JOINT NATURE CONSERVATION COMMITTEE

Coasts and seas of the United Kingdom

Region 6 Eastern England: Flamborough Head to Great Yarmouth

edited by
J.H. Barne, C.F. Robson, S.S. Kaznowska, J.P. Doody & N.C. Davidson

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This report has been produced by the Coastal Directories Project of the JNCC
on behalf of the project Steering Group

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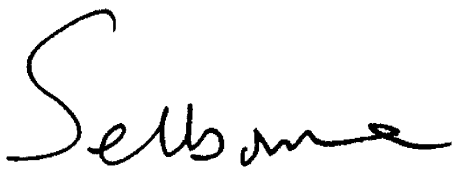
Foreword

Information is vital for sound policy formulation. Decision makers at national and local level need to know more than just the scale, location and importance of natural resources that are of value to humans. They have to understand how human activities affect the value of those resources and how to conduct those activities in an environmentally sustainable way. This is true for virtually every activity that impinges on the natural environment. In the coastal zone the complexity of the relationships between the physical and biological systems adds another dimension to the problems of formulating management policy.

I am pleased, therefore, to be introducing the *Coasts and seas of the United Kingdom* series. The Coastal Directories project, of which this series of seventeen regional reports, covering the whole of the UK coast, is an important product, has brought together an encyclopaedic range of information on our coastal resources and the human activities that are associated with them. Amongst the topics covered are the basic geology of the coasts around the United Kingdom and measures taken for coast defence and sea protection, the distribution and importance of the wildlife and habitats of our coasts and seas, including fish and fisheries, and the climate and sea level changes to which they all are subject.

In addition to the value of the information itself, the way the project has been run and the data collected has made an important contribution to the quality of the product. A wide range of individuals and organisations concerned with the conservation and use of the coastal margin have collaborated in collating the information, their variety reflecting the extent of the interplay between the coastal environment and human activities. These organisations included the Ministry of Agriculture, Fisheries and Food, the Scottish Office Agriculture and Fisheries Department, the National Rivers Authority, the Countryside Commission, the Scottish Office, the Welsh Office, the Department of the Environment, the Sea Fisheries Committees, English Nature, Scottish Natural Heritage and the Countryside Council for Wales, together with local authorities, voluntary conservation organisations and private companies (notably those in the oil industry, through the UK Offshore Operators Association). I am also pleased to be able to acknowledge the contribution made by the staff of the Joint Nature Conservation Committee. As the work has evolved since the first meetings of the Steering Group in 1990, the value of involving such a broad span of interests has been highlighted by the extent to which it has allowed new approaches and information sources to be identified.

The regional reports will be of value to all who live and work in the maritime areas of the UK, where informed management is the key to the sustainable use of resources. The reports should become indispensable reference sources for organisations shouldering new or expanded responsibilities for the management of marine Special Areas of Conservation under the EC Habitats Directive. In addition, the reports will make an important contribution to the implementation of the UK Biodiversity Action Plan.



The Earl of Selborne
Chairman, Joint Nature Conservation Committee

How to use this book

These notes provide some general guidance about finding and interpreting the information in this book.

Structure

The book is divided into ten chapters, each split into sections containing summary data on the topics shown in the Contents list. Chapter 2 provides a general physical background to the region. Sections in Chapters 3, 4 and 5 have been compiled to the following standard format:

- **Introduction**: presents the important features of the topic as it relates to the region and sets the region in a national context.
- **Important locations and species**: gives more detail on the region's features in relation to the topic.
- **Human activities**: describes management and other activities that can have an effect on the resource in the region.
- **Information sources used**: describes the sources of information, including surveys, on which the section is based, and notes any limitations on their use or interpretation.
- **Acknowledgements**
- **Further sources of information**: lists references cited, recommended further reading, and names, addresses and telephone numbers of contacts able to give more detailed information.

Sections in the remaining chapters all have the last three subsections and follow the other elements as closely as practicable, given their subject nature.

At the end of the book there is a list of the addresses and telephone numbers of organisations most frequently cited as contacts, as well as a core reading list of books that cover the region or the subject matter particularly well. Finally there is a full list of authors' names and addresses.

Definitions and contexts

The word 'region' (as in 'Region 6') is used throughout this book to refer to the coastal and nearshore zone, broadly defined, between the two points given in the title of this book. The area covered varies between chapter sections, depending on the form in which data is available. Coverage is usually either coastal 10 km squares, sites within one kilometre of Mean High Water Mark, or an offshore area that may extend out to the median line between the UK and neighbouring states. Inland areas of the counties concerned are not included unless specifically stated.

'Britain' here means Great Britain, i.e. including only England, Scotland and Wales. 'United Kingdom' also includes Northern Ireland.

The term 'North Sea Coast', as used here, means the coast of Britain covered by *The directory of the North Sea coastal margin* (Doody, Johnston & Smith 1993): that is, from Cape Wrath (longitude 5°W) along the east and south coasts of Britain to Falmouth (again longitude 5°W), and including Orkney and Shetland.

The 'West Coast', as used here, normally includes the coast and seas from Falmouth to Cape Wrath along the west coast of Britain. Only where explicitly stated have data for the Isle of Man and/or Northern Ireland been included in West Coast descriptions.

Sites within each chapter section are described in clockwise order around the coast, incorporating islands within the sequence. Maps and tables are numbered sequentially within their chapter section; for example in section 5.4, Map 5.4.1 is the first map referred to and Table 5.4.2 is the second table.

Throughout the book, the information given is a summary of the best available knowledge. The sites mentioned as important, the numbers and distributions of species, archaeological features discovered and information on all the other elements of the natural and man-made environment are as known at December 1994, unless otherwise stated. The fact that no information is presented about a topic in relation to a locality should not be taken to mean that there are no features of interest there, and fuller details should be sought from the further sources of information listed at the end of each section. Note, however, that under the Environmental Information Regulations (1992; Statutory Instrument No. 3240) you may be asked to pay for information provided by organisations.

Acknowledgements

This regional report is one of a series of products from the Coastal Directories Project of the JNCC. The compilation and publication of the series has been made possible by generous contributions from the members of the Coastal Directories Funding Consortium listed below:

Arco British Ltd [1]
Avon County Council
Banff and Buchan District Council
BHP Petroleum Ltd [1]
Ceredigion District Council
Cheshire County Council
Chevron UK Ltd [1]
Cleveland County Council
Clwyd County Council
Clyde River Purification Board
Colwyn Borough Council
Copeland Borough Council
Countryside Commission
Countryside Council For Wales
Cumbria County Council
Cunninghame District Council
Delyn Borough Council
Department of the Environment
Department of the Environment for Northern Ireland
Devon County Council
Dorset County Council
Dumfries and Galloway Regional Council
Dyfed County Council
Eastbourne Borough Council
English Nature
Essex County Council
Fife Regional Council
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Gwynedd County Council
Hampshire County Council
Highland River Purification Board
Humber Forum[2]
Isle of Man Government, Department of Industry
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Isle of Man Government, Department of Transport
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National Rivers Authority
Neath Borough Council
Norfolk County Council
North Cornwall District Council
North East Fife Regional Council
Nuclear Electric plc
Preseli Pembrokeshire District Council
Restormel Borough Council
Scottish Natural Heritage
Scottish Office Agriculture and Fisheries Department
Scottish Salmon Growers Association Ltd
Sefton Borough Council
Shepway District Council
Solway River Purification Board
Somerset County Council
South Pembrokeshire District Council
Standing Conference on Regional Policy in South Wales[2]
Stroud District Council
Tayside Regional Council
Torridge District Council
UK Offshore Operators Association [3]
Vale of Glamorgan Borough Council
Water Services Association
Welsh Office
World Wide Fund for Nature (UK)

Notes

[1] Funding from these companies was given to the Cardigan Bay Forum to fund the supply of information to the Project.

[2] Members of the Humber Forum are: East Yorkshire Borough of Beverley, Hull City Council, Boothferry Borough Council, Glanford Borough Council, Great Grimsby Borough Council, Holderness Borough Council, Scunthorpe Borough Council, Cleethorpes Borough Council, Humberside TEC and the Humber Chamber of Commerce.

[3] The UK Offshore Operators Association is the representative organisation for the British offshore oil and gas industry. Its 34 members are the companies licensed by HM Government to explore for and produce oil and gas in UK waters.

This collaborative project involves many other branches of JNCC in addition to the project team listed on page 2. These are: Marine Conservation Branch (Keith Hiscock, Tim Hill, Bill Sanderson, Colin McLeod), Vertebrate Ecology and Conservation Branch (Deirdre Craddock, David Stroud, Steve Gibson), Species Conservation Branch (Nick Hodgetts, Deborah Procter, Martin Wigginton), and Seabirds and Cetaceans Branch (Mark Tasker, Paul Walsh, Andy Webb). We thank them all for their help and support.

The project has also received widespread support from the country conservation agencies: Countryside Council for Wales, English Nature, Scottish Natural Heritage and the Department of the Environment (Northern Ireland). We are grateful to the many regional and headquarters staff listed below as well as the representatives on the Core Steering Group.

The editors would also like to thank the many people who have provided information for the project or gave their time to comment on drafts, as well as those who gave editorial assistance:

Miran Aprahamian, NRA; Roger Bamber, Fawley Aquatic Research Laboratories Ltd.; T J C Beebee, University of Sussex Brighton; R A Bird, Government Office for Eastern Region; Tricia Bradley, RSPB; Andrew Burr, Department of Transport; Tim Cleeves, RSPB; Keith Corbett, Herpetological Conservation Trust; Martyn Cox, The Crown Estate; Peter Cranswick, The Wildfowl and Wetlands Trust; J R Crook, Humberside County Council; Sandy Downie, EN; C J Durdin, RSPB; Joan Edwards, Devon Wildlife Trust; Lynette Evans, EN; Ben Ferrari, National Monuments Records Centre; Tony Gent, EN; David George, Natural History Museum; Wells Grogan, Marathon Oil; Neil Hailey, EN; Paul Harding, Institute of Terrestrial Ecology; John Hartley, AMOCO (UK); Richard Hobbs, Norfolk Wildlife Trust; Antony Jensen, University of Southampton; Graham King, National Coasts and Estuaries Advisory Group; Peter Lambley, EN; Colin Macduff-Duncan, ESSO; Clive Morgan, Cardigan Bay Forum; Roger Morris, EN; Paul Murby, Yorkshire Wildlife Trust; A J Murray, The Crown Estate; Ian Paterson, EN; Frank Parrish, The Crown Estate; Lindsay Pickles, NRA; Mike Roberts, Department of the Environment; Chris Rollie, RSPB; Pat Sargeant, EN; Alister Scott, Cardigan Bay Forum; John Sharpe, RSPB; Duncan Shaw, Irish Sea Forum; Pauline Simpson, Institute of Oceanographic Sciences; P M Stainer, NRA; Chris Stroud, Whale and Dolphin Conservation Society; C Vivian, MAFF; Graham Weaver, EN; Sarah Welton, Marine Conservation Society; and Ray Woolmore, Countryside Commission.

Where appropriate, individual acknowledgements are given also at the end of each section.

The shingle spit at Blakeney, north Norfolk, is a favourite haul-out site for common and grey seals. Local operators ferry boat-loads of 'green tourists' for a really close view, a rare opportunity in England. Photo: Nick Davidson, JNCC.

Chapter 1 Overview

1.1 The Coastal Directories project

Dr J.P. Doody

The Coastal Directories project sets out to collect and collate summary information that will provide an overview of coastal and marine resources and human activities at national and regional levels. It also provides an index to more detailed references and other sources of information.

Information on the coastal resource and its use is vital to the development of policy for environmental management. Because of the inter-related nature of the many components of the coastal zone, including both habitats and species, coastal management requires a knowledge of the interactions between human activities and the physical functioning of the zone and its biological components. In addition, it is essential to adopt a wide-ranging approach to collecting and collating this information.

For these reports, the definition of the coastal margin encompasses all the main marine, coastal and maritime zones, from offshore waters to terrestrial maritime habitats. By their nature the limits of the coastal, shoreline and marine zones are indistinct, as tidal movement, storms and the effects of sea level rise influence their relative positions. A wide definition of maritime habitats has been adopted here: tidal areas (mudflats, sand flats, saltmarshes and transitions to brackish marsh, swamps and salt-influenced grasslands) are included; rocky shores, shingle beaches, cliffs subject to salt spray, and terrestrial features including sand dunes and shingle structures that are maintained by marine processes are also covered. In addition, we have considered areas where combinations of these habitats occur. Examples include estuaries where lagoons or land claimed from the sea, such as coastal grazing marsh, form part of the functioning system. Also covered are habitats used by coastal species for at least part of their life cycle.

In the marine and nearshore environment we have not set any artificial limits to the areas to be discussed, except those imposed by the availability of information or the limits of national jurisdiction. A minimum distance of 35 km offshore has been agreed as a notional limit to the coastal zone for the Coastal Directories project, but in effect the median line between Britain and neighbouring states may be said to form the boundary in many instances. The offshore limits of geomorphological processes, affecting both the coast and the subtidal waters, and the seaward boundaries of nearshore benthic plant and animal communities, are important factors.

Because of the potentially wide influence of human use, the area from which we have derived data is occasionally wider than the strictly coastal zone. Fisheries, infrastructure development and sources of pollution are among the activities for which it is difficult to define a precise limit. The historical context, derived from archaeological evidence, must also be taken into account. However, when all these interactions are revealed they will help to inform the process of planning and delivering coastal management so that it allows for sustainable use and the maintenance of biological diversity.

1.1.1 Origins and aims of the work

Recognising the significant gaps that existed in scientific understanding of the North Sea, the Second International Conference on Protection of the North Sea established the North Sea Task Force in 1987. Under the guidance of the International Council for the Exploration of the Sea (ICES) and the Oslo and Paris Commissions, it organised a co-ordinated programme of research and monitoring with a primary aim of producing an assessment of the North Sea (the *Quality Status Report* (QSR)) by 1993.

The Coastal Directories project began following a suggestion in 1989 by the UK at the second meeting of the North Sea Task Force to include consideration of coastal habitats and species of conservation importance in the North Sea QSR. The work initially involved the collection and collation of information along the coastal margin of the North Sea, from Cape Wrath around the North Sea and the English Channel to the Fal Estuary. Funded as a joint project between the Department of the Environment and the Nature Conservancy Council (NCC), the information was compiled during 1990 and 1991 and a draft *Directory of the North Sea coastal margin* was circulated for comment in August 1991.

The principal original aim was to produce "a comprehensive description of the North Sea coastal margin, its habitats, species and human activities, as an example to other North Sea states" (North Sea Task Force 1993). It was hoped that this would help to ensure that habitats and species were considered in the QSR. The programme fulfilled this original aim, and the QSR published in 1993 included descriptions of both habitats and species in several of the sub-regional reports, together with an assessment of the human impacts on the ecosystems.

The *Directory of the North Sea coastal margin* was published in December 1993 (Doody *et al.* 1993). It was presented to Ministers at the Intermediate Ministerial Meeting on the North Sea held in Denmark in the same month.

The North Sea Task Force was wound up in December 1993 following completion of the QSR. Continuing work was subsumed into a new Assessment and Monitoring Committee (ASMO) under the 1992 Convention for the Protection of the Marine Environment of the North East Atlantic (the OSPAR Convention). The new OSPAR Convention requires that assessments similar to the *North Sea Quality Status Report* be produced for all the constituent

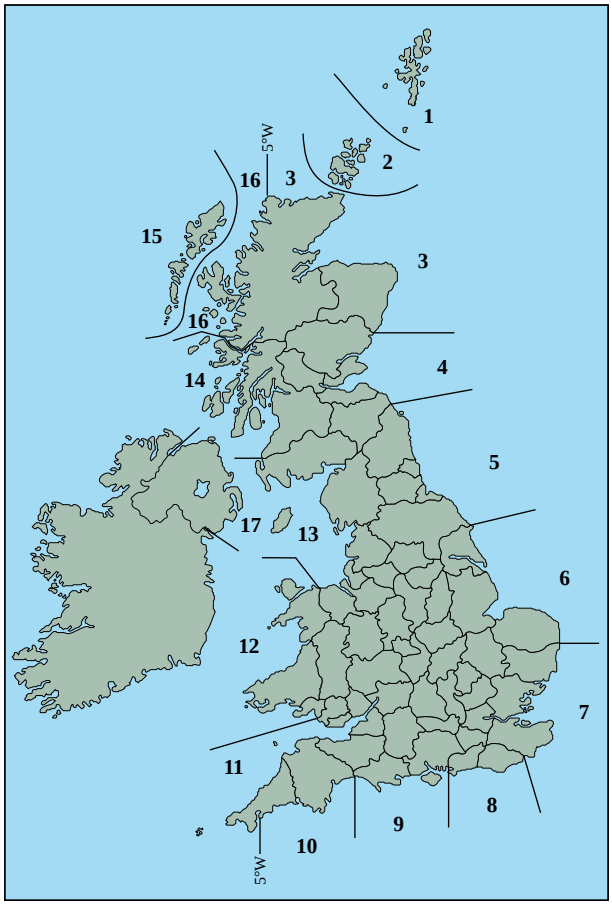
parts of the north-east Atlantic and for that area as a whole (which we have called for simplicity 'the West Coast') by the year 2000. The Irish Sea will be one of the first areas subject to assessment. The extension of the Coastal Directories project to the West Coast of Great Britain (thereby covering all the coast not included in the *Directory of the North Sea coastal margin*, and also including the Isle of Man and Northern Ireland) and the production of regional reports such as this one contribute to that assessment.

1.1.2 Methods - the North Sea and West Coast Directories

Throughout the work on the directories a simple approach to compiling the information has been adopted. This has involved identifying existing sources of compiled information at national, regional and local levels. The *Directory of the North Sea coastal margin* was largely produced by staff within the Nature Conservancy Council (NCC); following reorganisation of the NCC in 1991, responsibility for the work has rested with the Joint Nature Conservation Committee (JNCC). Table 1.1.1 shows how the Coastal Directories project is managed.

At the outset it was agreed that the work should involve a wide variety of individuals and organisations concerned with the conservation and use of the coastal margin, to reflect the complex nature of the habitats and species and the wide-ranging influence of human activities. Initially, a small group of individuals and organisations (including the Ministry of Agriculture, Fisheries and Food (MAFF), the National Rivers Authority (NRA), the Countryside Commission (CC), the Scottish Office (SO), the Welsh Office (WO), the Department of the Environment (DoE) and the conservation agencies for England, Scotland and Wales (English Nature, Scottish Natural Heritage, Countryside Council for Wales)) was invited to help steer the project and to identify and provide information. As the work evolved from the first meetings in 1990, the value of this approach was highlighted by the extent to which new approaches and information sources were identified.

Unlike for the preceding work on the North Sea coastal margin, which was funded principally through the DoE and the NCC/JNCC, a decision was made to seek funding for the continuation of the work on the West Coast from a consortium of private organisations and public bodies, including coastal local authorities. Early in 1993, JNCC appointed a co-ordinator for this work, part of whose responsibility was to obtain funding for the project. In the event a large number of organisations agreed to participate and showed a keen interest in the development of the work. Members of the Funding Consortium are listed in the Acknowledgements section of the book.



Map 1.1.1 Regions in the series. Region names are given in Table 1.1.2.

This interest was reflected in the extent of external funding that the project received (including an injection of funds from the UK Offshore Operators Association, see below), and in the commitment shown by the steering groups, which meet regularly. Of particular importance is the annual Main Steering Group seminar: so far it has reviewed the *Role of the Directories in the development of coastal zone management* (January 1994), and considered the *Use of electronic storage and retrieval mechanisms for data publication* (February 1995).

1.1.3 The Coastal Directories' contribution to coastal management

As the work on the *Directory of the North Sea coastal margin* proceeded, the emphasis of the approach changed. In the UK during the period 1990 - 1993 there was a considerable upsurge of interest in the principles of coastal management.

Table 1.1.1 The structure of the management arrangements

Group	*Role*	*Undertaken by*
JNCC Coastal Conservation Branch (CCB)	Day to day management	Head of CCB
Management Board	Liaison & executive decisions	Country agencies/JNCC Coastal Conservation Branch
Core Steering Group	Steer work, provide information and support	See page following title page
Main Steering Group	Review progress, consider new developments, provide advice	All Steering Group members, conferring annually at Steering Group Meeting

Table 1.1.2 Provisional titles and publication dates of the Coastal Directories reports

Directory of the North Sea Coastal Margin	Published 1993
Regional Report 1. Shetland	Publication due 1997
Regional Report 2. Orkney	Publication due 1997
Regional Report 3. North-east Scotland; Cape Wrath to St Cyrus	Publication due 1995
Regional Report 4. South-east Scotland; Montrose to Eyemouth	Publication due 1997
Regional Report 5. North-east England: Berwick-on-Tweed to Filey Bay	Published 1995
Regional Report 6. Eastern England: Flamborough Head to Great Yarmouth	Published 1995
Regional Report 7. South-east England: Lowestoft to Dungeness	Publication due 1997
Regional Report 8. Sussex: Rye Bay to Chichester Harbour	Publication due 1997
Regional Report 9. Southern England: Hayling Island to Lyme Regis	Publication due 1996
Regional Report 10. South-west England: Seaton to Falmouth Bay	Publication due 1996
Regional Report 11. The Western Appproaches: Falmouth Bay to Kenfig	Publication due 1996
Regional Report 12. Wales: Margam to Little Orme	Published 1995
Regional Report 13. Northern Irish Sea: Colwyn Bay to Stranraer	Publication due 1996
Regional Report 14. South-west Scotland: Ballantrae to Mull	Publication due 1996
Regional Report 15. The Outer Hebrides	Publication due 1996
Regional Report 16. North-west Scotland: Loch Linnhe to Cape Wrath	Publication due 1996
Regional Report 17. Northern Ireland	Publication due 1996
West Coast Directory	Publication due 1996
Coastal and marine UKDMAP datasets: Version 1	Published 1994

The House of Commons Environment Committee examined the issues during November 1991 and in January/February 1992 and published their report on *Coastal zone protection and planning* in March 1992 (House of Commons Environment Committee 1992).

That report, together with other initiatives at UK and European levels, continues to encourage a more integrated approach to management issues. The dialogue between the project consortium members has confirmed the importance of the Coastal Directories in providing basic resource information to support these new approaches. Increasingly, therefore, the Directories are seen as providing essential information to inform the development of coastal zone management policy at national levels.

The Directories provide information that complements the sectoral approach (control of different activities by separate regulations) currently being promoted by a range of Government reports. These include PPG 20: *Coastal planning* (Department of the Environment/Welsh Office 1992), and the two consultation documents that followed up the House of Commons Environment Committee report: *Development below low water mark* (Department of the Environment/Welsh Office 1993) and *Managing the coast* (Department of the Environment/Welsh Office 1993). MAFF too is promoting the setting up of 'coastal cell groups', to encourage sustainable shoreline management.

1.1.4 Regional reports

The coastal management developments fostered interest in the Coastal Directories project, and also increased demand for information at a regional level. It was decided, therefore, to produce a series of regional reports to cover the whole coast of Britain, in addition to the two overview volumes (*The Directory of the North Sea coastal margin*, published in 1993, and the *West Coast Directory)*. Discussions among consortium members indicated that early completion of the regional volumes should be the priority. Seventeen regions were identified for which reports are being prepared. These provide a more detailed level of information than the overview volumes, to help set each region in a national context and facilitate the preparation of regional plans.

It was also recognised that the summary data in the regional reports is valuable in preparing and assessing applications for oil and gas licensing around the coastal margin. An injection of funds from the United Kingdom Offshore Operators Association (UKOOA) made possible the early production of reports for most of the potential licensing areas in the 16th Offshore Oil and Gas Licensing Round.

The areas covered by the complete series of regional reports are shown in Map 1.1.1: Regions 1 - 10 cover the area of the *Directory of the North Sea coastal margin*; Regions 11 - 17 deal with the area of the *West Coast Directory*.

1.1.5 Outputs

The reports are published as conventional paper reports; in addition a first version using UKDMAP (the electronic atlas developed by the British Oceanographic Data Centre, Birkenhead) was published in 1994 (Barne *et al.* 1994). Other forms of electronic publication are being evaluated. The position on publication as at March 1995 is shown in Table 1.1.2.

1.1.6 Further sources of information

A. References cited

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North Sea Task Force. 1993. *North Sea quality status report*. London, Oslo and Paris Commissions.

B. Further reading

Bird, E.C.F. 1984. *Coasts - an introduction to coastal geomorphology*. 3rd ed. Oxford, Basil Blackwell.

British Oceanographic Data Centre. 1992. *United Kingdom digital marine atlas. User guide. Version 2.0*. Birkenhead, Natural Environment Research Council, British Oceanographic Data Centre.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Information about the Directories project and UKDMAP version	*Project Co-ordinator, Coastal Conservation Branch, JNCC, Peterborough, tel: 01733 62626
Sales outlet for the regional volumes, the Directories and other JNCC publications	Natural History Book Service Ltd, 2-3 Wills Road, Totnes, Devon TQ9 5XN, tel: 01803 865913

* Starred contact addresses are given in full in the Appendix.

At first hugging the distant line of the former seashore, Morston Creek, north Norfolk, winds through saltmarsh and mud flats before emerging in the open sea. A typical feature of this sheltered coast, it is a popular haven for leisure sailors and fishermen. Photo: Nick Davidson, JNCC.

1.2 Regional summary

Dr J.P. Doody

1.2.1 Introduction

This section gives a brief introduction to the character of the region, its wildlife and the extent of its human use and development, synthesising information presented in Chapters 2 - 10. The main coastal locations are shown on Map 1.2.1. Map 1.2.2 shows the coastal 10 km squares in the region.

Region 6 covers the major part of the coast of East Anglia, from just north of Flamborough Head to Great Yarmouth, including the counties of Humberside, Lincolnshire and Norfolk. The coast is 621 km long, which is 11.3% of the total coastline of England and 3.3% of that of Great Britain. Flamborough Head and Hunstanton have the only major (hard rock) cliffs. Low glacial cliffs dominate large stretches of coast in North Humberside (the Holderness coast) and along much of the east facing coast of Norfolk. The majority of the rest of the coast is low-lying and mainly estuarine and includes the coastal fringe of the important fenland basin (The Wash) and the barrier island coast of north Norfolk. The hinterland is mostly in intensive agriculture, and comprises some of the most productive and extensive cultivated land in Great Britain. The Humber estuary is the only area that has major industrial infrastructure development, though some towns, including Skegness, Hunstanton and Great Yarmouth, are important coastal tourist centres.

1.2.2 Structure and landscape

From north to south the solid geology of the region is composed of rocks of the Cretaceous Period (<144 million years ago). However, these rocks are obscured throughout most of the region by thick layers of glacial drift, deposited when the area was covered with ice. Deposits range in age from Pleistocene (up to 1.6 million years old) to Holocene, dating from the last glacial period, which ended only 10,000 years ago. The shape of the coastline is defined by its drift geology and the movement of sediment brought about by continuing geomorphological processes. Where sediment is moved from one place to another along the shore, the often large areas of sedimentary habitat that are so much a feature of the region have been and continue to be created and maintained.

The region can be considered in three sections, according to whether the coast is eroding or accreting. These are: the soft-rock eroding cliff exposures of the Holderness coast, which supply sediment to the south; the estuaries and sand dunes of South Humberside and Lincolnshire (including The Wash) and north Norfolk, which are generally sediment sinks with accreting intertidal estuarine habitats, beaches and shingle structures and sand dunes; and the softer eroding cliffs of north-east Norfolk.

Offshore the land shelves gently and water depths seldom fall to more than 20 m, except in the far north off Flamborough Head, where a depth of 30 m is reached within 3 km of the shore. The sequence of geological material offshore is similar to that onshore, with an extensive and thick covering of glacial strata of Pleistocene and Holocene age. The most important marine areas lie around the Humber estuary, The Wash and north Norfolk, and offshore there are two rich marine habitats associated with the chalk cliffs and reefs, off Flamborough Head and West Runton.

1.2.3 The natural environment

The coast of Region 6 includes important examples of all the main soft coast habitat types, with the Humber estuary, The Wash and the barrier island coast of north Norfolk all being of national significance. Taken together as an integrated sedimentary system (a 'coastal cell' - see section 2.4), they equal in nature conservation value the internationally important Waddensea off the coast of the Netherlands, Denmark and Germany. Flamborough Head is the only nationally important cliff site with biological interest in the region, though the cliffs at Hunstanton have important exposures of Cretaceous strata. There are a number of natural coastal lagoons, all of national importance.

In addition to its geomorphological features and wildlife habitats, the other main nature conservation interest of this region is its birds. The region is important for seabirds in both national and international contexts. Breeding kittiwake *Rissa tridactyla*, Sandwich tern *Sterna sandvicensis*, little tern *Sterna albifrons*, guillemot *Uria aalge* and razorbill *Alca torda* all occur in internationally important numbers in the region as a whole. In addition, several sites are internationally important in their own right: the massive kittiwake colony on the Bempton cliffs, Flamborough Head, is of world stature, as are the populations of guillemots and razorbills. Blakeney Point is of international importance for Sandwich and little terns, while the little tern colony at Great Yarmouth has also grown to this level in recent years.

The region supports high densities and large numbers of breeding waterfowl, especially waders, because large sections of the coast are either estuarine or soft coast. The saltmarshes and associated coastal grazing marshes of the Wash and north Norfolk coast are particularly important at a national level, whilst the seasonally flooding grasslands of the Ouse and Nene Washes (Cambridgeshire) and Norfolk Broads (e.g. Breydon Water) hold exceptionally diverse breeding waterfowl assemblages. These saltmarshes and grasslands hold nationally important populations of waders such as redshank *Tringa totanus*, oystercatcher *Haematopus ostralegus*, lapwing *Vanellus vanellu*s and snipe *Gallinago gallinago* as well as of wildfowl such as pintail *Anas acuta*, gadwall *Anas strepera*, mute swan *Cygnus olor* and others. Lapwing, redshank and snipe breeding densities are the highest in Britain.

The region is also of major international importance as one of the most important coastal areas in the UK for non-breeding waterfowl. The region holds, in mid-winter, about 366,000 waterfowl - about one quarter of the national total. The Wash holds more waterfowl in winter than any other site in Britain and supports internationally important numbers in nearly every month. For several non-breeding

Map 1.2.1 Rivers, major towns and other coastal locations in the region. For coastal 10 km squares see Map 1.2.2.

waterfowl species, sites within the region are the most important within the UK, and for several the region also holds a significant proportion of the total UK population, either in the migration periods or in winter.

Seven species of protected bats are present in the region, including the Barbastelle *Barbastella barbastellus*, one of Europe's rarest bats. The region holds populations of the rare natterjack toad *Bufo calamita* at a number of (mainly sand dune) sites, from Saltfleetby National Nature Reserve in the north to Winterton Dunes National Nature Reserve in the south. The region is nationally important for many coastal invertebrate species, which are often restricted to particular habitats, for example saltmarsh transitions, lagoons, shingle, strandlines and soft cliffs.

The region's most significant and characteristic habitats and their associated wildlife are described below.

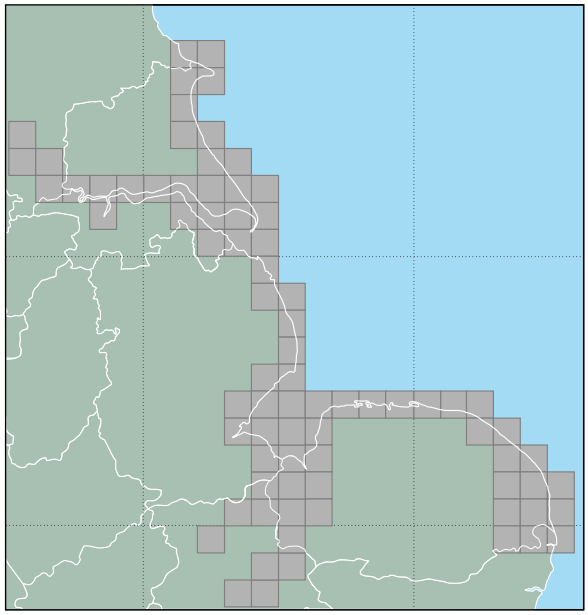
The sea and sea bed

The region contains only 48 of the GB total of 336 non-exploited fish species. The Wash is an important nursery ground for flatfish (plaice *Pleuronectes platessa* and Dover sole *Solea solea*), herring *Clupea harengus* and cod *Gadus morhua*. Of the three diadromous fish species widespread in British waters - the Atlantic salmon *Salmo salar*, sea trout *Salmo trutta* and eel *Anguilla anguilla* - eels are probably present in all the rivers in the region and salmon and sea trout mostly in the Yorkshire Ouse.

Both grey seals *Halichoerus grypus* and common seals *Phoca vitulina* occur in the region. Common seals are concentrated in The Wash, where a large proportion of the region's 7% of the UK total are found. They also occur at other sites, including Blakeney Point, where frequent boat trips to see them are a regular summer attraction. Grey seals are less numerous but breed in sufficient numbers at Donna Nook to produce 1% of the pups born in the UK (14% of those born in England). Only three species of cetaceans occur in the area regularly throughout the year or are seen annually, many fewer than occur further north. These are the harbour porpoises *Phocoena phocoena*, minke whale *Balaenoptera acutorostrata* and white-beaked dolphin *Lagenorhynchus albirostris*.

Kittiwakes and guillemots occur offshore throughout the year in large numbers, along the 'Flamborough front' (see section 4.2), making this area particularly sensitive to pollution.

Most of the region's value for sea-bed species relates to the two major estuaries (the Humber and The Wash) and off the north Norfolk coast. There are important near-shore distributions of exploited sea-bed species, such as brown shrimp *Crangon crangon* and cockles *Cerastoderma edule* in the Humber estuary and The Wash. The intertidal areas of the Humber estuary contain rich invertebrate communities dominated by dense populations of oligochaete worms, the Baltic tellin *Macoma baltica* and the ragworm *Neanthes diversicolor*. Similarly The Wash also supports a variety of species, which range from the dense populations of lugworm *Arenicola marina* and the small snail *Hydrobia ulvae*, which dominate the intertidal soft muddy sediments, to species of deeper water, where coarser sand and gravels provide attachments for various hydroids, bryozoan seamats and deadman's fingers *Alcyonium digitatum*. The highly productive waters in these estuaries and their dense plant and animal communities provide food for large wintering bird populations.



Map 1.2.2 National Grid 10 km by 10 km squares included as 'coastal' for this region.

There are also smaller areas of hard substrate off the region's coast. The chalk bedrock of Flamborough Head extends 15 km offshore; here rich communities of seaweeds and invertebrates occur, some of them not found elsewhere in England. To the east of Blakeney Point isolated stretches of chalk with large flints extend seawards from the shore, especially at West Runton. These are unusual in this mainly sedimentary environment, and the substrate includes a number of animal species not found elsewhere, including a wide range of crustaceans.

Estuarine shores

Estuarine shores comprise a range of habitats in sheltered locations, based on soft sediments with a saline or brackish-water influence, including mud and sand flats, saltmarsh, lagoons and grazing marsh, all of which are present in the region. Four estuaries identified in the Nature Conservancy Council's Estuaries Review (Davidson *et al.* 1991) occur in the region. These include two major estuaries, the Humber and The Wash, and the tidal system of Breydon Water and the Norfolk Broads; taken together with the estuarine area associated with the barrier islands of north Norfolk, they represent 18% of the UK resource. The Humber estuary in the north, at 30,000 ha, is one of the largest coastal plain estuaries in Britain and has a number of rivers, in particular the Yorkshire Ouse and the Trent, draining into it. Its catchment covers about one-fifth of England and includes major conurbations such as Nottingham, Sheffield and Leeds. At 66,500 ha The Wash is the largest estuary in Great Britain. As with the Humber it has been extensively enclosed, with at least 47,000 ha of tidal land being claimed since Roman times. All the region's estuaries are of major importance for wintering waterfowl, and in autumn and spring, migrating birds also occur in significant numbers.

The extensive saltmarshes of the region include those of The Wash, which make up the largest continuous area of saltmarsh in Great Britain, representing almost 10% of the total resource. They have been greatly altered over many

years, as enclosure for agriculture has led to a progressive loss of upper saltmarsh and transitions to swamp and tidal woodland. Today saltmarsh continues to accrete in front of sea walls but there is an overwhelming preponderance of lower-level vegetation communities (61% low/mid marsh). By contrast the saltmarshes of the north Norfolk coastal system, which are also extensive (approximately 2,000 ha), are largely unenclosed. As a consequence they retain transitional habitats, which are particularly important where they abut sand dunes. Several rare plant species occur in these transitional habitats, to which a number of them are restricted. They include matted sea-lavender *Limonium bellidifolium*, which in Great Britain is confined to this region, and sea heath *Frankenia laevis* and shrubby sea-blite *Suaeda vera,* which are species characteristic of warmer climates including the Mediterranean. A rich and varied saltmarsh fauna is also present, including many species associated with particular saltmarsh plants that are often found in transitional habitats towards the upper levels of the marsh, notably in association with sand dunes. There are also extensive areas of saltmarsh/terrestrial transitional vegetation on the north Lincolnshire coast.

Cord grass *Spartina anglica* is present throughout the region but appears to have become an integral part of the early saltmarsh community rather that a dominant species. So, unlike on sites elsewhere, it is not today treated as an invasive plant requiring control. It has expanded rapidly in recent years at the expense of the tidal flats in a few relatively limited areas of more muddy substrates.

All the saltmarshes are of considerable value for birds. On The Wash, extensive grazed saltmarsh also provides grazing for a wide variety of ducks and geese. In areas where grazing pressure is reduced, densities of breeding redshank *Tringa totanus* higher than anywhere else in Britain have been recorded, in total representing 10% of the British population. Large populations of smaller birds, such as twite *Carduelis flavirostris*, snow bunting *Plectrophenax nivalis*, lapland bunting *Calcarius lapponicus* and rock pipit *Anthus petrosus*, also winter here. The largely ungrazed saltmarshes in north Norfolk are equally, if not more, important for a wide variety of breeding waders, such as the redshank. Other species, such as yellow wagtail *Motacilla flava* and skylark *Alauda arvensis*, which have been restricted in inland locations by intensive farming, also breed in large numbers and high densities. Large flocks of a variety of species, including brent geese *Branta bernicla* and wigeon *Anas penelope*, feed during the early part of the winter on the eelgrass *Zostera* spp. beds here.

Avocets *Recurvirostra avosetta* and bitterns *Botaurus stellaris* have very specialised breeding habitat requirements. There are several highly managed sites in the region in which significant breeding populations are maintained. Amongst these is Cley on the north Norfolk coast, where the bittern is found, and Titchwell and Cley, sites for the avocet.

Enclosure of saltmarsh has been a major feature of this region, with many thousands of hectares of agricultural land being created around The Wash (Fenland Basin) and the Norfolk Broads. However, some areas of enclosed marsh have not been converted to arable. These grazing marshes occur at a number of locations along the coast and inland along the flood plains. They are particularly important for some of Britain's rarest invertebrates associated with the fresh- to brackish-water dykes.

There are eight natural lagoons or lagoon complexes in the region, representing a major part (11%) of the British resource, a figure that rises to 45% if the largest lagoon, The Fleet in Dorset, is excluded. The region is particularly important for lagoons that have developed within former saltmarshes behind dune-capped former barrier islands. Several of the rare or scarce plant species recorded from this region are associated with lagoons, including two that are protected under the Wildlife & Countryside Act 1981. Three very rare lagoonal invertebrates are present and the sites in the Humber estuary are particularly important.

Sand and shingle shores

The region includes only a moderate proportion of the total area of sand dune in Great Britain (4%), although this is 19% of the resource in England. However, a substantial length of coast features a sequence of spits and barrier island dunes, together with stretches of narrow mainland dunes cut off from the active sandy beach by saltmarsh. The most important areas of dune are those along the north Norfolk coast, where the sequence of barrier islands and spits is the most extensive and geomorphologically and biologically the most important in Britain. Most of the region's sand dunes are protected as National Nature Reserves or as reserves of the local Wildlife Trust or the RSPB.

One of only five nationally rare plants of dune systems, the Jersey cudweed *Gnaphalium luteoalbum*, occurs in the region, although there are several rare and scarce species typically found on other habitats but which have important populations in the dunes in the region. There is at least one rare liverwort of international significance: *Petalophyllum ralfsii*, which occurs in dune slacks on the dunes in north Norfolk. Winterton has the only example of dune heath in the region; its vegetation has important affinities with the dunes of north Holland and Denmark, including the presence of the characteristic but rare grey hair-grass *Corynephorus canescens*. The region's dunes are also outstanding for their invertebrate fauna, which includes many scarce species. The small but interesting dunes at Spurn Head and those at Saltfleetby/Theddlethorpe and Gibraltar Point are probably amongst the very best sand dune invertebrate sites in Britain. Sandwich and little terns occur in significant populations on the sand/shingle shores at Blakeney Point.

Several important shingle beaches and structures occur in the region, mostly in north Norfolk. The most important is Blakeney Spit, which stretches some 12 km westwards from Cley village, ending in a series of classic sand-covered recurves. There are a variety of shingle plant communities, which range from the open areas dominated by sea kale *Crambe maritima* to those that are more stable and have a matrix of sandy shingle with a turf including red fescue *Festuca rubra*. Blakeney Spit has a specialist invertebrate fauna that includes a moth whose larvae feed exclusively on sea pea *Lathyrus japonicus*, a species confined to shingle shores.

Sea cliffs

There are very few cliffs of any height in the region. The steep chalk cliffs of Flamborough Head and Bempton Cliffs rise up to 120 m and are exposed to the strong north-easterly gales. Pockets of maritime vegetation occur, as do significant populations of a number of cliff-nesting seabirds.

Internationally important populations of three species - kittiwakes, guillemots and razorbills - are present. These cliffs also support the only mainland colony of gannets *Morus bassanus* in England.

Other cliffs, mostly under 30 m high, are largely glacial in origin. Many have been artificially protected by a variety of physical structures, which obscure important geological features. Where they remain unprotected, as on the Holderness coast, they are prone to erosion and few opportunities arise for biological interest to develop. However, a mixture of flush communities, unstable communities and scrub, including good populations of a number of orchids, has developed on the 60 m high cliff at Overstrand, despite it being one of the few unprotected cliffs on the Norfolk coast.

1.2.4 Landscape and nature conservation

The high value of the region for landscape and nature conservation is reflected in the number and combined extent of sites afforded official protection. There are 56 Sites of Special Scientific Interest (SSSIs), nine coastal National Nature Reserves (NNRs), ten Special Protection Areas (SPAs) (one shared with Region 5) designated for their importance for birds, eight designated Ramsar sites - a relatively high number when compared with most other regions - and one Biosphere Reserve. In addition there are three Heritage Coasts, extending over 101 km, one National Park (NP) (The Broads), and one Area of Outstanding Natural Beauty (AONB), covering 45,100 ha (the North Norfolk Coast). The voluntary conservation movement also has a good presence in the area. The area covered by the each of the main designations is given in Table 1.2.1, although it should be noted that sites frequently have more than one designation, whose boundaries are not necessarily the same.

Table 1.2.1 Main landscape and nature conservation designations in Region 6

Designation	*No. of sites in region*	*Total area in region (ha)*	*Regional % of area/length in GB so designated*
Biosphere Reserve	1	5,497	20.2
Ramsar	8	93,944	37.4
SPA	9.5*	95,279	36.1
NNR	9	17,260	20.1
SSSI	56	97,109	13.9
LNR	1	453	3.4
National Trust	15	3,800	6.1
Wildlife Trusts	23	3,047	13.0
RSPB	10	5,033	13.5
Heritage Coast	3	101**	6.6
AONB	1	45,100	5.1
NP	1	27,200	3.6

Key: *One site lies half in this region and half in Region 5 - see section 7.1; **length (km); SPA = Special Protection Area; NNR = National Nature Reserve; SSSI = Site of Special Scientific Interest; LNR = Local Nature Reserve; RSPB = Royal Society for the Protection of Birds; AONB = Area of Outstanding Natural Beauty; NP = National Park.

1.2.5 Human activities, past and present

The archaeological record shows that humans have been present in the area for more than 9,000 years; there are numerous historic sites. Throughout the post-glacial period there have been episodes of both rising and falling sea levels. Submerged forests and peat beds occur throughout the region. People once roamed and hunted across vast areas now covered by the North Sea, evidence of human presence having been obtained from depths of 50 m offshore. The Humber estuary has been navigated for at least 3,500 years and there is an extensive legacy of offshore shipwrecks, many of which remain to be investigated. At Ingoldmells the traditional production of salt by the evaporation of sea water has been found to date from as early as the 4th century BC.

Now much of this coastal region is relatively sparsely populated and predominantly agricultural. The city and port of Hull and the surrounding area of Humberside represent the only major coastal infrastructure development. Major industry on enclosed tidal land mirrors some of the development in the metropolitan counties of Tyne & Wear and on Teesside (Region 5).

Of the coastlines of the UK, this region's is probably the one most modified by human activity. The scale of change over time has been enormous, with much of the region's coast now having an artificial contact with the sea. Throughout the region there are extensive sea walls, banks, groynes and other structures, and their continued maintenance is becoming more and more expensive. This is particularly important as relative sea level in the region is known to be rising, at a rate of 2-4 mm per year in The Wash (Cambridge Environmental Research Consultants 1992). Since a large part of the Fens lies below the +5 m contour OD, the risk of flooding is thought to be greater there than for any other area in Great Britain. Most often coastal works have been not for infrastructure development but to prevent cliff erosion or inundation of formerly tidal land enclosed for human use. The most notable example is the progressive enclosure of saltmarshes around The Wash, which continued in a piecemeal fashion from Roman times up to the 1970s. Much of the claimed land is in agricultural use, mostly intensive arable farming, and is some of the most productive land in Great Britain. However, as a consequence, in the major estuaries the area of tidal land is much smaller than existed historically.

The presence of extensive offshore sand and gravel deposits makes the region particularly attractive for marine aggregate dredging. The ports in the region, notably on Humberside, account for 1.4% of the total quantity of aggregates landed in British ports. Although much of the material dredged from near the Humber is used locally, much of the rest (some 30% of the aggregate extracted) is transported to the south-east. Navigational dredging is also important, and in the UK in 1992, 34% of the dredged spoil dumping at sea occurred in this region. Dredging takes place to maintain deep water channels, especially in the Humber.

Offshore gas production is important: the Southern Basin gas fields begin 25 km off north-east Norfolk, and land-fall is made at Bacton. To the north there are extensive areas of exploitation, and gas is brought ashore at Theddlethorpe and at Easington on the Holderness coast.

While not rivalling the largest of the south, south-west

and north-west coastal resorts, the region's coastal tourist resorts are still notable on a national scale. The Norfolk coast between Snettisham and Cromer has an important tourist industry and the Broads are very popular for their natural beauty and wildlife. The North Norfolk Coast Area of Outstanding Natural Beauty is the subject of a visitor management strategy and Estuary Management Plans are being developed for the Humber and The Wash.

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The eye-catching striped cliffs at Hunstanton take their colour from the white and red chalk of which they are formed. The chalk overlies Greensand, which can be seen in the foreground as large boulders occurring in a strikingly regular grid pattern. These cliffs are one of only two major hard-rock cliff sites in the region. Photo: Nick Davidson, JNCC.

Chapter 2 Geology and physical environment

2.1 Coastal geology

British Geological Survey

2.1.1 Introduction

Table 2.1.1 shows the geological column and highlights the ages of rocks that are important in the region. Map 2.1.1 shows the solid geology of the region. In this region the coastline is dominated by a variety of later 'drift' deposits, mainly Anglian to Holocene in age and not shown on the map. These include glacial material such as tills (boulder clay). During the Anglian cold period much of the region was covered by ice, which deposited thick sheets of till and glacially-derived sediment. In the most recent (late Devensian) cold period another ice sheet covered part of the area, again depositing till. During the Holocene period some sections of the coast were subject to erosion while others were sites of sedimentary accretion. In the Humber estuary, The Wash, and to a lesser extent elsewhere, the natural accretionary processes have been interrupted by human action through the construction of sea defences and associated land claim.

2.1.2 Description

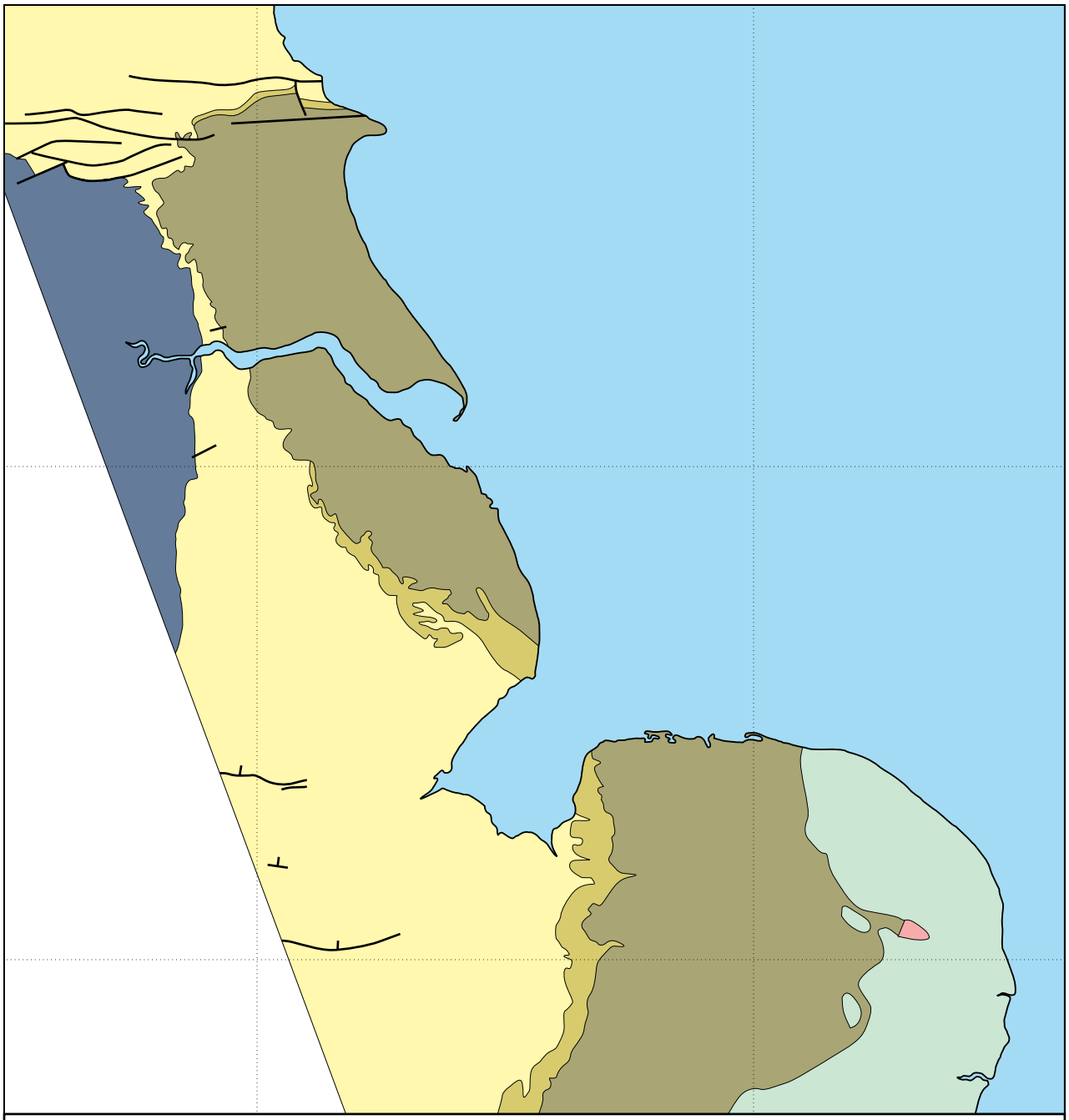
Flamborough Head — Hunstanton

The spectacular promontory of Flamborough Head is formed of Upper Cretaceous Chalk, with a cover of Devensian till. Southwards from there the actively receding Holderness coast comprises cliffs in a sequence of Devensian tills: the lower Skipsey Till and the upper Withernsea Till. There are localised areas of associated sands and gravels. Between the Humber and The Wash, till crops out in places on the foreshore, at Cleethorpes forming a low cliff partly masked by the promenade. Devensian till, referred to as the Hunstanton Till, outcrops on the eastern side of The Wash, south of Hunstanton: the most southerly known occurrence of Devensian Till in eastern Britain. At Hunstanton and to the east there is an excellent cliff section in Cretaceous strata which exposes the Carstone (Lower Greensand) in the lower cliffs, overlain in turn by the Red Chalk and the white Lower Chalk.

Table 2.1.1 Geological column

Era	*Period*	*Epoch*	*Age of start (million yrs)*	*Stratigraphic units mentioned in the text*	*Significant geological events*
Cenozoic	Quaternary	Holocene	0.01		Rapid sea-level rise
		Pleistocene		Devensian tills Anglian tills Cromer Forest Bed	Glaciations
			1.6	Crag	
	Tertiary (Neogene)	Pliocene	5.1		
		Miocene	25		
	Tertiary (Palaeogene)	Oligocene	38		
		Eocene	55		
		Palaeocene	65		
Mesozoic	Cretaceous			Chalk	
			144	Lower Greensand	
	Jurassic		213		
	Triassic		248		
Palaeozoic (Upper)	Permian		286		
	Carboniferous		360		
	Devonian		408		
Palaeozoic (Lower)	Silurian		438		
	Ordovician		505		
	Cambrian		590		
	Precambrian				

Note: Shaded boxes show ages of rocks with important or extensive exposures in the region



Stratigraphy

Pleistocene Crag	Sand, gravel, clay
Tertiary	Clay, silt, sand
Upper Cretaceous	Chalk, flint
Lower Cretaceous	Mudstone, sandstone
Jurassic	Mudstone, sandstone, limestone
Triassic	Mudstone, sandstone

Structures

Fault, tick on downthrow side

Source: British Geological Survey. Geology of the United Kingdom, Ireland and the adjacent continental shelf. 1:1,000,000 scale (1991).

Map 2.1.1 Onshore coastal geology ('drift' positions not shown)

North Norfolk coast — Great Yarmouth

Between Sheringham and Great Yarmouth, cliff sections expose a sequence of Anglian tills and associated sands and gravels. The tills include the (older) red-brown Cromer Till and its equivalent till layers within the Corton Formation of the Great Yarmouth district, and the (younger) olive-grey Lowestoft Till with conspicuous Chalk fragments contained within it. The sands and gravels include layers rich in broken shell debris, probably derived from Pleistocene Crag deposits. In the north Norfolk sections this glacial sequence has locally suffered intense folding and faulting due to glacial action, and has been referred to as 'contorted drift'. At West Runton, where the Chalk crops out on the foreshore, the glacial drift includes rafts of Chalk that may be tens of metres across. The north-east Norfolk coastal section also provides exposures of the Cromer Forest Bed, a pre-Anglian organic deposit underlying the glacial drift. This layer has proved to be an important source of bones, of both large and small extinct vertebrates. The underlying Pleistocene Crag (below the 'drift') is also exposed in a few places.

Traced southwards along the north-east Norfolk coastal section, the deformation of the Anglian glacial deposits becomes less intense, with sub-horizontal stratification preserved in the Corton Formation just north of Great Yarmouth.

2.1.3 Further sources of information

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Detailed descriptions of Geological Conservation Review (GCR) sites can be found in published volumes of the Geological Conservation Review. See also section 7.4 for a discussion of the GCR sites in the region.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Geological information for Region 6 and the whole of Britain	Coastal Geology Group, British Geological Survey, Keyworth, Nottingham NG12 5GG, tel: 0115 936 3100
Geological Conservation Review sites in North Humberside	*Conservation Officer, English Nature, North and East Yorkshire Local Area Team, York, tel: 01904 432700
Geological Conservation Review sites in South Humberside	*Conservation Officer, English Nature, Humber to Pennines Local Area Team, Wakefield, tel: 01924 387010
Geological Conservation Review sites in Lincolnshire	*Conservation Officer, English Nature, East Midlands Local Area Team, Grantham, tel: 01476 68431
Geological Conservation Review sites in Norfolk	*Conservation Officer, English Nature, Norfolk Local Area Team, Norwich, tel: 01603 620558

* Starred contact addresses are given in full in the Appendix.

2.2 Offshore geology

British Geological Survey

This section deals briefly with the geology of the rocks and sediments at and below the sea bed. The bulk of the information is shown on the maps, with some additional explanation provided by the text.

2.2.1 Holocene sea-bed sediments

Sea-bed sediments are defined here as the unconsolidated sediments at sea bed laid down since the sea transgressed across the area following the early Holocene rise in sea level. This is an area of complex sea-bed sediment distribution (Map 2.2.1), with Holocene sediments generally forming a veneer less than 1 m thick. Exceptionally, the sand-rich sediments comprising the Norfolk Banks in the south-east of this region attain a maximum thickness of about 40 m, but the intervening gravelly sand substrate remains thin. Extensive sheets of gravel and sandy gravel occur off the coasts of Lincolnshire and Humberside. The gravels off the Humber estuary have a varied composition: Carboniferous sandstone and limestones are particularly common, but chalk, Jurassic mudstone, flint and igneous and metamorphic rock types are also found. The gravels are believed to be derived by marine winnowing of glacial moraines and outwash fans deposited during the Devensian glaciation.

2.2.2 Pleistocene geology

Map 2.2.2 shows the offshore Pleistocene deposits of the region. The extensive deposits of till (boulder clay) of the Bolders Bank Formation (shown as QLP/1 and QLP/2 on the map) date from the last (late Devensian) glaciation. The till is a stiff, reddish to greyish brown clay containing patches of sand and silt. Its clasts (component particles) of chalk, red sandstone and grey mudstone are derived from the sedimentary rocks of eastern England. Over much of the region the Bolders Bank Formation is less than 5 m thick, although the till thickens toward the coast of Lincolnshire, where it may be 15-20 m thick.

To the north-east of Norfolk, south of the limit of Devensian ice advance, the sediments consist of discontinuous Upper Pleistocene lacustrine sands and muds, and Lower to Middle Pleistocene deltaic sediments (lagoonal clays, sands with plant remains, worn shells and pebbles of the Yarmouth Roads Formation).

Further to the south-east, offshore from east Norfolk, Early Pleistocene deposits comprise shelly grey marine sands with silt parings (Red Crag Formation) and grey marine clays and fine-grained sands (Westkapelle Ground Formation), equivalent to the upper parts of the Red Crag Formation onshore. Early to Middle Pleistocene deposits comprise fluviatile or estuarine sands with clay laminae and flint pebbles (Yarmouth Roads Formation). There is also a tongue of Late Pleistocene sediments (the Brown Bank Formation), comprising silty clays and fine sands, deposited in estuarine or fluviatile environments.

2.2.3 Solid (pre-Quaternary) geology

Rocks formed before the start of the Quaternary period (1.6 million years BP) are included by geologists in the category of 'solid geology'. Offshore in this region the solid geology is largely concealed by sea-bed sediments and drift (Map 2.2.3).

Most of the offshore area extending from north-east Norfolk to Flamborough Head (often referred to as the East Midlands Shelf) is underlain by Upper Cretaceous fine-grained limestones (Chalk Group). The Chalk may contain layers of flint, either as nodules or tabular sheets, as well as harder cemented chalk horizons (hardgrounds), but near Flamborough the Chalk it is almost flint-free. Tertiary rocks, mainly Eocene and Palaeocene sandstones and mudstones, underlie the Quaternary sediments east of the Norfolk coast. A variety of Lower Cretaceous and Jurassic sediments underlie The Wash and form the sea floor north of Flamborough Head.

2.2.4 Further sources of information

A. Maps

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British Geological Survey. 1988. *East Anglia.* Sheet 52°N-00°, Sea-bed sediments. 1:250,000 series.

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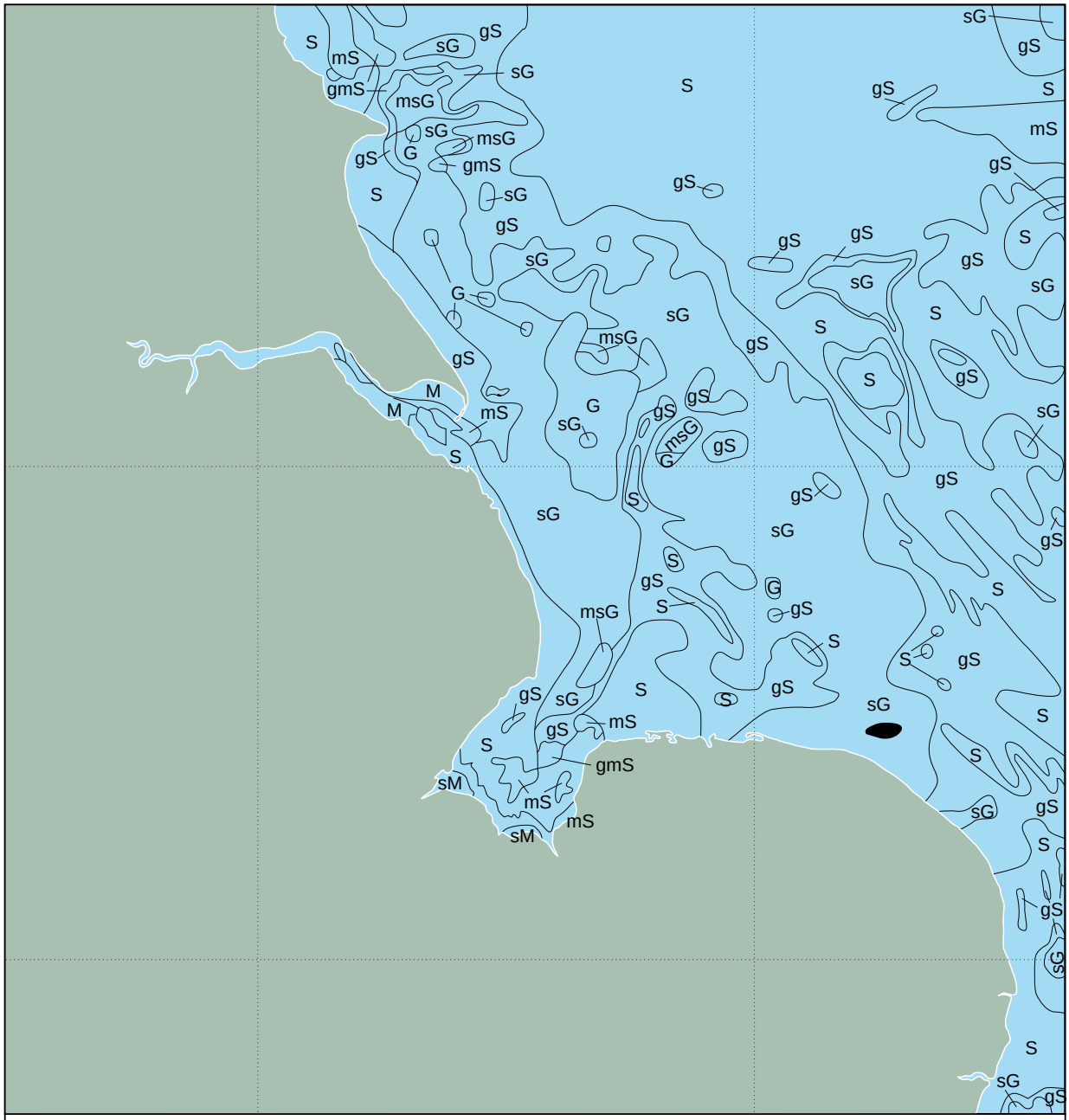


Key to sea-bed sediment symbols

M	Mud	gS	Gravelly sand
sM	Sandy mud	G	Gravel
gM	Gravelly mud	mG	Muddy gravel
S	Sand	msG	Muddy sandy gravel
mS	Muddy sand	sG	Sandy gravel
gmS	Gravelly muddy sand		

Areas of extensive rock at seabed

Source: British Geological Survey. Sediment classification modified after Folk, R.L. 1954.

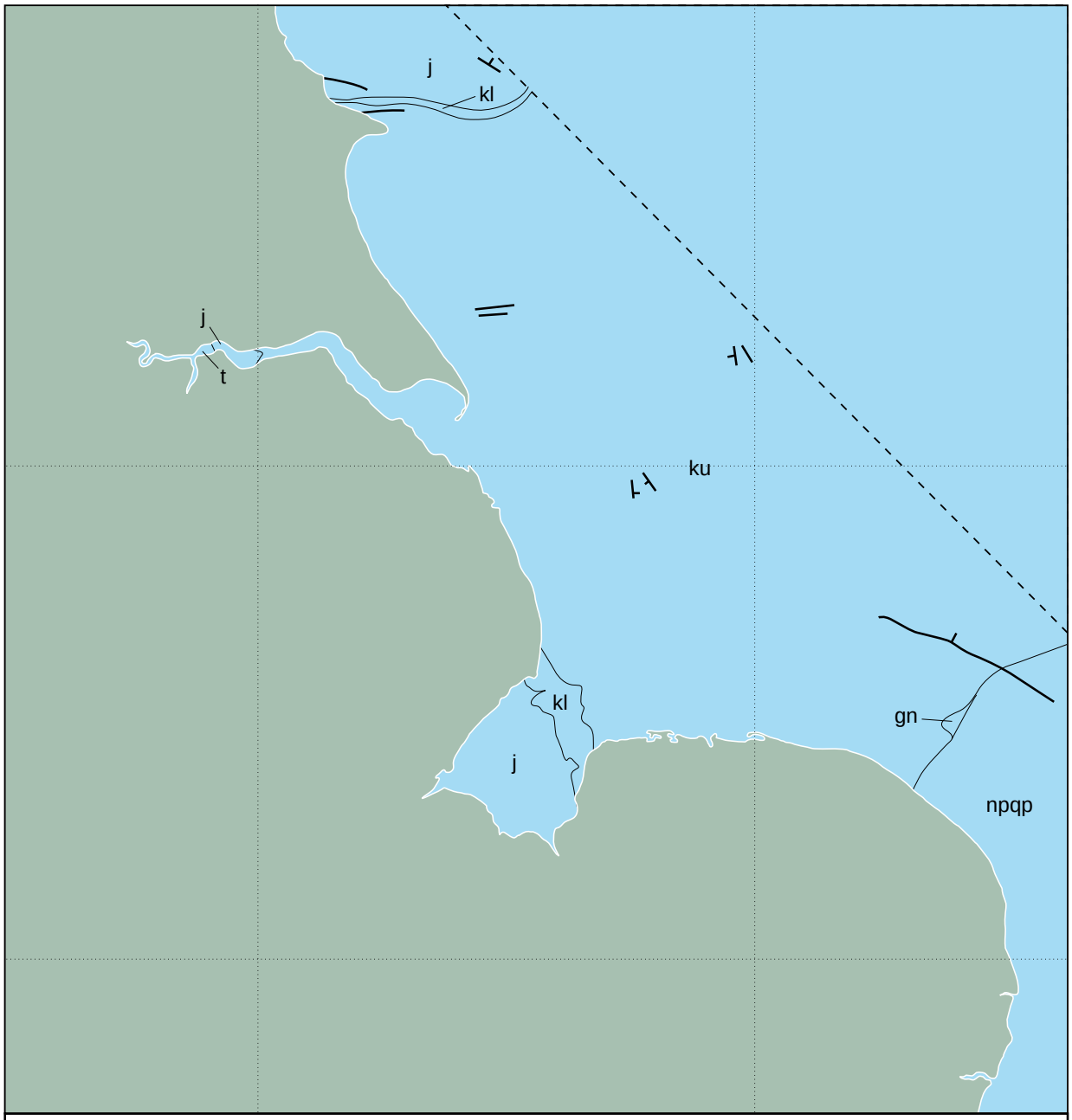
Map 2.2.1 Sea-bed sediments

Key to symbols

QLP	Late Pleistocene to Early Holocene	1	Predominantly till
QMP	Middle Pleistocene	2	Predominantly mud
QEP	Late Pliocene to Early Pleistocene	3	Predominantly interbedded mud and sand
Q	Quaternary, undivided	4	Predominantly sand
Q<5	Quaternary generally < 5 m thick	5	Predominantly gravel
ND	No data	6	Predominantly incision and channel deposits

Source: Adapted from Holmes, R., Jeffrey, D.H., Ruckley, N.A. and Wingfield, R.T.R. 1993.

Map 2.2.2 Offshore Pleistocene deposits



Stratigraphy

		Rock Types
npqp	Pleistocene Crag	Sand, gravel, clay
gn	Tertiary	Clay, silt, sand
ku	Upper Cretaceous	Chalk, flint
kl	Lower Cretaceous	Mudstone, sandstones
j	Jurassic	Mudstone,sandstones, limestones
t	Triassic	Mudstone, sandstones

Fault, tick on downthrow side

Source: British Geological Survey, 1991.

Map 2.2.3 Offshore pre-Quaternary geology

C. Further reading

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D. Contact names and addresses

Type of information	*Contact address and telephone no.*
Geological information for region and the whole of Britain	Coastal Geology Group, British Geological Survey, Keyworth, Nottingham NG12 5GG, tel: 0115 936 3100
UKDMAP 1992. Version 2. United Kingdom digital marine atlas. Oceanographic maps	British Oceanographic Data Centre, Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, tel: 0151 652 3950

2.3 Wind and water

British Geological Survey

2.3.1 Wind

In this region prevailing wind direction changes with the seasons. During the winter and early summer north-easterly winds are as common as south-westerly ones, but from July to September south-westerly and westerly winds predominate. Figure 2.3.1 shows that over the whole year westerly winds are commonest. The windiest months are December and January, when winds of Beaufort Force 7 (14-16.5 metres per second (m/s)) or more blow for six to ten days a month, and the least windy months are May to August with, on average, from one to three days of Force 7 (or greater) winds. On about half of these occasions winds reach gale Force 8 (17-20 m/s), the frequency of gales in the region decreasing from north to south (Maps 2.3.1 and 2.3.2). Land and sea breezes and topographical effects complicate the pattern of winds, and gales are less common on land than at sea.

During the summer there are occasional thundery squalls of Force 7 or more. These usually occur less than once a month near the land, but there are one or two destructive squalls of Force 8 or more in most years along some part of the coast. Squalls associated with cold fronts may occur in any season, and the showers of hail, sleet or snow that are common in winter and spring, during periods with north-westerly or northerly winds, often give rise to sudden changes in direction and speed of the wind.

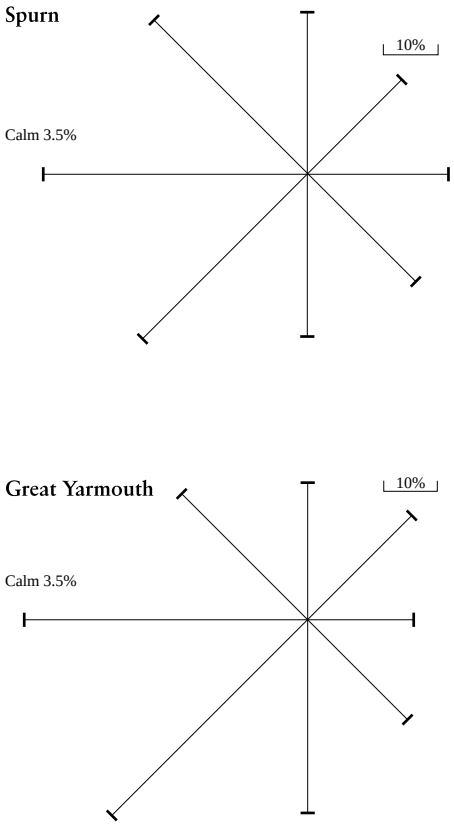
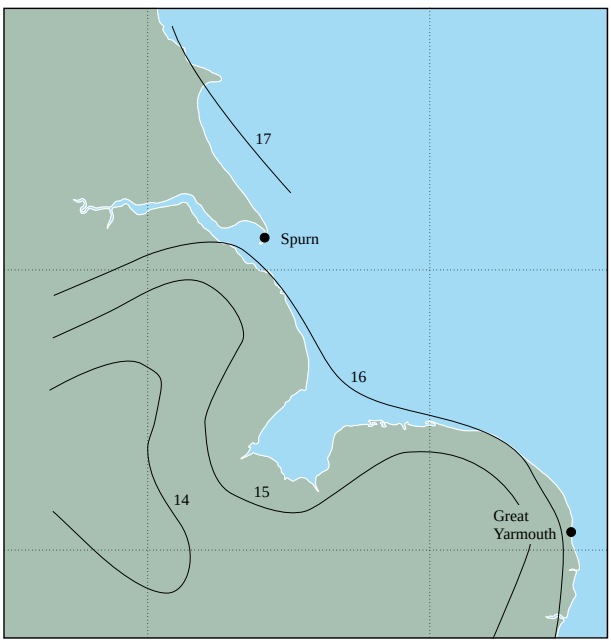


Fig 2.3.1 Wind directions at Spurn and Great Yarmouth shown as % of observations through the years 1913 - 1950. Source: Hydrographic Department (1960).

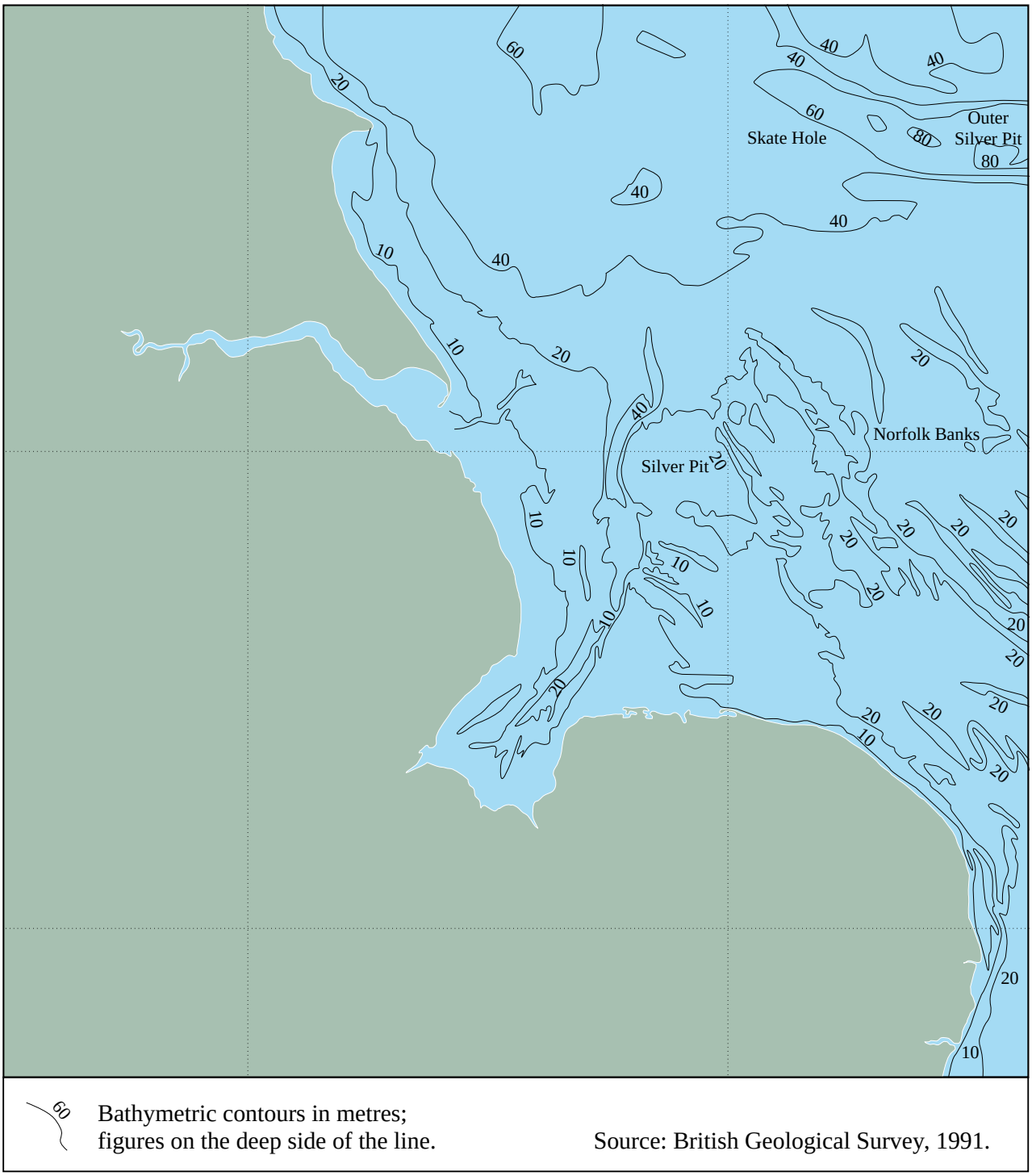
2.3.2 Water depth

Water depths vary considerably in this region (Map 2.3.3). Off the north-east Norfolk coast the 20 m bathymetric

Map 2.3.1 Hourly mean windspeed (in m/s) exceeded for 75% of the time. Source: Caton (1976).



Map 2.3.2 Hourly mean windspeed (in m/s) exceeded for 0.1% of the time. Source: Caton (1976).



Map 2.3.3 Bathymetry

contour marks the limit of the Norfolk Banks that run parallel to the shore. The elongate depression of the Silver Pit north-east of The Wash extends seaward into a broad area of relatively flat seafloor. In the north-east of the region water depths exceed 80 m from Skate Hole to the Outer Silver Pit.

2.3.3 Tidal currents

The tidal waters offshore from this coast flood southwards and ebb northwards. Maximum tidal current increases southwards (Map 2.3.4), as does the tidal range. Closer inshore, water flow is affected by coastal form and bathymetry. The maximum flood flow velocity is generally higher than the maximum ebb flow, resulting in a net littoral drift to the south. Tidal streams run strongly off prominent headlands, producing speeds of 1.5 m/s at Flamborough Head and giving rise to turbulence and eddies on both sides of the promontory.

The tidal currents within the Humber are strong and produce a complex tidal flow within the network of channels and sandbanks. At the entrance to the Humber Estuary the streams run very strongly on the north side and around Spurn Head (2.0 m/s) but they are generally weaker on the south side. Within The Wash the tidal streams set in the direction of the principal channels. The incoming stream is usually stronger than the outgoing stream, leading to deposition and gradual accumulation of sediment.

2.3.4 Tidal range

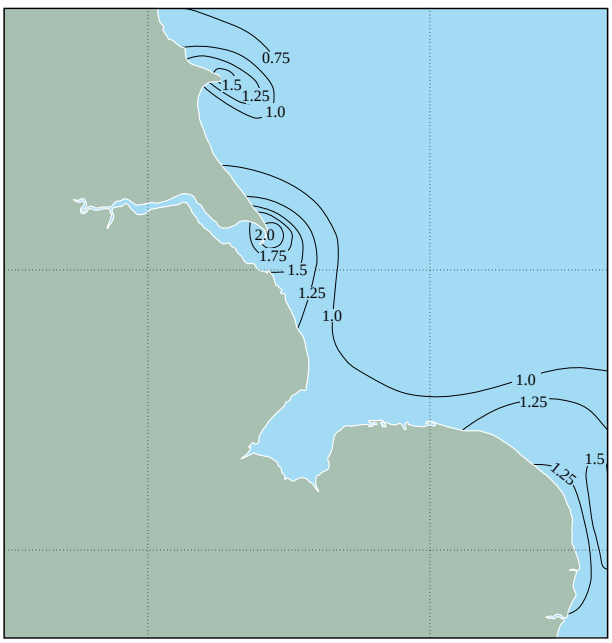
The tidal ranges found along the coast of this region (Map 2.3.5) are larger than those elsewhere in the North Sea: as the tide flows southwards down the eastern coast of Britain, water tends to pile up along the coast, owing to the effect of the earth's rotation. As the ebb tide flows northwards six hours or so later, the reverse happens and water moves away from the coastal zone. The net result is to cause higher high waters and lower low waters than might otherwise be expected. The mean spring tidal range increases from 5.0 m at Flamborough Head to 6.0 m at the Humber and to 6.5 m in The Wash.

Low atmospheric pressure may raise the water level in this region, with dramatic effects, especially when associated with northerly winds which force water into the narrowing funnel of the southern North Sea. Tidal ranges may be up to 30% greater during gales. The resulting extremely high tide levels, which increase in height towards the south, are known as surges. During surges, high water levels may be sustained for periods of up to several hours. Extreme conditions along the coast may arise if the surges coincide with high water spring tides, as was the case in 1953, when major flooding occurred along the low lying coasts of Holderness, Humberside, Lincolnshire and Norfolk.

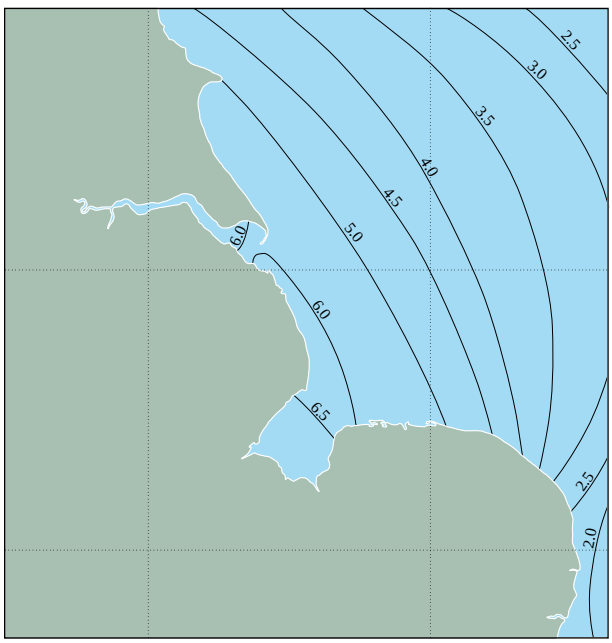
2.3.5 Wave exposure and sea state

The coast immediately south of Flamborough Head is sheltered from north-easterly winds but is exposed to winds from the east and south-east. The wide intertidal zones near the mouth of the Humber and in The Wash provide some protection to the coast. North-east of The Wash the numerous sandbanks cause variations in wave conditions over quite small distances.

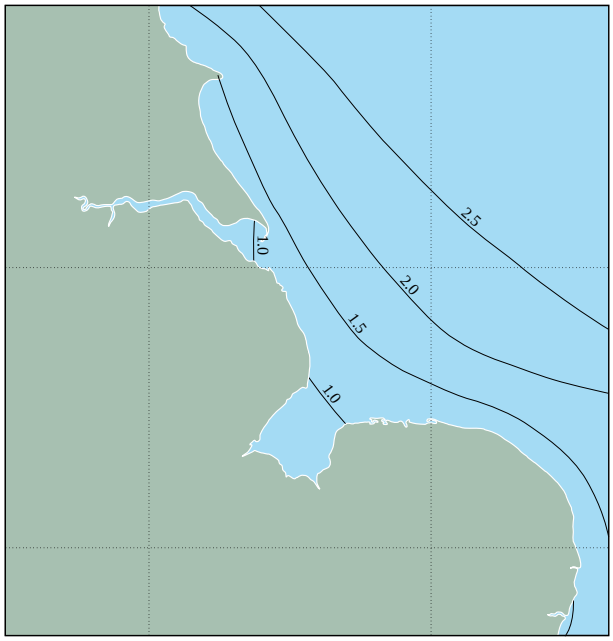
Map 2.3.6 shows the significant wave heights which can be expected to be exceeded for 10% of the year along the coast of the region. Except within the Humber and The Wash the height exceeded for 10% of the time lies between 1.0 and 1.5 m. South of Flamborough Head, for 75% of the year wave heights inshore do not exceed 0.5 m.



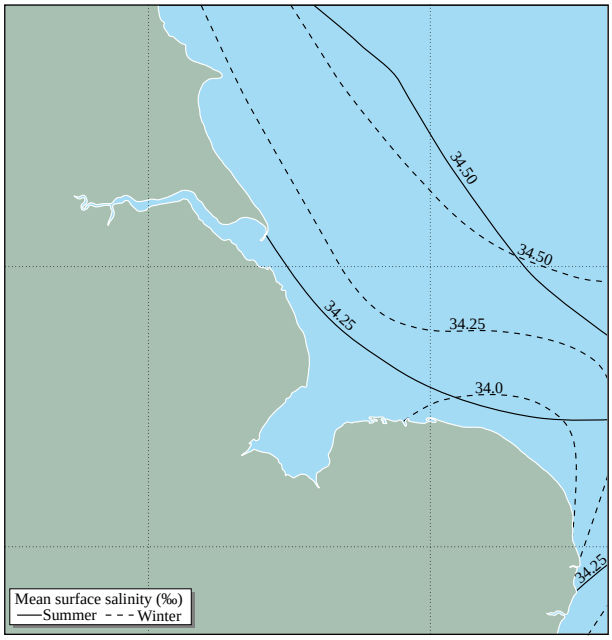
Map 2.3.4 Maximum tidal current speed (in knots) at mean spring tides. Source: Sager & Sammler (1968).



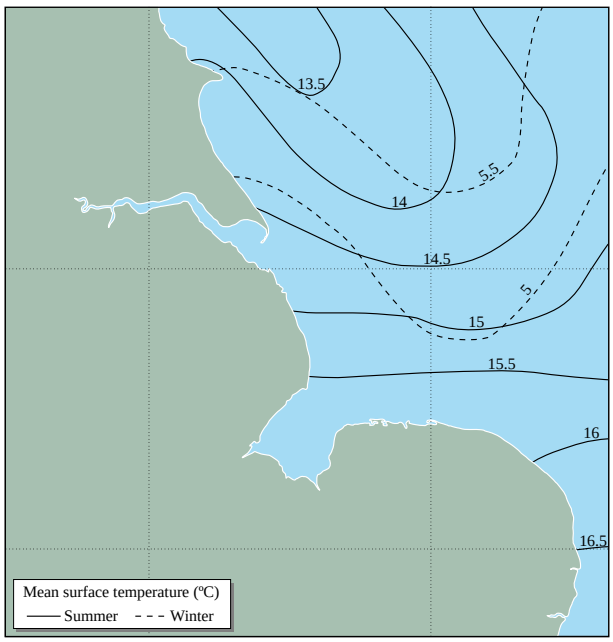
Map 2.3.5 Tidal range (m) at mean spring tides. Source: Lee & Ramster (1981). © Crown copyright.



Map 2.3.6 Significant wave height (m) exceeded for 10% of the year. Source: Draper (1992).



Map 2.3.8 Mean surface salinity of seawater in summer and winter in g/kg of total dissolved salt. Source: Lee & Ramster (1981). © Crown copyright.



Map 2.3.7 Mean surface water temperature in summer and winter (°C). Source: Lee & Ramster (1981). © Crown copyright.

2.3.6 Water characteristics

Temperature

The mean monthly sea-surface temperatures for summer and winter are shown on Map 2.3.7. Positions of summer and winter isotherms are based on data for August and February respectively, which are on average the months of warmest and coldest sea-surface temperatures. Offshore sea-surface temperatures show a significant regional variation in summer. In August temperatures increase progressively to the south (from 14 to 16.5°C), reflecting increased proximity to the warm European landmass. In February sea-surface temperatures cool slightly southwards in this region, as the European continent is relatively cold. This region is one of the coldest areas of the UK in terms of winter sea-surface temperatures, as are parts of the eastern Irish Sea (Region 13).

Salinity

The term salinity is used to describe the total weight of dissolved salts in seawater and is expressed in g/kg of dissolved salt. The values of mean surface salinity for summer and winter (Map 2.3.8) are based on data for August and February respectively. Data are averaged for the month in question.

On average, seawater salinity is below 34.25 g/kg in the coastal zone between the Humber estuary and The Wash, in both summer and winter. Tidal flows into and out of the Humber and The Wash allow mixing of saline water with freshwater, so reducing salinity.

2.3.7 Further sources of information

A. References cited

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
UKDMAP (United Kingdom digital marine atlas)	British Oceanographic Data Centre, Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, tel: 0151 652 3950
Windroses for rectangular areas defined by latitude and longitude, for monthly/ seasonal or annual periods, based on 10 or 20 years' data from ships of passage.	Meteorological Office Marine Enquiry Service, Johnstone House, London Road, Bracknell RG12 2SY, tel: 01344 854979

2.4 Sediment transport

British Geological Survey

2.4.1 Description

The coasts of the region are subject to a wide range of wave and tidal energies, these being dependent on the orientation and morphology of each coastal sector. Motyka & Brampton (1993) divided the coast of England and Wales into a number of major littoral cells and sub-cells, each defining a section of coast within which sediment erosion and accretion are inter-related and largely independent of other cells.

The region includes the coastal cell (No. 2) stretching from Flamborough Head to The Wash and part of a cell (No. 3) from The Wash to the Thames. These are divided into six sub-cells: Flamborough Head to Sunk Island, Immingham to Donna Nook, Donna Nook to Gibraltar Point, Gibraltar Point to Snettisham, Snettisham to Sheringham, and Sheringham to Lowestoft (Map 2.4.1). These are described below. Note that the sediment transport shown on the map is of sand and gravel 'bed load', not suspended sediments.

Flamborough Head – Sunk Island (Humber) (cell 2a)

Along this coast large amounts of sediment derived from cliff erosion are carried seawards and predominantly southwards by waves and tidal currents; however there is small but significant interchange of sediment around Flamborough Headland, between Filey and Bridlington Bays. Erosion in this sub-cell supplies sand to the Lincolnshire coast. From Bridlington to Spurn Head there is rapid and persistent cliff and beach erosion, which has resulted in a long-term retreat of the coastline, causing considerable loss of agricultural land. Where stretches of coast are defended there are erosion problems downdrift, including accelerated cliff retreat. Hornsea and Withernsea are becoming isolated by coastal recession and are therefore at increasing risk of beach erosion. There is little net erosion on the north shore within the Humber estuary, where sediment is accreting and saltmarsh forming.

Immingham – Donna Nook (cell 2b)

There is little littoral drift of sand into the Humber estuary from Donna Nook. Waves and tidal currents transport material southwards across the Humber estuary to the Lincolnshire coast. There is extensive open coast accretion of saltmarsh and mudflats around Cleethorpes and Humberston, while to the south of Cleethorpes there is minor local dune erosion. Further south at Donna Nook there are again extensive saltmarshes and sand accretion.

Donna Nook – Gibraltar Point (cell 2c)

Along this section of coast there is moderate southward littoral drift of sand. Tidal flows in and out of the Humber and Wash estuaries modify sediment transport processes. There is extensive open-coast accretion of saltmarsh at Saltfleet and Saltfleetby, and of dunes at Theddlethorpe. The erosion of the underlying clay unit, resulting from the erosion of the sand beach, is causing beach steepening between Mablethorpe and Skegness. South of Skegness dunes are building and the sand beach is extending seaward.

Gibraltar Point – Snettisham (cell 2d)

In The Wash there is no significant littoral drift and fine sands and silts are brought in by tidal action. Tidal currents distribute fine sediments, allowing saltmarsh to expand, particularly on the western and southern margins of the estuary.

Snettisham – Sheringham (cell 3a)

This is predominantly an accretionary sub-cell with an offshore supply of sand and silt, together with a supply of pebbles from the east. There is a moderate rate of westward drift from Sheringham to Hunstanton, reducing to near zero at Snettisham. Both waves and currents are important; waves dominate coastal processes east of Blakeney; westwards to Snettisham, tidal flows become increasingly important, particularly on the lower part of the foreshore. Saltmarsh is developing in the lee of shingle spits between Hunstanton and Blakeney. Between Hunstanton and Holme, sand dunes experience seasonal erosion. Particularly from Cley to Weybourne, there is some evidence of landward retreat of shingle ridges and, east of Weybourne, continued erosion of soft sand/clay cliffs. The eastern boundary of this sub-cell, at Sheringham, is a drift divide that tends to shift position from time to time, owing to minor variations in wave conditions.

Sheringham – Lowestoft (cell 3b)

Both waves and tidal currents play an important role in changing the coast of this sub-cell, where there is a high drift rate to the east and south. A number of major elongated sand banks are found off the coast and residual currents around these banks are linked with beach processes. The 'nesses', such as Winterton Ness, are points of accretion. Cliff erosion is widespread and locally rapid, and during some periods erosion affects the predominantly accreting sand dunes and nesses.

2.4.2 Further sources of information

A. References cited

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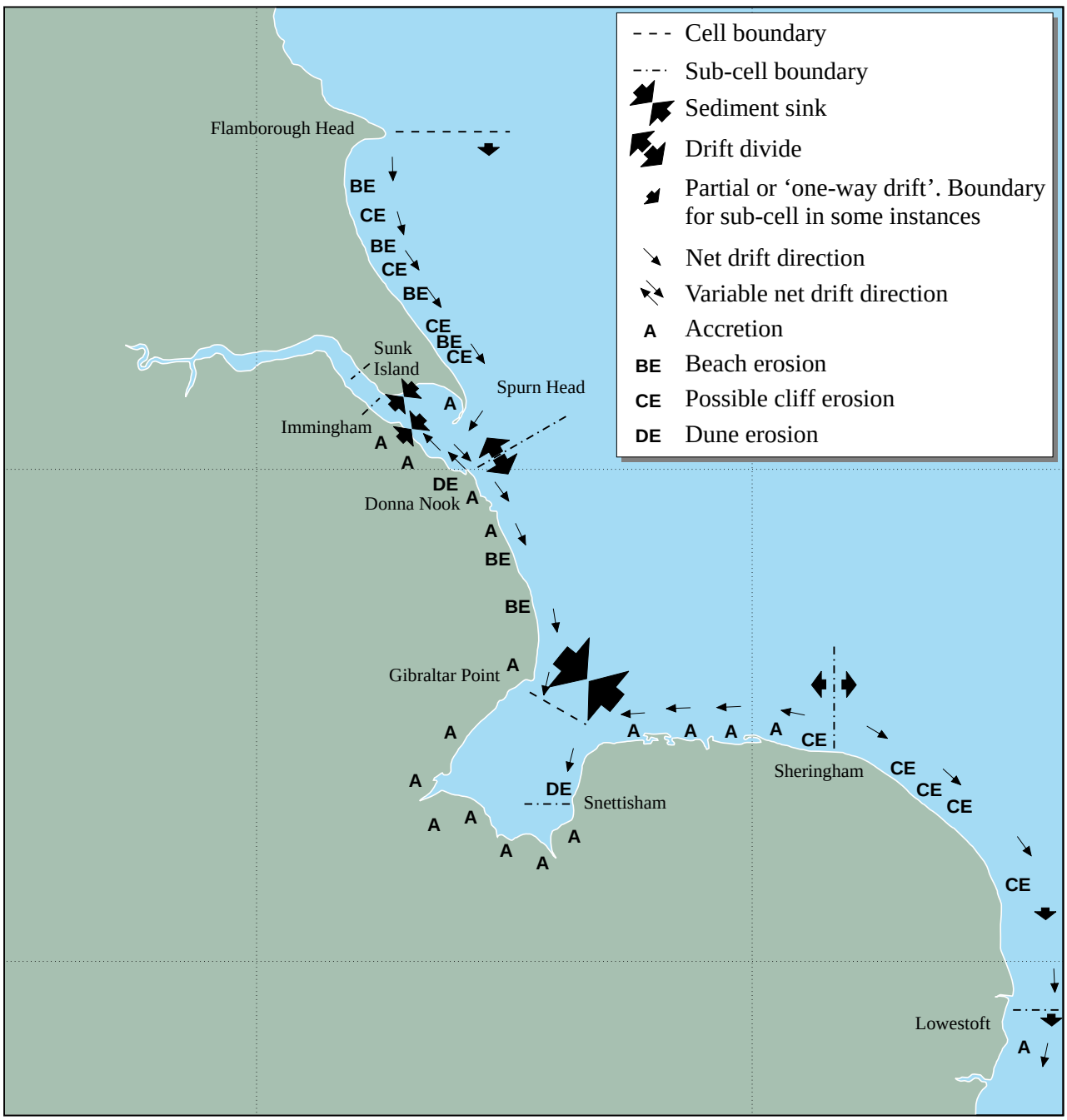
B. Further reading

Cambridge Environmental Research Consultants. 1992. *Coastal processes and conservation: The Wash*. Peterborough, unpublished report to English Nature.



Map 2.4.1 Sediment transport and coastal cells. Source: Motyka & Brampton (1993). Adapted with permission from MAFF Flood and Coastal Defence Division.

Hydraulics Research. 1986. *A macro review of the coastline of England and Wales. Vol.2. The Tees to the Wash.* Wallingford, Hydraulics Research, Report SR 107.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Coast protection policy; coast protection survey of England; sediment cells	*Ministry of Agriculture, Fisheries and Food (MAFF), Flood and Coastal Defence Division, London, tel: 0171 238 3000
Sediment cells	Institute of Hydrology, Crowmarsh Gifford, Wallingford, Oxfordshire OX10 8BB, tel: 01491 838800
North Sea Project data set CD ROM	British Oceanographic Data Centre, Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, tel: 0151 652 3950

* Starred contact addresses are given in full in the Appendix.

The golf course at Brancaster, Norfolk was laid out on dunes in the lee of the growing tip of Scolt Head Island. In recent years it has been increasingly threatened by erosion of the beach and foredunes, as patterns of sediment deposition have shifted in response to natural coastal processes and the construction of coast protection works. Photo: Pat Doody, JNCC.

2.5 Sea-level rise and flooding

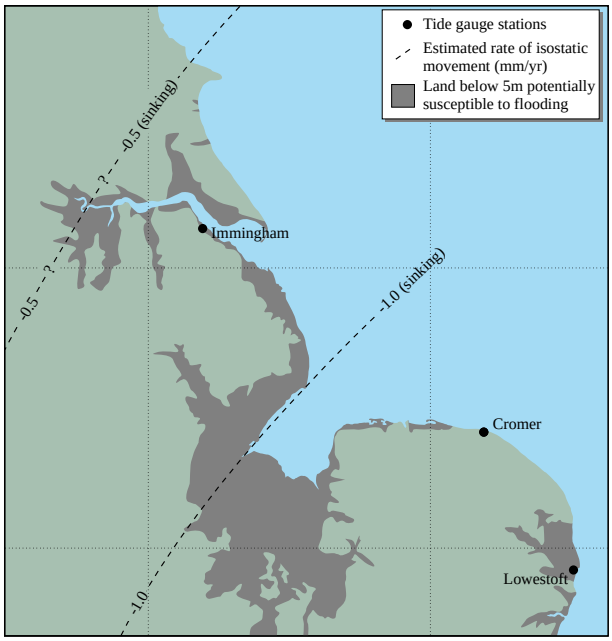
British Geological Survey

2.5.1 Description

Apparent sea-level rise in the region is the combined effect of local crustal movements (Scotland is rising whereas southern England is sinking, owing to the removal of the weight of ice since the last glacial period) and global rises in sea level.

There are a number of detailed studies of the evidence for sea-level rise and crustal movement (e.g. Shennan (1989), Carter (1989), Woodworth (1987) and Emery & Aubrey (1991)). The tide gauge data examined by Emery & Aubrey (1991) suggest that sea level across the region is rising at between 0 to 2 mm/year. Shennan (1989) estimated the region's coast to be subsiding currently at about 0.5 mm/year at Flamborough Head and possibly over 1.5 mm/year at Great Yarmouth. This subsidence re-enforces the global rise in sea level to produce a faster rise in relative sea level along the region's coast than in any other part of Britain except the Thames estuary. Cambridge Environmental Research Consultants (1992) estimated the relative sea-level rise in The Wash at 2-4 mm per year over the next century.

Map 2.5.1 shows that all the coast from the Humber estuary southwards to north Norfolk lies below the +5 m OD contour. Inland, much of the upper Humber estuary and around Goole lies below this level, as does all the Fens. South of King's Lynn the area below this level is over 60 km wide. The area in the Fens at risk of potential flooding is therefore the largest in the UK.



Map 2.5.1 Areas below 5 m above OD and thus susceptible to flooding; estimated rates of crustal uplift (mm/yr) after Shennan (1989) (negative values indicate subsidence).

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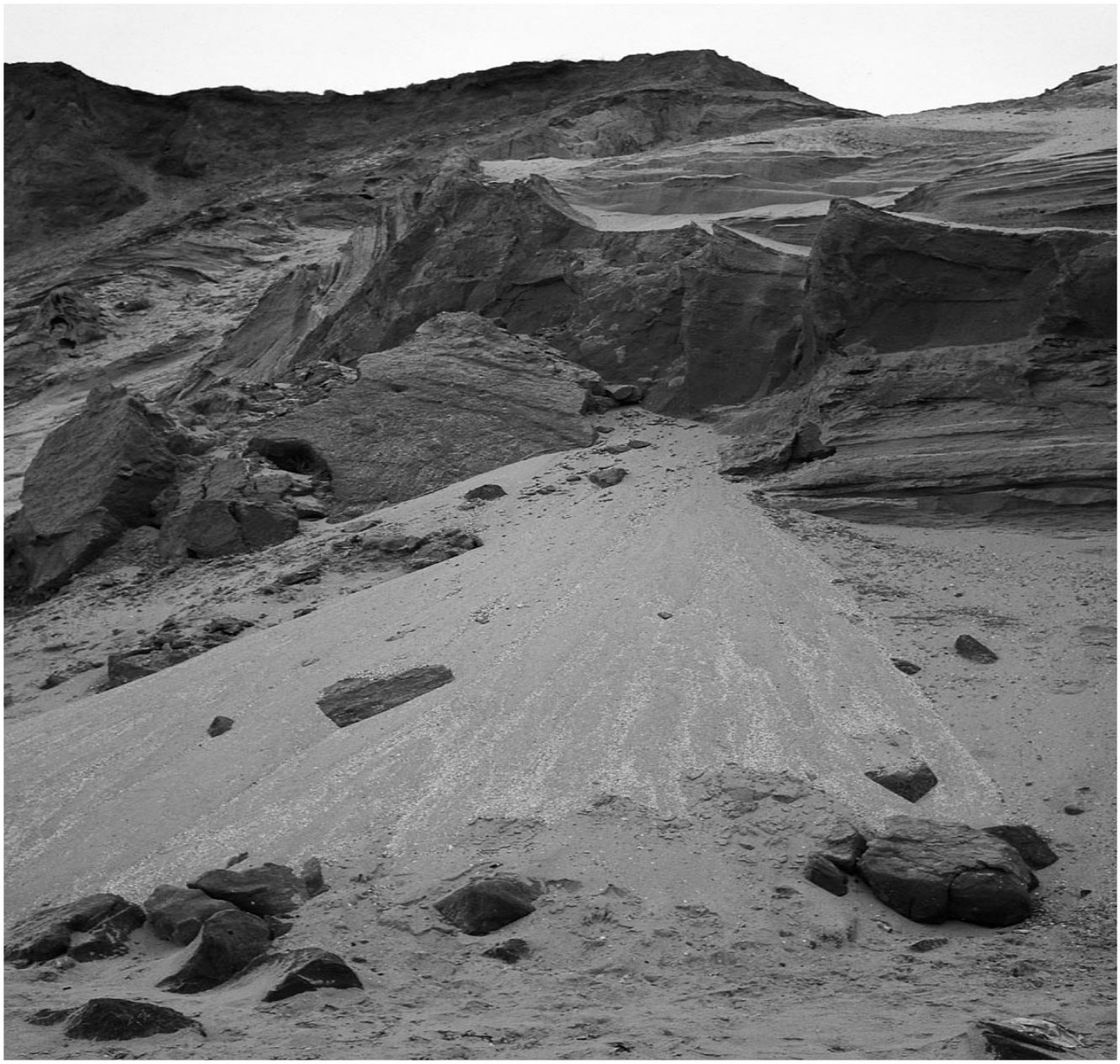
Woodworth, P. 1990. Measuring and predicting long term sea level changes. *NERC News, 15:* 22-25. Swindon, NERC.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Flood defence (see also section 8.4)	*National Rivers Authority - Anglian Region, Peterborough, tel: 01733 371811
Flood and coastal defence policy (see also section 8.4)	*Ministry of Agriculture, Fisheries and Food (MAFF), Flood and Coastal Defence Division, London, tel: 0171 238 3000
Tide gauge data	British Oceanographic Data Centre, Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, tel: 0151 652 3950

* Starred contact addresses are given in full in the Appendix.



At West Runton, Norfolk, tumbling cliffs of sand piled into huge dunes at the end of the last ice-age are now being eroded by wind and waves. Further along these cliffs, where they cut through ancient (Pleistocene) river sediments, internationally famous fossil beds are exposed. Photo: Bill Sanderson, JNCC.

2.6 Coastal landforms

British Geological Survey

2.6.1 Introduction

This section describes the landforms of the region's coast, focusing on the areas subject to short- and longer-term accretion and erosion (Map 2.6.1; see also section 2.4). Parts of this coast are eroding, especially along the Holderness coast. Elsewhere, particularly in the estuaries of the Humber and The Wash, sediments are accreting, although any seaward extension of the shoreline may be offset by rising sea levels, especially in the south.

The Humber estuary, The Wash and the Norfolk Broads all formed valley systems during the Devensian glaciation. The valleys were flooded by the subsequent rise in sea level and have to a large extent been back-filled with Holocene estuarine sediments including peat deposits. The Devensian till deposits of Holderness and Lincolnshire mask an earlier interglacial shoreline (of Ipswichian age), parallel to but several kilometres inland from the present coast. Erosion of the soft cliffs on the Holderness coast has exposed old meres in places.

2.6.2 Description

Flamborough Head – Spurn Head

Flamborough Head is one of the outstanding coastal landforms of the region, where Chalk cliffs form sheer faces; the overlying cap of glacial till is susceptible to slumping. To the south, the relatively unstable drift deposits of the Holderness coast suffer strong erosion by waves and local currents, which render this area the fastest eroding coast in Europe, retreating by more than a metre a year on average. Along this stretch the foreshore is characterised by sandy shingle, which forms low, southward-migrating bars oblique to the shore. Between the bars there may be little beach sediment or none at all. At the southern end of this stretch of coast Spurn Head forms a shingle spit 5 km long which carries a capping of blown sand.

The Humber – Hunstanton

Intertidal mudflats characterise the shores of the Humber estuary and are particularly extensive in the lee of Spurn Head at Trinity Sands.

The Lincolnshire foreshore to the south of the Humber carries a deposit of sand in a broad intertidal tract: in various places between Cleethorpes and Mablethorpe an accretionary foreshore of muddy sand is flanked by extensive saltmarsh. Barrier beach features have built up in the last 20 years on the north Lincolnshire coast between Donna Nook and Saltfleetby. Large areas of dunes are present on the Lincolnshire coast between Donna Nook and Mablethorpe.

South of Mablethorpe the shoreline is being eroded and the beaches are relatively narrow. The sand cover is thin, and underlying till is exposed on the foreshore in places. Peat, formed in the earlier Holocene and incorporating tree stumps, rests on till at Chapel Point and Ingoldmells. At Gibraltar Point, on the north-western shoulder of The Wash, sand dunes are present and a sand spit has built up.

Channelled intertidal sandflats characterise the main part of The Wash. Mudflats form the western margin of this embayment, and saltmarsh the southern margin. The eastern shore of The Wash at Heacham is formed by a shingle bank, recently artificially recharged. To the north, the well-known cliffs of Chalk and Greensand at Hunstanton form sheer faces.

North and east Norfolk

Between Hunstanton and Weybourne along the north Norfolk shore lies the finest barrier beach system in Britain, including Scolt Head Island and Blakeney Point. The system consists of dune-capped shingle ridges, with several generations of recurved spits; they protect a well-developed tract of intertidal mud and saltmarsh, as for example at Blakeney and Wells. Inland cliffs, former sea cliffs of Holocene age, mark the inshore limit of marsh deposits, which in many places have been converted for agricultural use.

Further east along the Norfolk coast the drift deposits form cliffs, but these tend to be unstable, with degraded cliff-faces resulting from mass movement by landslip or mudflow, as for example between Sheringham and Mundesley.

Sandy shingle beaches capped by dunes protect low-lying coastal tracts at Sea Palling and Horsey, forming a narrow coastal strip. Holocene peat is exposed on the foreshore at Sea Palling. Further south at Winterton degraded cliffs define a former Holocene shoreline: at Winterton Ness there has been extensive accretion of beach deposits, now covered by sand dunes.

At Caister-on-Sea blown sand forms low dunes on the cliff top. Between Caister-on-Sea and Great Yarmouth, the Denes are a tract of sandy shingle, forming a broad accretionary barrier protecting the Broadland embayment and causing the southward diversion of the River Yare. In the Middle Ages this deposit extended as a spit as far south as Lowestoft. Intertidal mudflats form the flanks of Breydon Water behind Great Yarmouth.

2.6.3 Further sources of information

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Map 2.6.1 Major coastal landforms (estuaries here exclude upper reaches of tidal rivers)

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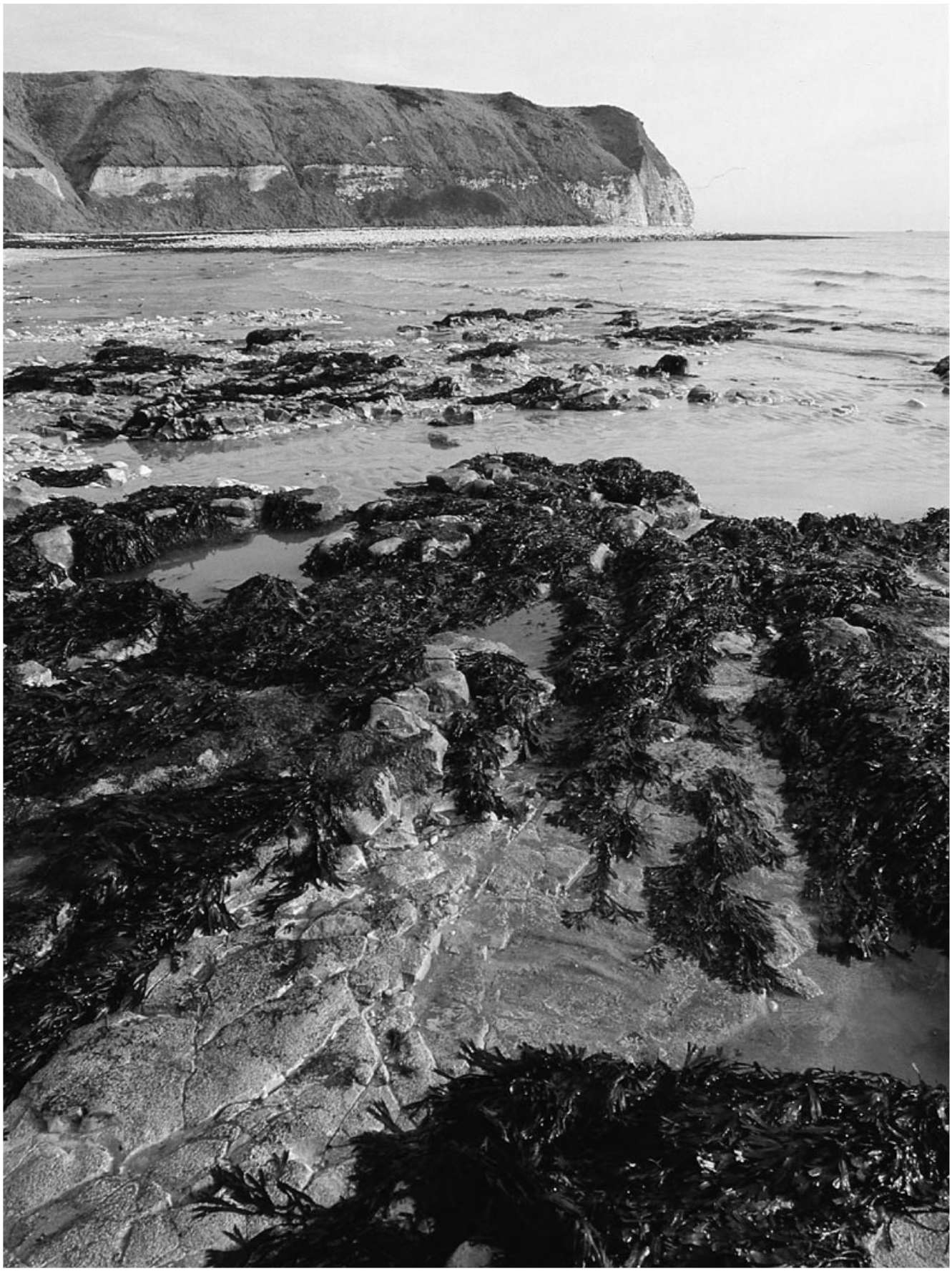
Whitaker, W., & Jukes-Browne, A.J. 1899. The geology of the borders of The Wash. *Memoir of the Geological Survey of England and Wales,* Old series Sheet 68E. London, HMSO.

B. Contact names and addresses

Type of information	*Contact address and telephone no.*
Coastal protection	*Ministry of Agriculture, Fisheries and Food (MAFF), Flood and Coastal Defence Division, London, tel: 0171 238 3000
Geomorphological information for region	Coastal Geology Group, British Geological Survey, Keyworth, Nottingham NG12 5GG, tel: 0115 936 3100

* Starred contact addresses are given in full in the Appendix.



Bempton Cliffs, on the south side of Flamborough Head, is an internationally important breeding site for kittiwakes, guillemots and razorbills, as well as having a nationally important puffin colony. The wave-cut chalk platform in the foreground is a rare feature on the British coast; both intertidally and below low-tide mark it supports a wide range of plants and animals that are uncommon elsewhere. Photo: Peter Wakely, English Nature.

Chapter 3 Terrestrial coastal habitats

3.1 Cliffs and cliff-top vegetation

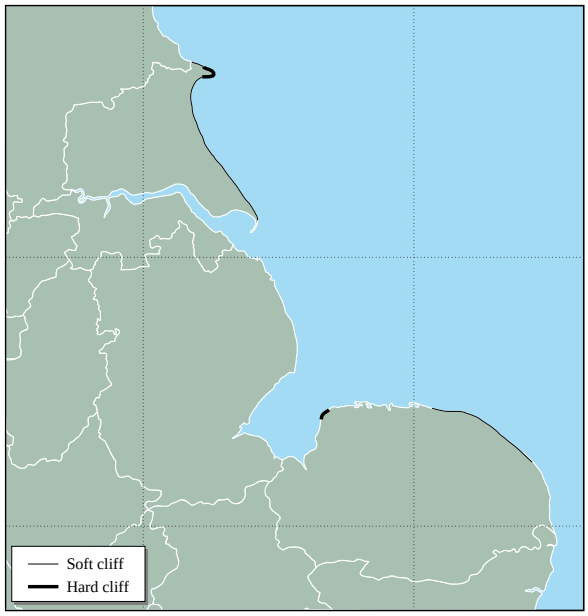
Dr T.C.D. Dargie

3.1.1 Introduction

The coast between North Humberside and Norfolk contains a moderate length of cliffed coast but has only a limited extent of semi-natural cliff and cliff-top habitats. Geology and geological structure, together with past environmental history (marine erosion past and present, and glacial processes), determine cliff form (see also sections 2.1 and 2.4). The most distinctive cliff types are consolidated (hard cliffs developed from resistant bedrock) and unconsolidated (soft cliffs developed in easily-eroded materials, including unconsolidated Jurassic shales and Quaternary deposits). The region has a total cliff length of 96.5 km (see Table 3.1.1 and Map 3.1.1), which represents 2% of the British resource. However, the total length of soft unprotected cliff is large (67 km) and represents a significant proportion (26%) of this cliff type in England. The 70 ha of maritime cliff grassland in the region represent 4% of the resource in England (1,894.8 ha) (Table 3.1.1).

Although cliffs in the region are only moderately extensive, they exhibit good diversity in form (Doody *et al.* 1993), being mostly either long steep slopes with a vertical face restricted to the base, or low cliffs with a great variety of local slope forms (Table 3.1.2). They are predominately of glacial till and fluvioglacial materials, with a short cycle of four to five years between cliff failure, removal of material by erosion, cliff steepening and further failure (Pethick 1992). However, spectacular near-vertical hard chalk cliffs capped with glacial till are present at Flamborough Head. These cliffs, which rise to 135 m and are the only ones in the region of recognised scenic value, are part of a 19 km length of Heritage Coast (Gubbay 1988; Heritage Coast Forum 1993) and form part of a proposed SAC (see section 7.2.4).

Cliff and cliff-top vegetation varies with slope angle, soil type, salt spray deposition and, locally around headlands, degree of exposure. Very sheltered cliffs and cliff-top sectors that receive little salt spray input are not here treated as coastal habitats (Mitchley & Malloch 1991). Of the twelve National Vegetation Classification (NVC) maritime cliff vegetation communities in the UK (Rodwell in prep.), ten are recorded in England, the remaining two being confined to Scotland. The full extent of cliff-top vegetation in the region has not been surveyed, but the (albeit infrequent) exposure of the coast to very strong winds and heavy spray deposition probably allows only maritime grassland to develop here, with most of this restricted to hard cliffs.



Map 3.1.1 'Hard' and 'soft' sea cliffs. Source: JNCC Coastal Database and OS Landranger maps. © Crown copyright.

Table 3.1.1 Region 6 cliff and maritime cliff grassland resource in context

Area	*Soft cliffs*		*All cliffs*		*Maritime cliff grassland*	
	Total length (km)	*% of total in Region 6*	*Total length (km)*	*% of total Region 6*	*Area (ha)*	*% of total Region 6*
Humberside	54.0	-	60.5	-	46.0	-
Lincolnshire	0	-	0	-	0	-
Norfolk	13.0	-	36.0	-	24.0	-
Region 6	**67.0**	**100**	**96.5**	**100**	**70.0**	**100**
North Sea Coast	unknown	unknown	1,799.5	5.0	unknown	unknown
England	256.0	26.0	1,164.5	8.0	1,894.8	4.0
GB	unknown	unknown	4,171.0	4	unknown	unknown

Source: Pye & French (1993)

Table 3.1.2 Region 6 cliff types in context

Area	*Vertical >20 m high*		*Vertical <20 m high*		*Non-vertical >20 m high*		*Non-vertical <20 m high*	
	Length (km)	*% area total in region*	*Length (km)*	*% area total in region*	*Length (km)*	*% area total in region*	*Length (km)*	*% area total in region*
Humberside	11.5	-	0	-	17.0	-	32.0	-
Lincolnshire	0	-	0	-	0	-	0	-
Norfolk	1.0	-	0	-	21.5	-	13.5	-
Region 6	**12.5**	**100**	**0**	**100**	**38.5**	**100**	**45.5**	**100**
North Sea Coast	600.5	2.1	379.5	0	558.5	6.9	261.0	17.4
England	320.0	3.9	49.0	0	628.5	6.1	167.0	27.2
GB	1,325	0.9	818.0	0	1,371	2.8	545	8.3

Source: JNCC Coastal Resources Database

3.1.2 Important locations and species

Lengths of soft cliffs often present continuity over time of relatively unmodified habitat. Owing to the interruption of natural succession by slumping, a range of vegetation communities may occur that can be particularly important for invertebrate species. On sheltered coasts soft cliffs can develop an undercliff vegetation of scrub, tall herb and rank grassland, often very close to the sea. This vegetation type is very rare in the region, owing to rapid erosion and removal of debris from the usually soft, unprotected cliffed coast. However it does occur at Overstrand Cliffs SSSI, where there is a noted example (Cooper 1988). Here freshwater seepage deposits clay outwash material in wet base-rich flush zones, which have fragmentary swamp vegetation and good orchid populations. This site is regarded as of national importance for its botanical interest, especially in relation to plant succession on landslips and flushes (Doody *et al.* 1993) (see also section 5.2). Slumped material is extensive on most of the region's cliffed coast and in a few places maintains a mosaic of cliff habitats of different age, enhancing biodiversity. It also provides a sediment source for beaches downdrift.

None of the nine nationally rare and four nationally scarce species or subspecies of higher plant that are found mainly or exclusively on cliffs is found in the region (see also section 5.2). Other nationally rare and scarce species more typical of other habitats also occur on cliffs but none is present in the region. In Norfolk, Yarrow broomrape *Orobanche purpurea* is confined to cliff tops although it does occur on other habitats elsewhere in the country.

The regional fauna is notable only at Flamborough Head and Bempton Cliffs (Humberside). This latter site has important seabird colonies warranting Special Protection Area status (Stroud *et al.* 1990). These populations are dominated by offshore species (fulmar, kittiwake, guillemot, razorbill, puffin and a small gannet colony) (see section 5.10). No systematic regional survey of invertebrates in cliff and cliff-top habitats has been carried out, but these environments generally have a rich habitat diversity and support large numbers of species (Mitchley & Malloch 1991). A few cliffs in the region have moderate invertebrate lists, with some notable and rare (Red Data Book) species (see section 5.3). Overstrand Cliffs (Norfolk), Bridlington and Bempton Cliffs (Humberside) are regionally important cliff locations in the JNCC's Invertebrate Site Register.

3.1.3 Human activities

Cliffs are among the least modified of terrestrial habitats, although nationally the cliff-top zone, especially its inner sectors, has been affected by a variety of human impacts, sometimes leading to major habitat loss. In this region, arable agriculture is widespread and often extends to the cliff edge, restricting the area of semi-natural cliff-top vegetation. Targets for recreating maritime cliff grassland from arable or improved pasture are discussed by Pye & French (1993).

Relatively little of the cliff base in Humberside has been protected by coastal defences and hence natural coastal erosion is prevalent. The high natural rates of erosion have historically posed a threat to agriculture and settlements in the region, particularly on the Holderness coast (1-1.8 m per year average rate of retreat this century), and Humberside County Council has adopted a policy of no development of permanent structures in a buffer zone adjacent to the Holderness cliff edge (Pye & French 1993). Protection of the cliff foot is only likely to be allowed in future adjacent to large settlements and important industrial installations. However, groynes are present for lengthy stretches of the Norfolk cliffs and these have altered patterns of sediment transport and deposition along the Norfolk coast over the past century (Clayton 1989).

Much of the cliffed coast in the region is largely undeveloped, the major exceptions being housing close to coastal settlements (e.g. Bridlington, Hornsea, Withernsea, Sheringham, Cromer, Mundesley). In places (e.g. Holderness) caravan parks have been developed close to cliffs. Footpaths have heavy usage in some parts of the region (particularly Norfolk) and local erosion is present. In general visitor erosion and residential development have caused only local habitat loss and vegetation disturbance.

3.1.4 Information sources used

Detailed NVC survey is confined to one study at Trimingham, Norfolk (Cooper 1988). This work covered a total coastal length of 8 km (8% of the region's cliffs) and was part of a pilot study involving thirteen surveys to assess the feasibility of mapping all cliff habitat in Britain. These surveys, all carried out in the summer of 1987, use a consistent methodology. The data provide a sound baseline

for future cliff vegetation studies and local management of the cliff resource. Other data sources (e.g. JNCC's Cliffs and Coastal Resources databases) do not have information on cliff vegetation but give details of cliff geology and size. No other detailed surveys exist for the region, and existing information is insufficient to describe the regional extent of individual cliff and cliff-top habitats, apart from maritime cliff grassland.

3.1.5 Acknowledgements

Assistance with sources was kindly provided by JNCC Species Conservation Branch.

3.1.6 Further sources of information

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Davidson, N.C., Laffoley, D.d'A., Doody, J.P., Way, L.S., Gordon, J., Key, R., Drake, C.M., Pienkowski, M.W., Mitchell, R.M., & Duff, K.L. 1991. *Nature conservation and estuaries in Great Britain.* Peterborough, Nature Conservancy Council.

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Mitchley, J. 1989. *A sea cliff bibliography*. Peterborough, Nature Conservancy Council. (Research and survey in nature conservation, No. 18.)

Steers, J.A. 1964. *The coastline of England and Wales*. Cambridge, Cambridge University Press.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Flora, fauna, habitat information, location of site reports, site management	*Coastal Ecologist, English Nature, Peterborough, tel: 01733 340345
Advice on national and international policy and cliff conservation; national databases.	*Coastal Conservation Branch, JNCC, Peterborough, tel: 01733 62626
Invertebrate fauna	*Invertebrate Site Register, Species Conservation Branch, JNCC, Peterborough, tel: 01733 62626

* Starred contact addresses are given in full in the Appendix.

3.2 Sand dunes

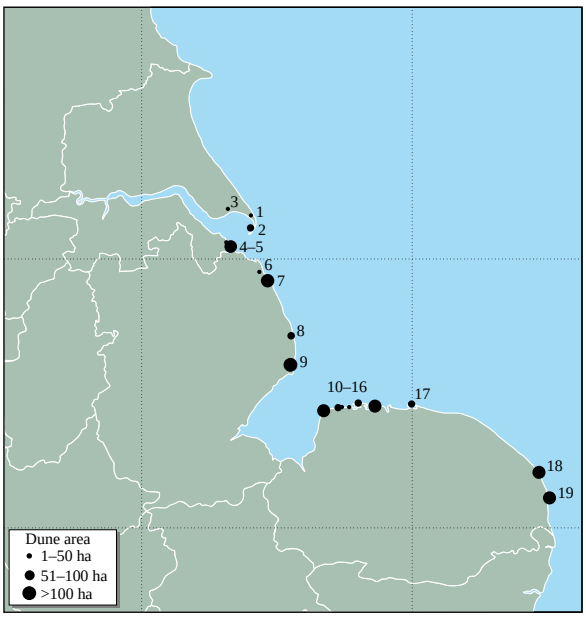
Dr T.C.D. Dargie

3.2.1 Introduction

The region contains 19 sand dune systems, totalling 1,761 ha of vegetated sand and representing 19% of the English and 4% of the British sand dune resource. The region is therefore of only moderate importance in the national context in terms of its total sand dune extent, but the distinctive and widespread barrier island dunes on the north Norfolk coast, closely associated with saltmarsh, extensive tidal sand flats and coastal grazing marsh, comprise a dune set of international importance. This is reflected in the designation of fourteen Sites of Special Scientific Interest (SSSIs) and five National Nature Reserves (NNRs) in the region, as well as international recognition of several localities as Ramsar sites, Special Protection Areas and a Biosphere Reserve. The National Trust owns seven dune sites and several occur in an Area of Outstanding Natural Beauty and Heritage Coast. County Naturalist Trusts and the RSPB each manage two dune reserves.

The major dune habitats are: strand and embryo dune; mobile and semi-fixed dune; acidic fixed dune grassland; neutral and calcareous fixed dune grassland; dune heath; dune slack; other dune wetland; dune woodland; transitions to saltmarsh; transitions to maritime cliff; other vegetation (e.g. coniferous plantation); and other land cover (e.g. bare ground, car park, caravan park). These are used here to set the dunes of the region in the context of counties and England (Table 3.2.1). Survey of dunes in Scotland is still in progress and it is not possible to give accurate figures on the extent of the resource for either the East Coast or Great Britain. An estimate of dune habitats for Scotland is used here, based on a sample set of sites (Dargie 1993), to allow some form of British context to be made. The region has good examples of transitional habitats from sand dune to saltmarsh, as well as strand and embryo dunes, extensive acidic fixed dune grassland and a large area of dune woodland and scrub.

90 National Vegetation Classification communities were recorded for all English dunes, with a total of 156 types for communities and sub-communities combined, not all of them exclusive to dunes (Radley 1994). The region has low extents of slack, neutral and calcareous dune grasslands but has a sizeable area of mobile dune (SD5 *Leymus arenarius* community), often in association with a semi-fixed dune type grading into saltmarsh (SD7e *Ammophila arenaria - Festuca rubra* community, *Elymus pycnanthus* sub-community). The acidic soils of the region, along with rabbit grazing, allow lichen dune (SD10 *Carex arenaria - Cornicularia aculeata* sub-community) to develop, the region having the largest extent of this sub-community in England. *Hippophae rhamnoides* scrub (SD18) is a characteristic natural habitat type of the region.



Map 3.2.1 Sand dune sites. Numbers refer to Table 3.2.2. Source: JNCC Coastal Database.

Table 3.2.1 Table of areas (ha) of dune vegetation types

Dune vegetation type	*Humberside*	*Lincolnshire*	*Norfolk*	*Region 6*	*England*	*North Sea Coast*	***Great Britain*
Strand and embryo dune	14	18	53	85	179	*	340
Mobile and semi-fixed dune	30	85	327	442	2,484	*	8,504
Acidic fixed dune grassland	0	1	265	266	671	*	4,953
Neutral and calcareous fixed dune grassland	8	121	56	184	2,710	*	15,228
Dune heath and bracken	0	0	28	28	197	*	2,615
Dune slack	0	1	10	10	487	*	2,175
Other dune wetland	6	10	45	61	150	*	4,114
Dune woodland and scrub	24	213	147	385	1,189	*	8,965
Transitions to saltmarsh	8	71	28	107	141	*	836
Transitions to maritime cliff	0	0	0	0	30	*	64
Other land cover	23	62	107	192	1,044	*	2,406
Total	**113**	**582**	**1,066**	**1,760**	**9,282**	**25,356****	**50,200**
% in Region 6	-	-	-	-	19	7	4

Sources: Dargie (1993), Dargie (1995), Radley (1994), JNCC Coastal Resources Database. Key: *not available; **GB and East Coast figures include estimates for Scotland.

3.2.2 Important locations and species

Table 3.2.2 lists the sand dune sites in the region, indicating their area, type and conservation status. The locations are shown on Map 3.2.1.

The dunes become larger to the south of the region. Bay dunes (e.g. North Lincolnshire Dunes), which develop upon sand trapped within the shelter of rock headlands or in bays or estuaries, are rare in the region. There are no climbing dunes (sand blown up onto terrain inland of the main dune system) in the region, reflecting the prevailing westerly winds. Spit dunes develop either at the mouths of rivers or, more frequently in this region, in areas with strong, sediment-laden currents. They are common in the region, at for example, Scolt Head Island, Blakeney Point and Spurn Head, where they have developed in association with the most distinctive geomorphological feature of the regional dunes: a large number of offshore barrier islands, whose formation also relates to coastal currents rather than the effects of a river. The region has a single example of ness/foreland dunes, at Winterton and Horsey Dunes. This dune type develops on shores with sand supply from two directions and gradually extends (progrades) seawards. Small relict dunes, cut off from their sand supply by developing salt marsh, are also present at Welwick and Saltfleetby/Theddlethorpe. There are no other types of dune in the region, as the prevailing strong onshore winds that would allow very large dune systems to develop do not occur here. Large dune systems develop a fresh (rarely brackish) watertable, resulting, in depressions, in a distinctive and nationally rare type of wetland termed dune slack. This habitat is commonest and most extensive in Britain on hindshore, ness/foreland and large spit dunes. These are either scarce or absent in the region, and Hunstanton Dunes is the only site with a sizeable extent (8 ha) of dune slacks. There is a 12 ha freshwater marsh contained within the sand dunes of Saltfleetby - Theddlethorpe Dunes NNR.

In Great Britain five nationally rare and twelve nationally scarce higher plants are found mainly or exclusively on dunes. Only one such nationally rare species, Jersey cudweed *Gnaphalium luteoalbum*, is present in the region. Sea buckthorn *Hippophae rhamnoides* (in its native area, not as an introduction), rush-leaved fescue *Festuca juncifolia*, dune fescue *Vulpia membranacea* and grey hair-grass *Corynephorus canescens* are nationally scarce plants found on the region's dunes, the last now being considered nationally rare (see section 5.2.2). Other nationally rare (crested buckler-fern *Dryopteris cristata*, matted sea-lavender *Limonium bellidifolium* and lizard orchid *Himantoglossum hircinicum*) and scarce species (suffocated clover *Trifolium suffocatum*, bird's-foot clover *Trifolium ornithopoides*, larger wintergreen *Pyrola rotundifolia*, sharp rush *Juncus acutus*, bulbous poa *Poa bulbosa* and curved hard-grass *Parapholis incurva*) more typical of other habitats also occur on dunes in the region (see section 5.2). No dune site in the region is recognised as an outstanding or notable area for lichens (Fletcher *et al*. 1984) (section 5.1).

Many dune sites fall within the North Norfolk Coast Ramsar site, Special Protection Area and Biosphere Reserve, an area outstanding for breeding, passage and wintering birds (Stroud, Mudge & Pienkowski 1990). Most sites in Lincolnshire and Humberside also fall within the Ramsar and Special Protection Areas for the Humber Flats, Marshes and Coast, and The Wash - Gibraltar Point or are of equivalent stature. Much of the dune resource is therefore part of a habitat network of international significance for birds (sections 5.10, 5.11 and 5.12). The major dune systems of Gibraltar Point, North Norfolk Coast and Winterton to Horsey are now listed as possible SACs (see section 7.2.4).

The JNCC Invertebrate Site Register summarises the invertebrate interest of sites, and the region as a whole has an outstanding sequence of dune sites which have records for Red Data Book and other rare/notable species. The list of major sites includes Spurn Head, Gibraltar Point, Scolt Head, Saltfleetby-Theddlethorpe, Winterton-Horsey Dunes,

Table 3.2.2 Sand dune sites in region

Code	*Name*	*Grid ref*	*Area (ha)*	*Dune type*	*Conservation status*
1	Holderness Coast	TA413173	25	Bay	SSSI
2	Spurn Head	TA412123	54	Spit	RS, SPA, SSSI, WTR
3	Welwick Dunes	TA329196	6	Bay, relict	
4	Cleethorpes and Humberston Dunes	TA325068	20	Bay, spit	RS, SPA, SSSI
5	North Lincolnshire Coast Dunes	TA338048	167	Bay, island	RS, SPA, WTR, NT, SSSI
6	Saltfleet Dunes	TF443951	12	Spit, island	RS, SPA, SSSI
7	Saltfleetby and Theddlethorpe Dunes	TF475920	195	Spit, relict, island	NNR, SSSI
8	Sutton on Sea to Skegness	TF565713	57	Bay	-
9	Ingoldmells to Gibraltar Point	TF567603	152	Spit	WTR, NNR, NT, SSSI
10	Hunstanton Dunes	TF690435	134	Spit	RS, SPA, SSSI
11	Holme Dunes	TF713451	0	Spit	RS, SPA, SSSI
12	Thornham	TF740451	108	Spit, island	AONB, B, HC, NT, RSPB, RS, SPA, SSSI,
13	Titchwell	TF756449	0	Spit, island	AONB, B, HC, NT, RSPB, RS, SPA, SSSI,
14	Brancaster Manor and Golf Course	TF780453	0	Spit, island	AONB, B, HC, NT, RSPB, RS, SPA, SSSI,
15	Scolt Head Island	TF819466	86	Spit, island	AONB, B, HC, NNR, NT, RS, SPA, SSSI
16	Holkham	TF880455	248	Spit	AONB, B, HC, NNR, RS, SPA, SSSI
17	Blakeney to Cley	TG017462	69	Spit	AONB, B, HC, NT, RS, SPA, SSSI
18	Winterton and Horsey Dunes	TG495202	309	Ness/foreland	Part SPA, NNR, SSSI
19	Caister to Yarmouth	TG533101	137	Spit	Part SPA

Source: Radley (1994). Code refers to location on Map 3.2.1. Abbreviations: AONB: Area of Outstanding Natural Beauty; B: Biosphere Reserve; WTR: Wildlife Trusts Reserve; HC: Heritage Coast; NNR: National Nature Reserve; NT: National Trust; RS: Ramsar site; RSPB: RSPB Reserve; SPA: Special Protection Area; SSSI: (Biological) Site of Special Scientific Interest.

Blakeney Point, Hunstanton and the North Lincolnshire Coast. Spurn Head, Gibraltar Point and Saltfleetby/Theddlethorpe are probably amongst the best dune invertebrate sites in Britain (section 5.3).

3.2.3 Human activities

In general sand dunes are less heavily modified than many terrestrial habitats. However, the inner edge of some sand dune sites in the region has been affected by a variety of human impacts, sometimes leading to habitat loss or conversion to more common vegetation types (Doody 1989). However, much near-natural dune coast survives. The largest single modification has been afforestation of dunes at Holkham. Residential and recreational developments are adjacent to several sites and relatively small areas show moderate or severe erosion due to trampling. Car parks, caravan and camp sites and golf courses are common adjacent to several sites, with damage by vehicles common. Military uses or structures are present on several sites but the total area of influence is slight. Conservation is now a major activity in many locations, with many sites having one or more designations or forms of planning control. An unusual feature of the Winterton Dunes is invasion by rhododendron *Rhododendron ponticum*; elsewhere in the region, notably at Saltfleetby (Fuller & Boorman 1977) and Spurn Head (Ranwell 1972), the regionally native sea buckthorn *Hippophae rhamnoides* tends to be invasive. Details of development for each site are given in Radley (1994).

Management is now common on many sites. Recreational use is controlled by car parking restrictions and the provision of hardened paths and boardwalks to reduce path erosion. Scrub control is widely practised and grazing by sheep and cattle is being re-introduced to some dunes (e.g. Saltfleetby) to reduce the extent of rank dune grassland and encroaching scrub (see also section 8.2). Coastal erosion is not a serious problem in most sites, although the neck of Spurn Head, where there is a mix of eroding, prograding and stable sites, has a long history of repeated breaches over past centuries, with repairs so far maintaining the spit.

3.2.4 Information sources used

All areas of vegetated sand dune in the region (nineteen sites - see Map 3.2.1 and Table 3.2.1) have been surveyed in recent years using the National Vegetation Classification (Rodwell in prep.). This work was part of the Sand Dune Survey of Great Britain initiated by the Nature Conservancy Council in 1987 and continued after 1992 by the Joint Nature Conservation Committee on behalf of country conservation agencies (Radley 1994).

These surveys, all carried out in the summer months, are very detailed and use a consistent methodology. Sites were surveyed between 1989 and 1990. The vegetation is mapped and described, and information on coastal erosion and accretion, atypical vegetation and adjoining land use is also recorded. Individual site reports are available, as well as a national report for England (Radley 1994). The data provide a sound baseline for future dune vegetation studies and both strategic and local management of the dune resource. Most information presented here is derived from the national report.

3.2.5 Acknowledgements

Assistance with sources was kindly provided by JNCC's Coastal Conservation and Species Conservation Branches.

3.2.6 Further sources of information

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Flora, fauna, habitat information, location of site reports, site management	*Maritime Team Leader, English Nature, Peterborough, tel: 01733 340345
Invertebrate data (Invertebrate Site Register)	*Invertebrate Site Register, Species Conservation Branch, JNCC, Peterborough, tel: 01733 62626
Advice on national and international policy and dune conservation, sand dune site survey reports, sand dune database	*Coastal Conservation Branch, JNCC, Peterborough, tel: 01733 62626

* Starred contact addresses are given in full in the Appendix.

3.3 Vegetated shingle structures and shorelines

Dr R.E. Randall

3.3.1 Introduction

'Shingle' is the term applied to sediments coarser than sand but smaller than boulders: i.e. between 2-200 mm in diameter. Shingle vegetation communities around Britain are defined by Sneddon & Randall (1993), with some communities being widespread and others limited to a particular region or substrate. This section covers both simple fringing beaches and also more complex structures where the shingle is vegetated yet not buried by more than 20 cm of sand (the depth at which shingle ceases to influence the vegetation, as at large areas of Gibraltar Point and Scolt Head Island - see section 3.2). The region contains only a very small proportion of the total resource of vegetated shingle in Britain (Table 3.3.1).

The sandy nature of the substrate at many of the region's shingle sites is strongly reflected in the vegetation, but elsewhere the influence of saltmarsh or the eastern location of these sites gives distinctive species assemblages. Humberside and Lincolnshire contain only a minute amount of the British shingle resource (Steers 1964) and no vegetated shingle structures. The Norfolk shingle, however, includes a major structure (Blakeney Point spit) composed of larger-sized pebbles, as well as considerable lengths of fringing shingle beach with a range of matrices from silt to sand and pure shingle. These sites support important examples of pioneer shingle vegetation communities, as well as shingle/saltmarsh, shingle/sand dune and wet/dry shingle sequences, through to lichen heath.

Table 3.3.1 Area of vegetated shingle structures in Region 6

	Area (ha)
Humberside	0
Lincolnshire	0
Norfolk	108.8
Region 6	**108.8**
North Sea Coast	4,472.3
England	4,353.1
Great Britain	5,129.1
% North Sea Coast total in region	2.4
% England total in region	2.4
% GB total in region	2.1

Source: Sneddon & Randall (1994)

3.3.2 Important locations and species

The main vegetated shingle structures in the region are listed in Table 3.3.2; Table 3.3.3 lists fringing shingle beaches; both types are shown on Map 3.3.1.

Spurn Head, Humberside, contains some very sandy vegetated shingle but the most characteristic shingle species are found in the debris from concrete blocks dumped in an attempt to stabilize the western side of the spit. Much shingle was removed from the beaches in the nineteenth century for ballast. Sandy shingle features, which are now being colonised by vegetation, are developing on the coast between Donna Nook and Saltfleetby. At Gibraltar Point

Map 3.3.1 Vegetated shingle structures and fringing shingle beaches.

(Lincolnshire), the beach is shingly after storm conditions, when pebbles from glacial deposits offshore are thrown up, but this material is quickly buried by sand. Beach ridges on the spit are of very sandy shingle with a pioneer flora. Norfolk, on the other hand, has extensive, though discontinuous, spreads of shingle, from Snettisham Spit in The Wash through to Weybourne in the east, with further outliers of sandy shingle at Caister-on-Sea and Yarmouth Denes. The Norfolk shingle is comprised mainly of flint pebbles derived from Cretaceous chalk from the cliffs at Sheringham or from offshore banks deposited in glacial times. There are also some glacial erratics of other materials. In the west the shingle at Wolferton has a silty matrix, which gives way to sand from Snettisham to Heacham. Small offshore barrier islands at Holme and Thornham have a typical shingle foreshore flora, giving way to dune behind. There is similar sandy shingle pioneer vegetation in Brancaster Bay, sometimes mingled with a silty matrix. Scolt Head Island is primarily dune covered, but at the actively accreting western end there is a series of bare shingle recurves which support an ephemeral flora subject to frequent inundation. Lateral shingle projections perpendicular to the main body of the island have varying amounts of sand cover and some support a more typically shingle flora. The most important area of shingle in the region stretches from Blakeney Spit eastwards for almost 12 km. At the western end there is considerable dune cover within which there are low areas of shingle on sand/shingle mixtures, flooded at high spring tides. The area of fringing shingle east of Cley contains less sand matrix but the inland edge of the shingle abutting saltmarsh frequently contains a silt matrix.

A common pioneer plant assemblage in the region on sandy shingle strands is a cosmopolitan community dominated by sea sandwort *Honkenya peploides*, fescue grass *Festuca rubra* and marram *Ammophila arenaria*. Where

Table 3.3.2 Vegetated shingle structures

Site name	*Site type*	*Location*	*Area surveyed* (ha)*	*Conservation status*	*Activities/management disturbances*
Snettisham Spit	Flint shingle spit with sandy shingle spreads and areas of saltmarsh	TF 650320	23.8	RSPB	Tourism; beach recharge scheme
Scolt Head	Sand covered barrier island with sandy shingle laterals	TF 810460	4.0	SSSI/NNR/NWT	Rabbit grazing
Blakeney Point	Flint shingle spit with marsh and dune complex	TG 015458	81.0	SSSI/NT	Light recreation and grazing
Total			108.8		

Source: after Sneddon & Randall (1994). Key: NT = National Trust; RSPB = Royal Society for the Protection of Birds; NNR = National Nature Reserves; NWT = Norfolk Wildlife Trust. *Area surveyed by Sneddon & Randall (1994) excludes areas of sand dune vegetation over shingle.

organic drift is significant, an open community of sea kale *Crambe maritima*, curled dock *Rumex crispus* and sea campion *Silene vulgaris maritima* occurs. Towards the eastern end of Blakeney Spit there are areas dominated by the nationally rare sea pea *Lathyrus japonicus*. This is a distinctively south-eastern component of the flora, reaching its northern limit as a shingle sub-species at Blakeney (Randall 1977), but it is known to have been planted in this area over 50 years ago by the naturalist E.A. Ellis. Sea heath *Frankenia laevis* is at or near its north-eastern limit in Britain at Gibraltar Point and between Holme and Blakeney, where it is a significant component of the vegetation of the low shingly areas. Slightly further inland the commonest assemblage is the cosmopolitan yellow horned-poppy *Glaucium flavum*, curled dock, and sea mayweed *Tripleurospermum maritimum*, but in places this is replaced by the south-eastern assemblage including ragwort *Senecio jacobaea*, with sticky groundsel *S. viscosus*, biting stonecrop *Sedum acre* and sea campion as associate species. Within the slacks at Blakeney the sandy shingle is turfed with the nationally rare grey hair-grass *Corynephorus canescens* (see section 5.2).

More stable, inland sandy shingle most commonly has a fescue turf with bird's-foot trefoil *Lotus corniculatus*, mosses and lichens. A southern variant of this at Blakeney includes sand sedge *Carex arenaria*, sea fern-grass *Desmazeria marina* and early hair-grass *Aira praecox*. Where the shingle does not have a sandy matrix the dominant grass is usually false-oat-grass *Arrhenatherum elatius*, with mosses and lichens in the most stable sites. A silt matrix or salt influences result in fescue swards with thrift *Armeria maritima* and buck's-horn plantain *Plantago coronopus*. In the most undisturbed areas the fescue-grass/bird's-foot trefoil swards usually contain sea campion or, when the matrix is more sandy, yarrow *Achillea millefolium*.

Shrubby seablite *Suaeda vera* occurs at Gibraltar Point in a deciduous form; otherwise it has its northern limit on the shingle-saltmarsh fringe to the lee of Blakeney spit and other similar locations in Norfolk. On the upper marsh-shingle boundary of the Norfolk and Wash coasts there are occurences of the Mediterranean matted sea-lavender *Limonium bellidifolium*. At Gibraltar Point and Donna Nook rock sea-lavender *L. binervosum* has its north-easternmost sites in Britain, occurring also on the stabilized sandy shingle recurves at Blakeney and Scolt Head Island (Defraine 1916). The clayey shingle along The Wash coast of Norfolk and at Gibraltar Point also contains curved hard-grass *Parapholis incurva*, a southern species otherwise limited to a few sites from Suffolk to the Bristol Channel. Oyster plant *Mertensia maritima* had one Norfolk shingle site until the 1930s, but apparently never fully recovered from burial by severe winter gales in 1911.

The Norfolk shingle sites, especially Snettisham, Scolt Head Island and Blakeney Point, are of considerable importance for breeding tern colonies (section 5.10). These and other shingle foreshores are breeding sites for oystercatcher and ringed plover, whereas the more vegetated inland shingle gives good nesting habitat for skylark and meadow pipit (section 5.11). Brent geese overwintering on the adjacent saltmarsh also use the shingle. The shingle spits of this region are sites of first landfall for passage migrants that find protection in shrubby seablite or the planted tree lupin *Lupinus arboreus* (section 5.12). Shingle at Blakeney Point has a rich assemblage of land snails (Oldham 1934) and significant invertebrate populations (section 5.3), and at Snettisham there occurs a nationally rare woodlouse (Oldham 1934).

Table 3.3.3 Fringing shingle beaches

Site name	*Location*	*Length of structure (km)*	*Site type*
Spurn Head	TA4011	5.0	Sandy shingle; concrete debris
Donna Nook / Saltfleetby	TF4399 - TF4791		Sandy shingle features developing, see text
Gibraltar Point	TF5658	2.5	Sandy shingle
Heacham	TF6637	0.5	Pure shingle
Thornham-Holme	TF7245	2.5	Sandy shingle
Brancaster	TF7845	2.0	Barrier islands; sandy shingle
Cley-Weybourne	TG0744	1.0	Sandy shingle
Caister-on-Sea	TG5313	1.0	Sandy shingle
Great Yarmouth	TG5305	6.0	Sandy shingle

Source: Randall, unpublished surveys, early 1980s.

3.3.3 Human activities

All the major shingle sites of the region have some form of conservation status and are wardened for all or part (during the breeding season for terns) of the year. However, they are subject to high levels of visitor pressure, especially in summer, and trampling has a marked effect on shingle

stability. At Snettisham there has been loss of the eastern shingle through development, but the area adjacent to the lakes has been protected. Snettisham shingle spit is affected by the Hunstanton - Heacham beach recharge scheme, with shingle being moved back to the Hunstanton area each winter. All sites are widely grazed by rabbits, but there is no grazing in this region by domestic stock. Eastwards from Cley the shingle ridge is the main sea defence and has been artificially regraded to improve its effectiveness.

3.3.4 Information sources used

The shingle structures of the region were surveyed between July 1988 and July 1990, during the National Vegetated Shingle Structures Survey undertaken by the Nature Conservancy Council, which used the National Vegetation Classification (NVC). For full details of methodology see Sneddon & Randall (1994). This survey did not include fringing beaches or unvegetated or minor sites. Scolt Head Island has been studied over many years by the Department of Geography, Cambridge University (Steers 1960), and Blakeney Point has been the focus of research by many contributors to the *Transactions of the Norfolk and Norwich Naturalists' Society* (e.g. Barfoot & Tucker 1980; Brown & Brown 1967; Oldham 1934; Oliver & Salisbury 1913; White 1967).

Many shingle fringing beaches were examined by the author in the early 1980s as part of a survey of shingle beaches sponsored by British Petroleum (BP). Beaches covered in this survey were only examined qualitatively; the information generated became the basis of the geographical variation data published in Randall (1989).

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Shingle on Gibraltar Point	Warden, Field Station, Gibraltar Point, Skegness PE24 4SU, tel: 01754 762677
Shingle at Snettisham Spit	Warden, RSPB, 13 Beach Road, Snettisham, King's Lynn PE31 7RA, tel: 01485 542689
Shingle at Holme-Thornham NNR	Warden, Norfolk WildlifeTrust, Holme Dunes Nature Reserve, Broadwater Rd, Holme-next-the-sea, Hunstanton, Norfolk PE36 6LQ, tel: 01485 525240
Shingle at Scolt Head Island	Site Manager, English Nature, Scolt Head Island NNR, 21 East Wood, Docking, King's Lynn, Norfolk PE31 8NR, tel: 01485 518746
Blakeney Point National Trust warden	35 The Cornfields, Langham, Holt, Norfolk NR25 7DQ, tel: 01263 740480
Shingle at Cley and Salthouse	Warden, Norfolk Wildlife Trust Cley Reserve, Watcher's Cottage, Cley Holt, Norfolk NR25 7RZ, tel: 01263 740380
Norfolk coast shingle sites	*Norfolk Local Team, English Nature, Norwich, tel: 01603 620558
Flora, fauna, habitat information, site management	*Coastal Ecologist, English Nature HQ, Peterborough, tel: 01733 340345
Advice on national and international policy, Shingle and Coastal Resources databases	*Coastal Conservation Branch, JNCC, Peterborough, tel: 01733 62626

* Starred contact addresses are given in full in the Appendix.

3.4 Coastal lagoons

Dr. R.N. Bamber & Dr. R.S.K. Barnes

3.4.1 Introduction

Coastal lagoons are pond- or lake-like, virtually tideless bodies of saline water either wholly or partially separated from the adjacent sea, but with some influx of sea water. The term is used here to include true lagoons, i.e. those wholly or partially separated from the sea by a natural sedimentary barrier, and also artificial brackish ponds and coastal pools, of a similarly restricted tidal range and often containing comparable lagoonal wildlife. Lagoons are commonly shallow, often with a varying salinity ranging from above to below normal sea-water levels (35 g/kg). Freshwater systems are not considered. Lagoons are a nationally rare habitat and a 'priority habitat type' under Annex 1 of the EC Habitats Directive.

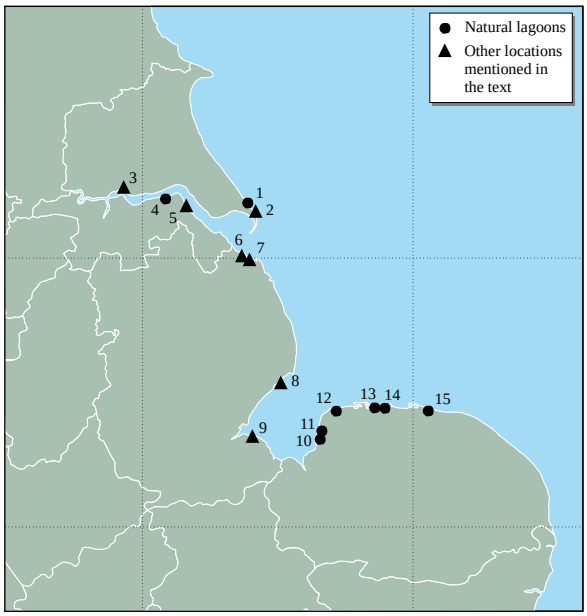
This chapter summarizes the coastal lagoons of the region. The scale of the contribution of the lagoons of the region to Britain as a whole is shown in Table 3.4.1. The eight natural lagoons or lagoon complexes total 77 ha, amounting to 11% of Britain's total natural lagoonal resource and 34% of that resource excluding The Fleet, Dorset (by far Britain's largest lagoon, comprising nearly 70% of the total natural resource). Of these, Easington and Barton Pools contribute 39 ha in Humberside, while the remainder consists of the natural lagoons on the north Norfolk coast. No natural lagoons occur in Lincolnshire. Overall in the region there are 93 ha of artificial lagoons, all in Humberside and Lincolnshire.

Sites in the region comprise 22% of the lagoonal resource that was regarded by Barnes (1989) as being "especially noteworthy in the national context", again excluding The Fleet (Table 3.4.2). The region is therefore highly significant in the national context, and is particularly important for lagoons that have developed where formerly there were salt-marshes behind dune-capped barrier islands.

3.4.2 Important locations and species

Map 3.4.1 shows the locations of the natural lagoons and other notable saline pools mentioned in the text; Table 3.4.3 lists these sites and their areas.

Throughout the region, there are a number of flooded clay pits and coastal ditches subject to sea-water percolation.



Map 3.4.1 Coastal lagoons and locations mentioned in the text.

Notable amongst these are the low salinity pools at Welton Waters, N. Humberside, and two saline pools at Killingholme, S. Humberside, both sluiced systems. Humberston Fitties, Lincolnshire, is an old boating lake. A number of saline (but not tidal) borrow pits occur on the north Lincolnshire coast between Donna Nook and Saltfleet, but these have not been surveyed. There are a number of ditches and farm pools in the land-claimed marshlands bordering The Wash: most of these are very small (<0.5 ha) and many are of very low salinity. There are numerous freshwater habitats in flooded clay pits on Humberside.

True lagoons support only three types of aquatic vegetation, namely stands of green algae (*Chaetomorpha*, *Ulva* and *Enteromorpha* spp.), of sea-grasses and similar plants (predominantly *Ruppia* spp.) and, much more rarely, of stoneworts (especially *Lamprothamnium* spp.). Much of the area of their beds, however, is in the form of bare sediment, devoid of vegetation cover. Fringing stands of reeds *Phragmites* spp., salt-marsh plants and/or sedges (e.g. *Scirpus maritimus*) are usual. All these communities, with the exception of the stoneworts, occur in the region. There

Table 3.4.1 Total lagoonal areas for region and country

Region	*Lagoonal area (ha)*	*% of GB total*	*% of GB total excl. The Fleet*
Humberside	117	9	15
Lincolnshire	15	1	2
Norfolk	38	3	5
Region 6	**170**	**13**	**22**
North Sea Coast	1,163	92	87
West Coast	98	8	13
Great Britain	1,261	-	-

Sources: see section 3.4.4

Table 3.4.2 Nationally noteworthy* lagoonal areas for region and country

Region	*Lagoonal area (ha)*	*Overall % of GB total*	*% of GB total excl. The Fleet*
Norfolk	14	3	22
Other Counties	0	0	0
Region 6	**14**	**3**	**22**
North Sea Coast	520.5	96	63
West Coast	24	4	37
Great Britain	544.5	-	-

* *sensu* Barnes (1989)

Table 3.4.3 Lagoons surveyed*

Name	*Grid ref.*	*Area (ha)*	*Type*
Humberside			
1. Easington North Lagoon	TA409180	6.0	Natural, bahira
2. Easington South Lagoon	TA412172	6.0	Inundation
3. Welton Waters Pools	SE958250	57.0	Sluiced clay pits
4. Barton Pools	TA048233	33.0	Natural, percolation
5. Killingholme Pools	TA167197	15.0	Sluiced clay pits
Lincolnshire			
6. Humberston Fitties	TA336048	1.8	Sluiced boating lake
7. Northcoates Lagoons	TA375034	3.0	Sluiced pond
8. New Marsh Drain	TF500551	5.0	Sluiced drain
9. Lawyer's Farm Pool	TF417333	<1.0	Percolation pool
Norfolk			
10. Snettisham	TF648320	18.0	Natural, percolation
11. Heacham Harbour	TF657356	4.5	Natural, percolation
12. Broad Water	TF716447	4.5	Natural, percolation
13. Holkham Salts Hole	TF886451	0.5	Natural, percolation
14. Abraham's Bosom	TF912453	1.5	Natural, percolation
15. Blakeney Spit Pools**	TG066447	9.0	Natural, percolation

Key: *other (unsurveyed) sites include some 5 ha of saline ditches and farm pools, principally in Lincolnshire. **Pools behind the Cley to Salthouse shingle ridge.

are no nationally rare or scarce lagoonal plant species in the region, although the spiral tasselweed *Ruppia cirrhosa*, the rarer of the two species of that genus, is present in the Easington lagoons, and Humberston Fitties lagoon is the northernmost site on the east coast of England for the alga *Chaetomorpha linum*.

Lagoons possess a characteristic invertebrate fauna that shows little regional variation, even within Europe. In Britain, several of these species are very rare and are protected under the Wildlife and Countryside Act 1981. Three of these protected species occur in the region: the lagoonal worm *Alkmaria romijni* in the Barton and Killingholme Pools, the lagoon sand shrimp *Gammarus insensibilis*, in a small pool at Lawyer's Farm and with its northernmost record in the UK in Humberston Fitties, and the starlet sea anemone *Nematostella vectensis*. Also notable in the region's lagoons are the opposum shrimp *Paramysis nouveli*, the lagoonal cockle *Cerastoderma glaucum*, the lagoonal periwinkle *Littorina lagunae*, the lagoonal mud snail *Hydrobia neglecta* and a full range of the classic lagoonal species, together with a significant marine component including the mud snail *Hydrobia ulvae*. Even many of the small saline ditches support lagoonal species such as the lagoonal snail *Hydrobia ventrosa* and the lagoonal prawn *Palaemonetes varians*.

Lagoons in the region also support numerous waders and wildfowl, and little terns breed beside the Easington Lagoons.

3.4.3 Human activities

Little or no active management is applied to coastal lagoons themselves, although the surrounding land is often managed intensively. In most cases sites in the region are maintained as nature reserves, largely for the benefit of their birdlife. Such management at Killingholme was criticized by Bamber, Batten & Bridgwater (1991) as being potentially deleterious to the specialist lagoon fauna and flora. There is some threat to Humberston Fitties from rubbish tipping, and to Abraham's Bosom, Norfolk, from pollution from an adjacent caravan site.

3.4.4 Information sources used

All candidate lagoons in the region were surveyed as part of the national lagoon survey undertaken on behalf of the Nature Conservancy Council between 1980 and 1988 (see Barnes 1985; Sheader & Sheader 1986a, 1986b; Irving 1987). Bamber, Batten & Bridgwater (1991) conducted surveys of the Killingholme lagoons in 1990. Surveys of the region's lagoons have been carried out by Barnes from 1984 onwards. The data are summarized by Barnes (1987, 1989), Sheader & Sheader (1989) and Smith & Laffoley (1992), from which the data given here are derived. Detailed reports of all surveys are available, including maps of the habitats and species lists. These studies comprise a significant, detailed database for this region.

3.4.5 Further sources of information

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Brackish lagoons of the region	Dr R.S.K. Barnes, St Catharine's College, Cambridge CB2 1RL, tel: 01223 336606
As above	Dr M. Sheader, Department of Oceanography, University of Southampton, Southampton SO9 5NH, tel: 01703 595000

3.5 Wet grassland

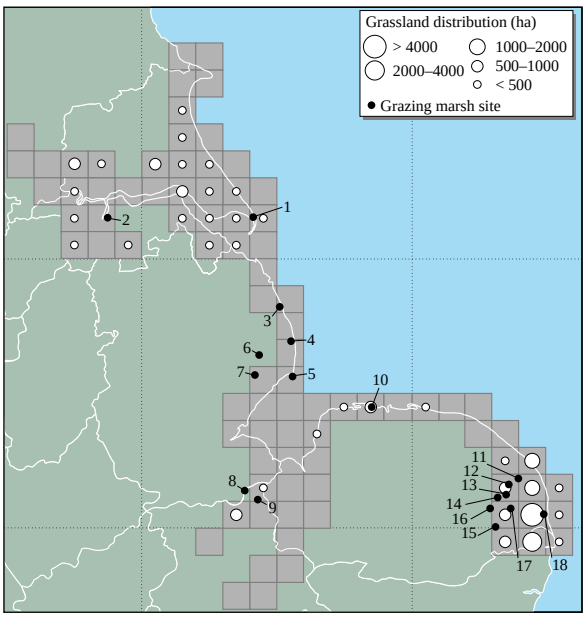
Dr H.T. Gee

3.5.1 Introduction

This section covers both coastal grazing marsh subject to maritime influence and lowland wet grassland adjacent to tidal reaches of estuaries.

Coastal grazing marsh is a distinctive habitat consisting of low-lying grassland drained by a series of ditches that may be either brackish or freshwater. Much grazing marsh was formed by the enclosure of saltmarsh behind sea walls. Smaller areas of freshwater grazing marsh have been created landward of natural barriers such as sand dunes or shingle beaches.

This section includes lowland wet grasslands in Cambridgeshire and the Norfolk Broads which lie several kilometres inland. They are included because they lie next to tidal stretches of rivers and show brackish influence. They may remain wet throughout the year and may be managed for stock grazing, or grazing may be used in conjunction with use as hay meadow or in rotation with arable crops. Characteristically, much of this region is low-lying, and freshwater marsh would once have been continuous with saltmarsh. With the land-claim of both habitats for agricultural purposes, large tracts of wet grassland were formed extending for many kilometres inland; these are covered along with the strictly coastal sites of this region.



Map 3.5.1 Wet grassland sites (numbers refer to Table 3.5.1, points are centre grid references) and areas of lowland grassland in coastal 10 km squares. Source: after Dargie (1994).

Table 3.5.1 Locations of wet grassland

No.	*Site*	*Grid ref.*	*Conservation status*
	Humberside		
1	The Lagoons	TA410177	Wet grassland adjacent to SSSI
2	Humberhead Levels	SE730150	Includes Thorne and Hatfield Moors SSSI
	Lincolnshire		
3	Mablethorpe to Saltfleet	TF500860 to TF450930 TF467917	Much of the wet grassland undesignated, but includes Saltfleetby-Theddlethorpe Dunes NNR
4	East Lindsey Coast	TF530802 to TF558740	Wet grassland adjacent to Sea Bank Clay Pits SSSI
5	Willoughby Meadow	TF473713	SSSI (0.52 ha)
6	Bratoft Meadows	TF484640	SSSI (2.2 ha)
7	Gibraltar Point	TF558588	NNR
	Cambridgeshre		
8	Nene Washes	TL200977 to TF395029	SSSI, RSPB reserve
9	Ouse Washes	TL471861	SSSI, RSPB reserve
	Norfolk		
10	North Norfolk Coast	TF690443	SSSI, SPA, Ramsar site,NNR (Scolt Head, Holkham); Holkham NNR includes National Trust land and Norfolk Wildlife Trust reserves
11	Upper Thurne Broads and Marsh	TG430210	SSSI includes area of wet grassland
12	Ludham-Potter Heigham Marshes	TG410178	SSSI (99 ha)
13	Shallam Dyke Marshes	TG399165	SSSI (71.7 ha)
14	Upton Broad and Marshes	TG390137	SSSI (194 ha)
15	Yare Broad and Marshes	TG330063	SSSI, including RSPB and Norfolk Wildlife Trust reserves and areas of wet grassland
16	Damgate Marshes	TG413097	SSSI (63.9 ha)
17	Geldeston Meadows	TM396916	SSSI (3.4 ha)
18	Berney Marshes	TG415055	RSPB reserve (523 ha of wet grassland)

Key: NNR = National Nature Reserve; SSSI = Site of Special Scientific Interest; RSPB = Royal Society for the Protection of Birds. Site numbers are as shown on Map 3.5.1.

In this section both coastal grazing marsh and lowland wet grassland are referred to as wet grassland. Wet grassland is probably more extensive within this region than anywhere else in Great Britain. However, because no national survey exists of wet grassland as here defined, or indeed of coastal grazing marsh or lowland wet grassland separately, more detailed comparisons are not possible.

Wet grassland forms a significant proportion of the coastal habitat of every county in the region (i.e. Humberside, Cambridgeshire, Lincolnshire and Norfolk) (Map 3.5.1). Wet grassland in this region contains areas of national value for plants and invertebrates. The ditches in wet grassland are also known to support important aquatic invertebrate and plant species. Wet grassland is recognised as an important habitat for breeding waders, especially in lowland Britain, although it usually supports lower densities than saltmarsh (Davidson 1991). The wintering populations of birds in north Norfolk, the Fens and Broadland are of international importance, and all three areas support breeding populations of nationally rare birds. In the region sixteen sites designated as Sites of Special Scientific Interest (SSSIs) comprise or include wet grassland, as do four National Nature Reserves (NNRs), three Royal Society for the Protection of Birds (RSPB) reserves and a number of Local Nature Reserves (LNRs) and Norfolk Wildlife Trust (NWT) reserves.

3.5.2 Important locations and species

Large areas of wet grassland are found alongside the south bank of the inner Humber Estuary and the estuary of the River Trent (the Humberhead Levels), northern Lincolnshire (the Middle Marsh and the Outmarsh), southern Lincolnshire, eastern Cambridgeshire and west Norfolk (the Fens), the north Norfolk coast and the Broads in east Norfolk. Figures from Dargie (1993) show that Humberside contains 4,835 ha of wet grassland, of which 2,798 ha were coastal, representing the majority of this habitat on the coast of England north of the Humber. Norfolk contains 12,754 ha of wet grassland, approximately half of which is on the coast, most of the remainder being freshwater marsh associated with the Norfolk Broads. Wet grassland sites in the region are shown on Map 3.5.1 and listed in Table 3.5.1.

The Humberhead Levels are of national importance for their invertebrate fauna. Wet grassland areas of former raised mire at Thorne Moor retain features of an actively developing *Sphagnum* bog and an exceptionally rich invertebrate fauna. A survey by Heaver & Eversham (1991) recorded fourteen Red Data Book (RDB – nationally rare) species plus 34 nationally notable and many regionally notable and local species. Three species are known only from these moors and of these, two species are considered internationally endangered.

In Lincolnshire good quality wet grassland lies mainly between Mablethorpe and Saltfleet, particularly in the plains of the Long Eau and Great Eau. The age of some of these pastures is demonstrated by the retention of ridge and furrow in many of the fields.

In the Fens, remnant areas of seasonal wet pasture are retained in the Washes - large, seasonal flood storage areas on the rivers Nene and Great Ouse - providing a relict habitat in the surrounding arable land. The Ouse Washes (in Cambridgeshire) continue to be managed mostly as wet grassland, as do increasing areas of the Nene Washes. The ditches of these Washes support a varied ditch flora including some uncommon species (Thomas *et al.* 1981) and important native populations of the fringed water lily *Nymphoides peltata*.

Norfolk contains over half the lowland wet grassland between the Humber and the Thames. The North Norfolk Coast SSSI is extensive, stretching along the coast for 40 km from Hunstanton to Weybourne. Large areas of wet grassland lie within and adjacent to the site. It has a number of other designations (see Table 3.5.1) and includes Holkham NNR and the NWT reserve at Cley. Holkham NNR includes 710 ha of former saltmarsh reclaimed in several stages starting in the 17th century. Much of this is permanent or temporary grassland, some of it used for arable farming each year. 50 macrophyte species were recorded from ditches at Holkham NNR by Driscoll (1986), who attributed this relatively limited species list to the extensive brackish influence across the site (plant communities in the ditches are related to salinity, ditch management and the management of surrounding land). Of particular interest on this coast are the two NVC vegetation communities (National Vegetation Classification - Rodwell 1995) typical of slightly saline ditches, the soft hornwort *Ceratophyllum submersum*/ common duckweed *Lemna minor* community and the fennel pondweed *Potamogeton pectinatus*/ brackish water-crowfoot *Ranunculus baudotii* community. The more saline ditches support plant communities containing saltmarsh species. Ditches in wet grassland on the north Norfolk coast are a national stronghold for the nationally scarce soft hornwort and blunt-leaved pondweed *Potamogeton obtusifolius* (Reid *et al.* 1988).

Much of the former marshland of the Norfolk Broads has been land-claimed to form some of the most extensive and biologically important wet grassland in Britain. Although many of the sites are several kilometres from the sea, for example the Shallam and Upper Thurne Broads and Marshes and the Ludham and Potter Heigham Marshes SSSIs, they receive distinct brackish influence from the rivers, many of which have extensive tidal reaches. These sites all support plants typical of brackish water, such as grey club-rush *Schoenoplectus tabernaemontani* and mare's-tail *Hippuris vulgaris*. Ludham SSSI is unusual in also supporting wet heath and acid grassland dominated by purple moor-grass *Molinia caerulea* and cross-leaved heath *Erica tetralix*. The ditches of the Norfolk Broads are particularly species-rich and along with the Fens support most of the native population of water soldier *Stratiotes aloides*, the nationally rare sharp-leaved pondweed *Potamogeton acutifolius*, as well as other uncommon species such as whorled water-milfoil *Myriophyllum verticillatum*, fen pondweed *Potamogeton coloratus*, bog pondweed *P. polygonifolius*, hair-like pondweed *P. trichoides*, grasswrack pondweed *P. compressus*, flat-stalked pondweed *P. friesii*, greater bladderwort *Utricularia vulgaris*, floating club-rush *Eleogiton fluitans* and greater water-parsnip *Sium latifolium*. The swallowtail butterfly *Papillo machaon* and the Norfolk aeshna dragonfly *Aeshna isoceles* are restricted to wet grassland on the Broads, where important populations are present, along with at least three other nationally scarce Odonata (dragonflies and damselflies), including *Libellula fulva*. The RDB snails *Valvata macrostoma* and *Viviparus contectus* are both present in Upton Broad and Marshes SSSI.

The Ouse Washes have been identified as a possible Special Area of Conservation (SAC) (see section 7.2.4) under the EC Habitats Directive for the spined loach *Cobitis taenia*.

Within this region, wet grassland supports important breeding populations of the commoner species of waders, such as snipe *Gallinago gallinago*, oystercatcher *Haematopus ostralegus* and redshank *Tringa totanus*, as well as the nationally rare ruff *Philomachus pugnax*, black-tailed godwit *Limosa limosa* and little-ringed plover *Charadrius dubius* (see section 5.11). The Yare Broads and Marshes SSSI supports the largest wintering flock of bean geese *Anser fabilis* in Great Britain. Internationally important populations of wintering waterfowl, including Bewick's swans *Cygnus columbianus bewickii*, white-fronted geese *Anser albifrons*, gadwall *Anas strepera*, wigeon *Anas penelope*, teal *Anas crecca* and pintail *Anas acuta*, use the wet grasslands of the region (see section 5.12). A number of other rare birds use the wet grassland of this region for breeding or feeding habitat, including marsh harrier *Circus aeruginosus* and garganey *Anas querquedula*. The Ouse and Nene Washes, the North Norfolk Coast and Broadland are Ramsar sites and SPAs for their internationally important bird populations (see also section 7.2.3).

3.5.3 Human activities

Throughout the region, but especially in the Fens, much former wet grassland has been turned over to arable use, destroying its conservation interest. There has also been loss to industrial land take on the Humber Estuary. Other large areas of wet grassland used as pasture have been agriculturally improved, reducing their botanical interest. On these, the ditches are often rich in plant species, but improved drainage of wet grasslands lowers the water table, making them less suitable for feeding wading birds. A combination of drainage, nutrient enrichment and reduced ditch management causes ditches to dry out or become clogged with vegetation (Doarks 1990; Doarks & Leach 1990). In one area in Broadland, Driscoll (1983) found that 33.5% of drainage ditches had been lost due to infilling between 1973 and 1981, while many of those remaining had become floristically impoverished.

Some areas of wet grassland in the region are being managed to preserve or enhance their conservation interest. Wet grassland in Saltfleetby-Theddlethorpe Dunes NNR on the Lincolnshire Coast is managed by grazing. Substantial areas of the Ouse and Nene Washes are now nature reserves managed especially for their wintering and breeding bird populations. Recent management of 400 ha of Holkham NNR has included reinstatement of permanent pasture and raising water levels (Harold 1995). The ditch system of the Yare Broads and Marshes has been isolated from the river, resulting in clear water of high quality in which an exceptional assemblage of aquatic higher plants has developed.

3.5.4 Information sources used

There has been no national survey specifically of grazing marsh in Britain. In England, however, the extent of lowland wet grasslands, including coastal grazing marsh, was surveyed by Dargie (1993). A fuller breakdown of information and listings of sites by county is given in Dargie *et al.* (1994). These county reports are held by English Nature. Information available varies widely between the counties of England. Within this region there was inadequate Phase 1 coverage throughout; it was particularly incomplete for Lincolnshire, Humberside and north-west Norfolk.

The invertebrate fauna of the Thorne and Hatfield Moors on the Humberhead Levels was surveyed by Heaver & Eversham (1991), and much survey work has been undertaken at Gibraltar Point NNR. The grazing marshes of the Humberhead Levels and in Norfolk are probably among the better studied grazing marsh sites in Britain. The Thorne and Hatfield Moors are probably the best surveyed site for invertebrates in the region. The dyke vegetation of the north Norfolk coast was surveyed in 1975 at Holkham NNR by Driscoll (1986) and between Snettisham and Weybourne by Reid *et al.* (1988).

3.5.5 Acknowledgements

Thanks are due to the staff of English Nature for providing information on wet grassland in their areas. Information was also received from Rob Driscoll at the Castle Museum, Norwich, Dr Ken Pye of Reading University and the Lincolnshire Trust for Nature Conservation.

3.5.6 Further sources of information

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Protected sites in Region 6; wet grassland on Humberside	*English Nature, Humber to Pennines Team, Wakefield, tel: 01904 432700
Wet grassland in the Nene and Ouse Washes	*English Nature, Beds., Cambs. and Northants. Team, Peterborough, tel: 01733 391110
Wildlife Trust sites in region; Spurn Heritage Coast Project	*Yorkshire Wildlife Trust, Spurn Heritage Coast Project, York, tel: 01904 659570
Wet grassland in south Holderness	South Holderness Countryside Society, The Station, Station Road, Patrington, Hull HU12 0NE, tel: 01964 631044
Protected sites in Lincolnshire	*English Nature, East Midlands Team, Grantham, tel: 01476 68431
Wet grassland in Lincs.	*Lincolnshire Trust for Nature Conservation, Horncastle, Lincolnshire tel: 01507 526667
Protected sites in Norfolk; wet grassland in north Norfolk, Ouse Washes and the Broads	*English Nature, Norfolk Team, Norwich, tel: 01603 620558
Wet grassland in Norfolk	R. Driscoll, Castle Museum, Norwich NR1 3JU, tel: 01603 223624
Grassland ecology	*Grassland Ecologist, Lowlands Team, English Nature HQ, Peterborough, tel: 01733 340345

* Starred contact addresses are given in full in the Appendix.

3.6 Saltmarsh

Dr M.I. Hill

3.6.1 Introduction

Saltmarshes in the region include sites of exceptional interest. There are two major estuaries, The Wash and the Humber, with open embayments and fringing saltmarshes. The Wash marshes (totalling more than 4,000 ha) are the largest continuous expanse of saltmarsh anywhere in Britain, despite extensive land claim, which began in Roman times and has produced some 32,000 ha of agricultural land since the 16th Century. The north Norfolk coast contains saltmarshes on the open coast and landward of barrier islands and spits; they are the most diverse in Britain in terms of their geomorphology and biology.

The total amount of saltmarsh in the region is 7,774 ha, representing 36% of the area on the North Sea coast, 25% of that in England and 18% of the British resource (Table 3.6.1). The Coastal Resources database held by JNCC shows that around 50% of the coastline (at Mean High Water) of Lincolnshire supports saltmarsh, compared with 32% in Norfolk and only 9% in Humberside.

Compared to other regions, there is a high percentage of low to mid marsh communities (Table 3.6.1). This regional picture reflects the situation in The Wash (by far the largest area of saltmarsh in the region), where 61% of the marsh area is in this category, the higher marshes having been land-claimed and most of the marshes being of recent origin. Because of this, transitions from saltmarsh to other habitats are not widespread in this region, except the transitions to dune and shingle in north Norfolk, where the proportion of mid to upper marsh vegetation is also much higher.

The saltmarshes of the north Lincolnshire coast, parts of The Wash and north Norfolk have sandy substrates. However, the Humber and inner Wash are typically more muddy (Pye & French 1993).

Map 3.6.1 Saltmarsh sites surveyed in National Saltmarsh Survey (see Table 3.6.3). Source: JNCC Coastal Database.

3.6.2 Important locations and species

The main saltmarsh sites, which were surveyed during the national saltmarsh survey (Burd 1989a, b), are listed in Table 3.6.2 and shown in Map 3.6.1.

Large areas of marsh have been claimed since medieval times in the Humber estuary (de Boer 1988). The remaining marshes form a narrow and discontinuous fringe on both shores, with a total area of approximately 650 ha. Much of the coastline from the Humber to The Wash was formerly tidal marshland, now behind sea walls. Saltmarsh is now found along the foreshore to Cleethorpes and between Tetney and Saltfleetby. In recent years, the marshes have spread, particularly in the shelter of developing sand bars (Pye & French 1993). In contrast to elsewhere in the region, common cord-grass *Spartina anglica* is the most extensive pioneer vegetation in the Humber. Upper marsh swamps of sea club-rush *Scirpus maritimus* and common reed *Phragmites australis* occupy a high proportion (19%) of the saltmarsh in the Humber.

In Lincolnshire, The Wash and north Norfolk, glasswort *Salicornia* spp., annual sea-blite *Suaeda maritima* and sea aster *Aster tripolium* are the typical pioneer saltmarsh plants. Throughout the region, driftline vegetation is widespread, mostly sea couch *Elymus pycnanthus*, with shrubby sea-blite *Suaeda vera* in north Norfolk.

The Wash saltmarshes have shown significant accretion, with new marshes developing after land claim and the construction of training walls. The high and low water

Table 3.6.1 Areas (ha) of saltmarsh communities in Region 6 compared with national totals

	Spartina	*Pioneer*	*Low mid*	*Mid upper*	*Drift line*	*Upper swamp*	*Trans-ition*	*Wet Depression*	*Total*	*% in/of region*
Humberside	108	26	72	78	171	123	0	0	648	8
Lincolnshire	88	642	2,396	377	534	3	11	0	4,223	54
Norfolk	216	372	1,283	640	297	39	29	0	2,903	37
Region 6	**412**	**1,040**	**3,751**	**1,095**	**1,002**	**165**	**40**	**0**	**7,774**	**-**
North Sea coast	3,461	2,130	8,194	4,772	1,350	1,066	342	2	21,788	36
England	5,166	2,641	10,299	9,948	1,493	686	833	0	31,533	25
GB	**6,948**	**3,470**	**12,353**	**16,042**	**1,824**	**1,475**	**1,670**	**2**	**44,370**	**18**

Source: Burd (1989a, b)

Table 3.6.2 Surveyed saltmarsh sites

Name	*Grid ref.*	*Area (ha)*
Humberside		
Humber Estuary, north shore	TA130280	468
Humber Estuary, south shore	TA075240	180
Lincolnshire		
North Lincolnshire Coast	TA420001	771
Gibraltar Point	TF566590	67
The Wash	TF360360	4,162
Norfolk		
Holme to Gun Hill	TF776445	687
Scolt Head Island	TF820463	225
Wells to Blakeney	TF980445	1,052
Blakeney Point	TG020460	163

Source: Burd (1989a, b)

marks have moved seaward, encouraging saltmarsh to prograde. However, some sections of saltmarsh were either stable or eroding between the 1970s and 1980s, and there was a net decline in saltmarsh area over this period, as land claim outstripped new saltmarsh development. No saltmarsh has been claimed since 1980. In The Wash, common saltmarsh-grass *Puccinellia maritima* occupies over half the saltmarsh area, and diverse upper marsh communities are very limited in extent (Hill 1988). Most of the saltmarshes are, or have been, grazed. There have been rapid changes in distribution of vegetation types, with a widespread decline in the dominance of sea purslane *Halimione portulacoides* since the 1970s.

In north Norfolk, saltmarshes form an almost continuous belt over 35 km long, a total area of more than 2,000 ha. Many areas of tidal marsh were reclaimed after 1650, reaching a peak in the 18th century, and causing the development of new marshes to seaward (Pye 1992). The marshes are mostly accreting slowly, with some localised areas of erosion due to changes in wave climate. Some of the north Norfolk marshes formed more than 6,000 years ago and are therefore more mature than elsewhere in the region. Saltmarshes of north Norfolk are some of the most botanically rich in Britain and contrast markedly with the grass-dominated marshes in The Wash. The slow rate of vertical accretion and lack of successional changes in north Norfolk mean that the plant communities have a high degree of stability. Most of the marshes are ungrazed, also increasing species diversity. A typical zonation is from a pioneer zone of *Spartina* or glasswort *Salicornia* spp. to a low-mid marsh with abundant sea aster. The mid-upper marsh frequently has a high cover of sea-lavender *Limonium* spp. and thrift *Armeria maritima*. The driftlines and transitions to dune or shingle are particularly noteworthy as they contain plant communities restricted to south-east Britain. Two National Vegetation Classification (NVC - Rodwell in prep.) communities, *Sueda vera - Limonium binervosum* saltmarsh and *Sueda vera* strandline, are found only in north Norfolk.

The three British species of eelgrass *Zostera* (all nationally scarce) are present in the region, although details of their distribution are not known. Most of the uncommon saltmarsh plants in this region are associated with the upper marsh and transitions. Sea heath *Frankenia laevis*, shrubby sea-blite *Sueda vera* and rock sea-lavender *Limonium binervosum* (all nationally scarce) and matted sea-lavender *Limonium bellidifolium* (nationally rare) reach their northern limits in this region and as an assemblage occur only in north Norfolk. Other nationally scarce species found on saltmarshes in this region are marsh mallow *Althaea officinalis* and perennial glasswort *Salicornia perennis*. Again, these are species characteristic of saltmarshes of south-east England.

As elsewhere in the UK, saltmarshes in this region provide roosting sites for migrating and wintering waders and food for wintering wildfowl such as brent geese *Branta bernicla* and wigeon *Anas penelope*. The extensive marshes also support flocks of smaller wintering birds such as twite *Carduelis flavirostris*, snow bunting, lapland bunting and rock pipit. Breeding birds of saltmarsh include yellow wagtail, skylark, linnet, redshank, lapwing, oystercatcher and shelduck. Cook *et al.* (in prep.) surveyed the breeding redshanks on 30% of The Wash saltmarshes in 1994, relating their results to grazing density, and extrapolated a total breeding redshank population of 1,925 pairs for The Wash as a whole or 6.4% of the estimated British population. Colonies of black-headed gulls and common terns breed on saltmarshes in The Wash. Reedbeds at upper levels of some saltmarshes, for example at Blacktoft Sands in the Humber, can be important for breeding birds. Here breeding birds include reed and sedge warbler, water rail, short-eared owl, bearded tit and marsh harrier.

The terrestrial invertebrate fauna is particularly rich in upper marsh zones, where pools, seepages, driftline debris and tall vegetation are found. Some of the more remote marshes provide haul-out sites for seals, e.g. at Blakeney in north Norfolk.

Most of the saltmarsh in the region is within SSSIs (Table 3.6.3). The marshes in The Wash (including Gibraltar Point) and north Norfolk are part of designated Ramsar Sites and Special Protection Areas. Substantial areas are also National Nature Reserves or are owned by the National Trust, the RSPB or the county Wildlife Trust. Saltmarsh therefore enjoys a high level of protection in this region, although it is vulnerable to 'coastal squeeze': the combined effect of coastal defence to landward and rising sea levels. The Wash and North Norfolk Coast is a proposed SAC (see section 7.2.4).

Table 3.6.3 SSSIs containing saltmarsh

Humberside
- Humber Flats and Marshes: Spurn Head to Saltend Flats (SPA, Ramsar)
- Humber Flats and Marshes: Barton and Barrow Clay Pits (SPA, Ramsar)
- Humber Flats and Marshes: The Grues (SPA, Ramsar)
- Humber Flats and Marshes: Upper Humber (SPA, Ramsar)
- Humber Flats and Marshes: Pyewipe and Cleethorpes Coast (SPA, Ramsar)

Lincolnshire
- The Lagoons, Holderness
- Saltfleetby to Theddlethorpe Dunes (NNR)
- North Lincolnshire Coast
- Gibraltar Point (SPA, Ramsar, NNR)
- The Wash (SPA, Ramsar, part NNR)

Norfolk
- North Norfolk Coast (SPA, Ramsar, part NNR)
- Breydon Water

Source: JNCC Coastal Database.

3.6.3 Human activities

Loss of saltmarsh by conversion to agriculture was formerly a major issue. In The Wash, raising and rebuilding sea defences and digging borrow pits in the saltmarshes has reduced the extent of some diverse upper marsh vegetation and caused deepening and widening of creeks. Now changes in planning policies and stronger site conservation measures mean that further enclosure is much less likely.

Many of the marshes are grazed by stock (see also section 8.2). Within the region, grazed marshes generally have short, grassy swards with a lower diversity of both plants and invertebrates than ungrazed sites. However, the least diverse communities are found where grazing has ceased on sites that historically were grazed. This is evident in The Wash, where grazing of the outmarshes has declined in the last 30 years. Saltmarsh management is one issue that will be addressed in the forthcoming Management Plan for The Wash.

Military use of the saltmarshes is important in Lincolnshire, with ranges at Holbeach, Wainfleet and Donna Nook (see Chapter 7). Other activities on saltmarshes in the region include wildfowling, reed cutting and harvesting of glasswort *Salicornia* spp.

3.6.4 Information sources used

Saltmarshes in this region have been the focus of much research effort and there is a considerable literature about them. Many early classic studies of saltmarsh geomorphology and biology were carried out in Norfolk by Professors Oliver, Chapman and Steers, giving an invaluable historical perspective. Examples of more recent surveys and site descriptions include: parts of the Humber (Armstrong 1988; Armstrong *et al.* 1985); Scolt Head Island and Blakeney Point (various papers in Allison & Morley 1989); and The Wash (Hill 1988; Hill & Randerson 1987). The Wash study used mapping and permanent quadrats to investigate changes in saltmarsh vegetation since the 1970s. Bibliographies of The Wash and north Norfolk coast provide a useful summary of work carried out (Pye 1991a, b; Paterson 1993). Further GIS-based habitat mapping of the Wash saltmarsh is being carried out by Durham University.

Saltmarshes in this region were surveyed from 1983-1987 as part of the National Saltmarsh Survey by the NCC (Map 3.6.1 and Table 3.6.2). Detailed reports are available and results are summarised in Burd (1989a-d). Data presented here are derived from that database. The national saltmarsh survey provided a intermediate level of detail between Phase 1 habitat survey and the National Vegetation Classification (NVC). However, for The Wash saltmarshes, information incorporated into the national survey is also available in NVC format. The national survey did not include all areas of transition to other habitats, or saltmarsh vegetation in non-tidal, reclaimed marshes. Areas of eelgrass *Zostera* spp. were not recorded. In some areas, notably the north Lincolnshire coast, recent changes mean that the national survey now underestimates the amount of saltmarsh.

The Wash is one of the few sites where population data are available for wintering birds using saltmarshes, other than wildfowl and waders (Davies 1987). Surveys and descriptions of the saltmarsh terrestrial invertebrate fauna are given by Muddiman (1988) for The Wash and Foster (1989) for Scolt Head Island and Blakeney Point.

3.6.5 Acknowledgements

Staff from English Nature kindly provided much reference material.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Data from national saltmarsh survey	*Coastal Conservation Branch, JNCC, Peterborough, tel: 01733 62626
Saltmarsh mapping around The Wash	Dept. of Geography, University of Durham, South Road, Durham DH1 3LE, tel: 0191 374 2473

* Starred contact addresses are given in full in the Appendix.

The Wash is the largest estuary in Britain. Many thousands of waterfowl spend all or part of the year there, and in midwinter it has the largest population of waterfowl in Britain, including over half the knots overwintering in Europe. Here, a flock of around 50,000 knots is coming in to roost on the RSPB reserve at Snettisham, Norfolk. Photo: Nick Davidson, JNCC.

Chapter 4 Marine and estuarine habitats

4.1 Estuaries

Dr N.C. Davidson

4.1.1 Introduction

Estuaries are "partially enclosed tidal areas at least partly composed of soft tidal shores, open to saline water from the sea, and receiving fresh water from rivers, land run-off or seepage" (Davidson *et al.* 1991; Davidson & Buck in prep.). They comprise both aquatic (marine, brackish and fresh water) and terrestrial habitats, including adjacent sand dunes, coastal grasslands and maritime heaths. All the estuaries discussed here are covered by the NCC Estuaries Review (Davidson *et al.* 1991) and have at least 2 km of tidal channel or 2 km of shoreline over 0.5 km wide at low tide, either now or historically. This section gives an overview of the main features of the estuarine resource in Region 6; for further details of habitats, species and human uses refer to the relevant sections in Chapters 3, 5 and 9 respectively.

Although there are only four estuaries in Region 6, they are large and individually are some of the most important for geomorphological and wildlife conservation in the UK, for their coastal processes, their coastal and marine habitats, their rare plant and animal species and their large migratory waterfowl populations, and include some of the most unspoilt estuarine habitats in southern Britain. The contribution of Region 6 estuaries to the wider resource is listed in Table 4.1.1. Overall the four estuaries in Region 6 - the Humber, The Wash, the north Norfolk coast and Breydon Water (Norfolk) - form 18% by area of the total UK estuarine resource and over 40% of the British North Sea resource. The large intertidal areas of the Humber Estuary and The Wash make a major contribution to the UK (15%) and British North Sea (36.6%) intertidal resources, and estuarine saltmarshes in Region 6 also contribute substantially to the national resource (see also section 3.6). Despite the long stretches of canalised tidal rivers on three of the estuaries, shorelines (25.2%) and main tidal channel lengths (19.4%) contribute rather less to the British North Sea resource. The areas of estuarine intertidal and subtidal habitat in Region 6 are very important in a European context, forming over 5.5% of the estuarine habitat of north-west Europe (Davidson *et al.* 1991).

All three counties in the region have major estuaries: most of the Humber Estuary is in Humberside; parts of both the Humber Estuary and The Wash lie in Lincolnshire; and Norfolk also, with all of the north Norfolk coast, most of Breydon Water and a major part of The Wash, is of great importance.

All four estuaries in Region 6 have been extensively altered over several centuries by land claim and resulting habitat modification.

Table 4.1.1 shows the extent of estuarine areas and lengths in Region 6 in the wider context.

Table 4.1.1 Contributions of the region's estuaries to the national resource

	Total area (ha)/length (km)	*%North Sea*	*% GB*	*% UK*
Intertidal area	49,934	36.6	15.6	15.0
Saltmarsh area	7,774	37.7	18.8	-
Total area	104,837	40.6	19.7	18.0
Shoreline length	1,422	25.2	15.7	14.7
Longest channel lengths	288	19.2	11.6	10.8

Sources: Buck (in prep.); Davidson & Buck (in prep). Note: Areas of saltmarsh were not available for Northern Ireland and so estuarine saltmarsh area comparisons are not made for the UK.

4.1.2 Important locations and species

At over 30,000 ha total area, the Humber Estuary in the north of the region is one of the largest coastal plain estuaries in Britain and is formed from the combined discharges of the Rivers Trent, Yorkshire Ouse, Don and Hull, which drain the extensive low-lying basins surrounding the estuary. The catchment of the estuary covers about one-fifth of England and includes major conurbations such as Nottingham, Sheffield and Leeds.

Map 4.1.1 Estuaries. Source: JNCC Coastal Database.

There are extensive mudflats in the inner estuary and in the shelter of the sand-capped shingle spit of Spurn Point, and broad sand flats sheltering saltmarsh and sand dunes stretching south down the Lincolnshire coast.

The Wash is the largest estuary in the UK (over 66,500 ha in total area). It is an embayment formed at the mouths of four rivers - the Great Ouse, Nene, Welland and Witham - which together drain the extensive low-lying basin of the Fens. Within The Wash embayment there are almost 30,000 ha of tidal flats - mudflats in the inner part of the embayment and firmer sandflats in the outer parts - and over 4,200 ha of saltmarshes, the largest saltmarsh area of any estuary in Britain.

The north Norfolk coast contrasts markedly with the low-lying river discharge systems of the other three estuaries in Region 6. It is of great significance as the most extensive barrier beach system in Britain. Here, along over 40 km of coast, there is a mosaic up to 4 km wide of tidal flats, channels and saltmarshes formed in the shelter of shingle spits and sand dunes fringed by outer sandy beaches - a geomorphological complex of great importance. Much of the system is marine-influenced, with freshwater inflows restricted to small rivers and streams.

At the southern boundary of the region is the tidal basin of Breydon Water, at the confluence of the Rivers Yare, Waveney and Bure. Breydon Water is a bar-built estuary with a large shingle spit, on which much of Yarmouth is built, at its mouth. Like the Humber and The Wash, Breydon Water drains an extensive low-lying basin, the Norfolk Broads. Extensive parts of the Broads system are tidal, with varying extents of saline penetration, and are bordered by extensive fen and marsh habitats.

The Humber Estuary and The Wash are macrotidal estuaries (i.e. their spring tidal range exceeds 4 m). Tidal range is much smaller on the north Norfolk coast (2.5 m: mesotidal, i.e. 2-4 m tidal range), and Breydon Water is microtidal, with a spring tidal range of only 1.9 m.

Table 4.1.2 summarises the physical characteristics of Region 6 estuaries.

One consequence of the extensive land-claims on the Humber and Wash is that their saltmarshes are mostly recent in origin, having developed outside sea defences. Although extensive, they lack upper saltmarsh communities and natural landward transitions, features of great importance on the north Norfolk coast (see section 3.6). Over at least the past 40 years there has been rapid accretion of saltmarsh (up to 1 km width in this period) on the Lincolnshire coast so that there are now extensive areas of upper saltmarsh with transitions to sand dune (G. Weaver pers. comm.). A particular feature of the three river-discharge estuaries in the region is their long stretches of freshwater tidal rivers. On the Humber and The Wash these are canalised, although the associated flood relief washlands on The Wash rivers are grazing marshes of great wildlife importance, and parts of the freshwater tidal Norfolk Broads have important fen and marsh transitions (see section 3.5).

4.1.3 Human activities

The Wash has a history of agricultural land-claim from Roman times to the mid-20th century, with the progressive claims totalling 47,000 ha being the largest area of land-claim for any British estuary. Similarly over 4,500 ha of Humber flats and saltmarshes have been claimed for agriculture since 1600, and parts of the Breydon Water river systems have been embanked to form grazing marshes, themselves now of major wildlife importance. Likewise parts of the north Norfolk coast have been claimed as grazing marshes, although some have now reverted to saltmarsh and others have been further modified as lagoons and reedbeds in nature reserves. Almost all the shorelines of the Humber Estuary, The Wash and Breydon Water have linear sea defences, as does over half the north Norfolk coast.

Only the Humber Estuary has extensively urban and industrialised shores, with major ports, chemical works and

Table 4.1.2 Physical characteristics of Region 6 estuaries

Estuary	*Centre grid ref.*	*Geomorph-ological type*	*Total area (ha)*	*Inter-tidal area (ha)*	*Salt-marsh (ha)*	*Shore-line length (km)*	*Main channel length (km)*	*Spring tidal range (m)*	*Sub-tidal (%)*
Humberside/Lincs.									
100. Humber Estuary*	TA2118	Coastal plain	30,357	13,521	1,419[a]	675.5	144.7	6.0	55.5
Lincs./Norfolk									
101. The Wash**	TF5540	Embayment	66,654	29,770	4,228	359.0	90.2	6.5	55.3
Norfolk									
102. North Norfolk Coast	TF8946	Barrier beach	6,292	5,874	2,217	70.2	6.0	2.6	6.6
Norfolk/Suffolk									
103. Breydon Water***	TG4907	Bar-built	1,534	769	<0.5	317.0	46.8	1.9	49.9

Sources: Buck (in prep.); JNCC Coastal database. Notes: Estuary numbers are those used in Buck (in prep.). 'Geomorphological type' relates to nine estuary categories, described further in Chapter 5.7 of Davidson *et al.* (1991) and Chapter 4.5 of Davidson & Buck (in press). 'Spring tidal ranges' are for the closest station to the mouth of the estuary. Subtidal includes tidal channels remaining water-filled at mean low water. Key: *Parts of the upper tidal reaches of the Humber Estuary are in Nottinghamshire and S. Yorkshire. **Upper tidal reaches of The Wash are in Cambridgeshire. ***Part of the tidal R. Waveney (Breydon Water) is the border with Suffolk, outside Region 6. [a] Recent major saltmarsh accretion on the Lincolnshire coast means this figure is now an underestimate.

Table 4.1.3 Human influences and water quality on estuaries in Region 6

Estuary	*Centre grid ref.*	*Human use type*				*Water quality*
		urban	*industry*	*rural**	*recreation*	
100. Humber Estuary	TA2118	●	●	●	○	C, B, A
101. The Wash	TF5540		○	●	○	(B), A
102. North Norfolk Coast	TF8946	○		●	●	A
103. Breydon Water	TG4907	○	○	●	●	C, A, (B)

Sources: Buck (in prep.), National Rivers Authority (1991). Key: *Includes natural resource exploitation. ● = major human use; ○ = minor human use. Multiple water quality codes are in downstream sequence; brackets indicate a water quality found in a small part of the estuary. Parts of the upper tidal reaches of the Humber Estuary are in Nottinghamshire and S. Yorkshire, and upper tidal reaches of The Wash are in Cambridgeshire. Part of the tidal R. Waveney (Breydon Water) is the border with Suffolk, outside Region 6.

oil refinery complexes. Elsewhere small parts of The Wash close to the tidal river mouths have ports and industrial developments, and there are urban and industrial shores with a major port, ship repair yards and other industry at Great Yarmouth at the mouth of Breydon Water. Water-based recreation is intensive throughout much of the Breydon Water system, and many types of recreation take place on parts of the north Norfolk coast. Recreational use of The Wash and Humber Estuary is more limited, restricted largely to the outer shores of The Wash and, on the Humber Estuary, to beach recreation on the Lincolnshire coast and water-based recreation in the parts of the upper estuary. Wildfowling is extensive on the Humber estuary, The Wash and parts of the north Norfolk coast. Natural resource exploitation, notably fisheries, shellfisheries and bait-collection, is an important feature of the region and is extensive on the three northerly estuaries. Sand dune and/or saltmarsh grazing occurs alongside The Wash and Humber, and reeds for thatching are cut on the Humber and Breydon Water marshes.

Estuarine water quality varies. It is good on the north Norfolk coast, The Wash (except for a part of the tidal River Great Ouse) and the outer parts of the Humber Estuary. On the Humber it is poorer on the southern shore and parts of the upper tidal reaches of the Don and Yorkshire Ouse. Water quality varies in Breydon Water, from poor in the upper reaches of the Yare to good in the middle part of the estuary, declining again at the estuary mouth around Great Yarmouth. Human uses of estuaries and estuarine water quality in the region are summarised in Table 4.1.3.

4.1.4 Information sources used

This chapter is summarised chiefly from JNCC's *An inventory of UK estuaries*, being published in six regional volumes along with an introductory and method volume (Davidson & Buck in prep.). All estuaries in Region 6 are included in *Volume 5. Eastern England* (Buck in prep.). Data presented in the inventory are drawn largely from material collected during 1989-90 (updated to 1993/4 where appropriate) for the NCC's Estuaries Review (Davidson *et al.* 1991). Saltmarsh data come originally from Burd (1989a, b), whose surveys covered mostly saltmarshes of >0.5 ha.

Hydrological data, e.g. catchment areas and river flows, are available for some but not all estuaries as defined here from sources including National Rivers Authority Catchment Management Plans. For Region 6 a final Catchment Management Plan is available for the Lower Nene (The Wash), and consultation reports already available or being prepared during 1994/5 include coverage of the Yare (Breydon Water), Humber estuary and north Norfolk rivers (north Norfolk coast). Chapter 10 gives further information on Catchment Management Plans and Estuary Management Plans. Catchment areas and river flows are summarised in a five-year catalogue of river flow gauging stations (Marsh & Lees 1993), but note that for whole estuary data further interpretation is usually necessary.

4.1.5 Acknowledgements

Thanks go to John Barne for help in preparing data used in this chapter, and to Dr Pat Doody, John Barne and Catherine Smith (JNCC) and Graham Weaver (English Nature) for helpful comments on draft texts.

4.1.6 Further sources of information

A. References cited

Buck, A.L. In prep. *An inventory of UK estuaries. 5. Eastern England.* Peterborough, Joint Nature Conservation Committee.

Burd, F. 1989. *The saltmarsh survey of Great Britain.* Peterborough, Nature Conservancy Council. (Research & survey in nature conservation, No. 17.)

Davidson, N.C., Laffoley, D.d'A., Doody, J.P., Way, L.S., Gordon, J., Key, R., Drake, C.M., Pienkowski, M.W., Mitchell, R.M., & Duff, K.L. 1991. *Nature conservation and estuaries in Great Britain.* Peterborough, Nature Conservancy Council.

Davidson, N.C., & Buck, A.L. In prep. *An inventory of UK estuaries. 1. Introduction and methods.* Peterborough, Joint Nature Conservation Committee.

National Rivers Authority. 1991. *The quality of rivers, canals and estuaries in England and Wales.* Bristol, National Rivers Authority. (Water Quality series, No. 4.)

B. Further reading

Further details of estuaries are in the *Coastal & Marine UKDMAP datasets* module (Barne *et al.* 1994), available from JNCC Coastal Conservation Branch, Peterborough. A list of selected further reading for each estuary discussed in section 4.1 is given in Buck (in prep.) (above).

Barne, J., Davidson, N.C., Hill, T.O., & Jones, M. 1994. *Coastal and Marine UKDMAP datasets: a user manual.* Peterborough, Joint Nature Conservation Committee.

British Oceanographic Data Centre. 1992. *United Kingdom Digital Marine Atlas. User Guide. Version 2.0*. Birkenhead, Natural Environment Research Council, British Oceanographic Data Centre.

Davidson, N.C. 1991. *Estuaries, wildlife and man.* Peterborough, Nature Conservancy Council.

Hill, T., & Northen, K. In prep. *Littoral survey of the inlets of south-east England.* JNCC Report. (Marine Nature Conservation Review series.)

Noble, L., *ed.* 1993. *Estuaries and coastal waters of the British Isles. An annual bibliography of recent scientific papers. Number 17.* Plymouth, Plymouth Marine Laboratory and Marine Biological Association.

Marsh, T.J., & Lees, M.L., *eds*. 1993. *Hydrometric register and statistics 1986-90.* Wallingford, Institute of Hydrology.

Peck, K. 1993. Estuaries inventory - research towards a better understanding of the interactions between birds and human activities on UK estuaries. *RSPB Conservation Review, 7*: 42-46.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Coastal database: national database of estuaries; coastal habitats; statutory & non-statutory protected sites. Summary data available also in Coastal Directories UKDMAP display version.	*Coastal Conservation Branch, JNCC, Peterborough, tel: 01733 62626
Statutory protected sites; detailed wildlife site information; coastal geomorphology. Estuaries Initiative & estuary management plans. Numerical and some digitised data.	*Estuarine Ecologist/Estuaries Initiative Officer/Marine Ecologist, EN HQ, Peterborough, tel: 01733 340345
RSPB Estuaries Inventory: mapped and numerical information on land use and selected human activities for 57 major UK estuaries (see Peck 1993). In region 6 covers the Humber Estuary and The Wash.	*Estuaries Inventory Project Officer, RSPB, Sandy, tel: 01767 680551
National River Flow Archive: catchments and river flows from upstream gauging stations; interpreted analyses for whole estuaries	National Water Archive Manager, Institute of Hydrology, Maclean Building, Crowmarsh Gifford, Wallingford, Oxfordshire OX10 8BB, tel: 01491 838800

* Starred contact addresses are given in full in the Appendix.

4.2 The sea bed

R.A. Irving

4.2.1 Introduction

This section covers the occurrence and distribution of groups of species that live on the sea bed (benthic communities, collectively called the benthos); the distribution and occurrence of individually rare and scarce species is covered in section 5.4.

Information on the precise extent of shore and sea-bed types in a national context is not yet available. This region borders the southern bight of the North Sea, and is characterised by turbid water, extremes in sea temperatures and a general lack of hard substrata - all important factors which limit the diversity of the marine fauna and flora found here (Covey 1995). Littoral rock is extremely limited, but occurs as chalk cliffs and wave-cut platforms around Flamborough Head, as chalk and greensand cliffs and intertidal rock at Hunstanton, and as chalk platforms at Sheringham and West and East Runton, north Norfolk. Littoral sediment is very extensive in the region and ranges from the coarse mobile sands of the moderately exposed Lincolnshire and Norfolk coast to the sheltered muds of the Humber Estuary, The Wash and the creeks along the north Norfolk coast. Mixed sediments are also present. In this region, as along the east coast in general, the communities associated with estuarine sediments and hard substrata are far less diverse than those found in the south-west of England (Davidson *et al*. 1991), a reflection of the more limited range of sea bed types present.

Sublittoral rock occurs to a limited extent in the region as chalk around Flamborough Head and off the north Norfolk coast between Weybourne and Overstrand. The sea bed remains shallow for some distance offshore along much of the region's coastline, with very extensive areas of sublittoral sediment (see section 2.2).

A number of wrecks (ships, aircraft and other solid material) occur off the coast of this region (see also section 6.1). These objects offer hard substrata in areas which may be largely sedimentary, thus providing discrete new habitats for opportunistic colonising species that otherwise would not be present.

4.2.2 Important locations and communities

Map 4.2.1 shows littoral surveys recorded on the JNCC's Marine Nature Conservation Review (MNCR) database and key locations of marine biological importance mentioned in the text; the latter are listed in Table 4.2.1. Map 4.2.2 shows MNCR-listed near-shore sublittoral surveys.

Flamborough Head to Cleethorpes (including the Humber estuary)

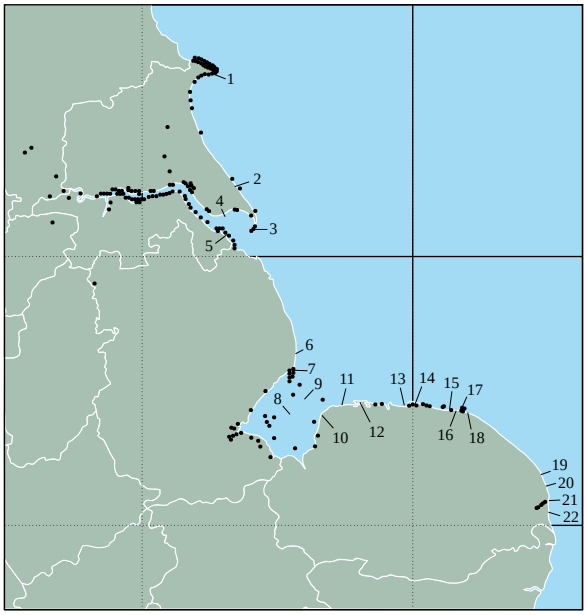
Flamborough Head has been identified by English Nature as a Sensitive Marine Area (SMA) (English Nature 1994); SMAs are listed in section 7.4.4. Chalk bedrock is the dominant characteristic of the coast around Flamborough Head. The exposure here represents nearly 9% of Europe's coastal chalk and is the most northerly outcrop of coastal chalk in the British Isles; to the south lies a long stretch of soft coastline. The chalk is harder than that exposed in southern England and is not so easily eroded; none of it has been modified by coast protection works (English Nature 1994). The area is exceptional in the distance that the chalk is found offshore - at least 3-4 km from the headland. The Head also acts as a biogeographic boundary, with certain marine species reaching their southern or northern distributional limits here.

The shore on the northern side of the headland is relatively steep and rugged, being exposed to wave action. Between the rocky headlands and shore platforms are small sandy coves. The water turbidity is relatively high around the headland, with strong tidal currents, yet some silt is found in sheltered areas. On the north and east side of the headland, the sea bed comprises chalk platforms dissected to form gullies and outcrops, with vertical faces up to 6 m high. These formations lead onto terraces with progressively lower steps and a bedrock plain further offshore (Wood 1988). The north-facing shore has been identified as being of international importance for its algal communities, particularly in the splash zone on the cliffs (extending 15-20 m above mean high water) and in caves (English Nature 1994; Tittley 1988).

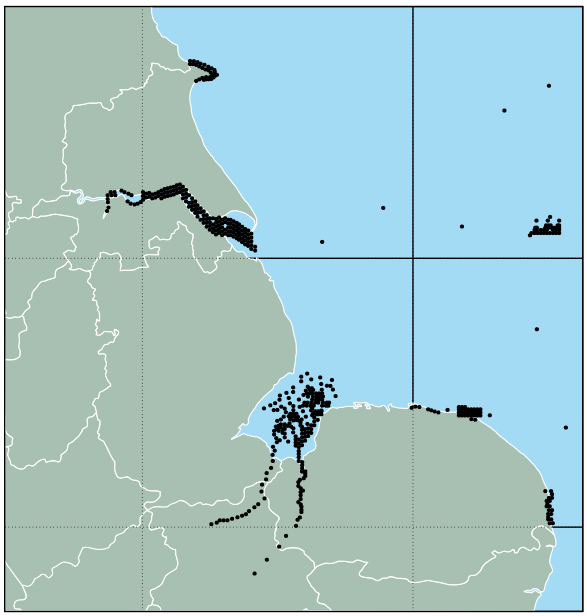
Wave-cut platforms are present on the more sheltered south side of the headland, where the chalk is softer. There are no bedrock outcrops and the terraces are lower, often being covered by boulders, cobbles and pebbles (mostly flint). On the southern side especially, a well developed kelp forest of *Laminaria hyperborea* extends down to a depth of 4 m. This species does not recur further south until the Dover Strait. A wide range of hydroids and bryozoans are

Table 4.2.1 Locations of marine interest mentioned in the text

No. on Map 4.2.1	*Location*	*Grid ref.*
1	Flamborough Head	TA2570
2	Withernsea	TA3427
3	Spurn Head	TA3910
4	River Humber	TA21, TA31
5	Cleethorpes	TA3108
6	Skegness	TF5763
7	Gibraltar Point	TF5657
8	The Wash	TF54, TF53
9	Lynn Deeps	TF54, TF64
10	Hunstanton	TF6640
11	Brancaster Bay	TF7445
12	Cockle Bight	TF8145
13	Blakeney Point	TG0047
14	Blakeney	TG0345
15	Sheringham	TG1643
16	West Runton	TG1843
17	East Runton	TG2042
18	Cromer	TG2242
19	Hemsby	TG5117
20	Caister	TG5212
21	Great Yarmouth	TG5307
22	River Yare	TG5303



Map 4.2.1 Littoral surveys (including tidal rivers) recorded on the MNCR database (source: JNCC) and key locations of marine biological importance described in the text (see Table 4.2.1). (See Map 7.4.1 for locations of Sensitive Marine Areas.)



Map 4.2.2 Near-shore sublittoral surveys recorded on the MNCR database. Source: JNCC.

dominant in areas of strong tidal streams and sand scour, along with the soft coral *Alcyonium digitatum* and colonial tunicates (sea squirts). Species able to bore into the chalk include the sponge *Cliona celata*, the polychaete *Polydora ciliata* and the bivalves *Hiatella arctica* and *Zirfaea crispata*. Interestingly, there are few sponge species present, and wrasse *Labridae* spp., which are normally plentiful around inshore rocks, are also uncommon.

A total of 270 invertebrates and 112 algal species have been recorded from the shores around Flamborough Head, with the greater proportion from the more sheltered sites (George *et al*. 1988). Many species found at Flamborough Head have not been recorded from other chalk shores in Britain.

From Flamborough Head to the Humber, the coast is predominantly sedimentary in nature. This stretch of coast is subject to particularly active coastal processes, resulting in continual changes to the coastline. An intertidal invertebrate survey carried out on the EC designated bathing beaches (Morris & Bird 1992) found that the fauna consisted of amphipods and polychaete worms, with the distribution of communities depending on sediment particle size. The sublittoral macrobenthos is typical of Jones' (1950) 'boreal offshore gravel association', with horse mussels *Modiolus modiolus*, brittlestars *Ophiothrix fragilis* and the bryozoan *Flustra foliacea* characterising the fauna. In the Humber estuary the ragworm *Neanthes diversicolor*, the bivalve *Macoma balthica*, the amphipod *Corophium volutator* and oligochaetes were found to be the most abundant and widespread littoral species, with species diversity increasing seawards from west (seven species per station) to east (40 species per station) (Hinton-Clifton 1964; Jones 1973). Regular monitoring of certain littoral sites has taken place since these early studies (e.g. for *Macoma balthica* by Jones 1991), and a recent noticeable change in the estuary's biota is the disappearance of *Corophium volutator* since a study by Barnett (1984) of the southern shore (Covey 1995). From benthic surveys, Rees *et al*. (1982) describe five main community types in the Humber estuary (Table 4.2.2).

Table 4.2.2 Main littoral and sublittoral communities of the Humber estuary

1	Impoverished marine sand, in the central channel from Immingham to the mouth, influenced by tidal action and characterised by *Nephtys* spp., Mysidae, *Spio filicornis* and *Spiophanes bombyx*.
2	'Transitional' muddy sand, mostly from Barton to Immingham on the south side, influenced by tidal current action, with *Capitella capitata*, *Polydora* sp., Mysidae, Gammaridae and *Nephtys* spp.
3	Impoverished estuarine muddy sand, from the upper estuary to Paull Roads on the north side, influenced by tidal current action. Sparse fauna, distinguished from transitional muddy sand by the absence of polychaetes.
4	Marine sand, at the southern mouth, containing a rich fauna in areas which were presumed to be less exposed than those of impoverished marine sand in the main channel. Characteristic species include *Spiophanes bombyx* and *Spio filicornis*.
5	Nearshore mud, off Immingham and Grimsby, with a rich mud fauna including *Polydora* sp. and *Pygospio elegans*.

Source: after Rees *et al*. (1982)

Cleethorpes to Hunstanton (including The Wash)

The Lincolnshire coast has received little attention, with no information known of surveys of the near-shore sublittoral along the open coast from Cleethorpes to Gibraltar Point. Probert (1981) provided a description of the main shore species, communities and substrata present and an assessment of the conservation importance of this stretch of coast. The Pyewipe and Cleethorpes SSSI (which includes the intertidal area up to 7 km either side of Grimsby) is notified (in part) for its rich infaunal communities.

The Wash is a large (66,000 ha) sea inlet, about half of it exposed at low water in the form of sand and mudflats, an area comparable in Britain only to Morecambe Bay. In the outer reaches there are deep channels between the sandbanks, the greatest depth (47 m) being recorded from the Lynn Deeps, midway between Hunstanton and the Friskney shore. Well mixed, turbid waters are present throughout the embayment, with predominantly sedimentary substrata varying from very soft muds (in sheltered areas) to coarse sands and mixed substrata (at the outer part of the embayment). The high turbidity results in the infralittoral (algal-dominated) zone being virtually absent.

The intertidal flats, amounting to around 40% of the total area of The Wash, consist mainly of fine sands supporting a community characterised by the lugworm *Arenicola marina*, with cockle *Cerastoderma edule*, Baltic tellin *Macoma balthica*, mussel *Mytilus edulis,* the gastropod *Hydrobia ulvae*, the crustacean *Corophium volutator* and the polychaete worm *Nephtys hombergii* (English Nature 1994).

A study by the National Rivers Authority (NRA 1994) in 1991 found that distinct faunal groups occur either side of the 10 m depth contour, with secondary differences resulting from variations in sediment types. Polychaete worms dominate The Wash fauna, in terms of numbers of both species and individuals, with the Crustacea and Mollusca being next in order of importance, as is typical for such habitats. Dipper *et al*. (1989) recorded five main sublittoral community types (see Table 4.2.3).

In parts of The Wash the polychaete *Sabellaria spinulosa* has an important influence on the composition of sediment communities. This worm builds reef-like structures from coarse sands, creating niches for other invertebrate species, which in turn provide an important food source for commercial species such as shrimps and flatfish. Sites where *S. spinulosa* was found in 1991, mostly to the north and north-east, had over twice the number of species recorded from them compared with sites where it was absent (NRA 1994). The Wash also acts as an important nursery area for cod *Gadus morhua*, plaice *Pleuronectes platessa* and sole *Solea solea* (see also section 5.7). Aldous (1987), in a review of fisheries in The Wash, commented on the disappearance of oysters *Ostrea edulis* in the early part of this century.

The Wash and north Norfolk, encompassing the coast and shallow sea from Skegness to Cromer, has been identified by English Nature as the region's second SMA (see section 7.4.4). The area features a diverse range of habitats (including the vast sandflats of The Wash and the chalk exposure at West Runton) and is important for its populations of seals (both common and grey), wildfowl and waders, and as a nursery area for fish and shellfish (English Nature 1994).

Hunstanton to Great Yarmouth

The striped Greensand and Chalk cliffs at Hunstanton provide an impressive backdrop to the shore of muddy sand and isolated boulders. Of interest are the discrete exposures of intertidal peat. The sandflats are characterised by lugworms, but exposures of Greensand rock at extreme low water mark support hard substratum communities, with a range of sponges, hydroids, molluscs and echinoderms (sea urchins).

Much of the open coast of north Norfolk between Brancaster Bay and Blakeney is composed of mobile sands and some shingle, backed by extensive sand dune systems, with spits and offshore islands sheltering intertidal flats. Wave-exposed sandy beaches occur on the open coast and are largely devoid of infauna, particularly on the well-drained area of the upper shore. Towards the low water mark, where the sand is noticeably wetter, dense aggregations of lugworms and the sandmason worm *Lanice conchilega* are common. Two littoral sites in the Brancaster area, surveyed by an MNCR team in 1993, contain extensive outcrops of a fossilised forest, which support a mat of algae and dense growths of sandmason worms and are intensively bored by piddocks (a bivalve) (T. Hill, pers. comm.). At Cockle Bight, in the shelter of Scolt Head Island, fine muddy sand is characterised by mussels and cockles, with small patches of eelgrass *Zostera* spp. also present. The

Table 4.2.3 Main sublittoral communities of The Wash

1 A brittlestar *Ophiura albida* community on fine sand and silt, particularly throughout the southern part of The Wash, with densities up to 1,500/m^2. Also with the *brittlestar Ophiura texturata*, the starfishes *Asterias rubens* and *Crossaster papposus*, the urchin *Psammechinus miliaris*, the anemone *Sagartia troglodytes*, the shrimps *Crangon crangon* and *Pandalus montagui* and the sandmason worm *Lanice conchilega*.

2 A fanworm *Sabella pavonina* community on fine sand overlying sticky clay mud, present at just two sites, NE of the Boston Deep and NE of Sunk Sand. The *Sabella* tubes provided a substratum for thick growths of the hydroid *Obelia dichotoma* and the bryozoan *Flustra foliacea*. The anemone *Sagartia troglodytes* is abundant in the mud between the *Sabella* tubes.

3 Muddy sand with shell gravel and pebbles characterised by hydroids, the bryozoan *Flustra foliacea* and the soft coral *Alcyonium digitatum*. Other prominent species included the anemone *Sagartia troglodytes*, the sandmason worm *Lanice conchilega* and the occasional brittlestar *Ophiura albida*.

4 Rippled sand with occasional empty shells and virtually no epifauna.

5 Soft mud with lugworm *Arenicola* casts.

Source: after Dipper *et al*. (1989)

seaward side of the peninsula at Blakeney consists of a barren, steep shingle beach along most of its length. The clean and mobile fine sand at Blakeney Point is characterised by a crustacean-polychaete community which lacks any bivalve molluscs (T. Hill pers. comm.).

To the east of Blakeney, mainly between Sheringham and West Runton but also at East Runton and Cromer, lie isolated stretches of chalk bedrock, which extend from the shore into the sublittoral. These represent the only appreciable area of natural hard substrate on the coast of East Anglia and are especially important because of the limited exposure of chalk bedrock in the European marine environment (Covey 1995; English Nature 1994). The chalk reefs of West Runton are unusual in not being backed by chalk cliffs, in having a relatively high number of flints and a rich subtidal fauna (particularly of filter feeders and edible crabs) and in lacking a kelp zone.

Offshore

Offshore (defined as beyond 3 km or 50 m depth) there occurs a distinct boundary of water types, the Flamborough Front. It is present during the summer months off Flamborough Head and extends across the North Sea to the German Bight, being associated with the separation of deep and shallow parts of the North Sea, and is visible on satellite photographs. The Humber plume is being monitored as part of the Land Ocean Interaction Study (LOIS) project (see section 4.2.6 C).

Off the mouth of the Humber the sea-bed substrate is composed largely of gravels and is characterised by species of genera such as bryozoans *Flustra*, whelks *Buccinum*, mussels *Modiolus* and polychaete worms *Sabellaria* (Murray *et al.* 1980). Further to the south, off Mablethorpe, the sediment is muddier. A total of 164 species were described by Resource Consultants Cambridge Ltd. (1993) in grab samples taken offshore about 100 km east of the mouth of the Humber. Polychaetes (91 species) were dominant, but other annelids were represented, along with eleven other phyla. Both numbers and abundance of species varied widely from place to place.

Creutzberg *et al.* (1984) describe the physical characteristics and selected benthic species of the central southern North Sea, finding the brittle star *Amphiura filiformis* to be the most generally abundant organism. Distributions are related to the proportion of mud in the sediment, with the parchment worm *Chaetopterus variopedatus* characteristic of muddy sand and the bivalve *Tellina fabula* of clean sand.

4.2.3 Human activities

A number of activities that affect marine habitats and communities take place within this region: most are dealt with at greater length in Chapters 8 and 9. Fisheries activity within the Flamborough Head area includes potting, trawling, static salmon netting and dredging for queen scallops (section 9.1). Off the north Norfolk coast in particular there are inshore fisheries for edible crab *Cancer pagurus* and lobster *Homarus gammarus*. Aldous (1987) reports that the fisheries of The Wash account for 100% of pink shrimp (also known as pink prawn) *Pandalus montagui* landings, 30% of UK brown shrimp *Crangon crangon* landings, 70% of UK mussel landings and 35% of UK cockle landings (see also sections 5.5 and 9.1). In addition, Pacific oysters *Crassostrea gigas* are cultivated in The Wash and also at some sites on the north Norfolk coast (see section 9.2). Cultivation of Manila clams *Tapes philippinarum* is proposed for The Wash. Many of the sedimentary shores in the region are used extensively for bait digging (Fowler 1992).

In surveying the infauna along the south shore of the Humber estuary, Barnett (1984) pointed out that the presence of pollution-tolerant worm species such as *Capitella capitata*, *Tubificoides benedeni* and *Neanthes diversicolor* suggested that the lower estuary was suffering the effects of pollution.

Monitoring studies have been carried out on the east coast of Norfolk in connection with the construction of the West Runton sewage outfall. These were unable to demonstrate clear changes to the benthic communities as a result of the outfall, but showed that there was a substantial change in species composition over time at the monitored sites even before the outfall was in place, correlated with changes in the quantity of sediment that overlies the chalk platform and flint cobbles (George *et al*. 1990, 1991, 1992).

4.2.4 Information sources used

Areas in the region that are well documented include Flamborough Head, the Humber Estuary and parts of the north Norfolk coast.

JNCC's Marine Nature Conservation Review (MNCR) team (and their contractors) use a standard recording methodology for both littoral and sublittoral surveys, which includes descriptions of both habitats and their associated communities (see Hiscock 1990). Survey information from other sources may vary considerably in its methodology and coverage. The Nature Conservancy Council contracted the British Museum (Natural History), London, to survey the chalk shores of Flamborough Head (George *et al*. 1988; Tittley 1988), and Wood (1988) to survey the sublittoral chalk of Flamborough Head. The types of sea bed present off Flamborough Head were surveyed using remote methods by a BioMar survey team in 1994 (see Foster-Smith & Davies 1994 for methodology). The north Norfolk shoreline, between Brancaster Bay and Blakeney Point, was surveyed by an MNCR survey team in 1993 (T. Hill pers. comm.). Table 4.2.4 shows the number of sites in the region with marine benthic habitat and species information held on the MNCR database, and Maps 4.2.1 and 4.2.2 show, respectively, littoral and near-shore sublittoral surveys recorded on the JNCC's MNCR database.

Table 4.2.4 Number of sites with marine benthic habitat and species information held on the MNCR database

Littoral	*Near-shore sublittoral*	*Offshore*	*Total*
72	138	0	210

Note: See also Maps 4.2.1 and 4.2.2. Note: this information is not comprehensive; additional records may exist in sources not consulted.

The coast from Bridlington to the Humber estuary has been only poorly studied. Some early records of the littoral fauna at Withernsea were provided by Petch (1907), whilst Philip (1936) gave details of the eelgrass *Zostera* spp. and tasselweed *Ruppia* spp. communities at Spurn Head. In contrast to the lack of published information on the adjacent coasts, the physical, chemical and biological nature of the River Humber has received considerable attention. A biological survey described the distribution of common intertidal species along the southern shore of the Humber estuary (Hinton-Clifton 1964), with subsequent more detailed investigations initiated by the Yorkshire and Lincolnshire River Authorities along both the north and south banks (Jones 1973). The distribution of sediment types within the estuary was described in symposium papers published by the Natural Environment Research Council (1979). Biological monitoring is used to assess water quality in the Humber, and the results are presented in the reports of the Humber Estuary Committee (Covey 1995). Other studies that have taken place in the Humber include work on the fouling biota of navigation buoys (Hemsley-Flint 1976); the ecology of the mud flats at Spurn Bight (Key 1983); and algae on the southern shore (Price *et al*. 1977a, b).

Work on the Lincolnshire coast prior to 1981 was summarised by Probert (1981) as part of a Nature Conservancy Council review of the shores of Lincolnshire and East Anglia (a section of coast not surveyed by the MBA/SMBA littoral survey of Great Britain). No surveys are known to have been carried out of the near-shore sublittoral along the open coast from Cleethorpes to Gibraltar Point.

The main environmental and ecological features of The Wash were discussed at a conference in 1987 (Doody & Barnett 1987). During 1985 and 1986, a survey of sublittoral sites within The Wash using diving and dredging was carried out by Dipper *et al*. (1989).

The marine fauna of the area between Hunstanton and Great Yarmouth (and much of the Norfolk and Suffolk coast) has been studied by Dr R. Hamond (see Covey 1995 for list of published papers). Littoral chalk areas on the east coast of Norfolk were surveyed by George *et al*. (1988), while Frid (1987) undertook a brief survey of the sublittoral, using diving. Subsequent sublittoral surveys have included a study for the Anglian Water Authority with particular reference to the crab fishery (George & Platt 1988); and a long-term monitoring study of the benthos, also for (the renamed) Anglian Water Services, associated with the commissioning of a new long sewage outfall at West Runton (George *et al*. 1990, 1991, 1992). Little has been published on the marine biological interest of the coast from Cromer to Caister. The effect of a sewage outfall at Caister was studied by Anglian Water Authority, with sublittoral benthic sampling between Hemsby and the mouth of the Yare both before (Anglian Water Authority 1984) and after (Anglian Water Authority 1987) the outfall came into operation.

Apart from that shown on Admiralty charts, limited detailed information is available on the nature of the offshore sea bed. Studies describing offshore sea-bed habitats and communities are prepared as part of environmental impact assessments before or after some kind of human activity. For example, Murray *et al*. (1980) described sea-bed types off the mouth of the Humber in an assessment of sludge dumping in the area. Resource Consultants Cambridge Ltd. (1993) carried out an offshore grab sample survey on an area which is being considered for aggregate extraction. Information from studies of this kind is held by English Nature, MAFF, the Crown Estate and the County Wildlife Trusts.

4.2.5 Acknowledgements

The author acknowledges the considerable help of JNCC's Marine Nature Conservation Review team (particularly Dr Tim Hill) in compiling and presenting the information given here. The MNCR literature reviews by Teresa Bennett and Dr Judy Foster-Smith (1995: Dunbar to Bridlington - MNCR Sector 5) and Roger Covey (1995: Bridlington to Folkestone - MNCR Sector 6) have been widely consulted.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Marine nature conservation issues in England	*Maritime Team, EN HQ, Peterborough, tel: 01733 340345
MNCR database	*MNCR Team, JNCC, Peterborough, tel: 01733 62626
Flamborough Head sublittoral habitats & communities	Dr L. Wood, Hollybush, Chequers Lane, Eversley, Basingstoke, Hants RG27 ONY, tel: 01734 734127
Studies of sublittoral benthos in the Humber; sediment beaches & sublittoral benthos, Scarborough to Spurn.	Dr M. Elliot, Department of Applied Biology, University of Hull, Hull HU6 7RX, tel: 01482 465503
Littoral infaunal studies in the Humber	Dr N. Jones, Department of Applied Biology, University of Hull, Hull HU6 7RX, tel: 01482 465511
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Marine and brackish invertebrates of Norfolk	Dr R. Hamond, Scaldbreck House, Morston, Holt, Norfolk, NR25 7BJ, tel: 01263 740247
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Benthic marine ecosystems of north Norfolk	Dr D. George, Head of Marine Biological Services Unit, Department of Zoology, The Natural History Museum, Cromwell Road, London SW7 5BD, tel: 0171 9389431
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* Starred contact addresses are given in full in the Appendix.

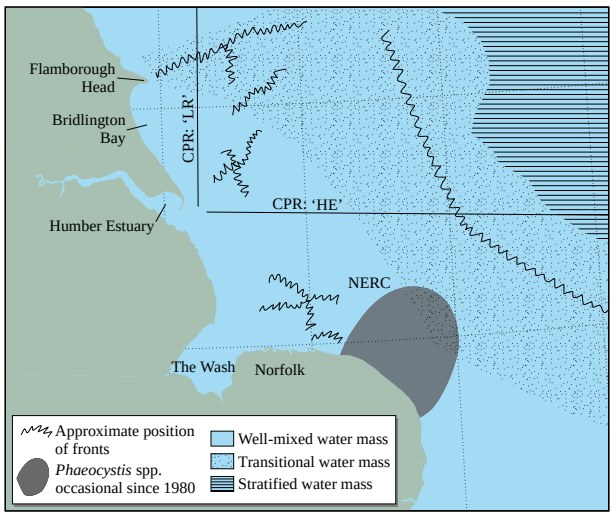
4.3 Plankton

M. Edwards & A.W.G. John

4.3.1 Introduction

Plankton include the bacteria (bacterio-), plant (phyto-) and animal (zoo-) plankton. In temperate continental shelf seas, as in this region, the phytoplankton assemblage is dominated by diatoms and dinoflagellates, and the zooplankton, although containing representatives of most animal phyla at some stage, is dominated by crustaceans, principally copepods. The plankton's abundance is strongly influenced by factors such as depth, tidal mixing and temperature stratification, which determine the vertical stability of the water column. The distribution of species, here and elsewhere, is influenced directly by salinity and temperature (section 2.3.5), by water flows into the area (section 2.3.5) and by the presence of local benthic (bottom-dwelling) communities (section 4.2.2). Many of the species in these communities, including commercially important fish and shellfish (sections 5.5 and 5.7), have temporary planktonic larval forms (meroplankton). Tidal fronts (boundary zones between stratified and well mixed water masses) in the region (Map 4.3.1) are likely to be of significant biological importance, since they are usually rich in plankton, which attracts other marine life. Phytoplankton blooms are a normal feature in the seasonal development of plankton. Some blooms (transient, unsustainable growths, usually of single species and often associated with a visible discolouration of the water) may reach exceptional proportions (>10^6 cells/l) or contain species (principally dinoflagellates) that can be toxic to humans and possibly have an important economic impact on mariculture, fisheries and tourism. Figure 4.3.1 shows the seasonality of phytoplankton blooms and the numbers of copepods present in the region.

In Region 6, as elsewhere, the plankton has a fundamental role in the food chain of both benthic (sea-bed) (see sections 4.2 and 5.5) and pelagic (water column) (see section 5.7) wildlife. For both ecosystems, the availability of food and nutrients, larval survival, maintainance of populations and timing of egg production are highly dependent on the amount of phyto/zooplankton available. Any environmental stress imposed on the plankton will have consequences throughout the food chain and may affect the amount of food available to fish, birds and marine mammals. In coastal management, plankton can also give early warning of adverse human impacts (for example the effects of eutrophication) and highlight different water masses.



Map 4.3.1 Plankton surveys and 'fronts' (see Table 4.3.1 for surveys and codes), *Phaeocystis* blooms and areas of stratified (layered) and well-mixed water.

4.3.2 Important locations and species

Evidence from CPR surveys indicates that in this region the planktonic assemblage is made up mainly of neritic (coastal water) species, although southern intermediate (mixed water) species are also present. During the autumn months, water from the north-western part of the North Sea sometimes enters the region, bringing in various oceanic species from the north-west (Adams 1987).

The spring phytoplankton bloom occurs during March to the east over the Dogger Bank and spreads westwards to cover most of this region by April (see Fig 4.3.1). After the phytoplankton diatom bloom, dinoflagellates (mainly *Ceratium tripos* and *C. lineatum*) become prominent in near-shore production zones (Williams *et al.* 1993). The Continuous Plankton Recorder (CPR) data suggest that the phytoplankton standing stock reaches its peak slightly

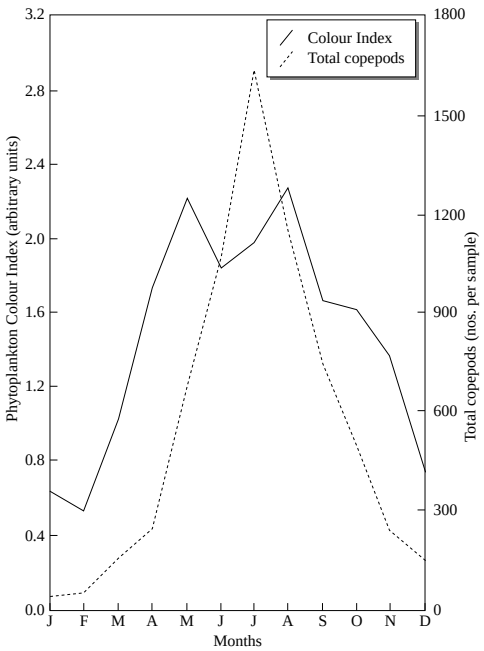


Fig 4.3.1 Seasonal cycles of an index of phytoplankton colour (a visual estimate of chlorophyll) and the numbers of copepods per sample (approximately 3 m^3 of water filtered), derived from Continuous Plankton Recorder data for 1958-1992.

earlier than in the southern North Sea and remains at a relatively high level until October or November.

Zooplankton sampled by the CPR has shown a general decline in abundance in the period from 1960 to 1981. Since 1981, the abundance of zooplankton has increased to an above average level. Total primary production is low (75-79 g C m^{-2} y^{-1}), compared with the central and eastern North Sea (120-260 g C m^{-2} y^{-1} (Joint & Pomroy 1992)). However, in the vicinity of the Humber, and particularly in summer/autumn, chlorophyll concentrations and primary production frequently rise well above average (Joint & Pomroy 1992). The zooplankton is dominated by small copepods (*Pseudocalanus, Paracalanus, Temora* and *Oithona*). Further offshore, larger species characteristic of the deeper central North Sea, such as *Calanus* and *Metridia*, are commoner. The predatory zooplankton, including fish larvae, decapods and medusae, peak between May and September. Harding & Nichols (1987) surveyed this area in 1976, finding eggs and larvae of over 60 fish species (ichthyoplankton) amongst the plankton, with highest concentrations near frontal boundary zones. They found that a succession of spawning occurred throughout the year, by different species on the same spawning grounds, which was linked to the seasonal movements of water masses and to plankton production cycles (on which fish larvae and young fish feed).

In May 1948 in the area off the Humber and The Wash, a large number of benthic species were found in the phytoplankton (Braarud *et al*. 1953)). Adams (1987) suggested that this community was more characteristic of an estuarine situation than a marine one and its presence was due to abnormally high turbulence in the area at that time.

4.3.3 Human activities

Phytoplankton are of particular importance to the coastal manager in this region because a number of *Phaeocystis* blooms (10^4-10^7 cells l^{-1}) have occurred (Oslo & Paris Commissions 1992) (Map 4.3.1). In Dutch coastal waters these blooms have been associated with eutrophication; also, once they collapse they may result in the accumulation on beaches of large banks of foam, which look and smell unpleasant.

4.3.4 Information sources used

The MAFF Directorate of Fisheries Research at Lowestoft undertook intensive plankton surveys of this region in 1976, combining hydrographic and biological observations. The NERC North Sea Community Research Project surveyed most of this region in 1988-89, sampling for chlorophyll concentration and primary production (Joint & Pomroy 1992). The inshore plankton off north Norfolk was investigated by George *et al.* (1989). Chlorophyll *a* concentrations have been measured in the Humber and The Wash as part of the Joint Nutrient Study (JONUS) programme, which is quantifying nutrient inputs to the North Sea (Dickson, Roche & Faber 1994). The Continuous Plankton Recorder surveys in this region (CPR 'LR' and 'HE' routes on Map 4.3.1) are of particular importance because they contain long-term plankton data which can be used to assess the effects of environmental variability and climatic changes on the marine biota (Table 4.3.1).

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Table 4.3.1 Details of surveys

Identification on Map 4.3.1	*Frequency*	*Period*	*Reference*
NERC	±Monthly	1988-1989	Joint & Pomroy (1992)
Whole region	Monthly	1976	Harding & Nichols (1987)
CPR: 'LR' route	Monthly	1959-1978, 1984 to present	
CPR: 'HE' route	Monthly	1984 to present	

Key: NERC - Natural Environment Research Council; CPR - Continuous Plankton Recorder.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Continuous Plankton Recorder (CPR) survey data	Director, Sir Alastair Hardy Foundation for Ocean Science, The Laboratory, Citadel Hill, Plymouth PL1 2PB, tel: 01752 222772
Plankton research	Director, Institute of Estuarine and Coastal Studies, University of Hull, Hull HU6 7RX, tel: 01482 465667
Inshore plankton	Senior Marine Scientist, Anglian Water Services Ltd, Mortlock House, Chivers Way, Histon, Cambridge CB4 4ZY, tel: 01223 372176

Chapter 5 Important species

5.1 Terrestrial lower plants

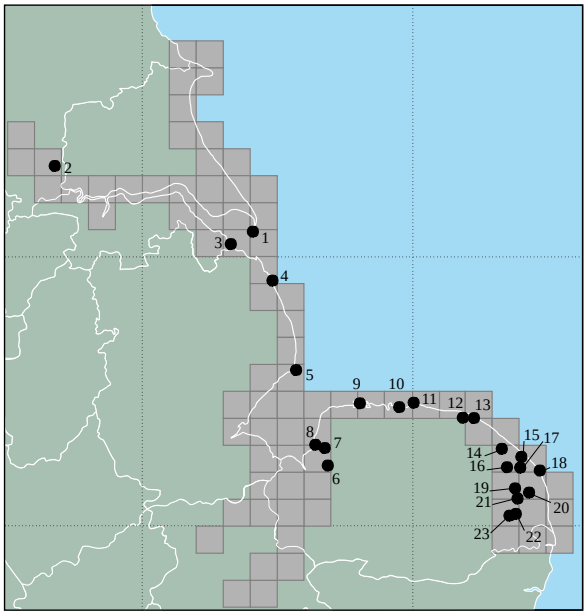
N.G. Hodgetts

5.1.1 Introduction

The terrestrial lower plants covered in this section are lichens, bryophytes (mosses and liverworts), stoneworts (a group of freshwater and brackish water algae) and fungi, occurring in the coastal 10 km squares within the boundaries of the region.

This large and varied east coast region also extends inland considerably along the River Humber, into the Fens and in the Norfolk Broads. While it cannot compare to west coast regions in diversity of lower plants, and there are broad stretches of countryside with little or no lower plant interest, there are features unique to this region. Principal among these are the Norfolk Broads, with their nationally important assemblages of stoneworts. Other important lower plant habitats in the region are the extensive dune systems, areas of wet heath, and coastal scrub. Most of the coast is 'soft', so there are few habitats available for coastal saxicolous lichens.

Several of the larger sites in the region are of national, or even international, importance for their lower plants. About 30% of the British bryophyte flora and about 48% of the stonewort flora occur in the region. Similar figures are not available for other groups. The region contains some of the most important sand dune systems in the country for lower plants, but many of them, particularly in Lincolnshire and Humberside, are now thought to have lost much of their value. The wet heathland of the region is important for bryophytes, and even supports some oceanic and sub-oceanic species. It is a very scarce habitat in the east of the country. Many of the interesting lower plant sites are small, such as old wooden fences and posts in saltmarsh, church walls, isolated trees etc. Some woodlands are of local importance.



Map 5.1.1 Sites known to be important for lower plants in coastal 10 km squares. Site numbers refer to those in Table 5.1.2. Source: JNCC Red Data Book database.

5.1.2 Important locations and species

The area contains a number of threatened species, some of which are given special protection under national and international legislation. Red Data Book (RDB) lower plant species, excluding those with a status of Data Deficient or Extinct (out of a total of 150 bryophytes, twelve stoneworts and 270 lichens on the British Red Lists) are listed in Table 5.1.1, together with their protected status. In addition the region contains 29 of the 313 nationally scarce bryophytes and four of the six nationally scarce stoneworts. For lichens and fungi there is insufficient information for a comprehensive count. The following very rare fungi, listed in the *Provisional Red Data list of British fungi* (Ing 1992), occur on coastal dune systems in the area: *Coprinus ammophilae* (Winterton Ness, Holme), *Leucoagaricus pilatianus* (Holkham), *Marasmius scorodonius* (Holkham), *Melanoleuca cinereifolia* (Gibraltar Point, Holkham, Holme), *Suillus fluryi* (Holkham), *Geastrum minimum* (Holkham) and *Tulostoma melanocyclum* (Holkham); as well as *Arcyria stipata* - a slime mould (Holkham). In addition, *Tubaria hiemale* (not on Ing's list) occurs at Gibraltar Point, its only known British site. A total of 278 species of fungi have been listed from Holkham dunes. The dunes of the north Norfolk coast are still very rich and have some unusual features, such as the presence of the lichen *Usnea articulata*, more usually an epiphyte in south-western Britain. Similarly, *Bryoria fuscescens*, normally an epiphytic lichen in northern Britain but very rare in the south-east, grows on shingle on the north Norfolk coast.

Another moss protected under Schedule 8 of the Wildlife and Countryside Act, Annex II of the EC Habitats Directive and Appendix I of the Bern Convention is *Drepanocladus vernicosus* (*Haematocaulis vernicosus*). Taxonomic problems with this plant have resulted in its being given an RDB status of Data Deficient until its true distribution is resolved.

Like higher plants (see section 5.2), lower plant species tend to occur in characteristic assemblages that are found in particular habitats. Habitats of importance in this region include dune systems, open water (fresh and brackish), wet heath and bog, and coastal scrub. Dune systems are important for bryophytes, lichens and fungi. Some bryophytes and many fungi are dune specialists (Table 5.1.1). Many of these fungi are mycorrhizal with higher

Table 5.1.1 Red Data Book lower plants

Species	*Locations/habitat*
Mosses	
Bryum knowltonii	Calcareous dune slacks and sandy ground at scattered localities
Bryum mamillatum[c]	Open damp dune slacks in the Cleethorpes area and on the Saltfleetby-Theddlethorpe coast, Lincs. (old record; probably now disappeared)
Liverworts	
Petalophyllum ralfsii[a,b,c]	Open damp dune slack on the north Norfolk coast
Stoneworts	
Chara baltica	Hickling Broad, Norfolk
Chara connivens	Hickling Broad, Norfolk
Chara intermedia	Martham & Hickling Broads & Horsey Mere, Norfolk
Nitellopsis obtusa	Martham & Hickling Broads, Norfolk
Lichens	
Bacidia incompta	On elm nr. Sandringham, Norfolk (but probably disappeared)
Cliostomum corrugatum	Wood of jetties and fences, Burnham Overy, Norfolk

Key: [a] = listed on Annex II of the EC Habitats Directive; [b] = listed on Appendix I of the Bern Convention; [c] = listed on Schedule 8 of the Wildlife & Countryside Act 1981.

plants, with willow and marram grass apparently being important associates; fungi are therefore probably instrumental in the process of dune stabilisation. Temporarily water-filled dune hollows can be important for stoneworts. The lakes, pools and ditches of the Norfolk Broads support a very rich stonewort flora. Stoneworts often form extensive and dominant communities where conditions are suitable. Sometimes, in the Broads, they may be associated with rare vascular plants. Fenland ditches are also capable of supporting a rich stonewort flora, but eutrophication has led to the disappearance of stoneworts from most formerly suitable sites. Bryophytes, particularly *Sphagnum* mosses, are often the dominant or co-dominant plants of wet heaths and bogs in the region. *Sphagnum molle*, predominantly a western species, occurs at Sandringham Warren. *Paludella squarrosa*, now extinct in Britain, used to grow at Skipwith Common. Some specialist fungi also occur on wet heaths and bogs in the region. Coastal scrub can also be extremely valuable for bryophytes and lichens, often forming a locally humid and clean environment where species common in the west of the country but rare or scarce in the east can thrive. Elder scrub is particularly valuable, as at Gibraltar Point.

Table 5.1.2 lists all the sites in the region that are known to be important for lower plants and that have had at least some degree of survey work (Map 5.1.1). Some are large, in which case the grid reference given refers to a reasonably central point.

5.1.3 Human activities

Activities occurring in the region that have the potential to diminish its value for lower plants include road construction programmes, housing schemes and industrial development. Lowering of the water table can affect wetland sites, particularly bogs, dune slacks and sites in Broadland. Some dune areas may be affected by holiday and leisure developments, such as caravan sites and golf courses. Boating is an important issue in the Norfolk Broads, where the unique stonewort communities are very sensitive to both physical disturbance and pollution. Pollution is a problem on habitats throughout the region but may be aggravated in some areas by agricultural run-off, oil spillages etc.

Many of the larger and more important sites in the region are NNRs or SSSIs and therefore nature conservation is taken into account in their management. Burning of bog and heathland sites can be damaging to the lower plant communities. Equally damaging, particularly in wet heathland sites, is scrub invasion. However, coastal scrub is often important for lower plants, and any clearance should be tackled with circumspection. Dune slacks important for bryophytes should be maintained in a damp and open condition, with a short herb- and bryophyte-rich sward.

5.1.4 Information sources used

Data for bryophytes and the larger lichens are generally good, but are less complete for fungi, algae and, in many areas, the smaller lichens. Most of the sites mentioned in this section were selected for protection on the basis of their bryophyte and lichen interest. Several others of the sites contain rare and scarce species and would qualify for SSSI status on the basis of their lower plant flora (Hodgetts 1992).

Most of the important bryophyte sites in the south of the region are well documented, but sites in the north are less well known. For example, the dunes in the Cleethorpes area are in need of further survey work in order to establish the current status of the rare *Bryum* species, although the limited amount of work that has taken place recently indicates that they have probably disappeared. Some habitats, such as chalk grasslands, are likely to be substantially under-recorded for bryophytes in some areas, but may be important. The computerised database at the Biological Records Centre (BRC), Monks Wood, and the Red Data Book database at JNCC include recent records collected over decades by expert bryologists as well as important historical records.

Most important and potentially important coastal lichen sites have been identified in recent surveys (Fletcher 1984; James & Wolseley 1991). However, relatively few of these sites have been comprehensively surveyed, so there are potentially more lichen sites than appear in Tables 5.1.1 and

Table 5.1.2 Lower plant sites in coastal 10 km squares

Site no.	*Site name*	*Grid ref.*	*Protected status*
	North Humberside		
1	Humber Flats & Marshes: Spurn Head to Saltend Flats	TA4011	SSSI
	North Yorkshire		
2	Skipwith Common	SE6537	SSSI
	South Humberside		
3	Humber Flats & Marshes: Pyewipe & Cleethorpes Coast	TA3207	SSSI
	Lincolnshire		
4	Saltfleetby - Theddlethorpe Dunes	TF4791	NNR
5	The Wash (Gibraltar Point)	TF5658	NNR
	Norfolk		
6	Roydon Common	TF6822	SSSI
7	Dersingham Bog	TF6729	SSSI
8	Snettisham Beach	TF6430	Not protected
9	Scolt Head Island	TF8046	NNR
10	Holkham	TF88458	NNR
11	North Norfolk coast (Blakeney Point)	TG0046	SSSI
12	Felbrigg Woods	TG1940	SSSI
13	Cottage Wood, Cromer	TG2340	Not protected
14	East Ruston Common	TG3428	SSSI
15	Calthorpe Broad	TG4125	SSSI
16	Ant Broads & Marshes	TG3621	SSSI
17	Hickling Broad (incl. Martham Broad & Horsey Mere)	TG4121	NNR
18	Winterton Dunes	TG4920	NNR
19	Upton Broad & Marshes	TG3913	SSSI
20	Burgh Common & Muckfleet Marshes	TG4411	SSSI
21	Decoy Carr, Acle	TG4009	SSSI
22	Limpenhoe Meadows	TG3903	SSSI
23	Poplar Farm Meadows, Langley	TG3702	SSSI

Sources: references listed in 5.1.6A and JNCC protected sites database. Key: NNR = National Nature Reserve; SSSI = Site of Special Scientific Interest. Note: site numbers refer to Map 5.1.1.

5.1.2. Blakeney Point, Scolt Head Island and Holkham have good lists but many sites mentioned here have only rather inadequate information for lichens, particularly microlichens.

Data collation for fungi is still at a relatively early stage, and it is not yet possible to incorporate fungi into criteria for selecting sites for protection, except in a rather *ad hoc* fashion. All British Mycological Society foray data are currently being put onto a computer database at the International Mycological Institute. Some recent survey work has been done on the coastal dune fungi of the region (Rotheroe 1992, 1993). This has resulted in records of several rare and scarce species that are found only on relatively intact dune systems, and good lists for some of the Norfolk dunes. Further information on Norfolk fungi is available from local naturalists.

With the exception of stoneworts, algae are poorly known. No sites are currently selected for protection on the basis of their algae other than stoneworts. Although some of the Norfolk Broads are known to be rich in stoneworts, many areas are still in need of further survey work. Computerised stonewort data are held at BRC and JNCC. More information on other freshwater algae may be available from the Freshwater Biological Association.

5.1.5 Acknowledgements

Thanks go to Peter Lambley (English Nature) for comments on the manuscript.

5.1.6 Further sources of information

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Hill, M.O., Preston, C.D., & Smith, A.J.E. 1994. *Atlas of the bryophytes of Britain and Ireland. Volume 3: Mosses (Diplolepideae).* Colchester, Harley Books.

Ratcliffe, D.A., *ed.* 1977. *A nature conservation review.* Cambridge, Cambridge University Press.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Lichens (hard rock coasts)	T. Duke, Sandrock, The Compa, Kinver, Staffs. DY7 6HS, tel: 01384 872798
Lichens (general coastal)	P.W. James, c/o Department of Botany, The Natural History Museum, Cromwell Road, London SW7 5BD, tel: 0171 9389123
Lichens (woodland and general: British Lichen Society database)	Dr A. Fletcher, Leicestershire Ecology Centre, Holly Hayes, 216 Birstall Road, Birstall, Leicester LE4 4DG tel: 0116 267 1950
Fungi (general and sand dune)	M. Rotheroe, Fern Cottage, Falcondale, Lampeter, Dyfed SA48 7RX, tel: 01570 422041
Fungi (British Mycological Society database)	Dr P. Cannon, International Institute of Mycology, Bakeham Lane, Englefield Green, Egham, Surrey TW20 9TY, tel: 01784 470111
Bryophytes (BRC database)	*C.D. Preston, Biological Records Centre, ITE Monks Wood, tel: 01487 773381
Bryophytes (British Bryological Society herbarium)	A.R. Perry, Department of Botany, National Museum of Wales, Cardiff CF1 3NP, tel: 01222 397951
Lower plants (Norfolk)	*Norfolk Local Team, English Nature, Norwich, tel: 01603 620558
Lower plants (species status; Red Data Book Database; site register etc)	*N.G. Hodgetts, JNCC, Peterborough, tel: 01733 62626

* Starred contact addresses are given in full in the Appendix.

5.2 Flowering plants and ferns

V.M. Morgan

5.2.1 Introduction

This section describes the importance of the region for vascular plants (i.e. flowering plants and ferns), particularly species that are rare or scarce in Great Britain, occurring in the coastal 10 km squares within the boundaries of the region. Rare and scarce species grow in a wide range of habitats, but of particular importance in this region are saltmarshes, dunes, fens and fresh and brackish water.

The region is of national importance for rare and scarce species (Table 5.2.1). Stewart, Pearman & Preston (1994: figures 38-45) showed that the region has a number of ten km squares which are amongst the richest in Britain for scarce coastal species. Classic British botanical localities include the north Norfolk coast and the Norfolk Broads.

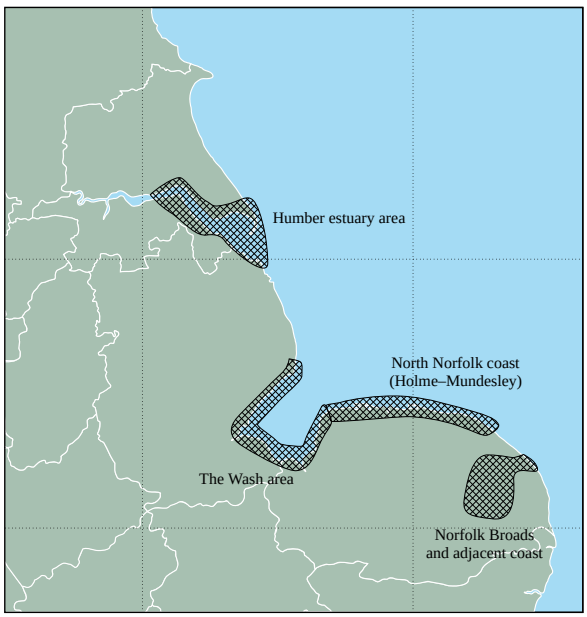
Table 5.2.1 Numbers of rare and scarce coastal species[1]

	Protected species[2]	*Other rare (RDB) species*	*Scarce species*
North Yorkshire	0	0	8
Humberside	0	1	22
Lincolnshire	1	0	22
Cambridgeshire	0	0	13
Norfolk	2	5	58
Region 6	***3***	***5***	***67***

Source: JNCC Rare Plants database; Stewart *et al.* (1994; 1993 draft used); BRC database. Key: RDB = Red Data Book. [1] excluding known introductions and records from before 1970; [2] listed for special protection in the Wildlife & Countryside Act (1981) or on appropriate annexes of the EC Habitats Directive or the Bern Convention.

The special conditions that support centres of plant biodiversity, such as those shown on Map 5.2.1, are a combination of climate, geology and history. The region is dry compared with western regions; Norfolk is one of the driest areas in the country, with less than 67 cm of precipitation per year and frequent dry north-easterly winds (Petch & Swann 1968). The Humberside and north Norfolk coasts are underlain by chalk, which is typically associated with a diverse flora. The exceptional diversity of the Norfolk Broads is in large part a product of the continuity of grazing and absence of agricultural improvement.

Because of these factors, a number of different elements, defined by Matthews (1955), are found in the flora. Typically continental species are fen orchid *Liparis loeselii*, grey hair-grass *Corynephorus canescens* and mousetail *Myosurus minimus;* Jersey cudweed *Gnaphalium luteo-album* is a southern continental element; and fibrous tussock-sedge *Carex appropinquata* is northern continental. Mediterranean species are well represented, for example by bearded fescue *Vulpia ciliata* subsp. *ambigua,* matted sea-lavender *Limonium bellidifolium*, sea-heath *Frankenia laevis* and shrubby sea-blite *Suaeda vera*. Both southern and western European oceanic elements are frequent, the former represented by species such as curved hard-grass *Parapholis incurva*, dune fescue



Map 5.2.1 Key localities for rare and scarce higher plants. Sites are listed in Table 5.2.3. Source: JNCC rare plants database.

Vulpia fasciculata and mossy stonecrop *Crassula tillaea* and the latter by sea kale *Crambe maritima*, amongst others. In contrast, northern oceanic elements are sparse, represented by species such as lax-flowered sea-lavender *Limonium humile* and sea pea *Lathyrus japonicus.*

5.2.2 Important locations and species

Rare species in the region are listed in Table 5.2.2. There are no species protected under international law, except fen orchid *Liparis loeselii,* which is known from two sites in the Broads. Although growing in a 'coastal' 10 km square, the species is not maritime and is, at most, only indirectly affected by its proximity to the sea. Three species are amongst the 107 listed on Schedule 8 of the Wildlife and Countryside Act (1981). Eight of the 317 nationally rare species listed for Great Britain in the *British Red Data Book of vascular plants* occur in the region (Perring & Farrell 1983). Of the 254 scarce (i.e. known from up to 100 ten km squares in Great Britain) species in Great Britain, 67 occur in the region (Stewart, Pearman & Preston 1994).

The only taxon which is endemic (i.e. occurs in no other country) is a subspecies of rock sea-lavender, *Limonium binervosum* subsp. *anglicum*. Two of the rare species, holly-leaved naiad *Najas marina* and matted sea-lavender *Limonium bellidifolium*, are confined to this region within the British Isles. Also, the region is the British stronghold of grey hair-grass *Corynephorus canescens* and water-soldier *Stratiotes aloides,* and the north Norfolk coast is one of only two areas on the east coast where sharp rush *Juncus acutus* is found.

Table 5.2.2 Nationally rare species

Species	*Occurrence of species in:*			*Key localities*	*Habitat*
	Sites in region (approx.)	*Coastal 10 km squares in region*	*10 km squares in GB*		
Grey hair-grass *Corynephorus canescens*[1]	12	9	12	North Norfolk coast; Norfolk Broads and adjacent coast	Dunes
Crested buckler-fern *Dryopteris cristata*	10	2	7	North Norfolk coast; Norfolk Broads and adjacent coast	Marshes, fens & dune slacks
Branched horsetail *Equisetum ramosissimum**	1	1	2	Wyberton (TF34)	Rough grassland
Jersey cudweed *Gnaphalium luteo-album**	1	1	2	North Norfolk coast	Dune slacks
Matted sea-lavender *Limonium bellidifolium*	16	5	5	North Norfolk coast	Saltmarsh/shingle interface
Holly-leaved naiad *Najas marina* *	4	3	3	Norfolk Broads	Brackish water
Yarrow broomrape *Orobanche purpurea*	9	6	17	Humber area; North Norfolk coast	Parasite on yarrow *Achillea millefolia* on cliff tops
Sharp-leaved pondweed *Potamogeton acutifolius*	6	2	11	Norfolk Broads	Freshwater ditches

Source: JNCC Rare Plants database and rare plant survey reports. Key: * = listed on Schedule 8 of the Wildlife & Countryside Act 1981. [1]*Corynephorus canescens* is a candidate Red Data Book species not yet in the Rare Plants database. Figures given (provisional) are for recorded occurrence since 1970 in numbers of 10 km squares in GB, excluding known extinctions. Grid references are given for localities not shown on Map 5.2.1.

Key localities that support two or more rare and/or many scarce species are listed in Table 5.2.3; their locations are shown on Map 5.2.1. Scarce species may occur near to rather than within some localities. In addition to these key localities, there are a few other moderately species-rich sites in the region.

5.2.3 Human activities

Although the region is still rich in scarce species, there are also a number of grid squares from which many have been lost (Stewart, Pearman & Preston 1994: figures 38-45). These extinctions are particularly frequent amongst sand dune species and are likely to be due largely to human activities. In the past, some species have been threatened by collecting, particularly in the era of botanical exchange clubs around the end of the last century, when herbarium specimens were swapped amongst botanists. This threat has largely passed.

Many species depend on bare substrate or the maintenance of low, open vegetation for regeneration and do not thrive if a closed sward or scrub develops. Examples include grey hair-grass (Trist 1994) and annual beard-grass *Polypogon monspeliensis* (Gray 1994). Closed vegetation can develop where such environments are artificially stabilised or where traditional grazing has ceased. Changes in land use, such as by afforestation, agricultural intensification or land claim, can also affect populations of uncommon plants. Aquatic and Broadland species, such as holly-leaved naiad and sharp-leaved pondweed, are vulnerable to changes in water quality (George 1992).

Holiday and urban areas experience pressures for development, and in some cases heavy recreational use may affect populations of plants. On sand dunes, such problems can usually be overcome by careful design and maintenance of paths, as moderate trampling is often beneficial to uncommon plants. In Broadland, more restrictive measures are required, and public access to some waterways is prohibited.

Mobile substrates such as sand dunes or the mud of saltmarshes can be affected by sea defences, either directly where defences are built on or near them, or indirectly when defences elsewhere affect currents and rates of deposition or erosion.

5.2.4 Information sources used

All the counties in the region were covered by rare plant surveys between 1974 and 1986, and a series of detailed confidential reports were produced, now in the care of English Nature (EN) and the Joint Nature Conservation Committee (JNCC). Further work has been carried out by EN as part of their programme of monitoring. JNCC maintains a database of nationally rare plant species, which includes site records. Members of the Botanical Society of the British Isles (BSBI) have recently finished collecting up-to-date records of scarce species; these data are held at the Biological Records Centre and have been summarised in *Scarce plants in Britain* (Stewart, Pearman & Preston 1994).

5.2.5 Acknowledgements

Thanks are due to J.H. Barne, J. Croft, P. Lambley, M.A. Palmer, M.J. Wigginton and staff at the Biological Records Centre.

Table 5.2.3 Key localities for rare (RDB) and scarce species

Locality	*Species*	*Status*
Humber estuary area	RDB: yarrow broomrape. 15 scarce species.	Part SSSI, part undesignated
The Wash area	No RDB species. Scarce: bur medick *Medicago minima,* hoary mullein *Verbascum pulverulentum*, long-stalked orache *Atriplex longipes*, sea-heath *Frankenia laevis,* small cord-grass *Spartina maritima,* plus 24 other scarce species.	SSSI, part NNR
North Norfolk coast (Holme-next-the-sea to Mundesley)	RDB: crested buckler-fern, grey hair-grass, Jersey cudweed, matted sea-lavender, yarrow broomrape. Scarce: annual beard-grass *Polypogon monspeliensis,* hoary mullein, long-stalked orache, sea heath, sharp-rush *Juncus acutus,* plus 28 other scarce species.	Part SSSI, part NNR, part LNR, part undesignated
Norfolk Broads area and adjacent coast	RDB: crested buckler-fern, grey hair-grass, holly-leaved naiad, sharp-leaved pondweed. Scarce: hoary mullein, marsh pea *Lathyrus palustris,* marsh sow-thistle *Sonchus palustris*, milk parsley *Peucedanum palustre,* plus 22 other scarce species.	Part SSSI, part NNR, part LNR, part undesignated

Source: JNCC Rare Plants database and rare plant survey reports. Key: SSSI: Site of Special Scientific Interest; NNR: National Nature Reserve; LNR: Local Nature Reserve. Note: Key localities are those which support two or more rare and/or many scarce species. Only scarce species known from 16-30 10 km squares in GB are listed by name.

5.2.6 Further sources of information

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Perring, F.H., & Walters, S.M. 1990. *Atlas of the British flora*. East Ardsley, Botanical Society of the British Isles. (Distribution maps.)

Stace, C. 1991. *New flora of the British Isles*. Cambridge, Cambridge University Press. Keys and descriptions, with notes on distribution, habitat and status.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Species on SSSIs and NNRs, other protected areas, rare and scarce species, rare plant surveys, licensing and protected species.	Coastal Conservation Officer, Maritime Team, English Nature, Roughmoor, Bishop's Hull, Taunton, Somerset TA1 5AA, tel: 01823 283211
Database of rare and protected species	*Species Conservation Branch, JNCC Peterborough, tel: 01733 62626
Biological Records Centre: Lincolnshire & South Humberside	*Conservation Officer, Lincolnshire Trust for Nature Conservation, Horncastle, tel: 01507 526667
Biological Records Centre: Norfolk	Norfolk Biological Records Centre, The Castle Museum, Norwich NR1 3JU, tel: 01603 223624
Local BSBI vice-county records	*C.D. Preston, ITE Monk's Wood, Huntingdon, tel: 01487 773381

* Starred contact addresses are given in full in the Appendix.

5.3 Land and freshwater invertebrates

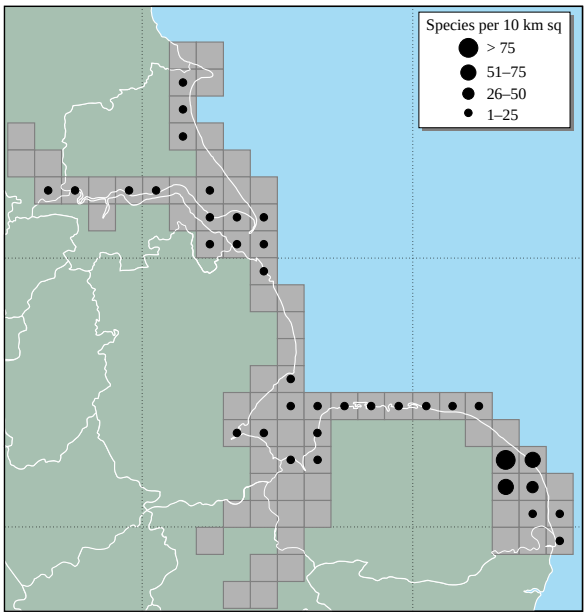
A.P. Foster & M.S. Parsons

5.3.1 Introduction

There are over 28,000 species in the better known invertebrate groups in Great Britain (Kirby 1992). This section deals with most insect orders, though not all families, together with a wide range of non-insect invertebrates, known from sites within the coastal 10 km Ordnance Survey grid squares of the region.

Red Data Book (RDB) and Nationally Scarce species are represented along the geographic spread of the region's coast, with a variety of the scarce species confined to particular habitat types, for example brackish pools and lagoons, fens and marshes, saltmarsh, sand dune, shingle, strandline habitats and soft rock cliffs. The region is nationally important for many coastal species that are either restricted to or have significant populations within this area. Among them are: the ground beetles *Nebria livida* (Yorkshire to Norfolk only) and *Pogonus luridipennis* (recently only recorded from Lincolnshire, Norfolk and Dorset), the rove beetle *Bledius filipes* (known only from Norfolk), the beetle *Malachius barnevillei* (also restricted to Norfolk), the caddisfly *Ylodes reuteri* (reliably recorded only from Humberside and Orkney), the pyralid moth *Pediasa fascelinella* (recently recorded from Lincolnshire to Essex), the marsh moth *Athetis palustris* (restricted to the fens of East Anglia and sites on the Lincolnshire coast), the soldierfly *Stratiomys longicornis* (very few localities in south-east England north to Lincolnshire) and the spiders *Clubiona similis* (restricted to Norfolk, Suffolk and Kent) and *Arctosa fulvolineata* (known only from a few localities from Hampshire to Norfolk).

Seven species of terrestrial or freshwater invertebrate recorded from the region are afforded legal protection under various international directives and conventions or are listed on Schedule 5 of the Wildlife and Countryside Act 1981 (Table 5.3.1). However, two of these have not been recorded within the region for some years and may now be extinct here.



Map 5.3.1 Numbers of nationally rare (i.e. RDB) species of invertebrates recorded in coastal 10 km squares (all dates). Distribution may reflect differences in recording effort. Source: Invertebrate Site Register, JNCC.

Table 5.3.1 Protected invertebrate species

Species	*EC Habitats Directive Annex*	*Bern Convention Appendix III*	*Wildlife & Countryside Act* Schedule 5*	*CITES** Appendix II*	*Comments*
Lincolnshire					
Fairy shrimp *Chirocephalus diaphanus*			✔***		Last record 1962 - ? extinct
Norfolk					
Narrow-mouthed whorl snail *Vertigo angustior*	II				
Desmoulins' whorl snail *Vertigo moulinsiana*	II				
Atlantic freshwater crayfish *Austropotamobius pallipes*	II & V	✔	✔****		
Norfolk aeshna dragonfly *Aeshna isosceles*			✔		
Swallowtail butterfly *Papilio machaon*			✔		
A diving beetle *Graphoderus bilineatus*	IV				Last record 1906 - ? extinct
Medicinal leech *Hirudo medicinalis*	V	✔	✔***	✔	

Source: JNCC Invertebrate Sites Register. Key: *Excludes Schedule 5 section 9(5), sale only; **Convention on International Trade in Endangered Species of Wild Fauna and Flora; ***Variation of Schedule Order 1988, ****in respect of section 9(1) only.

5.3.2 Important locations and species

Of the 361 Red Data Book (RDB) and 477 Nationally Scarce invertebrate species that are listed by Kirby (1994a, b) as known to be associated with coastal habitats, 68 and 178 respectively have been recorded from the region (data from JNCC's Invertebrate Site Register). These totals include recent (post 1969) records for ten RDB Lepidoptera (moths), nine RDB Diptera (flies) and four RDB Araneae (spiders). Coastal RDB species are listed in Table 5.3.2. Other species of equivalent rank, but not covered by Kirby, also occur within the region. Map 5.3.1 shows the numbers of all nationally rare (RDB) invertebrate species (including Kirby's 'coastal' species and all others) recorded in coastal 10 km squares in the region; Map 5.3.2 is the equivalent map for nationally scarce invertebrates. Note that survey effort has not been equivalent throughout the region, so actual occurrence may differ from recorded distributions.

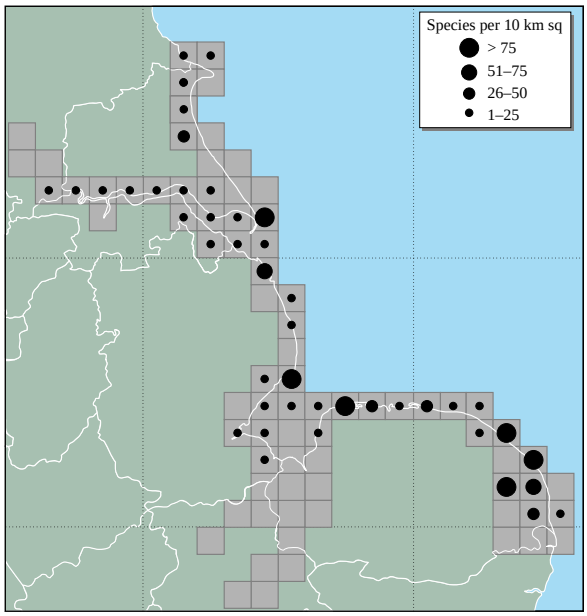
Most of the scarce or threatened species occurring in the region have exacting habitat requirements in one or more stages of their life histories. They are often restricted in range, and in some cases occur in one or a few localities. The Invertebrate Site Register (ISR) has records for a little over 170 sites in this region. However, some of these are subsites of much larger statutory areas - the north Norfolk coast SSSI, for example, contains eight ISR sites. Table 5.3.3 lists sites of major importance for the conservation of invertebrates. Site selection was based on the range and/or scarcity of species present, the species/habitat associations and the amount of available habitat. Many of these sites are either National Nature Reserves (NNRs) or Sites of Special Scientific Interest (SSSIs); other currently under-recorded unprotected sites may warrant similar status on the basis of their invertebrate interest. There may also be other equally good though as yet unrecorded sites.

Saltmarsh in the region has a rich and specialised invertebrate fauna. Many of the rarities are herbivores associated with particular saltmarsh plants, for example the scarce pug moth *Eupithecia extensaria*, whose larvae are specialist feeders on sea wormwood *Artemisia maritima* from Spurn Head to north Norfolk. Important foodplants for other rarities include sea-lavender *Limonium vulgare* and sea aster *Aster tripolium*. Many of the rare Diptera (flies) have larval stages living within damp muddy substrates. Drier areas of bare substrate are also important - the bee *Colletes halophilus* nests in upper saltmarsh but forages widely, favouring the flowers of *Aster tripolium*.

Shingle has a very specialist fauna and is well represented in the region. Among the rarest species specialising in open shingle are the jumping spider *Euophrys browningi*, at Blakeney Point, and the moth *Pima boisduvaliella*, whose larvae are specific to sea pea *Lathyrus japonicus*. The rare woodlouse *Buddelundiella cataractae* lives in humus-rich soil within the shingle. Some scarce sand dune invertebrates are recorded in the region, including the pygmy footman moth *Eilema pygmaeola*, associated with mature dunes at Winterton. Other species specialise in foredune habitats, for example the spider *Clubiona similis*, which lives in marram tussocks along the north Norfolk coast. Strandline habitats, whether on saltmarsh, sandy or shingle substrates, are vital to many scarce invertebrates, particularly predatory or scavenging species; others, for example the weevil *Pselactus spadix*, specialise by boring into drift wood.

Soft rock cliffs in the region are nationally important for their invertebrate communities, with Coleoptera (beetles), Diptera (flies)and Isopoda (woodlice) particularly significant. Cliff faces that are relatively dry and those flushed by seepages are equally important. One of the rarest species restricted to the cliffs in this region is the rove beetle *Bledius filipes* (at West Runton cliffs).

Marshes on the coast, and inland along flood plains of the major river systems, hold extant populations of some of Great Britain's rarest invertebrates, including, for example, three species given legal protection: narrow-mouthed whorl snail *Vertigo angustior*; Norfolk aeshna dragonfly *Aeshna isosceles* and the swallowtail butterfly *Papilio machaon* (see Table 5.3.1). The Norfolk Broadland contains populations of species unknown elsewhere in Great Britain, and coastal reedbeds throughout the region, such as those in the Humber estuary, also contain rare and scarce species, such as the hoverfly *Sphaerophoria loewi*.



Map 5.3.2 Numbers of nationally scarce species of invertebrates recorded in coastal 10 km squares (all dates). Distribution may reflect differences in recording effort. Source: Invertebrate Site Register, JNCC.

5.3.3 Human activities

As for other nature conservation interests, the main threats to invertebrate communities in the region include inappropriate management of sites and direct habitat loss or degradation, such as by construction of stabilising sea defences, for example on soft rock cliffs, the drainage of coastal marshes and infilling or drainage of brackish lagoons, and the clearing away of organic strandline debris. Appropriate site management may be vital for maintaining invertebrate interest. Most invertebrates have life cycles lasting for one year or less and require specific conditions in which to complete their life cycle, and many of the rarest species have poor powers of dispersal and are thus unable to colonise suitable habitat from afar. It is therefore vital that suitable breeding conditions are retained at sites year after year. The fundamentals of managing coastal habitats for invertebrates are covered by Kirby (1992).

Table 5.3.2 Coastal Red Data Book (RDB) species with post 1970 records

Species	*Notes*
RDB 1	
Pseudamnicola confusa	Small snail found on mud, often among reeds *Phragmites* spp., in the weakly brackish regions of estuaries. Sussex, the Thames estuary and localised areas in Suffolk and Norfolk. Though apparently suitable habitat remains widespread nationally, the species has undergone a dramatic decline, possibly mainly owing to declining water quality.
Segmentina nitida	Ramshorn snail; undergone marked decline this century. Occurs in ponds and marsh drains, particularly where well oxygenated and with lush vegetation. Formerly widespread in England as far north as York but is now restricted to a few unimproved grazing marsh sites in the south-east (outside this region) and East Anglia.
Vertigo angustior	Small snail found in permanently marshy grassland in dunes and lowland fens. Extremely rare nationally and locally; some colonies are under threat from natural changes to the habitat. There are populations in southern Cumbria, South Wales and East Anglia. The Flandrian fossil record shows it to have been formerly much more widespread.
Bledius filipes	Small rove beetle known only from Norfolk. Occurs at the base of soft rock cliffs. Adults are herbivorous, feeding on algae in their burrows. Populations have always been small and localised.
Bledius dissimilis	Rare rove beetle forming burrows in firm soil cliffs by water. Known only from the Yorks coast, Humber Estuary & a gravel pit in Berkshire.
Odynerus simillimus	A mason wasp which nests in the soil; was thought to be extinct, but recently rediscovered at one site in Norfolk.
pRDB 1	
Ethmia bipunctella	Black and white micro-moth. The larvae feed on the flowers and leaves of viper's-bugloss *Echium vulgare*, comfrey *Symphytum* spp. or other plants of the borage family, pupating in a dead stem or rotten wood. Very local, resident in Kent and East Sussex, occasionally occurs elsewhere on southern and eastern coasts.
Panagaeus cruxmajor	7.5-9 mm-long red and black ground beetle, very hygrophilous, occurring at the margins of standing or slow-flowing water amongst rich vegetation. Formerly widely distributed as far north as Yorkshire, but known recently from only a single coastal site in S. Wales.
RDB 2	
Valvata macrostoma	Aquatic snail found mainly in well-oxygenated, richly-vegetated marsh drains. Extremely local and vulnerable to agricultural changes. Frequently recorded in error because juveniles of *V. piscinalis* are a similar shape.
Anisus vorticulus	Ramshorn snail found in well-oxygenated weedy ditches in wet grassland of south-eastern England and East Anglia. Rather rare and declining owing to pollution of its habitat by agricultural runoff and reprofiling of ditches during conversion of grazing levels to arable agriculture.
Oxyloma sarsi	Semi-aquatic snail found on emergent vegetation such as sweet-grass *Glyceria* spp. in fens and marshes. Only reliably distinguished from its common relative *O. pfeifferi* by dissection. However, there have been sufficient searches for this species to confirm its rarity. There are modern records from East Anglia and the Herts/Essex border.
Bagous argillaceus	Aquatic weevil found in saltmarshes and ditches in coastal grazing marsh. Foodplant and larval biology unknown. Rare species recorded from only five vice counties, mainly around the Thames estuary.
Ylodes reuteri	Caddis fly associated with slightly brackish coastal water bodies.
Erioptera bivittata	Cranefly originally discovered as new to Britain during a survey of the North Kent marshes in 1966. Since proved to occur more widely in coastal wet grassland with mildly brackish ditches and ponds, favouring areas at the edges of ditches with sparse vegetation. A very few inland localities have also been discovered where a saline influence is present in fenland in East Anglia. Now known also from Essex, Suffolk and Norfolk.
Stratiomys longicornis	Large soldierfly with aquatic larvae developing in strongly brackish pools and ditches. Extremely local, recorded from the Thames estuary to Scotland.
Sphaerophoria loewi	Small yellow and black hoverfly. In wetlands, particularly brackish coastal marshes with stands of sea club-rush *Scirpus maritimus* and reeds *Phragmites* spp. A rarely found species known from Kent to Scotland.
Lejops vittata	Large hoverfly of brackish ditches, closely associated with sea club-rush *Scirpus maritimus* on the pollen of which the adults feed. Larvae aquatic. Scattered records from the coastal marshes of southern England including the Thames Estuary, Kent, Sussex and Somerset.
Salticella fasciata	Snail-killing fly found in fore dunes. Larvae predatory, parasitic or saprophagous in terrestrial snails. Rare in dune systems around the south coast from Spurn Head to Pembrokeshire.
Pherbellia argyra	Rare snail-killing fly found at the edge of permanent ponds. Larvae have been found in the snails *Planorbis planorbis* and *Anisus vortex*.
pRDB 2	
Gelechia hippophaella	Moth; larvae in web-linked shoots of buckthorn *Hippophae* spp., where that is native; often common where it occurs.
Pediasia fascelinella	Moth; frequents sandhills; larvae feed on various grasses. On the coast of Lincolnshire, Norfolk, Suffolk, Essex and south Devon.
RDB 3	
Graptodytes bilineatus	Water beetle, stagnant water close to the sea. Essex marshes, Dungeness, Chesil Beach, Outer Humber.
Malachius barnevillei	Malachite beetle, confined to the north Norfolk coast. Larvae predatory; adults found on flowers.
Scopula rubiginata	Moth confined to the Breckland district and the coastal sandhills near Thorpeness, Suffolk; probably immigrant elsewhere. Larvae possibly feed on low-growing plants.

Eupithecia extensaria	Moth frequenting saltmarshes. Larvae feed on *Artemesia maritima*. Noted only from around the Wash, north Norfolk coast and Spurn Head peninsula.
Eilema pygmaeola	Moth with two subspecies in Britain. Subsp. *pygmaeola* found on coastal sandhills in Kent and Norfolk, immigrant elsewhere. Subsp. *pallifrons* found on shingle at Dungeness, Kent. Larvae said to feed on lichens.
Photedes captiuncula	Moth; inhabits limestone hills and dales, scrubland, and grassy hollows on the tops of sea cliffs. Larvae feed in the stems of glaucous sedge *Carex flacca*. Local, found in Cumbria, Yorkshire, Co. Durham and Northumberland. East Anglian records are probably of migrants.
Athetis pallustris	Moth; resident in marginal fenland and marshy places in sand dunes. Larvae feed on meadowsweet *Filipendula ulmaria* and other low growing plants. A secretive species found locally in Lincolnshire, Huntingdonshire, Cambridgeshire and Norfolk; old records elsewhere.
Atylotus latistriatus	Horsefly; saltmarsh species, confined to southern England. Males attracted to flowers of sea-lavender *Limonium* spp.
Hydrophorus viridis	A little-known fly associated with small pools in a range of wetland habitats. Larvae probably semi-aquatic carnivores. The few records are widely spaced in southern England.
Passaloecus clypealis	Digger wasp, found predominantly in fens and marshes. Several British specimens have been reared from old cigar galls caused by the fly *Lipara* sp. in stems of reeds *Phragmites* spp. May also use other plant species as nesting sites.
Podalonia affinis	Large black and red solitary sand wasp nesting in sandy soil. Prey: caterpillars. England north to Yorks/Lancs. Nowhere common.
Coelioxys quadridentata	Rare bee parasitic on leaf cutter bee *Megachile willoughbiella* which nests in sandy places. Predominantly southern species.
Clubiona similis	Rare spider occurring on dunes from Norfolk to Kent, usually found in marram tussocks.
Euophrys browningi	Jumping spider, adult from April to June and August to October. Found in tide litter and in empty whelk shells on shingle banks. Norfolk, Suffolk, Essex and Kent. Possibly endemic to Britain.
Arctosa fulvolineata	Wolf spider found under debris and stones at the upper ends of saltmarshes. Coast from Norfolk to Hampshire. Such a large and obvious spider is unlikely to be greatly under-recorded.
Enoplognatha oelandica	Rare spider found on dunes and sandy heaths amid vegetation or under stones. Hampshire, Surrey, Kent and Norfolk.
pRDB 3	
Pogonus luridipennis	6-8.5 mm-long metallic green and yellow ground beetle found in saltmarshes under seaweed & driftwood. South and east England north to Humber. Very local.
Platytes alpinella	Moth; frequents sandy coasts; larvae feed on *Tortula* spp. and other mosses. Very local and rather uncommon, distributed along the south coast from Devon to Kent, also East Anglia, Lincolnshire and Yorkshire.
Cynaeda dentalis	Extremely local coastal micro-moth. Larvae feed in stems and on leaf bases of viper's-bugloss. Southern and south-eastern England, from Suffolk to Devon.
Limonia danica	Cranefly; in marshland, usually in coastal areas, though records also inland. About a dozen localities scattered throughout southern England and East Anglia, in particular around the Thames estuary. Larvae probably live in wet mud.
pRDB K	
Bibloplectus minutissimus	Beetle, rare and very local; found under stones, in grass tussocks and in shingle.
Corticarina truncatella	Small beetle feeding on mildew growing on decaying vegetable matter. Very local.

Key: Red Data Book categories: RDB 1 = endangered; RDB 2 = vulnerable; RDB 3 = rare; RDB K = insufficiently known; pRDB = proposed species as categorised in e.g. Hyman & Parsons (1992). Some records are doubtful (identified as 'unconfirmed'). For further description of RDB categories, see Shirt (1987) and Bratton (1991).

Table 5.3.3 Sites of importance for the conservation of invertebrates

Site	*Grid ref.*	*Status*
Humberside		
Flamborough Head	TA1476	SSSI, RSPB, SPA
Bridlington - Barmston Cliff	TA1763	
Hornsea Mere	TA1846	SSSI, RSPB
Humber Flats & Marshes: Spurn Head to Salt End Flats	TA2015	SSSI, County Trust reserve
Asselby Island	SE7226	
Swinefleet - Ousefleet reedbeds	SE7722 - SE8223	
Humber Flats & Marshes: Upper Humber	SE8323	SSSI, RSPB
Target Pit - Barton Reedbed	TA005230	SSSI, County Trust reserve
Barton Blow Wells	TA011228	
East Barton - New Holland Pits	TA0423	
Barrow Hall Pond	TA0620	
Fairfield Pit	TA0724	
Humber Flats & Marshes: Pyewipe & Cleethorpes coast	TA3107	SSSI
Lincolnshire		
North Lincs. coast	TF4496	SSSI, County Trust reserve, RSPB
Saltfleetby - Theddlethorpe Dunes	TF4891	NNR, SSSI, County Trust reserve
Sea Bank Clay Pits	TF5380	SSSI, LNR
Gibraltar Point	TF560580	SSSI, County Trust reserve
The Wash	TF5540	NNR, SSSI, RSPB, Ramsar site, SPA, County Trust reserve
Lawyers Farm Pool	TF417333	
Norfolk		
Roydon Common	TF6822	SSSI, County Trust reserve
Lynn Lodges	TF6727	
Sandringham Warren	TF6628	
Dersingham Bog	TF6829	NNR, SSSI
Snettisham Beach	TF6533	RSPB
Snettisham Carstone Quarry	TF685349	SSSI
Ringstead Downs	TF6940	SSSI, County Trust reserve
Hunstanton Cliffs	TF6742	SSSI
North Norfolk coast	TF6944 - TG0944	NNR, SSSI, County Trust reserve, NT, RSPB, Ramsar site, Biosphere Reserve
Sheringham & Beeston Regis Common	TG1642	SSSI
Sheringham Cliffs	TG1644	SSSI
West Runton Cliffs	TG1843	SSSI
Felbrigg Great Wood	TG1940	SSSI, NT
East Runton Cliffs	TG1943	SSSI
Overstrand Cliffs	TG2341	SSSI
Sidestrand Cliffs	TG2540	SSSI
Mundesley Cliffs	TG3136	SSSI
Happisburgh Cliffs	TG3831	SSSI
East Ruston Common	TG3428	SSSI
Honing Common	TG3426	
Stalham Moat	TG3726	
Sea Palling Dunes	TG4425	
Dilham Broad Fen	TG3425	SSSI
Ant Broads & Marshes	TG3621	SSSI, LNR, County Trust reserve
Ludham & Potter Heigham	TG4117	NNR, SSSI
Upper Thurne Broads & Marshes	TG4321	NNR, SSSI, County Trust reserve, NT
Winterton to Horsey Dunes	TG4921	NNR, SSSI
Filby - Ormesby Broad	TG4616	
Bure Marshes	TG3515	NNR, SSSI, County Trust reserve
Upton Broad	TG3812	SSSI, County Trust reserve
Burgh Common & Muckfleet Marshes	TG4412	SSSI, County Trust reserve
Halvergate Marshes	TG4306	SSSI
Acle Marshes	TG4808	
Wickhampton Marshes	TG4404	
Yare Valley Marshes	TG3305	SSSI, RSPB
Great Yarmouth	TG5307	
Breydon Water	TG4805	SSSI, LNR
Chedgrave Marshes	TG4401	
Norton Marshes	TG4000	
Fritton Marshes	TG4500	

Key: LNR - Local Nature Reserve; NNR - National Nature Reserve; NT - National Trust site; RSPB - Royal Society for the Protection of Birds reserve; SSSI - Site of Special Scientific Interest; SPA – Special Protection Area for birds.

5.3.4 Information sources used

Data are scattered over a wide range of sources, including local records centres and literature. The data used here come from the Invertebrate Site Register (ISR). The ISR database is based on literature searches of entomological journals and those of local naturalist societies, collation of data from local biological record centres and the Biological Records Centre, Monks Wood, and consultation with invertebrate specialists and non-governmental organisations.

The level of recording around the region varies considerably, and many areas, for example various localities along the north Norfolk and Lincolnshire coasts and some sites in the Norfolk Broadland, have been well studied in both historic and modern times. Most groups of invertebrates are recorded both historically and in modern times, although to varying degrees. Among the most popular and widely recorded groups are the Odonata (dragonflies and damselflies) and the Lepidoptera (butterflies and moths). Published works such as Duddington & Johnson (1983) and Hall (1991) reflect the wide base of recording that has taken place. Long-term studies are conducted at certain sites, for example butterfly monitoring at Saltfleetby and Gibraltar Point and at localities along the north Norfolk coast (Pollard, Hall & Bibby 1986). Detailed studies of other species groups have also been undertaken at particular sites, for example Coleoptera (beetles) at Scolt Head (Welch 1982). However, most of the ISR data originate from individual specialists, or short reports in entomological literature. Local journals, such as the *Transactions of the Norfolk and Norwich Naturalists' Society*, are also a valuable source of information.

National distribution maps are available for a wide range of invertebrate groups. Most of these are derived from national recording schemes coordinated through the Biological Records Centre at Monks Wood. Published examples cover some of the rarer coastal species occurring in this region, including the Norfolk aeshna dragonfly *Aeshna isosceles* (Hammond 1983), the pygmy footman moth *Eilema pygmaeola* (Heath & Emmet 1979), the marsh moth *Athetis palustris* (Heath & Emmet 1983), the horsefly *Atylotus latistriatus* (Drake 1991) and the woodlouse *Eluma purpurascens* (Harding & Sutton 1985).

Local mapping schemes have covered some of the more popular groups, for example butterflies (Hall 1991), and other county-based mapping schemes are underway, for example the Norfolk moth survey.

5.3.5 Acknowledgements

Thanks are due to D. Procter (JNCC) and Dr S. Ball (JNCC) for providing raw data from the ISR and for assistance in producing the maps and Table 5.3.2.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Invertebrate site and species information	*Invertebrate zoologists, English Nature HQ, Peterborough, tel: 01733 340345
National inventory of sites of significance for invertebrate conservation. Records of local, scarce and threatened species of all groups of non-marine invertebrates.	*Invertebrate Site Register, JNCC, Peterborough, tel: 01733 62626
Biological Records Centre for Lincolnshire & South Humberside	*Conservation Officer, Lincolnshire Trust for Nature Conservation, Horncastle, tel: 01507 526667
Occurrence of invertebrates in the region	*Biological Records Centre, ITE Monks Wood, Huntingdon, tel: 01487 773381
Invertebrate interest of National Trust holdings	*Biological Survey Team, National Trust, Cirencester, tel: 01285 651818
Norfolk Biological Records Centre	Norfolk Biological Records Centre, The Castle Museum, Norwich NR1 3JU tel: 01603 223624
Consultant entomologist with particular knowledge of sites in Lincolnshire	Dr P. Kirby, 21, Grafton Avenue, Peterborough, Cambs. PE3 8EH
Invertebrate zoologist with particular interest in aquatic invertebrates and sites in South Humberside	*J. Bratton, JNCC, Peterborough, tel: 01733 62626

* Starred contact addresses are given in full in the Appendix.

5.4 Rare sea-bed species

Dr W.G. Sanderson

5.4.1 Introduction

This section considers rare and scarce marine benthic (sea-bed) species, excluding fish. The occurrence and distribution of benthic communities is discussed in section 4.2. 'Nationally rare' marine benthic species in this section are those native organisms that occur in eight or fewer of the 10 km squares (of the Ordnance Survey national grid) containing sea within the three-mile territorial limit for Great Britain. 'Nationally scarce' are those that occur in 55 or fewer. This methodology and these criteria are analogous to those used for other groups of organisms in British Red Data Books (e.g. Bratton 1991) and by the International Union for Conservation of Nature and Natural Resources (IUCN) (see IUCN Species Survival Commission 1995). The development of the current criteria and the choice of study area for rarity assessment in the marine benthos of Great Britain are discussed in detail by Sanderson (in prep.). Species considered in this chapter are those conspicuous and readily identifiable in the field by the Marine Nature Conservation Review (MNCR) and similar techniques or for which taxonomic or biogeographic experts consider that sufficient data exist on a national basis to warrant their inclusion. Species at the limit of their global distribution (e.g. 'northern' or 'southern' species) may be rare only within Great Britain's territorial seas. A species described here as 'nationally rare' or 'nationally scarce' is therefore not necessarily endangered and the conservation importance of these species may need to be carefully considered. The analysis in this section represents the first attempt to quantify the rarity of marine benthic species and to summarise the known occurrence of rare and scarce species. As either more data become available or populations change, the status of species listed in this chapter will require re-evaluation.

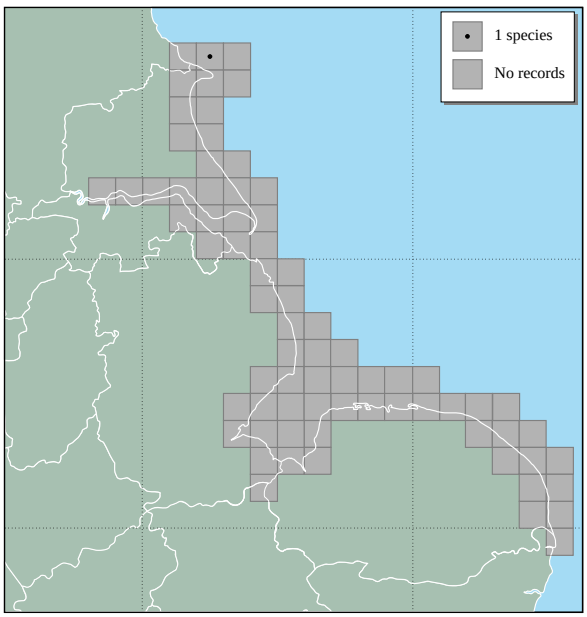
One rare and four scarce marine benthic species have been recorded from Region 6. Maps 5.4.1 and 5.4.2 summarise their current known occurrence. Some of these records are for lagoonal species (see also section 3.4.2) protected under the Wildlife & Countryside Act 1981.

5.4.2 Important locations and species

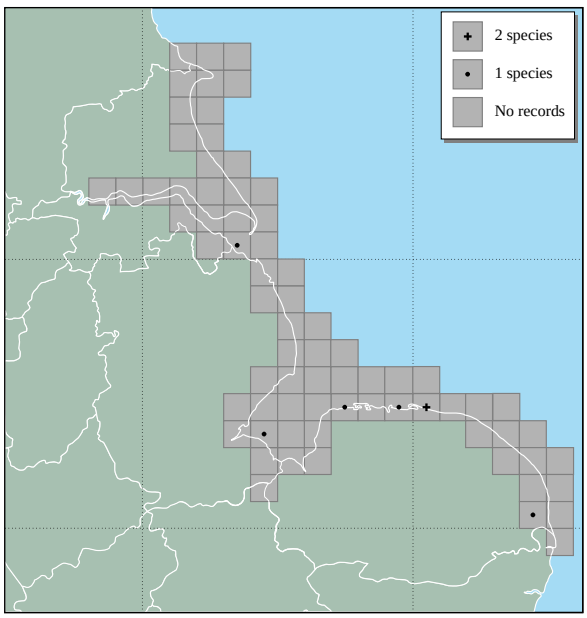
Table 5.4.1 lists the rare and scarce marine benthic species that have been recorded in Region 6, together with their known areas of occurrence. The codes given (after Howson 1987) are those often used in marine conservation and survey work.

Within this region of Great Britain certain species are 'nationally rare' or 'scarce' because they are Mediterranean-Atlantic species at the margins of their distribution in Great Britain. It has been argued that populations of many sessile (non-mobile) southern species have a poor capacity for recovery and recruit (²reproduce) slowly at the margins of their distribution and are therefore particularly vulnerable to even the most minor, infrequent impacts. Communities of southern species have therefore been considered important as reference sites for monitoring the marine environment (Fowler & Laffoley 1993). There are other genetic, ecological and pragmatic arguments for the conservation of species that are rare because they are at the margins of wider distributions (see Hunter & Hutchinson 1994).

None of the species from this region is known as a particularly deep water species, and so it is unlikely that any appear to be rare simply because their distributions only just include the generally shallower near shore sea area that is the focus of this study. Some species, however, will occur to



Map 5.4.1 Numbers of rare marine benthic species recorded in 10 km squares within the 3 mile limit



Map 5.4.2 Numbers of scarce marine benthic species recorded in 10 km squares within the 3 mile limit

Table 5.4.1 'Nationally rare' and 'nationally scarce' marine benthic species found in the region

Code	*Species*	*Common name*	*Area(s) of occurrence*	*Habitat/associations*	*Comments*	*Useful references*
D0715	*Hartlaubella gelatinosa*	Hydroid	Morston Creek (N. Norfolk)	Intertidal to 15 m depth or more, sometimes in brackish locations, often in gentle current and tolerant of some silt	Known from Norway to Mediterranean and Black Sea	Hayward & Ryland (1990)
D1331	*Nematostella vectensis* #	Starlet sea anemone	Wells-next-the-Sea, and formerly at Cley-next-the-Sea (Norfolk) (?)	Lagoon-like habitats; in fine soft mud	Known from isolated localities in Great Britain (also from a few sites in Canada and USA (Atlantic & Pacific))	Bratton (1991), Smith & Laffoley (1992)
P1892	*Alkmaria romijni* #	Tentacled lagoon worm	Barton and Killingholme (Humberside), Breydon Water (Yarmouth) (?)	Lagoon-like habitats; eulittoral to a depth of a few metres	Netherlands to Denmark, Baltic and Morocco	Holthe (1986)
S0773	*Gammarus insensibilis* #	Lagoon sand shrimp	Humberston Fitties (Humberside), Lawyers Farm Pool (the Wash), Titchwell Lagoon (North Norfolk) (?)	Lagoon-like habitats with small tidal ranges; associated with weed and other weed-associated fauna	Also known from Atlantic Europe and the Mediterranean and Black Seas	Bratton (1991), Smith & Laffoley (1992)
Y0357	*Smittina affinis**	Bryozoan	Selwick's Bay, Flamborough Head	Encrusting hard substrata from about 2-18 m	Also from Devon and from Brittany	Hayward & Ryland (1990)

Species codes are after Howson (1987); in the absence of a specific common name the nearest available group names have been used.
Key: * = nationally rare; # = protected under the Wildlife & Countryside Act 1981; (?) areas of occurrence that may require confirmation.
Note: in this region the scarce species listed are only marginally more common than the rare species listed, although occurring in nine or more 10 km squares.

some extent in UK waters outside the scope of this report. Three of the species listed here are from lagoon-like habitats, of which there is a concentration in Region 6. Such habitats are vulnerable in Great Britain (Smith & Laffoley 1992).

5.4.3 Information sources used

The sites of littoral and sublittoral benthic data utilised in the present work for Region 6 have been mapped in section 4.2. Some of the available data come from MNCR survey work and earlier NCC funded surveys. Data are also available from environmental impact assessments and NRA surveys, as well as publications arising from the extensive collections of local marine biological recorders and work by the University of Hull. Additional records have also been considered following personal communications with experts in many taxonomic fields. It has not been possible in this chapter to list all the available literature on which this analysis has been based, but the information reviews and recent papers listed in sections 4.2.6 and 5.4.5 should allow access to most of the available information.

Suitable information in the sublittoral zone is localised and mainly restricted to Flamborough Head, The Wash and to some extent the Humber estuary. Other areas, for example the Lincolnshire coast between the Humber and the Wash, lack suitable information. Littoral surveys in Region 6 are also patchily distributed, although lagoons in the region have received some attention. Barnes (1988), however, warns that species from lagoonal habitats may also occur in brackish drainage ditches, which have not yet been adequately surveyed.

In some areas within Region 6 records go back to the nineteenth century. Although every effort has been made to obtain biogeographic data for rarity assessment in the present study, data have not been used from reports more than thirty years old. There are, for instance, old records for the rarely recorded amphipods *Apherusa ovalipes* and *Pectenogammarus planicrurus* from Morston Creek and Sheringham Beach (North Norfolk) respectively (Hamond 1967); it would be valuable to re-confirm these records. There are also unconfirmed records for the hydroid *Hartlaubella gelatinosa* from the Wash (Dipper *et al.* 1989.) Species that are likely to be very under-recorded or overlooked on a national scale have been avoided.

MNCR survey work uses a consistent methodology to record conspicuous species (Hiscock 1990). Not all the data available from surveys in this region are as broad in scope as MNCR surveys and they may not include less common species or those less familiar to a specialist worker. Inconsistent recording has reduced the quantity of available information for rarity assessment in some areas of the region. The MNCR of Great Britain is at present incomplete but in future will substantially increase the quality and evenness of distribution of the available data. Combined with other surveys, this will almost certainly expand our knowledge of the 'nationally rare' and 'scarce' species in Region 6. Consequently the nationally rare and scarce status of the organisms presented here may require re-evaluation, and in future further species may be added to the list for this region.

5.4.4 Acknowledgements

The author is grateful for the assistance of the JNCC Marine Conservation and Coastal Conservation Branches, as well as the expert advice of Dr J.M. Baxter, Dr J. Brodie, P.F. Clark, D.W. Connor, Dr M.J. Costello, Dr R.L. Fletcher, Dr J.D. Fish, Dr P. Garwood, Dr J.M. Hall-Spencer, Dr T. Harris, Dr P.J. Hayward, Dr T.O. Hill, Dr K. Hiscock, J. Light, I. Killeen, Dr G. Könnecker, Dr C.A. Maggs, Dr D. McKenzie, Prof. P.G. Moore, D. Moss, Prof. T.A. Norton, Dr J.D. Nunn, D. Seaward, B.E. Picton, Dr E.C. Southward and Dr R.B. Williams. The regional expertise of Dr R. Hamond has also been of great value. Access to the Marine Nature Conservation Review Database and the NIBESRC Database at the Ulster Museum has been invaluable for the overall analysis.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Starlet sea anemone	Dr R.B. Williams, Norfolk House, Western Road, Tring, Herts. HP23 4BN
Hydroids	B.E. Picton, BioMar, Environmental Science Unit, University of Dublin, Trinity College, Dublin 2, Republic of Ireland, tel: 010 353167 72941
Lagoon sand shrimp	M. Sheader, Dept. of Oceanography, University of Southampton, Highfield, Southampton SO9 5NH, tel: 01703 595000
Bryozoans	Dr P.J. Hayward, School of Biological Sciences, University College Swansea, Singleton Park, Swansea, West Glamorgan, S. Wales SA2 8PP, tel: 01792 205678
Lagoons	Dr R.S.K. Barnes, Department of Zoology, Downing Street, Cambridge CB2 3EJ, tel: 01223 336606
Norfolk marine biological records	Dr R. Hamond, Scaldbeck House, Morston, Holt, Norfolk NR25 7BJ

5.5 Exploited sea-bed species

Dr M.G. Pawson & C.F. Robson

5.5.1 Introduction

This section describes the distribution of large populations of species that live on, near, or in the bottom sediments of the sea bed (collectively called 'the benthos') and that are routinely exploited, mainly for human food. The exploitation itself is described in sections 9.1 and 9.2. Many of these species also provide an essential food source for other species, such as fish and birds, for example migrant and wintering waders and wildfowl. Most of the species discussed have planktonic larvae; the dispersal of planktonic larvae and the interrelation between populations of the same species can only be inferred from studies on movements of water masses. Their distributions are determined by factors such as water temperature (see section 2.3) and available habitat/substrate type (see section 4.3). The species described may also be found elsewhere in the region, but in smaller numbers.

All species apart from *Nephrops* are referred to by their common names in the text. The scientific names of the species are given in Table 5.5.1.

This region is characterised by important inshore distributions of exploited sea-bed species, such as brown shrimp and cockles in the Humber estuary and The Wash. The brown shrimp in The Wash are of national importance. Although mussels and cockles are present elsewhere, the region's sites for these species, such as The Wash, are also nationally significant. Lobster and edible crab, though important in the region, are also important in most other parts of Britain. Compared with other areas there are no exploitable quantities of deep water prawns or spider crab and crawfish.

Table 5.5.1 Species names

Common name	*Scientific name*
Lobster	*Homarus gammarus*
Edible crab	*Cancer pagurus*
Spider crab	*Maja squinado*
Crawfish, spiny lobster	*Palinurus elephas*
Dublin Bay prawn, scampi, Norway lobster or langoustine	*Nephrops norvegicus*
Deep water prawn (or shrimp - referred to as both)	*Pandalus borealis*
Brown shrimp	*Crangon crangon*
Pink prawn (or shrimp - referred to as both)	*Pandalus montagui*
Cockle	*Cerastoderma edule*
Mussel	*Mytilus edulis*
Native oyster	*Ostrea edulis*
Periwinkle	*Littorina littorea*
Scallop	*Pecten maximus*
Queen scallop	*Aequipecten opercularis*
Whelk	*Buccinum undatum*
Lugworm	*Arenicola marina*
Ragworm	*Neanthes* spp.

5.5.2 Important locations and species

Crustacea

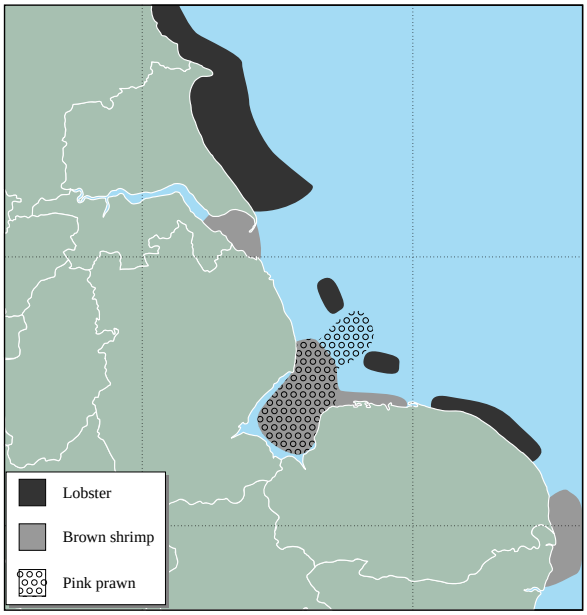
Lobsters are distributed throughout the region wherever there is suitable habitat, such as rocky reefs with crevices for protection. This occurs mainly along the Holderness coast and offshore from The Wash and the north Norfolk coast (see Map 5.5.1). Edible crabs are found along exposed or rocky shorelines in the region, often on softer sediments (ranging from sand/gravel to rock) than lobsters (see Map 5.5.2). Juveniles tend to be found inshore and adults further offshore (Rees & Dare 1993). Brown shrimp are present in large quantities in the region and in particular in, and offshore from, The Wash and the Humber. Pink prawns are also found around The Wash, with extensive fisheries off the north Norfolk coast on offshore grounds and east of the Humber (see Map 5.5.1). *Nephrops* is present in deeper water offshore from the Humber, in an area known as the 'Silver Pits'. Deep-water prawns are not known to be found in exploitable quantities in the region. Crawfish and spider crab are western species and are thus unlikely to be found in the region.

Molluscs - inshore and estuarine

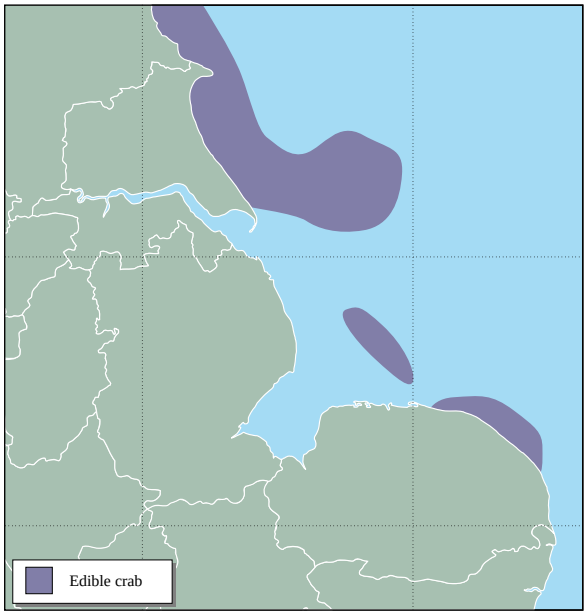
Cockles are found in the intertidal zones of the estuaries and other sheltered sites in this region; the main location of commercial significance is The Wash. There are no known exploitable stocks of native oyster in the region. Mussels are found from the mid shore to the subtidal zone in water of normal or variable salinity and in areas exposed to water currents. They attach themselves using 'byssus threads' to sand, gravel or pebble substrata or other mussels and empty shells, effectively binding the substratum. Small mussel stocks are distributed around coastal sites in the region, with the main areas being the Humber Estuary, The Wash and locations along the north Norfolk coast. Stocks of mussels in The Wash have plummeted recently, owing to recruitment failure, with the last significant spatfall occurring in 1986 (ESFJC pers. comm.). The main locations where cockles and mussels are found in the region are shown in Map 5.5.3. Periwinkles live on algae growing on rocky shorelines throughout the region, wherever suitable habitat is present.

Molluscs - offshore

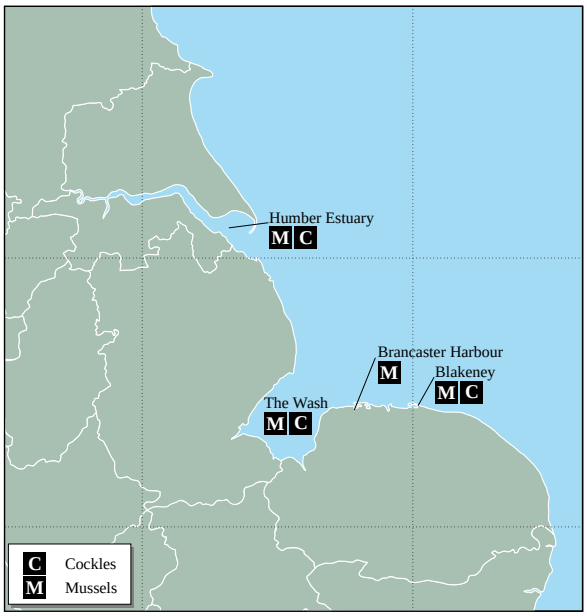
There are no known exploitable stocks of scallops in the region. Queen scallops are present in the region and normally live on sandy/gravel areas of the sea bed and are found in an area off the Yorkshire and Humberside coast. Whelks are widely distributed throughout the region, but the main concentration is offshore from the Holderness and north Norfolk coasts. The broad-scale distribution of queen scallops and whelks in the region is shown in Map 5.5.4.



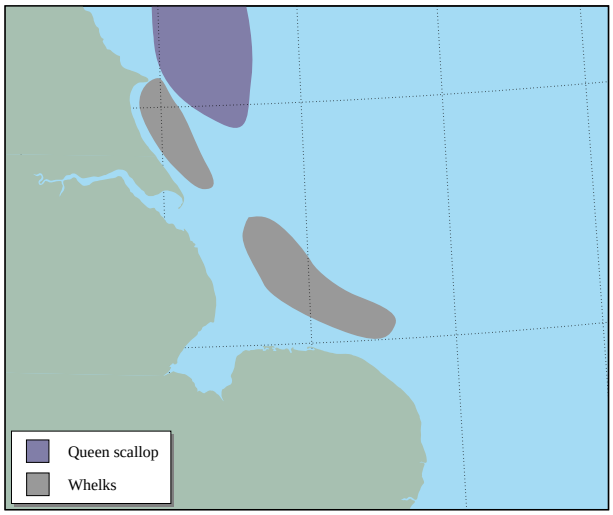
Map 5.5.1 Distribution of exploited lobster, brown shrimp and pink prawn. Copyright of the Shellfish Resource Group, MAFF Directorate of Fisheries Research (Lowestoft).



Map 5.5.2 Distribution of exploited edible crab. Copyright of the Shellfish Resource Group, MAFF Directorate of Fisheries Research (Lowestoft).



Map 5.5.3 Main inshore and estuarine locations of exploited cockles and mussels. Copyright of the Shellfish Resource Group, MAFF Directorate of Fisheries Research (Lowestoft).



Map 5.5.4 Main offshore locations of exploited queen scallops and whelks. Copyright of the Shellfish Resource Group, MAFF Directorate of Fisheries Research (Lowestoft).

Polychaetes

The intertidal and subtidal zones in the region's estuaries support populations of polychaetes such as lugworm and ragworm, which are commonly collected by anglers for bait (see section 9.1.2). Lugworms are common in less exposed areas where there is a higher organic content in the substratum. They occur elsewhere, for instance in north Norfolk and on the Lincolnshire/Humberside coast, in a wide range of sediment types from almost pure mud to clean sand (Davidson *et al.* 1991). Ragworms are usually found in the intertidal and sublittoral in slightly estuarine conditions, as for instance in The Wash. They live in burrows in muddy sediments or under rocks and stones.

5.5.3 Human activities

The exploitation by fisheries of the species covered in this section is described in Section 9.1, and by mariculture in Section 9.2. The major issues relating to the shellfish industry in the region are generally unregulated levels of exploitation, apart from restrictions on the exploitation of molluscan shellfish through The Wash Fishery Order (see section 9.1.3), and the possible effects on the benthos, feeding birds and cockle stocks of mechanical harvesting, such as by hydraulic suction dredges. To conserve cockle stocks in The Wash, in 1992 and 1993 the Eastern Sea Fisheries Joint Committee (ESFJC) and local cockle processors agreed to impose seasonal closures; in 1993 the

cockle fishery was closed from January to May. In 1994 approximately 25% of cockle beds were opened from June to August (inclusive) for from four to six days a week. A 14 mm riddle size was introduced to sort the cockles. In 1995, based on surveys carried out by ESFJC, a Total Allowable Catch of 4,500 tonnes was set (approximately 30% of fishable stock). Fishing is commonly limited to four days a week and to selected cockle beds, depending on the state of the stock.

The failure of the mussel stocks in The Wash has caused their exploitation to reach an all time low, and although over-exploitation has played a part in the decline of stocks, the absence of recruitment of young mussels in recent years is believed to be the main cause. Re-laying of mussels from outside the region has taken place in The Wash since 1992, to counteract the marked decline in the stock there since 1986 (see section 9.2.2). MAFF are undertaking a lobster re-stocking experiment off the Holderness coast from Hornsea to Tunstall (Bannister & Howard 1991).

Coastal areas in the region where the brown shrimp fishery takes place are also important nursery areas for juvenile fish (see section 5.7.3). There is a large by-catch of these juveniles, owing to the small mesh size of the nets used for shrimp, and concern about any possible effect this may have on fish populations is being researched by the University of Humberside (Wray 1995).

The exploitation of *Nephrops* is regulated in ICES Area IV (a, b & c) by the application of a catch quota management measure, with a precautionary Total Allowable Catch of 15,200 tonnes (in 1995), 13,165 tonnes of which is allocated to the UK (European Council Regulation No. 3362/94).

Bait collection, especially digging, can have major localised effects on intertidal habitats and communities and can also cause disturbance to birds, when they are concentrated in estuaries and embayments. These issues are explored in the references given in section 5.5.6.

5.5.4 Information sources used

The four maps in this section show schematically the known broad-scale distribution of the main exploited species, based on current knowledge from MAFF scientists and fishery officers on the location of the species and their fisheries. There is supporting information in the form of commercial landing statistics and biological samples of crustacea collected at local ports. These data provide some information about the location of spawning and nursery grounds, but to establish the links between individual spawning, nursery and recruitment areas requires further research on the planktonic stages, the hydrography, and the movement (or otherwise) of juveniles and adults. Barring substantial climate change or over-exploitation, these distributions and relationships are likely to remain stable over several decades. The seaward boundaries on the maps are only indicative, and because only large, exploitable populations are described, the species may also be found elsewhere in the region, but in smaller numbers.

5.5.5 Acknowledgements

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Seaward, D.R. 1993. Additions and amendments to the *Distribution of the marine molluscs of north-west Europe* (1990). *Joint Nature Conservation Committee Report*, No. 165.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Fish stocks and fisheries advice to assist with management and policy decisions for the coastal zone	*Head of Laboratory, MAFF Directorate of Fisheries Research, Fisheries Laboratory, Conwy, tel: 01492 593883
Assessment and provision of advice on the conservation of commercial fish and shellfish stocks.	*Director, MAFF Directorate of Fisheries Research, Lowestoft, tel: 01502 562244
Benthic surveys: Marine Nature Conservation Review Database	*Marine Conservation Branch, JNCC, Peterborough, tel: 01733 62626
Marine conservation issue and fisheries	*Marine Fisheries Officer, English Nature HQ, Peterborough, tel: 01733 340345
Marine Fisheries Task Group papers; marine conservation	*Marine Advisory Officer, Marine Conservation Branch, JNCC, Peterborough, tel: 01733 62626
Marine conservation and issues	*Conservation Officer, RSPB, Sandy, tel: 01767 680551
Marine conservation and issues	*Fisheries Officer, Marine Section, WWF-UK, Godalming, tel: 01483 426444
Marine conservation and issues	*Conservation Officer, Marine Conservation Society, Ross-on-Wye, tel: 01989 566017
Marine conservation and issues	Administrator, The Marine Forum for Environmental Issues, Department of Zoology, Natural History Museum, Cromwell Road, London SW7 5BD, tel: 0171 938 9114
Research, specifically into brown shrimp fishery methods	University of Humberside, School of Applied Science and Technology, Humber Lodge, 61 Bargate, Grimsby, South Humberside DN34 5AA, tel: 01482 440440

* Starred contact addresses are given in full in the Appendix.

5.6 Amphibians and reptiles

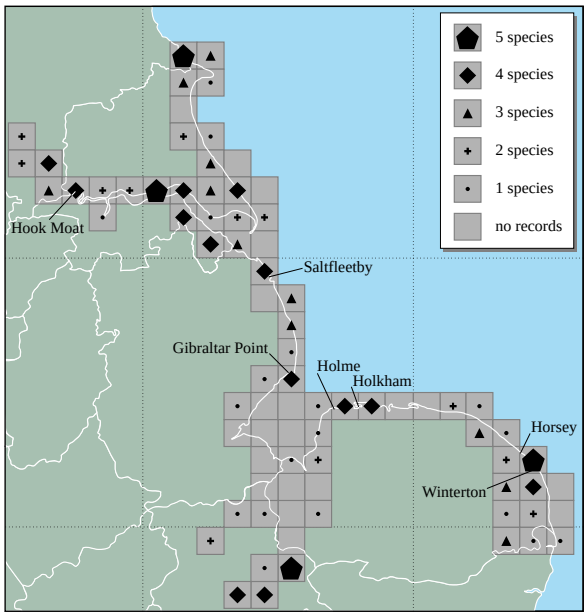
M.J.S. Swan

5.6.1 Introduction

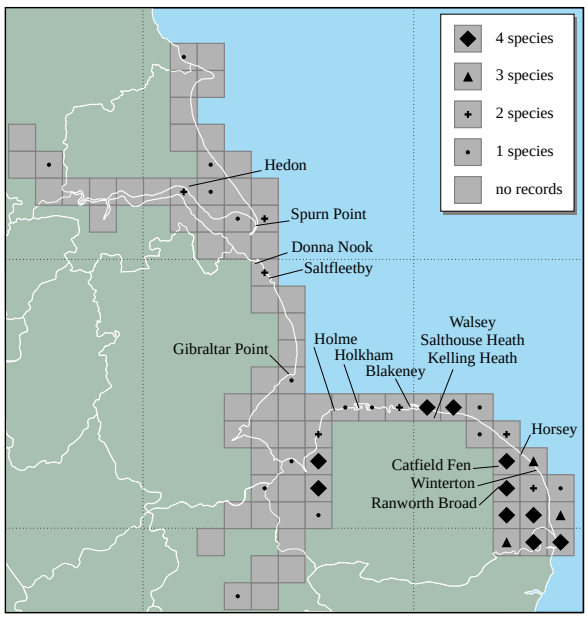
This region is important for herpetofaunal conservation in Britain. Not only does it support all nine of the widespread species of amphibian and terrestrial reptile (common frog *Rana temporaria*, common toad *Bufo bufo*, smooth newt *Triturus vulgaris*, palmate newt *T. helveticus*, great crested newt *T. cristatus*, slow-worm *Anguis fragilis*, common lizard *Lacerta vivipara*, grass snake *Natrix natrix* and adder *Vipera berus*), but also the rare and restricted natterjack toad *Bufo calamita*. Since 1980 the corpse of one leatherback turtle *Dermochelys coriacea* has been recovered from the Norfolk coast (Goldsmith pers. comm.). All amphibian and reptile species have some national and international protection, and three, the great crested newt, natterjack toad and the leatherback turtle, are of international significance.

Maps 5.6.1 and 5.6.2 show the distribution of records held for amphibian and reptile surveys by the Biological Records Centre at ITE Monks Wood. Throughout most of this region, amphibian and reptile diversities are comparatively low. Forty-eight percent of surveyed 10 km squares support at least three species of amphibian (Swan & Oldham 1993a), a much lower figure than that calculated for the entire British east coast (76%) but higher than for Great Britain as a whole (22%). Only 19% of surveyed 10 km squares in the region support at least three species of reptile, compared with 81% for the entire East Coast and 45% for the country as a whole. Nevertheless, the narrow coastal strip provides important habitat for both amphibians and reptiles, which are absent from much of the intensively farmed coastal hinterland of this region. Coastal habitats are essential to the continued existence of natterjack toads in the UK: of 46 recorded natterjack toad breeding sites in Britain, 41 (89%) are on the coast. Coastal dune and marsh systems within this region comprise 13% of all natterjack toad breeding sites within the UK (Beebee 1989).

Table 5.6.1 shows the numbers of amphibian and reptile records in relation to survey effort. The average numbers of individual records of amphibians and reptiles surveyed per 10 km square are considerably lower in this region than the average for the British coast (7.4 compared with 12.1 nationally for amphibians, and 4.3 compared with 5.7 nationally for reptiles). The region's 10 km squares within Cambridgeshire (included as coastal because of the presence of tidal rivers) had the greatest density of individual records in the region for amphibians (17.1 records per 10 km square). The truly coastal sectors showed lower values, returning between 3.9 (Norfolk) and 9.2 (Humberside) records per 10 km square. Except for Norfolk, this region has fewer individual records for reptiles per 10 km square than the country as a whole; unfortunately, Lincolnshire and Humberside have not been well enough surveyed for the apparent species distributions to be reliable. All four reptile species occur around Blakeney but otherwise adders, slow worms and grass snakes are virtually absent from most of the north Norfolk coast.



Map 5.6.1 Numbers of amphibian species recorded in coastal 10 km squares and key localities for amphibians. Distribution may reflect differences in recording effort. Source: Biological Records Centre, ITE Monks Wood.



Map 5.6.2 Numbers of reptile species recorded in coastal 10 km squares and key localities for reptiles. Distribution may reflect differences in recording effort. Source: Biological Records Centre, ITE Monks Wood.

Table 5.6.1 Records of amphibians and reptiles related to survey effort

	*Total no. of 10 km squares**	*Total no. of individual records*		*Mean no. of individual records per surveyed 10 km square*		*% 10 km squares surveyed for:*		
		Amphibians	*Reptiles*	*Amphibians*	*Reptiles*	*Any herp. species*	*Amphibians*	*Reptiles*
Humberside	26	211	24	9.2	3.4	88	88	27
Lincolnshire	18	50	5	4.5	1.7	61	61	17
Cambridgeshire	9	120	3	17.1	1.5	89	78	22
Norfolk	33	87	133	3.9	5.1	85	67	79
Region 6	**77**	**468**	**165**	**7.4**	**4.3**	**91**	**82**	**49**
North Sea coast	504	4,141	1,602	12.5	6.5	76	66	49
GB coast	1,124	7,524	3,138	11.3	5.7	69	59	49
Great Britain (coast and inland)	2,862	27,182	8,803	12.1	4.7	84	79	66

Sources: Biological Records Centre, Monks Wood; Beebee (1989). *Total includes squares that are partly in the county, but excludes squares that are exclusively marine.

5.6.2 Important locations and species

The highest diversity of amphibians occurs along the coast of Lincolnshire, where 55% of surveyed squares support at least three species (Map 5.6.1), but the amphibians have been most frequently recorded in Humberside. The natterjack toad sites in this region are located within sand dune and coastal heathland systems, all of them within nature reserves or SSSIs. There are seven, relatively isolated, sites: two in Lincolnshire, two on the north Norfolk coast and two others on the east coast of Norfolk (Table 5.6.2). Some of the more widespead species are often common in the natterjack areas: frogs, toads and smooth newts are present at almost all of the sites, and common lizards have been observed at every one except Gibraltar Point. The widespread amphibians also are relatively common in many of the dune slacks on the north Norfolk coast and at Saltfleetby in Lincolnshire. Palmate newts, the rarest amphibian species, are recorded at only four sites - in Humberside and in Cambridgeshire. Table 5.6.2 also lists regionally or nationally important great crested newt breeding sites.

Also listed in Table 5.6.2 are sites at which reptile sightings have been relatively frequent. Grass snakes are recorded in this region only around the coast of The Wash and at Blakeney, and adders only at Gibraltar Point and on the east Norfolk coast.

5.6.3 Human activities

Important coastal habitats in this region have been affected by agricultural encroachment and by coastal defence measures, which have led to changes in the sand dunes and their hinterlands (see also section 8.4). Natterjack toads have been affected directly by loss of dune habitats and also, indirectly, by changes in management, such as reduction of grazing, which has led to increased scrub encroachment, resulting in a detrimental increase in competition from common toads. Sea defence measures that prevent seawater inundation have allowed the growth of large competing populations of the commoner species in ditches and marshes inland. Eutrophication of water-bodies through run-off from agricultural hinterlands has also rendered some sites less suitable for natterjack toads.

The area of habitat favourable to the more common species has decreased as arable intensification has rendered many inland areas inhospitable and reduced the extent of the coastal strip. Reptiles have been adversely affected by human disturbance and habitat damage, particularly around seaside holiday resorts.

Natterjack toads are included in English Nature's Species Recovery Programme (Whitten 1990). After an initial pilot study, which identified sites within this region as potential reintroduction sites, the natterjack toad recovery programme is currently being implemented (Denton & Beebee 1992, 1993, 1994).

5.6.4 Information sources used

Amphibian and reptile surveying in Britain has been widespread, with 84% of 10 km squares receiving some coverage nationally, although coastal coverage (69% of squares) has been less extensive. In terms of the proportion of 10 km squares where some surveying has been carried out, the coastline of this region has been surveyed more extensively than most of the coast of Britain for amphibians (82% in the region compared with 59% on the British coast) but has received average coverage for reptiles (49%) (Table 5.6.1).

National distribution data for the widespread terrestrial amphibians and reptiles were provided by the Biological Records Centre (BRC) at Monk's Wood (Arnold 1983, Arnold in prep.). These sources comprise post-1970 species records held by BRC and include all the data collected during the National Amphibian and Reptile Surveys (NARS) undertaken by De Montfort University on behalf of English Nature. The NARS formed the focus of national amphibian and reptile recording during the 1980s and early 1990s (Oldham & Nicholson 1986; Swan & Oldham 1989, 1993a, b). Many of these data were collected through a volunteer, mainly amateur, recorder network. Further information was provided in a series of papers written by the Norfolk county herpetological recorder (Buckley 1975, 1985, 1986, 1987, 1988, 1991).

As in many kinds of species survey, the observed distribution of records will reflect differences in recording

Table 5.6.2 Sites supporting natterjack toads, nationally or regionally important great crested newt populations, and areas where reptiles are considered to be abundant

Site name	*Grid ref.*	*Habitat*	*Species present*
Humberside			
Hook Moat	SE7525	Farmland	Common frog, smooth newt, great crested newt
Hedon	TA1828	Ruined buildings	Common lizard, grass snake
Spurn Point	TA4112	Sand dune	Common lizard
Lincolnshire			
Donna Nook	TF4299	Upper saltmarsh	Common lizard
Saltfleetby NNR	TF4791	Sand dunes, marshes	Natterjack toad, common toad, common frog, smooth newt, common lizard
Gibraltar Point	TF5558	Sand dunes, marshes	Natterjack toad, common toad, great crested newt, adder
Norfolk			
Holme SSSI	TF7144	Sand dunes	Natterjack toad, common frog, common toad, smooth newt, common lizard
Holkham Meals NNR	TF8645	Sand dunes	Natterjack toad, common frog, common toad, smooth newt, common lizard
Horsey SSSI	TF4623	Sand dunes, marshes	Natterjack toad, common frog, common toad, smooth newt, great crested newt, common lizard, adder
Blakeney	TG0046	Sand dunes	Common lizard, adder, slow worm, grass snake
Walsey Hills	TG0644	Heathland	Common lizard, adder
Salthouse Heath	TG0742	Heathland	Adder
Kelling Heath	TG0941	Heathland	Common lizard
Ranworth Broad	TG3515	Wetland	Grass snake
Catfield Fen	TG3621	Wetland	Grass snake
Winterton NNR	TG4821	Sand dunes, scrub	Natterjack toad, common frog, common toad, smooth newt, great crested newt, common lizard, adder

Sources: Beebee (1989), Swan & Oldham (1993a & b), Buckley (pers. comm.).

effort as well as the real distribution of the species concerned. Results from Swan & Oldham (1993a & b) show that nationally, 98% of 10 km squares that have been surveyed show positive records of at least one of the common species: it is therefore a reasonable assumption that 10 km squares that have no records at all have not been surveyed.

Natterjack toad breeding sites are regularly monitored by nature reserve personnel, whose reports are incorporated into the natterjack toad site register for the UK (Beebee 1989), which is updated annually. This was the main source of the natterjack data presented in this section. The site register also contains current listings of site-, area- and region-specific published and unpublished research and monitoring papers.

English Nature and the county Wildlife Trusts hold lists of recorded great crested newt and other amphibian breeding sites.

Marine turtle distribution data were supplied by the Natural History Museum, Southampton University and the Castle Museum, Norwich; all sightings at sea and strandings should be reported to the Natural History Museum in London. Concise information on turtle identification, reporting of sightings, UK legislation and instructions on what to do with turtles caught in fishing gear is contained in the *Turtle code* (Nature Conservancy Council 1990).

5.6.5 Acknowledgements

The author wishes to thank the following people for information and for useful comments on the draft: Henry Arnold, Trevor Beebee, John Buckley, Keith Corbett, Tony Gent, Nick Gibbons, John Goldsmith and Kevin Wilson.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Conservation and captive breeding of amphibians and reptiles, nationally	British Herpetological Society, c/o The Zoological Society of London, Regent's Park, London NW1 4RY, tel: 0181 452 9578
Conservation of threatened reptiles and amphibians in Britain; priority species in Europe	Conservation Officer, The Herpetological Conservation Trust, 655A Christchurch Road, Boscombe, Bournemouth, Dorset BH1 4AP, tel: 01202 391319
National secretariat to local amphibian and reptile groups	Common Species Co-ordinator, Herpetofauna Groups of Britain and Ireland, c/o HCIL, Triton House, Bramfield, Halesworth, Suffolk IP19 9AE, tel: 0198 684 518
National recording schemes and biological data from throughout UK	*Environmental Information Centre, ITE Monks Wood, Huntingdon, tel: 01487 773381
Ecological research, monitoring and conservation of natterjack toads	Dr Trevor Beebee, University of Sussex, Falmer, Brighton, East Sussex BN1 9QS, tel: 01273 606755
Turtles	Dr Colin McCarthy, Natural History Museum, Cromwell Road, London SW7 5BD, tel: 0171 938 9123
Turtles	Dept. of Oceanography, Southampton University, Highfield, Southampton SO9 5NH, tel: 01703 595000
The turtle code	*English Nature HQ, Peterborough, tel: 01733 340345
Designated sites, Humberside	*English Nature North and East Yorkshire Local Team, York, tel: 01904 432700
Wildlife Trust sites in South Humberside and Lincolnshire	*Lincolnshire Trust for Nature Conservation, Horncastle, tel: 01507 526667
Saltfleetby NNR	*English Nature East Midlands Local Team, Grantham, tel: 01476 68431
Gibraltar Point	Gibraltar Point Field Station, Gibraltar Road, Skegness, Lincolnshire PE24 4SU, tel: 01754 762677
Wildlife Trust sites, Cambridgeshire	*The Wildlife Trust for Beds, Cambs, Northants and Peterborough, Cambridge CB2 2LE, tel: 01223 846363
Wildlife Trust sites, Norfolk	*Norfolk Wildlife Trust, Norwich, tel: 01603 625540
Designated sites, Norfolk	*English Nature Norfolk Local Team, Norwich, tel: 01603 620558
Records of wildlife in Norfolk	The Castle Museum, Norwich NR1 3JU, tel: 01603 223624
Holkham NNR	Site Manager, Holkham NNR, The Old Chapel, Holkam, Wells-next-the-Sea, Norfolk NR23 1RQ, tel: 01328 711183
Holme Dunes Nature Reserve	Norfolk Wildlife Trust, The Firs, Broadwater Road, Holme-Next-The-Sea, Hunstanton, Norfolk PE36 3LQ, tel: 01603 625540
Reptiles and amphibians on National Trust sites in region	The Warden, National Trust, Horsey Hall, Great Yarmouth, Norfolk NR29 4EF, tel: 01493 393235 (Estate tenant) or 01493 394961 (National Trust Warden)

* Starred contact addresses are given in full in the Appendix.

5.7 Fish: exploited sea fish

Dr M.G. Pawson & C.F. Robson

5.7.1 Introduction

This section describes distribution of sea fish that are of interest because they are exploited by people, mainly for food. Their exploitation by fisheries is described in section 9.1. Sea fish described as pelagic (Table 5.7.1) are most commonly found in shoals swimming in midwater; they typically make extensive seasonal movements or migrations between sea areas. 'Demersal' fish (Table 5.7.2) are those found living at or near the bottom of the sea. For this report, all sea fish that are not 'pelagic' are termed 'demersal', the latter term thus including bass and grey mullet. Demersal species are here divided into four groups: elasmobranchs (sharks, skates and rays), gadoids (the cod family), flatfish, and other demersal fish. Most demersal species gather in late winter or spring on persistent and recognisable spawning grounds, to release millions of minute free-floating eggs. From these hatch larvae, which feed on and move with the plankton, often for a hundred miles or more, before metamorphosing into tiny fish, which recruit to inshore nursery grounds.

The distribution of all exploited sea fish species can be mapped from expert analysis of catch data, but this is outside the scope of this volume. This description of their distribution covers only their occurrence at identifiable locations during particular phases of their life history, and the maps are restricted to showing the known spawning areas and nursery areas (Maps 5.7.1 - 4) of key species in the region. Barring substantial climate change, or complete over-exploitation, these distributions and relationships will remain stable over several decades.

Table 5.7.1 and 5.7.2 list the important pelagic and demersal species occurring in the region and gives examples of protection measures in this region.

Table 5.7.1 Pelagic species and examples of measures for their protection

Species	*Protection measures*
Mackerel *Scomber scombrus*	MLS/QM
Horse mackerel *Trachurus trachurus*	MLS/QM
Herring *Clupea harengus*	MLS/QM
Sprat *Sprattus sprattus*	QM

Source: European Council Regulation No. 3362/94; MAFF (pers. comm.). Key: MLS = minimum landing size; QM = catch quota management.

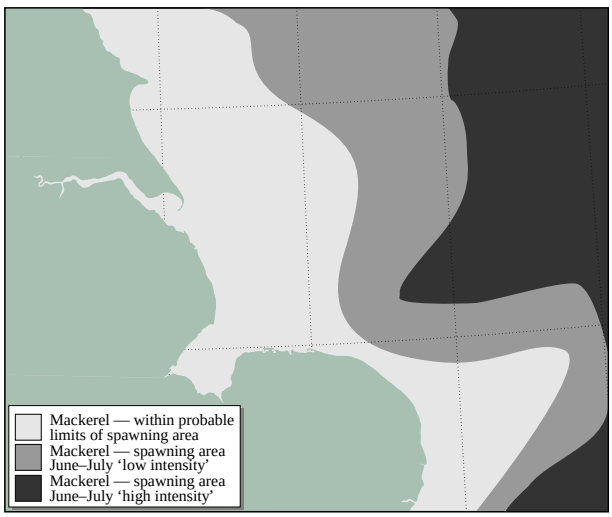
5.7.2 Important locations and species

Of the pelagic species, mackerel is widely distributed around Britain and is present in the region. Two stocks of mackerel are found in north-west European waters: the western stock, which spawns along the shelf edge west of Britain, and the North Sea stock, which feeds and spawns in June and July in the central North Sea, including offshore areas of this region (Map 5.7.1). The stock spawning in the

Table 5.7.2 Demersal species and examples of measures for their protection

Species	*Protection measures*
Elasmobranchs	
Spurdog *Squalus acanthias*	No limitation
Thornback ray *Raja clavata*	No limitation
Lesser spotted dogfish *Scyliorhinus canicula*	No limitation
Gadoids	
Cod *Gadus morhua*	MLS/QM
Haddock *Melanogrammus aeglefinus*	MLS/QM
Whiting *Merlangius merlangus*	MLS/QM
Ling *Molva molva*	No limitation
Pollack *Pollachius pollachius*	MLS
Saithe *Pollachius virens*	MLS/QM
Flatfish	
Plaice *Pleuronectes platessa*	MLS/QM
Dab *Limanda limanda*	MLS
Sole (Dover) *Solea solea*	MLS/QM
Lemon sole *Microstomus kitt*	MLS
Turbot *Scophthalmus maximus*	MLS
Brill *Scophthalmus rhombus*	MLS
Megrim *Lepidorhombus whiffiagonis*	MLS
Flounder *Platichthys flesus*	MLS
Other demersal fish	
Bass *Dicentrarchus labrax*	MLS
Grey mullets *Chelon labrosus*, *Liza ramada* and *Liza aurata*	MLS
Angler (monkfish) *Lophius piscatorius*	No limitation
Sandeels *Ammodytes* spp.	No limitation
Conger eel *Conger conger*	MLS
Gurnards*Triglidae* spp.	No limitation
Wrasse *Labridae* spp.	No limitation

Source: European Council Regulation No. 3362/94; MAFF (pers. comm.). Key: MLS = minimum landing size; QM = catch quota management.



Map 5.7.1 Mackerel spawning areas. Source: Lee & Ramster (1981). © Crown copyright.

North Sea is very small at present and has shown no signs of recovery since its decline in the 1970s. Overwintering concentrations are found west of Scotland, west of Ireland and off Cornwall, but not in this region (Lee & Ramster 1981). Herring are locally abundant in the summer and autumn in feeding areas throughout the region. There are five distinct autumn/winter spawning areas in the northern and southern areas of the region (Map 5.7.2). The timing of spawning depends on the locality, and the herring larvae drift to shallow nursery areas (Map 5.7.3). Sprats are widely dispersed throughout the shallower areas of the region, and especially in The Wash during the summer. They migrate to the offshore spawning areas, which are delimited by the main egg and larval distribution. Spawning mainly peaks from April to June and is temperature dependent. Sprats migrate inshore to overwinter, and no clearly defined nursery areas have been identified.

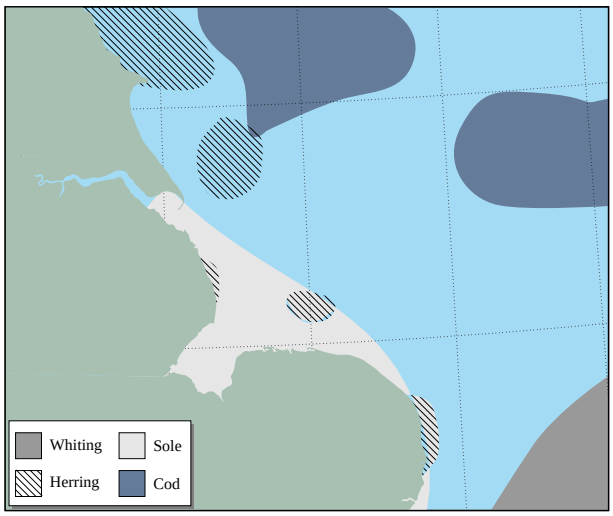
All elasmobranch species produce relatively small numbers of live young (10 - 100 per year, but can be fewer in big sharks) or lay large eggs on the sea bed close to their nursery areas. Several species of shark occur sporadically, but only the spurdog and lesser spotted dogfish are found regularly. The thornback ray is also important, especially *en route* to its spring spawning grounds in shallow bays around the region.

Cod is one of the most important commercial fish species in the North Atlantic. The North Sea population of cod is self contained, and in general the cod migrate south in winter to the spawning areas and in the summer are spread out over a wider area. Cod are abundant and widely distributed in the region (Map 5.7.2), and there are two large and pronounced aggregations of cod for spawning, which peaks during February. Whiting, also members of the cod family, are widely distributed around Britain and are extremely common in the North Sea, especially in inshore waters. The large whiting spawning area in the southern North Sea is just within the region's offshore area (Map 5.7.2). The spawning season is prolonged - from January to July depending on the latitude - and there are likely to be other spawning areas and nursery areas all over the North Sea that have not been identified. Haddock are not as widely distributed in the region as they are further north. Spawning takes place between February and June and the main spawning areas are outside the region (Lee & Ramster 1981). Ling, pollack and saithe are less abundant than other gadoids and more locally distributed, with saithe in particular here being close to the southern limits of its distribution. All three species are found in particular around areas of stony ground, reefs and wrecks.

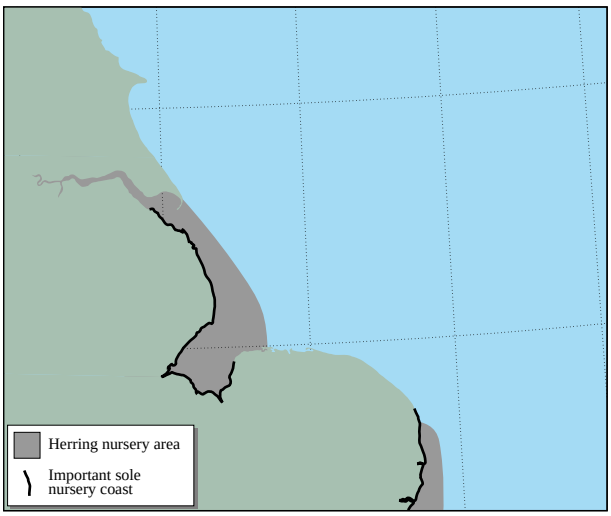
Plaice and dab are the most abundant flatfish species: much more is known about the life history of the commercially exploited plaice. These species occur on sandy areas of sea bed throughout the region, with juveniles living close to the shore in nursery areas, gradually moving to deeper water as they grow. The knowledge of plaice spawning areas (Map 5.7.4) is obtained from the distribution of newly spawned eggs, and has been determined from plankton surveys over 20 years (Lee & Ramster 1981). The Wash is an important nursery area for juvenile plaice. Dab spawn from January to June throughout the North Sea, but local concentrations of eggs occur off Flamborough Head; the juveniles move to coastal nurseries in the autumn and migrate to deeper water as they grow. Dover sole are present throughout the region and have a similar lifestyle to plaice and dab, though they are more confined to areas with higher bottom temperatures. Dover sole spawn in the early summer (April to June) in the region, in a large area stretching from the Humber down along the Norfolk coast (Map 5.7.2). The young may spend up to two years in the same inshore nursery areas in coastal sandy and muddy bays used by plaice, which in this region are the south shore of the Humber, the Lincolnshire coast and The Wash, and the east coast of north Norfolk (Map 5.7.3). Mature lemon sole occur in small numbers throughout the region but are more common further north. It is assumed that the adults spawn where they are found and probably do not make extensive migrations. Turbot and brill are much less abundant than plaice, dab or soles but have a similar lifestyle. None of these flatfish species exhibits extensive migrations, though their larvae can drift for 100 miles or more from offshore spawning grounds to inshore nursery areas, which are located on coasts with sandy or muddy bays. Megrim tend to be found only in the deepest water of this region. There are no separate nursery or spawning areas recognised in the North Sea. At the other extreme, flounder migrate between inshore, estuarine and even riverine nursery areas all along the coast of the region in the summer to spawn up to 20 or 30 miles offshore in late winter, and there appears to be little coastal movement other than in the egg or larval phase.

Bass occur in small numbers, mostly in the south of the region, which is just within its normal range, but there are no known bass nursery areas in the region (Kelley 1988). Thick-lipped grey mullet are more likely to be found, and spawning grey mullet have been recorded, mostly in the south of the region.

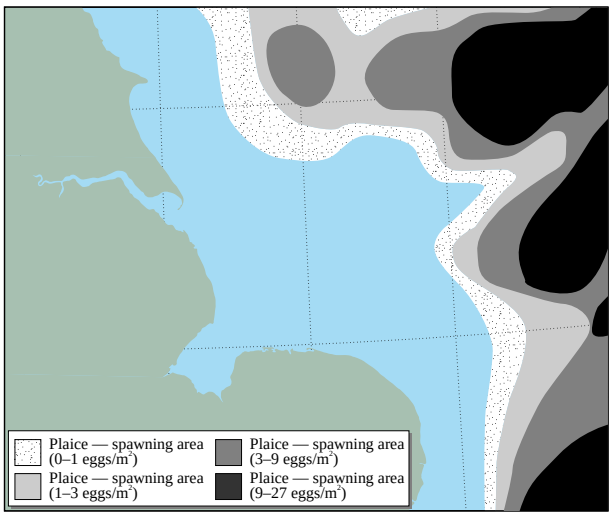
Monkfish (angler) is present in low densities in the region and spawns mainly between March and June in deeper waters offshore, but juveniles and non-spawning adults can be found throughout coastal areas, even in shallow nearshore waters. Sandeels are present in the region (Lee & Ramster 1981). They burrow in coarse sand at night and during the winter, and so their distribution is linked to that of coarse sand. Other demersal species of minor commercial importance are conger eel and various gurnards and wrasse species.



Map 5.7.2 Whiting, sole, herring and cod spawning areas Source: Lee & Ramster (1981). © Crown copyright.



Map 5.7.3 Pelagic and demersal fish species nursery areas. Source: Lee & Ramster (1981). © Crown copyright.



Map 5.7.4 Plaice spawning areas. Source: Lee & Ramster (1981). © Crown copyright.

5.7.3 Human activities

A feature of all fish stocks, and the primary reason for their fluctuation, is the variability of recruitment of juvenile fish to the exploited populations. This variability, the causes of which are not fully understood, is determined by environmental conditions at the time of spawning and in the subsequent larval survival. Exploitation of fish stocks may increase the extent of these fluctuations.

Efforts are made to conserve stocks of pelagic and demersal species by implementing protection measures (see Tables 5.7.1 and 5.7.2) reflecting their commercial importance or state of exploitation. Management measures are applied, including minimum landing sizes (MLS), minimum mesh size regulations and quantitative controls on catches (through catch quota management by the setting of annual Total Allowable Catches (TACs)) (further explained in section 9.1). Two such protection measures are presented in Tables 5.7.1 and 5.7.2: catch quota management (QM), which indicates that the UK has been allocated a TAC in ICES Fishing Areas IVb and IVc (which include Region 6), and Minimum Landing Size. Their implementation means that species caught below minimum landing size or for which the quota is exhausted may be discarded at sea, and this may affect the exploited species fish stocks, as well as other fish species, birds and species that live on the sea bed.

In order to reduce the by-catch of juvenile fish when *Nephops* nets with a mesh size of 70 mm are used, in June 1992 MAFF made it compulsory for a section of 80 mm square mesh panelling to be incorporated into the net, near to the cod end.

The beams used to catch brown and pink shrimp are not covered by the maximum aggregate length restriction of 9 m that applies to beams used by demersal fishermen fishing within the twelve mile limit (see section 9.1). More commonly, twin beams with an aggregate length of around 14-16 m are used, with a net mesh size of 20-25 mm. Despite the fact that only light ground gear is used, there is a concern that a high proportion of the catch can consist of juvenile fish, particularly flatfish such as plaice and Dover sole. The fish are separated from the crustacea and returned to the sea, but it is unlikely that they all survive (Gray 1994). However, natural mortality in juvenile flatfish is known to be very high, which may mean that the effect of the shrimp fishery may not be significant. MAFF-sponspored research is currently being carried out at the University of Humberside Applied Science and Technology Department in Grimsby to try and quantify and reduce this by-catch.

The elasmobranch species do not have any protected status and are vulnerable to exploitation as a result of the relatively long time they take to reach reproductive maturity and the small numbers of young that they produce.

Spawning and nursery areas may be vulnerable to activities such as sewage sludge dumping, dredging and dredge spoil dumping and the development of infrastructure such as barrages and pipelines. MAFF is a statutory consultee for activities such as these, in which the distributions of exploited fish populations and their identifiable spawning and nursery areas have to be taken into account.

5.7.4 Information sources used

Whereas the life history of the exploited crustacean and mollusc species can be observed at or near the sites at which they are harvested, the distributions of fish populations can change considerably between juvenile and adult phases and with seasonal migrations. Therefore the information used in this section is based on the distribution and relative abundance of fish species revealed by fisheries catch statistics obtained from recorded commercial landing figures. In addition, information is used from research vessel catch data and data from biological sampling during fishing surveys. Data from these surveys on the occurrence of spawning fish and juveniles can be used to identify spawning and nursery areas. However, this information is sometimes limited, and there may be other areas in addition to those described or shown on the maps where the species might also occur. Research surveys involving plankton sampling, hydrographic studies, fishing and tagging are required to establish the links between spawning groups and specific nursery areas, and between growing juveniles there and the adult populations to which they eventually recruit. Lee & Ramster (1981) has been used extensively as a source for the maps. Pawson (1995) shows distribution

maps of selected fish and shellfish species around the northeast Atlantic and the British Isles and has a species-specific bibliography.

European Council Regulation No. 3362/94 fixes, for 1995, details of the catch quotas for fish species for all European countries, i.e. the Total Allowable Catches (TACs) and certain conditions under which the species may be fished. European Council Regulations are published (where this is obligatory) in Luxembourg in the Official Journal of the European Communities. EC Regulation No. 3362/94 is updated annually (European Council 1994).

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Advice to assist with management and policy for the coastal zone	*Head of Laboratory, MAFF Directorate of Fisheries Research, Fisheries Laboratory, Conwy, tel: 01492 593883
Assessment and provision of advice on the conservation of exploited fish stocks. MAFF Databases e.g. young fish and ground fish surveys.	*Director, MAFF Directorate of Fisheries Research, Fisheries Laboratory, Lowestoft, tel: 01502 562244
UKDMAP software with maps showing distributions of selected sea fish species and spawning areas	Project Manager, British Oceanographic Data Centre, Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, tel: 0151 652 3950
Marine science research	Director/Librarian, University of Newcastle upon Tyne, Dove Marine Laboratory, Cullercoats, North Shields NE30 4P2, tel: 0191 252 4850
Marine conservation issues and fisheries	*Marine Fisheries Officer, English Nature HQ, Peterborough, tel: 01733 340345
Marine Fisheries Task Group papers and advice on marine conservation issues	*Marine Advisory Officer, Marine Fisheries Task Group, c/o JNCC, Peterborough, tel: 01733 62626
Marine conservation issues	*Conservation Officer, RSPB, Sandy, tel: 01767 680551
Marine conservation issues	*Fisheries Officer, Marine Section, WWF-UK, Godalming, tel: 01483 426444
Marine conservation issues	Conservation Officer, Marine Conservation Society, 9 Gloucester Road, Ross-on-Wye, Herefordshire HR9 5BU, tel: 01989 566017
Marine conservation issues	Administrator, The Marine Forum for Environmental Issues, Department of Zoology, Natural History Museum, Cromwell Road, London SW7 5BD, tel: 0171 938 9114
Research, specifically into brown shrimp fishery methods	University of Humberside, School of Applied Science and Technology, Humber Lodge, 61 Bargate, Grimsby, South Humberside DN34 5AA, tel: 01482 440440

* Starred contact addresses are given in full in the Appendix.

5.8 Fish: salmon, sea trout and eels

Dr M. Aprahamian & C.F. Robson

5.8.1 Introduction

Diadromous fish migrate between fresh water and the sea. The three diadromous fish species covered in this section because they are exploited for human consumption - the Atlantic salmon, sea trout and eel - are widespread in British waters and have been recorded in rivers in this region. (Twaite shad are also diadromous but are included in section 5.9, as they are not routinely exploited.) The salmonids (salmon and sea trout) spawn in fresh water and then migrate out to sea to mature, while the eel matures in fresh water and reproduces at sea. Sea trout and brown trout are the same species, but the latter is a freshwater form and is therefore not covered in this section. Information on the life-cycles of these fish can be found in Jones (1959), Mills (1971, 1989), Moriarty (1978), Shearer (1992), Sinha & Jones (1975) and Tesch (1977). Table 5.8.1 lists some of the protection measures for salmon, sea trout and eels in the region.

Table 5.8.1 Species and examples of measures for their protection

Species	*Protection measures*
Atlantic salmon *Salmo salar*	EC Habitats Directive Annexes IIa, Va (freshwater only), close season, minimum landing size
Sea trout *Salmo trutta*	MLS, close season
Eel *Anguilla anguilla*	MLS

Sources: European Council Regulation No. 3362/94; MAFF and NRA (pers. comm.). Key: MLS = minimum landing size.

5.8.2 Important locations

Salmon, sea trout and eels have a widespread distribution in rivers and the coastal seas of British waters. The distribution of salmon and sea trout is controlled by natural factors, such as river levels, and by man-made barriers that may limit the extent to which they can go upstream. Salmon and sea trout are present in the coastal seas of this region and also its rivers, mainly the Yorkshire Ouse, although it does not support large populations compared with many other rivers in the UK. The Humber is a corridor for migratory salmonids and the Trent has an emerging run of salmonid species (S. Bailey pers. comm.). Eels are probably found in all river systems in the region, as elsewhere in Britain, but are believed to be in decline in the (Yorkshire) River Ouse.

5.8.3 Human activities

Under the 1991 Water Resources Act, the Northumbria & Yorkshire and Anglian Regions of the National Rivers Authority (NRA) have a responsibility to regulate, protect and monitor salmon, sea trout and eel fisheries from rivers to coastal waters out to the 6 nautical mile limit. The two Sea Fisheries Committees of the region have powers to support the conservation of salmonid fisheries while exercising their responsibilities towards the regulation of sea fisheries (see section 9.1). The NRA uses a variety of techniques, such as netting, electric fishing and monitoring of angling catches, to assess fish stocks of salmon and sea trout. They are currently working to produce a 'Fisheries Classification Scheme', under which fisheries will be allocated to a quality class on the basis of fish and river habitat data. The NRA construct fish passes around natural barriers, or make them passable by fish in other ways. The NRA also undertakes physical habitat improvement by, for example, creating pools and adding spawning gravels, riffles and trees for cover.

The effects of exploitation, especially by different catch methods (rod and line or nets), is an issue for salmon and sea trout stocks (MAFF/SO 1991). The net fisheries along the north Norfolk and Yorkshire coasts are far more important than the very small declared catch from the Yorkshire Ouse (see Table 9.1.6). Maitland & Campbell (1992) describe the possible effects of a variety of factors on freshwater fish. Issues mentioned that are of relevance in the region include the possible effects on the populations of diadromous fish of industrial and domestic pollution in the Yorkshire Ouse and the Humber Estuary. The movement of salmonids into the Humber tributaries is restricted only by adverse water quality conditions and artificial barriers. Factors such as over-fishing, pollution and development are thought to have seriously reduced eel stocks in the region. For example eel in the Great Ouse are believed to be in decline, perhaps due to a change in the availability of food in the estuary.

5.8.4 Information sources used

The NRA publishes catch statistics for the Yorkshire Ouse, presented in section 9.1. Tributaries and minor rivers with a shared estuary are included by the NRA under the main river, and it is therefore highly likely that there are diadromous fish present in other smaller rivers in the region.

European Council Regulation No. 3362/94 fixes, for 1995, details of the catch quotas for fish species for all European countries, i.e. the Total Allowable Catches (TACs) and certain conditions under which the species may be fished. European Council Regulations are published (where this is obligatory) in Luxembourg in the Official Journal of the European Communities. EC Regulation No. 3362/94 is updated annually (European Council 1994).

5.8.5 Acknowledgements

Thanks are due to Stephen Bailey (NRA Northumbria and Yorkshire Region) for his comments on the draft of this section.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Regional scientific information and advice	*Regional Fisheries Manager, Fisheries Department, NRA Anglian Region, Peterborough, tel: 01733 371811
Regional scientific information and advice	*Regional Fisheries Manager, NRA Northumbria and Yorkshire Regional Office, Leeds, tel: 0113 244 0191
Scientific advice and policy; Fisheries Classification Scheme	*Head of Department, NRA Fisheries Department, Bristol, tel: 01454 624400
General enquiries	*Public Relations Officer, National Rivers Authority - Public Relations Department, Bristol, tel: 01454 624400
Research programme into freshwater habitats and species	Director, Institute of Freshwater Ecology - Head Office, Windermere Laboratory, Far Sawrey, Ambleside, Cumbria LA21 0LP, tel: 015394 42468
Conservation of wild salmon; salmonid research	Director, The Atlantic Salmon Trust, Moulin, Pitlochry PH16 5JQ, tel: 01796 473439

* Starred contact addresses are given in full in the Appendix.

5.9 Fish: other species

Dr G.W. Potts & S.E. Swaby

5.9.1 Introduction

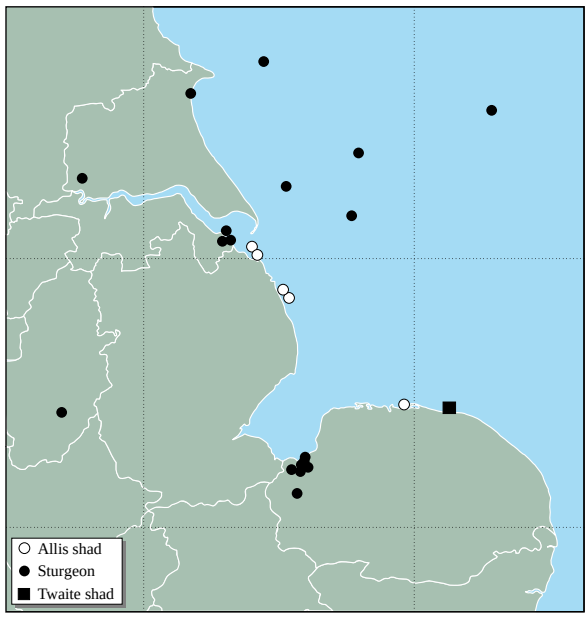
This description of the fish fauna of this region is based mainly on the fish species lists for the Humber Estuary and Flamborough Head, which totals 48 species (out of a national total of 336), consisting of one lamprey (Agnatha), four sharks & rays (elasmobranchs) and 43 bony fishes (teleosts) (Potts & Swaby 1993b; Wood 1988). However, some groups, such as skate, mullet and gobies, have not been identified to species level, so this list must be considered incomplete. The fish list for The Wash gives 22 species (Potts & Swaby 1993b). This region has published records of five of the seven British marine and estuarine species protected under national, European and international legislation. There are no confirmed records of the sea lamprey *Petromyzon marinus* or common goby *Pomatoschistus microps* (but see footnote to Table 5.9.1). The sand goby *Pomatoschistus minutus* is present (but probably under-recorded), whilst there are only occasional records of allis and twaite shads (*Alosa alosa* and *Alosa fallax*), the lampern *Lampetra fluviatilis* and the sturgeon *Acipenser sturio*. The sea lamprey and the latter four species are considered threatened in UK and European waters (Potts & Swaby 1993a).

5.9.2 Important locations and species

A relatively small number of species are recorded in this region, but this is mostly owing to under-reporting of non-exploited species and members of groups not being identified separately. The area is characterised by two large estuaries, the Humber Estuary and the Wash, and long stretches of exposed shoreline, which are comparatively less well studied. The Wash is important as a nursery ground for exploited species of fish in the North Sea (see section 5.7), but its significance for unexploited species is unknown. Scheduled species records are few and far between. A few specimens of sturgeon were recorded off Flamborough Head in 1970; one was landed at Bridlington in 1970, three at Grimsby (in 1872, 1953 and 1986) and three from the Great Ouse (in 1924, 1968 and 1987). Shad records are also few in this area. The lampern has records from the Humber (Potts & Swaby 1993b). Map 5.9.1 shows the distribution of records of sturgeon, allis shad and twaite shad.

The associations of fish with habitats are given in Potts & Swaby (1993c). Major marine habitat types have been identified and divided into a series of 'ecotypes', including; estuarine, littoral, sublittoral, offshore habitats and specialist habitats (symbiotic and other relationships). These are further refined with reference to substrate types (mud, sand, gravel and particulate substrate, bedrock or boulders (reef) and water column, where appropriate). This classification provides a structure for identifying and classifying fish/habitat associations. However, many fish have complex life-styles and habitat requirements and may occupy several habitats during different phases of their life-cycles.

The *Atlas of North Sea fishes* (Knijn *et al.* 1993) gives details of the distribution of fish in this region between 1985-1987. However, sampling did not occur in inshore and coastal areas, so those species not routinely caught by otter trawls are likely to have been missed. Fish recorded on the



Map 5.9.1 Distribution records on the British Marine Fishes Database of sturgeon, allis shad and twaite shad. After Potts & Swaby (1993b).

Table 5.9.1 Scheduled species and protected status (after Potts & Swaby 1993b)

Species	*Wildlife and Countryside Act (Schedule)*	*EC Directive (Annex)*	*Bern Convention (Appendix)*	*CITES (Appendix)*
Lampern		IIa, Va	III	
Sea lamprey		IIa	III	
Sturgeon	5	IIa, Va	III	I
Allis shad	5	IIa, Va	III	
Twaite shad		IIa, Va	III	
Common goby*			III	
Sand goby*			III	

*The sand and common gobies are both very abundant in UK.

shores of Flamborough Head include the sea scorpions *Myoxocephalus scorpius* and *Taurulus bubalis*, Yarrell's blenny *Chirolophis ascanii* and the two-spotted and leopard-spotted gobies *Gobiusculus flavescens* and *Thorogobius ephippiatus*. In the Humber Estuary, tidal scour and salinity are believed to be major limiting factors governing the distribution of many fish (Rees 1982). Nonetheless, the estuary is well studied by the NRA and MAFF who carry out regular beam trawl surveys (Potts & Swaby 1993b). While smelt *Osmerus eperlanus* fishing was once a seasonal pursuit, fishing on a commercial scale has now ceased (Rees 1982). They are also known to be present in the freshwater tributaries of the estuary (Gould *et al.* 1987). Exploited fish species are well represented by fishery and angling catches, but other species of note from the Humber Estuary include the sea snail *Liparis liparis,* which occurs in the middle reaches of the estuary where it adheres to stones, and the tope *Galeorhinus galeus,* which is mostly caught at the seaward end at Spurn Point (Rees 1982).

The fish list for The Wash gives 22 species, including mackerel and tope at the seaward end. The Great Ouse Estuary is an important area for spawning sole and supports several migratory fish species. A local smelt fishery was once operated on the Great Ouse, but now smelt are not exploited, although they have been caught in trawls in considerable numbers.

The Norfolk coast provides little shelter, is turbid, and has large shallow coastal areas and a wide temperature range offshore. Although some areas, such as Blakeney Harbour, are considered to have a rich flora and fauna, only pogge *Agonus cataphractus*, pipefish *Syngnathus acus*, flounder *Platichthys flesus* and whitebait *Clupea* spp. are recorded from here. Amongst rocks and stones at West Runton, five-bearded rockling *Ciliata mustela*, sea scorpion *Taurulus bubalis* and the butterfish *Pholis gunnellus* have been recorded. Offshore, between Wells Bar and Blakeney Bar, pogge, lesser weever *Echiichthys vipera*, plaice and sand eels Ammodytidae are present. The north Norfolk coast is known for strandings of an unusual fish, the Ray's bream *Brama brama*. Its occurrence is attributed to its movement into the North Sea and subsequent death when temperatures decrease. The dead fishes are then deposited on Norfolk coasts by the water movements in the North Sea.

5.9.3 Human activities

Human activities affecting estuaries and adjacent coasts are summarised in Davidson *et al.* (1991); these activities affect the abundance and distribution of fish. Nationally, estuaries are used by up to 180 fish species for migration, spawning, feeding and as nursery grounds (Potts & Swaby 1993b). Urban and industrial development and agricultural pollution have been shown to have a detrimental effect on the estuarine environment, in particular through heavy metals and pesticides in the water (Jones 1979; Gould *et al.* 1987), and dams, weirs and barrages can impede the passage of migratory fish. While salmon 'passes' allow some selected species to migrate up or down rivers and estuaries, they provide obstacles to the majority of fish, which are unable to reach spawning and feeding grounds. Urbanisation and the disposal of untreated sewage in estuaries results in a reduction in dissolved oxygen to which fish are particularly sensitive. The result is that fish leave the area and do not return until treatment plants reduce the amount of sewage and oxygen levels increase (Potts & Swaby 1993b). The possible effects of fisheries on species is discussed in section 5.7 and 9.1. Sea angling occurs in many places throughout the region (Orton 1994) (see section 9.1.2).

5.9.4 Information sources used

The fish of the Humberside, Lincolnshore and Norfolk coast have been studied on an area or site-by-site basis. Some areas are well studied, for example the Humber Estuary, but fish in other areas are only studied incidentally and generally only a few fish species are mentioned. Surveys in this region have been carried out by organisations such as the National Rivers Authority (NRA) and MAFF.

The review of estuarine fish in England (Potts & Swaby 1993b), carried out at the request of English Nature, is included in the British Marine Fishes Database and covers UK fishes and individual records for this area. Information is being gathered from a variety of sources, including the NRA, the Eastern Sea Fisheries Joint Committee, anglers and fishermen. The data include published literature, unpublished reports and personal communications from fish biologists.

5.9.5 Further sources of information

A network of persons with professional and personal interests in fish around the UK is being established and provides the basis of the recording scheme which reports to the British Marine Fishes Database, where the information is stored, compiled and analysed. Queries on marine and coastal fish should be directed to the British Marine Fishes Database in Plymouth·

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Williams, R.B. 1977. A note on Ray's bream in Norfolk. *Transactions of the Norfolk and Norwich Naturalists' Society, 24:* 81-82.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
British Marine Fishes Database	Dr G.W. Potts and S.E. Swaby, Marine Biological Association UK, Citadel Hill, Plymouth PL1 2PB, tel: 01752 222772
Marine conservation issues and fisheries	*Marine Fisheries Officer, English Nature HQ, Peterborough, tel: 01733 340345
Conservation	*Marine ecologist, EN HQ, Peterborough, tel: 01733 340345
Fishes of the Humber	Department of Applied Biology, University of Hull, Hull HU6 7RX, tel: 01482 465503
Fisheries	*Director, MAFF Directorate of Fisheries Research, Lowestoft, tel: 01502 562244

* Starred contact addresses are given in full in the Appendix.

5.10 Seabirds

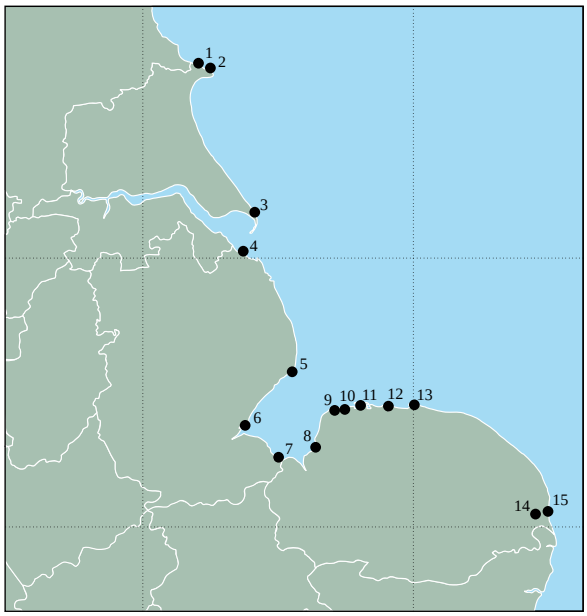
M.L. Tasker

5.10.1 Introduction

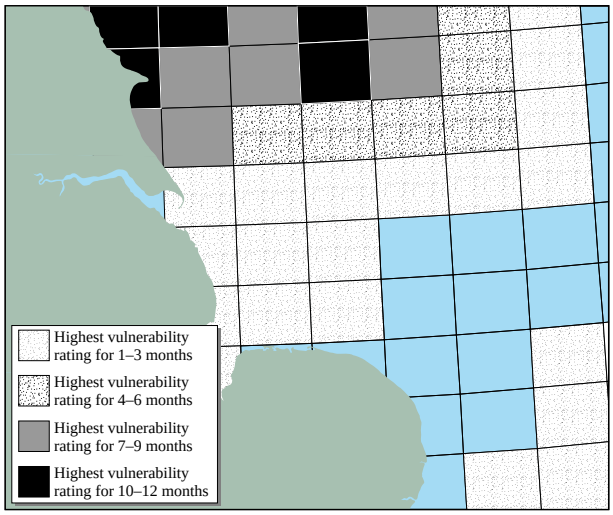
This section deals with seabirds both at their colonies on land and while at sea. It covers not only those species usually regarded as seabirds (see Table 5.10.1), but also divers, grebes and seaduck: in other words, those species reliant for an important part of their life on the marine environment. Scientific names of all species are given in the tables.

This region is important for seabirds in both the national and the international context. The species for which the region is important divide broadly into those feeding offshore (mainly cliff-breeding species) and those feeding in estuaries or other shallow inshore waters (terns, along with seaduck and divers). Total numbers of kittiwakes, Sandwich terns, little terns, guillemots and razorbills breeding in the region all exceed 1% of their European populations (Table 5.10.1) and the region is particularly important for breeding kittiwakes and Sandwich and little terns. In addition, breeding numbers of black-headed gulls and common terns exceed nationally important levels. There are 15 breeding colonies in the region that each hold more than 1% of the GB population of at least one seabird species (Map 5.10.1, Table 5.10.2).

Areas at sea are of great importance to seabirds. The waters around Flamborough Head (to a distance of 100-150 km offshore) hold vulnerable concentrations of seabirds during most of the year (Map 5.10.2). The numbers of several species (especially kittiwakes and guillemots) using this area are certainly of international importance. Numbers of red-throated divers, cormorants, common and velvet scoters, red-breasted mergansers and, probably, scaup wintering in the region all exceed nationally important levels (Table 5.10.3).



Map 5.10.1 Colonies holding at least 1% of the GB population of any seabird species. Numbers are those listed in Table 5.10.3. Source: JNCC Seabird Colony Register.



Map 5.10.2 Relative importance of region and adjacent seas for seabirds. The grid is of 15'N x 30'W rectangles; see text for explanation of vulnerability ratings. Source: JNCC Seabirds at Sea Team.

5.10.2 Important locations and species

Most breeding seabirds require habitat that is free from predatory mammals, so nearly all colonies are on offshore islands, cliffs or remote parts of saltmarshes. The large gulls appear to be able to tolerate more disturbance by mammals than the smaller seabird species. Four colonies, representing both cliff-breeding species and terns, hold numbers of seabirds at or above 1% of the total population of the species in the European Union (Table 5.10.2; Map 5.10.1). The massive kittiwake colony on the Bempton Cliffs, Flamborough Head, is of world stature, and is accompanied by internationally important populations of guillemots and razorbills. South of Flamborough, the lack of suitable cliffs means that few seabirds other than terns or gulls breed, but the latter groups are widespread and occur in nationally important numbers at a further eleven colonies (mainly on beaches, marshes etc.). Blakeney Point is of international importance for Sandwich and little terns, and in recent years the little tern colony at Great Yarmouth has grown to this level also.

At sea, seabird food sources range from zooplankton to small fish and waste from fishing fleets. Habitats that concentrate any of these foods are preferred. Zooplankton can be concentrated in zones where water masses meet, or where tides converge around islands or over some seabed features. Research in this area to determine feeding areas or general ranges has largely been confined to species breeding at Flamborough Head, where the greatest concentrations of birds at sea in this region occur (Map 5.10.2). The most important species breeding on this headland (kittiwake and

Table 5.10.1 Overall importance of seabirds breeding in the region

Species	*Total*	*% GB*	*% Europe*
Fulmar *Fulmarus glacialis*	1,203	<1.0	<1.0
Gannet *Morus bassanus*	1,035	<1.0	<1.0
Shag *Phalacrocorax aristotelis*	15	<1.0	<1.0
Black-headed gull *Larus ridibundus*	7,112	4.2	<1.0
Common gull *Larus canus*	3	<1.0	<1.0
Lesser black-backed gull *Larus fuscus*	56	<1.0	<1.0
Herring gull *Larus argentatus*	1,194	<1.0	<1.0
Kittiwake *Rissa tridactyla*	83,694	17.0	4.8
Sandwich tern *Sterna sandvicensis*	3,853	27.4	7.0
Common tern *Sterna hirundo*	778	6.1	<1.0
Arctic tern *Sterna paradisaea*	28	<1.0	<1.0
Little tern *Sterna albifrons*	582	24.2	3.2
Guillemot *Uria aalge*	32,288	3.1	1.1
Razorbill *Alca torda*	7,662	5.2	1.2
Puffin *Fratercula arctica*	6,946	<1.0	<1.0

Source: Figures for Britain from Walsh *et al*. (1994), and for Europe from Lloyd *et al*. (1991). Note: Counts are of pairs, except for guillemots, razorbills and puffins, which are counted individually. Figures are for the most recent available good-quality count, except for terns (whose numbers may fluctuate markedly from year to year, reflecting inter-colony movements), where the highest count from the period 1989-93 is used.

guillemot) may feed well offshore, particularly along the Flamborough Front (see section 4.3.2 and Map 4.3.1), where large numbers occur throughout the year, with high densities of these species (and of herring gulls in winter) extending well offshore. High densities of razorbills also occur around Flamborough in some months, mainly in near-shore waters. From late summer through to winter, substantial numbers of guillemots also occupy the more southern waters of the region.

The waters of The Wash and along the north and east coasts of Norfolk are important for feeding terns in summer, and for red-throated divers, cormorants and common and velvet scoters in winter (Table 5.10.3). In general, scoters and divers tend to be found in areas with less than about 20 m water depth.

5.10.3 Human activities

Seabirds can be particularly affected by marine oil pollution. Spills near the main cliff colonies during the breeding season would have a direct effect on breeding seabirds. Elsewhere in the region, an inshore spill could potentially have an impact on food availability to the large numbers of breeding terns that feed close to shore. Spills can also occur from non-tanker shipping movements. The major shipping route into the Humber passes through the region.
Seabird vulnerability is calculated from the abundance of birds in the rectangles shown on the map and a factor derived from the amount of time spent on the water, the overall population size and the rate at which the species recruits new individuals to the population (for discussion of vulnerability see Carter *et al*. (1993) and Webb *et al*. (in prep.)).

Table 5.10.2 Recent counts of seabird colonies in the region holding more than 1% of the EU or 1% of the Great Britain total for particular species

Site no.	*Colony*	*Grid ref.*	*Species*	*Year*	*Count*	*>1% EU/GB*
1	Bempton Cliffs	TA210735	Kittiwake	1987	75,000	EU
			Guillemot	1987	29,300	EU
			Razorbill	1987	7,350	EU
			Puffin	1987	6,050	GB
2	North Cliff, Flamborough	TA243720	Kittiwake	1987	8,368	EU
3	Easington Lagoons	TA410180	Little tern	1993	62	GB
4	Tetney	TA370036	Little tern	1989	85	GB
5	Gibraltar Point	TF561575	Little tern	1991	50	GB
6	Frampton Marsh	TF380384	Black-headed gull	1990	1,858	GB
7	Terrington outer trial bank	TF512295	Common tern	1990	150	GB
8	Snettisham	TF643300	Common tern	1990	130	GB
9	Holme	TF712450	Little tern	1991	32	GB
10	Titchwell - Thornham	TF750450	Little tern	1989	27	GB
11	Scolt Head	TF805465	Common tern	1989	159	GB
			Little tern	1989	63	GB
12	Holkham	TF911468	Black-headed gull	1992	2,314	GB
			Common tern	1991	154	GB
			Little tern	1993	89	GB
13	Blakeney Point	TG005468	Sandwich tern	1992	4,000	EU
			Common tern	1992	250	GB
			Little tern	1993	160	EU
14	Breydon Water	TG480060	Common tern	1993	143	GB
15	Great Yarmouth	TG532070	Little tern	1991	277	EU

Source: JNCC/Seabird Group Seabird Colony Register. Key: Site number refers to Map 5.10.1. Note: Counts are of pairs, except for guillemots, razorbills and puffins, which are counted individually. Count >1% GB total = nationally important population; count >1% EU total = internationally important. Figures are for the most recent available good-quality count, except for terns (whose numbers may fluctuate markedly from year to year, reflecting inter-colony movements), where the highest count from the period 1989-93 is used.

Table 5.10.3 Overall importance of offshore wintering waterfowl

Species	*Peak numbers*	*1% GB*	*1% NW Europe*
Humber Estuary			
Scaup *Aythya marila*	46	110	3,100
Saltfleetby - Theddlethorpe			
Common scoter *Melanitta nigra*	300	230	8,000
The Wash			
Cormorant *Phalacrocorax carbo*	239	130	1,200
Scaup *Aythya marila*	46	110	3,100
Common scoter *Melanitta nigra*	388	230	8,000
Red-breasted merganser *Mergus serrator*	101	100	1,000
North Norfolk coast			
Red-throated diver *Gavia stellata*	59	50	750
Common scoter *Melanitta nigra*	907	230	8,000
Velvet scoter *Melanitta fusca*	35	30	2,500

Source: Peak numbers from Kirby *et al*. (1993), Owen *et al*. (1986) and Birds database; 1% GB from Waters & Cranswick (1993); 1% NW Europe from Rose & Scott (1994).

Breeding terns are highly vulnerable to localised disturbance or predation, which may cause colony desertion or failure to rear chicks, and in this region large numbers of terns breed at potentially vulnerable sites, including beaches. Many tern colonies in this region are wardened or otherwise protected, but predation (e.g. by foxes) has nevertheless been a serious problem at some important colonies. Changes to habitats to the landward of tern colonies may increase numbers of foxes in an area, possibly leading to desertion.

5.10.4 Information sources used

All seabird colonies in the region were counted between 1984 and 1987. These counts, and all those made since 1979, are held on the JNCC/Seabird Group Seabird Colony Register. Annual assessment of numbers and breeding success is undertaken at most tern colonies in the region, while numbers and breeding success of several cliff-breeding species are monitored at Bempton. Surveys of birds at sea off the region have been carried out by JNCC's Seabirds at Sea Team. Survey effort from ships by this team has been greatest off Yorkshire/Humberside, and has been comparatively poor off Norfolk and Lincolnshire. Waters at 2 km and 5 km from the shore have been surveyed from the air by SAST on a bi-monthly basis over one year. Coverage from the land of most nearshore waters in the region has been generally poor.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Seabird colonies	*Co-ordinator, Seabird Colony Register, JNCC, Aberdeen, tel: 01224 642863
Seabirds at sea	*Head, Seabirds at Sea Team, JNCC, Aberdeen, tel: 01224 642863
Birds database	*Head, Vertebrate Ecology and Conservation Branch, JNCC, Peterborough, tel: 01733 62626
Nearshore waterfowl	*Wildfowl and Wetlands Trust, Slimbridge, tel: 01453 890333

* Starred contact addresses are given in full in the Appendix.

5.11 Other breeding birds

D.M. Craddock & D.A. Stroud

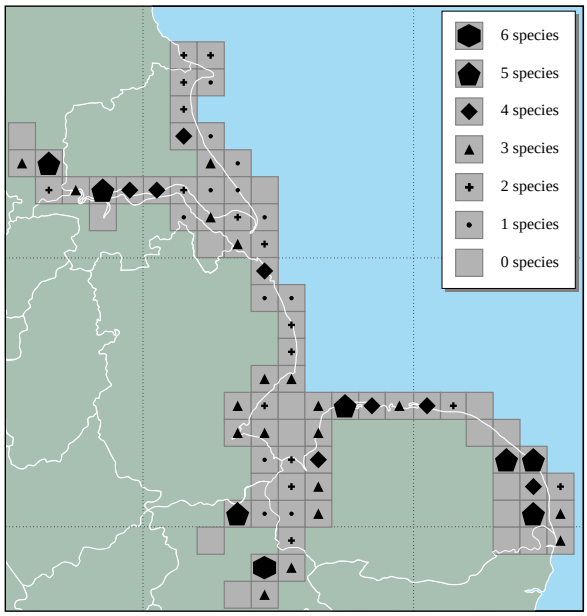
5.11.1 Introduction

This section outlines the importance of the region to breeding birds other than seabirds. Because of their distinctive ecology and mixed-species breeding colonies, seabirds are described separately in section 5.10.

Nearly all of the coast is either estuarine or soft coast, habitats that support very high densities of breeding waterfowl, especially waders, for which the saltmarshes and wet coastal grasslands of the region are of significance in both an English and a national context (Smith 1983; Davidson 1991; Davidson *et al.* 1991). The region is noted for widespread and diverse breeding waterfowl assemblages (Maps 5.11.1 and 5.11.2). Its estuarine areas are particularly important for breeding waders (Map 5.11.3). The diversity of estuarine assemblages of breeding waders is higher in the region than anywhere else in the UK (Davidson *et al.* 1991). The saltmarshes and associated coastal grazing marshes of the Humber estuary, The Wash and the north Norfolk coast, and the seasonally flooding grasslands of the (Great) Ouse and Nene Washes and the Norfolk Broads (e.g. around Breydon Water), hold especially high densities and exceptionally diverse breeding waterfowl assemblages.

Several wader species have major strongholds in this area, which is nationally important for both the numbers and the densities present. The region's saltmarshes and grasslands hold nationally important populations of redshank *Tringa totanus*, oystercatcher *Haematopus ostralegus*, lapwing *Vanellus vanellus* and snipe *Gallinago gallinago* as well as of wildfowl such as pintail *Anas acuta*, gadwall *Anas strepera*, mute swan *Cygnus olor* and others. Lapwing, redshank and snipe breeding densities are the highest in Britain.

Numbers of lowland breeding waders, especially those associated with wet grassland areas and saltmarshes, have been declining, not only nationally but also internationally (Hötker 1991), because of habitat loss or degradation, and sites in the region play an important role in maintaining their ranges. The importance of the region for these breeding birds is thus likely to increase.



Map 5.11.1 Number of confirmed breeding species characteristic of wet grassland (redshank, snipe, lapwing, teal and pintail) in coastal 10 km squares. Based on Gibbons, Reid & Chapman (1993).

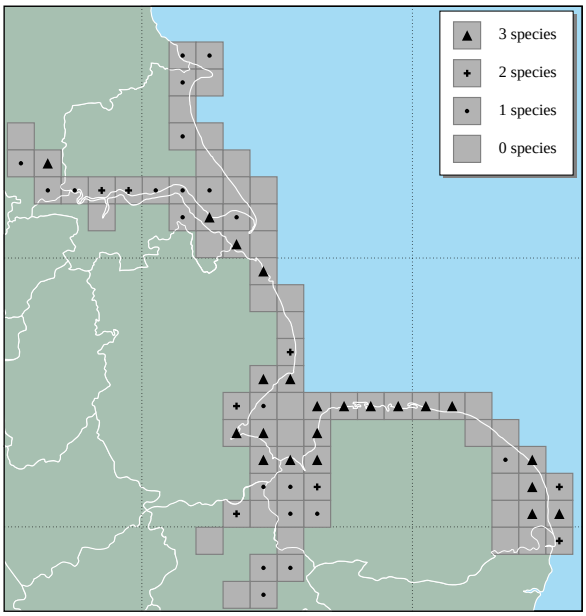
5.11.2 Important locations and species

Map 5.11.1 shows the incidence of confirmed breeding in coastal 10 km squares of selected species characteristic of wet grassland (teal, lapwing, redshank, mallard, snipe, pintail). A number of wader species breed in the wet grassland area around the Humber. The Wash and the north Norfolk coast have a particularly species-rich breeding wader assemblage in a national context (Map 5.11.1). The saltmarshes of The Wash and north Norfolk have high breeding densities of redshank (Table 5.11.1), whilst grassland areas have lower densities (although higher numbers). Cook *et al.* (in prep.) surveyed the breeding redshanks on 30% of The Wash saltmarshes in 1994, relating their results to grazing density, and extrapolated a total breeding redshank population of

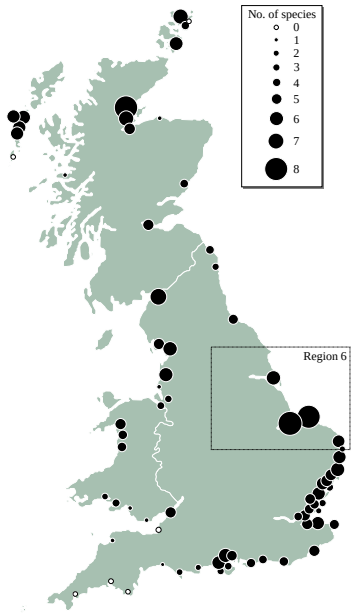
Table 5.11.1 Densities of breeding waders on a sample of saltmarshes surveyed in 1985*

Site	*Oystercatcher pairs/km²*	*Ringed plover pairs/km²*	*Redshank peak nests**/km²*	*Total wader pairs/km²*
Lincolnshire				
Kirton	13	1	115	129
Dawsmere	5		56	61
Gedney	10	6	79	95
Norfolk				
Wolferton	17		80	106
Thornham	14	3	29	46
Scolt Head	11		27	38
Stiffkey	5		50	55
Morston	38		56	94

Source: Allport, O'Brien & Cadbury (1986). Note: *Other saltmarshes in the region were not surveyed, so this is not a comprehensive listing. **For this table, redshank nest densities are treated as equivalent to pairs densities.



Map 5.11.2 Number of confirmed breeding species characteristic of shingle, sand dunes and other dry grasslands (ringed plover, oystercatcher and shelduck) in coastal 10 km squares. Based on Gibbons, Reid & Chapman (1993).



Map 5.11.3 Numbers of different breeding waders on estuaries in Britain (source: Davidson *et al.* 1991). Note that numbers relate only to estuarine sites and that the waders also breed elsewhere along the coast.

1,925 pairs for The Wash as a whole, 6.4% of the estimated British population. In contrast to redshanks, numbers and breeding densities of lapwing in these areas are greater on coastal grassland than on saltmarshes.

The (Great) Ouse and Nene Washes are of particular note for supporting a diverse assemblage of breeding waterfowl associated with seasonally flooding wet grassland. This includes breeding migratory waders of lowland wet grassland: oystercatcher, redshank and lapwing (the highest breeding densities in Britain), snipe, ruff *Philomachus pugnax* and black-tailed godwit *Limosa limosa* (for which they are a national stronghold), and a diverse assemblage of breeding wildfowl including mute swan *Cygnus olor,* shelduck *Tadorna tadorna,* gadwall *Anas strepera,* teal *A. crecca,* mallard *A. platyrhynchos,* pintail *A. acuta,* garganey *A. querquedula,* shoveler *A. clypeata,* pochard *Aythya ferina,* tufted duck *Aythya fuligula,* moorhen *Gallinula chloropus* and coot *Fulica atra.* The numbers and densities of snipe on the wet grasslands of the (Great) Ouse and Nene Washes are amongst the highest in Britain (Davidson *et al.* 1991). Smith (1983) found 37% of the lowland snipe population of England and Wales on the Nene and (Great) Ouse Washes (737 drumming males). Breeding gadwall, mallard, garganey, shoveler and black-tailed godwit are all present in nationally important numbers. A wide range of raptors, including marsh harrier *Circus aeruginosus,* sparrowhawk *Accipiter nisus,* short-eared owl *Asio flammeus,* long-eared owl *A. otus,* and barn owl *Tyto alba,* occur through the year on the Nene and (Great) Ouse Washes, as well as in other coastal areas.

Map 5.11.2 show the incidence of confirmed breeding in coastal 10 km squares of selected waterfowl species characteristic of shingle, sand dunes and other dry grassland (ringed plover, oystercatcher, shelduck). Breeding ringed plovers *Charadrius hiaticula* nest in sandier areas along the coast (Davidson *et al.* 1991; Prater 1989; Table 5.11.2, Map 5.11.4), especially on the Humber, Lincolnshire and north Norfolk coasts, which are major breeding sites in a national context for both this species and oystercatcher.

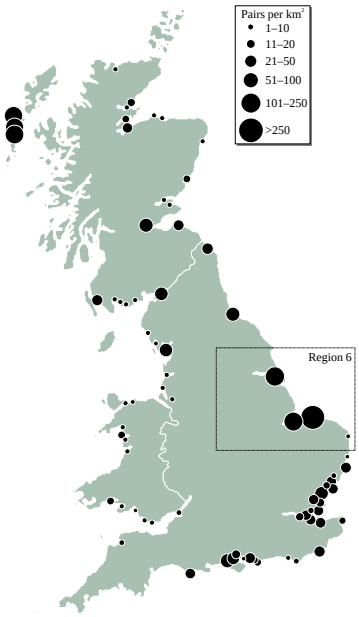
Table 5.11.2 Numbers of pairs of territorial (presumed breeding) ringed plovers in 1984

	Pairs (coastal) counted in survey	*% GB total counted in survey*
Humberside	43	0.6
Lincolnshire	185	2.6
Norfolk	523	7.3
Region 6	**751**	**10.4**
England	1,984	27.5
GB total	***7,207***	

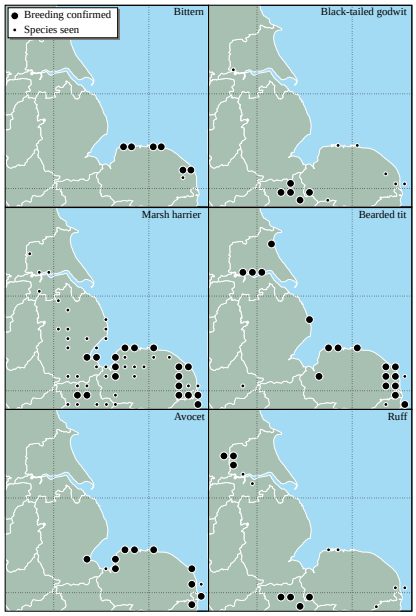
Source: Prater (1989). Note: survey coverage varied between counties, although it was generally good in the region overall.

The region is the centre of UK breeding distribution for several rare wetland species (Map 5.11.5). For example, many of the remaining British breeding bitterns *Botaurus stellaris*, which have undergone a massive and long-term decline (Everett 1989), are within the North Norfolk Coast Ramsar site and Special Protection Area (SPA) (Pritchard *et al.* 1992). Other species, including black-tailed godwit, formerly bred widely in wet grassland in East Anglia, but are now restricted to the (Great) Ouse and Nene Washes. The Norfolk coast also supports many pairs of breeding marsh harriers *Circus aeruginosus*, as well as bearded tits *Panurus biarmicus* and most of Britain's breeding Montagu's harriers *Circus pygargus*. Coastal lagoon systems are of particular importance for the increasing UK population of avocets *Recurvirostra avosetta,* which have the centre of their national breeding distribution in East Anglia. In 1988 avocets bred at 18 localities between the Wash and north Kent, and there are major colonies at Titchwell (Sills 1988) and Cley on the north Norfolk coast.

The Humber, Wash, north Norfolk marshes and Breydon Water are all important breeding areas for shelduck and have high numbers in a national context (Table 5.11.3).



Map 5.11.4 Numbers of breeding ringed plover in Britain. Source: Davidson *et al.* (1991) from data in Prater (1989). Note that numbers shown relate only to estuarine sites and that the species also breeds elsewhere along the coast.



Map 5.11.5 Distribution by 10 km square of rare breeding birds. Based on Gibbons, Reid & Chapman (1993).

Table 5.11.3 Sites holding at least 45 shelduck in 1992

Site name	*Total birds*	*Males*	*Pairs*	*Non-breeding birds*
Humber Estuary	2,495	49	369	945
The Wash	2,467	30	131	2,175
North Norfolk marshes	534	12	75	142
Breydon Water	531	-	-	-

Source: WWT (in press). Key: - = not available.

Many parts of the important breeding bird habitat in the region lie within designated sites (for example National Nature Reserves (NNRs), Sites of Special Scientific Interest (SSSIs), SPAs and Ramsar sites), although the sites were not always chosen principally for their breeding bird interest. Almost all the coastal NNRs - Saltfleetby/Theddlethorpe Dunes, Gibraltar Point, Holme Dunes, Scolt Head Island, Holkham, Blakeney and Winterton Dunes - include sand dune or shingle, important habitat for breeding birds. The Wash NNR is the largest single extent of estuarine habitat in the country; and Bure Marshes NNR contains freshwater marshes and reedbeds on which a number of rare species depend. In addition there are a number of other coastal SSSIs within the region containing cliff, sand dune and estuarine habitats. Internationally important sites include several Ramsar sites and Special Protection Areas for birds. The RSPB also has reserves along some parts of the coast, at Blacktoft Sands (Humber), Tetney Marshes, Frampton Marshes, Snettisham, Titchwell Marsh, the Nene Washes, the Great Ouse Washes and Berney Marshes & Breydon Water. Their management specifically for their bird populations provides ideal breeding habitat for a number of threatened species, including bittern (Everett 1989) and marsh harrier (Day 1988).

5.11.3 Human activities

In this region any incremental land claim along the soft coasts of estuaries and sand dune systems has the potential to affect breeding waterfowl populations through loss of nesting and feeding habitat, although at important sites SSSI designation can limit such activity. Human disturbance during the breeding season may have significant effects on breeding success (Pienkowski 1992), although for the birds discussed in this section there are few good assessments of the scale of the problem for this region. The appropriate agricultural and other management (e.g. by winter flooding) of wet grassland in the region (see e.g. Coleshaw 1995; Harold 1995; Scholey 1995; Thomas *et al.* 1995) is of crucial importance for their wader populations (see also papers in Hötker 1991). Likewise, different grazing regimes on saltmarshes can significantly alter the density and nesting success of breeding waders through effects on vegetation composition and structure (Cadbury, Green & Allport 1987).

Active land management for conservation in many coastal areas in the region has increased populations of breeding waterfowl. At Holkham NNR the numbers of breeding waders have increased markedly as a result of careful management of the dune habitat. The management of coastal reedbeds is of key importance for the continued survival of their characteristic bird assemblage, which, in this region, includes bittern, marsh harrier and bearded tit, whose needs are outlined by Everett (1989) and Sills (1988). Reed-bed management for bitterns on RSPB reserves has attempted to stabilise numbers (Everett 1989), although overall the population in the region and nationally is at critically low levels (just 15-16 calling males in Britain in 1994, of which 5-6 were in north Norfolk and the Broads). Damage from saline intrusion is also a key issue affecting coastal reedbeds, especially in north Norfolk, for example at Cley and Titchwell. In this region bitterns have also been indirectly affected by nutrient enrichment, primarily by

phosphates derived from sewage treatment works (which inhibit normal reed development (John Sharpe pers. comm.)) rather than agricultural pollution.

5.11.4 Information sources used

The most recent and comprehensive overview of the status of breeding birds throughout Britain and Ireland is provided by Gibbons, Reid & Chapman (1993). This summarises the results of a national breeding bird census undertaken between 1988 and 1991 and compares distributions at the 10 x 10 km square level with those recorded in the first breeding bird atlas of 1968-1972 (Sharrock 1976). Whilst these data are one of the best sources for comparisons at county, regional or national scales, care should be taken with their use to assess individual sites or 10 km squares. This is because the tetrad coverage of each 10 km square was not always the same, and since the atlas survey period (1988-1991) distributions of some breeding species may have changed. Between- and within-region comparisons of precise distributions and densities based on coastal 10 km squares should be undertaken with caution, as there may be greatly varying amounts of land within each square.

For a number of species, extensive survey work has also been undertaken by volunteers. Usually these surveys have been organised as part of wider British surveys (e.g. for ringed plover (Prater 1989) and shelduck (Delany pers. comm.)).

5.11.5 Acknowledgements

Thanks are due to David Cole and George Boobyer (JNCC), and Simon Delany and WWT (for the use of unpublished shelduck data). We would also like to thank Colin Macduff-Duncan (Esso), Tim Cleeves (RSPB), Peter Cranswick (WWT) and John Sharpe (RSPB) for their helpful comments.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Breeding atlas data and breeding wader data	*Development Unit, The British Trust for Ornithology, Thetford, tel: 01842 750050
Breeding bird surveys; coastal habitat management	*RSPB HQ, Sandy, tel: 01767 680551
Coastal breeding wildfowl data	*Wildfowl & Wetlands Trust, Slimbridge, tel: 01453 890333
Site designations	*English Nature HQ, Peterborough, tel: 01733 340345

* Starred contact addresses are given in full in the Appendix.

5.12 Migrant and wintering waterfowl

D.A. Stroud & D.M. Craddock

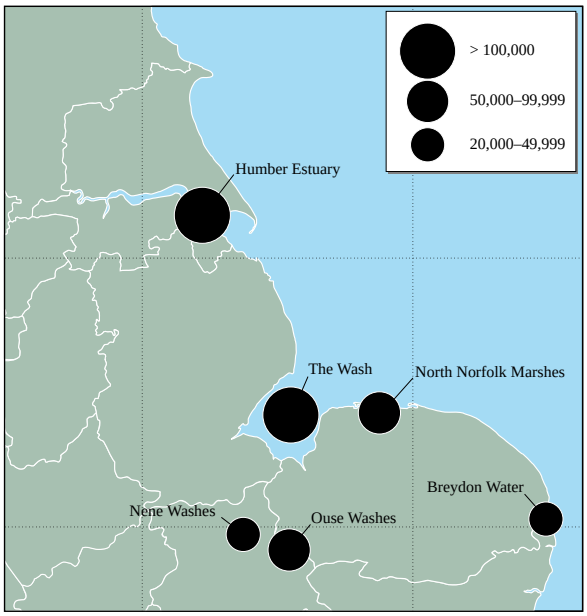
5.12.1 Introduction

This section describes the importance of the region for waterfowl, defined as waders and wildfowl (divers, grebes, ducks, geese and swans together with coot *Fulica atra*). The importance of offshore areas for wintering divers, grebes, seaducks and cormorant *Phalacrocorax carbo* is outlined in section 5.10. The Nene and (Great) Ouse Washes are included in the coverage, since although not lying on the coast, they are adjacent to tidal estuaries and have been considered to be linked with The Wash (Davidson *et al.* 1991). Similarly the tidal parts of the Norfolk Broads system are included.

A particularly large extent of this region's coast is estuarine in nature and the large size of many of these estuaries means that the region is of great importance for wintering waterfowl in UK and international contexts. Indeed, it is one of the most important coastal areas in the UK for non-breeding waterfowl. Twenty species occur in the region at levels of international importance on at least one estuary and a further twelve species occur at levels of national (i.e. Great Britain) importance. This region holds, in mid-winter, about 366,000 waterfowl - about one quarter of the English total. The Wash holds more waterfowl in winter than any other site in Britain. Regularly counted estuaries and adjacent marshes are shown on Map 5.12.1. For several non-breeding waterfowl species, sites within the region are the most important within the UK, and for several the region also holds a significant proportion of the total UK population, either in migration periods or in winter. The region can become more important in periods of severe cold weather further east in continental Europe. Under these conditions, there may be influxes of waterfowl, such as wigeon *Anas penelope* and teal *Anas crecca*, from other coastal regions or inland areas (Ridgill & Fox 1990). Locally, some sites also act as cold weather refuges where parts of the estuarine system freeze more slowly than other coastal and inland wetlands, and so can provide open-water feeding when other sites are unavailable (Owen, Atkinson-Willes & Salmon 1986).

Shelduck *Tadorna tadorna* is the most abundant duck in the region, and knot *Calidris canutus* and dunlin *C. alpina* are the most abundant wader species in the region (Figure 5.12.1). Table 5.12.1 gives the total January 1993 waterfowl count for this coastal region as a proportion of the coastal total for both England and Great Britain, although such comparisons can give only a rough approximation of relative regional importance, since the data (from Rose & Taylor 1993 and Waters & Cranswick 1993) are uncorrected for coverage: some areas are counted more thoroughly than others.

Although poorly monitored, the non-estuarine shoreline of the region has, in general, low densities of waders, with densities greater in the north of the region than in Norfolk (Moser & Summers 1987; Table 5.12.2).



Map 5.12.1. Distribution of main concentrations of wintering intertidal waterfowl. Size of circle proportional to 5-year mean of waterfowl numbers, from Waters & Cranswick (1993). Offshore sea-duck concentrations are not shown (see Kirby, Evans & Fox (1993) and section 5.10), nor are the distributions of those waterfowl, mainly waders, wintering on the non-estuarine coast (see Moser & Summers (1987)).

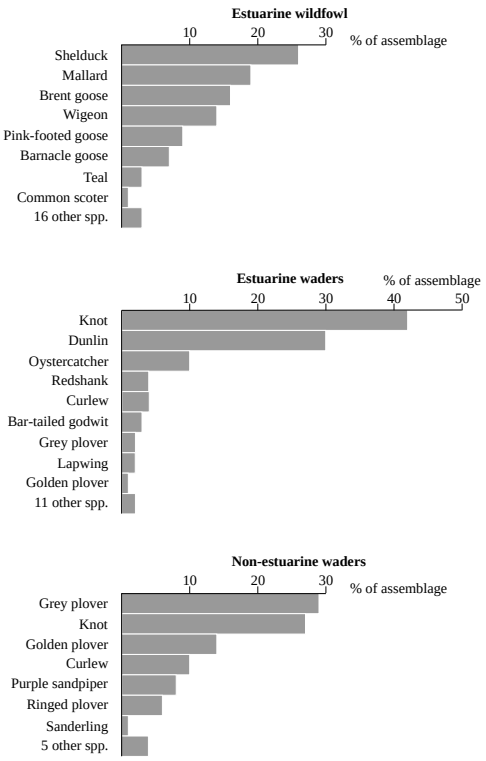


Fig 5.12.1 Relative species composition of non-breeding waterfowl assemblages on coastal areas of the region. Estuarine waterfowl data from Prater (1981), non-estuarine wader data from Moser & Summers (1987).

Table 5.12.1 Waterfowl counts in Region 6, England and Great Britain in January 1993

	Total waterfowl count in January 1993	*Number of sites counted*	*% of count in Region 6*
Coastal sites in Region 6	366,192	8	-
All counted English coastal sites	1,577,388	106	23.2
All counted British coastal sites	2,060,961	214	17.8

Source: Waters & Cranswick (1993) and Rose & Taylor (1993). Care should be taken in interpretation as count coverage varies from country to country and has not been corrected.

The coastline, and especially the estuaries of the region, is of major importance for migrant waterfowl in spring and autumn. The region lies on the principal migratory flyway of the east Atlantic, and many birds, moving to and from wintering areas on the African, Mediterranean and south-west European coasts to northern and arctic breeding grounds, pass through and stage here. The extent to which this is undertaken varies between species, but it emphasises the international responsibility for the conservation of these areas and their migrant waterfowl populations. The region is of considerable significance during spring and autumn migration periods for grey plover *Pluvialis squatarola* and dunlin, amongst others. Of particular note are the very significant proportions of some populations that occur in winter or on migration, e.g. the Canadian/Greenlandic population of knot *C. canutus islandica* (Davidson & Wilson 1992) and dark-bellied brent geese *Branta bernicla bernicla* (Salmon & Fox 1991).

5.12.2 Important locations and species

Wintering waterfowl species occurring on both estuarine and non-estuarine (Moser & Summers 1987) sites in the region are determined by habitat characteristics. Sites with extensive areas of saltmarsh or grazing marsh in close proximity to intertidal areas, such as The Wash and marshes of north Norfolk, typically have large populations of dark-bellied brent geese, Bewick's swans *Cygnus bewickii*, whooper swans *C. cygnus* and wigeon. Such areas are also attractive to lapwing *Vanellus vanellus*, curlew *Numenius arquata* and golden plover *Pluvialis apricaria*, as well as to many other wildfowl, as they provide a wide range of feeding opportunities. On estuaries, sheltered muddy substrates are especially attractive to dunlin, whilst sandier estuaries and embayments hold larger numbers of knot, oystercatcher *Haematopus ostralegus* and curlew. The determinants of wader feeding distribution have been intensively studied on The Wash by Goss-Custard *et al.* (1977) and by other Institute of Terrestrial Ecology (ITE) research cited in section 5.12.6. Ringing studies have shown that many species (e.g. dunlin and (on non-estuarine shores) grey plover) also demonstrate complex patterns of interchange between sites during the course of a winter, which means that individual sites cannot be considered in isolation (Davidson *et al.* 1991).

The Humber Estuary, The Wash, the north Norfolk coast and marshes, Nene and (Great) Ouse Washes and Breydon Water are individually and collectively of major international importance for their waterfowl populations. As well as their international importance for wintering populations of several species of waterfowl, all these sites qualify as of international importance by virtue of each holding of over 20,000 waterfowl (Table 5.12.3). The Wash is the site with the greatest number of wintering waterfowl in the UK, with an average of nearly 344,000 birds. It is also of particular note for holding populations of thirteen species at internationally important levels and ten at nationally important levels. It is one of the three sites in Britain with the largest populations of dark-bellied brent geese, shelduck, pintail *Anas acuta*, mallard *A. platyrhynchos*, oystercatcher, grey plover, lapwing, knot, dunlin, bar-tailed godwit *Limosa lapponica* and curlew. In recent years, mid-winter populations of knot on The Wash alone have accounted for up to 53% of the international population (WeBS data). The Wash and Humber are also important late summer moulting areas for waders and for shelduck (Prater 1981), whose numbers are especially notable in a national context (Prater 1981).

Large numbers of herbivorous wildfowl, such as mute swan *Cygnus olor*, whooper swan, Bewick's swan and wigeon, occur especially frequently on the (Great) Ouse and Nene Washes as well as on parts of the north Norfolk marshes and the grassland associated with Breydon Water. The Yare valley (Norfolk) is one of only two sites in the UK (the other being in Scotland) at which flocks of wintering bean geese *Anser fabalis* regularly occur (Allport 1989). There is an increasing population of pink-footed geese *Anser brachyrhynchus* that use farmland and grazing marshes in north Norfolk and which move during the winter to and from other regions (Fox *et al.* in press); formerly there were substantial numbers on the Humber (Pashby 1992). Other regularly occurring non-breeding waterfowl include cormorant, teal, golden plover, redshank *Tringa totanus* and black-tailed godwit *L. limosa*.

On non-estuarine shores, grey plover is the most common wader species, followed by knot, golden plover, curlew, purple sandpiper *Calidris maritima* and ringed

Table 5.12.2 Overall densities of wintering waders on non-estuarine coasts

	Number of wader species recorded	*Total number non-estuarine waders*	*Extent of non-cliff, non-estuarine coast in county (km)*	*Extent of coast surveyed (km)*	*Overall wader density (birds/km coast)*
Humberside	9	1,547	74.9	74.9	20.6
Lincolnshire	9	425	26.6	26.6	27.2
Norfolk	12	563	75.4	72.1	7.8

Source: Data from the Winter Shorebird Count - Moser & Summers (1987).

plover *Charadrius hiaticula* (Moser & Summers 1987; Figure 5.12.1). These species are different from those occurring in other non-estuarine coastal regions, reflecting the predominance of soft shoreline in this part of England (sandy beaches etc.), with little rocky coastline.

Many parts of the region's coast lie within designated sites (for example National Nature Reserves (NNRs), Sites of Special Scientific Interest (SSSIs), an Area of Special Protection (AoSP: the Humber Wildfowl Refuge), SPAs and Ramsar sites - Chapter 7). Many were selected wholly or partly for their migrant and wintering waterfowl interest. The Wash NNR is the largest single extent of estuarine habitats in the country. In addition there are a number of other coastal SSSIs within the region. Internationally important sites include several Ramsar sites and Special Protection Areas important for wintering waterfowl (Table 5.12.3). The RSPB also has several reserves along the coast and on wet grassland associated with the coast and tidal rivers, as do local Wildlife Trusts and the Wildfowl and Wetlands Trust.

5.12.3 Human activities

Wintering waterfowl are potentially affected, either directly or indirectly, by a wide range of human activities. The importance of saltmarsh and grazing marsh for wintering waterfowl can be greatly increased by appropriate management. Wildfowling occurs especially in estuaries, although it is generally well regulated (see also section 9.7). Pashby (1992) describes the establishment and operation of the Wildfowl Refuge on the Humber Estuary. The impacts and regulation of wildfowling on National Nature Reserves (NNRs) have been reviewed by Owen (1992). Permit systems generally operate, although on Scolt Head NNR shooting takes place under common rights. There is generally close liaison in the regulation of wildfowling between local shooting clubs, the British Association for Shooting and Conservation (BASC) and English Nature local staff. Owen (1992) made a number of recommendations for improving the operation of existing

Table 5.12.3 Wintering*** waterfowl numbers arranged in declining order of average waterfowl numbers for the period 1988/89 to 1992/93

Site	*International protected status*	*Five year mean nos. wintering*** waterfowl*	*1992/93 peak waterfowl numbers*	*1992/93 peak wildfowl numbers*	*1992/93 peak wader numbers*	*Species occurring at levels of national or international* importance*
Humber Estuary	SPA & Ramsar	**143,065	142,997	21,008	121,989	Dark-bellied brent goose*, shelduck*, golden plover*, grey plover*, lapwing*, knot*, dunlin*, bar-tailed godwit*, redshank*, wigeon, teal, pintail, pochard, oystercatcher, curlew, sanderling
Wash	SPA & Ramsar	**343,866	407,748	54,731	353,017	Pink-footed goose*, dark-bellied brent goose*, shelduck*, pintail*, oystercatcher*, grey plover*, lapwing*, knot*, dunlin*, bar-tailed godwit*, curlew*, redshank*, turnstone*, little grebe, cormorant, Bewick's swan, red-breasted merganser, common scoter, wigeon, sanderling, black-tailed godwit, golden plover
Nene Washes	SPA & Ramsar	[a]8,799	**25,278	12,903	12,375	Bewick's swan*, wigeon, gadwall, pintail, shoveler
Ouse Washes	SPA & Ramsar	** [a]52,654	72,465	57,404	15,061	Bewick's swan*, whooper swan*, wigeon*, gadwall*, teal*, pintail*, shoveler*, cormorant, mute swan, pochard, coot
North Norfolk marshes	SPA & Ramsar	**70,351	62,469	34,224	28,245	Pink-footed goose*, dark-bellied brent goose*, wigeon*, pintail*, knot*, bar-tailed godwit*, European white-fronted goose, shelduck, gadwall, teal, shoveler, common scoter, oystercatcher, avocet, grey plover, sanderling
Breydon Water	None	**21,428	30,731	7,037	23,694	Bewick's swan*, cormorant

Source: WeBS data from Waters & Cranswick (1993). International protected status follows Pritchard *et al.* (1992). Key: SPA = Special Protection Area, Ramsar = site classified as internationally important under the Ramsar Convention; * = species occurring at levels of international importance; ** = sites holding >20,000 waterfowl are of international importance by virtue of absolute numbers; *** winter season used by WeBS is November to March for waders and September to March for wildfowl. [a]for Nene Washes and Ouse Washes, five year mean total waterfowl values *do not* include wader counts, and thus significantly under-estimate the use of these sites by waterfowl. The 1992/93 total waterfowl count does include waders as well as wildfowl and is a better guide - see Waters & Cranswick (1993: p. 97) for further explanation. Note: wildfowl and wader figures given here include divers, grebes and cormorants (see also Table 5.10.2).

schemes to regulate shooting on NNRs.

Incremental land claim, including for barrage schemes, has the potential to affect waterfowl populations through loss of feeding habitat (Goss-Custard 1977; Goss-Custard & Yates 1992), although at important sites, SSSI designation allows limitation of such activity. Coastal windfarm developments in sensitive areas also have the potential to be highly disruptive to wintering waterfowl (as reviewed by Crockford 1992).

Bait digging and shellfish collection from intertidal sediments, as well as other recreational activities in the more heavily populated parts of the region, are potentially disruptive and may prevent waterfowl using feeding areas. Research is needed on the extent of disturbance caused by these activities and its significance for waterfowl populations, in order to ensure that coastal management planning can best minimise negative impacts. The significance of these activities varies not only from site to site (in relation to the intensity of the activity and the size/topography of the site) but also with the time of year (Davidson & Rothwell (1993) and papers therein). Disturbance may be a particular problem if it occurs in cold periods when wintering waterfowl need to feed almost continuously in order to survive. In the winter of 1992, for instance, an unusually high number of dead oystercatchers were found on The Wash, coinciding with periods of cold weather over Christmas; the birds were found to have died of starvation, although their prey were plentiful (Clarke 1993).

Other human activities to be noted include effluent discharges from industries on the Humber and The Wash (section 9.7), disposal of dredgings within The Wash (section 9.5) and military firings on The Wash. Oil pollution is well known as a serious potential threat to wintering waterfowl in areas where high densities of birds occur (section 9.6).

5.12.4 Information sources used

As with other areas of the UK, migrant and wintering waterfowl are well surveyed by the Wetland Bird Survey (WeBS - organised by the British Trust for Ornithology, the Wildfowl & Wetlands Trust, the Royal Society for the Protection of Birds and the JNCC). This volunteer-based survey collates monthly counts from coastal and inland wetlands through the UK. Coastal coverage is generally good for estuaries, although the open coast is not thoroughly surveyed on an annual basis (Waters & Cranswick 1993). The WeBS waterfowl count scheme publishes an extensive annual summary report, the most recent being Waters & Cranswick (1993), covering the winter season 1992/93. This report summarises species trends, based on counts at wetlands throughout the UK. It also tabulates counts of total waterfowl numbers at all counted estuaries. It is the primary source of information on wintering and migrant waterfowl in the UK. Copies are available from either of the WeBS National Organisers listed in section 5.12.6. The annual report can only summarise what are very detailed data, and in summary form such counts may be subject to misinterpretation for a number of reasons. Detailed count data for sites can be provided by WeBS, and inspection of these data is recommended for any planning-related activity. WeBS counts are generally undertaken at high tide, when waterfowl gather in high densities on traditional roosting areas. To complement this information, at selected estuaries WeBS organises low-tide counts to give information on the feeding distributions of waterfowl during the intertidal period. Sites in the region at which such information is already available include The Wash (Yates & Goss-Custard 1991) and Humber Estuary (Tasker & Milsom 1979; Shepherd & Rose 1988).

The whole UK coastline was surveyed for wintering waders during the Winter Shorebird Count of 1984/85 (Moser & Summers 1987). Information on the wintering waterfowl of the non-estuarine shore is important for placing annual estuaries counts in a wider perspective. WeBS are planning a repeat national survey in the near future, subject to funding availability.

Although now becoming slightly dated, Owen, Atkinson-Willes & Salmon (1986) give a thorough and comprehensive account of the wildfowl and wetlands of the region, summarising data available up to the mid-1980s. The volume is an invaluable source of initial information on sites and species, although this should now be supplemented by more recent count information available from WeBS and Davidson *et al.* (1991).

Prater (1981) gives useful descriptive accounts of the birds of British estuaries, as well as placing these in a wider national and international context, using data from the period 1969-1975. As in Owen, Atkinson-Willes & Salmon (1986), much of the numerical information is dated and the site accounts should be supplemented by the more recent reviews of Davidson *et al.* (1991).

For sites of international importance (either proposed or designated), *Important bird areas in the UK*, jointly published by RSPB and the country nature conservation agencies (Pritchard *et al.* 1992), provides further information. Data on the important bird populations of each site are summarised, together with information on location and habitats.

There have been a number of more detailed studies of the wintering waterfowl of the Humber Estuary (Tasker & Milsom 1979) and The Wash (e.g. Goss-Custard 1977; Goss-Custard *et al.* 1977; Goss-Custard, Jones & Newberry 1977; Goss-Custard & Yates 1992; Yates & Goss-Custard 1991; Yates *et al.* 1993); the latter studies have been especially associated with the assessment of impacts of potential habitat loss on waterfowl.

5.12.5 Acknowledgements

We would like to thank Simon Delany at WWT for providing unpublished shelduck data, and Peter Cranswick (WWT) and John Sharpe (RSPB) for their comments.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
High tide and low tide counts of wintering and migrant wildfowl (WeBS)	*Peter Cranswick, WeBS National Organiser (Waterfowl), The Wildfowl & Wetlands Trust, Slimbridge, tel: 01453 890333
High tide counts of wintering and migrant waders (WeBS)	*Ray Waters, WeBS National Organiser (Waders), The British Trust for Ornithology, Thetford, tel: 01842 750050
Low tide counts of wintering and migrant waders (WeBS)	*Julianne Evans, WeBS National Organiser (Low Tide Counts), The British Trust for Ornithology, Thetford, tel: 01842 750050
Wash ecosystem studies	J.D. Goss-Custard, Institute of Terrestrial Ecology, Furzebrook Research Station, Wareham, Dorset BH20 5AS, tel: 019295 51518
Site designations	*Designations Team, English Nature HQ, Peterborough, tel: 01733 340345

* Starred contact addresses are given in full in the Appendix.

5.13 Land mammals

Dr C.E. Turtle

5.13.1 Introduction

This section covers mammals that occur in the coastal 10 km squares in the region, concentrating on those that are truly coastal, such as otters, and those that occur on the coast for reasons of shelter and foraging, such as the greater horseshoe bat *Rhinolophus ferrumequinum*. Other mammals - common and widespread throughout Britain, feral or recently introduced - have not been considered.

The region varies in its importance for terrestrial mammals. The otter *Lutra lutra*, classed as endangered and absent from many areas of England (Morris 1993), is rare in the region and was not recorded from the coastal squares of this region during the 1984-1986 survey (Strachan *et al.* 1990). There are no recent records for red squirrels in the region (TGUK 1992). The region is important for bats as it supports seven of the fourteen British species, most of which are considered vulnerable in Europe (Stebbings & Griffith 1986). These are: the Natterer's *Myotis nattereri*, serotine *Eptesicus serotinus*, noctule *Nyctalus noctula*, pipistrelle *Pipistrellus pipistrellus*, barbastelle *Barbastella barbastellus*, brown long-eared *Plecotus auritus* and the Daubenton's *Myotis daubentonii*.

All British bats, the otter and the red squirrel are listed under Schedule 5 of the Wildlife & Countryside Act and Annex II of the Bern Convention (except for the red squirrel, which is on Annex III). Table 5.13.1 summarises the recorded distribution of protected species in the region.

Table 5.13.1 Distribution of protected species

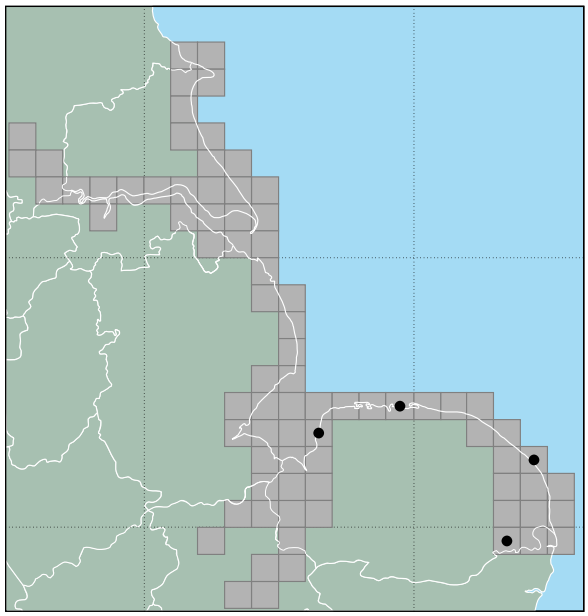
Species	*Estimate of importance in region*
Natterer's bat	Rare
Daubenton's bat	Rare
Noctule	Rare
Pipistrelle	Common Norfolk, occasional elsewhere
Barbastelle	Rare (Norfolk only, absent elsewhere)
Brown long-eared bat	Rare
Red squirrel	Extinct
Otter	Rare

Source: Arnold (1993).

5.13.2 Important locations and species

The otter is associated with semi-aquatic areas including rivers, lakes and coasts and is the terrestrial mammal that uses coastal areas most frequently. It is considered rare in Humberside and Lincolnshire (Arnold 1993) and in Norfolk. The small otter population in Norfolk is thought to be isolated from other populations and therefore unlikely to increase beyond low numbers without introductions. The most important sites in the region appear to be around Blakeney Point and Hemsby (Norfolk).

The national bat habitat survey (Walsh & Harris in prep.) includes coastal habitats and demonstrates that bats utilise the coast for foraging. Bats are likely to find areas of semi-natural habitat of most value for foraging, although shelter and natural features for flightlines are also important. The most important bat species recorded is the barbastelle, one of Europe's rarest bats. The barbastelle is known to favour forests, woodlands, riparian habitats and open water and is recorded from several areas along the Norfolk coast (Map 5.13.1). Only the pipistrelle is commonly recorded in the region and then only in Norfolk (Arnold 1993).



Map 5.13.1 Recorded distribution of the barbastelle in coastal 10 km squares. Records from 1960 onwards. Source: Arnold (1993).

5.13.3 Human activities

The industrial areas of the region, with their associated lack of natural habitats and poorer water quality, provide fewer areas suitable for bats to forage in and for otters to recolonise. The high levels of tourism in areas such as the Norfolk Broads and around Great Yarmouth may result in disturbance, which could affect the existing mammal populations and reduce further recolonisation by otters. Intensive farming systems, with their associated increase in insecticide use, result in lower and less diverse insect populations, with few natural areas for bats to forage and roost.

5.13.4 Information sources used

There are no reliable estimates of the numbers of mammals in the region or Britain that could be used to quantify the resource. Using data from Arnold (1993) (although these records are incidental rather than comprehensive), an estimate has been made of the frequency of their occurrence in the region. As a general observation (Morris 1993),

mammal surveys are not recorded with the same intensity as botanical ones and the occurrence of mammals within 10 km squares is not enough to establish the status of species. There have been no comprehensive surveys for any of the bats, and there are currently insufficient data to establish the importance of bat species in the region. It is probable that more species than those listed in Table 5.13.1 do occur and that the absence of records is due to under-recording. A red squirrel survey was undertaken in 1991 (Timber Growers UK 1992), based on questionnaires sent to all Timber Growers UK members.

5.13.5 Acknowledgements

The author thanks all those people cited in the text for contributing information and time.

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Verlander, K.A. 1983. *Pine marten survey of England, Scotland and Wales 1980-1982.* London, Vincent Wildlife Trust.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Local site and species information	*English Nature HQ, Peterborough, tel: 01733 340345
Mammal sites in Lincolnshire	*The Lincolnshire Trust for Nature Conservation, Horncastle, tel: 01507 526667
Mammal sites in Norfolk	*Norfolk Wildlife Trust, Norwich, tel: 01603 625540
Bats in Lincolnshire	Lincolnshire Bat Group, 64 Nightingale Crescent, Birch Wood, Lincoln LN6 OJT, tel: 01522 688427
Bats in Norfolk	Norfolk Bat Group, Castle Museum, Norwich NR1 3JU, tel: 01603 611277
Otters	The Otter Trust, Earsham, Nr. Bungay, Suffolk NR35 2AF, tel: 01986 893470
General mammal information	The Mammal Society, Unit 15, Cloisters Business Centre, 8 Battersea Park Road, London SW8 4BG, tel: 0171 498 4358
Biological Records Centre: records of mammal distributions	*ITE Monks Wood, Huntingdon, tel: 01487 773381

* Starred contact addresses are given in full in the Appendix.

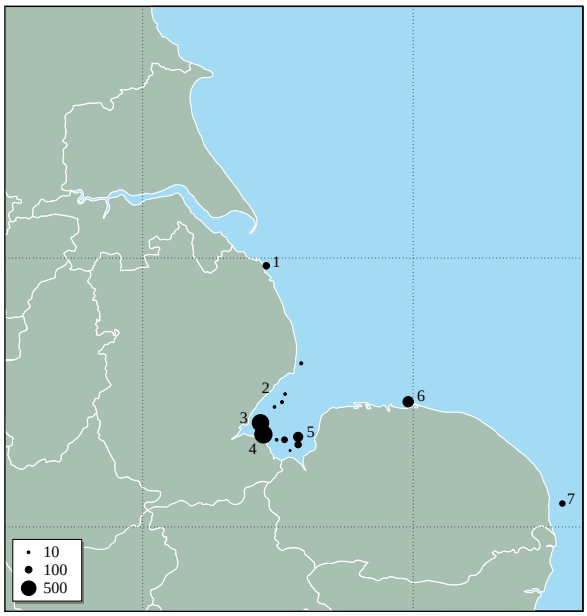
5.14 Seals

C.D. Duck

5.14.1 Introduction

The region holds almost 7% of the GB common seal *Phoca vitulina* population. They are concentrated in The Wash and are the only significant common seal population in England and, as such, one of the more important aggregations in Great Britain. Virtually all of the sites used by seals in the region are on sandbanks or mudflats. Some of the haul-out sites in The Wash are on the sides of creeks running out from extensive areas of saltmarsh. There are additional haul-out sites at Donna Nook (Lincolnshire), Blakeney Point and Scroby Sands (Norfolk).

Grey seals *Halichoerus grypus* are less numerous in this region than common seals. There is only one main breeding site, at Donna Nook in Lincolnshire, although occasionally pups are born along the Norfolk and Suffolk coasts. The Donna Nook colony produced 14% of the grey seal pups born in England in 1993 but less than 1% of the pups born in Great Britain (Table 5.14.1). Donna Nook and the Farne Islands (Region 5) are the only significant breeding sites on the east coast of England.



Map 5.14.1 Distribution of common seals in the region in August. Circle size represents the numbers of seals at each location (figures are breeding sites in Table 5.14.2). Data from SMRU, Lincolnshire Trust for Nature Conservation, National Trust.

5.14.2 Important locations

The distribution of common seals in the region in August is shown on Map 5.14.1. Circles represent the numbers of seals at principal haul-out sites (also see Table 5.14.2). A number of small groups have been integrated with larger groups for clarity. In 1988, The Wash population of common seals was reduced by approximately 50% after an outbreak of the phocine distemper virus (Hall, Pomeroy & Harwood 1992). There are indications that this population is now making the beginnings of a recovery (Sea Mammal Research Unit (SMRU) data). In August 1993 the Wash population represented approximately 56% of its pre-epidemic level, having shown an average increase of about 6% per year in 1992 and 1993. In contrast, populations on the east side of the North Sea, which were even more severely reduced in 1988, are expected to reach their pre-epidemic levels by 1995-1996 (Heide-Jørgensen *et al.* 1992). The reasons for the relatively slow recovery of The Wash population are unknown.

The distribution of grey seal breeding and haul-out sites is shown on Map 5.14.2. Circles represent the numbers of pups born at each site. Numbers on the map refer to important non-breeding haul-out sites listed, with breeding sites, in Table 5.14.3.

5.14.3 Human activities

Donna Nook, The Wash and Blakeney Point are all popular seal watching sites. At Donna Nook, an estimated 10,000 people visited the grey seal breeding colony during November and December 1993 (Fairhurst 1993). The increasing numbers of visitors may benefit from some form of managerial control in the future. There are regular seal-watching boat trips to Blakeney Point during the summer.

Table 5.14.1 Relative importance of common and grey seals in the region in relation to the rest of GB

	Common seals		*Grey seals*		
Region	*No. of seals (to nearest 50)*	*% of GB total*	*Pup production*	*Proportion of GB total (%)*	*Associated population 1 year old (to nearest 100)*
Humberside	0	0	0	0	0
Lincolnshire	1,300	4.6	200	0.6	700
Norfolk	600	2.1	1-3?	0	0
England	1,900	6.7	1,400	4.1	4,800
GB total	***28,350***		***33,850***		***115,000***

Sources: Sea Mammal Research Unit (SMRU), Lincolnshire Trust for Nature Conservation, National Trust.

Table 5.14.2 Common seal haul-out sites and seal numbers

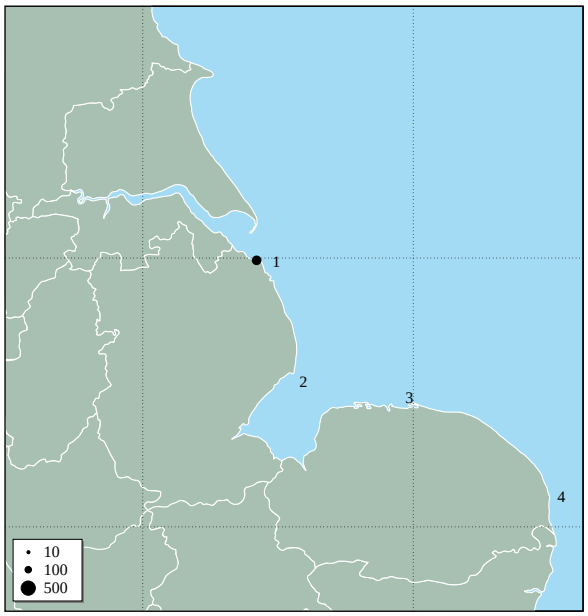
Site	*Location*	*Grid ref.*	*No. of seals*	*% of region total*
	Lincolnshire			
1	Donna Nook	TA430010	77	4.0
2	Inner Dog's Head to The Ants	TF580510 - TF550450	57	3.0
3	Blackbuoy to Toft	TF420390 - TF460400	600	31.4
4	South Wash	TF455355	581	30.5
	Norfolk			
5	Westmark Knock to Blackguard	TF500323 - TF600350	300	15.7
6	Blakeney Point	TF986468	233	12.2
7	Scroby Sands	TG570100	60	3.1

Source: Sea Mammal Research Unit (SMRU). Site numbers are those on Map 5.14.1.

Table 5.14.3 Grey seal breeding sites, pup production figures and important non-breeding haul-out sites

Site	*Grid ref.*	*Breeding (B)/ haul-out (H)*	*No. of pups born (to nearest 50)*	*% of region total*
Lincolnshire				
Donna Nook	TA400010	B	200	100
1 Donna Nook	TA430010	H		
2 Inner Dog's Head	TF595535	H		
Norfolk				
3 Blakeney Point	TF986468	H		
4 Scroby Sands	TG570100	B (occasional); H	Occasional	

Sources: Lincolnshire Trust for Nature Conservation; SMRU. Site numbers are those on Map 5.14.2.



Map 5.14.2 Grey seal pup production. Circle size represents the number of pups born along the section of coast. Figures refer to important haul-out sites in Table 5.14.3. Data from SMRU, Lincolnshire Trust for Nature Conservation, National Trust.

The Wash and Blakeney Point are heavily used by small leisure craft, particularly sailboards, sailing dinghies and small motor boats, which could cause disturbance to the seals.

Many of the haul-out sites at Donna Nook and in the south of The Wash are either in or adjacent to RAF bombing ranges (RAF Donna Nook, RAF Wainfleet and RAF The Holbeach). Public access to these areas is restricted to weekends and seals hauled-out inside the ranges are relatively undisturbed. Some areas are leased by the MoD and the Lincolnshire County Council to the Lincolnshire Trust for Nature Conservation (LTNC). The LTNC also manages the Gibralter Point National Nature Reserve through leasing agreements with the local authorities, as well as jointly managing Saltfleetby-Theddlethorpe Dunes, much of which is an NNR. The Trust also manages a reserve at Frampton Marsh, sometimes visited by common seals. Donna Nook is situated within the North Lincolnshire Coast SSSI; other sites in Lincolnshire are contained within The Wash SSSI, with Westmark Knock to Blackguard coming within The Wash NNR. Blakeney Point is a National Nature Reserve owned by the National Trust.

Under the Conservation of Seals (England) Order 1993, the close season for both common and grey seals within the territorial limits (12 nautical miles) of all of the region has been extended to cover the whole year, until 19 December 1996.

There are sanctuaries at Skegness, King's Lynn and Hunstanton for rescuing and rehabilitating seals.

5.14.4 Information sources used

Grey seal numbers and pup production at Donna Nook are monitored each breeding season by wardens from the Lincolnshire Trust for Nature Conservation (Holmes 1992; Fairhurst 1993). Although grey seal numbers and distribution are unpredictable outside the breeding season, they are recorded in SMRU's August surveys. Grey seals at Donna Nook also form part of a Sea Mammal Research Unit (SMRU) study into the movements of animals between haul-out sites along the east coast, using recognition of

distinctive individual pelage patterns, and their numbers are used for providing an alternative assessment of the size of the British grey seal population in the North Sea.

SMRU have conducted aerial surveys of common seals in The Wash since the 1960s. Currently surveys are carried out using conventional aerial photography from a fixed-wing aircraft. Although common seals breed in June, surveys are carried out during their August moult when the greatest and most consistent numbers of animals haul-out. The area surveyed extends from Donna Nook in Lincolnshire to Scroby Sands off Caister-on-Sea, in Norfolk. Common seal data used here are the result of surveys carried out between 1989 and 1993. John Watkins, of Conservation Research Ltd., monitors common seals at certain sites in The Wash throughout the year.

5.14.5 Acknowledgements

Grey seal breeding data from Donna Nook were provided by the Lincolnshire Trust for Nature Conservation. Thanks are due to John Barne (JNCC), John Watkins (Conservation Research Ltd), Ailsa Hall and Dave Thompson (SMRU) for their comments.

5.14.6 Further sources of information

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Vaughan R.W. 1978. A study of common seals in the Wash. *Mammal Review, 8*: 25-34.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Information on seal numbers and distribution around GB	Sea Mammal Research Unit, High Cross, Madingley Road, Cambridge CB3 0ET, tel: 01223 311354
Seals at Donna Nook	*The Warden, Donna Nook Nature Reserve, Lincolnshire Trust for Nature Conservation, Lincoln, tel: 01507 526667
Information on Blakeney Point Nature Reserve	The Warden, The National Trust, 35 The Cornfields, Langham, Holt, Norfolk NR25 7DQ, tel: 01263 740480
Seal Sanctuary, Skegness	Natureland Marine Zoo and Seal Sanctuary, North Parade, Skegness, Lincolnshire PE25 1DB, tel: 01754 764345
Seal Sanctuary, King's Lynn	RSPCA, Norfolk Wildlife Hospital, Station Road, King's Lynn, Norfolk PE31 8ND, tel: 01553 840045
Seal Sanctuary, Hunstanton	Sea Life Centre, Southern Promenade, Hunstanton PE36 5BH, tel: 01485 533576
Licences to kill seals	E Division, Home Office, Queen Anne's Gate, London SW1H 9AT, tel: 0171 273 3000

* Starred contact addresses are given in full in the Appendix.

5.15 Whales, dolphins and porpoises

Dr P.G.H. Evans

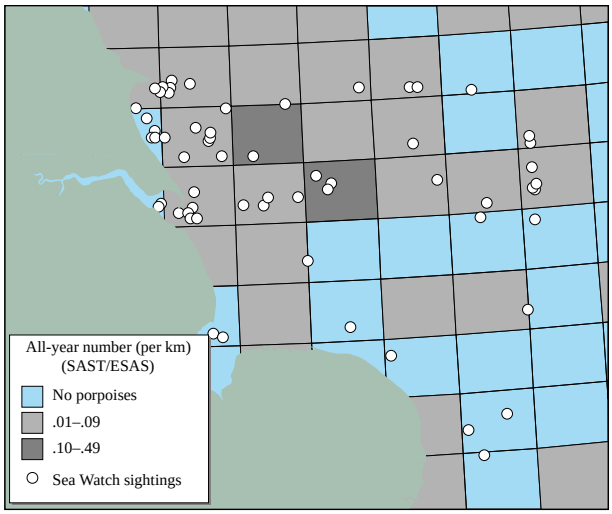
5.15.1 Introduction

The cetacean fauna (whales, dolphins and porpoises) increases progressively northwards in the North Sea, both in numbers of animals and diversity of species. The central and southern North Sea adjacent to the coast of eastern England nowhere exceeds 70 m in depth, and is generally less than 40 m deep. The most commonly occurring cetacean species are therefore those that are frequently associated with relatively shallow continental seas. By any standards (abundance or species diversity), this region is not particularly rich in cetaceans: ten species have been recorded since 1980 along the coasts or in nearshore waters (within 60 km of the coast) of the region, and little more than 10% (three out of 26 species) of the UK cetacean fauna is either present throughout the year or has been recorded annually since 1980 as seasonal visitors (see Table 5.15.1). Resident or regularly visiting species are the minke whale *Balaenoptera acutorostrata*, harbour porpoise *Phocoena phocoena* and white-beaked dolphin *Lagenorhynchus albirostris*. The most frequently sighted species is the harbour porpoise, joined offshore by the white-beaked dolphin. The harbour porpoise is listed in Annex II of the Habitats Directive as a species whose conservation requires the designation of Special Areas of Conservation.

Other cetacean species recorded in the region include fin whale *Balaenoptera physalus*, sperm whale *Physeter macrocephalus*, northern bottlenose whale *Hyperoodon ampullatus*, bottlenose dolphin *Tursiops truncatus*, Atlantic white-sided dolphin *Lagenorhynchus acutus*, killer whale *Orcinus orca* and long-finned pilot whale *Globicephala melas*. Some species (for example fin whale, sperm whale and northern bottlenose whale) are better represented from strandings than from live sightings, and this is probably the result of southward-moving currents along the eastern coasts of England. For geographical comparisons of sighting rates for various cetacean species in UK waters, see Evans (1990, 1992) and Northridge *et al.* (1995).

Table 5.15.1 Cetacean species recorded regularly in the region since 1980

Species	*Status, distribution, and seasonal occurrence*
Minke whale *Balaenoptera acutorostrata*	Present in small numbers off Flamborough Head and the north Humberside coast, mainly between July and October.
Harbour porpoise *Phocoena phocoena*	Widely distributed in small numbers. Recorded in all months of the year but most frequently (and in greatest numbers) between July and November, particularly September.
White-beaked dolphin *Lagenorhynchus albirostris*	Fairly common and widely distributed in offshore waters. Recorded in all months of the year but only rarely between January and March.



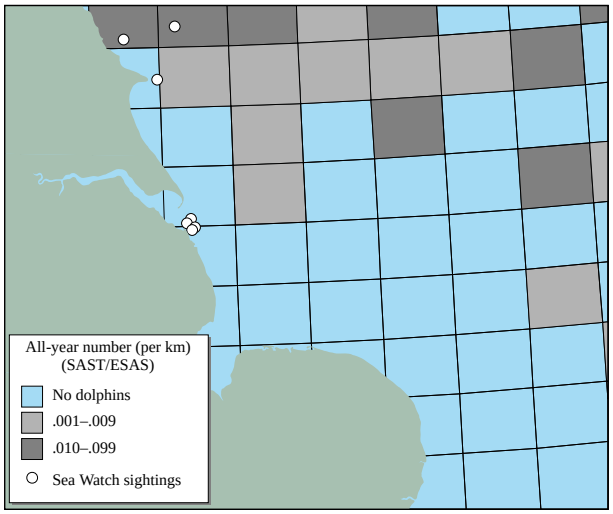
Map 5.15.1 Harbour porpoise: all-year number sighted per kilometre of Seabirds at Sea survey (source: JNCC: SAST/ESAS); and sightings reported to the Sea Watch sighting system (Evans 1992).

5.15.2 Important locations

Table 5.15.1 summarises the distribution of cetaceans in the region. Although watched only irregularly, harbour porpoises are reported regularly off Flamborough Head (Humberside), particularly between July and October (Map 5.15.1). Minke whales are also observed there in small numbers, generally between July and October. Pingree *et al.* (1978) demonstrated the existence of phytoplankton blooms in the region of a thermal mid-shelf front off Flamborough Head stretching south-eastwards towards Spurn Point (see also section 4.3). There is little information to date as to whether this leads to generally higher marine productivity, but if it does, it might account for the localised concentrations of porpoises and regular sightings of small numbers of minke whales reported from there.

Harbour porpoises are also observed throughout the year off Spurn Head and the entrance to the Humber Estuary (Humberside), but with peak numbers during July to October, and particularly in September. They are also seen occasionally off Gibraltar Point (Lincolnshire), between July and October.

Offshore banks are also important for cetacean sightings. Although cetacean densities appear to be low throughout the region, there is some indication that harbour porpoises and white-beaked dolphins occur more frequently offshore over Indefatigable Banks (60 km north-east of Norfolk), and minke whales are sometimes seen in the area (Map 5.15.2).



Map 5.15.2 White-beaked dolphins: all-year number sighted per kilometre of Seabirds at Sea survey (source: JNCC: SAST/ESAS); and sightings reported to the Sea Watch sighting system (Evans 1992).

5.15.3 Human activities

ASCOBANS (Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas) is an international agreement between countries bordering the North and Baltic Seas, with the aim of promoting the conservation of small cetaceans. It was ratified by the UK in 1993. Participating states agree to cooperate on issues including national legislation and research into, for example, cetacean population sizes and the effects of fishing.

Cetaceans in the region face three main pressures from human activities: conflicts with fisheries (either by competition for a common food resource, or accidental capture in fishing gear), habitat degradation (mainly by pollution), and disturbance (from underwater sounds).

Immediately north of the Humber (Withernsea, Hornsea and Bridlington), inshore fishermen have reported porpoises caught accidentally in trammel nets and set gill nets (Northridge 1988). There is no quantitative information on catch level but it is thought to be small.

Contaminant levels in cetaceans from the region are generally low: mean total PCB (for 25 congeners) levels of 32 harbour porpoises sampled from the east coast of England (Kent to Northumberland) between 1988 and 1992 amounted to 19 ppm (Kuiken *et al.* 1994). Large amounts of nitrogen and phosphorus enter the southern North Sea from rivers such as the Humber, Thames, Rhine and Elbe. This eutrophication can result in phytoplankton blooms causing deoxygenation of the water and, in some cases, toxins, which may cause at least temporary habitat degradation for cetaceans, although in this region the effects of these nutrients do not extend far beyond the mouths of the estuaries and the region's coastal waters as a whole do not appear to be experiencing excessive nutrient enrichment (North Sea Task Force 1993; see also section 9.6).

Although recreational activities (speedboats, jet skis etc.) off the coast are relatively unimportant in the region, heavy shipping may disturb cetaceans, as well as posing a threat of collisions. Sound frequencies produced by ships' engines overlap those used by cetaceans, particularly baleen whales, but also dolphins and porpoises when cavitation of the propeller occurs. Negative responses (vessel avoidance and increased dive times) by both bottlenose dolphins and harbour porpoises to such sounds have been reported by Evans *et al.* (1992; in press). Other underwater sounds from seismic activities (as part of oil and gas exploration in the North Sea) involve lower frequencies, and are therefore most likely to affect baleen whales (not resident in or a regular visitor to this region), which communicate primarily at these frequencies (20-500 Hz). It is possible that porpoises are also affected (Baines 1993), perhaps through changes to the distribution of their fish prey (Evans 1995). A code of conduct for boat users has been produced (Seawatch Foundation & UK Mammal Society 1992).

5.15.4 Information sources used

Information on cetacean status and distribution comes primarily from the national sightings database (1973 - present) maintained by the Sea Watch Foundation (SWF) and the strandings scheme organised by the London Natural History Museum (1913 - present). Systematic land-based watches have been carried out by the staff of Spurn Head Bird Observatory since 1965. Offshore effort-related data have been collected as part of seabird surveys of the North Sea by Dutch ornithologists, between 1987 and 1992 (Camphuysen & Leopold 1993), and by JNCC's Seabirds at Sea Team, mainly between 1979 and 1986 (Northridge *et al.* 1995). Survey effort is patchy, with some regions poorly covered (e.g. The Wash and coastal waters of north Norfolk). Generally, effort has been highest between the months of July and September, when sea conditions tend to be best.

A major international collaborative programme, the Small Cetacean Abundance in the North Sea (SCANS) project, has aimed to provide an authoritative baseline assessment of abundance from intensive survey work in summer 1994.

5.15.5 Acknowledgements

Thanks are due to J. Heimlich-Boran for help in the preparation of the maps and to all who have contributed valuable sightings data, particularly the systematic observations provided by C.J. Camphuysen, J. Cudworth, P.J. Dare, R.J. Law, M.F. Leopold, J. Ramster, M. Tasker and A. Webb.

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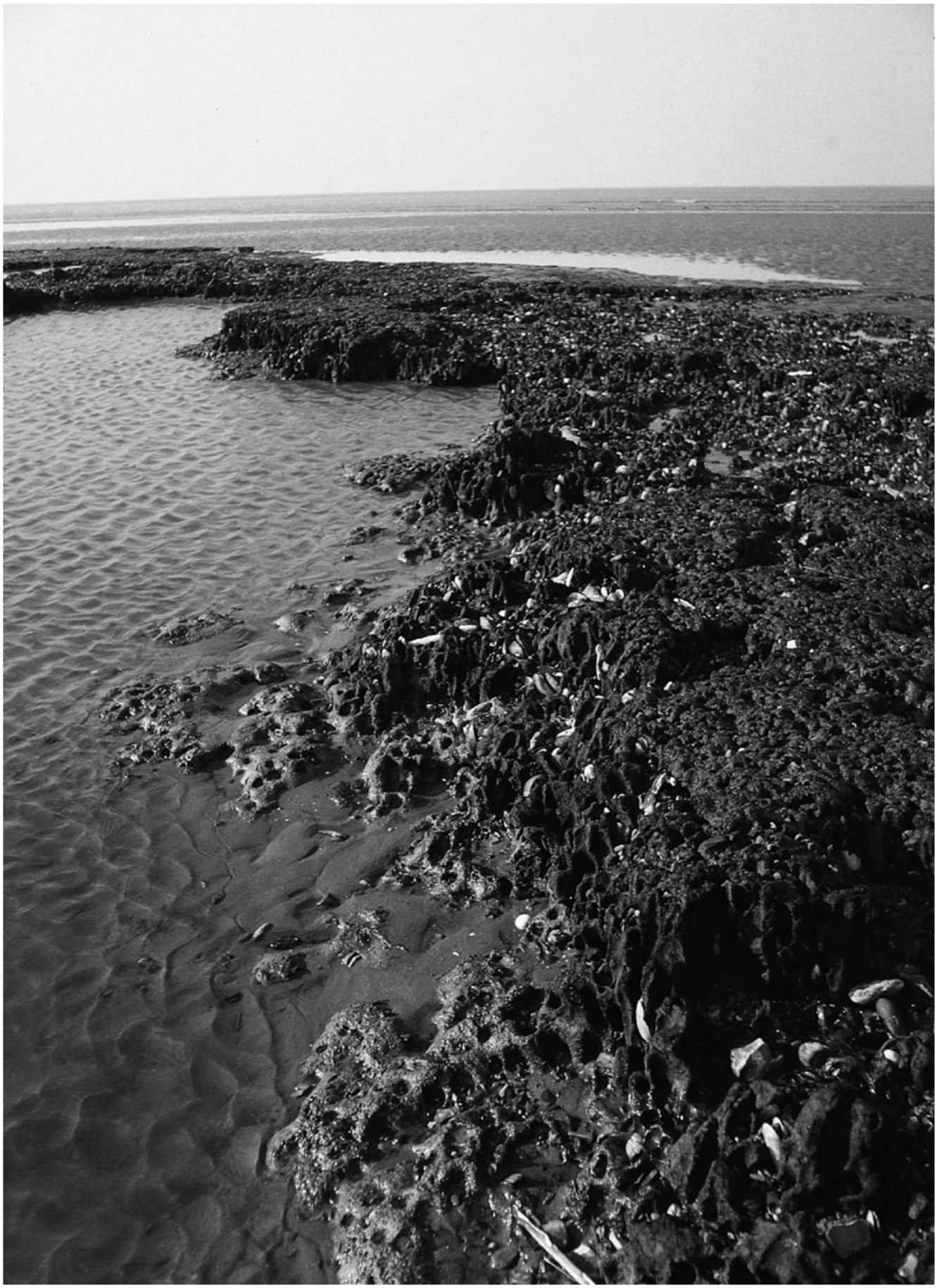
C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Cetacean strandings	Dr D. George & A. Muir, Natural History Museum, Cromwell Road, London SW7 5BD, tel: 0171 938 8861
Cetacean sightings & surveys	Dr P.G.H. Evans, Sea Watch Foundation, c/o Dept. of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, tel: 01865 727984
Cetacean sightings and surveys	*Head, Seabirds & Cetaceans Branch, JNCC Aberdeen, tel: 01224 642863
SCANS Project	*European Wildlife Division, Department of the Environment, Bristol, tel: 0117 987 8000
Cetacean organochlorine & heavy metal levels	*Dr R.J. Law, MAFF Directorate of Fisheries Research, Burnham-on-Crouch, tel: 01621 782658

* Starred contact addresses are given in full in the Appendix.



Evidence of palaeoenvironments is revealed in coastal peat beds at several locations in the region, including here at Holme, north Norfolk, where peat deposits dating from the end of the last ice-age jut out of a sandy beach. Photo: Nick Davidson, JNCC.

Chapter 6 History and archaeology

6.1 Introduction

A.B. Gale & V. Fenwick

This chapter tells of past human activity in the region, drawing on archaeological (the physical remains) and historical evidence. Distribution of known sites is biased by the uneven spread of survey work: many missing details can be found only by the discovery and investigation of new sites. Archaeological sites are vulnerable and those not yet located can unwittingly be destroyed. This chapter gives information on the provisions for safeguarding known and unknown sites and on the organisations that manage archaeology, sets out the extent of survey work and describes how to report new discoveries.

The history and archaeology of the region reflect the importance of rivers, estuaries and the coast since prehistoric times. The vast river basins of the Humber and The Wash, among the largest in Britain, reach deep into the country. Many natural and improved waterways are navigable throughout the industrial north and east midlands and East Anglia, and more were navigable in the past. The pattern of early settlement was shaped by these routeways, which were important in the economic development of the region. Reflecting this is the unrivalled concentration of prehistoric watercraft found in the region, including the oldest plank boat in northern Europe - a 3,000 year old find of international importance.

Map 6.1.1 shows locations mentioned in the text and described in section 6.2. Archaeological sites in the region range from ruined buildings to scatters of flint tools, and many are known only from documentary sources or, if buried, from aerial photographs. Finds of individual artefacts may be the only evidence of the existence of structures that have already disappeared. For many terrestrial sites, the dramatic changes in this region's coastline have distorted their relationship with the sea. For example, erosion and the changing sea level in parts of the Humber Estuary have moved the intertidal zone to encompass formerly terrestrial sites. In Lincolnshire, prehistoric saltworking sites, originally on the foreshore, now lie on the inland limit of the coastal plain. In Norfolk, the once active port of Wisbech, lying in its heyday 6 km from the sea on the River Great Ouse, is now 15 km inland on the River Nene. In contrast the loss of whole villages and many hectares of land by erosion makes it difficult to interpret surviving isolated elements of landscape now at the sea's edge. Also, terrestrial sites from as late as the Medieval period can now lie many metres beyond low water mark, because of rising sea levels. Their coherence will obviously depend on the process by which they were eroded: the site of a village that has toppled over a cliff or been destroyed along with the shingle spit on which it was situated will be more disrupted and difficult to interpret than one that has been inundated and then sealed by sediments.

Map 6.1.1 Archaeology: locations mentioned in the text

Shipwrecks are the most numerous sub-tidal sites. Written accounts show that the hazards of this region have caused thousands of shipwrecks. The discovery of the Betsy, lost off the mouth of the Humber in 1767, demonstrates that vessels can survive within the sea bed for centuries (Tyson 1994). Records of losses, which show the potential for ship sites to be found, are comprehensive for the 19th century, relatively complete for the 18th, and patchy for the 14th to 17th centuries. For earlier periods it is necessary to examine documentary evidence for sea-borne trade and extrapolate the opportunities for ship losses by considering the hazards to navigation. This process has then to be extended into the prehistoric period by looking at archaeological evidence for trade and seafaring.

6.2 History and archaeology of the region

6.2.1 Palaeo-environments

Palaeo-environments, the land surfaces of prehistory, survive as submerged or intertidal forests and peat beds. The fenlands of this region, including areas now beneath the sea, were formed in two main phases. From 12,000 BP the climate warmed and the Ice Age landscape was replaced by coastal forests. In time, the rising North Sea flooded these low-lying wetlands and deposited silt over the decayed forests. Sea level dropped during the Bronze Age to close to the level existing today, and on the re-exposed silt new vegetation formed an upper layer above the sealed forests. Peat and tree trunks have been trawled from the sea bed of this region at depths of up to 50 m. The beaches and estuaries of this region are rich in exposures of peat. Submerged forests and peat are exposed in intertidal areas in Lincolnshire, Humberside and Norfolk, including at Hornsea, Owthorne, Easington Beach, Spurn Head, the Humber Estuary, Cleethorpes, Mablethorpe to Ingoldmells, Hunstanton to Holme-next-the-Sea and Brancaster.

6.2.2 Hunters, gatherers and early farmers (Palaeolithic, Mesolithic and Neolithic)

Evidence of the earliest hunters is very limited from the Palaeolithic period before the last Ice Age. Apart from an important later Palaeolithic site at Titchwell, Norfolk, stray finds include a flint core from Sewerby and a stone hand axe at West Runton. Further axes from Carnaby and an elk antler harpoon from Barmston are possibly from the same period. The paucity of evidence on land reflects the fact that huge, formerly marshy areas in the southern half of the North Sea, used in the stone age as hunting grounds, are now covered by water.

By 9,000 BP Mesolithic groups were hunting across large dry-land areas of the present North Sea, but by 7,000 BP sea level in the Humber Estuary had risen to only 9 m below Ordnance Datum (Ellis 1987). Rare evidence of lake dwellings comes from Sand-le-Mere near Waxholme. Bone and antler harpoons and fish spears from Skipsea, Hornsea and elsewhere on the Holderness coast indicate a focus of fishing activity in an area of the highest archaeological potential.

Meres and forests in the region provided easy food for later hunters. On Holderness, platforms were built around lake margins and there is evidence of woodland management. Around 7,000 - 5,000 BP farming techniques were being evolved by Neolithic communities. They commemorated their dead in huge monuments known as long barrows, but evidence of houses is rarely found. At Melton and North Ferriby, on the Humber, and near Cleethorpes in Lincolnshire, Neolithic land surfaces with large fallen trees are being exposed by coastal erosion. On Sewerby Cliffs and south of Bridlington, flakes and implements in various stages of completion indicate tool production sites.

6.2.3 Metal-working peoples (Bronze Age and Iron Age)

The introduction of metal tools and weapons was a stimulus to trade, and the discovery at North Ferriby of the 'Ferriby Boats', plank-built craft of Bronze and Iron Age date, shows that the Humber has been navigated since at least 3,500 BP (Wright 1990). The sophisticated construction of these boats suggests a much older sea-faring and boatbuilding tradition. Bronze Age platforms or crannogs have been found in several Holderness meres, and pegged and railed structures have been exposed by erosion on the Humber foreshore at Melton. The Wash is of equal potential archaeological interest, since it and the Fenland basin remain one of the few extensive areas in southern Britain where entire prehistoric landscapes have been preserved (Bamford 1982).

From about 2,700 BP iron technology developed alongside bronze working. Peoples from Holland migrated into the region around 2,500 BP and later from parts of France and Germany. Defended sites characterise the period elsewhere but are rare in this region, probably owing to widespread erosion. An earthwork fortified Flamborough Head and coastal trade is suggested by numerous finds of Celtic coins on Humberside beaches and at Weybourne, Norfolk, in the territory of the Iceni. Their only known fort in the region is now 1 km from the sea, in Holkham Marshes (Davies *et al.* 1991). Imported continental artefacts eroded from the cliff at Redcliff (adjacent to North Ferriby) have revealed the port of the prosperous Celtic tribe of the Parisii, the precursor of the nearby Roman town of Brough. Across the Humber lies another Iron Age settlement, at South Ferriby, and a sewn planked boat has been found at Brigg. A ferry crossing may have been a focus for trade. At Ingoldmells the traditional production of salt by the evaporation of sea water has been found to date from as early as the 4th century BC; at Mablethorpe associated Iron Age rush-floored huts have been exposed by severe storms.

6.2.4 The Roman province

The region is notable for the lack of evidence of Roman occupation, but the picture has been distorted by erosion of coastal settlements, such as at Easington, the haven in Bridlington Bay, a reported fort at Sewerby and occupation debris at Skegness, Mablethorpe and Ingoldmells. A Roman military track, the Peddar's Way, reaches the coast at Holme-next-the-Sea and may once have continued to Lincolnshire. A major Roman settlement is thought to have existed at Old Clee, Grimsby, while Roman pottery has been found at Barrow-upon-Humber, which is a natural haven. Lincolnshire became a major producer of salt by evaporation in numerous workings along the shore. Brancaster (Branodunum), Norfolk - a major surviving Roman site in the region - is the most northerly of a string of shore forts established in the 3rd century to guard the coast

against Saxon pirates. It has been partly eroded by the sea, although this is now some distance away. Beside it there was a large earlier civilian settlement which may relate to an earlier fort (Hinchliffe 1985). Further south, on the Yare (which was a large open bay until the 5th century), the large walled port of Caister was set up in the 2nd century.

6.2.5 Roman departure to Norman conquest

There is little archaeological evidence of events in the region during this period, but late Roman cemeteries indicate the presence even at this early date of Germanic people who may have been mercenaries. Subsequent larger-scale immigration from Jutland is also known mainly from cemeteries. Little evidence exists because of erosion of coastal settlements combined with the devastation wrought in Viking raids: the north of this region was sacked no fewer than seven times before it was settled. The first port of Ravenser (west of Spurn Head) is reputed to have been of Viking origin (Tyson 1994). Barton-upon-Humber, where the Humber is now bridged, controlled a ford across the estuary and pre-dated Hull as an important port.

6.2.6 Medieval period

Merchant ships of this period were relatively small, the majority being between 20-50 tons. Such craft could be loaded and unloaded on open beaches, but ports within rivers provided shelter and access to inland markets. The ports of the region were well placed for trade with eastern and northern Europe. Norman castles at Skipsea and Barrow Haven defended the Humber. Hull and Boston prospered in the wool trade, assisted by laws compelling the use of English ships for exports to Calais. The Boston Stump (the tower of the parish church) both demonstrates the wealth of wool merchants and, like church towers at Patrington and Happisburgh, is a seamark. Hull, in addition, sent ships to Bordeaux for wine. King's Lynn, founded in 1101 on land claimed from the sea, was joined by Boston and Cromer in the Icelandic fishing trade. The Netherlands was the entrepot (trading hub) of Europe in this period. The region was visited by many Dutch ships, especially those carrying Baltic timber to Hull. In addition to the main trades a vast range of less valuable goods were carried, such as hops, garlic, tiles and rabbit skins.

In the 16th century the ports suffered from the decline in the wool trade and the emerging dominance of London, which became the centre of foreign merchant activity. However, the importance of the ports in strategic terms is apparent. Both Hull and King's Lynn were walled towns; the former was the site of the first English fortification (built by Henry VIII) with angular projections in the curtain wall, forming artillery platforms, and both were reinforced with bastions during the English Civil War.

6.2.7 Post medieval and modern times

By the end of the 17th century England had become active in trades formerly dominated by the Dutch, particularly those with the Baltic states and north Germany. This prompted some ports to improve their facilities to secure their trading positions: in 1697 Grimsby diverted the Freshney to flush the harbour and in the next century the Witham was deepened upstream of Boston, partly to scour the lower reaches to keep them open for navigation. Hull expanded its role in trade in timber, flax and iron with the Baltic states, although her main export was lead. Iron was crucial for the developing industries of its hinterland. King's Lynn and the lesser ports of the Norfolk coast established a major export trade in grain.

Dock construction, a major activity of the late 18th and 19th centuries, enabled vessels to lie upright alongside the quays and provided unloading and storage facilities. Hull, following the lead of London and Liverpool, built an enclosed dock covering 9 acres. In 1800 Grimsby opened a new dock, but this failed to capture trade from Hull. The 1840s brought further construction at the latter as railways enabled coal to be brought for export. Grimsby, also a railway port, was unusual on the east coast in serving the general, rather than mineral, export trade through its links with Sheffield. Provided with hydraulic power, her new facility was the first truly modern dock in Britain (Jackson 1983). The increasing size of ships demanded larger docks and open storage, rather than multi-floored warehousing. Hull responded with new coaling docks in the 1880s and, in 1906, the Salt End oil terminal just to the east of the city, while Grimsby opened similar facilities at Immingham in 1912.

The lesser ports south of the Humber also benefited from railway and dock construction, Boston in 1884, Wisbech in 1881 and King's Lynn in 1869. The latter covered just 6.9 acres, compared with the 46.5 acre Alexandra Dock at Hull. At Great Yarmouth the railway provided a rapid means of transporting fish to the London markets. In the mid 19th century Yarmouth's fishing fleet comprised over 200 luggers. By 1900, at the annual assembly of the east-coast herring fleets, her roadstead would be crammed with up to 1,000 vessels. Both Hull and Grimsby had docks especially for fishing vessels, which provided bases for north sea trawling; Grimsby was among the earliest builders of steam trawlers. By 1909 the port had a fleet of 514 steam fishing vessels. The trawler fleet was used for armed patrol during World War II, and the low coasts of the region were protected by shore defences.

The present century has seen the decline of docks, as activity moved downriver to deep-water container ports and oil terminals. Consequently the Humber, dominant in all periods, has become the main focus for modern shipping in the region, although King's Lynn retains trade by vessels up to 2,000 tons.

6.3 Human activities

6.3.1 Activities and processes affecting the archaeological resource

The region's archaeological resource does not consist entirely of discrete sites such as intact wrecks. Many sites are scattered. Some sites, including palaeo-environments (which can be extensive), straddle the terrestrial, inter-tidal and sub-tidal zones and are exposed to a wide variety of potentially damaging circumstances.

Coastal erosion is a major problem for coastal archaeological sites, especially on the open coast but also in some parts of the Humber Estuary. The rate of erosion is especially rapid in the Holderness area and between Mablethorpe and Skegness. Conversely, areas of the Humber and The Wash and north Norfolk are experiencing accretion, which buries sites and can distort their original relationship to the shoreline. Proposed sea and flood defence works can also affect the archaeological resource.

The relative lack of survey work on sub-tidal sites makes it difficult to assess the influence of human activities on the archaeological resource. Some, for example salvage diving, dredging for navigation or aggregates, or the use of fishing gear that is in contact with the sea bed, could directly damage or destroy sites. Chemical or physical change to the environment may also alter the stability of sites.

Many lengths of coast in the region carry conservation designations, and development is focused on currently undesignated areas. The Humber Estuary, for example, attracts industrial development, such as the installations for BP and British Gas at Easington. Elsewhere, economic regeneration based on redevelopment of historic ports for tourism and recreation requires skilful planning to preserve the fabric and setting of maritime buildings and installations. Conservation designations and management initiatives can provide opportunities to integrate management of archaeological sites. Thus the revised Flamborough Head Heritage Coast Plan takes account of both terrestrial and sea-bed archaeological interests; The Wash General Management Statement, jointly produced by Lincolnshire and Norfolk County Councils, received a direct archaeological input; and the Humber Estuary Management Strategy has the option to seek advice from the local Sites and Monuments Record.

6.3.2 Development control

In this region, three statutory designations are applied specifically to protect *in situ* remains of archaeological or historic importance. The Ancient Monuments & Archaeological Areas Act 1979 (AMAA) provides for Scheduled Ancient Monuments. The AMAA definition of monument includes sites both on land and in UK territorial waters, including remains of vehicles, vessels and aircraft. In practice, however, scheduling has only been applied above low water mark (Firth 1993). For England and Wales there is a published list of criteria for determining the national importance of a monument (DoE 1990). The Town & Country Planning (Listed Buildings and Conservation Areas) Act 1990 provides for buildings considered of special architectural or historic importance to be designated as Listed Buildings.

The numbers of Scheduled Ancient Monuments in the coastal 10 km squares of the region in the 'county lists' of March 1994 are given in Table 6.3.1. Numbers are expected to increase following current review programmes. Listed Buildings in the region include maritime structures such as customs houses and warehouses.

Table 6.3.1 Numbers of Scheduled Ancient Monuments in the coastal districts of the region

District	*No. of Scheduled Ancient Monuments*
Humberside	
East Yorkshire	21
Holderness	15
Glanford	14
Cleethorpes	2
Great Grimsby	0
Lincolnshire	
East Lindsey	9
Boston	6
South Holland	0
Norfolk	
King's Lynn and West Norfolk	54
North Norfolk	34
Great Yarmouth	14

Source: English Heritage county lists (1994)

Shipwrecks of archaeological or historic importance can be designated under the Protection of Wrecks Act 1973. However in this region no shipwrecks have been designated under this act (see section 6.3.2), but this should not be taken as indicating an absence of important shipwreck sites. As fewer than 45 wrecks have been designated for the whole of Britain, their distribution cannot be accepted as a guide to that of the total sea-bed resource. Table 6.3.2 gives the numbers of known and suspected wreck sites off counties in the region, as recorded in the National Monuments Record - Maritime Section.

Sites and Monuments Records, maintained at county level, are databases of archaeological sites. They are the key

Table 6.3.2 Records of wrecks entered in the National Monuments Record - Maritime Section

County	*Known wrecks*[1]	*Documented casualties*[2]	*Unidentified obstructions*[3]
Humberside	332	412	104
Lincolnshire	118	253	15
Norfolk	302	558	17
Region 6	***752***	***1,223***	***136***

Source: Royal Commission on the Historic Monuments of England (August 1995). Key: [1]Sites recorded on the Hydrographic Wreck Index. [2]Historic records of wrecks. [3]Net fasteners.

source of information on sites of regional and local significance.

Terrestrial and intertidal development

To landward of low water mark, archaeology is considered within the unified system of development control provided by the planning system. The Department of the Environment has issued guidance notes (DoE 1990) explaining the requirements for planning authorities and developers to have regard for archaeological remains. In essence there is a presumption in favour of preservation *in situ* of archaeological remains and their settings. DoE (1990) therefore recommends that it is in the interest of the developer, as part of their research into a potential project, "to make an initial assessment of whether the site is known or likely to contain such remains". The Sites and Monuments Records should be consulted at an early stage. Prior consent from English Heritage is necessary for any works which will destroy, damage, repair or remove a Scheduled Monument, and there is a presumption against destruction. There is now also a presumption against the destruction of Listed Buildings, and consent is required from English Heritage prior to any demolition, alteration or extension (DoE 1994). For certain types of development (listed in Schedules 1 and 2 to the Town & County Planning (Assessment of Environmental Effects) Regulations 1988), formal Environmental Assessments may be necessary. This should include information on any effects on the cultural heritage. Planning decisions should take into account the more detailed policies that appear in Development Plans. The County Structure Plans and the Local Plans of the constituent districts contain general archaological policies. Further policies and information related to archaeology appear in non-statutory management plans.

Subtidal development

To seaward of low water mark there is a sectoral approach to development control (DoE 1993). Regulation, including requirement for Environmental Assessment, is divided between a range of government departments and agencies. Until recently, the lack of information on the extent of the resource and the absence of a management structure for archaeology in the sub-tidal zone had precluded its consideration by many local authorities. For example, when approached by environmental consultants preparing information in advance of offshore dredging, the Humberside Sites and Monuments Record have only been able to refer them to national bodies concerned with maritime archaeology (Humberside SMR Officer pers. comm.). However growing awareness of marine archaeology is leading to voluntary consideration of the archaeological resource, and a *Code of practice for seabed developers* has been published (Joint Nautical Archaeology Policy Committee 1995).

6.3.3 Key organisations and their responsibilities

English Heritage and the Department of National Heritage are responsible for sites protected under, respectively, the Ancient Monuments & Archaeological Areas Act (1979) and the Protection of Wrecks Act (1973). English Heritage inspects monuments, assists owners by drawing up management agreements supported by grants, and directly manages those monuments in Guardianship. It also funds rescue archaeology and related research projects.

The Royal Commission on the Historical Monuments of England (RCHME) has a statutory responsibility for the survey and inventory of archaeological sites in England. It maintains a computerised database of archaeological sites: the National Monuments Record (NMR). In 1992 new Royal Warrants extended the remit of RCHME to the territorial seas, and a Maritime Section has since been added to the NMR.

RCHME is the lead agency overseeing data standards in local archaeological databases - Sites and Monuments Records (SMRs) - which are usually maintained at county level. SMRs provide the primary source of information on recorded and potential archaeological sites. Their role as a source of information and advice for planning authorities was recently confirmed (DoE 1990). In this region, Humberside, Lincolnshire and Norfolk County Councils maintain SMRs. In Lincolnshire, District Council funding also provides Community Archaeologists. In addition to education and interpretation functions, they monitor planning applications, using local archaeological information derived from the county SMR. Only the Boston Community Archaeologist has a responsibility in this region.

6.3.4 Reporting archaeological information

The Royal Commission on the Historical Monuments of England (RCHME) and the Sites and Monuments Records (SMRs) are the accepted reporting points for new archaeological information, although there is a legal requirement to report archaeological and historical artefacts only when the objects fall within the laws on either Treasure Trove or Salvage. Objects of gold or silver found on land must be reported to the British Museum, the police or the coroner.

The Merchant Shipping Act 1894 requires any recovered wreck to be reported to the Receiver of Wreck. Wreck is defined as any ship, aircraft, hovercraft or parts of these, their cargo, or equipment, found in or on the shores of the sea, or any tidal water. The Receiver provides advice and supplies forms for reporting recovered wreck. These include a form which finders may use to volunteer to the RCHME information on the identity and condition of wreck sites. The Receiver advertises reported wreck, regardless of age, in order that owners may claim their property. After one year, unclaimed wreck becomes the property of the Crown and is disposed of in order to pay the expenses of the Receiver and any salvage awards. During the statutory year, such items may be lodged with an appropriate museum or conservation facility with suitable storage conditions. There is a policy of offering unclaimed wreck of historic, archaeological or artistic interest to registered museums. Finders are often allowed to keep unclaimed wreck in lieu of a salvage award. The responsibility of the Receiver to the finder, with regard to salvage awards, remains regardless of the historic character of the wreck.

The Department of National Heritage (DNH) can protect shipwrecks of artistic, archaeological or historical importance under the Protection of Wreck Act 1973. Sites should be reported to DNH, which has prepared guidelines on their discovery.

6.4 Information sources

The Holderness coast was the pilot area for a survey of military sites now being undertaken by the Council for British Archaeology. Areas of the Humber foreshore at North Ferriby have been subject to intermittent survey since the discovery of the Ferriby Boats in 1948. All other coastal survey in Humberside has focused on the estuary and the wetlands. In Lincolnshire a coastal survey, funded by English Heritage, assessed the effects of erosion on peat exposures (Brooks 1990), but no subsequent work has been undertaken.

The archaeology of the peat beds in Fenland, on the landward fringe of this region, has been the subject of extensive survey programmes. A Fenland survey was funded by English Heritage to identify sites rapidly, to draw up management specifications for individual sites, and to consider the issues influencing the archaeological resource in this environment. A comparable survey of the Humber wetlands began in 1992.

The Norfolk Sites and Monuments Record (SMR) includes wreck sites shown on the Admiralty Charts, with details from the Hydrographic Department's Wreck Index. The Norfolk SMR records 170 wrecks and fifteen other sea-bed sites for the county.

The rapid compilation of records for the National Monuments Records - Maritime Section is due to end in 1995. The records have been compiled from the Hydrographic Department Wreck Index. This lists mainly 20th century shipwrecks and unidentified sea-bed obstructions. To these will be added records of shipping casualties and details of finds made by fishermen and divers. No other archaeological subtidal surveys are known to have been conducted.

Modern archaeological survey is focused on intertidal sites, which may reveal aspects of the prehistoric environment. English Heritage and the Royal Commission on the Historical Monuments of England (RCHME) have commissioned a project, England's Coastal Heritage, which will inform the development of a strategic approach to survey, recording and management. The latter element is examining the relationship between archaeology and current developments in the management of the coast. Under the project, the Aerial Photographic Unit of RCHME is investigating the feasibilty of using aerial photographs for intertidal survey, and Reading University is producing a synthesis of information within the National Monuments Record (NMR), Sites and Monuments Records (SMRs) and published sources. The executive summary is scheduled for publication in December 1995 by RCHME and EH.

6.4.1 Acknowledgements

Thanks are due to all the individuals and organisations mentioned in the text, for providing information. The author is also indebted to Jane Tyson, Reading University, who made available information from the England's Coastal Heritage project.

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Van De Noort, R., & Davies, P. 1993. *Wetland heritage. An archaeological assessment of the Humber wetlands.* Kingston-upon-Hull, English Heritage.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Scheduled Ancient Monuments; Listed Buildings	Chief Archaeologist, English Heritage, 23 Savile Row, London W1X 2HE, tel: 0171 9733000
Maritime archaeological sites in England; code of practice for sea bed developers (published by the Joint Nautical Archaeology Policy)	Head of Recording (Maritime), Royal Commission on the Historical Monuments of England, National Monuments Record Centre, Kemble Drive, Swindon SN2 2GZ, tel: 01793 414600
Archaeological sites in England (general)	National Monuments Record, Royal Commission on the Historical Monuments of England, National Monuments Record Centre, Kemble Drive, Swindon SN2 2GZ, tel: 01793 414600
Sites and Monuments Record, Humberside	SMR Officer, Humberside Archaeology Unit, Estate & Property Management Department, The Old School, Northumberland Avenue, Hull, HU2 0LN, tel: 01482 217466
Sites and Monuments Record, Lincolnshire	*SMR Officer, Lincolnshire County Council, 12 Friars Lane, Lincoln, tel: 01522 575292
Archaeological sites in Lincolnshire	Boston Community Archaeologist, Heritage Lincolnshire, The Old School, Cameron Street, Heckington, Sleaford, Lincolnshire NG34 9RW, tel: 01529 61499
Sites and Monuments Record, Norfolk	SMR Officer, Norfolk Landscape Archaeology Division, Union House, Gressenhall, Dereham, Norfolk NR20 4DR, tel: 01362 860528
Reporting of recovered wreck in Britain	Receiver of Wreck, Coastguard Agency, Spring Place, 105 Commercial Road, Southampton S015 1EG, tel: 01703 329474
Reporting of Treasure Trove in England	The British Musem, Bloomsbury, London WC1 3DG, tel: 0171 323 8454 (prehistoric & Romano-British); 0171 323 8629 (medieval - present)
Reporting of wreck sites of artistic, archaeological or historical importance	The Secretary, The Advisory Committee on Historic Wreck, Department of National Heritage, Room 306, 2-4 Cockspur Street, London SW1Y 5DH, tel: 0171 211 6369 or 6367

* Starred contact addresses are given in full in the Appendix.

The stretch of coast from Saltfleetby to Theddlethorpe, Lincolnshire, has been declared a National Nature Reserve for its range of unspoilt habitats and the rare plants and animals they support. Amongst these is the natterjack toad, whose breeding ponds in Britain are mostly confined to coastal sites, especially, as here, in dune slacks. Photo: Peter Wakely, English Nature.

Chapter 7 Coastal protected sites

7.1 Introduction

R.G. Keddie

7.1.1 Chapter structure

This chapter incorporates statutory and non-statutory site protection mechanisms operating at international, national and local level, including those administered by voluntary bodies and other organisations who own land. It covers only the various types of site protection mechanisms currently found within this region, giving a brief explanation for each category. For the purposes of this chapter, any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as 'coastal'. Where a site straddles the boundaries of two Coastal Directories Project regions and there is no easy way of calculating the percentage of the site lying in each, the site area has been halved, one half being included in each region. Data included in this section are correct as at August 1995, unless otherwise stated.

Statutory protected sites are those notified, designated or authorised under European Directives and/or implemented through British legislation (most notably the Wildlife and Countryside Act 1981) by a statutory body, thereby having recognised legal protection. 'Non-statutory sites' include a wide variety of sites that are not directly protected by legislation but which are recognised by statutory bodies or owned, managed or both by non-statutory organisations for their nature conservation or aesthetic value. Note that the categories of conservation protection (e.g. National Nature Reserve, RSPB Reserve) are not mutually exclusive. In many localities several different types of protected site overlap, since they have been identified for different wildlife and landscape conservation purposes. Patterns of overlap are often complex, since site boundaries for different categories of site are not always the same.

Further explanation of the various site protection mechanisms can be found in Davidson *et al.* (1991). Planning Policy Guidance Note (PPG) 9 - Nature Conservation (DoE 1994) also gives useful summaries of existing site protection mechanisms. It sets out the Government's objectives for nature conservation and provides a framework for safeguarding natural heritage under domestic/international law, emphasises the importance of both designated sites and undesignated areas for nature conservation, advises that potential SPAs and candidate SACs should be treated similarly to classified SPAs and designated SACs and deals with the treatment of nature conservation issues in development plans. PPG9 also includes full texts of the Ramsar Convention, the Birds Directive and the Habitats Directive (including lists of important species and habitat types).

The following types of protected site have not been included in this chapter:

- Archaeological designations and protected sites (covered in Chapter 6);
- 'Sites of Importance for Nature Conservation' (SINCs): a general term for the variously-named non-statutory sites identified by local authorities and wildlife trusts as having special local value for nature conservation but not currently managed for nature conservation; the most common are Sites of Nature Conservation Importance. For more information, see Collis & Tyldesley (1993).

Non-site based measures contained in conventions and directives aimed at broad species and habitat protection, such as the Bonn Convention, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), parts of the EC Birds Directive and parts of the EC Habitats Directive, are also not covered. For further information, see references in section 7.1.4 A.

This chapter is divided into five sections. A regional summary of all categories of site is given in Table 7.1.1. Section 7.2 covers those site-based protection measures falling under international conventions or European directives. Section 7.3 discusses sites identified under national statute, whereas section 7.4 covers sites without statutory protection but which are identified, owned or managed by statutory bodies; and finally, section 7.5 describes other types of site (i.e. those identified, owned or managed by charities, trusts etc.). For each category of protected site, a list of coastal sites is given (clockwise around the coast), showing their type, area/length and location, with an accompanying map. Each section concludes with further information sources and contact points relevant to the region.

7.1.2 Importance of the region

Because of the inclusion of the large areas of The Wash and, to a lesser extent, the Humber Flats and Marshes, the region contains a large proportion by area of the coastal protected wildlife sites in Britain. These include 37% and 36% respectively of Ramsar sites and Special Protection Areas, over 20% of the GB total area of coastal National Nature Reserves (NNRs), and 14% of Britain's coastal SSSIs (although less than 5% by number). These figures demonstrate the major conservation importance of the region.

Table 7.1.1 summarises site protection in the region, showing the numbers and areas of each type of site and comparing these with North Sea coast and British (whole country coast) totals.

Table 7.1.1 Summary of site protection in Region 6

	Number of protected sites					Area covered by site protection				
	Region	*North Sea coast*	*% of North Sea coast total in region*	*GB coast*	*% of GB coastal total in region*	*Region (ha)*	*North Sea Coast (ha)*	*% of North Sea coast total in region*	*GB coast (ha)*	*% of GB coast total in region*
Biosphere Reserves	1	1	100.0	8	12.5	5,497	5,497	100.0	27,243	20.2
Ramsar sites	8	31	25.8	51	15.7	93,944	168,545	55.7	251,508	37.4
Special Protection Areas	9.5*	43	22.1	76	12.5	95,279*	175,263	54.4	263,740	36.1
Environmentally Sensitive Areas	1	8	12.5	17	5.9	18,050	279,478	6.5	1,393,732	1.3
Geological Conservation Review sites	33	508	6.5	1,059	3.1	n/ap	n/ap	n/ap	n/ap	n/ap
National Nature Reserves	9	41	21.9	80	11.3	17,260	34,426	50.1	85,964	20.1
Sites of Special Scientific Interest	56	549	10.2	1,182	4.7	97,109	330,211	29.4	700,517	13.9
Areas of Special Protection	6	14	42.9	23	26.1	n/av	n/av	n/av	n/av	n/av
The Ministry of Defence sites	7	65	10.8	110	6.4	6,301	34,449	18.2	53,409	11.8
National Parks	1	2	50.0	6	16.7	27,200	173,900	15.6	745,000	3.6
Heritage Coasts	3	17.5	17.1	45	6.7	101[b]	661[b]	15.3[b]	1,525[b]	6.6[b]
Areas of Outstanding Natural Beauty	1	13.5	7.4	23	4.3	45,100	695,300	6.5	880,400	5.1
Local Nature Reserves	1	69	1.4	94	1.1	453	8,731	5.2	13,336	3.4
Country Parks	2	20	10.0	34	5.9	77	2,943	2.6	4,441	1.7
The National Trust sites[a]	15	191[a]	7.9[a]	446[a]	3.4[a]	3,800	17,457[a]	21.8[a]	62,648[a]	6.1[a]
Royal Society for the Protection of Birds reserves	11	53	20.8	80	13.8	6,292	24,555	25.6	38,401	16.4
The Wildfowl and Wetlands Trust reserves	1	3	33.3	6	16.7	405	472	85.8	1,585	25.5
The Wildlife Trusts reserves	23	122	18.9	218	10.5	3,047	10,411	29.3	23,398	13.0
Sensitive Marine Areas	1.5*	16.5	9.1	27	5.6	n/av	n/av	n/av	n/av	n/av
Candidate coastal/marine SACS	3.5*	33	10.6	71	4.9	n/av	n/av	n/av	n/av	n/av
Candidate coastal/terrestrial SACs	1.5+	15	10.0	40	3.8	n/av	n/av	n/av	n/av	n/av

Source: JNCC. Key: n/ap = not applicable; n/av = not available. [a] Includes The National Trust for Scotland sites; [b] Heritage Coast data in these columns refer to lengths in kilometres. *Sites lie partly within Region 5; for SPAs, half the area has been included in the total. +Sites lie partly within Region 7. Notes: Site types not currently found in the region: World Heritage (Natural) Sites, Biogenetic Reserves, Woodland Trust sites, Voluntary Marine Nature Reserves. In this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

7.1.3 Acknowledgements

The author wishes to thank all the staff of JNCC Coastal Conservation Branch, and particularly Nick Davidson and John Barne, for help in compiling this chapter.

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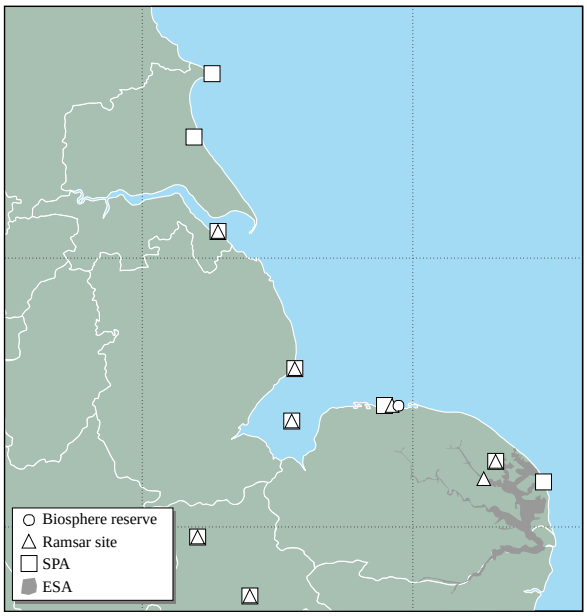
7.2 Sites designated under international conventions and directives

This section describes those types of site designated under international conventions to which the UK is a contracting party and sites designated under UK statute to implement EC Directives concerning wildlife and landscape conservation. Sites protected by domestic legislation only are covered in section 7.3.



Map 7.2.1 Coastal Ramsar sites, Special Protection Areas, Biosphere Reserve and Environmentally Sensitive Area. Source: JNCC.

7.2.1 Biosphere Reserves

Biosphere Reserves are non-statutory protected areas representing significant examples of biomes - terrestrial and coastal environments, throughout the world - protected for conservation purposes. They have particular value as benchmarks or standards for the measurement of long-term changes in the biosphere as a whole. They were devised by UNESCO as project number 8 of their Man and the Biosphere (MAB) ecological programme, and were launched in 1970. Criteria and guidelines for selection of sites were produced by a UNESCO task force in 1974.

There is one coastal Biosphere Reserve (5,497 ha) in Region 6, the only one on the North Sea coast (Table 7.2.1 and Map 7.2.1). This compares with a total of eight coastal Biosphere Reserves (27,243 ha) in Great Britain. The country as a whole (coastal and inland areas) has thirteen Biosphere Reserves (44,258 ha), all of them designated in 1976 and 1977. All these sites are also National Nature Reserves (data provided by International Policy Branch, JNCC).

Table 7.2.1 Biosphere Reserves

Site name	*Grid ref.*	*Area (ha)*	*County/ district*	*Date designated*
North Norfolk Coast	TF900460	5,497	Norfolk	1976

Note: In this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

7.2.2 Wetlands of international importance (Ramsar sites)

Ramsar sites are statutory areas designated by the UK government on the advice of the conservation agencies under the Ramsar Convention (the Convention on wetlands of international importance especially as waterfowl habitat). Contracting parties (of which the UK is one) are required to designate wetlands of international importance and to promote their conservation and 'wise use'. Ramsar sites are designated for their waterfowl populations, their important plant and animal assemblages, their wetland interest or a combination of these. There are eight coastal Ramsar sites (93,944 ha) in Region 6 (see Table 7.2.2 and Map 7.2.1). This compares with a total of 51 coastal Ramsar sites (251,508 ha) in Great Britain, of which 31 (168,545 ha) are on the North Sea coast. There are currently 82 designated Ramsar sites (342,019 ha) in Great Britain, as at November 1994 (data provided by Vertebrate Ecology and Conservation Branch, JNCC). Table 7.2.2 summarises the interest for which the sites have been designated, and sections 5.10, 5.11 and 5.12 describe their importance for the region's birds.

7.2.3 Special Protection Areas

The 1979 EC Directive on the Conservation of Wild Birds (the Birds Directive) requires member states to take conservation measures particularly for certain rare or vulnerable species and for regularly occurring migratory species of birds. In part this is achieved through the designation of statutory Special Protection Areas (SPAs) by the UK government on the advice of the statutory conservation agencies. This designation is implemented through the Wildlife and Countryside Act 1981; all SPAs have first to be notified as SSSIs.

There are nine whole and part of one other coastal SPAs (95,279 ha) in Region 6 (see Table 7.2.3 and Map 7.2.1). This compares with a total of 76 coastal SPAs (263,740 ha) in Great Britain, of which 43 (175,263 ha) are on the North Sea coast. There are currently 96 designated SPAs (292,878 ha) in Britain, as at November 1994 (data provided by Vertebrate Ecology and Conservation Branch, JNCC). Table 7.2.3 summarises the interest of these sites, and sections 5.10, 5.11 and 5.12 describe their importance for the region's birds.

Table 7.2.2 Ramsar sites

Site name	*Grid ref.*	*Area (ha)*	*Date designated*	*Selection criteria used*
Humber Flats and Marshes (Phase I), Humberside	TA2010	15,230	1994	Genetic and ecological diversity; critical stage of biological cycle; regularly supports 20,000 waterfowl and 1% of a waterfowl species population
Gibraltar Point (Wash Phase II), Lincolnshire	TF5660	414	1993	Representative wetland; rare species; regularly supports 20,000 waterfowl and 1% of a waterfowl species population
The Wash, Lincolnshire/Norfolk	TF550400	63,124	1988	Representative wetland; regularly supports 20,000 waterfowl and 1% of a waterfowl species population
Nene Washes, Cambridgeshire	TL200977	1,310	1993	Rare species; 1% of a waterfowl species population
Ouse Washes, Cambridgeshire/ Norfolk	TL393747	2,403	1976-1993	Representative wetland; rare species; regularly supports 20,000 waterfowl and 1% of a waterfowl species population
North Norfolk Coast	TF900460	7,701	1976-1988	Representative wetland; regularly supports 20,000 waterfowl and 1% of a waterfowl species population
Bure Marshes, Norfolk	TG335169	412	1976	Representative wetland; rare species; regularly supports substantial numbers of individual waterfowl indicative of wetlands
Broadland, Norfolk	TG3621	3,350	1994	Representative wetland; rare species; and 1% of a waterfowl species population
Total		***93,944***		

Source: JNCC, English Nature. Note: In this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

7.2.4 Special Areas of Conservation

Special Areas of Conservation (SACs) are one of the tools to be used to implement the 1992 EC Habitats Directive. They are areas considered to be important in a European context for habitats and non-avian species of interest. The protection measures are based around a series of six annexes: Annexes I & II require the designation of SACs for certain habitats and species; Annex IV prohibits the taking of certain species; Annex V requires the taking of certain species to be monitored; and Annex VI prohibits some means of capture or killing of mammals and fish. In the UK the Directive will be implemented through the Habitats etc. Regulations 1994. A list of possible SACs was announced by the Government on 31 March 1995. There are three whole possible SACs and part of one other proposed for their coastal/marine interest in Region 6, from a total of 71 such in GB, and one whole and part of one other proposed terrestrial coastal SAC, from a total of 40 in GB (Table 7.2.4) (see JNCC (1995) for more information).

7.2.5 Environmentally Sensitive Areas

European Community authorisation for Environmentally Sensitive Areas (ESAs) is derived from Article 19 of Council Regulation (EEC) No. 797/85 - National Aid in Environmentally Sensitive Areas. ESAs are statutory areas in which the Government seeks to encourage environmentally sensitive farming practices, prevent damage that might result from certain types of agricultural intensification, and restore traditional landscapes, for which member states are allowed to make payments to farmers.

There is one ESA, the Broads (18,050 ha), that includes land in Region 6 (Table 7.2.5 and Map 7.2.1). This compares with a total of seventeen coastal ESAs (1,393,732 ha) in Great Britain, of which eight (279,478 ha) are on the North Sea coast. 22 ESAs (3,101,200 ha) have been designated in England, seven in Wales and ten in Scotland (data from Parliamentary News (1994), English Nature, Welsh Office Agriculture Department and Scottish Office Agriculture and Fisheries Department).

7.2.6 Acknowledgements

Thanks are due to Alan Law and John Gibson (JNCC), Biotopes and International Policy Branches (JNCC), Siaron Hooper (English Nature) and the Ministry of Agriculture, Fisheries and Food (MAFF).

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Table 7.2.3 Special Protection Areas (SPAs)

Site name	*Grid ref.*	*Area (ha)*	*Date designated*	*Interest*
SPA				
Flamborough Head & Bempton Cliffs[a], Humberside/N. Yorkshire	TA258705	111	1993	Internationally important numbers of breeding kittiwakes; nationally important numbers of breeding guillemot, razorbill and puffin
Humber Flats and Marshes (Phase I), Humberside	TA2010	15,230	1994	Nationally or internationally important numbers of three breeding bird species and 21 wintering species; regularly supporting over 20,000 waterfowl
Hornsea Mere, Humberside	TA190470	230	1993	Internationally important numbers of gadwall, wintering wildfowl and breeding wetland species
Gibraltar Point (Wash Phase II), Lincolnshire	TF5660	414	1993	Wintering wildfowl (regularly supports 20,000 waterfowl and 1% of a waterfowl species population)
The Wash, Lincs./Norfolk	TF550400	63,124	1988	Internationally important numbers of thirteen species of wintering wildfowl; nationally important numbers of seven species of wintering wildfowl and one species of passerine; regularly supports over 20,000 waterfowl
Nene Washes, Cambridgeshire	TL200977	1,310	1993	Internationally important numbers of Bewick's swan and gadwall; nationally important numbers of wintering and breeding waterfowl
Ouse Washes, Cambridgeshire & Norfolk	TL393747	2,372	1993	Internationally important numbers of wintering wildfowl; nationally important numbers of wintering waterfowl and breeding waders; regularly supports over 20,000 waterfowl
North Norfolk Coast	TF900460	7,701	1989	Internationally important numbers of breeding terns and wintering wildfowl; nationally important numbers of breeding waders, wildfowl and bearded tit
Broadland, Norfolk	TG3621	4,646	1994	Internationally important numbers of wintering Bewick's swans, gadwall, wigeon and shoveler; nationally important numbers of seven species of wintering and ten species of breeding wetland birds
Great Yarmouth North Denes, Norfolk	TG5309	146	1993	Nationally important for breeding little terns
Total		***95,279***		

Source: JNCC, English Nature, Pritchard *et al.* (1992). Note: In this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal. [a]Flamborough Head and Bempton Cliffs are partly within Region 5 - half of the area has been included in the total for Region 6.

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Table 7.2.4 Possible Special Areas of Conservation (SACs) in Region 6

Interest	*County*	*Site name*	*Qualifying interest*
Coastal/marine	Humberside, North Yorkshire	Flamborough Head[a]	Reefs, submerged or partly submerged sea caves, vegetated sea cliffs of the Atlantic and Baltic coasts
Coastal/marine	Lincolnshire, Norfolk	North Norfolk Coast and Gibraltar Point Dunes	Embryonic shifting dunes, fixed dunes with herbaceous vegetation (grey dunes), humid dune slacks, lagoons, Mediterranean and thermo-Atlantic halophilous scrubs, perennial vegetation of stony banks, shifting dunes along the shoreline with marram (white dunes)
Coastal/marine	Lincolnshire, Norfolk	The Wash and North Norfolk Coast	Common seal, Atlantic salt meadows, large shallow inlets and bays, Mediterranean and thermo-Atlantic halophilous scrubs, Mediterranean salt meadows, mudflats and sandflats not covered by seawater at low tide, glasswort and other annuals colonising mud and sand, sandbanks which are slightly covered by sea water all the time
Terrestrial/coastal	Cambridgeshire, Norfolk	Ouse Washes	Spined loach
Coastal/marine	Norfolk	Winterton - Horsey Dunes	Embryonic shifting dunes, eu-Atlantic decalcified fixed dunes, humid dune slacks
Terrestrial/coastal	Norfolk, Suffolk	The Broads[b]	Fen orchid, Desmoulin's snail, alkaline fens, calcareous fens with great fen sedge and sedge species of the Caricion davallianae, natural eutrophic lakes with Magnopotamion or Hydrocharition-type vegetation, residual alluvial forests, transition mires and quaking bogs

Source: data from JNCC . Key: [a] partly within Region 5; [b] partly within Region 7. Note: In this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

Table 7.2.5 Environmentally Sensitive Areas

Site name	*Area (ha)*	*County/ district*	*Date designated*	*Interest*
The Broads[a]	18,050	Norfolk and Suffolk	1987	Lowland river valley grassland wetland: system of broads, waterways, reed swamps, fens, carr woodland and drained grazing marsh

Source: MAFF, English Nature. Key: [a]The Broads are partly within Region 7. Note: In this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Ramsar sites, SPAs, Special Areas of Conservation (Humberside)	*Conservation Officer North Humberside, English Nature (North and East Yorkshire Local Team), York, tel: 01904 432700
Ramsar sites, SPAs, Special Areas of Conservation (Lincolnshire)	*Conservation Officer Lincolnshire, English Nature (East Midlands Local Team), Grantham, tel: 01476 68431
Ramsar sites, SPAs, Special Areas of Conservation (Cambridgeshire)	*Conservation Officer, English Nature (Bedfordshire, Cambridgeshire, Northamptonshire Local Team), Peterborough, tel: 01733 391100
Biosphere Reserves, Ramsar sites, SPAs, ESAs, Special Areas of Conservation (Norfolk)	*Conservation Officer North Norfolk, English Nature (Norfolk Local Team), Norwich, tel: 01603 620558
Ramsar sites, SPAs (Humberside)	*Regional Officer, RSPB North England Office, Newcastle upon Tyne, tel: 0191 281 3366
Ramsar sites, SPAs (Lincolnshire, Norfolk, Cambridgeshire)	*Regional Officer, RSPB East Anglia Office, Norwich, tel: 01603 661662
ESAs	Ministry of Agriculture, Fisheries and Food, Whitehall Place, London SW1A 2HH, tel: 0171 270 3000
Special Areas of Conservation	*European Wildlife Division, DoE, Bristol, tel: 0117 9878811 ext. 8341

* Starred contact addresses are given in full in the Appendix.

7.3 Sites established under national statute

Included in this section are the eight types of site identification made under national legislation relating to wildlife, landscape and amenity value. Identifications are made by the statutory conservation agencies (in this region English Nature), local authorities or the government acting on advice from these bodies.

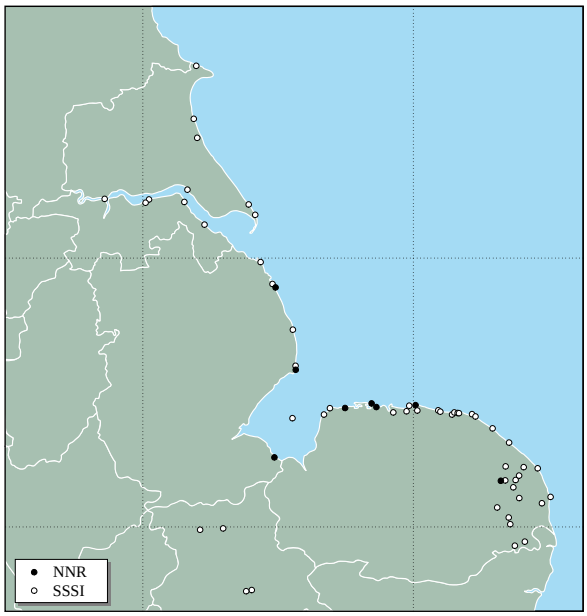
7.3.1 National Nature Reserves

National Nature Reserves (NNRs) contain examples of some of the most important natural and semi-natural ecosystems in Great Britain. They are managed to conserve their habitats, providing special opportunities for scientific study of the habitats, communities and species represented within them (Marren 1994). They are statutorily declared by the country agencies under section 19 of the National Parks and Access to the Countryside Act 1949, or section 35 of the Wildlife and Countryside Act 1981.

There are nine coastal NNRs (17,260 ha) in Region 6 (Map 7.3.1), including some of the most important areas of sand dune, shingle, saltmarsh, mudflat and wet grassland in the region (Table 7.3.1). This compares with a total of 80 (85,964 ha) coastal NNR sites in Great Britain, of which 41 sites (34,426 ha) are on the North Sea coast. The total number of NNRs in Britain is 288 (195,531 ha), as at March 1995 (data provided by Countryside Council for Wales, English Nature, Scottish Natural Heritage and Biotopes Conservation Branch, JNCC).

7.3.2 Sites of Special Scientific Interest

Sites of Special Scientific Interest (SSSIs) are statutorily notified under the Wildlife and Countryside Act 1981. They are intended to form a national network of areas,



Map 7.3.1 Coastal National Nature Reserves and Sites of Special Scientific Interest. Sources: English Nature, JNCC. Note: a single symbol may represent more than one site in close proximity.

representing in total the parts of Britain in which the natural features, especially those of greatest value to wildlife conservation, are most highly concentrated or of highest quality. Each SSSI represents a significant fragment of the much-depleted resource of wild nature remaining in Britain. Within the area of an SSSI the provisions of the Wildlife & Countryside Act 1981 and its 1985 amendments aim to ensure that actions damaging to the wildlife interest of the area are not carried out.

There are 56 coastal SSSIs (97,109 ha) in Region 6, as at September 1994 (Table 7.3.2 and Map 7.3.1). This compares

Table 7.3.1 National Nature Reserves

Site name	*Grid ref.*	*Area (ha)*	*Date last declared*	*Habitats*
Lincolnshire				
Saltfleetby/Theddlethorpe Dunes	TF485905	440	1968	Tidal flats, dunes, salt and freshwater marsh
Gibraltar Point	TF565585	414	1984	Tidal flats, dunes, shingle, grazing marsh
The Wash	TF492278	9,899	1986	Estuarine tidal flats, saltmarsh, sandbanks
Norfolk				
Holme Dunes	TF715449	187	1995	Sand dunes, sand flats, saltmarsh and reedbeds
Scolt Head Island	TF850470	737	1955	Saltmarsh, sand dunes, shingle and mudflats
Holkham	TF870450	3,925	1967	Sand dunes, saltmarsh, intertidal mudflats, freshwater grazing marsh and pine plantation
Blakeney	TG000462	1,097	1995	Shingle, sand dunes, saltmarsh, sand and mudflats, freshwater grazing and reedbed
Bure Marshes	TG345160	451	1982	Open water, reedbed, fen meadow, dykes and alder carr
Winterton Dunes	TG487214	109	1957	Sand dunes, dune slack and dune heath
Total NNR		***17,260***		

Source: EN, JNCC, Marren (1994). Note: In this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

Table 7.3.2 SSSIs in Region 6

Site name	*Grid ref.*	*Area (ha)*	*Date last notified*
N. Yorkshire			
Bolton Percy Ings	SE534401	7	1991
Acaster South Ings	SE594437	38	1988
River Derwent	SE678287-SE825757	387	1986
Breighton Meadows	SE704330	37	1992
Humberside			
Hoddy Cows Spring	TA182738	2	1984
Withow Gap, Skipsea	TA183546	8	1987
Dimlington Cliff	TA390220	55	1990
The Lagoons	TA409180	68	1990
Kelsey Hill Gravel Pits	TA239266; TA245274	11	1986
Hornsea Mere	TA190470	230	1983
Humber Flats & Marshes: Spurn Head to Salt End Flats	TA150275	5,442	1985
Humber Flats & Marshes: Upper Humber	SE835238	4,762	1989
South Ferriby Cliff	SE989215	26	1987
Humber Flats & Marshes: Barton & Barrow Clay Pits	TA005230	435	1989
Humber Flats & Marshes: The Grues	TA146229	219	1988
Pyewipe & Cleethorpes Coast	TA223147	1,118	1988
Lincolnshire			
North Lincolnshire Coast Saltfleetby to Theddlethorpe Dunes	TF480910	952	1988
Sea Bank Clay Pits	TF558740	17	1987
Gibraltar Point	TF562595	581	1988
The Wash	TF550400	63,135	1984
Cambridgeshire			
Nene Washes, Whittlesey	TL200977	1,310	1983
Ouse Washes	TL393747	2,403	1984
Bassenhally Pit, Whittlesey	TL286985	9	1984
Berry Fen	TL378745	18	1984
Norfolk			
Hunstanton Cliffs	TF672413	5	1984
North Norfolk Coast	TF690443	7,701	1986
Wells Chalk Pit	TF929429	6	1985
Cockthorpe Common	TF985430	7	1985
Morston Cliff	TF990441	1	1984
Wiveton Downs	TG024430	30	1992
Weybourne Cliff	TG111437	40	1985
Weybourne Town Pit	TG114431	1	1984
Sheringham and Beeston Regis Common	TG164424	24	1985
Beeston Cliff	TG167434	11	1985
West Runton Cliffs	TG183432	18	1984
East Runton Cliffs	TG194430	20	1985
Overstrand Cliffs	TG240415	21	1992
Sidestrand & Trimingham Cliffs	TG252408	68	1993
Mundesley Cliffs	TG317365	29	1984
Happisburgh Cliffs	TG379314	6	1985
Ant Broads and Marshes	TG362213	735	1989
Upper Thurne Broads & Marshes	TG430210	1,159	1988
Winterton - Horsey Dunes	TG490210	427	1989
Ludham - Potter Heigham Marshes	TG410178	99	1990
Shallam Dyke Marshes	TG399165	72	1986
Bure Broads & Marshes	TG360160	412	1991
Upton Broad (and Marshes)	TG390137	194	1986
Damgate Marshes, Acle	TG413095	64	1993
Great Yarmouth North Denes	TG535101	92	1992
Yare Broads & Marshes	TG330063	736	1988
Breydon Water	TG500075	307	1987
Poplar Farm Meadows, Langley	TG370021	7	1985
Hardley Flood	TM380997	50	1990
Stanley and Alder Carrs, Aldeby	TM434928	44	1986
Geldeston Meadows	TM396916	3	1988
Total		***97,109***	

Source: EN, JNCC. Note: In this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

with a total of 1,182 coastal SSSIs (700,517 ha) in Great Britain, of which 549 (330,211 ha) are on the North Sea coast. The total number of SSSIs in Britain as at June 1994 was 6,055 (1,920,527 ha), or 7.98% of the total land mass, with 3,794 (871,066 ha) in England, 1,371 (846,869 ha) in Scotland and 890 (202,592 ha) in Wales (data provided by Countryside Council for Wales, English Nature, Scottish Natural Heritage and Biotopes Conservation Branch, JNCC).

Of the 56 coastal SSSIs in the region, nearly half (46.4%) include intertidal land to Mean Low Water Mark, while over a quarter (28.6%) are purely terrestrial. Nearly three-quarters were selected at least partly for their biological interest and nearly one third at least partly for their geological or geomorphological interest. Of the total, only one twentieth have both biological and earth science interest. Examples of a very wide range of habitats and species occur within the SSSIs in this region, the most frequently occurring habitats being open water, tidal flats, saltmarsh, sand dunes, soft sea cliffs, wet grassland, dry grassland, woodland, fen and reed beds, all of which occur in between 18-34% of sites. SSSIs in the region include many sites of interest for their higher plants, terrestrial invertebrates, breeding seabirds and breeding waterfowl. The Wash, at over 63,000 ha, is the largest SSSI in Britain. Further details of SSSIs may be found in the coastal and marine UKDMAP datasets module disseminated by JNCC Coastal Conservation Branch (BODC 1992; Barne *et al.* 1994).

7.3.3 Local Nature Reserves

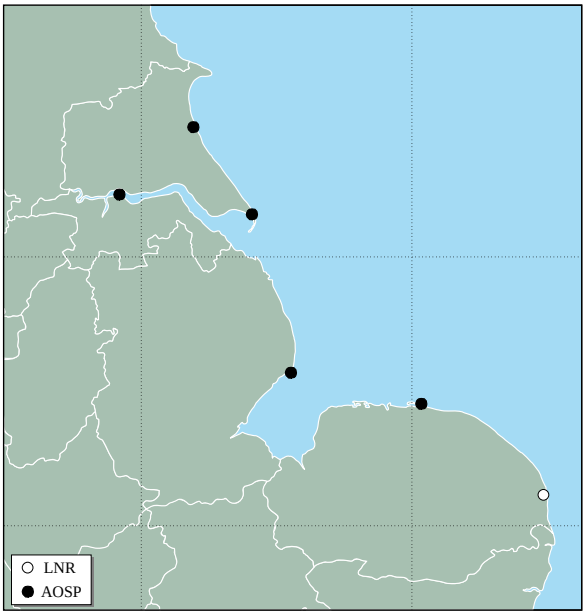
Local Nature Reserves (LNRs) are statutorily designated by local authorities, under section 21 of the National Parks and Access to the Countryside Act 1949, for the same purposes as NNRs, but because of the local rather than the national interest of the site and its wildlife. Under this Act local authorities have the power to issue bylaws to protect the

LNR. There is one LNR - Breydon Water (453 ha) - in Region 6 (Table 7.3.3 and Map 7.3.2). This compares with a total of 94 coastal LNRs (13,336 ha) in Great Britain, of which 69 (8,731 ha) are on the North Sea coast. There are 396 LNRs (21,513 ha) in total in Britain (data provided by English Nature, Countryside Council for Wales and Scottish Natural Heritage).

Table 7.3.3 Local Nature Reserves

Site name	*Grid ref.*	*Area (ha)*	*Date designated/ opened*	*Habitat*
Breydon Water (Norfolk)	TG5007	453	1968	Grazing marshes and mudflats; open water

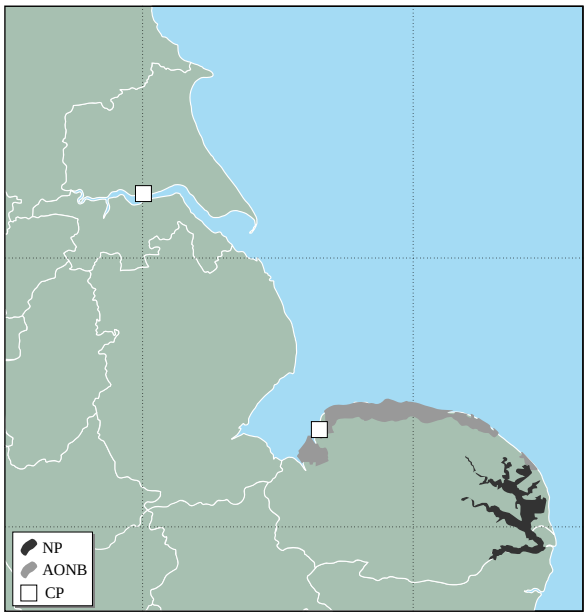
Source: English Nature. Note: In this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.



Map 7.3.2 Coastal Local Nature Reserves and Area of Special Protection. Large sites are shown as a centre grid reference. Source: English Nature.

7.3.4 Areas of Special Protection

'Area of Special Protection' (AoSP) is a statutory protection mechanism replacing Bird Sanctuary Orders made under the 1954 to 1967 Protection of Birds Acts, which were repealed and amended under the Wildlife and Countryside Act 1981. Designation aims to prevent the disturbance and destruction of the birds for which the area is identified, by making it unlawful to damage or destroy either the birds or their nests and in some cases by prohibiting or restricting access to the site. There are six AoSPs in Region 6 (Table 7.3.4 and Map 7.3.2), compared with a total of 23 sites identified as coastal in Great Britain, fourteen of them located on the North Sea coast. There are 38 AoSPs in total in Great Britain (data supplied by DoE European Wildlife Division).



Map 7.3.3 Coastal National Park (The Broads), Area of Outstanding Natural Beauty and Country Parks. Source: Countryside Commission.

Table 7.3.4 Areas of Special Protection (AoSPs)

Site name	*Grid ref.*	*Date designated*
Humberside		
Hornsea Mere (No. 403)	TA190470	1980
Easington Lagoons (1) (No. 1163)	TA409180	1987
Easington Lagoons (2) (No. 2059)	TA409180	1993
Humber Estuary (No. 1532 revoked by No. 1808)	SE880244	1955 then 1963
Lincolnshire		
Gibraltar Point (No. 557)	TF560574	1971
Norfolk		
Cley Marshes (No. 536)	TG052449	1966

Source: DoE. Note: In this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

7.3.5 Areas of Outstanding Natural Beauty

The primary purpose of the Area of Outstanding Natural Beauty (AONB) designation is to conserve natural beauty, but account is taken of the need to safeguard agriculture, forestry and other rural industries, and of the economic and social needs of local communities (Countryside Commission 1994). AONBs are statutorily designated, in England by the Countryside Commission, under the National Parks and Access to the Countryside Act 1949. There is one AONB (45,100 ha) in Region 6 (Table 7.3.5 and Map 7.3.3). This compares with a total of 23 (880,400 ha) that include areas within the coastal zone in Great Britain, of which the whole

of thirteen and half of one, together covering 695,300 ha, are on the North Sea coast. In 1993 the total area covered by AONBs in England and Wales was 2,104,200 ha (Countryside Commission 1994). These areas cover nearly 14% of the countryside of England and Wales.

Table 7.3.5 Areas of Outstanding Natural Beauty (AONBs) and National Parks

Type	*Site name*	*Area (ha)*	*Date designated*
AONB	Norfolk Coast (Norfolk)	145,100	1968
National Park	The Broads [a] (Norfolk/Suffolk)	27,200	1989

Source: Countryside Commission. Key: [a] 3,100 ha of this site are in Suffolk (Region 7). Note: In this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

7.3.6 National Parks

The purpose of National Parks is to preserve and enhance the most beautiful, dramatic and spectacular expanses of countryside in England and Wales (Countryside Commission 1993), while promoting public enjoyment of them, and having regard for the social and economic well-being of those living within them. The Countryside Commission (England) and the Countryside Council for Wales advise government on National Parks, each of which is administered by a Park Authority (the Broads Authority in this instance). National Parks in England and Wales were statutorily designated by the National Parks Commission and confirmed by the Government between 1951 and 1957; and in Region 6 the Broads (27,200 ha) were given equivalent status in 1989. It is the only National Park in Region 6 (Table 7.3.5). This compares with a total of six National Parks (745,000 ha) that include coastal areas in Great Britain, of which two sites (173,900 ha) are on the North Sea coast.

7.3.7 Country Parks

Country Parks are primarily intended for recreation and leisure opportunities close to population centres and do not necessarily have any nature conservation interest. Nevertheless, many are in areas of semi-natural habitat and so form a valuable network of locations at which informal recreation and the natural environment co-exist. They are statutorily declared and managed by local authorities under section 7 of the Countryside Act 1968. There are two coastal Country Parks (77 ha) in Region 6 (Table 7.3.6 and Map 7.3.3). This compares with a total of 34 coastal Country Parks (4,441 ha) in Great Britain, of which 20 (2,943 ha) are on the North Sea coast. There are 281 Country Parks (approximately 35,150 ha) in Britain (data provided by the Countryside Commission and the Countryside Council for Wales, and from Countryside Commission for Scotland (1985)).

Table 7.3.6 Country Parks

Site name	*Grid ref.*	*Area (ha)*	*Date designated/ opened*
Humber Bridge (Humberside)	TA012263	19	1986
Snettisham Coastal Park (Norfolk)	TF650340	58	n/a
Total		*77*	

Source: Countryside Commission, English Nature. Key: n/a = not available. Note: In this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

7.3.8 Acknowledgements

Thanks are due, in particular, to Ray Woolmore (Countryside Commission), and also to Roger Bolt (JNCC), Sylvia White, Phillip Biss (English Nature), Site Safeguards Team (Countryside Council for Wales), Kathy Duncan and Natasha O'Connel (Scottish Natural Heritage), Neale Oliver (DoE) and Paul Johnson (Countryside Commission).

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
SSSIs, AoSP (N. Yorks/Humberside)	*Conservation Officer North Yorkshire (East)/ Conservation Officer North Humberside, English Nature (North and East Yorkshire Local Team), York, tel: 01904 432700
NNRs, SSSIs, AoSPs (Lincs.)	*Conservation Officer Lincolnshire, English Nature (East Midlands Local Team), Grantham, tel: 01476 68431
SSSIs (Cambridgeshire)	*Conservation Officer, English Nature (Bedfordshire, Cambridgeshire, Northamptonshire Local Team), Peterborough, tel: 01733 391100
NNRs, SSSIs, AoSPs, LNRs (Norfolk)	*Conservation Officer North Norfolk, English Nature (Norfolk Local Team), Norwich, tel: 01603 620558
Areas of Special Protection	*European Wildlife Division, DoE, Bristol, tel: 0272 878811
National Park, AONB, Country Park (Norfolk)	*Countryside Commission Eastern Region, Cambridge, tel: 01223 354462
Country Parks (Humberside)	*Countryside Commission (Yorkshire & Humberside Region), Leeds, tel: 0113 246 9222
Norfolk Broads National Park	Broads Authority, Thomas Harvey House, 18 Colegate, Norwich, Norfolk NR3 1BQ, tel: 01603 610734
National Parks	Council for National Parks, 246 Lavender Hill, London SW11 1LJ, tel: 0171 924 4077
Coastal and marine UKDMAP datasets	*Coastal Conservation Branch, JNCC, Peterborough, tel: 01733 62626

* Starred contact addresses are given in full in the Appendix.

7.4 Sites identified by statutory agencies

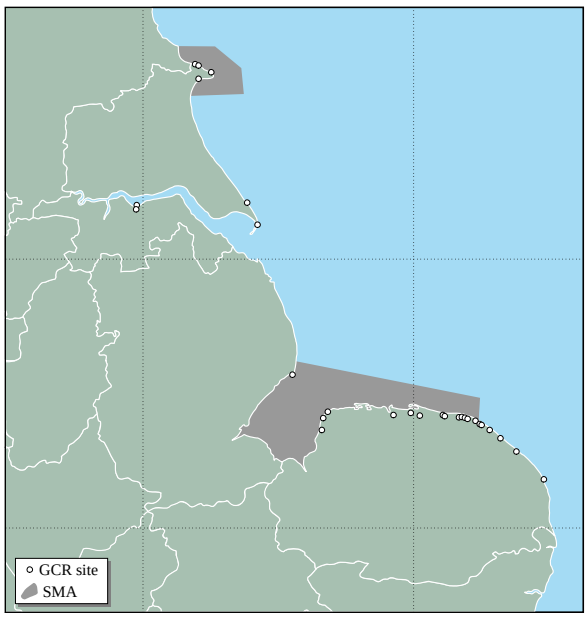
This section covers sites which, although not protected by statute, have been identified by statutory agencies as being of nature conservation or landscape importance.

7.4.1 Nature Conservation Review sites

There are 953 confirmed Nature Conservation Review (NCR) sites (approximately 1,500,000 ha) existing in Britain. NCR sites are non-statutory sites identified by statutory conservation bodies. As defined by Ratcliffe (1977), whose definition of 'coastal' differed from that adopted in this chapter (see section 7.1.1), 149 of these sites (approximately 360,000 ha) are coastal (data provided by Biotopes Conservation Branch, JNCC). In this region NCR sites include all coastal sites supporting nationally and internationally important bird populations, as well as those holding the best representative examples of vegetative habitats. The NCR series helps to identify suitable candidates for biological National Nature Reserve designation.

7.4.2 Geological Conservation Review sites

Geological Conservation Review (GCR) sites are non-statutory sites identified by the statutory conservation agencies; they are sites of national and international earth science importance. The GCR selection process describes and assesses key sites in the context of their geology, palaeontology, mineralogy or geomorphology; GCR sites are the earth science equivalent of NCRs. Almost 3,000 individual GCR Single Interest Localities (SILs) have been identified throughout Britain. Parts of two and the whole of 31 coastal GCR SILs are within Region 6, listed in Table 7.4.1 with an indication of whether they were selected for their geological or their coastal geomorphological interest (Map 7.4.1). This compares with a total of 1,059 coastal GCR SILs in Britain, 508 of which are on the North Sea coast (data provided by JNCC Earth Sciences Branch). Detailed scientific accounts of 519 (coastal and inland) GCR SILs have been published or are in preparation in nine volumes of a planned 42-volume Geological Conservation Review series.



Map 7.4.1 Coastal Geological Conservation Review sites and Sensitive Marine Areas. Source: English Nature, JNCC. Note: a single symbol may represent more than one site in close proximity.

Table 7.4.1 GCR sites

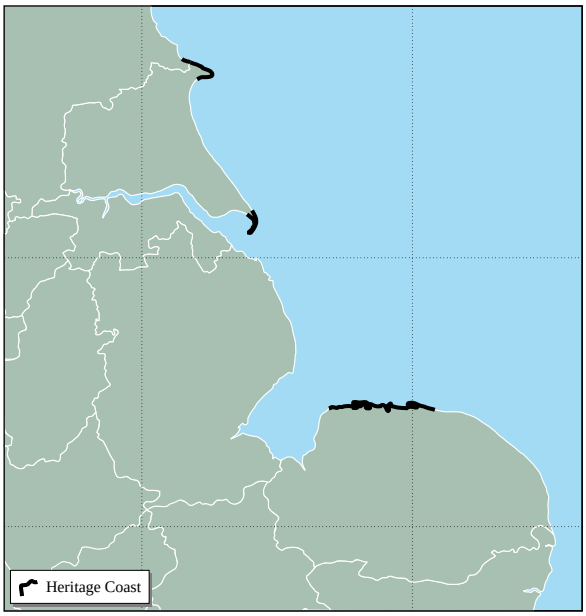
Site name
N. Yorks/Humberside
Speeton Beck to Red Cliff Hole**
Flamborough Head**
Humberside
Flamborough Head*
Sewerby Cliff
Sewerby
Dimlington
Spurn Head*
South Ferriby Cliff
South Ferriby
Lincolnshire
Gibraltar Point*
Norfolk
Heacham
Hunstanton Cliffs (2 SILs)
North Norfolk Coast
North Norfolk Coast*
Wells Chalk Pit
Morston Cliff
Blakeney Esker
Weybourne Cliffs (2 SILs)
Weybourne Town Pit
Beeston
West Runton (2 SILs)
East Runton (2 SILs)
Overstrand to Trimingham
Overstrand Cliff Section
Sidestrand (2 SILs)
Trimingham
Mundesley
Happisburgh
Winterton Ness*

Source: EN, JNCC. Key: * Sites selected wholly or partly for their coastal geomorphological interest (all other sites geological); **part of each of these sites is in Region 5. Note: In this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

Table 7.4.2 Heritage Coasts

Site name	*Grid ref.*	*Length (km)*	*Date designated*
Flamborough Headland[a, b] (Humberside/N. Yorkshire)	TA202686-TA151757	19	1979
Spurn[b] (Humberside)	TA393172-TA409184	18	1988
North Norfolk[b] (Norfolk)	TF695440-TG096441	64	1975
Total		***101***	

Source: Countryside Commission. Key: [a] 2 km of Flamborough Headland Heritage Coast is in Region 5 (North Yorkshire), but the whole length is included in the total for Region 6 as the greater part (17 km) is in Humberside; [b] completely defined, i.e. also has a defined landward boundary.



Map 7.4.2 Heritage Coasts. Source: Countryside Commission.

7.4.3 Heritage Coasts

A Heritage Coast is an area selected for having a coastline of exceptionally fine scenic quality, exceeding 1 mile in length, substantially undeveloped and containing features of special significance and interest. This non-statutory protection is agreed between local authorities and (in England) the Countryside Commission, as an aid to local authorities in planning and managing their coastlines. There are three Heritage Coasts (101 km) in Region 6 (Table 7.4.2 and Map 7.4.2). This compares with a total of 45 Heritage Coasts, defined as at May 1993, covering 1,525 km of the English and Welsh coast, of which the whole of seventeen and part of one, together covering 661 km, are on the North Sea coast. Of the English coastline encompassed by Heritage Coasts, 39.5% is protected by the National Trust (Heritage Coast Forum 1993).

7.4.4 Sensitive Marine Areas

Sensitive Marine Areas (SMAs) are non-statutory marine areas that are nationally important and notable for their marine animal and plant communities or which provide ecological support to adjacent statutory sites. They are identified by the statutory conservation body English Nature, with a further aim of raising awareness and disseminating information to be taken into account in estuarine and coastal management planning. These areas rely on the co-operation of users and local communities for sustainable management, with the help of grant aid. SMAs are the more commonly used term for areas described in previous technical documents (e.g. *Important areas for marine wildlife around England* (English Nature 1994a)) as 'Important Areas for Marine Wildlife' under English Nature's initiative *Managing England's marine wildlife* (English Nature 1994b). The whole of one and part of one other Sensitive Marine Areas are within Region 6 (Table 7.4.3 and Map 7.4.1), compared with a total of 27 around the coast of England, of which sixteen whole sites and part of one other are on the North Sea coast.

Table 7.4.3 Sensitive Marine Areas

Site name	*County*	*Date established*
Flamborough Head[a]	N. Yorkshire/Humberside	1994
The Wash & North Norfolk	Lincolnshire/Norfolk	1994

Source: EN (1994a). Key: [a]The N. Yorkshire part of Flamborough Head SMA is in Region 5.

7.4.5 Acknowledgements

Thanks are due to Ray Woolmore and Paul Johnson (Countryside Commission), Roger Bolt and Earth Sciences Branch (JNCC), Sylvia White, Phillip Biss, Paul Gilliland and Peter Lambley (English Nature), Kathy Duncan and Natasha O'Connel (Scottish Natural Heritage), and Site Safeguards Team (Countryside Council for Wales).

7.4.6 Further sources of information

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Gregory, K.J., *ed.* In prep. *Fluvial geomorphology of Great Britain.* London, Chapman and Hall. (Geological Conservation Review series.)

Joint Nature Conservation Committee. In prep. *Introduction to the Geological Conservation Review.* Peterborough, JNCC. (Geological Conservation Review series.)

Smith, D.B. In press. *Marine Permian of England*. London, Chapman & Hall. (Geological Conservation Review series.)

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Heritage Coasts (Humberside & N. Yorkshire)	*Countryside Commission (Yorkshire & Humberside Region), Leeds, tel: 0113 246 9222
Heritage Coasts (Norfolk)	*Countryside Commission Eastern Region, Cambridge, tel: 01223 354462
NCR sites, GCR sites, SMAs (Humberside)	*Conservation Officer North Humberside, English Nature (North and East Yorkshire Local Team), York, tel: 01904 432700
NCR sites, GCR sites, SMAs (Lincolnshire)	*Conservation Officer Lincolnshire, English Nature (East Midlands Local Team), Grantham, tel: 01476 68431
NCR sites, GCR sites (Cambridgeshire)	*Conservation Officer, English Nature (Bedfordshire, Cambridgeshire, Northamptonshire Local Team), Peterborough, tel: 01733 391100
NCR sites, GCR sites, SMAs (Norfolk)	*Conservation Officer North Norfolk, English Nature (Norfolk Local Team), Norwich, tel: 01603 620558

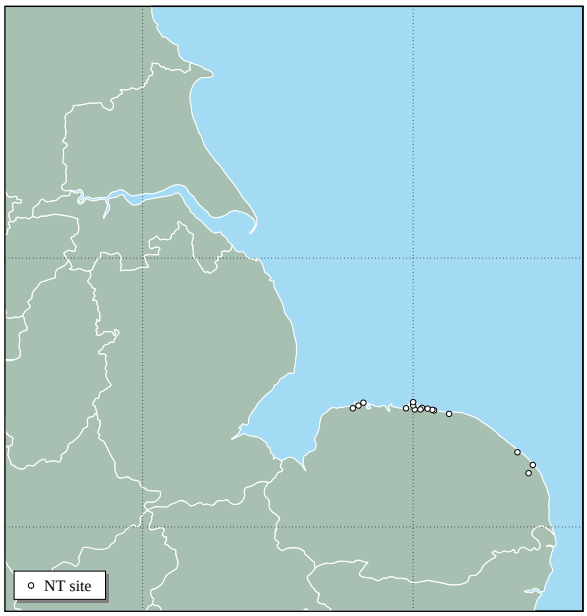
* Starred contact addresses are given in full in the Appendix.

7.5 Other types of protected site

7.5.1 The National Trust

The National Trust is an independent charity that is currently the largest private landowner in Britain. The National Trust owns about 230,000 ha of land in England, Wales and Northern Ireland, and over 200 buildings of outstanding importance. It has also accepted or bought covenants, which protect against development, for a further 31,600 ha of land and buildings. Many of the tenanted properties have individual intrinsic value; together they protect large areas of unique landscape and countryside. The National Trust has statutory powers to protect its properties, under an Act of Parliament (1907) which declares its holdings of land and buildings inalienable; these properties cannot be sold or mortgaged. In addition, National Trust properties can be protected by bylaws. In 1985 the National Trust relaunched its 1965 campaign 'Enterprise Neptune' to raise funds for the purchase of coastal areas. A total of 850 km of coast are now protected by the National Trust (National Trust 1993).

There are fifteen coastal National Trust sites (3,800 ha) in Region 6 (Table 7.5.1 and Map 7.5.1). This compares with a total of 446 coastal sites (62,648 ha) in Britain under the protection of the National Trust or National Trust for Scotland, of which 191 (17,457 ha) are on the North Sea coast. The National Trust (encompassing England and Wales) has 426 coastal sites (37,478 ha) (data extracted from National Trust (1992)); the National Trust for Scotland has nineteen coastal sites (25,170 ha) (data extracted from National Trust for Scotland (1993)).



Map 7.5.1 Coastal National Trust sites. Source: National Trust. Note: a single symbol may represent more than one site in close proximity.

Table 7.5.1 National Trust sites*

Site name	*Grid ref.*	*Area (ha)*	*Date acquired*	*Description*
Norfolk				
Holme-next-the-sea	TF713449	2	1991	Grass-covered dunes
Branodonum Roman Fort	TF782440	9	1984-1985	Roman shore fort
Brancaster	TF800450	870	1964-1967	Beach, tidal foreshore, sand dunes, marsh and saltings
Scolt Head Island	TF8146	656	1923-1937	Sand dune, saltmarsh, shingle ridge
Stiffkey Saltmarshes	TF980445	197	1976	Saltmarsh
Blakeney Point	TG005467	480	1912-1932	Shingle spit, foreshore, saltmarsh and sand dunes
Morston Marshes	TG010445	238	1973-1986	Saltings, tidal creeks, scrub covered grassland
Friary Farm	TG032440	32	1984	Coastal farmland and grazing marsh
Freshes	TG040447	73	1986-1989	Reclaimed grazing marshland
Salthouse Broad	TG061448	12	1950	Marsh, shingle, saline lagoons
Great Eye	TG081443	1	1987	Sand and shingle
Gramborough Hill	TG086441	28	1981	Saltmarsh and coastal hill
Sheringham Park	TG135420	311	1987	Coastal park
Horsey	TG4623	705	1948-1985	Marshes, marrams and mere
Heigham Holmes	TG444204	186	1987	Broadland grazing marsh
Total area		***3,800***		

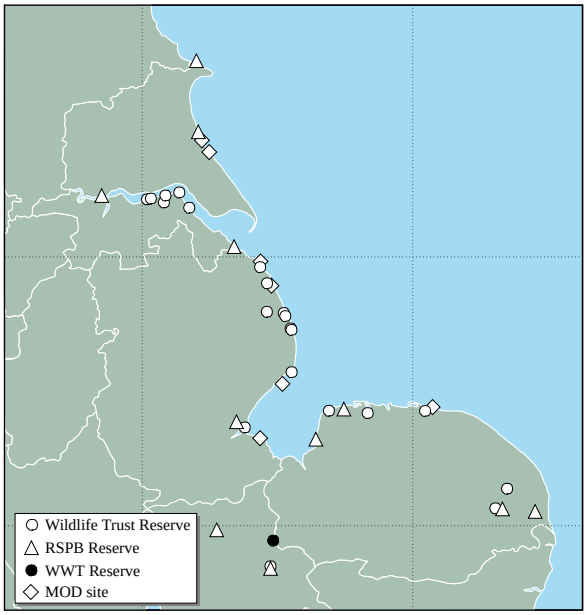
Source: The National Trust. Key: *includes only sites that are of mainly natural heritage interest. Note: In this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

7.5.2 The Royal Society for the Protection of Birds

The Royal Society for the Protection of Birds (RSPB) has substantial non-statutory reserve holdings and currently manages over 130 reserves (84,000 ha) in Britain (RSPB 1993). Wherever possible, reserves are purchased, so that the level of safeguard for the wildlife and their habitats is high. Where reserves are leased, the RSPB aims to acquire long leases (longer than 21 years) with appropriate management rights. There are eleven RSPB sites (6,292 ha) in Region 6 (Table 7.5.2 and Map 7.5.2). This compares with a total of 80 coastal RSPB sites (38,401 ha) in Great Britain, of which 53 (24,555 ha) are on the North Sea coast (data extracted from RSPB (1993) and RSPB (*in litt.*)).

7.5.3 The Wildfowl & Wetlands Trust

As well as their wildfowl collections, used extensively for education, The Wildfowl & Wetlands Trust (WWT - formerly the Wildfowl Trust) has established non-statutory reserves in a number of key wintering areas for migrant wildfowl. The level of protection afforded to such sites is high, since



Map 7.5.2 Other voluntary and private sites. Source: Ministry of Defence, Wildlife Trusts, RSPB, Wildfowl & Wetlands Trust. Note: a single symbol may represent more than one site in close proximity.

Table 7.5.2 Royal Society for the Protection of Birds sites

Site name	*Grid ref.*	*Area (ha)*	*Date first acquired/leased*	*Interest*
Humberside				
Bempton Cliffs	TA197738	24	1969	Chalk cliffs; cliff-nesting seabirds including gannetry
Hornsea Mere	TA202474	235	1978	Freshwater lake, reedbeds and mixed woodland; breeding reedbed species, breeding and wintering wildfowl, roosting seabirds, passing migrants
Blacktoft Sands	SE843232	197	1975	Tidal reedbed, saltmarsh & brackish lagoons; breeding waterfowl and reedbed species; migrant waders
Lincolnshire				
Tetney Marshes	TA345025	1,258	1974	Sandflats, sand dunes and saltmarsh; breeding terns, breeding waders and wildfowl, wintering waterfowl
Frampton Marshes	TF355394	387	1984	Saltmarsh & intertidal mudflats; breeding waders, wintering waterfowl and raptors
Cambridgeshire				
Nene Washes	TL277992	293	1982	Wet meadows/grazing marsh; breeding waders and wildfowl; wintering wildfowl
Ouse Washes	TL471861	881	1964	Wet meadows/grazing marsh; breeding waders and wildfowl; wintering wildfowl
Norfolk				
Snettisham	TF648333	1,315	1972	Shingle beach with flooded pits, saltmarsh, tidal flats with saltmarsh; major feeding and roosting area for wintering waders and wildfowl, breeding terns
Titchwell Marsh	TF749436	379	1973	Tidal and freshwater reedbeds, saltmarsh, brackish and freshwater pools, sand dunes, shingle beach; breeding terns, waders and reedbed species, migrant and wintering waders
Middle Yar Valley[a]	TG342066 & TG306064	670	1975	Fen, reed, sedge, broads, damp woodland, wet grazing marsh; breeding waterbirds, breeding reedbed species and wintering wildfowl
Berney Marshes & Breydon Water	TG465055 & TG495080	652	1985	Grazing marshes and mudflats; wintering wildfowl and waders
Total		***6,291***		

Source: RSPB (1994; *in litt.*). Key: a = Strumpshaw Fen and Surlingham Church Marsh. Note: In this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

the land is either owned or held on long-term leases. There is one WWT site (405 ha) in Region 6, at Welney on the (Great) Ouse Washes (Table 7.5.3 and Map 7.5.2). This compares with a total of six coastal WWT sites (1,585 ha) in Great Britain, of which three (472 ha) are on the North Sea coast (data provided by the Wildfowl & Wetlands Trust). The Welney reserve supports internationally important numbers of wintering and breeding waterfowl (see also sections 5.11 and 5.12).

Table 7.5.3 Wildfowl & Wetlands Trust sites

Site name	*Grid ref.*	*Area (ha)*	*Date acquired*
Welney (Cambridgeshire)	TL548946	405	1976

Source: WWT. Note: In this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

7.5.4 The Wildlife Trusts

The Wildlife Trusts were established to promote non-statutory nature conservation at a local level in Britain. They own, lease and manage, by agreement with owners, over 1,800 nature reserves (more than 52,000 ha). There is usually one Trust covering a whole county or group of counties, although both Scotland and the Isle of Man each have a single Trust. The Trusts in the region are the Yorkshire Wildlife Trust, the Bedfordshire and Cambridgeshire Wildlife Trust, the Norfolk Wildlife Trust and the Lincolnshire Trust for Nature Conservation. There are 23 coastal Wildlife Trust sites (3,047 ha) in Region 6 (Table 7.5.4 and Map 7.5.2). This compares with a total of 218 coastal Wildlife Trust sites (23,398 ha) in Great Britain, of which 122 (10,411 ha) are on the North Sea coast. The Wildlife Trusts were revising their databases when this section was being collated; 1990 data on English/Welsh Wildlife Trust Sites have therefore been used, with Scottish data extracted from the Scottish Wildlife Trust (1994). Of the 218 coastal sites in Britain 26 (13,805 ha) are in Scotland, 186 (9,578 ha) are in England or Wales and six (14 ha) are on the Isle of Man.

Table 7.5.4 Wildlife Trusts sites

Site name	*Grid ref.*	*Area (ha)*	*Date acquired*
Yorkshire Wildlife Trust			
Spurn	TA417151	306	1960
Saltmarsh/Delph	SE775248	6	1977
The Lincolnshire Trust			
Far Ings	TA010232	30	1983
Barton-on-Humber Reedbed	TA020233	9	1973
Barrow Blow Wells	TA072220	3	1968
Fairfield Pit	TA078242	8	1987
Dawson City Clay Pits	TA130252	17	1985
Killingholme Haven Pits	TA165199	36	1979
Donna Nook	TF440980	894	1978
Saltfleetby/Theddlethorpe	TF467917	39	1968
Sandilands Pit	TF529802	2	1959
Huttoft Bank Pits	TF533793	6	1959
Wolla Bank Field	TF554750	3	1965
Wolla Bank Pit	TF554747	4	1959
Chapel Pit	TF557740	3	1959
Gibraltar Point	TF560580	431	1949
Frampton Marsh	TF380380	271	1976
Bedfordshire and Cambridgeshire Wildlife Trust			
Ouse Washes	TL472855	177	1965
Norfolk Wildlife Trust			
Holme Dunes	TF697438	188	1965
Scolt Head Island (East)	TF465810	31	1945
Cley & Salthouse Marshes	TG054441	332	1926
Ranworth & Cockshoot Broad	TG357149	130	1949
Surlingham Broad	TG315078	122	1945
Total area		***3,047***	

Source: Wildlife Trusts (1990 data). Note: In this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

7.5.5 The Ministry of Defence

As at August 1994, the Ministry of Defence (MOD) owned, leased or used under licence landholdings covering some 320 km of coastline around the UK, not all of it significant

Table 7.5.5 MOD sites

Site name	*Area (ha)**	*Habitats*	*Conservation status*
Humberside			
Hornsea	24	Boulder clay cliffs	No designations
Cowden	284	Boulder clay cliffs	No designations
Lincolnshire			
Donna Nook	885	Sand flats & saltings backed by sand dunes	SSSI, LNR
Theddlethorpe	479	Sand flats & saltings backed by dunes in south	SSSI, NCR, LNR
Wainfleet	3849	Sand & mud backed by saltings near the HWM	SSSI, NCR, SPA, Ramsar, NNR
Holbeach	775	Mud & saltings	SSSI, NCR, SPA, Ramsar, NNR
Norfolk			
Weybourne	7	Cliff-top grassland	AONB
Total	***6,301***		

Source: Ministry of Defence. Key: * all areas are approximate and include land leased or used under licence. SSSI = Site of Special Scientific Interest; NRR = National Nature Reserve; SPA = Special Protection Area for birds; AONB = Area of Outstanding Natural Beauty; LNR = Local Nature Reserve; NCR = Nature Conservation Review site. Note: In this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

for its nature conservation value. The MOD gives high priority to nature conservation on the Defence Estate, subject to the overriding importance of military training. The restrictions to public access on some sites mean that they can be amongst the most pristine areas of wildlife habitat in the region. There are seven coastal MOD sites (6,301 ha) in Region 6 (Table 7.5.5 and Map 7.5.2). This compares with a total of 110 coastal MOD sites (53,409 ha) around the UK, of which 65 sites (34,449 ha) are on the North Sea coast (data provided by MOD).

7.5.6 Acknowledgements

The author wishes to thank Andrea Firth for MOD text and data, and Jo Burgon and Richard Offen (The National Trust), Dr. J. Fenton (National Trust for Scotland), Bob Scott (RSPB), Mark Pollitt (Wildfowl & Wetlands Trust), Sarah Hawkswell (The Wildlife Trusts), Dr A. Somerville (Scottish Wildlife Trust), Meryl Eales (Manx Trust for Nature Conservation) and Andrew Johnson (Manx Natural Heritage) for providing information.

7.5.7 Further sources of information

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C. Contact names and addresses

Type of information	*Contact, address and telephone no.*
National Trust sites (England and Wales)	*Coast and Countryside Adviser, The National Trust, Cirencester, tel: 01285 651818
National Trust sites in region	*Regional Land Agent, The National Trust, Blickling, tel: 01263 733471
RSPB sites (Humberside)	*Regional Officer, RSPB North England Office, Newcastle upon Tyne, tel: 0191 281 3366
RSPB sites (Lincolnshire, Norfolk, Cambridgeshire)	*Regional Officer, RSPB East Anglia Office, Norwich, tel: 01603 661662
Wildfowl and Wetlands Trust site	The Warden, The Wildfowl and Wetlands Trust, Hundred Foot Bank, Welney, nr. Wisbech, Cambs. PE14 9TN, tel: 01353 860711
Yorkshire Wildlife Trust sites	*Conservation Officer, Yorkshire Wildlife Trust, York, tel: 01904 659570
Lincolnshire Trust sites	*Conservation Officer, Horncastle, tel: 01507 526667
Wildlife Trust for Bedfordshire, Cambridgeshire, Northamptonshire & Peterborough sites	*Conservation Officer, The Wildlife Trust for Bedfordshire, Cambridgeshire, Northamptonshire & Peterborough, Cambridge, tel: 01223 846363
Norfolk Wildlife Trust sites	*Conservation Officer, Norfolk Wildlife Trust, Norwich, tel: 01603 614430
MOD sites	Conservation Officer, MOD Conservation Office, B2/3, Government Buildings, Leatherhead Road, Chessington, Surrey KT9 2LU, tel: 0181 391 3028/9

*Starred contact addresses are given in full in the Appendix.

The Ouse Washes (Norfolk) are seasonally flooded grasslands created as a flood prevention measure for towns such as Downham Market and King's Lynn. Now they support nationally important numbers of breeding waterfowl, including black-tailed godwit and snipe, which nest only in this habitat. Parts of the Washes are managed by the RSPB to maintain water levels in winter whilst allowing grazing and hay production in summer. Photo: Peter Wakely, English Nature.

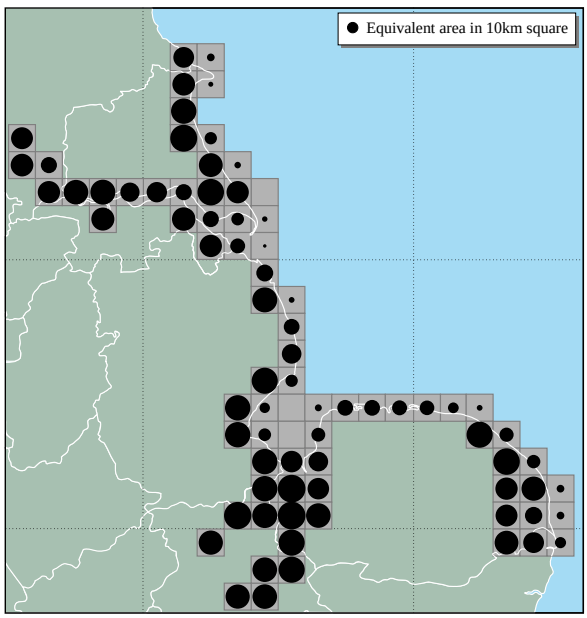
Chapter 8 Land use, infrastructure and coastal defence

S.L. Fowler, J.A. Norton, M.J. Dunbar, C.A. Crumpton & M.J. Goodwin

8.1 Introduction

This chapter is divided into three sections: (rural) land use, covering agriculture (especially as it affects important coastal wildlife habitats) and woodland; infrastructure, covering population distribution, industry, ports, harbours, ferries, pipelines, cables and power generation; and coastal defence, including sea defence and coast protection.

The North Humberside coast from Flamborough Head to Spurn Head is mainly rural, with little residential or industrial development. Bridlington, a fishing port and centre for recreation, is the main town, and there are further small settlements at Hornsea and Withernsea. The Humber estuary is a very busy waterway, with ports at Hull, Grimsby, Immingham and Goole. It handles 11% of Britain's foreign trade volume and its shores are heavily populated and industrialised. Lincolnshire, like North Humberside, is also predominantly rural, with a small coastal population and, especially in the north and south of the county, very little coastal development. In between lie the holiday resorts of Mablethorpe and Skegness, which have extensive seaside recreational facilities. The Wash is notable for its large intertidal area, bordered by the very productive agricultural land of the Fens, much of it claimed from the sea. It has very few industrial areas, with the exception of the small working ports at Boston (the start of a commercial waterway to the River Trent), Wisbech (15 km inland on the River Nene) and King's Lynn (at the mouth of the Great Ouse system, which drains the eastern Fens).



Map 8.2.1 Tilled land. Note: area of circle indicates the area of this land cover type in the 10 km square. Source: Countryside Survey (1990), ITE Monks Wood.

Norfolk also has a largely undeveloped, rural coast. Industry is centred around King's Lynn and the larger commercial centre of Great Yarmouth. There are numerous other smaller settlements along the coast, such as Hunstanton, Wells, Sheringham and Cromer. This is an important holiday coastline, but recreational developments are mostly quite restricted in scale.

Apart from the Holderness coast, where the soft cliffs are eroding faster than any other coastline in Europe, virtually the whole of the coast in this region has an artificial shoreline, whether in the form of coast protection works (against erosion) or sea defences (against flooding). Coast protection works are concentrated around the main industrial and residential centres, in Humberside and east and north-east Norfolk.

8.2 Land use

S.L. Fowler, J.A. Norton & M.J. Dunbar

8.2.1 Introduction

The main (rural) land use along the coast of the region is agriculture (arable farming), and the region is well known as one of the most productive agricultural areas in Britain. Lincolnshire, Norfolk and the Holderness coast (North Humberside) have a high proportion of arable farmland (cereals, vegetables, sugar beet), with a relatively small proportion of grazing land, particularly in comparison with the west coast of Britain. The area around The Wash is extremely productive silt farmland, claimed from the sea over some hundreds of years. Further inland, along the freshwater tidal stretches of the rivers flowing into The Wash, the draining of freshwater fen swamps over centuries created extensive areas of top quality peaty soils.

There are approximately 44,000 ha of saltmarsh in Great Britain. The oldest form of saltmarsh exploitation by man is probably agriculture. About 31,600 ha of saltmarsh in Great Britain are grazed, with major concentrations in the north-west and south-east of England. Stocking figures vary in the UK; Doody's (1988) study of saltmarsh management identified levels across the country ranging from one to six animals per hectare, with grazing usually only taking place from May to September. The 5,726 ha of grazed saltmarsh in this region represent 79% of the region's total saltmarsh area and approximately 13% of total British saltmarsh (Burd 1989) (see also section 3.6).

Historically, the region's sand dunes have been affected by agriculture for most of their existence. The characteristic semi-natural vegetation of most stable dunes has developed as a result of grazing of the indigenous vegetation by sheep, rabbits and cattle (Radley 1994). However, during a survey

of sand dune vegetation in England, grazing by domestic stock was recorded at only 34 out of 121 dune sites (Radley 1994). In England now the greatest concentrations of grazed dune are in the north and west, where livestock farming is generally strongest. In the south and east, stock grazing is rarely seen. Rabbits remain the most widespread dune grazing animal in England.

There has been little coastal afforestation in this region and there are no semi-natural coastal woodlands of any significance. The scarcity of coastal woodland is probably influenced by the predominance of agriculture in this generally low-lying, fertile region.

8.2.2 Locations and land uses

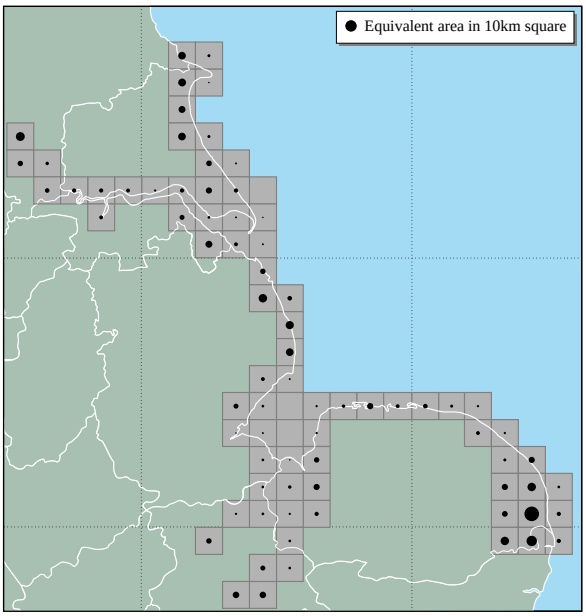
Maps 8.2.1, 8.2.2 and 8.2.3 show the distribution in the region of, respectively, tilled land, heavily managed mown/grazed turf and lightly managed meadow/semi-natural grassland. The size of the circles in relation to the squares is proportional to the amount of that land cover type in the 10 km square. As Map 8.2.1 shows, there is a very high proportion of tilled land around virtually the whole coastline of this region. In addition, further large areas of tilled land shown on the maps are set back from the coast, situated along the tidal reaches of the Humber and its tributaries and the tidal rivers flowing into The Wash and the Norfolk Broads. Both mown/grazed turf and meadow/semi-natural land are generally poorly represented in the region, except in the eastern part of Norfolk around the Broadland system, and to a lesser extent in Lincolnshire. Land claim has had a major impact in The Wash, where the saltmarshes have been progressively embanked and converted to become some of the most productive agricultural land in the country (Doody undated). Land claim continued until the 1970s, after which there was a ten-year moratorium. Further land claim is no longer permitted by county structure plans.

Map 8.2.4 shows the location of grazed sand dune and saltmarsh sites in the region (see also section 3.2). Saltmarsh grazing in the region occurs predominantly around The Wash, where extensive areas have been claimed from the sea for agriculture (Map 8.2.4) (Doody 1988; Radley 1994). During Radley's sand dune survey, rabbit grazing was recorded in this region at high levels only at Blakeney Point, although it is likely that it was generally under-recorded (Radley 1994).

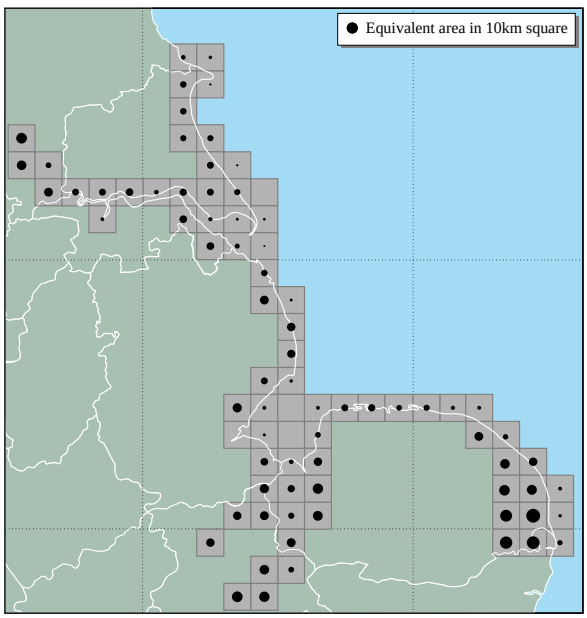
Coastal woodlands are shown on Map 8.2.5. In Lincolnshire, there is an area of conifer plantation (40 ha) about 1 km from the coast at North Somercotes. In Norfolk, there is a mixed plantation near the coast at Snettisham (80 ha) and a narrow belt of mature Corsican pine plantation at Holkham (100 ha), established on coastal sand dunes and extending for some 4 km along the coast.

8.2.3 Information sources used

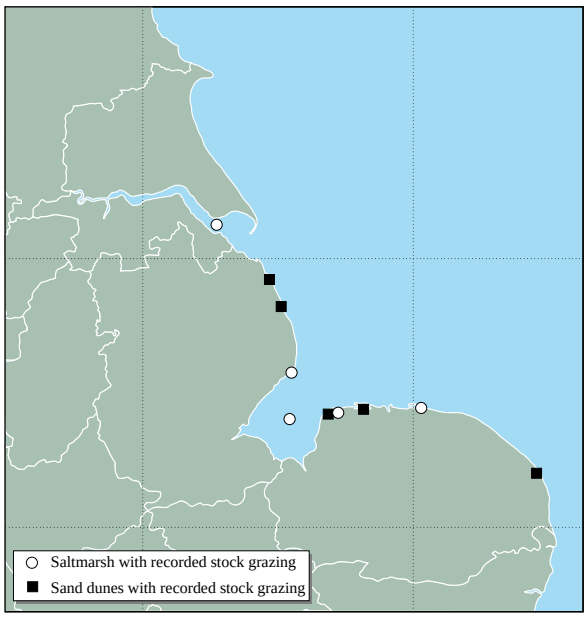
The main source of information for this section was the Countryside Survey 1990 (ITE 1993), which is based primarily on high resolution satellite images. These images show the dominant land cover for each 25 m x 25 m area (pixel) of Great Britain. Land cover is classified into seventeen key types (including tilled land and managed grassland) and field surveys of randomly selected areas were used to check the results. Maps 8.2.1, 8.2.2 and 8.2.3 are derived from printouts of these data from the DoE Countryside Information System. The main limitations of the data derive from errors in classifying areas covered by a mixture of land types and from the form of presentation used in the maps. The Countryside Information System can provide data on a 1 km square framework, but this level of



Map 8.2.2 Pastures and amenity swards, mown or grazed to maintain a short turf throughout the year. Note: the size of the circles in relation to the squares is proportional to the amount of that land cover type in the 10 km square. Source: Countryside Survey (1990), ITE Monks Wood.



Map 8.2.3 Meadows, verges and low intensity amenity grasslands and semi-natural cropped swards, not maintained as short turf. Note: the size of the circles in relation to the squares is proportional to the amount of that land cover type in the 10 km square. Source: Countryside Survey (1990), ITE Monks Wood.



Map 8.2.4 Saltmarshes and sand dunes with recorded grazing. See Maps 3.6.1 and 3.2.1 for distribution of saltmarsh and sand dune sites. Large sites are shown as a centre grid reference. Source: JNCC Coastal Database.

Map 8.2.5 Coastal woodland. Source: Ordnance Survey Landranger maps. © Crown copyright.

detail was not considered appropriate here. More detailed information on agricultural land use should be available from ADAS (for example, information on set-aside targets), Heritage Coast plans and local plans. Sand dune and saltmarsh grazing information for Map 8.2.4 comes from the JNCC's Integrated Coastal Database, and from cited references. Woodland information (Map 8.2.5) was obtained from the 1:50,000 scale Ordnance Survey Landranger maps. The former Nature Conservancy Council's inventory of ancient woodlands (Spencer & Kirby 1992) is a source of comparative data for the region, and the Forestry Commission has afforestation maps that cover the region.

8.2.4 Further sources of information

A. References cited

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Radley, G.P. 1994 *Sand dune vegetation survey of Great Britain. Part 1: England*. Peterborough, Joint Nature Conservation Committee.

Spencer, J.W., & Kirby, K.J. 1992. An inventory of ancient woodland for England and Wales. *Biological Conservation, 62:* 77-93.

B. Contact names and addresses

Type of information	*Contact address and telephone no.*
Land use, agricultural land grades, set-aside	MAFF/ADAS Land Service, MAFF, Whitehall Place, London SW1A 2HH, tel: 0171 270 3000
Countryside Survey 1990	*Department of Rural Affairs, DoE, Bristol, tel: 0117 9878811
Countryside Survey 1990	Land Use Group, Institute of Terrestrial Ecology, Merlewood, Windermere Road, Grange-over-Sands, Cumbria LA11 6JU, tel: 01539 582264
Countryside Survey 1990	*Environmental Information Centre, ITE, Monks Wood, Huntingdon, tel: 01487 773381
Maritime habitats, coastal science and pollution	*Maritime Team Manager, English Nature HQ, Peterborough, tel: 01733 340345
Saltmarsh grazing (general information)	Ministry of Agriculture, Fisheries and Food, Whitehall Place, London SW1A 2HH, tel: 0171 270 8080
Woodland extent, ownership, management	Conservator, Forestry Authority, East Midlands Conservancy, Willingham Road, Market Rasen, Lincolnshire LN8 3RQ, tel: 01673 843461/842644
Woodland extent, ownership, management	Conservator, Forestry Authority, East Anglia Conservancy, Santon Downham, Brandon, Suffolk IP27 0TJ, tel: 01842 815544
Ancient Woodland in East Yorkshire	*Conservation Officer, English Nature, North and East Yorkshire Local Team, York, tel: 01904 432700
Sand dune and saltmarsh grazing, and ancient woodland in Humberside	*Conservation Officer, English Nature, North and East Yorkshire Local Team, York, tel: 01904 432700
Sand dune and saltmarsh grazing, and ancient woodland in Lincolnshire	*Conservation Officer, English Nature, East Midlands Local Team, Grantham, tel: 01476 68431
Ancient woodland in Cambridgeshire	*Conservation Officer, English Nature, Bedfordshire, Cambridgeshire and Northamptonshire Local Team, Peterborough, tel: 01733 391100
Sand dune and saltmarsh grazing, and ancient woodland in Norfolk	*Conservation Officer, English Nature, Norfolk Local Team, Norwich, tel: 01603 620558

*Starred contact addresses are given in full in the Appendix.

The Holderness coast, North Humberside, is the fastest eroding stretch of coastline in Europe: up to a metre of land is lost every year. Destruction by these powerful natural processes is usually unavoidable for all except high-value installations, or where human lives are at risk. The cliff-top gas terminal at Dimlington is one such priority site. Photo: Peter Wakely, English Nature.

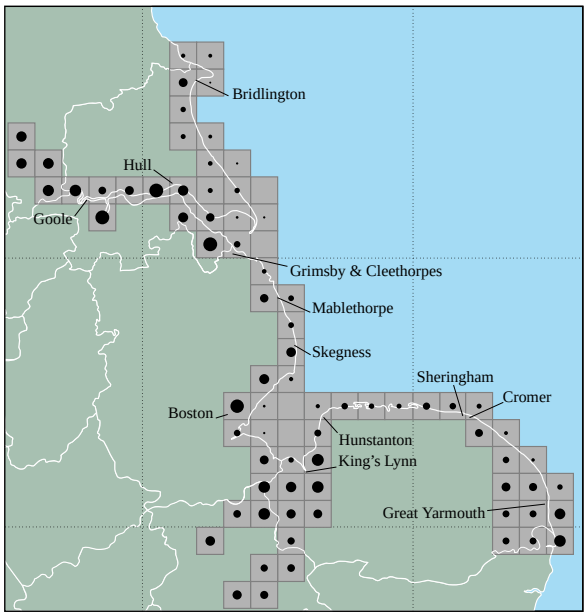
8.3 Infrastructure

S.L. Fowler, J.A. Norton, M.J. Dunbar, C.A. Crumpton & M.J. Goodwin

8.3.1 Introduction

This section summarises the infrastructure of the region, including population distribution, industry, ports, harbours, airports and airfields, ferries, pipelines, cables and power generation, and land claim for these developments. Oil and gas exploration and development are covered in section 9.5.

With the exception of the industrial centres of Kingston-upon-Hull (often called simply Hull) and Grimsby, on the Humber, and the holiday resort of Great Yarmouth, the region is generally sparsely populated. Agriculture is predominantly large-scale and a low-key tourist industry is present along parts of the coast. In total, about 25 square kilometres of coastal land in the region is, or has recently been, occupied by heavy industrial activity. Most of this is located in the Humber estuary, particularly along the south shore and the tidal reaches of tributaries such as the Yorkshire Ouse and the Trent. The shores of the Humber Estuary are dominated by major ports and industries, incorporating one of the largest shipping complexes in the UK. The Humber estuary supports the four most important ports in the region and handles about 17% by value of Britain's foreign sea-borne trade. Elsewhere in the region the small ports and fishing harbours support very little industry. The small ports in The Wash are regionally important for shipping agricultural products, and north Norfolk has a thriving recreational boating and local fishing industry (see also sections 9.1 and 9.7).



Map 8.3.1 Distribution of areas of industrial and residential development. Note: the size of the circles in relation to the squares is proportional to the amount of that land cover type in the 10 km square. Major towns and cities are also shown. Source: Countryside Survey (1990); ITE Monks Wood.

8.3.2 Important locations

Residential development

Map 8.3.1 shows the area of continuous urban and suburban development in the region and the location of centres of population (see also Table 8.3.1). There are a few other small coastal settlements, notably Hornsea and Withernsea on the Holderness coast; Sutton on Sea and Chapel St. Leonards around the Wash; and Wells, Blakeney, Mundesley, Happisburgh and Caister-on-Sea along the north and east Norfolk coast. Between Happisburgh and Caister-on-Sea is an undeveloped area of coast close to the Norfolk Broads.

Industrial development

All significant industries in the region are listed in Table 8.3.2 and the main industrial areas are also shown on Map 8.3.2. The northern part of the region's coast has little or no industry, the most northerly significant development being at Easington, about 10 km north of Spurn Head. Here there are two British Gas terminals and nearby, at Atwick (near Hornsea), caverns are used for onshore gas storage (see also section 9.5). There is also a gas terminal at Dimlington (Humberside).

Kingston-upon-Hull, some 30 km from the open coast, is a centre of industry, with oil refineries and flour milling, sawmilling and chemical and engineering industries. Shipbuilding and ship repair yards are situated along the estuary frontage at Hessle Haven and Paull. Goole, situated at the head of the Humber Estuary, hosts industries that include shipbuilding, flour milling and the manufacture of fertilisers, alum and dextrin. The Grimsby/Cleethorpes area includes a major fishing port (see below and section 9.1), with food processing and chemical industries and docks at nearby Immingham. Grimsby itself is a major centre for the fishing industry (see below and section 9.1) and is the country's premier centre for the frozen food industry.

There are many chemical works in the Humber Estuary, situated at Saltend, Hull, and along the south bank between Grimsby and Killingholme. There is a large steel works away from the upper estuary at Scunthorpe. A cement works is situated at Ferriby Sluice, to the west of Barton-upon-Humber.

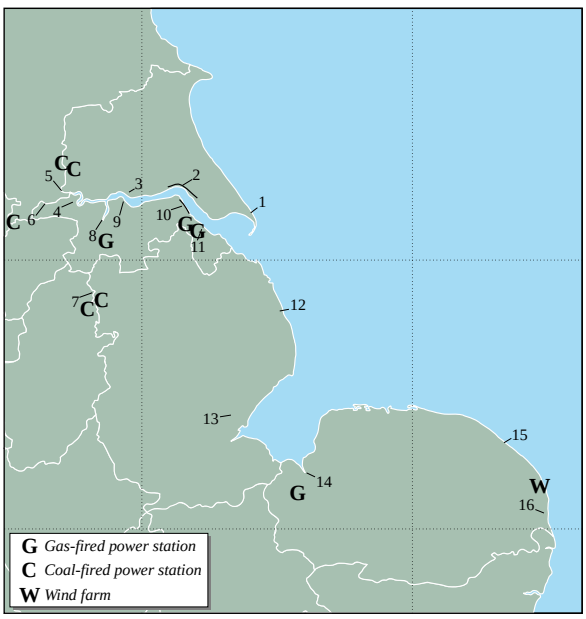
The oil refineries at Killingholme and South Killingholme have a capacity of 9.4 and 6.5 million tonnes per year respectively (15.9 million tonnes per year combined), representing 17% of the UK's total refining capacity. Crude oil is imported through a sea terminal and jetty at North Killingholme, constructed adjacent to the deep water port of Immingham. The jetty is capable of berthing two 100,000 tonne tankers, and also has export facilities for smaller tankers, coasters and barges. The terminal is connected to the refineries by 5.6 km of pipeline.

The industrial centres on the Humber have experienced economic decline. Two areas, at Glanford and Scunthorpe, were designated as Enterprise Zones in 1984 and 1983 respectively. The designation lasted for ten years and so has now expired.

Table 8.3.1 Populations of local authority boroughs/districts and their major centres of coastal residential development

County Borough/District Town/City	*Population*		*Comments*
Humberside			
East Yorkshire	87,800		
Bridlington		29,000	Seaside resort and small fishing port
Holderness	52,200		
Kingston upon Hull	267,900		
[a]Hull area		[a]430,000	Major seaport, fishing port and industrial centre
Beverley	115,800		
Boothferry	65,300		
[a]Goole		[a]18,200	Major port and industrial centre
Glanford	72,700		
Cleethorpes	70,500		
[a]Grimsby/Cleethorpes		[a]180,000	Port and industrial centre
Great Grimsby	91,500		
Lincolnshire			
East Lindsey	120,800		
Mablethorpe		7,500	Holiday resort and popular retirement area
Skegness		14,500	Holiday resort and popular retirement area
Boston	54,200		
Boston		54,000	Minor port, formerly situated on the sea
South Holland	69,300		
Norfolk			
King's Lynn and West Norfolk	131,600		
King's Lynn		33,000	Minor port, formerly situated on the sea
Hunstanton		4,100	Holiday resort and popular retirement area
North Norfolk	93,700		
Sheringham		5,500	Holiday resort and popular retirement area
Cromer		6,200	Holiday resort and popular retirement area
Great Yarmouth	88,800		
Great Yarmouth		89,000	Centre of developed resorts and holiday villages

Sources: Borough/District figures (mid-1993 population estimates based on 1991 census): Office of Population Censuses and Surveys (1994); town/city figures (1981 data): Cook (1993), except [a]Humberside County Council (1992 estimates). Towns/cities are shown on Map 8.3.1.



Map 8.3.2 Industrial infrastructure and coastal power stations and wind farms. Figures refer to Table 8.3.2.

Both the Lincolnshire and Norfolk coasts are relatively undeveloped, with some industry associated with the Wash ports of Boston, Wisbech and King's Lynn and minor industries associated with seaside resorts. There is a gas terminal at Theddlethorpe, connected by four pipelines to gas fields in the Southern Basin area of the North Sea (Map 9.5.1). Boston has minor industry associated with agriculture and a small port on the River Witham. King's Lynn has small-scale, largely agriculture-based industry linked to its minor port and fishing base.

There are tourism-related commercial developments at Hunstanton, Sheringham, Cromer and Great Yarmouth (see section 9.7). Great Yarmouth has minor industry (fish and food processing) and is a North Sea gas base. The three Bacton gas terminals receive North Sea gas from ten pipelines (see also section 9.5 and Map 9.5.1).

Ports and harbours

Ports and harbours in the region are shown on Map 8.3.3. In the north of the region there is a small fishing and recreational harbour at Bridlington. All the Humber ports, Kingston-upon-Hull, Goole, Immingham/Killingholme and Grimsby, are owned and operated by Associated British Ports. There are also about 50 private jetties and wharves,

Table 8.3.2 Major areas of coastal industrial development

Map no.	*Site/area*	*Grid ref.*	*Details*
1	Easington	TA4019	British Gas terminal onshore, with offshore storage near Hornsea
2	Paull	TA1626	Shipbuilding/repair yard
2	Saltend	TA1628	Petrochemicals (BP)
2	Kingston-upon-Hull (north bank of Humber from Hessle Haven to Paull)	TA0225-TA1627	Major seaport and fishing port, large docks, industrial centre with oil refineries, flour milling, sawmilling, chemicals and engineering industries, plus large area earmarked for 'estuary-related development'. Shipbuilding/repair yard at Hessle Haven.
2	Kingston-upon-Hull	TA1428	Major international commercial port with passenger ferry services to Europe. Industrial and commercial centre.
3	North Ferriby	SE9725	Smelter (closed). Area allocated for industry.
3	Brough	SE9426	British Aerospace site and light airfield
4	Goole	SE7423	Port. Industrial area (shipbuilding, flour milling, fertilisers, alum and dextrin manufacturing).
5	Drax, R. Ouse (Yorkshire)	SE6626	Power stations (Drax A & B) (coal fired)
6	Eggborough, R. Aire	SE4525	Power station (coal fired)
7	Cottam and West Burton, R. Trent	SK7985	Two power stations (coal fired)
8	Keadby	SE8211	Power station (gas fired)
9	Ferriby Sluice	SE9720	Cement works on south bank of R. Humber
10	North Killingholme Haven	TA1620	Oil terminal
10	North Killingholme/South Killingholme	TA1617	Oil refineries, two gas-fired power stations
10	Immingham	TA1816-TA2311	Docks, industrial estate, petrochemicals works (Ciba-Geigy). Coast fronting a deep-water channel earmarked for 'estuary-related development'.
11	Grimsby	TA2810	Major international fishing and commercial port with industry
12	Theddlethorpe	TF4887	North Sea gas terminal and pipelines
13	Boston	TF3343	Dock and miscellaneous industry
14	King's Lynn	TF6117	Glass works, two gas turbine power stations (one under construction)
		TF6319	Chemical works
15	Bacton	TG3434	Gas terminal
16	Great Yarmouth	TG5305	Power station (wind farm)

Note: Map numbers refer to Map 8.3.2.

many of them between the Humber Bridge and Immingham. With the increase in size and draft of modern vessels, there has been a tendency for dock and jetty construction to move to locations where deeper water is available close to shore. The Humber Estuary is very important for this reason, as it has deep water frontage for considerable lengths, where important industries have become established. The Humber itself is a busy commercial waterway.

Hull is a commercial and passenger port, handling almost six million tonnes of cargo and more than 700,000 passengers per year. There are passenger ferry services to Rotterdam and Zeebrugge. It is also an international transfer port, handling transhipments from Europe to world-wide destinations. There are four 'ro-ro' (roll-on, roll-off) terminals, as well as bulk liquid storage facilities. Hull handles a large timber traffic and is one of the major grain export ports in the UK. Bulk traffic includes imported coal, fertilisers and pyrites, edible oil and molasses.

Goole, located 65 km from the open sea and one of Britain's most inland ports, is the second Humber port to Grimsby. Formerly a solid fuel port, it now handles general cargo and container traffic. A bulk terminal handles cement and there are dedicated berths for solid fuel, animal feedstuffs and scrap. Bulk goods include solid fuel, timber, iron and steel, fertilisers, minerals, grain and animal feed.

Immingham has excellent deep-water facilities and specialises in dry and liquid bulk commodities, but recently there has also been considerable expansion in general cargo services. As well as the main international terminals, there are five specialised river terminals with three main jetties to

Map 8.3.3 Ports, harbours and jetties

handle bulk traffic, particularly for coal and steel exports and raw material imports for the steel industry. An oil terminal handles oil petroleum products for local refineries and a gas jetty handles propane, butane and petroleum products.

Grimsby, situated less than 10 km from the open sea, the major port on the Humber, is a major fishing port and plays an important role in food distribution, handling a third of all Danish butter and bacon imports into the UK. About 200,000 tonnes of fish (1989 data) are landed each year from around 100 Grimsby-based fishing vessels and larger foreign vessels, including Icelandic, Danish and Belgian ships. Fish from other UK ports, and containerised frozen fish from Denmark, Iceland and the Faeroes, is also brought in. Trade also includes imports of cars and exports of agricultural machinery and contractor plant to Europe.

Lincolnshire has only a small number of relatively small ports, located on The Wash rivers. In contrast to the Humber, the open embayment of The Wash is characterised by extensive tidal flats, and only a few small ports are still operating in its river estuaries. Boston, on the River Witham, has container and general cargo facilities and timber and steel bunkers. It is also the base for a small fishing fleet which uses The Wash (see section 9.1). The rivers Trent and Yorkshire Ouse and their associated canals are used by shipping, with a commercial waterway running from Boston to the River Trent. Fosdyke on the River Welland has bulk fertiliser-, feedstuff- and cereal-shipping facilities. Sutton Bridge also has limited port facilities.

Wisbech, on the tidal River Nene in Cambridgeshire, handles general cargo. The main port at King's Lynn, Norfolk, on the River Great Ouse, is operated by Associated British Ports. It has enclosed docks of about 12 ha and accepts vessels of up to 119 m in length. A 'ro-ro' and container service operates between the port and Hamburg. Dry and liquid bulk cargoes are also handled. The port has large storage warehouses and a grain silo. The King's Lynn Harbour Conservancy handles dry bulks at South Quay. A small fishing fleet, which primarily exploits The Wash, is based in the harbour. A number of the small settlements on the north Norfolk coast have small harbours or jetties for local fishing and recreational use. These include Thornham, Brancaster, Burnham Overy Staithe, Wells (also a small commercial port handling grain, fertilisers and timber), Morston and Blakeney.

The port at Great Yarmouth is owned and operated by Great Yarmouth Port and Harbour Commissioners. It has 'ro-ro' facilities, vehicle ferry services to Scheveningen (The Netherlands) (Map 8.3.3) and liquid and general bulk facilities. It is also a supply and fabrication base for the offshore oil and gas industry.

Power generation

Most power generation in the region takes place alongside the Humber Estuary and its tidal rivers, these providing the necessary cooling water. The locations of the region's ten coastal power stations are shown on Map 8.3.2 and listed in Table 8.3.2. There are two coal-fired power stations at Drax, North Yorkshire, and one at Eggborough (2,000 MW). Electricity is produced by two Combined Cycle Gas Turbine power stations (CCGTs) at Killingholme, one run by National Power and one by PowerGen, with capacities of 650 MW and 848 MW respectively; their combined capacity represents approximately 3.7% of the total UK capacity. Two coal-fired power stations, one run by PowerGen and the other by National Power, operate at Cottam and West Burton. A CCGT has also recently been constructed at Keadby, Humberside. These is a gas-fired power station with a planned capacity of 340 MW at King's Lynn, Norfolk (Eastern Electricity pers. comm.), and a further one is under construction.

There are no nuclear power stations in this region. The scope for wind farming is less in this region than on the west coast of Britain, as the prevailing south-westerly wind blows offshore rather than onshore. The only commercial renewable energy production operation in this region is the wind farm at Blood Hills, Great Yarmouth, which has ten turbines with a combined operating capacity of 2.25 MW. It produces approximately 1.4% of Britain's total wind energy power production, which in 1994 was 160 MW. There were 22 wind energy projects in Britain in 1994 (British Wind Energy Association pers. comm.).

8.3.3 Information sources used

Sources of information for this section included Cook (1993), Buck (in prep.) and Ordnance Survey Landranger 1:50,000 maps. Some information on industrial activity and infrastructure may be out of date, as the result of recent local and national declines in industrial activity. The Office of Population Censuses and Surveys publishes 1991 census data on a district basis and population estimates for subsequent years based on those data (e.g. OPCS 1994). Cook (1993) presents town and city data from population censuses from a number of dates, including the 1981 census, and is therefore somewhat out of date.

Map 8.3.1 is adapted from the ITE (1993) Countryside Survey database, which is derived from 1990 satellite imagery. Areas represent land cover types 'urban' and 'suburban/rural development' (see notes in section 8.2.3).

Most of the information on ports and harbours was derived from the two national handbooks for the British Ports Federation (undated) and Sutton (1989), which may be incomplete or out of date, and Frid *et al.* (1991). In 1991 the BPF was replaced by the British Ports Association and the UK Major Ports Group. Lord Donaldson (1994) records that there is virtually no clear information available on where ships go within UK waters, and that no records are kept of how many ships use UK port facilities. Under MARPOL (the United Nations' International Convention on the Prevention of Pollution from Ships), the UK must provide port facilities that are "adequate to meet the needs of ships using them and do not cause undue delay to ships". These facilities should prevent ships from discharging oil and other wastes into the sea. However, Lord Donaldson (1994) describes UK facilities as "inadequate". The UK government has commissioned a survey of all UK port reception facilities for the disposal of ship's wastes. The results, which should look at what facilities are available and their quality, were due in September 1994.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Existing and planned residential developments	*Local Authorities
Population statistics (Office of Population Censuses and Surveys)	Information Branch (Dept. M), OPCS, St Catherine's House, 10 Kingsway, London WC2B 6JP, tel: 0171 396 2208
Enterprise Zones	*Department of Environment, London, tel: 0171 276 6166
Major ports	The UK Major Ports Group Ltd, 150 Holborn, London EC1N 2LR, tel: 0171 404 2008
Port reception facilities	Marine Safety Agency, Spring Place, 105 Commercial Road, Southampton SO15 1EG, tel: 01703 329100
Ports	British Ports Association, Africa House, 64-78 Kingsway, London WC2B 6AH, tel: 0171 242 1200
Hull	Port of Hull, PO Box 1, Port House, Corporation Road, Hull HU9 5PQ, tel: 01482 27171
Grimsby and Immingham	Ports of Grimsby & Immingham, Port Office, Grimsby, South Humberside DN31 3LL, tel: 01472 359181
Goole	Port of Goole, East Parade, Goole, North Humberside DN14 5RB, tel: 01505 2691/5
Boston	Port of Boston Authority, Dock Office, The Docks, Boston, Lincs. PE21 6BN, tel: 01205 365571
Fosdyke	Port of Fosdyke Ltd., Fosdyke Bridge, Boston, Lincs. PE20 2DB, tel: 01205 85240
King's Lynn	King's Lynn Conservancy Board, Harbour Office, Common Staith, King's Lynn, Norfolk PE30 1LL, tel: 01553 773411
King's Lynn	Port of King's Lynn, St Ann's Fort, King's Lynn PE30 2EU, tel: 01553 691555
Wisbech	Port Manager's Office, Wisbech Port, Fenland District Council, Nene Parade, Wisbech, Cambs. PE15 8NQ, tel: 01945 61369
Great Yarmouth	Great Yarmouth Port and Haven Commissioners, 20-21 South Quay, Great Yarmouth, Norfolk NR30 2RE, tel: 01493 855151
Conventional power production	Corporate Communications Officer, PowerGen plc, Westwood Way, Westwood Business Park, Coventry, CV4 8LG tel: 01203 424000
Conventional power production	Public Information Officer, National Power plc., Senator House, 85 Queen Victoria Street, London EC4V 4DP, tel: 0171 454 9494
Conventional power production	Managing Director (Generation), Eastern Electricity, PO Box 40, Worstead Park, Worstead, Ipswich, Suffolk IP9 2AQ, tel: 01473 555550
Renewable energy	The Director, Renewable Energy Enquiries Bureau, Energy Technology Support Unit (ETSU), Harwell, Oxfordshire OX11 0RA, tel: 01235 432450
Wind energy	The Administrator, British Wind Energy Association, 42 Kingsway, London WC2B 6EX, tel: 0171 404 3433
Nuclear electricity production - general	Public Information Officer, Nuclear Electric plc., Barnett Way, Barnwood, Gloucester GL4 7RS, tel: 01452 652776
Energy production - general	Department of Energy, 1 Palace Street, London SW1E 5HE, tel: 0171 238 3000
Energy production - general	Secretary, Institute of Energy, 18 Devonshire Street, London W1N 2AU, tel: 0171 580 7124

* Starred contact addresses are given in full in the Appendix.

8.4 Coastal defence

M.J. Dunbar, S.J. Everett, S.L. Fowler & J.A. Norton

8.4.1 Introduction

Coastal defence covers two types of works: coast protection and sea or flood defence. Coast protection works prevent or slow the erosion of land and encroachment by the sea and are generally the responsibility of District Councils. The most important role of sea (flood) defences is to protect human life and property in coastal settlements and industrial areas; many were also built in the past to protect low-lying agricultural land from flooding by the sea and to enable agricultural improvement and drainage. Sea or flood defences protect against the flooding of low-lying land and are the responsibility of the National Rivers Authority (NRA), although Internal Drainage Boards and local authorities can also undertake flood defence works. Some forms of coastal defence may protect against both erosion and flooding and can provide vital 'toe' support to the base of coastal cliffs. Coastal defence works in Britain are most widely distributed along eroding coasts formed from relatively soft geological formations, and along urban and industrial coastlines, especially around the heavily developed coasts of south-east England (Regions 6 to 9) and north-west England (Region 13).

NRA data indicate that sea (flood) defences are more widespread in this region, particularly on the Lincolnshire coast, than in any other Coastal Directories Project region (Table 8.4.1). According to the NRA's Sea Defence Survey (NRA 1992), well over half of the 426 km of defences in the Anglian Region lie within Lincolnshire and Norfolk. Most of this is the responsibility of NRA, with only small lengths managed by local authorities or privately, or by bodies such as the Ministry of Defence. Railtrack (formerly British Rail) maintains some stretches of coastal protection/sea defence alongside railway lines.

Table 8.4.2 shows that 35% of the region's open coast is protected against erosion, a proportion typical of stretches of soft coast in England.

Table 8.4.1 Distribution of sea (flood) defences (km) in England and Wales

*NRA Region**	*NRA*	*Local authority*	*Privately owned*	*Total*
Northumbria	7.6	1.1	1.3	10.0
Yorkshire	**12.6**	**0.3**	**9.1**	**22.0**
Anglian	**363.1**	**12.4**	**50.9**	**426.4**
Southern	143.8	40.5	10.9	195.2
Wessex	43.4	30.1	24.1	97.6
South West	23.1	32.9	24.2	80.2
Severn Trent	30.6	0.0	8.7	39.3
Welsh	112.0	73.3	54.7	240.0
North West	68.6	51.3	28.0	147.9
Total	***804.8***	***241.9***	***211.9***	***1,258.6***

Source: NRA (1992). Key: *Region 6 includes part of NRA Yorkshire Region and about half of Anglian Region, but totals for Region 6 alone were not available.

Map 8.4.1 Locations of coastal defence works. Source: MAFF (1994), NRA, OS Landranger maps.

Table 8.4.2 Distribution of coast protection works (against erosion) in England

*Region**	*Coastline covered*	*Total length (km)*	*Undeveloped length(km)*	*Coast protection length(km)*	*% protected*
5	Berwick-upon- Tweed to Scarborough	318.0	241.0	77.0	24.2
6	**East Yorkshire to Great Yarmouth**	**171.5**	**111.9**	**59.6**	**34.8**
7	Waveney to Shepway	276.3	147.3	129.0	47.0
8	Rother to Chichester	148.8	39.4	109.4	73.5
9	Havant to West Dorset	625.4	363.3	262.1	42.0
10	East Devon to Carrick (South)	362.0	307.0	55.0	15 0
11	Kerrier to Forest of Dean	647.5	610.7	36.8	5.7
13	Wirral to Carlisle	375.4	244.6	130.8	35.0
Total	***English coastline***	***2,924.9***	***2,065.2***	***859.7***	**29.4**

Source: MAFF (1994). Key: * Coastal Directories Project region (excluding tidal stretches of rivers).

Table 8.4.3 Condition of coast protection works and state of coastal erosion on the English coast

Survey area	*Length of coast (km)*	*Coast protection*		*% requiring work*		*Coast experiencing significant erosion*	
		km	*%*	*Significant repairs*	*Moderate repairs*	*km*	*%*
York NW area (NW England)	471.7	130.8	28	6	24	39.9	8.5
York/Lincoln NE areas (NE England to Wash)*	514.9	95.5	18.5	15	26	51.2	10.0
Cambridge area (Wash to Thames)*	466.3	98.3	21.0	5	21	17.1	3.6
Tunbridge Wells (Thames to Hants.-Dorset border)	830.2	389.0	47.0	6	44	23.2	2.8
Taunton area (Dorset to Wales)	1,479.6	146.4	9.9	2	15	3.4	2.3

Source: MAFF (1994). Key: *These areas include parts of Region 6; figures for Region 6 alone were not available.

The Ministry of Agriculture, Fisheries and Food (MAFF) has recently published a detailed assessment of the extent and state of repair of coast protection works (against erosion) on the English coast (MAFF 1994). 10% of coast protection works in the north of this region, where nearly a fifth of the coast is protected, are experiencing significant erosion, and more than a third of their length requires significant to moderate repairs. In the south of the region, where erosion is less of a problem, more than a quarter of coast protection works require moderate to significant repairs (Table 8.4.3). Throughout the region, one sixth of all coast protection works have a residual life of five years or less.

8.4.2 Important locations

Coast protection

In the north of the region, coast protection works are associated with coastal towns and the spit of Spurn Head. In the south they are present along the eroding stretches of the eastern Norfolk coast. The main unmodified stretches of coast are rural areas of Holderness, where the coast is eroding so swiftly that coastal works are generally impracticable, the north Lincolnshire coast to Mablethorpe, and undeveloped sections of the Norfolk coast, where natural sand or shingle spits and saltmarsh form the coastal fringe. The resort town and fishing port of Bridlington has some extensive promenades and marks the northern end of the long and rapidly eroding soft rock coastline of Holderness, which extends south to the entrance to the Humber. The coast here is receding on average at about 2 m per year, and coast protection has to be upgraded regularly at Hornsea, Mappleton and Withernsea.

Spurn Head, at the northern entrance to the Humber estuary, has been the subject of a detailed study (Institute of Estuarine and Coastal Studies 1992) of the erosional processes, which are threatening to sever the Point from the mainland. The owners (the Yorkshire Wildlife Trust) have a policy of non-intervention, although *ad hoc* repairs have been carried out in the past. The present day morphology of the site is largely artificial, produced by 19th century engineering works, and the study recommends active intervention using 'soft' rather than 'hard' engineering methods.

Map 8.4.1 shows the distribution of man-made coast protection works in the region; lengths of coast protection in each coastal District Council in the region are given in Table 8.4.4.

Sea defences

Within the Humber estuary there are extensive areas of 'hard' sea defence works associated with the industrial sites, ports and towns along the estuary shore. The low-lying nature of the land means that rural areas have also required flood defences to be constructed against storm surges and high tides. The 100-foot high River Hull Tidal Surge Barrier was completed in 1980, built to protect Hull from flooding, as over 90% of the city is below the level of the highest recorded tide, which flooded most of the Old Town in September 1969. The barrier is lowered in times of flood danger and prevents tidal water entering the River Hull.

From the Humber estuary southwards, most of the coastline is flat, low-lying and below maximum recorded sea level. The NRA is responsible for the sea defences along this whole length of coast, with the exception of a small length in Skegness, which is the responsibility of the East Lindsey District Council (Lincolnshire County Council 1981). Some areas of sea defences between Saltfleet and Mablethorpe and at Gibraltar Point are natural features, which are reinforced and maintained by the NRA. To the north of Saltfleet and again to the south of Gibraltar Point, seabanks are constructed of local materials. There has been some land claim at Skegness for the development of holiday recreation areas, and new flood banks were constructed at Tetney Haven and Grainthorpe Haven in north Lincolnshire in 1974. The Tetney Haven Scheme involved the conversion of approximately one square kilometre of coastal marsh.

Sea defences around The Wash have been extensively studied. A useful synopsis can be found in Doody & Barnett (1987). The shallow intertidal areas of The Wash have been subject to land claim for many hundreds of years, continuing into the 1980s, when agricultural subsidies made this an attractive proposition. The claimed land is protected from the sea by artificially constructed flood embankments, which extend along the entire coastline of The Wash and border the major rivers that feed into it. There have been significant works to raise these banks by excavating material from the seaward side and depositing it on the top. Some of

Table 8.4.4 Lengths of coast protection in Region 6

Council frontage	*Total length (km)*	*Undeveloped length (km)*	*Coast protection length (km)*	*% protected*
East Yorkshire	32.5	27.4	5.1	15.6
Holderness	45.5	35.5	10.0	22.0
Cleethorpes	7.8	4.4	3.4	43.7
East Lindsey	5.5	5.5	0.0	0.0
King's Lynn & West Norfolk	8.7	7.2	1.5	16.9
North Norfolk	48.7	24.8	23.9	49.1
Great Yarmouth	22.8	7.1	15.7	68.9
Region 6	***171.5***	***111.9***	***59.6***	***34.8***
English coast	2,924.9	2,065.2	859.7	29.4
% of English coast in Region 6	5.8	5.4	6.9	-

Source: MAFF (1994)

these excavations have extended up to 70 m seaward into areas of conservation importance, such as at Frampton/Kirton. Work is also ongoing to improve the flood embankment alongside the Ouse Washes. The inflowing rivers have been considerably modified by straightening and deepening, and all but the Great Ouse are further regulated by tidal sluices. The barrier sluice on the Nene estuary is 40 km upstream of The Wash and does not have a significant restraining influence on tidal action. However, the Welland and Witham sluices, at 22 and 11 km respectively from the river mouths, significantly restrain tidal action in the rivers.

8.4.3 Management

Co-ordination between coastal defence agencies in the region is mainly undertaken through four non-statutory Coastal Groups (also known as coastal engineering groups - see section 10.3.3). The Humber Estuary Coastal Authorities Group covers the area from Flamborough Head to Donna Nook. The North East Coastal Authorities Group covers the small section of the region's coast north of Flamborough Head, but deals mainly with the coast of Region 5 to the north. The Holderness Coast Protection Project covers the area from Flamborough to Spurn Head, and the Anglian Coastal Authorities Group extends from Spurn to the Thames.

Norfolk County Council has new policies in its draft Structure Plan *Norfolk to 2006* which aim to reduce the risk of coastal flooding and erosion. These are "a presumption against development on land to the seaward side of sea defences" and "a presumption against new building in areas likely to be affected by marine erosion within the expected lifetime of the development" (Kay 1991).

The NRA is currently designing schemes in the region with an allowance of 6 mm per year increase in relative sea level up to 2030, based on the findings of the International Panel on Climate Change on predicted rises, and incorporating an allowance for land sink (see also section 2.5). The repair and upgrading of sea defences in these areas is a potentially huge and expensive task. Work planned or already in progress includes developing a flood defence strategy for the whole Humber estuary. Between Mablethorpe and Skegness, the NRA plans to raise beach height over a four-year period by pumping sea-dredged sand ashore along the 25 km of coast, to prolong the life of the rock and concrete sea defences built or rebuilt after the 1953 storm surge and floods. On the eastern shore of The Wash, where it broadens out into the open sea, between Hunstanton and Snettisham, the beach is being recharged with shingle and sand over a length of 7 km to protect the shoreline. The raised height of the beach will prolong the life of the concrete sea defences and protect the natural shingle ridge along the seafront. On the east Norfolk coast, between Happisburgh and Winterton, beaches are being recharged, and sixteen offshore rock breakwaters 200 m long will be constructed over the next 20 years along 14 km of coast around Sea Palling. This is intended to change wave patterns and help prevent the erosion which is removing beach material, exposing sand dunes and seawalls to erosion and threatening 6,000 ha of the Norfolk Broads with salt-water flooding. Other NRA capital flood defence projects to be carried out in the region in the mid 1990s include work on the Broadland Flood Alleviation Scheme and tidal defences at Halvergate, also in Broadland.

8.4.4 Information sources used

The Ministry of Agriculture, Fisheries and Food has recently published the Coast Protection Survey of England (MAFF 1994), which assesses the extent, adequacy and state of repair of coast protection works throughout the country and notes coastal defence requirements for the next three to five years. These detailed data are held on a GIS database by the contractors (Sir William Halcrow & Partners) and MAFF. Tables 8.4.2, 8.4.3 and 8.4.4, compiled from published summaries, present only some of the data.

The National Rivers Authority holds details of sea defence works obtained during a Sea Defence survey in 1991 (Table 8.4.1). Results are held in a proprietary database cross-referenced to maps, which may be viewed at regional NRA offices by prior arrangement.

Between 1988 and 1991, the NRA Anglian Region carried out a major Sea Defence Management Study on the coast from Flamborough Head to the Thames Estuary. These data, together with information on the hinterland land-use and hydrological, geological and ecological information, are now held on the Shoreline Management System GIS (Townend 1990; Townend & Leggett 1992).

8.4.5 Acknowledgements

Thanks are due to John Horne, MAFF Regional Engineer's Office, and Andy Swash, MAFF Flood and Coastal Defence Division, for supplying data from the Coast Protection Survey of England. Sarah Benson kindly provided data from the NRA Anglian Region database.

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Whitehead, T. 1993. Much binding in the marsh (managed retreat/offshore reefs off East Norfolk coast). *Surveyor*, *2* (September).

Yorkshire Wildlife Trust. 1994. *Spurn management plan.* Internal YWT report.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Departmental responsibility for flood defence and coast protection policy, provision of grants towards capital expenditure by the responsible bodies. Coast Protection Survey of England	*MAFF Flood and Coastal Defence Division, London, tel: 0171 238 3000
Coast protection and prevention of the flooding of non-agricultural land	*Maritime District Councils
Storm tide warning service	Meteorological Office, Johnstone House, London Road, Bracknell RG12 2SY, tel: 01344 854914
Flood defence	*National Rivers Authority (NRA) HQ, Bristol, tel: 01454 624400 *NRA Northumbria & Yorkshire Region, Leeds, tel: 01532 440191 *NRA Anglian Region, Peterborough, tel: 01733 371811
Co-operation between parties responsible for coastal defences	*English Coastal Groups Forum, Head of MAFF Flood and Coastal Defence Division, London, tel: 0171 238 6660
Co-ordination and liaison between agencies undertaking coastal works	North East Coastal Authorities Group, Scarborough Borough Council, Town Hall, St Nicholas Street, Scarborough YO11 2HG, tel: 01723 372351
Holderness Coast Protection Project (Flamborough to Spurn Head)	*Principal Engineer, Holderness Borough Council Development Dept., Hull, tel: 01964 562333
Anglian Coastal Authorities Group (Spurn Head to Thames)	*Waveney District Council, Mariners Street, Lowestoft, Suffolk NR32 1JT, tel: 01502 562111

* Starred contact addresses are given in full in the Appendix.

Chapter 9 Human activities

9.1 Fisheries

C.F. Robson

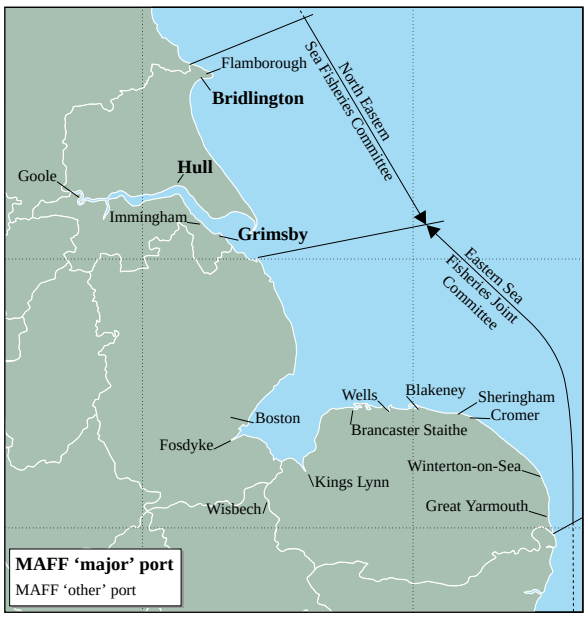
9.1.1 Introduction

This section gives an overview of the main fishing activities in the coastal waters and rivers of the region. There are fisheries for pelagic, demersal and several marine shellfish species (demersal fish live on or near the sea bed; pelagic fish do not) and diadromous species - salmon, sea trout and eels - which spend part of their lives in fresh water and part at sea. The section also covers sea angling and bait collection. For more information about the species concerned, including their scientific names, see sections 5.5, 5.7 and 5.8.

The three 'major' fishing ports (as defined by MAFF) (Bridlington, Hull and Grimsby) and 'other' ports landing fish and shellfish in the region are shown on Map 9.1.1. The inshore fishery for pelagic species is not very intensive in the region, but many species of demersal fish are targeted. Shellfish are a valuable resource in the region, especially in The Wash and surrounding areas, which support highly productive cockle and shrimp fisheries and, historically, mussels. The Holderness and north Norfolk coast also provide important brown crab, lobster and whelk fisheries.

The total tonnages of pelagic, demersal and shellfish species landed in the region in 1992 represent 0.3%, 8.0% and 7.9% respectively of the British totals (Table 9.1.1); the latter two percentages are higher than average for regions in the UK. The region is important for a wide range of shellfish species: the tonnage of shrimps landed in the region represents 66.4% of the British total and there are also significant landings of whelks (30.0%), mussels (18.6%), crabs (16.4%) and cockles (7.9%). Of all recorded landings of fish and shellfish species in 1992 in Britain, 4.9% were made in this region.

Three diadromous species - salmon, sea trout and eel - support a net fishery and a very small rod and line fishery in the region, the most important being for salmon (and grilse, which are young salmon that have spent not more than one winter at sea before maturing) and sea trout. Eel are exploited from the time they enter fresh water as elvers, during their stay in fresh and estuarine water and as they migrate to sea as silver eels. The only river where a catch was recorded between 1989 - 1993 is the (Yorkshire) River Ouse (three fish per year, on average). The majority of the region's catch is recorded from net methods off the Yorkshire and Norfolk coasts. As shown in Table 9.1.2, a relatively small percentage of the salmon and grilse recorded as caught by net fishing in GB is from this region, although the percentage is much higher for sea trout.



Map 9.1.1 MAFF-defined landing ports and coverage of the region by Sea Fisheries Committees

Table 9.1.1 Species group landings in 1992 (tonnes)

Species group	*Region 6*	*North Sea coast*	*England & Wales*	*Britain and Isle of Man*	*% of North Sea coast total landed in region*	*% of combined British and Isle of Man total landed in region*
Pelagic	761	184,311	23,809	252,339	0.4	0.3
Demersal	22,133	228,068	81,237	275,476	9.7	8.0
Shellfish	8,042	61,940	55,360	104,926	13.0	7.7
All species	***30,936***	***474,317***	***160,406***	***632,741***	***6.5***	***4.9***

Source: Ministry of Agriculture, Fisheries and Food (1994a); Scottish Office Agriculture and Fisheries Department (1993); Isle of Man Department of Agriculture, Fisheries and Forestry pers. comm. Note: Amounts landed are rounded up to the next whole tonne. Calculating the figures in this table was a complex process: refer to section 9.1.4.

Table 9.1.2 Average catch of salmon and grilse and sea trout 1989 - 1993

	Salmon and grilse	*Sea trout*
Region 6	4,803	17,288
North Sea coast	196,247	104,789
England & Wales	67,347	76,337
GB	254,829	141,813
% of North Sea coast total in region	2.4	16.4
% of GB total in region	1.9	12.1

Source: Department of Agriculture and Fisheries (1990); National Rivers Authority (1991, 1992, 1993, 1994a & 1994b) and Scottish Office (1991, 1992, 1993 & 1994). Note: Calculating the figures in this table was a complex process: refer to section 9.1.4.

9.1.2 The fisheries

Pelagic species

Table 9.1.3 gives the total landings of various pelagic species in 1992 in the region, on the North Sea coast, in England and Wales and in Britain. Sprats are targeted by trawlers in The Wash during the summer. Some are sent to Grimsby for processing into fishmeal; the juveniles are sometimes sold locally as whitebait. A small amount of herring are caught in drift nets between autumn and spring, but this fishery is limited by low market demand in the region.

Demersal species

Table 9.1.4 gives the total landings of various demersal species in 1992 in the region, on the North Sea coast, in England and Wales and in Britain. Fixed nets, longlines and trawls are used by the inshore fleet to catch demersal fish. Cod and whiting are targeted during the colder months when shoals appear inshore to feed. In the spring, rays and flatfish such as Dover sole, plaice and turbot are targeted. Dover sole are frequently caught inshore and the nets often take a high by-catch of crustacea. A high proportion of the catch from beam trawlers targeting brown shrimp and pink prawns can consist of juvenile flatfish, particularly plaice and Dover sole, owing to the small mesh size nets used to catch these crustacea. Beach-launched boats set longlines for cod, rays and dogfish and also take other species such as whiting, ling, pollack and turbot, mainly as a by-catch. Bass (included in the 'Others' category in Table 9.1.4) are targeted in the summer, mainly in the more southern area of the region, and sea trout and mullet are also often taken. Demand for bass is high and rising, whereas mullet are less in demand.

Shellfish species

Table 9.1.5 gives the total landings of various shellfish species in 1992 in the region, on the North Sea coast, in England and Wales and in Britain. In The Wash and around the north Norfolk coast, mussels on public and private beds are exploited by dredging in winter, as warmer temperatures ruin the meat quality. They are usually landed at King's Lynn (373 tonnes in 1992) and Boston (270 tonnes in 1992). Stocks of mussels in The Wash have plummeted since the mid-1980s, owing to recruitment failure, with the last significant spatfall occurring in 1986 (Eastern Sea Fisheries Joint Committee pers. comm.). For example, the total landing of mussels to the Eastern Sea Fisheries Joint Committee district (which includes The Wash) in 1992 was 1,217 tonnes (constituting the total landings in the region), whereas in 1989 it was over 7,000 tonnes. In 1994 there was a total closure of the fishery and in 1995 only mussels intended for use as seed were allowed to be landed.

Also in The Wash, cockles are exploited, normally from April until the end of the year, by approximately 35 vessels using hydraulic suction dredges, mostly based at Boston. Cockles are also gathered by hand, especially where they are found in lower densities. Overall cockle fishing effort has markedly increased since the mid-1980s, owing to the decline of other fisheries in the area and an improvement in the market demand. However, to conserve cockle stocks in The Wash, in 1992 and 1993 the Eastern Sea Fisheries Joint Committee (ESFJC) and local cockle processors agreed to impose seasonal closures; in 1993 the cockle fishery was closed from January to May.

The greatest catches of lobster in the region are from the Holderness and the north Norfolk coast in July and August, as the lobsters move inshore to feed on soft crabs that have recently moulted. The edible crab fishery centres around the Lincolnshire and north Norfolk coast from spring to autumn. Many beach-launched boats still use traditional

Table 9.1.3 Pelagic species landings in 1992 (tonnes)

Species	*Region 6*	*North Sea coast*	*England & Wales*	*Britain and Isle of Man*	*% of North Sea coast total landed in region*	*% of combined British and Isle of Man total landed in region*
Argentines	0	137	0	179	0	0
Herring	113	74,706	915	85,652	0.2	0.1
Horse mackerel	0	1,374	1,026	1,500	0	0
Mackerel	13	95,366	9,142	150,728	<0.1	<0.1
Pilchard	0	4,244	4,244	4,244	0	0
Sprat	635	8,478	8,478	10,033	7.5	6.3
Whitebait	0	1	1	1	0	0
Others	0	3	3	3	0	0
Total	***761***	***184,311***	***23,809***	***252,339***	***0.4***	***0.3***

Source Ministry of Agriculture, Fisheries and Food (1994a); Scottish Office Agriculture and Fisheries Department (1993); Isle of Man Department of Agriculture, Fisheries and Forestry pers. comm. Note: Amounts landed are rounded up to the next whole tonne. Calculating the figures in this table was a complex process: refer to section 9.1.4.

Table 9.1.4 Demersal species landings in 1992 (tonnes)

Species	*Region 6*	*North Sea coast*	*England & Wales*	*Britain and Isle of Man*	*% of North Sea coast total landed in region*	*% of combined British and Isle of Man total landed in region*
Elasmobranchs						
Dogfish	599	7,449	3,625	13,348	8.0	4.5
Skates and rays	399	3,816	4,142	7,827	10.5	5.1
Gadoids						
Cod	12,766	53,440	23,530	59,525	23.9	21.4
Haddock	1,383	49,221	3,706	53,587	2.8	2.6
Hake	19	589	1,621	3,619	3.2	0.5
Ling	289	4,594	1,708	6,027	6.3	4.8
Pollack (lythe)	81	1,921	1,734	3,022	4.2	2.7
Saithe	1,555	11,032	2,284	12,600	14.1	12.3
Whiting	379	36,733	5,088	41,055	1.0	0.9
Whiting, blue	0	6,531	**P**	6,531	–	–
Flatfish						
Brill	38	317	392	445	12.0	8.5
Dab	38	1,017	456	1,214	3.7	3.1
Dover sole	94	2,021	2,812	2,875	4.7	3.3
Flounder	**P**	167	269	274	0	0
Halibut	73	166	80	196	44.0	37.2
Halibut, Greenland	117	119	117	136	98.3	86.0
Lemon sole	506	5,004	3,000	5,573	10.1	9.1
Megrim	11	1,379	1,471	4,038	0.8	0.3
Plaice	2,480	20,749	15,970	23,887	12.0	10.4
Turbot	74	561	545	743	13.2	10.0
Other species						
Catfish	201	1,896	557	1,935	10.6	10.4
Conger eel	**P**	99	403	508	–	–
Gurnard	5	368	589	622	1.4	0.8
Monkfish/angler	214	9,813	3,102	14,679	2.2	1.5
Redfish	581	718	581	774	80.9	75.1
Sandeel	0	4,152	**P**	4,152	0	0
Torsk (tusk)	13	165	13	209	7.9	6.2
Witch	39	1,405	192	1,980	2.8	2.0
Others	135	2,420	3,151	3,835	5.6	3.5
Fish roes	44	195	99	244	22.6	18.0
Total	***22,133***	***228,068***	***81,237***	***275,476***	***9.7***	***8.0***

Source: Ministry of Agriculture, Fisheries and Food (1994a); Scottish Office Agriculture and Fisheries Department (1993); Isle of Man Department of Agriculture, Fisheries and Forestry pers. comm. Key: **P** = species landed in the region in small quantities (here <0.5 tonnes); – = % not calculated. Note: Amounts landed are rounded up to the next whole tonne. Calculating the figures in this table was a complex process: refer to section 9.1.4.

Table 9.1.5 Shellfish landings* in 1992 (tonnes)

Species	*Region 6*	*North Sea coast*	*England & Wales*	*Britain and Isle of Man*	*% of North Sea coast total landed in region*	*% of combined British and Isle of Man total landed in region*
Cockles	2,519	26,199	29,501	32,047	9.6	7.9
Crabs	2,781	9,117	9,453	16,971	30.5	16.4
Lobsters	76	622	504	1,073	12.2	7.1
Mussels	1,217	4,865	3,488	6,555	25.0	18.6
Nephrops	5	8,368	1,918	19,627	0.1	<0.1
Periwinkles	0	315	70	1,908	0.0	0.0
Queens	199	2,207	2,989	11,272	9.0	1.8
Scallops	0	4,519	2,589	8,291	0.0	0.0
Shrimps	493	615	563	743	80.2	66.4
Squids	10	1,382	919	2,007	0.7	0.5
Whelks	718	1,905	1,535	2,393	37.7	30.0
Others	24	1,819	1,831	2,026	1.3	1.2
Total	***8,042***	***61,940***	***55,360***	***104,926***	***13.0***	***7.7***

Source: Ministry of Agriculture, Fisheries and Food (1994a); Scottish Office Agriculture and Fisheries Department (1993); Isle of Man Department of Agriculture, Fisheries and Forestry pers. comm. Key: *excluding landings of farmed shellfish - see section 9.2.
Note: Amounts landed are rounded up to the next whole tonne. Interpretation of the figures in this table is complex: refer to section 9.1.4.

wooden inkwell pots. Some of the small fishing communities are highly dependent on this resource and prepare the crabs themselves to be sold locally. There are very important brown shrimp and pink prawn stocks in The Wash, which are targeted by inshore beam trawlers from autumn through to spring. Fishing can be restricted during the winter, owing to bad weather and low temperatures, which force these species further offshore. Brown shrimp are generally caught in shallower waters than pink prawns. A small fishery for brown shrimp also exists in the Humber estuary and along the Lincolnshire coast.

A queen scallop fishery exists, exploiting the stocks off the North Yorkshire coast. A thriving whelk fishery once existed from Brancaster to Wells, with boats fishing out to 30 miles. Although catch rates have fallen since the mid-1980s and few vessels remain in the fishery, a considerable quantity of whelks (over 700 tonnes in 1992) are still potted and landed in the region.

Diadromous species

Table 9.1.6 shows the average numbers of salmon and grilse and sea trout caught in the region's rivers and fisheries in the five years between 1989 and 1993, the methods used to catch them, and the numbers of net licences issued for catching salmon and grilse in 1993. Almost 100% of the salmon, grilse and sea trout in this region are caught with nets off Flamborough Head, the Holderness coast and Norfolk. Rods are used mainly by game fishermen. Fyke nets, used to target silver eels, are set in the lower reaches of the tidal Great Ouse (in Norfolk) in autumn. From spring onwards, eels are also netted by fyke nets in the rivers flowing into the Humber estuary (although this fishery has decreased recently) and in many rivers in Norfolk.

Sea angling

Sea angling is distinguished from two other types of sport fishing: game fishing for salmon, sea trout, brown and rainbow trout (the first two are covered here) and coarse fishing, which is for freshwater fish species and so is not covered here. Sea angling has three main forms: angling from the shore, inshore fishing within about 5 km of the shore and deep sea fishing. It is a popular sport practised by over two million people in Great Britain (Fowler 1992). Its governing body in England is the National Federation of Sea Anglers, which has approximately 570 affiliated clubs with approximately 33,000 individual members. Orton (1994) lists contact addresses for fishing clubs in the region and national organisations.

Fish angled on the wrecks off Flamborough Head include cod, haddock, ling and skates. The piers at Bridlington are also fished from, and a wide variety of species is caught from boats off Hornsea. Mablethorpe to Sutton-on-Sea has good sea fishing from boat and shore. Species caught include bass, skate, mackerel and tope. There is beach angling for cod, dab and plaice at Skegness, and further down the coast, at Salthouse, the sea is deep quite close inshore and fishing is considered good. Flatfish can be caught off Sheringham all year, and boat fishing is best well offshore. Cromer has good angling all year and all types of sea fishing are carried out at Great Yarmouth. Whiting, dab, flounder and cod are caught in the estuary and from the shore at Gorleston (Orton 1994). Orton (1994) also lists further sea fishing stations, the facilities available and likely catch species.

Bait collection

Bait collection for sea angling occurs in many areas in the region, although some areas are more prolific than others and may attract commercial collectors. Anglers often collect their own bait locally, while commercial collectors travel in teams to suitable shores. Many species are collected, including ragworm, lugworm, peeler crabs (moulting shore crabs), mussels, cockles, limpets, razor shells, squid, mackerel and sandeels (see section 5.5). Different bait species are targeted according to the species of fish being caught as well as the location and time of year. The main collecting techniques on the shore are digging and boulder turning. Bait digging, especially for lugworms, is carried out over the lower part of muddy and sandy shores around the time of low water. Fowler (1992) identified that the exploitation of bait species was taking place at many locations in the region. Areas such as Spurn Head, Grimsby, Cleethorpes Beach, Grainthorpe, the north shore of The Wash, Brancaster Harbour and Holkham Bay experience larger numbers of diggers and some problems have been encountered (see Section 5.5).

9.1.3 Management and issues

Responsibility for the management of fisheries in coastal waters, extending from low water mark, rests with the Commission for the European Union (EU), who delegate it to member states under the Common Fisheries Policy. EU regulations require enactment by UK law, usually by means of statutory instruments, which state the offences and set

Table 9.1.6 Salmon and grilse and sea trout five-year (1989-1993) average catch (as numbers of fish reported to NRA), catch methods used and number of net licences for salmon and grilse issued in 1993, for each river/fishery in the region

River/fishery	*Salmon & grilse*	*Sea trout*	*Method used/net licences issued*
River Ouse (Yorkshire)	1	2	rod
Yorkshire Coastal	4,790	14,660	drift nets (17) & T or J nets (25)
Anglian Coastal *	12	2,626	drift nets (54) & various nets (39)
Region 6	***4,803***	***17,288***	***135***
England & Wales	***67,347***	***76,337***	***780***

Source: Department of Agriculture and Fisheries (1990); National Rivers Authority (1991, 1992, 1993, 1994a & 1994b) and Scottish Office (1991, 1992, 1993, & 1994). Key: * The NRA Anglian coastal fishery also includes part of the Coastal Directories Project's Region 7. The figures given here are the totals within this NRA fishery for Regions 6 and 7 combined. 'Sea trout' here includes all migratory trout. 'Nets' are defined as instruments other than rod and line.

Table 9.1.7 Combined Regulating* and Several Order in the region

Title	*Species covered*	*Grid ref.*	*Location*	*Grantee*	*Area (ha)*	*Date expires*
The Wash Fishery Order 1992	Oysters, mussles, cockles, clams and scallops	TF700455 to TF565570	The Wash (parts of Lincolnshire and Norfolk)	Eastern Sea Fisheries Joint Committee	68,865 (approx.)	2023

Source: MAFF (1994b) and Grantee. Key: * In this region there are no separate Regulating Orders - see text.

down powers of enforcement and penalties, and which require Brussels approval for bylaws. Areas landward of low water mark (baseline) and areas within Bay Closing Lines (e.g. within The Wash) are excluded from these regulations, and bylaws for fisheries management in these areas do not need approval from Brussels. The Common Fisheries Policy seeks to manage stocks of fish in EU waters on a biological basis (MAFF 1994a) by implementing catch quota management measures by setting agreed annual Total Allowable Catches (TACs) for particular stocks. The policy came into effect in 1983 and was subject to a mid-term review in 1993, with a full review planned for 2002. Under the Policy, fishing in this region is restricted to national boats in an area of up to 12 nautical miles from the coast, in order to protect the interests of local fishermen. Outside this 12 mile limit, all European Union member countries have equal access to the Exclusive Fishing Zone, whereas under European, national and local bylaw legislation, non-member countries are only allowed to fish by agreement.

For the purpose of stock management, the UK coastal waters have been designated by the International Council for the Exploration of the Sea (ICES) into statistical areas. The coastal seas around this region are part of two 'divisions': IVb (Middle North Sea) and IVc (Southern North Sea). ICES provides scientific advice on the management of all the important commercial species of fin fish and some shellfish stocks in all areas of the north-east Atlantic. This work is summarised in the annual report of the Advisory Committee on Fishery Management, which is responsible for providing scientific advice on TACs and other conservation measures. The TACs, UK quotas and 'uptake' for 1991 and 1992 for each species in the two ICES statistical divisions in the region are given in MAFF (1994a). Restrictions applying in the region, minimum landing sizes and annual quotas for the important pelagic and demersal species are listed in Tables 5.7.1 and 5.7.2.

In this region the North Eastern Sea Fisheries Committee (NESFC) and the Eastern Sea Fisheries Joint Committee (ESFJC) manage the inshore fisheries from the high water mark out to 6 nautical miles (3 nautical miles until October 1993) offshore from the UK baselines (as defined by the Territorial Water Order in Council 1964). The boundary between these two Sea Fisheries Committees is near Donna Nook in Lincolnshire (Map 9.1.1). Local MAFF fishery officers deal with quota management, enforcement of UK and EC legislation and licensing of fishing vessels.

The NRA's Northumbria and Yorkshire Region and Anglian Region have a responsibility to regulate, protect and monitor salmon, sea trout and eel fisheries from rivers to coastal waters out to the 6 nautical mile limit. Orton (1994) describes the structure of the NRA and the licensing procedures, seasons, catch and size limits for each NRA region. The two Sea Fisheries Committees also have powers to support this conservation of salmonid fisheries whilst exercising their responsibilities towards the regulation of sea fisheries.

The single Fishery Order in the Region is the Wash Fishery Order (Table 9.1.7). It is very large compared with the eight Regulating Orders in Britain and is a combined Regulating and Several Order, that is, it is a Regulating Order with powers to grant leases of Several rights. At 68,865 ha it makes up over three quarters of the approximately 94,584 ha covered by Regulating Orders in Britain as at July 1994 (MAFF 1994b). (Table 9.2.2 lists separate Several Orders in the region.) Regulating Orders are granted in England by MAFF to a responsible body to enable it to regulate the natural fishery for particular molluscan shellfish species. The specified shellfish may only be taken in accordance with the terms of the order and any regulations made under it. The Wash Fishery Order allows the ESFJC to regulate and conserve molluscan shellfisheries in the whole Wash area. For example, ESFJC works very closely with the cockle fishermen to implement seasonal closures and varying restrictions on cockle harvesting (see also section 5.5.3) in order to limit unnecessary damage and to sustain stocks.

In England and Wales MAFF's Directorate of Fisheries Research (DFR) Laboratory at Lowestoft is responsible for collecting and collating information on fish stocks exploited by UK vessels. The MAFF DFR Fisheries Laboratory at Conwy is the Directorate's centre for assessing the implications of non-fisheries activities and coastal zone usage on fish stocks and fisheries. MAFF DFR databases are described in Flatman (1993).

Issues relating to the fisheries for pelagic, demersal and shellfish species and sea angling and bait collection are closely linked to wildlife conservation in several ways; for instance, factors such as over-fishing, pollution and development are thought to have been responsible for seriously reducing the eel fishery in the region. Issues include the effects on target species as major components in marine ecosystems, the changed availability of food for predators, the effects on non-target species (e.g. the shrimp fishery described in section 5.7.3), and effects on species and habitats of nature conservation interest. These issues are under consideration by the 'Marine Fisheries Task Force', an inter-agency team of the statutory nature conservation organisations (the Countryside Council for Wales, English Nature, Scottish Natural Heritage and the Department of the Environment for Northern Ireland, together with the JNCC). A consultation draft paper prepared by the group, entitled *Developing an action programme for sea fisheries and wildlife* (Marine Fisheries Task Force 1994), identifies the main areas where marine fisheries (broadly defined to encompass the exploitation of all living marine resources) affect wildlife and identifies any action needed.

Further information on issues concerning the species targeted is given in sections 5.5.3, 5.7.3, and 5.8.3.

9.1.4 Information sources used

Inshore fisheries review of England, Scotland and Wales, 1992/1993 (Gray 1994) has been used extensively in compiling this section. It gives details of the numbers of boats operating from ports in the region, the amount of fishing effort involved by various methods and which species or species groups are targeted during the different seasons. Brady (1995) lists details of all fishing vessels, their base port and main fishing methods. Figures given in Tables 9.1.1 and 9.1.3 - 9.1.5 come from two sources - MAFF and the Scottish Office Agriculture and Fisheries Department (SOAFD) and their interpretation is described below.

Pelagic, demersal and shellfish species

Statistics given here are for landings recorded in the region, not estimated catches made in the region. Some fish caught in the region may not be landed in the region's ports or even in the UK; other fish are landed in the region but are caught outside it; and until 1993, boats under 10 m were not obliged to register their landings. The tonnages of various pelagic, demersal and shellfish species (fresh and frozen) landed by UK vessels at the major ports in England and Wales come from *UK Sea Fisheries Statistics for 1991 and 1992* (MAFF 1994a): this applies to Bridlington, Hull and Grimsby, the three 'major ports' in the region. A total for the 'other', smaller, ports (see Map 9.1.1) was provided by the MAFF Fisheries Statistics Unit. These data have been combined to give the figures in the 'Region 6' column for Tables 9.1.1, 9.1.3, 9.1.4 and 9.1.5. The figures in the 'North Sea coast' column were calculated by adding together all the landings data for the ten regions on the North Sea coast of Great Britain, as covered by Doody (1993). The figures in the 'England & Wales' column were obtained by adding together all of the MAFF data for England and Wales and those in the 'Britain' column were obtained by combining MAFF, SOAFD and Isle of Man Department of Agriculture, Fisheries and Forestry (IOMDAFF) data. Because these organisations do not use the same categories, landings in some of their categories have been added to the 'others' rows in the tables in this section. Also, SOAFD publish the weight of fish as 'standard landed weight' (gutted fish with head on), whereas MAFF and IOMDAFF publish them as 'nominal live weight' (whole fish). These two are the same for pelagic and shellfish species, but converted data from SOAFD were used for all demersal species, apart from sandeels (which are not gutted), so that all the data presented are in 'nominal live weight'.

A specialist subset of the electronic mapping system UKDMAP (see 'Core reading list' - section A3 in the Appendix), called SHELLMAP, is being prepared by the MAFF Shellfish Division in Weymouth, to meet the requirements of the EC shellfish harvesting and hygiene directives (section 9.2.3; see also Ramster *et al.* in press). The software includes charts of all coastal areas (principally estuaries) that support known molluscan shellfisheries, showing all details of the production areas and their classification; however the software is confidential and access is restricted.

Diadromous species

NRA reported catches for salmon, grilse and sea trout vary in accuracy from year to year, as they represent only declared catches by individuals with a net or rod and line licence; in addition, catches themselves fluctuate, and so the relationship between catch and stock is not straightforward. Further, in 1992, the introduction of changes to the catch recording system may have resulted in a temporarily reduced level of recording. Therefore the figures given in Table 9.1.6 should be used only as an indication of the pattern of the catch in the region. The annual NRA *Salmonid and freshwater statistics for England and Wales* (National Rivers Authority 1991, 1992, 1993, 1994a & b) contain more detailed information.

Sea angling

In the 84th edition of *Where to fish*, Orton (1994) lists much useful information relating to angling, including the locations from which various species of fish can be caught.

Bait collection

Bait collection is discussed by Fowler (1992), who presents results from a survey around the coast of Britain in 1985.

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C. Contact names and addresses

Type of information	Contact address and telephone no.
Central contact for the local Sea Fisheries Committees; general policy issues	Chief Executive, Association of Sea Fisheries Committees, Buckrose House, Commercial Street, Norton, Malton, North Yorkshire YO17 9HX, tel: 01653 698219
Local inshore fisheries, local bylaws, national and EU legislation	Clerk and Chief Fishery Officer, North Eastern Sea Fisheries Committee, County Hall, Beverly, North Humberside HU17 9BA, tel: 01482 867131
Local inshore fisheries, local bylaws, national and EC legislation	Clerk and Chief Fishery Officer, Eastern Sea Fisheries Joint Committee, 6 North Lynn Business Village, Berger Way, King's Lynn, Norfolk PE30 2JG, tel: 01553 775321
Scientific aspects of managing important fish and shellfish stocks	General Secretary, International Council for the Exploration of the Sea, Palaegade 2 - 4, DK-1261 Copenhagen K, Denmark, tel: 00 45 33157092
Assessment of implications of non-fisheries activities and coast usage on fish stocks and fisheries; advice to assist with management and policy decisions for the coastal zone	*Head of Laboratory, MAFF of Directorate of Fisheries Research, Fisheries Laboratory (Conwy), tel: 01492 593883
Assessment and advice on the conservation of fish stocks exploited by UK vessels	*Director, MAFF Directorate of Fisheries Research, Fisheries Laboratory (Lowestoft), tel: 01502 562244
Preparation of SHELLMAP (a subset of UKDMAP)	Director, MAFF Shellfish Division, Fish Diseases Laboratory, Barrack Road, The Nothe, Weymouth, Dorset DT4 8UB, tel: 01305 206600
Additional statistics other than those in publications (available from HMSO)	MAFF Fisheries Statistics Unit, Nobel House, 17 Smith Square, London SW1P 3JR, tel: 0171 238 6000
Local fisheries, quota management, licensing of fishing vessels and enforcement, UK and EC legislation, from Redcar to Donna Nook.	District Inspector, MAFF Sea Fisheries Inspectorate, District Fisheries Office, 141, Cleethorpe Grimsby, South Humberside Road, DN31 3EW, tel: 01472 355112/3
Local fisheries, quota management, licensing of fishing vessels and enforcement, UK and EC legislation, from Donna Nook to the Thames.	District Inspector, MAFF Sea Fisheries Inspectorate, District Fishery Office, 'Seaview', Battery Green Road, Lowestoft, Suffolk NR32 1DD, tel: 01502 573149
National NRA fisheries policy and projects; salmonid and freshwater statistics for England and Wales.	*Head of Department, Fisheries Department, NRA Head Office, Bristol, tel: 01454 624400
Diadromous fisheries in the region; salmonid and freshwater statistics for Northumbria and Yorkshire Region	*Regional Fisheries Manager, National Rivers Authority - Northumbria and Yorkshire Regional Office, Leeds, tel: 0113 244 0191
Diadromous fisheries in the region; salmonid and freshwater statistics for Humberside south of the Humber, Lincolnshire and Norfolk	*Regional Fisheries Manager, NRA Anglian Region, Peterborough, tel: 01733 371811
Fin fish (commercial aspects)	Technical Director, Sea Fish Industry Authority, Seafish Technology Division, Sea Fish House, St Andrew's Dock, Hull, North Humberside HU3 4QE, tel: 01482 27837
UKDMAP software; mapped fishing areas of selected species, ICES Statistical Division boundaries etc.	Project Manager, British Oceanographic Data Centre, Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, tel: 0151 652 3950
Shellfish production	Director, Shellfish Association of the UK, Clerk, Fishmongers' Hall, London Bridge, London EC4R 9EL, tel: 0171 626 3531
Affiliated angling clubs	Secretary, National Federation of Sea Anglers, 51a Queens Street, Newton Abbot, Devon TQ12 2QJ, tel: 01626 331330
Interaction between fisheries and non-fisheries conservation issues	*Marine Fisheries Officer, English Nature HQ, Peterborough, tel: 01733 340345
Marine Fisheries Task Group paper; interaction between fisheries and non-fisheries conservation issues	*Marine Advisory Officer, JNCC Peterborough, tel: 01733 62626
Interaction between fisheries and non-fisheries conservation issues	*Marine Policy Officer, RSPB HQ, Sandy, tel: 01767 680551
Interaction between fisheries and non-fisheries conservation issues	*Fisheries Officer, WWF-UK, Godalming, tel: 01483 426444
Interaction between fisheries and non-fisheries conservation issues	*Conservation Officer, Marine Conservation Society, Ross-on-Wye, tel: 01989 566017
Interaction between fisheries and non-fisheries conservation issues	Administrator, The Marine Forum for Environmental Issues, Department of Zoology, The Natural History Museum, Cromwell Road, London SW7 5BD, tel: 0171 938 9114
Game fishing	Director, Salmon and Trout Association, Fishmongers' Hall, London Bridge, London EC4R 9EL, tel: 0171 2835838

* Starred contact addresses are given in full in the Appendix.

9.2 Mariculture

C.F. Robson

9.2.1 Introduction

Mariculture is the cultivation of marine species in coastal waters. In this region there is a small amount of shellfish farming for bivalve molluscs, located in The Wash and in the coastal creeks of north Norfolk.

9.2.2 Locations and species

The locations of commercial mariculture areas in the region and the species that are cultivated are presented on Map 9.2.1. Table 9.2.1 lists the main species that are under commercial cultivation in the region and in Great Britain and the Isle of Man. There is currently no cultivation of salmonids, non-salmonid fish, algae or polychaetes in the region.

Shellfish

In order to improve the quality of naturally-occurring stocks of mussels, young mussels - 'seed' - are transplanted from natural beds to man-made 'lays', usually in sheltered, inshore waters. For optimum growth they are laid in the sub-tidal zone. Mussels are cultivated in The Wash (off Boston), at Thornham, Brancaster and Blakeney and, in small amounts, at Burnham Overy. The production of mussels in 1992 at Brancaster was 231 tonnes and the production from The Wash that was landed at Boston was 270 tonnes (in addition to the non-farmed tonnages landed from the fishery - Table 9.1.5). Small amounts were also landed in 1992 at King's Lynn (50 tonnes) and Blakeney (15 tonnes).

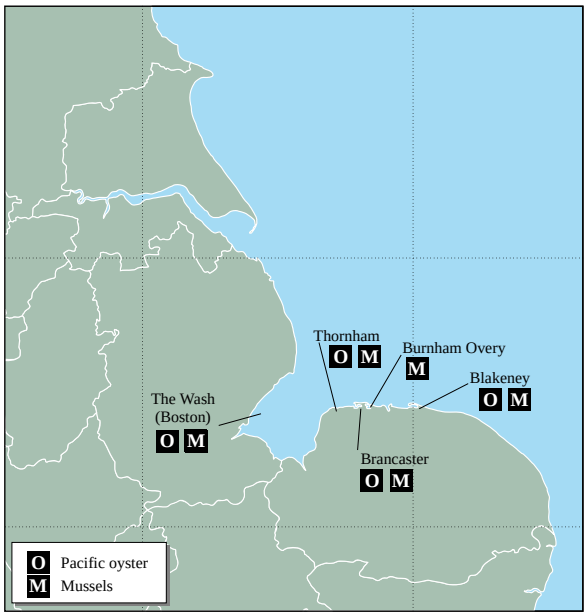
Pacific oyster seed, from commercial hatcheries, is reared in 'poches' (large mesh nets) on trestles at low water in three sheltered areas of this region, all on the north Norfolk coast, at Thornham, Brancaster and Blakeney. In 1992 the cultivation of Pacific oysters started at Hook Hill (near Boston); the first harvest from this new mariculture venture is due in 1995.

There are five Several Orders in this region out of a total of 22 for Britain, in addition to the combined Several and Regulating Order - The Wash Fishery Order - which is described in section 9.1.2. The Several Orders present in the region are described in Table 9.2.2. The existence of a Several Order does not necessarily mean that mariculture is actively occurring at the location covered. For example, mariculture covered by the Several Order at Wells-next-the-Sea has recently ceased; at Hunstanton, the private mussel beds are no longer used for cultivation, but when mussel seed is available it is sold to Brancaster Staithe Fishermens' Society for relaying at Burnham Deepdale.

Table 9.2.1 Main species that are cultivated in the region and in Great Britain

Species	*Native or non-native species*	*Cultivated in region?*
Salmonids		
Atlantic salmon *Salmo salar*	Native	
Rainbow trout *Onchorynchus mykiss*	Un-established introduction	
Non-salmonids		
Turbot *Scophthalmus maximus*	Native	
Halibut *Hippoglossus hippoglossus*	Native	
Shellfish: bivalve molluscs		
Common mussel *Mytilus edulis*	Native	✔
Native oyster *Ostrea edulis*	Native	
Pacific oyster *Crassostrea gigas*	Non-native	✔
Hard shelled clam *Mercenaria mercenaria*	Non-native	
Manila clam *Tapes philippinarum*	Un-established introduction	
Palourde *Tapes decussatus*	Native	
Scallop *Pecten maximus*	Native	
Queen scallop *Aequipecten opercularis*	Native	
Polychaetes		
King ragworm *Neanthes virens*	Native	

Note: For the JNCC's Marine Nature Conservation Review (MNCR), non-native species are those introduced species that are established in the wild; other introduced species are described as un-established introductions.



Map 9.2.1 General location of mariculture areas and species in culture

9.2.3 Management and issues

The Food Safety (Live Bivalve Molluscs) Regulations (which implement European Council Directives) require that all waters from which bivalve molluscs are taken for human consumption are classified by MAFF, following sampling carried out by the Port Health Authority or Local Authority.

Table 9.2.2 Several Orders in the region

Title	*Species covered*	*Grid ref.*	*Location*	*Grantee*	*Approx. area (ha)*	*Year of expiry*
Hunstanton (le Strange) Fishery Order 1947	Oysters, mussels and cockles	TF677423	The Wash, Hunstanton, Norfolk	Bernard le Strange	298	2007
Brancaster Staithe Fishery Order 1979	Oysters, mussels and cockles	TF803456	Burnham Deepdale (Brancaster), Norfolk	Brancaster Staithe Fisherman's Society	53	2004
Overy Creek Mussel and Cockle Fishery Order 1969	Mussels and cockles	TF850450	Holkham Bay, Norfolk	D & F Lane	4.0	1999
Wells Harbour Shell Fishery Order 1972	Oysters, mussels, cockles and clams	TF916439	Wells-next-the-Sea, Norfolk	Wells Harbour Commissioners	8.5	2032
Blakeney Harbour Mussel Fishery Order 1966	Mussels	TF990455	Blakeney Point, Norfolk	Blakeney Harbour Mussel Society Ltd	42	2026

Source: MAFF (1994b) and Grantees. Note: the region's combined Regulating and Several Order is detailed in Table 9.1.7.
Several Orders are granted under section 1 of the Sea Fisheries (Shellfish Act) 1967 and are administered in England by MAFF. They are granted to an individual, a co-operative or a responsible body to enable the cultivation of the sea bed within a designated area of water and to conserve and develop specified molluscan stocks of shellfish. In addition, Several rights may be granted to a Sea Fisheries Committee, which may lease the rights, subject to the consent of MAFF.

Samples of live shellfish are submitted to the Public Health Laboratory Service for bacteriological examination and, depending on the resulting category (A - D), restrictions and further treatment may apply before human consumption is permitted. Samples are taken regularly and the classification can change.

The consent of the owners or managers of the sea bed is required and a lease may be needed before structures for mariculture can be erected on the sea bed. In many areas consent must be sought from the Crown Estate, since it owns or manages 55% of the foreshore and the same proportion of the beds of tidal rivers between mean high and low water in GB, together with virtually the entire territorial sea bed. Of the remainder of the foreshore the majority is owned by the Duchies of Cornwall and Lancaster. If the structures are potentially hazardous to navigation the Department of Transport must also authorise their construction, and if they are to be above mean low water mark planning permission must be sought from the local authority. In this region much of the coast, including the locations of existing maricultural operations, is protected by national and international designations, including Site of Special Scientific Interest (SSSI), Heritage Coast and AONB (Area of Outstanding Natural Beauty), as well as local and voluntary conservation measures, so nature conservation and landscape considerations also apply.

The introduction of non-native shellfish species for cultivation has caused concern over their potential to establish self-sustaining populations, which may affect marine ecosystems. Since January 1993 there have been new, less stringent, requirements for the control of shellfish disease in Great Britain and for the 'deposit' and importation of molluscan shellfish and lobsters, under the EC Fish Health Directive (Directive 91/67). Under this legislation, only the deposit of shellfish originating from areas in which *Bonamia ostreae* occurs is now controlled. (*Bonamia* is a parasite that infects the blood cells of native oysters, causing high mortalities amongst the oysters.) These changes in the legislation have caused concern that the transfer of molluscan shellfish may be accompanied by accidental releases of associated non-native predators, pests, parasites and diseases. Shellfish and fish farms have to be registered with MAFF under the Fish Farming and Shellfish Farming Business Order 1985. Registration is designed to assist MAFF in dealing with any outbreaks of pests and diseases.

Mariculture and its effects are limited in this region compared with some other parts of Britain. However, issues relating to the cultivation of marine species are closely linked to marine nature conservation interests, particularly the possible effects on species and habitats of nature conservation interest. These issues for mariculture in general are under consideration by the 'Marine Fisheries Task Force', an inter-agency team of the statutory nature conservation organisations (the Countryside Council for Wales, English Nature, Scottish Natural Heritage and the Department of the Environment for Northern Ireland, together with the JNCC). A consultation draft paper prepared by the group, entitled *Developing an action programme for sea fisheries and wildlife* (Marine Fisheries Task Force 1994), identifies the main areas where marine fisheries (broadly defined to encompass the exploitation of all living marine resources and therefore including mariculture) affect wildlife and identifies any action needed.

9.2.4 Acknowledgements

Thanks are due to the following members of the Fisheries Working Group for their contributions and comments: Bill Cook (NW & NWSFC), Phil Coates (SWSFC), Brian Spencer (MAFF DFR Conwy), Dr P.D. McGovern (Crown Estate, Scotland), Paul Knapman (English Nature), Blaise Bullimore (Countryside Council for Wales), Indrani Lutchman (WWF UK), Clare Eno (JNCC), Mark Tasker (JNCC) and Nancy Harrison (RSPB). Additional thanks go to M.D. Wilkinson and P. Smith (North Eastern Sea Fisheries Committee), C.F. Beach (Eastern Sea Fisheries Joint Committee), P. Knapman (English Nature), and A. Herbert and A. Panayi (Crown Estate Commissioners).

9.2.5 Further sources of information

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B. Further reading

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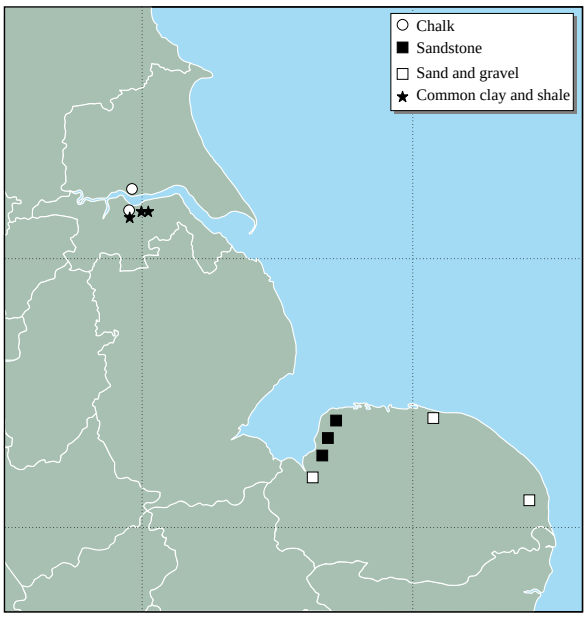
C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Central contact for the local Chief Executive, Association of Sea Fisheries Committees; general Sea Fisheries Committees policies	Sea Fisheries Committees, Buckrose House, Commercial Street, Norton, Malton, North Yorkshire YO17 9HX, tel: 01653 698219
Shellfish reports etc.; mariculture activities and local bylaws	Clerk and Chief Fishery Officer, North Eastern Sea Fisheries Committee, County Hall, Beverly, North Humberside HU17 9BA, tel: 01482 867131
Shellfish reports etc.; Several Orders; mariculture activities and local bylaws	Clerk and Chief Fishery Officer, Eastern Sea Fisheries Joint Committee, 10 Tuesday Market Place, King's Lynn, Norfolk PE30 1LD, tel: 01553 775321
Leases	The Crown Estate, Marine Estates, 16 Carlton House Terrace, London SW1Y 5AH, tel: 0171 210 4377
Scientific advice: marine fish and shellfish cultivation; advice on management and policy issues for the coastal zone	*Head of Laboratory, MAFF Directorate of Fisheries Research, Fisheries Laboratory (Conwy), tel: 01492 593883
Scientific advice on mariculture	*Director, MAFF Directorate of Fisheries Research, Fisheries Laboratory (Lowestoft), tel: 01502 562244
Bivalve mollusc production areas; classification of shellfish waters and shellfish diseases	Director, MAFF Shellfish Division, Fish Diseases Laboratory, Barrack Road, The Nothe, Weymouth, Dorset DT4 8UB, tel: 01305 206600
Commercial advice on shellfish	Sea Fish Industry Authority, Sea Fish House, St Andrews Dock, Hull, North Humberside HU3 4QE, tel: 01482 27837
Salmon farming	Director, Scottish Salmon Growers Association, Drummond House, Scott Street, Perth PH1 5EJ Scotland, tel: 01738 635420
Commercial advice on shellfish	Director, Shellfish Association of the UK, Fishmongers Hall, London Bridge, London EC4R 9EL, tel: 0171 6263531
Polychaete cultivation	Manager, Seabait Ltd., Woodhorn Village, Ashington, Northumberland NE63 9NW, tel: 01670 814102
Interaction between mariculture activities and marine nature conservation issues	*Marine Fisheries Officer, EN HQ, Northminster House, Peterborough PE1 1UA, tel: 01733 340345
Marine Fisheries Task Group paper; interaction between mariculture activities and marine nature conservation issues	*Marine Advisory Officer, JNCC Peterborough, tel: 01733 62626
Mariculture and marine nature conservation issues	*Coastal Policy Officer, RSPB HQ, Sandy, Beds., tel: 01767 680551
Mariculture and marine nature conservation issues	*Fisheries Officer, WWF-UK, Godalming, tel: 01483 426444
Mariculture and marine nature conservation issues	*Conservation Officer, Marine Conservation Society, Ross-on-Wye, tel: 01989 566017
Interaction between mariculture activities and marine nature conservation issues	Administrator, The Marine Forum for Environmental Issues, Department of Zoology, The Natural History Museum, Cromwell Road, London SW7 5BD, tel: 0171 938 9114

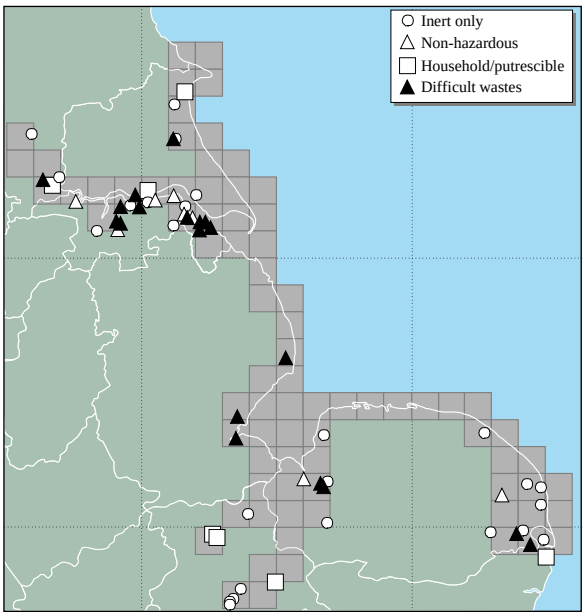
* Starred contact addresses are given in full in the Appendix.

9.3 Quarrying and landfilling

C.A. Crumpton & M.J. Goodwin



Map 9.3.1 Coastal quarries. Source: BGS (1994). © Crown copyright.



Map 9.3.2 Coastal landfill sites. Source: Site File Digest (Aspinwall 1994).

9.3.1 Introduction

In this section, quarries are included as coastal if they are less than 2 km inland, and landfill sites if they are in a coastal 10 km square. The minerals quarried in the region on a commercial basis are common clay and shale, silica sand, chalk, sand and gravel, and sandstone. These are put to a variety of uses including concrete mix, building stone, roadstone and glass making.

Table 9.3.1 presents production levels by county, compared with British levels, for the main minerals quarried in the region.

9.3.2 Important locations

There are ten coastal quarries in this region (Table 9.3.2; Map 9.3.1): two extract chalk, two extract clay and shale, three extract sand and gravel and three extract sandstone.

Map 9.3.2 shows the location of the region's currently used coastal landfill sites, according to Aspinwall's Sitefile Digest (Aspinwall 1994); the status codes are defined in Table 9.3.3. Most coastal landfill sites are clustered around the major centres of population and industry on the Humber Estuary, particularly the southern side. There are very few sites in Lincolnshire.

9.3.3 Management and issues

Landfill site licensing in Great Britain is the responsibility of the 152 Waste Regulation Authorities (WRAs). In England these are the County Councils, usually through the Environmental Health or Technical Services Departments (in Wales and Scotland this is done through District Councils). Waste management licences were introduced by the 1990

Table 9.3.1 Mineral production[a] in whole counties in the region for 1991

Area	*Chalk*		*Common clay and shale*		*Sandstone*		*Sand and gravel*	
	Tonnes	*% of GB total*	*Tonnes*	*% of GB total*	*Tonnes*	*% of GB total*	*Tonnes*	*% of GB total*
Humberside	2,513,000	24.4	n/a	n/a	0	0.0	**829,000	0.8
Lincolnshire[b]	399,000	3.9	0	0.0	0	0.0	3,142,000	3.2
Norfolk	n/a	n/a	0	0.0	*401,000	3.1	2,493,000	2.5
Region 6	***2,912,000***	***28.3***	***0***	***0.0***	****401,000***	***3.1***	*****6,464,000***	***6.5***
England	10,317,000	100	11,916,000	91.3	9,907,000	76.6	82,253	84.0
Great Britain	10,317,000	-	13,038,000	-	12,928,000	-	97,918	-

Source: BGS (1994) Key: [a]Amounts have been rounded up to the next thousand tonnes; [b]there are no coastal quarries in Lincolnshire. *Owing to the method of compiling the statistics, these figures include production in Bedfordshire, Kent and Cheshire; **includes marine dredged material landed in Humberside - see section 9.4.

Table 9.3.2 Coastal quarries (1992 data)

Location	*Operator*	*Mineral*
Humberside		
North Ferriby	Croxton and Garry Ltd.	Chalk
South Ferriby	Rugby Portland Cement	Chalk, common clay and shale
Barton upon Humber (2 quarries)	William Blyth	Common clay and shale
Norfolk		
King's Lynn	Hepworth Minerals and Chemicals Ltd	Sand and gravel
Wolferton	Frimstone Ltd.	Sandstone
Snettisham	Frimstone Ltd.	Sandstone
Heacham	King's Lynn Sand and Gravel	Sandstone
Sheringham	Carter Concrete Ltd.	Sand and gravel
Burgh Castle	M. Folkes & Sons	Sand and gravel

Source: BGS (1994). Note: there are no coastal quarries in Lincolnshire.

Table 9.3.3 The status of the region's coastal landfill sites (on Map 9.3.2)

Status code		*Definition*	*No. in region*
1	Inert only	Uncontaminated excavated natural earth materials, and uncontaminated brick rubble and concrete with similar properties to natural earth materials.	13
2	Non-hazardous	Mainly uncontaminated and industrial wastes such as packaging materials, wood and plastic. Some of these wastes are biodegradable but not rapidly so.	6
3	Household / putrescible	Typical contents of a household dustbin and similar wastes of industrial origin e.g. food processing wastes.	2
4	Difficult wastes	Any wastes which require particular handling techniques at the disposal site, e.g. vehicle tyres, dry feathers, animal carcasses. They are not the same as Special Wastes, which are toxic and require pre-notification of disposal to the Waste Regulation Authority.	14
Total			***35***

Environmental Protection Act to replace the disposal site licences previously required by the 1974 Control of Pollution Act. Each WRA is required to maintain a public register of waste management licences for private sites in its area and a register of resolutions referring to its own sites.

9.3.4 Information sources used

Data on quarrying were obtained from the British Geological Survey's *Directory of mines and quarries* (BGS 1994) and are the most up to date and comprehensive available. The data for landfilling were provided by Aspinwall & Co. from their *Sitefile digest* for waste treatment and disposal (Aspinwall & Co 1994). This contains regularly updated information from the 152 Waste Regulation Authorities and represents the most up to date collection of public information on British waste management available.

9.3.5 Acknowledgements

Thanks go to Dr Ron Moore and Susan Morley (Aspinwall and Co.) for providing information from the Sitefile Digest.

9.3.6 Further sources of information

A. References cited

Aspinwall & Co. 1994. *Sitefile digest. A digest of authorised waste treatment and disposal sites in Great Britain*. Shrewsbury, Environment Press.

British Geological Survey. 1994. *Directory of mines and quarries 1994.* 4th ed. Nottingham, British Geological Survey.

B. Further reading

Eno, N.C., *ed*. 1991. *Marine conservation handbook*. 2nd ed. Peterborough, English Nature.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Landfill database and Sitefile Digest	Aspinwall & Co., Walford Manor, Baschurch, Shrewsbury SY4 2HH, tel: 01939 261144
Mines and quarries (British Directory of Mines and Quarries)	Director, British Geological Survey, Keyworth, Nottingham NG12 5GG, tel: 0115 936 3100
Waste management licences, public registers and local mineral plans - Humberside	*Group Manager - Waste Regulation/Mineral Planning Officer, Humberside County Council, Beverley, tel: 01482 884069
Waste management licences, public registers and local mineral plans - Lincolnshire	County Waste Regulation Officer/Mineral Planning Officer, Lincolnshire County Council, City Hall, Beaumont Fee, Lincoln LN1 1DN, tel: 01522 553089
Waste management licences, Norfolk	*Waste Regulation Officer, Norfolk County Council, Norwich, tel: 01603 223373
County mineral plans - Norfolk	*Mineral Planning Officer, Norfolk County Council, Norwich, tel: 01603 222592

* Starred contact addresses are given in full in the Appendix.

At the outer limits of the sheltered estuary of the Wash, parts of the shoreline experience erosion. At Snettisham, Norfolk, where the beach is an important local leisure amenity and a renowned site for birdwatchers, dredged sediments are deposited back on the beach to maintain its level. Photo: Pat Doody, JNCC.

9.4 Marine aggregate extraction, dredging and disposal of dredge spoil

C.A. Crumpton & M.J. Goodwin

9.4.1 Introduction

This region is important for the extraction of marine aggregates, containing as it does most of two (Humber and East Coast) of the six major dredging areas in Britain licensed by the Crown Estate. Owing to the high mobility of the sediments on this part of the coast, dredging and the disposal of dredge spoil are also important activities in the region.

Sand and gravel on the sea bed are important sources of industrial aggregates for concrete production for road and buildings construction, and for beach nourishment ('soft' coastal defence: see also section 8.4). The areas of sand and gravel deposits in the region are shown on Map 2.2.2. Marine aggregates form an increasing part of the total demand for sand and gravel in Britain, each year accounting for 15% of the total national requirement (Crown Estate 1992). The main market for marine-dredged aggregates is in the south-east of England. There is no extraction of marine aggregates in Scottish waters.

The national demand for aggregates increased steadily during the 1980s. In response, the aggregate industry invested in new ships, which allowed more efficient exploitation of licence areas and new, deeper waters to be dredged (Kenny & Rees 1994). Marine extraction in England and Wales, including licences specifically for contract fill and beach nourishment (using material as extracted, not processed), reached a peak of 28 million tonnes in 1989 but still accounted for 22.1 million tonnes in 1994, of which 6.6 million tonnes were exported (Crown Estate 1995) (see Tables 9.4.1 and 9.4.2 and Map 9.4.1). This

Table 9.4.1 Marine dredged aggregate and contract fill/beach nourishment landings in 1994 (tonnes)

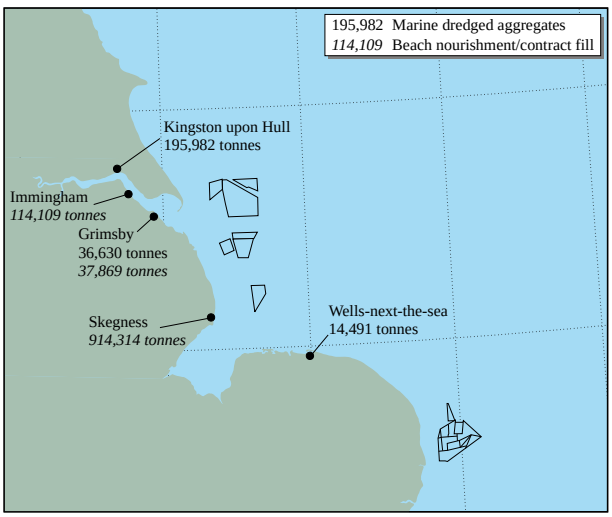
	Marine dredged aggregate	*Contract fill/ beach nourishment*	*Total*
Humberside	232,612	151,978	384,590
Lincolnshire	0	941,314	941,314
Norfolk	14,491	0	14,491
Region 6	***247,103***	***1,093,292***	***1,340,395***
England and Wales	14,155,129	1,286,372	15,441,501
% of GB total in region	1.7	85.0	8.7

Source: Crown Estate (1995)

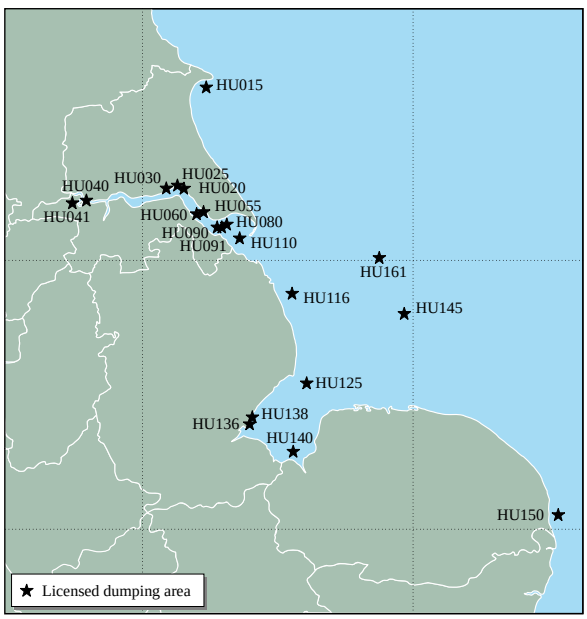
Table 9.4.2 Marine dredged aggregate (excluding contract fill/beach nourishment) licensed and extracted from the region, 1994

	Tonnes licensed	*Tonnes extracted*
Humber (off Humberside & Lincolnshire)	3,000,000	1,910,064
East Coast (off Gt. Yarmouth and Lowestoft)*	13,025,000	9,384,860
Region 6*	***16,025,000***	***11,294,924***
England and Wales**	37,726,599	20,792,887

Source: Crown Estate (1995). Key: *Figures for Region 6 include amounts for the whole of the 'East Coast' (as defined by Crown Estate (1995)), which extends south into Region 7. **No marine aggregates are dredged off Scotland.



Map 9.4.1 Licensed dredging areas and tonnages of marine dredged aggregates landed at ports in the region in 1994. Source: Crown Estate (1994).



Map 9.4.2 Dredge spoil dumping sites (see Table 9.4.2). Source: MAFF (1994). © Crown copyright.

Table 9.4.3 Dredged material licensed and disposed of at sea in 1992 (tonnes)

	Licences issued	*Licensed tonnage*	*Wet tonnage disposited*
England and Wales	123	55,741,813	24,243,998
UK	164	62,759,618	29,161,946

Source: MAFF (1994)

region is particularly important in a national context for beach nourishment and contract fill aggregate extraction.

The regional landing port totals do not equate to the amount dredged from each region, owing to the presence of the export market and the movement of aggregates to meet differing home market demands.

Navigational dredging is the responsibility of individual harbour authorities, although a licence from MAFF is required for disposal of the spoil offshore. Capital dredging is the one-off removal of sediment, chiefly when deepening shipping channels and during the construction of new dock facilities. Thereafter, maintenance dredging is regularly carried out in existing ports and their approaches, to maintain safe navigation.

The majority of dredged material, which can range in composition from silt to boulder clay and rock, is dumped at sea, usually as close as the licence allows to the place where it was collected. Dredged material may also be used for land claim (as contract fill) and, increasingly, for beach recharge. From 1988 to 1992, a yearly average of 34,700,000 tonnes (wet weight) of dredged material was dumped at sea in England and Wales.

Table 9.4.3 shows dredge spoil licensing information for 1992, the latest year for which full figures are available (MAFF 1994). In 1993 the wet tonnage of dredged material dumped at marine sites in the region constituted 19.7% of the total amount of dredged material deposited at offshore sites in the UK (Crown Estate 1994).

9.4.2 Important locations

Marine aggregates dredging

Map 9.4.1 shows the areas in the region licensed by the Crown Estate in 1994 for dredging, and the ports in the region at which marine dredged aggregate and contract fill/beach nourishment material is landed (Crown Estate 1995). Aggregates normally come from the extraction areas closest to the landing port concerned, but it is not always possible to specify where the aggregate landed at specific ports was dredged, owing to the movement of aggregate to different markets. In some cases an occasional cargo may have come from a completely different licence, as the dredger may have moved from one licensed area to another, but the amounts involved will be small in overall terms. The extraction areas off the Lincolnshire coast are one of the main dredging grounds licensed for marine sand and gravel extraction within the coastal waters of Britain. For example, in 1994, all the 895,357 tonnes of aggregate landed in Region 5 (Berwick-upon-Tweed to Filey Bay) were dredged from these grounds. Aggregate extracted from the coastal waters off Norfolk may be landed in south-east England, outside this region (BMAPA 1993). The aggregate landed at Wells-next-the-sea is mostly navigational maintenance dredging authorised by the Harbour Authority (Crown Estate pers. comm.).

Navigational dredging

During the Estuaries Review survey, carried out in 1989, capital dredging was found to be in progress or proposed in the Humber, at King's Lynn and at Burnham Overy Staithe, while maintenance dredging was under way in the Humber Estuary and at Boston, King's Lynn, Wells, Blakeney and Breydon Water (Davidson *et al.* 1991).

Dredge spoil dumping

Table 9.4.4 shows the main marine disposal sites used for the dumping of dredged material in the region in 1992 and 1993 and the quantities of material disposed of at each site (see also Map 9.4.2).

9.4.3 Management and issues

Marine aggregates dredging

Marine sand and gravel are extracted by commercial mineral companies under licence from the Crown Estate. Government policy for the provision of aggregates, formulated in 1982 and 1989, has encouraged marine extraction of sand and gravel: Minerals Planning Guidance Note 6 states that "it has a very important role to play in maintaining supplies of aggregate and, as far as possible, its use is to be encouraged" (Crown Estate 1992). Aggregates from terrestrial sources are insufficient to meet demand (Doody *et al.* 1993). Dredging for marine aggregates tends to be a less controversial activity than terrestrial extraction, and 'high quality' aggregate exists in coastal areas adjacent to the main markets in south-east England (Kenny & Rees 1994). The government promotes environmentally sustainable coastal defences, and, as a result, the use of sand and gravel for beach recharge is predicted to grow substantially (NERC undated; see also section 8.4).

Navigational dredging

All dredging activities have short-term, localised effects, such as the removal of material and organisms, but long-term effects on, say, fish stocks or morphology are much more difficult to assess, owing to the difficulty of determining which effects are the result of dredging and which the result of the many other factors operating (Doody *et al.* 1993).

Dredge spoil dumping

Disposal of dredged material in the UK is controlled by the Water Resources Act (1991), the Food and Environmental Protection Act (1985) (dumping at sea and inter-tidal areas) and the Town and Country Planning and Environmental Protection Acts, both 1990 (dumping on land). The Oslo Convention for the Prevention of Marine Pollution by

Table 9.4.4 Amounts of dredged material disposed of at licensed sites in the region in 1992 and 1993

Site name	*MAFF code*	*Dredging type*	*Depth (m)*	*Dumped tonnage*	
				1992	*1993*
Humberside					
Bridlington A	HU015	Maintenance	5	35,040	14,560
Humber 4B/Hook	HU020	Capital	3	32,370	0
		Maintenance		2,907,866	1,784,060
Alexandra Dock	HU025	Maintenance	n/a	162,350	n/a
Humber 4	HU030	Maintenance	3	24,000	20,930
Whitgift Bight (Yorkshire Ouse)	HU040	Maintenance	n/a	41,010	45,890
Goole Reach	HU041	Maintenance	n/a	7,855	6,945
Foul Holme Deposit	HU055	Capital	5	641,559	78,650
		Maintenance		0	0
Humber 3A	HU060	Maintenance	5	1,764,605	1,245,246
Humber 1A	HU080	Maintenance	5	3,190,200	1,758,640
Humber 2	HU090	Maintenance	5	740,310	482,740
Humber 2 ext A	HU091	Maintenance	0	N/A	0
Humber 1	HU110	Maintenance	n/a	0	0
Lincolnshire					
Pickerill Field	HU116	Capital	n/a	0	n/a
New Lynn Knock Buoy	HU125	Maintenance	17	0	0
Boston 4	HU136	Maintenance	0	51,950	47,500
Boston 5	HU138	Capital	n/a	0	n/a
Norfolk					
Breast Sand	HU140	Capital	0	9,327	n/a
		Maintenance		31,075	34,650
Dudgeon	HU145	Capital	19	47,971	0
Great Yarmouth	HU150	Maintenance	6	27,648	34,254
Conoco Pipeline Trench	HU161	Capital	n/a	151,789	326,764
Total				***9,866,925***	****5,880,769***

Source: MAFF. Key: n/a = not available; * approximate figure.

Dumping from Ships and Aircraft, and the London Convention on the Dumping of Wastes at Sea also include within their scope dumping of dredged material at sea. Licences to dump dredged material are granted by the Ministry of Agriculture, Fisheries and Food (MAFF). Each licence is subject to certain conditions, which have become more stringent in the last few years. Illegal dumping of material may occur: for instance, in 1986 and 1987 six and three cases respectively of alleged illegal dumping were investigated in England and Wales (MAFF 1989).

9.4.4 Information sources used

The statistics for aggregate extraction relate to royalty returns for 1994. Dredge spoil dumping figures cover dumping carried out under licences granted by the Ministry of Agriculture, Fisheries and Food. Some of the data on navigational dredging are derived from the (1989) Estuaries Review (Davidson *et al.* 1991) and are held on JNCC's integrated coastal database.

9.4.5 Acknowledgements

Thanks are due to the Crown Estate Commissioners for information on marine aggregate extraction in the region.

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Pullen, S. Undated. *Dumping of dredged spoils from ports: contamination, pollution control.* Unpublished note.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Marine sand and gravel extraction in the UK (BMAPA & BACMI)	British Marine Aggregate Producers Association/British Aggregate Construction Materials Industries, 156 Buckingham Palace Road, London SW1 9TR, tel: 0171 730 8194
Sand and gravel extraction in the UK	Director, Sand and Gravel Association (SAGA), 1 Bramber Court, 2 Bramber Road, London W14 9PB tel: 0171 381 8778
Marine aggregate extraction in the UK (Crown Estate)	Business Manager, Marine Estates (Offshore), Crown Estate, 16 Carlton House Terrace, London SW1Y 5AH, tel: 0171 210 4377
Marine resource management	Technical Manager, Posford Duvivier (Managing Agents offshore for The Crown Estate), Eastchester House, Harlands Road, Haywards Heath, West Sussex RH16 1PG, tel: 01444 458551
Offshore geoscience data for the UK, including 1:250,000 maps of geology of coastline	Director, British Geological Survey - Coastal Geology Group, Keyworth, Nottingham NG12 5GG, tel: 0115 936 3100
Dumping of dredge spoil at sea	The Oslo and Paris Commissions, New Court, 48 Carey Street, London WC2A 2JE, tel: 0171 242 9927
Licences for dredge spoil dumping: database	Marine Environmental Protection Division, Ministry of Agriculture, Fisheries and Food, Fisheries Laboratory, Remembrance Avenue, Burnham-on-Crouch, Essex CM0 8HA, tel: 01621 782658
Potential environmental conflicts in the region	East Coast Offshore Minerals Forum, c/o Minerals Officer, North Yorkshire County Council, County Hall, Northallerton DL7 8AD, tel: 01609 780780
Dumping of dredge spoil at sea - international	London Convention Secretariat, International Maritime Organisation (IMO), 4 Albert Embankment, London SE1 7SR, tel: 0171 735 7611

9.5 Oil and gas developments

C.A. Crumpton, M.J. Goodwin & J.H. Barne

9.5.1 Introduction

This section describes oil and gas exploration and related development in the region; some further information on oil and gas infrastructure is given in section 8.3.

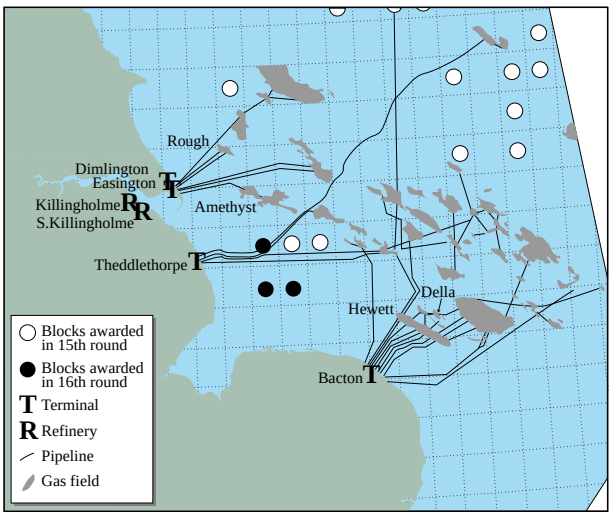
Map 9.5.1 shows sedimentary basins and structural 'highs' in the UK continental shelf, which determine the distribution of oil and gas deposits. Gas production dominates the area of the southern North Sea adjacent to this region, which is known as the Southern Basin: the northern part of the basin extends into Region 5. This activity is reflected in the concentration of gas-related industry along the region's coastline and the large number of pipelines bringing gas ashore. There are ten operational gas terminals in the UK servicing offshore fields, seven of them in this region: one at Dimlington (Humberside), two at Easington (Humberside), one at Theddlethorpe (Lincs.) and three at Bacton (Norfolk). The nearest major gas fields are located about 20-25 km offshore and stretch eastwards into the Dutch sector of the North Sea. There are no commercial oil fields in the Southern Basin. Activity in the region in 1993 included the first production in the North Sea of gas from rocks of Carboniferous age.

By the end of 1965, the bulk of the UK sector of the North Sea south of 56°N had been licensed, and interest in the area has been high in recent years. Of the total of 110 exploration and appraisal wells drilled during 1993 within the UK Continental Shelf (UKCS), 27% of exploration wells and 15% of appraisal wells were drilled within the southern North Sea. In the 14th offshore oil and gas licensing round, announced in June 1993, 27 out of the 110 blocks awarded lay in the Southern Basin, as did sixteen of the 29 blocks awarded in the 15th round, announced in August 1994. In the 16th Round, announced in June 1995, parts of three further blocks were awarded in this region: Map 9.5.2 illustrates how exploration is moving inshore towards The Wash area. Estuaries such as The Wash and the Humber are included in landward licensing rounds; elsewhere the offshore blocks are delineated right up to the coast.

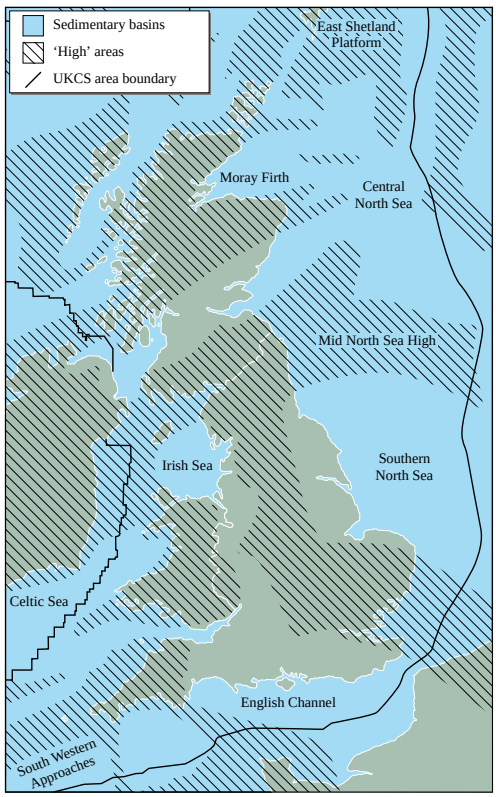
The UK sector of the southern North Sea holds reserves of gas equal to the amount already produced, although much of these reserves occurs in small fields. Estimated 'undiscovered recoverable reserves' in the Irish Sea (Regions 12 and 13), the Southern Basin and the Celtic Sea combined are 0-70 million tonnes for oil and 245-890 billion cubic metres for gas (DTi 1994).

9.5.2 Important locations

Virtually all blocks north of the latitude of Bacton, Norfolk, are currently under licence, with the exception of a few inshore blocks, especially off The Wash and north Norfolk. Map 9.5.2 shows major fields out to approximately 3°E, together with onshore installations and pipelines. Table 9.5.1 lists gas fields in production within approximately 30 km of the shore of this region, as at 15 March 1994. There are no fields in development for oil or gas, and no oil fields in production. British Gas use underground storage caverns at Atwick near Hornsea, as well as previously worked fields in the North Sea, to store gas for use in periods of peak demand.



Map 9.5.1 Oil and gas exploration and production. Source: DTI (1994). © Crown copyright.



Map 9.5.2 UK Continental Shelf (UKCS) exploration. Source: DTI (1994). © Crown copyright.

Table 9.5.1 Gas fields in production

Field name	*Estimated recoverable reserves (bcm)*	*Peak production (bcm/year)*	*Production start*
Amethyst East & West	21.0	1.5	1990/1992
Rough	10.2	1.7	1985
Hewett	115.0	8.6	1969
Della	1.7	0.2	1988

Source: DTi (1994). Key: bcm = billion cubic metres.

9.5.3 Management and issues

The potential for oil spills to harm birds and marine and coastal wildlife is well known. Concern has been expressed particularly about the potential risk to seals and dolphins of oil-related developments in the region. The air-gun arrays used in seismic surveys generate high levels of low frequency sound. Most of the energy in the output from these arrays is at low frequencies, outside the known hearing range of seals, and is unlikely to disturb them. Underwater sounds from seismic activities (as part of oil and gas exploration) are most likely to affect baleen whales, which communicate primarily at these frequencies (20-500 Hz) (Baines 1993), although this species is not recorded from the region. Results obtained during seismic surveys by Marathon Oil UK Ltd and BHP Petroleum Ltd in the Irish Sea were inconclusive, and experimental evidence for disturbance to cetaceans arising from seismic activities remains lacking (Evans *et al*. 1993). There is a very small risk of injury to seals in the immediate vicinity of a vessel conducting seismic surveys.

9.5.4 Information sources used

Many of the data used here come from the DTi's 'Brown Book' (DTi 1994), which should be referred to for further explanation. Note that the southern North Sea includes gas fields that lie in Region 5.

9.5.5 Acknowledgements

Thanks are due to Colin Macduff-Duncan, Esso, for assistance with this section.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Oil and gas developments in the UK	Public Relations Officer, Department of Trade and Industry, 1 Palace Street, London SW1E 5HE, tel: 0171 215 5000
Oil and gas industry issues	Public Relations Officer, UK Offshore Operators Association, 3 Hans Crescent, London SW1X 0LN, tel: 0171 589 5255
Oil transportation and terminals	Technical Adviser, Oil Companies International Marine Forum (OCIMF), 15th Floor, 96 Victoria Street, London SW1E 5JW, tel: 0171 828 7966
General information on the oil industry	Librarian, Institute of Petroleum Library and Information Service, 61 New Cavendish Street, London W1M 8AR, tel: 0171 467 7100
Oil spillages in the UK	Executive Secretary, British Oil Spill Control Association (BOSCA), 4th Floor, 30 Great Guildford Street, London SE1 0HS, tel: 0171 928 9199
Oil spillages	Marine Pollution Control Unit, Spring Place, 105 Commercial Road, Southampton SO15 1EG, tel: 01703 329484
Potential environmental conflicts in oil and gas exploration: East Coast Offshore Minerals Forum	Minerals Officer, North Yorkshire County Council, County Hall, Northallerton, North Yorkshire DL7 8AQ, tel: 01609 780780
Gas industry in Britain	Director and Secretary, Society of British Gas Industries, 36 Holly Walk, Leamington Spa, Warwickshire CV32 4LY, tel: 01926 334357

9.6 Water quality and effluent discharges

C.A. Crumpton & M.J. Goodwin

9.6.1 Introduction

This section summarises information about water quality and effluent discharge from a number of sources. Full interpretation of the information base on pollutants and water quality is complex and beyond the scope of this book.

Waste products and effluents containing contaminants reach the marine environment in this region in a number of ways: sewage, agricultural run-off and trade effluents are discharged from outfalls into rivers or directly into the sea, and contaminants can reach the sea by airborne means, for example aerosols and rain. Discharges occurring outside the region may also have an effect.

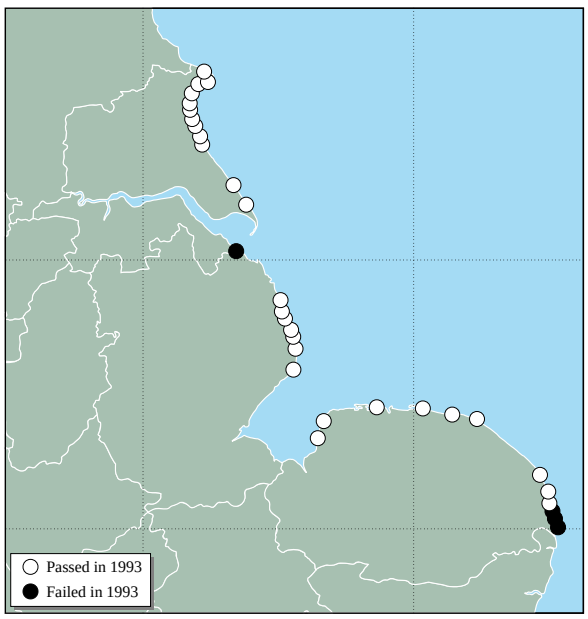
Some sewage sludges are principally of domestic origin and contain low levels of metals and other persistent components. Others include industrial inputs, resulting in higher concentrations of contaminants. In terms of sewage disposal, the UK produces some 1.1 million tonnes of dry solids (tds) annually and disposes of approximately 300,000 tds to the sea. UK sewage sludge production is set to increase dramatically over the next decade, with a predicted increase to 3.3 million tds by 2006. This will have to be disposed of on land, either by dumping or by incineration.

In this region depressed levels of dissolved oxygen occur within the Humber estuary, particularly during the summer months, mainly attributable to sewage effluents and industrial discharges. Oxygen levels on the open coast are average for the North Sea coast and there are no records of algal blooms causing oxygen deficiency.

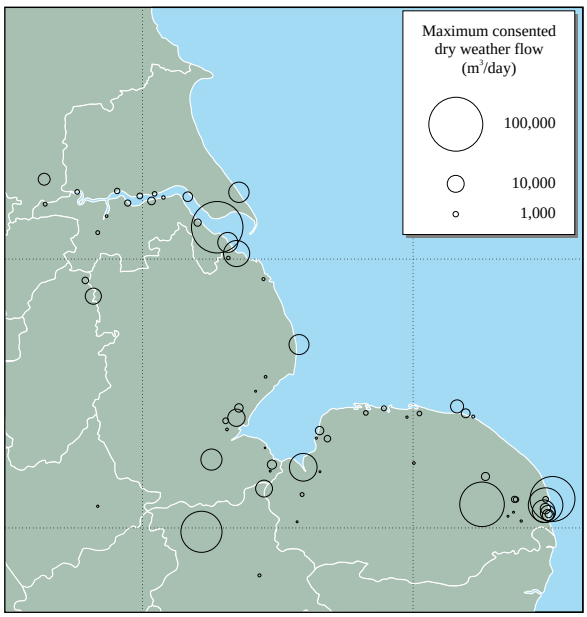
Surveys by the Ministry of Agriculture, Fisheries and Food (MAFF) and the Natural Environment Research Council (NERC) have shown the influence of industrial sources on the elevated levels of nickel, zinc and cadmium found in the Humber, although these effects do not extend far offshore. Elevated levels of lead in the Humber come from rocks eroded to the north of the estuary or in the catchment headwaters. Unusually high concentrations of arsenic are found in the estuarine sediments of the Humber, particularly along the south bank, owing to the presence on the north bank, until 1991, of a non-ferrous metal smelter. Levels of organochlorines (e.g. PCBs) in sediments off the region's coast are generally extremely low, although they are slightly higher off the Humber. Land-based nutrient inputs to the North Sea along its UK seaboard are dominated by those from the Humber, The Wash and the Thames (Region 7), although again their influence does not extend far beyond the mouths of these estuaries and the region's coastal waters as a whole do not appear to be experiencing excessive nutrient enrichment. These and other survey findings have been summarised in the *North Sea Quality Status Report* (North Sea Task Force 1993b). Overall, there is evidence of improvements in water quality along the region's coast in recent years.

In a report on marine pollution, MAFF Directorate of Fisheries Research (1994) gives details of the effects of dredge spoil dumping and the disposal of other kinds of waste off the region's shores (see also section 9.4) and points out the continuing high levels of TBT and metals in sediment.

There are 32 bathing waters in this region, as identified under the EC Bathing Water Directive (76/160/EEC). Of these, 28 (about 88%) comply with the mandatory standards (see Map 9.6.1 and Table 9.6.1). The 1993 data for the UK as a whole, assessed by DoE in accordance with the EC Bathing Water Directive (see section 9.6.3), show approximately the same compliance (79%) with the mandatory standards as in



Map 9.6.1 Bathing water quality. Locations of EC-identified bathing waters sampled in 1993 survey (see Table 9.6.1). Source: NRA (1994). Adapted with permission.



Map 9.6.2 Consented sewage outfalls discharging to tidal waters. Area of circle is proportional to consented 'dry weather flow'. Map shows all outfalls with consented flow greater than 10 m^3/day. Source: MAFF.

Table 9.6.1 Bathing waters survey 1992, 1993

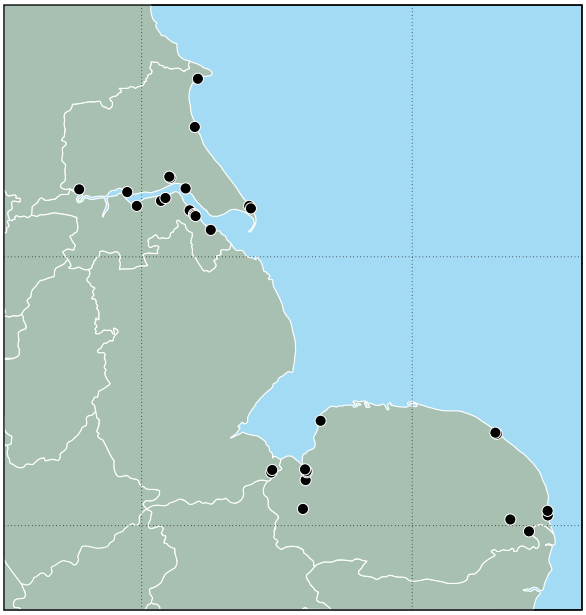
NRA region(s)	*Pass*		*Fail*		*Total*	
	1992	*1993*	*1992*	*1993*	*1992*	*1993*
Yorkshire*	20	21	2	1	22	22
Anglian	31	28	2	5	33	33
England and Wales	328	332	88	86	416	418
Scotland	15	18	8	5	23	23
UK	***358***	***365***	***97***	***92***	***455***	***457***

Source: DoE (1993). Note: Pass denotes compliance with Bathing Water Directive (76/160/EEC): Coliform standards. Key: *Northumbrian and Yorkshire NRA regions were merged in 1993.

Table 9.6.2 Beach quality in the region compared with national standards (1993)

Area	*% of beaches rated*		
	'excellent'	*'moderate'*	*'polluted'*
Humberside	8	24	68
Lincolnshire	0	46	54
Norfolk	4	49	47
Region 6	***4***	***40***	***56***
England	10	44	46
Great Britain	8	42	50

Source: Coastwatch UK (1993)



Map 9.6.3 Locations of authorised and consented trade effluent discharges to tidal waters (see Table 9.6.4). Only sites with grid references in Table 9.6.4 are shown; also, some locations have more than one discharge. Source NRA.

Table 9.6.3 Sewage outfalls to tidal waters in the region with consented 'dry weather flows' >6,000 m³ per day

Name of outfall	*Location*	*Grid ref.*	*Type of discharge*	*Max. consented daily dry weather flow (m³)*
N. Humberside				
Withernsea Outfall	Withernsea	TA367262	Fine screened sewage	13,824
S. Humberside				
Pyewipe Outfall	Pyewipe, Grimsby	TA282131	Macerated/comminuted sewage	91,000
Newton Marsh Sewage Treatment Works	Tetney	TA354032	UV treated sewage	23,867
Cleethorpes Southern Outfall	Cleethorpes	TA329079	Untreated sewage	13,582
Lincolnshire				
Gainsborough Lea Road Sewage Treatment Works	Gainsborough	SK816874	Secondary treated sewage	9,100
Boston Sewage Treatment Works	Boston	TF354409	Secondary treated sewage	10,000
Ingoldmells Outfall	Ingoldmells	TF590685	Untreated sewage	13,800
Spalding Sewage Treatment Works	Spalding	TF262250	Secondary treated sewage	15,720
Cambridgeshire				
Flag Fen Sewage Treatment Works	Peterborough	TL221981	Secondary treated sewage	58,000
West Walton Sewage Treatment Works	Wisbech	TF458141	Secondary treated sewage	9,844
Norfolk				
King's Lynn Sewage Treatment Works	King's Lynn	TF606222	Secondary treated sewage	26,000
Whitlingham Sewage Treatment Works	Norwich	TG282080	Secondary treated sewage	66,250
West Runton Outfall	West Runton	TG189451	Primary treated sewage	6,618
Caister Long Sea Outfall	Great Yarmouth	TG546098	Untreated sewage	65,000
Great Yarmouth No. 22	Great Yarmouth	TG520050	Untreated sewage	18,443
Bryants Quay Outfall	Great Yarmouth	TG524068	Macerated/comminuted sewage	6,800
Mariners Road Pumping Station Outfall	Great Yarmouth	TG522075	Primary treated sewage	40,914
Baker Street Outfall	Gorleston	TG529043	Untreated sewage	8,900

Source: MAFF sewage outfalls database

the previous year, although there were four more compliant bathing waters than in 1992. Trend data show that although the percentage of bathing waters consistently complying with the mandatory standards has remained at around 64%, the number consistently failing has reduced. Analysis of median faecal coliform values suggests that the improvement in water quality has been maintained over the last four years.

Beach quality in the region is unexpectedly poor, in a national context, given the relatively undeveloped nature of much of the region's coast. The main items of litter found along the coastline in this region are plastics (including sheeting, fishing gear, bottles and containers), textiles, paper and debris from ship wreckage; sewage and sanitary materials are also present (Coastwatch UK 1993). Medical waste, including syringes and needles, is an increasing problem of which the source is not known (McGilvray 1994). Table 9.6.2 summarises the results of the 1993 Coastwatch UK survey of beach quality.

9.6.2 Important locations

Map 9.6.2 shows the locations in Region 6 of all 104 sewage outfalls with consented 'dry weather flows' (i.e. flows undiluted by rain) in excess of 10 m^3 per day (see section 9.6.3). Table 9.6.3 lists the eighteen sewage outfalls in the region whose consented 'dry weather flows' are in excess of 6,000 m^3 per day, showing their locations and the type of discharge.

Table 9.6.4 lists sources of trade effluent in the region, with their maximum consented output, where specified; locations with grid references are shown on Map 9.6.3.

Beaches in the region vary in quality from county to county, being worst in the industrialised north (Coastwatch UK 1993). According to the 1993 Coastwatch survey, levels of littering in Humberside were generally higher than in 1992 and the overall beach quality was below the national average. Beaches in Lincolnshire were also generally more polluted, although several litter items showed a reduction over 1992 figures. In Norfolk, sixteen out of the seventeen litter categories sampled in 1993 were recorded at levels higher than the national average and ten at levels higher than in 1992.

In 1993 there was one Blue Flag beach in the region, at Hunstanton, out of 20 in the UK as a whole. In 1994 seven of the 165 Tidy Britain Group Seaside Award beaches in the UK were located in the region, at Flamborough (South Landing), Bridlington North, Bridlington South, Snettisham, Hunstanton, Wells-next-the-sea and Mundesley.

9.6.3 Management and issues

A range of legislation is in force to control discharges to the aquatic environment. In England the primary statute is the Water Resources Act 1991. The NRA has overall responsibility for the control of discharges and the maintenance of water quality. It authorises sewage discharges by issuing 'consents', with MAFF as a statutory consultee to safeguard fishery interests. Trade effluent involving 'scheduled' (hazardous) substances must be authorised by Her Majesty's Inspector of Pollution under the Environmental Protection Act 1990, with the NRA as a statutory consultee. Environmental Quality Standards (EQSs) for many of these substances are specified in the Environmental Protection (Prescribed Processes etc.) Regulation 1991. The substances are listed in the Trade effluents (prescribed substances and processes) Regulations 1989, 1990 and 1992. Environmental Quality Standards (EQSs) are set for many of the substances in the Surface Water (Dangerous substances) (Classification) Regulations 1989 and 1992. The NRA's booklet on *Discharge consents and compliance* (NRA 1994) contains details on national and European discharge regulations (see section 9.6.5).

MAFF issues licences for the dumping of sewage at sea. Sewage sludge is still disposed of off the Humber (MAFF pers. comm.). From early 1992 all dumping of liquid waste into the sea from ships ceased and all sewage sludge dumping by marine vessels is set to be phased out by 1998, under the Urban Waste Water Treatment Directive (91/271/EEC). Under the same Directive all significant sewage discharges, except those in 'High Natural Dispersion Areas', will require at least secondary treatment, to be phased in by 2005. Sewage disposal on land is controlled by the local Waste Regulation Authorities (see section 9.3). The new Environmental Protection Agency is due to come into being in April 1996. It will take over the functions of HMIP and of those of the NRA and the Waste Regulation Authorities.

There are currently several schemes (statutory and non-statutory) for assessing the quality of beaches and their waters in relation to waste disposal. First, there is the EC Bathing Water Directive (76/160/EEC), with its associated monitoring of identified bathing waters for levels of coliforms (bacteria that indicate sewage presence). Monitoring is carried out by the National Rivers Authority (NRA). Any measures required to improve the quality of the waters are a matter for the dischargers of industrial effluent or the sewerage authorities. Under the terms of the Environmental Protection Act 1990, the quality of bathing beaches is the responsibility of district councils. Secondly, there is the European Blue Flag Award Scheme for beaches that meet the EC guideline standards of beach and water quality, as well as certain land-based criteria. Thirdly, there is the Tidy Britain Group Seaside Award Scheme, designed to complement the Blue Flag scheme, for beaches that meet the minimum standards of beach and water cleanliness and selected land-based criteria but not the Blue Flag standard. Finally there are the annual litter surveys of Coastwatch UK and Beachwatch, both of which employ volunteers to survey lengths of coastline for litter and other signs of pollution. Beachwatch UK is organised by Readers Digest and the Marine Conservation Society.

9.6.4 Information sources used

The North Sea Quality Status Report (North Sea Task Force 1993a) and the accompanying subregional report (North Sea Task Force 1993b) give recent monitoring results for a range of pollutants and contaminant levels in organisms living in the water or the sediments and indicate the likely effects of poor water quality in the worst-affected areas. The North Sea Project (see section 9.6.6 C) also provided some insight into the seasonal variation of trace metal concentrations in response to physical, chemical and biological processes.

The Department of the Environment (DoE) Environmental Protection Statistics Division publishes an

Table 9.6.4 Consented and authorised trade effluent discharges to tidal waters in NRA Hull and Humber Area and (part of) NRA Anglian Region. (See Map 9.6.3.)

Discharger	*Grid ref. (where provided)*	*Maximum daily flow (m^3/day)*	*Dry weather flow (m^3/day)*
N. Humberside			
Munton & Fisons, Sewerby ('Deemed consent')	TA203687		
*British Gas Storage Facility, Atwick	TA192502		
*BP Exploration, Dimlington	TA398208		
*British Gas, Easington	TA405200		
BP Chemicals Ltd., Salt End Works, Hull	TA158274		
*Holliday Pigments, Hull	TA100312		
*Croda Universal Ltd., Hull	TA095318		
British Aerospace, Brough	SE938261	350	
N. Yorkshire			
*Howden Products, Howdendyke	SE755268		
S. Humberside			
*Rugby Cement, South Ferriby, Barton-upon-Humber	-		
*Rugby Cement, South Ferriby, Barton-upon-Humber	-		
New Holland Bulk Services, New Holland, Barrow-on-Humberside	TA080243	3	
British Sugar plc, Scawby, nr. Brigg	SE974212	2,045	
Anglian Water Services Ltd., Elsham WTW, Elsham, nr. Brigg	TA175191	1,440	
Anglian Water Services Ltd., Elsham WTW, Elsham, nr. Brigg	TA175191	1,440	
Anglian Water Services Ltd., Elsham WTW, Elsham, nr. Brigg	TA175191	1,750	
Anglian Water Services Ltd., Elsham WTW	TA175191		
Anglian Water Services Ltd., Elsham WTW	TA175191		
Anglian Water Services Ltd., Barrow PS, Barrow Vale, Barrow-on-Humberside	TA063226	1,545	
Anglian Water Services Ltd., Barrow PS, Barrow Vale, Barrow-on-Humberside	TA063226	1,200	
Anglian Water Services Ltd., Barrow PS, Barrow Vale, Barrow-on-Humberside	TA063226	1,200	
*Demin Plant, Lindsey Oil Refinery, North Killingholme	-	2,500	
*Biotreater Bypass, Lindsey Oil Refinery, North Killingholme	-		
*Aeration Lagoon Bypass, Lindsey Oil Refinery, North Killingholme	-		
*Treatment Plant, Lindsey Oil Refinery, North Killingholme	-		12,000.00
Conoco Ltd., Conoco Oil Works Docks, South Killingholme	TA191171		
Calor Gas Ltd., LPG Jetty, Marsh Lane, South Killingholme	TA187179	1,176	
Humber LPG Terminals, Storage Caverns, Humber LPG Terminals, South Killingholme	TA182179		264.00
*Conoco Humber Refinery, South Killingholme	-		16,000.00
*Conoco Viking Gas Terminal, South Killingholme	-	2,200	
British Steel, Immingham Bulk Terminal, Humber Road, Immingham	TA191175		
*Coal Prods., Immingham Works	-		750.00
*Hydro Agri, Immingham	-	16,000	13,000.00
*Harlow Chem., Stallingborough	-	680	
*Rivertex Chemicals, Stallingborough	-	100	
*Cray Valley Products, Stallingborough	-	400	
*Doverstrand Ltd., Stallingborough	-	3,000	999.00
*SCM Chemicals, Stallingborough	-	30,000	
*Courtalds, Pyewipe, Grimsby	-	32,500	30,000.00
Ciba-Geigy Chemicals Ltd., Pyewipe, Grimsby	TA251121		
*CIBA Grimsby, Pyewipe, Grimsby	-	6,000	
*Tioxide Ltd, Pyewipe, Grimsby	-	31,670	30,000.00
*Tetney Terminal, Tetney, Grimsby	-		
Lincolnshire			
Haywards Foods Ltd., Canning Factory, Bridge Road, Long Sutton	TF481209	4,000	
Turner's Turkeys Ltd., Langley Park, Chalk Lane, Sutton Bridge	TF480206	300	
Potato Marketing Board, Experimental Station, Sutton Bridge	TF479205	145	
DCA Foods Ltd., Chalk Lane, Sutton Bridge	TF480205	**5	
KFF (Potatoes) Ltd., Old Dock, Sutton Bridge	TF483217	**36	
Norfolk			
Heiploeg & Lynn Shrimpers, Heiploeg & Lynn Shrimpers, King's Lynn,	TF613208	80	
Heiploeg & Lynn Shrimpers, Fisher Fleet Jetty, King's Lynn	TF614208	50	
Porvair plc, Porvair Works, King's Lynn	TF609217		200.00
*Dow Chem, Estuary Road, King's Lynn	-	1,025	
*Dow Chem, Estuary Road, King's Lynn	-	2,050	
British Sugar plc, King's Lynn Sugar Factory	TF609180	400	
Beachcomber Ltd., Crossbank Rd, King's Lynn	TF612210	20	
Anglian Water Services Ltd., Marham WTW, The Street, Marham	TF603070	832	
Anglian Water Services Ltd., Hunstanton Storm Overflow	TF666400	140	
British Sugar plc, Cantley Sugar Factory, Norwich	TG386032	4,545	

Table 9.6.4 *(contd.)* Consented and authorised trade effluent discharges to tidal waters in NRA Hull and Humber Area and (part of) NRA Anglian Region. (See Map 9.6.3.)

Discharger	*Grid ref. (where provided)*	*Maximum daily flow (m^3/day)*	*Dry weather flow (m^3/day)*
Norfolk (continued)			
British Sugar plc, Cantley Sugar Factory, Norwich	TG389028	4,545	
Phillips Petroleum Co. UK Ltd., Phillips-Arpet Plant, Bacton Gas Terminal	TG331354	36	
Amoco (UK) Exploration Co., Amoco Exploration Co. Natural Gas Terminal, Bacton	TG332355	**12	
Shell Exploration & Production, Gas Terminal, Paston Road, Bacton	TG334349	150	
Wood Group Offshores Ltd., Yarmouth Marine Base, South Denes, Gt. Yarmouth	TG526057	1	
Griffin Diesel Ltd, Sea-Mar Diesel Ltd, Power Station Quay, South Denes, Gt. Yarmouth	TG530043	1	
National Rivers Authority, Haddiscoe Lab, Haddiscoe, Gt. Yarmouth	TM457987	2	

Source: NRA (pers. comm.). Note: Not not all consents specify a maximum volume; **rounded up to the next whole m^3. Effluent discharges will also be present on tidal reaches of rivers upstream of the Humber Estuary (not included here). Under the Environmental Protection Act 1990 trade effluent involving 'authorised' processes must be passed by Her Majesty's Inspectorate of Pollution, with the NRA as a statutory consultee. These discharges are marked with an asterisk*. 'Deemed consent' - discharges present before the Control of Pollution Act 1974.

annual *Digest of environmental protection and water statistics*, which provides detailed national statistics on aspects of environmental protection, including coastal and marine waters, radioactivity, waste and recycling, and wildlife (DoE 1995).

Schemes such as the Tidy Britain Group Seaside Award and the European Blue Flag are monitored during the year previous to the publication of their results. Monitoring of the EC Bathing Waters and other beaches under schemes such as Coastwatch UK and Beachwatch take place over one or two days. The results may therefore be skewed by heavy rain or localised effects at the time of survey. Coastwatch UK and Beachwatch do not sample the whole coastline in their region, owing to a shortage of volunteers. The results may therefore sometimes be unrepresentative because of the small sample size.

Other information sources available include the NRA's quarterly ship and air-borne National Coastal Baseline Survey, which monitors a large number of water quality parameters in coastal waters, including metals, nutrients and turbidity (Boxall *et al.* 1993). MAFF holds a database of consented sewage outfalls in England and Wales. Further information on discharges can be obtained from the local offices of the NRA or HMIP, who issue discharge consents and authorisations. Information on sewage sludge dumping grounds is available from MAFF, which licenses this activity (see section 9.6.5 C).

9.6.5 Acknowledgements

Thanks are due to Mrs F.L. Franklin (MAFF Fisheries Laboratory, Burnham-on-Crouch) for providing information from MAFF's database of consented sewage outfalls.

9.6.6 Further sources of information

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Discharge consents and pipeline outfalls. Water quality, including bathing waters and National Coastal Baseline Survey	*NRA Northumbria and Yorkshire Region, Leeds, tel: 0113 244 0191; or NRA Northumbria and Yorkshire Region (Willerby Office), 1 Viking Close, Great Gutter Lane, Willerby, Hull HU10 6DE, tel: 01482 651446; or *NRA Anglian Region, Peterborough, tel: 01733 371811
Consented discharges, River Ouse (Yorkshire)	NRA Dales Area, Coverdale House, Aviator Court, Amy Johnson Court, Clifton Moor, York YO3 4U2, tel: 01904 692296
Consented discharges, River Trent	NRA Severn-Trent Region, Sapphire East, 550 Streetsbrook Road, Solihull, West Midlands B91 1QT, tel: 0121 711 2324
Water supply and sewerage services	Anglian Water Services Ltd., Ambury Road, Huntingdon, Cambs. PE18 6NZ, tel: 01480 443000
Waste management licences and public registers - Humberside	*Group Manager - Waste Regulation, Humberside County Council, Beverley, tel: 01482 884069
Waste management licences and public registers - Lincolnshire	County Waste Regulation Officer, Lincolnshire County Council, City Hall, Beaumont Fee, Lincoln LN1 1DN, tel: 01522 553089
Waste management licences and public registers - Norfolk	*Waste Regulation Officer, Norfolk County Council, Highways Dept., Norwich, tel: 01603 223373
Water quality of the Humber	Humber Research Officer, Department of Applied Biology, University of Hull, Hull HU6 7RX
North Sea Project data set CD ROM	British Oceanographic Data Centre, Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, tel: 0151 652 3950
Litter on beaches	Coastwatch UK, Farnborough College of Technology, Boundary Road, Farnborough, Hampshire GU14 6SB, tel: 01252 377503
Beachwatch	*Marine Conservation Society, Ross-on-Wye, tel: 01989 66017
Tidy Britain Group Seaside Awards	Lion House, 26 Muspole Street, Norwich NR3 1DJ, tel: 01603 762888
Pollution from large industrial sites	HM Inspector of Pollution (HMIP), Swan House, Merchant's Wharf, West Point Road, Thornaby, Cleveland TS17 6PB, tel: 01642 633753
Aquatic environment monitoring reports relating to waste disposal; consented outfalls database	*MAFF Directorate of Fisheries Research, Fisheries Laboratory, Burnham-on-Crouch, tel: 01621 782658
Industrial effluent discharges	HMIP, Stockdale, 8 Victoria Road, Headingley, Leeds LS6 1PF, tel: 0113 278 6636

* Starred contact addresses are given in full in the Appendix.

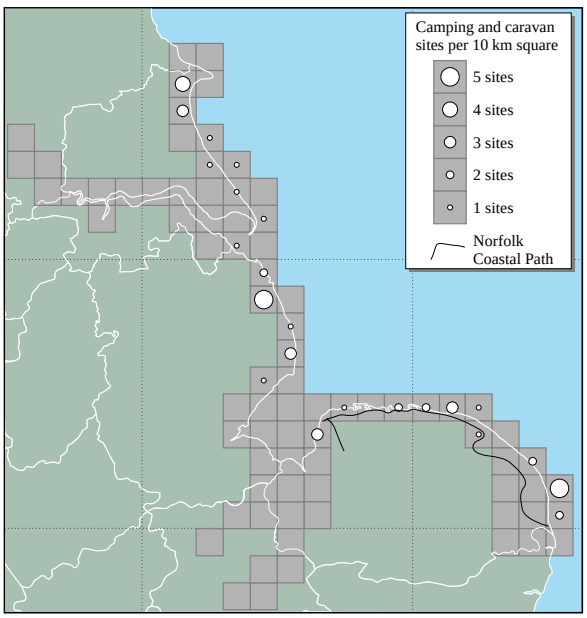
9.7 Leisure and tourism

M.J. Dunbar, S.L. Fowler, Dr N.C. Davidson & D.A. Stroud

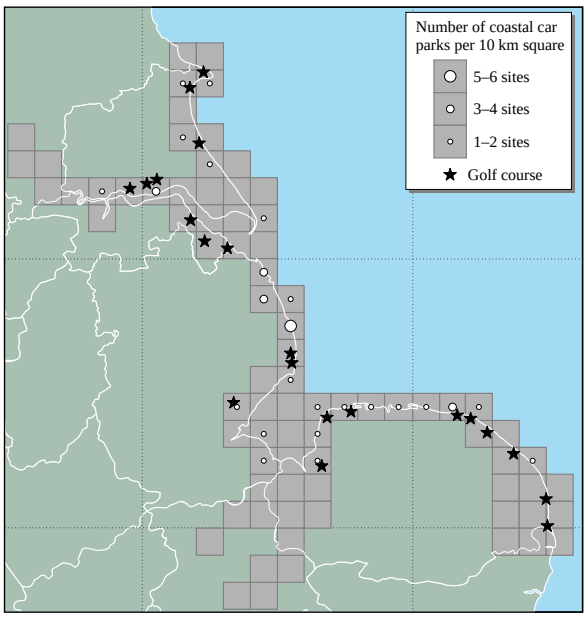
9.7.1 Introduction

This section covers the areas of the coast that are important for land- and water-based leisure activities and gives an overview of the infrastructure developments that are primarily concerned with these activities, such as amusement and theme parks, leisure centres, caravan and camp sites, golf courses, rural car parks (which provide the access points necessary for most land and water-based leisure activities), marinas, yacht moorings, dinghy parks and slipways.

While not rivalling the largest of England's south, south-west and north-west coast resorts, the region's coastal tourist resorts are still notable on a national scale. Many of the region's coastal towns have had a long association with the tourism industry, most notably Bridlington, Cleethorpes, Mablethorpe, Skegness, Hunstanton, Sheringham, Cromer and Great Yarmouth. A wide range of land-based leisure activities takes place along the coast, including walking, camping, golf (21 coastal golf courses), beach recreation, bird watching, wildfowling, horse riding and angling. There are at least 47 camping and caravan sites in the region. Off-road vehicle and trail-bike use is increasing in coastal areas. Facilities for water-based activities are generally concentrated near the main population centres, around the sheltered waters of small inlets, and at resorts where there are facilities for access to the sea (for example public slipways). The northern part of the region is not noted for its watersports facilities but the north Norfolk coast is a highly popular holiday destination with dinghy sailors and windsurfers and is certainly important for this activity at a regional, if not national, level.



Map 9.7.1 Number of camping/caravan sites in coastal 10 km squares in the region and long-distance footpath. Source: Ordnance Survey Landranger maps. © Crown copyright.



Map 9.7.2 Number of car parks in coastal 10 km squares in the region; locations of coastal golf courses. Source: Ordnance Survey Landranger maps. © Crown copyright.

9.7.2 Important locations

Table 9.7.1 lists the locations of land-based leisure and tourism facilities in the region (Maps 9.7.1 and 9.7.2).

In Humberside, Bridlington and Cleethorpes are popular seaside resorts and have a full range of leisure- and tourism-related developments, including a golf course and driving range, funfair, camping/caravan sites, themed attractions and slipways. There is also a large holiday camp at Flamborough Head and over a dozen camping or caravan sites between Flamborough and Spurn. There are three golf courses along this stretch of coastline.

Bridlington is also popular for sea angling; its harbour has 40 permitted trawler berths and seventeen berths for cobbles (fishing vessels). The area is popular for yachting, and the Royal Yorkshire Yacht Club promotes races in Bridlington Bay. Two pleasure steamers are based at Bridlington, offering cruises to Flamborough Head and Bempton Bird Sanctuary. Water-based activities at Cleethorpes include yachting, jet-skiing and water-skiing. There are five marinas in the Humber Estuary and 100 'non-marina' moorings. Hull Marina, with around 320 berths, was opened in 1983, following restoration of disused docks.

In Lincolnshire the coastal holiday industry is important, especially around Mablethorpe and Skegness but also at Sutton on Sea and between Chapel St. Leonard's and Skegness, with numerous hotels, guest houses, holiday flats, holiday camps, caravans, chalets and campsites. Facilities include leisure and amusement centres, fun fairs and other infrastructure. In 1981 Lincolnshire County Council estimated that there were over 120,000 bed spaces regularly available in holiday accommodation, about 90% of them in caravans and chalets. Static caravans occupy some 350 ha in

Table 9.7.1 Land-based leisure and tourism facilities

Site name	*Nature of development*	*Size*
Humberside		
North Cliff, Flamborough	Thornwick Holiday centre: caravan and camp site, incorporating Sea Farm	Large
Flamborough Head	Golf course	
South Cliff, Bridlington	Caravan park	750 permanent, 200 touring sites, 50 tents
South Sands, Bridlington	Golf course	
Bridlington	Fun park	
Barmston	Beach caravan site	300 permanent, 16 touring sites
Ulrome	Caravan park	72 permanent and seasonal
Ulrome	Sea side camp site	400 permanent, 300 touring
Ulrome, Skipsea	Beach Bank caravan site	18 permanent, 40 touring
Skipsea	Caravan park	740 permanent, 70 touring
North Cliff, Hornsea	Cliff top caravan and camp site; access to beach	240 static, 10 touring
Cowden, Hornsea	Static/camping caravans and tents	217 static, 25 touring
South Cliff, Hornsea	Longbeach Leisure Park; caravan park	304 static, 10 touring, 6 caravans for hire
Aldbrough	Static caravan park, cliff top site with steps to beach	230 static caravans
Tunstall, Withernsea	Caravan, tents and vans for hire	50 places
Withernsea	Leisure centre and caravan park	168 static, 10 touring caravans/tents
Easington, Kilnsea	Beach caravan site, swimming pool, tennis & badminton courts, bowling and putting green	18 acre site: 248 static, 40 touring/motor caravans, 25 tents
Barton on Humber	Camp site	24 caravans/tents
Cleethorpes	Golf course; theme attractions; funfair, pier etc.	Large
Cleethorpes	Thorpe Park Holiday Centre	320 static, 40 touring, 200 chalets and 100 caravans for hire
Lincolnshire		
North Somercotes	Caravan and campsite set back from coast behind saltmarshes	
Saltfleet	Several caravan sites on dunes	
Theddlethorpe St. Helen	Chalet and caravan sites behind dunes, beach chalets	
Theddlethorpe	Caravan site	
Mablethorpe	Major holiday centre: numerous caravan parks, holiday camp and commercial entertainment infrastructure including leisure centres and fun fairs/amusement parks	Large
Sutton on Sea	Holiday centre with commercial entertainment infrastructure, holiday camps, caravan parks etc.	
Sandilands	Golf course	
Anderby Creek	Caravan parks	
Chapel St. Leonard's	Small holiday centre, several caravan parks and holiday chalets	
Ingoldmells	Small holiday centre: very large coastal holiday camp, and numerous caravan parks; golf course	
Winthorpe, nr. Skegness	Butlins Holiday Centre and Fun Coast World; North Shore golf course	
Skegness	Major holiday centre, several caravan parks, leisure centres and fun fairs; Seacroft golf links; pier and coastal leisure facilities on land claim; beach chalets	Large
Holbeach Clough	Caravan site	
Norfolk		
Shepherd's Port, W. of Snettisham	Caravan and camping site; beach chalets	
Heacham	Caravan site	
Hunstanton	Major holiday centre with funfair, promenade, Sealife Centre, caravan sites e.g. Searles Holiday Centre, Manor Park Holiday Village	480 static caravans, pine lodges, touring caravans, tents, motor homes, 40 chalets
Old Hunstanton	Golf course	
Brancaster Marsh	Golf course	
Wells-next-the-sea	Camping/caravan site	
Sheringham	Golf course	
West Runton	Laburnum Caravan Park	13 acres: touring caravans, motor homes; 180 static units
East Runton	Woodhill Park camping/caravan site	Touring caravans, tents, motor homes, 132 static units
Cromer	Seaside resort; promenade; funfair; pier; holiday village	
Cromer	Golf course	
Bacton	Cable Gap Caravan Park	Tourers, motor homes, 47 static units
North of Sea Palling	Caravan/camping site	

Table 9.7.1 *(contd.)* Land-based leisure and tourism facilities

Site name	*Nature of development*	*Size*
Norfolk (continued)		
South of Waxham	Caravan/camping site	
Winterton-on-Sea, Hemsby Hole	Caravan site, holiday centre	
Hemsby Hole, Newport	Pontins Holiday Camp, numerous caravan sites, beach chalets	
Scratby/California	Caravan/camping sites, beach chalets, numerous leisure facilities	Large
Caister-on-Sea	Caister Beach Holiday Park[a], Caister Holiday Centre[b], race course, golf course	[a]212 static units, [b]288 static units, 313 chalets
Great Yarmouth	Major seaside resort with extensive leisure facilities, piers, Sealife Centre, camping/caravan sites, holiday centres, self-catering accommodation etc.	
Gorleston-on-Sea, Great Yarmouth	Promenade, model yacht pond, beach chalets, golf course	
Burgh Castle (Breydon Water)	Caravan/camping site	
Hopton-on-Sea	Hopton Holiday Village	850 static units

Sources: local tourism brochures, OS Landranger maps

the county, a large proportion of them (21,500 caravans in 1980) on or close to the coast. This excludes the area occupied by touring caravans (on average there were 2,473 of these on the coast in 1979) and camp sites. In 1981 there were three golf courses on the Lincolnshire coast, at Sandilands, North Shore (Skegness) and Seacroft (Skegness). Lincolnshire County Council surveyed the number and capacity of coastal car parks in rural areas in the 1970s. There were thirteen north of Mablethorpe with a combined capacity of 500, seven with a total capacity of 1,800 between Mablethorpe and Skegness, and fourteen with a total capacity of 300 cars south of Skegness (excluding the NNR park at Gibraltar Point).

Leisure craft facilities on the Lincolnshire coast are restricted to some areas of mud moorings at Saltfleet Haven and on the Steeping River at Gibraltar Point and in the rivers leading into The Wash, particularly the Witham (Boston), Welland (Sutton Bridge) and Nene (Fosdyke Bridge). Boats can also be launched over the sands in several locations (see Table 9.7.2).

The north Norfolk coast between Snettisham and Cromer supports an important tourist industry, although intensive coastal tourism in the county is confined to a number of key points around the coast, notably Hunstanton (with about 1 million day visitors per year), Sheringham, Cromer and some 20 km of the eastern coastline between Winterton-on-Sea and Great Yarmouth. These areas have a full range of leisure facilities, including camp sites, holiday centres and funfairs, with Great Yarmouth and its adjoining coast being the most intensively developed. These locations serve not only the coast but also the nearby Broads. Hunstanton is a nationally important venue for powerboating, and waterskiing is also popular.

Other popular destinations for day trippers on this coastline, which is internationally important for its landscape and wildlife, are Snettisham, Holme, Titchwell, Holkham, Wells, Blakeney and Cley. These locations have little formal leisure infrastructure except car parks. Many trippers visit to watch birds (e.g. at RSPB reserves at Snettisham and Titchwell, or at Cley and Blakeney Point). Pleasure boating trips are available from some harbours, including from Morston and Blakeney to Blakeney Point and from Brancaster Staithe to Scolt Head Island. Riding and walking are popular leisure activities in coastal Norfolk, and there are many kilometres of footpaths, including the Norfolk Coast Path National Trail. *A visitor management strategy for the Norfolk coast* (Hayes 1995) offers policy guidance on how the many visitors to the Norfolk coast can continue to enjoy its nationally important landscape and internationally important wildlife.

There are a number of slipways for launching small craft on the north Norfolk holiday coast and within the rivers and estuaries, and water-based recreation is a popular pastime at many locations, notably Brancaster, Burnham Overy Staithe, Wells and Blakeney. These more sheltered locations are popular places for learning to windsurf and water-ski, while the more exposed beaches to the east are popular with more experienced windsurfers and skiers. There are limited facilities for pleasure boats at the ports of Boston, King's Lynn and Cromer.

Sidaway (1991) recorded one marina and two mooring sites on the Norfolk coast and estimated that these represented a total of about 100 berths and 90 estuarial moorings in 1990 (this may possibly represent an underestimate of about 20-25% for berths and 50% for moorings, based on other comparisons). The small number of yachts based on this coast is partly due to the general unsuitability of the area for cruising and yachting, as many of the harbours are shallow and dry out for much of the tidal cycle.

Breydon Water, the inland tidal estuary of the River Yare (and its confluence with the Rivers Bure and Waveney), enters the sea via a narrow channel at Great Yarmouth. There are a number of marinas at Yarmouth and at Burgh Castle (at the southern tip of Breydon Water) and many pleasure boatyards in the rivers that serve the Broads. Great Yarmouth is a popular starting point for sea angling trips (see also section 9.1.2).

Table 9.7.2 lists the main locations of water-based leisure and tourism facilities in the region (Map 9.7.3).

Wildfowling - a traditional coastal activity - is now recreational, although formerly it was commercially practised for food. Wildfowling quarry species and shooting seasons (the open season for coastal wildfowling is 1 September to 20 February) are regulated through the Wildlife and Countryside Act 1981. Coastal quarry species include most ducks, some geese and three waders (only one of which - golden plover *Pluvialis apricaria* - is regularly coastal). In this region it is mostly ducks (mallard *Anas platyrhynchos*, wigeon *A. penelope* and teal *A. crecca*, and

Map 9.7.3 Important locations for water-based leisure. Sources: Tourist Offices.

some pintail *A. acuta*) and grey-lag geese *Anser anser* that are targeted.

Wildfowling is widespread in this region, occurring on much of the foreshore of each of the four areas of estuarine coast, and also on many parts of the coastal grasslands and washlands associated with the tidal estuaries. It occurs on about 80% of the foreshore and saltmarshes of the Humber estuary and north Lincolnshire. Substantial areas are licensed to wildfowling clubs, with private shooting over other parts; there is only rough shooting over the upper parts of the tidal rivers. On The Wash at least 75% of saltmarsh is shot over, as are parts of the tidal flats, by ten wildfowling clubs and in some areas groups of clubs. About 1,300 ha of the saltmarshes, tidal flats, dunes and grazing marshes of the north Norfolk coast are used for wildfowling, most by five wildfowling clubs but some parts also by individual wildfowlers and the Holkham Estate. The Brancaster Common Right Holders Gun Club has an unusual common right to take wildfowl. Three wildfowling clubs and many private owners and groups shoot on Breydon Water and in Broadland; overall about 60% of grazing marshes there are shot over, as is about three-quarters of Breydon Water. Most wildfowlers in the region use shoulder guns, but in addition several punt guns operate on The Wash, and punt-gunning occurs also on Breydon Water.

9.7.3 Management and issues

Many of the land-based leisure developments have had significant effects on coastal habitats. On the Lincolnshire coast, for example, sand dune systems have been affected by car parks and campsites. Golf course developments have also reduced the area of semi-natural vegetation along the coast. Low-key visitor activities, such as walking, climbing and bird-watching, may also cause conflicts with other uses of the coast in the region, either because of the numbers of visitors or because of the sensitivity of the areas involved.

The North Norfolk Coast Visitor Management Strategy aims to accommodate the needs of tourists in a sustainable way while still maintaining the popularity of the area. On the Norfolk Broads efforts are under way to control vegetation damage and river pollution caused by the high levels of tourist use.

Shooting on some coastal sites involves both local wildfowlers and those from further afield. As well as statutory constraints on species shot, several sites are subject to further regulation self-imposed by wildfowlers. As elsewhere in Britain, much of the wildfowling in Region 6 is operated and managed through wildfowling clubs and syndicates. Much takes place on areas covered by national and international site protection, including on several National Nature Reserves (NNRs), where it is mostly managed through permit systems. Wildfowling on NNRs in the region and elsewhere is reviewed by Owen (1992), and

Table 9.7.2 Main water-based leisure and tourism facilities

Site	*Grid ref.*	*Description*
Humberside		
Bridlington	TA1766	Small boat launching, sailing club, pleasure cruises
River Humber	TA31 - SE72	Five marinas, at least three sailing clubs
Lincolnshire		
Chapel St. Leonard's	TF5572	Launching over sands
Jackson's Corner, Ingoldmells	TF5668	Launching over sands
Skegness	TF5763	Sailing Club
Norfolk		
Snettisham		Sailing Club
King's Lynn	TF6220	Harbour
Hunstanton	TF6740	Sailing club and launch facilities
Brancaster Staithe	TF7546	Small boat launching, sailing club
Burnham Overy Staithe	TF8444	Small boat launching, sailing club
Wells-next-the-sea	TF9143	Slipway (lifeboat station), sailing club
Morston	TG0044	Boat launching, boat trips
Blakeney	TG0243	Small harbour, sailing club, boat trips
Cromer	TG2142	Boat launching
Norfolk Broads	TG30, TG31, TG40, TG41	Major water-based recreation area, tidal river channels; many boatyards and marinas
Great Yarmouth	TG5207	Burgh Castle Marina, harbour

the development of the Humber Wildfowl Refuge (an Area of Special Protection (see Section 7.3.4), first established in 1955 to provide safe roosting sites for pink-footed geese *Anser brachyrhynchus*) is described by Pashby (1992). The establishment of a network of refuges on The Wash is an objective in the draft Wash Estuary Management Plan (Wash Estuary Strategy Group 1994), and refuges exist on the north Norfolk coast and Breydon Water.

The representative body for sport shooting in the UK, the British Association for Shooting and Conservation (the BASC), has 19,000 wildfowling members, mostly in 200 affiliated wildfowling clubs; there are 36 clubs (18% of all affiliated clubs), with 2,795 members, operating in the region. At least 25 clubs plus several other associations shoot over the estuarine foreshore in the region.

In addition to the recreational wildfowling, since 1983/84 licences for the killing of specific numbers of dark-bellied brent geese *Branta bernicla bernicla* have been issued annually by the Ministry of Agriculture, Fisheries and Food (MAFF) to prevent serious damage to agriculture. These licences are intended as 'an enhancement of scaring'. Numbers of licences and numbers of geese shot have been increasing in recent years; up to 214 licences and 2,797 geese shot in 1991/92 (Stroud 1994). Most licences are issued for sites in Region 6. For example, in 1994/95 in South Humberside and Lincolnshire, seventeen licences to shoot up to 216 geese in total were issued and 85 geese were shot. In Norfolk, Suffolk and Essex in the same year there were 69 licences to shoot up to 1,619 geese in total, of which 850 were shot.

During periods of severe winter weather, disturbance to waterfowl (including non-quarry species) from shooting threatens the birds' survival: at these times national statutory wildfowling bans can be imposed after fourteen days of freezing conditions (voluntary restraint is called for after seven days). Bans are important in this region since it is used as a refuge when weather further east in Europe is severe (Ridgill & Fox 1990). Further information on the history and operation of cold-weather shooting bans is given by Stroud (1992).

9.7.4 Information sources used

Most of the above information is derived from materials received from Tourist Information Centres (up to date, but of varying detail within the region), from facilities shown on Ordnance Survey 1:50,000 Land Ranger maps and Admiralty Charts and from a nautical almanac (D'Olivera & Featherstone 1993). This last does not cover the facilities for small boat launchings, which are particularly common on the north Norfolk coast. It is not possible to gauge the scale of some facilities from these sources. The maps and tables are therefore only indicative of the distribution of leisure and tourism in the region. In addition to the references cited, some of the information about the distribution and management of wildfowling comes from the NCC's 1989 Estuaries Review data collection (Davidson *et al.* 1991), now held as part of JNCC's integrated coastal database.

9.7.5 Acknowledgements

The authors wish to thank the BASC for help in compiling information on wildfowling, R. Irving for providing other material for this section and Peter Clement (English Nature) for information on licensing.

9.7.6 Further sources of information

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Royal Yachting Association. 1992. *RYA affiliated organisations.* Eastleigh, RYA.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Tourism information service	Commercial Information Library, British Tourist Authority/English Tourist Board, Thames Tower, Black's Road, Hammersmith, London W6 9EL, tel: 0181 846 9000 x 3011/3015
Tourist facilities (Tourist Information Centres)	
Bridlington	25 Prince Street, Bridlington, Humberside YO15 2NP, tel: 01262 673474/606383
Kingston-upon-Hull	City Information Service, Central Library, Albion Street, Kingston-upon-Hull, Humberside HU1 3TF, tel: 01482 223344; or 75/76 Carr Lane, Humberside HU1 3TF, tel: 01482 223559
Grimsby	The National Fishing Heritage, Alexandra Dock, Grimsby, Humberside DN31 1UF, tel: 01472 342422
Cleethorpes	42-43 Alexandra Road, Cleethorpes, Humberside DN35 8LE, tel: 01472 200220
Mablethorpe	Dunes Family Entertainment, Central Promenade, Mablethorpe, Lincolnshire LN12 1RG, tel: 01507 472496
Skegness	Embassy Centre, Grand Parade, Skegness, Lincolnshire PE25 2UP, tel: 01754 764821
Boston	Blackfriars Arts Centre, Spain Lane, Boston, Lincolnshire PE21 6HP, tel: 01205 356656
King's Lynn	The Old Gaol House, Saturday Market Place, King's Lynn, Norfolk PE30 5DQ, tel: 01553 763044
Hunstanton	The Green, Hunstanton, Norfolk PE36 5AH, tel: 01485 532610
Wells-next-the-Sea	Staithe Street, Wells-next-the-Sea, Norfolk NR23 1AN, tel: 01328 710885
Sheringham	Station Approach, Sheringham, Norfolk NR26 8RA, tel: 01263 824329
Cromer	Bus Station, Prince of Wales Road, Cromer, Norfolk NR27 9HS, tel: 01263 512497
Mundesley	2a Station Road, Mundesley, Norfolk NR11 8JH, tel: 01263 721070
Great Yarmouth	Marine Parade, Great Yarmouth, Norfolk NR30 2EJ, tel: 01493 842195
Sports Council	Sports Council, Headquarters, 16 Upper Woburn Place, London WC1H 0QP, tel: 0171 388 1277
Sailing, windsurfing and powerboating	Royal Yachting Association (RYA), RYA House, Romsey Road, Eastleigh, Hants. SO5 4YA, tel: 01703 629962
Marine leisure industries	British Marine Industries Federation, Meadlake Place, Thorpe Lea Road, Egham, Surrey TW20 8HE, tel: 01784 473377
Canoeing	British Canoe Union, Adbolton Lane, Westbridgford, Nottingham NG2 5AB, tel: 0115 982 1100
Diving	British Sub Aqua Club, Telfords Quay, Ellesmere Port, South Wirral, Cheshire L65 4FY, tel: 0151 357 1951
Water skiing	British Water Ski Federation, 390 City Road, London EC1Z 2QA, tel: 0171 833 2855
Jet skiing	Personal Watercraft Association, PO Box 119, Farnborough, Hampshire GU14 8YH, tel: 01252 378882
Wildfowl and wetlands	*Publicity Officer, Wildfowl & Wetlands Trust, Slimbridge, tel: 01453 890333
Wildfowling (general, including details of affiliated clubs)	Information Officer, British Association for Shooting and Conservation, Marford Mill, Rossett, Wrexham, Clwyd LL12 0HL, tel: 01224 570881
Wildfowling (general information on wildfowl, habitats and conservation)	*Enquiry Officer, Royal Society for the Protection of Birds HQ, Sandy, tel: 01767 680551
Wildfowling (the sport)	Press and Information Officer, British Field Sports Society, 59 Kennington Road, London SE1 7PZ, tel: 0171 928 4742
Severe weather wildfowling bans	*Licensing Officer, English Nature HQ, Peterborough, tel: 01733 340345

* Starred contact addresses are given in full in the Appendix.

Chapter 10 Coastal management

S.L. Fowler

10.1 Introduction

This chapter describes national (section 10.2) and local and regional (section 10.3) coastal management initiatives taking place wholly or partly within Region 6. GB and UK national initiatives without a specific regional focus, notably those led by non-governmental agencies and user groups, are outside its scope. However, as the whole chapter concludes with a list of contacts with a wider involvement or interest in coastal management (section 10.4), contact points for some of these organisations are included there. In addition, names and addresses of many contacts are given within the relevant section.

10.1.1 Coastal management in the UK

This section outlines the direction of national policy-making, within which many of the regional initiatives operate. Many, frequently competing, issues and activities affect the coastal environment and inshore waters, making the task of coastal planning and management a very complex one, particularly as numerous different authorities are responsible for particular statutory duties. Coastal management promotes an inter-disciplinary approach to multiple use and conflict resolution between interest groups, 'to ensure the long-term future of the resources of the coastal zone through environmentally sensitive programmes, based on the principle of balanced, sustainable use' (Gubbay 1990). Coastal management ensures that all land and sea use issues are co-ordinated, including development, conservation, waste disposal, fisheries, transport, and coastal protection and flood defence. The advantages of this have been recognised by coastal planners in many areas, and several local authorities and other bodies now promote coastal management. However, approaches differ from area to area, with overlap in some places and patchy coverage elsewhere (Earll 1994).

The House of Commons Environment Committee Second Report (House of Commons 1992), although limited in scope to England and the estuaries it shares with Wales and Scotland, made recommendations for the planning and implementation of coastal management that have had policy and practical implications throughout the UK. Amongst these recommendations were:

- the endorsement of an integrated approach to coastal management, incorporating maritime land, sea and intertidal areas;
- a review of existing legislation;
- the need for international (EU-wide) policy initiatives;
- clearer responsibilities for planning and action in the coastal zone, based on a national strategic framework;
- appropriate funding for accountable bodies with responsibilities;
- research into the physical functioning of the coastal zone and associated protection and conservation measures;
- a review of planning mechanisms to allow effective safeguard of the coastal resource;
- monitoring and environmental assessment of coastal activities to assess their impacts;
- the involvement of local communities in coastal management planning;
- the integration of responsibility for coast protection and sea defence under one body;
- better statutory protection for sites of nature conservation importance;
- better provisions for control of marine pollution;
- the need for fisheries activities to take account of marine conservation issues.

Later in 1992, the Department of the Environment and the Welsh Office issued *Planning Policy Guidance: Coastal Planning (PPG 20)*, which made clearer the requirement for planning decisions to take account of environmental and conservation issues.

The Environment Select Committee's recommendations were followed up, in 1993, by the publication of *Development below low water mark: a review of regulation in England and Wales* (Department of the Environment/Welsh Office 1993a), in parallel with the discussion paper *Managing the coast: a review of coastal management plans in England and Wales and the powers supporting them* (Department of the Environment/Welsh Office 1993b). That same year, the Ministry of Agriculture, Fisheries and Food (MAFF) and the Welsh Office brought out their *Strategy for flood and coastal defence in England and Wales* (MAFF/WO 1993). In this their policy is spelled out: ". . . reducing the risks to people and the developed and natural environment from flooding and coastal erosion by encouraging the provision of technically, environmentally and economically sound and sustainable defence measures." Section 10.4 B gives additional notes on the content of these publications.

In 1994 the Department of the Environment announced the forthcoming publication of national policy guidelines for the coast and the creation of a standing forum (the Coastal Forum) on coastal management. It also undertook to highlight good practice in coastal management plans, clarify the interaction of the different elements of coastal management and review relevant bylaw powers. The European Commission was asked by the Council of the EC to propose a strategy for the whole of the Community coast before the end of 1994; it is still awaited at the time of writing. The strategy is to be based on the principles of sustainability and sound ecological and environmental practice, but will have no legal standing.

By the end of 1994, Government had published its Regulations to implement the EU Habitats Directive (Department of the Environment/Welsh Office 1994). As they relate to the coast, these regulations provide for single management groups to be set up for whole sites, including

areas of sea, making the production of unified management plans a practical proposition. For this, the regulations require all relevant authorities to exercise a general duty of care for their long-term conservation. At the time of writing, discussions are continuing on how these requirements will work in practice.

10.2 National coastal initiatives with regional elements

10.2.1 Introduction

Partly as a result of developments at a UK and international level, many national bodies are now becoming involved in the promotion of coastal management initiatives, including several with no direct management role through a statutory remit or ownership of coastal land. These include the National Coasts and Estuaries Advisory Group (NCEAG) and non-governmental organisations with a particular interest in the conservation of the coastal zone: the Marine Conservation Society, World Wide Fund for Nature (UK) and the Royal Society for the Protection of Birds (RSPB) (see section 10.2.3). Only national initiatives that have distinct local elements in the region are described here. Many other diverse interest groups and organisations now have national policies with regard to coastal management and estuaries management, for example the British Association for Shooting and Conservation and the Royal Yachting Association, and their representatives are involved in most local or regional groups or fora, listed in Table 10.3.3. For further information on regionally-led coastal management initiatives, see section 10.3.

Map 10.2.1 River catchment areas for catchment management plans. Reproduced by kind permission of the NRA.

10.2.2 English Nature's coastal management initiatives

Estuaries Initiative

The Estuaries Initiative for achieving the sustainable management of estuaries is described in *Caring for England's estuaries: an agenda for action* (English Nature 1992). Thirty sites on the English coast have been selected, out of a planned total of 35 by the year 2000, and management plans are being prepared for them in partnership with national and local statutory and voluntary bodies. Within the region, two estuaries are targeted under this initiative: the Humber estuary and The Wash (see section 10.3.4).

Sensitive Marine Areas

English Nature's Sensitive Marine Areas (SMA) initiative is set out in *Managing England's marine wildlife* (English Nature 1994) (see also section 7.4.4). Under the initiative, which is modelled on the Estuaries Initiative, English Nature and the managers and users of the marine environment are, with joint funding, developing ways of managing areas of marine wildlife importance, based on voluntary measures used in conjunction with existing regulatory controls. Flamborough Headland is one of two trial SMAs in the region, the other being The Wash (see Map 7.4.1).

Table 10.2.1 Shoreline management plans

Initiative name	*Contact address and telephone no.*
Shoreline Management Plan, Holderness Coast from Flamborough Head to Donna Nook (see Humber Estuary Authorities Group - Table 10.3.2)	*Eddie Knapp, Project Manager, Holderness Borough Council, Hull, tel: 01964 562333 or Ken Allison, NRA Northumbria & Yorkshire Region, Olympia House, Gelderd Lane, Gelderd Road, Leeds LS12 6DD, tel: 01132 440191 or *Richard Nunn, NRA Anglian Region, Peterborough, tel: 01733 371811
Sea defence survey and Anglian Region shoreline management system	*NRA East Anglia Regional Office, Peterborough tel: 01733 371811

* Starred contact addresses are given in full in the Appendix.

Table 10.2.2 Coastal catchment management plans timetable

Catchment	*Timetable*	*Contact address and telephone no.*
Hull and Coast	Due for completion in 1994/5	*NRA Northumbria & Yorkshire Region, Leeds, tel: 01113 244 0191
Humber Estuary	Due for completion in 1994/5	*NRA Northumbria & Yorkshire Region, Leeds, tel: 01113 244 0191, or *NRA Anglian Region, Peterborough, tel: 01733 371811, or NRA Severn-Trent Region, Sapphire East, 550 Streetsbrook Rd., Solihull B91 1QT, tel: 0121 711 2324
Ancholme	Due for completion 1995/96	*NRA Anglian Region, Peterborough, tel: 01733 371811
Grimsby Area	Due for completion in 1994/5	*NRA Anglian Region, Peterborough, tel: 01733 371811
Louth Coastal	Final Plan available	*NRA Anglian Region, Peterborough, tel: 01733 371811
Lower Witham	Due for completion 1995/96	*NRA Anglian Region, Peterborough, tel: 01733 371811
Lower Nene	Consultation Reports available	*NRA Anglian Region, Peterborough, tel: 01733 371811
North Norfolk rivers	Due for completion in 1994/5	*NRA Anglian Region, Peterborough, tel: 01733 371811
Stiffkey, Burn and Glaven	Due for completion 1996/97	*NRA Anglian Region, Peterborough, tel: 01733 371811
Yare	Consultation Reports available	*NRA Anglian Region, Peterborough, tel: 01733 371811

* Starred contact addresses are given in full in the Appendix.

Maritime Natural Areas

English Nature has, through consultation, identified 23 proposed Maritime Natural Areas around the coast of England (described in *Conserving England's maritime heritage - a strategy* (EN 1993)). These non-statutory areas represent coherent maritime wildlife systems based on major sediment cells and other coastal features. The seaward boundary of each is the 12 mile limit, and the landward boundary the limit of coastal habitats. The Natural Areas approach of defining the nature conservation resource is being tried out at one Maritime Natural Area (Lyme Bay, Dorset, in Region 9), and will be applied in future to the Maritime Natural Areas within this region, which include the southern section of the Saltburn to Bridlington MNA, Skegness to Gibraltar Point MNA, The Wash MNA, The Wash to Cromer MNA, and part of Cromer to Lowestoft MNA (including part of neighbouring Region 7).

10.2.3 Royal Society for the Protection of Birds

In 1990, the Royal Society for the Protection of Birds (RSPB) launched a national campaign to promote the importance of estuaries in the UK and the need for coordinated management (Rothwell & Housden 1990). The campaign ran for three years. The RSPB Estuaries Inventory project compiled mapped and numerical information on land use and selected human activities for 57 major UK estuaries. In Region 6 the Inventory covers the Humber and The Wash. In 1994, the RSPB launched its Marine Life Campaign, which aims to increase awareness of issues and to promote integrated coastal and marine management.

10.2.4 Shoreline management plans

Shoreline Management Plans (coastal defence plans based on coastal sub-cells compiled in accordance with government guidelines on assessing the environmental impacts of proposals, including soft defence and 'do nothing' options) are now being considered and will be produced in association with MAFF. This region is covered by two shoreline management plans (Table 10.2.1).

10.2.5 National Rivers Authority (NRA) catchment management plans

River catchments, including estuaries and coastal waters, are the NRA's basic management unit. A catchment management plan is an agreed strategy to realise the environmental potential of the catchment, within prevailing economic and political constraints. River catchments in the region for which catchment management plans are being prepared are shown in Map 10.2.1. Table 10.2.2 gives the National Rivers Authority's five year programme for the completion of consultation reports for the nine river catchment management plans bordering the coast in the region (National Rivers Authority Corporate Plan 1994-95).

10.2.6 Designated sites

Described in detail in Chapter 7, several statutory and non-statutory designations are also relevant here because they provide a degree of coastal management through their area or site management plans (Table 10.2.3). These often tend to focus strongly on the conservation of landscapes, buildings and/or habitats and species, rather than on wider and more integrated coastal issues, although in management planning for some sites a focus on visitor use and community involvement is important. Designated sites range from nature reserves, managed by English Nature, Wildlife Trusts, local authorities, the RSPB or other approved bodies for nature conservation objectives, to the proposed marine Special Areas for Conservation (see sections 7.2.3 and 10.2.7), and Heritage Coasts.

Most Heritage Coast Services (management teams working from within local authorities) are producing or implementing management plans through their respective local authorities and associated Steering Groups. The defined areas of Heritage Coasts include only the finest sections of undeveloped coast (section 7.4.3), but much larger coastal areas are frequently covered by local authority Coastal or Countryside Management Services plans (see section 10.3.4). Flamborough Headland Heritage Coast and Spurn Heritage Coast Project and the North Norfolk Coast Project are all producing or implementing management plans through their respective local authorities and associated Steering Groups. These plans cover coastal Areas

Table 10.2.3 Management of designated sites

Initiative name	*Scope/aims*	*Organisations involved*	*Contact address and telephone no.*
Flamborough Headland Heritage Coast Management Plan	Draft First Review of 1989 plan out for consultation and publication in 1995. Will have zoning policies and programmes of projects. Implementation through partnership with Project Officer. Sensitive Marine Area pilot project is being discussed with English Nature.	Elected members and representatives of Humberside and North Yorkshire CCs, East Yorkshire and Scarborough Borough Councils, Countryside Commission, English Nature.	Heritage Coast Officer, 4-6 Victoria Road, Bridlington, North Humberside YO15 2BW, tel: 01262 606322
Spurn Heritage Coast Management Strategy	Public Consultation Document, March 1995. General conservation, protection and management of Heritage Coast.	Spurn Heritage Coast Project and Steering Group (Holderness Borough Council, Humberside CC, Yorkshire Wildlife Trust, Easington Parish Council, English Nature & Countryside Commission).	Spurn Heritage Coast Project, Easington, Hull, Humberside HU12 0SU, tel: 01964 650139, or *Principal Planning Officer, Holderness Borough Council Development Department, Skirlaugh, Hull, tel: 01964 562333
North Norfolk Coast Project	Six-year project on conservation, tourism and recreation access, and sustainable development, begun in December 1991, implemented by Project Officer and Officer Working Group. Currently developing a Conservation Strategy for the North Norfolk SSSI and will go on to develop a wider one for the AONB.	Managed by Joint Advisory Panel from English Nature, Norfolk CC, Countryside Commission, North Norfolk DC, King's Lynn and West Norfolk Borough Councils.	North Norfolk Coast Project, 6 Station Road, Wells-next-the-Sea, Norfolk NR23 1AE, tel: 01328 711533
North Norfolk Coast Visitor Management Strategy	Part of the above three year project. Four working groups with local representation. Access control and provision, management planning. Published 1995.	Managed by Norfolk Coast Project as part of AONB & Joint Advisory Committee (12 NGOs and statutory bodies represented).	North Norfolk Coast Project, 6 Station Road, Wells-next-the-Sea, Norfolk NR23 1AE, tel: 01328 711533

* Starred contact addresses are given in full in the Appendix.

of Outstanding Natural Beauty in the region.

The National Trust, which has extensive coastal land holdings along the region's coast, has recently been carrying out a complete review of its Coastal Strategy Plans and is reviewing management plans for its coastal sites.

10.2.7 Management of marine SACs under the EC Habitats Directive

Under the EC Habitats Directive 1992, a list of marine Special Areas of Conservation (SACs) to be designated in the UK must be agreed by 1998 (see section 7.1). A list of possible sites on which consultations will be carried out was published in March 1995. Marine SACs include intertidal and subtidal areas; terrestrial SACs include important coastal maritime habitats such as lagoons, saltmarshes or sand dunes. Under the Habitats etc. Regulations 1994, marine and terrestrial SACs will have to be managed in a way that secures their 'favourable conservation status'. A range of bodies and individuals will be involved, including all 'relevant and competent authorities', e.g. local authorities, the National Rivers Authority (NRA), ports and harbour authorities, Sea Fisheries Committees and English Nature, as well as owners and occupiers of foreshore land and representatives of those who rely on marine areas for their livelihood or for recreation. Management will be coordinated through an agreed management scheme, backed by existing statutory measures.

10.3 Regional coastal management groups and initiatives

10.3.1 Introduction

There are currently numerous regional coastal management initiatives arising around the coastline under the leadership of local planning, harbours and ports authorities. Other locally-based coastal management initiatives, although not strictly integrated as defined in section 10.1.1, are also under way. These include Coastal Engineering Groups (see section 10.3.3), which are primarily concerned with promoting coordination and liaison between organisations undertaking coastal works (section 8.4).

10.3.2 Local authority and ports/harbours initiatives

The maritime local authorities are involved in most, if not all, of the major coastal management initiatives described in the following sections. Port and harbour authorities also have a statutory remit to control activities within their areas of authority, which may include coastal waters, and will receive wider powers to manage Special Areas of Conservation under the EC Habitats Directive (see section 10.2.7).

Local authorities are also instigating a large number of coastal management initiatives, not least through their own planning documents (County Structure, Unitary and Local Plans), which usually pay particular attention to coastal matters, particularly when produced following PPG 20 (see section 10.4). For example, in its draft Structure Plan *Norfolk to 2006*, Norfolk County Council has new policies which aim to reduce the risk of coastal flooding and erosion. These are "a presumption against development on land to the seaward side of sea defences . . . in areas liable to flood unless the standard of defence is appropriate to the development proposed", and "a presumption against new building in areas likely to be affected by marine erosion within the expected lifetime of the development (assuming that these areas will not be satisfactorily defended against sea level rise)" (Kay 1991). Table 10.3.1 includes examples of recent local authority planning documents.

10.3.3 Coastal (engineering) groups

Two main non-statutory coastal groups (sometimes known as coastal engineering groups) have been established within the region, to improve coordination and liaison between agencies undertaking coastal works (see section 8.4). A third coastal group, the North East Coastal Authorities Group, covers the small section of the region's coast north of Flamborough Head. The main aim of the groups is to seek a coordinated approach to all coastal engineering works by member authorities. The Holderness Coast Protection Project covers the area from Flamborough to Spurn Head, and the Anglian Coastal Authorities Group extends from Spurn to the Thames. The first of these covers part of the major natural coastal cell for coarse sediment transport between Flamborough and The Wash, and the second covers the southern section of this cell and the coastal cell between The Wash and Thames. The geographical boundaries of some groups may undergo adjustment to reflect the boundaries of the natural coastal cells.

10.3.4 Coastal fora

In some places wider coastal fora have developed from a range of coastal designations and various management initiatives. There are several of these operating in the region, with others likely to be established. The great value of these fora is that they bring all interest and user groups together and enable issues of concern to be examined from all points of view.

The two largest estuaries in the region, the Humber and The Wash, are the focus of much activity (Table 10.3.3). There are a number of interrelated initiatives under way in

Table 10.3.1 Local authority planning documents

Planning authority	*Title*	*Date*
East Yorkshire Borough Council	Bridlington Local Plan; review commenced 1991	1988
East Yorkshire Borough Council	Driffield Area Local Plan	1992
Holderness Borough Council	North and South East Holderness Local Plan	In prep.
Holderness Borough Council	South West Holderness Local Plan	1991
Holderness Borough Council	Holderness District Plan	1994
Kingston upon Hull District Council	Kingston-upon-Hull District Development Plan	Draft 1992
Humberside County Council	Approved Structure Plan & Humberside Structure Plan Alteration No. 1	1987, 1993
Great Grimsby Borough Council	Great Grimsby Local Plan	1994
Humberside County Council	Various local plans including those for Brandesburton Pits, coastal caravans and camping, and intensive livestock units	Various
Lincolnshire County Council	Lincolnshire Coast Local Plan	1986
Lincolnshire County Council	Reclamation on the Lincolnshire Coast Local Plan (unadopted)	1982
Lincolnshire County Council	Development on the Lincolnshire Coast: subject plan	1981
East Lindsey District Council	East Lindsey Local Plan	1993
Norfolk County Council	Norfolk to 2006 (draft Structure Plan)	In prep.
North Norfolk District Council	North Norfolk District Local Plan	1994

Table 10.3.2 Coastal groups in Region 6

Initiative name	*Scope/aims*	*Organisations involved*	*Contact address*
North East Coastal Authorities Group	Aims to improve coordination and liaison between agencies undertaking coastal works. Includes area to the north of Flamborough Head.	South Tyneside Metropolitan Borough Council and Sunderland, Easington, Langbaurgh, Scarborough and East Yorkshire Borough Councils	Scarborough Borough Council, Town Hall, St Nicholas Street, Scarborough YO11 2HG, tel: 01723 372351
Humber Estuary Coastal Authorities Group (HECAG)	Coordination between national and local authorities undertaking coastal defence. Covers area from Flamborough Head to Donna Nook. Preparing Shoreline Management Plan (autumn 1995).	East Yorkshire, Holderness Great Grimsby and Cleethorpes Borough Councils, Humberside County Council, East Lindsey District Council, NRA	*Eddie Knapp, Project Manager, Holderness Borough Council, Hull, tel: 01964 562333
Holderness Coast Protection Project	Aims to improve coordination and liaison between agencies undertaking coast protection.	Holderness Borough Council, Humberside County Council	*Principal Engineer, Holderness BC Development Dept., Hull, tel: 01964 562333
Anglian Coastal Authorities Group	Aims to improve coordination and liaison between agencies undertaking coastal works. Covers area from Donna Nook to the Thames.	Anglian NRA, English Nature, Cleethorpes BC, East Lindsey DC, King's Lynn and W. Norfolk BC, North Norfolk DC, Gt. Yarmouth BC, Waveney DC, Suffolk Coastal DC, Tendering DC, Maldon DC, Rochford DC, Southend DC	*T. Oakes, Waveney District Council, Lowestoft, tel: 01502 562111

* Starred contact addresses are given in full in the Appendix.

the Humber area, all of which are contributing towards an Estuary Management Plan within an emerging organisational framework. For example, English Nature appointed an Estuary Project Officer in January 1993 to initiate and assist in the preparation of an estuary management strategy for the Humber (see section 10.2.2). A coordinating panel of representatives of regulatory authorities has been established and their first task was to discuss and agree the way forward and to direct the work of the Project Officer in producing an Issues paper. The County Council is also managing and funding an annual Standing Conference, an Action Programme, and the Humberside Coast and Estuary Research Project (see Table 10.3.3).

A management strategy for The Wash was initiated in 1989. Several discussion papers on conservation and management topics have been published and others are in preparation. Local authorities have established a forum to discuss matters of mutual interest on The Wash and have agreed to take on the lead role in developing a management strategy. The English Nature Wash Estuary Project Officer will be working with the forum to prepare a Wash Strategy and Management Plan (consultation draft published 1994).

Table 10.3.3 Coastal fora and initiatives

Initiative name	*Scope/aims*	*Organisations involved*	*Contact address and telephone no.*
Humber Estuary Standing Conference	Annual meeting held as part of development of Humber Estuary management plan (see below). Implementation via Humberside CC Environment Team and NRA.	Humberside County Council Technical Services Dept. and NRA.	*Environment Team, Humberside County Council, Beverley, tel: 01482 884220
Humber Estuary Action Programme	Action Programme No. 2 published.	Humberside County Council Environment Team	*Environment Team, Humberside CC, Beverley, tel: 01482 884220
Humber Estuary Management Strategy (HEMS)	Steering Group, working party and topic groups set up. Intended to merge with NRA's catchment management plan.	Humberside CC, 7 District Councils, EN, NRA, BASC, RSPB, Associated British Ports, Hull University, Humber Chamber of Commerce, Humber Forum, Sports Council	*Lynette Evans, Estuary Project Officer, & Roger Mead, Chair of Steering group, EN Humber to Pennines Team, Wakefield, tel: 01924 387010
Cleethorpes Foreshore Management Strategy	State of the Environment report in preparation. Conflicts assessed and ways to reduce these evaluated. Several agencies undertaking work.	Cleethorpes Borough Council and others	*L. Unsworth, Cleethorpes Borough Council, Cleethorpes, tel: 01472 200200
The Wash Estuary Strategy and The Wash Forum	A management strategy was initiated by NCC in 1989 and several discussion papers were published on conservation and management topics. In 1992 local authorities agreed to lead in producing a management plan by working with other statutory bodies on a Wash Estuary Strategy Group. A draft strategy and a draft management plan were published for consultation in 1994. Implementation is expected in autumn 1995.	Norfolk and Lincolnshire County Councils, English Nature, Boston and King's Lynn & West Norfolk Borough Councils, South Holland and East Lindsey District Council, NRA, Eastern Sea Fisheries Joint Committee, port and harbour authorities, Internal Drainage Boards	*Graham L. King, Norfolk County Council, Norwich, tel: 01603 222959 *Peter Raspin, Lincolnshire County Council, Lincoln, tel: 01522 552222 *Ian Paterson, EN East Midlands Local Team, Grantham, tel: 01476 68431
Yorkshire and Lincolnshire Coastal Wildlife Plan	Aims to maximise the conservation, or where necessary restoration, of the natural integrity and wildlife interest of coastal habitats within the project area (Staithes - Gibraltar Pt.).	Lincolnshire Trust for Nature Conservation, Yorkshire Wildlife Trust, WWF UK and Institute of Estuarine and Coastal Studies (IECS), University of Hull	*Yorkshire Wildlife Trust, c/o University of Hull, tel: 01482 465667

* Starred contact addresses are given in full in the Appendix.

10.4 Further sources of information

A. References cited

Department of the Environment/Welsh Office. 1993a. *Development below low water mark: a review of regulation in England and Wales.* London, HMSO.

Department of the Environment/Welsh Office. 1993b. *Managing the coast: a review of coastal management plans in England and Wales and the powers supporting them.* London, HMSO.

Department of the Environment/Welsh Office. 1994. *The conservation (natural habitats etc.) regulations.* London, HMSO (SI 2716).

Department of the Environment/Welsh Office. 1992. *Planning policy guidance - coastal planning*. London, HMSO. (PPG 20.)

Earll, R.C., *ed.* 1994. *Statutory and non-statutory plans in the estuarine and coastal environment. Overlapping plans - is this an issue?* Unpublished report of a meeting in July 1994.

English Nature. 1992. *Caring for England's estuaries: an agenda for action.* Peterborough, English Nature.

English Nature. 1993. *Conserving England's maritime heritage - a strategy.* Peterborough, English Nature.

English Nature. 1994. *Managing England's marine wildlife.* Peterborough, English Nature.

Gubbay, S. 1990. *A future for the coast? Proposals for a UK coastal zone management plan*. Ross-on Wye, A report to the World Wide Fund For Nature from the Marine Conservation Society (unpublished).

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Ministry of Agriculture, Fisheries and Food/Welsh Office. 1993. *Strategy for flood and coastal defence in England and Wales.* London, MAFF.

National Rivers Authority. 1994. *Corporate Plan 1994/95.* Bristol, National Rivers Authority.

Rothwell, P.I.Y., & Housden, S.D. 1990. *Turning the tide, a future for estuaries.* Sandy, Royal Society for the Protection of Birds.

B. Further reading

Arkell, R. 1991. *Estuary development in the north-east of England: meeting the challenges of economic regeneration and environmental improvement*. Borough of Sunderland.

Blatchford, D., & Green, J. 1994. *Nature conservation and development plans: a review of good practice. Policy development, north-east England*. Newcastle, English Nature.

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Gubbay, S. 1994. *Seas: the opportunity. Working together to protect our marine life*. Sandy, Royal Society for the Protection of Birds.

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Jones, R. 1993. Coastal cell studies - a basis for coastal zone management. *Earth Science Conservation, 32:* 12-15.

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Wash Estuary Strategy Group. 1994. *Wash estuary management plan - draft.* Norwich, Norfolk County Council.

World Wide Fund for Nature UK. In prep. Coastal management plans. *Marine Update 18.* Godalming, World Wide Fund for Nature UK.

World Wide Fund for Nature UK. In prep. International commitments to integrated coastal zone management. *Marine Update 17.* Godalming, World Wide Fund for Nature UK.

Newsletters

Many national statutory, non-governmental and scientific bodies are now producing publications or newsletters on the subject of coastal management. These provide either information on particular local or national initiatives (such as the statutory or non-governmental organisations' estuaries and firths initiatives) or general information on a range of coastal news (for example the newsletters of Eurocoast UK and the European Union for Coastal Conservation). Some of these publications are listed below. Addresses of those publishing the newsletters are given in section 10.4 C.

Coastal News. Newsletter of the Coastal Research and Management Group. Publication intended to stimulate cooperation and communication between the many disciplines working in the coastal zone. Contains information on coastal management, reviews of publications and notices of meetings. Published by JNCC.

Coastline UK. Newsletter of the National Coasts and Estuaries Advisory group (NCEAG). Aimed at local authority planners. Published by NCEAG.

Coastline. Quarterly magazine of the European Union for Coastal Conservation (EUCC). Intended to establish a pan-European forum on coastal issues, including coastal management. Published by EUCC.

Coastline. The Bulletin of the Parliamentary All Party Coastal Group. Provides information summaries for MPs. Published by the All Party Coastal Group.

CZM News. Occasional Newsletter of Eurocoast UK, reporting on projects and developments in the field of coastal zone management. Published by Eurocoast UK.

Marine Scene. Occasional marine newsletter of the statutory conservation agencies in UK. Aimed at marine scientists, and users and regulators of the sea. Published by JNCC.

Wavelength. The Coastal Forum newsletter. Reports the work of the Forum to a wider audience. Published by the Department of the Environment.

National planning/management publications

DoE/Welsh Office. 1992. *Planning policy guidance - coastal planning*. London, HMSO. (PPG 20.) (Recognises the need to define a coastal zone incorporating areas affected by natural near-shore processes. Advises local authorities to consider the impacts of off-shore and on-shore developments within the full coastal zone. Endorses the precautionary approach.)

DoE/Welsh Office. 1993. *Development below Low Water Mark - a review of regulation in England and Wales*. London, HMSO. (Rejects the 1992 Environment Committee's recommendations for the extension of development controls off-shore. Seeks to strengthen existing arrangements to overcome limitations and draw-backs in the present land-use planning system.)

DoE/Welsh Office. 1993. *Managing the coast: a review of coastal management plans in England and Wales and the powers supporting them*. London, HMSO. (Includes proposals for coastal management plans to be based on a voluntary, multi-agency approach, generally led by local authorities.)

DoE/Welsh Office. In prep. *National coastal policy guidance statement*. (Government undertaking to produce this Statement made on 15 July 1994. Remit may go beyond PPG20 on coastal planning.)

House of Commons Environment Committee. 1992. *Second report - coastal zone protection and planning*. London, HMSO. (Recommended that coastal zone management be adopted as the framework for all coastal zone planning and management practice in the United Kingdom. Called for a national coastal strategy, a review of the many organisations responsible for the coast, the extension of planning controls offshore, and the establishment of a Coastal Zone Unit in Department of the Environment.)

MAFF. 1994. *Shoreline management plans.* (A procedural guide for operating authorities. 4th draft, July 1994.)

C. Contact names and addresses

(See also Tables 10.2.1 - 10.3.3.)

Organisation/group	*Activities*	*Contact address and telephone no.*
Coastal Forum	Launched in 1994 by the DoE, the Coastal Forum provides for an exchange of views on issues related to the coastal zone in England by a wide range of interested bodies, including central and local government, and conservation, commercial and recreation organisations. Forum proceedings are reported to government ministers.	Secretariat: Department of the Environment, Room 912, Tollgate House, Houlton Street, Bristol BS2 9DJ, tel: 0117 9878003
Coastal Research and Management Group (CR&MG)	Liaison between research workers and managers in the field of coastal ecology. Concentrates on research and management issues relevant to landscape and wildlife conservation along the coastal zone (marine and terrestrial).	*Coastal Technical Officers Group: Coastal Conservation Branch, JNCC Peterborough, tel: 01733 62626 (secretariat)
Coastal Technical Officers Group	The coastal group of the statutory conservation agencies (English Nature, Scottish Natural Heritage, Countryside Council for Wales, Department of the Environment for Northern Ireland, Joint Nature Conservation Committee and the Countryside Commission)	*Coastal Research and Management Group (CR&MG), Coastal Conservation Branch, JNCC, Peterborough tel: 01733 62626
English Coastal Groups Forum	Established by MAFF in 1991. Coordinates the work of the English Coastal Groups; promotes the formation of coastal groups; acts as a link between centrally-based organisations and coastal groups; promotes sustainable coastal management and common standards. Forum members include one representative from each coastal group, the National Rivers Authority, Local Authority Associations, English Nature, British Rail/Railtrack and Department of the Environment.	Head of Flood and Coastal Defence Division, MAFF, Eastbury House, 30/34 Albert Embankment, London SE1 7TL, tel: 0171 238 6660
English Nature	Management of designated coastal sites; nature conservation and development planning; Estuaries Initiative; Sensitive Marine Areas; Maritime Natural Areas	*English Nature, Northminster House, Peterborough, tel: 01733 340345
Eurocoast UK	The Eurocoast Association aims to improve the basis for protection, development and management of the coastal zone. Primarily a communication network.	Eurocoast UK, Burderop Park, Swindon, Wiltshire SN4 0QD, tel: 01793 812479
European Union for Coastal Conservation (EUCC)	International grouping of organisations and individuals with an interest in coastal nature conservation matters, including coastal management. The CR&MG (see above) is the core of the UK branch of EUCC.	European Union for Coastal Conservation (EUCC) Secretariat, PO Box 11059, NL-2301 EB Leiden, tel: +31 71 122900/123952
Coastal Heritage Forum	Funded by the Countryside Commission. Provides up to date factual information on 45 Heritage Coasts in England and Wales. Provides contact between individuals and groups concerned with the management of Heritage Coasts in England and Wales.	Coastal Heritage Forum, Centre for Environmental Interpretation, The Manchester Metropolitan University, St Augustines, Lower Chatham Street, Manchester M15 6BY, tel: 0161 247 1067
Joint Nature Conservation Committee - Coastal Conservation Branch	Information and advice on coastal management initiatives. Publishes *Coastal News*, aimed at stimulating cooperation and communication between those involved with the coast.	*Joint Nature Conservation Committee, Peterborough, tel: 01733 866825
Joint Nature Conservation Committee - Marine Conservation Branch	Information and advice on marine issues. Publishes *Marine Scene*, which summarises marine conservation news from the JNCC, Scottish Natural Heritage, English Nature and the Countryside Council for Wales.	*Joint Nature Conservation Committee, Peterborough, tel: 01733 866833
Les Esturiales Environmental Study Group	International programme for cooperation, the exchange of experience on estuarine management and personal contacts between local authority practitioners in Europe.	Esturiales Environmental Study Group, Professor Graham King, Swansea Institute of Higher Education, Faculty of Leisure and Tourism, Mount Pleasant Campus, Swansea SA1 6ED, tel: 01792 456326
Marine Conservation Society	Provides advice and supports local coastal management initiatives: runs grant-aided coastal management workshops and courses for coastal managers; promotes the establishment of voluntary coastal groups.	*Marine Conservation Society, Ross-on-Wye, tel: 01989 566017

C. Contact names and addresses

(See also Tables 10.2.1 - 10.3.3.)

Organisation/group	*Activities*	*Contact address and telephone no.*
Marine Forum	National network provides forum for discussion of marine issues relating to the seas around UK. Members include governmental and non-governmental organisations and individuals. Occasional seminars are held, covering a range of topics including coastal management.	Marine Forum, Natural History Museum, Cromwell Road, London SW7 5BD, tel: 0171 938 9114
Ministry of Agriculture, Fisheries and Food	Shoreline Management Plans (mainly aimed at formulating a coast protection strategy)	*MAFF Flood and Coastal Defence Division, Eastbury House, London, tel: 0171 238 3000
National Coasts and Estuaries Advisory Group (NCEAG)	On behalf of local authorities, provides advice on sustainable management of coastal and estuarine environments; published guide to good practice (NCEAG 1993)	Secretary, National Coasts and Estuaries Advisory Group (NCEAG), Environment Programme, Kent County Council, Springfield, Maidstone ME14 2LX, tel: 01622 696180
National Rivers Authority	Catchment management planning, five-year programme, sea defences, shoreline management plans	*Flood Defence Section, NRA HQ, Bristol, tel: 01454 624400, or *NRA Northumbria/Yorkshire Region, Leeds, tel: 0113 244 0191, or *NRA Anglian Region, Peterborough, tel: 01733 371811
National Trust	Has extensive coastal land holdings in the region (see section 7.5.1). Recently carried out a complete review of its Coastal Strategy Plans; has an ongoing review of coastal site management plans.	The National Trust Yorkshire Region, Goddards, 27 Tadcaster Road, Dringhouses, York YO2 2QG, tel: 01904 702021, or The National Trust Northumbria Region, Scots' Gap, Morpeth, Northumberland NE61 4EG, tel: 01670 74691
Royal Society for the Protection of Birds	Launched national campaign in 1990 to promote the importance of estuaries in the UK. Monitors the development of coastal zone initiatives around the UK. In 1994, launched Marine Life campaign, to increase awareness and to promote integrated coastal and marine management. Manages some coastal nature reserves.	*Coastal Policy Officer, RSPB HQ, Sandy, tel: 01767 68055
World Wide Fund for Nature - UK	Provides funding for research, local voluntary policy development and local initiatives, and publications on integrated coastal management. Draws on considerable international experience with coastal management initiatives.	*World Wide Fund for Nature - UK, Godalming, tel: 01483 426444

Addresses and telephone numbers of local planning authorities are given in full in the Appendix, as are * starred contact addresses.

Appendix

A.1 Frequently cited contact names and addresses

Name	*Contact address and telephone no.*
Countryside Commission, (CC) HQ	John Dower House, Crescent Place, Cheltenham, Gloucestershire GL50 3RA, tel: 01242 521381
CC Eastern Region	Ortona House, 110 Hills Road, Cambridge CB2 1LQ, tel: 01223 354462
CC, Yorkshire & Humberside Region	2nd Floor, Victoria Wharf, Embankment IV, Sovereign Street, Leeds LS1 4BA, tel: 0113 246 9222
Department of the Environment (DOE), European Wildlife Division/Dept. Rural Affairs	DoE, Room 9/03B, Tollgate House, Houlton Street, Bristol BS2 9DJ, tel: 0117 9878811
DOE Water Resources and Marine	Romney House, 43 Marsham Street, London SW1P 3PY, tel: 0171 276 0900
English Nature (EN), HQ	Northminster House, Peterborough PE1 1UA, tel: 01733 340345
EN, Beds., Cambs., Northants. Team	Ham Lane House, Ham Lane, Orton Waterville, Peterborough PE2 5UR, tel: 01733 391100
EN, East Midlands Team	The Maltings, Wharf Road, Grantham NG31 6BH, tel: 01476 68431
EN, Humber to Pennines Team	Bullring House, Northgate, Wakefield, West Yorkshire WF1 3BJ, tel: 01924 387010
EN, Norfolk Team	60 Bracondale, Norwich NR1 2BE, tel: 01603-620558
EN, North and East Yorkshire Team	Institute for Applied Biology, University of York, York YO1 5DD, tel. 01904 432700
Institute of Terrestrial Ecology (ITE)	Abbots Ripton, Huntingdon, Cambridgeshire PE17 2LS, tel: 01487 773381
ITE, Merlewood	Windermere Road, Grange-over-Sands, Cumbria LA11 6JU, tel: 01539 532264
Joint Nature Conservation Committee (JNCC), HQ	Monkstone House, City Road, Peterborough, Cambs. PE1 1JY, tel: 01733 62626
JNCC, Seabirds at Sea Team	Seabirds and Cetaceans Branch, JNCC, 17 Rubislaw Terrace, Aberdeen AB1 1XE, tel: 01224 642863
Ministry of Agriculture, Fisheries and Food (MAFF) Directorate of Fisheries Research (DFR), Fisheries Laboratory, Conwy	Benarth Road, Conwy, Gwynedd LL32 8UB, tel: 01492 593883
MAFF DFR, Fisheries Laboratory, Lowestoft	Pakefield Road, Lowestoft, Suffolk NR33 OHT, tel: 01502 562244

Name	*Contact address and telephone no.*
MAFF DFR, Fisheries Laboratory, Burnham-on-Crouch	Remembrance Avenue, Burnham-on-Crouch, Essex CM0 8HA, tel: 01621 782658
MAFF Flood and Coastal Defence Division	Eastbury House, 30/34 Albert Embankment, London SE1 7TL, tel: 0171 238 3000
National Rivers Authority (NRA), HQ	Rivers House, Waterside Drive, Aztec West, Almondsbury, Bristol BS12 4UD, tel: 01454 624400
NRA, Anglian Region	Kingfisher House, Goldhay Way, Orton Goldhay, Peterborough PE2 5ZR, tel: 01733 371811
NRA, Northumbria and Yorkshire Regional Office	Rivers House, Park Square South, Leeds LS1 2QG, tel: 0113 244 0191
Lincolnshire Trust for Nature Conservation	Banovallum House, Manor House Street, Horncastle, Lincolnshire LN9 5HF tel: 01507 526667
Norfolk Wildlife Trust	72 Cathedral Close, Norwich, Norfolk, NR1 4DF, tel: 01603 625540
Wildlife Trust for Beds., Cambs., Northants. & Peterborough	Enterprise House, Maris Lane, Trumpington, Cambridge CB2 2LE, tel: 01223 846363
Yorkshire Wildlife Trust	10 Toft Green, York YO1 1JT, tel: 01904 659570 or c/o Institute of Estuarine and Coastal Studies, University of Hull, Hull HU6 7RX tel: 01482 465667
British Trust for Ornithology	The Nunnery, Nunnery Place, Thetford, Norfolk IP24 2PU, tel: 01842 750050
Marine Conservation Society	9 Gloucester Road, Ross-on-Wye, Herefordshire HR9 5BU, tel: 01989 566017
National Trust, HQ	33 Sheep Street, Cirencester, Gloucestershire GL7 1QW, tel: 01285 651818
National Trust, East Anglia Regional Office	Blickling, Norwich, Norfolk NR11 6NF, tel 01263 733471
Royal Society for the Protection of Birds (RSPB), HQ	The Lodge, Sandy, Bedfordshire SG19 2DL, tel: 01767 680551
RSPB, North England Office	4 Benton Terrace, Newcastle upon Tyne, NE2 1QU, tel:-0191 281 3366
RSPB, East Anglia Office	Stalham House, 65 Thorpe Rd, Norwich, Norfolk NR1 1UD, tel: 01603 660066
RSPB, East Midlands Office	The Lawn, Union Road, Lincoln LN1 3BU, tel: 01552 535596
Wildfowl & Wetlands Trust (WWT), HQ	Slimbridge, Gloucestershire GL2 7BX, tel: 01453 890333
Worldwide Fund For Nature - UK (WWF-UK)	Panda House, Weyside Park, Cattershall Lane, Godalming, Surrey GU7 1XR, tel: 01483 426444

A.2 Local planning authorities, ports and harbour authorities addresses

Name	*Address and telephone no.*
Beverley (E. Yorks) Borough Council	The Hall, Lairgate, Beverley, East Yorkshire HU17 8HL, tel: 01482 882255
Boothferry Borough Council	Council Offices, Church Street, Goole, North Humberside DN14 5BG, tel: 01405 765141
Boston Borough Council	Municipal Buildings, Boston, Lincolnshire PE21 8QR, tel: 01205 357400
Port of Boston Authority	Dock Office, The Docks, Boston, Lincs. PE21 6BN, tel: 01205 65571
Cleethorpes Borough Council	Civic Offices, Cleethorpes, South Humberside DN35 8LN, tel: 01472 200200
East Lindsey District Council	Tedder Hall, Manby, Lincolnshire LN11 8UP, tel: 01507 601111
East Yorkshire Borough Council	Town Hall, Bridlington, North Humberside YO16 4LP, tel: 01262 679151
Port of Fosdyke Ltd	Fosdyke Bridge, Boston, Lincs. PE20 2DB, tel: 01205 85240
Glanford Borough Council	Council Offices, Station Road, Brigg, South Humberside DN20 8EG, tel: 01652 652441
Goole port	Associated British Ports (Goole), East Parade, Goole, North Humberside DN14 5RB, tel: 01505 32691/5
Great Grimsby Borough Council	Devonshire House, Bull Ring Lane, Great Grimsby DN31 1ES, tel: 01472 242000
Grimsby and Immingham ports	Associated British Ports (Grimsby and Immingham), Port Office, Grimsby, South Humberside DN31 3LL, tel: 01472 359181
Great Yarmouth Borough Council	Town Hall, Great Yarmouth, Norfolk NR30 2QF, tel: 01493 856100
Great Yarmouth Port and Haven Commissioners	20-21 South Quay, Great Yarmouth, Norfolk NR30 2RE, tel: 01493 855151
Holderness Borough Council	Skirlaugh, Hull HU11 5HN, tel: 01964 562333
Hull City Council	Guildhall, Hull, North Humberside HU1 2AA, tel: 01482 223111
Hull port	Associated British Ports (Hull), PO Box 1, Port House, Corporation Road, Hull HU9 5PQ, tel: 01482 27171
Humberside County Council	County Hall, Beverley, North Humberside HU17 9XA, tel: 01482 867131
King's Lynn and West Norfolk Borough Council	King's Court, Chapel Street, King's Lynn, Norfolk PE30 1EX, tel: 01553 692722
King's Lynn Conservancy Board	Harbour Office, Common Staith, King's Lynn, Norfolk PE30 1LL, tel: 01553 34451
King's Lynn port	Associated British Ports (King's Lynn), St Ann's Fort, King's Lynn PE30 2EU, tel: 01553 691555
Lincolnshire County Council	Lincolnshire County Council, County Offices, Newland, Lincoln LN1 1YL, tel: 01522 552222
Norfolk County Council	County Hall, Martineau Lane, Norwich NR1 2DH, tel: 01603 222959
North Norfolk District Council	Council Offices, Cromer, Norfolk NR27 9EL, tel: 01263 513811
North Yorkshire County Council	County Hall, Northallerton DL7 8AD, tel: 01609 780780
South Holland District Council	Council Offices, Priory Road, Spalding, Lincs. PE11 2XE, tel: 01775 711253
Waveney District Council	Mariners Street, Lowestoft, Suffolk NR32 1JT, tel: 01502 562111
Wisbech port	Fenland District Council (Wisbech Port), Port Manager's Office, Nene Parade, Wisbech, Cambs. PE15 8NQ, tel: 01945 61369

A.3 Core reading list

There are a number of important publications that either provide information on a variety of topics covered in these regional reports (and so are frequently referred to) or give a good overview of regional and national information on coasts and seas. They are listed below.

Barne, J., Davidson, N.C., Hill, T.O., & Jones, M. 1994. *Coastal and marine UKDMAP datasets: a user manual.* Peterborough, Joint Nature Conservation Committee.

British Oceanographic Data Centre. 1992. *UKDMAP (United Kingdom Digital Marine Atlas).* Birkenhead, BODC. (Computer software.)

Davidson, N.C., Laffoley, D.d'A., Doody, J.P., Way, L.S., Gordon, J., Key, R., Drake, M.C., Pienkowski, M.W., Mitchell, R., & Duff, K.L. 1991. *Nature conservation and estuaries in Great Britain.* Peterborough, Nature Conservancy Council.

Doody, J.P., Johnston, C., & Smith, B. 1993. *The directory of the North Sea coastal margin.* Peterborough, JNCC.

Eno, N.C., *ed*. 1991. *Marine conservation handbook.* 2nd ed. Peterborough, English Nature.

Gubbay, S. 1988. *A coastal directory for marine conservation.* Ross-on-Wye, Marine Conservation Society.

Lee, A.J., & Ramster, J.W. 1981. *Atlas of the seas around the British Isles.* Lowestoft, MAFF.

North Sea Task Force. 1993. *North Sea quality status report 1993.* London; Oslo and Paris Commissions.

North Sea Task Force. 1993. *North Sea quality status report 1993. Report on Subregion 3b.* Lowestoft, Ministry of Agriculture Fisheries and Food Fisheries Laboratory.

Robinson, A., & Millward, R. 1983. *The Shell book of the British coast*. Newton Abbot, David and Charles.

Steers, J.A. 1964. *The coastline of England and Wales*. Cambridge, Cambridge University Press.

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