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Final Report

2021/2022 Drop Camera Survey of Benthic Communities and Substrate in the 522 Study Area

Submitted to:
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Final Report

2021/2022 Drop Camera Surveys of Benthic Communities and Substrate in the 522 Study Area

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Project Summary: The University of Massachusetts Dartmouth School for Marine Science and Technology (SMAST) conducted drop camera surveys to examine the benthic community and substrate in Vineyard Offshore LLC's (Vineyard Offshore's) Lease Area OCS-A 0522 (the "522 Study Area"). The primary goal of this project was to collect preliminary data to help determine the sampling intensity needed to collect enough baseline data for the environmental assessment of wind farm development impact. Our objectives were to provide:

1) Distribution and density estimates of dominant benthic megafauna and,
2) Classify substrate across the survey domain.

A centric systematic grid sampling design was used to sample 22 stations in the 522 Study Area. Stations were placed 5.6 kilometers (km) apart. A sampling pyramid mounted with a high-resolution camera was deployed at each station and used to take four quadrat (2.3 square meter [m^2] images) samples. The area was surveyed in May 2021 and May 2022 using a commercial scallop fishing vessel to deploy the sampling pyramid. Sixteen different benthic animal groups were observed in the 522 Study Area during both years. Increases in common animal group densities and frequencies occurred from 2021 to 2022. The animals appeared randomly distributed across the 522 Study Area. Sand, silt, shell debris, and gravel were the substrate types observed in both years.

Table of Contents

List of Tables

List of Figures

Introduction

In 2019, Vineyard Offshore affiliate Vineyard Wind LLC leased a 516 square kilometer (km^2) area for renewable energy development on the United States (US) Atlantic Outer Continental Shelf (OCS), referred to as Lease Area OCS-A 0522, which is located south of Nantucket, Massachusetts. Vineyard Offshore is conducting fisheries surveys in the 522 Study Area to gain baseline data of the substrate and benthic megafauna, which is the focus of this report. Additional fisheries studies are being conducted in Lease Area OCS-A 0501 and Lease Area OCS-A 0534; these studies are reported separately.

SMAST has developed an image-based drop camera survey that allows for sampling of the epibenthic community with minimum disturbance to the seafloor. The SMAST drop camera survey can be used to better understand benthic macrofaunal community characteristics, substrate habitats, and the spatial and temporal scales of potential impacts on these communities and habitats. The survey techniques were developed collaboratively with scallop fishers and use quadrat sampling methods based on diving studies (Stokesbury and Himmelman, 1993;1995). Initial surveys in the early 2000s focused on estimating the density of scallops within closed portions of the US Georges Bank fishery and the survey approach has since expanded to cover most of the scallop resource in eastern US and Canadian waters (approximately 100,000 km^2; Figure 1). Information from the survey has been incorporated into the scallop stock assessment through the Stock Assessment Workshop process and reliably provided to the New England Fisheries Management Council (NEFMC) to aid in annual scallop harvest allocation (NEFSC, 2010; 2018).

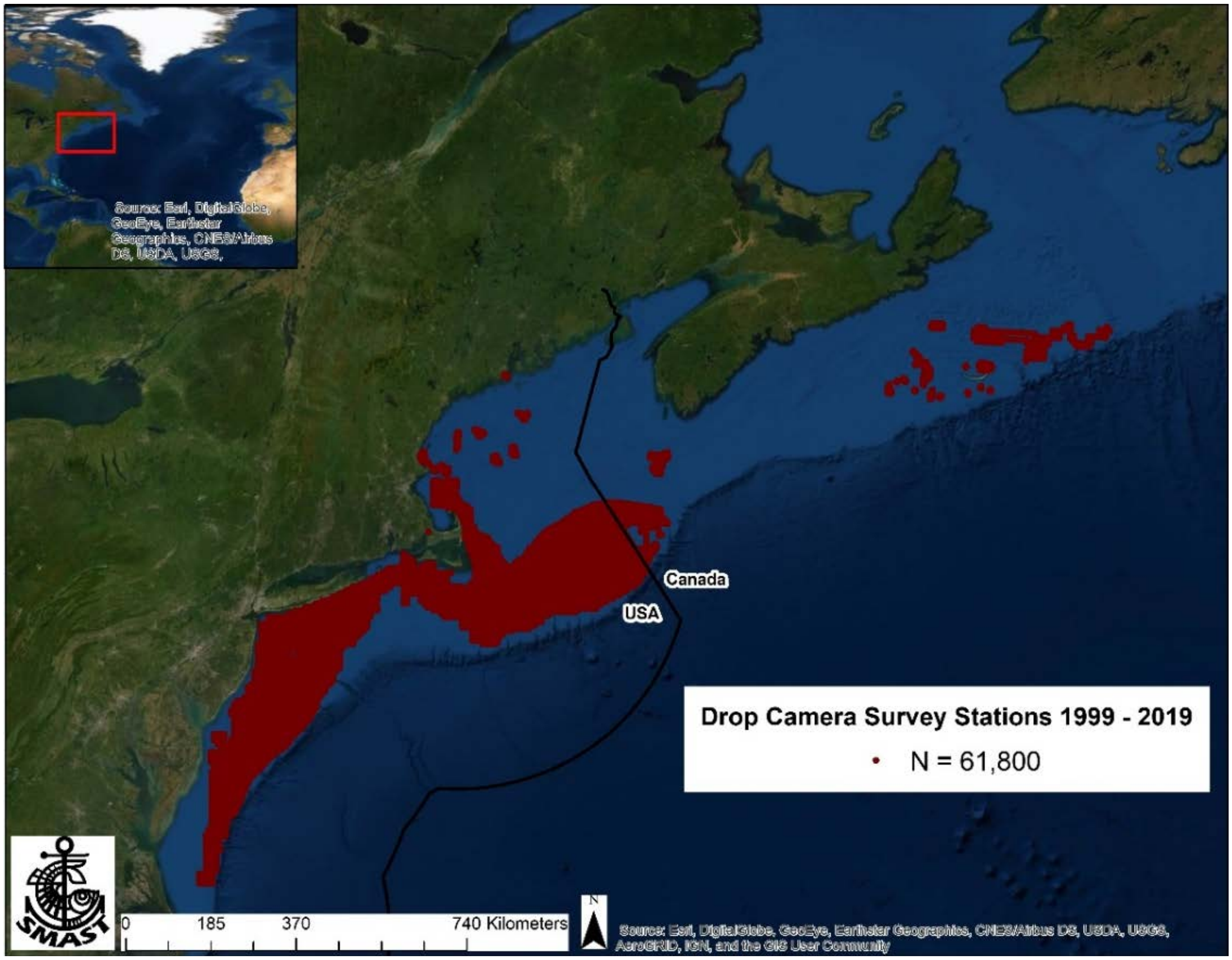


Figure 1. The spatial extent of SMAST drop camera surveys in eastern US and Canadian waters. All stations surveyed from 1999 to 2019 are displayed in red.

Data from the drop camera surveys have contributed in numerous ways to understanding the ecology of non-scallop species (Marino et al., 2009; MacDonald et al., 2010; Bethoney et al., 2017; Asci et al., 2018; Rosellon-Druker and Stokesbury, 2020) and the characterization of benthic habitat (Stokesbury and Harris, 2006; Harris and Stokesbury, 2010; NEFMC, 2011; Harris et al., 2012). This work contributed to several ecosystem-based management activities, such as the NEFMC Swept Area Seabed Impact model (NEFMC, 2011). Drop camera surveys have also been used to define habitat characteristics and spatial distribution of benthic marine invertebrates in potential wind energy areas off the coasts of Maryland and southern New England (Guida et al., 2017). Ecologically and economically important species that would be difficult to sample with a net or dredge, such as Atlantic longfin squid (*Doryteuthis pealeii*) egg clusters or habitat-forming filamentous fauna (bryozoans or hydrozoans), can be counted using drop camera surveys (Figure 2).

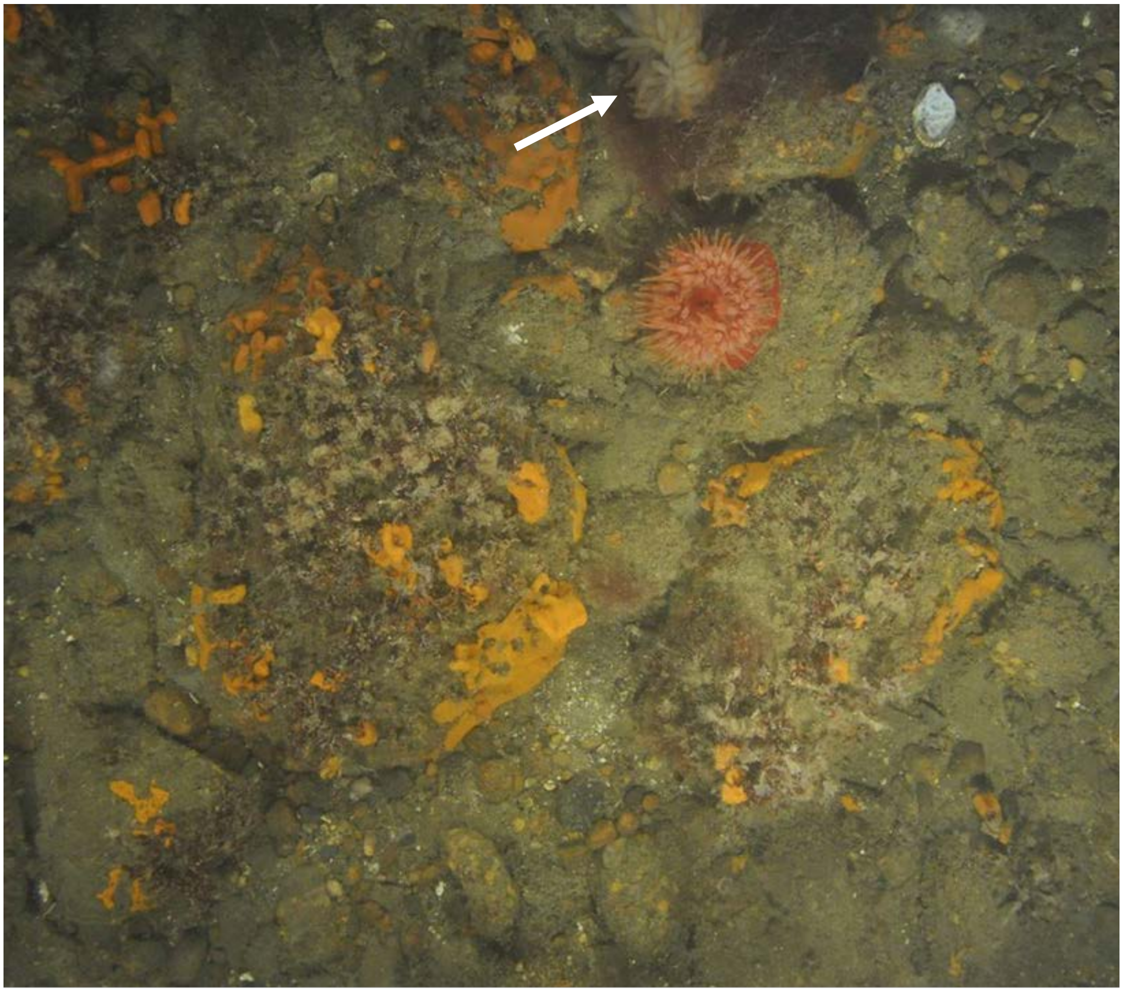


Figure 2. Example of a digital still image taken by the SMAST drop camera survey in complex habitat in the Rhode Island Wind Energy Lease Area on Cox's Ledge during a survey in 2013. An Atlantic longfin squid egg cluster was present (top, middle).

The data collected by the drop camera surveys can be used in an impact assessment to determine whether a change to the environment occurred due to a specific stressor, such as wind development, and to what extent the benthic animals are affected (Smith, 2006). The Before-After Control-Impact (BACI) study is an experiment designed for assessing anthropogenic impacts on natural habitats and is particularly useful in large-scale anthropogenic disturbances or environmental management (Green, 1979; Underwood, 1991; Kerr et al., 2020). To account for naturally fluctuating characteristics, a designated area outside of the impact area, but containing similar environments and communities, is chosen as a control site (Eberhardt, 1976). This approach can be strengthened with an asymmetrical design that uses multiple control sites at different distances from the impact site, incorporating the concepts of Beyond BACI (Underwood, 1993) and Before After Gradient (Elllis and Scheider, 1997). The drop camera survey data can be used to compare epibenthic faunal distributions between impact and control sites over time. The drop camera surveys will aid in building a regional, standardized baseline dataset needed to address development impacts on epibenthic communities and habitats. From this study, the data collected can be used to provide preliminary estimates and enable analysis detailing the number of samples required to detect significant changes with a specific level of precision. This will enable a precisely designed control-impact experiment prior to the development of the area.

Goal and Objectives

The primary goal of this project is to collect preliminary data on the benthic community and substrate in the 522 Study Area. These data could be used to help determine the sampling intensity needed to collect enough baseline data for environmental assessment of wind farm development in the 522 Study Area. The preliminary data were gathered using drop camera surveys in the 522 Study Area (Figure 3) to:

1) Map the distribution and estimate the density of dominant benthic megafauna, and
2) Classify substrate types.

These two objectives document the primary epibenthic animals and habitats within the 522 Study Area, which could be used to identify the sampling intensity needed for future statistical tests and surveys. The objectives will also document seasonal and/or annual changes in distribution and density.

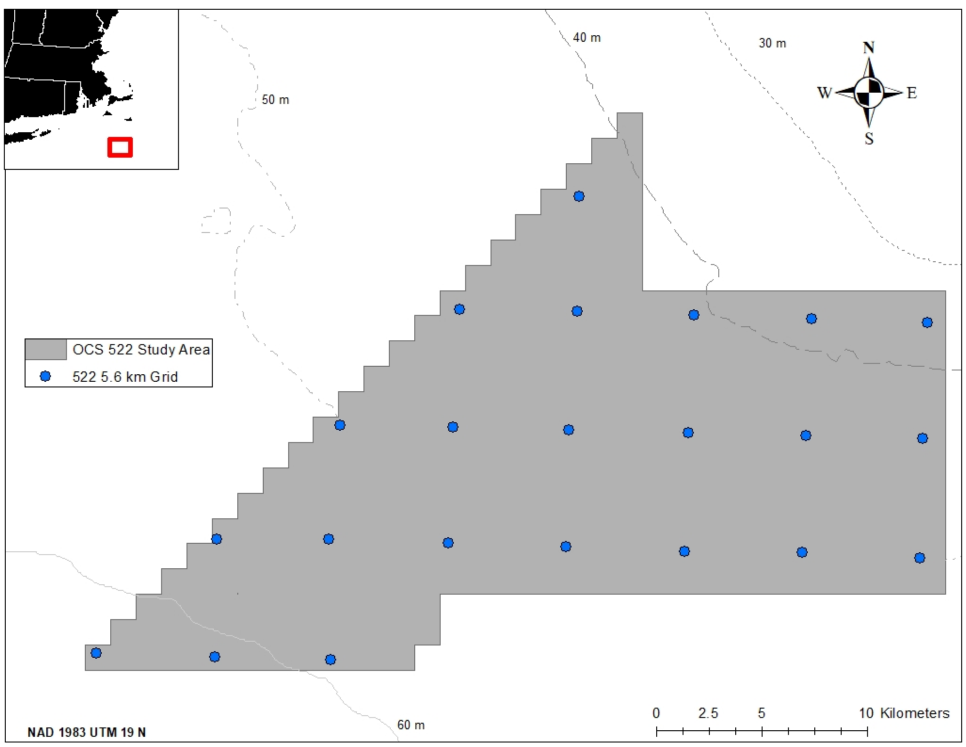


Figure 3. The 2021 and 2022 drop camera survey station grid in the 522 Study Area.

Methods

A centric systematic grid design was used to sample stations in the 522 Study Area. Stations were placed 5.6 km apart (Figure 3). At each station, a sampling pyramid was deployed, and a high-resolution camera was used to take four quadrat (2.3 m^2 images) samples (Figure 4). This was the same sampling resolution as the 2012 and 2013 drop camera surveys of the Massachusetts Wind Energy Areas (Stokesbury, 2014; 2021).

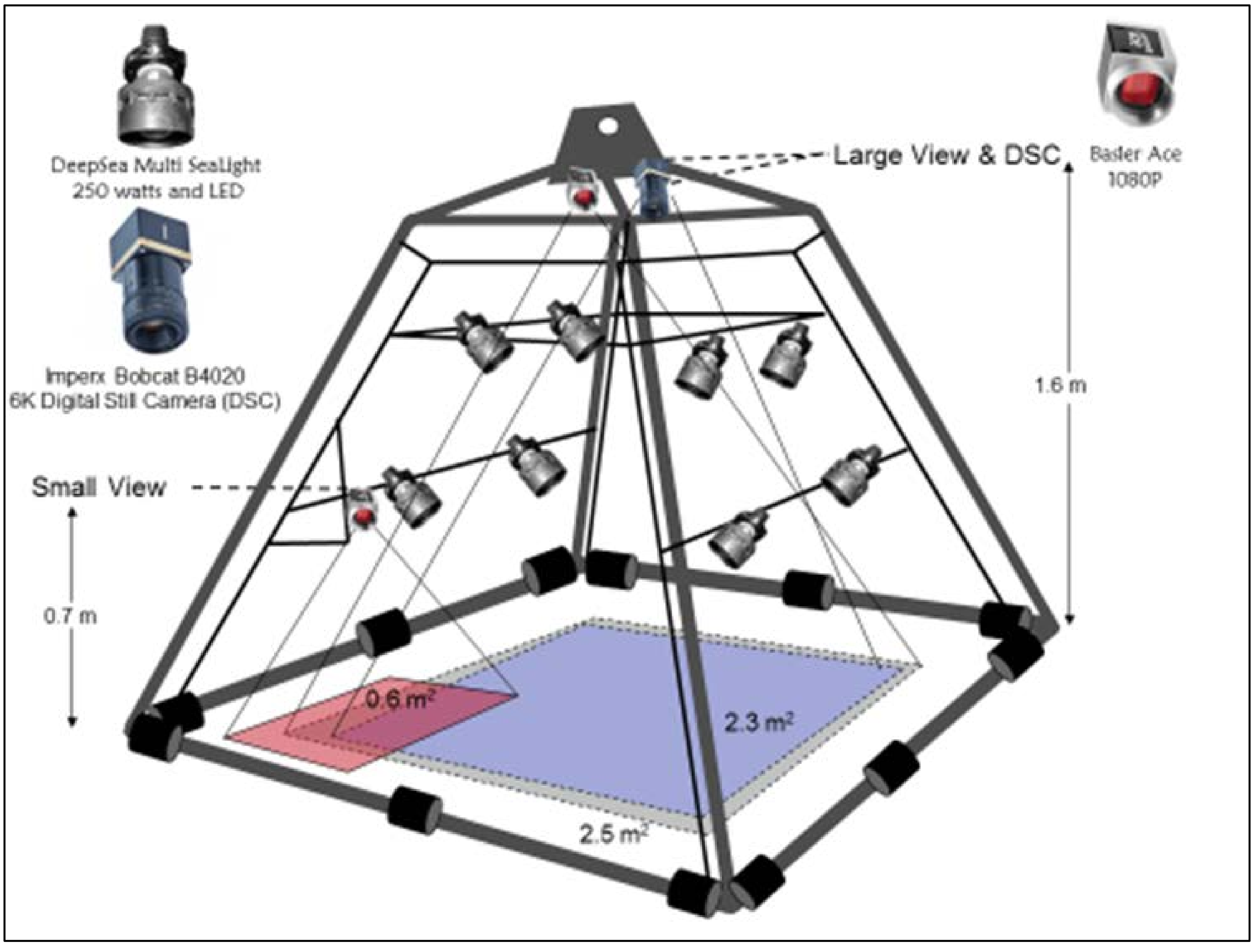


Figure 4. The SMAST drop camera survey pyramid with cameras and lights used for data collection. The camera used for the small view was turned to the side to provide a view parallel to the seafloor for some stations.

A commercial scallop fishing vessel was used to deploy the pyramid (Stokesbury, 2002; Stokesbury et al., 2004; Bethoney and Stokesbury, 2018). A mobile studio including monitors, computers for image capturing and data entry, and survey navigation (software integrated with the differential global positioning system) was assembled in the vessel's wheelhouse. Two downward-facing cameras mounted on the sampling pyramid provided 2.3 m^2 and 2.5 m^2 quadrat images of the seafloor for all stations. Additionally, a third camera providing a 0.6 m^2 view parallel to the seafloor was also deployed. Images from all cameras and video footage from the 2.5 m^2 camera of the first quadrat were saved and the pyramid was raised, so that the seafloor could no longer be seen. The vessel was allowed to drift approximately 50 meters (m), and the pyramid was lowered to the seafloor again to sample a second quadrat; this was repeated two additional times so that each station had four images from each camera. Onboard the survey vessel, scallop counts, station location, and depth were recorded and saved through a specialized field application for entry into an SQL Server Relational Database Management System.

After the survey, the images from the high-resolution digital still camera were used as the primary data source (Figure 2). Other images and videos collected were used as digitizing aids. Within each quadrat, macrobenthos taxa were counted or noted as present, and the substrate was classified (Stokesbury, 2002; Stokesbury et al., 2004; Bethoney and Stokesbury, 2018). Fifty taxa of macrobenthos could have been identified if present in the sample (Appendix I). In addition, Atlantic longfin squid egg clusters, , were counted . Sediments were classified following the Wentworth particle grade scale from images, where the sediment particle size categories (in grain diameters) are based on a doubling or halving of the fixed reference point of 1 millimeter (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 (Lincoln et al., 1992). The presence of each sediment category was noted for each quadrat image. Maps and analysis focused on classifying stations by the largest sediment particle size observed in a digital still image from that station (Harris and Stokesbury, 2010). Shell debris was also identified. After the images were digitized, a quality assurance check was performed on each image to ensure the accuracy of counted and identified species and sediments. Note, this sediment classification was not the only method used in Lease Area OCS-A 0522 and there were other more comprehensive efforts completed by Vineyard Offshore to classify the benthic habitat in Lease Area OCS-A 0522 reported elsewhere.

Mean densities and standard errors of animals counted were calculated using equations for a two-stage sampling design where the mean of the total sample is (Cochran 1977):

$$\bar{\bar{x}} = \sum_{i=1}^{n} \left(\frac{\bar{x}_i}{n} \right)$$

where *n* is the number of stations and $\bar{x}_i$ is the mean of the four quadrats at station *i*. The SE of this two-stage mean was calculated as:

$$S.E.(\bar{x}) = \sqrt{\frac{1}{n}(s^2)}$$

where:

$$s^2 = \sum^{n} (\bar{x}_i - \bar{\bar{x}})^2 / (n-1)$$

According to Cochran (1977) and Krebs (1989), this simplified version of the two-stage variance is appropriate when the ratio of sample area to survey area (*n*/*N*) is small. In this case, thousands of square meters (*n*) are sampled compared with millions of square meters (*N*) in the 522 Study Area. A similar multi-stage approach was used to calculate mean presence values. Mean density or quadrats present per station of taxa and substrate within the 522 Study Area were mapped (Figures 8 to 26). This analysis focused on the most observed benthic animal groups in the 522 Study Area as these were detected at high enough rates for statistical analysis (Bethoney et al., 2017). Densities for each animal group were compared by graphing mean estimates with their associated 95% confidence intervals (Sokal and Rohlf, 2012).

Results and Discussion

The two drop camera surveys of the 522 Study Area were conducted on May 23, 2021, and May 6 – 7, 2022. All images and videos were shared with Vineyard Offshore. All 22 stations were surveyed in both years. Sixteen different benthic animal groups were observed in the 522 Study Area, with the 12 most common displayed (Table 1). Nine of the common animal groups were found in both years; sponges were not observed in 2022 and clams, flounder, and bryozoans/hydrozoans were not observed in 2021 (Table 1). Sea robin and whelk were also observed in 2022 but were not within the 12 most common groups. Most animal groups were found at higher densities in 2022 except for hermit crabs and more animal groups were observed in 2022 than in 2021 (Figures 5 and 6). Sea stars had wide confidence intervals around mean densities due to their large numbers at few stations (Figures 5 and 8). Animals in presence/absence groups had higher frequencies per quadrat in 2022 than in 2021 as well (Figure 6). Substrates changed from silt/sand dominance to silt, sand, and shell debris mix from 2021 to 2022 (Figure 7). The animals appear to be randomly distributed from year to year within the 522 Study Area (Figures 8 to 24). Sand was the most frequently observed largest substrate over both years, but some gravel was observed in 2022 (Figures 25 and 26).

Both surveys were completed in May to try and mitigate the poor visibility from turbidity in the water column that has been problematic in the previous surveys in this area. Five stations out of 22 had fewer than four quadrats visible in 2021, while the 2022 survey had 100% visibility at all stations (Figures I-1 and I-2). The increase in densities and animal groups observed may be attributed, in part, to the increase in visibility from 2021 to 2022. The visibility was an improvement from the prior years (2019 and 2020) and future surveys will be conducted during the same month to achieve maximum visibility.

Table 1. The 12* most common benthic animal groups, in order of most to least quadrats present, during the May 2021(left) and May 2022 (right) drop camera surveys of the 522 Study Area. Groups left blank in the "Counts" column are tracked as present or absent. *In 2021, only 1l animal groups were identified.

Animal Group	Quadrats Present	Counts
Hermit Crabs	18	29
Sand Dollars	17	
Moonsnail	5	6
Sea Stars	4	36
Crabs	3	4
Holes	2	
Sponges	1	1
Eel	1	1
Hake	1	1
Skate	1	1
Silver Hake	1	1
Quadrats Sampled	88	

Animal Group	Quadrats Present	Counts
Holes	48	
Sand Dollars	23	
Hake	21	25
Sea Stars	9	96
Hermit Crabs	9	10
Bry./Hyd.	9	
Clams	7	
Moonsnail	7	8
Skate	5	5
Crabs	4	8
Flat Fish	2	2
Silver Hake	2	2
Quadrats Sampled	88	

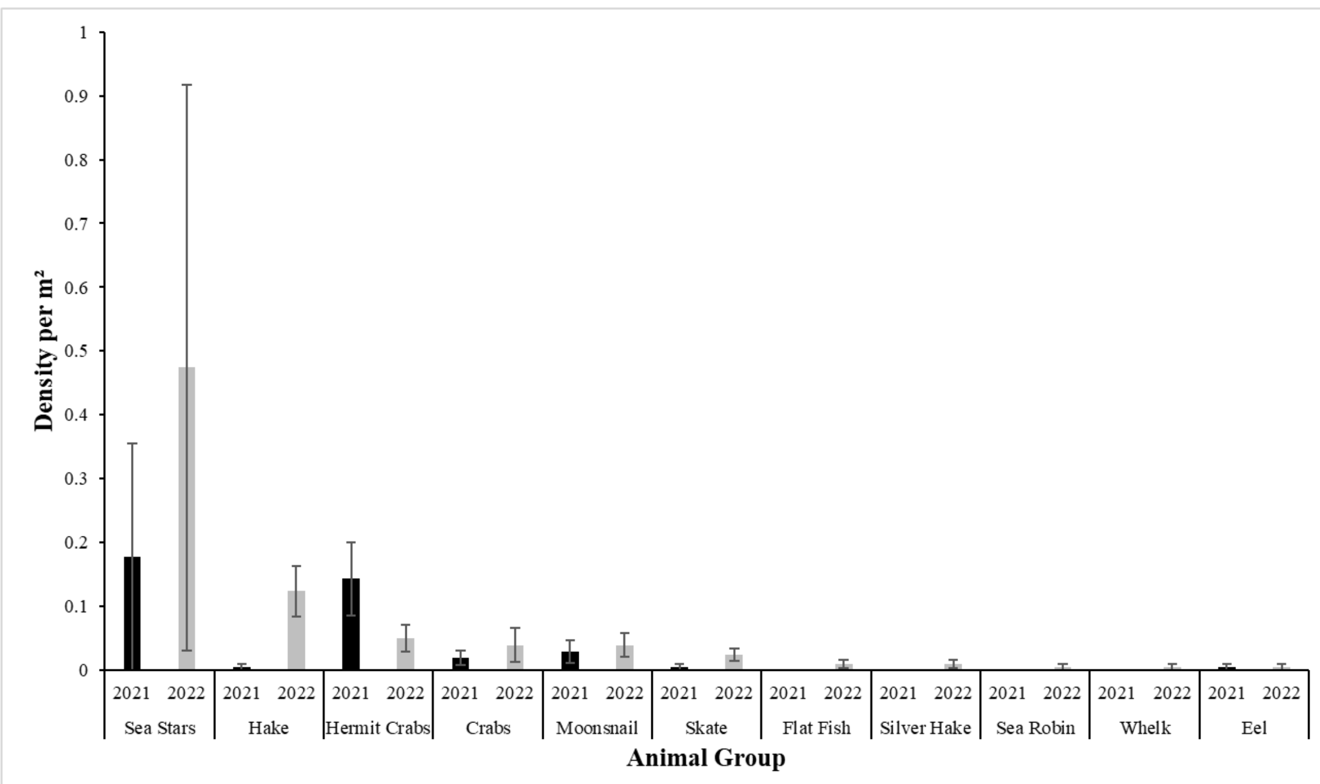


Figure 5. The mean densities of common benthic animals from the May 2021 and May 2022 drop camera surveys of the 522 Study Area. Error bars represent 95% confidence intervals.

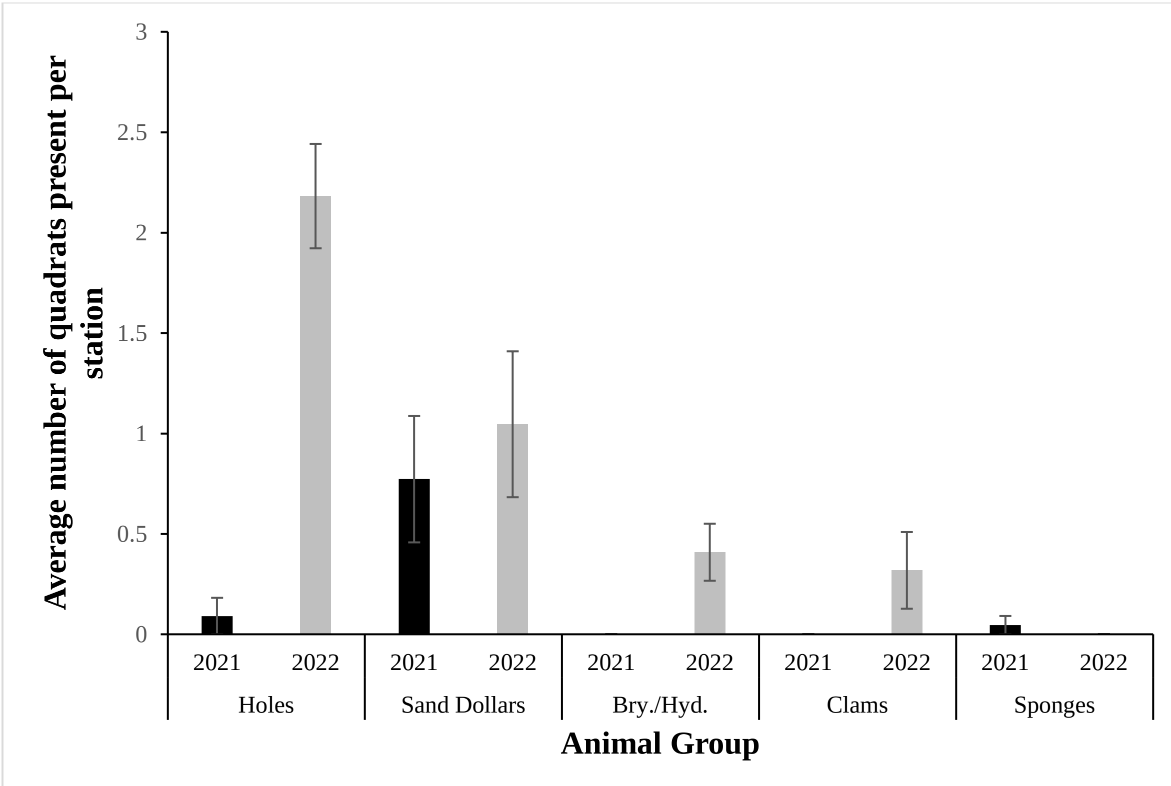


Figure 6. The average number of quadrats benthic animals were present at per station during the May 2021 and May 2022 drop camera surveys of the 522 Study Area. Holes represent burrowing animals and Bry./Hyd. represents bryozoans and hydrozoans. Four quadrats (each consisting of 2.3 m^2 images) were observed at each station.

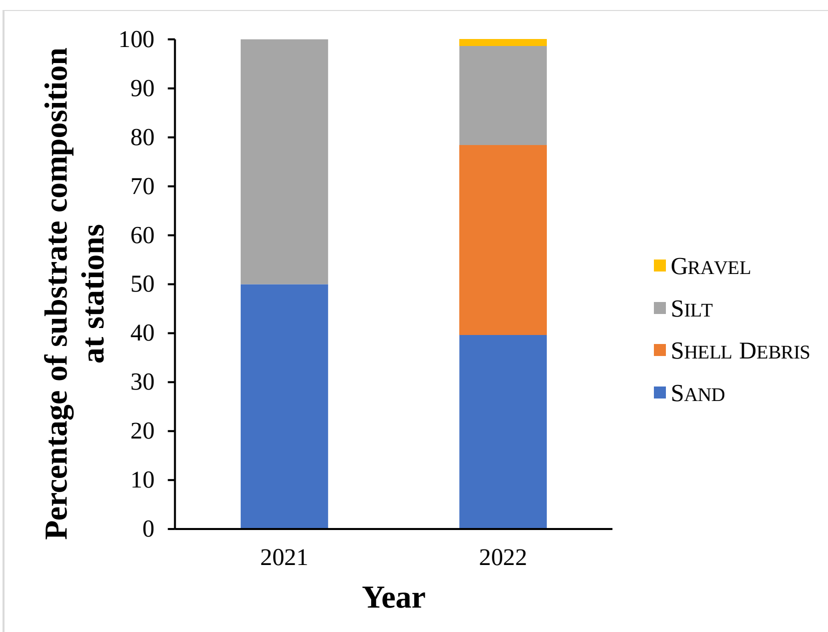


Figure 7. Substrate composition, defined by the most common substrate type observed at a station, during the May 2021 and May 2022 drop camera surveys of the 522 Study Area. Cobble and rock were not observed at any station.

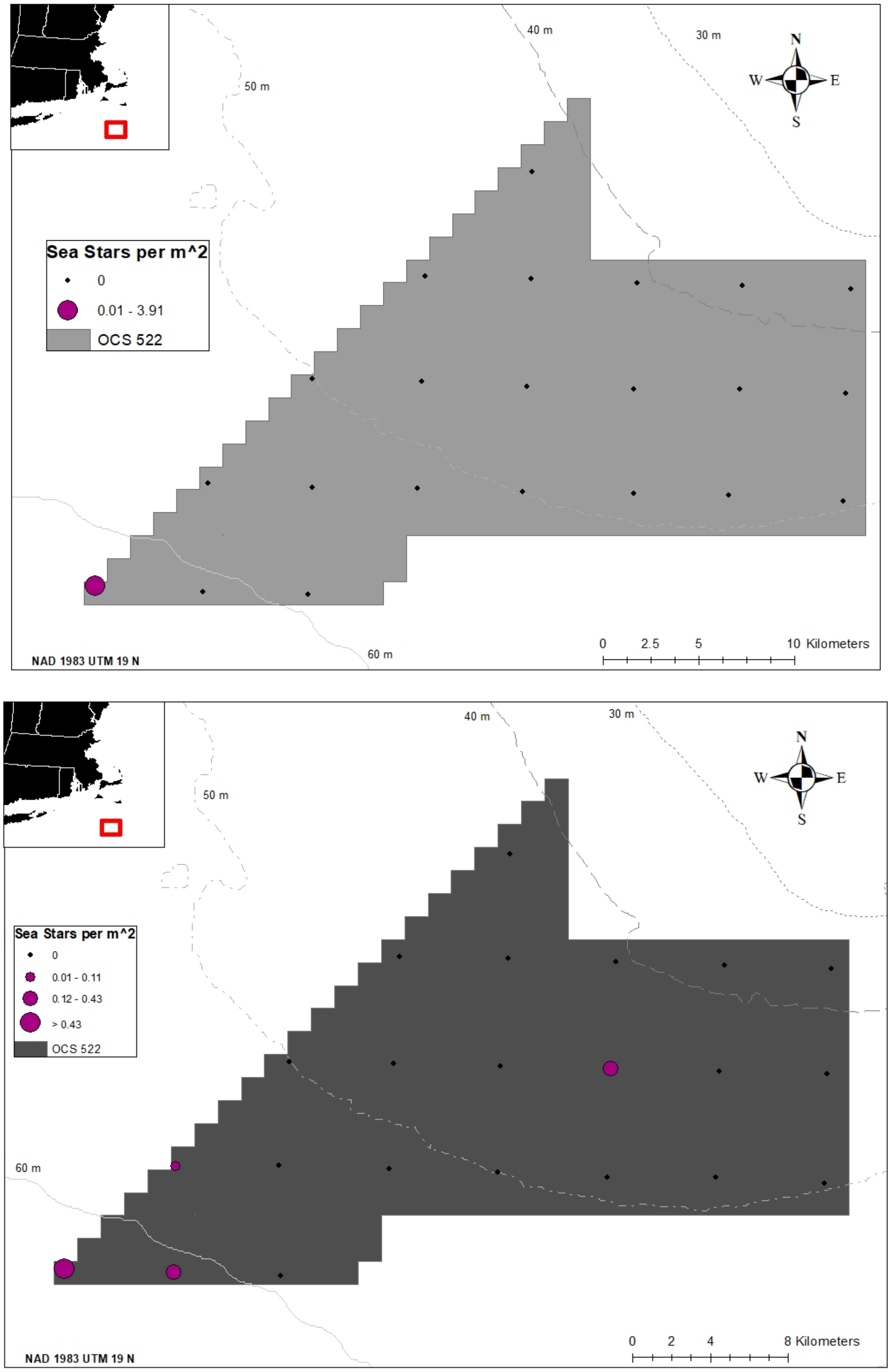


Figure 8. The distribution of sea stars from the May 2021 (top) and May 2022 (bottom) drop camera surveys of the 522 Study Area. Density categories divide the data into quantiles above zero based on observations in May for both years.

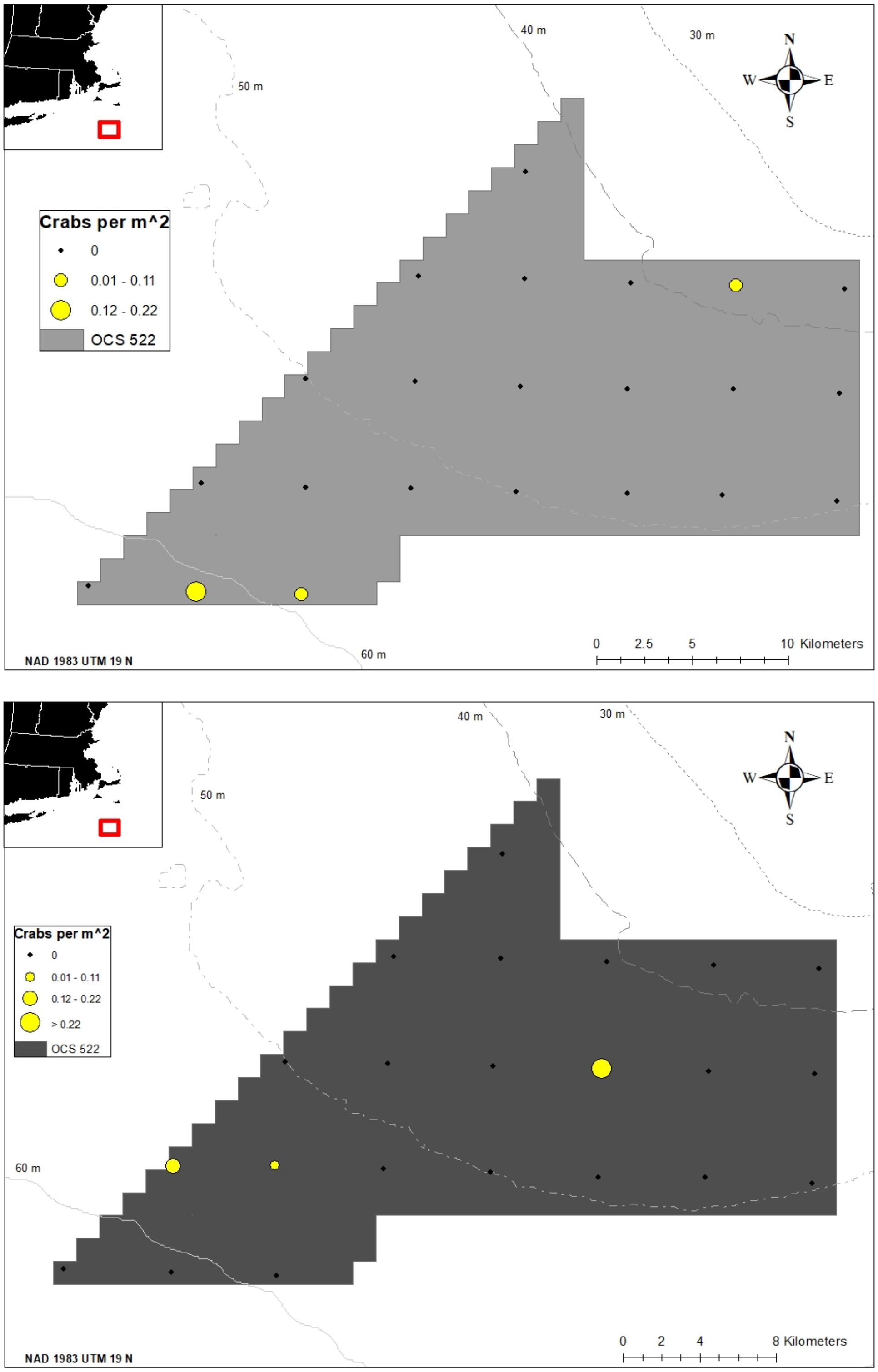


Figure 9. The distribution of crabs from the May 2021 (top) and May 2022 (bottom) drop camera surveys of the 522 Study Area. Density categories divide the data into quantiles above zero based on observations in May for both years.

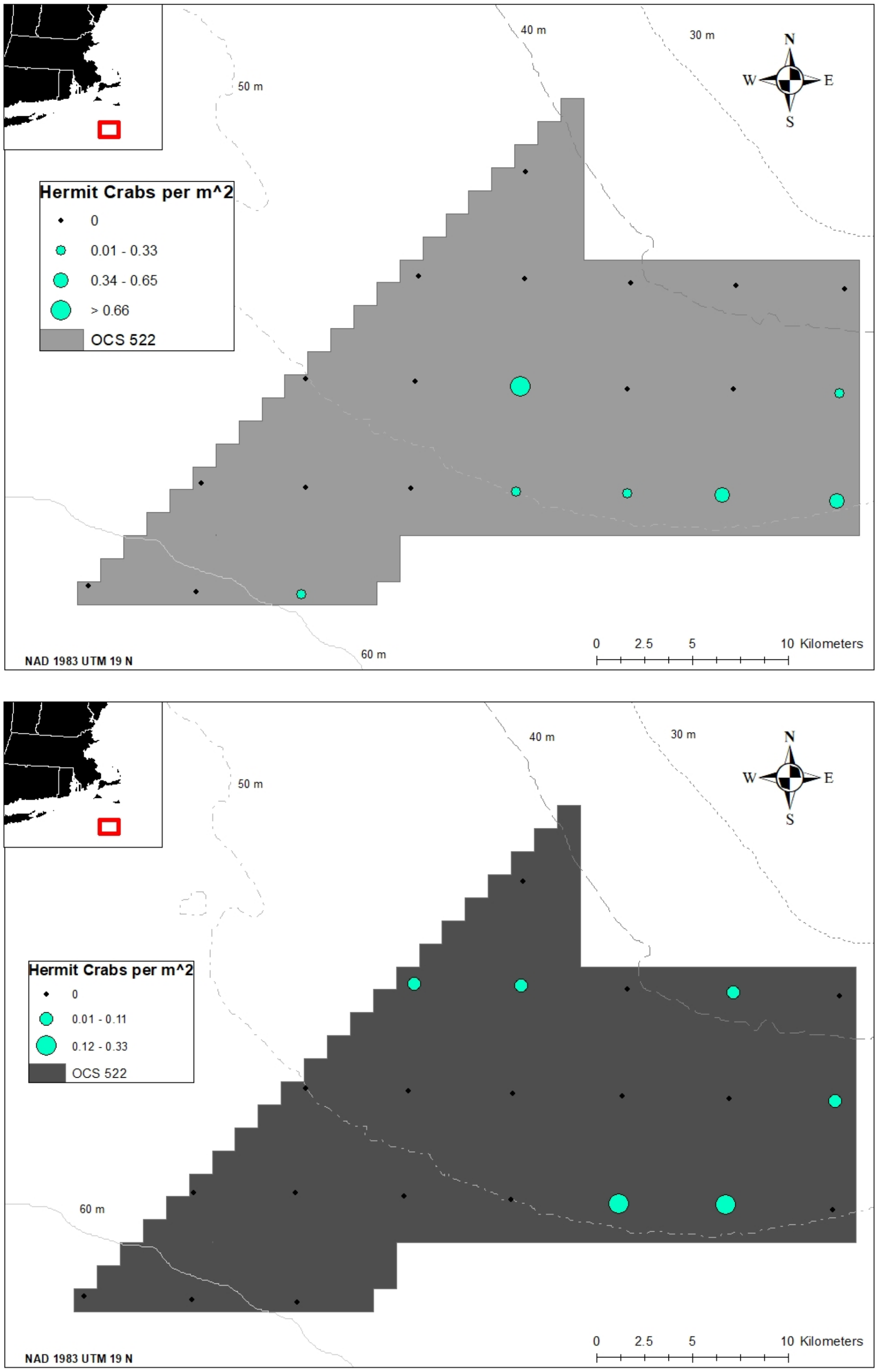
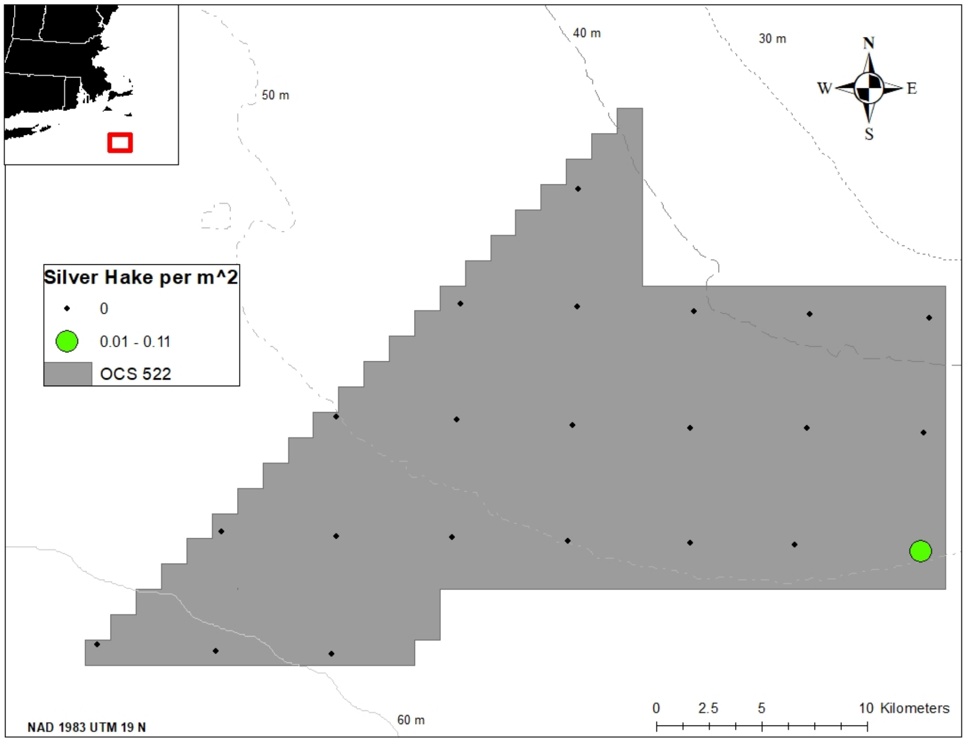


Figure 10. The distribution of hermit crabs from the May 2021 (top) and May 2022 (bottom) drop camera surveys of the 522 Study Area. Density categories divide the data into quantiles above zero based on observations in May for both years.



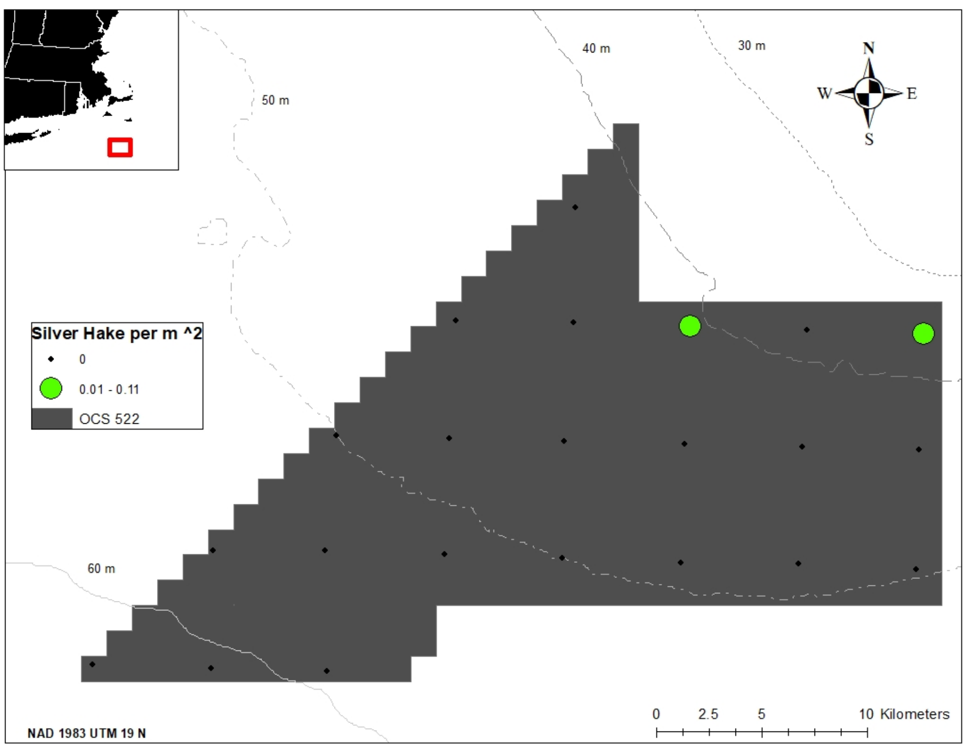


Figure 11. The distribution of silver hake from the May 2021 (top) and May 2022 (bottom) drop camera surveys of the 522 Study Area. Density categories represent zero or one silver hake observed at a station in both years.

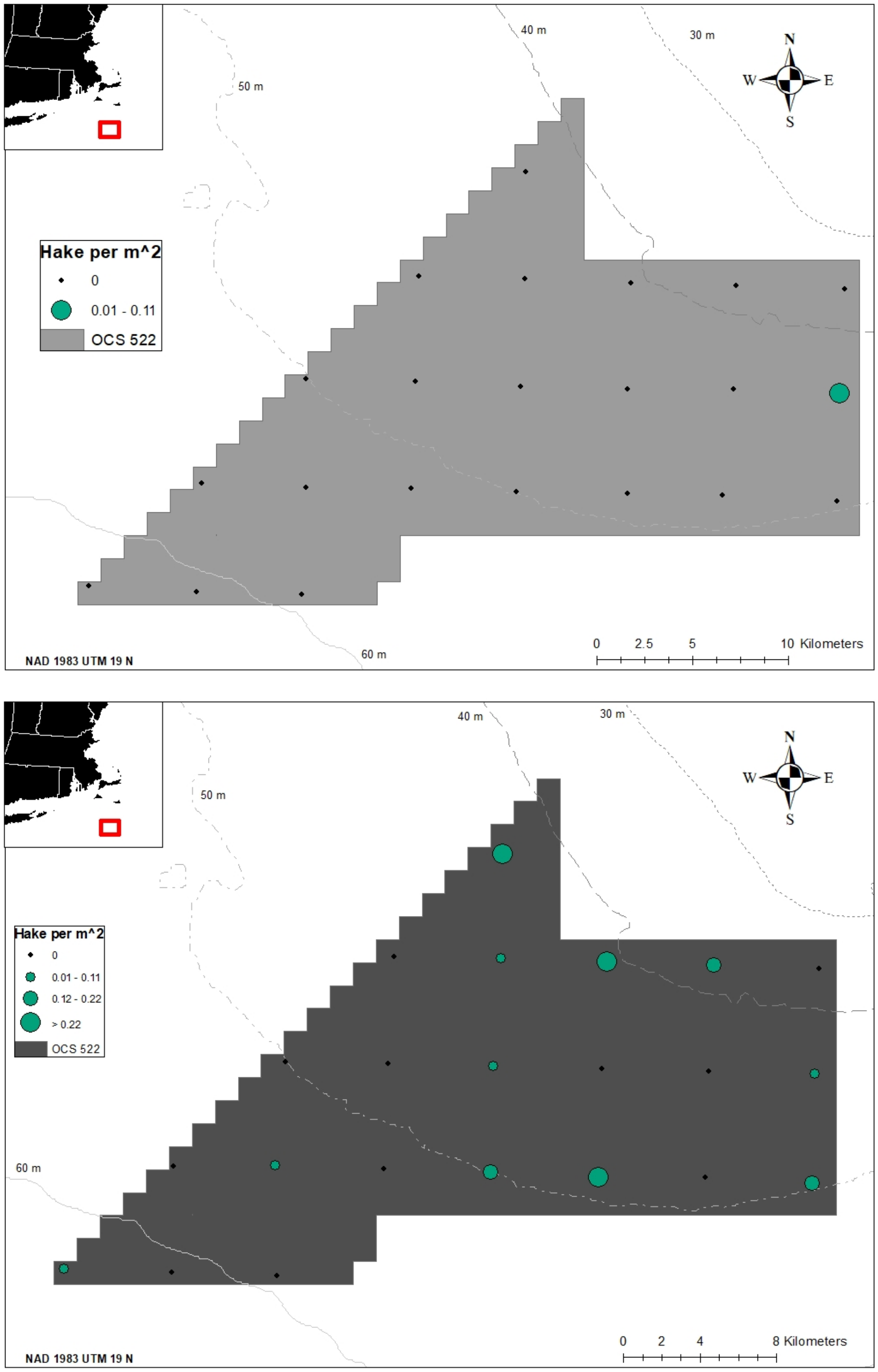


Figure 12. The distribution of hake from the May 2021 (top) and May 2022 (bottom) drop camera surveys of the 522 Study Area. Density categories divide the data into quantiles above zero based on observations in May 2022. Density categories represent zero or one hake observed at a station in 2021.

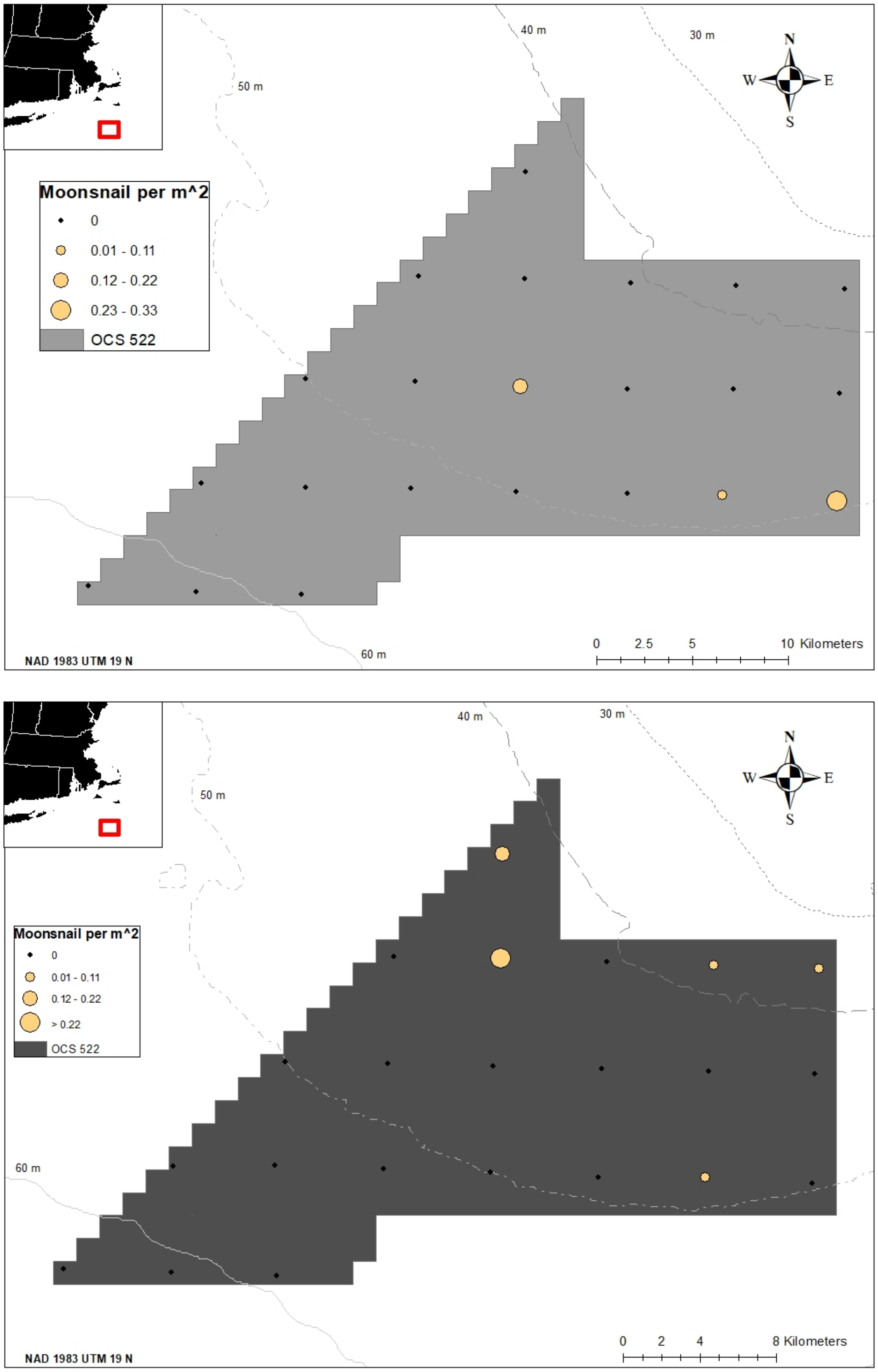


Figure 13. The distribution of moon snails from the May 2021 (top) and May 2022 (bottom) drop camera surveys of the 522 Study Area. Density categories divide the data into quantiles above zero based on observations in May for both years.

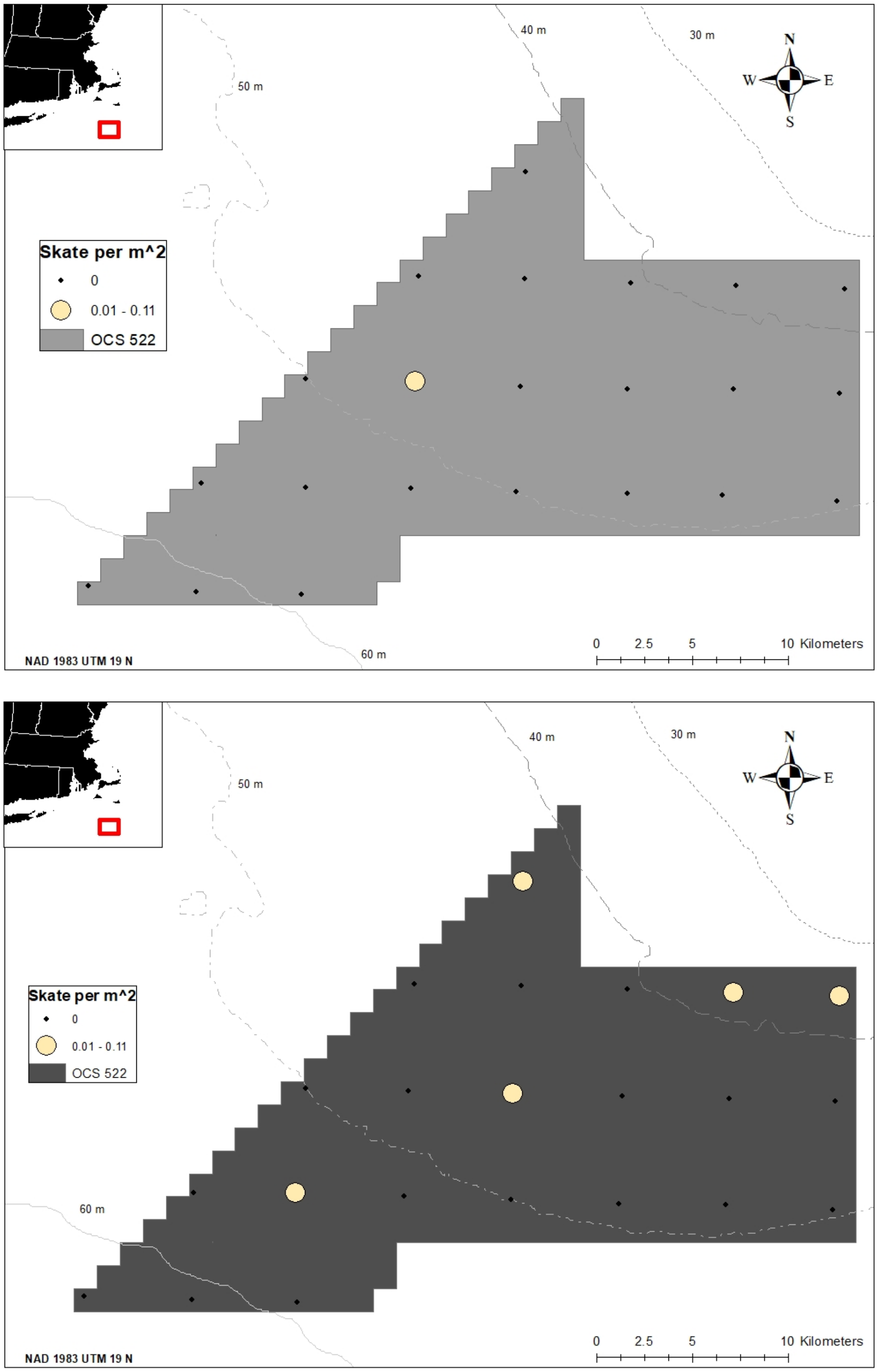


Figure 14. The distribution of skates from the May 2021 (top) and May 2022 (bottom) drop camera surveys of the 522 Study Area. Density categories represent zero or one skate observed at a station in both years.

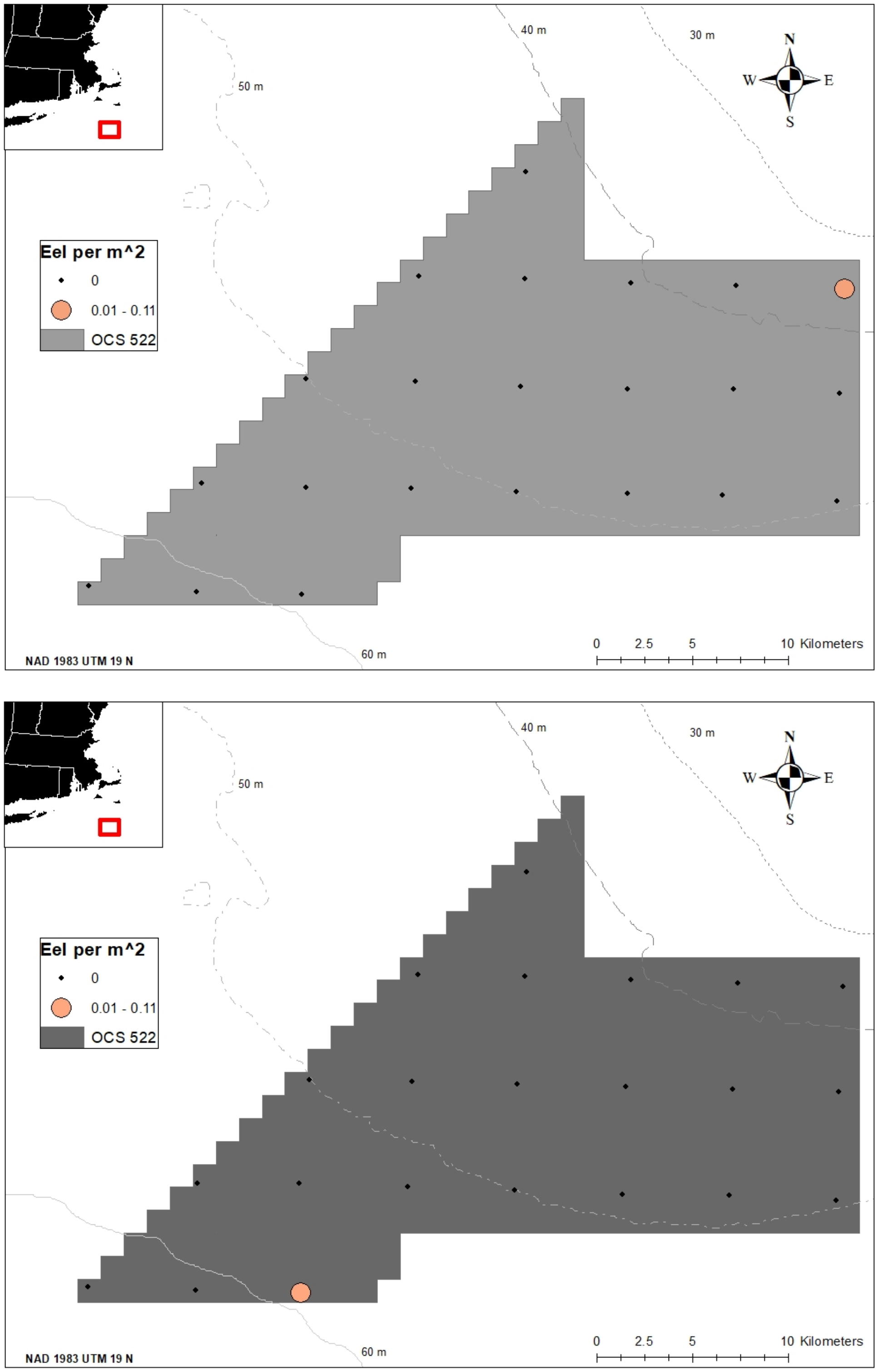


Figure 15. The distribution of eels from the May 2021 (top) and May 2022 (bottom) drop camera surveys of the 522 Study Area. Density categories represent zero or one eel observed at a station in both years.

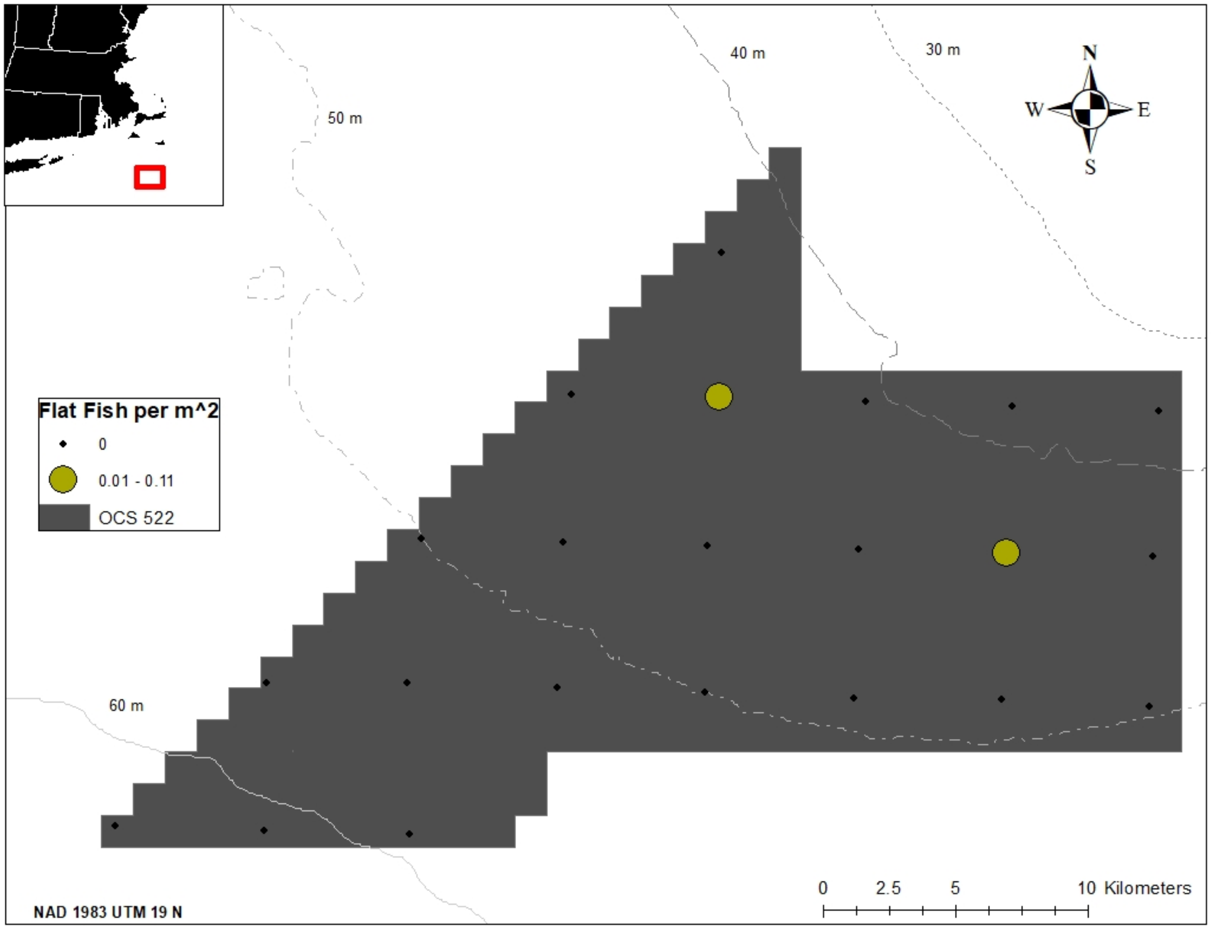


Figure 16. The distribution of flat fish from the May 2022 drop camera survey of the 522 Study Area. No flat fish were observed in the May 2021 survey. Density categories represent zero or one flat fish observed per station in 2022.

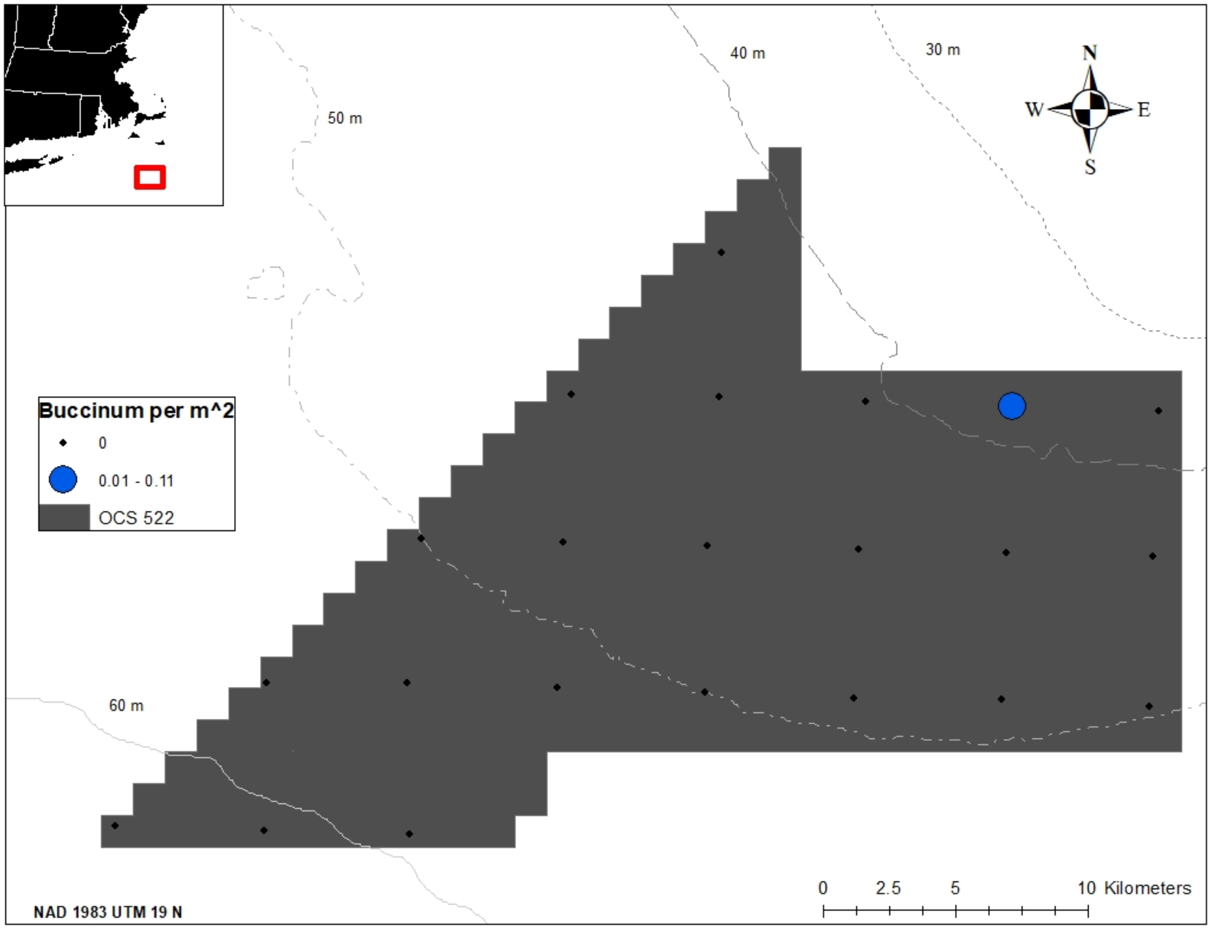


Figure 17. The distribution of whelk (*Buccinum undatum*) from the May 2022 drop camera survey of the 522 Study Area. No whelk were observed in the May 2021 survey. Density categories represent one zero or one whelk observed per station in 2022.

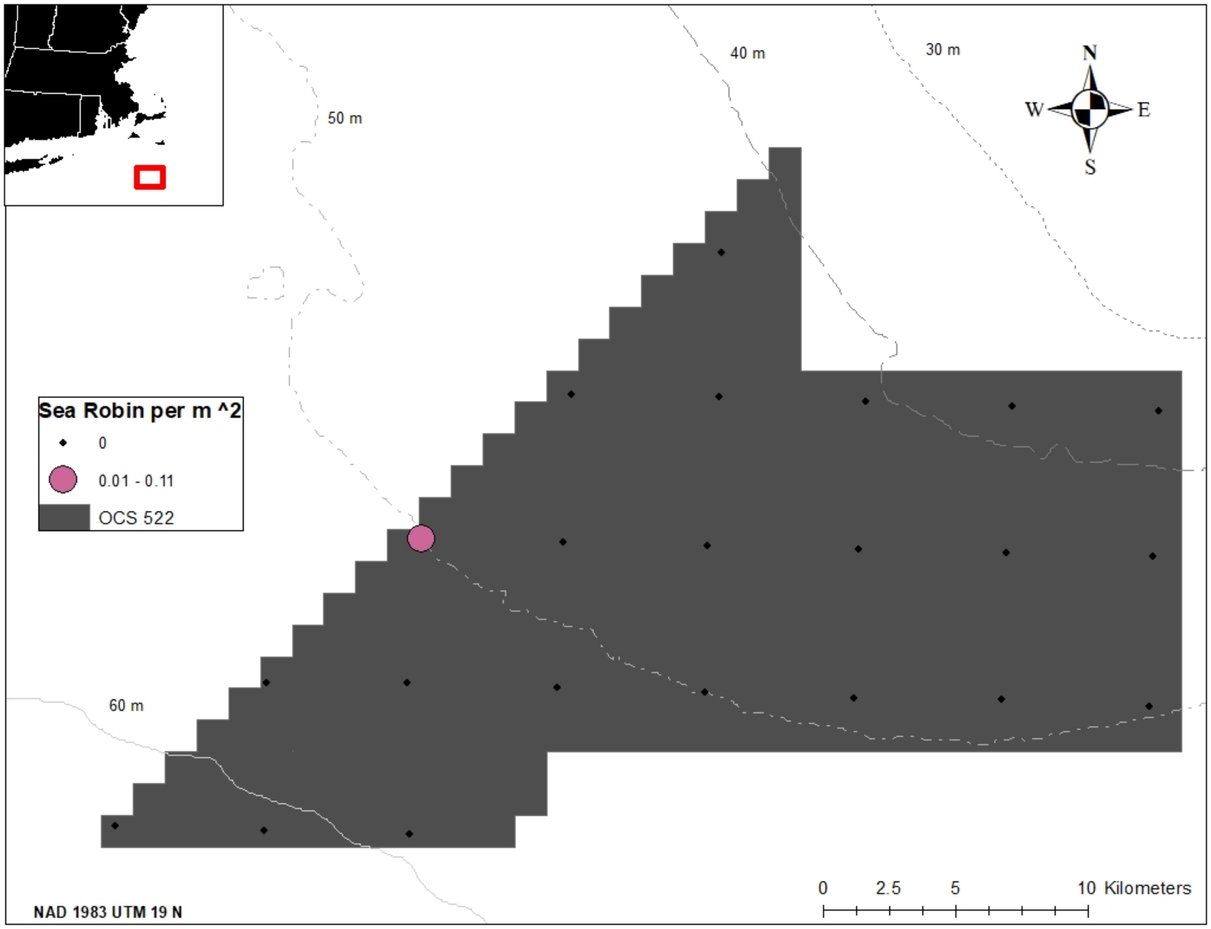


Figure 18. The distribution of sea robin from the May 2022 drop camera survey of the 522 Study Area. No sea robin were observed in the May 2021 survey. Density categories represent zero or one sea robin observed per station in 2022.

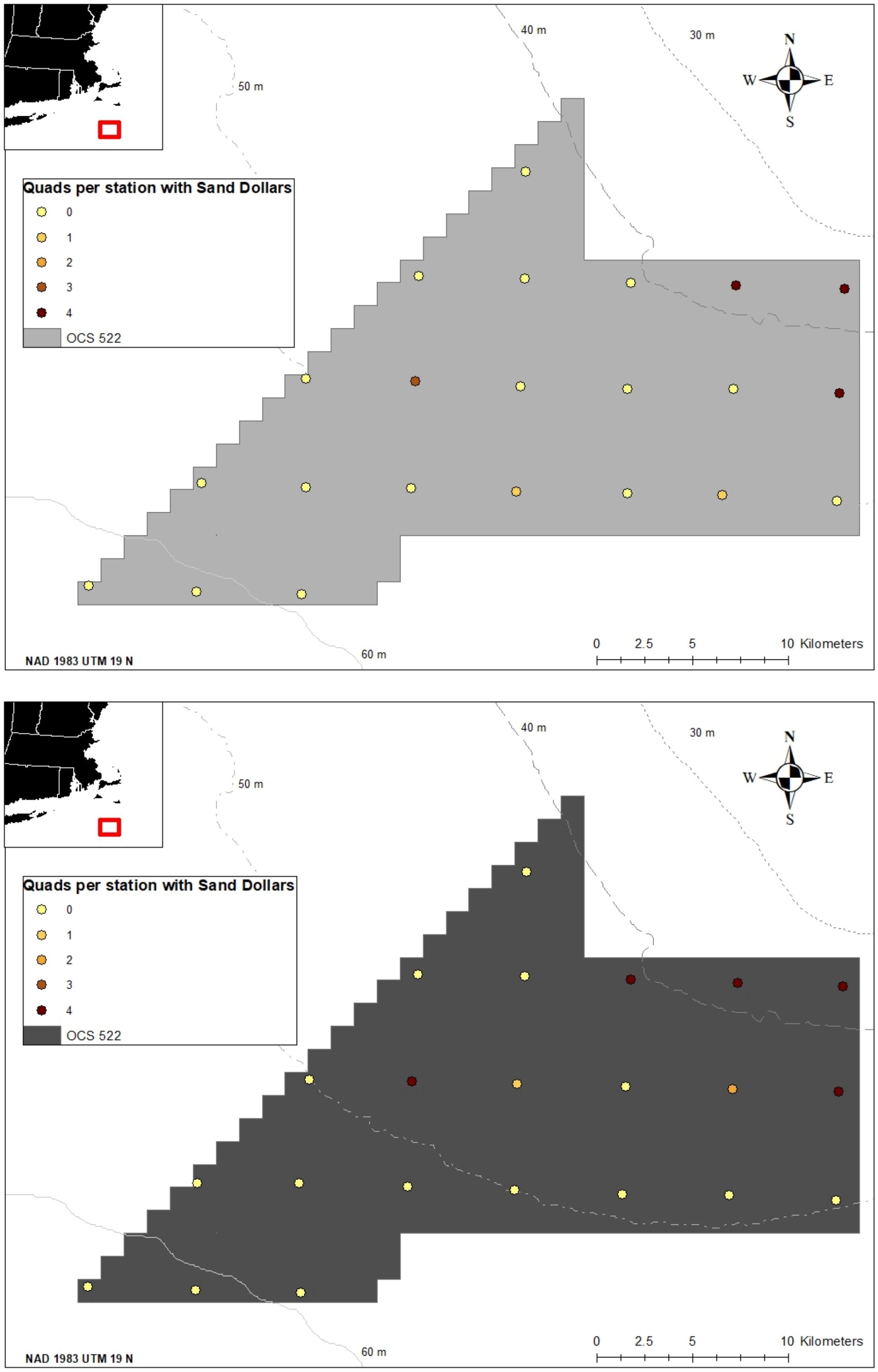


Figure 19. The distribution of sand dollars from the May 2021 (top) and May 2022 (bottom) drop camera surveys of the 522 Study Area, where each station is colored by the number of quadrats that sand dollars were observed as indicated in the figure legend. Four quadrats (2.3 m^2 images) were observed at each station.

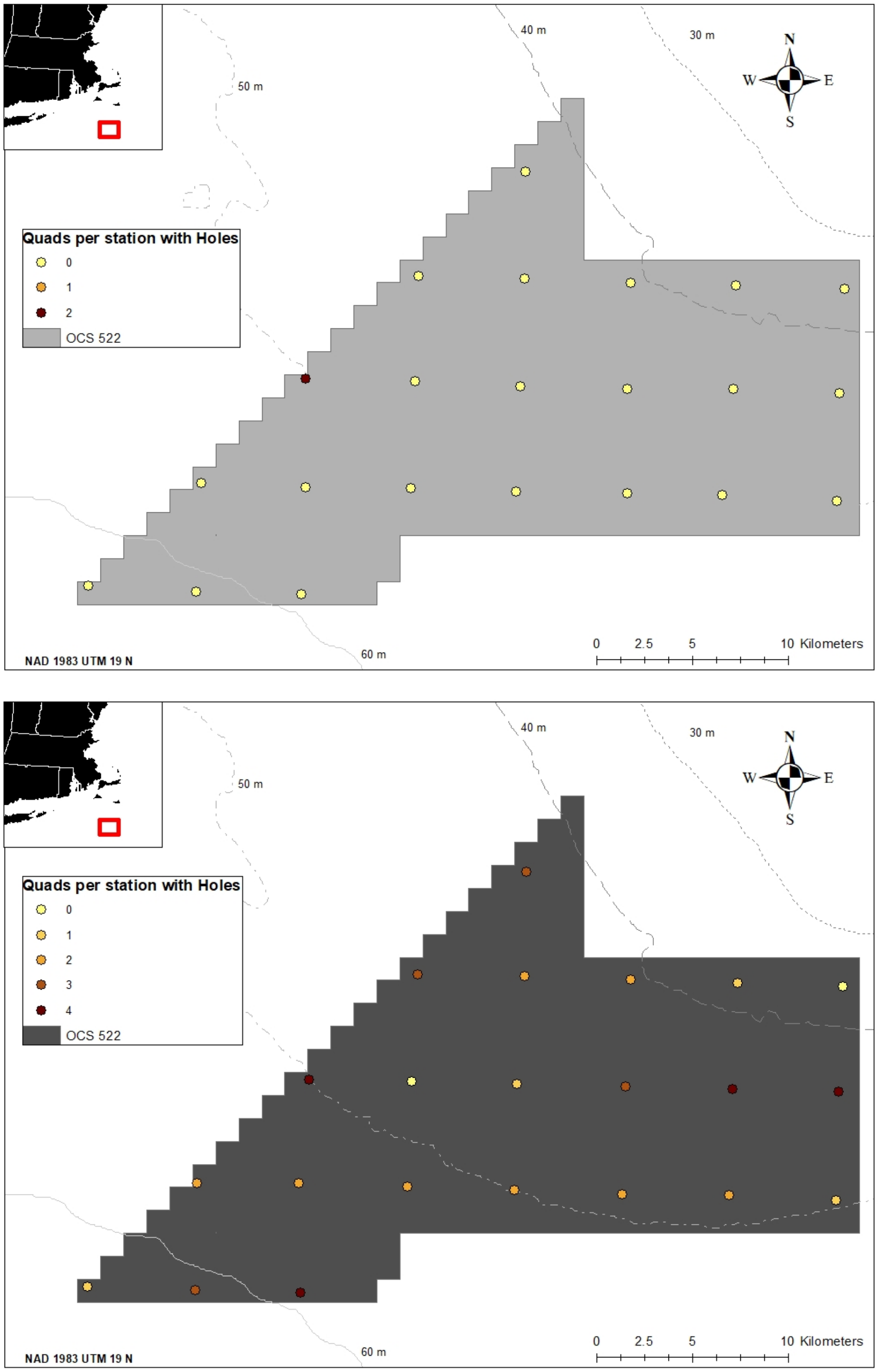


Figure 20. The distribution of holes (burrowing animals) from the May 2021 (top) and May 2022 (bottom) drop camera surveys of the 522 Study Area, where each station is colored by the number of quadrats that sand dollars were observed as indicated in the figure legend. Four quadrats (2.3 m^2 images) were observed at each station.

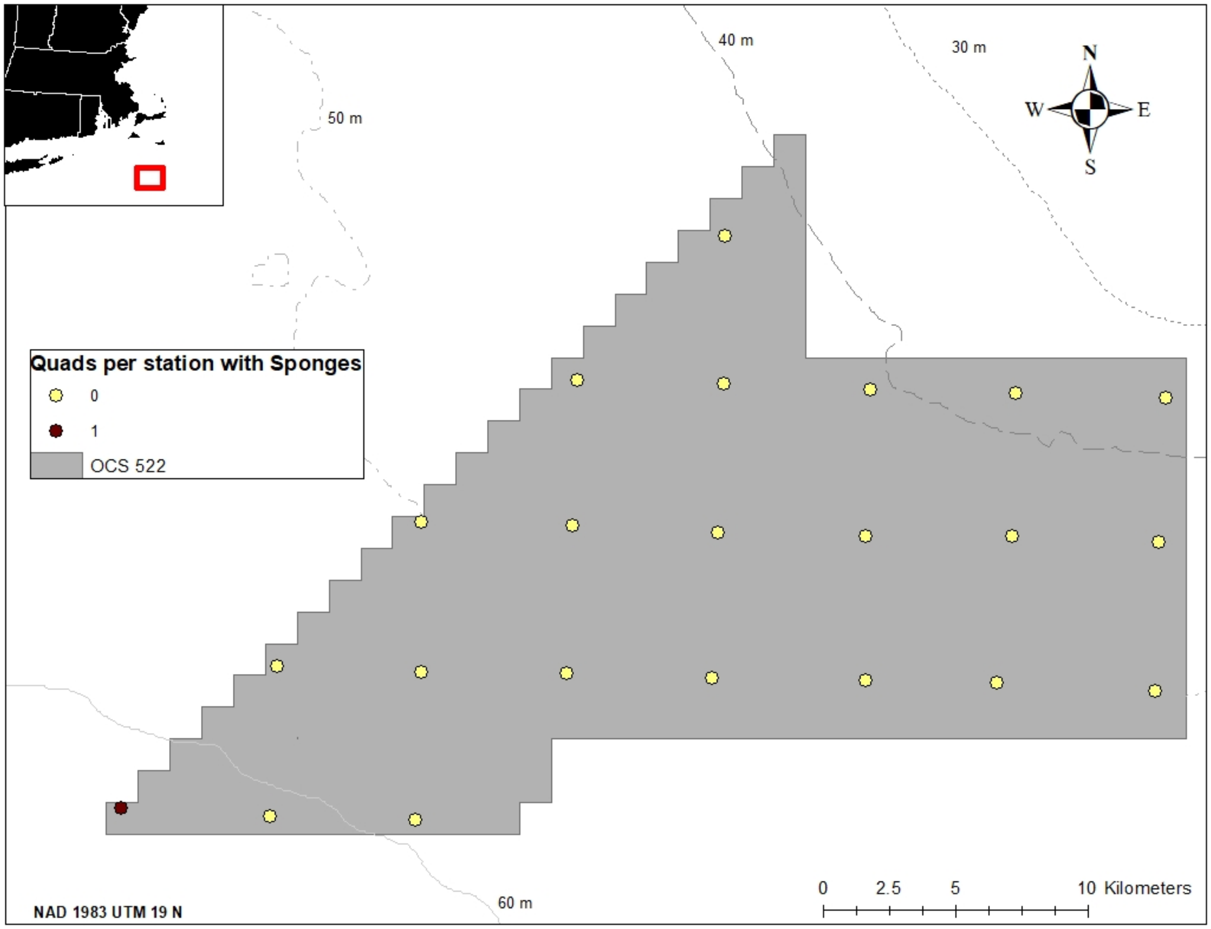


Figure 21. The distribution of sponges from the May 2021 drop camera survey of the 522 Study Area, where each station is colored by the number of quadrats that sand dollars were observed as indicated in the figure legend. No sponges were observed in the May 2022 survey. Four quadrats (2.3 m^2 images) were observed at each station.

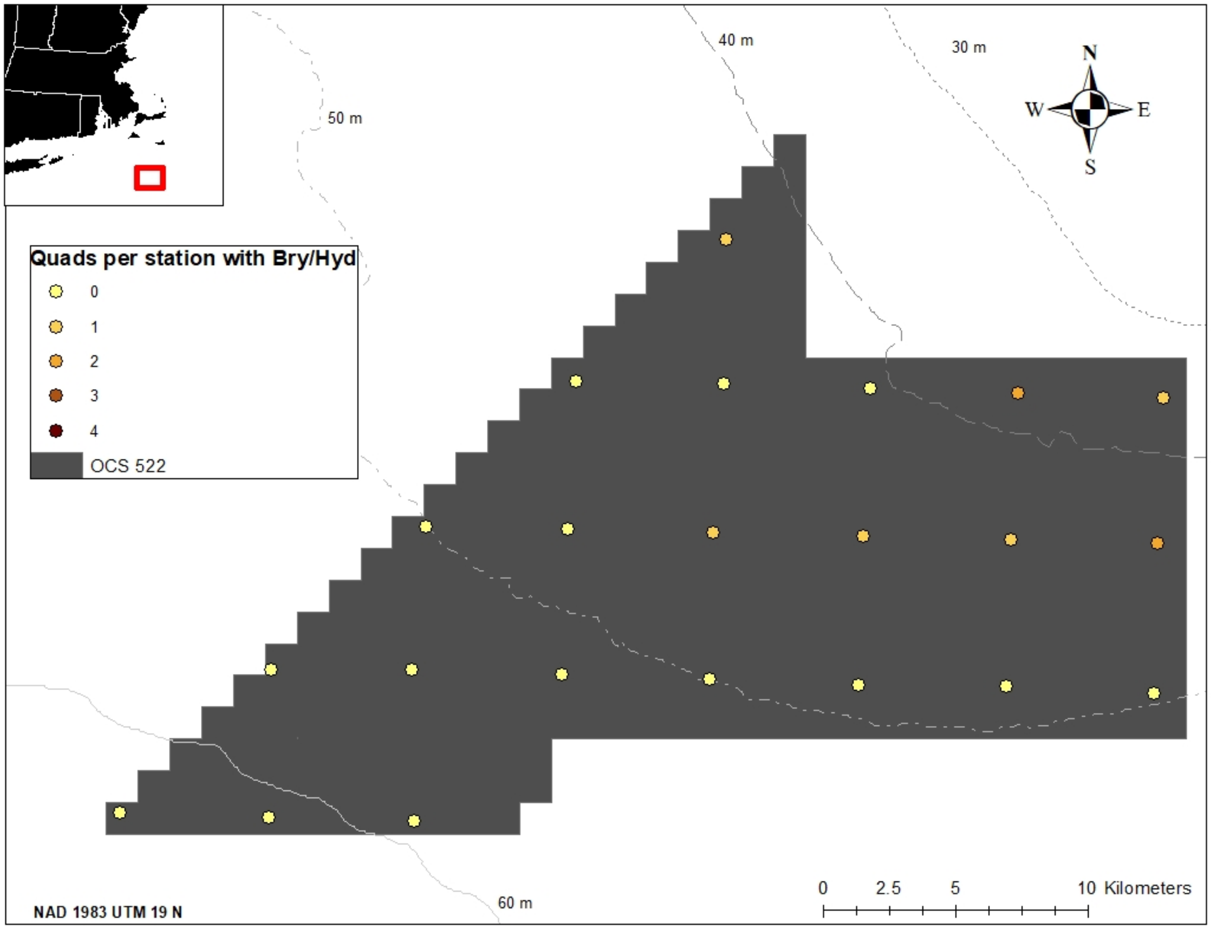


Figure 22. The distribution of bryozoans and hydrozoans from the May 2022 drop camera survey of the 522 Study Area, where each station is colored by the number of quadrats that sand dollars were observed as indicated in the figure legend. No sponges were observed in the May 2021 survey. Four quadrats (2.3 m^2 images) were observed at each station.

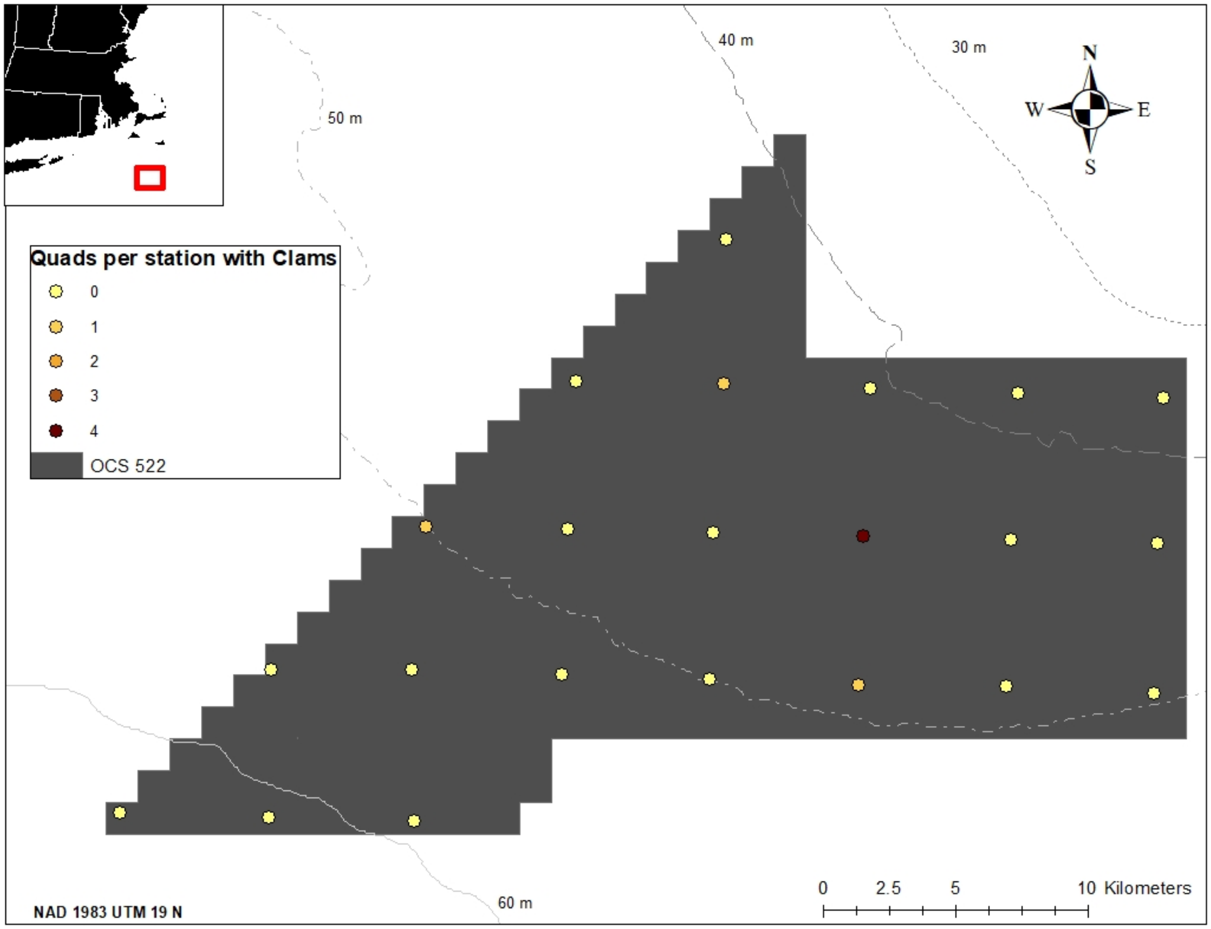


Figure 23. The distribution of clams from the May 2022 drop camera survey of the 522 Study Area, where each station is colored by the number of quadrats that sand dollars were observed as indicated in the figure legend. No clams were observed in a May 2021 survey. Four quadrats (2.3 m^2 images) were observed at each station.

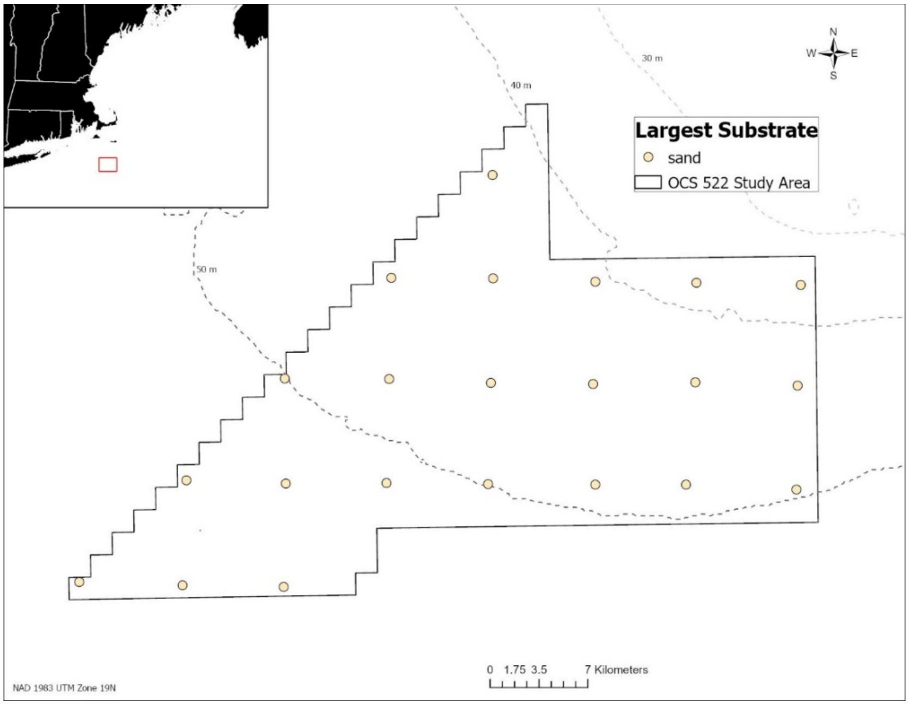


Figure 24. The distribution of the largest observed substrate type from the May 2021 drop camera survey of the 522 Study Area. Four quadrats (2.3 m^2 images) were observed at each station.

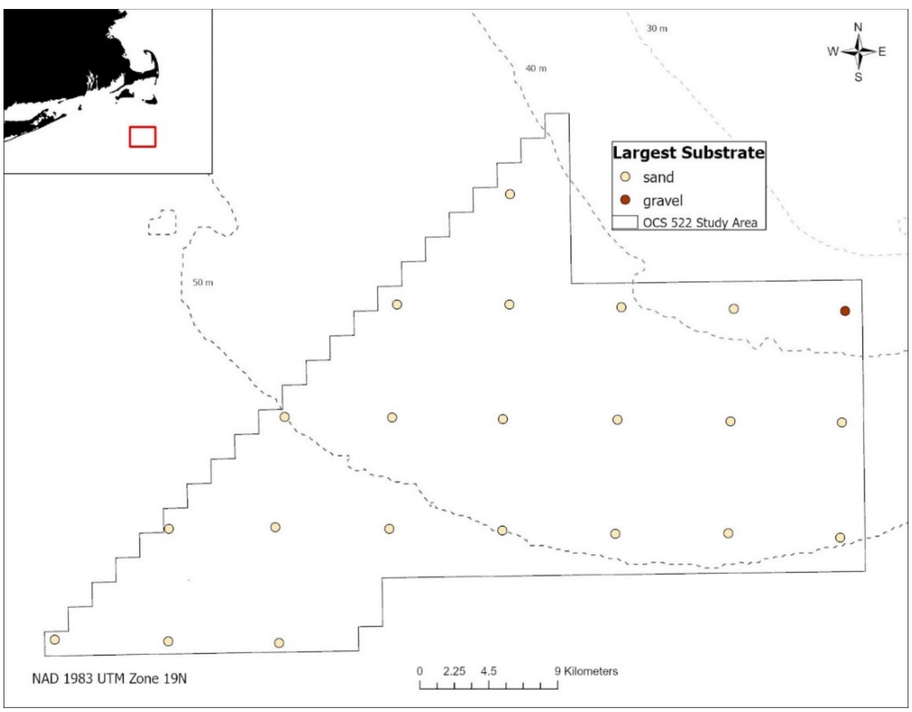


Figure 25. The distribution of the largest observed substrate type from the May 2022 drop camera survey of the 522 Study Area. Four quadrats (2.3 m^2 images) were observed at each station. Note, more comprehensive efforts have been completed by Vineyard Offshore to classify the benthic habitat in Lease Area OCS-A 0522 and are reported elsewhere.

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Appendix I: Species list and visibility information.

Table I-1. A list of Georges Bank species that can be quantified using drop camera surveys and are grouped into taxonomic categories (Stokesbury and Harris 2006).

Category	Scientific name	Common name
Scallop	*Placopecten magellanicus*	Sea scallop
Starfishes	*Solaster endeca*	Purple sunstar
	Crossaster papposus	Spiny sunstar
	Leptasterias Polaris	Polar sea star
	Asterias spp.	Sea stars
	Henricia spp	Blood star
Sand dollars	*Echinarachnius parma*	Sand dollar
Bryozoans/hydrozoans	*Flustra foliacea*	Bryozoans
	Callopora aurita	Bryozoans
	Electra monostachys	Bryozoans
	Cribrilina punctate	Bryozoans
	Eucratea loricate	Bryozoans
	Tricellaria ternate	Bryozoans
	Eudendrium capillare	Hydrozoans
	Sertularia cupressina	Sea cypress hydroid
	Sertularia argentea	Squirrel's tail hydroid
	Diphasia fallax	Hydrozoans
	Filograna implexa	Lacy tube worm
Sponges	*Suberites ficus*	Fig sponge
	Haliclona oculata	Finger sponge
	Halichondria panacea	Crumb of bread sponge
	Cliona celata Grant	Boring sponge
	Polymastia robusta	Encrusting sponge
	Isodictya palmate	Palmate sponge
	Microciona prolifera	Red beard sponge
Lobster	*Homarus americanus*	American lobster
Crabs	*Cancer irroratus Say*	Atlantic rock crab
	Cancer borealis Stimpson	Jonah crab
Hermit crabs	*Diogenidae*	Left-handed hermit crabs
	Paguridae	Right-handed hermit crabs
	Parapaguridae	Deep water hermit crabs
Eel pout	*Zoarces americanus*	Ocean pout
Flounder	*Paralichthys dentatus*	Summer flounder
	Paralichthys oblongus	Fourspot flounder
	Scophthalmus aquosus	Windowpane flounder
	Pseudopleuronectes americanus	Winter flounder
	Limanda ferruginea	Yellowtail flounder
	Glyptocephalus cynoglossus	Witch flounder
	Trinectes maculatus	Hogchoaker
Haddock	*Melanogrammus aeglefinus*	Haddock
Hake	*Merluccius bilinearis*	Silver hake
	Urophycis spp.	Red and white hake
Sculpins	*Myoxocephalus octodecemspinosus*	Longhorn sculpin
	Prionotus carolinus	Northern sea robin
Skates	*Leucoraja erinacea*	Little skate
	Leucoraja ocellata	Winter skate
	Dipturus laevis	Barndoor skate
Other fish	*Myxine glutinosa*	Atlantic hagfish
	Scyliorhinus rotifer	Chain dogfish
	Squalus acanthias	Spiny dogfish
	Anguilla rostrate	American eel
	Conger oceanicus	Conger eel
	Clupea harengus	Atlantic herring
	Brosme brosme	Cusk
	Gadus morhua	Atlantic cod
	Lophius americanus	Goosefish
	Ammodytes dubius	Northern sand lance
	Scomber scombrus	Atlantic mackerel
	Sebastes fasciatus	Acadian refish
	Anarhichas lupus	Atlantic wolfish
Shell debris	*Buccinum undatum*	Waved whelk
	Euspira heros	Northern moonsnail
	Mercenaria mercenaria	Northern quahog
	Modiolus modiolus	Northern horse mussel
	Ensis directus	Atlantic jackknife
	Placopecten magellanicus	Sea scallops

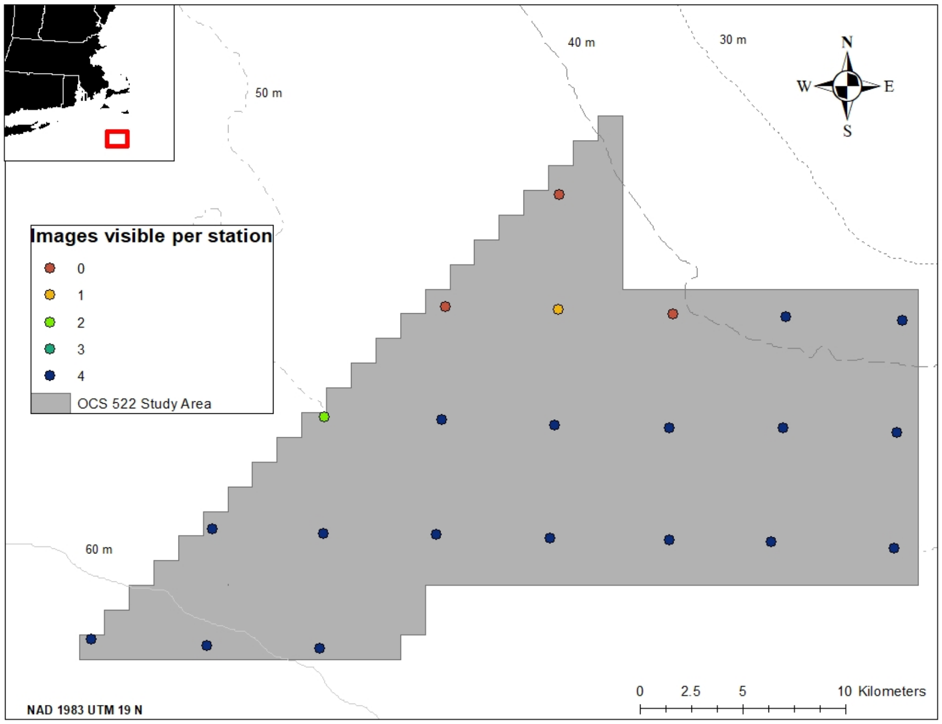

Figure I-1. The distribution of quadrat image visibility per station for the May 2021 drop camera survey. The color of the stations represents the number of quadrats that were visible as indicated in the figure legend.

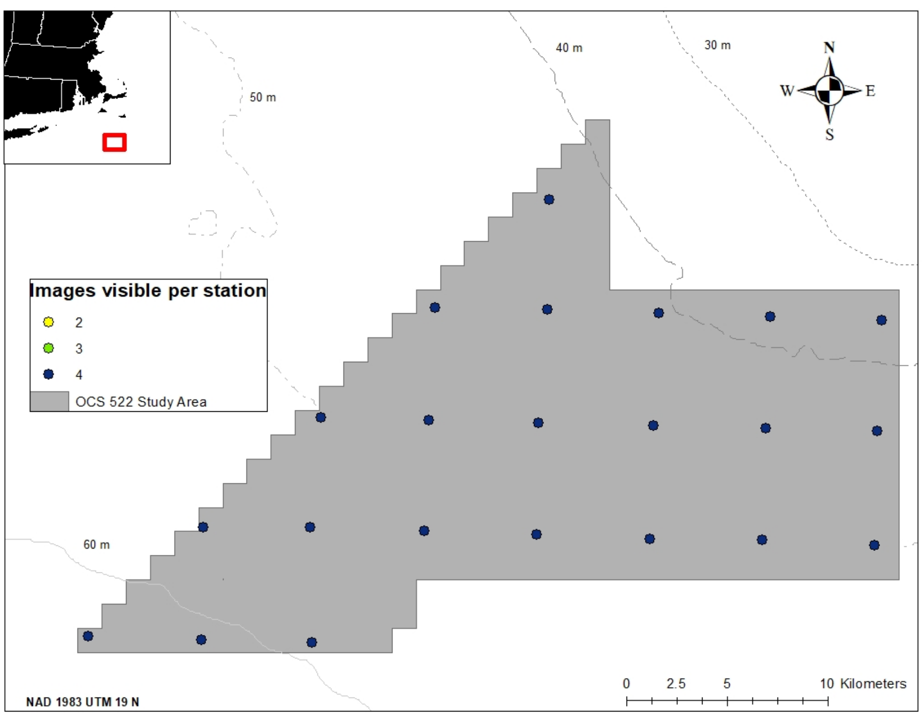

Figure I-2. The distribution of quadrat image visibility per station for the May 2022 drop camera survey. The color of the stations represents the number of quadrats that were visible as indicated in the figure legend.