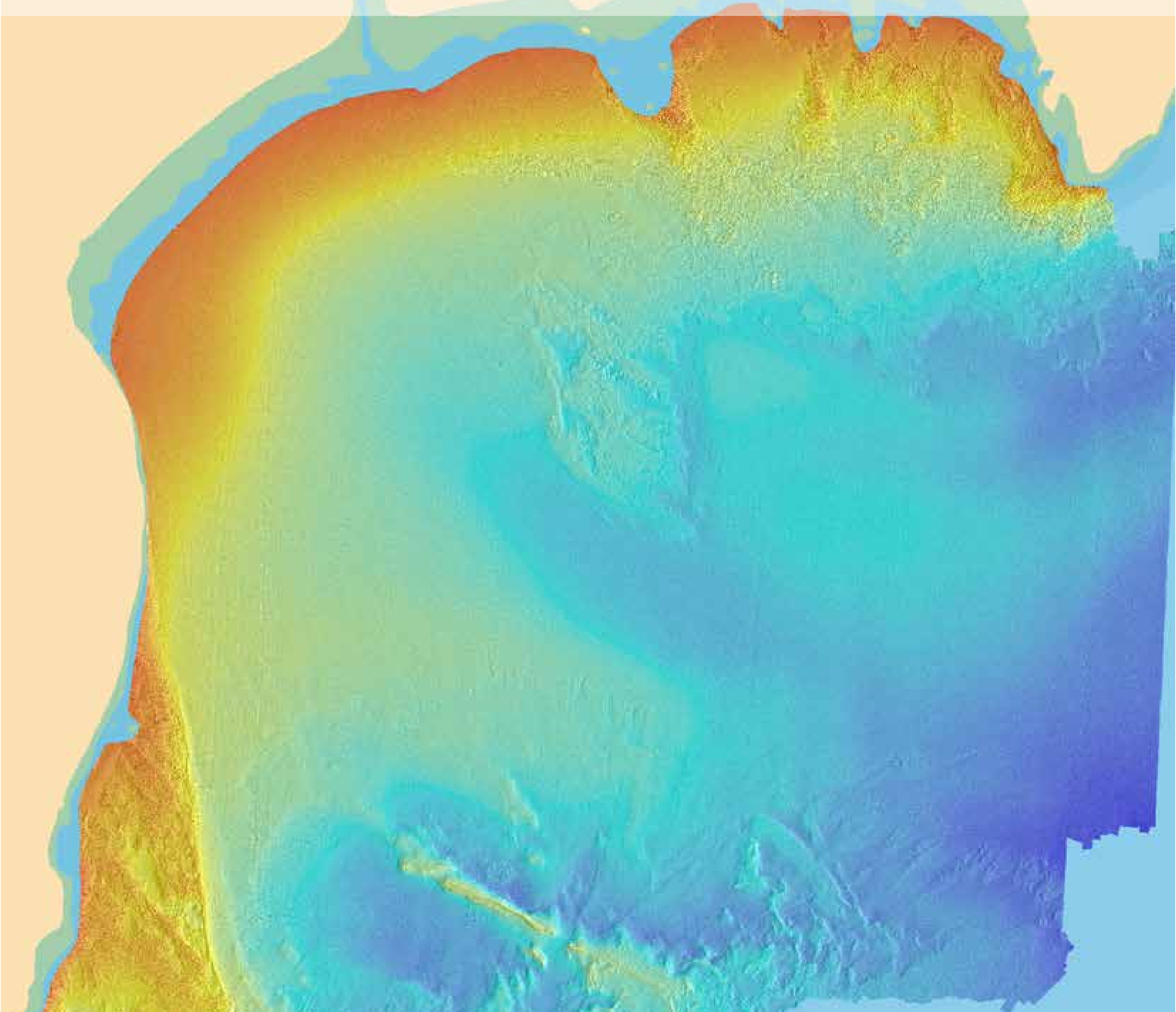
Agri-Food and Biosciences Institute ®

BATHYMETRIC AND HABITAT MAP FOR MURLOUGH SPECIAL AREA OF CONSERVATION AND OFFSHORE, NORTHERN IRELAND.



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1. Introduction

Knowledge of the distribution and extent of benthic habitats and associated marine life is fundamental to marine resource management, and an integrated approach to marine stewardship. In 1998, the Oslo and Paris Commission (OSPAR) recognised the need to assess which marine habitats required protection, through the production of an inventory of habitats. This added to those habitats specified for protection and sensitive management under the EC Habitats Directive (Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora). Furthermore, features of conservation interest (FOCI) have been identified as part of the UK Marine Conservation Zone (MCZ) designation process, as a result of enactment of the Marine Bill (England and Wales - Marine and Coastal Access Act 2009).

The existing conservation lists (listed below) were amalgamated to identify marine features of nature conservation importance in Northern Irish waters. This is to ensure the range of representative, threatened, rare or declining species and habitats are protected. From these lists, the Priority Marine Feature (PMF) Habitats, PMF Limited/low mobility species and PMF Highly mobile species lists were developed:

- The OSPAR list of Threatened and/or Declining Species and Habitats (OSPAR T&D);
- The UK Biodiversity Action Plan list (UK BAP);
- Northern Ireland List of Priority Habitats and Species (NI Priority);
- Species of Conservation Concern (SOCC), and
- Nationally Important Marine Features (NIMF).

The Department carried out a comprehensive criterion based review of all habitats and species on the PMF lists to identify the Proposed Marine Conservation Zone (pMCZ) features (Table 1 below describes the pMCZ Habitats). These will underpin the MCZ designation process and be used to identify areas of search.

Table 1 pMCZ Habitats. This list describes the broad scale habitats (based on EUNIS Level 2 & 3 classification system) and their corresponding finer sub-scale habitats contained for which marine protected areas are considered an appropriate conservation measure. These pMCZ Habitats will be used in the early stages of the MCZ development, underpinning the initial selection of search locations.

pMCZ Habitat	Examples of component (sub-scale) habitats
Deep sea bed	• Cold water coral reefs
Low energy circalittoral (subtidal) rock	• Estuarine rocky habitats
Sublittoral (subtidal) biogenic reefs	• Horse Mussel (*Modiolus modiolus*) beds • Blue Mussel (*Mytilus edulis*) beds • Brittlestar beds
Sublittoral (subtidal) muds	• Mud habitats in deep water • Sea-pen and burrowing megafauna communities • Blue Mussel (*Mytilus edulis*) beds
Sublittoral (subtidal) sand	• Circalittoral sand and gravel communities • Tide-swept channels • Native oyster (*Ostrea edulis*) beds
Sublittoral (subtidal) mixed sediments	• Brittlestar beds

Identified pMCZ features also feed into assessments needed under the Marine Strategy Framework Directive (MSFD - Directive 2008/56/EC on establishing a framework for community action in the field of marine environmental policy) in order to achieve Good Environmental Status (GES).

DOE commissioned AFBI to produce the habitat map to assist with two key marine conservation drivers:

1. The identification and selection of MCZs within Dundrum Bay;
2. To further the knowledge on the location and extent of EC Habitats Directive Annex 1 habitats within Murlough SAC.

Within this report the survey area is reported as Dundrum Bay within which is Murlough SAC.

1.1 Dundrum Bay

Dundrum Bay lies on the south-eastern coast of Northern Ireland in the Irish Sea, off the County Down coastline. The Mourne mountains border the Bay to the southwest and the sand-dunes of Murlough/Tyrella Beach to the northwest. It is a large, shallow bay with a gentle gradient offshore, and is afforded protection from the prevailing winds (which are usually westerly). Approximately 50% of the study area lies within the Murlough Special Area of Conservation (SAC), as shown in Figure 1. The offshore boundary of the study area was decided upon consultation with DOE to be 1nM from the marine boundary of the SAC.

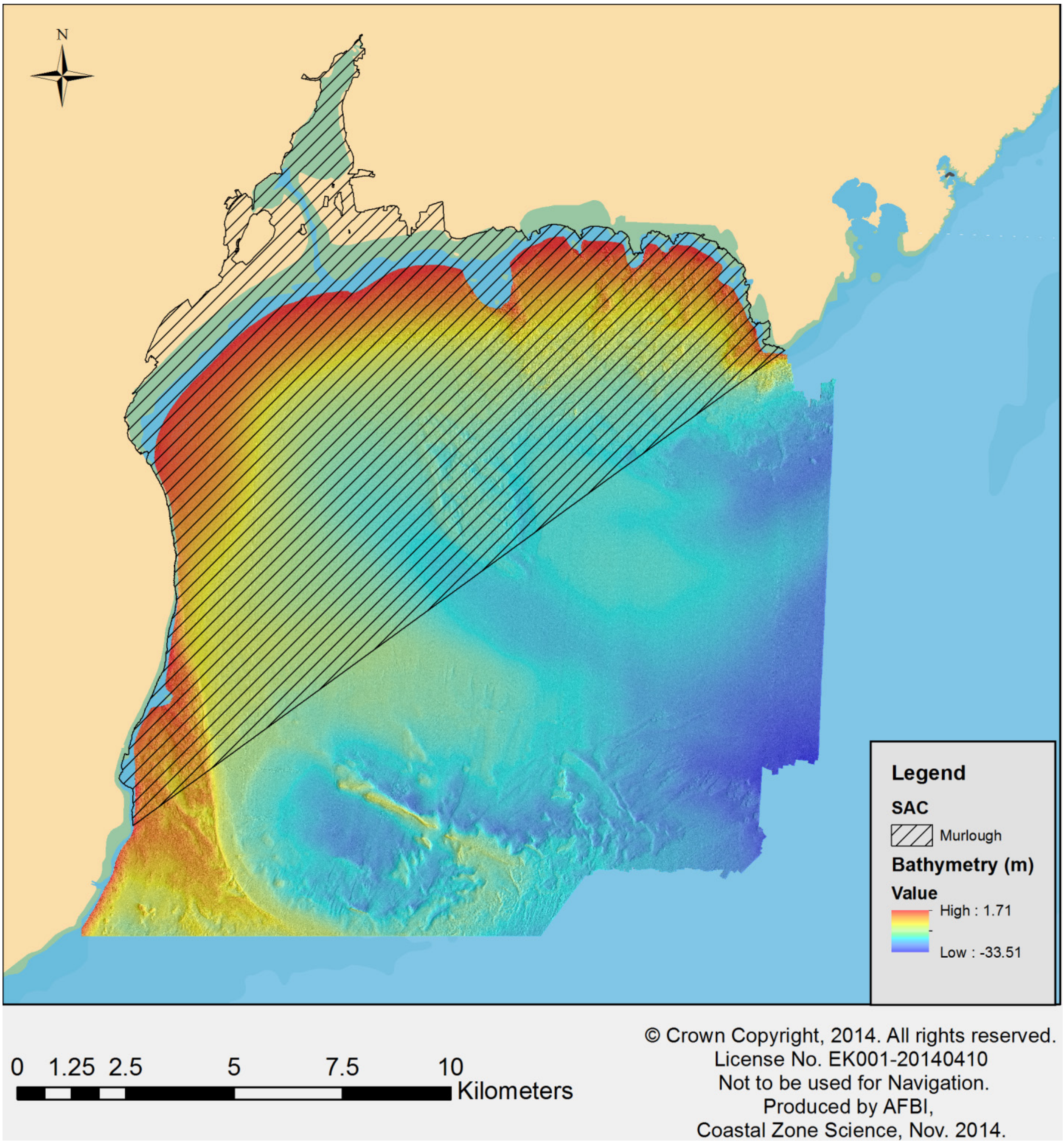

Figure 1. The survey area and Murlough SAC boundary.

Murlough (within Dundrum Bay) was designated as a Special Area of Conservation (SAC) (EU Code UK0016612) under the 1992 EC Habitats Directive, including the following specific subtidal habitat features which are a qualifying feature, but not a primary reason for the selection of this site:

- Sandbanks which are slightly covered by sea water all the time;
- Mudflats and sandflats not covered by seawater at low tide.

The designation also includes a marine Annex II species present as a qualifying feature, but not a primary reason for site selection – the harbour seal, *Phoca vitulina*.

From these features, the following attributes require assessment as part of SAC monitoring and management undertaken by the Department of the Environment, in order to ensure the features are maintained in favourable condition (allowing for natural change):

- Extent of the feature;
- The presence of a selection of characteristic biotopes at sites chosen to indicate the distribution and extent of each feature;
- Species composition of selected biotopes at monitoring sites.

However, to date there is not a published management scheme or appointed management group for the SAC.

1.1.1 Morphology and hydrography

Bathymetry in the study area ranges from 1.7m above chart datum in the deep intertidal zone, to 33m below chart datum in the southeast, over a distance of 16 km, producing a very shallow gradient (Figure 1). The area experiences the largest tidal variations in Northern Ireland (Atkins, 1997), with a mean spring range of 5m (Jackson et al, 2005). This tidal variation produces weak streams (< $0.2ms^{-1}$) that run along the shore north and east with the flood tide, and west and south with the ebb tide (Great Britain Hydrographic Department, 1985). Net sediment transport by these tidal streams is in a northerly direction, with net accretion observed in the northern section of the bay (Atkins, 1997; Cooper & Navas, 2004). Due to this net accretion, the morphology of the seabed changes significantly with time, which in turn affects incoming wave energy. In the outer bay, net wave energy moves in a westerly direction. In the inner bay, net wave energy moves in a north- northwesterly direction (Cooper & Navas, 2004). Prevailing winds below gale force originate from the southwest, with the majority of winds blowing at gale force or stronger (>13.9 ms^{-1}) coming from the south to southeast (Atkins, 1997).

1.1.2 Geology

The bedrock geology of the region is dominated by Silurian greywackes, with overlying Pleistocene deposits composed predominantly of till and sand (GSNI, 1997). Holocene sand, muddy sand and gravel dominate the surficial sediments in the region, with a large area of cohesive mud further offshore (Atkins, 1997), which adjoins the western Irish Sea mud patch, noted for its *Nephrops* fishery.

1.2 Project aims

The aim of this project is to utilise high resolution acoustic data (multibeam sonar) to facilitate development of an up-to-date subtidal habitat map for Dundrum Bay. In particular, efforts will be focussed on using existing and recent data for biotope classification and identification, ensuring that these records are representative of the current status of the lough.

2. Methodology

2.1. Multibeam echosounder (MBES) data acquisition and processing

The area was surveyed as part of the EU INTERREG INIS (Ireland, Northern Ireland and Scotland) Hydro project (http://www.inis-hydro.eu/). Geophysical data were acquired during June and July 2011 aboard the R.V. *Corystes*, using a hull-mounted Kongsberg EM3002 single head MBES system operating at 300 kHz. Further surveys of the inshore section were completed in 2011 and 2012 aboard the Fisheries Protection vessel *Banrion Uladh*., with the dual head EM3002 configuration on a pole mount. Prior to beginning the survey, two Valeport Midas water level recorders were deployed, one north and one south of the survey area. A patch test was performed before beginning survey work, in order to calibrate the MBES system for any error in mounting, heading or positioning. The survey was undertaken at an average speed of 4 ms^{-1}, with an average ping rate of 8 Hz. Swath-width was limited to a total angular coverage of 120˚ with an overlap of 100% maintained throughout the survey. Positioning was achieved using a Kongsberg Seapath 200 dGPS system integrated with a Kongsberg MRU 5 motion reference unit for heave, pitch and roll corrections. Bathymetry and backscatter data were logged using Kongsberg Seafloor Information Systems (SIS) software. Sound velocity profiles were taken using a Yellow Springs International (YSI) CastAway CTD at a minimum interval of every 4 hours or when there was suspected stratification as indicated by the sound velocity sensor on the sonar head. Sound velocity profiles were subsequently loaded into SIS and applied to the incoming sonar data before being logged.

Processing of the acoustic data was carried out to IHO Order 1a standard using Caris HIPS & SIPS version 7.1. This included correcting for relative position of the sonar head and vessel draft, tidal corrections to chart datum (which approximates lowest astronomical tide (LAT)) and visual inspection of positioning and motion reference data. A Combined Uncertainty and Bathymetric Estimator (CUBE) surface was generated for the study area, and the data were filtered to reject any soundings lying outside the 95% confidence level for the CUBE surface. Bathymetric data were exported as a 32-bit floating point Bathymetric Attributed Grid (BAG). Backscatter data were processed using the Geocoder engine in Caris SIPS. Beam pattern and time varying gain corrections were applied, and the data were mosaiced and exported as a 4-bit uncompressed GeoTiff. Both the bathymetry and backscatter data were exported with a horizontal resolution of 1 m.

Bathymetry data were further checked and cleaned by the UK Hydrographic Office, and all Report of Survey data verified in order to meet the strict Order 1a hydrographic standard as part of INIS-Hydro. These data were formally signed off by UKHO on 15/11/2014.

2.2. Multibeam data post-processing

The bathymetric data were post-processed to yield the following derivatives using the Spatial Analyst toolset in ArcGIS 10.1 and Benthic Terrain Modeller (Wright *et al.,* 2012) extension:

1. Slope angle
2. Aspect – northness and eastness
3. Terrain ruggedness
4. Benthic position index (BPI)

Due to differences in the backscatter data between surveys and vessels, it was decided not to attempted automated segmentation of these data, but instead use them in manual interpretation and to correlate with bathymetric spatial patterns.

2.3. Ground-truthing data collation

All data were analysed and assigned to UK MNCR/EUNIS biotope complex categories, following guidelines published by Connor *et al.*, 2004. MNCR biotopes are all incorporated within the EUNIS classification, and both the MNCR codes and their sister EUNIS codes will be referred to together in the Results section.

2.3.1. Historic diver survey records (CEDaR)

Subtidal biotope records were requested from CEDaR for the study area, which included all historic records from 1982 to 2007 (no more recent data available). Where available, sediment descriptions were also included.
All diver survey data provide the dive start point as a location (latitude and longitude, in WGS 1984 datum). Due to lack of information about distance covered during a dive, biotopes are associated only with this start point location. 24 records were available from this dataset.

2.3.1 2011 Video Ground Truth Survey

Underwater video ground truth data were acquired in September 2011 on board R.V. *Corystes*. Stations were pre-determined independently of the MBES data using a regularly spaced grid in order to objectively direct the sampling effort as there was no a priori knowledge of seabed composition for the entire study area. Video data were recorded at a total of 23 stations spaced approximately 2.8 km apart. Equipment consisted of a drop frame fitted with a Simrad underwater camera, with an arrangement of four lasers spaced at 25 cm from each other to provide scale. Positioning of the camera was achieved using a TrackLink Ultra Short Baseline (USBL) system. Each video tow was conducted for 15 minutes at an average speed of 0.5 ms^{-1}, and the camera was suspended an average height of 1m from the seafloor giving an approximate field of view of $1m^2$. Video data were categorised using the EUNIS habitat classification scheme.

For its broad applicability, level 4 was chosen to classify habitats in this study. Distinction between habitat types at this level is based mainly on the abiotic component of the environment for unconsolidated substrata. The only biotic information is contained within the description, and indicator species are often infaunal. For hard substrata, habitats at this level are distinguished by introducing a description of community structure. Video data were originally recorded as continuous lines of habitat codes, breaking only where a change in habitat was observed.

2.3.2. Sediment grab sampling

Sediment samples were taken from aboard the R.V. *Corystes* in 2011 as close as possible to each video station using a $0.1m^2$ Day grab (23 samples fell within the survey area). A sub-sample from each grab was retained for particle size analysis (PSA). The remainder of the sample was sieved using a 1mm sieve, and the residue stored in buffered formalin for processing of infauna. Only a subset of the samples collected were processed for infauna due to cost constraints (8 in this area). All samples were processed for PSA and the results analysed through Gradistat to help identify textural group and Folk category (which bears relation to the EUNIS biotope classification). The infaunal data were pre-treated to remove species with no records, and biomass data were square root transformed prior to analysis within PRIMER (results available upon request). These data were used to build a resemblance matrix and this was subjected to cluster analysis. Within the cluster analysis, the SIMPROF routine (with a 1% significance level) was used to identify factors which in turn were plotted using multi-dimensional scaling to examine grouping of the infaunal communities from the samples. SIMPER was then used to extract the species responsible for the similarity of each community group. Each sample's group identity was plotted within ArcGIS and information used to extract potential biotope complex identity.

2.4. Data integration and analysis

A number of approaches were trialled to classify the multibeam data (bathymetry, bathymetric derivatives and backscatter) and incorporate the biotope ground-truthing data:
A supervised classification approach: Signature files were created from the ground-truthing data, using (a) un-buffered locations, and (b) buffered by 10m locations. Examination of the signature files revealed a considerable overlap between each biotope category, which results in difficulties classifying the multibeam data and a high rate of "miss classification".

1. An unsupervised classification approach:
    a. The ISO Cluster technique organises the data in the input raster into a user-defined number of groups in order to produce signatures which are then used to classify the data using the Maximum Likelihood Classification function. The number of iterations for the clustering procedure was set to 200, as it was found that higher numbers of iterations had a negligible effect on the clustering results with significant increases in computing time. The number of classes, and the choice of input data layers, was based on an iterative approach following manual examination of the datasets, and ranged from 6 to 12. The final cluster number chosen for the Dundrum Bay was 11, The input data layers for cluster analysis that gave the most ecologically coherent results (in terms of compatibility with the ground-truthing) were the broadscale BPI, slope angle and terrain ruggedness.
    b. Following the generation of the cluster map, the ArcGIS tool "extract by…" was used to extract the cluster number beneath each video ground-truthing location, and the resulting table was then examined to determine the "majority" cluster number for each biotope category. This biotope category was then manually assigned to the relevant cluster. Where more than one biotope category could be assigned to a

cluster number, the cluster was attributed by the range of biotopes as a mosaic, e.g. “biotopeX/biotopeY/biotopeZ”.

2. An unsupervised classification approach with manual interpretation/editing: This follows the same steps as (2) above, with the difference that the cluster map was then overlaid with a broadscale manual interpretation of the backscatter data mosaics, and the two maps manually combined. This involved editing vertices of mapped polygons to best synthesise the two maps, and removing obvious artefacts (of which many had been propagated through the cluster analysis, particularly along-track artefacts in shallow water).

2.5. Confidence assessment

Accuracy assessment was undertaken by comparing the ground-truthing biotope complexes (MNCR Level 4) with the mapped polygons (also classified at biotope complexes). The video data were used as a measure of internal accuracy, as these were used in the comparison between ground-truthing data and cluster identity, while the diver data were used as a measure of external accuracy, as these were not directly used in map production. Due to the use of mosaics, agreement was given if an example of the biotope complex in the ground-truthing samples was also in the polygon classification.

In addition to the accuracy assessment, a confidence assessment was completed following the MESH method (MESH, 2007).

3. Results

3.1. Multibeam data

Cleaned bathymetry was produced for both the Dundrum Bay (1m horizontal resolution), as shown in Figure 3.1. Maximum depth attained was -33.7m (to Chart Datum, which approximates Lowest Astronomical Tide (LAT)).

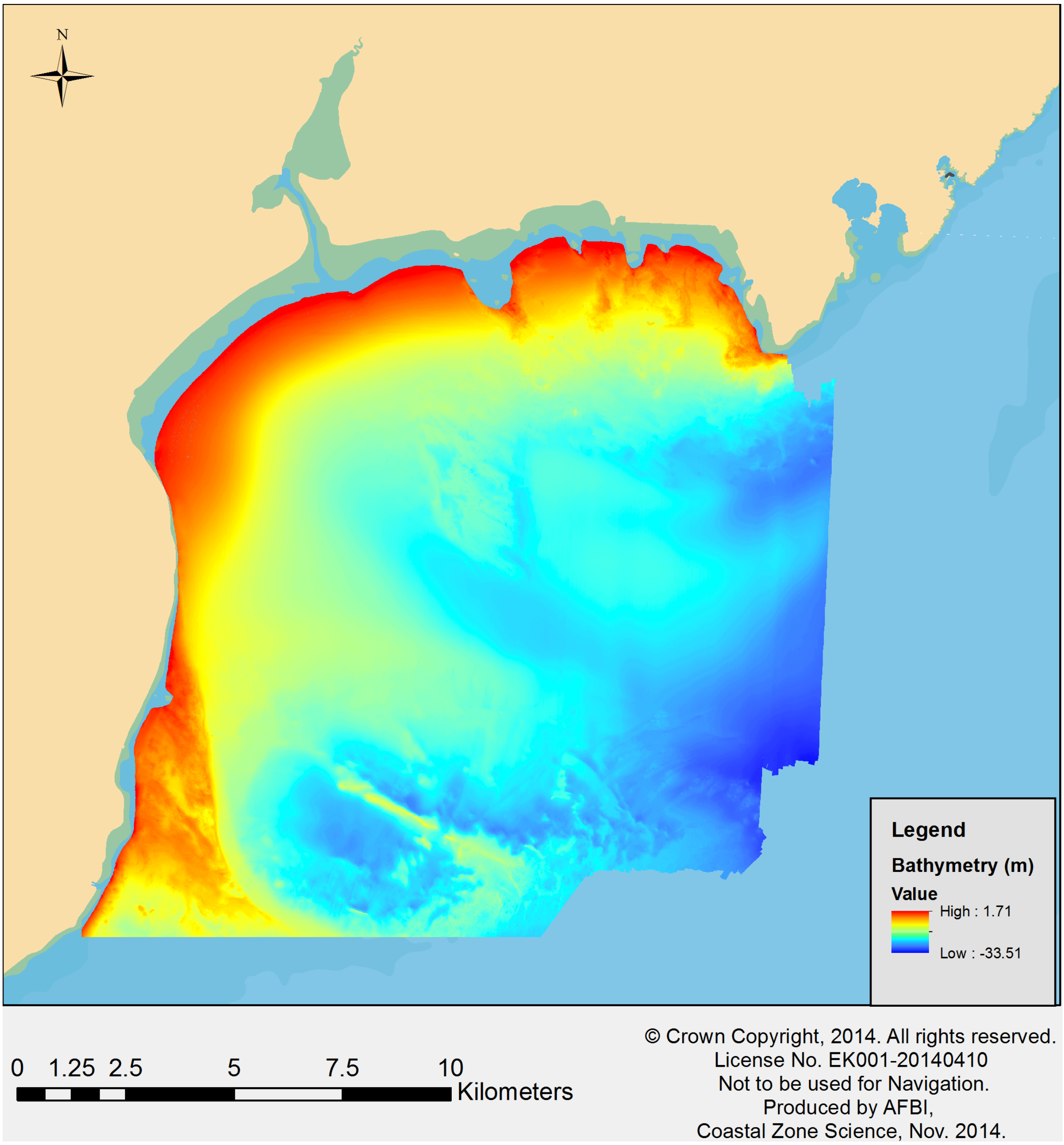

Figure 3.1. Multibeam bathymetry for Dundrum Bay.

Backscatter data were mosaiced as shown in Figure 3.2. The softest ground (resulting in low backscatter value) is shown as darker areas, while coarser/rougher/harder ground results in higher backscatter values and is shown as the lighter areas. Latter areas often correspond to reef areas or very coarse sediments; a substantial area of potential reef is shown in the northeast of the Bay, and to the southwest of the site (adjacent to the Mourne mountains). There is also a moraine-like feature which extends across the Bay in the southern section, at an east-southeast to west-northwest orientation. North of this potential moraine, there is a complex pattern of winnowing sediments. These features correspond with the complex bathymetry in this region, as also shown in the subsequent figures (slope angle, rugosity, BPI).

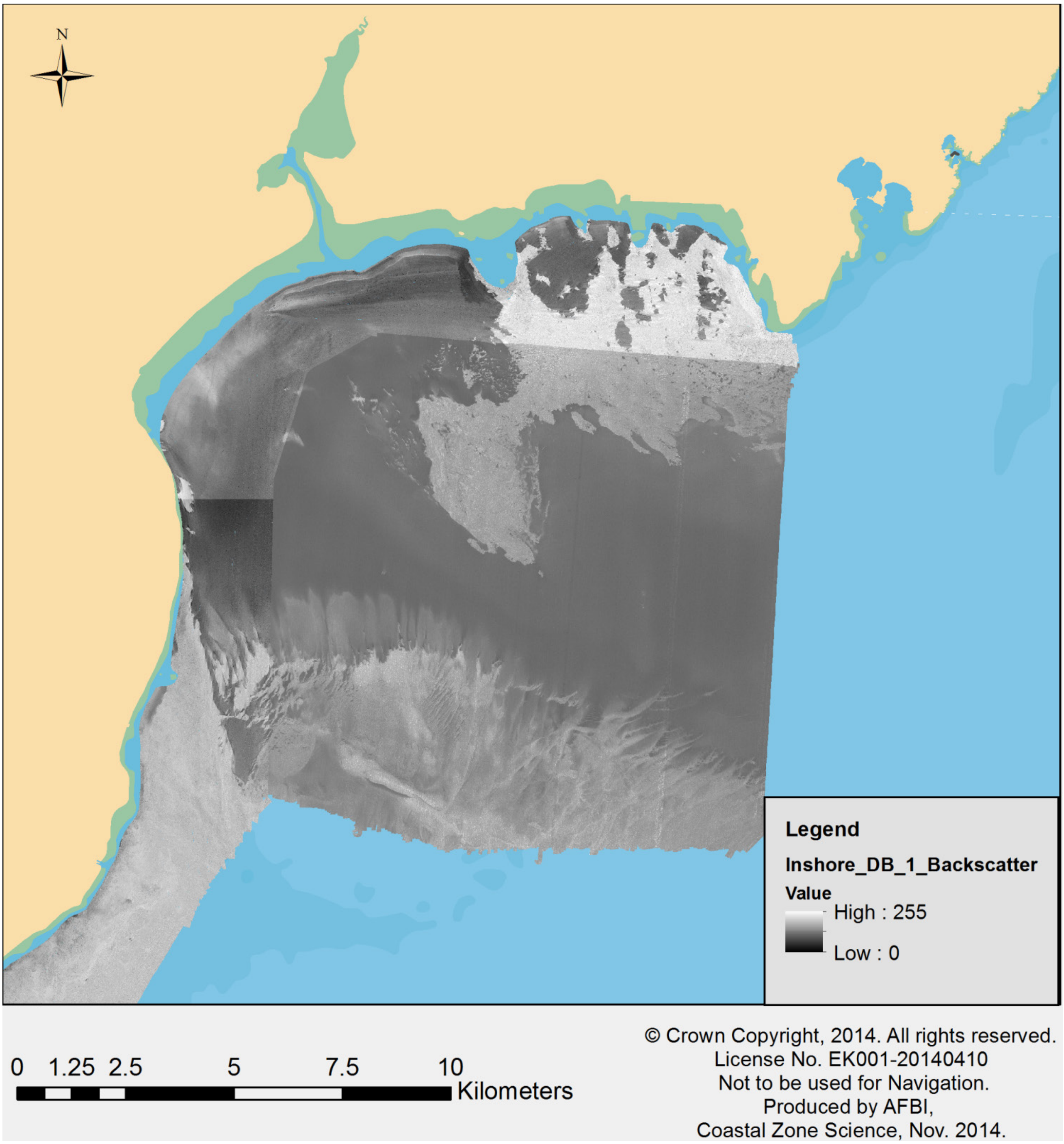

Figure 3.3 Multibeam backscatter mosaics for Dundrum Bay. Low image values = low reflectivity (softer ground), high image values = high reflectivity (harder or rougher ground).

Slope angles were produced from the bathymetric data, as shown in Figure 3.3. Slope angles are generally very gentle, with the majority of the survey area below 1.5°. Maximum slope angles are found in the potential reef areas (northeast and southwest) and also along the potential moraine, but no near-vertical surfaces were found at a 1m resolution horizontal scale, with maximum slope angle being 23.2°.

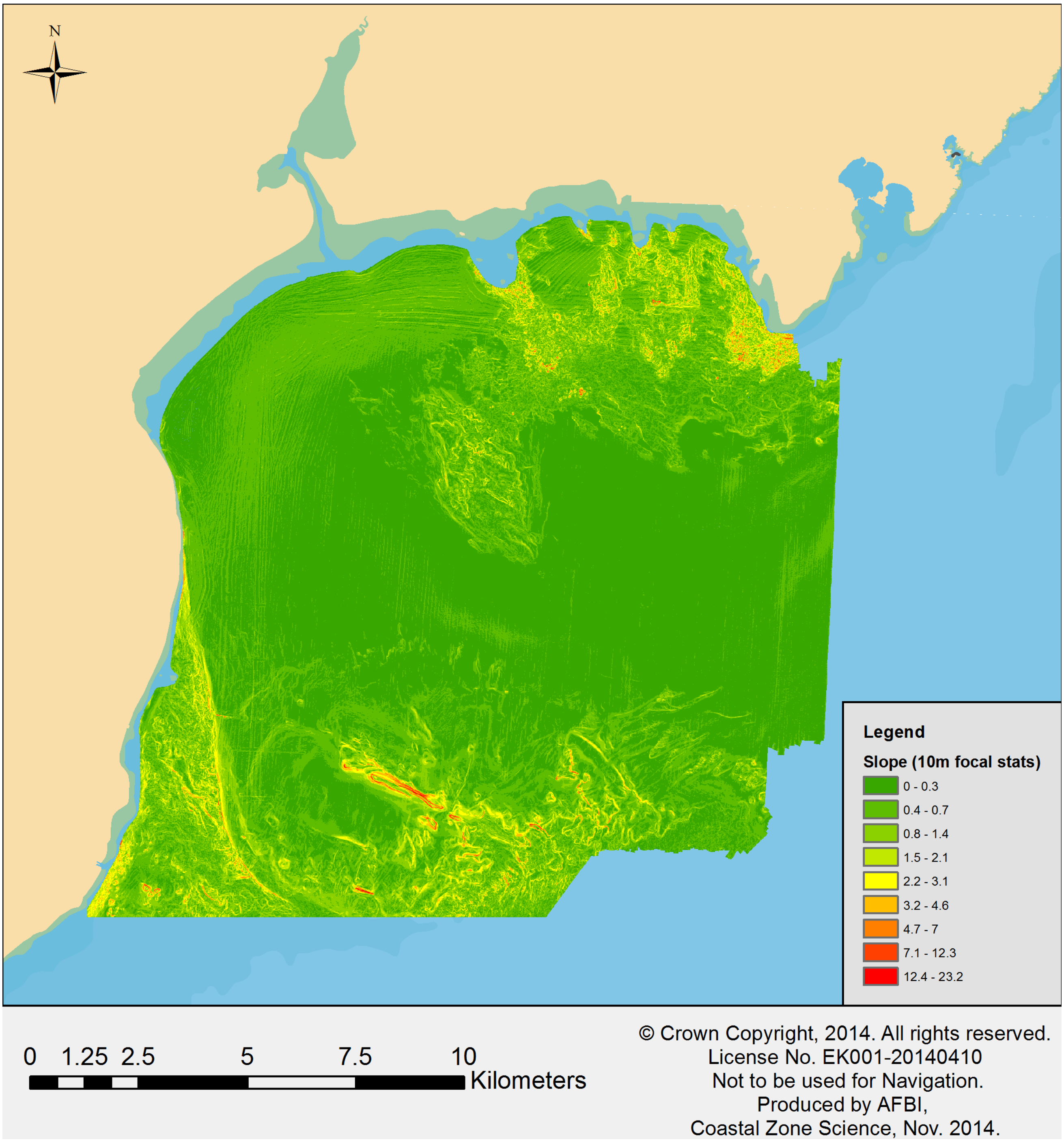

Figure 3.3. Slope angles (in degrees) for Dundrum Bay.

Terrain ruggedness (Figure 3.4) allowed a depiction of the heterogeneity of the seabed, largely following the patterns identified from the slope angle and backscatter data. Again, the overall ruggedness was very low even over potential reef areas.

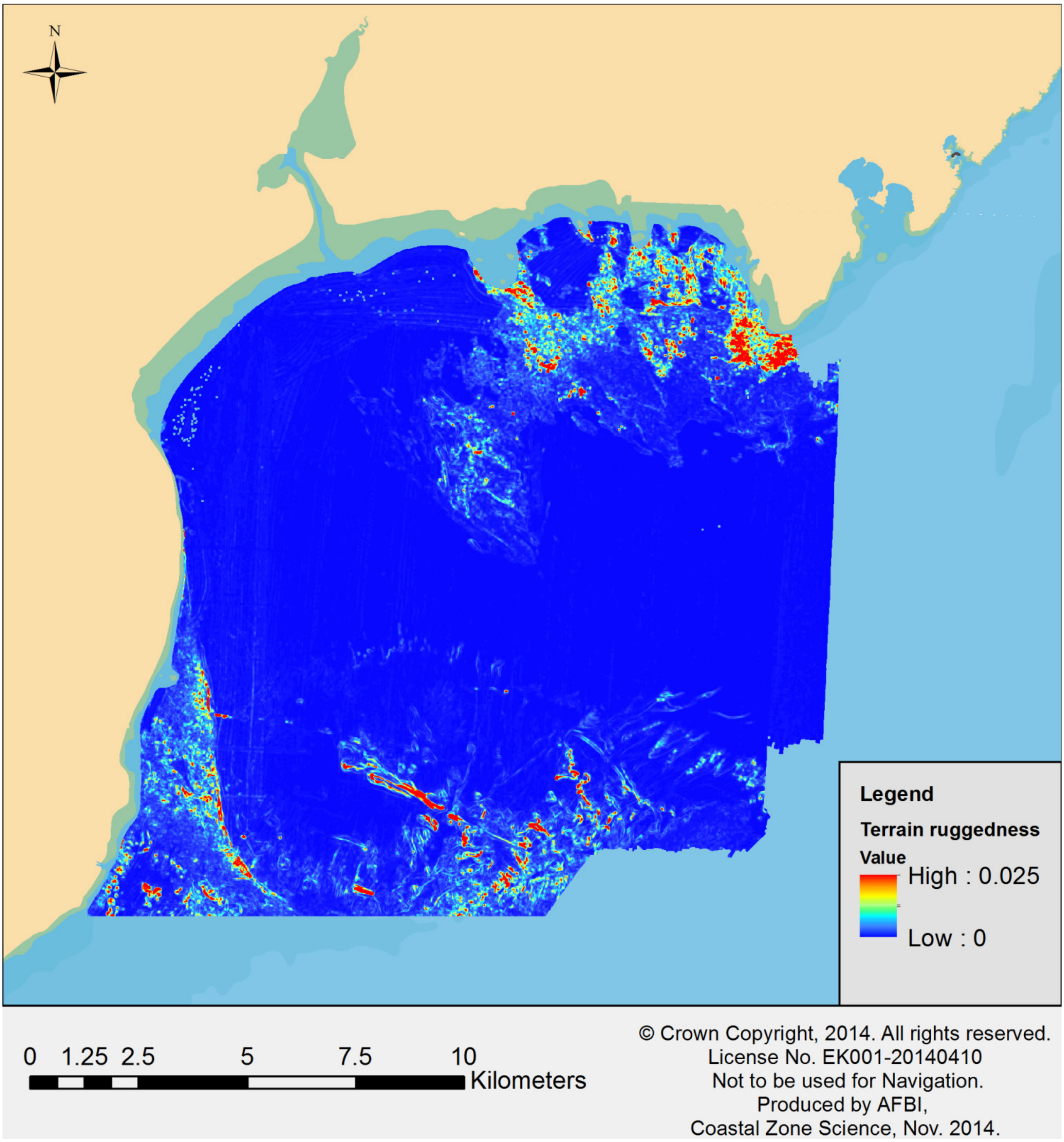

Figure 3.4. Terrain ruggedness from bathymetric data in Dundrum Bay.

The bathymetric data were successfully utilised to calculate broad Benthic Position Index over a length of 1km (Figure 3.5). This integrates slope angle, aspect and rugosity to highlight trough and crest areas, and are related to the distribution of sediments. This re-emphasises the fairly flat nature of the majority of the Bay, with crest and trough areas found close to the coastline, on potential reef areas and around the potential moraine.

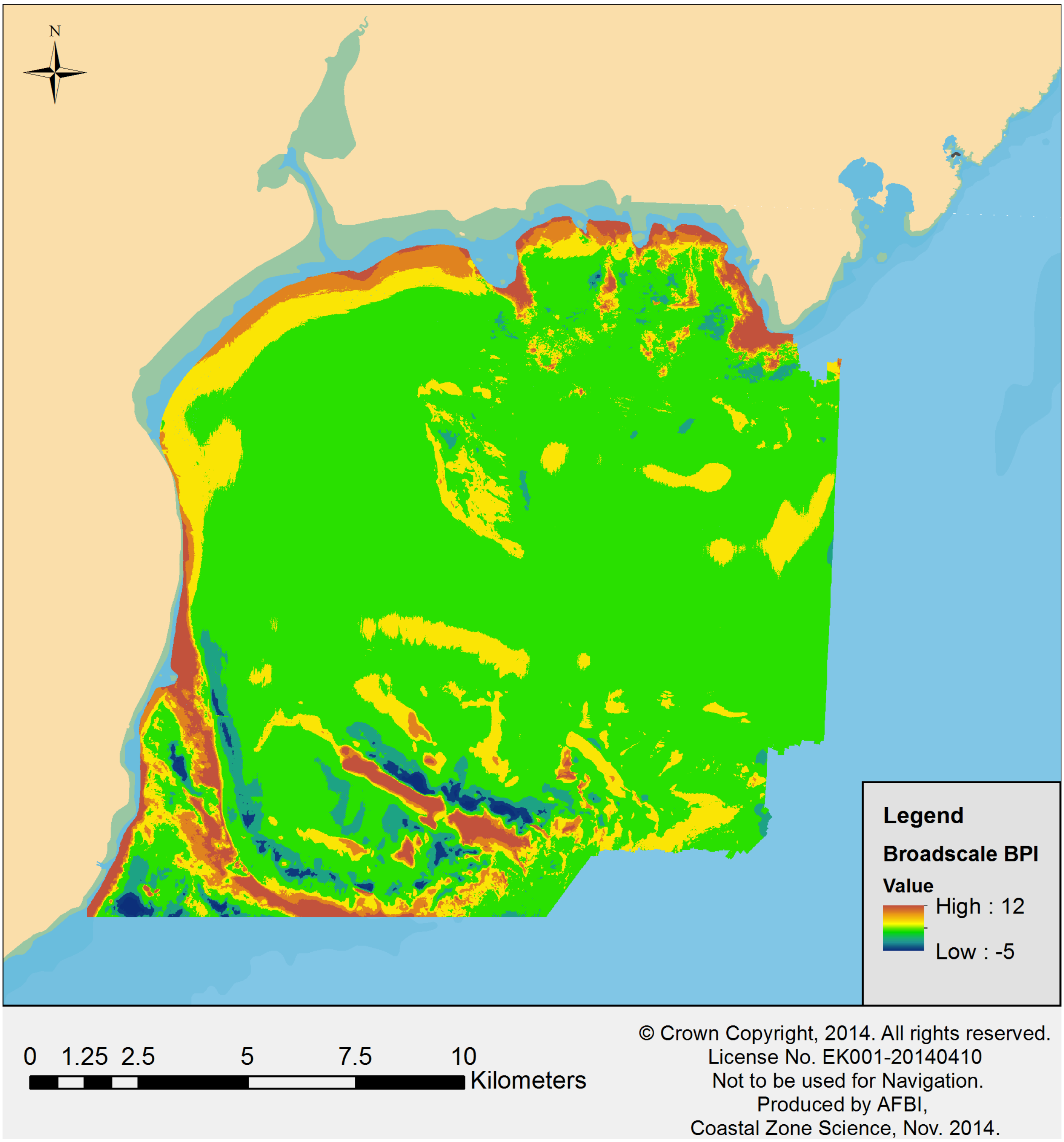

Figure 3.5. Broadscale benthic position index (BPI) for Dundrum Bay with crest areas shown as high positive values and trough areas shown as high negative values.

Backscatter data were subjected to a broadscale manual interpretation in order to extract general spatial patterns across the INIS-Hydro survey area (Figure 3.6 below). This “texture mapping” followed a protocol as defined by UKHO for the INIS-Hydro project. Categories relate to the Folk classification from particle size analysis of the grab samples within the area.

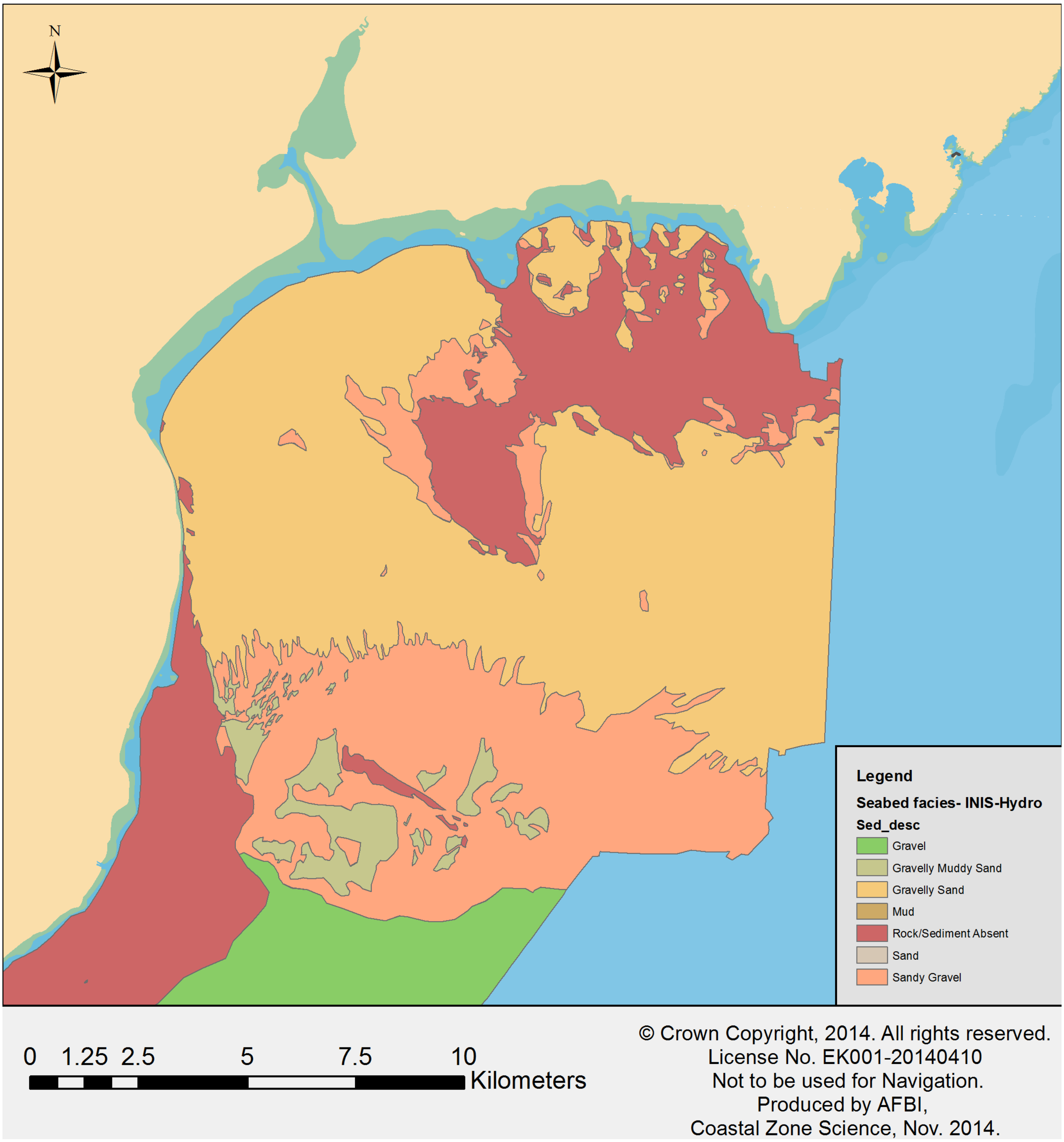

Figure 3.6. Texture map from broadscale backscatter data interpretation

3.2. Ground-truthing classification

All ground-truthing data were analysed through use of (a) video footage review or (b) multivariate statistical routines (results available upon request) to yield biotope complexes (EUNIS/MNCR Level 4), with the exception of the CEDaR dive biotope records which included level 2 to 5 habitats.

The habitat map utilised the 2011 video records and grab sample data for map development, with the diver records held back for external accuracy assessment. This was also decided in part because of the age of the diver records and the difficulty in assessing the footprint of the area surveyed/scale of biotope complex attribution.

Table 3.1. Biotope complexes identified from video ground-truthing data

BiotopeL4	EUNIS Code	Title	Number of video records	Number of grab samples	Number of diver records
IR.MIR.KR	A3.21	Kelp and red seaweeds (moderate energy infralittoral rock)	4	0	3
IR.LIR.K	A3.31	Silted kelp on low energy infralittoral rock with full salinity	0	0	1
CR.HCR.XFa	A4.13	Mixed faunal turf communities on circalittoral rock	0	0	10
CR.MCR.EcCr	A4.21	Echinoderms and crustose communities on circalittoral rock	12	0	0
SS.SCS.CCS	A5.14	Circalittoral coarse sediment	17	1	0
SS.SMU.IMuSa	A5.24	Infralittoral muddy sand	0	0	5
SS.SSA.CFiSa	A5.25	Circalittoral fine sand	30	4	0
SS.SSA.CMuSa	A5.26	Circalittoral muddy sand	7	1	0
SS.SMU.CFiMu	A5.36	Circalittoral fine mud	60	0	1
SS.SMX.CMx	A5.44	Circalittoral mixed sediments	22	1	1
SS.SMP.KSwSS	A5.52	Kelp and seaweed communities on sublittoral sediment	0	0	1

The distribution of the classified ground-truthing data, by biotope complex, is shown in Figure 3.7 below.

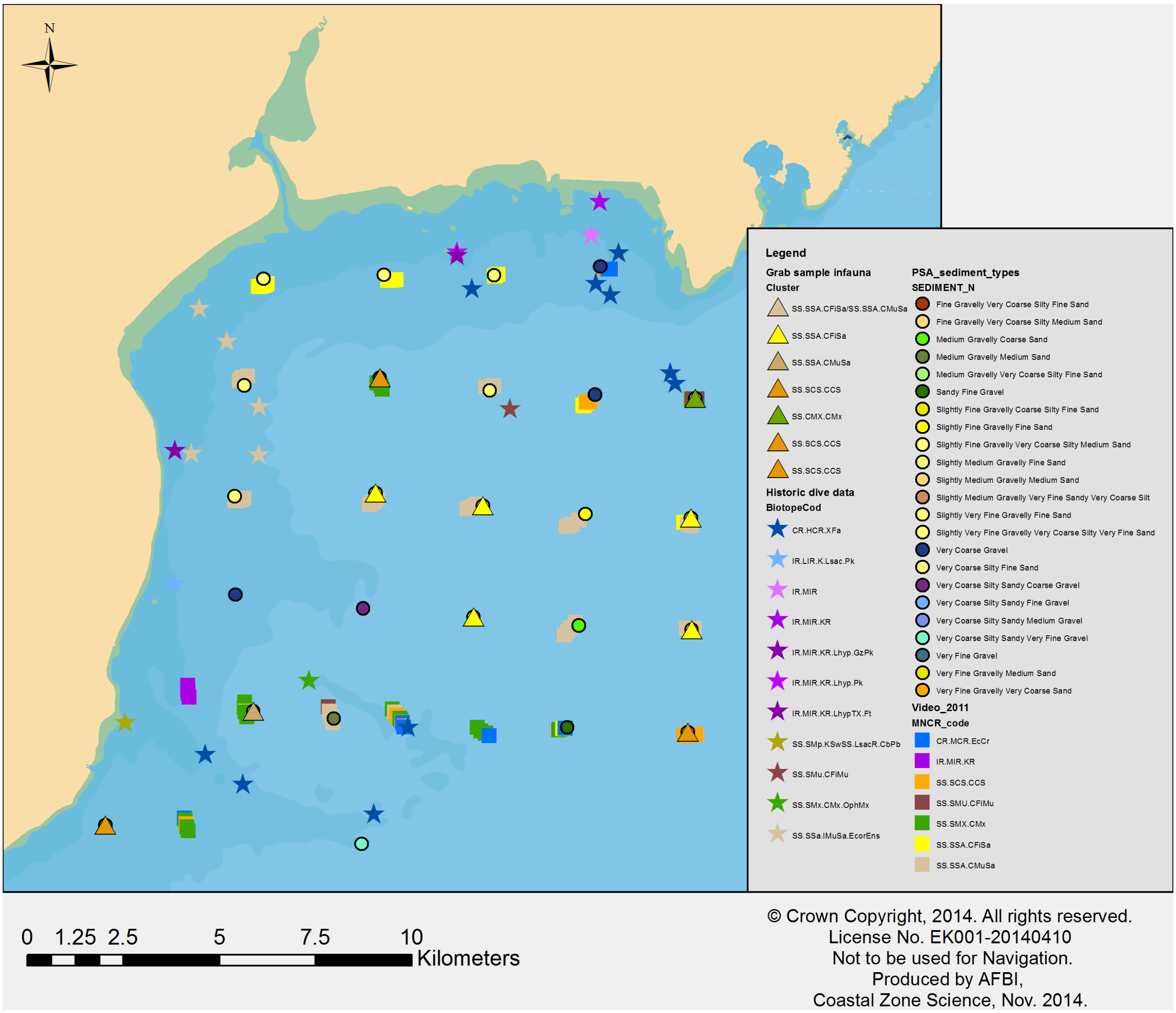

Figure 3.7. Ground-truthing records classified by biotope complex.

3.3. Final habitat map production

Figure 3.8 below presents the final habitat map. This reveals a dominance of fairly homogeneous muddy sands throughout the centre of the Bay, with coarser sediments revealed near the beach at Newcastle, and reef-like regions to the northeast and southwest, and along the moraine-like feature. The coastal fringing reef areas were often characterised by outcropping bedrock, boulders and cobbles, while the moraine like-feature was characterised by cobbles, many of which were embedded and had notable epifauna, and could therefore be classified as “stony reef”. Both the moraine-like area and the reef areas showed a complex pattern of coarse sediments, mixed sediments (muddy sands with cobble and gravel) interspersed around the outcropping bedrock or boulders. All these regions were fairly low relief, and many of the cobbles surrounding the more stable outcrops appeared mobile. There are reportedly substantial changes to the sediment in the intertidal region of Dundrum Bay, particularly near Newcastle Beach, with increased erosion of finer sediments revealing cobbles. This was certainly found adjacent to this area in the shallow subtidal region. Rippled sand (fine sand) was also found in various locations near the shore to the north of the Bay. Small pockets of mud or sandy mud were shown on the video near the moraine-like features, were local hydrodynamics leads to deposition, but these areas were very limited and difficult to map. Following particle size analysis of all the grab samples, none were classified as "mud" but the majority fell in the "muddy sand" category, which covers the most extensive area of the Bay. The video showed much of this area to be extensively bioturbated, often with *Nephrops norvegicus* burrows and smaller burrows, and *Turitella* sp. shell that are frequently found in muddy sand. The sea potato, *Echinocardium cordatum* was also found in grab samples within this area, along with burrowing shrimps such as *Jaxea nocturna, Calianassa subterranean* and *Upogebia* sp., the burrowing crab *Goneplax rhomboids* and the brittlestar *Amphiura filiformis.* The anemone *Ceriathus lloydii* and opisthobranch *Pholoe baltica* were also frequent. According to the MNCR biotope classification scheme, many of these characterising species would relate to the bioturbated mud biotopes, however sediment granulometry is clear that these areas are muddy sands.

The coarser and mixed sediments were characterised by keel worms (*Spirobranchus triqueter*) and often had dense brittlestar coverage (mostly *Ophiothrix fragilis* but also *Ophiocomina nigra*). The hydroids *Abietinaria abietina, Hydrallmania falcata,* and, more rarely, *Tubularia indivisa,* were also recorded from cobbles sampled by grabs. The starfish *Asterias rubens* was seen frequently on video footage, along with swimming crabs *Liocarcinus* sp. In reef areas, encrusting fauna dominated due possibly to the sediment scour in the area, with frequent *Echinus esculentus* and occasional-rare *Alcyonium digitatum.* Unfortunately the visibility was quite poor in shallower areas, so information is fairly limited on the infralittoral (kelp dominated) reefs.

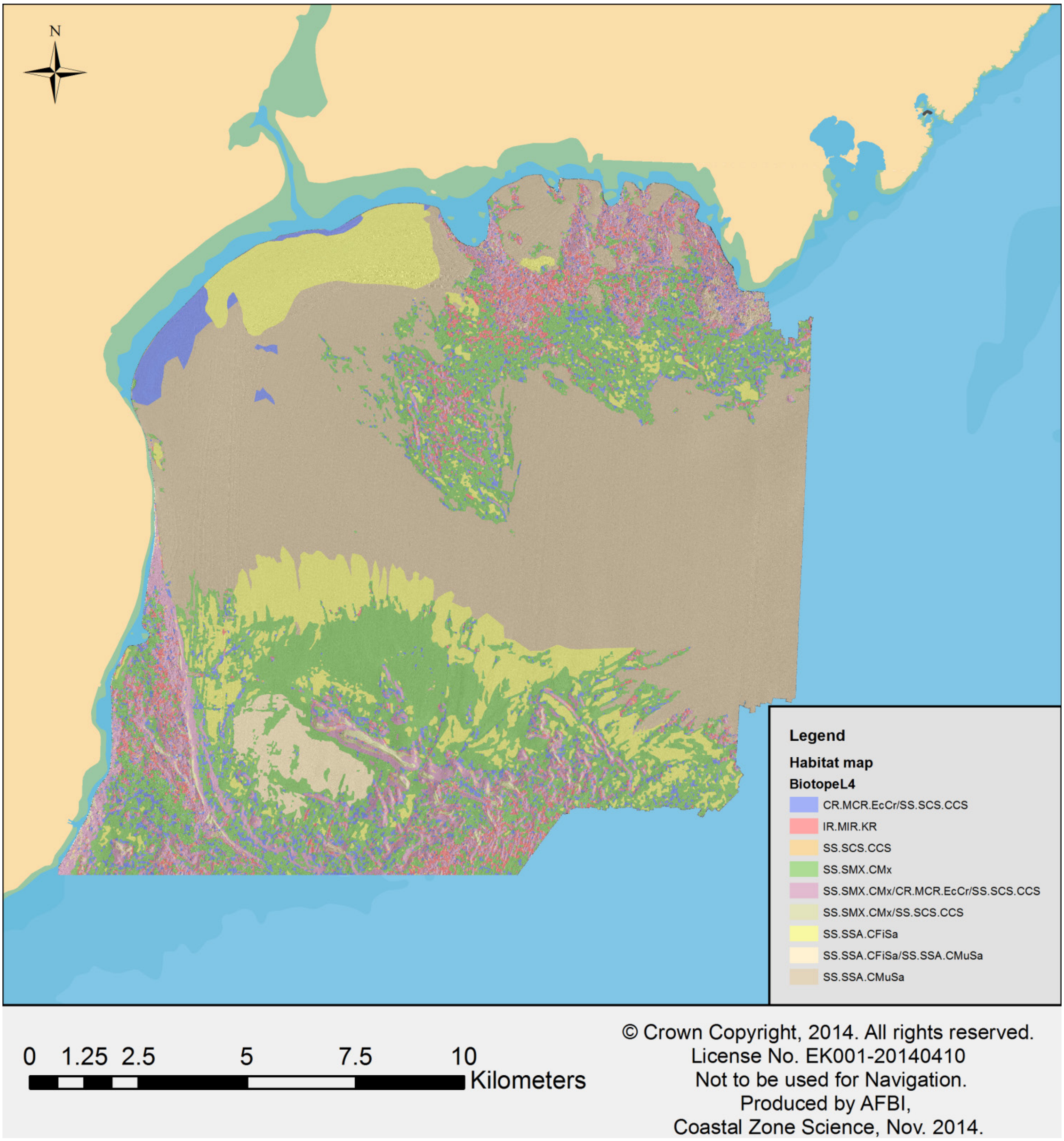

Figure 3.8. Habitat map (level 4 biotope complexes) for Dundrum Bay, overlaid on hillshaded bathymetry.

Table 3.2. Summary area tables for dominant biotope complexes, with habitats of conservation interest extracted.

Biotope complex	Area (km^2)
CR.MCR.EcCr/SS.SCS.CCS	12.32
IR.MIR.KR	7.84
SS.SCS.CCS	1.23
SS.SMX.CMx	51.89
SS.SMX.CMx/CR.MCR.EcCr/SS.SCS.CCS	19.10
SS.SMX.CMx/SS.SCS.CCS	1.36
SS.SSA.CFiSa	26.01
SS.SSA.CFiSa/SS.SSA.CMuSa	3.98
SS.SSA.CMuSa	92.72

Annex I habitats

Sand/muddy sand	122.72
Reef (bedrock)	20.16
Reef (stony reef)	19.10

3.4. Confidence assessment

The correspondence between the mapped dominant biotope complexes and the ground-truthing biotope complex records, known as 'accuracy assessment', was completed through extraction of co-located records in ArcGIS, and percentage agreement between biotope complexes calculated in Excel. This analysis gave the following results:

a) Agreement of 65% for internal accuracy (match between mapped polygons are video segment biotopes)
b) Agreement of 22% for external accuracy of actual biotope complexes (regardless though of infralittoral or circalittoral splitting) with diver records (single points)
c) Agreement of 65% for external accuracy if broad categories are considered (rock, mixed substratum, muddy sand)

The results for (a) and (c) are greater than the potential agreement between ground-truthing records and mapped habitats that could be generated by chance, however the result for (b) is lower.

The assessment of confidence in the final habitat maps was undertaken following the MESH confidence assessment methodology, and the following scores in Table 3.3 were derived for Dundrum Bay. This included an assessment of the remote sensing (multibeam) data, the ground-truthing data, the ground-truthing interpretation and the map accuracy. Together, these were combined in the confidence tool macro to give an overall score of **90.**

Table 3.3. Habitat map confidence assessment

RemoteTechnique	RemoteCoverage	RemotePositioning	RemoteStdsApplied	RemoteVintage	BGTTechnique	PGTTechnique	GTPositioning	GTDensity	GTStdsApplied	GTVintage	GTInterpretation	RemoteInterpretation	DetailLevel	MapAccuracy	Remote score	GT score	Interpretation score	Overall score
3	3	3	3	3	3	2	3	2	2	3	2	3	2	3	100.00	86.67	83.33	90

4. Discussion

The multibeam remote sensing of Dundrum Bay has provided a unique insight into the subtidal seabed environment. It has revealed a large, homogeneous region with high complexity, though low relief, fringing reefs and a moraine-like feature. Although part of the Bay has been designated for subtidal sandbanks and mudflats, no notable areas of mud were mapped in this project, and there is no evidence for mud from grab sample granulometry, but rather the sediment classification is “muddy sand”. However, the characterising species in such areas are very similar to those of mud biotopes, with extensive bioturbation. Further offshore these muddy sands grade into cohesive mud, which forms the western Irish Sea mud patch. There is also evidence of cobbles which may have been exposed through erosion in the very shallow sublittoral/deep littoral region, especially near the Newcastle shore. Interestingly, diver survey data from 1984 shows this region as being “muddy sand”; this mismatch in records could be due to (a) sedimentary change or (b) positional accuracy issues.

There was moderately high internal agreement between the mapped polygons and the video ground-truthing data, at the biotope complex level, but very low agreement between the mapped biotope complexes and the diver records, which may be due to an issue of scale, positional issues or change. There are also records from the diver surveys of “CR.HCR.XFa” (faunal turf on high energy circalittoral rock), which were not found from the video survey, where only medium energy circalittoral rock was recorded (“CR.MCR.EcCr”), however this could be due to different parts of the reef being surveyed with higher relief areas potentially falling into the high energy category; further ground-truthing would be needed to verify this. The grab samples largely corroborate the biotope complex information derived from video analysis, although with only eight infaunal samples processed the sediment data was more useful in distinguishing habitats according to the Folk method used in the MNCR classification.

There was difficulty in distinguishing infralittoral and circalittoral biotopes within the resulting map; this could be due to the similar acoustic signature for these, and the fact that very few ground-truthing records fell into the infralittoral category from the video analysis. With adequate secchi data, such a split could be made using the bathymetric data, if required.

Although there is some ground-truthing on the moraine-like feature, it would be very interesting to gather more data around this feature, particularly to the north where there appear to be winnowing sediments coming from the moraine, and where there is an absence of ground-truthing (with the exception of two grab samples). These areas appear coarser than the muddy sands, and grab samples reported the sediments as gravels. It would be interesting to build a more complete picture of this area, to see how stable the sediments are and what fauna they support.

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