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High-resolution Seafloor Mapping and an Assessment of the Effectiveness of the Western Gulf of Maine Closure Area (WGOMCA)

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High Resolution Seafloor Mapping and an Assessment of the Effectiveness of the Western Gulf of Maine Closure Area (WGOMCA)

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UNH: Andy Cooper, Hunt Howell, Larry Mayer, Andy Rosenberg
Fishermen: Pete Kendall, Craig Mavrikis, Jayson Driscoll, Mike Leary

THE UNIVERSITY OF NEW HAMPSHIRE 1866 1893 SCIENCE ARTS INDUSTRY 1923

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION NOAA U.S. DEPARTMENT OF COMMERCE

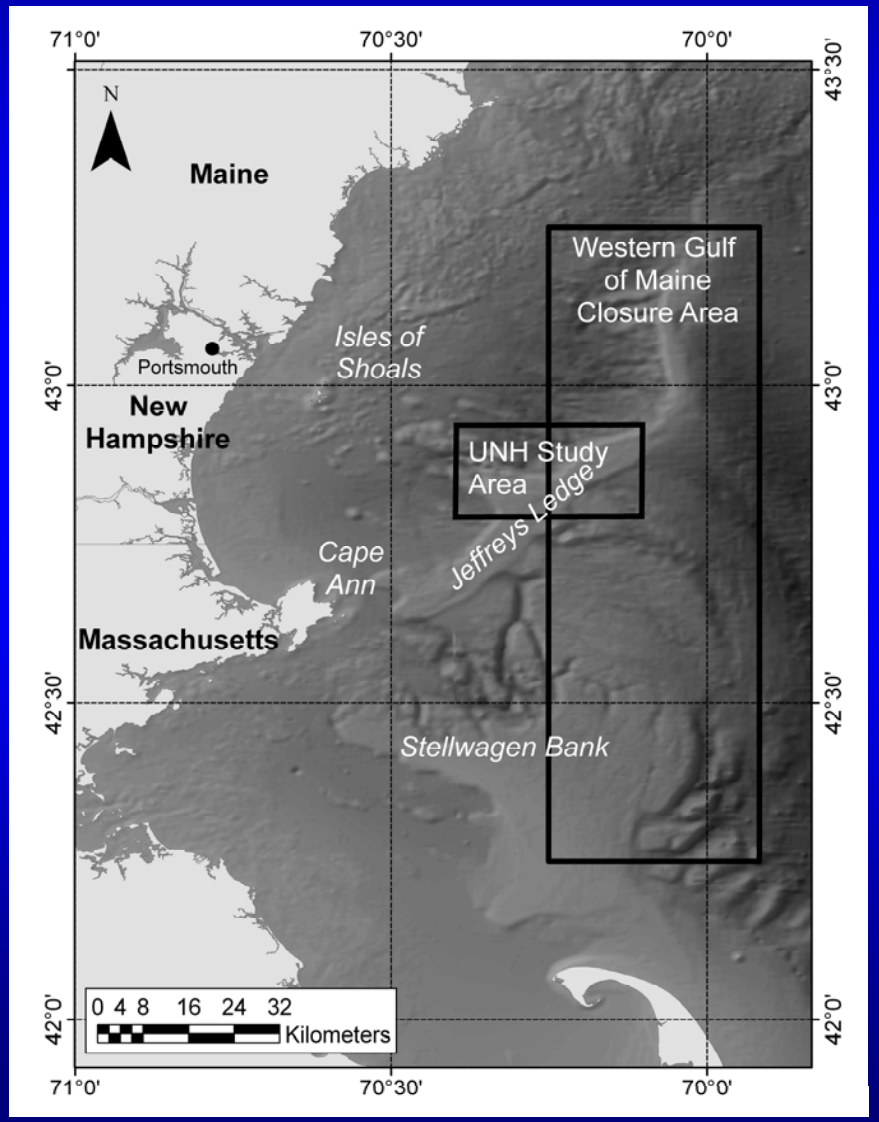
Northeast Consortium
The University of New Hampshire • Woods Hole Oceanographic Institution
The University of Maine • Massachusetts Institute of Technology

atlantic marine aquaculture center

Center for Coastal & Ocean Mapping Joint Hydrographic Center University of New Hampshire CCOM JHC

Objectives of Our Research Program

- Assess effects of WGOMCA (implemented in 1998) on Seafloor Habitats and Fish
- Mapping objectives
  - Quaternary Geology
  - Depositional Environment
  - Bottom Habitats
- Improve seafloor mapping technologies
- Understand species/habitat relationships



Presentation Overview

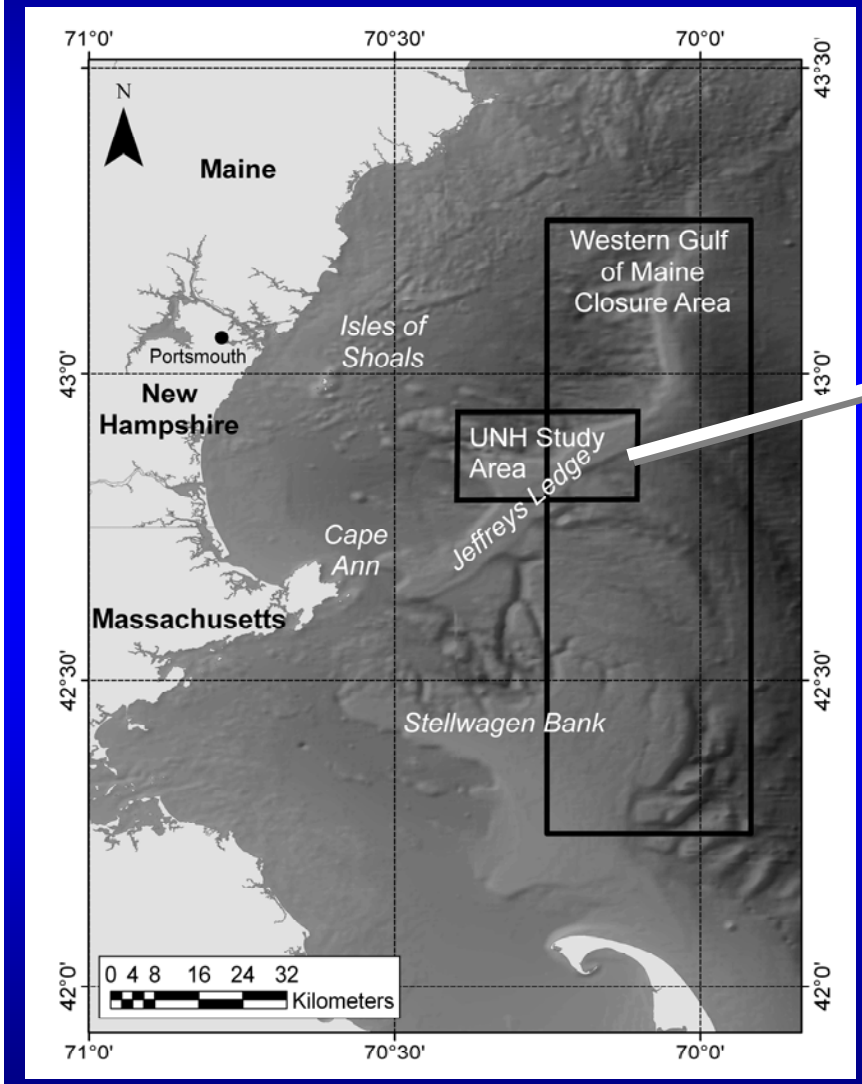
I. Seafloor mapping: multibeam, videography, extractive sampling

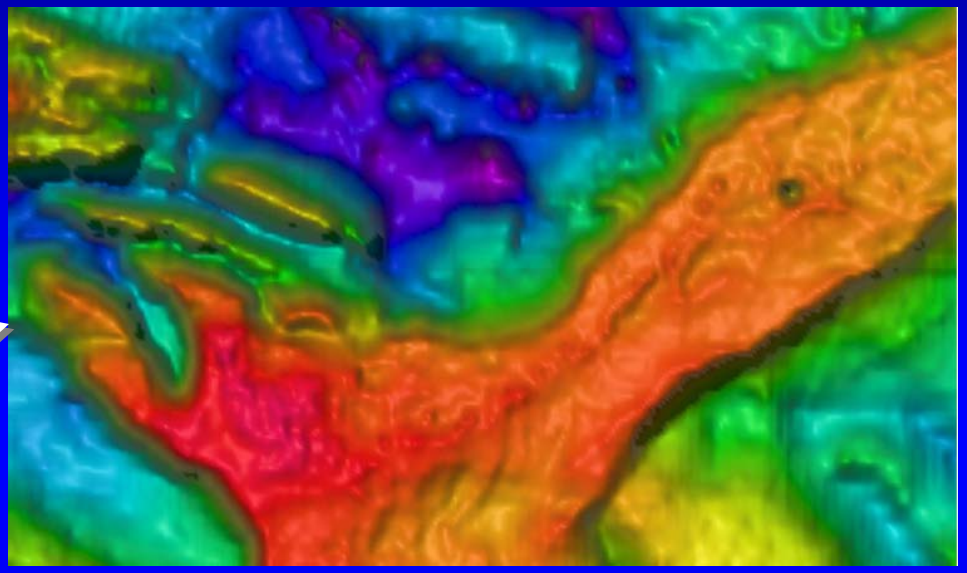
II. Benthic ecology: epifauna and infauna distribution patterns

III. Management: effects of WGOMCA on seafloor habitats and groundfish

I. Seafloor mapping: multibeam, videography, extractive sampling

High-Resolution Multibeam Survey





Why?

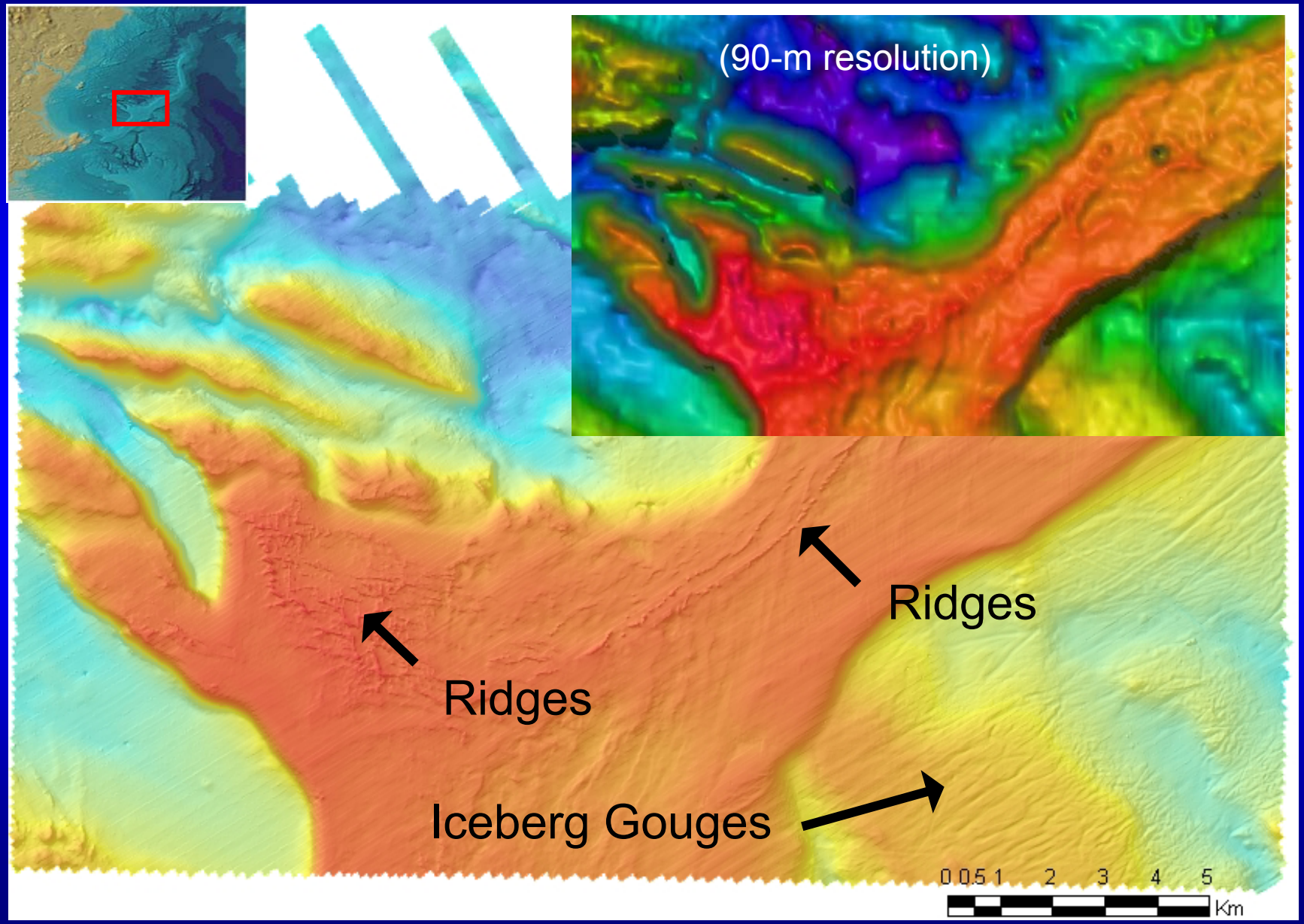
Best Resolution Available was at 90 m pixels

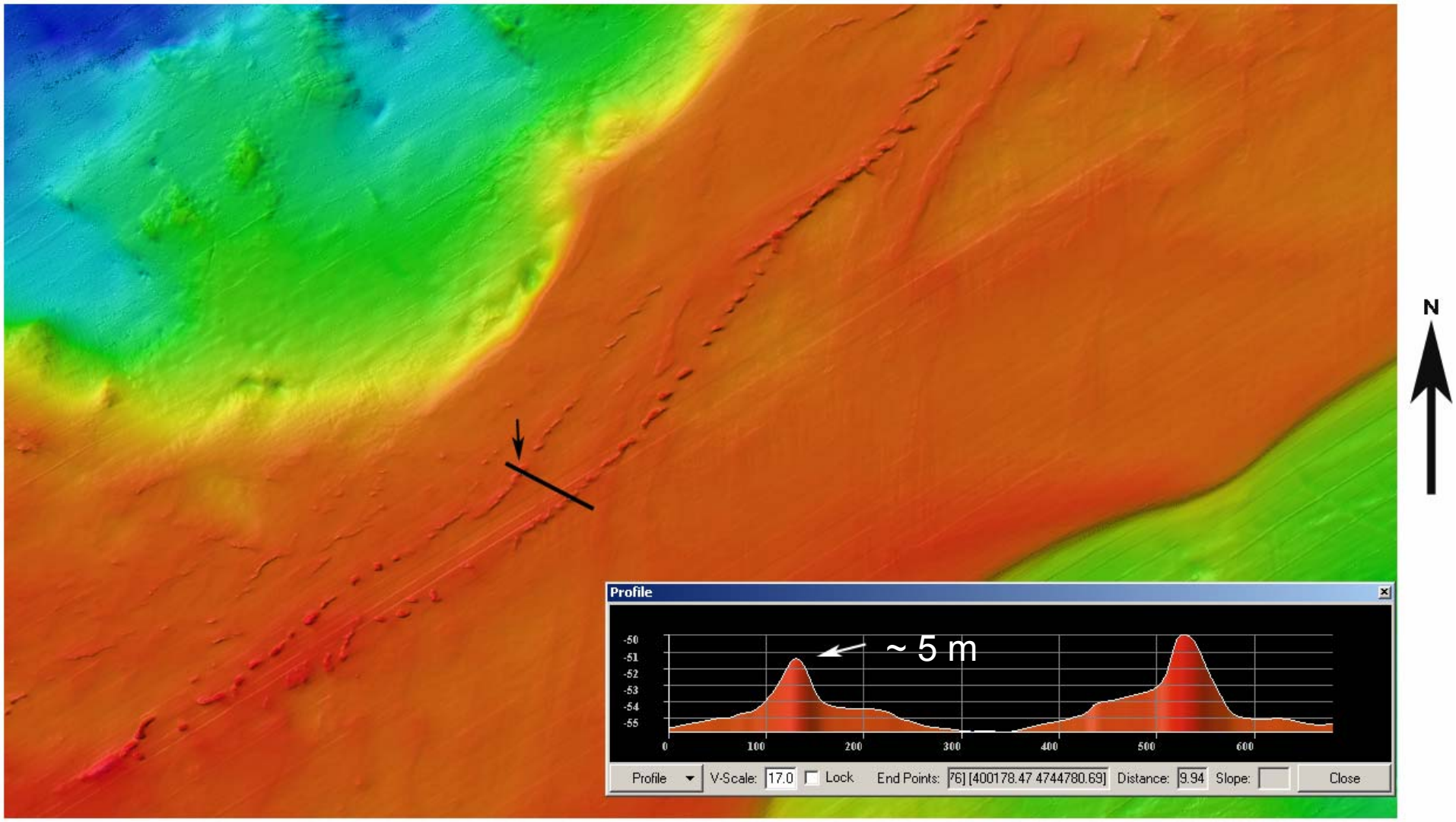
Not adequate for some applications

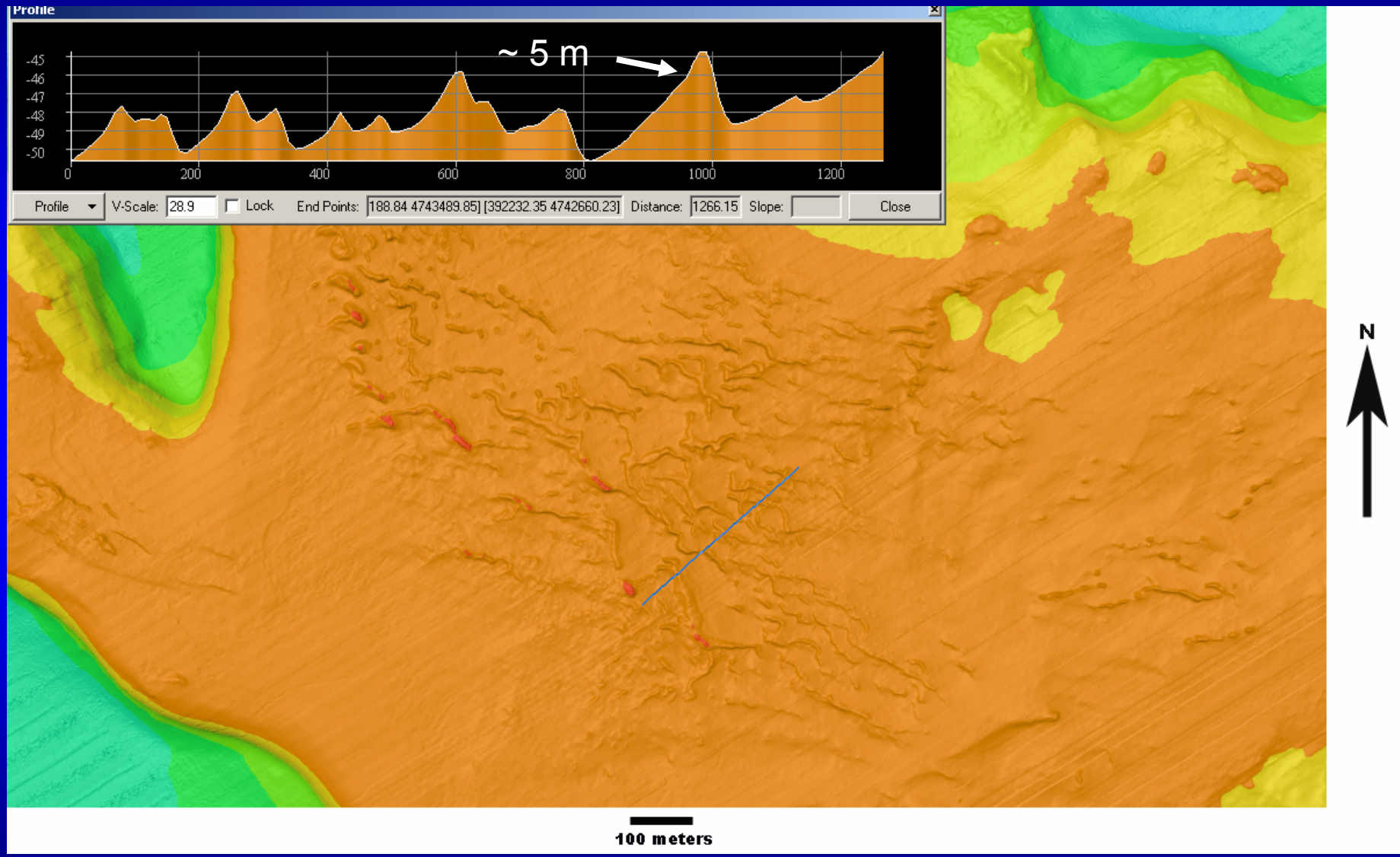
Multibeam Sonar Echo Sounder Survey

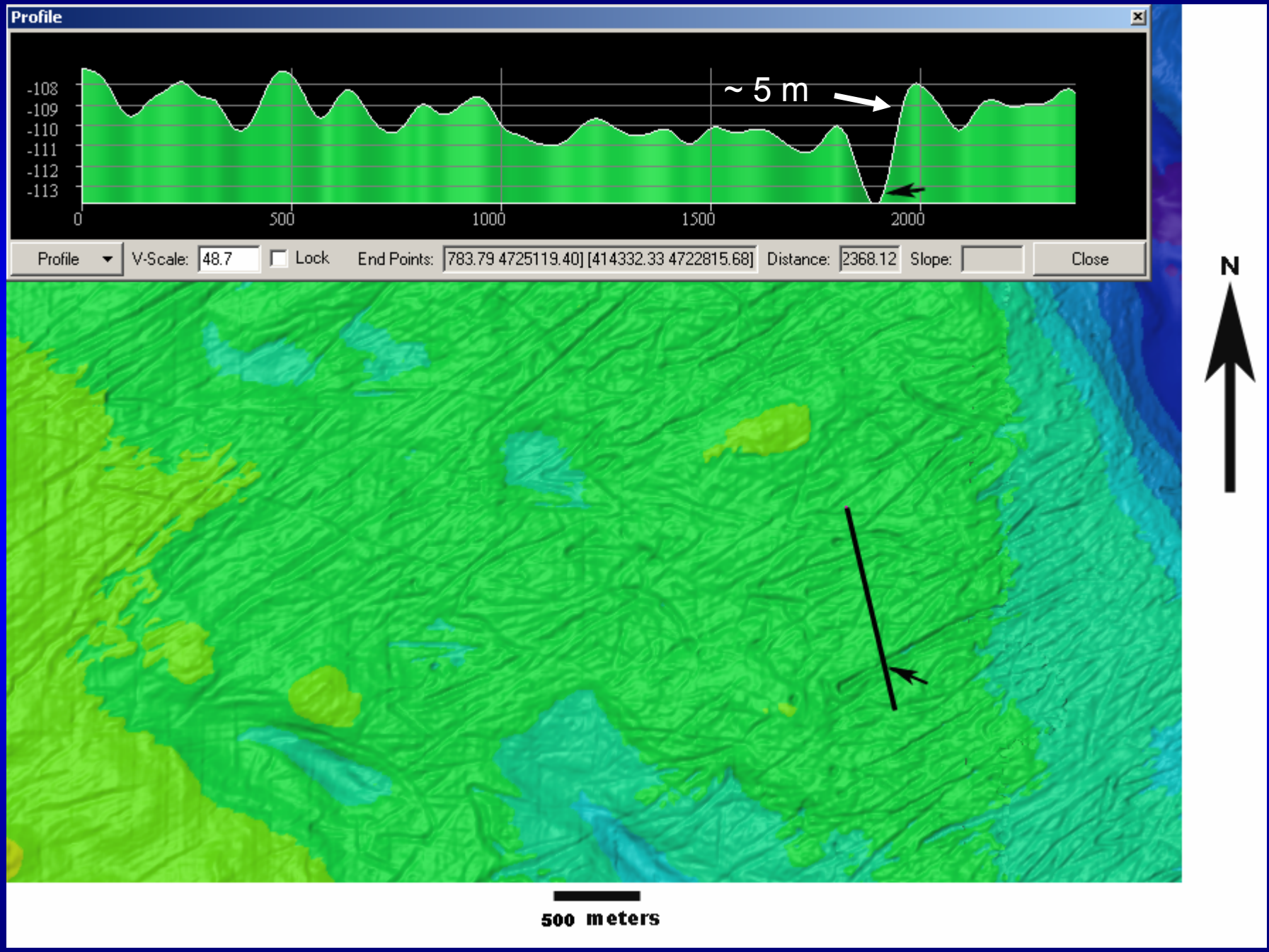
- SAIC survey
  - Reson 8101 (240 kHz) Dec 2002-Jan 2003 (23 km x 12 km)
  - Processed to yield 5-m pixel bathymetry
- NOAA (*Thomas Jefferson*) / UNH survey
  - Reson 8125 (455 kHz) Oct 2003 (3 km x 2km)
  - Processed to yield ~1-m pixel bathymetry

Examples of Morphologic Features Seen on 5-m Multibeam Survey




N
Profile
~ 5 m
-50
-51
-52
-53
-54
-55
0
100
200
300
400
500
600
Profile
V-Scale: 17.0
Lock
End Points: 76] [400178.47 4744780.69]
Distance: 9.94
Slope:
Close
100 meters

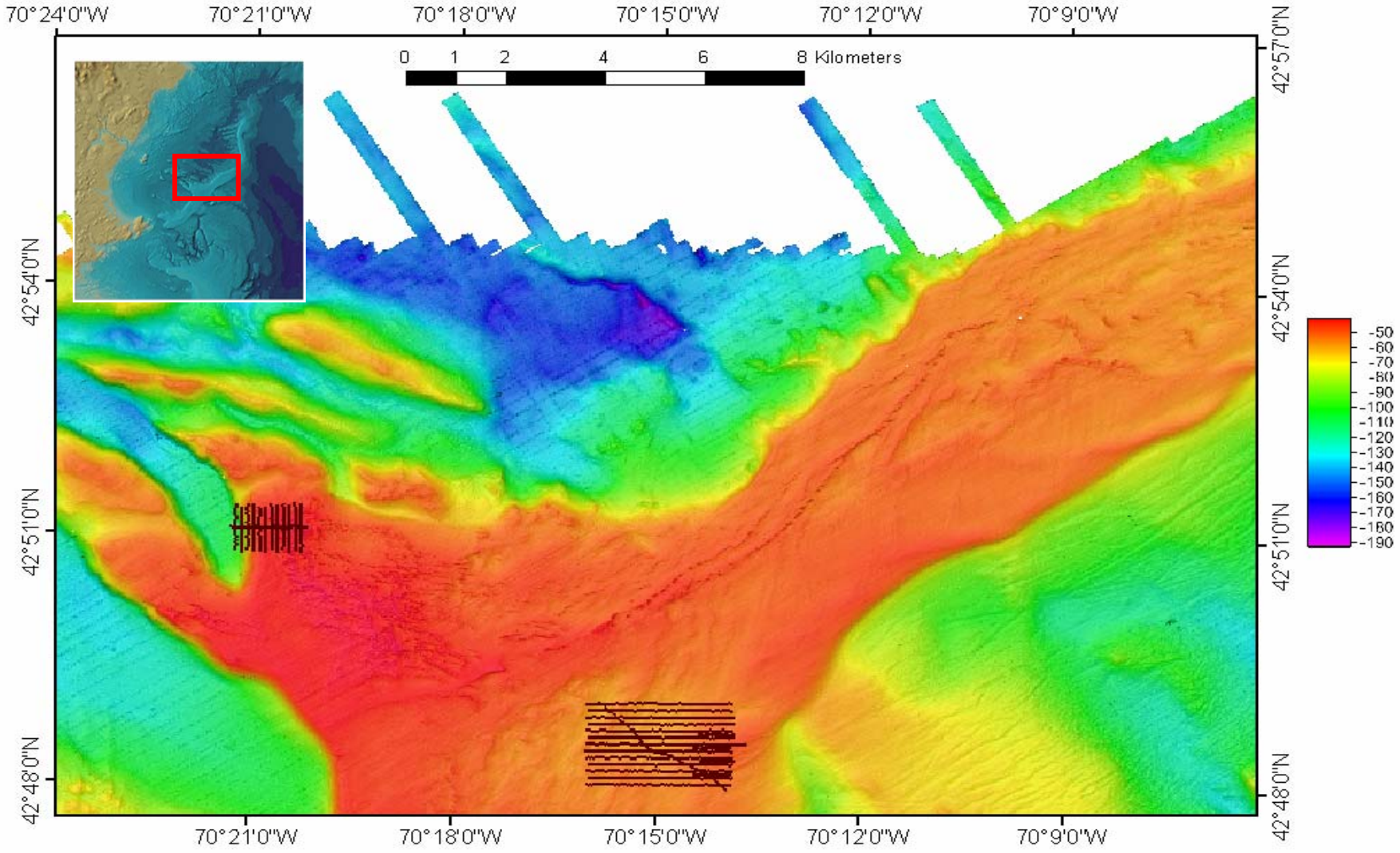

Profile
~ 5 m
-45
-46
-47
-48
-49
-50
0
200
400
600
800
1000
1200
Profile
V-Scale: 28.9
Lock
End Points: 188.84 4743489.85] [392232.35 4742660.23]
Distance: 1266.15
Slope:
Close
N
100 meters


Profile
-108
-109
-110
-111
-112
-113
0
500
1000
1500
2000
~ 5 m
Profile
V-Scale:
48.7
Lock
End Points:
783.79 4725119.40] [414332.33 4722815.68]
Distance:
2368.12
Slope:
Close
N
500 meters

High-Resolution Multibeam Survey at 5 m Pixels - Summary

- Identified Numerous Morphologic Features
  - Ridges
    - Push Ridges?
    - Shoreline Features?
    - Large Scale Bedforms?
  - Ice Berg Scour Gouges
- However, Not Adequate for Identification of Anthropogenic Features
  - e.g., Dredge Marks
- Higher resolution needed?...

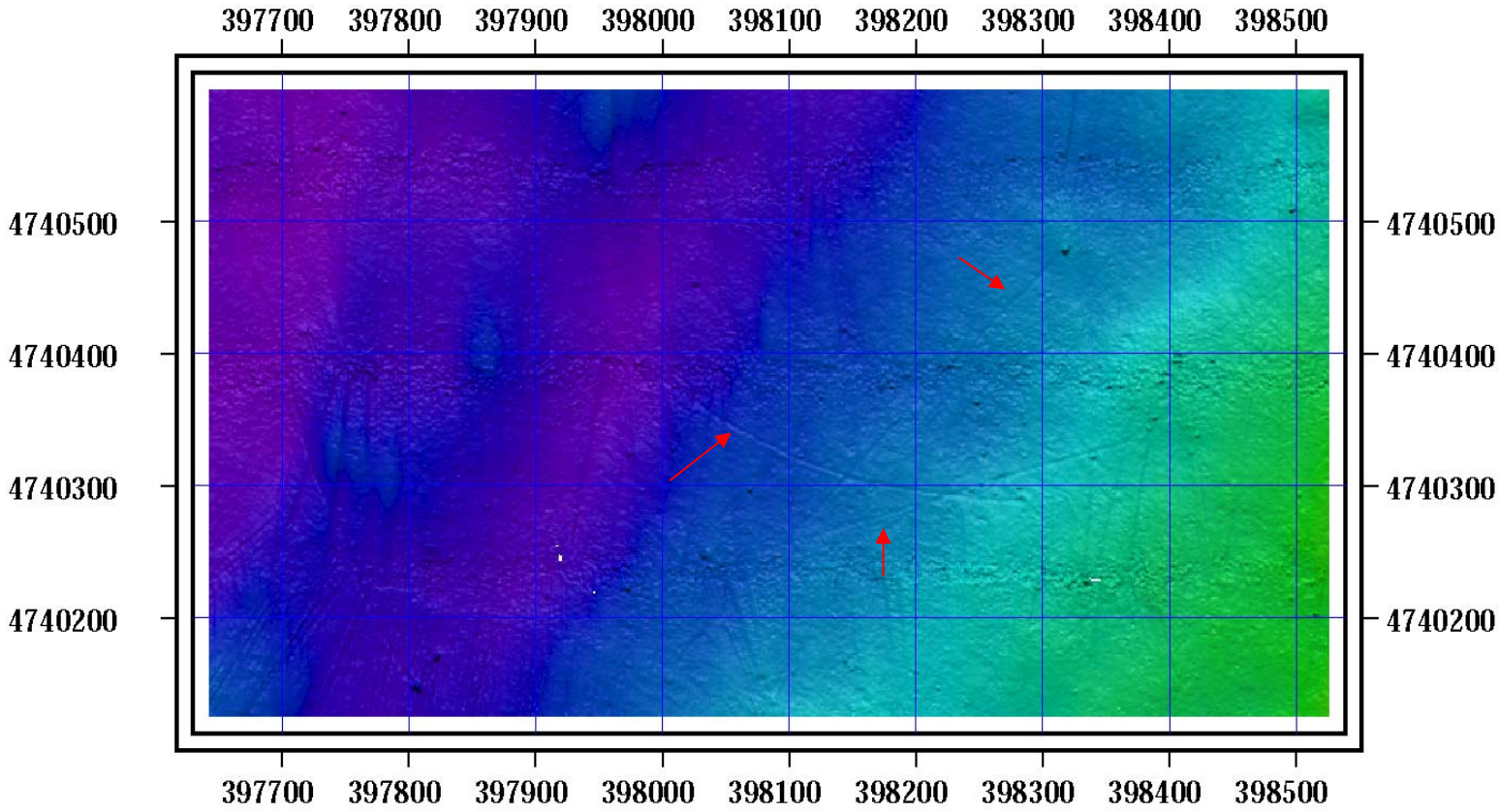
Reson 8125 MBES (455 kHz) survey areas



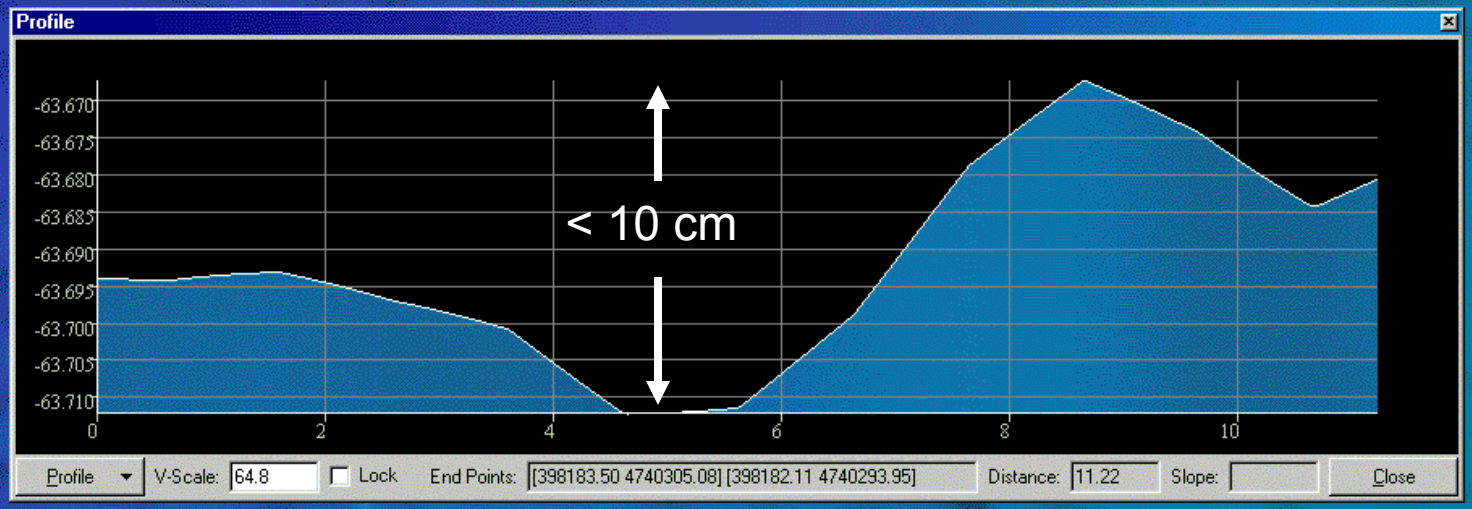
(Malik and Mayer 2007)

Jeffreys Ledge 8125 Survey

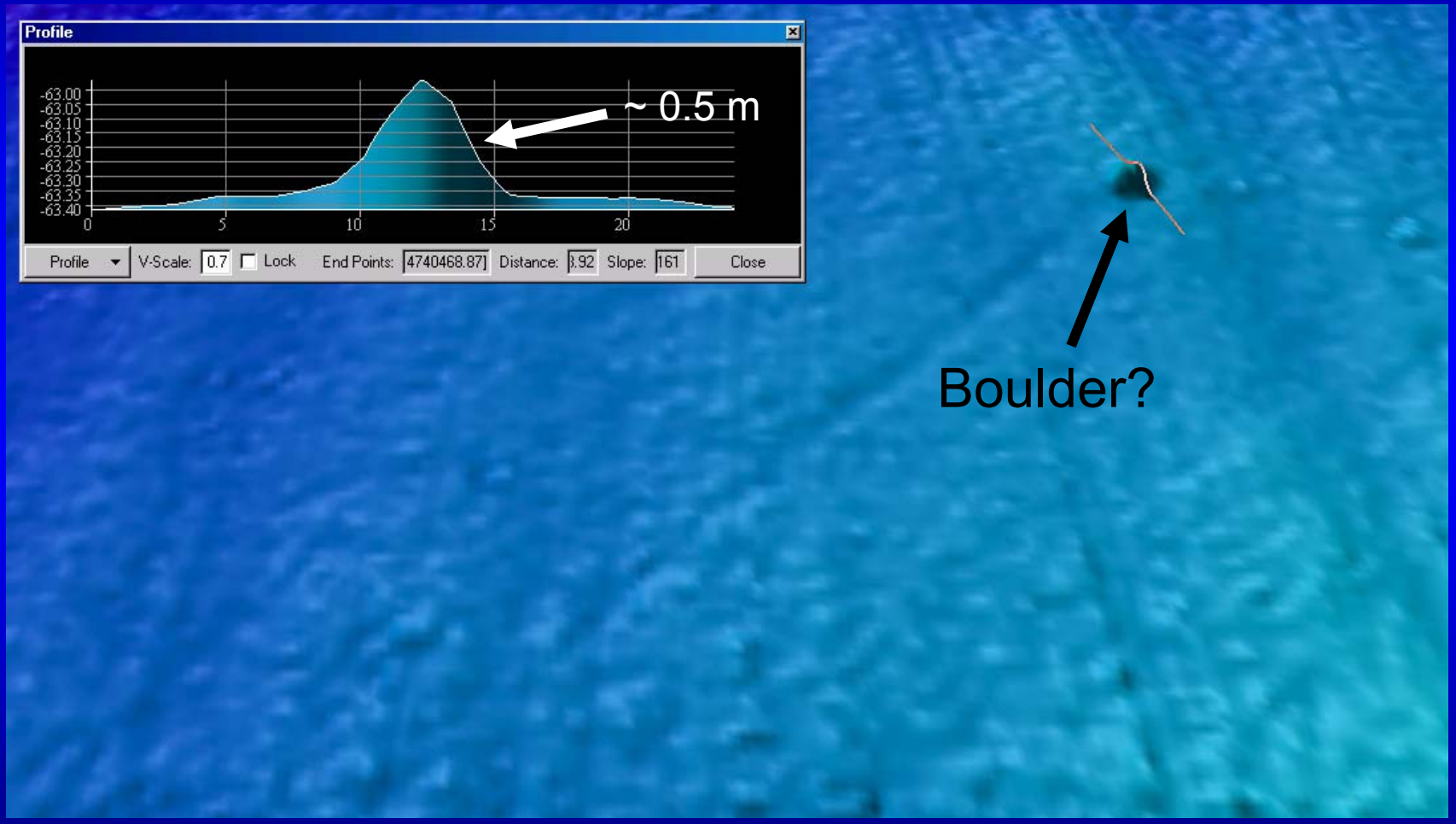
Projection UTM Zone 19

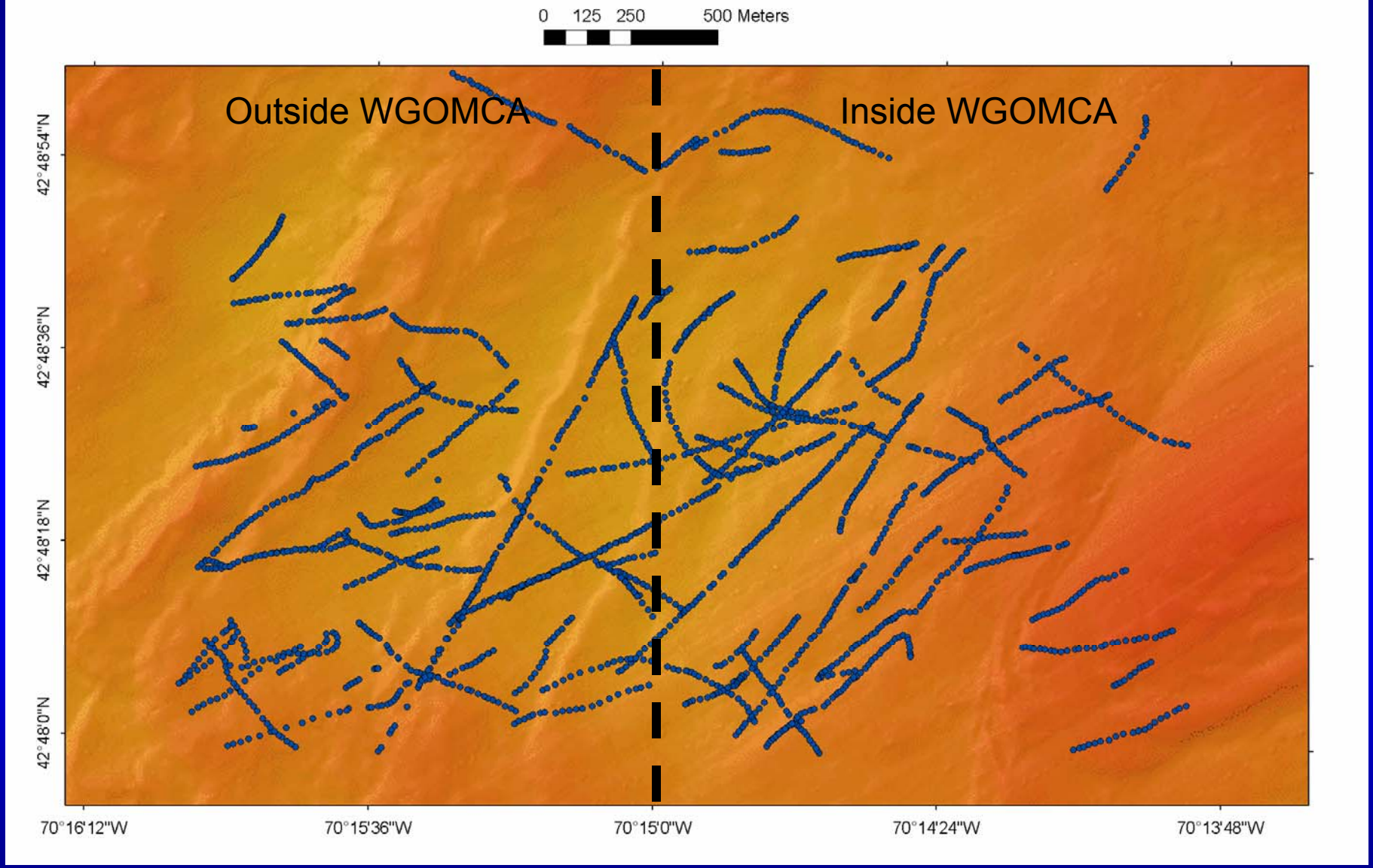


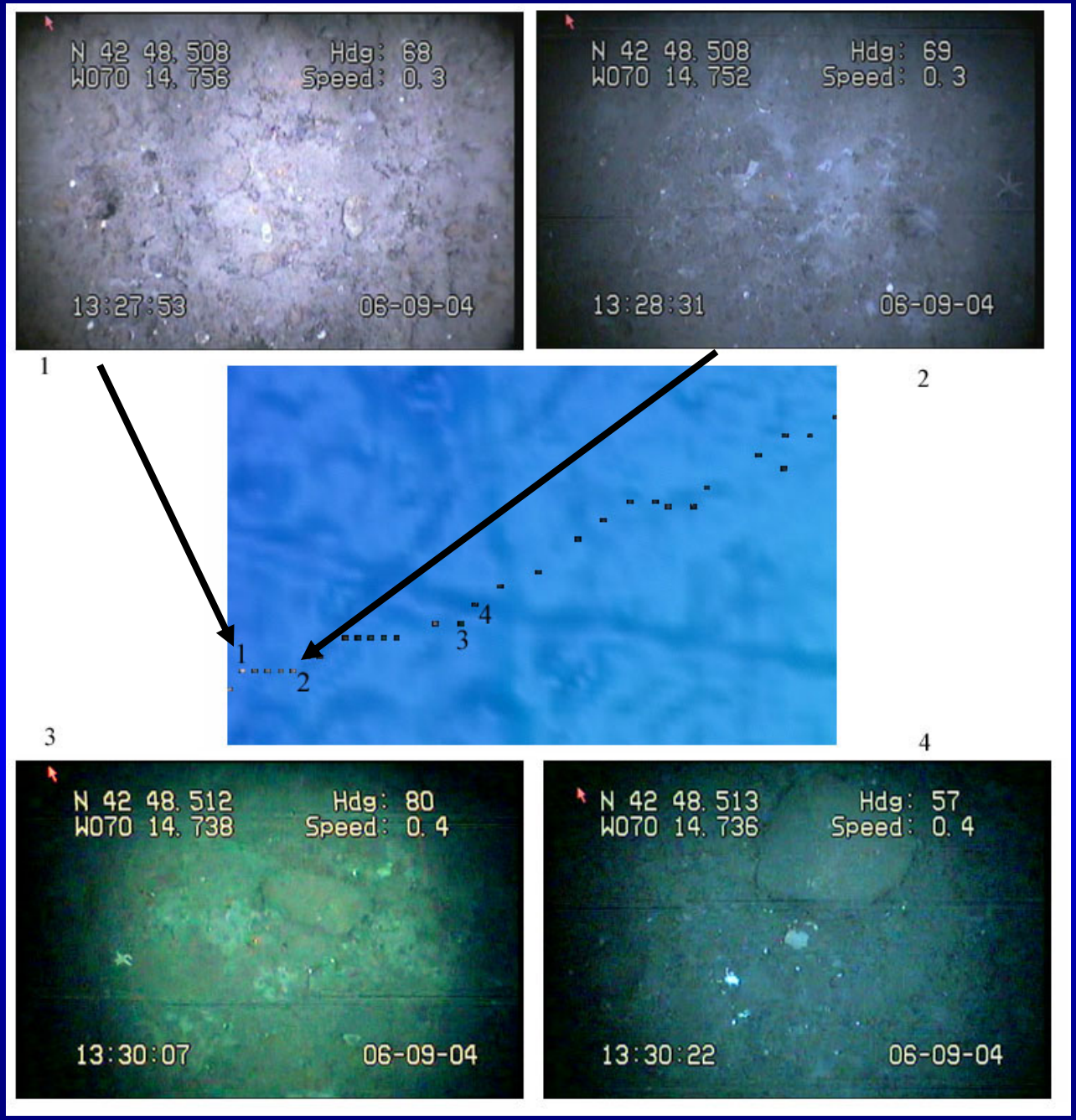
Reson 8125 MBES, October 2003



Reson 8125 MBES, October 2003




0 125 250 500 Meters
Outside WGOMCA
Inside WGOMCA
42°48'54"N
42°48'36"N
42°48'18"N
42°48'0"N
70°16'12"W
70°15'36"W
70°15'0"W
70°14'24"W
70°13'48"W



- No bottom marks detected in the video
- Bottom marks too old?

Sampling Methods for Benthos and Sediments

Epifauna

Hubbard Camera – towed video system with strobes, deployable to ~200 m water depth

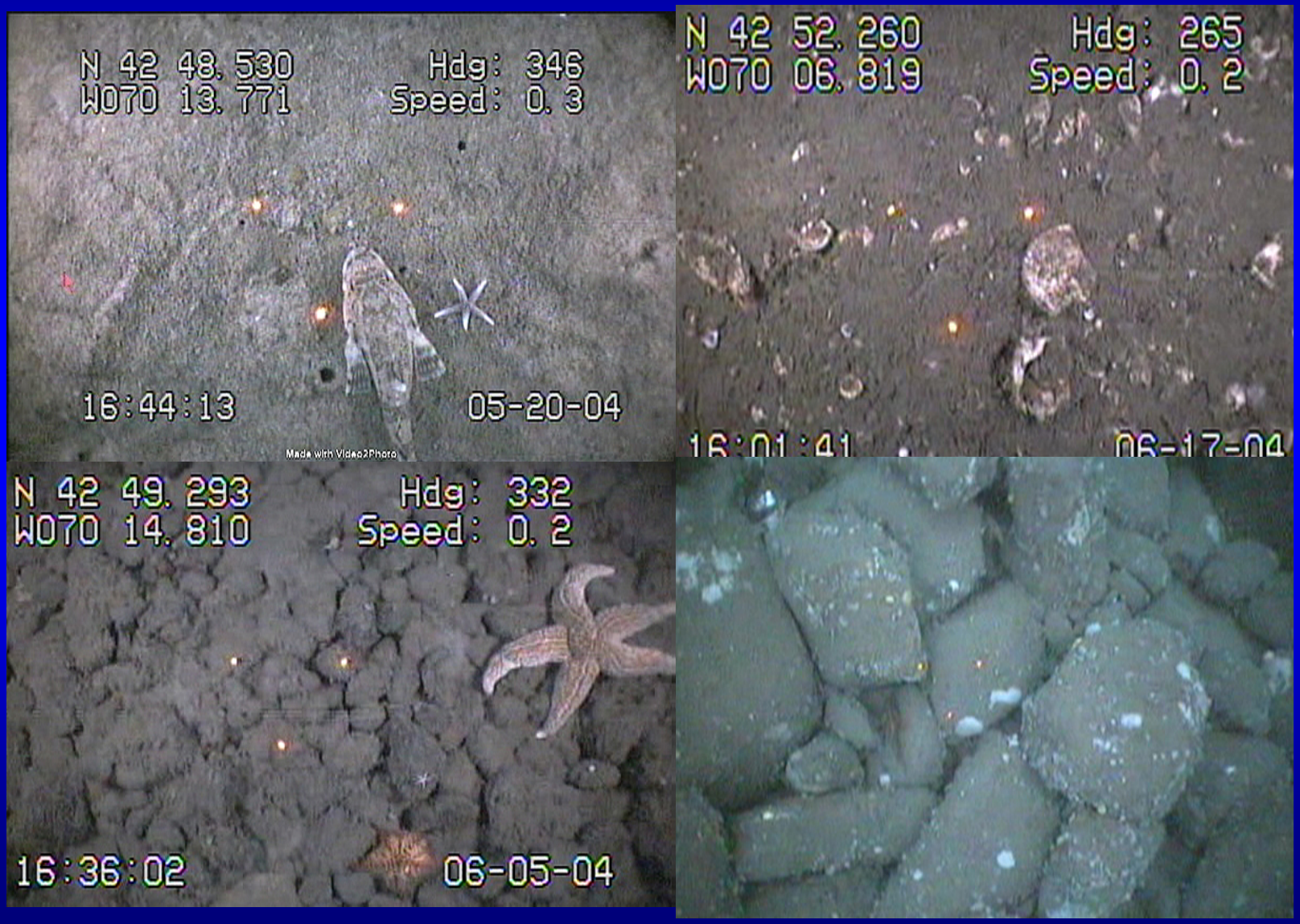
Infauna and Sediments

Wildco Box Corer, Shipek grab – effective soft-sediment sampling devices suitable for deployment on fishing vessels

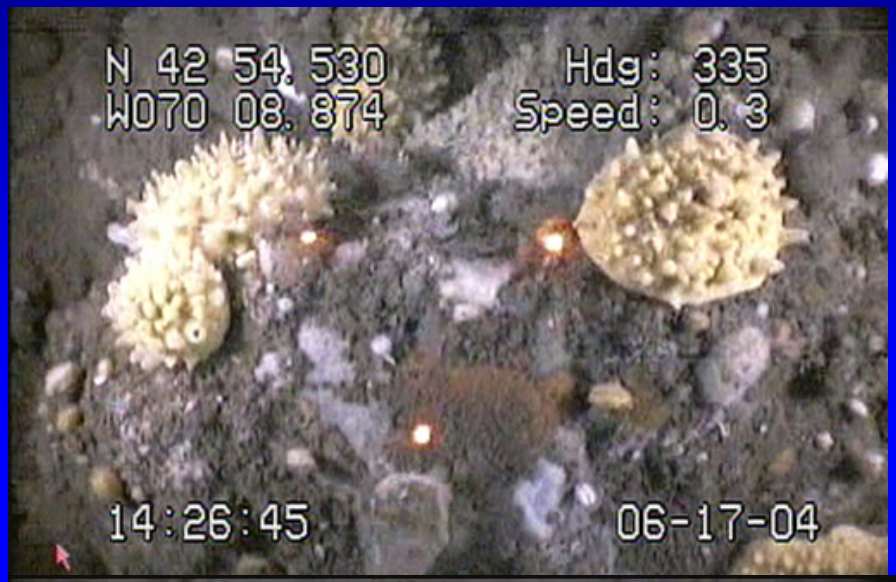
Bottom Videography Survey (UNH Hubbard Camera)

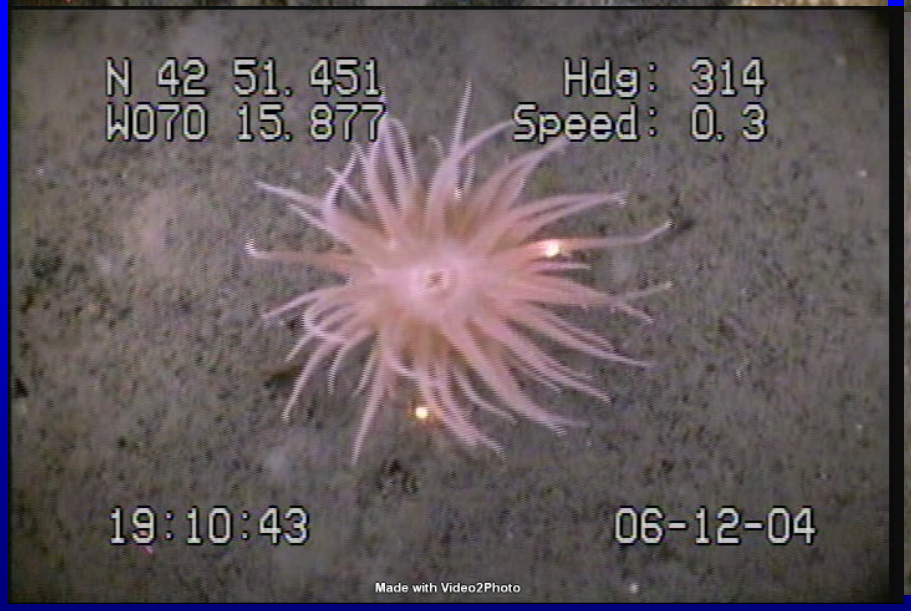
- Downward Looking Video
- Illumination with Synchronized Strobe Lights
- Lasers for Scale
- Hard Wired to Deck
  - Slip Ring Winch
- Electronic Controls and Recording Done Shipboard
- Video Stored on Tape and Hard Drive
- Simultaneously Records Video, GPS, and Cable Out

Examples of Bottom Types



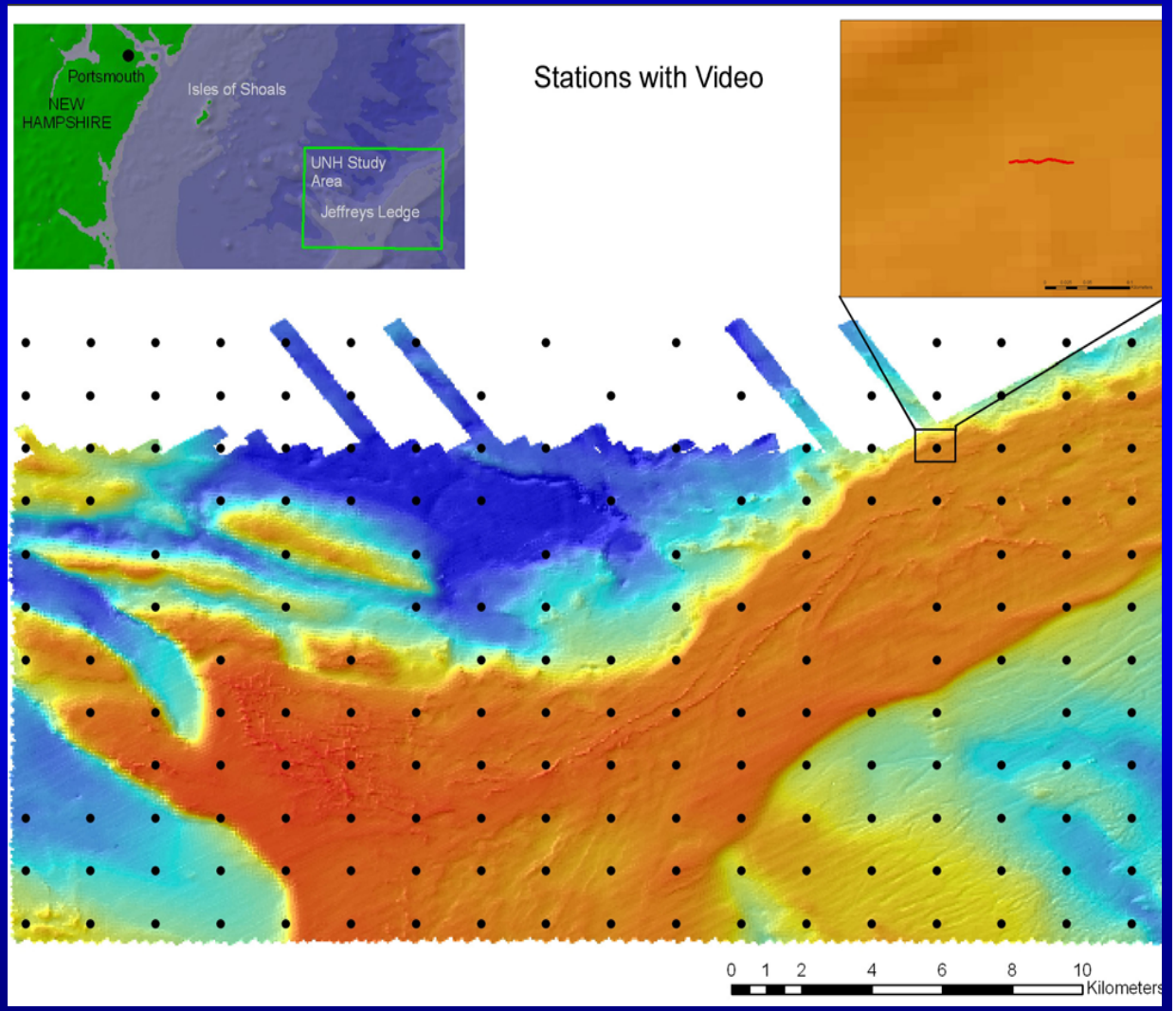
Examples of Organisms





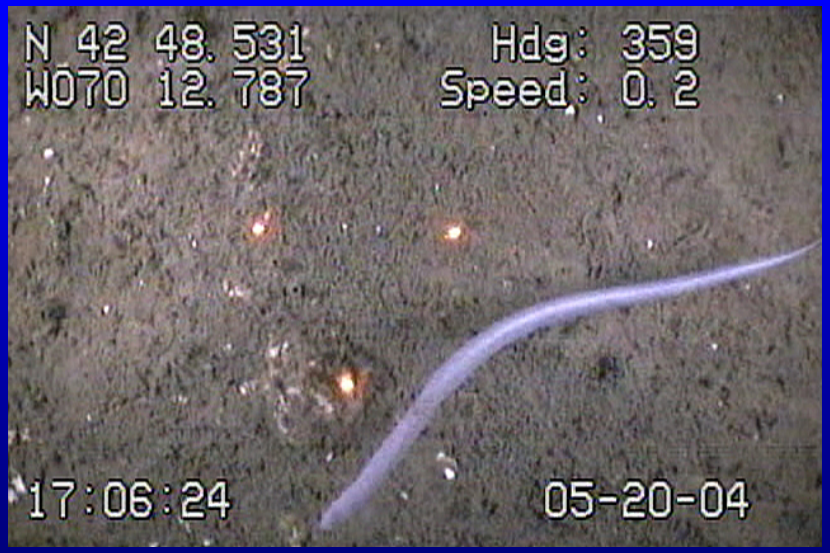
Video and Bottom Sampling Stations

- Obtained some combination of video and bottom samples at 186 Stations
- Targets Located at ~1 nm Spacing
- Each Station Had ~5 to 10 minutes Recorded Video



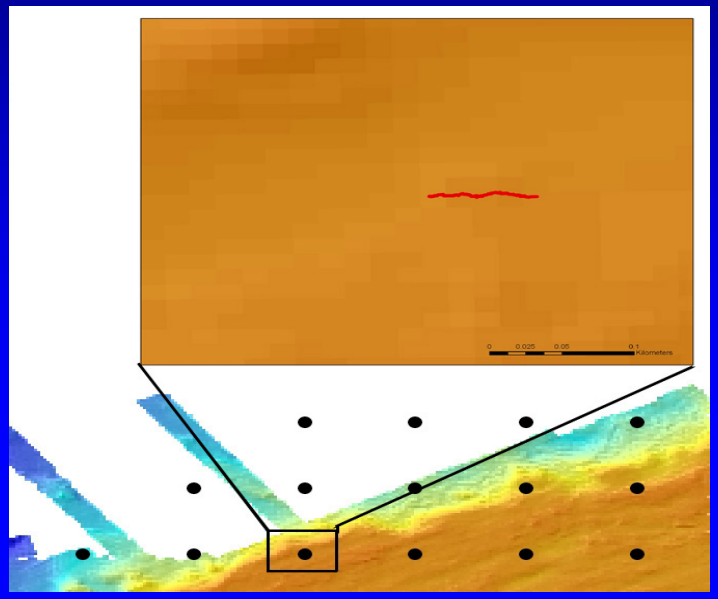
Quantitative Analyses of Video

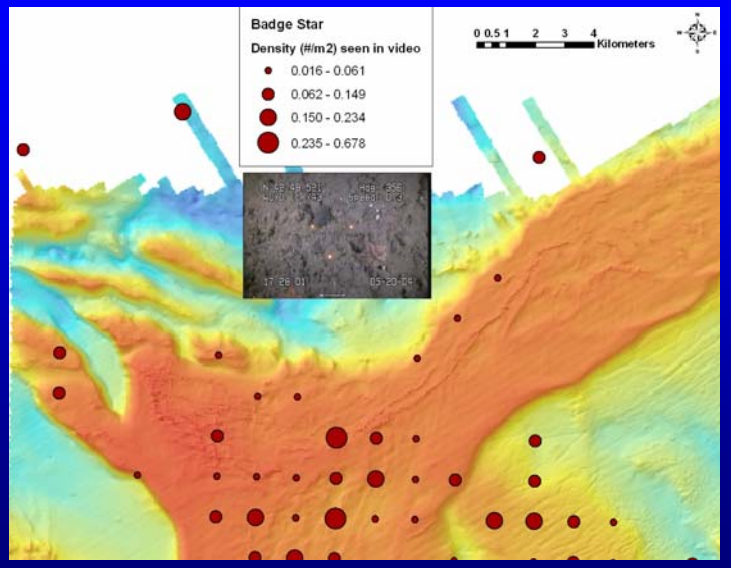
- Video Recorded on Ship via Magnetic Tape
- Downloaded in Lab to Computer (.avi files)
- Subsampled to 1 frame per second
- Frames Merged with GPS



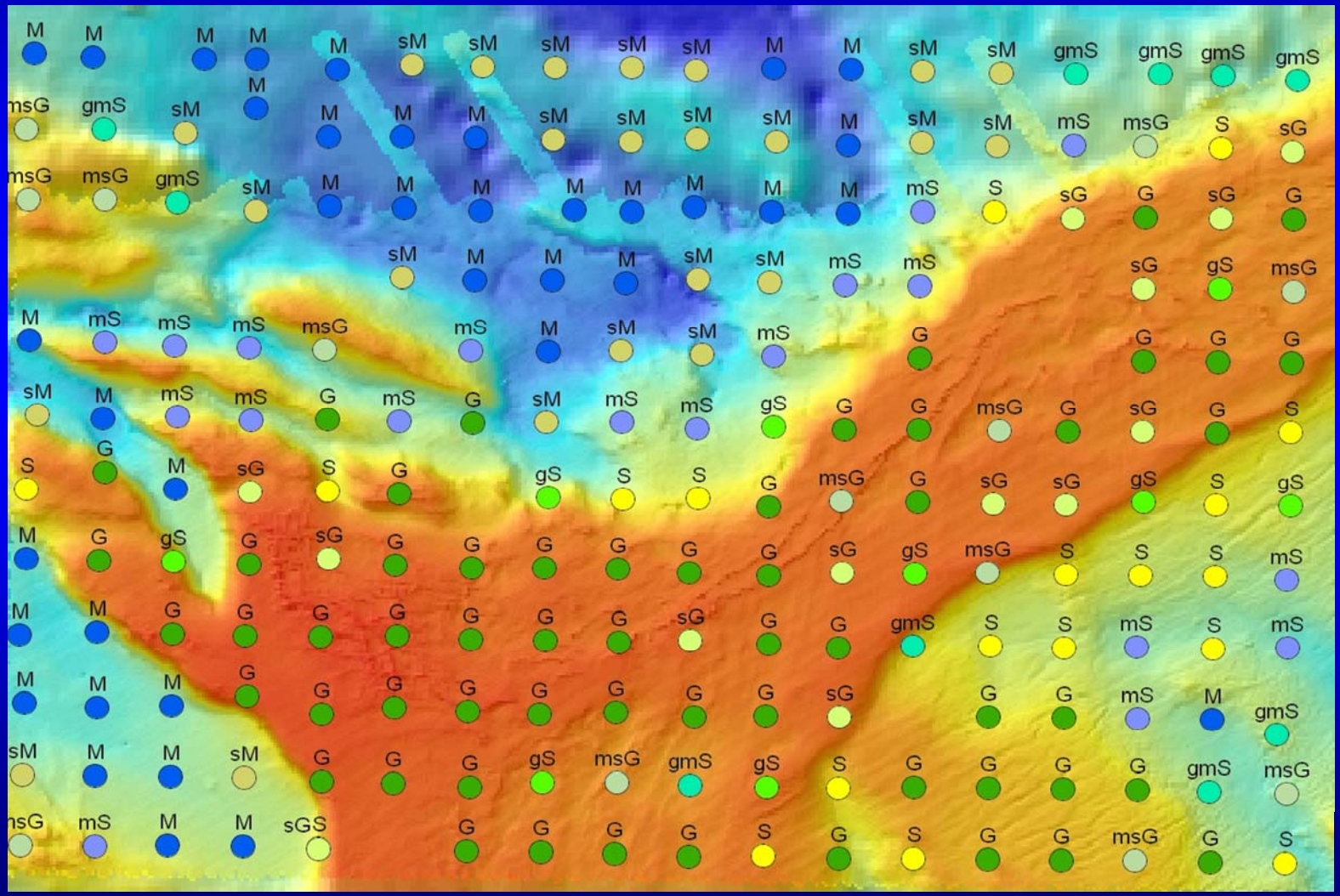
Quantitative Analyses of Video

- Clip Video to ≤ 50 m Bottom Distance
- Analyze All Visible Scenes
- Create Spreadsheet with Counts
- Display in GIS

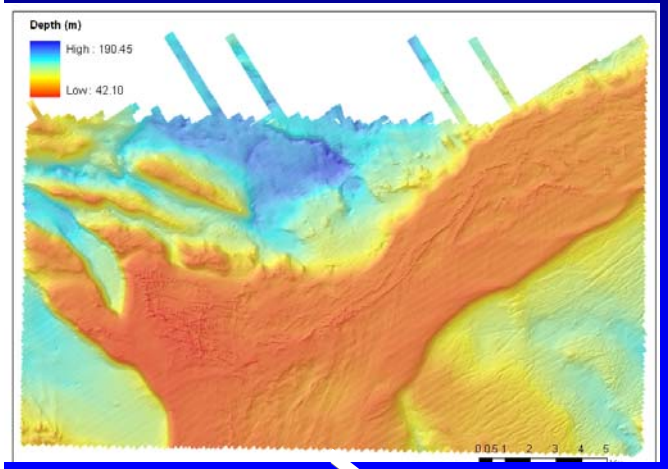


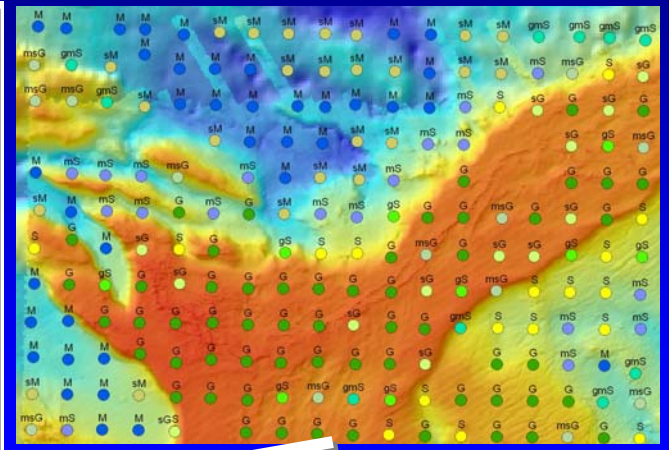


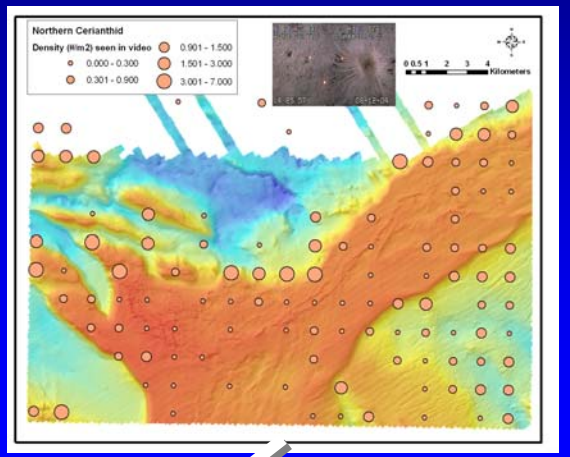
Bottom Sediment Classification Based on Grain Size Analysis Supplemented by Video

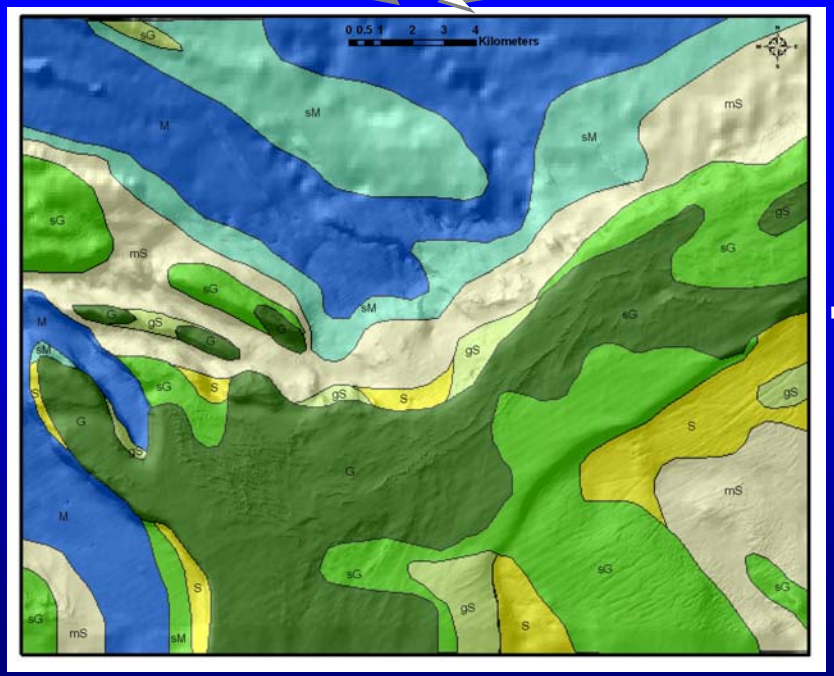


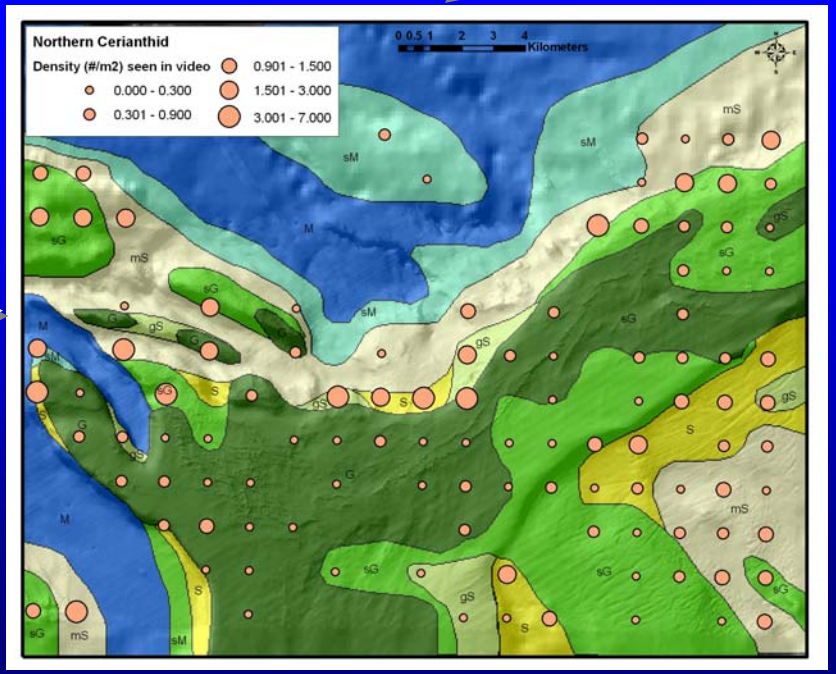
Seafloor Mapping Summary: Combining High-Resolution Bathymetric, Sediments, and Epifauna







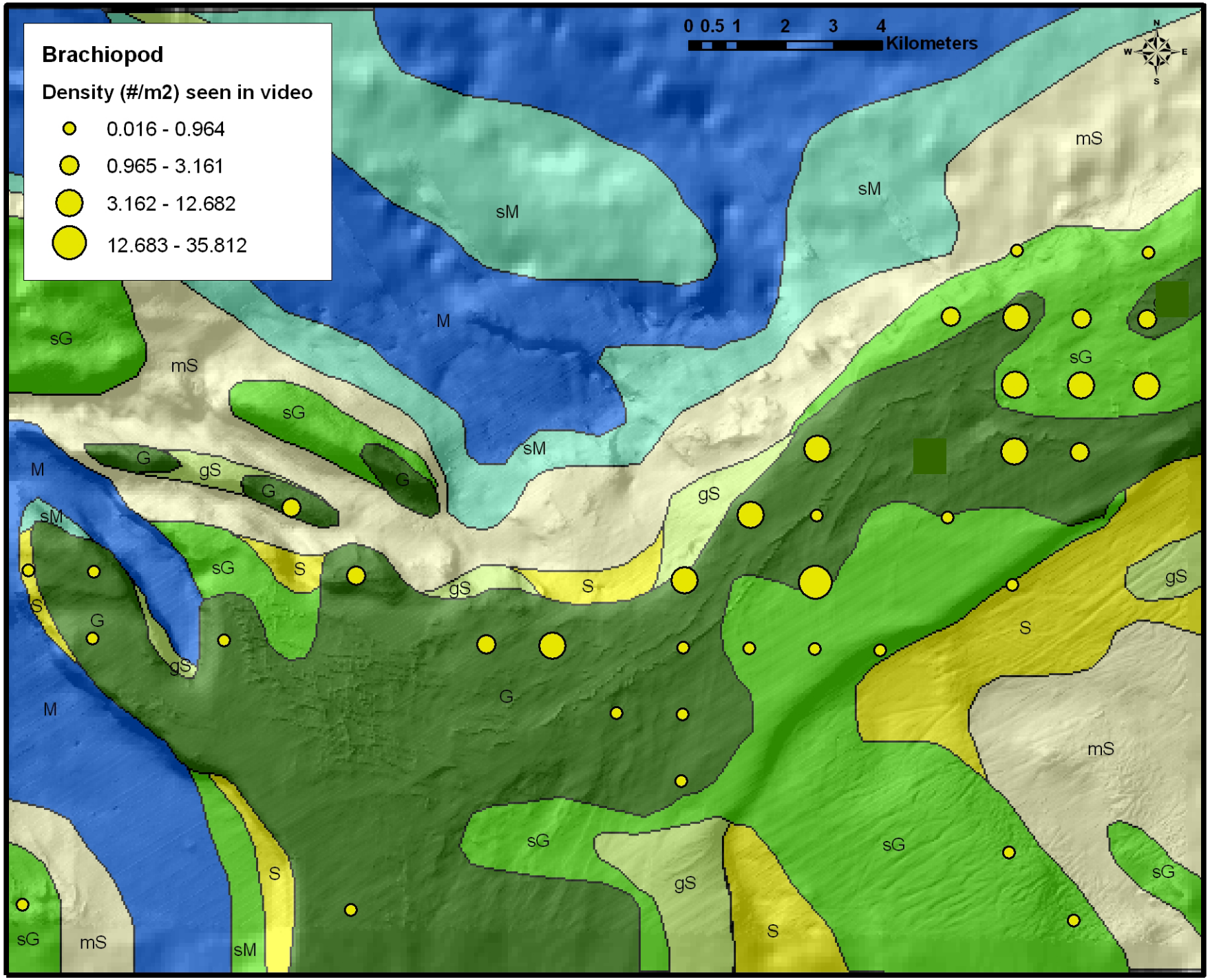


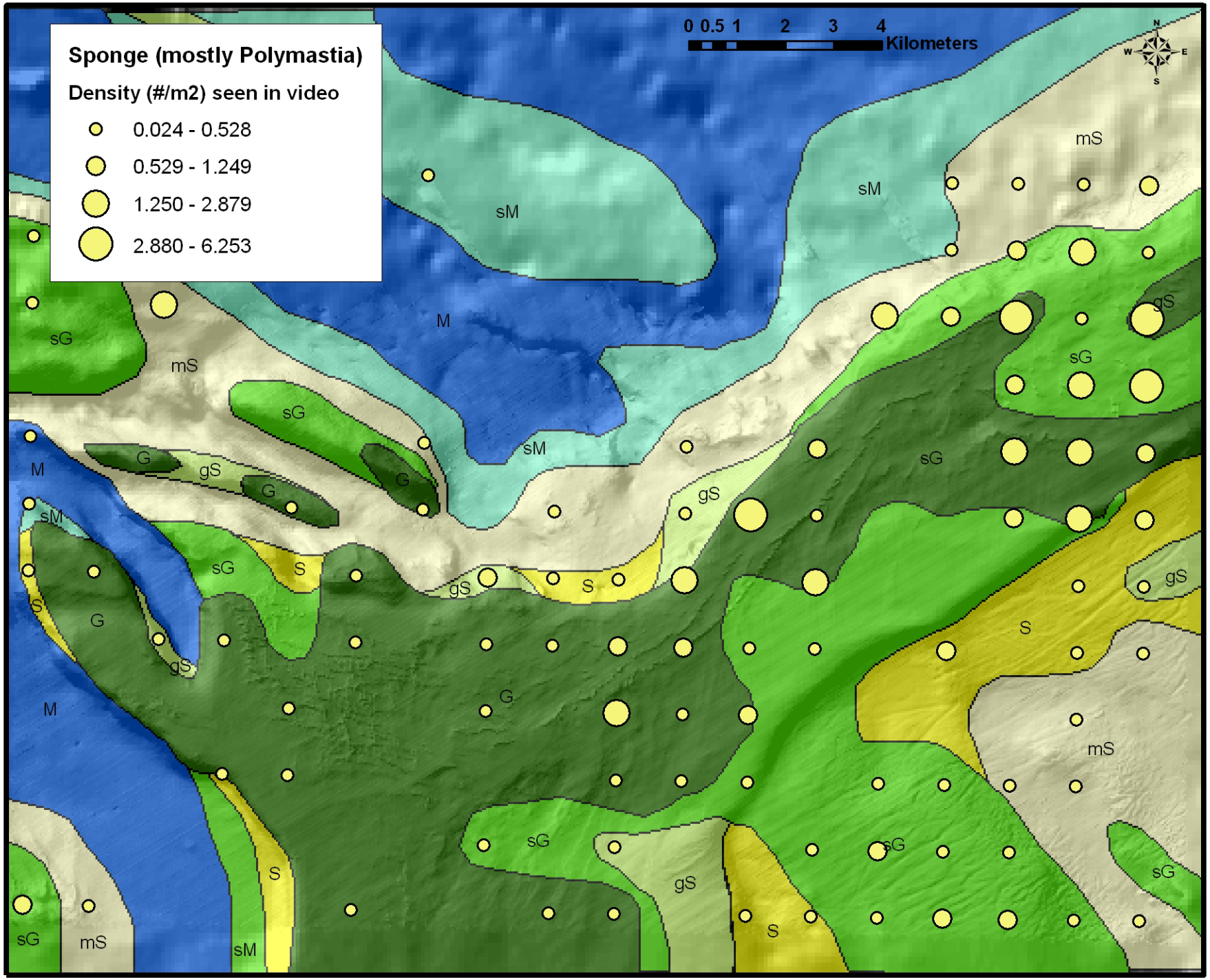


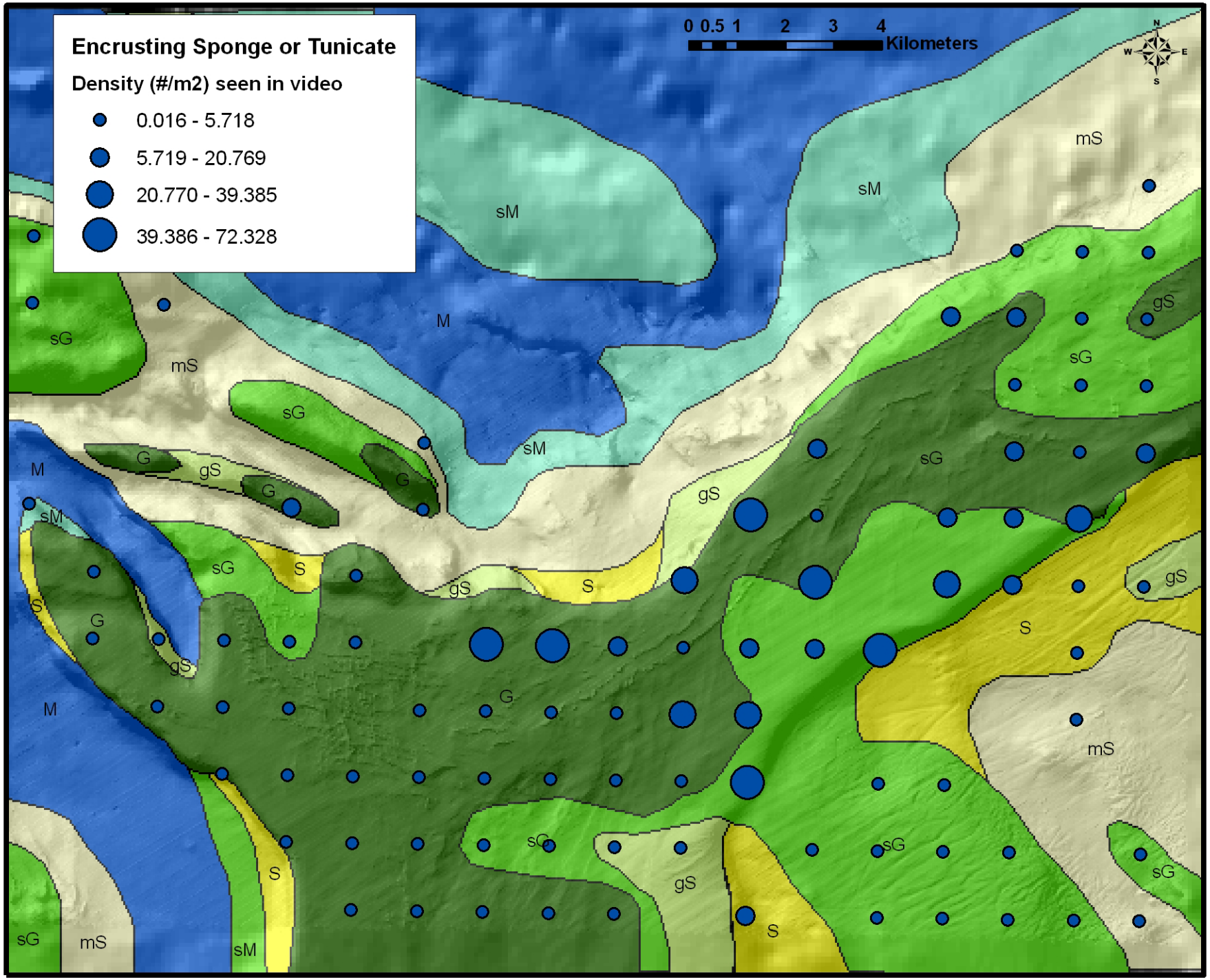
Seafloor Mapping Conclusions

- Integration of Multibeam, Video, and Sediment Sampling Provided:
  - High Resolution Seafloor Morphology Mapping
  - High Resolution Surficial Sediment Mapping
  - High Resolution Epifaunal Distribution Mapping
- Impact of Some Anthropogenic Effects Observable
  - Dredge Marks?
- Characterization of Habitat/Species Relations…

II. Benthic ecology: epifauna and infauna distribution patterns


Brachiopod
Density (#/m2) seen in video
0.016 - 0.964
0.965 - 3.161
3.162 - 12.682
12.683 - 35.812
0 0.5 1 2 3 4
Kilometers
N
W
E
S
sM
mS
M
sG
G
gS
S


Sponge (mostly Polymastia)
Density (#/m2) seen in video
0.024 - 0.528
0.529 - 1.249
1.250 - 2.879
2.880 - 6.253
0 0.5 1 2 3 4
Kilometers
N
W
E
S
M
sM
mS
sG
gS
G
S


Encrusting Sponge or Tunicate
Density (#/m2) seen in video
0.016 - 5.718
5.719 - 20.769
20.770 - 39.385
39.386 - 72.328
0 0.5 1 2 3 4
Kilometers
N
W
E
S
sM
mS
sM
M
sG
mS
sG
gS
sG
sM
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gS
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G
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sM
sG
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gS
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gS
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G
mS
sG
S
sG
gS
S
sG
sG
sG
S
mS
sM

III. Management: effects of WGOMCA on seafloor habitats and groundfish

- Effect on benthic communities (video, grab, corer)

(i.e., Is WGOMCA protecting habitat?)

- Effect on fish populations (gillnets in rocky areas only)

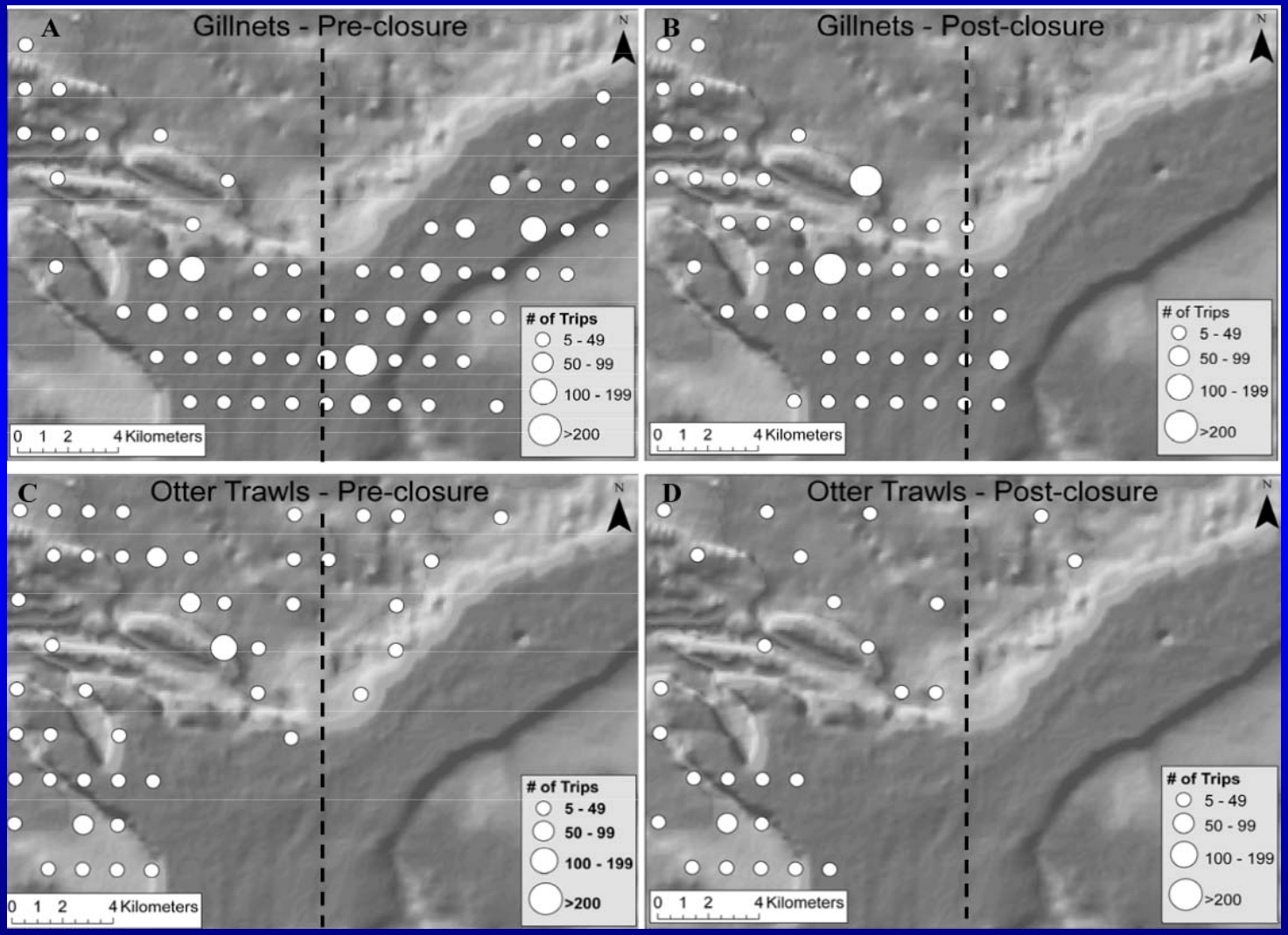
(i.e., Is WGOMCA contributing to recovery of groundfish populations?)

OVERALL STUDY DESIGN: Control / Impact

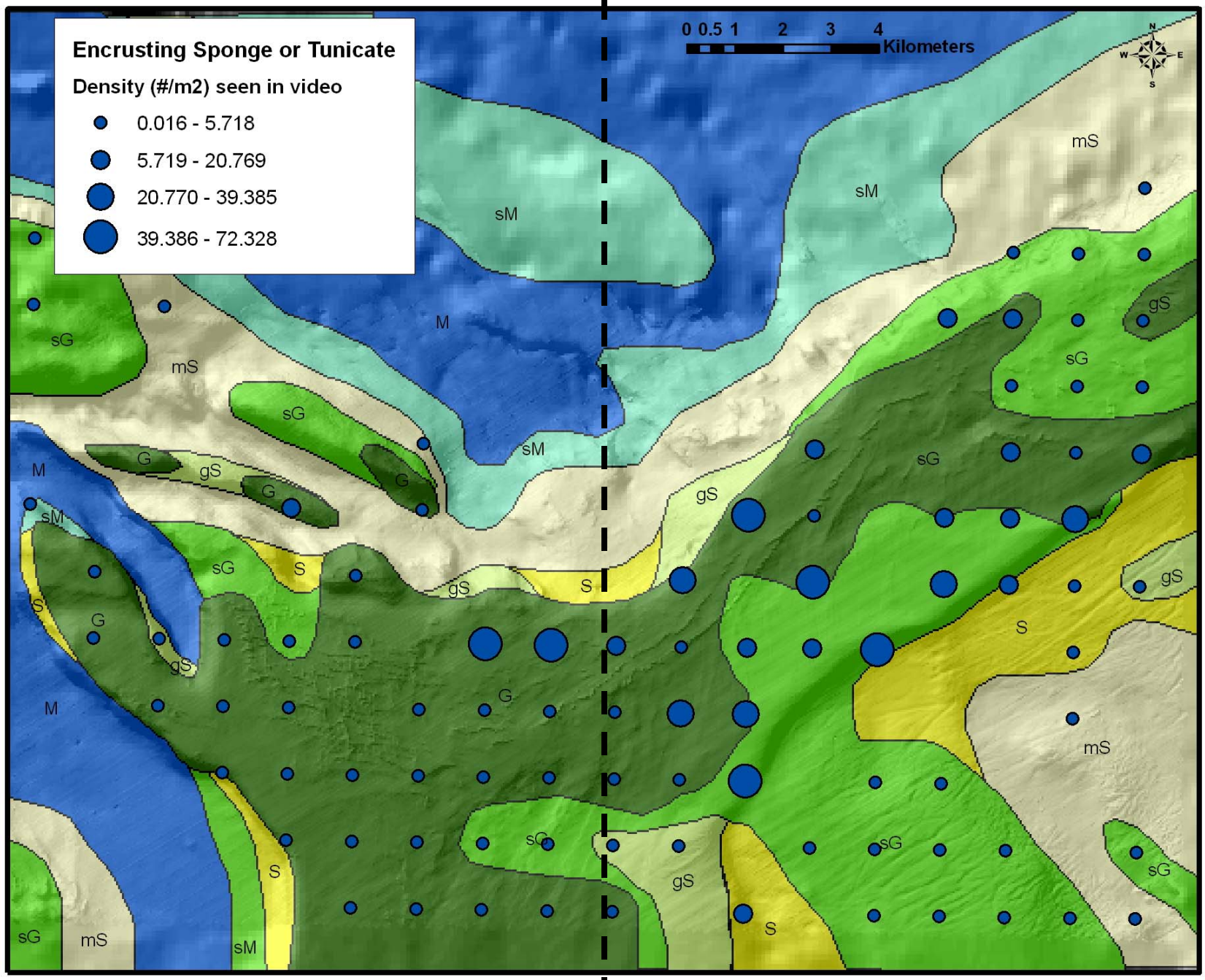
- Good historical and spatially detailed knowledge of fishing gear use. However...
- No knowledge of seafloor conditions or fish populations in “impact” (inside closure) or “control” (outside) areas ***before*** closure was established
- Several potentially confounding factors (e.g., sediment type) not related to cessation of bottom trawling and gillnetting

NMFS Fishing Vessel Trip Report Raw Data

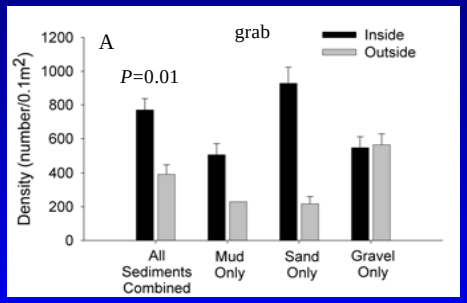
Total Trips 4.5 yr pre-closure and 4.5 yr post-closure

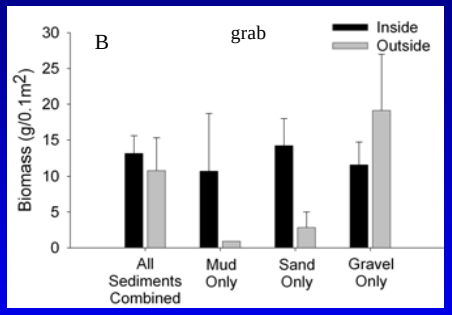


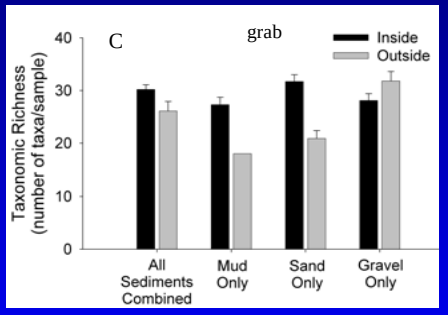
(Grizzle et al. 2009)

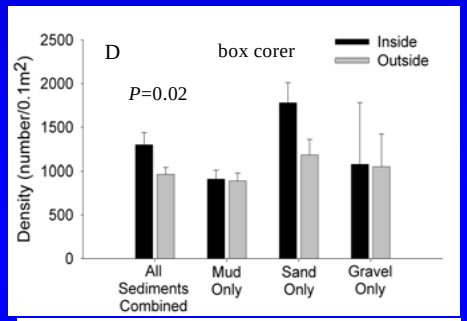

Encrusting Sponge or Tunicate
Density (#/m2) seen in video
0.016 - 5.718
5.719 - 20.769
20.770 - 39.385
39.386 - 72.328
0 0.5 1 2 3 4
Kilometers
N
W
E
S
sM
mS
sG
M
gS
G
S

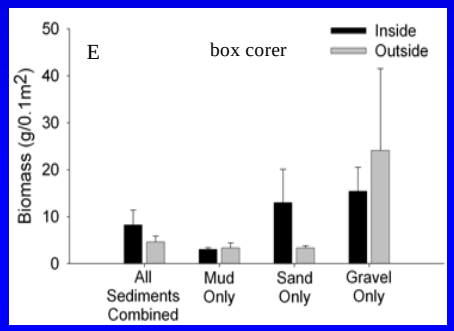
Four Cases of Significant Difference

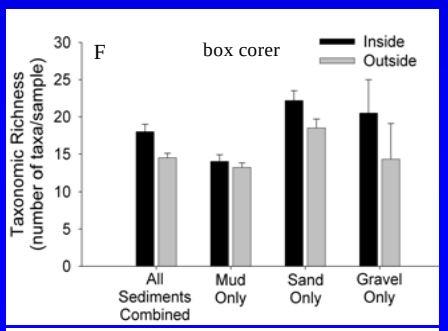


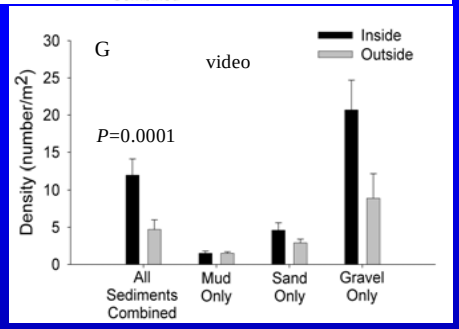


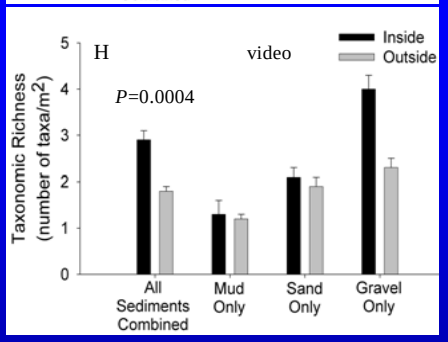












- INFAUNA: most increase in “sand” (mixed sandy sediments) up to 4.6x higher inside closure
- EPIFAUNA: most increase in “gravel” (pebbles to boulders) up to 2.3x higher inside closure

Conclusions - WGOMCA and Benthic Communities

- Major effect of the closure was to remove gillnet impacts from rocky habitats inside
- Epifauna and infauna density and taxonomic richness were significantly higher (up to 4.6x) inside compared to outside of the closure
- This suggests substantial recovery of benthic communities inside WGOMCA

Effects of WGOMCA on Fish in Rocky Habitats (2005, 2007-08)

Major Objectives: (1) Characterize the effects of the WGOMCA on fish communities in rocky habitats; (2) Develop sampling protocol for fish in rocky habitats

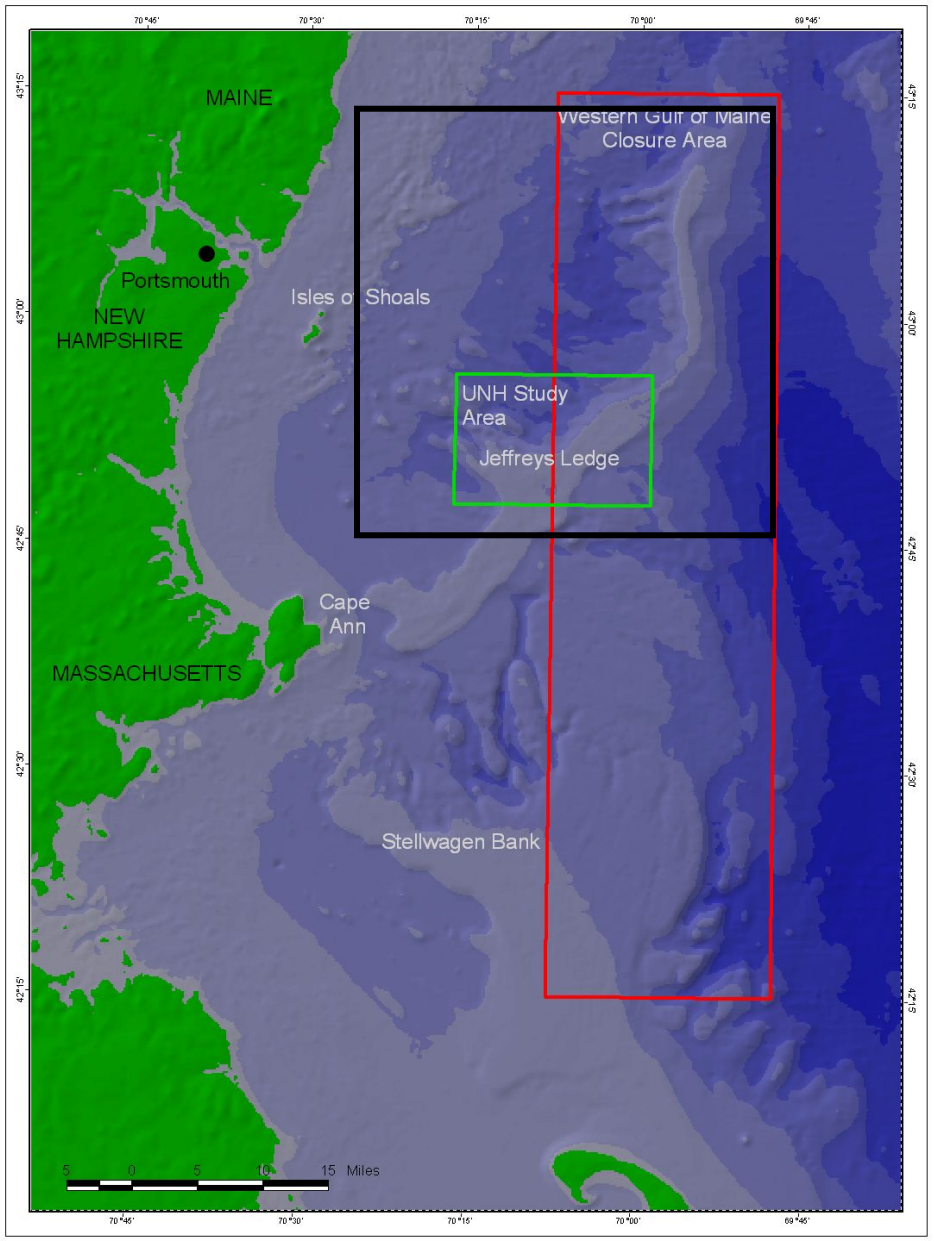
Methods: Deployment of multi-mesh (2-in, 4-in, 8-in) gillnets inside and outside the closed area – a total of 25 sampling trips (44 paired net hauls)



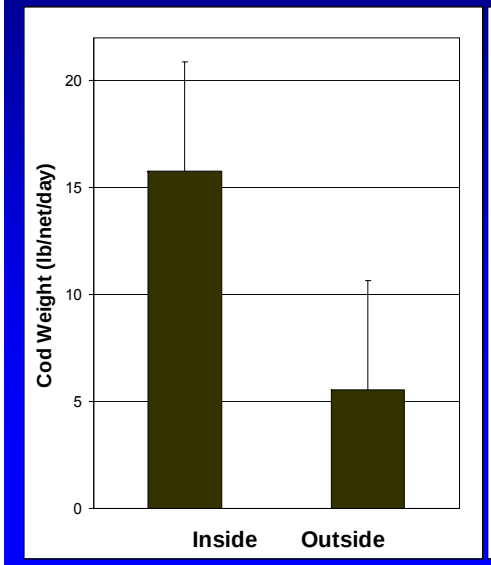

Red box = Western Gulf of Maine Closure Area

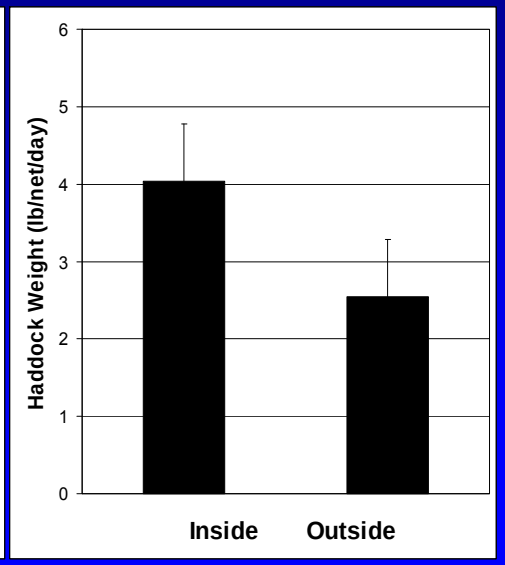
Green box = University of New Hampshire seafloor study area

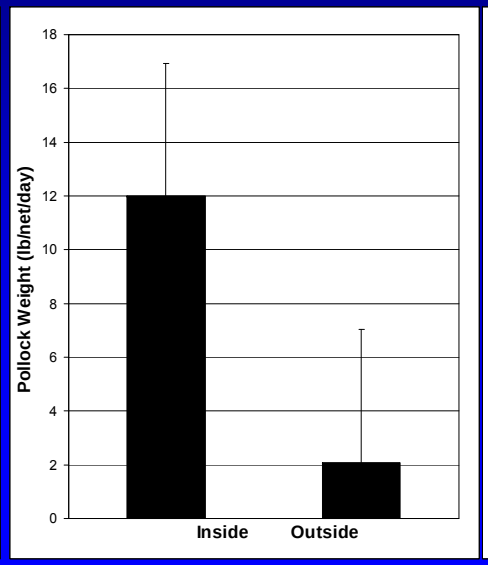
Black box = University of New Hampshire fish study area

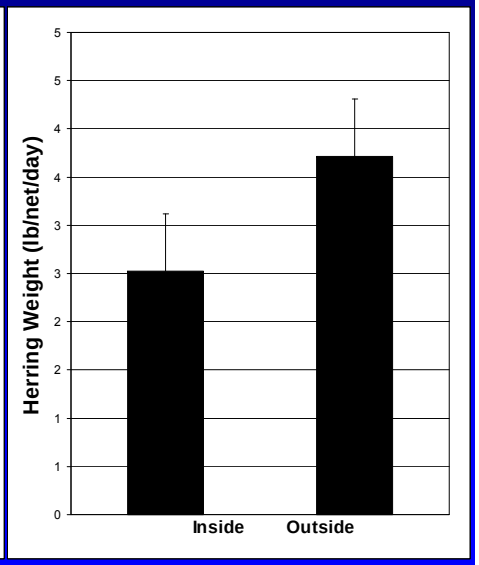


Effects of WGOMCA on Fish Populations in Rocky Habitats









- Groundfish (cod, haddock, pollock) 2x – 3x more biomass inside closure
- A major prey item (herring) less abundant inside closure
- A few species (e.g., spiny dogfish) same inside and outside

Management Implications

WGOMCA effect on seafloor - Benthic communities in some areas have recovered substantially since the WGOMCA was established, indicating that the closure has resulted in improved habitat. Recovery is probably ongoing.

WGOMCA effect on groundfish - Gillnet sampling in rocky habitats indicated higher numbers and biomass of groundfish (cod/haddock/pollock) in the closed area compared to outside.

- Is the WGOMCA a refuge for juvenile groundfish?
- Is the WGOMCA a refuge for adult groundfish?
- Is the WGOMCA contributing to stock re-building?

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- Statistical analysis

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