Report No: 2007R022

England's Historic Seascapes
Scarborough to Hartlepool
and Adjacent Marine Zone

Historic Seascape Characterisation Method

Historic Environment Service (Projects)

Cornwall County Council

A Report for

England's Historic Seascapes, Scarborough to Hartlepool and Adjacent Marine Zone

Historic Seascape Characterisation Method

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The views and recommendations expressed in this report are those of the Historic Environment Service projects team and are presented in good faith on the basis of professional judgement and on information currently available.

Cover illustration

Long-line fishermen with hooked lines. © Sutcliffe Galleries.

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Abbreviations

ADS	Archaeological Data Services
ALSF	Aggregates Levy Sustainability Fund
BGS	British Geological Society
BNG	British National Grid
CCC	Cornwall County Council
CEFAS	Centre for Environment, Fisheries and Aquaculture
DEFRA	Department of the Environment, Food and Rural Affairs
EH	English Heritage
ESRI	Environmental Systems Research Institute
GIS	Geographical Information System
HER	Historic Environment Record
HES	Historic Environment Service, Cornwall County Council
HLC	Historic Landscape Characterisation
HSC	Historic Seascape Characterisation
HTML	Hypertext Markup Language
HWTMA	Hampshire and Wight Trust for Maritime Archaeology
JNCC	Joint Nature Conservation Committee
MHLC	Marine Historic Landscape Characterisation
MHW	Mean High Water
MIDAS	Manual and data standard for Monument Inventories
MoLAS	Museum of London Archaeological Service
MSP	Marine Spatial Planning
NESFC	North East Seas Fisheries Committee
Nm	Nautical mile
NMM	National Maritime Museum
NMR	National Monuments Record, Swindon
NP	National Park

OS	Ordnance Survey
RCHME	Royal Commission on the Historic Monuments of England
RMSE	Root Mean Square Error
SAC	Special Area of Conservation
SMR	Sites and Monuments Record
SSSI	Site of Special Scientific Interest
UKDEAL	UK Digital Energy Atlas and Library
UKHO	United Kingdom Hydrographic Office, Taunton
WA	Wessex Archaeology

1 Summary

This report describes the methodology of a project, commissioned by English Heritage and undertaken by Cornwall County Council's Historic Environment Service (Projects) in 2006-7, to apply Marine Historic Landscape Characterisation to the coastal, inter-tidal and marine zones of North Yorkshire and Teesside, from Scarborough to Hartlepool (Fig 1), as part of England's Historic Seascapes project. Sponsored by the Aggregates Levy Sustainability Fund (ALSF), it is one of four pilot projects considering varying coastal and marine contexts designed to test and further develop an initial methodology developed by Wessex Archaeology in Liverpool Bay (Fig 2). The pilot projects were undertaken concurrently and presage a nationwide marine characterisation programme.

Marine Historic Landscape Characterisation, now referred to as Historic Seascape Characterisation (HSC), aims to provide an historic environment context for the traditional archaeological and historical resource, such as HERs. It offers a base survey that may better inform marine spatial planning and encourage the sustainable future use and management of the marine environment. It will improve understanding of the marine historic environment more generally, enabling it to be more fully involved in strategic debates about the future of the sea. HSC will also strengthen the sense of identity of those individuals and communities who either live by or make their living from the sea, giving them the confidence to engage in those debates.

The whole study area is an historic seascape altered, transformed and affected by human activities. Seeking an archaeological understanding of the historical and cultural development of the present marine, inter-tidal and coastal areas, this pilot project maps historic character and sea-use within a GIS, using historic charts, maps and associated documentary sources alongside modern marine data.

Source-led and guided by current terrestrial multi-mode HLC methodology (Aldred and Fairclough, 2003) it defines 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.

To reflect the multi-dimensional or multi-layered nature of the marine environment (ie. the seabed, seafloor, water column and surface) a fine grid of cells, with tiered attributes, is used in this HSC to record the present and dominant historic character for each marine layer. (Inter-tidal and coastal areas, whose sources are those of the established terrestrial HLC, are captured as polygons.) From this complex database a single, conflated HSC layer is derived.

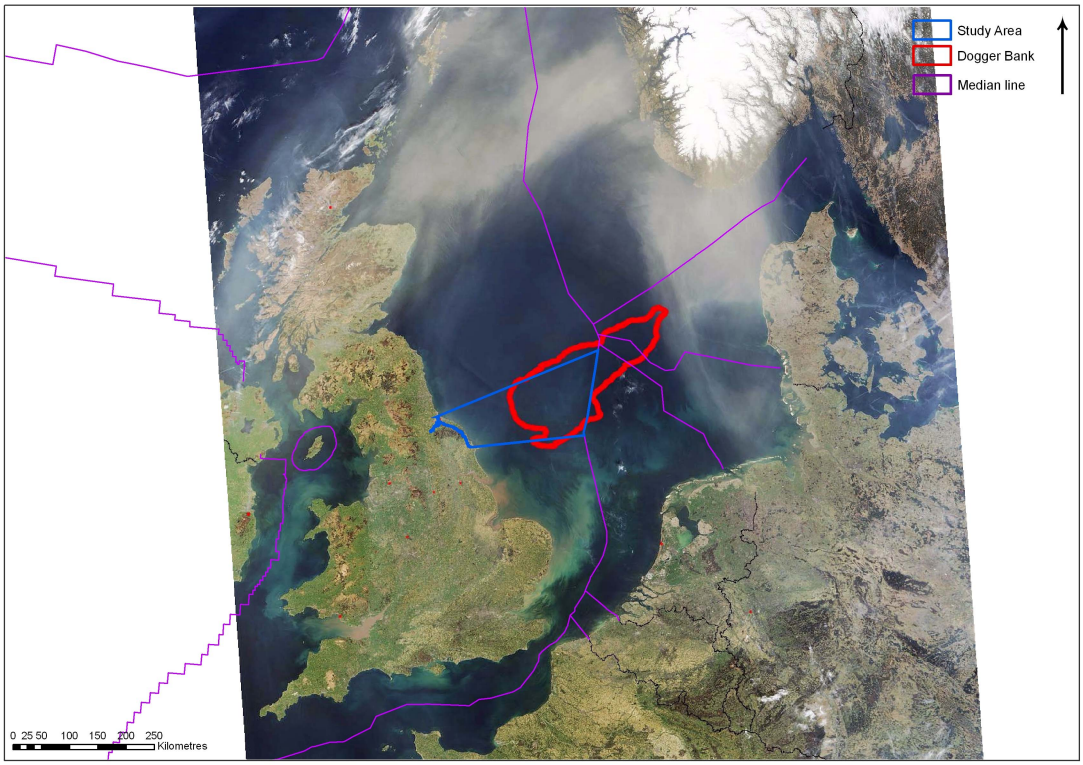

Fig 1 The Scarborough to Hartlepool Seascapes pilot area

To assist the wide variety of users of HSC, texts have been prepared for each HSC Type, describing different aspects of the historic character including identifying distinguishing attributes and principal locations; their constituent components, features and variability; the values and perceptions that people have of these areas; the research, amenity and education potential they offer; their present condition and forces for change affecting them, which in turn inform statements on their rarity and vulnerability allowing broad recommendations to be suggested for their management.

For the greater part of its southern length, the Scarborough to Hartlepool coastline is sheer, rocky and inhospitable. Capped by glacial tills, cliffs of Jurassic sedimentary rocks – in places mineral-loded and fossil-laden – are interspersed by narrow and steeply cut watercourses, some wooded, and by small sheltered bays and prominent headlands. Though comparatively safe when the wind blows offshore, it is treacherous in northerly and easterly gales, with hazardous 'scars' and shoals nearshore, as thousands of inshore wrecks bear testament. Further north in the sweep of Tees Bay and at the mouth of the Tees Estuary the coast is low and flat, once extensive tidal sand flats and saltmarsh, with some peripheral rough grazing but mostly reclaimed in the twentieth century for vast industrial complexes.

The central-southern North Sea, 'Doggerland', once formed a living landscape (Coles 1998),

a low-lying landmass indented with rivers and inlets, and festooned with archipelagos, lagoons, wetlands and marshlands. As Holocene sea-levels rose, often imperceptibly but sometimes catastrophically, this landscape was submerged by *c*5000BC. Late Devensian sands and gravels hold potential for *in situ* Middle and Upper Palaeolithic deposits and Mesolithic palaeo-geographies are well known though imprecisely defined. Trawled seabed close to Dogger Bank has offered up numerous floral and faunal remains and the potential for further prehistoric landscapes, finds and environmental material is significant (Flemming 2004). The inter-tidal and estuarine sediments of the area also conceal palaeo-environmental deposits of considerable potential.

Historically the study area has been dominated by coastal trade, mineral extraction, ship building and fisheries. Throughout prehistory rivers, such as the Tees and Esk, have been important access points to and from the region's agricultural hinterlands, linking into wider North Sea networks of trade and communication. During the Roman and Anglo-Saxon periods these networks became highways of invasion, immigration and trade (Clarke 1985).

The important late medieval and early post-medieval coal and alum trades established early shipyards such as at Stockton and Whitby. In many places coastal mining for ironstone, alum, and jet and quarrying for building stone has left the cliffs and foreshore cut, tunnelled

and rent whilst dredging has channelled and scoured rivers of accumulated sediment and cleared harbours of sand driven onshore. Since the 19th century the Teesside and Hartlepool Ports area has been one of the foremost industrial and commercial shipping centres in Britain, founded on coal, iron and shipbuilding, but later steel, chemical and hydrocarbon industries (Le Guillou 1975).

The fishing communities perched and tucked away on this coast traditionally farmed inshore waters: trapping for salmon, potting for shellfish and crustacea, and netting for seasonal herring in distinctive local craft such as cobles, yawls and mules, with Scarborough, Whitby, Staithes and Hartlepool leading. They also sought distant offshore cod with long-lines, about Dogger Bank and further afield, before the advent of trawling methods and the late 19th century adoption of steamers heralded the era of extensive and intensive exploitation of pelagic and demersal fisheries (Frank 2002). Once internationally important fishing grounds are today in a state of remittance as strategies for conservation of fish-stocks limit seasons and catch size.

Settlements are generally dispersed excepting industrial Teesside. Historic areas and routes of navigation strike out from these ports and harbours, negotiating notorious local hazards, before immediately entering the open sea, warded by the numerous landmarks and navigation aids and by innovative life-saving institutions. Railways, tramways and road

networks link mineral industry to the sea. Recreational spas, gardens, trails and links cluster about Victorian seaside resorts such as Scarborough and Redcar. Defensive military positions bristle on defensive headlands and eerie military listening devices dot the cliff tops.

Though modern impositions on this landscape, such as aggregate dredging, spoil dumping, hydrocarbon extraction, telecommunications cables and renewable energy industries, put pressure on historic seascape character they nevertheless reflect it and their interventions often offer opportunities to investigate and understand the historic environment further.

Throughout the past the North Sea has served more as a unifier than a barrier. The peoples living around its coasts exploited the sea as a means of trade and communication, and were linked closely together culturally, economically, and even politically.

The historic seascape is, however, a contested place. Various communities and interests, from particular localities and from particular opinion, have a concern in ongoing developments or activities that are potentially or actually damaging, diluting, distorting or destroying important or well-regarded features or character. HSC mapping and text helps place such positions and challenges in context, allowing debate about the present and future to be more properly grounded in an understanding of the past. It enables such debate to be welcomed and joined by the historic environment community, and by local people. It is a product and a process expressly designed and intended to facilitate discussion and dialogue about the sustainable management of the marine historic environment as a whole (Herring, 1998).

2 Introduction

2.1 Project background

The purpose of this document is to describe the methods used to produce the Scarborough to Hartlepool Historic Seascape Characterisation, commissioned by English Heritage (EH) and funded by the Aggregates Levy Sustainability Fund.

The HSC aims to improve our understanding of the present historic character of the area, shaped as it is by human activities and natural processes, and place that understanding on an even based footing. The project was designed to have a particular application in contextualising responses to marine aggregate extraction and licence area applications for future extraction.

2.2 The study area

The project's characterisation methodology ultimately needed to have relevance to an extensive area comprising England's inter-tidal zone, its share of UK territorial waters and the adjacent UK Continental Shelf. Definition of the overall limits of such an area inevitably reflects administrative and practical constraints rather than any break in the continuum of the historic environment (English Heritage Characterisation Team 2005).

The landward limit of the Scarborough to Hartlepool and adjacent marine zone pilot project area extends to the OS-mapped level of Mean High Water (MHW). MHW was not however used arbitrarily to truncate character polygons: characterisation for this project continued above MHW to encompass the full physical extent of any polygons with an essentially marine character that reach beyond that level from seaward (*ibid*).

The seaward limit of this pilot area was the limit of the UK Continental Shelf, here following the Median Line with Holland, as defined in the UK Continental Shelf Act 1964 as subsequently amended (*ibid*).

The southern lateral extent of this pilot area was determined by a line extending from the North Yorkshire coast at Yons Nab at 54°14' 35"N, 00°20' 22"W, 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 (*ibid*).

The northern lateral extent of this pilot area was determined by a line extending from the Hartlepool coast where the Crimdon Beck meets the sea at 54°43' 21"N, 01°14' 29"W, north eastwards to the point where latitude 55° 40' 00"N intersects with the UK Continental Shelf Limit, where the Median Line meets with Dutch Waters (*ibid*).

All estuaries within the project area were included to the Normal Tidal Limit along their rivers and tributaries (*ibid*).

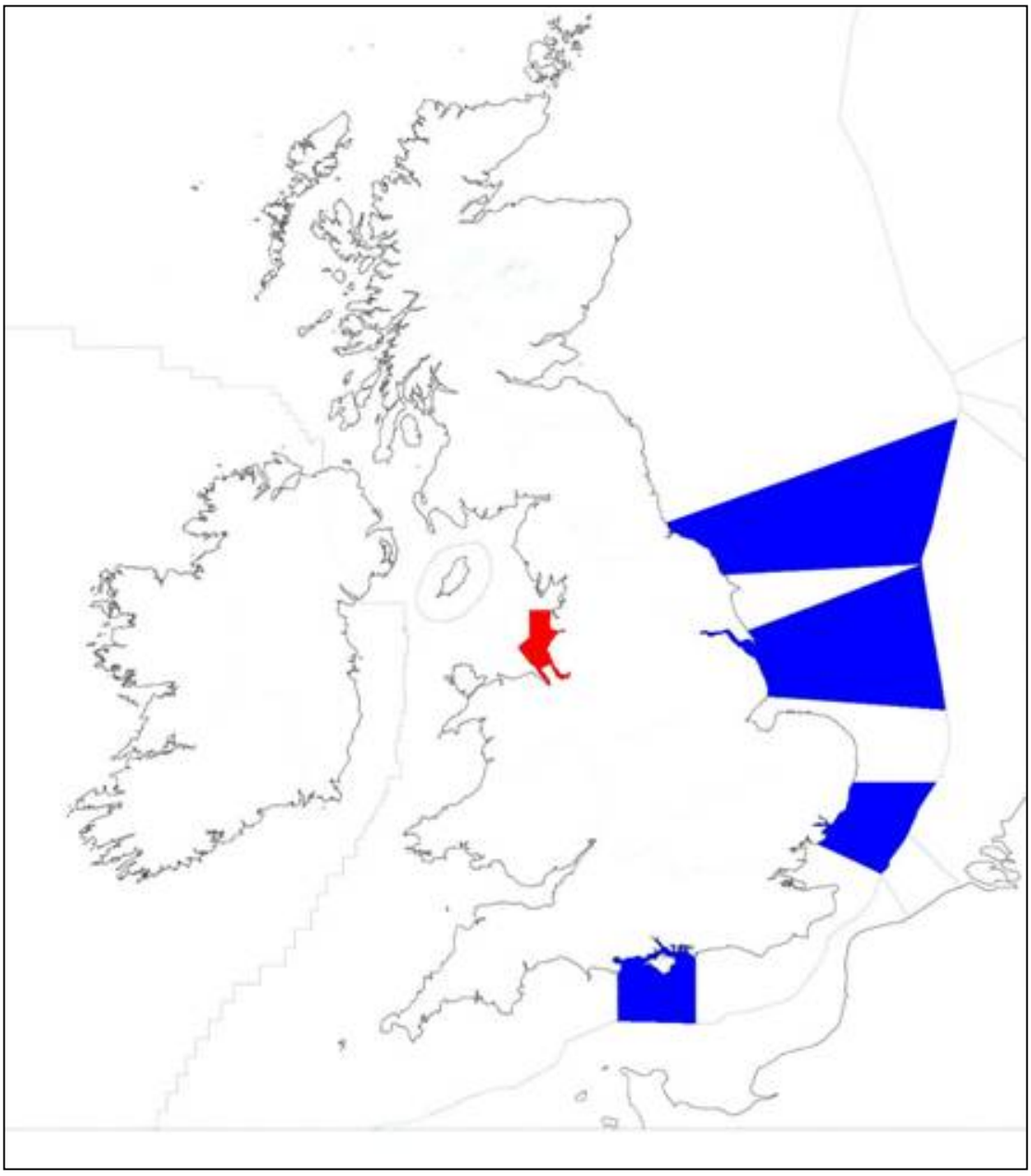

Fig 2 The Seascapes pilot areas: Red, Liverpool Bay; Blue, 1) Scarborough to Hartlepool (HES), 2) Withernsea to Skegness (MoLAS), 3) Clacton to Southwold (Oxford Archaeology), 4) Solent (Bournemouth University / Southampton University / Hampshire and Wight Trust for Maritime Archaeology)

2.3 Rationale

The project outlined in the EH Brief aimed to deploy, assess and, as appropriate, further develop in a radically different context the methodology for inter-tidal and marine HLC created in the initial pilot project focussed on Liverpool Bay (Wessex Archaeology 2005). Considerations involved in selecting such differing contexts for this and other pilot exercises included *inter alia* the need to ensure the piloting process results in a robust methodology to inform responses to, among other things, marine aggregates extraction and, arising from that, the need to ensure it has been tested against the limits of the contrasting environmental and management complexities which it will need to accommodate. The pilot area encompassing the inter-tidal and marine zones of the Scarborough to Hartlepool project area was designed to ensure the methodology's validity in hard coastline contexts beyond those currently subject to aggregate licensing. The entirety of this pilot project area was characterised (English Heritage Characterisation Team 2005, 6).

2.4 Overall aims and objectives

These aims and objectives, developed from the project brief (English Heritage Characterisation team 2005), can be summarised as follows.

- To create a GIS-based characterisation of the historic and archaeological dimension in the present landscape of the inter-tidal and marine zones of the whole of the project area, to the limit of the UK Continental Shelf.
- To apply and, if necessary, develop Wessex Archaeology's Liverpool Bay methodology in a different type of coastal and marine environment
- To create 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 environment in the inter-tidal and marine zones.
- To enhance and contextualise the Maritime Record of the National Monuments Record and those County HERs impinging upon the project area, with particular regard to providing landscape-scale contextualisation of results from the Rapid Coastal Zone Assessment programme, where available.
- To structure, inform and stimulate future research programmes and agendas relating to the project area.
- To improve the awareness, understanding and appreciation of the historic dimension

of the project area to professional and non-professional users of the database.

- To be a demonstration project in the development of a methodology for extending HLC to the breadth of environmental and management conditions in England's inter-tidal and marine zones and adjacent UK Continental Shelf (English Heritage Characterisation team 2005, 6).
- To assess present uses and potential for the HLC in informing sustainable management of change and spatial planning issues surrounding marine aggregates extraction in the project area and in informing outreach and research programmes;
- To produce an archive and a report reviewing the methodological validation, development and practical application of HLC in this project area and assessing the benefits of extending such characterisation more widely to the historic environment in the inter-tidal and marine zones to the limit of the UK Continental Shelf;
- To disseminate information on the progress and results of the project through professional and popular publications and other media (*ibid*, 7).

2.5 Key objectives for the GIS method

Again, these aims and objectives were developed from the project brief (English Heritage Characterisation team 2005) and can be summarised as follows.

- To deploy, assess and, as appropriate, develop the GIS-database structure created for the Liverpool Bay pilot area to enable it effectively to accommodate the distinctive qualities of the Scarborough to Hartlepool project area while retaining compatibility of the database with the interfacing or partly overlapping terrestrial characterisation databases.
- To produce a GIS-based HLC characterising the project area's landscapes in historic and archaeological terms, by means of:
    - identifying and gaining access to the range of data sources relevant to understanding the historic and archaeological dimension of the project area, placing greatest emphasis on sources with consistent national coverage;
    - using GIS polygons to define areas sharing similar historic character;
    - defining polygons on the basis of combined shared values of dominant character attributes, with secondary attributes recorded in a consistent, structured manner;
    - identifying trends and recurrent groupings among the attributes to define historic landscape types which will, together, encompass all of the polygons

and reflect the differing historical processes in their formation.

- To record the sources and data-sets supporting each stage of the characterisation, to meet the needs of transparency and assist future updates against the initial benchmark characterisation;
- To analyse and interpret the HLC to produce preliminary syntheses from it;
- To ensure that the historic environment GIS-database for the project area can be readily integrated with analogous databases for the natural environment.

2.6 Final HSC Product

The final product comprises the following datasets (see Appendix 3 for more details and metadata):

- A number of GIS shapefiles (ESRI ArcGIS) of the HSC:
    - Final HSC layer – comprising characterisation of all tiers, as polygons and grids, with associated 'layer' (legend) files for the following representations;
        - present seascape character;
        - past seascape character;
        - sub-benthic character;
        - benthic character;
        - pelagic character;
        - surface character,
    - The derived HSC layer – a conflated layer based on historic character predominance from all the tiered marine layers (using criteria based on likely impact);
    - Two associated datasets, digitised by source;
        - A layer mapping modern seascape and sea-use based on OS maps;
        - A layer mapping historic seascape and sea-use based on historic OS maps and UKHO charts;
    - Character Area layer – identifies unique historic areas that may be recognisable to local people
- An easy to use HTML interface which requires no knowledge of GIS to be able to access the characterisation. The HTML pages consist of an interactive map that allows users to identify seascape 'Character Types' and link to descriptions and images of the Type. The users may also link to the character type description via the GIS layers, using the attribute fields 'Link1' and 'Link2'.

3 Methodology

This section describes the methodology developed by Cornwall HES to build the HSC for the Scarborough to Hartlepool pilot area.

3.1 Approaches to GIS-based HSC

3.1.1 Guiding Principles

This section describes the principles adopted by HES to guide the development of the Historic Seascape Characterisation (based on the principles of terrestrial HLC as set out in Clark *et al* 2004).

- Characterisation covers the whole landscape/seascape.
- It defines historic landscapes/seascapes through present-day landscape/seascape.
- It is built on a recognition that landscape/seascape is dynamic not static; it is the product of change and change will continue in the future. It does, however, assert that better informed change can be better guided.
- It recognises that all Historic Environment has value, and can be managed more or less appropriately.
- It brings an archaeological approach to the consideration of landscape/seascape.
- Landscape/seascape, rather than individual features, is its main source. Characterisation is about being comprehensive, not selective and viewing the whole (areas) rather than individual parts (sites). It is concerned with the commonplace and the locally distinctive.
- Although it is as objective as possible in its method, it provides a framework for understanding that can be read and used differently by a wide range of varying interest groups. Interpretation and perception of the HSC is as fluid as the interpretation and perception of the landscape/seascape it characterises. It is therefore capable of reflecting the world "as perceived by people".
- Sources used in preparing the HSC; and the confidence in interpretations are made explicit, giving greater transparency to the decision-making process.

3.1.2 Multi-mode method

The multi-mode method draws on best practice from the most recent terrestrial HLC projects. Whilst essentially interpretative the subjective decision-making inherent in the method is framed and controlled, being qualified and quantified by the use of attribute-based approaches, documenting sources and providing explanatory descriptions, within (or linked

to) GIS.

The multi-mode method uses the best elements of both descriptive HLC (ascribing attributes to polygons without initially assigning interpretations) and prescriptive HLC (interpretation as the main means of identifying character, ie pre-definition) criteria for establishing HLC basing characterisation on the manipulation of computer data to produce models of landscape and seascape character.

3.1.2.1 Attribute-led (descriptive) HLC

The descriptive attribute-led method attempts to underpin interpretation with greater 'objectivity'. This method was applied during the data capture stage of the project. Once sites, features and landscapes were identified and recorded they were ascribed to a particular HSC type:

- record attributes (ie use descriptive criteria) rather than attributing predefined types;
- computer analysis of attributes to derive HSC models and types,
- explicit data structures.

3.1.2.2 Classification (prescriptive) HLC

The classification-led method uses existing understanding of historical processes in a landscape to predefine the landscape and seascape it characterises. This method was applied following the initial attribute-led stage and was used to identify (and therefore prescribe) the broad character and character level HSC types.

- Prescriptive criteria used to assign areas to pre-defined classification of types. This was only possible once the attribute-led stage had identified the variety and detail of the historic landscape and seascape of the project area, and historical and archaeological literature searches had generated a reasonable level of historical understanding.
- Build models from HSC data rather than recording what documentary or map sources suggest.
- Implicit data structures (however based on the manual computer manipulation GIS interrogation of the attribute data to develop HSC interpretation classifications).

3.2 Sources, core datasets and data structure

The consultation and treatment of sources is one of the principal determining factors in establishing marine seascape character. Understanding data sources also requires a greater

understanding and development of data structure. What is used and how it is used ultimately influence the decisions made in defining historic landscape/seascape character. It is important therefore that sources used are relevant and consistent, and that they are treated in a similar and even-handed way.

- Sources are used in a consistent manner to reflect time-depth and past-change.
- Standard terminologies are used to maintain clarity.
- Consistent capture of historic seascape character.
- Establishment of common 'perception scale(s)' – that is, the scale at which characterisation is expected to be read and applied.

Core data	**Format**	**Location/Source**
Hydrospatial • Bathymetry & elevation (offshore only) • Natural & physical features (coastal and offshore) • Structures & obstructions • Socio-economic & marine use • Conservation & environment • Climate & oceanography Wrecks	Digital	UKHO (SeaZone Solutions Ltd).
Modern UKHO charts	Digital	UKHO (SeaZone Solutions Ltd)
Historic UKHO charts	Hard copy	UKHO Research
Modern OS maps	Digital	English Heritage
Modern Aerial Photos	Digital	North York Moors National Park
Historic OS maps (1st & 2nd Editions)	Digital	English Heritage
Supplementary data	**Format**	**Location/Source**
Anatec shipping data	Digital	Anatec UK Ltd

NMR (including Defence of Britain project)	Digital	NMR database
North Yorkshire SMR	Digital	
North York Moors NP SMR	Digital	
Tees Archaeology SMR	Digital	
CEFAS North Sea Fishing Effort and pressures (Nursery Grounds, Shellfish, Spawning Grounds)	Digital	CEFAS
North Eastern Sea Fisheries Committee GIS Fishing Effort Project	Digital	North Eastern Sea Fisheries Committee
UKDEAL (North Sea industry data)	Digital	UKDEAL www
English Nature (Semi-natural Environment data)	Digital	EN
Bibliographic references and other documentary sources (eg NMM Historic Atlases & Charts)	Hard copy, digital	Various

Fig 3 Table of core datasets and supplementary information

3.2.1 Data structure

The data structure underpinning the HSC is attribute-led and hierarchical, nesting historic character at four levels **(see Appendix 1 for list of Historic Seascape Character Types)**. From detailed to generic they are as follows.

3.2.1.1 Sub-Character Type

This is the finest and most detailed mapping in the HSC dataset, being the level at which most areas of land or sea are not readily divisible at the scale of mapping used in HSC. It is the base map from which the higher, more generic levels of character are derived. In terms of applications, this may be most useful for distinguishing and perceiving HSC at the very local level, and can be expected to be of high value when assessing the likely impact of particular developments.

3.2.1.2 Character Type

Character Types are functionally related groupings of Sub-Character Types. They provide the baseline mapping for the descriptive and interpretative text. (Detailed definitions of Character Types in the Scarborough to Hartlepool study area are given in the associated HSC report). It is the standard level of HSC (equivalent to terrestrial HLC character types) and may be the most useful for distinguishing and perceiving HSC at the local to regional level. It may therefore be the level to which local and regional strategies can be attached.

3.2.1.3 Broad Character Type

Broad Character Type is the highest, most generic level of characterisation summarisation. It is the aggregation of Character Types, mapping blanket and generic seascapes. This may be the most useful for distinguishing and perceiving HSC at the regional to national level.

3.2.1.4 Character Areas

Character Areas are unique areas of historic character familiar or recognisable to people of the area. These are not generated from below through the characterisation process and so may combine a number and variety of HSC Character Types. It is partly because of this more top-down derivation, that the descriptive and interpretative characterisation text has been attached to the Types rather than the areas. However, it is to the areas that has been attached most of the material that reflects perception and human responses to the seascape.

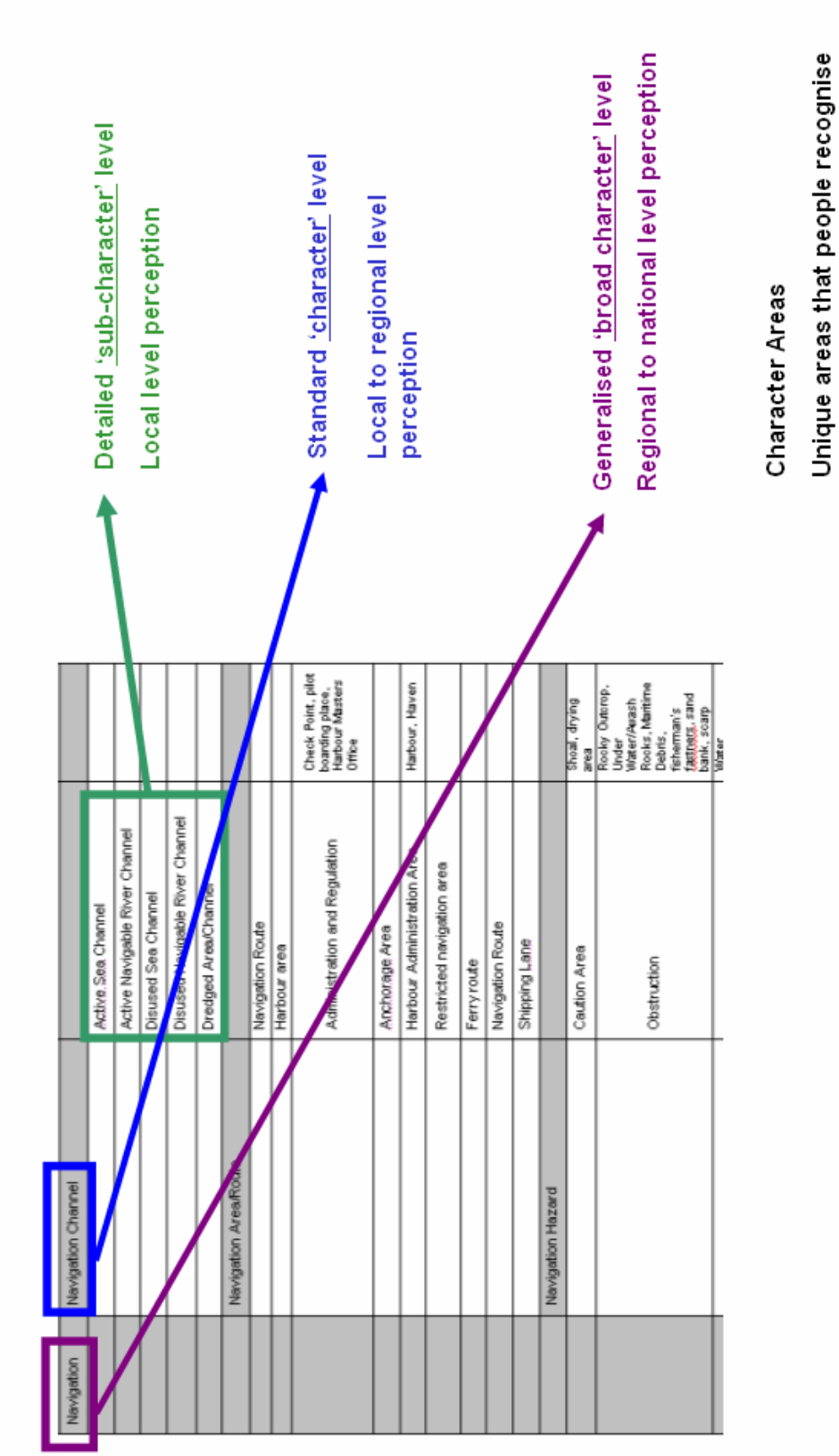

Fig 4 Hierarchical 'nesting' of character levels (using example of Character Type 'Navigation')

3.2.2 Attributes

3.2.2.1 Recording the multi-dimensional nature of the sea

Identifying the historic character of the marine environment requires greater emphasis on the multi-dimensional aspects of the sea as a body of water sitting on a sea floor which itself has depth. This can be achieved by recording the historical (and archaeological) character of the seabed, the seafloor (benthic zone), the water column (pelagic zone), and the sea surface separately in the GIS. Query and interpretation of these attributes may in turn inform and determine the predominant historic character prevailing throughout the body of a particular area of water; whilst maintaining the original detail.

In terms of palaeo-landscapes, of particular relevance to the North Sea, recording in this way also informs 'Previous historic character' (ie seabed/sea-floor character may equate to previous historic character, or 'palaeo-landscape').

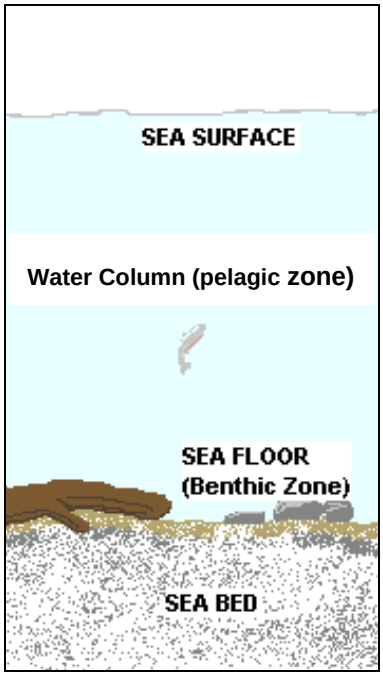

Fig 5 Marine 'Layers'

The three-dimensional aspects have been captured during digitisation by recording attributes that reflect the following:

- Sub-benthic character (seabed);
- Benthic character (sea-floor);
- Pelagic character (water column);
- Surface character.

The importance of identifying the character at each of these levels (or at least at a two-tiered level, ie the seabed/seafloor and water column/surface) is in the detail and consistency this information will provide to managers of the historic environment for each. Broadly, material culture and character associated with the seabed and seafloor is easily mapped and can be considered to have archaeological potential to a greater or lesser degree. The identification of activities (both historic and modern) within the water column and on the surface will help to

infer likely archaeological potential, where there are gaps in our knowledge of the benthos, whilst also providing some indication of current sea-use and the associated threats (or benefits) these pose to the marine historic environment.

The derivation of a single HSC layer from the tiered database will be of broad strategic value and may provide a useful point of entry to the database for awareness-raising initiatives, but, as noted above, we anticipate that most users of the HSC material will concentrate on the 'layer' that is most relevant to their immediate interests.

The criteria used to determine historic character are dependent on what attributes are considered and in what way these are likely to be treated in the variety of intended applications.

Figure 6 (below) sets out the attribute 'fields' recorded in the final HSC datasets (held behind each polygon mapped in the GIS) and from which all other layers are derived by query and analysis (attributes marked with an asterisk* are omitted from the derived and 'conflated' HSC dataset).

Attribute name	**Abbreviated Name in GIS**	**Population method**	**Description**
Name (Sea Area)	NAME	Automated/Manual	Name of sea area or topographic identifier
Location	LCTN	Automated	General location (eg. Offshore marine, inshore marine, estuary, coast etc
Character Area	CHRCTRAR	Automated	Character Area
Broad Character Type	BRD_CHRCTR	Automated	Broad Character type (present)
Character Type	CHRCTR	Automated	Character type (present)
Sub Character Type	SUBCHRCTR	Automated	Sub-character type (present)
Previous Character Type	PRVSCHRCTR	Automated/Manual	Previous HSC for which evidence is available
Period1	PERIOD1	Manual	Present Character date
Period2	PERIOD2	Manual	Previous Character date
Sub-Benthic Character*	SBBNTHC	Automated/Manual	Seabed HSC (present sub-character level)
Benthic Character*	BENTHC	Automated/Manual	Seafloor HSC (present sub-character level)

Attribute name	Abbreviated Name in GIS	Population method	Description
Pelagic Character*	PELAGIC	Automated/Manual	Water column HSC (present sub-character level)
Surface Character*	SURFACE	Automated/Manual	Sea surface HSC (present sub-character level)
Habitat*	HABITAT	Automated	Semi-natural habitat (incl. sedimentology)
Sea Level	SEALVL	Automated	Sea level date for submerged landscapes, ie the date at which land was submerged?
Confidence	CNFDNC	Manual	Confidence of HSC interpretation (Certain, Probable, Possible, Uncertain)
Source1	SOURCE1	Automated/Manual	Sources used to identify present character
Source2	SOURCE2	Automated/Manual	Sources used to identify previous character
Scale*	SCALE	Automated	Scale of original data
Link1	LINK1	Automated	URL hyperlink to present Character Type description texts and images
Link2	LINK2	Automated	URL hyperlink to previous Character Type description texts and images
Creation Date	CRTDATE	Automated	Date of completion of characterisation dataset

Fig 6 Table of HSC GIS dataset attributes

3.2.2.2 Confidence rating

Confidence ratings are given to the polygons comprising the HSC dataset. Confidence is informed by the level of detail observed from sources, whether cartographic or textual. Essentially this provides a basis for gauging the certainty or otherwise that can be ascribed to the interpretation, and therefore by extension, the archaeological and historical potential of any given area.

There are three levels of confidence:

Certain: established as true or sure; unquestionable; indisputable;

Probable: having more evidence for than against, but some room for doubt;

Possible: some evidence for, but considerable room for doubt;

3.2.2.3 Fuzzy boundaries

The adoption of a 250m grid for the HSC was based on three necessities.

- Overcoming issues of copyright and directly derived data, especially for digital datasets. The HSC database is required to be 'free' of others' copyright restrictions, but nevertheless depends on several critical primary sources; it would not be viable without these. The use of a grid enables distance to be put between the original data and the gridded and thus fuzzy representation of it without the data becoming incomprehensible (as might be the case if the original data shapes were over-simplified or deliberately distorted). Users are not able to securely derive the original shapes of copyrighted data from this gridded representation. Should precision be required, the source recorded in the dataset would signpost the user to the original material, ensuring that the bodies holding the copyright are properly consulted as appropriate. It may be supposed that this method will lead to a fuller use of the original material and so is of mutual benefit to both its originator and the HSC user.
- A larger grid cell size was initially trialled (1 nautical mile) but this was felt to be too coarse given the extent of smaller features and impositions. The 250m grid was able to pick up relatively discrete seascapes.
- The grid allowed varyingly sourced information to be spatially correlated with relative ease without the need for extensive digitising or re-digitising.

The texture created by the grid also goes some way towards introducing fuzzy boundaries which reflect the often imprecise nature of aspects of the seascape in that there are rarely definitive, immovable lines.

3.2.3 Data standards

The Hartlepool to Scarborough Seascapes Project has been guided by 'Guidelines for English Heritage projects involving GIS' (English Heritage 2004).

- The scale of data capture varied according to the resolution of the source information, scales ranging from 1:2500 to 1:250,000. Actual data capture was 1:10,000 for terrestrial landscapes and variable for marine seascapes. The adoption of a 250m grid for the marine zone however means that any data for that area, SeaZone's Hydrospatial for example, is effectively 'pixelated' at the scale at which it

itself was captured (some datasets were however 'smoothed', such as the fishing pressure data from CEFAS and NESFC. This was done by digitising a new polygon layer from the original grids that reflected the general and predominant trends of the data)

- All datasets are projected to British National Grid (OSGB36) and all measurements are in metres. Although maritime projection is usually WGS84, for ease of presentation and matching to terrestrial data, BNG is favoured. ESRI's ArcGIS is able to re-project between these coordinate systems for any given dataset.

3.2.3.1 Data capture

Data captured followed the following sequence (see Figures 7, 8, 9 and 13).

1. Data capture under three thematic headings:
    - Historic sea use;
    - Modern sea use;
    - Semi-natural environments.

2. Digitise features according to SOURCE at 1:25,000 or less depending on resolution of source data

3. Create point, line and polygon datasets for each of the data sources (where necessary).

4. Identify data attribute fields to be included and data standard for shapefiles.

5. Point and line data converted to polygon using buffer tools and incorporated into landward polygon datasets or spatially correlated against marine 250m grid.

3.2.3.2 Terminology

Attribute values, where possible, were controlled using standard terminologies and wordlists including:

- MIDAS;
- INSCRIPTION wordlists;
- SeaZone Hydrospatial data wordlists;

To facilitate inclusion of the current North Yorkshire HLC project that project's Character Types lists were also consulted (Stephen Toase pers comm). This also ensured that any merging between the HSC and HLC in areas of overlap would be feasible.

Further HSC and HLC Character Type lists were drawn from the pilot Liverpool Bay

MHLC project undertaken by Wessex Archaeology (2006) and, for the terrestrial areas adjacent to the sea, from the Cornwall HLC project (Cornwall County Council 1996).

3.2.3.2.1 Period

• Pleistocene	Middle Palaeolithic c300000
	Late Palaeolithic c40000
• Holocene	Mesolithic 10000 to 4000BC
	Neolithic 4000-2500BC
	Bronze Age 2500-750BC
	Iron Age 750BC – AD43
	Roman AD43-AD410
	Anglo-Saxon 410-1065
	Medieval 1066-1540
	Post-medieval 1540-1750
	Early Modern 1750-1900
	Modern 1901-present
	Neolithic 4000-2500BC

The date ranges used for the 'period' attribute in this HSC pilot are those suggested by MIDAS data Standard (RCHME 1998) and Inscription lists.

Where more reliable information on which to base assessment of time-depth is available this is noted in the 'source' attribute.

3.2.3.3 Data cleansing

Due to the large number of separately generated datasets brought together to produce the final HSC and the extensive geo-processing (unioning and dissolving) employed to merge these datasets, data cleansing was an important part of the digitisation process. Slivers, multi-parts etc were systematically deleted from the final dataset manually.

3.2.3.4 Metadata

Datasets were recorded according to UK Gemini standard

(http://www.gigateway.org.uk/metadata/standards.html) using the MetaDragon application (developed by Restormel Borough Council in consultation with CCC).

3.2.3.5 Software

The characterisation geo-database was created using ESRI's ArcGIS 9.1 (http://www.esriuk.com/). This application has good interoperability with other desk-top GIS, including MapInfo.

3.3 Establishing HSC

Fundamental to establishing 'seascape character' is the ability to recognise human influences on the seascape.

'Character is defined as a distinct and recognisable pattern of elements that occur consistently in a particular type of landscape. The elements are drawn from geology, landform, soils, vegetation, landuse, field patterns and human settlement. Hence, exploring and understanding the character of any area requires systematic investigation of many different factors that have helped to create and influence that location. Such an exploration can result in relatively objective value-free descriptions, but inevitably incorporates an element of subjective, personal judgement. Visual appearance implied perception, and suggests that the impressions of the observer are also recorded. Perceptual aspects are likely to be coloured by the experience of the individual and the senses. For example, visual impressions might include a sense of wildness, a sense of security, the quality of light, and perceptions of beauty or scenic attractiveness. Factors perceived by other senses might include noisiness, tranquillity and exposure to the elements' (Wessex Archaeology 2006, 13).

'Whilst the ambiguity of the more perceptual impressions might be criticised for being "elusive", "ill-defined" or "vague", the alternate view is that its very subjectivity is a strength, revealing landscapes to be a rich repository of human values, the embodiment of attitudes, ideals and beliefs, and infused with cultural symbolism and imagery' (*ibid* 2006, 13).

'The intertidal and marine landscape is very rich in perceptual impressions and cultural associations, but they are difficult to pin down to identifiable parcels of character. In many instances perceptions of an area are too different to be grouped under a single impression. A wide sandy beach that extends miles from the shore can be seen as a popular recreational area to local inhabitants and visitors, but from the sea, it represents a significant navigational hazard should a vessel get too close in the wrong set of conditions. In many cases it is hard to choose between these two perceptions unless one takes a particular viewpoint' (*ibid* 2006, 14).

For the purposes of the Scarborough to Hartlepool HSC the maritime perspective has always been applied when identifying and assigning character to seascapes. The best example of this is the characterisation of terrestrial landmarks, under the Character Type 'Maritime Safety'. Whereas many landmarks, lighthouses, daymarks and such like are deliberately constructed for navigation purposes many other buildings and structures are incidentally used by mariners for navigation, often because of their striking profile on the coast when viewed from sea. These include churches and spires, chapels, chimneys and other clearly defined sites. Whereas in a terrestrial HLC these might fall into broader and entirely different HLC character types, from the sea they represent important and distinguishable features. Although most properly categorised as discrete sites, they nevertheless contribute significantly to maritime character.

3.3.1 Identifying predominant historic seascape character: seascapes and sea-use

During the characterisation process the various datasets generally informed two types of historic character which may be termed seascapes and sea-use:

1. Those that could directly inform seascape assessment, that is, physical artefacts, landscapes, features, sites etc on the seabed. These can be relatively easily and precisely mapped and give an indication of the likely archaeological potential of any given area.

2. Those that indirectly inform seascape assessment by identifying sea-use. These map activities and processes that principally occur in or exploit the sea itself, that is, the water column, as with fishing, and on the surface, as with shipping routes. It is a moot point as to whether sea-use can be used as a proxy indicator of historic character and therefore likely archaeological and historical potential. For the purposes of this study it has been assumed that it can; this is partly because given the lack of further region-wide historical information it is often the only indication of human activity. Given the indirect nature of this information the confidence values are essential to the application of the material. Present character necessarily includes modern 'surface' impositions such as shipping lanes. Although arguably of limited archaeological importance and therefore 'historic character' they may constitute a threat to the archaeological resource.

Determining predominant character in the multi-dimensional seascape is difficult. Attempting to produce a conflated 2-dimensional map or conflated HSC layer from the tiers of the sea normally requires that one HSC layer be imposed over another. Decision making used the following rationale, in the order presented below:

- Seascapes take predominance over sea-use. Largely in archaeological terms this is represented by artefacts, mapped landscapes and such like on the seabed.

Impositions are included here;

- Those sea-uses that most likely to disturb, threaten or impact on the seabed predominate over less intrusive ones (eg with regard to fisheries, trawling has predominance over seining or lining);
- Confidence rating has predominance when considering different sea-use types.

These criteria were taken into account when deriving the conflated HSC dataset from the final HSC dataset. Predominance was based on likely impact to likely archaeological resource and historic character.

3.3.2 Geo-processing methods

3.3.2.1 Determining best-fit models: polygons and grids

Producing the HSC involved the collection and collation of a wide number and variety of sources in a number of formats (see figures 7 and 8). Several geo-processing techniques were applied to the various datasets in order to make them suitable for inclusion in the HSC dataset. Principally this was to ensure a fault-line exists between the original data to:

a) separate the original data from the interpretative exercise of historic characterisation, thus preventing the process becoming purely a mapping exercise;

b) overcome copyright and issues concerning derived data and;

c) ensure that there is no further need by users to obtain further 'licences' and in the process restricting the range of applications of the database (especially for non-professional users).

It was decided that a combination of two approaches would be used during the characterisation process:

- Polygons would be used to digitise terrestrial and inter-tidal components of the HSC where base mapping is sufficiently detailed to provide accurate extents and where copyright precedents of deriving data are well established or stated;
- Grids (250m resolution) would be used to capture marine components of HSC based on spatial correlation with original data, generating quadrat analyses, point density and frequency counts. Also used to overcome copyright and data derivation issues.

Determining the most appropriate method of geo-processing was based on four principal aspects of any given dataset:

1). Copyright and data derivation issues

In order to navigate around issues of data copyright and limitations of data derivation,

especially for digital data, the 250m resolution marine grid was set as a mesh over the whole of the marine zone. Data from marine data vendors (eg SeaZone, BGS etc) who were unable to permit data to be directly derived was intersected against this grid, effectively as mentioned above, 'pixelating' it.

2). Geographic coverage and location. Generally, historic character types mapped beyond the low water mark of the inter-tidal zone were represented through the 250m resolution GRID. Historic character mapped above low-water was represented as POLYGONS.

3). Format of the data (hard-copy or digital)

a) If the source data was hard copy it required digitisation usually by scanning and geo-rectification to the appropriate map base or other control points. Data derived in this manner was regarded as 'new' project data (although intellectual copyright might still apply - this was assessed case by case) and captured as vector polygons, lines or points. Incorporation and conversion of this information to the final HSC was achieved by further geo-processing.

b) If the source data was provided digitally it was spatially referenced against the 250m grid with the attributes being carried over via a 'spatial join' (ie. linking of attributes in one dataset to another based on spatial correlation). This in effect produced a 'pixelated' rendition of the original data. Any data of point or line feature class were converted to polygons using appropriate buffers and similarly set against the grid (however, see geographic caveat below for the processing of terrestrial data).

4). Format of the digital data (vector, raster or GRID-based)

Vector data was displayed in the GIS and assessed for its applicability and any geo-processing necessary to render it suitable for use in the HSC.

Raster data was geo-referenced and digitised to produce vector polygons, lines or points suitable for inclusion or further geo-processing into the HSC.

GRID data was used 'as is', with cell-size assessed against 250m resolution marine grid. Generally such datasets represented distribution/frequency maps and their resolution was maintained in the marine grid via 'spatial joins'.

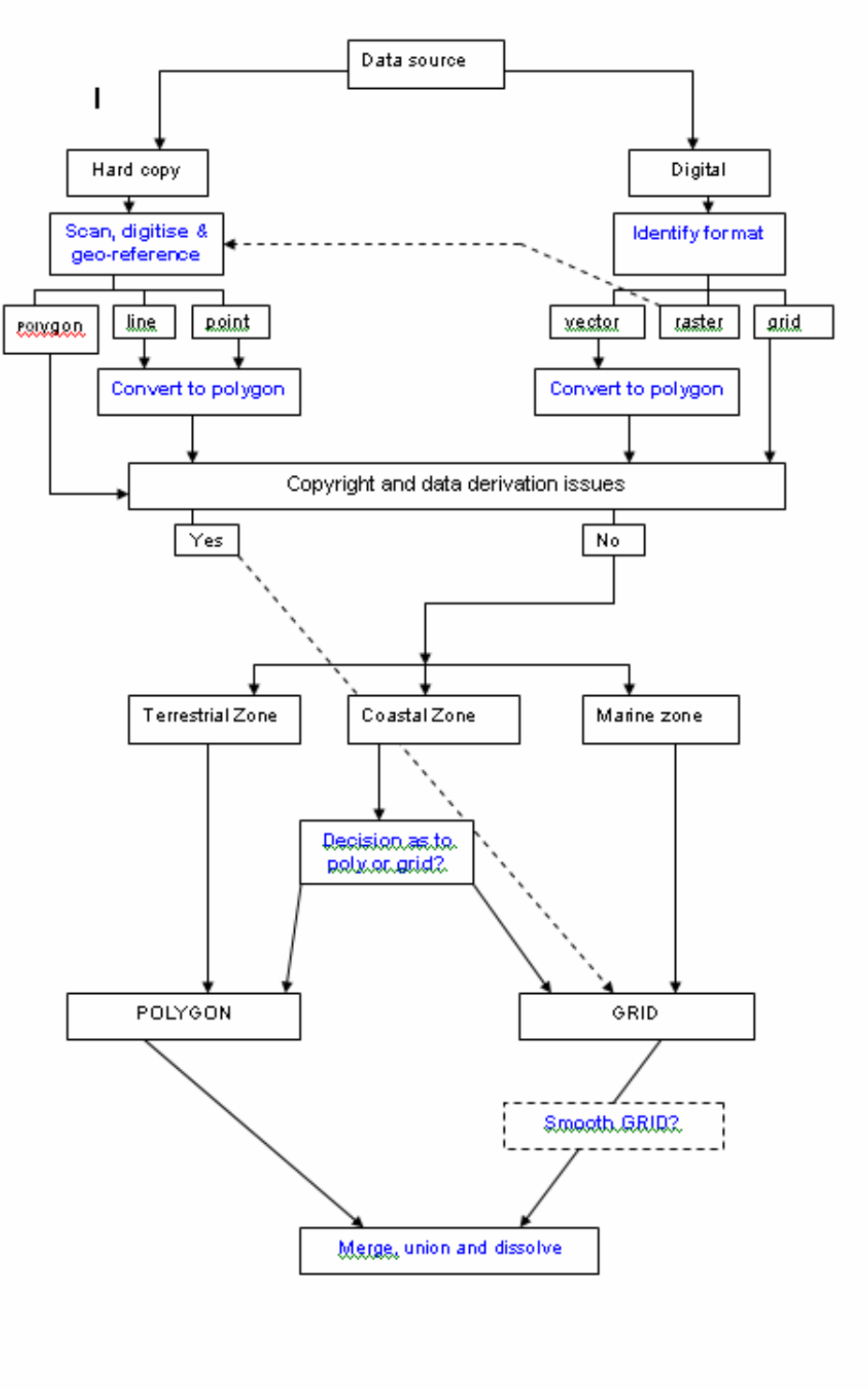

Fig 7 Digitisation workflow and treatment of data sources

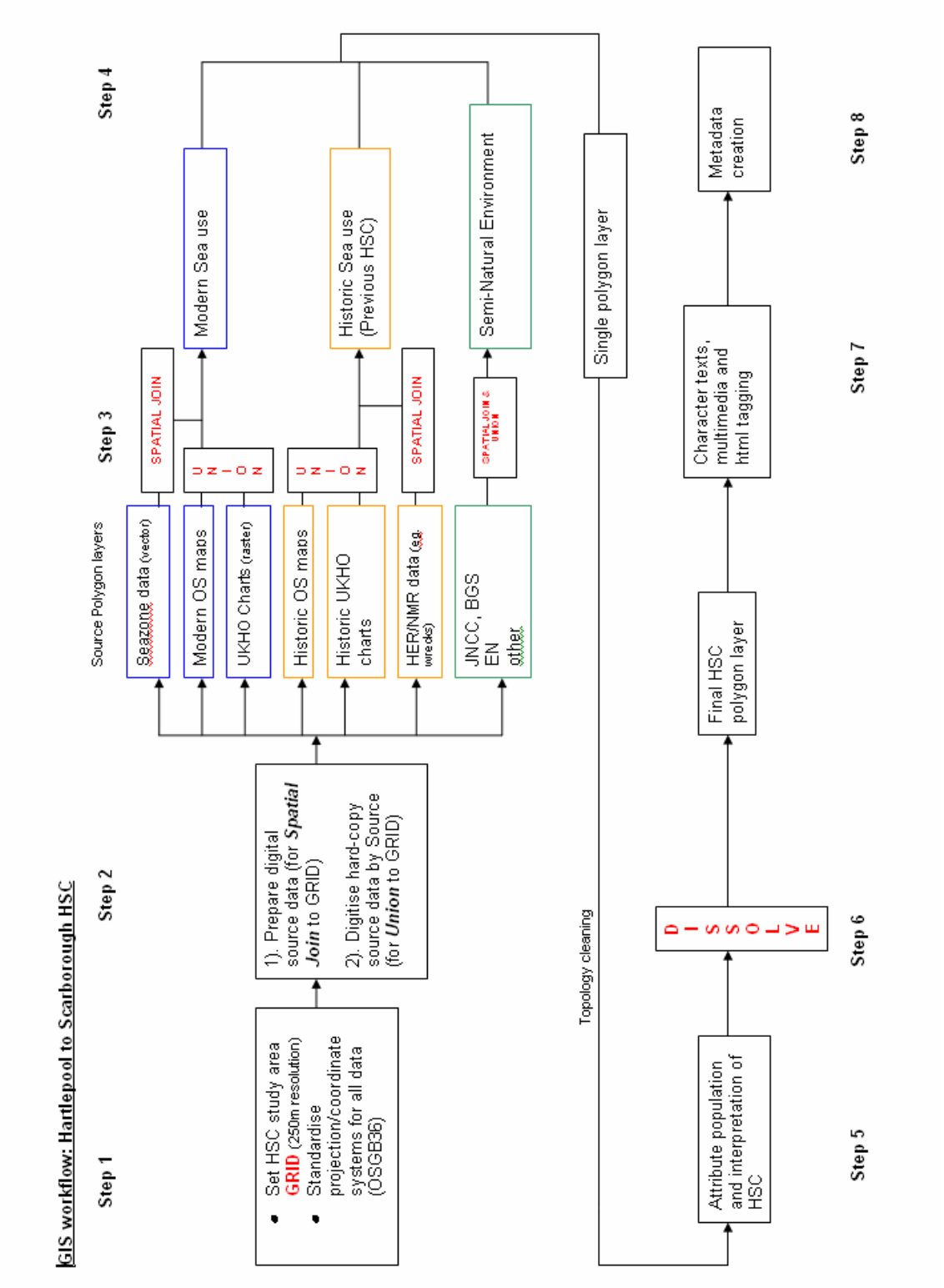

Fig 8 HSC GIS geo-processing workflow

3.3.3 Evidence for Modern Sea Use

The use of the sea in the present was identified from a number of sources.

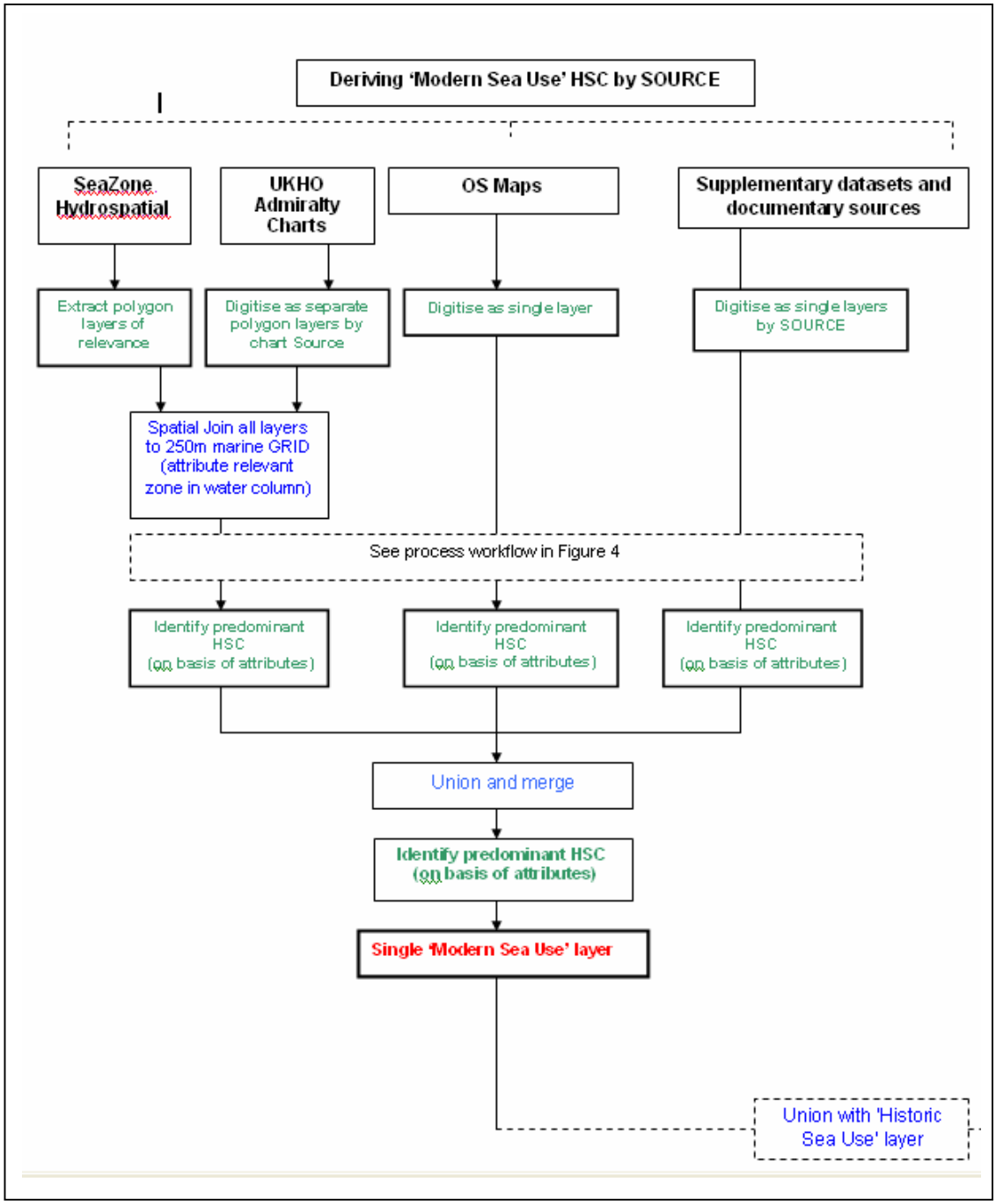

Fig 9 GIS workflow - Deriving 'Modern Sea Use' HSC by Source

3.3.3.1 SeaZone Hydrospatial

Constituting the most up-to-date marine mapping, this data was used to identify aspects of the following topics:

Bathymetry and Elevation: Depth and height contours, spot heights and soundings and digital elevation models. Also included are Depth Areas and Inter-tidal Areas, showing cartographic representations of areas of water depth.

Natural and Physical Features: Natural and physical components of the coastal and marine environment, including the biological, physical and chemical features within it. It describes the type and landscape setting of the marine environment to include the geology, seabed, water column and coastal landforms. Natural and physical components include biota, habitats, fish spawning and nursery areas and current streams, rocks and some human impacts such as dams, canals and dykes.

Structures and Obstructions: Those features which are man-made and physically exist on land or under the sea. These features range from wind turbines and pipelines to those of a more general socio economic purpose eg buoyage. Wrecks, obstructions and offshore installations included in this layer are obtained from the full database held by the UK Hydrographic Office. This contains much more than is usually displayed on a traditional nautical chart, including those wrecks that are not navigationally significant.

Socio-economic and Marine Use: Socio-economic and Marine Use specifies areas where one or more activities have been designated, are known to occur or are restricted. These are largely non-physical human boundaries defining areas or zones of economic or social importance such as military areas, oil and gas or wind farm licence areas, navigation zones, dredging areas, fishing areas and national boundary limits.

Conservation and Environment: The Conservation and Environment topic contains information on boundaries designated for the purposes of conservation and environmental protection of natural and cultural heritage. These boundaries include SSSI, SAC, some archaeological sites, shellfish beds and monitoring and assessment points.

Climate and Oceanography: The Climate and Oceanography topic contains data relating to climate, weather and tides. This varies from locations where measurement and monitoring is or has been known to occur to predicted tidal currents. All these datasets are of a mainly temporal nature.

As the most accurate marine mapping, and to all extents and purposes the nearest marine equivalent to terrestrial OS mapping, this dataset was extensively used to inform many

aspects of the present day historic seascape character. All data was spatially correlated against the 250m grid and interpreted, given a Sub-Character Type and assigned to a Character Type, to populate the appropriate marine layer.

3.3.3.2 Modern UKHO maritime charts

Fifteen modern UKHO Admiralty charts (raster) were consulted and cross-referenced against the SeaZone Hydrospatial datasets (see Section 6.1.1). Any differences were noted and digitised as appropriate.

Features identified from different charts were then merged to form a single polygon layer which itself was merged with other datasets informing modern sea use.

3.3.3.3 Modern OS maps

1:10,000; 1:25,000 and 1:50,000 OS maps were all used to determine the present day character of the immediate coastline adjacent to the study area's marine zone. Features were identified if they were spatially adjacent to inter-tidal and marine zone, their primary function was associated with maritime/marine use (eg coastguards, harbours, ports etc) or they had secondary function associated with maritime use (eg landmarks etc).

Field name	**Type and length**	**Description**
ID,	long integer	Unique feature reference no.
Name,	text, 250	[locational or topographic identifier from historic maps]
Site_Type1	text, 50	[type of feature, derived from MIDAS wordlists] 1st ed OS
Site_Type2		[type of feature, derived from MIDAS wordlists] 2nd Ed OS
Form,	text, 50	[condition of site or feature] 1st ed OS
Form,		[condition of site or feature]
Source1,	text, 50	Eg. 1:10k OS
Source2,	text, 50	Eg. 1:2500 OS
Source3	text, 50	Other source

Field name	Type and length	Description
CaptureScale,	text, 25	Scale at which data digitised (precision)
Description1,	text, 250	[description associated with Source1 identifying further useful information]
Description2,	text, 250	[description associated with Source2 identifying further useful information]
Description3,	text, 250	[description associated with Source3 identifying further useful information]

Fig 10 Attribute table for modern OS map sources

3.3.3.4 Fishing and Fisheries

Fishing effort data was used to inform the plotting and understanding of inshore and offshore fisheries.

- Inshore fishery: historically defined as areas that fishermen could fish safely and return to port before cargo spoiled. In present-day determined by 6-mile fishing limit in UK waters. Usually netting, long-lining and potting.
- Offshore fishery: waters beyond inshore zone, often deepwater trawling, netting and long lining. Identified as those areas of named fishing grounds.

The following efforts were noted and recorded in the relevant attribute fields in the HSC database (recording the activity of craft on the surface of the sea and the zone(s) in which the fishing activity actually takes place:

- Long lining;
- Netting (including Drifting, Set nets and Seining);
- Trawling (including Bottom Trawling, Beam trawling and Shellfish trawls);
- Potting;
- Baiting;
- Mariculture.

Of varying resolution, each dataset was correlated against the 250m marine grid. Predominance of any particular fishing effort over another was based on the perceived impact on the material remains of the historic environment and inferred material culture associated with one method over another.

Fishing Effort	Marine zone	HSC attribute(s)
Lines • Long lining (demersal)	Surface (craft) • Benthic, Pelagic	BENTHC, PELAGIC
Netting • Drift • Set nets • Seining	Surface (craft) • Surface, Pelagic • Benthic, Pelagic • Benthic, Pelagic	SURFACE, PELAGIC BENTHC, PELAGIC BENTHC, PELAGIC
Trawling • Beam • Bottom (single/pair) • Shellfish dredging	Surface (craft) • Benthic • Benthic • Benthic, sea-bed	BENTHC BENTHC BENTHC, SBBNTHC
Potting	Benthic	BENTHC

Fig 11 Attribution table for 'fishing effort'

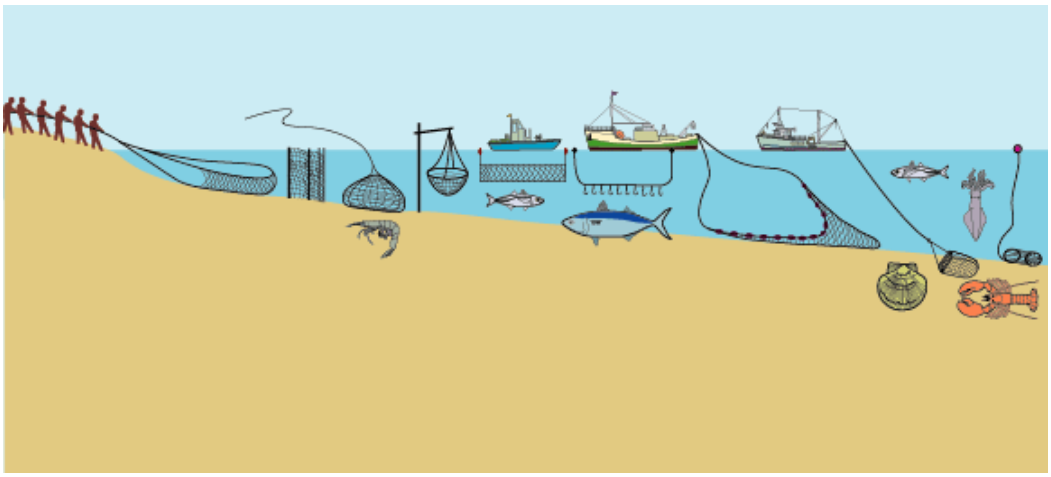

Fig 12 Types of Fishing effort

3.3.3.4.1 (CEFAS 2005,)

Data for offshore beam trawling fishing effort was acquired from CEFAS. Based on vessel sightings it may be used as a proxy indicator informing the likely impact on the marine

historic environment; especially that which may disturb archaeological material, artefacts or landscapes on the seafloor. The CEFAS GIS data are for trawlers and dredgers greater than 18m long in 2004 only (as calculated from VMS records). The data are gridded at a resolution of 4 square nautical miles and show the area of each cell trawled once or more, in other words it does not show cumulative fishing effort. The Mean effort for the study area was a value of 0.049, therefore all cells with values greater than or equal to 0.049 were considered characteristic of trawling fishing effort.

'For assessment of pressure from fishing, only those vessels deploying mobile seabed gear, namely beam trawlers, trawlers, and shellfish dredgers. In 2004, coverage was extended to all vessels over 19m. Smaller vessels and inshore fleets are therefore not represented. Positional records for the trawlers and dredgers were used to estimate the spatial extent of fishing on the seabed…. a broad estimate of the spatial extent of demersal fishing'. (Eastwood *et al*, 2006).

3.3.3.4.2 North East Sea Fisheries Committee

NESFC data (frequency cells based on vessel sightings) for UK 6 mile inshore fishery limit. Data was transferred by spatial analysis into a density plot based on 1nm Grid (from point data) and then overlain against 250m marine grid. This data supersedes the CEFAS and UKOOA data for the inshore fishery zone. Only high medium and high vessel sighting counts have been taken into account (on the basis of identifying predominance) with the following types of fishing method and intensity used: Netting: greater than nine vessel sightings per square nautical mile; Trawling: greater than 12 vessel sightings per sqnm; Potting: greater than 17 vessel sightings per sqnm and Lines: greater than 6 vessel sightings per sqnm.

3.3.3.4.3 Albert Close's Fisherman's Chart of the North Sea, 1953

Held by the UKHO, this annotated maritime chart for the eastern coast of Britain, from East Anglia to Scotland, identifies fishing grounds, hazards, topographic features as recorded by local fishermen and mariners. It was used to identify the following areas:

- Fishing grounds and types of catch expected
- Pelagic fisheries using seine netting
- Hazards of relevance to fishermen
    - Very foul ground: risk of losing trawling gear
    - Medium: good ground but occasional risk of split net

- Fair: stony ground but little risk of losing gear
- Catchy: especially for Seine nets

- Wrecks

3.3.3.5 UKDeal

Geospatial data for all oil and gas infrastructure were obtained from UKHO SeaZone data and the UK Digital Energy Atlas and Library (UKDEAL). To estimate and characterise this, activity data for platforms, subsea wells and pipelines was used and referenced against the 250m marine grid.

- Platforms: depicted as point data, these were buffered by 250m and set against the 250m grid. This gives an overestimate for the actual installation itself but takes account of associated drilling and production gear and other components. The platform is recorded throughout the water column from seabed to sea surface.
- Wells: active and abandoned wells were buffered by 500m and set against the 250m grid. This overestimates the actual installation but picks up the potential area affected by the well's drilled rock cuttings that might be dispersed over and smothering the nearby seabed. Wells are recorded in seabed and benthic zones only.
- Pipelines: depicted as lines these were set against the 250m grid with those cells intersected being tagged as an overestimate of the pipeline corridor. Pipelines are recorded in seabed and benthic zones only.

3.3.3.6 Anatec ShipRoutes data

Anatec manage the ShipRoutes database which provides information on shipping movements within UK waters. This is of particular use for collision risk assessment, managing shipping hazards, applying for consent to locate and performing marine risk assessments. The type of information that can be obtained from this system includes number of routes passing within a defined area, departure and destination ports for each route, passing range and bearing per route, vessel type and size distribution per route.

Although of limited historical interest this data directly informs modern sea-use and is useful for identifying possible threats or likely impacts from modern shipping to and on the historic environment. It was used primarily to inform offshore surface character.

3.3.4 Evidence for Historic Sea Use

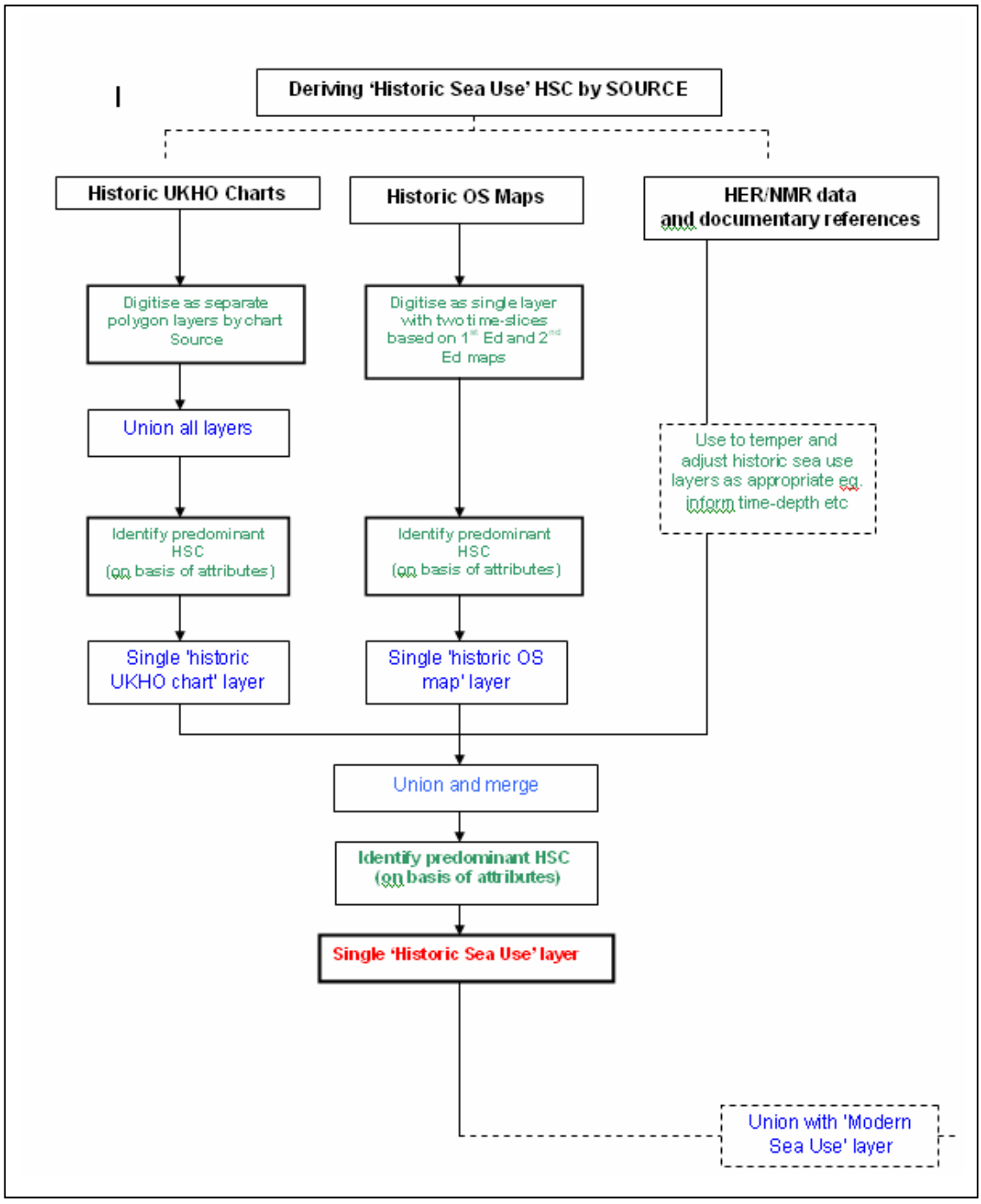

Fig 13 GIS workflow - Deriving 'Historic Sea Use' HSC by Source

3.3.4.1 Historic UKHO maritime charts

Over 40 historic UKHO charts and folios (coastline profiles) were consulted from the research section at the UKHO, Taunton. These charts identify features, sites and monuments related directly or indirectly to the maritime environment or maritime activity. These include historic shipping channels, historic anchorages, drying areas, hazards, landmarks etc. A list of historic UKHO Maritime/Admiralty Charts consulted may be found in Section 6.1.2.

For the purposes of the HSC it was necessary to record the information on these charts in a GIS. Of the historic UKHO charts consulted, 18 mapped information considered relevant to the characterisation of historic sea use. These charts were scanned, geo-referenced as accurately as possible and digitised as separate polygon layers (either as polygons or points – the points being buffered at a later stage) with the following tabular attributes recorded: Site Name, Site Type and Source. The information from the 18 charts was then unioned and aggregated into a single 'historic UKHO chart' layer with relevant information from each chart being recorded and cross-referenced against another wherever necessary and possible. This ensured that collectively the historic charts could be used, alongside historic OS maps, to inform historic sea use.

The original digitised layers for each historic chart form part of the supplementary data archive accompanying the final HSC database.

3.3.4.2 Historic OS maps (1st and 2nd editions, 1:2500 and 10,560 series)

This dataset identifies features, sites and monuments related directly or indirectly to the maritime environment or maritime activity. Each feature is recorded with a series of attributes that identify its type, form and source etc. This dataset can inform discussions on previous sea and coastal use and time-depth as well as generating useful information on the analysis of change between the dates of the two maps and modern HSC.

Field name	Type and length	Description
ID,	long integer	Unique feature reference no.
Name,	text, 250	[locational or topographic identifier from historic maps]
Site_Type1	text, 50	[type of feature, derived from MIDAS wordlists] 1st ed OS
Site_Type2		[type of feature, derived from MIDAS wordlists] 2nd Ed OS

Field name	Type and length	Description
Form,	text, 50	[condition of site or feature] 1st ed OS
Form,		[condition of site or feature] 2nd Ed OS
Source1,	text, 50	Eg. 1st ed OS
Source2,	text, 50	Eg. 2nd Ed OS
Source3	text, 50	Other source
CaptureScale,	text, 25	Scale at which data digitised (precision)
Accuracy,	text, 25	[RMSE -/+ m]
Description1,	text, 250	[description associated with Source1 identifying further useful information]
Description2,	text, 250	[description associated with Source2 identifying further useful information]
Description3,	text, 250	[description associated with Source3 identifying further useful information]

Fig 14 Attribution table for historic OS maps

3.3.4.3 NMR and SMR data (terrestrial and maritime)

NMR and SMR data was used to complement the historic character texts, providing examples of the components and features expected to be found within any given Character Type. The majority of the wreck sites were acquired from this data as were some landmarks.

3.3.4.4 Models of Sea level change: sea-level curve for western North Sea

See Appendix 2. Characterising the palaeo-geographies of this area of the North Sea was problematic. A GIS-based sea-level curve after Shennan *et al,* 2002 was crudely attempted for the western North Sea and was based on modern bathymetry. All bathymetric soundings/depths are in reference to Chart Datum (LAT). Therefore application of Shennan *et al*'s sea-level model against SeaZone Hydrospatial's BGS bathymetry requires that the difference between OD and CD datum be added to the mean Relative Sea Level (RSL) values given below for each thousand-years BP stage (this is because the model calculates RSL by subtracting the Reference water level from Altitude (which itself is referenced to OD)). Using two Chart Datum values and averaging them, Whitby (CD -3.00m) and North

Shields (CD -2.6m), gives a difference between OD and CD of -2.8m for the project area.

Additionally, extensive documentary references were consulted (Flemming 2004; Coles 1998) to gather information as to the nature of the palaeo-geographies of the North Sea. From these sources a purely indicative map of the likely areas and regions of archaeological potential was derived and used to identify 'Previous Historic Charcater'. Essentially, based on modern bathymetry, but informed by sedimentology and tentative sea-level curve, the following tentative gradings are suggested:

- Pleistocene:
    - Palaeolithic;
        - Possible
- Holocene:
    - Mesolithic;
        - High (30-50m depth and coastal/estuary)
        - Medium (20-30m depth)
        - Low (10-20 depth erosion zone, sand banks and sand waves and dredged areas)

The coarse rendering of Shennan *et al*'s sea-level curve of the western North Sea, and the use of modern bathymetry as an analogue for past submerged landscapes when it is not (the problems of this are highlighted by Coles 1998) means that this approach is indicative at best. However, the mapping is further informed by documentary references to the potential of early prehistoric use of specific topographic locales such as the following (after Flemming 2004, 15):

- 'Fossil' estuaries and river valleys;
- The flanks of submerged banks and ridges proven to have peat layers, or which are likely to have peat layers (eg Dogger Bank);
- Valleys, depressions, or basins;
- 'Fossil' archipelago topographies where sites were sheltered by low-lying islands as the sea level rose;
- Cliff coasts of unconsolidated glacial drift contain artefacts which are eroded onto the shore (the rocky Yorkshire coasts present such potential).

3.3.4.5 Wrecks and obstructions

Wreck and obstruction data was acquired from a number of sources including the NMR, Tees Archaeology and SeaZone Solutions Ltd (UKHO) and historic UKHO charts. General

processing included merging all the wrecks into a single layer and cross-referencing (where possible) to remove duplicate records (both surveyed and documentary records are included however). A frequency count based distribution based on the 250m grid was then used to identify those areas where two or more wrecks occurred.

Wrecks were geo-processed separately from other obstructions such as foul ground sites or fishermens' fasteners.

3.3.5 Semi-natural environmental datasets

Semi-natural environment datasets were used to inform land-use along the coast and for those marine areas where no other information or character could be identified or ascribed. There are no truly 'wild' landscapes and seascapes in and about Britain, all have been influenced directly or indirectly and to a greater or lesser degree by human activity.

3.3.5.1 BGS sediment and bedrock geology

Geological and sedimentological data was acquired by proxy via a licence to use the SeaZone Hydrospatial datasets. The sediment and bedrock geology was plotted at 1:250,000 scale. Due to licence and copyright and data derivation issues surrounding this data, a number of methods were tested by which to include the information recorded but at a resolution that the BGS would feel would not allow the data to be re-engineered.

Sedimentological data was intersected against the 250m grid and categorised as four broad 'Habitat' Types informing benthic character where archaeological, historic features are absent:

- Coarse sediment plains (predominantly gravel);
- Fine sediment plains (predominantly sand);
- Very fine sediment plains (predominantly mud);
- Sand banks with sand waves.

3.3.5.2 English Nature

Datasets acquired from English Nature (now Natural England) help characterise areas of semi-natural environment, including the followings Types:

- Coastal rough ground and sand dunes;
- Coastal and floodplain grazing marsh;

- Maritime cliffs;
- Mudflats and sandflats;
- Ancient woodland.

3.4 Explaining HSC via accompanying text

In order to explain the GIS-based HSC, texts were prepared to define, describe and interpret the Types, to consider condition, potential for research and amenity and forces for change and to suggest recommendations for safeguarding the type (see below, for more detail). Unlike the Liverpool Bay Seascapes pilot project, the Scarborough to Hartlepool pilot associated texts with the Character Types rather than unique Character Areas. As noted earlier, Character Areas were based to some extent, but not entirely on the Character Types, as a final tier or layer in the GIS. They reflect areas that local people might recognise or more readily identify with, and it is for this reason that the only text attached to these was that on 'Values and Perceptions'. The rationale for this approach is explained more fully elsewhere (Herring 1998, 47) and is paraphrased here.

- The initial characterisation, being bottom-up, focused on identifying sub-character, character and broad character types in a hierarchy of scaleable perspective. As such, maps, documentary sources and images were used to identify repeating and similar seascapes rather than unique definable areas which are inherently less objectively defined than these Types.
- Unique areas, though simpler and perhaps more easily used by seascape managers, planners etc may in practice disguise the benefits of characterisation and the holistic understanding that it brings.
- By extension the definition of unique areas may also introduce notions and rankings of relative importance which may lead to a form de facto designation and consequent influencing of planning controls and targeting of resources. This would run counter to the philosophy of sustainability underlying characterisation.

The Character Type texts are an essential tool that should be used alongside the GIS mapping as they qualify and discuss the nature and extent of each Type. For this reason they have been attached to polygons of the relevant Character Type and users can call up them, and any associated images, by clicking on the polygon on the GIS. The following are the subsections under which the Types texts are arranged.

Introduction: defining/distinguishing attributes and principal locations

Basic defining or distinguishing attributes and principal locations (reflcting the distribution of the Type through the study area).

Historical processes; components, features and variability

A brief review of the historical development of the Type, including an outline chronology where appropriate. Emphasis is laid on the processes which have produced surviving historical or semi-natural features. This is in some ways an elaboration of the Introduction and is important in allowing particular landscape/seascape features and below-ground/submerged remains a place in the characterisation. Semi-natural habitats are presented here as well as archaeological features and historic processes.

Includes comment on major differences in extent and components of the Type in different parts of the study area, with brief explanations where appropriate.

Values and perceptions.

A highly subjective discussion of the ways local people and visitors appear to perceive the Type and the value that is given to it and its components. It is recommended that others undertaking characterisation projects treat this as a critically important part of the text, bringing subjectivity explicitly into the process, and identifying variances in attitudes, and disputes over interpretations. Will include oral history, local myths, tales etc.

Research, amenity and education

A statement on the extent of archaeological and historical research on the development of both the Type itself and also its typical components. Includes a discussion of the likely interest visitors and educators may find in the Type, its components, and its history, and the practical problems that might be encountered in developing that interest. Also a discussion of the directions future research might take to help understand the development of both the Type itself and its components.

Condition and forces for change

Statements on the typical condition of both the Type as a whole and its defining components; the influences currently affecting the Type (Note: these need not be all negative); and the typical survival of historical/archaeological and semi-natural components and features within this Type. In some cases the survival of the whole Type is also considered. May also include a statement on the typical extent that inter-related components

from specified periods survive to be seen and understood in the Type.

Rarity and vulnerability

A statement of the rarity regionally and nationally of both the Type itself and the features typically found within it, including a statement on the degree of statutory or customary protection the Type typically receives.

Using some of the foregoing sections as a guide, a statement is made on the importance regionally and nationally of both the Type and its typical components (these statements are necessarily tentative given the incomplete coverage of the current Seascapes programme in English waters)

Recommendations

Two or three initial recommendations are made in the light of the foregoing sections with the intention of conserving the Type, its components, and its character.

Sources

Lists key sources utilised to generate descriptive texts. In some cases these include webpages.

3.5 Fieldwork

Limited fieldwork (two people for one week) was undertaken in the area. Primarily this was to familiarise project staff with the North Yorkshire coast and Tees Estuary. It was also an invaluable opportunity to visit the HERs/SMRs for each county bordering the study area; to visit archives and museums and collect further information relevant to the study to meet people with vested interests; and to acquire field notes and photographs to compliment the final characterisation. The two Stakeholders meetings (in Whitby and Scarborough) also provided an opportunity to gauge local people's responses to the characterisation project and collect, ideas and thoughts they wished to contribute.

3.6 Updating the HSC

The adoption of a grid to frame the HSC allows the dataset to be easily updated and amended as further information comes to light. The spatial correlation, or intersection, of existing datasets and information against grid cells, using GIS, makes this structure flexible.

However, the 250m resolution grid employed for the Scarborough to Hartlepool HSC GIS constitutes a very large dataset, over 1GB in size with an excess of 400,000 individual polygons (not including the landward polygons). Such a dataset is too unwieldy for use on a desktop GIS. Thus the derivation of a conflated HSC layer or layers is essential for practical

use. This can be achieved by 'auto-unioning' or merging all those cells that share a common value, be it at Sub-Character Type, Character Type or Broad Character Type levels.

Given their detailed attribution, any combination of values can be queried to produce a derived layer based on users' needs or requests, giving the user flexibility over the kind of character map they wish to produce. The additional provision, as part of the HSC data product and archive, of the component source datasets that were generated during the characterisation of the modern and historic seascapes will provide further information that may be used alongside the final characterisation.

4 Methodological review

4.1 Introduction

In this section HES, with the benefit of hindsight, reviews the methodology that it developed for the Scarborough to Hartlepool HSC.

4.2 Review of current method

4.3 Grid-based dataset

Although the grid-based method employed, for the marine zone, allowed the various levels of the marine environment to be characterised, any future characterisation needs to offset that advantage against the cumbersome nature of the dataset itself. This can be achieved through the query and analysis of the HSC attributes to produce derived Sub-Character, Character or Broad Character Type layers, or a conflated layer representing the area in a single map. Alternatively grid cells that share historic character at all tiered levels (benthic through to surface) could be dissolved together thus reducing the size of the overall dataset and improving its manipulations in GIS. This may however reduce the dataset's flexibility when updates or additions are required.

Users of the grid are encouraged to derive their own layers from it according to their needs and queries.

Future HSC projects that utilise grids may wish to employ a 'differential grid'; that is one that comprises grids and cells of varying, though ratio-ed, size. The size of any given cell might depend and accord to the source and scale of the base data and mapping used for characterisation (a crude example of this sliding scale may be that fine resolution datasets might be overlain against 250m or 500m cells, medium resolution datasets over 1000m cells and coarse ones over 5000m cells). Such a sliding scale would ensure that fine meshes were not used for coarse or poorly defined data and vice versa. This method would need further investigation to ascertain appropriate cell sizes for particular dataset scale ranges.

4.4 Proxy data for characterisation

Given the nature of the marine archaeological record, a more informed discussion relating the differences between Seascapes and Sea-use would be beneficial. Much of the characterisation, especially in the marine environment, is inferred. In terrestrial HLC this may be akin to using land-use as a proxy for landscape where landscapes cannot be readily identified morphologically.

Greater discussion is required of the usefulness of proxy data for characterisation, for example the use of fishing intensity or shipping movement data as indicators of

archaeological potential or indication of possible threats. There is a considerable interpretative leap taken when using proxy data for any given place or time-lapse as a model for general activity or indications of pressure on the marine historic environment. Instead of vessel sightings, definitive seismic data for beam trawling tracks and scars, for example, are one way whereby the quantitive and qualitative effects of this form of fishing could be measured and assessed.

4.5 Digitisation by Source

The digitisation by Source, especially of the landward present and historic seascape character, has necessarily meant geo-processing, and specifically unioning, the two datasets into a single layer. Due to the overlapping of boundaries and polygons the resultant dataset comprise a large number of features, many irregular slivers, small intersections and the such like. Whilst not ideal from a technical and aesthetic point of view these reflect the methodology. Further resources and time would allow further 'cleaning' of these features.

4.6 Detailed seismic survey data

Access to high quality seismic survey data for the seafloor is desirable, preferably already interpreted and analysed. This would not only help identify relatively modern impacts, such as trawling, pipeline laying and such like, but should also reveal successive seabed layers, identifying series of marine environmental processes and bedforms and potential for stratigraphic palaeolandscapes (eg the 'North Sea Palaeolandscapes' project undertaken by University of Birmingham for English Heritage and funded by ASLF (http://www.arch-ant.bham.ac.uk/research/fieldwork_research_themes/projects/North_Sea_Palaeolandscapes/index.htm). In many ways this would provide an equivalent of the detailed topographical mapping which underpins terrestrial characterisation.

5 Recommendations for further work

5.1 New techniques (eg Welsh Seascapes and visual impact assessments)

Using viewsheds as the principal driver, several visual impact pilot studies were undertaken for the Countryside Council of Wales in 2001, including assessments of the north Anglesey coast, the Pembrokeshire coast around Milford Haven, Swansea Bay, Ireland's Eye to Skerries, Arklow to Morriscastle and Dun Laoghaire to Greystones. The studies looked at physical forms in the areas – such as coastal features, the nature of the shore and settlements – and human activity – such as recreation, shipping, fishing etc and views from land to sea and from sea to land and along the coastline. These were then evaluated to derive seascape assessments.

For more see http://www.ccw.gov.uk/News/index.cfm?action=Press&ID=140&lang=en.

Visual characterisation, as undertaken in Wales, can further inform the more intangible elements of the historic seascape character of the English Seascape projects with particular emphasis on using viewsheds and line-of-sights to help understand navigation routes and areas and the use of landmarks for navigation. It may be of particular use to emphasise the maritime use and perspective of terrestrial landscapes and features.

6 References

6.1 Primary sources

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Ordnance Survey, *c*1850s. *1:10,560* First Edition (licensed digital copy from EH)

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Ordnance Survey, 1:10,000. (licensed digital copy from EH)

Ordnance Survey 1:25,000 (licensed digital copy from EH)

Ordnance Survey 1:50,000 (licensed digital copy from EH)

6.1.1 Modern UKHO Admiralty Charts

Chart 1612-5, Scarborough Bay, 1:10,000.

Chart 1612-6, Scarborough Harbour, 1:5000.

Chart 129, Whitby to Flamborough Head, 1:75,000.

Chart 134. River Tees to Scarborough, 1:75,000.

Chart 152, River Tyne to River Tees, 1:75,000.

Chart 266, North Sea Offshore Charts, Sheet 11: Dogger Bank, 1:200,000.

Chart 268, North Sea Offshore Charts, Sheet 9. 1:200,000.

Chart 1191-0, River Tyne to Flamborough Head, 1:200,000.

Chart 1612-1, Runswick Bay, 1:25,000.

Chart 1612-4, Whitby Harbour, 1:7500

Chart 1612-9, Approaches to Whitby, 1:25,000.

Chart 2566-1, Tees Bay, 1:25,000

Chart 2566-2, Continuation of the River Tees, 1:20,000.

Chart 2566-3, Hartlepool Bay, 1:10,000.

Chart 2567, Approaches to Tees Bay, 1:200,000.

6.1.2 Historic UKHO Charts

Date	Title	Surveyor	UKHO Chart Ref.	UKHO Shelf ref.
1762	River Teese	Dobson	A50	Qf
1791	Yorkshire Coast, Robin Hood's Bay to Runswick Bay	Pickernell	i73/1&2	Pu41
1802	River Tees (1762 corrected 1802)	Dobson	D611	Qf
1815	Hartlepool to Redcliff	Thompson	F11	Df
1824	River Tees	Edgeworth	H274	Og*
1830	Flamborough Head to Robin Hood's Bay		H23, H24	15c
1839	Tees Bay	Hewett/Brooks	L1704	3a
1839	Staithes	Calver	L4151	Qf
1843	Scarborough	Calver	L6160	Oi*
1847	Scarborough (Same as L6160 but with an 1847 update)		L3803	Dl
1851	Plan for Navel Station & Asylm Harbourb at Redcar		L4587	
	Longitudinal section of engineering of Tees River.			
1852	Chapman's Cut 1808 to Bamblett's Bight (Cockel's Gat)	Beaufort	L8801	35c
1852	River Tees Plan		L8802	15c
1853	Seaton Carew to Redcar to Stockton		L9763	13e
1854	Plans for improvements to Scarborough Harbour		L262	
1858	Tees Bay	Calver	L9526	
1874	Tees Bay		A3918	40l
1875	East Coast	Imray	A5594	
		Tees		
1885	Tees Estuary	Conservancy	A9275	49a
1891	Hartlepool to Redcar (Tees Bay)		B400	at TNA
1891	Tees to Redcar	Maxwell	B3636	Dn
1894	Whitby	Triton	B4784	Qi
1897	Skinningrove to Marske	Triton	B6288	7d
1901	Scarborough	Triton	B8195	Dn
1914	Whitby		C5589	
1914	Whitby	Triton	C5588	Oa
1929	Tees Bay (from 2567)	HMS Fitzroy	n	Ou
1930	Tees Bay	HMS Fitzroy	E3390	8a
1931	Scarborough		H23	
1931	Runswick Bay to Robin Hood's Bay		H24 10 f2	15c
				England
1932	England East Coast. Whitby	HMS Fitzroy	E3972	Folio 18
1932	Hartlepool Bay	HMS Fitzroy	E3970	

Date	Title	Surveyor	UKHO Chart Ref.	UKHO Shelf ref.
1932	Whitby	HMS Fitzroy	E3971	Oh
1955	England East Coast. River Tees and Tees Bay		E9862	31m
1963	Tees Bay to Whitby		K4023/1-2	Kn
1967	Whitby Harbour		K5171	Folio 61
1974	Whitby		K6962	Folio 67
?	East Coast: Scarborough to Hartlepool	D&E Steel	B605/1	
1838/1853	Tees Bay	Slater/Calver	D9526	
1849 and 1857	Stockton to the Sea	Johnston	D3198	Ag1
?	Burlington Bay (Scarborough & Hartlepool) - use for illustrating report	Grenville Collins	B900	Historical Press
?	Huntcliff to Sandsendness		H24 10 f2	15c

6.2 Publications

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7 Project archive

The HES project number is **2006022**. The project's documentary, photographic and drawn archive is housed at the offices of the Historic Environment Service, Cornwall County Council, Kennall Building, Old County Hall, Station Road, Truro, TR1 3AY. The contents of this archive are as listed below:

1. A project file containing site records and notes, project correspondence and administration and copies of documentary/cartographic source material (file no 2006022).

2. This report held in digital form as: G:\CAU\HE PROJECTS\SITES\MARITIME\SEASCAPES SCARBOROUGH TO HARTLEPOOL 2006A6022\REPORT\FINAL REPORT\SCARBOROUGH_HARTLEPOOL_HSC_METHOD_FINAL_REPORT.DOC

8 Appendices

8.1 Appendix 1: HSC data structure and list

Broad Character	Character Type	Sub-character	Components
Industry	Extractive Industry (Hydrocarbon)		
		Hydrocarbon Field (Gas)	Fixed Platform/Rig Installation, wellhead, pipeline
		Hydrocarbon Field (Oil)	Fixed Platform/Rig Installation, wellhead, pipeline
	Extractive Industry (Minerals)		
		Alum Works	
		Ironstone Works	
		Jet Works	
		Salt & Potash Works	Brine Reservoirs
		Quarries	Sandstone, Limestone, Clay
	Energy Industry		
		Gas Refinery	Gas Works
		Oil Refinery	Oil Terminal
		Power Station	Nuclear
		Renewable Energy Installation	Windfarm app.
	Processing Industry		
		Production Area	Timber, Cement, Bricks, Tiles, Steel, Iron, Mill, Lime Kiln, Works, Clay/Pottery, Coal, Aggregates, Scrap Metal, Depot, Electricity sub-station, Salt Works, Industrial Estates, Business Estate/Centre
		Sewage and Water Works	Sewage Pipeline, Diffuser, Outfall, Pumping Station, Reservoirs
	Shipping Industry		
		Boat Yard	

Broad Character	Character Type	Sub-character	Components
		Dockyard	Dry, wet, floating, warehouses, landing stages, container terminals, conveyers, Boom Chain, Boom Tower, Cranes, Deep water facility, Basin
		Ship Yard	
Coastal Infrastructure			
	Port	Administration and Regulation	Open Area, Custom Area, Free Port Area, Licensed Area, Previously Licensed Area, Dock Office, Quarantine Area, Restricted Area, Pilot Station, Preventative Watch House
		Landing Place	eg wharf, jetty, pontoon, slipway, Coble Landing, Rutways, landing stages, small craft facility, slipway, terminal
		Pier	
		Port Area	
		Quay	
		Warehouses/Storage Area	
	Sea Defences	Breakwater	Breakwater, Sea Wall, Groyne, Reclamation Wall
Fishing and Mariculture	Fishery		
		Seining	
		Netting and Lining	
		Shellfishing	Mussel Beds/Cockle beds
		Beam Trawling	
		Hazardous Fishing Ground	
	Mariculture		
	Fish Processing		
		Fish Market	
		Storage Sheds	

Broad Character	Character Type	Sub-character	Components
Navigation	Navigation Channel		
		Active Sea Channel	
		Active Navigable River Channel	
		Disused Sea Channel	
		Disused Navigable River Channel	
		Dredged Area/Channel	
	Navigation Area/Route		
		Navigation Route	
		Harbour area	
		Administration and Regulation	Check Point, pilot boarding place, Harbour Masters Office
		Anchorage Area	
		Harbour Administration Area	Harbour, Haven
		Restricted navigation area	
		Ferry route	
		Shipping Lane	
	Navigation Hazard		
		Caution Area	Shoal, drying area
		Obstruction	Rocky Outcrop, Under Water/Awash Rocks, Maritime Debris, fisherman's fasteners, sand bank, scarp
		Tidal	Water Turbulence, Tidal Currents
		Dangerous Wreck (cluster)	Aircraft, ship
		Wreck Cluster	
	Maritime Safety		
		Navigation Aids (Sea)	Buoy, Beacon, Radar Transponder Beacon Light,
		Navigation Aids (Land)	Lighthouse, Fog Station, Landmark (e.g. Church, Beacon, Hill), Daymark, Topmark, Distance Mark, Light
		Safety Services	Coastguard Station, Lifeguard Area, Lifeboat Station, Rocket Post, Rocket Station

Broad Character	Character Type	Sub-character	Components
Semi-Natural Environment	Cliff		
		Cliff	Steep, gentle, precipitous, slumped, wooded, springs
	Dunes		
	Foreshore		
		Sandy Foreshore	
		Rocky Foreshore	
		Kelp	
	Woodland		
		Ancient Woodland	
		Plantation	
		Semi-Natural Woodland	
	Coastal Rough Ground		
		Rough Ground	
		Scrub	
	Salt Marsh & Sandflats		
		Salt Marsh	
		Sand & Mudflats	
		Sandflats	
		Mudflats	
	Water		
		Lake	
		Pond	
		Spring	
		Watercourse	Stream, non-navigable river
	Marine Features		
		Coarse sediment plains	
		Fine sediment plains	
		Very fine sediment plains	
		Sand banks with sand waves	
	Palaeo-landscape		
		Palaeo-environmental deposit	Forests, landscapes, peatbogs
		Submerged Forest	
Communication	Transport		

Broad Character	Character Type	Sub-character	Components
		Rail	Tunnel, Engine Works, Engine Shed, Marshalling Yard, Bridge
		Road	Bridge
		Tram?	
	Telecommunications		
		Telecommunications	Cable (submarine, on land), satellite, radio, telegraph station
Military	Military Defences		
		Anti-tank Defences	
		Artillery	Battery, gun emplacement, gun
		Fortification	Castle, Fort, Moat, Dike, Town Wall, Gate
		Anti-landing	Minefield, Pill Box
	Military Facility		
		Military Airfield	Runway, hangers
		Military Base	Army, Naval, RAF, Barracks, Navel dock, Submarine, Radar Base
		Military Dump	Unexploded Ordinance
		Military Practice Area	Firing range/Rifle Range, Submarine exercise area
Settlement	Settlement		
		City/Urban	
		Town	
		Village	
		Hamlet	
		Facilities/Amenities (merge into settlement)	Car park, hotels, public toilets, allotment gardens
Recreation	Recreation		
		Angling site	
		Coastal Heritage	Scarborough Castle,, Roman Signal Station, Battle Site
		Dive site	
		Holiday Park	Camp site, caravan park

Broad Character	Character Type	Sub-character	Components
		Parks & Gardens	Cliff gardens, pleasure, landscape park
		Seaside entertainment	Theme park, amusement park, promenade, beach huts, spa, miniature railway, bathing pools. Pavilion, Cliff Railway, Cliff Tramway, Theatre
		Sport Facility	Golf course, swimming pool, Diving Club , Recreation Ground, Race Course, Athletics Ground, Angling Site , bowling greens, Cycle trail (Dismantled Railways), Bridal Path, Sailing Club, Leisure Centre, Playing Fields, Footpaths
		Marina	Jetties, pontoons

8.2 Appendix 2: Western North Sea sea-level curve

After Shennan et al 2000a, 302.Table. 1: Summary of sea-level index points and limiting data from the North Sea.)

11,000 years BP (c9000BC)

Code	14C age ±	Altitude	Change in RSL
AA25602	11145±75 (11220-11070yBP)	-51.40	-53.95±0.54 (-53.41 to -54.49)
AA27137	11425±95 (11520-11330yBP)	-51.52	≤-53.09±1.28 (-54.37 to -51.81)
AA23945	11325±85 (11410-11240yBP)	-38.97	≤-40.37±1.15 (-41.52 to -39.22)
Total	67790/6	-141.89/3	-147.41/3 (-294.82/6)
Mean	***11298yBP***	***-47.3***	-49.13 + (-2.8) = **-51.93m**

9,000 years BP (c7000BC)

Code	14C age ±	Altitude	Change in RSL
AA27143	9145±60	-37.52	-39.29±1.29
AA27145	9045±65	-38.61	-40.38±1.29
AA23944	9270±75	-38.53	-40.88±0.20
AA27146	9155±70	-38.88	-41.85±1.33
AA27147	9155±75	-37.59	-39.36±1.33
Elbow Formation	9374±90	-35.00	≤-36.14±1.36
Elbow Formation	9949±120	-35.00	≤-36.14±1.36
OXA332	9335±105	-59.00	≤-60.57±1.24
GRN5758	9935±55	-46.00	≤-47.10±1.21
GRN5759	9445±80	-47.00	≤-48.10±1.21
Total	93808/10	-413.13/10	-429.81/10
Mean	93808yBP	-41.3	-42.9+ (-2.8) = **-45.7m**

8,000 years BP (c6000BC)

Code	14C age ±	Altitude	Change in RSL
AA27144	8995±60	-37.92	-39.696±1.29
AA23946	8775±70	-32.77	-35.12±0.20
AA22662	8140±55	-31.06	-33.26±1.30
HV7095	8190±140	-38.00	-39.80±1.66
HV7094	8485±125	-38.09	-39.89±1.66
HV7091	8950±95	-37.27	≤-38.34±1.91
HV6189	8075±60	-29.00	≤-30.04±1.08
Total	59610/7	-244.11/7	-256.14/7
Mean	8515yBP	-34.8	-36.59 + (-2.8) = **-39.39m**

7,000 years BP (c5000BC)

Code	14C age ±	Altitude	Change in RSL

HV7094	7540±80	-21.50	-23.30±1.66
HV8602	7960±205	-22.60	-24.40±1.66
HV8601	7980±60	-21.90	-23.70±1.66
AA27148	7975±55	-22.87	≤-23.89±1.59
HV628	7115±90	-12.00	≤-13.04±1.08 ???
HV2575	7790±90	-24.90	≤-25.94±1.08
HV2143	7720±65	-24.35	≤-25.39±1.08
Total	54080/7	-150.12/7	-159.66/7
Mean	7725yBP	-21.44	-22.8 + (-2.8) = -25.6m
If sea-level index point HV628 is excluded:		*-23.00*	*-24.4 + (-2.8) =* ***-27.2m***

6,000 years BP (c4000BC)

Code	**14C age ±**	**Altitude**	**Change in RSL**
German Bight 290	c6000-7000	-27.00	≤-28.04±1.08
Miele Bay 307	6705±60	-7.00	≤-8.04±1.08
Total	c13205/2	-34.00/2	-36.08/2
Mean	6602yBP	-17.00	-18.04 + (-2.8) = **-20.84m**

5,000 years BP (c3000BC)

Code	**14C age ±**	**Altitude**	**Change in RSL**
German Bight 85	c5000-6000	-17.00	≤-18.04±1.08 + (-2.8) = **-20.84m**

8.3 HSC datasets metadata

The following metadata accompanies the HSC geodatabase and ArcGIS shapefiles and layer files. The metadata has been compiled using an application called MetaDragon, developed by Restormel Borough Council in partnership with Cornwall County Council (undertaken by E. Dunn, M. Bennett and B. Tapper in 2005). The metadata database exports UK Gemini standard metadata to Microsoft Access MDB, Text and XML file formats. The text file output is offered below.

8.3.1 HSC dataset

Filename: *scarborough_hartlepool_hsc_final.shp*

Title : Scarborough to Hartlepool Historic Seascape Characterisation

Alternative Titles : Seascapes: Hartlepool to Scarborough Historic Seascape Character Pilot project

Originators : Historic Environment Service, Cornwall County Council (for English Heritage)

Abstract :

This dataset is the final historic seascape characterisation produced as part of the methodology of a project, commissioned by English Heritage and undertaken by Cornwall County Council's Historic Environment Service (Projects) in 2006-7, to apply Marine Historic Landscape Characterisation to the coastal, inter-tidal and marine zones of North Yorkshire and Teesside, from Scarborough to Hartlepool, as part of England's Historic Seascapes project. Sponsored by the Aggregates Levy Sustainability Fund (ALSF), it is one of four pilot projects considering varying coastal and marine contexts designed to test and further develop an initial methodology developed by Wessex Archaeology in Liverpool Bay. The pilot projects were undertaken concurrently and presage a nationwide marine characterisation programme.

The dataset comprises over 400,000 individual polygons identifying the historic character of the Scarborough to Hartlepool seascapes at varying levels. The historic character has been systematically mapped from various sources ranging from historic OS maps and UKHO charts to modern OS maps and digital marine data from the UKHO and BGS.

The attribute table of the dataset comprises the following fields which can be queried and analysed by the user to produce maps and layers of character at varying levels of perception.

Name	Type	Width
Shape,	FIELD_SHAPEPOLY,	8,
Name,	FIELD_CHAR,	250,
Location,	FIELD_CHAR,	50,
Chrctrar,	FIELD_CHAR,	100,
Brdchrctr,	FIELD_CHAR,	250,
Chrctr,	FIELD_CHAR,	250,
Subchrctr,	FIELD_CHAR,	250,
Prvschrctr,	FIELD_CHAR,	100,
Period1,	FIELD_CHAR,	25,
Period2,	FIELD_CHAR,	25,
Sbbnthc,	FIELD_CHAR,	100,
Benthic,	FIELD_CHAR,	100,
Pelagic,	FIELD_CHAR,	100,
Surface,	FIELD_CHAR,	100,
Habitat,	FIELD_CHAR,	50,
Sea_level,	FIELD_CHAR,	25,
Confidence,	FIELD_CHAR,	25,
Source1,	FIELD_CHAR,	250,
Source2,	FIELD_CHAR,	250,
Link1,	FIELD_CHAR,	250,
Link2,	FIELD_CHAR,	250,
Crtdate,	FIELD_CHAR,	10,

Topic Category : Environment, Imagery / Base Maps / Earth Cover, Oceans

Subject : Archaeology**,** Historic Landscape Characterisation**,** Marine Historic Environment

Dataset Language : English

Capture Start Date: 2006

Capture End Date: 2007

Dataset Reference Date: 2006-03-21

Frequency of Update : Not Planned

Geographic Co-ordinates : British National Grid W437382 E482630 N735250 S654500

Geographic Identifiers : HARTLEPOOL, MIDDLESBROUGH, NORTH YORKSHIRE

Access Constraints : English Heritage Copyright, English Heritage Intellectual Property Rights

Use Constraint : English Heritage Copyright, English Heritage Intellectual Property Rights

Presentation Types : Map Digital

Spatial Representation Type : Vector

Supply Media : CD, DVD

Data Format : ESRI shapefile

Feature Type : polygons

Number Of Features : 421022

Size : 1.2GB

Spatial Reference System : National Grid of Great Britain

Additional Information Sources : See accompanying reports:

'England's Historic Seascapes: Scarborough to Hartlepool and Adjacent Marine Zone Historic Seascape Characterisation Method' by Bryn Tapper, Megan Val Baker, Charles Johns and Peter Herring, 2007. Report No: 2007R022.

and

'England's Historic Seascapes: Scarborough to Hartlepool and Adjacent Marine Types Historic Seascape Characterisation' by Megan Val Baker, Bryn Tapper, Charles Johns and Peter Herring, 2007. Report No: 2007R021.

Distributor :

National Maonument Record,
English Heritage

8.3.2 HSC derived 'conflated' dataset

Filename: *scarborough_hartlepool_hsc_derived.shp*

Title : Scarborough to Hartlepool Historic Seascape Characterisation

Alternative Titles : Seascapes: Hartlepool to Scarborough Historic Seascape Character Pilot project

Originators : Historic Environment Service, Cornwall County Council (for English Heritage)

Abstract :

This dataset is derived from the final historic seascape characterisation dataset. It represents a conflated HSC for all the marine tiers. This has been achieved by unioning individual polygons on the basis of predominant present character thereby reducing the number of polygons considerably and making this dataset more user friendly for use in a desktop GIS.

It has been produced as part of the methodology of a project, commissioned by English Heritage and undertaken by Cornwall County Council's Historic Environment Service (Projects) in 2006-7, to apply Marine Historic Landscape Characterisation to the coastal, inter-tidal and marine zones of North Yorkshire and Teesside, from Scarborough to Hartlepool, as part of England's Historic Seascapes project. Sponsored by the Aggregates Levy Sustainability Fund (ALSF), it is one of four pilot projects considering varying coastal and marine contexts designed to test and further develop an initial methodology developed by Wessex Archaeology in Liverpool Bay. The pilot projects were undertaken concurrently and presage a nationwide marine characterisation programme.

The dataset comprises over 7000 individual polygons identifying the historic character of the Scarborough to Hartlepool seascapes at varying levels. The historic character has been systematically mapped from various sources ranging from historic OS maps and UKHO charts to modern OS maps and digital marine data from the UKHO and BGS.

The attribute table of the dataset comprises the following fields which can be queried and analysed by the user to produce maps and layers of character at varying levels of perception.

Name	Type	Width
Shape,	FIELD_SHAPEPOLY,	8
Name,	FIELD_CHAR,	250
Location,	FIELD_CHAR,	50

Brdchrctr,	FIELD_CHAR,	250
Chrctr,	FIELD_CHAR,	250
Subchrctr,	FIELD_CHAR,	250
Prvschrctr,	FIELD_CHAR,	250
Sea_level,	FIELD_CHAR,	25
Period1,	FIELD_CHAR,	25
Period2,	FIELD_CHAR,	25
Source1,	FIELD_CHAR,	250
Source2,	FIELD_CHAR,	250
Confidence,	FIELD_CHAR,	25
Link1,	FIELD_CHAR,	250
Link2,	FIELD_CHAR,	250

Topic Category : Environment, Imagery / Base Maps / Earth Cover, Oceans

Subject : Archaeology**,** Historic Landscape Characterisation**,** Marine Historic Environment

Dataset Language : English

Capture Start Date: 2006

Capture End Date: 2007

Dataset Reference Date: 2006-03-21

Frequency of Update : Not Planned

Geographic Co-ordinates : British National Grid W437382 E482630 N735250 S654500

Geographic Identifiers : HARTLEPOOL, MIDDLESBROUGH, NORTH YORKSHIRE

Access Constraints : English Heritage Copyright, English Heritage Intellectual Property Rights

Use Constraint : English Heritage Copyright, English Heritage Intellectual Property Rights

Presentation Types : Map Digital

Spatial Representation Type : Vector

Supply Media : CD, DVD

Data Format : ESRI shapefile

Feature Type : polygons

Number Of Features : 7292

Size : 17mb

Spatial Reference System : National Grid of Great Britain

Additional Information Sources : See accompanying reports:

'England's Historic Seascapes: Scarborough to Hartlepool and Adjacent Marine Zone Historic Seascape Characterisation Method' by Bryn Tapper, Megan Val Baker, Charles Johns and Peter Herring, 2007. Report No: 2007R022.

and

'England's Historic Seascapes: Scarborough to Hartlepool and Adjacent Marine Types Historic Seascape Characterisation' by Megan Val Baker, Bryn Tapper, Charles Johns and Peter Herring, 2007. Report No: 2007R021.

Distributor :

National Maonument Record,
English Heritage

8.3.3 Historic OS Maps and UKHO Charts dataset

Filename: *scarborough_hartlepool_hsc_historic_maps_charts.shp*

Title : Scarborough to Hartlepool Historic Seascape Characterisation

Alternative Titles : Seascapes: Hartlepool to Scarborough Historic Seascape Character Pilot project

Originators : Historic Environment Service, Cornwall County Council (for English Heritage)

Abstract :

This dataset identifies HSC from historic UKHO Charts and historic OS maps (1st and 2nd Ed OS maps of 1856-61 and 1895 respectively). UKHO record character below MSL whilst OS maps record it above. This dataset identifies features, sites and monuments related directly or indirectly to the maritime environment or maritime activity. Each feature is recorded with a series of attributes that identify its type, form and source etc. This dataset can inform discussions on previous sea and coastal use and time-depth as well as generating useful information on the analysis of change between the dates of the two maps and modern HSC.

Over 40 historic UKHO charts and folios (coastline profiles) were consulted from the research section at the UKHO, Taunton. These charts identify features, sites and monuments related directly or indirectly to the maritime environment or maritime activity. These include historic shipping channels, historic anchorages, drying areas, hazards, landmarks etc. A list of historic UKHO Maritime/Admiralty Charts consulted may be found in Appendix 2.

For the purposes of the HSC it was necessary to record the information on these charts in a GIS. Of the historic UKHO charts consulted, 18 mapped information considered relevant to the characterisation of historic sea use. These charts were scanned, geo-referenced as accurately as possible and digitised as separate polygon layers (either as polygons or points – the points being buffered at a later stage) with the following tabular attributes recorded: Site Name, Site Type and Source. The information from the 18 charts was then unioned and aggregated into a single 'historic UKHO chart' layer with relevant information from each chart being recorded and cross-referenced against another wherever necessary and possible. This ensured that collectively the historic charts could be used, alongside historic OS maps, to inform historic sea use.

The original digitised layers for each historic chart form part of the supplementary data archive accompanying the final HSC database.

This dataset also identifies features, sites and monuments related directly or indirectly to the maritime environment or maritime activity. Each feature is recorded with a series of attributes that identify its type, form and source etc. This dataset can inform discussions on previous sea and coastal use and time-depth as well as generating useful information on the analysis of change between the dates of the two maps and modern HSC.

The attribute table of the dataset comprises the following fields which can be queried and analysed by the user .

Alias	**Type**	**Width**
Shape,	FIELD_SHAPEPOLY,	8,
Name,	FIELD_CHAR,	250,
Type1,	FIELD_CHAR,	50,
Type2,	FIELD_CHAR,	50,
Dmntchrctr,	FIELD_CHAR,	250,
Source2,	FIELD_CHAR,	250,
Period2,	FIELD_CHAR,	25,
Subchrctr,	FIELD_CHAR,	250,
Chrctr,	FIELD_CHAR,	250,
Brdchrctr,	FIELD_CHAR,	250,
Prvscrctr,	FIELD_CHAR,	250,

Topic Category : Environment, Imagery / Base Maps / Earth Cover, Oceans

Subject : Archaeology**,** Historic Landscape Characterisation**,** Marine Historic Environment

Dataset Language : English

Capture Start Date: 2006

Capture End Date: 2007

Dataset Reference Date: 2006-03-21

Frequency of Update : Not Planned

Geographic Co-ordinates : British National Grid W437382 E482783 N510260 S539989

Geographic Identifiers : HARTLEPOOL, MIDDLESBROUGH, NORTH YORKSHIRE

Access Constraints : English Heritage Copyright, English Heritage Intellectual Property Rights

Use Constraint : English Heritage Copyright, English Heritage Intellectual Property Rights

Presentation Types : Map Digital

Spatial Representation Type : Vector

Supply Media : CD, DVD

Data Format : ESRI shapefile

Feature Type : polygons

Number Of Features : 1955

Size : 3.5mb

Spatial Reference System : National Grid of Great Britain

Additional Information Sources : See accompanying reports:

'England's Historic Seascapes: Scarborough to Hartlepool and Adjacent Marine Zone Historic Seascape Characterisation Method' by Bryn Tapper, Megan Val Baker, Charles Johns and Peter Herring, 2007. Report No: 2007R022.

and

'England's Historic Seascapes: Scarborough to Hartlepool and Adjacent Marine Types Historic Seascape Characterisation' by Megan Val Baker, Bryn Tapper, Charles Johns and Peter Herring, 2007. Report No: 2007R021.

Distributor :

National Monument Record,
English Heritage

8.3.4 Modern OS Maps and UKHO Charts dataset

Filename: *scarborough_hartlepool_hsc_modern_maps_charts.shp*

Title : Scarborough to Hartlepool Historic Seascape Characterisation

Alternative Titles : Seascapes: Hartlepool to Scarborough Historic Seascape Character Pilot project

Originators : Historic Environment Service, Cornwall County Council (for English Heritage)

Abstract :

1:2500, 1:10,000; 1:25,000 and 1:50,000 OS maps were all used to determine the present day character of the immediate coastline adjacent to the study area's marine zone. Features were identified if they were spatially adjacent to inter-tidal and marine zone, their primary function was associated with maritime/marine use (eg coastguards, harbours, ports etc) or they had secondary function associated with maritime use (eg landmarks etc).

Fifteen modern UKHO Admiralty charts (raster) were consulted and cross-referenced against the SeaZone Hydrospatial datasets. Any differences were noted and digitised as appropriate.

Features identified from different charts were then merged to form a single polygon layer which itself was merged with other datasets informing modern sea use.

The attribute table of the dataset comprises the following fields which can be queried and analysed by the user .

Alias	Type	Width
Shape,	FIELD_SHAPEPOLY,	8
Name,	FIELD_CHAR,	250
Site_type,	FIELD_CHAR,	50
Brdchrctr,	FIELD_CHAR,	250
Chrctr,	FIELD_CHAR,	250
Subchrctr,	FIELD_CHAR,	250
Period1,	FIELD_CHAR,	25
Source1,	FIELD_CHAR,	250
Scale,	FIELD_CHAR,	25

Topic Category : Environment, Imagery / Base Maps / Earth Cover, Oceans

Subject : Archaeology**,** Historic Landscape Characterisation**,** Marine Historic Environment

Dataset Language : English

Capture Start Date: 2006

Capture End Date: 2007

Dataset Reference Date: 2006-03-21

Frequency of Update : Not Planned

Geographic Co-ordinates : British National Grid W438291 E482630 N510260 S537537

Geographic Identifiers : HARTLEPOOL, MIDDLESBROUGH, NORTH YORKSHIRE

Access Constraints : English Heritage Copyright, English Heritage Intellectual Property Rights

Use Constraint : English Heritage Copyright, English Heritage Intellectual Property Rights

Presentation Types : Map Digital

Spatial Representation Type : Vector

Supply Media : CD, DVD

Data Format : ESRI shapefile

Feature Type : polygons

Number Of Features : 1777

Size : 2.3mb

Spatial Reference System : National Grid of Great Britain

Additional Information Sources : See accompanying reports:

'England's Historic Seascapes: Scarborough to Hartlepool and Adjacent Marine Zone Historic Seascape Characterisation Method' by Bryn Tapper, Megan Val Baker, Charles Johns and Peter Herring, 2007. Report No: 2007R022.

and

'England's Historic Seascapes: Scarborough to Hartlepool and Adjacent Marine Types Historic Seascape Characterisation' by Megan Val Baker, Bryn Tapper, Charles Johns and Peter Herring, 2007. Report No: 2007R021.

Distributor :

National Monument Record,
English Heritage

8.3.5 Character Area dataset

Filename: *scarborough_hartlepool_hsc_character_areas.shp*

Title : Scarborough to Hartlepool Historic Seascape Characterisation

Alternative Titles : Seascapes: Hartlepool to Scarborough Historic Seascape Character Pilot project

Originators : Historic Environment Service, Cornwall County Council (for English Heritage)

Abstract :

Character Areas are unique areas of historic character familiar or recognisable to people of the area. They are not generated through the characterisation process and so any area may combine a number and variety of HSC Character Types. It is partly because of this more top-down derivation, that the descriptive and interpretative characterisation text has been attached to the Types rather than the areas. However, it is to the areas that has been attached some material that reflects perception and human responses to the seascape.

The attribute table of the dataset comprises the following fields which can be queried and analysed by the user .

Alias	Type	Width
Shape,	FIELD_SHAPEPOLY,	8
Name,	FIELD_CHAR,	50

Topic Category : Environment, Imagery / Base Maps / Earth Cover, Oceans

Subject : Archaeology**,** Historic Landscape Characterisation**,** Marine Historic Environment

Dataset Language : English

Capture Start Date: 2006

Capture End Date: 2007

Dataset Reference Date: 2006-03-21

Frequency of Update : Not Planned

Geographic Co-ordinates : British National Grid W437382 E482630 N735250 S654500

Geographic Identifiers : HARTLEPOOL, MIDDLESBROUGH, NORTH YORKSHIRE

Access Constraints : English Heritage Copyright, English Heritage Intellectual Property Rights

Use Constraint : English Heritage Copyright, English Heritage Intellectual Property Rights

Presentation Types : Map Digital

Spatial Representation Type : Vector

Supply Media : CD, DVD

Data Format : ESRI shapefile

Feature Type : polygons

Number Of Features : 11

Size : 161kb

Spatial Reference System : National Grid of Great Britain

Additional Information Sources : See accompanying reports:

'England's Historic Seascapes: Scarborough to Hartlepool and Adjacent Marine Zone Historic Seascape Characterisation Method' by Bryn Tapper, Megan Val Baker, Charles Johns and Peter Herring, 2007. Report No: 2007R022.

and

'England's Historic Seascapes: Scarborough to Hartlepool and Adjacent Marine Types Historic Seascape Characterisation' by Megan Val Baker, Bryn Tapper, Charles Johns and Peter Herring, 2007. Report No: 2007R021.

Distributor :

National Monument Record,
English Heritage

8.4 Appendix 3: Glossary

For more ArcGIS terminology go to the ESRI dictionary webpage at: http://support.esri.com/index.cfm?fa=knowledgebase.gisDictionary.gateway.

Attribute: Information about a geographic feature in a GIS, usually stored in a table and linked to the feature by a unique identifier. For example, attributes of a river might include its name, length, and average depth. In raster datasets, information associated with each unique value of raster cells. Cartographic information that specifies how features are displayed and labelled on a map; the cartographic attributes of a river might include line thickness, line length, colour, and font

Attribute query: A request that selects features or records from a database containing information about a geographic feature in a GIS, generally stored in a table and linked to the feature by a unique identifier

Attribute table: A database or tabular file containing information about a set of geographic features, usually arranged so that each row represents a feature and each column represents one feature attribute. In raster datasets, each row of an attribute table corresponds to a certain zone of cells having the same value. In a GIS, attribute tables are often joined or related to spatial data layers, and the attribute values they contain can be used to find, query, and symbolize features or raster cells.

Bathymetry: The science of measuring and charting the depths of water bodies to determine the topography of a lake bed, seafloor, or ocean bottom

Bedforms: Features on the seabed (e.g. sandwaves, ripples) resulting from the movement of sediment over it, from seabed erosion, from deposition of stable sediment

Cell: The smallest unit of information in (usually raster) dataset, usually square in shape. In a map or GIS dataset, each cell represents a portion of the earth, such as a square meter or square mile, and usually has an attribute value associated with it, such as soil type or vegetation class.

Cleaning: Improving the appearance of scanned or digitized data by correcting overshoots and undershoots, making lines thicker or thinner, closing polygons, and so forth.

Coordinate system: A reference system used to measure horizontal and vertical distances on a planimetric map. A coordinate system is usually defined by a map projection, spheroid of reference, a datum, one or more standard parallels, a central meridian, and possible shifts in the x- and y- directions to locate x,y positions of point, line and area features An item in ArcCatalog representing a projection file, which contains the param defining a coordinate system. The contents of the projection file can either be in the format defined by ArcWorkstation or in the format defined by ArcCatalog

Database: One or more structured sets of persistent data, managed and stored as a unit and generally associated with software to update and query the data. A simple database might be a single file with many records, each of which references the same set of fields. A GIS database includes data about the spatial locations and shapes of geographic features recorded as points, lines, areas, pixels, grid cells, or TINs, as well as their attributes

Data standard: Data standard allows you to describe your digital assets with consistency as well as establishing the use of a common terminology that can be readable both by people and machines.

Datum: In the most general sense, any set of numeric or geometric constants from which

other quantities, such as coordinate systems, can be defined. A datum defines a reference surface. There are many types of datums, but most fall into two categories: horizontal and vertical.

Dissolve: A geoprocessing command that removes boundaries between adjacent polygons that have the same value for a specified attribute. Removing unnecessary boundaries between features after data has been captured, such as the edges of adjacent map sheets.

Feature: A representation of a real-world object on a map. Features can be represented in a GIS as vector data (points, lines, or polygons) or as cells in a raster data format. To be displayed in a GIS, features must have geometry and locational information. A group of spatial elements that together represent a real-world entity. A complex feature is made up of more than one group of spatial elements: for example, a set of line elements with the common theme of roads representing a road network.

Field: A column in a table that stores the values for a single attribute

Geodatabase: A collection of geographic datasets for use by ArcGIS. There are various types of geographic datasets, including feature classes, attribute tables, raster datasets, network datasets, topologies, and many others

Geoprocessing: A GIS operation used to manipulate GIS data. A typical geoprocessing operation takes an input dataset, performs an operation on that dataset, and returns the result of the operation as an output dataset. Common geoprocessing operations include geographic feature overlay, feature selection and analysis, topology processing, raster processing, and data conversion. Geoprocessing allows for definition, management, and analysis of information used to form decisions.

Georeferencing: Aligning geographic data to a known coordinate system so it can be viewed, queried, and analyzed with other geographic data. Georeferencing may involve shifting, rotating, scaling, skewing, and in some cases warping or rubber sheeting the data

Grid: In cartography, any network of parallel and perpendicular lines superimposed on a map and used for reference.

HTML: Hypertext markup language. An HTML file contains text and tags instructing an Internet browser application on how to present the text

Layer: The visual representation of a geographic dataset in any digital map environment. Conceptually, a layer is a slice or stratum of the geographic reality in a particular area, and is more or less equivalent to a legend item on a paper map. On a road map, for example, roads, national parks, political boundaries and rivers are examples of different layers. In ArcGIS, a reference to a data source, such as a coverage, geodatabase feature class, raster, and so on, that defines how the data should be symbolized on a map. Layers can also define additional properties, such as which features from the data source are included. Layers can be stored in map documents (.mxd) or saved individually as layer files (.lyr). Layers are conceptually similar to themes in ArcView 3.x

Mean sea level: The average height of the surface of the sea for all stages of the tide over a nineteenyear period, usually determined by averaging hourly height readings from a fixed level of reference

Merging: Combining input features from multiple input data sources of the same data type into a single, new, output feature class

Metadata: Information that describes the content, quality, condition, origin, and other characteristics of data or other pieces of information. Metadata for spatial data may document its subject matter; how, when, where, and by whom the data was collected;

availability and distribution information; its projection, scale, resolution, and accuracy; and its reliability with regard to some standard. Metadata consists of properties and documentation. Properties are derived from the data source (for example, the coordinate system and projection of the data), while documentation is entered by a person (for example, keywords used to describe the data).

Morphology: The structure, form and arrangement of rocks in relation to the development of landforms

Point: A geometric element defined by a pair of x,y coordinates

Polygon: On a map, a closed shape defined by a connected sequence of x,y coordinate pairs, where the first and last coordinate pair are the same and all other pairs are unique

Polyline: In ArcGIS software, a shape defined by one or more paths, where a path is a series of connected segments. If a polyline has more than one path (a multipart polyline) the paths may either branch or be discontinuous

Projected coordinate system: A reference system used to locate x, y, and z positions of point, line, and area features in two or three dimensions. A projected coordinate system is defined by a geographic coordinate system, a map projection, any param needed by the map projection, and a linear unit of measure

Projection: A method by which the curved surface of the earth is portrayed on a flat surface. This generally requires a systematic mathematical transformation of the earth's graticule of lines of longitude and latitude onto a plane. It can be visualized as a transparent globe with a light bulb at its centre casting lines of latitude and longitude onto a sheet of paper. Generally, the paper is either flat and placed tangent to the globe (a planar or azimuthal projection) or formed into a cone or cylinder and placed over the globe (cylindrical and conical projections). Every map projection distorts distance, area, shape, direction, or some combination thereof

Query: A request that selects features or records from a database. A query is often written as a statement or logical expression

Raster: A spatial data model that defines space as an array of equally sized cells arranged in rows and columns (e.g. images in .TIFF, .JPG, .GIF, .BMP and .PNG file extensions). Each cell contains an attribute value and location coordinates. Unlike a vector structure, which stores coordinates explicitly, raster coordinates are contained in the ordering of the matrix. Groups of cells that share the same value represent the same type of geographic feature.

Shapefile: A vector data storage format for storing the location, shape, and attributes of geographic features. A shapefile is stored in a set of related files and contains one feature class

Spatial Join: A type of table join operation in which fields from one layer's attribute table are appended to another layer's attribute table based on the relative locations of the features in the two layers.

Topology: In geodatabases, the arrangement that constrains how point, line, and polygon features share geometry. For example, street centerlines and census blocks share geometry, and adjacent soil polygons share geometry. Topology defines and enforces data integrity rules (for example, there should be no gaps between polygons). It supports topological relationship queries and navigation (for example, navigating feature adjacency or connectivity), supports sophisticated editing tools, and allows feature construction from unstructured geometry (for example, constructing polygons from lines)

Vector: A coordinate-based data model that represents geographic features as points, lines, and polygons. Each point feature is represented as a single coordinate pair, while line and polygon features are represented as ordered lists of vertices. Attributes are associated with each feature, as opposed to a raster data model, which associates attributes with grid cells.

Union: A topological overlay of two or more polygon spatial datasets that preserves the features that fall within the spatial extent of either input dataset; that is, all features from both datasets are retained and extracted into a new polygon dataset

XML: Acronym for Extensible Markup Language. Developed by the World Wide Web Consortium (W3C), XML is a standardized general purpose markup language for designing text formats that facilitates the interchange of data between computer applications. XML is a set of rules for creating standard information formats using customized tags and sharing both the format and the data across applications.