



Coasts and seas of the United Kingdom

Region 8 Sussex: Rye Bay to Chichester Harbour

edited by
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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, the Department of the Environment (Northern Ireland), the Environment Agency, the Countryside Commission, the Welsh Office, the Department of the Environment (now the Department of the Environment, Transport and the Regions), 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 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 Region 7 and sets the region in a national context.
- **Important locations and species:** gives more detail on the features of the region 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 8') 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 are available. Coverage is usually either coastal 10 km squares, sites within 1 km of Mean High Water Mark, or an offshore area that may extend out to the median line between the UK and neighbouring states.

'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 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 up-to-date as possible at the time of publication. 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.

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Arco British Ltd ¹	Isle of Man Government, Department of Industry
Ards Borough Council	Isle of Man Government, Department of Local
Avon County Council	Government & the Environment
Banff and Buchan District Council	Isle of Man Government, Department of Transport
Belfast City Council	Kyle and Carrick District Council
BHP Petroleum Ltd ¹	Lancashire County Council
Centre for Environment, Fisheries & Aquaculture Sciences	Lincolnshire County Council
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Cleveland County Council	Newtownabbey Borough Council
Clwyd County Council	Norfolk County Council
Clyde River Purification Board	North Cornwall District Council
Colwyn Borough Council	North East Fife District Council
Copeland Borough Council	Nuclear Electric plc
Countryside Commission	Preseli Pembrokeshire District Council
Countryside Council For Wales	Restormel Borough Council
Cumbria County Council	Samara Consulting
Cunninghame District Council	SCOPAC (Standing Conference on Problems Associated with
Delyn Borough Council	the Coastline)
Department of the Environment (DoE)	Scottish Natural Heritage
DoE (Northern Ireland) Environment & Heritage Service	Scottish Office Agriculture, Environment and Fisheries
DoE (Northern Ireland) Water Service	Department
Derry City Council	Scottish Salmon Growers Association Ltd
Devon County Council	Sefton Borough Council
Dorset County Council	Shepway District Council
Down District Council	Solway River Purification Board
Dumfries and Galloway Regional Council	Somerset County Council
Dyfed County Council	South Pembrokeshire District Council
Eastbourne Borough Council	Standing Conference on Regional Policy In South Wales
English Nature	Stroud District Council
Environment Agency	Tayside Regional Council
Essex County Council	Torridge District Council
Fife Regional Council	UK Offshore Operators Association ²
Forest of Dean District Council	Vale of Glamorgan Borough Council
Gwynedd County Council	Water Services Association
Hampshire County Council	Welsh Office
Highland River Purification Board	World Wide Fund for Nature (UK)
Humber Forum	

Notes

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

² 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.

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Pagham Harbour, West Sussex, is one of only two large estuaries in the region (the other being Chichester Harbour). A Ramsar site and Special Protection Area, it is a renowned locality for waterfowl: in winter it supports an internationally important population of dark-bellied brent geese (pictured); in autumn large numbers of spotted redshank and greenshank rest and feed here during their migration south, and dunlin gather on the shores to moult into their winter plumage. Photo: Peter Wakely, English Nature.

Chapter 1 Overview

1.1 The Coastal Directories Project

Dr J.P. Doody

1.1.1 Introduction

Developing sound policies for coastal environmental management depends on wide ranging contextual information being available. Collecting such information is always time-consuming and difficult, especially ensuring that all relevant aspects are covered.

This problem is widely recognised. Nevertheless the solution - amassing the encyclopaedic knowledge required, collating it in useable form and disseminating it to potential users while the information is still current - has until recently been too daunting a project for any single organisation to tackle. However, with the help of sponsorship from a large number of organisations and support and practical help from many bodies, ranging from government departments to voluntary organisations, and using numerous experts as writers and consultees, the Joint Nature Conservation Committee undertook to prepare such a compendium of information for the coast of the whole United Kingdom.

This undertaking - the Coastal Directories Project - collates existing information on the United Kingdom and Isle of Man coastal zone to provide national and regional overviews of its natural resources and human activities, and indexes more detailed sources of information. The project uses a broad definition of the coastal margin that encompasses all the main habitats from offshore waters through to dry land, including any habitat forming part of the functioning coastal system; in addition areas of former tidal land now enclosed from the sea and lowland wet grassland alongside tidal rivers are included. At times it can be either unhelpful or impossible to set precise limits on the geographic areas that need to be covered, for example in the marine environment, such as when discussing fisheries or sources of contamination. However, where possible, coverage is of coastal 10 km squares, or sites within one kilometre of Mean High Water Mark, or (for marine topics) from the landward limit of high tides out to the median line between the UK and neighbouring states. Areas inland of these limits are not included unless specifically stated.

The relationships between the many and varied components of the coastal zone, that is, between the physical functioning of the zone, its biological components and the human activities that take place there, are complex. With this in mind, a wide-ranging approach to collating coastal information was adopted in the project; information was drawn from many sources, from national databases and nation-wide published surveys to the personal observations of field specialists and the newsletters of amateur societies. The approach also served to highlight the interactions and interdependence between the environmental components (and between the various bodies and individuals) involved. This should help to ensure that users of the information

develop policies and adopt strategies that secure the integrated, sustainable use and management of the coastal zone while maintaining biological diversity - a key element of Agenda 21 of the Rio Earth Summit in 1992.

1.1.2 Origins and early development of the project

The concept of providing integrated coastal information took a long time to evolve into the Coastal Directories Project. As early as 1984, the need for such data was acknowledged at the first International Conference on the Protection of the North Sea. In 1987, recognising the significant gaps that existed in the scientific understanding of the North Sea, the Second International Conference on the Protection of the North Sea established the North Sea Task Force (NSTF). Under the guidance of the International Council for the Exploration of the Sea (ICES) and the Oslo and Paris Commissions, the NSTF organised a programme of study with the primary aim of producing a (mainly marine) assessment of the North Sea (the *North Sea Quality Status Report (QSR)*) by 1993.

In 1989, at the second meeting of the NSTF, the UK suggested that the North Sea QSR should include consideration of terrestrial habitats and species. This was to involve the collection of information dealing with the coastal margin of the North Sea (defined as being east of longitude 5° West - i.e. from Cape Wrath in northern Scotland around the North Sea and the English Channel coasts to the Fal Estuary in Cornwall) and the collation of this information into book form. A project was set up by the Nature Conservancy Council (NCC) and, after 1991, the Joint Nature Conservation Committee (JNCC), to produce this information, with part funding from the Department of the Environment (DoE). A small group was invited to steer the project and to help identify information sources, including the DoE, the Ministry of Agriculture, Fisheries and Food (MAFF), the National Rivers Authority (NRA) (now the Environment Agency (EA)), the Countryside Commission (CC), the Scottish Office (SO), the Welsh Office (WO) and the country conservation agencies (English Nature, Scottish Natural Heritage (SNH) and Countryside Council for Wales (CCW)). With its help, a draft text was prepared in 1990-91; the resulting *Directory of the North Sea coastal margin* - the first product of the Coastal Directories Project, as it was to become - was presented to Ministers at the Intermediate Ministerial Meeting on the North Sea held in Denmark in December 1993 (Doody *et al.* 1993).

The principal aims of the *Directory* were to produce “a comprehensive description of the North Sea coastal margin, its habitats, species and human activities, as an example to other

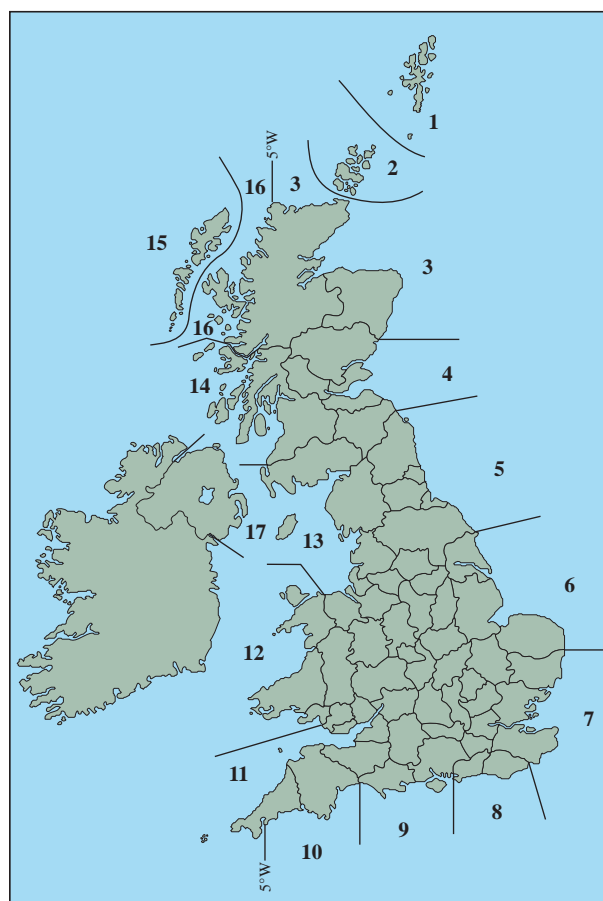
North Sea states" (North Sea Task Force 1993), and thus to help to ensure that terrestrial habitats and species were considered in the QSR. In this it succeeded, and the QSR, also published in 1993, included descriptions of terrestrial habitats and species in several of the sub-regional reports, together with comments on the human impacts on the ecosystems.

The North Sea Task Force was wound up in December 1993, following completion of the *North Sea QSR*, and its work is now carried on by 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). This convention requires that assessments similar to the North Sea QSR be produced for all the constituent parts of the north-east Atlantic, and for that area as a whole, by the year 2000. The Celtic Seas, including the Irish Sea and the west coast of Britain, are one of the first areas to be subject to assessment.

In the UK during the period 1990 - 1993 there was a considerable upsurge of interest in the principles of coastal zone management. For example, between November 1991 and February 1992 the House of Commons Environment Committee examined the issues for England and published their report on *Coastal zone protection and planning* in March 1992 (House of Commons Environment Committee 1992). This report, together with initiatives at UK and European levels, encouraged a more integrated, local approach to management issues. At the same time, as the work on the *Directory of the North Sea coastal margin* proceeded, the emphasis of the approach changed. The main aim had been the collection of information, but gradually the process of working with people to gather the data threw the spotlight more on the benefits of a partnership approach and its value for promoting coastal zone management, with which the Coastal Directories Project became more directly linked.

1.1.3 Recent developments

These developments in coastal management fostered interest in the Coastal Directories Project and increased demand for information at a regional level, as well as at the level of whole seaboard (the approach adopted for the *Directory of the North Sea coastal margin*). In 1992, therefore, it was proposed to produce a *West Coast Directory* to cover the remainder of the coast of Great Britain, the Isle of Man and, by later agreement, Northern Ireland, as well as a series of regional volumes to cover the whole of the coast of the UK. Regions were defined, wherever possible, by the current local or national government coastal boundaries that most closely approximated to the limits of major coastal process cells (see [section 2.4](#)), to ensure that pragmatic management requirements were matched by an ecologically coherent information base. Volumes covering all seventeen regions have now been published: the areas that they cover are shown on [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 west coast of the United Kingdom and the Isle of Man. These regional volumes provide a more detailed level of information than the *Directory of the North Sea coastal margin*, to help set each region in a national context and facilitate the preparation of regional plans. Discussions in the main steering group (see below) in January 1994 resulted in a decision to make the completion of the regional volumes the priority, rather than the overview *West Coast Directory*. At the meeting of the main



Map 1.1.1 Regions in the series. Region names are given in [Table 1.1.2](#).

steering group in February 1996 it was decided not to publish the *West Coast Directory* at all, as it would duplicate material already published in the regional volumes.

Whereas work for the *Directory of the North Sea coastal margin* was funded principally by the DoE and the NCC/JNCC, it was decided to seek funding for the extended project from a consortium of private organisations and public bodies, including the original steering group members, as well as coastal local authorities (see page 7). In the event more than 200 organisations, from government departments and oil, water and power companies to nature conservation organisations, both statutory and voluntary, contributed either money or information or both to the project. Those organisations that contributed money - the funding consortium - and a number of others comprise the main steering group, and from this group a smaller number were identified to form the core steering group ([Table 1.1.1](#)).

Interest in the project was reflected in the level of sponsorship that the project received and in the commitment shown by members of the steering groups, which met regularly. The main steering group met annually for a seminar: it considered the *Role of the Directories in the development of coastal zone management* (January 1994); *Use of electronic storage and retrieval mechanisms for data publication* (February 1995); and *The tide turns for coastal management: Coastal Directories users report back on their experiences* (February 1997). The final meeting in February 1997 discussed future options for developing the project, including the possibility of providing access to the information in the form of a multi-media CD-ROM. Consideration is being given to producing a

Table 1.1.1 Coastal Directories project management structure

<i>Group</i>	<i>Role</i>	<i>Undertaken by</i>
JNCC Coastal Directories Project Team	Day to day management	Head of Team, project coordinators
Project management board	Liaison & executive decisions	Country conservation agencies (English Nature, Scottish Natural Heritage, Countryside Council for Wales), JNCC Coastal Directories Project Team, Department of the Environment (Northern Ireland)
Core steering group	Steer work, provide information and support	See page 2
Main steering group (includes, amongst others, all funding consortium members)	Review progress, consider new developments, provide expert advice and act as consultees	All members, through an annual steering group seminar and individually

companion volume to the North Sea Directory, for the Celtic Seas. In addition the core steering group also met at least annually.

1.1.4 The contribution of the project to coastal management

At the outset it was agreed that the work should involve as many as possible of the individuals and organisations concerned with the use of the coastal margin, to reflect the complex nature of the habitats and species and the wide-ranging influence of human activities. As the project evolved, the value of this approach was highlighted by the extent to which new approaches and information sources were identified. The dialogue between the Coastal Directories Project funding consortium members confirmed the importance of the project in providing basic resource information to support new approaches to coastal management.

Increasingly, the regional volumes are seen as providing

essential information to inform the development of coastal zone management policy at a national level. They provide information that complements the approach currently being promoted by a range of government reports. These include PPG 20: *Planning Policy Guidelines: coastal planning* (DoE/Welsh Office 1992), the *Policy guidelines for the coast* (DoE 1995) and the two consultation documents that followed up the House of Commons Environment Committee report: *Development below low water mark* (DoE/Welsh Office 1993) and *Managing the coast* (DoE/Welsh Office 1993) (note that these reports do not cover Scotland, Northern Ireland or the Isle of Man). MAFF too has promoted the setting up of flood and coastal defence 'coastal cell groups', to encourage sustainable shoreline management.

It has also been recognised that the summary information in the regional volumes 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 draft regional reports for most of the potential licensing areas in the 16th Offshore Oil and Gas Licensing Round in 1994.

Table 1.1.2 Titles and publication dates of products of the Coastal Directories Project

<i>Product</i>	<i>Publication date</i>
Book editions	
Directory of the North Sea coastal margin	1993
Region 1. Shetland	1997
Region 2. Orkney	1997
Region 3. North-east Scotland: Cape Wrath to St. Cyrus	1996
Region 4. South-east Scotland: Montrose to Eyemouth	1997
Region 5. North-east England: Berwick-on-Tweed to Filey Bay	1995
Region 6. Eastern England: Flamborough Head to Great Yarmouth	1995
Region 7. South-east England: Lowestoft to Dungeness	1998
Region 8. Sussex: Rye Bay to Chichester Harbour	1998
Region 9. Southern England: Hayling Island to Lyme Regis	1996
Region 10. South-west England: Seaton to the Roseland Peninsula	1996
Region 11. The Western Approaches: Falmouth Bay to Kenfig	1996
Region 12. Wales: Margam to Little Orme	1995
Region 13. Northern Irish Sea: Colwyn Bay to Stranraer including the Isle of Man	1996
Region 14. South-west Scotland: Ballantrae to Mull	1997
Regions 15 & 16. North-west Scotland: the Western Isles and west Highland	1997
Region 17. Northern Ireland	1997
Electronic editions	
Coastal and marine UKDMAP datasets: Version 1	1994
Regions 3, 5, 6, 9, 10, 11, 12, 13	1996
Regions 1, 2, 4, 7, 8, 14, 15 & 16, 17	Due 1998

1.1.5 Outputs

The regional volumes have been published as hardback books. In addition, a first release of coastal conservation data, covering national surveys of terrestrial habitats and coastal Sites of Special Scientific Interest (SSSIs), and a second release of marine conservation data, covering marine benthic surveys, have been published in electronic format (Barne *et al.* 1994) compatible with UKDMAP, the electronic atlas developed by the British Oceanographic Data Centre, Birkenhead (BODC 1992). Electronic editions of the published regional volumes are also being made available. The publication dates of book and electronic editions is shown in [Table 1.1.2](#).

1.1.6 Further sources of information

A. References cited

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- Scottish Office Agriculture, Environment and Fisheries Department. 1996. *Scotland's coast: a discussion paper*. Edinburgh, HMSO.

B. Further reading

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

C. Contact names and addresses

Type of information	Contact address and telephone no.
Information about UKDMAP	*Coastal Data Custodian, JNCC, Peterborough, tel: 01733 562626
Sales outlet for book editions of the regional volumes, the <i>Directory of the North Sea coastal margin</i> and other JNCC publications	NHBS Ltd, 2-3 Wills Road, Totnes, Devon TQ9 5XN, tel: 01803 865913

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

1.2 Introduction to the region

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 8 covers the counties of East and West Sussex on the south coast of England. The coast is 285 km long, which is 5.2% of the total coastline of England and 2.4% of that of Great Britain. In much of the region the solid geology is overlain by gravel, sand and clay deposits that are post-glacial in origin (<10,000 years old). The soft cliffs near Hastings are formed from sandstones, siltstones and clays of Lower Cretaceous age, while the South Downs, which are never more than 260 m high, form vertical cliffs between Eastbourne and Brighton. River valleys cut through the Downs and a series of low-lying areas of land (known as 'levels') lie behind the small estuaries that punctuate the coast.

The coastal zone is one of the most densely urbanised in the UK, a reflection of the intensity of the tourist industry, which has developed over the last 150 years. The hinterland has a mixed landscape including downland, much of which is now under intensive agriculture, along with grazing pasture, market gardens and woodland. Littoral processes along the coastline are extremely dynamic and erosion and accretion have been major determinants of the present configuration of the coast. There are significant stretches of coastal defence, built to prevent erosion or flooding. Several of the estuaries have small ports, Newhaven and Shoreham being the largest. The proximity of the region to the continent has resulted in a rich archaeological and historical legacy, with numerous forts and other features.

1.2.2 Structure and landscape

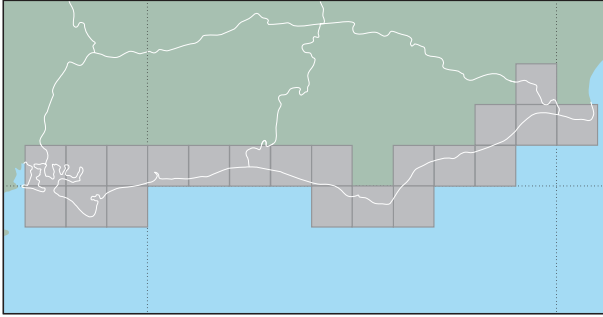
The whole coastline is underlain by rocks of the Cretaceous Period (144-65 million years old). These rocks are some of the oldest in south-east England, although they are young compared with much of the rest of the UK. Rocks from the Lower Cretaceous period are exposed in the east of the region, where the cliffs at Fairlight are formed from sandstones, siltstones and clays. Chalk, of Upper Cretaceous age, forms the South Downs and outcrops on the coast at Beachy Head and the Seven Sisters. In recent geological times siltation of the river plains helped to create the Sussex levels, such as those around Pett and Pevensey. Deposition of sand and gravel derived from cliff erosion has helped to form the shingle shores and sand dunes around Rye Harbour in the east and Pagham and Chichester in the west.

The processes of erosion and accretion continue and rapid rates of coastal retreat are prevalent, particularly in the chalk cliffs, where several metres may be lost annually in places. Erosion and the resulting movement of sediment along the shore continue the development of sedimentary coastal habitats such as sand and shingle bars, although artificial coastal defences have tended to restrict this natural mobility. Extensive areas of tidal flats and saltmarshes remain in Chichester and Pagham Harbours, though most other intertidal areas have been extensively enclosed and drained for agricultural use.

Offshore the land shelves gently to a depth of 40 m, where the depth increases suddenly, marking the line of a submerged cliff. The geological sequence offshore is similar to that onshore, although there are also deposits of Pleistocene age formed from river systems present during periods of lower sea level. More recent sediments include sand and gravel



Map 1.2.1 Rivers, major towns and other coastal locations in the region



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

deposits, which form sand waves with gravel or rock surfaces in between. Although generally the sand deposits form a relatively thin layer, in places they are up to 20 m thick, for example off Beachy Head. In Rye Bay and to the west of Selsey Bill the sea is shallow and sediments are generally muddy.

1.2.3 The natural environment

The sea and sea bed

The shores of both East and West Sussex are mostly of mobile shingle, formed of rounded flint pebbles, with occasional patches of muddy sand, particularly on the lower part of the shore. Between Brighton and Eastbourne, at the base of the impressive chalk cliffs, extensive wave-cut chalk platforms occur, extending up to 500 m from the shore. Sussex is the only location in the British Isles where chalk appears as offshore cliffs as well as reefs. However, below low water mark the sea bed is mainly of mixed sediments and sand, though there are also sandstone and limestone reefs of bedrock and boulders; chalk and clay exposures; mud (within harbours, estuaries and marinas); and wrecks - the Sussex coast has more 'modern' wrecks lying off it than almost any other part of Britain's coastline.

The areas of hard substrate off the region's coast support rich communities of seaweeds and invertebrate populations including rock-boring bivalves, polychaete worms and sponges. Fifty-one fish species have been recorded in the seas off this region, and there are spawning areas for exploited species such as mackerel, herring, cod, plaice, Dover sole and bass. Salmon are present in coastal waters and occasionally in the region's rivers, but sea trout and eels are more common. In addition the region has locally important exploited populations of lobsters, edible crabs, spider crabs, scallops and whelks.

Only nine species of whales, dolphins and porpoises have been recorded recently in the region's nearshore waters. Of these, only two species, bottlenose dolphin *Tursiops truncatus* and long-finned pilot whale *Globicephala melas*, are present throughout the year or recorded annually. Two other species, harbour porpoise *Phocoena phocoena* and common dolphin *Delphinus delphis*, are occasional visitors. As in Region 7, grey seals *Halichoerus grypus* and common seals *Phoca vitulina* are only infrequently recorded; there are no breeding colonies of seals.

Estuarine shores

The four natural lagoons in the region total 16.5 ha, which represents less than 1% of Britain's total natural lagoonal resource. Throughout the region there are a number of artificial lagoonal habitats, such as ponds retained behind sea walls, old mill ponds and restricted saltmarsh channels, some of which are notable for their faunal diversity. Three rare sea-bed species protected under the Wildlife & Countryside Act 1981 occur in lagoons in the region: the lagoonal sand-shrimp *Gammarus insensibilis*, recorded at Birdham Pool in Chichester Harbour, the starlet sea anemone *Nematostella vectensis*, in Pagham Lagoon and Chichester Harbour, and Ivell's sea anemone *Edwardsia ivelli*, which in the UK has only ever been recorded from Widewater Lagoon; however, it has not been seen since 1983 and is now thought to be extinct there.

The seven estuaries in the region have only limited lengths of shoreline, with Pagham and Chichester Harbours being the only significant areas. Here the range of habitats include soft sediments such as mud and sand flats, along with saltmarsh and wet grassland. Saltmarshes are found within most estuaries in the region but total only 816 ha in area (2% of the British total), the majority being found in Chichester Harbour, which has more than 700 ha. A high percentage (68%) of the saltmarsh area is dominated by cord-grasses *Spartina* spp., because much of the saltmarsh is of recent origin, formed in response to the establishment of common cord-grass *S. anglica* in the first half of this century. Further from the shore, and on older saltmarshes, the marshes are relatively rich in species and include upper marsh communities and transitions to sand dune, as at East Head, for example. Higher plant species present include sea-heath *Frankenia laevis*, golden-samphire *Inula crithmoides*, marsh-mallow *Althaea officinalis*, lax-flowered sea-lavender *Limonium humile* and curved hard-grass *Parapholis incurva*.

In several areas saltmarsh has been truncated by the construction of sea walls and has been converted to agricultural use, initially as wet grassland. This has occurred on land behind shingle on low-lying coastlines around Rye, Pett and Pevensey, and along the narrow estuaries that cut through gaps in the South Downs chalk escarpment. The former are represented by the extensive Pevensey Levels and the latter by Amberley Wild Brooks on the River Arun, a site some 15 km inland. Unimproved wet grasslands are important for rare plants and breeding birds, but their invertebrate interest is probably their most important conservation feature. The associated ditches may have a rich aquatic flora and the emergent vegetation may include several scarce plant species. Many of the ditches support a wide range of water-beetles, flies, dragonflies and damselflies, and there are a number of nationally threatened snails, such as the large-mouthed valve snail *Valvata macrostoma*. This region holds the only known British site for the leech *Placobdella costata* and one of the few locations for the nationally rare (Red Data Book) fen raft spider *Dolomedes plantarius*. Pett Level holds a notable assemblage of fly species, a rare weevil *Macrolepta mutica*, which lives on the roots of *Potamogeton trichoides*, and a range of uncommon moths that live in the reedbeds.

Wet grasslands in the region are also important for breeding birds: Pagham Harbour holds one of the highest densities of grassland breeding waders in Britain. In areas where grazing is light or infrequent, densities of breeding redshank *Tringa totanus* are as high as any recorded in Britain,

their total numbers representing 10% of the British population. Lapwing *Vanellus vanellus* and snipe *Gallinago gallinago* are also present in high densities, both overwintering and breeding. The Pett and Pevensey Levels are the most important sites; they also support nationally important populations of garganey *Anas querquedula*, shoveler *A. clypeata* and gadwall *A. strepera*. In addition, internationally important numbers of wintering Bewick's swan *Cygnus columbianus bewickii* have been counted in the area from Dungeness to Pett Levels.

The small estuaries and harbours support several species of waterfowl (wildfowl and waders), either in the migration periods or in winter, and although total numbers are low by comparison with other regions, five species attain levels of international importance in at least one estuary. In January the region holds 52,000 waterfowl - about 3% of the total for all English coastal regions. Dark-bellied brent goose *Branta bernicla bernicla* and dunlin *Calidris alpina* are the most numerous species wintering on estuaries in the region. Estuarine sand/mudflat habitats are also attractive to grey plover *Pluvialis squatarola* and bar-tailed godwit *Limosa lapponica*. Large concentrations of dark-bellied brent geese winter in Pagham and Chichester Harbours, where they feed on the mudflats; both these sites have been designated as Ramsar sites and Special Protection Areas on account of their bird populations. The region can become more important for wintering waterfowl during periods of severe cold weather further east in continental Europe.

Non-estuarine shores

The region includes only 1% of the total area of sand dune in Great Britain, at four sites with an overall extent of 96 ha. Of these, three are spits and the other, Camber Sands, is a small ness dune that has suffered considerable damage and loss of habitat as a result of human activities.

This region contains a significant proportion of the total resource of vegetated shingle in Britain. Two sites are of national importance: Dungeness (mostly in Region 7 and discussed there) and Rye Harbour, which holds more than 16% (721 ha) of England's vegetated shingle. A third site, the Crumbles, near Eastbourne, may have been important in the past but has now had virtually the whole of its natural shingle surface destroyed by human activity. The region's shingle sites support important examples of pioneer shingle vegetation, as well as transitions between shingle and saltmarsh or sand dune. The shingle at Rye Harbour comprises a complex apposition beach whose origins date back some 4,000 years to when falling sea levels enabled the coast to accrete seawards: the old cliff line is now several kilometres inland. The site of Camber Castle, built by Henry VIII in 1538 and now some distance from the sea, testifies to the rapid extension of the shoreline. Rye Harbour has suffered extensive gravel extraction, but there are significant tern *Sterna* spp. nesting sites on the shingle and a diverse range of invertebrates can still be found. These include many species restricted to specific foodplants, such as the sea kale *Crambe maritima*, which supports a leaf beetle *Dilobia cynoglossi*, recently recorded at Rye Harbour after an apparent absence of sixteen years. Historically Rye Harbour has been famous for its water beetle fauna: gravel extraction may have helped to create wetland habitat suitable for a range of rare species. West Sussex has a considerable length of fringing shingle beach between Shoreham and Bognor Regis, as well as

an example of a more developed structure (a breached shingle barrier lying across the entrance to the harbour) at Pagham Harbour.

The coast of the region contains a moderate length of cliff (32 km, representing approximately 1% of the British resource) but only a limited area of cliff-top habitats, because of the intensity of residential and agricultural development. Hard cliffs in the region are all in chalk; they have vertical faces with an undulating cliff top, such as at the famous Seven Sisters. The region has both high (163 m at Beachy Head) and low cliffs (<20 m) with vertical and non-vertical cliff faces. They are often subject to relatively rapid erosion and retreat, and landslides are extensive west of Fairlight Cove, giving rise to the only large area of undercliff vegetation in the region. Many sections of cliff have been artificially protected by a variety of physical structures, which obscure important geological features and prevent the natural renewal of the cliff face.

One nationally rare (RDB) plant, hoary stock *Matthiola incana*, occurs on the cliffs of the region, as does the nationally scarce wild cabbage *Brassica oleracea* var. *oleracea*. Other nationally rare and scarce higher plant species more typical of other habitats also occur, and the narrow cliff-top chalk grasslands support eight nationally scarce species. Pockets of maritime vegetation occur on cliffs, although these are restricted to the lower slopes, where species such as sea-heath *Frankenia laevis* occur at the foot of cliffs in the splash zone. Many cliffs in the region have excellent invertebrate lists, with Fairlight, Beachy Head and the Seven Sisters Park each supporting large numbers of notable and rare (RDB) species. These cliffs provide a range of microhabitats and many of the species present, such as the adonis blue butterfly *Lysandra bellargus*, depend on the sparsely vegetated, sheltered and south-facing chalk slopes. The rapidly eroding soft rock cliffs of Fairlight support a different assemblage of invertebrates, including the scarce ground beetle *Tachys micros*. The cliff-top vegetation supports typical heathland birds such as linnet *Carduelis cannabina*, yellow hammer *Emberiza citrinella* and the rare nightjar *Caprimulgus europaeus*. Reptiles include the adder *Vipera berus* and slow-worm *Anguis fragilis*.

1.2.4 Landscape and nature conservation

Region 8 has the shortest coastline of any Coastal Directories region with some of the highest coastal human population densities in Great Britain. Nevertheless it contains 28% by area of Britain's coastal Areas of Outstanding Natural Beauty, associated mainly with the chalk cliffs of Beachy Head and the Seven Sisters, and approximately 9% of the nation's coastal Local Nature Reserves and Country Parks. Other designations in Region 8 represent only a small proportion (less than 5%) of the national totals. There are only two internationally important bird areas, Pagham Harbour and Chichester Harbour, 30 Sites of Special Scientific Interest (SSSIs) and one coastal National Nature Reserve (NNR). The area covered by each of the main designations is given in Table 1.2.1.

1.2.5 Human activities, past and present

During the glacial period the ice sheets did not reach as far south as this part of Britain and hence very ancient

Table 1.2.1 Main landscape and nature conservation designations in Region 8

<i>Designation</i>	<i>No. of sites in region</i>	<i>Total area in the region (ha)</i>	<i>% of GB coast total in region by area</i>
Ramsar sites	1.5*	3,498	1.0
Special Protection Areas	1.5*	3,498	1.0
National Nature Reserves	1	54	0.1
Sites of Special Scientific Interest	30.5*	12,713	1.8
Local Nature Reserves	7	1,296	9.7
Areas of Outstanding Natural Beauty	2.5*	250,300	27.8
Heritage Coasts	1	13**	0.8
National Trust properties	6	335	0.5
Wildlife Trusts reserves	11	292	1.1
RSPB reserves	2	28	0.1

Key: *one site (Chichester Harbour) shared with Region 9. **length (km).

archaeological evidence has survived, including evidence of the earliest human occupation of Britain. Changes in sea levels have altered the relative positions of archaeological remains in relation to the shore. Nationally important Palaeolithic sites, for example, occur inland of the present shoreline on raised beaches that were formed during some of the interglacial periods when sea level was higher than today. By contrast, peat beds and submerged forests may be seen at low water on today's beaches at Pett Levels, Hastings, Bulverhithe and Pevensey Levels, providing evidence of periods of lower sea levels, when trees grew in areas now offshore.

The archaeological record shows that humans have been present in the area since around 500,000 years ago. By about 4,500 years ago Neolithic farmers had all but cleared the forest along the coast and on the Downs. Bronze-working took place from about 3,400 years ago and by the early Iron Age (6-5th centuries BC) a pattern of mixed farming, with smiths working in bronze and iron, became established. Rare saltmaking sites at Chidham and a coin mould from Boxgrove are indicative of industrial and economic activity.

The region's importance for trade with the Continent dates from before the Roman invasion. The proximity of this region to continental Europe has always been an important influence and the region's defences and ports testify to the threat of invasion and the development of communication, travel and trade. There is an exceptionally rich legacy of military remains from the Roman period onwards. The Normans built castles along rivers and in coastal locations such as Hastings, Pevensey, Lewes and Arundel. Cross-channel trade continued to be important, although as rivers silted up and shingle was moved along the shore by wave action access to the ports became more difficult. During the 12th century the Cinque Ports of the region - Rye, Winchelsea and Hastings - received trading privileges in return for providing ships and men for the Crown. The threat of invasion by the French prompted Henry VIII to build Camber Castle on the coast around 1538. It now stands in the middle of a grazed undulating pasture some 2.4 km from the coast. During the Napoleonic Wars Martello Towers were built around the south-east coast of England. Many have since been lost to erosion, as for example in Pevensey Bay.

The maritime history of the area is exceptional and there are many important wrecks along the coast and offshore. The

estuaries and natural harbours are locations for cross-channel trade. Before the denudation of the Wealden forest and the decline of industry there, iron and timber were shipped out of the region. These two commodities also supported local shipbuilding. Although many of the original inland river ports, such as Lewes and Arundel, were abandoned some time ago because of river siltation and coastal accretion, limited activity continues today. Today Rye Harbour imports significant quantities of aggregate and Newhaven is a freight and ferry terminal.

Fishing is an important activity in the region. Demersal species, such as the cod family and flatfish, make up the majority of fish landings. The total tonnage of demersal species landed represents 13.6% of the England and Wales total. Shell fisheries target lobster, edible crab, spider crab, velvet crab, scallops, native oysters and whelks. The main fishing ports or landing areas in the region are Rye, Hastings, Eastbourne, Newhaven, Brighton, Shoreham and Worthing, but fish and shellfish landings are also recorded at a scattering of smaller places throughout the region, for example Selsey. The fleet of fishing boats based at Hastings is the largest beach-launched fleet in Europe; most of the boats, known locally as 'punts', are between 6-8 m long. A large fleet of full-time vessels is moored on jetties along the narrow Ouse Estuary at Newhaven, which is a centre for deep-sea fishing. In Brighton fishing boats are either moored in marinas designed for pleasure craft or hauled up the beach. Beach boats work along the stretch of coast around Worthing, the majority of them small and owned by part-time fishermen and anglers.

The region is perhaps most famous for its long-established tourist industry. Royal patronage helped the development of Brighton and Bognor Regis and a massive expansion in popularity occurred when the railway reached Brighton in 1841. Brighton is now one of the most important holiday resorts in the UK and is an international conference centre. Westwards from Brighton the coast is almost completely built up as far as Littlehampton, a distance of nearly 30 km. In addition to traditional beach holidays there is a highly-developed leisure boating industry. The Solent and Chichester Harbour represent one of the major water recreation areas in Europe and there is a large new marina at Brighton. A new marina village is under construction inland from the coast at the Crumbles (Eastbourne). Power boating, water-skiing and jet-skiing are increasingly popular pastimes.

Developments have greatly reduced the extent of semi-natural coastal habitat throughout the region. In addition the region is experiencing some of the highest relative rates of sea level rise in the UK (estimated in West Sussex to be between 7.5-13 mm per year) and coastal erosion (locally approaching 2 m per year). Coast protection works and sea defences necessitated by the spread of housing and infrastructure have reduced the ability of the coast to accommodate changes in sea level and sediment movement. The high cost of maintaining sea defences has meant that alternative, coordinated strategies for flood defence are now being developed by coastal defence agencies in the region through involvement in the East Sussex Coastal Group and the Standing Conference on Problems Associated with the Coastline (SCOPAC), which cover East and West Sussex respectively. This region is covered in the first comprehensive Shoreline Strategy Study to be undertaken under new MAFF guidelines, covering the shoreline between South Foreland (in Region 7) and Eastbourne.

1.2.6 Further sources of information

A. Further reading

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Where chalk outcrops on the region's coast it forms some of the best known and most spectacular cliffs in the country. Vertical chalk faces rise to 163 m at Beachy Head (pictured), east of the Seven Sisters, which themselves reach between 40 m and 70 m in height. Photo: Peter Wakely, English Nature.

Chapter 2 Geology and physical environment

2.1 Coastal geology

British Geological Survey & J. Sawyer

2.1.1 Introduction

The solid geology exposed on the Sussex coast consists of sedimentary rocks of Lower Cretaceous to Palaeogene (Lower Tertiary) age (Map 2.1.1; Table 2.1.1). The rocks of Lower Cretaceous age include some of the oldest rocks in south-east England. The strata dip towards the south-west, so the oldest beds are exposed in the east and the youngest in the west. Together these rocks form the southern part of the Wealden anticline and the eastern part of the Hampshire Basin, structures which developed in association with the Alpine phase of mountain building. Superimposed on this sequence in the Hampshire Basin are the relatively narrow Littlehampton Anticline and its counterpart, the Chichester Syncline. These local folds represent draping of the surface strata across major deep-seated faults. This region lay beyond the southern limit of the Pleistocene glaciations, so there are no glacial deposits along the coast.

2.1.2 Stratigraphy

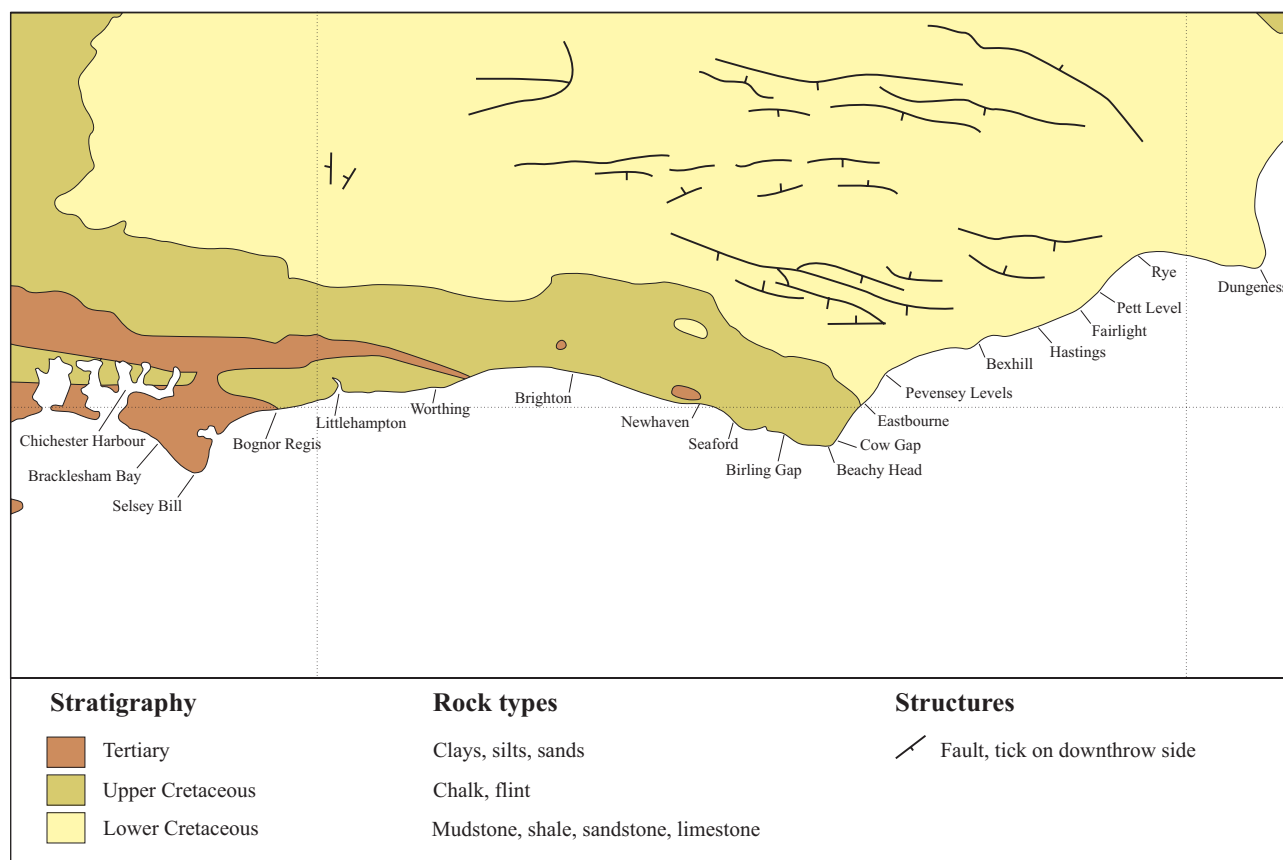
Rye - Eastbourne

Underlying this stretch of the coast are the rocks of the Wealden Series, which are of Lower Cretaceous age. These are exposed in cliffs between Pett Level and Bexhill but are buried beneath expanses of superficial alluvial deposits on either side. The coast from the Kent border to Pett Level is formed by gravel beach deposits, marine alluvial clays and blown sand. The gravel deposits join with extensive shingle ridges, which extend into Kent and form the Dungeness foreland. The cliffs from Pett Level to Hastings offer the best exposures of solid geology in the region and have been designated as a geological Site of Special Scientific Interest (SSSI). They are formed from the heavily faulted sandstones, siltstones and clays of the Lower Cretaceous Hastings Beds. At Fairlight, where the faulting of the rocks can be seen, downthrows of around 50 m have taken place. Between Fairlight and Hastings there are superb examples of ancient channel deposits and cross-stratification that are up to 10 m thick and

Table 2.1.1 Geological column

<i>Era</i>	<i>Period</i>	<i>Epoch</i>	<i>Age of start (million yrs)</i>	<i>Stratigraphic units mentioned in the text</i>	<i>Significant geological events</i>
Cenozoic	Quaternary	Holocene	0.01		Rapid rise in sea level
		Pleistocene	1.6		
	Tertiary - Neogene	Pliocene	5.1		Alpine Orogeny
		Miocene	25		
	Tertiary - Palaeogene	Oligocene	38		
Mesozoic	Cretaceous	Eocene	55	Bracklesham Beds	
				London Clay	
		Palaeocene	65	Reading Beds	
		Upper	144	Chalk Upper Greensand	
		Lower		Gault Clay	
				Weald Clay	
				Hastings Beds	
Palaeozoic (Upper)	Jurassic		213		
	Triassic		248		
	Permian		286		
	Carboniferous		360		
Palaeozoic (Lower)	Devonian		408		
	Silurian		438		
	Ordovician		505		
	Cambrian		590		
	Precambrian				

Note: shaded boxes show ages of rocks with important or extensive exposures in the regions.



Map 2.1.1 Onshore coastal geology. Source: British Geological Survey (1991).

0.5 km wide. These cliffs are important for their fossils; the strata have yielded fossils of insects, molluscs, fish, reptiles and mammals, as well as fossil tree stumps, dinosaur footprints, rain prints and sun cracks. To the west of Hastings the exposures are not as dramatic, and from Bexhill to Eastbourne the Pevensey Levels, comprising claimed marshland fronted by shingle, have obscured the solid geology.

Eastbourne - Bognor Regis

Upper Cretaceous chalk dominates the solid geology along this stretch of the coast and forms the South Downs. Less extensive exposures of Lower Cretaceous and Palaeogene rocks are also present. From Eastbourne to Beachy Head the rocks form cliffs of Chalk over Upper Greensand and Gault Clay. Beachy Head itself is an impressive Chalk headland over 150 m high, and from here to Brighton the Chalk is exposed in high, steep cliffs locally having a thin capping of Palaeogene beds or Quaternary deposits. The cliffs between Eastbourne and Seaford are part of an SSSI and are of particular geological interest because of the Chalk stratigraphy exposed in the cliffs near Seaford and because of the Quaternary features and deposits that are visible at Cow Gap and Birling Gap. From Brighton to Bognor Regis Chalk and Palaeogene rocks are poorly exposed. They can be seen in places at the base of low cliffs, where they are overlain by brickearth of Pleistocene age, and also to the east of Littlehampton, where Chalk is exposed on the foreshore.

Bognor Regis - Hampshire border

Palaeogene rocks underlie this stretch of the coast, but they are usually obscured by superficial deposits of brickearth or alluvium. At Bognor Regis the Reading Beds of Palaeocene age may be seen, followed by the full sequence of London Clay, although some of the latter can only be seen at particularly low tides. The London Clay strata usually comprise soft clays and sands, but they also include harder beds of sandstone and sandy limestone, which form the prominent 'reefs' known as the Bognor Rocks and Barn Rocks.

Further west, sandy Bracklesham Beds underlie the coast and are exposed at the base of low cliffs at Selsey Bill and on the foreshore of Bracklesham Bay.

2.1.3 Further sources of information

A. Maps

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B. Further reading

Section 7.4 lists the Geological Conservation Review (GCR) sites occurring in the region. Detailed descriptions of GCR sites in the region can be found in volumes of the Geological Conservation Review (e.g. Ellis *et al.* 1995).

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- Young, B., & Lake, R.D. 1988. *Geology of the Brighton and Worthing Districts*. Keyworth, British Geological Survey. (Memoir of the British Geological Survey. Sheets 318 and 333 (England and Wales).)

C. Contact names and addresses

Type of information	Contact address and telephone no.
Geological information for region and the whole of Britain: 1:50,000 scale map sheets.	Coastal Geology Group, British Geological Survey, Keyworth, Nottingham NG12 5GG, tel: 0115 936 3100
Geological information for the region	Keeper of Geology, Booth Museum, 194 Dyke Road, Brighton BN1 5AA, tel: 01273 713299
Geological Conservation Review (GCR) sites: Sussex	*English Nature Sussex Team, Lewes, tel: 01273 476595

*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

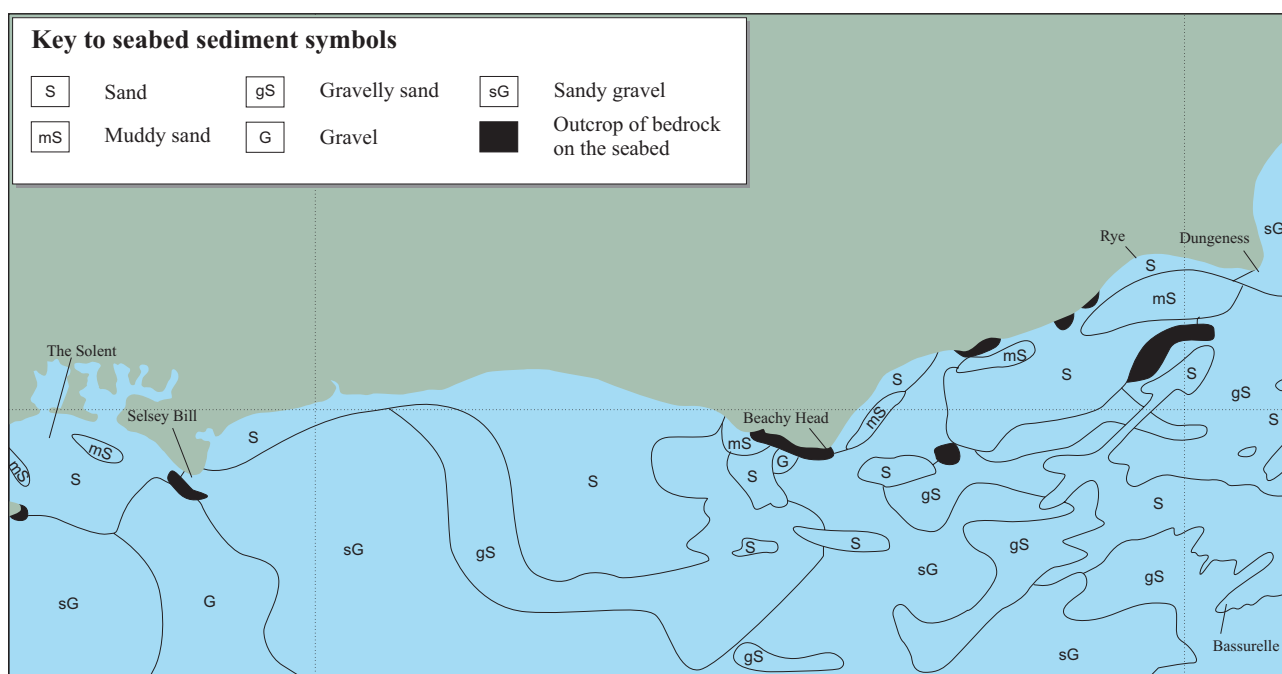
Sea-bed sediments are defined here as the unconsolidated sediments at sea bed laid down since the sea transgressed across the area following the early Holocene rise in sea level. The type and thickness of the sediments have been determined by sampling, high resolution seismic profiling and sidescan sonar. Sea-bed sediments in the region are shown on [Map 2.2.1](#).

East of Beachy Head there is a more-or-less continuous cover of mobile sediments, generally in the form of tidal sand ridges, for example the Bassurelle in mid-Channel. The ridges are composed largely of medium-grained sand, which consists of well-rounded quartz grains, with a little feldspar, mica, heavy minerals and comminuted shell debris; their gravel content is low and generally consists of shell debris. Between the sand ridges, 'lag' (relict) deposits form a discontinuous cover less than 0.5 m thick, interspersed with areas of bare rock. These lag deposits comprise gravels, sandy gravels and gravelly sands. The sand fraction is generally coarse to very coarse and poorly to moderately sorted, with a high shell-derived carbonate content. The gravel consists mainly of flint pebbles, but limestone, chalk, sandstone and ironstone derived from underlying solid rocks are locally important. Muddy sands occur nearer the coastline, derived from the underlying clay and soft clayey sandstone strata. The sea bed of Rye Bay has a cover of muddy fine sand. South-west of

Beachy Head an extensive area of sand waves covers a layer of sandy sediments up to 20 m thick. Towards the coast, in the direction of Selsey Bill, the sand cover thins to less than 0.5 m and becomes slightly gravelly. Further to the south-west sand waves reduce in size, and grade into irregular sand patches, sand ribbons and a smooth, flat sea bed. Still further offshore the sea bed sediments consist of a discontinuous cover of coarse lag deposits less than 0.5 m thick. West of Selsey Bill a variety of sediment types occur, with muddy sands and sandy mud in the intertidal areas passing into sand and gravelly sand further offshore and sandy lag gravel exposed locally. The muddy sediments which fill the eastern Solent Channel are probably derived from the underlying channel-fill deposits. Sand ripples, sand waves and even gravel waves occur in areas of strong tidal current.

2.2.2 Pleistocene geology

Pleistocene deposits are limited to palaeovalley infills beneath the Holocene sea-bed sediments ([Map 2.2.2](#)). The palaeovalleys were incised during the Pleistocene and appear to comprise a complex river system formed during periods of lower sea level and later modified by marine processes. West of Selsey Bill, the 'Palaeo-Solent' valley is the offshore continuation of the rivers of Southampton Water. The East Solent is a partly infilled, north-westerly orientated palaeovalley incised to at least 46 m below chart datum, with a complex infill that includes gravel layers.



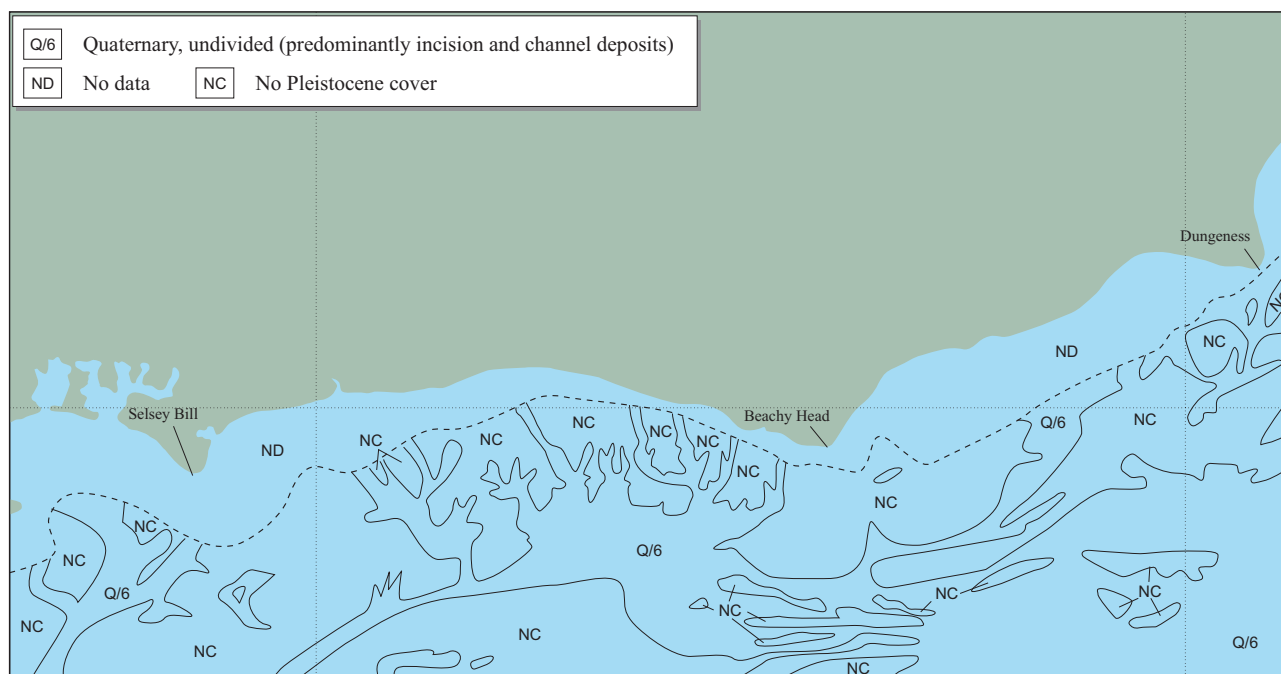
Map 2.2.1 Sea-bed sediments. Source: British Geological Survey (1987); sediment classification modified after Folk (1954).

2.2.3 Solid (pre-Quaternary) geology

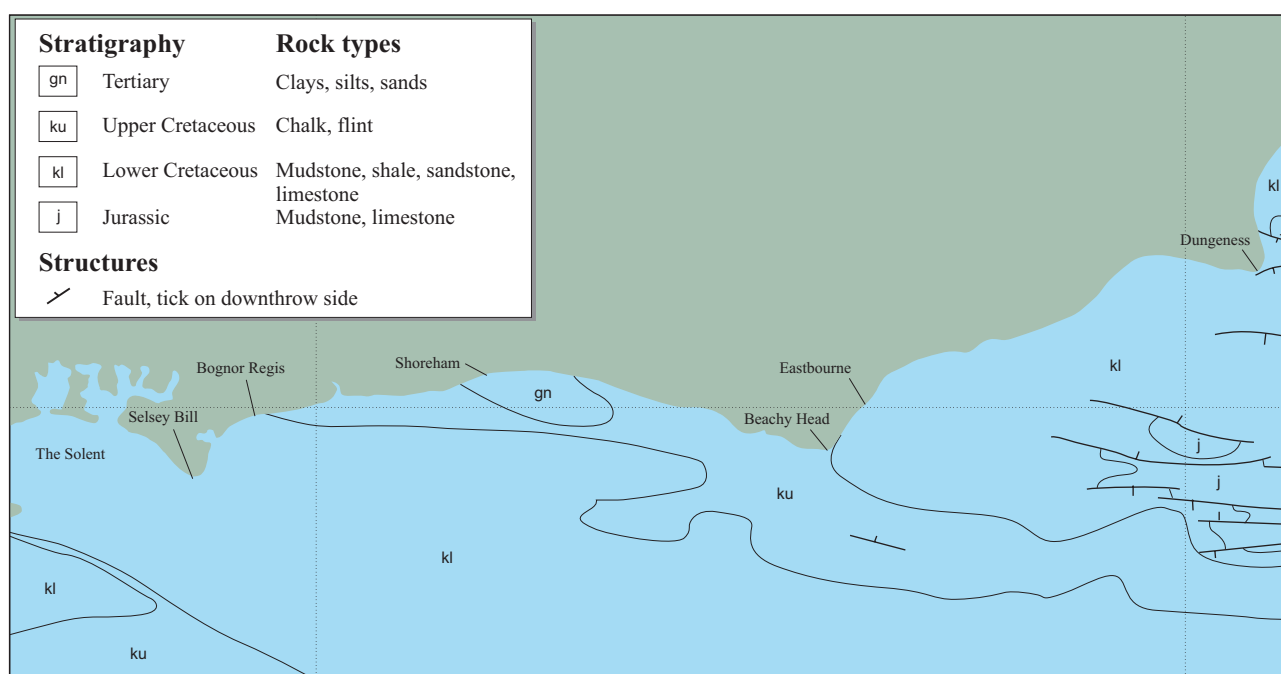
Offshore, most solid geology (Map 2.2.3) is concealed by seabed sediments and palaeovalley infill sediments, but isolated outcrops do occur at the sea bed.

East of Eastbourne the Lower Cretaceous sandstones, clays and limestones exposed in the cliffs continue south-east into the English Channel, forming the southern part of the Weald - Artois Anticline. Towards the central part of the English Channel Jurassic shales, mudstones and limestones are exposed in the cores of small eroded anticlines and faulted blocks.

The Chalk which forms the cliffs at Beachy Head dips south-westwards beneath the English Channel as the northern rim of a broad, gently-dipping syncline known as the Hampshire - Dieppe Basin. The boundary between the Upper Cretaceous Chalk and underlying Lower Cretaceous clays can be traced across the English Channel as a small submarine escarpment. Further west towards the centre of the basin, the Chalk is concealed beneath Tertiary clays, sandstones and limestones. These rocks occur in a minor syncline that touches the coast near Shoreham, but the main outcrop meets the coast at Bognor Regis and continues westwards into the Solent.



Map 2.2.2 Offshore Pleistocene deposits. Source: British Geological Survey (1994).



Map 2.2.3 Offshore pre-Quaternary geology. Source: British Geological Survey (1991).

2.2.4 Further sources of information

A. Maps

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B. Further reading

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- Welsby, J., & Motyka, J.M. 1987. *A macro review of the coastline of England and Wales. Vol. 4. The Thames to Selsey Bill.* Oxford, HR Wallingford. (Report SR 136.)

C. 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, Birkenhead, tel: 0151 653 8633

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

2.3 Wind and water

British Geological Survey, D. Dales & K. Gilbert

2.3.1 Wind

The prevailing winds throughout the year are from the south-west and west (Figure 2.3.1), with the strongest winds occurring in winter. Maps 2.3.1 and 2.3.2 show, respectively, the contours of the windspeeds exceeded for 75% and 0.1% of the time. In strong winds (which may persist for several days) the Dover Strait becomes very rough as it narrows eastwards, and the south coast is very exposed when there are strong southerly winds. During westerly gales, winds of 80 knots have been recorded between the Isle of Wight and Dover. During offshore winds some locations can be affected by sudden gusts as the result of the local topography.

2.3.2 Water depth

The morphology of the sea bed is influenced by the nature of its bedrock, the exposure of the area to wave attack and the supply of mobile sediment. In this region of the English

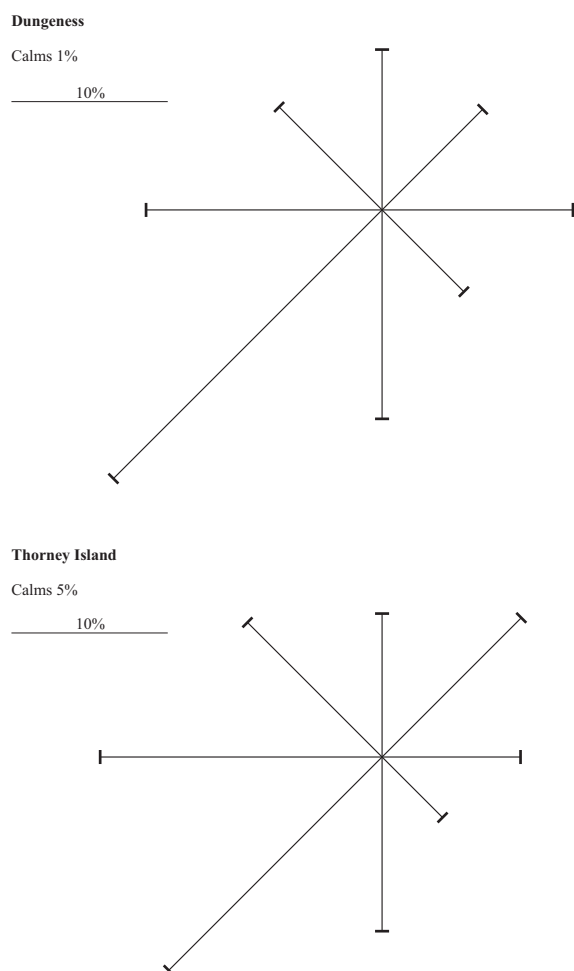
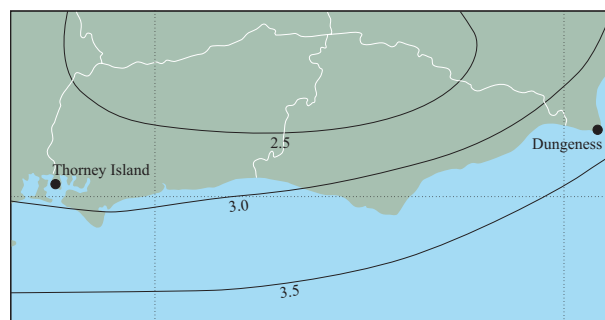
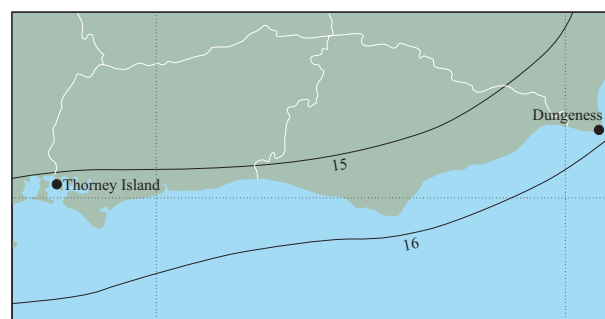


Figure 2.3.1 Wind directions at Dungeness (1941-1970) and Thorney Island (1943-1959). Sources: Hydrographic Department (1985); Shellard (1968).



Map 2.3.1 Hourly mean windspeed (in m/s) exceeded for 75% of the time: 1965-1973. Source: Caton (1976).



Map 2.3.2 Hourly mean windspeed (in m/s) exceeded for 0.1% of the time: 1965-1973. Source: Caton (1976).

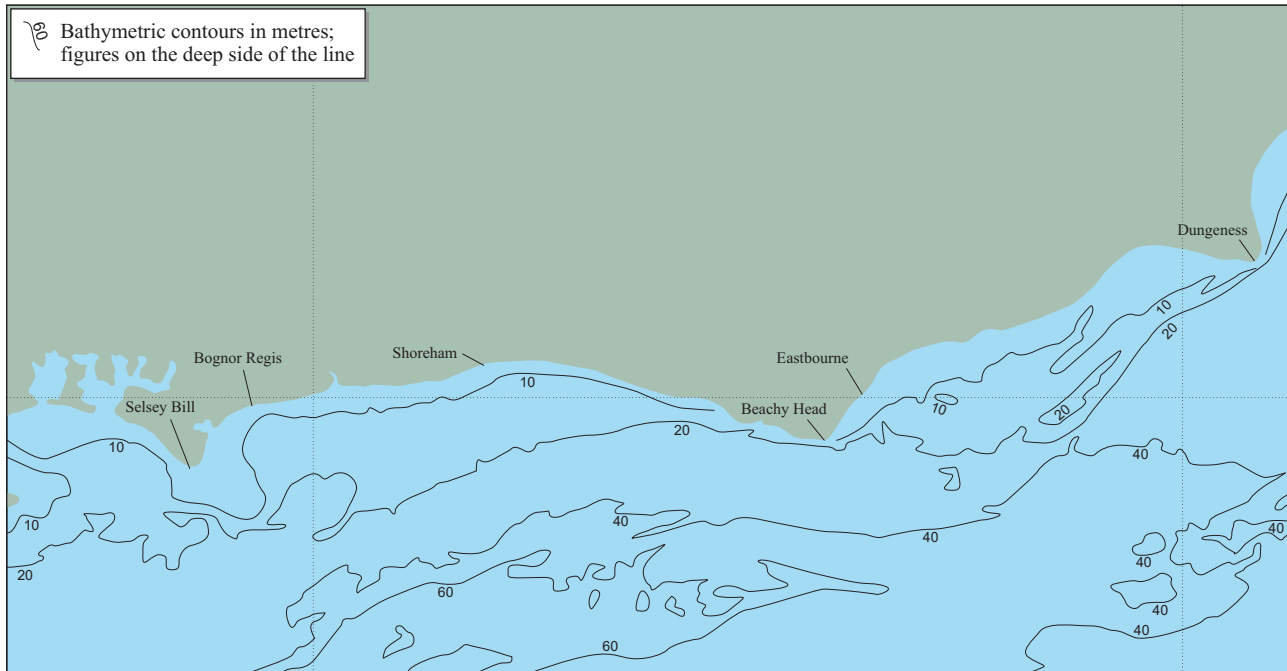
Channel the sea bed forms a regular submarine erosion surface. In places this surface is cut by a submerged cliff line which approximately follows the 40 m isobath (Map 2.3.3). Inshore of this isobath the sea bed is shallow and gently shelving. At the Royal Sovereign Shoals east of Beachy Head and at the Outer Owers off Selsey Bill, upstanding areas of bedrock outcrop at the sea bed. Extensive shallow areas less than 5 m deep also occur in Rye Bay and to the west of Selsey Bill, approaching the coast near Chichester.

2.3.3 Tidal currents

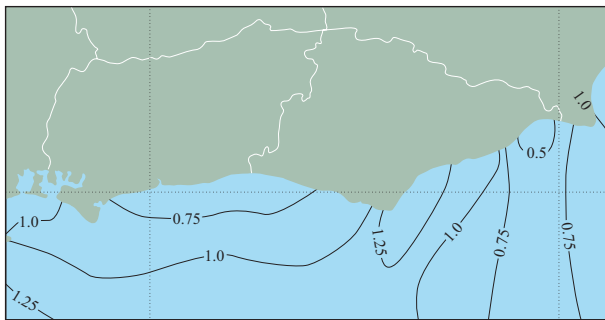
In the Atlantic Ocean tidal streams are very weak, but as the tidal wave reaches the shallower areas of the UK continental shelf the speed of the tidal streams increases greatly. In the central part of the English Channel the maximum speed of tidal currents is between 0.75 m/s and 1.25 m/s (Map 2.3.4). Maximum current speeds decrease eastwards: in Rye Bay they are reduced to 0.5 m/s. Close to headlands, however, speeds increase, for example to 1.25 m/s at Beachy Head.

2.3.4 Tidal range

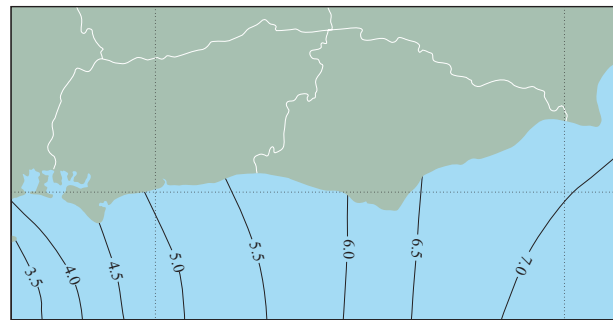
Map 2.3.5 shows the tidal ranges in the region at mean spring tides. Values decrease westwards from 7.0 m near Dungeness to 4.0 m off Chichester Harbour, with the variation due in part to the narrowing of the English Channel towards the Straits of Dover. Tidal ranges increase towards the French coast.



Map 2.3.3 Bathymetry. Source: British Geological Survey (1987).



Map 2.3.4 Maximum tidal current speed (in m/s) 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.

Tidal surges caused by weather conditions may produce extreme conditions in the North Sea but in the English Channel the results are less extreme. The maximum surge level expected to occur once in 50 years at Selsey Bill is 1.25 m in height, with maximum surge-induced currents of 0.6 m/s. At Beachy Head the equivalent figures are 1.50 m and 0.8 m/s. The storm surges along this coast tend to be accompanied by onshore wave action from either the south-west or south-east. The resulting combination of surge, wave action and high tide can cause problems along stretches of coast susceptible to flooding or erosion.

2.3.5 Wave exposure and sea state

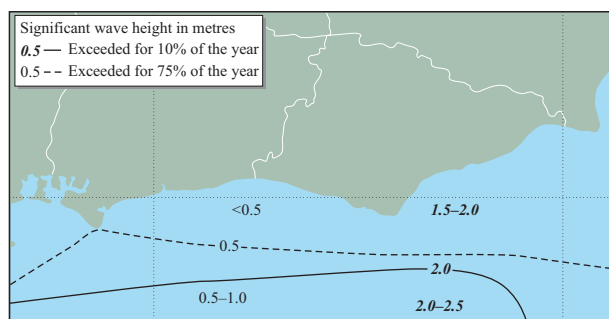
Much of the coastline is exposed to waves generated by south-westerly winds. There is a long fetch from the Western Approaches of the English Channel, resulting in large waves during periods of strong wind. However, much of the coastline of this region is sheltered by the Isle of Wight, Selsey Bill and Beachy Head. Wave period, the time between successive waves, is significant when considering sea state

and exposure. Close to the coast, and especially within the surf zone, the apparent period may be less than offshore, as refraction increases the frequency of the waves. **Map 2.3.6** shows the significant wave heights that can be expected to be exceeded for 10% and 75% for the entire year: for example, south of Beachy Head the significant wave height exceeds 1.5-2 m for 10% of the year and 0.5 m for 75% of the year.

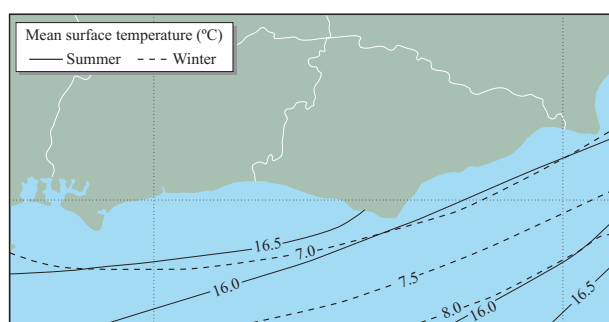
2.3.6 Water characteristics

Water temperature

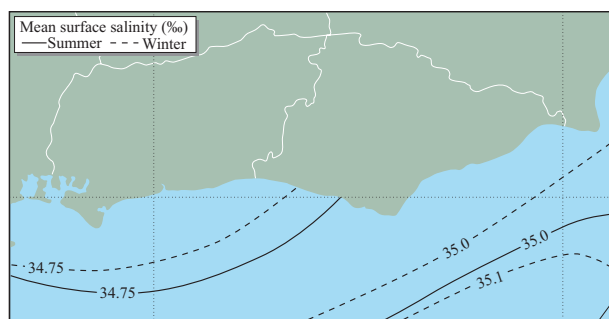
The mean sea surface temperatures for summer and winter are shown on **Map 2.3.7**. The data are for August and February, the months of, respectively, highest and lowest surface sea temperature. Sea surface temperatures in this region are strongly influenced by the movement of water along the English Channel, modifying the effects of the region's proximity to continental Europe. In winter, relatively warm waters move up the English Channel, and average



Map 2.3.6 Significant wave height (m) exceeded for 10% and 75% of the year. Source: Draper (1991).



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



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.

February temperatures range between 6.5° and 8°C, considerably warmer than the coastal waters of Holland, Belgium and Germany, which fall wholly under the cold continental influence. In August surface water temperatures in the central English Channel are on average 16-16.5°C, with temperatures increasing progressively toward both shores.

Salinity

Salinity values remain high along the centre of the English Channel in summer, owing to the eastward movement of Atlantic water. The mean surface salinity values for summer and winter are shown on [Map 2.3.8](#), based on data for August and February respectively. Although salinity values decrease toward the coast of Sussex and Kent, values remain above 34.5 g/kg, except locally at river mouths, owing to freshwater discharge. In summer, values in the central English Channel are lower, but along the coast they remain similar to those of the winter season.

2.3.7 Further sources of information

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B. Further reading

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- Welsby, J., & Motyka, J.M. 1987. *A macro review of the coastline of England and Wales. Vol. 4. The Thames to Selsey Bill*. Oxford, HR Wallingford. (Report SR 136.)

C. Contact names and addresses

Type of information	Contact address and telephone no.
UKDMAP (United Kingdom digital marine atlas) Version 1. Oceanographic maps.	*British Oceanographic Data Centre, Birkenhead, tel: 0151 653 8633
Monthly, seasonal and annual windroses	Meteorological Office Marine Enquiry Service, Johnstone House, London Road, Bracknell RG12 2SY, tel: 01344 854979

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



The promontory of Selsey Bill deflects tidal currents westward into the Solent, carrying sediment into the mouth of Chichester Harbour, where it accumulates as dunes and saltmarsh. In the sheltered waters behind the sandy spits of East Head (pictured) and Eastoke Point there are at least five marinas and many hundreds of moorings, making this one of the biggest yacht harbours on the south coast. It is also an Area of Outstanding Natural Beauty, a Ramsar site and a Special Protection Area for birds. Photo: Peter Wakely, English Nature.

2.4 Sediment transport

British Geological Survey, D. Dales & K. Gilbert

2.4.1 Introduction

Sediment transport is described within the context of coastal cells and sub-cells. These divide the coastline into sections within which sediment erosion and accretion are inter-related and largely independent of other cells (Motyka & Brampton 1993). Boundaries between sediment cells are usually either littoral drift divides or sediment sinks. Sub-cells are defined on the basis of lesser differences in the sediment transport regime within cells. Littoral drift divides usually occur at a point where the orientation of the coast changes abruptly and the beach material moves away from the point on both sides. Sediment sinks are points at which sediment transport paths meet, and so beach material tends to build up, usually in sheltered areas such as bays, tidal inlets and estuaries.

In this region there are parts of two coastal cells (Map 2.4.1): that from the Thames to Selsey Bill (of which one sub-cell lies in the region) and that from Selsey Bill to Portland Bill (of which two sub-cells lie in the region). Note that the sediment transport shown is of sand and gravel 'bed load', not suspended sediments.

Sub-cell 4c: Dover Harbour - Beachy Head

This is a large sub-cell where there is continuity in shingle drift. There is moderate eastward transport of sand and shingle by the predominant south-westerly waves, with local reversal on the east face of Dungeness foreland. As a result of losses of sediment offshore at Dungeness the coastline to the east is experiencing a deficit in the supply of beach material. There are natural accretionary features at Dungeness and

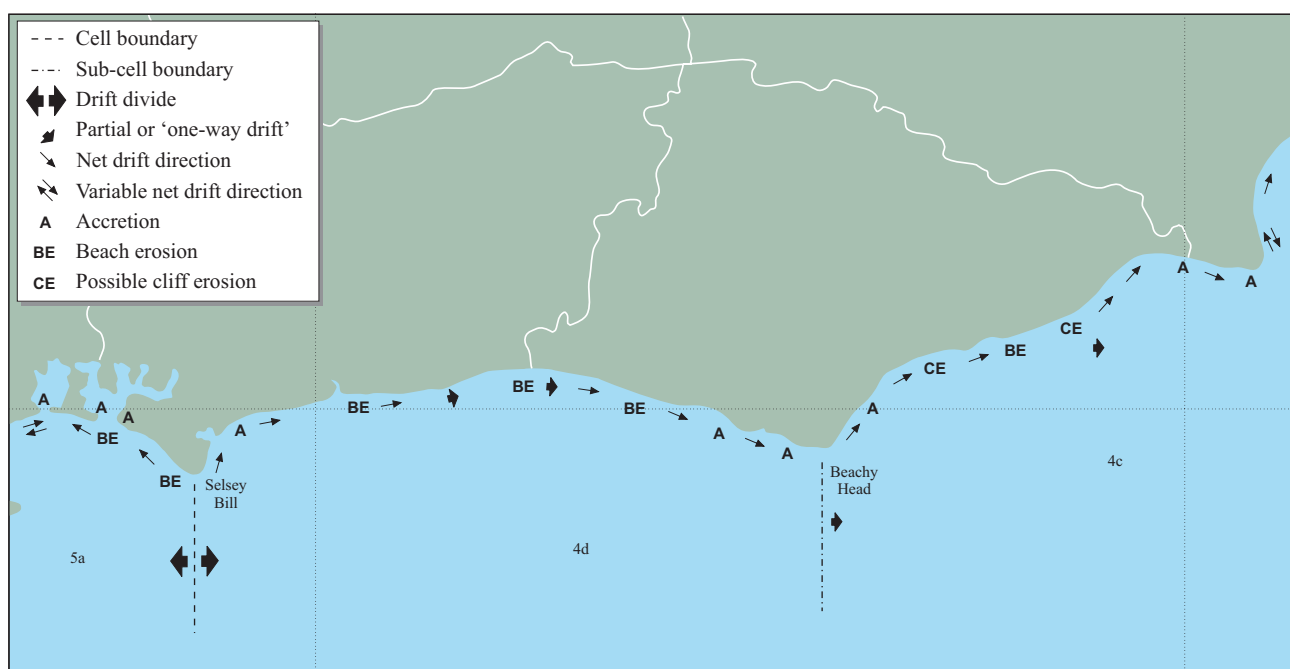
between Eastbourne and Pevensey, with localised accretion wherever drift is interrupted by harbour arms. However, erosion is prevalent over the major part of this sub-cell.

Sub-cell 4d: Beachy Head to Selsey Bill

The predominant south-westerly waves cause moderate eastward transport of sand and shingle, which is interrupted by a number of harbours. There is variable shingle movement onshore from banks off Selsey Bill; this occurs in pulses caused by wave action from the south. There is localised accretion wherever drift is interrupted by harbour arms, with significant accretion at Pagham Harbour entrance and at river mouths such as the Cuckmere and Ouse. Elsewhere, erosion of shingle beaches is very widespread. There is a proliferation of coastal defences, restricting the supply of shingle to beaches.

Sub-cell 5a: Selsey Bill - Portsmouth Harbour

In this sub-cell there is moderate westward drift because of wave action from the south and east, a result of waves being diffracted towards the north around the eastern end of the Isle of Wight. In recent years the rate of drift has been considerably reduced by coast protection measures, which have diminished the supply of beach material. The drift is intercepted by harbour mouths and beach material is transported offshore by ebb currents. There is accretion at the west end of the Selsey peninsula. Beach erosion is prevalent, particularly between Selsey and Hayling Island.



Map 2.4.1 Sediment transport and coastal cells. Source: Motyka & Brampton (1993).

2.4.2 Further sources of information

A. References cited

Motyka, J.M., & Brampton, A.H. 1993. *Coastal management - mapping of littoral cells*. Oxford, HR Wallingford. (Report SR 328.)

B. Further reading

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Bray, M.J., Carter, D.J., & Hooke, J.M. 1992. *Sea-level rise and global warming: scenarios, physical impacts and policies*. Portsmouth, University of Portsmouth. (Report to the Standing Conference on Problems Associated with the Coastline (SCOPAC).)

King, A., Glasser, N., Larwood, J., Littlewood, A., Moat, T., & Page, K. 1996. *Earth heritage conservation in England: a natural areas perspective*. Peterborough, English Nature. (English Nature Research Reports, No. 158.)

Rendel Geotechnics. 1995. *Coastal planning and management: a review of earth science information needs*. London, HMSO.

Welsby, J., & Motyka, J.M. 1987. *A macro review of the coastline of England and Wales*. Vol. 4. *The Thames to Selsey Bill*. Oxford, HR Wallingford. (Report SR 136.)

C. Contact names and addresses

Type of information	Contact address and telephone no.
Coast protection policy; sediment cells	*Ministry of Agriculture, Fisheries and Food, Flood and Coastal Defence Division, London, tel: 0171 238 3000
Review of erosion, deposition and flooding in Great Britain (maps and database)	Minerals Division, Room C15/19, Department of the Environment, Transport and the Regions, 2 Marsham Street, London SW1P 3EB, tel: 0171 276 0900
Sediment cells	HR Wallingford Ltd., Howbury Park, Wallingford, Oxfordshire OX10 8BA, tel: 01491 835381

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



The increased risk of flooding caused by sea-level rise and the more frequent storms associated with global warming are a threat, not only to the human population of this densely populated region, but to its wildlife as well. Low-lying coastal habitats, such as these mudflats and saltmarshes in Pagham Harbour, are vital links in the chain of sites used each year by, for example, thousands of wintering and migrating birds. Their unreplaced loss would affect the global wildlife resource. Photo: Peter Wakely, English Nature.

2.5 Sea-level rise and flooding

British Geological Survey, D. Dales & K. Gilbert

2.5.1 Sea-level changes in the region

Apparent sea-level rise is the combined effect of local crustal movements (owing to the removal of the weight of ice since the last glacial period, much of Scotland is rising whereas southern England is sinking) and global rises in sea level, estimated as rising between 1.5 and 2 mm/yr. Reviews that attempt to estimate future changes in apparent sea level (e.g. Woodworth 1987) cite the regional and temporal variability shown by tide gauge data as major causes of uncertainty.

Estimates for relative sea-level rise in the region vary considerably. Emery & Aubrey (1985, 1991) and Wallace (1990) suggest that the strongest crustal subsidence in Britain is focused upon West Sussex and south-east Hampshire. Emery & Aubrey (1985, 1991) indicate a relative sea level rise of 6-8 mm/yr, centred on Sussex, reducing to 2-4 mm/yr in Dorset and Kent (Map 2.5.1). However, Shennan (1989) suggests a relative rise in sea level in the region of only of 2-3 mm/yr.

2.5.2 Flooding risk in the regions

The potential for flooding (Map 2.5.1) is high in the low-lying ground along the coast (taken as land below the 10 m contour on the Ordnance Survey 1:50,000 series maps). Areas at risk include the marshes behind Dungeness, Eastbourne and Shoreham, and from Littlehampton round to Hayling Island in Chichester Harbour. In addition, flooding can occur along the banks of several of the rivers. Elsewhere, the coastline is mostly cliffed or rises rapidly away from the coast.

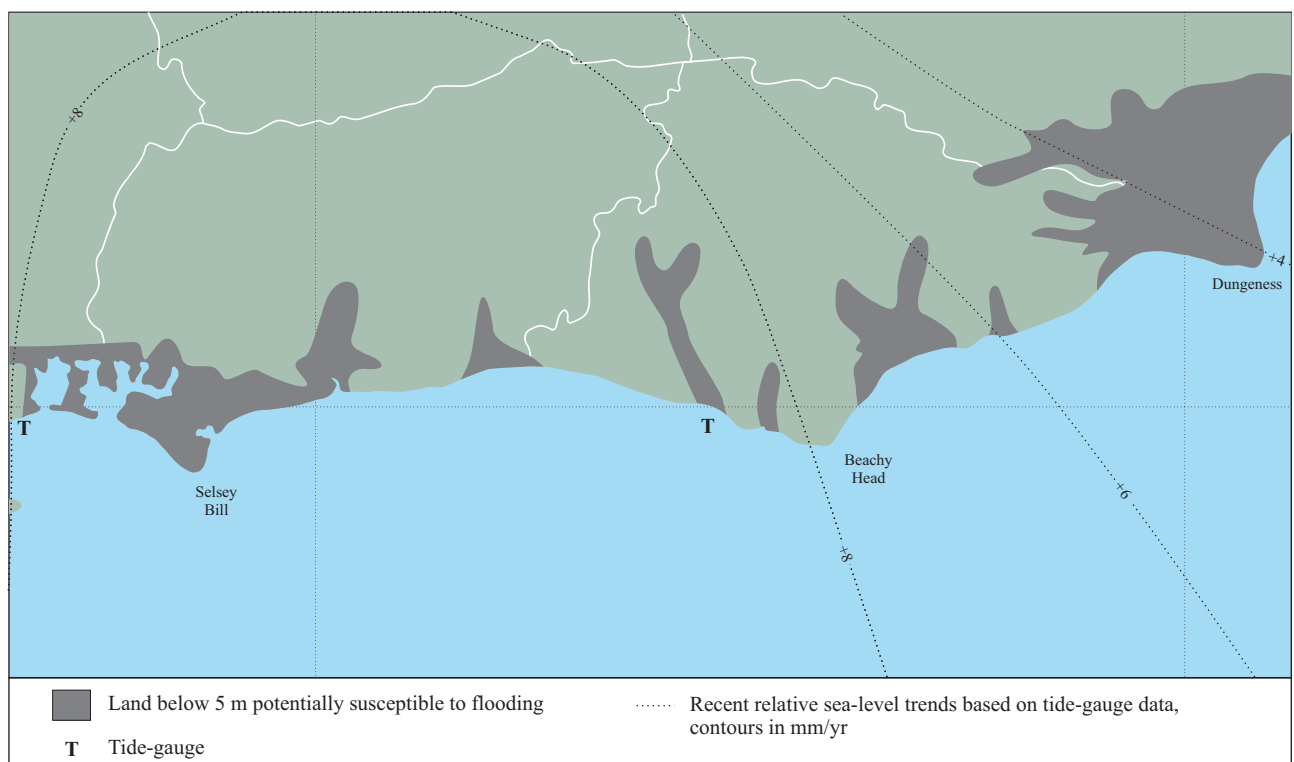
2.5.3 Further sources of information

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Map 2.5.1 Areas below 5 m above OD and thus susceptible to flooding, and estimated rates of relative sea-level rise. Source: OS Landranger maps and Emery & Aubrey (1985). © Crown copyright.

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C. Contact names and addresses

Type of information	Contact address and telephone no
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
Review of erosion, deposition and flooding in Great Britain (maps and database)	Minerals Division, Room C15/19, Department of the Environment, 2 Marsham Street, London SW1P 3EB, tel: 0171 276 0900
Tide gauge data	*British Oceanographic Data Centre, Birkenhead, tel: 0151 653 8633

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

2.6 Coastal landforms

British Geological Survey & J. Sawyer

2.6.1 Description

The south and east coasts of England, including the Sussex coast, are formed of relatively soft rocks. This has contributed to the shape of the region's coast, with its long sweeping curves, resulting from marine erosion and the infilling of old estuaries with alluvium. Shingle ridges and beaches form long stretches of this coast, interrupted by cliffs where outcrops of harder rocks occur (Map 2.6.1).

Rye - Eastbourne

This part of the coast has a high section between Cliff End (Pett) and Bexhill, with low-lying land - coastal wet grassland that has been claimed from the sea - lying on either side. Considerable changes to the coastline have been recorded here in historic times: both these low-lying areas cover broad, open valleys which were incised during glacial times when sea level was lower. As the ice melted and sea-level rose, the lower reaches of these valleys filled with marine and estuarine deposits. In the east around Rye, the marshland is protected to seaward by a series of shingle ridges that have built up since the 16th century, while the mouth of the River Rother has been kept open by a series of breakwaters. There are deposits of blown sand at Camber, to the east of the river mouth. Sandstones form cliffs between Pett Level and Bexhill, interrupted at intervals by hanging valleys and landslips. Near Fairlight the cliffs rise to nearly 150 m above sea level. At each end of this cliffed section there are submerged forests dating from around 5,000 BC. At Hastings, wide shingle beaches are maintained with the assistance of groynes and breakwaters, while beyond the easternmost breakwater there

is erosion of the cliff foot where the foreshore is starved of shingle. To the west, between Bexhill and Eastbourne, a complex of shingle ridges known as the Crumbles, culminating in the foreland of Langney Point, protect the Pevensey Levels.

Eastbourne - Brighton

Sheer Chalk cliffs extend westwards from Eastbourne to Brighton, interrupted by the narrow valleys of the Rivers Cuckmere and Ouse, which cut through the South Downs. The rivers, which meander across narrow floodplains, much of which is occupied by wet grassland, are tidal for many kilometres inland. The river mouths at Cuckmere Haven and Newhaven are protected by shingle bars. The cliffs at Beachy Head, where the South Downs meet the sea, rise to 163 m above sea level, and the truncated remnants of a landslide are visible in the wave-cut platform immediately to the east. West of Beachy Head the undulating cliff-line of the Seven Sisters provides magnificent examples of hanging dry valleys.

Brighton - Chichester Harbour

At Black Rock, behind Brighton Marina, the cliff is set back from the coast to a line, at Worthing, some 3 km inland behind a raised beach that is about 5 m above sea level. From Brighton westwards, shingle beaches are almost continuous to Chichester Harbour, forming spits at Shoreham and Pagham Harbour and bars at the smaller inlets. The River Adur, diverted 3 km to the east by the shingle bar of Shoreham Beach, meets the sea at Shoreham, although most of the estuary has been extensively developed for human use.



Map 2.6.1 Major coastal landforms.

The port of Shoreham is further sheltered by the long sand and shingle spit on which the industrial area of Portslade-by-Sea is sited. Heavily modified coastline continues to Littlehampton, the mouth of the River Arun, and then from Middleton-on-Sea to Pagham. There are deposits of blown sand near Climping. The embayment of Pagham Harbour is characterised by intertidal mudflats fringed by saltmarshes. A narrow depression from here to Bracklesham Bay means that Selsey Bill is not far from being an island. At Chichester Harbour there are areas of intertidal mudflats fringed by saltmarshes, and at East Head near West Wittering there are deposits of blown sand. Further back from the coast, from near Arundel westwards to behind Chichester, there is at least one other raised beach, at around 30 m above sea level. Here the raised beach deposits and associated cliffs are largely obscured by solifluction deposits and brickearth.

2.6.2 Further sources of information

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B. Contact names and addresses

Type of information	Contact address and telephone no.
Coast protection	*Ministry of Agriculture, Fisheries and Food, Flood and Coastal Defence Division, London, tel: 0171 238 3000
Geomorphological information for the 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.



Pagham Lagoon, a brackish pool separated from the sea by a natural barrier of shingle, supports only a very limited range of plants and animals. Common green algae (*Chaetomorpha* spp., *Ulva* spp. and *Enteromorpha* spp.) predominate, but this lagoon is notable in having populations of the starlet sea anemone *Nematostella vectensis*, a species protected under the Wildlife & Countryside Act. Photo: Peter Wakely, English Nature.

Chapter 3 Terrestrial coastal habitats

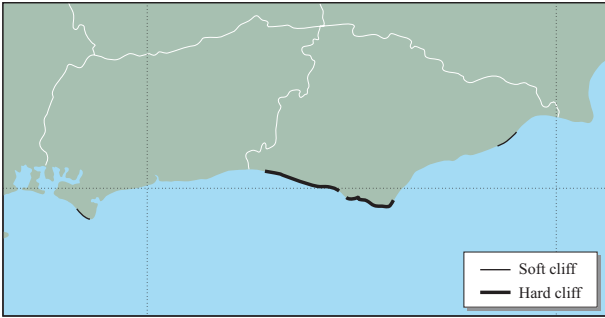
3.1 Cliffs and cliff-top vegetation

Dr. T.C.D. Dargie

3.1.1 Introduction

Geology and geological structure, together with environmental history (marine erosion past and present, plus glacial processes) determine cliff form. The most distinctive cliff types are consolidated (hard cliffs developed from resistant bedrock) and unconsolidated (soft cliffs developed in easily-eroded materials, including unconsolidated or poorly consolidated deposits such as mixed sand and clay strata). The coast of West and East Sussex contains 32 km of cliff (Table 3.1.1), which represents 1% of the British resource and is therefore of modest importance in the national context. The total extent of soft cliff is also low (6 km), representing only a small proportion (2%) of this cliff type in England. The distribution of hard and soft cliffs in the region is shown on Map 3.1.1.

The soils and vegetation of cliffs and cliff-tops are closely related to slope angle, soil type and salt spray deposition, with much local variability possible with changing exposure around headlands. Table 3.1.2 shows the lengths of different cliff types in the region and nationally. The major natural and semi-natural cliff and cliff-top habitats in Great Britain are bare ground, spray-zone lichen-covered rock, rock crevice, cliff-ledge, seabird colony, perched saltmarsh, maritime grassland and maritime heath. The full regional extent of cliff-top habitat has not been surveyed but the frequent exposure of the coast to very strong winds and heavy spray deposition probably allows only maritime grassland to develop (Table 3.1.1), with most of this restricted to hard cliffs. Seabird colony, perched saltmarsh and maritime heath are probably either absent or very rare in the region. Soft cliffs on sheltered coasts can develop undercliff vegetation of scrub, tall herbs and rank grassland, often very close to the sea. Significant undercliff vegetation in the region is probably restricted to Fairlight Cove, east of Hastings. The general lack of undercliff vegetation elsewhere on cliffs in the region is due to rapid erosion and removal of debris from the soft coast, with a short



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

cycle of four to five years between cliff failure, removal of material by erosion, cliff steepening and further failure (Pethick 1992).

The scenic contribution of cliffs within the region is concentrated in East Sussex, with an outstanding sector west from Beachy Head (Gubbay 1988; Heritage Coast Forum 1993) and further interest at Fairlight Cove. The quality of the spectacular chalk cliffs of the region is recognised by their designation as part of the Sussex Heritage Coast and the Sussex Downs Area of Outstanding Natural Beauty. They also fall within the South Downs Environmentally Sensitive Area.

3.1.2 Important locations and species

Cliffs in the region are not extensive but exhibit good diversity in form (Doody *et al.* 1993). Ashdown Sand and Fairlight Clay are the predominant lithologies of soft cliffs in East Sussex, with Tertiary sands and gravels in West Sussex. These result in mainly relatively low (<20 m), non-vertical cliff faces subject to relatively rapid erosion and retreat, of which there are only two short stretches in the region, at Fairlight Cove (5.1 km) and Selsey Bill (0.8 km) (Pye & French 1993). Landslips are

Table 3.1.1 Cliff and maritime cliff grassland resource in context

	Soft cliffs		All cliffs		Maritime cliff grassland	
	Soft cliff length	% of total in Region 8	Total length (km)	% of total in Region 8	Total area (ha)	% of total in Region 8
East Sussex	5	-	31	-	32	-
West Sussex	1	-	1	-	0	-
Region 8	6	-	32	-	32	-
England	256	2	1,165	3	1,895	2
North Sea Coast	?	?	1,800	2	?	?
Great Britain	?	?	4,059	1	?	?

Source: maritime cliff grassland data from Pye & French (1993), soft cliff lengths from JNCC Coastal Database. Key: ? = not known. Note: figures have been rounded to the nearest whole km, hectare or percentage point.

Table 3.1.2 Lengths (km) of cliff types

	Vertical >20 m height		Vertical <20 m height		Non-vertical >20 m height		Non-vertical <20 m height	
	Length (km)	% of total length in Region 8	Length (km)	% of total length in Region 8	Length (km)	% of total length in Region 8	Length (km)	% of total length in Region 8
East Sussex	24	-	0	-	6	-	2	-
West Sussex	0	-	0	-	0	-	1	-
Region 8	24	-	0	-	6	-	3	-
England	320	8	49	0	629	1	167	2
North Sea Coast	601	4	380	0	559	1	261	1
Great Britain	1,325	2	818	0	1,371	<0.5	545	1

Source: JNCC Coastal Database (cliff height and angle categories). Note: figures have been rounded to the nearest whole km or percentage point.

extensive west of Fairlight Cove (Jones & Lee 1994), where they support the only large area of undercliff vegetation in the region. Hard cliffs in the region are developed entirely in chalk, with vertical faces formed by cliff recession cutting across the grain of inland topography to create an undulating cliff-top with surfaces ranging between 40 m and 70 m along the most scenic stretches (e.g. Seven Sisters Cliff west of Beachy Head) and rising to a maximum height of 163 m at Beachy Head itself.

The National Vegetation Classification (NVC) (Rodwell in press) covers twelve maritime cliff communities and twenty-nine sub-communities, though almost all refer to hard cliff habitats. Ten cliff NVC communities are recorded for England, the remaining two being confined to Scotland. No detailed NVC mapping is available for any locality in this region, but the MC1 rock samphire *Crithmum maritimum* maritime rock-crevice, MC4 wild cabbage *Brassica oleracea* maritime cliff ledge, MC5 thrift *Armeria maritima* - sea mouse-ear *Cerastium diffusum* subsp. *diffusum* maritime therophyte, MC8 red fescue *Festuca rubra* - thrift maritime grassland and MC11 red fescue - wild carrot *Daucus carota* subsp. *gummifer* maritime grassland types are all probably present on chalk cliffs of the region. These types conform to the zonation of vegetation known elsewhere on the Channel coast where south-facing limestone cliffs and thin soils produce very dry conditions.

In Great Britain nine nationally rare and four nationally scarce species or subspecies of higher plant are found mainly or exclusively on cliffs. Most are restricted to cliff habitats in the south and west of Britain with calcareous soils and a mild climate. One such nationally rare (Red Data Book) species occurs in the region: sea stock *Matthiola incana*, plus the nationally scarce wild cabbage *Brassica oleracea* var. *oleracea*. Other nationally rare and scarce species more typical of other habitats also occur and eight nationally scarce species occur on the chalk cliffs: rock sea-lavender *Limonium binervosum sensu stricto*, yellow vetch *Vicia lutea*, bulbous meadow-grass *Poa bulbosa*, curved hard-grass *Parapholis incurva*, suffocated clover *Trifolium suffocatum*, field fleawort *Senecio integrifolius* subsp. *integrifolius*, Nottingham catchfly *Silene nutans* and bastard-toadflax *Thesium humifusum*. Lichens of regional importance are recorded on closely rabbit-grazed turf at Seven Sisters Cliff between Birling Gap and Cuckmere Haven (Fletcher *et al.* 1984). The vegetation of the soft cliffs at Fairlight Cove is regarded as of national importance for its botanical interest, especially the plant succession on landslips, which includes woodland and scrub habitat (Doody *et al.* 1993).

There are no important cliff seabird colonies warranting

Special Protection Area status in the region (Stroud *et al.* 1990). No systematic survey of invertebrates of cliff and cliff-top habitats in the region has been carried out, but these environments have a rich habitat diversity and thus can support large numbers of species (Mitchley & Malloch 1991). The major cliffs in the region all have excellent invertebrate lists, and Seaford to Beachy Head SSSI, Fairlight and Seven Sisters Park each contain large numbers of notable and rare (Red Data Book) species, for which they are nationally important (see also section 5.3).

3.1.3 Human activities

Cliffs are among the least modified of terrestrial habitats, although the cliff-top zone, especially its landward sectors, has been affected by a variety of human impacts, sometimes leading to major habitat loss. Local heavy impacts have occurred in the region, affecting both soft and hard cliff sectors.

In general, residential development and recreational pressures have produced only local habitat loss in the region, and the bulk of the regional cliff resource remains in good condition. In West Sussex a small length (0.8 km) of soft cliff at Selsey Bill is backed entirely by residential development; this, combined with erosion, has eliminated natural and semi-natural cliff-top habitats in this area. The cliff foot is also modified by an extensive length of groyne, which changes the natural pattern of erosion and sedimentation. Soft cliff in East Sussex is largely unmodified west of Fairlight Cove, although residential development occurs almost to the cliff edge along a 2 km stretch at Fairlight itself (40% of the soft cliff extent). The majority of the chalk cliff-top in East Sussex has no residential building, although there has been encroachment south of Seaford at the western end of the cliffed sector. A large proportion of cliff in this sector is owned by the National Trust and is managed as farmland with open public access. Regional cliffs and their immediate hinterlands are major recreational resources, with a very large population catchment within easy travelling distance. Country parks are present at Seven Sisters and Fairlight. There is a long-distance walk (the South Downs Way) along the cliffs from Seven Sisters to Beachy Head. Walkers and visitors have caused some local erosion and compaction of grassland turf. There is no caravan park development close to cliffs in the region.

At a national scale the most extensive influences upon hard cliff vegetation are grazing and burning, the major management techniques for cliff-top habitat (Mitchley &

Malloch 1991). Grazing continues on chalk cliff-tops in the region but is rare on the soft cliffs. Targets for re-creating maritime cliff grassland from arable or improved pasture are discussed by Pye & French (1993), but there is probably limited scope in the region.

The base of all the soft cliffs in West Sussex is protected by groynes, but elsewhere there are few coastal defences and hence natural coastal erosion is present. Cliff toe erosion provides a sediment source for beaches downdrift (Pye & French 1993) and is probably important in maintaining beach sedimentation elsewhere in the region.

3.1.4 Information sources

Cliff lengths come from the JNCC's Coastal Database, which records lengths and areas of coastal habitats in 10 km squares, measured at 1:50,000 scale. No detailed vegetation survey is available for the region and the closest available NVC study is for Trimmingham, Norfolk (Cooper 1988); existing information is therefore insufficient to detail 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 Deborah Procter (JNCC).

3.1.6 Further sources of information

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- 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, site reports, site management	*Coastal Ecologist, English Nature HQ, Peterborough, tel: 01733 450000
Cliff conservation	*Coastal Advisor, JNCC, Peterborough, tel: 01733 562626
Cliff sites in the region	*English Nature, Sussex and Surrey Team, Lewes, tel: 01273 476595
National Landslide Databank	Rendel Geotechnics, Norfolk House, Smallbrook Queensway, Birmingham B5 4LJ, tel: 0121 627 1777
Invertebrate fauna	*Invertebrate Site Register, JNCC, Peterborough, tel: 01733 562626

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

3.2 Sand dunes

Dr T.C.D. Dargie

3.2.1 Introduction

The sand dunes of the region include 96 ha of vegetated sand and other land cover (Table 3.2.1). This represents 1% of the English resource and 0.2% of dunes in Britain and the region is therefore of modest importance in the national context.

Table 3.2.1 Region 8 vegetated dune resource in context

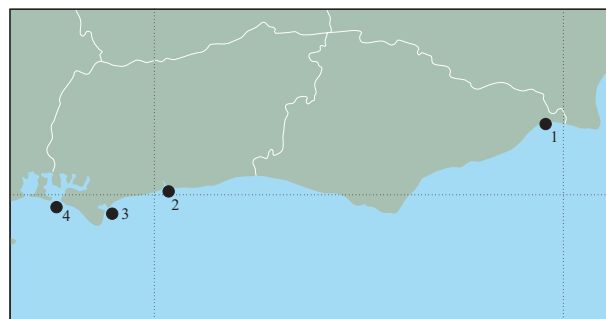
	Total area (ha*)	% of total in Region 8
East Sussex	67	-
West Sussex	29	-
Region 8	96	-
England	9,282	1.0
North Sea Coast	25,356	0.4
GB	50,200	0.2

Sources: Dargie (1993, 1995), Radley (1994), JNCC Coastal Database.

Key: *to the nearest whole hectare. Note: totals for the North Sea Coast and Great Britain are provisional estimates, as sand dunes systems in Scotland have not yet been systematically surveyed.

90 National Vegetation Classification (NVC) communities have been 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 most extensive types in the region are mobile (SD6 marram *Ammophila arenaria* community) and semi-fixed dunes (SD7 marram - red fescue *Festuca rubra* community), plus neutral grasslands (SD8 red fescue - ladies' bedstraw *Galium verum* fixed dune grassland, SD9 marram - false oat grass *Arrhenatherum elatius* coarse grassland). There are also notable small extents of strandline vegetation (SD2 sea sandwort *Honkenya peploides* - sea rocket *Cakile maritima* and SD3 sea mayweed *Tripleurospermum maritimum* - cleavers *Galium aparine* communities). Dune slack (a habitat influenced by the dune watertable) is absent, probably because most sites are small. The extent of dune vegetation types occurring in the region is given in Table 3.2.2.

Despite their relatively small size, all sites in the region have high quality dune habitats, and this is recognised in their designation as Sites of Special Scientific Interest (SSSIs). Two



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

sites, Pagham Beach and East Head (West Wittering), are designated as Local Nature Reserves, Ramsar sites and Special Protection Areas, and East Head (West Wittering) is within an Area of Outstanding Natural Beauty (Table 3.2.3).

3.2.2 Important locations and species

There are four dune sites in the region (Map 3.2.1), of which Camber Sands is the most extensive (Table 3.2.3). Three sites have spit dune systems. These develop at the mouths of rivers, which supply sediment for spit formation, with coastal currents and their sediments helping to form and shape individual systems further. East Head, West Wittering, lies at the mouth of Chichester Harbour and tidal currents are the main agents in determining its shape. Pagham Beach is formed at the mouth of Pagham Harbour. Climping Beach is developed at the mouth of the River Arun. All the spit systems in the region provide important shelter for estuarine habitats inland, with saltmarsh developing on the inside of East Head and Pagham Beach. Camber Sands is an example of a ness/foreland dune, a type that develops on shores with sediment supply from two directions and gradually extends seawards. In this case the bulk of the sediment is the shingle of Dungeness: the dune system has developed on its western flank in a confined area with sand supply. There are no bay dunes, climbing dunes or hindshore type dunes in the region.

Table 3.2.2 Areas (ha*) of dune vegetation types

	Strand and embryo dune	Mobile and semi-fixed dune	Acidic fixed dune grass- land	Neutral and calcareous fixed dune grassland	Dune heath and bracken	Dune slack	Other dune wetland	Dune woodland and scrub	Transition to salt- marsh	Transition to maritime cliff	Other land cover
East Sussex	4	18	7	16	0	0	0	9	0	0	23
West Sussex	4	12	0	0	0	0	0	0	0	0	2
Region 8	8	31	7	16	0	0	0	9	0	0	25
England	179	2,484	671	2,710	197	487	150	1,189	141	30	1
GB	340	8,504	4,953	15,228	2,615	2,175	4,114	8,965	836	64	1

Sources: Dargie (1993, 1995), Radley (1994), JNCC Coastal Database. Key: *to the nearest whole hectare. Note: country totals for Scotland (and therefore Great Britain) are provisional estimates.

Table 3.2.3 Sand dune sites in region

No. on Map 3.2.1	Location	Grid ref.	Area (ha*)	Dune type	Conservation status
1	Camber Sands	TQ955187	67	Ness/foreland	SSSI
2	Climping Beach	TQ021013	9	Spit	SSSI
3	Pagham Beach	SZ887967	1	Spit	LNR, Ramsar, SPA, SSSI
4	East Head, West Wittering	SZ771984	19	Spit	AONB, LNR, NT, Ramsar, SPA, SSSI

Source: Radley (1994). Key: *to the nearest whole hectare; AONB = Area of Outstanding Natural Beauty; LNR = Local Nature Reserve; NT = National Trust; Ramsar = Ramsar site; SPA = Special Protection Area; SSSI = Site of Special Scientific Interest.

In Great Britain, four nationally rare and thirteen nationally scarce higher plants are found mainly or exclusively on dunes (Radley 1994; Stewart *et al.* 1994). No nationally rare dune species is present in the region, although there are two nationally scarce plants: sea-buckthorn *Hippophae rhamnoides* and dune fescue *Vulpia fasciculata*. Other rare and scarce species more typical of other habitats also occur on regional dunes, including the nationally scarce sand catchfly *Silene conica*, Nottingham catchfly *S. nutans* and suffocated clover *Trifolium suffocatum*. Three dune sites (Camber Sands, East Head (as part of Chichester Harbour SSSI) and Pagham Beach (as part of Pagham Harbour SSSI)) are outstanding in terms of Invertebrate Site Register records.

3.2.3 Human activities

In general, sand dunes are among the least heavily modified of terrestrial habitats. However, the restricted extent and small number of sites in this heavily populated region has resulted in pressure on dune vegetation, most notably at Camber Sands (Pizzey 1975; Ranwell & Boar 1986). Here, heavy recreational pressure in the form of car damage, chalet construction and trampling before 1939 and subsequent wartime amphibious training destabilised the dune system, with post-war recreation further preventing stabilisation. Dune blowouts carried sand to the rear, inundating roads and private property. A dune restoration scheme was begun in 1967 and within four years control of dune movement and recreational access was achieved. The dunes remain relatively open and there is still a risk of further destabilisation without careful management of the site. Sand carried to the rear of the dunes at Camber was used in the construction of Dungeness Power Station. Recreational impacts continue at all sites (Radley 1994), with moderate trampling erosion from visitors present at all sites and widespread, severe erosion at Pagham Beach. Vehicle damage to dunes is recorded at East Head (West Wittering). Three sites have golf courses and there has been some modification of dune swards on greens and fairways. In general sites are carefully managed and cope well with high visitor numbers. Two sites (Pagham Beach and East Head) are managed for nature conservation as Local Nature Reserves.

3.2.4 Information sources used

All dune sites have been surveyed as part of the Sand Dune Vegetation Survey of Great Britain (Radley 1994). These studies have used the National Vegetation Classification (NVC) (Rodwell 1991a, 1991b, 1992, 1995, in press). The Sand

Dune Vegetation Survey of Great Britain was initiated by the Nature Conservancy Council in 1987 and continued after 1992 by the Joint Nature Conservation Committee on behalf of country conservation agencies. The NVC surveys, all carried out in the summer months, are very detailed and use a consistent methodology. The vegetation is mapped and described, and information on coastal erosion and accretion, atypical vegetation and adjoining land use is also recorded.

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- Rose, F. 1995. *The habitats and vegetation of Sussex*. Brighton, Booth Museum of Natural History.

C. Contact names and addresses

Type of information	Contact address and telephone no.
Sand dune flora, fauna, habitat information, site management - England	*Maritime Team Leader, English Nature, Peterborough, tel: 01733 455000
Advice on national and international policy and dune conservation	*JNCC, Peterborough, tel: 01733 562626
Sand dune sites in the region	*English Nature, Sussex and Surrey Team, Lewes, tel: 01273 476595
Invertebrate data	*Invertebrate Site Register, JNCC, Peterborough, tel: 01733 562626

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



The Sussex coast is well known for its shingle beaches. At Norman's Bay, East Sussex, a caravan park lies directly behind the fringing shingle, which nevertheless supports many plants of sea-kale *Crambe maritima*, a species that is declining over most of Britain but is widely found in this region. Photo: Peter Wakely, English Nature.

3.3 Vegetated shingle structures and shorelines

Dr R.E. Randall

3.3.1 Introduction

Shingle means sediments larger than sand but smaller than boulders: that is, between 2-200 mm in diameter. This section includes 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 Camber and East Head - see [section 3.2](#)). The region contains over 15% of the vegetated shingle resource in Britain ([Table 3.3.1](#)), a significant proportion of the total resource of vegetated shingle in Britain (Hubbard 1970). Most of this occurs at Rye Harbour ([Table 3.3.2](#)), where over 16.5% of England's shingle occurs.

Table 3.3.1 Area of vegetated shingle structures in Region 8

	Area (ha)
East Sussex	721.0
West Sussex	56.5
Region 8	777.5
England	4,353.1
North Sea Coast	4,472.3
Great Britain	5,129.1
% North Sea Coast total in region	17.4
% England total in region	17.9
% GB total in region	15.2

Sources: Sneddon & Randall (1994), JNCC Coastal Database

At some of the region's shingle sites the sandy nature of the substrate is strongly reflected in the vegetation, but elsewhere pure shingle, the influence of saltmarsh or the southern location of these sites give distinctive species assemblages. Many of these sites support important examples of pioneer shingle vegetation communities, as well as transitions between shingle and saltmarsh, sand dune or (at Rye Harbour) scrub, or between wet and dry shingle.

3.3.2 Important locations and species

Major shingle structures in the region are listed in [Table 3.3.2](#) ([Map 3.3.1](#)). The East Sussex shingle includes, at Rye Harbour, a major shingle structure: a complex apposition beach at which deposition dates back to the 12th century. In West



Map 3.3.1 Vegetated shingle structures and fringing shingle beaches. Source: Sneddon & Randall (1993).

Sussex, the shingle structures at Pagham and Church Norton are the remains of a breached barrier bar across the entrance to Pagham Harbour. Pagham Spit comprises multiple ridges of flint shingle with little matrix, whereas Church Norton Spit has a fine shingle matrix and merges inland to saltmarsh (Rayner 1981). East Head is a sandy shingle spit projecting into Chichester Harbour and backed by saltmarsh.

The fringing shingle beaches in the region ([Map 3.3.1](#)) have a range of matrices from silt to sand to pure shingle, with Langney Point (at the western end of Pevensey Bay) containing a graded series of non-flint pebbles, including quartz-tourmaline from Budleigh Salterton (Devon - Region 10) (Steers 1964). The West Sussex coast has considerable lengths of fringing shingle beach from Shoreham to Bognor Regis ([Table 3.3.3](#)).

The nationally scarce sea pea *Lathyrus japonicus* is abundant from Camber to Rye but is extinct at its other previously known sites in this region (Randall 1977). Sea-kale *Crambe maritima* is declining over most of Britain (Scott & Randall 1976) but is found extensively with sea pea in the pioneer communities at Rye and at Church Norton Spit and Cuckmere Haven. The once extensive spreads of sea kale at Shoreham Beach have partly been lost to residential building, though many plants remain as relicts in gardens. A remnant of a once larger population of nationally rare starry clover *Trifolium stellatum* is found at Shoreham Beach. Scrub communities are a rare component of shingle vegetation, but at Nook Beach, Rye Harbour, blackthorn *Prunus spinosa* thickets occur and at Church Norton there is damp lichen-rich blackthorn scrub with oak *Quercus robur*, common reed *Phragmites australis* and ivy *Hedera helix*. Pagham Spit is

Table 3.3.2 Shingle sites surveyed

Site name	Location	Area surveyed (ha)	Site type	Conservation status
Rye Harbour	TQ935180	721.0	Apposition beach ridge system accreting southwards	SSSI/LNR
Pagham and Church Norton Spits	SZ880950	42.4	Flint shingle breached barrier bar with little or no matrix	SSSI/LNR
East Head	SZ770980	14.1	Sandy shingle spit partly overlain by dunes and backed by saltmarsh	NT

Source: after Sneddon & Randall (1994). Key: SSSI = Site of Special Scientific Interest; LNR = Local Nature Reserve; NT = National Trust property.

Table 3.3.3 Fringing shingle beaches

Site name	Grid ref.	Length of shoreline (km*)	Site type
Camber	TQ9818	3.5	Sandy shingle apposition ridge
Pevensey Bay	TQ6705	8.0	Apposition and fringing shingle
Cuckmere Haven	TV5298	0.5	Estuarine shingle
Seaford	TV4998	0.5	Pure shingle, little vegetation
Newhaven	TQ4300	1.0	Pure shingle, disturbed
Shoreham	TQ2304	2.5	Pure shingle, disturbed
Worthing	TQ1703	8.5	Pure shingle, disturbed
Littlehampton	TQ0302	9.5	Extensive pure shingle fringing beach
Bognor Regis	SZ9498	3.0	Pure shingle, disturbed

Source: Randall (unpublished survey, early 1980s). Key: *to the nearest 0.5 km.

important for its saline shingle flora around Little Lagoon, where sea-purslane *Halimione (Atriplex) portulacoides*, sea beet *Beta vulgaris* subsp. *maritima*, annual sea-blite *Suaeda maritima* and frosted orache *Atriplex laciniata* grow on silty shingle.

East Head has an unusual, slightly saline, open pioneer community on low, sandy shingle with sea beet, curled dock *Rumex crispus*, lesser sea-spurrey *Spergularia marina* and saltmarsh rush *Juncus gerardii*. At higher elevations rock samphire *Crithmum maritimum* and sea-holly *Eryngium maritimum* become important. Yellow horned-poppy *Glaucium flavum* is an important component of the flora of the shingle beaches of this region that have a sandy matrix.

Rye Harbour shingle has a nationally important little tern *Sterna albifrons* colony, while there are less significant tern populations at Church Norton Spit and East Head. Rye is also important for breeding waders such as ringed plovers *Charadrius hiaticula*.

The invertebrates of Rye Harbour have been studied by Morris & Parsons (1991a, b). The sea kale zone contains the rare spider *Euophrys browni*. The ridges south of Castle Water have a particularly rich spider fauna that includes *Argenna subnigra* and the rare *Lathys stigmatisata*. The heat-tolerant ants *Myrmica specioidea* and *M. schenki* are abundant on drier ridges, as is the bee *Andrena labiata*. Wet hollows contain the rare flies *Limonia complicata* and *Eristalinus aeneus*. Historically Rye Harbour has been famous for its water beetle fauna; species include *Omophron limbatum*, *Dyschirius obscurus*, *Hydrophilus piceus* and *H. clypealis*. On dry shingle winnings the beetles *Cymindis axillaris* and *Brachinus crepitans* are present.

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, affecting the plant communities that can survive there. At Rye Harbour large quantities of shingle have been extracted, creating a series of gravel pits filled with water that ranges from fresh to brackish. In areas of the Rye shingle just behind the storm crest, shallow extraction has created a low-lying area subject to occasional flooding. Currently the most significant activities at this site are sea defence works, which have resulted in extensive damage from vehicle tracks, and agricultural activities to landward (cattle grazing in the marsh areas and arable fields further inland). Some areas of

vegetated shingle have been ploughed in the past to encourage extension of the tern colony, and electric fencing has been put in place around the nesting area to discourage foxes. Building work along the road to the Watch House has caused a limited loss of natural vegetation, as has the golf course near Camber Castle.

Pagham Spit has been extensively built over at its north-eastern end and is also the site of a large car park. Sea defence works have disturbed the shingle between Little Lagoon and the harbour entrance. East Head is an extremely popular tourist venue and suffers considerable visitor erosion, but the National Trust is involved in restoration projects in the dune areas. Grazing of domestic stock on shingle in this region is limited to the fenced areas at Rye Harbour. Rabbit grazing is ubiquitous.

3.3.4 Information sources used

The vegetated shingle structures of the region were surveyed between May and August 1990 during the National Vegetated Shingle Structures Survey undertaken by the Nature Conservancy Council, which used the National Vegetation Classification (NVC) (Rodwell in press). For full details of the methodology see Sneddon & Randall (1993) and Ferry *et al.* (1990). Rye Harbour has been studied over many years by geomorphologists (e.g. Lovegrove 1953) as well as ecologists (Morris & Parsons 1991a, b) and Pagham Harbour was examined by Bognor Regis Natural Science Society in the early 1980s (Rayner 1981), and again in 1996 (Antonini & Benatt 1996). Many shingle fringing beaches were examined by the author in the early 1980s as part of a survey of shingle beaches sponsored by BP. Beaches covered by 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 sites, Sussex	*Conservation Officer, Sussex Wildlife Trust, Henfield, tel: 01273 492630
Shingle sites, Sussex	*English Nature, Sussex and Surrey Team, Lewes, tel: 01273 476595
Rye Harbour	The Warden, 2 Watch Cottages, Front Ridge, West Beach, Rye Harbour, Rye, East Sussex TN31 7TS, tel: 01797 223862
Pagham Harbour	Director of Property West Sussex County Council, The Tannery, Westgate, Chichester PO19 1RJ, tel: 01243 777100

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

3.4 Coastal lagoons

R.N. Bamber & 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 physiographic lagoons (*sensu* Barnes 1988), i.e. those separated from the sea by a natural sedimentary barrier, as well as other lagoonal areas (*sensu* Thorpe *et al.* in prep.), e.g. isolated percolation pools, sluiced or culverted pools, silled inlets and artificial brackish ponds and coastal pools, of a similarly restricted tidal range and often containing a comparable lagoonal biota. Lagoons are commonly shallow, often with a varying salinity ranging both above and below normal sea-water levels (35 g/kg).

The contribution of the region's lagoons to the size of the British lagoon (*sensu* Barnes 1988) resource as a whole is shown in Table 3.4.1.

Table 3.4.1 Lagoon+ areas* for region in context

Region	Lagoonal area (ha)	Overall % of GB total	% of GB total excl. The Fleet
East Sussex	5.0	0.4	0.6
West Sussex	11.5	0.9	1.5
Region 8	16.5	1.3	2.1
North Sea Coast	1,163	92.2	87.5
Great Britain	1,261	100	100

Key: +*sensu* Barnes (1988); *to the nearest 0.5 ha.

Other definitions of 'lagoon' and 'lagoonal' are also current. Using Thorpe *et al.* (in prep.)'s broad definition, the region contains 52.5 ha of lagoonal habitat, approximately 2% of the GB total (Table 3.4.2). The region is therefore of modest importance for lagoons in a national context.

Table 3.4.2 Lagoon+ areas* for region in context

Region	Lagoonal area (ha)	Overall % of GB total	% of GB total excl. The Fleet
East Sussex	18.0	0.7	0.8
West Sussex	34.5	1.3	1.6
Region 8	52.5	2.0	2.4
North Sea Coast	1,819	68.4	61.4
Great Britain	2,658	100	100

Key: +including areas classified as 'lagoonal' by Thorpe *et al.* (in prep.); *to the nearest 0.5 ha.

The four natural lagoons in the region (totalling 16.5 ha) amount to 6.9% of the lagoonal resource that was regarded by Barnes (1989) as being 'especially noteworthy in the national context', excluding The Fleet in Dorset (Table 3.4.3).

There are another 36 ha of artificial lagoonal habitat within the region, some sites being notable for their faunal diversity.

Lagoons as defined by the European Commission, whose definition differs from that used to compile the figures in Table 3.4.1 and Table 3.4.3 and more closely matches that used by Thorpe *et al.* (in prep.) (see Table 3.4.2), are a nationally rare

Table 3.4.3 Nationally noteworthy lagoonal* areas for region and country

Region	Lagoonal area (ha)	Overall % of GB total	% of GB total excl. The Fleet
Region 8	16.5	3.0	6.9
North Sea Coast	521	96	63.0
Great Britain	545	100	100

Key: +*sensu* Barnes (1989); *to the nearest 0.5 ha.

habitat and a 'priority habitat type' under Annex I of the EC Habitats & Species Directive. Therefore examples of the habitat type in the region are of national and international importance. The region is also of significance in the national context owing to the presence of Widewater Lagoon, Sussex, which is the sole known site in the world for Ivell's sea anemone *Edwardsia ivelli*, now feared extinct, and one of the very few sites in the world and the only site in Britain for the hydroid *Clavopsella navis* (although this species is possibly not native here).

3.4.2 Important locations and species

Map 3.4.1 shows the location of the lagoonal and other saline pools mentioned; Table 3.4.4 lists their areas and physiography.

In addition to the sites listed in Table 3.4.2 there are a number of ponds retained behind sea walls, and old mill ponds and restricted saltmarsh channels, many of which contain freshwater or estuarine habitats (e.g. Bishopstone Tide Mill near the mouth of the River Ouse, Newhaven; Pagham Saltmarsh Channel, West Sussex). The Hove Lagoon at Portslade, E. Sussex, has been lined with concrete as a boating pond. The inner harbour of Brighton Marina, E. Sussex, is a recently constructed feature with lagoon-like habitat.

True lagoons support only three types of aquatic vegetation, namely stands of green algae (*Chaetomorpha* spp., *Ulva* spp. and *Enteromorpha* spp.), seagrasses (predominantly *Ruppia* spp.) and, much more rarely, stoneworts (especially *Lamprothamnium* spp.). Much of the area of their beds, however, is in the form of bare sediment, devoid of vegetation



Map 3.4.1 Coastal lagoons and other saline ponds.

Table 3.4.4 Lagoonal areas surveyed

Name	Grid ref.	Area (ha*)	Type
East Sussex			
Rye Harbour	TQ940178	5	'Natural' (flooded gravel pit)
Winchelsea Beach	TQ922165	<1	Percolating pond
Seaford Ponds	TV518980	13	Sluiced pond system
West Sussex			
Widewater Lagoon	TQ200042	3.5	Natural, percolation
Pagham Little Spit	SZ882962	1	Natural, percolation
Pagham Lagoon	SZ855970	7	Natural, percolation
Church Norton	SZ874946	1	Percolation pool
Birdham Pool	SU825010	4	Sluiced
Great Deep	SU755040	18	Sea-wall sluiced pond

Source: Sheader & Sheader (1985a, b). Key: *to the nearest 0.5 ha.

cover. Fringing stands of common reeds *Phragmites australis*, saltmarsh plants and/or sea club-rush *Scirpus maritimus* are usual. All these communities, with the exception of the stoneworts, occur in the region, although they are relatively poorly developed. No important lagoonal plant species occur in the region, although the shingle surrounding Rye Harbour lagoon supports sea-kale *Crambe maritima* and sea pea *Lathyrus japonicus*.

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 & Countryside Act 1981. Three of these protected species occur in the region, the lagoonal sand-shrimp *Gammarus insensibilis* at Birdham Pool, the starlet sea anemone *Nematostella vectensis* in Pagham Lagoon, and most notably Ivell's sea anemone *Edwardsia ivelli*, which has only ever been recorded from Widewater Lagoon. However, it has not been seen since 1983 and may now be extinct. Other notable lagoonal species in the region's saline lagoons are the lagoonal snails *Hydrobia ventrosa* and *Littorina tenebrosa*, the bryozoan *Conopeum seurati*, the lagoonal cockle *Cerastoderma glaucum* and the lagoonal isopod *Idotea chelipes*, a species apparently characteristic of the lagoons of south-eastern Britain. The region's lagoons also support numerous wading birds and wildfowl, notably at Rye Harbour and Widewater (the former part of a bird reserve and containing artificial nesting islands).

3.4.3 Human activities

Little or no active management is applied to the region's coastal lagoons themselves, although the surrounding land is often managed intensively. Widewater Lagoon has suffered a marked and accelerating decline over the last few decades, possibly as a result of changes to its hydrology (see e.g. McDonagh & Sheader 1991). An 'Action Plan' for its future management has been commissioned (Everett 1993). Rye Harbour and Pagham Lagoons lie within Local Nature Reserves, largely for the benefit of the birdlife. No ecological management is carried out for the other saline ponds in the region.

3.4.4 Information sources used

All likely lagoons in the region were surveyed as part of the national lagoon survey undertaken by Sheader & Sheader in 1984-5 on behalf of the Nature Conservancy Council. Detailed reports of these surveys are available (Sheader & Sheader 1985a, b); they include maps of the habitats and species lists. The data are summarised by Barnes (1989), Sheader & Sheader (1989) and Smith & Laffoley (1992), from which the data given here are derived. There were a number of earlier studies of Widewater Lagoon by Southampton University staff (e.g. Ward 1983), and the Lagoon has been surveyed intensively over recent years (Sheader & Sheader 1990; Everett 1993). Fawley Aquatic Research Laboratories studied potential early colonisation in the artificial lagoon-like basin at Brighton Marina in 1991 (Bamber & Bridgwater 1991). Downie (1996) summarises the conservation value of saline lagoons and lagoon-like saline ponds in England.

3.4.5 Acknowledgements

The authors wish to thank Dr Martin Sheader for the information he supplied for this section.

3.4.6 Further sources of information

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JNCC. 1996. *Guidelines for selection of biological SSSIs: intertidal marine habitats and saline lagoons*. Peterborough, Joint Nature Conservation Committee.

C. Contact names & addresses

Type of Information	Contact address and telephone no.
Lagoons in England	*Maritime Team, English Nature HQ, Peterborough, tel: 01733 455000
Brackish lagoons of the region	Dr R.S.K. Barnes, St. Catharine's College, University of Cambridge, Cambridge CB2 1RL, tel: 01223 336606
Brackish lagoons and saline pools of the region	Dr M. Sheader, Department of Oceanography, University of Southampton, Southampton SO9 5NH, tel: 01703 595000
Rye Harbour Local Nature Reserve	Dr B. Yates, 2 Watch Cottages, Nook Beach, Winchelsea, E. Sussex TN36 4LU, tel: 01797 223862
Pagham Harbour Local Nature Reserve	S. Knapp, Pagham Harbour Local Nature Reserve, Pagham Information Centre, Selsey Road, Sidlesham, W. Sussex PO20 7NE, tel: 01243 641508

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



The ditches of wet grasslands in Sussex are at least as important for wildlife as the meadows themselves. Some of the plants are nationally rare, but more typical ditch species in the region include common reed *Phragmites australis* and the white water-lily *Nymphaea alba* (pictured here at Pevensey Levels National Nature Reserve). Photo: Peter Wakely, English Nature.

3.5 Wet grassland

Dr H.T. Gee

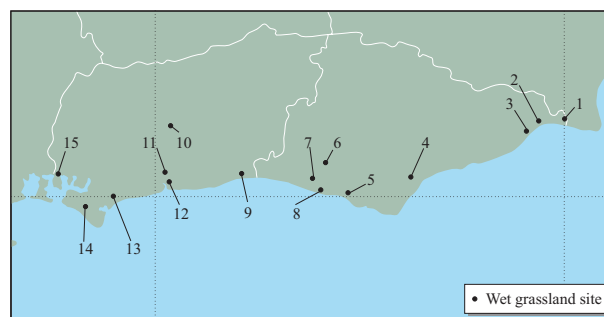
3.5.1 Introduction

Wet grassland includes 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 lowland wet pasture drained by a series of ditches that may be either brackish or freshwater. The conservation interest of wet grassland can be in the pastures themselves or in the ditches. Some sites are of interest for both, but many sites are agriculturally improved and are of interest only for their ditch flora and fauna. Wet grassland sites may remain wet throughout the year and may be managed for stock grazing and/or as hay meadow.

No national survey exists of wet grassland as here defined, or indeed of coastal grazing marsh or lowland wet grassland separately, so detailed inter-region comparisons are not possible. However, Dargie (1993) estimated that there were a total of 12,000 ha of lowland wet grassland in the region, of which around 7,720 ha were in East Sussex and 4,279 ha in West Sussex.

3.5.2 Important locations and species

Table 3.5.1 lists the locations of wet grassland sites in the region (Map 3.5.1). Areas of wet grassland have formed behind shingle on the low-lying coastline at either end of the county. The eastern end of the county supports substantial areas of wet grassland, notably on Walland Marsh and adjacent land around Rye Harbour, Pett Level and the extensive Pevensy Levels. In the west there is wet grassland associated with Chichester and Pagham Harbours. Pagham Harbour was drained for agriculture in the nineteenth century, but much of it was subsequently inundated by the sea in the early twentieth century and has reverted to saltmarsh. A range of fresh and brackish marsh is present around



Map 3.5.1 Locations of coastal wet grassland (Table 3.5.1).

Chichester Harbour. In places, saltmarsh grades through common reed *Phragmites australis* marsh to freshwater marsh receiving spring water from the underlying chalk. At some localities, there are small pockets of former wet grassland behind sea walls, for example at Thorney Deeps. Elsewhere the coastline is more elevated, and the narrow estuaries of the Rivers Cuckmere, Ouse, Adur and Arun flow through gaps in the South Downs chalk escarpment. These estuaries are tidal for many kilometres inland and have been heavily engineered, with fringing saltmarsh cut off from estuarine influence through the construction of embankments. The saltmarsh and adjacent wetlands were subsequently converted to wet grassland, often referred to as 'brooks' or 'water meadows'. Amberley Wild Brooks, for example, is at least 15 km inland.

Much of the coastal wet grassland in the region is agriculturally 'improved', overlying either Wealden clays or alluvium, and supports plant species typical of nutrient-rich wet grasslands and ditches. At some sites, such as Lewes Brooks on the River Ouse, there is a gradation from fresh to brackish ditches, which enhances the diversity of the site. Similarly, the floristic wealth of Amberley Wild Brooks on the River Arun is attributed to the range of water chemistry in the ditches, which overlie patches of alluvium, greensand and

Table 3.5.1 Wet grassland sites in Region 8

No. on Map 3.5.1	Location	Grid ref.	Conservation status
East Sussex			
1	Walland Marsh	TQ960240	Part SSSI
2	Rother Estuary	TQ935180	Parts in Rye Harbour SSSI
3	Pett Level	TQ903157	SSSI
4	Pevensy Levels	TQ650070	SSSI
5	Cuckmere Estuary	TQ515000	In Seaford to Beachy Head SSSI
6	Offham Marshes	TQ404118	SSSI
7	Lewes Brooks	TQ410085, TQ430075	SSSI
8	Lower Ouse Valley	TQ455010, TQ440030	Undesignated
West Sussex			
9	River Adur	TQ200075	Undesignated
10	Amberley Wild Brooks	TQ033142	SSSI
11	Arun Banks	TQ029100	Adjacent to SSSI
12	Arundel Water Meadows	TQ013050	Undesignated
13	Pagham Harbour	SZ875970, SZ878982	SSSI
14	Broad Rife	SZ868982	Partly in Bracklesham Bay SSSI
15	Chichester Harbour	SZ830950	
		SU760000	Mostly SSSI

Source: Dargie *et al.* (1994). Key: SSSI = Site of Special Scientific Interest.

peat and receive water from calcium-rich springs. The grassland at this site is of noted conservation value and, where ungrazed, has developed into fen and marsh communities.

The ditch flora of the Sussex wet grasslands includes a number of nationally rare (Red Data Book - RDB) species, such as sharp-leaved pondweed *Potamogeton acutifolius*, cut-grass *Leersia oryzoides*, and nationally scarce species such as hair-like pondweed *Potamogeton trichoides*, water soldier *Stratiotes aloides* and greater water-parsnip *Sium latifolium*. Other typical ditch species in the region include flat-stalked pondweed *Potamogeton friesii*, soft hornwort *Ceratophyllum submersum*, frogbit *Hydrocharis morsus-ranae* and arrowhead *Sagittaria sagittifolia*. Bank-side species include the nationally scarce marsh-mallow *Althaea officinalis*. In the meadows themselves, the RDB red star-thistle *Centaurea calcitrapa* is recorded from the fields adjacent to the Cuckmere Estuary, and the nationally scarce slender hare's-ear *Bupleurum tenuissimum*, bulbous foxtail *Alopecurus bulbosus* and divided sedge *Carex divisa* are present on wet grasslands elsewhere in the region. At Offham Marshes there are poorly-drained fields supporting swards rich in sedges, such as brown sedge *Carex disticha* and common sedge *C. nigra*, plus meadowsweet *Filipendula ulmaria*. The unimproved wet pasture of Broad Rife experiences seasonal inundation and supports a number of saltmarsh species in the sward, such as sea aster *Aster tripolium* and sea-purslane *Halimione (Atriplex) portulacoides*.

As elsewhere in Britain, wet grassland is of local importance for breeding waders, such as lapwing *Vanellus vanellus*, redshank *Tringa totanus* and snipe *Gallinago gallinago*. Important numbers of wintering golden plover *Pluvialis apricaria*, grey plover *Pluvialis squatarola* and curlew *Numenius arquata* are also found. Waltham Brooks on the River Arun includes the Pulborough Brooks RSPB Reserve and supports nationally important populations of Bewick's swan *Cygnus columbianus*, teal *Anas crecca* and shoveler *Anas clypeata*. The lowland wet grassland around Chichester and Pagham Harbours provides valuable feeding grounds for the internationally important populations of wintering brent geese *Branta bernicla* that these two harbours support (Round 1982).

The aquatic invertebrate fauna of wet grasslands is typically species-rich and in this region includes some rare and spectacular species. The Pevensey Levels are outstanding nationally and are the top national site for molluscs and aquatic Coleoptera. Carr (1984) surveyed the aquatic beetle fauna of the Pevensey Levels and recorded a total of seven species currently included in the Red Data Book, as well as sixteen nationally notable (nationally scarce) species (see section 5.3). At least fifteen species of dragonfly and damselfly - a high total for a wet grassland - have been recorded from the Pevensey Levels, including the nationally scarce hairy dragonfly *Brachytron pratense* and variable damselfly *Coenagrion pulchellum*, both of which are wet grassland specialists. Pevensey Levels is the only known British site for the leech *Placobdella costata* and one of the few locations of the RDB fen raft spider *Dolomedes plantarius*. Pett Level is of particular note for the assemblage of fly (Diptera) species it supports, plus *Macroplea mutica*, a rare weevil that lives on the roots of hair-like pondweed. The reedbeds on Pett Level support a range of uncommon moths.

The wet grasslands of the Arun Valley also support a rich invertebrate fauna. A survey of the wet grassland between Arundel and Pulborough identified three RDB and four nationally notable beetles, six RDB and seven nationally

notable flies and one RDB bug species (Hodge 1990). The nationally scarce downy emerald dragonfly *Cordulia aenea* breeds at Amberley Wild Brooks. Two RDB snails are recorded from Amberley Wild Brooks, *Anisus vorticulatus* and *Pseudamnicola confusa*. The latter has also been recorded, along with the snail *Valvata macrostoma*, from Arundel Water Meadows (Environmental Advisory Unit 1993). Offham Marshes support a large amphibian population, unusually for wet grassland (see also section 5.6). They include populations of common toads *Bufo bufo*, common frogs *Rana temporaria* and smooth and palmate newts *Triturus vulgaris* and *T. helveticus*. The amphibian population provides a valuable food source for the local population of grass snakes *Natrix natrix*.

The conservation value of coastal wet grassland in Sussex is recognised by its inclusion in eleven SSSIs and one Site of Nature Conservation Interest (SNCI). A small part of the Pevensey Levels is also designated as a National Nature Reserve (NNR) and Pulborough Brooks on the River Arun is an RSPB Reserve. The Wildfowl & Wetlands Trust Reserve at Arundel is also located on wet grassland.

3.5.3 Human activities

There are a number of threats to the areas of wet grassland in Sussex, the most serious being agricultural improvement. About 60% of Romney Marsh and Walland Marsh was affected by drainage schemes between 1940 and 1980 (Mountford & Sheail 1989). As a result the area under permanent grassland fell from 82% in the 1930s to approximately 30% in 1983 (Latimer 1980).

Palmer (1984) compared the aquatic flora and invertebrate fauna of areas of Romney Marsh converted to arable with areas remaining under grassland. While distinct changes in the floral community composition occurred with conversion to arable, the mean number of aquatic plant species, including nationally scarce species, remained similar. The pattern for aquatic invertebrates was similar. This suggests that while conversion to arable reduces the ornithological and floral value of the wet grassland itself, the ditches may retain features of conservation interest.

Water levels in areas of coastal wet grassland such as the Pevensey Levels are largely managed through active pumping, which lowers the levels artificially and reduces the species diversity, but some patches remain gravity drained, and it is the ditches in these areas that are noted as being of highest conservation interest.

Other human influences on wet grassland in the region are associated with leisure developments, reflecting the importance of the Sussex coast as a holiday destination. Golf courses have been proposed for areas of wet grassland, although none has recently been passed. There have been plans to extract gravel from beneath the wet grasslands at Rye Harbour, and a route for the Arundel bypass has been proposed across the Arundel Watermeadows.

3.5.4 Information sources used

There are some data available for wet grassland in SSSIs, mostly on breeding and wintering birds but some on vegetation and *ad hoc* records of invertebrates. Reflecting their national importance, the Pevensey Levels are the best

surveyed for flora and invertebrates (e.g. Carr (1984); Palmer (1984); Hodge (1992)). Much of the remaining work has concentrated on the wet grasslands of the Arun Valley. Byrne & Palmer (1991) reviewed the monitoring work undertaken at Amberley Wild Brooks. The Arundel Water Meadows south of Arundel were thoroughly studied as a result of the Arundel by-pass scheme. Palmer (1984) and Mountford & Sheail (1989) studied the effects of agricultural changes on the wet grassland ecosystems of Romney Marsh and Walland Marsh.

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C. Contact names and addresses

Type of information	Contact address and telephone no.
Lowland wet grassland in Sussex	*English Nature, Sussex & Surrey Team, Lewes, tel: 01273 476595
Lowland wet grassland in England	*English Nature HQ, Peterborough, tel: 01733 455000
Lowland wet grassland sites around Chichester Harbour	Environmental Manager, Chichester Harbour Conservancy, Itchenor, Chichester, West Sussex PO20 7AW, tel: 01243 512301

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

3.6 Saltmarsh

Dr M.I. Hill

3.6.1 Introduction

Saltmarsh is found at only a few places in the region: the main sites are the harbours of Chichester and Pagham and along the tidal reaches of the Rivers Rother, Cuckmere and Adur.

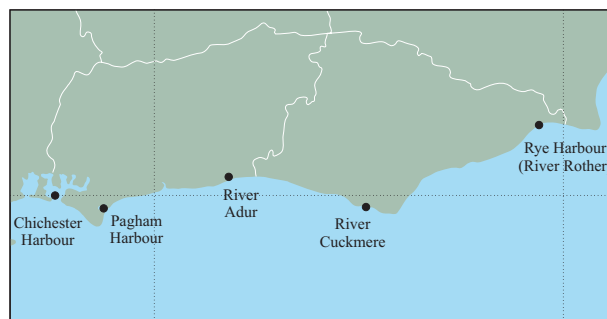
The total amount of saltmarsh recorded in the region during the national survey was 816 ha. This is 4% of the resource on the North Sea Coast and 2% of that in Britain (Table 3.6.1). Of this total, 92% is found in West Sussex, since the Sussex part of Chichester Harbour contains more than 700 ha of saltmarsh, by far the largest saltmarsh site in the region. The Coastal Database held by JNCC shows that only 1% of the coastline of East Sussex supports saltmarsh, compared with 31% of that of West Sussex.

A high percentage (68%) of the saltmarsh area is *Spartina* or other pioneer vegetation types, a much greater proportion than in England or Great Britain as a whole (Table 3.6.1). This is because much of the saltmarsh is of recent origin, formed since the rapid spread of common cord-grass *Spartina anglica* in the first half of this century. Also, substantial areas of saltmarsh have been reclaimed for agriculture. Therefore, the extent of low-mid and mid-upper marsh vegetation is correspondingly low.

Compared with other parts of the south coast, in this region saltmarsh erosion is neither rapid nor widespread (Pye & French 1993).

3.6.2 Important sites and species

Saltmarsh sites surveyed during the national survey (see section 3.6.4) are listed in Table 3.6.2 and shown on Map 3.6.1. The most extensive saltmarshes in the region are in Chichester Harbour. This is a restricted entrance embayment with fringing saltmarshes and islands, plus back-barrier marshes behind the West Wittering Spit, on the east side of the entrance (Pye & French 1993). Saltmarshes in the harbour have experienced erosion in recent decades. The rate of erosion is variable, with the highest rates on the more exposed eastern shore; however, there are also areas of stability. Pagham Harbour was subjected to land claim in the 19th century but reverted to being a tidal embayment when the shingle spit was breached in 1910. Saltmarsh has developed in the



Map 3.6.1 Saltmarsh sites surveyed in National Saltmarsh Survey (see Table 3.6.2). Source: JNCC Coastal Database.

embayment since then, protected behind the two shingle spits, and the marshes are now mainly stable or accreting. The remaining saltmarshes are found in the narrow estuaries of the Rivers Rother, Cuckmere and Adur. Saltmarshes at their mouths are sheltered by shingle ridges growing eastwards along the coast. These rivers are tidal for a considerable distance upstream and saltmarsh vegetation is found fringing the channel well inland of the coast. Saltmarsh is also present at Bracklesham Bay in the shelter of the shingle bar.

SSSIs containing saltmarsh are listed in Table 3.6.3.

A typical saltmarsh zonation begins with a pioneer and low marsh of common cord-grass and glasswort *Salicornia* spp.; common cord-grass is the more abundant species in Chichester and Pagham Harbours, but elsewhere in the region glasswort species are the main pioneers. In the middle to upper marsh, sea-purslane *Halimione (Atriplex) portulacoides* is often the dominant species. In places within the mid-upper marsh a more diverse vegetation is found, including species such as common sea-lavender *Limonium vulgare* and thrift *Armeria maritima*. Sea couch *Elymus pycnanthus* is the characteristic plant of the driftline, occasionally with sea wormwood *Artemisia maritima*.

Natural transitions between saltmarsh and other habitats are often of particular interest as they have a high diversity of both plants and invertebrates. In this region there are only a few such transitions (mostly to shingle and grassland), as saltmarshes are generally backed by seawalls, although there is a transition to the oak woodland of Oldpark Wood in Fishbourne Channel, Chichester Harbour. These areas of

Table 3.6.1 Area (ha)* of saltmarsh communities in region in context

	<i>Spartina</i>	Pioneer	Low-mid	Mid-upper	Driftline	Upper swamp	Transition	Wet depression	Total	% of region	% of area total in region
East Sussex	3	9	40	4	7	<1	0	0	64	8	-
West Sussex	488	51	75	116	16	4	0	0	752	92	-
Region 8	492	60	116	121	23	4	0	0	816	-	-
England	5,166	2,641	10,299	9,948	1,493	686	833	0	31,533	-	3
North Sea Coast	3,461	2,130	8,194	4,772	1,350	1,066	342	2	21,788	-	4
Great Britain	6,948	3,470	12,353	16,042	1,824	1,475	1,670	2	44,370	-	2

Source: National Saltmarsh Survey (Burd 1989a, b). Key: *to the nearest whole hectare. Note: sites not surveyed in detail (<1 ha) are included in totals but not subdivided into communities.

Table 3.6.2 Saltmarsh sites surveyed

Name	Grid ref.	Area (ha*)
Rye Harbour (River Rother)	TQ925205-TQ948184	54
River Cuckmere	TQ512000-TV516978	10
River Adur	TQ204073-TQ214047	9
Pagham Harbour	SZ870970	33
Chichester Harbour	SU760000	710

Source: National Saltmarsh Survey (Burd 1989a, b). Key: *to the nearest whole hectare.

Table 3.6.3 SSSIs containing saltmarsh

Name	Grid ref.
East Sussex	
Camber Sands and Rye Saltings	TQ947190
Rye Harbour	TQ935180
Seaford to Beachy Head	TV540970
West Sussex	
Adur Estuary	TQ208056
Pagham Harbour	SZ875970
Bracklesham Bay	SZ844930
West Sussex/Hampshire	
Chichester Harbour	SU760000

transitional habitat were not recorded in the National Saltmarsh Survey.

Nationally scarce plants found on saltmarshes in the region include sea-heath *Frankenia laevis*, golden samphire *Inula crithmoides*, small cord-grass *Spartina maritima*, marsh-mallow *Althaea officinalis*, lax-flowered sea-lavender *Limonium humile* and curved hard-grass *Parapholis incurva* (Stewart *et al.* 1994). Two seagrass species, dwarf eelgrass *Zostera noltii* and narrow-leaved eelgrass *Z. angustifolia*, both nationally scarce, are present in Chichester Harbour on tidal sediment flats.

As elsewhere, saltmarshes in this region provide roosting sites for waders and grazing for wildfowl. Eelgrass beds are an important source of food for dark-bellied brent geese *Branta bernicla bernicla*. Breeding birds of the saltmarshes include redshank, lapwing and shelduck. Saltmarshes can also support a diverse terrestrial invertebrate fauna with many rare (Red Data Book - RDB) and nationally notable species. The invertebrate fauna is particularly rich in the upper marsh and transition zones where pools, freshwater seepage, driftline debris and tall vegetation are found. Saltmarshes of this region, for example along the River Rother, are known to hold several uncommon moth species (see also [section 5.3](#)).

3.6.3 Human activities

Common cord-grass is a hybrid which originated in Southampton Water and spread to various sites around the turn of the century; it was also planted in the region. It spread rapidly over the next fifty years, but has declined in cover since the 1960s.

There has been substantial land claim of saltmarsh for agriculture in the region, both in harbours and along rivers. The lower reaches of rivers such as the Rother and the Cuckmere have been canalised, removing most of the

saltmarsh from tidal influences. In recent years some of the sea walls around Chichester Harbour have been breached and areas behind them are reverting to saltmarsh: the area of claimed saltmarsh is smaller now than it was in the last century.

The effects on saltmarshes of boat moorings and the construction of marinas has been an issue in the past. Some sites are used for grazing stock and most are now covered by management plans, for example Pagham Harbour (West Sussex County Council 1994) and Chichester Harbour (Chichester Harbour Conservancy 1994).

3.6.4 Information sources used

Saltmarshes in this region were surveyed in 1985 as part of the National Saltmarsh Survey by the Nature Conservancy Council (Burd 1989a, b). This survey provided an intermediate level of detail between Phase 1 habitat survey and the National Vegetation Classification (NVC) (Rodwell in press). It did not include all areas of transition to other habitats, or areas of eelgrasses *Zostera* spp. Some small areas of saltmarsh vegetation, such as at Bracklesham Bay and along the Rivers Ouse and Arun, were not covered.

Chichester Harbour Conservancy are carrying out studies of saltmarsh development and vegetation in Chichester Harbour. These include fixed point photography, measurements of vertical and lateral accretion/erosion by both field survey and comparison of aerial photographs, and vegetation surveys using the NVC. Past surveys in Chichester Harbour include that by Budd & Coulson (1981).

3.6.5 Acknowledgements

Staff of English Nature and Chichester Harbour Conservancy kindly provided information and reference material.

3.6.6 Further sources of information

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- Hall, P.C. 1980. *Sussex plant atlas*. Brighton, Booth Museum of Natural History.
- Rose, F. 1995. *The habitats and vegetation of Sussex*. Brighton, Booth Museum of Natural History.

C. Contact names and addresses

Type of information	Contact address and telephone no
Saltmarsh sites in the region	*English Nature, Sussex and Surrey Team, Lewes, tel: 01273 476595
Saltmarsh sites in the region	*Environment Agency Southern Area Office, Worthing, tel: 01903 832000
Saltmarsh sites in England	*Marine Ecologist, English Nature HQ, Peterborough, tel: 01733 455000
Data from National Saltmarsh Survey	*Coastal Data Custodian, JNCC, Peterborough, tel: 01733 562626
Saltmarsh studies in Chichester Harbour	Environmental Manager, Chichester Harbour Conservancy, Itchenor, Chichester, West Sussex PO20 7AW, tel: 01243 512301

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



At the base of the Seven Sisters cliffs, a wave cut platform up to 200 m wide extends from Beachy Head to Cuckmere Haven, including Friar's Bay (pictured). The rock is furrowed with gullies that radiate out from the shore, growing deeper as the water deepens. These conditions provide a wide range of habitats for algae, sponges and an animal 'turf' made up of worms, sea mats and hydroids. Photo: Marine Nature Conservation Review, JNCC.

Chapter 4 Marine and estuarine environments

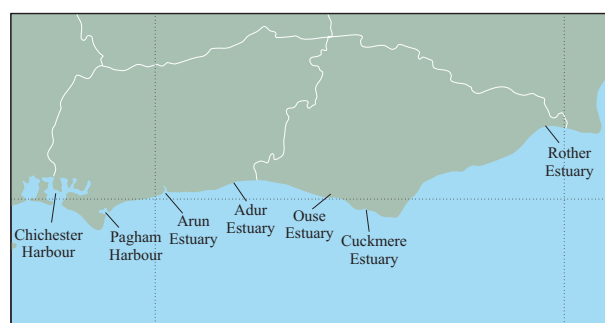
4.1 Estuaries

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). 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 were covered by the NCC’s 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. This section gives an overview of the main features of the estuarine resource in Region 8; for further details of habitats, species and human uses and influences refer to relevant sections in Chapters 3, 5 and 9 respectively.

Estuaries make up only a small part of the region’s shoreline, except in the extreme west at Chichester Harbour, the most easterly part of the major Solent estuarine complex (Map 4.1.1). The total estuarine area in the region forms less than 1% of the north-west European resource. The contribution of the seven estuaries in Region 8 to the national resource is summarised in Table 4.1.1. The 4,080 ha of the region’s estuarine area forms 1.6% of the North Sea Coast resource and just under 1% of the UK resource, with intertidal areas forming slightly larger proportions of the resource. The long narrow estuaries characteristic of the region result in shorelines and tidal channels making a larger contribution: estuarine shorelines in the region form almost 5% of those on the North Sea Coast. Although the canalised nature of many of the region’s estuaries means that saltmarsh areas are now generally small, overall these saltmarshes form about 2.7% of the British saltmarsh area, largely owing to the more than



Map 4.1.1 Estuaries. Source: JNCC Estuaries Database.

1,000 ha of saltmarsh in Chichester Harbour (including the part in Hampshire), which represents over 80% of the saltmarsh in the region. Chichester Harbour (almost 3,000 ha) is the only large estuary in the region and forms over 70% of the regional resource. Other estuaries are small, with none larger than 400 ha and four each less than 200 ha. Most of the region’s estuaries have some river discharge, although catchments are small and discharges relatively low, especially in the more westerly harbours. Surrounding many of the estuaries in the region are brackish and freshwater grasslands, many formerly tidally influenced, that are some of the most important remaining in southern England.

Two of the region’s estuaries (Pagham and Chichester Harbours) are individually internationally important for their wintering waterfowl populations, notably for dark-bellied brent geese *Branta bernicla bernicla*, and both are designated Ramsar sites and Special Protection Areas. Parts of all the region’s estuaries and their surrounding grasslands, shingle systems and saline lagoons are Sites of Special Scientific Interest. These areas are important for nationally rare

Table 4.1.1 Contribution of Region 8 estuaries[†] to the national resource⁺

Resource	Regional total (ha/km)*	North Sea Coast total (ha/km)*	% North Sea Coast	GB total (ha/km)*	% GB	UK total (ha/km)*	% UK
Intertidal area	3,000	136,580	2.2	321,050	0.9	332,350	0.9
Saltmarsh area	1,180	21,788	5.4	44,370	2.7	*	*
Total estuarine area	4,080	258,100	1.6	525,650	0.8	581,290	0.7
Shoreline length (km)	306	5,645	5.4	9,054	3.4	9,727	3.1
Longest channel lengths (km)	104	1,484	7.0	2,461	4.2	2,640	3.9

Sources: Buck (1997); Davidson & Buck (1997). Key: [†]includes that part of Chichester Harbour lying in Hampshire (Region 9); ⁺areas of saltmarsh were not available for Northern Ireland and so estuarine saltmarsh area comparisons are not made for the UK; also, some saltmarsh may occur outside estuaries as defined in this section (see section 3.6); *areas rounded to the nearest 1 ha; lengths rounded to the nearest 1 km.

invertebrates, specialist lagoonal fauna and rare plants.

Low-lying surrounding land and rising relative sea-levels mean that almost all the estuarine shore is now defended by sea-walls, chiefly earth banks, and there are few remaining stretches of natural shoreline. Nevertheless many parts of most of the region's estuaries remain rural, providing important areas of wild landscape in the densely populated south of England.

4.1.2 Important locations and species

Table 4.1.2 lists the estuaries in the region and summarises their main physical characteristics. Five of this region's estuaries are long and narrow, four of them cutting through the chalk uplands of the South Downs. In addition in the west of the region there are the bar-built embayments of two 'harbours' - Pagham and Chichester Harbours, where most of the region's estuarine resource lies.

In East Sussex three small river estuaries flow into the English Channel. The most easterly, the Rother Estuary, flows past the town of Rye in an area of major shingle accretion to the west of Dungeness. Rye was formerly a major medieval port but the eastwards movement of shingle has progressively diverted the estuary mouth and infilled much of the former estuary. The estuary is now largely a narrow river channel with fringing saltmarsh, bordered to its west by the only extensive area of shingle in East Sussex and including two lagoonal areas supporting specialist lagoonal species (see also [section 3.4](#)). The River Cuckmere cuts through the South Downs west of the Seven Sisters cliffs, forming a broad valley discharging into a bay filled with shingle banks and surrounded by extensive chalk foreshores. Although much of the estuary has been artificially embanked and its natural course much altered, the former flood-plain meanders remain and these and the surrounding seldom-flooded meadows support a number of unusual plants. Parts of the former estuarine channels around the estuary mouth are now partially-isolated lagoons (the Seaford Ponds - see also [section 3.4](#)). Like the Cuckmere, the Ouse Estuary now has a narrow, embanked tidal channel flowing through a formerly brackish

floodplain. Very little saltmarsh or tidal flat remains, but the former meanders of the estuary and the surrounding brackish and freshwater marshes support many rare and scarce invertebrates (see also [section 5.3](#)), as well as regionally important amphibian populations (see also [section 5.6](#)).

Like the East Sussex estuaries, the Adur Estuary in West Sussex is incised through the South Downs and is now embanked for much of its tidal length, although near the estuary mouth tidal mudflats and small areas of saltmarsh remain. Of particular importance is the shallow saline Widewater Lagoon to the west of the estuary mouth, separated from the sea by a shingle ridge. The estuary of the River Arun has a particularly long tidal channel, discharging into the sea at Littlehampton. Although the remaining tidal estuary has little saltmarsh or tidal flat, the estuary is surrounded by some very important areas of alluvial wet grassland, notably the Amberley Wild Brooks and Pulborough Brooks, supporting particularly rich plant and invertebrate ditch faunas, especially dragonflies, and breeding and wintering waterfowl populations.

In marked contrast to the narrow embanked estuaries in the east of the region, the two estuaries to the west are harbours that have developed in low-lying land behind sand and shingle spits. The smaller of the two, Pagham Harbour, is now an extensive area of tidal flats and saltmarshes, much of it dominated by common cord-grass *Spartina anglica*. Much of the saltmarsh has developed since the early 1900s when the harbour entrance was breached and much of the area previously claimed for agriculture was inundated. The harbour supports important wintering waterfowl populations, notably of dark-bellied brent geese *Branta bernicla bernicla*. The surrounding shingle banks, which enclose a natural lagoon that was formerly the natural exit of the harbour to the sea, support nationally rare plants (see also [section 3.3](#)).

By far the largest estuary in the region is Chichester Harbour (part of which lies in Hampshire (Region 9)). The harbour is predominantly saline, with little freshwater inflow, and is largely sediment-filled. There are extensive mud and sand flats with eelgrass *Zostera* spp. beds and broad swathes of saltmarsh, the lower marshes dominated by cord-grasses *Spartina* spp. Like several of the region's estuaries, it has a

Table 4.1.2 Physical characteristics of Region 8 estuaries*

Estuary	Centre grid ref.	Geomorphological 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 (%)
East Sussex									
122. Rother Estuary	TQ9419	Bar-built	376	344	54	23.0	6.6	5.3	8.5
123. Cuckmere Estuary	TV5197	Coastal plain	47	15	10	16.7	8.4	6.5	68.1
124. Ouse Estuary	TQ4402	Coastal plain	124	6	0	49.2	20.3	6.1	95.2
West Sussex									
125. Adur Estuary	TQ2105	Coastal plain	153	46	9	46.5	20.6	5.5	69.9
126. Arun Estuary	TQ0103	Coastal plain	171	3	0	80.3	37.1	5.3	98.2
127. Pagham Harbour	SZ8796	Bar-built	266	245	33	9.8	2.6	4.9	7.9
West Sussex/Hampshire									
128. Chichester Harbour*	SU7600	Bar-built	2,946	2,342	1,077	80.6	8.1	4.2	20.5

Sources: Burd (1989a, b); Buck (1997); JNCC Coastal Database. Key: ⁺ to the nearest whole hectare; *includes that part of Chichester Harbour lying in Hampshire (Region 9). Notes: estuary numbers are those used in Davidson *et al.* (1991); 'geomorphological type' relates to nine estuary categories, described further in Chapter 5.7 of Davidson *et al.* (1991); 'spring tidal ranges' are for the monitoring station closest to the mouth of the estuary.

Table 4.1.3 Human influences and water quality in Region 8 estuaries

Estuary	Centre grid ref.	Human use type				Water quality
		urban	industrial	rural*	recreational	
East Sussex						
122. Rother Estuary	TQ9419	○	○	○	●	A
123. Cuckmere Estuary	TV5197			●	○	A
124. Ouse Estuary	TQ4402	○	○	●	○	(B), A
West Sussex						
125. Adur Estuary	TQ2105	○	●	●	●	A
126. Arun Estuary	TQ0103	○	○	●	●	A
127. Pagham Harbour	SZ8796	○	○	●	○	A
West Sussex/Hampshire						
128. Chichester Harbour	SU7600	○	○	●	●	A

Sources: Buck (1997); National Rivers Authority (1991). Key: *includes natural resource exploitation; ● = major human use; ○ = minor human use. Water quality: A = good, B = fair; multiple water quality codes are in downstream sequence; brackets indicate a water quality found in only a small part of the estuary.

number of lagoonal areas near its mouth. Chichester Harbour is the most important estuary in the region for migrant and wintering waterfowl, supporting thirteen waterfowl species at nationally important levels, six of them also of international importance (see also [section 5.12](#)). The harbour also supports breeding waders and colonies of terns and gulls (see also [sections 5.10](#) and [5.11](#)). Chichester Harbour is the only estuary in the region that is a major nursery for sea bass *Dicentrarchus labrax* (see also [section 5.7](#)).

4.1.3 Human activities

[Table 4.1.3](#) summarises human activities on estuaries in the region.

Although the coastline in this region supports a large human population, the estuaries lie in predominantly rural areas. The only major towns adjacent to estuaries are Rye, Lewes, Shoreham and Littlehampton, although the overall largest population surrounds Chichester Harbour. The estuaries in the region provide sheltered anchorages on an otherwise exposed coast. The largest port is Shoreham-on-Sea; Newhaven on the Ouse is also significant as a ferry terminal, and there are boat-building yards in several parts of Chichester Harbour and at Littlehampton, Shoreham-by-Sea and Newhaven. Rye on the Rother Estuary had a long history as a trading port, although it now lies inland of the coast. There are leisure craft moorings and jetties in several estuaries, notably in Chichester Harbour, which has around 4,000 moorings and five marinas. There are marinas or moorings also at Littlehampton and Ford on the Arun, at Shoreham-by-Sea (Adur), Newhaven and Lewes (Ouse) and Rye (Rother). Water-based recreation, including sailing, sail-boarding, water-skiing and canoeing, occurs widely on the region's estuaries, and there is beach recreation around the mouths of most of them.

The development of ports has led to land claim and modification of estuary mouths, and extensive agricultural land claim has removed most of the tidally-inundated flood plains and created extensive lowland wet grasslands, notably around the Ouse and Arun Estuaries. As elsewhere, parts of these grasslands have subsequently been further drained for intensive agriculture, but important areas remain, notably Amberley Wild Brooks alongside the Arun Estuary. Agricultural land claim has been most extensive at Pagham

Harbour, where by the end of the 19th century almost the entire estuary had been claimed, only to revert to a tidal state in the early 20th century after storms breached the shingle bank at its mouth.

The absence of large conurbations means that water quality is good throughout the estuarine waters of the region, except for a short section of 'fair' water quality downstream of Lewes on the Ouse. There is some indication of eutrophication in Chichester Harbour, with extensive mats of green algae present on the mudflats.

There is widespread exploitation of the natural resources of the tidal estuaries and their surroundings. Wildfowling takes place extensively in Chichester Harbour, where some refuge areas have been established. Much of Pagham Harbour is a Local Nature Reserve managed as a refuge area. There is some wildfowling also on the meadows around the Arun, Adur and Ouse and on gravel pits adjacent to the Rother. Much of the grassland surrounding these estuaries is grazed, mostly by cattle, and some saltmarsh is grazed on the Cuckmere. There is a mussel fishery in the Adur, and major shellfisheries, notably for native oysters, in Chichester Harbour. Some bait-digging occurs in most of the region's estuaries.

4.1.4 Information sources used

This section is summarised chiefly from JNCC's series *An inventory of UK estuaries; Volume 6. Southern England* (Buck 1997). The data come largely from material collected during 1989-90 (updated to 1996 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. 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 Anne de Potier (Chichester Harbour Conservancy) and Ben Ferrari (National Monuments Record Centre) for their helpful comments on draft texts.

4.1.6 Further sources of information

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B. Further reading

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- Peck, K. 1995. *Estuaries inventory project report*. Sandy, Royal Society for the Protection of Birds.

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.	*Marine and Coastal Data Custodian, JNCC Peterborough, tel: 01733 562626
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, English Nature HQ, Peterborough, tel: 01733 455000
RSPB Estuaries Inventory: mapped and numerical information on land use and selected human activities for 57 major UK estuaries. In Region 8 the Inventory covers Pagham Harbour and Chichester Harbour.	*Research Data Manager, 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
UKDMAP 1992. Version 2. United Kingdom digital marine atlas.	*British Oceanographic Data Centre, Birkenhead, tel: 0151 653 8633

*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 sea-bed habitats and groups of species that live on the sea bed (benthic communities, collectively called the benthos), both in the intertidal zone and subtidally; 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 habitat types in a national context is not yet available.

The marine environment of this region is influenced mainly by a body of water that flows up the English Channel from the south-west; there is some influence from water coming from the North Sea, though to a far lesser degree. The region lies on the eastern side of the transition zone (centred on the Isle of Wight) between the biogeographic provinces of the eastern and western English Channel. The distribution of many intertidal organisms along the channel may be explained by differences in water temperature (Crisp & Southward 1958), modified by other factors such as substrate type, the effect of water movement on the dispersal of larvae, and the aspect of the shoreline. The shores of both East and West Sussex are mostly of mobile shingle, formed of rounded flint pebbles, with occasional patches of muddy sand, particularly on the lower part of the shore. However, between Brighton and Eastbourne, at the base of the impressive chalk cliffs, occur extensive wave-cut chalk platforms, which can extend up to 500 m beyond low water mark. Exposure to wave action varies from moderately exposed (west of Selsey Bill; and from Newhaven to Beachy Head) to very sheltered (within Chichester Harbour).

In the near-shore sublittoral, the predominant sea-bed types are mixed sediments and sand, though there are also sandstone and limestone reefs of bedrock and boulders; chalk and clay exposures; and mud (within harbours, estuaries and marinas). Sussex is the only location in the British Isles where chalk strata appear as offshore cliffs as well as reefs: they are relatively low (>3.5 m high) but up to several hundred metres long. Another noteworthy feature is the 25 m high offshore clay cliff and associated hole, known as the Mixon Hole, which lies 2 km south-east of Selsey Bill and is believed to be a segment of an ancient river gorge swept clear by tidal currents: it is of regional, if not national, geomorphological importance. An even more dramatic feature is the 67 m deep hole at the Shoal of the Lead of the Outer Owers, some 8 km south-east of Selsey Bill.

Several sublittoral species reach the easternmost extent of their distribution within Sussex waters. These include the jewel anemone *Corynactis viridis*, the Devonshire cup coral *Caryophyllia smithii* and the bryozoan *Pentapora foliacea*. Several non-native species have also become established, such as slipper limpet *Crepidula fornicata* and the stalked ascidian *Styela clava*.

Recognised sites of importance within the region include the Solent and Isle of Wight Sensitive Marine Area (SMA), which extends as far east as Pagham Harbour (English Nature 1994). The SMA also coincides with the proposed Special Area of Conservation (SAC). The Seven Sisters Voluntary Marine Conservation Area (VMCA) was designated in 1986 and includes the intertidal area from Seaford Head to Eastbourne

(including Beachy Head), extending into the sublittoral for 2 km from low water mark. The area has particularly extensive intertidal chalk platforms and well developed chalk gullies below low water mark. The Seven Sisters area has also been identified by English Nature as an SMA (English Nature 1994). In 1996, twelve marine Sites of Nature Conservation Importance (SNCIs) were identified by the two County Councils within the region and English Nature (Irving 1996), the first such sites in the country. These are non-statutory sites which recognise the importance of particular discrete habitats or communities, geological or geomorphological features.

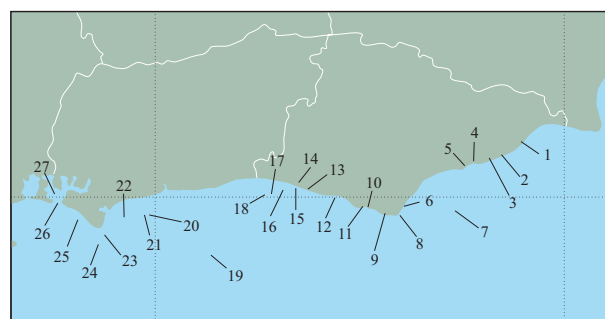
A large number of wrecks (ships, aircraft and other solid material) occur off the coast of this region (see also section 6.1) - the Sussex coast is reported to have more 'modern' wrecks lying off it than almost any other part of Britain's coastline (McDonald 1985). These objects offer hard substrata in areas that may be largely sedimentary, thus providing discrete new habitats for opportunistic colonising species that otherwise would not be present. Four wrecks, all within 700 m of the shore, are designated as protected wrecks (see Chapter 6).

4.2.2 Important locations and communities

Table 4.2.1 shows the locations of marine interest mentioned in the text, which are also shown on Map 4.2.1.

Rye to Beachy Head

A large expanse of intertidal sand stretches from Broomhill Sands (close to the Kent/East Sussex border) westwards to Pett Level, where it becomes muddy sand mixed with shingle. This section of shore has little marine biological interest, with the most conspicuous organisms (such as barnacles and limpets) being confined to groynes. The sandy sediment communities here are typical, featuring polychaete worms, amphipods and bivalves such as the cockle *Cerastoderma edule*, the peppery furrow shell *Scrobicularia plana* and the thin tellin *Angulus tenuis* (Arnott *et al.* 1978). Below low water the sea bed is of a similar nature, with sand predominating over a vast area. The cliffs between Fairlight Cove and Hastings provide the only length of sandstone cliffs with clay on the south coast and is of 'potential interest' for its wildlife (Arnott *et al.* 1978). There are reports of a submerged neolithic forest



Map 4.2.1 Locations of marine biological interest described in the text (numbers refer to Table 4.2.1).

Table 4.2.1 Locations of marine interest mentioned in the text

No. on Map 4.2.1	Location	Grid ref.
East Sussex		
1	Cliff End	TQ8913
2	Ecclesbourne Glen, Hastings	TQ8410
3	Hastings Sea Front	TQ8109
4	Glyne Gap	TQ7708
5	My Lord's Rock, Bexhill	TQ7507
6	The Pound, Eastbourne	TV6097
7	Royal Sovereign Shoals	TV7296
8	Head Ledge, Beachy Head	TV5995
9	Birling Gap	TV5595
10	Hope Gap, Cuckmere Haven	TV5197
11	Seaford Head Gullies	TV5097
12	Shore west of Newhaven	TV4399
13	Roedean - Rottingdean	TQ3701- TQ3502
14	Brighton Marina	TQ3403
15	Marina reef, off Brighton Marina	TQ3302
16	Kingswest Ledge, off Brighton	TQ3001
17	Looe Gate, off Hove	TQ2700
West Sussex		
18	South-West Rocks, off Shoreham	TQ2600
19	Worthing Lumps	TV1285
20	Shelley Rocks, off Middleton	SZ9795
21	The Waldrons Reef, off Bognor	SZ9695
22	'Outer' Mulberry Harbour Wreck, off Pagham	SZ9194
23	The Mixon Hole	SZ8690
24	Reefs off Selsey Bill	SZ8588
25	Bracklesham Balls, Bracklesham Bay	SZ8094
26	Chichester Harbour mouth	SZ7598
27	Moorings within Chichester Harbour	SU7400

just below low water mark at Cliff End at the northern end of these cliffs, with a similar exposure on Hastings sea front visible at low water spring tides.

The shore at Ecclesbourne Glen, to the north-east of Hastings, is a wave-cut sandstone platform with angular boulders (some very large - over 3 m high) with areas of sand or shingle and dissected by rocky reefs and ridges. There are at least 66 species of macro-invertebrates at this location (Tittley *et al.* 1989), despite the fact that there may have been some deterioration in the faunal richness since studies in the 1930s. Algal diversity is poor: furoid algal cover is sparse and there is no kelp zone at low water, probably because of high turbidity. However, two invertebrate species occur on the low shore here (squat lobster *Galathea squamifera* and shore urchin *Psammechinus miliaris*) that have not been recorded from other rocky shores in the south-east (Tittley *et al.* 1989). Further to the west, in the Brighton area, squat lobsters are often found on the low shore (Ventham (1990, 1992), and the shore urchin also occurs.

Beyond low water mark at Ecclesbourne Glen the rocky shore is replaced by sand, which extends at least 2 km offshore. A few typical conspicuous sand species occur, such as sandmason worms *Lanice conchilega*, sea mice *Aphrodita aculeata* and netted dogwhelks *Hinia reticulata* (Wood 1986). Another exposure of submarine forest is present at Glyne Gap to the east of Bexhill. My Lord's Rock, on the lower shore further to the west, has a covering of barnacles *Semibalanus balanoides* and *Elminius modestus* and mussels *Mytilus edulis*, with an assortment of algae including *Fucus vesiculosus*,

Enteromorpha sp., *Ulva lactuca*, *Mastocarpus stellatus* and *Porphyra* sp. possibly *Porphyra purpurea* (Arnott *et al.* 1978). This site is representative of most of the other rocky outcrops along this section of shore.

Between the exposures of sandstone rock on the sheltered shore at The Pound, Eastbourne, are channels, pools and a large shallow lagoon on the lower shore, all floored with soft clay and chalk. As a result of the varied geology, topography and increased shelter, the shore supports rich faunal communities, though only a limited diversity of algae (Tittley *et al.* 1986). On the low shore, the sheltered conditions permit the growth of very large, long-fronded species of seaweed such as knotted wrack *Ascophyllum nodosum*, sea oak *Halidrys siliquosa* and bootlace weed *Chorda filum* (Wood & Jones 1986). The invasive japweed *Sargassum muticum* was recorded by Tittley *et al.* (1986) as being a major constituent of the lagoon system flora here, and the kelp *Laminaria hyperborea* was also present. The Pound is the second most important chalk or greensand shore in south-east England for faunal diversity (the most important being Copt Point, east of Folkestone) (Tittley *et al.* 1986).

Beachy Head to Brighton

At Head Ledge at the eastern end of Beachy Head there is an exposure of greensand jutting out into the sea and exposed to strong currents and wave action. Raised blocks and ridges are present on the shore here, forming extensive block/boulder fields. Barnacles, with some mussels, are dominant over most of the vertical range of the shore (Wood & Jones 1986). The mid-shore zones, characterised by furoid algae and limpets, occupy only a small area. The sandstone, which is relatively hard, does not support the piddocks and other boring organisms that are typical of softer substrata such as chalk and clay. The Gault Clay exposed on the shore is easily eroded and appears as flat, bare depressions below the level of the chalk. It is extensively burrowed by piddocks, especially *Barnea candida* low on the shore, to the extent of hundreds of individuals per square metre (Wood & Jones 1986). Near low water, empty piddock holes in the clay support a rich burrow/crevice fauna. In the subtidal, the sea bed shelves reasonably steeply to 25 m, with raised angular sandstone blocks whose surfaces are covered by large numbers of the ascidian (sea squirt) *Molgula manhattensis*. The high turbidity of the water and the fast tidal currents have a strong influence on the marine life that manages to settle here.

A wave-cut chalk platform extends westwards from Beachy Head to the mouth of the Cuckmere River at Cuckmere Haven, below the impressive chalk cliffs of the Seven Sisters. It then continues for a short distance around Seaford Head and stretches for a further 10 km between Newhaven and Brighton. In most places the platform extends for about 150-200 m from the cliff base to low water mark. Gullies running perpendicular to the coast are a typical feature, becoming deeper lower down the shore. To the east of Cuckmere Haven at Cliff End, the chalk shore is typical for the area, with occasional chalk boulders occurring on the wave-cut platform together with cobbles, pebbles and some patches of sand (Wood & Jones 1986). The most diverse site of the chalk shores in the Seven Sisters area (Wood & Jones 1986) is at Hope Gap, to the west of Cuckmere Haven. Besides a wide, open wave-cut platform, there are boulder beds, rocky reefs and rockpools present. Hope Point, at Cuckmere Haven, represents the easternmost limit of the scarce Lusitanian

isopod *Synisoma lancifer*, which was recently found at this locality (Bamber 1992).

Below low water along much of this stretch of coast, the horizontal chalk platforms are cleft by surge gullies up to 2 m deep, running out perpendicular to the shore. Tidal currents sweep across the gullies in an east/west or west/east direction. The combination of exposure to currents on the ridges between the gullies, and shelter from currents within the gullies, adds to the diversity of habitats present here. The height of the ridges and the extent of chalk bedrock decrease offshore. The gullies at Hope Gap are regarded as being particularly well developed and have been identified as a marine Site of Nature Conservation Interest (Irving 1996). In the shallowest zone closest to the edge of the wave-cut platform, the chalk ridges lining the gullies are about 1.5 m high and have a dense growth of the kelps *Laminaria saccharina* and *L. digitata*. The kelp does not extend below 2.5 m (below chart datum); beyond this, upward-facing surfaces are dominated by smaller brown and red algae such as *Taonia atomaria*, *Calliblepharis ciliata* and *Ceramium rubrum*. Algal cover becomes sparse below 5 m and is absent below 7 m. On upper surfaces of the chalk ridges there are large growths of the breadcrumb sponge *Halichondria panicea* and, in less exposed places, the sponges *Halichondria bowerbanki* and *Esperiopsis fucorum*. The sides of the ridges have a thin covering of animal 'turf', made up largely of bryozoans (*Bugula* spp.) and hydroids, with various tubicolous worms including *Sabellaria spinulosa* and *Pomatoceros triqueter*. The lower sides of the ridges are affected by the movement of sand and pebbles from the gully floor and are often bare (Wood & Jones 1986). There is, however, a narrow (10–20 cm) band between the animal turf and the bare rock that is colonised by large numbers of horseshoe worm *Phoronis hippocrepia*. Other major burrowing organisms in the chalk include the polychaete worm *Polydora ciliata* and the piddocks *Pholas dactylus*, *Barnea parva* and *Hiatella arctica*. Common fishes associated with the gullies include tompot blenny *Parablennius gattorugine*, long-spined sea scorpion *Taurulus bubalis* and leopard spotted goby *Thorogobius ephippiatus* (which here is near the eastern limit of its distribution). Beyond 500 m from the low water mark, the sea bed flattens out and sand predominates.

The diversity of habitats on the shore just to the west of Newhaven (cliffs, platform, ridges, large boulders, deep gullies, pools, lagoons and sandy areas) supports a particularly rich algal flora, with the mid-shore zone being variously dominated by mussels, limpets, winkles or barnacles (Tittley *et al.* 1986). The presence of assemblages of green algae on damp, shaded surfaces of caves and cliffs at the top of the shore here is particularly noteworthy (Tittley 1985). The invasive japweed *Sargassum muticum* occurs on the shore at Rottingdean/Saltdean, and though the diversity of algae is good here, the range of faunal species is limited owing to the low habitat diversity (Tittley *et al.* 1986).

Brighton to Pagham

Brighton Marina was built during the 1970s on Black Rock Ledge, a chalk exposure of considerable geological and marine biological interest. The chalk platform to the east of the marina has been shown to support a diverse intertidal invertebrate and fish fauna (Ventham 1990, 1992), including the scarce isopod *Synisoma lancifer* and the little-recorded small-headed clingfish *Apletodon microcephalus*. The floating

pontoons of the marina provide suitable conditions for several species that would otherwise be found only in deeper water (Natural Science Services 1990). Shallow subtidal algal species, typical of such sheltered conditions, include *Laminaria* spp. and *Nitophyllum punctatum*, as well as the non-native japweed *Sargassum muticum* and *Grateloupia* spp. Non-mobile animals include the ascidians *Ciona intestinalis*, *Ascidia mentula* and *Ascidiella aspersa*, the plumose anemone *Metridium senile* and the sponges *Suberites domuncula* and *Halichondria bowerbanki*. About 1.5 km south of the marina is Marina Reef, a chalk outcrop rising 3 m above the surrounding sea bed, which lies at 18 m depth. The reef appears to comprise a narrow band of chalk about 30 cm wide, with softer grey clay beneath it, together with chalk slabs and boulders which have broken off (C. Wood 1992). The dominant faunal cover is a hydroid-bryozoan turf in which *Hydrallmania falcata*, *Sertularia cupressina* and *Bugula* spp. are conspicuous. On silted sloping surfaces, the sponges *Ciocalypa penicillus* and *Polymastia mamillaris* are common, together with horseshoe worm *Phoronis hippocrepia*.

To the west of Brighton a discontinuous chalk ledge runs roughly parallel to the coast, following the line of the 10 m depth contour as far as Worthing. The ledge gives rise to a unique series of low underwater chalk cliffs that, interestingly, face north towards the coast. Kingswest Ledge, Looe Gate and South-west Rocks are single cliff exposures that are relatively close together; Worthing Lumps consists of two cliffs separated by an area of sand. Of these sites, the last three, which are the best developed, have been identified as marine SNCIs (Irving 1996). The cliffs vary in both length (200–500 m) and height (0.5–3 m) and meander, rather than following a straight line. Foliose red algae, including *Calliblepharis ciliata*, *Plocamium cartilagineum* and *Delesseria sanguinea*, dominate the upper horizontal surfaces at the top of the cliffs. Their vertical faces have a general covering of faunal turf, a major component of which is the hydroid *Tubularia indivisa*. Other conspicuous species include bushy bryozoans *Bugula* spp., the orange encrusting bryozoan *Cellepora pumicosa*, the tubeworm *Filograna implexa* and black tar sponge *Dercitus bucklandi*. Much of the cliff face is bored by piddocks, *Barnea candida* and *B. parva* dominating the upper parts, with *Pholas dactylus* more common on the lower, horizontal surfaces. Encrusting sponges include *Aplysilla rosea*, *A. sulfurea*, *Hemimyscale columella* and discrete cushions of *Dysidea fragilis*. Several large species of crustacea occupy crevices and holes in the cliffs.

Within the Adur Estuary, which opens to the sea at Shoreham, the communities are varied but typical of an estuary of its type (Johnston 1989), their substrates ranging from pebbles, cobbles and muddy sand at Soldier's Point close to the mouth of the river to silt and clay with fine sand. Muddier sites featured the polychaete worms king ragworm *Hediste diversicolor* and *Streblospio shrubsolei* and the oligochaete worms *Tubifex costatus* and *Tubificoides pseudogaster*. Beds of mussels *Mytilus edulis* dominate the area under the A259 road bridge, where the channel narrows and tidal streams are stronger. The barnacle *Semibalanus balanoides*, the shore crab *Carcinus maenas* and horse mussel *Modiolus modiolus* are also present here (Johnston 1989).

In the early summer months shallow areas of gravel off Littlehampton are favoured by black sea bream *Spondylusoma cantharus* for egg laying. Just to the west of the mouth of the River Arun at Littlehampton occurs another exposure of chalk reef, known as Winter Knoll. Unlike the cliff exposures found

further east it is partially covered from time to time by gravel and sand. The reef is sufficiently shallow to allow for the growth of the kelps *Laminaria hyperborea* and *L. saccharina* (C. Wood 1992). Shelley Rocks, which lie 2 km south of Middleton-on-Sea, comprise an extensive shallow area of boulders, cobbles and a mix of gravel, sand and shell overlying chalk bedrock or clay. The marine life associated with this site is typical of broken, mixed sediment grounds in shallow and medium depths (Irving 1996). In general, the larger the particle size (and hence stability) of the substratum, the greater the density and diversity of marine life it supports. Ephemeral species of algae can form 80-90% cover of the sea bed during the summer months, although this cover decreases over winter as the fronds of many species decay. Areas of pebbles, gravel, shell and sand can be dominated by chains of slipper limpets *Crepidula fornicata*, with sandmason worms *Lanice conchilega*, stalked ascidians *Styela clava*, dahlia anemone *Urticina felina*, and netted dogwhelks *Hinia reticulata* common.

Between Littlehampton and Pagham a number of sandstone reefs occur, the best known of which is the Waldrons Reef, which covers an extensive area in shallow to medium depths 3-5 km off Bognor. The reef is formed of sandstone bedrock and boulders, with areas of cobbles, pebbles and gravel in between. Much of the sandstone bedrock has a covering of encrusting pink calcareous algae (*Lithothamnion coralloides* and/or *Phymatolithon calcareum*). The uppermost surfaces are dominated by foliose algae with sparse, stunted kelp plants of *Laminaria hyperborea* and *L. digitata*. Sponges are the most conspicuous components of the attached fauna, 24 species being recorded during a sublittoral survey (Wood 1984). A number of larger crustacean species are common, including lobster *Homarus gammarus*, edible crabs *Cancer pagurus* and velvet swimming crabs *Necora puber*.

Pagham to Chichester Harbour

The shallow sea bed to the east of Pagham is littered with a large amount of wreckage, much of it dating from the Second World War, when the area was used for parking several Mulberry Harbour units. Of those that were left behind, the most intact is now known as the Outer Mulberry and has become a popular dive site. As an artificial reef, it provides a variety of habitats in an area of sea bed generally devoid of hard substrata. The uppermost kelp-covered surfaces of the main part of the wreck are visible from the surface at low tide. On silty, inclined surfaces within the shelter of the wreck, sponges such as *Polymastia boletiforme* and small zoanthid anemones are found. A small number of Devonshire cup corals *Caryophyllia smithii* occur on one part of the wreck, and the jewel anemone *Corynactis viridis*, rarely recorded this far east in the Channel, was recorded from here in 1983 but has not been found since (Irving 1996).

The Mixon Beacon lies approximately 2 km south-east of Selsey Bill and marks the highest point of a limestone reef that breaks the surface at low water. On the south side of the beacon is an abrupt, near-vertical clay cliff, which drops from 6 m to 20 m, forming the northern wall of the Mixon Hole, while the southern side of the hole is bounded by a steep slope. The exposed soft clay of the main cliff has many ledges, crevices and fissures, and is being continually eroded by currents sweeping across its face. It is one of the best known dive sites in Sussex (Ackers 1977) and has been identified as a marine SNCI (Irving 1996). It is a remarkable feature, of interest to coastal geomorphologists and also to marine

archaeologists because at its base lie the remains of worked stone blocks, known to date from Roman times. The cliff is extensively bored by piddocks *Pholas dactylus*, although many of the holes are empty and crustaceans such as squat lobster *Galathea squamifera*, edible crab *Cancer pagurus* and velvet swimming crab *Necora puber* make use of them. At the base of the cliff, at 25 m depth, is a level area of tide-swept pebbles and shells with lumps of muddy clay. The hydroids *Plumularia setacea*, *Hydrallmania falcata* and *Amphisbetia operculata* are found here, together with keel worm *Pomatoceros triqueter*, the sea squirt (ascidian) *Dendrodoa grossularia* and chains of slipper limpets *Crepidula fornicata*.

Slipper limpets *Crepidula fornicata* are found in large numbers to the east of Selsey Bill and there are extensive mussel *Mytilus edulis* beds to the south and east of the Bill. Outcrops of limestone bedrock and boulders form reefs to the west and south of Selsey Bill, from the Hounds to Pullar Bank. These support the most diverse flora and fauna of the area. In some areas, e.g. Boulder Bank, the underlying clay strata have been eroded, leaving extensive pavements of limestone slabs with large gaps between them occupied by fish such as bib *Trisopterus luscus*, leopard spotted gobies *Thorogobius ephippiatus* and species of wrasse (Collins & Mallinson 1983). The limestone rock is extensively bored in places by piddocks *Barnea* spp. and *Hiatella arctica*, and a rich sponge fauna is present including *Dysidea fragilis*, *Haliclona* spp. and *Hemimycale columella*. The yellow sponge *Cliona celata* occurs in its boring phase rather than its massive form.

Coarse mobile sand is present in areas between reef outcrops around and immediately to the south of the Pullar Bank and Middle Ground Bank (Hiscock 1985). Few benthic species can tolerate this inhospitable substratum, fauna being generally limited to mobile species such as the whelks *Buccinum undatum* and *Hinia reticulata*, the hermit crab *Pagurus bernhardus* and various fish, including dragonet *Callionymus lyra*, plaice *Pleuronectes platessa*, sole *Solea solea* and sand goby *Pomatoschistus minutus*. Strong currents (of up to 2.5 knots) occur over the shallow grounds and reefs in this area to the south of Selsey Bill. The extensive limestone reefs and boulders are considered to be of regional marine nature conservation importance (Fowler 1995).

Within Bracklesham Bay the sea bed is mainly of sand and gravel, with occasional ridges of clay to the south and east of the entrance to Chichester Harbour. There are also many mounds of cobbles and boulders, e.g. at Bullock Patch, north and west Medmery Bank and New Grounds (Collins & Mallinson 1983). Of particular interest are the large spherical boulders, up to 1.5 m in diameter, which occur at about 6 m depth within the bay, popularly known as the Bracklesham Balls. It is believed that they are concretions of the Myocardia Bed (consisting of fine shelly sand, sandstone nodules and many fossilised bivalve molluscs), standing proud of the sea bed (E.M. Wood 1992). The tops of the shallowest boulders have kelp plants growing on them, together with an assortment of red foliose algae including *Callibepharis ciliata* and *Griffithsia flusculosa*. In deeper waters the tops and sides are dominated by bryozoans (such as *Bugula* spp. and *Frustra foliacea*) and hydroids (including *Nemertesia antennina*), anemones, ascidians and a rich assortment of encrusting sponges.

In the vicinity of the Hounds reef, south of Bracklesham, limestone forms a 20 cm-thick cap rock over soft grey clay, erosion of which has led to mushroom-like features. To the south and west, the Medmery Bank comprises mostly pure

sand which is mobile and forms distinct waves on the sea bed, while Bullock Patch, 8 km due south of Chichester Harbour, is an area of limestone boulders. A ready supply of fine muddy silt enters Bracklesham Bay and Chichester Harbour from the Solent.

Conspicuous species on 'broken' ground (i.e. mixtures of sand, gravel, pebbles and small cobbles) within Bracklesham Bay include the ascidians *Dendrodoa grossularia*, *Polycarpa pomaria* and *Styela clava*; the hydroids *Nemertesia antennina* and *Tubularia indivisa*; and the bryozoans *Flustra foliacea* and *Alcyonidium diaphanum*. The tubicolous polychaete worm *Sabellaria* sp. is common, binding together gravel and pebbles with its hard sandy tubes. Within the sand and gravel, sandmason worms *Lanice conchilega* are frequently encountered, as well as the anemones *Urticina felina* and *Cerianthus lloydii*. Mobile species include the predatory gastropod molluscs *Buccinum undatum* and *Hinia reticulata*, hermit crabs *Pagurus* spp. and occasionally the starfishes *Asterias rubens* and *Crossaster papposus*. There is only limited algal growth throughout much of the Bracklesham Bay area, due to the depth of the substratum, its unstable nature and the turbidity of the water column. Exposed clay and limestone outcrops are extensively bored by the bivalve piddocks *Pholas dactylus* and *Barnea* spp. respectively. Large beds of the slipper limpet *Crepidula fornicata* are frequently encountered, particularly in the approaches to the East Solent.

Pure gravel occurs at the mouth of Chichester Harbour, while further out the sea bed is sandier (Collins & Mallinson 1983). Strong currents (of up to 6 knots on spring tides) flow through the narrow entrance to the harbour, where a steep-sided hole drops to 25 m. The east side of this hole is composed of sand held together by a continuous mat of tubes of polychaete worms *Sabellaria* spp. (Collins & Mallinson 1983). The tube worms *Lanice conchilega* and *Sabella pavonina* also occur on the sides of the hole as dense forests (Capp 'n' Cook Diving 1996). The sea bed near to permanent moorings within the harbour has the richest faunal communities (Irving 1994a). Here chains of slipper limpets *Crepidula fornicata* and pebbles were encrusted by numerous sponges (including *Hymeniacidon perleve*, *Myxilla incrustans* and *Suberites* spp.) and ascidians (including *Dendrodoa grossularia* and *Styela clava*). Intertidal sediments within the harbour range from well-sorted sand with a crustacean fauna (such as on Pilsey Sands), through muddy sand with polychaete worms and crustaceans (around East Head and within the Emsworth Channel) to fine muds with a few polychaetes and small prosobranch molluscs at the upper reaches of the drainage channels (Thomas & Culley 1981). Eelgrasses *Zostera* spp. dominate the eastern side of the upper reach of the Thorney Channel, although it is mixed with extensive areas of *Enteromorpha* spp.

Offshore (defined as beyond 3 km or 50 m depth)

For many offshore areas there is little information available on the detailed nature of the sea bed. General information on bathymetry, sea bed geology and sediments is shown on Admiralty charts and British Geological Survey maps. The sea remains relatively shallow for some distance off much of the Sussex coast (for example the 10 m depth contour is more than 5 km off Pagham - see section 2.3.2), with occasional exceptions such as Beachy Head, where the 20 m depth contour lies barely 500 m from the base of the cliffs, and the Mixon Hole, off Selsey Bill.

A number of offshore sandstone reefs occur to the south-

east of Eastbourne, between 5-12 km from the coast, including Elphick Tree, Horse of Willingdon, Long Shoal, the Royal Sovereign Shoals and the outcrop on which stands the Royal Sovereign lighthouse. The sandstone of the reefs is considerably harder than the chalk of which most other offshore reefs in the eastern English Channel are made. The nearest comparable sandstone reefs are those off Bognor Regis and Selsey Bill, although these have less silt cover.

In the rocky places there is a high diversity of habitats within relatively small areas (Wood 1990). The Royal Sovereign Shoals reef, which lies 12 km east of Beachy Head, has been identified as a marine SSCI (Irving 1996). It rises to 3.5 m depth below chart datum from a surrounding sea bed of gravel and sand at 18 m. Kelp is absent, although red foliose algae occur on upward-facing surfaces. Parts of the reef comprise rectangular sandstone slabs, 2-3 m long and 0.5 m high, and in places the slabs are piled on top of one another, creating deep fissures, overhangs and small caves. Common sessile species include the soft coral dead-man's fingers *Alcyonium digitatum*, the tubeworm *Filograna implexa* and small bushy bryozoans *Bugula* spp. The site provides the easternmost records in the English Channel for a number of species, including elephant's hide sponge *Pachymatisma johnstonia*, the bryozoan *Pentapora foliacea*, the sea squirt *Pycnoclavella aurilucens* and cuckoo wrasse *Labrus mixtus*.

Further to the west, in depths of 10-14 m to the south of the Pullar Bank off Selsey Bill, the sea bed is of clean flint pebbles and cobbles with occasional bedrock outcrops (Hiscock 1985). A little to the east, south of Middle Ground, the cobbles are consolidated by tubes of the worm *Sabellaria spinulosa* and densely colonised by encrusting fauna, particularly ascidians. Deep clay ridges with cobbles and pebbles in between are present in deeper water further to the east. Running up to the western edge of the Outer Owers Bank are large boulders and bedrock outcrops, colonised by erect and encrusting animals, particularly hydroids, sponges and the ascidian *Molgula manhattensis* (Hiscock 1985). The Outer Owers itself, 8 km south east of Selsey Bill, consists of a series of limestone outcrops that are a natural progression of the rock features further to the west. At the Shoal of the Lead on the eastern side of the Outer Owers the sea bed drops steeply from 0 m to 67 m and there are powerful overfalls (submarine cataracts). This feature is believed to be the only example of its kind in the British Isles (Fowler 1995).

Further out into the English Channel the commonest of the five species/habitat associations (based on sediment type rather than biota, as defined by Jones (1950)) that occur are the boreal offshore sand community and the muddy sand and gravel associations (Holme 1966).

4.2.3 Human activities

Gravel extraction and fishing are the main commercial uses of the sea bed of the region. Most fishing effort off East Sussex is for whitefish, while off West Sussex it is mostly for crustacea. Within Chichester Harbour, oyster dredging takes place during the winter months along the main drainage channels, and benthic life appears impoverished where the dredges operate (Irving 1994a). Concern has been raised in recent years about the persistence of plankton blooms off the coast between Beachy Head and Brighton in early summer (D. Harvey pers. comm. 1996). It has been suggested that this may be linked to increases in land-derived nutrients entering

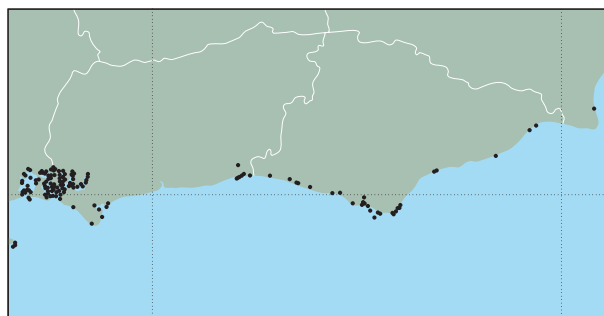
nearshore waters from sewage outfalls or as run-off from farmland.

4.2.4 Information sources used

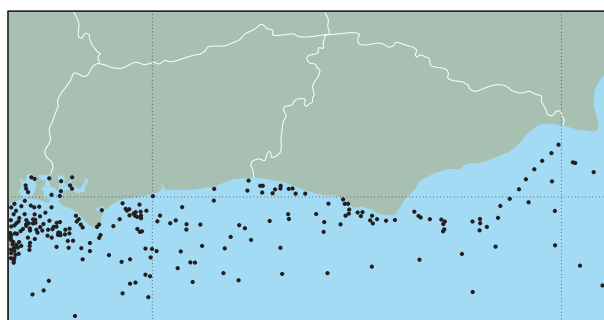
JNCC's Marine Nature Conservation Review (MNCR) uses a standard recording methodology for littoral and sublittoral surveys that includes descriptions of both habitats and their associated communities (Hiscock 1996). Survey information from other sources may vary considerably in its methodology and coverage. Table 4.2.2 shows the number of sites with detailed marine benthic (sea bed) habitat and species information held on the JNCC's MNCR database and Maps 4.2.2 and 4.2.3 show, respectively, littoral and near-shore sublittoral surveys recorded on the MNCR database.

A broad-scale survey of the Sussex (and Kent) coast for the Nature Conservancy Council (Arnott *et al.* 1978) provided a description of the main features of the littoral and maritime habitats along this stretch of open coast. A list of marine fauna (both littoral and sublittoral) for Sussex was produced by Anon. (1960). Much of the information on the near-shore sublittoral for this region has come from dives undertaken as part of the Sussex Seasearch project (Irving in prep.; Irving 1994a), which has surveyed the whole of the Sussex nearshore zone, starting in 1992. A draft sublittoral Habitat Manual for the area between Chichester Harbour and Littlehampton was produced as a result of the first two years' work of this project (Irving 1994b). Other Marine Conservation Society (MCS) diving surveys were undertaken in 1982-83 between Beachy Head and Selsey Bill (Wood 1984) and in 1987-89 of the sandstone reefs off Eastbourne (Wood 1990). The Seven Sisters VMCA was set up in 1986 as a direct result of the MCS surveys in 1982-83 (Wood 1984) and 1984 (Wood & Jones 1986). In 1985 an environmental assessment study was undertaken by the Oil Pollution Research Unit on behalf of Esso Exploration in the area to the south-east of Selsey Bill (Hiscock 1985).

E.M. Wood (1992) compiled a review of existing data on all aspects of the features, uses and conservation importance of the shallow sublittoral zone (low water to 6 km seawards) from the mouth of the River Arun to the mouth of Chichester Harbour. Farnham (1975) recorded the algae within Pagham Harbour, and Rayner (1975) gives records of marine invertebrates. Intertidal soft sediment areas within Chichester Harbour were surveyed by Thomas & Culley (1981) on behalf of the Nature Conservancy Council, and a number of sublittoral sites were surveyed by Capp 'n' Cook Diving (1996). As a supplement to the Sussex Seasearch project, a remote survey of sea bed types (Beachy Head to Shoreham) using RoxAnn analysis was carried out in 1995 by the BioMar team from Newcastle University (Foster-Smith & Davidson 1995), and in 1996 (Rye to Beachy Head) (Foster-Smith in



Map 4.2.2 Littoral surveys recorded on the MNCR database. Source: JNCC.



Map 4.2.3 Near-shore sublittoral surveys recorded on the MNCR database. Source: JNCC.

prep.). The fauna and flora of the shore at Ecclesbourne, Hastings, was examined by Booth (1966); the intertidal fauna in the Eastbourne area by Paul (1958); and the intertidal fauna in the Brighton area was thoroughly studied by Ventham (1990, 1992). Intertidal areas of the River Adur at Shoreham were surveyed by an MNCR team in 1988 (Johnston 1989) as part of a major survey of harbours, rias and estuaries in southern Britain. The presence of large quantities of drift weed cast ashore at Worthing was the subject of reports by Binnie & Partners (1987) and Price & Tittley (1987).

4.2.5 Acknowledgements

The author acknowledges the help of JNCC's Marine Nature Conservation Review team (particularly Dr Tim Hill and Kate Northen) in compiling and presenting the information given here. Thanks also go to David Harvey, David Ventham and Dr Bill Farnham for additional comments.

4.2.6 Further sources of information

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Table 4.2.2 Number of surveyed sites in the region on the MNCR database

Littoral	Near-shore sublittoral	Offshore	Total
13	45	0	58

Source: MNCR Field Database 1994. Note: these figures are not comprehensive; additional records exist in sources that were not consulted.

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C. Contact names and addresses

<i>Type of information</i>	<i>Contact address and telephone no.</i>
Marine nature conservation issues in England	*Maritime Team, English Nature HQ, Peterborough, tel: 01733 455000
MNCR database	*MNCR Team, JNCC, Peterborough, tel: 01733 562626
Marine nature conservation issues in Sussex	*English Nature, Surrey & Sussex Team, tel: 01273 476595
Sussex marine database information	Dr Gerald Legg, Curator of Biology, Booth Museum of Natural History, 194 Dyke Road, Brighton BN1 5AA, tel: 01273 552586
Sublittoral benthic habitats & communities (Sussex Seasearch Project)	Robert Irving, 14 Brookland Way, Coldwaltham, Pulborough, West Sussex RH20 1LT, tel: 01798 873581
Sublittoral benthic habitats and communities	Chris Wood, Hollybush, Chequers Lane, Eversley, Hook, Hants. RG27 0NY, tel: 01734 734127
Littoral fauna and flora in the Brighton area	David Ventham, 48 Arundel Street, Brighton BN2 5TH, tel: 01273 681287
Marine sites of nature conservation importance within East Sussex	*County Ecologist, East Sussex County Council, Planning Department, tel: 01273 481621
Marine sites of nature conservation importance within West Sussex	*County Ecologist, West Sussex County Council, Planning Department, tel: 01243 752052
Sussex Sea Fisheries Committee	Steve Holman, Secretary, Sussex Sea Fisheries Committee, 106 Station Road, Hailsham, East Sussex BN27 2EQ, tel: 01323 841912
Marine ecology of Chichester Harbour and its environs	Philip Couchman, Environmental Manager, Chichester Harbour Conservancy, Ferryside, West Itchenor, Chichester, West Sussex PO20 7AW, tel: 01243 512301
Distribution of marine algae	Dr Bob Fletcher, Marine Laboratory, University of Portsmouth, Eastney, Hants. PO4 9LY, tel: 01705 876543

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

4.3 Plankton

M. Edwards & A.W.G. John

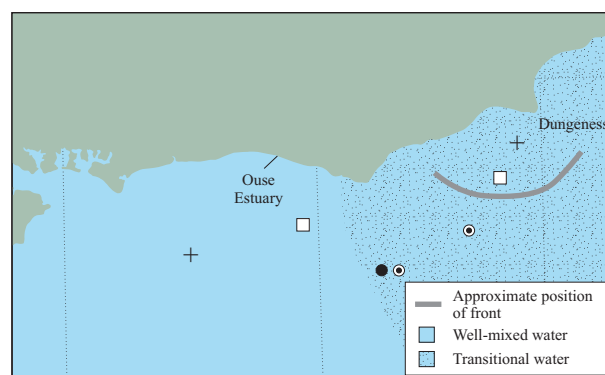
4.3.1 Introduction

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, by water flows into the area and by the presence of local benthic (bottom-dwelling) and littoral (shoreline) communities. Many of the species of these communities, including commercially important fish and shellfish, have temporary planktonic larval forms (meroplankton). Tidal fronts (boundary zones between stratified and well mixed water masses) in this region are likely to be of significant biological importance, since they are usually rich in plankton, which attracts other marine life. Phytoplankton blooms (transient, unsustainable growths, usually of a single species and often associated with a visible discolouration of the water) are a normal feature in the seasonal development of plankton. Some blooms may reach exceptional proportions ($>10^6$ cells/l) or contain species (principally dinoflagellates) that could be toxic to humans and possibly have an important economic impact on mariculture, fisheries and tourism.

In Region 8, as elsewhere, the plankton has a fundamental role in the food chain of both benthic (sea-bed) and pelagic (water column) wildlife. For both ecosystems, the availability of food and nutrients, larval survival, maintaining 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, marine mammals etc. In coastal management, plankton can give early warnings of adverse human impacts (e.g. the effects of eutrophication) and indicate different water masses.

Mean surface temperature and salinity in the region vary (depending on season) between 7–16°C and 34.75–35 g/kg respectively. In winter the water column of the whole Channel is mixed homogeneously. During spring/summer an area of stratified water develops in the Celtic Sea and spreads eastwards up the Channel. Although the waters of this region are mainly mixed and transitional (Map 4.3.1), transient and shallow thermoclines may develop in warm summers (e.g. 1990) in the eastern Channel south of Dungeness (North Sea Task Force 1993). Areas where thermoclines develop tend to be dominated by dinoflagellate species rather than the diatoms found in mixed water.

Estimated surface chlorophyll *a* for this region is $<2 \mu\text{g/l}$ (Boucher 1980). Holligan *et al.* (1978) found these waters to be very turbid and low in diatom numbers in March 1976. They suggested that small flagellates probably accounted for the major part of the chlorophyll content of the water. During the summer, zooplankton biomass levels can be reasonably high,



Map 4.3.1 Plankton surveys, 'front' (from Pingree & Griffiths 1978) and areas of well mixed and transitional water. See Table 4.3.1 for details of surveys.

e.g. 6,200–7,800 mg C m⁻² (dry weight) in the area south of Dungeness (Boucher 1980). During winter the biomass production in this region substantially decreases, to $<10 \text{ mg C m}^{-2}$ (dry weight); higher values start to reappear in April.

4.3.2 Important locations and species

The plankton of this region consists of neritic (coastal water) species, although southern intermediate (mixed water) species can also be present. The English coastal waters of the eastern Channel can be characterised as being a strongly mixed and highly turbid pelagic environment and, as a result, the region is an area of low phytoplankton growth and diversity. Although Boucher (1980) found quite high levels of zooplankton biomass in this region, Holligan *et al.* (1978) analysed a zooplankton sample taken south of Dungeness in March 1976 and found it to be quite lacking in diversity compared with French coastal waters (no fish larvae and only seven fish eggs were present in 43 m³ of water filtered). Pingree *et al.* (1986) surveyed parts of the eastern English Channel in March of two consecutive years (1983 and 1984) and found it to contain a large quantity of sediment particles and little phytoplankton. Other than the surveys mentioned above, few measurements of phytoplankton have been made in the English coastal waters of the English Channel. In March along the coast of France, the spring phytoplankton bloom is well developed, while on the English coast strong mixing and turbid waters delay the development of the spring bloom. The dominant dinoflagellates found in this region are *Scrippsiella trochoidea* and *S. faeroense*, species which Holligan *et al.* (1980) found to be characteristic of well-mixed conditions. Information on the distribution of the zooplankton in this region is almost entirely limited to general surveys of biomass, with limited detail on composition (e.g. Holligan *et al.* 1978; Boucher 1980). Copepods typically dominate the zooplankton populations (forming more than 75% of the biomass), with a predominance of *Temora longicornis*, *Acartia clausi*, *Pseudocalanus elongatus* and *Centropages hamatus*.

Table 4.3.1 Details of surveys

Identification on Map 4.3.1	Frequency	Period	Reference
PS (☉)	Occasional	May 1978 & June 1980	Boucher 1980
PS (☐)	Occasional	March 1976	Holligan <i>et al.</i> 1978
PS (●)	Occasional	April 1984	Agoumi 1985
PS (+)	Occasional	July 1977	Holligan <i>et al.</i> 1980
Whole region	Occasional	1970-1984	Riley <i>et al.</i> 1986
Ouse Estuary	Monthly	1953-1964	Hopkins 1964

Key: PS = plankton samples.

4.3.3 Human activities

Phytoplankton are of importance to the coastal manager in this region because of the importance of the leisure and tourism industry here. Although regional data are rather limited, MAFF observed a number of *Phaeocystis* blooms (10^4 - 10^7 cells/l) off Bognor Regis during the late 1980s, which caused temporary local problems for amenities and fishing activities. These blooms have been associated with eutrophication in Dutch coastal waters and may result in the accumulation on beaches of large banks of foam, which look and smell unpleasant.

4.3.4 Information sources used

In the eastern English Channel, especially in English coastal waters, there have been few systematic studies of plankton distribution. Information on the distribution, chlorophyll *a* concentrations, species composition and biomass of plankton is limited to a few sporadic surveys (e.g. Holligan *et al.* 1978; Boucher 1980; Agoumi 1985) and, as a result, little is known of the plankton in this region. One of the few long time series of plankton data collected in this region was concentrated around the Ouse Estuary and only concerned the total number of diatoms present (Hopkins 1964). The MAFF Directorate of Fisheries Research at Lowestoft undertook occasional surveys of this region during the 1970s and early 1980s, investigating the distribution of fish eggs and larvae (ichthyoplankton) in the plankton (Riley *et al.* 1996). There have been no Continuous Plankton Recorder (CPR) tows in this region.

4.3.5 Further sources of information

We thank all the consultees who provided comments on the draft of the text.

4.3.6 Further sources of information

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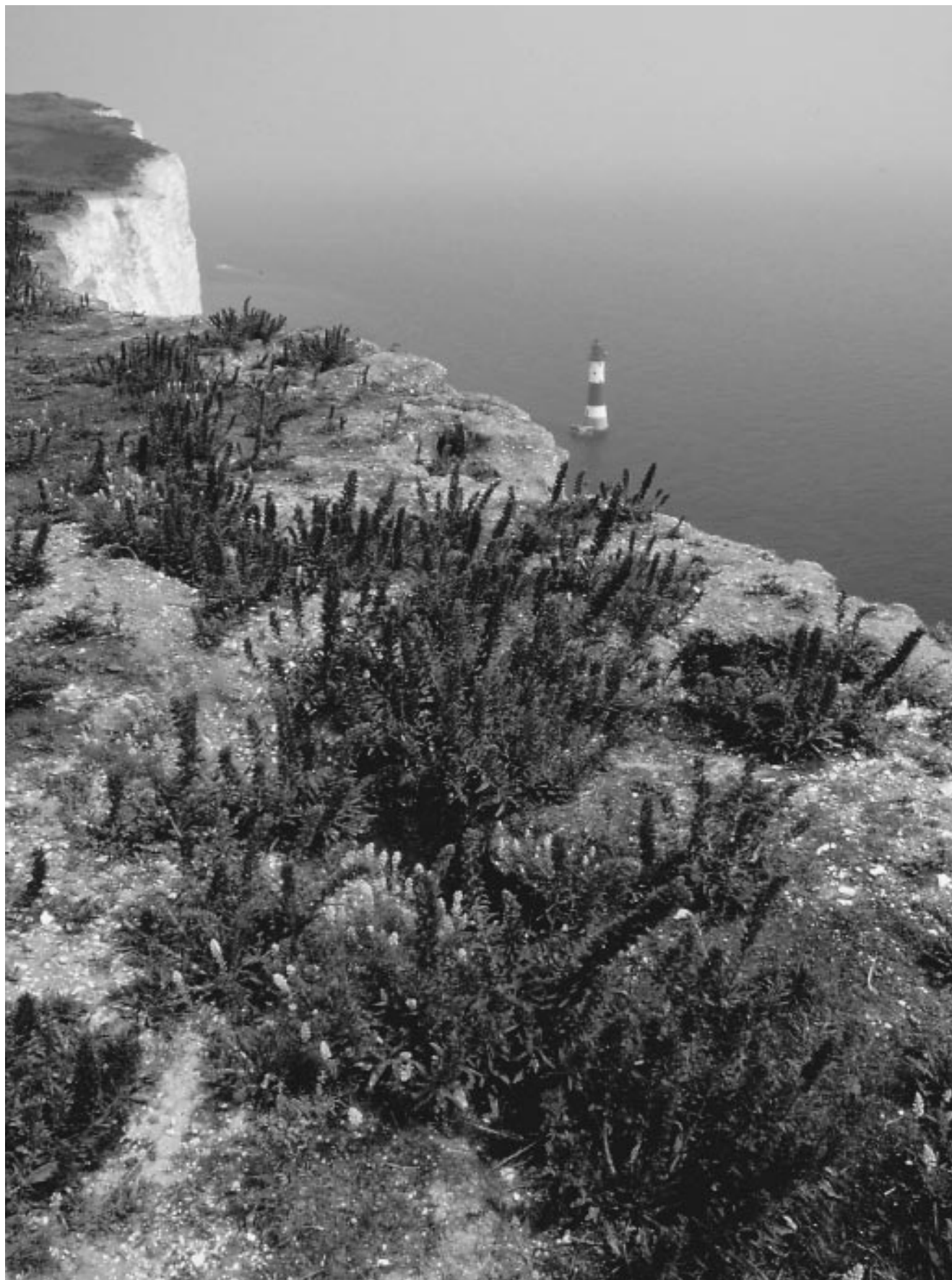
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C. Contact names and addresses

Type of information	Contact address and telephone no.
CPR survey data	Director, Sir Alister Hardy Foundation for Ocean Science, The Laboratory, Citadel Hill, Plymouth PL1 2PB, tel: 01752 633130
Plankton research	Head of Department, Department of Oceanography, Southampton University, University Road, Southampton SO9 5NH, tel: 01703 595000
Ichthyoplankton	*Director, Centre for Environment, Fisheries & Aquaculture Sciences Lowestoft Laboratory, tel: 01502 562244
Algae; marine ecology	Dr W.F. Farnham, Portsmouth University, Marine Laboratory, Ferry Road, Hayling Island, Hampshire PO11 0DG, tel: 01705 463231

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



The thin, parched soils on chalk cliff tops in the region support several rare and scarce higher plant species, particularly here in the Seaford to Beachy Head SSSI, where the glorious spikes of the rare and endangered purple viper's bugloss *Echium plantagineum* flourish. Found elsewhere in Britain mainly in Cornwall and the Isles of Scilly, these plants have probably grown from seed blown from local gardens. Photo: Peter Wakely, English Nature.

Chapter 5 Important species

5.1 Terrestrial lower plants

N.G. Hodgetts

5.1.1 Introduction

This section covers lichens, bryophytes (mosses and liverworts), stoneworts (a group of freshwater and brackish water algae - the latter are covered in [section 5.4](#)) and fungi occurring in the coastal 10 km squares within Region 8. The location of Region 8 on the south coast of England means that it is at the northern edge of the ranges of many southern species. Many warmth-loving species are relatively frequent in the region. About 35% of the British bryophyte flora and about 14% of the stonewort flora occur in this area. Precise figures are not available for other groups.

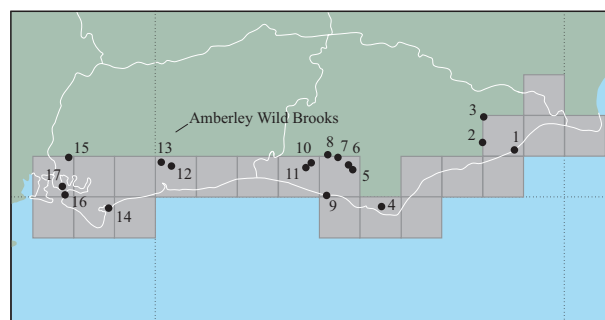
Region 8 is heavily populated and urbanised, with extensive ribbon developments or intensive agriculture along much of the coast. In spite of this, there is still a considerable amount of habitat suitable for lower plants and a great deal of lower plant interest remains. However, quite a high proportion of the species recorded at some time in the region have not been seen in recent years.

5.1.2 Important locations and species

[Table 5.1.1](#) 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. Some are large, in which case the grid reference given refers to a reasonably central point. Many of the sites contain rare and scarce species and qualify for SSSI status on the basis of their lower plant flora alone (Hodgetts 1992). Locations are shown on [Map 5.1.1](#).

Like higher plants (see [section 5.2](#)), lower plants tend to occur in characteristic assemblages that are found in particular habitats. The region's woodland is of some importance for its lower plant flora. In particular, coastal gill woodlands such as Fairlight Glen are rich in oceanic bryophytes, supporting several species that are very rare or unknown elsewhere in south-eastern England. Other woodlands have moderately rich bryophyte or lichen floras. Many of the woods in the region are rich in fungi, but little information is available on these at present. Several parkland sites in the region are important for epiphytic lichens, with Firle Park recorded as being of particular importance for its lichens on elms, although these may now have succumbed to Dutch elm disease. Parham Park is also important for lichens. Coastal scrub is important for epiphytes, apparently increasingly so as sulphur dioxide air pollution improves.

Coastal (usually clifftop) grassland and heath with thin turf can frequently be rich in bryophytes, lichens and higher plants, the communities often forming complex mosaics. The grassland on the Sussex cliffs is of great importance for rare and scarce bryophytes, and some of the best cliff-top



Map 5.1.1 Sites known to be important for lower plants in coastal 10 km squares ([Table 5.1.1](#)). Source: JNCC Red Data Book database.

grassland sites for bryophytes and lichens in the country occur in the region. Unstable areas are important for maintaining bare ground for colonisation by some of the uncommon ephemeral lower plants. Chalk downland is a feature of the parts of the region within the South Downs, including many large sites. Calcareous grassland is usually richer in lower plants than neutral or acidic grassland. There is an extensive specialist lichen and bryophyte flora that grows on thin, grazed turf, especially where there is bare chalk and open, thin soil. Many of the calcareous grassland species are ephemeral colonisers, moving on when the sward becomes too dense for them. North-facing downs (e.g. Amberley Mount to Sullington Hill SSSI) tend to be richer in bryophytes than south-facing downs, but south-facing downs (e.g. Castle Hill NNR) also support a distinctive range of warmth-loving bryophytes and lichens.

Shingle is an important habitat for lichens and is well represented in the region. Small crustose species occur on the stones themselves and, at some sites, an epiphytic community has developed on scrub that has colonised the shingle. Although none of the coastal shingle sites in this region is quite as large or as rich as Dungeness (Region 7), this habitat is so infrequent that the Sussex sites are of considerable importance.

Marshes and ditches, notably at Amberley Wild Brooks, some 15 km from the sea on the tidal River Arun, can be important for communities of stoneworts. There are several lakes and reservoirs in the region that regularly dry up at least partially in the late summer, leaving exposures of mud. This can be colonised by a range of specialist ephemeral bryophytes (as well as vascular plants). Other ephemeral species may be characteristic of woodland rides or the margins of arable fields.

Gravestones and walls in churchyards can form a substitute for natural rock exposures in the south-east and are usually colonised by a variety of saxicolous lichens and bryophytes, including uncommon species for which

Table 5.1.1 Important lower plant sites in coastal 10 km squares

Site no. on Map 5.1.1	Location	Grid ref.	Conservation status
East Sussex			
1	Hastings Cliffs to Pett Beach	TQ8711	SSSI
2	Maplehurst Wood	TQ8013	SSSI
3	Powdermill Reservoir	TQ8019	Undesignated
4	Seaford to Beachy Head	TV5497	SSSI
5	Firle Escarpment	TQ4806	SSSI
6	Firle Park	TQ4707	Undesignated
7	Glynde	TQ4509	Undesignated
8	Lewes Downs	TQ4310	SSSI, part NNR
9	Chene Gap, Peacehaven	TQ4200	Undesignated
10	Kingston Escarpment & Iford Hill	TQ3808	SSSI
11	Castle Hill	TQ3707	SSSI, part NNR
West Sussex			
12	Wepham Wood	TQ0507	Undesignated
13	Arundel Park	TQ0108	SSSI
14	Pagham Harbour	SZ8896	SSSI
15	Lordington Park	SU7809	Undesignated
16	Chichester Harbour	SU7600	SSSI
17	West Thorney church	SU7602	Undesignated

Sources: references listed in section 5.1.4, and JNCC's Protected Sites Database. Key: SSSI = Site of Special Scientific Interest; NNR = National Nature Reserve.

churchyards are therefore an important habitat in the region. Clay roof tiles and old walls can be important for mosses in the region.

The region contains a number of threatened species, some of which are given special protection under national legislation. Species protected under the Wildlife & Countryside Act 1981 and occurring in Region 8 are the moss *Acaulon triquetrum* and the lichen *Caloplaca luteoalba*. Table 5.1.2 lists the Red Data Book species found in the region (out of a total of 139 bryophytes, 11 stoneworts and 177 lichens on the British Red Lists), excluding extinct species. The lichen *Lecanactis hemisphaerica*, which is considered 'near threatened' but is included on Schedule 8 of the Wildlife & Countryside Act, also occurs in the region, on the plaster of church walls. In addition, the region contains 39 out of the 375 near threatened and nationally scarce bryophytes (figures for

nationally scarce species are provisional). There is currently insufficient information to provide even provisional regional lists of nationally scarce lichens and fungi.

5.1.3 Human activities

Current issues that may have a bearing on the lower plant flora of this region include house building, holiday and leisure developments, road construction and agricultural intensification. Land available for construction is at a premium in this part of the country and therefore areas of interest for lower plants and other wildlife may be more affected here than elsewhere. Some coastal and cliff grassland areas can be affected by holiday and leisure developments such as caravan sites and golf courses. Nutrient enrichment of

Table 5.1.2 Red Data Book lower plant species in Region 8

Species	Location/habitat
Liverworts	
<i>Cephaloziella baumgartneri</i>	Calcareous ground, Arundel Park, West Sussex
<i>Dumortiera hirsuta</i>	On rock in stream, Fairlight Glen (Hastings Cliffs to Pett Beach SSSI), East Sussex
<i>Riccia huebeneriana</i>	Exposed mud in draw-down zone of reservoir, Powdermill Reservoir, East Sussex
Mosses	
<i>Acaulon triquetrum</i>	Bare patches in turf on cliff top, Chene Gap, Peacehaven, East Sussex
<i>Atrichum angustatum</i>	On soil, Wepham Wood, West Sussex
<i>Ephemerum cohaerens</i>	On exposed mud by lake, Swanbourne Lake (Arundel Park), West Sussex
Lichens	
<i>Caloplaca flavorubescens</i>	On ash tree, Lordington Park, West Sussex
<i>Caloplaca luteoalba</i>	Glynde, East Sussex
<i>Chaenotheca phaeocephala</i>	Untreated timber on ancient barn, Parham Park, West Sussex
<i>Cryptolechia carneolutes</i>	On elm, Parham Park, West Sussex
Stoneworts	
<i>Tolypella prolifera</i>	In ditches, Amberley Wild Brooks, West Sussex

Source: JNCC lower plants database

streams due to agricultural activities can affect the integrity of the gill woodlands. Other forms of agricultural and industrial pollution can seriously affect lower plants, particularly epiphytes. Dutch elm disease has led to a catastrophic decline in epiphytes, since the bark of living elms is an ideal substrate for many species. Gravel extraction is an economically important activity with implications for several lower plant-rich shingle sites on the coast. Churchyard management activities can have an effect on the churchyard lichen and bryophyte floras, which are often important in this part of the country.

Some sites in the region are nature reserves managed for nature conservation. Many more are Sites of Special Scientific Interest (SSSIs), in which nature conservation considerations must be taken into account.

5.1.4 Information sources used

Data for bryophytes and the larger lichens are generally good, but they are less complete for fungi, algae and the smaller lichens. 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. Rose *et al.* (1991) is also a valuable source of information for this region. Some important, or potentially important, coastal lichen sites have been identified in recent surveys (Fletcher 1984; James & Wolseley 1991), but as relatively few have been comprehensively surveyed, there may be more sites of interest for lichens than are shown in Table 5.1.1. Data collation for fungi is still at a relatively early stage. All British Mycological Society foray data are currently being put onto a computer database at the International Mycological Institute under a JNCC contract. Computerised stonewort data are held at BRC and JNCC. More information on freshwater algae may be available from the Freshwater Biological Association.

5.1.5 Further sources of information

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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 938 9123
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 (general)	Dr R. Watling, Royal Botanic Garden, Inverleith Row, Edinburgh EH3 5LR, tel: 0131 552 7171
Fungi (British Mycological Society database)	Dr P. Cannon, International Institute of Mycology, Bakeham Lane, Englefield Green, Egham, Surrey TW20 9TY, tel: 01784 470111
Bryophytes & lichens (general and epiphytic)	Dr F. Rose, Rotherhurst, 36 St. Mary's Road, Liss, Petersfield, Hampshire GU33 7AH, tel: 01730 893478
Bryophytes (BRC database)	*Biological Records Centre, Institute of Terrestrial Ecology, 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
Bryophytes (general)	D.G. Long, Royal Botanic Garden, Inverleith Row, Edinburgh EH3 5LR, tel: 0131 552 7171
Freshwater algae	Freshwater Biological Association, The Ferry House, Far Sawry, Ambleside LA22 0LP, tel: 01539 442468
Lower plants (species status, Red Data Book Database, site register etc)	*Species Advisor, Joint Nature Conservation Committee, Peterborough, tel: 01733 562626

*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) occurring in the region's coastal 10 km national grid squares, particularly species that are rare or scarce in Great Britain. Despite its short coastline, the region is of national importance for its many rare and scarce species (Table 5.2.1). In total, 18 Red Data Book species occur in the region, out of approximately 290 extant species that are likely to be included in the next edition of the Red Data Book (Wigginton in prep.). Of the 254 scarce species (i.e. known from 16 to 100 ten km squares) in Great Britain, 75 occur in the region. There are no endemic (i.e. confined to Great Britain) species in the region.

Table 5.2.1 Numbers of rare and scarce higher plant species in Region 8

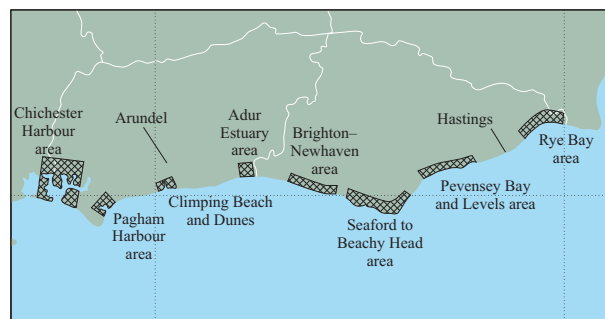
	Protected species	Other RDB species	Scarce species
East Sussex	7	7	54
West Sussex	4	2	61
Region 8	11	7	75

Sources: JNCC rare plants database; Stewart *et al.* (1994); BRC database. Key: RDB = Red Data Book, i.e. nationally rare. Note: excludes known introductions and records from before 1970.

Classic British botanical localities include Rye Bay and the Beachy Head area. Centres of plant biodiversity such as these and the other areas shown on Map 5.2.1 result from a combination of climate, geology and history. The climate is equable compared with more inland parts of Sussex (Hall 1980), although plants growing in thin soils over south-facing chalk slopes can experience extremes of insolation and desiccation.

A number of different elements, defined by Matthews (1955), are found in the flora. Continental and southern continental species are well represented and include galingale *Cyperus longus*, musk stork's-bill *Erodium moschatum*, burnt orchid *Orchis ustulata* and loose silky-bent *Apera spica-venti*. Oceanic species are also important, such as bulbous foxtail *Alopecurus bulbosus* and yellow bartsia *Parentucellia viscosa*. A number of the rare plants are species that are more widespread in western France or the Channel Islands and are at or near the limits of their European distribution in the region. Two such species, childing pink *Petrorhagia nanteuilii* and wall germander *Teucrium chamaedrys* are found here in their only native British sites; others are red star-thistle *Centaurea calcitrapa*, oxtongue broomrape *Orobancha loricata*, small hare's-ear *Bupleurum baldense*, perennial centaury *Centaureum scilloides*, moon carrot *Seseli libanotis* and late spider-orchid *Ophrys fuciflora*.

Rare and scarce plants grow in a wide range of habitats but of particular importance in the region are chalk grassland and open vegetation on shingle, sand or gravel. Maritime woodland, a rare habitat in the UK, is present at Chichester Harbour, where woodland with ancient oaks grows right down to the shore (Rose 1995).



Map 5.2.1 Key localities for rare and scarce higher plants (listed in Table 5.2.2) and other locations mentioned in the text. Source: adapted from BRC data.

5.2.2 Important locations and species

Key localities that support important populations of rare species and/or 20 or more scarce species are listed in Table 5.2.2; their locations are shown on Map 5.2.1. Scarce species may occur near to rather than within some localities.

Rare and protected species are listed in Table 5.2.3. Eleven species are amongst the 107 listed on Schedule 8 of the Wildlife & Countryside Act 1981, including one, Killarney fern *Trichomanes speciosum*, which is listed on the EC Habitats & Species Directive and the Bern Convention. The fern has two forms: the larger, vascular form is extremely rare and is not found in the region. The tiny, non-vascular form resembles a liverwort and has recently been discovered to be relatively widespread, being known from over 80 ten km squares in Great Britain, of which one is in the region. It is expected that more sites will be found nationally (F. Rumsey pers. comm.).

5.2.3 Human activities

Although the threat of botanical collecting has largely passed, the whereabouts of potentially collectable species such as certain orchids are still kept confidential.

Rose (1995) considers that the coast of Sussex has suffered "more than . . . any other English county" from urbanisation. Other developments such as caravan parks have also reduced the extent of semi-natural habitat. Sand and shingle habitats have been adversely affected by quarrying, human disturbance and military use. Most of the good remaining sites have now been designated as National Nature Reserves (NNRs) and/or notified as Sites of Special Scientific Interest (SSSIs), and their management must take nature conservation considerations into account.

5.2.4 Information sources

Sussex was covered by a rare plant survey between 1985 and 1987 and a series of detailed confidential reports were produced (FitzGerald 1988a, b), now held by English Nature and the Joint Nature Conservation Committee (JNCC). Further work has been carried out by English Nature as part

Table 5.2.2 Key localities for rare and scarce species

Locality	Status	Species
Rye Bay area	Part LNR, part SSSI, part undesignated	Red Data Book species: least lettuce <i>Lactuca saligna</i> , lizard orchid <i>Himantoglossum hircinum</i> , saltmarsh goosefoot <i>Chenopodium botryodes</i> , wall germander <i>Teuchrimum chamaedrys</i> (introduced) Scarce species: annual beard-grass <i>Polypogon monspeliensis</i> , bur medick <i>Medicago minima</i> , rootless duckweed <i>Wolffia arhiza</i> , sea-heath <i>Frankenia laevis</i> , shrubby sea-blite <i>Suaeda vera</i> , white horehound <i>Marrubium vulgare</i> plus 26 other species
Pevensey Bay and Levels area	Part NNR, part SSSI, part undesignated	Red Data Book species: perennial centaury <i>Centaureum scilloides</i> , sharp-leaved pondweed <i>Potamogeton acutifolius</i> Scarce species: 12 species
Seaford to Beachy Head area	Part LNR, part SSSI, part undesignated	Red Data Book species: Deptford pink <i>Dianthus armeria</i> , early spider-orchid <i>Ophrys sphegodes</i> , late spider-orchid <i>Ophrys fuciflora</i> , moon carrot <i>Seseli libanotis</i> , red star-thistle <i>Centaurea calcitrapa</i> , small hare's-ear <i>Bupleurum baldense</i> , wall germander Scarce species: sea-heath, white horehound plus 18 other species
Brighton to Newhaven area	Part SSSI, part undesignated	Red Data Book species: sea knotgrass <i>Polygonum maritimum</i> , early spider-orchid Scarce species: sea-heath plus 27 other species
Adur Estuary area	Part SSSI, part undesignated	Red Data Book species: meadow clary <i>Salvia pratensis</i> , oxtongue broomrape <i>Orobancha loricata</i> , red star-thistle, sharp-leaved pondweed Scarce species: 17 species
Climping Beach and Dunes	SSSI	Red Data Book species: none Scarce species: sand catchfly <i>Silene conica</i> , sea-heath, white mullein <i>Verbascum lychnitis</i> plus 21 other species
Pagham Harbour area	Part LNR, part SSSI, part undesignated	Red Data Book species: chiding pink <i>Petrorhagia nanteuilii</i> Scarce species: sea-heath plus 13 other species
Chichester Harbour area	Part LNR, part SSSI	Red Data Book species: grass-poly <i>Lythrum hyssopifolia</i> , sea knotgrass Scarce species: annual beard-grass, galingale <i>Cyperus longus</i> , sea-heath, spiked star-of-Bethlehem <i>Ornithogalum pyrenaicum</i> plus 22 other species

Sources: JNCC rare plants database; Stewart *et al.* (1994); SSSI citation sheets; BRC database. Key: SSSI - Site of Special Scientific Interest; NNR - National Nature Reserve.

of their programme of monitoring. Records of Red Data Book species are kept in the JNCC's rare plants database. 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 *et al.* 1994).

5.2.5 Acknowledgements

Thanks are due to G. Barter, G. Legg, F. Rose, M. Wigginton, F. Rumsey and staff at the Biological Records Centre.

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Table 5.2.3 Recorded occurrence of nationally rare (RDB) and/or protected species

Species	Recorded occurrence in:			Key localities	Habitat
	10 km squares in GB	No. of coastal 10 km in region	No. of sites in region (approx.)		
Childing pink <i>Petrorhagia nanteuilii</i> *	1	1	2	Pagham Harbour area	Sandy and gravelly places
Deptford pink <i>Dianthus armeria</i>	25	1	1	Seaford to Beachy Head area	Dry, open grassland
Early spider-orchid <i>Ophrys sphegodes</i> *	14	2	7	Seaford to Beachy Head area; Brighton to Newhaven area	Open calcareous grassland
Grass-poly <i>Lythrum hyssopifolia</i> *	6	1	1	Chichester Harbour area	Winter-wet hollows in arable fields
Killarney fern <i>Trichomanes speciosum</i> *, **	>80	1	2	Near Hastings	Wet, shady places
Late spider-orchid <i>Ophrys fuciflora</i> *	5	1	1	Seaford to Beachy Head area	Grassland on south-facing chalk slopes
Least lettuce <i>Lactuca saligna</i> *	2	1	3	Rye Bay area	Disturbed vegetation on shingle or sea walls
Lizard orchid <i>Himantoglossum hircinum</i> *	18	1	1	Rye Bay area	Calcareous grassland
Meadow clary <i>Salvia pratensis</i> *	24	1	1	Adur Estuary area	Herb-rich chalk grassland
Moon carrot <i>Seseli libanotis</i>	3	1	3	Seaford to Beachy Head area	Species-rich chalk grassland
Oxtongue broomrape <i>Orobancha loricata</i> *†	3	1	1	Adur Estuary area	Chalk undercliff & slopes; parasitic on hawkweed oxtongue <i>Picris hieracioides</i>
Perennial centaury <i>Centaureum scilloides</i>	4	1	2	Pevensy Bay and Levels area	Short turf
Red star-thistle <i>Centaurea calcitrapa</i>	6	3	5	Seaford to Beachy Head area; Adur Estuary area	Disturbed chalky grassland
Saltmarsh goosefoot <i>Chenopodium botryodes</i>	12	1	1	Rye Bay area	Dry brackish mud
Sea knotgrass <i>Polygonum maritimum</i> *	5	1	1	Brighton to Newhaven area; Chichester Harbour area	Beaches
Sharp-leaved pondweed <i>Potamogeton acutifolius</i>	12	3	9	Pevensy Bay and Levels area; Adur Estuary area; north of Arundel	Calcareous ditches
Small hare's-ear <i>Bupleurum baldense</i> *	2	1	1	Seaford to Beachy Head area	Open turf on chalk
Wall germander <i>Teucrium chamaedrys</i>	4	2	2	Rye Bay area (introduced); Seaford to Beachy Head area	Short turf on chalk

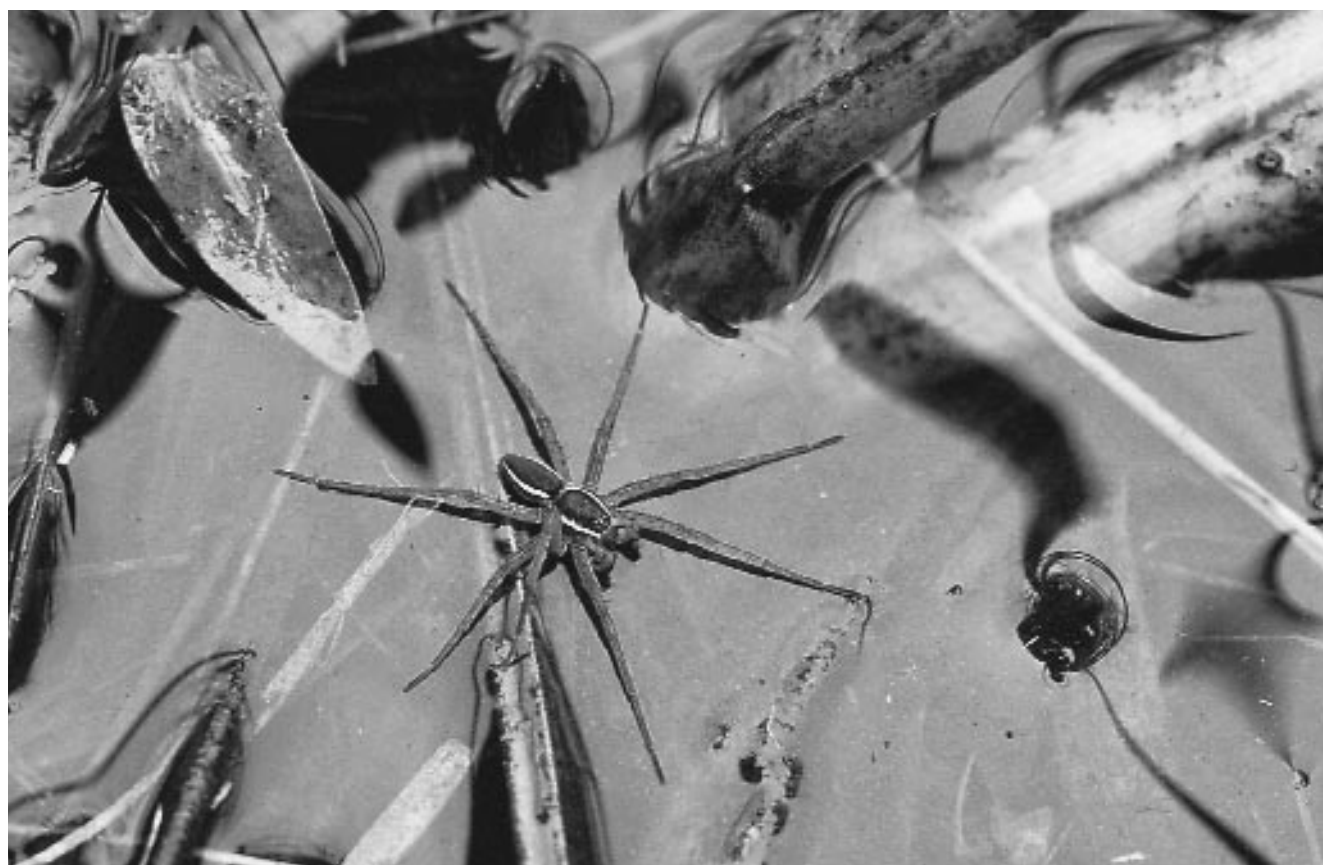
Source: JNCC rare plants database and BRC scarce plants database. Key: *listed on schedule 8 of the Wildlife & Countryside Act 1981; **listed on Annexes IIb & IVb of EC Habitats & Species Directive and Annex I of the Bern convention; †site still requires confirmation (FitzGerald 1988a).

Note: box *Buxus sempervirens*, broad-leaved cudweed *Filago pyramidata*, cut-grass *Leersia oryzoides*, early gentian *Gentianella anglica*, fly honeysuckle *Lonicera xylosteum* and true fox-sedge *Carex vulpina* are also known from the 10 km squares of the region. They are not maritime and are, at most, only indirectly affected by their proximity to the sea, and have therefore been excluded from this section.

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 Ecologist, Maritime Team, English Nature HQ, tel: 01733 455000
Database of rare and protected species	*Species Advisor, JNCC, Peterborough, tel: 01733 562626
Biological records for Brighton and Hove, also some other coastal areas and the original data from the Sussex Plant Atlas (Hall 1980)	Dr Gerald Legg, Keeper of Biology, The Booth Museum of Natural History, 194 Dyke Road, Brighton BN1 5AA, tel: 01273 713299
Local BSBI vice-county recorders' records	*C.D. Preston, Biological Records Centre, ITE, Monks Wood, tel: 01487 773381

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



The ditches in the region's wet grasslands teem with invertebrates, many rare and some spectacular. The Pevensy Levels National Nature Reserve is nationally outstanding for such species, especially snails and beetles; it is also one of the few locations for the rare - and enormous - fen raft spider *Dolomedes plantarius*, whose delicate legs span up to 75 mm. Photo: Peter Wakely, English Nature.

5.3 Land and freshwater invertebrates

M.S. Parsons & A.P. Foster

5.3.1 Introduction

There are over 28,000 species in the better known groups of invertebrates in Great Britain (Kirby 1992). This section covers most orders of insects, but not all families, and a wide range of non-insect invertebrates. Lagoonal species are covered in [section 5.4](#).

Four species of terrestrial and freshwater invertebrates listed on international directives and conventions or on Schedule 5 of the Wildlife & Countryside Act 1981 have been recorded within the region ([Table 5.3.1](#)), although one of these, the Sussex emerald moth *Thalera fimbrialis*, has not been recorded recently.

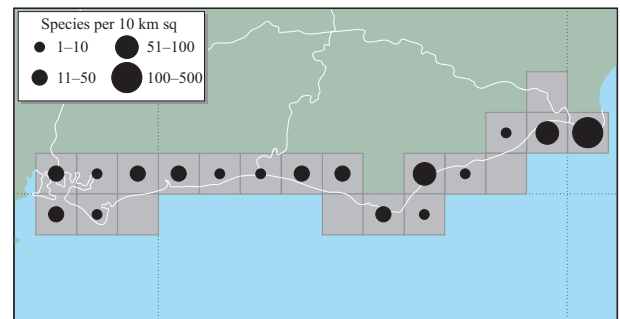
Table 5.3.1 Protected invertebrate species in the region

Species	Protected status	Locations
Medicinal leech <i>Hirudo medicinalis</i>	1, 2, 3 and 4	East Sussex
Fairy shrimp <i>Chirocephalus diaphanus</i>	3	East Sussex
Sussex emerald moth <i>Thalera fimbrialis</i>	3	East Sussex (extinct and possibly never resident)
Fen raft spider <i>Dolomedes plantarius</i>	3	East Sussex

Key to protected status codes: 1 = Annex V, EC Habitats Directive; 2 = Appendix III, Bern Convention; 3 = Wildlife & Countryside Act 1981 Schedule 5 (including Variation of Schedules 1988 and 1992, but excluding Schedule 5 section 9(5), sale only); 4 = Appendix II, Convention on International Trade in Endangered Species (CITES).

The Sussex coast is important in the national context for a wide range of invertebrates. Many species have exacting habitat requirements and are consequently restricted in their distribution. The weevil *Limobius mixtus* is, in Britain, currently known only from this region. Many other species have very restricted distributions and much of their British range is along this coastal region, e.g. the shining ram's-horn snail *Segmentina nitida*, the flea beetle *Dibolia cynoglossi*, the moth *Ethmia bipunctella* and the fen raft spider *Dolomedes plantarius*. Subspecies *lunigera* of the crescent dart moth *Agrotis trux* is recorded from only a very small number of sites outside the British Isles, and the occurrence of the Matthew's wainscot moth *Mythimna favicolor* on continental Europe is open to question. Both are known from the Sussex coast. There are also examples of species with geographically isolated populations in this region, for example the northern rustic moth *Standfussiana lucerneae*.

Parts of the region's coast are known to be nationally important not only for the number of scarcer species found, many of which are at the edge of their range in Britain, but also for species assemblages. For example, Marshall & Haes (1988) list Chichester Harbour as an outstanding site for Orthoptera (grasshoppers and crickets) and allied families, with fourteen species recorded.

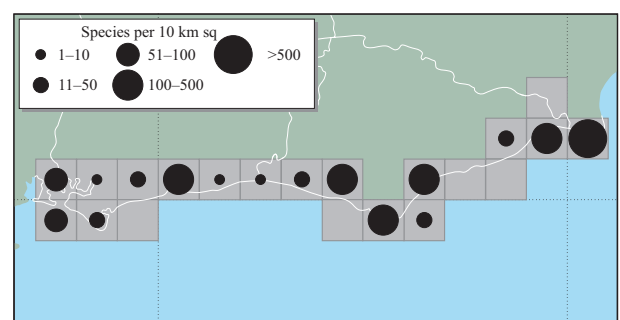


Map 5.3.1 Numbers of nationally rare (i.e. RDB) invertebrate species recorded in coastal 10 km squares (all dates). Distribution may reflect differences in recording effort. Source: JNCC Invertebrate Site Register.

5.3.2 Important locations and species

Of 358 coastal Red Data Book (RDB) and 455 coastal nationally scarce species listed by Kirby (1994a, b), 79 and 224 respectively have been recorded in the region at some time, according to the Invertebrate Site Register (ISR). As with other regions, many further scarce and threatened species not falling into the coastal categories of Kirby (1994a, b) can also be found along this part of the coast. [Map 5.3.1](#) shows the numbers of all nationally rare (RDB) invertebrate species (including Kirby's 'coastal' species and others) recorded in coastal 10 km squares in the region at some time, according to the ISR. [Map 5.3.2](#) shows the numbers of all nationally scarce invertebrates recorded in coastal 10 km squares in the region at some time, according to the ISR. [Table 5.3.2](#) lists the coastal terrestrial or freshwater RDB species as defined by Kirby (1994a, b) that have been recorded in the region from 1970 onward, according to the ISR.

The Invertebrate Site Register (ISR) has records for just over 80 sites within this region. Several of these support a range of RDB species, and many are known to be the habitats of a number of nationally scarce species. The sites in [Table 5.3.3](#), which is based primarily on data from the ISR, are those considered to be particularly important in the region for the conservation of invertebrates. They were selected on the basis of the range and/or scarcity of species present, the species



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

Table 5.3.2 Coastal Red Data Book (RDB) species recorded in the region from 1970 onwards

Species	Description and notes on recorded occurrence in the region
RDB1	
<i>Atylotus rusticus</i>	Horsefly frequenting grazing levels. Extremely local in southern England.
<i>Dibolia cynoglossi</i>	Small (2-3 mm) flea beetle associated with various species of labiate, including <i>Galeopsis</i> , <i>Mentha</i> , <i>Salvia</i> , <i>Stachys</i> , <i>Ballota</i> and also <i>Cynoglossum</i> . Very rare, with scattered records in southern Britain.
Fen raft spider <i>Dolomedes plantarius</i>	Spectacularly large spider with only two known populations in Britain: Redgrave and South Lopham Fens, Suffolk, and the Pevensey Levels, Sussex.
<i>Segmentina nitida</i>	Ramshorn snail occurring in ponds and marsh drains, particularly if well oxygenated and with lush vegetation. Now restricted to a few unimproved grazing marsh sites in the south-east and East Anglia.
RDB2	
<i>Anisus vorticulus</i>	Ramshorn snail found in well oxygenated weedy ditches in grazing levels of south-eastern England and East Anglia. Rather rare.
<i>Lejops vittata</i>	Large hoverfly of brackish ditches. Closely associated with sea club-rush <i>Scirpus maritimus</i> , on which the adults feed on pollen. The larvae are aquatic. Scattered records from the coastal marshes of southern England including Sussex.
<i>Odontomyia ornata</i>	Soldier fly; larvae develop in shallow water of ponds and rivers, adults visiting flowers nearby. Locally frequent in the coastal levels of Sussex, Somerset and Gwent.
<i>Pherbellia argyra</i>	Rare snail-killing fly found at the edge of permanent ponds. Larvae have been found in the snails <i>Planorbis planorbis</i> and <i>Anisus vortex</i> . Mostly found in East Anglia, but also as far north as Yorkshire.
<i>Sphaerophoria loewi</i>	Small yellow and black hoverfly; in wetlands, particularly brackish coastal marshes, with stands of sea club-rush <i>Scirpus maritimus</i> and common reed <i>Phragmites australis</i> . Widely, though rarely, recorded.
<i>Stratiomys longicornis</i>	Large soldier fly; aquatic larvae develop in strongly brackish pools and ditches. Extremely local in south-east England north to Lincolnshire.
<i>Valvata macrostoma</i>	Aquatic snail found mainly in well-oxygenated, richly-vegetated marsh drains. Extremely local in southern England north to south Lincolnshire.
RDB3	
<i>Atylotus latistriatus</i>	Saltmarsh species of horsefly, confined to southern England. Males are attracted to flowers of sea-lavender <i>Limonium</i> spp.
Toadflax brocade moth <i>Calophasia lunula</i>	Shingle beaches, waste land and gardens. Larva feeds on yellow toadflax <i>Linaria vulgaris</i> and occasionally other <i>Linaria</i> spp. Resident in Kent and Sussex, also a suspected immigrant.
<i>Cathormiocerus myrmecophilus</i>	Weevil recorded from coastal cliffs and rough open ground near the coast. Only known on the coast from East Sussex to West Cornwall.
<i>Dyschirius angustatus</i>	Small (3-3.5 mm) blackish brown fossorial ground beetle of sandy ground by water, particularly on the coast. A predator on small burrowing rove beetles of the genus <i>Bledius</i> . Very rare. Recorded from isolated areas of south-east England, the west Cumbrian coast and eastern Scotland.
Pigmy footman moth <i>Eilema pygmaeola</i>	Two subspecies in Britain: subsp. <i>pygmaeola</i> , found on coastal sandhills in Kent and Norfolk, immigrant elsewhere, and subsp. <i>pallifrons</i> , found on shingle at Dungeness.
<i>Haematopota bigoti</i>	Coastal blood-sucking cleg; larvae found in soil in saltmarshes. Recorded from southern coastlands north to to Humber/Mersey. Very local.
<i>Haematopota grandis</i>	Cleg which frequents coastal marshes and sometimes occurs a short distance inland along tidal rivers. Very local in southern England and south Wales.
<i>Lathys stigmatisata</i>	Small spider so far recorded only from Kent, East Sussex, Cornwall and Lundy Island. Found on coastal heath and shingle.
<i>Monacha cartusiana</i>	Pale disc-shaped snail with a brown lip, up to 17 mm in diameter. Occurs on chalk grassland and dunes in Kent, Sussex and Suffolk.
RDB K	
<i>Placobdella costata</i>	Large leech which feeds on the blood of vertebrates including frogs, water birds and mammals. In Europe, it is found in a variety of freshwaters, usually where aquatic macrophytes are present. The mature leeches carry their young attached to the ventral surface. Recorded from Pevensey Levels and Ridham Marshes (Kent - Region 7)).
pRDB1	
<i>Limobius mixtus</i>	Weevil found in sandy habitats and associated with common storks-bill <i>Erodium cicutarium</i> . Very local in southern England.
pRDB2	
<i>Andrena nitidiusculus</i>	Mining bee recorded from southern England, where it is usually found in coastal exposures of clay. Pollen is collected from umbels, with a wider range of plants being utilised for nectar.
<i>Ethmia bipunctella</i>	Black and white micro-moth; larva feeds on the flowers and leaves of viper's-bugloss <i>Echium vulgare</i> , comfrey <i>Symphytum</i> spp. or other Boraginaceae, pupating in a dead stem or rotten wood. Very local, resident in Kent and East Sussex, occasionally occurs elsewhere on southern and eastern coasts.
<i>Ethmia terminella</i>	Small black and white moth; larva feeds on the flowers and unripe seeds of viper's-bugloss. Only recorded from Kent and Sussex and from a single example in Essex.

Table 5.3.2 Coastal Red Data Book (RDB) species recorded in the region from 1970 onwards (continued)

Species	Description and notes on recorded occurrence in the region
pRDB2 continued	
<i>Hybomitra expollicata</i>	Horsefly; adults occur in brackish coastal levels and possibly in saltmarshes at Studland (Dorset - Region 9) and some Essex (Region 7) sites. Larvae of this genus develop in damp soil, so those of this species will probably be found in mud at the edges of saline ditches and ponds. Recorded from only 7 sites since 1900, all in Dorset, Sussex, Kent and Essex.
pRDB3	
<i>Agriotes sordidus</i>	Click beetle associated with tidal rivers, coasts and estuaries. Larvae probably develop in the soil at the roots of plants. Very local in southern England as far north as Lancashire.
<i>Ceutorhynchus verrucatus</i>	Small weevil, apparently exclusively associated with yellow horned-poppy <i>Glaucium flavum</i> in Britain. Found on coastal shingle and recorded from Sussex, Essex, Hampshire and Devon.
<i>Cynaeda dentalis</i>	Extremely local micro-moth frequenting coastal localities. Larva feeds in the stem and on the leaf bases of viper's-bugloss. Recorded from southern and south-eastern England, from Suffolk to Devon.
<i>Gelechia hippophaella</i>	Micro-moth; frequents coastal dunes where the larval foodplant, sea-buckthorn <i>Hippophae rhamnoides</i> , grows. Range includes much of the foodplant's native distribution.
<i>Hypocaccus metallicus</i>	Predatory beetle occurring in dung and carrion on coastal sandhills. Recorded from Sussex to Lincolnshire.
<i>Melissoblastes zelleri</i>	Micro moth which flies from June to August. Larva feeds on <i>Brachythecium albicans</i> . A rare species occurring on the coasts of Norfolk, Suffolk, Essex, Kent and Sussex. Also recorded from the Isle of Wight and dubiously from Gloucestershire.
<i>Ochthebius exaratus</i>	Water beetle associated with mud by coastal pools. Very local, primarily eastern in distribution.
<i>Orthotylus rubidus</i>	Infrequently recorded plantbug of the upper levels of saltmarshes on the south and east coasts of England, where it feeds on glassworts <i>Salicornia</i> spp. in infrequently flooded areas.
<i>Platytes alpinella</i>	Micro-moth of sandy coasts; larva feeds on <i>Tortula</i> spp. and other mosses. Very local and rather uncommon, distributed along the south coast from Devon to Kent, also recorded from East Anglia, Lincolnshire, Yorkshire, and recently a single site in Scotland.
<i>Trixagus elateroides</i>	Rare beetle with very few modern records. Seemingly coastal in distribution, associated with saltmarshes and river estuaries. A south-eastern species.
pRDB I	
<i>Neofriseria peliella</i>	Micro-moth recorded from a few southern coastal shingle sites. Larva feeds in a silken tube at the base of sheep's sorrel <i>Rumex acetosella</i> . This species is easily confused with <i>N. singula</i> .
pRDB K	
<i>Atomaria scutellaris</i>	Small beetle found in a range of habitats usually near the coast. Only known from a few sites in southern England.
<i>Bledius diota</i>	Small rove beetle which feeds on seaweed. It builds burrows in coastal sand or the banks of saltmarsh creeks, leaving small piles of soil similar to wormcasts. Very local in southern England and recorded as far north as Lincolnshire.
<i>Bledius occidentalis</i>	Rove beetle burrowing into firm sand or clay, usually on the coast. Predominantly a south-eastern species, recorded as far north as the Humber.
<i>Corticarina truncatella</i>	Small beetle feeding on mildew growing on decaying vegetable matter. Very local. Recorded from Sussex, Essex, Kent, Suffolk and Norfolk.
<i>Heriades truncorum</i>	Solitary bee largely confined to southern heathlands, where it nests in dead wood and pithy stems in sunny situations. Has also been found on chalk grassland. May have been introduced to Britain in timber.
<i>Peritrechus gracilicornis</i>	Very rare groundbug of the south coast of England. The only locality where it has been found in any numbers was dune heath. Other records come from dunes, heathland and chalk scree. Species dubiously native.
<i>Trichohydriobius suturalis</i>	Very local beetle found in sandy places on the coast. It is recorded from widely scattered localities from Devon to Wester Ross.

Source: JNCC Invertebrate Site Register (after Kirby 1994a, b). Key: Red Data Book categories: RDB1 = endangered; RDB2 = vulnerable; RDB3 = rare; RDB I = indeterminate; RDB K = insufficiently known; pRDB = proposed species as categorised in e.g. Hyman & Parsons (1992), except pRDBK = proposed species as categorised in e.g. Hyman & Parsons (1994). For further description of RDB categories, see Shirt (1987) and Bratton (1991).

habitat associations and the amount of available habitat. Many of the coastal sites in Table 5.3.3 are made up of a mosaic of habitats; for example, Rye Harbour is primarily an area of vegetated shingle, but also has some saltmarsh, open water and areas of rough grazing with drainage ditches.

The full range of microhabitats is utilised by invertebrates. Cliffs within the region provide a range of microhabitats. Many of the species associated with cliffs are dependent on warm microhabitats, such as sparsely vegetated, sheltered and south-facing slopes. Slopes such as those at Cow Gap and Holywell are known to support several scarce species, including small colonies of the adonis blue butterfly *Lysandra*

bellargus. The plume moth *Cnaemidophorus rhododactyla* has recently been found at one site on the region's chalk cliffs. This is a species typical of scrubby situations. The soft-rock cliffs of Fairlight are known to support an assemblage of invertebrates different from that found on chalk cliffs. This assemblage includes the scarce ground beetle *Tachys micros*.

A surprising range of invertebrates can be found on shingle habitats and many species are restricted to specific foodplants. For example viper's-bugloss *Echium vulgare* is known to support a number of species, including several extremely local moths, e.g. *Ethmia terminella*, and the nationally scarce weevil *Ceutorhynchus geographicus*.

Table 5.3.3 Sites of importance for invertebrate conservation

Site	Grid ref.	Conservation status
Kent/Sussex		
Dungeness	TR0718	SSSI, RSPB reserve (in part)
Walland Marsh (including East Guldeford Level)	TQ9923	SSSI
East Sussex		
Camber Sands and Rye Saltings	TQ9618	SSSI
Rye Harbour	TQ9318	SSSI, LNR
Pett Level	TQ9015	SSSI, NT (in part)
Hastings Cliffs to Pett Beach (includes Fairlight)	TQ8410	SSSI, NT (in part)
Norman's Bay	TQ6905	
Pevensey Levels	TQ6705	NNR (in part), SSSI
The Crumbles	TQ6402	
Seaford to Beachy Head (includes Holywell, Whitbread Hollow, Cow Gap and Cuckmere Haven)	TV5397	SSSI, NT (in part), LNR (in part)
Friston Forest	TV5399	
Lewes Levels	TQ4207	SSSI (in part)
Brighton to Newhaven Cliffs (including Friars' Bay Cliffs)	TV4399	SSSI
West Sussex		
Highdown Hill	TQ0904	
Climping Beach	TQ0201	SSSI
Pagham Harbour (includes The Lagoon)	SZ8797	SSSI, LNR, Ramsar site and SPA
Chichester Harbour (includes West Wittering)	SZ7698	SSSI, NT (in part), Ramsar site and SPA
Thorney Island (includes Thornham Marshes)	SU7504	SSSI (in part)

Key: LNR = Local Nature Reserve, NNR = National Nature Reserve, NT = National Trust, RSPB = Royal Society for the Protection of Birds, SPA = Special Protection Area, SSSI = Site of Special Scientific Interest; Ramsar site = wetland of international importance for birds.

Predatory species such as the ground beetle *Cymindis axillaris* can be found under stones. In invertebrate terms, two nationally important areas of coastal shingle occur within the region; Dungeness (mostly covered in Region 7) and Rye Harbour. In the past, the Crumbles was probably also of national significance and different in character from the other two sites. On the Crumbles the nationally scarce beetle *Helops caeruleus* has recently been recorded in an often overlooked microhabitat - old railway sleepers and groynes. The sandy edges of gravel pits on Rye Harbour support a significant invertebrate assemblage, including the endangered ground beetle *Omophron limbatum*. Where these pits are edged with common reed *Phragmites australis* a range of species characteristic of reedbeds can be found.

Coastal wet grasslands are well represented in East Sussex; Pevensey Levels, Lewes Levels and Pett Levels are probably all of national significance for invertebrates. Most of the invertebrate interest of these levels is associated with the dykes and drains. Many of these dykes support a wide range of water-beetles, Diptera (flies) and Odonata (dragonflies and damselflies). In clean, still waters with a rich aquatic flora nationally threatened snails, such as the large-mouthed valve snail *Valvata macrostoma*, may be found. Where the edges of the dykes are bordered by emergent vegetation a significant assemblage of invertebrates, including several scarcer species, can occur. In places willow trees border the dykes and these can be home to species such as the scarce and declining goat moth *Cossus cossus*.

Sand dunes have a range of microhabitats at each stage of the succession through to the more mature dunes. Only a comparatively few invertebrates can tolerate the conditions found in the unstable fore-dunes. The sand dart moth *Agrotis ripae* is typical of this habitat and has been recorded on all of Sussex's main dune systems. As grasses, such as marram *Ammophila arenaria*, start to stabilise the dunes a further range of species can be found. On Camber Sands (a nationally

important site), where lyme-grass *Leymus arenarius* occurs, the lyme-grass moth *Photedes elymi* can be found at its most westerly point along the south coast. On more stabilised areas of dunes a wide range of scarcer species can occur, e.g. the pyralid moth *Melissoblastes zelleri*, whose larvae feed on moss. Although the Hymenoptera (bee and wasp) fauna of the dunes of Sussex does not appear to be as well known as other groups, the compacted sand of the mature dunes is ideal for these species, providing nesting sites and an abundance of nectar sources. Scrub can be important; for example areas of sea-buckthorn *Hippophae rhamnoides* on Camber are known to support the rare micro-moth *Gelechia hippophaella*. Standing water in dune systems adds diversity to dune habitat, with interesting species found at the water's edge and within the ponds and dykes. There are a few smaller areas of dunes, such as Climping Sands, that are comparatively under-recorded but could prove to be important.

Several of the saltmarshes in Sussex, particularly in East Sussex, are of a comparatively small size. Nevertheless they support many species that are typical of the habitat, e.g. the star-wort moth *Cucullia asteris*. The rare mirid bug *Orthotylus rubidus*, which is associated with glasswort *Salicornia* spp., has been found at Chichester Harbour and Thorney Island. It primarily occurs in areas which, although saline, are not regularly inundated by the sea. The ground beetle *Dicheirotichus obsoletus* usually occurs on mud, under vegetation or under driftwood, whereas larvae of the soldier fly *Stratiomys longicornis* have been found in mud at the edge of brackish ditches.

The few estuaries of any size wholly within the region often have a range of habitats, e.g. shingle beaches, saltmarshes etc., which are exploited by invertebrates. The crescent striped moth *Apamea oblonga* is typical of brackish estuaries and has been found at a number of sites including Pagham Harbour.

The coast of Sussex is well placed to receive migrants from

the continent. Individual species can sometimes become established in this country (although on occasion only temporarily). A recent example is the Channel Islands pug *Eupithecia ultimaria*, a moth which now occurs at suitable localities between Southsea, Hampshire and Brighton.

5.3.3 Human activities

In common with other nature conservation interests the main threats to invertebrate communities include inappropriate management or direct habitat loss or degradation. For example, a marina and shops have recently been constructed on the Crumbles, although some vegetated shingle remains. The importance of this site for invertebrate conservation is deduced mainly from data collated prior to the site's development. Remnants of the site, however, may still be of some interest, although survey work is needed to confirm this. Site neglect is a further threat to some invertebrate populations; scrub invasion, for example, such as the spread of non-native *Cotoneaster* at Holywell and Cow Gap, can reduce the amount of habitat available to species typical of grassland and open conditions. The effects of mechanical beach cleaning on invertebrate populations over a small area of the Welsh coastline are discussed by Llewellyn & Shackley (1996). Much of the discussion in that article is applicable to other sandy areas of the coastline in Great Britain.

Many invertebrates require subtle features of vegetation structure; others, areas of bare ground. As invertebrates generally have annual life cycles, the precise habitat features they utilise must be present in the right condition in each and every year. This is compounded by the fact that many scarce species have poor powers of dispersal and are thus unable to colonise suitable habitat from afar. Site management often overlooks features that are of importance to invertebrates, many species surviving by default. The management of coastal habitats for invertebrates is covered by Kirby (1992), and the Butterflies Under Threat Team (BUTT 1986) discuss the management of chalk grassland for butterflies.

5.3.4 Information sources used

Many of the data used here come from the JNCC's Invertebrate Site Register (ISR), a computerised GB-wide database based on literature searches of entomological journals and the journals of local naturalist societies, data from local biological record centres and the Biological Records Centre, Monks Wood, and consultation with invertebrate specialists and non-governmental organisations.

The Sussex coast has been comparatively well-recorded in the British context, but the full potential of many sites along the Sussex coast may not have been fully realised. The level of recording varies along the coast as well as between the various invertebrate groups. This region's coast is, however, known to be particularly rich, with high species diversity, including a substantial number of scarce species. The more popular groups such as the Lepidoptera (butterflies and moths) and Coleoptera (beetles) are possibly the best recorded in this region, and the faunas of several other groupings are also reasonably well known. The Lepidoptera fauna of the Eastbourne area was considered to be so well known by the late 1920s that a local list was produced (Adkin 1928-34).

Modern reviews such as Pratt (1981), covering the butterflies and larger moths, include records from over 30 contributors.

There have been a number of surveys of aspects of the region's fauna in recent years. Morris & Parsons (1991, 1992) reported on surveys of the invertebrate faunas of selected south-east England coastal shingle sites, including Rye Harbour and the Sussex section of Dungeness. The *Journal of the Hastings & East Sussex Natural History Society* includes records of various insect orders, but with a bias toward the Lepidoptera. The British Entomological and Natural History Society has held a few field meetings on the Sussex coast and the National Trust has undertaken invertebrate surveys of some of its holdings in East Sussex. National recording schemes for a range of groups also have records from this part of the coast. Most of these schemes are co-ordinated by specialists with assistance from the Biological Records Centre. Provisional distribution maps are available for a wide range of invertebrates, including many for which this region is important. For example, Heath & Emmet (1979, 1983, 1990) map many Lepidopteran species. Maps have also been produced for 34 species of butterfly in Sussex (Gay 1992).

5.3.5 Acknowledgements

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C. Contact names and addresses

Type of information	Contact address and telephone no.
Terrestrial and freshwater invertebrates in Britain and Ireland, Invertebrate Site Register	*Biological Records Centre, Institute of Terrestrial Ecology, Monks Wood, tel: 01487 773381
Conservation of butterflies in Sussex	Butterfly Conservation, 17 Mallard Drive, Ridgewood Vale, East Sussex TN22 5PW, tel: 01825 768943
British Coleoptera (beetles), Hemiptera, (bugs) certain families of Diptera (flies) and aculeate Hymenoptera (ants, bees and wasps)	P. Hodge, 8 Harvard Road, Ringmer, Lewes, East Sussex BN8 5HJ, tel: 01273 812047
British Coleoptera (beetles), Hemiptera (Heteroptera - bugs) and certain families of Diptera (flies)	D.A. Porter, 76 London Road, Hailsham, East Sussex BN27 3DD
British Hymenoptera (bees, ants & wasps) and certain families of Diptera (flies)	M. Edwards, Lea-side, Carron Lane, Midhurst, West Sussex GU29 9LB, tel: 01730 813785
South-east England regional Odonata (dragonflies & damselflies) recorder	A. Hold, 22 Brook Road, Fair Oak, Eastleigh, Hampshire SO5 7BA, tel: 01703 694309
Lepidoptera (butterflies and moths) and Neuroptera (lacewings)	C.W. Plant, 14 West Road, Bishops Cleeve, Hertfordshire CM23 3QP, tel: 01279 507687
Invertebrate zoologists for English Nature	*Invertebrate Zoologist, English Nature HQ, Peterborough, tel: 01733 455000
National Trust property and surveys	*The National Trust, Cirencester, tel: 01285 651818
British macrolepidoptera (butterflies and larger moths)	C. Pratt, 5 View Road, Peacehaven, Newhaven, East Sussex BN10 8DE, tel: 01273 586780
Ecological surveys of Sussex	*Sussex Environmental Survey Directory, c/o Sussex Wildlife Trust, Henfield, tel: 01273 492630
National recording databank for aquatic Coleoptera (beetles)	Balfour-Browne Club/ Dr G.N. Foster, 3 Eglinton Terrace, Ayr KA7 1JJ, tel: 01292 525294

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

5.4 Rare sea-bed species

J. Plaza

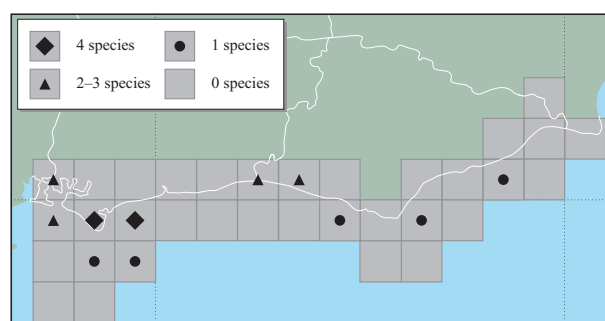
5.4.1 Introduction

This section considers rare and scarce marine benthic (sea-bed) species, excluding fish. 'Nationally rare' marine benthic species in this section are those that occur in eight or fewer of the 1,546 10 km by 10 km squares (of the Ordnance Survey national grid) that contain sea within the three-mile territorial limit for Great Britain. 'Nationally scarce' species are those that occur in nine to 55 such squares.

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 (1996, 1997) and are analogous to the criteria and methodologies 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 1995). Species considered in this chapter are those that are conspicuous and readily identifiable in field surveys for the Marine Nature Conservation Review (MNCR) or using similar survey techniques, or for which taxonomic experts consider that sufficient data exist on a national basis to warrant their inclusion. Species that are likely to be grossly under-recorded or overlooked on a national scale have been avoided in the present work. None of the species from this region is known to be a common deep-water species, so it is unlikely that any appear rare because their distribution just extends into the generally shallower near-shore sea area that is the focus of this study. Some species, however, will occur to some extent in the offshore waters of Great Britain outside the scope of this series.

Species at the limit of their global distribution (e.g. 'southern' or 'northern' species) may be rare within Great Britain's territorial seas but occur more commonly towards the centre of their biogeographic range. Species described here as 'nationally rare' or 'nationally scarce' are therefore not necessarily endangered globally, and although they are of national interest, their conservation importance needs to be carefully considered. In Britain, populations of many sessile (non-mobile) southern species are thought to be particularly sensitive to environmental impacts because the closer they are to the margins of their global distribution the more their capacity to recover from impacts and successfully reproduce after them is reduced. As a result, communities of southern species have been considered important for monitoring the marine environment in the UK (Fowler & Laffoley 1993). A number of the species mentioned in this section are thought to reach their eastern geographical limits in Region 8 and hence would appear to fit this 'sensitive' category. An analogous argument may apply to northern species as they approach the southern limit of their biogeographical range. Other genetic, ecological and pragmatic arguments for the conservation of populations of species that are rare because they are at the margins of wider distributions are summarised by Hunter & Hutchinson (1994). The importance of genetic, species and habitat biodiversity in the UK has recently been the focus of *Biodiversity: the Steering Group report* (Anon. 1995), in which the starlet sea anemone *Nematostella vectensis*, one of the protected scarce species in this region, is targeted for action.

The analysis in this section forms part of the first attempt



Map 5.4.1 Numbers of rare and scarce marine benthic species recorded in 10 km squares within the 3 mile limit. Distribution may reflect differences in recording effort.

to quantify the rarity of marine benthic species and to summarise the known occurrence of rare and scarce species in Great Britain. As more data become available or populations change, the status of species listed in this chapter will require re-evaluation.

Three rare and ten scarce marine benthic species have been recorded from Region 8. The western reaches of the region, particularly Chichester Harbour and the zone around Selsey Bill, appear to contain more rare and scarce marine benthic species than other areas. Three of the species known to occur in the region are currently protected by the Wildlife & Countryside Act (1981) and occur in a priority habitat listed in the EC Habitats & Species Directive 1992.

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 8, together with their known areas of occurrence and other key information. Map 5.4.1 summarises their current known distribution. As survey effort in this region has not been uniform (see Maps 4.2.2 and 4.2.3), assertions made as to the distribution of rare and scarce species may be somewhat artificial and should be regarded with caution.

5.4.3 Information sources used

An important starting point for the collection of information and literature on the distribution of rare and scarce species has been the MNCR database (McDonald & Mills 1996), which contains data on species present from more than 10,500 sites around Britain. Most of the data reproduced here have been confirmed by critical appraisal of the available scientific literature and through liaison with many eminent marine biologists and experts in taxonomic fields.

The sites of intertidal and subtidal benthic survey data for this region are mapped in section 4.2. It has not been possible in this section to list all the available literature on which the present analysis has been based, but the reviews and recent papers listed in sections 4.2.6 and 5.4.5 should allow access to the majority of the available information.

Table 5.4.1 'Nationally rare' and 'nationally scarce' marine benthic species found in Region 8

<i>Species</i>	<i>Type of organism</i>	<i>Area(s) of occurrence</i>	<i>Habitat/associations</i>	<i>Comments reference</i>	<i>Useful</i>
<i>Hartlaubella gelatinosa</i>	Hydroid	Roedean (Brighton)	Tolerant of silt and brackish water. Intertidal to 15 m. Often in gentle current.	From Oslo Fjord to Mediterranean and Black Sea. Hydroids are susceptible to under-recording.	Hayward & Ryland (1990)
<i>Laomedea angulata</i>	A hydroid	Langstone Harbour	Extreme low water to 8 m, often on seagrass	South coast of England and further south.	Hayward & Ryland (1990)
<i>Edwardsia ivelli</i> ##	Ivell's sea anemone	Widewater Lagoon	Lagoons	In Britain, known only from Widewater Lagoon. Current status of the population is unclear. 1997 survey failed to find the species at this locality.	Bratton (1991)
<i>Nematostella vectensis</i> ##	Starlet anemone (Isle of Wight thread star)	Pagham Harbour	Brackish-water habitats. In fine soft mud with tentacles exposed. Sometimes attached to vegetation such as sea grasses or filamentous algae.	Also at limited number of known sites in Canada and USA (Pacific and Atlantic coasts). Vulnerable habitat.	Bratton (1991)
<i>Apherusa ovalipes</i>	An amphipod	Chichester Harbour	Generally amongst subtidal algae	Mainly southern GB coast. Also Atlantic Europe and North Sea. Possibly under-recorded.	Hayward & Ryland (1990)
<i>Gammarus insensibilis</i> ##	Lagoon sand shrimp	Birdham Pool	Brackish water. In Britain from lagoon-like habitats. Part of weed-associated fauna.	Atlantic Europe to Mediterranean and Black Sea. In GB it is probably restricted to lagoonal habitat.	Bratton (1991)
<i>Pectenogammarus planicrurus</i>	An amphipod	Newhaven, Kemptown	Intertidal on clean shingle beaches	Restricted to very specific habitats within shingle beaches. <i>P. planicrurus</i> is the only amphipod which makes a permanent home of this habitat.	Bell & Fish (1996)
<i>Synisoma lancifer</i>	A sea slater	Worthing, Roedean, Ovingdean, Saltdean (Brighton), Hope Point	Amongst algae and boulders in the subtidal fringe	Distinctive southern species. South of GB to Mediterranean.	Bamber (1992)
<i>Truncatella subcylindrica</i> *	Looping snail	Pagham Harbour	Under high shore rocks and detritus in estuaries and in lagoons on sheltered shores. Also found in shingle to depths of 15 cm.	Southern. Atlantic France, Spain, Portugal and Mediterranean. In GB may have suffered habitat loss.	Bratton (1991); Graham (1988)
<i>Epistomia bursaria</i> *	A bryozoan	Selsey Bill	Unknown. Has occasionally been found on driftweed. In the Mediterranean it occurs between 20-40 m.	Also known from north and west Mediterranean. May be common at its few sites of occurrence.	Ryland & Hayward (1977)

Table 5.4.1 'Nationally rare' and 'nationally scarce' marine benthic species found in Region 8 (continued)

Species	Type of organism	Area(s) of occurrence	Habitat/associations	Comments reference	Useful
<i>Microcosmus claudicans</i>	A sea squirt	Between Selsey Bill and East Solent	On rock and stones, in shallow water down to c. 40 m.	Also known from the Mediterranean.	Millar (1970)
<i>Gracilaria bursa-pastoris</i>	A red seaweed	Chichester Harbour	On stone in sheltered places. Upper subtidal, often with sand deposition.	Southern. Outside UK is widely distributed in warm waters. Difficult to distinguish from the commoner <i>G. verrucosa</i> , hence may be somewhat overlooked.	Dixon & Irvine (1977)
<i>Padina pavonica</i>	Peacock's tail (a brown seaweed)	Bognor Rocks	On hard substrata	Southern. Ephemeral species - substantial changes in populations with time.	Price <i>et al.</i> (1979)

Species names after Howson (1987); in the absence of a specific common name the nearest available group name has been used. Key: * = nationally rare; # = protected by the Wildlife & Countryside Act 1981. Note: some of the scarce species listed here may be only a little more common than the rare species listed.

The marine natural history of Region 8 was relatively unknown until the 1970s, and studies had hitherto focused primarily on the fauna and flora of the shore. For example, an algal (thus littoral) species list was prepared by Merryfield as early as 1863, whilst a Sussex marine faunal list was not published until almost a century later (Anon. 1960). As a result, the majority of information on the subtidal fauna and flora of the region is relatively recent and stems mainly from Nature Conservancy Council-sponsored surveys (e.g. Ventham 1990, 1992) and Marine Conservation Society 'Seasearch' initiatives (see section 4.2.4). In this analysis, data have not been used from reports prior to 1965, in order to reflect only current known occurrence. Nevertheless, old records do exist for various rare and scarce species in Region 8, e.g. for the sponge crab *Dromia personata*, the pink sea-fan *Eunicella verrucosa* and the peacock's tail alga *Padina pavonica*. The shrimp *Alpheus macrocheles* has been found offshore of the study area (Anon. 1960).

MNCR survey work uses a consistent methodology to record conspicuous species (Connor & Hiscock 1996). 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. The MNCR of Great Britain is at present incomplete but has already substantially increased the quality and evenness of distribution of the available data. Combined with other surveys, completion of the MNCR will almost certainly expand our knowledge of the 'nationally rare' and 'scarce' species in Region 8. Consequently, the nationally rare and scarce status of the organisms presented here may require re-evaluation and species may be added to, or removed from, the list for this region in the future. Populations of species with short life histories, such as ephemeral algae and sea slugs, may require more regular re-evaluation of their occurrence than others.

5.4.4 Acknowledgements

The author thanks Dr W.G. Sanderson for his advice and input to draft copies of this section. The author is grateful for the assistance of the JNCC Marine Nature Conservation Review as well as the expert advice of Dr R.N. Bamber, Dr J.M. Baxter, Dr J. Brodie, P.F. Clark, D.W. Connor, P. Cornelius, Dr M.J. Costello, Dr W.F. Farnham, Dr R.L. Fletcher, Dr J.D. Fish, Dr P.R. Garwood, Dr J.M. Hall-Spencer, Dr T. Harris, Dr P.J. Hayward, Dr T.O. Hill, Dr K. Hiscock, Dr R.G. Hughes, I.J. Killeen, Dr G. Könnecker, J.M. Light, Dr C.A. Maggs, Dr J.D. McKenzie, Prof. P.G. Moore, D. Moss, Prof. T.A. Norton, Dr J.D. Nunn, B.E. Picton, D.R. Seaward, Dr S. Smith, Dr E.C. Southward, I. Tittley, S.M. Turk and Dr R.B. Williams. The author also thanks Dr R. Bamber, D.W. Connor, Dr K. Hiscock, R. Irving, I.J. Killeen, Dr M. Kerney, J.M. Light, Dr D. Lothian, Dr M. Willing and D. Ventham for taking time to read and comment on drafts. Access to the MNCR Database at the Joint Nature Conservation Committee, the NIBESRC Database at the Ulster Museum and the ERICA database run by the Cornish Biological Records Unit has been invaluable for the overall analysis.

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B. Further reading

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C. Contact names and addresses

Type of information	Contact address and telephone no.
Sponges & hydroids	B.E. Picton, Ulster Museum Botanic Gardens, Belfast BT9 5AB, tel: 01232 383146
Lagoonal specialist species	Dr R.S.K. Barnes, Department of Zoology, Downing Street, Cambridge CB2 3EJ, tel: 01223 336606
Synisoma lancifer	Dr R. Bamber, Fawley Aquatic Research Labs Ltd., Southampton SO45 1TW, tel: 01703 893513
Amphipods	Prof. P.G. Moore, University Marine Biological Station, Millport, Isle of Cumbrae KA28 0EG, tel: 01475 350581
Molluscs	Ian Killeen, 163 High Road, Felixstowe, Suffolk IP11 9BD, tel: 01394 274618
Bryozoans	Dr P.J. Hayward, School of Biological Sciences, University College Swansea, Singleton Park, Swansea, West Glamorgan SA2 8PP, tel: 01792 205678
Red seaweeds	Dr C.A. Maggs, School of Biology & Biochemistry, Queen's University of Belfast, Belfast BT7 1NN, tel: 01232 245133
Brown seaweeds	Dr R.L. Fletcher, University of Portsmouth, Marine Laboratory, Ferry Road, Hayling Island, Hants. PO11 0DG, tel: 01705 876 543

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 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 groups, such as fish and birds, including 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 also determined by factors such as water temperature (see section 2.3) and available habitat/substrate type (see also section 4.2). The species described may be found elsewhere in the region, but in smaller numbers.

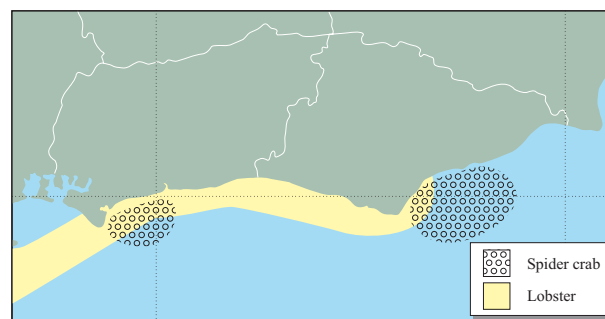
All species are referred to by their common names in the text. The scientific names of the species are to be found in Table 5.5.1.

There are important populations of lobsters, edible crabs, spider crabs, scallops and whelks in the region.

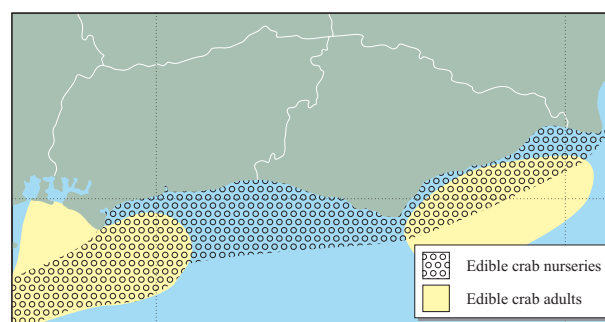
5.5.2 Important locations and species

Crustacea

The broadscale distributions of lobster and spider crab in the region are shown on Map 5.5.1 and of edible crab on Map 5.5.2. Lobster, edible crab, spider crab, green crab and velvet crab are distributed throughout the region wherever there is suitable habitat, from close inshore and offshore out into the Channel. Edible crabs are often found on softer sediments - ranging from sand/gravel to rock - and often further offshore than lobsters.



Map 5.5.1 Distributions of lobsters and spider crabs. Source: Gray (1995). © Shellfish Resource Group, CEFAS (Lowestoft).



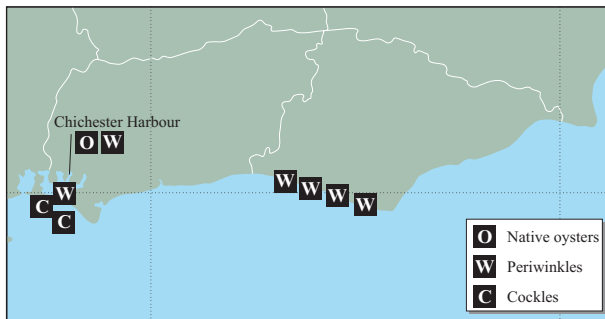
Map 5.5.2 Distribution of edible crab adults and nursery areas. Sources: Gray (1995), Pawson (1995). © Shellfish Resource Group, CEFAS (Lowestoft).

Molluscs

The main locations where exploitable populations of native oysters, periwinkles and cockles are found in this region are shown on Map 5.5.3. Periwinkles live throughout the region on algae growing on rocky shorelines. Chichester Harbour is one of the few places where *Bonamia* has not killed all the native oysters. Hard-shelled clams, a non-native species, were introduced into Southampton Water in the 1920s and have since colonised Chichester Harbour.

Table 5.5.1 Species names

Common name	Scientific name
Lobster	<i>Homarus gammarus</i>
Edible or brown crab	<i>Cancer pagurus</i>
Velvet crab	<i>Necora puber</i>
Green crab	<i>Carcinus maenas</i>
Spider crab	<i>Maja squinado</i>
Cockle	<i>Cerastoderma edule</i>
Mussel	<i>Mytilus edulis</i>
Hard-shelled clams (un-established introduction)	<i>Mercenaria mercenaria</i>
Native oyster	<i>Ostrea edulis</i>
Periwinkle	<i>Littorina littorea</i>
Scallop	<i>Pecten maximus</i>
Queen scallop	<i>Aequipecten opercularis</i>
Whelk	<i>Buccinum undatum</i>
Cephalopods including octopus, squid and cuttlefish	<i>Eledone cirrhosa</i> , <i>Loligo</i> spp. & <i>Sepia officinalis</i>
Lugworm	<i>Arenicola marina</i>
Ragworm/king ragworm	<i>Neanthes virens</i> & <i>Hediste diversicolor</i>



Map 5.5.3 Main locations of native oyster, periwinkles and cockles. Source: Gray (1995). © Shellfish Resource Group, CEFAS (Lowestoft).

Cuttlefish and squid are concentrated in the western Channel during the winter and move inshore and eastwards to spawn in April and May. They are common close inshore in spring and summer after spawning, after which they die.

Scallops live on sandy/gravelly areas of sea bed and are present in the region. Some scallop beds may be self-recruiting, whereas others depend on immigration from other areas (Pawson 1995). Whelks are widely distributed throughout the region, with important areas immediately to the east of the Isle of Wight. The broad-scale distributions of scallops and whelks in the region are shown in Map 5.5.4.

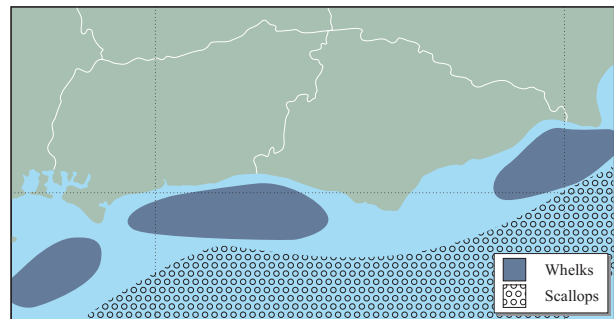
Polychaetes

The intertidal and subtidal zones in the region's estuaries support populations of polychaetes, such as lugworm and ragworm. Lugworms are common in less exposed areas where there is a higher organic content in the substratum. They occur elsewhere in a wide range of sediment types from almost pure mud to clean sand (Davidson *et al.* 1991). Both ragworm and lugworm are dug for angling bait in several parts of the region (see section 9.1.2).

5.5.3 Human activities

The exploitation by fisheries of the species covered in this section is described in detail in section 9.1, and by mariculture in section 9.2. Issues relating to exploited sea-bed species are commonly the method by which they are exploited and the amounts taken. Efforts are made to conserve shellfish stocks by implementing a number of local and national management measures. There are EC and national statutory Minimum Landing Size (MLS) limits for edible crab, lobster, spider crab, scallops and velvet crab. The actual size limits may vary, and local Sea Fisheries Committee (SFC) bylaws may set minimum landing sizes greater than those specified by EC law or national regulations. Fishing for lobster requires a permit issued by the Sussex Sea Fisheries Committee; the number of lobster pots is limited to 300 per boat within 6 miles of the coast. Sussex Sea Fisheries Committee operates an annual closed season for periwinkle gathering, from 15th May to 15th September.

Native oyster beds are now quite rare, and their decline around Britain has been attributed to various factors, including overfishing, the failure of spatfall, cold winters (Waugh 1964) and the spread of the protozoan parasite *Bonamia ostreae*. The native oyster population in Chichester



Map 5.5.4 Main locations of scallops and whelks. Source: Gray (1995). © Shellfish Resource Group, CEFAS (Lowestoft).

Harbour has been reduced by heavy exploitation and mortalities caused by *Bonamia*. The non-native Pacific oyster is now cultivated in preference to the native oyster (see section 9.2), owing to its faster growth rate and its resistance to *Bonamia* (Spencer 1990). The native oyster fishery is open from November 1st to April 30th (between 0730 - 1530 Monday to Friday), although in practice dredging ceases after a few weeks when all marketable sized oysters are taken. A Minimum Landing Size is imposed: oysters that can be passed through a circular ring with an internal diameter of 70 mm have to be returned to the sea.

Bait collection, especially digging for polychaetes, can have major localised effects on intertidal habitats and communities and can also cause disturbance to birds when they are concentrated in estuaries and bays (see sections 5.11.3 and 5.12.3 and references in section 5.5.6.B). Bait collection in the region is described in section 9.1.2.

5.5.4 Information sources used

The four maps in this section show schematically the known broad-scale distributions of the main species of interest, based on current knowledge from the Centre for Environment, Fisheries and Aquaculture Sciences (CEFAS), Sea Fisheries Inspectorate officers and the Sussex Sea Fisheries Committee on the locations of the species and their fisheries. There is supporting information in the form of landing statistics, and biological samples of crustacea, collected at the main ports and some secondary ports (see sections 9.1 and 9.2), plus intertidal surveys for molluscs in selected areas. These data provide some information about the location of spawning and nursery areas, but to establish the links between individual areas for spawning, nursery and adults would require specific investigations 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.

Maps were provided by the Shellfish Resource Group at the CEFAS Lowestoft Laboratory, and the Sussex Sea Fisheries Committee. Information was also used from Lee & Ramster (1981). Pawson (1995) presents information including distribution maps of selected species (scallop, cuttlefish, lobster, edible crab and spider crab) in the Channel and has a species-specific bibliography.

5.5.5 Acknowledgements

The authors thank R.C.A. Bannister (Shellfish Resource Group, CEFAS Lowestoft) for his helpful comments and additional written sections. Thanks also to Paul Knapman (English Nature) and staff from the English Nature Sussex and Surrey Local Team.

5.5.6 Further sources of information

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C. Contact names and addresses

<i>Type of information</i>	<i>Contact address and telephone no.</i>
Shellfish stocks and fisheries; advice to assist with management and policy decisions for the coastal zone	*Head of Laboratory, Centre for Environment, Fisheries & Aquaculture Sciences Conwy Laboratory, tel: 01492 593883
Assessment and provision of advice on the conservation of commercial fish and shellfish stocks	*Director, Centre for Environment, Fisheries & Aquaculture Sciences Lowestoft Laboratory, tel: 01502 562244
Local inshore fisheries information and advice on bylaws, National and EC legislation	Clerk and Chief Fishery Officer, Sussex Sea Fisheries Committee, 106 Station Road, Hailsham, East Sussex BN27 2EG, tel: 01323 841912
Benthic surveys: Marine Nature Conservation Review Database	*Marine Nature Conservation Review, JNCC, Peterborough, tel: 01733 562626
Marine conservation issues and fisheries	*Fisheries Liaison Officer, English Nature HQ, Peterborough, tel: 01733 455000
Marine Fisheries Task Group papers; marine conservation	*Fisheries Officer, JNCC, Peterborough, tel: 01733 562626
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	*Honorary Secretary, The Marine Forum for Environmental Issues, Scarborough, tel: 01723 362392

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

5.6 Amphibians and reptiles

Dr M.J.S. Swan

5.6.1 Introduction

This region supports all nine of the widespread species of amphibian and terrestrial reptile native to the UK: 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*. One alien amphibian species, the marsh frog *Rana ridibunda*, is also established. Since 1990, one leatherback turtle *Dermochelys coriacea*, one loggerhead turtle *Caretta caretta* and one other unidentified marine turtle have been reported in this region.

All of the above species are subject to some degree of protection under national or international law (Table 5.6.1). The great-crested newt and marine turtles are fully protected under UK legislation and are also of international conservation significance.

Table 5.6.1 Protected status of amphibians and reptiles occurring in the region

Species	Protection (see foot note)
Amphibians	
Common frog <i>Rana temporaria</i>	1, 2, 3
Common toad <i>Bufo bufo</i>	1, 2
Marsh frog <i>Rana ridibunda</i>	1
Smooth newt <i>Triturus vulgaris</i>	1, 2
Palmate newt <i>Triturus helveticus</i>	1, 2
Great-crested newt <i>Triturus cristatus</i>	1, 2, 3
Reptiles	
Common lizard <i>Lacerta vivipara</i>	1, 2
Slow worm <i>Anguis fragilis</i>	1, 2
Grass snake <i>Natrix natrix</i>	1, 2
Adder <i>Vipera berus</i>	1, 2
Loggerhead turtle <i>Caretta caretta</i>	1, 2, 3, 4
Leatherback turtle <i>Dermochelys coriacea</i>	1, 2, 3, 4

Key: 1 = Wildlife & Countryside Act (1981); 2 = Bern Convention (1979); 3 = EC Habitats & Species Directive (1992); 4 = CITES Convention.

In terms of both the extent of survey coverage (numbers of 10 km squares recorded) and the thoroughness of recording (number of records per 10 km square), this region has been well surveyed, compared with regions elsewhere on the North Sea Coast or Great Britain as a whole (Table 5.6.2). A high percentage of coastal 10 km squares have been surveyed for amphibians (87%) and reptiles (87%), from which averages of 18.2 and 14.2 records per square have been returned, respectively.

5.6.2 Important locations and species

For most of the species, the coastal strip contains vital semi-natural habitats such as sand dunes, woodland and scrub, wet grassland, ponds, ditches and flooded areas, but in this region parks, gardens and abandoned urban and industrial sites also play an important role.

Of the reptiles, common lizards, slow-worms and adders are found in scrubby areas on the downs, whereas grass snakes are more common in the moister habitats of river valleys, such as the Ouse. On the coast itself, numerous small populations of common lizards and slow worms survive on ageing, and sometimes ramshackle, sea fronts. Dilapidated buildings, bathing huts, embankments, wasteland, sea walls, rubbish dumps and heaps of debris provide ample cover and important coastal habitats for these species. Adders are locally abundant on cliffs - around Newhaven for example. The adder apparently requires larger areas of suitable habitat than the common lizard and slow-worm and is also more vulnerable to human disturbance and persecution. Slow-worms and, to a lesser extent, grass snakes have colonised gardens.

Virtually the only breeding habitat available to amphibians on the chalk downland in the region is dew ponds, in which all five native species are recorded; in this region the great-crested newt is most often found in the dew ponds in central areas of the downs. The species does not colonise gardens readily and is uncommon in the river valleys, ponds, ditches and flooded areas, which provide breeding habitat for frogs, toads and smooth newts. Overall

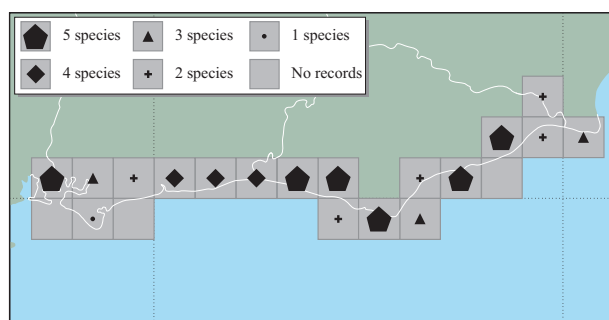
Table 5.6.2 Records of amphibians and terrestrial reptiles related to survey effort

	Total no. of 10 km squares*	% 10 km squares surveyed for:			Total no. of individual records		Mean no. of individual records per surveyed 10 km square	
		any herp. species	amphibians	reptiles	amphibians	reptiles	amphibians	reptiles
East Sussex	14	100	93	86	315	191	24.2	15.9
West Sussex	10	90	80	90	67	107	8.4	11.9
Region 8	24	96	87	87	382	298	18.2	14.2
North Sea Coast	504	76	66	49	4,141	1,602	12.5	6.5
GB coast	1,124	69	59	49	7,524	3,138	11.3	5.7
Great Britain (coast and inland)	2,862	84	79	66	27,182	8,803	12.1	4.7

Source: Biological Records Centre, ITE.

in the region, the smooth newt is more widespread than the palmate, although the latter predominates inland in the Weald heathland and on the northerly scarp edge of the downs. Frogs and smooth newts have colonised gardens in the coastal towns. The marsh frog is found in ditch systems within the Walland Marsh area, close to the Kent border.

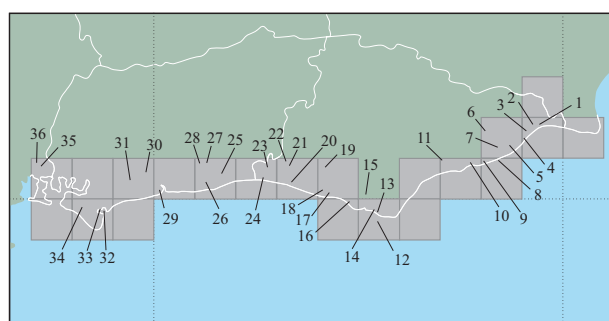
Table 5.6.3 lists sites and areas that are known to have important amphibian assemblages (Map 5.6.1) (Swan & Oldham 1989, 1993a) or in which reptiles are considered to be abundant in a regional context (Map 5.6.2) (Swan & Oldham 1993b); this list is not exhaustive.



Map 5.6.1 Numbers of amphibian species recorded in coastal 10 km squares. Distribution may reflect differences in recording effort. Source: Biological Records Centre, ITE Monks Wood. Note: not all rare species data are held by BRC and therefore some records may not be shown.



Map 5.6.2 Numbers of reptile species recorded in coastal 10 km squares. Distribution may reflect differences in recording effort. Source: Biological Records Centre, ITE Monks Wood. Note: not all rare species data are held by BRC and therefore some records may not be shown.



Map 5.6.3 Locations known to be important for amphibians and reptiles in the region (see Table 5.6.3). Source: Biological Records Centre, ITE Monks Wood.

5.6.3 Human activities

Loss of dew ponds threatens amphibians on the South Downs and great-crested newts in particular: approximately two-thirds of great-crested newt breeding sites there have been lost through neglect since the 1970s (Beebee pers. comm.). Within the coastal towns, the popularity of garden ponds has led to an increase in available breeding sites for frogs and smooth newts but great-crested newts seldom colonise these habitats. The expansion of the towns and ports and linking infrastructure reduces the extent of available reptile habitats. Efforts to 'improve' Victorian seaside resorts may also remove important reptile habitats.

The marsh frog was introduced in 1934/5 and had colonised East Sussex by the 1940s. It is reported to prey on other amphibians but this has not been substantiated. The species range increased until the 1960s/1970s, since when the degradation of the grazing marshes caused by the cessation of grazing, drainage and ploughing-up has caused significant decline and range contraction.

5.6.4 Information sources used

National distribution data for the widespread amphibians and terrestrial reptiles were provided by the Biological Record Centre (BRC) at Monk's Wood (Arnold 1983, 1995). These 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).

Most of the Sussex data, which were collated by English Nature and the county amphibian and reptile recorder, are reviewed in a separate English Nature report (Banks 1988) and held by English Nature in a site database. Lists of recorded great-crested newt and other herpetofauna sites are held by the Sussex Wildlife Trust. Turtle data and information were supplied by the Natural History Museum and Southampton University. Further information on habitat associations and local impacts was provided by Dr Trevor Beebee of Sussex University.

5.6.5 Acknowledgements

The author wishes to thank the following people for providing information: Henry Arnold, Brian Banks, Trevor Beebee and Dennis Dey.

5.6.6 Further sources of information

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Table 5.6.3 Important locations for amphibians and reptiles

Site no. on Map 5.6.3	Site/area name	Grid ref.	Species present	Habitat
East Sussex				
1	Rye Harbour SSSI	TQ9317	Common lizard, slow-worm, grass snake	Grassland, sea shore
2	Nook Beach Gravel Pit	TQ9217	Grass snake	Gravel pit
3	Winchelsea Beach	TQ9116	Slow-worm	Sea shore
4	Pett Level	TQ9014	Slow-worm	Heathland
5	Icklesham	TQ8716	Regionally important species assemblage: common frog, common toad, smooth newt, palmate newt	Pond
6	Smiths Wood, Guestling	TQ8416	Common lizard, grass snake	Woodland
7	Mallydams Wood	TQ8512	Common lizard, grass snake, adder	Woodland
8	Hastings Country Park	TQ8510	Common lizard, slow-worm, grass snake, adder	Grassland, heathland
9	St Leonard's-on-Sea	TQ7909	Nationally important species assemblage: common frog, common toad, smooth newt, palmate newt, great-crested newt	Pond
10	Filsham Reed Bed	TQ7709	Grass snake	Wetland
11	Highwoods, Bexhill-on-Sea	TQ7109	Adder	Woodland, heathland
12	Belle Tout	TV5695	Adder	Grassland
13	Birling Gap	TV5596	Adder	Grassland
14	Crowlink	TV5496, TV5497	Common lizard, adder	Grassland
15	Friston Forest	TV5399	Common lizard, slow-worm, grass snake, adder	Woodland, parkland
16	Seaford Golf Course	TV4998	Adder	Grassland
17	Newhaven cliffs	TQ4400	Adder	Cliff, downland
18	Newhaven	TQ4301	Common lizard, slow-worm, adder	Scrub
19	Ashcombe Farm, Lewes	TQ3809	Slow-worm, adder	Grassland
20	Brighton	TQ3505	Nationally important species assemblage: common frog, common toad, smooth newt, palmate newt, great-crested newt, common lizard and slowworm	Gardens, parks
21	Allotments, Hollingbury	TQ3107	Slow-worm, common lizard	Allotments, gardens
22	Patcham Graveyard	TQ3009	Slow-worm, grass snake	Graveyard, grassland
23	Westdean Park	TQ2908	Slow-worm	Parkland
West Sussex				
24	Shoreham: airport, beach, allotments, residential areas	TQ2005	Common lizard, slow-worm, grass snake	Sea shore, grassland, wetland, gardens
25	Lancing Ring	TQ1706	Common lizard, slow-worm, grass snake, adder	Grassland, woodland
26	Garcia Industrial Estate	TQ1504	Common lizard, slow-worm	Disused railway
27	Cissbury Ring	TQ1308, TQ1408	Common lizard, slow-worm, adder	Sand dune, cliff, downland, grassland
28	Homewood, Findon	TQ1209	Slow-worm	Parkland
29	Littlehampton: West Beach, golf course, marina	TQ0101	Common lizard	Grassland
30	Binstead Wood	SU9906	Common lizard, slow-worm	Woodland
31	Barnham	SU9603	Slow-worm, grass snake, adder	Grassland
32	The Severals, Pagham	SZ8795	Common lizard	Grassland
33	Pagham Harbour	SZ8696	Common lizard	Sea shore, grassland
34	Sidlesham	SZ8497	Common lizard, adder	Grassland
35	Kingley Vale NNR	SU8209	Common lizard, adder	Grassland
36	Fontington	SU8009	Slow-worm, adder	Grassland

Sources: Swan & Oldham (1993a, b); Perrins (1991). Note: this list should not be considered as exhaustive.

- Oldham, R.S., & Nicholson, M. 1986. *Status and ecology of the warty newt (Triturus cristatus)*. Final report. Peterborough, Nature Conservancy Council.
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- Whitten, A.J. 1990. *Recovery: a proposed programme for Britain's protected species*. Peterborough, Nature Conservancy Council.

C. Contact names and addresses

Type of information	Contact address and telephone no.
Conservation and captive breeding of amphibians and reptiles	The 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 Coordinator, Herpetofauna Groups of Britain and Ireland, c/o Froglife, Triton House, Bramfield, Halesworth, Suffolk IP19 9AE, tel: 01986 84518
Centre for amphibian ecological research	Dr Trevor Beebee, University of Sussex, Falmer, Brighton, East Sussex BN1 9QS, tel: 01273 606755
National recording schemes and biological data from throughout UK	*Environmental Information Centre, ITE, Monks Wood, Huntingdon, tel: 01487 773381
Species Recovery Programmes	*Lowlands Team, English Nature HQ, Peterborough, tel: 01733 455000
Turtles	Dr Colin McCarthy, Natural History Museum, Cromwell Road, London SW7 5BD, tel: 0171 938 9123
Turtles	Department of Oceanography, Southampton University, Highfield, Southampton SO9 5NH, tel: 01703 595000
Designated sites in Sussex	*English Nature, Sussex and Surrey Team, Lewes, tel: 01273 476595
Reptiles and amphibians in Sussex	*Sussex Wildlife Trust, Henfield, tel: 01273 492630

*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

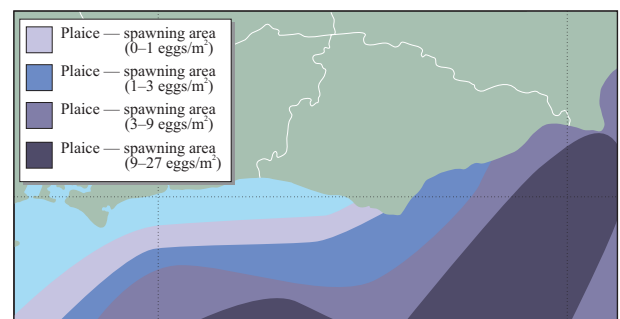
This section describes the distribution of sea fish that are of interest because they are exploited by people, mainly for food. Their exploitation by fisheries is described in [section 9.1](#). Sea fish described as pelagic are most commonly found in shoals swimming in midwater; they typically make extensive seasonal movements or migrations between sea areas. Demersal fish 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'; thus the latter term includes bass and grey mullet. Demersal species are divided here 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 exploited sea fish species can be mapped from analysis of catch data from commercial fisheries and resource surveys. This description of their distribution covers their occurrence at identifiable locations in the region during particular phases of their life history, and [Maps 5.7.1 - 5.7.5](#) show the known spawning and nursery areas of key species. Barring substantial climate change, or stock collapse, these distributions and relationships will remain stable over several decades.

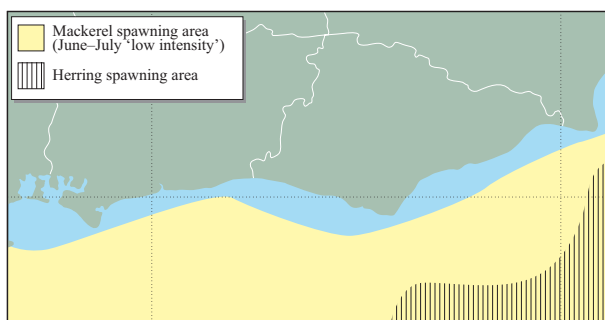
[Table 5.7.1](#) lists the important pelagic and demersal species occurring in the region and gives examples of protection measures in this region.

5.7.2 Important locations and species

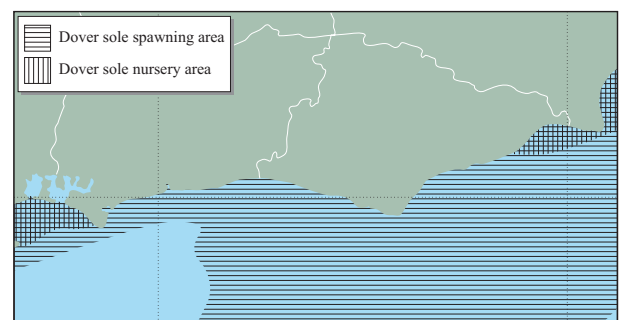
Of the pelagic species, mackerel are present in the region during their migration between their spawning areas, on the continental shelf edge to the west of Britain and in the North Sea, and overwintering areas west of Scotland, Ireland and Cornwall. They also spawn at low intensity in the waters offshore of this region ([Map 5.7.1](#)) (Lee & Ramster 1981). Herring are locally abundant in the autumn in feeding areas throughout the region. There is an autumn/winter spawning area south of the region ([Map 5.7.1](#)) (Hopkins 1991). Sprats are widely dispersed throughout the shallower areas of the



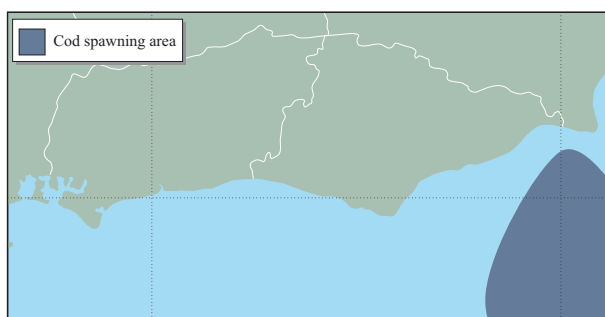
Map 5.7.3 Plaice spawning areas. Source: Lee & Ramster (1981). © Crown copyright.



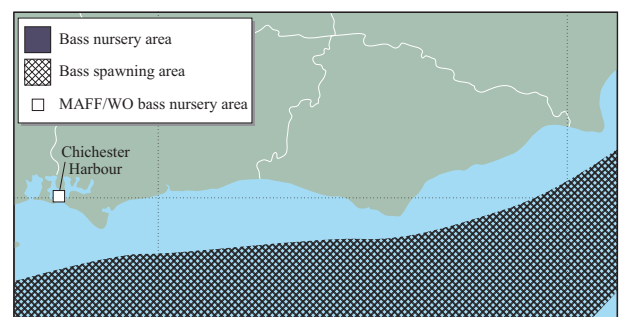
Map 5.7.1 Mackerel and herring spawning areas. Sources: Hopkins (1991); Lee & Ramster (1981). © Crown copyright.



Map 5.7.4 Dover sole spawning and nursery areas. Source: Pawson (1995). © Crown copyright.



Map 5.7.2 Cod spawning areas. Source: Brander (1994). © Crown copyright.



Map 5.7.5 Distribution of bass spawning and nursery areas. Sources: MAFF & VO (1990); Pawson (1995). © Crown copyright.

Table 5.7.1 Pelagic and demersal species and examples of measures for their protection

<i>Species</i>	<i>Protection measures</i>
Pelagic species	
Mackerel <i>Scomber scombrus</i>	QM
Herring <i>Clupea harengus</i>	QM/MLS
Sprat <i>Sprattus sprattus</i>	QM
Demersal species	
Elasmobranchs	
Spurdog <i>Squalus acanthias</i>	No limitation
Lesser spotted dogfish <i>Scyliorhinus canicula</i>	No limitation
Cuckoo ray <i>Raja naevus</i>	No limitation
Thornback ray <i>Raja clavata</i>	No limitation
Gadoids	
Cod <i>Gadus morhua</i>	MLS/QM
Whiting <i>Merlangius merlangus</i>	MLS/QM
Ling <i>Molva molva</i>	No limitation
Pollack <i>Pollachius pollachius</i>	MLS/QM
Flatfish	
Plaice <i>Pleuronectes platessa</i>	MLS/QM
Dab <i>Limanda limanda</i>	MLS
Dover sole <i>Solea solea</i>	MLS/QM
Lemon sole <i>Microstomus kitt</i>	MLS
Turbot <i>Psetta maxima</i>	MLS
Brill <i>Scophthalmus rhombus</i>	MLS
Flounder <i>Platichthys flesus</i>	MLS
Other demersal fish	
Bass <i>Dicentrarchus labrax</i>	MLS
Black bream <i>Spondylusoma cantharus</i>	MLS
Grey mullets <i>Chelon labrosus</i> , <i>Liza ramada</i> and <i>L. aurata</i>	MLS
Red mullet <i>Mullus barbatus</i>	MLS
Monkfish (angler) <i>Lophius piscatorius</i>	QM
Sandeels <i>Ammodytes</i> spp.	No limitation
Conger eel <i>Conger conger</i>	MLS

Source: European Council (1986, 1995). Key: MLS = minimum landing size; QM = catch quota management.

region, and the whole region is a spawning area. Spawning mainly peaks from February to April and is temperature-dependent. No clearly-defined nursery areas have been identified. Juvenile sprat are often found mixed with young herring in inshore areas, such as Chichester Harbour, when they are known as 'whitebait'.

Elasmobranch species produce relatively small numbers of live young (10-100 per year, but can be fewer in big sharks) or lay eggs on the sea bed close to their nursery areas. Several species of shark occur sporadically, such as the spurdog and lesser spotted dogfish. Rays such as the thornback ray and the cuckoo ray are also present.

Of the gadoids, cod are seasonally abundant and widely distributed in the region, and there is a pronounced spawning aggregation of cod off East Sussex (Map 5.7.2). Whiting are widely distributed around Britain and are common in the region, especially in inshore waters. The spawning season is prolonged - from January to July depending on the latitude - and there are likely to be spawning areas and nursery areas all around the coast that have not been identified. Ling and pollack are less abundant than other gadoids and more locally distributed and 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. Plaice spawn from December to March, the spawning peak being in January and February towards the centre of the Channel. Knowledge of plaice spawning areas is obtained from the distribution of newly spawned eggs in spring, determined by plankton surveys (Lee & Ramster 1981) (Map 5.7.3). Plaice are found on sandy areas of sea bed throughout the region, the juveniles living close to the shore in the same nursery areas as Dover sole (see below), gradually moving to deeper water as they grow. Dab spawn from January to June and juveniles of this species also move to coastal nurseries in the autumn and migrate to deeper water as they grow. Dover sole, which have a similar lifestyle to plaice, spawn in the early summer (April to June) all along, and offshore of, the coast of the region. Juvenile Dover sole may spend up to two years in inshore nursery areas. The spawning and nursery areas in the region are shown on Map 5.7.4. Turbot and brill have a similar lifestyle to plaice, dab and Dover sole but are much less abundant. Flounders migrate between inshore, estuarine and even riverine nursery areas all along the coast of the region to spawn up to 20 or 30 miles offshore in late winter, and there appears to be little long-shore coastal movement other than in the egg or larval phase. None of the flatfish species exhibits extensive migrations, though the larvae can drift for several weeks from offshore spawning grounds to inshore nursery areas. There may be some interchange, either way, between spawning stocks and nursery grounds in this region and the southern North Sea.

Bass, black bream and the grey mullet species are seasonally abundant inshore in the region and arrive at the region's coast in the early spring from warmer areas further west. Bass spawn in the region from March to May (Map 5.7.5) and there has been a strong recruitment of stocks that is thought to be linked to warmer sea temperatures (Pawson 1992). From June onwards juvenile bass and mullet are found extensively in coastal areas in the region. There are known nursery areas in Rye Bay and Chichester Harbour (Kelley 1988). Chichester Harbour has been designated by MAFF as a bass nursery area, in which bass fishing restrictions imposed (see Map 5.7.5 and section 5.7.3). Black bream spawn on the sea bed off the Sussex coast in May, and juveniles are found inshore all year round.

Other demersal species of commercial importance are red mullet and monkfish. Sandeels are distributed widely throughout the region and are common in the shallow harbours and bays. Sandeels provide an important food source for many other exploited fish species. They burrow in coarse sand at night and during the winter; their distribution is thus influenced by that of coarse sand.

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 scale of these fluctuations.

Efforts are made to conserve stocks of pelagic and demersal species by implementing a variety of management measures, 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 (TAC), explained further in [section 9.1](#)). Two such protection measures are listed in [Table 5.7.1](#): MLS, and catch quota management (QM), which indicates that the UK has been allocated a quota in ICES Divisions VIIId (English Channel, East), which covers Region 8. Their implementation means that fish caught below MLS or for which the quota is exhausted must 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. A Sussex Sea Fisheries Committee (SSFC) bylaw stipulates a Minimum Mesh Size for trammel and gill nets of 100 mm, unless pelagic species are being targeted, in which case the mesh size has to be in the range of 16-65 mm. Another SSFC bylaw determines that the mesh size of a herring net must be between 32 mm and 65 mm. There are also bylaws prohibiting fishing within 3 miles of the coast by boats over 12 m, including pair trawls or trawling. In order to protect shoals of juvenile black bream, demersal pair trawling with nets of mesh size below 90 mm is prohibited between 1 April and 1 July off Shoreham.

In order to safeguard the bass fishery in coastal waters of the UK, 34 areas have been designated statutory bass nurseries (The Bass (Specified Sea Areas) (Prohibition of Fishing) Order 1990: SI 1990 No. 1156 (Ministry of Agriculture, Fisheries and Food & Welsh Office Agriculture Department 1990)). These areas are where juvenile bass are abundant and are most easily caught, particularly during the summer months. There is one designated bass nursery area in the region, at Chichester Harbour ([Map 5.7.5](#)), where the duration of the closed season is from 1 May to 31 October. The legislation prohibits fishing for bass from any vessel for the duration of the closed season, and although fishing from the shore is not covered, anglers are expected to return to the sea any bass caught within nursery areas. The SFC Fishery Officers spend a lot of time enforcing bass sea fishing regulations, as a black market for under-size bass (the MLS for bass is 36 cm) is known to exist.

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 aggregate extraction, sewage sludge dumping, dredging and dredge material disposal and the development of infrastructure such as barrages and pipelines. MAFF is a statutory consultee for, or licenses, 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. Local fishermen have voiced concern over the aggregate dredging activities that have taken place on Shingle Bank, a traditional fishing ground. Other activities, such as sea angling (see [section 9.1.2](#)) and seismic activity for oil and gas exploration ([section 9.5](#)) (Turnpenny & Nedwell 1994) may also have a localised effect on fish populations.

5.7.4 Information sources used

Whereas the life history of most 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 particular 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 as a source for the maps, as well as Pawson (1995), which shows distribution maps of selected fish and shellfish species around the north-east Atlantic and in the Channel and has a species-specific bibliography.

European Council Regulations detailing the Total Allowable Catches (TACs) and the national catch quotas for fish and shellfish species for all European countries, and certain conditions under which the species can be fished, are published in Luxembourg in the Official Journal of the European Communities. These regulations are updated annually; the regulations for 1996 were given in European Council (1995).

5.7.5 Acknowledgements

Thanks are due to Paul Knapman (English Nature) and staff from the English Nature Sussex and Surrey Local Team for helpful comments on drafts of this section.

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- Vas, P. 1995. The status and conservation of sharks in Britain. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 5: 67-79.

C. Contact names and addresses

Type of information	Contact address and telephone no.
Advice to assist with management and policy for the coastal zone. Marine conservation issues	*Head of Laboratory, Centre for Environment, Fisheries & Aquaculture Sciences, 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, Centre for Environment, Fisheries & Aquaculture Sciences Lowestoft Laboratory, tel: 01502 562244
Local inshore fisheries information and advice on bylaws, national and EC legislation	Clerk and Chief Fishery Officer, Sussex Sea Fisheries Committee, 106 Station Road, Hailsham, East Sussex BN27 2EG, tel: 01323 841912
UKDMAP software with maps showing distributions of selected sea fish species and spawning areas	*Project Manager, BODC, Birkenhead, tel: 0151 653 8633
Marine conservation issues and fisheries	*Fisheries Liaison Officer, English Nature HQ, Peterborough, tel: 01733 455000
Marine Fisheries Task Group papers and advice on marine conservation issues	*Fisheries Officer, JNCC, Peterborough, tel: 01733 562626
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

*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 spend part of their lives in fresh water and part at sea. The three exploited diadromous fish species covered in this section - the Atlantic salmon *Salmo salar*, sea trout *Salmo trutta* and eel *Anguilla anguilla* - are widespread in British waters and sea trout and eel are commonly recorded in rivers in this region. (Twaite shad *Alosa fallax* and allis shad *A. alosa* 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).

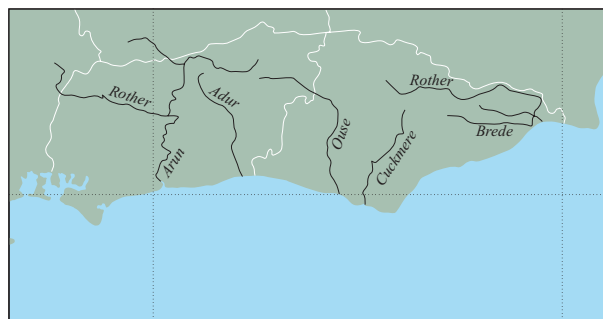
5.8.2 Important locations

The distribution of salmon and sea trout is controlled by natural factors, such as river levels, by man-made barriers that may limit the extent to which they can go upstream, and by pollution levels. Although salmon are present in coastal waters and occasionally in rivers in the region, there are no major salmon rivers here. [Map 5.8.1](#) show the rivers where sea trout are known to be present. The River Ouse and the eastern Rother have the most important populations of sea trout in the region. Eels are probably found in all river systems in the region, as elsewhere in Britain, and are common in locations such as the Royal Military Canal.

5.8.3 Human activities

Under the Environment Act 1995, the functions of the NRA under the Water Resources Act 1991 were transferred to the Environment Agency on 1 April 1996. The Southern Region of the Environment Agency has a responsibility to regulate, protect and monitor salmon, sea trout and eel fisheries from rivers to coastal waters out to 6 nautical miles from baselines. The Sussex Sea Fisheries Committee (SFC), which covers the region, has powers to support the conservation of salmonid fisheries while exercising its responsibilities towards the regulation of sea fisheries (see [section 9.1](#)). The Environment Agency constructs fish passes around man-made barriers, such as mills. Physical habitat improvements may also be made 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 not an issue for sea trout stocks (MAFF/SO 1991) in this region as no net methods are used, and compared to elsewhere in GB a small amount of rod-and-line fishing for sea trout takes place. The eel fishery is very important in the region, with fyke nets used to catch eels. They are often set in a series across a river. The Environment Agency encourages the use of bars fixed over the entrance of



Map 5.8.1 Sea trout rivers. Source: Environment Agency.

the net to prevent otters being trapped. The eel population is currently threatened by a nematode parasite *Anguillicola crassus* and its future impact on the eel fishery remains unclear.

Maitland & Campbell (1992) summarise the possible effects of various issues of relevance to freshwater fish. Issues mentioned of relevance in the region include the effects on salmonids of poor water quality, changing land use, such as the change in flow of rivers from canalisation, and increased siltation.

5.8.4 Information sources used

Rivers in the region are shown on the maps in Orton (1986) and National Rivers Authority (1994), and the distribution of Atlantic salmon in England and Wales is described in Russell (1989). The information on the salmon and sea trout caught in the region has been derived from the published catch statistics of the Environment Agency (see [section 9.1.2](#)). The Institute of Freshwater Ecology (part of the Natural Environment Research Council) conducts a programme of research into freshwater habitats and species.

5.8.5 Acknowledgements

Thanks are due to Robin Crawshaw and other staff of the Environment Agency Southern Regional Office for providing information used for this section and for checking drafts.

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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, EA Southern Region, Worthing, tel: 01903 832000
Scientific advice and policy; Fisheries Classification Scheme	*Head of Department, EA Fisheries Department, Bristol, tel: 01454 624400
General enquiries	*Public Relations Officer, Environment Agency - 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
Inter-government convention regulating salmon fishing on the high seas	Secretary, North Atlantic Salmon Conservation Organisation, 11 Rutland Square, Edinburgh EH1 2AS, tel: 0131 228 2551

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

5.9 Fish: other species

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

5.9.1 Introduction

Out of a national total of 336 fish species, 52 species have been recorded in this region, including two sharks (the lesser-spotted dogfish *Scyliorhinus canicula* and the tope *Galeorhinus galeus*), the remainder being bony fishes (teleosts). In addition, many common species are likely to be present although this has not yet been confirmed.

This region has confirmed records of two out of the seven British marine and estuarine species protected under national, European and international legislation (Table 5.9.1). These are the common and sand goby (*Pomatoschistus microps* and *P. minutus*). However, even though these fishes are listed under Appendix III of the Bern Convention, they are both very abundant in this region and in the UK as a whole. The sturgeon *Acipenser sturio*, allis and twaite shads *Alosa alosa* and *A. fallax*, lampern *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus* are considered threatened (Potts & Swaby 1993a) and although this region is within the range of all these species, there are no published records.

5.9.2 Important locations and species

There is little information available for individual locations in the region. The fish list for Pagham Harbour (Culley 1975), comprising 26 species, was considered incomplete by the author, who expected to find large populations and a wide range of species.

The associations of fish with habitats are given in Potts & Swaby (1993b). 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.

5.9.3 Human activities

Human activities affecting estuaries and adjacent coasts are summarised in Davidson *et al.* (1991); they can 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 1993c). Urban and industrial development and agricultural pollution have been shown to have a detrimental effect on the estuarine environment. Urbanisation and the disposal of untreated sewage in estuaries result 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). There are no published reports on human activities having a detrimental effect on fishes that are specific to this region. Barker (1992) reports major changes with the closure of riverside commercial and industrial sites and pollution associated with them no longer affecting fish populations. The possible effects of fisheries on fish species is discussed in sections 5.7 and 9.1. Sea angling occurs in many places throughout the region (Orton 1996) (see also section 9.1.2).

5.9.4 Information sources used

There is very little information available on non-commercial marine and estuarine fishes in this region, at least partly owing to the absence of major estuaries or coastal bays. There are two published fish lists for this area: Culley (1975) lists fish species from Pagham Harbour, while Ventham (1992) lists fish species from Brighton.

The British Marine Fishes Database covers UK fish and individual records for this area. A network is being established of those with a professional or other interest in fish around the UK, forming the core of the recording scheme that reports to the British Marine Fishes Database. Information is being gathered from a variety of sources including the Natural History Museum, the Environment Agency, the Sussex Sea Fisheries Committee, anglers and fishermen. The database contains published literature, unpublished reports and personal communications from fish biologists.

Table 5.9.1 Scheduled species and protected status

Species	Wildlife & Countryside Act (Schedule)	EC Habitats & Species 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	

Source: after Potts & Swaby (1993a). Key: *the sand and common gobies are both very abundant in UK.

5.9.5 Acknowledgements

Thanks go to J.S. Barker, A. Horton and D. Venham for their help in compiling this section.

5.9.6 Further sources of information

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C. Contact names and addresses

Type of information	Contact address and telephone no.
British Marine Fishes Database	Dr G.W. Potts/S.E. Swaby, Marine Biological Association UK, Citadel Hill, Plymouth PL1 2PB, tel: 01752 633100
Marine conservation issues and fisheries	*Fisheries Liaison Officer, English Nature HQ, Peterborough, tel: 01733 455000
Fish conservation - England	*Marine Ecologist, English Nature HQ, Peterborough, tel: 01733 455000
Fish conservation - UK	*Fisheries Officer, JNCC Peterborough, tel: 01733 562626
Fisheries	*Director, Centre for Environment, Fisheries & Aquaculture Sciences, Lowestoft Laboratory, 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, but also divers, grebes and seaduck: in other words those species reliant for an important part of their life on the marine environment. (Section 5.12.2 includes information on these waterfowl species, where they occur close inshore, especially within estuaries.)

This region is not of great importance for seabirds. Nine species of seabird breed in the region, two (common tern *Sterna hirundo* and little tern *S. albigrons*) in nationally important numbers. Concentrations of birds at sea in this region are generally low (Stone *et al.* 1995). Few offshore waterfowl winter in this region, with common scoter *Melanitta nigra* being present in largest numbers, mostly off the Pett Levels/Rye Harbour area (Owen *et al.* 1986), and Slavonian grebe *Podiceps auritus* overwintering in nationally important numbers in Pagham Harbour. Moderate concentrations of divers were found by aerial survey off the coast in spring 1991 (Barton *et al.* 1994).

5.10.2 Important locations and species

The little tern colony at Rye Harbour holds approximately 35 pairs of breeding birds each year, a level of national importance. No single colony of common terns holds nationally important numbers of breeding birds in every year, although the colony at Rye Harbour regularly approaches these levels and sometimes exceeds them. Small numbers of Mediterranean gull *Larus melanocephalus* have bred in the region also. Most breeding seabirds require habitat that is free from predatory mammals, hence nearly all colonies are on cliffs or remote parts of saltmarshes. Some of the tern colonies in this region are on beaches and are particularly vulnerable to disturbance and predation. The large gulls appear to be able to tolerate more disturbance by mammals than the smaller seabird species. Seabirds find food offshore, ranging from

small fish to waste from fishing fleets. Habitats that concentrate any of these foods are preferred. Most of the breeding seabird species in the region feed in estuaries, often on exposed intertidal areas, or in other shallow, inshore waters.

The waters off the east of the region are visited in winter by seabirds breeding further north, including red-throated divers *Gavia stellata* (occasionally present in nationally important numbers), guillemots *Uria aalge* and razorbills *Alca torda* (sometimes present in moderate densities in mid-winter) and the larger gulls. Pagham Harbour supports nationally important numbers (20-25 individuals) of Slavonian grebe *Podiceps auritus* during the winter.

5.10.3 Human activities

The English Channel as a whole is an important route for oil tankers and other vessels, from which oil spills can occur. The main breeding seabird species in this region (terns and gulls) are not particularly vulnerable to direct effects of marine oil pollution. However, seabirds at sea can be particularly affected, and in both December and February the sea off the eastern part of the region holds numbers of wintering birds at concentrations that make them highly vulnerable to local oil pollution (Webb *et al.* 1995). Some birds may become entangled in fishing nets in the region, but the scale at which this occurs is not believed to be large overall. Tern colonies are particularly vulnerable to disturbance and predation (which may cause desertion of colonies or breeding failure). Most of the tern colonies in the region are subject to some degree of wardening or other protection, but serious incidents of predation (e.g. by foxes) have occurred in some years.

5.10.4 Information sources used

All seabird colonies in the region were counted or reappraised between 1984 and 1987. Most tern colonies have been recounted in the past two years. These counts, and all those made since 1979, are held on the JNCC/Seabird Group Seabird Colony Register. Numbers and breeding performance of various species of seabird are evaluated annually at about five colonies in the region (Thompson *et al.* 1996). Surveys of birds at sea off this coast have been carried out by JNCC's Seabirds at Sea Team (SAST). 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 (1991) (Barton *et al.* 1994). There has been no systematic coverage from the land.

5.10.5 Acknowledgements

Kate Thompson abstracted information from the JNCC/Seabird Group Seabird Colony Register, and Emma Brindley (RSPB) kindly provided information on tern and grebe numbers.

Table 5.10.1 Overall importance of seabirds (pairs) breeding in the region

Species	Total	% GB	% Europe
Fulmar <i>Fulmarus glacialis</i>	43	<0.1	<0.1
Mediterranean gull <i>Larus melanocephalus</i>	Rare	<1.0	<0.1
Black-headed gull <i>Larus ridibundus</i>	1,084	0.6	0.1
Lesser black-backed gull <i>Larus fuscus</i>	16	<0.1	<0.1
Herring gull <i>Larus argentatus</i>	191	0.1	<0.1
Kittiwake <i>Rissa tridactyla</i>	1,330	0.3	0.2
Sandwich tern <i>Sterna sandvicensis</i>	100	0.7	0.2
Common tern <i>Sterna hirundo</i>	133	1.0	0.3
Little tern <i>Sterna albigrons</i>	40	1.7	0.2

Sources: figures for the region come from the most recent available good quality counts up to 1996; figures for Britain from Thompson *et al.* (1996), for Europe from Lloyd *et al.* (1991), with some updating.

5.10.6 Further sources of information

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C. Contact names and addresses

Type of information	Contact address and telephone no.
Seabird colonies	*Coordinator, Seabird Colony Register, JNCC, Aberdeen, tel: 01224 655700
Seabirds at sea	*Seabirds at Sea Team, JNCC, Aberdeen, tel: 01224 655700
Birds database	*Species Advisor, JNCC, Peterborough, tel: 01733 562626
Nearshore waterfowl	*WeBS National Organiser (Wildfowl), The Wildfowl & Wetlands Trust, Slimbridge, tel: 01453 890333
Sussex birds	David Gold, Sussex Ornithological Society, 63 Sullington Crescent, Worthing BN14 0HS, tel: 01903 872096

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

5.11 Other breeding birds

R.T. May & A.B. Law

5.11.1 Introduction

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

Coastal habitats in this region include estuaries, wet grassland, shingle/sand beaches and chalk cliff. The wet grassland and dry habitat areas are noted for their breeding waterfowl assemblages ([Maps 5.11.1](#) and [5.11.2](#)), particularly for the densities of estuarine wet grassland-breeding waders ([Map 5.11.3](#)) (Smith 1983; Davidson 1991; Davidson *et al.* 1991). In the context of British estuaries, Pagham Harbour holds one of the highest densities of grassland breeding waders ([Map 5.11.4](#)) (Davidson *et al.* 1991). The region's extensive areas of wet grassland hold nationally important numbers of garganey *Anas querquedula*, shoveler *A. clypeata* and gadwall *A. strepera* (Pritchard *et al.* 1992).

Numbers of lowland breeding waders, especially those associated with wet grassland areas and saltmarshes, have been declining not only nationally but also internationally (Hötter 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.

5.11.2 Important locations and species

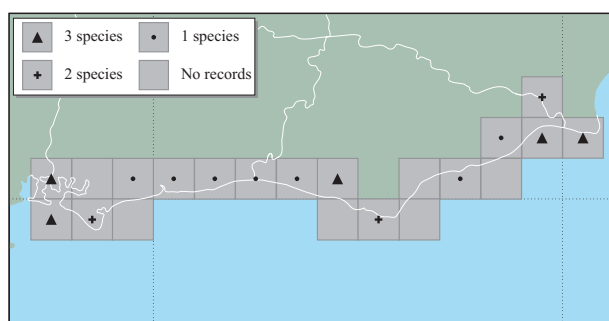
Wet grasslands are a key habitat for breeding waders, but have diminished significantly over this century. The wet grasslands in this region support important assemblages of breeding bird species (Pritchard *et al.* 1992).

[Map 5.11.1](#) shows the incidence of confirmed breeding in coastal 10 km squares of selected species characteristic of wet grassland (teal *Anas crecca*, lapwing *Vanellus vanellus*, redshank *Tringa totanus*, mallard *Anas platyrhynchos*, snipe *Gallinago gallinago* and pintail *Anas acuta*). Pett Levels have a diverse breeding wader and wildfowl assemblage that includes nationally important numbers of garganey and shoveler (Pritchard *et al.* 1992), while the highest densities of wet grassland breeding waders in the region are found at Chichester and Pagham Harbours. These wet grassland areas support particularly high densities of lapwing ([Map 5.11.5](#)). The Pevensey Levels support waterfowl such as mute swan *Cygnus olor*, mallard, lapwing and snipe and redshank, as well as passerines (songbirds) such as reed warbler *Acrocephalus scirpaceus*, reed bunting *Emberiza schoeniclus* and yellow wagtail *Motacilla flava*.

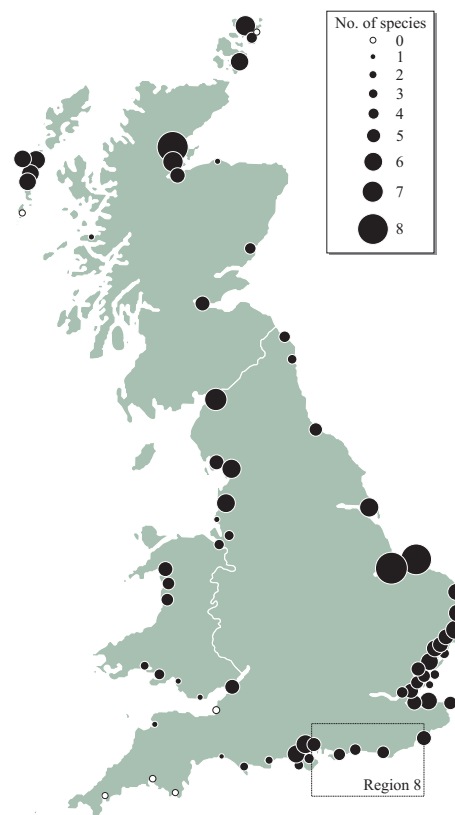
[Map 5.11.2](#) show the incidence of confirmed breeding in coastal 10 km squares of selected waterfowl species characteristic of shingle, sand dunes and other dry grassland



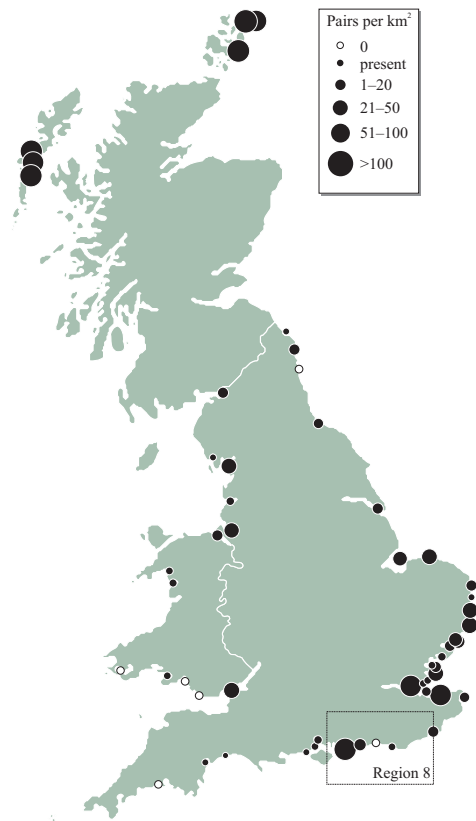
Map 5.11.1 Number of confirmed breeding species characteristic of wet grassland (redshank, snipe, lapwing, mallard, teal and pintail) in coastal 10 km squares. Source: based on Gibbons *et al.* (1993).



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. Source: based on Gibbons *et al.* (1993).



Map 5.11.3 Numbers of different breeding wader species on estuaries in Britain (waders also breed elsewhere along the coast). Source: Davidson *et al.* (1991).



Map 5.11.4 Maximum densities (pairs/km²) of all waders breeding on wet grasslands adjacent to estuaries in Britain. Source: Davidson *et al.* (1991).



Map 5.11.5 Maximum densities (pairs/km²) of lapwing breeding on wet grassland sites adjacent to estuaries (species also breeds elsewhere along the coast). Source: Davidson *et al.* (1991).

Table 5.11.1 Numbers of pairs of territorial (presumed breeding) ringed plovers in 1984		
	<i>Pairs (coastal) counted in survey</i>	<i>% GB total counted in survey</i>
<i>Region 8</i>	128	1.8
England	1,984	27.5
GB total	7,207	

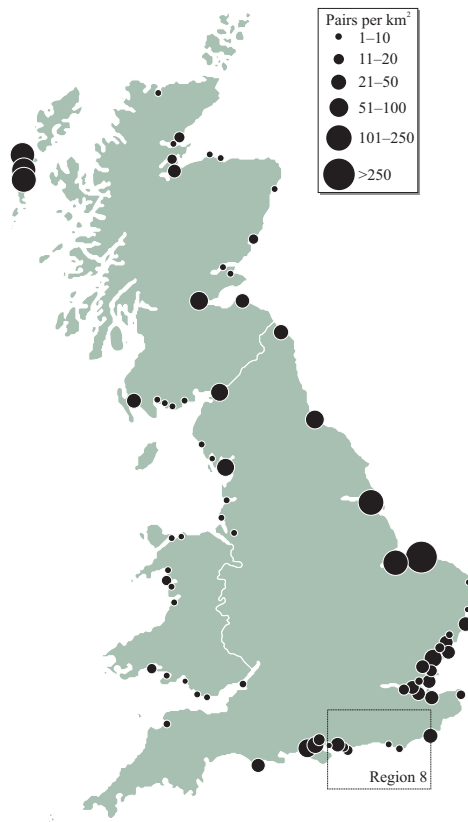
Source: Prater (1989). Note: survey coverage varied between counties, although it was generally good in the region overall.

Table 5.11.2 Sites holding at least 45 shelduck in 1992		
<i>Site name</i>	<i>Total including non-breeding birds</i>	<i>Breeding pairs</i>
Rye Harbour SSSI	50	14
Pagham Harbour	147	20
Chichester Harbour	772	133

Source: WWT (unpublished data).

(ringed plover *Charadrius hiaticula*, oystercatcher *Haematopus ostralegus* and shelduck *Tadorna tadorna*). Breeding ringed plovers nest in shingle and sand areas along the coast (Table 5.11.1, Map 5.11.6) (Davidson *et al.* 1991; Prater 1989), especially in the Rye and Chichester Harbour areas. In this region, 69% of all ringed plover breed in wardened reserves in 1984 (Prater 1985).

There are a few important breeding areas for shelduck, Chichester Harbour having particularly high numbers (Table 5.11.2).



Map 5.11.6 Numbers of pairs (per km²) of breeding ringed plover on estuaries in Britain from data in Prater (1989).

Many parts of the important breeding bird habitat in the region lie within designated sites (for example Local Nature Reserves (LNRs), Sites of Special Scientific Interest (SSSIs), Special Protection Areas (SPAs) and Ramsar sites), although the sites were not always chosen principally for their breeding bird interest. There are a number of coastal SSSIs within the region containing wet grassland, shingle beaches and estuarine habitats. The RSPB also has reserves along some parts of the coast, at Adur Estuary and Pilsey Island. Their management specifically for the bird populations provides ideal breeding habitat for a number of species.

5.11.3 Human activities

In this region any incremental land claim along the soft coasts of estuaries/harbours 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; Scholey 1995; Thomas *et al.* 1995) is of crucial importance for their wader populations (see also papers in Hötter 1991). Drainage of these areas and lack of traditional management are potential threats to these wader populations. 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 *et al.* 1987). Active land management for conservation in many coastal areas in the region has increased populations of breeding waterfowl.

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 *et al.* (1993). This summarises the results of a national breeding bird census undertaken between 1988 and 1991 and compares distributions at the 10 km grid 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 x 10 km squares. This is because the 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 x 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 go to D.A. Stroud and D.M. Craddock (JNCC) and

S. Delany (Wildfowl and Wetlands Trust) for their help with this section.

5.11.6 Further sources of information

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B. Further reading

- Green, R.E. 1991. Breeding waders of lowland grasslands in England and Wales. In: *Birds and pastoral agriculture in Europe*, ed. by D.J. Curtis, E.M. Bignal & M.A. Curtis, 32-34. Paisley, Scottish Chough Study Group.

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	*The Wildfowl & Wetlands Trust, Slimbridge, tel: 01453 890333
Site designations	*English Nature HQ, Peterborough, tel: 01733 455000
Sussex birds	David Gold, Sussex Ornithological Society, 63 Sullington Crescent, Worthing BN14 0HS, tel: 01903 872096

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

5.12 Migrant and wintering waterfowl

R.T. May & A.B. Law

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*) during their non-breeding period. The section also notes the occurrence of wintering waterfowl and cormorant *Phalacrocorax carbo* where they occur close inshore, especially within estuaries. The importance of offshore areas for wintering divers, grebes, seaducks and cormorant is outlined in section 5.10 and by Kirby *et al.* (1993).

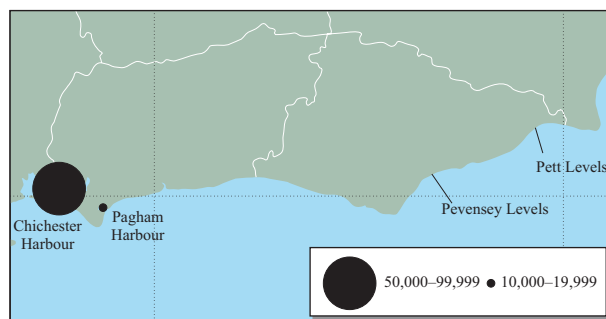
This region's coast is characterised by chalk cliffs and shingle beaches, with small estuaries and harbour areas. Relatively few migrant and wintering wildfowl occur in the region, but the area contains some important roosting areas and wader populations outside the breeding season (Prater 1981). The region holds, in mid-winter, over 52,000 waterfowl - about 3% of the English total. Table 5.12.1 gives the total January 1993 waterfowl count for the region as a proportion of the coastal totals for both England and Great Britain.

Table 5.12.1 Waterfowl counts in Region 8, England and Great Britain in January 1993

	Total waterfowl count	No. of sites counted	% of count in Region 8
Coastal sites in Region 8*	52,699	7	100
All counted English coastal sites	1,577,388	106	3.3
All counted British coastal sites	2,060,961	214	2.6

Source: Rose & Taylor (1993). Key: *including the whole of Chichester Harbour, which falls partly in Region 9. Note: care should be taken in interpretation as count coverage varies from country to country and the data have not been corrected.

According to the WeBS national survey of wetland sites (see section 5.12.4), six species occur in the region at levels of international importance on at least one estuary and a further seven species occur at levels of national (i.e. Great Britain) importance. The relative importance of the regularly counted wetlands (estuaries and adjacent marshes) is shown on Map 5.12.1. The region can become more important when there are periods of severe cold weather further east in continental Europe. Under these conditions, there may be influxes of waterfowl from other coastal regions or inland areas (Ridgill & Fox 1990).



Map 5.12.1 Distribution of main estuarine concentrations of wintering intertidal waterfowl. Size of circle proportional to 5-year mean of waterfowl numbers. Source: Waters & Cranswick (1993).

Although poorly monitored, the non-estuarine shoreline of the region has, in general, a low density of non-breeding waders in relation to the UK as a whole (Table 5.12.2) (Moser & Summers 1987).

The coastline is of 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, although the region is of considerable significance during spring and autumn migration periods for spotted redshank *Tringa erythropus*, greenshank *T. nebularia* and curlew *Numenius arquata*, amongst others (Prater 1981; Pritchard *et al.* 1992).

5.12.2 Important locations and species

The distribution of wintering waterfowl species occurring on both estuarine and non-estuarine sites in the region is determined by habitat characteristics (Moser & Summers 1987) and the species compositions of assemblages of estuarine and non-estuarine migrant and wintering waterfowl in the region are shown in Figure 5.12.1. On estuarine shores the dark-bellied brent goose *Branta bernicla bernicla* is the most abundant wildfowl in the region and the dunlin *Calidris alpina* the most abundant wader species. The estuarine sand/mudflat habitats are also attractive to grey plover *Pluvialis squatarola* and bar-tailed godwit *Limosa lapponica*, as they provide a wide range of invertebrate food. The shingle

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

	Number of wader species recorded	Total number non-estuarine wader	Extent of non-cliff, non-estuarine coast in county (km)	Extent of coast surveyed (km)	Overall wader density (no. of birds/km coast)
West Sussex	8	1,080	53.0	32.8	33
East Sussex*	10	730	88.9	77.9	9

Source: data from the Winter Shorebird Count - Moser & Summers (1987). Key: *including the whole of Chichester Harbour, which falls partly in Region 9

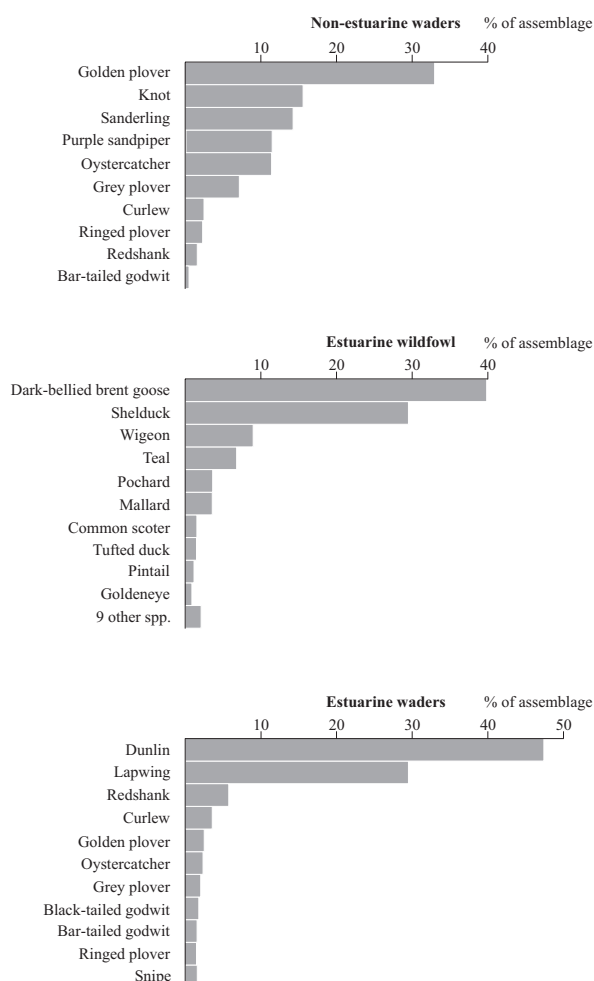


Figure 5.12.1 Relative species composition of non-breeding waterfowl assemblages on coastal areas of the region. Source: estuarine waterfowl data from Prater (1981), non-estuarine wader data from Moser & Summers (1987).

beaches and saltmarsh provide roosting sites for dunlin, amongst other species. Ringing studies have shown that many species (e.g. dunlin and (on non-estuarine shores) grey plover) 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 non-estuarine shores in the region consist of sand and shingle beaches and areas of chalk cliffs, which do not provide such rich and diverse feeding habitats as the estuaries in this region. In these areas, golden plover *P. apricaria* is the most common wader species, followed by knot *Calidris canutus*, sanderling *C. alba* and purple sandpiper *C. maritima* (Figure 5.12.1) (Moser & Summers 1987).

This coastal region contains only two extensive areas of estuarine habitat (Chichester and Pagham Harbours) that include areas of intertidal mudflats and saltmarsh. These habitats are important feeding grounds for many wintering waterfowl and large numbers of dark-bellied brent geese use these areas, as well as a number of wader species. Dark-bellied brent geese graze and roost on coastal mudflats and saltmarshes within the region. The estuarine areas also contain shingle areas and islands, which can be important roosting sites. Chichester Harbour (which falls partly in the adjacent Region 9) supports the largest flock of wintering knot on the south coast (Prater 1981).

Chichester Harbour qualifies as of international importance by virtue of holding over 20,000 waterfowl (Table 5.12.3). It is also of international importance by supporting five species of wintering waterfowl and nationally important numbers of wintering little grebe, shelduck, red-breasted merganser, sanderling, redshank and black-tailed godwit (Table 5.12.3). Pagham Harbour represents an important area in this region in terms of waterfowl diversity (Prater 1981) and supports an internationally important population of wintering dark-bellied brent goose and nationally important numbers of wintering pintail. Chichester and Pagham Harbours support significant numbers of autumn passage waterfowl, such as spotted redshank and greenshank (Pritchard *et al.* 1992), while dunlin use these sites for moulting their wing feathers during their autumn passage (Davidson *et al.* 1991).

This region also contains important areas of wet grassland: the Pett Levels and the Pevensy Levels. The Pett Levels contain a mosaic of ditches and pastures and are nationally important for wintering shoveler *Anas chlypeata*, while the Pevensy Levels are notable for wintering lapwing *Vanellus vanellus* and snipe *Gallinago gallinago*. In addition, internationally important numbers of wintering Bewick's swan *Cygnus columbianus bewicki* have been counted in the area from Dungeness to Pett Levels (Pritchard *et al.* 1992).

Table 5.12.3 Wintering waterfowl numbers on monitored sites in the region

Site	Conservation status	Five year mean nos. wintering waterfowl	1994/95 peak waterfowl numbers	1994/95 peak wildfowl numbers	1994/95 peak wader numbers	Species occurring at levels of national or international* importance
Rye Harbour/Pett Levels		8,936	11,916	2,801	9,115	Shoveler
Adur Estuary		3,245	4,132	209	3,923	
Ouse Estuary		1,246	1,290	12	1,278	
Pagham Harbour	SPA & Ramsar	15,646	18,541	7,234	11,307	Dark-bellied brent goose*, pintail
Chichester Harbour ⁺	SPA & Ramsar	**54,309	60,370	14,837	45,533	Grey plover*, dunlin*, bar-tailed godwit*, black-tailed godwit*, ringed plover*, little grebe, shelduck, red-breasted merganser, sanderling, redshank

Sources: WeBS data from Waters *et al.* (1996); Cranswick *et al.* (1995). Key: SPA = Special Protection Area; Ramsar = internationally important wetland under the Ramsar Convention.; ⁺site overlaps boundary with Region 9; data (for 1993) for the whole site are included there also; *species occurring at levels of international importance; **sites holding >20,000 waterfowl are of international importance by virtue of absolute numbers. Note: the winter season used by WeBS is November to March for waders and September to March for wildfowl. WeBS data include divers, grebes and cormorants.

5.12.3 Human activities

Wintering waterfowl are potentially affected, either directly or indirectly, by a wide range of human activities. Conservation designations can result in land management that favours the conservation of wildfowl. For example, appropriate management of saltmarsh and wet grassland can greatly increase its importance to wintering waterfowl. Many parts of the region's coast lie within designated sites (e.g. Sites of Special Scientific Interest (SSSIs), Special Protection Areas (SPAs) and Ramsar sites - see [chapter 7](#)), several selected wholly or partly for their migrant and wintering waterfowl interest, including two SPAs/Ramsar sites ([Table 5.12.3](#)). Other sites include two RSPB reserves and five local Wildlife Trusts reserves. There is also one Wildfowl & Wetland Trust centre (Arundel), adjacent to the Arun Estuary, the home of a mainly ornamental wildfowl collection.

Wildfowling occurs in the region, especially in estuaries, and is a potential cause of disturbance to waterfowl, although it is generally well regulated (see also [section 9.7](#)). The impacts and regulation of wildfowling on National Nature Reserves (NNRs) have been reviewed by Owen (1992). 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 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 provides a planning control mechanism which can be used to limit such activity.

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. 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.

Other human activities to be noted include oyster dredging, which disrupts sediments and invertebrate fauna and therefore has an impact on waterfowl (Pritchard *et al.* 1992). Increasing pressure from recreational development and organic pollution can also affect wintering waterfowl.

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 jointly by the British Trust for Ornithology, The Wildfowl & Wetlands Trust, the Royal Society for the Protection of Birds and the Joint Nature Conservation Committee). 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 count scheme

publishes an extensive annual summary report, the most recent being Waters *et al.* (1996). 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.

The whole UK coastline was surveyed for wintering waders during the Winter Shorebird Count of 1984/85 (Moser & Summers 1987). Such 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.

Although now becoming slightly dated, Owen *et al.* (1986) gives 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. 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 *et al.* (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.

5.12.5 Acknowledgements

We would like to thank D.A. Stroud and D.M. Craddock (JNCC) for their useful comments on the draft text.

5.12.6 Further sources of information

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B. Further reading

- Crockford, N.J. 1992. A review of the possible impacts of wind farms on birds and other wildlife. *JNCC Report*, No. 27.

C. Contact names and addresses

Type of information	Contact address and telephone no.
Birds in Sussex	*RSPB South-east England Office, Brighton, tel: 01273 775333
High tide and low tide counts of wintering and migrant wildfowl (WeBS)	*WeBS National Organiser (waterfowl), The Wildfowl & Wetlands Trust, Slimbridge, tel: 01453 890333
High tide counts of wintering and migrant wader (WeBS)	*WeBS National Organiser (Waders), The British Trust for Ornithology, Thetford, tel: 01842 750050
Low tide counts of wintering and migrant wader (WeBS)	*WeBS National Organiser (Low Tide Counts), The British Trust for Ornithology, Thetford, tel: 01842 750050
Birds in England	*Ornithologist, English Nature HQ, Peterborough, tel: 01733 455000
Local sites and species information Sussex	*English Nature Sussex and Surrey Team, Lewes, tel: 01273 476595

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

5.13 Land mammals

Dr C.E. Turtle & K.D. Meakin

5.13.1 Introduction

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

Several nationally important mammal species occur in the region, although most of them are vulnerable and declining here (Morris 1993). Eight of the fourteen British bat species are recorded from the region (Arnold 1993). The presence of the serotine bat *Eptesicus serotinus* in the region is of note as it is a vulnerable species in Britain (Stebbings 1988) with a strong south-easterly distribution (Arnold 1993); since 1970, however, it has been found further north and west. The other species recorded from the area are the common dormouse *Muscardinus avellanarius* and the otter.

All British bats, the otter and dormouse are listed under Schedule 5 of the Wildlife & Countryside Act 1981 and the EC Habitats & Species Directive. The otter and thirteen British bats are listed under Appendix II of the Bern Convention, and the pipistrelle bat and the dormouse are listed under Appendix III. Table 5.13.1 summarises the recorded distribution of protected species in the region.

Table 5.13.1 Recorded distribution of protected species

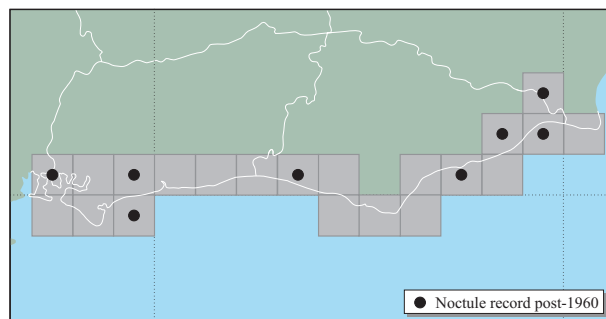
Protected species	Estimate of occurrence in region
Natterer's bat <i>Myotis nattereri</i>	Occasional
Daubenton's bat <i>M. daubentonii</i>	Rare
Serotine bat <i>Eptesicus serotinus</i>	Occasional
Noctule bat <i>Nyctalus noctula</i>	Occasional
Pipistrelle bat <i>Pipistrellus pipistrellus</i>	Frequent
Barbastelle bat <i>Barbastella barbastellus</i>	Rare
Brown long-eared bat <i>Plecotus auritus</i>	Occasional
Grey long-eared bat <i>P. austriacus</i>	Rare
Dormouse <i>Muscardinus avellanarius</i>	Occasional
Otter <i>Lutra lutra</i>	Rare

Source: Arnold (1993).

5.13.2 Important locations and species

Serotine bats in Sussex were originally associated with the south-east of the county but they have now been recorded along the coast to the west (V. Downer, Sussex Bat Group, pers. comm.). This is probably due to an increase in recording rather than a true extension of range (Stebbings & Griffith 1986). The national bat habitat survey shows that other bats also use the coast for foraging (Walsh & Harris 1996a, b). Bats thought to be noctules are regularly seen feeding on the insects of shingle beaches (Map 5.13.1), despite a general lack of tree cover and flight lines near to the sea (V. Downer, Sussex Bat Group, pers. comm.).

The dormouse in Britain is on the western edge of its range in Europe (Corbett & Harris 1991) and is considered as



Map 5.13.1 Records of noctule bats in coastal 10 km squares since 1960. Source: Arnold (1993).

vulnerable and locally endangered (Morris 1993). Dormice are associated with ancient semi-natural woodland and edge habitats such as broadleaved trees on the edge of forestry plantations or mature, diverse hedgerows and scrub. Isolated areas of suitable habitat under 20 ha in extent are unlikely to hold viable populations (Bright *et al.* 1994). There are a small number of records of dormice from the scattered woodlands along the south slope of the South Downs. There are also records from the woods around Arundel, from north of Worthing, from Beachy Head and from woodlands around Hastings (Arnold 1993). The findings of the Great Nut Hunt (Morris *et al.* 1994) show that dormice still occur in the Arundel area and around Hastings.

The otter is the terrestrial mammal that uses the coast most frequently. Arnold (1993) notes two records of otter on the Sussex coast from 1975 onwards. However, there were no positive records from the 1984-86 otter survey of England (Strachan *et al.* 1990). An otter road casualty in West Sussex in 1986 confirmed the presence of a very small population (Strachan *et al.* 1990). However, during the 1990s the Sussex Wildlife Trust have had only one or two reports of otters (S. Curson pers. comm.).

5.13.3 Human activities

Areas of the region's coastline are densely populated and this is reflected in the poor water quality of many of the rivers (NRA 1994). The population swells over summer in the coastal resorts, resulting in increased pressure on the environment of the surrounding coastline and river systems. These combined factors may prevent recolonisation by otters. Habitat fragmentation is continuing to some extent, owing to expansion in housing, industrial estates and the roads network, with resulting effects on bats and dormice. However, much of the remaining semi-natural habitat in the region is now within Sites of Special Scientific Interest (SSSIs) or is in areas covered by the Countryside Stewardship Scheme (e.g. the Pevensey Levels), furthering their sustainable management.

5.13.4 Information sources used

Data from Arnold (1993) (although these records are incidental rather than comprehensive) have been used to estimate the frequency of the occurrence of rare mammals 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 specifically coastal mammal surveys within this region, and therefore even the nationally comprehensive surveys, such as for otters, have their limitations when assessing the importance of the coast. Nor have there been any nationally comprehensive surveys for any of the bats or for dormice, although there are recent records for all species (Biological Records Centre (BRC) data).

5.13.5 Acknowledgements

The authors thank all those people cited in the text for their valuable information and their time.

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C. Contact names and addresses

Type of information	Contact address and telephone no.
Local site and species information	*Sussex Wildlife Trust, Henfield, tel: 01273 492630
Bats in Sussex	Vic Downer, Sussex Bat Group, 26 Command Road, Eastbourne BN20 8RA, tel: 01323 638366
General mammal information	The Mammal Society, Unit 15, Cloisters House, Cloisters Business Centre, 8 Battersea Park Road, London SW8 4BG, tel: 0171 498 4358
National recording schemes and collated biological data from throughout the UK	*Biological Records Centre, Institute of Terrestrial Ecology, Huntingdon, tel: 01487 773381

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

5.14 Seals

C.D. Duck

5.14.1 Introduction

Common (harbour) seals *Phoca vitulina* are scarce in the region (Table 5.14.1). Similarly, grey seals *Halichoerus grypus* are only occasionally sighted along the coast.

5.14.2 Important locations

There may be a very small group of common seals inhabiting Chichester Harbour, as seals are seen more regularly here than elsewhere in the region. Their precise location is not advertised in order to minimise unnecessary disturbance. There are very occasional sightings (about twelve individuals per year) of common seals in Pagham Harbour. Individual grey seals may remain locally for periods of up to two months.

5.14.3 Human activities

Most of the region's coast supports extensive urban developments and consequently tourism and recreation are major industries. These urban developments will preclude any colonisation of this coast by seals, with the exception of one or two sites. Recreational boating is extremely popular in the region and there are numerous marinas scattered along the coast which are potential sources of disturbance. Southern Marine Life Rescue and Chichester Harbour Conservancy monitor the effects of recreational boating on common seals. Southern Marine Life Rescue have rescued, rehabilitated and returned common seal pups into Chichester Harbour.

5.14.4 Information sources used

Chichester Harbour Conservancy and Southern Marine Life Rescue monitor common seals in Chichester Harbour in conjunction with English Nature. Pagham Harbour Local Nature Reserve maintain records of seals seen in Pagham Harbour. The Booth Museum of Natural History in Brighton keeps records of marine mammal sightings.

5.14.5 Acknowledgements

Thanks go to Anne de Potier (Chichester Harbour Conservancy), Andy Williams (Southern Marine Life Rescue), Steve Knapp (Pagham Harbour Local Nature Reserve), David Kay (Seven Sisters Country Park), David Harvey (English Nature) and Gerald Legg (Booth Museum of Natural History) for providing the information presented here and for comments on the manuscript.

5.14.6 Further sources of information

A. Further reading

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Table 5.14.1 Common and grey seal numbers in the region in relation to the rest of GB

Location	Common seals		Pup production (to nearest 50)	Grey seals % of GB total	Associated population 1 year old
	No. of seals (to nearest 50)	Proportion of GB total			
East Sussex	0		0		0
West Sussex	c. 6	0	0		0
Region 8	c. 6	0	0		0
England	1,900	6.7	1,400	4.1	4,800
GB	28,350		33,850	100	115,000

Source: Sea Mammal Research Unit

B. Contact names and addresses

<i>Type of information</i>	<i>Contact address and telephone no.</i>
Seal numbers and distribution around GB	Callan Duck, Sea Mammal Research Unit, Gatty Marine Laboratory, St. Andrews University, St. Andrews, Fife KY16 8LB, tel: 01334 476161
Seals in Chichester Harbour	Chichester Harbour Conservancy, The Harbour Office, Itchenor, Chichester, West Sussex PO20 7AW, tel: 01243 512301
Seals in Pagham Harbour	Pagham Harbour Local Nature Reserve, Selsey Road, Sidlesham, Chichester, West Sussex PO20 7NE, tel: 01243 641508
Chichester Harbour and rescued seals	Southern Marine Life Rescue, 60 Braishfield Road, Havant, Hampshire PO9 2HS, tel: 01705 552631
Seals in Sussex	*English Nature Sussex and Surrey Local Team, Lewes, tel: 01273 476595
Records of marine mammals	Booth Museum of Natural History, 194 Dyke Road, Brighton, East Sussex BN1 5HA, tel: 01273 552286
Marine issues in the region	Robert Irving, Seasearch Co-ordinator, 14 Brookland Way, Coldwaltham, Pulborough, West Sussex RH20 1LT, tel: 01798 873581
The coast west of Beachy Head	Seven Sisters Country Park, Exceat, Seaford, East Sussex BN25 4AD, tel: 01323 870280

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

5.15 Whales, dolphins and porpoises

Dr P.G.H. Evans

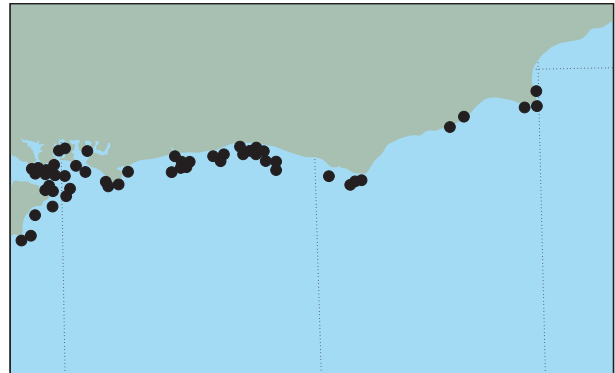
5.15.1 Introduction

The cetacean fauna (whales, dolphins and porpoises) of the eastern English Channel is poor, in both numbers of animals and diversity of species. Since 1980, nine species of cetaceans have been recorded along the coast or in nearshore waters (within 60 km of the coast) of the region. Of these, two species (7% of the 27 UK species) are either present throughout the year or recorded annually as seasonal visitors to the region, and another two species occur on a more casual basis. No species is abundant, the most frequently observed in nearshore waters being the bottlenose dolphin *Tursiops truncatus*, whilst the harbour porpoise *Phocoena phocoena* is seen occasionally. Offshore, long-finned pilot whale *Globicephala melas* is recorded annually and the common dolphin *Delphinus delphis* occurs occasionally. The uniform and shallow sea bed of the eastern English Channel probably largely accounts for the scarcity of cetaceans in the region (Evans 1990b).

The harbour porpoise and bottlenose dolphin are listed in Annex II of the Habitats & Species Directive as species whose conservation requires the designation of Special Areas of Conservation (see [Chapter 7](#)).

5.15.2 Important locations

[Table 5.15.1](#) summarises the distribution of cetaceans in the region. The distribution of bottlenose dolphin, pilot whale and harbour porpoise sightings are shown on [Maps 5.15.1](#), [5.15.2](#) and [5.15.3](#) respectively. There are no notable bays or headlands in the region from which cetacean sightings might be made, other than Selsey Bill and Beachy Head, which yield occasional cetacean sightings, mainly of bottlenose dolphins. Bottlenose dolphins have been reported nearshore in most months (but particularly between April and August), with most sightings records coming from the vicinity of the resorts of Littlehampton, Shoreham, Brighton and Eastbourne. Harbour porpoises are also occasionally reported, mainly between May and October, with no particular location



Map 5.15.1 Bottlenose dolphins: sightings reported to the Sea Watch sighting system (source: Evans 1992). No sightings during Seabirds at Sea surveys (source: JNCC: SAST/ESAS).

favoured. Offshore, long-finned pilot whale and common dolphin are the most frequently recorded species, but both appear to be wide-ranging, with no specific location favoured in the English Channel.

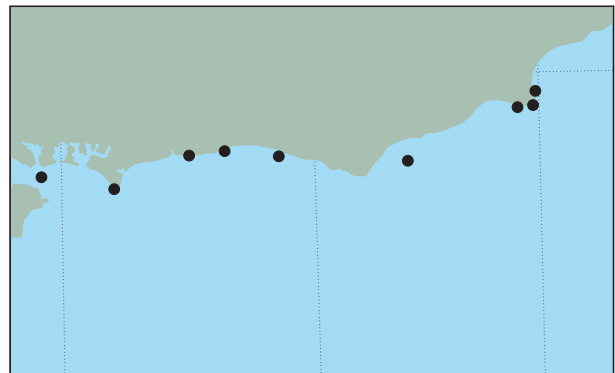
5.15.3 Human activities

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 (including the English Channel), 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). Fishing in the region is summarised in [section 9.1](#). The only



Map 5.15.2 Pilot whales: sightings reported to the Sea Watch sighting system (source: Evans 1992). No sightings during Seabirds at Sea surveys (source: JNCC: SAST/ESAS).



Map 5.15.3 Harbour porpoises: sightings reported to the Sea Watch sighting system (source: Evans 1992). No sightings during Seabirds at Sea surveys (source: JNCC: SAST/ESAS).

Table 5.15.1 Cetacean species recorded in the region

Species	Status, distribution and seasonal occurrence
Harbour porpoise <i>Phocoena phocoena</i>	Rare, occurring casually in very small numbers in nearshore waters mainly between May and October
Bottlenose dolphin <i>Tursiops truncatus</i>	The most frequently observed cetacean in nearshore waters, though rarely in groups exceeding ten individuals. Most sightings come from coastal waters near the towns of Littlehampton, Shoreham, Brighton and Eastbourne. Peak numbers and frequency of sightings occur between April and August, but with some variation between years.
Common dolphin <i>Delphinus delphis</i>	Casual offshore visitor mainly recorded between August and December
Long-finned pilot whale <i>Globicephala melas</i>	Seasonal offshore visitor mainly recorded between November and January

recent report in the region of a bycaught dolphin was of an unidentified species from a set gill net at Brighton in early 1987 (Evans 1994), although some strandings may have been casualties of bycatches. Further west in the English Channel there have been several reports of small cetaceans (mainly common dolphins and long-finned pilot whales in autumn and winter) killed accidentally in fishing gear, primarily involving purse seine nets or gill nets bottom set around wrecks, although bottom trawls and beam trawls may bring up already dead animals. Actual figures on catch levels have not been available (Northridge 1988).

Contaminant levels in cetaceans from the region are poorly known, since the number of post-mortem strandings is very low. Most samples from Southern England come from the Channel coast west of Sussex. Mean total PCB (25 congeners) levels of nine harbour porpoises sampled from Sussex to Cornwall between 1988 and 1992 were moderately low, amounting to 31 ppm (Kuiken *et al.* 1994b). These include two porpoises stranded in East Sussex, one of which had a total PCB level of 16.31 ppm and the other of 37.85 ppm. Eight common dolphins sampled in 1990-91 and eleven in 1992 gave mean values of 50 ppm and 31 ppm total PCBs respectively (Kuiken *et al.* 1994a).

Recreational activities (speedboats, jet skis etc.) are intensive at several locations along the Sussex coast, notably Chichester Harbour and the region's seaside resorts. Such vessels pose threats of direct physical damage from collisions as well as disturbance from the high frequency noise they generate (Evans *et al.* 1992). Heavy shipping may also disturb cetaceans, but most of the sound produced by vessels with large engines is at frequencies below 1 kHz, thus overlapping more with baleen whales (not resident in or regular visitors to the region) than with dolphins and porpoises (Evans 1987, 1996), although Baines (1993) reported a possible temporary effect on the presence of porpoises around Strumble Head, Dyfed (Region 12). However, vessels can also generate high-frequency (>1 kHz) sound overlapping the frequencies used by small cetaceans, and vessel avoidance and increased dive times by bottlenose dolphins and harbour porpoises have been reported by Evans *et al.* (1992, 1994). A code of conduct for boat users has been produced (Sea Watch Foundation 1992).

Underwater sounds from seismic activities involve low frequencies (20-500 Hz) and therefore are most likely to affect baleen whales. Nevertheless recent studies indicate that other cetaceans may also be disturbed by seismic surveying, as they are sighted less frequently, either acoustically or visually, during seismic surveys (Goold 1996). It is possible that porpoises are affected (Baines 1993), perhaps indirectly by changing the distribution of their fish prey (Evans *et al.* 1994).

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 Natural History Museum in London (1913-present). Systematic land-based watches have been carried out at Selsey Bill, Brighton, Hastings, and Fairlight. Sea-based coverage is generally poor in this portion of the Channel, although the Channel Fisheries Protection vessel conducts systematic observations, and watches are sometimes made from the Newhaven ferry. Opportunistic sightings effort has been highest between the months of April and September when sea conditions usually are also best, although this has not prevented offshore species such as long-finned pilot whale from being most often seen in late autumn or early winter.

For geographical comparisons of sightings rates for various cetacean species in UK waters, see Evans (1990a, 1992) and Northridge *et al.* (1995).

A major international collaborative programme, the Small Cetacean Abundance in the North Sea (SCANS) project, aims to provide a baseline assessment of abundance from intensive survey work in July 1994 (Hammond *et al.* 1995).

5.15.5 Acknowledgements

Thanks are due to I. Grant and J. Heimlich-Boran for help in the preparation of the maps, and to all those persons who have contributed valuable sightings data, particularly the systematic observations provided by T. Cutler, K. Hawley, S. Savage, M.L. 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 & surveys	*Seabirds & Cetaceans Team, JNCC, Aberdeen, tel: 01224 655700
Cetacean organochlorine & heavy metal levels	*Dr R.J. Law, Centre for Environment, Fisheries & Aquaculture Sciences, Burnham-on-Crouch Laboratory, tel: 01621 787200
Cetacean pathology	Paul Jepson, Veterinary Pathology Group, Institute of Zoology, Regent's Park, London NW1 4RY, tel: 0171 449 6691

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

Chapter 6 History and archaeology

A. Gale & V. Fenwick

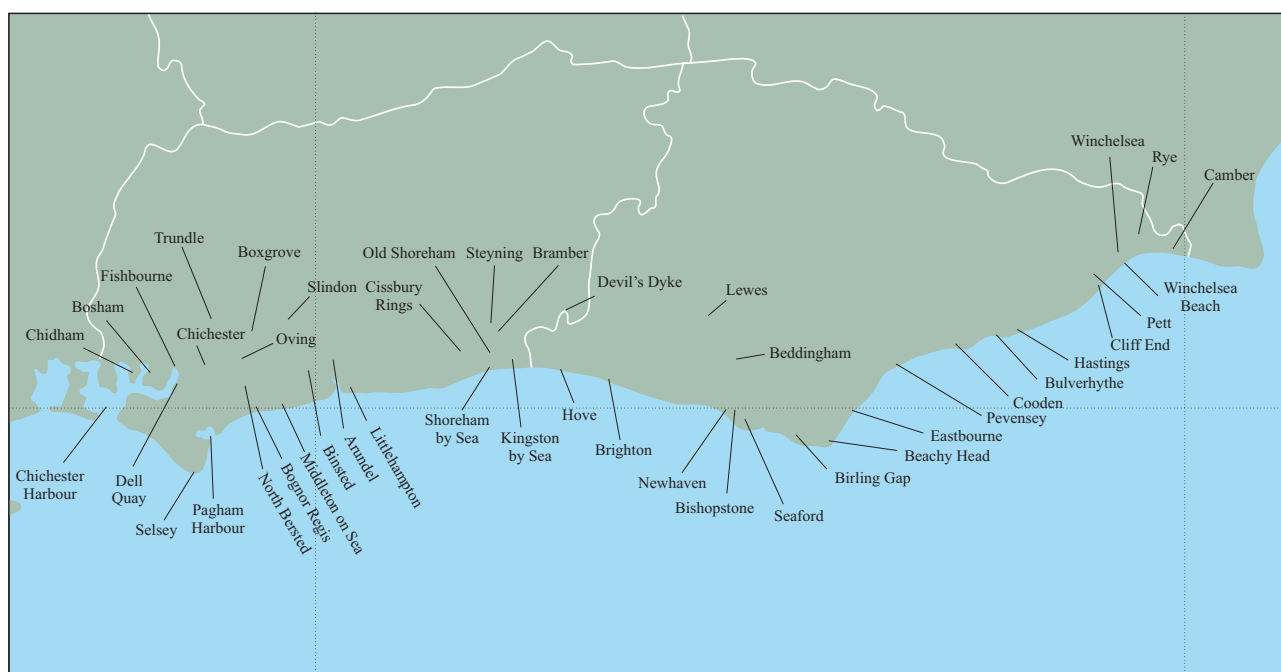
6.1 Introduction

The physical remains of the human past - archaeological evidence - are an integral and irreplaceable part of the coastal resource. Archaeological sites, whether discrete or part of wider landscapes, are fragile, and those not yet located can unwittingly be destroyed. The distribution of known sites is biased by the uneven spread of survey work, and the discovery and scientific investigation of new sites is vital to developing a full picture of the past. This chapter provides an introduction to the archaeology of the region, giving information on the provisions for safeguarding known and unknown sites and describing the extent of survey work and how to report new discoveries. Locations of sites mentioned in the text are shown on [Map 6.1.1](#).

This region has revolutionised knowledge of the earliest human occupation of Britain, which dates to some 500,000 years ago, and its diverse archaeological sites demonstrate the complexity of tracing coastal communities through the intervening millennia. The nationally important Palaeolithic sites lie on raised beaches at Slindon and Boxgrove, inland of the present shoreline and formed at a time of higher sea-level during Pleistocene interglacials. On today's shores, peat beds and submerged forests, for example at Pett Level, Hastings, Bulverhithe and Pevensy Levels, are the remains of ancient landscapes. Available data suggest they were dry land during the Neolithic period and have been inundated by rising sea-level during the present interglacial (i.e. in the past 10,000 years).

Coastal change has been a constant feature during the documented history of this region. Ports have been relocated as their river mouths became blocked by shingle; for example, the port activity on the River Ouse at Seaford shifted to Newhaven; and that on the River Adur from Old Shoreham to Shoreham-by-Sea. Remains of old waterfronts can, therefore, be fossilised behind the coast within old river channels or beneath urban areas. Catastrophic flooding or gradual erosion have overcome villages and towns, as occurred at Old Winchelsea and Hastings in the 13th century and Brighthelmstone (precursor of Brighton) in the 18th century. Investigation has yet to discover whether any elements of these settlements can be found on the sea bed.

Proximity to the continent conferred importance on the region's ports for travel, trade and defence. Shipwrecks of all kinds produce extensive information both on ship design and construction, and on the economic organisation and material culture of the communities that they served. The remarkable preservation of the *Amsterdam* (see also [section 6.3.3](#)) demonstrates the possibilities for surviving wrecks to be found in this region (Marsden 1985). The potential sea-bed resource can be gauged from known ship losses. Records of these 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 extent of ship losses by considering hazards to navigation. This process has then to be extended into the prehistoric period by looking at archaeological evidence for trade and seafaring.



Map 6.1.1 Archaeology: locations mentioned in the text.

6.2 History and archaeology of the region

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

In many parts of Britain the archaeological record for the Palaeolithic comprises only stray finds of flint tools. At Boxgrove such tools have been found in large quantities. This is the location in which the first known hunters in Britain made tools using flints from the chalk cliffs or beach; it has also provided the earliest human remains in Britain, dated to 500,000 BC. The sequence of finds suggests that Palaeolithic hunters were present even during periods of colder climates: a site at Newhaven is one of the very few in south-east Britain to date from the last glaciation, when this region experienced tundra-like conditions.

By 8,500 BC the improving climate was causing sea level to rise. By 6,000 BC trees had spread back through the region and Britain was severed from Europe. Only a scatter of sites dated to this period of Mesolithic hunter-gatherers have been found on the present Sussex coastal plain, the original having been more extensive. Sites such as Marsh Farm, Binsted, may indicate seasonal use of marine resources from the marshy plain. Pollen from the Ouse Valley near Lewes shows the land had been cleared of woodland by the mid-4th millennium BC. The tool kit of Neolithic farmers, with its heavy stone axes, was well suited to forest clearance, the essential prerequisite of cultivation. Settlements, fortified by a bank and ditch, overlook the coastal plain at Whitehawk and Trundle. In contrast to the known enclosures further inland, faunal remains here clearly show the use of marine resources as a supplement to cultivation, animal husbandry, hunting and gathering. On the coast, Bishopstone offers evidence of open agricultural settlements, while the supposition of seasonal or specialist use of coastal resources is supported by sites such as Chidham, where the flint assemblage seems specialised for preparing withies for fishtraps.

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

Metal-working technology was practised in Britain from early in the 2nd millennium BC, but the artefacts from this region suggest that stone continued to dominate the tool kit, albeit extended in range and form. Only after 1,400 BC did bronze become a common material rather than being confined to high-status settings such as the Hove Barrow. Enclosures such as that at Belle Tout surrounded small agricultural settlements: coastal erosion here shows that groups of bronze implements and ornaments from cliff, intertidal and sea-bed locations elsewhere may indicate entire sites that have been lost or are disappearing. Such finds come from near Cliff End, Cooden, Beachy Head, Birling Gap, Seaford, the mouth of the Adur and Selsey. The distribution of bronzes is usually the only indicator of the agriculture that was practised on the coastal plain, in the river valleys and on the downlands. However, the recently discovered settlement near Eastbourne, waterlogged beneath river alluvium, offers a rare insight into the full material culture of the period (Council for British

Archaeology 1995). Further valuable sites may be preserved in comparable locations.

Enclosures and field systems of the early Iron Age (6-5th centuries BC) are located on coastal high ground at Heathy Brow, Beachy Head, Slonk Hill, Shoreham and Bishopstone. The occupants practised mixed farming and smiths worked in bronze and iron. Ditched field systems at North Bersted and Oving show that drainage allowed farming to be practised on the West Sussex coastal plain. Shale bracelets originating from the Dorset coast have been found at these sites and at downland sites, showing their integration in a wider, possibly maritime, exchange network; the geographical extent of this network is illustrated at Oving, where Mediterranean wine amphoras have been found.

From the 3rd century BC, strategic hillforts were constructed above key river valleys at Cissbury Rings, Torberry and the Trundle. These settlements are seen as foci of economic activity until the 1st century BC. They are without parallel to the east of the Adur. After their demise smaller hillforts were built, such as Devil's Dyke, Castle Hill at Newhaven and Beddingham. In the west the coastal plain became more intensely occupied, and an *oppidum* (urban centre) is postulated in the Chichester area, possibly at Fishbourne or Selsey. Intertidal finds point to lost sites. The continental influence exhibited by local metalwork and the level of exchange evidenced by coins and pottery give substance to Julius Caesar's description of the area as being occupied by Belgic tribes who maintained ties with Gaul. Rare salt-making sites at Chidham and a coin mould from Boxgrove are further indicators of this region's industrial and economic activity.

6.2.3 The Roman province

In AD 43 the invading Roman army moved quickly along the south coast, where at least one tribe, the Atrebates, was already in friendly contact. Chichester Harbour provided an ideal supply base from which to support the campaign as it moved westwards; at Fishbourne there is evidence of a military harbour and granaries, which could easily have been turned to civilian use once military needs subsided. The port may have served Chichester as it developed as the capital of a second tribe, the Regni. Profits from trade could have funded the construction of both the palace at Fishbourne and the Roman-style villas, many of which lie near the River Arun, a known trading river in later periods warranting mention by a Roman geographer.

Excavation of these villas and the palace complex has overshadowed the study of more humble, rural settlements. Digs at sites such as Bullock Down on Beachy Head and more restricted investigation at sites such as Middleton-on-Sea (Barber 1992) have shown remains of low-status buildings of wattle and daub in association with field systems. Rural villas were also the foci of mixed farming; many were on the West Sussex plain, where they may have supported coastal industries. Salt-making sites have been found at Chidham and tileries at Dell Quay and Copperas Point, all within Chichester Harbour. Roman buildings contain stone shipped

from the Isle of Wight, Dorset and a local source that is now submerged, the Mixon. In the east, the Roman fleet had an interest in the iron industry which operated adjacent to the estuaries of the Brede and Rother. At Pevensey in the 3rd century a great fortress was built as part of a chain of defence. It overlooked a now silted harbour, which would have sheltered the fleet.

6.2.4 Roman departure to Norman conquest

The events that followed the final Roman departure in about AD 410 can be seen as a continuation of changes in the preceding century (Drewett *et al.* 1985). Withdrawal of imperial troops reduced the quantity of currency coming into the island, adversely affecting manufacturing. There was also a trend of movement out of the urban centres to rural villas. The urban decay of the 4th/5th centuries can be traced archaeologically in the stratigraphy of centres such as Chichester.

The progress of Saxon immigrants, who carved out the South Saxon Kingdom in the 6th century, has to be traced largely through their cemeteries. Conversion to Christianity came relatively late, and grave goods show that cross-Channel contacts resumed. Archaeological evidence for boats of this period is rare, but a plank fragment dated to about AD 790 has come from Medmerry. This site, and those at Bishopstone and Old Erringham, shows a complex mix of land, shore and sea activities (Goodburn 1987). The coastal plain provided fertile land, but from the 8th century seaborne Viking raids brought danger. The foci of economic activity may be traced in coastal and riverine burghs at Chichester, with its own mint and port at Bosham, Burpham near Arundel and Lewes. In addition to burgh defences, Saxon fortifications are documented at Hastings, Pevensey, Bramber and Arundel. Coastal industries were of economic importance: salt-making for example was centred on 34 locations, and Rye, with over 100 salt pans, was an exporter. Chichester became the seat of the Saxon bishopric, which was transferred from Selsey, where the missionary Wilfred had established a monastery.

6.2.5 From the conquest to modern times

William the Conqueror's invasion bridgehead was established at Pevensey. As Norman control was established, the authority of his nobles was secured and proclaimed by castle-building. River and coastal castle locations include Pevensey, Hastings, Lewes and Arundel. Norman needs encouraged cross-channel trade, bringing in, for example, French stone for castles and ecclesiastical buildings, and wine. The silting-up of rivers, increased by the 'inning' (land-claim) of marshes, the canalisation of waterways and the movement of shingle, affected the region's ports. The course of the River Rother in East Sussex was completely altered by violent storms, which washed away Old Winchelsea in 1283 and left the new town with no haven. Rye maintained its navigation only by extensive dredging and pier construction. In the 18th century a new port infrastructure was soon overcome by shingle; the remains can be seen at Winchelsea Beach. In contrast to Rye, where the walled town is preserved on raised ground, the core of Norman Hastings, which was possibly in Priory Valley, was destroyed by the sea.

The development of ports to the west is characterised by relocation downstream, followed by the cutting of new channels or shifting of wharves as river mouths migrated. Thus up-river Steyning gave way to Old Shoreham, New Shoreham and eventually, in 1818, to new docks at Kingston; Lewes gave way to Seaford and then to a fresh cut creating Newhaven in 1539; and Arundel gave way to Littlehampton, which required a new cut in 1657, to be followed by the present harbour in 1736. Chichester Harbour itself was seriously choked by sediment by the early 18th century.

Before the denudation of the Wealden forest and the decline of industry there, iron and timber were shipped out of the region. These two commodities also supported local shipbuilding. Archaeological evidence of shipbuilding techniques is rare and the Cinque Ports' contribution of ships is notable; by the 16th century Rye was renowned as a building centre and Rye vessels were owned in many British ports in the 19th century, while in Shoreham shipwrights are known from at least the 13th century. Surviving physical remains of either home-built or foreign trading ships are scarce. The Rother Barge (a 16th century vessel) (Fenwick 1978), timbers from Camber (probably from a 14th century vessel) (Goodburn 1990) and two medieval rudders from Rye Bay (Marsden 1992) show the potential for important ship remains to be discovered in the region. The medieval seal of New Shoreham depicts its 'hulk', a vessel type of which as yet no remains have been found.

In foreign trade the region's small ports could not compete with London or, latterly, Southampton, and without reserves of coal their manufacturing was outstripped by the industrial Midlands and the north of England. Agricultural produce featured in coastal shipments: Chichester Harbour, for example, developed this trade through grain mills in the 18th century. The port also shipped large quantities of oysters. Rye and Hastings have traditionally supplied fresh fish to the capital. At Hastings, the present fleet drawn up on the beach in front of the fishermen's chapel and the rebuilt 'net shops' preserves the setting of an activity that once was common on the coast. The strand and the lower town of Brighton were washed away in 1705.

The development of the modern coastal towns originated in the popularity of seaside resorts, Bognor Regis and Brighton both benefitting from royal patronage. Massive expansion resulted from the provision of rail links to the capital, which opened the seaside to day-trippers and holiday-makers. The railway reached Brighton in 1841 and in the first half of 1844 the trains delivered 300,000 passengers. The architecture of seaside resorts provided escapism through exotic design while embracing innovative engineering: Brighton was in the forefront with its Pavilion, 1823 chain pier and the Volks Railway. Not all the innovations were successful: a floating breakwater intended to provide a harbour was towed away to Shoreham. Continued expansion of the seaside towns brought economic benefits to the ports. In 1933, Shoreham, for example, constructed a lock for the Aldringham Basin to meet the needs of ships delivering materials for property development.

6.3 Human activities

6.3.1 Integrated management

The growing number of coastal zone management initiatives provide opportunities for developing integrated management of land, shore and sea-bed archaeological sites. Coastal zone management enables research projects, providing baseline information on the archaeological resource, to be set in a wider context. The need for consideration of the archaeological resource can be written into appropriate management plans: for example the West Sussex Coastal Strategy contains specific reference to the importance of maritime archaeology (West Sussex County Council 1994) and a detailed overview of the archaeological resource and its needs is included in the South Downs Shoreline Management Plan Study (Gifford Associated Consultants 1995). The recognition of a Voluntary Marine Conservation Area at Seven Sisters has provided the opportunity to establish the place of archaeological remains in the protection of the marine environment (Robertson 1993).

6.3.2 Activities and processes affecting the archaeological resource

The known archaeological material in this region is concentrated in the West Sussex coastal plain and the downs which define its northern edge. The small amount of material recorded from the low-lying coast to the east may under-represent its true potential. The configuration of the coast and its navigable estuaries has changed greatly and former maritime settlements are likely to be found in what today are not obviously coastal locations. Artefacts recovered from peat exposed on the foreshore bear witness to human presence, and it is reasonable to assume the existence of undiscovered sites comparable to, or earlier than, the Eastbourne settlement.

In areas such as the Pett and Pevensy Levels drainage can dessicate any buried, waterlogged remains. The discovery of the Rother Barge shows that clearing of drainage or navigation channels can disturb material. Ploughing may damage material near the surface and has been a factor in the destruction of early saltworking and tile manufacturing sites around Chichester Harbour. The recovery of ship timbers at Camber demonstrates the potential for the excavation of marine gravels to damage sites preserved in the anaerobic layers below.

Processes affecting archaeological sites on land are the most easily recognised. Regeneration of urban and industrial waterfronts requires skilful planning to maintain the fabric and setting of historic maritime buildings and facilities. Building work can be designed to seal remains intact, but where development requires activity such as earth-moving or the sinking of piles it can directly destroy sites. Regeneration of urban and industrial waterfronts requires skilful planning to maintain the fabric and setting of historically-important maritime buildings and facilities. Construction work can reveal the buried remains of earlier quayside facilities such as the 16th century harbour at Hastings, but structures may also be found in quiet creeks and backwaters that were not

developed during the heyday of Victorian engineering.

The numbers of artefacts that have been discovered in cliff exposures or the intertidal area demonstrates the large-scale impact of coastal erosion on the open coast. Erosion also threatens sites on low-lying, sheltered coasts within, for example, Chichester Harbour (Cartwright 1984). Boat wash and tides can contribute to erosion of hulls in shallow water or lying aground. Archaeology on the foreshore can be threatened by developments such as sewage outfalls and land claim. Sea defence/coast protection measures, including managed retreat, also have implications for the archaeological resource.

Derelict vessels, which are now seen to be of archaeological value, have sometimes been cleared in order to improve the amenity value of waterways. Those remaining on the foreshore have no protection from vandalism, theft of 'aged' timber for re-use, use as mooring points or damaging wash from large vessels. The removal of the 19th century Rother Barge *Primrose* to the Shipwreck Heritage Centre was in response to such threats. Wrecks of beached vessels have been pillaged, as was the case with the *Amsterdam* (1749) and the *Anne* (1690) prior to their receiving statutory protection.

Both natural processes and human activities affect sea-bed sites. Fishing nets frequently pull up artefacts ranging from pottery to stone anchors, cannon and massive medieval side-rudders. Dredging for navigation and aggregates, cable-laying and pipe-laying are also potentially damaging. Salvage divers and today's numerous sports divers may strip wreck sites of all moveable objects and valuable metals.

6.3.3 Protection of sites, monuments and wrecks

Three statutory designations can be applied to protect *in situ* remains of archaeological or historic importance. The Ancient Monuments & Archaeological Areas Act (AMAA) 1979 provides for Scheduled Ancient Monuments (SAMs). The AMAA definition of monument includes sites both on land and in UK territorial waters, including the remains of vehicles, vessels and aircraft. In practice, however, scheduling in England has been applied only above low water mark. There is a presumption against the destruction of SAMs, and prior consent is necessary for any works that will destroy, damage, repair or remove such a monument. The number of SAMs is being increased as a result of a review (the Monuments Protection Programme) that uses a list of criteria designed to assess national importance. Table 6.3.1 shows the numbers of coastal SAMs in the region.

The Town & Country Planning (Listed Buildings and Conservation Areas) Act 1990 provides for the protection of Listed Buildings (buildings considered to be of special architectural or historic importance) and Conservation Areas (historic environments, particularly in urban settings). There is now a presumption in favour of the preservation of Listed Buildings and their settings, and consent is required prior to any demolition, alteration or extension.

The Protection of Wrecks Act 1973 provides for the

Table 6.3.1 Numbers of Scheduled Ancient Monuments (SAMs) in coastal 10 km squares in the region

Area	No. of SAMs
East Sussex	121
Rother	30
Hastings	8
Wealden	11
Eastbourne	20
Lewes	43
Brighton	7
Hove	2
West Sussex	76
Adur	8
Worthing	1
Arun	26
Chichester	41
Region 8	197

Source: English Heritage 1994 lists.

designation of shipwrecks of national importance for their archaeological, historical or artistic value. There are no standard criteria for designation but the Department of National Heritage (DNH) receives guidance from the Advisory Committee on Historic Wreck. Archaeological investigation is permitted only under licence from the DNH. Designation usually applies to an area of sea bed in which the wreck is considered to lie. Within the designated area it is illegal to tamper with or remove material, to use diving or salvage equipment or to deposit anything that may damage or obliterate the wreck (Archaeological Diving Unit 1994). Table 6.3.2 lists the four designated wrecks located in this region; however, as fewer than 45 wrecks have been designated in the whole of Britain, their distribution cannot be accepted as a reasonable guide to the total sea-bed resource. The East Sussex Sites and Monuments Record (SMR) and the National Monuments Record - Maritime Sites (NMR-MS) contain information on many more undesigned wreck sites in the region.

6.3.4 Key organisations and their responsibilities

English Heritage is responsible for maintaining the lists of Listed Buildings and the Schedule of Ancient Monuments. They schedule and inspect sites, assist owners in drawing up management agreements supported by grants, and directly manage those monuments in guardianship. They also fund elements of survey and rescue archaeology.

The Department of National Heritage is responsible for designated wreck sites. Inspection is carried out on their behalf by the Archaeological Diving Unit.

The Royal Commission on the Historical Monuments of England (RCHME) has national responsibility for survey and inventory of archaeological sites. They maintain a database of archaeological sites known as the National Monuments Record (NMR), which combines the computerised National Archaeological Record, the National Buildings Record and the National Library of Air Photographs. In 1992 a new Royal Warrant extended the Commission's responsibility to the territorial seas. RCHME has since added a Maritime Section to the NMR, and has recently published *The national inventory of maritime archaeology for England* (RCHME 1996).

The RCHME is also the lead agency for Sites and Monuments Records (SMRs), which in this region are maintained by the County Councils of East and West Sussex. These are the key sources of information on local archaeological sites and areas of archaeological potential. County Archaeological Officers and SMR Officers fulfil a curatorial role in respect of archaeological sites. This is achieved primarily through the planning system, although their responsibilities may include other aspects of management and interpretation of the resource.

The Nautical Museums Trust was created to increase understanding of the historical significance of wreck sites and to undertake studies of wrecks on the East Sussex coast. The Trust recognises the specific need for the curation of artefactual and structural remains from wreck sites. Its collections are housed at the Shipwreck Heritage Centre in Hastings, which is registered with the Museums & Galleries Commission.

6.3.5 Development control

To landward of low water mark archaeology is considered within the unified system of development control provided by the planning system. Planning Policy Guidance Note 16 (Department of the Environment 1990) explains the regard that should be accorded to archaeological remains. In essence there is a presumption in favour of preservation *in situ* because "the desirability of preserving an ancient monument and its setting is a material consideration in determining planning applications whether that monument is scheduled or unscheduled". Stress is laid on early consultation between planning authorities and developers, with information and advice from the County Archaeological Officer, in order to reconcile the needs of archaeology and development. Where preservation *in situ* is not justified, planning authorities may require the developer to make "appropriate and satisfactory provision for excavation and recording of remains". The

Table 6.3.2 Historic wreck sites designated in the region

Name	Location	Grid ref.	Description	Designation order
Anne	Pett Level	TQ897136	70 gun warship, lost 1690	1992 No. 1; 1992/347
Amsterdam	Bulverhythe	TQ778083	Dutch East Indiaman, lost 1749	1974 No. 3; 1974/57
Brighton Marina	Brighton	TQ332029	Unidentified armed vessel, probably 16th century	1983 No. 1; 1983/1400
Hazardous	Bracklesham Bay	SZ805953	54 gun 4th rate ship, lost 1706	1986 No. 1; 1986/1441

Source: Archaeological Diving Unit (1994); conversions from latitude and longitude by RCHME.

presumption in favour of preservation *in situ* has been extended to Listed Buildings and their settings (Department of the Environment and Department of National Heritage 1994).

Planning decisions should take into account the more detailed policies that appear in Development Plans. The County Structure Plans and the Local Plans of their constituent districts contain archaeological policies. The region is within the SERPLAN area, for which policy guidance has been issued concerning maritime archaeology, highlighting the need for local authorities to compile marine SMRs (SERPLAN 1993). Both East and West Sussex County Councils have archaeological strategies, which provide overviews of the resource and its management within the counties. The strategies include specific information and policies on maritime archaeology, highlighting, for example, the desirability of including the respective local authority whenever activities are proposed that threaten sites offshore (East Sussex County Council 1993; West Sussex County Council 1995).

To seaward of low water mark there is a sectoral approach to development control (Department of the Environment 1993). Regulation, including the 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 subtidal zone had precluded its consideration by many local authorities. However, growing awareness of marine archaeology, the development of the NMR-MS and the addition of maritime sites to the SMRs are encouraging closer consideration of the marine resource. In East Sussex developers have already incorporated archaeological survey into their preparatory work. Such practice is encouraged by a *Code of practice for seabed developers* (Joint Nautical Archaeology Policy Committee 1995).

6.3.6 Reporting archaeological information

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. The only legal requirement to report

archaeological and historical artefacts arises when the object falls within the laws of Treasure Trove or Salvage. The law of Treasure Trove is used to secure important treasures for the nation (Longworth 1993). Objects of gold or silver found on land must be reported to the police, the Coroner or the British Museum. Should a Coroner's inquest declare the objects Treasure Trove, the British Museum may retain them and, in return, provide an *ex gratia* payment to the finder. The Museum may waive its right in favour of another museum.

The old common law of Treasure Trove was replaced in September 1997 by the Treasure Act, which sets out a new definition of treasure: (a) all hoards of coins at least 300 years old (if the coins have a precious metal content of less than 5% then the hoard must consist of at least 10 coins); (b) objects at least 300 years old with a minimum precious metal content of 5%, and (c) objects found with an association with treasure. Finds of potential treasure must be reported to the coroner within fourteen days. A code of practice has been drawn up providing guidance to finders of treasure and setting out the policy on rewards.

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 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, historic items may be lodged with a museum or conservation facility with suitable storage conditions. In this region the Shipwreck Heritage Centre, Hastings, has served this function. There is a policy of offering wreck of historic, archaeological or artistic interest to registered museums. The responsibility of the Receiver to the finder, with regard to salvage awards, remains regardless of the historic character of the wreck. The Receiver has prepared new forms for reporting wreck, including one that finders may use to volunteer information to RCHME on the identity and condition of wreck sites. The Shipwreck Heritage Centre at Hastings provides an informal contact point for local fishermen and divers. Information and enquiries concerning designated wrecks should be directed to DNH, and those concerning SAMs and Listed Buildings to English Heritage.

6.4 Information sources

6.4.1 Information gathering and collation

The initial compilation of the National Monuments Record - Maritime Sites (NMR-MS) was completed in 1995 (RCHME 1996). RCHME drew records from the historical accounts of shipping losses and the Hydrographic Department Wreck Index, which contains mainly 20th century shipwrecks and unidentified seabed obstructions located by remote sensing surveys. Development of the NMR-MS using archives of the Cinque Ports significantly extended the number of 17th and 18th century ship losses recorded for the Rye, Hastings and Seaford area (Table 6.4.1) (Gale 1994).

Table 6.4.1 Records entered in the National Monuments Record - Maritime Section

	<i>Known wrecks</i>	<i>Documented casualties</i>	<i>Unidentified obstructions</i>
East Sussex	528	115	107
West Sussex	209	62	98
Region 8	737	177	205

Source: RCHME (1995); named wrecks and unidentified obstructions are drawn from the Hydrographic Department Wreck Index; documented casualties are drawn from historic accounts of shipping ship losses.

As part of the English Heritage and RCHME project England's Coastal Heritage, the Aerial Photographic Unit of RCHME is investigating the feasibility of using aerial photographs for intertidal survey; Reading University is producing a synthesis of information within the NMR, SMR and published sources.

The Director of the Shipwreck Heritage Centre has collated information on wrecks in the eastern English Channel and on sea bed finds, particularly in Rye Bay (Marsden 1987). This information has been passed to the East Sussex SMR, which has been extended to territorial waters. The SMR now contains some 1,000 entries based on ship losses, the Hydrographic Department Wreck Index, net fastenings and finds reported by divers and fishermen. The West Sussex SMR has not been formally extended to the sea bed. Background material has been collected and it is hoped that this can be incorporated into the SMR and the record extended once funding is available.

In East Sussex funding is being sought for a project to evaluate areas of archaeological potential within eroding cliffs and foreshore. The results will inform future archaeological strategies. On the Sussex Heritage Coast, between Eastbourne and Seaford, a survey is being made of shoreline remains and several sites offshore are being assessed (Robertson 1993).

In West Sussex, survey has targeted the saltmarsh fringe on the western side of Chichester Harbour (Cartwright 1984). A projected survey by the Marine Conservation Society of the sea bed outside Pagham Harbour will include archaeological sites and installations related to D-Day operations. Other 20th century military installations in the region are being considered by a nation-wide survey, The Defence of Britain Project, a collaborative project between the Council for British

Archaeology and the Fortress Study Group (Morris 1993; Lowry 1995).

A private researcher has integrated historical and archaeological evidence in a study of sea level change between Pagham Harbour and Portsmouth (Wallace 1990). Following this work the Hampshire & Wight Trust for Maritime Archaeology is planning reconnaissance of the Mixon Reef with its presumed quarry site.

6.4.2 Acknowledgements

Thanks are due to the staff of all the organisations mentioned in the text who gave their time to provide information.

6.4.3 Further sources of information

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B. Contact names and addresses

Type of information	Contact address and telephone no.
Scheduled Monuments and Listed Buildings	Chief Archaeologist, English Heritage, 23 Savile Row, London W1X 1AB, tel: 0171 973 3000
Designated Historic Wrecks	The Secretary, Advisory Committee on Historic Wreck Sites, Department of National Heritage, Room 306, 2-4 Cockspur Street, London SW1Y 5DH, tel: 0171 211 6360
RCHME NMR - Maritime Section. Code of Practice for Seabed Developers (published by the Joint Nautical Archaeology Policy Committee).	National Monuments Record, Head of Recording (Maritime) Royal Commission on the Historical Monuments of England, National Monuments Record Centre, Kemble Drive, Swindon SN2 2GZ, tel: 01793 414600
Sites and Monuments Record, managing the archaeological resource and development in East Sussex	County Archaeologist, Transport & Environment Department, Southover House, Southover Road, Lewes, East Sussex BN7 1YA, tel: 01273 481608
Sites and Monuments Record, managing the archaeological resource and development in West Sussex	County Archaeologist, County Planning Department, County Hall, Tower Street, Chichester, West Sussex PO19 1RQ, tel: 01243 777100
Shipwrecks in East Sussex area. Museum, shipwreck tours and preservation	Shipwreck Heritage Centre, Rock-a-Nore Road, Hastings, East Sussex TN34 3DW, tel: 01424 437452
Reporting recovered wreck	Receiver of Wreck, Coastguard Agency, Spring Place, 105 Commercial Road, Southampton SO15 1EG, tel: 01703 329474
Reporting Treasure Trove	British Museum, Great Russell Street, Bloomsbury, London WC1B 3DG, tel: 0171 036 1555

Chapter 7 Coastal protected sites

J. Plaza & R. Keddie

7.1 Introduction

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. National data included in this section have been collated since 1994 and are as up to date as practicable; regional data are correct as at January 1997, 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 and/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 the natural heritage under domestic/international law, emphasises the importance of both designated sites and undesignated areas for nature conservation, advises that potential Special Protection areas (SPAs) and candidate Special Areas of Conservation (SACs) should be treated similarly to classified SPAs and designated SACs, and deals with the treatment of nature conservation issues in development plans. It also includes copies of the Ramsar Convention, the EC Birds Directive and the EC

Habitats & Species 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; in this region the most commonly used term is Site of Nature Conservation Importance. For more information, see Collis & Tyldesley (1993);
- sites designated for fisheries purposes, e.g. areas covered by Several Orders and Regulating Orders (discussed in [sections 5.7, 9.1 and 9.2](#)).

Non-site based measures contained in conventions and directives aimed at broad species and habitat protection, such as in 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 & Species Directive, are also not covered. For further information, see references in [section 7.1.3](#).

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. Sites identified under national statutes are discussed in [section 7.3](#), whereas [section 7.4](#) covers sites without statutory protection but which are identified, owned or managed by statutory bodies; and finally, other types of site (i.e. those identified, owned or managed by charities, trusts etc.) are described in [section 7.5](#). 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

Region 8 has one of the highest population densities on the coast in Great Britain and is the Coastal Directories Project region with the shortest coastline. The combination of these factors may explain the relative dearth of coastal protected wildlife sites within the region. Nevertheless, Region 8 contains 28% of the nation's Areas of Outstanding Natural Beauty (mainly owing to the presence of chalk cliffs) and approximately 10% of the nation's Local Nature Reserves and 9% of its Country Parks, by area. Region 8 contains only a small proportion (less than 5%) of all the other protected site designations by area. [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 8

	Number of protected sites					Area/length ⁺ covered by site protection				
	Region	North Sea Coast	% of North Sea Coast total in region	GB coast	% of GB coast 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
Ramsar sites	1.5*	37	4.1	61	2.5	3,498	189,145	1.8	343,524	1.0
Special Protection Areas	1.5*	60.5	2.5	99	1.5	3,498	199,727	1.8	363,103	1.0
Possible Special Areas of Conservation	1.5*	49	3.1	112	1.3	n/av	n/av	n/av	n/av	n/av
Environmentally Sensitive Areas	0.5*	7	14.3	17	5.9	3,450	279,478	2.5	1,397,545	0.5
National Nature Reserves	1	43	2.3	80	1.2	54	35,850	0.2	87,936	0.1
Sites of Special Scientific Interest	30.5*	557	5.5	1,208	2.5	12,713	335,607	3.8	716,548	1.8
Local Nature Reserves	7	73	10.0	98	7.1	1,296	10,710	12.1	15,279	8.5
Areas of Outstanding Natural Beauty	2.5*	14.5	20.7	24	12.5	250,300	714,800	35.0	899,900	27.8
Country Parks	2	24	8.3	38	5.3	401	3,130	12.8	4,628	8.7
Geological Conservation Review sites	37	551	6.7	1,098	3.4	n/ap	n/ap	n/ap	n/ap	n/ap
Heritage Coasts	1	17.5	5.7	45	2.2	13 ^a	649 ^a	2.0	1,539 ^a	0.8
Sensitive Marine Areas	1.5	16.5	6.1	27	3.7	n/av	n/av	n/av	n/av	n/av
Voluntary Marine Nature Reserves	1	9	11.1	13	7.7	n/av	n/av	n/av	n/av	n/av
The National Trust ^b	6	191	3.2	453	1.3	335	18,610	1.8	64,127	0.5
Royal Society for the Protection of Birds reserves	2	54	3.7	85	2.4	28	24,610	0.1	39,662	0.1
The Wildfowl and Wetlands Trust reserves	1	3	33.3	6	16.7	26	472	5.5	1,585	1.6
The Wildlife Trusts reserves	11	145	7.6	241	4.6	292	11,574	2.5	25,884	1.1
Ministry of Defence sites	1	65	1.5	110	0.9	700	34,449	2.0	53,410	1.3

Source: JNCC (November 1996 Ramsar/SPA data). Key: ⁺to the nearest whole hectare/kilometre; n/ap = not applicable; n/av = not available; *site overlaps boundary with adjacent region; half the total area has been included here; ^alength (km); ^bincludes National Trust for Scotland sites. Notes: site types not currently found in the region: World Heritage (Natural) Sites, Biogenetic Reserves, Biosphere Reserves, Areas of Special Protection, National Parks, National Scenic Areas, Marine Nature Reserves, Woodland Trust sites and John Muir Trust sites. 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 Further sources of information

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B. Further reading

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7.2 Sites designated under international conventions and directives

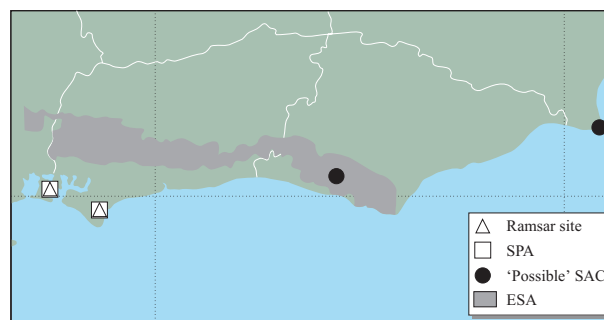
This section describes those types of site designated under international conventions to which the UK is a contracting party and sites designated under UK statute to implement EC Directives concerning wildlife and landscape conservation. Sites protected by domestic legislation only are covered in [section 7.3](#).

7.2.1 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 at least one wetland 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. One Ramsar site lies entirely within Region 8 and a second site spans the border with Region 9, bringing the total area of land under this designation in Region 8 to 3,498 ha ([Table 7.2.1](#); [Map 7.2.1](#)). [Table 7.2.1](#) summarises the interest for which the sites have been designated, and [sections 5.11](#) and [5.12](#) describe the importance of the sites for the region's birds.

7.2.2 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



Map 7.2.1 Coastal Ramsar sites, Special Protection Areas (SPAs), 'possible' Special Areas of Conservation (SACs) and Environmentally Sensitive Area. Sources: JNCC, English Nature.

of the statutory conservation agencies. This designation is implemented through the Wildlife & Countryside Act 1981; all SPAs have first to be notified as Sites of Special Scientific Interest. There is one coastal SPA lying entirely within Region 8, and a second one is shared with Region 9, bringing the total area under this designation to 3,498 ha ([Table 7.2.2](#); [Map 7.2.1](#)). [Table 7.2.2](#) summarises the interest of these sites, and [sections 5.10](#), [5.11](#) and [5.12](#) describe the importance of these sites for the region's birds.

7.2.3 Special Areas of Conservation

The Special Areas of Conservation (SAC) designation is one of the main mechanisms by which the EC Habitats & Species Directive 1992 will be implemented. SACs are areas considered to be important for habitats and non-avian species of interest in a European context. The protection measures are based around a series of six annexes: Annexes I and II list the habitats and species that require the designation of SACs; Annex IV prohibits the taking of certain species; Annex V requires the taking of certain species to be monitored; and

Table 7.2.1 Ramsar sites

Site name	No. of sites	Grid ref.	Area (ha*)	Date designated	Qualifying interest
West Sussex Pagham Harbour	1	SZ875970	616	1984	1% of a waterfowl species population
Hampshire/West Sussex Chichester & Langstone Harbours ⁺	0.5⁺	SU740010	2,882 ⁺	1987	Representative wetland; regularly supports 20,000 waterfowl; 1% of a waterfowl species population
Region 8	1.5⁺		3,498⁺		
North Sea Coast	37		189,145		
GB coast	61		343,524		
GB whole country	103		357,911		

Sources: JNCC November 1996 data; English Nature. Key: ⁺site overlaps boundary with adjacent region; half the total area/number has been included here; *to the nearest whole hectare. 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 7.2.2 Special Protection Areas (SPAs)

Site name	No. of sites	Grid ref.	Area (ha*)	Date designated	Qualifying interest
West Sussex Pagham Harbour	1	SZ875970	616	1984	Internationally important numbers of wintering dark-bellied brent goose <i>Branta bernicla bernicla</i> ; nationally important numbers of wintering pintail <i>Anas acuta</i> , grey plover <i>Pluvialis squatarola</i> and black-tailed godwit <i>Limosa limosa</i>
Hampshire/West Sussex Chichester & Langstone Harbours*	0.5 ⁺	SU740010	2,882 ⁺	1987	Internationally important numbers of 7 species of wintering waterfowl; nationally important numbers of 8 wintering species; nationally important numbers of 2 species of breeding tern <i>Sterna</i> spp.; regularly supports over 20,000 waterfowl
Region 8	1.5⁺		3,498⁺		
North Sea Coast	60.5		199,727		
GB coast	99		363,103		
GB whole country	136		495,843		

Sources: JNCC October 1996 data; English Nature; Pritchard *et al.* (1992). Key: *to the nearest whole hectare; ⁺site overlaps boundary with adjacent region; half the total area has been included here. 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.

Annex VI prohibits some means of capture or killing of mammals and fish. In the UK the Directive is implemented through the Conservation (Natural Habitats etc.) Regulations 1994. A list of 'possible' SACs was announced by the Government on 31 March 1995. One possible SAC lies entirely within Region 8, whilst a second site is shared with Region 7 (Table 7.2.3; Map 7.2.1). In Great Britain, there are a total of 112 coastal possible SACs (see JNCC (1995) and Brown *et al.* (1997) for more information).

Table 7.2.3 Possible Special Areas of Conservation (SACs)

Site name	No. of sites	Qualifying interest
East Sussex/Kent Dungeness	0.5*	Annual vegetation of drift lines; perennial vegetation of stony banks
East Sussex Lewes Downs	1	Semi-natural dry grasslands and scrubland facies on calcareous substrates (<i>Festuco-Brometalia</i>): important orchid sites
Region 8	1.5*	
North Sea Coast	49	
GB	112	

Sources: JNCC, English Nature. Key: *site overlaps boundary with adjacent region; half the total number has been included here. 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 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 (6,900 ha) that includes land in Region 8 (Table 7.2.4; Map 7.2.1).

7.2.5 Acknowledgements

Thanks are due to John Gibson and other staff of the JNCC, Alan Law and Siaron Hooper (English Nature) and the Ministry of Agriculture Fisheries and Food (MAFF).

7.2.6 Further sources of information

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Table 7.2.4 Environmentally Sensitive Areas

<i>Site name</i>	<i>No. of sites</i>	<i>Area (ha*)</i>	<i>Date designated</i>	<i>Interest</i>
Hampshire/West Sussex South Downs	0.5*	3,450	1987	Scenic value for its open rolling downland and wildlife value of grazed chalk grassland, pasture, ditches and dykes; ancient field systems
Region 8	0.5*	3,450*		
North Sea Coast	7	279,478		
GB coast	17	1,397,545		

Sources: MAFF, SOAEFD, SNH. Key: *site overlaps boundary with adjacent region; half the total area/number has been included here; *to the nearest whole hectare. 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.

B. Further reading

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C. Contact names and addresses

<i>Type of information</i>	<i>Contact address and telephone no.</i>
Ramsar sites, SPAs, Special Areas of Conservation (E. Sussex and W. Sussex)	*Conservation Officer, English Nature Sussex and Surrey Local Team, tel: 01273 476595
Ramsar sites, SPAs (E. Sussex and W. Sussex)	*Regional Officer, RSPB, South East England Office, Brighton, tel: 01273 775333
Environmentally Sensitive Areas	MAFF Conservation Management Division, Ministry of Agriculture, Fisheries and Food, Whitehall Place, London SW1A 2HH, tel: 0171 270 3000
Special Areas of Conservation	*Department of the Environment, Transport and the Regions (DETR), European Wildlife Division, Bristol, tel: 0117 987 8811

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

7.3 Sites established under national statute

Included in this section are the types of site identification made under national legislation relating to wildlife, landscape and amenity value. Identifications are made by the statutory nature conservation agencies (in this region English Nature), local authorities or the government acting on advice from these bodies.

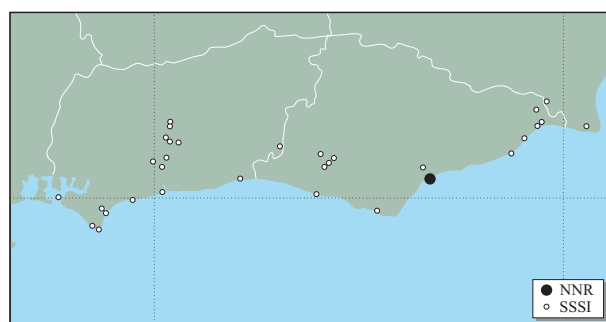
7.3.1 National Nature Reserves

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 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 & Countryside Act 1981. All NNRs are also Sites of Special Scientific Interest (SSSIs). There is one coastal NNR (54 ha) in Region 8 (Table 7.3.1; Map 7.3.1).

7.3.2 Sites of Special Scientific Interest

Sites of Special Scientific Interest (SSSIs) are notified under the Wildlife & Countryside Act 1981. They are intended to form a national network of areas, representing in total the parts of Britain in which the natural features, especially those of greatest value to wildlife and earth science 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 limit or prevent operations that are potentially damaging to the wildlife interest of the area. There are 29 coastal SSSIs entirely within Region 8 and three coastal SSSIs falling partially within other regions, bringing the total to 12,712 ha (Table 7.3.2; Map 7.3.1). Around 8% of the total land mass of Britain is SSSI.

Over two-thirds of the SSSIs in the region (67%) have some intertidal land. Four fifths of the SSSIs were selected at least partly for their biological interest and 43% at least partly for



Map 7.3.1 Coastal National Nature Reserve (NNR) and Sites of Special Scientific Interest (SSSIs). Note: a single symbol may represent more than one site in close proximity. Sources: English Nature, JNCC, Marren (1994).

their earth science (geological or geomorphological) interest. Of the total, 27% have both biological and earth science interest. Examples of a wide range of habitats and species occur within the SSSIs in this region, the most frequently occurring habitats being tidal flats, open water, saltmarshes, vegetated shingle, wet grasslands/grazing marsh, dry grasslands, woodland and reed beds and scrub, these habitats occurring in 25–47% of sites. SSSIs in the region include several sites of interest for their reptiles (26%), terrestrial invertebrates (60%), waders (23%) and wildfowl (27%). Further details of SSSIs may be found in the *Coastal and marine UKDMAP datasets* module disseminated by the JNCC (BODC 1992; Barne *et al.* 1994).

7.3.3 Local Nature Reserves

Local Nature Reserves (LNRs) are 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 are seven LNRs (1,296 ha) in Region 8 (Table 7.3.3; Map 7.3.2).

Table 7.3.1 National Nature Reserves

Site name	No. of sites	Grid ref.	Area (ha*)	Date last declared	Habitats
E. Sussex	1				
Pevensey Levels		TQ670058	54	1985	Flood pasture and drainage dykes
Region 8	1		54		
North Sea Coast	43		35,850		
GB coast	80		87,936		
GB whole country	288		196,312		

Source: English Nature, JNCC, Marren (1994). Key: *to the nearest whole hectare. 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.

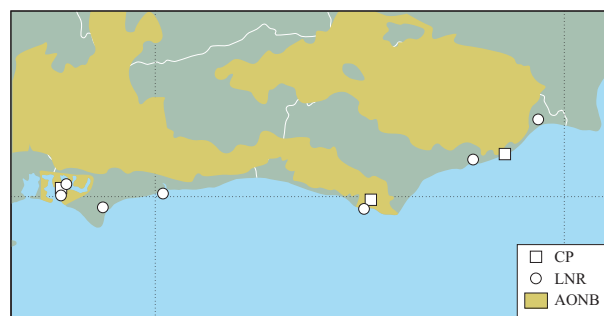
Table 7.3.2 SSSIs in Region 8

Site name	No. of sites	Grid ref.	Area (ha ⁺)	Date last notified
Kent/E. Sussex	1*			
Dungeness*		TR050180	1,586*	1988
Walland Marsh*		TQ960240	2.5*	1986
E. Sussex	14			
Houghton Green Cliff		TQ931224	<1	1990
Camber Sands & Rye Saltings		TQ947190	239	1986
Rye Harbour		TQ935180	759	1988
Pett Level		TQ903157	352	1989
Hastings Cliffs to Pett Beach		TQ872112	299	1990
Pevensey Levels		TQ650080	3,501	1990
Seaford to Beachy Head		TV540970	1,091	1986
Brighton to Newhaven Cliffs		TQ390015	168	1986
Lewes Brooks		TQ410085	333	1988
Southerham Works Pit		TQ426096	1	1996
Southerham Grey Pit		TQ427090	8	1990
Lewes Downs		TQ437103	150	1986
Offham Marshes		TQ404118	38	1989
Clayton to Offham Escarpment		TQ301136-TQ400120	30	1986
W. Sussex	15			
Adur Estuary		TQ208056	62	1987
Arun Banks		TQ029100	25	1985
Parham Park		TQ059148	263	1986
Amberley Wild Brooks		TQ033142	323	1985
Waltham Brooks		TQ025159	43	1987
Upper Arun		TQ030184	40	1988
Park Farm Cutting		TQ039190	<1	1986
Fairmile Bottom		SU990094	68	1987
Arundel Park		TQ015082	141	1987
Climping Beach		TQ020010	65	1985
Felpham		SZ948993	2	1988
Bognor Reef		SZ886966	64	1988
Pagham Harbour		SZ875970	615	1986
Selsey East Beach		SZ861925	2	1988
Bracklesham Bay		SZ844930	203	1986
W. Sussex/Hampshire	0.5*			
Chichester Harbour		SU760000	1840.5*	1985
Region 8	30.5*		12,713	
North Sea Coast	557		335,607	
GB coast	1,208		716,548	
GB whole country	6,095		1,940,843	

Source: English Nature. Key: *site overlaps boundary with adjacent region; half the total area has been included here; ⁺generally to the nearest whole hectare. 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.

7.3.4 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 designated in England by the Countryside Commission under the National Parks and Access to the Countryside Act 1949. Three AONBs (250,300 ha) fall partially



Map 7.3.2 Coastal Country Parks (CPs), Local Nature Reserves (LNRs) and Areas of Outstanding Natural Beauty (AONBs). Source: Countryside Commission, English Nature.

Table 7.3.3 Local Nature Reserves

Site name	No. of sites	Grid ref.	Area (ha ⁺)	Date designated/opened
East Sussex	3			
Rye Harbour		TQ935180	220	1970*
Filsham Reed Bed		TQ777097	23	1983
Seaford Head		TV510975	128	1969
West Sussex	4			
West Beach		TQ025009	23	1993
Pagham Harbour		SZ875970	518	1964
Nutbourne Marshes		SU780020	366	1976
Pilsey Island		SU770006	18	1985
Region 8	7		1,296	
North Sea Coast	73		10,710	
GB coast	98		15,279	
GB whole country	398		21,632	

Source: English Nature. Key: *extended 1976; ⁺to the nearest whole hectare. 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 7.3.4 Areas of Outstanding Natural Beauty (AONBs)

Site name	No. of sites	Area (ha ⁺)	Date designated
E. Sussex and W. Sussex	2		
High Weald		146,000	1983
Sussex Downs		98,300	1966
W. Sussex and Hampshire	0.5^a		
Chichester Harbour* ^a		6,000* ^a	1968
Region 8	2.5^a	250,300	
North Sea Coast	14.5	714,800	
GB coast	24	899,900	
GB whole country		2,123,700	

Source: Countryside Commission. Key: *comprising several disjunct areas; ^asite overlaps boundary with adjacent Region 9; Region 8 contains 6,000 ha; ⁺to the nearest 100 ha. 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.

within Region 8 (Table 7.3.4; Map 7.3.2). In 1995 the total area covered by AONBs was just over 14% of the countryside of England and Wales.

7.3.5 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 (401 ha) in Region 8 (Table 7.3.5; Map 7.3.2).

Table 7.3.5 Country Parks

Site name	No. of sites	Grid ref.	Area (ha*)	Date designated/opened
E. Sussex	2			
Hastings		TQ850103	221	1972
Seven Sisters		TV522984	180	1972
Region 8	2		401	
North Sea Coast	24		3,130	
GB coast	38		4,628	
GB whole country	285		35,337	

Source: Countryside Commission. Key: *to the nearest whole hectare. 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 Acknowledgements

Thanks are due, in particular, to Ray Woolmore and Paul Johnson (Countryside Commission), and to Roger Bolt (JNCC), Sylvia White and Phillip Biss (English Nature) and Neale Oliver (DETR).

7.3.7 Further sources of information

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- Nature Conservancy Council. 1989. *Local Nature Reserves*. Peterborough, Nature Conservancy Council. (Library information sheet No. 6.)

C. Contact names and addresses

Type of information	Contact address and telephone no.
NNRs, SSSIs, LNRs, (E. Sussex and W. Sussex)	*Conservation Officer, English Nature Sussex and Surrey Team, Lewes, tel: 01273 476595
LNRs, Country Parks (E. Sussex)	*East Sussex County Council, Lewes, tel: 01273 481000
LNRs, Country Parks (W. Sussex)	*West Sussex County Council, Chichester, tel: 01243 777100
AONBs	*Countryside Commission (HQ), Cheltenham, tel: 01242 521381
Coastal and marine UKDMAP datasets	*Marine and Coastal Data Custodian, JNCC, Peterborough, tel: 01733 562626

*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

Nature Conservation Review (NCR) sites are non-statutory sites that are the best representative examples of wildlife habitat; for some coastal sites, for example estuaries, all sites that were above a critical standard of nature conservation importance were selected. Ratcliffe (1977) related this particularly to migrant and wintering waterfowl populations and breeding bird assemblages. The NCR helps to identify sites that may qualify for declaration as National Nature Reserves. There are 953 NCR sites (approximately 1,500,000 ha) in Britain. 149 of them (approximately 360,000 ha) are coastal as defined by Ratcliffe (1977), but his definition of 'coastal' differed from that adopted in this chapter.

7.4.2 Geological Conservation Review sites

Geological Conservation Review (GCR) sites are non-statutory sites identified as having national or international importance for earth science. As such, it is intended that most GCR sites will eventually be notified as SSSIs. 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. There are 36 coastal GCR sites in Region 8 and one bridging Regions 7 and 8 (Table 7.4.1; Map 7.4.1). Detailed scientific accounts of coastal and inland GCR sites are contained in the 42-volume *Geological Conservation Review* series, 22 volumes of which have been published or are in preparation (see e.g. Ellis *et al.* 1995).

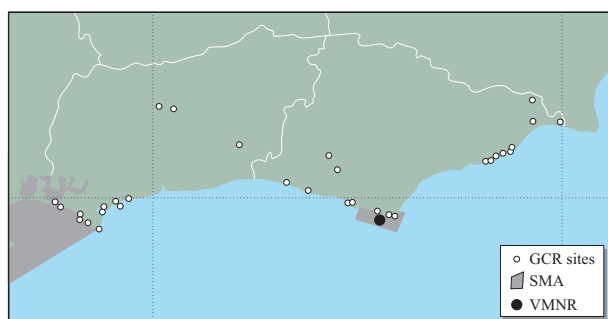
7.4.3 Sensitive Marine Areas

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 English Nature with the 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. SMA is the term used for areas described in previous technical documents (e.g. English Nature 1994a) as 'Important Areas for Marine Wildlife' under English Nature's initiative '*Managing England's marine wildlife*' (English Nature 1994b). One Sensitive Marine Area falls entirely within Region 8, while a second (Solent and Isle of Wight) extends into this region (Table 7.4.2; Map 7.4.1): all were identified in 1994.

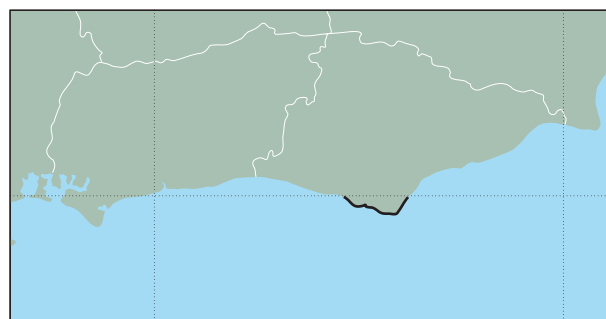
Table 7.4.1 GCR sites

Site name	No. of sites
Kent/E. Sussex	0.5⁺
Dungeness ⁺ *	
E. Sussex	21
Rye Harbour*	
Iden	
Cliff End (2 sites)	
Fairlight Cove and Haddocks	
Fairlight	
Covehurst	
Hastings	
Hastings - Pett Level	
Cow Gap	
Birling Gap	
Beachy Head - Seaford*	
Cuckmere - Seaford	
Asham Quarry	
Southerham Grey Pit (2 sites)	
Southerham Lime Kiln Quarry	
Southerham Pit	
Saltdean	
Black Rock	
Newhaven - Brighton	
W. Sussex	16
Horton Clay Pit	
Marehill Quarry	
Park Farm Cutting	
Felpham	
Bognor Regis (4 sites)	
Pagham Harbour*	
Selsey (2 sites)	
Earnley	
Bracklesham Bay	
Wittering - Selsey	
Bracklesham	
East Head*	
Region 8	37.5⁺
North Sea Coast	551
GB coast	1,098
GB whole country	3,023

Sources: English Nature, JNCC. Key: ⁺site overlaps boundary with adjacent region; half the total is included here; *site selected wholly or partly for its coastal geomorphological 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.



Map 7.4.1 Coastal Geological Conservation Review (GCR) sites, Sensitive Marine Areas (SMAs) and Voluntary Marine Nature Reserve (VMNR). Note: a single symbol may represent more than one site in close proximity. Sources: English Nature, JNCC.



Map 7.4.2 Heritage coast. Source Countryside Commission

is agreed between local authorities and the Countryside Commission, as an aid to local authorities in planning and managing their coastlines. There is one Heritage Coast (13 km) in Region 8 (Table 7.4.4; Map 7.4.2). Of the English coastline encompassed by Heritage Coasts, 39.5% is protected by the National Trust (Heritage Coast Forum 1993).

Table 7.4.2 Sensitive Marine Areas

Site name	No. of sites	Date established
W. Sussex/Hampshire	0.5*	
Solent and Isle of Wight*		1994
E. Sussex	1	
Seven Sisters		1994
Region 8	1.5*	
North Sea Coast	16.5	
GB coast	27	

Source: English Nature (1994a). Key: *site lies partly within Region 9; half the total has been included.

7.4.4 Voluntary Marine Nature Reserves

Voluntary Marine Nature Reserves (VMNRs) (also called Voluntary Marine Conservation Areas or Voluntary Marine Wildlife Areas) may be set up by representatives of the users of a subtidal area or an area of shore in order to initiate management of that area. Management may have a variety of purposes, from the conservation of an area important for marine biology to its use for educational purposes. These Reserves or Conservation Areas usually have a management committee or steering group composed of users of the area, interested members of the public, fishermen, harbour authorities and local Wildlife Trusts. There is one Voluntary Marine Nature Reserve in Region 8 (Table 7.4.3; Map 7.4.1).

Table 7.4.3 Voluntary Marine Nature Reserves

Site name	No. of sites	Date established
E. Sussex	1	
Seven Sisters		1984
Region 8	1	
North Sea coast	9	
GB coast	13	

Source: English Nature.

7.4.5 Heritage Coasts

A Heritage Coast is an area selected for having a coastline of exceptionally fine scenic quality exceeding 1 mile (1.6 km) in length, substantially undeveloped and containing features of special significance and interest. This non-statutory protection

Table 7.4.4 Heritage Coasts

Site name	No. of sites	Grid ref.	Length (km*)	Date designated
E. Sussex	1			
Sussex		TV489981-TV600967	13	1973
Region 8	1		13	
North Sea Coast	17.5		649	
England & Wales	45		1,539	

Source: Countryside Commission. Key: *to the nearest whole kilometre. Note: all Heritage Coasts are 'completely defined', i.e. they also have a defined landward boundary.

7.4.6 Acknowledgements

Thanks are due to Ray Woolmore and Paul Johnson (Countryside Commission), Roger Bolt (JNCC) and Marcus Polley, Paul Gilliland and Peter Lambley (English Nature).

7.4.7 Further sources of information

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- Smith, D.B. 1995. *Marine Permian of England*. London, Chapman & Hall. (Geological Conservation Review series, No. 8.)

C. Contact names and addresses

Type of information	Contact address and telephone no.
NCR sites, GCR sites, SMA, VMNR (E. Sussex and W. Sussex)	*English Nature Sussex and Surrey Local Team, Lewes, tel: 01273 476595
Regionally Important Geological Sites in Sussex (RIGS) data centre	J.A. Cooper, Keeper of Geology, Booth Museum, 194 Dyke Road, Brighton BN1 5AA
Heritage Coasts (E. and W. Sussex)	*Countryside Commission South East Region, London, tel: 0171 831 3510

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

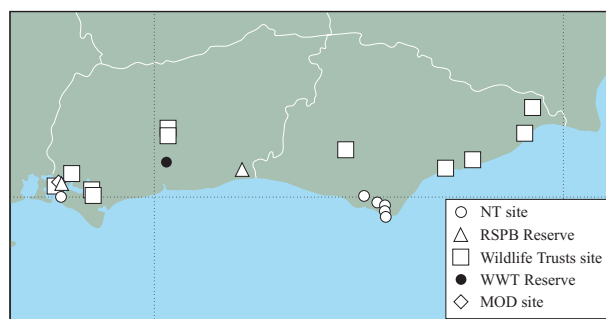
7.5 Other types of protected site

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 240,000 ha of land in England, Wales and Northern Ireland, and over 200 buildings of outstanding importance. It has also accepted or bought covenants that protect against development for a further 48,000 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 (National Trust 1993). A total of 900 km of coast are now owned or managed by the National Trust (National Trust 1996). There are six National Trust sites (335 ha) in Region 8 (Table 7.5.1; Map 7.5.1).

7.5.2 The Royal Society for the Protection of Birds

The Royal Society for the Protection of Birds (RSPB) currently manages over 140 reserves (97,100 ha) in Britain (Steve Gilbert pers. comm.). 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 two RSPB reserves (28 ha) in Region 8 (Table 7.5.2; Map 7.5.1).



Map 7.5.1 Other types of coastal protected site. Note: a single symbol may represent more than one site in close proximity.
Sources: National Trust (NT), RSPB, Wildlife Trusts (WT), Ministry of Defence (MoD), Wildfowl & Wetlands Trust (WWT).

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 the land is either owned or held on long leases. There is one coastal WWT site (26 ha) in Region 8 (Table 7.5.3; Map 7.5.1).

7.5.4 The Wildlife Trusts

The Wildlife Trusts were established to promote non-statutory nature conservation at a local level. 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. The Sussex

Table 7.5.1 National Trust sites*

Site name	No. of sites	Grid ref.	Area (ha ⁺)	Date acquired	Landform
E. Sussex	5				
Belle Tout		TV557957	27	1967	Chalk cliffs
Birling Gap		TV554960	3	1982	Coastland
Crowlink Village		TV544975	2	1988	Scrubland
Crowlink, Michel Dene & Went Hill		TV540970	256	1928-63	Cliff, down and farmland
Exceat Saltings		TV510990	2	1935	Saltings and bank
W. Sussex	1				
West Wittering beach		SZ766990	45	1966	Coastal spit: sand dunes, saltings and
Region 8	6		335		
North Sea Coast ^a	191		18,610		
GB whole coast ^a	453		64,127		

Source: National Trust (1996). Key: ⁺ to the nearest whole hectare; *includes only sites that are of natural heritage interest; ^a includes National Trust for Scotland sites. 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 7.5.2 Royal Society for the Protection of Birds reserves

Site name	No. of sites	Grid ref.	Area (ha ⁺)	Date acquired	Interest
W. Sussex	2				
Adur Estuary		TQ211050	10	1986	Intertidal mudflats and saltmarsh, wintering waders, seabirds and waterfowl
Pilsey Island		SU760020	18	1985	Shingle, sand dunes and saltmarsh, wader roost and nests, wintering waterfowl
Region 8	2		28		
North Sea Coast	54		24,610		
GB coast	85		39,662		

Sources: RSPB (1994; *in litt.*, pers. comm.). Key: ⁺to the nearest whole hectare. 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 7.5.3 Wildfowl & Wetlands Trust sites

Site name	No. of sites	Grid ref.	Area (ha ⁺)	Date acquired
W. Sussex	1			
Arundel		TQ020081	26	1970
Region 8	1		26	
North Sea Coast	3		472	
GB coast	6		1,585	

Source: Wildfowl & Wetlands Trust. Key: ⁺to the nearest whole hectare. 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.

Wildlife Trust is responsible for sites in Region 8. There are eleven coastal Wildlife Trust sites (292 ha) in Region 8 (Table 7.5.4; Map 7.5.1).

Table 7.5.4 Wildlife Trusts sites

Site name	No. of sites	Grid ref.	Area (ha ⁺)	Date acquired
E. Sussex	5			
Castle Water, Rye		TQ925185	88	1993
Pett Pools		TQ903145	12	1996
Fisham Reedbeds		TQ778098	17	1993
Gillham Wood		TQ718064	3	1978
Malling Down		TQ423107	38	1993
W. Sussex	6			
Amberley Wild Brooks		TQ029146	61	1963
Waltham Brooks		TQ026159	43	1976
Stakes Island		SU779014	0.4	1976
Chidmere Pond		SU791037	2	1965
Mill Pond Marsh		SZ856980	9	1992
Ferry Field		SZ855964	19	1988
Region 8	11		292	
North Sea Coast	145		11,588	
GB coast	241		25,898	

Source: Wildlife Trusts (1996 data). Key: ⁺to the nearest whole hectare. 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 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 is one coastal MoD site (700 ha) in Region 8 (Table 7.5.5; Map 7.5.1).

Table 7.5.5 MoD sites

Site name	No. of sites	Area (ha)*	Habitats	Conservation status
W. Sussex	1			
Thorney Island		700	Intertidal mudflat	SSSI, AONB, LNR
Region 8	1	700		
North Sea Coast	65	34,449		
GB coast	110	53,410		

Source: Ministry of Defence. Key: *all areas are approximate and include land leased or used under licence; SSSI = Site of Special Scientific Interest; AONB = Area of Outstanding Natural Beauty; LNR = Local Nature Reserve. 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.

7.5.6 Acknowledgements

The authors wish to thank Andrea Firth (MoD), Jo Burgon and Richard Offen (The National Trust), Bob Scott and Steve Gilbert (RSPB), Sarah Hawkswell (The Wildlife Trusts) and the Woodland Trust for providing information.

7.5.7 Further sources of information

A. References cited

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B. Further reading

- 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., & Duff, K.L. 1991. *Nature conservation and estuaries in Great Britain*. Peterborough, Nature Conservancy Council.

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 (W. Sussex)	*The National Trust Southern Regional Office, Dorking, tel: 01372 453401
National Trust sites (E. Sussex)	*The National Trust Kent & East Sussex Regional Office, Tunbridge Wells, tel: 01892 890651
RSPB sites (E. and W. Sussex)	*Regional Officer, RSPB, South East England Office, Brighton, tel: 01273 775333
The Wetlands and Wildfowl Trust reserve (Arundel)	The Wildfowl and Wetlands Trust, Mill Road, Arundel BN18 9PB, tel: 01903 883355
Wildlife Trust sites (E. and W. Sussex)	*Conservation Officer, Sussex Wildlife Trust, Henfield, tel: 01273 492630
MOD sites	Conservation Officer, MoD Conservation Office, DEO, Blandford House, Farnborough Road, Aldershot, Hants. GU11 2HA, tel: 01252 348989

*Starred contact addresses are given in full in Appendix.

Chapter 8 Land use, infrastructure and coastal defence

S.L. Fowler & S.J. Everett

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 and harbours; and coastal defence, including sea defence and coast protection.

This is a very densely populated coast and in many areas the towns and holiday resorts form continuous blocks of urban or suburban residential development, particularly between Brighton and Bognor Regis. However, many of the undeveloped stretches of coast are of high quality for wildlife, particularly in East Sussex. Development pressures in the area are considerable, although planning and other policies appear

to provide strong protection. Land between the developed areas is generally in agricultural use and there is little coastal woodland.

There is no large-scale industrial development in the region. Service industries are predominant in the urban areas and tourism is economically important to many of the seaside towns. There are a number of commercial freight ports and Newhaven is a channel ferry port. A number of small rivers flow into the sea here, but, with the exception of Rye and Chichester, their estuaries and harbours are quite small. Chichester Harbour, however, is one of the largest leisure boating centres on the south coast and in recent years there has been considerable pressure for further marina development within the Harbour.



Camber Castle, in the Rye Harbour Site of Special Scientific Interest, looks out over a scene that has changed dramatically over the centuries. Sheep now graze where ships once sailed. Henry VIII started to build Camber in 1539 to defend a shallow harbour that reached right up to the track in the foreground. Less than a hundred years later the castle had to be abandoned, as the harbour had silted up and its entrance was blocked by a shifting shingle bar. Photo: Peter Wakely, English Nature.

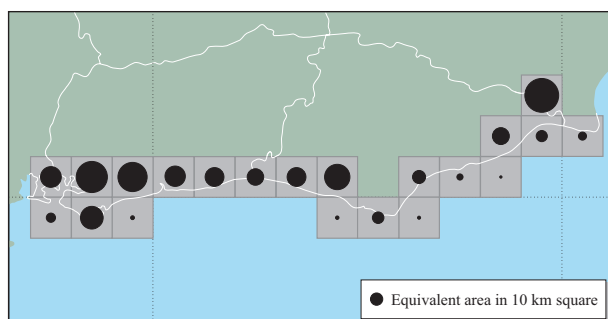
8.2 Land use

S.L. Fowler & S.J. Everett

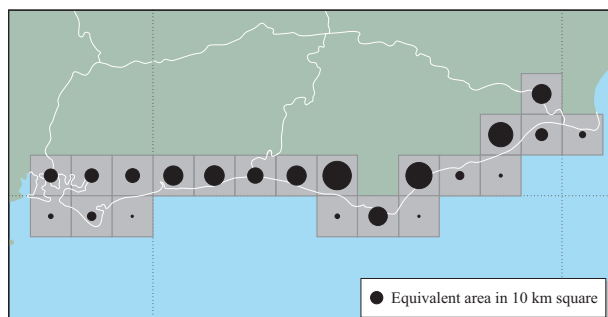
8.2.1 Locations and land uses

Maps 8.2.1, 8.2.2 and 8.2.3 show the distribution of tilled land, mown/grazed turf and meadow/semi-natural grassland in the coastal 10 km squares of the region, according to the Countryside Survey (ITE 1993). Land not under urban use in East Sussex is predominantly Grade 3, with smaller amounts of Grade 4. Of the agricultural land, only small pockets of high grade land are found near the East Sussex coast, with the exception of the low-lying land around Rye. Large areas of mown or grazed grassland occur in East Sussex, particularly on the Pevensey Levels and South Downs. Livestock farming predominates on the chalk downland where it abuts the coast, as at Beachy Head. A range of national agri-environment schemes funded partly by the EC, such as Environmentally Sensitive Areas (in this region the South Downs), the Countryside Stewardship Scheme and the Habitats Scheme, aim to encourage wildlife-sensitive farming practices. Proposals for land claim for agricultural purposes in the Rother Estuary, Rye, were recorded by Davidson (1991).

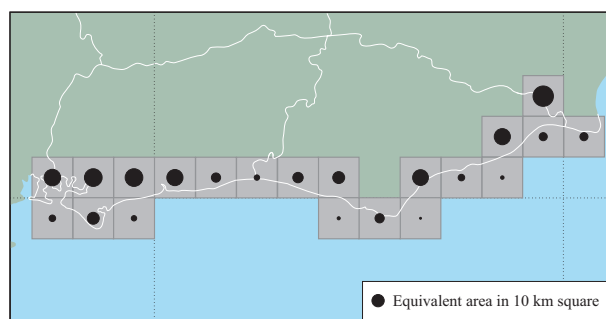
About one-third of the high quality agricultural land in Sussex lies on the coastal plain. Most of the tilled land in the region is in West Sussex, where the coastal plain is wider, although the majority of coastal land between Eastbourne and Selsey Bill is in urban use. Agricultural land in the West Sussex part of the region is intensively farmed and typically



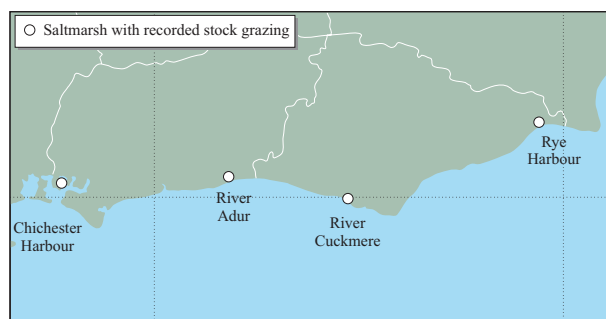
Map 8.2.1 Tilled land in coastal 10 km grid squares. Note: area of circle indicates the area of this land cover type in the 10 km square. Sources: Countryside Survey (1990); ITE Monks Wood.



Map 8.2.2 Pastures and amenity swards, mown or grazed to maintain a short turf throughout the year. Note: area of circle indicates the area of this land cover type in the 10 km square. Sources: 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: area of circle indicates the area of this land cover type in the 10 km square. Source: Countryside Survey (1990), ITE, Monks Wood.



Map 8.2.4 Saltmarshes with recorded grazing. See Map 3.6.1 for distribution of saltmarsh sites. Source: JNCC Coastal Database.

Grade 1 or 2. Cereal production and horticulture are important, with livestock farming of lesser significance. Map 8.2.4 shows the incidence of stock grazing on the saltmarshes of the region.

Semi-natural and planted woodlands are scarce on the coast of this region, but there is some natural woodland above the cliffs at Fairlight (Hastings), designated as a Country Park. Small patches of recent woodland are present around Beachy Head, Cuckmere Haven and Newhaven. Oldpark Wood, which lies next to Chichester Harbour, represents a rare example of ancient semi-natural woodland that has a direct transition to saltmarsh and mudflats. Table 8.2.1 lists the major coastal woodlands in the region, including the larger (>5 ha) ancient semi-natural woodlands listed in English Nature's Ancient Woodland Inventories (Map 8.2.5).

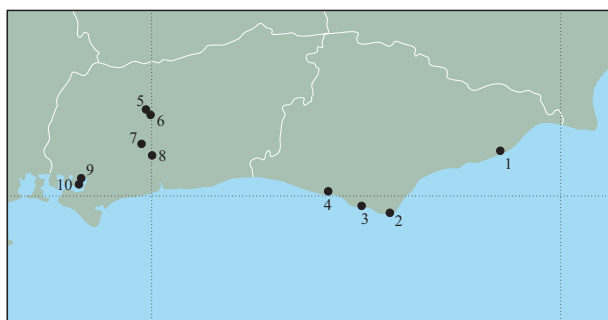
8.2.2 Information sources used

The main source of information for the maps of 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 of Great Britain. Land cover is classified into seventeen key types (including tilled land and managed grassland), and field

Table 8.2.1 Areas of significant woodland within 500 m of the coast

Site no.	Site name	Grid ref.	Total area of wood (ha)	Area of ancient semi-natural woodland included in total (ha)	Notes
East Sussex					
1	Fairlight Glen	TQ8511	5	5	AWI, with other areas of more recent woodland in the vicinity
2	Beachy Head and Seven Sisters	TV5895	n/a	-	Patches of broad-leaved woodland on top of cliffs
3	Cuckmere Haven	TV5197	n/a	-	Patches of woodland at Cliff End, South Hill and Seaford Head
4	Newhaven	TQ4300	n/a	-	Woodland at Harbour Heights and on golf course
West Sussex					
5	The Quells	TQ031208	12	12	AWI - adjacent to tidal stretch of River Arun
6	Mill Copse	TQ032202	6	6	AWI - adjacent to tidal stretch of River Arun
7	South Wood	TQ011104	33	16	AWI - adjacent to tidal stretch of River Arun
8	Offham Hanger/ Heron's Wood	TQ022085	25	25	AWI - adjacent to tidal stretch of River Arun
9	Oldpark Wood	SU824023	40	40	AWI - abuts arm of Chichester Harbour
10	Upper Wolves Copse	SU815015	7	7	AWI - abuts arm of Chichester Harbour

Sources: English Nature Ancient Woodland Inventory; OS Landranger 1:50,000 series maps. Key: AWI = Ancient Woodland Inventory site. Note: site numbers refer to [Map 8.2.5](#).



Map 8.2.5 Significant areas of woodland within 500 m of the coast ([Table 8.2.1](#)). Source: English Nature Ancient Woodland Inventory; Ordnance Survey Landranger maps. © Crown copyright.

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 these data, which are held in the Department of the Environment, Transport and the Regions (DETR) Countryside Information System. The main limitations of the data derive from errors in classifying areas covered by a mixture of land types. The Countryside Information System can provide data on a 1 km square framework, but this level of detail was not considered appropriate here.

Information on agricultural land grades comes from the Ministry of Agriculture, Fisheries and Food and Welsh Office Development Department (1979), and some information on agricultural land use was obtained from West Sussex County Council (1993). Saltmarsh grazing information for [Map 8.2.4](#) comes from the JNCC's Coastal Database and from cited references. Woodland information was obtained from English Nature's Ancient Woodlands Inventory and from the 1:50,000 scale Ordnance Survey Landranger maps.

8.2.3 Acknowledgements

Thanks go to Chris Reid (English Nature) for Ancient Woodland Inventory data.

8.2.4 Further sources of information

A. References cited

- 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., & Duff, K.L. 1991. *Nature conservation and estuaries in Great Britain*. Peterborough, Nature Conservancy Council.
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B. Further reading

- Radley, G.P. 1994. *Sand dune vegetation survey of Great Britain. Part 1: England*. Peterborough, Joint Nature Conservation Committee.

C. Contact names and addresses

Type of information	Contact address and telephone no.
Agriculture, agri-environment schemes	MAFF Regional Service Centre, Block A, Government Buildings, Coley Park, Reading, Berkshire RG1 6DT, tel: 01734 581222
Farming and wildlife	Farming and Wildlife Advisory Group, National Agricultural Centre, Stoneleigh, Kenilworth, Warwickshire CV8 2RX, tel: 01203 696699
ITE Countryside Survey 1990	*Department of Rural Affairs, DETR, Bristol, tel: 0117 921 8811
Soil surveys in England and Wales	John Hazelden, Soil Survey and Land Research Centre, Cranfield University, Silsoe, Bedford MK45 4DT, tel: 01525 863000
Forestry, including woodland grants in West Sussex	The Forestry Authority, Hampshire and West Downs, Alice Holt, Wrecclesham, Farnham, Surrey GU10 4LF, tel: 01420 23337
Forestry, including woodland grants in East Sussex	The Forestry Authority, Furnace Lane, Lamberhurst, Tunbridge Wells, Kent TN3 8LE, tel: 01892 891100
Ancient semi-natural woodland - East and West Sussex	*English Nature Sussex and Surrey Local Team, Lewes, tel: 01273 475595

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

8.3 Infrastructure

S.L. Fowler, S.J. Everett & Scott Wilson Resource Consultants

8.3.1 Introduction

This section summarises the infrastructure of the region, including population distribution, industry, ports and harbours, power generation, and land claim for these developments. Oil and gas exploration and development are covered in [section 9.5](#). In this section, power producing plants are included as coastal if they are less than 2 km inland.

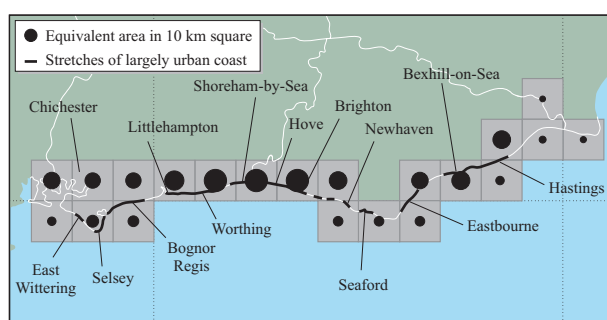
Much of the Sussex coastline is very heavily urbanised. The coastal towns consist of mainly residential areas: they have virtually no heavy industry and there is only a small manufacturing sector. Most employment stems from service industries and tourism, although the ports in region are also of particular economic importance.

Competition in the electricity generating industry has been intense since privatisation in 1990. This has stimulated some diversification, which has been further encouraged by guidelines such as the government's Non Fossil Fuel Obligation (NFFO) and the 1988 EC Directive on Large Combustion Plants. Although the number of power producers has increased since privatisation, conventional power production is still largely controlled by two companies: PowerGen and National Power. UK power stations owned by National Power and PowerGen have a combined capacity of 36,500 MW: approximately 90% of conventional power production in the UK (40,555 MW) (PowerGen pers. comm.). The remainder is produced by a number of smaller companies. There is currently no power generation on the Sussex coastline produced by conventional, nuclear or renewable processes. In the NFFO Third Renewables Order, 141 projects with a combined output capacity of 630 MW were awarded contracts in England and Wales, although none in this region.

8.3.2 Important locations

Residential development

[Map 8.3.1](#) shows the distribution of urban and suburban development and the location of centres of population (Table



Map 8.3.1 Distribution of residential/urban development, and major towns and cities. Note: area of circle indicates the area of this land cover type in the 10 km square. Source: Countryside Survey, ITE (1990).

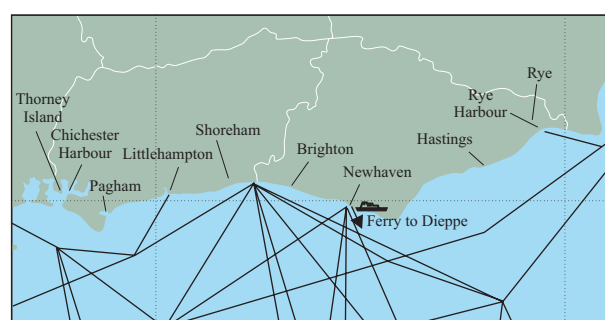
[8.3.1](#)) in the region. Westwards from Brighton, the coast is almost completely built up as far as Littlehampton, a distance of nearly 30 km. Brighton and Hove comprise the largest urban centre in the region. Brighton is a nationally renowned holiday resort; it also hosts an international conference centre and has a large university. Other popular resorts in the region include Eastbourne, Hastings, Worthing and Bognor Regis. Additional housing required by the end of the period 1991-2006 for East Sussex is projected to be 35,300 units (2,333 per year), and a significant number of the new units will be established within the existing urban boundaries designated for development of the coastal towns of Hastings, Eastbourne, Brighton and Hove (East Sussex County Council 1996).

Industrial development

East Sussex has historically had relatively poor strategic road and rail links with the rest of the country, although major trunk road improvements linking the M23 (London - Brighton) with Rye have recently been completed. Much employment is reliant on low-paid service industries, a small and declining manufacturing sector and a relatively small number of high growth industries. Strategic planning policies include the development of business parks at Bexhill, Polegate and Eastbourne. There is practically no heavy industry in the region, with the exception of chemical works at Rye Harbour and Shoreham and metal industries at Shoreham and Littlehampton. Boat-building and repair yards are found at Rye, Rye Harbour, Newhaven, Shoreham and Littlehampton. Chichester Harbour, which is a major centre for water recreation, has significant boat-building and chandlery industries. There is an airport serving the central part of the region at Shoreham ([Map 8.3.2](#)). Hastings stands to benefit from its proximity to the Channel Tunnel and planning policies aim to enhance road access to the town and regenerate its seafront and urban area.

Ports, harbours, docks and jetties

Port and harbour developments have grown up in the estuaries and natural harbours of the region, which traditionally have been important serving cross-channel trade and



Map 8.3.2 Locations mentioned in the text, shipping routes and Traffic Separation Scheme. Sources: Walker (1996), Marine Safety Agency and others. Shipping routes reproduced from the COAST database, held by Dovre Safetec Ltd.

Table 8.3.1 Centres of population in Region 8

<i>Place</i>	<i>Population</i>
East Sussex	
Hastings*	83,700
Bexhill-on-Sea	35,500
Eastbourne*	85,200
Seaford	17,800
Newhaven	9,900
Brighton*	153,800
Hove*	90,000
West Sussex	
Shoreham by Sea	20,800
Worthing*	98,200
Littlehampton	22,200
Bognor Regis	39,500
Selsey, East Wittering and Chichester	103,100

Sources: Cook (1993) figures (derived from the 1981 census); *1993 district figures estimated from 1991 population census (OPCS 1994).

fisheries. Many of the original inland river ports, such as Lewes and Arundel, have long been abandoned as the result of river siltation, and others have lost commercial importance because traffic has transferred to the larger ports and harbours of the Solent and Thames areas. Some fishing fleets are still based in the region (including small vessels launched from beaches), but with a few exceptions most harbours are used primarily as recreational yachting bases (see [section 9.7](#)).

The main commercial ports and harbours in the region are located at Rye, Hastings, Newhaven, Shoreham, Littlehampton and Chichester ([Map 8.3.2](#)). The port of Rye is owned by the Environment Agency and has a multi-functional harbour catering for recreational boating, commercial shipping and fishing vessels. It is locally important as a freight port, especially for importing marine aggregates. Newhaven is owned by Sealink Harbours Ltd. and offers ro-ro (roll-on, roll-off), container and general cargo handling and cross-channel car ferry and passenger facilities to Dieppe. It is particularly important to the local economy for importing marine aggregates.

Expansion and development are planned for the ports at Shoreham and Littlehampton, which are predominantly import-based. Shoreham handles about 2.5 million tonnes p.a. of general cargo, timber and conventional bulk cargoes, and has space for expansion of its commercial activities. It is particularly important for the importing and distribution of marine-dredged and other aggregates for the Sussex construction industry. Littlehampton also has facilities for handling general cargo (300,000 tonnes p.a.). Both ports provide moorings for fishing boats and recreational craft. Development to increase the recreational use of these ports will not be permitted if it inhibits the handling of commercial traffic (West Sussex County Council 1994).

Chichester Harbour is a major location for leisure sailing and boating and has no commercial shipping. A small passenger ferry service operates between Bosham and West Itchenor in Chichester Harbour.

Power generation

There are no power stations sited on the region's coast. The conventional power station at Shoreham in West Sussex ceased production in 1992 (West Sussex Council pers. comm.). Recent proposals to site wind turbines at Shoreham and Selsey Bill were turned down on the grounds that they would cause undue noise disturbance to neighbouring residents.

8.3.3 Information sources used

The Office of National Statistics (formerly the Office of Population Censuses and Surveys) has published 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. Land cover types shown on the maps are 'urban' and 'suburban/rural development'. Information on industrial land use and the ports was obtained

Table 8.3.2 Major areas of coastal industrial development, and locations of ports and harbours

<i>Site name</i>	<i>Grid ref</i>	<i>Details</i>
Rye	TQ9320	Small multi-function port used by about 500 vessels p.a.; 3 berths (2 commercial wharves): 185 m length; 150,000 tonnes p.a.; 4 ha open storage: covered storage: 250,000 sq m; dry bulks, grain/feedstuffs, hazardous cargoes, forest products, general cargo, project cargo (heavy lift), fish, roadstone; shiprepair/graving docks; boat building/repair yards; lay up berths.
Rye Harbour	TQ9220	Chemical works
Newhaven	TQ4400	General cargo/ro-ro handling and continental ferry port; 9 berths, total length: 1,000 m; 1,750,000 tonnes p.a.; open storage: 30,000 sq. m; covered storage: 5,500 sq. m ro-ro, dry bulks, fruit/vegetables, hazardous cargoes, forest products, general cargo, fish. Two boat building/repair yards. Industrial works.
Shoreham	TQ2304	Commercial port (a Trust Port) with 53 wharves and 39 berths (total length: 5,993 m) located in 58 ha of land; 2,000,000 tonnes p.a.; 250,000 sq. m of open storage; 38,000 sq. m covered storage; lo-lo (crane load on and off), dry bulks, grain/feedstuffs, fruit/vegetables, hazardous cargoes, forest products, oil/petroleum and other liquid bulk, general cargo, livestock, fish; boat building/repair yard and metal industry; yacht marina. Regional airport.
Littlehampton	TQ0202	Commercial port and leisure harbour/marina with capacity for up to 600 small craft; boat building/repair yard; two wharves, including an aggregate grading plant; berths total length: 300,000 tonnes p.a.; dry bulks. Metal industry.
Chichester Harbour	SU70/80	10 harbours and around 250 slipways/jetties/pontoons; boat-building and chandlery industry.
Thorney Island	SU7603	RAF training area

Sources: Walker (1996); local authority planning documents; Ordnance Survey 1:50,000 maps.

from Buck (1997), Craig (1996) and Ordnance Survey Landranger 1:50,000 maps. The majority of information on ports and harbours was derived from the Compass UK Ports Directory 1996/97 (Walker 1996).

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 (Waste Regulation Council 1995). Lord Donaldson (1994) records that there is virtually no clear information available on where ships go within UK waters. The Department of Transport, UK Offshore Operators Association and the Health and Safety Executive have addressed this issue by jointly funding a project to produce a ship traffic database (COAST) which provides details of 3,500 shipping routes across the UK continental shelf, giving the number of vessels and their distribution by ship type, age and flag. Shipping routes on Map 8.3.2 are reproduced from the COAST Database, developed and held by Dovre Safetec Ltd.

General information relating to coastal planning and development was obtained from the Transport and Environment Department of the East Sussex Council, and the Planning Department of the West Sussex Council. More detailed information is available from these councils as well as from the appropriate District and Borough Councils, most of whom have published local plans and other relevant documents.

8.3.4 Acknowledgements

The authors wish to thank Compass Publications for permission to use information from their Directory (Walker 1996) and Dovre Safetec Ltd for permission to reproduce information on shipping routes extracted from the COAST Database.

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C. Contact names and addresses

Type of information	Contact address and telephone no.	Type of information	Contact address and telephone no.
Planning developments (Local Planning Authorities)	*Local authorities	Chichester	Chichester Harbour Conservancy, The Harbour Office, Itchinor, Chichester PO20 7AW, tel: 01243 512301
Population statistics	Information Branch, Office of National Statistics (ONS, formerly OPCS), 1 Drummond Gate, London SW1V 2TQ, tel: 0171 233 9233	Power generation	
Ports		Energy production general	Department of Energy, 1 Palace Street, London SW1E 5HE, tel: 0171 238 3000
British Ports Association	Africa House, 64-78 Kingsway, London WC2B 6AH, tel: 0171 242 1200	Energy production general	Secretary, Institute of Energy, 18 Devonshire Street, London W1N 2AU, tel: 0171 580 7124
The UK Major Ports Group Ltd	150 Holborn, London EC1N 2LR, tel: 0171 404 2008	Energy production, East Sussex	Transport and Environment Department, Sackville House, Brookes Close, Lewes BN7 LUE, tel: 01273 481618
Port reception facilities	Marine Safety Agency, Spring Place, 105 Commercial Road, Southampton SO15 1EG, tel: 01703 329100	Energy production, West Sussex	County Planning Department, County Hall, Cower Street, Chichester, West Sussex PO19 1RL, tel: 01243 777100
Rye	Harbour Office, Port and Harbour of Rye, New Lydd Road, Camber, Rye, East Sussex TN31 7QS, tel: 01797 225225	Conventional power production general	Electricity Association, Business Information Centre, 30 Millbank, London SW1P 4RD, tel: 0171 963 5700
Newhaven	Managing body: Newhaven Port & Properties, Beach Road, Newhaven BN9 0BG, tel: 01273 514131	Renewable energy	Secretary, Energy Technology Support Unit (ETSU), Renewable Energy Enquiries Bureau, Harwell, Oxfordshire OX11 0RA, tel: 01235 432450
Shoreham	Shoreham Port Authority, Harbour Office, 84-86 Albion Street, Southwick, Brighton BN42 4ED tel: 01273 592613	Nuclear issues - general	Secretary-General, British Nuclear Forum, 22 Buckingham Gate, London SW1E 6LB, tel: 0171 828 0166
Littlehampton	Littlehampton Harbour Board, Harbour Office, Pier Road, Littlehampton, West Sussex BN17 5LR, tel: 01903 721215	Radioactive monitoring reports	*Centre for Environment, Fisheries & Aquaculture Sciences, Lowestoft Laboratory, tel: 01502 562244

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

8.4 Coastal defence

S.L. Fowler

8.4.1 Introduction

Coastal defence covers two types of works: coast protection and sea (or flood) defences. Coast protection works prevent or slow the erosion of land by the sea. Sea defences protect against the flooding of low-lying land, especially to preserve human life and property in coastal settlements and industrial areas. Many sea defences were built in the past to protect agricultural land from flooding and to enable agricultural improvement and drainage. It is sometimes difficult to differentiate between the two different categories of coastal works, particularly where they protect against both erosion and flooding, or where they are owned and maintained privately or by bodies not usually responsible for coastal defences, such as the Ministry of Defence. For this reason this section describes coastal defence works in general, regardless of the purpose for which they were constructed. **Map 8.4.1** shows the distribution of coast protection works and sea defences in the region.

Coastal defence works in Britain are most widely distributed along urban and industrial coastlines on subsiding or eroding coasts. They are therefore particularly common along the heavily-developed coasts of south-east and north-west England. This region extends along a very heavily defended section of the British coastline that is experiencing rapid sea level rise relative to the land surface. The rate of sea level rise in West Sussex is thought to be 6-13 mm per year (WSCC 1992), although estimates vary widely. With the exception of a few stretches, such as around Beachy Head, the coast is largely sedimentary, consisting mainly of soft sediments that are protected by groynes, which prevent lateral movement of shingle and sand, or hard coastal defences which provide stability and protection for urban stretches of the coast. **Table 8.4.1** shows that 73% of the region's coast is protected against erosion (MAFF 1994).

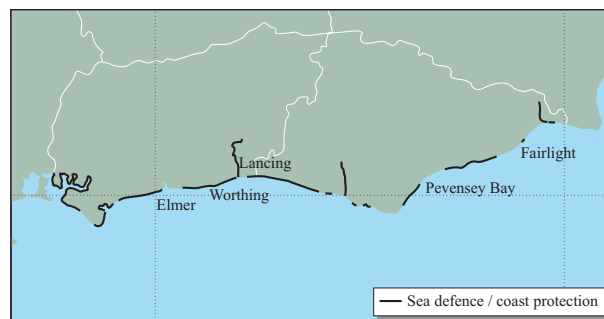
Table 8.4.1 Coast protection in Region 8 and England

Coastline	Total length* (km ⁺)	Undeveloped length (km ⁺)	Coast protection length* (km)	% protected
Region 8	149	40	109	73
England coastline	2,925	2,065	860	29

Source: MAFF 1994 database. Key: *surveyed length, i.e. excluding estuary and harbour shorelines; +to nearest whole km.

Table 8.4.2 shows the condition of coast protection works, as identified in the MAFF survey, and the degree of erosion they are experiencing. This indicates that in Kent, Sussex and Hampshire taken together, although only 2.8% of the coastline is experiencing significant erosion, 50% of the coast protection works are in need of significant or moderate repairs.

Flood defences are particularly common on the British coast (and also in the region) where areas of former intertidal land (including saltmarsh) have been claimed from the sea for agricultural or industrial use, particularly in estuaries. They often take the form of artificial embankments bordering areas of land-claim. Storm surges, particularly when combined



Map 8.4.1 Locations of major sea defence/coast protection works. Sources: MAFF (1994), NRA (1992) and Ordnance Survey maps. © Crown copyright.

with high spring tides and/or heavy rain causing peak river flows, are the major flooding threat to this type of area. Rising sea levels and increasing frequency of storm conditions in the Atlantic and North Sea as a result of climate change are also increasing the future potential for coastal flooding and erosion on the coast and decreasing the expected useful life of coastal works in many regions (Irish Sea Forum 1992).

Table 8.4.3 shows the pattern of ownership of lengths of sea defences in the Environment Agency's Southern Region, which includes Region 8.

8.4.2 Important locations

Table 8.4.4 shows the distribution of coast protection works in the region, by local authority area. West Sussex has an extremely high proportion (93%) of protected coastline.

Some novel coastal defence techniques have been used in places; for example, cliff strengthening at Fairlight Cove, East Sussex, is described in MAFF (1993). A rock bund has been built below the mean high water mark and out from the base of the cliff. Debris is building up between the bund and the cliff, while still enabling natural weathering of the cliff base to take place. The construction of eight major offshore rock breakwaters at Elmer, east of Middleton-on-Sea, is a new departure in coast protection. This area has been threatened by over-topping and flooding problems, which have been tackled through regular beach replenishment. The breakwaters reduce wave action on the shore, which previously removed the beach material. Beach replenishment using marine-dredged shingle is undertaken at other key locations, such as at Lancing and Worthing. The largest sea defence scheme in Sussex is planned for Pevensy Bay, costing some £40 million. It will protect a 9 km stretch of beach between Cooden Bay (Bexhill) and Langney Point (Eastbourne), using new groynes with rock structures at their ends, together with beach recharge techniques.

Table 8.4.2 Condition of coast protection works and state of coastal erosion

Survey area	Total length of coast**	Length of coast defended	Proportion of coast defended	Length of coast suffering significant erosion	Proportion of coast suffering significant erosion	Proportion of defences requiring work	
	(km ⁺)	(km ⁺)	(%)	(km ⁺)	(%)	Significant work (%)	Moderate work (%)
Tunbridge Wells (Thames to Hants. -Dorset border)*	830	389	47	23	2.8	6	44
England	3,763	860	23	134	3.6	6	29

Source: MAFF (1994). Key: *includes Region 8; figures for Region 8 alone were not available; **including estuaries and harbours; ⁺to the nearest whole km.

Table 8.4.3 Ownership of sea (flood) defences in England and Wales

Environment Agency region	Lengths of defended coast (km ⁺) owned by			Total defended coast (km ⁺)
	Environment Agency	Local authority	Privately owned	
Southern*	144	41	11	196
England & Wales	805	242	212	1,259

Source: NRA (1992). Key: *includes Region 8; data for Region 8 alone were not available; ⁺to the nearest whole km.

8.4.3 Management

Departmental responsibility for sea defence and coast protection in England and Wales lies with the Ministry of Agriculture, Fisheries and Food (MAFF). Operational responsibility for coast protection works (to combat erosion) lies generally with District Councils under the Coast Protection Act (1949), although other bodies may maintain

some stretches of coast protection, for example, Railtrack (formerly British Rail) and the Ministry of Defence. Flood or sea defences in England and Wales are the responsibility of the Environment Agency under the Water Resources Act 1991 and the Land Drainage Act 1994, although Internal Drainage Boards and local authorities are also empowered to undertake flood defence works.

SERPLAN (1993) supports the maintenance of coastal defences where they protect existing communities, commercial and industrial assets, port facilities, high grade agricultural land, irreplaceable habitats and coastal aquifers. However, where the cost of maintenance outweighs property values or the environmental costs of flooding or erosion, SERPLAN advises that managed retreat should be considered; it also advises that development should not normally be permitted where new coastal defences would be required. However, options for managed retreat in this region are limited, owing to the highly urbanised nature of the coastal fringe and the high quality of the agricultural land in the low-lying areas of the West Sussex coast.

MAFF set up an English Coastal Groups Forum in 1991 to promote the formation of coastal groups, to further co-operation between parties responsible for coastal defences, to

Table 8.4.4 Coast protection works in local authority districts in Region 8

Council	Total length* of coast (km ⁺)	Length of unprotected coast (km ⁺)	Length of coastal works (km ⁺)	Proportion of coast protected (%)
East Sussex	68	34	34	50
Rother	12	5	7	58
Hastings	10	6	4	40
Eastbourne	13	7	6	46
Wealden	5	5	0	0
Lewes	11	7	4	36
Brighton	13	4	9	69
Hove	4	0	4	100
West Sussex	81	7	75	93
Adur	11	1	10	90
Worthing	8	0	8	100
Arun	20	4	17	85
Chichester	42	2	40	95
Region 8	149	41	109	73
English coast	2,925	2,065	860	29
% of English coast total in region	5.1	2.0	12.7	-

Source: MAFF 1994 database. Key: *surveyed length, i.e. excluding estuary and harbour shorelines; ⁺to the nearest whole km.

identify research needs and to promote strategic planning of coastal defences. The forum meets twice a year and includes representatives of the Environment Agency and the regional coastal groups, which coordinate the work of adjacent coastal defence agencies. Coordination between coastal defence agencies in the Sussex region is undertaken through the South East Coastal Group, the South Downs Coastal Group and the East Solent Coastal Group (see [Chapter 10](#)). A Shoreline Management Plan has been initiated by the South Downs Coastal Group, encompassing the shoreline between Beachy Head and Selsey Bill, and a plan is in place for the area from Dover Harbour to Beachy Head. A Shoreline Management Plan for Selsey Bill to Hamble is currently in preparation (see [section 10.2.5](#)). The Standing Conference on Problems Associated with the Coastline (SCOPAC) also deals with coastal defence issues in the west of the region.

8.4.4 Information sources used

The *Coast protection survey of England* (MAFF 1994) assessed the extent, adequacy and state of repair of coast protection works and noted defence requirements over the next three to five years. The survey also identified lengths of unprotected coast that were significantly eroding and where works might be necessary during the next ten years. These detailed data are held on a GIS database by the contractors (Sir William Halcrow & Partners) and MAFF. The information in [Tables 8.4.1, 8.4.2 and 8.4.4](#) was extracted from this database with permission from MAFF; it may have become out of date since the survey was conducted. In these tables it is important to distinguish between whole-coast length and figures that refer only to coastal lengths covered in the survey.

The Environment Agency holds details of sea defence works in England and Wales obtained during the NRA Sea Defence Survey in 1991 (NRA 1992). The results are held on a proprietary database cross-referenced to maps, which may be viewed at regional Environment Agency offices by prior arrangement. No detailed information from the database was available for this review, so [Table 8.4.3](#) is from the published survey and is general in scope. However, the database is an accurate and detailed source of information, although now due for updating.

8.4.5 Acknowledgements

Thanks are due to MAFF and Sir William Halcrow & Partners for the provision of information from the Coast Protection Survey of England and Wales.

8.4.6 Further sources of information

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C. Contact names and addresses

Type of information	Contact address and telephone no.	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.	*Ministry of Agriculture, Fisheries and Food (MAFF), Flood and Coastal Defence Division, London, tel: 0171 238 6000	Co-ordination and liaison between agencies undertaking coastal works - Sussex	South East Coastal Group, The Chief Engineer, Swale Borough Council, Swale House, East Street, Sittingbourne, Kent ME10 3HT, tel: 01795 417338 *South Downs Coastal Group, The Chief Engineer, Arun District Council, tel: 01903 716133 *East Solent Coastal Group, The Chief Engineer, Chichester District Council, tel: 01243 785166 The Secretary, SCOPAC, c/o Isle of Wight Council, Newport, Isle of Wight PO30 1UD, tel: 01983 821000
Coast protection and prevention of the flooding of non-agricultural land - England and Wales	*District Councils	National Landslide Databank	Rendel Geotechnics, Norfolk House, Smallbrook Queensway, Birmingham B5 4LJ, tel: 0121 627 1777
Storm Tide Warning Service	Meteorological Office, Johnstone House, London Road, Bracknell, Berkshire RG12 2SZ, tel: 01344 420242	Coastal Engineering Advisory Panel	Institution of Civil Engineers, 1 Great George Street, London SW1P 3AA, tel: 0171 222 7722
Flood defence - general	*Environment Agency HQ, Flood Defence Section, Bristol, tel: 01454 624400	Coastal Engineering Research Advisory Committee	International Council for the Exploration of the Sea, Palægade 2-4, DK-1261, Copenhagen K, Denmark, tel: 00 45 33 15 42 25
Flood defence - East and West Sussex	*Environment Agency Southern Region, Worthing, tel: 01903 832000		
Co-operation between parties responsible for coastal defences, identification of research needs and promotion of strategic planning of coastal defences - England	*English Coastal Groups Forum, MAFF Flood and Coastal Defence Division, London, tel: 0171 238 3000		

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



Coast protection and sea defence are a major preoccupation in this part of Britain, where sea level is rising rapidly and storms are increasingly frequent and severe. 73% of the region's coast is protected against erosion. At Elmer, near Bognor, two rock berms on the low-water line absorb wave energy and create calm water in their lee, protecting the sea wall and houses behind from the threat of over-topping, and in the foreground a rocky revetment performs the same function. Photo: Peter Wakely, English Nature.

Chapter 9 Human activities

9.1 Fisheries

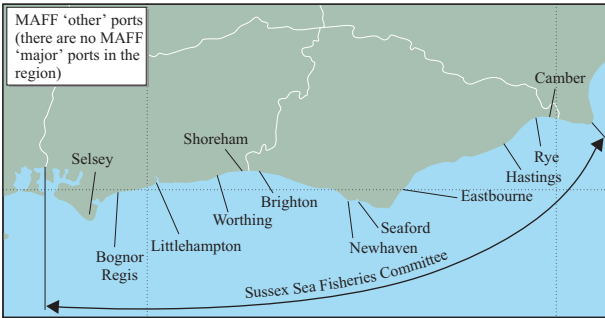
C.F. Robson

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 and demersal fish (demersal fish live on or near the sea bed; pelagic fish tend to be found in midwater) and several marine shellfish species and diadromous species - in this section 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](#).

There are no MAFF-defined 'major' fishing ports in the region. The main fishing ports or landing areas in the region are at Rye, Hastings, Eastbourne, Newhaven, Brighton, Shoreham and Worthing; fish and shellfish landings are also recorded by the Ministry of Agriculture, Fisheries and Food (MAFF) at a scatter of smaller places throughout the region, for example Selsey ([Map 9.1.1](#)). A total of 426 fishing boats are registered in the region. The fleet of fishing boats based at Hastings, most of them 6-8 m long and known locally as 'punts', is the largest beach-launched fleet in Europe. Part-time fishing boats fish along the rocky coastline of Birling Gap and Seaford; a couple of boats are lifted up a cliff at Birling Gap. A large fleet of full-time vessels are moored on jetties along the narrow Ouse Estuary at Newhaven. In Brighton fishing boats are either moored in marinas specifically designed for pleasure craft or are hauled up the beach. Beach boats work along the stretch of coast around Worthing; the majority are small and owned by part-time fishermen and anglers. There is one fish market in the region, at Hastings.

In 1992, 0.8% of all recorded landings of fish and shellfish species in Britain and the Isle of Man were made in this region ([Table 9.1.1](#)), which is well below the average of all regions of 5.9%. The total tonnages of pelagic, demersal and shellfish species landed in the region in 1992 represent 0.1%, 1.3% and



Map 9.1.1 MAFF-defined fisheries landing ports.

1% respectively of the British and Isle of Man totals. The total tonnage of demersal species is the highest for all species groups in the region and, although only 1.3% of the British and Isle of Man total, represents 4.4% of the England and Wales total. The tonnage of plaice (the species landed in the greatest quantities) landed in the region represents 4.7% of the British and Isle of Man total and there are also significant landings of Dover sole (14.2%) and flounder (24.2%). The landings of pelagic species in the region are low. Of these species, horse mackerel is landed in the greatest quantities, amounting to 9.2% of the total landed in Britain and the Isle of Man.

The majority of all fish landed in the region in 1992 were landed to the port of Shoreham. [Table 9.1.2](#) summarises landings to this port in the four years from 1991 to 1994, showing trends in landings in relation to 1992, the year on which the more detailed landings data analysis in [Table 9.1.1](#) was based.

Sea trout support a licensed rod-and-line fishery in the region, with the main river of interest being the Ouse. There are no nets licensed to fish sea trout in the region; however, the eel fishery is very important.

Table 9.1.1 Species group landings in 1992 (tonnes)

Species group	Region 8	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	341	184,309	23,809	252,335	0.2	0.1
Demersal	3,535	228,056	81,237	275,460	1.6	1.3
Shellfish	1,059	61,933	55,360	104,917	1.7	1.0
All groups	4,935	474,298	160,406	632,712	1.0	0.8

Sources: Ministry of Agriculture, Fisheries & Food (1994); Scottish Office Agriculture & Fisheries Department (1993); Isle of Man Department of Agriculture, Fisheries & Forestry (pers. comm.). Notes: 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 Landings* of all fish species to Shoreham 1991 - 1994 (thousands of tonnes)

	1991	1992	1993	1994
Shoreham	0.5	0.9	0.9	1.4
England & Wales	169.0	160.6	165.5	178.7
% of England & Wales total landed in Shoreham	0.3	0.6	0.5	0.8

Sources: Ministry of Agriculture, Fisheries & Food (1995b). Key: *landings totals relate to 'nominal live weight', i.e. weight of the whole fish.

9.1.2 The fisheries

Pelagic species

Table 9.1.3 gives the quantities of various pelagic species landed in 1992 in the region, compared with landings nationally. The herring fishery usually starts from around October and the sprat fishery from January. The herring and sprat fisheries generate little effort in the region, owing to low national demand, though drift netmen target herring from autumn to satisfy local demand. A few beach boats in the region use drift nets to catch herring and sprat. Trawlers, which sometimes operate in pairs, periodically target herring and sprat when other fisheries are unprofitable. Shoals of sprat found off Beachy Head and Shoreham are fished by trawlers from Newhaven, Brighton and Shoreham; landings are sometimes sold to be turned into fish meal. In addition to herring and sprats other pelagic species such as mackerel and horse mackerel may be caught.

Demersal species

Table 9.1.4 gives the quantities of various demersal species landed in 1992 in the region, compared with landings nationally.

The majority of the boats in the fishing fleet based within the region work trammel and gill nets for most of the year, targeting a range of flatfish. Dover sole, plaice and rays are caught in the greatest quantities using this method from spring through to late autumn, before they migrate to deeper waters to over-winter. Smaller amounts of turbot, brill, monkfish (angler), dab and dogfish are also caught. During winter, gill and trammel nets are set by several boats targeting cod and whiting. The larger boats fish out to the middle of the English Channel, e.g. Bullock Banks, close to the shipping

lanes. Large mesh tangle nets are set for turbot, rays, monkfish and brill during the summer. Nets are set over wrecks for a variety of species, including pollack, bass and ling.

Some of the fishing fleet rely on trawling; these trawlers fish up to 20 miles offshore and catch a mixture of demersal species. By summer, the smaller boats trawl for flatfish inshore, often at night, landing Dover sole, plaice, brill and dab. The Dover sole fishery attracts visiting beam trawlers, which land valuable quantities of plaice, turbot, brill, rays and lemon sole. During the colder months, the otter trawlers concentrate their efforts on demersal trawling for cod and whiting, plus valuable bycatches of plaice and lemon sole. Since the mid-1980s there has been an increase in the quantity of gurnards caught beyond 6 miles offshore; the smaller fish are usually sold as pot bait and the larger fish are sold for human consumption.

Bass are caught by a variety of methods, including drift nets, monofilament gill nets, trammel nets, longlines, handlines, otter trawls and pair trawling. Gill nets are also set around wrecks for bass from spring until autumn, and handlines are also used. An offshore bass fishery has been developed in recent years, which has attracted visiting pair trawler teams. Grey mullet are often taken as a bycatch to bass. Otter trawlers target shoals of black bream and mullet, which appear off this coast during the summer. The popularity of the bass handline fishery has resulted in the development in Chichester Harbour of a small sandeel fishery for bait. This fishery involves the use of light otter trawls or beach seines.

Shellfish species

Table 9.1.5 gives the quantities of various shellfish species landed in 1992 in the region, compared with landings nationally.

Table 9.1.3 Pelagic species landings for 1992 (tonnes)

Species group	Region 8	North Sea Coast	England & Wales	Britain and Isle of Man	% of North Sea Coast total landed in region	% of British and Isle of Man total landed in region
Herring	77	74,706	915	85,650	0.1	<0.1
Horse mackerel	138	1,374	1,026	1,499	10.0	9.2
Mackerel	94	95,366	9,142	150,726	0.1	<0.1
Pilchard	0	4,244	4,244	4,244	0	0
Sprat	32	8,478	8,478	10,032	0.4	0.3
Whitebait	P	1	1	1	-	-
Others	P	140	3	183	-	-
Total	341	184,309	23,809	252,335	0.2	0.1

Sources: Ministry of Agriculture, Fisheries & Food (1994), Scottish Office Agriculture & Fisheries Department (1993), Isle of Man Department of Agriculture, Fisheries & 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 9.1.4 Demersal species landings in 1992 (tonnes)

<i>Species group</i>	<i>Region 8</i>	<i>North Sea Coast</i>	<i>England & Wales</i>	<i>Britain and Isle of Man</i>	<i>% of North Sea Coast total landed in region</i>	<i>% of British and Isle of Man total landed in region</i>
Elasmobranchs						
Dogfish	113	7,449	3,625	13,348	1.5	0.8
Skates and rays	91	3,816	4,142	7,827	2.4	1.2
Gadoids						
Cod	373	53,440	23,530	59,524	0.7	0.6
Haddock	P	49,221	3,706	53,586	-	-
Hake	P	589	1,621	3,620	-	-
Ling	2	4,594	1,708	6,027	<0.1	<0.1
Pollack (lythe)	180	1,921	1,734	3,023	9.4	6.0
Saithe	P	11,032	2,284	12,602	-	-
Whiting	383	36,733	5,088	41,055	1.0	0.9
Whiting, blue	0	6,531	P	6,531	0	0
Flatfish						
Brill	31	317	392	443	9.8	7.0
Dab	90	1,017	456	1,215	8.8	7.4
Dover sole	407	2,021	2,812	2,876	20.1	14.2
Flounder	66	167	269	273	39.5	24.2
Halibut	0	166	80	194	0	0
Halibut, Greenland	0	119	117	137	0	0
Lemon sole	91	5,004	3,000	5,573	1.8	1.6
Megrim	P	1,379	1,471	4,037	-	-
Plaice	1,186	20,749	15,970	23,887	5.7	4.7
Turbot	24	561	545	742	4.3	3.2
Other species						
Catfish	0	1,896	557	1,935	0	0
Conger eel	9	99	403	510	9.1	1.8
Gurnard	24	368	589	627	6.5	3.8
Monkfish/angler	54	9,813	3,102	14,678	0.6	0.4
Redfish	P	718	581	774	-	-
Sand eels	0	4,152	P	4,152	0	0
Torsk (tusk)	0	165	13	207	0	0
Witch	P	1,405	192	1,981	-	-
Others	408	2,419	3,151	3,833	16.9	10.6
Fish roes	3	195	99	243	1.5	1.2
Total	3,535	228,056	81,237	275,460	1.6	1.3

Sources: Ministry of Agriculture, Fisheries and Food (1994), Scottish Office Agriculture and Fisheries Department (1993), Isle of Man Department of Agriculture, Fisheries & 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](#).

The most important potting activity for shellfish species such as lobster, edible crab, spider crab and velvet crabs occurs off the Selsey and Eastbourne coast. Virtually all of the boats in the local fleet set pots for lobster and edible crab all year round out to 8 miles offshore. Lobsters are the mainstay shellfish species and provide the greatest revenue for fishermen in the region. Lobsters are caught almost all year round and a proportion of the landings are sold direct to local restaurants and hotels. The shellfish fishery attracts maximum effort during the summer, when part-time and recreational fishermen join the full-time boats. The inshore reefs off Selsey provide the most prolific lobster fishery in the region. The lobster fishery first peaks in June and July when female lobsters predominate in catches. Following a quiet period, usually in August, the fishery picks up again in September, when male lobsters are most common. A few of the larger boats, some having vivier holding tanks, venture out to grounds some 25 miles offshore to catch edible crab. The rocky reefs found off the coast around Eastbourne make

its port the second most important crab and lobster port in the region. Edible crab are targeted from spring virtually through to the end of the year, with a break during the moulting period in the summer. Fixed nets, set for fish species, also entangle crustacea, and during the summer landings of edible and spider crab and lobster can account for a significant proportion of the total catch. Velvet and green crabs, once considered a nuisance, are now important bycatch species, especially during colder months. Living crabs, transported using vivier holding tanks on board the boats, are bought by the French and Spanish markets. Boats from Eastbourne and Hastings are developing a tangle net fishery for spider crabs.

Several boats from Rye dredge for scallops, some working grounds off Dungeness Point and Newhaven between autumn through to spring. Large beam trawlers from Shoreham and Portsmouth dredge for scallops from January to May.

Fishermen based in Chichester Harbour dredge for native oysters in the harbour and surrounding areas, such as the

Table 9.1.5 Shellfish* landings in 1992 (tonnes)

Species group	Region 8	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	0	26,199	29,501	32,047	0	0
Crabs	403	9,117	9,453	16,970	4.4	2.4
Lobsters	69	622	504	1,069	11.1	6.5
Mussels	0	4,865	3,488	6,555	0	0
<i>Nephrops</i>	0	8,368	1,918	19,639	0	0
Periwinkles	20	315	70	1,907	6.3	1.0
Queen scallops	0	2,207	2,989	11,273	0	0
Scallops	22	4,519	2,589	8,290	0.5	0.3
Shrimps	0	615	563	743	0	0
Squids	23	1,382	919	2,005	1.7	1.1
Whelks	165	1,905	1,535	2,393	8.7	6.9
Others	357	1,819	1,831	2,026	19.6	17.6
Total*	1,059	61,933	55,360	104,917	1.7	1.0

Sources: Ministry of Agriculture, Fisheries & Food (1994), Scottish Office Agriculture & Fisheries Department (1993), Isle of Man Department of Agriculture, Fisheries & Forestry (pers. comm.). Key: *excluding landings of farmed shellfish - see [section 9.2](#). 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](#).

Emsworth Channel (covered by a Several Order - see [section 9.2.3](#)) and The Solent (in Region 9). The oyster fishery is open from 1 November to 30 April (between 0730 - 1530 Monday to Friday), although in practice dredging ceases after a few weeks when all marketable-sized native oysters have been taken. Native oysters that can be passed through a circular ring with an internal diameter of 70 mm have to be put back into the sea. The area is naturally replenished, relying on the successful spawning of the wild native oysters, although 'cultch' (crushed oyster shells) is put down as substrate for the 'spatfall'.

The whelk fishery has recently (1995/6) expanded, as it has done in many other regions. Whelks are trapped using pots often made out of plastic drums. Periwinkles are gathered by hand in the west of the region. Trawlers and, to a lesser extent, fixed, drift net and creel fishermen land cuttlefish and squid, which have become more important in summer as traditionally targeted demersal fish have become either scarce or subject to quota restrictions (see [section 9.1.3](#)). The landing figures for cuttlefish are included in the 'Others' category in [Table 9.1.5](#).

Diadromous species

The distribution of sea trout in rivers in the region is discussed in [section 5.9](#). Sea trout support a licensed rod-and-line fishery in the region, based mainly on the River Ouse. The numbers reported are not high enough to be published for individual rivers, although the total reported rod catches for sea trout for the Environment Agency Southern Region are given in National Rivers Authority (1991, 1992, 1993, 1994a, b). There are no net licences issued for fishing salmon or sea trout in the region. However the eel fishery, which uses fyke nets, is very important in the region. The nets are often set in a series across a river.

Sea angling

Sea angling is a popular sport practised by over two million people in Great Britain (Fowler 1992). Sea angling is distinguished from two other types of sport fishing: game

fishing for salmon, sea trout, brown and rainbow trout (sea trout fishing is covered here; salmon are not present in the region) 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. Boats based in places such as Hastings, Newhaven, Brighton, Shoreham and Littlehampton are chartered for angling trips, especially in the summer. Newhaven is also a centre for deep-sea fishing. There are many places in the region where beach boats are launched by leisure anglers. For example, the Bulverhythe/Bexhill/Pevensy coast is popular with sea anglers, and approximately two hundred small beach boats are launched from here. Littlehampton is noted for black bream, which are taken in large numbers during May and early June. There is also good sea fishing for bass, mackerel, whiting and wrasse at several locations off Bognor Regis, where black bream are also plentiful from May to July. Sea angling is carried out from piers at Hastings, Eastbourne and Worthing. Sea angling from the shore - mostly from beaches - occurs at St. Leonards, Bexhill, Eastbourne, Seaford, Shoreham, Worthing and Littlehampton. Beachy Head provides some of the best beach fishing for bass. Orton (1996) also lists further sea fishing stations, the facilities available and potential catch species.

Bait collection

Bait collection for sea angling occurs in many areas in the region: the more prolific areas may attract commercial collectors. Anglers often collect their own bait locally, while commercial collectors travel in teams to suitable shores (Fowler 1992). Ragworm, lugworm, peeler crabs (moulting shore crabs), mussels, cockles, limpets and razor shells (see [section 5.5](#)) are collected. 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 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 in areas such as Camber Sands at Rye, Rye Harbour, Hastings,

Bexhill, Pevensey Bay, the coast between Brighton and Worthing and Pagham Harbour. These areas experience varying levels of bait collecting activity, and some problems have been encountered at Sites of Special Scientific Interest such as Adur Levels at Shoreham and Chichester Harbour (see also [section 5.5](#)).

9.1.3 Management and issues

Responsibility for the management of fisheries in coastal waters rests with the Commission for the European Union (EU), who delegate it to member states under the Common Fisheries Policy (CFP). European Council regulations are implemented through UK law (see Gray (1995) for a brief description), usually by means of statutory instruments, which define limits and restrictions and set down powers of enforcement and penalties. All national regulation measures, including local sea fisheries bylaws, must conform with requirements of the CFP, not the least being that they are non-discriminatory.

The CFP seeks to manage stocks of fish in EU waters on a biological basis, principally 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. The CFP is described in Coffey (1995), which sets out the basic elements of the policy and contributes to the debate on fisheries and the environment. A central principle of the policy is the rule of 'equal access' - that all member states of the EU have equal access to all community waters and all fishing resources. However, this rule is subject to the principle of 'relative stability', which takes account of established practice, and consequently a number of exceptions have been adopted, based on various precedents and historic fishing patterns. There is no access for vessels from other member states inside the 6 nautical mile fishery limit. Between 6 and 12 nautical miles from baselines (low water mark) (the limit of the British Territorial Seas), fishing is limited to UK registered vessels and to ones from members states with historic fishing rights. Beyond 12 nautical miles, access by vessels from other member states is limited to those that have been allocated quotas, based on historic fishing rights, and by vessels from non-member countries by reciprocal agreements within the European Union.

For the purpose of stock assessment, northern European waters have been designated by the International Council for the Exploration of the Sea (ICES) into statistical areas. The UK coastal seas around this region are part of Division VIIId (English Channel, East). 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 for Fisheries Management, which is responsible for providing scientific advice on TACs and other conservation measures to the international fisheries commissions, including the EU. The TAC is a fishery management tool which may, amongst other management needs, take account of the maximum level of exploitation that a given stock can sustain. Precautionary TACs are applied to important stocks where there are not enough scientific data to make an analytical assessment. Once the TACs are set for each stock they are divided between member states in the

form of catch quotas. European Council Regulation No. 3074/95 (European Council 1995) fixed, for 1996, national catch quotas for fish and shellfish species for all European countries and certain conditions under which the species could be fished. The annual TACs, UK quotas and 'uptake' for each species in the ICES statistical division in the region are given in Ministry of Agriculture, Fisheries & Food (1994, 1995a, 1995b, 1996b). European Council Regulation No. 3760/92 (European Council 1992) summarises the CFP, including the proportions by which TACs are allocated as national quotas. Minimum landing sizes and whether an annual quota applies in the region for the important pelagic and demersal species are listed in [Table 5.7.1](#).

In this region the Sussex Sea Fisheries Committee (SSFC) manages the inshore fisheries from the high water mark out to 6 nautical miles from UK baselines (as defined by the Territorial Water Order in Council 1964, as amended). Local MAFF Fisheries Inspectorate Officers deal with quota management, enforcement of UK and EC fisheries legislation and licensing of fishing vessels. Fisheries managers have been given environmental responsibilities under the Environment Act 1995 and the Conservation (Natural Habitats etc.) Regulations 1994.

In this region the Environment Agency's Southern Region has 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 SSFC also has powers to support the conservation of salmonid fisheries whilst exercising its responsibilities towards the regulation of sea fisheries. Rod licences issued by the Environment Agency are subject to seasonal closures.

In England and Wales MAFF's Sea Fisheries Inspectorate is responsible for collecting information on principal fish stocks exploited by UK vessels, and the Centre for Environment, Fisheries and Aquaculture Sciences (CEFAS) Laboratory at Lowestoft is responsible for its collation. The CEFAS Fisheries Laboratory at Conwy assesses the implications of non-fisheries activities and coastal zone usage for fish stocks and fisheries. CEFAS fisheries databases are described in Flatman (1993).

Regulating Orders are granted in England by MAFF to a co-operative or responsible body to enable it to regulate the fishery for particular wild stocks of molluscan shellfish species. The specified shellfish stock may only be exploited in accordance with the terms of the Order and any regulations made under it. There are no Regulating Orders in the region.

The governing body of sea angling in England is the National Federation of Sea Anglers, which has approximately 570 affiliated clubs with some 33,000 individual members.

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 of fisheries on target species as major components in marine ecosystems, the changed availability of food for predators, the effects on non-target species, and effects on species and habitats of nature conservation interest. Further information on issues concerning fisheries can be found in references such as Commission of the European Communities (1995), and concerning the species targeted in references given in [sections 5.5, 5.7 and 5.8](#).

9.1.4 Information sources used

The coastal fisheries of England and Wales (Gray 1995) has been used in compiling this section. It describes the different types of fishing gear used inshore to catch specific species. Its 'Regional' section 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. Shellfish News (Ministry of Agriculture, Fisheries & Food 1996a) includes information on shellfish harvesting (and figures on total shellfish landings in the UK in 1994) and is published twice yearly. Brady (1995) lists details of all fishing vessels, their base ports and main fishing methods. The key GB statutes relating to fisheries are described in Eno & Hiscock (1995). Figures given in Tables 9.1.1 - 9.1.5 come from various sources: MAFF, National Rivers Authority (now the Environment Agency), the Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD) and the Isle of Man Department of Agriculture Fisheries & Forestry (IoM DAFF); their interpretation is described below.

Pelagic, demersal and shellfish species

Statistics given here are for landings recorded in the region, as distinct from fish catches made. 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 data presented give an indication of the economic importance of the species that were landed in the region in 1992 (used as a reference year), compared with the rest of Britain and the Isle of Man. Data for 1993, 1994 and 1995 for England and Wales have also been published in Ministry of Agriculture, Fisheries & Food (1995a, 1995b, 1996b).

The tonnages of various pelagic, demersal and shellfish species (fresh and frozen) landed by UK vessels at the major ports in England and Wales, from UK sea fisheries statistics for 1991 and 1992 (Ministry of Agriculture, Fisheries & Food 1994) and a total for the other, smaller, ports (including all the ports landing fish in the region), provided by the MAFF Fisheries Statistics Unit, have been combined to give the figures in the 'Region 8' column for Tables 9.1.1 and 9.1.3 - 9.1.5.

The figures in the 'North Sea Coast' column in Tables 9.1.1 and 9.1.3 - 9.1.5 were calculated by adding together all the landings data for the ten regions on the North Sea Coast of Great Britain, as defined in section 1.1.

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 and Isle of Man' column were obtained by combining MAFF, SOAEFD and IoM DAFF 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, SOAEFD publish the weight of fish as 'standard landed weight' (gutted fish with head on), whereas MAFF and IoM DAFF publish them as 'nominal live weight' (whole fish). These two are the same for pelagic and shellfish species, but converted data from SOAEFD were used for all demersal species, apart from sand eels (which are not gutted), so that all the data presented are as 'nominal live weight'.

Sea angling

In the 85th edition of *Where to fish*, Orton (1996) 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.	Type of information	Contact address and telephone no.
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	UKDMAP software; mapped fishing areas of selected species, ICES Statistical Division boundaries etc.	*Project Manager, BODC, Birkenhead, tel: 0151 653 8633
Central contact for 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	National representation of fishermen's and boat owners' interests in the fishing industry	Honorary Secretary, National Federation of Fishermen's Organisations, Marsden Road, Fish Docks, Grimsby DN31 3SG, tel: 01472 352141
Local inshore fisheries information and advice on bylaws, national and EC legislation	Clerk and Chief Fishery Officer, Sussex Sea Fisheries Committee, 106 Station Road, Hailsham, East Sussex BN27 2EG, tel: 01323 841912	Shellfish production (commercial)	Director, Shellfish Association of the UK, Fishmongers' Hall, London Bridge, London EC4R 9EL, tel: 0171 626 3531
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. Interaction between fisheries and non-fisheries conservation issues.	*Head of Laboratory, Centre for Environment, Fisheries & Aquaculture Sciences, Conwy, tel: 01492 593883	Affiliated angling clubs	Secretary, National Federation of Sea Anglers, 51a Queens Street, Newton Abbot, Devon TQ12 2QJ, tel: 01626 331330
Assessment and advice on the conservation of fish stocks exploited by UK vessels	*Director, Centre for Environment, Fisheries & Aquaculture Sciences, Lowestoft Laboratory, tel: 01502 562244	Game fishing	Director, Salmon and Trout Association, Fishmongers' Hall, London Bridge, London EC4R 9EL, tel: 0171 2835838
Shellfish hygiene and fish diseases	Director, Centre for Environment, Fisheries & Aquaculture Sciences, Fish Diseases Laboratory, Barrack Road, The Nothe, Weymouth, Dorset DT4 8UB, tel: 01305 206600	Interaction between fisheries and non-fisheries conservation issues in England	*Fisheries Liaison Officer, English Nature HQ, Peterborough, tel: 01733 455000
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	Marine Fisheries Task Group paper; interaction between fisheries and non-fisheries conservation issues	*Fisheries Officer, JNCC Peterborough, tel: 01733 562626
Local fisheries, quota management, licensing of fishing vessels and enforcement, UK and EC legislation for the region	District Inspector, MAFF Sea Fisheries Inspectorate, Breeds Place, Hastings, East Sussex TN34 3AA, tel: 01424 424109	Interaction between fisheries and non-fisheries conservation issues	*Marine Policy Officer, RSPB HQ, Sandy, tel: 01767 680551
National fisheries policy and projects; salmonid and freshwater statistics for England and Wales	*Fisheries Department, Environment Agency Head Office, Bristol, tel: 01454 624400	Interaction between fisheries and non-fisheries conservation issues	*Fisheries Officer, WWF-UK, Godalming, tel: 01483 426444
Regional information and advice on the sea trout and eel fisheries and statistics	*Regional Fisheries Manager, EA Southern Region, Worthing, tel: 01903 832000	Information and advice on marine conservation issues - Sussex	*Conservation Officer, Marine Conservation Society, Ross-on-Wye, tel: 01989 566017
Research and development, marketing and training for the fishing industry	Technical Director, Sea Fish Industry Authority, Seafish Technology Division, Sea Fish House, St Andrew's Dock, Hull HU3 4QE, tel: 01482 327837	Seals and fisheries	*Conservation Officer, Sussex Wildlife Trust, Henfield, tel: 01273 492630
		Seals and fisheries	Sea Mammal Research Unit (SMRU), University of St. Andrew's, School of Biochemical and Medical Sciences, St. Andrew's, Fife KY16 8LB, tel: 01334 463472
		Seals and fisheries	Susan Joy, Co-ordinator, Wildlife & Countryside Link Seals Group, 105 Halsford Park Road, East Grinstead, West Sussex RH19 1PR, tel: 01342 315440

*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. There is currently no mariculture occurring in the region. However there are plans to cultivate mussels in the Emsworth Channel area.

9.2.2 Locations and species

Table 9.2.1 lists the main species that are under commercial cultivation in Great Britain and the Isle of Man. Currently none of these species is cultivated in the region.

Although there is currently no mariculture occurring in the region there are plans to cultivate mussels in the Emsworth Channel area, covered by the Emsworth Channel Fishery Order ([section 9.2.3](#)) (Sussex Sea Fisheries Committee pers. comm.). Cultivation involves placing the juvenile mussels directly on the sea bed on sub-tidal ground lays ('relaying'), where they are left to grow to marketable size, before being dredging for sale. Shellfish News (e.g. Ministry of Agriculture, Fisheries & Food 1996) includes information on shellfish cultivation (and figures on the total shellfish production in the UK in 1994) and is published twice yearly.

Table 9.2.1 Main species cultivated in the region and in Great Britain and the Isle of Man

Species	Species status
Salmonids	
Atlantic salmon <i>Salmo salar</i>	Native
Sea trout <i>Salmo trutta</i>	Native
Non-salmonids	
Turbot <i>Psetta maxima</i>	Native
Halibut <i>Hippoglossus hippoglossus</i>	Native
Shellfish: bivalve molluscs	
Common mussel <i>Mytilus edulis</i>	Native
Native oyster <i>Ostrea edulis</i>	Native
Pacific oyster <i>Crassostrea gigas</i>	Un-established introduction
Hard-shelled clam	Non-native
<i>Mercenaria mercenaria</i>	
Manila clam <i>Tapes philippinarum</i>	Un-established introduction
Palourde <i>Tapes decussatus</i>	Native
Scallop <i>Pecten maximus</i>	Native
Queen scallop <i>Aequipecten opercularis</i>	Native
Polychaetes	
King ragworm <i>Neanthes virens</i>	Native

Sources: Ministry of Agriculture, Fisheries & Food, The Crown Estate, La Tène Maps (1995). 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.

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. 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. Shellfish must also meet the 'End Product Standard', with which all live bivalves intended for immediate consumption must comply. A database of the current hygiene status of shellfish harvesting areas is maintained by MAFF (Fisheries Division, Nobel House, and CEFAS Fish Diseases Laboratory, Weymouth).

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 requirements for the control of shellfish disease in Great Britain and for the importation and 'deposit' of molluscan shellfish and lobsters, under the EC Fish Health Directive (Directive 91/67). The Directive lists diseases on which national authorities will take action and those animals that are susceptible to notifiable diseases. The lists may be amended with changing circumstances. In Great Britain two shellfish diseases are now notifiable: *Bonamia* and *Marteilia*, both of which are of serious economic importance and are present in one or more EU member states. The agents of the diseases, *Bonamia ostreae* and *Marteilia refringens*, are parasites that cause high mortalities in susceptible species, notably the native oyster. Movements of species susceptible to these diseases can be made only from areas of equal or better health status, and imports of Pacific oysters are subject to screening for species contamination. Importation from non-EU countries is permitted only under licence, and imports must enter through designated border inspection posts. 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.

The Crown Estate owns 55% of the foreshore and the same proportion of the beds of tidal rivers between mean high and low water in Great Britain, together with virtually the entire territorial sea bed. Of the remainder of the foreshore in this region the majority is owned by private landowners, local authorities and port authorities. The consent of the owners of the sea bed (or their lessees or licencees) is required and a lease may be needed before structures for mariculture can be erected on the sea bed. 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 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.

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 cultivation on the sea bed within a designated area of water and to conserve and develop named molluscan species of shellfish. Sea Fisheries Committees may sub-let the rights of a several fishery, subject to the consent of MAFF. The specified shellfish stock may only be exploited in accordance with the terms of the Order and any regulations made under it. There is one Several Order in the region (Table 9.2.2), out of 22 in Britain covering a total of approximately 3,299 ha (as at July 1995). The existence of a Several Order does not necessarily mean that mariculture is actively occurring at the location covered; for example, no mariculture is currently practised in the area of the Emsworth Channel Fishery Order.

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 Group', 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 paper prepared by the group, entitled *Developing an action programme for sea fisheries and wildlife* (Marine Fisheries Task Group 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 (North Wales & North Western Sea Fisheries Committee (SFC)), Phil Coates (South Wales SFC), Brian Spencer (CEFAS Conwy), Neil Downes (Devon SFC), Dr P.D. McGovern (The Crown Estate, Scotland), Paul Knapman (English Nature), Blaise Bullimore (Countryside Council for Wales), Indrani Lutchman (WWF-UK), Clare Eno and Mark Tasker (JNCC) and Nancy Harrison (RSPB).

Thanks also go to A.J. Morrison (Crown Estate) and Paul Knapman and staff from Sussex and Surrey Local Team (English Nature) for providing information, and to them and S.A. Holman (Sussex Sea Fisheries Committee) for commenting on drafts.

9.2.5 Further sources of information

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Wildlife & Countryside Link Seals Group. 1995. *Seals and fisheries: the facts*. East Grinstead, Wildlife & Countryside Link Seals Group.

Table 9.2.2 Several Orders in the region

Title	Species covered	Location	Grid ref.	Grantee	Approx. area (ha)	Year of expiry
Emsworth Channel Fishery Order 1975	Oysters, mussels, clams	Emsworth Channel	SZ744020	Emsworth Fishermen's Federation Ltd.	49	2005

Source: Ministry of Agriculture, Fisheries & Food (1995).

C. Contact names and addresses

<i>Type of information</i>	<i>Contact address and telephone no.</i>	<i>Type of information</i>	<i>Contact address and telephone no.</i>
Central contact for the local Sea Fisheries Committees; general Sea Fisheries Committees policies	Chief Executive, Association of Sea Fisheries Committees, Buckrose House, Commercial Street, Norton, Malton, North Yorkshire YO17 9HX, tel: 01653 698219	Commercial advice on shellfish	Director, Shellfish Association of the UK, Fishmongers Hall, London Bridge, London EC4R 9EL, tel: 0171 6263531
Local inshore fisheries information and advice on bylaws, national and EC legislation	Clerk and Chief Fishery Officer, Sussex Sea Fisheries Committee, 106 Station Road, Hailsham, East Sussex BN27 2EG, tel: 01323 841912	Interaction between mariculture activities and marine nature conservation issues in England	*Fisheries Liaison Officer, English Nature HQ, Northminster House, Peterborough PE1 1UA, tel: 01733 340345
Scientific advice: marine fish and shellfish cultivation; advice on management and policy issues for the coastal zone. Mariculture and marine nature conservation issues.	*Head of Laboratory, Centre for Environment, Fisheries & Aquaculture Sciences, Conwy, tel: 01492 593883	Marine Fisheries Task Group paper; interaction between mariculture activities and marine nature conservation issues	*Fisheries Officer, JNCC Peterborough, tel: 01733 562626
Bivalve mollusc production areas; classification of shellfish waters and shellfish diseases	Head of Laboratory, Centre for Environment, Fisheries & Aquaculture Sciences Fish Diseases Laboratory, Barrack Road, The Nothe, Weymouth, Dorset DT4 8UB, tel: 01305 206600	Interaction between mariculture activities and marine nature conservation issues	*Coastal Policy Officer, RSPB HQ, Sandy, Beds., tel: 01767 680551
Fisheries and mariculture in England, including Several Orders.	Director, MAFF (Aquaculture Division), Nobel House, 17 Smith Square, London SW1P 3JR, tel: 0171 238 5940	Interaction between mariculture activities and marine nature conservation issues	*Fisheries Officer, WWF-UK, Godalming, tel: 01483 426444
Technical advice on shellfish purification (depuration)	Sea Fish Industry Authority, Sea Fish House, St Andrews Dock, Hull HU3 4QE, tel: 01482 27837	Interaction between mariculture activities and marine nature conservation issues	*Conservation Officer, Marine Conservation Society, Ross-on-Wye, tel: 01989 566017
Leases	The Crown Estate, Marine Estates, 16 Carlton House Terrace, London SW1Y 5AH, tel: 0171 210 4377	Information and advice on marine conservation issues - Sussex	*Conservation Officer, Sussex Wildlife Trust, Henfield, tel: 01273 492630
Salmon farming	Director, Scottish Salmon Growers Association, Drummond House, Scott Street, Perth PH1 5EJ, Scotland, tel: 01738 635420	Seals and mariculture	Sea Mammal Research Unit (SMRU), Gatty Marine Laboratory, University of St. Andrews, Fife KY16 8LB, tel: 01334 463472/476161
		Seals and mariculture	Susan Joy, Co-ordinator, Wildlife & Countryside Link Seals Group, 105 Halsford Park Road, East Grinstead, West Sussex RH19 1PR, tel: 01342 315440

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

9.3 Quarrying and landfilling

S.L. Bell & K. Gilbert

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. In Region 8 there are no coastal quarries operating on a commercial basis. There is a dormant sand and gravel quarry at Rye Harbour (East Sussex County Council pers. comm.).

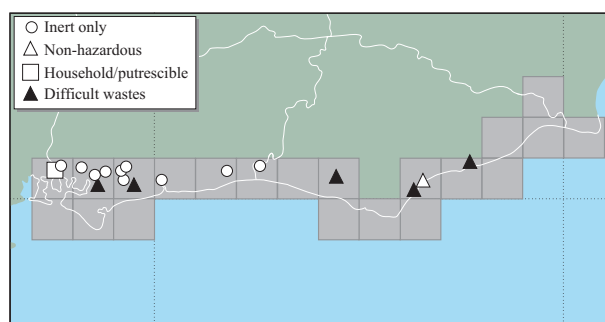
9.3.2 Important locations

Map 9.3.1 shows the location of the region's currently used coastal landfill sites, according to Aspinwall's Sitefile Digest (Aspinwall & Co. 1994); the status codes are defined in Table 9.3.1. Most of the landfill sites in the region are in West Sussex and set slightly inland of the coast.

9.3.3 Management

Planning for mineral extraction in England is guided by *Minerals Planning Guidance Note 6: guidelines for aggregate provision in England* (Department of the Environment 1994). This predicts that the demand for primary aggregates will rise to 5.9 - 6.4 billion tonnes by 2011. It identifies a general need for the south-east to supply a total of some 29-30 million tonnes of sand and gravel to the south-west over the period up to the year 2006. East Sussex County Council has undertaken a minerals policy review, and a Minerals Local Plan for 1996-2006 is in preparation. West Sussex County Council is preparing a Minerals Local Plan intended to run until 2006.

Landfill regulation, including landfill site licensing, now falls within the remit of the Environment Agency, under the 1995 Environment Act. The new agency integrates the functions of Her Majesty's Inspectorate of Pollution (HMIP), the local Waste Regulation Authorities (WRAs) and the National Rivers Authority (NRA). In general terms the agency's regional boundaries follow local authority or national administrative boundaries, to facilitate local accountability. The activities of the Environment Agency are grouped under two broad headings: pollution prevention and control, including waste regulation, the work of HMIP and the



Map 9.3.1 Coastal landfill sites. Note: a single symbol may represent more than one site in close proximity. Source: Aspinwall & Co. (1994).

NRA's work on water quality; and water management, covering the NRA's other functions. Also within the Environment Act 1995 is the requirement for mine operators to give the agency at least six months' notice of their intention to abandon a mine, in order that steps can be taken to avoid pollution from minewater. Provisions relating to producer responsibility for waste will provide a mechanism to ensure that business initiatives on re-using, recovering and recycling waste are not undermined by operators' seeking to avoid their obligations. Waste management licences were introduced by the 1990 Environmental Protection Act to replace the disposal site licences previously required by the 1974 Control of Pollution Act.

9.3.4 Information sources used

Information on quarrying was obtained from the British Geological Survey's *Directory of mines and quarries* (British Geological Survey 1994) and was the most up-to-date and comprehensive available. Nevertheless these data were up to three years old in 1994 and may therefore include information on some operations that have now ceased or exclude operations of more recent date.

The data for landfilling were provided by Aspinwall & Co. from their Sitefile Digest on waste treatment and disposal (Aspinwall & Co. 1994). This contains regularly updated

Table 9.3.1 The status of the region's coastal landfill sites

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.	2
3 Household/ putrescible	Typical contents of a household dustbin and similar wastes of industrial origin e.g. food processing wastes.	1
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.	6
Total		22

Source: Aspinwall & Co. (1994).

information from the Environment Agency and represents the most up-to-date collection of publicly available waste management statistics in Britain.

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

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- Department of the Environment. 1994. *Minerals Planning Guidance Note 6: guidelines for aggregate provision in England*. London, HMSO.

B. Further reading

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- South East Regional Aggregates Working Party. 1995. *Aggregates Monitoring 1994*. London, SERAWP.

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 262200
Aggregates extraction (land-based) in the region	South East Regional Aggregates Working Party, 14 Buckingham Gate, London, SW1E 6LB tel: 0171 931 8777
Local minerals plans, East Sussex	*East Sussex County Council, Lewes, tel: 01273 481000
Local minerals plans, West Sussex	*West Sussex County Council, Chichester, tel: 01243 777100
Mines and quarries (British Directory of Mines and Quarries)	Director, British Geological Survey, Keyworth, Nottingham NG12 5GG, tel: 0115 936 3393

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

9.4 Marine aggregate extraction, dredging and solid waste disposal at sea

S.L. Bell & K. Gilbert

9.4.1 Introduction

Sand and gravel on the sea bed are important sources of industrial aggregate for concrete production, road construction, building, and increasingly for beach replenishment and soft coastal defences. The national demand for aggregate from all sources increased steadily during the 1980s. Aggregates from terrestrial sources are insufficient to meet the rising total demand for sand and gravel in Britain (Doody *et al.* 1993), and marine aggregates satisfy an increasing proportion of the requirement - 15% in 1992 (Crown Estate 1996).

Marine sand and gravel are extracted by commercial mineral companies under licence from the Crown Estate. Marine aggregates extracted in England and Wales reached a peak of 28 million tonnes in 1989, but amounts have since fallen steadily. In 1995, a total of 20,953,623 tonnes of aggregate (excluding contract fill and beach nourishment) were dredged from the bed of the territorial sea and continental shelf of England and Wales. This figure includes approximately 6.8 million tonnes of aggregate that were dredged in Great Britain but exported to landing ports abroad. The 3,711,541 tonnes of marine aggregate landed on the south coast represent 14% of the total dredged in Great Britain in 1995 (Table 9.4.1) (Crown Estate 1996).

Navigational dredging is of two types: capital dredging and maintenance dredging. Capital dredging refers to the one-off removal of sediment, chiefly when deepening shipping channels and during the construction of new dock facilities. Thereafter, maintenance dredging is the regular dredging of existing ports and their approaches to maintain safe navigation. The majority of dredged material, which can range in composition from silts to boulder clay and rock, is deposited at sea, although dredged material is also used for

land claim and increasingly for beach recharge. During the NCC's Estuaries Review surveys, carried out in 1989, out of a total of 155 estuaries around Great Britain, capital dredging was taking place in fifteen and maintenance dredging in 72 - 9.7% and 46.5% respectively of the estuaries surveyed (Davidson *et al.* 1991).

Between 1988 and 1993 there was a downward trend in the wet tonnage of dredged material deposited in the seas around the UK, from 44,303,995 tonnes in 1989 to 29,866,256 tonnes in 1993. However this trend was reversed in 1994, when 35,962,835 tonnes were deposited (Table 9.4.2). The amount of dredged material deposited in the region in 1994 (1,115,237 tonnes) constituted 3.1% of the total dredged material deposited around the UK as a whole (MAFF 1995). In 1994, there were five licensed disposal sites within the region.

Other wastes deposited under licence from MAFF include sewage sludge and solid industrial waste. 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 (equivalent to about 10,000,000 wet tonnes) to the sea. UK sewage sludge production is set to increase dramatically over the next decade, to a predicted 3.3 million tds by 2006. Under the Urban Waste Water Treatment Directive (91/271/EEC), all sewage sludge disposal at sea is to be phased out by 1998. It will have to be replaced by disposal on land, by tipping or incineration. In 1994 a total of 264,405 wet tonnes were deposited in Region 8, at the Nab Tower site. This site receives sludge from Portsmouth and Southampton (Region 9).

Solid industrial waste is waste rock from mining operations, and disposal at sea occurs chiefly in north-east England. There are no licensed disposal sites for solid industrial waste in this region.

Table 9.4.1 Marine dredged aggregates and contract fill/beach nourishment material licensed, extracted and landed in the region and Great Britain in 1995 (tonnes)

	Aggregates		Contract fill/beach nourishment	Total aggregates and contract fill/beach nourishment
	licensed	extracted	extracted	landed
South Coast*	13,545,400	4,428,356	932,607	3,711,541
England and Wales**	42,068,599	20,953,623	5,169,136	26,122,758

Source: Crown Estate (1996). Key: *the Crown Estate's 'South Coast' region includes all of Region 8 and parts of Regions 7 and 9; **no marine aggregates are dredged off Scotland.

Table 9.4.2 Dredged material licensed and disposed of at sea in 1994

	Licences issued	Sites under licence	Sites used	Tonnes licensed	Wet tonnage deposited
Region 8	27	5	5	1,662,743	1,115,237
England and Wales	106	84	71	53,087,009	34,049,468
UK	134	120	98	56,843,459	35,962,835

Source: MAFF (pers. comm. 1996). Note: licences may commence at any time and generally last for one year.

9.4.2 Important locations

Marine aggregates dredging

Map 9.4.1 shows the areas in the region that are licensed by the Crown Estate for marine aggregate dredging (Crown Estate 1996). Table 9.4.3 lists ports in the region landing marine aggregates and the annual tonnages landed. 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. Occasionally a 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.

Table 9.4.3 Total tonnages of marine dredged aggregates landed in the region (1995)

Landing port	Tonnes landed
East Sussex	
Newhaven	393,634
Portslade	41,264
West Sussex	
Shoreham	845,025
Littlehampton	198,812
Region 8	1,478,735

Source: Crown Estate (1996)

Navigational dredging

Navigational dredging occurs in the River Ouse at Newhaven and in the River Adur at Shoreham.

Dredged material disposal

Table 9.4.4 lists the main sites used for the disposal of dredged material in Region 8 and the quantities of material disposed of at each site (Map 9.4.2).

9.4.3 Management and issues

In response to the increase in demand for aggregate in the 1980s, the aggregate industry invested in new ships, which allowed more efficient exploitation of licence areas and new,

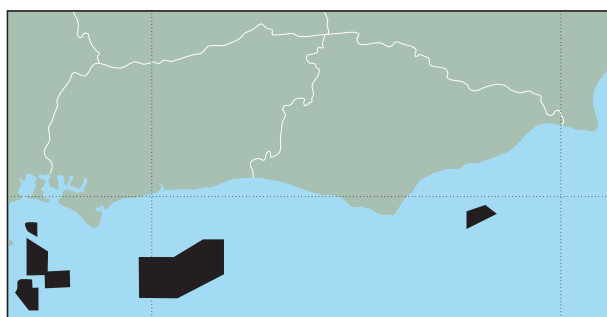
deeper waters to be dredged (Kenny & Rees 1994). These factors expand the area of sea bed affected by aggregate dredging and potentially intensify the effects. All dredging activities have short-term, localised effects, such as the removal of material and organisms, but long-term effects on, say, fish 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).

Marine aggregates dredging

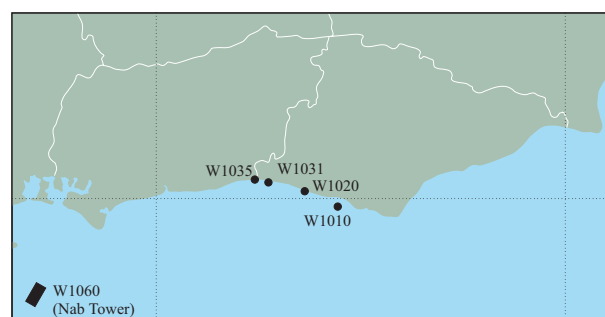
Government policy for the provision of aggregates, formulated in 1982 and 1989, has encouraged marine extraction of sand and gravel: Minerals Planning Guidance Note 6 states that “it has a very important role to play in maintaining supplies of aggregate and, as far as possible, its use is to be encouraged” (DoE 1992). The government (in November 1995) announced its intention to change the system whereby approval is given for the issuing of licences for aggregate extraction. The current system involves obtaining a favourable ‘Government View’, through a non-statutory analysis and consultation process co-ordinated by the Department of the Environment, Transport and the Regions (DETR). The government intends that, in future, applications for marine aggregate extraction licences should be subject to the same type of process as terrestrial planning applications under the Town and Country Planning Acts, regardless of the ownership of the sea bed. The interim position is described in policy guidelines (Department of the Environment 1995), which recommend that “the dredging industry will find it helpful to produce a formal environmental statement to support most applications for a production licence”.

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).

The biological implications of aggregate extraction depend upon the characteristics of the individual area concerned. If an area is used by fish for spawning, for which a stable bed is required, egg laying can be disrupted. Short- or long-term changes in sediment deposition can result, as well as inevitable changes in the topography of the bed. Disturbance of muddy material in order to access underlying aggregate can destroy feeding grounds for flatfish through the displacement of muddy sand fauna. In general, the principal biological impact of marine aggregate extraction is the disturbance and removal of benthic infauna and epifauna and alteration of the substrate upon which colonisation depends. Where the remnant substrate is identical to the surface



Map 9.4.1 Licensed dredging areas for marine aggregates. Source: Crown Estate (1996).



Map 9.4.2 Sites used for the disposal of dredged material and sewage sludge. Source: MAFF (1996).

Table 9.4.4 Waste material disposed of at licensed sites in the region in 1994

Site name	MAFF code (on Map 9.4.2)	Waste type	Depth (m)	Tonnage disposed of 1994
Newhaven	WI010	Maintenance dredgings	<1	197,223
Brighton/Rottingdean	WI020	Maintenance dredgings	<1	25,026
Shoreham	WO031	Maintenance dredgings	<1	108,439
Shoreham (Aggregates)	WI035	Maintenance dredgings	<1	3,960
Nab Tower	WI060	Maintenance dredgings; capital dredgings	n/a	1,044,994
Nab Tower	WI060	Sewage sludge	-	264,405

Sources: MAFF, CEFAS (pers. comm. 1997). Key: n/a = not available. Note: the Nab Tower site falls on the boundary with Region 9; data for the site have therefore been included in that volume also.

sediments, disturbance is unlikely to be permanent and the extraction area will be recolonised. Licences are generally granted only where these conditions are fulfilled (Campbell 1993).

Navigational dredging

Navigational dredging is the responsibility of individual harbour authorities, although a licence from MAFF is required for disposal of the dredged material offshore.

Dredged material and sewage sludge disposal at sea

The primary legislation in force to control the disposal of dredged material at sea in the UK is the Food and Environmental Protection Act (1985) (deposition at sea and in intertidal areas). Also, the Oslo Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft and the London Convention on the Dumping of Wastes at Sea include within their scope disposal of dredged material at sea. In this region, licences to deposit dredged material are issued by MAFF. Each licence is subject to conditions, which have become more stringent in the last few years. Illegal dumping of material may occur: for instance, in 1993, MAFF investigated three alleged cases of licence infringement within England and Wales (MAFF 1995).

Blanketing of the sea bed is the main impact of the disposal of dredged material. If the input rate is significantly greater than the natural sedimentation rate, benthic flora and fauna may be killed through the prevention of respiration and feeding. Other impacts include the localised elevation of levels of metals originating in industrial waste and effluent discharged into the rivers from which the material was dredged. Localised increases in water column turbidity, which are often caused by dredged material disposal, may interfere with fish migration for as long as the increase lasts. Changes in sediment particle size can result in changes in benthic flora and fauna which, whilst not damaging *per se*, may affect the distribution of higher animals by altering the food chain. Shallows over banks of sediment may also be created, which could be a navigation hazard.

9.4.4 Information sources used

The statistics on marine aggregate extraction relate to royalty returns to the Crown Estate (as owners of the foreshore and sea bed) for 1995. The regional landing port totals do not

equate to the amount dredged from each region, owing to the presence of the export market and movement of aggregate to meet differing home market demands. It is not always possible to state definitively where the aggregate landed at specific ports was dredged, owing to the movement of aggregate to different markets within Britain. Generally however, the material is supplied from the adjacent dredging areas. The information on the disposal of dredged material, sewage sludge and solid industrial waste is derived from licences granted by MAFF; information on navigational dredging was obtained from the Nature Conservancy Council's 1991 Estuaries Review (Davidson *et al.* 1991) and from personal communication with Harbour Commissioners and the Centre for Environment, Fisheries & Aquaculture Sciences (CEFAS).

9.4.5 Acknowledgements

Thanks are due to Andrew Morrison of the Crown Estate for information on marine aggregate extraction in the region and to Dr C. Vivian of CEFAS, Burnham-on-Crouch, for providing information on waste disposal at sea and navigational dredging.

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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
Marine resource management (managing agents offshore for the Crown Estate)	Technical Manager, Posford Duvivier, Eastchester House, Harlands Road, Haywards Heath, West Sussex RH16 1PG, tel: 01444 458551
Marine aggregate extraction licensing	Business Manager, Marine Estates (Offshore), Crown Estate, 16 Carlton House Terrace, London SW1Y 5AH, tel: 0171 210 4377
Offshore geoscience data including 1:250,000 maps of geology of coastline	Director, British Geological Survey, Keyworth, Nottingham NG12 5GG, tel: 01159 363100
Disposal of dredge spoil at sea - International	The Oslo and Paris Commissions, New Court, 48 Carey Street, London WC2A 2JE, tel: 0171 242 9927
Database of licensed disposal operations at sea	*Centre for Environment, Fisheries & Aquaculture Sciences, Burnham-on-Crouch, tel: 01621 787200
Disposal of dredged material at sea - international	London Convention Secretariat, International Maritime Organisation (IMO), 4 Albert Embankment, London SE1 7SR, tel: 0171 735 7611
Disposal of pulverised fuel ash as artificial reefs	Oceanography Centre, Southampton University, University Road, Southampton SO9 5NH, tel: 01703 595666

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

9.5 Oil and gas developments

S.L. Bell & K. Gilbert

9.5.1 Introduction

This section describes oil and gas exploration and related development in the region; oil and gas infrastructure is described in [section 8.3](#).

[Map 9.5.2](#) shows sedimentary basins and structural 'highs' around the UK Continental Shelf, which determine the distribution of oil and gas deposits. Total UK Continental Shelf (UKCS) oil and gas production in 1995 was a record 220 million tonnes of oil equivalent and accounted for some 2% of Gross Domestic Product (DTI 1996). A total of 98 exploration and appraisal wells were drilled in 1995, and seven significant discoveries were announced, although none in this region. Gas production was a record 75.4 billion m³ from 77 fields, including twelve new ones. Total UK oil consumption in 1993, including imports, was 84.6 million tonnes (Department of Trade and Industry 1994). The Gross National Product arising within the UK oil and gas production sector was £7.7 billion in 1993 (1.4% total UK GNP).

There are no offshore or onshore oil/gas fields in production or under development in Region 8 (DTI 1996). In the 17th Offshore Oil and Gas Licensing Round (1997), no blocks in this region were awarded exploration licences. In July 1995 the 7th Landward Round for oil and gas exploration was announced, under which applications were invited for licences covering both land and certain inshore 'watery areas'. Results were announced in March 1996, when 74 blocks were awarded, although none in this region. The 8th Landward Round is imminent.

9.5.2 Important locations

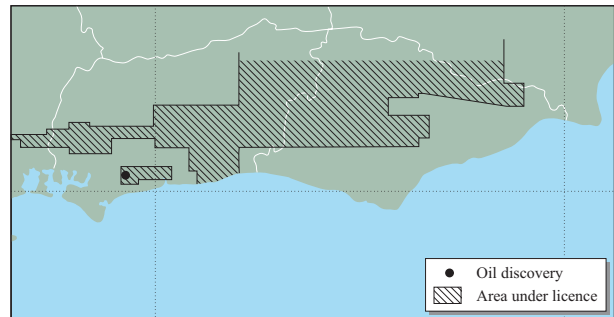
Two areas in the region are under licence and oil has been discovered at one location, Lidsey ([Map 9.5.1](#)).

9.5.3 Management and issues

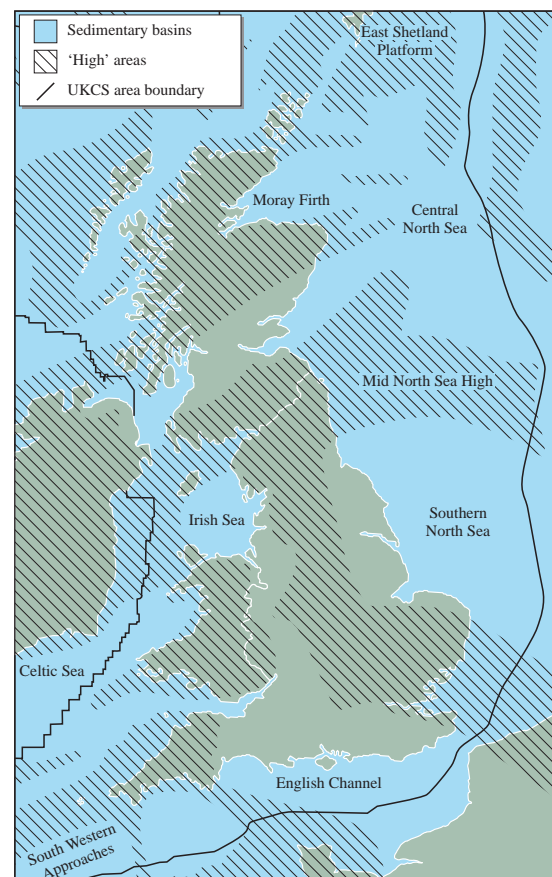
Licences for both offshore and onshore oil and gas exploration are awarded by the Department of Trade and Industry, in consultation with a wide range of organisations, including government departments, the Joint Nature Conservation Committee, other environmental agencies, local groups, local authorities, fishermen's federations and other non-governmental organisations. A range of conditions may be applied, according to the environmental sensitivity of the block (Davies & Wilson 1995). A number of potential issues for nature conservation may arise. For example, the potential for oil spills to harm birds and marine and coastal wildlife is well known, especially in sheltered embayments and estuaries.

9.5.4 Information sources used

Many of the data used here come from the DTI's 'Brown Book' (e.g. Department of Trade and Industry 1996), which should be referred to for further explanation. It is updated annually.



Map 9.5.1 Oil and gas exploration. Source: DTI (1996). © Crown copyright.



Map 9.5.2 UK Continental Shelf (UKCS) sedimentary basins and structural 'highs'. Source: DTI (1996). © Crown copyright.

9.5.5 Further sources of information

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- United Kingdom Offshore Operators Association (UKOOA). 1995. *Environmental guidelines for exploration operations in near-shore and sensitive areas*. London, UKOOA.

C. Contact names and addresses

Type of information	Contact address and telephone no.
Oil and gas developments	Public Relations Officer, Department of Trade and Industry, 1 Victoria Street, London SW1H 0ET, 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
Gas industry	Director and Secretary, Society of British Gas Industries, 36 Holly Walk, Leamington Spa, Warwickshire CV32 4LY, tel: 01926 334357
Oil spillages: government body carrying out pollution control at sea	Marine Pollution Control Unit, Spring Place, 105 Commercial Road, Southampton SO15 1EG, tel: 01703 329484
Response (privately-funded) to oil spills: worldwide	Oil Spill Response, Oil Spill Service Centre, Lower William Street, Northam, Southampton SO14 5QE, tel: 01703 331551
Research into oil pollution	Oil Pollution Research Unit, Environmental Science and Interpretation, 3 Dolphin Court, Brunel Quay, Neyland, Pembrokeshire SA73 1PY, tel: 01646 691000
Advice on oil pollution strategies worldwide	International Tanker Owner's Pollution Federation Ltd, Staple Hall, Stonehouse Court, 87-90 Houndsditch, London EC3A 7AX, tel: 0171 621 1255
Advice on oil spill control equipment	British Oil Spill Control Association (BOSCA), 4th Floor, 30 Great Guildford Street, London SE1 0HS, tel: 0171 928 9199
Licensing of drilling muds and oil spill dispersants	MAFF Marine Environment Protection Division, Nobel House, 17 Smith Square, London SW1P 3JR, tel: 0171 238 6000
Toxicological assessment of drilling muds and oil spill dispersants	*Head of Laboratory, Centre for Environment, Fisheries & Aquaculture Sciences, Burnham-on-Crouch Laboratory, tel: 01621 787200
Information on the environmental effects of exploration and production	*WWF-UK, Godalming, tel: 01483 426444

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

9.6 Water quality and effluent discharges

S.L. Bell & K. Gilbert

9.6.1 Introduction

This section summarises information about water quality and effluent discharge from a number of sources. Sewage sludge disposal is covered in [section 9.4](#). 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 also reach the sea by airborne means, for example aerosols and rain. Industrial pollutants can enter the marine environment under licensed discharge or by accidental release. Discharges occurring outside the region may also have a detrimental effect on coastal water quality. Water abstraction can adversely affect water quality and quantity in rivers, estuaries and inshore waters.

Much of the coastline of Region 8 has been developed for residential use or tourism. Few industries are located on the coast in this region. [Table 9.6.1](#) shows the numbers of major trade and sewage outfalls in the region, all discharging several kilometres offshore.

Table 9.6.1 Numbers of trade and sewage outfalls with maximum consented daily flows >6,000 m³

	<i>Sewage</i>	<i>Trade</i>	<i>Total</i>
East Sussex	4	0	4
West Sussex	5	0	5
Region 8	9	0	9

Sources: Environment Agency Southern Region pers. comm.

In 1996 there were 24 bathing waters in this region identified under the EC Bathing Water Directive (76/160/EEC). Of these, 22 complied with mandatory standards, showing a slight decrease (0.1%) in compliance with the mandatory standards from 1995. However, analysis of faecal coliform values suggests that an overall improvement in water quality has been maintained over the last four years. Trend data show that though the percentage of bathing waters consistently complying with the mandatory standards has remained at around 64%, the number consistently failing has reduced. The Environment Agency

expects an increase in compliance after the completion in 1995 of the majority of capital schemes being undertaken by the Water Service companies (Environment Agency 1996).

There were nine Tidy Britain Seaside Awards in the region in 1996, representing 4.4% of the UK total of 203. None of the UK's 1996 total of 31 Blue Flag beaches was in the region.

The results of the 1994 Coastwatch UK survey showed that, overall, beach quality in the region is slightly better than average for Great Britain, with only 40% of beaches rated as polluted, compared with the national average of 50%. However, only 4% of the regions beaches were rated as excellent, compared with 6.7% of beaches in Great Britain (Coastwatch UK 1995) ([Table 9.6.3](#)). The main items of litter found along the coastline in this region are plastics (including sheeting, fishing gear, bottles and containers), and paper, often at levels above the national average. The perceived threat from sewage in the region was found to be lower than the national average (Coastwatch UK 1995). Medical waste, including syringes and needles, is an increasing problem (McGilvray 1994).

Table 9.6.3 Beach quality in the region compared with national standards in 1994

<i>Area</i>	% of beaches rated as		
	<i>excellent</i>	<i>moderate</i>	<i>polluted</i>
East Sussex	5	50	45
West Sussex	3	62	35
Region 8	4	56	40
England	6	50	44
Wales	7	39	55
Scotland	10	41	49
Great Britain	7	43	50

Source: Coastwatch UK (1995).

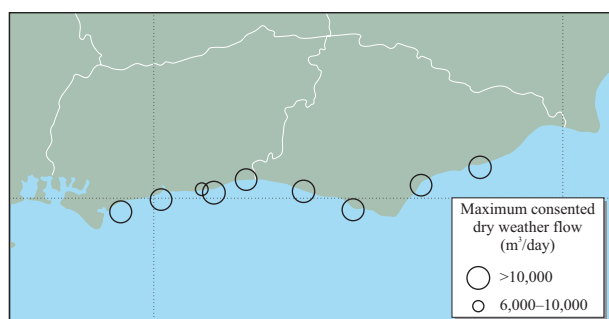
9.6.2 Important locations

All sewage outfalls with consented dry weather flows greater than 6,000 m³ per day are shown on [Map 9.6.1](#) and listed in [Table 9.6.4](#). The great majority (over 60%) of the sewage discharged from the larger outfalls in the region is untreated crude effluent. There are no large trade effluent outfalls in the region with a consented daily effluent flow in excess of 6,000 m³ per day.

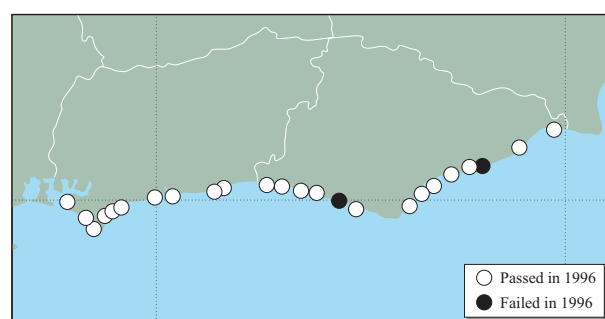
Table 9.6.2 Bathing waters survey, EC identified beaches, 1995 and 1996

	<i>Pass</i>		<i>Fail</i>		<i>Total</i>	
	<i>1995</i>	<i>1996</i>	<i>1995</i>	<i>1996</i>	<i>1995</i>	<i>1996</i>
East Sussex	11	11	0	2	11	13
West Sussex	10	11	1	0	11	11
Region 8	21	22	1	2	22	24
England & Wales	379	386	45	47	424	433
Scotland	19	21	4	2	23	23
Northern Ireland	15	16	1	0	16	16
UK	413	423	50	49	463	472

Sources: DoE (1996), NRA (1996), Environment Agency (1997). Note: pass denotes compliance with Bathing Water Directive (76/160/EEC): coliform standards.



Map 9.6.1 Consented sewage outfalls. Map shows all outfalls with consented flows greater than 6,000 m³/day. Source: Environment Agency.



Map 9.6.2 EC-identified bathing waters: results of 1996 sampling. Source: Environment Agency.

Map 9.6.2 shows the locations of bathing waters in the region identified under the EC Bathing Water Directive (76/160/EEC) and their compliance with mandatory standards in 1996 (Table 9.6.5).

The beaches at Camber, Winchelsea, Bexhill, Pevensey Bay, Eastbourne, Cuckmere, Worthing, Littlehampton and West Wittering were awarded Tidy Britain Seaside Awards in 1996.

9.6.3 Management

In April 1996 the new Environment Agency (EA) became operational. It integrates the functions of Her Majesty's Inspectorate of Pollution, the local waste regulatory authorities and the National Rivers Authority (NRA). Its activities are grouped under two broad headings: pollution prevention and control, including waste regulation and water quality; and water management. However, a strong link is maintained between pollution prevention and control and water management, to ensure continuing integrity of estuarine and coastal water quality management.

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 Environment Agency has overall responsibility for the control of discharges and the maintenance of water quality. It authorises sewage discharges to the sea by issuing 'consents', with MAFF as a statutory consultee to safeguard fisheries' interests. Trade effluent discharges involving scheduled (hazardous) substances must be authorised by the Environment Agency under the Environmental Protection Act 1990. 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 booklet on *Discharge consents and compliance* (NRA 1994) contains details on national and European discharge regulations. Sewage disposal on land is also controlled by the Environment Agency (see section 9.3).

In 1990 all disposal of liquid industrial waste at sea ceased, in accordance with the Ministerial Declarations of the 2nd and 3rd North Sea Conferences. In common with other parts of the UK coast, coastal waters in the region receive sewage effluent directly from both large and small outfalls. In addition other outfalls, both large and small, discharge into rivers a short distance from the coast. Cumulatively, these discharges are capable of affecting the maritime environment, both in this region and beyond. Under the Urban Waste Water Treatment Directive (91/271/EEC), except in 'High Natural Dispersion Areas' (HNDAs), all significant sewage discharges to coastal waters, where the outfalls serve populations >10,000 (roughly equivalent to 1,800 m³ per day), and to estuaries, where they serve populations >2,000 (roughly 360 m³ per day), thus including all those in Table 9.6.4, will require at least secondary treatment, to be phased in by 2005. However, some outfalls will be permitted to discharge sewage with a minimum of primary treatment, provided that comprehensive studies, currently being carried out by the relevant water companies, show that there will be no adverse effects on the environment. In this region HNDAs have been declared at Hastings, Eastbourne, Brighton/Seaford Bay, Portslade/Worthing, Littlehampton and Bognor Regis.

Table 9.6.4 Coastal sewage outfalls in the region with consented 'dry weather flows' >6,000 m³ per day

Name of outfall	Location	Grid ref.	Maximum consented daily dry weather sewage flow (m³)		
			Crude effluent	Treated effluent	Undefined
East Sussex					
Bulverhythe Tower Sewage Outfall	Bulverhythe	TQ781058	19,008		
Langney Point Outfall Works	Langney Point	TQ647003	33,000		
Seaford Bay Outfall	Seaford	TV459975			11,200
Portobello Outfall Works	Saltdean	TV386997	58,752		
West Sussex					
Shoreham Marine Treatment Works	Shoreham-by-Sea	TQ241042		13,320	
East Worthing Sewage Works	Worthing	TV173985		51,200	
West Worthing Sewage Works	Worthing	TQ114011		*8,825	
Littlehampton Sewage Outfall Works	Littlehampton	TV050981	22,982		
Bognor Outfall Works	Bognor Regis	SZ922956	*19,008		

Source: Environment Agency Southern Region pers. comm. Key: *maximum consented daily all-weather flow (m³/day).

Table 9.6.5 Results for the EC-identified bathing beaches in 1996

Location	Passed	Also met 'Guideline' criteria*	Failed
Camber	✓		
Winchelsea	✓		
Hastings			✓
St Leonards	✓		
Bexhill	✓		
Norman's Bay	✓		
Pevensey Bay	✓		
Eastbourne	✓		
Seaford	✓		
Newhaven			✓
Saltdean	✓	✓	
Brighton	✓		
Hove	✓	✓	
Southwick	✓	✓	
South Lancing	✓	✓	
Worthing	✓		
Littlehampton	✓		
Middleton-on-Sea	✓	✓	
Felpham	✓		
Bognor Regis	✓	✓	
Pagham	✓	✓	
Selsey	✓	✓	
Bracklesham Bay	✓	✓	
West Wittering	✓	✓	

Source: Environment Agency 1997. Key: *more stringent water quality standard than 'pass' (see [section 9.6.3](#)).

A new management tool, the General Quality Assessment (GQA) classification scheme for estuaries and coastal areas, is to be introduced by the Environment Agency. This scheme is intended to enable a consistent and quantitative comparison of water quality to be made, both over time and between geographic areas. The proposed components to be used in this classification are basic water chemistry (estuaries only), nutrient levels and aesthetic, sediment and biological quality. The basic chemistry, nutrient and aesthetic components will be implemented and tested in 1996, although further research is required to determine appropriate criteria to establish sediment and biological quality (NRA 1996).

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). The Directive establishes two sets of pass criteria. 'Mandatory' or 'imperative' standards represent the minimum quality to be achieved for a site to be considered as 'passing' the Directive. There are also more stringent 'guideline' standards. Monitoring is carried out by the Environment Agency and the beaches are tested regularly to assess whether they have met the 'mandatory' or more stringent 'guideline' standards. 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 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. Coastwatch UK is organised by Farnborough College of Technology and Beachwatch by Reader's Digest and the Marine Conservation Society.

9.6.4 Information sources used

Monitoring of water quality in the region is carried out by the Environment Agency and MAFF, with the Environment Agency concerned mainly with point sources of contamination from outfalls in the nearshore environment. The interests of MAFF lie with the disposal of sewage sludge and dredge spoil further offshore, and their possible effects on fisheries, and they carry out a wide range of sampling work associated with this. The Environment Agency and MAFF contribute to the National Marine Monitoring Plan, which monitors a wide range of listed chemicals in water, biota and sediments at a range of frequencies that decrease from the estuarine to the offshore environment.

The Department of the Environment, Transport and the Regions (DETR) Environmental Protection Statistics Division publishes an annual *Digest of environmental statistics* (e.g. DoE 1996), which provides detailed national statistics on aspects of environmental protection, including coastal and marine waters, radioactivity, waste and recycling, and wildlife.

Schemes such as the Tidy Britain Group Seaside Award and the European Blue Flag monitor beaches 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 takes 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 the 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 Water Quality Series reports (e.g. NRA 1995) and its 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). A national database of consented sewage outfalls in England and Wales is maintained at the Centre for Environment, Fisheries & Aquaculture Sciences (CEFAS) at Burnham-on-Crouch. Further information on discharges can be obtained from the local offices of the Environment Agency, who issue discharge consents and authorisations. Further information on discharges can be obtained from the local offices of the Environment Agency, who issue discharge consents and authorisations.

9.6.5 Acknowledgements

Thanks are due to staff of the Environment Agency's Southern Region for providing information from their databases for this

section. Thanks also go to Dr Chris Vivian (CEFAS) and Richard Clayton (Southern Water Services) for their helpful comments on the draft text.

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C. Contact names and addresses

Type of information	Contact address and telephone no.
Water quality and discharge consents - Southern Region. EC Bathing Water survey results.	*Environment Agency Southern Region, Public Register Department, Worthing, tel: 01903 832000
Beachwatch	*Marine Conservation Society, Ross-on-Wye, tel: 01989 566017
Coastwatch UK	Project Officer, Coastwatch UK, Farnborough College of Technology, Boundary Road, Farnborough, Hampshire GU14 6SB, tel: 01252 377503
Tidy Britain Group Seaside Award and European Blue Flag beaches	Tidy Britain Group, Lion House, 26 Muspole St., Norwich NR3 1DJ, tel: 01603 762888
Aquatic environmental research and monitoring related to water quality and waste disposal at sea; consented outfalls database	*Head of Laboratory, Centre for Environment, Fisheries & Aquaculture Sciences Burnham-on-Crouch Laboratory, tel: 01621 787200

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

9.7 Leisure & tourism

S.L. Fowler & S.J. Everett

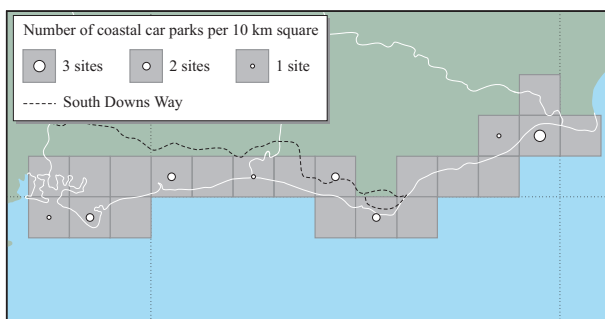
9.7.1 Introduction

This region is one of the most highly-developed in Britain for coastal tourism and leisure, and some of Britain's largest coastal resorts are found in this region. Despite a decline over the last thirty years in the numbers of people taking long-stay seaside holidays on this part of the coast, 'Sussex by the sea' is still an important recreational asset for local residents and visitors from south-east England. The major resorts cater for a wide range of land- and water-based recreational activities, and many new or expanded facilities for recreational boating have been established in recent years. Although the number of visitors to the region has been rising again in some places as a result of new initiatives designed to reinvigorate the tourist industry, some seaside towns are still in economic decline.

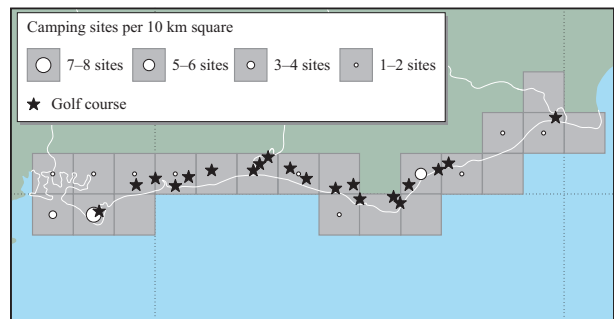
Many of the centres and facilities for leisure and tourism are located in the major towns and holiday resorts in the region. Infrastructure such as rural car parks (which provide access to the access points for land and water-based activities) (Map 9.7.1) and caravan parks and campsites (Map 9.7.2) are present in less built-up parts of the region, e.g. at Rye and Pevensey. Golf courses are dotted along the coast of Sussex (Map 9.7.2). An initial estimate of the numbers of berths and moorings on the coast of the region produced a figure of 2,850 berths, 290 estuarial moorings and 37 unspecified moorings in East Sussex, and 1,390 berths, 630 estuarial moorings and 555 unspecified moorings in West Sussex, but this was known to be an underestimate (Sidaway 1991). The total number of berths and moorings in West Sussex has been revised upwards to 7,800 (mostly within Chichester Harbour). Important locations for land- and water-based leisure and tourism activities are shown on Maps 9.7.3 and 9.7.4 respectively.

9.7.2 Important locations

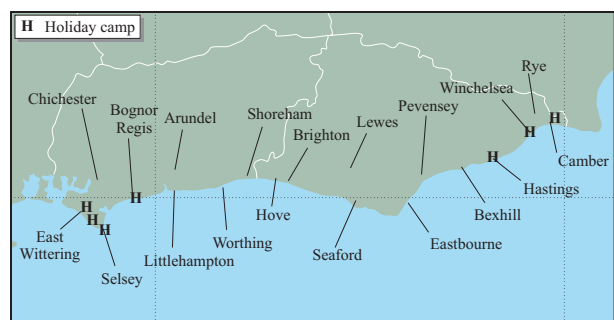
Tourism is centred on the larger urban areas, including Hastings, Bexhill, Eastbourne, Brighton, Worthing, Littlehampton and Bognor Regis. Eastbourne and Brighton are the largest traditional seaside towns in the region, with many seaside hotels, attractions and piers. Brighton has long been one of the top four seaside resorts in England (Brighton



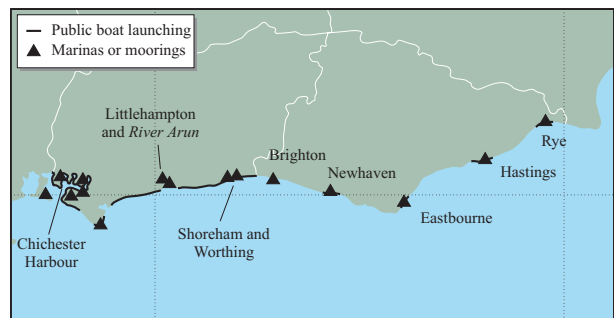
Map 9.7.1 Number of non-urban car parks in coastal 10 km squares in the region and long-distance footpath. Source: Ordnance Survey Landranger maps. © Crown copyright.



Map 9.7.2 Number of camping/caravan sites in coastal 10 km squares in the region and locations of golf courses. Source: Ordnance Survey Landranger maps. © Crown copyright.



Map 9.7.3 Important locations for land-based leisure. Sources: Tourist Offices.



Map 9.7.4 Important locations for water-based leisure. Sources: Tourist Offices.

Tourist Information pers. comm.); the resort towns of Rye, Selsey and East Wittering are smaller. Rye, Winchelsea and Hastings are promoted for their historic interest, as they were 'Cinque Ports', towns given trading privileges in medieval times to defend the Sussex and Kent coastlines from attack. Hastings has a wide range of seaside attractions, including a Heritage Centre and a Sea Life Centre.

Many parts of the East Sussex coast are attractive and important for informal recreational pursuits, such as birdwatching and rambling. A long distance footpath, the South Downs Way, ends at Eastbourne, one route following the coast past Beachy Head and the Seven Sisters cliffs before heading inland. The South Downs Way was the first national long-distance bridleway and cycling is popular along or near

the coast. Beachy Head, a popular birdwatching area, is one of the best migration watchpoints on the south coast and is also a venue for hang-gliding. Selsey Bill is a regular location for watching migratory birds and sea duck, and Pagham and Chichester Harbours are internationally important sites for wildfowl, attracting many birdwatchers. There are Country Parks at Seven Sisters and Hastings.

Although holiday accommodation tends to be concentrated in and around the seaside towns, there are a number of camping and caravan sites along the coast (Map 9.7.2) and some major holiday camps and holiday parks, situated at Camber, Winchelsea, Hastings, Bognor Regis, Selsey and East Wittering (Map 9.7.3). These facilities occupy significant areas of land and comprise chalets and/or mobile homes with centralised facilities such as bars, entertainment and amusement complexes, indoor swimming pools and sports facilities.

Leisure boating is very popular in the region, with good facilities along the coast, and there is a high demand for trailer parks and launch sites. Because there are few sheltered estuarine mooring areas along this coast, most yachts are kept in yacht havens and marinas. Brighton has a large marina village development and there are smaller marinas at several other towns, such as Newhaven, Shoreham, Littlehampton and Ford (upriver from Littlehampton) (Table 9.7.2). There are at least five marinas in Chichester Harbour, which has very sheltered waters and easy access to the Solent. For example, Chichester Yacht Basin is one of the biggest yacht harbours on the south coast, with 1,000 boats moored along its jetties. Together, the Solent and Chichester Harbour represent one of the densest concentrations of water recreation in Europe. A large new marina village is under construction inland from the coast at the Crumbles, east of Eastbourne, with lock gates connecting it to the sea through a shingle beach. Other water-based recreation, such as dinghy sailing, water-skiing, windsurfing, rowing, canoeing and surfing, takes place at

many locations along the coast, including Camber Sands, Winchelsea Beach, Hastings, St Leonards, Bexhill, Pevensey Bay, Eastbourne, Seaford, Saltdean, Brighton, Hove, Worthing, Shoreham, Goring-by-Sea, Rustington, Bognor Regis, East Wittering, West Wittering, East Head and Chichester Harbour.

Region 8 is an important area for wildfowling, with many wildfowling clubs affiliated to the British Association for Shooting and Conservation. These clubs lease or own major areas of foreshore and marshland. Low levels of wildfowling take place in the estuaries and valleys of the Rivers Rother, Ouse, Adur and Arun. Pagham and Chichester Harbours support more organised shooting activities, although the areas leased to the clubs include no-shooting zones. Target species include mallard *Anas platyrhynchos*, wigeon *A. penelope*, pintail *A. acuta* and tufted duck *Aythya fuligula*.

9.7.3 Management and issues

The tourist industry is very important to the economy of this region and planning policies recognise the need to support and develop the range of leisure facilities that are currently available within the major resorts. Nationally, the seaside resorts' share of the domestic holiday market for stays of four nights or more has fallen steadily from 82% in 1972 to 58% in 1993 (Hutchings 1995). The need to stimulate the south coast tourist industry and its infrastructure is recognised at both local and national levels. East Sussex County Council has recently joined other UK and European resort authorities in an initiative named COAST (Coordinated Action for Seaside Towns), which aims to promote the regeneration of seaside areas and to diversify the economy by attracting new investment. It is partly funded by the European Union. Hastings has recently received a government grant to promote urban and economic regeneration. As with other areas, there is pressure to provide heritage centres, wet-weather tourist

Table 9.7.1 Land-based leisure infrastructure

Location	Grid ref	Tourist attractions
East Sussex		
Camber	TQ9618	Holiday park
Rye	TQ9220	Museums, nature reserve, castle, golf course
Winchelsea, Winchelsea Beach	TQ9116	Museum, holiday park
Hastings, St Leonards	TQ8109	Nature reserve, country park, holiday park, sea life centre, castle, tourist information, museums, cave, pier
Bexhill	TQ7407	Tourist information, museum, golf courses
Pevensey	TV6404	Castle, museum, tourist information
Eastbourne	TV6198	Tourist information, museum, aquarium, pier, golf courses
Seaford	TV4899	Tourist information, museum, golf course
Lewes	TQ4110	Castle
Brighton	TQ3104	Museums (including HMS Cavalier), electric railway, Royal Pavilion, aquarium, racecourse, two piers, golf courses
Hove, Portslade-by-Sea	TQ2804	Tourist informations, two museums, golf courses
West Sussex		
Southwick, Shoreham-by-Sea	TQ2105	Museum
Worthing	TQ1502	Pier, golf course
Rustington, Littlehampton	TQ0301	Tourist information, museum, golf courses
Arundel	TQ0106	Castle, museum, cathedral, wildfowl reserve
Middleton-on-Sea, Bognor Regis	SZ9399	Tourist information; holiday camp, pier, golf course
Selsey	SZ8592	Holiday park, golf course
East Wittering	SZ8096	Two holiday camps
Chichester	SU8504	Tourist information centre, cathedral, Roman palace, theatre, museum

Sources: Ordnance Survey & Hamlyn (1995); tourist brochures; Ordnance Survey Landranger series 1:50,000 scale maps.

Table 9.7.2 Existing and proposed water-based leisure facilities

<i>Site</i>	<i>Grid ref.</i>	<i>Description</i>
East Sussex		
Rye Harbour	TR9119	Moorings
Hastings	TV8008	Landing on pier at St Leonards; anchorage near pier
Crumbles, Eastbourne	TQ6401	Marina village under construction
Newhaven	TQ4400	Marina and moorings (300 permanent moorings plus 50 visiting); three sailing/yacht clubs; moorings at Piddinghoe and Lewes upstream on the River Ouse
Brighton	TQ3302	Large marina, 2,000 moorings; Marina Village Yacht Club
West Sussex		
Shoreham	TQ2304	Lady Bee Marina (1,000 berths), two yacht clubs
Littlehampton	TQ0202	Littlehampton Marina, Ship and Anchor Marina (1,400 berths); moorings; two yacht clubs
Arundel	TQ0206	Moorings on the River Arun
Chichester Harbour	SU70, SU80	Whole harbour important for recreation. About 8,700 yacht berths and moorings (perhaps only 4,000 on the West Sussex side) and 3,000 tenders (300 on waiting list) plus 136 visitor moorings/berths. Five marinas, 14 sailing and yachting clubs (although several lie on the Hampshire side of the harbour (in Region 9)) and at least six sailing schools/activity centres. Six public hards/slipways (including Bosham and Prinsted).

Source: Sidaway (1991).

attractions and other facilities which will retain the interest of British holidaymakers.

A number of coastal strategies have been prepared for the Sussex coast, intended to guide the action of the County Councils and to propose ways of achieving stated objectives. These objectives include: undertaking research to monitor the scale and effects of recreational pressures; continuing to develop tourist facilities that are in keeping with the character of the area; regeneration of underused or outdated areas of the developed coast with increased involvement by landowners; protecting and enhancing undeveloped coastline in conjunction with external agencies; and promoting informal recreation by seeking to establish a continuous coastal path by connecting existing roads to the adjoining Rights of Way network (Williams 1996; West Sussex County Council 1992).

Nature conservation tourism is not highly developed in this region and tends to be concentrated at specific locations such as Pagham Harbour, where management policies are in place to avoid disturbance to birds. Some of the conflicts between nature conservation and golfing interests are being resolved through the establishment of a partnership approach between nature conservation bodies and golfing enterprises, and new environmental management initiatives have been agreed by members of national and European golfing organisations such as the English Golf Union and European Golf Association.

Water-based recreation has developed enormously over the last 25 years and pressures for expansion are expected to continue, although the leisure boating industry may have already reached saturation point at key locations, such as Brighton and Chichester Harbour. Chichester Harbour Conservancy has imposed a ban on the development of further moorings. Power boating, water-skiing and jet-skiing cause concern in many coastal locations, as these activities often conflict with quieter traditional beach activities as well as with nature conservation objectives. The authorities concerned have increasingly sought to address such issues through the implementation of coastal strategies and management plans, particularly in the tidal river valleys and popular sites such as Chichester Harbour. In general, marina planning applications submitted over the last decade have tended to be for large sites, with property development being an integral part of the scheme. The provision of facilities for

cruising boats along the coast remains a priority which is under consideration by all the harbour authorities.

The representative body for sport shooting in the UK is the British Association for Shooting and Conservation (the BASC). Targeted wildfowling species and shooting seasons (the open season for coastal wildfowling in England and Wales is 1 September to 20 February) are regulated through the Wildlife & Countryside Act 1981. As elsewhere in Britain, much of the wildfowling in this region is operated and managed through wildfowling clubs and syndicates. Chichester Harbour Wildfowlers lease and own parts in the harbour area and are represented on the Solent Forum. Pagham Harbour Wildfowlers Association have a long-standing commitment to Pagham Harbour Local Nature Reserve and sit on the West Sussex Countryside Committee.

9.7.4 Information sources used

Most of the above information is derived from materials received from Tourist Information Centres (which are of varying detail), from Ordnance Survey Landranger maps, Admiralty Charts and D'Oliveira & Featherstone (1993). It is not possible to gauge the scale of some facilities from the information that was available for this review, and the maps and tables are therefore only indicative of the distribution of leisure and tourism in the region. Further general information on tourist infrastructure and planning was sourced from coastal strategy reports produced by East and West Sussex County Councils. Information on moorings in the region is difficult to obtain because no one organisation is responsible for collating it. Information about wildfowling comes from the NCC's 1989 Estuaries Review data collection (Davidson *et al.* 1991), now held as part of JNCC's Coastal Database.

9.7.5 Acknowledgements

Thanks go to the BASC for their help in compiling additional information on wildfowling, and to the Sports Council for providing details of leisure activities in the region. Thanks also go to A. Bullar of the Sports Council for comments on the draft.

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C. Contact names and addresses

Type of information	Contact address and telephone no.	Type of information	Contact address and telephone no.
Tourism information service - Britain	Commercial Information Library, British Tourist Authority /English Tourist Board, Thames Tower, Black's Road, Hammersmith, London W6 9EL, tel: 0181 846 9000	Coastal recreation, particularly related to planning policy	*County and District Councils
Tourist Information Centres		Windsurfing	British Windsurfing Association, 86, Sinah Lane, Hayling Island, Hampshire PO11 9JX, tel: 01705 468182
Arundel	61 High Street, Arundel BN18 9AJ, tel: 01903 882268	Yachting	Royal Yachting Association, RYA House, Romsey Road, Eastleigh, Hampshire SO50 9YA, tel: 01703 627400
Battle	88 High Street, Battle TN33 1QG, tel: 01424 773721	Board sailing	UK Board Sailing Association, PO Box 28, Fareham, Hants. PO14 3XD, tel: 01329 664779
Bexhill-on-Sea	De La War Pavillion, Marina, Bexhill-on-Sea TN40 1DP, tel: 01424 212023	Wildfowling/sporting shooting	British Association for Shooting & Conservation, Marford Mill, Rossett, Wrexham LL12 0HL, tel: 01244 573000
Bognor Regis	Belmont Street, Bognor Regis PO21 1BJ, tel: 01243 823140	Canoeing	British Canoe Union, John Dudderidge House, Adbolton Lane, West Bridgford, Nottinghamshire NG2 5AS, tel: 0155 982 1100
Brighton	10 Bartholomew Square, Brighton BN1 1JS, tel: 01273 323755	Coastal rowing	P. Challen, Coast Amateur Rowing Association, 92 Hoddern Avenue, Peacehaven, East Sussex BN10 7QU
Chichester	29a South Street, Chichester PO19 1AH, tel: 01243 775888	Jet skiing	UK Jet Ski Association, Goodwood Road, Boyatt Road Industrial Estate, Eastleigh, Hampshire SO5 4NT, tel: 01703 601684
Eastbourne	3 Cornfield Road, Eastbourne BN21 4QL, tel: 01323 411400	Yacht harbours	The Yacht Harbour Association, Hardy House, Somerset Road, Ashford, Kent TN24 8EW, tel: 01233 643837
Hastings	4 Robertson Terrace, Hastings TN34 1EZ, tel: 01424 718888	Marine industries	British Marine Industries Federation, Meadlake Place, Thorpe Lea Road, Egham, Surrey TW20 8HE, tel: 01784 473377
Hove	King Alfred Leisure Centre, Kingsway, Hove BN3 2WW, tel: 01273 746100	Bognor Task Force Studies; regeneration of tourist-related facilities	*Countryside Management Unit, West Sussex County Council, tel: 01243 777100
Lewes	187 High Street, Lewes BN7 2DE, tel: 01273 483448	East Sussex Heritage Coast Recreational Study, Eastbourne to Newhaven. Study of land and water recreation (c. 1993).	University of Brighton, Lewes Road, Brighton BN2 4AT, tel: 01273 600900
Littlehampton (seasonal)	Windmill Complex, Coastguard Road, Littlehampton BN17 5LH, tel: 01903 713480		
Pevensey (seasonal)	Pevensey Castle, High Street, Pevensey BN24 5LE, tel: 01323 761444		
Rye	The Heritage Centre, Strand Quay, Rye TN31 7AY, tel: 01797 226696		
Seaford	Station Approach, Seaford BN25 2AR, tel: 01323 897426		
Worthing	Chapel Road, Worthing BN11 1HL, tel: 01903 210022		
Sports	Sports Council Headquarters, 16 Upper Woburn Place, London WC1H 0QP, tel: 0171 273 1500, and Sports Council South East Region, PO Box 480, Crystal Palace National Sports Centre, Ledrington Road, London SE19 2BQ, tel: 0181 778 8600		

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

Chapter 10 Coastal management

S.L. Fowler & S.J. Everett

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 8. GB and UK national initiatives without a specific regional focus, notably those led by non-governmental agencies and user groups, are outside the scope of this chapter. However, as the whole chapter concludes with a list of contacts with a wider involvement or interest in coastal management (section 10.3.5), 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 zone 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 zone 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 (Earl 1994; King & Bridge 1994).

The House of Commons Environment Committee Second Report (House of Commons 1992) made recommendations for the planning and implementation of coastal zone management that have had policy and practical implications throughout the UK. Amongst the Environment Committee’s 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 zone 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 (DoE) and the Welsh Office (WO) issued *Planning Policy Guidance: coastal planning* (DoE/WO 1992), which clarified 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* (DoE/WO 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* (DoE/WO 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.”

In December 1994 the Department of the Environment launched a standing forum on coastal management for England (the Coastal Forum); it meets twice a year (see section 10.2.2). In 1995 the Department of the Environment published national policy guidelines for the coast (DoE 1995). These guidelines do not replace existing documents but provide a concise digest, pointing out common themes and principles. Public and private bodies are asked to have close regard to them in taking forward their coastal zone management functions. In 1994 the Department also undertook to highlight good practice in coastal zone management plans, clarify the interaction of the different elements of coastal zone management and review relevant bylaw powers. *Coastal zone management, towards best practice* (DoE 1996a) sets out the basic principles and objectives relating to coastal zone management plans, helping to define the respective roles of key players, taking account of the diverse uses of the coastal zone and giving examples of best practice in helping to resolve competing pressures on the coast, and help make clearer how the different elements of coastal zone management interact, including relationships with other strategies. The *Review of bylaw-making powers for the coast* (DoE 1996b) examines the bylaw powers available to bodies with responsibilities for the coast and aims to assess whether they meet modern needs. It also considers the broader relationship between the voluntary principle and other regulatory mechanisms.

In 1994, the UK Government published its Regulations to

implement the EC Habitats & Species Directive (DoE/WO 1994). As they relate to the coast, these regulations provide for single management groups to be set up for whole sites, making the production of unified management plans a practical proposition. Where these sites are of European importance for their nature conservation interest, the conservation of that interest must be the primary consideration of the management plan. For this, the regulations require all relevant authorities to exercise a general duty of care for their long-term conservation.

The European Commission was asked by the Council of the EU to propose a strategy for the whole of the Community coast before the end of 1994. The initial response was to adopt the *Communication on integrated management of coastal zones* (COM/511/95), which sets out proposals for EU funding for

demonstration programmes of coastal management. The strategy is to be based on the principles of sustainability and sound ecological and environmental practice, but will have no legal standing. In February 1996 the European Commission published a *Demonstration programme on integrated management of coastal zones* (European Commission Services 1996), intended as a spur to urgent co-operative action for Europe's coast.

The UK government published a Rural White Paper in October 1995, which was to have included a statement on coastal policy, although in the event only sea fishing was addressed. In 1995 the Local Government Management Board issued *Roundtable Guidance* on the implementation of Local Agenda 21 on the coast (LGMB 1995).

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, including several with no direct management role through a statutory remit or ownership of coastal land, are now becoming involved in the promotion of coastal management initiatives. These include non-governmental organisations with a particular interest in the conservation of the coastal zone, such as CoastNET (the Coastal Heritage Network), the Marine Conservation Society, World Wide Fund for Nature (UK) and the Royal Society for the Protection of Birds (see [section 10.2.5](#)). Only national initiatives that have distinct local elements in the region are described here. Many other diverse interest groups and organisations, for example the British Association for Shooting and Conservation and the Royal Yachting Association, now have national policies with regard to coastal management and estuaries management, and their representatives are involved in most local or regional groups or fora ([Table 10.3.1](#)). For further information on regionally-led coastal zone management initiatives, see [section 10.3](#).

10.2.2 National coastal fora

The Coastal Forum

The Coastal Forum, chaired by the Department of the Environment, was launched in December 1994 and meets twice yearly. It brings together key bodies with interests in the coast, from commerce and industry to leisure and environmental bodies, and includes representatives of central and local government. It provides for an exchange of views by a wide range of interested bodies on issues related to the coastal zone in England. In particular, it seeks to promote understanding of coastal zone initiatives; build on existing liaison arrangements at regional and local level; assist evaluation of action to implement coastal zone initiatives and monitor preparation of a guide to good practice; complement

the work of other bodies with interests in coastal issues; and liaise with other relevant initiatives elsewhere in the United Kingdom. Forum proceedings are reported to government ministers.

English Coastal Groups Forum

Established in 1991, the English Coastal Groups Forum has a remit to promote the formation of coastal groups, including bodies with responsibilities for coastal defence and management and the strategic and local planning functions that would influence coastal defence; to further co-operation between those bodies; to act as a link between centrally-based organisations and coastal groups; to facilitate the development of a coastal zone appraisal and management approach, ensuring that the most environmentally consistent practice is adopted in relation to physical development in the coastal zone; to promote common standards of approach; and to identify policy, administrative and research requirements. Forum members include one representative from each coastal group, the Environment Agency, Local Authority Associations, English Nature, Railtrack and the Department of the Environment, Transport and the Regions.

CoastNET: the Coastal Heritage Network

Launched in 1996, the Coastal Heritage Network (CoastNET) (formerly the Heritage Coast Forum) provides for contact between those individuals and groups concerned with the management of the undeveloped coastline in England; proposals have been put forward to broaden this forum to the whole of the UK. CoastNET is jointly funded by the Countryside Commission, English Nature and Scottish Natural Heritage. CoastNET is a membership body open to all those with an interest in the practical management of the UK coastline.

10.2.3 English Nature

English Nature organises or participates in a number of national coastal zone management initiatives; some major examples are described below.

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); estuary projects are listed in Grabrovaz (1995). Out of a total of 37 estuary projects in England and Wales, in this region there are two estuary plans completed, covering Pagham Harbour and Chichester Harbour. English Nature's involvement in these projects can vary from full involvement in the management committee through participation in a Topic Group to responding to consultation drafts.

Sensitive Marine Areas

English Nature's Sensitive Marine Areas (SMAs) initiative is set out in *Managing England's marine wildlife* (English Nature 1994) (see also section 7.4.3). 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. In Region 8 the Seven Sisters, adjacent to Beachy Head, has been identified as an SMA.

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* (English Nature 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 is being tried out at one Maritime Natural Area (Lyme Bay, Dorset, in Regions 9 and 10), and will be applied in future to the Maritime Natural Areas within this region, which include those from Folkestone to Selsey Bill, and from Selsey Bill to Studland Cliffs.

10.2.4 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 their 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, including in this region Pagham Harbour and Chichester Harbour. In 1994, the RSPB launched its 'Marine Life' campaign, which aims to increase awareness of the problems facing the marine environment and its wildlife, including pollution, fisheries and shipping safety. It has recently published a *Review of coastal zone management powers* (RSPB 1995), which reviews strategic planning and management initiatives in part of the region. RSPB regional staff also participate in estuary and coastal management projects.

10.2.5 Shoreline management plans

Shoreline Management Plans (SMPs) set out a strategy for coastal defence for a specified length of coast, taking account of natural processes and human and other environmental influences and needs (MAFF *et al.* 1994). They are based on coastal sub-cells (see Map 2.4.1) and are compiled in accordance with government guidelines on assessing the environmental impacts of proposals, including soft defence and 'do nothing' options, to be produced in association with and grant aided by MAFF (MAFF/Welsh Office/Association of District Councils/English Nature/NRA 1994). Three Shoreline Management Plans cover this region (Table 10.3.1) (see also section 8.4.3).

The first comprehensive Shoreline Strategy Study covering a long section of the English coastline, under new MAFF guidelines, was carried out between Dover, South Foreland and Beachy Head, Eastbourne (sub-cell 4c). It defines a framework with individual management units, within which each authority can formulate its own Shoreline Management Plan. Shepway District Council was the lead authority, with other participating bodies being Dover District Council, Rother District Council, Hastings Borough Council, Wealden District Council, Eastbourne Borough Council and the Environment Agency. Much of the funding came from MAFF.

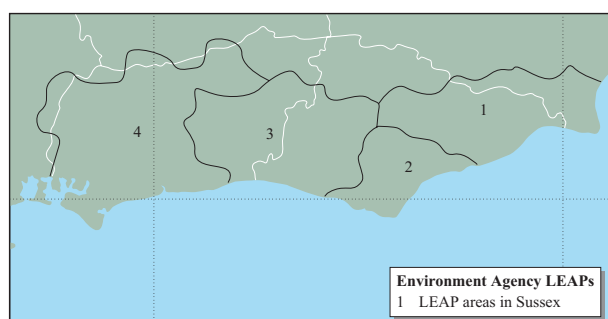
10.2.6 Local Environment Action Plans

River catchments, including estuaries and coastal waters, are the Environment Agency's basic water management units (Map 10.2.1). The Environment Agency is building on the success of the former NRA's Catchment Management Plans to provide an integrated strategy for each catchment area - a Local Environment Agency Plan (LEAP). LEAPs deal with a wide range of environmental issues, including environmental protection and the enhancement of water, land and air. Table 10.2.2 lists catchments in the region where LEAPs are being prepared, and their projected publication dates.

Table 10.2.1 State of progress of Shoreline Management Plans in the region

Coastal cell	Coastal cell no.	Status of SMP	Lead authority
Dover Harbour to Beachy Head	4c	Complete	Shepway District Council
Beachy Head to Selsey Bill	4d	Complete	Arun District Council
Selsey Bill to Hamble	5a	In progress	Chichester District Council

Source: MAFF



Map 10.2.1 Local Environment Action Plans (LEAPs). Leap boundaries are based upon river catchment areas. Source: Environment Agency; reproduced by kind permission.

Table 10.2.2 LEAPs progress as at 8/5/97

No. on <i>Map 10.2.1</i>	Catchment	Current state LEAPs
1	Rother	To be published 1998
2	Cuckmere	To be published 1997
3	Adur and Ouse	To be published 1998
4	Arun	To be published 1999

Source: Environment Agency

10.2.7 Designated sites

Site designations are discussed in detail in [Chapter 7](#). However, 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. 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 include nature reserves managed by English Nature, wildlife trusts, local authorities, the RSPB or other bodies for nature conservation objectives, Heritage Coasts (see below) and proposed marine Special Areas for Conservation (see also [section 7.1](#)). The National Trust, which has extensive coastal land holdings in the region, has recently been carrying out a complete review of its Coastal Strategy Plans and has an ongoing review of coastal site management plans.

Heritage Coasts

The defined areas of Heritage Coasts include only the finest sections of undeveloped coast (see [section 7.4.5](#)), although much larger coastal areas are frequently covered by local authority Coastal or Countryside Management Services plans. 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. There is one Heritage Coast in the region, the Sussex Heritage Coast, which extends along the coast at Beachy Head where the South Downs AONB meets the coast.

Marine Special Areas of Conservation (SACs)

Under the EC Habitats & Species Directive 1992, a list of marine Special Areas of Conservation (SACs) to be designated in the UK must be agreed by the UK Government and the European Commission by 1998 (see [section 7.2.3](#)). Marine SACs may include intertidal areas and/or subtidal areas; terrestrial SACs may include important coastal maritime habitats such as lagoons, saltmarshes or sand dunes. A list of 280 possible marine and terrestrial sites was published in March 1995; of these, 112 were coastal and 37 were selected, in whole or in part, for their marine habitats and/or species. Consultations are being carried out for all possible sites; meanwhile, all sites on the published list should be managed, on a voluntary basis, as though they were already designated. Under the Conservation (Natural 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 Environment Agency, 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. The Department of the Environment and Welsh Office drafted guidance (DoE/WO 1996) on the preparation and application of management schemes for SACs. A European marine sites handbook is being prepared by the UK nature conservation agencies to provide guidance on all aspects of developing management schemes within marine SACs.

10.3 Regional coastal management groups and initiatives

10.3.1 Introduction

In April 1993 the London and South-East Regional Planning Conference (SERPLAN) issued coastal guidelines for the south-east. In general, the overall strategy aims to guide development that requires a coastal location to areas of developed coast and to protect all stretches of the undeveloped coast against development. SERPLAN suggests that the guidelines should be implemented through Structure Plans and Local Plans together with Shoreline Management Plans, Coastal Strategies and coastal zone management plans prepared in cooperation with interested bodies and adjoining authorities. In March 1994, the Department of the Environment issued *Regional Planning Guidance for the South East* (RPG9), which recognises the importance of the sensitive areas of the region's coastline (DoE 1994).

There are currently numerous regional coastal management initiatives arising around the coastline under the leadership of local planning, harbour and ports authorities. Other locally-based coastal management initiatives are also under way. These include coastal engineering groups (see [section 10.3.2](#)), which are primarily concerned with promoting coordination and liaison between organisations undertaking coastal works ([section 8.4](#)). [Table 10.3.1](#) lists regional coastal management initiatives, in many of which local authorities are involved or take a leading role.

10.3.2 Coastal (engineering) groups

Coordination between coastal defence agencies in the region is undertaken through the non-statutory coastal groups (sometimes known as coastal engineering groups) that have been established to improve co-ordination and liaison between agencies undertaking coastal works (see [section 8.4](#)). The geographical coverage of these groups is based on natural coastal sediment cells (see [section 2.4](#)). Their main aim is to seek a co-ordinated approach to all coastal engineering works by member authorities; reduce the risk of works adversely affecting the neighbouring coastline; and improve their understanding of coastal processes. The three coastal groups in this region are the South East Coastal Group, South Downs Coastal Group and SCOPAC ([Table 10.3.1](#)). In 1996 the South Downs Coastal Group completed a consultation document, the South Downs Shoreline Management Plan, covering the coastline from Selsey Bill to Beachy Head. The South Foreland Shoreline Management Plan crosses the boundary of Regions 7 and 8 and stretches from Beachy Head in East Sussex (Region 8) to South Foreland in Kent (Region 7) and was the first SMP to be completed in 1996 ([Table 10.3.1](#)). The East Solent Coastal Group is preparing an SMP for the coastline between Selsey Bill and Hamble that is currently under consultation.

10.3.3 Local planning authority and ports/harbours initiatives

The maritime local planning authorities are involved in most, if not all, of the major coastal management initiatives described in this chapter ([Table 10.3.1](#)), including shoreline management plans, estuaries initiatives and ports and harbour initiatives. Their own planning documents (County Structure Plans and Local Plans) also usually pay particular attention to coastal matters, particularly if produced following PPG20 (DoE/WO 1992).

County Structure Plans and Local Plans provide the statutory planning framework for development control purposes. In many cases these plans are supplemented by regular reviews, monitoring documents and survey reports covering a variety of topics. For current information and a publications list contact the appropriate authority (see [Appendix A2](#)). All coastal districts have policies within their local plans relative to the coast and have issued more specific guidance for certain areas of the coast, or have contributed to joint management initiatives such as those established through English Nature's Estuaries Initiative.

In April 1993 SERPLAN issued coastal guidelines for the south-east (SERPLAN 1993) which recognised the undeveloped coastline as an environmental resource and the need for its enhancement and protection from development wherever possible. In general, the overall strategy aims to guide development that requires a coastal location to areas of developed coast and to protect all stretches of the undeveloped coast against development. SERPLAN suggests that the guidelines should be implemented through Structure Plans and Local Plans, together with Shoreline Management Plans, Coastal Strategies and Coastal Zone Management Plans, which should be prepared in cooperation with interested bodies and adjoining authorities.

Port and Harbour Authorities also have a statutory remit to control activities within their areas of authority, which may include coastal waters, and will have additional responsibilities in the management of marine Special Areas of Conservation under the EC Habitats & Species Directive.

10.3.4 Acknowledgements

Thanks are due to Ray Woolmore, Countryside Commission, for comments on the draft text.

Table 10.3.1 Regional coastal management initiatives

<i>Initiative name</i>	<i>Scope/aims</i>	<i>Organisations involved</i>	<i>Contact details</i>
The London and South East Regional Planning Conference (SERPLAN)	Draft <i>Coastal planning guidelines</i> (SERPLAN 1993) deal with development control for the coast, energy generation, policies for the marine environment, coastal defences and water quality. Working Party from coastal counties will monitor implementation of guidelines.	Essex County Council, Kent County Council, East Sussex County Council, West Sussex County Council, Hampshire County Council, Isle of Wight County Council Joint Planning Unit and SERPLAN.	Director, SERPLAN, 14 Buckingham Gate, London SW1E 6LB, tel: 0171 931 8777
Standing Conference on Problems Associated with the Coastline (SCOPAC)	Covers Worthing to Weymouth. Activities include co-ordinating activities of member authorities relating to the coast; promoting and undertaking research into natural processes; preparing Shoreline Management Plan for whole coast and integrating it into a coastal zone management plan. Six research projects completed/in progress. Holds three meetings per year.	West Sussex, Hampshire & Dorset CCs, seventeen DCs, three Harbour Authorities, Environment Agency, Southern Sea Fisheries Committee, English Nature, Sports Council and one major landowner. Elected members of Conference are assisted by an Officers Working Group.	*The Secretary, SCOPAC, c/o Isle of Wight County Council, Newport, tel: 01983 821000
East Sussex County Council Coastal Countryside Management Project	The project employs countryside rangers who lend support to the Arun and Adur Valley Projects, particularly in the Climping Gap (see below).	East Sussex County Council	*East Sussex County Council tel: 01273 481000
South East Coastal Group	Coordinates coastal defence works from Beachy Head eastwards.	MAFF, local authorities, Environment Agency	The Chief Engineer, Swale Borough Council, Swale House, East Street, Sittingbourne, Kent ME10 3HT, tel: 01795 417338
South Downs Coastal Group	Coordinates coastal defence works from Beachy Head up to and including Pagham Harbour.	MAFF, local authorities, Environment Agency	*Engineering Services Manager, Arun District Council, tel: 01903 716133
East Solent Coastal Group	Coordinates coastal defence works from Selsey Bill to Hamble	MAFF, local authorities, Environment Agency	*Chichester District Council, tel: 01243 785166
South Foreland to Beachy Head Shoreline Strategy Study	Aims to sustainably protect coastal land against erosion and flooding. Implementation through Shoreline Management Plans (South East Coastal Group).	Shepway District Council, grant aid from MAFF	Environmental Services, Shepway District Council, Civic Centre, Castle Hill Avenue, Folkestone CT20 2QY, tel: 01303 850388
Strategy for the East Sussex Coast	Aims to guide the action of the County Council in all coastal matters and proposes the means of achieving integrated coastal planning and management at all levels.	East Sussex CC Transport and Environment Department and Coastal Forum members.	Stephen Ankers, Pelham House, St Andrew's Lane, Bournemouth BN7 1YA, tel: 01273 481722
Sussex Heritage Coast Management Plan	Detailed maritime archaeological strategy, green tourism and eco-sports. <i>Sussex Heritage Coast Management Draft Plan</i> to be implemented by the Sussex Downs Conservation Board.	Sussex Downs Conservation Board (East and West Sussex County Councils, Countryside Commission)	Sussex Downs Conservation Board, Chanctonbury House, Church Street, Storrington, West Sussex RH20 4LT, tel: 01903 741234
Seven Sisters Country Park Management Plan	Promotes public/private sector partnerships; eco-sports. Draft Plan 1993; review of draft in preparation. Implemented by the Sussex Downs Conservation Board.	Sussex Downs Conservation Board and Recreation & Countryside Management Service of East Sussex County Council.	Sussex Downs Conservation Board, Chanctonbury House, Church Street, Storrington, West Sussex RH20 4LT, tel: 01903 741234

Table 10.3.1 Regional coastal management initiatives (continued)

<i>Initiative name</i>	<i>Scope/aims</i>	<i>Organisations involved</i>	<i>Contact details</i>
West Sussex Coastal Strategy	Supplements the County Structure Plan (West Sussex County Council 1992). Four strategic issues: conservation, public safety, sustainable development and recreation. Priorities include production of coastal zone management plans for whole coast, establishing Coastal Steering Group, improved database for coastal defence.	West Sussex County Council and Steering Group.	*Countryside Management Unit, West Sussex County Council, Chichester, tel: 01243 777100
Adur Valley Project	To establish a successful initiative for recreation and conservation. <i>Adur Valley Project Management Strategy</i> (1993) to be implemented through partner agencies including Sussex Downs Conservation Board. Water Recreation Study (1993) prepared by Sports Development Officer for Adur Valley.	Adur, Horsham and Mid Sussex DCs, West Sussex CC, Sports Council, Environment Agency. Managed by Steering Group.	*Barry Newman, Adur District Council, Adur, tel: 01273 455566
Arun Valley Countryside Project	Development control, visitor management, habitat management and conservation. Commenced 1991, reviewed and extended 1995. Climping Gap Management Strategy and Arun Valley Management Plan implemented.	Arun District Council, Environment Agency, West Sussex County Council, Sussex Downs Conservation Board, Countryside Commission.	Andrew Blake, Arun District Council, tel: 01903 716133
Arun District Local Coastal Management Plan	Water Recreation Strategy completed, covering River Arun and coastal area of Worthing to Selsey. Aims to give an overview of water recreation management issues, recognise the needs of users, recommend management and development strategies and promote water recreation in suitable locations within the Arun District.	Coastal Forum of key agencies.	*Nick White, Arun District Council, tel: 01903 716133, ext. 3645
Pagham Harbour Project	Management Plan to be revised and implemented. (Part of English Nature's Estuaries Initiative.)	Management Committee includes local planning authorities, wildfowling associations, parish councils, English Nature, Sussex Wildlife Trust, West Sussex County Council, Environment Agency and other local interested groups.	*Countryside Management Unit, West Sussex County Council, tel: 01243 777100
Chichester Harbour Management Plan	Develops and promotes sustainable use of resources through consultation, consensus and improved understanding; maintenance of a balance of use between interests. 10 year management plan with initial 5 year implementation programme (draft 1993); regular reviews.	Chichester Harbour Conservancy, Countryside Commission, English Nature, West Sussex & Hants. County Councils, various commercial and voluntary organisations.	*Environmental Manager, Chichester Harbour Conservancy, tel: 01243 512301 and *Bob Edgar, English Nature Sussex and Surrey Team, tel: 01273 476595

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

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- English Nature. 1994. *Environmental objective setting for shoreline management plans*. Peterborough, English Nature (Marine Guidance Note.)
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- National Coasts and Estuaries Advisory Group. 1993. *Coastal planning and management: a good practice guide*. Maidstone, NCEAG.
- Rendel Geotechnics. 1994. *Coastal planning and management: a review*. London, HMSO. (Report for the Department of the Environment.)
- Royal Society for the Protection of Birds. 1992. *A shore future. RSPB vision for the coast*. Sandy, Royal Society for the Protection of Birds.
- Scottish Natural Heritage. 1997. *Natura 2000: managing European marine sites - an introduction*. Edinburgh, Scottish Natural Heritage.
- West Sussex County Council. 1992. *Towards a coastal strategy for West Sussex*. Chichester, West Sussex County Council.
- West Sussex County Council. 1994. *A coastal strategy for Sussex*. Chichester, West Sussex County Council.
- World Wide Fund for Nature UK. 1995. *Coastal management plans*. Godalming, World Wide Fund for Nature UK. (Marine Update No. 18.)
- World Wide Fund for Nature UK. 1995. *International commitments to integrated coastal zone management*. Godalming, World Wide Fund for Nature UK. (Marine Update No. 17.)
- World Wide Fund for Nature. 1995. *Integrated coastal zone management UK and European initiatives*. Godalming, World Wide Fund for Nature UK. (Marine Update No. 19.)

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 10.3.5C](#).

- Coastline*. Quarterly magazine of the European Union for Coastal Conservation (EUCC). Intended to establish a pan-European forum on coastal issues, including coastal management.
- Coastline*. The Bulletin of the Parliamentary All Party Coastal Group. Provides information summaries for MPs. Published by the All Party Coastal Group.
- Coastline UK*. Newsletter of the National Coasts and Estuaries Advisory group (NCEAG). Aimed at local authority planners. Published by NCEAG.

CoastNET. The Bulletin of the Coastal Heritage Network. Published quarterly and covers all matters concerned with coastal management in the UK.

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.

Marine Update. A briefing to highlight the World Wide Fund for Nature's work in marine conservation. Published by WWF-UK.

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 drawbacks 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.)

Department of the Environment. 1995. *Policy guidelines for the coast*. London, HMSO. (Highlights government coastal policy and summarises essential guidelines.)

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 the Department of the Environment.)

Local Government Management Board. 1995. *Local Agenda 21: roundtable guidance. Action on the coast*. Luton, Local Government Management Board.

MAFF. 1994. *Shoreline management plans. A procedural guide for operating authorities*. London, MAFF. (4th draft, July 1994.)

C. Contact names and addresses

(See also Table 10.3.1.)

Organisation/group	Activities	Contact address and telephone no.
Cambridge Coastal Research Unit (CCRU)	Research in coastal, estuarine and floodplain geomorphology and sedimentology, intertidal and marine biology, coastal ecology and habitat survey, and environmental baselines and impact assessments, including coastal zone management	CCRU, Dept. of Geography, University of Cambridge, 62 Sidney Street, Cambridge CB2 3JW, tel: 01223 339775
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, Transport and the Regions, Room 912, Bristol, tel: 0117 987 8433
CoastNET (Coastal Heritage Network)	An independent Charitable Trust and membership organisation. Established in 1995 by the Countryside Commission, English Nature and Scottish Natural Heritage with a part-time secretariat. Links individuals and organisations working for the sustainable management of the coastal and marine environment.	CoastNET, The Manchester Metropolitan University, St. Augustines, Lower Chatham Street, Manchester M15 6BY, tel: 0161 247 1067
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 Technical Officers Group, English Nature, Maritime Team, Peterborough, tel: 01733 455000 (secretariat)
Countryside Commission	Promotion of policies for Heritage Coasts, and coastal management generally.	*National Park & Planning Branch, Countryside Commission, HQ, Cheltenham, tel: 01242 521381
English Coastal Groups Forum	Established by MAFF in 1991. Co-ordinates the work of the English Coastal Groups (see 10.2.2); 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 Environment Agency, Local Authority Associations, English Nature, British Rail/Railtrack and Department of the Environment, Transport and the Regions.	*MAFF, Head of Flood and Coastal Defence Division, London, tel: 0171 238 3000
English Nature	Management of coastal Nature Reserves; nature conservation and development planning, Estuaries Initiative, Sensitive Marine Areas, Maritime Natural Areas	*English Nature HQ, Peterborough, tel: 01733 455000
Environment Agency (EA)	Local Environmental Action Plans, sea defences	*Flood Defence Section, Environment Agency HQ, Bristol, tel: 01454 624400, or *Regional Office, EA Southern Region, Worthing, tel: 01903 832000
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 Secretariat, Dept. of Maritime Studies & International Transport, UWCC, P.O. Box 907, Cardiff CF1 3YP, tel: 01222 874271
European Union for Coastal Conservation (EUCC)	International grouping of organisations and individuals with an interest in coastal nature conservation matters, including coastal management.	European Union for Coastal Conservation (EUCC) Secretariat, PO Box 11232, NL-2301 EB Leiden, tel: +31 71 122900/123952
European Union for Coastal Conservation - United Kingdom (EUCC-UK)	UK membership network affiliated to EUCC, providing focus for information exchange about European-level coastal conservation issues.	EUCC, c/o 5 Green Lane, Brampton, Huntingdon, Cambridgeshire PE18 8RE, tel: 01480 457624

C. Contact names and addresses (continued)

(See also Table 10.3.1.)

Organisation/group	Activities	Contact address and telephone no.
Joint Nature Conservation Committee - Geology/Coastal Advisor	Advice and information on coastal conservation in Great Britain as a whole and internationally	*JNCC, Peterborough, tel: 01733 562626
Joint Nature Conservation Committee - Marine Advisor	Advice and information on marine nature conservation in Great Britain as a whole and internationally	*JNCC, Peterborough, tel: 01733 562626
Les Estuaries Environmental Study Group	International programme for co-operation, the exchange of experience on estuarine management and personal contacts between local authority practitioners in Europe.	Estuaries 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
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.	*Honorary Secretary, The Marine Forum for Environmental Issues, Scarborough, tel: 01723 362392
Ministry of Agriculture, Fisheries and Food (MAFF) Flood & Coastal Defence Division	Shoreline Management Plans (mainly aimed at formulating a coast protection strategy)	*MAFF, Flood and Coastal Defence Division, Eastbury House, London, tel: 0171 238 3000
MAFF, Marine Environment Protection Division	Policy advice on marine environmental management	MAFF, Marine Environment Protection Division, Nobel House, 17 Smith Square, London SW1P 3HX, tel: 0171 238 6433
MAFF, Directorate of Fisheries Research	Scientific advice on marine environment and living resources management	*Head of Laboratory, Centre for Environment, Fisheries & Aquaculture Sciences, Conwy, tel: 01492 593883
National Coasts and Estuaries Advisory Group (NCEAG)	Provides advice to local authorities on sustainable management of coastal and estuarine environments; published guide to good practice (NCEAG 1993)	Alan Inder, Secretary, National Coasts and Estuaries Advisory Group (NCEAG), Hampshire County Council, The Castle, Winchester SO23 8UJ, tel: 01962 846749
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.	*National Trust HQ, Cirencester, tel: 01285 651818 *National Trust Kent & East Sussex Regional Office, Tunbridge Wells, tel: 01892 890651 *National Trust Southern Regional Office (West Sussex), Dorking, tel: 01372 453401
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. Produced a regional strategy.	*Coastal Policy Officer, RSPB HQ, Sandy, tel: 01767 680551
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.	*WWF - 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

<i>Name</i>	<i>Contact address and telephone no.</i>	<i>Name</i>	<i>Contact address and telephone no.</i>
Statutory bodies		Statutory bodies (continued)	
British Oceanographic Data Centre - NERC (BODC), Proudman Oceanographic Laboratory	Bidston Observatory, Birkenhead, Merseyside L43 7RA, tel: 0151 653 8633	JNCC, Seabirds and Cetaceans Team	Seabirds and Cetaceans Team, JNCC, 11 Dunnet House, 7 Thistle Place, Aberdeen AB10 1UZ, tel: 01224 655700
Centre for Environment, Fisheries & Aquaculture Sciences Conwy Laboratory	Benarth Road, Conwy, Gwynedd LL32 8UB, tel: 01492 593883	MAFF Flood and Coastal Defence Division	Eastbury House, 30/34 Albert Embankment, London SE1 7TL, tel: 0171 238 3000
Centre for Environment, Fisheries & Aquaculture Sciences Lowestoft Laboratory	Pakefield Road, Lowestoft, Suffolk NR33 OHT, tel: 01502 562244	UKDMAP (United Kingdom digital marine atlas) Version 1. Oceanographic maps.	British Oceanographic Data Centre, Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, tel: 0151 653 8633
Centre for Environment, Fisheries & Aquaculture Sciences Burnham-on-Crouch Laboratory	Remembrance Avenue, Burnham-on-Crouch, Essex CM0 8HA, tel: 01621 787200	Wildlife Trusts	
Countryside Commission (CC), HQ	John Dower House, Crescent Place, Cheltenham, Gloucestershire GL50 3RA, tel: 01242 521381	Sussex Wildlife Trust	Woods Mill, Shoreham Road, Henfield, West Sussex BN5 9SD, tel: 01273 492630
CC, South-east Region	4th floor, 71 Kingsway, London WC24 6ST, tel: 0171 831 3510	National voluntary bodies	
Department of the Environment, Transport and the Regions (DETR), European Wildlife Division/ Dept. of Rural Affairs	DETR, Room 9/03B, Tollgate House, Houlton Street, Bristol BS2 9DJ, tel: 0117 987 8000	British Trust for Ornithology	The Nunnery, Nunnery Place, Thetford, Norfolk IP24 2PU, tel: 01842 750050
DETR, Water Resources and Marine	Romney House, 43 Marsham Street, London SW1P 3PY, tel: 0171 276 0900	Marine Conservation Society	9 Gloucester Road, Ross-on-Wye, Herefordshire HR9 5BU, tel: 01989 566017
English Nature, HQ	Northminster House, Peterborough PE1 1UA, tel: 01733 455000	The National Trust, HQ	33 Sheep Street, Cirencester, Gloucestershire GL7 1RQ, tel: 01285 651818
English Nature Sussex and Surrey Team	English Nature, Howard House, 31 High Street, Lewes, East Sussex BN7 2LU, tel: 01273 476595	The National Trust, Southern Regional Office (West Sussex)	Polesden Lacey, Dorking, Surrey RH5 6BD, tel: 01372 453401
Environment Agency (EA), HQ	Rio House, Waterside Drive, Aztec West, Almondsbury, Bristol BS12 4UD, tel: 01454 624400	The National Trust, Kent & East Sussex Regional Office	Scotney Castle, Lamberhurst, Tunbridge Wells, Kent TN3 8JN, tel: 01892 890651
EA Regional Office, Southern Region	Guildbourne House, Chatsworth Road, Worthing, Sussex BN11 1LD, tel: 01903 832000	Royal Society for the Protection of Birds (RSPB), HQ	The Lodge, Sandy, Bedfordshire SG19 2DL, tel: 01767 680551
Institute of Terrestrial Ecology (ITE), Monks Wood	Abbots Ripton, Huntingdon, Cambridgeshire PE17 2LS, tel: 01487 773381	RSPB, South-east England Office	Second Floor, 42 Frederick Place, Brighton, East Sussex BN1 1AT, tel: 01273 775333
ITE, Merlewood	Windermere Road, Grange-over-Sands, Cumbria LA11 6JU, tel: 01539 532264	Wildfowl & Wetlands Trust (WWT), HQ	Slimbridge, Gloucestershire GL2 7BX, tel: 01453 890333
Joint Nature Conservation Committee (JNCC), HQ	Monkstone House, City Road, Peterborough, Cambs PE1 1JY, tel: 01733 562626	Worldwide Fund for Nature - UK (WWF-UK)	Panda House, Weyside Park, Cattershall Lane, Godalming, Surrey GU7 1XR, tel: 01483 426444
		Universities	
		University of Brighton, Faculty of Engineering and Environmental Studies	Lewes Road, Brighton, Sussex BN2 4AT, tel: 01273 600900

<i>Name</i>	<i>Contact address and telephone no.</i>	<i>Name</i>	<i>Contact address and telephone no.</i>
Universities (continued)		Others (continued)	
University of Sussex, Faculty of Engineering and Applied Sciences	Falmer, Brighton, Sussex BN1 9RH, tel: 01273 606755	SERPLAN (South East Regional Planning Conference)	14 Buckingham Gate, London SW1E 6LB, tel: 0171 931 8777
Others		SCOPAC (Standing Conference on Problems Associated with the Coastline)	The Secretary, c/o Isle of Wight County Council, County Hall, Newport PO30 1UD, tel: 01983 821000
British Geological Survey	Keyworth, Nottingham NG12 5GG, tel: 0115 936 3100		
Marine Forum for Environmental Issues	c/o University College of Scarborough, Filey Road, Scarborough, Yorkshire YO11 3AZ, tel: 01723 362392		

A.2 Local planning authorities, port and harbour authorities

<i>Name</i>	<i>Address and telephone no.</i>	<i>Name</i>	<i>Address and telephone no.</i>
East Sussex County Council	Pelham House, St Andrew's Lane, Lewes BN7 1UN, tel: 01273 481000	Worthing Borough Council	Town Hall, Chaple Road, Worthing BN11 1HA, tel: 01903 239999
West Sussex County Council	County Hall, Tower Street, Chichester, West Sussex PO19 1RQ, tel: 01243 777100	Arun District Council	Centre, Maltravers Road, Littlehampton BN17 5LF, tel: 01903 716133
Rother District Council	Town Hall, Bexhill-on-Sea, East Sussex TN39 3JX, tel: 01424 216321	Chichester District Council	Pallent House, East Pallent, Chichester PO19 1TY, tel: 01243 785166
Hastings Council	Town Hall, Hastings, East Sussex TN34 1QR, tel: 01424 781066	Port and harbour authorities	
Eastbourne Borough Council	Town Hall, Eastbourne BN21 4UG, tel: 01323 410000	Chichester Harbour Conservancy	Itchenor, Chichester, West Sussex PO20 7AW, tel: 01243 512301
Wealden District Council	Council Offices, Pine Grove, Crowborough TN6 1DH, tel: 01892 653311	Littlehampton Harbour Board	Harbour Office, Pier Road, Littlehampton, West Sussex BN17 5LR, tel: 01903 721215
Lewes Council	32, High Street, Lewes BN7 2LX, tel: 01273 479011	Newhaven Port and Properties Ltd	Newhaven Harbour, Newhaven, East Sussex BN9 0BG, tel: 01273 514131
Brighton Council	Town Hall, Brighton BN1 1JA, tel: 01273 710000	Rye Harbour Authority	Harbour Office, Rye, East Sussex TN31 7QS, tel: 01797 225225
Hove Borough Council	Town Hall, Hove BN3 4AH, tel: 01273 755400	Shoreham Port Authority	84-86 Albion Street, Southwick, Brighton, Sussex BN42 4ED, tel: 01273 592613
Adur District Council	Civic Centre, Ham Road, Shoreham-on-Sea BN43 6PR, tel: 01273 455566		

A.3 Core reading list

There are a number of 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.)
- Brown, A. 1992. *The UK environment*. London, HMSO.
- Buck, A.L. 1997. *An inventory of UK estuaries*. 6. *Southern England*. Peterborough, Joint Nature Conservation Committee.
- 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., & 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.
- Edgar, R.D.M. 1995. *South-east England habitat resources survey*. Peterborough, English Nature.
- Eno, N.C., ed. 1991. *Marine conservation handbook*. 2nd ed. Peterborough, English Nature.
- Environment Agency. 1996. *The environment of England and Wales: a snapshot*. Bristol, Environment Agency.
- 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.
- Local Government Management Board. 1995. *Local Agenda 21: roundtable guidance. Action on the coast*. Luton, Local Government Management Board.
- North Sea Task Force. 1993. *North Sea quality status report 1993*. London, Oslo and Paris Commissions.
- Reid, P.C., Auger, C., Chaussepied, M., & Burn, M. 1993. *North Sea quality status report 1993. Report on Sub-region 9*. London, DoE/Republic Française Ministère de l'Environnement/IFREMER.
- Robinson, A., & Millward, R. 1983. *The Shell book of the British coast*. Newton Abbot, David and Charles.
- Rose, F. 1995. *The habitats and vegetation of Sussex*. Brighton, Booth Museum of Natural History.
- Steers, J.A. 1964. *The coastline of England and Wales*. Cambridge, Cambridge University Press.

A.4 Contributing authors

<i>Author</i>	<i>Address</i>	<i>Author</i>	<i>Address</i>
Dr M. Aprahamian	Environment Agency - North West Region, Fisheries Department, PO Box 12, Richard Fairclough House, Knutsford Road, Warrington WA4 1HG	K. Gilbert	Scott Wilson Resource Consultants, 7-9, Mentone Gardens, Edinburgh EH9 2DJ
Dr R.N. Bamber	Fawley Aquatic Research Laboratories Ltd, Marine and Freshwater Biology Unit, Fawley, Southampton, Hants. SO4 1TW	Dr M.I. Hill	SGS Environment, Yorkshire House, Chapel Street, Liverpool L3 9AG
Dr R.S.K. Barnes	Department of Zoology, Downing Street, Cambridge CB2 3EJ	N.G. Hodgetts	JNCC, Monkstone House, City Road, Peterborough PE1 1JY
S.L. Bell	Scott Wilson Resource Consultants, 7-9, Mentone Gardens, Edinburgh EH9 2DJ	R.A. Irving	14 Brookland Way, Coldwaltham, Pulborough, W. Sussex RH20 1LT
British Geological Survey	Coastal Geology Group, British Geological Survey, Keyworth, Nottingham NG12 5GG	A.W.G. John	Sir Alister Hardy Foundation for Ocean Science, c/o Plymouth Marine Laboratory, Citadel Hill, Plymouth, Devon PL1 2PB
Dr T.C.D. Dargie	Loch Fleet View, Skelbo Street, Dornoch, Scotland IV25 3QQ	R.G. Keddie	JNCC, Monkstone House, City Road, Peterborough PE1 1JY
D. Dales	Scott Wilson Resource Consultants, 7-9, Mentone Gardens, Edinburgh EH9 2DJ	A.B. Law	JNCC, Monkstone House, City Road, Peterborough PE1 1JY
Dr N.C. Davidson	Kerkstraat 38, 6668 AP Randwijk, The Netherlands	R.T. May	JNCC, Monkstone House, City Road, Peterborough PE1 1JY
Dr J.P. Doody	5 Green Lane, Brampton, Huntingdon, Cambridgeshire PE18 8RE	K.D. Meakin	SGS Environment, Units 15 & 16, Pebble Close, Amington, Tamworth, Staffs. B77 4RD
C.D. Duck	NERC Sea Mammal Research Unit (SMRU), University of St. Andrews, School of Biochemical and Medical Sciences, St. Andrews, Fife KY16 8LB	V.M. Morgan	34 High Street, Warboys, Huntingdon PE17 2TA
M. Edwards	Sir Alister Hardy Foundation for Ocean Science, c/o Plymouth Marine Laboratory, Citadel Hill, Plymouth, Devon PL1 2PB	M.S. Parsons	3, Stanton Road, Raynes Park, London SW20 8RL
Dr P.G.H. Evans	Seawatch Foundation, Dept. of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS	Dr M.G. Pawson	Centre for Environment, Fisheries and Aquaculture Sciences, Pakefield Road, Lowestoft, Suffolk NR33 0HT
S.J. Everett	Nature Conservation Bureau, 36 Kingfisher Court, Hambridge Road, Newbury, Berkshire RG14 5SJ	J. Plaza	JNCC, Monkstone House, City Road, Peterborough PE1 1JY
V. Fenwick	Riverbank House, River Road, Taplow, Maidenhead SL6 0BG	Dr G.W. Potts	The Marine Biological Association of the UK, The Laboratory, Citadel Hill, Plymouth PL1 2PB
A.P. Foster	23, The Dawneys, Crudwell, Malmesbury, Wiltshire SN16 9HE	Dr R.E. Randall	Girton College, Huntingdon Road, Cambridge CB3 0JG
S.L. Fowler	Nature Conservation Bureau, 36 Kingfisher Court, Hambridge Road, Newbury, Berkshire RG14 5SJ	C.F. Robson	JNCC, Monkstone House, City Road, Peterborough PE1 1JY
A. Gale	34 Brintons Road, St. Mary's, Southampton SO14 0BY	J. Sawyer	Scott Wilson Resource Consultants, 7-9, Mentone Gardens, Edinburgh EH9 2DJ
Dr H.T. Gee	SGS Environment, Yorkshire House, Chapel Street, Liverpool L3 9AG	Scott Wilson Resource Consultants	7-9 Mentone Gardens, Edinburgh EH9 2DJ
		S.E. Swaby	The Marine Biological Association of the UK, The Laboratory, Citadel Hill, Plymouth PL1 2PB
		Dr M.J.S. Swan	19 St Judith's Lane, Sawtry, Huntingdon, Cambs. PE17 5XE
		M.L. Tasker	JNCC, Dunnet House, 7 Thistle Place, Aberdeen AB10 1UZ
		Dr C.E. Turtle	SGS Environment, Units 15 & 16, Pebble Close, Amington, Tamworth, Staffs. B77 4RD