Conimicut Point benthic environments and *Mya arenaria* habitats

Emily J. Shumchenia, Sheldon Pratt, and John W. King

1. Introduction

Upper Narragansett Bay, and the Conimicut Point area in particular, contain the habitat for approximately 86% of the soft shell clam (*Mya arenaria*) resources in the state of Rhode Island (RI DEM, 2011). *M. arenaria* abundances have been difficult for the Rhode Island Department of Environmental Management (RI DEM) to estimate due to the dynamic nature of the Conimicut Point region and the shellfishing activities that are permitted there. Currently, RI DEM infers clam abundance based on catch-per-unit-effort data for the fishery. We sought to characterize *M. arenaria* distribution in relation to habitat characteristics of the Conimicut Point region so that abundances might be estimated independent of fisheries activity. We concentrated our sampling near a management area known as the "triangle", just east of Conimicut Point in upper Narragansett Bay. The triangle opened to shellfishing on June 13, 2010 with a daily catch limit of 12 bushels per day for 593 soft shell licenses and 700 multipurpose licenses (RI DEM, 2011).

1.1 Purpose

The goals of this study were to (1) characterize relationships between benthic community composition, *Mya arenaria* abundance, and benthic abiotic variables (e.g., geologic features); and (2) test for any effects from opening the "triangle" to shellfishing from June 13 through October 13, 2010 on *M. arenaria* abundance or benthic community structure. To address these goals, we conducted an acoustic survey to map the geomorphology of the study area, and took grab samples to characterize surficial sediments, *M. arenaria* abundance, and their co-occurring benthic macrofauna communities. Sediment sample sites were chosen in order to ground truth acoustic facies, and macrofauna sample sites were chosen in order to examine changes in abundance in time. Our first sampling event occurred before the triangle opened to shellfishing. We sampled two sites inside the triangle and two sites outside the triangle. We revisited these sites approximately four months later, after the triangle had been fished for X days (find out exact number from Najih). We compared the abundances of *M. arenaria* and the composition of benthic communities before and after shellfishing occurred.

2. Methods

2.1 Acoustic survey

The spatial extent of the acoustic survey was defined by boundaries provided by RI DEM. The northern-most limit was a line between the end of Stokes Street in Warwick and the Mussachuck Creek outlet in Barrington to the east; the southern-most limit was a line between the end of Samuel Gorton Avenue in Warwick and the corner of Bay Road to the east (Figure 1). The RI DEM management area known as the "triangle" was in the center of the acoustic survey area (Figure 1). We conducted an interferometric side scan sonar and bathymetry survey from the URI R/V McMaster on May 26 and 27, 2010. A Teledyne Benthos C3D interferometric sonar was pole-mounted to the starboard side of the vessel and operated at 200 kHz with a swath width of 50 m. Navigation was provided by a Hemisphere DGPS (0.5 – 2.0 m accuracy) and corrections for pitch, heave and roll were provided by a TSS DMS-05 motion reference unit (+/- 0.05˚ dynamic accuracy). Survey transects were oriented in a northeast-to-southwesterly fashion and spaced at 75 m to ensure at least 125% bottom coverage for the side scan sonar data. Bathymetry coverage for the C3D was between 6 and 10 times the altitude of the instrument (i.e., the water depth).

Data was processed using Cleansweep 3 (Ocean Imaging Consultants, Honolulu, HI) to correct for water column returns and angle-varying gains in the side scan, and for tide in the bathymetry data. Both acoustic datasets were mosaicked at a resolution of 1.0 m (Figure 2). Side scan sonar backscatter intensity is typically high (white) when the seafloor is dense and/or rough, i.e., compact sand or rock; backscatter intensity is low (black) when the seafloor is composed of fine-grained and/or soft materials, i.e., silty, and/or high in organic matter. The backscatter and bathymetry mosaics were then interpreted for differences in acoustic facies based on similarities in backscatter intensity and bottom morphology as deduced from the bathymetry.

2.2 Sediment and macrofauna samples

The acoustic facies, along with the boundaries of the triangle, were used to plan the locations of 45 sediment and macrofauna grab samples (Figure 3). We aimed to retrieve at least one sample from each different acoustic facies in order to characterize relationships between acoustic facies, macrofauna abundance, sediment type, and *Mya arenaria* abundance. A Smith-McIntyre grab (0.06 m^2 sample area) was used to collect samples on June 7, 2010, and the presence of *M. arenaria* was noted in the field. The surface of each grab sample was sub-sampled (50 mL) for grain size analysis using a Mastersizer 2000 laser particle size analyzer. Grain size samples were characterized by the weight percent gravel, sand, silt and clay, and by mean phi values acquired from the Mastersizer, and then classified using the Wentworth (1922) grain size classification scheme. For samples that were analyzed biologically, the grab was sieved on 0.5 mm mesh to retain *M. arenaria* and other macrofauna for identification and enumeration. We measured the volume of each grab sample before sieving and storage and normalized macrofauna counts by grab volume. Abundance data was transformed using the 4th root in order to decrease the influence of highly abundant species. We then constructed a matrix of the Bray-Curtis similarity index for all samples in order to conduct multivariate analyses using PRIMER 6 (Clarke and Gorley, 2006).

At the time of this writing, only eight samples had been characterized completely for total macrofauna abundance. Four stations (3, 17, 28, 31) were chosen to be sampled twice (eight total) for *Mya arenaria* and other macrofauna; once each on June 7, 2010 and October 13, 2010 (Figure 4).

2.3 Relationships between benthic community composition, Mya arenaria abundance, and abiotic variables

Since we noted the presence or absence of *M. arenaria* in the field, we were able to test for significant differences in sediment variables when *M. arenaria* was present, using Analysis of Similarity (ANOSIM) for all 45 June 7 samples. To test for significant differences in benthic community composition at stations containing *M. arenaria*, we used ANOSIM on the eight samples that had been completed for macrofauna abundance. We also used ANOSIM to test for significant differences in benthic community composition among the three sediment classes present in these same eight macrofauna samples.

2.4 Differences in benthic community composition and Mya arenaria abundance between June and October

The purpose of the repeat sampling was to determine if changes had occurred to *M. arenaria* abundance and/or benthic communities since the original sampling on June 7. At the time of the second sampling, the triangle was closed to shellfishing after having been open for X days since June 13, 2010. Stations 3 and 28 were located outside of the triangle and stations 17 and 31 were located inside the triangle (Figure 4).

We tested for significant differences in benthic community composition between June and October using ANOSIM. We then used a paired t-test to test for significant differences in *M. arenaria* abundance before and after the triangle opened to shellfishing. Finally, we used the multivariate Similarity Percentages (SIMPER) analysis to determine which organisms best characterized benthic community composition in June versus October.

3. Results

3.1 Acoustic maps

Depths ranged from 0 to 22 meters within the survey area (Figure 2A). The side scan sonar backscatter mosaic revealed several interesting bottom features that seemed to be correlated with both bottom morphology (from the bathymetry mosaic) (Figure 2B). The current navigational channel is visible in Figure 2B (labeled) and consists of a narrow zone of high backscatter return and small-scale wave bedforms surrounded by lower backscatter on either side. Overall, ten acoustic facies were identified for ground-truthing by sediment samples. Four of the facies contained more than one grab sample, but the majority contained a single sample (Figure 3).

3.2 Sediment and macrofauna samples

The coarsest samples were classified as medium sand and were located close to shore, south and east of Conimicut Point and south and west of Nayatt Point. Grain size decreased towards the center of the Upper bay, with the finest-grained samples containing medium silt. Grain size classes did not visually correlate to changes in backscatter intensity. The majority of the identified acoustic facies contained medium silt (Figure 5, top), including facies characterized by generally low and generally high backscatter. Two acoustic facies had multiple sediment samples that were classified into different classes (Figure 5, bottom). This was interpreted to mean that the visually uniform backscatter intensity did not represent uniform sediment type and that these facies each contained a gradient of grain sizes.

3.3 General characteristics of benthic communities near Conimicut Point

The eight grab samples that were analyzed biologically for this report ranged in volume from 2 - 6 liters, depending on the sediment grain size. Over 3 times more macrofauna were found at these sites in October (8,650 individuals) than in June (2,543 individuals). The most abundant organism was the glassy tubeworm *Spiochaetopterus oculatus*, with an average abundance across all stations and sampling times of 15,076 individuals per m^2. This is not surprising, since similar depositional environments in Greenwich Bay (sandy depositional platforms and bayfloor sandsheets) also were the habitat for *Spiochaetopterus* tube worms at average densities of over 1,200 individuals per m^2 (Shumchenia and King, 2010). The second-most abundant organism in the study area was the polychaete *Tharyx acutus*, a pollution-tolerant, mud-tube-dwelling species. *T. acutus* was found mainly at the soft-bottomed site 17, with very high abundances in June only (11,952 individuals/m^2). *Mya arenaria* was the third-most abundant species across all stations and sampling times (Figure 6). Across all stations, *M. arenaria* was much more abundant in June (average 1,765 individuals/m^2) than in October (average 55 individuals/m^2). The highest single-sample abundances of *M. arenaria* were found during the June sampling north of Conimicut Point at station 28 in fine sand (6,833 individuals/m^2) (refer to Figure 4 for sample locations). In October, the abundance at this same station was 33 individuals/m^2. Station 3, south of Conimicut Point, was also composed of fine sand, but contained zero *M. arenaria* in June and 66 individuals/m^2 in October. Station 17 was located within the triangle, composed of coarse silt, and had 143 and 0 individuals/m^2 in June and October, respectively. During these sampling campaigns, the most stable *M. arenaria* abundances were found at Station 31, also within the triangle, which was composed of medium sand and had 83 individuals/m^2 in June and 121 individuals/m^2 in October.

3.4 Differences in benthic community composition and <u>Mya arenaria</u> abundance between June and October

The first ANOSIM showed that there was no relationship between *M. arenaria* presence and the sediment variables weight percent gravel, sand, silt, and clay at all 45 stations ($R = -0.035$, $p = 0.67$). For the the tests involving benthic communities at the eight completed stations, there was no significant difference in benthic community composition between stations with or without *M. arenaria* ($R = 0.25$, $p = 0.18$). In addition, there was no significant difference in benthic community composition among the three sediment classes (fine sand, medium sand, and coarse silt) present at the eight stations ($R = -0.25$, $p = 0.86$).

3.5 Differences in benthic community composition and Mya arenaria abundance between June and October

The multivariate ANOSIM also found no significant difference ($R = 0.125$, $p = 0.25$) between benthic community composition between June and October. The t-test on station-averaged *M. arenaria* abundance also reflected no significant difference between the June and October sampling ($t_8 = 1.01$, $p = 0.18$). There was no significant difference in benthic community composition among sampling sites ($R = -0.146$, $p = 0.71$). The SIMPER analysis indicated that *M. arenaria* typified benthic communities in June, and was responsible for 12.8% of the similarity between stations in June. October benthic communities were characterized by *Spiochaetopterus oculatus*, accounting for 13.3% of the similarity between stations.

4. Discussion

The preliminary results of this study show that the Conimicut Point study area is a dynamic and patchy environment. Because only eight of the 45 samples were available to examine the full suite of abiotic and biotic variables, the power of many of our statistical tests was limited. A subsequent addendum to this report will contain the full test of the relationships between benthic community composition, *Mya arenaria* abundance, and sediment characteristics.

The results presented here do suggest, however, that *M. arenaria* abundances were generally higher and more influential to benthic community composition during the June sampling event. The cause of this pattern should be interpreted with caution because the station with the most "stable" population of *M. arenaria* between the two sampling events (station 31) was actually located within the triangle shellfishing area. If shellfishing activities were the primary cause of the general decline in *M. arenaria* abundance, then we would expect to see much lower abundances at this station in October. Because this was not observed, there were likely other factors influencing *M. arenaria* abundance between June and October. Examples of such factors include non-human predation and physical disturbance, such as poor water quality. We did not collect any data that would address the issue of natural predation. However, there are datasets available to address physical disturbances. Between the June and October sampling events, the water quality buoy at Conimicut Point only recorded one bottom-water dissolved oxygen reading below the 2.9 mg L^{-1} hypoxia threshold, on August 6 (RI DEM, 2010a). This finding suggest that water column hypoxia was not a major stressor on the benthos during this period. *M. arenaria* tend to occupy the intertidal zone and are thus less susceptible to this type of water column hypoxia, but smothering by macroalgae can also deprive clams of oxygen. As of August 11, 2010, DEM reported the removal of 65 cubic yards of seaweed from Conimicut Point (RI DEM, 2010b). During our June sampling, we noted the presence of either *Ulva spp*., *Gracilaria spp*. and/or *Enteromorpha spp.* macroalgae in seven of the grab samples. Of these, four also contained *M. arenaria* juveniles or adults. These observations suggest that macroalgae is at least abundant in the habitats where *M. arenaria* are found and some level of interaction can be hypothesized. Subsequent analyses will investigate any relationships between *M. arenaria* abundance and the presence of macroalgae.

Lastly, we cannot rule out any effects on the results of this study from the sampling tools we chose to utilize. Several grab samples contained just the siphons of *M. arenaria* adults, and were included in the counts of individuals. However, this result suggests that either clams are able to burrow away from the grab very quickly, or that the grab sampler did not sample deep enough into the sediments at these sites. A quantitative examination of the effectiveness of the Smith-McIntyre grab for sampling *M. arenaria* populations was beyond the scope of this report, but we were able to recover one sample from a location where *M. arenaria* were very abundant and where DEM scientists utilized a different sampling device - the suction dredge. A single-sample comparison will not provide strong conclusions, but when the DEM sample data are made available, some qualitative comparisons can be made.

5. References

Clarke, K.R. & Gorley, R.N. (2006) PRIMER 6. Plymouth, UK.

RI DEM (Rhode Island Department of Environmental Management) (2010a). Characteristics of fixed-site monitoring stations and recent data on water quality in Narragansett Bay. Station B3, South of Conimicut Point. DEM OWR. Available online: http://www.narrbay.org; Accessed 2/6/11.

RI DEM (2010b). Narragansett Bay Assessment and Response Team (BART) Weekly Report for 8/7/10 - 8/13/10. Available online: http://www.dem.ri.gov/bart/latest.htm.

RI DEM (2011). 2011 Management plan for the shellfish fishery sector. RI Department of Environmental Management Division of Fish and Wildlife, Marine Fisheries. Report of December 29, 2010, 19 pp.

Shumchenia, E.J. & King, J.W. (2010) Comparison of methods for integrating biological and physical data for marine habitat mapping and classification. *Continental Shelf Research*, **30**, 1717-1729.

Wentworth, C.K. (1922) A scale of grade and class terms for clastic sediments. *Journal of Geology*, 30, 377-392.

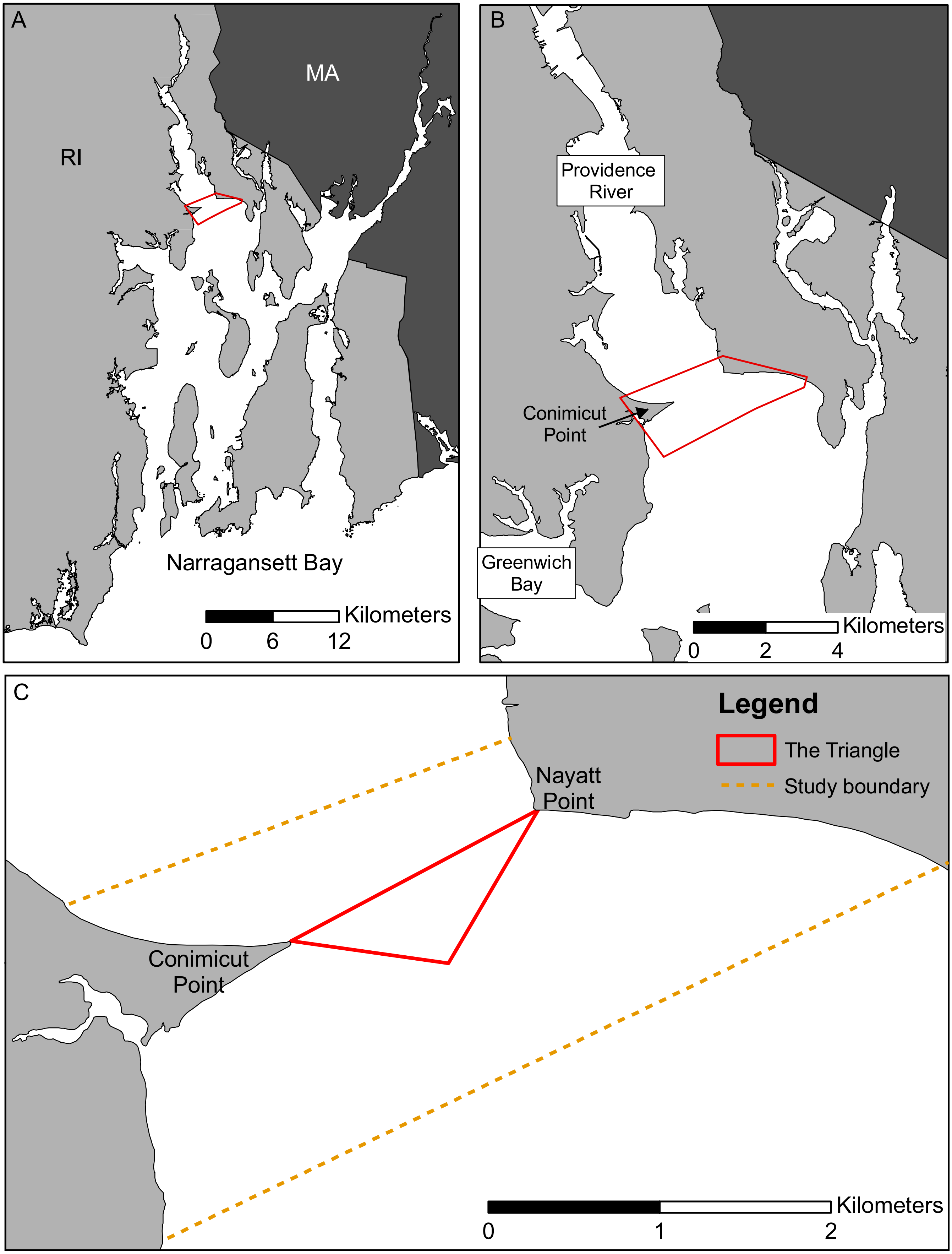

Figure 1. The Conimicut Point study area (red box) in the context of Narragansett Bay (A) and the Upper Bay (B). The study area boundaries are shown in (C) as orange dotted lines, with the Triangle management area shown in red.

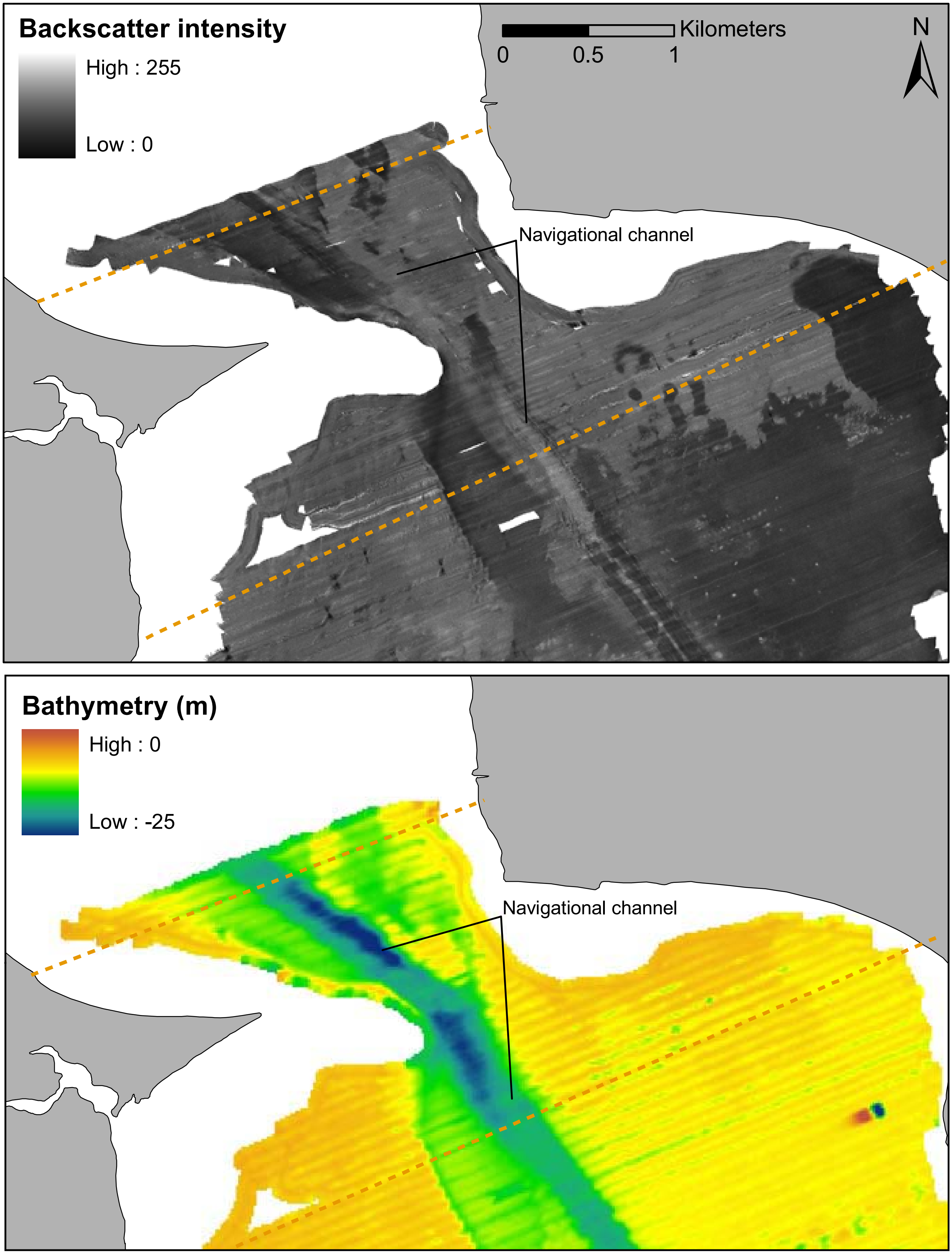

Figure 2. Interferometric side scan sonar backscatter intensity mosaic (top) and interferometric bathymetry (bottom), with position of navigational channel noted.

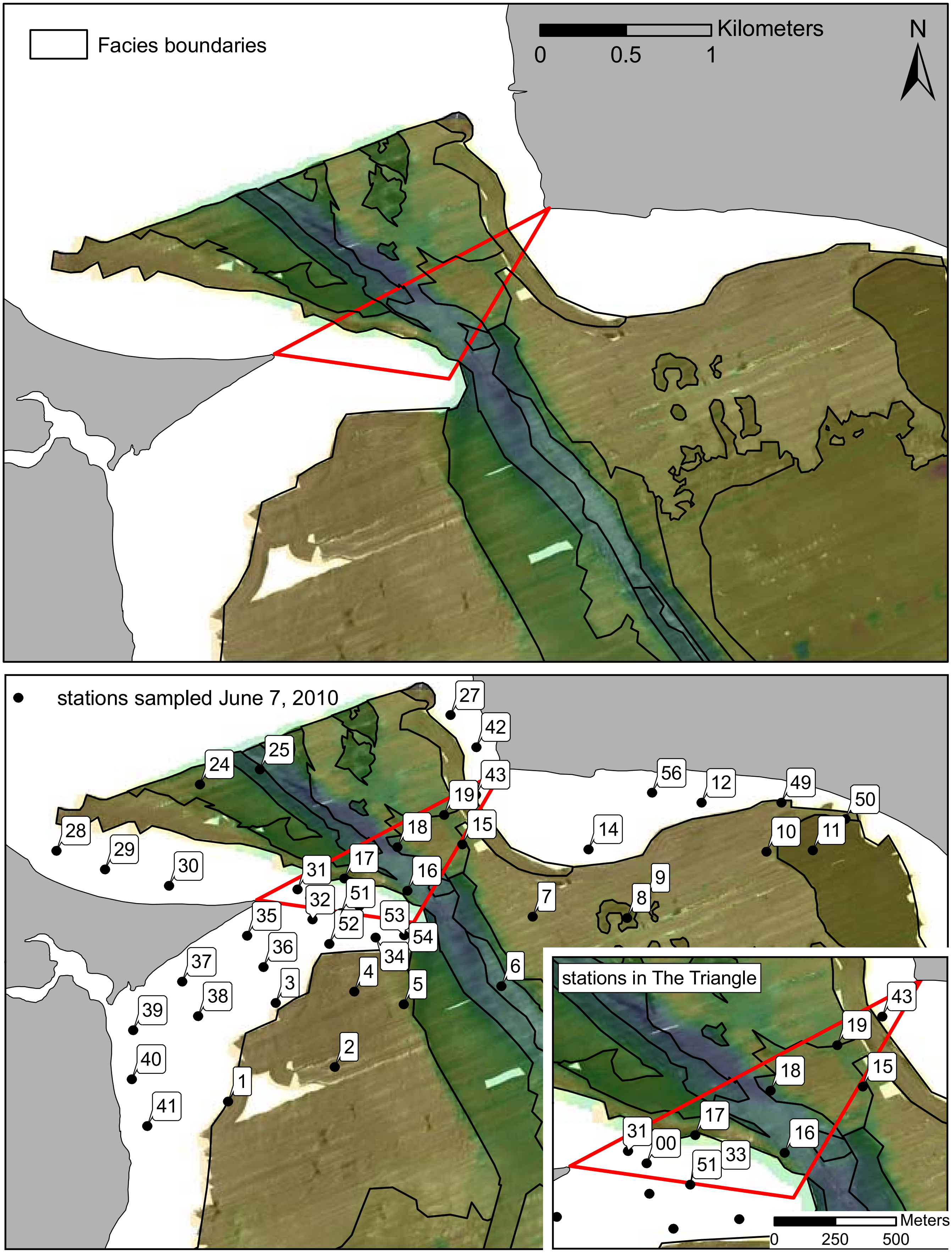

Figure 3. Bathymetry overlaid on top of side scan mosaic with facies boundaries delimited (top), showing the location of sediment and macrofauna grab sites for the June 7, 2010 sampling. Inset shows samples located within Triangle managment area for clarity.

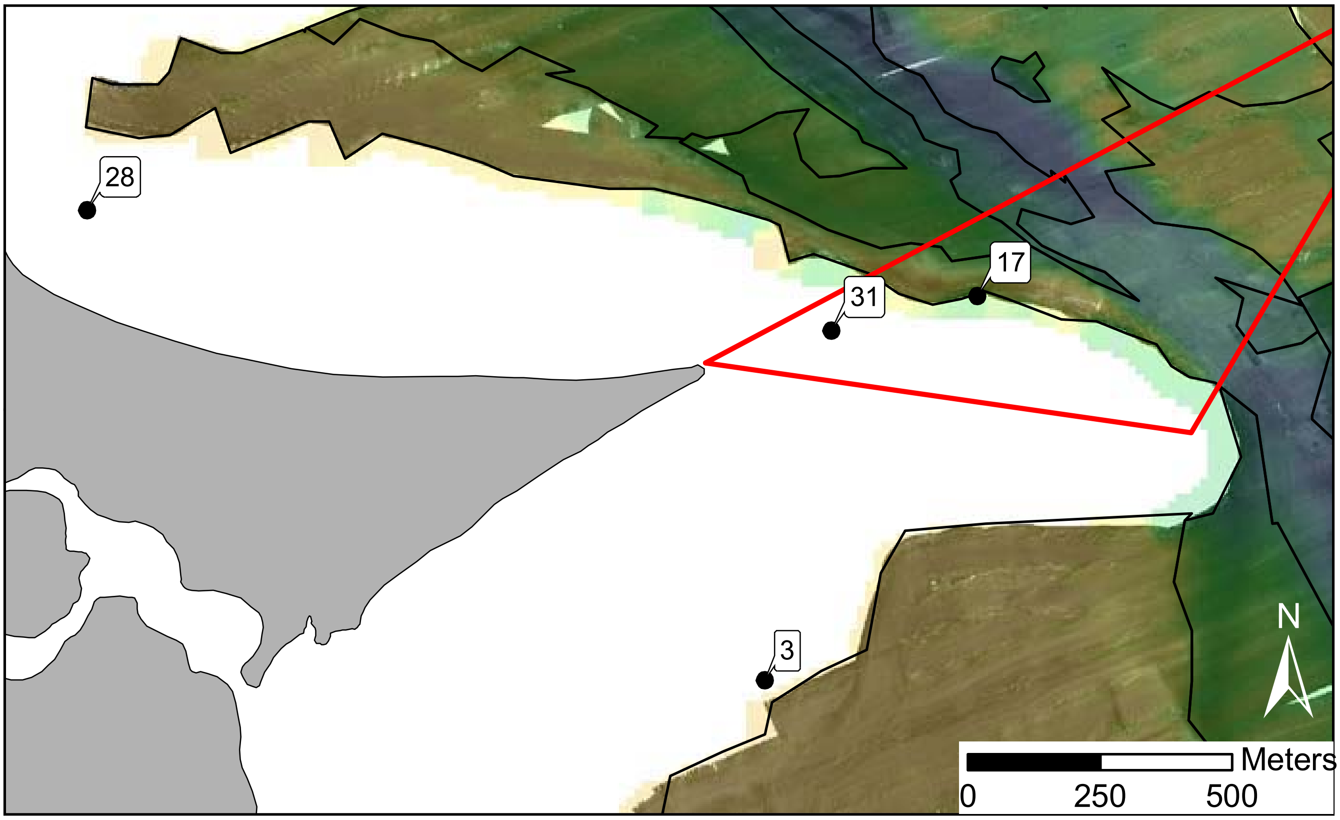

Figure 4. The four stations that were sampled twice for this study - once on June 7, 2010 and again on October 13, 2010.

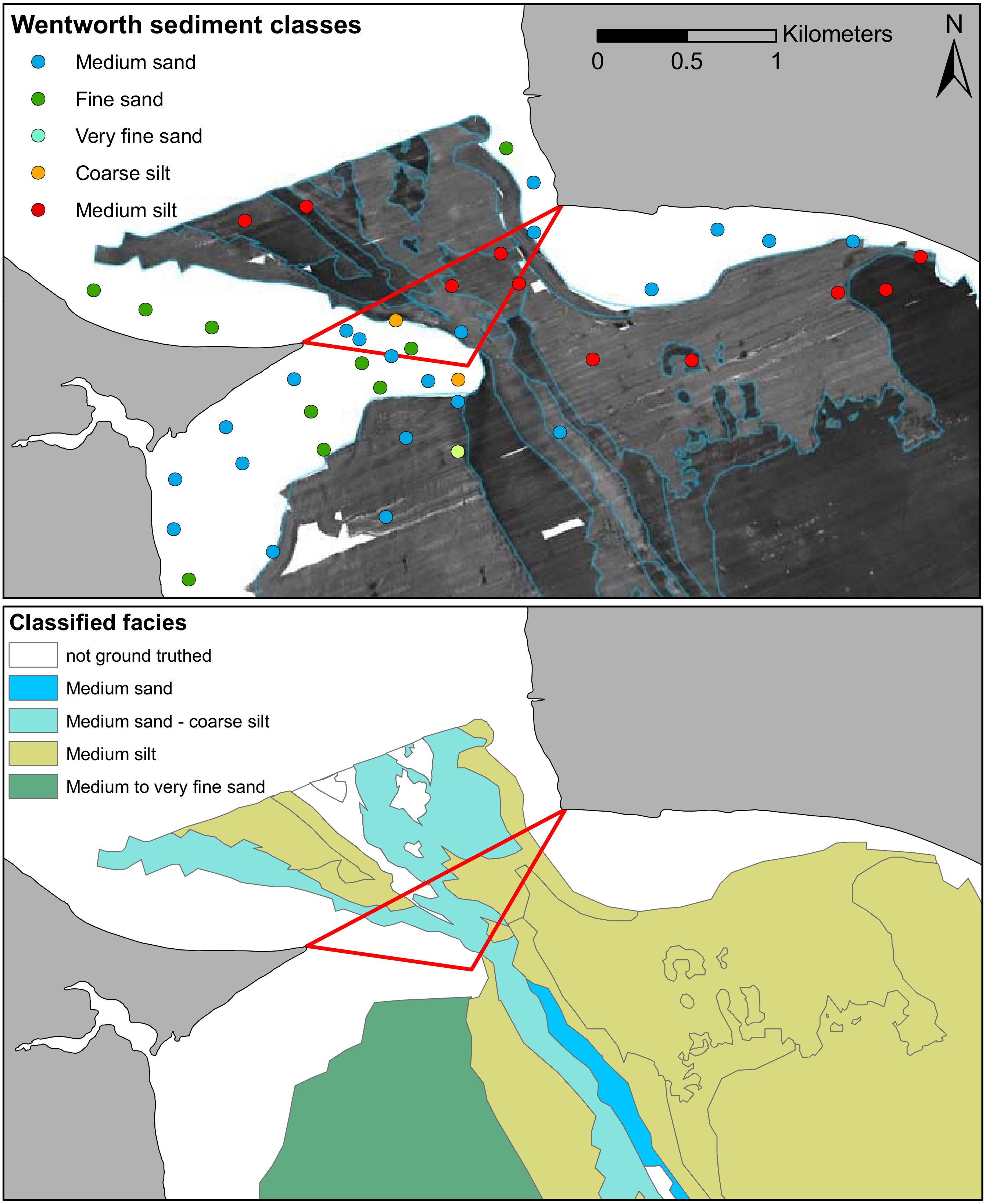

Figure 5. The side scan sonar mosaic with facies boundaries showing the results of the sediment classification for each grab sample (top) and the interpreted classification of the acoustic facies (bottom).

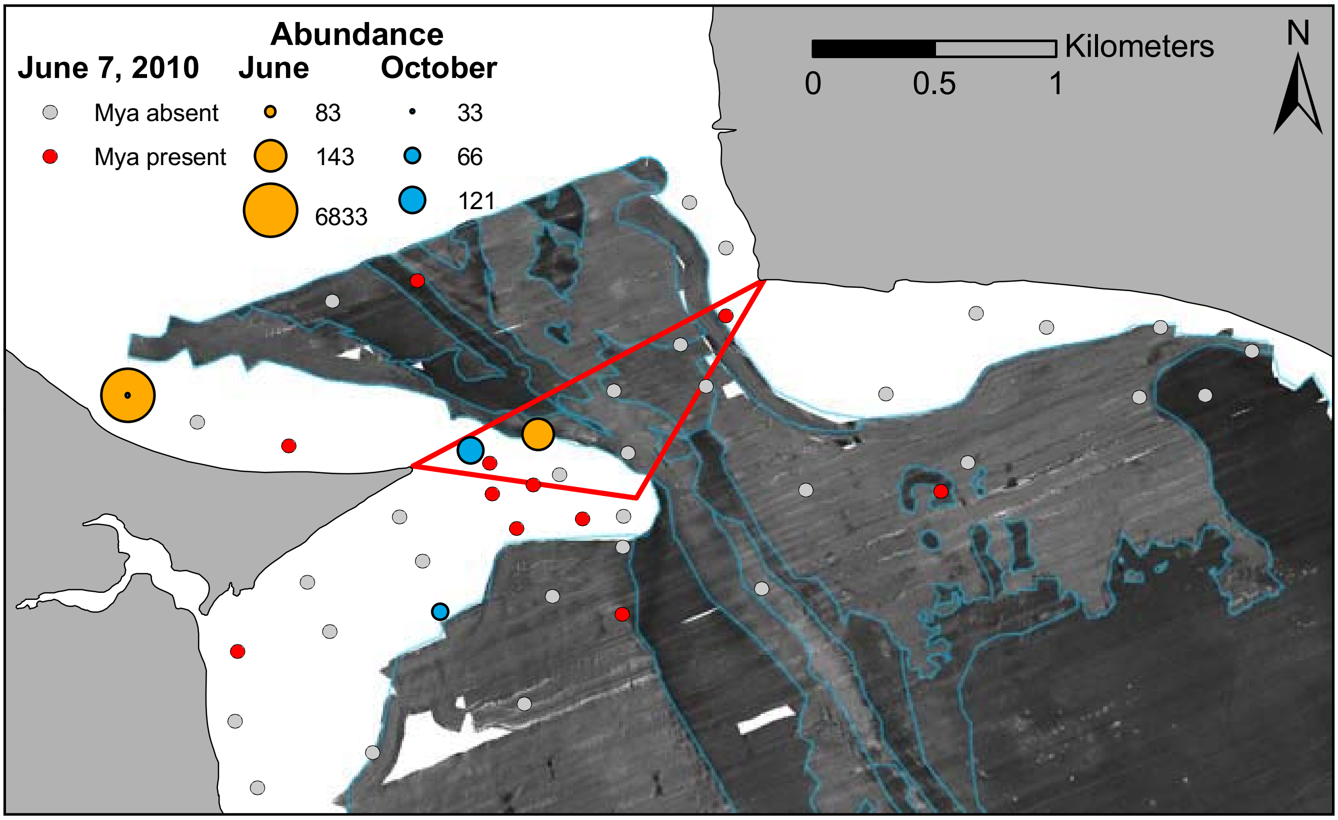

Figure 6. Red and grey dots indicate the presence (red) or absence (grey) of *Mya arenaria* in grab samples collected on June 7, 2010. The size of the orange dots indicates the abundance of *M. arenaria* as quantified in the grab samples taken on June 7; the size of the blue dots indicates the abundance of *M. arenaria* as quantified in the grab samples taken in October.