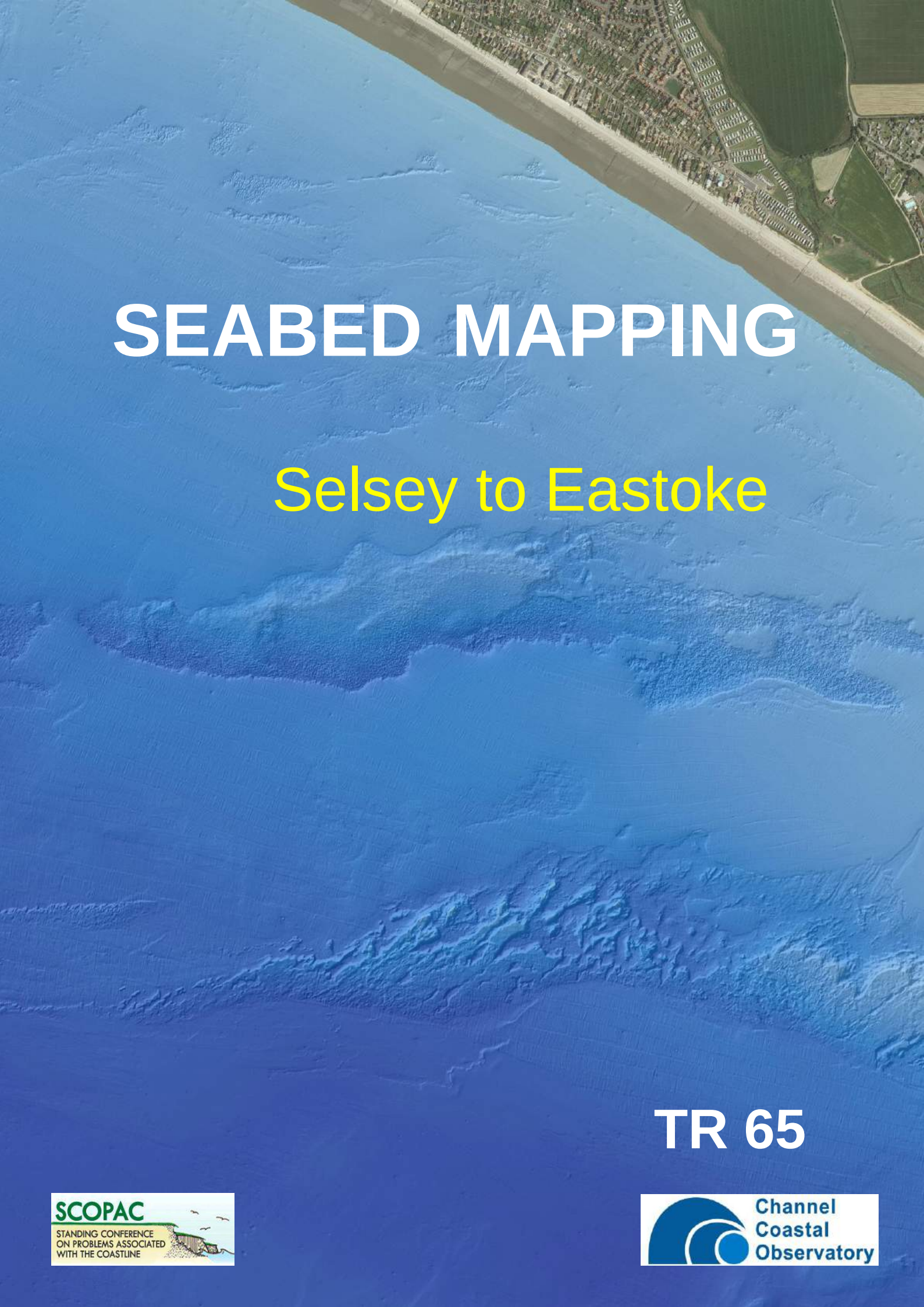

SEABED MAPPING

Selsey to Eastoke

TR 65

SCOPAC
STANDING CONFERENCE ON PROBLEMS ASSOCIATED WITH THE COASTLINE

Channel Coastal Observatory

Contents

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Website: www.channelcoast.org

Document Title: **Seabed Mapping: Selsey to Eastoke**

Reference: **TR65**

Status: **FINAL**

Date: **15 January 2015**

Project Name: **SCOPAC East Solent Seabed Mapping**

Authors: **J. Evans and A. Colenutt**

Checked By: **A. Colenutt**

Approved By: **T. Mason**

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Introduction

Technological improvements in bathymetric survey equipment and the widespread introduction of multibeam echosounder systems (MBES) within the offshore survey industry have meant that it is now increasingly cost-effective to achieve 100% sea floor coverage. Although the primary purpose is generally to survey the bathymetry of the seabed, interpretation of acoustic backscatter information and groundtruthing data collected during the survey, in combination with the bathymetry, can be used to produce detailed indicative maps of other features, such as marine habitats, substrate type and anthropogenic features.

A swath bathymetry survey of the nearshore zone between Lee-on-the-Solent and Selsey was commissioned by the Southeast Regional Coastal Monitoring Programme, managed by the Channel Coastal Observatory (CCO) and completed in 2013. This survey delivered 100% seafloor coverage to IHO Order 1a, and covered 194km^2, extending offshore to the 10mCD contour, and to the west to abut previous surveys off the Isle of Wight. The survey included coverage of the entrance channels of Chichester, Langstone and Portsmouth Harbours. The Standing Conference of Problems Associated with the Coastline (SCOPAC) commissioned the CCO to interpret a sub-section, approximately 40km^2 of the surveyed area (Figure 1). This report describes the methodology and interpretation of the bathymetry, backscatter and groundtruthing data to produce a series of detailed thematic maps, including surficial substrate, EUNIS marine habitats and anthropogenic features, which may be used to inform a range of coastal management, marine conservation, and planning policy objectives.

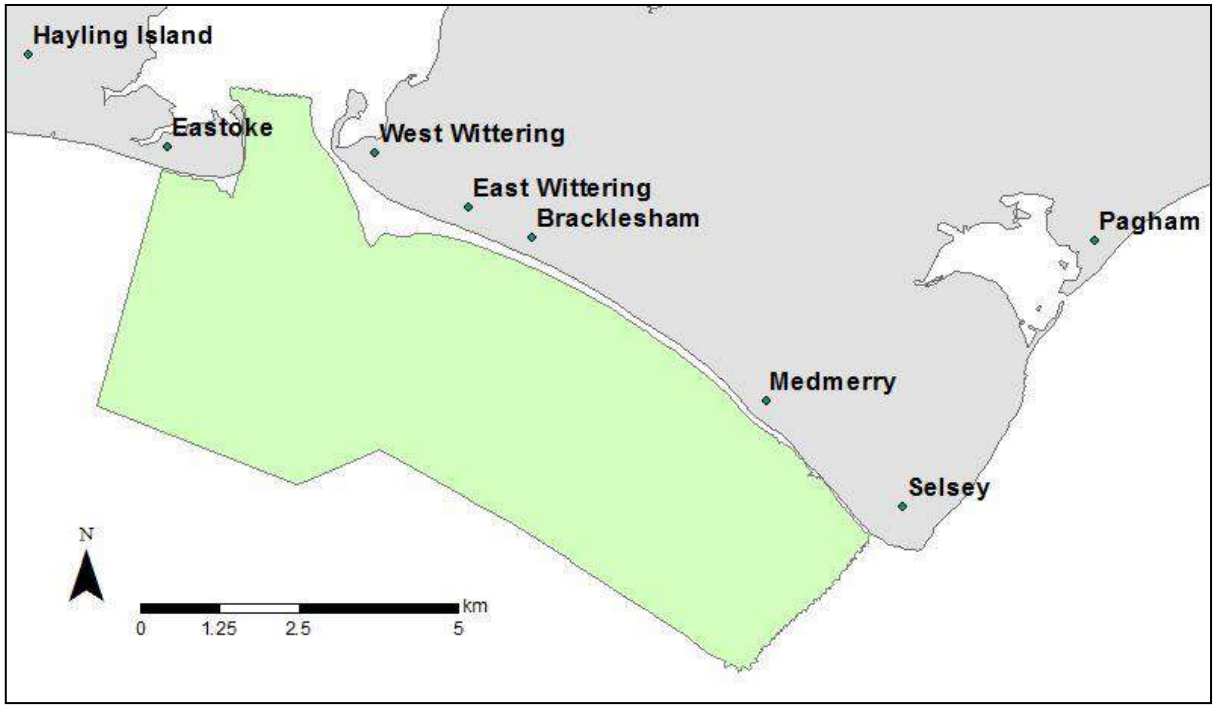


Figure 1: Seabed mapping study area

Marine Habitat Classification Scheme

Marine habitats were mapped using the European Nature Information System (EUNIS) habitat types classification, as modified by the Joint Nature Conservation Committee (JNCC, see http://jncc.defra.gov.uk/pdf/04_05_introduction.pdf). EUNIS is a hierarchical classification ranging from basic descriptions (high level classifications) such as littoral rock, through to very detailed descriptions (low level classifications). Up to 6 levels are defined but Levels 4-6 involve the biology and accordingly the MBES survey can be used to map to Level 3 only; nevertheless, the results of Level 3 and substrate mapping can be used by other agencies who might wish to map to a more detailed level.

Level 1 Environment (marine)

A single category is defined within EUNIS to distinguish the marine environment from terrestrial and freshwater habitats.

Level 2 Broad habitats

These are extremely broad divisions of national and international application for which EC Habitats Directive Annex I habitats (*e.g.* reefs, mudflats and sandflats not covered by seawater at low tide) are the approximate equivalent. At EUNIS Level 2, there are eight broad marine habitats classifications (Table 1).

Table 1: EUNIS Level 2 marine habitat classifications

Typical UK boundary depths	Rock	Rock and thin Sediment	Sediment
	Littoral Rock	*Littoral Rock and thin Sediment*	*Littoral Sediment*
MLWS	*Infralittoral Rock*	*Infralittoral Rock and thin Sediment*	*Sublittoral Sediment*
10m OD	*Circalittoral Rock*	*Circalittoral Rock and thin Sediment*	

Level 3 Main habitats

These serve to provide very broad divisions of national and international application which reflect major differences in biological character. They are equivalent to the intertidal Sites of Special Scientific Interest (SSSI) selection units (for designation of shores in the UK) (JNCC, 1996) and can be used as national mapping units. At EUNIS Level 3 (Table 2), the broad habitat types from EUNIS Level 2 are sub-divided further based on sediment type, wave exposure and tidal current strength.

Table 2: EUNIS Level 3 marine habitat classifications

Rock			Rock and thin Sediment			Sediment			
High energy littoral rock	*Moderate energy littoral rock*	*Low energy littoral rock*	*High energy littoral rock and thin Sediment*	*Moderate energy littoral rock and thin Sediment*	*Low energy littoral rock and thin Sediment*	*Littoral mud*	*Littoral sand*	*Littoral mixed sediment*	*Littoral coarse sediment*
High energy infralittoral rock	*Moderate energy infralittoral rock*	*Low energy infralittoral rock*	*High energy infralittoral rock and thin Sediment*	*Moderate energy infralittoral rock and thin Sediment*	*Low energy infralittoral rock and thin Sediment*	*Sublittoral mud*	*Sublittoral sand*	*Sublittoral mixed sediment*	*Sublittoral coarse sediment*
High energy circalittoral rock	*Moderate energy circalittoral rock*	*Low energy circalittoral rock*	*High energy circalittoral rock and thin Sediment*	*Moderate energy circalittoral rock and thin Sediment*	*Low energy circalittoral rock and thin Sediment*				

In the classifications, ‘Rock’ refers collectively to bedrock, stable and artificial substrata (concrete, wood, metal). Cobbles and pebbles with gravel and coarse sand are collectively referred to as ‘Coarse Sediment’. ‘Mixed Sediment’ consists of mixtures of gravel, sand and mud which may contain stones and shells.

The littoral zone lies landward of Mean Low Water Springs (MLWS) with the sublittoral zone seaward of MLWS. For areas of ‘Rock” or ‘Rock and thin Sediment’, the sublittoral zone is split into the infralittoral zone and the circalittoral zone based upon site-specific biological parameters. ‘Rock and thin Sediment’ is applied to areas with some thickness of surficial sediment through which the underlying bedrock geology is discernible in the bathymetry.

The EUNIS classification considers both wave and tidal current information to determine the various energy levels for the rock and rock and thin sediment categories, at a relative scale throughout Europe. The interpretation undertaken in the Eastern Solent has considered the available information to determine average wave exposure and tidal current conditions and compared relatively to conditions at other sites, nationally.

Wave exposure takes account of the aspect of the coast (related to direction of prevailing or strong winds), the fetch (distance to nearest land), its openness (the degree of open water offshore) and its profile (the depth profile of water adjacent to the coast). Estimation of wave exposure requires inspection of charts and maps. In broad terms:

- ‘Extremely exposed’ is applicable for the few open coastlines which face into prevailing wind and receive oceanic swell without any offshore breaks (such as islands or shallows) for several thousand km and where deep water is close to the shore (50 m depth contour within about 300 m, e.g. Rockall).

- ‘Very exposed’ are open coasts which face into prevailing winds and receive oceanic swell without any offshore breaks (such as islands or shallows) for several hundred km but where deep water is not close (>300 m) to the shore. They can be adjacent to extremely exposed sites but face away from prevailing winds (here swell and wave action will refract towards these shores) or where, although facing away from prevailing winds, strong winds and swell often occur (for instance, the east coast of Fair Isle).

- At ‘Exposed’ sites, prevailing wind is onshore although there is a degree of shelter because of extensive shallow areas offshore, offshore obstructions, a restricted (<90o)

window to open water. These sites will not generally be exposed to strong or regular swell. This can also include open coasts facing away from prevailing winds but where strong winds with a long fetch are frequent.

- ‘Moderately exposed’ sites generally include open coasts facing away from prevailing winds and without a long fetch but where strong winds can be frequent.

- ‘Sheltered’ sites have a restricted fetch and/or open water window. Coasts can face prevailing winds but with a short fetch (say <20 km) or extensive shallow areas offshore or may face away from prevailing winds.

- ‘Very sheltered’ sites are unlikely to have a fetch greater than 20 km (the exception being through a narrow (<30 m) open water window, they face away from prevailing winds or have obstructions, such as reefs, offshore.

- ‘Extremely sheltered’ sites are fully enclosed with fetch no greater than about 3 km.

In the EUNIS habitat classification the category exposed encompasses the extremely exposed, very exposed and exposed categories.

Tidal currents (or streams) refer to the maximum surface tidal current strength which affects the actual area surveyed. It is worth noting that for shore and inshore areas this may differ considerably from the tidal currents present offshore. In some narrows and sounds the top of the shore may only be covered at slack water, but the lower shore is subject to fast running water. (The classification is Very strong >6 knots (>3 m/sec.); Strong 3-6 knots (>1.5-3 m/sec.); Moderately strong 1-3 knots (0.5-1.5 m/sec.); Weak <1 knot (<0.5 m/sec.); Very weak Negligible). In the EUNIS habitat classification tide-swept habitats typically have moderately strong or stronger tidal currents.

Habitat Mapping Methodology

Bathymetry, backscatter and groundtruthing data were used (Figure 2) to provide information for the production of maps displaying anthropogenic features (*e.g.* cables and pipelines, wrecks, trawl marks and sea defence structures), substrate type and EUNIS Level 2 and Level 3 seabed habitat maps.

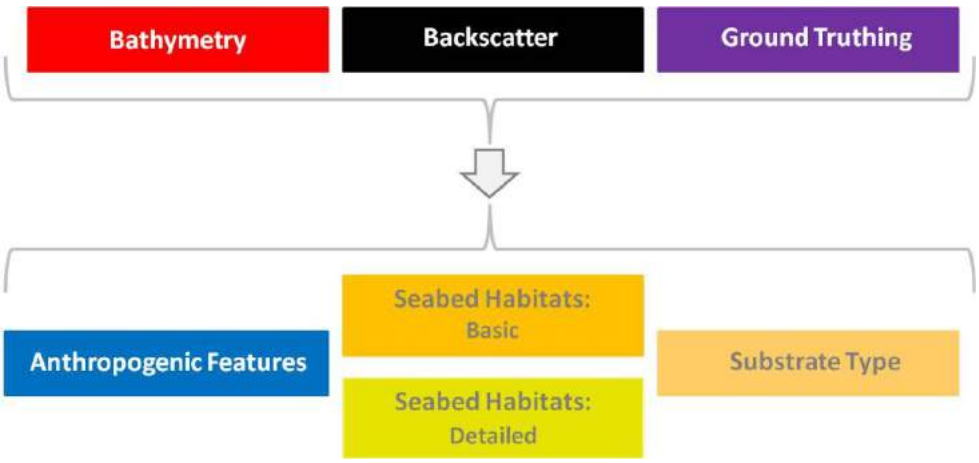


Figure 2: Seabed mapping stages

Bathymetry

The IHO Order 1a standard swath bathymetry survey of the nearshore zone from Lee-on-Solent was commissioned by the Southeast Regional Coastal Monitoring Programme, and collected in accordance with the Maritime & Coastguard Agency (MCA) Civil Hydrography Programme Survey Specification August 2013. The survey commenced on 15 May 2013 and was completed on 10 July 2013. Bathymetric data was acquired using a hull-mounted Kongsberg EM2040D Multibeam Echo-Sounder (MBES) on MV Ping and a Kongsberg EM3002D MBES on MV Ocean Star. The UKHO undertook quality-control of the data, and converted the processed, quality-controlled data set from WGS84/Chart Datum to OSGB/Ordnance Datum, at 1m resolution with vertical uncertainty +/- 0.22m.

The bathymetry data was loaded into IVS Fledermaus version 7.3 in order to export the files as one single layer for subsequent use in ArcGIS v10.2. Figure 3 illustrates the high resolution of the bathymetry and, superimposed on aerial photography, also demonstrates the required overlap with land-based survey data thus avoiding the well-known "white ribbon" strip of seabed close to the shore where data seldom is captured. Depths in a number of the figures are colour-coded with orange colours indicating shallow depths and dark blue the deepest areas.

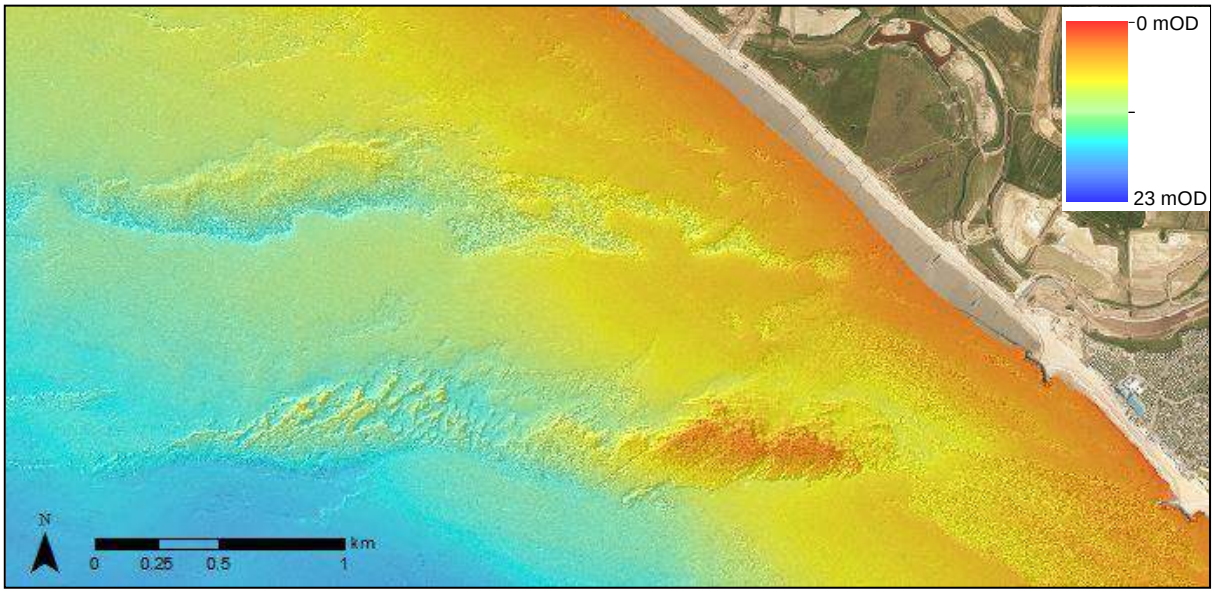


Figure 3: Bathymetry (with underlying hillshade), Medmerry

Hillshade

Within ARCGIS v10.2, a hillshade layer was derived which is a form of artificial sun-illumination which helps to enhance depth changes and features in the bathymetry dataset. The images and maps used in this report use an azimuth direction of 315º and an angle of 45º. This layer is particularly useful for displaying and enhancing areas of bedforms and seabed of variable texture where there are numerous depth changes across relatively short distances (Figure 4).

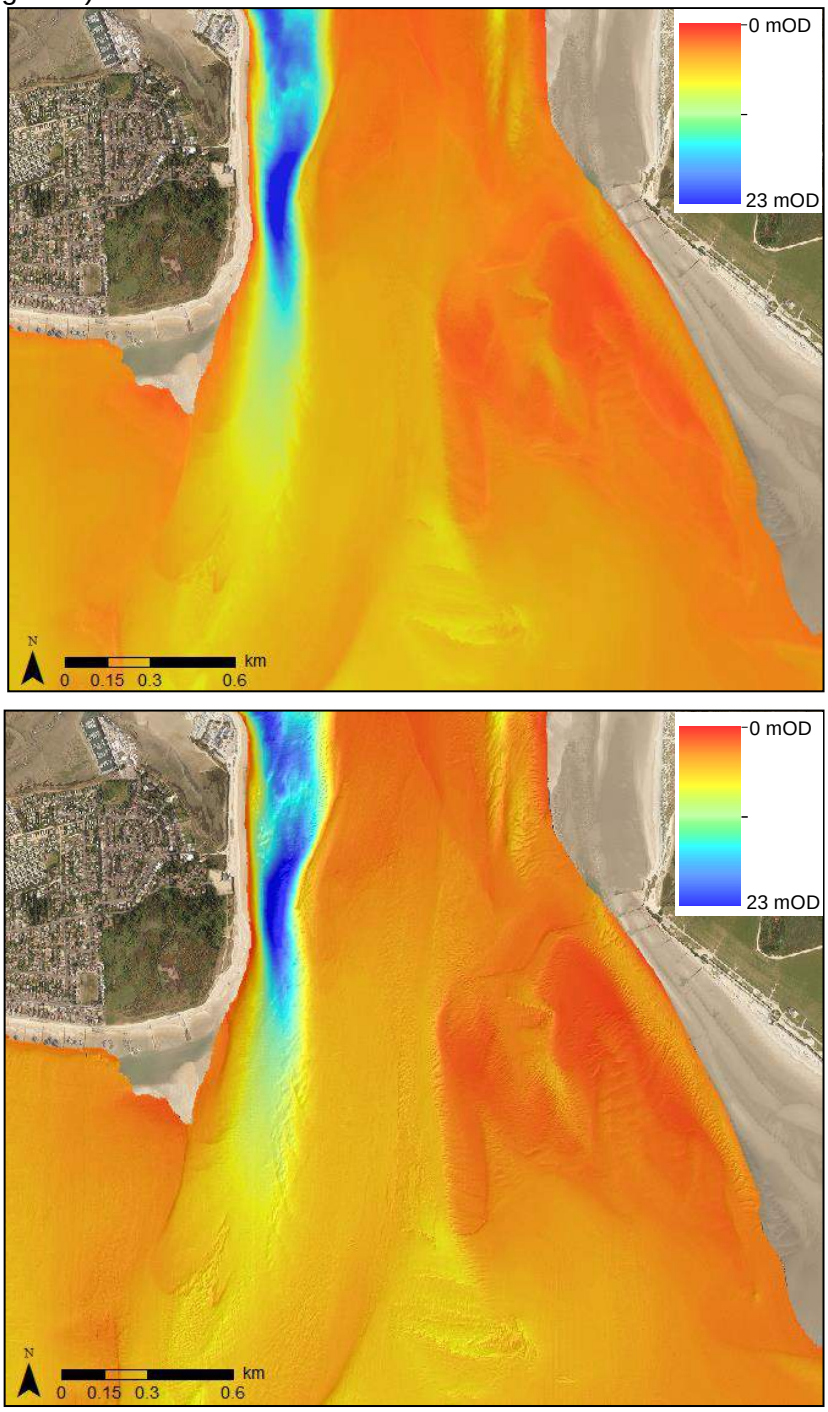


Figure 4: Bathymetry (top); bathymetry plus hillshade (bottom), Chichester Harbour Entrance

Seabed Slope

The seabed slope map distinguishes those areas of the seabed that have a steep gradient or sharp changes in slope from those areas which are relatively flat; this aids the identification of bedrock and geological features, sedimentary bedforms and anthropogenic features (*e.g.* pipelines and channels). The seabed slope is derived within ARCGIS by calculating the slope angle of the seabed by using a central cell and comparing its value to those around it. An extensive rock platform and geological features are clearly shown in Figure 5. The colour scheme used is a classified symbology dividing the slope angles into 9 categories. Green indicates relatively flat or low angle topography, with increasing slope represented by gradation from yellow to orange, and red indicating steepest slope angles.

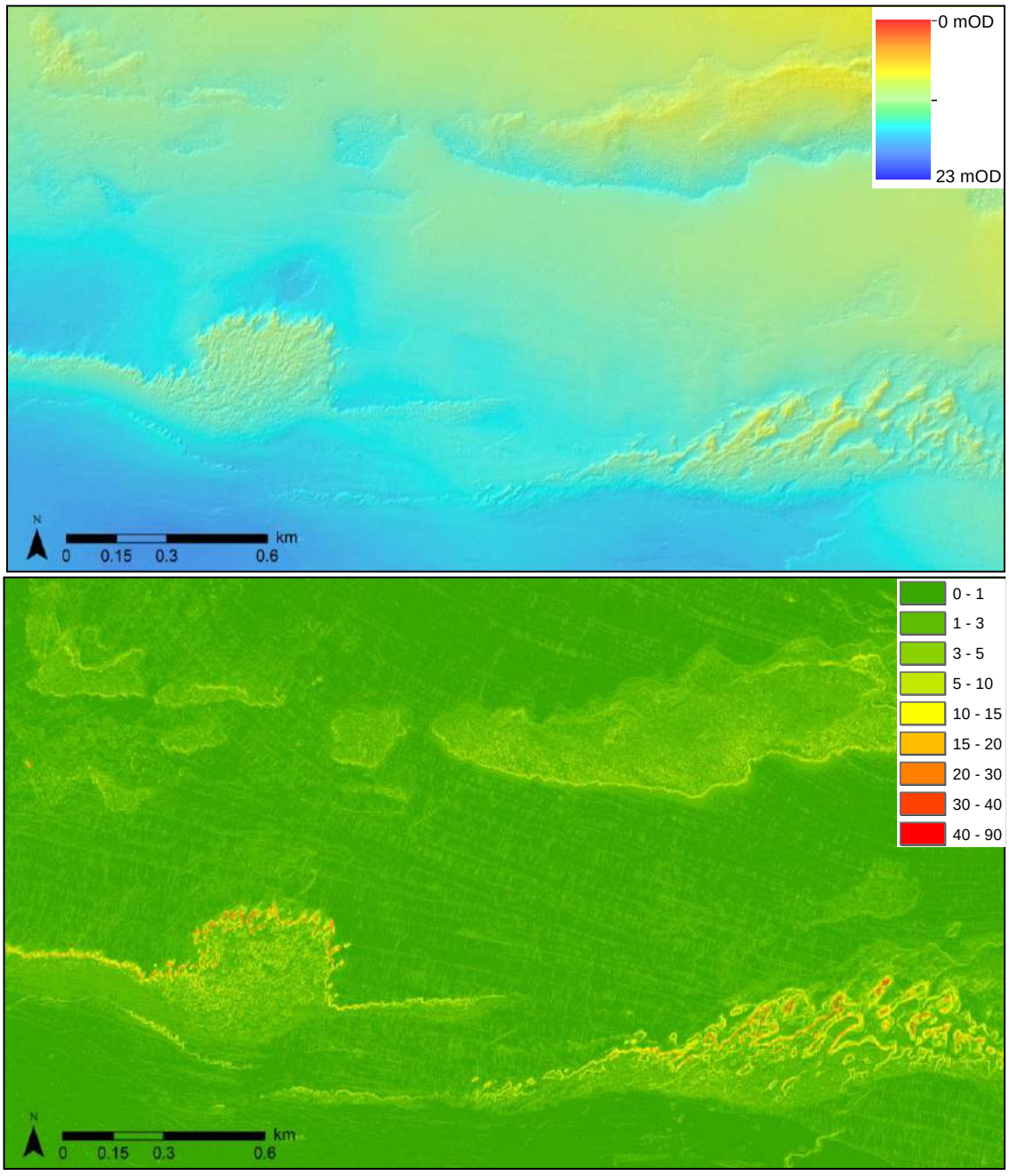


Figure 5: Bathymetry (mOD) (top); Seabed Slope (degrees) (bottom)

Backscatter

The intensity of the return acoustic signal, termed “backscatter”, indicates the nature and relative composition of the seabed, which can provide information on the roughness and texture of the seabed substrate, and variability and changes in sediment type (Figure 6). Backscatter files were delivered by the survey contractor in a post-processed file format with the mosaiced GeoTIFF images combined in ARCGIS to produce a single map.

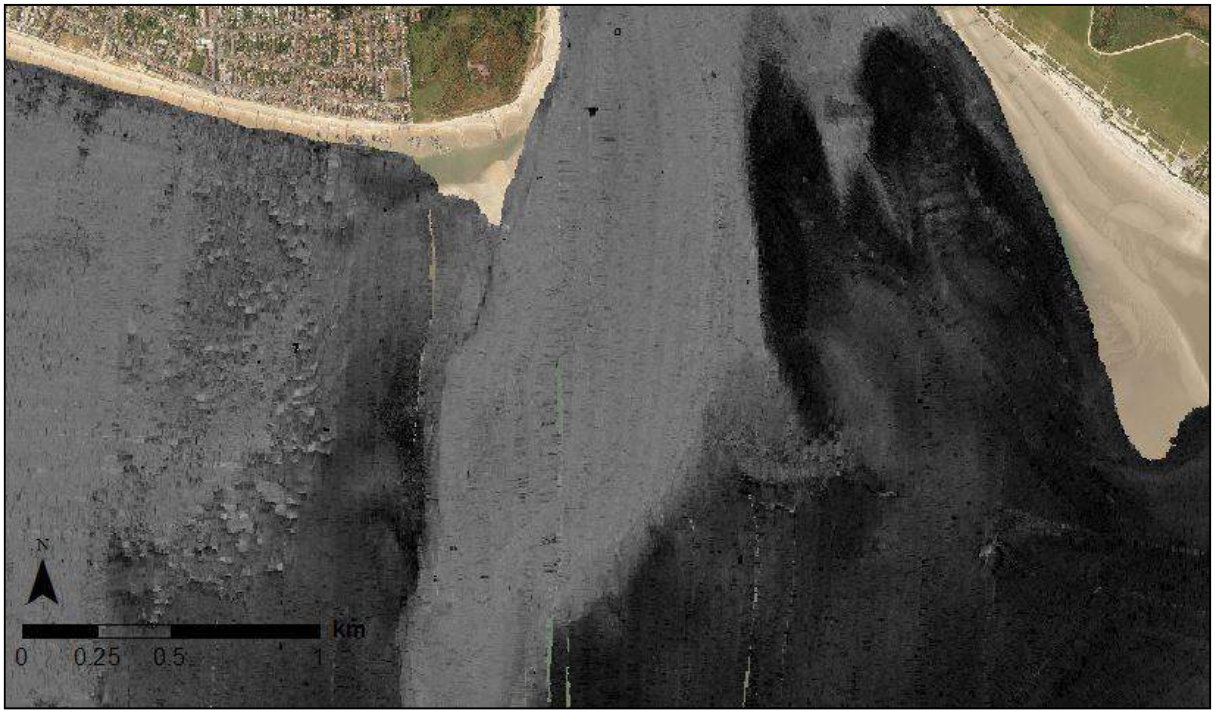


Figure 6: Backscatter, Chichester Harbour Entrance

Many factors can influence backscatter intensity, for example changes in seabed slope or adjustments to survey vessel equipment configurations. It is not simply the case that a given backscatter intensity represents a defined sediment type. The backscatter data layer does not provide information as to what types of sediment the boundaries are showing – for example gravel to sand or sand to mud. To define this substrate type or marine habitat, combined analysis of bathymetry, backscatter and groundtruthing information is required. Backscatter therefore, requires expert analysis and must be viewed in combination with bathymetry and groundtruthing information to give confidence in the resulting substrate and marine habitat maps.

The importance of backscatter for substrate classification and habitat mapping can be seen by the changes in the intensity (grey scale) of the backscatter that are not visible in the bathymetry, as exemplified in Figure 7. Since the backscatter boundaries are observed across numerous survey track lines, it can be concluded that these denote a real change in seabed texture; for example, either constrained pockets of sediment within an area of exposed or outcropping bedrock, or of a different grain-size to the surrounding substrate.

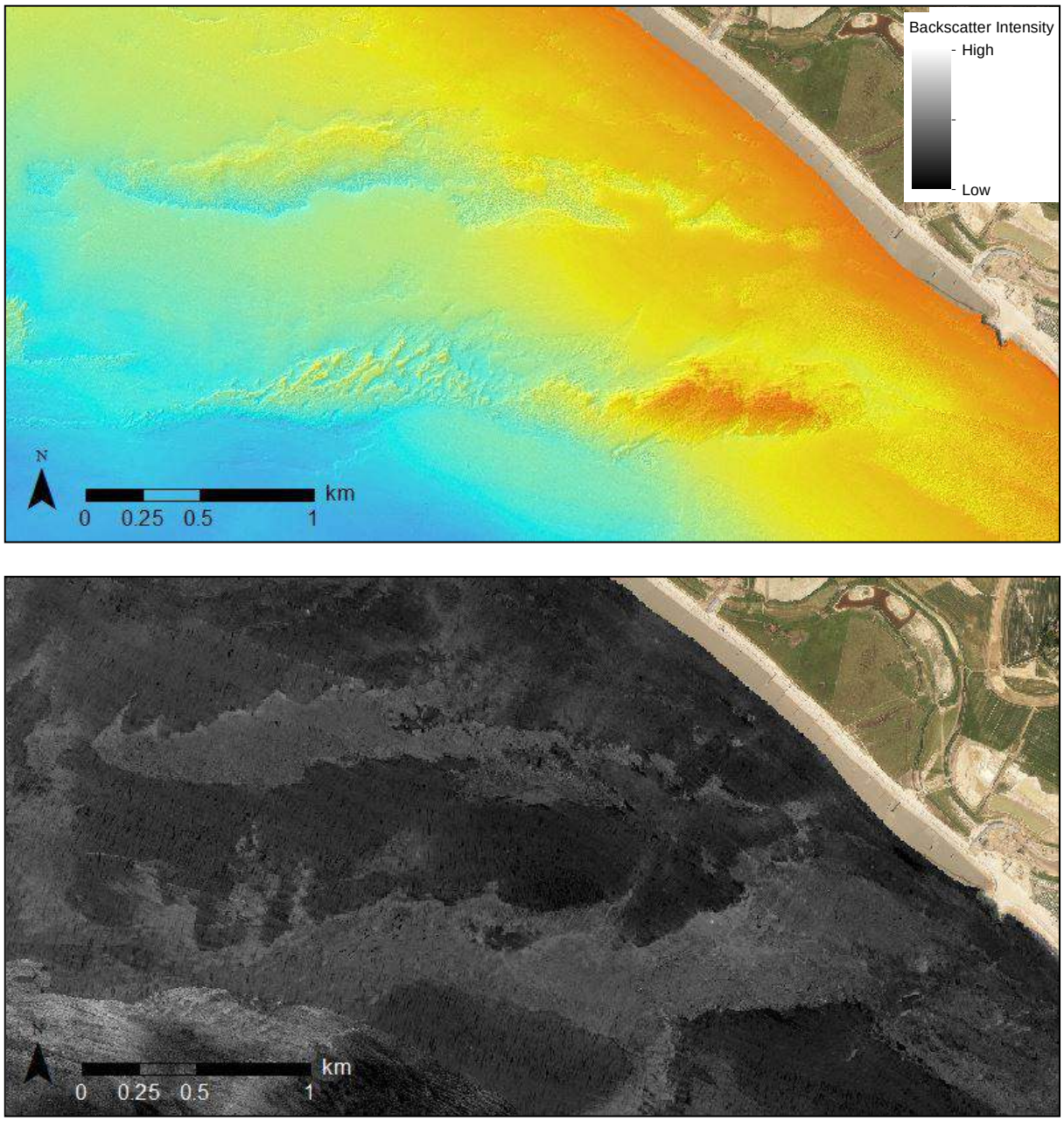


Figure 7: Bathymetry (top) and backscatter (bottom), Bracklesham

Groundtruthing

Groundtruthing data is a key requirement to enable the production of detailed substrate, marine habitat and biotope-type maps. A wide range of information can be useful, such as sediment samples, photographs and videos of seabed and features, topographic beach survey data for inter-tidal areas, nearshore marine geology maps (solid and drift) and visual dive records and observations. Due to the higher resolution of the available bathymetry and backscatter data, the existing nearshore geological maps are not sufficiently detailed to describe fully the outcrops observed. Further investigation and collaboration between the Regional Coastal Monitoring Programmes and the British Geological Survey will continue to revise the nearshore marine geology maps at a number of sites around the UK. Within the Solent, such partnership working will improve the understanding of the outcropping features,

structures and extent of the Upper and Middle Eocene units that comprise of a series of interbedded clays, marls (calcium or lime-rich mud or mudstone) and sand.

Five of the 24 sediment samples taken during the swath bathymetry survey are within the extent of the area of interest. Figure 8 shows some examples of the principal sediment types identified in the survey area.

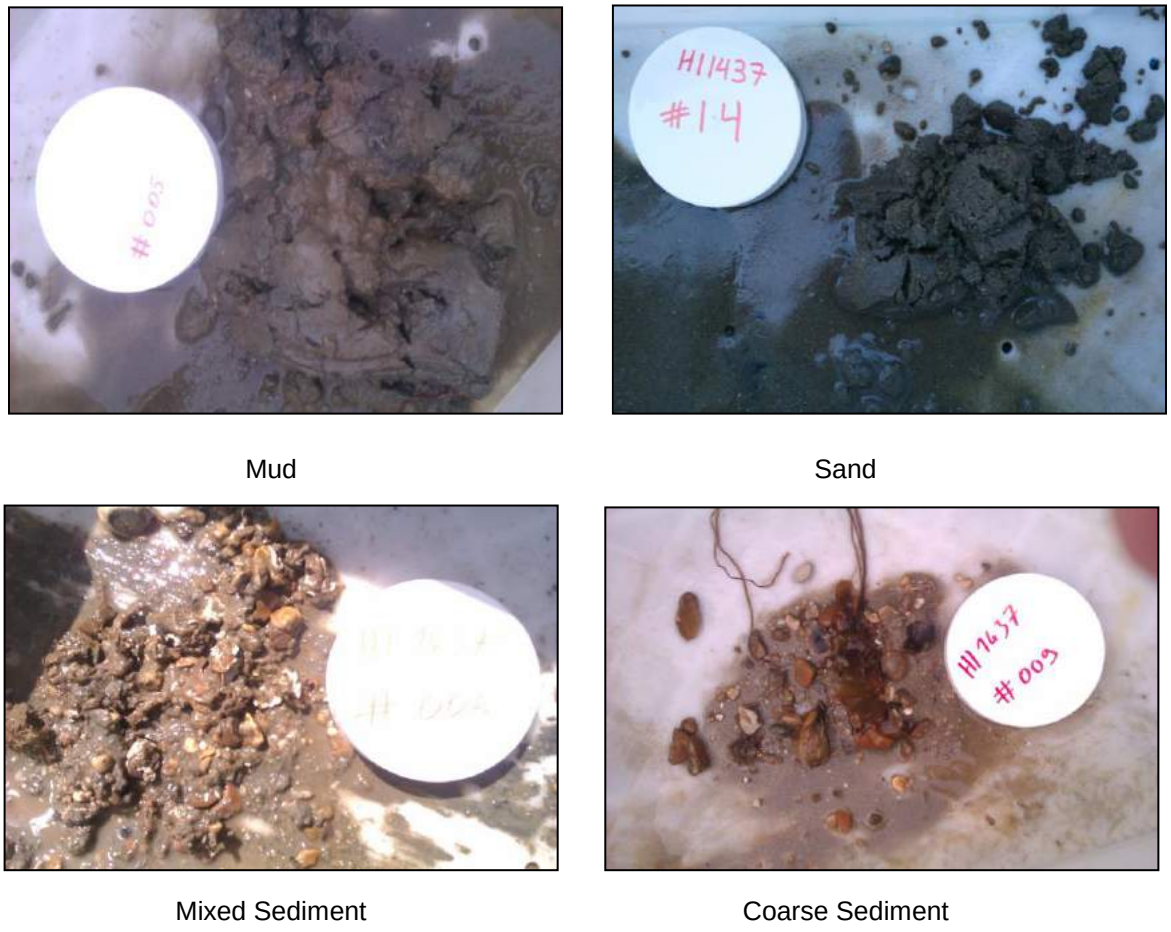


Figure 8: Sediment variation in the nearshore zone

An assessment of sediment volume recovered from each sample also provided an indication of the thickness of sediment. This aided interpretation in areas of seabed where the surface expression of the underlying geology was spatially variable. Further substrate information was kindly provided by Sussex Inshore Fisheries and Conservation Authority (IFCA) and Sussex Seasearch who provided point data with an attached description of the seabed from local divers between 1992 - 2012.

Hydrodynamic Data

To inform the interpretation of the marine habitats within the area of interest information from the Southeast Regional Coastal Monitoring Programme's network of waverider buoys, in particular a Datawell Waverider MKIII buoy, located approximately 3.5km offshore of Selsey, was used to assess the hydrodynamic conditions. Tidal currents were estimated from UKHO Admiralty Chart tidal diamonds. These data were collectively assessed against national indicative criteria to determine the typical hydrodynamic energy conditions within the study area.

Marine Habitat Boundaries

The littoral to sublittoral boundary was created by producing an interpreted Mean Low Water Springs (MLWS) contour through the bathymetry (values ranged across the area of interest between -1.84mOD at Chichester and -2.3mOD at Selsey).

Following a literature review and discussions with Sussex IFCA, academics and local dive clubs, the infralittoral to circalittoral boundary, which is defined by the level of sunlight reaching the seabed, was taken as -10mOD. This contour was determined taking into account the boundary in neighbouring frontages that have been previously mapped and using the Secchi disk depths measured during bathymetric data acquisition.

Substrate Map

A substrate map was derived by removing the depth boundaries and the 'Rock and thin Sediment' category. Where the seabed was categorised as 'Rock and thin Sediment' it was re-classified to reflect the surficial sediment type of the thin veneer of sediment overlying the rock. The example shown in Figure 9 indicates areas of bedrock and variations in broad sediment types.

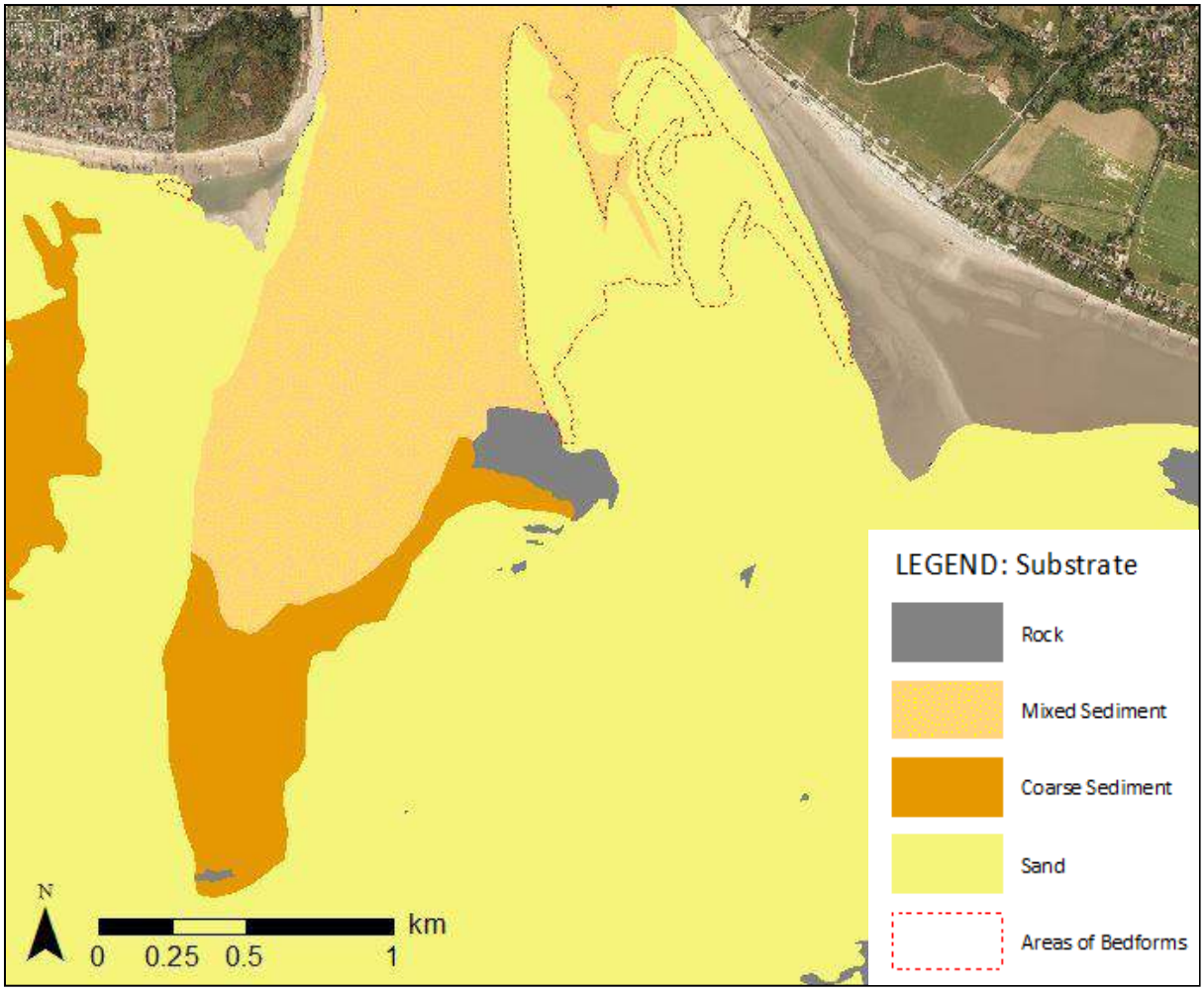


Figure 9: Substrate mapping, Chichester harbour entrance

Anthropogenic Features

A number of anthropogenic features were identified in the area of interest, including coastal defences and a total of 10 wrecks (Figure 10).

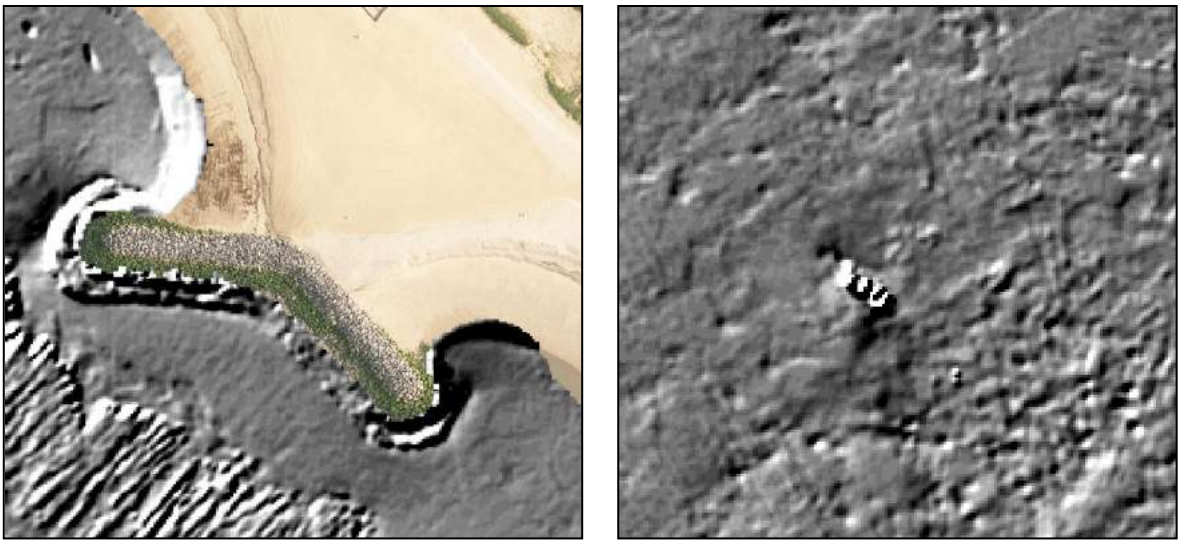


Figure 10: Anthropogenic features
Left - Sea defence (Bunn Leisure, Selsey): Right - a wreck

Confidence

The MESH confidence assessment tool was used to determine confidence levels in the acquired remote sensing data, groundtruthing data and the interpreted mapping and data products, so that end-users can determine their adequacy for decision-making (see http://www.emodnet-seabedhabitats.eu/confidence/confidenceAssessment.html)

Bathymetric data collected in accordance with and achieving compliance with the MCA Civil Hydrography Programme Specification generally produces a high confidence level due to the 100% seafloor coverage and vertical and horizontal positional accuracies. The Confidence Assessment for the marine habitat mapping produced for the East Solent survey was 86, indicating a high level of confidence in the remote sensing data acquisition, groundtruthing available and interpretation of the various datasets to generate the series of maps and datasets. The full results of the confidence assessment can be found in Annex 1.

Seabed Mapping Results

All swath bathymetry data collected through the Southeast Regional Coastal Monitoring Programme are freely available, under Open Government Licence from www.channelcoast.org either as text, ascii or SD (Fledermaus) files. The EUNIS Level 3 Marine Habitat map and Substrate Type map are also available for viewing and download as shapefiles. Summary maps of:

- Bathymetry
- Backscatter
- EUNIS level 3 marine habitat
- Substrate
- Seabed slope
- Anthropogenic features

have been prepared for the following sections of coastline:

- Selsey to Eastoke
- Western Extent (East Wittering to Eastoke)
- Eastern Extent (Selsey to East Wittering)

An overview of the bathymetric features observed is provided for each geographic area. The surveyed area was found to contain a wide range of substrate and habitat types.

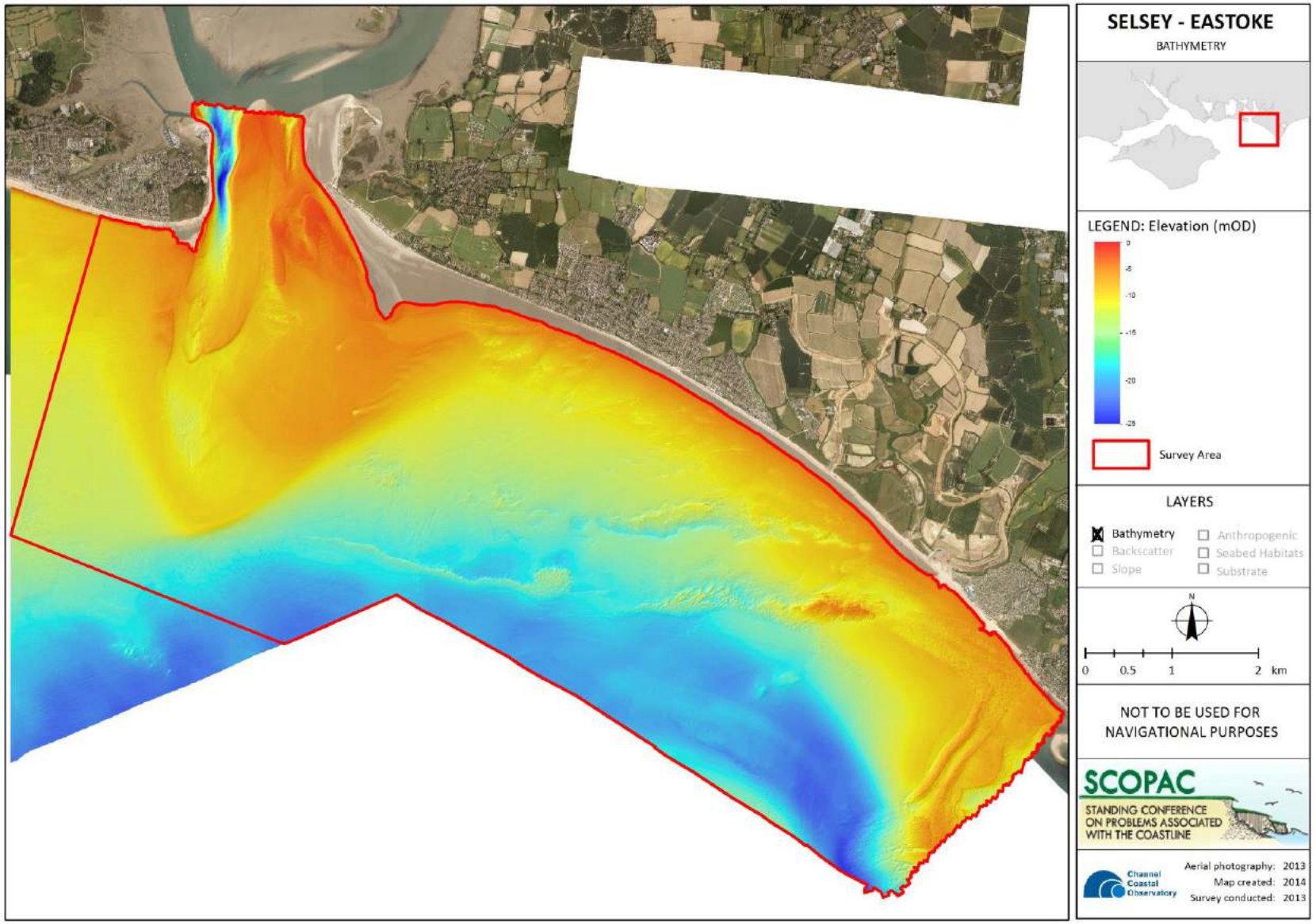
Selsey to Eastoke

The seabed comprises predominately gently sloping sediments, with areas of exposed rock outcrops in the east of the survey area. The majority of the seabed is situated in water depths shallower than -10mOD; depths gradually increase offshore to a depth of -15mOD at the survey boundary. The Chichester harbour entrance channel has a maximum depth of approximately -23mOD.

Analysis indicates that the majority of the seabed sediment is comprised of homogenous sand, with areas of mixed sediment in the Chichester Harbour channel, ebb delta deposits, and in the deeper basin offshore of Selsey, and coarse sediments at the southern end of the harbour channel, the central southern offshore area and the western margin of the study area. Despite the relatively extensive areas of sediment, the study area is comparatively sparse in terms of bedforms. However, localised areas of bedforms have been identified, generally in association with steeper slopes, such as the banks of the harbour channel, and adjacent to or within the intertidal zone, on the flanks of the sand bars in Chichester harbour entrance.

Significant outcrops of compacted clay or marl mudstone bedrock are evident extending westwards and south-south-westwards offshore of Selsey, with isolated outcrops south of the harbour channel and closer to the shore off West Wittering. Throughout the eastern half of the study area the surficial sediment is generally of insufficient thickness to mask the underlying bedrock, and comprises relatively constrained pockets of mixed sediments and sand. There are localised constrained areas of bedforms located within pockets of sediment offshore of Selsey that may reflect the higher tidal current velocities, and the interaction with the surrounding rock outcrops.

The Eastern Solent is relatively sheltered from southwesterly waves from the English Channel as it is afforded some protection by the Isle of Wight. Average wave climate conditions for the study area, as indicated from analysis of wave and tidal stream data, has resulted in this area being classified as a relatively low energy environment, compared to high energy locations such as western Scotland, or medium energy sites such as Chesil. In 2013, for all months apart from December, the average significant wave height measured from the Bracklesham Bay waverider buoy was less than 1 metre, predominantly from the southwest (190-215 degrees).


SELSEY - EASTOKE
BATHYMETRY
LEGEND: Elevation (mOD)
0
-5
-10
-15
-20
-25
Survey Area
LAYERS
Bathymetry
Backscatter
Slope
Anthropogenic
Seabed Habitats
Substrate
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NOT TO BE USED FOR NAVIGATIONAL PURPOSES
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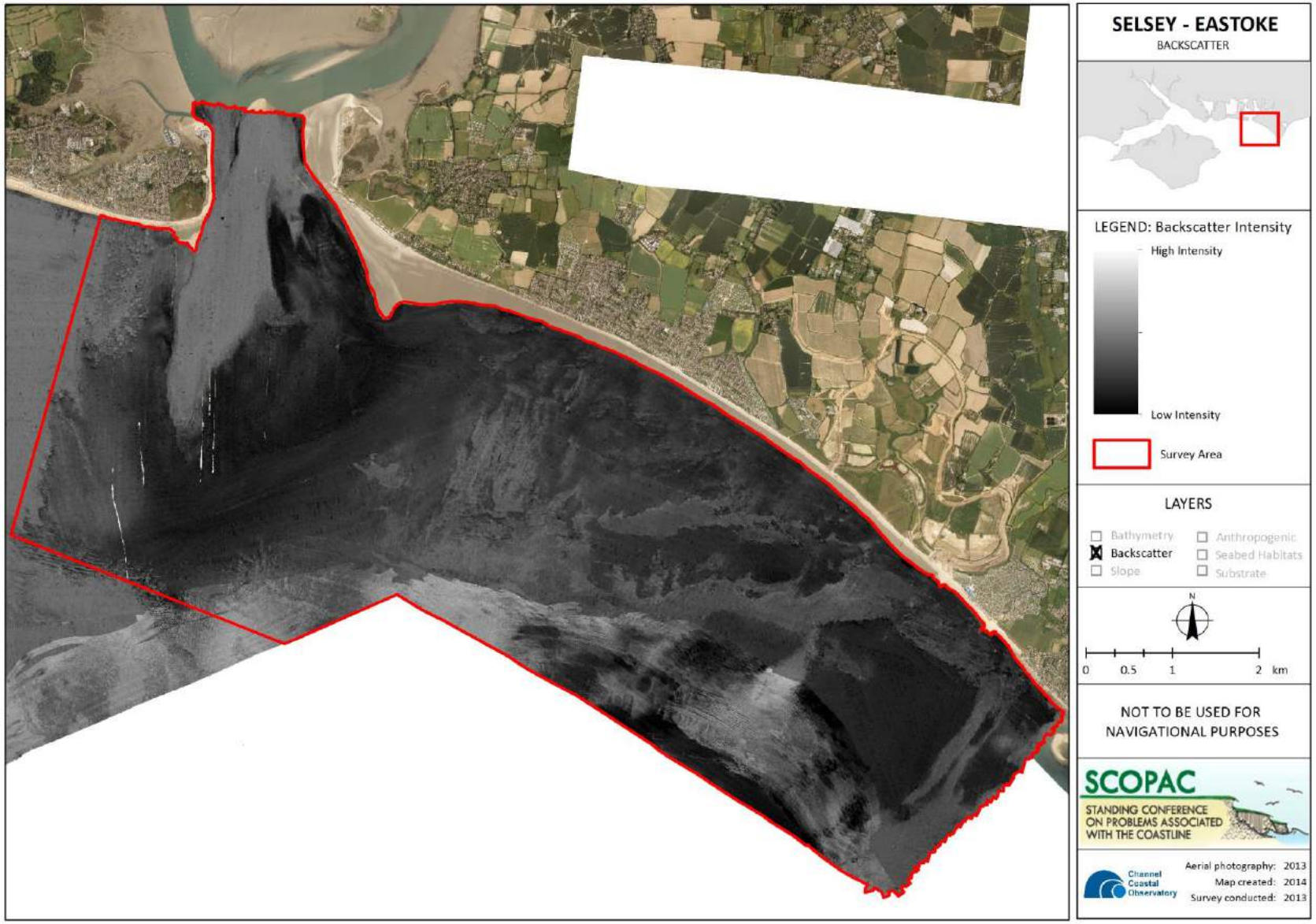
STANDING CONFERENCE ON PROBLEMS ASSOCIATED WITH THE COASTLINE
Channel Coastal Observatory
Aerial photography: 2013
Map created: 2014
Survey conducted: 2013


SELSEY - EASTOKE
BACKSCATTER
LEGEND: Backscatter Intensity
High Intensity
Low Intensity
Survey Area
LAYERS
Bathymetry
Backscatter
Slope
Anthropogenic
Seabed Habitats
Substrate
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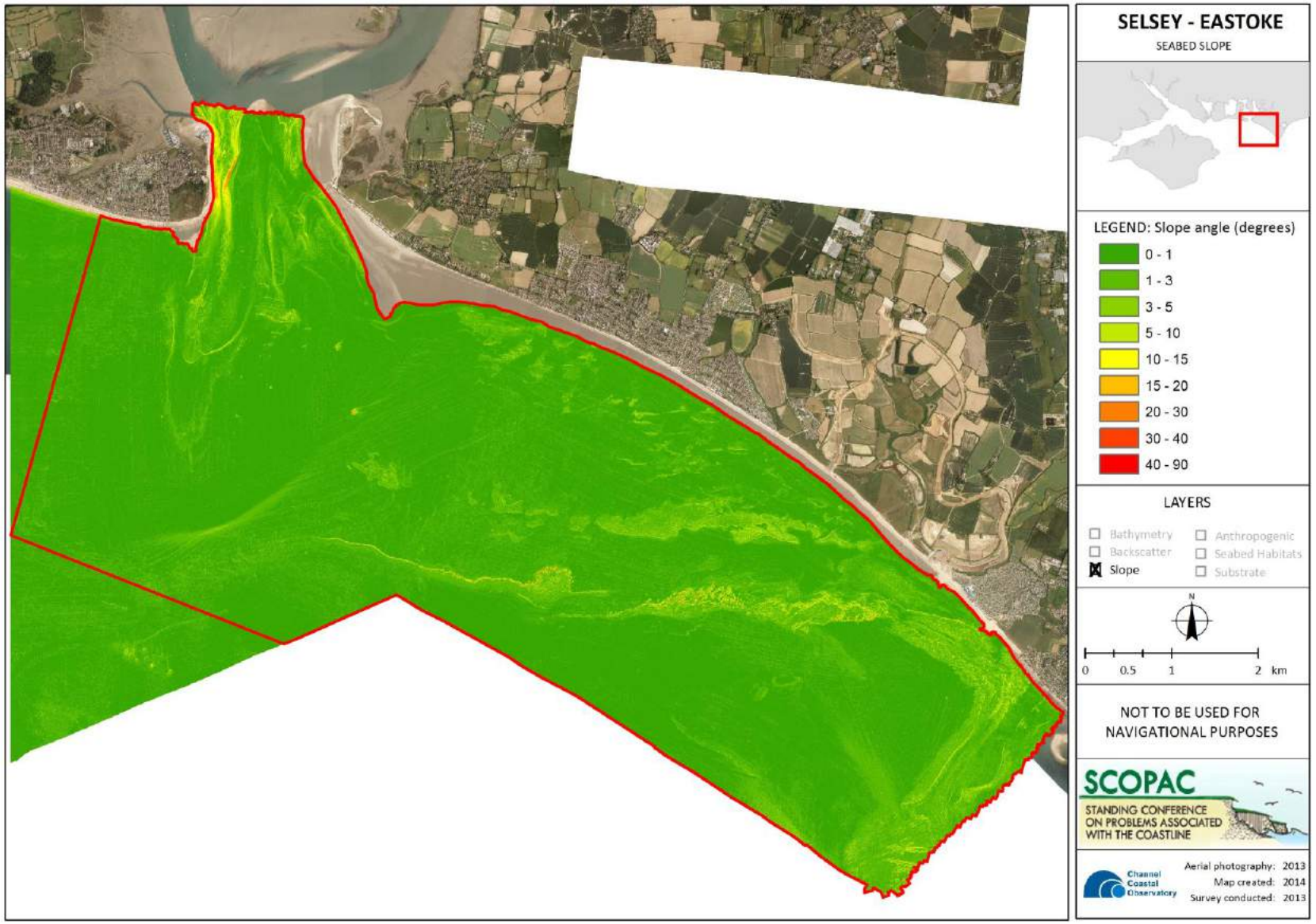
SELSEY - EASTOKE
SEABED SLOPE
LEGEND: Slope angle (degrees)
0 - 1
1 - 3
3 - 5
5 - 10
10 - 15
15 - 20
20 - 30
30 - 40
40 - 90
LAYERS
Bathymetry
Backscatter
Slope
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Seabed Habitats
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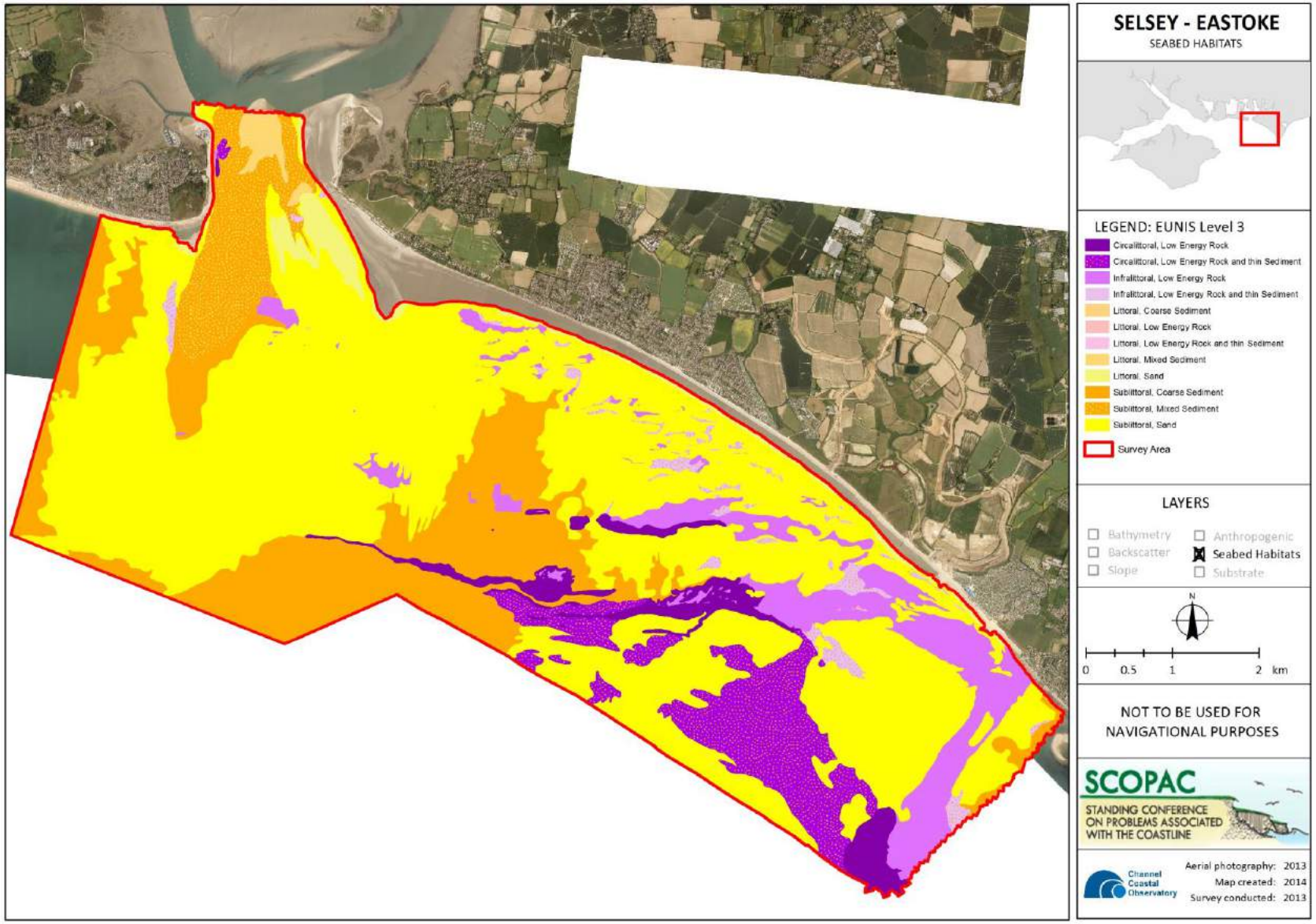
SELSEY - EASTOKE
SEABED HABITATS
LEGEND: EUNIS Level 3
Circalittoral, Low Energy Rock
Circalittoral, Low Energy Rock and thin Sediment
Infralittoral, Low Energy Rock
Infralittoral, Low Energy Rock and thin Sediment
Littoral, Coarse Sediment
Littoral, Low Energy Rock
Littoral, Low Energy Rock and thin Sediment
Littoral, Mixed Sediment
Littoral, Sand
Sublittoral, Coarse Sediment
Sublittoral, Mixed Sediment
Sublittoral, Sand
Survey Area
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Backscatter
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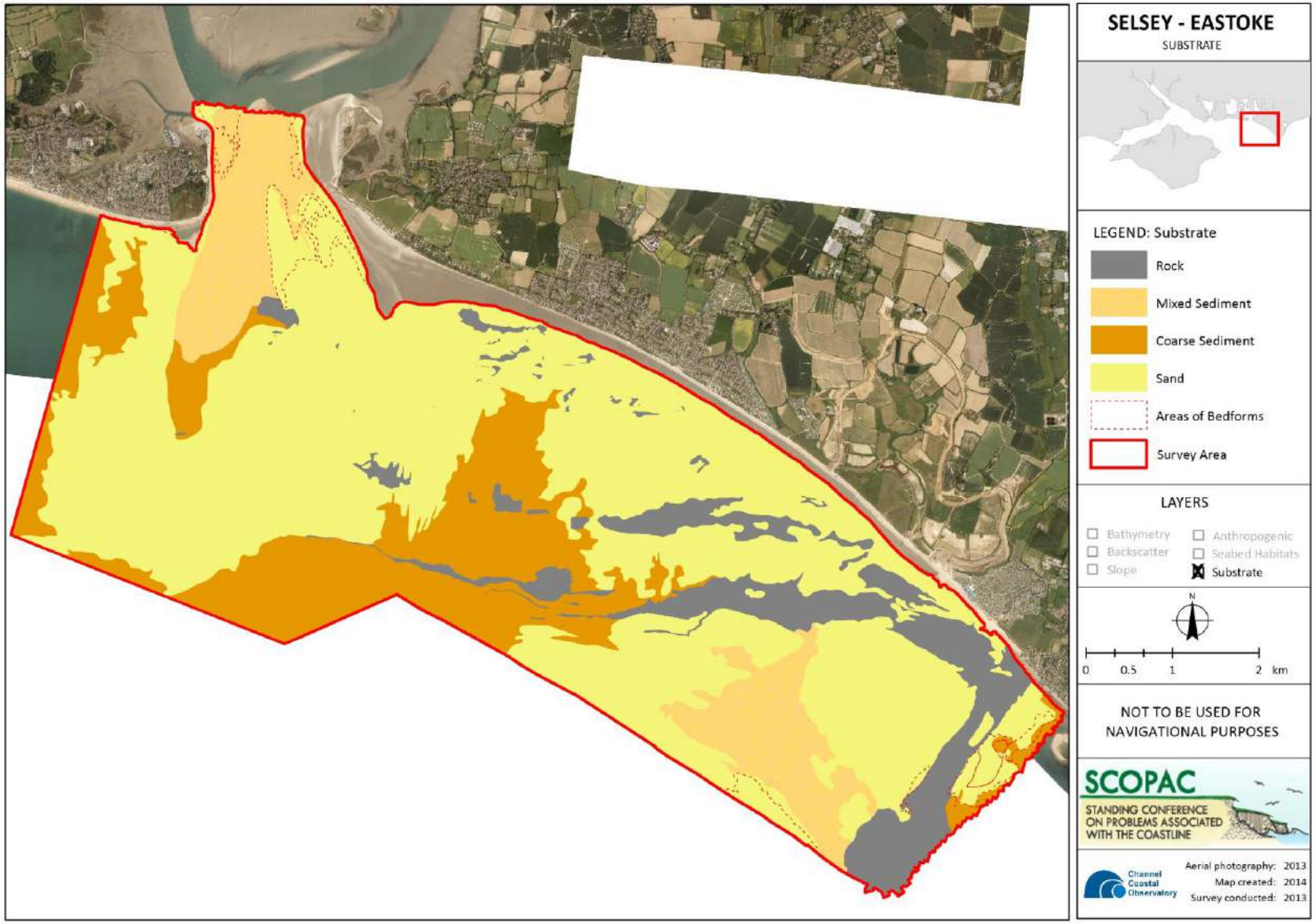
SELSEY - EASTOKE
SUBSTRATE
LEGEND: Substrate
Rock
Mixed Sediment
Coarse Sediment
Sand
Areas of Bedforms
Survey Area
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Bathymetry
Backscatter
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Map created: 2014
Survey conducted: 2013


SELSEY - EASTOKE
ANTHRPOGENIC AND GROUNDTRUTHING
LEGEND: Groundtruthing Points
Wave Buoy
Wrecks
Sediment Sample
Seasearch Point
Other Groundtruthing Point
Survey Area
LAYERS
Bathymetry
Backscatter
Slope
Anthropogenic
Seabed Habitats
Substrate
N
0 0.5 1 2 km
NOT TO BE USED FOR NAVIGATIONAL PURPOSES
SCOPAC
STANDING CONFERENCE ON PROBLEMS ASSOCIATED WITH THE COASTLINE
Channel Coastal Observatory
Aerial photography: 2013
Map created: 2014
Survey conducted: 2013

Western Extent (East Wittering to Eastoke)

The most prominent bathymetric features of the western section are the entrance to Chichester Harbour and the ebb delta. The narrow, steep sided channel, as shown in Figure 11 and displayed above in Figure 4, is relatively constrained, with the deepest section (below -20mOD) extending approximately 200m southwards, where it then rises relatively steeply to shallower than -6mOD, demarking the western margin of the ebb delta deposits, as shown in Figure 12. Bedrock is exposed in the base of the channel's deepest section.

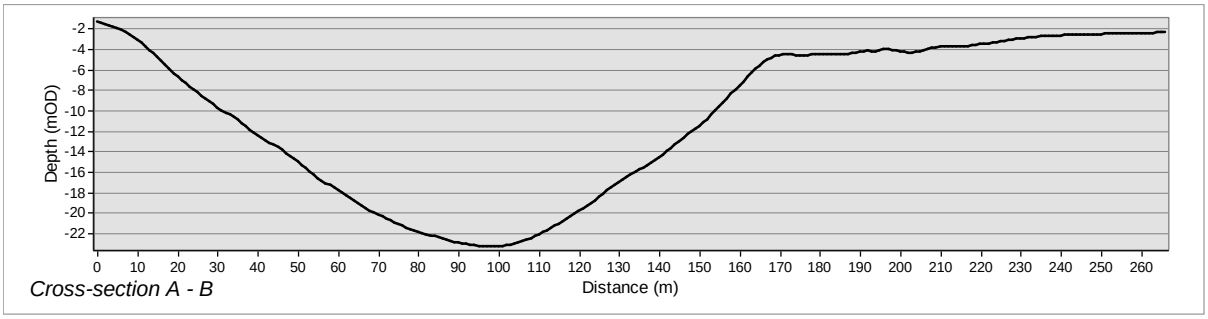


Figure 11: Cross-section A – B. Chichester Harbour cross-channel cross-section (east-west)

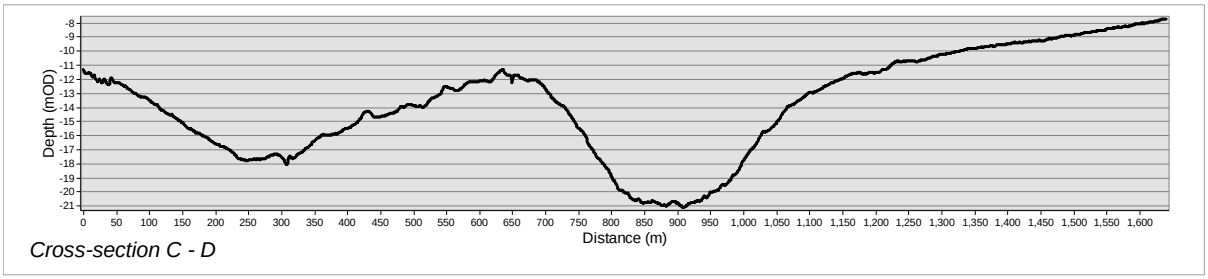


Figure 12: Cross-section C – D. Chichester Harbour along-channel cross-section (north-south)

To the east of the deep channel, the remainder of the harbour entrance comprises complex, shallow bars consisting of mixed sediment and sand. The ebb delta that extends south from the harbour entrance is principally comprised of mixed sediment. There are sands on the eastern flanks of the harbour mouth, with islands and bars overlying the mixed sediment that are exposed at low tides; coarse grained sediments are evident at the southern extent of the ebb delta. The southern end of the ebb delta is marked by a steep slope, which drops 2.5m over approximately 50m (Figure 13). Isolated rock outcrops are also discernible on the southeastern and southern margin of the ebb delta, which may control the morphology and extent of the harbour mouth sediments.

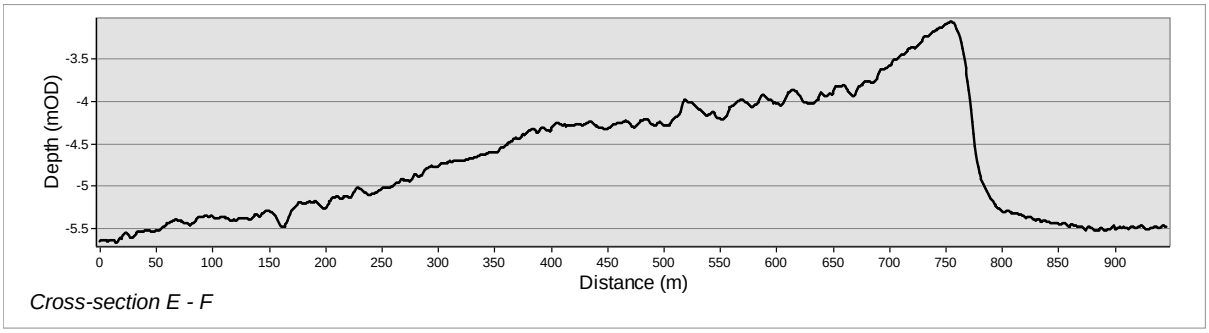
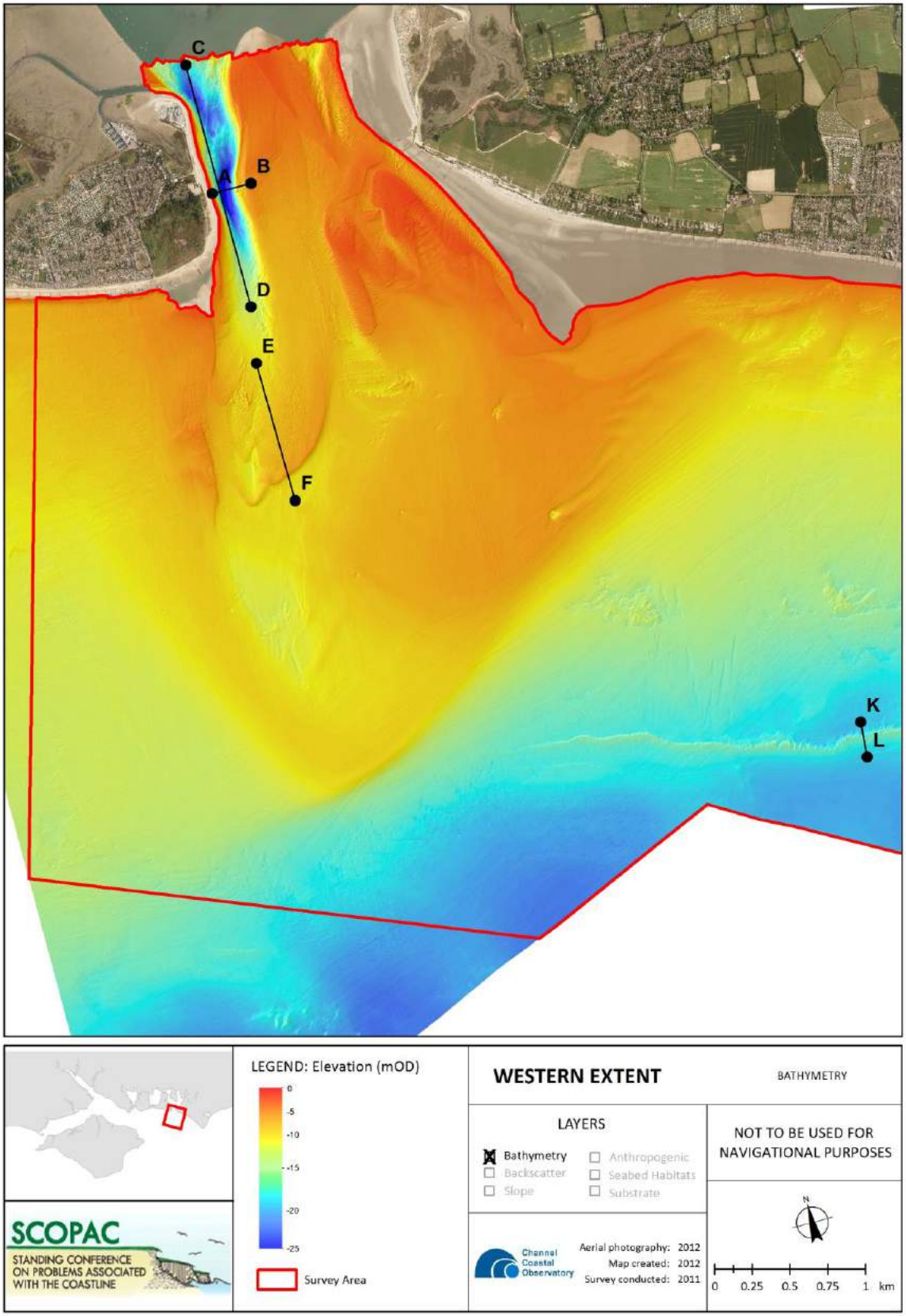
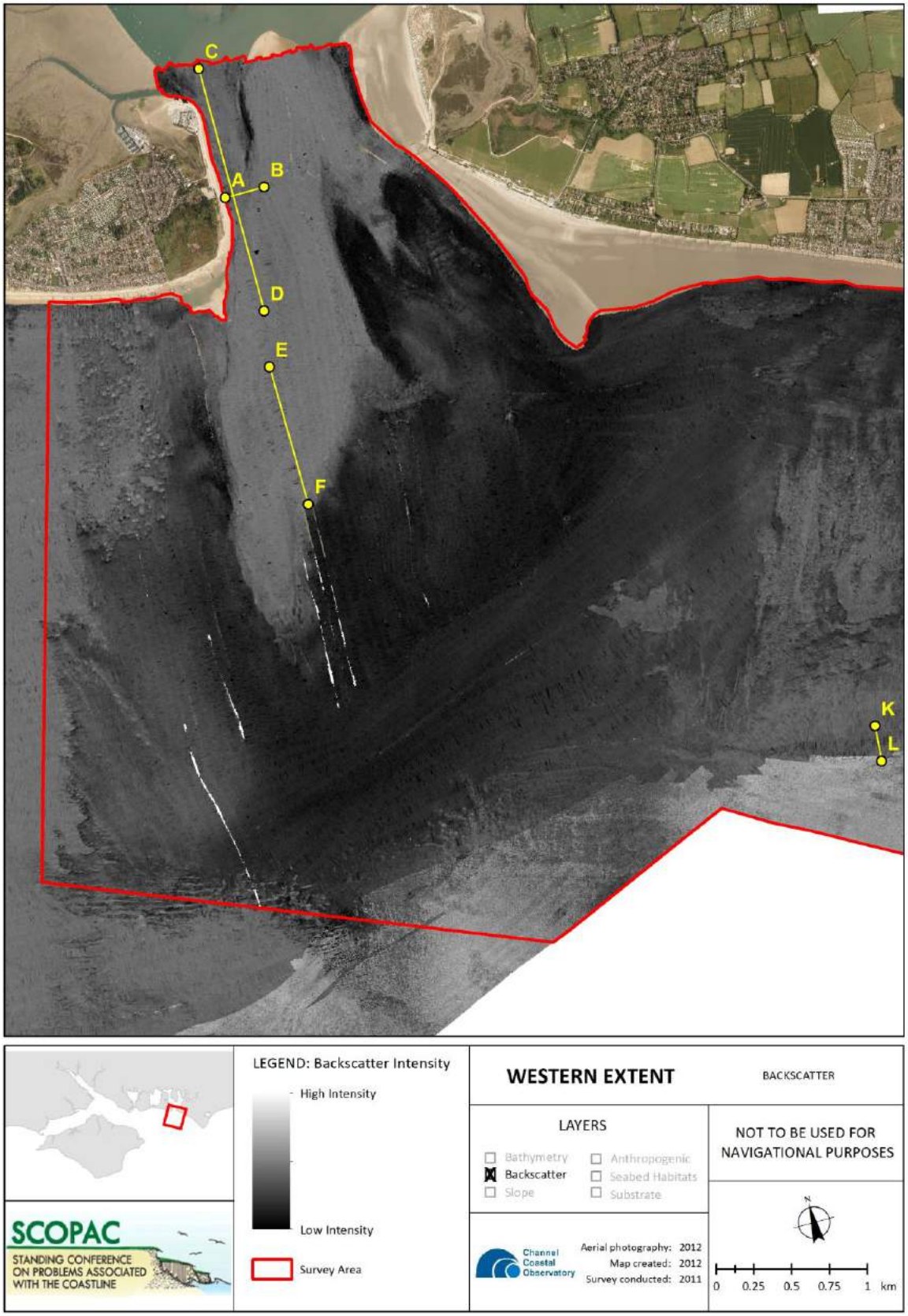
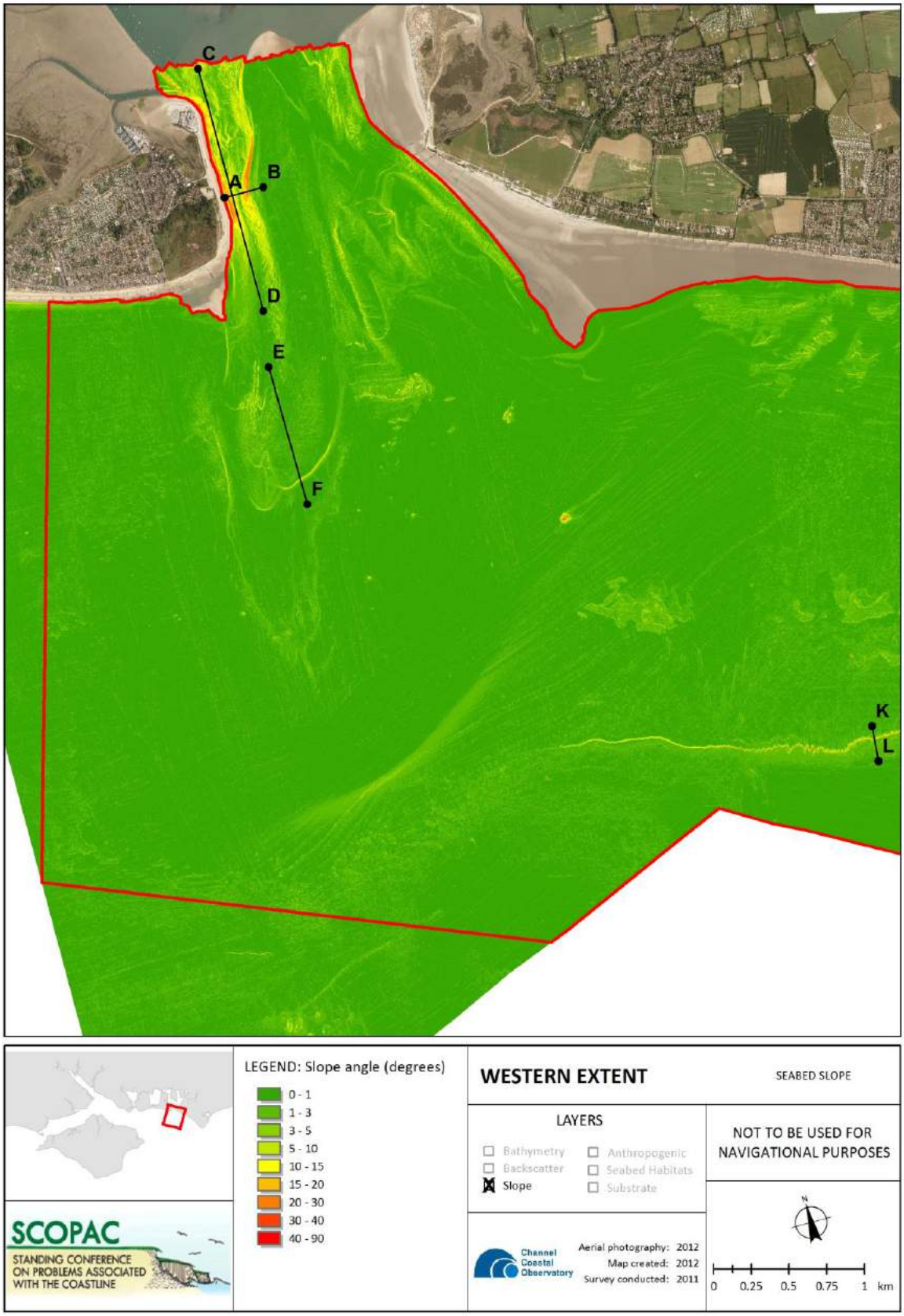
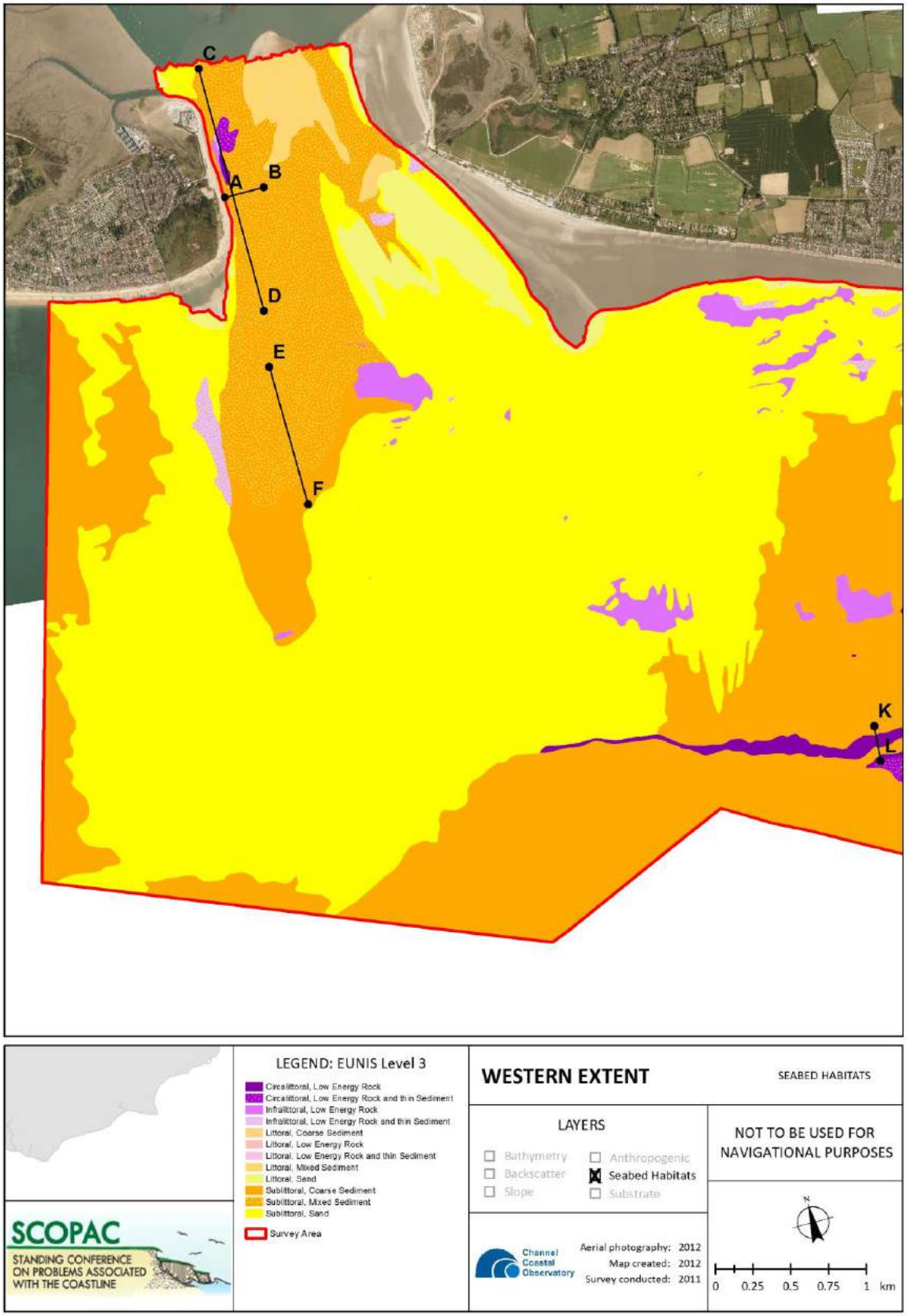


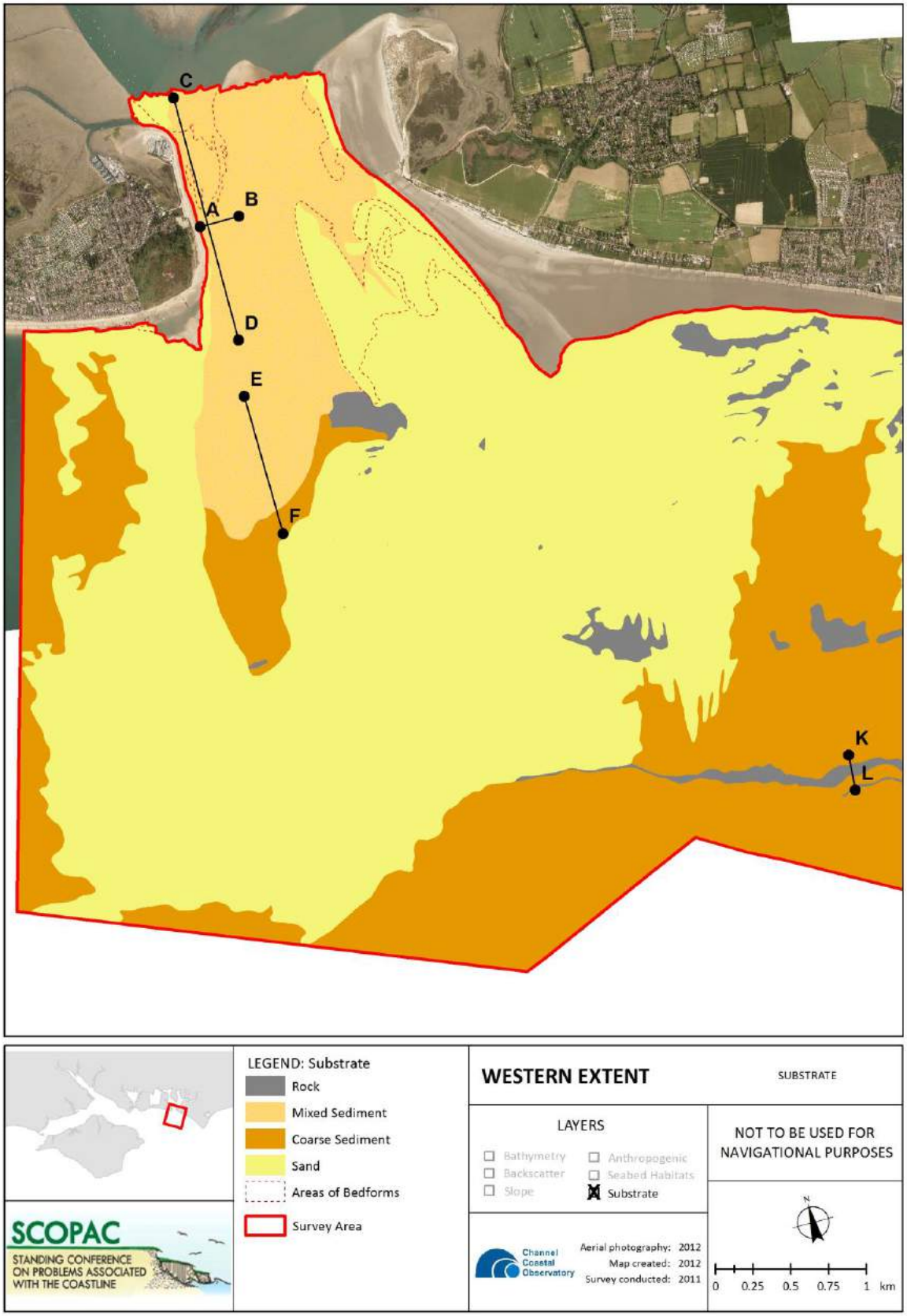
Figure 13: Cross-section E – F. Chichester Harbour ebb delta (north-south)


C
A
B
D
E
F
K
L
LEGEND: Elevation (mOD)
0
-5
-10
-15
-20
-25
Survey Area
WESTERN EXTENT
BATHYMETRY
LAYERS
Bathymetry
Backscatter
Slope
Anthropogenic
Seabed Habitats
Substrate
NOT TO BE USED FOR NAVIGATIONAL PURPOSES
Channel Coastal Observatory
Aerial photography: 2012
Map created: 2012
Survey conducted: 2011
N
0 0.25 0.5 0.75 1 km
SCOPAC
STANDING CONFERENCE ON PROBLEMS ASSOCIATED WITH THE COASTLINE


C
A
B
D
E
F
K
L
LEGEND: Backscatter Intensity
High Intensity
Low Intensity
Survey Area
WESTERN EXTENT
BACKSCATTER
LAYERS
Bathymetry
Backscatter
Slope
Anthropogenic
Seabed Habitats
Substrate
NOT TO BE USED FOR NAVIGATIONAL PURPOSES
Channel Coastal Observatory
Aerial photography: 2012
Map created: 2012
Survey conducted: 2011
N
0 0.25 0.5 0.75 1 km
SCOPAC
STANDING CONFERENCE ON PROBLEMS ASSOCIATED WITH THE COASTLINE


C
A
B
D
E
F
K
L
LEGEND: Slope angle (degrees)
0 - 1
1 - 3
3 - 5
5 - 10
10 - 15
15 - 20
20 - 30
30 - 40
40 - 90
WESTERN EXTENT
SEABED SLOPE
LAYERS
Bathymetry
Backscatter
Slope
Anthropogenic
Seabed Habitats
Substrate
NOT TO BE USED FOR NAVIGATIONAL PURPOSES
SCOPAC
STANDING CONFERENCE ON PROBLEMS ASSOCIATED WITH THE COASTLINE
Channel Coastal Observatory
Aerial photography: 2012
Map created: 2012
Survey conducted: 2011
0 0.25 0.5 0.75 1 km


C
A
B
D
E
F
K
L
LEGEND: EUNIS Level 3
Circalittoral, Low Energy Rock
Circalittoral, Low Energy Rock and thin Sediment
Infralittoral, Low Energy Rock
Infralittoral, Low Energy Rock and thin Sediment
Littoral, Coarse Sediment
Littoral, Low Energy Rock
Littoral, Low Energy Rock and thin Sediment
Littoral, Mixed Sediment
Littoral, Sand
Sublittoral, Coarse Sediment
Sublittoral, Mixed Sediment
Sublittoral, Sand
Survey Area
WESTERN EXTENT
SEABED HABITATS
LAYERS
Bathymetry
Backscatter
Slope
Anthropogenic
Seabed Habitats
Substrate
NOT TO BE USED FOR NAVIGATIONAL PURPOSES
SCOPAC
STANDING CONFERENCE ON PROBLEMS ASSOCIATED WITH THE COASTLINE
Channel Coastal Observatory
Aerial photography: 2012
Map created: 2012
Survey conducted: 2011
N
0 0.25 0.5 0.75 1 km


C
A
B
D
E
F
K
L
LEGEND: Substrate
Rock
Mixed Sediment
Coarse Sediment
Sand
Areas of Bedforms
Survey Area
SCOPAC
STANDING CONFERENCE ON PROBLEMS ASSOCIATED WITH THE COASTLINE
WESTERN EXTENT
SUBSTRATE
LAYERS
Bathymetry
Backscatter
Slope
Anthropogenic
Seabed Habitats
Substrate
NOT TO BE USED FOR NAVIGATIONAL PURPOSES
Channel Coastal Observatory
Aerial photography: 2012
Map created: 2012
Survey conducted: 2011
N
0 0.25 0.5 0.75 1 km

Eastern Extent (Selsey to East Wittering)

The depth range in the eastern section of the survey area is less variable, gently sloping from approximately -2mOD down to -15mOD at the seaward limit; there is however, a greater diversity of seabed features and habitats. The seabed sediments are generally dominated by sand. A significant area of coarse sediment is also evident offshore of East Wittering, present in a slight depression, 0.5m lower than the surrounding seabed. Evidence from groudtruthing suggests that the exposed rock outcrops and ridges and areas of rock and thin sediment nearshore, are likely to be exposed clay or marl mudstone bedrock units from the Bracklesham or Barton Beds. A variety of such rock outcrops have been identified in Figure 14.

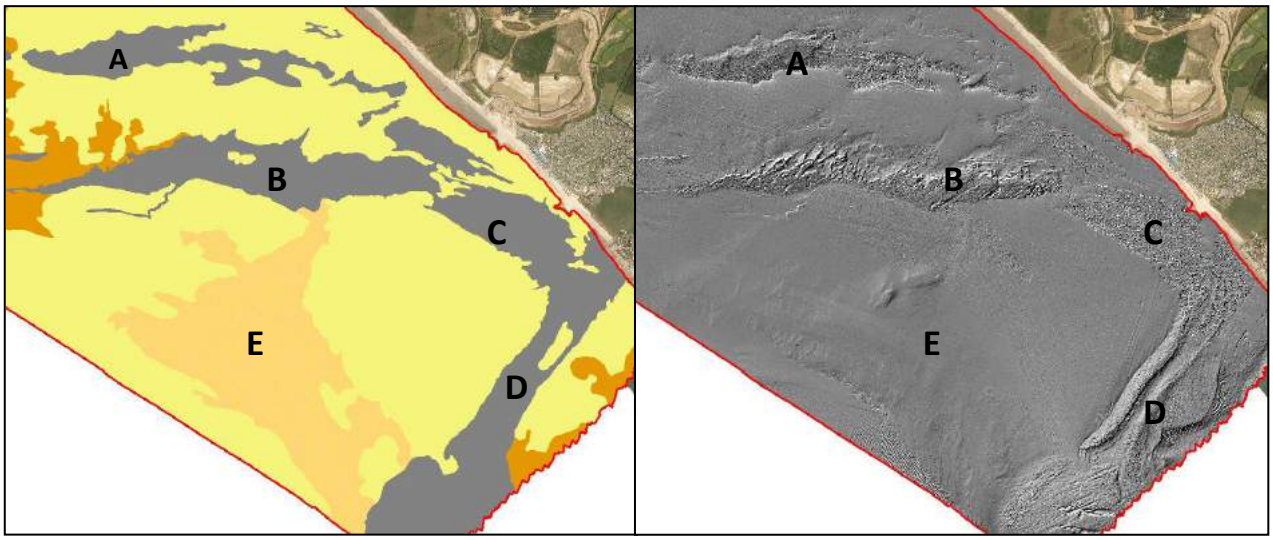


Figure 14: Rock outcrops – Selsey to East Wittering

Rock Outcrop A

The groundtruthing indicates that 'Rock outcrop A' comprises of cobbles and boulders (measured examples ranged from 0.20 – 0.50m in diameter) resting on the exposed surface and northern flank of the underlying hard compact mud or marl mudstone bedrock ridge, which slopes downwards into a slight depression in the seabed. The seabed topography for this location is shown in Figure 15.

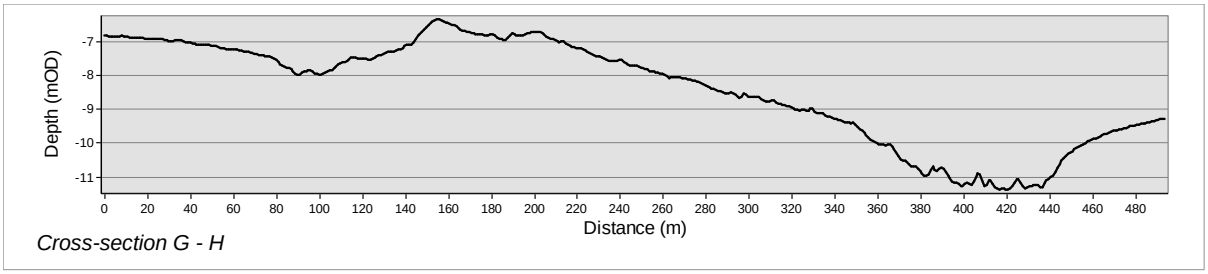


Figure 15: Cross-section G – H. Rock Outcrop A (north-south)

Rock Outcrop B

Groundtruthing indicates that this prominent east-west trending rock outcrop ridge is composed of hard compact mud or marl mudstone bedrock. The outcrop is largely exposed but as it extends further to the west, the ridge narrows and is increasingly covered and masked by sediment. The rocky outcrop is steep sided and rises up to 4m above the seabed

at cross-section I - J (Figure 16). As it continues west and the seabed depth increases it becomes less prominent above the seabed but maintains the steep northern face and rises approx. 2m above the surrounding seabed over a length of approx. 30m as seen in cross-section K - L (Figure 17).

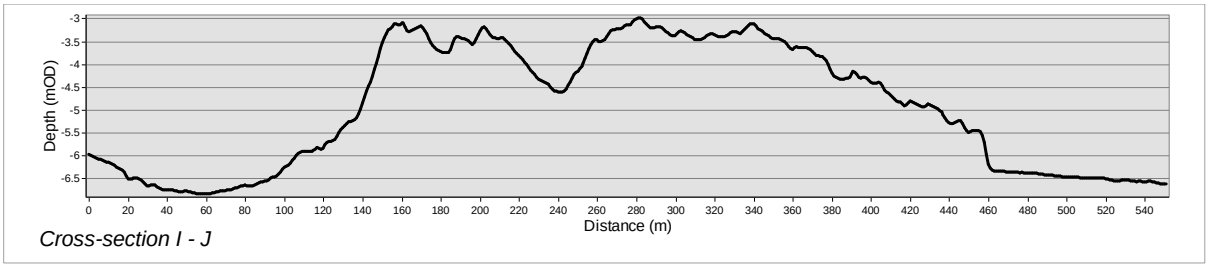


Figure 16: Cross-section I – J. Rock Outcrop B

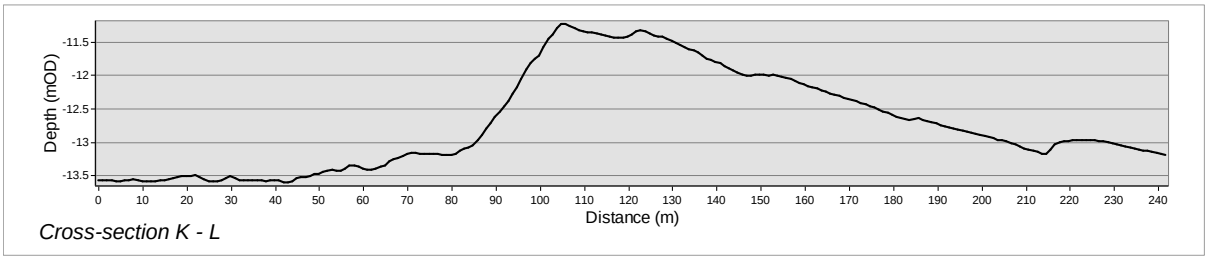


Figure 17: Cross-section K – L. Rock Outcrop B

Rock Outcrop C

The extensive eroded shore-parallel outcrops found closer to shore, offshore of Selsey, are considered to be hard compact mud or marl mudstone bedrock, and are at a slightly different orientation to the outcropping rocks at location B. These outcrops appear to occur where the surficial sediments, in the order of 0.2m thick, have been eroded away to expose the mudstone. Exposed and eroded former mudflats have been observed during low tide topographic surveys at Medmerry (Figure 18).

Figure 18: Exposed 'mudstone' at Medmerry (CCO, 29/10/2014)

Rock Outcrop D

Rock outcrop D extends south-southwest from rock outcrop C, offshore of Selsey and consists of a parallel pair of compact mud or marl mudstone bedrock ridges and valley. These ridges are 1400m long and the valley is 2m deep and 120-150m wide, as shown in Figure 19. This rocky outcrop acts as an effective barrier, separating two shallow basins of sandy sediment; the western basin has an elevation of -5mOD and the eastern basin at -4mOD. Due to variable topography, a section of the rock valley has been in-filled by sandy sediment.

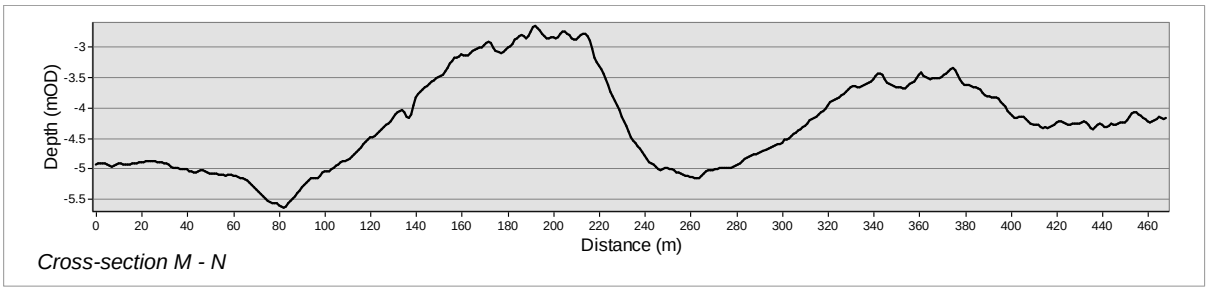


Figure 19: Cross-section M – N. Rock Outcrop D

Rock Outcrop E

To the south of rock outcrop B, there is a substantial area of surficial sediment of insufficient thickness to mask the underlying bedrock. Shore-parallel rocky ridges can be discerned, which are perpendicular to the mudstone outcrops observed at outcrop C. A distinct rocky outcrop has been identified in the centre of the basin area of rock and thin sediment, which has been measured up to -1.5mOD above the surrounding seabed but is still covered by a thin veneer of sediment. The surrounding sandy seabed slopes into the centre of the basin, from less than -10mOD to -16mOD (Figure 20). The base of this sediment basin appears to comprise mixed sediment, which extends southeast and separates an area of thicker sediment and rock outcrop at the southern edge of the study area.

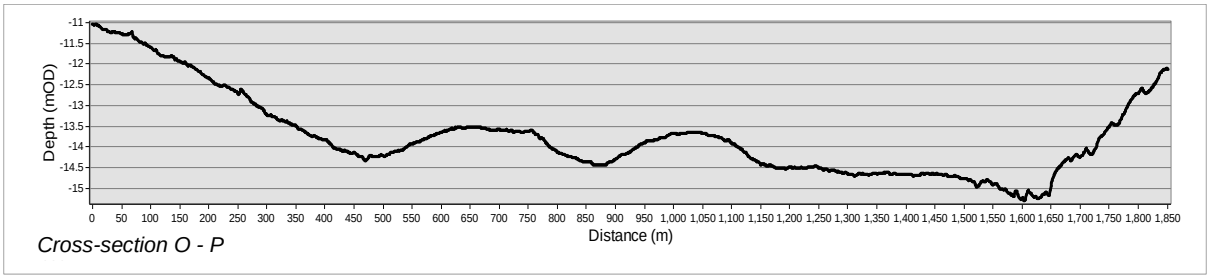
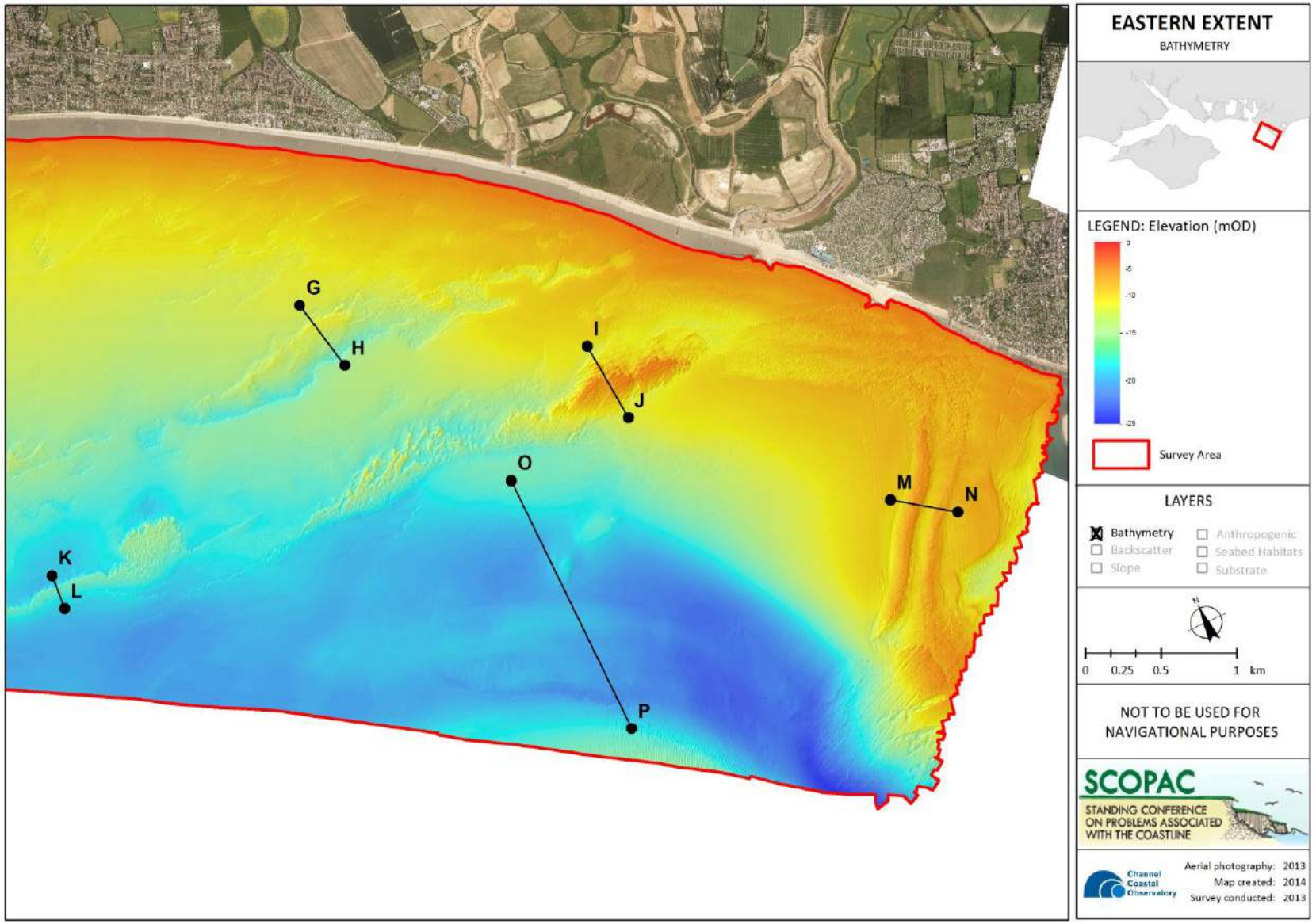


Figure 20: Cross-section O – P. Rock Outcrop E


G
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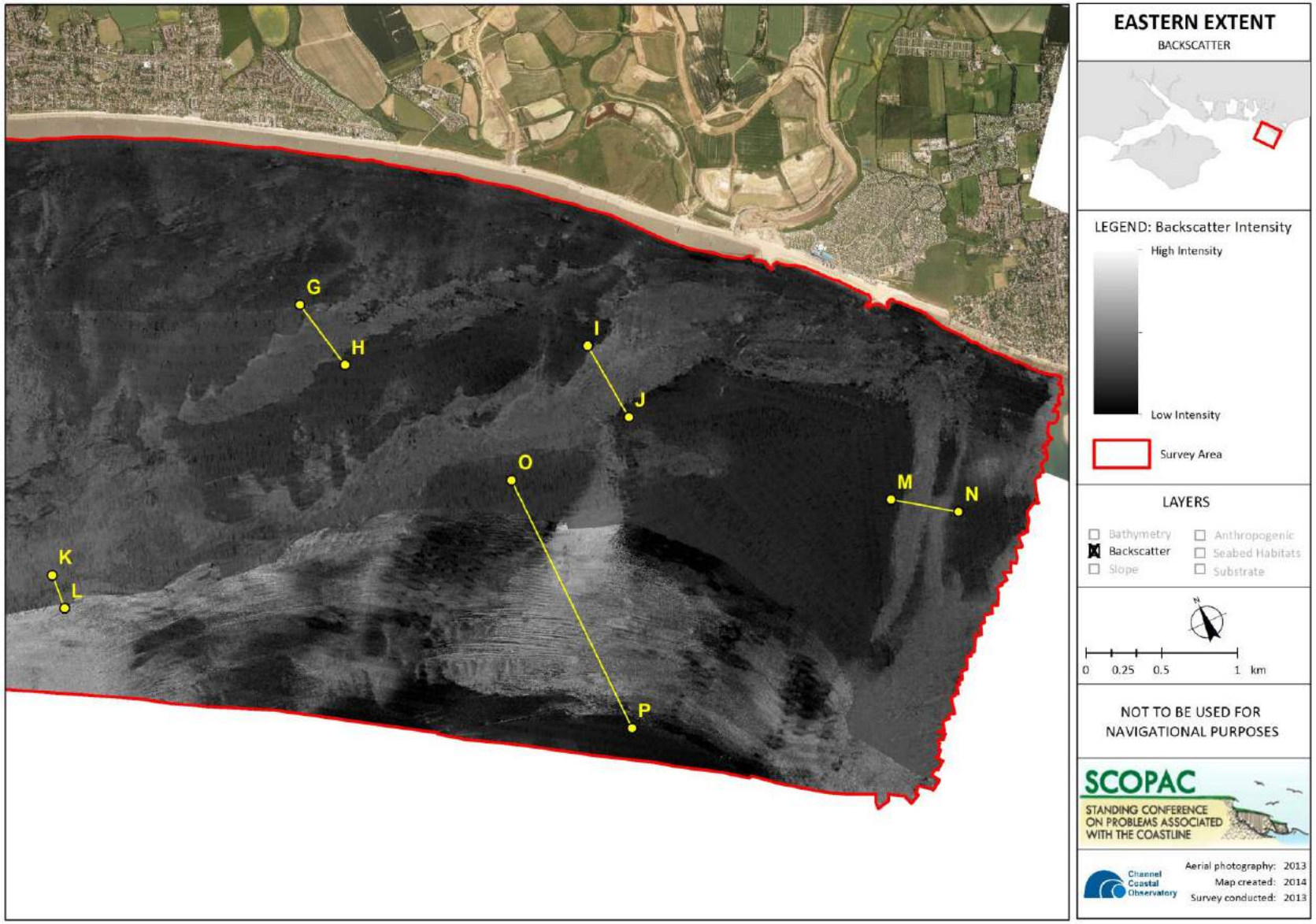
K
L
P
EASTERN EXTENT
BATHYMETRY
LEGEND: Elevation (mOD)
0
-5
-10
-15
-20
-25
Survey Area
LAYERS
Bathymetry
Backscatter
Slope
Anthropogenic
Seabed Habitats
Substrate
0 0.25 0.5 1 km
NOT TO BE USED FOR NAVIGATIONAL PURPOSES
SCOPAC
STANDING CONFERENCE ON PROBLEMS ASSOCIATED WITH THE COASTLINE
Channel Coastal Observatory
Aerial photography: 2013
Map created: 2014
Survey conducted: 2013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EASTERN EXTENT
BACKSCATTER
LEGEND: Backscatter Intensity
High Intensity
Low Intensity
Survey Area
LAYERS
Bathymetry
Backscatter
Slope
Anthropogenic
Seabed Habitats
Substrate
0 0.25 0.5 1 km
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SCOPAC
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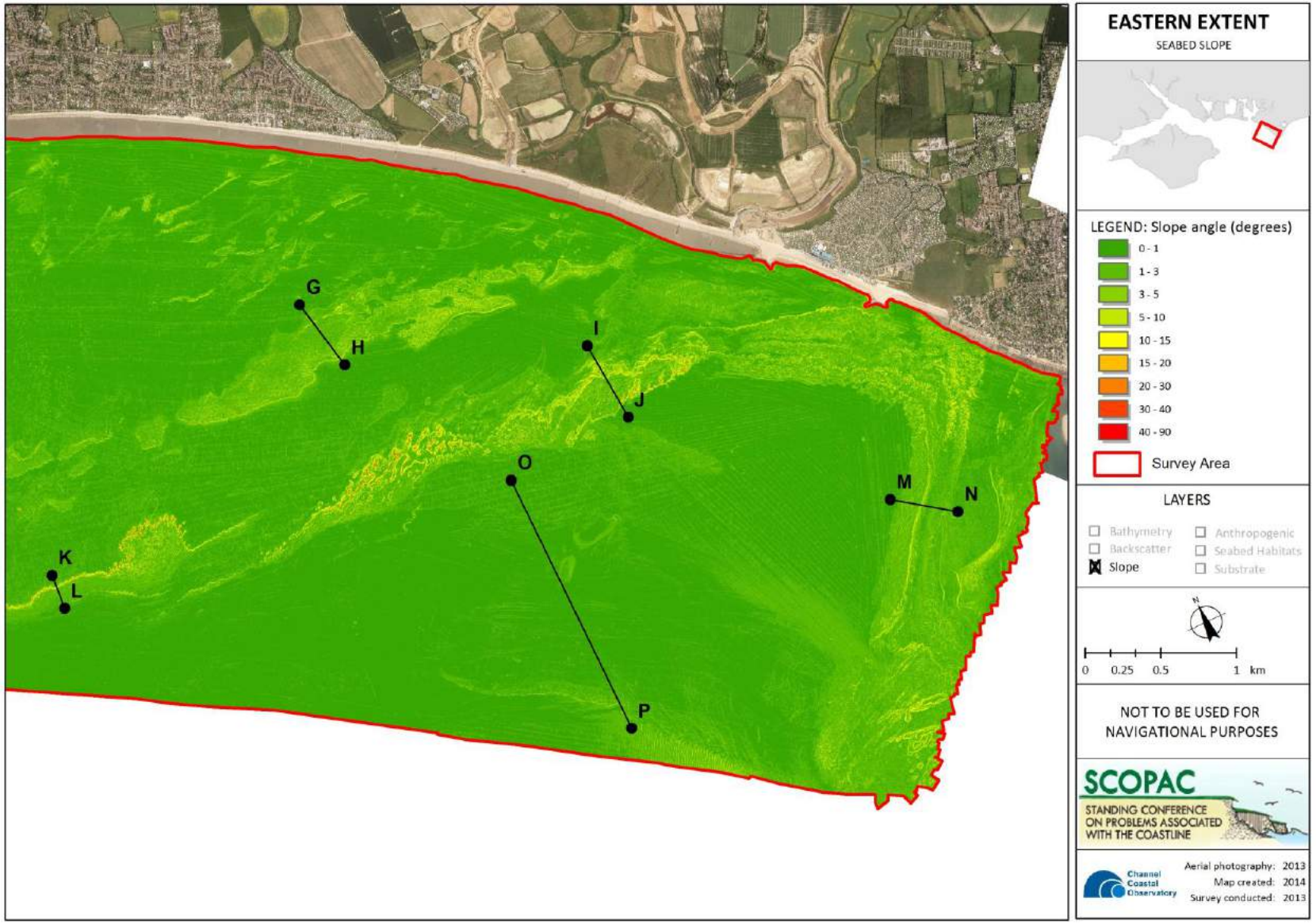
Survey conducted: 2013


G
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P
EASTERN EXTENT
SEABED SLOPE
LEGEND: Slope angle (degrees)
0 - 1
1 - 3
3 - 5
5 - 10
10 - 15
15 - 20
20 - 30
30 - 40
40 - 90
Survey Area
LAYERS
Bathymetry
Backscatter
Slope
Anthropogenic
Seabed Habitats
Substrate
0 0.25 0.5 1 km
NOT TO BE USED FOR NAVIGATIONAL PURPOSES
SCOPAC
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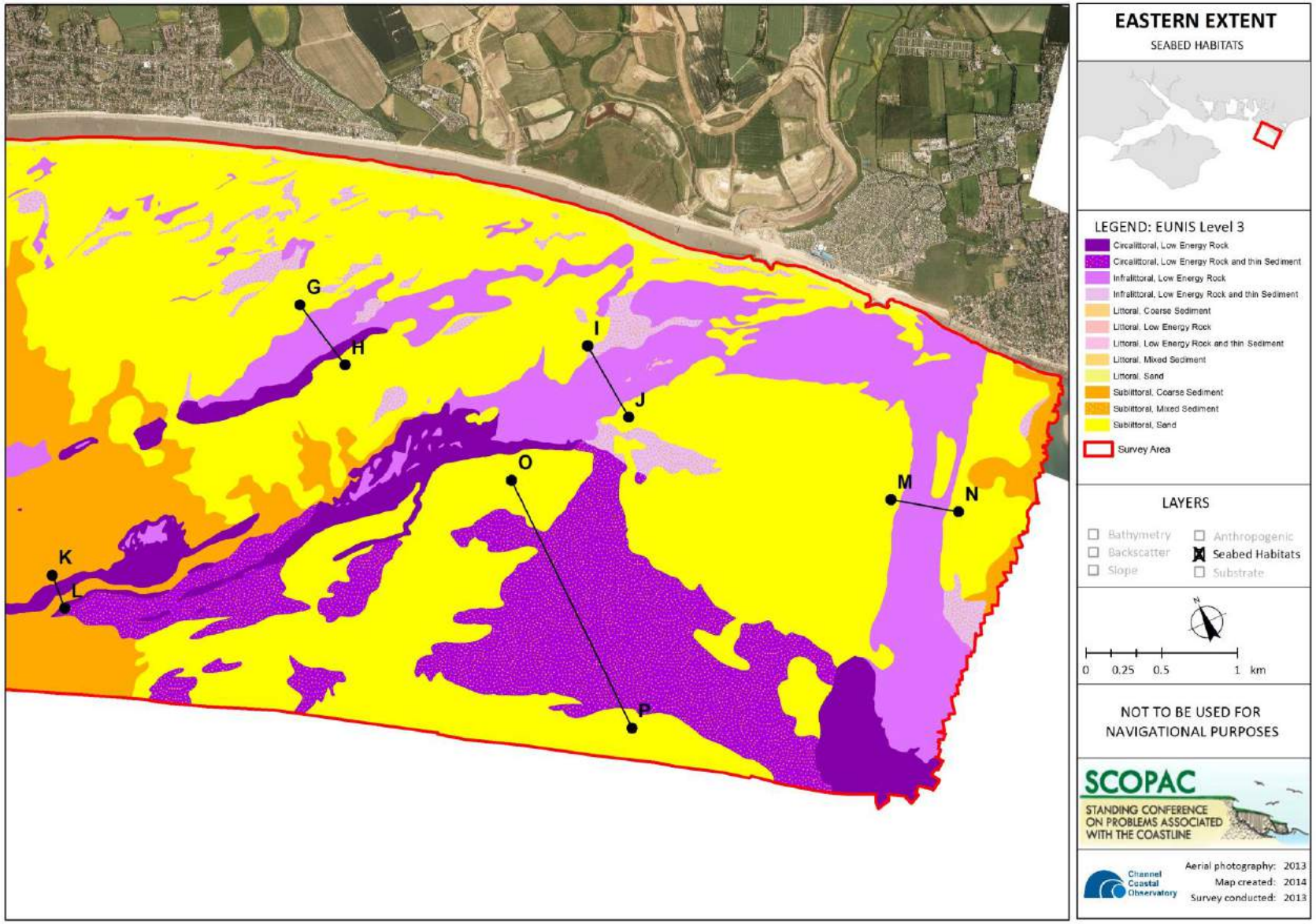
G
H
I
J
K
L
M
N
O
P
EASTERN EXTENT
SEABED HABITATS
LEGEND: EUNIS Level 3
Circalittoral, Low Energy Rock
Circalittoral, Low Energy Rock and thin Sediment
Infralittoral, Low Energy Rock
Infralittoral, Low Energy Rock and thin Sediment
Littoral, Coarse Sediment
Littoral, Low Energy Rock
Littoral, Low Energy Rock and thin Sediment
Littoral, Mixed Sediment
Littoral, Sand
Sublittoral, Coarse Sediment
Sublittoral, Mixed Sediment
Sublittoral, Sand
Survey Area
LAYERS
Bathymetry
Backscatter
Slope
Anthropogenic
Seabed Habitats
Substrate
0 0.25 0.5 1 km
NOT TO BE USED FOR NAVIGATIONAL PURPOSES
SCOPAC
STANDING CONFERENCE ON PROBLEMS ASSOCIATED WITH THE COASTLINE
Channel Coastal Observatory
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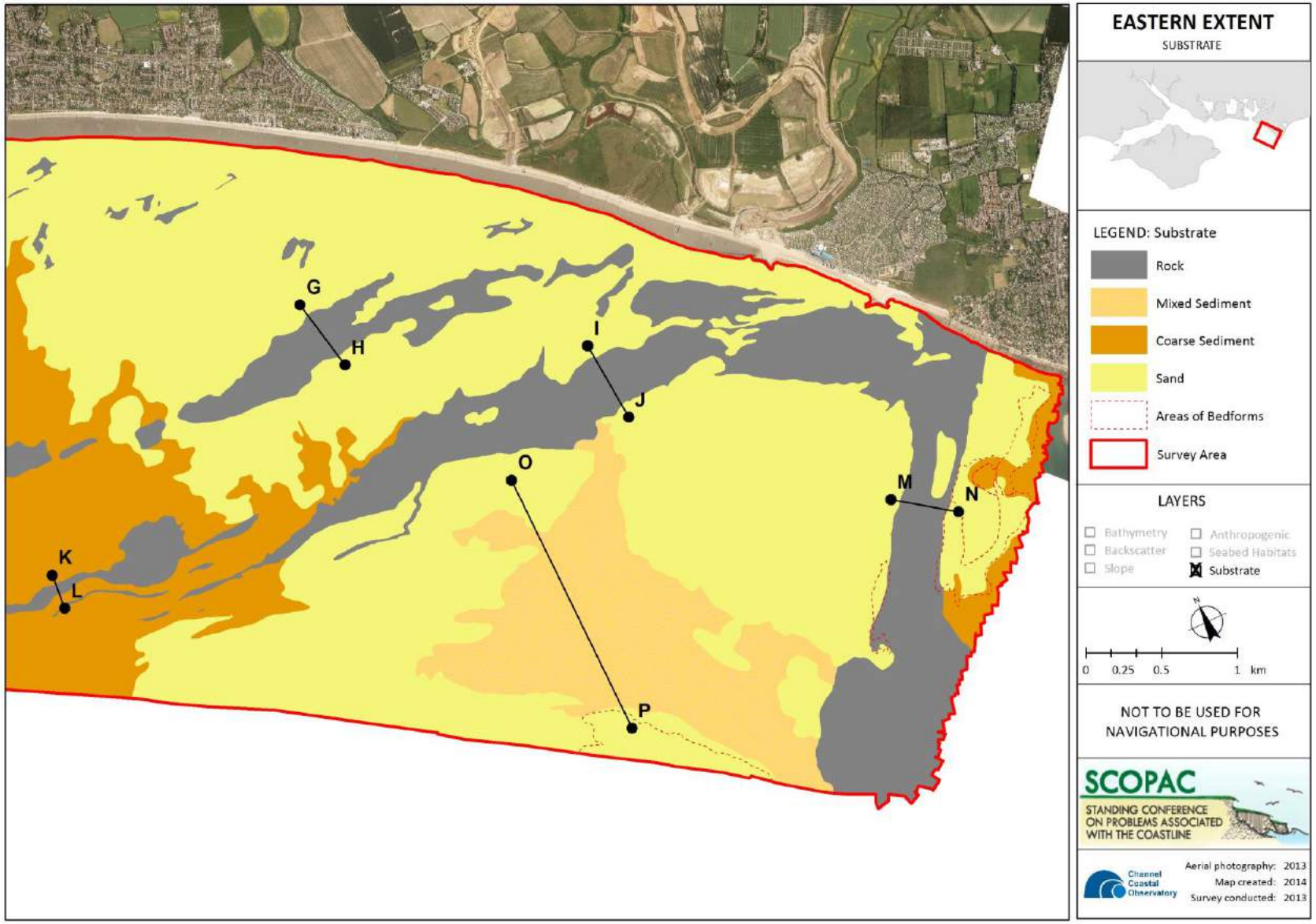
Map created: 2014
Survey conducted: 2013


G
H
I
J
O
M
N
K
L
P
EASTERN EXTENT
SUBSTRATE
LEGEND: Substrate
Rock
Mixed Sediment
Coarse Sediment
Sand
Areas of Bedforms
Survey Area
LAYERS
Bathymetry
Backscatter
Slope
Anthropogenic
Seabed Habitats
Substrate
0 0.25 0.5 1 km
NOT TO BE USED FOR NAVIGATIONAL PURPOSES
SCOPAC
STANDING CONFERENCE ON PROBLEMS ASSOCIATED WITH THE COASTLINE
Channel Coastal Observatory
Aerial photography: 2013
Map created: 2014
Survey conducted: 2013

Acknowledgements

This seabed mapping for the Selsey to Eastoke area was funded by SCOPAC.

Data interpretation was undertaken with the support of MAREMAP programme partners and the advice and guidance of Dr Tim Le Bas (NERC). Groundtruthing and substrate information was kindly provided by Erin Pettifer, Sussex Inshore Fisheries and Conservation Authority and by Sussex Seasearch.

Annex 1 Confidence Assessment

Remote Technique	Remote Coverage	Remote Positioning	RemoteStdsApplied	Remote Vintage	BGTTechnique	PGTTechnique	GTPositioning	GTDensity	GTStdsApplied	GTVintage	GTInterpretation	Remote Interpretation	Detail Level	Map Accuracy	Remote score	GT score	Interpretation score	Overall score
3	3	3	3	3	2	2	3	2	3	3	2	3	1	3	100	82	75	86

http://www.searchmesh.net/confidence/confidenceAssessment.html

Remote Techniques
An assessment of whether the remote technique(s) used to produce this map were appropriate to the environment they were used to survey. If necessary, adjust your assessment to account for technique(s) which, although appropriate, were used in deep water and consequently have a significantly reduced resolution (i.e. size of footprint):
3 = technique(s) highly appropriate
2 = technique(s) moderately appropriate
1 = technique(s) inappropriate

Remote Coverage
An assessment of the coverage of the remote sensing data including consideration of heterogeneity of the seabed. This can be simply achieved in a coverage x heterogeneity matrix, as illustrated below:

		Heterogeneity		
		Low	Moderate	High
Coverage	Poor (large gaps between swaths; Track spacing >100m)	2	1	1
	Moderate (50%; track spacing <100m)	3	2	1
	Good (100%; track spacing <50m)	3	3	3

Remote Positioning & Ground Truthing Position
An indication of the positioning method used for the remote / ground-truth data:
3 = differential GPS
2 = GPS (not differential) or other non-satellite 'electronic' navigation system
1 = chart based navigation, or dead-reckoning

Remote & Ground Truthing Standards Applied
An assessment of whether standards have been applied to the collection of the remote / ground-truth data. This field gives an indication of whether some data quality control has been carried out:
3 = remote / ground-truth data collected to approved standards
2 = remote / ground-truth data collected to 'internal' standards
1 = no standards applied to the collection of the remote / ground-truth data

Remote Vintage & Ground Truthing Vintage
An indication of the age of the remote / ground-truth data:
3 = < 5yrs old.
2 = 5 to 10 yrs old.
1 = > 10 years old

Biological Ground Truthing Technique
An assessment of whether the groundtruthing techniques used to produce this map were appropriate to the environment they were used to survey. Use scores for soft or hard substrata as appropriate to the area surveyed.

Soft substrata predominate (i.e. those having infauna and epifauna)	Hard substrata predominate (i.e. those with no infauna)
3 = infauna AND epifauna sampled AND observed (video/stills, direct human observation) 2= infauna AND epifauna sampled, but NOT observed (video/stills, direct human observation) 1 = infauna OR epifauna sampled, but not both. No observation.	3 = sampling included direct human observation (shore survey or diver survey) 2 = sampling included video or stills but NO direct human observation 1 = benthic sampling only (e.g. grabs, trawls)

Physical Ground Truthing Technique
An assessment of whether the combination of geophysical sampling techniques were appropriate to the environment they were used to survey. Use scores for soft or hard substrata as appropriate to the area surveyed.

Soft substrata predominate (i.e. gravel, sand, mud)	Hard substrata predominate (i.e. rock outcrops, boulders, cobbles)
3 = full geophysical analysis 2 = sediments described following visual inspection of grab or core samples (e.g. slightly shelly, muddy sand) 1 = sediments described on the basis of remote observation (by camera).	3 = sampling included in-situ, direct human observation (shore survey or diver survey) 2 = sampling included video or photographic observation, but NO in-situ, direct human observation 1 = samples obtained only by rock dredge

Ground Truthing Sample Density
An assessment of what proportion of the polygons or classes (groups of polygons with the same 'habitat' attribute) actually contain ground-truth data:
3 = Every class in the map classification was sampled at least 3 times
2 = Every class in the map classification was sampled
1 = Not all classes in the map classification were sampled (some classes have no ground-truth data)

Ground Truthing Interpretation
An indication of the confidence in the interpretation of the groundtruthing data. Score a maximum of 1 if physical ground-truth data but no biological ground-truth data were collected:
3 = Evidence of expert interpretation; full descriptions and taxon list provided for each habitat class
2 = Evidence of expert interpretation, but no detailed description or taxon list supplied for each habitat class
1 = No evidence of expert interpretation; limited descriptions available

Remote Interpretation
An indication of the confidence in the interpretation of the remotely sensed data. (Interpretation techniques can range from 'by eye' digitising by experts to statistical classification techniques):
3 = Appropriate technique used and documentation provided
2 = Appropriate technique used but no documentation provided
1 = Inappropriate technique used

Detail Level
The level of detail to which the 'habitat' classes in the map have been classified:
3 = Classes defined on the basis of detailed biological analysis
2 = Classes defined on the basis of major characterising species or lifeforms
1 = Classes defined on the basis of physical information, or broad biological zones

Map Accuracy
A test of the accuracy of the map:
3 = high accuracy, proven by external accuracy assessment
2 = high accuracy, proven by internal accuracy assessment
1 = low accuracy, proved by either external or internal assessment OR no accuracy assessment made