Final Report

Sea Scallop Research

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Project Title: **Examination of benthic substrates and macroinvertebrate distributions in the western Great South Channel and Nantucket Shoals.**

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1. Project Summary

Objectives: We proposed to characterize benthic substrate and macroinvertebrate distributions in the western Great South Channel (GSC) and Nantucket Shoals. This work expands the spatial coverage of the previous SMAST video surveys examining the spatial distribution of substrates and associated megabenthic communities of Georges Bank and the Mid-Atlantic. Further, we tested a high-resolution still camera system aimed at providing high-quality fine-scale images for better identification of microfaunal structure.

Methodology: We conducted one 6-day video survey in the western GSC and Nantucket Shoals using a multistage centric systematic design with stations separated by 1.57 km, similar to the 1999-2004 SMAST surveys. To more precisely identify and measure invertebrates and fishes we added a high-resolution still camera (3008 x 2000 pixels) with paired lasers and a strobe to the sampling pyramid. The video survey data were used to map the sea floor, detailing the distributions of substrates, macroinvertebrates (sponges, starfish, filamentous fauna), depth, live scallops, and dead scallops. These data will be combined with SMAST video survey data collected in adjacent areas to create high resolution maps.

Conclusions: We successfully completed one 6-day video survey of the proposed area. The maps comprise the first visual census of the benthos in the western Great South Channel and Nantucket Shoals, and will be included with previous SMAST video survey data from Georges Bank for an in-depth evaluation of the benthic habitats. These data have been summarized and the maps provided to the NEFMC Habitat Plan Development Team (Support Document 1), presented at three international scientific conferences (Support Documents 2-4), and will be submitted for publication in a peer-reviewed scientific journal.

Rationale: Substrate information is fundamental to the designation of Marine Protected Areas (MPA), Habitat Area of Particular Concern (HAPC), and Essential Fish Habitat (EFH). Recently, the New England Fisheries Management Council (NEFMC) developed Amendments 10 and 13 for sea scallop and groundfish management, respectively. Both of these management plans contain a series of habitat alternatives to protect EFH. In addition, the Habitat EFH Omnibus Amendment, presently being developed by the NEFMC, relies heavily on substrate information. The maps of substrate and macroinvertebrates generated from these surveys will be presented to the NEFMC Habitat Technical Team. This proposal has direct implications for scallop stock assessment, habitat impact reduction, rotational management and the Habitat Omnibus Amendment under consideration by the NEFMC. This research has broad based industry support.

2. Description of the issue/problem

Project goals and objectives:
We proposed to characterize benthic substrate and megabenthos distributions in the western Great South Channel (GSC) and Nantucket Shoals. This work expands the spatial coverage of previous SMAST video surveys examining the spatial distribution of substrates and associated megabenthic communities of Georges Bank. Further, we tested a high-resolution still camera system aimed at providing high-quality fine-scale images for better identification of microfaunal structure.

The problem addressed:
In 2003, the NEFMC Joint Advisors identified the western GSC and Nantucket shoals as a potential region for habitat protection. Unfortunately, substrate data for this region are spatially and temporally patchy, have low sampling frequencies, and were examined with a variety of sampling methods that are not standardized to each other. In 2003 and 2004, the SMAST – Industry 5.56 km resolution cooperative video survey identified cobble/boulder substrates along the western GSC and Nantucket Shoals. In 2004, a 1.57 km resolution video survey of the western GSC, south of the proposed study area, revealed complex cobble/boulder habitat. We will extend the 1.57 km resolution video survey to cover the remaining cobble/boulder areas identified in the 5.56 km resolution cooperative survey.

3. Approach

Results

In June 2006 we video surveyed 406 stations on a 1.57 km sampling grid in the proposed survey area (Figure 1).

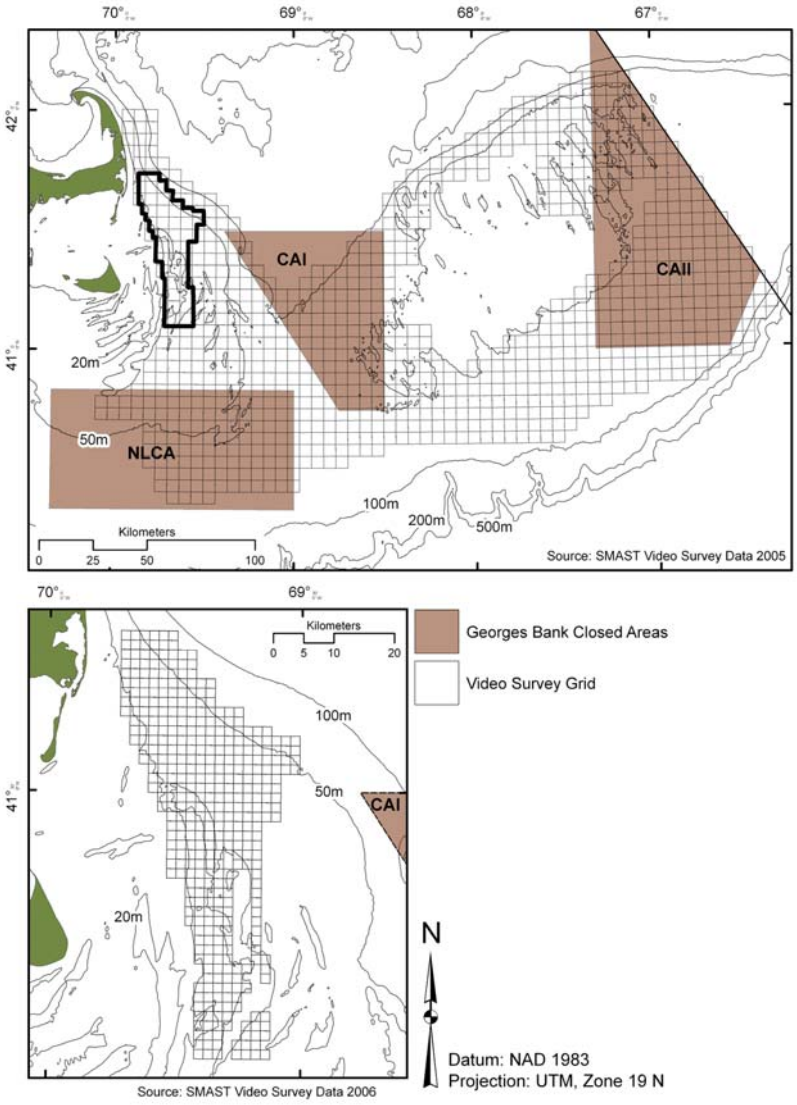


Figure 1. The upper panel shows the 2005 SMAST 5.56 km grid survey used to identify the proposed 1.57 km grid survey area outlined in black. The lower panel shows the 1.57 km grid survey conducted in 2006.

<u>Substrate</u>

Substrates were visually identified using texture, color, relief and structure in the video footage and still images, following the Wentworth scale (Wentworth 1922, Lincoln et al. 1992). Silt, sand and sand ripple were grouped as “Sand” (Figure 2).

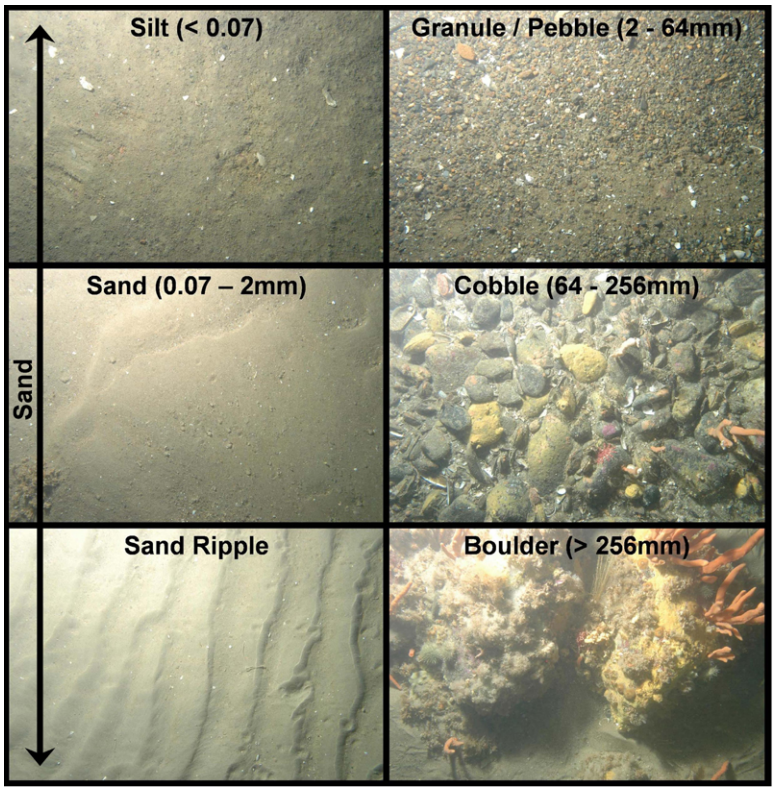


Figure 2. Substrate categories shown with digital still images of Sand, Granule/pebble, Cobble and Boulder substrates including particle size ranges.

Benthic substrates were scored by quadrat with sand = 10, granule/pebble = 100, cobble = 1000, and boulder = 10,000. The four quadrat scores are summed to provide a station substrate score (12,320). The station substrate score is log10 transformed (4.0906). The station log10 substrate score (Subscore) provides an index of substrate complexity while preserving the substrate information at the quadrat-level (Figure 3).

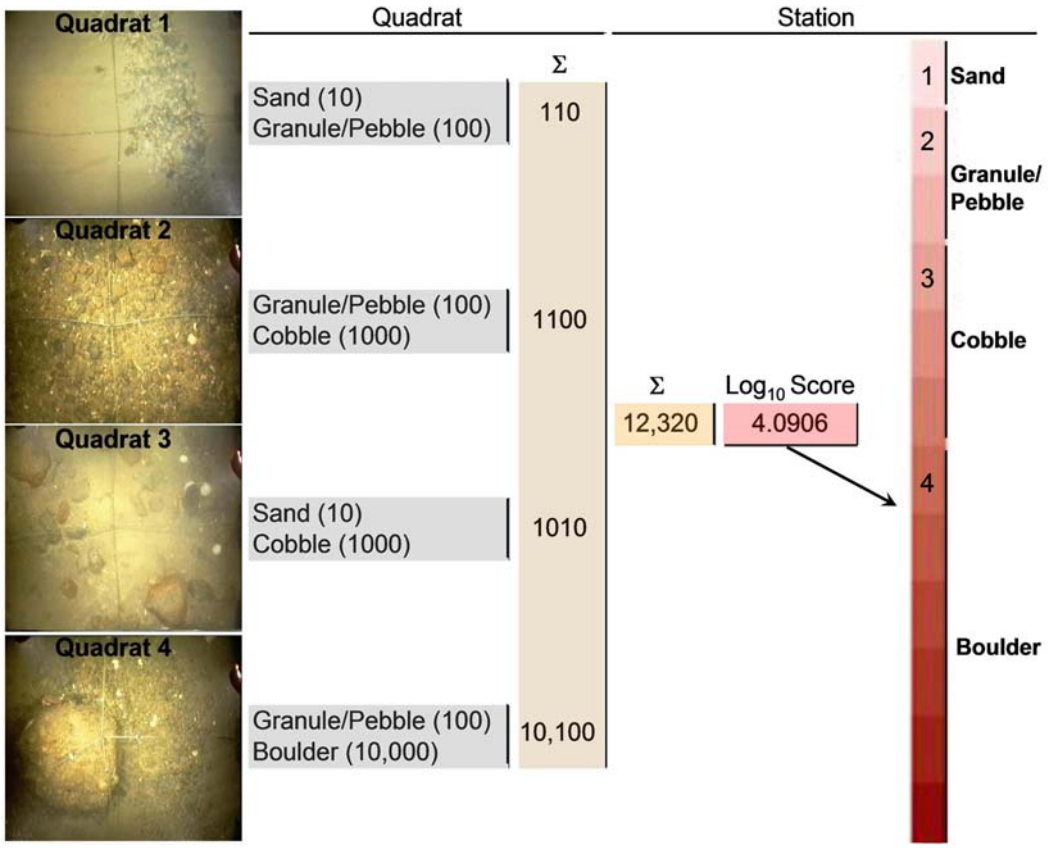


Figure 3. Substrate scoring (Subscore).

Megabenthos

Megabenthos were identified to the lowest taxon possible and grouped accordingly. Counts of sea scallops and sea stars are standardized to individuals m^{-2}. Colonial organisms such as sponges, and hydrozoa/bryozoans, which tend to occur in large aggregations, were quantified using a presence/absence scale of 1 - 4. The presence/absence of these organisms was evaluated at each quadrat, and stations were scored by summing quadrats.

Substrate and megabenthos distributions are mapped below (Figs. 4 - 9). In each map the upper panel shows the 2005 SMAST 5.56 km grid survey used to identify the proposed 1.57 km grid survey area outlined in black. The lower panel shows the 1.57 km grid survey conducted in 2006.

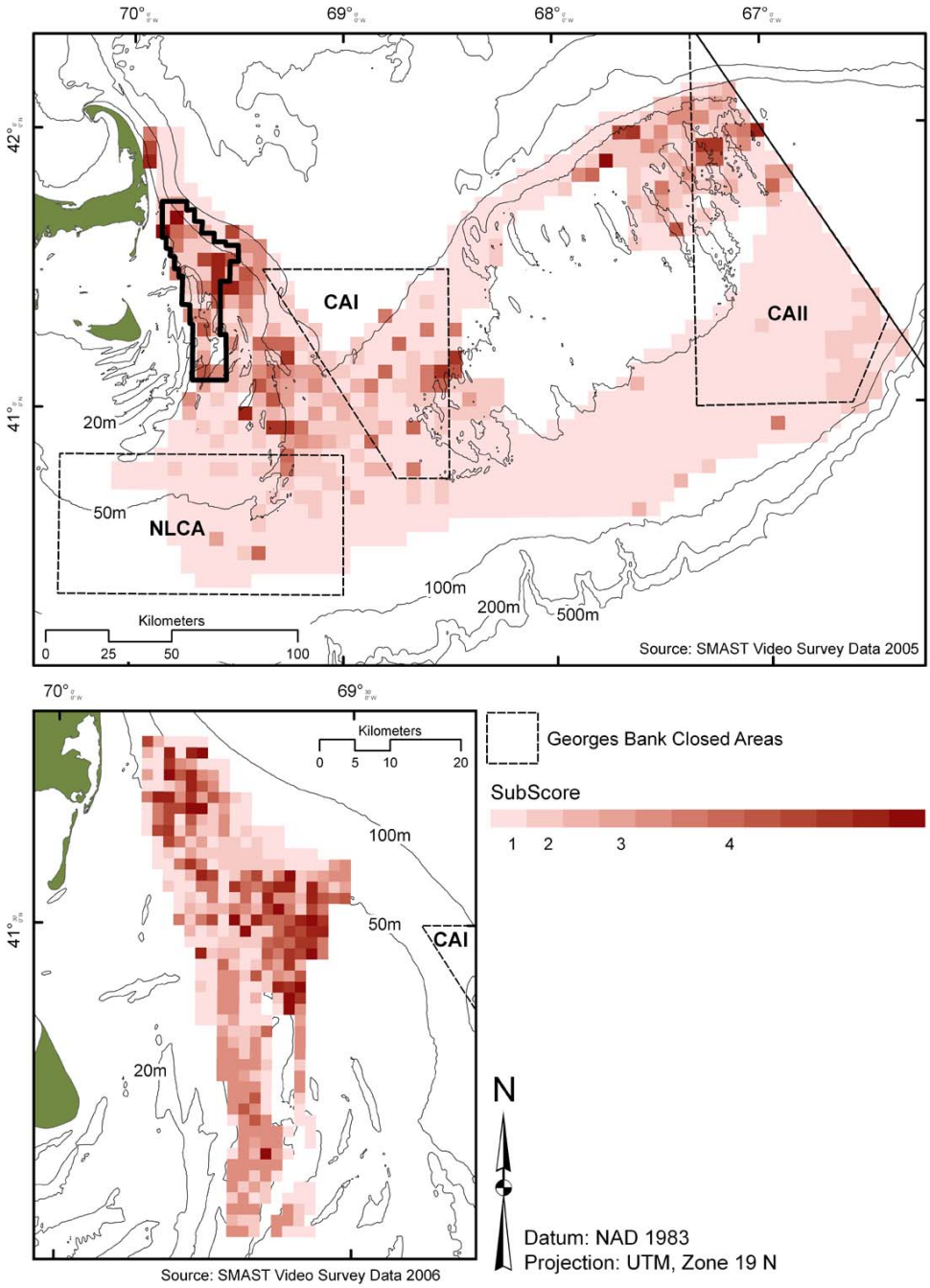


Figure 4. Distribution and Subscore of benthic substrates. See Figure 3 for SubScore Key.

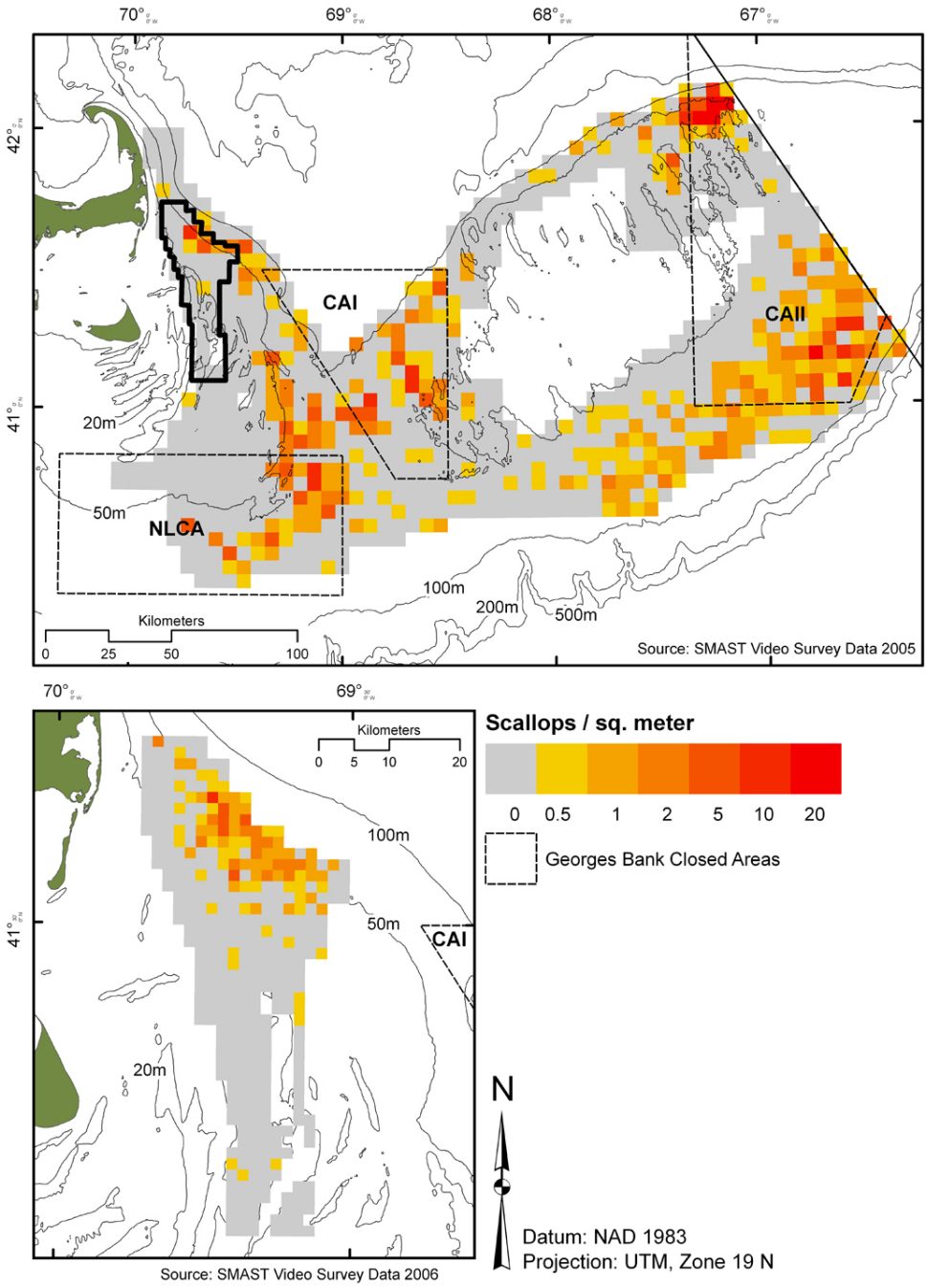


Figure 5. Distribution and density of sea scallops (*Placopecten magellanicus*).

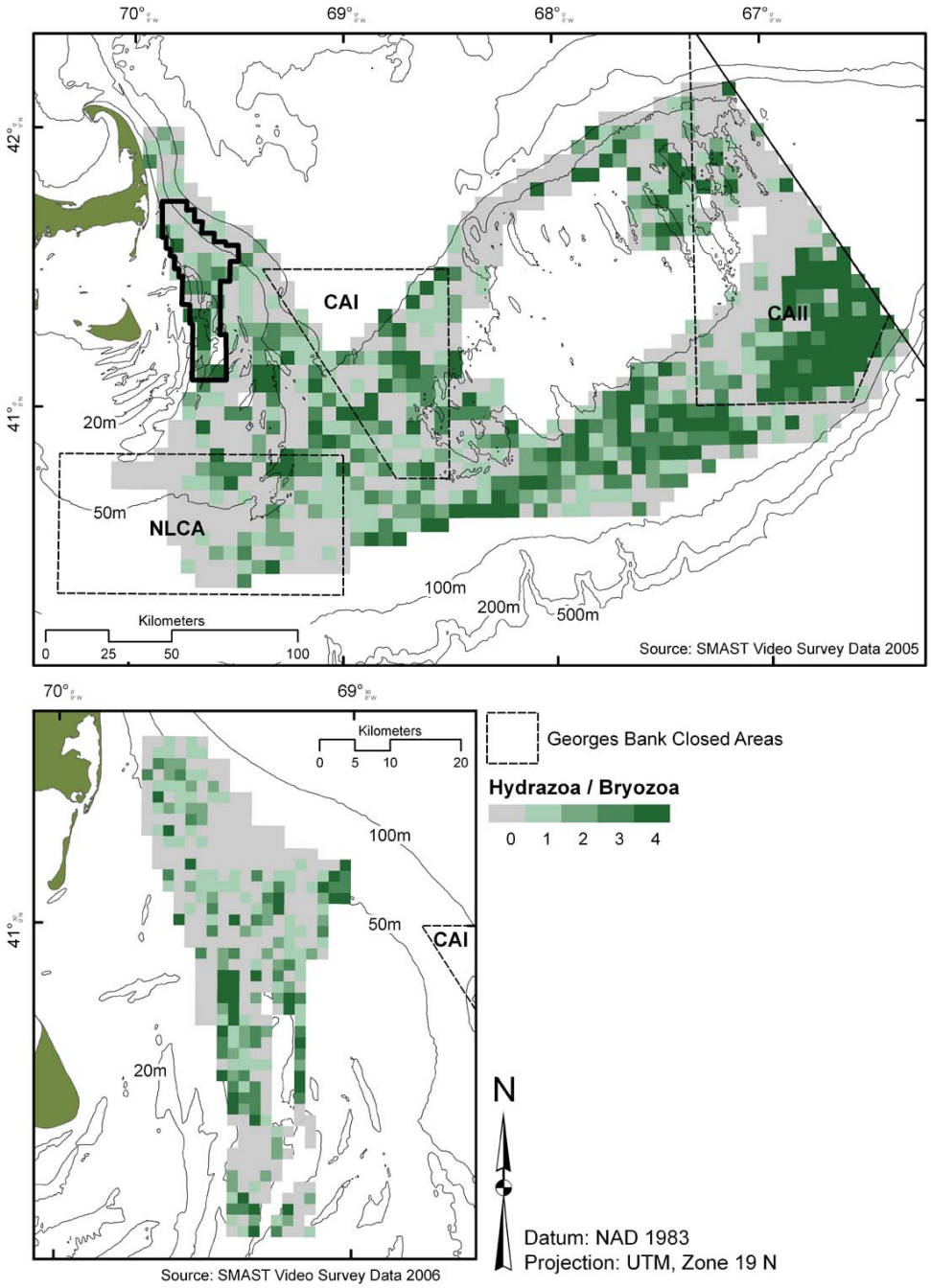


Figure 6. Distribution of hydrozoans and bryozoans (*Flustra foliacea*, *Callopora aurita*, *Electra monostachys*, *Cribrilina punctata*, *Eucratea loricata*, *Tricellaria ternata*, *Eudendrium capillare*, *Sertularia cupressina*, *Sertularia argentea*).

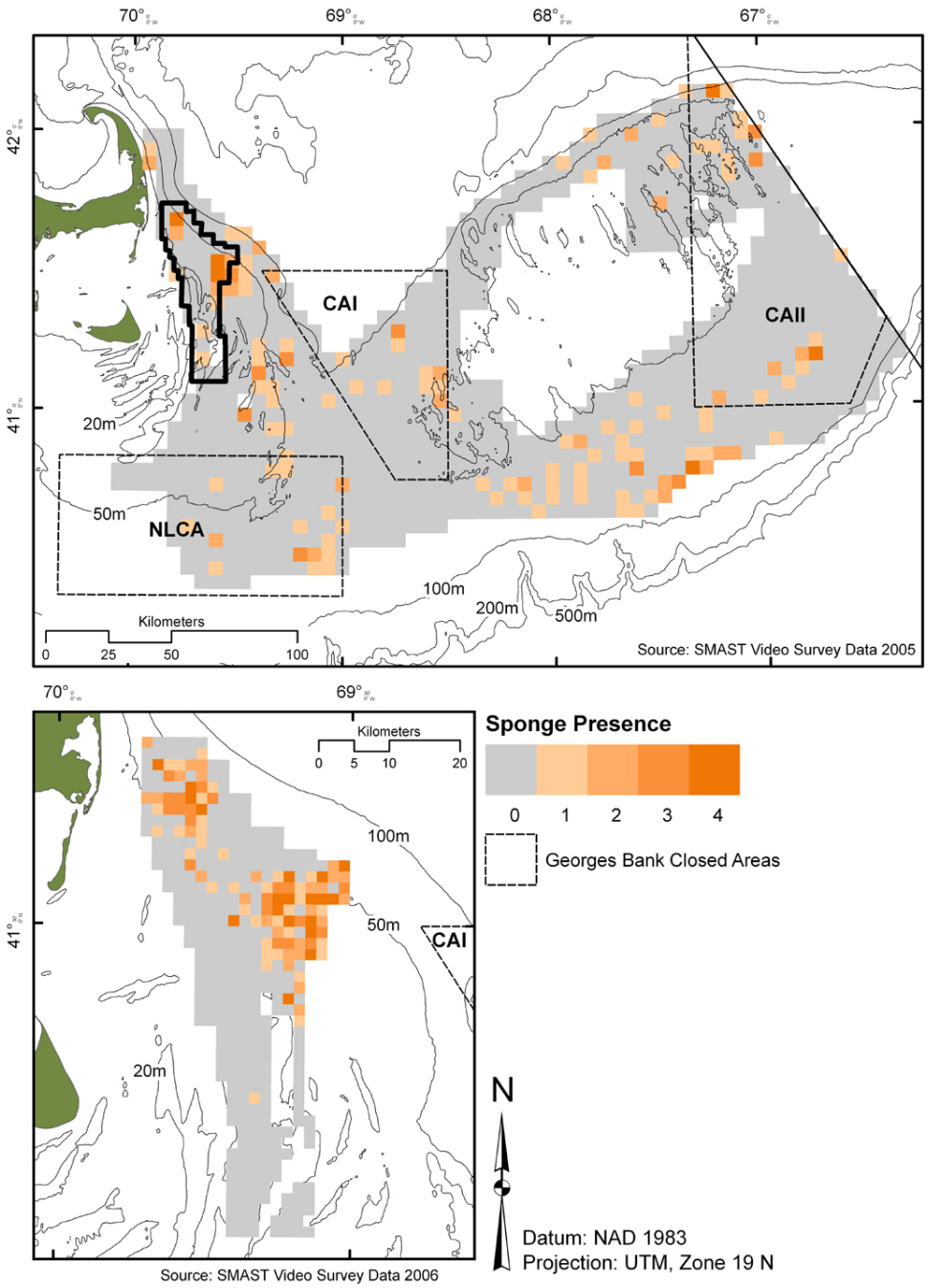


Figure 7. Distribution of sponges (*Suberites ficus, Haliclona oculata, Halichondria panicea, Cliona celata, Polymastia robusta, Isodictya palmata, Microiona prolifera*).

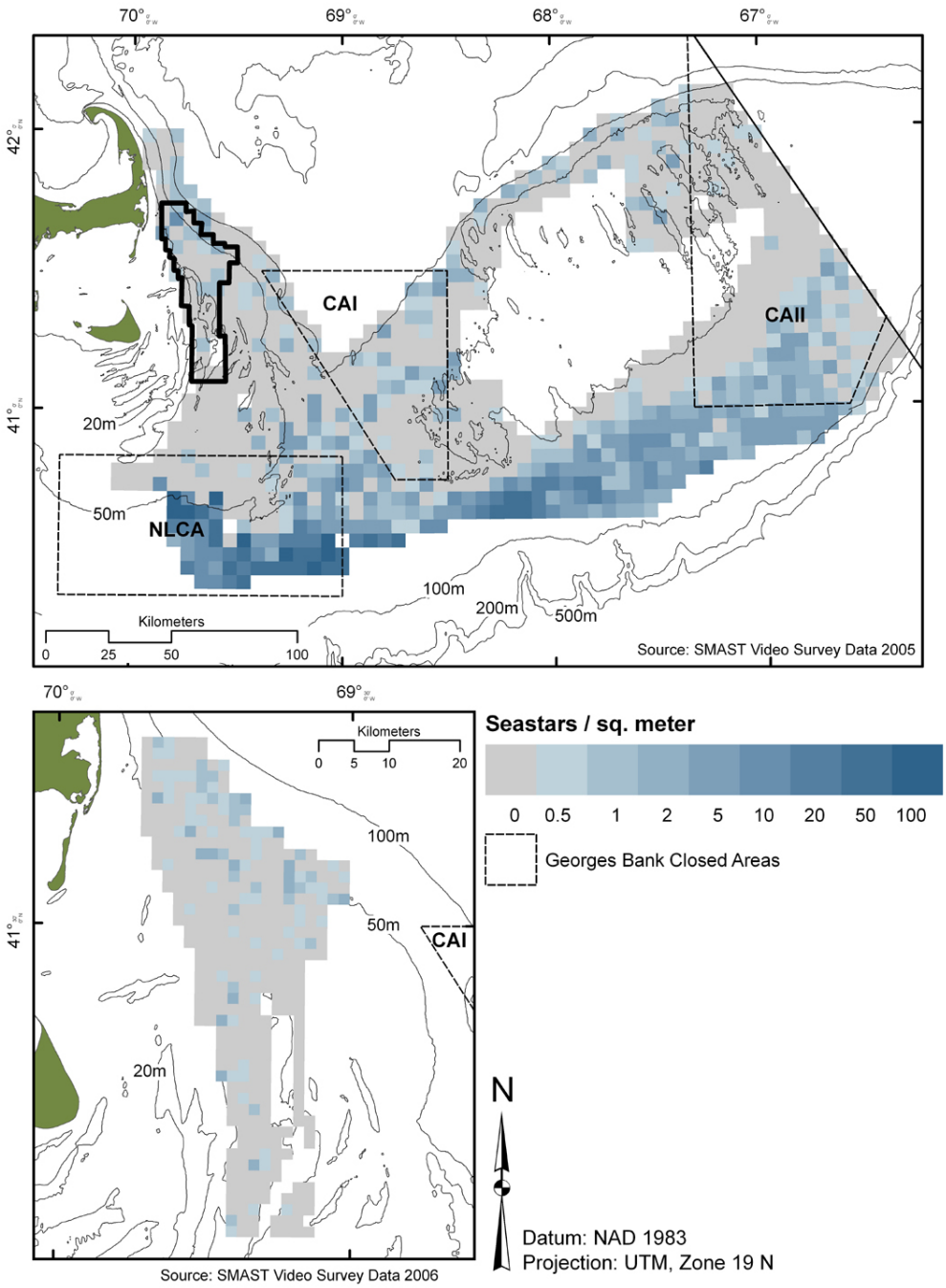


Figure 8. Distribution and density of sea stars (*Solaster endeca*, *Crossaster papposus*, *Leptasterias polaris*, *Asterias* spp., *Henricia* spp.).

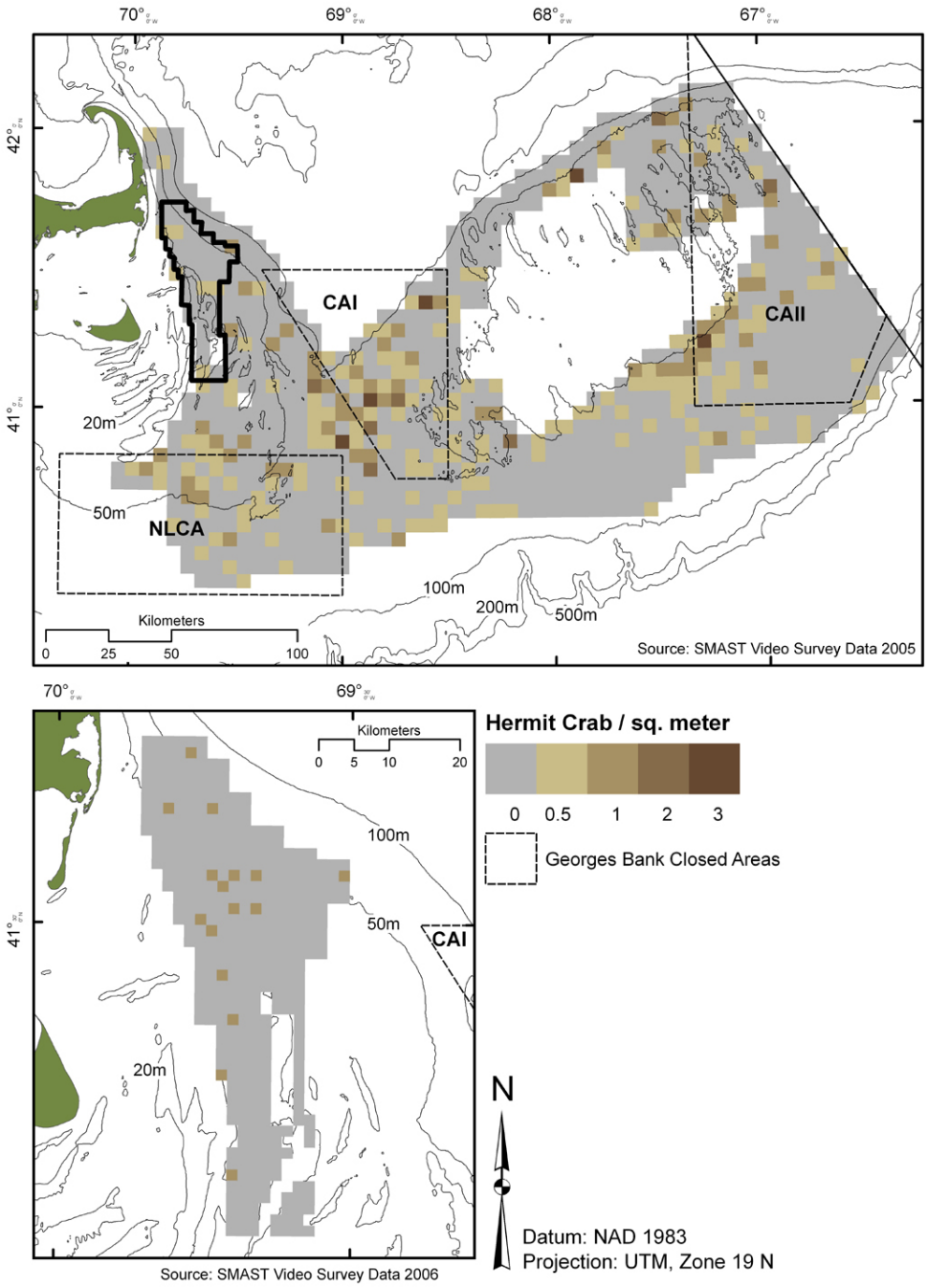
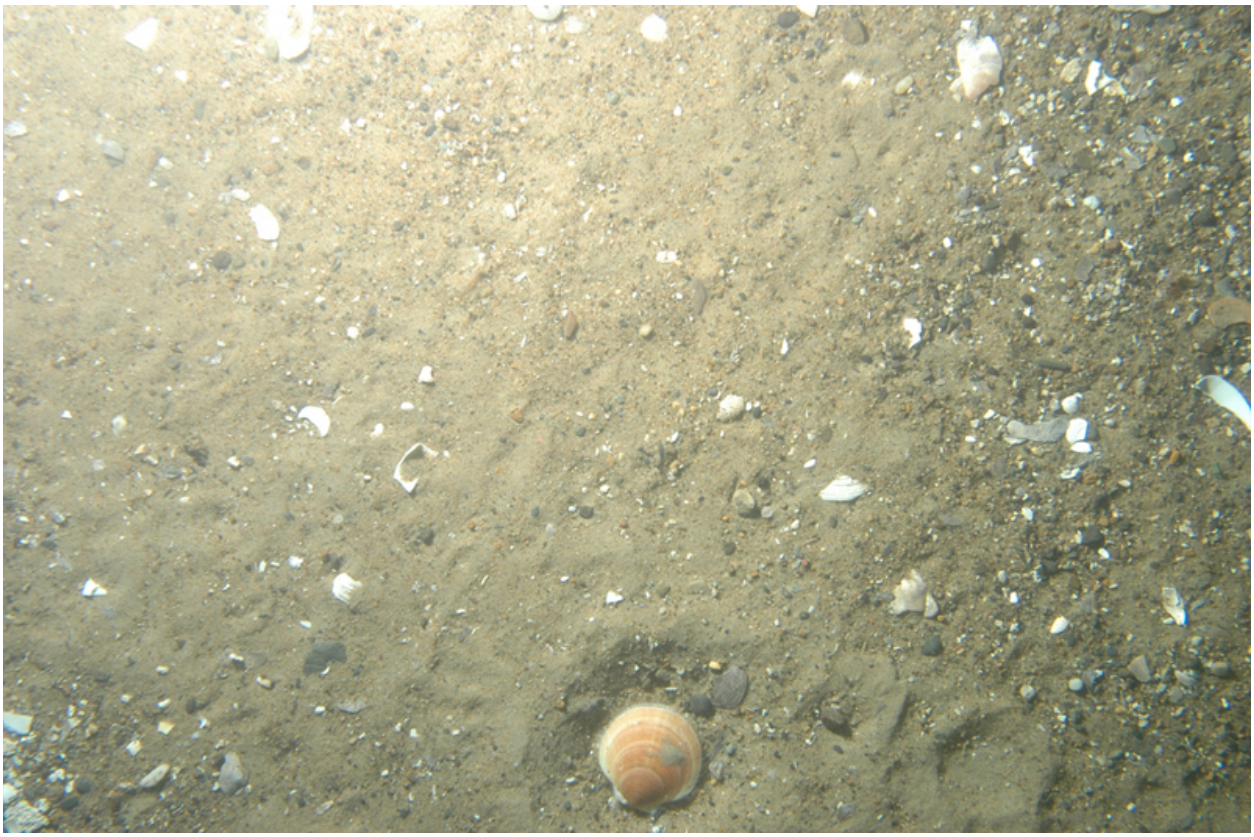
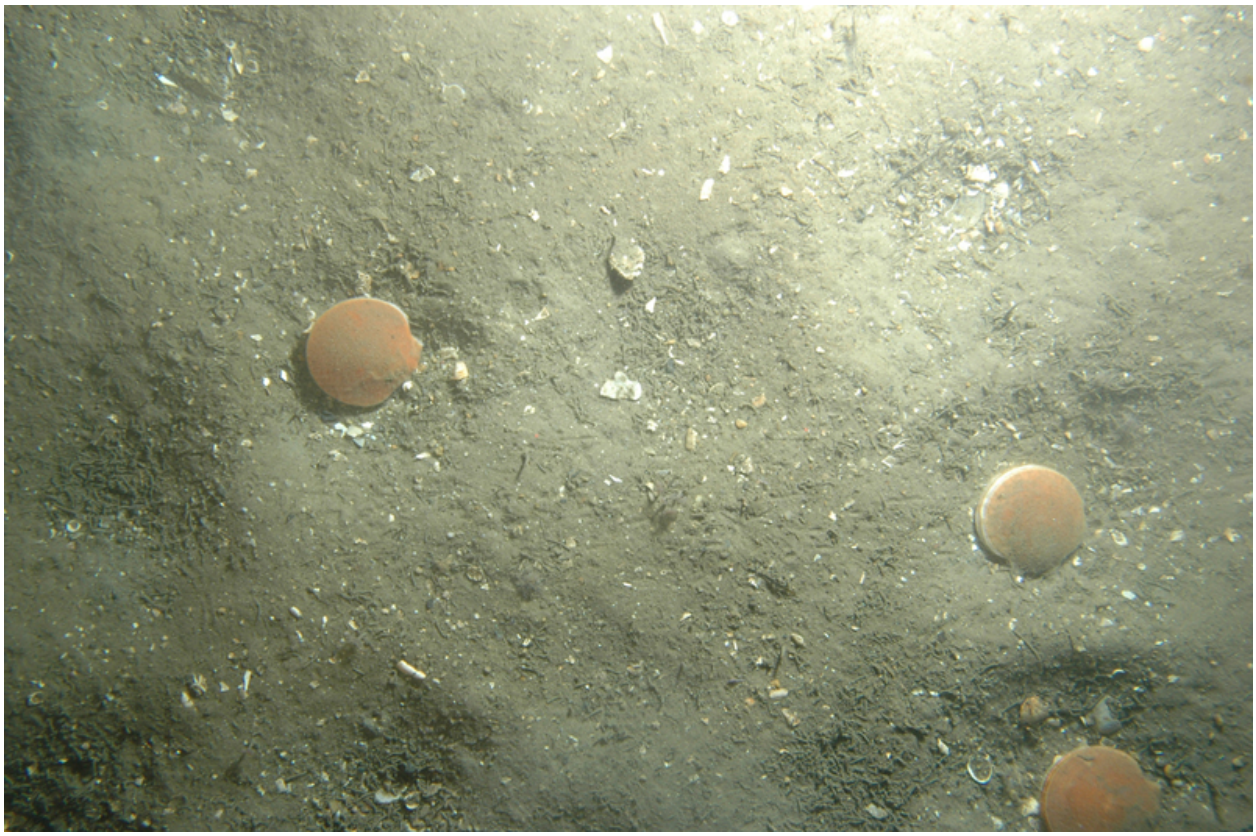


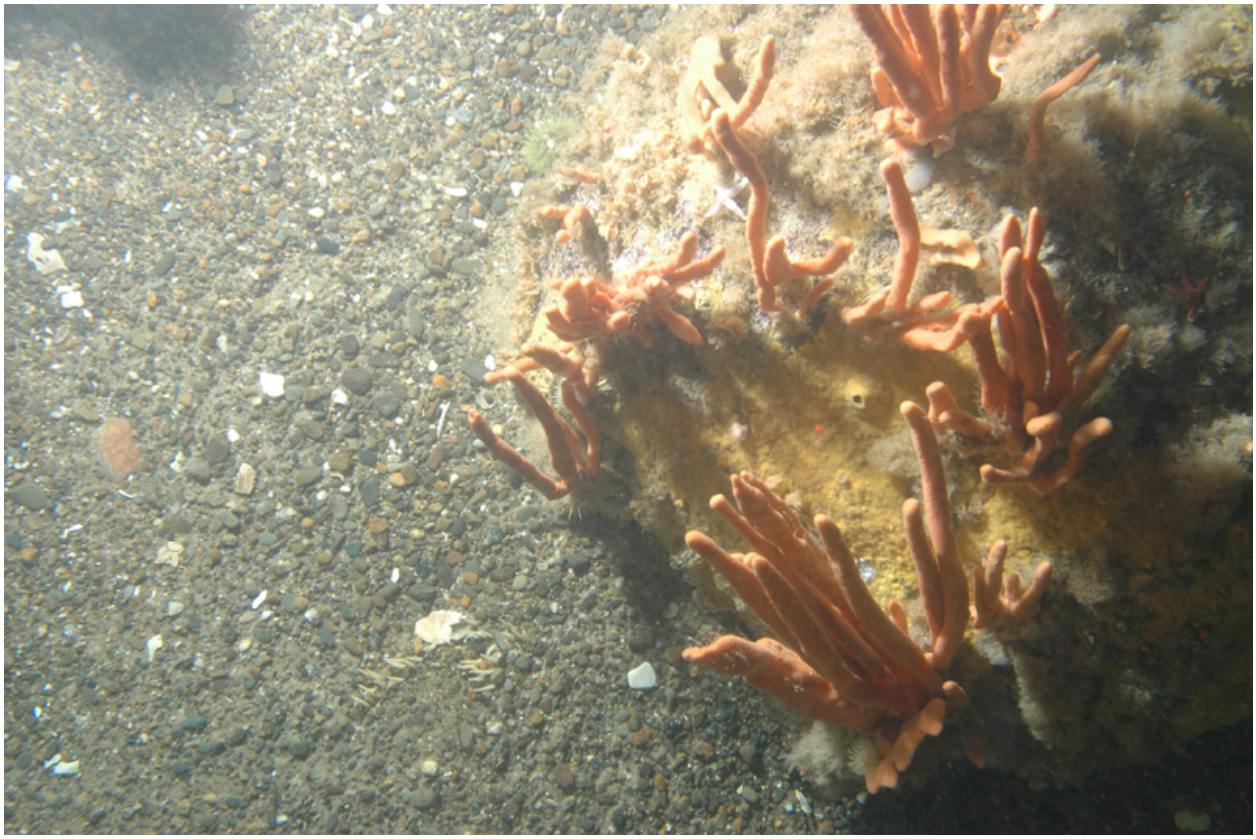
Figure 9. Distribution of hermit crabs (*Calcinus spp.,Dardanus spp., Isocheles spp., Paruristes spp., Petrochirus spp., Aragicochirus spp., Cataguroides spp., Catapagurus spp., Discorpopagarus spp., Elassochirus spp., Enallopaguropsis spp,. Haigia spp., Iridopagurus spp., Labidochirus spp., Manucoplanus spp., Nematopaguroides spp., Ostraconotus spp., Orthopagurus spp., Parapagurodes spp., Philochirus spp., Pylopagurus spp., Rhodochirus spp., Solenopagurus spp., Tomopagurus spp.*).

High Resolution Digital Camera

In order to improve survey image quality and better identify megabenthos, we tested a high-resolution still camera system. We employed an Ocean Imaging DSC with a 6.1 megapixel Nikon D80 digital camera and strobe. The camera system functioned successfully throughout the survey and obtained very high quality images (samples provided below). The view area in these images is 1.13 m^2.







Evaluation

We successfully completed the proposed 6-day video survey and characterized benthic substrate and macroinvertebrate distributions in the western Great South Channel (GSC) and Nantucket Shoals. The maps provided above comprise the first visual census of the benthos in the western Great South Channel, and form the basis for much more in-depth evaluation of the benthic habitats found in this region. We were able to delineated substrate and megabenthos distributions identified in the previous 5.56 km grid survey with a 3.5 fold increase in detail.

The higher resolution digital still camera system obtained images with sub-millimeter resolution and thus contain a tremendous amount of benthos information. We are presently developing image analysis protocols.

These data have been summarized and the maps provided to the NEFMC Habitat Plan Development Team (Support Document 1), presented at three scientific conferences (See abstracts below, Support Documents 2-4), and will be submitted for publication in a peer-reviewed scientific journal.

Conference presentation abstracts

American Fisheries Society – Southern New England Chapter Winter Meeting 2007
(Support Document 2)

Mapping surficial substrates and megabenthos along the Northwestern Atlantic continental shelf with underwater video surveys.

Bradley P. Harris, Jacob I. Nogueira, Michael C. Marino II and Kevin D. E. Stokesbury

Comprehensive assessments of marine ecosystems incorporating abiotic and biotic components, natural and anthropogenic disturbances, including fishery harvests, are being pursued with increasing frequency. Mapping the benthos at appropriate spatial scales is an essential first step, providing a backdrop for assessing fisheries as well as the impacts of environmental change. Presently, the benthos of the Northeastern USA continental shelf are poorly understood. Substrate distribution information relies heavily on geological sampling (e.g. grabs and cores), while megabenthos information is typically derived from by-catch in fisheries surveys. These historical datasets are spatially and temporally inconsistent. Sidescan, and more recently, multibeam sonar methods provide sea floor backscatter and morphology information, but presently little of the continental shelf has been mapped. Further, these methods do not directly sample megabenthos. Beginning in 1999, we conducted a visual census of surficial substrates and megabenthos based on the distribution of the dominant macroinvertebrate, sea scallops, Placopecten magellanicus, using underwater video in a centric, systematic, quadrat survey design. We have examined 172,848 quadrats, viewing >250,000 sq. m of sea floor along 60,000 sq. km of continental shelf. These data were used to map the distributions of surficial substrates

and megabenthos, and provide fishery managers spatially explicit sea scallop density and size distribution information.

Keywords: Benthos, Mapping, Sea scallop, Substrate, Megabenthos

Australian Society for Fish Biology – 2006 Conference and Workshop on Cutting Edge Technologies in Fisheries and Fish Biology. (Support Document 3)

Benthic habitat mapping in offshore USA sea scallop, (*Placopecten magellanicus)*, beds based on underwater video surveys.

Bradley P. Harris, Jacob I. Nogueira Michael C. Marino II and Kevin D. E. Stokesbury

Comprehensive assessments of marine ecosystems incorporating abiotic and biotic components, natural and anthropogenic disturbances, and fishery harvests are being pursued with increasing frequency. Mapping benthic habitats, on appropriate spatial scales, is an essential first step, providing a backdrop for assessing fisheries, as well as the impacts of environmental change, and disturbances on the benthos. The habitats of the northeastern USA continental shelf are poorly understood. Substrate distributions rely heavily on geological sampling (e.g. grabs and cores), while megabenthos information is typically derived from by-catch in fisheries surveys. These historical datasets are spatially and temporally inconsistent. Sidescan, and more recently, multibeam sonar methods provide improved sediment and sea floor morphology information but presently little of the continental shelf has been mapped. Further, these methods do not directly sample megabenthos. Beginning in 1999, we conducted a visual census of surficial substrates and megabenthos in offshore sea scallop, *Placopecten magellanicus*, beds using underwater video in a centric, systematic, quadrat survey design. We have examined 123,192 quadrats, viewing 184,642 m^2 of sea floor along 60,000 km^2 of continental shelf. These data were used to map surficial substrates and megabenthos, assess the impacts of a short term sea scallop fishery, produce an identification key for megabenthos and substrates, and provide fishery mangers spatially explicit sea scallop density and size distribution information.

Keywords: Habitat mapping, Sea scallop, Substrate, Megabenthos

International Council for Exploration of the Sea – 2006 Annual Science Conference (Support Document 4)

Benthic habitat mapping in offshore USA sea scallop, (*Placopecten magellanicus)*, beds based on underwater video surveys.

Bradley P. Harris, Kevin D. E. Stokesbury, Jacob I. Nogueira and Michael C. Marino II

Comprehensive assessments of marine ecosystems incorporating abiotic and biotic components, natural and anthropogenic disturbances, and fishery harvests are being pursued with increasing frequency. Mapping benthic habitats, on appropriate spatial scales, is an essential first step,

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Keywords: Habitat mapping, Sea scallop, Substrate, Megabenthos

Benefits and contributions to management decision making:

Substrate information is fundamental to the designation of Marine Protected Areas, Essential Fish Habitat, and Habitat Area of Particular Concern. The maps of substrate and megabenthos generated from this project have been provided to the NEFMC Habitat Plan Development. Further, these data were used to address specific questions raised by the Habitat PTD regarding the nature of proposed HAPC in the western GSC (Support Document 1). Presently, these date are being reexamined to better understand the distribution of bottom types proposed as juvenile cod EFH and may be presented at a 15 August 2007 Habitat PDT meeting.

List of Supporting Documents:

1) Review of Proposed Juv Cod HAPC in GSC. B. P. Harris 2006. Report provided to New England Fisheries Management Council Habitat Plan Development Team

2) Mapping surficial substrates and megabenthos along the Northwestern Atlantic continental shelf with underwater video surveys. Presentation for American Fisheries Society – Southern New England Chapter Winter Meeting 2007

3) Benthic habitat mapping in offshore USA sea scallop, (*Placopecten magellanicus)*, beds based on underwater video surveys. Presentation for Australian Society for Fish Biology – 2006 Conference and Workshop on Cutting Edge Technologies in Fisheries and Fish Biology.

4) Benthic habitat mapping in offshore USA sea scallop, (*Placopecten magellanicus)*, beds based on underwater video surveys. Presentation for International Council for Exploration of the Sea – 2006 Annual Science Conference.

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Review of substrate composition and megafauna in the proposed Juvenile Cod HAPC in the Great South Channel.

Bradley P. Harris and Kevin D. E. Stokesbury

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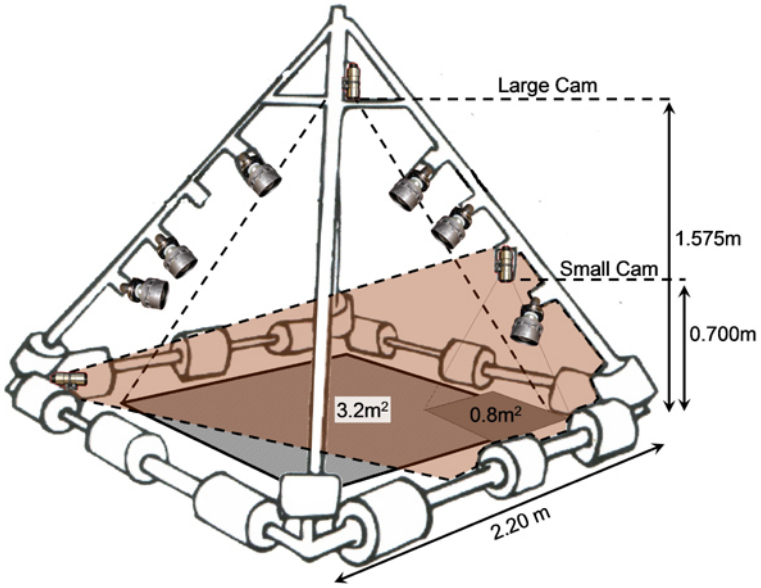
This document was prepared at the request of Leslie-Ann S. McGee, NEFMC Habitat Committee.

Objectives: We use the SMAST video survey database to summarize substrate compositions and the distribution of megafauna in the proposed juvenile cod Habitat Areas of Particular Concern (HAPC) located in the Great South Channel (GSC).

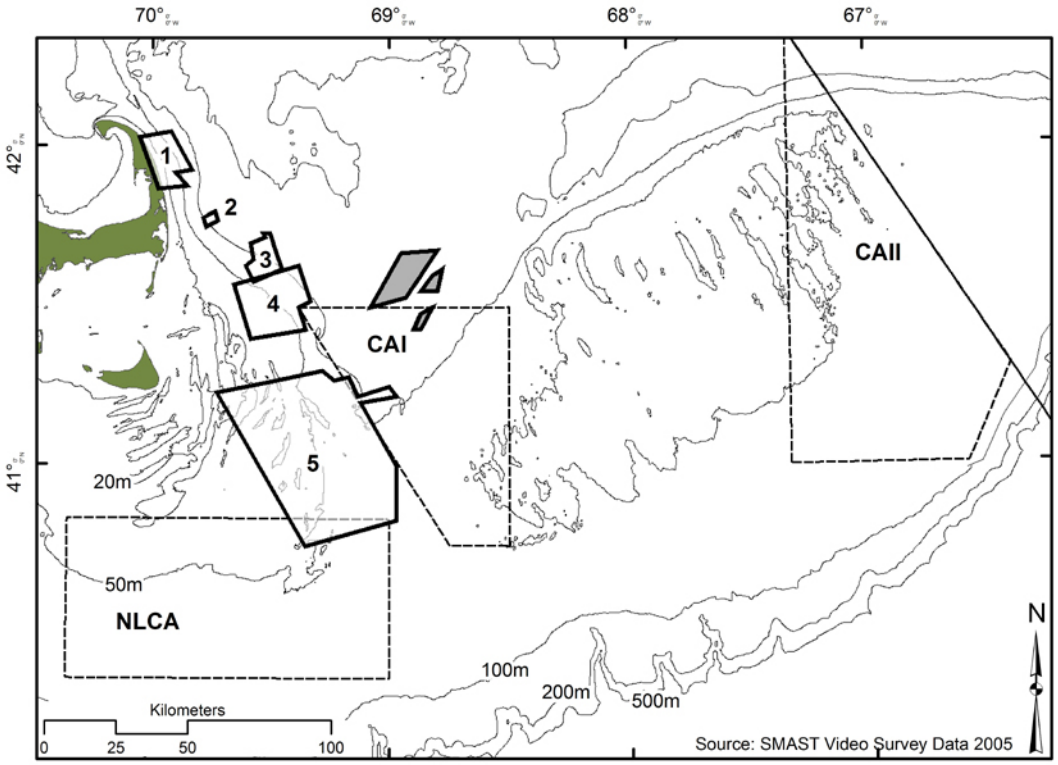
Methodology: The SMAST video survey is a multistage centric systematic survey with stations separated by 5.56 km, or by 1.57 km. The sampling pyramid supports three DeepSea multi Seacam underwater cameras. This analysis is based on the large camera quadrat view. The large camera is mounted vertically on the pyramid at a height of 1575 mm above the pyramid's base provided a 2.841 m^2 quadrat of the sea floor, and all sea scallops in the view area were counted, including those along the edge of the quadrat image that were only partially visible. To correct for this edge effect, 56 mm, based on the average shell height of the sea scallops observed, was added to each edge of quadrat image, increasing the quadrat size to 3.235 m^2 (Stokesbury, 2002; Stokesbury et al, 2004).

Video footage of the sea floor was recorded on S-VHS tapes. Time, depth, number of live and dead sea scallops, and latitude and longitude at each station, were noted. After each survey, the videotapes were reviewed in the laboratory; the field data were verified.

SMAST video survey pyramid, with three live-feed S-VHS video cameras.

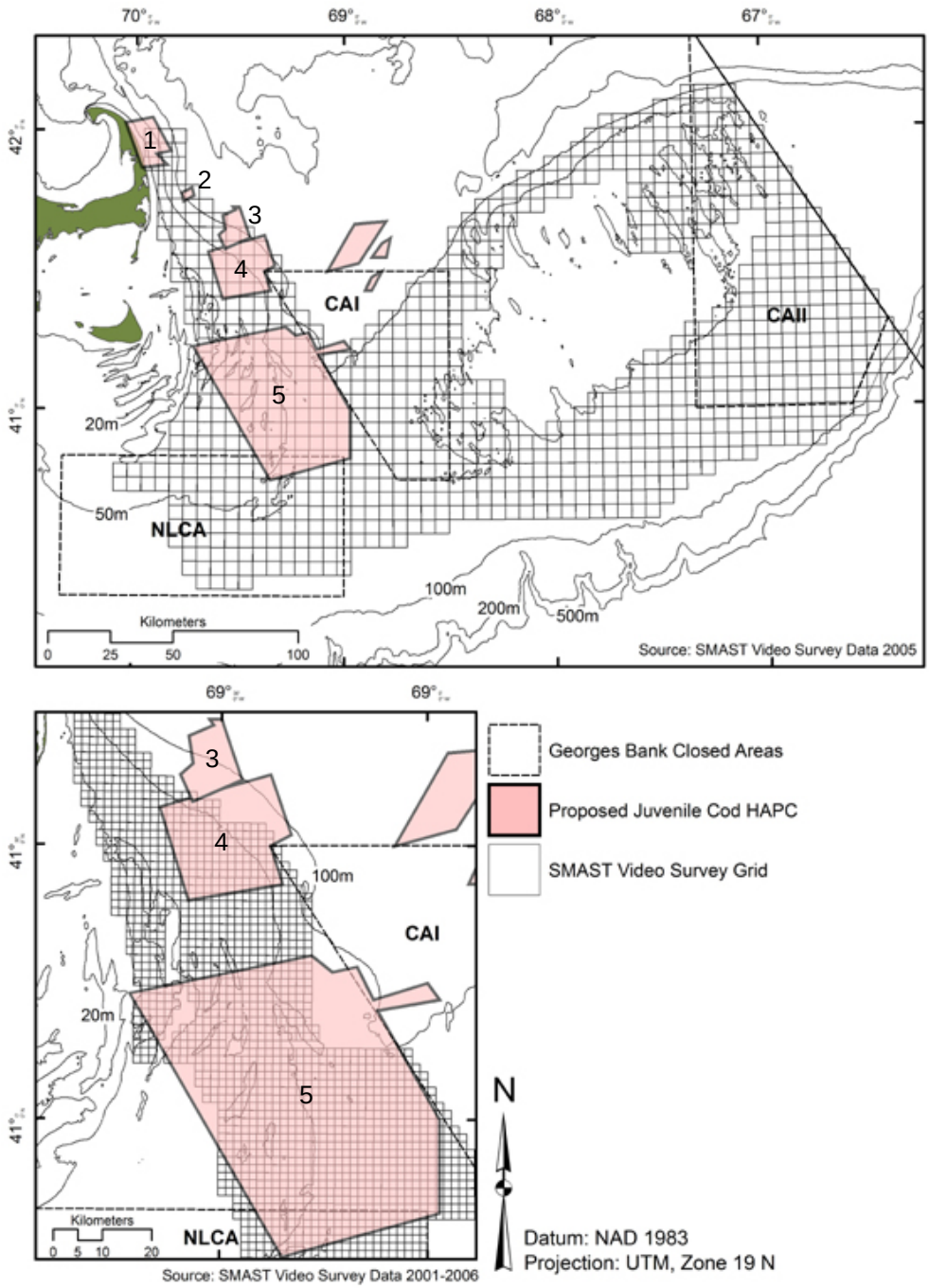


Proposed Juvenile Cod HAPC areas (numbered from North to South). Areas in grey were not analyzed.



Projection: UTM, Zone 19 N
Datum: NAD 1983

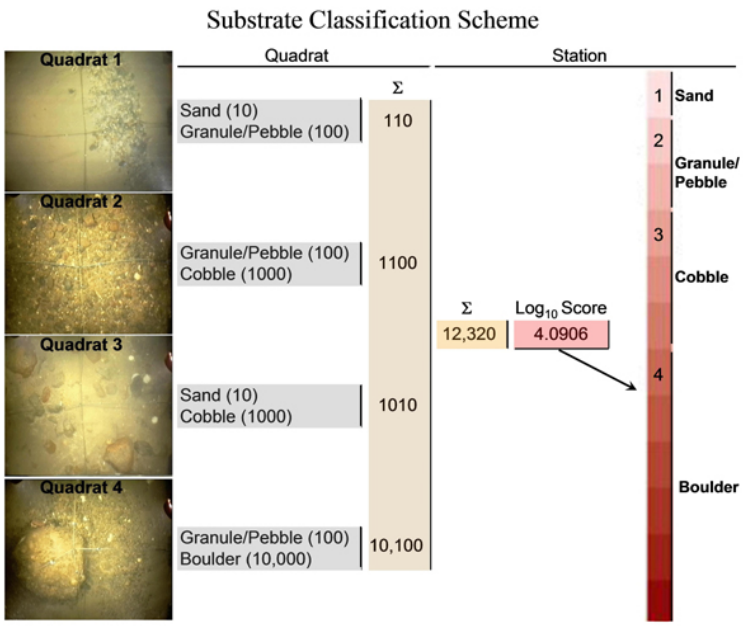
The SMAST video survey grids. The upper box shows the 5.56 km grid and the lower the 1.57 km grid along with the proposed HAPC. **In the 5.56 km grid survey only a small numbers of stations (N) were sampled in proposed HAPC areas 1 (N = 5), 2 (N = 1), and 3 (N = 3). Further, the 1.57 km grid survey does not cover areas 1 - 3 and only partially covers areas 4 and 5.**



Substrate Composition

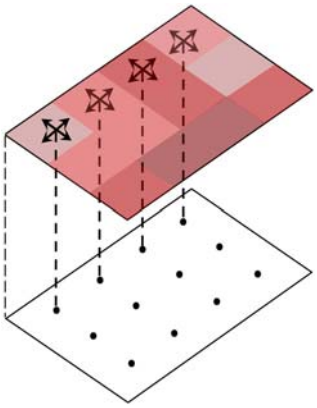
Sediments are visually identified following the Wentworth particle grade scale from the video images, where the sediment particle size categories are based on a doubling or halving of the fixed reference point of 1 mm; sand = 0.0625 to 2.0 mm, gravel = 2.0 to 256.0 mm and boulders > 256.0 mm (Lincoln et al. 1992). Gravel was divided into two categories, granule/pebble = 2.0 to 64.0 mm and cobble = 64.0 to 256.0 mm.

Surficial substrate classification scheme (SubScore)



We scored benthic substrates by quadrat with sand = 10, granule/pebble = 100, cobble = 1000, and boulder = 10,000. The four quadrat scores are summed to provide a station substrate score (12,320). The station substrate score was $\log_{10}$ transformed (4.0906). The station log10 substrate score provides an index of substrate complexity while preserving the substrate information at the quadrat-level (Harris and Stokesbury 2005).

Substrate Mapping



The *Thessian tool* (ArcInfo®) was used to create a grid of polygons (5.6 x 5.6 km) each centered on a survey station. Each polygon was given the substrate attributes of the survey station it contained. This technique is simple and does not involve mathematical interpolation to create a surface for visualizing the data (Harris and Stokesbury 2005).

2005 Video Survey Substrate

Survey Substrate Composition by Area

Substrate data in the video survey are presence or absence. The table below provides the percentage of each substrate class present in each survey area (e.g. the number of stations containing cobble / total number of samples in the area x 100) taken in each area. The percentages do not sum to 100 because several substrate classes may be present in a station. **Note the very small numbers of stations (N) sampled in proposed HAPC areas 1 (N = 5), 2 (N = 1), and 3 (N = 3) during the 5.56 km survey. Percent presence values are strongly influenced by low sample sizes.**

2005 Video Survey 5.56 km Grid

Area	Area km^2	N	Mean SubScore	Sand Complex	Granule / Pebble	Cobble	Boulder
GB All	29,244	946	2.066	97.3	29.4	13.1	6.9
GB OPEN	16,724	541	2.161	97.0	32.7	17.7	8.1
GSC	5,595	181	2.721	100	58.0	39.2	18.8
NLCA	3,957	128	1.785	100	17.2	2.3	2.3
CAI	2,875	93	2.141	97.8	35.5	8.6	11.8
CAII	5,750	186	1.941	95.7	24.7	9.1	3.8
HAPC All	3,184	103	2.982	100	70.9	47.6	23.3
HAPC 1	155	5	3.202	100	60.0	20.0	60.0
HAPC 2	31	1	1.602	100	0.0	0.0	0.0
HAPC 3	93	3	2.974	100	0.0	33.3	33.3
HAPC 4	526	17	3.560	100	82.4	76.5	41.2
HAPC 5	2,380	77	2.858	100	72.7	48.1	16.9

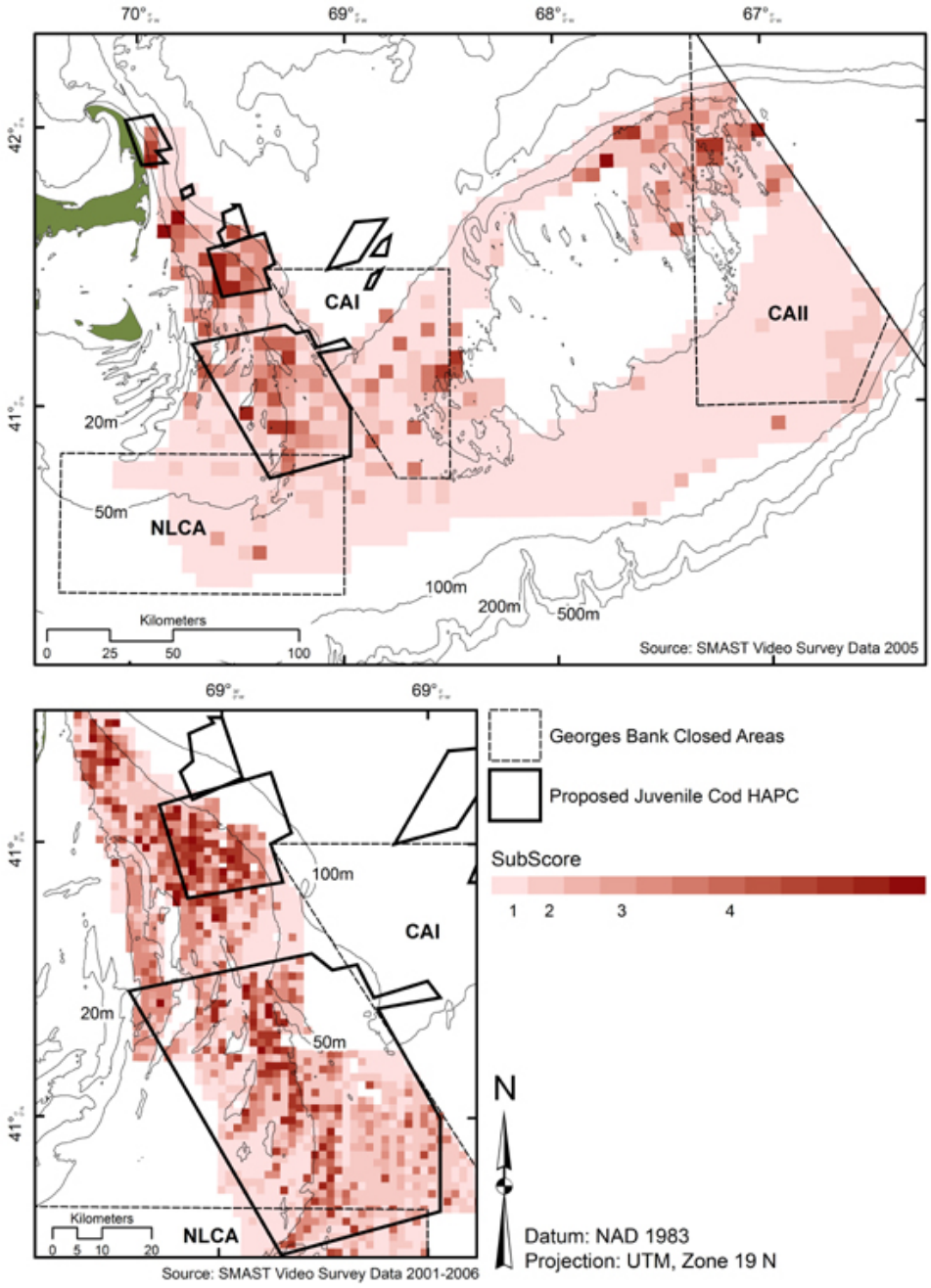
GB All = All Georges Bank Video Samples
GB OPEN = Video samples in open area
GSC = Video samples in GSC
HAPC All = Video samples in all 5 proposed HAPC

2001 -2006 Video Surveys 1.57 km Grid

Area	Area km^2	N	Mean SubScore	Sand Complex	Granule / Pebble	Cobble	Boulder
GSC	4368	1772	2.626	100	57.6	29.5	18.5
HAPC 4	362	147	3.515	92.5	78.9	61.9	51.0
HAPC 5	2093	849	2.698	98.7	66.9	31.8	17.8

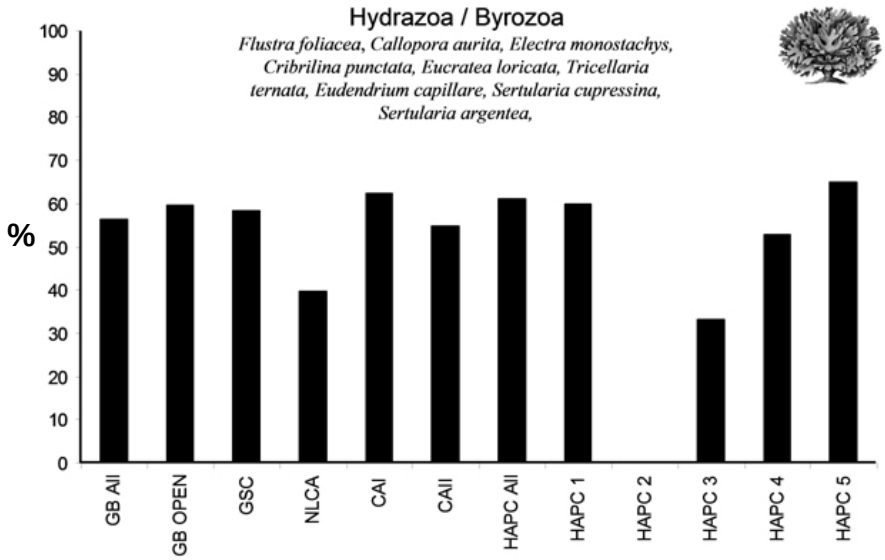
GSC = Video samples in GSC

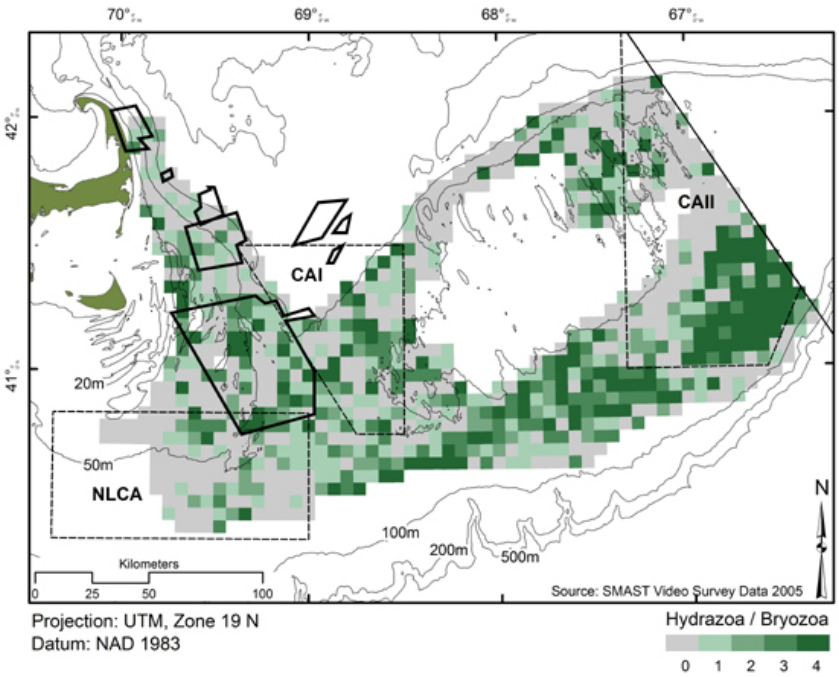
SubScore Map of Georges Bank with proposed HAPC. Upper panel shows 5.56 km grid and lower shows 1.57 km grid. The 5.56 grid survey data are from 2005. The 1.57 km grid survey data are a composition of multiple surveys conducted between 2001 and 2006 with the most recent data used for each region.

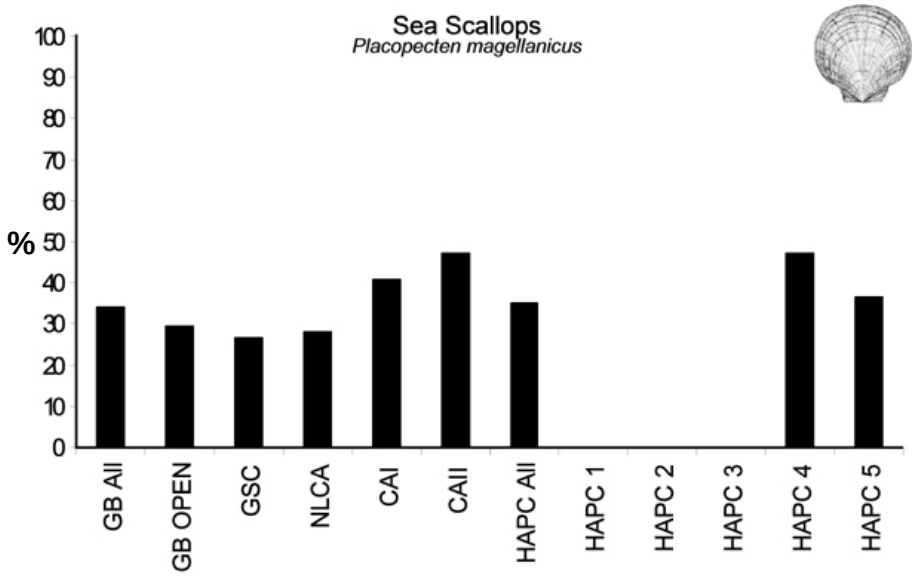


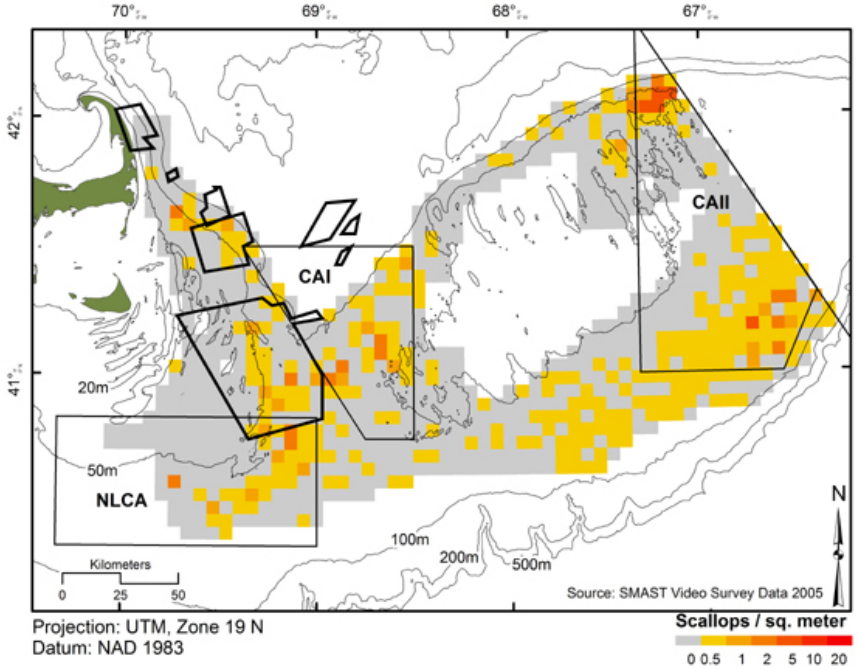
Megafauna Composition

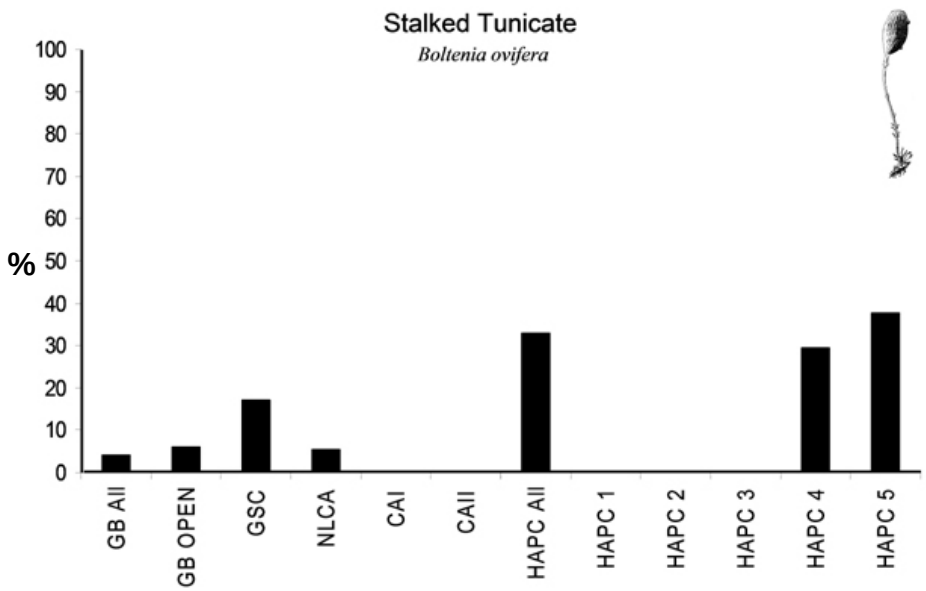
The megafauna were assessed based only on the 5.56 km grid survey (2005) as the 1.56 km grid contains data from multiple years. In the 2005 video survey the six most commonly observed megafauna (species or species group) in the proposed HAPC were Hydrazoa / Bryozoa, Sea scallops, Stalk tunicates, Sea stars, Sponges and Hermit crabs. The graphs below show the percent presence (number of stations with species / total number of stations x 100) of each megafauna category by area. The maps show scallops and sea stars per m^2 and all other megafauna by presence at survey quadrats (4 per station) (i.e. 2 = observed in 2 of 4 replicate samples).

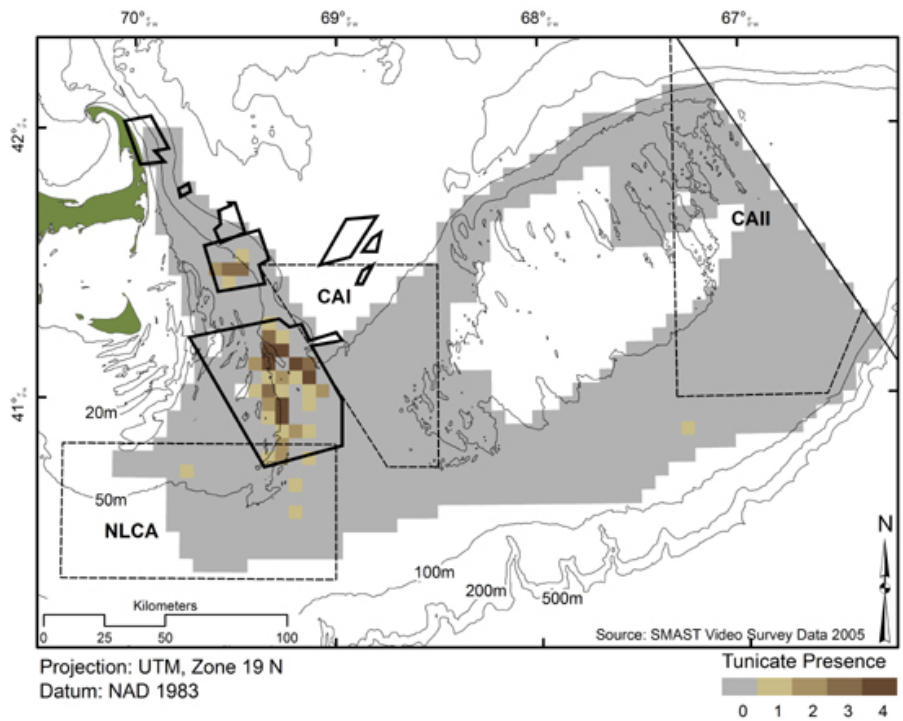


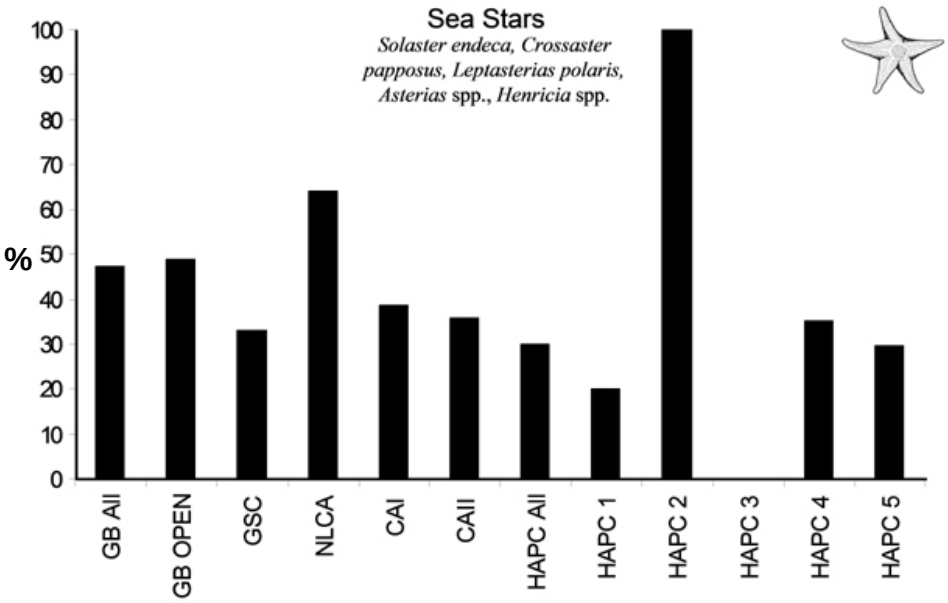


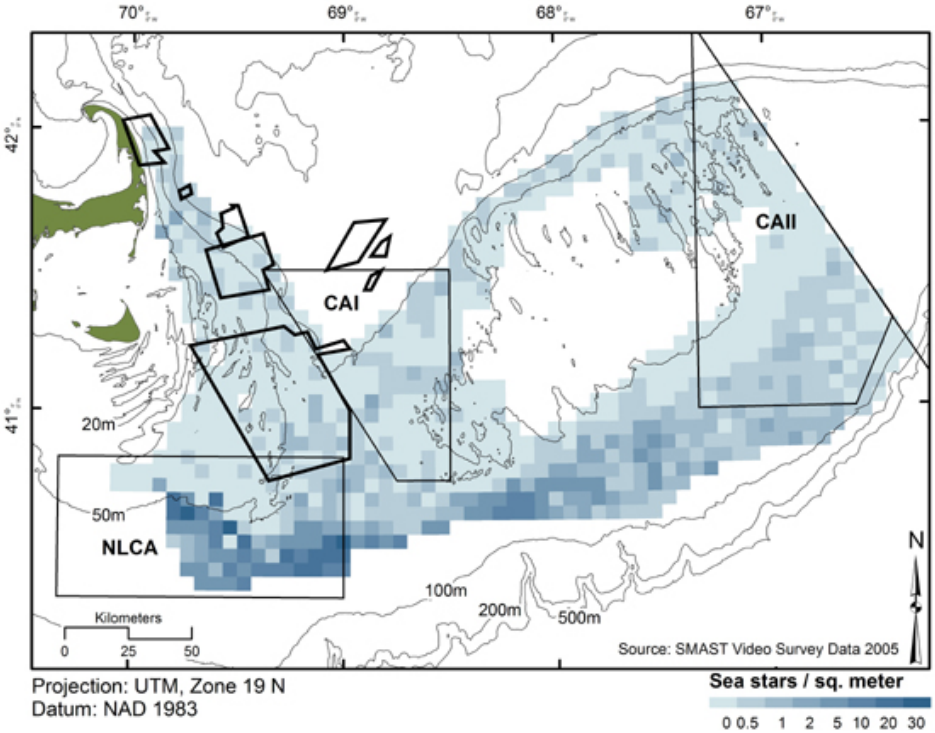

Sea Scallops
Placopecten magellanicus
%
100
90
80
70
60
50
40
30
20
10
0
GB All
GB OPEN
GSC
NLCA
CAI
CAII
HAPC All
HAPC 1
HAPC 2
HAPC 3
HAPC 4
HAPC 5

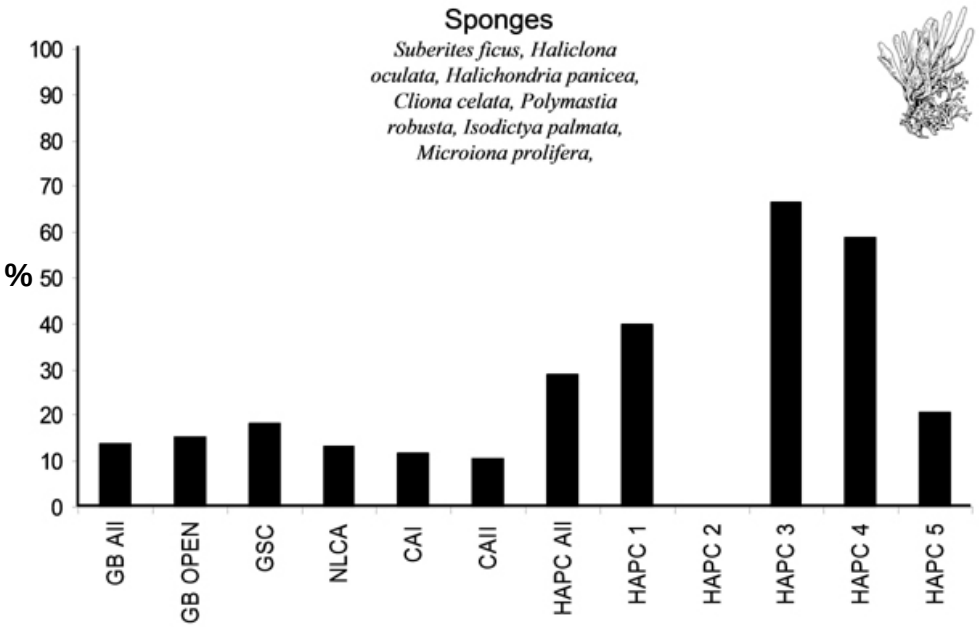

70°
69°
68°
67°
42°
41°
CAI
CAII
NLCA
20m
50m
100m
200m
500m
Kilometers
0
25
50
N
Source: SMAST Video Survey Data 2005
Projection: UTM, Zone 19 N
Datum: NAD 1983
Scallops / sq. meter
0 0.5 1 2 5 10 20

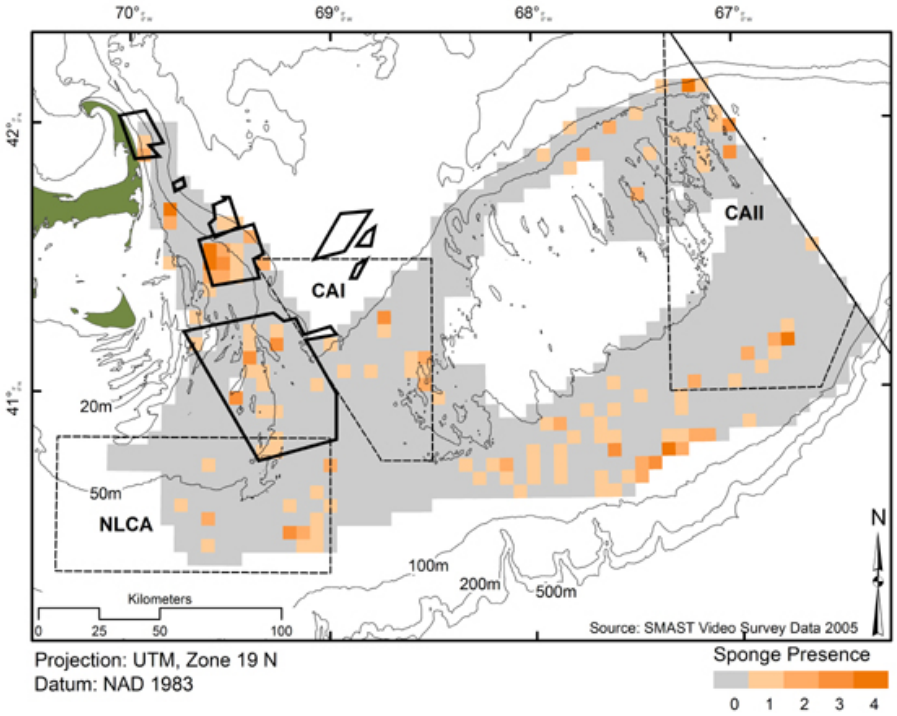

Stalked Tunicate
Boltenia ovifera
%
100
90
80
70
60
50
40
30
20
10
0
GB All
GB OPEN
GSC
NLCA
CAI
CAII
HAPC All
HAPC 1
HAPC 2
HAPC 3
HAPC 4
HAPC 5


70°
69°
68°
67°
42°
41°
CAI
CAII
NLCA
20m
50m
100m
200m
500m
Kilometers
0
25
50
100
N
Source: SMAST Video Survey Data 2005
Projection: UTM, Zone 19 N
Datum: NAD 1983
Tunicate Presence
0
1
2
3
4


Sea Stars
Solaster endeca, Crossaster papposus, Leptasterias polaris, Asterias spp., Henricia spp.
%
100
90
80
70
60
50
40
30
20
10
0
GB All
GB OPEN
GSC
NLCA
CAI
CAII
HAPC All
HAPC 1
HAPC 2
HAPC 3
HAPC 4
HAPC 5

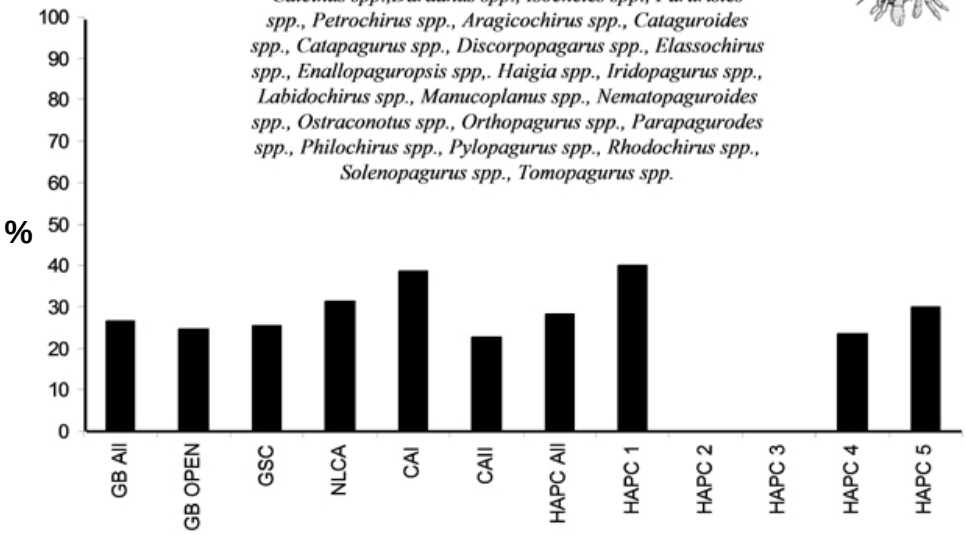

70°
69°
68°
67°
42°
41°
CAI
CAII
NLCA
20m
50m
100m
200m
500m
Kilometers
0
25
50
N
Source: SMAST Video Survey Data 2005
Projection: UTM, Zone 19 N
Datum: NAD 1983
Sea stars / sq. meter
0 0.5 1 2 5 10 20 30

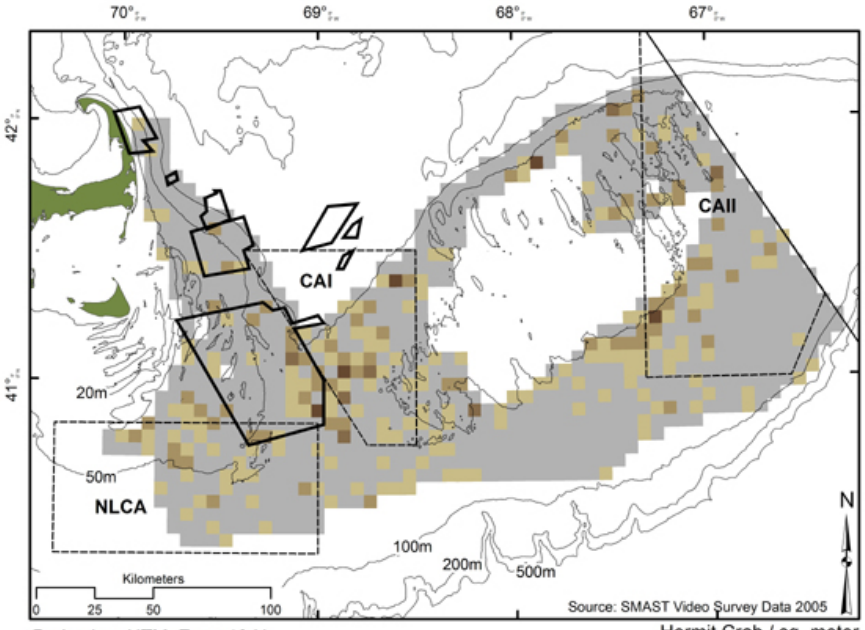

Sponges
Suberites ficus, Haliclona oculata, Halichondria panicea, Cliona celata, Polymastia robusta, Isodictya palmata, Microiona prolifera,
%
100
90
80
70
60
50
40
30
20
10
0
GB AII
GB OPEN
GSC
NLCA
CAI
CAII
HAPC AII
HAPC 1
HAPC 2
HAPC 3
HAPC 4
HAPC 5


70°
69°
68°
67°
42°
41°
CAI
CAII
NLCA
20m
50m
100m
200m
500m
Kilometers
0
25
50
100
N
Source: SMAST Video Survey Data 2005
Projection: UTM, Zone 19 N
Datum: NAD 1983
Sponge Presence
0
1
2
3
4

Hermit Crab

Calcinus spp.,Dardanus spp., Isocheles spp., Paruristes spp., Petrochirus spp., Aragicochirus spp., Cataguroides spp., Catapagurus spp., Discorpopagarus spp., Elassochirus spp., Enallopaguropsis spp,. Haigia spp., Iridopagurus spp., Labidochirus spp., Manucoplanus spp., Nematopaguroides spp., Ostraconotus spp., Orthopagurus spp., Parapagurodes spp., Philochirus spp., Pylopagurus spp., Rhodochirus spp., Solenopagurus spp., Tomopagurus spp.





The table below shows the percent presence (number of stations with species / total number of stations x 100) of each megafauna category observed in the HAPC. **Only a very small numbers of stations (N) were sampled in proposed HAPC areas 1 (N = 5), 2 (N = 1), and 3 (N = 3) during the 2005 survey. Percent presence values are strongly influenced by low sample sizes.**

							Proposed HAPC Areas					
	GB All	**GB OPEN**	**GSC**	**NLCA**	**CAI**	**CAII**	**All**	**1**	**2**	**3**	**4**	**5**
Area km^2	29,244	16,724	5,595	3,957	2,875	5,750	3,184	155	31	93	526	2,380
N	946	541	181	128	93	186	103	5	1	3	17	77
Hydra / Bryozoa	56.3	59.7	58.6	39.8	62.4	54.8	61.2	60.0	0.0	33.3	52.9	64.9
Scallops	34.0	29.6	26.5	28.1	40.9	47.3	35.0	0.0	0.0	0.0	47.1	36.4
Stalk Tunicate	4.1	5.9	17.1	5.5	0.0	0.0	33.0	0.0	0.0	0.0	29.4	37.7
Sea Stars	47.4	48.8	33.1	64.1	38.7	36.0	30.1	20.0	100.0	0.0	35.3	29.9
Sponges	13.8	15.3	18.2	13.3	11.8	10.8	29.1	40.0	0.0	66.7	58.8	20.8
Hermit Crab	26.6	24.8	25.4	31.3	38.7	22.6	28.2	40.0	0.0	0.0	23.5	29.9
Skate	12.9	12.2	17.7	23.4	15.1	6.5	17.5	0.0	0.0	0.0	5.9	22.1
Flounder	4.9	5.2	2.2	8.6	3.2	2.2	4.9	20.0	0.0	0.0	5.9	3.9
Anemone	5.3	6.5	5.5	2.3	3.2	4.8	3.9	0.0	0.0	0.0	11.8	2.6
Crabs	5.6	5.2	3.3	16.4	2.2	1.1	3.9	0.0	0.0	33.3	5.9	2.6
Urchin	0.6	0.2	0.6	1.6	0.0	1.6	2.9	20.0	0.0	0.0	0.0	2.6
Buccinum	1.0	0.6	1.1	0.8	4.3	0.5	1.9	0.0	0.0	0.0	0.0	2.6
SandDollar	20.7	14.2	5.0	28.9	28.0	30.1	1.9	20.0	0.0	0.0	0.0	1.3
Cod	0.3	0.2	0.6	0.8	0.0	0.5	1.9	0.0	0.0	0.0	5.9	1.3
Dogfish	0.5	0.9	2.8	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	2.6
Silver Hake	0.3	0.4	1.1	0.8	0.0	0.0	1.9	0.0	0.0	0.0	0.0	2.6
Clams	0.1	0.2	0.6	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	1.3
Hagfish	0.1	0.2	0.6	0.0	0.0	0.0	1.0	0.0	0.0	0.0	5.9	0.0
Hake	9.0	9.4	1.7	14.1	5.4	5.9	1.0	0.0	0.0	0.0	0.0	1.3

Discussion

Due to the limited numbers of stations sampled in proposed HAPC areas 1, 2, and 3 data from theses areas should be considered cautiously.

The substrate composition data from the 5.56 (2005) and the 1.57 (2001- 2006) km grid surveys are very similar though these surveys are independent and cover differing time scales. The overall substrate composition of the proposed HAPC areas is reflective of the GSC. Within the proposed HAPC areas the 5.56 and the 1.57 km gird surveys show the substrates in area 4 have the highest composition of granule / pebble, cobble, and boulder.

The overall megafauna composition of the proposed HAPC areas is reflective of the GSC but contain more hydrozoa / bryozoa, tunicates, and sponges. Within the proposed HAPC areas the 5.56 km gird survey shows the megafauna composition in area 4 have the highest composition of scallops, sea stars, and sponges, while area 5 has the highest composition of hydrozoa / bryozoa, and tunicates.

In areas 4 and 5 there is a clear division in substrate composition along the 50 m depth contour with more cobble and boulder substrates west of this line. Further, tunicates and sponges appear to be more prevalent west of this boundary while hydrozoa / bryozoa, scallops, sea stars and hermit crabs do not.

For further information or analysis contact the author.

References

Harris, B. P. and Stokesbury K. D. E., 2005 Mapping Benthic Substrate and Macroinvertebrates along the Northwest Atlantic Ocean Continental Shelf with Underwater Video Surveys. ICES CM 2005/ L:39

Stokesbury, K. D. E., 2002. "Estimation of sea scallop abundance in closed areas of Georges Bank, USA." *Transactions of the American Fisheries Society* **131**: 1081-1092.

Stokesbury, K. D. E., B. P. Harris, et al., 2004. "Estimation of sea scallop abundance using a video survey in off-shore USA waters." *Journal of Shellfish Research* **23**: 33-44.

Stokesbury, K.D.E., and B.P. Harris, 2006 Impact of a limited fishery for sea scallop, *Placopecten magellanicus*, on the epibenthic community of Georges Bank closed areas, Mar. Ecol. Prog. Ser. 307:85-100**.**