Historic Seascape Characterisation (HSC)

East Yorkshire to Norfolk

Section One: Background, Methodology and Results

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REPORT STRUCTURE

This Project Report for 'Historic Seascape Characterisation (HSC): East Yorkshire to Norfolk' (EH Project 6228) is divided into three sections for ease of use.

Section 1 outlines the project's method implementation. Section 2 outlines an applications review and case studies. Section 3 contains the Character Type text descriptions from both National and Regional perspectives: digital versions of those texts are also linked to the project GIS. This Project Area encompasses two sets of Regional perspectives (East Anglia Region and East Yorkshire to The Wash Region).

This document constitutes Section 1 of the Project Report produced by Newcastle University detailing the execution of the different phases of the project.

EXECUTIVE SUMMARY

In 2012 English Heritage (EH) invited the School of History, Classics and Archaeology at Newcastle University to tender for a project as a part of the *National Heritage Protection Plan* (NHPP) Activity 3A1 to undertake a Historic Seascape Characterisation (HSC) across the areas of England's coast and English Inshore and Offshore regions, contributing to English Heritage's national HSC database (EH Project 6228).

The HSC methodology, published in 2008 (Tapper 2008), consolidates and builds on the method development undertaken between 2004 and 2008 by the *England's Historic Seascapes Programme*.

The national HSC Method (Tapper 2008) produced a robust approach that applies the principles underpinning Historic Landscape Characterisation (HLC) to England's coastal and marine zones, extending seaward to the limit of UK Controlled Waters. Further, practical, experience from subsequent implementation of the HSC Method across the coasts and seas of north east England (Merritt and Dellino-Musgrave 2009) highlighted the need for some clarifications and amendments that were incorporated into a revised working draft of the HSC Method Statement in 2010 (Tapper and Hooley 2010). That revision has guided this project.

This is one of three projects commissioned during 2012 which will complete the implementation of the national HSC Method across England's coasts, Inshore and Offshore Regions. Together with the products from the seven other HSC implementation projects undertaken between 2008 and 2013, this project's outputs will contribute towards a national HSC database for England to be held by English Heritage.

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1. INTRODUCTION

1.1. PROJECT BACKGROUND

In March 2012 the Department of Archaeology in the School of History, Classics and Archaeology at Newcastle University was commissioned by English Heritage to undertake a Historic Seascape Characterisation (hereafter HSC) across two areas: East Yorkshire to Norfolk, which covered the area between Withernsea and Newport, roughly corresponding to the upper part of the area designated as the Southern North Sea by Centre for Environment, Fisheries & Aquaculture Science (CEFAS) in North-East Atlantic Region II ('Oslo and Paris' Convention for the Protection of the marine Environment of the North-East Atlantic (OSPAR)), and the northernmost area of England's Offshore Region between England and Scotland (see figure 1.1).

The project was funded by English Heritage under NHPP Activity 3A1. It started at the end of April 2012 for a period of 12 months in accordance with a Project Brief supplied by English Heritage (Hooley 2011) and guided by a revised working draft of the national HSC Method Statement (Tapper and Hooley 2010).

Historic Characterisation uses a suite of related techniques to map interpretations of historic character in the past and present. The results are used to inform research, management and planning for the future. Thus, the Historic Characterisation looks both backwards and forwards in time (Turner 2006) and creates robust tools for the management of change and for research applications. This project undertook a GIS-based characterisation of East Yorkshire to Norfolk, adjacent waters and coastal zones, as defined in the Project Design. It is part of a broader programme of HSC implementation which is building, through a series of projects, a HSC of the whole of England's coasts, Inshore and Offshore regions, creating a national HSC database to inform a breadth of applications including coastal and marine management and spatial planning.

The five pilot projects undertaken in the earlier *England's Historic Seascapes Programme* include the 'Withernsea to Skegness' HSC pilot (MoLAS 2009). That HSC pilot's outputs had substantial methodological differences from the national HSC Method as eventually consolidated so this East Yorkshire to Norfolk HSC project has not attempted to re-work its data. This East Yorkshire to Norfolk HSC project is wholly independent from that earlier work and supersedes it.

2. AIMS AND OBJECTIVES

2.1. PROJECT AIMS

The overall aim of the project was to carry out a GIS-based characterisation of a specified area of England's coastal and marine zones and adjacent waters to the limit of UK Controlled Waters using the national method for HSC.

Specifically, the project aimed:

- to follow the national HSC method to create a GIS-based characterisation of the historic and archaeological dimension of the present seascapes across the full extent of the project area, at a scale appropriate to national strategic level applications and in a manner that will contribute to a national HSC database and form an exemplar for future HSC projects

- to demonstrate how the application of HSC produces a framework of understanding which will structure and promote well-informed and positive decision-making relating

to the sustainable management of change and conservation planning affecting the historic environment in the coastal and marine zones;

- to ensure that application of HSC produces a GIS-database fully compliant with the principles of HLC, with the present and anticipated user-needs of English Heritage and with available standards for data content, management, inter-operability and accessibility developed to meet the implications of the Marine and Coastal Access Act 2010;

- to structure, inform and stimulate future research programmes and agendas relating to the coastal and marine historic environment;

- to improve awareness, understanding and appreciation of the historic dimension of the coastal and marine environment to its professional and non-professional users.

2.2. PROJECT OBJECTIVES

The project objectives are:

- to produce a GIS-based characterisation of the historic and archaeological dimension of the present-day seascapes across the full extent of the specified project area, using the established national HSC method, adopting at least a national perspective for its descriptions, and coordinating its marine HSC with a national data framework to be advised by English Heritage;

- to produce a database of referenced structured texts relating to Character Types assessed during the characterisation, supplemented by imagery from the Project Area;

- to analyse and interpret the project's HSC database to identify contexts and applications in the project area typifying those which the HSC approach is designed to inform, as noted in the national HSC Method Statement (Tapper and Hooley 2010), with particular reference to English Heritage's curatorial responsibilities and influences for the sustainable management of change, the provisions of the Marine and Coastal Access Act, and UK commitments arising from the European Landscape Convention;

- to document those HSC contexts and applications in the project area by description, including scenario examples as appropriate;

- to document from the project area, by description and by case study, the close inter-relationships between historic and natural environment character and the advantages of inter-operability between historic and natural environment spatial datasets;

- to document the potential of the HSC from the project area for raising public awareness and understanding of the coastal and marine historic environment;

- to produce an Archive and a Project Report documenting all aspects of the project's application of the national HSC method. Included within the Project Report will be: a project method statement detailing the project's practical implementation of the national HSC methodology; documentation of the project area's contexts and applications, current and potential, which HSC can advantageously inform; the relationships between the project area's historic and natural environment character, and the potential of the project's HSC for raising public awareness and understanding of the coastal and marine historic environment;

- to detail in the Project Report's method statement the specific tasks and aspects of implementing the national HSC methodology across the project area, including

records of the sources and data-sets supporting each stage of the characterisation and noting the inter-relationship between HSC and HLC where the latter has been undertaken within the project area, to meet the needs of transparency and to assist future updates against the initial benchmark characterisation;

- to disseminate information on the progress and results of the project through the internet and through professional and popular publications and other media.

2.3. INTERFACES

The project was undertaken in consultation with staff from English Heritage, both the former Characterisation and Maritime Archaeology Teams. Where required, advice was sought both from English Heritage and those contractors involved in the consolidation and initial implementation of the national HSC Method, and from those conducting the three other HSC projects running concurrently with this one. In further demonstrating practicalities of *implementing* the methodology, this project extended the process of *defining* the method, to complement the National HSC Method Statement in giving methodological and practical direction to future HSC practitioners. Close consultation with English Heritage was at a level appropriate to ensuring this project met English Heritage's needs, especially in line with changes in marine legislation, strategic developments in English Heritage and the range of applications that a might be implemented by a national HSC database.

Beyond the consultation with English Heritage staff and others noted above, the project had inputs, guidance and advice from other parties within and beyond English Heritage at various points during the project, especially during the characterisation and development of application scenarios. These included:

- ALGAO East of England
- Cambridgeshire County Council
- Cornwall Council
- Heritage Lincolnshire
- Hull City Council
- Lincolnshire County Council
- Norfolk County Council
- North Lincolnshire Council
- Humber Field Archaeology
- Heritage Lincolnshire
- LOCUS
- UKHO
- UK DEAL
- APBmer
- SeaZone Solutions Ltd (part of H R Wallingford)

3. METHODOLOGY

3.1. PROJECT AREA

The area to which the national HSC Method has relevance comprises the whole of England's coastal zone (land and sea), England's share of UK territorial waters, and adjacent UK Controlled Waters as defined in the Marine and Coastal Access Act 2009 Section 322. For HSC, 'coastal land' comprises those areas above Mean High Water (MHW) which possess or possessed a distinctly maritime historic cultural character.

Within that overall extent, the project consisted of two Project Areas (Turner & Newman 2011; see also figure 1.1):
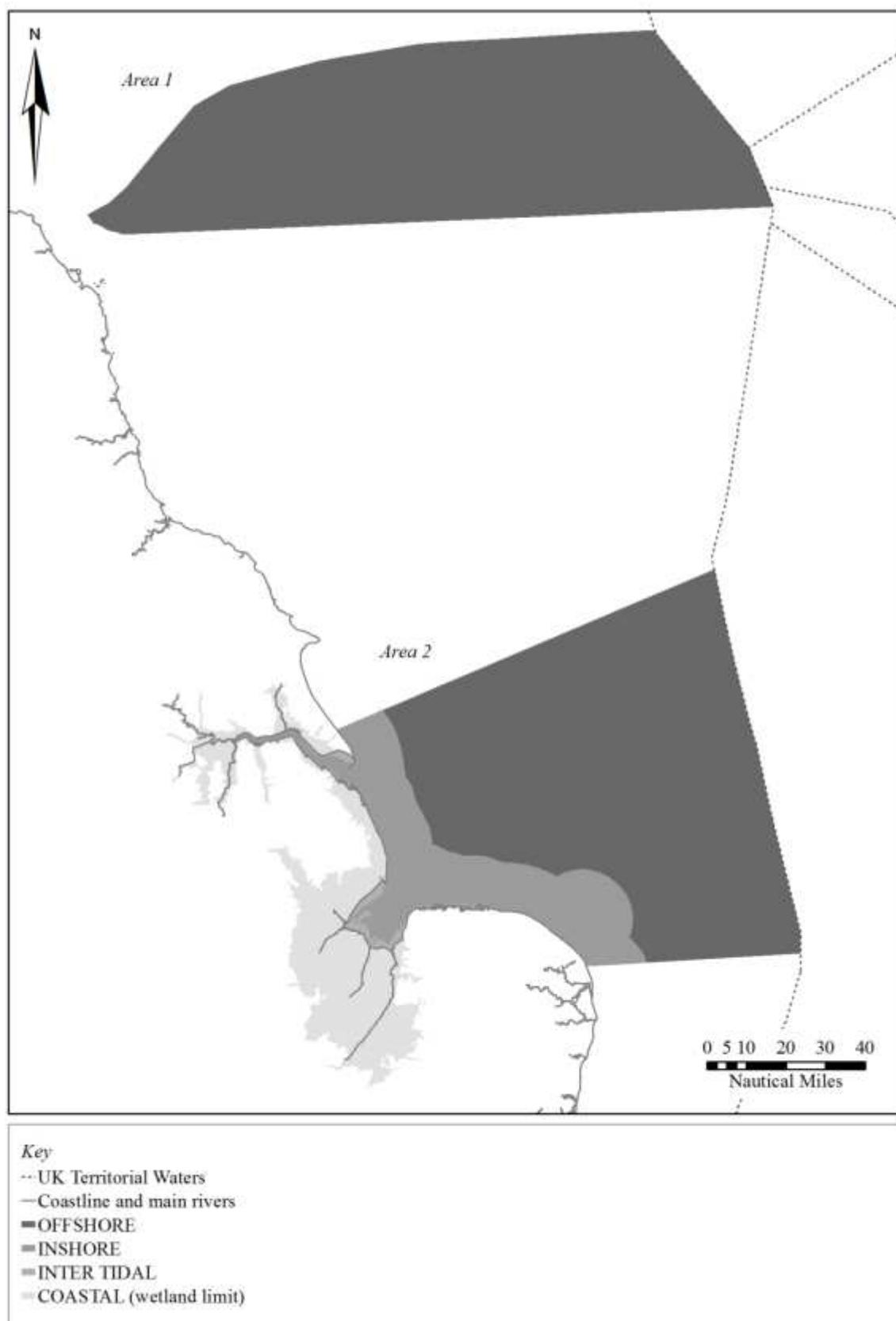

Figure 1.1. Areas 1 and 2.

Project Area 1: that northernmost part of the English Offshore region off the east coast which lies between the Anglo-Scottish boundary defined in the Civil Jurisdiction (Offshore Activities) Order 1987 1 (2) and the northern boundary of the English Offshore region as defined in the Marine and Coastal Access Act 2009 Section 322.

Project Area 2: the coastal land and English Inshore and Offshore regions off England's east coast between the areas already covered by two completed national HSC projects: the northern of those had a coastal extent from the Anglo-Scottish border near Berwick to Withernsea, East Riding of Yorkshire (Merritt & Dellino-Musgrave 2009); the southern extended from Newport near Great Yarmouth, Norfolk, to Jaywick near Clacton, Essex (Oxford Archaeology 2011).

It is recognised that the boundaries of these Project Areas reflect administrative and practical constraints, and do not reflect any division in the continuum of the historic environment.

To clarify the northern and southern limits of Project Area 2, its northern boundary to seaward was defined by a line extending north-east from the coast near Withernsea at 53°44' 15"N, 00°01' 48"E, to the intersection of latitude 54° 20' 00"N with the outer boundary of England's Offshore region. Its southern boundary to seaward was defined by latitude N52°42' 00", crossing the Norfolk coast near Newport and extended east to its intersection with the outer boundary of England's Offshore region.

The landward extent of Project Area 2 reaches the OS-mapped line of Mean High Water (MHW) but in accordance with the national HSC method, its coverage continues landward beyond that line to accommodate inland areas perceived, from a maritime perspective, as possessing distinctively maritime historic cultural character. This resulted in the inclusion of some inland areas which are discontinuous with MHW, for example to accommodate inland maritime features or areas serving as navigational daymarks, producing HSC polygons separate from the main body of the characterisation. The landward coverage by this project extended to, but did not overlap, that of the completed national HSC projects to north and south.

Subject to accommodation of inland areas perceived as possessing distinctive maritime historic cultural character, the estuaries, rivers and their tributaries, along with associated drainage channels within Project Area 2, were included at least to their Normal Tidal Limits. However the project's upstream extent along the River Trent's tidal course was curtailed at the railway bridge south of Gainsborough, Lincolnshire, at SE80948812, stated in the Project Brief (Hooley 2011) and Project Design (Turner and Newman 2011).

The landward extent of the project area reaches the OS-mapped line of Mean High Water (MHW) but in accordance with the national HSC methodology, it continues 5km landward beyond that line to avoid any arbitrary truncation of HSC polygons and to accommodate inland areas perceived, from a maritime perspective, to possess a distinctively maritime character. This results in the inclusion of some areas on land which are discontinuous with MHW, for example to accommodate prominent inland areas serving as navigational daymarks, producing HSC polygons separate from the main body of the characterisation. The landward extent of the project area was confined to areas lying within England. Although the 5km buffer was applied throughout the project area, there was a low feasibility of maritime character being perceived along far inland rivers. In many cases features of a maritime character were restricted to areas close to the rivers' banks, well within a 5km selection buffer. Subject to accommodation of inland areas perceived as possessing distinctive maritime character and the extent that they lie within England, all estuaries within the project area were included to their rivers' and tributaries' Normal Tidal Limits.

On a related matter, the area of the Fens and The Wash include large landward areas which possess both terrestrial and maritime character, but which also have a previous maritime character. This includes large areas of sea-reclamation and their associated sea banks. The exact extent of data-capture buffers appropriate to encompass the Fens and Wash areas was discussed with the PAO and Steering Group at the onset of the project. The approach agreed at the inception meeting was that the characterisation would include the full extent of pre-drainage marsh and estuarine deposits; that these should be characterised as Reclaimed Character Types (from wetland, tidal marsh, or sea) in the Present-day historic character, but under Previous historic character these areas should be subsumed under the Palaeolandscape Character Type. As indicated, there was little time within the project to undertake more detailed work as this was deemed unnecessary for the intended strategic-scale HSC.

In practice the marine character of Fens and The Wash region was deemed to be sufficiently well represented and unambiguous up to the so-called 'Roman' Sea Bank indicated on the 1:25000 OS map. This also represented the limit of the post-Roman and Saxon sea extent (Crowson 2005: 5, figure 1.). This delimited boundary was unambiguous because the available evidence for seascape historic character was evident in the archaeological data, even though the *actual* limit of the Holocene transgression could not be precisely placed. While the Holocene extent could be partially reconstructed from marine silts and silty clay, the overlying peat made its actual westward extent difficult to determine. Adopting the notion that *all* wetland was reclaimed from the sea, or former sea may have been misrepresented ude to the lack of accessible and continuous scientific evidence for areas below the peat that were a part of the Holocene transgressions. As such the land-ward extent of the seascape character was defined by the surface evidence, indicated by reclamation, as well as archaeological features such as sea banks and flood defences, as well as drainage channels - that was related to the visible historic character of the present-day landscape. And therefore, in order to meet the requirements of the inception meeting decision, a single, large polygon was used to characterise the area between the line of the Roman Sea Bank (as indicated on Crowson 2005) and the full extent of the Fens in Norfolk, Cambridgeshire and Lincolnshire indicated by the Fenland Survey project (Waller 1994) even though the *actual* limit would be greatly enhanced by more precise scientific data that was not available at the time of characterisation.

3.2. SOURCE DATASETS

The national HSC Method Statement (Tapper and Hooley 2010) was used as the basis for applying the national HSC Methodology to meet the requirements of English Heritage. The characterisation was broken down into the following stages:

1. Data Collation
2. Data Preparation
3. GIS Development
4. Database Development
5. Character Assessment
6. Development of Character-type Text Descriptions

3.3. DATA COLLATION

The emphasis was placed on datasets listed in the HSC Method Statement that currently had, when completed, consistent national coverage. There was also an emphasis on available digital sources. More locally based or hard-copy sources were treated as supplementary data. Additional sources were sought in some cases to complement or increase the coverage of datasets proposed in the HSC Method Statement (Tapper and Hooley 2010). The information

gathered to produce text description for character types was based on desk-based research. The basic requirements were that:

- sources were relevant and consistent;
- core dataset coverage was national (or at least regional);
- sources were treated in a consistent manner and even-handed way, following a clearly stated workflow; and were used where possible to reflect time-depth and past change;
- standard terminologies were used to maintain clarity meeting MIDAS/INSCRIPTION requirements;
- consistent assessment and capture of historic seascape character was deployed;
- common 'perception scale(s)' were established – that is, the scale at which characterisation is expected to be read and applied.

A list of core data sources was identified for the purpose of the project (Table 1, based on Tapper and Hooley 2010; Hooley 2011).

Data Group	*Format*	*Feature Types*	*Datasets*	*Supplier*
Admiralty charts	Digital	Points, polygons, polylines	Bathymetry, navigational hazards, navigational channels	SeaZone Hydrospatial
Historical charts, views and sailing directions	Paper based/ digital	Raster images	Navigational features, Offshore development, intertidal peat beds	UKHO archives, National Maritime Museum, local museums
Ordnance Survey maps	Digital	Points, polygons, polylines		English Heritage, Ordnance Survey
Historic maps	Digital	Raster images	1st Edition, 2nd Edition and modern Ordnance Survey maps	English Heritage, Landmark, Ordnance Survey
SeaZone Hydrospatial	Digital	Points, polygons, polylines	- Bathymetry & elevation (BE), - Natural & physical features (NP) - Structures & obstructions (SO) - Socio-economic & marine use (SE) - Conservation & environment (CE) - Climate & oceanography (CO)	SeaZone Solutions Ltd

			- Wrecks (W)	
Adjacent County HLCs	Digital	Polygons		Local Authorities
Fisheries data	Digital	Points, polygons, raster images, paper charts	Fishing grounds, fishing snags	CEFAS (outside 6nm), Sea Fisheries Committees (within 6nm), JNCC, Kingfisher charts, NMR, Misc. fishing charts, Fishing pressure
Offshore Industry	Digital	Points, polygons, polylines	Aggregate extraction areas, oil and gas installations	UK Deal, JNCC, SeaZone Hydrospatial
Environmental data and land classifications	Digital			Natural England/JNCC/ MAGIC database, CEFAS, BGS (www.searchmesh.net/webGIS)

Table 1. Core Data Identified for the Project.

English Heritage supplied modern Ordnance Survey and historic Ordnance Survey Landmark data. Data on fisheries, offshore industry, and most environmental and land classification data were obtained through SeaZone Solutions Ltd, but provided through English Heritage. Additional data were also gathered to supplement the core sources recommended in the National HSC Method Statement (Tapper and Hooley 2010).

Supplementary datasets identified included local and regional datasets, point data and data which are not currently available in a digital format (Table 2). These are datasets which are not consistently available to inform all historic landscape and seascape characterisation, but in some cases they can help fine-tune the assessment, providing valuable information on regional character expression during the characterisation. HER data were requested and obtained from local authorities and Rapid Coastal Zone Assessment Surveys (RCZAS) data were obtained with National Record of the Historic Environment (NRHE) data.

Data Group	Format	Feature Types	Datasets	Supplier
NRHE	Digital	Points, polygons, polylines	Monument records, maritime records, RCZA	English Heritage
HER	Digital	Points, polygons, polylines	Monument records, maritime records	Local Authorities
Palaeoenvironmental data	Digital/paper	Various	Peat beds, palaeochannels,	Birmingham University, ABPmer, HER/SMR, BGS
Geomorphology	Digital	Raster	Coastal geomorphology	FutureCoast (DEFRA)
Seabed sediments	Digital	Polygons	Sediment type	BGS, SeaZone Hydrospatial
Offshore solid geology	Digital	Polygons	Bedrock type	BGS, SeaZone Hydrospatial
Morphology	Digital	Raster	Coastal morphology	FutureCoast

Tidal range	Digital	Raster images	Sea level model	DTI
Sea level index points	Various	Various	Sea level model	Various
Tides and Currents	Digital	Points, polygons, polylines	Tides and currents	SeaZone Hydrospatial
Shipping Data and Navigational Hazards	Digital	Polygons, Raster	Navigational hazards, England's Shipping, ANATEC, DfT	Bournemouth University, English Heritage, ANATEC, DfT
Documentary sources	Hard copy, Digital	Various		Various: libraries, Record Offices, Museum libraries

Table 2. Supplementary Data Identified for the Project

The collation of documentary resources played a key role in the contextualisation of the character assessment and the development of character-type text descriptions. A wide range of primary and secondary, online and paper-based documentary sources were assessed. Data gathering was streamlined using the design of the database structure to guide the assessor in the level of information required. Data were entered directly into the database from the source documents. The timescale required to collate such a broad range of resources was considerable and was started in the first stages of the project during the initial Set-up and Familiarisation phase. Additionally, sources such as Anatec's shipping data and RYA leisure sailing data was not used due to the high cost and low resolution of the data in informing characterisation.

Although there were core sets of data used between the HSC projects both to the north and south (cf. Tapper and Hooley 2010), there were some differences in character types that extended across this project and the two projects to the north and south. For example, the northern project (conducted by SeaZone/MA) indicated a pipeline that should have been present in the East Yorkshire to Norfolk project area. Using the data provided by SeaZone, there was no pipeline indicated in the corresponding area within the East Yorkshire to Norfolk project area. The data was also checked against the Offshore Industry data provided by UK Government and UKDeal (https://www.gov.uk/oil-and-gas-offshore-maps-and-gis-shapefiles; https:/ www.ukdeal.co.uk). The discrepancy may have been a result of a wrong selection in the spatial operation of lines by the northern project. In another example, the southern project (conducted by Oxford Archaeology) had a high concentration of navigation routes that were not indicated by the corresponding data provided by SeaZone in the reported project area. It may have been that there were some differences in the data sources used by Oxford Archaeology that were not available during the East Yorkshire to Norfolk characterisation.

3.4. ADDITIONAL DATASETS DEPLOYED, NOT PREVIOUSLY USED IN HSC

There were several other datasets, or rather references sources, used in this project's HSC that had not been previously used in other HSCs.

The use of Google Earth for aerial photo cover and Google Street View for land-based characterisation was a useful supplement to check coastal areas. The websites of agencies and companies referenced in tables 1 and 2 were consulted.

The Fenland Survey and Humber Wetland project published maps and information gleaned from the various reports was used to inform the characterisation in these areas. For example,

the land that had a seascape character derived from having been reclaimed from wetland or associated with the Holocene transgressions was mapped on several figures in the Fenland Survey and Humber Wetland project. This was used to inform the character boundaries for inland areas that have a distinctive a historic seascape character.

Fishing Character Types were informed by various sources, but especially by oral histories that had been documented in local histories relating to Grimsby, as well as Lowestoft (fishing activities were focused in North Sea in general, but specifically in many of the areas located in the project study area). These were used to identify the types of fishing activities occurring in the late-19th and early-20th century. The places indicated by named parts of the North Sea and the type of fishing being caught and the type of netting were used to inform the character of fishing in the study area (Butcher 1979, 1982).

The Palaeolandscape was characterised from information contained in several datasets including the data provided by ABP Marine Environmental Research Ltd (ABPmer). The data was part of a project called Waterlands - Developing Management, Indicators for Submerged Palaeo-environmental Landscapes (© Crown Copyright 2010, Goodwyn NJ, Brooks AJ and Tillin HM and published by the MALSF).

3.5.   DATA PREPARATION

Data preparation was undertaken as outlined in both the national HSC Methodology (Tapper and Hooley 2010) and the Project Design. A digital geographic dataset containing extent polygons was produced to define 'Location' areas for the coastal and intertidal, Inshore and Offshore zones, as specified by the UK Hydrographic Office (UKHO) for the intertidal and marine zone, and the Ordnance Survey (OS) for the coastal zone. They are defined as follows:

- the coastal zone extends inland from MHW for areas shown to possess a maritime character;
- the intertidal zone is the area from Mean High Water (MHW) to Mean Low Water (MLW);
- Inshore waters were defined between MLW and the 12nm limit
- Offshore waters were the area beyond the 12nm limit to the outer extent of the project study area – the UK Territorial Waters.

During the compilation of the data and the establishment of the project areas – for the 5km buffer and tidal limit as prescribed in the Project Design several sources were used in order to define the extent of the Holocene transgression: the limit of the landward coastal zone which had an historic seascape character. The sources used in the process of defining the landward limit were derived from the Fenland Survey (Hall & Coles 1994; Crowson 2005) as well as from the Humber Wetland project (Van de Noort 2004, 2011).

These areas provided the location attribute [LCTN] for each HSC polygons. This was first defined using a 250m grid that covered the Inshore and Offshore areas and creating separate gridded datasets for each marine zone, and then combined, as specified in the HSC Method Statement. Although the representation of the intertidal zone is more detailed in UKHO chart data than it is for OS MasterMap, the inconsistencies between the definition of MHW and MLW between the two made the use of UKHO data above MLW impractical in the context of this project without the undertaking extensive feature deconfliction between two datasets. Therefore, a polyline version was created using both datasets based on the OS 1:25,000 maps for the study area.

For projects based in terrestrial England, it is suggested that all data should be in the OSGB 1936 projection (OSGB36). For maritime projects GIS data should be in World Geodetic System 1984 datum (WGS84). UK reference datum for terrestrial datasets is typically in the Ordnance Survey British National Grid based on the OSGB36 datum which is intended to provide as little distortion as possible for the UK as a whole. However distortion increases the further one gets away from the centre of the UK, and for this reason, maritime datasets use the WGS84 which gives a better fit for the earth as a whole. Terrestrial sources were transformed into OSGB36 prior to inclusion in the character assessment. All marine source data were transformed between OSGB36 and WGS84 using conversion algorithms in ArcGIS. The East Yorkshire to Norfolk used OSGB96 to deliver the project's map based outputs.

The data was collated to meet English Heritage standards of best practice. The resolution for data capture was determined by the scale at which the data is to be viewed and the scale at which it was originally displayed. All newly digitised data were captured at a scale of at least 1:25,000 as recommended in the "Guidelines for English Heritage Projects Involving GIS" (Froggatt 2004) and the AHDS GIS guide to Good Practice (http://ads.ahds.ac.uk/project/goodguides/gis/). MIDAS Heritage complies with this data standard which is used by the GIgateway™ metadata service run by the Association for Geographic Information (AGI) and also to the UK e-Government Metadata Standard (e-GMS) which is based on Dublin Core. It is designed for use in GIgateway™, and for other metadata applications in the UK. All output GIS files will be documented using the UK GEMINI Discovery Metadata Standard, and is encoded according to ISO 19139.

3.6. GIS DEVELOPMENT

A series of GIS tools was developed during the initial HSC implementation project across north eastern coasts and seas (Merritt & Dellino-Musgrave 2009), along with a strategy for ensuring continuity between the processing of all data collated. The East Yorkshire to Norfolk HSC project used a vector grid that was created on the basis of edge matching between the two previous HSC projects to north and south. There were, however, inconsistencies between these two projects which created several problems in establishing a single consistent grid across the three conjoining projects. To resolve this problem, the East Yorkshire to Norfolk project adopted the grid alignment of SeaZone/MA's north eastern HSC project rather than Oxford Archaeology's grid alignment for their Newport-Clacton HSC project to the south). This ensured a close measure of consistency with the SeaZone/MA Ltd project for the north east. The future collation of projects to produce the national HSC database will need to consider how to achieve grid alignment consistency so that all grids/characterisation polygons produced by HSC projects are brought into the same grid structure. For example, while some disjointedness is evident between the two project areas either side of the project boundaries being reported here, this can be resolved relatively easily by adopting a single, uniform grid across the whole of England's Inshore and Offshore Regions, in which existing projects can be mapped into. These could then be clipped to each project area. As a result, alignments when viewed alongside each other, would ensure coherence and interoperability between different project products

The project used a 250m² grid consistently throughout the project area which was referenced to British National Grid co-ordinates (OSGB36). The cells were then clipped using ArcGIS to remove unnecessary tiles to reflect the full extent of the study area below LAT.

The HSC database is a geodatabase created in ArcGIS 10, coupled with a join to the attribute data in a Microsoft Access 2007 database, with compatibility mode set for Microsoft Access 2003. The database utilises a series of tables, queries and data entry forms to feed data into a

single main underlying data table (in the MS Access attribute database cf. *HSC_data_structure*). The structure of this main table follows the naming conventions outlined in the national HSC Method Statement (see Table 3 below). Data types also follow the conventions outlined within this document but the width of each of the data strings was modified in line with its final contents to provide a more streamlined data set with less redundancy within the fixed length data fields. Character types were stored within a single Access table named *ALL_HSC_Types* to simplify additions and changes to the master list. Filtering of this list, for display during data entry, was achieved by the use of a number of static 'Broad Character Type' specific queries. 'Lookup Tables' were also included for 'Period' and 'Confidence' to enable more rapid and accurate data entry. Entry of the ObjectID for each record also differed in not being generated automatically within the GIS but was controlled manually within both Access and ArcGIS so that record numbering could be kept sequential even where deletions or additions may have been necessary.
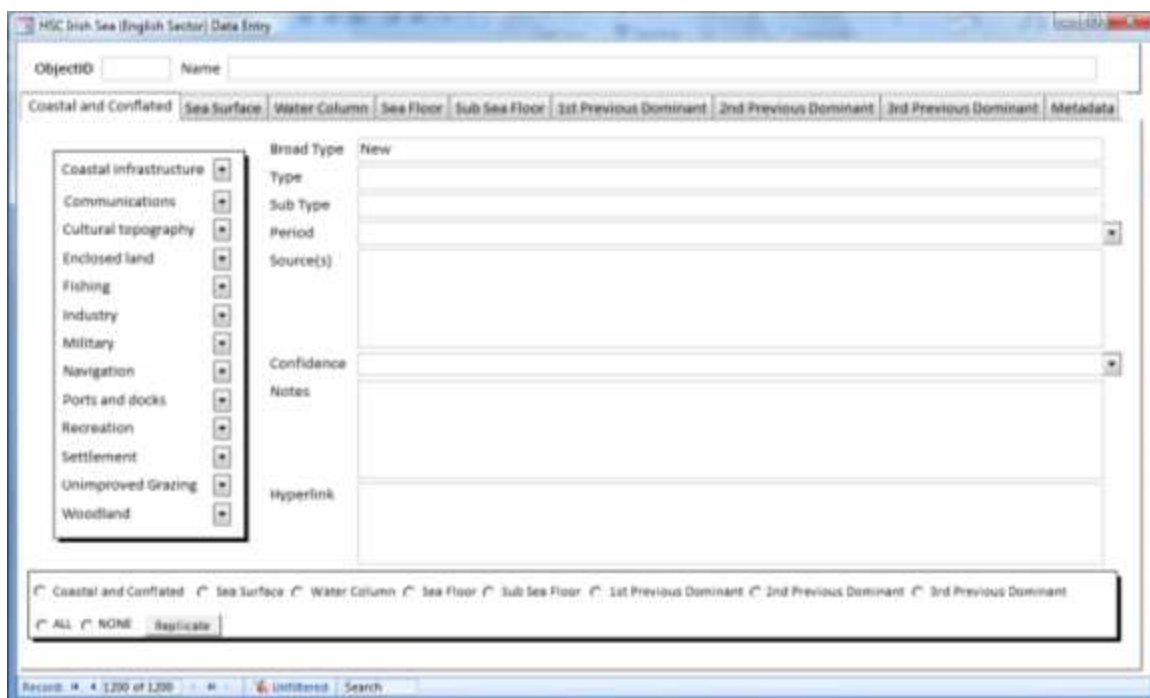
Figure 1.2. Data entry form.

All OS Mastermap vector data is stored within the main geodatabase as a series of feature classes. Raster-based historic mapping, for each of the available epochs, is stored as a series of Raster Catalogues with a file geodatabase. Visibility of these datasets is controlled by parameters set within ArcGIS. HSC 250m and 500m grids and HSC polygons are also stored as feature classes within the database. HSC spatial polygon data and HSC character data are linked within ArcGIS using the ObjectID field.

Data entry was controlled by the use of a multi-tab data entry form (Fig. 2) that allows all fields within the main underlying data table to be accessible on the screen at any one time. In addition to the main tabbed pages, a number of additional features were programmed into the main data entry form. Dropdown lists relating to the 'Broad Character Type' were programmed to ensure that only relevant terms are available at the point of data entry. Colour tagging of the 'Broad Character Type' after data entry acted as a reminder of the character type chosen. The main data entry form provided for duplication of data across individual tabbed pages. A series of check boxes with a 'Replicate' button was programmed to allow for easy duplication of data between underlying database fields. Check box choice and visibility were also programmed into this form. All coding was in Access Basic and has been designed to be easy to modify in the event of changes to the database structure.
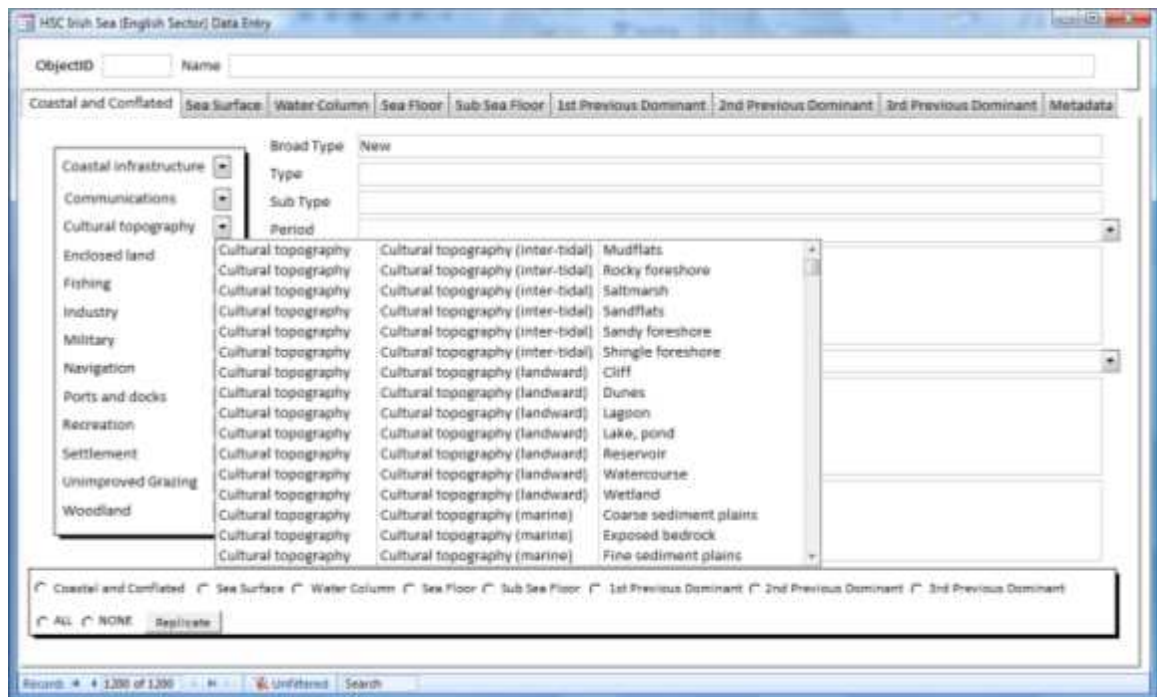
Figure 1.3. An example of a drop down list on the database entry form.

3.7.   INTERPRETATIVE CHARACTER ASSESSMENT

3.7.1.   MULTI-MODE CHARACTERISATION

The need for a multi-mode approach to HSC was demonstrated during the development of the HSC Method and accords with normal practice on land in HLC (Aldred & Fairclough 2003). An HSC 'Character Type' hierarchy was developed using a multi-mode approach based on and amalgamation of the Character Types produced during the five pilot projects.

HSC polygons define continuous and contiguous areas sharing dominant patterns of past cultural development and present historic cultural character. They were digitised using ArcGIS, with their attributes recorded in an Access database linked to the GIS. These attributes were related to three major categories:

1. The historic seascape 'Character Type' hierarchy (i.e. Broad Type, Type and Sub-type);
2. Present historic seascape character;

3. Previous historic seascape character.

The hierarchy compiled using that approach forms the basis of the structure consolidated in the national HSC Method (Tapper and Hooley 2010). The topological requirements for the project are as follows:

- polygons are to be discrete (No overlaps);
- polygons are to be contiguous (No gaps);
- all attributes are to be filled in where possible with 'N/A' used for empty entries as appropriate;
- every feature (point, line, polygon) should have at least one attribute record;
- there should be no slivers, dangles, knots or cross-overs;
- multi-part polygons are acceptable; they should have one set of attributes associated with them.

During the first phase of the GIS development process, data were combined into a single data layer using a combination of attribute-led descriptive characterisation, followed by a prescriptive phase of characterisation, once the data had been interpreted. The two approaches were used in combination across different parts of the project area. The approaches have however been described separately below for the sake of clarity. The characterisation for each marine level has thus been classified to reflect its dominant character to produce a set of continuous, discrete character polygons for each level. The character assessment was undertaken following the GIS workflow diagram published in the national HSC Method (Tapper and Hooley 2010).

Following the HSC Method the data sources and the information that they represent are used to inform the HSC assessment. This is used to identify the dominant historic seascape character and assess the variation across the vector grid. In this way, the relationship between source data and the final product is used to inform the initial stages of the HSC assessment.

The different phases of characterisation described in the national HSC Method have been applied and the results are described below.

3.7.2. DESCRIPTIVE ATTRIBUTION

The initial stage of characterisation involved the description and mapping of historic character at a Sub-character Type level, and the production of a series of intermediate source-based datasets/layers.

Each dataset was reviewed and assessed in the early stages of GIS development to determine the suitability of its contents based on its coverage, resolution, date of publication, comparison with other similar data sources and relationship to defining historic character. The same preliminary attribute structure was applied to all datasets upon their extraction from source data and was designed as follows:

- a temporary feature type field [SUB_CHAR]
- a source field [SOURCE]
- a period field [PERIOD]
- a notes field [NOTES]
- an internal unique identifier field [SSC_ID]

These fields were created alongside the baseline attributes required to populate core information on each feature or area. Where necessary, data were processed to produce a set of character polygons. The fields for each dataset in each data group were then populated as far as possible, reflecting the attribute-led stage of characterisation described in the national HSC

Method, to produce a range of datasets with matching fields, enabling features from different sources to eventually be brought together in a cohesive single dataset and given a definitive sub-character type. During this stage, the field [SUB_CHAR] was populated in a way that most closely described the features, enabling a considered approach to classification of the final selection of areas of character expression produced from a selection of different sources.

Data collated from non-digital sources such as geo-referenced paper maps and charts were digitised during this phase using the same descriptive attribute structure, to enable the data collated manually to be conflated with digital sources. Duplicate records between datasets were removed during this stage of the GIS development.

The methodology described follows the thought processes employed to organise the data in the first instance to facilitate the description of features and areas, in preparation for the assigning of character sub-types during the classification of contiguous areas of shared character. The approach to each group of data has been described below to inform English Heritage and future HSC projects.

3.7.3. BROAD CHARACTER TYPES

3.7.3.1. NAVIGATION

Data were collated from a range of sources including SeaZone Hydrospatial, historic maps and charts, OS MasterMap, sailing directions, and ALSF England's Shipping database (Wessex Archaeology 2003). Data on modern navigational activities was provided by SeaZone Solutions Ltd covering DfT Shipping Density data.

Navigational features: Modern defined navigational channels are recorded under S-57 charting standards and are therefore provided as part of SeaZone Hydrospatial and contemporary Admiralty Charts. All channel-related data including channel marker buoys, navigational lines, recommended route centrelines, and traffic separation zones were extracted from Hydrospatial and then Admiralty Charts so that they could be viewed as a group. The features defining the outlines of modern navigational channels and dredged channel areas were separated out, compiled into a single dataset and reattributed.

Historic charts were reviewed to identify areas where previous channels could be identified, as well as previous buoyage. Where possible, channel outlines were digitised from historic charts or extracted from Hydrospatial depth areas using historic data and documentary evidence as a guide in order to define their extent.

Navigation activity: The DfT shipping high density polygons were used as a base and the historic shipping routes network from the England's Shipping database. Where there was a lack of a route due to clipping of the data provided by SeaZone as DfT data were limited to 12nm Offshore, the navigation route was taken from Admiralty charts. In these instances a polygon was drawn extending from the DfT polygons out to the edge of the UK waters; these matched the breadth and trajectory of the routes represented by the DfT coverage. This was used to inform the dominant character in the selected gridded areas. England's Shipping database was used to identify previous character.

Ferry routes were recorded in SeaZone Hydrospatial, and were extracted, given a 200m buffer and reclassified. Those no longer in use were digitised from historic charts and OS maps using modern maps as a reference to accurately reflect the route. Historic records of ferry routes were used in the interpretation of previous historic seascape character.

Anchorages are recorded in modern and historic charts. The anchorage areas recorded in S-57 were extracted from SeaZone Hydrospatial while ALSF Navigational Hazards and historic charts were used as sources for gathering historical records of anchorages. The data gathered as point data in the first instance was given a 500m buffer, before those below MHW were fed through the grid.

Navigation hazards: Information on navigational hazards was sourced from a broad range of resources including SeaZone Hydrospatial, ALSF Navigational Hazards data (Merritt 2007), historic charts and sailing directions, NMR wrecks and obstructions, HER data, and OS MasterMap.

The UKHO and NMR both hold extensive wreck data repositories. SeaZone Hydrospatial holds the UKHO wrecks database, as well as a list of sites recorded in S-57. The NMR hold records of known wrecks, fishermen' fastenings, and reported losses. Duplicates exist between the S-57 records and UKHO records, as well as between SeaZone Hydrospatial and the NMR wrecks database. SeaZone Solutions Ltd assessed the existing data for the project area and manipulated it to provide a consistent dataset showing areas of wreck clusters. This was created by removing duplicates between UKHO and S57, and cross-referencing those results with the NMR data. A density analysis was run using ArcGIS Spatial Analyst across all UK wrecks, using a search area of 200m and an output cell size of 250m. The results were converted from raster to vector, removing the null value, into a single set of polygons areas that were then used to identify grid clusters that were assigned wreck character type.

Drying areas are defined by the fact that they lie above charted LAT and mapped MLW, these were identified by comparing rocky and sandy foreshore areas recorded in OS MasterMap and depth areas in SeaZone Hydrospatial. The ALSF Navigational Hazards project contained a series of historically mapped hazards which have been related to their modern equivalents (Merritt 2007). The project reviewed a broad range of historical charts for the entire English coast and was therefore considered sufficiently comprehensive to cover historic records of navigational hazards for the purposes of this HSC project. The characterisation of navigational hazards, and the original point data collated from geo-referenced historical maps and charts during the development of the project output, were used to support the characterisation. Shoals and flats were assessed from depth areas in SeaZone Hydrospatial, contemporary Admiralty Charts and historic charts. Rock outcrops, defined as areas within the intertidal zone which are permanently exposed or visible at low water, were assessed from their representation on Ordnance Survey maps.

Maritime Safety: The perception of historic cultural character may match or differ between land-based and maritime viewpoints. Features such as churches, distinctive hills and windmills, may also serve as navigational aids or daymarks, when interpreted from a maritime perspective. OS MasterMap, sailing directions and coastal views, historic charts and maps, and SeaZone Hydrospatial were used in combination to identify maritime safety features along the coast such as daymarks, lighthouses and beacons, coastguard and lifeguard stations. Features from the georeferenced historic charts and maps and as well as SeaZone Hydrospatial data were used to inform the maritime safety. The resulting datasets were then compared to remove duplicates and given descriptive attributes. Where necessary, points were buffered following the scale prescribed in the national HSC Method: a 250m buffer around the point, creating a 500m diameter circle. Buoys and beacons offshore were extracted from SeaZone Hydrospatial and used in some cases to demarcate the features they marked such as the edges of navigational channels or navigational hazards.

3.7.3.2.   INDUSTRY

Data was supplied by SeaZone Solutions Ltd and collated from a range of sources including UK Deal, SeaZone Hydrospatial and JNCC. As each dataset contains a range of industrial features, all features of potential relevance to the character of the coastal and marine landscape were extracted and buffered to produce polygons.

Extractive industries: Licensed aggregate dredging areas were defined by SeaZone Hydrospatial. Mines and quarries were mapped where a maritime character was identified, using OS MasterMap, supported by historical maps, HER and NMR records, documentary sources and HLC.

Energy Industry: All marine features relating to hydrocarbon extraction, including well-heads, pipelines, and oil and gas fields was taken from data supplied by UKDeal, and compared with data from SeaZone Solutions Ltd and UKHO. Hydrocarbon installations, recorded as points, were given a 500m buffer. Pipelines, depicted as polylines, were given a 250m buffer. Hydrocarbon refineries and power stations were identified along the coastline using a combination of OS MasterMap and HLC. Their extent was defined using an HLC polygon, where available. Where necessary that extent was defined by extracting and dissolving OS MasterMap polygons, before giving them a set of preliminary attributes.

Processing Industry: Marine spoil dumping grounds were mapped by SeaZone Solutions Ltd. All industrial areas along the coastal zone, including chemical works, iron and steel works, nuclear reprocessing, sewage works, spoil and waste dumping, and other production sites, were identified using a combination of OS MasterMap, historic maps and HLC. Their extent was then defined using an HLC polygon. Where necessary that extent was defined by extracting and dissolving OS MasterMap polygons, before giving them a set of preliminary attributes. The same approach was used to define all industrial areas along the coastal zone, including chemical works, production areas and sewage works.

Shipping Industry: Boat yards and ship yards were identified using a combination of OS MasterMap, historic maps and HLC. Their extent was defined using an HLC polygon where available. Where necessary that extent was defined by extracting and dissolving OS MasterMap polygons, before giving them a set of preliminary attributes.

3.7.3.3.   FISHING

Several datasets were used to determine fishing activities within the project area. This included data that was supplied by SeaZone Solutions Ltd and from already-processed positional data for fishing vessels derived from EC vessel monitoring system (VMS). Both the SeaZone and VMS data was classified on the basis of gear type in a broad way, and discriminated between different sub-types of activity that was used to define historic seascape character. It must be noted that the data used was the product of a research project and does not reflect an official Defra description of fishing activity. To supplement the spatial distribution several other sources were used. This included CEFAS fishing pressure which measures fishing effort and its effect on the biodiversity of the sea and the impact of fishing activities on the seabed (Eastwood *et al.* 2007). In addition to this GIS model, Albert Close's Fishermen's Chart (from UKHO dated to 1938) was georeferenced into ArcGIS and used as an indicator of different kinds of fishing activities that supported the characterisation. Oral history data that has been transcribed and drawn on from several books, was also an inspirational source for characterising the fishing areas (http://communityfishingheritageuk.wikispaces.com/Catcher%27s+angle; Butcher 1979, 1982).

3.7.3.4.   PORTS, DOCKS AND HARBOURS

Formal 'harbour areas' reflect the water on the approaches to a harbour or dock and are essentially an administrative area whose regulations control the activities taking place within it. These are defined in SeaZone Hydrospatial under S-57 and were therefore extracted and reclassified.

Coastal features relating to the shipping industry, such as wet docks, dockyards, shipyards, boat yards, etc. were defined using a combination of modern and historic OS mapping to identify the extents and ages of different parts of ports and harbours. In Hull, there were several dockyards and wet docks that were indicated on Historic OS maps, but on present-day OS maps were incorporated into the urban fabric. These were therefore defined as docks under Previous character.

3.7.3.5. COASTAL INFRASTRUCTURE

Data on flood and erosion defences were supplied by SeaZone Solutions Ltd and taken from SeaZone Hydrospatial data. Other information was taken from OS MasterMap and historic maps. Where necessary that extent was defined by extracting and dissolving OS MasterMap polygons, before giving them a set of preliminary attributes.

The definition of Sea Defences was enhanced to include areas of flood defence that were located in the Inshore area, such as in the locality of Happisburgh.

3.7.3.6. COMMUNICATIONS

Transport: Information on transport systems were extracted from OS MasterMap and HLC, NMR and HER records, and documentary sources. Where possible, polygons were isolated. Data reflected as polylines were given a 50m buffer either side of the polyline, which was digitised from OS 1:25,000 as well as extracted from NMR. Roads were defined where they were found to be key to the maritime character of an area, and were given a 50m buffer. The HLC databases within the project area were used to inform the assessment of the dominance of major roads over their surrounding character types, although few HLC projects in the study area had included roads as a defined character type except motorways.

Telecommunications: Information on submarine telecommunications cables was extracted from SeaZone Hydrospatial, and supplied by SeaZone Solutions Ltd. It was supplied as polylines, and was given a 500m buffer, before being fed through the grid. The data was also checked against KingFisher Cable Awareness Charts (North Sea South & North Sea Central [Dec 2011], http://www.kis-orca.eu/map#.UVq9WqK-2uI).

3.7.3.7. MILITARY

Character areas relating to military activity were drawn from a wide range of sources including OS MasterMap, SeaZone Hydrospatial, historic maps and charts, NMR, HER and HLC data and documentary sources. Ordnance dumping grounds and military practice areas in Inshore and Offshore areas were extracted from SeaZone Hydrospatial and supplied by SeaZone Solutions Ltd.

Military practice areas were restricted to firing ranges, located in Coastal, Intertidal and Inshore areas. Coastal areas included other types of military areas such as airfields, military bases, military coastal defences, fortifications, 20th century firing ranges. These were defined using OS MasterMap, historic maps and HLC polygons. SeaZone Hydrospatial, HER and NMR data and historical maps were used to assess suitable extents reflecting both present and previous historic character.

3.7.3.8. SETTLEMENTS

The extents of towns and villages were defined by taking the overall settlement perimeter as defined in OS MasterMap, and HLC (where available) to provide context to the characterisation. The concentration in settlement around harbours, estuaries and industrial or recreational centres along the coast is a significant indicator of the scale of human activity activities within an area.

3.7.3.9.   RECREATION

Recreational areas on land such as golf courses, holiday parks, recreational open ground, or parks and gardens, etc. where a maritime character could be identified, were defined using OS MasterMap, supported by SeaZone Hydrospatial, historical maps and HLC, HER and NMR data. Large resorts were located along the entire stretch of the Lincolnshire coast. OS MasterMap polygons were used to define leisure beaches, promenades, areas of seaside entertainment, pleasure piers, and other recreational areas.

3.7.3.10.   CULTURAL TOPOGRAPHY

Palaeolandscape component: data for palaeolandscape components, palaeochannels, submerged forests and peat deposits were drawn from HER and NMR records in the first instance, as well as references in documentary sources. Further information was obtained from ABPmer and the ALSF-funded project, North Sea Palaeolandscapes. Both of these sources were invaluable in identifying significant areas of palaeolandscape areas in the marine zone.

This included the southern areas of Dogger, as well as Silver Pits (Inner and Outer), and topographic features such as lakes (wetlands) and valleys. A compiled dataset from available evidence about the spatial extents of palaeolandscape data was created by ABPmer. This data was used to characterise a suggested 10,000 BP extent of the land bridge that connected the British Isles to mainland Europe. The ALSF North Sea Palaeolandscapes project was used to identify specific topographic features in the palaeolandscape characterisation; such as wetland (low lying ground) and ridges. Research into palaeoenvironments is increasing and future reviews of HSC databases will need to be aware of the results of future research when updating.

Cultural topography (landward): in coastal areas, such areas as water bodies, cliffs, dunes, wetland etc. were identified using a range of sources including OS MasterMap, HLC, historic maps and charts, Natural England's GIS Digital Boundary Datasets, aerial photographs and documentary sources. Aerial photographs proved particularly useful in identifying areas of this Character Type, whose cultural dimension is brought out in the texts accompanying the GIS.

Cultural topography (inter-tidal): in intertidal areas, areas such as salt marsh, sandy or rocky foreshore, mudflats and sandflats, were identified using a range of sources including OS MasterMap, HLC, historic maps and charts, Natural England's GIS Digital Boundary Datasets, aerial photographs and documentary sources. Aerial photographs and GoogleEarth satellite imagery proved useful for identifying the character of these areas, whose cultural dimension is brought out in the texts accompanying the GIS.

Cultural topography (marine): sources for these Character Types in Inshore and Offshore areas were provided by SeaZone Solutions Ltd, informed by data based primarily on BGS seabed sediments (SBS250) which is of a finer resolution than UK SeaMap. Data was queried using the UKSeaMap classification as a guide to produce a set of attributed polygons for each cultural topography Character Sub-type (fine sediment plains, exposed bedrock, coarse

sediment plains, etc.), whose cultural dimension is brought out in the texts accompanying the GIS.

3.7.3.11. WOODLAND

Data for woodland were drawn from HLC and OS MasterMap, historic maps and charts, Natural England's GIS Digital Boundary Datasets, aerial photographs and documentary sources. Only woodland which could be demonstrated to have a maritime character was characterised. Significant areas of woodland, indicated on historic charts from UKHO, were used to identify present-day character of woodland areas that had a seascape character. Due to their inclusion on Admiralty charts, these areas of woodland were being used as notional landmarks, supplementing the established navigational aids such as church towers and spires, beacons and lighthouses.

3.7.3.12. RECLAIMED LAND

Data for reclamation from tidal marsh, the sea and from wetland were drawn from HLC and OS MasterMap, historic maps and charts, Natural England's GIS Digital Boundary Datasets, aerial photographs and documentary sources. There were extensive areas of reclaimed land in project Area 2, but only land which could be demonstrated to have a maritime character was characterised, often indicated by activities spatially associated with this type. Areas included the Norfolk Broads (not already characterised), The Wash, and parts of the Humber region. Most of the Fenland and Humber Wetland areas were once reclaimed land, but to what extent this still has an active presence in determining its present-day historic seascape character has been discussed above (see 3.1 above). The landward Fenland area, inland from the sea banks that are characteristic of this region, was characterised on the basis that further evidence about the seascape character will be refined and enhance in the future.

3.7.3.13. UNIMPROVED GRAZING

Data for rough grassland, scrub and heathland were drawn from HLC and OS MasterMap, historic maps and charts, Natural England's GIS Digital Boundary Datasets, aerial photographs and documentary sources.

3.7.4. PRESCRIPTIVE CLASSIFICATION

From the descriptive assessment, data was reviewed in groups of related features and, based on the comparison and interpretation of the descriptive attributes, it was accorded a Sub-character Type, either from an appropriate term previously used in HSC or, if none was felt appropriate, a new term was created; no new terms were proposed by this project. This process combined descriptive and prescriptive classification.

The higher level classifications in the hierarchy, Character Type and Broad Character Type, were assigned prescriptively and auto-populated in accordance with the HSC Method Statement. The characterisation process above LAT and below LAT required slightly different approaches because of the differences in data processing required. Both approaches were undertaken following the national HSC Method Statement and treatment of sources remained the same. Once grouped into Sub-character Types, the datasets were then attributed with Coastal, Intertidal, Inshore or Offshore, and assessed with respect to the datasets for the following stages of characterisation. The results were then brought together to form a single, coherent data set.

Characterisation occurred in two parts, divided into Inshore and Offshore on the one hand, and Coastal and Intertidal areas on the other. The Inshore and Offshore areas used a 250m^2 cell grid across the whole of the study area, which was then characterised by correlating other

data sets with the centroid location of each cell. This resulted in a diverse but clearly defined basis for the character assessment. Furthermore, the data for Inshore and Offshore areas was grouped to reflect the marine level of the seascape (Sea-surface, Water column, Sea-floor, Sub-sea floor) to which they relate.

The data for each level was then combined using a vector grid. This approach uses the principles of a raster spatial data model while enabling the association of vector attributes with individual cells, allowing each cell to be characterised. The transfer of information to grid cells was undertaken as stipulated in the HSC Method. Following the removal of duplicates, consolidation of features of similar types into a single data layer and descriptive attribution, all Inshore and Offshore data was gridded using the vector cells produced using the SeaZone-created grid. The datasets needed to be buffered in the first instance using the same value of the grid-cell size to ensure that the cells populated reflected the underlying polygons. In addition, features of the same Sub-character Type which shared a boundary therefore had to be dissolved to create a single area. This also restricted the integration of more than a single Sub-character Type at a time. Each data subgroup was processed separately in the first instance and gridded before being combined with other data. Once joined, the output cells were dissolved based on the recurring attributes of each dataset.

The Coastal and Intertidal areas used spatial data to build polygons that were derived from OS MasterMap and HLC polygons. The baseline data from which polygons were created, were then used in associated with a broad range of data sources to identify and interpret character and its extent. The Coastal and Intertidal areas used spatial data to build polygons that were derived from OS MasterMap and HLC polygons. The baseline data from which polygons were created, were then used in association with a broad range of data sources to identify and interpret character and its extent.

The Coastal and Intertidal areas were characterised using the conventional HLC method, without the complexity of spatial correlations operating at multiple marine levels. Rather than using a 250m^2 grid, the spatial data used to build polygons were derived from OS MasterMap and HLC polygons. The baseline data from which polygons were created, were then used in association with a broad range of data sources to identify and interpret character and its extent. This involved reviewing historic and modern mapping and charting in the same data frame, while referring to aerial photographs, HER and NMR records, and the sub-groups of features collated during the descriptive phase of characterisation. Data were selected to assess the character, time-depth and extent of each polygon. Once the boundary to a polygon had been defined, OS MasterMap polygons which made up the area were selected and dissolved into a single polygon. A Sub-character Type term was then applied, either from the existing HSC terminology, or using an entirely new term to most appropriately matched the character of the polygon's collated features. Where features overlapped, an assessment of dominance was made for the intersecting areas. Where possible, areas were identified as having a distinct marine or maritime character through the review of a wide range of sources, using the spatial extents defined by OS MasterMap or HLC polygons. However, where features were not identifiable from these latter two sources, these Sub-character Types were defined by integrating features from other sources, such as historic maps and charts.

The HSC assessor worked first in the Inshore and Offshore areas before characterising the Coastal and Intertidal areas. Once the project area had been digitised, it was consolidated into a single data layer and classified using Sub-character types. Data groups reflecting individual Sub-character types were consolidated into the levels reflecting the different principle layers of the marine landscape.

Once all datasets had been treated in this way, they were unioned bringing each layer in at a time, applying Sub-character Type attribution based on the descriptive attributes, and making an assessment of dominance wherever overlaps occurred. In instances where a Character Type or Sub-character Type was not recorded in the list provided in the national HSC Method, a proposal for an appropriate new Sub-character Type was circulated to EH Characterisation Team and the other concurrent HSC projects for comment and agreement before being added to the HSC MS 'Hierarchy of Character Types'. That approach was to ensure consistency across all projects contributing to the national HSC database. Where more than one polygon overlapped with a vector cell, a decision was made by the assessor with regard to which was predominant. The GIS tool developed to facilitate the gridding process tackles the issue of which polygon occupies most of the cell area by identifying the polygon(s) which overlaps with the centroid of each cell. The use of centroids to identify overlaps resolves the problem as the cells overlapping two adjoining polygons will adopt the attributes of the one which intersects with its centre point. However if that still results in a cell's centroid overlapping with more than one polygon, then the HSC assessor made an assessment of dominance according to the guidance set out in the HSC Method Statement.

All data relating to a marine level was unioned and interpreted to create a single set of discrete polygons. Data reflecting the historic character of areas within each marine level was then integrated through a combination of spatial joins, unions and spatial queries (where the boundaries of areas of distinct historic character had already been defined). Time depth is reflected in the character assessment through the differentiation between present HSC and previous HSC within the attributes, and the recording of a benchmark period reflecting the *origin* of the activity represented for each of the levels and the conflated character groups. The fields were populated using a series of unions of historic character polygons with the completed characterisation of present character sub-types. Once the interpretation for each marine level was completed, HSC polygons for the intertidal and coastal areas were unioned with the Inshore and Offshore character polygons to produce a single layer of HSC character types for each level.

To ensure that the geometries produced were as clean as possible, slivers were removed and the polygons for each marine level were dissolved by HSC attribute fields to ensure that all polygons with identical attributes were brought together in a single polygon. During Stage 4, the four marine levels were brought together as a single set of polygons for the conflated characterisation, using the same process of unions used to construct each level. The HSC assessor identified the dominant character between the different marine levels in order to populate the Present Sub-Character Type. A prescriptive attribution process was then applied to automatically populate the Character Type and Broad Character Type based on the classification hierarchy structured around the Sub-character Types. Historic character was then ascribed based on the attributes within the marine levels. The output of this phase is a single layer of discrete polygons for each marine level, which have been reclassified to reflect a single layer of Sub-character Type expressions. The attributes collated during the descriptive phase of the method were used to populate the field structures drawn for each marine level.

The final attribute structure for the HSC was drawn from the national Method Statement (Tapper and Hooley 2010, 43-45). Each level contains the attributes relevant to that level in order to reduce the number of empty fields where possible, while the conflated level contains the full set of fields as shown in Table 3.

Attribute Name	Description and guidance, terminology	GIS database alias	Population Method	Format	Width
ObjectID	Unique reference number for HSC polygon/grid cell	FID	automated	numeric	10
Name	Name of area or topographic identifier, local or popular name	NAME	manual	string	100
Coastal and Conflated Broad Character Type	Broad Character Type (present, dominant; national strategic level). Landward (above MHW) this will relate to coastal land HSC, whereas seaward it will relate to the 'conflated' HSC as derived from the marine levels.	CC_BDTY, CONF_BDTY	automated	string	100
Coastal and Conflated Character Type	Character type (present, dominant; regional level). Landward (above MHW) this will relate to coastal land HSC, whereas seaward it will relate to the 'conflated' HSC as derived from the marine levels.	CC_TY, CONF-TY	automated	string	100
Coastal and Conflated Sub Character Type	Sub-character type (present, dominant; local level). Landward (above MHW) this will relate to coastal land HSC, whereas seaward it will relate to the 'conflated' HSC as derived from the marine levels.	CC_SBTY, CONF_SBTY	manual	string	100
Coastal and Conflated HSC Period	Benchmark period of origin of the area represented in the polygon or cell. Recorded for present historic character. Landward (above MHW) this will relate to coastal land HSC, whereas seaward it will relate to the 'conflated' HSC as derived from the marine levels.	CC_PRD, CONF_PRD	manual	string	50
Coastal and Conflated HSC Source	Sources used to identify present and previous historic character. Attribute values to record supplier, date, precise GIS file name. To include reference to the scale of original data used. Landward (above MHW) this will relate to coastal land HSC, whereas seaward it will relate to the 'conflated' HSC as derived from the marine levels.	CC_SRC, CONF_SRC	manual	string	250
Coastal and Conflated HSC Confidence	Degree of certainty/confidence of HSC interpretation of present historic character. Landward (above MHW) this will relate to coastal land HSC, whereas seaward it will relate to the 'conflated' HSC as derived from the marine levels.	CC_CNF, CONF_CNF	manual	string	25
Coastal and Conflated HSC Notes	Further background information on history of the polygon. Expansion on information recorded at broad character and sub-character levels.	CC_NTS, CONF_NTS	manual	string	250
Coastal and Conflated	URL hyperlink to Character Type texts and multi-media. Landward (above MHW) this will record coastal land	CC_LINK, CONF_LINK	manual	string	250

HSC Link	HSC, whereas seaward it will record the 'conflated' HSC as derived from the marine levels.				
Sea-surface HSC sub-type	Present and dominant historic character of the sea- surface (recorded at sub-character, character and broad character levels)	SSRFC_SBTY	manual	string	100
Sea-surface HSC type		SSRFC_TY	automated	string	100
Sea-surface HSC broad-type		SSRFC_BDTY	automated	string	100
Sea-surface HSC Period	Benchmark period of origin of the area represented in the polygon. Recorded for present historic character levels and previous historic character	SSRFC_PRD	manual	string	50
Sea-surface HSC Source	Sources used to identify historic character. Attribute values to record Supplier, Date, precise GIS file name. To include reference to the scale of original data used.	SSRFC_SRC	manual	string	250
Sea-surface HSC Confidence	Degree of certainty/confidence of HSC interpretation of present historic character.	SSRFC_CNF	manual	string	25
Sea-surface HSC Notes	Further background information on history of the polygon. Expansion on information recorded at broad character and sub-character levels.	SSRFC_NTS	manual	string	250
Sea-surface HSC Link	URL hyperlink to Character Type texts and multi-media	SSRFC_LINK	manual	string	250
Water Column HSC sub- type	Present and dominant historic character of the water- column (recorded at sub-character, character and broad character levels)	WTRCL_SBTY	manual	string	100
Water Column HSC type		WTRCL_TY	automated	string	100
Water Column HSC broad-type		WTRCL_BDTY	automated	string	100
Water Column HSC Period	Benchmark period of origin of the area represented in the polygon cell.	WTRCL_PRD	manual	string	50
Water Column HSC Source	Sources used to identify historic character. Attribute values to record Supplier, Date, precise GIS file name. To include reference to the scale of original data used.	WTRCL_SRC	manual	string	250
Water Column HSC Confidence	Degree of certainty/confidence of HSC interpretation of present historic character.	WTRCL_CNF	manual	string	25

Water Column HSC Notes	Further background information on history of the polygon. Expansion on information recorded at broad character and sub-character levels.	WTRCL_NTS	manual	string	250
Water Column HSC Link	URL hyperlink to Character Type texts and multi-media	WTRCL_LINK	manual	string	250
Sea-floor HSC sub-type	Present and dominant historic character of the sea- floor (recorded at sub-character, character and broad character levels	SFLR_SBTY	manual	string	100
Sea-floor HSC type		SFLR_TY	automated	string	100
Sea-floor HSC broad-type		SFLR_BDTY	automated	string	100
Sea-floor HSC Period	Benchmark period of origin of the area represented in the polygon cell.	SFLR_PRD	manual	string	50
Sea-floor HSC source	Sources used to identify historic character. Attribute values to record Supplier, Date, precise GIS file name. To include reference to the scale of original data used.	SFLR_SRC	manual	string	250
Sea-floor HSC Confidence	Degree of certainty/confidence of HSC interpretation of present historic character.	SFLR_CNF	manual	string	25
Sea-floor HSC Notes	Further background information on history of the polygon. Expansion on information recorded at broad character and sub-character levels.	SFLR_NTS	manual	string	250
Sea-floor HSC Link	URL hyperlink to Character Type texts and multi-media	SFLR_LINK	manual	string	250
Sub sea-floor HSC sub-type	Present and dominant historic character of the sea- bed (recorded at sub-character, character and broad character levels)	SBFLR_SBTY	manual	string	100
Sub sea-floor HSC type		SBFLR_TY	automated	string	100
Sub sea-floor HSC broad-type		SBFLR_BDTY	automated	string	100
Sub-sea floor HSC Period	Benchmark period of origin of the area represented in the polygon cell.	SBFLR_PRD	manual	string	50
Sub-sea floor HSC Source	Sources used to identify historic character. Attribute values to record Supplier, Date, precise GIS file name. To include reference to the scale of original data used.	SBFLR_SRC	manual	string	250
Sub-sea floor HSC	Degree of certainty/confidence of HSC interpretation of present historic	SBFLR_CNF	manual	string	25

Confidence	character.				
Sub-sea floor HSC Notes	Further background information on history of the polygon. Expansion on information recorded at broad character and sub-character levels.	SBFLR_NTS	manual	string	250
Sub-sea floor HSC Link	URL hyperlink to Character Type texts and multi-media	SBFLR_LINK	manual	string	250
Previous HSC Type	Previous historic character for which evidence is available. Recorded for multiple time-slices on basis of source dataset.	PRVS_SBTY1, 2 etc	manual	string	100
Previous HSC Period	Benchmark period of origin of the area represented in the polygon. Recorded for present historic character levels and previous historic character	PRVS_PRD1, 2 etc	manual	string	50
Previous HSC Source	Sources used to identify previous historic character. Attribute values to record Supplier, Date, precise GIS file name. To include reference to the scale of original data used.	PRVS_SRC1, 2 etc	manual	string	250
Previous HSC Confidence	Degree of certainty/confidence of HSC interpretation of previous historic character.	PRVS_CNF1, 2 etc	manual	string	25
Previous HSC Notes	Further background information on history of the polygon. Expansion on information recorded at broad character and sub-character levels.	PRVS_NTS1, 2 etc	manual	string	250
Previous HSC Link	URL hyperlink to Character Type texts and multi-media	PRVS_LINK1, 2 etc	manual	string	250
Character Area	Unique character area	CA1, CA2 etc	manual	string	100
Location	General location (e.g. Offshore marine, Inshore marine, estuary, coast etc)	LCTN	manual	string	50
Shape_Area	Area in map units (usually metres square) covered by polygon.	AREA	automated	string	9.9
Cell/grid size	Size of grid used for marine zone (e.g. 100mx100m, 500mx500m etc)	CELL_SZ	manual	numeric	5
Creation Date	Date of dataset /polygon creation/completion.	CRT_DT	manual	string	10
Creator	Name of the person/organisation who compiled the HSC	CRTR	automated	string	250

Table 3. Attribute field structure outlined in the National HSC Method Statement

3.7.5. DEVELOPMENT OF CHARACTER TYPE TEXT DESCRIPTIONS

Brief structured summary texts were written in accessible language relating to the character type hierarchy to inform users of all levels of the HSC GIS database. In particular, they are designed to facilitate understanding of the HSC by others, providing a connection and initial

stimulus for various future applications of the database, as noted in the national HSC Method Statement. The characterisation of shared trends in the definition, distribution and regional significance of feature types, and their relationships with natural processes in the environment are a fundamental output of HSC. The analysis and interpretation of these trends is fundamentally a perceptual process, informed from a combination of baseline information and documentary resources.

A text-based description was developed for each Character Type using the structure proposed in the national HSC Method (Tapper and Hooley 2010) under the following headings:

- Introduction: defining/distinguishing attributes and principal locations
- Historical processes; components, features and variability
- Values and perceptions.
- Research, amenity and education
- Condition and forces for change
- Rarity and vulnerability
- Sources

For each Character Type, text descriptions encompassed both a national and a regional perspective. The individual Character Types expressed in polygons within the GIS have a hyperlink to the text descriptions, and provide the basis for a stand-alone awareness-raising resource which may be produced in the future. The texts have been designed to inform users on the character of the historic landscape at a range of scales. They can be used as an outreach tool, as well as being designed for use in GIS alongside other marine and coastal datasets to inform a broad range of applications. The text descriptions for each Character Type are contained within Section 3 of this Project Report.

4. PROJECT PRODUCTS AND DISSEMINATION

4.1. PROJECT OUTPUTS

The outputs of the project include a leaflet and webpage (http://www.ncl.ac.uk/historical/research/project/4302) providing background information on the project, the Project Report and a mapped GIS project database with linked texts. This Project Report is divided into three sections. The first section documents the project's implementation, the second outlines the System's application review and case-studies, and the third contains the Appendices with Character Type Text Descriptions.

The project archive comprises the project leaflet, the webpage, Project Brief, Project Design, Project Report, the GIS and associated structure, and relevant correspondence. Digital data from the project will be sent by English Heritage to the Archaeological Data Service (ADS) for dissemination online after the close of the project.

4.2. PROJECT GIS

The HSC GIS generated by this project covers many Character Types, Sub-types and their attributes, expressed across a large physical area. A series of images have been included below to illustrate the expression of Character Types at each marine level and in a conflated map. However, as for any GIS, the database can be queried on a multiplicity of combinations of the attributes and generate a range of mapping tailored to suit the needs of the enquirer. The mapping below cannot convey that flexibility or the use of the mapping in conjunction with the linked text descriptions produced by the project.

The GIS and its associated database are in the form of an ESRI Personal Geodatabase alongside linked character text descriptions. Data is designed to be viewed at 1:50,000. All

data is compliant with MIDAS standards, and all metadata is UK Gemini compliant, and encoded according to ISO 19139.

4.3. TEXT DESCRIPTIONS

Text based descriptions were developed for each Character Type, written in non-technical language and consistently structured as discussed in 3.7.5 above.

The text descriptions present each Character Type in terms both of a National perspective and a Regional Perspective. The term 'National' here refers to England and England's Inshore and Offshore Areas. Character Type texts giving that National Perspective were inherited from the previous HSC Implementation Projects and updated by this project in respect of the nationally relevant historic character contributions present in its Project Areas. This Project's main area, Area 2 (see figure 1.1), extends wholly or in part across two Regions: East Anglia and East Yorkshire to The Wash. As a result, it has generated two sets of 'Regional Perspective' texts. The East Anglia Region was already partly covered by Newport to Clacton HSC project, and it included an area from Clacton to King's Lynn. Texts initially created for that Region by that earlier project were updated by this project for the additional area it covered. The second Region, East Yorkshire to The Wash, was covered entirely by the project being reported here. The text descriptions have been compiled as Word documents which allow the information to be exported as .html files. The texts are available in Section 3 of the report.

The rationale underlying the boundary between the project area's two regions follows an inherited decision that was taken during the Newport to Clacton HSC project to enable it to compile its provisional East Anglia Region Character Type texts. Following the advice and local knowledge of its Project Officer, the western limit of the East Anglia Region along coastal land was taken as extending to and including, King's Lynn. West of King's Lynn, coastal land around The Wash, together with The Wash itself, are taken as part of the East Yorkshire to the Wash Region. Beyond these regions' coastal limits on land, their mutual boundary across the Inshore and Offshore Regions is not intended to be a viewed as a hard one. The perception of regional boundaries is far more marked on coastal land, rapidly becoming highly diffuse across the Inshore and Offshore Regions where activities such as fishing undertaken by those from neighbouring or more distant differing coastal regions may overlap considerably. Accordingly, beyond coastal land, HSC's regional 'boundaries' are 'fuzzy' and broad, not intended to be seen as narrow linear divides between exclusive territories. The subsequent Section 3 report discusses the different character types within each of the two regions.

4.4. DISSEMINATION AND OUTREACH

The project has been promoted via the Newcastle University website through the development of an HSC project page. A flyer was developed for distribution at appropriate events. Opportunities were taken where appropriate to disseminate the progress and results of the project at seminars or conferences, primarily through the distribution of project fliers. Events attended included the Society for Historical Archaeology, at University of Leicester where aspects of the project were presented. Furthermore, the HSC assessor visited UKHO and Cornwall County Council in preparing for the characterisation work.

Key

Coastline and main rivers

—— Coastline and main rivers

HSC Character types

Aggregate dredging
Aggregate quarrying
Anchorage
Ancient woodland
Barracks
Bottom trawling
Bridge
Buoyage
Canal
Chemical works
Civilian airfield
Clay and mud extraction
Cliff
Daymark
Dockyard (civilian)
Drift netting
Dunes
Early modern fortification
Firing range (land)
Fish trapping
Fishing ground
Fixed netting
Flood defence
Golf course
Harbour
Hazardous water
Holiday park
Hydrocarbon installation
Hydrocarbon pipeline
Hydrocarbon refinery
Industrial production (unspecified)
Lagoon
Lake, pond
Leisure beach
Leisure sailing
Lighthouse
Longlining
Medieval fortification
Military airfield
Military practice area
Mining (other)

Mudflats
Navigation channel (active)
Navigation channel (disused buried)
Navigation route
Parks and gardens
Plantation
Pleasure pier
Port
Potting
Power station (fossil fuel)
Quarrying
Quay
Railway
Reclamation from sea
Reclamation from tidal marsh
Reclamation from wetland
Recreation open ground
Renewable energy installation (wind)
Reservoir
Road
Rocky foreshore
Roman fortification
Rough grassland
Safety services
Saltmaking
Saltmarsh
Sand banks with sand waves
Sandflats
Sandy foreshore
Scrub
Sea defence
Seaside entertainment
Seine netting
Sewage works
Shingle foreshore
Shoals and flats
Spoil & waste dumping
Submarine power cable
Submarine telecommunications cable
Town
Village
WW1 fortification
Warehousing
Watercourse
Wet dock

Wetland
Wildlife watching
Working pier
Wreck hazard

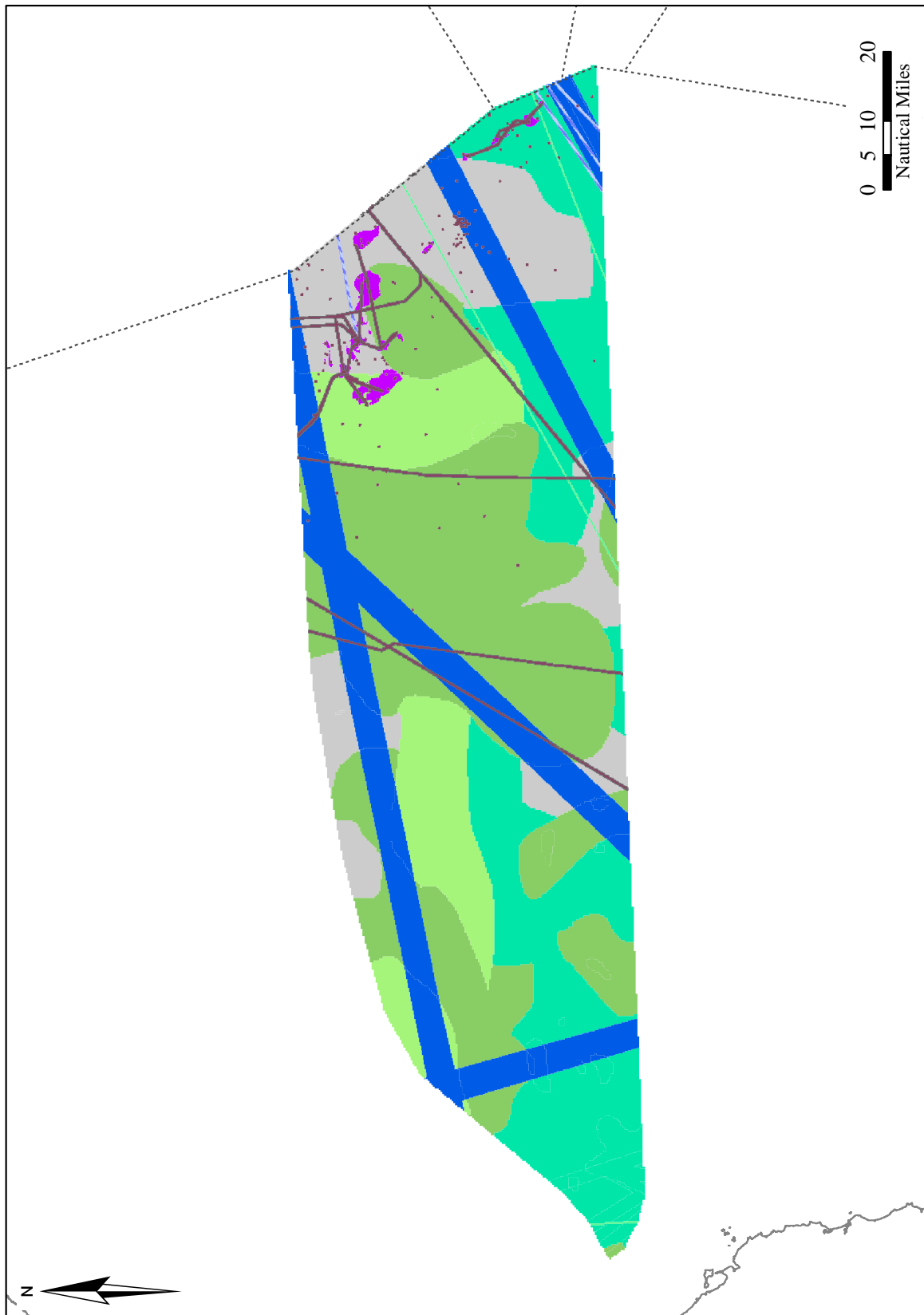*Figure 1.4. East Yorkshire to Norfolk HSC Key (Symbology).*

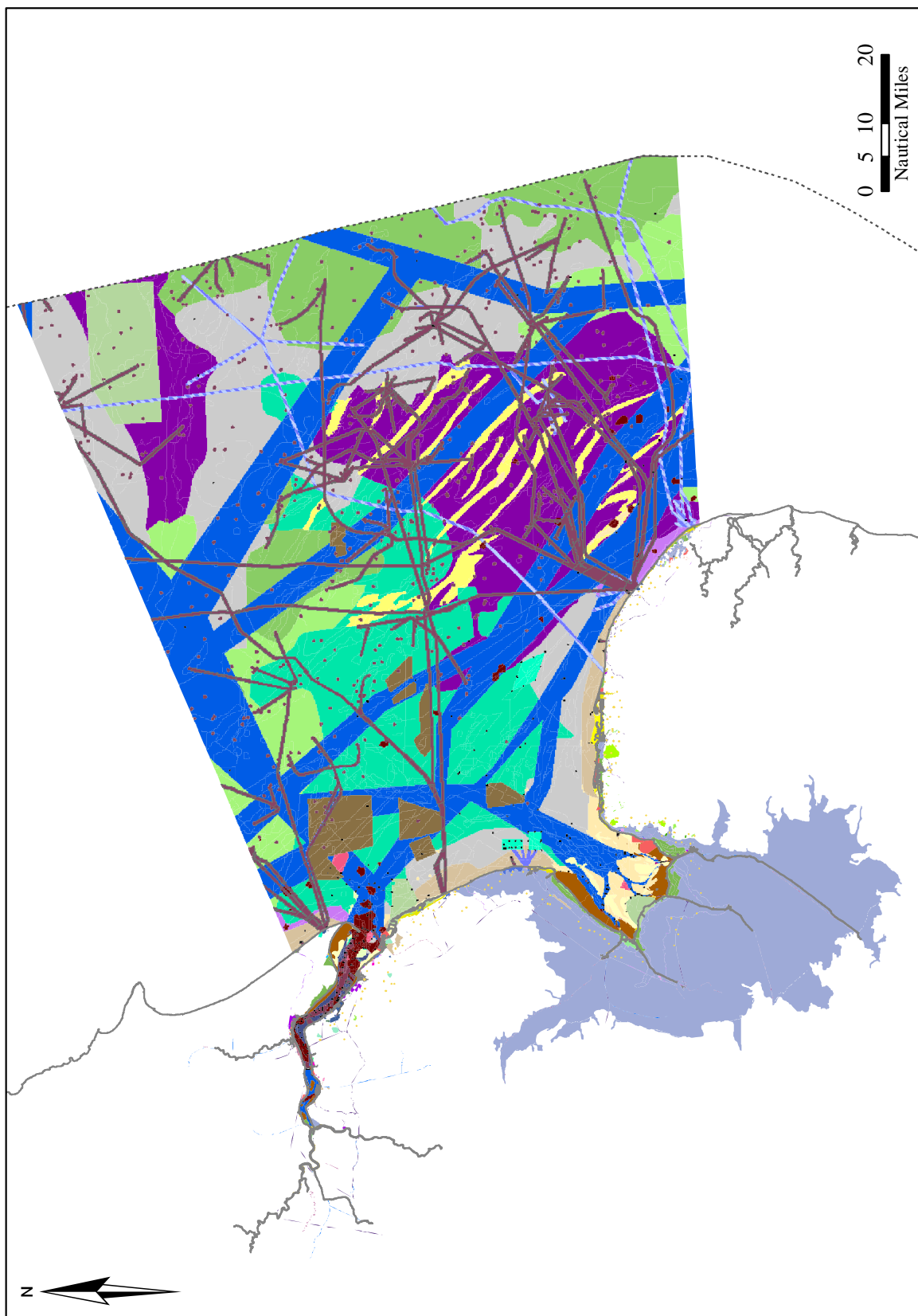*Figure 1.5. Area 1 – Conflated Sub-character Types.*

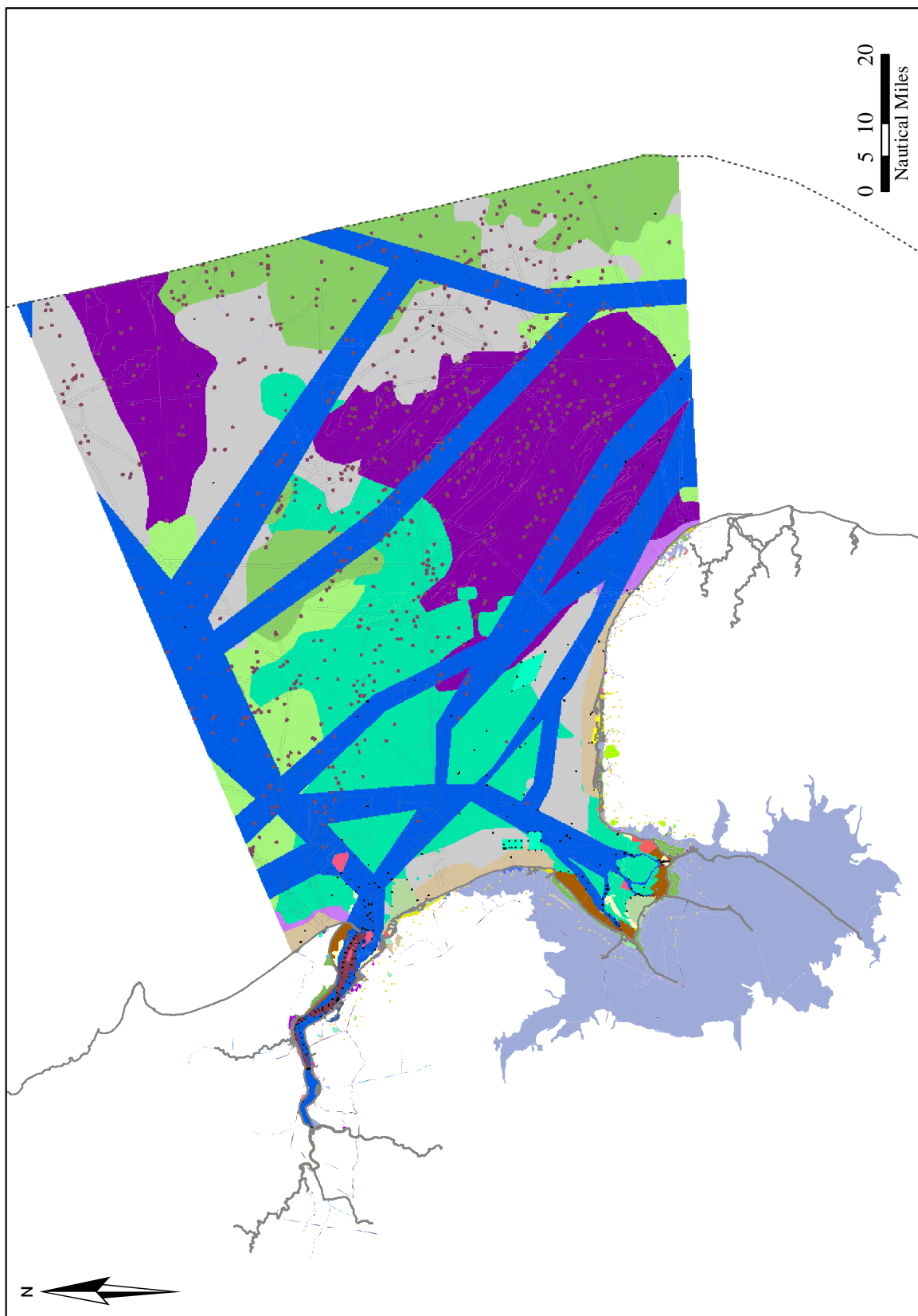*Figure 1.6. Area 2 - Coastal and Conflated Sub-character Types.*

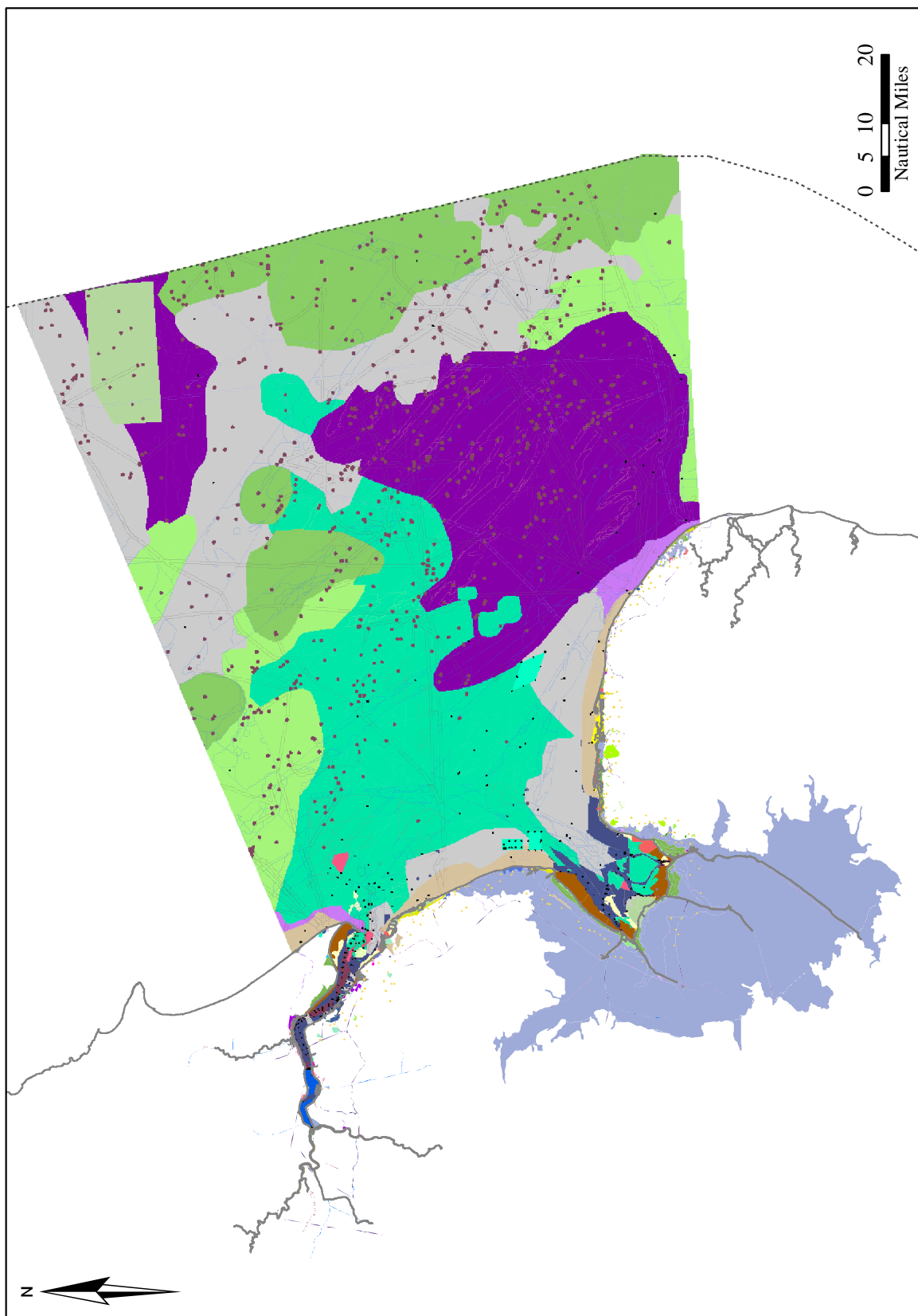*Figure 1.7. Coastal and Sea surface Sub-character Types.*

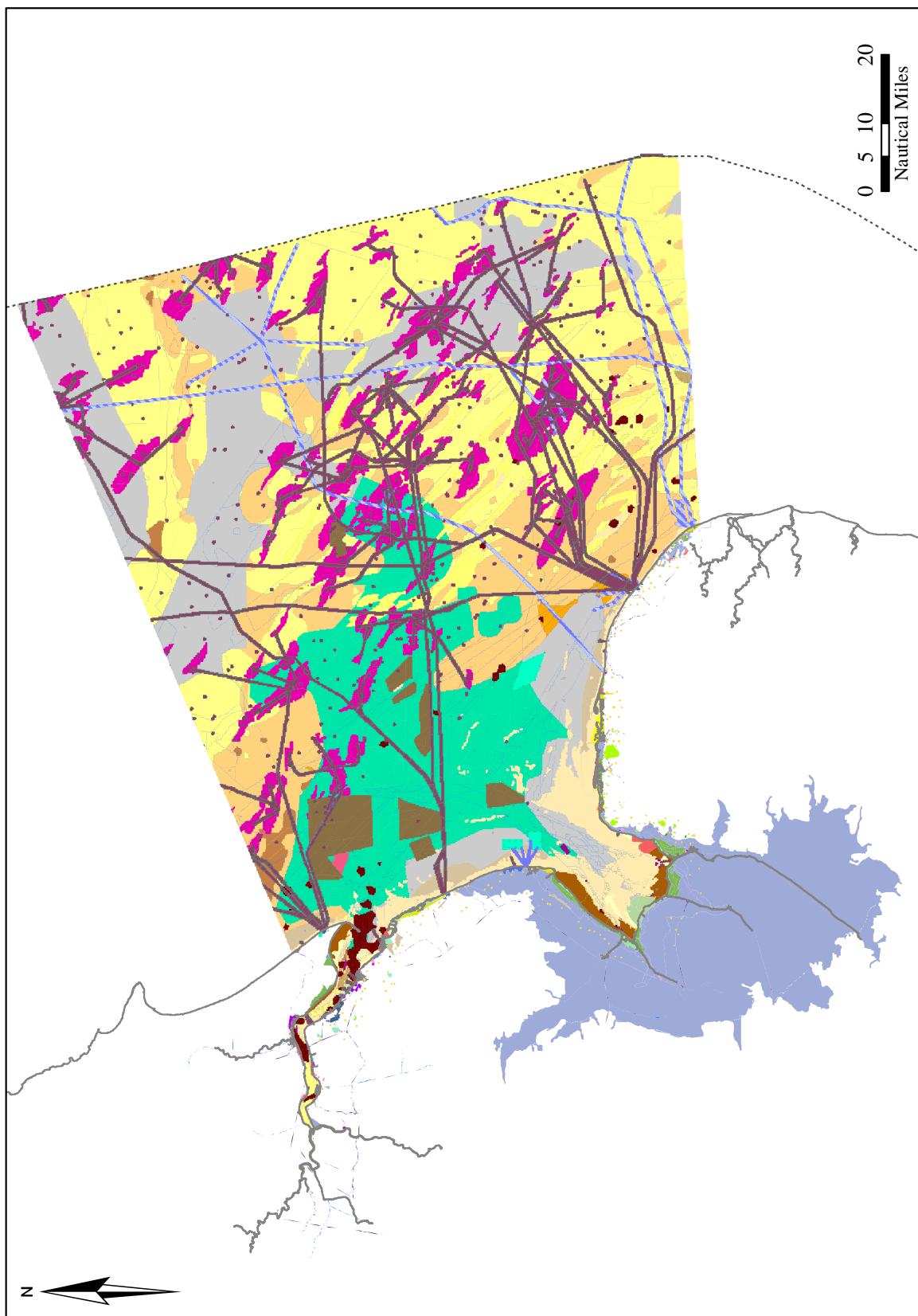*Figure 1.8. Coastal and Water column Sub-characterTypes.*

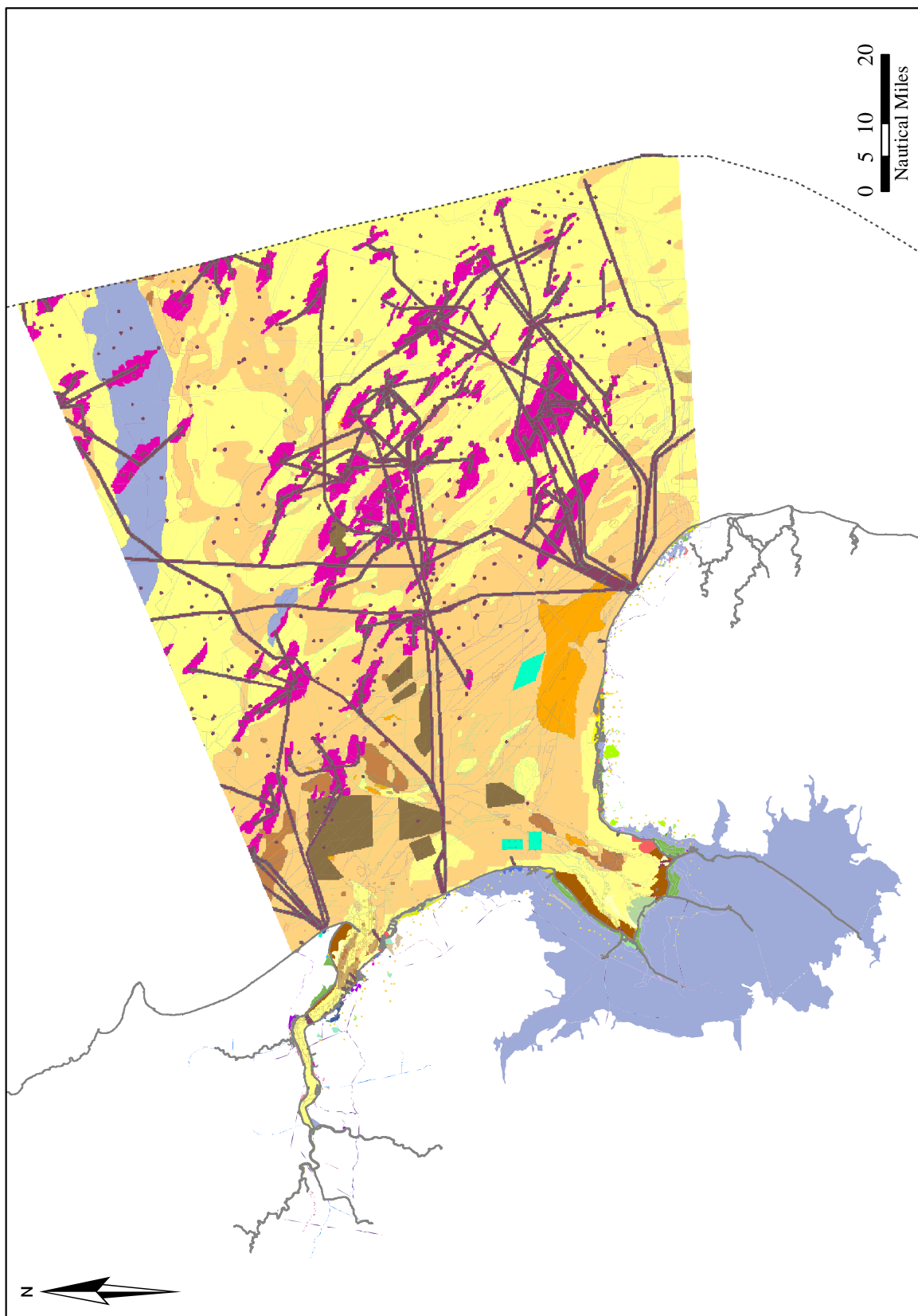*Figure 1.9. Coastal and Sea- floor Sub-character Types.*

Figure 1.10. Coastal and Sub-sea floor sub-character types.

REFERENCES

Aldred, O. and Fairclough, G. 2003. *Historic Landscape Characterisation. Taking Stock of the Method.* English Heritage & Somerset County Council: London & Taunton

Butcher, D. 1979. *The Driftermen*. Reading: Tops'l Books.

Butcher, D. 1982. *Living from the sea*. Sulhamstead: Tops'l Books.

Crowson, A. 2005. *Anglo-Saxon settlement on the siltland of Eastern England*. Sleaford: Heritage Trust of Lincolnshire.

Eastwood, P. D., Mills, C. M., Aldridge, J. N., Houghton, C. A., and Rogers, S. I. 2007. Human activities in UK offshore waters: an assessment of direct, physical pressure on the seabed, *ICES Journal of Marine Science* 64: 453–463.

Froggatt, A. 2004. *Guidelines for English Heritage Projects involving GIS*. London: English Heritage.

Hall, D. and Coles, J. 1994. *Fenland survey: an essay in landscape and persistence.* London: English Heritage.

Hooley, D. 2011. *A brief to undertake HSC across a substantial area of England's coast and adjacent UK Controlled Waters, contributing to English Heritage's National HSC Database*. English Heritage: Project Brief 6228.

Merritt, O., 2007. *Enhancing our Understanding of the Marine Historic Environment: Navigational Hazards project*. Report for English Heritage: Bournemouth University.

MoLAS 2009. *England's Historic Seascapes: Withernsea to Skegness Pilot Study. Report for English Heritage*: Museum of London Archaeology Service.

Merritt & Dellino-Musgrave 2009. *Historic Seascape Characterisation (HSC): Demonstrating the Method. Part 1: Implementing the Method.* Final Report for English Heritage. SeaZone Solutions Ltd.

Newman, C. 2011. *Historic Seascape Characterisation. The Irish Sea (English Sector). Report for English Heritage*: Newcastle University.

Oxford Archaeology 2011. Historic Seascape Characterisation Project. Newport to Clacton (Project No: 5735). Report for English Heritage: Oxford Archaeology (South).

Tapper, B. 2008. *Historic Seascape Characterisation (HSC). National HSC Method Statement*. Report for English Heritage: Historic Environment Service, Cornwall County Council

Tapper, B. and Hooley, D. 2010. *Historic Seascape Characterisation (HSC). National HSC Method Statement.* Revised Working Draft. Report for English Heritage: Historic Environment Service, Cornwall Council

Turner, S. 2006. 'Historic Landscape Characterisation: a landscape archaeology for research, management and planning', *Landscape Research*, 31(4), 385-398

Turner, S. and Newman, C. 2011. *Historic Seascape Characterisation. East Yorkshire to Norfolk (project number 6228)*. Project design: Newcastle University.

Van de Noort, R. 2004. *The Humber wetlands. The archaeology of a dynamic landscape*. Bollington: Windgather.

Van de Noort, R. 2011. *North Sea archaeologies: a maritime biography, 10,000 BC to AD 1500*. Oxford: Oxford University Press.

Waller, M. (ed.) 1994. *The Fenland project. Number 9: Flandrian Environmental Change in Fenland*. Cambridge: Cambridge Archaeological Committee.

Wessex Archaeology, 2003, England's Shipping: Progress report on Recording and Mapping. Report for English Heritage: Wessex Archaeology.

http://ads.ahds.ac.uk/project/goodguides/gis/. Retrieved March 2013.

http://www.ncl.ac.uk/historical/research/project/3537. Retrieved March 2013.

http://www.thecrownestate.co.uk/dredge_areas_statistics. Retrieved March 2013.

http://communityfishingheritageuk.wikispaces.com/Catcher%27s+angle. Retrieved March 2013.

http://www.kis-orca.eu/map#.UVq9WqK-2uI. Retrieved March 2013.