Historic Seascape Characterisation (HSC): Demonstrating the Method

Section 1: Implementing the Method

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Report Structure

The Project Report for 'HSC: Demonstrating the Method' is divided into three sections for ease of use. The first documents the project's implementation. The second contains the application review and case studies, while the third contains the HSC character type text descriptions for the report.

This document comprises section 1 of the 'HSC: Demonstrating the Method' Project

EXECUTIVE SUMMARY

In May 2008 English Heritage (EH) invited SeaZone Solutions Ltd (SeaZone) to tender for a project, funded through the Aggregate Levy Sustainability Fund (ALSF), to demonstrate the Method for Historic Seascape Characterisation (HSC). The methodology, published in March 2008, consolidates and builds on the results of two previous phases of method development undertaken since 2004 which fall within the *England's Historic Seascapes Programme*. The *HSC: Demonstrating the Method* project seeks to demonstrate the practical application of that methodology in the context of the management of change affecting the coastal and marine historic landscape. HSC seeks to further the aims of the ALSF through the Identification and characterisation of the historic landscape in key existing or potential areas of aggregate extraction.

The HSC national Method was developed by the Historic Environment Service at Cornwall County Council (Tapper & Johns 2008) in close consultation with English Heritage, bringing together and learning from the experiences gained during the two earlier rounds of the *England's Historic Seascapes* Programme*.* Publication of the resulting national HSC Method completed that Programme, having substantially realised its over-arching aim of producing a robust method for applying the principles of Historic Landscape Characterisation (HLC) to England's coastal and marine zones, extending seaward to the limit of UK Controlled Waters.

This document constitutes a project report produced by SeaZone and Maritime Archaeology Ltd. detailing the execution of the different phases of the project. The report is divided into three sections; the first describes the practical implementation of the national HSC Methodology. The second part comprises an Applications Review, illustrating the application of HSC using practical exemplars and scenarios where appropriate. The character type texts have been collated as a third section to the report.

Section 1: Implementing the Method

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1. INTRODUCTION

The *HSC: Demonstrating the Method* Project, funded by the ALSF, marks the initial implementation of a rigorous, repeatable methodology for Historic Seascape Characterisation, applying the principles already underpinning Historic Landscape Characterisation (HLC) to the coastal and marine zones.

Extending those principles to the coastal and marine zone to produce a Historic Seascape Characterisation (HSC) Method presents challenges due to the inherent differences between marine and terrestrial environments. The methodology was developed through the *England's Historic Seascapes* Programme involving five pilot method development studies, beginning in 2004, in which each presented different but related approaches to HSC. The results were consolidated into a single nationally-applicable HSC methodology for the area-based characterisation of historic coastal and marine landscapes.

Following that development of the national HSC Methodology in 2008, SeaZone was invited to tender for a project which aims to demonstrate the practical implementation of the HSC Method and promote its relevance to future applications through demonstrative case-studies (English Heritage 2008).

The robust national method for HSC is source-led, assessing and defining areas that share similar and repeating historic character as Historic Seascape Character 'Types', allowing historic trends and processes to inform and frame the broader sustainable management of change through marine spatial planning, outreach and research projects.

The HSC approach takes a holistic view of the historic landscape and can provide context for the often 'point-based' datasets available for the marine zone. The resulting product is designed to enable the distinctive historic cultural character of the present to be understood and contribute positively to the sustainable management of change in the future affecting the coastal and marine environment.

This project complies with MoRPHE guidelines (English Heritage 2006), and successfully demonstrates the implementation of the national HSC Method (Tapper 2008), across a sufficiently substantial area to provide effective practical demonstration of the method's operation and capabilities. The worked example provided by this project builds on the consolidation of the national HSC Method, as outlined in the Project Brief (English Heritage 2008), both by ensuring clarity and consistency in its future implementation and by enabling cogent practical demonstration of the method's fitness for purpose across its range of applications, thereby promoting and optimising the use of the method.

2. BACKGROUND

2.1 Historic Landscape and Historic Seascape Characterisation

HLC is a method of assessing and classifying an archaeologist's view of the historic cultural landscape as an aid to inform the management of the historic environment. The approach brings together historic and natural environmental datasets in a GIS format to enable the interpretation of landscape character types and the areas in which they are expressed. This method encourages the interpretation of data in a manner transcending their isolated expressions to encourage the identification of recurring trends which characterise the historical and cultural landscape.

The landscape is characterised by HLC according to a series of recurring 'Types' reflecting the dominant historic cultural processes which shape our perceptions of an area's present character. It is designed to inform a broad range of applications including spatial planning, conservation and wider approaches to heritage management which emphasise the positive contributions to be gained for everyone's quality of life in understanding and maintaining the cultural legibility of the world we inhabit.

HLC has being applied across England, in multiple contexts including county based HLC, urban HLC, AONBs and National Parks, undertaken predominantly by Council HERs. To date HLCs is approaching two thirds of National completion (English Heritage website).

HSC draws on the same core principles as underpin HLC (Tapper 2008) to produce a characterisation of the marine and coastal historic landscape.

2.2 Characterising the Marine Zone

The HSC Method, while maintaining the principles used in HLC, recognises the need for different expressions of those principles in the coastal and marine environment.

The coastal zone to landward and seaward of mean sea level is an area of overlapping, not abutting, terrestrial and maritime perceptions, demanding assessment of both landward and seaward perspectives and requiring interoperability between the overlapping HSC and HLC coverage.

The marine environment provides a number of distinct differences from land for historic character assessment. Methods developed and used to apply characterisation principles in terrestrial and near shore HLC have required adjustment in order to apply the principles effectively to offshore areas. Some of the key attributes that characterise the coastal and marine landscape itself in this respect include:

- Understanding the way the character of marine landscapes is perceived in contrast with that of terrestrial landscapes

- The sea has multiple vertical levels which can vary greatly for any given area in their historic character: the character of the sub-sea floor, sea floor, water column and sea surface all need to be understood in their own right.

- Dynamic marine environment: the natural environment of much of the inter-tidal and marine zone is dynamic and constantly changing due to natural physical processes such as currents, tidal range and sediment mobility.

With the current increase in coastal and marine developments, the review of marine heritage legislation and the drafting of a Marine and Coastal Access Bill (Defra 2008) outlining the UK strategy for sustainable management of the marine and coastal zone, the benefits of having HSC in place are clear.

The application of HLC to the coastal and marine environment was first trialled in a single area – 'Liverpool Bay and waters off the Fylde'. The four successive pilot projects provided a range of related approaches to the effective expression of characterisation principles in the coastal and marine zones.

The key issues highlighted during the five pilot projects were addressed during the HSC Method consolidation in 2007-8. The multi-dimensionality of the coastal and marine zones, married with the need for recognising time depth during the characterisation of the historical and cultural landscape, has been resolved through the use of a multi-level approach.

In order to recognise the contrasts in character potentially existing at differing levels in the marine environment, the following classification has been prescribed within the recorded attributes (Tapper 2008):

- Sub-sea floor HSC: identifying the dominant historic character beneath the sea floor veneer
- Sea floor HSC: identifying the dominant historic character within or directly on the sea floor veneer,
- Water column HSC: identifying the dominant historic character across the vertical height of the water column
- Sea surface HSC: identifying the dominant historic character of the surface of the water
- Previous historic character (recorded where information bears on it)

The time depth of the assessed marine historic character is recorded in the attributes in two main ways in the national HSC Methodology: by recording in the 'Period' attribute the date at which an area adopted its present character, and by recording multiple expressions of 'Previous HSC' for a given area where available evidence bears on that (Tapper 2008, 3.3.2).

Similarly, the contrast between the character type structures and the nature of available and appropriate mapping frameworks for the coastal, intertidal and marine zones has been recognised and dealt with in the national HSC Methodology (Tapper 2008) by adapting the approach to representing character assessment so that coastal and intertidal character is mapped using polygons, whereas offshore the character type mapping uses a grid mesh. This approach has encouraged a more seamless transition between HLC and HSC by matching the extents of character polygons between the two datasets where possible.

3. AIMS & OBJECTIVES

The *HSC: Demonstrating the Method* project Aims and Objectives as specified by English Heritage to meet the requirements of the project brief (English Heritage 2008) are outlined below.

3.1 Project Aims

The primary aim of the project is to provide an exemplary implementation of the national methodology for coastal and marine HSC developed by the England's Historic Seascapes Programme to extend the principles of historic landscape characterisation (HLC) to England's coastal and marine zones to the limit of UK Controlled Waters.

The overall aim of the project has been broken down by English Heritage in the project brief (English Heritage 2008) as follows:

- To deploy the national HSC Methodology to create a GIS-based characterisation of the historic and archaeological dimension of the present seascapes across the full extent of the project area
- To be an exemplary project for further implementation of the national HSC Methodology to a fuller extent of England's coastal and marine zones and adjacent UK Controlled Waters
- To provide a working demonstration showing how the application of HSC produces a framework of understanding which will structure and promote well informed decision-making relating to the sustainable management of change and conservation planning affecting the historic landscape in the coastal and marine zones
- To provide a working demonstration showing how the application of HSC produces a historic seascapes 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, interoperability and accessibility developed to meet the implications of the Marine and Coastal Access Bill (Defra 2008)
- To structure, inform and stimulate future research programmes and agendas relating to the coastal and marine historic environment
- To improve the awareness, understanding and appreciation of the historic dimension of the coastal and marine landscape to its professional and non-professional users

3.2 Project Objectives

The objectives for the project have been defined by English Heritage (English Heritage, 2008) as follows:

- To use the national HSC Methodology to characterise the historic and archaeological dimension of the present seascapes across the full extent of the project area in the north east of UK Controlled Waters
- To detail in the Project Report the specific aspects involved in implementing the national HSC Methodology across the project area, including a record of the sources and data-sets supporting each stage of the characterisation and the inter-relationship between HSC and HLC where the latter is completed adjacent to

the project area, to meet the needs of transparency and assist future updates against the initial benchmark characterisation

- 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 2008) and with particular reference to the provisions of the Marine and Coastal Access Bill (Defra 2008), English Heritage's curatorial responsibilities and influences for the sustainable management of change, and commitments arising from the European Landscape Convention.
- To document those HSC contexts and applications in the project area by description and, as appropriate, by case study, to demonstrate the potential of HSC for informing the sustainable management of change, spatial planning, research planning and prioritisation, and outreach affecting the historic environment in the project area.
- To document from the project area by description and, as appropriate, by case study, the close inter-relationships between historic and natural landscape character and the advantages of inter-operability between historic and natural environment spatial datasets.
- To document from the project area the potential of the HSC for raising public awareness and understanding of the coastal and marine historic environment.
- To produce an interactive resource suitable for posting on the internet, in .html or similar format, containing the Character Type mapping and structured texts generated for the GIS during the characterisation.
- To produce an Archive and a Project Report documenting all aspects of the project's application of the national HSC Method, including among the sections of the Project Report: a detailed account of the project's practical implementation of the national HSC Methodology; documentation of the project area's contexts and applications for the HSC Method; the relationships between the project area's historic and natural landscape character, and the potential of the HSC for raising public awareness and understanding of the coastal and marine historic landscape.
- To disseminate information on the progress and results of the project through the internet and through professional and popular publications and other media

4. INTERFACES

4.1 SHAPE 2008

This project helps deliver the newly published 'Strategic Framework for the Historic Environment Activities and Programmes in English Heritage'. The project has most relevance for:

Corporate Objective 1A: 'Ensure that our research addresses the most important and urgent needs of the historic environment'

Research Program A1: What's out there?: Defining, characterising and analysing the historic environment

Sub program: Understanding Place: Historic Seascape Characterisation (number 11111.240)

HSC addresses this EH corporate objective by capturing the historic character of the coastal and marine environment, including past sea surface use, water-column use, sea bed use and buried historic assets through a holistic area-based characterisation (see www.english-heritage.org.uk/characterisation).

Additionally, HSC contributes to the following objectives:

Corporate Objective 1A: 'Ensure that our research addresses the most important and urgent needs of the historic environment'

Research Program A2: Spotting the gaps: Analysing poorly understood landscapes, areas and monuments

Sub program: New Frontiers: Mapping our marine heritage (number 11112.110)

HSC builds on this with an emphasis on holistic area-based characterisation (see SHAPE 2008: 23).

4.2 English Heritage – ALSF Priorities

HSC contributes towards English Heritage ALSF priorities, specifically towards:

Theme 2: Marine. 2.1: Identification and characterisation of the historic environment in key existing or potential areas of marine extraction. 'Seabed mapping projects in this strand seek to improve our understanding of the disposition of vessel and submarine wrecks and lost aircraft and of inundated prehistoric landscapes for the key licensed aggregates extraction areas around England's coast. Additional projects will undertake Historic Seascapes Characterisation to develop our understanding of the historic character of the marine zone for the key licensed aggregates extraction areas to the median line with UK neighbours' (http://www.english-heritage.org.uk/server/show/nav.1317).

5. STUDY AREA

The overall area to which the national HSC Methodology has relevance comprises England's coastal zone and its share of UK territorial waters and adjacent UK Continental Shelf to the limit of UK Controlled Waters.

The project area defined in this project's brief (English Heritage 2008) encompasses the former Seascapes pilot area from Scarborough to Hartlepool and extends that area to cover the areas adjacent to it, northwards to the Scottish border and southwards to the northern limit of the former Seascapes pilot area from Withernsea to Skegness.

The project area so defined (Figure 1) is as follows:

Northern Extent: defined across UK Controlled Waters by the northern boundary of England's civil jurisdiction as defined by the Scottish border in the North Sea in the Civil Jurisdiction (Offshore Activities) Order 1987 1 (2). Across the inter-tidal zone and on land, the northern extent of this project area will be defined by the administrative boundary between England and Scotland as mapped on OS MasterMap.

Southern Extent: determined by a line extending from the East Riding of Yorkshire coast near Withernsea at 53°44' 15"N, 00°01' 48"E, north eastward to the point where latitude 54° 20' 00 "N intersects with the UK Continental Shelf Limit, where the Median Line meets with Dutch Waters. Across the inter-tidal zone and on land, the southern extent of this project area will be defined by a straight continuation south westward of the line defining its southern marine extent.

Seaward Extent: the limit of the UK Continental Shelf, here following the Median Line with Germany and Holland, as defined in the UK Continental Shelf Act 1964 as subsequently amended.

Landward Extent: Defined as reaching, "at least the OS-mapped line of Mean High Water (MHW) but will continue landward beyond that line to avoid any arbitrary truncation of HSC polygons and to accommodate inland areas perceived, from a maritime perspective, as possessing distinctively maritime character. This may result in the inclusion of some areas on land which are discontinuous with MHW, for example to accommodate prominent inland areas serving as navigational daymarks, resulting in HSC polygons separate from the main body of the characterisation (though the intervening areas will of course be subject to HLC coverage).

River and Estuary Extents: The inland extents for key rivers are limited to the co-ordinates below:

- River Wear: A19(T) bridge, at NZ 34845676
- River Tyne: Newburn Bridge, at NZ 16506515
- River Tweed: to its bisection by Scottish border at NT 94725208

Subject to the accommodation of inland areas perceived from a maritime perspective as possessing distinctive maritime character, estuaries within the project area will normally be included to their Normal Tidal Limit along their rivers and tributaries.

The accurate definition of the landward boundary is dependent on the completion of the characterisation process in order to identify landward areas of distinctive maritime historical significance.

The project area encompasses the coastal and marine zone across several different counties including Humberside, North Yorkshire, Durham and Northumberland, as well as the North Yorkshire Moors National Park and the unitary authorities of Tyne & Wear, East Riding and Cleveland.

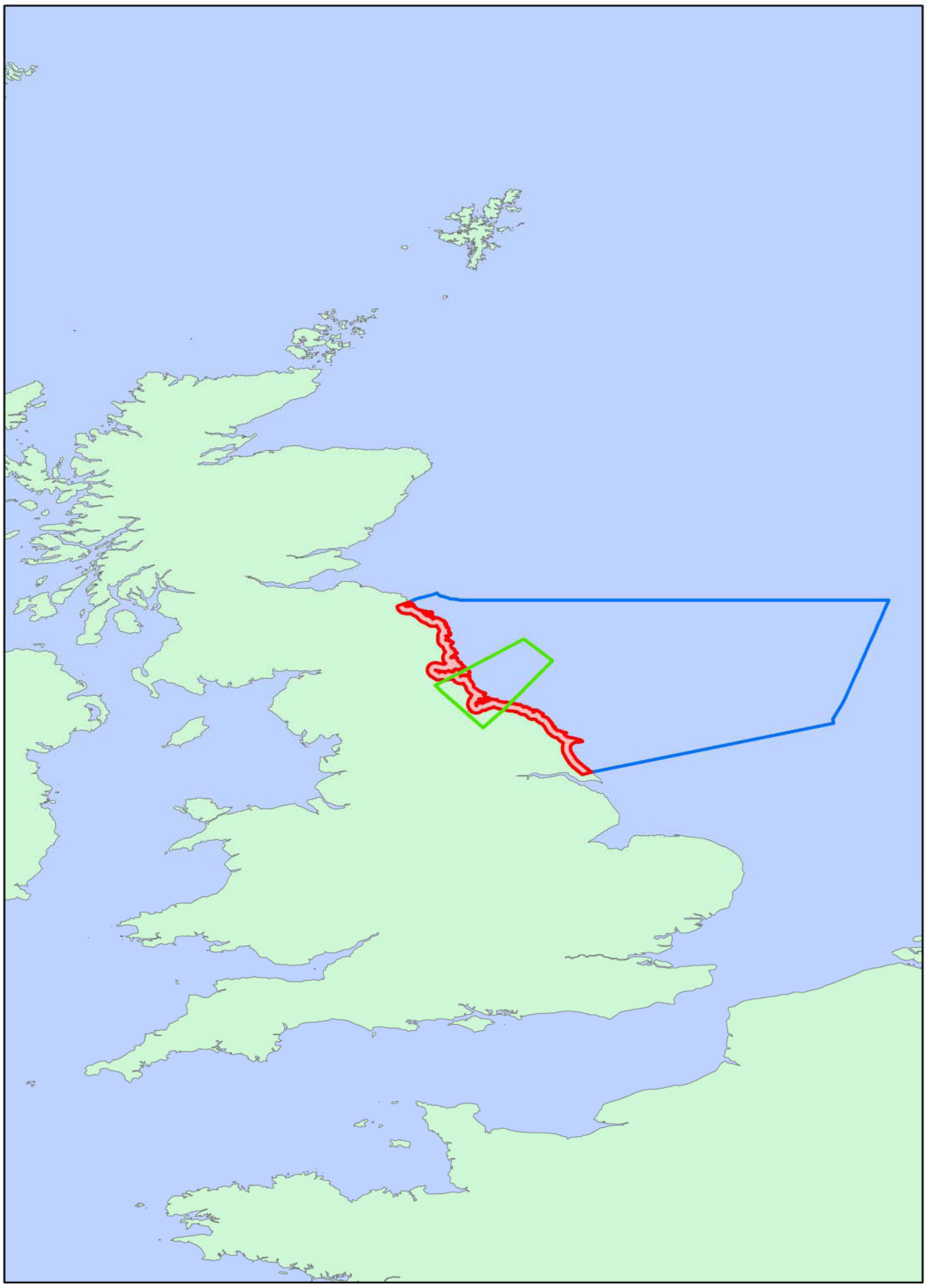


Figure 1: Demonstrating the Method Project Area and Trial Area

6. IMPLEMENTING THE HSC METHOD

6.1 Introduction

The project was undertaken in accordance with MoRPHE guidelines (English Heritage 2006) over a period of 11 months.

The Method Statement for HSC produced in March 2008 (Tapper 2008) was used as the basis for applying the national HSC Methodology. The methodology has been applied as specified in the national HSC Method Statement to meet the requirements of English Heritage to demonstrate the method.

The method was applied to a trial area which encompasses part of the Scarborough to Hartlepool area and an adjacent area to which HSC has not yet been applied. The trial area (Figure 1) which included coastal, intertidal and offshore areas, was agreed with English Heritage at the first Project Board meeting.

The characterisation phase of the Method Statement has been broken down to reflect individual tasks within the method, as described in the national HSC Method Statement. Additional phases in the method development such as the development of GIS tools have also been described. The characterisation phase of the project, divided in the project brief between its application to (1) an initial trial area in Stage 2 and (2) the full project area in Stage 3, is described under the following sub-headings:

- Data Collation
- Data Preparation
- GIS Development
- Database Development
- Character Assessment
- Development of Character-type Text Descriptions

Challenges arising during the application of the method have been described chronologically as far as possible, distinguishing where necessary between issues arising during the initial Trial Area method application and during ensuing characterisation of the full project area.

6.2 Data Collation

The emphasis during collation of core data for the project was placed on datasets listed in the HSC Method Statement that currently have consistent national coverage or will, have when completed. Emphasis was also placed on those available in digital formats, treating more localised or hard-copy source data available as supplementary.

Additional sources were sought in some cases to complement or increase the coverage of datasets proposed in the HSC Method Statement.

The information gathered to produce text description for character types was based on a strategy of desk-based research.

The basic requirements for data collated 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

The data issues such as limited coverage, accuracy and recording biases were taken into account during the collation of data and application of the method. Marine data and records of archaeological evidence tend to be concentrated towards shallow, intertidal and coastal areas. The level of accuracy and degree of bias is variable, dependent on the method used to gather the data and purpose for which the data was gathered. Finally, as the integration of non-digital resources may often be time consuming, data was gathered in a digital format where possible.

A list of core data sources was identified for the purpose of the project (Table 1), based on Tapper 2008 and English Heritage 2008. These are datasets which are available on a national scale and provided the core data on which the HSC Demonstration was applied.

Table 1 – Core Data Identified for the Project

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, NMM, 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)	SeaZone Solutions Ltd.

Data group	Format	Feature Types	Datasets	Supplier
			- Socio-economic & marine use (SE) - Conservation & environment (CE) - Climate & oceanography (CO) - Wrecks (W))	
Adjacent County HLCs	Digital pol	ygons		Local Authorities
Aerial photographs	Digital	Raster images		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
Offshore Industry	Digital	Points, polygons, polylines	Aggregate extraction areas, oil and ga s installations	UK Deal, JNCC, SeaZone hydrospatial
Environmental data and l and classifications	Digital			Natural England/JNCC/MAGIC database, CEFAS, BGS (www.searchmesh.net/webGIS.)

English Heritage supplied OS MasterMap and historic Landmark data where possible. HER data, RCZASs and HLCs were requested from local authorities where available.

Supplementary datasets identified included local and regional datasets, point data and data which is 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. Additional data gathered to supplement the sources recommended in the HSC national Method (Tapper, 2008) have been annotated in green.

Table 2 - Supplementary Data Identified for the Project

Data group	Format	Feature Types	Datasets	Supplier
NMR Di	gital	Points, polygons	Monument records, maritime records	English Heritage
HERs and SMRs	Digital	Points, polygons	Monument records, maritime records	Local Authorities
Palaeo-environmental data	Digital/paper vari	ous	Peat beds, palaeo-channels,	Birmingham University, HER/SMR, BGS
Geomorphology Di	gital	raster	Coastal geomorphology	FutureCoast (DEFRA)
Seabed sediments	digital	polygons	Sediment type	SeaZone Hydrospatial
Offshore solid geology	digital	polygons	Bedrock type	SeaZone Hydrospatial
Morphology Di	gital	raster	Coastal morphology	FutureCoast
Tidal range	Digital	Raster Images	Sea level model	DTI
Sea level index points	various	various	Sea level model	Various
Tides & Currents	Digital	Points, polygons, polylines	Tides and currents	SeaZone Hydrospatial
Shipping Data and Navigational Hazards	Digital	Polygons, Raster	Navigational hazards, England's Shipping, ANATEC, RYA, DfT	Bournemouth University, English Heritage, ANATEC, RYA, DfT
Documentary sources	Hard copy , Digital	various		Various: libraries, Record Offices, Museum libraries

The collation of documentary resources plays a key role in the contextualisation of the character assessment and the development of character-type text descriptions. A wide range of 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 was gathered as word documents, then entered directly into the database to produce a centralised and searchable resource.

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.

6.3 Additional datasets deployed, not previously used in HSC

During the presentation of the trial area characterisation to the Project Board, questions were raised regarding the coarse texture which resulted from the use of Anatec data to represent commercial ship routes. The scale of Anatec shipping density cells are 5x5km and far exceeded the grain of cell sizes employed to process other data.

Alternative methods for representing shipping routes were therefore researched. The Maritime and Coastguard Agency (MCA) were contacted regarding access to ship tracks recorded using Automatic Identification System (AIS). The MCA are currently working on making their data widely available but are currently in the process of ensuring that there are no data protection or other legal issues associated with the information, so were unable to provide the information for the purpose of the project.

An analysis of shipping density was provided by the Department for Transport (DfT) under the Freedom of Information Act (2000). The project was commissioned in 2008 by the MCA and undertaken by BMT Group Ltd to develop a "shipping clearways map" designating areas where wind farms cannot be located.

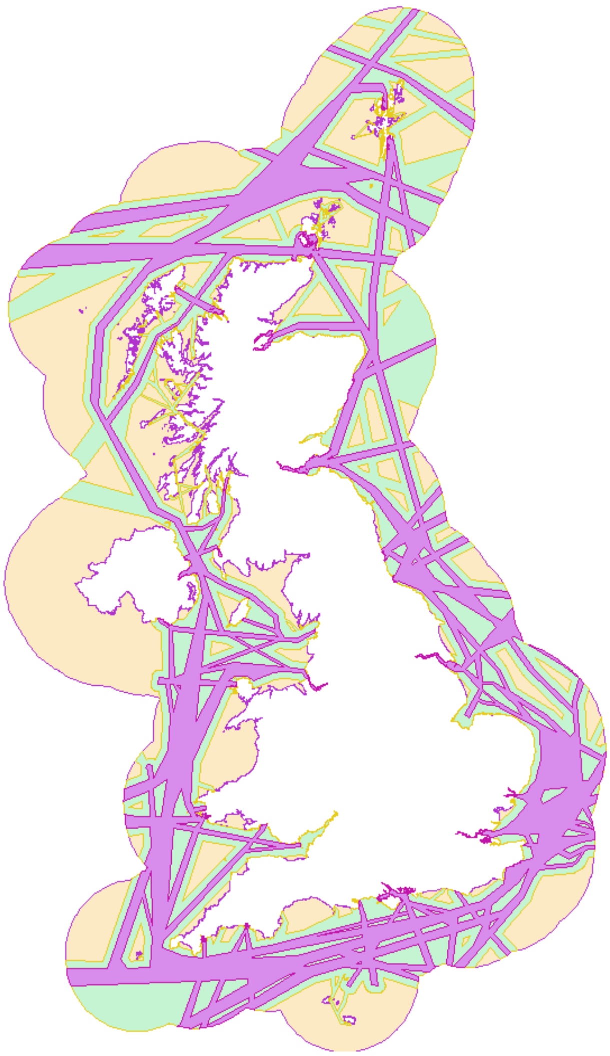


Figure 2: Analysis of shipping density supplied by DfT

The dataset reflects three zones of shipping traffic density have been identified within waters up to 100km off the UK coastline (Figure 2). These are:

1. Major lanes for shipping traffic (purple on map);
2. Areas subject to moderate levels of commercial shipping traffic (pale green on map);
3. Areas experiencing low levels of commercial shipping traffic (beige on map).

The data delivered by the DfT was used in combination with Anatec data and the ALSF England's Shipping to produce an assessment of main shipping routes within the project area.

In addition, a dataset representing recreational sailing routes and areas produced by the Royal Yachting Association was identified (Figure 3). The data for the UK was delivered at an annual fee of £200 plus VAT for government funded projects and provided valuable insight into concentrations in some classes of leisure activities in UK waters.

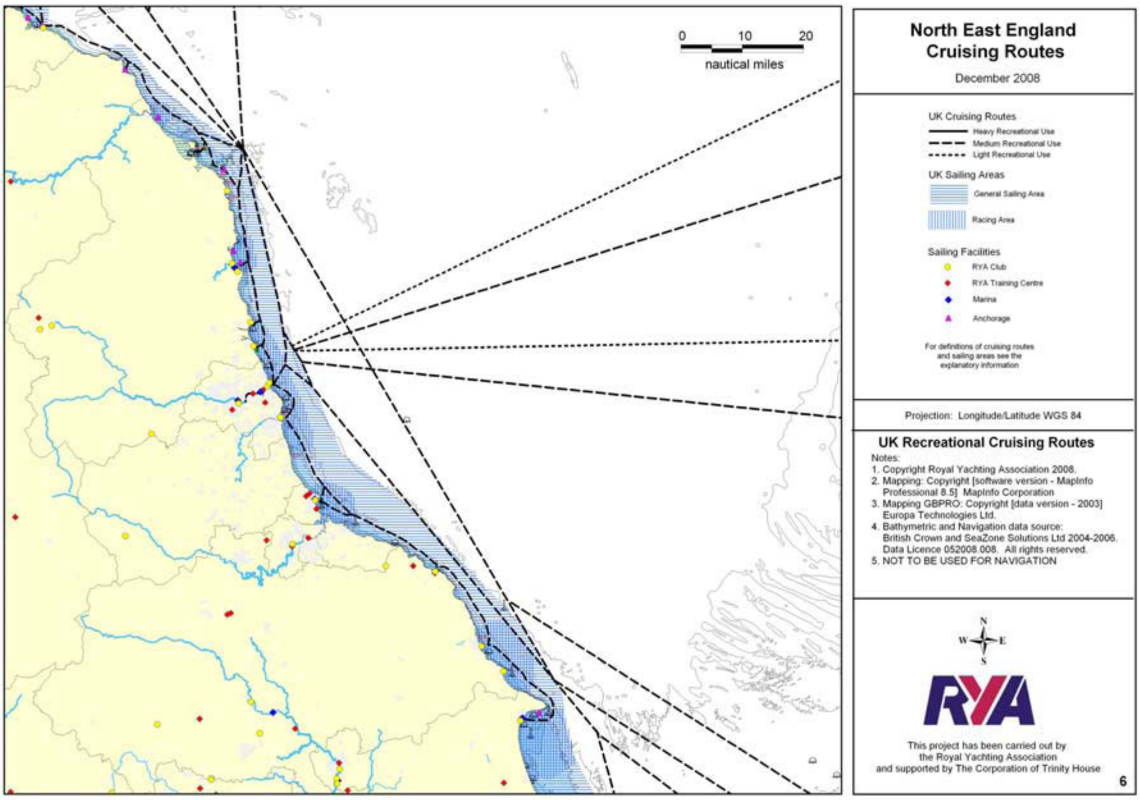


Figure 3: Recreational sailing information provided by the Royal Yachting Association (RYA) (Copyright RYA 2008)

6.4 Data Preparation

Data preparation was undertaken as outlined in both the national HSC Methodology (Tapper 2008) and the project brief (English Heritage 2008).

A digital geographic dataset containing extent polygons was produced to define 'Location' areas for the coastal and intertidal, inshore and offshore zones. These are delineated as specified by the UK Hydrographic Office (UKHO) for the intertidal and marine zone, and the Ordnance Survey (OS) for the coastal zone. In these contexts, the coastal zone is defined as the area extending inland from MHW which can be shown to possess a maritime character. The intertidal zone is defined using the intertidal area represented in OSMasterMap, which reflects the area from Mean High Water (MHW) to Mean Low Water (MLW). Inshore waters are defined between MLW and the 12nm limit, and offshore reflects the area beyond the 12nm limit to the outer extent of the project study area. This dataset was to attribute the location field [LCTN] of HSC polygons using their centroids, 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.

The project methodology specifies that all data will be referenced to British National Grid as it is comparable with English land-based data including HLC projects. However SeaZone consider the use of a WGS84 compliant datum below MLW as best practice for marine GIS, at least in the vicinity of the coast of the UK, because, strictly speaking, the OSGB36 datum does not exist offshore.

The project work was therefore undertaken using a WGS84 based and Transverse Mercator projected Coordinate Reference System (CRS). The WGS84 / UTM Zone 31N CRS (EPSG: 32631) for the marine area. Data capture on land was undertaken referenced to British National Grid. Datum transformations between OSGB36 and WGS84 were undertaken using a version of the OS TN02 transformation that has been extended for use beyond its normal 10km offshore limit. All marine datasets were therefore transformed in this way for processing below MLW and were converted back to British National Grid, as required by the project terms of reference, before integration with the character areas above MLW.

Paper maps and charts were geo-referenced using graticules and taking account of projections and co-ordinate systems where possible. Those containing limited information of the co-ordinate reference system were digitised by rubbersheeting the charts using recognisable static reference points along the coastline.

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 was 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.

6.5 GIS Development

During the set-up of the project, a series of GIS tools were developed along with a strategy for ensuring continuity between the processing of all data collated. As agreed at the outset of this project, development of these tools is relevant to the purpose and application of this project. However the tools themselves do not form an addition to the national HSC Method.

6.5.1 Vector Grid Creation Tool

In the first stage of developing GIS tools for the project, an ESRI-compatible GIS tool was created to enable a range of sized vector grid tiles (polygons) to be produced across the project area. The tool is designed to ensure that all grids produced for future HSC projects can conform to the same grid structure (Figure 4), aligning themselves when viewed alongside each other, thus encouraging coherence and interoperability between different project areas.

The tool produces a vector cell structure via two methods (Figure 5). You can either input the co-ordinates for the bottom left and top right corners of the outer extent of the required area, or you can select a shapefile to use as a base dataset, in which case, the tool will produce coherent cells wherever a tile's centroid lies within the extent of a polygon from that shapefile.

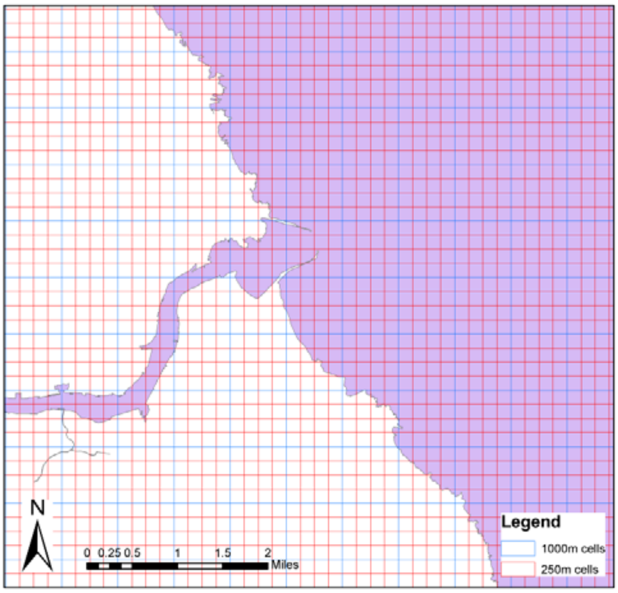


Figure 4: Different sizes of cells produced by the grid creator tool using a common framework

A series of grids were then produced, initially to cover the trial area, later extending across the full area, including a 250m², 500 m², 1000m² and 2000 m² grid. The tool is designed to produce cells referenced to British National Grid co-ordinates (OSGB36).

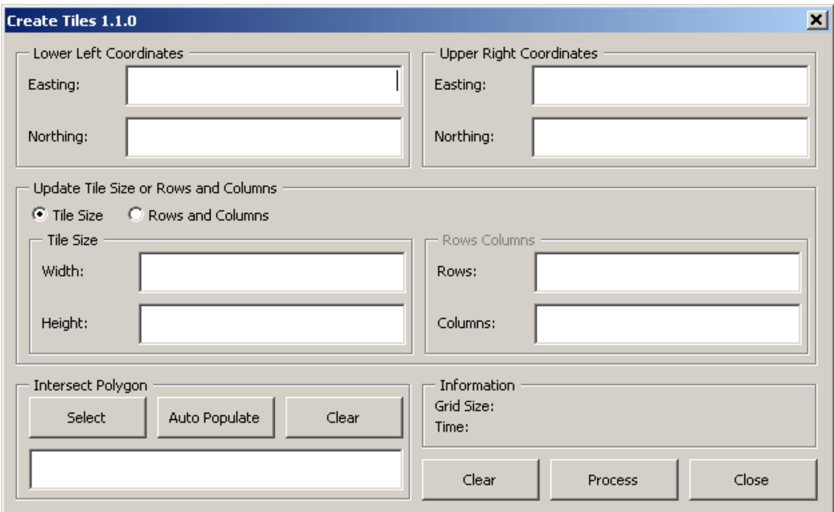


Figure 5: Graphical User Interface for the vector grid creation tool

For the trial area, the marine zone of the project area lying below Lowest Astronomical Tide (LAT) was used to create the tiles, as reflected in Admiralty charts, to provide a basis for the offshore HSC polygon layer. However the size of the project area restricted the use of an underlying shapefile to produce high resolution tiled datasets. Therefore for cell sizes below 1000m², the tiles were produced by defining the co-ordinates of the bottom left and top right corners, as this approach uses far less virtual memory as it doesn't require the tool to continually search for the edge of the project area extent. The cells were then clipped using ArcGIS to remove unnecessary tiles to reflect the full extent of the study area below LAT.

6.5.2 Data Preparation Tool

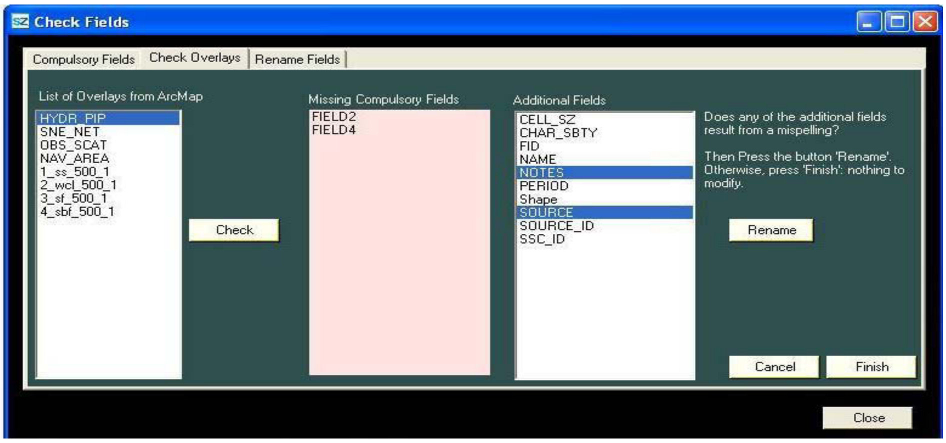
This tool set is designed to ensure that during the early phases of descriptive characterisation, a consistent approach is taken to the management of data. The aim of the tool is to ensure that all shapefiles produced during the descriptive phase of the project share the same attribute structure. This consistency has a number of benefits:

1) It enables the data to be processed using the Dominance Assessment Tool
2) It allows the varied attribute structures of source data to be consolidated to provide a format which facilitates the manipulation of data
3) It facilitates the movement of features between shapefiles
4) It simplifies the field formats, facilitating manipulation of attributes during geoprocessing applications such as unions of spatial joins

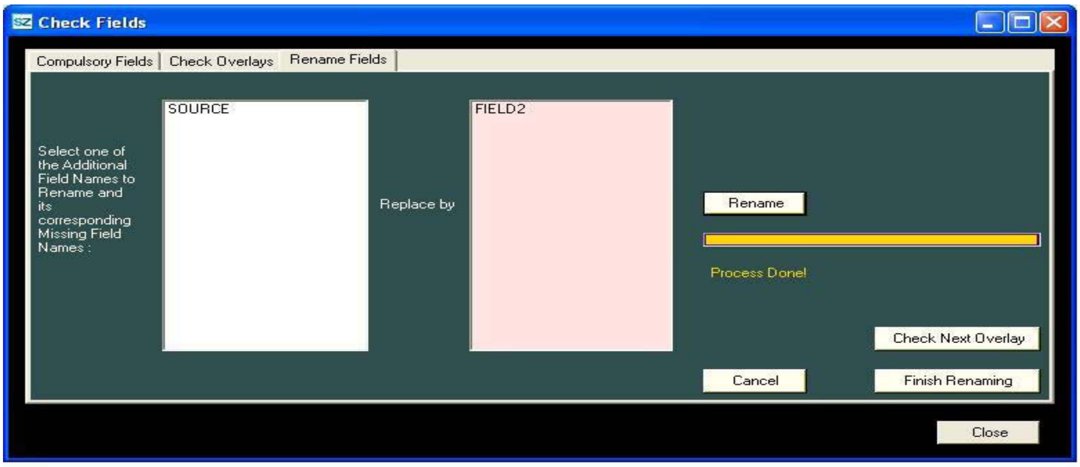
The tool works in three stages:

1) define your compulsory fields for the descriptive attributes you want to assign to each data group.

2) Check the overlays to ensure that each shapefile contains the field structure required.



3) The third part of the tool allows you to rename fields to ensure they are consistent with the compulsory fields



6.5.3 Dominance Assessment Tool

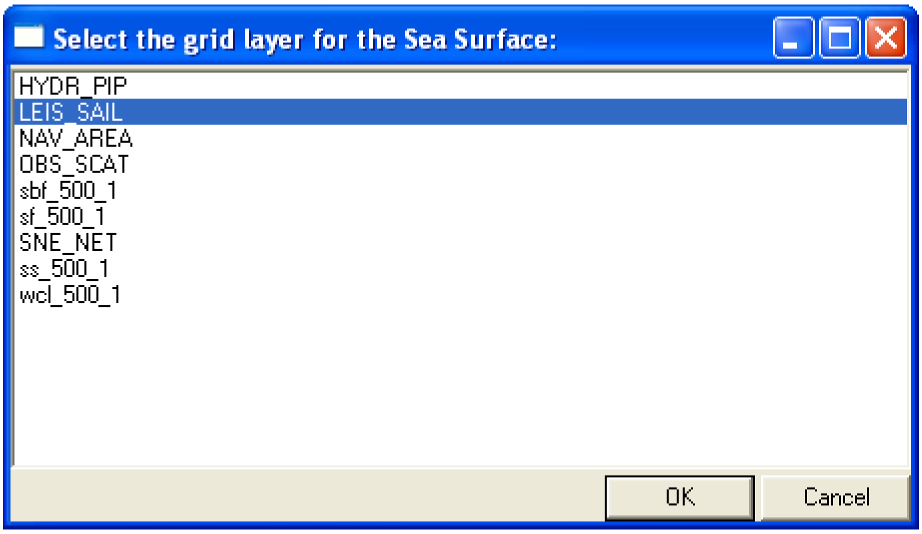
Following the development of a vector grid cell creation tool, considerable work was undertaken to build a tool, as proposed in the project design (Merritt, 2008a) to facilitate the dominance assessment and population of attributes to produce the multi-level character layers. The aim was to encourage consistency in the processing of data in advance of characterisation and facilitate the application of the national HSC Method to other areas. SeaZone sought to produce a tool which (1) auto-populated fields with associated attributes and (2) identified overlaps during the different phases of the method for which subjective choices need to be made.

The tool enables a series of processed data layers attributed following the structure used for the attribute-led and prescriptive phases of characterisation to be put into ArcGIS alongside a vector grid. It also records the HSC assessor's decisions made during the predominance assessment to ensure the transparency of process necessary for future applications and potentially to feed into future research on seascape perceptions as a whole. The approach used also ensures that all overlaps are dealt with and identifies situations where decisions on predominance could potentially be repeatable. This enables the assessor to reduce duplication of effort in repeating the same decision while highlighting cases where decisions over predominance may differ.

The tool works in 5 stages:

Stage 1 allows the user to load the data into the tool by defining which layers will be related to each marine level. The results are stored as a text file which may be edited if necessary.

Stage 2 allows you to select the vector grid shapefile to be populated for each marine level. These must all be loaded into the GIS. Once selected, and the tool is run, each cell will be assessed to identify overlaps between character polygons. The results are then stored in a MS Access database.



Stage 3 identifies cells where a conflict exists between two or more imputed layers, This can be done for all four levels at once if the four grids have been added to the data frame. The identification is based on identifying layers which overlap with the centroid of each cell.

Stage 3 populates the grid cells in each marine level where only one dataset has been detected.

Stage 4 opens a window showing the conflicts within cells for each level. The HSC tool allows the HSC assessor to select the dominant character type within each level where a conflict has been recorded. The attributes of the cell relating to each level will then be populated accordingly. Where a dominance decision can be applied across the project area, the tool provides the option to apply the decision to all cells where the dominance decision can be applied to every instance. For instance, if the HSC assessor wants to ensure that all dangerous wreck character sub-types dominate when overlapping with a wreck scatter on the sea floor, then the decision can be made to apply that assessment to all instances where that conflict exists within one or more levels. However great care would be needed to anticipate whether it would be appropriate to make such a generalised application of a dominance decision between two types, effectively making it a rule. It may risk overlooking particular instances where the HSC assessor would otherwise depart from the general rule.

Stage 5 records the decisions made in the database and the number of instances for which one character type was chosen to dominate over another.

The HSC tool was developed and tested alongside the application of the national HSC Method to ensure that its processes mirrored the manual processes employed to apply the methodology. It was found during the development of the tool that the need to process all data in inshore and offshore areas through a vector grid, where the resolution of the output grid cells for HSC is 250m sq., restricted the size of the area which could be processed using the tool. That required the project area to be divided into smaller areas to apply the tool. Although the tool does facilitate the GIS processing required to undertake the dominance assessment and production of characterisations for each marine level and encourages transparency in the decision making applied during the development of HSC, the need to repeat the process over a series of smaller areas makes its use time consuming.

6.5.4 Attribute Transfer Tool

To ensure that the requirements of the brief were met, a fourth tool was developed which allows the contents of the attributes of one field from the union of two shapefiles to be transferred to that of another field. As the HSC Method requires extensive unions to be applied during the development of the four marine levels and the conflated characterisation, this tool allows the user to easily transfer information between fields where the recipient attributes remain null.

The tool allows the user to first define a unioned dataset (Figure 6), then to create associations between fields, enabling the transfer of attributes from multiple fields for which a 1 to 1 relationship has been defined (Figure 7).

Where a conflict arises due to the destination field being already populated, caused for instance by an intersection between two character types, a text file will be created which records the identifiers relating to the cells for which an assessment of dominance is required, enabling the HSC assessor to isolate those specific character polygons.

This tool provides a valuable extension to ArcGIS during the day to day development of HSC characterisation by facilitating the manipulation of the contents of shapefiles and highlighting vector cells and overlaps between areas where a decision over character dominance needs to be made.

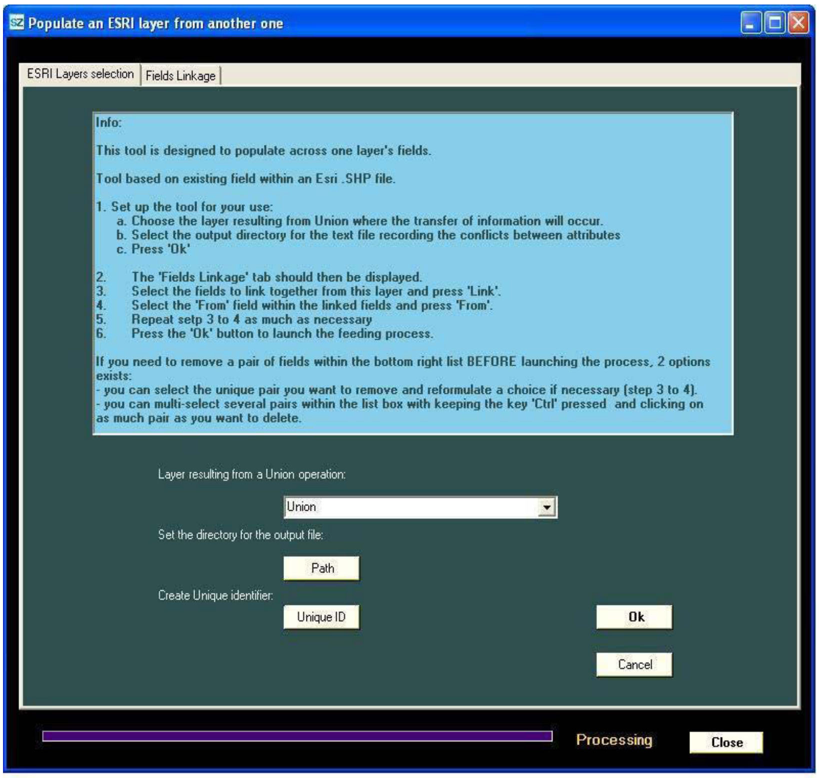


Figure 6: Layer selection screen for attribute transfer tool

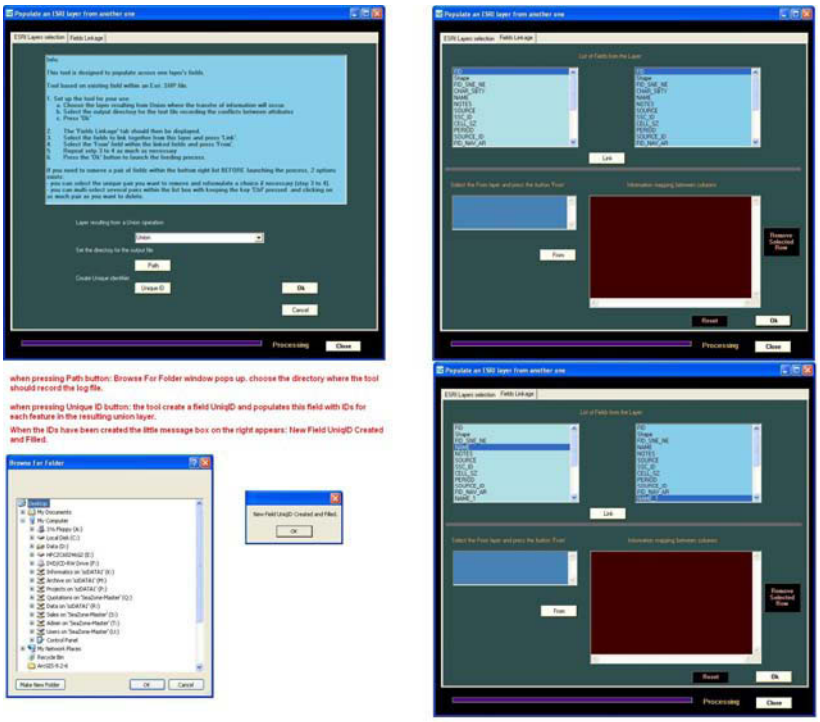


Figure 7: filed association screen for attribute transfer tool

6.6 Interpretative Character Assessment

6.6.1 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 the character types produced during the five pilot projects. That hierarchy compiled using that approach forms the basis of the structure consolidated in the national HSC Method (Tapper 2008).

Based on the HSC Method Statement (Tapper 2008), 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 'NA' used for empty entries as Appropriate
- Every feature (point, arc, polygon, region, etc) 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 (stage 3) of the GIS development process, data which is significant to the characterisation has been combined into a single data layer using a combination of 1) attribute-led descriptive characterisation in the first instance, followed by 2) a prescriptive phase of characterisation, once the data has been interpreted. The two approaches were used in combination, where most suitable across different parts of the project area. The approaches have however been described separately 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 2008). The different phases of characterisation described in the national HSC Method (Tapper 2008) have been applied and the results are described below:

6.6.2 Descriptive Attribution

"*The initial stage of characterisation involves the description and mapping of historic character at a detailed level (attributed at character sub-type level) and the production of a series of intermediate source-based datasets/layers*" (Tapper, 2008, 59).

Therefore, the first stage of data assessment was a considered interpretation of the data gathered. The methodology applied to the project area has been applied in line with the nHSC Method Statement which describes the requirements for descriptive attribution (Tapper, 2008):

- Record attributes (i.e. use descriptive criteria) rather than attributing predefined types
- Use computer analysis of attributes to derive HSC models an types
- Create explicit data structures

Each dataset was reviewed upon its delivery and assessed individually 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. In the first instance each data source was assessed individually. All data of potential value to the project was extracted into themed sub-groups to simplify the number of datasets being viewed.

The sub-groups identified generally reflect the broad character classification to some degree, due to logical division between different types of human activities already employed by the national HSC Method. However, the descriptions employed to populate the attributes of each feature or area were not prescribed using HSC character types, but instead reflected the perception of the HSC assessor: that is a defining aspect of a descriptive, rather than prescriptive, approach. For instance, all data relating to navigation, including navigational aids, hazard and channels were extracted from their respective sources, grouped within a separate data frame and given a series of preliminary attribute fields.

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 was processed to produce a set of character polygons. For example, Sea Fishery Committee fishing vessel sightings, recorded as point data, was interpreted using density analyses to produce area-based portrayal of different types of fishing.

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 character areas 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.

During the trial character assessment, the derived character polygons from the Scarborough – Hartlepool pilot project produced by Cornwall County Council, were integrated with the source data during the descriptive phase of attribution to optimise the resolution of the characterisation where additional sources were available.

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;

6.6.2.1 Navigation

Data relating to navigational activities was collated from a broad range of sources including the RYA, Anatec, SeaZone Hydrospatial, historic maps and charts, HLC, OS MasterMap, sailing directions, the ALSF England's Shipping (Wessex Archaeology, 2003) database and DfT Shipping Density data. Once extracted, data from each source was divided between the following groups of information as follows:

Shipping:

The shipping route related datasets including Anatec, England's Shipping, RYA cruising routes and DfT Shipping Densities were viewed together to assess the degree to which they overlapped and agreed with each other.

RYA cruising routes are defined as polylines. As the routes needed to be represented as areas, rather than lines, these were given a 250m buffer zone to convert them to polygons and give them a scale which highlighted the routes in the context of the characterisation.

The DfT shipping density polygons were limited to 100km offshore. As the project extends to the outer limits of UK Controlled Waters, data from Anatec and the historic shipping routes network from the England's Shipping project GIS were used as a guide to extrapolating the routes out to the limit of the project area. These were superimposed with the DfT polygons. Where the routes from multiple sources coincided, centre lines were drawn through the middle of routes and buffered to match the breadth of routes displayed in the DfT data.

Ferry routes recorded in Hydrospatial were extracted and reclassified. Ferry routes no longer in use where digitised from historic charts were digitised using modern charting as a reference to accurately reflect the route. These often depicted river crossing ferries which have since been replaced by bridges. Historic records of ferry routes were used in the interpretation of previous historic seascape character.

Navigational channels:

Modern defined navigational channels are recorded under S-57 charting standards and are therefore provided as part of SeaZone Hydrospatial. All channel-related data including channel marker buoys, navigational lines, recommended route centrelines, and traffic separation zones were extracted from Hydrospatial 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 re-attributed.

Historic charts were reviewed to identify areas where previous channels could be identified. 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.

Anchorages:

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.

6.6.2.2 Ports, Docks and Harbours

Formal 'harbour areas' reflect the water on the approaches to a harbour or dock and are essentially an administrative area. These are defined in Hydrospatial under S-57 and were therefore extracted and reclassified. The names of different polygons were in some cases ratified in order to generalise the extent to a single area such as 'Blyth Harbour', which was divided between several administrative areas.

Coastal features relating to the shipping industry, such as 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.

6.6.2.3 Maritime Safety

Safety Areas:

Safety areas are provided as part of SeaZone Hydrospatial and are mapped by the UKHO under S-57 charting standards. The features where therefore extracted from SeaZone Hydrospatial and given descriptive attributes.

Safety Services and Features:

This is one of the key areas where the perception of character differs between land and maritime viewpoints. Features such as churches, hills and windmills, are characterised as navigational marks when interpreted from a maritime perspective, and cannot be taken at face value when drawn from OS mapping.

OS Master Map, 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. The features were digitised from the geo-referenced historic charts and maps and extracted from SeaZone Hydrospatial. The resulting datasets were then compared to remove duplicates and given descriptive attributes in preparation for the prescriptive phase of the analysis. Where necessary, points were buffered following the scale prescribed in the HSC national Method (Tapper 2008).

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.

6.6.2.4 Hazards

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

Wrecks and obstructions:

The UKHO and NMR both hold extensive wreck data repositories. The hold a separate list of wrecks in 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. In addition, local authorities hold some wreck data while some sites are also depicted on historic charts.

SeaZone Hydrospatial contains both the S-57 records and UKHO records, many of which are duplicates of each other. Further duplicates exist between SeaZone Hydrospatial and the NMR wrecks database.

All wreck data therefore had to be viewed together and compared to isolate as many duplicates as possible. First, the Hydrospatial wrecks were separated into two layer, one for S-57, the other for UKHO wrecks. Duplicates were removed from SeaZone Hydrospatial by looking at the distances between S-57 and UKHO wrecks identified as the same. All wrecks identified as likely were then removed. The remaining S-57 wrecks were combined with the UKHO wrecks to form a single dataset.

The NMR wrecks include numerous 'obstructions'. These had to be isolated as a separate dataset using LIKE queries such as "*Desc LIKE "%Unidentified seabed obstruction%".* This remains a process which is to some degree manual and required considerable re-checking of the description field for the NMR data to ensure all obstructions have been removed.

SeaZone Hydrospatial and NMR wrecks were then compared to identify sites which were not duplicates. This is a difficult process as records often do not contain enough information to accurately match them. The same method employed to remove duplicates between UKHO and S-57 wrecks within Hydrospatial was therefore repeated to minimise the duplicates between the UKHO and NMR.

Additional wreck sources such as wrecks on historic charts which were accurate enough for geo-referencing, and HER wrecks were then reviewed in light of the resulting datasets.

These issues are inherent within projects dealing with wreck data on this scale. Work currently being taken forward by English Heritage along with ongoing enhancement of SeaZone's Hydrospatial data should eventually minimise these issues. However, no immediate solution exists to produce a coverage of wrecks in which no duplicate geometries can be guaranteed to exist.

The methodology used to clean the wreck data was repeated to deal with obstructions. The S-57 and UKHO obstructions were first compared, followed by the integration of the fishermen's fastenings and obstruction data from the NMR and isolated records of obstructions in historical charts.

Once a cleaned, single layer of points had been produced for wrecks and obstructions respectively, the *Density Analysis* tool in the ArcGIS *Spatial Analyst* extension was used to identify areas where densities in wrecks existed. The raster image on which the density scatters was based were produced using a search radius of 2000m, and an output cell size of 250m in line with the output cell size of the project grid. The output raster was then saved as a floating grid raster and reclassified using the no value field in order to put the data in a format which enabled the use of the *Convert raster to vector* tool, to produce character polygons which could be attributed.

Dangerous wrecks and protected wrecks were extracted from SeaZone Hydrospatial using NMR wrecks as a reference to ensure all sites were identified. UKHO and NMR wrecks which are duplicated are often represented by points or polygons which have been given different spatial locations. The UKHO wrecks are recognised as displaying the definitive locations as recorded in S-57 and are regularly updated as new surveys are undertaken. The geometries for protected wrecks and dangerous wrecks were therefore drawn from SeaZone Hydrospatial and attributed using information drawn from the NMR, documentary sources and HERs.

Natural hazards:

As rock outcrops and drying areas are defined by the fact that they lie above LAT and 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 GIS contains 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 to 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.

Water turbulence data is recorded in SeaZone Hydrospatial as well as having been recorded as part of the ALSF Navigational Hazards project. The output from both sources was combined into a single dataset and re-attributed.

Submerged rock were identified using a combination of querying out shallow depth areas and comparing the results to attribute queries on rocks in Hydrospatial, OS MasterMap, ALSF England's Shipping points and historical maps and charts.

Rock outcrops, defined as areas within the intertidal zone which are permanently exposed or visible at low water are represented on Ordnance Survey maps and were therefore drawn from OS MasterMap.

6.6.2.5 Industry

Data was 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 into separate datasets. For instance, pipelines displayed as polylines were extracted into one shapefiles while well-heads recorded as points were recorded as a separate dataset. This approach enabled features displayed as points or polylines to be buffered to produce polygons in order to integrate them with equivalent datasets from other sources.

Extractive industries:

Licensed aggregate dredging areas were extracted from SeaZone Hydrospatial. The features were compared with areas supplied by the Crown Estate, UKDEAL and BMAPA and found to be up-to-date, although no current license areas lie within the project area. Two proposed license areas were present within the project area. As these are as have not yet been agreed, there were no active dredging areas to bring into the characterisation process. However, the proposed license areas were digitised for use during the Application Review as case-study areas.

Mines and quarries were mapped on land, where a maritime character was identified, using OS MasterMap, supported by historical maps, HER and NMR records, documentary sources and HLC where available. The extent of quarries was defined using a process of selecting and dissolving OS MasterMap polygons into a single area polygon, following recognisable boundary extents. These extents were guided by a review of historical mapping where the extent of inactive quarries needed to be defined for use during the assessment of historic character.

Spoil dumping grounds are recorded on modern navigational charts to delineate areas where spoil resulting from dredging, drilling or waste has been deposited on the seabed. These areas recorded in S-57 and were therefore extracted from SeaZone Hydrospatial. UK DEAL data was compared with the results to ensure all areas had been identified.

Energy Industry:

All marine features relating to hydrocarbon extraction, including well-heads, pipelines, and oil and gas fields are recorded by UK DEAL and included in SeaZone Hydrospatial. The features where queried out into separate groups, depending on the geometries. Hydrocarbon installations, recorded as points, were given a 500m buffer and 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, HLC where available, and SeaZone Hydrospatial to identify the sites. Their extent was then defined using an HLC polygon where possible. 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.

6.6.2.6 Fishing

Data on fishing activities was drawn from a wide range of sources, some directly bearing on the extent and character of the fishing industry, others providing proxy information. These included regional Sea Fishery Committee (SFC) fishing sightings, JNCC, CEFAS, historic charts and documentary sources.

Albert Close's Fisherman's Chart of the North Sea (1950) was georeferenced and overlaid with offshore depth areas (SeaZone Hydrospatial) and seabed sediments (BGS SBS250) to define areas of specified fishing activities and named fishing grounds.

The results of the UKSeaMap marine habitat mapping project funded by JNCC was used to identify semi-natural environment character areas. The project's interactive geographical information system (GIS) allows users to access and download maps showing that project's perception of seabed landscapes and seasonal water column features. http://www.jncc.gov.uk/page-3663

ICES data, provided by CEFAS, characterises the physical pressures on the seabed from human activities in offshore waters (Eastwood, et Al, 2007). The data provided by CEFAS highlighted areas where physical pressures such as oil and gas extraction, wrecks, waste disposal and fishing affected the seabed.

The study found that selective extraction caused by demersal trawling affected a minimum of 5.4%, rising to a possible maximum of 21.4%, of the total area of the seabed (Eastwood, et Al, 2007). . The analysis of fishing activities was drawn from processed positional data for fishing vessels derived from EC vessel monitoring system (VMS). As VMS data is unable to discriminate between different types of activity (e.g. fishing, steaming, in port) and vessel gear types were often not recorded, considerable analysis of the data was undertaken for CEFAS to produce the ICES pressures map. This data was used in combination with other sources mapping demersal trawling activities to identify areas where trawling accounts for the dominant character of human impact on the sea floor. 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 (Pers Comm Andy South, CEFAS).

Raw VMS data was not used in the development of HSC following recommendations from CEFAS (Pers Comm Andy South, CEFAS) that the data, supplied as 10's of millions of points contained errors due to the data being collected for operational enforcement rather than as a record of past activity. The data contains no indication of fishing gear unless further analysis is conducted to interpret the evidence.

6.6.2.7 Transport

Transport systems were documented through their extraction from OS MasterMap, SeaZone Hydrospatial and the review of HLC, NMR and HER records, and documentary sources. Where possible, polygons were isolated. Data reflected as polylines such as the railways documented by the NMR were given a 100m buffer and unioned with other landward HSC character areas.

Features relating to transport systems were extracted from NMR and HER records using "Like" queries such as *"DESCRIPTIO" LIKE '%Canal%'* which identify all records containing the word "Canal".

Initially, OS MasterMap polygons for railways were extracted and used to define character areas. Their application over the pilot showed the polygons to be heavily fragmented by their intersection with roads and bridges. The use of buffered NMR polylines provided a more continuous representation of railways for the purpose of the project. The scale of characterisation of transport activities in the Scarborough-Hartlepool project was used as a guide when deciding which features to include in the HSC on land.

The definition of roads proved complex to integrate within the characterisation due to the large number of roads existing within the project area. Roads where defined where they were found to be key to the maritime character of an area, though in most cases, roads were not found to be mapped as a scale which met the needs of HSC. The HLC characterisations within the project area were used to guide the assessment of the dominance of major roads over their surrounding character types.

6.6.2.8 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. Military practice areas include a range of activities including submarine practice areas. These were extracted as a single group and differentiated during the descriptive attribution of the areas.

Coastal and intertidal military areas such as airfields, military bases, military coastal defences, fortifications, firing ranges, dockyards, etc were defined using OS MasterMap and HLC polygons were available. SeaZone Hydrospatial, HER and NMR data and historical maps were used to assess suitable extents reflecting both present and previous historic character.

6.6.2.9 Settlements

The extents of towns and villages were defined by taking the overall settlement perimeter as defined in OS MasterMap to provide context to the characterisation. The concentration in settlement around harbours, estuaries and industrial or recreational centres along the coast are a significant indicator of the scale of human activity activities within an area. These were therefore broadly recorded using Hydrospatial Land Regions for areas where no HLC was available.

Recreational areas on land such as golf courses, holiday parks, or parks and gardens, where a maritime character could be identified were identified and defined using OS MasterMap polygons as the primary resource, supported by SeaZone Hydrospatial, historical maps and HLC, HER and NMR data.

6.6.2.10 Palaeo-environments

Palaeo-environmental data for coastal areas can be drawn from historic maps and charts which in some cases record submerged forests or peat deposits. However, the majority of data will be drawn from HER and NMR records and from references in documentary sources.

Research into modelling palaeo-channels and submerged prehistoric land surfaces has been undertaken for parts of the North Sea, particularly around the Southern North Sea. Palaeo-landcapes (Gaffney et Al, 2007) have been modelled by academic researchers at the University of Birmingham. The North Sea Palaeolandscape Project (NSPP) data was downloaded as a kmz file and converted to shapefile in order to extract the palaeo-channels from the results.

It must be noted that the scale of research into palaeo-environments is rising with the increase in data available from offshore surveys and Regional Environmental Characterisation (REC). There must therefore be provision for incorporating the results of future research in order to keep HSC up to date with current research (Pers Comm. Peter Murphy, English Heritage).

6.6.2.11 Semi-natural environments

Semi-natural environments are those character has been modified by human activity and impacts, either directly or incidentally, but whose present expression results from natural environmental processes acting in concert with unintensive, unintentional, sporadic, and/or no active human management (though there may still be impacts from 'passive management') (Tapper 2008).

Environmental datasets help inform the characterisation of areas of semi-natural environment which although employ natural environment terminologies, for ease of popular recognition and simplicity, have clearly definable human dimensions, where cultural influences have often been directly responsible for the evolution of the various types of semi-natural environments over centuries or even millennia (Tapper 2008).

In coastal and intertidal areas, environmental character areas such as salt marshes, coastal rough ground, cliff, mudflats, dunes, etc, were identified using a range of sources including OS MasterMap, historic maps and charts, Natural England's GIS Digital Boundary Datasets, aerial photographs and documentary sources. Aerial photographs proved particularly useful in identifying current semi-natural environments, along with the use of desk-based research into place names and the review of areas defined by Natural England.

Semi-natural environments for inshore and offshore areas were documented primarily using UKSeaMap, BGS seabed sediments (SBS250) and JNCC data. UK SeaMap is "an interpreted broad scale map of the dominant seabed and coastal features (termed "Marine Landscapes") based on geological, physical and hydrographical data" produced by JNCC.

These datasets were brought together in a single data frame and assessed to identify areas where patterns of human activity have impacted in various ways to create the distinct semi-natural landscapes we perceive today.

6.6.3 Prescriptive Classification

"*The second stage involves the classification of the character type hierarchy and development of the final characterisation layer*" (Tapper, 2008, 59). Inevitably any HSC project will inherit from previous projects a list of sub-character types which it will be appropriate for it to use for some of its polygons of shared character: they will be applied prescriptively to once the outcome from the descriptive analysis indicates to the HSC assessors that they are appropriate for those polygons

Driven by 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, a process combining 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 (Tapper 2008, 3.3.6.3-5).

The characterisation process above LAT and below LAT required slightly different approaches due to 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 divided between coastal and intertidal or inshore and offshore datasets for the following stages of characterisation. The results were then re-united following the characterisation of the inshore and offshore areas for each marine level.

Coastal and Inter-tidal Areas

Characterisation in the coastal and intertidal areas used OS MasterMap and HLC polygons as baseline data from which polygons were created, using a broad range of data sources to identify and interpret character and then define the extent of an area through the identification of significant boundaries.

The HSC assessor worked along the coastal and intertidal areas, 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 was selected out 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 and a character sub-type term was sought, whether from the existing HSC terminology or an entirely new term as most appropriately matched the polygon's collated features. The selection of a series of MasterMap polygons often included unwanted branches of road where polygons did not end at the boundary required.

Where features overlapped, an assessment of dominance was made for the intersecting areas.

Where possible, areas identified as having a distinct marine or maritime character through the review of a wide range of sources were defined using MasterMap or HLC polygons. However, where features were not identifiable from these sources, such as some instances of coastal wind farms, these character sub-types were defined by integrating features from other sources.

Where a suitable sub-type could not be ascribed based on those listed in the HSC Method Statement, addition character sub-types were determined by the descriptive attributes and added to the list in line with the multi-mode approach to characterisation.

Inshore and Offshore Areas

Once the data has been digitised, consolidated into a single data layer, gridded where necessary and classified using character sub-types, data groups reflecting individual sub-character types were consolidated into the levels reflecting the different dimensions of the marine landscape.

The baseline data for inshore and offshore areas was very diverse but in many cases, the extent of features was already relatively clearly defined and required interpretation to define the nature and scale of character for each feature.

First, the data for inshore and offshore areas, was grouped to reflect the level of the marine landscape (Coastal, Sea-surface, Water column, Seabed surface, Seabed sub-surface) 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 (Tapper, 2008).

During the development of the GIS over a Trial Area, 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 in to a single data layer and descriptive attribution, all inshore and offshore data was gridded using the vector cells produced using the SeaZone grid creation tool. The size of grid cells used varied depending on the nature and resolution of the data.

Data was fed through the grid using a spatial join (via the ESRI Join by location tool), allowing the attributes of the character polygons to be fed into the grid. Where conflicts existed between data, a decision was made as to the dominance of one feature over another.

The ESRI join by location tool recommended in the HSC national Method (Tapper, 2008) functions by identifying and populating cells which fall entirely within a polygon. Therefore where two polygons share a boundary, the cells overlapping along that boundary will not be selected as lying inside either feature (Figure 8). 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 character sub-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 character sub-type at a time.

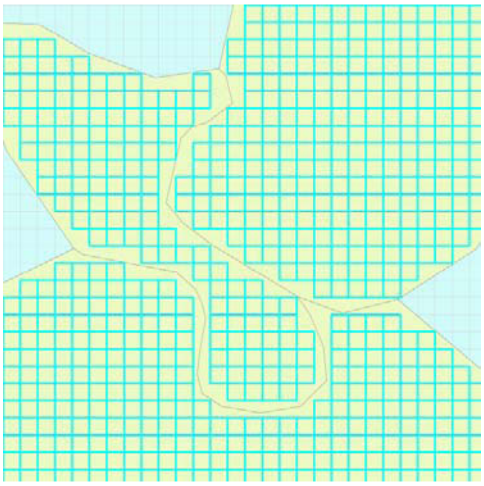


Figure 8: Vector grid cells joined by location that don't fall completely within one or the other feature will not be automatically attributed

Buffering features before feeding them through the grid resolved the problem when working on the Trial Area where an output grid of 500m² had been chosen, producing 353,628 cells to be processed across the area. However, the application of the same approach to the full project area proved more difficult as the output grid was reduced to 250m² over a much larger area, requiring 1,412,111 cells to be processed. The number of cells was too great for a computer, running 1GB of RAM and 1536MB of virtual memory, to support the processing of the entire grid.

In order to shrink the numbers of cells being processed, a different approach was adopted during the application of the method to the full project area. Each data sub-group was processed separately in the first instance and gridded before being combined with other data.

First each dataset was overlaid with a suitable scaled output grid, chosen based on the resolution and accuracy of the data, as suggested in the national HSC Method. All cells which intersected the polygons with the layer were selected using the *Select by location* tool and saved out as a separate dataset (Figure 10b). This approach significantly reduced the number of cells being processed, allowing the GIS analyst to apply a spatial join between the select group of cells and the character polygons. Once joined, the output cells were dissolved based on the recurring attributes of each dataset (all but the unique IDs)(Figure 10c).

Figure 9: Converting polygons to dissolved grids, by selecting cells required then joining the polygons to the cells by location, before dissolving by attributes

Once all datasets had been treated in this way, they were unioned bringing each layer in at a time (Figure 10), 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-type was not recorded in the list provided in the national HSC Method , a sub- character types was added using a bottom up approach where necessary in communication with English Heritage.

The HSC Method Statement highlighted the problem of gridding data along boundaries between polygons, where more than one polygon overlaps with a vector cell.

It states that, " *where the boundaries between two or more polygons in the underlying data source are encompassed by grid square, a decision has to be made by the assessor with regard to which is predominant (this may be achieved automatically by assuming that any cell 'intersected' by underlying dataset is included or by manual selection on the part of the assessor)"* (Tapper, 2008)

The GIS tool developed to facilitate the gridding process deals with this issue by identifying the polgygon(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. If a cell's centroid overlaps with more than one polygons, then the HSC assessor will the make an assessment of dominance.

The tool developed to facilitate the identification and resolution of dominance struggled with the size of the project area and the large numbers of vector grid cells being processed at one time. A solution was found, splitting the project area into a series of smaller tiled areas. Once the first area has been processed, the decisions made can be transferred to the next area and applied if required. The tool resolves conflicts where the decision has been made to apply to all other similar cases on a specific marine level. The conflict will be flagged up by the tool where it has not previously been seen or resolved, or where the decision was seen to be unique to a specific area.

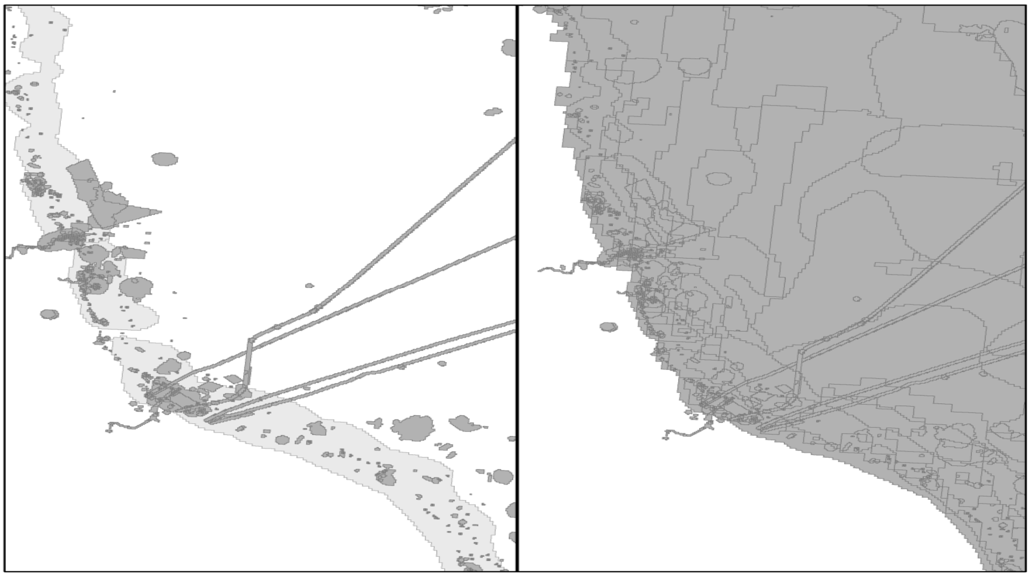


Figure 10: Once each data layer has been gridded individually, the results were unioned one by one to produce a single layer of polygons for each marine level

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 (Figure 10).

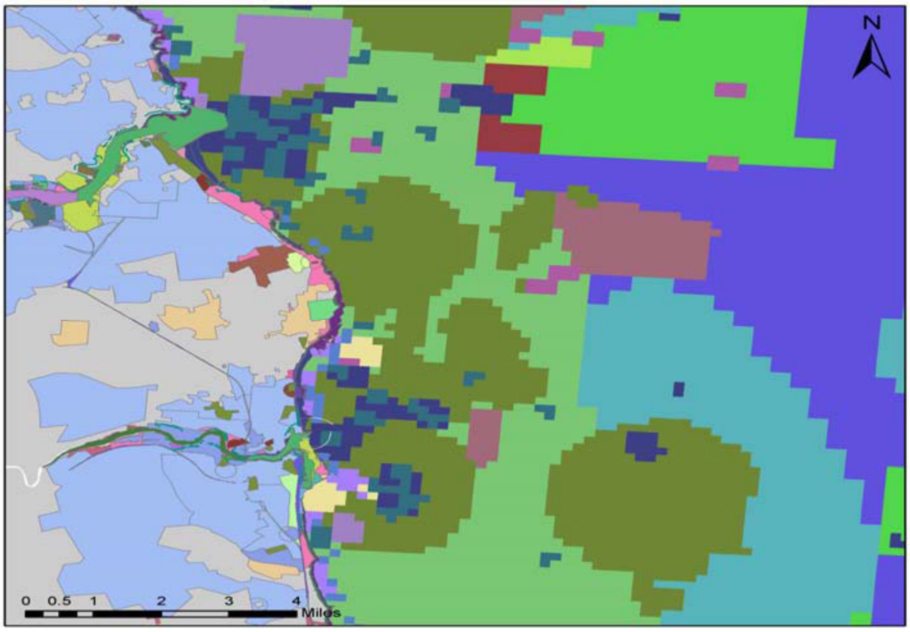


Figure 11: Coastal and intertidal polygons were unioned with inshore and offshore polygons to produce a single layer of HLC character types

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 co nflated characteri sation, usi ng the same process of u nions used to co nstruct each level. The HSC a ssessor identified th e dominant character between the different marine levels in orde r t o popu late t he Present Sub-Character Type. A prescriptive attribution process was then appl ied to auto matically popul ate the character type an d broad character type based on the classific ation hierarch y str uctured around the sub-character types. Historic character was the n ascribed based on the attri butes within the marine levels.

The ou tput of t his phase is a s ingle lay er of discret e polygons f or each mari ne lev el, which have been reclassified to reflect a single layer of sub-character areas. 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 2008) (Table 3). 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 field as shown in Table 3.

Table 3 - Attribute field structure outlined in the National HSC Method Statement (Tapper 2008)

Attribute Name	Description and guidance, terminology	GIS database Alias	Pop. Method	F Format	Width
ObjectID	Unique reference number for HSC polygon/grid cell	FID	automated		
Name (Sea Area)	Name of sea area or topographic identifier, local or popular name	NAME	manual	string	100
Broad Character Type *(conflated)*	Broad Character Type (present, dominant; national strategic level	PRSNT_BDTY	automated	string	100
Character Type	Character type (present, dominant;	PRSNT_TY	automated	string	100

(conflated)	regional level)				
Sub Character Type *(conflated)*	Sub character type (present, dominant; local level).	PRSNT_SBTY	automated	string	100
Character Area (1-_)	Unique character area	CA1, CA2 etc	manual	string	100
Sub-sea floor HSC	Sea-bed historic character (present, dominant; sub-character level)	SBFLR_SBTY	manual	string	100
Sea-floor HSC	Sea-floor historic character (present, dominant; sub-character level)	SFLR_TY	manual	string	100
Water Column HSC	Water column historic character (present, dominant; sub-character level)	WTRCL_SBTY	manual	string	100
Sea-surface HSC	Sea surface historic character (present, dominant; sub-character level)	SSRFC_SBTY	manual	string	100
Previous Character Type (1-_)	Previous historic character for which evidence is available. Recorded for multiple time-slices on basis of source dataset.	PRVS_SBTY1 , PRVS_SBTY2 etc	manual	string	100
Period (1-_)	Benchmark period of origin of the area represented in the polygon. Recorded for present and previous historic character levels	SBFLR_PRD, SFLR_PRD, WTRCL_PRD, SSRFC_PRD, PRVS_PRD1	manual	string	50
Location	General location (eg. Offshore marine, inshore marine, estuary, coast etc)	LCTN	manual	string	50
Confidence (1-_)	Degree of certainty/confidence of HSC interpretation of present and previous historic character (recorded per HSC level and time-depth).	SBFLR_CNF, SFLR_CNF, WTRCL_CNF, SSRFC_CNF, PRVS_CNF1 etc	manual	string	25
Source (1-_)	Sources used to identify present and previous historic character (recorded per HSC level and time-depth). Attribute values to record Supplier, Date, precise GIS file name – see Solent/IoW seascapes method. To include reference to the scale of original data used.	PRSNT_SRC, SBFLR_SRC, SFLR_SRC, WTRCL_SRC, SSRFC_SRC, PRVS_SRC1 etc	manual	string	250
Links (1-_)	URL hyperlink to Character Type texts and multi-media	NAT_LNK, REG_LNK	manual	string	250
Notes	Further background information on history of the polygon. Expansion on information recorded at broad character and sub-character levels	SBFLR_NTS, SFLR_NTS, WTRCL_NTS, SSRFC_NTS, PRVS_NTS1 etc	manual	string	250
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 (eg. 250mx250m, 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 who compiled the HSC	CRTR	automated	string	250

6.6.4 Development of Character Type Text Descriptions

As stated in the HSC Method Statement, 'brief structured summary texts relating to the character type hierarchy allows them to inform users of all levels of the HSC GIS database' (Tapper 2008, 3.4.4.1). In particular, they are designed to provide a connection and initial stimulus for various future applications of the database' (Tapper 2008, 3.4.4.1).

The characterisation of shared trends in the definition, distribution and regional significance of feature types, and their relationship with the natural environment represents the fundamental output of HSC. The analysis and interpretation of these trends is fundamentally a perceptual process, undertaken using 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, 2008) 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

Following the commissioning of the Project Design, it was agreed with English Heritage that the text description would be developed to encompass both a national and regional perspective, each perspective to be retrievable separately from the eventual database of texts.

To avoid un-necessary duplication of work, the character-type descriptions produced for the Scarborough to Hartlepool Seascapes Pilot Project (Val Baker et al 2007) were used as the basis from which the descriptions for the Demonstration Project were produced, providing a valuable starting point and contextual reference for describing the North East region.

The character type text descriptions have been compiled in to a relational database (Figure 12), providing a digital archive on the information gathered. The database has been designed provide a central resource for storing text descriptions for the national HSC database in a format which allows the information to be managed, queried and exported in an html format. This allowed the text descriptions to be both hyperlinked to individual

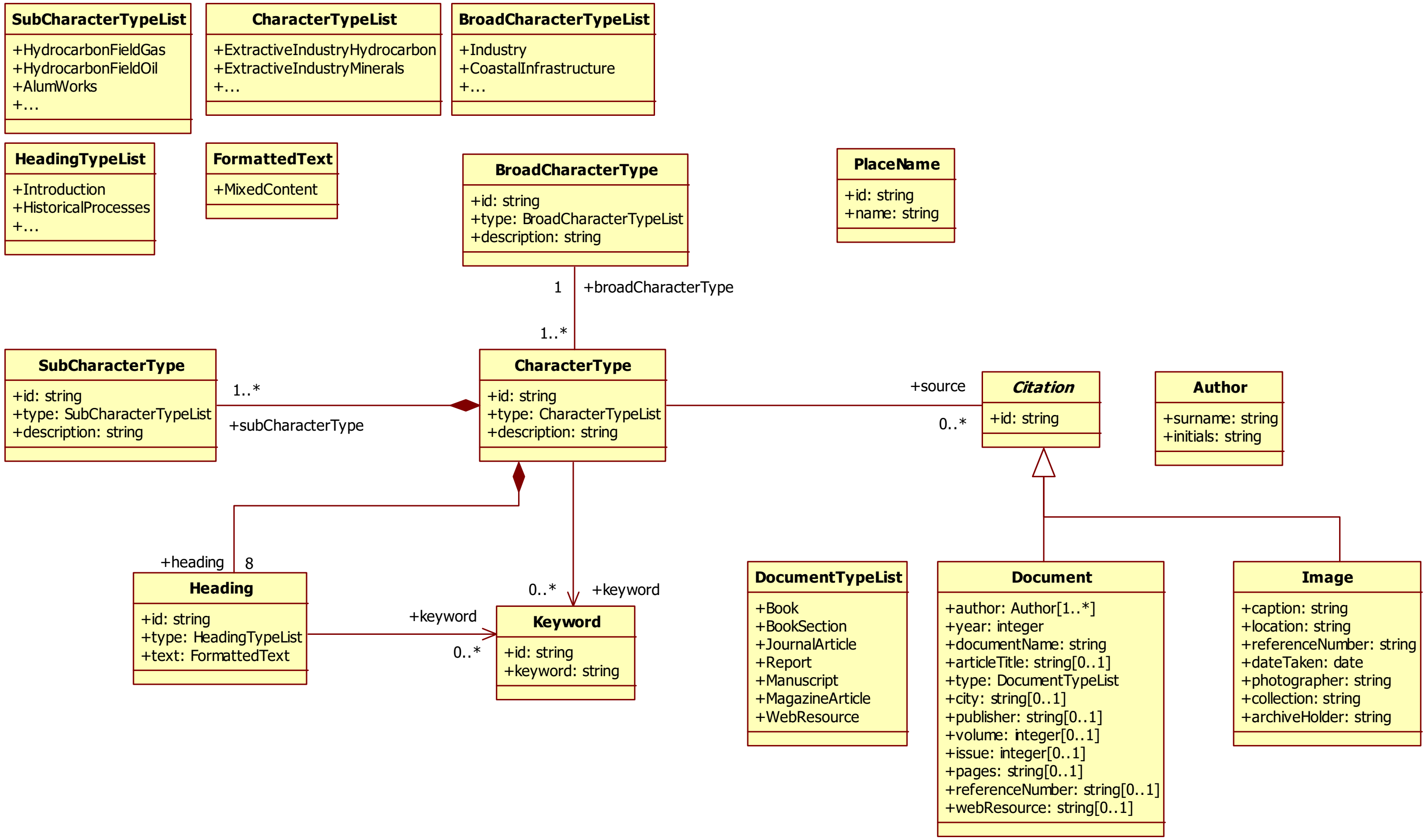


Figure 12: Relational Database Diagram

character types within the GIS and provided a basis from which to produce a stand-alone interactive multimedia resource.

The HTML pages have been designed to include descriptions, images and other available multimedia resources within a consistent and user friendly structure. The system has been designed to inform users on the character of the historic landscape at a range of scales and can be used both 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 the project report.

7. RESULTS

7.1 Applying the HSC Method

7.1.1 Introduction

The HSC Method Statement is designed to provide general guidelines on creating and compiling an HSC while maintaining the necessary flexibility to allow for implementation at a range of scales, for a range of purposes and using a range of software options.

The key areas where this project felt interpretation of the method was required in the manipulation and interpretation of data during the application of the method are as follows:

- Developing an approach for descriptive characterisation
- Processing of individual sources e.g. integration of point data such as wrecks to represent scatters
- Consolidation of data from different sources into a single dataset
- Creation of vector grid cells
- Using vector grid cells for marine data
- Defining inland extent
- Method for deriving character polygons on land from OS MasterMap
- Application of the attribute structure prescribed in the method to individual marine levels

7.1.2 Multi-mode Characterisation

The HSC Methodology describes the descriptive or attribute-led element of characterisation as the first stage of a multi-mode approach where descriptive character attributes are analysed using a bottom-up approach. This process takes place during the data capture stage of the project when information is being processed to create source-based layers for use in the character assessment process (Tapper 2008).

The method describes the attribute-led method but leaves the approach for implementing these rules down to the assessor.

The approach adopted for this project, described in section 6.6.2, where a standard set of descriptive fields has been applied to all data during the descriptive phase of characterisation, facilitated the application of the method during several stages of the methodology:

It enables multiple datasets from different sources to be brought together within a single dataset. The format for attribution used during the descriptive phase of characterisation is not covered by the national HSC Method. Therefore, an integrated approach to processing the data to allow integration of points, polygons and lines from different sources needed to be decided upon.

It also simplifies the integration of attributes from multiple datasets during the unioning process and the processing required to resolve overlaps between character polygons during the dominance assessment.

7.1.3 Data Processing

Individual Datasets

The processing of individual datasets for incorporation into the character assessment is described in the HSC Method Statement (section 3.1.), although in some cases does not specify how the data should be processed to produce character polygons.

If the search areas selected and algorithms employed differ between projects, the results will not be consistent. For HSC projects contributing to a particular application therefore, a method for representing scatters of features would need to be consolidated between HSC projects for the representation to be meaningful. Communication between future HSC projects should be encouraged to ensure that the approaches used for interpreting point data are comparable.

Consolidating Data

A broad range of character sub-types are interpreted from a numerous sources, within which exist considerable overlaps. A key part of the characterisation process is the integration of features from different sources together during the descriptive element of characterisation. Although the sources available will differ to some degree between regions, the majority of data sourced for HSC are available on a national scale. For HSC projects contributing to a particular application therefore, the processing applied to national datasets between different HSC project areas should be co-ordinated to ensure that the results are comparable.

Different interpretations in the grain of HSC would lead to differences in the display of these datasets. Therefore, most data for this project was gridded using a 250m² grid following discussions with English Heritage to reflect the output cell size for the project. Each marine dataset was gridded once the data from multiple sources had been characterised and consolidated into a single layer. Future HSC projects contributing to a particular application would benefit from continued communication between HSC assessors regarding the nature, scale and reliability of sources employed and their approach to managing data for character sub-types such as those relating to fisheries and mariculture, navigational hazards (particularly wreck and obstruction scatters), or palaeolandscapes, where boundaries may be more difficult to define.

7.1.4 Using Vector Grid Cells

The HSC Method recommends the combination of two approaches to produce a single layer of discrete polygons for each level of the characterisation (Tapper, 2008, section 3.2.3.1).

- The use of a vector grid to combine data below MLW, and
- The use of vector polygons above MLW

The creation of a set of vector cells was facilitated by the grid creation tool produced by SeaZone. The tool ensures that grids created at different scales and in different areas of England will remain interoperable by ensuring that they relate to the same datum.

The project highlighted potential challenges for future HSC projects where the study area is equivalent or greater that the one selected for this project. With the software and hardware used by the project team, the processing of data through the grid using a spatial join was however only possible when working on the trial area due to the large number of cells in the full project area.

The solution identified was to select only the cells required to feed each dataset through from the grid. The HSC Methodology can then be implemented by using a spatial join to ascribe the descriptive attributes to the cells, then dissolving the cells back to polygons, before applying a union to the gridded polygons in a similar way to the polygons processed above MLW.

As the HSC Method suggests dissolving the final output for each coastal and marine level, the dissolving of cells was applied before the character areas were unioned, to minimise the number of polygons being produced. This approach, though time consuming, worked effectively while adhering to the approach prescribed in the national HSC Method.

7.2 Project Outputs

7.2.1 Introduction

The output of the project outlined in the project Brief is described below to include the products specific to the tender submitted by SeaZone

- Project Report, deliverable in two parts:
  - HSC Demonstration Project Report
  - HSC Application Review
- Mapped GIS, Project Database and Linked Texts
- GIS Tools
- Web Resource
- Archive

The Project Report will be delivered as five hard copies and five CDs to English Heritage on completion of the project. Any additional copies requested will be available at an additional cost per copy in line with standard SeaZone fees. The report will be divided into two sections as specified in the project brief (English Heritage 2008); the first documenting the project's implementation and the second outlining the System's application review and case-studies.

An offline web resource will be delivered on CD as a series of HTML pages containing, maps, character type descriptions and character area descriptions.

The project archive, comprising the Project Brief, Project Design, Project Report, the GIS and associated structure, web resource pages/multimedia package and relevant correspondence will be delivered to the NMR. All digital reports will be sent by English Heritage to the Archaeological Data Service (ADS) for dissemination online after the close of the project.

7.2.2 Project GIS

The character maps generated following the HSC Methodology cover a large area of the coastal and marine historic environment. A series of images have been included in the report to illustrate the overall results of the characterisation. However, due to the scale of the project the results of the characterisation are best illustrated through the use of the output GIS and multimedia resource produced by the project.

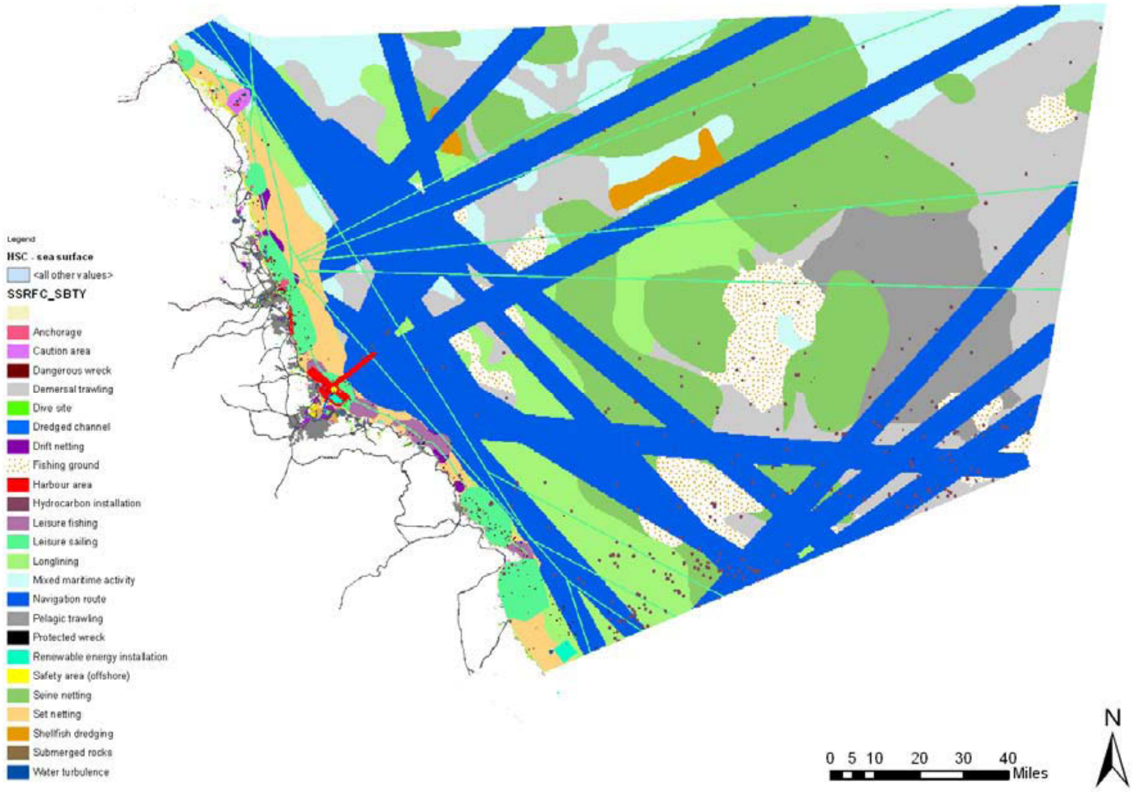


Figure 13: Historic Seascape Characterisation - Sea Surface

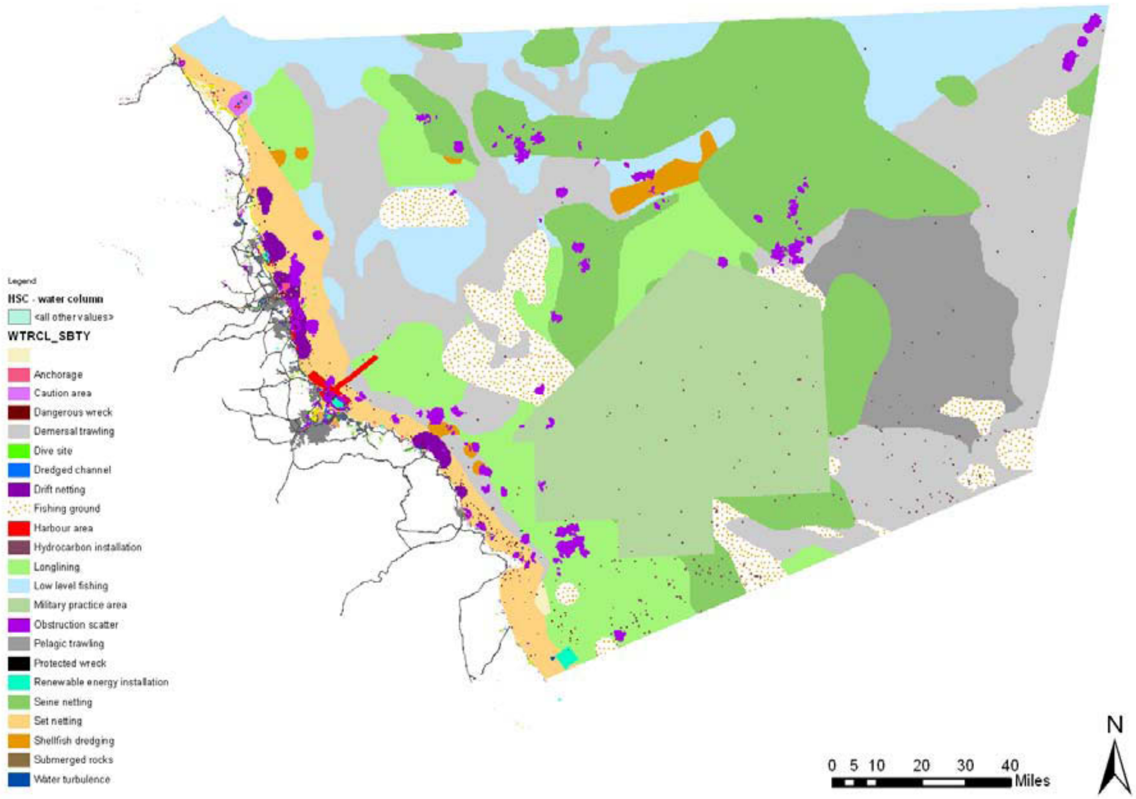


Figure 14: Historic Seascape Characterisation - Water Column

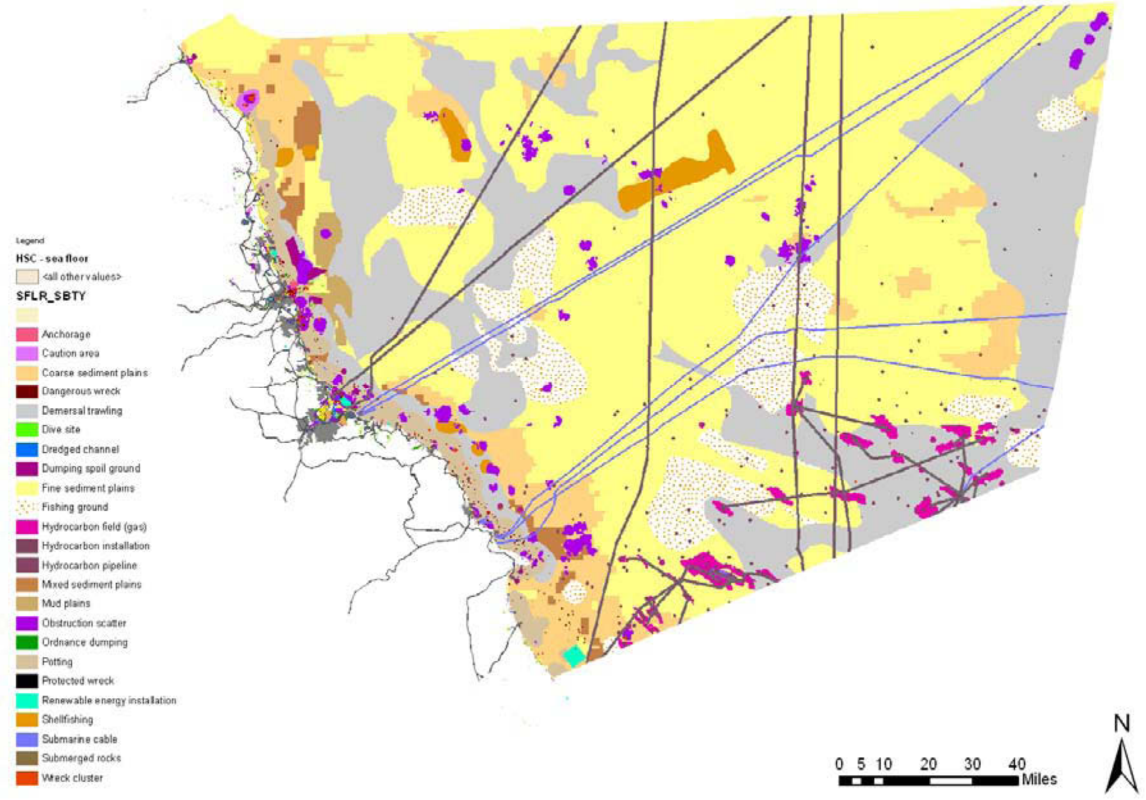


Figure 15: Historic Seascape Characterisation - Sea Floor

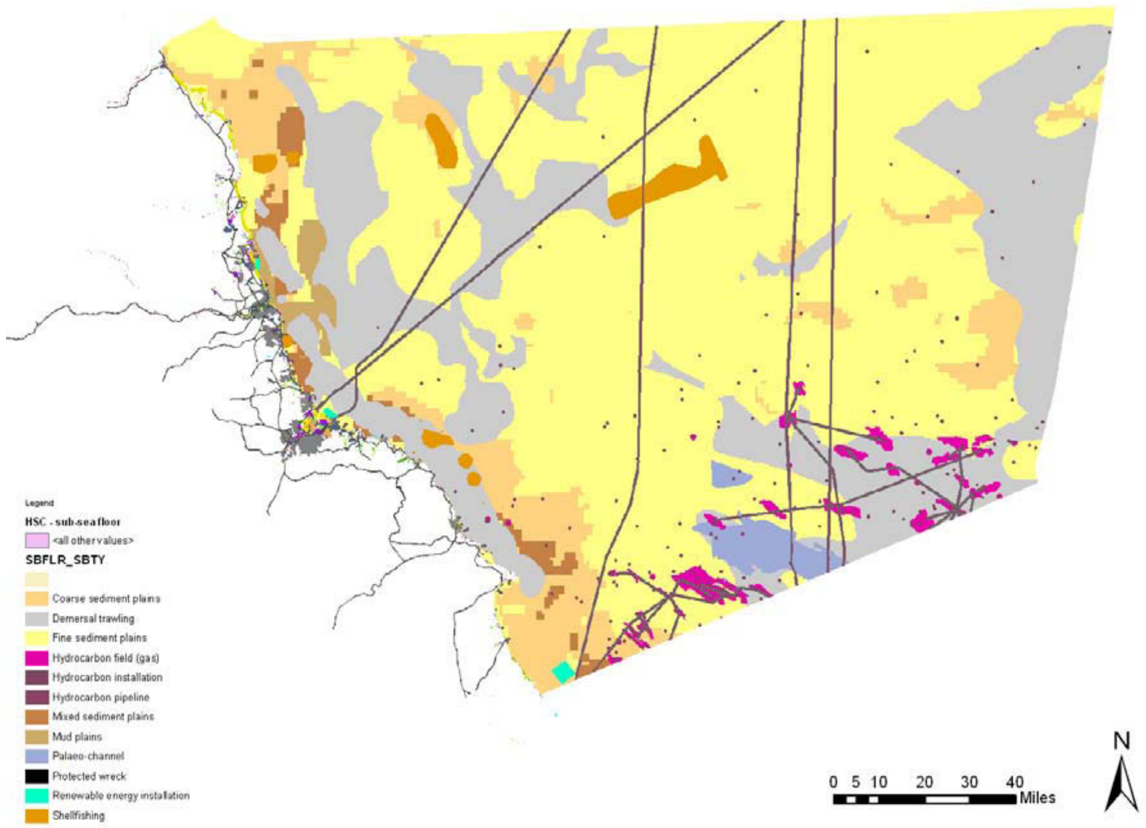


Figure 16: Historic Seascape Characterisation - Sub-Seafloor

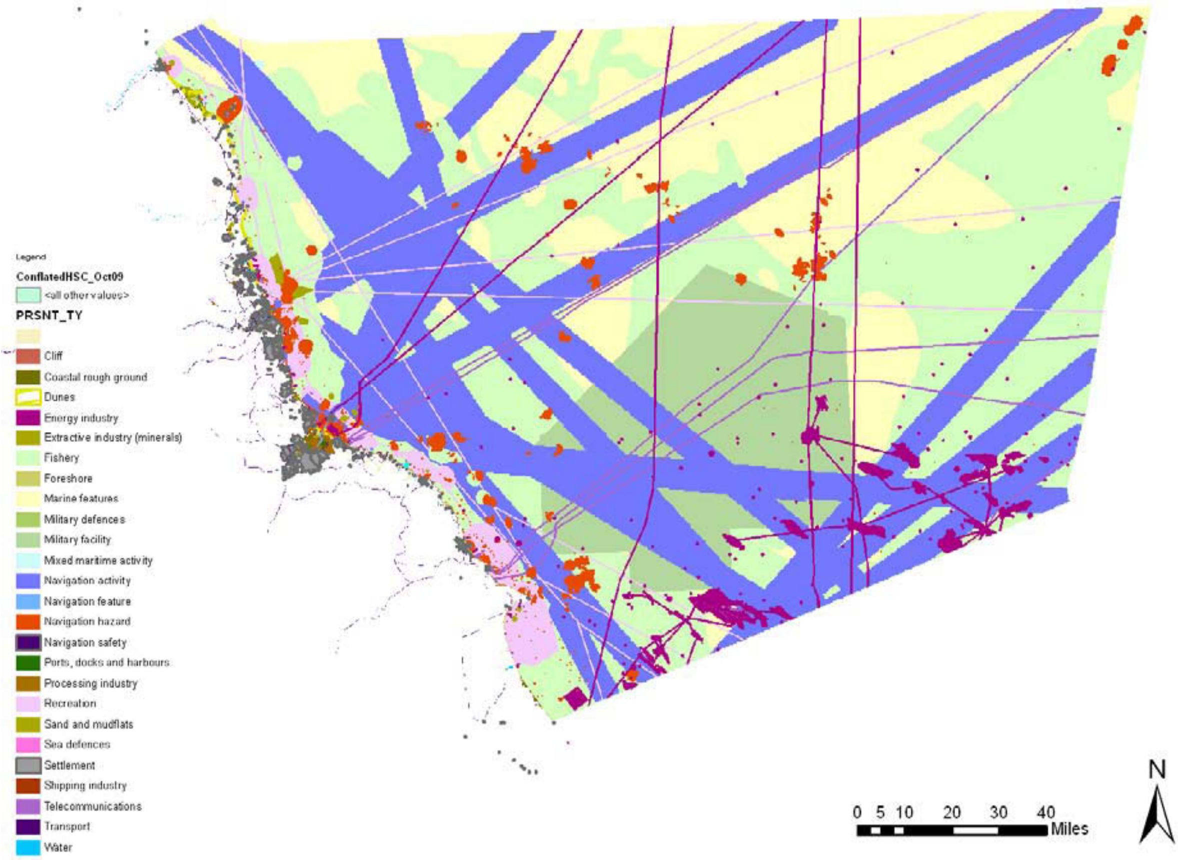


Figure 17: Historic Seascape Characterisation – Conflated layer

Five copies of the GIS and its associated database will be delivered as an ESRI Personal Geodatabase alongside linked character text descriptions, providing a "ready-to-load" format for viewing the data. The GIS will be delivered as specified in section 6.2.2 (English Heritage, 2008):

- Spatial data will be delivered as a digital geographic format agreed with English Heritage, such as a shapefile or personal geodatabase (PGD)
- All data will be delivered in an agreed format.
- Spatial data will be referenced to British National Grid.
- All non spatial data recorded about any features will be recorded as attributes in line with the recommendations made in English Heritages Guidelines for English Heritage Project involving GIS (Froggatt, 2004).
- All spatial relationships will be topologically clean and correct and will follow the guidelines defined in English Heritages Guidelines for English Heritage Project involving GIS (Froggatt, 2004).
- Data will be supplied to be viewed at 1:50,000.
- All data will be compliant with MIDAS standards.
- All metadata will be UK Gemini compliant, and encoded according to ISO 19139.

Software developed under the contract shall be made available under licence for unlimited use by EH (or its contractors, agents etc). The intellectual property rights to the software remain with SeaZone Solutions Ltd unless otherwise negotiated. SeaZone will provide support to EH for the use of the software by email and telephone during normal office hours for a period of 3 months after completion of the contract.

7.2.3 Text Descriptions and Multimedia Resource

Text based descriptions were developed for each character type, based on the interpretation of the following research areas defined in the national HSC Method (Tapper 2008):

- 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

Each sub-heading has been divided to reflect historic character on a national scale and on a regional scale. The term 'National' refers to a 'whole nation' perspective, including England and adjacent waters out to the limit of UK Controlled Waters.

The 'Regional' scale of the project refers in this instance to the north east of England, to the extent to which regional trends in character are perceived by the HSC assessor to extend to that region. In this case, the name of the region, selected by the project team in agreement with English Heritage, approximately reflects the project area off North East England, although for other HSC projects the definition of a region may not necessarily reflect their project area. The perception of the region may vary between HSC assessors and the scale of the region may therefore be perceived differently in future HSC projects.

The text descriptions have been compiled within a purpose-built MS Access database which allows the information to by exported as .html files for integration within a multimedia output, the structure of which was developed using an *Opus 6* software package. The texts are available in section 3 of the report (Annex A2).

Once compiled, texts describing the regional and national perspectives for each character type were used as the basis for developing a multimedia resource which allows the user to interrogate the data in a range of ways, either through navigation between pages or via a map search.

7.2.4 Project Report

The project report is divided into three sections to facilitate access to different parts of the document. The first section documents the project's implementation, while the second describes the results of the application review and case-studies.

Section 1 outlines the different stages in the methodology employed in the application of the national HSC Method and the results of the project.

The Application Review, outlined in Section 2 is designed to identify and demonstrate the actual and potential capabilities of Historic Seascape Characterisation and its application to a range of planning and outreach scenarios. The review seeks to illustrate the value of the HSC Method in making a positive contribution to different aspects of the management of change in the marine environment, using a series of case-studies to support the discussion.

The review of HSC applications has been approached in two phases. In the first instance the review considered the wider applications of HSC (English Heritage, 2008). The second part of the application review uses exemplars to assess and promote the benefits that HSC implementation can have in the context of heritage management and planning, as well as in an educational context. A series of case-studies were identified to help identify applications using current scenarios.

The Appendices have been separated into a third section of the report as they contain the text descriptions which have been integrated within the multimedia resource for the project.

7.2.5 Dissemination and Outreach

The project has been promoted via the SeaZone website through the development of an HSC project page. The webpage contains a hyperlink to the English Heritage HSC web-pages.

A flyer was developed for distribution at appropriate events and for inclusion in invitations to the stakeholder seminar.

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 and promotion of the project in SeaZone newsletters and documentation.

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9. ABBREVIATIONS

ADS – Archaeological Data Service

ALSF – Aggregate Levy Sustainability Fund

AMAP – Area of Maritime Archaeological Potential

BGS – British Geological Survey

CRS – Co-ordinate Reference System

Defra – Department for the Environment, Food and Rural Affairs

DNF – Digital National Framework

EH – English Heritage

EIA – Environmental Impact Assessment

ESRI – Environmental Systems Research Institute

EU – European Union

HER – Historic Environment Record

HLC – Historic Landscape Characterisation

HO – Hydrographic Office

HTML – Hyper Text Mark-up Language

HWTMA – Hampshire & Wight Trust for Maritime Archaeology

HSC – Historic Seascape Characterisation

IACMST - Inter Agency Committee for Marine Science and Technology

INSPIRE – INfrastructure for SPatial InfoRmation in Europe

LAT – Lowest Astronomical Tide

MEDIN - Marine Environmental Data and Information Network

MEDAG - Marine Environmental Data Action Group

MDIP – Marine Data Information Partnership

MHW – Mean High Water

MLW – Mean Low Water

OS – Ordnance Survey

OSGB36 – Ordnance Survey Great Britain 1936, the geographic datum of British National Grid

UKHO – United Kingdom Hydrographic Office

RAA - Regional Archaeological Assessments

SEA – Strategic Environmental Assessment

SMR – Sites and Monuments Record