APPENDIX A

BOTTOM IMAGING AND HABITAT CHARACTERIZATION OF POTENTIAL SAND BORROW AREAS IN THE FENWICK SHOAL REGION OFFSHORE MARYLAND

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A report submitted to Versar, Inc. by

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PURPOSE OF STUDY

The Minerals Management Service (MMS) has jurisdiction over all mineral resources lying three nautical miles seaward of the coastline, including sand, gravel, and shell that can be used for beach protection activities. Anticipated and on-going beach replenishment projects along the coast of Maryland and Delaware have increased the demand for sand for restoration activities. The increased demand has led to evaluations of submerged offshore shoal areas within the federal Outer Continental Shelf (OCS) as potential sand sources.

MMS must comply with all relevant federal, state and local policies and regulations in planning and implementing any sand mining in the federal OCS. MMS must also coordinate with the National Marine Fisheries Service (NMFS) to comply with requirements of the Magnuson-Stevens Act with regard to protection of Essential Fish Habitat (EFH).

The purpose of this video survey is to 1) map four shoal and five nearby reference areas, 2) and identify which of five reference areas are most representative of the four shoals based on the physical and biological habitat characteristics collected in the survey.

MATERIALS AND METHODS

Field

From 16 to 19 September 2002 we towed our video sled, described below, over four regions of interest identified by State and Federal personnel as potential areas for sand mining activities (Fenwick, Weaver, Shoal B, and Shoal D; Figure A-1) and five areas that would serve as reference sites to the regions of interest (Reference Areas 1-5; Figure A-1).

The total track line coverage is plotted in Figure A-1. The sled was towed from 1.5 to 2.8 knots. Weather conditions were poor during the entire survey period with seas running about 1 to 2 m. These poor weather conditions resulted in reduced visibility at the bottom. While the sled was being towed, DGPS position was logged to a computer file every second. Latitude and longitude were later combined with the data from the videotapes for spatial plotting of features using the program Arcview.

Video Sled

The towed sled (Figure A-2) had three video cameras mounted in three different configurations to provide 1- a broad overview of the bottom and cables leading to the surface, 2- near bottom horizontal view to see fish over the bottom and bed form types, and 3- a vertical high resolution view for sediment type and biogenic features. The broad overview camera was mounted about 0.5 m off the bottom and angled to view the bottom out in front of the sled from 2 to 10 m. The near bottom horizontal camera was mounted 0.2 m off the bottom at an oblique angle of 20^{o} to provide a close-up view of bottom morphology and the presence of juvenile fish and other mobile fauna from 0.2 to 1.0 m in front of the sled. Its field of view was a trapezoid with an area of approximately 0.9 to 1.0 m^2 being about 0.25 m near the sled and about 1.5 m at

a distance of about 1.0 m from the sled. The vertical camera was mounted perpendicular to the bottom at a distance of 0.3 m from the sediment surface and had a field of view of 28 cm x 21 cm or 588 cm^2, about 0.06 m^2. Illumination for the vertical and horizontal cameras was provided by electronic video strobes. The video sled was linked to the surface via two cables that provided power to the cameras and strobes. The video signals were transmitted to the surface where sled performance and bottom features could be viewed in real-time. The video signal from each camera was multiplexed and recorded on to a single master tape that was used for aligning the video from the horizontal and vertical cameras. Video signals from the horizontal and vertical cameras were also recorded on higher resolution digital recorders for later analysis.

Video analysis

Benthic habitats were classified by analyzing videotapes recorded from the horizontal and vertical cameras. Physical and biological features were sampled from the recorded videotape at 2.5-minute intervals. If video images were not visible because of poor near-bottom visibility, the last instance the bottom was visible and the first moment the bottom reappeared were analyzed. All fish visible from the forward or downward cameras were identified to the lowest possible taxon and physical and biological features of the benthic habitats at the instance the fish was noted were recorded. Analysis of the videotape was conducted using a Sony editing deck and high-resolution video monitor. Data on bed roughness, sediment type, shell hash, biogenic structures, epifaunal and infaunal organisms, and fishes and rays were collected and entered into an excel spreadsheet. The features recorded and used in this analysis are listed in Table A-1.

Data Reduction

Video data files for each region of interest and reference area were combined with the DGPS positions by aligning timing mark placed in the DGPS files, the time code recorded with the mutiplex video, and the time code generated by the digital video recorders used with the horizontal and vertical cameras. Bottom habitats were then classified based on both physical and biological characteristics.

Bottom habitats were then classified based on both physical and biological characteristics. Physical characteristics included variables for bedforms type and size, which were primarily wavelength and form (Figure A-3), and sediment grain size (Figure A-4). Biological characteristics included variables for shell fragment cover, mobile fauna, sedentary fauna, and other biogenic structures (Table A-1). In addition, the following biological features were used to estimate the intensity of biogenic activity: Subsurface deposit feeder burrows that appeared to be mostly surf clam (*Spisula solidissima*) siphon holes (Figure A-5A). Shell hash encrusted tubes formed by the polychaete *Diopatra curprea* (Figure A-5B). Mobile fauna, mostly juvenile and large individuals, usually starfish (*Asterias* spp.), sea urchins (*Arbacia spp.*), various crabs, fishes, rays and skates (Figures A-5A, A-5C, A-5D, A-5E, A-5F). Biogenic feeding mound produced by subsurface feeding organisms (Figure A-4A).

Table A-1. The final habitat classification scheme had three categories of physical and two categories of biological variables, as follows:

Physical characteristics:
Bedform size and shape:
- Large bedforms, wavelength 30 cm or more
- Small bedforms, wavelength less than 30 cm
- None, no bedforms, flat relatively even bottom.

Bedform shape
- Smooth crested, with top of bedform rounded
- Sharp crested, with top of bedform peaked

Sediment type:
- Fine to medium sand
- Medium to coarse sand
- Coarse sand to small granules

Biological characteristics:
Shell cover:
- <10% of the bottom covered by shell and shell fragments.
- >10% of the bottom covered by shell and shell fragments.

Biogenic structure:
- No biology obvious
- Burrow opening, tubes, or sessile fauna present

RESULTS

Habitat characterization

The data sampled from the horizontal and vertical cameras are contained in the Excel file Appendix. The 2.5-minute sampling interval produced a total of 1071 data points (Figure A-1). These data were combined to arrive at a benthic habitat classification for the video track lines. Of the 60 total possible combinations of habitat classification, 41 occurred (Table A-2 and A-3). Overall, the most commonly occurring habitat type was bottom with large-smooth crested bedforms, fine-medium-sand sediments, <10% shell cover and little biogenic activity (200 out of 1071 samples). The second most common habitat type was the same except for the bedforms being small and sharp instead of smooth crested (188 samples). Sharp crested bedforms dominated the crests of shoals and smoother crested features were common on the shoal flanks and in the deeper regions sampled. The spatial distribution of habitat types in each area sampled is discussed below.

Fenwick Shoal

Much of this shoal was covered by sharp-crested bedforms (Figure A-6). These bedforms were small (<30 cm) on the flanks of the shoal and large (>30 cm) on the shoal crest. The crest of the shoal had medium to coarse sands with slightly finer sands on the flanks (Figure A-7). Off the shoal, at >30 ft depths, bedforms were smaller and sediments mostly fine sands. Little biogenic structure was seen in the 2.5-min video data (Figure A-8). Burrow openings of sedentary infauna and mounds produced by subsurface feeding organisms were observed in moderately high densities on the northern flank of the shoal. Little to no shell hash was observed in the northern portion of Fenwick Shoal. The southern part of the shoal was covered by between 5 and 25% shell hash (Figure A-9). Fishes were observed in eight of the 49 video samples from this area (Figure A-10). All but two of the eight fishes observed were sea robins, *Prionotus* spp. Four skates were observed in the video samples, and all observations were from the southwestern region of the shoal crest, coincident with large, sharp bedforms (Figure A-11). No flatfishes were observed in any of the video samples collected from this area (Figure A-12).

Weaver Shoal

Much of this shoal was covered by large, sharp-crested bedforms (Figure A-6). The crest of the shoal had fine to medium sands with slightly finer sands on the flank to the north (Figure A-7). Off the shoal, at >30 ft depths, bedforms were smaller and smooth-crested and sediments mostly fine sands (Figures A-6 and A-7). Hermit crabs, starfish and biogenic structures, primarily burrow openings of sedentary infauna and mounds produced by subsurface feeding organisms, were seen in most of the 2.5-min video data (Figure A-8). Little to no shell hash was observed except for isolated patches in the northern and eastern most portions of the shoal (Figure 9). Twenty-three fishes were observed on the flanks surrounding the shoal (Figure A-10). Seventy percent of these fishes were sea robins, *Prionotus* spp. Skates were only observed to the north and south of the shoal (Figure A-11). No flatfish species were observed in the video samples from Weaver Shoal (Figure A-12).

Shoal B

This entire shoal was covered by sharp-crested bedforms, except one video sample taken from the northeastern part of the shoal that had smooth-crested bedforms (Figure A-6). The northeastern crest of the shoal and northern flank had medium sands. The southern portion of the shoal crest had coarse sands. Gravel and a mixture of coarse sand and gravel were observed to the south of the shoal (Figure A-7). Biogenic structures were present in 40 of the 107 video samples, with the majority of these being mounds produced by subsurface feeding organisms (Figure A-8). Much of the southern most reach of Shoal B was covered by >10% shell hash. Shell hash was absent from the center of the shoal. The northern portion of the shoal was covered by between 5 and 10% shell hash (Figure A-9). A total of 40 fish were observed in the video tract data from Shoal B. Most of these were observed to the north and south of the shoal crest (Figure A-10). All of the fishes apart from one sparid were sea robins, *Prionotus* spp. One skate was observed on the shoal crest (Figure A-11).

Shoal D

Much of the northeast half of this shoal, to the southeast of Shoal B, was covered by small sharp-crested bedforms (Figure A-6). This region was fine to medium sands with few biogenic structures apart from a small area in the center of the shoal crest with mounds produced by subsurface feeding organisms (Figures A-7 and A-8). The bedforms on the southwest half were more variable with large smooth-crested bedforms occurring in the southern most part of the shoal (Figure A-6). This half of the shoal made up of was medium and coarse sands, with no biogenic structures (Figure A-7). Much of the southwest half of the shoal was covered by >10% shell hash. There were also patches in the northeast half of the shoal with >10% shell hash over the bottom (Figure A-9). Fishes, mainly *Prionotus* spp., were observed along most of the video track line (Figure A-10) and a total of nine skates were noted on the crest of Shoal D (Figure A-11).

Reference Area 1

Much of this area, to the south of Isle of Wight Shoal, was covered by small bedforms, with sharp-crested bedforms toward the northern part of the area and smooth-crested bedforms from the center to the southern part (Figure A-6). Poor visibility prevented us from collecting data from part of the southern most part of this area. Most of the area had fine to medium sands with coarser sediments in the northern most section surveyed (Figure A-7). The southern portion of Reference Area 1 was covered by >5% shell hash and bedforms were absent (Figures A-8 and A-9). Biogenic structures (urchins and hermit crabs) were only seen at the northern end of the area with coarser sediments. A total of 44 fish were observed in the video tract data from Reference Area 1 (Figure A-10).

Reference Area 2

Much of this area, to the southwest of Shoal B and west of Shoal D, was covered by smooth-crested bedforms. There were two regions of large smooth-crested bedforms in the eastern and center portions of the area. Small smooth-crested bedforms were scattered throughout the area. Small sharp-crested bedforms were observed in the northwestern portion of Reference Area 2 (Figure A-6). The entire area was comprised of fine to medium sands (Figure A-7). Few biogenic structures were observed apart from the few incidences of epibenthic fauna including decapods and urchins (Figure A-8). Patches of shell habitat occurred throughout this area but no shell was observed in the eastern most section (Figure A-9). Fishes, mainly *Prionotus* spp., were observed along most of the video track line (Figure A-10).

Reference Area 3

Much of this area, to the east of Weaver Shoal, was covered by large bedforms, with sharp-crested bedforms toward the northern part of the area and smooth-crested bedforms from the center to the southern part. Small, sharp-crested bedforms dominated the southern portion of this area (Figure A-6). Most of the area had medium to coarse sands with a patch of finer sediments in the northeast corner (Figure A-7). Biogenic structures predominated in the southern half of the area. Few biogenic habitats were observed in the northern half of Reference Area 3

(Figure A-8). Most of the bottom was covered by >5% shell hash (Figure A-9). Fishes, mainly *Prionotus* spp., and skates were observed along most of the video track line (Figures A-10 and A-11).

Reference Area 4

Much of this area, to the northeast of Shoal B and north of Shoal D, was covered by small sharp-crested bedforms. There was an area of large smooth-crested bedforms at the northern end of the area (Figure A-6). The entire area appeared to be fine to medium sands (Figure A-7). Biogenic habitat, consisting of mounds produced by subsurface feeding organisms, predominated in the southwestern half of the area and extended over toward Shoal B. There was only one video sample with biogenic mound structures in the eastern half of this area (Figure A-8). Patches of shell habitat were present in the eastern half of this area. The southwestern portion of the area toward Shoal B had >10% shell hash (Figure A-9). Fishes, mainly *Prionotus* spp., were observed along most of the video track line and were most abundant on the southwestern half of this area (Figure A-10).

Reference Area 5

Much of this area, to the east-southeast of Isle of Wight Shoal, was made up of fine to medium sands (Figure A-7). The northeastern portion of Reference Area 5 was covered by large smooth-crested bedforms. The southern part of the area was covered by small bedforms and about evenly split between sharp and smooth-crested forms. There were also patches of large sharp-crested bedforms in the center of the southernmost portion of this area (Figure A-6). Biogenic structures, in the form mounds produced by subsurface feeding organisms, were seen only in the center toward the southern half of the area. There were no biogenic habitats in the northern half of this area (Figure A-8). Areas with >10% shell hash were concentrated in the southern part of this area (Figure A-9). Fishes, mainly *Prionotus* spp., were observed along most of the video track line and were most abundant on the southern portion of this area (Figure A-10). Skates and flatfishes were only observed along the northern part of the video track (Figures A-11 and A-12).

Observation of Fishes and Skates:

Fish were observed in video samples from all of the areas surveyed. The dominant fish was the sea robin, *Prionotus* spp., occurring in 333 of the 416 occurrences of fishes out of 1013 video samples. A total of 503 fishes were observed in the video data, comprising 10 bony fish species or species groups (Table A-4). Skates, *Raja* spp., were observed in all areas surveyed but Reference Areas 1 and 2. A total of 61 skates were observed over 59 occurrences of skates in the video data. There was a relationship between the odds of a fish being present and the factors used to classify the bottom (bedform type, sediment grain-size, shell hash, biogenic structures) (Likelihood Ratio = 18.11, df = 4, p = 0.0012) (Table A-5).

Logistic regression indicated that shell hash and biogenic structure significantly affected the odds of a fish being present. For shell hash going from <10% to >10% cover over the bottom

decreased the odds of a fish being present by 0.53 (0.31 to 0.89 95% Wald CI). The presence of biogenic structure increased the odds of a fish being present by 1.54 (1.14 to 2.06 95% Wald CI).

CONCLUSION

Habitats were patchy over multiple spatial scales. The shoal areas examined provide megascale physical relief on the predominantly flat inner continental shelf. On a smaller scale, bedform size and shape varied within and among shoals and reference areas of interest. Microscale properties of the benthic habitat, such as sediment type and the density of biogenic structures also varied throughout the study area. The significant relationship of shell hash density and the presence of biogenic structures demonstrate that small scale changes in the physical habitat can have significant effects on the suitability of habitat to demersal fishes.

The frequency of demersal fish encounters estimated by the video sled is likely an underestimate due to the poor visibility at the bottom from adverse sea conditions during the sampling event. While video from the downward-facing vertical camera was interpretable for bedform size and shape, grain size, and biogenic features, suspended flocculent particles near the bottom often reduced visibility of the forward-facing horizontal camera. Many fishes that were observed by the horizontal camera fled the path of the sled and were not recorded by the vertical camera. It is likely that in areas where visibility in the horizontal camera was reduced, fishes were not recorded. Unlike trawls that sample over large spatial scales, the video sled was able to locate fishes and their microscale habitats simultaneously where visibility was sufficient to detect the presence of fish.

Table A-2. Physical and biological features sampled from horizontal camera videotapes.

Bedforms
- 0 = absent
- 1 = present

Size of bedforms
- 0 = <30 cm wavelength
- 1 = >30 cm wavelength

Waveform of bedforms
- 0 = smooth rounded crest
- 1 = sharp peaked crest

Shape of bedforms
- 0 = straight
- 1 = asymmetric

Secondary ripples
- 0 = absent
- 1 = present

Silt & Clay
- 0 = absent
- 1 = present

Fine to Medium sand
- 0 = absent
- 1 = present

Coarse sand & Gravel
- 0 = absent
- 1 = present

Shell fragments
- 0 = 0-5% coverage of bottom
- 1 = 5-10% coverage of bottom
- 2 = 10-25% coverage of bottom
- 3 = >25% coverage of bottom

Whole shell
- 0 = absent
- 1 = present

Count of:
Burrow opening
Biogenic mounds or pits
Tubes
Mobile epifauna
Sessile epifauna
Fishes
Skates/Rays

Table A-3. Benthic habitat classes that occurred in the 2.5-minute analysis of video from the horizontal and vertical cameras. Habitat combination not included did not occur in the 2.5-minute analysis.

Habitat Code	Bedform Size	Bedform Shape	Grain-size	Shell Cover	Biogenic	Total Freq'cy									
						All areas	Fenwick Shoal	Weaver Shoal	Shoal B	Shoal D	Ref. 1	Ref. 2	Ref. 3	Ref. 4	Ref. 5
1000	Large	Sharp	Fine-Medium sand	<10% Shell	Not Biogenic	47	7	2	3	0	5	7	12	0	11
1001	Large	Sharp	Fine-Medium sand	<10% Shell	Biogenic	41	9	20	5	0	2	0	5	0	0
1100	Large	Sharp	Medium-Coarse sand	<10% Shell	Not Biogenic	7	7	0	0	0	0	0	0	0	0
1101	Large	Sharp	Medium-Coarse sand	<10% Shell	Biogenic	4	4	0	0	0	0	0	0	0	0
1200	Large	Sharp	Coarse sand-Granules	<10% Shell	Not Biogenic	4	0	0	4	0	0	0	0	0	0
1201	Large	Sharp	Coarse sand-Granules	<10% Shell	Biogenic	1	0	0	1	0	0	0	0	0	0
2000	Large	Smooth	Fine-Medium sand	<10% Shell	Not Biogenic	200	0	1	1	35	1	3	56	19	84
2001	Large	Smooth	Fine-Medium sand	<10% Shell	Biogenic	67	0	9	0	10	0	0	24	5	19
2010	Large	Smooth	Fine-Medium sand	>10% Shell	Not Biogenic	17	0	0	0	5	3	0	0	1	8
2011	Large	Smooth	Fine-Medium sand	>10% Shell	Biogenic	1	0	0	0	0	0	0	0	0	1
2100	Large	Smooth	Medium-Coarse sand	<10% Shell	Not Biogenic	33	0	2	6	2	0	0	23	0	0
2101	Large	Smooth	Medium-Coarse sand	<10% Shell	Biogenic	10	0	1	0	1	0	0	8	0	0
2110	Large	Smooth	Medium-Coarse sand	>10% Shell	Not Biogenic	9	0	0	1	7	0	0	0	0	1
2111	Large	Smooth	Medium-Coarse sand	>10% Shell	Biogenic	1	0	0	0	1	0	0	0	0	0
2200	Large	Smooth	Coarse sand-Granules	<10% Shell	Not Biogenic	13	0	0	6	4	0	0	3	0	0
2201	Large	Smooth	Coarse sand-Granules	<10% Shell	Biogenic	2	0	0	0	1	0	0	1	0	0
2210	Large	Smooth	Coarse sand-Granules	>10% Shell	Not Biogenic	5	0	0	2	3	0	0	0	0	0
2211	Large	Smooth	Coarse sand-Granules	>10% Shell	Biogenic	2	0	0	1	1	0	0	0	0	0
3000	Small	Sharp	Fine-Medium sand	<10% Shell	Not Biogenic	188	4	0	12	29	43	20	0	37	43
3001	Small	Sharp	Fine-Medium sand	<10% Shell	Biogenic	87	8	5	17	19	11	2	0	17	8

Table A-3 (continued). Benthic habitat classes that occurred in the 2.5-minute analysis of video from the horizontal and vertical cameras. Habitat combination not included did not occur in the 2.5-minute analysis.

Habitat Code	Bedform Size	Bedform Shape	Grain-size	Shell Cover	Biogenic	Total Freq'cy									
						All areas	Fenwick Shoal	Weaver Shoal	Shoal B	Shoal D	Ref. 1	Ref. 2	Ref. 3	Ref. 4	Ref. 5
3010	Small	Sharp	Fine-Medium sand	>10% Shell	Not Biogenic	2	0	0	0	1	1	0	0	0	0
3101	Small	Sharp	Medium-Coarse sand	<10% Shell	Biogenic	2	0	0	0	2	0	0	0	0	0
3200	Small	Sharp	Coarse sand-Granules	<10% Shell	Not Biogenic	6	0	0	6	0	0	0	0	0	0
3201	Small	Sharp	Coarse sand-Granules	<10% Shell	Biogenic	11	0	0	10	1	0	0	0	0	0
3210	Small	Sharp	Coarse sand-Granules	>10% Shell	Not Biogenic	6	0	0	6	0	0	0	0	0	0
3211	Small	Sharp	Coarse sand-Granules	>10% Shell	Biogenic	1	0	0	1	0	0	0	0	0	0
4000	Small	Smooth	Fine-Medium sand	<10% Shell	Not Biogenic	146	3	5	5	45	22	20	16	4	26
4001	Small	Smooth	Fine-Medium sand	<10% Shell	Biogenic	37	1	15	0	8	1	1	5	1	5
4010	Small	Smooth	Fine-Medium sand	>10% Shell	Not Biogenic	18	0	0	7	1	0	1	0	1	8
4100	Small	Smooth	Medium-Coarse sand	<10% Shell	Not Biogenic	1	0	0	0	0	0	0	1	0	0
4101	Small	Smooth	Medium-Coarse sand	<10% Shell	Biogenic	4	0	0	0	0	0	0	4	0	0
4200	Small	Smooth	Coarse sand-Granules	<10% Shell	Not Biogenic	2	0	0	2	0	0	0	0	0	0
4201	Small	Smooth	Coarse sand-Granules	<10% Shell	Biogenic	1	0	0	1	0	0	0	0	0	0
5000	None	.	Fine-Medium sand	<10% Shell	Not Biogenic	25	3	2	2	4	11	1	2	0	0
5001	None	.	Fine-Medium sand	<10% Shell	Biogenic	3	1	1	1	0	0	0	0	0	0
5010	None	.	Fine-Medium sand	>10% Shell	Not Biogenic	1	1	0	0	0	0	0	0	0	0
5011	None	.	Fine-Medium sand	>10% Shell	Biogenic	1	1	0	0	0	0	0	0	0	0
5100	None	.	Medium-Coarse sand	<10% Shell	Not Biogenic	1	0	0	1	0	0	0	0	0	0
5200	None	.	Coarse sand-Granules	<10% Shell	Not Biogenic	4	0	0	4	0	0	0	0	0	0
5210	None	.	Coarse sand-Granules	>10% Shell	Not Biogenic	1	0	0	1	0	0	0	0	0	0
5211	None	.	Coarse sand-Granules	>10% Shell	Biogenic	1	0	0	1	0	0	0	0	0	0
					sum:	1013	49	63	107	180	100	55	160	85	214

Table A-4. Species and groups of species and observed in the 2.5-minute analysis of video from the horizontal and vertical cameras.

Species or species groups	common name	total overall number observed
Lophius sp.	goosefish	3
Paralichthys dentatus	summer flounder	9
Prionotus spp.	sea robin	405
Raja spp.	skate	61
Sparidae	porgies (pinfish)	8
Sphoeroides maculatus	northern puffer	2
Synodus foetens	inshore lizardfish	49
Urophycis sp.	hake	4
unknown eel species (c.f. Congridae)		1
unknown species - not flat		20
unknown species - flat		2

Table A-5. Analysis of Maximum Likelihood Estimates of Fish Occurrences for Logistic Regression:

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	0.4319	0.1959	4.8598	0.0275
HabSurface	1	-0.0613	0.0638	0.9244	0.3363
HabSediment	1	0.1406	0.1303	1.1641	0.2806
HabShell	1	-0.6366	0.2677	5.6540	0.0174
HabBiogenic	1	0.4283	0.1495	8.2014	0.0042

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
HabSurface	0.941	0.830	1.066
HabSediment	1.151	0.892	1.486
HabShell	0.529	0.313	0.894
HabBiogenic	1.535	1.145	2.057

Figure A-1: Location of video track lines. Habitat classification explained in text.

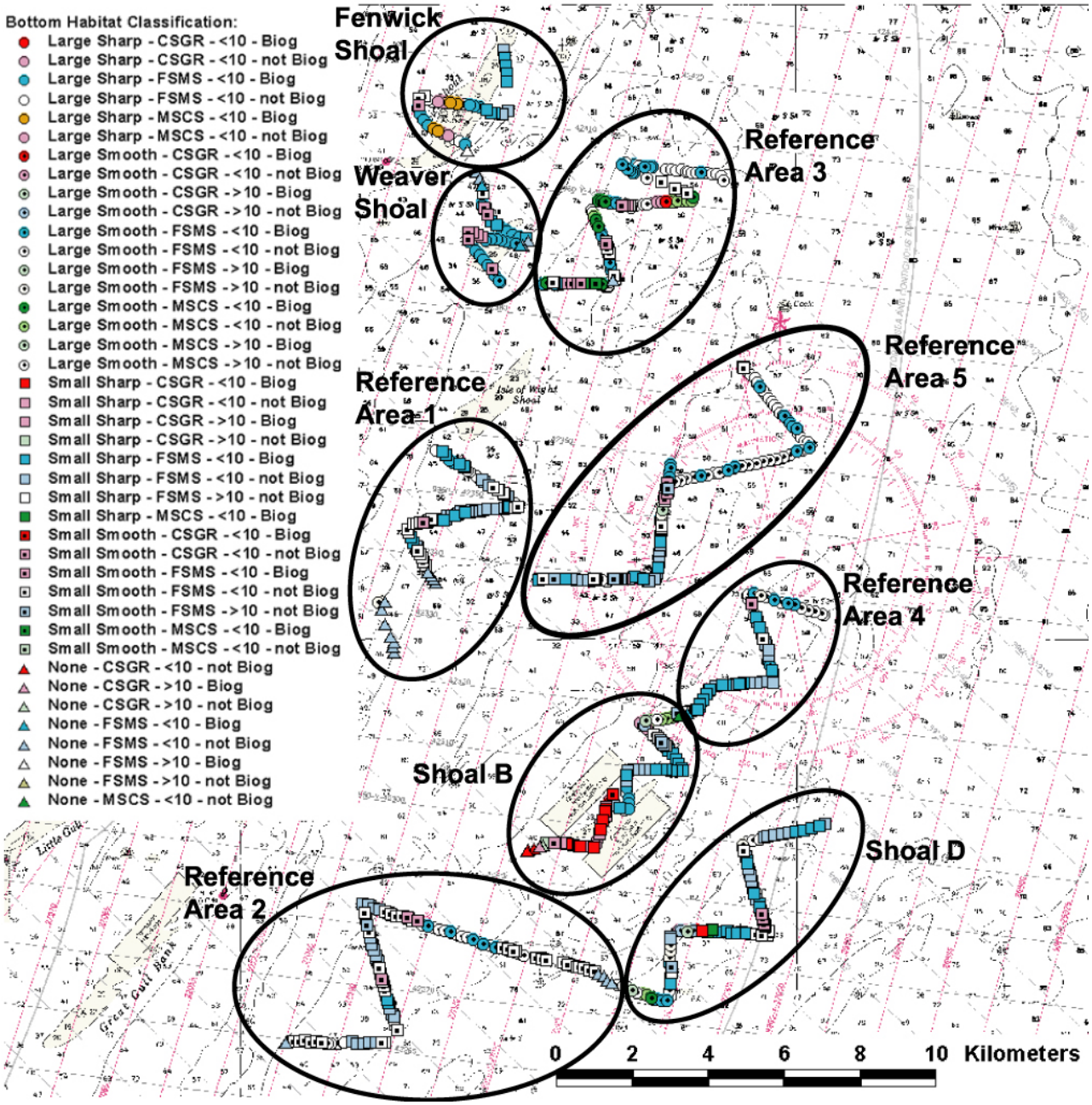
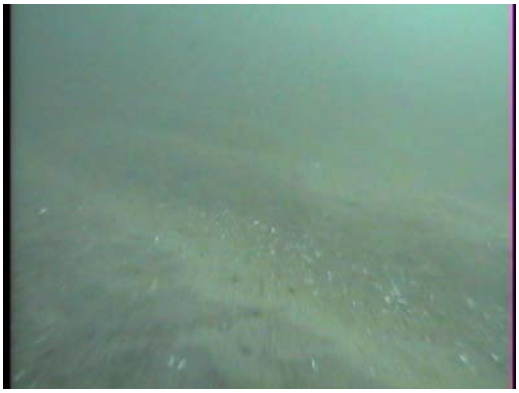


Figure A-2: Examples of bedform size and shape: A – Large, sharp-crested bedforms with fine to medium sand, starfish in the lower right corner; B – Large, smooth-crested bedforms with fine to medium sand; C – Small, sharp-crested bedforms with fine to medium sand, starfish in the lower right corner, sled tow cables are visible in the background; D – Small, smooth-crested bedforms with fine to medium sand.

A

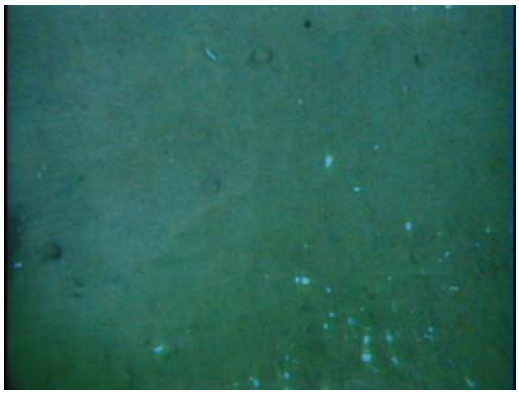


B

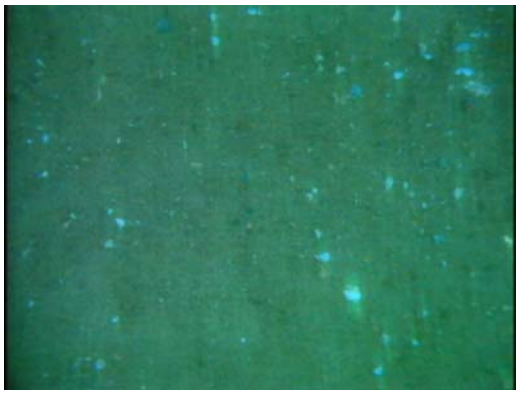
C

D

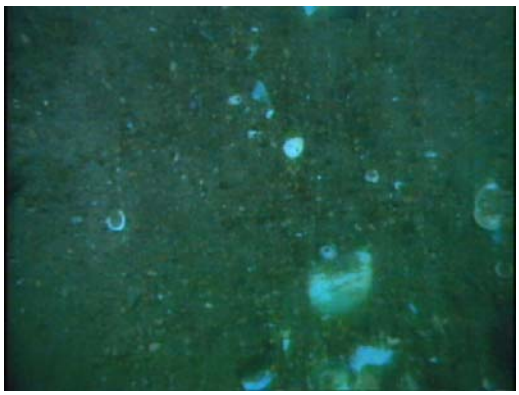
Figure A-3: Examples of sediment grain size categories. Each image is 28 cm wide: A –Fine to medium sand. A burrow opening of a sedentary infaunal organism is pictured in the upper center of the frame and several mounds produced by subsurface feeding organisms are scattered over the surface of the sediment; B – Medium to coarse sand; C – Coarse sand and granules with shell fragments.



A



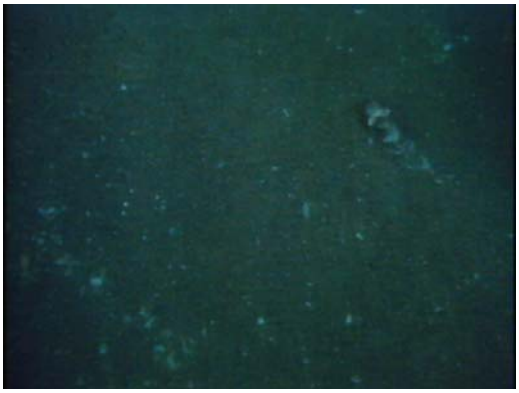
B



C

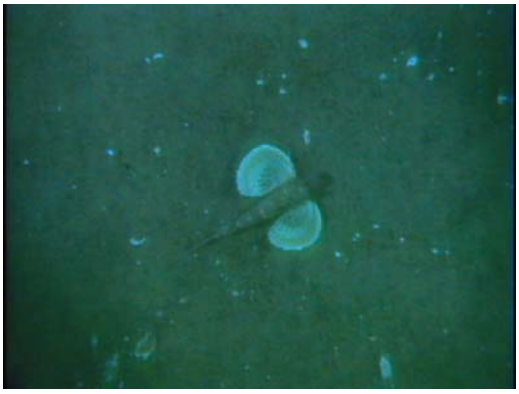
Figure A-4: Examples of fauna and biogenic features observed in the study area: A – Burrow openings of a sedentary infaunal organisms. Starfish (*Asterias* spp.) and an unknown eel species (c.f. Congridae) are also pictured; B – Shell fragment encrusted tube of *Diopatra curprea* in the upper right corner; C – Copulating pair of the crab *Ovalipes ocellatus*; D – sea robin *Prionotus* spp.; E – skate *Raja* spp.; F – summer flounder *Paralichthys dentatus.*

A



B

C



D

E

F

Figure A-5: Distribution of bedform types. Habitat classification explained in text.

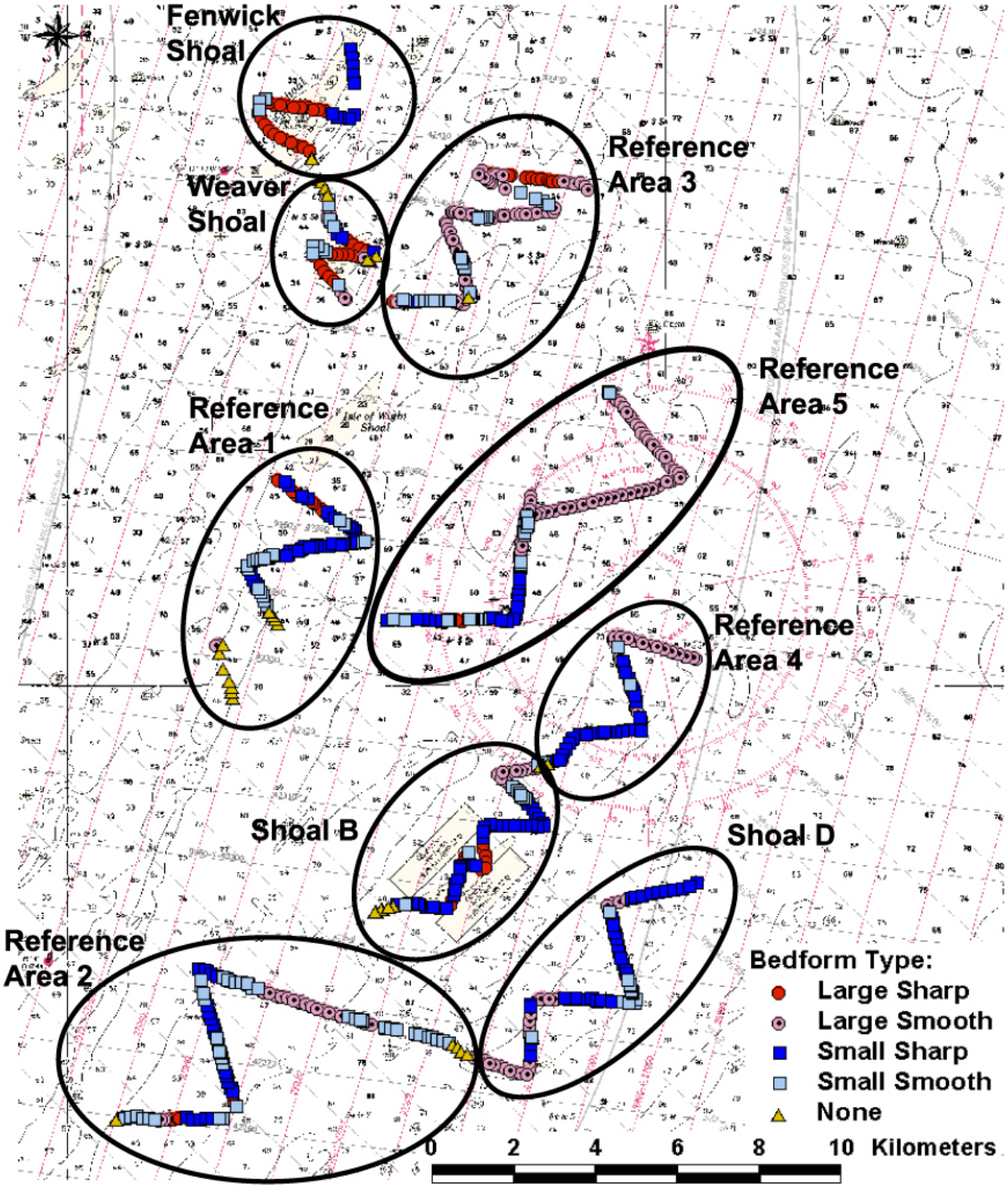


Figure A-6: Distribution of sediment types.

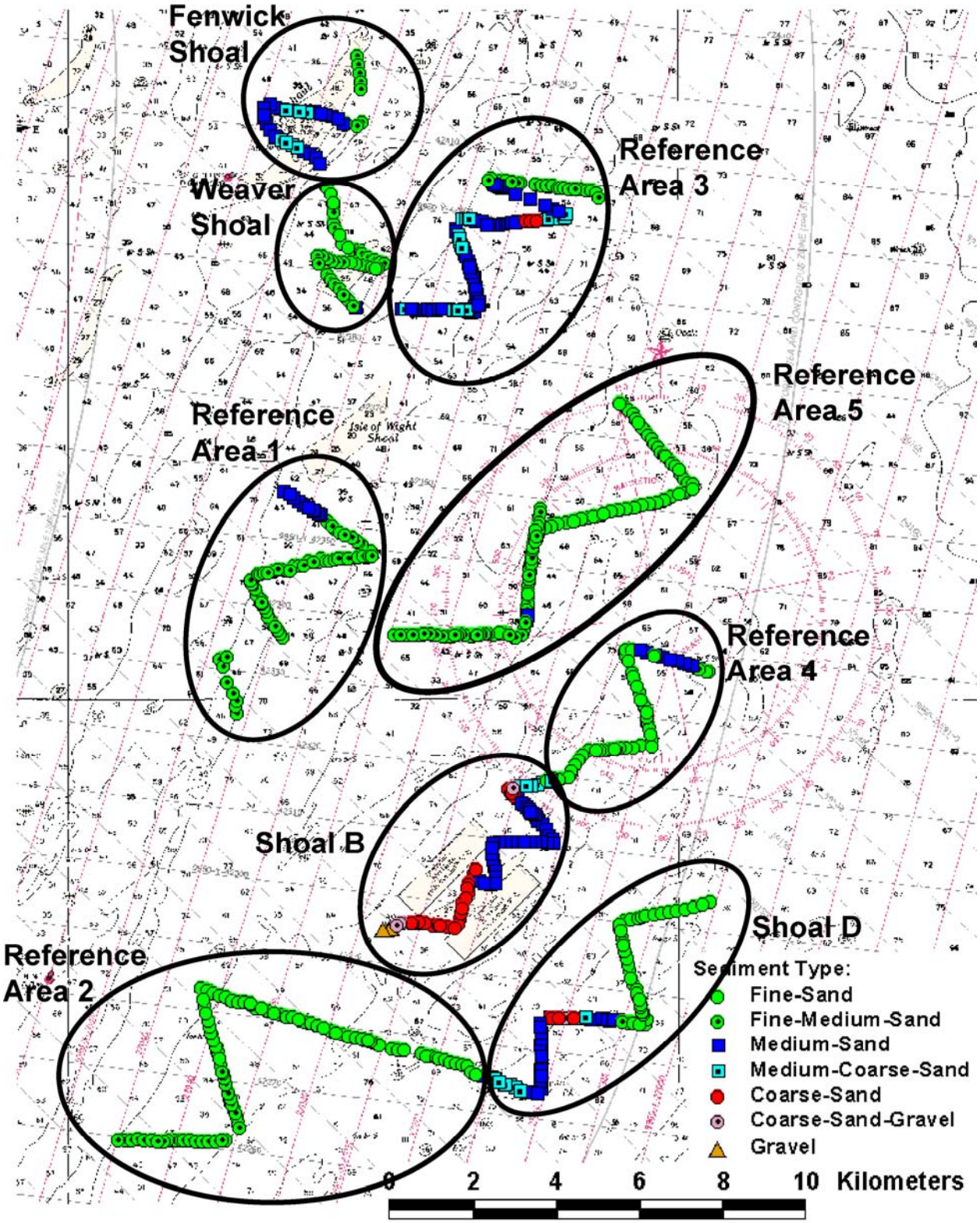


Figure A-7: Distribution of biogenic features observed in video samples. Legend refers to number of features observed in each video sample.

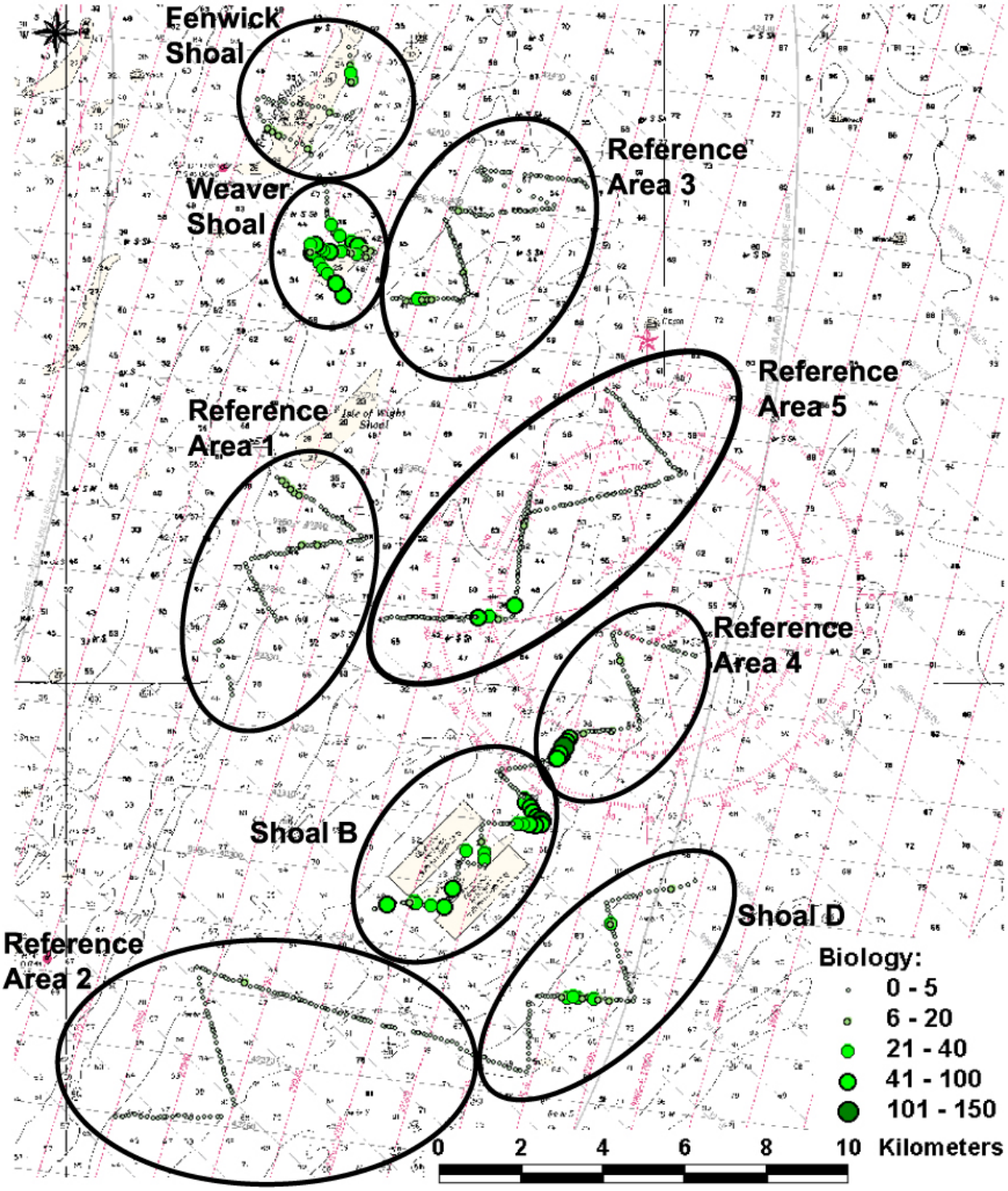


Figure A-8: Distribution of shell hash cover. Habitat classification explained in text.

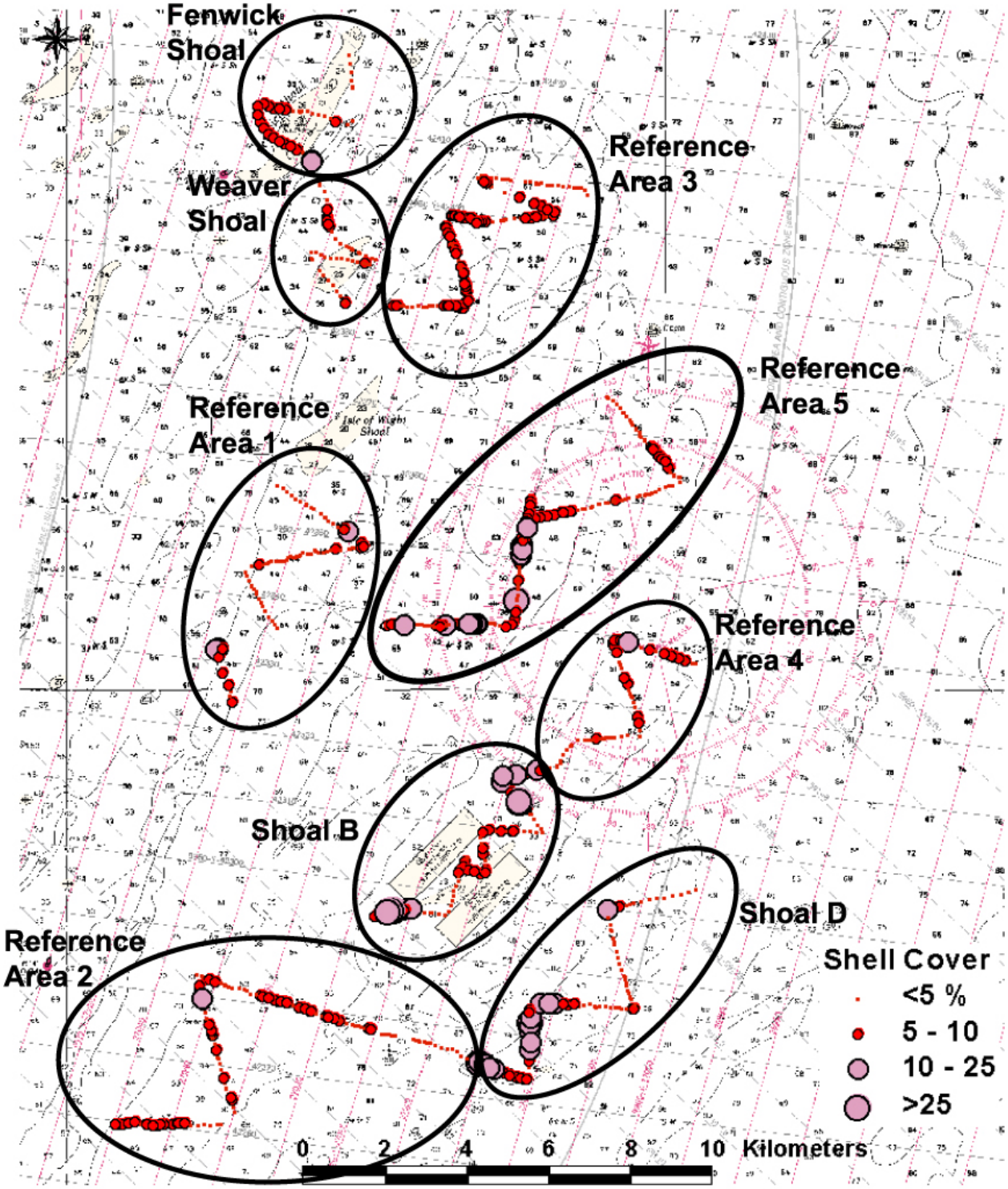


Figure A-9: Distribution of fish observed in video samples. Legend refers to number of individuals observed in each video sample.

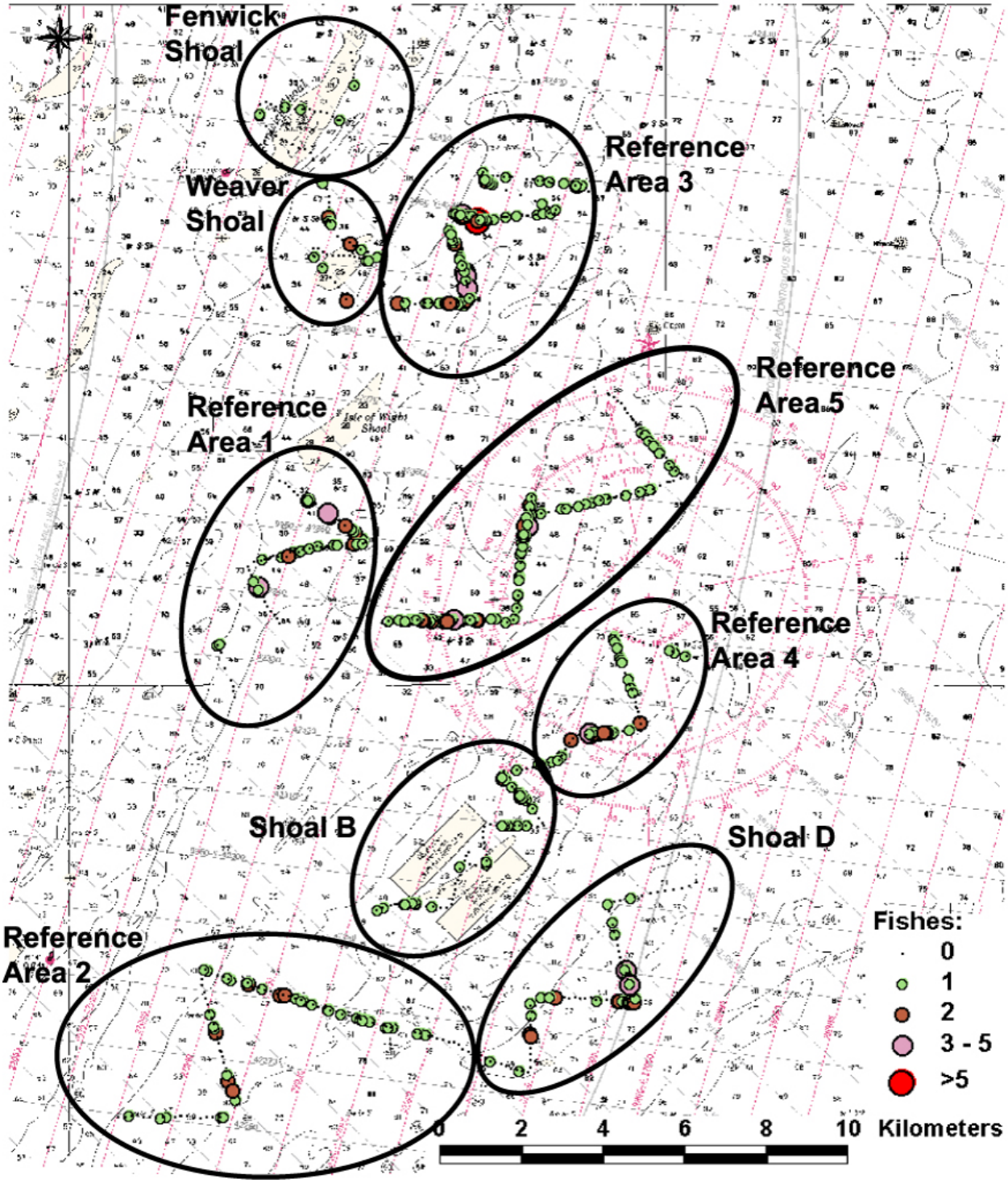


Figure A-10: Distribution of skates/rays observed in video samples. Legend refers to number of individuals observed in each video sample.

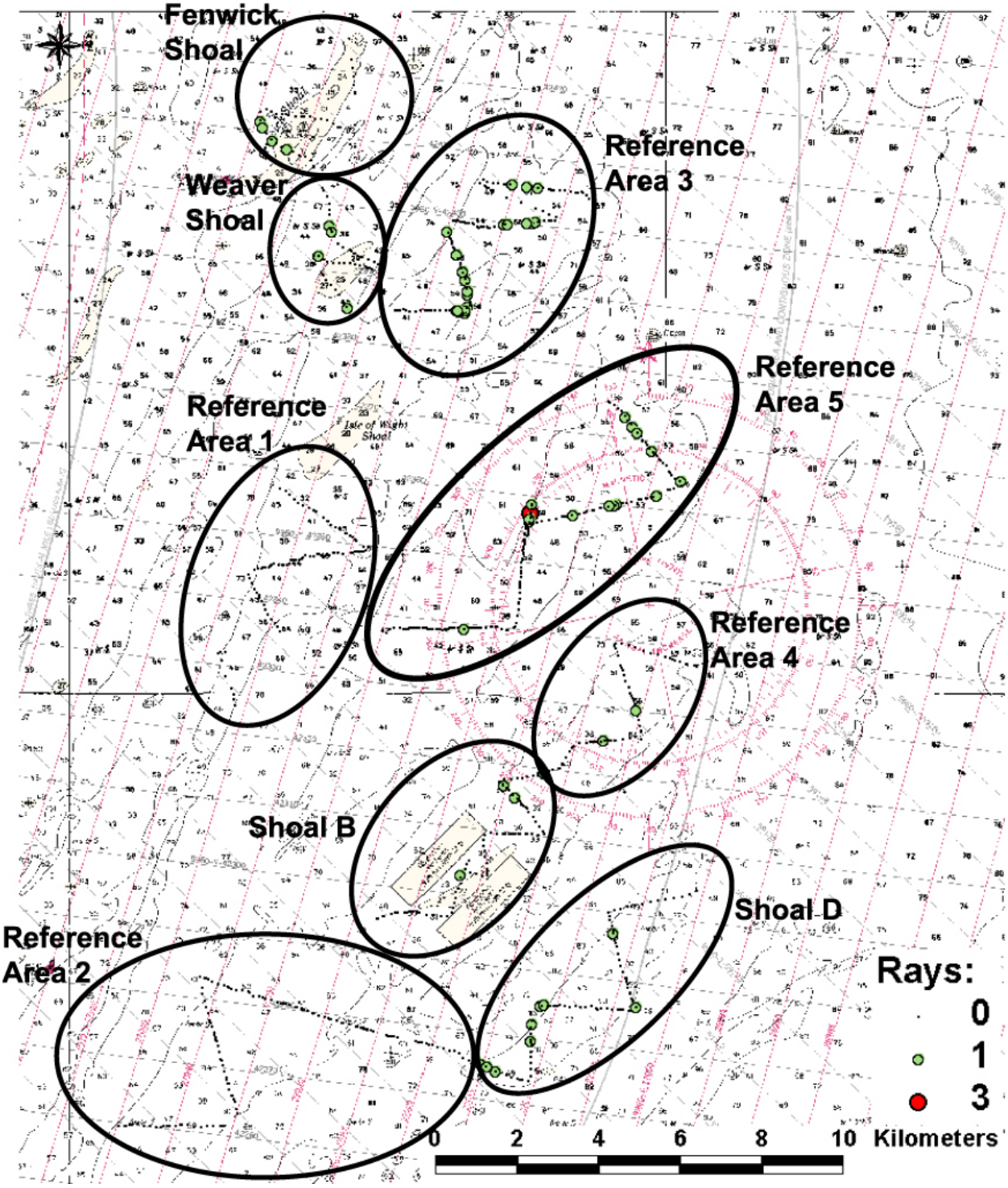


Figure A-11: Distribution of flatfish observed in video samples. Legend refers to number of individuals observed in each video sample.