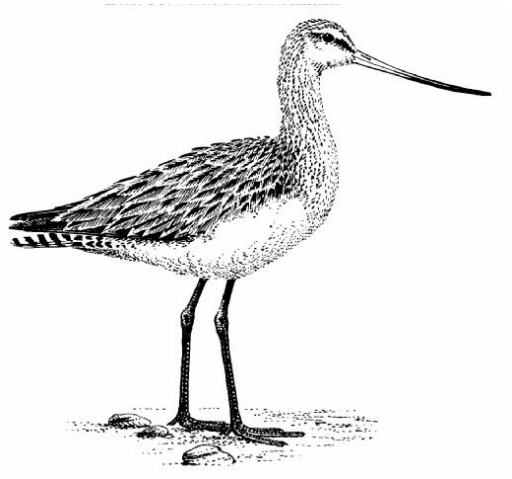
ENGLISH NATURE

THE HUMBER ESTUARY EUROPEAN MARINE SITE

comprising:

Humber Estuary possible Special Area of Conservation
Humber Flats, Marshes and Coast Special Protection Area & potential Special Protection Area
Humber Flats, Marshes and Coast Ramsar Site & proposed Ramsar Site

English Nature's advice given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994



INTERIM ADVICE
APRIL 2003

English Nature's advice for the Humber Estuary European marine site given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994

Preface

This document provides English Nature's advice to other relevant authorities as to (a) the conservation objectives and (b) any operations which may cause deterioration of natural habitats or the habitats of species, or disturbance of species for the Humber Estuary European marine site. This advice is being prepared to fulfil our obligations under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994.

European sites include Special Areas of Conservation (designated under the Habitats Directive, which support certain natural habitats and species of European importance) and Special Protection Areas (classified under the Birds Directive which support significant numbers of internationally important wild birds). Ramsar sites support internationally important wetlands and wetland species (listed under the Convention on Wetlands of International Importance especially as Waterfowl Habitat). In accordance with DETR's[i] Planning Policy Guidance (PPG9) and the DETR statement *Ramsar Sites in England* (November 2000)*;* Ramsar sites must be given the same consideration as European sites when considering plans and projects that may affect them.
European marine sites are defined in the Conservation (Natural Habitats &c.) Regulations 1994 as any part of a European site covered (continuously or intermittently) by tidal waters or any part of the sea in or adjacent to Great Britain up to the seaward limit of territorial waters.

The Humber Estuary European marine site comprises a possible Special Area of Conservation – the Humber Estuary; a Special Protection Area and Ramsar site - Humber Flats, Marshes and Coast Phase 1 (classified in July 1994) and a potential Special Protection Area and proposed Ramsar site - Humber Flats, Marshes and Coast Phase 2 (yet to be classified). Although parts of these European sites have not yet been formally designated, it has been agreed by the relevant authorities that this Regulation 33 advice will be progressed for the pSAC, pSPA and pRamsar, as well as for the designated areas. Our advice within this document will cover the marine elements of all of these sites.

This 'Regulation 33 package' is structured to help relevant and competent authorities, who have responsibilities on and around the Humber, to implement the Habitats Directive, and to:

- understand the international importance of the site, underlying physical processes and the ecological requirements of the habitats and species involved;
- advise relevant authorities as to the conservation objectives for the site and operations which may cause deterioration and disturbance;
- set the standards against which the condition of the site's interest features can be determined and undertake compliance monitoring to establish whether they are in favourable condition; and
- develop, if deemed necessary, a management scheme to ensure that the features are maintained.

In addition, the Regulation 33 package will provide a basis to inform on the scope and nature of 'appropriate assessments' required in relation to plans and projects (Regulations 48 & 50 and by English Nature under Regulation 20). English Nature will also provide more detailed advice to competent and relevant authorities to assess the implications of any given plan or project under the Regulations, where appropriate, at the time a plan or project is being considered.
The designations on the Humber Estuary are currently under review by English Nature. This Regulation 33 advice will be updated in the future to reflect any subsequent changes to the boundaries or the features of the Humber Estuary European marine site.

Richard Leafe, General Manager
English Nature, September 2002

i Now DEFRA

Acknowledgements

English Nature would like to thank all the organisations and individuals who have assisted in the development of this Regulation 33 advice package, in particular:

Peter Barham	ABP
Peter J Cook	BSBI Recorder
Julie Eaton	DEFRA
Tony Edwards	Environment Agency
Richard Freestone	Environment Agency
Judith Stoutt	ESFJC
Ray Eades	Humber Advisory Group
Andrew Grieve	Humber Advisory Group
Walter Houlton	Humber Advisory Group
Mike Sleight	Humber Advisory Group
Emma Giles	Humber Project Officer
Nick Cutts	IECS
Paul Jackson	Lower Ouse Internal Drainage Board
Lionel Grooby	LWT
Giles Bartlett	NESFC
Squadron Leader Neil Jones	RAF Donna Nook
Nicola Melville	RSPB
Ian Higginson	RSPB Humber Reserves Area Manager
Professor Boyd	Sea Mammal Research Unit
Josephine Clarke	WDCS
Ali Champion	WWF-UK
Will Kemp	Yorkshire and Humber Assembly
Alice Owen	Yorkshire Forward

In addition, the members of the Humber Estuary European marine site management group and advisory group, and those people attending the exposure score workshop.

Contents

List of tables

INTRODUCTORY SECTIONS

English Nature's advice for the Humber Estuary European marine site given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994

1. Introduction to Regulation 33 advice

1.1 Natura 2000

The European Union Habitats[1] and Birds Directives[2] are international agreements that set out a number of actions to be taken for nature conservation. The Habitats Directive aims to promote the maintenance of biodiversity, taking account of economic, social, cultural and regional requirements, and sets out measures to maintain or restore natural habitats and species of European Union interest at favourable conservation status[3]. The Birds Directive protects all wild birds and their habitats within the European Union, and there are special measures for migratory birds and those that are considered rare or vulnerable.

The Habitats and Birds Directives include requirements for the designation of conservation areas. In the case of the Habitats Directive, these are Special Areas of Conservation (SACs) that support certain natural habitats or species, and in the Birds Directive, Special Protection Areas (SPAs) that support wild birds of European Union interest. In 1999, lists of candidate Special Areas of Conservation were submitted to the European Commission for a process known as moderation. Shortfalls across the whole Atlantic Biogeographic Region were identified, and in the UK these have been addressed by including further interest features occurring on existing sites, or by extending site boundaries to include more of particular habitats and species. However, 81 new sites were also identified and this included the Humber Estuary pSAC.

These SACs and SPAs are known as European sites and will form a network of conservation areas across the EU to be known as "Natura 2000". Where these sites consist of areas continuously or intermittently covered by tidal waters or any part of the sea in or adjacent to Great Britain up to the limit of territorial waters, they are referred to as European marine sites.

The Convention on Wetlands of International Importance especially as Waterfowl Habitats was signed in Ramsar, Iran in 1971. The broad objectives are to stem the loss and progressive encroachment on wetlands now and in the future, through the designation of Ramsar sites. A habitat can qualify as a Ramsar site for its representation of a wetland, the plant or animal species it supports and for its role in supporting internationally important waterfowl. In accordance with DETR's Planning Policy Guidance (PPG9) and the DETR statement *Ramsar Sites in England* (November 2000)*;* Ramsar sites classified under the Convention on Wetlands of International Importance[4] must be given the same consideration as European sites when considering plans and projects that may affect them.

Further guidance on European marine sites is contained in the Department of the Environment Transport and Regions/Welsh Office document: *European marine sites in England & Wales: A guide to the Conservation (Natural Habitats &c.) Regulations 1994 and to the preparation and application of management schemes,* and Department of the Environment. 1998. *Planning Policy Guidance No. 9: Nature Conservation*. London, HMSO.

[1] Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora

[2] Council Directive 79/409/EEC on the conservation of wild birds

[3] A habitat or species is defined as being at favourable conservation status when its natural range and the areas it covers within that range are stable or increasing and the specific structure and functions which are necessary for its long term maintenance exist and are likely to continue to exist for the foreseeable future

[4] Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention), 1971.

1.2 English Nature's role

The Conservation (Natural Habitats &c.) Regulations 1994 transpose the Habitats Directive into law in Great Britain. It gives English Nature a statutory responsibility to advise relevant authorities as to the conservation objectives for European marine sites in England and to advise relevant authorities as to any operations which may cause deterioration of natural habitats or the habitats of species, or disturbance of species for which the sites have been designated. This information will be a key component of any management scheme, which may be developed for these sites.

This document is English Nature's interim advice for the Humber Estuary European marine site issued in fulfilment of Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994 (the 'Regulation 33 package'). Copies of key references quoted in this document may be held at the English Nature local office, in Wakefield, West Yorkshire.

In addition to providing such advice, the Regulation 33 package informs on the scope and nature of 'appropriate assessments' which the Directive requires to be undertaken for plans and projects (Regulations 48 & 50 and by English Nature under Regulation 20, shown in appendix IX and sections 4.6 and 4.7). English Nature may also provide more detailed advice to competent and relevant authorities to assess the implications of any such plans or projects.

1.3 The role of relevant authorities

The Conservation (Natural Habitats &c.) Regulations 1994 require competent authorities to exercise their functions so as to secure compliance with the Habitats Directive. The single management scheme which the relevant authorities are drawing up under Regulation 34 for the Humber Estuary European marine site will provide the framework through which this will be done and it should be based on the advice in this package. Relevant authorities must, within their areas of jurisdiction, have regard to both direct and indirect effects on interest features of the site. This may include consideration of issues outside the boundary of the European marine site.

Relevant authorities should ensure that all present and future plans for the area integrate with the management scheme for the European marine site. Such plans may include shoreline management plans, local Environment Agency plans, SSSI/Ramsar management plans, Local Nature Reserve (LNR) management plans, National Park management plans, Coastal Habitat Management Plans (CHaMPs), Sites of Nature Conservation Interest (SNCI), local and national Biodiversity Action Plans (BAP) and sustainable development strategies for estuaries. This must occur to ensure that there is only a single management scheme through which all relevant authorities exercise their duties under the Conservation (Natural Habitats &c.) Regulations 1994.

Relevant authorities also need to have regard to changing circumstances of the SAC, SPA and Ramsar site and may therefore need to modify the management scheme and/or the way in which they exercise their functions so as to maintain the favourable condition of interest features. There is no legal requirement for relevant authorities to take any actions outside their statutory functions.

Under certain circumstances, where another relevant authority is unable to act for legal reasons, or where there is no other relevant authority, English Nature is empowered to use its bylaw-making powers for Marine Nature Reserves (MNR) and National Nature Reserves (NNR) for use in European marine sites.

1.4 Activity outside the control of relevant authorities

Nothing within this Regulation 33 package will require relevant authorities to undertake any actions or ameliorate changes in the condition of interest features if it is shown that the changes result wholly from natural causes[5].

[5] Determination of what constitutes natural change will be based on the best available information and scientific opinion at the time.

Having issued Regulation 33 advice for European marine sites, English Nature will work with relevant authorities and others to agree, within a defined time frame, a protocol for evaluating all observed changes to baselines and to develop an understanding of natural change and provide further guidance as appropriate and possible. For the Humber Estuary European marine site a management group has already been set up and should be used to alert all relevant authorities to such issues so that they may be assessed and any appropriate measures taken. This does not, however, preclude relevant authorities from taking action to prevent deterioration to the interest features, for example by introducing or promoting codes of practice through the management group.

1.5 Responsibilities under other conservation designations

In addition to its possible SAC; SPA and Ramsar site phase 1 and potential SPA and proposed Ramsar site phase 2 status, parts of the Humber Estuary European marine site are also designated and subject to agreements under other conservation mechanisms (e.g. SSSIs notified under the Wildlife and Countryside Act 1981). The obligations of relevant authorities and other organisations under such designations are not affected by the advice contained in this document.

1.6 Role of conservation objectives

Sections 6, 10 and 14 of this document set out the conservation objectives for the Humber Estuary European marine site. They are the starting point from which management schemes and monitoring programmes may be developed as they provide the basis for determining what is currently, or may in the future cause a significant effect, and for informing on the scope of appropriate assessments of plans or projects. The conservation objectives set out what needs to be achieved and thus deliver the aims of the Habitats Directive.

1.7 Role of advice on operations

The advice on operations set out in Sections 8, 12 and 16 provide the basis for discussion about the nature and extent of the operations taking place within or close to the site, which may have an impact on its interest features. It is given on the basis of the working assumption that sites were in favourable condition at the time they were identified. In the 2000-2006 reporting period an assessment of the condition of the site will be made to support this assumption. However, it is known that some features of the site in some areas are currently not in favourable condition, although these habitats contribute to this interest features across the UK. The advice should also be used to identify the extent to which existing measures of control, management and use are, or can be made, consistent with the conservation objectives, and thereby focus the attention of relevant authorities and surveillance to areas that may need management measures.

This operations advice may need to be supplemented through further discussions with any management and advisory groups for the European marine site.

1.8 European sites

A European site is any one of the following, as defined in the Conservation (Natural Habitats, &c.) Regulations 1994, as amended.

- A special area of conservation (SAC) (designated under the Habitats Directive, which supports certain natural habitats and species of European importance);
- A site of community importance (SCI) (after a cSAC has been accepted by the government and European Commission it becomes an SCI);
- A site hosting a priority natural habitat type or priority species which the European Commission thinks should be on the list submitted by the UK government;
- A classified Special Protection Area (SPA) (classified under the Birds Directive which supports significant numbers of internationally important wild birds);

- A candidate Special Area of Conservation (after submission to the European Commission (but before designation by government) a site becomes a candidate SAC).

Also, in accordance with DETR's Planning Policy Guidance (PPG9) and the DETR statement *Ramsar Sites in England* (November 2000)*;* Ramsar sites must be given the same consideration as European sites when considering plans and projects that may affect them.

Where the European site lies below highest astronomical tide i.e. land covered (continuously or intermittently) by tidal waters, or any part of the sea, in or adjacent to Great Britain, up to the seaward limit of territorial waters, it is described as a European marine site.
The marine areas of the Humber Estuary possible Special Area of Conservation and the Humber Flats, Marshes and Coast Special Protection Area and Ramsar site Phase 1 and Phase 2, together form the Humber Estuary European marine site.

1.9 Precautionary principle

All forms of environmental risk should be tested against the precautionary principle which means that where there are real risks to the site, lack of full scientific certainty should not be used as a reason for postponing measures that are likely to be cost effective in preventing such damage. It does not however imply that the suggested cause of such damage must be eradicated unless proved to be harmless and it cannot be used as a licence to invent hypothetical consequences. Moreover, it is important, when considering whether the information available is sufficient, to take account of the associated balance of likely costs, including environmental costs, and benefits (DETR & the Welsh Office, 1998).

2. Identification of interest features under the EU Habitats and Birds Directives and the Convention on Wetlands of International Importance

2.1 Introduction

The Humber Estuary is one of the largest estuaries in the UK. At over 30,550 ha, (75,492 acres) and 14km at its widest point, it is the largest macro-tidal coastal plain estuary on the British North Sea, draining around 20% of the total land surface of England. It encompasses the outflow from the rivers Trent, Ouse and Hull and provides the largest single output of fresh water from Britain into the North Sea.

The estuary formed after the last glaciation and resulted from the influence of the sea on the soft boulder clay left after the ice retreated and subsequent sea level rise. It is macro-tidal with a mean spring tidal range of 5.7m at Spurn, increasing to 7.4m at Saltend, and decreasing to 6.9m at Hessle, which is 45km inland. The average width of the estuary is 4.3km and the depth 6.5m (Allen *et al*., 2003). The bed of the estuary is mostly sandy with some patches of gravel and glacial till, grading into silty clay in the intertidal areas. The exception is the outer part of the south bank where the higher energy environment and greater marine sediment component results in the intertidal area being predominantly sandy. There are no natural rocky outcrops, except where the Humber Bridge is situated on the chalk of the Lincolnshire and Yorkshire Wolds. A small chalk cliff is also present at South Ferriby on the south bank, and an area of cobble substratum is found at Skitterness. In the outer estuary, Spurn Peninsula, a conspicuous spit of land protrudes 8kms into the mouth of the estuary from the south-eastern extremity of Holderness. The tip of Spurn is surrounded by hard glacial deposits known as moraine, which protect it from erosion. Inside this protective rim, sand dunes up to 15m high and extensive mudflats, known as Spurn Bight have formed. As the Holderness coast erodes, the mouth of the estuary moves inland and Spurn Point moves with it. Historical records show that the spit does occasionally break through.

The Humber Estuary is extremely turbid and sediment transport is particularly important within the estuary, with sediment entering the system from the North Sea, the Holderness coastline and from fluvial sources. The majority of suspended sediment is from the sea, with over 1,500 tonnes carried in per tide, compared to an average of 320 tonnes from riverine sources (Environment Agency, 1998). It has been estimated that up to 1.26 million tonnes of sediment may be present in the water column, with around 170 tonnes deposited in the estuary on each tide, and 150 tonnes exported to the sea (Environment Agency, 1998). The deposited sediments provide essential material to maintain the mudflats, sandflats and saltmarsh, and concentrate where the River Trent enters the estuary and on the extensive intertidal flats of the outer estuary. The erosion and accretion of sediments is a feature of much of the estuary, as is the changing position of the main channel upstream of the bridge. General channel morphology however is subject to regular spring-neap and winter-summer erosion-deposition cycles. Also, in the upper reaches of the estuary, the steeply sloping bed produces a tidal bore, which is particularly noticeable in the north channel around Whitton Sands (Allen *et al*., 2003). The constant resuspension of sediment and the associated high suspended solids load gives the estuary its characteristic brown colouration (IECS 1994).
The natural processes acting on the estuary are immensely powerful, but the coastline (without human influence) can adapt in response to these forces as a dynamic system. On the Humber, much of the dynamic nature of the estuary is constrained by sea defences along almost its entire length, with these structures restricting the development of intertidal mudflats and saltmarsh (Allen *et al*., 2003). Possibly the most dynamic section of the estuary is the inner reach between the Humber Bridge and Trent Falls where there are frequent channel migrations around Read's Island. Recent research has revealed a number of mechanisms responsible for channel movement in this area, including fresh water discharge and tidal regime. There are also dynamic interactions between the various bank systems in the inner and middle estuary releasing sediment which form mud and sand bars that create semi-permanent islands. There are also channel movements in the outer estuary.

Today, the Humber Estuary is a busy commercial waterway. The main influences on the system are urban developments, sea defences, industrial use and dock associated activities. The sea defences enclose much of the estuary and industrial complexes such as chemical works, oil refinery complexes and power stations dominate areas of its shores. It also houses the largest shipping complex in the UK. Alongside all this activity, the estuary also supports an impressive array of habitats and species.
The east coast of England contains almost 30% of the total area of tidal flats in Great Britain and the Humber Estuary contributes significantly to this figure. The intertidal area was estimated at 10,002ha in 1998 (Binnie *et*

al., 2001) and more than 90% of this is mudflat and sandflat. Intertidal flats, especially soft mudflats, support important populations of marine worms, molluscs and other invertebrates, often living in high densities and with high biomass. These provide an abundant food source for fish and are of particular importance for waterfowl, with over 175,000 visiting the site during the winter months.

Saltmarshes also have an important role to play in estuarine processes, both through the recycling of nutrients within the estuary, and through their role as soft sea defences, dissipating wave energy. They are highly productive biologically, providing nutrients that support other features within the marine ecosystem. They also have an important physical role, acting as a sediment store to the estuary as a whole and in providing roosting sites for waders and wildfowl at high tide. In addition, the upper and transitional marsh supports rare coastal invertebrates such as the scarce pug moth *Eupithecia extensaria occidua*. The combination of historical land claim for agricultural use and erosion has reduced the saltmarshes on the Humber. Also, the effects of "coastal squeeze", whereby saltmarshes (and other intertidal habitats) are squeezed out between sea defences and rising sea levels, has caused the saltmarsh to erode at its seaward edge. In a natural system without sea walls, rising sea levels would cause the saltmarsh to move landwards, enabling it to compensate for its seaward losses. Sea defences however, prevent this landward migration and truncate the upper marsh, favouring the development of pioneer marsh species at the expense of Atlantic salt meadows. Local studies indicate that sea levels have been rising in the estuary at an average rate of 2 to 3mm per year in recent times. However, Government has asked defence and planning authorities to plan for an annual increase of 6mm per year over the next 50 years based on official predictions (Environment Agency, 2000). In some places on the Humber, the saltmarsh has been squeezed out completely and the mudflats themselves are being lost. The Environment Agency, through the Humber Shoreline Management Plan are currently proposing sites for managed realignment. These will provide new habitat to compensate for some of the predicted losses. Today, few saltmarshes in the UK show a full transition from pioneer saltmarsh species through to non-tidal vegetation. On the Humber, at Cherry Cobb on the north bank and south of Cleethorpes, there is some transition of saltmarsh vegetation, from pioneer species through to mid to upper marsh communities.

Saline lagoons also occur on the Humber Estuary and at Easington on the Holderness Coast. Lagoons are a priority habitat under the Habitats Directive and are the only priority maritime habitat that occurs in the UK. Lagoons in this region support a high species diversity, including some rare and uncommon species such as the starlet sea anemone *Nematostella vectensis* and the nationally scarce spiral tasselweed *Ruppia cirrhosa*. The lagoonal sand shrimp *Gammarus insensibilis* is found at its northernmost location in Humberston Fitties lagoon, which has been described as the third most important saline lagoon in Britain (Bamber 1992). The lagoons are also important for numerous waders and wildfowl. Little terns *Sterna albifrons* breed beside Easington Lagoons, and following the creation of saline lagoons on Reads Island and at Blacktoft Sands in the upper estuary, avocets *Recurvirostra avosetta* have returned to breed on the Humber after an absence of over 150 years.

The subtidal zone of the Humber is highly dynamic and the community structure is governed primarily by the salinity gradient, and also by the composition of the bottom sediments, sediment load, turbidity and anthropogenic factors related to water quality and dredging. Many of these factors vary with the season and state of the tide. Invertebrates dominate the Humber benthic community with diversity increasing towards the mouth of the estuary. The subtidal area also provides an important breeding, sheltering and nursery area for fish species. It is a major spawning area for the Dover sole *Solea solea* and low levels of commercial fishing for this species takes place as well as for plaice *Pleuronectes platessa*, cod *Gadus morhua,* eel *Anguilla anguilla* and shrimp *Crangon crangon*. In recent years, 82 species of fish have been recorded in the Humber Estuary, including the primitive river *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus*. Although numbers of lamprey have declined over the last 100 years, the UK is still one of their strongholds. They use the Humber as a migratory passage to and from their spawning and nursery grounds in the River Derwent and the River Ouse system.

Many estuaries in the UK are of great importance to migratory and wintering wildfowl, and the habitat mosaics of estuaries found on the east coast of England provide feeding and roosting sites. The relatively mild winter weather conditions found here compared to continental Europe can be of additional importance to the survival of wintering waterfowl during periods of severe weather. The Humber Estuary ranks amongst the top five British estuaries for the size of visiting waterfowl populations that it supports over winter. Outside of this period, it is of particular importance as a staging and moulting area in autumn and spring for migratory waterfowl species as it lies on the East Atlantic Flyway route and is also of importance for scarce and declining breeding birds.

Marine mammals are also found in and around the Humber Estuary. Donna Nook on the north Lincolnshire coast is an important breeding site for grey seals *Halichoerus grypus;* and harbour porpoises *Phocoena phocoena* are observed throughout the year off Spurn Head and at the entrance to the estuary.

At the time of compiling this advice, the Humber Estuary European marine site comprises the marine components of the Humber Estuary possible Special Area of Conservation (pSAC), the Humber Flats, Marshes and Coast Special Protection Area (SPA) Phase 1 and Phase 2, and the Humber Flats, Marshes and Coast Ramsar site Phase 1 and Phase 2. Phase 1 of these sites was classified in July 1994; Phase 2 is an extension to these sites and has not yet been classified. (These phase 2 sites are referred to as a potential SPA and proposed Ramsar site).
Although the pSAC, pSPA and pRamsar have not yet been formally designated; as stated in PPG 9[6] (Para 13), 'for the purpose of considering development proposals affecting them, potential SPAs. …should be treated in the same way as classified SPAs'. While not required by law, or explicitly stated within Government policy, it is also good practice for developers and competent authorities to take account of the possible SAC in the preparation and assessment of applications for plans and projects, (particularly in light of the Review of Consents procedure under the Habitats Regulations). Likewise, developers should take account of the proposed Ramsar site, following the application of the Review of Consents procedure to these sites, stated in the UK Government's Policy Statement on Ramsar sites in England released in November 2000. It has therefore been agreed to develop this Regulation 33 advice for the Humber Estuary European marine site using the April and June 2000 citations, which cover the designated sites and pSAC, pSPA and pRamsar site to inform this process.

The marine components of all of these sites qualify as European marine sites, but for simplicity and for the purposes of this advice, the SAC, SPA and Ramsar site Phases 1 and 2 are referred to as the Humber Estuary European marine site and are covered within this single Regulation 33 package.
The boundaries of the European marine site are shown in Appendices I to IV.

Please note that the designations on the Humber Estuary are currently under review by English Nature, and this Regulation 33 advice will be updated in the future to reflect any subsequent changes to the boundaries or features of the European marine site.

2.2 Interest features under the EU Habitats Directive

The Humber Estuary possible Special Area of Conservation, as designated under the Habitats Directive, qualifies as a SAC for the following Annex I habitats as listed in the EU Habitats Directive:

- Estuaries
- Coastal lagoons
- Atlantic salt meadows
- *Salicornia* and other annuals colonising mud and sand
- Mudflats and sandflats not covered by seawater at low tide (intertidal mudflats and sandflats)
- Sandbanks which are slightly covered by seawater all the time (subtidal sandbanks)

The Humber Estuary possible Special Area of Conservation, as designated under the Habitats Directive, also qualifies as a SAC for the following Annex II species as listed in the EU Habitats Directive:

- *Lampetra fluviatilis* (river lamprey)
- *Petromyzon marinus* (sea lamprey)

The Humber Estuary possible Special Area of Conservation has yet to be designated. It is the citation dated June 2000 on which this Regulation 33 advice is based.

2.3 Interest features under the EU Birds Directive

The Humber Flats, Marshes and Coast Special Protection Area qualifies under Article 4.1 of the EU Birds Directive by supporting:

- Internationally important populations of regularly occurring Annex I species

6 Planning Policy Guidance Nature Conservation

It also qualifies under Article 4.2 of the EU Birds Directive in that it supports:

- Internationally important populations of regularly occurring migratory species; and
- An internationally important assemblage of waterfowl

The Humber Flats, Marshes and Coast Special Protection Area Phase 1, with an area of 15,230ha was classified on 28 July 1994. The Humber Flats, Marshes and Coast Special Protection Area Phase 2, with an area of 2,188 ha has yet to be classified.
It is the citation for the SPA Phases 1 and 2, dated April 2000 on which this Regulation 33 advice is based.

2.4 Criterion under the Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat

The Humber Flats, Marshes and Coast Ramsar site qualifies under Criterion 2 as it supports vulnerable, endangered or critically endangered species or threatened ecological communities;

- It holds an assemblage of threatened coastal and wetland invertebrates

The Humber Flats, Marshes and Coast Ramsar site qualifies under Criterion 3 as it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region:

- It holds a breeding colony of grey seal, *Halichoerus grypus* on the southern edge of its distribution

The Humber Flats, Marshes and Coast Ramsar site qualifies under Criterion 5 as it regularly supports

- 20, 000 or more waterfowl

The Humber Flats, Marshes and Coast Ramsar site qualifies under Criterion 6 as it regularly supports

- 1% or more of the individuals in a population of one species or sub-species of waterfowl

The Humber Flats, Marshes and Coast Ramsar site Phase 1, with an area of 15,230ha was listed on 28 July 1994.
The Humber Flats, Marshes and Coast Ramsar site Phase 2, with an area of 2,188 ha has yet to be listed.
It is the citation for the Ramsar site Phases 1 and 2, dated April 2000 on which this Regulation 33 advice is based.

(This information is summarised in Table 1)

2.5 Other qualifying features or features of interest within the SAC, SPA and Ramsar designations outside the European marine site

The following features also qualify for each designation (SAC, SPA and Ramsar site) but do not, however, occur within the European marine site as they occur above the highest astronomical tide (HAT). Consequently, there are no specific conservation objectives within this document for these habitats and species. Objectives to maintain these features in favourable condition are identified within English Nature's conservation objectives for the relevant SSSIs within each European site boundary and will be dealt with through procedures outlined in the Conservation (Natural Habitat &c.) Regulations 1994. However, relevant authorities need to have regard to such adjacent interests as they may be affected by activities taking place within, or adjacent to the European marine site.

2.5.1 Humber Estuary pSAC

The Humber Estuary also qualifies as a possible SAC for the Annex I habitats **fixed dunes with herbaceous vegetation ("grey dunes")** (a priority interest feature); **embryonic shifting dunes** and **shifting dunes along the shoreline with *Ammophila arenaria* ("white dunes")**. These do not however, occur within the European marine site as they lie above highest astronomical tide and therefore are not considered further within this document.

Objectives to maintain these habitats in favourable condition are found within English Nature's conservation objectives for the relevant SSSI within the SAC boundary and will be dealt with through procedures outlined in the Conservation (Natural Habitats &c) Regulations 1994. Relevant authorities need to have regard to such adjacent European interests, as they may be affected by activities taking place within, or adjacent to the European marine site.

2.5.2 Humber Flats, Marshes and Coast SPA

There are a number of habitats, such as wet grazing marsh and areas required for avocet to nest, which occur within the boundary of the SPA and support the qualifying bird species. They do not, however, occur within the European marine site as they occur above highest astronomical tide. Objectives to maintain this aspect of bird interest in favourable condition are found within English Nature's conservation objectives for the relevant SSSI within the SPA boundary and will be dealt with through procedures outlined in the Conservation (Natural Habitats &c) Regulations 1994. Relevant authorities need to have regard to such adjacent European interests, as they may be affected by activities taking place within, or adjacent to the European marine site.

2.5.3 Humber Flats, Marshes and Coast Ramsar site

There are a number of **threatened coastal and wetland invertebrate species** listed under Criterion 2 of the Ramsar Convention on Wetlands of International Importance that occur within the boundary of the Ramsar site but outside of the European marine site as they occur above highest astronomical tide. Objectives to maintain habitats important to these species in favourable condition are found within English Nature's conservation objectives for the relevant SSSI within the Ramsar site boundary and will be dealt with through procedures outlined in the Conservation (Natural Habitats &c) Regulations 1994. Relevant authorities need to have regard to such adjacent European interests, as they may be affected by activities taking place within, or adjacent to the European marine site.

Table 1 A summary of all the designations associated with the Humber Estuary European marine site and the habitats protected.

Site name	Designation	Qualifying feature	Habitats protected under each designation										
			Estuary	Coastal lagoons	Atlantic salt meadows	*Salicornia* and other annuals	Intertidal mudflats and sandflats	Subtidal sandbanks	River lamprey	Sea lamprey	Saltmarsh communities	Tidal reedbeds	Unvegetated sand and shingle
Humber Estuary	Possible SAC (Yet to be designated, citation dated June 2000 used for this advice)	Annex I habitats[1]	√	√	√	√	√	√					
		Annex II species[2]							√	√			
Humber Flats, Marshes and Coast	SPA and potential SPA (Phase 1 classified 28/07/94, phase 2 yet to be classified, citation dated April 2000 used for this advice)	Annex I species[3]		√			√				√	√	√
		Migratory species[4]		√			√				√	√	
		Waterfowl assemblage[5]		√			√				√	√	
	Ramsar and proposed Ramsar (Phase 1 listed 28/07/94, phase 2 yet to be listed, citation dated April 2000 used for this advice)	Criterion 2[6]		√							√		
		Criterion 3[7]					√						
		Criterion 5[8]		√			√				√	√	
		Criterion 6[9]		√			√				√	√	

1. Qualifies under Annex I of the EU Habitats Directive. These habitat types are considered to be in most need of conservation at a European level
2. Qualifies under Annex II of the EU Habitats Directive. These species are considered to be in most need of conservation at a European level
3. Qualifies under Article 4.1 of the EU Birds Directive by supporting internationally important populations of regularly occurring Annex I birds
4. Qualifies under Article 4.1 of the EU Birds Directive by supporting internationally important populations of regularly occurring migratory species
5. Qualifies under Article 4.1 of the EU Birds Directive by supporting an internationally important assemblage of waterfowl
6. Qualifies under Criterion 2 of the Convention on Wetlands of International Importance, especially as a waterfowl habitat for hosting an assemblage of threatened coastal and wetland invertebrates
7. Qualifies under Criterion 3 of the Convention on Wetlands of International Importance, especially as a waterfowl habitat for supporting a breeding colony of grey seals on the southern edge of their distribution
8. Qualifies under Criterion 5 of the Convention on Wetlands of International Importance, especially as a waterfowl habitat for regularly supporting 20,000 or more water birds
9. Qualifies under Criterion 6 of the Convention on Wetlands of International Importance, especially as a waterfowl habitat for regularly supporting 1% or more of the biogeographic population of waterfowl species

3. Background to favourable condition tables

The favourable condition table is supplied as an integral part of English Nature's Regulation 33 advice package. It is intended to supplement the conservation objectives only in relation to management of activities and requirements on monitoring the condition of the site and its features. The table **does not by itself** provide a comprehensive basis on which to assess plans and projects as required under Regulations 20 and 48-50, but it does provide a basis to inform the scope and nature of any 'appropriate assessment' that may be needed. It should be noted that appropriate assessments are, by contrast, a separate activity to condition monitoring, requiring consideration of issues specific to individual plans or projects. English Nature will provide more detailed advice to competent and relevant authorities to assess the implications of any given plan or project under the Regulations, where appropriate, at the time a plan or project is being considered.

The favourable condition table is the principle source of information that English Nature will use to assess the condition of an interest feature and as such comprises indicators of condition. On many terrestrial European sites, we know sufficient about the preferred or target condition of qualifying habitats to be able to define measures and associated targets for all attributes to be assessed in condition monitoring. Assessments as to whether individual interest features are in favourable condition will be made against these targets. In European marine sites we know less about habitat condition and find it difficult to specify favourable condition. Individual sites within a single marine habitat category are also all very different, further hampering the identification of generic indicators of condition. Accordingly, in the absence of such information, condition of interest features in European marine sites will be assessed against targets based on the existing conditions, which may need to be established through baseline surveys in many cases.

The assumption that existing interest features on European marine sites are in favourable condition will be tested in the 2000 - 2006 reporting period and the results subsequently fed back into our advice and site management. Where there is more than one year's observations on the condition of marine habitats, all available information will need to be used to set the site within long-term trends in order to form a view on favourable condition. Where it may become clear that certain attributes are a cause for concern, and if detailed studies prove this correct, restorative management actions will need to be taken to return the interest feature from unfavourable to favourable condition. It is the intention of English Nature to provide quantification of targets in the favourable condition table during the 2000 - 2006 reporting period.

This advice also provides the basis for discussions with management and advisory groups, and as such the attributes and associated measures and targets may be modified over time. The aim is to produce a single agreed set of attributes that will then be monitored in order to report on the condition of features. Monitoring of the attributes may be of fairly coarse methodology, underpinned by more rigorous methods on specific areas within the site. To meet UK agreed common standards, English Nature will be committed to reporting on each of the attributes subsequently listed in the final version of the table, although the information to be used may be collected by other organisations through agreements.

The table will be an important, but not the only, driver of the site monitoring programme. Other data, such as results from compliance monitoring and appropriate assessments, will also have an important role in assessing condition. The monitoring programme will be developed as part of the management scheme process through discussion with the relevant authorities and other interested parties. English Nature will be responsible for collating the information required to assess condition and will form a judgement on the condition of each feature within the site, taking into account all available information and using the favourable condition table as a guide.

- The favourable condition table for the pSAC can be found in Section 7
- The favourable condition table for the SPA and pSPA can be found in Section 11
- The favourable condition table for the Ramsar and pRamsar can be found in Section 15

Box 1	Glossary of terms used in favourable condition table
Interest feature	The habitat or species for which the site has been selected.
Sub-feature	An ecologically important sub-division of the interest feature
Attribute	Selected characteristic of an interest feature/sub-feature which provides an indication of the condition of the feature to which it applies.
Measure	What will be measured in terms of the units of measurement, arithmetic nature and frequency at which the measurement is taken. This measure will be attained using a range of methods from broad scale to more specific across the site.
Target	This defines the desired condition of an attribute, taking into account fluctuations due to natural change. Changes that are significantly different from the target will serve as a trigger mechanism through which some further investigation or remedial action is taken.
Comments	The rationale for selection of the attribute.

4. Advice on operations

English Nature has a duty under Regulation 33(2)(b) of the Conservation (Natural Habitats &c.) Regulations 1994 to advise other relevant authorities as to any operations which may cause deterioration of natural habitats or the habitats of species, or disturbance of species, for which the site has been designated. Information on how English Nature has developed this advice is given in Section 4.2 and on how it may be reviewed and updated in the future, in Section 4.4.

The advice is provided in summary form in Table 2 with more detail in Tables 4, 5, 8-13, 16 and 17 and in Sections 8, 12 and 16 including advice in relation to specific interest features and their sub-features.

4.1 Purpose of advice

The aim of this advice is to enable all relevant authorities to direct and prioritise their work on the management of activities that pose the greatest potential threat to the favourable condition of interest features on the Humber Estuary European marine site. The advice is linked to the conservation objectives for interest features and will help provide the basis for detailed discussions within the management group to formulate and agree a management scheme to agreed timescales for the site. The advice given here will inform on, but is without prejudice to, any advice given under Regulation 48 or Regulation 50 on operations that qualify as plans or projects within the meaning of Article 6 of the Habitats Directive.

4.2 Methods for assessment

To develop this advice on operations English Nature has used a three step process involving:

- an assessment of the **sensitivity** of the interest features or their component sub-features to operations;
- an assessment of the **exposure** of each interest feature or their component sub-features to operations; and
- a final assessment of **current vulnerability** of interest features or their component sub-features to operations.

This three step process builds up a level of information necessary to manage activities in and around the European marine site in an effective manner. Through a consistent approach, this process enables English Nature to both explain the reasoning behind our advice and identify to competent and relevant authorities those operations which pose the most current threats to the favourable condition of the interest features on the site.

All the scores of relative sensitivity, exposure and vulnerability are derived using best available scientific information and informed scientific interpretation and judgement. The process uses sufficiently coarse categorisation to minimise uncertainty in information, reflecting the current state of our knowledge and understanding of the marine environment. Information has been gathered from a range of sources including reports such as ABP Research (1999).

4.2.1 Sensitivity assessment

The sensitivity assessment used is an assessment of the relative sensitivity of the interest features or the component sub-features of the Humber Estuary European marine site to the effects of broad categories of human activities. In relation to this assessment, sensitivity has been defined as the intolerance of a habitat, community or individual (or individual colony) of a species to damage, or death, from an external factor (Hiscock, 1996). As an example, eelgrass beds are highly sensitive to changes in nutrient loading. Nutrient enrichment can lead to phytoplankton blooms that increase turbidity. This leads to a lack of light penetration, which may limit the ability of the eelgrasses to photosynthesise.

The sensitivity assessments of the interest features or their component sub-features of the Humber Estuary European marine site are based upon a series of scientific review documents. These include reports produced for the UK Marine SAC LIFE project (Davison & Hughes 1998; Elliott *et al* 1998), the Countryside Council for Wales Science Report (Holt *et al*, 1995) and the Marine Habitats Reviews (Jones *et al*, 2000.).

The sensitivity assessments are based on current information but may develop with improvements in scientific knowledge and understanding. In particular, English Nature and Scottish Natural Heritage have commissioned the Marine Biological Association of the UK, through its Marine *Life* Information Network (MarLIN) to provide detailed sensitivity information to underpin this advice, over the next three years, and available to all over the World Wide Web (www.marlin.ac.uk).

4.2.2 Exposure assessment

This has been undertaken for the Humber Estuary European marine site by assessing the relative exposure of the interest features or their component sub-features to the effects of broad categories of human activities currently occurring on the site (as at July 2002). This was done through a workshop with relevant and competent authorities and members of the Humber Advisory Group. A meeting was also held with Environment Agency staff. It should be noted that the advice drawn together as a result of these discussions may be subject to further refinement in the future. As an example, high nutrient loads enter the Humber Estuary and therefore the subtidal habitats have a high exposure to changes in nutrient loading.

4.2.3 Vulnerability assessment

The third step in the process is to determine the vulnerability of interest features or their component sub-features to operations. This is an integration of sensitivity and exposure. Only if a feature is both sensitive and exposed to a human activity will it be considered vulnerable. In this context therefore, 'vulnerability' has been defined as the exposure of a habitat, community or individual (or individual colony) of a species to an external factor to which it is sensitive (Hiscock, 1996). The process of deriving and scoring relative vulnerability is provided in Appendix VII.

4.3 Format of advice

The advice is provided within six broad categories of operations, which may cause deterioration of natural habitats or the habitats of species, or disturbance of species. This approach therefore:

- enables links to be made between human activities and the ecological requirements of the habitats or species, as required under Article 6 of the Habitats Directive;

- provides a consistent framework to enable relevant authorities in England to assess the effects of activities and identify priorities for management within their areas of responsibility; and

- is appropriately robust to take into account the development of novel activities or operations which may cause deterioration or disturbance to the interest features of the site and should have sufficient stability to need only infrequent review and updating by English Nature.

These broad categories provide a clear framework against which relevant authorities can assess activities under their responsibility. The more detailed information in Tables 4,5, 8-13, 16 and 17 provides relevant authorities with a context against which to consider an assessment of 'significant effect' or any plans or projects that may affect the site and a basis to inform on the scope and nature of appropriate assessments required in relation to plans and projects. It is important to note that this advice is only a starting point for assessing impacts. It does not remove the need for the relevant authorities to consult English Nature formally over individual plans and projects where required to do so under the Regulations.

4.4 Update and review of advice

Information as to the operations which may cause deterioration of natural habitats or the habitats of species, or disturbance of species, for which the site has been designated, is provided in light of what English Nature knows about current activities and patterns of usage at the Humber Estuary European marine site. English Nature expects that the information on current activities and patterns of usage (which was used to derive tables 4, 8, 10, 12 and 16) will be supplemented as part of the process of developing the management of the site, and through further discussion with the relevant authorities. The option of zoning this information may be appropriate, and has been used for the SPA section of this advice (see section 12). As such, it is important that future consideration of this advice by relevant authorities and others takes account of changes in the usage patterns that have occurred at the site, over the intervening period, since the advice was issued. In contrast, the information provided in this advice on the sensitivity of interest features or sub-features (tables 5, 9, 11, 13 and 17) is relatively stable and will only change as a result of an improvement in our scientific knowledge, which will be a relatively long term process. Advice for sites will be kept under review and may be periodically updated through discussion with relevant authorities and others to reflect significant changes in our understanding of sensitivity together with the potential effects of plans and projects on the marine environment.

4.5 Summary of advice on operations for the SAC, SPA and Ramsar interest features

Table 2 is a summary of the advice on operations for the SAC, SPA and Ramsar interest features. More detailed information can be found in sections 8, 12 and 16.
In pursuit of the conservation objectives for all the interest features, the relevant and competent authorities for the Humber Estuary European marine site are advised to manage human activities within their remit such that they do not result in deterioration or disturbance of the habitats through any of the categories of operation listed in the table.

4.6 Plans and Projects

Under Regulation 48(1), an appropriate assessment must be undertaken in respect of any plan or project which:

a. either alone or in combination with other plans or projects is likely to have a ***significant effect*** on a European Site; and
b. is not directly connected with or necessary to the management of the site for nature conservation.

This legal requirement applies to all European sites. Regulation 48 is also applied, as a matter of Government policy, to potential SPAs and listed Ramsar sites.

English Nature's 'Habitats regulations guidance note 1: The Appropriate Assessment (Regulation 48)', is at Appendix IX for further information.

Tables 4, 5, 8-13, 16 and 17 provide relevant authorities with a guide against which to initiate an assessment of the 'significance' of any plans or projects (and ongoing operations or activities) proposed for the site although this will only be the starting point for assessing impacts and does not remove the need for relevant authorities to formally consult English Nature over individual plans and projects where required under the Regulations.

4.7 Review of consents

Regulation 50 of the Conservation (Natural Habitats, &c.) Regulations 1994, as amended, requires a competent authority to undertake a review of any existing consent or permission to which Regulation 48(1) would apply if it were being reconsidered as of the date on which the site became a European site. Where a review is required under these provisions it must be carried out as soon as reasonably practicable. This will have implications for discharge and other consents, which will need to be reviewed in light of these objectives and may mean that lower targets for background levels of contaminants etc. will need to be set.

Table 2 Summary of operations that may cause deterioration or disturbance to the Humber Estuary European marine site interest features at current levels of use[7]

The advice below is not a list of prohibitions but rather a checklist for operations for discussion with the management group, which may need to be subject to some form of management measure(s) or further measures where actions are already in force. Examples of activities that may be under relevant authority jurisdiction are also provided. Operations marked with a √ indicate those features (habitats and/or species) that are considered to be highly or moderately vulnerable to the effects of the operations.

Categories of operations which may cause deterioration or disturbance	SAC interest features						
	Estuary	**Coastal lagoons**	**Atlantic salt meadows**	***Salicornia* and other annuals**	**Intertidal mudflats and sandflats**	**Subtidal sandbanks**	**River and sea lamprey**
Physical Loss							
Removal (eg land claim, dredging)	√	√	√	√	√	√	√
Smothering (eg depositing dredge spoil, beach feeding)	√		√		√	√	
Physical Damage							
Siltation (eg dredging, outfalls)	√		√	√	√		
Abrasion (eg recreational activity, vehicles)	√		√	√	√		
Selective extraction (eg aggregate extraction)	√			√	√		
Non-physical disturbance							
Noise (eg land/water-based recreation, marine traffic)							
Visual presence (eg land/water-based recreation, marine traffic)							
Toxic contamination							
Introduction of synthetic compounds (eg TBT, PCBs)	√	√	√	√	√	√	√
Introduction of non-synthetic compounds (eg trace metals from industrial or domestic effluent, crude oil)	√		√	√	√	√	√

Introduction of radionuclides							
Non-toxic contamination							
Changes in nutrient loading (eg agricultural run-off, domestic effluent outfalls)	√	√	√	√	√	√	√
Changes in organic loading (eg domestic effluent outfalls, aquaculture)	√	√	√	√	√	√	√
Changes in thermal regime (eg power station discharges)							√
Changes in turbidity (eg effluent outfalls, dredging, depositing dredged spoil)	√					√	
Changes in salinity (eg water abstraction, effluent outfalls)							
Biological disturbance							
Introduction of microbial pathogens (eg domestic/ industrial effluent outfalls)							
Introduction of non-native species and translocation	√		√	√			
Selective extraction of species (e.g. samphire picking, bait collection)	√			√	√		

Categories of operations which may cause deterioration or disturbance	SPA interest features								
	Inner Estuary			Middle Estuary			Outer Estuary		
	Annex I species	Migratory species	Waterfowl Assemblage	Annex I species	Migratory species	Waterfowl Assemblage	Annex I species	Migratory species	Waterfowl Assemblage
Physical Loss									
Removal (eg land claim, dredging)	√	√	√	√	√	√	√	√	√
Smothering (eg depositing dredge spoil, beach feeding)	√	√	√	√	√	√			
Physical Damage									
Siltation (eg dredging, outfalls)				√	√	√			
Abrasion (eg recreational activity, vehicles)	√	√	√	√	√	√	√	√	√
Selective extraction (eg aggregate extraction)							√		
Non-physical disturbance									
Noise (eg land/water-based recreation, marine traffic)	√	√	√	√	√	√	√	√	√
Visual presence (eg land/water-based recreation, marine traffic)	√	√	√	√	√	√	√	√	√
Toxic contamination									
Introduction of synthetic compounds (eg TBT, PCBs)	√	√	√	√	√	√	√	√	√
Introduction of non-synthetic compounds (eg trace metals from industrial or domestic effluent, crude oil)	√	√	√	√	√	√	√	√	√
Introduction of radionuclides									
Non-toxic contamination									
Changes in nutrient loading (eg agricultural run-off, domestic effluent outfalls)	√	√	√	√	√	√	√	√	√
Changes in organic loading (eg domestic effluent outfalls, aquaculture)	√	√	√	√	√	√	√	√	√
Changes in thermal regime (eg power station discharges)									

Categories of operations which may cause deterioration or disturbance	SPA interest features								
	Inner Estuary			Middle Estuary			Outer Estuary		
	Annex I species	Migratory species	Waterfowl Assemblage	Annex I species	Migratory species	Waterfowl Assemblage	Annex I species	Migratory species	Waterfowl Assemblage
Changes in turbidity (eg effluent outfalls, dredging, depositing dredged spoil) Changes in salinity (eg water abstraction, effluent outfalls)									
Biological disturbance									
Introduction of microbial pathogens (eg domestic/ industrial effluent outfalls)									
Introduction of non-native species and translocation							√	√	√
Selective extraction of species (e.g. samphire picking, bait collection)		√	√		√	√	√	√	√

Categories of operations which may cause deterioration or disturbance	Ramsar site interest features		
	Criterion 2: Assemblage of threatened coastal and wetland invertebrate species	**Criterion 3: Breeding colony of grey seals**	**Criterion 5: Regularly supports 20,000 or more waterfowl species Criterion 6: Regularly supports 1% or more of a species or sub-species of waterfowl**
Physical Loss Removal (eg land claim, dredging) Smothering (eg depositing dredge spoil, beach feeding)	For information on operations affecting the saltmarsh communities and coastal lagoons, see the assessments made under the SPA section.	√	For information on operations affecting the waterfowl assemblage and populations of waterfowl species, see the assessments made under the SPA sections
Physical Damage Siltation (eg dredging, outfalls) Abrasion (eg recreational activity, vehicles) Selective extraction (eg aggregate extraction)			
Non-physical disturbance Noise (eg land/water-based recreation, marine traffic) Visual presence (eg land/water-based recreation, marine traffic)		√ √	
Toxic contamination Introduction of synthetic compounds (eg TBT, PCBs) Introduction of non-synthetic compounds (eg trace metals from industrial or domestic effluent, crude oil) Introduction of radionuclides		√ √	
Non-toxic contamination Changes in nutrient loading (eg agricultural run-off, domestic effluent outfalls) Changes in organic loading (eg domestic effluent outfalls, aquaculture) Changes in thermal regime (eg power station discharges)			

Categories of operations which may cause deterioration or disturbance	Ramsar site interest features		
	Criterion 2: Assemblage of threatened coastal and wetland invertebrate species	**Criterion 3: Breeding colony of grey seals**	**Criterion 5: Regularly supports 20,000 or more waterfowl species Criterion 6: Regularly supports 1% or more of a species or sub-species of waterfowl**
Changes in turbidity (eg effluent outfalls, dredging, depositing dredged spoil) Changes in salinity (eg water abstraction, effluent outfalls)	For information on operations affecting the saltmarsh communities and coastal lagoons, see the assessments made under the SPA section.		For information on operations affecting the waterfowl assemblage and populations of waterfowl species, see the assessments made under the SPA sections
Biological disturbance Introduction of microbial pathogens (eg domestic/ industrial effluent outfalls) Introduction of non-native species and translocation Selective extraction of species (e.g. samphire picking, bait collection)		√	

[7]This advice has been developed using best available scientific information and informed scientific interpretation and judgement (as at July 2002). This process has used a coarse grading of relative sensitivity, exposure and vulnerability of each interest feature to different categories of operation based on the current state of our knowledge and understanding of the marine environment. This is shown in the sensitivity and vulnerability matrices in Tables 5, 9, 11, 13 and 17. The advice is indicative only, and is given to guide relevant authorities and others on particular operations which may cause deterioration of natural habitats or the habitats of species, or disturbance of species for which the site has been designated. The advice, therefore, is not a list of prohibitions but rather a check list for operations which may need to be subject to some form of management measure(s) or further measures where actions are already in force.
The precise impact of any category of operation occurring on the site will be dependant upon the nature, scale, location and timing of events. More detailed advice is available from English Nature to assist relevant authorities in assessing actual impacts and cumulative effects. Assessment of this information should be undertaken in the development of management of the site through wider consultation.

In accordance with Government policy guidance, the advice on operations is feature and site specific, and provided in the light of current activities and patterns of usage at the site as at July 2002. As such, it is important that future consideration of this advice by relevant authorities, and others, takes account of changes in usage patterns that have occurred at the site over the intervening period. Advice for sites will be kept under review and may be periodically updated through discussions with relevant authorities, and others, to reflect significant changes in our understanding of sensitivity together with the potential effects of plans or projects on the marine environment. The provision of the statutory advice given here, on operations which may cause deterioration of natural habitats or the habitats of species, or disturbance of species, for which the site has been designated, under Regulation 33(2), is provided without prejudice to specific advice given under Regulation 48(3) or Regulation 50 on individual operations that qualify as plans or projects within the meaning of Article 6 of the Habitats Directive.

SPECIAL AREA OF CONSERVATION

5. The Humber Estuary pSAC interest features

The Humber Estuary pSAC includes both marine areas (ie. land covered continuously or intermittently by tidal waters) and land that is not subject to tidal influence. The marine part of the pSAC is termed a European marine site. The seaward boundary of the European marine site is concurrent with that of the pSAC. The landward boundary of the European marine site is the upper boundary of the pSAC, or where that extends above land covered continuously or intermittently by tidal waters, it is at the limit of the marine habitats (highest astronomical tide).

Where the pSAC qualifying habitats and species occur within the European marine site, they are referred to as interest features. Sub-features (habitats) have also been identified to highlight the ecologically important components of the European marine site for each interest feature.

The Humber Estuary European marine site includes a possible Special Area of Conservation with eight interest features qualifying under Annex I and Annex II of the Habitats Directive. This section describes and explains the importance of each of these interest features together with their component sub-features.

5.1 Estuary

5.1.1 Definition

Estuaries are complex and highly productive ecosystems, supporting a wide range of habitats and species. They form the interface between freshwater and marine environments and extend from the upper limit of tidal influence to the open sea. Where freshwater and seawater meet, and where current flows are reduced in the shelter of estuaries, fine sediments are deposited, often forming extensive intertidal mudflats and sandflats. These are typically inhabited by a variety of infaunal invertebrates, many of which provide important sources of food for fish, waterfowl and seabirds. At higher elevations within the tidal range, the mudflats and sandflats are exposed for sufficient periods to become vegetated with salt-tolerant plants forming saltmarshes, which play an important role in the nutrient and sediment cycling processes within the estuarine ecosystem. Saltmarshes also provide essential feeding and roosting areas for waterfowl. Towards the mouth of an estuary, where the water gradually becomes more saline, the silt content of the sediment declines and infaunal communities are dominated by invertebrates such as free-swimming polychaete worms and infaunal bivalve molluscs. Many of the habitats within an estuary are interdependent and inextricably linked to the structure and functioning of others.

The UK has a particularly large number of estuaries. In fact, more than a quarter of the area of the north-western European estuaries are located in the UK (Brown *et al.*, 1997). The wide range of estuary types occurring in the UK is also unusual in a European context. Sites in the UK have been selected to represent the geographical range of estuaries, and include examples of four geomorphological types (coastal plain, bar-built, complex estuaries and rias) and a range of substrates and associated fauna. The intertidal and subtidal sediments of estuaries support biological communities that vary depending on their geographic location, sediment type, salinity gradients and the tidal currents within the estuary.

5.1.2 Importance of the estuary interest feature in the Humber Estuary European marine site

Estuaries in the UK have been selected to take account of the UK's EU responsibility for this habitat type and so the site series contains a high proportion of the total UK resource. Sites have generally been selected as entire units, extending from the tidal limit or extent of brackish influence to the estuary mouth, and including all habitats that are important to the integrity of the site. In particular, the entire water column has been included due to its importance not only in the biological functioning of the system, but also as the means by which sediment is mobilised and transported.

The Humber is the second largest coastal plain estuary in the UK, and the largest coastal plain estuary on the east coast of Britain. A coastal plain estuary is formed when pre-existing valleys were flooded at the end of the last glaciation. They are usually less than 30m deep with a large width to depth ratio. The Humber is a muddy, macro-tidal estuary, which is fed by the rivers Trent, Ouse and Hull. Suspended sediment loads are high and are derived from a variety of sources, mostly marine from the North Sea and the eroding boulder clay along the Holderness coast, but also from riverine sediments. This is the northernmost English east coast estuary whose structure and function is intimately linked with soft eroding shorelines.

Habitats within the Humber Estuary include Atlantic salt meadows and *Salicornia* beds, together with subtidal sandbanks, extensive intertidal mudflats and sandflats, sand dunes and coastal lagoons. The saltmarshes on the estuary are predominantly ungrazed and species rich, but are not of the extent that one might expect for an estuary of this size due to historical land claim and drainage. It is estimated that nearly 2,700ha of intertidal land has been lost in the middle and outer estuary between 1828 and 1996, with 2,330ha attributed to land claim (Murby 2001). Nevertheless, there are still extensive mudflats and sandflats in the estuary, which support rich benthic communities. The most extensive intertidal areas are the mudflats of Spurn Bight on the north bank and the sandy areas of Cleethorpes to Donna Nook on the south bank. The inner estuary is also characterised by large, often mobile, mud and sand flats which are exposed at high water. The benthic communities of these areas provide an important food source for birds and also for fish species.
The Humber Estuary is extremely turbid and sediment transport is particularly important within the estuary. The majority of suspended sediments are from the North Sea, with smaller amounts coming from fluvial sources. Erosion and accretion of these sediments is a feature of much of the estuary, as is this changing position of the main channel upstream of the bridge. Possibly the most dynamic section of the estuary is the inner reach between the Humber Bridge and Trent Falls where there are frequent channel migrations around Read's Island. Recent research has revealed a number of mechanisms responsible for channel movement in this area, including fresh water discharge and tidal regime. There are also dynamic interactions between the various bank systems in the inner and middle estuary releasing sediment which form mud and sand bars that create semi-permanent islands. There are other channel movements in the outer estuary.
As salinity decreases upstream, reedbeds and brackish saltmarsh communities fringe the estuary, although much of this area is backed by sea defences. These habitats are best represented at the confluence of the rivers Ouse and Trent at Blacktoft Sands and also at Whitton Sands. Reedbeds across the estuary are important for bittern and marsh harrier. They also support some of the rarer species of hoverfly, moths and ground beetles.
Records of 82 different fish species have been recorded in the estuary including the river and sea lamprey, Alis and twaite shad and salmon (Mike Elliot, pers com). It is also used as a nursery for fish such as plaice and has some cockle and mussel beds in the outer estuary (McLeod, *et al*., 2001).

The Humber, along with most other UK estuaries, is subjected to urban and industrial pressures. Many have been subjected to some form of sea defence measures, such as embankments or the construction of sea walls. This is due, in part to areas of land, rising or sinking relative to sea level. North of the Humber Estuary the land is rising relative to sea level, this lessens the need for sea defences. However, in the lower lying areas south of the Humber, the risk of flooding is greater. From the Humber southwards, almost all estuaries have linear defences along more than 50% of their shoreline, for most it is over 80% and the Humber is no exception.

5.1.3 Sub-features

Saltmarsh communities – 'Atlantic salt meadows' and '*Salicornia* and other annuals colonising mud and sand' are both classified in the Habitats Directive as interest features in their own right and are therefore described separately in sections 5.3 and 5.4 below.

Intertidal mudflats and sandflats communities – 'Mudflats and sandflats not covered by seawater at low tide' are classified in the Habitats Directive as interest features in their own right and are therefore described separately in sections 5.5 below.

Subtidal sediment communities - The subtidal habitats and their associated communities form an important component of the Humber's estuarine ecosystem. The bed of the estuary is mostly sandy, with some patches of gravel and glacial till grading into silty clay in the intertidal areas of the main body of the estuary. An exception is the outer part of the south bank, where the intertidal is sandy.

In addition, 'Sandbanks which are slightly covered by seawater all the time' are classified in the Habitats Directive as interest features in their own right and are therefore described separately in section 5.6 below.

5.2 Coastal Lagoons

5.2.1 Definition

Coastal lagoons are areas of typically (but not exclusively) shallow, brackish or salt water, wholly or partially separated from the sea by sandbanks, shingle or, less frequently, rocks or other hard substrata. They retain a portion of their water at low tide and may develop as brackish (due to dilution of seawater by freshwater), fully saline or hypersaline (more salty than seawater due to evaporation). Lagoons show a wide range of geographical and ecological variations. Five main sub-types that differ in their form and function have been identified in the UK, on the basis of their physiography. These are isolated lagoons, percolation lagoons, silled lagoons, sluiced lagoons and lagoonal inlets. Some of these sub-types have a very restricted distribution.
Lagoons are the UK's only maritime priority habitat, i.e. they are considered in danger of disappearing, and the European Union has particular responsibility for their conservation. As well as being relatively uncommon in the UK, some of the lagoon sub-types found here are rare elsewhere in Europe. Therefore, a high proportion of the total UK resource of lagoons has been included within the site series. Site selection has aimed to represent the range of physiographic sub-types and to provide good geographical coverage across the UK.
The plant and animal communities of lagoons vary according to the physical characteristics and salinity regime of the lagoon, and consequently there are significant differences between lagoons, although they all possess a characteristic invertebrate fauna that shows little variation, even within Europe. The species present are specially adapted to varying salinity regimes and some are unique to lagoon habitats. The species found are often characterised by mysid shrimps and other small crustaceans, worms that burrow into the sediment, gastropod molluscs and some fish species. The vegetation may include beds of eelgrass *Zostera* spp., tasselweeds *Ruppia* spp. and pondweeds *Potamogeton* spp., or stoneworts such as *Lamprothamnium papulosum*. In more rocky lagoons, communities of fucoid wracks *Fucus* spp., sugar kelp *Laminaria saccharina*, and red and green algae are also found. Lagoonal specialist species and species associated with coastal lagoons, consequently have restricted distributions in the UK. These include the starlet sea anemone *Nematostella vectensis*, lagoon sand worm *Armandia cirrhosa*, lagoon sand-shrimp *Gammarus insensibilis* and the foxtail stonewort *L. papulosum*. Several of these species are very rare and are protected under the Wildlife and Countryside Act 1981.

Although uncommon, coastal lagoons may be clustered together on stretches of coast, where they are dependent on local physical processes, such as sediment transport systems. Such clusters have been considered particularly important for the conservation of lagoon structure and function and so site selection has reflected this distribution. However, only natural or near natural lagoon sites have been selected, although this may include sites that have been artificially created from natural substrata. Sites that are entirely artificial in origin are excluded such as disused docks, even though in some cases the communities present may be similar to those of more natural sites (McLeod *et al*. 2001).

5.2.2 Importance of the coastal lagoons interest feature in the Humber Estuary European marine site

The Humber region is highly significant in a national context and is particularly important for lagoons that have developed where there were formerly saltmarshes behind dune-capped barrier islands. The invertebrate fauna of the lagoons of this region include three nationally scarce species; the lagoon sand-shrimp *Gammarus insensibilis*, the tentacled lagoon worm *Alkmaria romijni* and the starlet sea anemone *Nematostella vectensis*. *N. vectensis* is particularly interesting as all the individuals found in the UK are female and are clones of one original animal, regardless of their location. The nationally scarce stonewort *Tolypella glomerata* is also found. Also notable in this region's lagoons are the oppossum shrimp *Paramysis nouveli*, the lagoonal cockle *Cerastoderma glaucum*, the lagoonal periwinkle *Littorina saxatilis* var. *lagunae*, the lagoonal mud snails *Hydrobia ventrosa* and *H. neglecta*, together with a significant marine component, including the mud snail *Hydrobia ulvae* (Bamber and Barnes 1995).

The Humber Estuary supports two coastal lagoons within the Special Area of Conservation boundary.
Humberston Fitties, south of Cleethorpes supports diverse communities of several lagoon specialist species and has been described as the third most important lagoon in Britain (Bamber 1992). The lagoon had its origins as a saltmarsh pool, although it has obviously had some human interference and appears to have been used as a boating lake at some time. The site comprises, one main lagoon and four saltmarsh pools. These saltmarsh pools dry out and become hypersaline during the summer, although one of them may be subject to more regular tidal inundation. The physiography of the site appears to have changed somewhat since the survey carried out by Sheader and

Sheader in 1986, which reports that the lagoon was connected to the estuary via a long channel through the saltmarsh. However, both Sheader and Sheader's 1998 survey and Seaton's 2001 survey report that this channel has silted up and Humberston Fitties now persists as an isolated lagoon, its water acquired through overtopping of the bank during spring tides. It has also been observed that although the channel is silted up, it is still slightly lower than the surrounding saltmarsh and so on high spring tides water will flow over it into the main lagoon (Andrew Grieve, pers com). Isolated lagoons are described in McLeod *et al* (2001) as being separated completely from the sea (or estuary) by a barrier of rock or sediment. Seawater enters by limited groundwater seepage or by overtopping of the sea barrier. The salinity is variable but often low. Isolated lagoons are often transient features with a limited lifespan due to the natural processes of infilling and coastal erosion. There is no freshwater input into Humberston Fitties lagoon, except from rain and surface runoff.

Humberston Fitties is a very important site; the community is diverse for a lagoon and comprises many lagoon specialist species (Seaton, 2001). Bamber (1992) devised a biotic index, which compares the relative abundance of specialist and non-specialist species. When used at Humberston Fitties, the lagoon receives a very high score which places it as the third most important lagoon in Britain in terms of community composition (Seaton, 2001). This is even more remarkable when its location is taken into account. Humberston Fitties is the most northerly site in Europe for the lagoon sand shrimp *Gammarus insensibilis*, an amphipod protected under Schedule 5 of the Wildlife and Countryside Act 1981. (The next nearest colony is believed to be in Norfolk.) The population of *G. insensibilis* is entirely confined upon the alga *Chaetomorpha linum* for which Humberston Fitties is one of the most northerly sites in Britain, if not Europe for this species. This association is well known and *G. insensibilis* does not occur in Britain without this plant. Other specialist species found are the lagoon mudsnail *Hydrobia ventrosa,* the lagoon sea mat *Conopeum seurati*, the lagoon slater *Idotea chelipes* and the beaked tasselweed *Ruppia maritima* (Seaton 2001).

Northcoates Lagoon is an extensive and narrow lagoon system behind low dunes and saltmarsh on the north Lincolnshire coast, south of Humberston Fitties. It is a complex system consisting of a high salinity silled lagoon and a moderate salinity percolation lagoon. Seawater enters the system at high tide through two channels and then moves through to fill the channels and flow through to the north and south of the system. In the late summer the lagoons occasionally dry out completely and become hypersaline, although the channel system that provides the in-flow of saltwater from the estuary is deeper and usually retains water throughout the summer (Andrew Grieve, pers com). It is therefore likely that the invertebrate species that have been recorded in the northern lagoon persist in the channel rather than in the desiccated lagoons during the summer (Andrew Grieve, pers com).

Unicomarine surveyed Northcoates Lagoon system in 2001 and a relatively diverse species list was identified, reflecting the progression from marine to brackish habitats through the system. The marine estuarine southern part of the system has a typical, unremarkable estuarine fauna. However, the brackish lagoon system to the north, supports saline lagoon specialists including *Gammarus chevreuxi,* which is only known from a few lagoon sites in the UK, *Idotea chelipes* and the lagoon mudsnails *Hydrobia acuta* and *H. ventrosa.* A limited distribution of spiral tasselweed *Ruppia cirrhosa* was also recorded.

5.3 Atlantic salt meadows (*Glauco-Puccinellietalia*)

5.3.1 Definition

Atlantic salt meadows (*Glauco-Puccinellietalia*), develop when salt-tolerant vegetation colonises intertidal sediments of mud and sand in areas protected from strong wave action. This vegetation forms the middle and upper reaches of saltmarshes, where tidal inundation occurs with decreasing frequency and duration. The vegetation varies depending on the climate and position in the marsh. In the UK, Atlantic salt meadows occur on the North Sea, English Channel and Atlantic shores, with the largest examples in the sheltered estuaries of England. There are more than 29,000 hectares of this habitat in the UK (Brown *et al*., 1997), which suggests that up to two-thirds of British saltmarshes are represented by this category. Sites have been selected to cover the geographical range and ecological variation of this habitat type, and for the most part they are the largest examples, supporting a well-developed zonation of plant communities. Many have transitions to terrestrial habitat assemblages, such as freshwater reedbed, sand dunes, vegetated shingle and woodland. There are marked regional variations in Atlantic salt meadow communities in the UK and those which are grazed differ significantly from those which are ungrazed, in terms of both structure and species composition.

Saltmarshes play a fundamental role in the life of an estuary, bringing stability to its margins and also operating as a source of primary production. They are a rare and specialised habitat in their own right and many of the plants that occur there survive nowhere else. Saltmarshes provide an important habitat for both marine and terrestrial fauna and serve as roosting and feeding areas for internationally important waterfowl.

5.3.2 Importance of the Atlantic salt meadows interest feature in the Humber Estuary European marine site

There are an estimated 627ha of saltmarsh on the Humber, accounting for only 2% of the estuarine area, compared with a national average of 6% (Billings *et al.* 2002). This is due to large historical losses from land claim. The composition of the Humber's saltmarshes is also unusual compared to other UK estuaries. Over half the marsh is dominated by common reed *Phragmites australis* and sea club-rush *Scirpus maritimus* especially in the inner estuary. Typical saltmarsh communities – pioneer marsh and low, mid and upper marsh communities are scarce, amounting to less than 1% of the total estuarine area.

Historically, land claim has been the greatest cause of saltmarsh loss on the Humber. Today, coastal squeeze is the biggest threat to the remaining saltmarsh, particularly the upper marsh communities, which may be 'squeezed out' and replaced by lower marsh communities. The extent to which the saltmarsh can migrate inland as sea level rises is likely to be especially valuable in re-dressing losses incurred to the feature through submersion. It is estimated that over the past 20 years, there has been a net loss of 24ha of saltmarsh in the outer estuary, although there has also been an increase in tidal marsh of 58ha in the inner estuary (Billings *et al*. 2002). The area along the North Lincolnshire coast from Cleethorpes southwards has also seen some saltmarsh accretion. For example, over the last 50 years, over 240ha of saltmarsh has developed around Saltfleet Haven (Graham Weaver, pers com). Further investigation to monitor the rate of change in the saltmarsh communities, and the degree to which this can be attributed to coastal squeeze is needed. Actions may also be identified to offset this net loss.

The Humber Estuary supports saltmarsh on both its northern and southern banks in varying degrees of diversity. In some places, the upper marsh communities have been lost due to coastal squeeze, but in other areas such as Cherry Cobb on the north bank, and south of Cleethorpes, there is clear zonation of saltmarsh vegetation from pioneer species through to mid to upper marsh communities. The Atlantic salt meadows of the Humber are notable as being predominantly ungrazed and subsequently support a range of communities dominated by sea purslane *Atriplex portulacoides* and *Puccinellia maritima* with frequent sea aster *Aster tripolium* and sea lavender *Limonium vulgare*. Atlantic salt meadows within the Humber provide a valuable habitat for a range of marine and terrestrial fauna and flora, including invertebrates and birds.

5.3.3 Sub-features

Low to mid marsh communities - Lying immediately landward of the pioneer saltmarsh zone, the low to mid marsh communities experience a greater number of tidal inundations than the mid to upper marsh, usually more than 360 a year. As a result of this, the vegetation communities of the low and mid marsh are often relatively species-poor, composed of halophytic plants that can withstand such conditions. Communities of common saltmarsh grass *Puccinellia maritima* and sea purslane *Atriplex portulacoides* typify the low to mid marsh.

Mid to upper marsh communities - The mid to upper marsh community is dominated by the saltmarsh rush *Juncus gerardii* and saltmarsh grass/fescue communities *Puccinellia*/*Festuca*. In the mid marsh zone, as the number of tidal inundations becomes less frequent, the vegetation becomes more diverse, with a more complex structure and a greater proportion of herbs. At the upper levels of the marsh, tidal inundation only occurs at the highest spring tides. The vegetation communities here reflect this with a greater diversity of species and some being restricted to this zone.

Transitional communities – Where there is a significant influence of fresh water in the upper reaches of the estuarine system, and where the marsh joins higher ground, important transitional communities are found. These occur around the extreme high water mark and commonly comprise of sea couch grass *Elymus pycnanthus* and *Phragmites australis* tidal reedbeds. This forms an important transition into freshwater reedbed habitats.

5.4 *Salicornia* and other annuals colonising mud and sand (pioneer saltmarsh)

5.4.1 Definition

This feature is known locally as samphire or glasswort and together with other annuals occurring on mud and sand is generally known as pioneer saltmarsh as these plants are the first saltmarsh species to colonise the bare flats. These species occur in many saltmarshes in the UK, and European marine sites were chosen to represent the geographical range of the habitat type. Generally the largest areas of pioneer saltmarsh have been selected, and since it occurs as an integral part of a sequence of habitats, from bare sand and mud flats through to more stable saltmarsh vegetation, preference is given to sites where it forms part of well-developed successional sequences (Brown *et al*., 1997).

Pioneer saltmarsh vegetation colonises intertidal mud and sand flats in areas protected from strong wave action and is an important precursor to the development of more stable saltmarsh vegetation. It develops at the lower reaches of the saltmarshes where the vegetation is frequently flooded by the tide, and can also colonise open creek sides, depressions or pans within a saltmarsh, as well as disturbed areas of upper saltmarsh. The vegetation in this habitat comprises a very small number of species and is dominated by open stands of samphire *Salicornia* species or annual sea-blite *Suaeda maritima.* Pioneer saltmarsh also provides an important feeding area and a food source for many species of waterfowl.

5.4.2 Importance of the *Salicornia* and other annuals colonising mud and sand interest feature in the Humber Estuary European marine site

As mentioned under Section 5.3.2, the composition of the saltmarshes on the Humber is unusual. Recent saltmarsh surveys have determined that pioneer saltmarsh species are found predominantly in the outer estuary on both the north and the south banks with the largest concentration south of Cleethorpes, forming a key stage in the transition from intertidal sand and mud flats to saltmarsh vegetation. In the upper Humber, bare mud and sand flats are colonised by small amounts of common cordgrass *Spartina anglica* (SM6), and where freshwater influence is greater, sea club-rush *Scirpus maritimus* (S21). *Spartina anglica* is a non-native species, which was first planted on the Humber in 1936. It is a fertile hybrid and a naturally invasive species that may be considered damaging to pioneer marsh species, although more research is necessary. The area covered by *Spartina anglica* on the Humber has decreased from 160ha in 1969 to 120ha in 1989 (Billings *et al*. 2002). The recent NVC survey by Bullen Consultants (2002) also recorded almost 120ha of *Spartina anglica.*

5.4.3 Sub-features

Annual *Salicornia* (samphire) saltmarsh community – The annual *Salicornia* community (SM8) is the most extensive pioneer marsh community in the Humber pSAC and is dominated by annual species of *Salicornia* (samphire). *Salicornia* species germinate in May from a widespread dispersion of seeds over the whole marsh surface. The lower limit of the *Salicornia* community is set by the time between tides and the time taken for the seeds to become firmly anchored. *Salicornia* species are tolerant of frequent tidal inundations, enduring around 600 flooding per year at its lower limits where it forms the familiar pioneer stands. This sub-feature forms a distinct zone in the lower marsh (sometimes hundreds of metres wide) and can be separated from the main marsh by several hundred metres of bare flats, particularly on sandy substrates. SM8 communities can also form a mosaic community with other saltmarsh communities eg SM13 (common saltmarsh grass, *Puccinellia maritima*) and SM6 (common cordgrass, *Spartina anglica*). In some locations, the spread of the non-native species *Spartina anglica* has restricted the availability of lower marsh colonisation by *Salicornia* species (Rodwell, 2000). On the Humber, the annual *Salicornia* community (SM8) is found within the Humber Flats and Marshes Pyewipe and Cleethorpes Coast SSSI, Spurn head to Saltend Flats SSSI and North Lincolnshire Coast SSSI.

***Suaeda maritima* (sea-blite) saltmarsh community** – The *Suaeda maritima* community (SM9) is an annual pioneer community tolerant of a wide variety of soil types and tidal inundation regimes. Its growth appears to be dependent on nutrient supplies, especially nitrogen and it is particularly characteristic of open situations, free of competition from other established perennials. SM9 communities are dominated by *Suaeda maritima* with associations of *Salicornia* and occasional *Puccinellia maritima*, *Spartina anglica,* sea purslane, *Atriplex portulacoides* and sea aster, *Aster tripolium.* The community is characteristic of gravelly mud on the lower marsh, forming mosaics with stands of *Salicornia*. Pure stands of *Suaeda maritima* are a distinctive feature of

disturbed situations, such as those that may occur following the dumping of sediment onto marshes. On the Humber, the *Suaeda maritima* community (SM9) is uncommon. It is found within the Humber Flats and Marshes Spurn Head to Saltend Flats SSSI and the North Lincolnshire Coast SSSI, however the total extent is minimal.

5.5 Mudflats and sandflats not covered by seawater at low tide

5.5.1 Definition

Intertidal mudflats and sandflats are submerged at high tide and exposed at low tide. They form a major component of estuaries and embayments in the UK, but also occur extensively along the open coast. The physical structure of the intertidal flats ranges from the mobile, coarse sand beaches of wave-exposed coasts to the stable, fine sediment mudflats of estuaries and other embayments. This habitat type can be divided into three broad categories, clean sands, muddy sands and muds, although in practice there is a continuous gradation between them. Within this range, the plant and animal communities present vary according to the type of sediment, its stability and the salinity of the water.
Intertidal mudflats and sandflats are a widespread habitat type that occurs throughout the UK. European marine sites were selected to encompass the ecological variation across the geographical range of this habitat type in the UK. Sites with large areas of intertidal flats, as well as a range of environmental conditions and an associated diversity of communities were favoured. (McLeod *et al*., 2001).

5.5.2 Importance of the mudflats and sandflats not covered by seawater at low tide interest feature in the Humber Estuary European marine site

The Humber Estuary supports a large area of intertidal habitats that are highly representative of North Sea estuaries. They range from gravels and sands, to muddy sands and mud, reflecting varying degrees of exposure to waves, currents and inflowing rivers. The Humber's intertidal flats represent 4.5% of the total British resource.
In contrast to other highly industrialised estuaries, the Humber has no abiotic areas or large areas dominated by opportunist species. Mudflats or sandflats fringe most of the shores of this large estuary, although in many places the intertidal zone is narrow and constrained by coastal defences. Substantial areas have also been lost to land claim. Of all British estuaries, only the Wash compares to the Humber in the area of intertidal land that has been taken. Since the 17th century, over 6,500ha of intertidal land on the Humber has been lost to land claim (Billings *et al* 2002). Studies have also shown that over the last 150 years, the form of the estuary has been changing with a loss of intertidal area as a result of sea level rise. The estuary has been moving slowly towards its equilibrium state, with a loss of coarse bed material and an import of fine sediment, and an increase in accretion in the inner estuary, together with erosion in the outer estuary around Grimsby (Townend *et al*., 2000). The inner estuary is particularly dynamic, for instance the reach between Crabley and Brough has undergone accretion over the last 20 years, with Whitton Sands accreting to such an extent that it is now well-vegetated, whilst Read's Island has undergone a period of erosion. The interactions in local sediment budgets between these areas is important, with erosion of one area, leading to deposition elsewhere in the estuary (IECS, 1994).
At low tide, nearly 50% of the area of the Humber Estuary is exposed, and the intertidal flats extend from the confluence of the Rivers Trent and Ouse to the western outskirts of Hull and are dissected by two main channels. There are also extensive areas of mudflats in the outer estuary, particularly inside Spurn Bight and Cherry Cobb and there are smaller muddy embayments at Saltend/Paull on the north bank and at Pyewipe on the south. The effects of wave energy on the estuarine system and the movement of sediment due to wave action are largely restricted to the outer estuary and coastal reaches. This higher energy environment and greater marine sediment component means that the intertidal flats of this area are predominantly sandy. Near the sand capped shingle spit of Spurn Point, there are beds of dwarf eelgrass *Zostera noltei.* Areas such as the upper and mid-shore flats, are highly productive, supporting a large number of invertebrates, with 180 species of macrofauna, meiofauna and microfauna recorded at Spurn Bight alone (Key 1983). These features are fundamental to the ecology of the estuary, providing an important food source for internationally important numbers of waders and wildfowl and commercial fish species.

The Humber Estuary also supports several sand dune systems covering an area of over 200ha. Coastal dunes develop behind a sandy beach with a surface that dries out between high tides. The dry sand is then blown landwards and if deposited above the high water mark and trapped by obstacles and vegetation, the dune system begins to grow. Although the dunes are above highest astronomical tide and therefore outwith the European

marine site boundary, processes occurring within the site will affect them, particularly as the sandflats are their source of material.

5.5.3 Sub-features

Intertidal gravel and sand communities - This habitat occurs particularly on open coast beaches and in bays where wave action or strong tidal currents prevent the deposition of finer silt. On the Humber Estuary, the high energy environment and greater marine sediment component of the outer estuary means that the intertidal flats of this area are predominantly sandy. Areas of shingle are found around Hessle and South Ferriby. Owing to the mobility of the sediment and consequent abrasion, species that inhabit sands tend to be robust. They support high numbers of species such as polychaete worms, *Nephtys cirrosa* and *Scolelepis squamata*, amphipods crustaceans and the sand mason worm *Lanice conchilega*. The sandflats also support cockle beds on the north Lincolnshire coast and are also an important source of material for the areas of mature dunes that lie behind them.

Intertidal muddy sand communities - These occur particularly on more sheltered shores and at the mouth of the estuary from Cleethorpes to Donna Nook where sediment conditions are relatively stable. A wide range of species, such as dense populations of lugworm *Arenicola marin*a, other polychaete worms and bivalve molluscs colonise these sediments.

Intertidal mud communities - These form in the most sheltered areas of the estuary, usually where large quantities of silt derived from rivers has been deposited. There are extensive mudflats in the mid and outer estuary and the stable sediment supports communities that are often highly abundant, typically dominated by polychaete worms such as *Arenicola marina* and *Manayunkia aestuarina* and bivalve molluscs. They may also support very high densities of the mud-snail *Hydrobia ulva*e, an important food source for many wading birds. The intertidal muds in the outer estuary support bivalves such as the Baltic Tellin *Macoma balthica* and the common cockle *Cerastoderma edule* and the catworm *Nephtys hombergii*. In the middle estuary, *M. balthica* and the fanworm *Manayunkia aestuarina* are more common. The upper estuary supports the polychaete worms *Hediste diversicolor*, *Heterochaeta costata*, *Tubificidae* species and the crustacean *Corophium volutator*. The high biomass of invertebrates in such sediments provides an important food source for a diverse range and large number of fish and benthic predators. Mudflats also provide a valuable feeding, roosting and resting area for species of wading birds and waterfowl.

Eelgrass bed communities – Eelgrass beds are nationally rare and are an important habitat as they provide spawning, nursery and refuge areas for fish. They also help to stabilise the sediment, contribute to primary productivity and are an important food source for overwintering wildfowl. In 1997, Buck reported that there were extensive beds of *Zostera noltei* (dwarf eelgrass) and *Zostera marina* (common eelgrass) on Spurn Bight and in the Grimsby area. These eelgrass beds have since declined, although the reasons why are not fully understood. It is likely that some eelgrass still exists in these areas.

5.6 Sandbanks which are slightly covered by seawater all the time

5.6.1 Definition

Subtidal sandbanks consist of sandy sediments that are permanently covered by shallow seawater, typically at depths of less than 20m below chart datum (but sometimes including channels or other areas greater than 20m deep). The habitat comprises distinct banks (i.e. elongated, rounded or irregular 'mound' shapes), which may arise from horizontal, or sloping plains of sandy sediment. Where these areas of sandy sediment are closely associated with the banks, they are included within the habitat type.

The diversity and types of community associated with subtidal sandbanks are determined by sediment type and a variety of other physical, chemical and hydrographic factors. These include geographical location (influencing water temperature), the relative exposure of the coast (from wave-exposed open coasts to tide-swept coasts or sheltered inlets and estuaries), the topographical structure of the habitat and differences in the depth, turbidity and salinity of the surrounding water. Subtidal sandbanks are frequently associated with other marine habitats, for example grading into intertidal mudflats and sandflats. They are often component habitats of estuaries too.

Key features of these subtidal areas are the range of invertebrate animals and seaweeds that colonise the seabed (epifauna) or which live in the seabed sediments (infauna). Shallow sandy sediments are typically colonised by a burrowing fauna of worms, crustaceans, bivalve molluscs and echinoderms. Mobile species at the surface of the

sand banks may include shrimps, crabs and fish. Where coarse stable material, such as shells or stones is present on the sediment surface, species of foliose seaweeds, hydroids, bryozoans and ascidians may form distinctive communities. Shallow sandy sediments are often important nursery areas for fish, and feeding grounds for seabirds.
Subtidal sandbanks occur extensively around the UK coast. They are widespread in inshore waters (within 12 nautical miles of the coast) and also occur more locally in offshore waters. The sites selected represent different physiographic types and the differing geographic character of this habitat around the UK coast.

5.6.2 Importance of the sandbanks which are slightly covered by seawater all the time interest feature in the Humber Estuary European marine site

The subtidal environment of the Humber is highly dynamic and varies according to the composition of the bottom sediments, salinity, sediment load and turbidity, dissolved oxygen and anthropogenic factors relating to water quality and dredging. Many of these factors vary with the season or state of the tide (Billings *et al*. 2002).
The subtidal area of the Humber Estuary is over 16,800 ha or 55% of the total area of the estuary. The seabed is mostly sandy with some patches of gravel and glacial till, grading into silty clay in the intertidal areas of the main body of the estuary. Invertebrates such as polychaete worms, mysid shrimp and gammarid amphipod species dominate the benthic community with a general increase in benthic diversity towards the mouth of the estuary where conditions become more marine influenced.
The subtidal zone of the Humber Estuary also provides an important breeding, sheltering and nursery area for marine fish species and a migratory corridor for Atlantic salmon and sea trout. The Humber supports about 15% of the east coast population of juvenile plaice and large numbers of juvenile sole are also found. It is also a spawning ground for species such as bass. (Billings *et al*., 2002)

5.6.3 Sub-features

Subtidal gravel and sands - The subtidal gravel and sands are patchily distributed throughout the estuary. In the upper estuary, impoverished mobile sands support mysid shrimp and *Gammarus* species; in the middle estuary medium and fine sands occur with an infauna of the polychaete worms, *Capitella capitata, Nephtys cirrosa* and the amphipod *Bathyporeia* species. The outer to middle estuary supports a community of polychaete worms, crustaceans and bivalves, found on very poorly sorted sandy shell gravel. On the southern side of the outer estuary, more sheltered marine sands are characterised by the polychaetes *Spiophanes bombyx* and *Spio filicornis*. Off the mouth of the Humber, the seabed is composed largely of gravels and is characterised by species such as the bryozoan, *Flustra foliacea*, the common whelk *Buccinum undatum*, the horse mussel *Modiolus modiolus* with the tube-dwelling polychaete worm *Sabellaria spinulosa*.

Subtidal muddy sands - Subtidal muddy sands are found predominantly in the middle and outer estuary. A 'transitional' muddy sand community consisting of species such as the polychaete worms, *Scoloplos armiger*, *Nephtys hombergii* and *Polydora* species, along with the phoronid, *Phoronis muelleri* and the bivalve, the Baltic tellin *Macoma balthica*.

5.7 Lamprey

Lamprey are one of the most primitive of all living vertebrate animals. They are distinct from all other fish in the British Isles, as they have no lower jaw. Their mouth is surrounded by a round sucker-like disc within which the adults have strong, rasping teeth. Other characteristic features are their eel-like shape, lack of paired fins or scales and a skeletal structure made of strong but flexible cartilage, rather than bone.

Most species of lamprey have similar life cycles and ecologies that involve the migration upstream into rivers to reach spawning grounds – normally stony or gravelly stretches of running water. Here they spawn in pairs or groups, laying eggs in crude nests. After hatching, the young, elongate larvae, known as ammocoetes swim, or are washed downstream by currents to areas of sandy silt in still water. The distribution of the larvae depends on the hydrodynamic regime of the river and, where the profile of a river is low, there may be little downstream movement. Here, the young lamprey burrow and spend the next few years in tunnels.

The metamorphosis from larvae to adult is a dramatic change which takes place within a relatively short time – usually a few weeks after up to four years of larval development. The lamprey then migrate downstream, away from the nursery areas and into estuaries where they may remain for some time to allow their osmoregulatory mechanisms to acclimatise before moving into coastal or offshore feeding grounds.

As adults they feed by attaching to the sides of other fish such as salmonids, gadoids and clupeids. They rasp through the skin, eating it and the body fluids and muscle underneath. However, although the lamprey is a parasitic species, there is no evidence of any significant damage to native fish stocks in Europe. Furthermore, it is a beneficial species to the ecology of rivers, both in helping to stabilise and aerate silt beds and in providing food for a range of other wildlife.
On reaching sexual maturity, the adult lamprey stop feeding and migrate to their spawning grounds. After spawning most adults die, although some do survive and migrate back out to sea.
Substantial lamprey fisheries did exist at one time on some large British rivers, however they are no longer of any commercial importance in Great Britain. (Maitland, 1997)

5.7.1 *Lampetra fluviatilis* (river lamprey)

General description

The average adult length of the river lamprey is around 40cm with a weight of some 60g. It is confined to Western Europe, migrating from the sea to spawn in silt beds of many UK rivers. The species is normally anadromous – growing to maturity in estuaries and coastal waters and then migrating into freshwater to spawn. Like all species of lamprey, it requires clean gravel for spawning and marginal silt or sand for the burrowing juvenile fish. The larvae spend several years in silt beds before metamorphosing and migrating downstream into estuaries. Here they can be found in numbers feeding on estuarine fish. After 1-2 years, they stop feeding and migrate upstream to spawn in freshwater.
Pollution – either from direct toxic effects or through smothering of eggs, and barriers to migration are of particular concern for this species. Also, although considerable information is available on the biology of the river lamprey in freshwater, much less is known about its habits in estuaries and the sea. (Maitland, 1997)

5.7.1.1 The importance of the river lamprey in the Humber Estuary European marine site

Little is known about the river lamprey in the Humber Estuary, although data from power station fish impingement assessments indicate that they are present throughout the year. The mature adults begin their upstream migration to spawn in the River Derwent and the rivers of the Ouse system in November, although they do not actually spawn until May. It is thought that the migration is triggered by both water temperature and pheromones from juvenile lamprey. After spending several years as ammocoetes, the juvenile lamprey begin their descent into the estuary between October and March. (Paul Frear, pers com)
Although numbers have declined over the last 100 years, the UK is one of the strongholds of the river lamprey, which, although rare and threatened in some European countries, is still fairly widespread in England and other parts of the UK. These populations are considered important for the conservation of this species at an EU level. Marine sites that are considered to be important migration routes or feeding grounds have been selected. River lamprey are known to use the Humber as a migratory passage to and from their spawning and nursery grounds in the River Derwent, itself a candidate SAC for this species, and they also appear to feed in the estuary.

5.7.2 *Petromyzon marinus* (sea lamprey)

General description

The sea lamprey is the largest and least common of the three lamprey species found in the UK and may reach a length of 120cm and weigh 2.5kg, although more usually is around 50cm. Relatively little is known about the precise habitats occupied by adult sea lamprey, but it is thought to occur over much of the North Atlantic, both in shallow coastal waters and deep offshore. The species is anadromous – growing to maturity in the sea and then migrating into fresh water to spawn. The larvae spend several years in silt beds before metamorphosing and migrating downstream to the sea. Like all species of lamprey, it requires clean gravel for spawning and marginal silt or sand for the burrowing juvenile fish.
The sea lamprey has a widespread distribution within the UK, although populations have declined over the last hundred years due to pollution and barriers to migration. Sea lamprey are probably more highly migratory than other species of lamprey and also appear to be particularly poor at ascending obstacles to migration. They have subsequently become extinct in a number of rivers (Maitland, 1997).

5.7.2.1 The importance of the sea lamprey feature in the Humber estuary

Very little is known about the sea lamprey in the Humber Estuary, although data from power station fish impingement assessments indicate that they are present throughout the year. It is thought that the mature adults begin their run up to the River Derwent and the rivers of the Ouse system in May, although little else is known about their behaviour. It is thought that the migration is triggered by both water temperature and pheromones from juvenile lamprey. After spending several years as ammocoetes, the juvenile lamprey begin their descent into the Estuary between October and March (Paul Frear, pers com).
The UK is one of the strongholds of the sea lamprey, which, although rare and threatened in some European countries and extinct in others, is fairly widespread in England and other parts of the UK. Marine sites that are considered to be important migration routes or feeding grounds have been selected. Sea lamprey are known to use the Humber as a migratory passage to and from their spawning and nursery grounds in the River Derwent, itself a candidate SAC for this species, and they also appear to feed in the estuary.

6. The Humber Estuary pSAC conservation objectives

Under Regulation 33(2)(a) of the Conservation (Natural Habitats &c.) Regulations 1994, English Nature has a duty to advise other relevant authorities as to the conservation objectives for the European marine site. The conservation objectives for the Humber Estuary pSAC interest features are provided below and should be read in the context of other advice given in this package, particularly:

- the attached maps showing the extent of the sub-features;
- summary information on the interest of each of the features; and
- the favourable condition table, providing information on how to recognise favourable condition for the interest feature and which will act as a basis for the development of a monitoring programme.

6.1 The conservation objective for the estuary

Subject to natural change, maintain* the **estuary** in favourable condition[8], in particular the:

- Saltmarsh communities
- Intertidal mudflat & sandflat communities
- Subtidal sediment communities

6.2 The conservation objective for coastal lagoons

Subject to natural change, maintain* the **coastal lagoons** in favourable condition[8].

6.3 The conservation objective for Atlantic salt meadows

Subject to natural change, maintain* the **Atlantic salt meadows** in favourable condition[8], in particular the:

- Low to mid marsh communities
- Mid to upper marsh communities
- Transitional communities

8 For a detailed definition of how to recognise favourable condition see attached table 3.
* Maintain implies restoration if the feature is not currently in favourable condition.

6.4 The conservation objective for *Salicornia* and other annuals colonising mud and sand.

Subject to natural change, maintain* ***Salicornia* and other annuals colonising mud and sand** in favourable condition[8], in particular the:

- Annual *Salicornia (*samphire) saltmarsh community
- *Suaeda maritima* (sea-blite) saltmarsh community

6.5 The conservation objective for mudflats and sandflats not covered by seawater at low tide

Subject to natural change, maintain* the **mudflats and sandflats not covered by seawater at low tide** in favourable condition[8], in particular the:

- Intertidal gravel and sand communities
- Intertidal muddy sand communities
- Intertidal mud communities
- Eelgrass bed communities

6.6 The conservation objective for sandbanks which are slightly covered by water all the time.

Subject to natural change, maintain* the **sandbanks which are slightly covered by seawater all of the time** in favourable condition[8], in particular the:

- Subtidal gravel and sands
- Subtidal muddy sands

6.7 The conservation objective for *Lampetra fluviatilis* (river lamprey)

Subject to natural change, maintain* the habitats of ***Lampetra fluviatilis* (river lamprey)** in favourable condition[8].

6.8 The conservation objective for *Petromyzon marinus* (sea lamprey)

Subject to natural change, maintain* the habitats of ***Petromyzon marinus* (sea lamprey)** in favourable condition[8].

8 For a detailed definition of how to recognise favourable condition see attached table 3.
* Maintain implies restoration if the feature is not currently in favourable condition.

7.

Table 3 Favourable Condition Table for pSAC interest features of the Humber Estuary European marine site

NB – It will be possible to monitor many of the attributes at the same time or during the same survey. The frequency of sampling for many attributes may need to be greater during the first reporting cycle in order to characterise the site and establish the baseline. Where relevant, National Vegetation Classification codes (NVCs) and marine biotope codes are provided and then referenced in Appendices V and VIII.

THE HUMBER ESTUARY pSAC INTEREST FEATURES

Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
Estuary	All sub-features	Extent	Area (ha) of the estuary measured periodically during the reporting cycle (frequency to be determined).	No decrease in extent from an established baseline[9], subject to natural change.	Extent is an attribute on which reporting is required by the Habitats Directive.
		Morphological equilibrium.	Intra and inter-estuarine Tidal Prism/Cross Section ratio (TP/CS ratio) measured during the reporting cycle (frequency to be determined).	The intra- and inter-estuarine TP/CS relationship should not deviate significantly from an established baseline subject to natural change.	TP = Tidal Prism = total volume of water crossing a given cross section during the flood tide (m^3). CS = Area of a given cross section at high water springs (m^2). The relationship between TP & CS provides a measure of the way the estuary has adjusted to tidal energy. Substantial departures from this characteristic relationship (determined on a regional basis) may indicate the influence of anthropogenic factors and this would trigger more detailed evaluation of potential problems.
		Water density - temperature and salinity	Water temperature and salinity measured periodically during the reporting cycle (frequency to be determined).	Average temperature and salinity should not deviate significantly from an established baseline, subject to natural change.	Temperature and salinity are characteristic of the overall hydrography of the area. Changes in temperature and salinity influence the presence and distribution of species (along with recruitment processes and spawning behaviour) including those at the edge of their geographic ranges and non-natives.
	Saltmarsh communities	*For information on attributes for the saltmarsh communities sub-feature see the sections of this table which relate to the following interest features:* *Atlantic salt meadows and Salicornia and other annuals colonising mud and sand*			

Estuary	Intertidal mudflat and sandflat communities	*For information on attributes for the intertidal mudflat & sandflat communities sub-feature see the sections of this table which relate to the following interest feature:* *Mudflats and sandflats not covered by seawater at low tide*			
	Subtidal sediment communities	Distribution and extent of characteristic subtidal sediment biotopes for example: IMU, IMX biotopes (see Appendix VIII)	Distribution and extent of biotopes measured during the reporting cycle (frequency to be determined).	Distribution and extent should not deviate from an established baseline subject to natural change	The variety and location of subtidal biotopes are important structural and functional aspects of the interest feature. The subtidal biotopes demonstrate biological assemblages representative of a range of salinity conditions. Changes in extent and distribution may indicate long term changes in the physical condition of the estuary interest feature.
		For information on attributes for the subtidal sediment communities sub-feature see the sections of this table which relate to the following interest feature: *Sandbanks which are slightly covered by seawater all the time*			
Coastal lagoons	All sub features	Extent	Area (ha) of lagoon basin, measured once per reporting cycle	No decrease in extent from an established baseline[9], subject to natural change	Extent is an attribute on which reporting is required by the Habitats Directive. Natural gradual reduction in area of the lagoons may be inevitable due to natural dynamic coastal processes.
		Salinity	Seasonal averages measured periodically throughout the reporting cycle (frequency to be determined).	Average seasonal salinity and seasonal maxima and minima, should not deviate significantly from an established baseline subject to natural change.	Salinity is a key structuring factor within lagoons. Note should be made of natural fluctuations that occur according to year on year variations in rainfall.
		Water clarity	Average light attenuation measured periodically throughout the reporting cycle (frequency to be determined).	Average light attenuation should not deviate significantly from an established baseline, subject to natural change.	Water clarity is important for maintaining the extent and density of algal and plant dominated communities. Clarity decreases through increased suspended organic/inorganic matter.
		Nutrient status – green algal mats	Extent and cover across whole or parts of the site, measured during summer months annually.	No increase in extent or cover of green algal mats from an established baseline, subject to natural change.	Nutrient status is important for the structure and functioning of the lagoon and its communities. Opportunistic and seasonal green algae compete with other vegetation and may affect associated faunal communities.

Coastal lagoons		Characteristic species - density of *Chaetomorpha linum* and *Ruppia* spp.	Density (number of shoots/ m^2) measured during peak growth (Aug), twice per reporting cycle.	Average shoot density should not deviate significantly from an established baseline, subject to natural change.	*Chaetomorpha linum* and *Ruppia* species are characteristic species of lagoons. Reduction in the density of plants is an early indicator of stress and reflects changes in biomass.
Atlantic salt meadows	All sub-features	Distribution and extent	Area (hectares) measured at low spring tide, once during the reporting cycle	No decrease in extent of saltmarsh communities from an established baseline[9] subject to natural change.	Monitoring will need to take account of the dynamic nature of these habitats and seasonal and periodic random variations in vegetation types. Coastal squeeze may result in the replacement of Atlantic salt meadows with pioneer saltmarsh. A reduction in extent could be further indicated by a ground survey to assess for signs of erosion such as toppled vegetation blocks, signs of roots in intertidal mud, signs of stress/damage to plants. Extent needs to be measured at low tide. Much of the upper /transitional saltmarsh communities on the Humber are constrained by sea walls, and sea level rise may squeeze the habitat against these sea defences and submerge existing vegetation zones. The extent to which this habitat can migrate inland as sea levels rises, is likely to be especially valuable in re-dressing losses incurred to the feature from submersion. Monitoring the rate of change is therefore important. Site integrity will be dependent on maintaining the range of community types from low to high marsh by allowing natural rollback of the saltmarsh to occur.
		Creek system pattern	Density and morphology of creek systems measured during the reporting cycle (frequency to be determined)	Creek system pattern should not deviate significantly from an established baseline, subject to natural change	Meanders in creeks help to absorb tidal energy. Creeks transport sediment to and from the saltmarsh and act as drainage channels. The efficiency of this process depends on creek pattern. Vegetation cover, suspended sediment load and tidal influence influence creek density. Creeks allow pioneer vegetation to establish along their banks higher in the saltmarsh system than they would normally be found. Widening, lengthening and flattening of creeks are an indication of sea level rise/ increase in tidal energy. Though this dissipates the increased tidal energy over a larger area, it also allows higher energy to spread further inland.
		Topography	Surface elevation of saltmarsh and intertidal region, measured periodically during the reporting cycle (frequency to be determined).	Topography should not deviate significantly from an established baseline, subject to natural change.	The presence of sea walls may prevent the saltmarsh from keeping pace with sea level rise and maintaining its position in the tidal frame (the landward migration of saltmarsh to compensate for sea level rise is prevented)

Atlantic salt meadows	Low to mid marsh communities	Species composition of characteristic low to mid marsh communities, for example: - SM10 - SM11 (See Appendix V)	Presence and abundance of constant species, measured once during the reporting cycle.	Presence and abundance of constant species of characteristic low to mid marsh communities should not deviate significantly from an established baseline, subject to natural change.	A recent NVC survey by Bullen Consultants (March 2002) recorded low to mid marsh NVC communities: SM10, SM11, SM12, SM13, SM13a, SM13b, SM13c, SM13f, SM14, SM14a, SM14c. Dargie's 2002 survey of the North Lincolnshire Coast SSSI also recorded SM10, SM11, SM12, SM13, SM14.
	Mid to upper marsh communities	Species composition of characteristic mid-marsh communities, for example: - SM15 - SM 16 (See Appendix V)	Presence and abundance of constant species, measured once during the reporting cycle.	Presence and abundance of constant species of characteristic mid to upper marsh communities should not deviate significantly from an established baseline, subject to natural change.	A recent NVC survey by Bullen Consultants (March 2002) recorded mid to upper NVC communities: SM15, SM16a, SM16b, SM16c. Dargie's 2002 survey of the North Lincolnshire Coast SSSI also recorded SM15, SM16.
	Transitional communities	Species composition of characteristic transitional communities, for example: - SM24 - SM28 - S4 (See Appendix V)	Presence and abundance of constant species, measured once during the reporting cycle.	Presence and abundance of constant species of characteristic transitional communities should not deviate significantly from an established baseline, subject to natural change.	A recent NVC survey by Bullen Consultants (March 2002) recorded transitional NVC communities: SM24, SM28, S4. Dargie's 2002 survey of the North Lincolnshire Coast SSSI also recorded SM24.
***Salicornia* and other annuals colonising mud and sand**	Annual *Salicornia/ Suaeda maritima* saltmarsh communities	Distribution and extent	Area (hectares) measured at low spring tide, once during the reporting cycle.	No decrease in extent of saltmarsh communities from an established baseline[9], subject to natural change.	Monitoring will need to take account of the dynamic nature of these habitats and seasonal and periodic random variations in vegetation types.

***Salicornia* and other annuals colonising mud and sand**		Species composition of characteristic pioneer marsh communities, for example: - SM8 - SM9 (See Appendix V)	Presence and abundance of constant species, measured once during the reporting cycle.	Presence and abundance of constant species of characteristic pioneer marsh communities should not deviate significantly from an established baseline, subject to natural change.	
		Algal mat cover	Area and thickness of algal mat, measured once during the reporting cycle	No increase in algal mat cover from an established baseline, subject to natural change.	Algal mats (eg *Enteromorpha* spp) are often associated with pioneer and low marsh communities and are important primary producers. They can be affected by changes in water quality – eutrophication may lead to expansion and smothering of vegetation, or pollution can cause a decline which can then lead to destabilisation of sediment surfaces and initial erosion. An increase in algal cover can also indicate a decline in grazing invertebrates. (A reduction in algal mat cover can indicate active erosion)
		Distribution and extent of common cordgrass *Spartina anglica* community (SM6)	Distribution and extent of *Spartina anglica*, measured once during the reporting cycle	No significant increase in extent from an established baseline, subject to natural change.	*Spartina anglica* is considered to be an invasive species and may impact on pioneer and low-mid marsh communities. However, *Spartina* stands may have a role in sediment trapping following periods of erosion, although under certain tidal conditions, erosion around stands may be greater. Natural dieback has also been observed along the east and south coasts of England. If *S. anglica* increases to cover 20% or more of the site unit, then a monitoring programme may be advisable, possibly followed by control measures.
Mudflats and sandflats not covered by seawater at low tide	All sub-features	Extent	Area (ha) of intertidal flats, measured periodically during the reporting cycle (frequency to be determined).	No decrease in extent from an established baseline[9], subject to natural change.	Extent is an attribute on which reporting is required by the Habitats Directive. Loss of intertidal mudflat communities is likely to be detrimental to the structure of the interest feature, e.g. associated with a change in sediment budget or geomorphological regime, and may indicate long term changes in the physical conditions of the estuaries interest feature. It will be important to assess the impact of coastal squeeze on coastal processes.
		Topography	Tidal elevation and shore slope, measured periodically during the reporting cycle (frequency to be determined).	Shore profile should not deviate significantly from an established baseline, subject to natural change.	In the intertidal, topography reflects the energy conditions and stability of the sediment, which is key to the structure of the interest feature. Topography is a major influence on the distribution of communities throughout the mudflats. Measuring topography may also indicate the position of channels through the interest feature, which is another important indicator of the processes influencing the site.

Mudflats and sandflats not covered by seawater at low tide		Nutrient enrichment - macroalgal mats	Extent and cover of macroalgal mats, measured in the summer during the reporting cycle (frequency to be determined)	Average abundance of macroalgal mats should not increase from an established baseline, subject to natural change	Nutrient status is a key functional factor that influences biota associated with sediments, including fauna as well as plants/algae at the surface. Certain macroalgae (eg *Enteromorpha* and *Ulva* spp) can act as indicators of elevated nutrient levels which can reduce the quality of the sediments and their communities, primarily through smothering and deoxygenation. The duration of the algal mats on the surface of the sediments is also important.
		Sediment character	1. Particle size analysis (PSA). Parameters include percentage sand/ silt/ gravel, mean and median grain size, and sorting coefficient, used to characterise sediment type. Measured in summer, once during the reporting cycle.	Average PSA parameters should not deviate significantly from the baseline, subject to natural change.	Sediment character defined by particle size analysis is key to the structure of the feature, and reflects all of the physical processes acting on it. Particle size composition varies across the feature and can be used to indicate spatial distribution of sediment types thus reflecting the stability of the feature and the processes supporting it.
			2. Organic content- % carbon from sediment sample measured periodically (frequency to be determined)	Average organic carbon content should not deviate significantly from an established baseline, subject to natural change.	Organic content critically influences the infaunal community and can cause deoxygenation of the feature which can be detrimental to the biota. However, a balance needs to be struck as organic content provides a measure of the material available to detritivores. A reduction in organic content could lead to a reduction in detritivores, with subsequent knock on effects throughout the food chain.
			3. Oxidation - reduction potential. Depth of black anoxic layer. Measured periodically during the reporting cycle (frequency to be determined).	Average black layer depth should not deviate significantly from an established baseline, subject to natural change.	Degree of oxidation / reduction, reflecting oxygen availability within the sediment, critically influences the infaunal community and the mobility of chemical compounds. It is an indicator of the structure of the feature.
	Intertidal gravel and sand communities	Range and distribution of characteristic gravel and sand biotopes, for example: LGS biotopes (see Appendix VIII)	Range and distribution of biotopes measured during reporting cycle (frequency to be determined).	Range and distribution should not deviate significantly from an established baseline, subject to natural change	The variety and location of biotopes is an important structural and functional aspect of the feature. Changes in extent and distribution may indicate long-term changes in the physical conditions at the site.

Mudflats and sandflats not covered by seawater at low tide	Intertidal muddy sand communities	Range and distribution of characteristic muddy sand biotopes, for example: LMS biotopes (see Appendix VIII)	Range and distribution of biotopes measured during reporting cycle (frequency to be determined).	Range and distribution should not deviate significantly from an established baseline, subject to natural change	Muddy sands dominated by the worm *Arenicola marina* (e.g. LMS.MacAre) are found throughout this sub-feature. The invertebrates within the sediment play an important structural and functional role as well as providing an important source of food for marine predators and birds.
	Intertidal mud communities	Range and distribution of characteristic mud biotopes, for example: LMU biotopes (see Appendix VIII)	Range and distribution of characteristic mud biotopes measured during late summer / early autumn, periodically during the reporting cycle (frequency to be determined).	Range and distribution should not deviate significantly from an established baseline, subject to natural change.	The variety and location of biotopes is an important structural and functional aspect of the feature. Littoral mud biotopes such as LMU.HedScr, LMU.HedStr and LMU.HedMac often support a high number of polychaete worms and bivalve molluscs, which form an important food source for birds and marine predators such as fish.
	Eelgrass bed communities	Extent	Extent (m^2) of the *Zostera* beds measured during the peak growth period (May to Aug) every three years during the reporting cycle	No decrease in extent from an established baseline, subject to natural change	Eelgrass beds (LMS.Zos.Znol) contribute to sediment structure and stabilise foreshore sediments by reducing wave energy. The extent of *Zostera* beds is a key structural component of the sediments and provides a long-term integrated measure of environmental conditions across the feature. It is also particularly important in being an internationally scarce and declining habitat. The eelgrass beds provide a rich source of food for wintering wildfowl and provide an important nursery area for fish.
Sandbanks which are slightly covered by seawater all the time	All sub-features	Extent	Area (ha) of subtidal sandbanks, measured periodically during the reporting cycle (frequency to be determined).	No decrease in extent from an established baseline[9], subject to natural change.	Extent is an attribute on which reporting is required by the Habitats Directive. Loss of subtidal sediment communities is likely to be detrimental to the structure of the interest feature, e.g. associated with a change in sediment budget or geomorphological regime, and may indicate long term changes in the physical conditions of the estuaries interest feature. However, monitoring will also need to take into account the dynamic nature of the feature.
		Topography	Depth distribution of sandbanks from selected sites, measured periodically (frequency to be determined).	Depth should not deviate significantly from an established baseline, subject to natural change	Depth and distribution of the sandbanks reflects the energy conditions and stability of the sediment, which is key to the structure of the feature. Depth of the feature is of a major influence on the distribution of communities throughout.

Sandbanks which are slightly covered by seawater all the time		Sediment character	Grain size analysis. Parameters include percentage sand/ silt/ gravel, mean and median grain size, and sorting coefficient, used to characterise sediment type. Sediment type to be measured during summer once during the reporting cycle.	Average grain size parameters should not deviate significantly from an established baseline, subject to natural change.	Sediment character defined by grain size is key to the structure of the feature, and reflects all of the physical processes acting on it. Particle size composition varies across the feature and can be used to indicate spatial distribution of sediment types, thus reflecting the stability of the feature and the processes supporting it.
	Subtidal gravel and sands	Distribution and extent of characteristic subtidal gravel and sand biotopes, for example: IGS biotopes (see Appendix VIII)	Distribution and extent of biotopes measured during the reporting cycle (frequency to be determined).	Distribution and extent should not deviate from an established baseline subject to natural change	The variety and location of subtidal biotopes are important structural and functional aspects of the interest feature. The subtidal biotopes demonstrate biological assemblages representative of a range of salinity conditions. Changes in extent and distribution may indicate long term changes in the physical condition of the subtidal sandbank interest feature
	Subtidal muddy sands	Distribution and extent of characteristic subtidal mud biotopes, for example: IMS biotopes (see Appendix VIII)	Distribution and extent of biotopes measured during reporting cycle (frequency to be determined).	Distribution and extent should not deviate significantly from an established baseline, subject to natural change.	The variety and location of subtidal biotopes is an important structural and functional aspect of the interest feature. The subtidal biotopes demonstrate biological assemblages representative of a range of salinity conditions.
River lamprey *Lampetra fluviatilis* and **Sea lamprey** *Petromyzon marinus*		Water quality (physico-chemical properties)	Water quality measured regularly throughout the reporting cycle (frequency to be determined).	No significant variation in temperature, salinity, turbidity and pH, and no reduction in dissolved oxygen levels, from an established baseline[9].	Significant variation in these physico-chemical parameters may be injurious to lamprey populations or act as a barriers to migration. (E.g. Effects on temperature regime may have important consequences for lamprey.) Mature adult river lamprey begin their upstream migration to the River Derwent and the rivers of the Ouse system in November. The sea lamprey begin their run in May. The timing, duration and consistency of this upstream migration is closely related to temperature and pheromone triggers from the juvenile lamprey during periods of high water flow. Peak migration usually coincides with temperatures that remain above 10^{o}C and continues until temperatures reach 18^{o}C. Dissolved oxygen can also be significantly reduced in stretches receiving significant BOD inputs, or through the resuspension of organic rich sediments.

River lamprey *Lampetra fluviatilis* and **Sea lamprey** *Petromyzon marinus*		Habitat structure	Estuary form	Maintain the characteristic physical form and flow dynamics of the estuary	The characteristic morphology provides the diversity of water depths, current velocities and substrate types necessary to fulfil the migratory requirements of the species.
		Access	Any barriers should be mapped and quantified (in relation to height, type and water depth below obstruction).	No artificial barriers significantly impairing adults from reaching existing and historical spawning grounds, or juveniles from moving downstream.	Dams, navigation and other weirs may prevent lamprey from reaching their spawning grounds. In particular, sea lamprey are known to be poor at ascending obstacles. Lamprey can pass some potential barriers by attaching themselves to structures or riverbanks by their suctorial discs and creeping up by strong bursts of swimming.
		Population structure	Population structure measured in terms of viability.	Maintain age/size class structure	Where there is a shift in the age/size class structure (e.g. loss of mature adults or recruitment failure) or if disturbance causes a significant reduction in abundance, then this would be considered unfavourable. On the Humber, sources of disturbance are likely to result from large numbers of lamprey being lost through impingement in power station cooling waters. Also, lamprey have recently become popular in the UK as bait for pike-fishing and are caught as by-catch in an eel fishery on the Ouse. There are also indications that UK populations are sought after as a delicacy in Europe, where stocks are declining. Adult lamprey are usually caught by trapping, whilst juvenile lamprey can be removed by sieving, netting or digging out nursery habitats. Anecdotal evidence of adult trapping suggests heavy losses of fish in some areas.

9 Baselines to be determined during the first reporting cycle

NB: Extreme events (such as storms reducing or increasing salinities or warm summers) also need to be recorded as they may be critical in influencing ecological issues in the Humber Estuary European marine site and may well be missed by routine monitoring

8. Detailed operations advice for the Humber Estuary SAC interest features

This section provides information to help relate general advice to each of the specific interest features of the Special Area of Conservation.
These interest features are:

- Estuary
- Coastal lagoons
- Atlantic salt meadows
- *Salicornia* and other annuals colonising mud and sand
- Mudflats and sandflats not covered by seawater at low tide
- Sandbanks slightly covered by seawater all the time
- River lamprey
- Sea lamprey

This advice relates to the vulnerability of the interest features and sub-features of the pSAC within the Humber Estuary European marine site boundary as summarised in Table 2 and set out in more detail in Tables 4 and 5. An explanation of the sensitivity of the interest features or sub-features follows with an explanation of their exposure and therefore their vulnerability to damage or disturbance from the listed categories of operations. This enables links between the categories of operation and the ecological requirements of the European marine site's interest features, as set out in Section 5, to be made.

The categories of operation may cause damage or disturbance to the interest features and sub-features of the European marine site, either alone or in combination.

The Humber Estuary European marine site covers an extremely large geographical area and this operations advice refers to the interest features across the estuary. Therefore, activities have been allocated an 'average' exposure score based on their occurrence within the estuary. The following text will reflect where activities only occur in a small area of the site but may be undertaken intensively or frequently. Also, particularly in the middle and outer estuary, there may be a difference in the intensity of activities occurring on the north and south bank.

i) Physical loss

- The Humber Estuary European marine site is a complex system, comprising one of the largest estuaries in the UK, and supporting an important diversity of intertidal and subtidal habitats. In turn, these support a rich variety of marine communities, many of which are dependent upon the ecological functioning of other communities. Physical loss through either removal or smothering could affect the survival of these communities and would be detrimental to the favourable condition of the European marine site.

- Physical loss can occur through the removal or smothering of the interest features and/or sub-features and can result from many sources, including one-off developments such as infrastructure construction and modification, coastal protection works, or from land claim. This can result in the loss of part of one or more of the interest features or sub-features and may occur more frequently in certain areas of the site – such as those close to heavy industry. Physical loss may also occur from the cumulative effects of ongoing activities such as maintenance dredging. Developments and activities may also indirectly cause the loss of estuarine habitats through changing the morphology and modifying coastal processes, subsequently leading to habitat erosion. Changes to coastal processes may also affect the sediment budget of the estuary and reduce the sediment supply to areas such as the intertidal flats, reducing the rates of accretion.
  Hard frontages such as embankments and sea walls further compromise the estuarine system on the Humber, constraining the upper boundary and preventing the landward migration of intertidal habitats in response to rising sea levels.
  Many of the interest features have a high or medium exposure to removal and this results in a high or moderate vulnerability for all the features.

- The **coastal lagoons** are highly sensitive to removal, as the loss of this habitat would impact directly on the characteristic plant or animal communities, some of which are internationally important and many are restricted to lagoon habitats. Lagoons and their associated flora and fauna also have long recovery times once damaged.
  The lagoons were determined to have a low exposure to removal and smothering, which may be due to occasional land claim or coastal developments. However, combined with the high sensitivity score for removal, results in a moderate vulnerability.

- The **saltmarsh communities** were determined to have a high exposure to physical loss through removal. This may occur as a result of coastal squeeze – whereby intertidal habitats are trapped between man-made structures such as sea defences, and rising sea levels. Under natural conditions, the saltmarsh would respond by migrating backwards, however the presence of sea defences restricts this process. Where this occurs on saltmarshes, it may result in the replacement of mid to upper marsh communities by pioneer marsh species. The Humber Estuary is almost entirely confined by sea defences, and much of the Humber's high marsh communities have already been lost due to coastal squeeze. In some areas, the low to mid marsh communities are now also threatened. Further investigation into the favourable condition of the saltmarshes on the Humber Estuary and the effects of coastal squeeze is needed.
  There have also been reports of large scale samphire collections on the Lincolnshire coast and on Spurn Bight. Samphire picking can be classed as a traditional longshore activity and may be sustainable when traditional methods are employed. However, large scale exploitation for resale is unlikely to maintain this interest feature in favourable condition and it has been reported that there are few plants left after these collections. The uprooting of plants will also result in the loss of the seed-bank and a lack of recolonisation of the mudflats.
  It has also been reported that in the past, dredged spoil from land-drainage outfalls has been dumped alongside the drainage channels and this has resulted in areas of saltmarsh being smothered.
  The saltmarsh communities are therefore highly vulnerable to removal and the mid to high marsh communities and transitional communities are moderately vulnerable to smothering.

- The **intertidal mudflats and sandflats** were determined to have a medium exposure to removal, except for the intertidal mud communities that are found in the mid to outer estuary. It was felt that there was considerable development in the areas where intertidal mudflats occurred, and this would result in the physical loss of the habitat and so the exposure score was determined to be high. There are also areas of mudflats being lost to erosion and coastal squeeze. Initial modelling for the Humber Shoreline Management Plan indicates intertidal losses of 460ha due to coastal squeeze over the next 50 years. In addition, North East Lincolnshire Council carries out beach feeding at Cleethorpes as part of their sea defence programme. The need for beach feeding is identified through twice yearly beach profile surveys and although it is undertaken infrequently, they have consent to remove up to 2000m^3 of sand each year from within the European marine site. This operation will cause physical loss of the intertidal flats both through removal and smothering.
  The intertidal mudflats and sandflats may also be exposed to smothering in localised areas from jetting and flushing of drainage outfalls. However, across the site as a whole, the exposure of the intertidal features to smothering is classed as low.

- The Humber is a busy commercial waterway, housing the largest shipping complex in the UK, and frequent maintenance dredging is carried out. The dredged spoil is put back into the estuary system, although it is currently unclear whether all the spoil is actually retained. The main dredging areas include the approaches to the main ports of Grimsby, Immingham and Hull, as well as within the docks themselves (although these areas are outwith the European marine site boundary). Maintenance dredging of the main Humber navigation channel at the Sunk Dredge Channel is also carried out. The material dredged is a mixture of sand, fine sand, muddy sand and silt depending on location, and ABP are licensed to remove up to 16,150,000 tonnes of sediment each year. Other companies also undertake maintenance dredging around wharfs and jetties to maintain access. There are a number of sites mainly within the middle and outer estuary, licensed for the disposal of the dredged material. In general, these are close to the areas where the dredge spoil was removed from and tend to be dispersive, redistributing the material throughout the estuary (ABP report 903).

Nevertheless, dredging will lead to physical loss of subtidal material in the areas dredged, and localised smothering of the benthic communities at and close to the depositing grounds. The Humber is an extremely turbid system with a naturally high sediment load and so depositing of dredge spoil is likely to have only localised effects. The exposure to smothering is classed as medium for the subtidal gravels and sands as these occur throughout the estuary, and low for subtidal muddy sands as these occur in the mid to outer estuary where these habitats are subject to a higher degree of flushing by seawater. Dredging and the disposal of dredge spoil may also lead to a change in the extent, distribution and nature of intertidal habitats, either through the removal of the source of intertidal sediment, or through the smothering of the intertidal flats.
The **subtidal sediment communities** and the **subtidal sandbanks** are therefore highly or moderately vulnerable to both removal and smothering.

- **River and sea lamprey** have a high exposure to physical loss through removal as large numbers are sucked up in power station cooling water systems. Studies by the Institute of Estuarine and Coastal Studies on Stallingborough power station recorded annual losses of over 13,000 lamprey (1999-2000) and nearly 17,000 lamprey the following year. Many of these lamprey were river lamprey as they tend to migrate along the banks of the estuary and are therefore more likely to be impinged by the cooling water intake. The sea lamprey tend to migrate through the middle of the estuary, and are less likely to be impinged. It has been calculated that the annual impingement of fish by this power station equals over 18% of the total fish biomass of the Humber Estuary. However, these figures have been derived using the estuary as a closed system without taking account that wider stocks replenish the estuarine fish biomass. This would result in lowering the percentage (Proctor *et al*., 2000). It is believed that other power station cooling water systems must also remove both river and sea lamprey from the estuary, although there is currently little data on this.
  In addition, lamprey are caught as by-catch in an eel fishery on the River Ouse at Naburn and are sold on as bait for pike fishing. Other fishing methods, such as trawling for shrimp and fyke netting for eels may also result in the removal of lamprey from the estuarine system (G. Bartlett, pers com).
  These activities may have a significant impact on numbers of lamprey in the Humber Estuary and the river and sea lamprey are currently highly vulnerable to removal.

ii) Physical damage

- Most estuarine communities are not considered to be highly sensitive to siltation, as estuaries are naturally silty environments. However, several of the sub-features are moderately sensitive to siltation and combined with a medium exposure score this leads to a moderate vulnerability.
  Silt in the water column can smother or block the feeding and respiratory organs of marine invertebrates living in the substrate. It can also affect recruitment processes of both marine flora and fauna and can contribute to a reduction in light penetration through the water column. Light penetration is of particular importance for the eelgrass beds that are found on Spurn Bight and in the Grimsby area. Eelgrasses can also be easily dislodged or uprooted from the sediment by physical damage from anchoring or abrasion from boats, vehicles or fishing gear.

- Siltation can occur from effluent outfalls, maintenance dredging and dredged spoil disposal and is likely to have localised effects. The exposure to siltation from dredging and other activities throughout the estuary is not considered to be high, due to dispersal and the Humber's naturally high sediment load. However, further investigation into the effects and distances travelled by sediment plumes would be useful.

- Abrasion can physically damage individual marine organisms and plants, as well as causing deterioration to the structure of saltmarshes and sediment communities. **Intertidal mudflats and sandflats** in particular are naturally dynamic, and therefore many of the organisms inhabiting them are not highly sensitive to abrasion. However, if the damage is intensive or persistent, this may be detrimental to the favourable condition of the interest features in relation to their structure and functioning.
  Exposure to abrasion varies across the site, arising from one-off developments or from on-going activities such as recreation or cockling.

- Abrasion of the **intertidal habitats** may occur from both land-based and water-based activities. Physical damage to soft sediment communities can alter the habitat structure and may lead to a change in species composition. Excessive damage may ultimately result in the destabilisation of the sediment and lead to rapid erosion.
  The intertidal habitats were determined to have a medium exposure to abrasion due to the number of activities that may cause physical damage. Bait collection on the intertidal flats locally disturbs the sediment through digging and to a lesser extent trampling. In many cases, the sediment is not put back into the dug holes which results in an increased recovery time for the benthos.
  On the southern shore of the outer estuary, the intertidal habitats are exposed to abrasion from recreational activities such as quad biking, canoeing and large numbers of visitors, which use areas such as Cleethorpes beach and Donna Nook National Nature Reserve. Until the cockle beds were closed in June 2002, cockle fishing took place at Horseshoe Point and the beds were accessed via an area of saltmarsh. This led to significant localised damage, both to the **saltmarsh** habitat and to the intertidal flats, particularly from the tractors and quad bikes that were driven onto the site. These cockle beds are currently closed after a stock survey undertaken by North Eastern Sea Fisheries Committee revealed the beds to be depleted. In addition, beach feeding is undertaken at Cleethorpes using excavators and large dumper trucks. This is likely to result in abrasion of the intertidal flats, although it is only undertaken infrequently.
  In the inner estuary, the exposure of the intertidal habitats to abrasion is likely to be lower, as there is little access to the foreshore.

- The **subtidal sediment communities** and **subtidal sandbanks** have a medium exposure to abrasion, which may result from maintenance dredging or from mobile benthic fishing gear such as beam trawls. Shrimp fishing is undertaken on the Humber, either using push nets, otter trawls or beam trawls. More commonly however, twin beam trawls between 4 and 9m in diameter are towed along the seabed, and 10 to 12 vessels operate in the estuary between August and January. Beam trawling is also undertaken heavily along the north Lincolnshire coast. In recent years, competition on the Wash has forced many shrimp trawlers to begin fishing in the Humber Estuary. Both dredging and to a lesser extent, beam trawls, can damage the benthic communities of the subtidal habitats, either through abrasion or removal of the substrate. This may lead to a change in the community structure.

- Exposure to selective extraction is low across the European marine site, except for the **pioneer marsh communities** where the exposure was determined to be medium, due to large scale samphire collecting. This extensive gathering may also cause physical damage to non-target species such as the *Suaeda maritima* (sea-blite) that grows on the lower shore alongside the samphire. There is also some offshore aggregate extraction which has the potential to affect the geomorphological processes within the estuary.

iii) Toxic contamination

- Many estuarine species and communities are highly sensitive to toxic contamination through the introduction of synthetic compounds such as pesticides, PCBs (polychlorinated biphenyl) and biocides such as TBT (tributyltin). They are also moderately sensitive to non-synthetic compounds such as heavy metals and hydrocarbons. Toxicity may be increased by synergistic effects when there are mixtures of pollutants and this may also result in the loss of communities. The EC Directive on "pollution caused by the discharge of dangerous substances to the aquatic environment" aims to reduce the pollution of waters by seeking to eliminate the most dangerous substances in terms of persistence, toxicity and bioaccumulation. These substances are known as List I substances and include contaminants such as mercury, cadmium and DDT. The Directive also aims to reduce the input of List II substances such as lead, copper and TBT.

- Many synthetic compounds such as PCBs are known to have toxic effects even in low concentrations, and high levels of bioaccumulation can occur within many benthic organisms, such as molluscs, which are poor at regulating their uptake of contaminants. Such compounds may then 'biomagnify' up the food chain if these organisms are predated upon. Whilst the effects of individual synthetic compounds upon

the many species found within the habitats of the Humber Estuary are poorly understood, there is evidence of high levels of toxicity to some groups of species such as crustaceans (Cole *et al*., 1999). The potential effects of toxic pollutants also vary according to the state and availability of the compound and the characteristics of the receiving environment. Where the effects are lethal and result in the removal of individual species, key grazers or predators may be lost and a dominance of pollution tolerant organisms may result. Sub-lethal effects however, may affect the healthy functioning of an organism such as its reproduction, physiology or genetics, which may ultimately reduce the organism's fitness for survival. Faunal communities within sediments, which primarily consist of species relying on larval dispersal for recruitment, are particularly recognised as being sensitive to toxic contamination. In sheltered low energy environments such as estuaries, muddy sediments can act as a sediment sink, with both synthetic and non-synthetic compounds binding to the fine sediments. If the sediment is disturbed (for example by dredging), the contaminants may be remobilised, making them available once more as potential pollutants and increasing water toxicity.

- Oil pollution can also cause deterioration of marine communities, and can persist in low energy environments, where natural degradation and weathering of the oil tends to be slow. Oil can also have a significant smothering effect on marine communities. In 2001, over 40 million tonnes of oil and chemicals were transported in and out of the Humber Estuary, so there is the possibility of a large spill occurring. Oil may also be brought into the estuary from an incident at sea or via the river systems. Consequently, there is a need to maintain and enhance measures to reduce the risk of pollution, and to have effective contingency plans for dealing with an incident. There are several plans currently in place on the Humber, and the organisations concerned with the containment and clean-up of an oil spill are advised by the Humber Environment Group, which involves environmental regulators supported by NGOs.
  Although the exposure to toxic contamination is medium, if a large oil spill occurred, the exposure scores may increase to high, which would in turn increase the vulnerability scores of the SAC habitats.

- The Humber Estuary lies in a heavily populated, industrialised and intensively farmed catchment area and receives contaminants from the following sources:
  - Point source discharges from industry and waste water treatment works,
  - Wash-off from the land, roads and paved areas,
  - Leachate from landfill sites and contaminated land,
  - Pollution incidents involving the release of oil and/or chemicals.

  These inputs may go directly into the estuary or the contaminants may be delivered from the wider catchment via the river systems. Pollution can also be brought in from the sea or from the washout and other deposition of atmospheric contaminants. A further source is the release of pollutants from the sediments of the estuary, which may result from activities such as dredging.
  Over the last 20 years, there has been much investment in the clean up of point sources of pollution and reducing the risk of spillages. In addition, many consents and authorisations for direct discharges, and permits for existing activities that may impact on the estuary are the subject of 'appropriate assessments' in order to meet the requirements of the Habitats Regulations.

- The Humber receives sewage and industrial effluent from one-fifth of the area and population of England, both through the fresh water river systems and from direct effluent discharges. Although sewage and industrial effluents are treated to meet environmental quality standards, there will still be residual contaminants in the discharges (Environment Agency, pers com). Therefore, it was determined that there was a medium exposure score throughout the estuary to toxic contamination from synthetic and non-synthetic compounds, although the exposure may be lower in the outer estuary, as these habitats are subject to a higher degree of flushing by seawater. The **saline lagoons** are separated from the estuary by natural barriers, and so do not have riverine or effluent discharges released directly into them. Their exposure to synthetic and non-synthetic compounds, particularly those deposited in estuarine sediments was therefore determined to be low.

- A wide range of chemical determinants are regularly measured on the estuary by the Environment Agency, and the vast majority comply with environmental quality standards (Richard Freestone, pers com). However, several contaminants are present in the sediments of the upper estuary at higher levels than the standards set. These are TBT, copper and TPT (an organotin compound used as a fungicide to

protect crops). The use of TBT as an antifoulant on vessels less than 25m in length, has been banned since 1987 and the International Maritime Organisation (IMO) has agreed a global ban on all TBT application from 2003. Occasionally levels of TBT up to 10 times the environmental quality standard have been recorded on the Humber.

Much of this toxic contamination is due to historic discharges and reflects the persistent nature of certain contaminants, which may remain in the sediments and only leave the estuary when washed out by currents. Copper discharges are an exception to this historic contamination. Elevated levels of copper still enter the estuary in some of the main river inputs, such as the Trent, although levels are reducing.

Levels of other heavy metals, including lead, mercury and zinc fail the 'interim marine sediment quality guidelines', although they pass the levels set for 'probable effect'. Again, much of this contamination is due to historic discharges and lead mining in the Pennines in the 19th Century and earlier. There is also some arsenic contamination remaining in the sediments from Capper Pass – a metal smelting plant near Brough that closed down about 10 years ago.

(No environmental quality standards have been developed for sediments in the UK and so the Canadian/US approach was recommended. This uses 'probable effect levels' where the contaminant is likely to cause adverse effects in a wide range of organisms. 'Interim sediment quality guidelines' have also been adopted by Environment Canada for a range of toxic substances and these are currently in use in the UK. However, it should be noted that these guidelines have been developed using species that are not indigenous to the UK and that there may be fundamental differences in sediment geochemistry. In general, where sediment concentrations of toxic substances are close to or above the probable effect level, they indicate a high probability of risk of adverse effects and should be identified as a cause for concern (Cole *et al*., 1999).

- Permethrin and other chemicals used in sheep dips and moth proofing enter the estuary via sewage treatment works and the river system. The wool scouring industry is centred on West Yorkshire, and produces up to 30,000 tons of scouring sludge per annum. The wool is prepared to make into clothes and carpets and the insecticides in the wool are washed into the sewers during the scouring process. There is likely to be a concentration gradient of these chemicals away from the point sources, which are generally the rivers that enter the system in the inner estuary. In addition, the high turbidity of the estuary means that contaminants can attach themselves to particles and be dispersed throughout the estuary fairly rapidly. In sheltered areas such as at Pyewipe and Saltend there may be some accumulation of sediments, however, eventually these will also be washed out of the estuary.

- The **saline lagoon** communities of the Humber are very diverse and include several internationally important species. Therefore, any disturbance to species composition, which may result in changes to the population structure and hence biodiversity is considered harmful. Communities within the lagoons are also sensitive to acute events such as oil spills due to their toxicity and smothering effects. Lagoonal communities often take many years to recover from pollution events, depending on their recruitment rates and the dispersal of the toxic substance. Lagoons are also poorly flushed and so any contaminant is likely to remain. The high sensitivity of the saline lagoons to synthetic compounds results in a moderate vulnerability score.

- **Saltmarshes** have a high sensitivity to toxic contamination by synthetic compounds and moderate sensitivity to non-synthetic compounds. Although saltmarsh plants may be reasonably tolerant of certain synthetic compounds, they can bioaccumulate toxic compounds and act as sinks for them (Holt *et al*., 1995). They are also sensitive to oil and oil products, even at low levels, mainly due to their ability to trap sediments. Acute events such as an oil spill can be particularly damaging to saltmarsh plants, and the dispersants used to treat the spill can sometimes have an even more toxic effect on the plants than the oil itself. The use of dispersants to clean up oil spills on or close to saltmarshes is therefore, not recommended. Saltmarshes have been reported to take up to 10 years to recover from chronic oil pollution, although recovery depends largely on the degree to which oil is retained in the sediment and the clean up procedures used.

  The saltmarsh communities on the Humber are highly vulnerable to the introduction of synthetic compounds and moderately vulnerable to the introduction of non-synthetic compounds.

- The eelgrass beds of the **intertidal flats** can readily take up heavy metals and TBT, and this may reduce nitrogen fixation, leading to the loss of the plant in nutrient-poor substrates. Eelgrasses are also susceptible to hydrocarbon spills, however, the associated communities may be more sensitive to oil pollution, both from the toxic effects and from smothering, than the eelgrass beds themselves. The eelgrass beds were determined to be moderately vulnerable to synthetic and non-synthetic contamination.
  The benthic communities of both the intertidal flats and the **subtidal sediments communities** and **subtidal sandbanks** are known to be sensitive to toxic contamination, particularly those which rely upon larval dispersal for recruitment, therefore these sub-features were determined to be moderately or highly vulnerable to toxic contamination.

- The **river and sea lamprey** are moderately vulnerable to toxic contamination through the introduction of synthetic and non-synthetic compounds, as they are exposed to these contaminants as they live in or migrate through the estuary waters. The levels of toxic contaminants are considered to be higher in the upper estuary, where levels of contaminants such as copper and TBT fail environmental quality standards. This may affect both the adult river and sea lamprey as they migrate through the estuary to their fresh water spawning grounds, and the juvenile lamprey as they migrate down the estuary away from their nursery areas.

- None of the interest features or sub-features were determined to be vulnerable to the introduction of radionuclides, due to a low exposure throughout the site. Radioactive substances from hospitals or research and industrial waste may enter the Humber Estuary from effluent discharges. In addition, radionuclides from nuclear installations can be flushed into the estuary from the sea.
  A surveillance programme undertaken by the Centre for Environment, Fisheries and Aquaculture Science into the distribution of key radionuclides, concluded that the coastal waters of the British Isles, including the North Sea, are contaminated by radionuclides. The 1998 data for the North Sea shows a general distribution of falling concentrations as the distance from Sellafield increases.

iv) Non-toxic contamination

- Certain contaminants can have non-toxic, but nevertheless harmful effects on the features of the Humber Estuary European marine site, mainly because they can enter the environment in large quantities from sewage and industrial outfalls, riverine inputs and agricultural run-off.

- The over-enrichment of an aquatic environment with inorganic nutrients (especially nitrates and phosphates) can result in the stimulation of phytoplankton and bacterial growth. This may lead to a reduction in the oxygen content of water, particularly in areas of limited or reduced water circulation. Increased nutrient levels can also lead to the localised growth of opportunistic algae such as *Enteromorpha* species and *Ulva lactuca* on the foreshore, which can cause smothering and deoxygenation of the sediment communities (Cole *et al*., 1999). Nutrient pollution can also reduce the diversity of communities and some species could be sensitive in terms of recovery, due to their slow growth and low larval dispersal.
  Increased levels of organic compounds can lead to a localised depletion of oxygen levels due to the increased activity of anaerobic bacteria that break down organic matter. A good supply of oxygen within the sediments and water column is important for the healthy functioning of most marine species. Elevated levels of organic matter can alter this natural balance, potentially causing changes to the species composition and distribution within the sediments and saltmarsh communities, caused primarily by the increased growth of opportunistic species at the expense of more sensitive species (Cole *et al*., 1999).

- On the Humber Estuary, high nutrient and organic loads enter the system from sewage and industrial outfalls, and agricultural run-off. Between 1998 and 2001, two stage sewage treatment was provided for Cleethorpes, Goole, Grimsby and Hull. Previously, the effluent was discharged untreated into the estuary. This sewage treatment will not however, affect the concentrations of nitrogen and phosphorus in the estuary as by far the greatest loading of these contaminants comes from diffuse agricultural run-off from the wider catchment.

- The Humber Estuary is hyper-nutrified with the highest levels of nitrates found in the tidal rivers and the concentrations reducing towards the mouth of the estuary as a result of dilution with seawater. Nutrient levels may also vary over the tidal cycle and seasonally with freshwater flow. The Humber was originally designated under the Urban Waste Water Treatment Directive as a water for which nutrient removal is not required as the adverse effects of nutrient enrichment were not found. The high turbidity of the estuary greatly reduces light penetration through the water column and limits the photosynthesis of algae. However, it has been suggested by the EC that the Humber Estuary should be designated as a 'sensitive area' for the purpose of this Directive. Sensitive areas are described as 'freshwater bodies, estuaries and coastal waters which are eutrophic, or which may become eutrophic if protective action is not taken'. If this is enforced there will be an obligation to ensure that the input from effluent treatment works does not increase, and that the nutrient and eutrophication status of the estuary is periodically re-assessed. Recently, much of the Humber's catchment area became a Nitrate Vulnerable Zone under the Nitrates Directive. This requires restrictions on the application of manures and artificial fertilisers and may stem the leaching of nitrate from farmland in the Humber's catchment area. However, it may take some time before the benefits are visible due to the large amounts of nitrates stored in some groundwaters.

- Some sediment communities are sensitive to non-toxic contamination, which may result in excessive blanketing of green algae and smothering of benthic communities. The sediments of the **saline lagoons** are particularly susceptible to nutrient and organic enrichment, due to the poor flushing rates. It is also suspected that there is some seepage into Humberston Fitties lagoon from the adjacent farmland and caravan site (Andrew Grieve, pers com). The **intertidal flats, subtidal sediment communities** and **subtidal sandbanks** are also highly or moderately sensitive to nutrient and organic loading. An excessive input of organic matter can result in anoxic conditions in the sediments, particularly in sheltered areas with low tidal flows, such as at Pyewipe and Saltend. Anoxic conditions can lead to the extinction of fauna living in the sediments, although some species may be tolerant to eutrophication. This can result in numbers of these species increasing, ultimately altering the community composition. The eelgrass beds are highly sensitive to changes in nutrient levels and moderately sensitive to changes in organic levels. Nutrient and organic enrichment can lead to phytoplankton blooms that increase turbidity, leading to a lack of light penetration, which may limit the ability of the eelgrasses to photosynthesise.
  Studies in North America have suggested that **saltmarshes** are unlikely to be highly sensitive to changes in water quality due to nutrient enrichment (Holt *et al*., 1995). However, increased growth of algal species, as a result of eutrophication may cause localised smothering of lower saltmarsh species and have been known to have a detrimental effect on *Salicornia* species in particular. Saltmarshes may also trap nutrient and organic matter, retaining it within the estuarine system with the opportunity for it to be remobilised.
  A zone of deoygenation on the tidal Ouse is present during the summer months. This has occurred for many years and is partially a natural phenomenon as currents stir up the silt; but it is also a result of effluent discharges. In recent years however, these have improved significantly due to improvements made by Yorkshire Water and industries. This zone of deoxygenation could potentially affect both the adult **river and sea lamprey** (and other fish species such as salmonids) as they migrate upstream to breed and the juveniles as they migrate downstream into the estuary.

- The Humber Estuary is considered to have a high nutrient regime from sewage and agricultural inputs, therefore it was determined that the sub-features which were covered continually or frequently by seawater were highly exposed to changes in nutrient loading. The sub-features that were less frequently inundated were considered to have a medium exposure. The **saline lagoons** were also determined to have a medium exposure as although they would be less exposed to contamination from the estuary waters, nutrient and organic enrichment may result from agricultural run-off entering the lagoons. These exposure scores resulted in all sub-features, (except for the low to mid saltmarsh communities) being moderately or highly vulnerable to nutrient loading. In addition, all sub-features are also highly or moderately vulnerable to changes in organic loading.

- Changes to the thermal regime of the water column may lead to changes in the distribution and composition of marine organisms. Ultimately a long-term thermal discharge is likely to lead to a change in community, with colonisation by species adapted to warm water temperatures. Changes in species productivity may also occur as some species may thrive in warmer temperatures, whilst others may

decline. This situation may consequently favour more opportunistic species and there are examples where increased temperatures have affected the growth and reproduction of invertebrates (Langford *et al*. 1998). The impact of heated water discharges are likely to depend on the location of the discharge point, the temperature of the discharge and the nature of tidal currents in the area. The temperature of the Ouse and Trent fell in the 1970s and 1980s as the older 'direct-cooled' power stations were closed. The water cooled power stations that are now found on and around the Humber, have cooling towers or return the discharge to deeper waters so that any temperature rise is minimised. Consequently, the sub-features of the European marine site were determined to have a low exposure to changes in thermal regime. However, the **river and sea lamprey** are highly sensitive to changes in water temperature, as their upstream migration is thought to be temperature dependent, relying on the detection of a small increase in water temperature. Therefore, the river and sea lamprey were determined to be moderately vulnerable to changes in thermal regime.

- The Humber Estuary is an extremely turbid system; therefore any increases in turbidity from anthropogenic actions are likely to have a minimal impact on the sub-features and their associated communities. The exposure to changes in turbidity was determined to be low throughout the estuary, except for the **subtidal sandbanks** and **river and sea lamprey**, which are continually covered by water and may be affected by changes in turbidity due to activities such as dredging and the depositing of dredge spoil. The **lagoons** are moderately sensitive to changes in turbidity as a decrease in the clarity of the water column will inhibit submerged macrophyte growth in species such as *Ruppia* with a consequent depletion of dependent invertebrates.
  The Humber has been described as hyper-nutrified but not eutrophic, and it is likely that the turbidity of the estuary limits algal growth. Therefore, any activity that reduces turbidity in the estuary may trigger eutrophic effects, although the large amounts of sediment currently in the water column, mean that the activity would have to be significant, and this would also have other major impacts such as erosion and affect sedimentation.

- The exposure scores throughout the estuary to changes in salinity were determined to be low as the main influences on the salinity of the estuary would be from natural sources such as the tide and rainfall. However, warm water outfalls from power stations would have a slight effect on the salinity in a localised area, and the River Trent has an artificially high water flow due to receiving waste water from Wales and this may affect the salinity of water in the upper Humber. In addition, climate change resulting in extended or more frequent summer droughts, and sea level rise may result in increasing salinities in the upper estuary, which may affect the transitional saltmarsh communities.

v) Biological disturbance

- The **saltmarsh communities** on the Humber Estuary are moderately vulnerable to biological disturbance through the introduction, translocation and/or spread of non-native species. Introduced species may thrive at the expense of native species, resulting in a change in the biological composition, structure and functioning of estuarine habitats.
  Common cordgrass *Spartina anglica* is a fertile strain of a hybrid between a native and non-native species. It demonstrates vigorous growth and is able to grow low down on the shore where the sediments are highly mobile. In the past, *Spartina anglica* was planted to assist in coastal defence and land claim of the intertidal area and was first planted on the Humber in 1936. Its role in saltmarsh development is poorly understood, but it is considered by some people to be a invasive species that may be damaging to other marsh communities. Conversely, on the Humber, the area covered by *Spartina anglica* has reduced from 160ha in 1969 to 120ha in 1989 and recent observations at Welwick suggest that saltmarsh grass *Puccinellia maritima* has largely replaced areas of *Spartina* (Billings *et al*., 2002).
  There are also records of other non-native species within the European marine site and the potential for further introductions which can have unforeseen consequences. Some species, such as the slipper limpet *Crepidula fornicata* may have been transported from overseas on the hulls of ships or in ballast waters in the pelagic larval stage. Others were deliberately introduced. The Chinese mitten crab *Eriocheir sinensis* has been reported from one of the tributaries on the Humber since 1976. During August, adult crabs migrate seawards and gather in large swarms to breed in estuaries. When populations are high, they may cause damage to soft sediment banks by burrowing. This may increase erosion and affect flood defences.

The Chinese mitten crab is also an intermediate host for the mammalian lung fluke, which may affect the grey seal population at Donna Nook.

- On the Humber, both *Zostera noltei* (dwarf eelgrass) and *Zostera marina* (common eelgrass) have been recorded on Spurn Bight and from the Grimsby area. These eelgrass beds have declined over recent years, although the reasons why are not fully understood. During the 1930's, a wasting disease was responsible for the loss of eelgrass beds around the UK and this has since reappeared in the south-west. However, other factors such as natural physical phenomena, dredging (resulting in a loss of deposition of sediments), increased turbidity, and abrasion from boats can all result in damage to eelgrass beds. Survey work would be advisable to establish the current status of the eelgrass beds on the Humber Estuary.

- The interest features and sub-features of the European marine site have a low exposure to the selective extraction of species, except for the **intertidal muddy sand communities** and the **intertidal mud communities**. These are the areas where activities such as baitdigging and cockling are carried out. The exposure score was determined to be medium for these activities, as although in areas such as on Spurn Bight and south of Cleethorpes these activities are fairly intensive, over the estuary as a whole the exposure is likely to be medium. Bait digging occurs frequently between Grimsby and Cleethorpes and at Tetney on the south bank, and at Spurn Bight to Easington Clays on the north bank. Cockling on the estuary is very localised and seasonal, although currently the cockle beds at Horseshoe Point are closed due to low stock densities. These cockle beds have an erratic presence, due to periodic dramatic movements of sediment around the Grainthorpe Haven basin, and the unpredictable nature of good spat fall years (Graham Weaver, pers com). In February this year, DEFRA confirmed a new byelaw to strengthen the management of the Humber cockle fishery. All fishermen harvesting more than 5kg of cockles per day require a permit from NESFC and the issuing of this permit is subject to the submission of monthly catch returns. In addition, the fishery can only be exploited using hand rakes and all cockles under 20mm must be returned to the beds. The beds will also be closed to commercial exploitation between May 1st and August 31st and NESFC also retain the right, following consultation with permit holders, to close the beds for several reasons, including environmental protection or conservation. As in other areas, such as the Wash, an ecological balance is achieved through the thirds rule, which allocates a third of the cockles to the fishermen, a third to birds and the remaining third to the stock.

- Exposure to the selective extraction of species was also determined to be medium for the **pioneer marsh communities**, due to the large scale collection of samphire on the north Lincolnshire coast and on Spurn Bight. Traditional samphire picking at these sites was localised and seasonal, however, there have been recent reports of gathering at Humberston and some large-scale gathering on Spurn Bight. Members of the Humber Advisory Group have reported that little samphire has been left at these sites after collection and that the whole plant has been pulled up, resulting in the loss of seeds to recolonise the intertidal flats.

- The unsustainable removal of particular species from estuarine habitats may affect the ecological balance of the marine communities and predator species, such as birds and fish that may rely upon them as a food source. However, the levels at which removal of a species becomes unsustainable are difficult to define. Fowler (1999) has produced guidelines on the collection of bait and other shoreline animals within European marine sites, and a bait-digging guide is given out on the Humber when people apply for licences in northeast Lincolnshire.

Table 4 Assessment of the relative exposure of interest features and sub-features of the Humber Estuary European marine site (pSAC) to different categories of operations (as at July 2002)

Key: **High** = High exposure **Med** = Medium exposure **Low** = Low exposure **None** = No exposure

Categories of operations which may cause deterioration or disturbance	SAC interest features									
	Estuaries				Coastal Lagoons	Atlantic salt meadows			*Salicornia* and other annuals	
	Saltmarsh communities	Intertidal mudflat and sandflat communities	Subtidal sandbanks	Subtidal sediment communities		Low to mid marsh communities	Mid to high marsh communities	Transitional communities	Annual *Salicornia* (samphire) saltmarsh communities	*Suaeda maritima* (sea-blite) saltmarsh communities
Physical Loss										
Removal (eg land claim, dredging)	For information on these sub-features, see the individual assessments made under the separate interest feature sections: **- Atlantic salt meadows;** **- *Salicornia* and other annuals;** **- Mudflats and sandflats not covered by seawater at low tide;** **- Sandbanks slightly covered by seawater all the time**			Med	Low	High	High	High	Med	Med
Smothering (eg depositing dredge spoil, beach feeding)				Med	Low	Low	Low	Low	Low	Low
Physical Damage										
Siltation (eg dredging, outfalls)				Med	Low	Med	Med	Med	Med	Med
Abrasion (eg recreational activity, vehicles)				Med	Low	Med	Med	Med	Med	Med
Selective extraction (eg aggregate extraction)				Low	None	Low	Low	Low	Med	Med
Non-physical disturbance										
Noise (eg land/water-based recreation, marine traffic)				N/A	N/A	N/A	N/A	N/A	N/A	N/A
Visual presence (eg land/water-based recreation, marine traffic)				N/A	N/A	N/A	N/A	N/A	N/A	N/A

Toxic contamination Introduction of synthetic compounds (eg TBT, PCBs) Introduction of non-synthetic compounds (eg trace metals from industrial or domestic effluent, crude oil) Introduction of radionuclides	For information on these sub-features, see the individual assessments made under the separate interest feature sections: **- Atlantic salt meadows;** **- *Salicornia* and other annuals;** **- Mudflats and sandflats not covered by seawater at low tide;** **- Sandbanks slightly covered by seawater all the time**	Med Med Low	Low Low None	Med Med Low	Med Med Low	Med Med Low	Med Med Low	Med Med Low
Non-toxic contamination Changes in nutrient loading (eg agricultural run-off, domestic effluent outfalls) Changes in organic loading (eg domestic effluent outfalls, aquaculture) Changes in thermal regime (eg power station discharges) Changes in turbidity (eg effluent outfalls, dredging, depositing dredged spoil) Changes in salinity (eg water abstraction, effluent outfalls)		High High Low Med Low	Med Med None Low Low	Med Med Low Low Low	Med Med Low Low Low	Med Med Low Low Low	Med Med Low Low Low	Med Med Low Low Low
Biological disturbance Introduction of microbial pathogens (eg domestic/industrial effluent outfalls) Introduction of non-native species and translocation Selective extraction of species (e.g. samphire picking, bait collection)		Low Low Low	Low Low Low	Low Med Low	Low Med Low	Low Low Low	Low Med Med	Low Med Low

Categories of operations which may cause deterioration or disturbance	SAC Interest Features						
	Mudflats and sandflats not covered by seawater at low tide				Sandbanks which are slightly covered by seawater all the time		River and Sea lamprey
	Intertidal gravel and sand communities	Intertidal muddy sand communities	Intertidal mud communities	Eelgrass bed communities	Subtidal gravels and sands	Subtidal muddy sands	
Physical Loss							
Removal (eg land claim, dredging)	Med	Med	High	Low	Med	Med	High
Smothering (eg depositing dredge spoil, beach feeding)	Low	Low	Low	Low	Med	Low	Low
Physical Damage							
Siltation (eg dredging, outfalls)	Med	Med	Med	Med	Med	Med	Low
Abrasion (eg recreational activity, vehicles)	Med	Med	Med	Low	Med	Med	None
Selective extraction (eg aggregate extraction)	Low	Low	Low	Low	Low	Low	Low
Non-physical disturbance							
Noise (eg land/water-based recreation, marine traffic)	N/A	N/A	N/A	N/A	N/A	N/A	Low
Visual presence (eg land/water-based recreation, marine traffic)	N/A	N/A	N/A	N/A	N/A	N/A	Med
Toxic contamination							
Introduction of synthetic compounds (eg TBT, PCBs)	Med	Med	Med	Med	Med	Med	Med
Introduction of non-synthetic compounds (eg effluent outfalls, crude oil)	Med	Med	Med	Med	Med	Med	Med
Introduction of radionuclides	Low	Low	Low	Low	Low	Low	Low
Non-toxic contamination							
Changes in nutrient loading (eg agricultural run-off, effluent outfalls)	High	High	High	High	High	High	High
Changes in organic loading (eg effluent outfalls, aquaculture)	High	High	High	High	High	High	High
Changes in thermal regime (eg power station discharges)	Low	Low	Low	Low	Low	Low	Low
Changes in turbidity (eg effluent outfalls, dredging, depositing dredged spoil)	Low	Low	Low	Low	Med	Med	Med
Changes in salinity (eg water abstraction, effluent outfalls)	Low	Low	Low	Low	Low	Low	Low

Biological disturbance							
Introduction of microbial pathogens (eg effluent outfalls)	Low	Low	Low	Low	Low	Low	Low
Introduction of non-native species and translocation	Low	Low	Low	Low	Low	Low	Low
Selective extraction of species (eg samphire picking, bait collection)	Low	Med	Med	Low	Low	Low	Low

Table 5 Assessment of the relative vulnerability of interest features and sub-features of the Humber Estuary European marine site (pSAC) to different categories of operations.

Shading indicates categories of operation to which the features or sub-features of the site are highly or moderately vulnerable to. This table also incorporates the relative sensitivity scores, used in part to derive vulnerability[10].

Key:

	High vulnerability
	Moderate vulnerability

●●●●	High sensitivity
●●●	Moderate sensitivity
●●	Low sensitivity
●	No detectable sensitivity

Categories of operations which may cause deterioration or disturbance	SAC interest features									
	Estuaries				Coastal Lagoons	Atlantic salt meadows			*Salicornia* and other annuals	
	Saltmarsh communities	Intertidal mudflat and sandflat communities	Subtidal sandbanks	Subtidal sediment communities		Low to mid marsh communities	Mid to high marsh communities	Transitional communities	Annual *Salicornia* (samphire) saltmarsh communities	*Suaeda maritima* (sea-blite) saltmarsh communities
Physical Loss										
Removal (eg land claim, dredging)	For information on these sub-features, see the individual assessments made under the separate interest feature sections: **- Atlantic salt meadows;** **- *Salicornia* and other annuals;** **- Mudflats and sandflats not covered by seawater at low tide;** **- Sandbanks slightly covered by seawater all the time**			●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●
Smothering (eg depositing dredge spoil, beach feeding)				●●●	●●●	●●●	●●●●	●●●●	●●●	●●●
Physical Damage										
Siltation (eg dredging, outfalls)				●●	●●●	●●●	●●	●●	●●●	●●●
Abrasion (eg recreational activity, vehicles)				●●●	●●●	●●●	●●●	●●●	●●●	●●●
Selective extraction (eg aggregate extraction)				●●●	●●●	●●●	●●●	●●●	●●●	●●●
Non-physical disturbance										
Noise (eg land/water-based recreation, marine traffic)				●	●	●	●	●	●	●
Visual presence (eg land/water-based recreation, marine traffic)				●	●	●	●	●	●	●

Toxic contamination	For information on these sub-features, see the individual assessments made under the separate interest feature sections: **- Atlantic salt meadows;** **- *Salicornia* and other annuals;** **- Mudflats and sandflats not covered by seawater at low tide;** **- Sandbanks slightly covered by seawater all the time**							
Introduction of synthetic compounds (eg TBT, PCBs)		●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●
Introduction of non-synthetic compounds (eg trace metals from industrial or domestic effluent, crude oil)		●●●	●●●	●●●	●●●	●●●	●●●	●●●
Introduction of radionuclides		●●	●●	●●	●●	●●	●●	●●
Non-toxic contamination								
Changes in nutrient loading (eg agricultural run-off, domestic effluent outfalls)		●●●	●●●	●●	●●●	●●●	●●●	●●●
Changes in organic loading (eg domestic effluent outfalls, aquaculture)		●●●	●●●	●●●	●●●	●●●	●●●	●●●
Changes in thermal regime (eg power station discharges)		●●●	●●●	●●	●●	●●	●●	●●
Changes in turbidity (eg effluent outfalls, dredging, depositing dredged spoil)		●●	●●●	●●	●●	●●	●●	●●
Changes in salinity (eg water abstraction, effluent outfalls)		●●	●●●	●●	●●	●●●	●●	●●
Biological disturbance								
Introduction of microbial pathogens (eg domestic/industrial effluent outfalls)		●●	●●	●●	●●	●●	●●	●●
Introduction of non-native species and translocation		●●	●●	●●●	●●●	●●●	●●●	●●●
Selective extraction of species (e.g. samphire picking, bait collection)		●●●	●●●	●●	●●●	●●●	●●●	●●●

Categories of operations which may cause deterioration or disturbance	SAC Interest Features						
	Mudflats and sandflats not covered by seawater at low tide				Sandbanks which are slightly covered by seawater all the time		River and Sea lamprey
	Intertidal gravel and sand communities	Intertidal muddy sand communities	Intertidal mud communities	Eelgrass bed communities	Subtidal gravels and sands	Subtidal muddy sands	
Physical Loss							
Removal (eg land claim, dredging)	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●
Smothering (eg depositing dredge spoil, beach feeding)	●●●●	●●●	●●●	●●●●	●●●●	●●●	●●
Physical Damage							
Siltation (eg dredging, outfalls)	●●	●●●	●●	●●●	●●	●●	●●
Abrasion (eg recreational activity, vehicles)	●●	●●	●●●	●●●	●●	●●	●●
Selective extraction (eg aggregate extraction)	●●●	●●●	●●●	●●●●	●●●	●●●	●●●
Non-physical disturbance							
Noise (eg land/water-based recreation, marine traffic)	●	●	●	●	●	●	●●
Visual presence (eg land/water-based recreation, marine traffic)	●	●	●	●	●	●	●●
Toxic contamination							
Introduction of synthetic compounds (eg TBT, PCBs)	●●●●	●●●●	●●●●	●●●	●●●	●●●●	●●●
Introduction of non-synthetic compounds (eg effluent outfalls, crude oil)	●●●	●●●●	●●●●	●●●	●●●	●●●	●●●
Introduction of radionuclides	●●	●●	●●	●●	●●	●●	●●
Non-toxic contamination							
Changes in nutrient loading (eg agricultural run-off, effluent outfalls)	●●●●	●●●●	●●●	●●●●	●●●	●●●	●●
Changes in organic loading (eg effluent outfalls, aquaculture)	●●●	●●●	●●●	●●●	●●●	●●●	●●
Changes in thermal regime (eg power station discharges)	●●	●●●	●●	●●	●●●	●●●	●●●●
Changes in turbidity (eg effluent outfalls, dredging, depositing dredged spoil)	●●	●	●●	●●●	●●	●●●	●●
Changes in salinity (eg water abstraction, effluent outfalls)	●●	●●●	●●	●●	●●	●●	●●
Biological disturbance							
Introduction of microbial pathogens (eg effluent outfalls)	●●	●●	●●●	●●●	●●	●●	●●

Categories of operations which may cause deterioration or disturbance	SAC Interest Features						
	Mudflats and sandflats not covered by seawater at low tide				Sandbanks which are slightly covered by seawater all the time		River and Sea lamprey
	Intertidal gravel and sand communities	Intertidal muddy sand communities	Intertidal mud communities	Eelgrass bed communities	Subtidal gravels and sands	Subtidal muddy sands	
Introduction of non-native species and translocation	●●	●●●	●●●	●●●	●●	●●	●●●
Selective extraction of species (eg samphire picking, bait collection)	●●●	●●●	●●●	●●●	●●	●●●	●●●

[10] English Nature's advice on operations is derived from an assessment combining relative sensitivity of the features or sub-features with information on human usage of the site (as at July 2002), to identify relative vulnerability to categories of operations. In accordance with Government policy guidance this advice is provided in the light of current activities and patterns of usage at the site. It is important therefore that future consideration of this advice by relevant authorities, and others, takes account of changes in the usage patterns at the site. In contract the sensitivity of interest features, or sub-features, is relatively stable with alterations reflecting improvement in our scientific knowledge and understanding. To this end, information on sensitivity has been included in this table to assist the management and advisory groups with the future management of the site.

SPECIAL PROTECTION AREA

9. Humber Flats, Marshes and Coast SPA interest features

The Humber Estuary European marine site also includes a Special Protection Area qualifying under the EU Birds Directive. An extension to the SPA has also been proposed, but this has not yet been designated and is therefore known as a potential SPA. This section describes and explains the importance of each the interest features of the SPA and pSPA, together with their component sub-features within the Humber Estuary European marine site.

The Humber Flats, Marshes and Coast SPA and pSPA include both marine areas (i.e. land covered continuously or intermittently by tidal waters) and land that is not subject to tidal influence. The marine part of the SPA or pSPA is termed a European marine site. The seaward boundary of the European marine site is concurrent with that of the SPA or pSPA. The landward boundary of the European marine site is the upper boundary of the SPA or pSPA, or where that extends above land covered continuously or intermittently by tidal waters, it is at the limit of the marine habitats.

Where the SPA or pSPA qualifying species occur within the European marine site, they are referred to as interest features. Sub-features (habitats) have also been identified to highlight the ecologically important components of the European marine site for each interest feature.

This section on the Humber Flats, Marshes and Coast SPA, applies to both the classified site and to the potential SPA.

9.1 Background and context

A major aim of the Birds Directive is to take special measures to conserve the habitats of qualifying birds in order to ensure their survival and reproduction within the European Union. A key mechanism in achieving this is the classification by Member States of the most suitable sites as SPAs.

English Nature's conservation objectives at a site level, focus on maintaining the condition of the habitats used by the qualifying species. Habitat condition will be delivered through appropriate site management including the avoidance of damaging disturbance. In reporting on Favourable Conservation Status, account will need to be taken both of habitat condition and the status of the birds on the SPA.

Accordingly, English Nature will use annual counts, in the context of five year peak means for qualifying species, together with available information on population and distribution trends, to assess whether an SPA is continuing to make an appropriate contribution to the Favourable Conservation Status of the species. Count information will be assessed in combination with information on habitat condition, at the appropriate time within the reporting cycle, in order to report to the European Commission.

English Nature's advice focuses on the qualifying species for which the SPA was originally classified, despite the fact that numbers and species composition may have changed on this site since that time. Such population and species composition changes are being documented through the UK SPA Network Review, led by JNCC, which will provide advice to Ministers on any changes required in SPA citations. Depending on the review and decisions from DEFRA, English Nature may reissue this advice.

In addition to focusing on avoiding deterioration to the habitats of the qualifying species, the Habitats Directive also requires that actions be taken to avoid significant disturbance to the species for which the site was designated. Such disturbance may include alterations in population trends and/or distribution patterns. Avoiding disturbance to species requirements is mentioned in the favourable condition table underpinning the conservation objectives for the SPA. In this context, five-year peak mean information on populations will be used as the basis for assessing whether disturbance is damaging.

Attention is also directed to the inclusion of disturbance in the advice on operations provided in Section 12. Where disturbance is highlighted in such advice, relevant authorities need to avoid damaging disturbance to qualifying species when exercising their functions under the Directive.

9.2 Reductions in organic inputs

Under the Urban Waste Water Treatment (UWWT) Directive, all coastal discharges above a certain volume must have had secondary treatment installed by the end of 2000. Secondary treatment of sewage will significantly reduce organic loading and to a lesser extent reduce concentrations of dissolved nutrients. The effects of these reductions on coastal features and the birds they support are difficult to predict. On the one hand, it might be expected that there would be a redistribution of feeding birds or a reduction in the overall capacity of a coastal area to support bird populations. On the other hand, where bird populations are currently adversely affected by eutrophication, cleaner discharges may contribute to improving site condition.

English Nature supports the cleaning up of coastal discharges. On balance, the overall ecological benefits of cleaner discharges are likely, in general, to outweigh any subsequent local decline in bird numbers, although there is presently insufficient knowledge to accurately predict the effects in general or for individual SPA sites. Consequently, English Nature, with input from the Countryside Council for Wales and the Environment Agency, is commissioning a related research project to study the relationship between birds and organic nutrient levels, the overall effects on the ecosystem and thereby the effects of the clean-up programme under the UWWT.

Under the Habitats Regulations, if significant effects are likely from such activities, the competent authority (in this case the Environment Agency) will be required to undertake an appropriate assessment to determine whether there is an adverse effect on site integrity.

9.3 General description

In recognition that bird populations may change as a reflection of regional, national or international trends or events, this advice on the bird interests of the European marine site focuses on the condition of the habitats necessary to support the bird populations. As with SAC interest features, sub-features are identified which describe the key habitats necessary to support the birds that qualify within the Humber Flats, Marshes and Coast SPA. Detailed information and targets for habitat condition will be listed in the favourable condition tables in section 11.

Bird usage of the sites varies, with different areas and prey species being favoured over others at certain times of the year. However, annual counts for qualifying species will be used by English Nature in the context of five-year peak means, together with available information on UK populations and distribution trends, to assess whether this SPA is continuing to make an appropriate contribution to the Favourable Condition Status of the species across Europe.

Bird communities are highly mobile and exhibit patterns of activity related to tidal water movements and many other factors. Different bird species exploit different parts of a marine area and different prey species. Changes in the habitat may therefore affect their food distribution and availability differently. The bird populations at this site require habitats that are capable of supporting their feeding, roosting and nesting requirements. The most important factors related to this include:

- current extent and distribution of suitable feeding and roosting habitat;
- sufficient food availability;
- minimal levels of disturbance consistent with maintaining conditions for birds feeding and roosting and;
- water quality, quantity and salinity necessary to maintain plant and animal communities suitable for bird feeding, nesting and roosting.

There are also a number of habitats, such as the Grues and Goxhill Marsh Fields that support the qualifying bird species and occur within the SPA and pSPA boundary. However, these habitats lie above highest astronomical tide and therefore are not within the European marine site. Objectives to maintain these aspects of bird interest in favourable condition are found within English Nature's conservation objectives for the relevant SSSI within the SPA boundary and will be dealt with through relevant procedures outlined in the Conservation (Natural Habitats & c.) Regulations 1994.
Some species will also use areas of land and coastal waters outside the boundaries of both the European marine site and the SPA. Relevant authorities need to have regard to such adjacent interests, as they might be affected by activities taking place within, or adjacent to the European marine site.

9.4 Internationally important populations of the regularly occurring Annex I species

The species listed in Annex I of the Birds Directive are the subject of special conservation measures concerning their habitat, in order to ensure their survival and reproduction in their area of distribution. Species listed on Annex I are in danger of extinction, rare or vulnerable. Annex I species that regularly occur at levels over 1% of the national population, meet the SPA qualifying criteria.
The Humber Flats, Marshes and Coast SPA supports internationally important populations of seven Annex I species (see Table 6).

The qualifying breeding species that occur within the European marine site are:

- marsh harrier *Circus aeruginosus*
- avocet *Recurvirostra avosetta*
- little tern *Sterno albifrons*

The qualifying wintering species that occur within the European marine site are:

- bittern *Botaurus stellaris*
- hen harrier *Circus cyaneus*
- golden plover *Pluvialis apricaria*
- bar-tailed godwit *Limosa lapponica*

The following Annex I species also occur on the Humber Estuary over winter; Bewick's swan *Cygnus columbianus*, whooper swan *Cygnus cygnus*, merlin *Falco peregrinus*, avocet *Recurvirostra avosetta*, ruff *Philomachus pugnax*, short-eared owl *Asio flammeus* and kingfisher *Alcedo atthis*. However, they occur in numbers of less than European importance (i.e. less than 1% of the Great Britain population).

9.4.1 Key sub-features for the Annex I species

Intertidal mudflats and sandflats – Extensive areas of intertidal flats are found throughout the Humber Estuary European marine site, supporting rich populations of intertidal invertebrate species. In turn, these provide a crucial food source for several of the Annex I species. In general, more sheltered areas with a relatively high silt content such as at Paull, support a richer biomass than more exposed areas. This high biomass of invertebrates includes key species such as mudsnails *Hydrobia ulvae*, cockles *Cerastoderma edule*, marine worms such as ragworms *Nereis diversicolor* and lugworms *Arenicola marina* and crustaceans such as *Corophium volutator*.

Avocet feed on small invertebrates such as marine worms and crustaceans, which they obtain from the intertidal flats, feeding close to Reads Island and Blacktoft Sands, their main breeding areas. They favour saline still, shallow waters, flat bare sand and sheltered muddy tidal flats. Here the loose sediments are rich in food, which the avocet search for with their specialised bills.
The intertidal flats also provide important roosting sites for avocet and overwintering golden plover. The Humber is the only estuary in the UK that supports internationally important numbers of golden plover and large flocks of several thousand birds are found here. During periods of very cold weather, flocks on the Humber are augmented by populations from further afield. The birds may also feed on the intertidal flats when the surrounding farmland is frozen. Golden plover are very mobile and major concentrations occur in the inner estuary, although large numbers also occur east of the Humber Bridge, particularly around Saltend to Sunk Island, where flocks regularly contain in excess of 10,000 birds. The intertidal flats close to the RSPB reserve at Tetney Marshes also support large flocks of roosting golden plover.

The overwintering bar-tailed godwit relies on a small number of feeding and roosting sites on the estuary. They feed on the intertidal mudflats, favouring areas with abundant invertebrate food such as polychaete worms. Bar-tailed godwits occur almost exclusively on the outer estuary, although smaller numbers are found around Whitton Sands, Reads Island and Barton and Barrow Claypits.

When the tide is in, little terns will feed over the intertidal flats, hunting for sprats, sandeels and the fry of other fish. They will also feed on small crustaceans, molluscs and marine worms. They breed in the outer estuary - along the Holderness coast and south of Cleethorpes on the north Lincolnshire coast and often nest very close to shallow clear water where fish can be caught by plunging and without the necessity for making extended foraging flights.

Saltmarsh Communities – Saltmarsh are found throughout the Humber Estuary and provide important roosting and feeding sites for many of the Annex I birds. Avocet, golden plover and bar-tailed godwit require unrestricted views when roosting, and will utilise areas of saltmarsh with short sward heights as a roost site. Marsh harrier and hen harrier will use the saltmarshes as a hunting ground, quartering low over the vegetation, searching for small birds and mammals.

Tidal reedbeds- Stands of common reed *Phragmites australis* are found throughout the estuary. They exist as a fringe of varying width along the banks or as substantial reedbeds, such as at Blacktoft Sands, which is thought to be the second largest tidal reedbed in Britain. Broken stands of reed are also found along the north Lincolnshire coast.

Marsh harriers are now regular breeders on the Humber, requiring wetlands with tall dense vegetation for nesting and particularly favouring reedbeds. They nest on the ground where the vegetation is thick and are found throughout the inner estuary. They will also hunt over the reedbeds and adjacent farmland. The wintering population of hen harrier will use the reedbeds as a roost, favouring the south bank of the inner estuary, although they are also seen in the dune slacks on the north Lincolnshire coast and at Humberston Fitties.
When breeding, the bittern is predominantly a freshwater bird, however it will utilise areas of intertidal reedbed during the winter. This rare bird is seen regularly in the reedbeds of the inner estuary, and also at North Killingholme Haven pits. The Lincolnshire Wildlife Trust are currently undertaking a management programme to encourage bitterns to breed on the Humber after an absence of over 20 years. The first booming males were heard in 2000, with 3 chicks fledging that year. They have bred every year since, at a number of sites in the inner estuary with several chicks fledging each year.

Coastal lagoons – The Humber Estuary supports over 10% of the total UK resource of coastal lagoons. This rare and threatened habitat provides important breeding and feeding areas for avocet and little tern.

Avocet nest on open or bare ground, close to areas of shallow water and up to 90% of breeding avocet are associated with saline lagoons. On the Humber, the lagoons at Blacktoft Sands and on Reads Island support breeding avocet. The RSPB created six brackish lagoons at Blacktoft Sands between 1978 and 1987 and the water levels are controlled to provide a range of feeding and breeding habitats. Avocets colonised the lagoons in 1992 when a single pair nested. Reads Island has the fourth largest lagoon system occurring on an island in a British estuary. Although people once inhabited the island, it was finally abandoned in 1989 and is now jointly managed by the RSPB and the Lincolnshire Wildlife Trust as a nature reserve. In 1997, work was carried out to create nearly 20ha of saline lagoon habitat and the following year avocet began breeding on the island – the first breeding success in Lincolnshire since 1837! Avocet feed primarily on small crustaceans, marine worms and molluscs, which they obtain from the lagoon waters or sediments by sweeping their bills through the shallow water or by picking them from the surface of the mud. Following the digging of these lagoons in the upper estuary, avocet now breed in numbers of European importance on the Humber – in 2000, 71 pairs were recorded.

In the past there have been five little tern breeding colonies on the Humber, with the largest one at Easington lagoons. Unfortunately, over recent years, breeding success has varied greatly and Easington lagoons now appears to be the most successful colony with few birds fledging from any of the other sites. The lagoons are an important feeding area for the adult little terns, which feed on small fish and crustaceans. The little terns also feed on the lagoons at Humberston Fitties.

Golden plover and bar-tailed godwit may also utilise the lagoons such as those on Read's Island as a high tide roost.

Unvegetated sand and shingle – Little terns nest on bare sand and shingle, only just above normal tide, preferring a shallow, sloping shoreline to give maximum protection against flooding. However, whole colonies may still get washed out on spring tides. They usually nest in small single species groups, preferring areas with little vegetation so that they can see approaching predators. Easington lagoons support the largest colony of breeding little terns in the Humber Flats and Marshes SPA and have one of the highest success rates in eastern Britain. This is probably due to the intensive wardening and management of the site.
Little terns also nest on areas of sand at Donna Nook, in particular the extensive sandbars, and several pairs attempt to nest at other sites including Tetney, Spurn Point and Saltfleetby to Theddlethorpe dunes, although these sites have not been successful for several years. It is possible that where terns have moved from some areas due to disturbance or predation they may return in the future.

9.5 Internationally important populations of regularly occurring migratory bird species

Britain's wildfowl belong to the north-west European population and the waders to the East Atlantic flyway population. Migratory species of these biogeographic populations that regularly occur at levels of 1% or more of the total biogeographical population meet the SPA criteria and qualify in their own right.

The Humber Flats, Marshes and Coast SPA supports internationally important numbers of regularly occurring migratory species on passage;

- ringed plover *Charadrius hiaticula*
- sanderling *Calidris alba*
- redshank *Tringa totanus totanus*

It also supports internationally important numbers of regularly occurring migratory species over winter;

- shelduck *Tadorna tadorna*
- grey plover *Pluvialis squatarola*
- lapwing *Vanellus vanellus*
- knot *Calidris canutus islandica*
- dunlin *Calidris alpina alpina*
- redshank *Tringa totanus totanus*

9.5.1 Key sub-features for the migratory bird species

Intertidal mudflats and sandflats – The extensive mudflats and sandflats of the Humber Estuary support rich populations of invertebrate species, which in turn provide an important food source for many species of migratory birds. The Humber supports massive populations of birds, many of which are highly mobile, feeding and roosting in different areas, depending on food availability and the state of the tide.

Ringed plover, grey plover, redshank and dunlin feed throughout the estuary on marine polychaete worms, crustaceans and molluscs such as the Baltic tellin *Macoma balthica*. They favour areas that have abundant invertebrate prey species and unrestricted views for the early detection of predators. Large flocks of feeding and roosting waders are found at the RSPB reserve at Tetney Marshes. During the winter of 1995-1996, the reserve held over 82% of the grey plover counted on the estuary.
Shelduck also exploit the rich resources of invertebrates found in the intertidal mudflats. Common prey species include the mudsnail, *Hydrobia* spp, mussels *Mytilus edulis*, the Baltic tellin *Macoma balthica* and small crustaceans such as the common shore crab *Carcinus maenas*. They feed in groups, on the mid to outer estuary where there are extensive areas of intertidal flats. Large numbers of moulting shelduck are also found on the estuary during July and August. They are concentrated to the west of the Humber Bridge, particularly around Whitton Sands and Brough.
Sanderling feed on small invertebrates found on sandy beaches, mainly by probing the substrate, but also by snatching prey items washed in on the tide. As a species that is mostly confined to sandy beaches, it is largely restricted to the outer southern shore of the estuary. Large numbers are found from Humberston to Cleethorpes, at Tetney Marshes and along the northern shore of Spurn Peninsula. Knot also feed on the outer estuary, although they will move further inshore during periods of severe weather, when the flats in the outer estuary may become

frozen. The intertidal sandflats of Cleethorpes are an important feeding area for sanderling and knot during the winter months when there are fewer tourists.
The Humber supports more lapwing than any other English estuary. They feed on polychaete worms and small crustaceans found in the intertidal mudflats, especially when surrounding farmland is frozen. Lapwing and golden plover are very similar in their habits and will often form mixed species flocks when feeding and roosting.

The extensive intertidal flats of the outer estuary provide feeding and low tide roosting sites for large numbers of waders, including ringed plover, grey plover, lapwing, sanderling, dunlin and redshank.

Saltmarsh Communities – The largest areas of saltmarsh on the estuary occur at Welwick, Skitter and south of Cleethorpes along the north Lincolnshire coast. The saltmarshes provide a rich feeding habitat for redshank and shelduck, which feed on invertebrate species in the sediments, such as the mudsnail *Hydrobia.* The saltmarshes also have an important function providing a safe haven from the tides that flood the mudflats twice a day. The low-growing dense vegetation provides a suitable roosting habitat for many waders, which prefer to roost on areas of short vegetation ensuring good visibility. The saltmarshes throughout the estuary provide an important communal roosting site for redshank, dunlin, grey plover, shelduck, knot and lapwing. The saltmarshes at Tetney and Grainthorpe Havens, Pye Hall, Skidbrooke to Saltfleet and Saltfleetby to Theddlethorpe are all important roosting habitats for these species. In addition, Donna Nook is of particular important on very high spring tides when Tetney and Grainthorpe are completely covered by water.

Tidal reedbeds - Beds of common reed *Phragmites australis* are found throughout the tidal reach of the estuary. They exist as a fringe of varying width along the banks, or as substantial reedbeds such as at Blacktoft Sands and Whitton Sands on the inner estuary. Several of the migratory species, such as redshank and shelduck may use the reedbeds as a high tide roost as they provide some protection from predators and human disturbance.

Coastal lagoons – The lagoons on the Humber are important high tide roosts for several of the migratory species. Dunlin, redshank, grey plover and shelduck use Easington lagoons and Humberston Fitties, and North Killingholme Haven pits are also an important high tide roost. These pits were once used by wildfowlers, but are now managed by the Lincolnshire Wildlife Trust. They support notable numbers of lapwing, ringed plover, sanderling and redshank and there appears to be a close link between the use of the pits and the adjacent foreshore. Dunlin and large flocks of roosting redshank also use the lagoons on Reads Island, and lapwing, shelduck, redshank and other waders use the lagoons at Blacktoft Sands as a high tide roost.

9.6 Internationally important assemblage of waterfowl

The Humber Estuary is one of the key estuaries in the UK for wintering waterfowl (wildfowl and waders). In addition to supporting internationally important populations of birds, it also qualifies for its wintering waterfowl assemblage, regularly supporting over 20,000 birds (Cranswick *et al.,* 1999). The wintering waterfowl assemblage (consisting of over 175,000 birds) includes all the internationally important regularly occurring migratory species as well as the Annex I wintering species. It also includes species present in nationally important numbers or species whose populations exceed 2,000 individuals. These species are dark-bellied brent geese *Branta bernicla bernicla,* wigeon *Anas penelope,* mallard *Anas platyrhynchos,* pochard *Aythya farina,* scaup *Aythya marila,* goldeneye *Bucephala clangula,* oystercatcher *Haematopus ostralegus,* ringed plover *Charadrius hiaticula,* sanderling *Calidris alba,* black-tailed godwit *Limosa limosa islandica and* curlew *Numenius arquata.*

9.6.1 Key sub-features for the waterfowl assemblage

Intertidal mudflats and sandflats - The Humber Estuary supports immense numbers of birds, supporting over 175,000 during winter. Many of these species are highly mobile, feeding and roosting in different areas, depending on food availability and tides.

Many of the waterfowl species, including ringed plover, sanderling and oystercatcher feed on the invertebrate species found in the extensive intertidal flats of the estuary. Oystercatchers also feed on shellfish such as cockles, oysters and mussels, and marine worms and crustaceans, which they find at low tide. They feed predominantly on the outer estuary, around Spurn Bight and along the north Lincolnshire coast. Black-tailed godwit and curlew also feed on the invertebrates in the intertidal mudflats. The Pyewipe frontage is of key importance as a feeding

and roosting area for black-tailed godwit, although smaller numbers also feed at Immingham docks. After their breeding season, curlew move to coastal habitats, especially where there are extensive mudflats and sandflats exposed at low tide. They are often found in flocks with lapwing and golden plover and regularly feed inland, on a variety of sites from wet pasture to ploughed fields. They occur throughout the estuary, but larger numbers are found around Spurn Bight and along the north Lincolnshire coast.

The Humber Estuary no longer receives the large arrivals of wintering mallard from Scandinavia and the east that once formed a large proportion of winter totals. It is believed that the increasingly mild winters which northern Europe now experiences, means that birds remain on the continent and only come to Britain to escape the harshest weather conditions (Catley, 2000). The Humber has experienced a huge decline in mallard numbers, 80% over the last 10 years, whilst the UK as a whole has only experienced a 50% decrease, therefore it is assumed that there are other factors affecting the mallard population on the Humber (Andrew Grieve, pers com). The distribution of mallard has also changed on the estuary, shifting from the inner estuary to the outer north shore. This redistribution is thought to reflect increasing releases of captive bred mallard of unknown origin by wildfowling clubs. These releases may be contributing to the long term inability of mallard to sustain natural populations, as released birds may comprise 50% of the birds overwintering (Andrew Grieve, pers com). Although mallard are typically a freshwater species, they are attracted to New Holland Jetty, which is used to unload animal feed from ships. A mixture of grain and feedstuff are spilt into the estuary during the handling procedure. This has resulted in a number of species exploiting this artificial food source. Alongside the mallards, several species of diving duck also feed here – pochard, goldeneye and scaup. These species will also feed close to Goxhill Skitter. The pochard and goldeneye feed on a falling tide and then roost and loaf on the ebbing water, drifting down as far as Immingham docks and Pyewipe. These diving ducks will utilise habitats of varying salinity, although scaup are the most marine species. They feed at night, predominantly on mussels, although they also feed where there are artificially high densities of food, such as those found around sewage outfalls. On the Humber, they gather in large flocks to feed around Spurn Bight.

Intertidal sand and mud flats also support surface plants and green algae, and dark-bellied brent geese feed over mudflats rich in *Zostera*, *Enteromorpha* and less frequently other green plants. They rarely dive, so when these plants are covered by the tide they will up-end or swim with their head and neck below the water surface. They occur almost exclusively on the outer estuary, principally along the southern shore from Cleethorpes to Saltfleetby with lesser numbers on Sunk Island and Spurn Bight where there are areas of dwarf eelgrass beds, *Zostera noltei.* Brent geese will also feed and roost on inland areas, on fields of pastures, cereals and oilseed rape. Wigeon and pochard also feed on plant material, using mostly maritime habitats during the winter, especially where there are extensive areas of intertidal muds and sands.
The intertidal mudflats and sandflats are also important low tide roosting sites for the wildfowl and waders.

Saltmarsh Communities – Large areas of saltmarsh occur throughout the Humber Estuary, providing important feeding and roosting habitats for many of the wildfowl and waders.
The vegetation height and species composition of the saltmarsh sward, combines to provide a rich feeding habitat for grazing species such as wigeon and dark bellied brent geese. These birds are almost entirely vegetarian and feed on the leaves, stems, rhizomes and seeds of saltmarsh plants such as *Salicornia* species and *Puccinellia maritima*. Large flocks of brent geese feed on the marshes near Humberston Fitties and around Grainthorpe and Saltfleet Havens on the north Lincolnshire coast.
The saltmarshes at Brough and Crabley are also utilised by wigeon as a high tide roost site. At night and when the marsh is covered on spring tides, they will often use areas of pastures and late oilseed rape adjacent to the estuary.

Mallard will also occasionally graze on marsh plants, plucking at the leaves and shoots and black-tailed godwit will also feed on the invertebrates in the saltmarsh substrate.
Oystercatchers and curlew roost on the saltmarshes of the outer estuary, particularly at Welwick, Cherry Cobb and on the extensive saltmarshes on north Lincolnshire coast, south of Cleethorpes.

Tidal reedbeds - Beds of common reed *Phragmites australis* are found throughout the tidal reach of the estuary. Substantial reedbeds occur at Blacktoft Sands and Whitton Sands within the Humber Wildfowl Refuge. The reedbeds provide important feeding and roosting areas for several of the wildfowl species, and are of particular importance for pochard, which feed in the open water pools of the reedbeds at Blacktoft Sands, Faxfleet and

Broomfleet. Reedbeds also provide protection from predators and human disturbance, and mallard, goldeneye and scaup may feed and roost in the reedbed pools.

Coastal lagoons – The lagoons of the Humber Estuary are an important high tide wader roost, particularly during spring high tides. The edges of the lagoons are also an important feeding habitat for many of the wildfowl species.

Large numbers of black-tailed godwit use North Killingholme Haven pits as a high tide roost. Numbers have grown rapidly on the estuary since the 1990s, and during the autumn months almost the entire population roosts at North Killingholme Haven. Other roosts for this species are found on Read's Island and at Blacktoft Sands. Black-tailed godwit are not widely dispersed throughout the estuary and are heavily reliant on certain areas for roosting and feeding (Nick Cutts, pers com).

Easington lagoons are also used as a high tide roost by oystercatcher, black-tailed godwit and curlew, and are also important feeding habitats for pochard, goldeneye and scaup. The open water areas of the lagoons at Barton are frequented by flocks of overwintering wildfowl, and are of particular importance for pochard and goldeneye.

Wigeon will use the lagoons on Reads Island and are found in smaller numbers at Blacktoft Sands and North Killingholme Haven pits. Mallard are adapted to a wide range of habitats and utilise the saline lagoons at Blacktoft Sands and Reads Island, where the waters are shallow and sheltered. Their numbers have declined nationally, and although in the past the Humber was the only UK nationally important site for mallard in Great Britain; the species has declined below this level here too.

10. The Humber Flats, Marshes and Coast SPA conservation objectives

Under Regulation 33(2)(a) of the Conservation (Natural Habitats &c.) Regulations 1994, English Nature has a duty to advise other relevant authorities as to the conservation objectives for the European marine site.
The conservation objectives for the Humber Flats, Marshes and Coast SPA interest features are provided below and should be read in the context of other advice given in this package, particularly:

- the attached maps showing the extent of the sub-features;
- summary information on the interest of each of the features; and
- the favourable condition table, providing information on how to recognise favourable condition for the interest feature and which will act as a basis for the development of a monitoring programme.

10.1 The conservation objective for the internationally important populations of the regularly occurring Annex I species

Subject to natural change, maintain* in favourable condition[11] the habitats for the internationally important populations of the **regularly occurring Annex I species**, in particular:

- **Intertidal mudflats and sandflats**
- **Saltmarsh communities**
- **Tidal reedbeds**
- **Coastal lagoons**
- **Unvegetated sand and shingle**

Numbers of bird species using these habitats are given in Table 6.

10.2 The conservation objective for the internationally important populations of regularly occurring migratory bird species

Subject to natural change, maintain* in favourable condition[11] the habitats for the internationally important populations of the **regularly occurring migratory bird species**, in particular:

- **Intertidal mudflats and sandflats**
- **Saltmarsh communities**
- **Tidal reedbeds**
- **Coastal lagoons**

Numbers of bird species using these habitats are given in Table 6.

11 For a detailed description of how to recognise favourable condition, see the attached table 7

10.3 The conservation objective for the internationally important assemblage of waterfowl

Subject to natural change, maintain* in favourable condition[11] the habitats for the internationally important **assemblage of waterfowl**, in particular:

- **Intertidal mudflats and sandflats**
- **Saltmarsh communities**
- **Tidal reedbeds**
- **Coastal lagoons**

Numbers of bird species using these habitats are given in Table 6.

Note: These SPA conservation objectives focus on habitat condition in recognition that bird populations may change as a reflection of national or international trends or events. Annual counts for qualifying species will be used by English Nature, in the context of five year peak means, together with available information on UK population and distribution trends, to assess whether this SPA is continuing to make an appropriate contribution to the Favourable Conservation Status of the species across Europe.

11 For a detailed description of how to recognise favourable condition, see the attached table 7
* Maintain implies restoration if the feature is not currently in favourable condition.

Table 6 Information on populations of bird species qualifying under the Birds Directive using the Humber Flats, Marshes and Coast SPA at the time the SPA citation was compiled

Internationally important populations of regularly occurring Annex I species.

Species	Population (5 yr peak mean)*	Importance	Period
Marsh harrier *Circus aeruginosus*	9 pairs – breeding (Five year mean)	5.7% of GB population	1994-1998
Avocet *Recurvirostra avosetta*	23 pairs – breeding (Five year mean)	3.9% of GB population	1995-1999
Little tern *Sterno albifrons*	69 pairs – breeding (Five year mean)	2.9% of GB population	1994-1998
Bittern *Botaurus stellaris*	2 individuals - wintering	2.0% of GB population	1991/92-1995/96
Hen harrier *Circus cyaneus*	9 individuals - wintering	1.2% of GB population	1993/94 - 1997/98
Golden plover *Pluvialis apricaria*	34,615 individuals - wintering	13.8 % of GB population	1993/94 - 1997/98
Bar-tailed godwit *Limosa lapponica*	1,780 individuals - wintering	3.4 % of GB population	1993/94 - 1997-98

Internationally important populations of regularly occurring migratory bird species[12]

Species	Population (5 yr peak mean)*	Importance	Period
Ringed plover *Charadrius hiaticula*	1,357 individuals - passage	2.7 % of Europe/Northern Africa	1993 - 1997
Sanderling *Calidris abla*	1,263 individuals - passage	1.3 % E Atlantic/W & S Africa	1993 -1997
Redshank *Tringa totanus totanus*	5,117 individuals - passage	3.4 % Eastern Atlantic	1993 - 1997
Shelduck *Tadorna tadorna*	4,369 individuals - wintering	1.5 % Northwestern Europe	1993/94 - 1997/98
Grey plover *Pluvialis squatarola*	1,667 individuals - wintering	1.1 % Eastern Atlantic	1993/94 - 1997/98
Lapwing *Vanellus vanellus*	33,635 individuals - wintering	1.7 % Europe	1993/94 - 1997-98
Knot *Calidris canutus islandica*	28,060 individuals - wintering	8.0 % NE Can/Grl/Iceland/NW Eur	1993/94 - 1997/98
Dunlin *Calidris alpina alpina*	20,325 individuals - wintering	1.5 % N Siberia/Europe/W Africa	1993/94 - 1997/98
Redshank *Tringa totanus totanus*	4,284 individuals - wintering	2.9 % Eastern Atlantic	1993/94 - 1997/98

Internationally important numbers of waterfowl

Importance	Population (5 yr peak mean)*	Season	Period
The Humber Estuary regularly supports over 20,000 waterfowl	175,768 individuals	Wintering	1993/94 - 1997/98

Nationally important bird populations within the internationally important assemblage of waterfowl

Species	Population (5 yr peak mean)*	Importance	Period
Dark-bellied brent goose *Branta bernicla bernicla*	2,203 individuals	2.2 %of GB population	1993/94 - 1997-98
Wigeon *Anas penelope*	5,952 individuals	2.1 % of GB population	1993/94 - 1997/98
Mallard *Anas platyrhynchos*	2,360 individuals	0.5 % of GB population	1993/94 - 1997/98
Pochard *Aythya farina*	1,283 individuals	2.9 % of GB population	1993/94 - 1997-98
Scaup *Aythya marila*	202 individuals	1.8 % of GB population	1993/94 - 1997/98
Goldeneye *Bucephala clangula*	359 individuals	2.1 % of GB population	1993/94 - 1997/98
Oystercatcher *Haematopus ostralegus*	3,612 individuals	1.0 % of GB population	1993/94 - 1997-98
Ringed plover *Charadrius hiaticula*	302 individuals	1.0 % of GB population	1993/94 - 1997/98
Sanderling *Calidris alba*	504 individuals	2.2 % of GB population	1993/94 - 1997/98
Black-tailed godwit *Limosa limosa islandica*	495 individuals	7.1 % of GB population	1994/95 - 1998/99
Curlew *Numenius arquata*	2,446 individuals	2.0 % of GB population	1993/94 - 1997/98

12 The Humber Estuary is regularly used by 1% or more of the biogeographical population of a regularly occurring species (other than those listed on annex I) in any season (Cranswick *et al.*, 1995).

* SPA citation (**April 2000**) held on Register of European marine sites for Great Britain.

11.

Table 7 Favourable Condition Table for the Humber Flats, Marshes and Coast SPA interest features of the Humber Estuary European marine site Numbers of bird species using these habitats are given in Table 6

NB – It will be possible to monitor many of the attributes at the same time or during the same survey. The frequency of sampling for many attributes may need to be greater during the first reporting cycle in order to characterise the site and establish the baseline.

Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
Internationally important populations of regularly occurring Annex I species (eg marsh harrier, avocet, little tern, bittern, hen harrier, golden plover, bar-tailed godwit)	All sub-features	Extent of habitat	Area (ha), measured once per reporting cycle.	No significant decrease in extent from an established baseline[13], subject to natural change.	The habitats provide important breeding sites for marsh harriers, little terns and avocets and feeding and roosting areas for all Annex I species. In addition, if these habitats are unable to keep pace with sea level rise (coastal squeeze may be implicated in this), inundation of these features will become more frequent – decreasing feeding and roosting areas and increasing the risk of flooding to little tern nests, which are located close to the high tide mark.
		Disturbance	Reduction or displacement of all Annex I birds and productivity of breeding birds, measured periodically (frequency to be determined)	No significant reduction in bird numbers and productivity or displacement of birds attributable to human disturbance from an established baseline, subject to natural change.	Significant disturbance attributable to human activities can result in reduced food intake and/or increased energy expenditure. Breeding birds are particularly vulnerable to disturbance and significant disturbance to adults on and off their nests can result in failure of egg clutches and fledged young. Productivity (number of successfully fledged young), together with other measures will also be used to monitor disturbance. Five-year peak mean information on populations will be used as the basis for assessing whether disturbance is damaging.
		Absence of obstructions to viewlines	Openness of terrain unrestricted by obstructions, measured periodically (frequency to be determined)	No increase in obstructions to existing bird view lines, subject to natural change.	Avocet, little tern, golden plover and bar-tailed godwit require unrestricted views to allow early detection of predators when feeding, nesting and roosting.

Internationally important populations of regularly occurring Annex I species (eg marsh harrier, avocet, little tern, bittern, hen harrier, golden plover, bar-tailed godwit)	Intertidal mudflats and sandflats	Food availability	Presence and abundance of suitable prey species, measured periodically (frequency to be determined)	No significant reduction in the presence and abundance of prey species from an established baseline, subject to natural change.	Important prey species for avocet and bar-tailed godwit are marine invertebrates such as crustaceans, molluscs and marine worms. Golden plover may also feed on the intertidal mudflats and sandflats during periods of harsh weather. When the tide is in, the breeding little terns will feed over the intertidal flats, feeding on sand eels and sprats.
	Saltmarsh Communities	Vegetation characteristics	Open, short vegetation or bare ground predominately in areas used for roosting, measured periodically (frequency to be determined)	Vegetation height and density throughout areas used for roosting should not deviate significantly from an established baseline, subject to natural change.	Vegetation height of <10cm is required throughout roosting areas. The bar-tailed godwit in particular, requires short vegetation with unrestricted views for roosting. The saltmarshes are also an important hunting area for hen harrier and marsh harrier.
	Tidal reedbeds	Food availability	Presence and abundance of small - medium sized birds and mammals, measured periodically (frequency to be determined).	Presence and abundance of prey should not deviate significantly from an established baseline, subject to natural change.	Reedbeds are particularly important as a hunting area for marsh harriers and hen harriers. Prey species include small mammals and birds.
			Presence and abundance of fish and amphibians, measured periodically (frequency to be determined).	Presence and abundance of prey should not deviate significantly from an established baseline, subject to natural change.	Reedbeds are a particularly important habitat for wintering bittern which feed on fish, eels and amphibians.
		Vegetation characteristics	Vegetation height, density and age structure, measured periodically (frequency to be determined).	Vegetation height, density and age structure should not deviate significantly from an established baseline, subject to natural change	Suitability of reedbed vegetation for the Annex I species: Bittern and marsh harrier prefer pure reed stands with vigorous growth for nesting and concealment. Hen harrier will also use reedbeds for roosting.

Internationally important populations of regularly occurring Annex I species (eg marsh harrier, avocet, little tern, bittern, hen harrier, golden plover, bar-tailed godwit)	Coastal lagoons	Food availability	Presence and abundance of crustaceans, annelids, fish and molluscs measured periodically (frequency to be determined)	Presence and abundance of prey species should not deviate significantly from an established baseline, subject to natural change.	Little terns and avocets feed on crustaceans, annelids, fish and molluscs found in the lagoons. Food availability is important in maintaining the little tern and avocet breeding populations.
	Unvegetated sand and shingle	Vegetation cover	Predominately open ground with sparse vegetation and bare surfaces, measured periodically (frequency to be determined)	Extent of vegetation height and bare ground should not deviate significantly in the nesting area from an established baseline, subject to natural change.	Vegetation cover <10% during the breeding season in areas used by little terns. Areas of largely bare sand and shingle are important for nesting little terns for early detection of predators.
Internationally important migratory species and waterfowl assemblage	All sub-features	Extent of habitat	Area (ha), measured once per reporting cycle.	No significant decrease in extent from an established baseline[13], subject to natural change	The habitats provide important feeding and roosting areas for the migratory species and waterfowl assemblage. If these habitats are unable to keep pace with sea level rise (coastal squeeze may be implicated in this), inundation of these features will become more frequent – decreasing feeding and roosting areas.
		Disturbance	Reduction or displacement of birds measured periodically (frequency to be determined)	No significant reduction in bird numbers or displacement attributable to human disturbance from an established baseline, subject to natural change	Significant disturbance attributable to human activities can result in reduced food intake and / or increased energy expenditure. Five year peak mean information on populations will be used as the basis for assessing whether disturbance is damaging. Tidal reedbeds are an important high tide roost as they provide some protection from predators and human disturbance.
		Absence of obstructions to viewlines	Openness of terrain unrestricted by obstructions, measured periodically (frequency to be determined)	No increase in obstructions to existing bird view lines, subject to natural change.	Waders normally require unrestricted views >200m and brent geese >500m, to allow early detection of predators when feeding and roosting. Grey plover in particular require unrestricted views when feeding and roosting.

Internationally important migratory species and waterfowl assemblage	Intertidal mudflats and sandflats	Food availability	Presence and abundance of suitable invertebrate prey species, measured periodically (frequency to be determined).	Presence and abundance of food species should not deviate significantly from an established baseline, subject to natural change.	Many species require areas of high biological productivity for feeding. Important prey species include marine polychaete worms, crustaceans and molluscs such as Baltic tellin.
			Presence and abundance of marine algae and eelgrass, measured periodically (frequency to be determined)	Presence and abundance of plant species should not deviate significantly from an established baseline, subject to natural change.	Intertidal sand and mudflats also support surface plants and green algae and dark-bellied brent geese, pochard and wigeon will feed over mudflats rich in *Zostera*, *Enteromorpha* and other green plants.
	Saltmarsh communities	Food availability	Presence and abundance of soft-leaved grasses, herbs and seed bearing plants measured periodically (frequency to be determined)	Presence and abundance of food species should not deviate significantly from an established baseline, subject to natural change.	Saltmarsh communities such as *Puccinellia maritima* and *Salicornia* species are an important food source for wigeon and dark-bellied brent geese. Mallard will occasionally also graze on the leaves and shoots of saltmarsh plants.
			Presence and abundance of surface and sub-surface invertebrates measured periodically (frequency to be determined)	Presence and abundance of prey species should not deviate significantly from an established baseline, subject to natural change.	Black-tailed godwit and other species feed on marine invertebrates in the substrate.
		Vegetation characteristics	Open, short vegetation or bare ground predominantly in areas used for roosting, measured periodically (frequency to be determined).	Vegetation height and density throughout areas used for roosting should not deviate significantly form an established baseline, subject to natural change.	Vegetation height of <10cm is required throughout roosting areas. A vegetation height of <10cm is also required for feeding areas used by dark-bellied brent geese and wigeon.

Internationally important migratory species and waterfowl assemblage	Tidal reedbeds	Food availability	Presence and abundance of aquatic plants and invertebrates measured periodically (frequency to be determined).	Presence and abundance of aquatic plants and invertebrates should not deviate significantly from an established baseline, subject to natural change.	Reedbeds are of particular importance for pochard which feed in the open water pools of the intertidal reedbeds.
		Open water	Presence, size and depth of open water pools measured periodically, (frequency to be determined).	Presence, size and depth of pools should not deviate significantly from an established baseline, subject to natural change	Medium to large open water pools are used as high tide roosts and feeding areas by species such pochard and goldeneye. They also provide some protection from predators and human disturbance.
	Coastal lagoons	Food availability	Presence and abundance of aquatic plants and invertebrates measured periodically (frequency to be determined)	Presence and abundance of aquatic plants and invertebrates should not deviate significantly from an established baseline, subject to natural change.	The saline lagoons are an important feeding habitat for wigeon, mallard, pochard, goldeneye and scaup.

[13] Baseline to be determined during the first reporting cycle.

NB: Extreme events (such as storms reducing or increasing salinities or warm summers) also need to be recorded as they may be critical in influencing ecological issues in the Humber Estuary European marine site and may well be missed by routine monitoring.

12. Detailed operations advice for the Humber Flats, Marshes and Coast SPA interest features

This section provides information to help relate general advice to each of the specific interest features of the Special Protection Area.

This advice relates to the vulnerability of the interest features and sub-features of the SPA within the Humber Estuary European marine site boundary as summarised in Table 2 and set out in more detail in Tables 8 to 13. An explanation of the sensitivity of the interest features or sub-features follows with an explanation of their exposure and therefore their vulnerability to damage or disturbance from the listed categories of operations. This enables links to be made between the categories of operation and the ecological requirements of the European marine site's interest features, as set out in Section 9.

The categories of operation may cause damage or disturbance to the interest features and sub-features of the Humber Estuary European marine site, either alone or in combination.

Zoning of the advice

The Humber Flats, Marshes and Coast SPA covers an extensive area from the M62 bridge near Goole on the River Ouse, down to Spurn Point on the north coast and Saltfleetby - Theddlethorpe dunes on the south coast. Easington lagoons are also included. To make this Regulation 33 advice easier to use, we have decided to zone this section of the advice. The zoning has been based on the scoping report for the Humber Coastal Habitat Management Plan (Binnie, Black and Veatch, 2001), which splits the Humber Estuary into ecological cells. These cells are based on analyses of benthic samples collected between 1984 and 1998. The analysis showed that the assemblages of benthic organisms found in the estuary showed significant spatial variability. As many of the SPA species feed on these benthic assemblages it would seem logical to use this same zonation. The maps in Appendix IV show the geographical position of the three zones.

12.1 Inner estuary

The inner estuary 'zone' stretches from the M62 bridge near Goole on the River Ouse to the Humber Bridge.

i) Physical Loss

- The Humber Flats, Marshes and Coast SPA provides important nesting, feeding and roosting habitats for the SPA birds. The loss by removal or smothering of any of the habitats on which they depend, could result in the loss of nesting and roosting sites and/or the reduction of food resources. It could also result in increased competition for food and space in areas that are already occupied, and ultimately reduce bird numbers on the estuary.
  Physical loss may result primarily from one-off developments such as land-claim, infrastructure construction and modification, as well as indirectly as a result of modification of the local hydrography and subsequent coastal erosion, as well as through coastal squeeze. The containment of the estuary by sea walls prevents the intertidal habitats from migrating inland with sea level rise, and this leads to a decrease in intertidal area over time. Current estimates for the Shoreline Management Plan indicate that due to sea level rise, 460ha of intertidal habitat will be lost from the estuary over the next 50 years. The **intertidal flats** and **saltmarsh communities** are particularly sensitive to coastal squeeze and these habitats are important for many of the SPA species as feeding and roosting areas. Reads Island is currently eroding on its northern side and this is affecting the **lagoon habitats** used by the breeding colony of avocets.

- **All the habitats** used by the Annex I species and the migratory and waterfowl species are considered to be highly sensitive to physical loss by removal and moderately sensitive to smothering. The inner estuary has less industry than other sections of the estuary, and so the exposure of the habitats to physical loss through developments was determined to be low to medium. However, the high sensitivity of the features to removal results in either a moderate or high vulnerability.

ii) Physical Damage

- Physical damage can alter habitat structure and lead to a change in species composition. This is likely to affect the bird species of the European marine site, either through the loss of the habitat or through the loss of prey species. Physical damage to intertidal habitats may ultimately lead to sediment de-stabilisation and increased erosion, and reduce the suitability of the area as a feeding and roosting habitat. There are many activities that could cause physical damage to the European marine site sub-features such as land-based and water-based recreation, and developments and their associated activity. It is also important to ensure that any development proposals outside the European marine site do not have a knock-on impact on the habitats within the boundary.

- Activities or developments resulting in siltation can cause localised increases in the levels of suspended sediments. Siltation may have an adverse effect on some species of birds through increased turbidity levels. This may reduce visibility, affecting birds which often feed by sight, such as avocet, dunlin and black-tailed godwit. Turbidity may also reduce light penetration through the water column, limiting photosynthesis and this may affect species that feed on plant material such as brent geese, wigeon and pochard. Siltation may also lead to a decrease in prey species through smothering, leading to blocked feeding and respiratory structures and affecting recruitment processes of both marine fauna and flora.
  Maintenance dredging is undertaken within the European marine site and the dredge spoil is deposited within the system and this may lead to localised siltation of the sub-features used by the birds. However, none of the sub-features are currently considered to be vulnerable to siltation.

- Activities that cause direct scouring or abrasion to the intertidal habitats may damage marine organisms and plants, as well as causing deterioration to the structure of saltmarshes and sediment communities. Repetitive or permanent damage can adversely affect the ability of these habitats to recover and may ultimately lead to their loss.
  Recreational activities can cause physical damage through abrasion from the wash from boats or by trampling from walkers. The **tidal reedbeds** that support nesting marsh harriers and provide an important roosting habitat for several other species are particularly sensitive to abrasion. However, the large areas of reedbeds found in the inner estuary are unlikely to be accessible to large numbers of people or vehicles. There have also been reports of quad biking on the flood banks of the inner estuary. Quad bikes would cause considerable damage to the **saltmarsh communities** and **intertidal flats** if they came onto the European marine site. However, much of the shoreline of the inner estuary is difficult to access and so the exposure to abrasion was determined to be low to medium.
  Areas of saltmarsh in the inner estuary are grazed by cattle and sheep. Grazing by livestock radically alters the floristic composition and structure of a saltmarsh, suppressing many of the dominant dwarf shrub and herb species and promoting the dominance of grasses. However, grazed sites result in a short turf that provides an important feeding and roosting habitat for many bird species. Once grazing is established, its abandonment leads to the invasion of upper saltmarsh communities by sea couch grass, which suppresses other plants and is unpalatable to wildfowl. Consequently, traditionally grazed marshes should continue to be grazed, although overgrazing can cause physical damage by trampling which can damage plants, compact mudflats and lead to a localised loss of habitat and excessive bare ground on saltmarshes (Toft *et al*. 1995). Traditionally ungrazed marshes should not be grazed to ensure the conservation of their plant and invertebrate interests.
  Due to their sensitivity, the saltmarsh communities and tidal reedbeds are currently considered to be moderately vulnerable to abrasion.

iii) Non-physical Disturbance

- Industry, transport and recreational activities may all result in noise and visual disturbance, although in the inner estuary, the sources are more likely to be related to recreation or transport.
  Transport related activities, such as shipping and aircraft, can have serious impacts on bird populations, and studies have shown that the most widespread and long-lasting disturbance often comes from aircraft. Slower aircrafts, such as helicopters, micro-lights and light aircraft (even when not low flying) are more

likely to cause disturbance than jets (Smit & Vassar 1993, Stock 1993). However, fast (jet) planes can also cause disturbance when flying low over feeding grounds and roosts (Koolhaas *et al*. 1993), although it is not clear whether the disturbance is due to the sudden loud noise or the plane's movement. A study of waders on a high-tide roost at Terschelling, the Netherlands, summarised by Smit & Vassar (1993), identified small aircraft and pedestrians as being the most significant sources of disturbance to the roosting birds. In the inner estuary, light aircraft are frequently seen, although it is unknown where these originate from as Brough airfield is only used infrequently. Under normal conditions the birds may become habituated to the presence of continuous aircraft noise, but are sensitive when under stress, for example during severe weather, and this could have a negative impact on the overwintering birds.

- The most disturbing human activities are those that cause fast or unpredictable movements, or loud and unexpected noises. The type of disturbance also has a bearing on the birds' response. For example, sudden noises and visual impacts, such as guns being fired or pedestrians are more likely to cause disturbance than continual noise that many species of birds will habituate to. Visual disturbance by people walking along the foreshore disturbs waterfowl more often than other activities, as species tend to feed in these or adjacent areas (Sidaway 1990). Some species such as dunlin, ringed plover, redshank and shelduck may be fairly tolerant to disturbance from recreation, but other species are more susceptible (Sidaway 1990), although responses will vary according to the time of year and the intensity of the activity. Flocks of golden plover for example, regularly move between Read's Island and New Holland in mid winter, often in response to disturbance levels (Catley, 2000). Much of the disturbance in the inner estuary may be due to pedestrians, as long distance footpaths - the Trans Pennine Trail, the Wolds Way and the Viking Way all run alongside the estuary, often on top of the flood bank. In addition, there have been reports of quad biking along the sea defences and disturbance from microlights and wildfowling are known causes of disturbance (Catley, 2000).
  In the past, the use of the Humber Estuary for water sports and recreation remained comparatively undeveloped, partly because the waters are difficult for navigation due to the shifting sandbanks, high levels of commercial shipping and strong tidal currents (Rule, 1996). Over recent years however, there has been a large increase in the number of boats, particularly powerboats and the estuary is an established venue for powerboat racing.
  Much of the foreshore of the inner estuary is difficult to access and so any disturbance is more likely to occur from afar and so have less impact than direct approaches. Lack of access to the foreshore, may also limit recreational boating activity. However, it should be also noted that the **intertidal flats** are very narrow in places, and so roosting and feeding birds using these areas may be susceptible to both land and water based disturbance.

- Areas subjected to persistent noise and visual disturbance may reduce the feeding and roosting opportunities for birds on the estuary. Birds will concentrate where feeding is best, and disturbance in these areas can prevent birds from feeding and effectively cause a loss of available habitat. In response to disturbance, birds either decrease their energy intake at their present (disturbed) feeding site through displacement activity, or they will move to an alternative, less favoured site, or one which is already occupied. This increases competition, with a larger number of birds dependent on one particular area. Such a response affects energy budgets and thus survival, and will be of particular concern during prolonged periods of cold weather, when energy requirements are increased and during severe conditions when intertidal flats can freeze. In addition, waders find it difficult to obtain sufficient food in mid to late winter as energy reserves and food resources are at their lowest and foraging for food can be difficult. The response of birds to disturbing events depends on a wide range of factors. These include the level of disturbance, reactions of other birds nearby, flock size and knowledge from earlier experiences (eg. habituation). Additional factors determine either their willingness to remain in the same place (scarcity of food, adverse weather, physiological condition of individual birds) or their motivation to leave for another place (daily and annual patterns of movement, related to time of year and tidal level, or the presence of alternative sites).

- Nesting birds are highly sensitive to noise and visual disturbance as this will cause them to expend energy at a time when they require more energy to breed and forage for food. The SPA birds nesting within the inner estuary are marsh harrier and avocet. The marsh harriers nest in the **tidal reedbeds** and so may be less exposed to noise and visual disturbance from recreational activities as the general public are less likely to access these areas. Also, although the overwintering birds using the reedbeds may be subjected

to noise and visual disturbance from wildfowling, breeding marsh harriers are not likely to be affected since they will be using the reedbeds for nesting outside the designated wildfowling season. However, in September at the start of the wildfowling season, recently fledged marsh harriers will still use areas of the tidal reedbeds to roost in. On the Humber, numbers of marsh harrier decline in September whereas in more secure areas such as East Anglia, roost numbers are sustained throughout the month (Andrew Grieve, pers com).

It has been documented that marsh harriers are particularly sensitive to disturbance when breeding, although they may become habituated to some noise and visual impacts. There have been reports of marsh harriers nesting alongside Environment Agency flood defence works, close to a footpath and busy road, although habituation may only occur in some birds that are previously used to some level of disturbance (Nick Cutts, pers com). It has also been reported that several marsh harrier nesting sites suffer from disturbance from the general public, and one site constantly fails due to this (Andrew Grieve, pers com).

Avocet also nest within the inner estuary – on Reads Island and at Blacktoft Sands. The RSPB and Lincolnshire Wildlife Trust manages both of these sites, and there is no public access to Reads Island. Disturbance from the general public and recreational activities are likely to be well managed, although the birds will still be subject to other forms of disturbance such as from aircraft.

- The exposure of the birds in the inner estuary to noise and visual disturbance was determined to be low to medium, with the exception of the reedbeds used by the overwintering and migratory birds. Their exposure to noise was determined to be high, due to wildfowling that occurs during the winter months throughout the inner estuary, particularly around the large areas of reedbeds. Wildfowling can also cause considerable noise disturbance to non-target waterfowl. Other sources of disturbance may come from aircrafts, which frequently fly over the inner estuary, pedestrians, horse riders and powerboats. In places, the intertidal areas of the inner estuary are very narrow and so birds using these areas will be particularly susceptible to both land and water based disturbance.

iv) Toxic contamination

- Birds are subject to the accumulation of toxic contaminants through the food chain or through direct contact with toxic substances when feeding. Their ability to feed can also be affected by changes in the palatability and/or abundance of prey items caused by toxic contamination. Bird populations may also be affected indirectly by contaminants affecting the abundance of their prey items. Toxic contamination may enter the European marine site from point and non-point sources, such as land-based discharges, sewage and industrial outfalls. Diffuse agricultural pollution also reaches the Humber Estuary, through its catchment area and so there is the possibility of pesticides entering the system.

- Toxic contaminants may have lethal or sub-lethal effects on marine organisms. Pollution-tolerant species may become dominant, reducing species richness, while sub-lethal effects can reduce the fitness of individuals by affecting reproduction, genetics, physiology and general health. Birds that are specialist feeders may be affected by the loss of a particular prey species, whilst generalist species may benefit from an abundance of opportunistic prey species. The combined effects of several pollutants may be responsible for causing the loss of communities and this will affect the bird species of the SPA through a loss or decrease in food items. Consideration should also be given to the potential indirect effects of toxic substances in depleting the food supply of birds as a result of lethal and sublethal effects of toxic substances on marine communities.

  Marine organisms such as algae, invertebrates and fish are most sensitive to toxic substances (Cole *et al.*, 1999). Many synthetic compounds, such as PCBs are known to have toxic effects even in low concentrations, and are capable of high levels of bioaccumulation within many benthic organisms. Such compounds may then biomagnify up the food chain if these organisms are predated upon, and may have an adverse effect on the SPA birds. In addition, habitats such as saltmarshes and reedbeds can bioaccumulate toxic compounds and act as sinks for them (Holt *et al.*, 1995). This could have implications for the wildfowl, such as brent geese and wigeon that feed on the saltmarsh plants and seeds.

- The Humber Estuary receives effluent discharges from $1/5^{th}$ of the population and area of England, and therefore some toxic contamination is likely to enter the site. Studies carried out by the Environment

Agency have shown that although most chemical determinants meet environmental quality standards, levels of TBT (tributyltin), copper and TPT (an organotin compound used as a fungicide to protect crops) do not. Many of these contaminants are present in the sediments of the upper estuary. The remobilisation of these sediments through dredging, bait collecting or erosion will cause these pollutants to be made available to feeding birds and for wider distribution throughout the estuary.

- All the sub-features are moderately sensitive to the introduction of synthetic and non-synthetic compounds, except for the lagoons, which are determined to be highly sensitive due to the restricted distribution of the communities and the poor flushing rates.

v) Non-toxic contamination

- Nutrient or organic enrichment can have indirect effects on bird populations, both through increasing and decreasing food availability. Nutrient and organic pollution can lead to an increase in benthic populations such as opportunistic marine worms. Whilst it may appear that birds are benefiting from this augmentation since large numbers feed at the site, it could indicate opportunism by a limited number of bird species. In the absence of such artificially enriched areas, a greater diversity of bird species may be more widely distributed throughout the estuary. Consequently, there is an apparent 'trade-off' between high benthic biomass and bird numbers, and a more diverse, stable ecosystem.
  An excessive supply of nutrients and organic carbon can result in deoxygenation of the sediments and water column and lead to the establishment of anoxic conditions, increasing oxygen demand and stimulating the release of ammonia and hydrogen sulphide which can be toxic to aquatic life. Severe eutrophication can also lead to the death of many benthic invertebrate species (Cole *et al*., 1999), many of which may be key prey species. An increased growth of algal mats on the intertidal area can cause smothering, resulting in deoxygenation of the sediments and leading to the death of invertebrate prey species. Species such as wigeon may benefit from an increase in opportunist algae such as *Enteromorpha,* but other waders and wildfowl that feed on mud-dwelling invertebrates, will experience a reduction in prey and feeding areas. Algal blooms can also cause a reduction in water clarity, which will affect the visibility of prey items. This will impact on sight feeders such as avocet and redshank.

- On the Humber Estuary, high nutrient and organic loads enter the system from sewage and industrial outfalls, and agricultural run-off. Many of these nutrients and organic matter enter the estuary via rivers, such as the Trent and Ouse, and therefore levels will decrease towards the mouth of the estuary, away from the source and where the water is more strongly mixed. The habitats of the inner estuary were determined to have a high or medium exposure to changes in nutrient and organic loading, depending on the duration and frequency of submersion. This resulted in several of the habitats being moderately or highly vulnerable.

- The primary sources of thermal discharges to the Humber Estuary are from power station cooling water discharges. Changes to the thermal regime of the water column may lead to changes in the distribution and composition of marine organisms, resulting in changes to bird distribution. Ultimately a long-term thermal discharge is likely to lead to a change in community, with colonisation by species adapted to warm water temperatures. Changes in species productivity may also occur as some species may thrive in warmer temperatures, whilst others may decline. This situation may consequently favour more opportunistic species and there are examples where increased temperatures have affected the growth and reproduction of invertebrates (Langford *et al*. 1998). The impact of heated water discharges are likely to depend on the location of the discharge point, the temperature of the discharge and the nature of tidal currents in the area. The water cooled power stations on and around the Humber, have cooling towers or return the discharge to deeper waters so that the temperature rise is minimised. It is therefore unlikely that the intertidal habitats will be affected by changes in temperature from this source.

- Turbidity levels are usually much higher in estuaries than those in adjacent coastal waters, and the Humber is a particularly turbid system. Activities such as dredging and the depositing of dredge spoil, and the desilting of effluent outfalls may further increase turbidity, but the degree to which this occurs was thought to be low. Coastal defences such as sea walls deflect wave energy along the coast and can lead to scouring of saltmarshes and intertidal flats, resulting in a re-suspension of sediments (Cole *et al*.

1999). Most estuarine communities can tolerate turbid conditions, however excessive turbidity may have adverse effects on filter-feeding organisms, clogging feeding and respiratory structures that in turn may reduce food availability for the birds.

- Salinity gradients exist throughout the estuary and most of the estuarine communities are able to tolerate a wide range of salinities due to the dynamic environment they inhabit. Salinity changes caused by water abstraction or outfalls may have localised impacts on the benthic communities of intertidal habitats. For example, benthic invertebrate communities vary in response to salinity, with diversity decreasing with a decrease in salinity (Cole *et al*. 1999). The principle effect on the birds of the SPA to changes in the salinity regime is a potential change in bird communities in response to changes in communities of benthic invertebrates (Cole *et al*. 1999).
  Studies carried out in Suffolk and Essex have indicated that freshwater flows over intertidal habitats may be important for waders and wildfowl (Ravenscroft, 1997 and 1998). The study found that the number and density of some wildfowl such as shelduck, wigeon, grey plover and redshank all showed statistically greater densities close to flows when compared with remaining areas of mudflats. However, the actual numbers recorded are generally low compared to numbers feeding in the adjacent areas.

vi) Biological disturbance

- The marine environment provides a hostile environment to microbial pathogens and they tend to die off rapidly, particularly in the presence of sunlight (Cole *et al*. 1999). However, they can become associated with suspended particles and accumulate to some extent in sediments, surviving for days or weeks (Cole *et al*. 1999). Microbial pathogens can also accumulate in filter-feeding organisms to levels that can be harmful to birds (Cole *et al*. 1999). However, the current exposure in the inner estuary to the introduction of microbial pathogens was determined to be low.

- The introduction of non-native species, both flora and fauna, could have an impact on the natural system and have a knock-on effect on the bird species. The introduction of a new species may out-compete the native invertebrate prey species and result in an altered community structure and may lead to a reduction in suitable food items.
  Spartina anglica, common cordgrass was first planted on the Humber in 1936 to assist in coastal defence and land claim. It is considered by some people to be a naturally invasive species that may be damaging to other **saltmarsh communities** and lead to the loss of **intertidal mudflats**. This may impact on birds such as dunlin, redshank and shelduck, which use these flats as a feeding area. It also grows too tall for small waders to roost on, resulting in the loss of suitable roosting habitat. On the Humber however, the area covered by *Spartina* has decreased and in places been replaced by *Puccinellia*.
  There are also records of other non-native species on the Humber Estuary, and species such as mink are likely to be particularly damaging to nesting bird populations, predating both the eggs and young. Currently however, mink are not thought to be a problem on the estuary.

- Selective extraction of prey species or habitat necessary for the maintenance of the SPA bird species may reduce the suitability of the estuary for feeding and roosting birds. The Annex I birds using the inner estuary, have a low exposure to selective extraction. However, there are a number of wildfowling clubs and private syndicates that operate in the inner estuary, and the migratory species and waterfowl assemblage were determined to have a high exposure to these activities, resulting in a high vulnerability score.

Table 8 Assessment of the relative exposure of interest features and sub-features of the Humber Estuary European marine site (SPA & pSPA) inner estuary to different categories of operations (as at July 2002)

Key: **High** = High exposure **Med** = Medium exposure **Low** = Low exposure **None** = No exposure

Inner Estuary

Categories of operations which may cause deterioration or disturbance	SPA Interest Features							
	Internationally important populations of regularly occurring Annex I species				Internationally important migratory species and waterfowl assemblage			
	Intertidal mudflats and sandflats	Saltmarsh communities	Reedbeds	Lagoons	Intertidal mudflats and sandflats	Saltmarsh communities	Reedbeds	Lagoons
Physical Loss								
Removal (eg land claim, dredging)	Med	Low	Low	Low	Med	Low	Low	Low
Smothering (eg depositing dredge spoil, beach feeding)	Med	Med	Low	Low	Med	Med	Low	Low
Physical Damage								
Siltation (eg dredging, outfalls)	Med	Med	Low	Low	Med	Med	Low	Low
Abrasion (eg recreational activity, vehicles)	Med	Med	Low	Low	Med	Med	Low	Low
Selective extraction (eg aggregate extraction)	Low	Med	Low	None	Low	Low	Low	None
Non-physical disturbance								
Noise (eg land/water-based recreation, marine traffic)	Med	Med	Med	Low	Med	Med	High	Low
Visual presence (eg land/water-based recreation, marine traffic)	Med	Med	Med	Low	Med	Med	Med	Low
Toxic contamination								
Introduction of synthetic compounds (eg TBT, PCBs)	Med	Med	Low	Low	Med	Med	Low	Low
Introduction of non-synthetic compounds (eg effluent outfalls, crude oil)	Med	Med	Low	Low	Med	Med	Low	Low
Introduction of radionuclides	Low	Low	Low	Low	Low	Low	Low	Low
Non-toxic contamination								
Changes in nutrient loading (eg agricultural run-off, effluent outfalls)	High	Med	Med	Med	High	Med	Med	Med
Changes in organic loading (eg effluent outfalls, aquaculture)	High	Med	Med	Med	High	Med	Med	Med
Changes in thermal regime (eg power station discharges)	Low	Low	None	None	Low	Low	None	None

Changes in turbidity (eg effluent outfalls, dredging, depositing dredged spoil)	Low	Low	None	Low	Low	Low	None	Low
Changes in salinity (eg water abstraction, effluent outfalls)	Low	Low	Low	Low	Low	Low	Low	Low
Biological disturbance								
Introduction of microbial pathogens (eg effluent outfalls)	Low	Low	Low	Low	Low	Low	Low	Low
Introduction of non-native species and translocation	Low	Low	Low	Low	Low	Low	Low	Low
Selective extraction of species (eg samphire picking, bait collection)	Low	Low	Low	Low	High	High	High	Low

Table 9 Assessment of the relative vulnerability of interest features and sub-features of the Humber Estuary European marine site (SPA & pSPA) inner estuary to different categories of operations

Shading indicates categories of operation to which the features or sub-features of the site are highly or moderately vulnerable to. This table also incorporates the relative sensitivity scores, used in part to derive vulnerability[14].

Key:

	High vulnerability
	Moderate vulnerability

●●●●	High sensitivity
●●●	Moderate sensitivity
●●	Low sensitivity
●	No detectable sensitivity

Inner Estuary

Categories of operations which may cause deterioration or disturbance	SPA Interest Features							
	Internationally important populations of regularly occurring Annex I species				Internationally important migratory species and waterfowl assemblage			
	Intertidal mudflats and sandflats	Saltmarsh communities	Reedbeds	Lagoons	Intertidal mudflats and sandflats	Saltmarsh communities	Reedbeds	Lagoons
Physical Loss								
Removal (eg land claim, dredging)	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●
Smothering (eg depositing dredge spoil, beach feeding)	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●
Physical Damage								
Siltation (eg dredging, outfalls)	●●	●●	●●	●●●	●●	●●	●●	●●●
Abrasion (eg recreational activity, vehicles)	●●	●●●	●●●●	●●●	●●	●●●	●●●●	●●●
Selective extraction (eg aggregate extraction)	●●●	●●	●●	●●	●●●	●●	●●	●●
Non-physical disturbance								
Noise (eg land/water-based recreation, marine traffic)	●●●●	●●●●	●●●	●●●●	●●●●	●●●●	●●●	●●●●
Visual presence (eg land/water-based recreation, marine traffic)	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●
Toxic contamination								
Introduction of synthetic compounds (eg TBT, PCBs)	●●●	●●●●	●●●	●●●●	●●●	●●●●	●●●	●●●●
Introduction of non-synthetic compounds (eg effluent outfalls, crude oil)	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●

Introduction of radionuclides	● ●	● ●	● ●	● ●	● ●	● ●	● ●	● ●
Non-toxic contamination								
Changes in nutrient loading (eg agricultural run-off, effluent outfalls)	● ● ●	● ●	● ● ●	● ● ●	● ● ●	● ●	● ● ●	● ● ●
Changes in organic loading (eg effluent outfalls, aquaculture)	● ● ●	● ●	● ● ●	● ● ●	● ● ●	● ●	● ● ●	● ● ●
Changes in thermal regime (eg power station discharges)	● ●	●	●	● ● ●	● ●	●	●	● ● ●
Changes in turbidity (eg effluent outfalls, dredging, depositing dredged spoil)	● ●	● ●	●	● ● ●	● ●	● ●	●	● ● ●
Changes in salinity (eg water abstraction, effluent outfalls)	● ●	● ●	● ● ●	● ● ●	● ●	● ●	● ● ●	● ● ●
Biological disturbance								
Introduction of microbial pathogens (eg effluent outfalls)	● ●	● ●	● ●	● ●	● ●	● ●	● ●	● ●
Introduction of non-native species and translocation	● ● ●	● ● ●	● ●	● ●	● ● ●	● ● ●	● ●	● ●
Selective extraction of species (eg samphire picking, bait collection)	● ● ●	● ● ●	● ● ●	● ● ●	● ● ●	● ● ●	● ● ●	● ● ●

[14] English Nature's advice on operations is derived from an assessment combining relative sensitivity of the features or sub-features with information on human usage of the site (as at July 2002), to identify relative vulnerability to categories of operations. In accordance with Government policy guidance this advice is provided in the light of current activities and patterns of usage at the site. It is important therefore that future consideration of this advice by relevant authorities, and others, takes account of changes in the usage patterns at the site. In contract the sensitivity of interest features, or sub-features, is relatively stable with alterations reflecting improvement in our scientific knowledge and understanding. To this end, information on sensitivity has been included in this table to assist the management and advisory groups with the future management of the site.

12.2 Middle Estuary

This advice relates to the vulnerability of the interest features and sub-features of the SPA within the Humber Estuary European marine site boundary as summarised in Table 2 and set out in more detail in Table 10 and 11. An explanation of the sensitivity of the interest features or sub-features follows with an explanation of their exposure and therefore their vulnerability to damage or disturbance from the listed categories of operations. This enables links to be made between the categories of operation and the ecological requirements of the European marine site's interest features, as set out in Section 9.

The middle estuary 'zone' stretches from the Humber Bridge to a line drawn across the estuary at Grimsby docks. For more detailed information on each category of operation please refer to the inner estuary section.

i) Physical loss

- Much of the middle estuary is highly industrialised and there are several large dock complexes, power stations and chemical factories along the shores. Consequently, there is significant pressure in this area for development, and the exposure of the **intertidal flats** to physical loss was determined to be high. In addition, the highly developed nature of this section of the estuary means that there is limited scope for restoration or mitigation of similar habitats. The other habitats used by the birds within this section of the European marine site are also subject to considerable pressures, both from commercial and to a lesser extent recreational uses, in what is already a busy developed area. Therefore, the **saltmarsh communities** and **tidal reedbeds** were determined to have a medium exposure to physical loss through removal.
  The removal of habitats may lead to changes in coastal processes, such as increased wave exposure and this can exacerbate further habitat loss and change the nature of the existing sediments. In addition, sea defences confine much of this section of the estuary, and the saltmarshes and intertidal sediments are particularly vulnerable to coastal squeeze due to their inability to naturally migrate landward in response to rising sea levels.
  Maintenance dredging and the disposal of dredge spoil is undertaken within this section of the estuary, and this may lead to a change in the extent, distribution and nature of intertidal habitats, either through the removal of the source of intertidal sediment, or through the smothering of the intertidal flats. This will impact on the dynamics on the system and could lead to a reduction in bird feeding and roosting areas.
  All the habitats used by the SPA birds are currently vulnerable to physical loss through removal and the intertidal mudflats and sandflats and saltmarsh communities are moderately vulnerable to smothering.

ii) Physical damage

- The **intertidal mudflats and sandflats** of the middle estuary were determined to have a medium exposure to physical damage through siltation. Siltation can reduce visibility through the water column and is likely to affect sight feeders such as black-tailed godwit. These birds have a very limited distribution through the estuary and large numbers feed on the mudflats from North Killingholme Haven pits to Pyewipe, and to a lesser extent, Saltend and Cherry Cobb. The maintenance and capital dredging, and depositing of dredge spoil that occurs primarily in this section of the estuary may affect the suitability of the intertidal flats for supporting black-tailed godwits.

- The intertidal flats and **saltmarsh communities** were determined to have a medium exposure to abrasion. In this section of the estuary, there is a large volume of commercial shipping and the wash from these vessels may result in abrasion and scouring of the intertidal habitats. In addition, the machinery used for developments and construction work may cause physical damage through abrasion to the intertidal habitats.

iii) Non-physical disturbance

- Much of the middle estuary is highly industrialised, and persistent noise and visual disturbance is an everyday occurrence. Visual disturbance, such as the presence of artificial lights from industry, such as the oil refineries, has an impact on the birds using the intertidal habitats (Hill 1990). These impacts may

have some benefit, such as enabling some bird species to feed at night. This may be particularly advantageous during the winter when the day length is shorter. Night feeding also extends the foraging period and thus increases food intake. There is also evidence to show that invertebrates move closer to the surface at night and are therefore more readily available for foraging birds (Evans 1987). However, much of this evidence is largely inconclusive, and feeding at night may upset the natural biological functioning of some bird species. Artificial lights are also likely to have detrimental effects, causing aberrant behaviour in flying birds, causing them to disorientate, lose control of their flight and collide with the light source or its associated structures (Alerstam 1990). This may have a significant impact on the SPA birds if artificial lighting occurs along flyways or close to regular feeding and roosting areas. In these circumstances, the movements of large numbers of birds along with poor visibility and low cloud cover, could lead to very high levels of mortality. Such mortality could arise not only from collision with structures or the ground, but could also be due to birds becoming disorientated and wasting valuable energy reserves by flying around light sources for hours at a time (A. Drewitt, 2000). Some types of lighting will be less harmful than others (although any light source visible to humans is likely to constitute a potential hazard to birds) and as with all developments that have the potential to affect the SPA, consideration should be given to lighting when planning future developments.

- Noise and visual disturbance is likely to vary considerably between the north and south bank of this section of the estuary. Although along large sections of the bank there is heavy industry, the north bank, east of Hull is largely farmland. Sources of noise and visual disturbance in this section of the estuary may result from powerboating, wildfowling and there may also be some disturbance from the cycle path that runs from Grimsby to Immingham. There are also several national trails, such as the Viking Way, which runs along the south bank, and the Trans-Pennine Trail which runs along the north bank. On the south bank, there are also several caravan sites adjacent to the estuary.
  It should be noted that the **intertidal habitats**, particularly on the south bank, are very narrow in places and so roosting and feeding birds using these areas will be susceptible to both land and water based disturbance. This is especially true for birds using the **tidal reedbeds**, which exist as extremely narrow fragments in this section of the estuary.

iv) Toxic contamination

- Toxic contamination may reach this section of the estuary from point and non-point source sources, such as land-based discharges, run-off from roads, water-based discharges and atmospheric deposition. The levels of toxic contaminants are likely to be higher in the inner estuary and decrease towards the mouth. This is mainly due to the fact that many of these contaminants are the result of historic discharges and these reached the Humber via its major tributaries such as the Trent and the Ouse. However, diffuse agricultural pollution may reach this section of the estuary and so there is the possibility of pesticides entering the system. In addition, sheltered areas such as at Pyewipe and Saltend may accumulate contaminated sediments, which may be remobilised through activities such as dredging or bait digging. North Killingholme Haven Pits also suffers some atmospheric pollution from industry.

- The Humber Estuary supports a large volume of commercial shipping, consisting of large vessels carrying chemicals and hydrocarbons into and out of ports or Conoco and Lindsey oil refinery. Therefore, there is the potential for pollution events arising from these vessels and there are two oil spill contingency plans for the estuary.
  Oil pollution is well known as a potential threat to the interest features and sub-features of the European marine site. **Intertidal habitats** are under the greatest threat from the physical effects of oil. Oil covering the intertidal area will prevent oxygen transport to the sediments, leading to anoxia and the death of infaunal species. The most vulnerable habitats are those that are sheltered and **saltmarshes** that may trap the oil. As well as the loss or contamination of food items, the birds of the SPA are directly threatened by oil pollution. Oil can cause physical damage to plumage and be ingested by the bird as it tries to preen. Wildfowl are more likely to be directly affected by water-borne oil pollution as they spent large amounts of time loafing and diving in the water. Oil affects the waterproofing of the bird's feathers by causing them to stick together. This results in waterlogging and the bird may die from hypothermia. Different oils vary in their toxicities, and effects are dependent upon exact conditions and duration of

exposure. The use of dispersants to remove the oil may also be harmful to both the intertidal habitats and their associated communities, and to the birds themselves.

- The intertidal mudflats and sandflats and the saltmarsh communities were determined to be moderately vulnerable to the introduction of synthetic and non-synthetic compounds. The coastal lagoons were also determined to be moderately vulnerable to the introduction of synthetic compounds.

v) Non-toxic contamination

- The Humber Estuary is considered to have a high nutrient regime, and high nutrient and organic loads enter the system from sewage and industrial outfalls, and agricultural run-off. The habitats of the middle estuary were determined to have a high or medium exposure to changes in nutrient and organic loading, depending on the frequency and duration of submersion.

vi) Biological disturbance

- The internationally important migratory species and waterfowl assemblage were determined to have a medium exposure to the selective extraction of species due to wildfowling that occurs along the north bank of this section of the estuary. There is also some bait digging on the north bank.

Table 10 Assessment of the relative exposure of interest features and sub-features of the Humber Estuary European marine site (SPA & pSPA) middle estuary to different categories of operations (as at July 2002)

Key: **High** = High exposure **Med** = Medium exposure **Low** = Low exposure None = No exposure

Middle Estuary

Categories of operations which may cause deterioration or disturbance	SPA Interest Features							
	Internationally important populations of regularly occurring Annex I species				Internationally important migratory species and waterfowl assemblage			
	Intertidal mudflats and sandflats	Saltmarsh communities	Reedbeds	Lagoons	Intertidal mudflats and sandflats	Saltmarsh communities	Reedbeds	Lagoons
Physical Loss								
Removal (eg land claim, dredging)	High	Med	Med	Low	High	Med	Med	Low
Smothering (eg depositing dredge spoil, beach feeding)	Med	Med	Low	Low	Med	Med	Low	Low
Physical Damage								
Siltation (eg dredging, outfalls)	Med	Med	Low	Low	Med	Med	Low	Low
Abrasion (eg recreational activity, vehicles)	Med	Med	Low	Low	Med	Med	Low	Low
Selective extraction (eg aggregate extraction)	Low	Low	Low	None	Low	Low	Low	None
Non-physical disturbance								
Noise (eg land/water-based recreation, marine traffic)	High	High	High	High	High	High	High	High
Visual presence (eg land/water-based recreation, marine traffic)	High	High	High	Med	High	High	High	Med
Toxic contamination								
Introduction of synthetic compounds (eg TBT, PCBs)	Med	Med	Low	Low	Med	Med	Low	Low
Introduction of non-synthetic compounds (eg effluent outfalls, crude oil)	Med	Med	Low	Low	Med	Med	Low	Low
Introduction of radionuclides	Low	Low	Low	Low	Low	Low	Low	Low

Non-toxic contamination								
Changes in nutrient loading (eg agricultural run-off, effluent outfalls)	High	Med	Med	Med	High	Med	Med	Med
Changes in organic loading (eg effluent outfalls, aquaculture)	High	Med	Med	Med	High	Med	Med	Med
Changes in thermal regime (eg power station discharges)	Low	Low	None	None	Low	Low	None	None
Changes in turbidity (eg effluent outfalls, dredging, depositing dredged spoil)	Low	Low	None	Low	Low	Low	None	Low
Changes in salinity (eg water abstraction, effluent outfalls)	Low	Low	Low	Low	Low	Low	Low	Low
Biological disturbance								
Introduction of microbial pathogens (eg effluent outfalls)	Low	Low	Low	Low	Low	Low	Low	Low
Introduction of non-native species and translocation	Low	Low	Low	Low	Low	Low	Low	Low
Selective extraction of species (eg samphire picking, bait collection)	Low	Low	Low	Low	Med	Med	Med	Med

Table 11 Assessment of the relative vulnerability of interest features and sub-features of the Humber Estuary European marine site (SPA & pSPA) middle estuary to different categories of operations

Shading indicates categories of operation to which the features or sub-features of the site are highly or moderately vulnerable to. This table also incorporates the relative sensitivity scores, used in part to derive vulnerability[15].

Key:

	High vulnerability
	Moderate vulnerability

●●●●	High sensitivity
●●●	Moderate sensitivity
●●	Low sensitivity
●	No detectable sensitivity

Middle Estuary

Categories of operations which may cause deterioration or disturbance	SPA Interest Features							
	Internationally important populations of regularly occurring Annex I species				Internationally important migratory species and waterfowl assemblage			
	Intertidal mudflats and sandflats	Saltmarsh communities	Reedbeds	Lagoons	Intertidal mudflats and sandflats	Saltmarsh communities	Reedbeds	Lagoons
Physical Loss								
Removal (eg land claim, dredging)	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●
Smothering (eg depositing dredge spoil, beach feeding)	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●
Physical Damage								
Siltation (eg dredging, outfalls)	●●	●●	●●	●●●	●●	●●	●●	●●●
Abrasion (eg recreational activity, vehicles)	●●	●●●	●●●●	●●●	●●	●●●	●●●●	●●●
Selective extraction (eg aggregate extraction)	●●●	●●	●●	●●	●●●	●●	●●	●●
Non-physical disturbance								
Noise (eg land/water-based recreation, marine traffic)	●●●●	●●●●	●●●	●●●●	●●●●	●●●●	●●●	●●●●
Visual presence (eg land/water-based recreation, marine traffic)	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●
Toxic contamination								
Introduction of synthetic compounds (eg TBT, PCBs)	●●●	●●●●	●●●	●●●●	●●●	●●●●	●●●	●●●●
Introduction of non-synthetic compounds (eg effluent outfalls, crude oil)	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●

Introduction of radionuclides	●●	●●	●●	●●	●●	●●	●●	●●
Non-toxic contamination								
Changes in nutrient loading (eg agricultural run-off, effluent outfalls)	●●●	●●	●●●	●●●	●●●	●●	●●●	●●●
Changes in organic loading (eg effluent outfalls, aquaculture)	●●●	●●	●●●	●●●	●●●	●●	●●●	●●●
Changes in thermal regime (eg power station discharges)	●●	●	●●●	●●●	●●	●	●	●●●
Changes in turbidity (eg effluent outfalls, dredging, depositing dredged spoil)	●●	●●	●	●●●	●●	●●	●	●●●
Changes in salinity (eg water abstraction, effluent outfalls)	●●	●●	●●●	●●●	●●	●●	●●●	●●●
Biological disturbance								
Introduction of microbial pathogens (eg effluent outfalls)	●●	●●	●●	●●	●●	●●	●●	●●
Introduction of non-native species and translocation	●●●	●●●	●●	●●	●●●	●●●	●●	●●
Selective extraction of species (eg samphire picking, bait collection)	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●

[15] English Nature's advice on operations is derived from an assessment combining relative sensitivity of the features or sub-features with information on human usage of the site (as at July 2002), to identify relative vulnerability to categories of operations. In accordance with Government policy guidance this advice is provided in the light of current activities and patterns of usage at the site. It is important therefore that future consideration of this advice by relevant authorities, and others, takes account of changes in the usage patterns at the site. In contract the sensitivity of interest features, or sub-features, is relatively stable with alterations reflecting improvement in our scientific knowledge and understanding. To this end, information on sensitivity has been included in this table to assist the management and advisory groups with the future management of the site.

12.3 Outer Estuary

This advice relates to the vulnerability of the interest features and sub-features of the SPA within the Humber Estuary European marine site boundary as summarised in Table 2 and set out in more detail in Table 12 and 13. An explanation of the sensitivity of the interest features or sub-features follows with an explanation of their exposure and therefore their vulnerability to damage or disturbance from the listed categories of operations. This enables links to be made between the categories of operation and the ecological requirements of the European marine site's interest features, as set out in Section 9.

The outer estuary 'zone' stretches from a line drawn across the estuary at Grimsby docks, to Saltfleetby to Theddlethorpe on the southern shore and to Spurn Point on the northern shore. Easington lagoons are also included.
For more detailed information on each category of operation please refer to the inner estuary section.

i) Physical loss

- The outer estuary is mostly undeveloped and there is little heavy industry other than around Grimsby. The exposure of the intertidal habitats in this section of the estuary to physical loss through removal or smothering was therefore determined to be low, although it may higher in localised areas.
  Beach feeding is carried out at Cleethorpes as part of a sea defence programme. The need for beach feeding is identified through twice yearly beach profile surveys and although it is undertaken infrequently, North East Lincolnshire Council may remove and deposit up to 2,000m^3 of sand each year within the European marine site. This operation will cause physical loss of the **intertidal flats** both through removal and smothering.
  During the summer months, beach cleaning is undertaken every day at Cleethorpes and this may result in the loss of food material, such as invertebrates, which are often found in strandline debris. This may impact on specialist feeders, however, this area is used more frequently by the SPA species during the winter months. At this time, there is less disturbance from tourists and beach cleaning does not take place.
  There have also been reports of large scale samphire collections at Humberston on the Lincolnshire coast and on Spurn Bight. Samphire picking can be classed as a longshore activity and may be sustainable when undertaken using traditional methods. However, it has been reported that few plants are left after these large scale collections and this will result in the loss of the seed bank as well as the plants themselves. This may have a knock-on effect on birds such wigeon, pochard and brent geese that feed on these pioneer marsh plants and seeds. The **saltmarsh communities** were determined to be highly vulnerable to removal.

ii) Physical damage

- The **intertidal mudflats and sandflats** were determined to have a medium exposure to siltation, which may occur as a result of dredging, depositing of dredge spoil and from effluent outfalls. The eelgrass beds are particularly sensitive to physical damage, and the Biodiversity Audit of Yorkshire and the Humber states that the eelgrass beds that were found on Spurn Bight and close to Grimsby may have now disappeared. The extent of eelgrass beds may vary as a result of many factors, both natural and anthropogenic, although dredging may have a significant effect. Dredging may alter the deposition of sediments onto eelgrass beds and increase turbidity, thus reducing photosynthesis. In addition, eelgrass beds are sensitive to abrasion, which may result from boat moorings and anchorages. Eelgrass beds are an important food source for brent geese and wigeon and further investigation into the status of eelgrass on the Humber Estuary is needed. Boat moorings and anchorages, plus the wash from boats may also cause physical damage through abrasion to the pioneer **saltmarsh communities** and also to the benthic communities of the intertidal flats. This may result in a loss of food species for the SPA birds.

- Several of the sub-features of the outer estuary were determined to be highly exposed to abrasion due to the large number of activities occurring in this section of the estuary that may lead to abrasion. Much of this activity is seasonal, such as large numbers of tourists visiting the south bank of the estuary during the

summer months. There are also reports of quad bikes, four-wheel drive vehicles, canoeing, and cockling and large scale samphire collections in this section of the estuary.
Cockling takes place at Horseshoe Point and limited gathering also occurs on a smaller bed on Cleethorpes foreshore. NESFC undertake regular stock surveys, and during 2002-03 the cockle beds at Horseshoe Point were closed due to a low abundance of fishable cockles. In February this year, DEFRA confirmed a new byelaw to strengthen the management of the Humber cockle fishery, which includes measures such as a permit system, a closed season, and a minimum landing size. When these beds are open there have been problems regarding the access route taken by the cocklers across an area of saltmarsh. Tractors and quad bikes have been driven onto the site, leading to significant localised damage to the **saltmarsh vegetation** and to the **intertidal flats**. It is possible to access the cockle beds via Stonebridge car park and when the cockle beds reopen, this alternative access route will be implemented. This will help to prevent damage to the saltmarsh vegetation.
Commercial fishing for shrimp also takes place in the outer estuary. It is usually undertaken by twin beam trawls, which are towed along the seabed; however, it is also carried out on the foreshore, using push nets. These may cause physical damage through abrasion to the intertidal flats and can damage the benthic communities, leading to a change in the community structure. However, this is only likely to occur in localised areas.

- Bait digging may also cause abrasion of the **intertidal flats** and occurs frequently between Grimsby and Cleethorpes and at Tetney on the south bank, and at Spurn Bight to Easington Clays on the north bank. Gatherers mainly target lugworm (*Arenicola* spp.) and ragworm (*Nereis* spp.). However, bivalve species may also be gathered such as gaper (*Mya* spp.) and razor (*Ensis* spp.). Bait-digging usually involves making holes or trenches and piling the removed sediments at the side. This alters the nature of the intertidal sediments and the invertebrate communities that they support, and this may have implications for birds feeding in the area (A. Drewitt, 2000). In particular, the overturning and piling of mud and sand next to the bait holes can cause the mortality of species sensitive to burying. It has also been found that mounds created by diggers are not fully repopulated until the mounds have been completely flattened by natural tidal processes. Conversely, the basins created by digging were quickly repopulated by lugworms (up to 34 days for complete recovery) and trenches that were infilled following digging were repopulated quickest of all (22 days) (McLusky *et al* 1983). This study shows that some of the impacts of bait-digging can be significantly reduced simply by back-filling holes and returning rocks and weed to their original position. This increases the rate of recolonisation of the bait species and decreases the mortality of other benthic invertebrates, as well as reducing damage to substrates.

- **Unvegetated sand and shingle** supports the breeding colonies of little terns that nest around the outer estuary. This habitat was determined to be highly vulnerable to physical damage from abrasion, resulting from land-based recreational activities. The areas where little terns nest, are easily accessible to the general public and are particularly popular during the spring and summer when the terns are nesting. The eggs are laid in shallow scrapes on the gravelly sand and can be easily damaged by human activity, especially as they are well camouflaged. The little tern colonies are considered to be highly exposed to activities such as trampling by people and dogs, and are also subject to damage from off-road vehicles such as quad bikes, which are frequently driven across the site.

- The **saltmarsh communities** were determined to have a medium exposure to selective extraction, due to the large scale samphire collecting that occurs at Humberston and on Spurn Bight. It is not known how the samphire is removed from the site, as it is often carried out during the night, but large areas are cleared and so it is likely that some physical damage occurs.

iii) Non-physical disturbance

- The habitats of the outer estuary were determined to have a high or medium exposure to noise and visual disturbance due to the large number of activities that can cause this type of disturbance. However, it is likely that there is a significant difference between the levels, type and seasonality of disturbance, between the north and south bank.
The outer estuary is popular with tourists, in particular Humberston, Cleethorpes beach and Donna Nook National Nature Reserve on the Lincolnshire coast, and Spurn Point. Saltfleetby to Theddlethorpe dunes

also have large numbers of tourists, possibly over 100,000 each year (Graham Weaver, pers com). Golden plover occur from Cleethorpes to Humberston and it has been reported that they suffer high levels of human disturbance (Catley, 2000). There are also reports of power boating at Cleethorpes, canoeing and off-road vehicles on the site. There are also several caravan sites, close to the north and south banks. These types of disturbances are more likely to occur in the spring and summer months, and so will have less impact on the migratory and overwintering birds that feed and roost on the **intertidal areas**. Disturbances likely to affect these birds may come from wildfowling, which occurs on both the north and south bank of this section of the estuary, and will also disturb non-target species. Punt-gunning also occurs at North Coates, although at very low levels. Bait-diggers and cocklers will also cause disturbance, particularly as they are likely to occur in the same areas as feeding birds, where prey density is highest. This accidental disturbance may prevent birds from feeding, or force them to expend energy flying to alternative and perhaps less favourable feeding areas. The Ministry of Defence has a bombing range at Donna Nook, which is used throughout the week. These sudden loud noises are more likely to cause disturbance than continual noise, which some birds may habituate to. Individuals engaged in bait-digging

There is currently a problem with microlights which have come from the old North Cotes airfield. The microlights fly out across the **saltmarsh** and **intertidal flats**, causing disturbance to feeding and roosting waterfowl (Graham Weaver, pers com).

- In the past there have been five little tern breeding colonies on the Humber, with the largest one at Easington **lagoons**. Unfortunately, over recent years, breeding success has varied greatly and Easington lagoons now appears to be the most successful colony with few birds fledging from any of the other sites. The breeding little terns were determined to have a high exposure to noise and visual disturbance, due to the high frequency of disturbances from people, dogs and vehicles. The areas used by the terns for breeding are accessible to the public and there are high levels of public activity, particularly during the spring and summer months, when the terns are nesting. Disturbance causes birds to expend energy at a time when they often require more energy to breed and forage for food, both for themselves and for their young.
  Easington lagoons support the largest colony of breeding little terns in the Humber Flats and Marshes SPA and have one of the highest success rates in eastern Britain. This is probably due to the intensive wardening and management of the site. Disturbances from people are minimal and usually caused by people inadvertently entering the nesting areas. However, human disturbance can prevent the adult birds from landing and feeding chicks, which may lead to predation from birds of prey such as kestrels. In 1998 and 1999 over 40 chicks fledged from this colony, although the numbers have decreased over the last two years. The most recent figures (2002) are 32 birds fledging from 34 pairs.
  Little terns also nest on areas of sand at Donna Nook, and several pairs attempt to nest at other sites including Tetney and Spurn Point, although none of these sites have been successful for several years, probably due to the high levels of disturbance.
  Little terns have also attempted to nest at Saltfleetby to Theddlethorpe National Nature Reserve in recent years, however, all the nests have failed due to human disturbance. In 2001, 10 pairs nested when the site was closed due to foot and mouth disease. However, the site was reopened before the terns had successfully fledged their young and people, dogs and vandalism caused the little terns to abandon their nests, preventing any chicks from fledging. This year, around 60 little terns were seen in the area during the spring, and 3 pairs attempted to nest, but again disturbance, including 3,000 bird watchers attracted to the reserve by a lesser sand plover, caused the little terns to desert the site.

iv) Toxic contamination

- The levels of toxic contaminants are likely to be higher in the inner estuary and decrease towards the mouth. This is mainly due to the fact that many of these contaminants are the result of historic discharges and these reached the Humber via its major tributaries such as the Trent and the Ouse. However, toxic contaminants may still reach this section of the estuary from diffuse agricultural pollution, land-based discharges, run-off from roads, water-based discharges and atmospheric deposition. In addition, activities such as dredging and bait digging (which is fairly intensive on Spurn Bight) may remobilise contaminated

sediments. There have been several oil pollution incidents in the past from Tetney monobuoy and birds may be affected either through direct oiling, or indirectly through loss of their food source.

- The **intertidal mudflats and sandflats** and the **saltmarsh communities** were determined to be moderately vulnerable to the introduction of synthetic and non-synthetic compounds. The **coastal lagoons** were also determined to be moderately vulnerable to the introduction of synthetic compounds. Lagoons are particularly susceptible to pollution events due to their poor flushing rates and this results in a high sensitivity score.

v) Non-toxic contamination

- The Humber Estuary is considered to have a high nutrient regime, and high nutrient and organic loads enter the system from sewage and industrial outfalls, and agricultural run-off. The **intertidal habitats** of the outer estuary were determined to have a high or medium exposure to changes in nutrient and organic loading, depending on the frequency and duration of submersion. However, the area south of Donna Nook is likely to have a lower exposure due to its location on the open coast, where the waters are more strongly mixed. The **lagoons** at Easington are also likely to have a lower exposure to contamination from the Humber Estuary, although they may be affected from other sources, such as from diffuse agricultural run-off.

- Eutrophication of the shallow coastal waters or the lagoons can have a detrimental effect on the small fish and invertebrates that the breeding little terns feed on. In addition, an increase in turbidity can lead to a decrease in the clarity of the water column and in turn reduce the ability of the terns to catch food items. Areas of the Humber Estuary are important fish nursery areas and water quality is an important factor for their survival.

vi) Biological disturbance

- The **saltmarsh communities** were determined to have a medium exposure to the introduction of non-native species, as there are records of common cordgrass *Spartina anglica* from this section of the estuary. A recent survey (2002) by Bullen Consultants recorded over 90ha of *Spartina anglica* (SM6) within the Spurn Head to Saltend Flats SSSI. *S. anglica* is able to grow low down on the shore where the sediments are highly mobile and is considered by some to be an invasive species that may be damaging to other marsh communities. The encroachment of *S. anglica* over the intertidal flats may impact on birds such as dunlin, redshank and shelduck, which use these flats as a feeding area. It also grows too tall for small waders to roost on, resulting in the loss of suitable roosting habitat. On the Humber however, the area covered by *S. anglica* appears to be decreasing and in places *Puccinellia* has replaced it.
  There are also records of other non-native species occurring in the Humber Estuary, and species such as mink are likely to be particularly damaging to nesting little terns, predating both the eggs and young.

- The **saltmarsh communities** were also determined to have a medium exposure to the selective extraction of species due to large scale samphire collecting. It has been reported that the plants have been uprooted and large areas have been cleared. Collecting on this scale also removes the seed bank and will impact on the recolonisation of the intertidal flats and on species such as wigeon, pochard and brent geese which may feed on these plants and seeds. Wildfowling also occurs in this section of the estuary and there is a small amount of punt-gunning allowed at Northcoates.

- Bait digging results in the removal of sediment and associated sediment communities from **intertidal areas**. This may result in a localised reduction in food availability for feeding birds, particularly as the birds and bait diggers are likely to occur in the same areas, where prey density is highest. Extraction may also remove or damage non-target species, altering the species composition of marine communities and affecting waterfowl that may feed on these species. The sensitivity of the community to such damage will depend upon the destructiveness of the method of extraction, with less damage resulting where the species is extracted manually, compared to more damage to both species and habitat when mechanical means are used.

Different invertebrate species vary in their ability to recover from the effects of bait-digging. Long-lived, infrequently recruiting species such as the larger bivalves will take much longer to become re-established after removal or damage from digging. Other benthic invertebrates may also be vulnerable to bait-digging disturbance due to their fragile nature. Furthermore in some species, particularly the larger bivalves, recovery can take longer due to the annual variation in spat quality. As a result the older classes of large bivalve species may disappear in severely worked areas (Heiligenberg 1987).
The effects of bait-digging are unlikely to be restricted to the target species, and non-target species may be even more vulnerable to bait-digging as they may be less mobile and less able to repopulate dug-out areas. For example, a study of the exploitation of lugworms in the Wadden Sea showed a severe impact on other benthic species (Heiligenberg 1987). The reduction in numbers and biomass of these non-target species could have been caused by increased mortality, either as a direct consequence of digging or indirectly due to increased vulnerability to predation, or as a result of dispersal of populations away from the dug over area.
In another study of benthic species subject to bait-digging activities at Chichester Harbour, there was a dramatic and significant reduction in the density of six out of ten species sampled one month after removal, with four species still at low levels at least two years after the initial digging (Farrel 1999). There was also a long-term reduction in algal cover related to changes in mudflat topography. In contrast, there was no significant reduction in the density of ragworms, the target species.
The potential effects of the collection of bait and other shoreline animals within European marine sites has been documented by Fowler (1999).

- Commercial fishing for shrimp and cockles occurs in the outer estuary. Bird populations may be affected if they are in competition with humans in exploiting the food species. For example, cockling may affect birds such as oystercatchers, which feed on cockles. Cockling takes place at Horseshoe Point and limited gathering also occurs on a smaller bed on Cleethorpes foreshore. NESFC undertake regular stock surveys, and during 2002-03 the cockle beds at Horseshoe Point were closed due to low abundance of fishable cockles. In February this year, DEFRA confirmed a new byelaw to strengthen the management of the Humber cockle fishery, which includes measures such as a permit system, a closed season, and a minimum landing size. In addition, an ecological balance is achieved through the thirds rule, which allocates a third of the cockles to the fishermen, a third to birds and the remaining third to the stock. NESFC are still working towards an Regulating Order, which would further license cockle gatherers and limit the quantity of cockles exploited.
  This fishery is currently closed until September 2003, although several people have been prosecuted for still fishing here.

Table 12 Assessment of the relative exposure of interest features and sub-features of the Humber Estuary European marine site (SPA & pSPA) outer estuary to different categories of operations (as at July 2002)

Key: **High** = High exposure **Med** = Medium exposure **Low** = Low exposure **None** = No exposure

Outer Estuary

Categories of operations which may cause deterioration or disturbance	SPA Interest Features								
	Internationally important populations of regularly occurring Annex I species					Internationally important migratory species and waterfowl assemblage			
	Unvegetated sand and shingle	Intertidal mudflats and sandflats	Saltmarsh communities	Reedbeds	Lagoons	Intertidal mudflats and sandflats	Saltmarsh communities	Reedbeds	Lagoons
Physical Loss									
Removal (eg land claim, dredging)	Low	Low	Med	Low	Low	Low	Med	Low	Low
Smothering (eg depositing dredge spoil, beach feeding)	Low	Low	Low	Low	Low	Low	Low	Low	Low
Physical Damage									
Siltation (eg dredging, outfalls)	Low	Med	Low	Low	Low	Med	Low	Low	Low
Abrasion (eg recreational activity, vehicles)	High	High	High	Low	Low	High	High	Low	Low
Selective extraction (eg aggregate extraction)	Low	Low	Med	Low	Low	Low	Med	Low	Low
Non-physical disturbance									
Noise (eg land/water-based recreation, marine traffic)	High	High	High	Med	High	High	High	Med	High
Visual presence (eg land/water-based recreation, marine traffic)	High	High	High	Med	High	High	High	Med	High
Toxic contamination									
Introduction of synthetic compounds (eg TBT, PCBs)	Low	Med	Med	Low	Low	Med	Med	Low	Low
Introduction of non-synthetic compounds (eg effluent outfalls, crude oil)	Low	Med	Med	Low	Low	Med	Med	Low	Low
Introduction of radionuclides	Low	Low	Low	Low	Low	Low	Low	Low	Low

Non-toxic contamination									
Changes in nutrient loading (eg agricultural run-off, effluent outfalls)	Low	High	Med	Med	Med	High	Med	Med	Med
Changes in organic loading (eg effluent outfalls, aquaculture)	Low	High	Med	Med	Med	High	Med	Med	Med
Changes in thermal regime (eg power station discharges)	None	Low	Low	None	None	Low	Low	None	None
Changes in turbidity (eg effluent outfalls, dredging, depositing dredged spoil)	Low	Low	Low	None	Low	Low	Low	None	Low
Changes in salinity (eg water abstraction, effluent outfalls)	None	Low	Low	Low	Low	Low	Low	Low	Low
Biological disturbance									
Introduction of microbial pathogens (eg effluent outfalls)	Low	Low	Low	Low	Low	Low	Low	Low	Low
Introduction of non-native species and translocation	Low	Low	Med	Low	Low	Low	Med	Low	Low
Selective extraction of species (eg samphire picking, bait collection)	Med	Med	Med	Low	Low	High	High	Med	Med

Table 13 Assessment of the relative vulnerability of interest features and sub-features of the Humber Estuary European marine site (SPA & pSPA) outer estuary to different categories of operations

Shading indicates categories of operation to which the features or sub-features of the site are highly or moderately vulnerable to. This table also incorporates the relative sensitivity scores, used in part to derive vulnerability[16].

Key:

	High vulnerability
	Moderate vulnerability

●●●●	High sensitivity
●●●	Moderate sensitivity
●●	Low sensitivity
●	No detectable sensitivity

Outer Estuary

Categories of operations which may cause deterioration or disturbance	SPA Interest Features								
	Internationally important populations of regularly occurring Annex I species					Internationally important migratory species and waterfowl assemblage			
	Unvegetated sand and shingle	Intertidal mudflats and sandflats	Saltmarsh communities	Reedbeds	Lagoons	Intertidal mudflats and sandflats	Saltmarsh communities	Reedbeds	Lagoons
Physical Loss									
Removal (eg land claim, dredging)	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●
Smothering (eg depositing dredge spoil, beach feeding)	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●
Physical Damage									
Siltation (eg dredging, outfalls)	●	●●	●●	●●	●●●	●●	●●	●●	●●●
Abrasion (eg recreational activity, vehicles)	●●●●	●●	●●●	●●●●	●●●	●●	●●●	●●●●	●●●
Selective extraction (eg aggregate extraction)	●●●●	●●●	●●	●●	●●	●●●	●●	●●	●●
Non-physical disturbance									
Noise (eg land/water-based recreation, marine traffic)	●●●●	●●●●	●●●●	●●●	●●●●	●●●●	●●●●	●●●	●●●●
Visual presence (eg land/water-based recreation, marine traffic)	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●
Toxic contamination									
Introduction of synthetic compounds (eg TBT, PCBs)	●●	●●●	●●●●	●●●	●●●●	●●●	●●●●	●●●	●●●●
Introduction of non-synthetic compounds (eg effluent outfalls, crude oil)	●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●

Introduction of radionuclides	●●	●●	●●	●●	●●	●●	●●	●●	●●
Non-toxic contamination									
Changes in nutrient loading (eg agricultural run-off, effluent outfalls)	●	●●●	●●	●●●	●●●	●●●	●●	●●●	●●●
Changes in organic loading (eg effluent outfalls, aquaculture)	●	●●●	●●	●●●	●●●	●●●	●●	●●●	●●●
Changes in thermal regime (eg power station discharges)	●	●●	●	●	●●●	●●	●	●	●●●
Changes in turbidity (eg effluent outfalls, dredging, depositing dredged spoil)	●	●●	●●	●	●●●	●●	●●	●	●●●
Changes in salinity (eg water abstraction, effluent outfalls)	●	●●	●●	●●●	●●●	●●	●●	●●●	●●●
Biological disturbance									
Introduction of microbial pathogens (eg effluent outfalls)	●	●●	●●	●●	●●	●●	●●	●●	●●
Introduction of non-native species and translocation	●●	●●●	●●●	●●	●●	●●●	●●●	●●	●●
Selective extraction of species (eg samphire picking, bait collection)	●●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●

[16] English Nature's advice on operations is derived from an assessment combining relative sensitivity of the features or sub-features with information on human usage of the site (as at July 2002), to identify relative vulnerability to categories of operations. In accordance with Government policy guidance this advice is provided in the light of current activities and patterns of usage at the site. It is important therefore that future consideration of this advice by relevant authorities, and others, takes account of changes in the usage patterns at the site. In contract the sensitivity of interest features, or sub-features, is relatively stable with alterations reflecting improvement in our scientific knowledge and understanding. To this end, information on sensitivity has been included in this table to assist the management and advisory groups with the future management of the site.

RAMSAR

13. Humber Flats, Marshes and Coast Ramsar site interest features

The Humber Estuary European marine site also includes a Ramsar site qualifying under the Ramsar Convention. An extension to the Ramsar site has also been proposed, but this has not yet been listed and is therefore known as a proposed Ramsar site. This section describes and explains the importance of each the features of the Ramsar and pRamsar, together with their component sub-features within the Humber Estuary European marine site.

The Humber Flats, Marshes and Coast Ramsar and pRamsar includes both marine areas (ie. land covered continuously or intermittently by tidal waters) and land that is not subject to tidal influence. In accordance with a DETR policy statement, "Ramsar sites in England" (November 2000), Ramsar sites must be given the same consideration as European sites. Therefore, the areas of the Ramsar and pRamsar below highest astronomical tide will be considered as part of the Humber Estuary European marine site. The seaward boundary of the European marine site is concurrent with that of the Ramsar or pRamsar. The landward boundary of the European marine site is the upper boundary of the Ramsar or pRamsar, or where that extends above land covered continuously or intermittently by tidal waters, it is at the limit of the marine habitats.
Where the Ramsar or pRamsar qualifying species occur within the European marine site, they are referred to as interest features. Sub-features (habitats) have also been identified to highlight the ecologically important components of the European marine site for each interest feature.

This section on the Humber Flats, Marshes and Coast Ramsar site, applies to both the listed site and to the proposed Ramsar site.

13.1 Background and context

The Convention on Wetlands of International Importance especially as Waterfowl Habitats was signed in Ramsar, Iran in 1971. The broad objectives are to stem the loss and progressive encroachment on wetlands now and in the future through the designation of Ramsar sites. In addition, signatories to the Convention are required to promote the conservation of wetland habitats and wise use of wetlands within their territories.

A habitat can qualify as a Ramsar site for its representation of a wetland, for supporting wetland plant or animal species or for its role in supporting internationally important waterfowl. Interest features are identified within certain criteria.

The Humber Flats, Marshes and Coast Ramsar site qualifies under the following San José criteria:

Criterion 2: A wetland should be considered internationally important if it supports vulnerable, endangered or critically endangered species or threatened ecological communities

Criterion 3: A wetland should be considered internationally important if it supports populations of a plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region

Criterion 5: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds

Criterion 6: A wetland should be considered internationally important if it regularly supports 1% or more of the individuals in a population of one species or sub-species of waterbird.

As with SPAs, English Nature's conservation objectives provide information on maintaining the favourable condition of the habitats listed on the citation and/or the habitats used by the qualifying species. Also, the UK Ramsar Committee, led by JNCC, is scoping a review of listed Ramsar sites. This will document any changes to qualifying features on Ramsar sites since the sites were listed, taking account of the revised Ramsar site selection criteria and the need to increase coverage of non-avian interests. This will provide advice to Ministers on any changes required to Ramsar citations. Depending on the conclusions of the review, English Nature may review this advice.

The Ramsar site boundary within the Humber Estuary European marine site is concurrent with the corresponding SPA boundary. There are also a number of habitats within the Ramsar site that supports qualifying species but lie landward of the point of highest astronomical tide and therefore outside the European marine site. Objectives to maintain habitats important to these species in favourable condition are found within English Nature's conservation objectives for the relevant SSSI within the Ramsar site boundary and will be dealt with through procedures outlined in the Conservation (Natural Habitats &c.) Regulations 1994. Some species also use areas of land and coastal waters outside the boundaries of the Ramsar site. Relevant authorities need to have regard to such adjacent interests, as they might be affected by activities taking place within, or adjacent to the European marine site.

13.2 Internationally important wetland, hosting an assemblage of threatened coastal and wetland invertebrates

The Humber Flats, Marshes and Coast qualifies as a Ramsar site under Criterion 2 because it supports an assemblage of threatened coastal and wetland invertebrate species (see table 14).

The qualifying invertebrate species that occur within the European marine site are:

- *Eupithecia extensaria occidua* – scarce pug moth
- *Gammarus insensibilis* – lagoon sand shrimp
- *Spilogona biseriata* – muscid fly
- *Pogonus luridipennis* – ground beetle

There are also a large number of qualifying invertebrate species that utilise habitats above highest astronomical tide and hence are outwith the European marine site boundary. Objectives to maintain habitats important to these species in favourable condition are found within English Nature's conservation objectives for the relevant SSSI within the Ramsar site boundary and will be dealt with through relevant procedures outlined in the Conservation (Natural Habitats & c.) Regulations 1994.

13.2.1 Key sub-features

Saltmarsh communities – Although saltmarsh vegetation is found throughout much of the estuary, the invertebrate species utilising this habitat tend to be localised.
Eupithecia extensaria occidua, the scarce pug moth was once common at Spurn Point, the larvae feeding on sea wormwood *Artemesia maritima,* a saltmarsh plant. In 1979, it seemed to disappear and then was recorded twice in 1988 and then not again until 1997. This species is only found around the Wash and Spurn Point.
Spilogona biseriata, a muscid fly is also found on saltmarshes, feeding on algal mats of *Enteromorpha.* There are records of this species from Spurn Point and at Blacktoft Sands.
Pogonus luridipennis is a green and yellow ground beetle found in saltmarshes under seaweeds and driftwood and under strandline litter. It is rare in Britain and has declined during the twentieth century, probably due to development on coastal habitats and pollution. It is very localised and has been recorded from the saltmarshes at Spurn and between Cleethorpes and Humberston.

Coastal lagoons – *Gammarus insensibilis,* the lagoon sand shrimp is an amphipod protected under Schedule 5 of the Wildlife and Countryside Act 1981. It is a lagoonal specialist species that is almost always associated with the green alga *Chaetomorpha linum*, which may form extensive drifting mats. Within the UK, the amphipod is fairly widely distributed in lagoons along the south and east coasts of England. On the Humber, the species is found at Humberston Fitties.

13.3 Internationally important wetland, supporting a breeding colony of grey seals

The Humber Flats, Marshes and Coast qualifies as a Ramsar site under Criterion 3 because it supports a breeding colony of grey seals (*Halichoerus grypus*) on the southern edge of its distribution (see table 14).

Grey seals are amongst the rarest seals in the world and the UK population represents about 40% of the world population and 95% of the EU population. At the start of the 2000 breeding season, Great Britain held 124,000

grey seals (SCOS, 2000) and Donna Nook on the Humber Estuary holds Britain's most south-easterly breeding colony. Nationally, grey seal colonies have been growing by 6% each year since 1984, but at Donna Nook the colony grew by 21% in 2000. The most recent years count (2001), revealed the grey seal pup production at Donna Nook to be 634.

The grey seals will also utilise habitats outwith the boundary of both the European marine site and the Ramsar site, such as areas for feeding. Relevant authorities need to have regard to such adjacent European interests, as they might be affected by activities taking place within, or adjacent to the European marine site.

13.3.1 Key sub-features

Intertidal mudflats and sandflats – The intertidal flats of the north Lincolnshire coast provide an important habitat for grey seals which come ashore in Autumn to form breeding colonies. Grey seals have been breeding at Donna Nook since the early 1970s and are probably related to the Farne Island colonies.
The seal pups are conceived in the shallow waters or on the beaches in November. After one weeks development, the foetus stops growing for about 100 days. After this, it continues to develop and is born the following November. Grey seal pups are born with white coats and suckle from their mothers for two to three weeks after which the mother leaves them and goes into the shallows to mate again for next years pup.
The intertidal flats also provide an important habitat throughout the year for grey seals to haul out or rest, particularly during the spring when all grey seals, except young born the previous year, are moulting. When the tide covers the flats, the seals will spend a large proportion of their time foraging for shellfish and sandeels or resting.

The Humber Estuary is also host to small numbers of common seals, although given the large areas of potential habitat for common seals, it seems surprising that this species is not found in larger numbers (SMRU, pers com).

13.4 Internationally important wetland, regularly supporting an assemblage of waterfowl

The Humber Flats, Marshes and Coast qualifies as a Ramsar site under Criterion 5 because it regularly supports 20,000 or more waterbirds (see table 14).

13.4.1 Key sub-features

The key sub-features for the 20,000 or more waterbirds are as for the **SPA section 9.6.1**:

- Intertidal mudflats and sandflats
- Saltmarsh communities
- Tidal reedbeds
- Coastal lagoons

13.5 Internationally important wetland, regularly supporting populations of waterfowl species

The Humber Flats, Marshes and Coast qualifies as a Ramsar site under Criterion 6 because it regularly supports 1% or more of the biogeographic populations of waterfowl species (see table 14).

13.5.1 Key sub-features

The key sub-features for the populations of waterfowl species are as for the **SPA section 9.5.1**:

- Intertidal mudflats and sandflats
- Saltmarsh communities
- Tidal reedbeds
- Coastal lagoons

14. The Humber Flats, Marshes and Coast Ramsar site conservation objectives

Under Regulation 33(2)(a) of the Conservation (Natural Habitats &c.) Regulations 1994, English Nature has a duty to advise other relevant authorities as to the conservation objectives for the European marine site.
The conservation objectives for the Humber Flats, Marshes and Coast Ramsar site interest features are provided below and should be read in the context of other advice given in this package, particularly:

- the attached maps showing the extent of the sub-features;
- summary information on the interest of each of the features; and
- the favourable condition table, providing information on how to recognise favourable condition for the interest feature and which will act as a basis for the development of a monitoring programme.

14.1 Criterion 2: Conservation objective for the internationally important wetland, hosting an assemblage of threatened coastal and wetland invertebrates

Subject to natural change, maintain* **the wetland hosting an assemblage of threatened coastal and wetland invertebrates** in favourable condition[17], in particular:

- Saltmarsh communities
- Coastal lagoons

The species using these habitats are given in Table 14

14.2 Criterion 3: Conservation objective for the internationally important wetland, supporting a breeding colony of grey seals *Halichoerus grypus*

Subject to natural change, maintain* the **wetland hosting a breeding colony of grey seals** in favourable condition[17], in particular:

- Intertidal mudflats and sandflats

14.3 Criterion 5: Conservation objective for the internationally important wetland, regularly supporting 20,000 or more waterfowl

Subject to natural change, maintain* the **wetland regularly supporting 20,000 or more waterfowl** in favourable condition[17], in particular:

- Intertidal mudflats and sandflats
- Saltmarsh communities
- Tidal reedbeds
- Coastal lagoons

Number of bird species using these habitats are given in Table 14

14.4 Criterion 6: Conservation objective for the internationally important wetland, regularly supporting 1% or more of the individuals in a population of one species or sub-species of waterfowl

Subject to natural change, maintain* the **wetland regularly supporting 1% or more of the individuals in a population of one species or sub-species of waterfowl** in favourable condition[17], in particular:

- Intertidal mudflats and sandflats
- Saltmarsh communities
- Tidal reedbeds
- Coastal lagoons

Number of bird species using these habitats are given in Table 14

Note: The Ramsar site conservation objectives for **criterion 2 & 3** interest focus on the condition of the habitats that support or host species of international importance. Information on the status of the species in terms of national and international population and distribution trends will be used to inform judgements made with regards to the management and protection of the sites.

The Ramsar site conservation objectives for **criterion 5 & 6** interest focus on the condition of the habitats that support the bird populations. This is in recognition of changes in bird populations that may take place as a consequence of national or international trends or events. Annual counts for qualifying species will be used by English Nature in the context of five-year peak means together with other available information on the national and international population and distribution trends to inform judgements regarding the management and protection of the site.

17 For a detailed description of how to recognise favourable condition, see the attached table 15

* Maintain implies restoration if the feature is not currently in favourable condition.

Table 14 Information on populations of species qualifying under the Ramsar Criterion 2, 3, 5 and 6 using those parts of the Humber Flats, Marshes and Coast Ramsar site lying within the European marine site boundary, at the time the Ramsar citation was compiled

Criteria 2: Internationally important wetland hosting an assemblage of threatened coastal and wetland invertebrates

Eupithecia extensaria occidua – scarce pug moth
Gammarus insensibilis - lagoon sand shrimp
Spilogona biseriata – muscid fly
Pogonus luridipennis – ground beetle

Criterion 3: Internationally important wetland hosting a breeding colony of grey seals

Grey seal *Halichoerus grypus*

Criteria 5: Internationally important wetland regularly supporting 20,000 or more waterfowl

Importance	Population (5 yr peak mean)*	Season	Period
The Humber Estuary regularly supports 20,000 or more waterfowl	175,768 individuals	Wintering	1993/94 - 1997/98

Criterion 6: Internationally important wetland regularly supporting 1% or more of the individuals in a population of one species or sub-species of waterfowl

Species	Population (5 yr peak mean)*	Importance	Period
Ringed plover *Charadrius hiaticula*	1,357 individuals - passage	2.7 % of Europe/Northern Africa	1993 - 1997
Sanderling *Calidris abla*	1,263 individuals - passage	1.3 % E Atlantic/W & S Africa	1993 -1997
Redshank *Tringa totanus totanus*	5,117 individuals - passage	3.4 % Eastern Atlantic	1993 - 1997
Shelduck *Tadorna tadorna*	4,369 individuals - wintering	1.5 % Northwestern Europe	1993/94 - 1997/98
Golden plover *Pluvialis squatarola*	34,615 individuals - wintering	1.9% Northwestern Europe	1993/94 - 1997/98
Grey plover *Pluvialis squatarola*	1,667 individuals - wintering	1.1 % Eastern Atlantic	1993/94 - 1997/98
Lapwing *Vanellus vanellus*	33,635 individuals - wintering	1.7 % Europe	1993/94 - 1997-98
Knot *Calidris canutus islandica*	28,060 individuals - wintering	8.0 % NE Can/Grl/Iceland/NW Eur	1993/94 - 1997/98
Dunlin *Calidris alpina alpina*	20,325 individuals - wintering	1.5 % N Siberia/Europe/W Africa	1993/94 - 1997/98

Bar-tailed godwit *Limosa lapponica*	1,780 individuals - wintering	1.8% Western Palearctic	1993/94 - 1997/98
Redshank *Tringa totanus totanus*	4,284 individuals - wintering	2.9 % Eastern Atlantic	1993/94 - 1997/98

* Ramsar citation (**April 2000**) held on Register of European marine sites for Great Britain.

15.

Table 15 Favourable Condition Table for Humber Flats, Marshes and Coast Ramsar site interest features of the Humber Estuary European marine site

Species using these habitats are given in Table 14.

NB – It will be possible to monitor many of the attributes at the same time or during the same survey. The frequency of sampling for many attributes may need to be greater during the first reporting cycle in order to characterise the site and establish the baseline.

Criterion	Sub-feature	Attribute	Measure	Target	Comments
Criterion 2: Internationally important wetland hosting an assemblage of threatened coastal and wetland invertebrates	All sub-features	Extent of habitat	Area (ha), measured once per reporting cycle.	No significant decrease in extent from an established baseline[18], subject to natural change.	The habitats provide important feeding sites and cover for the invertebrate species.
Criterion 3: Internationally important wetland hosting a breeding colony of grey seals	Intertidal mudflats and sandflats	Extent of habitat	Area (ha) measured once per reporting cycle.	No significant decrease in extent from an established baseline[18], subject to natural change	The intertidal flats at Donna Nook are an important breeding and haul-out site for grey seals
		Disturbance	Reduction, displacement and productivity of grey seals, measured periodically using average count information (frequency to be determined)	No significant reduction in seal numbers, productivity or displacement of seals attributable to human disturbance from an established baseline[18], subject to natural change.	Excessive disturbance can cause stress to both adults and pups and result in reduced food intake and/or increased energy expenditure. Disturbance in breeding areas may result in a reduced pup production.

Criterion 5: Internationally important wetland regularly supporting 20,000 or more waterfowl	Intertidal mudflats and sandflats	For information on the favourable condition of intertidal mudflats and sandflats see Humber Flats, Marshes and Coast SPA favourable condition table
	Saltmarsh communities	For information on the favourable condition of saltmarsh communities see Humber Flats, Marshes and Coast SPA favourable condition table
	Tidal reedbeds	For information on the favourable condition of tidal reedbeds see Humber Flats, Marshes and Coast SPA favourable condition table
	Coastal lagoons	For information on the favourable condition of coastal lagoons see Humber Flats, Marshes and Coast SPA favourable condition table
Criterion 6: Internationally important wetland regularly supporting 1% or more of the individuals in a population of one species or sub-species of waterfowl	Intertidal mudflats and sandflats	For information on the favourable condition of intertidal mudflats and sandflats see Humber Flats, Marshes and Coast SPA favourable condition table
	Saltmarsh communities	For information on the favourable condition of saltmarsh communities see Humber Flats, Marshes and Coast SPA favourable condition table
	Tidal reedbeds	For information on the favourable condition of tidal reedbeds see Humber Flats, Marshes and Coast SPA favourable condition table
	Coastal lagoons	For information on the favourable condition of coastal lagoons see Humber Flats, Marshes and Coast SPA favourable condition table

[18] Baselines to be determined during the first reporting cycle.

NB: Extreme events (such as storms reducing or increasing salinities or warm summers) also need to be recorded as they may be critical in influencing ecological issues in the Humber Estuary European marine site and may well be missed by routine monitoring.

16. Detailed operations advice for the Humber Flats, Marshes and Coast Ramsar site interest features

This section provides information to help relate general advice to each of the specific interest features of the Ramsar site.

This advice relates to the vulnerability of the interest features and sub-features of the Ramsar site within the Humber Estuary European marine site boundary as summarised in Table 2 and set out in more detail in Tables 16 and 17. An explanation of the sensitivity of the interest features or sub-features follows with an explanation of their exposure and therefore their vulnerability to damage or disturbance from the listed categories of operations. This enables links between the categories of operation and the ecological requirements of the European marine site's interest features, as set out in Section 13, to be made.

The categories of operation may cause damage or disturbance to the interest features and sub-features of the Humber Estuary European marine site, either alone or in combination.

- The Humber Flats, Marshes and Coast qualifies as a Ramsar site for supporting an assemblage of threatened coastal and wetland invertebrate species. The conservation objectives for these invertebrates focus on the condition of the habitats that support or host the species. The habitats identified as being of importance for the invertebrates, occurring within the European marine site are **saltmarsh communities** and **coastal lagoons**. For detailed operations advice on these habitats, please see the advice under section 12.

i) Physical loss

- The intertidal flats of Donna Nook are an important habitat for the grey seal colony. Each year large numbers of female grey seals come ashore from October to January to give birth. They have been breeding here since the early 1970s and the colony has grown each year. The intertidal flats are also important for hauling out and resting at other times of the year. The loss by removal or smothering of these habitats or part of habitats may affect the suitability of Donna Nook for the breeding colony of grey seals. Currently, the exposure of the intertidal flats to removal or smothering was determined to be low, however, the high sensitivity score to removal results in a moderate vulnerability.

ii) Physical damage

- It was determined that the intertidal flats at Donna Nook were highly exposed to abrasion due to the large number of visitors coming onto the site and the use of four wheel drive vehicles and quad bikes in the outer estuary.

- The use of netting to catch fish sometimes results in the accidental release of large nets into the marine environment. Seals may become entangled in these nets and may drown directly; or smaller pieces of netting may restrict normal swimming and diving activity, and therefore reduce the ability of the seal to hunt for food. Entanglement may also increase drag and therefore increase energy expenditure. There is very little netting used in the Humber Estuary, and so any entanglement is likely to result from the seals travelling to other locations where nets are used, or from lost nets being carried by currents.
  Seals are also sensitive to other forms of debris, such as small plastic fragments that may be ingested, or plastic packing bands that may get caught around a seal's neck. If this occurs whilst the seals are still growing, they could eventually die from strangulation or from infected wounds. On the Humber, entanglement in netting and plastic debris is not believed to be a problem, although it does occur infrequently and therefore the exposure was determined to be low.

iii) Non-physical disturbance

- Grey seals are highly sensitive to both noise and visual disturbance. Although there is evidence that they can become habituated to human presence, unfamiliar or sudden noises or movements may cause disturbance and can displace seals from their haul-out sites or breeding grounds. Seals affected by such disturbance may move to an alternative and perhaps less favourable site, or increase their energy intake through stress.
  Female seals are particularly susceptible to disturbance during pupping, and disturbing nursing pups can result in poor condition and low weaning weights. This is likely to have an adverse effect on the pups' survival rates, especially as up to 60% are thought to die in their first year under normal conditions. Disturbance at haul-out sites, which are important for resting, sleeping and skin maintenance, can also lead to increased energy expenditure.

- Donna Nook attracts up to 45,000 visitors a year and many of these come to see the grey seal colony. The site is owned by the Ministry of Defence and is managed jointly by them and Lincolnshire Wildlife Trust. Whilst regular commercial boat traffic and controlled seal watching is not currently considered to be a problem, irregular disturbance for example, uncontrolled approaches made to the seals by people or dogs, or recreational activities may have an adverse effect on the seal colony. There have been infrequent reports of seals being found with propeller marks in their heads, and it is suspected that these have resulted from jet skis. The time of year the breeding seals use the site is likely to keep recreational disturbances to a minimum, although the colony also uses Donna Nook at other times of the year as a haul out and moulting site. A low fence has also been installed to keep visitors away from the breeding colony of seals.

- The grey seals are in close proximity to both land based and water based activities and the Ministry of Defence bombing range, which is used throughout the week. However, the Ministry of Defence have modified their activities to take account of the seals using the site. For example, during the breeding season, seals often encroach onto the bombing range and the targets have to be declared unusable. The seals also appear to have habituated to the MoD's current activities (Squadron Leader Jones pers com).
  Donna Nook was declared a National Nature Reserve in July 2002. It is currently very well managed and the seal colony appears to be suffering no adverse effects - numbers at the colony grew by 21% in 2000, whereas nationally grey seal rookeries are growing by 6% a year. However, noise and visual disturbance should be kept under review, especially if changes in on-site activities or management measures were to occur.

- The adult grey seals also spend a large proportion of their time in the waters offshore; therefore regard should be given to the potential to disturb the seals whilst they are in the waters or coming ashore, particularly those with nursing pups.

iv) Toxic contamination

- Grey seals can be exposed to toxic contaminants through many routes, including uptake through the skin and ingestion of water and food, although the primary exposure route is likely to be via food intake. The grey seals at Donna Nook will feed offshore on species such as cod, sand eels and shellfish and may pick up contaminants such as organochlorines. Many toxic contaminants are thought to bioaccumulate in marine mammals with known sub-lethal toxicological effects. Certain synthetic compounds are also believed to be endocrine disruptors, posing a potential hazard for the local populations of grey seals or their prey species (WRc, 1999). Toxic contaminants that have accumulated in the blubber may be released into the seal's body when the animal is stressed or when its fat reserves are in demand. Here, they may cause damage to tissues, hormone balance and the immune system (SMRU website).
  In the UK, both grey and common seals have been found to have high levels of pollutants, especially fat-soluble organochlorine compounds such as DDT and industrial polychlorinated biphenyls (PCBs), which accumulate in the blubber. There is also evidence that the accumulation of chemicals such as PCBs in marine mammals can lead to lowered reproductive capacity (Reijnders, 1986) and may suppress the immune system, making them more susceptible to death from infectious diseases (de Swarl *et al*., 1994). It is probable that the grey seals at Donna Nook are exposed to low levels of organochlorides and other

toxic contaminates, as data from Cole *et al*., (1999) recorded positive levels of DDT, PCBs and HCBs in shellfish collected in the Humber Estuary. Therefore, although the exposure to the introduction of synthetic and non-synthetic compounds is considered to be low, the grey seals are currently moderately vulnerable to toxic contamination.

vi) Biological disturbance

- In 1988, seals around the UK coast were subject to an outbreak of the phocine distemper virus, which is thought to have killed 18,000 common seals or half the northern European total. Although no large-scale mortality was observed in grey seals (400 were believed to have died), pup production in 1988 and 1989 was lower than expected. This may have been caused by a temporary effect of PDV on grey seal reproduction (DEFRA website). During this phocine distemper virus outbreak, a local vet carried out research on grey and common seals at Donna Nook. The results showed that the seals were carrying very high burdens of a wide range of sewage derived infections, which led to depressed immune systems. In turn, this also led to unusually high parasitic burdens (Graham Weaver, pers com). Since this time the sewage outfalls in the UK have been cleaned up and so it would be useful to have further work done on the seals at Donna Nook.
  Phocine distemper virus returned to Denmark in May 2002 and has killed thousands of seals in Denmark, Sweden and Norway. Holland and northern France have also been affected. The highly infectious virus cannot be treated, it attacks the seals' immune system and leaves them vulnerable to infection. PDV was identified in the UK seal population in August, and recent figures (November 2002) estimate that it has killed 3,285 seals around the UK, at least 370 are thought to be grey seals (DEFRA, pers com).
  Although the exposure of the grey seals to this virus is low, their high sensitivity to infections, results in a moderate vulnerability score.

- The Humber Flats, Marshes and Coast qualifies as a Ramsar site for regularly supporting 20,000 or more waterbirds and 1% or more of the biogeographic population of waterfowl species. These criteria are identical to the Special Protection Area interest features; **an assemblage of waterfowl** and **internationally important migratory species**. For detailed operations advice on these features, please see the advice under section 12.

Table 16 Assessment of the relative exposure of interest features and sub-features of the Humber Estuary European marine site (Ramsar & pRamsar) to different categories of operations (as at July 2002)

Key: **High** = High exposure **Med** = Medium exposure **Low** = Low exposure **None** = No exposure

Categories of operations which may cause deterioration or disturbance	Ramsar Interest Features						
	Criterion 2: Assemblage of threatened coastal and wetland invertebrates		Criterion 3: Breeding colony of grey seals	Criterion 5: Regularly supports 20,000 or more waterfowl species Criterion 6: Regularly supports 1% or more of a species or sub-species of waterfowl			
	Saltmarsh communities	Coastal lagoons	Intertidal mudflats and sandflats	Intertidal mudflats and sandflats	Saltmarsh communities	Reedbeds	Lagoons
Physical Loss							
Removal (eg land claim, dredging)	**For information on these sub-features, see the assessments made under the SPA sub-features**		**Low**	**For information on these sub-features, see the individual assessments made under the SPA interest feature sections:** **- Internationally important migratory species and waterfowl assemblage**			
Smothering (eg depositing dredge spoil, beach feeding)			**Low**				
Physical Damage							
Siltation (eg dredging, outfalls)			**Low**				
Abrasion (eg recreational activity, vehicles)			**High**				
Selective extraction (eg aggregate extraction)			**Low**				
Non-physical disturbance							
Noise (eg land/water-based recreation, marine traffic)			**High**				
Visual presence (eg land/water-based recreation, marine traffic)			**High**				
Toxic contamination							
Introduction of synthetic compounds (eg TBT, PCBs)			**Low**				
Introduction of non-synthetic compounds (eg effluent outfalls, crude oil)			**Low**				
Introduction of radionuclides			**Low**				
Non-toxic contamination							
Changes in nutrient loading (eg agricultural run-off, effluent outfalls)			**Med**				

Changes in organic loading (eg effluent outfalls, aquaculture)	**For information on these sub-features, see the assessments made under the SPA sub-features**	**Med**	**For information on these sub-features, see the individual assessments made under the SPA interest feature sections:** **- Internationally important migratory species and waterfowl assemblage**
Changes in thermal regime (eg power station discharges)		**Low**	
Changes in turbidity (eg effluent outfalls, dredging, depositing dredged spoil)		**Low**	
Changes in salinity (eg water abstraction, effluent outfalls)		**Low**	
Biological disturbance			
Introduction of microbial pathogens (eg effluent outfalls)		**Low**	
Introduction of non-native species and translocation		**Low**	
Selective extraction of species (eg samphire picking, bait collection)		**Low**	

Table 17 Assessment of the relative vulnerability of interest features and sub-features of the Humber Estuary European marine site (Ramsar & pRamsar) to different categories of operations

Shading indicates categories of operation to which the features or sub-features of the site are highly or moderately vulnerable to. This table also incorporates the relative sensitivity scores, used in part to derive vulnerability[19].

Key:

	High vulnerability
	Moderate vulnerability

●●●●	High sensitivity
●●●	Moderate sensitivity
●●	Low sensitivity
●	No detectable sensitivity

Categories of operations which may cause deterioration or disturbance	Ramsar Interest Features						
	Criterion 2: Assemblage of threatened coastal and wetland invertebrates		Criterion 3: Breeding colony of grey seals	Criterion 5: Regularly supports 20,000 or more waterfowl species Criterion 6: Regularly supports 1% or more of a species or sub-species of waterfowl			
	Saltmarsh communities	Coastal lagoons	Intertidal mudflats and sandflats	Intertidal mudflats and sandflats	Saltmarsh communities	Reedbeds	Lagoons
Physical Loss Removal (eg land claim, dredging) Smothering (eg depositing dredge spoil, beach feeding)	**For information on these sub-features, see the assessments made under the SPA sub-features**		●●●● ●●	**For information on these sub-features, see the individual assessments made under the SPA interest feature sections:** **- Internationally important migratory species and waterfowl assemblage**			
Physical Damage Siltation (eg dredging, outfalls) Abrasion (eg recreational activity, vehicles) Selective extraction (eg aggregate extraction)			● ● ●●●				
Non-physical disturbance Noise (eg land/water-based recreation, marine traffic) Visual presence (eg land/water-based recreation, marine traffic)			●●●● ●●●●				
Toxic contamination Introduction of synthetic compounds (eg TBT, PCBs) Introduction of non-synthetic compounds (eg effluent outfalls, crude oil) Introduction of radionuclides			●●●● ●●●● ●●				

Non-toxic contamination Changes in nutrient loading (eg agricultural run-off, effluent utfalls) Changes in organic loading (eg effluent outfalls, aquaculture) Changes in thermal regime (eg power station discharges) Changes in turbidity (eg effluent outfalls, dredging, depositing dredged spoil) Changes in salinity (eg water abstraction, effluent outfalls)	**For information on these sub-features, see the assessments made under the SPA sub-features**	● ● ● ● ●	**For information on these sub-features, see the individual assessments made under the SPA interest feature sections:** **- Internationally important migratory species and waterfowl assemblage**
Biological disturbance Introduction of microbial pathogens (eg effluent outfalls) Introduction of non-native species and translocation Selective extraction of species (eg samphire picking, bait collection)		●●●● ● ●●	

[19]English Nature's advice on operations is derived from an assessment combining relative sensitivity of the features or sub-features with information on human usage of the site (as at July 2002), to identify relative vulnerability to categories of operations. In accordance with Government policy guidance this advice is provided in the light of current activities and patterns of usage at the site. It is important therefore that future consideration of this advice by relevant authorities, and others, takes account of changes in the usage patterns at the site. In contract the sensitivity of interest features, or sub-features, is relatively stable with alterations reflecting improvement in our scientific knowledge and understanding. To this end, information on sensitivity has been included in this table to assist the management and advisory groups with the future management of the site.

17 Bibliography

ABP RESEARCH & CONSULTANCY LTD. 1999. Natura 2000: *Good practice guidelines for ports and harbours operating within or near UK European marine sites.* UK Marine SACs Project.

ABP RESEARCH AND CONSULTANCY 2001, "*Immingham Outer Harbour Environmental Statement*" Report No R.903.

ALERSTAM, T. 1990. *Bird migration*. Cambridge University press. Cambridge.

ALLEN, J., BOYES, S., BURDON, D., CUTTS, N., HEMINGWAY, K., JARVIS, S., JENNINGS, K., MANDER, L., MURBY, P., PROCTOR, N., THOMSON S. & WARREN, R. 2003. *Humber Data Review* English Nature Research Report

ALLEN, Y., HURRELL, V.,JONES, C.,REED, J., MATTHIESSEN, P. 2000. *Endocrine disruptors and European marine sites in England*. CEFAS report.

ANON. 1994. *The Conservation (Natural Habitats, &c.) Regulations*. Statutory Instrument No. 2716.

ANON. 1995. *Biodiversity: The UK Steering Group Report. Vol 1: Meeting the Rio Challenge*. Vol 2: Action Plans. London: HMSO

ANON. 1999. Natura 2000: *A review of the effects of fishing within UK European marine sites.* UK Marine SACs Project.

BAMBER, R.N. 1992 *The ecology of brackish water lagoons in Great Britain* In Aquatic Ecology, 2, pp65-94

BAMBER, R.N. 1997 *Assessment of saline lagoons within Special Areas of Conservation* English Nature Research Reports No. 235

BAMBER, R.N., BARNES, R.S.K 1995. Chapter 3.4 Coastal Lagoons. *In: Coasts and seas of the United Kingdom. Region 6 Eastern England: Flamborough Head to Great Yarmouth,* ed. By J.H. Barne, C.F. Robson, S.S. Kaznowska, J.P. Doody & N.C. Davidson, 63-66. Peterborough, Joint Nature Conservation Committee.

BAMBER, R.N., GILLILAND, P.M. & SHARDLOW, M.E.A. 2001. *Saline lagoons: a guide to their management and creation (interim version)*. Peterborough, English Nature.

BILLINGS, I., Cutts, N., Boyes, S. 2002 *Humber Estuary Biodiversity Action Plan (draft).* Institute of Estuarine and Coastal Studies

BINNIE BLACK & VEATCH, 2001. *Scoping report and brief for the Humber CHaMP.* Environment Agency

BROWN, A.E., BURN, A.J., HOPKINS, J.J., WRAY, S.F. 1997. *The Habitats Directive: Selection of Special Areas of Conservation in the UK*. JNCC Report No. 270.

BUCK, A.L. 1997. *An inventory of UK estuaries. Volume 5*. Eastern England. Peterborough, Joint Nature Conservation Committee

BULLEN CONSULTANTS, 2002. *National Vegetation Classification (NVC) of the Humber Estuary*. Report to English Nature.

BURD, F. 1989 Research and survey in nature conservation, No. 17 *The saltmarsh survey of Great Britain. An inventory of British saltmarshes*. Peterborough, Nature Conservancy Council

BURGESS, N.D., & HIRONS, G.J.M. 1992. *Creation and management of artificial nesting sites for wetland birds.* Journal of Environmental Management 34(4), 285-295.

CATLEY, G. 2000. *Humber Estuary Wetland Bird Survey Twelve months of high and low tide counts September 1998 to August 1999*. Parts one and two. English Nature Research Report 339.

CAYFORD, J. 1993. *Wader disturbance: a theoretical overview.* Wader Study Group Bull. 68 (special issue)

CLARK, R.B., 1989. *Marine Pollution* (2nd edn). Clarenden Press, Oxford.

COLE, S.,CODLING, I.D., PARR, W., ZABEL, T. 1999. Natura 2000: *Guidelines for managing water quality impacts within UK European marine sites*. UK Marine SACs Project.

CRAMP, S., BOURNE, W.R.P., SAUNDERS, D. 1974. *The seabirds of Britain and Ireland.*

CRANSWICK ,P., POLLITT, M., MUSGROVE, A., & HUGHES, B. 1999. *The Wetland Bird Survey 1997-98 Wildlife and Wader Counts*. British Trust for Ornithology, WWT, RSPB & JNCC.

DARGIE, T., 2002. *An NVC Suvey of the North Lincolnshire Coast SSSI*. Peterborough: English Nature.

DAVISON, D.M, HUGHES, D.J. 1998. *Zostera Biotopes (volume I). An overview of dynamics and sensitivity characteristics for conservation management of marine SACs*. Scottish Association for Marine Science (UK Marine SACs Project).

DAVISON, N.C. & ROTHWELL, P.I. 1993. *Human disturbance to waterfowl on estuaries: conservation and coastal management implications and current knowledge*. Wader Study Group Bull. 68.

DE SWART, R.L., ROSS, P.S., VOS, J.G., and OSTERHAUS, A.D.M.E. 1996. *Impaired immunity in harbour seals Phoca vitulina exposed to bioaccumulated environmental contaminants: review of a long-term study.* Environmental Health Perspective. **104** (suppl. 4): 823-828. (In Covey, R. & Laffoley, D.d'A. 2002. *Maritime State of Nature Report for England: getting onto an even keel.* Peterborough, English Nature)

DE SWART, R.L., ROSS, P.S., VEDDER, L. TIMMERMAN, H.H., HEISTERKAMP, S., VAN LOVEREN, H., REIJNDERS, P.J.H. & OSTERHUAS, A.D.M.E. 1994 *Impairment of immune function in harbour seals (Phoca vitulina) feeding on fish from polluted waters*. **Ambio** 23: 155-159

DEFRA WEBSITE www.defra.gov.uk

DETR & THE WELSH OFFICE. 1998. *European marine sites in England and Wales. A guide to the Conservation (Natural Habitats & c.) Regulations 1994 and to the preparation and application of management schemes.* London.

DREWITT, A. 2000. *Bait-digging and birds*. English Nature Birds Network Information Note

DREWITT, A. 2000. *The effects of artificial lights on birds*. English Nature Birds Network Information Note

DUNCAN, K. 1992 *Campaign for a living sea. An introduction to England's marine wildlife*. English Nature

ELLIOTT, M., NEDWELL, S., JONES, N .V, READ S.J, CUTTS N.D., HEMINGWAY KL 1998. *Intertidal sand and mud flats and subtidal mobile sandbanks (volume II). An overview of dynamics and sensitivity characteristics for conservation management of marine SACs*. Scottish Association for Marine Science (UK Marine SACs Project).

ENGLISH NATURE. 1998. *Advice on European marine sites: some common questions answered*. Peterborough.

EN, SNH, EHS(DOE(NI)), CCW, JNCC & SAMS. 1998. Natura 2000: *European marine sites: Guidance relating to statutory conservation objectives and operations which may cause deterioration or disturbance*. Peterborough.

ENO, C. 1991. *Marine Conservation Handbook* . English Nature. Peterborough

ENTEC UK LIMITED 2002 Environment Agency Anglian region – *Hydro-ecological review of selected European sites within the Agency's Anglian Region*. The Grues SSSI

ENVIRONMENT AGENCY, 1998. *Strategic studies, shoreline management plan, geomorphology review. The Humber estuary tidal defence strategy*. Environment Agency.

ENVIRONMENT AGENCY, 2000. *Planning For The Rising Tides. The Humber Estuary Shoreline Management Plan*. September 2000.

EU COMMISSION. 25 April 1996. *Interpretation Manual of European Union Habitats*

EVANS, A. 1987. *Relative availability of the prey of wading birds by day and by night*. Marine Ecology Progress Series 37:103-107.

FARREL, P. 1999. Environmental impact of bait-digging: effects on the infauna and epifauna of Chichester Harbour. Unpublished report.

FOWLER, S. E. 1999. *Guidelines for managing the collection of bait and other shoreline animals within UK European marine sites*. English Nature UK Marine SACs Project.

GRIEVE, A. 1999 *Read's Island Management Plan* RSPB

HEILIGENBERG, T. VAN DEN, 1987. Effects of mechanical and manual harvesting of lugworms *Arenicola marina* on the benthic fauna of tidal flats in the Dutch Wadden Sea. *Biological Conservation* 39: 165-179.

HILL, D. 1990. *The impact of noise and artificial light on waterfowl behaviour: a review and synthesis of available literature.* BTO Research Report 61. British Trust for Ornithology. Thetford.

HIRST, A. 1997 *The Humber Estuary Natural Area.* English Nature

HISCOCK, K., ed. 1996. Marine Nature Conservation Review: rationale and methods. Peterborough, Joint Nature Conservation Committee.

HOLT, T.J., JONES, D.R., HAWKINS, S.J., HARTNOLL, R.G. 1995. *The sensitivity of marine communities to man-induced change - a scoping report*. CCW Contract Science Report no.65.

IECS, 1994. *Humber estuary and coast.* Hull: Institute of Estuarine and Coastal Studies, University of Hull. *A report to Humberside County Council.*

IECS 1987 *The Humber Estuary. Environmental Background,* Shell UK Ltd

JOHNS, M. *A survey of English Rivers for Lamprey*. APEM Ltd

JOHNS, M. 2002 Lamprey: relicts from the past in British Wildlife August 2002. P381-388

JONES, N.V., ELLIOT, M., HEMINGWAY, K.L., ALLEN, J., PROCTOR, N. 2000 *The Humber Estuary – An Environmental Assessment*, IECS

JONES, L.A., HISCOCK, K., CONNOR, D.W. 2000. Marine Habitat Reviews. *A summary of ecological requirements and sensitivity characteristics for the conservation and management of marine SACs* Peterborough , Joint Nature Conservation Committee.

JONES, N.J., (EDITOR) 1988 A DYNAMIC ESTUARY: MAN, NATURE AND THE HUMBER HULL UNIVERSITY PRESS

KEY, R.S., 1983. *Ecology of Spurn Bight mudflats: an area proposed for reclamation*. Ph.D. Dissertation, University of Hull.

KOOLHAAS, A., DEKINGA, A & PIERSMA, T. 1993. *Disturbance of foraging knots by aircraft in the Dutch Wadden sea in August-October 1992.* Wader study group bull 68 (special issue)

LANGFORD, T.E., HAWKINS, S.J. BRAY, S. HILL, C., WELS, N. & YANG, Z. 1998. *Pembroke Power station: impact of cooling water discharge on the marine biology of Milford Haven*. Report No. UC285 by the aquatic and coastal ecology group, Geodata institute, University of Southampton for the Countryside Council for Wales

MAITLAND, P.S. 1997 *Species Action Plans for Lampreys in England.* A Report to English Nature.

MCLEOD, CR, YEO, M, BROWN, AE, BURN, AJ, HOPKINS, JJ, & WAY, SF (eds.) (2001) *The Habitats Directive: selection of Special Areas of Conservation in the UK*. 2nd ed. *JNCC Repor*t.

McLUSKY, D.S., ANDERSON, F.E & WOLFE-MURPHY, S. 1983. Distribution and population recovery of *Arenicola marina* and other benthic fauna after bait-digging. *Marine Ecol. Progr. Ser.* 11: 173-9.

MOUNCEY, D. 1997 *Read's Island Saline Lagoon Project* Environment Agency

MURBY, P.J., 2001. *The Causes, Extent and Implications of Intertidal Change - a regional view from eastern England.* MSc Dissertation. Hull: University of Hull.

POLLITT M.S., CRANSWICK, P.A., MUSGROVE, A.J., HALL, C., HEARN, R.D., ROBINSON, J.A. AND HOLLOWAY, S.J. 2000 *The Wetland Bird Survey 1998-1999: Wildfowl and Wader Counts*. BTO/WWT/RSPB/JNCC, Slimbridge

PROCTOR, N. & MUSK, W., 2001. *Fish Impingement Assessment: South Humber Bank Power Station 2000-2001.* Hull: Institute of Estuarine and Coastal Studies (IECS), University of Hull. Report Number Z109-F-2001. Final Report to Humber Power Limited.

PROCTOR, N., ELLIOTT, M. & ALLEN, J., 2000. *Fish Impingement Assessment: South Humber Bank Power Station 1999-2000.* Hull: Institute of Estuarine and Coastal Studies (IECS), University of Hull. Report Number Z096-F1-2000. Final Report to Humber Power Limited.

RAVENSCROFT, N.O.M. 1997 *The distribution of wintering waterfowl around freshwater flows over the mudflats of the Orwell Estuary*

RAVENSCROFT, N.O.M. 1998 *Associations of wintering waterfowl with freshwater on the mudflats of East Anglian estuaries*

REIJNDERS, P.J.H 1986. *Reproductive failure in common seals feeding on fish in polluted coastal waters*. **Nature** 324: 456-457

RIFE. 2000. *Radioactivity in Food and the Environment*, 1999. Food Standards Agency & SEPA.

RODWELL, J. S. (ed) 2000 *Maritime Communities and vegetation of open habitats. British Plant Communities* Volume 5

RULE, I, 1996, *The sport, recreation and access topic paper for the Humber Estuary Management Strategy*

RSPB BIRD RECORDS Various years

SEA MAMMAL RESEARCH UNIT WEBSITE www.smub.st-and.ac.uk/

SEATON R. 2001 *Survey of Humberstone Fitties Lagoon (part of RSPB Tetney Marshes Reserves)*

SIDAWAY, R. 1990. *Birds and walkers. A review of existing research on access to the countryside and disturbance to birds*. Ramblers Association.

SMIT, C.J. & VASSER, G.J.M. 1993. *Effects of disturbance on shorebirds: a summary of existing knowledge from the Dutch Wadden Sea and Delta area* . Wader study group bull. 68 (special issue)

SNOW, D.W., PERRINS, C.M., GILLMOR, R., HILLCOAT, B., ROSELAAR, C.S., VINCENT, D., WALLACE, D.I.M., WILSON, M.G. 1998 *The Birds of the Western Palearctic* Concise Edition Volume I Non-Passerines Oxford University Press

SNH, EN, EHS(DOE(NI)), CCW and JNCC. 1997. *Natura 2000: European marine sites: an introduction to management*. Perth.

STOCK, M. 1993. *Studies on the effects of disturbances on staging Brent Geese: a progress report.* Wader Study Group Bull. 68 (special issue)

TOFT, A.R., PETHICK, J.S., BURD, F., GRAY, A.J., DOODY J.P.& PENNING-ROSWELL ,E. 1995. *A Guide to the Understanding and Management of Saltmarshes* (produced by Sir William Halcrow and Partners Ltd. and commissioned by the National Rivers Authority).

TOWNEND, I., PETHICK, J.S., BALSON, P., ROBERTS, W. & YOUNG, R., 2000. The geomorphology of the Humber estuary. *In*: *Proceedings of the 35th MAFF Conference of River and Coastal Engineers,* Keele.

WILDLIFE TRUSTS *Natural world*. The magazine of The Wildlife Trusts. No. 62 Summer 2001

WORSFOLD, T. 2001 *North Lincolnshire Coast survey of potential saline lagoons*. Unicomarine.

WRc (Water Research Centre). 1999. *Guidelines for Managing Water Quality Impacts within UK European Marine Sites.*

18. Glossary

Abrasion	The process of scraping or wearing down by friction
Advisory Group	The body of representatives from local interests, user groups and conservation groups, formed to advise the management group
Algal bloom	A massive reproduction and growth of algae, often free-floating, in response to the presence of higher than normal levels of nutrients.
Annex 1 birds	Bird species listed on Annex 1 of the Birds Directive. These are in danger of extinction, are rare, or are considered vulnerable within the European Union. Those that regularly occur at levels over 1% of the national population meet the SPA qualifying criteria.
Annex I habitat type(s)	A natural habitat(s) listed in Annex I of the Habitats Directive for which Special Areas of Conservation can be selected.
Annex II species	A species listed in Annex II of the Habitats Directive for which Special Areas of Conservation can be selected.
Anthropogenic	Produced by human activity.
Assemblage	A collection of plants and/or animals characteristically associated with a particular environment but not necessarily interdependent.
Attribute	Characteristic of an interest feature/sub-feature, which provides an indication of the condition of the feature or sub-feature to which it applies.
BAP	Biodiversity Action Plan.
Baseline	A standard or value from which it is possible to determine any deviation in the integrity of the interest features for which the site has been designated.
Benthos	Those organisms attached to, or living on, in or near, the seabed, including that part which is exposed by tides.
Bioaccumulation	The ability of organisms to retain and concentrate substances from their environment. The gradual build-up of substances in living tissue, usually used in referring to toxic substances, may result from direct absorption from the environment or through the food chain.
Biodegradation	Breakdown or decomposition by bacteria or other biological means.
Biodiversity	Biological diversity - the total variety of life on earth. This includes diversity within species, between species and of ecosystems.
Biogeographic region	A region which is separated from adjacent regions by barriers or a change in environmental conditions which limits the movement of species or prevents their establishment outside their natural geographical range.
Biomagnification	Increasing concentrations of a substance in successive trophic levels of a food chain.
Biomass	The total quantity of living organisms in a given area.

Biotope	The physical habitat with its biological community; a term which refers to the combination of physical environment and its distinctive assemblage of conspicuous species.
Bioturbation	The mixing of a sediment by the burrowing, feeding or other activity of living organisms.
Characteristic	Special to, or especially abundant in, a particular situation or biotope. Characteristic species should be immediately conspicuous and easily identified.
Chart datum	Approximately the lowest tidal level due to astronomical effects, and excluding meteorological effects.
Circalittoral	The rocky subtidal zone dominated by animals and below that which is dominated by algae (Animal dominated subtidal zone).
Community	A group of organisms occurring in a particular environment, presumably interacting with each other and with the environment, and identifiable by means of ecological survey from other groups.
Competent authority	Any Minister, government department, public or statutory undertaker, public body or person holding a public office that exercises legislative powers.
Conservation objective	A statement of the nature conservation aspirations for a site, expressed in terms of the favourable condition that we wish to see the species and/or habitats for which the site has been selected to attain. Conservation objectives for European marine sites relate to the aims of the Habitats Directive.
Crustaceans	A class of invertebrates that include crabs, shrimps and barnacles.
Diversity	The richness of different types in a location, including the number of different biotopes and numbers of species.
Epifauna	Animals living on the surface of sediments or hard substrates.
Eulittoral	The main part of the intertidal zone characterised by limpets, barnacles, mussels, fucoid algae and with red algae often abundant on the lower part.
European marine site	A European site (SAC or SPA) which consists of, or in so far as it consists of, marine areas.
Eutrophication	The over-enrichment of an aquatic environment with inorganic nutrients, especially nitrates and phosphates, often anthropogenic (e.g. sewage, fertiliser run-off), which may result in stimulation of growth of algae and bacteria, and can reduce the oxygen content of water.
Exposure	The relative extent and intensity of the effects of broad categories of human activities currently occurring on the site to which the interest features or their component sub-features on the site are subject.
Fauna	Animal life in an area.
Favourable conservation status	A range of conditions for a natural habitat or species at which the sum of the influences acting upon that habitat or species are not adversely affecting its distribution, abundance, structure or function throughout the biogeographic region in the long term. The condition in which the habitat or species is capable of sustaining itself on a long-term basis.

Favourable condition	A range of conditions for a natural habitat or species at which the sum of the influences acting upon that habitat or species are not adversely affecting its distribution, abundance, structure or function within an individual Natura 2000 site in the long term. The condition in which the habitat or species is capable of sustaining itself on a long-term basis.
Habitat	The place in which a plant or animal lives.
Habitats Directive	The abbreviated term for *Council Directive 92/43/EEC of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora*. It is the aim of this Directive to promote the conservation of certain habitats and species within the European Union.
Halophytic	Plants which thrive in, or tolerate the presence of saline conditions.
Highest Astronomical Tide	The highest tidal level that can be predicted to occur under average meteorological conditions and in any combination of astronomical conditions.
Hydrodynamic regime	The particular conditions of water movement at one particular site, including wave action, tidal streams and residual currents.
Infauna	Benthic animals that live within the seabed.
Infralittoral	The subtidal zone in which upward facing rocks are dominated by erect algae, typically kelps.
Interest feature	A natural or semi-natural feature for which a European site has been selected. This includes any Habitats Directive Annex I habitat, or any Annex II species and any population of a bird species for which an SPA has been designated under the Birds Directive.
Littoral	The area of the shore that is occupied by marine organisms which are adapted to or need alternating exposure to air and wetting by submersion, splash or spray. Also called intertidal.
Maintain	The action required for an interest feature when it is considered to be in favourable condition.
Management group	The body of relevant authorities formed to manage the European marine site.
Management scheme	The framework established by the relevant authorities at a European marine site under which their functions are exercised to secure, in relation to that site, compliance with the requirements of the Habitats Directive.
Molluscs	Soft-bodied unsegmented invertebrate animals usually with shells and includes cockles, whelks, limpets, oysters and snails.
Nationally scarce/rare	For marine purposes, these are regarded as species of limited national occurrence
Natura 2000	The European network of protected sites established under the Birds Directive and the Habitats Directive
Natural change	Changes in the condition of features that result wholly from natural causes, such as sea level rise. Natural change is determined to be something that is outside the control of the relevant authorities.
Non-synthetic contamination	Non-synthetic compounds are those materials that occur naturally. They may have to be refined before they are useful to man and could occur in many slightly

	different forms. Examples of non-synthetic materials are; heavy metals and hydrocarbons (oil and petrol).
Notable species	A species that is considered to be notable due to its importance as an indicator, and may also be of nature conservation importance, and which is unlikely to be a 'characteristic species'.
Operations which may cause deterioration or disturbance	Any activity or operation taking place within, adjacent to, or remote from a European marine site that has the potential to cause deterioration to the natural habitats for which the site has been designated, or disturbance to the species and its habitats for which the site was designated. The purpose of the operations advice is to assist relevant authorities and others in managing those activities that could inhibit or prevent the conservation objectives for an interest feature being achieved. This advice is not limited to those activities being undertaken within the site boundary. The intent is to consider all activities that may have an effect on the interest features.
Opportunistic species	A species which is able to rapidly exploit changes in habitat conditions or circumstances to its own advantage.
Plan or project	Any proposed development that is within a relevant authority's function to control, or over which a competent authority has a statutory function to decide on applications for consents, authorisations, licences or permissions.
Ramsar site	A site listed under the Convention on Wetlands of International Importance especially as Waterfowl Habitat, which was agreed at Ramsar, Iran.
Relevant authority	The specific competent authority which has powers or functions which have, or could have, an impact on the marine environment, or adjacent to, a European marine site.
Reporting cycle (also known as the monitoring cycle)	A six year cycle where interest features on European sites will be monitored by the country agencies e.g. English Nature. Information on the condition of the features will be used to report to Europe as part of our obligations under the Habitats Directive.
Restore	The action required for an interest feature when it is not considered to be in a favourable condition.
Sensitivity	The intolerance of a habitat, community or individual species to damage, or death, from an external force.
Sub-feature	An ecologically important sub-division of an interest feature.
Sublittoral	The zone of the shore below low water exposed to air only at its upper limit by the lowest spring tides.
Synthetic contamination	Synthetic compounds are those materials that have been manufactured artificially by chemical reaction. Examples of some synthetic compounds are; antifoulant paints, detergents, pesticides (Polychloronatedbiphenyls or PCBs) and biocides (tributyltin or TBT).
Turbidity	This is a measure of the attenuation of light in the water column and can be caused by the light adsorption properties of the water, plankton, suspended particulate organic and inorganic matter and dissolved colour.
Typical species	A species that is considered to be a typical component of a feature or sub-feature.

Vulnerability	The exposure of a habitat, community or individual of a species to an external factor to which it is sensitive.
WeBS	Wetland Bird Survey a collaborative national surveillance scheme of the UK's waterfowl based on counts undertaken once per month outside of the breeding season.

Appendix I Maps showing the boundary of the Humber Estuary possible Special Area of Conservation

Appendix II **Maps showing the marine habitats of the Humber Estuary possible Special Area of Conservation**

Data sources:

NVC surveys – Saltfleetby to Theddlethorpe, Terra (digitising) 2000
North Lincolnshire Coast, Terra 2001
All other sites, Bullens 2001

Land cover map 2000, CEH 2000

Aerial photography, Getmapping 1999-2001

OS Landline intertidal, last comprehensive tide line survey 1983, with local revisions 1993, 1995 and 1999.

Appendix III Maps showing the boundary of the Humber Flats, Marshes and Coast Special Protection Area and Ramsar site

Appendix IV **Maps showing the marine habitats of the Humber Flats, Marshes and Coast Special Protection Area and Ramsar site**

Data sources:

NVC surveys – Saltfleetby to Theddlethorpe, Terra (digitising) 2000
North Lincolnshire Coast, Terra 2001
All other sites, Bullens 2001

Land cover map 2000, CEH 2000

Aerial photography, Getmapping 1999-2001

OS Landline intertidal, last comprehensive tide line survey 1983, with local revisions 1993, 1995 and 1999.

Appendix V Saltmarsh NVC communities occurring within the Humber Estuary European marine site pSAC (from Bullen Consultants 2002 and Dargie 2002)

Interest feature	Sub-feature	NVC community	Saltmarsh plant species
Salicornia and other annuals colonising mud and sand		SM8	*Salicornia*
		SM9	*Suaeda maritima*
Atlantic salt meadows	Low to mid marsh communities	SM10	Transitional low marsh with *Puccinellia maritima* annual *Salicornia* spp and *Suaeda maritima*
		SM11	*Aster tripolium*
		SM12	*Rayed Aster tripolium*
		SM13	*Puccinellia maritima*
		SM13a	*Puccinellia maritima* sub-community dominated by *Puccinellia maritima*
		SM13b	*Puccinellia maritima Glaux maritima* sub-community
		SM13c	*Puccinellia maritima Limonium vulgare* sub-community
		SM13f	*Puccinellia maritima Puccinellia maritima – Spartina anglica* sub-community
		SM14	*Atriplex portulacoides*
		SM14a	*Atriplex portulacoides* - sub-comm *Atriplex portulacoides* dominant
		SM14c	*Atriplex portulacoides Puccinellia maritima* sub-community
	Mid to upper communities	SM15	*Juncus maritimus Triglochin maritima*
		SM16	Festuca rubra
		SM16a	*Festuca rubra-Puccinellia maritima* sub-community
		SM16b	*Festuca rubra - Juncus gerardi* dominant
		SM16c	*Festuca rubra-Festuca rubra Glaux maritima* sub-community
	Transitional communities	SM24	*Elymus pycnanthus*
		SM28	*Elymus repens*
		S4	*Phragmites australis*
		S4a	*Phragmites australis* with *Phragmites australis* sub-community
		S21	*Scirpus maritimus* swamp

Appendix VI **Map showing the extent and distribution of saltmarsh NVC communities occurring within the Humber Estuary European marine site pSAC**

Data sources:

NVC surveys – Saltfleetby to Theddlethorpe, Terra (digitising) 2000
North Lincolnshire Coast, Terra 2001
All other sites, Bullens 2001

Aerial photography, Getmapping 1999-2001

Appendix VII Matrix of relative vulnerability

The relative vulnerability of an interest feature or sub-feature is determined by combining the relative sensitivity and exposure assessments according to the table below:

Relative exposure of the interest feature	Relative sensitivity of the interest feature: High (●●●●)	Medium (●●●)	Low (●●)	None detectable (●)
High				
Medium				
Low				
None				

Categories of relative vulnerability

High	
Moderate	
Low	
None Detectable	

Appendix VIII Summary of key biotopes for SAC features

LR	Littoral rock
MLR	Moderately exposed littoral rock
MLR.Ent	*Enteromorpha* spp. on freshwater-influenced or unstable upper eulittoral rock
SLR	Sheltered littoral rock
SLR. Fspi	*Fucus spiralis* on moderately exposed to very sheltered upper eulittoral rock
SLR. FvesX	*Fucus vesiculosus* on mid eulittoral mixed substrata
LS	Littoral sediment
LGS	Littoral gravels and sands
LGS.BarSh	Barren shingle or gravel shores
LGS. Tal	Talitrid amphipods in decomposing seaweed on the strand-line
LGS. AEur	Burrowing amphipods and *Eurydice pulchra* in well-drained clean sand shores
LGS.AP.P	Burrowing amphipods and polychaetes (often with *Arenicola marina*) in clean sand shores
LGS. AP.Pon	Burrowing amphipods *Pontocrates* spp. and *Bathyporeia* spp. in lower shore clean sand
LGS. Lan	Dense *Lanice conchilega* in tide-swept lower shore sand
LGS.Ol	Oligochaetes in reduced or low salinity gravel or coarse sand shores
LMS	Littoral muddy sands
LMS. MacAre	*Macoma balthica* and *Arenicola marina* in muddy sand shores
LMS. Znol	*Zostera noltei* beds in upper to mid shore muddy sand
LMU	Littoral muds
LMU. HedMac	*Hediste diversicolor* and *Macoma balthica* in sandy mud shores
LMU.HedMac.Are	*Hediste diversicolor*, *Macoma balthica* and *Arenicola marina* in muddy sand or sandy mud shores
LMU.HedMac.Mare	*Hediste diversicolor*, *Macoma balthica* and *Mya arenaria* in sandy mud shores
LMU. HedScr	*Hediste diversicolor* and *Scrobicularia plana* in reduced salinity mud shores
LMU. HedStr	*Hediste diversicolor* and *Streblospio shrubsolii* in sandy mud or soft mud shores
LMU. HedOl	*Hediste diversicolor* and oligochaetes in low salinity mud shores
SS	Sublittoral sediments
IGS	Infralittoral gravels and sands
IGS. NcirBat	*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand
IGS. MobRS	Sparse fauna in reduced salinity infralittoral mobile sand
IGS. Ncir	*Nephtys cirrosa* and fluctuating salinity-tolerant fauna in reduced salinity infralittoral mobile sand
IGS. NeoGam	*Neomysis integer* and *Gammarus* spp. in low salinity infralittoral mobile sand
IMS	Infralittoral muddy sands
IMS. Cap	*Capitella capitata* in enriched sublittoral muddy sediments
IMU	Infralittoral muds
IMU. PolVS	*Polydora ciliata* in variable salinity infralittoral firm mud or clay
IMU. AphTub	*Aphelochaeta marioni* and *Tubificoides* spp. in variable salinity infralittoral mud
IMU. NhomTub	*Nephtys hombergii* and *Tubificoides* spp. in variable salinity infralittoral soft mud
IMX	Infralittoral mixed sediments
IMX. CreAph	*Crepidula fornicata* and *Aphelochaeta marioni* in variable salinity infralittoral mixed sediments
IMX. PolMtru	*Polydora ciliata*, *Mya truncata* and solitary ascidians in variable salinity infralittoral mixed sediment

Taken from IECS, 2000, The Humber Estuary – An Environmental Assessment. Report to English Nature. Unpublished

Biotope codes taken from: Connor, D.W., Brazier, D.P., Hill, T.O. & Northen, K.O. 1997a. *Marine Nature Conservation Review: marine biotope classification for Britain and Ireland. Volume 1. Littoral biotopes*. Version 97.06 JNCC Report, No. 229. and Connor, D.W., Dalkin, M.J., Hill, T.O., Holt, R.H.F. & Sanderson, W.G.. 1997b. *Marine Nature Conservation Review: marine biotope classification for Britain and Ireland. Volume 2. Sublittoral biotopes.* Version 97.06 JNCC Report, No. 230.

Appendix IX English Nature's Habitats Regulations Guidance Note HRGN1 'The Appropriate Assessment (Regulation 48)'

Appendix X List of relevant authorities on the Humber Estuary European marine site

Associated British Ports Port House Northern Gateway HULL, HU1 1XB	North East Lincolnshire Council Devonshire House, Bullring Lane, GRIMSBY DN31 1ES	Adlingfleet & Whitgift IDB The Gables Business Court, Belton Road, Epworth North Lincs DN9 1JL	North East Lindsey IDB High Street, Ulceby, North Lincs DN39 6TG
Associated Petroleum Terminals (Immingham) Ltd, Queens Road, IMMINGHAM DN40 2PN	North Lincolnshire Council Church Square House, PO Box 42, SCUNTHORPE DN15 6XQ	Ancholme IDB c/o Grantham, Brundell and Farran, Pillar House, 20, South Parade, DONCASTER DN1 2DP	Ottringham IDB c/o 34, Lairgate, BEVERLEY HU17 8ES
British Waterways Board, 5, Bramley's Barn, The Menagerie, Skipwith Road, Escrick, YORK YO19 6ET	Anglian Water Services Ltd Endurance House, Chivers Way, Histon, Cambridgeshire CB4 9ZR	Dempster IDB 64-66 Aire Street, GOOLE DN14 5QS	Preston IDB c/o 34, Lairgate, BEVERLEY HU17 8ES
Crude Oil Terminals (Humber) Ltd, (Conoco Ltd), Humber Refinery, Eastfield Road South Killingholme, IMMINGHAM DN40 3DW	Eastern Sea Fisheries Joint Committee Unit 6, North Lynn Business Village, Bergen Way, KINGS LYNN PE30 2JG	Garthorpe IDB c/o Grantham, Brundell and Farran, Pillar House, 20, South Parade, DONCASTER DN1 2DP	Reedness and Swinefleet IDB c/o Grantham, Brundell and Farran, Pillar House, 20, South Parade, DONCASTER DN1 2DP
Hessle Dock Company, Livingstone Road, HESSLE HU13 0EA	English Nature Humber to Pennines Team, Bullring House, Northgate, WAKEFIELD WF1 3BJ	Goole and Airmyn IDB 7-13 Gladstone Terrace, GOOLE DN14 5AH	Scunthorpe IDB c/o Grantham, Brundell and Farran, Pillar House, 20, South Parade, DONCASTER DN1 2DP
Humber Sea Terminals Ltd, Simon Storage, North Killingholme Cargo Terminal, Clough Lane, North Killingholme DN40 3JP	Environment Agency 1 Viking Street, Great Gutter Lane East, Willerby, HULL HU10 6DE	Goole Fields IDB Clegg and Son, 69, Aire Street, GOOLE DN14 5QE	Skeffling IDB c/o 34, Lairgate, BEVERLEY HU17 8ES
East Lindsey District Council Tedder Hall, Manby Park, LOUTH LN11 8UP	North Eastern Sea Fisheries Committee County Hall, BEVERLEY HU17 9BA	Keyingham IDB c/o 34, Lairgate, BEVERLEY HU17 8ES	Thorngumbald IDB Ocean Chambers, 54, Lowgate, HULL HU1 1JF
East Riding of Yorkshire Council County Hall, BEVERLEY HU17 9BA	Yorkshire Water Services Ltd Western House, Western Way, Halifax Road, BRADFORD BD6 2LZ	Lindsey Marsh IDB Wellington House, Manby Park, LOUTH LN11 8UU	Thorntree IDB 4, Belgravia, GOOLE DN14 5BU
Kingston upon Hull City Council Kingston House, Bond Street, HULL HU1 3ER	Ministry of Defence, Defence Estates, East Stirling House, Denny End Road Waterbeach Cambs CB5 9QE	Lower Ouse IDB 91, Bridgegate, Howden, GOOLE DN14 7JJ	Winestead IDB c/o 34, Lairgate, BEVERLEY HU17 8ES
Lincolnshire County Council City Hall, Beaumont Fee, LINCOLN LN1 1DN		Market Weighton IDB Burnby Hall, Pocklington YORK YO42 2QF	

Appendix XI Copies of the citations for the European sites: Humber Estuary pSAC Humber Flats, Marshes and Coast SPA and pSPA Humber Flats, Marshes and Coast Ramsar and pRamsar

The **Sites of Special Scientific Interest** that underpin the European designations on the Humber Estuary are:

Humber Flats and Marshes: The Grues
Humber Flats and Marshes: Pyewipe and Cleethorpes Coast
Humber Flats and Marshes: Spurn Head to Saltend Flats
Humber Flats and Marshes: Upper Humber
Humber Flats and Marshes: Barton and Barrow Clay Pits
North Lincolnshire Coast
The Lagoons
North Killingholme Haven Pits
Saltfleetby-Theddlethorpe Dunes

The citations for these sites can be found on the English Nature website: www.english-nature.org.uk