as soft corals, sponges, and tunicates. Between 60 and 100 percent of the bottom is colonized. Typically, only ledges and other areas of bathymetric relief are densely colonized. Ledges typically have a relief of 0.5 to 2 m.

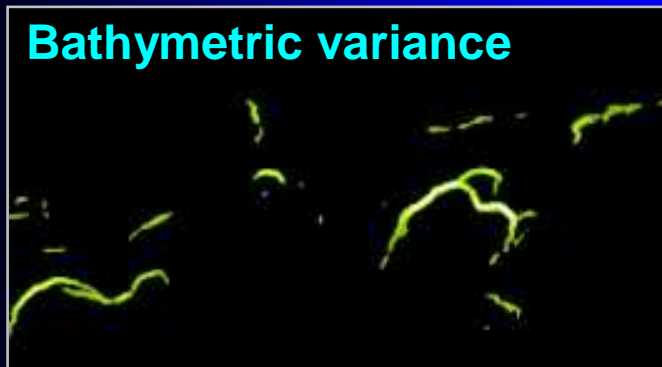


Digitizing benthic habitats...

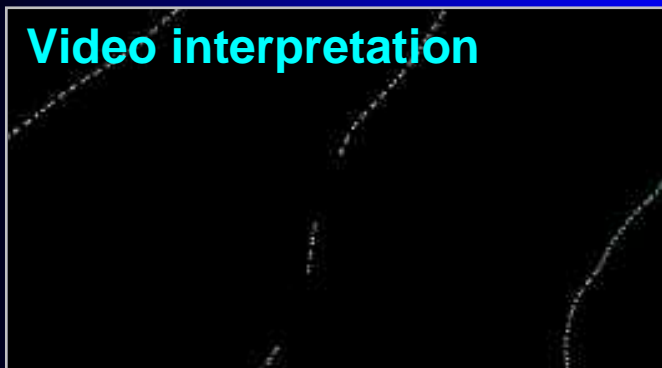
Backscatter mosaics



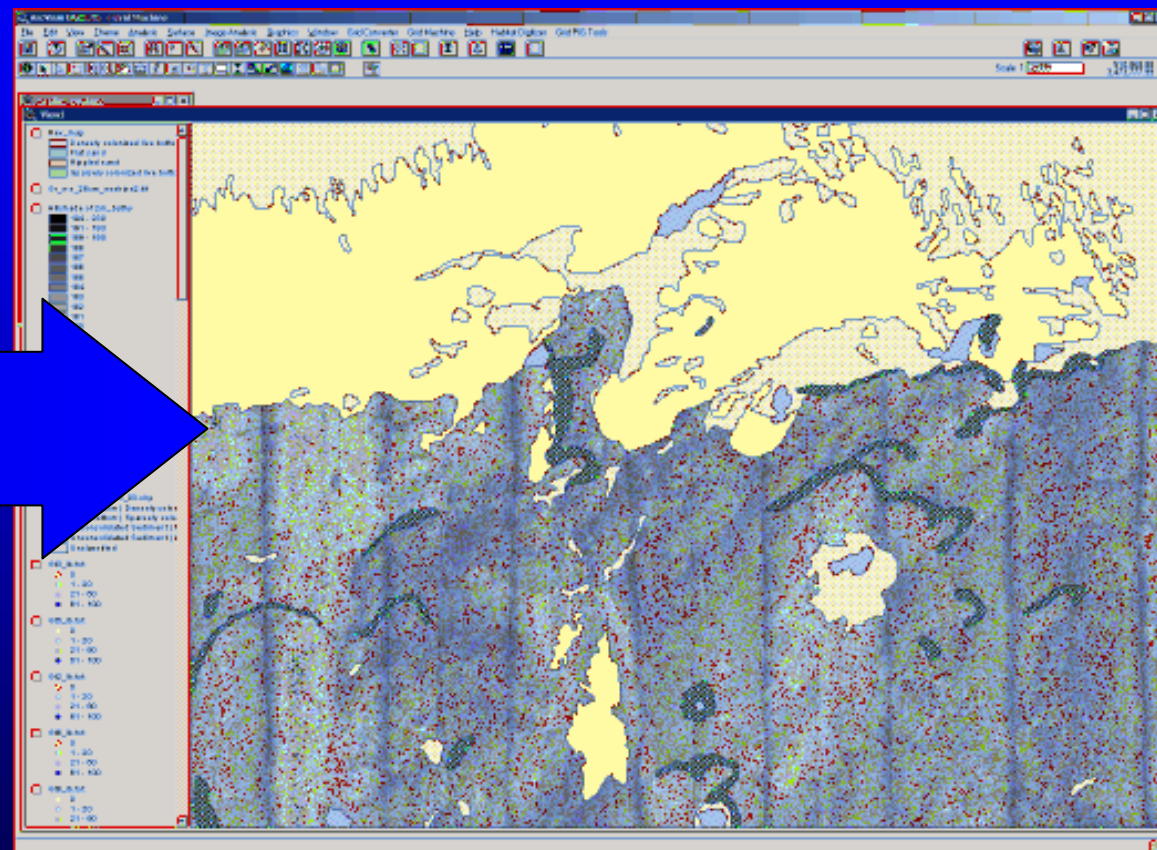
Bathymetric variance



Video interpretation



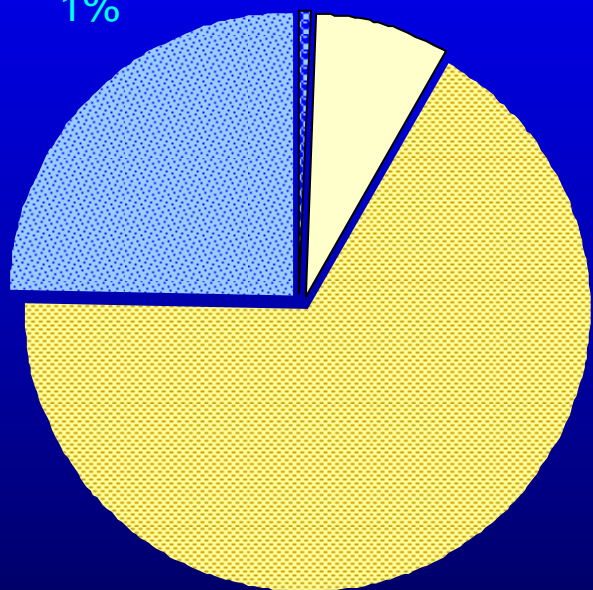
Visual Interpretation Habitat Digitizer Extension (ArcView 3.2)



Preliminary results...

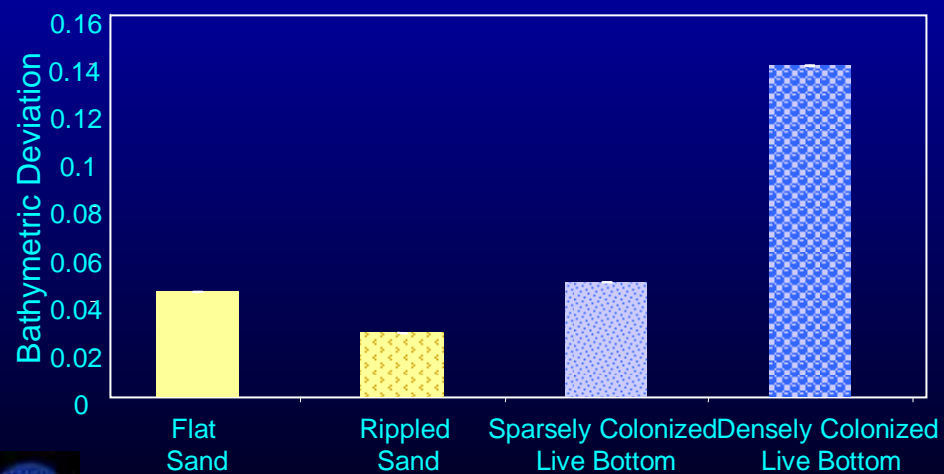
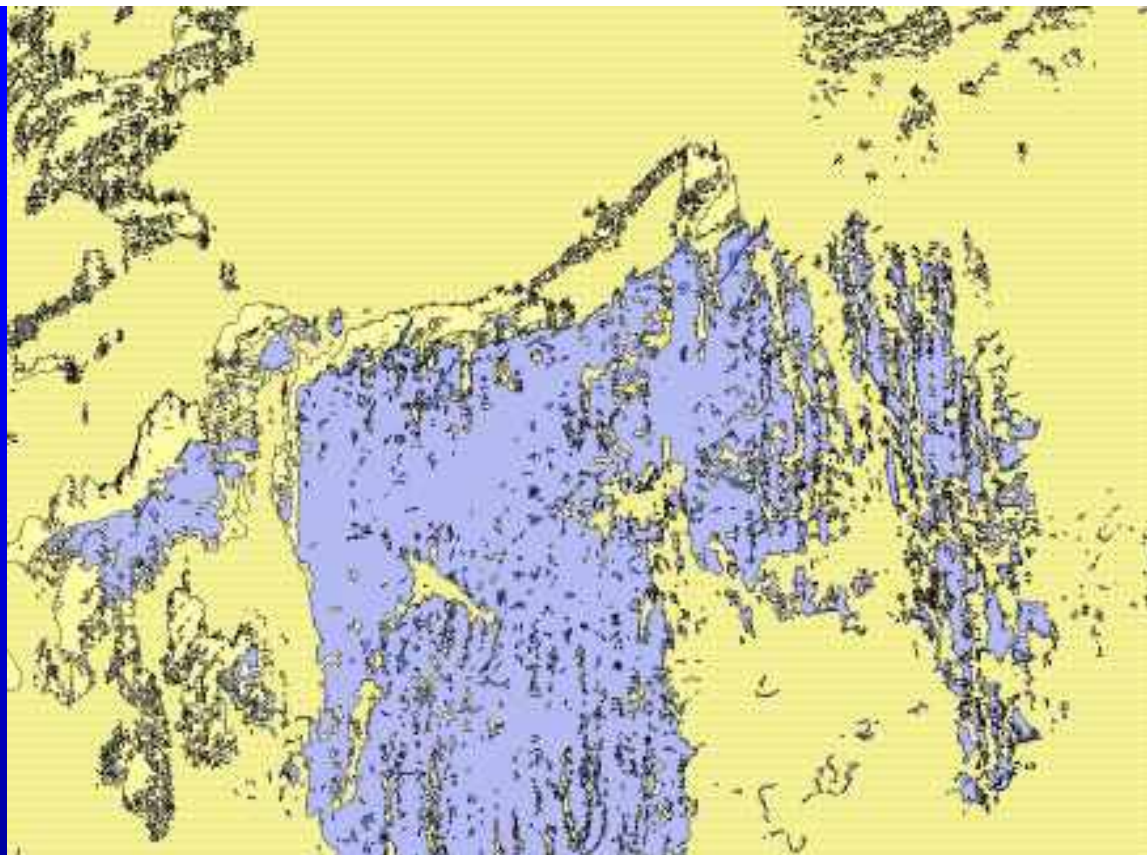
Sparsely colonized live bottom
14.8 km²
24%

Densely colonized live bottom
0.36 km²
1%



Rippled sand
40 km²
67%

Flat sand
4.6 km²
8%



Accuracy Assessment

- **Goal:** Compare map habitat classifications with those observed in an independent survey
- **Method:**
 - 1) Obtain random start systematic video line transect data
 - 2) Select appropriate points (video frames) for comparison
 - 3) Calculate a contingency table and classification accuracy statistics



Accuracy Assessment

Results:

1) 94.8% Classification

accuracy for regions without
small scale habitat

heterogeneity (87% of the
mapped area)

$K = 0.88$ ($p < 0.001$)

2) 82.7% Classification

accuracy for all regions
(includes error due to
spatial misalignment)

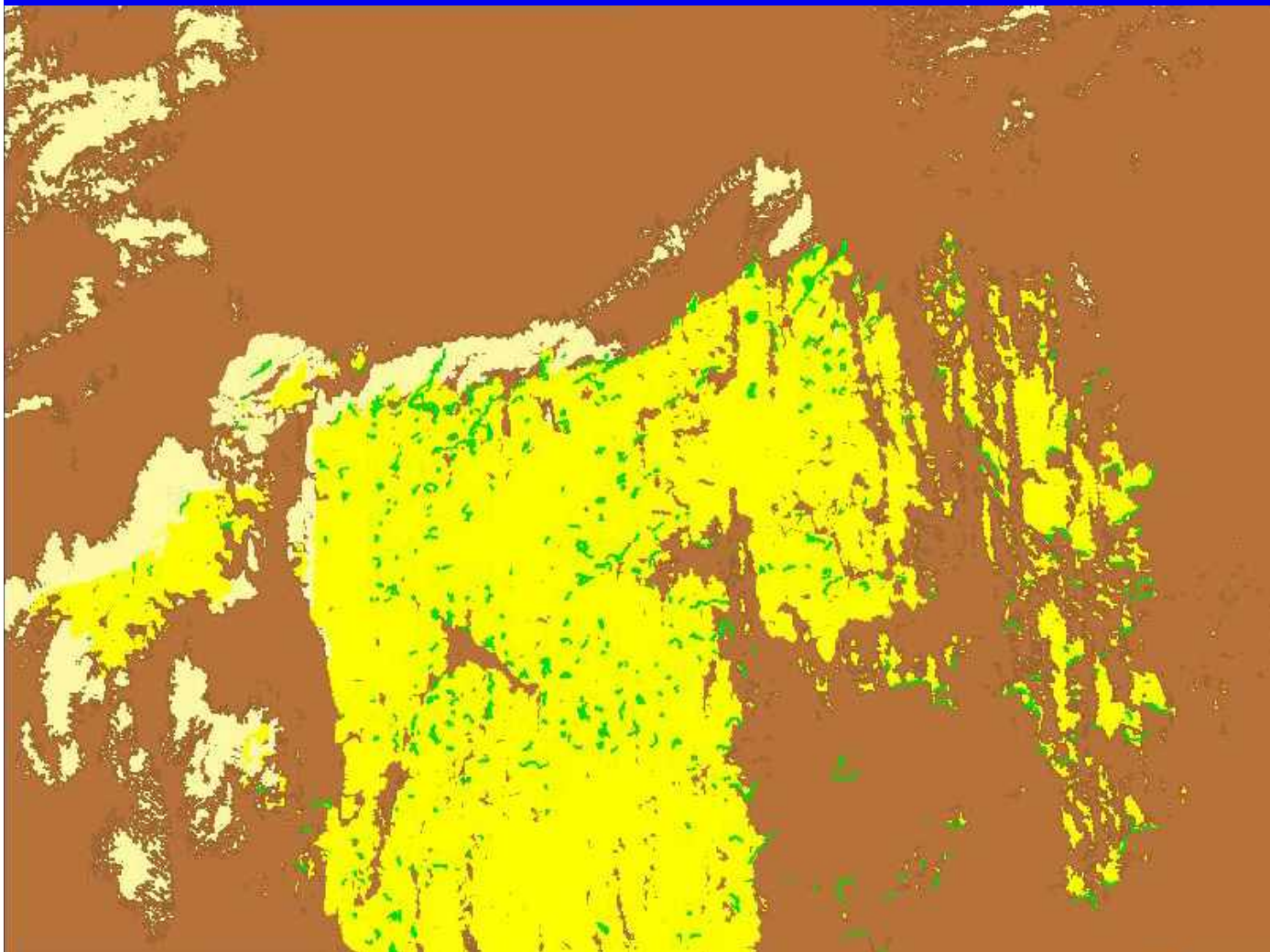
$K = 0.62$ ($p < 0.001$)

Classification Matrix


Mapped Habitat Type	Video Observed Habitat Type	
	<i>Unconsolidated Sediment</i>	<i>Sparsely Colonized Hard Bottom</i>
<i>Unconsolidated Sediment</i>	88 96.7%(U) 95.7%(P)	3
<i>Sparsely Colonized Hard Bottom</i>	4	40 90.9%(U) 93.0%(P)





Bio-Geographic Characterization



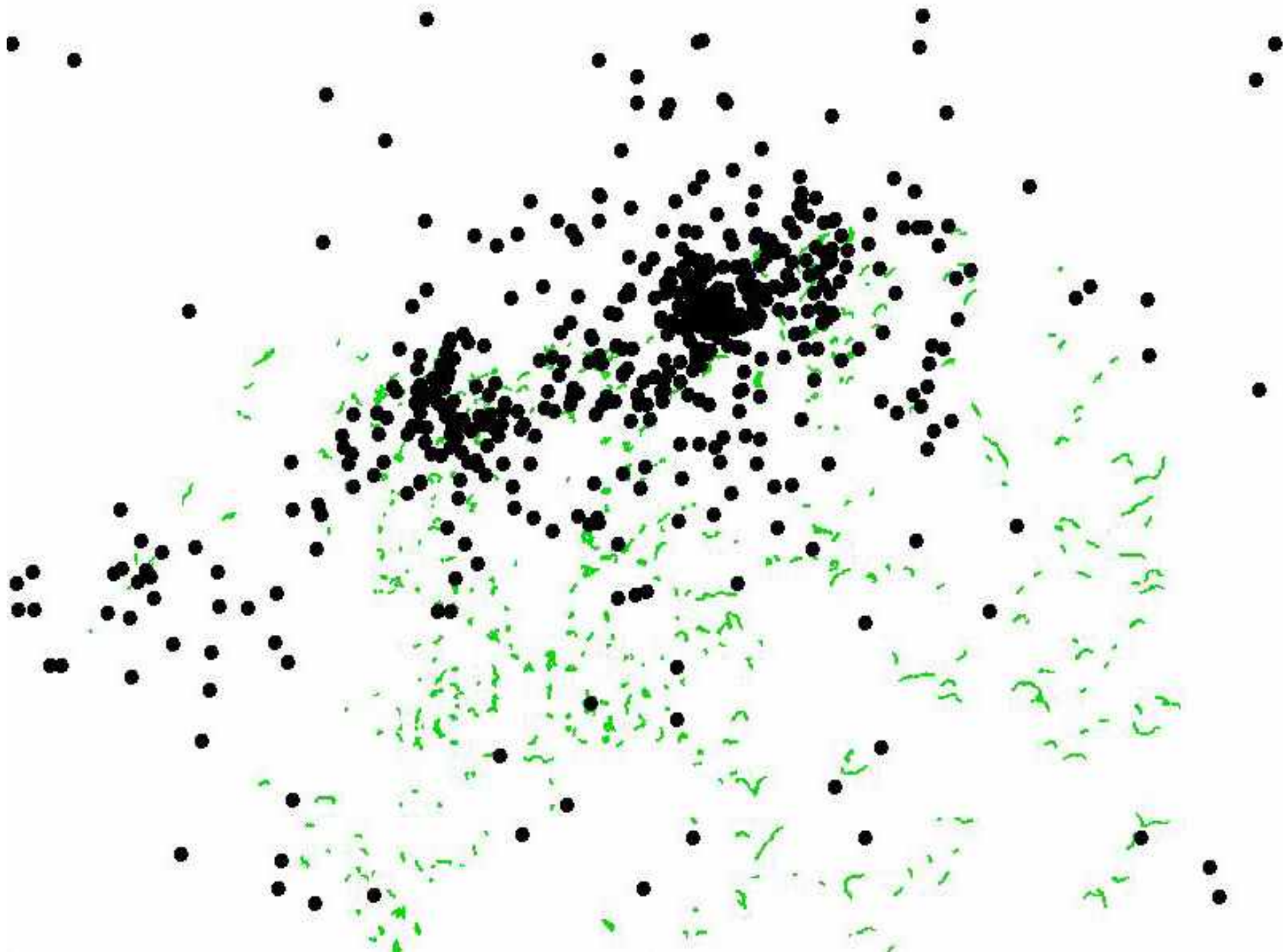
**Rippled Sand =
66.9%** 

**Sparse Live
Bottom = 24.8%** 

Flat Sand = 7.7% 

**Dense Live
Bottom = 0.60%** 

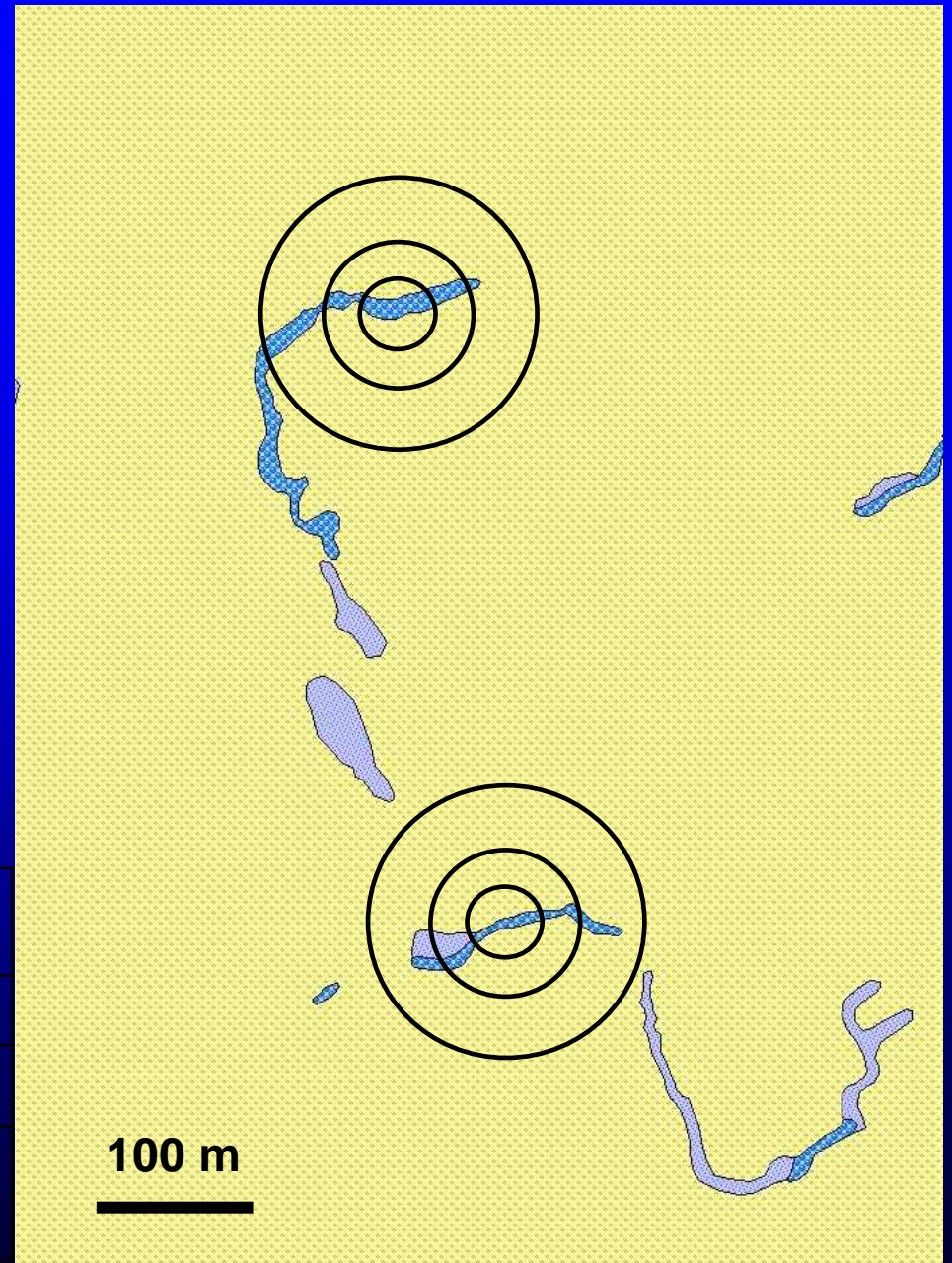
**Total Area =
59.76 km²**



Next Steps...

- Publish or perish!
- Automate mapping
- Bio-geographic coupling
- Continue groundtruthing
- Change analysis
- Continue mapping areas

	Current Study	Hunt 1974 Parker et al 1994	Hopkinson et al 1991 citing GA DNR
Sand	74.6%	18%	53%
Some colonization /live bottom	24.8%	58%	13%
Dense or moderate colonization/ledge habitat	0.6%	24%	34%



Other Considerations...

Pros

- 1) We can use the product to monitor cumulative effects over time
- 2) Has allowed us to develop a tool to analyze (optimize) the placement of a research area within the sanctuary
- 3) Will serve as a baseline for comparison of dynamic habitat distribution over time

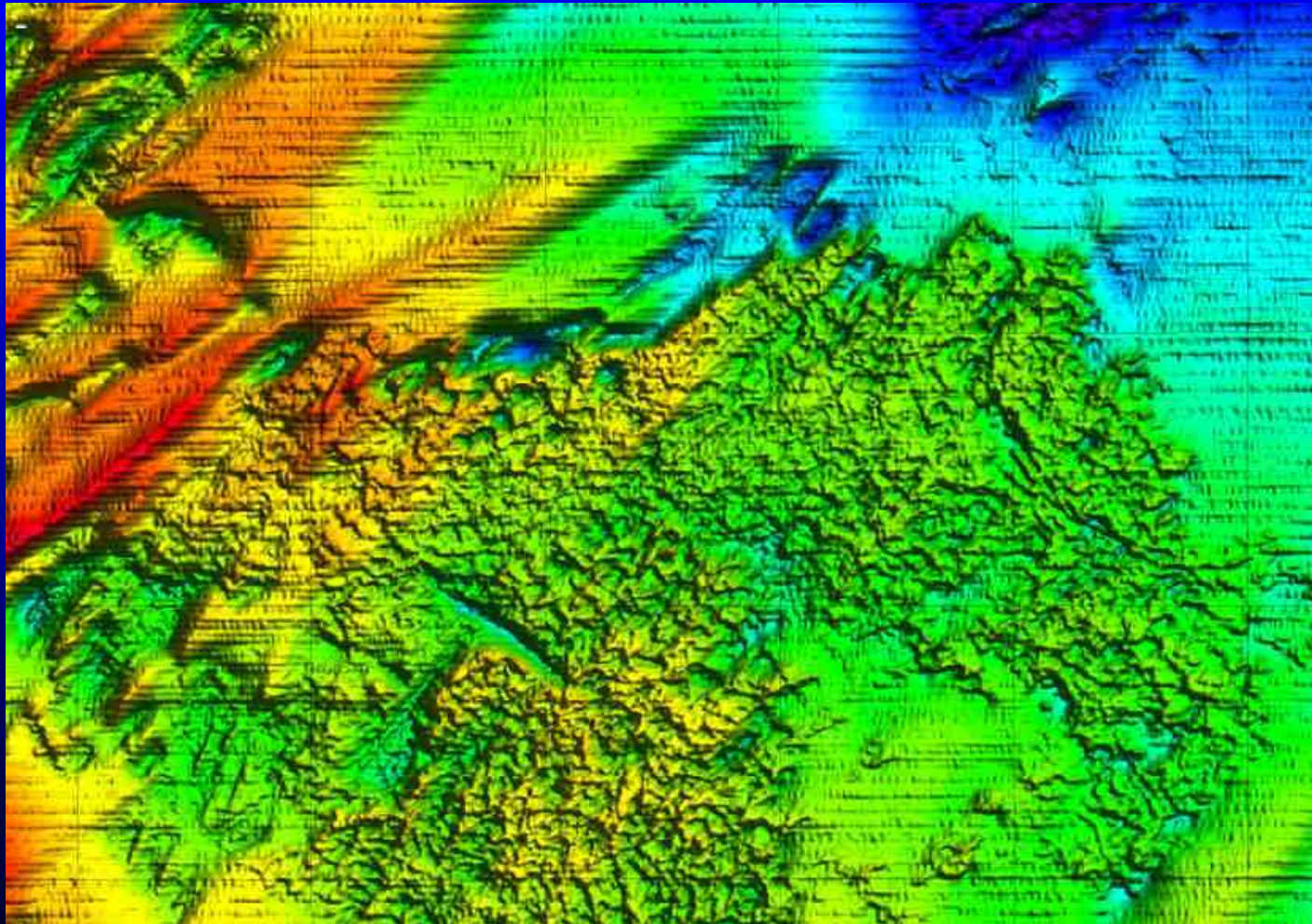
Cons

- 1) While the map tells you what geology is there, it does not tell you what biology is there
- 2) The map is accurate enough to allow for further exploitation of areas that are not traditionally fished





It's All About the Habitat!!!!!!





Acknowledgements



Staff of Gray's Reef National Marine Sanctuary

Reed Bohne – Sanctuary Manager

Debbie Meeks – Program Assistant

Cathy Sakas – Education Coordinator

Becky Shortland – Planning Coordinator

Gail Krueger – Outreach Coordinator

Dr. Jim Sullivan – Regional Projects Coordinator

Lt. Keith Golden – NOAA Corps Officer

Sanctuary Advisory Council

www.graysreef.nos.noaa.gov