Biotope survey of the littoral sediments of the North Norfolk Coast Candidate SAC

ENGLISH NATURE

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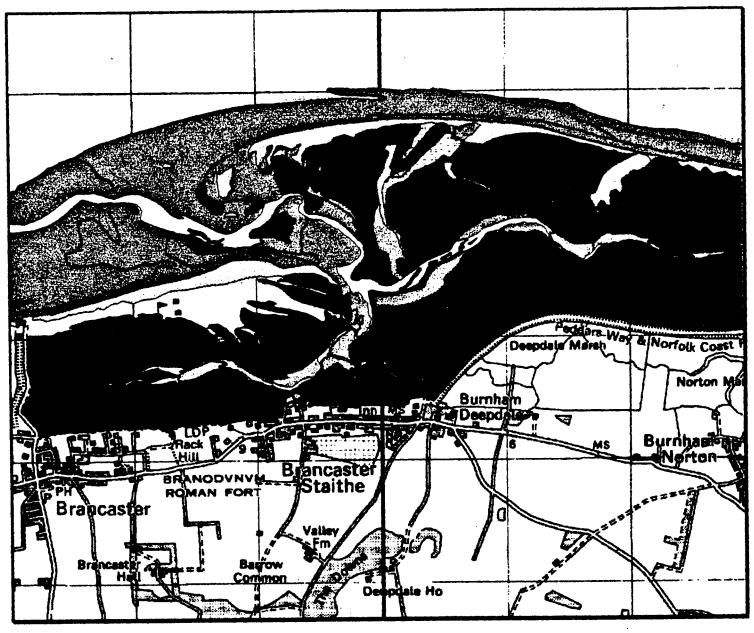
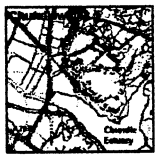
February 1998



A report to English Nature
by
James Perrins and Francis Bunker

marine_seen
environmental survey and images



exeGesIS
Spatial Data Management

Synopsis

- English Nature commissioned marine_seen and exeGesIS SDM to carry out a survey of the north Norfolk coast between Thornham TF727444 and Cley TG040455. The survey was carried out in order to provide information to facilitate the management for this section of the Wash and North Norfolk Coast candidate Special Area of Conservation (cSAC). The main objective of the survey was to gather data to enable the compilation of baseline maps to help in the future management and monitoring of the cSAC. The plan was that the maps produced would provide a spatial context against which previous and future detailed sampling could be overlaid.

- The survey was carried out at the Phase 1 level using adaptations of the methodology defined in the "Handbook for Marine Intertidal Phase 1 and SSSI Habitat mapping" by A. Richards, F. Bunker and R. Foster-Smith (1996) and Phase 1 Littoral Biotope Mapping by Foster-Smith, R.L. & Bunker, F.St.P.D (1997). Biotopes were identified according to the "Marine Biotope Classification for Britain and Ireland" (version 97.06) by Connor *et al.* (1997)

- Good quality colour aerial photographs provided by NERC as part of the LOIS project formed the basis of the survey mapping. These were corrected using software and techniques designed by exeGesIS SDM. The emphasis on data collection and manipulation was designed around direct transcription from field notes to PC's and storage on a Geographical Information System (GIS). The data and the maps produced in this report are outputs from the GIS.

- The report is based on data outputs from the GIS and includes biotope complex maps, biotope map and life form maps. These maps cover 64,750.267 km^2 of littoral biotopes. Information on biotopes is presented by geo-referenced target notes.

- The report discusses the main attributes shown by the different maps. Also discussed are the accuracy and limitations of the maps, features and observations of interest and comparisons with previous work.

- A series of recommendations for future work are given.

Reference for this report:

Perrins, J.M. and Bunker F.StP.D (1998). A survey of the Littoral Sediments of the north Norfolk coast. A report to English Nature from marine_seen and exeGesIS SDM.

Perrins, J.M. - exeGesIS SDM, Great House Barn, Talgarth, Powys, LD3 0AH
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1. Introduction

The Wash & north Norfolk coast has been submitted as a candidate marine Special Area of Conservation (cSAC) under the 1992 EC Habitats Directive. This report presents the findings of a survey of the littoral sediments of the north Norfolk coast undertaken under contract to English Nature. The following description has been derived from the *"The Habitats Directive: selection of Special Areas of Conservation in the UK"* by A.E. Brown, A.J. Burn, J.J. Hopkins and S.F. Way (1997).

The Wash and north Norfolk coast maritime site is one of the most important marine areas on the British and European North Sea coast. It is primarily comprised of extensive areas of sand and mudflats, ranging from estuarine to fully marine conditions and from sheltered conditions in the west of the Wash to wave exposed conditions on the north Norfolk Coast. The intertidal mudflats and sandflats are one of the Annex habitats, under the Directive, for which the Norfolk Coast has been selected.

This present survey concentrates on the section of the cSAC known as the north Norfolk coast. The westward limit of the survey area was Thornham TF727444 and the eastern limit was Cley TG040455. The north Norfolk coast includes the only classic British example of a barrier beach system. This encloses an area of estuarine communities including "estuarine" creeks and sand and mud flats, as well as an actively developing shingle spit and barrier island. The open coast is characterised by large areas of clean mobile sand subject to fully marine conditions. Communities here vary from typical estuarine examples characterised by the bivalve *Scrobicularia plana* (peppery furrow shell), to lugworm dominated muddier sand in the lee of islands and spits to a sparse infauna in more exposed areas. The cSAC is also important for breeding and moulting of one of Europe's largest populations of common seal *Phoca vitulina*, with currently about 2,000^{+} animals, 8% of the UK population.

The cSAC also includes the saltmarshes which are considered to be one of the best in the United Kingdom. More than 10% of the United Kingdom resource of the European habitat of interest 'Glasswort and other annuals colonising mud and sand' occurs within the SAC.

Several saline lagoons are present along the coastline to be surveyed. These habitats are considered to be of high conservation value in both a European and a national context. Although saline lagoons were not part of the present survey (they are included in the adjoining Gibraltar Point and North Norfolk Coast Dunes and Lagoons cSAC), where these habitats were encountered, brief notes were taken.

1.1 Reasons for Undertaking the Survey

The reasons for undertaking the survey were defined as follows in the contract with English Nature:

Historically sampling of the intertidal zone has tended to concentrate on small stretches of the north Norfolk coastline or specific habitat types leading to the production of localised data and maps. To support the cSAC Scheme of Management there is a need to obtain standardised infaunal information of the intertidal zone and to produce baseline maps of the main sediment types, and their associated communities (together called biotopes), to act as the baseline for future management and monitoring of the cSAC. These baseline maps will also provide the spatial context against which previous and future detailed sampling can be overlaid. Baseline maps were produced for this stretch of coastline in 1996 by Posford Duvivier (Worley, A. and Adnitt C., 1996), based upon a literature review, but due to the quantity and quality of data available at the time English Nature wished to undertake further survey work to ground truth and verify these maps.

1.2 Survey Aims

The aims of the survey as defined by English Nature were as follows:

- To carry out a Phase 1 survey of the intertidal zone of the north Norfolk coast.
- To map the biological and physical diversity of the habitats and their location, extent and distribution by producing life form and biotope distribution maps.
- To provide the geographical information upon which more detailed Phase 2 survey could be targeted which could be used to obtain information on the frequency and abundance of communities and species.

2. Methodology

The contract specified that the methodolgoy used in this work should be based on that described in *"Handbook for Marine Intertidal Phase 1 and SSSI habitat mapping"* A. Richards, F. Bunker and R. Foster-Smith (1996), in conjunction with the *Marine biotope classification for Britain and Ireland. Volume 1. Littoral biotopes* Version 97.06 Connor *et al.*, 1997). The methodology was adapted slightly with agreement of the project officer to suit the particular area to be mapped. Some of the adaptations were based on *"Phase 1 Littoral Biotope Mapping"* Foster-Smith & Bunker, F.St.P.D (1997). These adaptations are detailed below.

The coast was divided up into a number of blocks, based mainly on physiographic features or sections of uniform life form composition. In addition, from a practical point of view, consideration was also given ensuring that the stretches of coast could be surveyed without having to waste time circumventing or crossing large estuaries.

Wire-framing was not generally used, as past experience has shown that this often complicates the issue as initial guesses of boundary extents have to be redrawn in the field, making the map overly complex to interpret. A preferred method is to use copies (often enlarged) of the aerial photographs directly in the field. This means that boundaries can be drawn where appropriate with reference to features actually occurring on the ground. It actually often takes less time to draw the boundary directly in the field than it does to correct a pre-drawn wire frame. In addition, it prevents incorrect wire frames being drawn before hand (e.g. showing wet and dry sand, or perhaps an area which is in shadow) as these can immediately be recognised when actually in the field.

The area being surveyed consisted of an extremely wide and often featureless intertidal zone (up to 4km in places), potentially making field mapping difficult. In order to avoid this problem, corrected aerial photographs were used in conjunction with handheld GPS units. This enabled the surveyors to identify immediately which part of the aerial photograph they were currently ground truthing - a task which sounds easy, but in large uniform featureless areas would have proved virtually impossible any other way.

2.1 Corrected Aerial Photography

Aerial photography was obtained from the NERC LOIS project (colour photographs flown at low tide in 1995 at 1:20,000 scale) and also from the Environment Agency (1:5,000 scale black and white). Ideally, 1:10000 colour photography would have been used, but this was not available, so enlarged 1:20,000 scale photography was used instead. Black and white photography does not generally allow sufficient distinctions to be drawn between the different biotopes.

The aerial photographs were scanned at about 300dpi using full colour onto a PC. This allowed:

- Low cost copies to made for field use (using a high quality inkjet printer)
- Selected areas which could be identified as being complex could be enlarged to 1:5,000 scale or even larger to allow for maximum clarity in the field.
- the photographs to be corrected for use on a GIS system.

The aerial photographs were corrected using a software package called OrthoPhoto developed by exeGesIS SDM. This allows aerial photographs to be fully ortho-rectified to remove a variety of errors such as:

- The camera not pointing directly downwards at the moment the picture was taken resulting in a change of scale across the photograph (a square on the ground might appear a trapezium).
- Hill tops are close to the camera than the bottom of valleys and so are captured at a larger scale (i.e. scale varies across the photograph).
- Land of different heights at the same distance from the centre of the photograph are displaced away from the photo centre to different degrees (commonly called relief displacement)

All these factors mean that aerial photography can not be used without correction directly to produce accurate boundaries.

Given the nature of the north Norfolk coast, English Nature opted not to use the full ortho-rectification process (which includes the use of a grid of spot heights - often called a digital terrain mode or DTM). This will have resulted in the corrected aerial photographs not being as accurate as they could be, but due to the fact that the north Norfolk coast is extremely flat, these errors are not likely to be too large.

The corrected aerial photographs could be used as basemaps within a GIS package, on this occasion MapInfo. This allowed:

- All the aerial photographs to be tiled together so that a section of the coast could be viewed and printed out without any problems with it being half on one photo and half on another.
- Stretches of coast could be printed out at an exact scale.
- Maps for use in the field could be prepared with the Ordnance Survey gridlines printed on top of the aerial photographs at whatever scale was appropriate. This proved essential in the field, as it enabled the surveyors, with the aid of a GPS, to always know exactly which part of the aerial photograph they were currently ground truthing (see Figure 1).
- When the polygons were being entered onto the PC, the corrected aerial photographs could be used as the basemap, and the boundaries accurately traced using the boundaries that were gained from field ground truthing.

Figure 1- Portion of corrected aerial photograph with OS grid superimposed.

Ordnance survey raster data at scaled of 1:10,000 and 1:50,000 were also used within the GIS. The 1:10,000 data provided the basis for the ground control points to correct the aerial photography.

2.2 Field Survey

2.2.1 Area surveyed

The area surveyed was the stretch of the north Norfolk coast (candidate SAC) between Brancaster (TF770452) and Cley (TG040455). In addition, following a request from Helen Vine, a 3km stretch of coast West of Brancaster to Thornham was also surveyed to fill what would otherwise have been a gap of unmapped coastline (See Figure 2 - Map showing area of north Norfolk coast surveyed).

2.2.2 Logistics

The survey was performed over 6 days (10^{th} to 16^{th} January 1998) based around a set of spring tides. The survey team consisted of 4 people (Francis Bunker, James Perrins, Dale Rostron and Helen Vine (EN) with assistance on one day from Paul Gilliland (EN)).

Two teams of two surveyors were used, both from a practical and from a safety point of view. The team made use of a 4.5m inflatable boat ("Plankton") which was necessary for access to some of the shores, and also a useful safety feature in case of being caught by incoming tides. A boat with extremely shallow draught is necessary due to the large expanses of sand flat in the area.

On most days, one pair would work from the boat, sampling the lower shore and less accessible areas, whilst the second team would be dropped off by the boat and would survey sites where boat access was difficult, rendezvousing with the boat later in the day. This combined approach worked well allowing us access to virtually any part of the coast. The boat also worked with the ebbing tide, enabling access and crossing of some of the deeper and more inaccessible creek systems which would have been difficult or dangerous on foot.

2.2.3 GPS

Both teams had hand held GPS units. These were not differential GPS units so could not be relied upon to give position readings much more accurate than +/- 60m However given the flat nature of the landscape, the handheld GPS units had a reliably clear "view" of the sky and so generally always had a very good signal from a large number of satellites giving a better than average fix. It was agreed with English Nature that differential GPS was not appropriate for this type of survey as the additional accuracy given by differential GPS would have made very little difference for this scale of mapping.

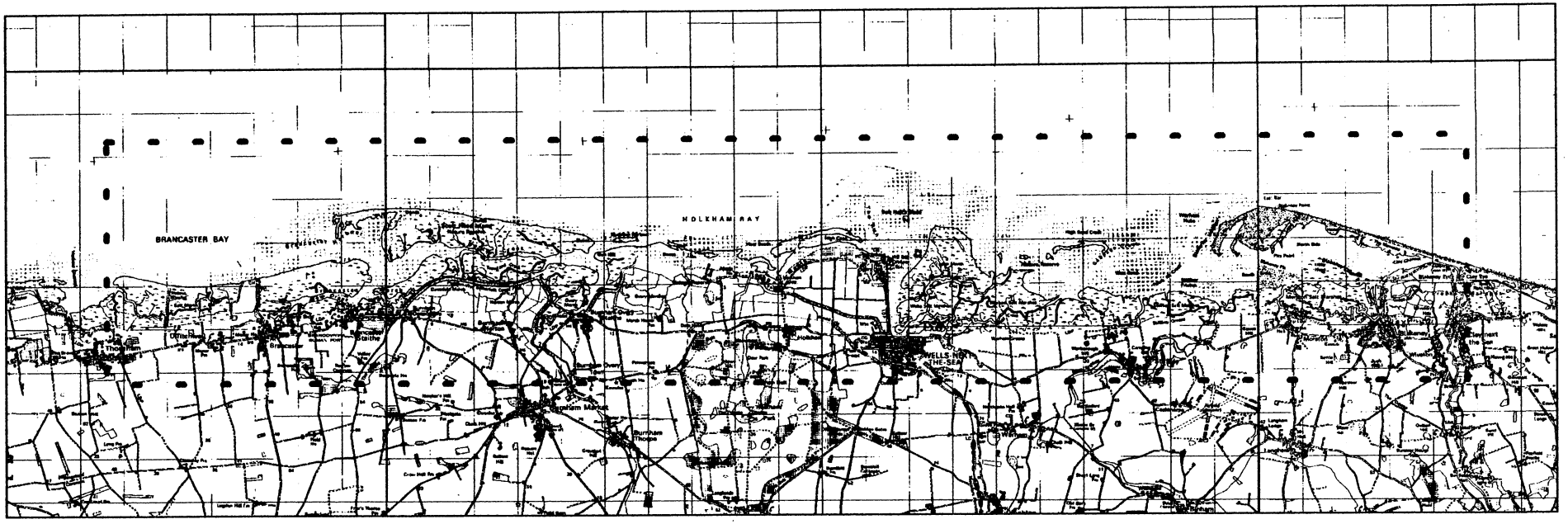

Figure 2 - Map showing area of north Norfolk coast surveyed

2.2.4 Collecting Field data

Whilst in the field, surveyors attempted to ground truth every identifiable polygon from the aerial photographs, identifying these to biotope level. Sometimes these would turn out to be an artefact (i.e. shadow or standing water or wet sand) rather than a real difference, and on other occasions distinctions could be seen in the field that failed to show up on the aerial photographs.

Boundaries were drawn on the aerial photographs and biotopes recorded. The ability to take the aerial photographs in the field with the OS gridlines superimposed proved to be essential - due to the featureless nature of the shore, the surveying would have been virtually impossible and certainly a lot less accurate without this.

The surveyors on foot left the GPS logging their track so that the exact course covered could be identified. In addition numerous waypoints were taken wherever samples were noted or photographs taken. The waypoints from the GPS were also plotted directly in the aerial photograph as this aided in the drawing up of boundaries and was a security measure in the unlikely event that the GPS malfunctioned and lost the waypoints.

These formed the basis of:

- a series of geo-referenced target notes for many of the polygons
- a geo-referenced slide set, including the direction of the slide

Target notes included:

- the biotope present at the location
- any notable species identified
- notes on the substrate
- any additional notes

2.2.5 Identification of biotopes

Biotopes were recognised in the field using the MNCR manual. For sediment areas, infaunal organisms were identified by sieving sediment samples and identifying organisms in a white tray with the aid of a hand lens when necessary.

On occasion, samples were brought back for identification in the lab. This included individual organisms for examination and occasional mud samples for more detailed examination.

2.2.6 Writing up field data

As much as possible of the field data was written up in the evening following a days surveying. This is definitely the preferred option as it still fresh in the surveyors minds, and any discrepancies can easily be resolved at this point.

The waypoints and tracks were downloaded from the GPS and plotted onto the GIS to check that they were correct (one GPS allowed for direct download, the other had to be manually transcribed - the ability to directly download saved a considerable amount of effort every evening - and removed the possibility of any transcribing errors).

The target notes were written up directly onto PCs. Site and survey forms were completed.

The polygon boundaries identified in the field and drawn onto the copies of the aerial photographs were drawn directly onto the computer using the corrected aerial photography as a basemap to trace from. This methodology allowed for maximum accuracy of boundary placement, and the fact that it was done immediately following the collection of the field data meant that the site was still fresh in the surveyors mind when it came to transcribing the field notes and polygon boundaries.

Due to time constraints, not all the boundaries could be entered onto the GIS the same evening, but all the difficult ones always were. For example, many of the saltmarsh boundaries, which can readily be seen from the aerial photographs and were outside the area surveyed by this contract, were left for digitising at a later date.

In general, the aim was to always to get as much data as possible directly written up the same day. This minimised transcription errors and allowed any problems to be resolved there and then, rather than several weeks later when trying to write up the report. It meant some additional work in the evenings, but not much more than doing a thorough job transcribing field data. With careful prioritisation, the more difficult elements of the data collected could always be written up directly.

3. Results

All the data that is discussed in this report is also supplied in digital format on the accompanying CD. It is anticipated that if additional detail is required on a specific area, the digital data may be a more appropriate source than the printed version.

3.1 Areas of each biotope surveyed

The table below gives the areas of each of the biotopes surveyed.

Biotope Complex	Biotope	Area (Square metres)
Littoral Gravels and Sands (LGS)	AEur	1093765
Littoral Gravels and Sands (LGS)	AP	256863
Littoral Gravels and Sands (LGS)	Ap.P	13834706
Littoral Gravels and Sands (LGS)	BarSh	3412917
Littoral Gravels and Sands (LGS)	BarSnd	8271750
Clircalittoral Muds (CMU)	Beg	7706
Sheltered Littoral Rock (SLR)	BLlit	78396
Sheltered Littoral Rock (SLR)	EphX	15374
Sheltered Littoral Rock (SLR)	FvesX	178993
Littoral Muds (LMU)	HedMac	967062
Littoral Muds (LMU)	HedMac.Are	2381861
Littoral Muds (LMU)	HedMac.Pyg	203738
Littoral Muds (LMU)	HedOl	406727
Littoral Muds (LMU)	HedScr	2742643
Littoral Gravels and Sands (LGS)	Lan	106529
Littoral Muddy Sands (LMS)	MacAre	1997676
Littoral Muddy Sands (LMS)	Mare	6991
Sheltered Littoral Rock (SLR)	MytX	458440
Littoral Gravels and Sands (LGS)	Ol	110198
Moderately Exposed Littoral Rock (MLR)	RPid	108416
Infralittoral Muddy Sands (IMS)	Rup	8168
Littoral Muds (LMU) *	Saltmarsh	23532856
Moderately Exposed Littoral Rock (MLR)	SwSed	4844
Littoral Muddy Sands (LMS)	ZNol	74501

* The saltmarsh area was not part of this survey - so this is an approximate area.

3.2 Target Notes

These are included as a printed version in the Appendices (Appendix - Target notes for North Norfolk SAC.) as well as on the CD.

On the printed version each target note is geo-referenced via a grid reference, but if extensive use is to be made of these it is strongly recommended that you use the electronic version.

3.3 Photographs

A set of slides is included with this report. A description of the slides along with a grid reference is included in the Appendices (Appendix - slide catalogue of North Norfolk SAC.), but again if extensive use of geo-referenced slides is to be made it is strongly recommended that you use the electronic version.

3.4 Map colouring schemes

3.4.1 Technical issues in producing maps

Printing of colour maps is a not entirely straight forward. The exact colour which is reproduced can be dependent upon a large number of factors such as:

- the model of printer you are using
- the version of printer drivers that you are using
- the screen drivers that are in use on your PC
- the resolution you print at
- the settings for your printer
- the quality of paper on which you print
- the ageing of ink

Initially RGB colour values were used as stated in the MNCR guidelines, but due to the factors listed above these had to be modified in order to get a reasonable colour match to the specified pantone colours.

In addition, when shading patterns are used, certain patterns can make a colour *appear* different - especially when a dense stippling is used. It was generally found that the dense shading patterns produced more reliable results, and the mixing of colours was to be avoided. All shading patterns were printed on a white background to hide the underlying OS map, as this appeared to hinder rather than improve clarity. Diagonal lines or waves were also generally found to reduce the overall impression of the final map and so were avoided.

Care was taken to try and ensure that the biotopes occupying smaller areas had the denser shading patterns so that they showed up most clearly. Whilst MapInfo has a wide range of shading patterns it was found that not all produced good reliable results for this type of map.

A considerable amount of effort was required to get colours that matched the MNCR specifications. Even changing the brand of paper used within the printer could produce significantly different colours.

3.4.2 Maps produced

Maps were printed at a scale of 1:50,000 showing three different colouring schemes, each of which were beneficial for highlighting different types of feature on the shore. At a scale of 1:50,000 there are two maps (an East and a West) for each colouring scheme to cover the whole extent of the shore line.

One of the major advantages of using a GIS system with properly structured data is that maps using any chosen colouring scheme can easily be generated. The maps included in this report use MapInfo's thematic mapping facility, and the statements which apply the colouring and shading patterns could be applied to any map produced, or modified to produce maps highlighting different features.

The three colouring schemes used are discussed below along with the advantages and disadvantages of each.

1. Solid colours representing the biotopes according to the MNCR colouring scheme (Connor *et. al.*, 1997). This provides a good overall impression of the biotope complexes present to a national standard. Inevitably it does mask some of the differences as all biotopes within a biotope complex appear the same. (Figure 4 and Figure 5)
2. Shading patterns using the MNCR colouring scheme (Connor *et. al.*, 1997). This allows the identification of individual biotopes on the map, and still uses the standard national colouring scheme. Choosing the shading patterns is a difficult task to produce an effective end result as shading patterns (even more than colours) are likely to reproduce differently on different printers. (Figure 6 and Figure 7)
3. Solid colours representing the life form colouring scheme (Richards *et. al*, 1996 - See Foster-Smith *et. al.*, 1997 for definition of life forms). This highlights different features from the MNCR scheme (for example it picks out the barren sand patches) but as with the solid MNCR colours it again masks some of the differences as all biotopes within a life form appear the same. (Figure 8 and Figure 9).

In addition an A1 poster was produced showing the whole coast at 1:50,000 and showing all three colouring schemes discussed above, along with a mosaic of the aerial photographs.

3.5 Digital map data supplied

All data is help in MapInfo files. These should be visible on any version of Mapinfo 4.x, but you may need MapInfo 4.5 in order to load some of the workspaces. Data associated with map objects are held in .DBF (dBase III) files rather than MapInfo's own .DAT files allowing easy access from most databases.

The sections below assume some basic familiarity with MapInfo.

3.5.1 Biotope polygons

This data is in \MAPDATA\NORFOLK\DATA\BIOTOPES.*. It is a layer of polygons showing the extents of areas mapped. Each polygon is tagged with a biotope code (field Biotope) allowing thematic maps to be easily produced. The colours displayed in this layer are simply used for ease of data entry. The data should be viewed via a thematic map layer.

3.5.2 Thematic map layers

There are 3 thematic map layers included in \MAPDATA\NORFOLK\WORKSPACES. These all have the .THM extension, but are in effect MapInfo workspaces. They should be opened using the MapInfo *File, Open Workspace* menu command when a map window containing the BIOTOPE layer as the top layer is active within MapInfo.

The table below shows which file gives which thematic map colouring scheme and also which file contains the related legend

File name	*Legend*	*Description*
Biotope_X.THM	Biotope_X_Key.*	Solid colours using standard MNCR colouring scheme. Shows biotope complexes.
Biotope.THM	Biotope_Key.*	Shaded patterns for each biotope using standard MNCR colouring scheme.
Lifeform.THM	Lifeform_Key.*	Solid colours using life form colouring scheme.

Once opened, the MapInfo thematic layer can be edited (for example to change colours or patterns) using the standard MapInfo tools. Alternatively a new colouring scheme could be devised from scratch.

NOTE: The colours specified in the \MAPDATA\NORFOLK\WORKSPACES are NOT the original MNCR RGB values as these were found to give unsuitable results on our printer. The original RGB values can be found in the \MAPDATA\NORFOLK\WORKSPACES\Original_Colours directory.

3.5.3 Tracks

There are two track files in the \MAPDATA\NORFOLK\DATA directory showing the routes surveyed by the two survey teams. These are:

TRACK_JP.*
TRACK_FB.*

There is a map in the appendices showing the tracks along with the target notes recorded.

3.5.4 Target Notes

These give all the details recorded at each location where are target note was taken.

They are in \MAPDATA\NORFOLK\DATA\TARGET.*. The associated data for each map object contains:

Field name	*Description*
TargetId	ID number for target
Date	Date or record
GridRef	Grid reference
RecordedBy	Recorders name
Biotope	Biotope code recorded at station
Species	Notable species recorded
Substrate	Notes on substrate
Notes	Any other notes

There is a map in the Appendices showing the location of all the target notes along with the tracks covered, and a table giving all the associated target note data.

3.5.5 Photographs

These give the locations of all the photographs taken during the survey.

These are in \MAPDATA\NORFOLK\DATA\SLIDES.*. The arrow symbol is rotated to show the direction in which the picture was taken.

The associated data for each map object contains:

Field name	***Description***
Id	ID number for slide - matches slide label
Date	Date or record
Photograph	Photographed by
Subject	Description of photo
Direction	Compass bearing in degrees
View	W(ide), N(ormal), C(loseup), M(acro)
Wpt	Original GPS wpt reference - redundant now.
SlideNum	Fuji slide number - redundant now
GridRef	Grid reference

There is a map in the Appendices showing the location of all the slides, and a table giving all the associated data.

3.5.6 Workspaces

All workspaces are in the \MAPDATA\NORFOLK\WORKSPACES directory. They should run either directly from the CD, or from the hard disk.

If data is copied to the hard disk, it is important that whichever drive it is place on, all the subdirectories in the \MAPDATA directory are also copied and that the \MAPDATA directory is a root directory (e.g. C:\MAPDATA)

If you already have a MAPDATA directory in the root of your hard disk, you can simply copy the \MAPDATA\NORFOLK directory from the CD.

All the workspaces below have one layout included in them which can be used for printing. They were designed to use an HP DesignJet 250C, so may need slight adjustment for other printers.

Workspace name	*Paper Layout*	*Description*
A1_Poster	A1 - Landscape	4 maps showing shading for Biotope complex, Biotopes, life forms and aerial photo mosaic (1:50,000)
A3_Biotope_E	A3 - Landscape	Shading showing Biotopes (1:50,000) Eastern end
A3_Biotope_W	A3 - Landscape	Shading showing Biotopes (1:50,000) Western end
A3_BiotopeX_E	A3 - Landscape	Shading showing Biotope complexes (1:50,000) Eastern end
A3_BiotopeX_W	A3 - Landscape	Shading showing Biotope complexes (1:50,000) Western end
A3_Lifeform_E	A3 - Landscape	Shading showing Life forms (1:50,000) Eastern end
A3_Lifeform_W	A3 - Landscape	Shading showing Life forms (1:50,000) Western end
Photos	A3 - Landscape	Map showing location of photographs (1:75,000)
Target_Tracks	A3 - Landscape	Map showing location of target notes and tracks surveyed (1:75,000)

3.6 Base map data

All the Ordnance Survey data used was supplied by English Nature under licence number GD272299

3.6.1 Ordnance Survey 1:50,000 rasters.

These are standard OS tiles and have been automatically registered using the file names. This ensures that there are no registration errors and there is no rotation on the map sheets.

All the maps are in \MAPDATA\NORFOLK\OS50K. They have been combined in a seamless layer \MAPDATA\NORFOLK\OS50K\OS50K.

3.6.2 Ordnance Survey 1:10,000 rasters.

These raster sheets have apparently come from a range of different sources (e.g. via Intergraph, scanned and manually cropped etc.). These have then been hand registered, so as a result, there are some slight registration errors. Some have been corrected for the maps included on the CD. Due to the varied sources (and hence slight differences in sizes) of the rasters, it will be very difficult to get completely accurate registration. Most of the time this does not matter, but on occasion when multiple map sheets are loaded together (as in a seamless layer) the slightly different rotations cause the display to be inaccurate.

All the maps are in \MAPDATA\NORFOLK\OS10KT. They have been combined in a seamless layer \MAPDATA\NORFOLK\OS50K\OS10KT.

3.6.3 Corrected Aerial photography.

The aerial photographs are corrected but not fully ortho-rectified (i.e. a digital terrain height model was not used). However due to the fairly uniform flat nature of the coast, the errors are not too bad. The use of corrected aerial photography was particularly valuable given the rapidly changing nature of the coast.

All the aerial photographs are in the \MAPDATA\NORFOLK\AP directory. They have been combined in a seamless layer \MAPDATA\NORFOLK\AP\AP. These images are saved as compressed TIFF files with 256 colours.

The scans of the original aerial photographs (before rectification) are stored in the \MAPDATA\NORFOLK\BACKUP\Original_photo_scans directory.

3.6.4 Additional files on the CD

Under the \MAPDATA\NORFOLK\BACKUP directory there are a few other files that were used during this project. They are simply included for completeness - in case additional work is required at some point in the future.

..\Original_photo_scans	Full colour scanned images of the aerial photographs before rectification.
..\OrthoPhoto grd files	Ground control registration files used for rectifying aerial photographs using OrthoPhoto™
..\HP Deskjet 250C prn	Print files for the maps produced for this report. These can be copied directly to an HP Deskjet 250C printer to produce additional copies (NOTE: They will not work on other printers !)

4. Discussion

4.1 Interpretation of the Maps

Three different maps have been compiled based on survey data, in order to highlight differing biological features along the north Norfolk coast. These show distributions of biotope complexes (Figure 6 and Figure 7), life forms (Figure 8 and Figure 9) and biotopes (Figure 4 and Figure 5).

4.1.1 Biotope complexes

In the hierarchical classification of Connor *et al.* (1997), biotope complexes are one level above the biotope unit and are defined as follows:

Biotope complexes are groups of biotopes with similar overall character, suitable for local mapping where biotopes consistently occur together and are relatively restricted in their extent. This is especially applicable to rocky shores and very nearshore subtidal rocky habitats, giving better units for management and for assessing sensitivity than the individual biotopes. They are relatively easy to identify, either by non-specialists or by coarser methods of survey (such as video or rapid shore surveys), thereby offering opportunities for data collection by a wide range of people and without recourse to specialist species identification skills.

The difficulty in reliably identifying MNCR sediment biotopes and their boundaries in the field is discussed in section 4.3 Definition of Boundaries. The boundaries on the map showing biotope complexes are not so prone to the inaccuracies inherent when mapping sediment biotopes.

The basis of the hierarchical classification given in Connor *et al.* (1997) is to arrange biotopes according to habitat type defined largely by zone, exposure to waves and tides and substratum type (or sediment grade). The biotope complexes map will tend to highlight distinctions in habitat and particularly sediment type. The barrier beach feature of the coast shows up well on these maps, as does the distinction between Littoral Muddy Sands and Littoral Muds. The colour scheme emphasises the sporadic occurrence of hard substrata (such as the muddy gravels colonised by *Mytilus* and the outcrops of fossilised peat off Brancaster) where they show up as splashes of green and blue.

4.1.2 Life Forms

Foster-Smith and Bunker (1997) include a framework for arranging MNCR biotopes and sub-biotopes and colour coding them according to Life Form. Life Forms are defined as follows:

Life forms are the conspicuous, morphological adaptations of organisms to their environment, particularly adaptations to trophic requirements, maintenance of their position in the physical milieu in which they live and avoidance of predation.

The life form map gives a different picture of the data to that presented by the biotope complexes map. The barren mobile nature of much of the open coast sediment is shown in contrast to the more stable biotopes encountered behind the barrier beach. The saltmarshes together with their creek systems are emphasised by this map, as are the *Mytilus* beds and outcrops of fossilised peat off Brancaster. The maps also clearly differentiates the *Zostera noltii* seagrass bed.

4.1.3 Biotopes

Each polygon defined during mapping survey has been labelled with a biotope code as defined by Connor *et al.* (1997). A biotope is defined as follows:

A biotope is the habitat (i.e. the environment's physical and chemical characteristics) together with its recurring associated community of species, operating together at a particular scale. The habitat is taken to encompass the substratum (rock, sediment or biotic reefs such as mussels) and the particular conditions of wave exposure, salinity, tidal streams and other factors which contribute to the overall nature of the location. The term community is used here to signify a similar association of species which regularly recurs in widely separated geological locations; the degree of similarity will vary, depending on the scale considered.

The biotope map gives information on the main distribution patterns of individual biotopes. It presents the maximum detail which can be derived from the current survey. The distribution of individual biotopes can be discerned from this map. Biotopes of interest and / or of limited distribution can be readily identified from the map (especially when viewed in electronic form).

4.2 Appraisal of methods

The maps and data produced as a result of this survey provide a good overall assessment of the distribution of biotopes along the north Norfolk coast. They also provide a useful tool to help in the planning of littoral monitoring strategies, as well as providing a basis for focusing any further survey work.

The broad brush approach used in mapping over 40 km^2 of coastline (excluding the saltmarsh) in 6 days has resulted in producing maps with certain limitations. It is important to recognise the limitations of the data when using the maps. The survey took place during spring tides and in exceptionally good weather conditions for January. The results were undoubtedly better than those that would have been obtained during poor weather conditions at any time of year.

4.3 Definition of Boundaries

The accuracy of the biotope boundaries on the maps depend on a variety of factors. Biotope categories grade into each other so there is no sharp dividing line between them. Defining polygons used a combination of information from a variety of sources, the main ones of which are summarised below:

- Interpretation of features on the aerial photographs (see Methods for the difficulties associated with this).
- Using (non differential) GPS to locate the positions of change on large featureless sediment plains.

- Digging and sieving the sediment occasionally to determine the biotope.

Due to the indistinct nature or sediment biotope boundaries, drawing the polygon boundaries is not an exact science and hence one of the main limitations regarding the accuracy of the map.

Much of mapping, has been achieved by extrapolation, Figure 10 shows the actual places visited during the survey. Time and budgetary considerations for the survey governed the amount of ground which was covered.

4.4 Temporal Changes

Sediments, particularly offshore sand bars, are a mobile environment and will change over time. This will have impacts on the accuracy of the maps produced both now and when planning future work. In this study, mapping was undertaken using aerial photographs taken in 1995. Whereas many of the features visible from photographs, such as raised sand bars and depressions were recognisable in the field, their exact nature and extent may have changed since the pictures were taken. Some sediment features e.g. exposed sand bars may appear and disappear in hours following storms. Changes to more sheltered areas will also occur, but more slowly. Dredging of river channels is a routine procedure in Wells. Evidence of recent dredging recorded during the survey was not visible on the 1995 aerial photographs. Mussel beds are managed ranching activities and so the exact extent and distribution of the mussel beds will change over time. Gross temporal changes have occurred since the OS maps were produced. Orthorecified 1995 aerial photographs overlain on OS maps have revealed changes to the river channels and creek systems (Figure 3). Ideally, biotope mapping should be undertaken using photographs taken immediately prior to the survey. This ideal scenario can rarely, if ever be achieved due to cost implications. Although the 1995 aerial photographs will give a good approximation of boundaries to the biotopes, limitations on accuracy due to changes over time must be considered.

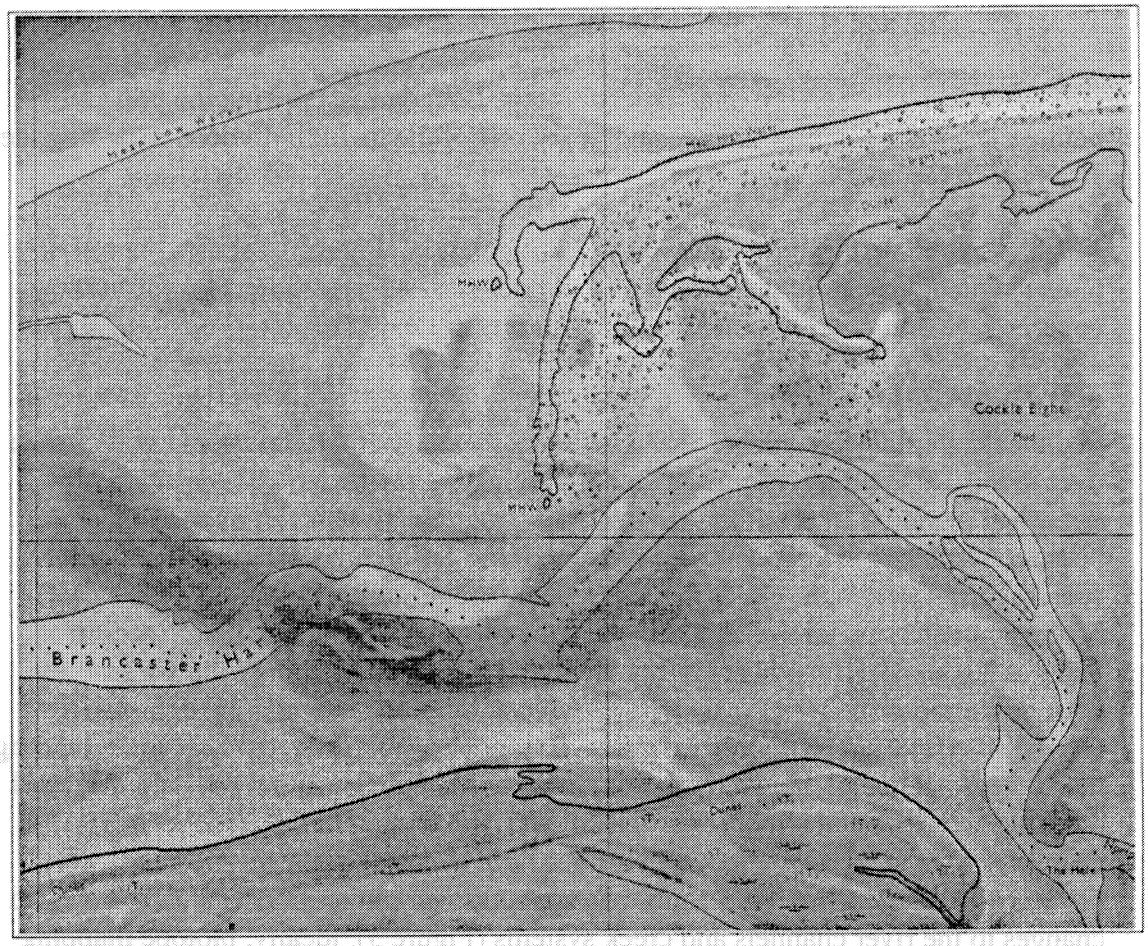

Figure 3 - Corrected aerial photograph with OS 1:10,000 map superimposed showing changes to Brancaster channel and Scolt head

Temporal change will effect the flora and fauna of sediment biotopes, seasonally and certainly in the longer term. An important example of this was in the mapping of the distribution of *Zostera*. A survey carried in 1997 (McCallum J.R. (1997)) showed there to be two areas with intertidal beds of *Zostera noltii*. During this survey, only one of these areas was located, north of Blakeney (Figure 5). A second area, described by McCallum J.R. (1997) was not located despite being traversed on foot. In January, *Zostera* spp. is very difficult to see as not only has it died back for the winter, but it is also grazed by the large flocks of Wigeon and Brent geese which frequent the area. The Blakeney *Zostera* spp .may have been easily overlooked by the field workers were it not for them stopping to take a sediment sample at that point. When closely examining the sediment, small plants of *Zostera* were noted. The plants would have been a lot more obvious had the survey been undertaken during the summer.

Many areas recorded as LGS.S.BarSnd had one or two polychaetes or crustacean present. It may well be that at certain times of the year, the fauna may increase and the barren sediment would be classed as AEur, AP or AP.P. This is an example of where time of year may affect the boundaries of biotopes.

The fossilised peat burrowed into by Piddocks is a biotope which may be covered and uncovered by sand over time. The aerial photograph of 1995 seems to suggest more extensive areas of piddock habitat than encountered during the present survey.

The saline lagoons which occur along the coast are an important feature of the SAC. These lagoons were recently surveyed by Bamber (1997) and data on the biotopes present and the extent of the lagoons has been obtained from this report. Determination of the extent of the Blakeney Spit lagoons from the aerial photographs was difficult. The boundaries of these lagoons should therefore not be considered as very accurate.

4.5 MNCR Biotopes

The field team's experience from this survey has emphasised that recognition of the MNCR sediment biotopes in the field can be difficult. On several occasions during this survey there was some doubt as to the classification of biotopes, so additional comments were recorded as target notes. 'Pigeon holing' biotopes encountered in the field into a classification scheme requires the judgement of an experienced field worker. Sediment biotopes are more difficult to recognise than most in the field as the categories are frequently based on species which are very small, difficult to find and when found, difficult to identify. This survey was carried out by very experienced field workers, but it was still necessary on occasion to map and label a biotope as a "best guess", especially the LMU.SMu and LMU.Mu biotopes containing *Hediste* (ie HedMac, HedScr etc) as these could contain *Hediste* and other associated species, but be missing the *Scrobicularia* or *Macoma* species.

Hiscock (1996) outlines the methodology for providing Phase 2 MNCR descriptions of sediment biotopes. The biotopes have been defined using species data obtained from combining the contents of several cores sieved using a 0.5mm mesh. The species present include small worms and crustaceans only easily seen when stained with eosin and sorted in a laboratory. Identification often involves high powered microscopy. It was beyond the scope of the present survey to identify biotopes using such a procedure. However, attention should be given to creating more well defined protocols regarding the recognition of MNCR biotopes in the field.

Bamber (1997) presents his own classification of biotopes for English saline lagoons and attempts to relate this to the MNCR classification. It is clear from this report that more development is needed of the MNCR classification to adequately cater for saline lagoons. The survey maps produced in this work are based on the MNCR classification. These lagoons are a major feature of interest in the SAC (Brown et al.; 1997) and reference should be made to Bamber (1997) for details.

4.6 Saltmarshes and Creeks

Although saltmarshes are an important and extensive component of the SAC, they were specifically excluded from the remit of the survey as they were being surveyed as part of a separate project. Despite this, it was felt essential to show the extent of the saltmarshes together with the major creek systems on the maps as they are an important component of the whole ecosystem. Only the major creek systems which could easily be seen from the aerial photographs have been included on the maps. It is difficult to determine from theses photographs the location of *Phragmites* beds which

fringe many of the saltmarsh creeks. Also the impacts on saltmarsh biotopes from human influence in terms of drainage and the damming is not easily determined. The exact boundaries of the saltmarshes as well as the extent of the creek systems on the maps are therefore only an approximation. It can be seen from the tracks given in Figure 10 that the large areas of saltmarsh to the east of Blackney and around Wells were not surveyed.

4.7 Features and Observations of Interest

The intertidal sandflats and mudflats of the north Norfolk coast are one of the main features for which the area has been proposed as an SAC under the European Habitats Directive and it is this feature which was the main focus of this survey. The north Norfolk coast is listed as the only classic example of a barrier beach system. Extensive areas of sand (LGS.S.BarSnd or LGS.S.AP.P), shingle (LGS.Sh.BarSh) and occasionally dune form a seaward barrier behind which more sheltered sand, mud and saltmarsh biotopes have developed. It is in these more sheltered areas that most of the features of biological interest were found (a notable exception being the piddocks in peat biotope, MLR.R.Rpid, off Brancaster beach). The main features of interest recorded in the survey are described below:

4.7.1 LGS.S.AP.P

This was the most extensive sediment biotope recorded during the survey. It occurred both along the open coast and right up into the innermost reaches of the main tide swept river channels. There must be much variation in the biological composition of this biotopes in different areas but the survey method did not really cater for detecting this. It was noted that the richest AP.P areas on the open coast seemed to coincide with lower shore sites favoured for feeding by wading birds such a Curlew and Dunlin. On a number of occasions recorders noted that these rich AP.P areas coincided with sandflats adjacent to river entrances. However there were also areas of barren mobile sand associated with river inlets, so the pattern was not straightforward.

4.7.2 LMS.Zos.Znol

A small bed of *Zostera noltii* occupying approximately 0.07 km^2 was located to the north of Brancaster. Another bed of *Zostera* spp. has been recorded in the past from the Wells area but not during the present survey (McCallum J.R. (1997)). The exact extent of *Zostera* spp. is difficult to determine in January and it is likely that it would be seen to be more extensive during summer months. Both *Zostera noltii* and *Z. angustifolia* have been recorded in the Blakeney and Wells areas, but *Zostera noltii* is the commoner of the two.

4.7.3 MLR.R.Rpid

The biotope of *Ceramium* sp. and piddocks on eulittoral fossilised peat (MLR.R.Rpid) in the MNCR National Classification comes mainly from the work of Hill and Emblow (in prep) and is based on a description from the Brancaster area. This biotope has been rarely recorded in Britain and known only from a handful of sites.

The best example of this biotope was found on the lower shore along the open coast by Brancaster (TF754452). It was obvious that this biotope is subject to being covered by shifting sands. On low lying outcrops, sand covered the peat with the only

dense *Lanice* giving away its presence. Dense *Mytilus edulis* beds formed on the outcrops, especially on the western end of the main outcrop.

4.7.4 Lagoons

Two potential saline lagoon habitats were recorded during the survey which were not described in Bamber (1997). These were both in the Brancaster area (TF753448 and TF740451). A detailed examination of the infauna of these lagoons was beyond the scope of the present survey, but due to the conservation importance of saline lagoons both regionally and nationally, they should be examined in more detail.

4.7.5 Common Seal

The common seal (*Phoca vitulina*) is a marine species of conservation importance and one of the reasons for the area being put forward as an SAC. Although not part of this survey it is worth mentioning that large colonies of common seals were recorded on the sandbanks at the mouth of the Blakeney River.

4.7.6 The Disused Sewage Pipe by Cabbage Creek

A disused sewage pipe terminates in a flooded basin in Cabbage Creek (opposite Stiffkey; TF971455). This site was notable for its rich fauna and flora, including *Mytilus* beds and rich muddy gravels. The area around the disused pipe is known as being an important bird feeding area (Micheal Rooney, Site Manager for Scolt Head pers. comm). This small area provided a great contrast to the relatively barren and extensive LGS.S.AP.P biotopes which surrounded it and is worthy of further study. Quite why this area should be so rich is not known. It is possible that the disused sewage pipe sets up some eddies during ebbing and flooding tides keeping the area free of sand. Whilst this may seem unlikely, there was no other obvious explanation as to why the area was not covered by the surrounding sand.

4.7.7 River Channels

Four main inlets were surveyed along the stretch of coast surveyed; The Bancaster Channel, Burnham Overy , The Wells Channel and the Blakeney Channel. Burnham Overy and Blakeney Channel were of particular interest due to the large number of biotopes found in a small area (Figure 4 and Figure 5).. Each of the main river channels had its own characteristics. The detail of these is best studied on the electronic maps, where details of biotopes can be examined. This is particularly true of biotopes occupying small areas which do not show up will on the 1:50000 maps.

Interesting environmental gradients occurred from the open sea to the inner reaches of the channels and similar patterns were noted for each inlet surveyed. Sheltered muddy channels feeding saltmarsh systems occurred at inlets head and these were generally characterised by the LMU.Smu.HedScr and sometimes LMU.Mu.HedOl. These channels were generally small and fed into the main river channels. Here, channel sides were often characterised by the biotope LMU.Smu.HedMac.Pyg. Sediments sometimes formed flats either side of the main channels with either or both the biotopes LMS.MS.MacAre and LMU.SMu.HedMac (especially in the Blakeney Channel). Sediment banks in the channel were frequently the more mobile LGS.S.AP.P. In some tide swept areas, mixed coarse sediments occurred with LGS.S.Lan.

Beds of *Mytilus edulis* (SLR.MX.MytX) were a chacteristic of tideswept areas of both the Brancaster Channel and the Blakeney River. Both Brancaster and Blakeney have "Several Orders" for the commercial ranching of mussels (Robin Gay, Eastern Sea Fisheries Joint Committee pers. comm) . Although *Mytilus edulis* occurs and seeds naturally in these areas, it can be assumed that the mussel beds at these particular sites are managed.

Patchy *Fucus vesiculosus* (SLR.FX.FvesX) also occurred on some mixed sediment areas of the main channels. Approaching the mouths of the inlets, two biotopes tended to dominate: LGS.S.AP.P and LGS.S.BarSnd. Where the sediments were unstable and regularly scoured by wave action and current over the tidal cycle, LGS.S.BarSnd was found. Surrounding these barren sands, rich more stable LGS.S.AP.P sediments were encountered. These were observed to be popular feeding sites for wading birds.

4.7.8 Erosion of Saltmarshes

Large areas of eroded marsh were present at a number of locations, notably in the Brancaster area (TF989445). Although saltmarsh was not the focus of the present survey, this observation may be of interest when devising monitoring schemes for the SAC as there will be implications to adjacent biotopes. As there is no Biotope for eroded marsh and as there was often some shingle associated, this habitat was defined as the barren shingle biotope LGS.S.BarSh with appropriate target notes.

4.7.9 Bait Digging

Bait digging was noted in a number of sites e.g. in the LMU.Smu.HedMac.Are biotope in the Brancaster area. This activity may be of interest when planning monitoring of the biotopes in the SAC.

4.7.10 Outcrops of Relict Muddy Sediments on the Open Coast

A feature of geological interest located on the open coast between Brancaster and Burnham Overy were outcrops of relict sediment habitats now consolidated as clay. These occurred at the base of the shingle slope leading up to the dunes. The clay was soft and imbedded in it were shells of bivalves, mainly *Scrobicularia plana* and *Cerastoderma edule*. In the recent past, the sandy beach presumably extended further northward with more extensive soft sediment and saltmarsh habitats occurring behind.

4.8 Comparison with Previous Work

The main emphasis of this work has been survey and mapping. It is beyond the scope of this report to undertake a thorough comparison of the results of this survey to previous data. Recent reviews of data relating to the cSAC have been carried out by Hill *et al.* (1996) and Worley and Adnitt (1996).

Comparison of the accuracy of the maps produced by the recent reviews and those from this report is not really valid. The maps given in this report have been produced by ground truthing features from aerial photographs. Those contained in Worley and Adnitt (1996) were produced as a result of a desk study, and those in Hill *et al* (1997) as the result of limited Phase 2 type surveys (Hiscock; 1996). However, it is worth commenting on some differences in the biotopes mapped during this survey and those recorded in the reviews.

Worley and Adnitt (1996) have mapped areas of sediment between Stiffkey and Blakeney as being characterised by biotopes containing the cockle *Cerastoderma edule* (LMU.SMu.HedMac.Are). Hill *et al* (1996) refers to the presence of *Cerastoderma* in both the Brancaster and Blakeney area from MNCR survyes. This report also mentions the commercial harvesting of cockles in the Brancaster, Holkham Bay, Wells and Blakeney areas. Although this survey located habitats suitable for cockles especially in the Blakeney area, only two or three live *Cerastoderma* were recorded despite intensive searching. However, many empty shells were located. Micheal Rooney (pers. comm.) tells of a decline in the cockle population in recent years.

Elsewhere in this discussion the unsuitability of January for the location and mapping of *Zostera* spp. was stated. Worley and Adnitt (1996) map the intertidal *Zostera* at Blakeney and Wells. Hill *et al* (1996) refers to the presence of intertidal *Zostera* at Brancaster. Micheal Rooney (pers. comm.) has informed the authors of unpublished work relating to Zostera at both Brancaster and Thornton. Also that the Brancaster *Zostera* has declined markedly since the 1950's.

Cerastoderma is of commercial interest as well as ecological importance to both sediment communities and wintering birds. Intertidal *Zostera* is generally uncommon and of conservation importance as well as being a food source for wintering Brent Geese and Wigeon. It would be useful therefore to carry out more thorough surveys of these species and monitor the populations in the cSAC.

5. Recommendations

- The maps produced by this survey are not directly suitable for monitoring. Remapping of the SAC in 5 to 10 years time may be a useful exercise which would give an indication of any gross changes that have occurred. Ideally mapping would use colour photographs taken at a scale of 1:10,000 rather than 1:20,000. The smaller scale photographs resulted in some details being obscured, meaning areas had to be marked on in the field. This was particularly true of small areas of biotopes such as *Lanice* beds on the edges of river channels, saltmarsh creeks and small lagoons.

- The present maps can be used to target areas for more detailed monitoring. If this monitoring involved determining changes in extent of biotopes eg *Zostera* spp. or Saltmarsh, then it is recommended that the boundaries be defined using differential GPS. This is only practical for the relatively few biotopes which have a clearly defined boundary. Another obvious target for monitoring would be the apparently declining cockle (*Cerastoderma edule*) population.

- It would be useful to design a standard set of protocols for the recognition of MNCR biotopes in the field. Maps such as those produced during this survey are potentially a very useful management tool. However, these maps could be improved if sediment biotopes could be recognised with a greater degree of accuracy.

- Revision of the MNCR biotope classification to cater for saline lagoon biotopes would be of benefit in order to highlight these features of special conservation interest.

- In order to gain a greater understanding of the biotopes and species present, useful work could be undertaken by doing Phase 2 descriptions (Hiscock, 1996) on most of the sediment biotopes found throughout the survey area. The maps produced in this report could be used to plan the survey strategy. Particular attention should be given to some of the biotopes outlined under section 4.7 Features and Observations of Interest.

- Time of year and seasonality should be considered when planning further survey work or monitoring. This is especially true of species such as *Zostera* spp. which should be surveyed in the summer.

- Monitoring in the SAC should include the detailed mapping of lagoon biotopes. Especially those in the Blakeney Spit area. Also the previously undescribed lagoon features recorded in the Brancaster area (see section 4.7 Features and Observations of Interest).

6. References

Bamber, R.N. (1997). Assessment of saline lagoons within Special Areas of Conservation. English Nature Research Report no. 235.

Brown, A.E., Burn, A.J., Hopkins, J.J. and Way, S.F. (1997). The Habitats Directive: selection of Special Areas of Conservation in the UK. JNCC Report No. 270.

Bunker, FSt.P.D and Foster-Smith, R.L (1996). Phase 1 Littoral Biotope Mapping: A Field Guide. Scottish Natural Heritage, Countryside Council for Wales and English Nature.

Connor, D.W., Brazier, D.P., Hill, T.O. & Northen, K.O. (1997). Marine Nature Conservation Review: Intertidal biotope manual. Version 97.06 Joint Nature Conservation Committee Report, 249pp.

Foster-Smith, R.L. and Bunker, F.St.P.D (1997). Phase 1 littoral biotope mapping: a methodology. Biomar, University of Newcastle Upon Tyne.

Hill, T.O., Emblow, C.S. and Northern, K. (1996). Marine Nature Conservation Review Sector 6. Inlets in eastern England biotope classification. *JNCC Report.*

Hiscock, K., ed. (1996). Marine Nature Conservation Review: rationale and methods (Summary Report). Peterborough, Joint Nature Conservation Committee. (Coast and seas of the United Kingdom, MNCR series).

McCallum J.R. (1997). Distribution of *Zostera* spp. on the north Norfolk coast between Wells Harbour and Blakeney Harbour. Unpublished English Nature Report.

Richards, A., Bunker, F. & Foster-Smith, R. (1996). Handbook for marine phase 1 survey and SSSI mapping. With contributions from G.Moffett, C.Uttley and T. Franks. Countryside Council for Wales, Bunker (Natural Science Report, No 95/6/1)

Worley, A. and Adnitt C. (1996) Mapping the intertidal habitat and species of selected Marine Special Areas of Conservation. A report to English Nature by Posford Duvivier Environment

7. Software

All the map production was done using MapInfo™ (© MapInfo corporation) desktop mapping GIS software.

The aerial photographs were corrected using OrthoPhoto™ (© exeGesIS SDM).

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9. Appendix - Target notes for North Norfolk SAC.

This information is contained in the Mapinfo layer called TARGET. Each target note has a point on the map layer and is associated with the data listed below which can be accessed from within MapInfo by using the Info tool. The data can also be accessed by displaying the contents of the TARGET.DBF dBase III file using any suitable software.

Species abundance has been indicated using the ACFOR scale when appropriate.

See Figure 10 - Map showing tracks taken by field workers and locations of target notes

Target Id	Date	GridRef	RecordedBy	Biotope	Species	Substrate	Notes
1	10/01/98	TF90824688	Dale Rostron	LGS.A.Eur	*Eurydice ?pulchra, Bathyporeia spp*	Rippled medium/coarse sand with a bit of gravel. No mud.	No polychaetes or bivalves in sample material.
2	10/01/98	TF90374700	Dale Rostron	LGS.AEur	*Bathyporeia spp, Eurydice pulchra, Scololepis squamata, Arenicola marina (R)*	Medium sand,damp, with a small amount of gravel present No mud.	
3	10/01/98	TF90114662	Dale Rostron	LGS.AP.P	*Scololepis squamata (F), Nephtys cirrosa, Urothoe spp, Sandy (spionid) tubes*	Medium/fine sand - soft ripples. Gravel present in small quantities.	Alongside a channel. No bivalves. Bird prints present.
4	10/01/98	TF89864628	Dale Rostron	LGS.AP.P	*Pygospio elegans (C), Scololepis squamata, Nephtys cirrosa, Arenicola marina, Cerastoderma edule (R)*	Soft, damp rippled sand.	No bivalves and no amphipods recorded. A few lugworm casts. (Spionid to be identified)
5	10/01/98	TF89824624	Dale Rostron	LGS.AP.P	*Arenicola marina (O), Lanice conchilega, Urothoe sp (check), Cumacean sp, Scololepis squamata, Nephtys sp*	Sand quite firm with a relatively high proportion of mud, but also signs of gravel layers deeper down.Anoxic layer present at ca 7cm.Lots of silty deposit on the surface. Slope of smooth sand with some gravel present. No anoxic layer	No spionid tubes. No cocklesThis is where water from the sandbank drains down and into the channel.
6	10/01/98	TF89294610	Dale Rostron	LGS.BarSnd			
7	10/01/98	TF88674600	Dale Rostron	LGS.AP	*Arenicola marina (R), Nephtys sp, Bathyporeia sp, Bathyporeia sp, Scololepis squamata, AMPHIPODA indet*	Run off creek. Rippled sand with medium amounts of silt debris. No obvious anoxic layer.	No bivalves or evidence of Pygospio elegans.

Target Id	Date	GridRef	RecordedBy	Biotope	Species	Substrate	Notes
8	10/01/98	TF87894591	Dale Rostron	LGS.AP	*Eteone longa, Scololepis squamata, AMPHIPODA indet*	Medium sand but without the organic debris of some other damp patches. No anoxic layer.	Wet patch in creek at western most end of survey area. No Arenicola or bivalves.
9	10/01/98	TF88634539	Dale Rostron	SM	*Salicornia, Enteromorpha*	Shallow lagoon with fine/medium sand and mud. Clay a few cm down.	Probably ephemeral. No evidence of Hediste diversicolor or Corophium. Gulls footprints.
10	10/01/98	TF88764533	Dale Rostron	LMS.PCer	*Arenicola marina, Cerastoderma edule (R), Pygospio elegans*	Saltmarsh creek/lagoon.Quite fine sediment, probably sandy mud. Anoxic layer a couple of cm down	Bird prints round the edge but no Corophium obvious.
11	10/01/98	TF90954594	Dale Rostron	LMS.HedMac.Are	*Arenicola marina (F), Hediste (burrows only), Pygospio elegans, Bathyporeia sp, Hydrobia ulvae, POLYCHAETA indet*	Well consolidated hard sediment Anoxic layer at varying depth and very black. Sand/mud mixture.	Rather estuarine creek on the upper shore surrounding bits of Spartina saltmarsh. Scrobicularia plana was present in (small) areas of deposited mud and Hydrobia ulvae was abundant in the salt marsh.
12	10/01/98	TF89834630	Dale Rostron	LGS.BarSnd	*Pygospio elegans (R)*	Dry medium sand with hardly any gravel and no mud.	Elevated dry sandbank on downtide side of creek.
13	10/01/98	TF90324716	Francis Bunker	LGS.AP.P	*Bathyporeia sp Nephts cirrosa*	Medium sand with some rippling. No black layer	Edge of sand bank near low water
14	10/01/98	TF90054704	Francis Bunker	LGS.AEUR	*Spiophanes bombyx Scololepis squamata Haustorius arenarius Bathyporeia sp Nephts cirrosa*	Medium rippled sand with sandy tubes of Spiophanes common. No black layer	Edge of sand bank near low water Few Nephtys No Arenicola
15	10/01/98	TF85644642	Francis Bunker	LGS.AP.P	*Nephts cirrosa Haustorius arenarius*	Slightly rippled medium sand, no tubes. No black layer	By low water. Strand line with hydroids and bryozoans characteristic of scour: Flustra, Sertularia cupressina, Alcyonidium diaphanum, Nemertesia antennina, Hydrallmania
16	10/01/98	TF86254622	Francis Bunker	LGS.AP.P	*Nephtys cirrosa Scololepis*	Slightly rippled medium sand, no tubes. No black layer	No amphipods
17	10/01/98	TF86264611	Francis Bunker	LGS.BarSnd	*Sphaeromatidae indet.*	Very rippled medium sand, no tubes. No black layer	Raised above lower shore. One Sphaeromatidae indet. found in 3 seived spadefuls.
18	10/01/98	TF86264610	Francis Bunker	LGS.AP.P	*Nephtys cirrosa Haustorius arenarius Arenicola marina*	Slightly rippled medium sand, no tubes. No black layer	Down at low level by banks of sandy inlet flooded by incoming tide.

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19	10/01/98	TF86264607	Francis Bunker	LGS.BarSnd	*Nephtys cirrosa*	Smooth medium sand. No black layer	Raised bank of sand in middle shore. One Nephtys found in 3 seived spadefuls
20	10/01/98	TF86264600	Francis Bunker	LGS.BarSnd		Rippled medium sand. No black layer	Slope of sand. No fauna.
21	10/01/98	TF87954584	Francis Bunker	LGS.AP.P	*Haustorium arearius Etone ?longa Spiophanes bombyx*	Smooth medium sand	By incoming tide
22	10/01/98	TF87954573	Francis Bunker	LGS.BarSnd		Smooth medium sand	
23	10/01/98	TF87884584	Francis Bunker	LGS.BarSnd		Smooth medium sand.	Vast plain of sand in MS
24	10/01/98	TF87824562	Francis Bunker	LGS.BarSnd		Coarse gravel and some sand by dunes	Berm in front of dunes
25	10/01/98	TF86274601	Francis Bunker	LGS.BarSnd	*Spiophanes bombyx*	Rippled medium sand. No black layer	At position of MHWS strandline. One worm found in 3 seived spadefuls.
26	10/01/98	TF86274596	Francis Bunker	LGS.BarSnd		50% sand, 50% gravel	Berm in front of dunes
27	11/01/98	TF91584630	Dale Rostron	LGS.ShBar Sh		Mobile shingle and thin veneer of sand with bright red clay deposits protruding. Anoxic layer present at 2-3cm on sand patches,	No fauna observed (small sample)
28	11/01/98	TF91864646	Dale Rostron	LMU.Hed MacAre	*Corophium sp, Arenicola marina (F), Pygospio elegans (C), Hydrobia ulvae, Hediste diversicolor, AMPHIPODA indet*	Area of muddy sand sheltered behind a shingle bank. Sediment surface flat without any ripples.	Birds feeding
29	11/01/98	TF92394687	Dale Rostron	LGS.Snd.AP.P	*Arenicola marina, Pygospio elegans, Bathyporeia sp, Eteone longa, ?Spiophanes*	Sand ripples - medium sand with gravel. No apparent anoxic layer.	
30	11/01/98	TF92764724	Dale Rostron	LGS.SBar Snd	*POLYCHAETA indet*	Dry sand bank by a creek. Medium to coarse sand with almost no gravel present. Mobile.	
31	11/01/98	TF94274644	Dale Rostron	LMU.SMUHed Mac	*Cerastoderma edule, Pygospio elegans, Arenicola marina (O)*	Flat muddy sand with surface deposit of silt material. Lots of flint gravel beneath. No anoxic layer apparent.	Standing water. Waders feeding
32	11/01/98	TF95454551	Dale Rostron	LGS.ShBar Sh		Shingle bank with oyster shells, shell gravel and flint gravel which was well mixed with sand. No anoxic layer. Dry.	

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33	11/01/98	TF95204527	Dale Rostron	LMS.MSMacAre	*Scoloplos armiger, Arenicola marina, ?Macoma, POLYCHAETA indet, Hydrobia ulvae*	Saltmarsh creek, muddy, well oxygenated sand. Scrobicularia shells were present in patches.	
34	11/01/98	TF94324585	Dale Rostron	LMS.HedMac Are	*Arenicola marina (C), Scoloplos armiger, Pygospio elegans, Cerastoderma edule*	Muddy sand, with a flat sediment surface. Standing water and silty surface deposit. Anoxic layer ca 1cm down.	Scoloplos egg masses
35	11/01/98	TF93924573	Dale Rostron	LMS.HedMac Are	*Pygospio elegans, Spionids in general (A), Macoma balthica (shells), Angulus tenuis, Cerastoderma edule, Scoloplos armiger, Arenicola marina*	Flat sediment surface apart from the Arenicola mounds. Ca 90% sand and 10% mud. Anoxic layer variable.	
36	11/01/98	TF93734562	Dale Rostron	?pioneer saltmarsh	*Enteromorpha, Hydrobia ulvae*	Thin veneer of silty mud with the anoxic layer very close to the surface.	No Arenicola, Scoloplos (eggs) or cockles apparent although cockles found close by.
37	11/01/98	TF93204608	Dale Rostron	LMU.SMUHed Mac	*Spionidae, Corophium sp, Hydrobia ulvae, AMPHIPODA indet, POLYHAETA indet,*	Level sand, with channels of water. Not too muddy, not very anoxic. Grey layer ca 10cm down but not seen in channels.	Quite rich, but no Arenicola or cockles.
38	11/01/98	TF92894666	Dale Rostron	LMUSMuHed Mac	*Arenicola marina, Bathyporeia sp?, Pygospio elegans (C), Hydrobia ulvae*	Level sand which was wet with small ripples	Cleaner than site 20.
39	11/01/98	TF92794701	Dale Rostron	LGS.Snd A.P		Rippled sand with no anoxic layer	No Hydrobia ulvae.
40	11/01/98	TF92094616	Dale Rostron	LMU.SMuHed Mac	*Arenicola marina, Hydrobia ulvae, Pygospio elegans, Cerastoderma edule, Abra tenuis*	Flat expanse of muddy sand, anoxic layer at 5cm. Surface with standing water and lots of Arenicola.	No amphipods, but Scoloplos eggs present.
41	11/01/98	TF92074576	Dale Rostron	LMU.HedSc	*Hediste diversicolor, Spionidae, Scrobicularia (shells)*	Dry, well consolidated mud wiith a little sand. Brown layer on top but anoxic >5cm.	
42	11/01/98	TF91364754	Francis Bunker	LGS.AP.P	*Scololepis squamata Nephtys cirrosa Bathyporeia sp*	Rippled medium sand No black layer	Low water mark
43	11/01/98	TF91844751	Francis Bunker	LGS.AP.P	*Nephtys cirrosa Small decapod shrimp*	Smooth sand and scattered gravel and shell.. No black layer	10-15m fringe at low water mark
44	11/01/98	TF92794777	Francis Bunker	LGS.AP.	*Spiophanes Cumacea indet.*	Rippled medium sand. Some black layering	At low water mark. Many Spiophanes tubes a feature of this sediment.
45	11/01/98	TF93514742	Francis Bunker	LGS.AP.P	*Spiophanes Haustorius Nephtys cirrosa*	Coarse sand and Spiophanes tubes. No black layer	Low water mark

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46	11/01/98	TF93474725	Francis Bunker	LGS.AP.P	*Nephtys cirrosa Spiophanes Arenicola marina*	Slightly muddy rippled sand with Spiophanes tubes. No black layer	In depression beside Lagoon behind low water mark. Detritus in wet depressions
47	11/01/98	TF93444717	Francis Bunker	LGS.BarSnd		Smooth sand. No black layer	Down at low level by banks of sandy inlet flooded by incoming tide.
48	11/01/98	TF93564717	Francis Bunker	LGS.AP.P	*Haustorius Bathyporeia spp. Scololepis*	Slightly muddy rippled sand No black layer	In depression beside 2nd Lagoon back behind low water mark. Detritus in wet depressions. No Nephtys cirrosa recorded
49	11/01/98	TF93994719	Francis Bunker	LGS.AP.P	*Scololepis Haustorius*	No ripples, medium sand. No black layer	Low water mark
50	11/01/98	TF93554728	Francis Bunker	LGS.AP.P	*Spiophanes Haustorius Scololepis*	Medium / coarse sand and gravel (20%). No black layer	Low water mark. Spiophones dominant
51	11/01/98	TF93894723	Francis Bunker	LGS.AP.P	*Spiophanes Haustorius Scololepis Nephtys cirrosa Bathyporeia sp*	Rippled medium sand. No black layer	Low water mark. (Lagoon behind, rising to smooth (barren) sand slope).
52	11/01/98	TF93854708	Francis Bunker	LGS.BarSnd	*?Spionidae* indet	Smooth medium sand	Rather barren except for one or two ?Spionidae indet. which was (large and clings to gravel in sieve). Smooth rather barren sand
53	11/01/98	TF93684702	Francis Bunker	LGS.BarSnd	*?Spionidae* indet	Rippled medium sand. No black layer	Vast expanse of rippled sand. Rather barren except for one or two ?Spionidae indet. which was (large and clings to gravel in sieve).
54	11/01/98	TF93534718	Francis Bunker	LGS.BarSnd		Rippled medium sand. No black layer.	A large expanse with smooth island like patches behind and in front
55	11/01/98	TF98034555	Francis Bunker	LGS.BarSnd		Medium rippled sand	Descend to Arenicola dominated sandy sediment to North
56	11/01/98	TF91754557	Francis Bunker	SLR.BLlit	*Elminius modestus Corophium sp. Pygiospio elegans*	Gravel 90% Mud 10%	Beside tideswept channel to Well harbour
57	12/01/98	TF99054645	Dale Rostron	LGS.AP.P	*Haustorius arenarius, Scololepis squamata*	Sand, with very little stony material.No anoxic layer, no mud.	

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59	12/01/98	TF99074633	Dale Rostron	LGS.AP.P	*Urothoe sp, Bathyporeia sp, Arenicola marina (R)*	Medium/coarse sand with ripples. Little gravel, some silt in pools on waterlogged surface.	
62	12/01/98	TF99444568	Dale Rostron	LMSMacAre	*Scoloplos armiger, Arenicola marina, Hydrobia ulvae, Fucus vesciculosus, Littorina littorea, Corophium, Pygospio elegans, ?Goniada maculata, ?Macoma balthica, Cerastoderma edule, OLIGOCHAETA indet*	Wet sand.	
65	12/01/98	TF98924552	Dale Rostron	SLR.FvesX	*Fucus vesciculosus, Elminius modestus, Mytilus edulis, Cerastoderma edule, Littorina littorea, Dynamena pumila, Gammaridae indet*	Tideswept pebble bank, with some sand.	
71	12/01/98	TF98974653	Dale Rostron	LGS.SAEur	*Eurydice pulchra, Bathyporeia sp*	Medium coarse clean sand with ripples, No anoxic layer, no, no mud.	
72	12/01/98	TF99124597	Dale Rostron	(LMUHed.Ol)	*Hydrobia ulvae*	Lagoon with soft, aerated medium fine sand and small amount of silt. No anoxic layer, but some clay balls found.	
73	12/01/98	TF99374608	Dale Rostron	LMU.HedSc	*Scrobicularia plana, Anaitides maculosa, Arenicola marina, Hydrobia ulvae*	Hard mud (with intermixed sand) and an anoxic layer at <1cm. Very black, lots of shell gravel, cockle shells.	No sign of Hediste diversicolor. Bird prints here.
74	12/01/98	TF99504578	Dale Rostron	LMU.Hed.Ol	*Fucus vesiculosus, Hediste (burrows), Fucus ceranoides?, Salicornia*	Pioneer saltmarsh with pebbles.Muddy sand sediment with silt veneer. Sediment well drained.	No Hydrobia visible. Fucus vescic on pebbles.
75	12/01/98	TF98954561	Dale Rostron	LGS.Lan	*Lanice conchilega, Cerastoderma edule, Fucus vesciculosus*	Sand and stones.,	Not sampled.
76	12/01/98	TF99034584	Dale Rostron	(LMU.HedOl)	*Hydrobia ulvae, Probably oligochaeta*	Large pool. Hard clay/sand with shingle mixed in. Surface silt veneer with green algae.	
77	12/01/98	TF99954572	Dale Rostron	LMU.HedScr	*Abra tenuis, Macoma balthica, Cerastoderma edule, Scrobicularia plana, Pygospio elegans, Corophim sp, Carcinus maenas, Hydrobia ulvae, POLYCHAETA indet, OLIGOCHAETA indet, Arenicola marina*	Muddy sand, with an anoxic layer at about 6cm.	Quite rich.,

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78	12/01/98	TG00274561	Dale Rostron	LMU.HedSc	*Arenicola marina, Hediste diversicolor, ?Scrobicularia plana*	Pools, and hard mud covered by (sparse) Enteromorpha.	Arenicola in pools., Hediste not very common!
79	12/01/98	TG00584541	Dale Rostron	LGS.Lan	*Lanice conchilega, Nephtys sp, Arenicola marina, AMPHIPODA indet, POLYCHAETA indet*	Large quantities of shingle mixed with low lying, damp sand. Anoxic layer at 3cm.	
80	12/01/98	TF99154695	Francis Bunker	LGS.BarSnd	*Polychaete indet.*	Smooth medium sand No black layer	Low water mark. End of spit. Big seal haul out 50m to East.
81	12/01/98	TF99234673	Francis Bunker	LGS.BarSnd	*Nephtys cirrosa Small decapod shrimp*	Rippled sand (25%) and gravel (75%). No black layer	Extensive plain over mid shore
82	12/01/98	TF99964688	Francis Bunker	LGS.BarSnd		Smooth medium sand No black layer	Low water mark
83	12/01/98	TF99974665	Francis Bunker	LGS.BarSnd		Rippled sand (25%) and gravel (75%). No black layer	Extensive plain over mid shore
84	12/01/98	TG00034659	Francis Bunker	LGS.BarSh	*Nephtys cirrosa Spiophanes Arenicola marina*	Gravel / Shingle with sand on top	Steep sandy shingle ridge at back of beach
85	12/01/98	TG00584678	Francis Bunker	LGS.BarSnd		Rippled sand (60%) and gravel (40%). No black layer	
86	12/01/98	TG00564672	Francis Bunker	LGS.BarSnd	*Haustorius Bathyporeia spp. Scololepis*	Rippled sand (60%) and gravel (40%). No black layer	
87	12/01/98	TG00584667	Francis Bunker	LR.Rkp.SwSed	*Lanice conchilega Ectocarpaceae Chaetomorpha sp Ulva sp Enteromorpha sp Ceramium sp. Polysiphonia fucoides Dumontia contorta Cystoclonium purpureum*	Sandy pools. Medium sand, cobbles and pebbles.	Sandy pools at base of shingle / sand Ridge.
88	12/01/98	TG00564659	Francis Bunker	LGS.BarSh		Shingle	Shingle ridge
89	12/01/98	TG01254655	Francis Bunker	LGS.BarSnd		Smooth sand (90%) and gravel (10%). No black layer	Low water mark
90	12/01/98	TG01234650	Francis Bunker	LGS.BarSnd	*Bathyporeia*	Rippled sand over shingle 30cm down.. No black layer	Salt water running in pools in sediment at back of shore.
91	12/01/98	TG02174610	Francis Bunker	LGS.BarSh		Shingle	Shingle ridge
92	12/01/98	TF98414571	Francis Bunker	LGS.Lan	*Lanice conchilega, Mytilus edulis, Enteromorpha sp, Fucus vesiculosus*	Gravel 80%, fine sand 15%, mud 5%	Sediment spits at side of Blakeney River channel
93	12/01/98	TF98744499	Francis Bunker	LMU.AP.P	*Arenicola marina, Haustorius, Spiophanes bombyx.*	Slightly muddy sand. Black layer 20cm deep.	Haustorius dominant
94	12/01/98	TF98674487	Francis Bunker	LMU.Hed.Mac.Are	*Arenicola marina, Haustorius, Scoloplos armiger, Nephtys ?hombergii*	Muddy sand. Black layer 3cm deep	A large area of heavily bait dug muddy sand..
95	12/01/98	TF98494483	Francis Bunker	LMU.Hed.Mac	*Hediste diversicolor Scoloplos armiger, Cerastoderma edule, Arenicola marina Fucus spiralis*	Claylike mud with thin fine muddy sand coating on top	Eroded saltmarsh. Very hard and clay-like. Fucus spiralis band in some areas in upper part.

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96	12/01/98	TF99154463	Francis Bunker	LMU.HedScr	*Scrobicularia plana Hediste diversicolor*	Soft muddy sand	By side of creek
97	12/01/98	TF98984479	Francis Bunker	LMU.Hed.Mac.Are	*Arenicola marina, Haustorius, Scoloplos armiger*	Muddy sand. Black layer 3cm deep	
98	13/01/98	TF79584691	Dale Rostron	LS.S.AP.P		Rippled sand mixed with pebbles and shell.	
99	13/01/98	TF78624602	Dale Rostron	SLR.Fves.X	*Fucus vesiculosus, Dumontia , Ceramium spp, Enteromorpha sp, Arenicola marina, Lanice conchilega, Pygospio elegans*	Flat area of pebbles mixed with sand. Tideswept, no anoxic layer apparent.	
100	13/01/98	TF78804596	Dale Rostron	LGS.Sh.Bar.Sh	*Enteromorpha sp*	Barren tideswept shingle.	
101	13/01/98	TF78874607	Dale Rostron	LMS.MacAre	*Arenicole marina R, Mytilus edulis R, Pygospio elegans, Lanice conchilega, Macoma balthica, POLYCHAETA indet*	Sediment with intermixed stones and shells in a shallow pool. Medium sand. Anoxic layer ca 3cm,	
102	13/01/98	TF78984605	Dale Rostron	SLR.Myt.X	*Mytilus edulis (C), Littorina littorea, Elminius modestus, Cerastoderma edule, Fucus vesiculosus, Ceramiu nodulosum, Arenicola marina, Dumontia incrassata*	Bed of Mytilus edulis on sand and stones. Also patches of anoxic clay.	
103	13/01/98	TF79214621	Dale Rostron	LMU.Hed.Scr	*Hediste diversicolor, Pygospio elegans, Arenicola marina, Scrobicularia (shells), ?Oligochaeta*	Firm mud with diatoms on the surface and bird prints. Anoxic layer at ca 1cm. Waterlogged surface. Not much sign of Hydrobia ulvae.	
104	13/01/98	TF79424642	Dale Rostron	LMU.Hed.Mac.Pyg	*Fucus ceranoides?, Pelvetia canaliculata, Hydrobia ulvae, Abra tenuis, Pygospio elegans, POLYCHAETA indet,*	Close to pioneer saltmarsh - not mud but muddy sand. the anoxic layer was ca 1.5cm	
105	13/01/98	TF79844552	Dale Rostron	SLR.Myt.X	*Mytilus edulis, Littorina littorea, Elminius modestus, Lanice conchilega, ?Cerastoderma edule, Fucus vesiculosus, Dumontia incrassata, Cladophora sp, Chondrus crispus, Enteromorpha, Laurencia sp.*	Banks of Mytilus edulis on stones and pebbles.	Fishing for shellfish.
106	13/01/98	TF80034544	Dale Rostron	SLR.Myt.X	*Elminius modestus, Mytilus edulis (C), Ceramium spp*	Mussel bed on soft substrata.	
107	13/01/98	TF80154553	Dale Rostron	LMU.HedOl	*Hediste diversicolor*	Pioneer saltmarsh on sandy mud, with hard anoxic clay ca 1cm down	

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108	13/01/98	TF80544571	Dale Rostron	LMU.Hed.Mac.Pyg (reduced)	*Hediste diversicolor, Pygospio elegans*	Hard sand/mud banks with softer mud alongside creeks. No Hydrobia. Anoxic layer not distinct - just intermixed grey in the sand.	
109	13/01/98	TF80734584	Dale Rostron	LGS.S.AP.P	*Nephtys ?cirrosa, Arenicola marina, Spionids, AMPHIPODA indet, ?Bathyporeia sp*	Surprisingly clean sand with some silt deposition in ripple troughs.	
110	13/01/98	TF81494574	Dale Rostron	LGS.S.AP.P	*Arenicola marina*	Clean sand with silt on top. Anoxic layer present.	Not sampled. Bait diggers.
111	13/01/98	TF81514565	Dale Rostron	LMS.Mac.Are	*Enteromorpha sp, Arenicola marina, Pygospio elegans , Fucus vesiculosus*	Stones	Not sampled - but definitely not exciting,
112	13/01/98	TF83454563	Dale Rostron	LGS.S.AP.P		Channel bed sand. Thixotropic in places. Mobile	Not sampled but probably a mixture of high barren and low AP.P sand.
113	13/01/98	TF84304572	Dale Rostron	LMU.Hed.Mac.Are (reuced)	*Hediste diversicolor, Arenicola marina, Pygospio elegans, Enteromorpha sp*	Muddy sand with aerated burrows. Anoxic patches. Surface wet with diatoms.	No sign of Hydrobia or bvalves but there were Cerastoderma shells on surface.
114	13/01/98	TF79634700	Francis Bunker	LGS.BarSnd		Rippled medium and coarse sand over gravel. No black layer	Lower shore. Obviously mobile
115	13/01/98	TF79634685	Francis Bunker	LGS.BarSnd		Rippled medium and coarse sand over gravel. No black layer	Mid shore. Extensive plain over mid shore
116	13/01/98	TF79614681	Francis Bunker	LGS.BarSh		Sand over shingle	Shingle ridge at back of beach
117	13/01/98	TF80914693	Francis Bunker	LGS.BarSnd		Smooth sand, little gravel. No black layer	LS smooth sand..
118	13/01/98	TF80884680	Francis Bunker	LGS.BarSh		Medium and coarse sand (50%) and gravel (50%)	Sand and gravel by edge of sandy pools below shingle slope
119	13/01/98	TF81534684	Francis Bunker	LGS.AP	*Scololepis Spiophanes bombyx.*	Silty sand (50%) and gravel (60%)	Sand lighter up the beach.
120	13/01/98	TF81514675	Francis Bunker	LGS.BarSnd		Sand (80%) and gravel (20%). No black layer	Clean yellow sand
121	13/01/98	TF82424665	Francis Bunker	LGS.BarSnd		Smooth medium sand (80%) and gravel (20%). No black layer.	Lower shore
122	13/01/98	TF82384653	Francis Bunker	LGS.AEur	*Arenicola Haustorius*	Rippled wet medium sand	Mid shore
123	13/01/98	TF82394645	Francis Bunker	LGS.Sh		Sand on shingle and gravel	Slope at back of shore

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124	13/01/98	TF82464647	Francis Bunker	LGS.BarSnd		Clay like consolidated mud	Remnant outcropping of clay like mud at base of shingle slope with empty cockle and Macoma shells
125	13/01/98	TF83484650	Francis Bunker	LGS.AEur	*Bathyporeia Nephtys caeca*	Medium smooth sand (90%) and gravel (10%)	LS smooth sand
126	13/01/98	TF83464628	Francis Bunker	LGS.BarSnd		Clay like consolidated mud	Large area of remnant outcropping of clay like mud at base of shingle slope with empty cockle and Macoma shells
127	13/01/98	TF83464633	Francis Bunker	LGS.AEur	*Bathyporeia*	Rippled medium sand (95%) and gravel (5%)	Dominates the middle shore
128	13/01/98	TF83464639	Francis Bunker	LGS.AEur	*Bathyporeia Spiophanes bombyx.*	Rippled medium sand	Middle shore
129	13/01/98	TF84834627	Francis Bunker	LGS.AP.P	*Spiophanes bombyx. Nephtys caeca*	Smooth medium sand	Opposite Overy entrance. Many worms present. A wide expanse of smooth sandy shore
130	13/01/98	TF84764604	Francis Bunker	LGS.BarSnd		Loose medium aerated sand	North of the east / west running extensive pool in the sand (which forms part of river when tide high)
131	13/01/98	TF84754597	Francis Bunker	LGS.AEur	*Bathyporeia sp*	Rippled medium sand	Extensive to south of sand channel
132	13/01/98	TF84864597	Francis Bunker	LGS.BarSnd		Gravel and sand plain	Scoured sediment subject to current when tide ebbing and flowing
133	13/01/98	TF84794579	Francis Bunker	LGS.AEur	*Bathyporeia sp*	Medium soft sand waves	Banks of river. Many Bathyporeia present.
134	13/01/98	TF84684567	Francis Bunker	LGS.Lan		Gravel and sand	South of river bed and base of river
135	13/01/98	TF84654560	Francis Bunker	SLR.EphX	*Enteromorpha sp*	Gravel and fine sand	Enteromorpha sp
136	13/01/98	TF84584550	Francis Bunker	LGS.BarSnd		Soft fine sand and gravel	Barren soft fine sand and gravel
137	13/01/98	TF84584542	Francis Bunker	LMU.Hed.Mac.Pyg	*Hediste diversicolor Pygiospio*	Mud on soft fine silty sand	Between wind blown sand and saltmarsh behind. No Macoma
138	13/01/98	TF84654546	Francis Bunker	LMU.Hed.Mac	*Arenicola marina Scoloplos armiger Pygiospio*	Muddy rippled sand	By river No Macoma
139	13/01/98	TF84784545	Francis Bunker	SLR.FvesX	*Fucus vesiculosus Enteromorpha*	Gravel	Tideswept gravel bank. Scattered Fucus vesiculosus plants (a narrow aberrant form)

Target Id	Date	GridRef	RecordedBy	Biotope	Species	Substrate	Notes
140	13/01/98	TF84904535	Francis Bunker	LGS.AP.P	*Nephtys caeca*	Spongy sand	Current swept spongy sand as raised area of river channel
141	13/01/98	TF84784557	Francis Bunker	LMU.Hed.Mac.Pyg	*Pygiospio*	Gravel overlain by muddy sand	No sieved
142	14/01/98	TF77584541	Dale Rostron	LGS.APP	*Bathyporeia sp, Spiophanes bombyx (tubes), Arenicola marina*	Medium coarse rippled sand with standing water, no anoxic layer. Small amount of gravel.,	
143	14/01/98	TF77854593	Dale Rostron	LGS.BarSnd	*No fauna detected in sieve, but widely spaced Arenicola were present.,*	Waterlogged sand with no anoxic layer.	
144	14/01/98	TF78454584	Dale Rostron	LGS.BarSh	*Fucus vesiculosus (sparse). No fauna in sieve.*	Barren shingle by the tidal outflow stream with sand.,	
145	14/01/98	TF78574574	Dale Rostron	SLR.Myt.X	*Fucus vesiculosus, Littorina littorea (C), Elminius modestus, Mytilus edulis (C), Lanice conchilega, Enteromorpha sp,*	Pebble banks on which the stones were tied down by byssus threads.	There were patches of very dense Lanice on the lower wet bits, and clumps of Littorina littorea amongst the Mytilus.
146	14/01/98	TF79154567	Dale Rostron	LGS.Lan	*Lanice conchilega*	Lower shore shingle with Lanice, but upper shore mud/clay.,	
147	14/01/98	TF79544588	Dale Rostron	LGS.BarSnd	*Barren*	Medium/coarse rippled sand, mobile and thixotropic in parts. Very small amount of gravel present.,	
148	14/01/98	TF79684539	Dale Rostron			Boundary at creek. Sand/clay with deposited organic debris. Shingle bank on one side and saltmarsh on the other.	
149	14/01/98	TF79714533	Dale Rostron	LMU.HedMac	*Enteromorpha*	Sandy mud with a thin anoxic layer between the mud and underlying sand.	No Hydrobia seen.
150	14/01/98	TF79754507	Dale Rostron	LGS.BarSh	*Fucus vesiculosus, Enteromorpha,*	Shingle and stones.	
151	14/01/98	TF79404481	Dale Rostron	LMU.HedScr	*Scrobicularia plana, Pygospio elegans, Macoma balthica, Hydrobia ulvae, Hediste diversicolor,*	Soft mud at edge of saltmarsh, brown on top clay beneath.	Birds feeding and Scrobicularia shells on the surface.
152	14/01/98	TF78714483	Dale Rostron	LMX.Mare(eroded)	*Pygospio elegans (tubes), Polychaeta indet*	Tideswept stone/sand mixture.	Large Mya arenaria shells protruding from the stony substratum.
153	14/01/98	TF78674486	Dale Rostron	LMX.Mare	*Scrobicularia plana, (Mya arenaria),*	Very gloopy mudy sand with stones and shells.	
154	14/01/98	TF78174469	Dale Rostron	LMU.HedMacPyg, (reduced)	*Pygospio elegans, Hediste diversicolor,*	Mud washed by the tide with a sand veneer.	Bird prints, Scrob shells.

Target Id	Date	GridRef	RecordedBy	Biotope	Species	Substrate	Notes
155	14/01/98	TF77684462	Dale Rostron	LMU.HedScr	*Scrobicularia plana, Hydrobia ulvae, Hediste diversicolor*	Very soft gloopy mud.	
156	14/01/98	TF77114530	Francis Bunker	MLR.RPid	*Barnea candida Enteromorpha sp.*	Fossilised Peat on clay	A mid shore reef. Very low lying and sand scoured. Few associated species. Only one or two Barnea.
157	14/01/98	TF77104533	Francis Bunker	LGS.AP.P	*Scololepis Bathyporeia Nephtys caeca*	Rippled silty medium and fine sand. Black layer 7cm deep	Mid shore around exposed peat and clay. Muddy feel.
158	14/01/98	TF77084544	Francis Bunker	LGS.AP.P	*Haustorias Bathyporeia Nephtys caeca Arenicola marina Lanice conchilega*	Rippled medium sand (75%) and gravel (25%). Black layer 5cm.	Shingle ridge at back of beach. Lanice and Arenicola sparse.
159	14/01/98	TF76934529	Francis Bunker	MLR.RPid	*Barnea candida Enteromorpha sp. Lanice conchilega Polysiphonea sp.*	Fossilised Peat on clay	Peat has shallow sandy pool on N side with muddy sand. Few piddocks noted. Polysiphonia sp. conspicuous.
160	14/01/98	TF76944522	Francis Bunker	LGS.AEur	*Bathyporeia*	Smooth medium sand. No black layer	Sand and gravel by edge of sandy pools below shingle slope
161	14/01/98	TF76954516	Francis Bunker	LGS.BarSnd	*?Spionidae indet.*	Smooth medium sand. No black layer.	Upper shore sand just to the west of the golf club. Polychaete worm named Spionidae indet. Curls up in dish and attaches to gravel
162	14/01/98	TF76634507	Francis Bunker	LGS.BarSh		Shingle and gravel mixed with sand	No true shingle ridge
163	14/01/98	TF76614513	Francis Bunker	LGS.BarSnd		Exposed clay, barren.	Similar to the MLR.RPid found on the beach, but with peat layer missing and sand scoured. Dead Macoma and Ceraastoderma shells present.
164	14/01/98	TF76584518	Francis Bunker	LGS.AP.P	*Arenicola*	Medium sand.	Extensive in the middle shore, not seived
165	14/01/98	TF76564528	Francis Bunker	MLR.RPid	*Barnea candida Enteromorpha sp. Lanice conchilega Polysiphonea sp.*	Fossilised Peat on clay	Lanice abundant. LGS.AP.P silty sand between peat / clay outcrops. Extensive LGS.AP.P to north
166	14/01/98	TF76564546	Francis Bunker	LGS.AP.P	*Bathyporeia Scololepis Lanice*	Rippled sand. Black layer 15cm deep	Lower shore below MLR.RPid biotope.

Target Id	Date	GridRef	RecordedBy	Biotope	Species	Substrate	Notes
167	14/01/98	TF75774537	Francis Bunker	LGS.AP.P	*Arenicola Nephtys caeca*	Medium smooth sand (90%) and gravel (10%)	No amphipods found. Site is where salt river fans down beach draining saltmarsh behind dunes. The two works were quite abundant
168	14/01/98	TF75534531	Francis Bunker	MLR.RPid	*Barnea candida Enteromorpha sp. Polysiphonia sp. Mytilus edulis Lanice conchilega*	Fossilised Peat on clay	Main lower shore reef of fossilised peat. Live Barnea seen. Pools around reefs, some deep. Some soft muddy sediment too.
169	14/01/98	TF75584514	Francis Bunker	LGS.AP.P	*Bathyporeia Nephtys caeca Arenicola marina*	Rippled medium sand	Sand N of piddock reefs
170	14/01/98	TF75574493	Francis Bunker	LGS.BarSnd		Medium sand and some shingle	Back of beach leading up to dunes. Not a proper shingle ridge
171	14/01/98	TF75534502	Francis Bunker	LGS.AP.P	*Scololepis Arenicola marina*	Rippled medium sand	Sand pools area in upper middle shore. Very sparse Arenicola
172	14/01/98	TF75564485	Francis Bunker	LGS.Ol		Medium and fine sand covered in silt with dark and light layers	Behind dunes at head of creek. No fauna found in sieve but warrants further investigation
173	14/01/98	TF75454487	Francis Bunker	LGS.BarSh		Shingle by lagoon entrance	Scoured sediment subject to current when tide ebbing and flowing
174	14/01/98	TF75394488	Francis Bunker	LGS.BarSnd		By lagoon channels	One unidentified polychaete found by sieving
175	14/01/98	TF75334489	Francis Bunker	LGS.OL	*Hediste diversicola*	Spongy fine sandy mud	No Hydrobia. On banks of lagoon
176	14/01/98	TF75044526	Francis Bunker	MLR.RPid	*Barnea candida Enteromorpha sp. Polysiphonia sp. Mytilus edulis Lanice conchilega*	Fossilised Peat on clay	Dense Mytilus on the top of the peat.
177	14/01/98	TF74944533	Francis Bunker	LGS.AP.P	*Scololepis Nephtys caeca Arenicola marina*	Medium rippled sand	Scololepis large and numerour. Sparse Areinicola
178	14/01/98	TF74644527	Francis Bunker	LGS.AP.P	*Bathyporea Nephtys caeca Arenicola marina*	Smooth medium sand	Arenicola very sparse
179	14/01/98	TF74424524	Francis Bunker	LGS.BarSnd		Medium sand	
180	14/01/98	TF74264526	Francis Bunker	LGS.AP.P		Medium sand	Upper middle shore. Sparse fauna (records missing)
181	14/01/98	TF74024522	Francis Bunker	LGS.BarSnd		Medium sand	Strand line of dense Flustra foliacea

Target Id	Date	GridRef	RecordedBy	Biotope	Species	Substrate	Notes
182	14/01/98	TF73734501	Francis Bunker	LGS.BarSnd		Current swept waves of medium sand	By bank of tidal inlet
183	14/01/98	TF73854500	Francis Bunker	LGS.BarSh		Shingle with much shell material	Above banks to tidal inlet
184	14/01/98	TF73884495	Francis Bunker	LMU.Hed.Mac.Pyg	*Hediste Pygiospio Scoloplos*	Silty sand	No waypoint taken
185	14/01/98	TF73974507	Francis Bunker	IMU.Tub		Fine sandy mud	Shallow saline pool surronded by pioneer saltmarsh dominated by Salicornia. Infauna (if present) too small to see in field. This biotope is a best guess
186	14/01/98	TF74094515	Francis Bunker	IMU.Tub		Fine sandy mud	Shallow saline pool surronded by pioneer saltmarsh dominated by Salicornia. Infauna (if present) too small to see in field. This biotope is a best guess
187	14/01/98	TF75844467	Francis Bunker	LGS.Ol		Medium sand and silt with a mud veneer on sediment surface	East side of inlet. Infauna requires further study. Oligochaetes could not be seen in the field
188	14/01/98	TF75744468	Francis Bunker	LMU.Hed.Scr	*Hediste diversicolor*	Thick anoxic clay like mud	Fringes banks of tidal inlet
189	14/01/98	TF75644479	Francis Bunker	LMU.Hed.Mac.Pyg	*Hediste diversicolor*	Medium sand and silt with a mud veneer on sediment surface	Hediste burrows found. Not sieved. No Scrobicularia found.
190	15/01/98	TF96674493	Dale Rostron	LMUHed Mac Are	*Arenicola marina (C), Macoma balthica, Abra tenuis, Pygospio elegans, Corophium sp, Hediste burrows ?, POLYCHAETA indet*	Fine sand with a grey layer at ca 5cm	
191	15/01/98	TF96764547	Dale Rostron	SLR.B.Llit	*Lanice conchilega, Arenicola marina, Fucus vesiculosus, Littorina littorea, Gammaridae, Chromophycota indet, Polysiphonia sp, Elminius modestus, Pomatoceros sp, Enteromorpha sp,*	Initial site to west of major hole feature. Stones and pools, with flat areas of standing water. Grey clay was found just underneath the stones in some areas.	

Target Id	Date	GridRef	RecordedBy	Biotope	Species	Substrate	Notes
192	15/01/98	TF97104545	Dale Rostron	SLR.B.Llit	*Elminius modestus, Chromophycota indet, Fucus vesiculosus, Pomatoceros sp, Dumontia contorta, Balanus ?crenatus, Laurencia sp, Entromorpha sp, Lanice conchilega, Mytilus edulis, Cerastoderma edule, Carcinus maenas, Littorina littorea,*	Dark, barnacle covered pebbles with substantial amounts of brown algae present. A stable environment of mixed muddy sand and stones. , Contains SLR.MytX and LGS.Lan.	Very dense Lanice beds and Mytilus edulis at the northern edge of the pebble patch. Lanice throughout. The presence of numerous Venerupis shells was interesting.
193	15/01/98	TG02814451	Dale Rostron	?LMU.HedStr	*Not sieved,*	Mud with Scrobicularia shells	Alongside a creek
194	15/01/98	TG02844484	Dale Rostron	LMU.HedScr	*Hediste diversicolor, Scrobicularia plana,*	Brown diatomaceous mud with relatively hard grey clay underneath.	
195	15/01/98	TG02954526	Dale Rostron	LMUHedScr	*Not sampled, would expect:, Hydrobia ulvae, Abra tenuis, Hediste diversicolor, Scrobicularia plana, Polychaetes, Oligochaetes,*	Plateau of classic mud habitat with diatoms on the surface.	Bird prints all over the surface.
196	15/01/98	TG02974537	Dale Rostron	LGS.Ol	*Pygospio tubes*	Small patch of medium sand by the creek with some mudballs. Anoxic layer at ca 5cm.,	
197	15/01/98	TG02754562	Dale Rostron	LGS.Ol	*Arenicola marina R, ?oligochaetes*	Soft rippled medium sand. Silt and organics present.,	
198	15/01/98	TG02494564	Dale Rostron	LMU.Hed.Ol	*Hediste diversicolor, ?Oligochaetes*	Hard clay, grey with holes.	
199	15/01/98	TG02574527	Dale Rostron	LMU.HedOl	*Hediste diversicolor, Enteromorpha sp, ?Oligochaetes*	Hard grey clay, some muddy sand. Numerous channels running to the creek.,	Patches of Spartina. Mya arenaria shells in the eroded bank. No Hydrobia.
200	15/01/98	TG02724528	Dale Rostron	LMS.Znol	*Zostera noltii*	Slightly more sandy than above.,	Thin surface foliage but quite substantial root system.,
201	15/01/98	TG02824536	Dale Rostron	LGS.Ol		Shell debris, thin silt with black sand clay beneath.,	No Hediste burrows.
202	15/01/98	TG02674496	Dale Rostron	LMU.Hed.Ol	*Hediste diversicolor, ?oligochaetes,*		By the bank of the creek.
203	15/01/98	TG02654479	Dale Rostron	LGS.Ol	*Arenicola marina*	Bank of soft medium sand, containing organic debris but no sign of life when sieved. No anoxic layer.	
204	15/01/98	TF91574395	Francis Bunker	SLR.FvesX	*Fucus vesiculosus Hediste diversicolor*	Cobbles, pebbles, gravel and mud	Banks of channel
205	15/01/98	TF91644415	Francis Bunker	LGS.AP.P	*Haustorius araneus Nephtys caeca Bathyporeia Sphaeroma*	Medium sand.	Aerated soft rippled medium and fine sand in mid channel
206	15/01/98	TF91624441	Francis Bunker	HMU.HedMac.Pyg	*Hediste diversicolor Scrobicularia plana Pygiospio elegans Bathyporeia*	Sandy mud on clay	Dredged steep E bank of channel

Target Id	Date	GridRef	RecordedBy	Biotope	Species	Substrate	Notes
207	15/01/98	TF91704445	Francis Bunker	HMU.HedMac.Pyg	*Hediste diversicolor Pygiospio elegans*	Sandy mud on clay	Dredged sloping bank of channel
208	15/01/98	TF91754454	Francis Bunker	LMU.HedScr	*Hediste diversicolor Scrobicularia plana Oligochaetes*	Soft sandy mud, anoxic just below surface.	Creeks of main channel
209	15/01/98	TF91764460	Francis Bunker	LMU.HedScr	*Hediste diversicolor Scrobicularia plana Oligochaetes*	Soft mud, anoxic just below surface	Raised mud plateau just below saltmarsh
210	15/01/98	TF91634476	Francis Bunker	HMU.HedMac.Pyg	*Hediste diversicolor Pygiospio elegans*	Muddy sand on slope of channel	Not recently dredged
211	15/01/98	TF91634480	Francis Bunker	SLR.FvesX	*Fucus vesiculosus*	Gravel	Top of sandy mud bank on bend of river, subject to scour
212	15/01/98	TF91754505	Francis Bunker	LMU.HedMac.Pyg	*Hediste diversicolor Pygiospio elegans*	Thin layer of muddy sand on clay	Eroded saltmarsh. Hediste burrowing into the clay
213	15/01/98	TF91514504	Francis Bunker	SLR.FvesX	*Fucus vesiculosus Hediste diversicolor*	Cobble, pebbles, gravel and mud	Middle of wetern bank to channel
214	15/01/98	TF79184449	Francis Bunker	LMU.HedScr	*Hediste diversicolor Scrobicularia plana*	Soft sandy mud, anoxic just below surface.	Very soft and deep
215	15/01/98	TF79144437	Francis Bunker	LMU.HedScr	*Hediste diversicolor Scrobicularia plana*	Soft sandy mud, anoxic just below surface.	Very soft and deep
216	15/01/98	TF79304450	Francis Bunker	LMU.HedOl	*Hediste diversicolor Oligochaetes*	Soft anoxic mud.	Very soft and deep
217	15/01/98	TF79354459	Francis Bunker	HMU.HedMac.Pyg	*Hediste diversicolor Scrobicularia plana Pygiospio elegans Arenicola marina*	Muddy sand on raised bank	Hediste holes noted, but none seen. See 4a
218	15/01/98	TF79524471	Francis Bunker	HMU.HedMac.Pyg	*Hediste diversicolor Scrobicularia plana Pygiospio elegans Arenicola marina*	Muddy sand	
219	15/01/98	TF79604471	Francis Bunker	LMU.HedScr	*Hediste diversicolor Scrobicularia plana Oligochaetes*	Very soft mud, anoxic just below surface.	Wet soft mud plateau. Many Bar-tailed Godwits feeding there.
220	15/01/98	TF79714477	Francis Bunker	LMS.AP.P	*Nephtys caeca Bathyporeia sp. Arenicola marina*	Rippled medium soft sand of river channel	Bait digging for Arenicola noted

10. Appendix - slide catalogue of North Norfolk SAC.

This information is contained in the Mapinfo layer called SLIDES. Each slide has a point on the map layer which is represented as an arrow rotated so that it is pointing in the direction the photograph was taken. The data for each slide can be accessed from within MapInfo by using the Info tool. The data can also be accessed by displaying the contents of the SLIDES.DBF dBase III file using any suitable software.

The contents of the Id column matches the number on the printed slide label.

See Figure 11 - Map showing location and orientation of photographs

ID	Date	Photographer	Subject	Compass bearing (degrees)	View W(ide) N(ormal) C(loseup) M(acro)	Wpt	Slide number	Grid Ref
F1/01	10/01/98	JMP	General view by channel with D.Rostron, HV & FB working	30	W	1		TF908468
F1/02	10/01/98	JMP	Rippled Ap.P sand	240	W	2		TF903470
F1/03	10/01/98	JMP	Muddier sand showing contrast up creek	110	W	5		TF898462
F1/04	10/01/98	JMP	Barren sand with muddy creek edge being covered	90	W	7		TF892461
F1/05	10/01/98	JMP	Wetter patch on mid shore	120	W	8		TF886460
F1/06	10/01/98	JMP	View across 2 wet channels & D.Rostron sampling	340	W	10		TF878459
F1/07	10/01/98	JMP	Saltmarsh & lagoon	90	W	12		TF886453
F1/08	10/01/98	JMP	Saltmarsh & lagoon	140	W	12		TF886453
F1/09	10/01/98	JMP	Brackish pool	90	W	13		TF887453
F1/10	10/01/98	JMP	Barren shingle on dunes	90	W	14		TF893459
F1/11	10/01/98	JMP	Primary saltmarsh & sandy/muddy creek looking towards beach	135	W	15		TF909459
F1/12	11/01/98	JMP	Barren shingle bank on Ap.P - Clay underlying	220	W	2		TF915463
F1/13	11/01/98	JMP	Raised shingle bank with sandy/muddy hollow in lee	250	W	3		TF918464
F1/14	11/01/98	JMP	Shingle bank with Ap.P around & saltmarsh in distance	45	W	10		TF954455
F1/15	11/01/98	JMP	*Phyllodosea* eggs in saltmarsh creek	90	C	12		TF952452
F1/16	11/01/98	JMP	Dale sieving in saltmarsh creek	60	W	12		TF952452

ID	Date	Photographer	Subject	Compass bearing (degrees)	View W(ide) N(ormal) C(loseup) M(acro)	Wpt	Slide number	Grid Ref
F1/17	11/01/98	JMP	Barren shingle bank with sand & vegetation before saltmarsh	270	W	13		TF948453
F1/18	11/01/98	JMP	Dense *Arenicola* casts & D.Rostron - into light	180	W	16		TF939457
F1/19	11/01/98	JMP	Mud covered anoxic sand with compass for scale	0	N	17		TF937456
F1/20	11/01/98	JMP	Estuarine mud in Wells harbour entrance	90	W	25		TF920457
F1/21	12/01/98	JMP	Damp sandy hollow between shingle & dunes	210	W	6		TF991459
F1/22	12/01/98	JMP	D.Rostron on hard muddy area next to pioneer saltmarsh	10	W	7		TF993460
F1/23	12/01/98	JMP	View from dunes at Blakeney	250	W	10		TF996460
F1/24	12/01/98	JMP	View from dunes at Blakeney	180	W	10		TF996460
F1/25	12/01/98	JMP	View from dunes at Blakeney	0	W	10		TF996460
F1/26	12/01/98	JMP	*F. vesiculosus* on pebbles on pioneer saltmarsh	0	N	11		TF995457
F1/27	12/01/98	JMP	*F. vesiculosus* on pebbles and sand	60	W	15		TF993455
F1/28	12/01/98	JMP	*F.vesiculosus* on pebbles with barnacles (*Elminius*)	300	W	17		TF989455
F1/29	12/01/98	JMP	*F.vesiculosus* on pebbles with barnacles (*Elminius*)	0	C	17		TF989455
F1/30	12/01/98	JMP	Shingle bar with pioneer saltmarsh & pools banked by shingle &	20	W	19		TF990458
F1/31	12/01/98	JMP	F.vesiculosus, barnacles, mussels on cobbles	60	W	23		TF985455
F1/32	12/01/98	JMP	Sand, mud, pioneer saltmarsh looking towards dunes & blue NT	340	W	26		TF999456
F2/01	10/01/98	FB	Spade in sand to show LGS.Ap.P sediment	0	W	1	200198 T2A 2363	TF903471
F2/02	10/01/98	FB	H. Vine sampling sediment	110	N	1	200198 T2A 2363	TF903471
F2/03	10/01/98	FB	Beam trawler	90	W	1	200198 T2A 2363	TF903471
F2/04	10/01/98	FB	LGS.Ap.P + ripples & *Scololepis* tubes	315	M	2	200198 T2A 2363	TF901472
F2/05	10/01/98	FB	Sieved sample	0	M	2	200198 T2A 2363	TF901472
F2/06	10/01/98	FB	LGS.Ap.P & H. Vine	90	W	3	200198 T2A 2363	TF856464
F2/07	10/01/98	FB	LGS.Ap.P	270	W	3	200198 T2A 2363	TF856464
F2/08	10/01/98	FB	*Nephtys cirrosa* & *Haustorius araneus* in sample	270	N	3	200198 T2A 2363	TF856464
F2/09	10/01/98	FB	Rippled LGS.BarSnd ridge	90	W	7	200198 T2A 2363	TF862460
F2/10	10/01/98	FB	Coarse gravel & sand sloping up towards dunes	90	W	10	200198 T2A 2363	TF862459
F2/11	10/01/98	FB	Beam trawler - fishing for shrimps	45	W	0	200198 T2A 2363	TF867479
F2/12	10/01/98	FB	Washed up *Flustra* etc on lower shore	90	W	11	200198 T2A 2363	TF879458
F2/13	11/01/98	FB	D. Rostron & J. Perrins at work	110	W	3	200198 T2A 2363	TF927477
F2/14	11/01/98	FB	View of sand lagoons characteristic of area	315	W	5	200198 T2A 2363	TF934472
F2/15	11/01/98	FB	Sieved fauna from LGS.Ap.P sample	0	M	7	200198 T2A 2363	TF935471
F2/16	11/01/98	FB	Smooth raised LGS.BarSnd ridges near LS	270	W	12	200198 T2A 2363	TF938470

ID	Date	Photographer	Subject	Compass bearing (degrees)	View W(ide) N(ormal) C(loseup) M(acro)	Wpt	Slide number	Grid Ref
F2/17	12/01/98	FB	Paul Gilliland (EN staff) examining sieved sample	90	W	1	200198 T2A 2363	TF991469
F2/18	12/01/98	FB	Paul Gilliland (EN staff) examining sieved sample	90	W	1	200198 T2A 2363	TF991469
F2/19	12/01/98	FB	Shingle	90	W	12	200198 T2A 2363	TG021461
F2/20	12/01/98	FB	View from top of shingle	90	W	8	200198 T2A 2363	TG005466
F2/21	12/01/98	FB	View from top of shingle	270	W	8	200198 T2A 2363	TG005466
F2/22	12/01/98	FB	Shingle	270	W	12	200198 T2A 2363	TG021461
F2/23	12/01/98	FB	*Mytilus*, gravel & *Lanice*	90	W	13	200198 T2A 2363	TF984457
F2/24	12/01/98	FB	Bait dig	0	W	15	200198 T2A 2363	TF986448
F2/25	12/01/98	FB	*Mytilus*, gravel & *Lanice* & *F. vesiculosus*	315	W	13	200198 T2A 2363	TF984457
F2/26	12/01/98	FB	Narrow leaved *Fucus vesiculosus*	0	M	13	200198 T2A 2363	TF984457
F2/27	12/01/98	FB	Eroded salt marsh	270	W	16	200198 T2A 2363	TF984448
F3/01	13/01/98	JMP	Shingle ridge onto sand flats - wreck in distance	320	W	2		TF786460
F3/02	13/01/98	JMP	*F.vesiculosus*, mussels, sand and shingle	75	W	5		TF789460
F3/03	13/01/98	JMP	Pioneer saltmarsh, *F.vesiculosus*, gravel going to mud	240	W	8		TF793462
F3/04	13/01/98	JMP	Scolt head, NNR sign, saltmarsh and mud	0	W	9		TF794463
F3/05	13/01/98	JMP	View from Scolt head	90	W	9		TF794463
F3/06	13/01/98	JMP	View from Scolt head	180	W	9		TF794463
F3/07	13/01/98	JMP	View from Scolt head	270	W	9		TF794463
F3/08	13/01/98	JMP	*Lanice* on side of channel	320	N	12		TF797459
F3/09	13/01/98	JMP	Mussel bed	180	W	14		TF800454
F3/10	13/01/98	JMP	Muddy sand, sparse fucoids & mussel bed in shallows	100	W	16		TF805457
F3/11	13/01/98	JMP	Saltmarsh in foreground onto higher shore mud	250	W	19		TF814457
F3/12	13/01/98	JMP	Saltmarsh upriver & eroding muddy edge	120	W	19		TF814457
F3/13	13/01/98	JMP	View up tidal creek	90	W	20		TF815456
F3/14	13/01/98	JMP	Sand creek with cockle shells in foreground	90	W	25		TF834456
F3/15	13/01/98	JMP	Mud, Ap.P, saltmarsh and dunes	90	W	27		TF843457
F3/16	13/01/98	JMP	Mud, Ap.P, saltmarsh and dunes	0	W	27		TF843457
F3/18	14/01/98	JMP	Winkles, *F.vesiculosus*, *Elminius* & tied down cobbles at side of	100	W	5		TF785457
F3/19	14/01/98	JMP	Muddy creek, saltmarsh in foreground & boats in distance	90	W	14		TF795449
F3/20	14/01/98	JMP	*Mya* - dead - eroded away at side of channel	120	N	16		TF787448
F3/21	14/01/98	JMP	View down creek across Ap.P	120	W	16		TF787448
F3/22	15/01/98	JMP	Sandy mud by saltmarsh, old sewage pipe in distance	310	W	1		TF966449

ID	Date	Photographer	Subject	Compass bearing (degrees)	View W(ide) N(ormal) C(loseup) M(acro)	Wpt	Slide number	Grid Ref
F3/23	15/01/98	JMP	*F.vesiculosus*, cobbles, sand - rocky island surrounded by sand	90	W	2		TF967454
F3/24	15/01/98	JMP	Dense *Lanice* in sand	0	N	3		TF968454
F3/25	15/01/98	JMP	Dense *Lanice*; mussels behind	90	W	4		TF970455
F3/26	15/01/98	JMP	*Mytilus* beds	90	N	6		TF971455
F3/27	15/01/98	JMP	V. dense *Lanice* beds	90	N	7		TF970455
F3/28	15/01/98	JMP	D.Rostron on mud flats	40	W	10		TG029452
F3/29	15/01/98	JMP	River channel with sand then mud behind	270	W	11		TG029453
F3/30	15/01/98	JMP	*Hediste* clay (old saltmarsh?) looking towards Blakeney village	160	W	14		TG025452
F3/31	15/01/98	JMP	*F.vesiculosus* on boulders & mud on side of flood embankment	30	W	0		TF845444
F4/01	13/01/98	FB	LGS.BarSnd beach backed by dunes	60	W	1	200198 R4V 8405	TF796470
F4/02	13/01/98	FB	LGS.BarSh - shingle and sand mixed	90	W	9	200198 R4V 8405	TF823465
F4/03	13/01/98	FB	View down beach from top of shingle ridge	0	W	9	200198 R4V 8405	TF823465
F4/04	13/01/98	FB	Eroded clay/sediment below shingle on open coast	90	W	9	200198 R4V 8405	TF823465
F4/05	13/01/98	FB	*Macoma* shells in eroded clay below shingle ridge	90	W	11	200198 R4V 8405	TF824464
F4/06	13/01/98	FB	*Macoma* shells in eroded clay below shingle ridge	0	N	11	200198 R4V 8405	TF824464
F4/07	13/01/98	FB	View of sandy beach in Overy area	270	W	16	200198 R4V 8405	TF848462
F4/08	13/01/98	FB	LGS.BarSnd ridge and Overy river channel	270	W	17	200198 R4V 8405	TF847460
F4/09	13/01/98	FB	Scoured sand and gravel of Overy river channel	270	W	19	200198 R4V 8405	TF848459
F4/10	13/01/98	FB	Scoured sand and gravel of Overy river channel	90		19	200198 R4V 8405	TF848459
F4/11	13/01/98	FB	LGS.AEur on banks of Overy river	180	W	20	200198 R4V 8405	TF847457
F4/12	13/01/98	FB	*Lanice* in sandy gravel, S side Overy river	90	W	21	200198 R4V 8405	TF846456
F4/13	13/01/98	FB	*Lanice* in sandy gravel, S side Overy river	45	W	21	200198 R4V 8405	TF846456
F4/14	13/01/98	FB	Cut away of LMU.HedMac by Overy river bank	225	W	24	200198 R4V 8405	TF845454
F4/15	13/01/98	FB	Sandy mud with no conspicuous fauna LMU.Ol	180	W	24	200198 R4V 8405	TF845454
F4/16	13/01/98	FB	Area of SLR.FvesX	90	W	26	200198 R4V 8405	TF847454
F4/17	14/01/98	FB	View down shore showing peat outcrops from sand	0	W	7	200198 R4V 8405	TF766450
F4/18	14/01/98	FB	MLR.Rpid biotope - piddocks in peat	45	W	7	200198 R4V 8405	TF766450
F4/19	14/01/98	FB	MLR.Rpid biotope - surveyed by H Vine	90	W	10	200198 R4V 8405	TF765452
F4/20	14/01/98	FB	MLR.Rpid biotope - surveyed by H Vine	90	W	10	200198 R4V 8405	TF765452
F4/21	14/01/98	FB	MLR.Rpid biotope - main extent	270	W	13	200198 R4V 8405	TF755453
F4/22	14/01/98	FB	Live *Barnea candida* on peat	270	W	13	200198 R4V 8405	TF755453
F4/23	14/01/98	FB	Lagoon behind dunes	225	W	20	200198 R4V 8405	TF753448

ID	Date	Photographer	Subject	Compass bearing (degrees)	View W(ide) N(ormal) C(loseup) M(acro)	Wpt	Slide number	Grid Ref
F4/24	14/01/98	FB	*Mytilus* bed on W end of piddock beds	90	W	22	200198 R4V 8405	TF750452
F4/25	14/01/98	FB	*Mytilus* bed on W end of piddock beds	90	W	22	200198 R4V 8405	TF750452
F4/26	14/01/98	FB	View east over sandy shore	90	W	24	200198 R4V 8405	TF746452
F4/27	14/01/98	FB	View west over sandy shore	270	W	24	200198 R4V 8405	TF746452
F4/28	14/01/98	FB	*Flustra* dominated strandline	270	W	27	200198 R4V 8405	TF740452
F4/29	14/01/98	FB	Razor shell strand line & sand / gravel	115	W	29	200198 R4V 8405	TF738450
F4/30	15/01/98	FB	Boat "Jenny" & LMU.HedScr	270	W	1	200198 R4V 8405	TF791444
F4/31	15/01/98	FB	Saltmarsh creeks with LMU.HedScr	315	W	1	200198 R4V 8405	TF791444
F5/01	15/01/98	FB	LGS.Ap.P sand in channel + boat	270	W	7	280198 G1L 2422	TF797447
F5/02	15/01/98	FB	LGS.Ap.P sand in channel + boat	90	W	7	280198 G1L 2422	TF797447
F5/03	15/01/98	FB	Aberrant *Fucus spiralis* in pioneer saltmarsh	270	W	7	280198 G1L 2422	TF797447
F5/04	15/01/98	FB	SLR.FvesX + HedMac along river channel w bank	0	W	8	280198 G1L 2422	TF915439
F5/05	15/01/98	FB	LGS.Ap.P sand in mid channel	45	W	9	280198 G1L 2422	TF916441
F5/06	15/01/98	FB	FB crossing Wells channel	90	W	9	280198 G1L 2422	TF916441
F5/07	15/01/98	FB	FB crossing Wells channel	90	W	9	280198 G1L 2422	TF916441
F5/08	15/01/98	FB	Geese flying above	0	W	9	280198 G1L 2422	TF916441
F5/09	15/01/98	FB	Sunset down Wells River channel	180	W	9	280198 G1L 2422	TF916441

ENGLISH NATURE

North Norfolk Coast (candidate SAC)

Biotopes

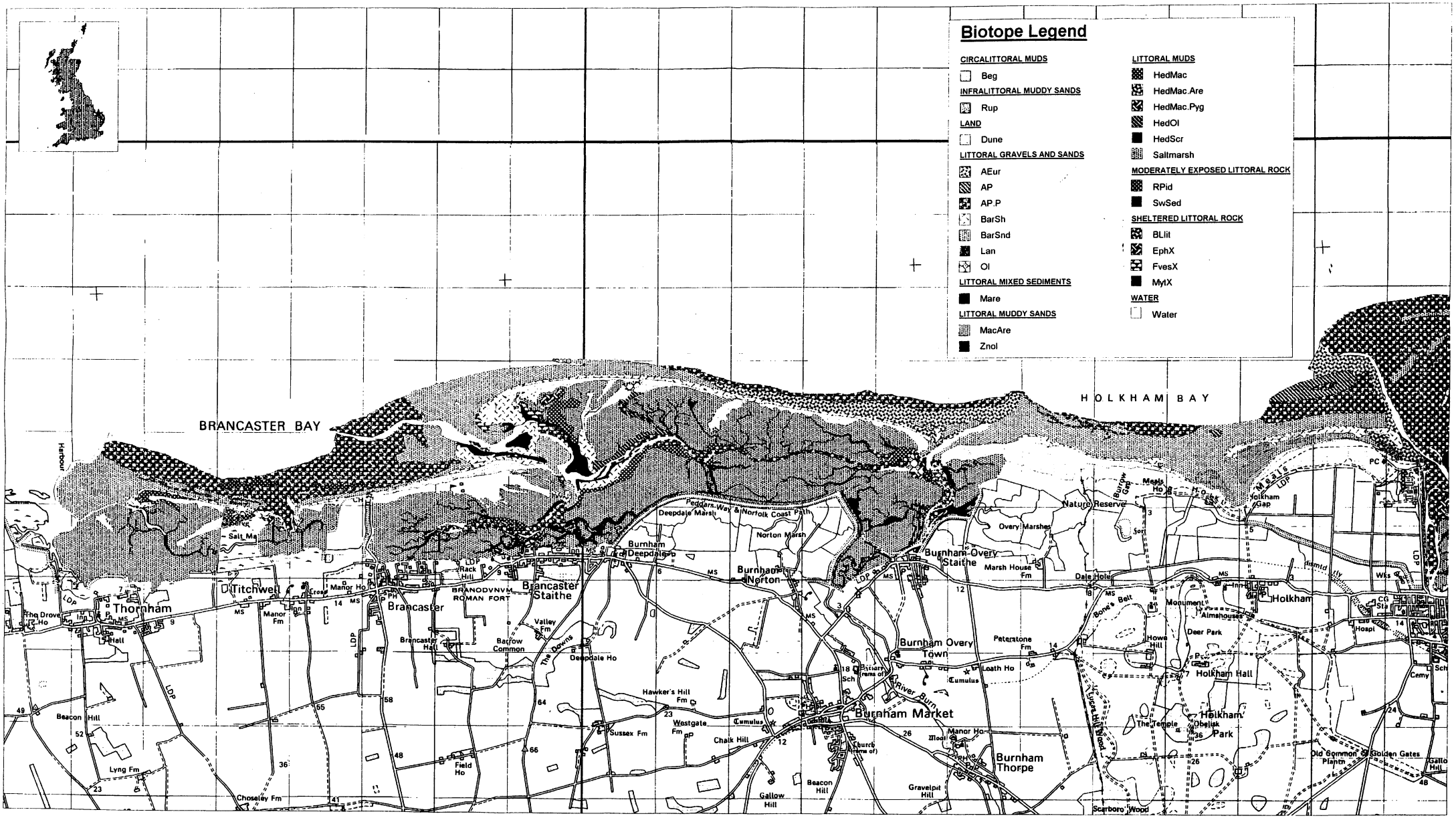
Compiled by JMP on 3 February 1998

Figure 4 - Biotope map of western area of north Norfolk coast

marine_seen
environmental survey and images

exeGesIS
Spatial Data Management

Scale 1:50000



ENGLISH NATURE

North Norfolk Coast (candidate SAC)

Biotopes

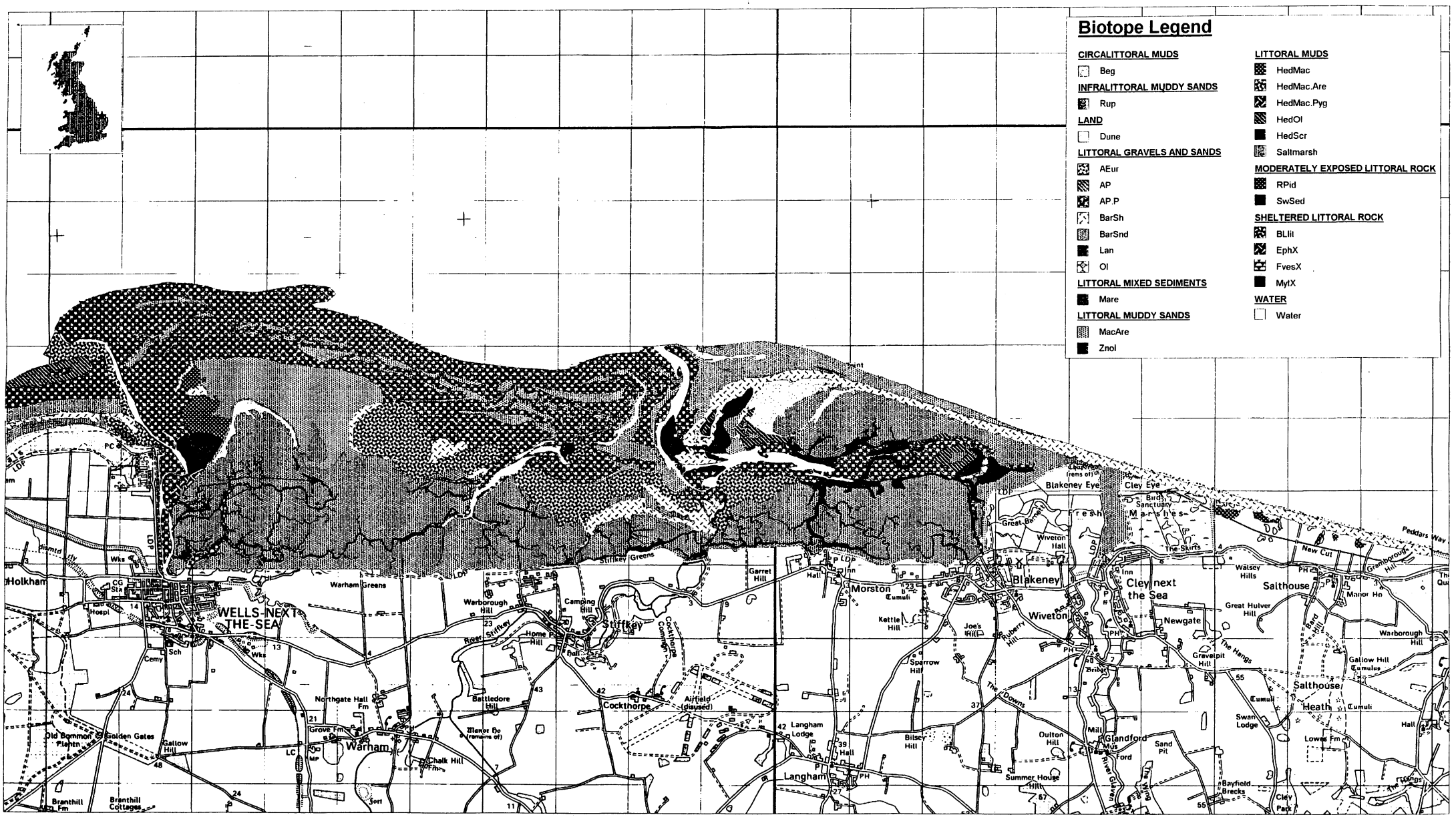
Compiled by JMP on 3 February 1998

Figure 5 - Biotope map of eastern area of north Norfolk coast

marine_seen
environmental survey and images

exeGesIS
Spatial Data Management

Scale 1:50000



ENGLISH NATURE

North Norfolk Coast (candidate SAC)

Biotope complex

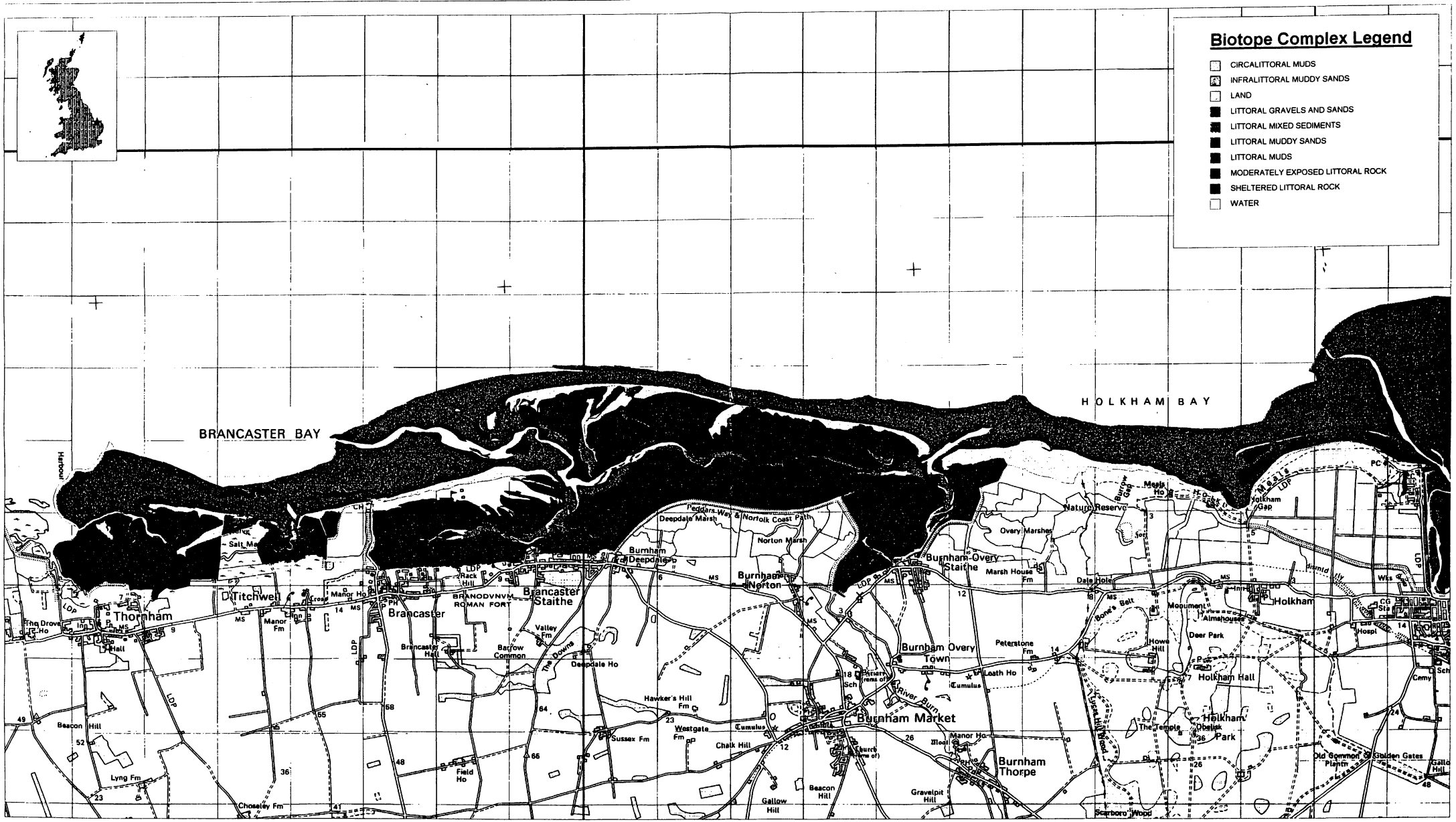
Compiled by JMP on 3 February 1998

Figure 6 - Biotope complex map of western area of north Norfolk coast

marine_seen
environmental survey and images

exeGesIS
Spatial Data Management

Scale 1:50000



ENGLISH NATURE

North Norfolk Coast (candidate SAC)

Biotope complex

Compiled by JMP on 3 February 1998

Figure 7 - Biotope complex map of eastern area of north Norfolk coast

marine_seen
environmental survey and images

exeGesIS
Spatial Data Management

Scale 1:50000

ENGLISH NATURE

North Norfolk Coast (candidate SAC)

Lifeforms

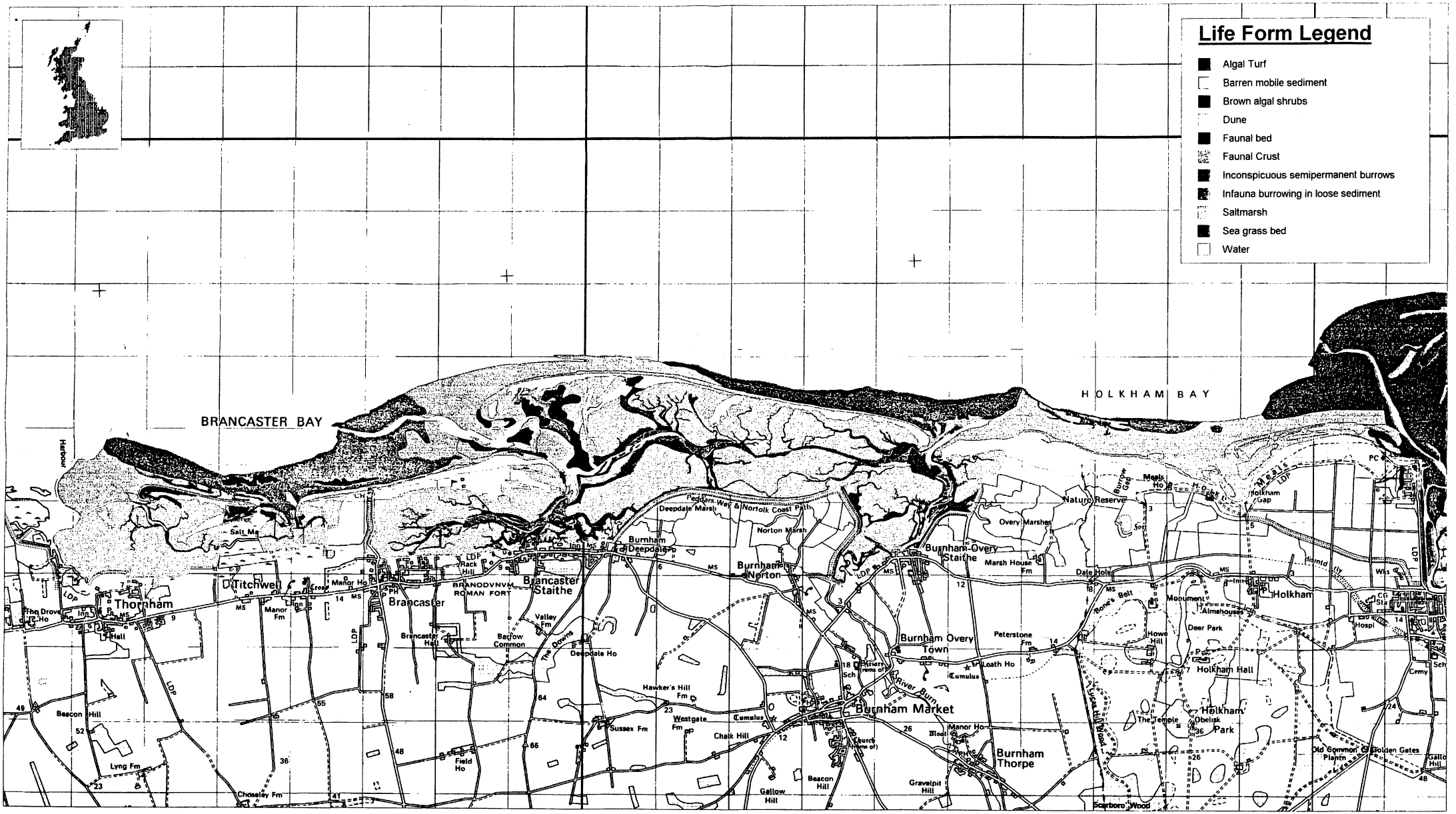
Compiled by JMP on 3 February 1998

Figure 8 - Life form map of western area of north Norfolk coast

marine_seen
environmental survey and images

exeGesIS
Spatial Data Management

Scale 1:50000



ENGLISH NATURE

North Norfolk Coast (candidate SAC)

Lifeforms

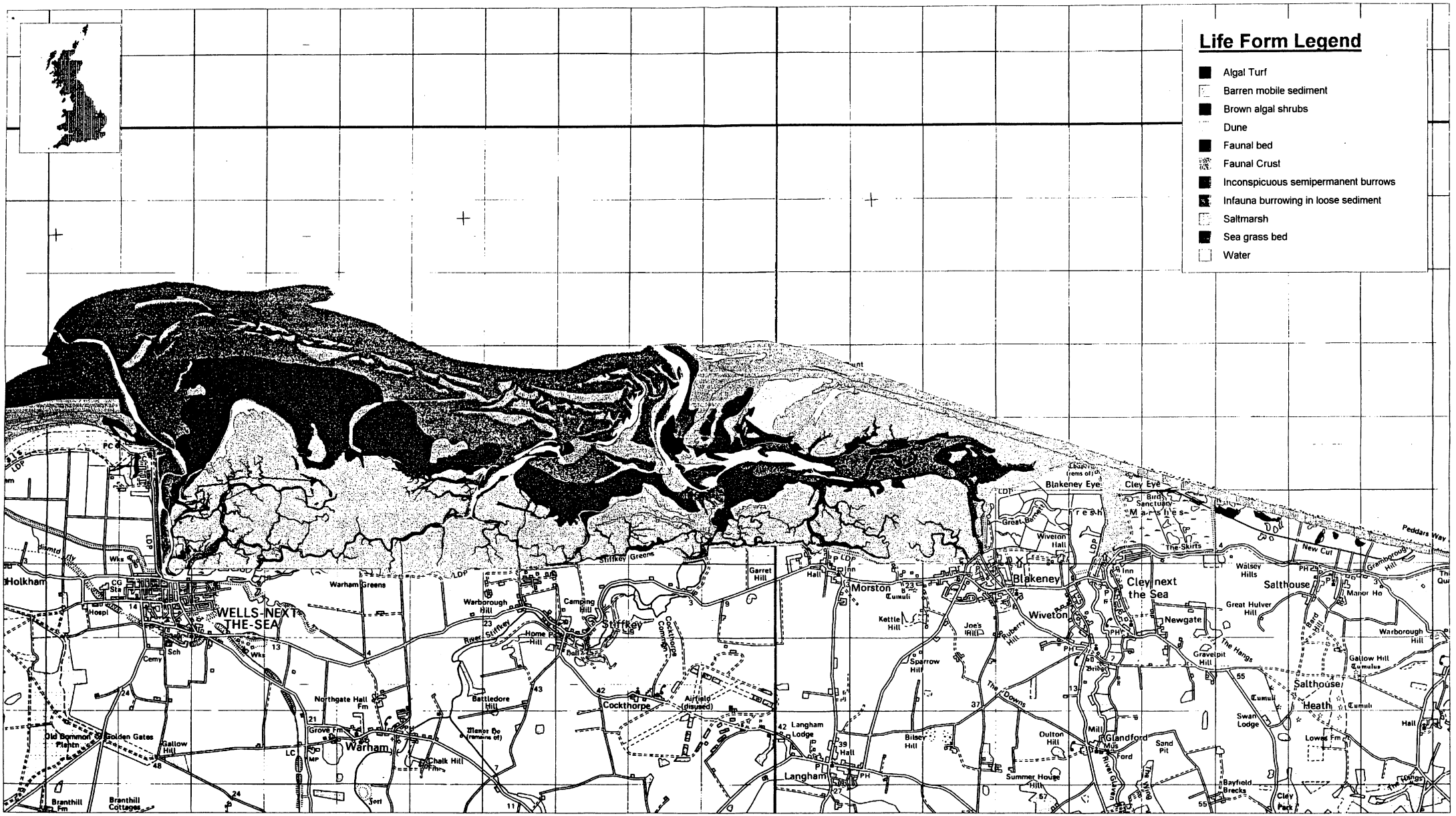
Compiled by JMP on 3 February 1998

Figure 9 - Life form map of eastern area of north Norfolk coast

marine_seen
environmental survey and images

exeGesIS
Spatial Data Management

Scale 1:50000



ENGLISH NATURE

North Norfolk Coast (candidate SAC)

Target note locations and tracks of area surveyed

Compiled by JMP on 3 February 1998

Figure 10 - Map showing tracks taken by field workers and locations of target notes

marine_seen
environmental survey and images

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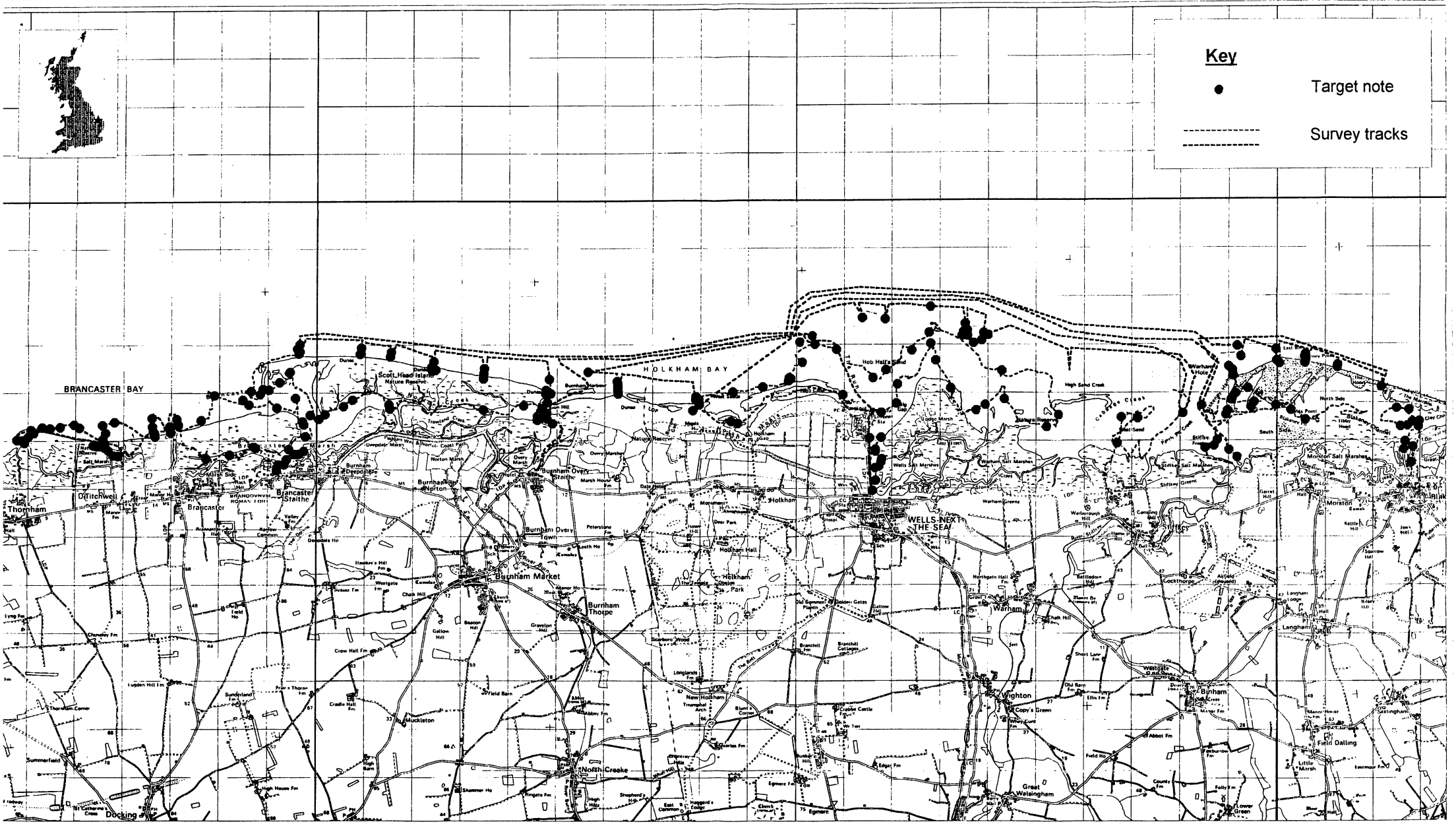
Spatial Data Management

Scale 1:75000



ENGLISH NATURE

North Norfolk Coast (candidate SAC)

Location and direction of photographs taken

Compiled by JMP on 3 February 1998

Figure 11 - Map showing location and orientation of photographs

marine_seen
environmental survey and images

exeGesIS
Spatial Data Management

Scale 1:75000