

FINAL TECHNICAL MEMORANDUM

**BENTHIC HABITAT SURVEY OF
TWO OFFSHORE BORROW SITES**

**WALLOPS FLIGHT FACILITY
SHORELINE RESTORATION AND
INFRASTRUCTURE PROTECTION
PROGRAM**

Prepared for



National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
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This Technical Memorandum summarizes the results of a video survey of benthic habitats conducted at the two potential offshore borrow sites for the SRIPP. The survey was conducted in July 2009.

1.0 PROJECT STUDY AREA

The video survey was conducted on two offshore sand shoals (Unnamed Shoal A and B) that are being evaluated as potential borrow sources for beachfill sand for NASA's SRIPP (Attachment 1 - Figure 1). These sand ridges trend from northeast to southwest and the shoal crests and generally get deeper further offshore.

1.1 Unnamed Shoal A

Unnamed Shoal A is located approximately 11 kilometers (7 miles) east of Assateague Island. The southern end of Unnamed Shoal A is approximately 15 kilometers (10 miles) from the Wallops Island shoreline, and the north end of this shoal is approximately 21 kilometers (13 miles) from the shoreline. Unnamed Shoal A has a depth of approximately 7.5 to 12 meters (25 feet to 40 feet). Between Unnamed Shoals A and B, water depth ranges from 23 to 12 meters (75 to 40 feet).

1.2 Unnamed Shoal B

Unnamed Shoal B is located approximately 16 kilometers (10 miles) east of Assateague Island. The southern end of Unnamed Shoal B is approximately 21 kilometers (13 miles) from the Wallops Island shoreline, and the north end of this shoal is approximately 26 kilometers (16 miles) from the shoreline. Unnamed Shoal B ranges in depth from approximately 9 to 15 meters (30 to 50 feet).

2.0 METHODS

2.1 Review of Existing Data

To understand the potential benthic habitat and communities that may exist in the project area, URS reviewed existing data collected in the general vicinity of the borrow sites. There are no existing benthic studies of Unnamed Shoal A and B. Relevant existing data consists of studies conducted on primarily shoals offshore of Ocean City, MD and to a lesser degree Sandbridge Shoal, VA.

In addition, sediment sampling was conducted by Alpine Ocean Seismic Survey in July 2007 and January 2008 on the shoals considered for borrow sites (Alpine 2007, 2008). Vibracores were collected throughout the shoal area with grain size analyses conducted on discrete strata of the cores indicating that the sediment in both shoals is generally fine to medium sand.

2.2 Video Survey

The video survey was conducted within and adjacent to approximate 5.2 square kilometer (2.0 square miles) blocks of each shoal. These blocks were delineated by the USACE Norfolk District and each one contains an adequate volume of suitable sand for the entire 50-year life cycle of the beachfill.

A digital drop camera with light assembly was deployed at approximately 40 stations on each shoal to collect video of the benthic habitats present. The camera was a VSPNTM

3003 High Resolution video camera. Video images were fed to an onboard display in realtime and images recorded on a DVD. Distance off the bottom was maintained by hand feeding the camera's umbilical line. Select still shots were collected from the video during post-processing using Snagit software from TechSmith Corporation.

The video stations were comprised of eight (8) transects across each shoal roughly perpendicular to the shoreline with each transect including five (5) stations throughout the two potential borrow areas: one station on the shoreward trough, one station on the shore-facing slope, one station on the shoal crest, one station on the seaward-facing slope, and one station on the seaward trough. Figures 2 and 3 depict the locations of the video stations on Unnamed Shoal A and B, respectively.

Video was collected for approximately 5 minutes at each station. The video included a date and time stamp along with a display of the geographic coordinates in Virginia State Plane North (NAD-83). A Hemisphere Crescent R130 DGPS with inertial navigation corrections (for up to 45 minutes after loss of signal) was used for the survey. The Hemisphere system transmits information in NMEA 0183 code to a computer navigation system using the *Hypack 2009a* survey software. The *Hypack* software incorporates the NMEA 0183 data string and displays vessel position on a computer screen relative to pre-programmed track lines and each instrument sensor. It also performs instantaneous data translations between various geodetic projections, which combine all incoming data with accurate positions for seamless data integration and post acquisition processing. The Hemisphere Crescent 130 DGPS is considered to be accurate to within 8 inches Root Mean Square (RMS) values under optimal conditions.

The survey vessel was allowed to drift during deployment of the camera. Starting and ending coordinates were collected and recorded for each station.

The images were analyzed for benthic habitat type and biological structures such as tubes or burrows. Organisms captured on the video were identified to lowest practical taxon. The videos were post-processed and reviewed by a benthic ecologist. The video processing followed methods presented and described by Cutter and Diaz (2000). Data sheets were developed to summarize the data collected from each video. The data collected at each station included:

- 1) Shoal Name
- 2) Starting Coordinates (Easting, Northing)
- 3) Ending Coordinates (Easting, Northing)
- 4) Length of Video
- 5) Average Water Depth
- 6) Bottom Type
 - a. 1 = sand
 - b. 2 = fine sand/silt
- 7) Bedform size
 - a. 1 = none, no bedforms – bottom relatively flat and uniform
 - b. 2 = large bedforms, wavelengths approximately 30 cm or greater
 - c. 3 = small bedforms, wavelengths less than approximately 30 cm
- 8) Bedform shape
 - a. 1 = none

- b. 2 = smooth crested with top of bedform rounded
 - c. 3 = sharp crested with top of bedform peaked
- 9) Shell Cover
- a. < 10% of surface area
 - b. > 10% of surface area
- 10) Biogenic structures such as tubes and burrow openings
- 11) Fauna observed
- 12) Comments – visibility conditions, sea state, etc.

3.0 RESULTS

3.1 Summary of Existing information

Benthic Communities

Relevant recent studies have been conducted of the offshore benthic communities in this region (Maryland and Virginia) of the Mid-Atlantic Bight. Cutter et al. (2000), Diaz et al. (2004) and Slacum et al. (2006) reported on the benthic communities of the sand shoals and reference areas offshore of northern Maryland (approximately 35 to 50 kilometers [20 to 35 miles] north of the proposed SRIPP borrow sites). The sampling sites were located approximately 16 to 25 kilometers (10 to 15 miles) offshore in water depths between 10 and 20 meters (6 and 12 feet). In addition, VIMS (Diaz et al 2006) examined Sandbridge Shoal located approximately 5 kilometers (3 miles) offshore of Virginia Beach to the south of the SRIPP study area.

Cutter and Diaz (2000) collected benthic grab samples, video, and sediment profile imaging data of sand shoals offshore northern Maryland and southern Delaware in 1998 and 1999. Cutter and Diaz (2000) and Diaz et al. (2004) reported that in the sediment grab samples they collected offshore of northern Maryland and southern Delaware, they found that the infaunal communities were dominated by annelid worms, followed by mollusks and crustaceans. Mollusks accounted for over 85 percent of the biomass.

Cutter and Diaz (2000) also reported on the epifauna of the area. They found that three crabs (hermit crabs [*Pagurus* spp.], portly spider crab [*Libinia emarginata*], and Atlantic rock crab [*Cancer irroratus*]) were most abundant. Large gastropods such as the whelk (*Busycon canaliculatum*) and moon snail (*Polinices* spp.) were also collected. Other large benthos collected were the infaunal bivalves such as the surf clam (*Spisula solidissima*) and common razor clam (*Ensis directus*). Astartes (*Astarte* spp.), bivalves known to lie on the sediment surface, were collected along with starfish (*Asterias* spp.) and common sand dollar (*Echinarachnius parma*). Overall, crabs were most abundant in the habitats with biogenic structure, such as tubes created by the polychaetes *Asabellides* and *Diopatra*, and appeared to be using these habitats as nursery areas since the most of the individuals were small (<5 centimeters [<2 inches]). Other species were broadly distributed across all habitats such as nudibranchs, *Pagurus* spp., sand shrimp (*Crangon septemspinosa*), and *Asterias* spp. The two species that appeared to prefer the sandy and more dynamic habitats were moon snail and sand dollar.

Slacum et al. (2006) collected large epifauna during their trawling efforts on shoals offshore Maryland (Table 1). These organisms are expected to occur on the offshore shoals in the project area.

Table 1: Organisms Collected by Slacum et. al. (2006) in Trawls Collected from Shoals Offshore of Maryland (seasonal sampling from fall 2002 to summer 2004).

Scientific Name	Common Name
Asteroidea	Starfishes
<i>Busycon carica</i>	Knobbed whelk
<i>Busycotypus canaliculatus</i>	Channeled whelk
<i>Callinectes sapidus</i>	Blue crab
<i>Cancer irroratus</i>	Atlantic rock crab
<i>Crangon septemspinosa</i>	Sand shrimp
Echinoidea	Heart urchins
Gastropoda	Gastropods
<i>Libinia emarginata</i>	Portly spider crab
<i>Limulus polyphemus</i>	Horseshoe crab
<i>Nudibranchia</i>	Nudibranchs
<i>Octopus vulgaris</i>	Common octopus
<i>Ovalipes ocellatus</i>	Lady crab
<i>Ovalipes stephensoni</i>	Coarsehand lady crab
Paguridae	Right-handed hermit
<i>Polinices</i>	Moon snails

Slacum et al. (2006) reported that the abundance of epifaunal groups between two habitats, i.e., the shoal and uniform bottom, showed no differences; suggesting that shoals are not preferred by epifaunal species when compared to their reference site habitat.

Diaz et al (2006) reported on the benthic habitat and fauna of Sandbridge Shoal located 4.5 – 6.6 km (2.8 – 4.1 mi) offshore in approximately 10 – 13 m (32 – 43 ft) of water. They reported that the sediment surface was dominated by physical processes and the habitats were relatively uniform. The most common fish were sea robins (*Prionotus* spp.). The most common epifauna were hermit crabs (*Pagurus* spp.) and sand shrimp (*Crangon septemspinosa*). They also collected grabs samples and characterized the infaunal community. It was dominated by polychaetes, amphipods, bivalves, and lancelets.

Sediments

Table 1 below lists the grain sizes and vibracore samples collected by Alpine on Unnamed Shoal A and Unnamed Shoal B. Vibracore strata to approximately 6 feet are provided. In general, the sediment at both shoals ranged from fine to medium sand.

Table 1: Grain size found in samples taken within the boundaries of the proposed borrow site options.

Shoal	Core Sample Number	Sample Depth in meters (feet)	Mean Grain Size (ϕ)	Mean Grain Size (mm)
A	07-WIVC-30	0-1.2 (0-4.1)	0.74	0.60
A	07-WIVC-30	1.2-2.9 (4.1-9.5)	1.03	0.49
A	WIVC-54	0-1.5 (0-5)	0.525	0.69
A	WIVC-54	1.5-3.5 (5-11.4)	0.35	0.78
A	WIVC-55	0-1.7 (0-5.6)	1.45	0.37
A	WIVC-55	1.7-2.7 (5.6-9)	1.15	0.45
A	07-WIVC-29	0-1.1 (0-3.7)	1.40	0.38
A	07-WIVC-29	1.1-2.2 (3.7-7.2)	1.40	0.38
A	WIVC-58	0-1.2 (0-4)	1.725	0.30
A	WIVC-58	1.2-2.4 (4-8)	1.825	0.28
A	WIVC-56	0-1.9 (0-6.1)	1.5	0.35
A	WIVC-56	1.9-3 (6.1-10)	1.975	0.25
A	WIVC-57	0-1.2 (0-4)	2.04	0.24
A	WIVC-57	1.2-2.4 (4-8)	2.025	0.24
A	WIVC-65	0-0.6 (0-2)	1.325	0.40
A	WIVC-65	0.6-1.5 (2-5)	1.55	0.34
A	WIVC-66	0-0.5 (0-1.8)	1.09	0.47
A	WIVC-66	0.5-2.6 (1.8-5)	2.05	0.24
B	WIVC-67	0-1.5 (0-5)	1.625	0.32
B	WIVC-67	1.5-3 (5-10)	1.075	0.47
B	WIVC-68	0-1.5 (0-5)	1.45	0.37
B	WIVC-68	1.5-2.8 (5-9.3)	1.225	0.43
B	WIVC-69	0-1.5 (0-5)	1.24	0.43
B	WIVC-69	1.5-3 (5-10)	1.9	0.27
B	WIVC-70	0-1.5 (0-5)	1.9	0.27
B	WIVC-70	1.5-2.8 (5-9.2)	1.8	0.29

Shoal	Core Sample Number	Sample Depth in meters (feet)	Mean Grain Size (ϕ)	Mean Grain Size (mm)
B	WIVC-71	0-0.4 (0-1.3)	1.675	0.31
B	WIVC-71	0.4-1.5 (1.3-5)	2.55	0.17
B	WIVC-72	0-0.8 (0-2.6)	1.5	0.35
B	WIVC-72	0.8-1.5 (2.6-5)	2	0.25

Source: Alpine Ocean Seismic Survey (2007, 2008)

3.2 Survey Results

The video survey was conducted from July 7 – 9, 2009. In general, visibility was better at Unnamed Shoal B than Unnamed Shoal A. Data sheets summarizing the analysis of the video are provided in Attachment 2. Representative photographs are provided on the following pages.

In general, results of the video survey indicated that sediment on the shoal crests and topographically higher portions of the shoals were dominated by physical features such as ripple marks. These higher areas were typically uniform sand and had a lower surface cover of shell than deeper portions of the study area. The deeper portions of each of the shoals were dominated by shell fragments and hash, as well as biological features such as tubes and mounds created by benthic organisms with little or no evidence of ripple marks.

The benthic habitats and epifaunal communities were similar on the two shoals. The benthic habitat was comprised of unvegetated soft sediment dominated by fine to medium sand. No hard bottom habitats were observed. Dominant epifaunal benthos included; hermit crabs (*Pagurus* spp.) (Photo B-16), sand dollars (*Echinarachinus parma*) (Photo B-9, B-10), crabs [*Libinia emarginata* (Photo A-7), *Cancer* spp. (Photo B-15)], moon snail (*Polinices* spp.) (Photo B-7) and whelk (*Busycon* spp.). Hermit crabs were observed at most of the stations. Moon snail sand collars or egg cases (Photo B-7) were observed at many of the stations. In addition, there was a patch of ascidians (sea squirts) located at Station 24 in approximately 58 ft of water. Fish were rarely seen at any of the stations; those that were observed were primarily (*Prionotus* spp.) (Photo B-20).

Representative Photographs from Unnamed Shoal A (Note that the Photo contains the date and time of collection in upper left and Virginia State Plane North NAD-83 coordinates in upper right)

Photo A-1 : Station #2 from Unnamed Shoal A at a depth of 55 ft with high shell content and lack of surface bedforms.

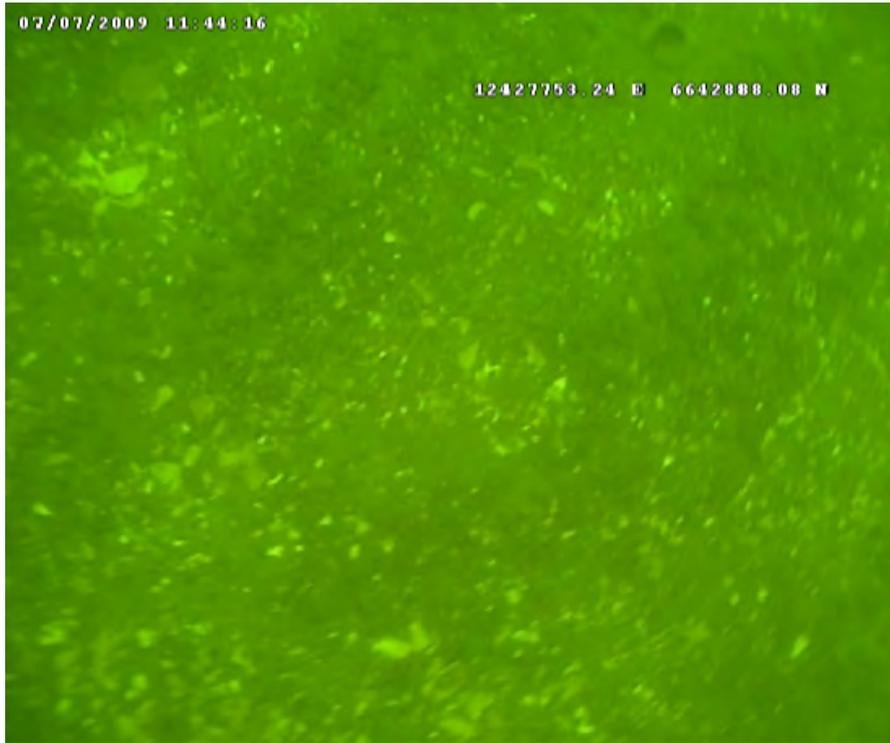


Photo A-2 : Station #6 from Unnamed Shoal A at a depth of 44 ft with well-defined ripple marks and low shell content.



Photo A-3 : Station #6 from Unnamed Shoal A at a depth of 44 ft with well-defined ripple marks and low shell content.

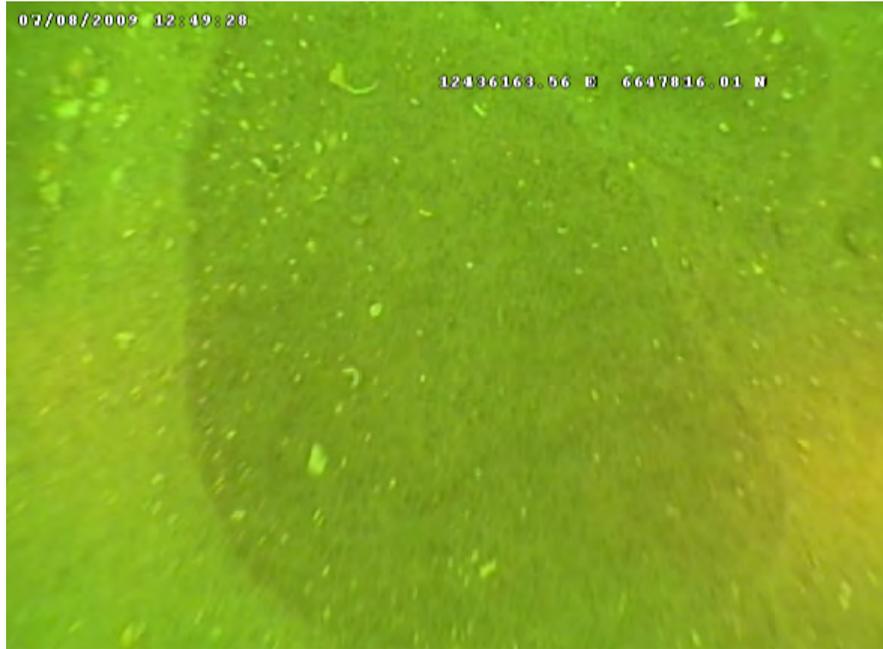


Photo A-4: Station #14 from Unnamed Shoal A at a depth of 53 ft with a lack of surface bedforms.



Photo A-5: Station #15 from Unnamed Shoal A at a depth of 53 ft with a lack of surface bedforms.

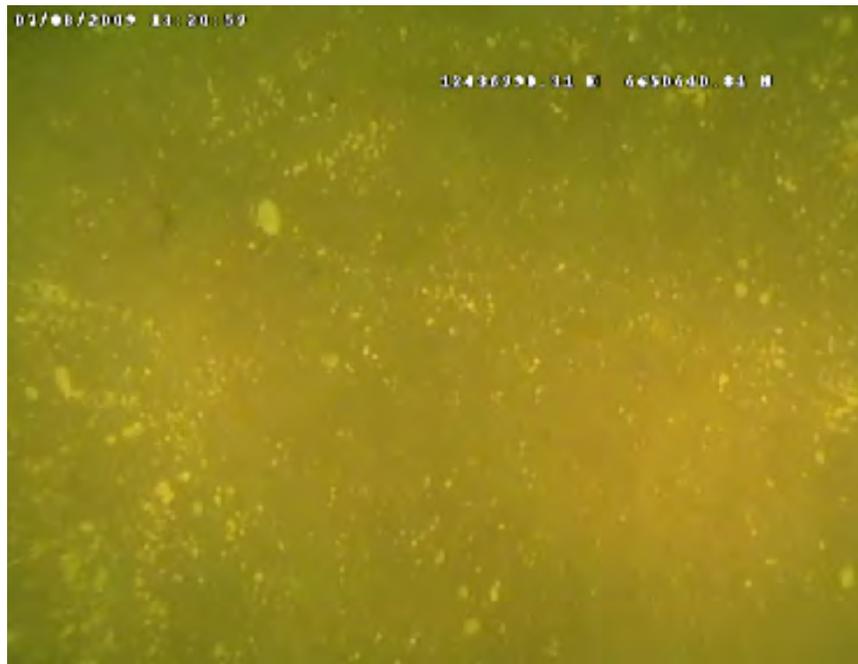


Photo A-6: Station #17 from Unnamed Shoal A at a depth of 64 ft with a high shell content and lack of surface bedforms.



Photo A-7: Station #23 from Unnamed Shoal A at a depth of 60 ft. Portly spider crab (*Libinia emarginata*) in lower right quadrant.



Photo A-8: Station #31 from Unnamed Shoal A at a depth of 50 ft with a lack of surface bedforms and low shell content.

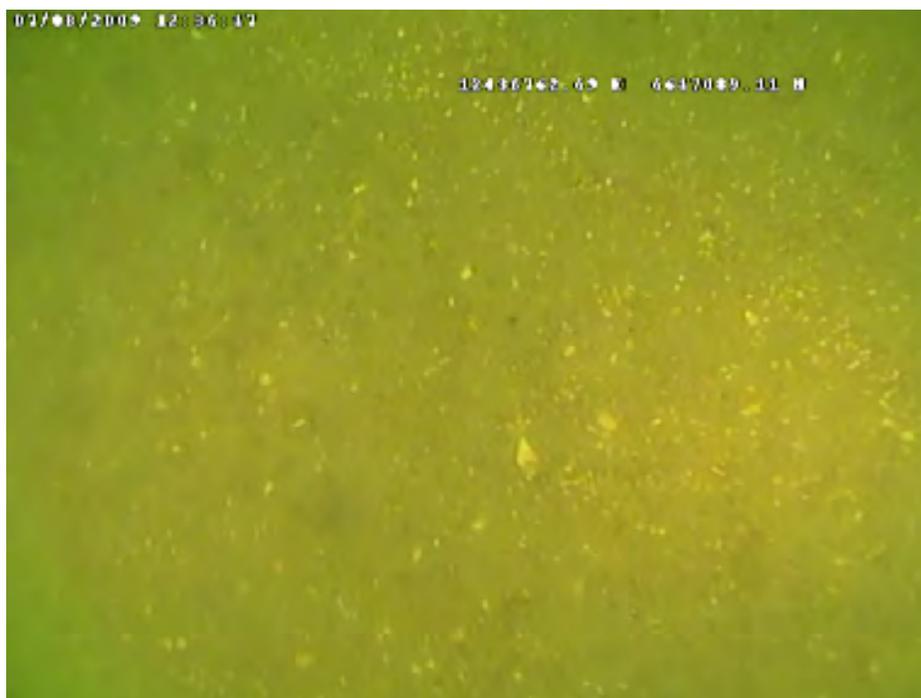


Photo A-9: Station #36 from Unnamed Shoal A at a depth of 42 ft with ripple marks and low shell content.



Photo A-10: Station #38 from Unnamed Shoal A at a depth of 33 ft depicting well-defined ripple marks and a sand dollar (*Echinarachinus parma*) in upper right quadrant.



Photo A-11: Station #39 from Unnamed Shoal A at a depth of 31 ft. Shell concentrated in troughs of ripple marks.



Representative Photographs from Unnamed Shoal B

Photo B-1: Station #1 Unnamed Shoal B at a depth of 42 ft.
Tube/burrow opening to right of center.



Photo B-2: Station #2 Unnamed Shoal B at a depth of 42 ft with well-defined ripple marks and low shell content characteristic of stations on shoal crest.



Photo B-3: Station #6 Unnamed Shoal B at a depth of 45 ft depicting surface bedforms.



Photo B-4: Station #9 Unnamed Shoal B at a depth of 55 ft. Starfish (*Astropecten* spp.) in upper left quadrant.



Photo B-5: Station #9 Unnamed Shoal B at a depth of 55 ft with no surface bedforms and high shell content.



Photo B-6: Station #10 Unnamed Shoal B at a depth of 55 ft. Portly spider crab (*Libinia emarginata*) in lower right quadrant.



Photo B-7: Station #10 Unnamed Shoal B at a depth of 55 ft. Moon snail (*Polinices* spp.) sand collars in upper right quadrant and moon snail in upper left quadrant.



Photo B-8: Station #12 Unnamed Shoal B at a depth of 58 ft with lack of surface bedforms and high shell content.

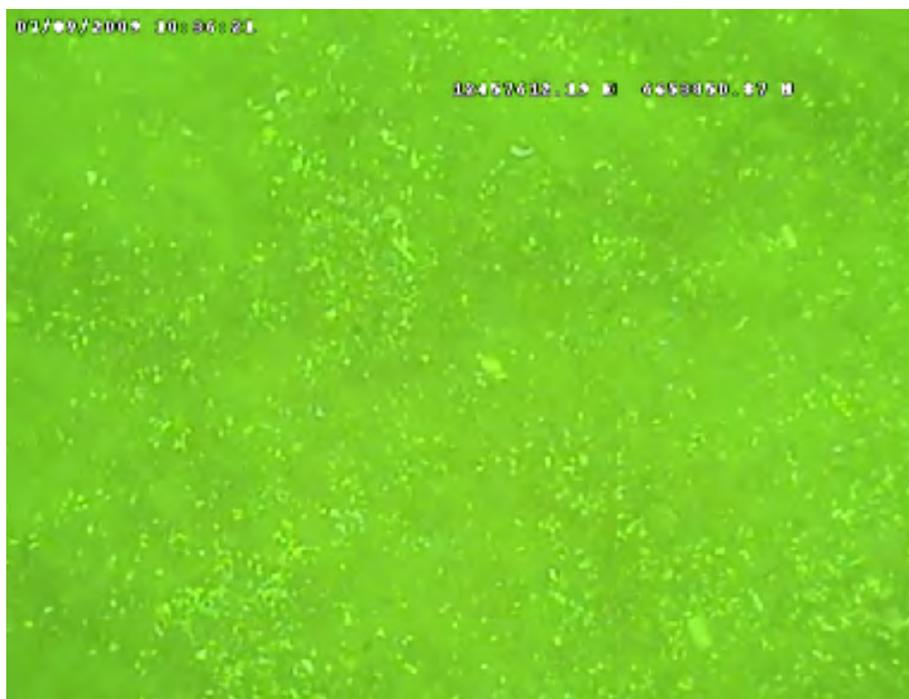


Photo B-9: Station #14 Unnamed Shoal B at a depth of 48 ft. Sand dollars (*Echinarachinus parma*) at upper right and lower left quadrants.



Photo B-10: Sand dollars (*Echinarachinus parma*) from Station #14 Unnamed Shoal B at a depth of 48 ft.



Photo B-11: Station #20 from Unnamed Shoal B at a depth of approximately 45 ft depicting well-defined ripple marks and low shell content.



Photo B-12: Station #20 from Unnamed Shoal B at a depth of approximately 45 ft with well-defined ripple marks and low shell content.



Photo B-13: Station #22 from Unnamed Shoal B at a depth of approximately 43 ft with well-defined ripple marks and low shell content.



Photo B-14: Station #22 from Unnamed Shoal B at a depth of approximately 43 ft with well-defined ripple marks and low shell content.



Photo B-15: Station #25 from Unnamed Shoal B at a depth of approximately 74 ft. Crab (*Cancer irroratus*) located in upper left quadrant with high shell content.

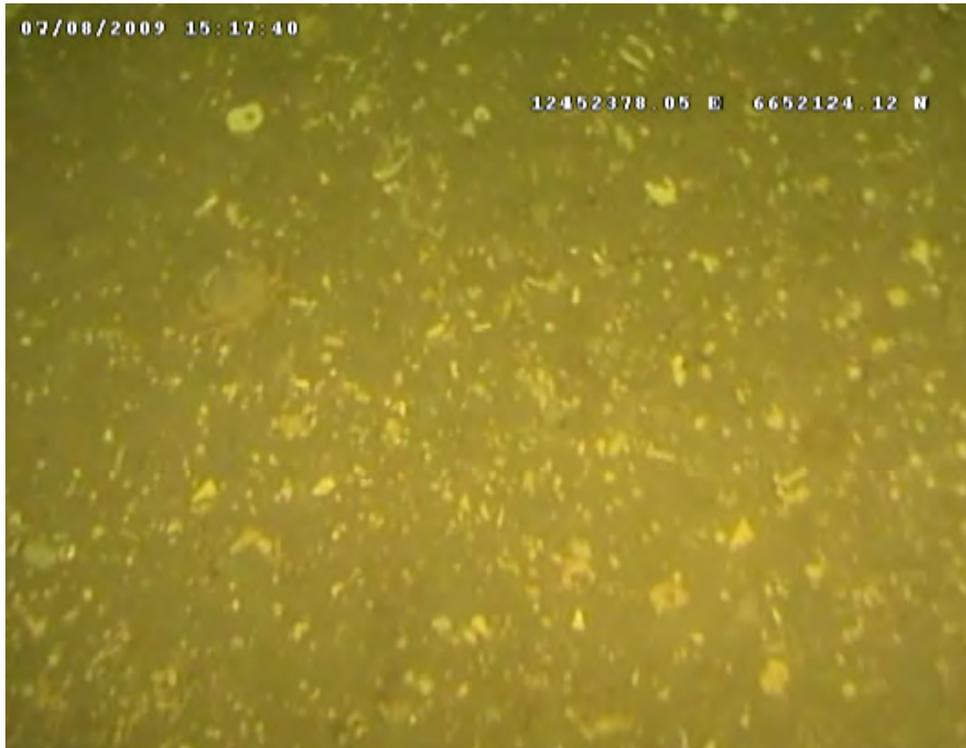


Photo B-16: Station #29 from Unnamed Shoal B at a depth of approximately 66 ft. Hermit crab (*Pagurus* spp.) located in lower right quadrant.



Photo B-17: Station #31 from Unnamed Shoal B at a depth of approximately 60 ft with lack of well-defined bedforms.



Photo B-18: Station #35 from Unnamed Shoal B at a depth of approximately 63 ft with defined bedforms and organic material concentrated in troughs.

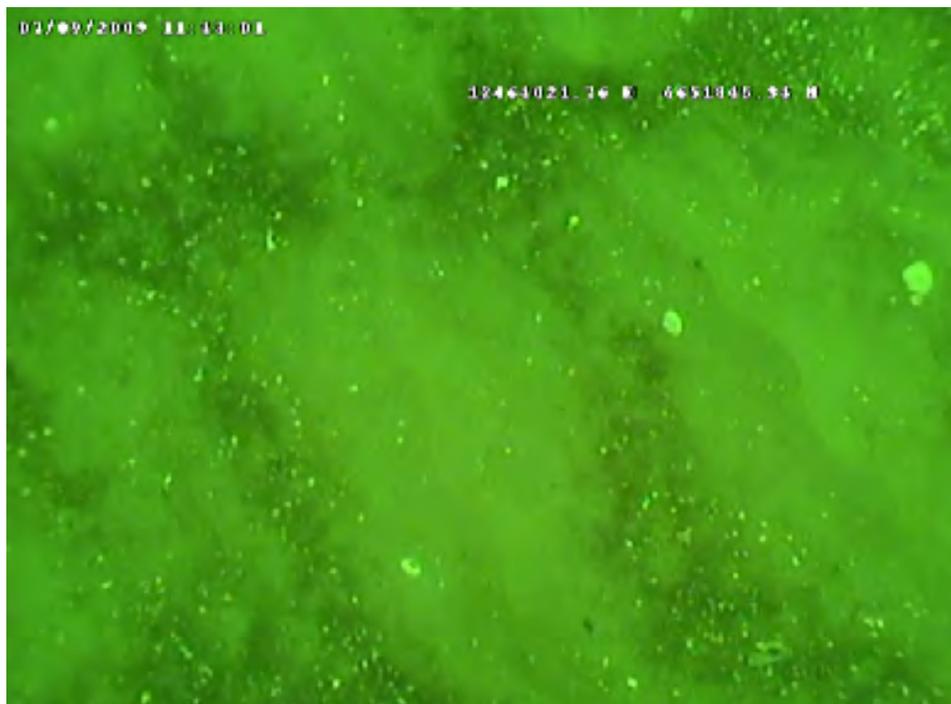


Photo B-19 : Station #39 from Unnamed Shoal B at a depth of approximately 56 ft with defined bedforms and low shell content.



Photo B-20: Sea robin (*Prionotus* spp.) in lower right quadrant from Station #39 Unnamed Shoal B at a depth of 56 ft.



4.0 CONCLUSIONS

The results of the video survey indicate that the two shoals are comprised of unconsolidated sand. These results were confirmed with results of the cultural resource remote sensing survey of the two shoals. Sub bottom profiler data analysis for both Unnamed Shoal A and B indicated that these sand features have relatively poor bedding, which indicates that the sands are homogenous in nature. This sediment homogeneity has likely resulted from long-term preferential grain size sorting by current, wave action, and large storm events.

The benthic habitats and epifaunal communities were similar on the two shoals. Dominant epifaunal benthos included sand dollars, hermit crabs, crabs such as the portly spider crab and Atlantic rock crab, moon shell, and whelk. Fish were rarely seen at any of the stations; those that were observed were primarily (*Prionotus* spp.)

In general for both shoals, the shallowest video stations located on the crests of the shoals contained evidence of well-defined bedforms or ripple marks with wavelengths less than 30 cm (12 in) (e.g., Photos A-3, A-9, A-10, A-11 and Photos B-2, B-9, B-11, B-12, B-13, and B-14). In addition, the shallow stations had low surface shell content. The presence of these bedforms is typically associated with physically-dominated (i.e., waves and currents) habitats, where the presence of worm tubes and burrows would be indicative of a more biologically accommodated habitat (Rhoads and Germano 1986). The lack of apparent biogenic features does not necessarily indicate a paucity of biological resources (Cutter and Diaz 1998). The majority of the benthos on the shoal crests are adapted to the energetic conditions, live within the sediment, and were not visible to the camera. They do not construct tubes or feeding mounds; thereby, resulting in the “clean” appearance of the sand (Cutter and Diaz 1998).

5.0 REFERENCES

- Alpine Ocean Seismic Survey, Inc. 2007. Vibracore Sampling Wallops Island Sand Search. Prepared for USACE Norfolk District. (July 20, 2007)
- Alpine Ocean Seismic Survey, Inc. 2008. Vibracore Sampling Wallops Island Flight Facility. Prepared for USACE Norfolk District. (January 17, 2008)
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- Slacum, H.W. Jr., W.H. Burton, J.H. Vølstad, J. Dew, E. Weber, R. Llansó, and D. Wong. 2006. Comparisons Between Marine Communities Residing on Sand Shoals and Uniform-bottom Substrate in the Mid-Atlantic Bight. Final Report to the U.S. Department of the Interior, Minerals Management Service, International Activities and Marine Minerals Division, Herndon, VA. OCS Report MMS 2005-042, 149 pp. + app.

ATTACHMENT 1

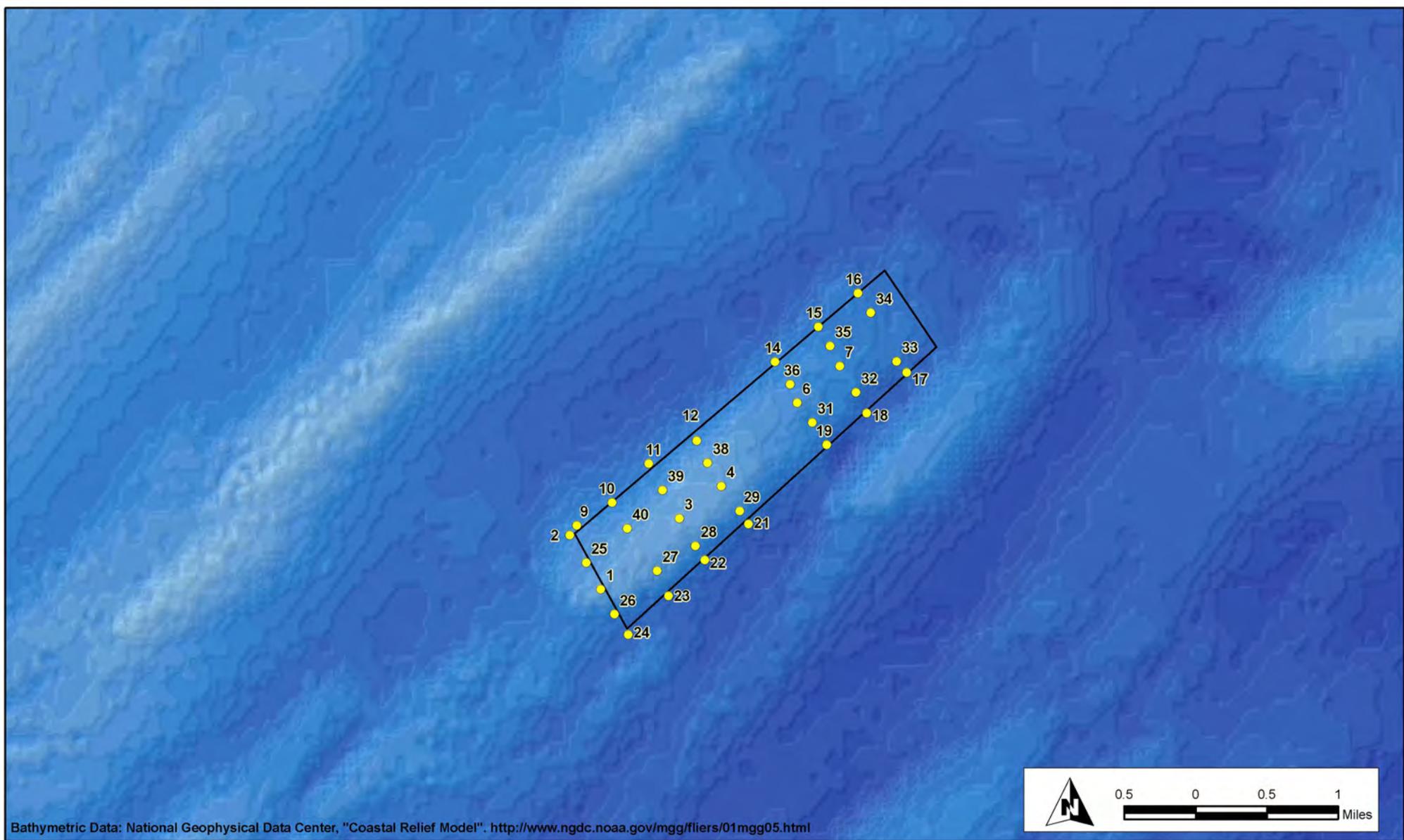
FIGURES



Bathymetric Data: National Geophysical Data Center, "Coastal Relief Model". <http://www.ngdc.noaa.gov/mgg/filers/01mgg05.html>



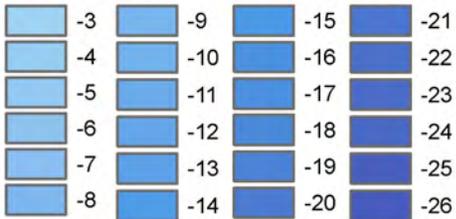
Title: Offshore Bathymetry	
URS Proj No: 15301785	Figure: 1
Client: NASA	
Shoreline Restoration Environmental Impact Statement	



Bathymetric Data: National Geophysical Data Center, "Coastal Relief Model". <http://www.ngdc.noaa.gov/mgg/fliers/01mgg05.html>

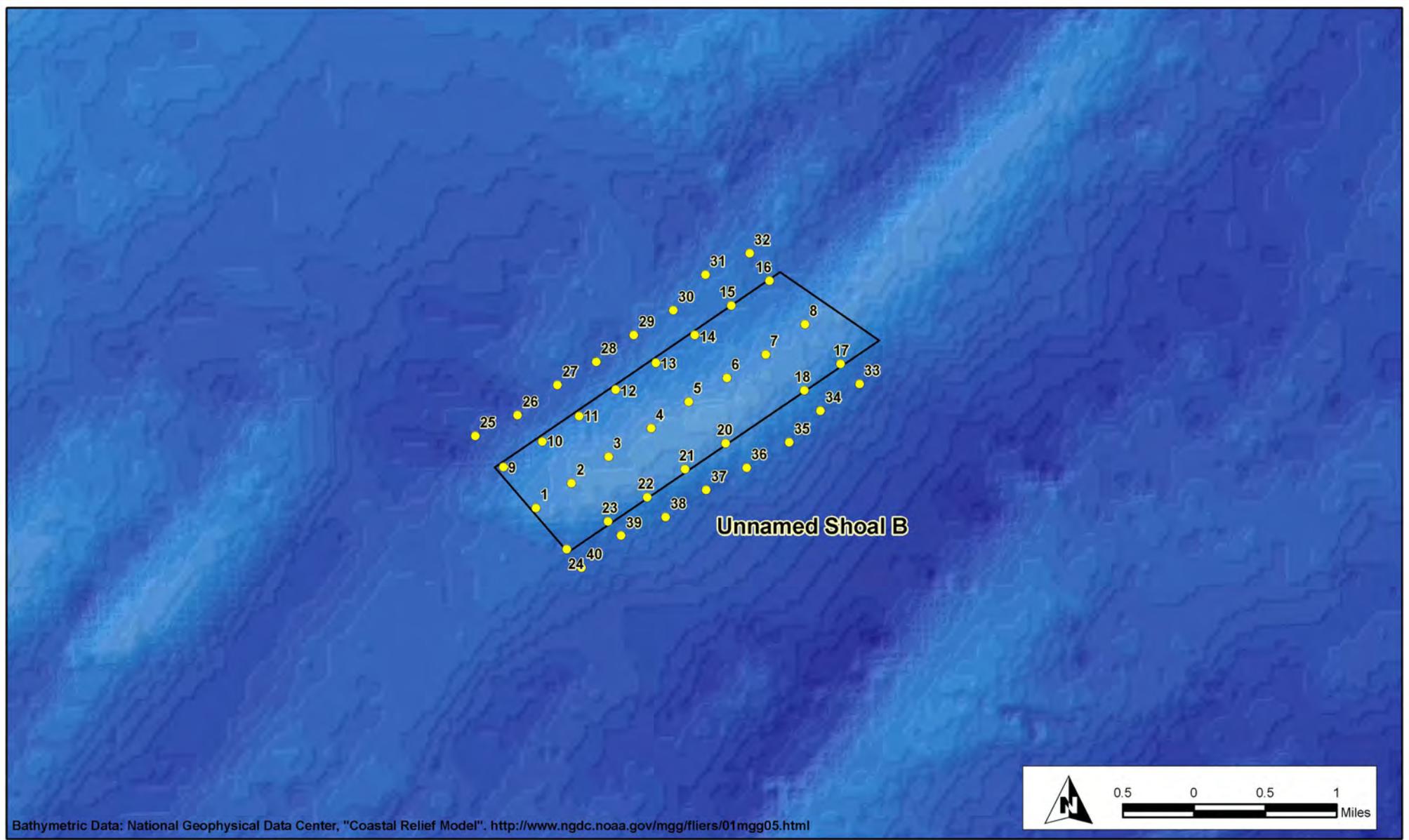


Elevation Relative to Mean Seal Level

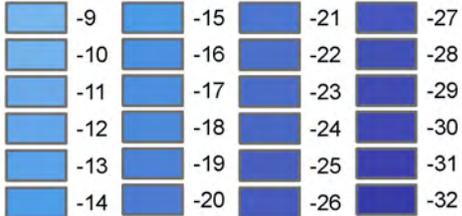


- Unnamed Shoal A Stations
- Shoal Location

Title: Unnamed Shoal A Stations	
	URS Proj No: 15301785
	Figure: 2
Client : NASA	
Shoreline Restoration Environmental Impact Statement	



Elevation Relative to Mean Seal Level



- Unnamed Shoal B Stations
- Shoal Location

Title: Unnamed Shoal B Stations	
	URS Proj No: 15301785
Figure: 3	
Client : NASA	
Shoreline Restoration Environmental Impact Statement	

ATTACHMENT 2

DATA SHEETS

NASA SRIPP EIS Benthic Video Survey Project # - 15301785											
Unnamed Shoal A											
Shoal #	Station #	Starting coordinates	Ending coordinates	Video Length	Depth (ft)	Bottom Type	Bedform Size and Shape	Shell Cover	Biogenic Structures	Fauna Observed	Comments (sea conditions, visibility, etc.)
A	1	12428912.24 E, 6640926.18 N	12428911.29 E, 6640923.13 N	4:56	28	1	2,3	1			7/7/09 - visibility poor
A	2	12427765.17 E, 6642925.32 N	12427856.87 E, 6643139.26 N	3:49	55	1	1,1	2		crab (Cancer spp?) at 0:02	7/7/09 - visibility good
A	3	12431820.61 E, 6643554.58 N	12431874.42 E, 6644025.12 N	4:58	25	1	2/3,3	1		Echinarachinus parma	7/7/09 - visibility poor
A	4	12433373.77 E, 6644751.13 N	12433381.86 E, 6644722.18 N	5:11	30	1	3,2	1			7/7/09 - visibility poor
A	5	NOT COLLECTED LOW VISIBILITY									
A	6	12436181.21 E, 6647845.81 N	12436152.68 E, 6647778.55 N	6:33	44	1	3,3	1		Pagurus spp.	7/8/09 - visibility poor
A	7	12437769.93 E, 6649201.59 N	12437783.06 E, 6649140.07 N	4:56	53	1	1,1	2			7/8/09 - visibility poor
A	8	NOT COLLECTED LOW VISIBILITY									
A	9	12428034.16 E, 6643288.51 N	12428047.27 E, 6643321.72 N	0:29	55	2	1,1	2			7/7/09 - visibility good
A	10	12429333.69 E, 6644135.29 N	12429444.39 E, 6644486.58 N	4:32	60	1	1,1	2		Spisula shell	7/7/09 - visibility poor/good
A	11	12430686.81 E, 6645585.45 N	12430639.92 E, 6645967.35 N	3:49	54	1	1,1	2			7/7/09 - visibility v. poor
A	12	12432468.35 E, 6646432.14 N	12432433.46 E, 6646939.08 N	5:05	51	1	3,2	2		Spisula shell, crab (Cancer spp?)	7/7/09 - visibility v. poor, shell hash concentrated in troughs
A	13	NOT COLLECTED LOW VISIBILITY									
A	14	12435362.78 E, 6649357.31 N	12435353.80 E, 6649282.98 N	7:38	53	1	3,2	1		Spisula shell	7/8/09 - visibility poor
A	15	12436972.83 E, 6650649.31 N	12437007.84 E, 6650609.53 N	7:36	53	1	1,1	2		crab (Cancer spp?) white chelipeds - 13:26:08	7/8/09 - visibility poor
A	16	12438431.38 E, 6651895.95 N	12438432.06 E, 6651904.12 N	7:35	68	1,2	1,1	2		Spisula shell, Ensis shell	7/8/09 - visibility poor
A	17	12440236.84 E, 6648959.79 N	12440150.32 E, 6648937.86 N	6:44	64	2	1,1	2		fish (14:13:22), whelk (14:16:08), Spisula shell	7/8/09 - visibility poor
A	18	12438761.28 E, 6647461.56 N	12438717.16 E, 6647457.92 N	7:06	64	2	1,1	2	mud tubes	Spisula shell, Ensis shell, Pagurus spp, algae filaments ?	7/8/09 - visibility poor
A	19	12437275.94 E, 6646284.31 N	12437153.01 E, 6646158.13 N	6:29	63	1,2	1/3, 1/2	2		Pagurus spp., Polinices spp., crab w/ white chelipeds (12:27:57)	7/8/09 - visibility good
A	20	NOT COLLECTED LOW VISIBILITY									
A	21	12434390.08 E, 6643349.56 N	12434297.11 E, 6643951.86 N	5:06	60	1,2	1/3, 1/2	2	mud tubes	crab (red) spp ?, Pagurus spp., starfish (13:37:16), Echinarachinus parma, Pagurus spp.	7/7/09 - visibility poor, bouncing along bottom
A	22	12432764.81 E, 6642009.33 N	12432815.13 E, 6642457.94 N	5:03	60	1	1/2, 1/2	1			7/7/09 - visibility poor
A	23	12431428.80 E, 6640677.82 N	12431545.28 E, 6641268.30 N	6:53	60	1	1/3, 1/2	1	burrow	crab white chelipeds Libinia emarginata (13:22:35), Echinarachinus parma, crab	7/7/09 - visibility poor/good, camera moving quickly
A	24	12429938.93 E, 6639252.66 N	12430131.06 E, 6639618.35 N	5:30	58	1,2	1,1	1		Ascidian (red) patch (12:27:15), Pagurus spp., Spisula shell, Ensis shell, crab spp ?	7/7/09 - visibility poor/dark, camera moving quickly
A	25	12428372.96 E, 6641911.43 N	12428562.37 E, 6642244.81 N	4:55	54	1	1/3, 1/2	2		Pagurus spp., Spisula shell	7/7/09 - visibility poor
A	26	12429426.10 E, 6640002.76 N	12429567.71 E, 6640268.00 N	4:08	45	1	1/3, 1/3	1		Spisula shell	7/7/09 - visibility poor/good
A	27	12431003.98 E, 6641612.42 N	12431074.50 E, 6642071.83 N	4:55	43	1	3,2	1	black coloring in spots	Echinarachinus parma, Polinices spp.	7/7/09 - visibility poor
A	28	12432424.52 E, 6642531.76 N	12432448.72 E, 6642991.17 N	5:08	38	1	3, 2/3	1	black coloring in spots	Polinices sand collar, no fauna observed	7/7/09 - visibility poor/good, not much shell present
A	29	12434064.88 E, 6643837.64 N	12433972.10 E, 6644410.81 N	5:02	35	1	3, 2/3	1	black coloring in spots	starfish observed in several spots (ex. 14:56:32, 14:58:28), Polinices sand collar	7/7/09 - visibility poor/good

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Project # - 15301785											
Unnamed Shoal A											
Shoal #	Station #	Starting coordinates	Ending coordinates	Video Length	Depth (ft)	Bottom Type	Bedform Size and Shape	Shell Cover	Biogenic Structures	Fauna Observed	Comments (sea conditions, visibility, etc.)
A	30	NOT COLLECTED LOW VISIBILITY									
A	31	12436751.31 E, 6647108.45 N	12436694.42 E, 6647018.60 N	6:18	50	1	1,1	1		Pagurus spp.	7/8/2009 - visibility poor
A	32	12438363.88 E, 6648226.51 N	12438356.41 E, 6648177.22 N	5:24	60	1	1,1	1		Pagurus spp., Echinarachinus parma, Polinices sand collar	7/8/09 - visibility v. poor
A	33	12439867.04 E, 6649374.47 N	12439841.78 E, 6649418.65 N	7:18	60	1	1,1	1		Pagurus spp., Spisula shell	7/8/09 - visibility v. poor
A	34	12438910.18 E, 6651176.29 N	12438922.36 E, 6651150.82 N	6:57	58	1	1,1	2		Pagurus spp., Spisula shell, Ensis shell	7/8/09 - visibility v. poor
A	35	12437397.64 E, 6649943.08 N	12437018.82 E, 6649611.21 N	7:03	50	1	1,1	1		Pagurus spp., Echinarachinus parma	7/8/09 - visibility v. poor, last half of video camera moving very quickly
A	36	12435928.10 E, 6648526.07 N	12435937.30 E, 6648464.97 N	7:36	42	1	3,3	1		Pagurus spp., Echinarachinus parma	7/8/09 - visibility poor/good
A	37	NOT COLLECTED LOW VISIBILITY									
A	38	12432866.12 E, 6645616.23 N	12432817.77 E, 6646154.23 N	5:05	33	1	3,3	1		Echinarachinus parma	7/7/09 - visibility good
A	39	12431204.83 E, 6644596.15 N	12431251.70 E, 6645098.58 N	5:03	31	1	3,2	1		Pagurus spp., Polinices sand collar	7/7/09 - visibility v. poor, shell concentrated in ripple troughs
A	40	12429894.04 E, 6643181.30 N	12430004.60 E, 6643579.79 N	4:36	36	1	1,1	1	tubes		7/7/09 - visibility good, camera moving quickly
Note:											
Video Length = minutes:seconds											
Bottom type - (1) sand; (2) mud/silt											
Bedform size - (1) none, no bedforms, flat relatively uniform bottom; (2) large bedforms, wavelength approx. 30 cm or greater; (3) small bedforms, wavelength less than approx. 30 cm											
Bedform shape - (1) none, (2) smooth crested with top of bedform rounded; (3) sharp crested with top of bedform peaked											
Shell cover - (1) <10% or (2) >10% of the bottom covered by shell and shell fragments											
Biogenic structure - none, tubes, burrow openings											

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Benthic Video Survey												
Project # - 15301785												
Unnamed Shoal B												
Shoal #	Station #	Starting coordinates	Ending coordinates	Video Length	Depth (ft)	Bottom Type	Bedform Size and Shape	Shell Cover	Biogenic Structures	Fauna Observed	Comments (sea conditions, visibility, etc.)	
B	1	12454655.72 E, 6649458.59 N	12454656.74 E, 6649457.60 N	5:34	42	1	2/3,3	1	burrow (approx 1:00),	Pagurus spp., (2:22), Polinices sand collars	7/8/09 - video not recording correctly first approx 50 sec, visibility v. good	
B	2	12455979.52 E, 6650375.24 N	12455907.54 E, 6650511.21 N	5:06	42	1	3,3	1		Echinarachinus parma (low density), Pagurus spp., Polinices sand collars, Spisula shell, Ensis shell	7/8/09 - visibility v. good	
B	3	12457350.89 E, 6651354.57 N	12457339.05 E, 6651328.98 N	5:11	44	1	3,3	1	burrow openings (09:38:22, 09:42:06)	Pagurus spp.	7/9/09 - visibility v. good - "cross-rippling" of sand (09:38:12)	
B	4	12458929.23 E, 6652417.15 N	12458885.54 E, 6652569.62 N	5:48	44	1	3,3	1		Echinarachinus parma (low density), Pagurus spp.,	7/9/09 - visibility good	
B	5	12460328.49 E, 6653402.49 N	12460352.25 E, 6653260.74 N	5:03	44	1	3,2/3	1		Pagurus spp.	7/9/09 - visibility good	
B	6	12461736.04 E, 6654280.46 N	12461764.61 E, 6654165.27 N	5:05	45	1	3,2	1		Pagurus spp., Polinices sand collars, Spisula shell	7/9/09 - visibility good	
B	7	12463177.31 E, 6655159.22 N	12463447.31 E, 6655134.82 N	5:06	43	1	1/3, 1/2	1		Pagurus spp., Spisula shell	7/9/09 - visibility poor/good	
B	8	12464630.83 E, 6656273.85 N	12464691.71 E, 6656116.10 N	5:15	41	1	3,3	1		crab exiting sediment (13:37:30), Polinices sand collar, Spisula shell, Ensis shell	7/9/09 - visibility poor/good	
B	9	12453447.41 E, 6650964.83 N	12453399.31 E, 6651018.65 N	5:33	55	2	1,1	1		starfish Astropecten spp? (15:25:25), Pagurus spp., Polinices sand collar, Spisula shell, Ensis shell	7/8/09 - visibility poor	
B	10	12454891.79 E, 6651912.73 N	12454771.57 E, 6652063.81 N	5:05	55	1	3/1,2/1	1	feeding pits, tubes, burrows	crab Libinia emarginata (white chelipeds) (16:32:31), Pagurus spp., Polinices sand collar, Polinices spp (16:33:14), crabs Libinia, Cancer spp (16:34:23), Spisula shell, Ensis shell	7/8/09 - visibility good	
B	11	12456258.22 E, 6652866.68 N	12456204.76 E, 6652943.67 N	5:12	55	1	1,1	1	curled tube (09:27:10)	Pagurus spp., Polinices sand collars, Spisula shell, Ensis shell	7/9/09 - visibility good	
B	12	12457611.09 E, 6653847.69 N	12457632.10 E, 6653975.65 N	5:06	58	1	1,1	1		Pagurus spp., Spisula shell	7/9/09 - visibility poor/good	
B	13	12459105.28 E, 6654846.55 N	12459102.91 E, 6654844.27 N	5:07	54	1	3,3	1		Pagurus spp., ctenophores,	7/9/09 - visibility v. good	
B	14	12460551.34 E, 6655873.06 N	12460630.78 E, 6655835.14 N	5:17	48	1	3,3	1		Echinarachinus parma (patchy high density), Pagurus spp., Polinices sand collars, Spisula shell, Ensis shell	7/9/09 - visibility v. good	
B	15	12461899.30 E, 6656967.95 N	12461919.25 E, 6656929.67 N	5:05	56	1	3,3	1		Echinarachinus parma, Pagurus spp., Polinices sand collars, Ensis shell	7/9/09 - visibility good	
B	16	12463321.67 E, 6657892.14 N	12463320.16 E, 6657872.95 N	5:04	65	1	3/1,2/1	1		crab - Cancer spp? (13:48:14), Pagurus spp., Echinarachinus parma, Spisula	7/9/09 - visibility good	
B	17	12465959.95 E, 6654815.13 N	12465952.38 E, 6654756.45 N	5:17	56	1	3,2	1		Polinices sand collar, crabs Cancer spp. (13:29:28), Pagurus spp.	7/9/09 - visibility poor/good	
B	18	12464612.03 E, 6653834.03 N	12464622.72 E, 6653725.02 N	5:10	48	1	3,2	1	sparse tubes	crab Cancer spp. (12:56:13), Pagurus spp.	7/9/09 - poor	
B	19	12463033.50 E, 6652921.65 N	12463052.63 E, 6652836.26 N	5:03	40	1	3,2	1	tubes	Pagurus spp.	7/9/09 - visibility poor, v similar to #18	
B	20	12461687.55 E, 6651863.08 N	12461723.48 E, 6651686.81 N	5:03	45	1	3/2,3	1	scattered tubes	Echinarachinus parma, Pagurus spp., Polinices sand collars, Spisula shell, Polinices spp.	7/9/09 - visibility good, cross rippling	
B	21	12460188.94 E, 6650906.74 N	12460153.74 E, 6650896.20 N	5:18	41	1	3,3	1		Pagurus spp., Polinices sand collar, Spisula shell	7/9/09 - visibility poor/good, cross rippling	
B	22	12458781.46 E, 6649858.66 N	12458751.53 E, 6649842.06 N	5:25	43	1	3,3	1		Pagurus spp., Polinices sand collar, gastropod (?) in trail (09:49:52)	7/9/2009 - visibility good	
B	23	12457337.38 E, 6648957.19 N	12457264.15 E, 6649082.95 N	5:04	50	1	3,3	1		Pagurus spp., crab ? (16:17:15), Polinices sand collars, sea robin	7/8/09 - visibility good, cross rippling	
B	24	12455806.30 E, 6647921.81 N	12455661.63 E, 6648078.05 N	5:32	63	1	3,3/2	1		Pagurus spp., crab ? (15:47:01), Polinices sand collars, Spisula shell, Ensis shell	7/8/09 - visibility good	

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Project # - 15301785											
Unnamed Shoal B											
Shoal #	Station #	Starting coordinates	Ending coordinates	Video Length	Depth (ft)	Bottom Type	Bedform Size and Shape	Shell Cover	Biogenic Structures	Fauna Observed	Comments (sea conditions, visibility, etc.)
B	25	12452407.08 E, 6652123.96 N	12452349.19 E, 6652091.10 N	5:52	74	1	1,1	2		crab cancer spp. (15:17:41), Pagurus spp., Spisula shell, Ensis shell	7/8/09 - visibility poor/good, dark
B	26	12453978.91 E, 6652900.79 N	12453886.19 E, 6653033.38 N	5:45	73	1/2	1,1	1		Pagurus spp., crab Cancer spp., Polinices sand collar, Ensis shell, Spisula shell	7/8/09 - visibility poor/good
B	27	12455454.76 E, 6654020.51 N	12455409.31 E, 6654032.50 N	5:48	72	1	1,1	1/2		horseshoe crab carapace, crabs Cancer spp. ? (09:19:31), Spisula shell, Ensis shell	7/9/09 - visibility good
B	28	12456891.41 E, 6654878.36 N	12456859.50 E, 6654920.46 N	5:16	67	1	1,1	1		crab ?? Spp. (10:43:16), Pagurus spp., Spisula shell, Ensis shell	7/9/09 - visibility good
B	29	12458288.05 E, 6655872.13 N	12458276.12 E, 6655833.93 N	5:07	66	1	1,1	2		starfish Astropecten spp? (10:53:48), Pagurus spp., Polinices sand collar, ophiuroid ? (10:54:21), Spisula shell, Ensis shell	7/9/09 - visibility good
B	30	12459752.01 E, 6656799.42 N	12459673.94 E, 6656732.60 N	5:19	60	1	1,1	2		Pagurus spp., Polinices sand collar, Spisula shell	7/9/09 - visibility good
B	31	12460939.18 E, 6658111.10 N	12460936.87 E, 6658064.60 N	5:37	60	1	3/1,2/1	1		Pagurus spp., Polinices sand collars, whelk Busycon spp. (12:28:12), Echniarachinus parma, Spisula shell, Ensis shell	7/9/09 - visibility v. good
B	32	12462579.47 E, 6658907.85 N	12462529.40 E, 6658737.04 N	5:08	61	1	1,1	1		Pagurus spp., Polinices sand collar, Spisula shell, Ensis shell	7/9/09 - visibility good
B	33	12466661.84 E, 6654067.28 N	12466587.57 E, 6654134.22 N	5:11	66	1	3,2	1		Pagurus spp., Polinices sand collar	7/9/09 - visibility good
B	34	12465212.08 E, 6653073.16 N	12465193.50 E, 6653026.45 N	5:05	63	1	3,3	1		Pagurus spp.	7/9/09 - visibility good
B	35	12464060.44 E, 6651901.12 N	12464023.44 E, 6651834.66 N	5:09	63	1	3,3	1		Pagurus spp., Polinices sand collar, Spisula shell	7/9/09 - visibility good, not continuous ripples
B	36	12462471.53 E, 6650957.65 N	12462443.44 E, 6650896.96 N	5:05	64	1	3,3	1		Pagurus spp., crab ??spp. (14:32:14), Spisula shell	7/9/09 - visibility - v. good
B	37	12460979.07 E, 6650139.04 N	12460942.35 E, 6650152.76 N	5:18	64	1	3,3	1		Pagurus spp., crab Cancer spp., Spisula shell	7/9/09 - visibility good
B	38	12459473.68 E, 6649118.43 N	12459463.89 E, 6649160.24 N	5:41	64	1	3,3	1		Pagurus spp., Spisula shell, Ensis shell	7/9/09 - visibility good
B	39	12457824.00 E, 6648440.68 N	12457714.11 E, 6648630.16 N	5:06	56	1	3/1,3/2/1	1		Pagurus spp., sea robin (16:08:31), crab Cancer spp.(16:11:12), Spisula shell	7/8/09 - visibility good
B	40	12456357.79 E, 6647242.04 N	12456220.05 E, 6647415.24 N	5:08	65	1	3/1,2/1	1		crab Libinia emarginata, Pagurus spp., Spisula shell, Ensis shell, algal strands ?	7/8/09 - visibility good, dark
Note:											
Video Length = minutes:seconds											
Bottom type - (1) sand; (2) mud/silt											
Bedform size - (1) none, no bedforms, flat relatively uniform bottom; (2) large bedforms, wavelength approx. 30 cm or greater; (3) small bedforms, wavelength less than approx. 30 cm											
Bedform shape - (1) none (2)smooth crested with top of bedform rounded; (3) sharp crested with top of bedform peaked											
Shell cover - (1) <10% or (2) >10% of the bottom covered by shell and shell fragments											
Biogenic structure - none, tubes, burrow openings											