JOINT NATURE CONSERVATION COMMITTEE

Coasts and seas of the United Kingdom

Region 10 South-west England: Seaton to the Roseland Peninsula

edited by
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Contents

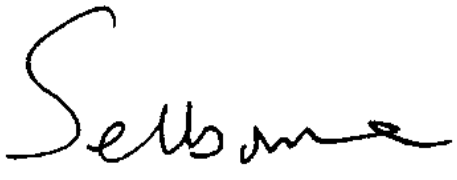
Foreword

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, the Department of the Environment (Northern Ireland), the National Rivers Authority (now the Environment Agency (EA)), the Countryside Commission, the Welsh Office, 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 the region and sets the region in a national context.
- **Important locations and species**: gives more detail on the region's features in relation to the topic.
- **Human activities**: describes management and other activities that can have an effect on the resource in the region.
- **Information sources used**: describes the sources of information, including surveys, on which the section is based, and notes any limitations on their use or interpretation.
- **Acknowledgements**
- **Further sources of information**: lists references cited, recommended further reading, and names, addresses and telephone numbers of contacts able to give more detailed information.

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

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

Definitions and contexts

The word 'region' (as in 'Region 10') is used throughout this book to refer to the coastal and nearshore zone, broadly defined, between the two points given in the title of this book. The area covered varies between chapter sections, depending on the form in which data is available. Coverage is usually either coastal 10 km squares, sites within one kilometre of Mean High Water Mark, or an offshore area that may extend out to the median line between the UK and neighbouring states. Inland areas of the counties concerned are not included unless specifically stated. Information is presented in the context of the local authority units existing before April 1996, except where data are very recent, making reference to the new local authority units possible.

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

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

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

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

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

Acknowledgements

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

Arco British Ltd[1]
Ards District Council
Avon County Council
Banff and Buchan District Council
BHP Petroleum Ltd[1]
Ceredigion District Council
Cheshire County Council
Chevron UK Ltd[1]
Cleveland County Council
Clwyd County Council
Clyde River Purification Board
Colwyn Borough Council
Copeland Borough Council
Countryside Commission
Countryside Council For Wales
Cumbria County Council
Cunninghame District Council
Delyn Borough Council
Department of the Environment (DoE)
DoE (Northern Ireland) Environment & Heritage Service
DoE (Northern Ireland) Water Service
Derry City Council
Devon County Council
Dorset County Council
Down County Council
Dumfries and Galloway Regional Council
Dyfed County Council
Eastbourne Borough Council
English Nature
Essex County Council
Fife Regional Council
Forest of Dean District Council
Gwynedd County Council
Hampshire County Council
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National Rivers Authority
Neath Borough Council
Newry and Mourne District Council
Newtownabbey Borough Council
Norfolk County Council
North Cornwall District Council
North East Fife District Council
Nuclear Electric plc
Preseli Pembrokeshire District Council
Restormel Borough Council
Samara Consulting
SCOPAC (Standing Conference on Problems Associated with the Coastline)
Scottish Natural Heritage
Scottish Office Agriculture, Environment and Fisheries Department
Scottish Salmon Growers Association Ltd
Sefton Borough Council
Shepway District Council
Solway River Purification Board
Somerset County Council
South Pembrokeshire District Council
Standing Conference on Regional Policy In South Wales
Stroud District Council
Tayside Regional Council
Torridge District Council
UK Offshore Operators Association[2]
Vale of Glamorgan Borough Council
Water Services Association
Welsh Office
World Wide Fund For Nature (UK)

Notes

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

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

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

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

Special thanks for consultation on this volume go to Sam Davies of English Nature and Joan Edwards and Mike Camplin of the Devon Wildlife Trust. The editors would also like to thank the many people who have provided information for the project or gave their time to comment on drafts, as well as those who gave editorial assistance:

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

Hallsands, Devon. Once an entire hamlet stood on this spot; however, offshore aggregate extraction early this century is thought to have exposed to wave attack the beach that fronted the village, resulting in the destruction of all but a couple of houses. Photo: Pat Doody, JNCC.

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 has undertaken 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 has been adopted in the project; information has been 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 has 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 (NSTF 1993).

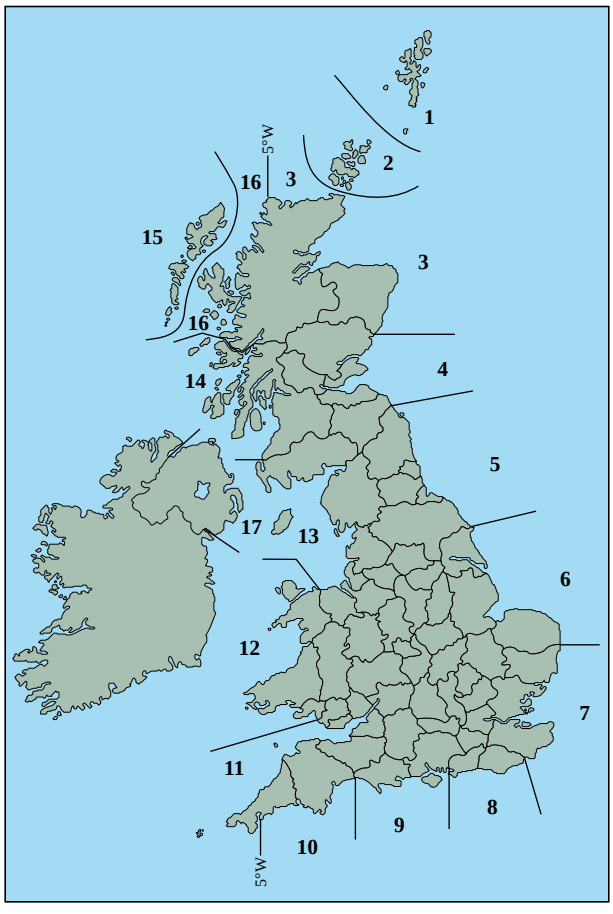
At the second meeting of the NSTF, in 1989, the UK suggested that the North Sea QSR should include consideration of terrestrial habitats and species. This was to involve the collection of information dealing with the coastal margin of the North Sea (defined as being east of longitude 5° West - i.e. from 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, Countryside Council for Wales). 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 management. For example, between November 1991 and February 1992 the House of Commons Environment Committee examined the issues for England; their report on *Coastal zone protection and planning* was published in March 1992 (House of Commons Environment Committee 1992). This report, together with initiatives at UK and European levels, encourages 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.



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

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 seaboards (the approach adopted for the *Directory of the North Sea coastal margin*). In 1992, therefore, it was decided 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 coastline. 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 seventeen regions have been or are now being prepared: the areas that they cover are shown in Map 1.1.1. Regions 1 - 10 cover the area of the *Directory of the North Sea coastal margin*; Regions 11 - 17 deal with the 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 have resulted in early completion of the regional volumes, rather than the overview *West Coast Directory*, becoming the priority.

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, have contributed either money or information or both to the project; further participants are still coming forward. 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 has been reflected in the level of sponsorship that the project has received and in the commitment shown by members of the steering groups, which meet regularly. The main steering group meets annually for a seminar, discussing amongst other things the *Role of the Directories in the development of coastal zone management* (January 1994), and the *Use of electronic storage and retrieval mechanisms for data publication* (February 1995); in addition the core steering group also meets at least annually.

Table 1.1.1 Coastal Directories project management structure

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

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 has been highlighted by the extent to which new approaches and information sources have been identified. The dialogue between the Coastal Directories Project funding consortium members has 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 (Provisional) titles and publication dates of products of the Coastal Directories Project

Product	*Publication date*
Book editions	
Directory of the North Sea coastal margin	1993
Region 1. Shetland	Due 1997
Region 2. Orkney	Due 1997
Region 3. North-east Scotland: Cape Wrath to St. Cyrus	1996
Region 4. South-east Scotland: Montrose to Eyemouth	Due 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	Due 1997
Region 8. Sussex: Rye Bay to Chichester Harbour	Due 1997
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	Due 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	Due 1997
Regions 15 & 16. North-west Scotland: the Western Isles and west Highland	Due 1997
Region 17. Northern Ireland	Due 1997
Electronic editions	
Coastal and marine UKDMAP datasets: Version 1	1994
Region 5	1996
Region 6	1996
Region 9	1996
Region 12	1996
Region 13	1996
Other regions	Following book publication

1.1.5 Outputs

The regional volumes are being 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). Other forms of electronic publication are now being evaluated, and electronic editions of the published Regions 12, 5, 6, 13 and 9 are now available. The current position on the publication of book and electronic editions is shown in Table 1.1.2.

1.1.6 Further sources of information

A. References cited

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

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Department of the Environment/Welsh Office. 1993b. *Managing the coast: a review of coastal management plans in England and Wales and the powers supporting them*. London, HMSO.

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House of Commons Environment Committee. 1992. *Coastal zone protection and planning. Second Report.* 2 volumes. London, HMSO.

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

B. Further reading

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

C. Contact names and addresses

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

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

Slapton Bar is one of the largest and most floristically rich shingle structures in Britain. Formed by the landward movement of sea-bed pebbles, it now encloses a freshwater lake - Slapton Ley - once part of the open sea. Photo: Peter Wakely, English Nature.

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 human use and development, synthesising information presented in Chapters 2-10. The main coastal locations are shown in Map 1.2.1. Map 1.2.2 shows the coastal 10 km squares in the region.

Region 10 covers the major part of the coastline of south Devon and Cornwall bordering the western part of the English Channel. The coast is 621 km long, which is 11.3% of the total coastline of England and 3.3% of that of Great Britain. It has a varied geology and is composed of predominantly rocky coast, with major lengths of cliffed landscapes, including the prominent peninsulas of Start and Dodman Points, which help to define the two major sweeping crescent-shaped bays: Lyme Bay and that between Salcombe and Falmouth. The coast is punctuated by the numerous narrow, steep sided, often wooded estuaries (rias), with the River Exe being the only typical coastal plain estuary in this region. The coast has a rugged and open character and is a one of the most popular tourist destinations in the UK, containing some of the country's oldest resorts, first patronised in the 18th and early 19th centuries.

Agriculture is a major land use, comprising mainly a mixture of arable and grazing, particularly dairy farming. Fishing continues to be an important industry, with the region accounting for 4% of commercial fish and shellfish landed in Britain in 1992, landed mainly at Plymouth and Brixham. Inshore fishing is centred upon the many small and large villages located in sheltered coves. The whole area is relatively free from human infrastructure development, except around the principal population centres of Exeter, Torbay and Plymouth, where tidal land has been enclosed. Elsewhere, particularly on what is often known as the English Riviera, the towns of Seaton, Sidmouth, Teignmouth, Dartmouth and others are important tourist centres.

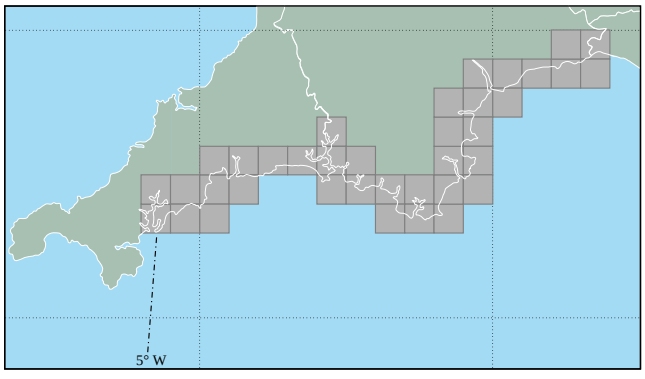
1.2.2 Structure and landscape

The solid geology of the region changes from east to west as the coast is composed of progressively 'harder' rocks. Unlike much of the rest of the UK this region is thought to have been free from ice for most of the Pleistocene glacial period. There are therefore virtually no Quaternary sediments obscuring the solid geology of the region. The youngest and 'softest', least stable rocks, which predominate in the east, are of Jurassic (213-144 million years) and Permo-Triassic (286-213 million years) age. They extend from Lyme Regis to Torbay. The Axmouth to Lyme Regis undercliffs, which mark the eastern limits of the region, are predominantly Jurassic in age, although the coast stretching from Axmouth westwards to Sidmouth has exposures of Cretaceous age (144-65 million years), for example at Beer Head. From Torbay to the western limits of the region, sedimentary rocks of Devonian age (408-360 million years ago) abound, forming extensive cliffs including Start Point and Dodman Point. Some of the rocks of which these promontories are formed are thought to have originated on the ocean floor.

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

Start Point marks a significant division in the offshore sea bed. To the east, Lyme Bay shelves gently to a depth of less than 60 m, and in several areas, notably off the mouth of the Exe Estuary, barely reaches 10 m over wide areas. West of Start Point, where cliffs are present the sea bed shelves steeply to a depth of between 7 and 20 m within a short distance offshore. Further offshore the sea bed descends to between 50 and 70 m in a series of steps, each step representing a former shoreline, progressively submerged at the end of the last glaciation some 10,000 years ago. The offshore geology is similar to that on land, and because of the absence of the ice sheet from this area the rocks have only a thin veneer of Quaternary (glacial and recent) material.

The prevailing wind is from the south-west and several of the cliff sections are exposed to its full force, though parts of the long sweeping bays are relatively sheltered. The tidal range is less than 4 m in Lyme Bay, increasing to 4.5 m in the west of the region. A funnelling effect of the tides on the French side of the English Channel may increase the tidal amplitude, which can be increased even further (by up to 30%) during gales. However, nowhere in the region has a tidal range approaching that of the Bristol Channel (Region 11), where tides of 12.3 m occur.



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

1.2.3 The natural environment

The coast of Region 10 includes all the main coastal habitat types. There is a wide range of cliff habitats, including important examples of cliff vegetation, such as exposed maritime grassland (Start Point), calcareous cliff vegetation (Beer Head and Berry Head) and mature woodland (Axmouth to Lyme Regis undercliffs). Elsewhere there are other significant stretches of sea cliffs, with tall grassland, scrub and, on unstable ground, open ephemeral communities, which provide important refuges for a wide variety of species requiring less intensive land management. These habitats, combined with the estuaries, rias, heaths, woods and mines, render the region of considerable importance for nature conservation.

Unlike in the flatter alluvial landscapes of south-east and north-west England, coastal plain estuarine systems are few in this region, being confined to the Exe Estuary and the area around Plymouth. In contrast, however, rias (drowned river valleys) are virtually confined in Britain to this and the adjacent Region 11.

There is only one significant sand dune site, Dawlish Warren in the Exe Estuary, and one vegetated shingle structure (at Slapton), although there are several important shingle beaches. The absence of extensive soft sedimentary habitats in the region results in the total wintering waterfowl population representing only 1% of the British population. However, the Exe Estuary is internationally important for wintering waterfowl, partly because it usually remains frost-free during the winter and in periods of hard weather elsewhere in the UK, which may result in major influxes, including of teal and wigeon.

Because of the wide range of habitats, the relatively low intensity of use of adjacent agricultural land and the presence of often inaccessible sea cliffs or steep-sided river valleys, the region supports a number of bird species that, although not confined to the coast, have some of their most important populations along the coastal margin of the region. These include some of the country's rarest and still declining passerines (e.g. songbirds). Of these, the cirl bunting, possibly the rarest resident passerine, is now confined in this region to the coastal strip between Exeter and Plymouth. The (non-coastal) nightjar and Dartford warbler similarly occur here in nationally important numbers. The whole region also supports significant populations of both the greater and lesser horseshoe bats; these species depend on the close proximity of low intensity farmland, with unimproved coastal pasture and traditionally managed hedgerows for food supplies, and suitable breeding and hibernating sites.

The sea and sea bed

Region 10 has diverse communities of both sea and sea-bed plants and animals. This is a reflection of the range and types of substrate present and the mixing of warm water from the south-west with colder waters of the east. The region's coastal nearshore area is one of the richest in Britain for southern species, including those from the Mediterranean (many at the edge of their range) and vagrants from the waters of the North Atlantic drift.

In the east of the region the sea bed of Lyme Bay is relatively shallow and predominantly covered in sand and gravel; it shelves gently to about 60 m. Generally, the marine flora in this area is not rich, but where cobbles overlie the sand there is a rich diversity of sponges. In addition, and of particular note, is the network of caves at the base of Berry Head. The environmental conditions in these caves are thought to be unique in the UK and the caves support populations of Devonshire cup corals, as well as numerous sponges, tubes worms and bryozoans. Offshore from the clean sandy beach at Dawlish Warren in the shallower water is one of only two sites in Britain for the Mediterranean worm *Ophelia bicornis*.

To the west on the open coast kelp forests dominate the shallow sub-tidal waters, populated by an array of species including large numbers of sea-urchins. Below the kelp, near-vertical walls support a mixture of animal-dominated communities, with large numbers of featherstars, dead man's fingers and (locally) starfish and sea cucumber. Again, a feature of the species diversity is the presence of a number of warmth-loving species from the Mediterranean, many of which have become well established.

The region supports an important fishery, exploiting pelagic, demersal and shellfish species; it also has some of the richest and most diverse populations of non-exploited fish in British waters, with 181 species recorded out of the 336 found around the UK coast. This figure is much higher than the 48 found off eastern England.

As a breeding species seals are virtually non-existent in the area, except for a small colony of grey seals. Whales and dolphins are also poorly represented in the region's waters, although overall thirteen species have been recorded and seven of them (25% of the British species) are seen regularly, most of them throughout the year.

Estuarine shores

Extensive estuarine shores are only present at three sites: the Exe Estuary, the rivers which feed into Plymouth Sound, and around Falmouth Bay (mostly within Region 11). By comparison with other regions the overall size of the estuary resource, including the rias, is small (1.7% of British resource), with 25% of the resource occurring in north-west England (Region 13). However this is more than made up for by the diversity of the tidal waters and sediments and the extent of transitions from intertidal to other terrestrial habitats. Coupled with this is the presence of some of the more important examples of ria systems in the UK; rias have steep, narrow littoral zones rich in both marine and coastal plants and animals. The ria of Plymouth Sound (a 'possible' Special Area of Conservation (SAC) under the EC Habitats & Species Directive) is among the finest in Britain.

One of the features of the region's estuaries is the presence of transitions to other habitats. Although the larger estuaries, notably the Exe and part of the Tamar, have been enclosed in their upper reaches, good extents of upper saltmarsh, swamp and coastal grazing marsh habitat survive. These provide important breeding sites for shelduck, lapwing, redshank and snipe (especially in the Exe), although numbers are low compared with other parts of Britain. Transitional habitats are even more important in the rias, where woodlands often have their tree roots dipping into the tidal waters. The region has one of the few surviving British examples of a saltmarsh succession to woodland, on the Fal River; it is associated with accumulated sediments from clay workings upstream.

Saltmarshes in the region are not significant in combined extent, representing only 2% of the England resource, and only three sites (Exe, Tamar and Lynher estuaries) have areas greater than 50 ha. Loss of saltmarsh to enclosure is also not particularly significant, although there are areas of coastal grazing marsh derived from enclosed, unimproved saltmarsh in the Exe, where approximately 10% of the habitat in south-west England occurs, mostly within an RSPB Reserve.

Non-estuarine shores

Sandy shores are important in the region and include a number of recreational beaches, such as that at Exmouth. However, sand dunes in the region comprise less than 1% of the national resource, with Dawlish Warren spit containing the only significant extent in the region. The site is an important nature reserve and supports a number of rare species, including the sand crocus *Romulea columnae* at its only site in Britain.

There are few shingle structures in the region apart from Slapton Bar. This narrow shingle beach encloses a freshwater lagoon that includes the nationally rare brackish-water sand-shrimp *Gammarus chevreuxi* and provides the only British location for the strapwort *Corrigiola litoralis*. Some areas of shingle shore, for example those with a sandy matrix, such as occurs between Dodman Point and Falmouth Bay, support important populations of the nationally rare shore dock *Rumex rupestris*.

Sea cliffs abound in the region. Near Axminster they occur as extensively landslipped cliffs; steeper but less rugged sections of cliff occupy the south Devon coast to Torbay. Further west, harder, more resistant rocks predominate to the limit of the region, at Dodman Point. Generally the rocks are non-calcareous and so the richest vegetation (in terms of species diversity) is restricted to the few sites where limestone (e.g. Berry Head) or chalk (e.g. Beer Head) outcrop. The former of these two sites has a particularly rich flora, with two species protected by the Wildlife and Countryside Act (1981), a further six Red Data Book (nationally rare) species and fourteen scarce species. Exposed headlands (e.g. Start Point), whether calcareous or not, may also support important examples of Atlantic cliff vegetation. Species include the scarce autumn squill *Scilla autumnalis*, found at a number of sites, including Start Point, where exposure helps to discourage the competing growth of coarse grasses and scrub.

The majority of the cliff landscape fulfils a less spectacular, though no less important, role in providing refuges for a wide variety of species of plants and animals that survive in the narrow strip of unimproved cliff and cliff-top grassland, scrub and woodland habitats. Unstable cliffs are also significant for scarce ephemeral plants restricted to open ground and seepages, and for invertebrates that require bare soil for burrowing. The many relatively sheltered, warm, south-facing areas also attract warmth-loving species, notably invertebrates, on both hard and soft substrates. Perhaps the most important area of coastal woodland in Britain occurs on the land-slipped Axmouth to Lyme Regis Undercliffs. Here the common dormouse - not in fact a common species - has a stronghold in the structurally diverse woodland and scrub. This site, an example of extremely sheltered Atlantic cliff vegetation, is within a section of cliff (Sidmouth to West Bay) that is a possible SAC.

This region is not particularly significant for overall numbers of seabirds, but it is at the limit of the southern breeding ranges of several species. There is only one seabird breeding colony of national importance in the region, of cormorants at Great Mew Stone. Several other colonies within Sites of Special Scientific Interest (SSSIs) hold regionally important numbers of birds. Most notable among these is the colony at Berry Head, which is the largest guillemot colony on the coast of southern England. Berry Head is also designated an Area of Special Protection, to protect breeding birds from disturbance during the breeding season.

1.2.4 Landscape and nature conservation

The value of the region for landscape and nature conservation is shown by the number and combined extent of sites afforded official protection, especially designations reflecting national or international importance. These include 45 Sites of Special Scientific Interest, although only two coastal National Nature Reserves. The Exe Estuary is the only Special Protection Area and the sole Ramsar site in the region - a relatively small tally compared with most other regions. The region also includes three possible SACs. The total numbers and total areas of the sites covered by the main designations are given in Table 1.2.1.

Table 1.2.1 Main landscape and nature conservation designations in Region 10

Designation	*No. of sites in region*	*Total area in this region (ha)*	*% of GB coast total in region*
Ramsar sites	1	2,389	0.9
Special Protection Areas (SPAs)	1	2,389	0.8
National Nature Reserves (NNRs)	2	513	0.6
Sites of Special Scientific Interest (SSSIs)	45	8,123	1.2
Local Nature Reserves (LNRs)	11	1,862	14.0
National Trust sites	65	4,590	7.3
RSPB reserves	1	96	0.3
Wildlife Trusts sites	9	676	2.9

Source: JNCC. Note: 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'.

Although the area includes a relatively small number of sites protected by statute, many sites are managed by non-governmental organisations including the RSPB and Wildlife Trusts, and significant areas are owned by the National Trust. The great national significance of the south Devon and Cornwall coasts lies in their combination of low-intensity use, relative inaccessibility and high landscape value. This is reflected in the extent of coast designated as Areas of Outstanding Natural Beauty (AONB), representing 14% of the England and Wales total.

1.2.5 Human activities, past and present

The ice sheets of the Pleistocene glaciation probably never reached as far as this part of Britain. As a consequence evidence of some of the earliest human settlements in Britain survives in this region. In areas where flint axes have been found in association with the remains of animals that became extinct at around that time, these settlements can be dated to 400,000 years ago. Evidence of occupation since then has also been found from the last ice-age (70,000-12,000 years ago). Evidence of occupation has also been identified on lower-lying land surfaces, now covered by the sea since the rise in sea level that resulted from the melting of the ice at the end of the last glaciation. Roman occupation appears to have left no lasting impression on the area.

During the later Medieval period the area was of considerable importance for exporting raw materials such as slate, silver, lead and tin, and this importance was sustained into the 19th century with exports of copper and tin. Also during the later Medieval period china clay (kaolin) was extracted around St. Austell; it is still a significant export today. The outwashings from the workings flowed into the nearby rivers and streams and the sediment was carried seaward, in some areas having a major influence on the coast. The development of the Par Spit and the silting up of a number of estuaries, including the Fal, are examples of the effects.

Coastal production of salt encouraged the preservation of fish, and from the 14th century the area became an important fishery for pilchards, which were exported to the Mediterranean in great quantities from the 16th century. When the pilchard shoals failed, in 1870, many of the smaller fishing ports, which had developed in response to the abundant fish stocks, became unviable. The exception was Brixham, which developed a deep-sea trawler fleet working around the British coast and as far afield as Newfoundland in Canada. The harbour survives today, but fishing activity is at a much reduced level. Pilchards are still fished in the region, with the recorded catch representing a significant proportion of the total British landings.

Today, Plymouth and Brixham are the two main fishing ports in the area and most of the 'offshore' fleet is based at these locations. They and the other smaller ports exploit a wide range of fish stocks. More than 50% of the horse mackerel, 10% of the pollack and 20% of both Dover sole and flounder total British landings are made in this region. Local landings include a high proportion of shellfish, to meet the demand from tourists: the region supports the UK's largest fleet targeting edible crab, based in the Salcombe and Kingsbridge Estuary. Both scallops and queen scallops are dredged inshore, and nearly 30% of the total squid catch for Britain is landed in the region. The three diadromous fish species widespread in British waters, the Atlantic salmon, sea trout and eel, are all present in this region. Basking sharks, the world's second biggest fish, are regularly sighted offshore.

Because of the strategic importance of the area the early centuries of economic activity resulted in the building of numerous land-based military defences. Dartmouth Castle was built in the 1400s and the former naval dockyard at Plymouth was established in 1691 and continued to be developed after the Second World War. It is ironic that the extraction some 80 years ago of material from the shoreline at Hallsands just north of Start Point for the development of the dockyard appears have resulted in the virtual destruction of the fishing village there.

Unlike fishing and mineral exports, tourism is a major and expanding activity in the area, based on the older resorts of Lynne, Sidmouth, Torquay and Exmouth. The mild climate, sandy beaches and fine scenery continue to attract visitors much as they did in the late 18th and early 19th centuries, when much of the infrastructure was built. The industry provides some of the smaller fishing communities with their main revenue, replacing that traditionally obtained from pilchards.

1.2.6 Further sources of information

A. Further reading

Robinson, A., & Millward, R. 1983. *The Shell book of the British coast*. Newton Abbot, David and Charles.

Steers, J.A. 1973. *The coastline of England and Wales*. 2nd ed. Cambridge, Cambridge University Press.

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Chapter 2 Geology and physical environment

2.1 Coastal geology

British Geological Survey

2.1.1 Introduction

The coast between Lyme Regis and Falmouth is composed of sections of Jurassic, Triassic, Permian and Devonian rocks. With the exception of the Devonian rocks, which are structurally complex, the rocks dip (i.e. bedding planes slope) to the east and thus older strata are seen in the west. There are exposures of noticeably different rocks, such as chalk, which overlies older rocks in eastern Devon, and the metamorphic and igneous rocks of the southern tip of Devon and Dodman Point, which are of uncertain age and complex history. There are many classic sections illustrating features of stratigraphic and structural importance (Map 2.1.1; Table 2.1.1).

2.1.2 Stratigraphy

Lyme Regis to Tor Bay

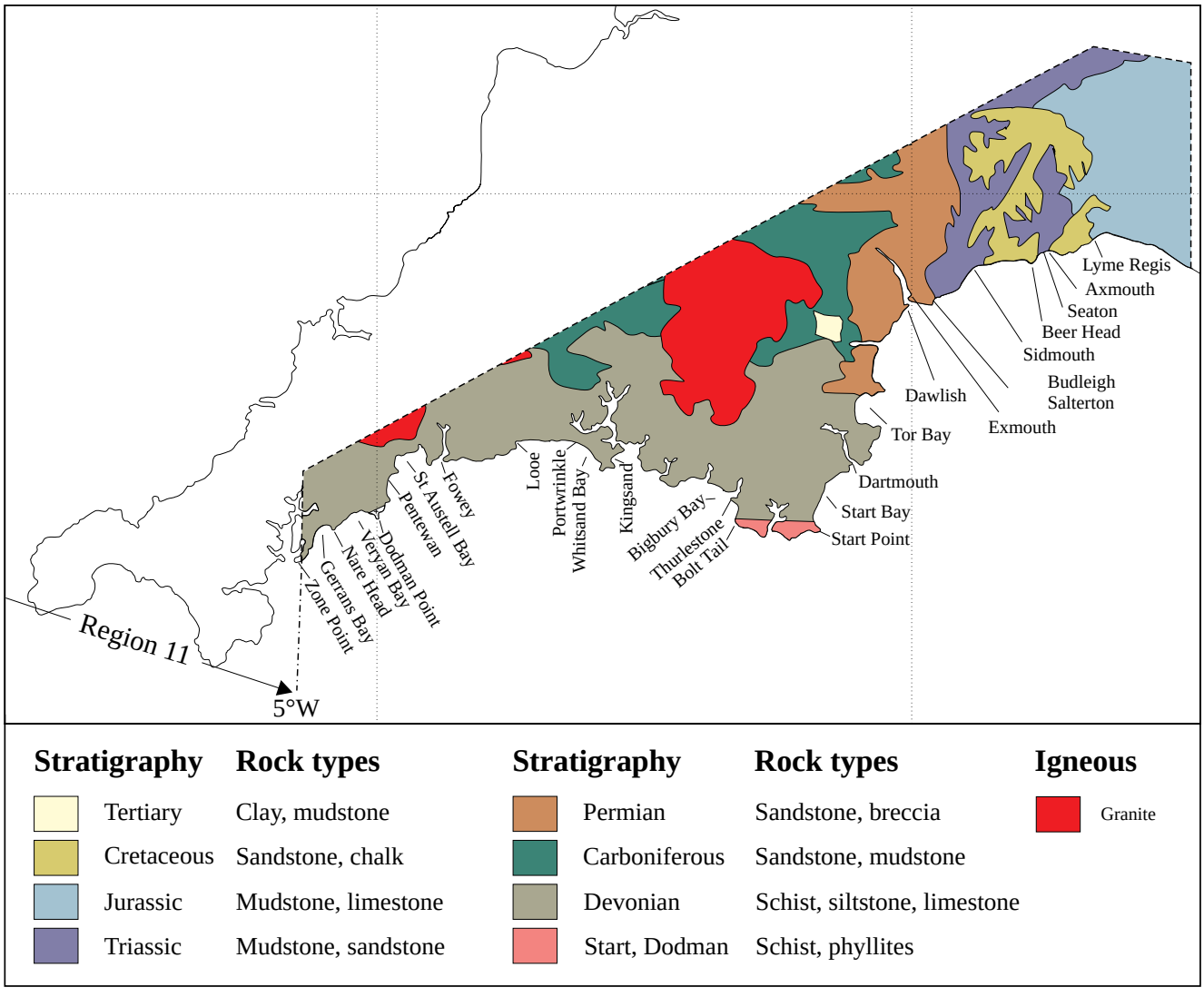
The coastal geology from Lyme Regis to Tor Bay is made up largely of Permian and Triassic red breccias, sandstones and mudstones, in marked contrast to that in the west of the region. A short section of Jurassic rocks, overlain by Cretaceous rocks, forms the coastal section east of Seaton. Cretaceous rocks also cap the Triassic formations between Beer and Sidmouth.

Mainly flat-lying Upper Greensand and overlying Chalk extend along the whole coastal section between Lyme Regis

Table 2.1.1 Geological column

Era	*Period*	*Epoch*	*Age of start (million yrs)*	*Stratigraphic units mentioned in the text*	*Significant geological events*
Cenozoic	Quaternary	Holocene	0.01		
		Pleistocene	1.6	Clay-with-flints	Periglacial conditions; fluctuating sea-levels
	Tertiary (Neogene)	Pliocene	5.1		
		Miocene	25		Erosion of Mesozoic rocks from much of the region
	Tertiary (Palaeogene)	Oligocene	38		
		Eocene	55		
		Palaeocene	65		
Mesozoic	Cretaceous		144	Chalk	Marine deposition
				Upper Greensand	Uplift and erosion: unconformity
	Jurassic		213	Liassic ('Blue Lias')	Marine deposition
	Triassic		248	Penarth Group	Deposition of non-marine 'continental' sediments
				Mercia Mudstone	
				Otter Sandstone	
				Budleigh Salterton Pebble Beds	
				Aylesbeare Mudstone	
Palaeozoic (Upper)	Permian		286	Dawlish Sandstone	Deposition of non-marine 'continental' sediments
				Exeter Group	
	Carboniferous		360		Variscan Orogeny; emplacement of granites
	Devonian		408		Marine deposition; Variscan Orogeny
Palaeozoic (Lower)	Silurian		438		
	Ordovician		505		
	Cambrian		590		
	Precambrian				

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



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

and Axmouth. Beneath this lie Jurassic rocks (Lower Liassic mudstones and 'Blue Lias' cementstones), and along the western part of this section, between Culverhole Point and Humble Point, the limestones and mudstones of the Triassic Penarth Group are exposed. This is the uppermost limit of these Triassic rocks, which, further west, have been removed by erosion, the surface then being covered unconformably by Cretaceous strata.

At Seaton Hole a north-south fault throws Cretaceous Upper Greensand strata against Triassic Mercia Mudstone, and at Beer the Upper Greensand is overlain by chalk, forming high, sheer cliffs. Between Branscombe and Sidmouth the cliffs are formed of eastward-dipping Mercia Mudstone with unconformable cappings of Upper Greensand and chalk. Superficial periglacial deposits of clay-with-flints overlie the Cretaceous formations and fill irregularities in its surface. The Triassic Otter Sandstone forms cliffs from near Sidmouth to the mouth of the River Otter at Budleigh Salterton. At Big Picket Rock it is overlain by red Mercia Mudstone in the cliffs that rise to form High Peak at 157 m OD, while at Ladram Bay it forms sea stacks. An outlier of Upper Greensand caps the Mercia mudstone in this section.

At Budleigh Salterton the Otter Sandstone gives way to the older Budleigh Salterton Pebble Beds, which form a prominent feature to the west of the town and which in turn give way to the gently eastward-dipping (tilted) Aylesbeare Mudstone, which is Permian or Triassic in age. This forms the cliffs westwards towards Exmouth, and sandstone beds within it form Orcombe Rocks and the headland of Straight Point. Between Dawlish Warren and Dawlish the Permian Dawlish Sandstone, a succession of red, cross-bedded sandstones of wind-blown origin, forms the coastline, with breccias (a coarse sedimentary rock composed of large, angular fragments) at Langstone Rock. South of Dawlish as far as Torquay, northward-dipping red breccias of the Permian Exeter Group form a cliffed coastline, broken by the Teign Estuary.

Tor Bay to Falmouth

The Devonian rocks of this section have a complex structure. During the Variscan orogeny, which occurred between 375 and 300 million years ago, they were faulted, folded and cleaved (compressed so as to become fissile along a plane), with two generations of major thrust faults slicing up the sequence. The generalised structure of an east-west dividing line between the main rock units in south Devon and central Cornwall, cutting the coast at Pentewan, has been further complicated by major north-west-trending

strike-slip faults, as at Kingsand and Portwrinkle, which have dextral (clockwise) lateral displacements of up to 8 km. Thus there are few uninterrupted stratigraphic sequences along this section of the coast, and the following description is ordered by the age of the rocks rather than the coastal sequence.

Lower Devonian mudstones, siltstones and sandstones make up the cliffs of Start Bay and the coastline to the west, as far as Pentewan. The lowermost rocks, of lacustrine and fluvial origin, outcrop around Dartmouth, along the western side of Bigbury Bay, Whitsand Bay and parts of the coast between Looe and Fowey. Younger, shallow marine mudstones and thin sandstones form stretches of the coast north of Start Point, in parts of Whitsand Bay and in St. Austell Bay. Coarse fluvial and deltaic sandstones, of the youngest Lower Devonian age, are present in the cliffs between Berry Head and Dartmouth and form the high ground on either side of Plymouth Sound.

Tor Bay is bound to the north by the Hope's Nose promontory and to the south by Berry Head, both largely comprising Middle Devonian coral and stromatoporoid (fossil algal) limestones, but which occur in separate thrust sheets. Middle Devonian limestones also form the famous Plymouth Hoe.

South of Pentewan the sedimentary rocks seen at the coast are of Middle and Upper Devonian age and originated in a deep water basin to the south. They were transported northwards in late Devonian times, within thick thrust sheets (nappes), onto shallow shelf deposits. They comprise thick sandstone and mudstone sequences at Mevagissey Bay and Gerrans Bay, limestone and chert on the north side of Gerrans Bay, and sedimentary breccias at Gorran Haven, Veryan Bay and the east side of Gerrans Bay, with a great variety of exotic blocks, such as the Nare Head basalt, which is over 1 km across.

The rocks of Start Point to Bolt Tail and Dodman Point are also thought to be part of this family of large thrust nappes. These originated as mudstones, sandstones and lavas on the deep basin floor and were then recrystallised under high temperature and pressure to form schists.

In small sections near Thurlestone and Kingsand, Permian breccias and lavas rest unconformably on Devonian rocks.

2.1.3 Further sources of information

A. Maps

British Geological Survey. 1983. *Lizard Sheet 49°N-06°W, Solid geology. 1:250,000 series.* Keyworth, British Geological Survey.
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B. References cited

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C. 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.

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Selwood, E.B., Edwards, R.A., Simpson, S., Chesher, J.A., Hamblin, R.J.O., Henson, M.R., Riddolls, B.W., & Waters, R.A. 1984. Geology of the country around Newton Abbot. *Memoir of the British Geological Survey*, Sheet 339 (England and Wales).

D. Contact names and addresses

Type of information	*Contact address and telephone no.*
Geological information for region and the whole of Britain, including geological maps at 1:50,000 scale	Coastal Geology Group, British Geological Survey, Keyworth, Nottingham NG12 5GG, tel: 0115 936 3100
Geological Conservation Review sites: Devon	*English Nature Devon Office, Okehampton, tel: 01837 55045
Geological Conservation Review sites: Cornwall	*English Nature Cornwall Office, Truro, tel: 01872 262550

*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 sediments and rocks 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 in the early Holocene. The lithology (rock types) and thickness of the sediments have been determined by sampling, high resolution seismic profiling and sidescan sonar.

In many areas the sediment cover is thin and the form of the sea bed is a close approximation to that of the bedrock erosion surface. Areas of virtually sediment-free rock occur, particularly in Lyme Bay, between Start Point and Plymouth, near Eddystone Rocks and at the eastern entrances of St. Austell and Falmouth Bays. However, in Start Bay, off Tor Bay and the mouth of the River Exe, sediments greater than 5 m in thickness occur (Map 2.2.1).

Over much of the region the sea-bed sediments consist of a discontinuous cover of coarse 'lag' (i.e. winnowed) deposits less than 0.5 m thick. These deposits are mostly gravels and sandy gravels formed of pebbles of flint, chalk, sandstone, limestone and ironstone; fine-grained granite and igneous and metamorphic pebbles are less common. The gravel is often muddy as a result of contamination with clay from the underlying clay bedrock. Pebbles and cobbles are heavily encrusted with serpulids, bryozoans and barnacles, indicating that they are not being moved about under the present current regime, and that they were probably transported when sea levels were lower and fluctuating. In some areas longitudinal gravel furrows have formed parallel to the direction of tidal currents.

The lag deposits are locally overlain by mobile bodies of sand, in the form of ribbons, sand waves and rippled sand patches. Nearshore, thicker sands occur, notably in Lyme Bay. The main component of the sandy sediments is detrital quartz, with smaller amounts of feldspars, micas and heavy minerals. Shell material occurs in most sediments, with shell beds at some locations, for example in Lyme Bay.

In Lyme Bay, sandy mud and muddy sand are found in the areas most sheltered from strong tidal currents. The sand is fine to very fine. South-west of Start Point the sands tend to become cleaner and finer and contain more carbonate in the form of finely-broken shell material.

2.2.2 Pleistocene geology

In the English Channel generally, Pleistocene deposits tend to be limited to palaeovalley infills beneath Holocene sea-bed sediments, but few such valleys have been identified in this region (Map 2.2.2). Offshore, near the base of submerged cliffs, some rias can be shown to have once extended to below the 37 m isobath, but these valleys are now infilled and have little topographic expression. Pleistocene infill of sand, clay and gravel may extend to 56 m depth. Sub-aerial and fluvial erosion during the late Pleistocene led to over-deepening of the channel of the River Exe and its extension as far south as Tor Bay. The buried palaeovalley of the River Tamar in Plymouth Sound was also formed during this period of low sea-level.

2.2.3 Solid (pre-Quaternary) geology

Rocks deposited before the start of the Quaternary Period (1.6 million years ago) are included by geologists in the category of 'solid geology'. The rocks at sea bed fringing the coast are largely an extension of what is seen on the coast (Map 2.2.3). Jurassic mudstones, shales, sandstones and limestone off the east Devon coast give way to Permo-Triassic clastic sediments (for example sandstones and brecchias) in the section between Beer Head and Hope's Nose. Farther offshore in Lyme Bay and to the south these sediments are unconformably overlain by sandstone and chalk of Cretaceous age.

Resistant, metamorphosed Devonian sediments, locally intruded by mainly granitic igneous rocks, extend from Tor Bay to beyond the western limit of the region as a sea-bed outcrop which extends about 5 km offshore. The rocks include schist, siltstone and limestone. Farther offshore these rocks are overlain by a thick sedimentary basin of Permo-Triassic, Cretaceous and Jurassic sediments - sandstones, siltstones and breccias - which have been subject to later uplift and local deformation.

Off Start Point green hornblende and chlorite schists are faulted against Devonian rocks. The schists extend offshore for nearly 10 km to the south and west before they are buried beneath Permian-Triassic sediments. The Eddystone Rocks consist of an isolated pinnacle of garnetiferous, granitoid gneiss that is part of a larger submarine outcrop of mica schist and gneiss surrounded by Permian-Triassic sediments.

2.2.4 Further sources of information

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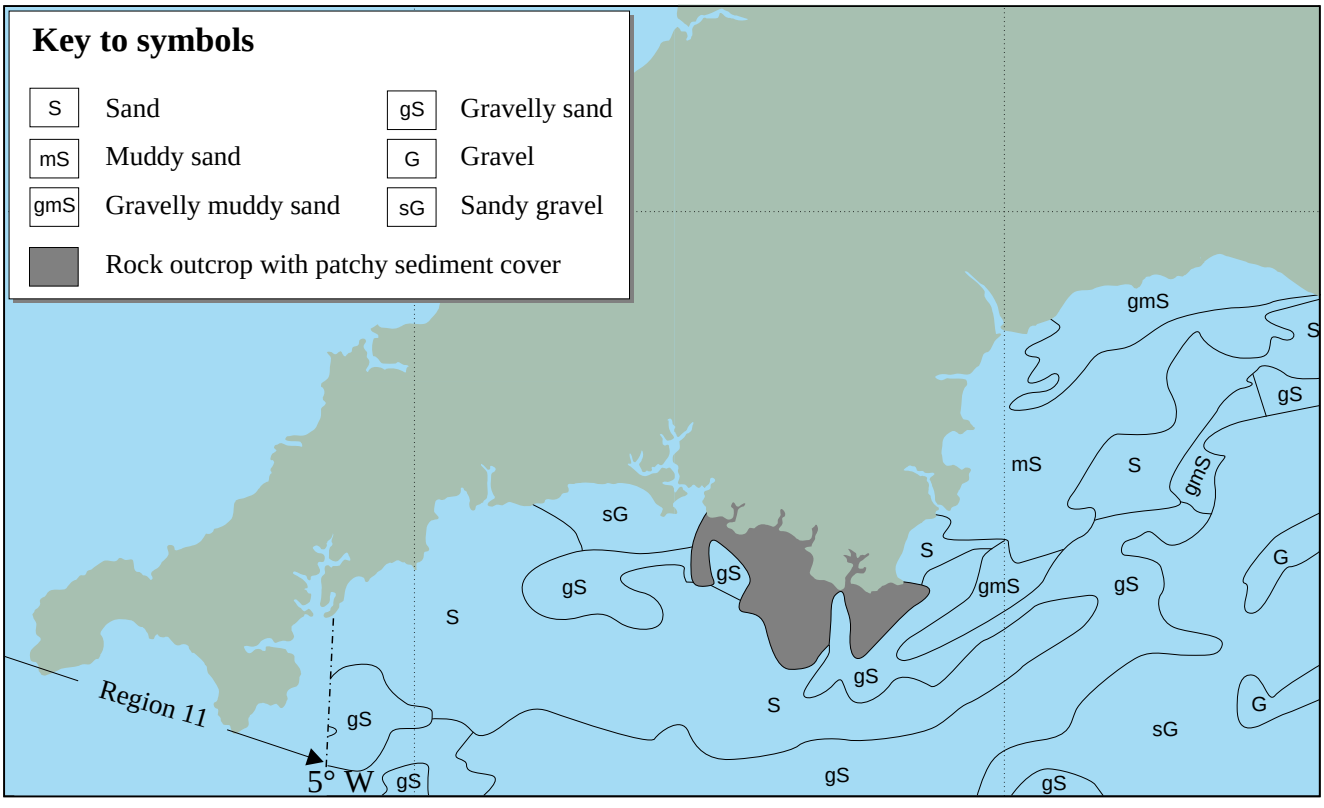
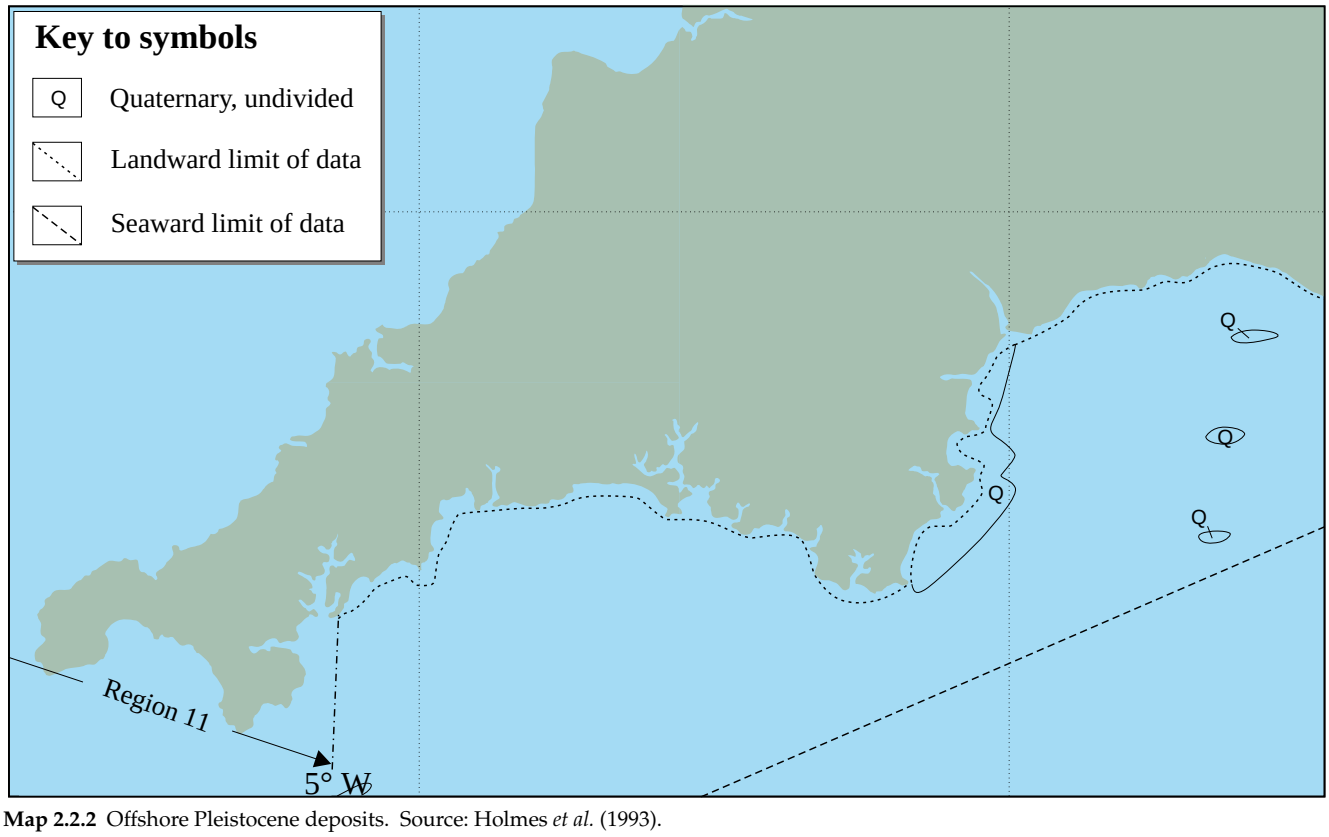
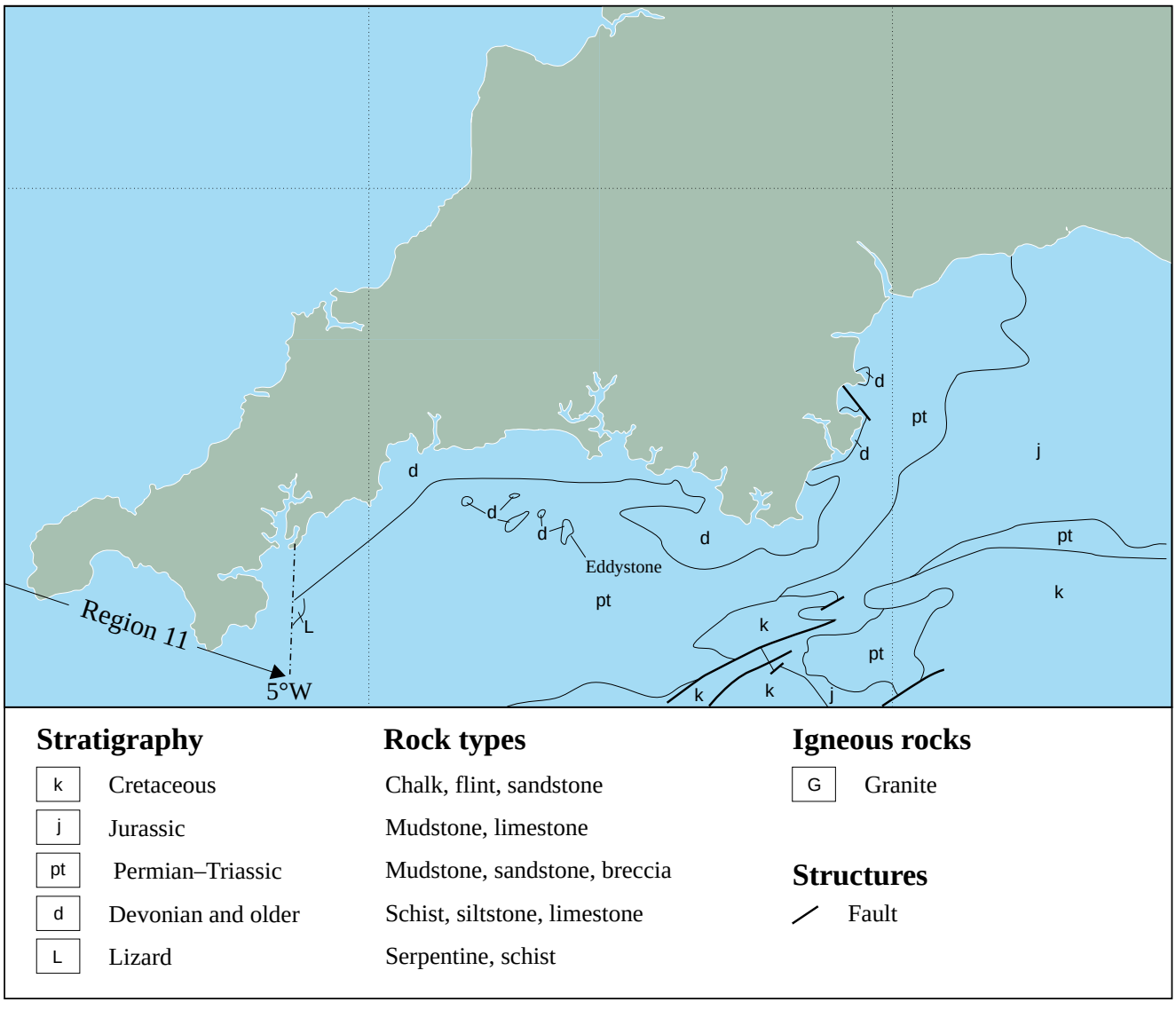


Map 2.2.1 Sea-bed sediments. Source: British Geological Survey (1991); sediment classification modified after Folk (1954).



Map 2.2.2 Offshore Pleistocene deposits. Source: Holmes *et al.* (1993).



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

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D. Contact names and addresses

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

2.3 Wind and water

British Geological Survey

2.3.1 Wind

The prevailing winds throughout the year are from the south-west (Figure 2.3.1), with strong winds occurring in winter, when a series of gales, lasting on average 4-6 hours each, may persist for several days. Speeds of 45 m/sec (90 knots) or more have been recorded at various places in the region. Small depressions develop rapidly and move quickly eastwards causing frequent changes in wind conditions but not in wind direction. Winds from the south-east are less frequent and usually less persistent. Spring is the most common season for north-east winds. Maps 2.3.1 and 2.3.2 show, respectively, contours of the wind speeds exceeded for 75% and 0.1% of the time.

The coastal waters, estuaries and harbours are subject to local variations in wind conditions, compared with the open sea. For example, the cliffs of Start Point and Dodman Point are exposed to south westerly winds, while the lee sides of such headlands are relatively sheltered, particularly in Lyme Bay.

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.

East of Start Point is the wide expanse of Lyme Bay, where depths are less than 60 m and the nearshore sea-bed slope is relatively gentle. At the mouth of the River Exe and in Babbacombe, Tor and Start Bays there are large areas less than 10 m in depth (Map 2.3.3).

The nearshore zone is steepest around major promontories such as Start Point. West of Start Point the cliffed coast is broken by rias where the sea penetrates along drowned river valleys. Away from these valleys, from the foreshore to a depth of about 7 m to 20 m, the sea bed is typically a continuation of the present day cliff slope, although slopes are gentler in bays that lack a cliff surround. Below 20 m the sea bed slopes relatively steeply to a depth of about 50 m. A series of cliffs, separated by nearly horizontal 'benches' (submerged beaches), mark submerged coast lines. Below about 50 m depth the sea bed is formed by a planar submarine erosion surface.

Around Eddystone, where metamorphic and igneous rocks have resisted erosion, the sea bed rises to less than 20 m depth.

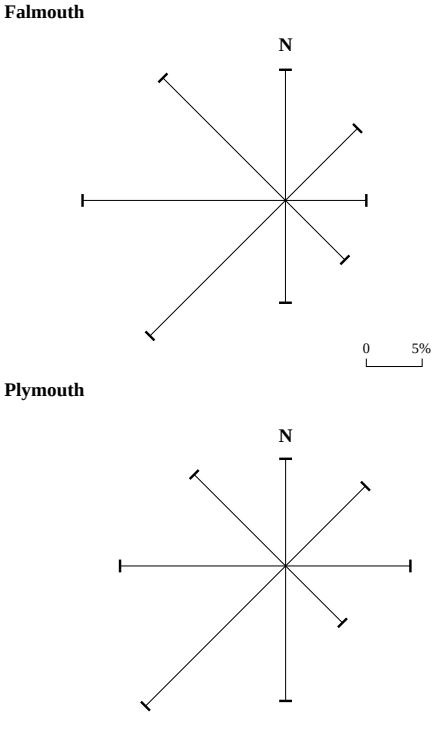
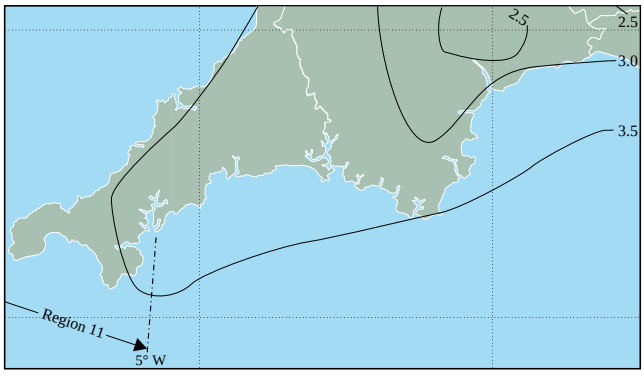


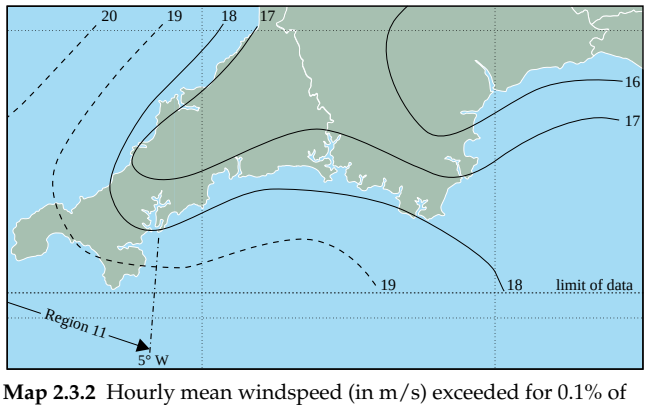
Figure 2.3.1 Wind directions at Plymouth and Falmouth, shown as % of observations during the years 1913-1950. Source: Hydrographic Department (1984).



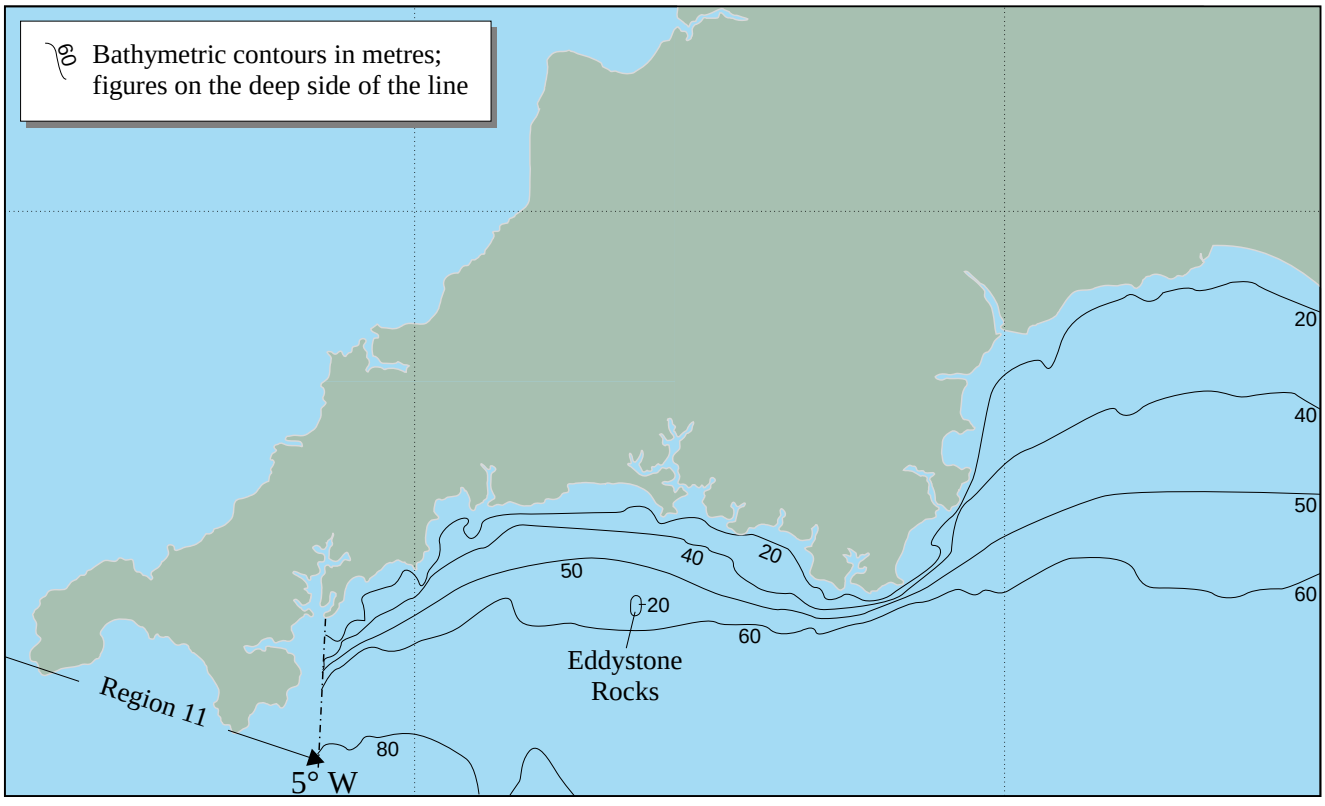
Map 2.3.1 Hourly mean windspeed (in m/s) exceeded for 75% of the time. Source: Caton (1976).

2.3.3 Tidal currents

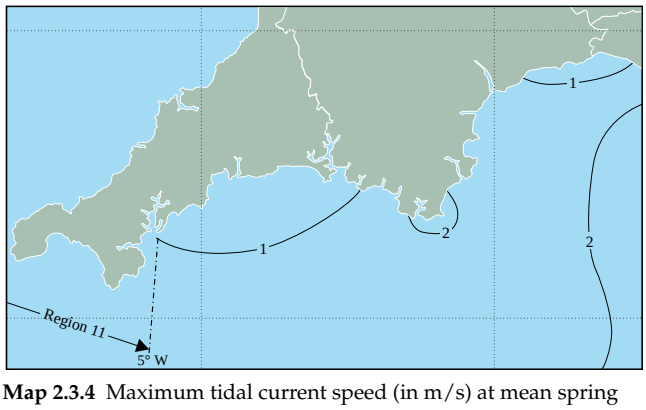
Tidal current speeds (Map 2.3.4) are increased by the constriction of Atlantic water flow between Start Point and the Cotentin Peninsula on the French coast, although currents tend to be greater near to headlands such as Start Point. Maximum tidal streams of less than 0.5 m/s occur in parts of Lyme Bay and along some of the coastline between Plymouth and Falmouth.



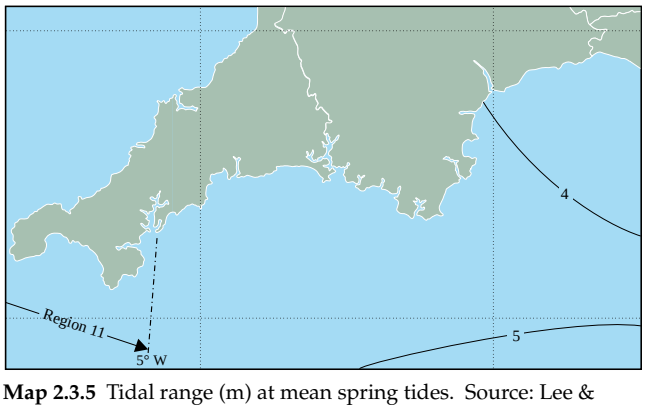
Map 2.3.2 Hourly mean windspeed (in m/s) exceeded for 0.1% of the time. Source: Caton (1976).



Map 2.3.3 Bathymetry. Source: British Geological Survey (1991).



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



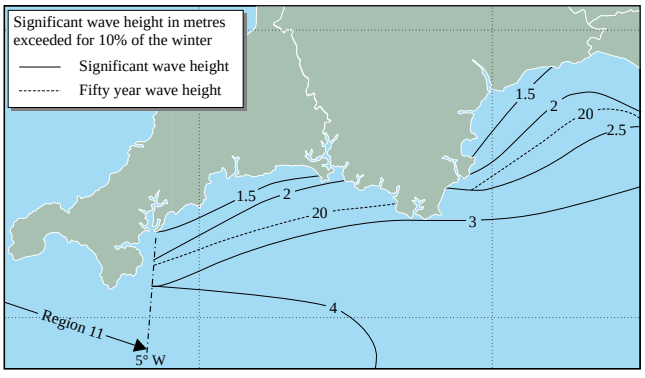
Map 2.3.5 Tidal range (m) at mean spring tides. Source: Lee & Ramster (1981). © Crown copyright.

2.3.4 Tidal range

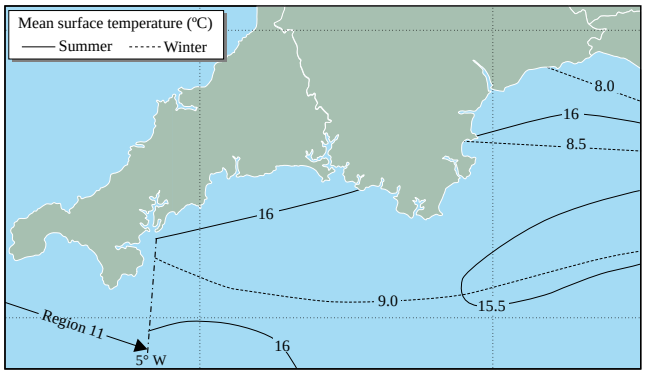
Tidal ranges for the region are shown on Map 2.3.5. Values are not exceptionally large (as they are in parts of Region 11 and across the English Channel in Brittany) or small (as in Region 9): the tidal range at mean spring tides is less than 4.0 m in Lyme Bay, increasing to over 4.5 m towards the west. The tidal range increases towards the French coast and particularly towards the Channel Islands, where the shallow water and the funnelling effect between the Brittany coast and Cotentin Peninsula amplify the tidal wave.

2.3.5 Wave exposure and sea state

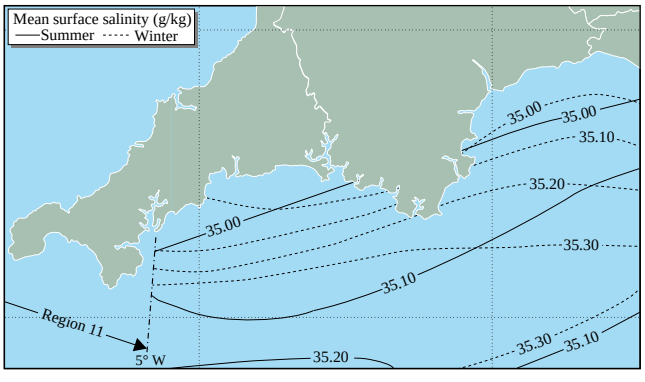
Large waves are generated by the prevailing south-westerly winds, which have a long 'fetch' from the Western Approaches of the English Channel onto the south-westerly facing coasts of the region, such as between Start Point and Plymouth. Map 2.3.6 shows the significant wave heights that can be expected to be exceeded for 10% of the winter. For example off Start Point one would expect a significant wave height of at least 3 m for 10% of the winter, while the maximum wave height expected about once in 50 years is more than 20 m.



Map 2.3.6 Significant wave height (m) exceeded for 10% of the winter, and 50-year wave height. 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 sea water in summer and winter in g/kg of total dissolved salt. Source: Lee & Ramster (1981). © Crown copyright.

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, which are the months of, respectively, highest and lowest average sea surface temperature. In winter, relatively warm Atlantic waters flow up into the English Channel; average sea surface temperatures in this region (and to the west) are the warmest in Britain, up to nearly 9°C in February. In summer temperatures fluctuate around 16°C.

Salinity

Overall the salinity of waters in this region is high (more than 35 g/kg), mainly because of the movement of Atlantic waters into the English Channel. Where there is dilution from freshwater discharge, salinity values decrease toward the coast in both summer and winter. The mean surface salinities for summer and winter are shown on Map 2.3.8, based on data for August and February respectively. Data are averaged for each month, which has the effect of smoothing out salinity gradients in some areas.

2.3.7 Further sources of information

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
UKDMAP (United Kingdom digital marine atlas) Version 2. Oceanographic maps.	British Oceanographic Data Centre, Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, tel: 0151 652 3950
Monthly, seasonal and annual windroses	J. Hammond, Meteorological Office Marine Enquiry Service, Johnstone House, London Road, Bracknell RG12 2SY, tel: 01344 854979

2.4 Sediment transport

British Geological Survey

2.4.1 Description

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). The region forms the major part of Coastal Cell 6, which runs from Portland Bill to Land's End. The cell has been divided into five sub-cells, of which four are in this region. Each sub-cell is considered in terms of its littoral drift and any active erosion or accretion. Sub-cells are described below and shown on Map 2.4.1. Note that the sediment transport shown is of sand and gravel 'bed load', not suspended sediments.

Sub-cell 6a: Portland Bill to Dawlish Warren

Littoral drift is variable but generally eastward in this sub-cell and sediment transport is low and intermittent. There is sand and shingle build up at Lyme Regis, owing to the trapping effect of the harbour wall, and consequent downdrift erosion to the east because of the interruption of sediment flow. Sand accretion occurs at Exmouth, the sand coming from Dawlish Warren and being transported by waves and tidal currents across the bar at the estuary mouth.

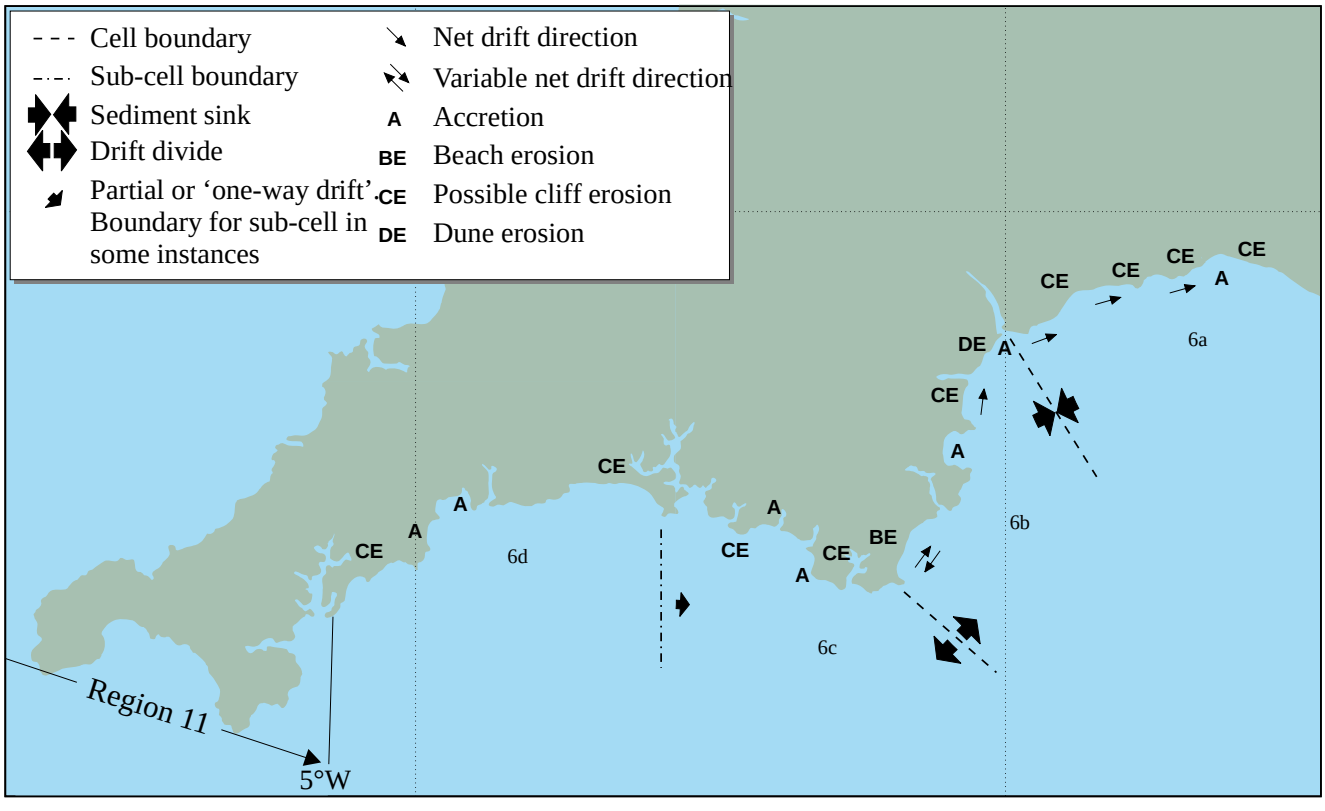
Between Lyme Regis and Exmouth the cliffs are subject to rapid erosion and slippage. At Lyme Regis the coastline consists of soft, easily erodible cliffs of clay. Waves erode these cliffs and 'rip' currents transport fine sediments seaward in suspension. There is dune erosion at Dawlish Warren.

Sub-cell 6b: Dawlish Warren to Start Point

There is weak northward drift within this sub-cell, but the extensive beaches are subject to strong seasonal changes in drift direction. Wave action dominates the coastal processes, and in areas such as Start Bay onshore-offshore movement is as important as along-shore movement in controlling beach sediments. The barrier shingle beach at Slapton in Start Bay is prone to strong along-shore and onshore-offshore movement, resulting in beach draw-down. There is erosion of sandstone cliffs north of Torquay, which provides beach sand. In sand-filled estuary mouths, as at Teignmouth, waves and tidal currents interact to produce very complex and largely unpredictable patterns of movement. Owing to the indented nature of the coast there is little interaction between adjacent bays, but there are certainly major drift movements within individual bays, such as Babbacombe, Tor and Start Bays.

Sub-cell 6c: Start Point to Rame Head

Potential drift is eastwards, but the transport rate is insignificant. Wave action includes an element of Atlantic swell, which helps to produce extensive sandy beaches in the estuaries of the Rivers Avon and Erme. The coastline is



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

strongly dissected by estuary mouths and promontories and there is very little interaction between adjacent stretches of coast. In Bigbury Bay the shale and slate cliffs are subject to weathering and erosion.

Sub-cell 6d: Rame Head to Lizard Point

There is virtually no net drift within this sub-cell. Some Atlantic swells penetrate to the eastern end of Whitsand Bay, producing extensive sand beaches. There are significant beaches of gritty china clay residual sand in St. Austell Bay, where tidal currents have redistributed china clay waste. At the west end of Whitsand Bay and at Veryan Bay, wave action in the English Channel is an important element in the production of local cliff erosion.

2.4.2 Further sources of information

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

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Coast protection policy; sediment cells	*Ministry of Agriculture, Fisheries and Food (MAFF), Flood and Coastal Defence Division, London, tel: 0171 238 3000
Sediment cells	HR Wallingford Ltd, Howbury Park, Wallingford, Oxfordshire OX10 8BA, tel: 01491 835381
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
North Sea Project data set CD ROM	British Oceanographic Data Centre, Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, tel: 0151 652 3950

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

2.5 Sea-level rise and flooding

British Geological Survey

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, Scotland is rising whereas southern England is sinking) and changes in global sea level, estimated as rising between 1.5 and 2 mm/year.

The best estimates of recent sea-level change across the region are based on information from the tide gauges at Newlyn, with corroborative data from Devonport and sites further afield. Measurements from 1916 to 1983 show an average rise in sea level of about 1.6 mm/year (Woodworth 1987), with no recent increase in this rate attributable to global warming, the effects of which can only be estimated from the predicted response of theoretical models of the oceans. 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 factors contributing to the uncertainty.

Evidence for land-level changes comes from dating Holocene freshwater or marine sediments, such as the submerged forest beds located around the coast of the region. In Britain a line from the Llyn Peninsula to the River Tees separates areas to the south, which are largely subsiding, from areas to the north, which are rising. However, Cornwall is known to be rising (Shennan 1989) (Map 2.5.1).

2.5.2 Flooding in the region

The mainly cliffed nature of the coasts has restricted the risk of flooding in the region to areas surrounding the major estuaries, such as the Axe, Otter, Exe and Tamar, Salcombe Harbour, and the major spit and sand dune complexes, for example Dawlish Warren and Slapton (Motyka & Brampton 1993). These areas are shown on Map 2.5.1. The sea fronts at Seaton, Sidmouth and Budleigh Salterton are at risk from flooding during storms, especially those blowing from the east. Wave overtopping can occur along the sea front at Dawlish and at Slapton in Start Bay.

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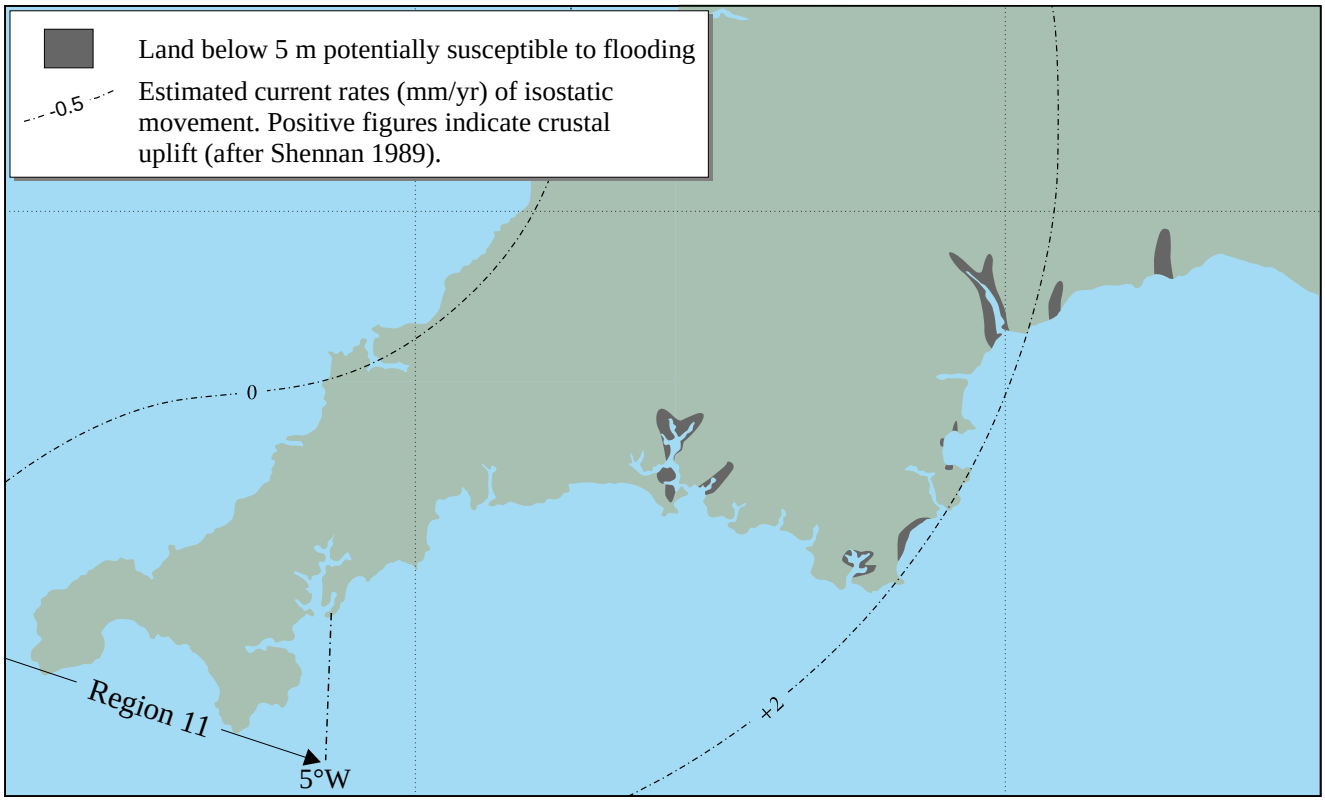

Map 2.5.1 Areas below 5 m above OD and thus susceptible to flooding. Source: estimated rates of crustal uplift (mm/yr) after Shennan (1989).

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Flood defence	*Environment Agency - South-western Region, Exeter, tel: 01392 444000
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, Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, tel: 0151 652 3950

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

2.6 Coastal landforms

British Geological Survey

2.6.1 Description

Much of this section of coastline is dominated by cliffs. These are relatively soft and even slumped to the east, where the rocks are less well consolidated, and harder and more rugged to the west, where the rocks are older and more crystalline. The coastline is broken by a series of drowned valleys, which were cut during the Pleistocene in periods of lower sea level and subsequently filled with estuarine deposits. 'Soft' shores are few and far between in this region, but there is saltmarsh associated with sheltered areas in the rias and sand dune systems at Dawlish Warren, at the mouth of the Exe, and at Par near St. Austell. There is a significant shingle structure at Slapton Sands, which encloses a lagoon behind it. There are many examples of Tertiary and Pleistocene coastal retreat features in this region (see also section 2.2.2). Periods of consistent higher sea levels produced widespread marine erosion surfaces on which raised beaches may be preserved, backed by the former cliff lines. Major coastal landforms are shown on Map 2.6.1.

Dorset border to Torquay

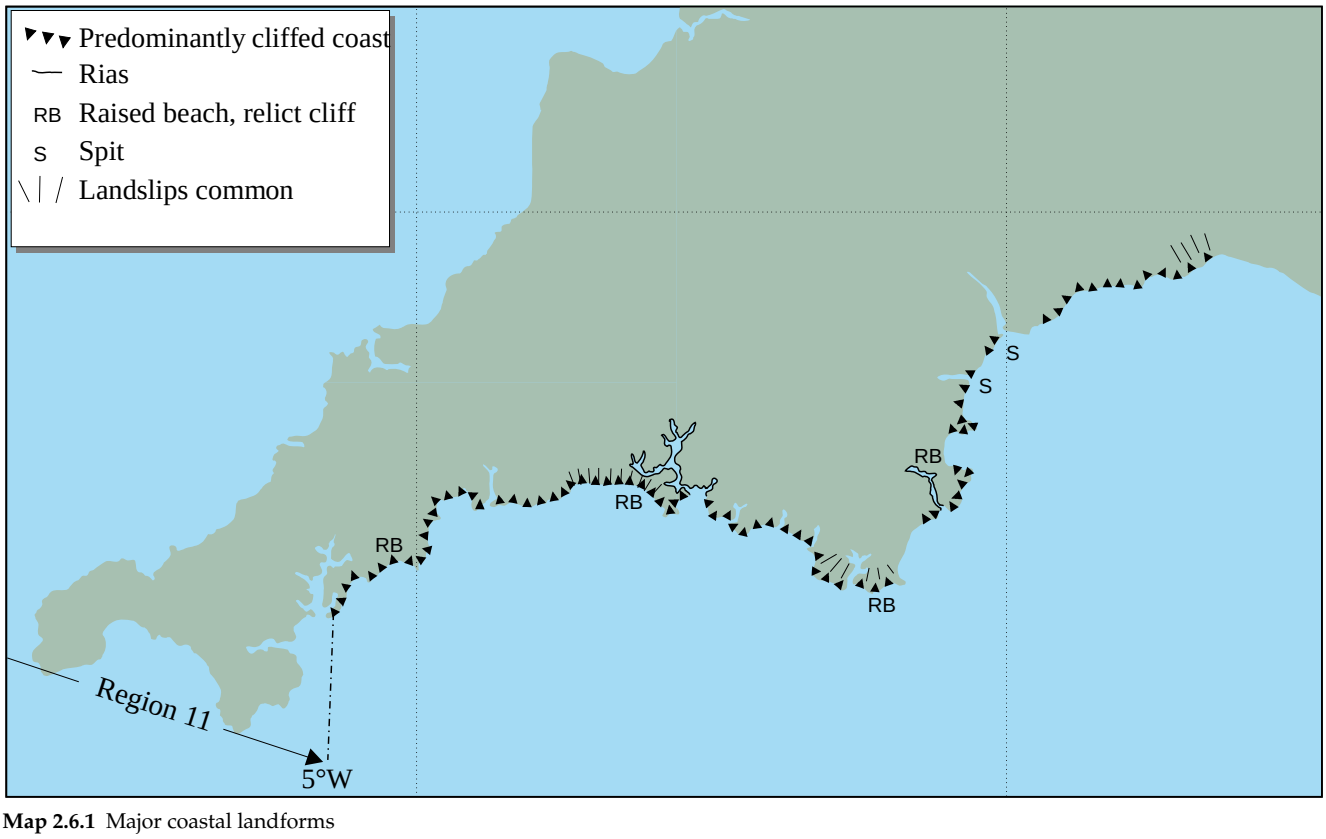
In the extreme east of the region some 8 km of slumped Jurassic rocks topped by Upper Cretaceous strata form the well known Lyme Regis to Axmouth Undercliffs. This flat-topped landform reaches a height of between 100 and 150 m. The River Axe, which reaches the coast at Seaton, cuts between these cliffs and the chalk headland of Beer Head. To the west Triassic rocks emerge from under the chalk to form less rugged, though generally sheer, cliffs along the exposed shoreline. Steep, partly wooded coombes break the cliffs at Branscombe and Dunscombe. Cliffs of Triassic rocks persist almost to Exmouth, broken by the Rivers Sid and Otter at Sidmouth and Budleigh Salterton respectively. There are few beaches and relatively little intertidal area along this section of coast. A small area of sand dune is present south of Exmouth at The Maer.

The Exe is a large drowned river valley, whose channel, cut at a time of lower sea levels, reached a depth of nearly 50 m but is now filled with sediment. It has extensive areas of intertidal mudflats and a sand bar at the mouth. Upstream there are significant areas of saltmarsh. The sand spit at Dawlish Warren, which partially closes off the Exe Estuary, is capped by dunes, forming the largest area of blown sand on the south Devon coast.

Southwards to Teignmouth, Babbacombe and Torquay the coast is again rock-bound and often cliffed. Softer shores of mudflats and saltmarsh are present around the drowned estuary of the River Teign.

Torquay to Falmouth

South and west of Torquay the character of the coast is of cliffs and rocky headlands, interspersed with small 'pocket' beaches and rias (drowned river valleys). The two headlands enclosing Tor Bay, Berry Head and Hope's Nose are formed of hard Devonian limestone and slates; the centre of the bay itself is cut into softer Permian sandstones.



Map 2.6.1 Major coastal landforms

The River Dart is a fine example of a ria, with steep, locally wooded, sides: there is no bar at its mouth. Start Bay to the south is a classic example of submerged coastline, with a rolling landscape to landward, bordered seaward by a continuous flint-rich shingle beach. At the centre of the bay shoreline the Slapton Ley lagoon separates the beach from the land.

The spectacular cliffed coast between the Bolt Tail and Start Point is formed of green and mica schists traversed by numerous quartz veins. This tract of coast is broken by the Kingsbridge Estuary, a ria with a restricting bar at Salcombe Harbour at its mouth.

The coast from the Lizard to Bolt Tail is formed of slates and sandstones and consists of major headlands, such as Rame Head and the Dodman, separated by low cliffs, commonly falling to a raised beach erosion platform. Larger inlets such as Carrick Roads east of Falmouth and Plymouth Sound are major ria systems, more complex in form than those to the east. The shores are commonly wooded, and peninsulas between the rias, such as Roseland, are very beautiful. The complexity of the coastal landforms is a function of the variations in rock type, leading to differential erosion, and the structural complexity of the rocks.

The largest beach in Region 10 is Whitsand, west of Plymouth, material from which is transported eastwards by the prevailing south-westerly waves. Pocket beaches are formed within the small coves, and small sandy bars may be formed where minor rivers reach the sea.

Pleistocene cliffs and raised beaches occur at heights up to 35 m above OD on this coast. Around Torbay fossils are preserved on a wave-cut platform at 9 m to 11 m OD and overlain by head - a periglacial deposit that has moved down-hill under gravity. Semi-consolidated raised beach deposits, blown sand and relict cliff scree are preserved under the head at Prawle Point. Dating of the features is uncertain and it is probable that their preservation is due to the land having risen since their formation rather than sea level having fallen.

2.6.2 Further sources of information

A. Further reading

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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

The woods of the National Nature Reserve on the massive landslip undercliffs between Axmouth and Lyme Regis are home to many different kinds of invertebrates and lower and higher plants. They are also one of the relatively few locations in England for the misnamed 'common' dormouse. The instability of the slope sustains the mixture of vegetation that the animal needs to supply its varied diet. Photo: Nick Davidson, JNCC.

Chapter 3 Terrestrial coastal habitats

This chapter covers terrestrial habitats that are maritime influenced, i.e. are distinctive because of their association with the coast and coastal processes. Adjacent to some parts of the UK coast there are other semi-natural habitats of importance that are not directly influenced by the sea, including for example lowland heathland, woodland, dry grassland (other than that on typically coastal substrates - sand, shingle or cliff) and peatland. In this region, there are a number of important areas of non-maritime habitat close to the coast, principally lowland heaths, woodland and old mine workings.

The east Devon pebblebed heaths include extensive areas of dry heath. There are fine examples of the western gorse *Ulex gallii* - bristle bent *Agrostis curtsii* vegetation type, primarily for which this site has been chosen as a possible Special Area of Conservation (SAC). The presence of plants such as cross-leaved heath *Erica tetralix* illustrates the oceanic nature of these heathlands. Both wet and dry heathland at this site is important for lower plants. The heaths are also important for invertebrates such as the southern damselfly *Coenagrion mercuriale*, a priority species under the EC Habitats & Species Directive, and birds such as the Dartford warbler *Sylvia undata* and nightjar *Caprimulgus europaeus*, species not typically associated with the coast. The east Devon pebblebed heaths are considered to be one of the twenty best sites in the country for Orthoptera (grasshoppers and crickets) and allied insects, with seventeen species recorded. Heathland in this region is also valuable habitat for adders, slow-worms and common lizards. The region supports one nationally important amphibian species assemblage, at Chudleigh Knighton Heath, Devon, where all five of the widespread species are reported to breed.

Woodland in the region is second only to heathland in its importance as lower plant habitat, and some areas support a flora substantially influenced by their proximity to the sea. Many oceanic lower plant species, particularly some liverworts, are almost confined to woodland. The epiphytic lichen flora on trees at Slapton Ley is particularly notable. Woodland on the slumping cliffs from Sidmouth to Beer and Bolt Head to Bolt Tail, Devon, is known to be of national importance for invertebrate conservation. Many scarce and threatened species have been recorded in the region's coastal woodland, including at Ethy Woods the beetle *Thymalus limbatus* and the weevil *Mesites tardii*. Blomer's rivulet *Discoloxia blomeri*, a moth with a primarily western distribution, has been found at Sheviock Wood. Woodland associated with the east Devon pebblebed heaths supports several scarce or rare invertebrate species: the ringed carpet moth *Cleora cinctaria* inhabits the lightly wooded heathland, the wood cricket *Nemobius sylvestris* can be found deep in leaf litter in warm sunny clearings, and the bog bush cricket *Metrioptera brachyptera* is found in clearings in damp woodland. The steep wooded valleys of the rias of the region, for example at Looe, provide nesting habitat for grey heron *Ardea cinerea*. In Region 10 the dormouse is on the western edge of its range in Europe; it occurs here in ancient coppiced or scrubby woodland along the east Devon coast, particularly the wooded undercliffs of the coastal National Nature Reserve between Axmouth and Lyme Regis. Woodland in the region is particularly important in a national context for bats. In Britain the lesser horseshoe bat *Rhinolophus hipposideros* is restricted to the south-west, where it is concentrated along the south-east coast of Devon and is associated particularly with ancient woodlands.

Old mine-workings and china clay quarries are a characteristically Cornish landscape feature and support a unique and specialised lower plant flora. Some bryophytes and lichens are specialists of soils rich in heavy metals and are virtually confined to old lead and copper mines. The mine workings themselves are frequently used by bats. In Devon, the population of the greater horseshoe bat *Rhinolophus ferrumequinum* is of national importance, being at the northern and western limit of its range. There are several important underground roost sites in the county, and a nursery roost is known from an old mine system near Par, Cornwall. Beer Quarry and Caves, Devon, a complex of abandoned mines, is a possible SAC for its regular use by a small number of Bechstein's bats *Myotis bechsteinii* and its nationally important assemblage of other bat species.

3.1 Cliffs and cliff-top vegetation

Dr T.C.D. Dargie

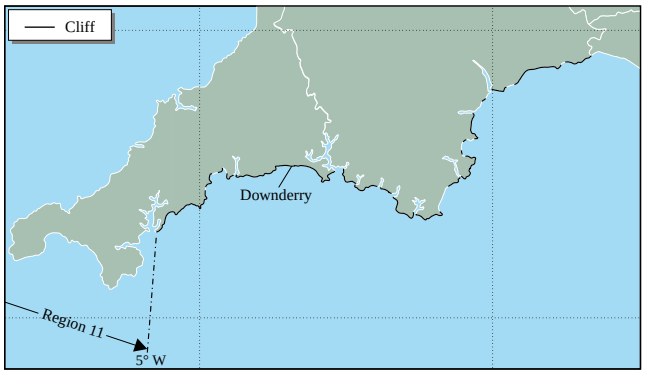
3.1.1 Introduction

Geology and geological structure, together with past environmental history (marine erosion past and present and 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 soft shales and Quaternary deposits).

The coast of the region contains fine extents of cliff and cliff-top habitats. The region has a total cliff length of 240 km, representing 6% of the British resource, and is therefore of importance in the national context (Table 3.1.1; Map 3.1.1).

Cliffs in the region exhibit good diversity of form (Table 3.1.2) (Doody *et al*. 1993). Spectacular soft cliffs have developed between Lyme Regis, west Dorset, and Axmouth, east Devon, involving stiff Jurassic clays with hard cap-rock, which form a continuous stretch of stepped landslips and wooded undercliffs, in places extending 600 m inland and rising to 160 m in height. Hard cliffs are much more extensive, with fine lengths of tall (50-100 m) near-vertical cliffs developed in varied sedimentary and igneous rocks between Beer in Devon and Zone Point in Cornwall. The maximum hard cliff height of 162 m is found in Triassic sandstone at Weston Cliff, east of Sidmouth.

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. 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. Very sheltered cliffs and cliff-top sectors that receive little salt spray input are not here treated as coastal habitats. Soft cliffs on sheltered coasts can develop undercliff vegetation of woodland, scrub, tall herb and rank grassland, often very close to the sea. The full regional extent of cliff-top habitat has not been surveyed but the moderate exposure of the coast to very strong winds and heavy spray deposition allows mainly maritime grassland to develop, with most of this restricted to hard cliffs. The total extent of maritime cliff grassland in the region is estimated at 529 ha, representing 28% of the total extent in England (Table 3.1.1).



Map 3.1.1 Sea cliffs. Source: JNCC Coastal Database and OS Landranger maps. © Crown copyright.

The scenic contribution of cliffs within the region is outstanding, with tall and soft cliffs in Jurassic strata for part of the east Devon coast, and imposing hard vertical cliffs of Triassic, Permian and Devonian strata and older igneous rocks for the remaining coast in Devon and Cornwall (see also section 2.1). This scenic value is recognised with 103 km (Devon) and 25 km (Cornwall) of largely cliffed coast fronting Areas of Outstanding Natural Beauty (Gubbay 1988) and 102 km (Devon) and 59 km (Cornwall) of Heritage Coast (Heritage Coast Forum 1993) (see also section 7.4.3).

3.1.2 Important locations and species

Of the twelve National Vegetation Classification (NVC) maritime cliff communities in the UK (Rodwell in prep.), ten are recorded from England, the remaining two being confined to Scotland. No detailed map information is available for the region's cliff vegetation, but a zonation is recognised on the hard limestone cliffs of the south coast (Mitchley & Malloch 1991), ranging from high spray and exposure conditions (NVC cliff vegetation communities MC1 rock samphire *Crithmum maritimum* - rock sea-spurrey *Spergularia rupicola* rock-crevice, MC4 wild cabbage *Brassica oleracea* cliff ledge, MC8 red fescue *Festuca rubra* - thrift *Armeria maritima* maritime grassland) to more sheltered cliff-top conditions (MC11 red fescue *Festuca rubra* - wild carrot

Table 3.1.1 Cliff and maritime cliff grassland resource in context

	Soft cliffs		*All cliffs*		*Maritime cliff grassland*	
	Total length (km)	*% of total in Region 10*	*Total length (km)*	*% of total in Region 10*	*Total area (ha)*	*% of total in Region 10*
Devon	18	-	113	-	163	-
Cornwall (part)	0	-	127	-	366	-
Region 10	***18***	***-***	***240***	***-***	***529***	***-***
England	256	7	1,165	21	1,895	28
North Sea Coast	?	?	1,800	13	?	?
Great Britain	?	?	4,059	6	?	?

Source: Pye & French (1993), JNCC Coastal Resources Database. Key: ? = area, length or percentage not known. Note: figures have been rounded to the nearest whole km or percentage point.

Table 3.1.2 Lengths (km) of cliff types

	Vertical >20 m high		*Vertical <20 m high*		*Non-vertical >20 m high*		*Non-vertical <20 m high*	
	Length (km)	*% of total length in Region 10*	*Length (km)*	*% of total length in Region 10*	*Length (km)*	*% of total length in Region 10*	*Length (km)*	*% of total length in Region 10*
Devon	42	-	8	-	60	-	4	-
Cornwall (part)	24	-	1	-	85	-	17	-
Region 10	***66***	***-***	***9***	***-***	***145***	***-***	***21***	***-***
England	320	21	49	18	629	23	167	13
North Sea Coast	601	11	380	2	559	26	261	8
Great Britain	1,325	5	818	1	1,371	11	545	4

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

Daucus carota maritime grassland and CG2 sheep's fescue *Festuca ovina* - meadow oat-grass *Avenula pratensis* calcicolous grassland, which is probably common on Cretaceous chalk cliff tops).

In Great Britain nine nationally rare and four nationally scarce species or subspecies of higher plant are found mainly or exclusively on cliffs (see section 5.2). Most cliff occurrences of these species are restricted to the south and west of Britain. Nationally rare species on regional cliffs are slender bird's-foot-trefoil *Lotus angustissimus*, four-leaved allseed *Polycarpon tetraphyllum*, honewort *Trinia glauca,* nit-grass *Gastridium ventricosum,* toadflax-leaved St. John's-wort *Hypericum linariifolium,* white rock-rose *Helianthemum apenninum,* small hare's-ear *Bupleurum baldense*, early gentian *Gentianella anglica,* small restharrow *Ononis reclinata*, goldilocks aster *Aster linosyris*, purple gromwell *Lithospermum purpurocaeruleum,* shore dock *Rumex rupestris* and the whitebeam *Sorbus anglica.* There is a long list of nationally scarce species, the most notable being balm-leaved figwort *Scrophularia scorodonia*, white horehound *Marrubium vulgare*, autumn squill *Scilla autumnalis*, carrot broomrape *Orobanche minor* var. *maritima*, maidenhair fern *Adiantum capillus-veneris*, twiggy mullein *Verbascum virgatum* and the whitebeam *Sorbus porrigentiformis*. The most important cliff locations for these rare and scarce species are the Lyme to Axmouth Undercliffs, the Torquay coast, Berry Head to Kingswear and Start Point to Bolt Tail. Maritime heath is an important national feature of cliff-top habitat and is present on the more acidic rocks in western Devon and Cornwall. The lichen flora of such heath between Start Point and Bolt Head (Devon) and at Nare Head (Cornwall) is rated of national importance (Fletcher *et al*. 1984).

The region has no major cliff sites with important seabird colonies (Stroud *et al.* 1990), though smaller seabird populations are present (see also section 5.10). Berry Head has been designated an Area of Special Protection for birds (see also section 7.3.4), having the largest breeding guillemot colony along the southern English coast (although it is not of national importance). Peregrines breed in nationally important numbers along this stretch of coast.

No systematic survey of invertebrates in cliff and cliff-top habitats has been carried out, but these environments have a rich habitat diversity and thus support large numbers of species (Mitchley & Malloch 1991). Several cliffs in the region have many notable and rare (Red Data Book) species; Lyme Regis to Axmouth, Beer coast to Sidmouth, Walls Hill to Hope's Nose, Start Point to Prawle Point and Bolt Head to Bolt Tail are nationally or regionally important cliff locations on the JNCC's Invertebrate Site Register (see also section 5.3).

A series of large, ancient landslides dominates the coastline between Lyme Regis and Axmouth, creating the unique landscape of the Landslip National Nature Reserve. Of particular interest is the spectacular Bindon Landslip, which was created on Christmas Eve 1839 and attracted visitors from all over the country. Significant erosion problems also occur on the soft rock cliffs between Seaton and Budleigh Salterton, around the Torquay Peninsula, on the Permian breccia cliffs of Paignton and at St. Mary's Bay, Brixham. The cliffs formed of periglacial head deposits around Downderry in Cornwall have been prone to landsliding and cliff recession.

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. 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). Arable agricultural land often reaches close to the cliff edge, and targets for re-creating maritime cliff grassland from such arable land or improved pasture are discussed by Pye & French (1993).

Footpaths have heavy usage in some parts of the region, and local erosion is present (e.g. the Cornwall section of the South West Coast Path). Much of the cliffed coast of the region is largely undeveloped, the major exceptions being coastal settlements catering for visitors (e.g. Beer, Budleigh Salterton, Torquay, Brixham, Downderry, Looe, Duporth, Mevagissey). Car parks to take advantage of the fine views commanded from cliffs and headlands are common. Some very large coastal tracts are in the ownership of the National Trust; much attention is paid to careful visitor management in these locations, especially along long-distance footpaths. In places access is restricted by military activity: in Devon at Straight Point, and in Cornwall at Wembury Point, Black Head and between Portwrinkle and Freathy. In maritime heath at Nare Head in Cornwall, fire and trampling by visitors have damaged the exceptional lichen interest of the site (Fletcher *et al*. 1984).

The very slow retreat of the predominantly hard cliffs of the region and the lack of residential development on soft cliff sectors has resulted in a low level of coastal works. However, over the next five decades it is anticipated that coast protection will be required for property adjacent to soft cliffs at Budleigh Salterton, Corbyns Head, Hope Cove and Challaborough (Pye & French 1993) and at a number of locations in Cornwall, such as Kingsand, East Looe and Pendower Beach (English Nature pers. comm.). These works will probably alter local patterns of sediment input to the coast, as slumped material is a sediment source for beaches downdrift. Stabilisation and coast protection activities have already had an impact on the distribution of shore dock *Rumex rupestris* at the base of cliffs, as has the culverting of streams. Coast protection works have recently been undertaken along part of the frontage at Downderry.

3.1.4 Information sources used

NVC survey has not been completed for any cliffs in the region and no other detailed surveys exist. Current information is 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 the Species Conservation Branch of the Joint Nature Conservation Committee. Thanks also go to Rendel Geotechnics for information on landsliding and cliff erosion.

3.1.6 Further sources of information

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Stroud, D.A., Mudge, G.P., & Pienkowski, M.W. 1990. *Protecting internationally important bird sites.* Peterborough, Nature Conservancy Council.

B. Further reading

Further details of coastal habitat sites, including cliffs, are given in the *Coastal & marine UKDMAP datasets* module disseminated by JNCC Coastal Conservation Branch, Peterborough.

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

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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, location of site reports, site management	*Coastal Ecologist, English Nature HQ, Peterborough, tel: 01733 340345
Advice on national and international policy and cliff conservation	*Coastal Conservation Branch, JNCC, Peterborough, tel: 01733 62626
Local cliff sites and species - Devon	*Devon Wildlife Trust, Exeter, tel: 01392 79244
Local cliff sites and species - Cornwall	*Cornwall Wildlife Trust, Truro, tel: 01872 73939
Cliffs owned by the National Trust	*National Trust, Exeter, tel: 01392 881691
National Landslide Databank	Rendel Geotechnics, Norfolk House, Smallbrook Queensway, Birmingham B5 4LJ, tel: 0121 627 1777
Invertebrate fauna of cliffs	*Invertebrate Site Register, Species Conservation Branch, JNCC, Peterborough, tel: 01733 62626

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

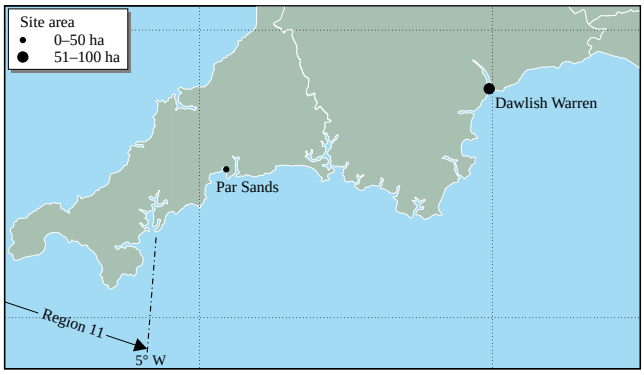
3.2 Sand dunes

Dr T.C.D. Dargie

3.2.1 Introduction

The region has only a small extent of vegetated sand dune habitat, represented by two sites: Dawlish Warren, Devon, and Par Sands, south-east Cornwall (Map 3.2.1). Their total area is 61 ha, representing less than 1% of the dune resource of England and even less of that for Great Britain (Table 3.2.1). On area alone the regional dunes are of only minor importance in the national context. However, they are important in a regional context, owing to their rarity.

The extent of National Vegetation Classification (NVC) dune vegetation types (Radley 1994) occurring in the region, including other land cover (e.g. bare ground, car park, caravan park), is given in Table 3.2.2. 90 NVC communities (Radley 1994) have been recorded for all the sand dunes of England, Scotland and Wales, with a total of 156 types for communities and sub-communities combined, not all of them exclusive to dunes. The small size of the region's sites restricts the range of habitats present, and the number of communities and sub-communities is only a small proportion of the national total. Mobile and semi-fixed dunes form a very large component of the region's dune systems, but they lack a large extent of fixed dune grassland. The relatively large area of scrub in relation to other habitats is also notable, suggesting a lack of grazing in recent decades despite the presence of rabbit populations.



Map 3.2.1 Sand dune sites. Numbers refer to Table 3.2.3. Source: JNCC Coastal Database.

3.2.2 Important locations and species

Sand dune sites in the region are summarised in Table 3.2.3. The only large dune system in the region, at Dawlish Warren, is a Site of Special Scientific Interest (SSSI) and Local Nature Reserve, and also forms part of the Exe Estuary Special Protection Area (SPA) and Ramsar site (Table 3.2.3).

The dunes at Dawlish Warren near the mouth of the River Exe are an example of spit dunes, which develop at the mouths of estuaries and depend strongly on river sediment for their sand supply. At Dawlish Warren they are noted for the effects of the fresh water table, which influences the vegetation of depressions, forming a distinct type of wetland termed dune slack; they are also as the only UK site for the nationally rare sand crocus *Romulea columnae* (see also section 5.2). Bay dunes, such as Par Sands, St. Austell Bay, develop upon sand trapped within the shelter of rock headlands. This site is considerably smaller, with limited development of vegetation types.

In Great Britain, three nationally rare and thirteen nationally scarce higher plants are found mainly or exclusively on dunes. Of these, only one nationally rare species (the sand crocus) and two nationally scarce (Portland spurge *Euphorbia portlandica* and dune fescue *Vulpia fasciculata)* are present in the region. Other nationally rare and scarce species more typical of other habitats also occur on dunes in the region, including Babington's leek

Table 3.2.1 Region 10 vegetated dune resource in context

	Total area (ha)	*% of total in Region 10*
Devon	56.8	-
Cornwall (part)	3.8	-
Region 10	***60.6***	**-**
England	9,282	0.7
North Sea Coast	25,356	0.2
GB	50,200	0.1

Sources: Dargie (1993, 1995), Radley (1994), JNCC Coastal Resources Database. Note: the totals for the North Sea Coast and Great Britain are provisional estimates, as Scotland has not been systematically surveyed.

Table 3.2.2 Areas (ha) of dune vegetation types

	Strand and embryo dune	*Mobile and semi-fixed dune*	*Acidic fixed dune grassland*	*Neutral and calcareous fixed dune grassland*	*Dune heath and bracken*	*Dune slack*	*Other dune wetland*	*Dune woodland and scrub*	*Transitions to saltmarsh*	*Transitions to maritime cliff*	*Other land cover*
Devon	0	27.0	0.9	0	0.2	1.1	1.6	6.0	0.4	0	19.6
Cornwall (part)	0.4	2.4	0	0.4	0	0	0	0.3	0	0	0.4
Region 10	***0.4***	***29.4***	***0.9***	***0.4***	***0.2***	***1.1***	***1.6***	***6.3***	***0***	***0***	***20.0***
England	179	2,484	671	2,710	197	487	150	1,189	141	30	1,044
GB*	340	8,504	4,953	15,228	2,615	2,175	4,114	8,965	836	64	2,406

Sources: Radley (1994), JNCC Coastal Resources Database. Key: *in the absence of full data for Scotland, figures for the North Sea Coast have not been calculated; totals for Great Britain are provisional estimates.

Table 3.2.3 Sand dune sites in Region 10

Name	*Grid ref.*	*Area (ha)*	*Dune type*	*Conservation status*
Dawlish Warren	SX986795	56.8	Spit	SSSI, LNR, SPA, Ramsar site
Par Sands	SX083534	3.8	Bay	None

Source: Radley (1994). Key: SSSI - Site of Special Scientific Interest; LNR - Local Nature Reserve; SPA - Special Protection Area.

Allium ampeloprasum var. *babingtonii*, four-leaved allseed *Polycarpon tetraphyllum*, orange bird's-foot *Ornithopus pinnatus*, Ray's knotgrass *Polygonum raii*, ivy broomrape *Orobanche hederae*, bearded fescue *Vulpia ambigua* and clustered clover *Trifolium glomeratum*. Most of Britain's nationally rare and scarce species have a southern distribution and those present on the region's dunes are good examples of such types. English Nature's dune site reports contain details of some of the notable species present.

There are no detailed ecological studies on animal populations of the region's sand dunes; however, English Nature has reintroduced the sand lizard *Lacerta agilis* to Dawlish Warren, and the invertebrate fauna of dunes in the region is well studied. The JNCC's Invertebrate Site Register summarises the invertebrate interest of sites. Dawlish Warren has good records for nationally rare (Red Data Book) and other rare/notable invertebrate species (see also section 5.3). Dawlish Warren provides a roosting area for many wintering bird species, especially oystercatcher, brent goose and bar-tailed godwit (see also section 5.12).

3.2.3 Human activities

In general sand dunes are among the least heavily modified of terrestrial habitats. Conservation management is a major activity at Dawlish Warren and is also carried out at Par Sands (Radley 1994). Nevertheless, the inner edge of both sand dune sites in the region has been strongly affected by a variety of human impacts, which typically lead to habitat loss or conversion to other, common, vegetation types (Doody 1989). The most notable case in the region is that of a golf course at Dawlish Warren, which has converted about 20 ha of fixed dune grassland into modified fairways and greens.

Because of their high recreational value, both sand dune sites have leisure facilities (car parks) on site and leisure-related development on adjacent ground. Recreational use is managed by controlling car parking and by the provision of hardened paths and boardwalks to reduce path erosion. Both sites show the effects of heavy visitor pressure and have moderate or severe erosion from trampling over part of their area. In addition, Par Sands has moderate to severe vehicle damage. A long-term problem, especially at Dawlish Warren, is reduced grazing activity by stock and rabbits, leading to reduced floristic diversity as scrub develops. Dune stabilisation work has been necessary at both locations. Coastal erosion is a problem at Dawlish Warren and coastal defences are present. The erosional or accretional status of Par Sands is uncertain.

Details of development that has occurred at each site are given in Radley (1994).

3.2.4 Information sources used

Survey of dunes in Scotland is still in progress and it is not possible to give accurate figures on the extent of the resource for either the North Sea Coast or Great Britain. An estimate of dune habitats for Scotland has been used here, based on a sample set of sites (Dargie 1993), to allow some form of British context to be made for the region.

All areas of vegetated sand dune in the region have been surveyed in recent years using the National Vegetation Classification (Rodwell in prep.). This work was part of the sand dune survey of Great Britain initiated by the NCC in 1987 and continued after 1991 by the JNCC on behalf of the country conservation agencies. NVC surveys use a reliable, consistent methodology yielding very detailed information (Rodwell in prep.). The vegetation is mapped and described, and information on coastal erosion and accretion, atypical vegetation and adjoining land use is also recorded. The data represent a sound baseline for future dune vegetation studies and both strategic and local management of the dune resource. Individual site reports and national reports for England (Radley 1994), Scotland (Dargie 1993) and Wales (Dargie 1995) are available.

3.2.5 Acknowledgements

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

3.2.6 Further sources of information

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Rodwell, J.S., *ed*. 1995. *British plant communities. Volume 4: aquatic communities, swamps and tall herb fens.* Cambridge, Cambridge University Press.

C. Contact names and addresses

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

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

3.3 Vegetated shingle structures and shorelines

Dr R.E. Randall

3.3.1 Introduction

Shingle means sediments larger than sand but smaller than boulders: that is, between 2-200 mm in diameter. Where the coast features shingle, it is often mixed with large amounts of sand, or else sand dunes have developed on it. Such sites are covered in section 3.2. Shingle sites include both simple fringing beaches and also more complex structures where the shingle is vegetated yet not buried by more than 20 cm of sand (e.g. at Dawlish Warren). Shingle vegetation around Britain was surveyed by Sneddon & Randall (1993), who showed that some communities were widespread and others limited to a particular region or substrate.

Only short stretches of the coast of this region are bordered by shingle, with most of the coast being sand, cliff or drowned estuary (Steers 1964). The major exception is Slapton Bar. The 7.5 km of fringing shingle beaches in the region are good examples of sand matrix on shingle. The scale of the region's shingle resource in a national context is shown in Table 3.3.1.

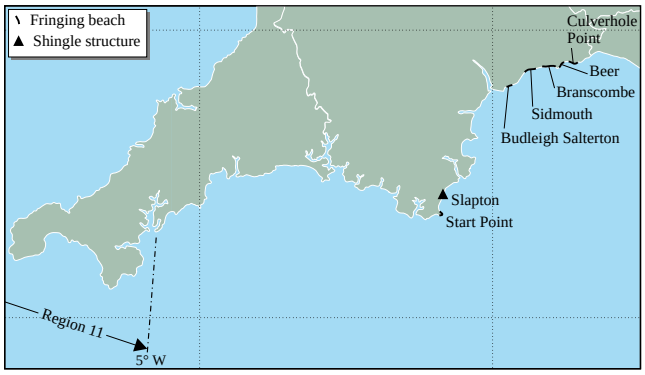
Table 3.3.1 Area of vegetated shingle structures in Region 10

	Area (ha)
Devon (part)	34
Cornwall (part)	0
Region 10	***34***
England	4,353
North Sea Coast	4,472
Great Britain	5,129
% North Sea Coast total in region	0.8
% England total in region	0.8
% GB total in region	0.7

Source: Sneddon & Randall (1994). Note: area totals have been rounded to the nearest hectare.

3.3.2 Important locations and species

The major shingle sites are shown on Map 3.3.1 and listed in Tables 3.3.2 and 3.3.3. According to Sneddon (1992), Slapton Bar is one of the largest and most floristically rich shingle structures in Britain. Here a sandy shingle bar, once an offshore structure, has moved landwards to dam a former estuary, which subsequently became a freshwater lagoon and marsh (Slapton Ley). A variety of rock types can be seen in the shingle, though most commonly pebbles are derived from the local slate. Unique to Slapton is a stable grassland community of red fescue *Festuca rubra*, yarrow



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

Achillea millefolium and common bird's-foot-trefoil *Lotus corniculatus*, also rich in other herbs. Two vegetation communities present at Slapton elsewhere display a classic western distribution: in places on the foreshore there is an open community of sand couch *Elymus farctus boreali-atlanticus*, sea sandwort *Honkenya peploides* and sea-holly *Eryngium maritimum*, while on the banks of the Higher Ley there is a false oat-grass *Arrhenatherum elatius* grassland with some bramble *Rubus fruticosus* and gorse *Ulex europaeus*. However, two other communities are typically southern in distribution: along much of the foreshore there is sea mayweed *Tripleurospermum maritimum* and sea campion *Silene maritima* with sea spurge, and along the shores of the leys there is an ivy *Hedera helix* - bramble community with false oat-grass.

Elsewhere in the region, shingle occurs as fringing beach material on exposed points at Culverhole and Beer, at the mouths of the Rivers Sid and Otter in Lyme Bay and near Start Point (Map 3.3.1; Table 3.3.3). The sandy nature of the shingle beaches of this region is strongly reflected in the vegetation, with sand couch, sea sandwort, sea-holly and sea spurge *Euphorbia paralias* being commonplace.

Few rare shingle plant species occur in this region, although the declining Ray's knotgrass *Polygonum oxyspermum* occurs at Culverhole Point and in some of the Cornish coves. The nationally rare little-robin *Geranium purpureum* and nationally scarce sea-kale *Crambe maritima* have been recorded from the western sites of Lyme Bay. The purple spurge *Euphorbia peplis*, now extinct, had its last mainland site on Lyme Bay shingle, and the nationally rare sea knotgrass *Polygonum maritimum* also had its last known mainland sites in Devon and Cornwall.

The shingle beaches of this region are not known for

Table 3.3.2 Surveyed shingle sites

Site name	*Location*	*Area surveyed (ha)*	*Site type*	*Conservation status*	*Activities/management/ disturbances*
Slapton Bar	SX826441	34.0	Sandy shingle bar with freshwater lagoon	SSSI, LNR, AONB	Roadway, recreational pressure, bulldozer clearance

Source: after Sneddon & Randall (1994). Key: SSSI = Site of Special Scientific Interest; LNR = Local Nature Reserve; AONB = Area of Outstanding Natural Beauty.

Table 3.3.3 Fringing shingle beaches

Site name	*Location*	*Length of structure (km)*	*Site type*
Culverhole Point	SY2989	1.0	Sandy shingle
Beer	SY2389	1.0	Sandy shingle
Branscombe	SY2088	1.0	Sandy shingle
Sidmouth	SY1287	3.0	Sandy shingle
Budleigh Salterton	SY0682	1.0	Sandy shingle
Start Point	SX8237	0.5	Sandy shingle

Source: Randall (unpublished survey, early 1980s).

their important faunal associations, although the wealth of data collected by the Field Studies Council at Slapton has resulted in both its invertebrate (see also section 5.3) and bird (see also sections 5.10 - 5.12) life being better known than at many shingle sites.

3.3.3 Human activities

Most of this region's shingle sites are subject to high levels of recreational pressure, including trampling and vehicular access. Only Slapton has some conservation status; however, trampling pressure remains high, as a road runs the length of the Bar and there is a large car park opposite the causeway that separates the Higher and Lower Leys. No grazing occurs on the Bar, but on the northern section of the lee shore of the Ley bulldozer clearance has caused heavy vehicle damage to the shingle substrate and resulted in reversion to a ruderal (wasteland) flora. Removal of drift debris by the local council may have a long-term effect on the nutrient supply to an impoverished foreshore environment.

3.3.4 Information sources used

Not all shingle sites are vegetated, especially not those on exposed high-energy coasts or where disturbance is great. Unvegetated sites have not been surveyed. The shingle of Slapton Bar was surveyed during the NCC's 1990 national shingle structure survey, which used the National Vegetation Classification (NVC) framework (Sneddon & Randall 1993, 1994). Slapton has also been studied over many years by the Field Studies Council (Mercer 1966; Brooks & Burns 1969; Hawksworth 1972).

Not all shingle sites fall into the category of shingle structures. The fringing shingle beaches in the region were examined by the author in the early 1980s as part of a survey sponsored by British Petroleum. Beaches visited were only examined qualitatively and target notes were used to describe physical or biological features of interest. This information 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.*
Slapton Bar	Warden, Field Studies Council, Slapton Ley Field Centre, Slapton, Devon, tel: 01548 580466
Shingle sites in Devon	*English Nature Devon Office, Okehampton, tel: 01837 55045
Shingle sites in Cornwall	*English Nature Cornwall Office, Truro, tel: 01872 262550
Biological records, Devon	*Conservation Officer, Devon Wildlife Trust, Exeter, tel: 01392 79244
Biological records, Cornwall	*Conservation Officer, Cornwall Wildlife Trust, Truro, tel: 01872 73939

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

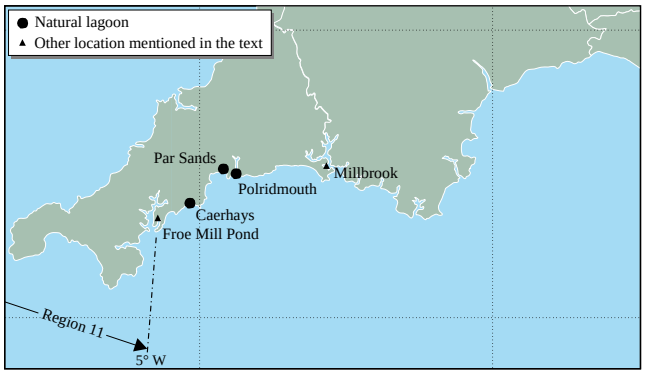
3.4 Coastal lagoons

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

3.4.1 Introduction

Lagoons are a nationally rare habitat and a 'priority habitat type' under Annex 1 of the EC Habitats & Species Directive. The term coastal lagoons is used here to include true lagoons, i.e. those wholly or partly separated from the sea by a natural sedimentary barrier, and also artificial brackish ponds and coastal pools, of a similarly restricted tidal range and often containing comparable lagoonal wildlife. Lagoons are commonly shallow, often with a varying salinity ranging from above to below normal sea-water levels (35 g/kg). Freshwater systems are not discussed, although the region contains some fine examples of former lagoons that have long since evolved into purely freshwater coastal lakes, for example Slapton Ley, Devon.

This chapter summarises the coastal lagoons of the region. The three natural lagoon systems, at Polridmouth, Par Sands and Caerhays, total 6 ha, only 1% of Britain's total natural lagoonal resource; they are not, therefore, collectively nationally significant, and none of the lagoons was regarded by Barnes (1989) as being 'especially noteworthy in the national context'. The scale of the contribution of the lagoons of the region to Britain as a whole is shown in Table 3.4.1.



Map 3.4.1 Coastal lagoons and locations mentioned in the text

Table 3.4.1 Lagoonal areas for region in context*

	Lagoonal area (ha)	*Overall % of GB total*	*% of GB total excl. The Fleet*
Devon	0	0	0
Cornwall (part)	6	<1	1
Region 10	***6***	***<1***	***1***
North Sea Coast	1,163	92	87
Great Britain	1,261	-	-

Sources: Seaward (1985), Sheader & Sheader (1989). Key: *figures are rounded to the nearest whole hectare or percentage point.

3.4.2 Important locations and species

Map 3.4.1 shows the location of the lagoons and other notable saline pools discussed; Table 3.4.2 lists the area of the surveyed lagoons and that of the habitat as a whole. The natural lagoons of the region are all in Cornwall, at Polridmouth, Par Sands and Caerhays. Their salinity is low and they are subject to only periodic sea-water influx. A number of artificial lagoon-like habitats exist behind sea-walls or sluices, all of low or zero salinity except Froe Mill Pond, a small sluiced tidal millpond usually with salinity around 30 g/kg. None of them is a significant coastal lagoon.

Table 3.4.2 Lagoons surveyed

Name	*Grid ref.*	*Area (ha)*	*Type*
Cornwall			
Millbrook	SX425523	3.5	Sluiced pond
Polridmouth	SX103506	1.0	Natural, estuarine
Par Sands	SX085534	3.5	Natural, estuarine
Caerhays	SX974415	1.5	Natural, estuarine
Froe Mill Pond	SW867333	<1.0	Sea inlet

Source: Barnes (1988, 1989). Note: areas correct to the nearest 0.5 ha.

True lagoons support only three types of aquatic vegetation, namely stands of green algae (*Chaetomorpha*, *Ulva* and *Enteromorpha* spp.), of seagrasses and similar plants (predominantly *Ruppia* spp.) and, much more rarely, stoneworts (especially *Lamprothamnium*). Much of the area of their beds, however, is bare sediment, devoid of vegetation cover. Fringing stands of reeds *Phragmites* spp., saltmarsh plants and/or sea club-rush *Scirpus maritimus* are usual. No significant communities of submerged vegetation are present in lagoons in the region.

Lagoons possess a characteristic invertebrate fauna that shows little regional variation, even within Europe. In Britain, several of these species are very rare and are protected under the Wildlife and Countryside Act 1981. None of these protected species occurs in the region, although the presence of the brackish water sand-shrimp *Gammarus chevreuxi* in the lagoon at Par Sands is notable. This species is restricted to brackish waters in south-western Britain. Together with the lagoonal prawn *Palaemonetes varians* it was also recorded in Millbrook Pond in 1984, at a time when the pond appears to have passed through a brackish lagoonal phase. Both species were absent there in 1990, by which time the salinity had dropped to zero (Bamber, Batten & Bridgwater 1993).

3.4.3 Human activities

Little active management is applied to the coastal lagoons themselves, although the surrounding land is often intensively managed for nature conservation or recreation, especially where the site has been designated. In this region the Caerhays Lagoon is stocked with trout; the water level of the Polridmouth Lagoon is managed artificially and the lagoon is occasionally allowed to drain completely. Deliberate restriction of sea-water inflow at the pond at Millbrook had allowed the salinity to drop to zero in 1990, with consequent loss of the two lagoonal species recorded there in 1985.

3.4.4 Information sources used

All likely lagoons in the region were surveyed as part of the NCC's national lagoon survey in 1980-1988. Further incidental surveys were undertaken by Fawley Aquatic Research Laboratories in 1990 (although there are no published reports). Little (1985) and Seaward (1985) are detailed survey reports and include maps of the habitats and species lists. Most surveys have been brief (single visits), with little intensive sampling. The data are summarised by Barnes (1989), Sheader & Sheader (1989) and Smith & Laffoley (1992), from which the data given here are derived.

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Smith, B.P., & Laffoley, D. 1992. *A directory of saline lagoons and lagoon-like habitats in England.* Peterborough, English Nature.

B. Further reading

Further details of coastal habitat sites are available on the *Coastal & marine UKDMAP datasets* module disseminated by the JNCC. Further details of lagoons and quasi-lagoonal features are available on the *UKDMAP datasets* module disseminated by the British Oceanographic Data Centre (BODC 1991).

Bamber, R.N., Batten, S.D., & Bridgwater, N.D. 1992. On the ecology of brackish water lagoons in Great Britain. *Aquatic Conservation: Marine and Freshwater Ecosystems, 2*: 65-94.

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Little, C. 1986. Lagoon types in Cornwall. *Porcupine Newsletter, 3*: 166-169.

Seaward, D.R. 1986. NCC survey of coastal saline lagoons in Dorset, Devon and Somerset. *Porcupine Newsletter, 3*: 164-165.

C. Contact names & addresses

Type of information	*Contact address and telephone no.*
Brackish lagoons of the region	Dr R.S.K. Barnes, St. Catharine's College, Cambridge CB2 1RL, tel: 01223 333296
Lagoons in England	*Maritime Team, English Nature HQ, Peterborough, tel: 01733 340345
Species in Cornwall	The Director, Cornish Biological Records Unit, Trevithick Centre, Trevenson Road, Pool, Redruth, Cornwall TR15 3PL, tel: 01209 710424

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

3.5 Wet grassland

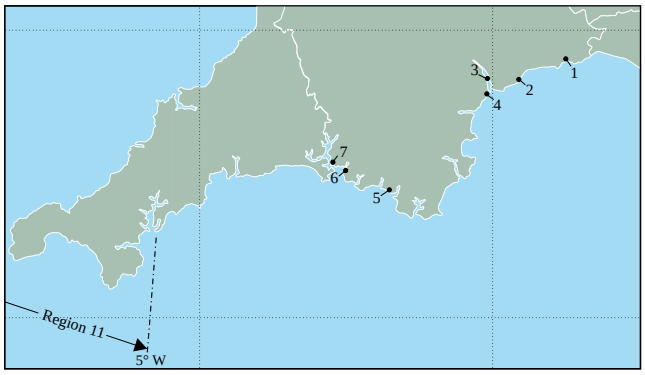
Dr H.T. Gee

3.5.1 Introduction

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

Coastal wet grassland is a distinctive habitat consisting of low-lying grassland drained by a series of ditches that may be either brackish or freshwater. Much wet grassland was formed by the enclosure of saltmarsh behind sea walls. Smaller areas of freshwater wet grassland have been created landward of natural barriers such as sand dunes or shingle beaches. Also included are lowland wet grasslands that lie next to tidal stretches of rivers and transitional areas of wet grassland between upper saltmarsh and dry land. Wet grassland sites may remain wet throughout the year and may be managed for stock grazing and/or as hay meadow.

The coast of this region is predominantly cliffed (see sections 2.6 and 3.1) and many of the estuaries of the region are rias, which are typically steep-sided. Consequently, there has been little opportunity for land claim and there is much less wet grassland in this region than along the rest of the south coast of England. Dargie (1993) estimated that there were a total of 63,499 ha of lowland wet grassland in south-west England, of which only 481 ha were in Cornwall and 5,909 ha in Devon. These two counties, which account for about half the total area of south-west England, hold only about 10% of its lowland wet grassland (although Region 10 includes only the south coasts of these two counties). Adjacent to some estuaries of the region there are areas of transitional freshwater marsh.



Map 3.5.1 Wet grassland sites (numbers refer to Table 3.5.1). Source: Dargie *et al.* (1993).

3.5.2 Important locations and species

Map 3.5.1 shows the locations of wet grassland sites (Table 3.5.1) in coastal 10 km squares in the region. Wet grassland is chiefly located on the Exe Estuary, where 830 ha of land have been claimed from the sea (Pye & French 1993). Much of the existing resource - the Exminster Marshes - forms part of the complex of habitats comprising the Exe Estuary Special Protection Area (SPA), Ramsar site and Site of Special Scientific Interest (SSSI), with an estimated 29 km of ditches within the SSSI boundary. Adjoining areas, including the wet grasslands associated with the River Clyst, are also of considerable size. The RSPB manages part of the wet grassland on the Exe Estuary as a reserve, which provides habitat for breeding waders and warblers, including Cetti's warbler *Cettia cetti*, and supports nationally important wintering populations of brent geese *Branta bernicla* and black-tailed godwits *Limosa limosa* (see also section 5.12). The ditches on the Exminster Marshes support a range of plant and animal species of conservation interest, including corky-fruited water-dropwort *Oenanthe pimpinelloides* and the nationally scarce hairlike pondweed *Potamogeton trichoides*, as well as sixteen other plant species considered rare in south-west England (Palmer & Newbold 1983). Seventeen species of dragonflies and damselflies have been recorded on the RSPB reserve, including healthy populations of the nationally notable hairy dragonfly *Brachytron pratense* and the ruddy darter *Sympetrum sanguineum* (see also section 5.3). Elsewhere in the region smaller patches of wet grassland lie adjacent to the estuaries

Table 3.5.1 Wet grassland in Region 10

*Site no.**	*Site*	*Grid ref.*	*Conservation status of the wet grassland*
	Devon		
1	Axe Estuary	SY260910	Undesignated; includes Seaton Marsh and Colyford Common
2	Otter Estuary	SY073830	Adjacent to SSSI
3	Exminster Marshes	SX955875	SSSI, SPA, Ramsar site and RSPB Reserve. 96 ha of wet grassland in the SSSI.
4	Dawlish Warren	SX985795	SSSI; coastal freshwater marsh
5	River Avon	SX695472	Adjacent to upper estuary
6	Saltram	SX510547	NT; wet grassland now subject to managed retreat
	Cornwall		
7	Tamar-Tavy Estuary	SX445615 SX445595 SX455627	SSSI; estuarine freshwater marsh; some wet grassland at St. Budeaux and Bere Ferrers

Source: Dargie *et al.* (1994). Key: *site no. refers to Map 3.5.1; SSSI = Site of Special Scientific Interest; SPA = Special Protection Area; NT = National Trust property; RSPB = Royal Society for the Protection of Birds.

of the Axe, Otter, Avon and the Plym-Tamar-Tavy, but their conservation value is as yet unknown.

In south Devon and Cornwall there are freshwater habitats of significant conservation value associated with the estuaries and leys. The freshwater marsh at Dawlish Warren at the mouth of the Exe Estuary contributes to the range of habitats in this area, and thus to the overall diversity of the SSSI. The reed bed of upper saltmarsh in the Plym-Tamar-Tavy Estuary supports Britain's only population of the triangular club-rush *Schoenoplectus triqueter*.

3.5.3 Human activities

In addition to the nationwide threats to wet grassland of agricultural improvement, conversion to arable use and loss beneath landfill and industrial development, coastal wet grassland around the Tamar and Exe Estuaries has been lost to urban development. However, remaining areas on the Exe Estuary now receive considerable protection and are managed for their conservation interest. Water level management is undertaken at Exminster Marsh by the RSPB and more widely on the Exe marshes by the Environment Agency (formerly the National Rivers Authority). Management by the RSPB includes the maintenance of traditional agricultural practices such as hay making and winter flooding of the pastures, while grazing densities have been reduced and artificial fertilisers avoided, resulting in a significant beneficial impact on the pastures (RSPB pers. comm.). Ditch clearance is of fundamental importance for the maintenance of conservation interest on wet grasslands, and over-deepening of ditches may be as damaging as neglect. Field ditches on Exminster Marshes are cleared out on a six-year cycle, and some work is carried out on the main rivers annually. Drainage ditch dredging is undertaken in accordance with Environment Agency guidelines for the preservation of conservation interest.

Wet grassland has been lost by conversion to saltmarsh through 'managed retreat' at Saltram on the Plym Estuary. At this site the sea wall was intentionally breached for conservation purposes, allowing periodic tidal inundation by salt water and the establishment of saltmarsh vegetation.

3.5.4 Information sources used

There has been no national survey specifically of grazing marsh in Britain. In England, however, the extent of lowland wet grasslands, including coastal grazing marsh, was surveyed by Dargie (1993). Information available varies widely between the counties of England. A fuller breakdown of information and listings of sites by county is given in Dargie *et al.* (1994). These county reports are held by English Nature.

Several surveys have been carried out around the Exe Estuary, but elsewhere in the region little survey information is available for wet grassland. After extensive consultation, Posford Duvivier (1992) produced proposals for the management of the Exe Estuary. The report outlines the views of interested parties and contains a useful selection of references.

The RSPB have survey data for breeding, migrant and wintering birds on their reserve on the Exminster Marshes. In 1988 a study was commissioned by the RSPB of the ditch flora on the reserve (Amphlett 1988), which identified its considerable interest. Leach *et al.* (1991) undertook a floral survey covering a more extensive area of the Exminster Marshes. This survey showed relatively little floristic variation in the ditches across the site, indicative of the homogeneity of the whole wet grassland area. The study showed that the ditch flora was sufficiently rich for the site to qualify as an SSSI.

3.5.5 Acknowledgements

Thanks are due to the regional staff of English Nature, Mike Williams of the Environment Agency and Malcolm Davies, the RSPB Warden on the Exe Estuary, for providing information on wet grasslands and associated habitats.

3.5.6 Further sources of information

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B. Further reading

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Thomas, G., José, P., & Hirons, G. 1995. Wet grassland in the millenium. *Enact*, *3*(1): 4-6.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Lowland wet grassland in Cornwall	*English Nature Cornwall Office, Truro, tel: 01872 262550
Lowland wet grassland in Devon	*English Nature Devon Office, Okehampton, tel: 01837 55045
RSPB Reserve on the Exe Estuary	The Warden, Victory Hall Annex, Main Road, Exminster, Exeter, Devon EX6 8DB, tel: 01392 833632
Lowland wet grassland, national context	*English Nature HQ, Peterborough, tel: 01733 340345

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

Region 10 is unusual in having all three eelgrass *Zostera* species present in its saltmarshes. Each is considered nationally scarce. *Zostera marina* (pictured) occurs in the subtidal zone in the Kingsbridge Estuary and at a number of other locations. Photo: Keith Hiscock, JNCC.

3.6 Saltmarsh

Dr M.I. Hill

3.6.1 Introduction

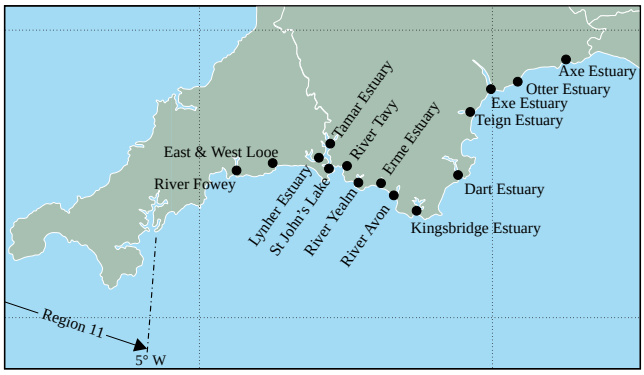
Because of the largely cliffed nature of the open coast of this region and the morphology of the estuaries, saltmarshes here are typically situated in the upper reaches of drowned river valleys and occupy only a small proportion of the intertidal zone. Some sites, such as the Exe and Lynher Estuaries, also contain some back-barrier marshes (i.e. where marshes have formed behind a barrier that has partly blocked the estuary mouth (Pye & French 1993)). Individual sites are small, with muddy sediments, and in the National Saltmarsh Survey (Burd 1989a, b), only three estuaries - the Exe, Tamar and Lynher - were found to contain more than 50 ha of saltmarsh. Trends in erosion or accretion of the marshes vary across the region, with rates of loss or gain being generally low. Several marshes have cliffed edges, a result of proximity to low water channels (Pye & French 1993).

The region's saltmarsh is not particularly significant in a national context. Only 10% of the whole of Devon and Cornwalls' coastline (including parts in Region 11) supports saltmarsh, compared with the England average of 24% (JNCC Coastal Resources Database). Upper marsh swamps form a more important part of the saltmarsh vegetation than in other regions and occupy over 10 ha in the Dart, Lynher and Tamar Estuaries. A low proportion (35%) of the saltmarsh area is pioneer (including common cord-grass *Spartina anglica* marsh) or low marsh vegetation, much less than on the North Sea coast or around England as a whole (average 63% and 57% respectively) (Table 3.6.1).

3.6.2 Important sites and species

The saltmarsh sites surveyed during the national survey (Burd 1989a, b) are listed in Table 3.6.2 and shown on Map 3.6.1. The largest areas of saltmarsh are on the Exe Estuary in Devon and the Tamar and Lynher Estuaries in Cornwall. Most of the larger saltmarsh sites in the region are designated Sites of Special Scientific Interest (SSSIs).

A typical saltmarsh vegetation zonation is from a pioneer zone of common cord-grass *Spartina anglica* or glasswort *Salicornia* spp. to a middle marsh of common saltmarsh-grass *Puccinellia maritima*, sea purslane *Halimione portulacoides* and sea arrowgrass *Triglochin maritima*; the dominant plants of



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

the upper marsh are red fescue *Festuca rubra* and sea rush *Juncus maritimus*, with swamps of common reed *Phragmites australis* and sea club-rush *Scirpus maritimus*.

In terms of vegetation, the best saltmarsh sites are considered to be those with the widest range of plant communities: in this region these are the Otter, Exe and Lynher Estuaries. Transitions between saltmarsh and freshwater marsh are present in several sites, including the Axe, Teign and Lynher Estuaries. For example, in the upper reaches of the Lynher Estuary, such transition communities contain species such as marsh marigold *Caltha palustris*, fool's water-cress *Apium nodiflorum* and bulrush *Typha latifolia*. In the Erme Estuary there are transitions from saltmarsh to woodland and wet meadows.

The reed bed of upper saltmarsh in the Tamar-Tavy Estuary is the only site in Great Britain of the nationally rare triangular club-rush *Schoenoplectus triqueter*. The nationally rare dwarf spike-rush *Eleocharis parvula* is found at one site in south Devon (Ivimey-Cook 1984) (see also section 5.2). All three species of eelgrass *Zostera* spp. are nationally scarce and present in intertidal and subtidal zones in the region, but details of their distribution are not known. In south Devon there are records for *Z. marina* in the Kingsbridge Estuary, *Z. angustifolia* in the Exe and Kingsbridge Estuaries, and *Z. noltii* in the Exe, Avon and Tavy Estuaries. *Z. noltii* and *Z. angustifolia* are found in St. John's Lake SSSI. Other nationally scarce plants found on saltmarshes in the region are bulbous foxtail *Alopecurus*

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

	Spartina	*Pioneer*	*Low-mid*	*Mid-upper*	*Driftline*	*Upper swamp*	*Transition*	*Wet depression*	*Total*	*% of region total in county*	*% of area total in region*
Devon (part)	53	16	45	83	11	87	16	0	310	54	-
Cornwall (part)	39	2	47	112	18	35	15	0	269	46	-
Region 10	***92***	***18***	***92***	***195***	***29***	***122***	***31***	***0***	***579***	**-**	**-**
North Sea Coast	3,461	2,130	8,194	4,772	1,350	1,066	342	2	21,788	-	3
England	5,166	2,641	10,299	9,948	1,493	686	833	0	31,533	-	2
GB	6,948	3,470	12,353	16,042	1,824	1,475	1,670	2	44,370	-	1

Source: National Saltmarsh Survey (Burd 1989a, b). Key: *areas have been rounded to the nearest whole hectare, proportions to the nearest whole percentage point.

Table 3.6.2 Saltmarsh sites surveyed

Name	*Grid ref.*	*Area (ha)**	*Conservation status*
Devon			
Axe Estuary	SY254910	34	
Otter Estuary	SY075825	19	SSSI
Exe Estuary	SX980840	67	SSSI, SPA, Ramsar site
Teign Estuary	SX905725	13	
Dart Estuary	SX860558	25	
Kingsbridge Estuary	SX746408	4	SSSI
River Avon	SX678462	26	
Erme Estuary	SX622490	21	SSSI
River Yealm	SX540510 - SX566510	2	
River Tavy	SX460625	35	SSSI
Devon/Cornwall			
Tamar Estuary	SX430650	136	SSSI
Cornwall			
St. John's Lake	SX427540	14	SSSI
Lynher Estuary	SX400560	175	SSSI
East and West Looe Rivers	SX252538	6	
River Fowey	SX115567	3	

Sources: National Saltmarsh Survey (Burd 1989a, b), JNCC Integrated Coastal Database. Key: *areas have been rounded to the nearest hectare.

bulbosus, perennial glasswort *Salicornia perennis* and stiff saltmarsh-grass *Puccinellia rupestris*.

As elsewhere, saltmarshes in this region provide roosting sites for waders and grazing for wildfowl; for example, saltmarshes on the Exe hosts large populations of wigeon. A large area of saltmarsh within the Lynher Estuary and smaller areas elsewhere support breeding and wintering waterfowl.

3.6.3 Human activities

Grazing is probably the oldest form of saltmarsh management; in this region many of the saltmarshes are grazed. In saltmarshes managed for nature conservation, a choice may have to be made between maintaining a shorter (and often species-poor) sward attractive to birds or a more diverse vegetation with less value for birds. Figures for stocking densities vary in the UK, from one to six animals per hectare, with grazing usually taking place only from May to September (Doody 1988). Achieving an appropriate grazing regime is the main saltmarsh management issue for sites in the region.

Land claim of saltmarsh has not been widespread here. The main areas of claimed marshland are in the Exe (830 ha), Axe (80 ha), Tamar, Otter and upper Avon Estuaries (Pye & French 1993). At Saltram, on the Plym Estuary, the sea wall has been breached to restore saltmarsh that had previously been subject to land claim.

3.6.4 Information sources used

Saltmarshes were surveyed in 1982 as part of the Nature Conservancy Council's national saltmarsh survey; detailed reports are available and results are summarised in Burd (1989a, b). Data presented here are derived from that survey. The national saltmarsh survey provided an intermediate level of detail between Phase 1 habitat survey and the National Vegetation Classification (NVC: Rodwell in prep). It did not include all areas of transition to other habitats such as sand dune, shingle and freshwater marsh, and areas of eelgrass were not recorded.

Detailed studies of the history and development of saltmarshes in the Exe and Axe Estuaries are reported in Parkinson (1980, 1985). A survey of the extent of *Zostera* spp. in the Exe was carried out in 1991 by the British Association for Shooting and Conservation and the Wildfowl and Wetlands Trust.

3.6.5 Acknowledgements

Staff of English Nature kindly provided information and reference material.

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Halcrow & Partners. 1994. *A guide to the understanding and management of saltmarshes.* Bristol, National Rivers Authority. (R & D Note No. 324.)

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Data from National Saltmarsh Survey	*Coastal Conservation Branch, JNCC, Peterborough, tel: 01733 62626
Saltmarsh sites in England	*Marine Ecologist, English Nature HQ, Peterborough, tel: 01733 340345
Saltmarsh in Devon	*English Nature Devon Office, Okehampton, tel: 01837 55045
Saltmarsh in Cornwall	*English Nature Cornwall Office, Truro, tel: 01872 262550
Wildlife Trust sites in Devon	*Devon Wildlife Trust, Exeter, tel: 01392 79244
Saltmarsh on the Exe Estuary	The Warden, Victory Hall Annex, Main Road, Exminster, Exeter, Devon EX6 8DB, tel: 01392 833632

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

All the region's estuaries from the Teign westward, such as the Salcombe-Kingsbridge Estuary in Devon (shown here), are drowned river valleys - rias. This estuary type has only limited areas of intertidal habitat, but the steep valley sides are often swathed in ancient semi-natural woodland. Photo: Peter Wakely, English Nature.

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 freshwater) and terrestrial habitats, including adjacent sand dunes, coastal grasslands and maritime heaths. Estuaries in the Coastal Directories Series are all those covered by the Nature Conservancy Council's Estuaries Review, with the minimum size for selection being 2 km of tidal channel or 2 km of shoreline over 0.5 km wide at low tide, either now or historically. This section gives an overview of the main features of the estuarine resource in Region 10; for further details of habitats, species and human uses refer to relevant sections in Chapters 3, 5 and 9 respectively.

Little more than 500 km of Region 10's coastline is estuarine, and the twelve estuaries present (Map 4.1.1) are individually small and generally narrow. Overall, the estuaries in Region 10 form less than 2% by area of the total UK estuarine resource, 3.5% of the North Sea coast resource, and less than 0.5% of the estuarine habitat of north-west Europe (Davidson *et al.* 1991). However, the small estuaries in the region make an important contribution to the diversity of UK estuaries; they include nine of the country's fifteen rias - non-glaciated river valleys submerged by rising sea-levels. The contribution of Region 10 estuaries to the wider resource is summarised in Table 4.1.1. Although small in area, the region's estuaries make a significant contribution to the national resource by virtue of their natural shorelines and unspoilt nature, and they contribute to the high landscape value of the coast. Several of the estuaries have considerable geomorphological, wildlife and nature conservation importance. Some of these estuaries have important sea-bed communities and rare plant and animal species, including internationally important bird populations.

Map 4.1.1 Estuaries. Source: JNCC Coastal Database.

Many estuaries in the region remain substantially water-filled at low tide and in most the intertidal flats are narrow and mostly muddy, fringing the sheltered river channels. There are few extensive areas of saltmarsh - only in the two largest estuaries in the region, the Tamar and the Lynher, within the Plymouth Sound estuary complex, does the saltmarsh area exceed 100 ha - and overall the region has less than 1.5% of the UK resource. Additional interest comes from the natural shoreline transitions, from saltmarsh and tidal flats to fringing woodlands in the upper parts of several rias, and from rocky shores at the mouths of the rias, which further increase the variety of habitats in these estuaries. The narrow, sinuous nature of many of the region's estuaries, with some of the rias having several tidal arms, means that shoreline and channel lengths are relatively long, each forming around 9% of the North Sea coast's estuarine resource.

Table 4.1.1 Contributions of the region's 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	4,630	136,580	3.4	321,050	1.4	332,350	1.4
Saltmarsh area	578	20,651	2.8	48,380	1.4	*	*
Total estuarine area	9,024	258,102	3.5	525,650	1.7	581,290	1.6
Shoreline length	517	5,645	9.2	9,054	2.6	9,727	2.6
Longest channel lengths	130	1,484	8.7	2,461	4.9	2,640	4.6

Sources: Buck (in prep.); Davidson & Buck (in prep). Key: *areas of saltmarsh were not available for Northern Ireland and so estuarine saltmarsh area comparisons are not made for the UK. Note: areas rounded to the nearest 10 ha; lengths rounded to the nearest 1 km.

4.1.2 Important locations and species

Table 4.1.2 lists the estuaries in the region and summarises their main physical characteristics. Only four of the twelve estuaries in Region 10 are larger than 500 ha, with the largest less than 4,000 ha in total area. Four estuaries cover less than 200 ha in area. Most of the region's estuaries are on the south Devon coast, with Plymouth Sound straddling the Devon/Cornwall boundary and only the small Looe and Fowey Estuaries lying entirely on the Cornish part of the region's coast. In the east of the region the small Axe and Otter Estuaries and the larger Exe Estuary are substantially sediment-filled in the shelter of shingle and sand spits. Further west all the estuaries are rias. The Teign Estuary is unusual in having become largely sediment filled in the shelter of a small spit. Tidal range increases progressively westwards, from 3.7 m in the Axe Estuary to 4.8 m in the Looe and Fowey Estuaries.

Although small, saltmarshes in the Otter Estuary are among the most diverse in the region. There are tidal reedbeds in upper reaches of this and the Exe Estuary. The Exe Estuary has particular wildlife importance in the region: it is one of the few UK localities for the polychaete worm *Ophelia bicornis*; there are diverse sea-bed communities, including eelgrass *Zostera* spp. beds; the estuary also has diverse and internationally important wintering waterfowl populations; and at its mouth the spit dunes of Dawlish Warren are the only UK locality for the sand crocus *Romulea columnae*.

Several of the rias, notably the Salcombe & Kingsbridge, Dart and Yealm Estuaries and Plymouth Sound, have rich and diverse intertidal and subtidal sea-bed communities, with sheltered rocky shores inside the estuary mouths often being of particular significance. The ancient woodlands fringing parts of the Dart, Erme, Yealm and Fowey Estuaries and Plymouth Sound, with their natural saltmarsh and tidal flat transitions, are an important feature of the region's estuarine habitats.

Nationally rare plants are associated with three of the region's rias: dwarf spike-rush *Eleocharis parvula* on the Erme Estuary; triangular club-rush *Schoenoplectus triqueter* on the Tamar Estuary; and field eryngo *Eryngium campestre* on Plymouth Sound (and also on the Exe Estuary). Westwards from the Teign, all but the Erme and Looe Estuaries are nursery areas for sea bass.

4.1.3 Human activities

Throughout the region, estuaries are predominantly rural, those in the west having generally little low-lying ground in their upper reaches and rocky shores around their mouths. Along most estuaries in the region, urban areas are chiefly close to the estuary mouths, and the towns and villages are predominantly holiday resorts or harbours for fishing and leisure craft. The only major urban and industrial developments are on the Exe Estuary, on Plymouth Sound, where Plymouth and its associated dockyards, naval bases and shipbuilding and repair dominate the lower part of the estuary, and the commercial harbour at Fowey. In several estuaries (Exe, Teign, Dart, Salcombe & Kingsbridge, Fowey) towns have also grown up at the upstream tidal limit; most were originally associated with docks that are now little used.

Estuarine water quality is classified as good throughout the region, under the National Rivers Authority (now the Environment Agency) classification scheme (NRA 1991). A small area of the upper Plym (Plymouth Sound) is classified as fair and a number of smaller coastal riverine stretches are classed as poor in the St. Austell area, as a result of influx of waste from the china clay industry and drainage from other mining operations (see section 9.6).

Since there is relatively little low land around the region's estuaries, land claim has affected only small parts. Aside from those areas claimed or modified for docks, ports and urban developments, parts of the former tidal marshes

Table 4.1.2 Physical characteristics of Region 10 estuaries

Estuary	*Centre grid ref.*	*Geomorph-ological type*	*Total area (ha)*	*Inter-tidal area (ha)*	*Salt-marsh (ha)*	*Shoreline length (km)*	*Main channel length (km)*	*Spring tidal range (m)*	*Sub-tidal (%)*
Devon									
142. Axe Estuary	SY2591	Bar-built	79	62	34	8.1	3.8	3.7	21.5
143. Otter Estuary	SY0782	Bar-built	36	19	19	6.1	1.1	4.1	47.2
144. Exe Estuary	SX9883	Bar-built	1,874	1,201	66	47.8	16.7	4.1	35.9
145. Teign Estuary	SX9172	Ria	370	219	13	20.4	9.1	4.2	40.8
146. Dart Estuary	SX8753	Ria	863	313	25	60.5	19.8	4.0	63.7
147. Salcombe & Kingsbridge Estuary	SX7441	Ria	674	446	4	48.6	8.3	4.6	33.8
148. Avon Estuary	SX6745	Ria	214	146	26	19.8	7.8	4.7	31.8
149. Erme Estuary	SX6249	Ria	145	72	21	17.1	6.0	4.7	50.3
150. Yealm Estuary	SX5449	Ria	446	154	2	28.1	7.7	4.7	65.5
Devon/Cornwall									
151. Plymouth Sound	SX4356	Ria	3,962	1,809	359	208.6	34.1	4.7	54.3
Cornwall									
152. Looe Estuary	SX2554	Ria	56	43	6	12.6	4.1	4.8	23.2
153. Fowey Estuary	SX1255	Ria	305	146	3	39.2	11.1	4.8	52.1

Sources: Buck (in prep.); JNCC Integrated Coastal Database. 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) and Chapter 4.5 of Davidson & Buck (in prep.); 'spring tidal ranges' are for the monitoring station closest to the mouth of the estuary; 'subtidal' includes tidal channels remaining water-filled at mean low water.

Table 4.1.3 Human uses and water quality on estuaries in Region 10

Estuary[a]	*Grid ref.**	*Human use type*				*Water quality*
		urban	*industrial*	*rural***	*recreational*	
Devon						
142. Axe Estuary	SY2591			•	○	A
143. Otter Estuary	SY0782			•	○	A
144. Exe Estuary	SX9883	○	○	•	•	A
145. Teign Estuary	SX9172	○	○	•	•	A
146. Dart Estuary	SX8753	○	○	•	•	A
147. Salcombe & Kingsbridge Estuary	SX7441	○	○	•	•	A
148. Avon Estuary	SX6745			•	•	A
149. Erme Estuary	SX6249			•	○	A
150. Yealm Estuary	SX5449			•	•	A
Devon, Cornwall						
151. Plymouth Sound	SX4356	•	•	•	•	A (B)
Cornwall						
152. Looe Estuary	SX2554	○		•	○	A
153. Fowey Estuary	SX1255	○	○	•	•	A

Sources: Davidson & Buck (in prep.), National Rivers Authority (1991). Key: [a]estuary names and numbers correspond to those used in the NCC Estuaries Review; *central point; **includes natural resource exploitation; • = major human use; ○ = minor human use. Notes: multiple water quality codes are in downstream sequence; brackets indicate a water quality found in only a small part of the estuary.

of the Exe, Axe and Otter Estuaries are now lowland grasslands behind sea walls and a small part of the lower Plymouth Sound has a tidal barrier. Recreational use of these sheltered estuaries is widespread, with many moorings and intensive water-based recreation, notably on the Exe, Teign, Dart, Salcombe & Kingsbridge and Fowey Estuaries and Plymouth Sound. There is general recreational use of beaches around the mouths of several of the region's estuaries, including the Exe, Teign, Salcombe & Kingsbridge, Avon, Yealm and Fowey. Natural resource exploitation, chiefly shell fisheries and mariculture, fisheries and bait-collecting, is widespread, being an important use of all but the smaller estuaries, and there is wildfowling on parts of the Exe and Teign Estuaries and Plymouth Sound.

4.1.4 Information sources used

This section is summarised chiefly from JNCC's *An inventory of UK estuaries,* being published in six regional volumes along with an introductory volume. All estuaries in Region 10 are included in *Volume 6. Southern England* (Buck in prep.). Data presented in the inventory are drawn largely from material collected during 1989-90 (updated to 1994 where appropriate) for the NCC's Estuaries Review (Davidson *et al.* 1991). Saltmarsh data come originally from Burd (1989a, b), which summaries the results of the Nature Conservancy Council's National Saltmarsh Survey.

Hydrological data, e.g. catchment areas and river flows, are available for some but not all estuaries as defined here, from sources including Local Environment Agency Plans (formerly Catchment Management Plans) (see also section 10.2.6). Chapter 10 also gives further information on Estuary Management Plans (section 10.2.3). 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 are due to Dr Pat Doody and John Barne (JNCC), and to staff of English Nature for helpful comments on draft texts.

4.1.6 Further sources of information

A. References cited

Buck, A.L. In prep. *An inventory of UK estuaries. 6. Southern England.* Peterborough, Joint Nature Conservation Committee.

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

Burd, F. 1989b. *Saltmarsh survey of Great Britain. Regional supplement No. 3. South-west England*. Peterborough, Nature Conservancy Council.

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

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

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

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

B. Further reading

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

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

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

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

Noble, L., *ed.* 1995. *Estuaries and coastal waters of the British Isles.* Plymouth, Plymouth Marine Laboratory and Marine Biological Association. (Annual bibliography of recent scientific papers, No. 19.)

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

Smith, J., & Moore, J. In prep. Marine nature conservation review. The marine biology of marine inlets in south-west Britain: area summaries (MNCR Sectors 8). *JNCC Report.*

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Integrated Coastal Database: national database of estuaries; coastal habitats; statutory and non-statutory protected sites. Summary data available also on UKDMAP (see Barne *et al.* 1994).	*Coastal Conservation Branch, Joint Nature Conservation Committee, Peterborough, tel: 01733 62626
Statutory protected sites; detailed wildlife site information; coastal geomorphology. Estuaries Initiative and estuary management plans. Numerical and some digitised data.	*Estuarine Ecologist/Estuaries Initiative Officer/Marine Ecologist, English Nature HQ, Peterborough, tel: 01733 340345
Information on the Exe, Salcombe/Kingsbridge and Tamar/Tavy Estuaries	*Estuary Project Officer, English Nature, Okehampton, tel: 01837 55045
Information on the Tamar/Tavy Estuary	*Estuary Project Officer, English Nature, Truro, tel: 01872 262550
RSPB Estuaries Inventory: mapped and numerical information on land use and selected human activities for 57 major UK estuaries	*Estuaries Inventory Project Officer, RSPB, Sandy, tel: 01767 680551
Exe Estuary ecosystem research	Dr J. Goss-Custard, Institute for Terrestrial Ecology, Furzebrook Research Station, Wareham, Dorset BH20 5AS, tel: 01929 551598
National River Flow Archive: catchments and river flows from upstream gauging stations; interpreted analyses for whole estuaries.	National Water Archive Manager, Institute of Hydrology, Maclean Building, Crowmarsh Gifford, Wallingford, Oxfordshire OX10 8BB, tel: 01491 838800

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

4.2 The sea bed

R.A. Irving

4.2.1 Introduction

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

In the context of the north-east Atlantic as a whole, the region lies at the north-eastern edge of the warm Lusitanian biogeographical province. Lyme Bay borders the transition zone with the colder Boreal province to the east - a zone that spans the central English Channel. Several sea-bed communities throughout the region support species characteristic of the Lusitanian province, and in Britain many of these are confined to the south-west. In comparison with many other areas of the country, the marine biology of the south-west has been well studied. The region has a large number of sites of marine nature conservation interest, with several sites being of regional or national importance on account of the marine species they feature. However, information on the precise extent of littoral (shore) and sublittoral (below low water mark) habitat types in a national context is not yet available.

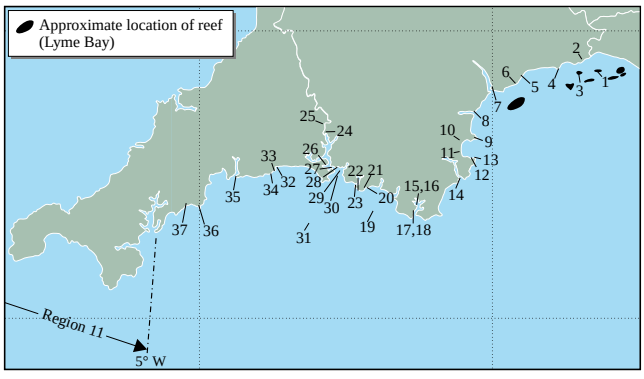
There is a mix of shore types, from sand and pebbles through to boulder and bedrock, and a similar diversity is found in the sublittoral. The degree of exposure to wave action is one of the main factors determining the types of community present on rocky shores, and in this region it is only within inlets and estuaries that shores can be described as sheltered. Other physical parameters affecting the composition of communities both on the shore and below low water mark include tidal currents and salinity gradients, especially within the marine inlets. Arguably the richest and most diverse stretch of littoral and sublittoral habitat within the region is found in the vicinity of Tor Bay.

A number of wrecks (ships, aircraft and other solid material) occur off the region's coast. These objects offer hard substrata in areas that may be largely sedimentary and provide habitats for opportunistic colonising species that otherwise would not be present (see also section 6.4.1).

4.2.2 Important locations and communities

Table 4.2.1 lists locations of marine biological importance mentioned in the text (Map 4.2.1).

English Nature has identified six Sensitive Marine Areas (SMAs), covering a large proportion of the region's coast (English Nature 1994). The SMA designation is non-statutory, serving to highlight areas of particular marine conservation interest (see also section 7.4.4). The Lyme Bay SMA includes the shore and sea bed within a line from Burton Bradstock (Region 9) to Straight Point, east of Exmouth. Lyme Bay features some rare marine species associated with its reefs (at Lane's Ground and Eastern Heads). The Exe Estuary SMA adjoins the Lyme Bay SMA at Straight Point and includes the whole estuary to just beyond Langstone Rock on the western side of its mouth.



Map 4.2.1 Key locations of marine biological interest described in the text (see Table 4.2.1) and approximate locations of surveyed reef areas in Lyme Bay (after Devon Wildlife Trust 1993a). See Map 7.4.1 for locations of Sensitive Marine Areas.

Table 4.2.1 Locations of marine interest mentioned in the text

No. on Map 4.2.1	*Location*	*Grid ref.*
	Devon	
1	Lane's Ground, Lyme Bay	SY3584
2	Pinhay Bay (west)	SY3090
3	Eastern Heads, Lyme Bay	SY2384
4	Beer Head	SY2287
5	Ladram Bay/Hern Rock Bay	SY0985
6	Budleigh Salterton	SY0782
7	The Point, Exmouth	SX9981
8	Denn Point, River Teign	SX9472
9	Hope's Nose	SX9463
10	Hollicombe, Tor Bay	SX8962
11	Saltern Cove, Tor Bay	SX8958
12	Shoalstone Point, Berry Head	SX9356
13	Berry Head	SX9456
14	The Range, River Dart	SX8949
15	The Saltstone, Kingsbridge Estuary	SX7440
16	Tosnos Point, Kingsbridge Estuary	SX7440
17	Salcombe Harbour	SX7338
18	Castle Rocks, Salcombe	SX7338
19	East Rutts pinnacle, off Bolt Tail	SX5938
20	Wadham Rocks	SX5746
21	Cunnimall Rocks	SX5646
22	Hilsea Point	SX5445
23	Cellars Beach, River Yealm	SX5347
24	Weir Quay, River Tamar	SX4365
25	Calstock Bend, River Tamar	SX4268
26	Ballast Pound, Torpoint	SX4354
27	The Narrows, Plymouth Sound	SX4553
28	The Hoe, Plymouth Sound	SX4753
29	Batten Bay, Plymouth Sound	SX4852
30	Plymouth breakwater	SX4750
	Cornwall	
31	Eddystone Rocks	SX3734
32	Looe Bay	SX2653
33	Hannafore Point	SX2552
34	Portnadler Bay	SX2451
35	Polruan Point	SX1250
36	Hemmick Beach	SW9940
37	Portholland	SW9541

The Exe Estuary also supports international important numbers of over-wintering wildfowl and waders. The Torbay to Start Point SMA includes Berry Head and the Dart Estuary and contains a wide diversity of marine habitats. The Start Point to Bolt Tail SMA includes the whole of the Salcombe-Kingsbridge inlet, together with the cliffs and exposed rocky coast either side. It contains a high diversity of habitats and associated varied communities, together with several species restricted in their distribution in Britain. It is of significant marine biological importance for the presence of many southern species. The Plymouth Sound, Tamar and Yealm SMA includes the Wembury Voluntary Marine Conservation Area (see also section 7.4.5) to the east and an area offshore around the Eddystone Reef and the Hand Deeps. The Dodman Point to the Lizard SMA extends into Region 11. This area supports a wide range of marine habitats, communities and species characteristic of south-west England.

Lyme Regis to Start Point

This stretch of coast is dominated by cobble, pebble and sand beaches backed by high cliffs. From Lyme Regis to the Axe Estuary the lower shore is characterised by boulders on bedrock ledges, where rich and diverse communities occur, particularly where the honeycomb worm *Sabellaria alveolata* is present. The turf formed by various red algae at low water mark is especially lush (M. Camplin pers. comm.). At the western side of Pinhay Bay the rock platform, surmounted by broken rock and boulders, is considered to be species-rich (Ambios Environmental Consultants 1995). The estuary of the River Axe contains impoverished low-salinity mud communities dominated by polychaetes, oligochaetes and bivalves (Smith & Moore in prep.). The westernmost outcrop of Upper Chalk in England forms Beer Head; the shore here is of rounded flint pebbles and scattered limestone boulders, with particularly large numbers of the small periwinkle *Littorina neritoides* present in shady fissures on the boulders (Ambios Environmental Consultants 1995).

On the lower shore at Ladram Bay near Otterton there are rich underboulder communities with sea squirts, anemones and crabs. Rock surfaces are dominated by the red alga *Mastocarpus stellatus*, with the scarce brown seaweed *Padina pavonia* also present. The sand reefs of the honeycomb worm *Sabellaria alveolata* found on the mid-shore at neighbouring Hele Rock Bay are considered to be some of the best examples in Britain (Devon Wildlife Trust 1995). The enclosed shore at the mouth of the River Otter at Budleigh Salterton is of mud with scattered cobbles and is considered to be of regional conservation importance for its sediment infauna (Ambios Environmental Consultants 1995). The most numerous animals are the burrowing amphipod *Corophium volutator*, the ragworm *Hediste diversicolor* and, further upstream, the small polychaete *Manayunkia aesturina*. In the sublittoral off Otterton Ledge, fragments of dead maerl (a calcareous red alga) have been found to make up a high percentage of the sediment (Devon Wildlife Trust 1995), though a survey of the sediment infauna has yet to be undertaken.

The near-shore sea bed within Lyme Bay is relatively shallow and gently shelving, the substratum being predominantly sand, dead maerl and gravel, with extensive bedrock and boulder reefs being found further offshore, which support a relatively impoverished epifauna. South-east of Beer Head, close inshore, a level plain of flint shards covers the sea bed, forming an unusual habitat (Devon Wildlife Trust 1993a), but the epifauna here is impoverished, probably due to the mobility of the substratum.

The Exe Estuary is a marine inlet that receives freshwater input from a wide, largely agricultural, catchment area. Besides giving rise to a high sediment load, this input also causes a noticeable salinity gradient from north to south. Sediment is deposited within the estuary to form extensive mud- and sand-flats, of which there are large areas (compared with most other marine inlets of south-west Britain), and which provide rich feeding grounds for internationally important numbers of waders and wildfowl. Patches of eelgrasses *Zostera* spp. occur in the muddier reaches. Smith (Ambios Environmental Consultants 1995, Vol. 8) considers the sandy gravel shore at the Point, Exmouth, to be of national conservation importance. 29 taxa have been recorded from the sediment at this site (National Rivers Authority 1994), including large numbers of the polychaetes *Pygospio elegans* and *Ophelia rathkei*. The clean, tide-swept sand near the mouth of the estuary is one of the few sites in Britain where the Mediterranean polychaete *Ophelia bicornis* is found.

Between Dawlish and Torquay rocky outcrops predominate, with some sand and shingle beaches; the latter, due to their mobile nature, support a limited biota. At the entrance to the River Teign, the permanent spit of Denn Point effectively shelters the whole inlet from wave action. The communities found on the shore and in the sublittoral within the ria are characteristic examples resulting from the range of habitats present (Frid 1989). Just outside the inlet, a sublittoral scour pit is present, up to 9 m deep. The sides of the pit are lined with boulders, densely covered in bryozoans, hydroids, sponges, sea squirts and occasional red algae, while the floor is of gravel, cobbles and coarse sand. From Mackerel Cove south to Berry Head, the steep exposed rocky shores feature many intertidal caves.

In the vicinity of Torbay are found the richest and most diverse marine habitats and communities in the region (M. Camplin pers. comm.). The shores of Tor Bay are predominantly sandy, but a few outcrops of limestone and Permian conglomerate occur as well, which support an exceptionally rich fauna and flora. A high diversity of algae is present, including scarce species such as the peacock's tail *Padina pavonia*. At the northern end of the bay, off the promontory of Hope's Nose, a number of small islets increase the range of habitats; the tide-swept channels and limestone ledges between them support dense mussel beds and a community of anemones, hydroids and sponges, including the massive form of the boring sponge *Cliona celata*. Within the bay itself, the eelgrass *Zostera marina* occurs in patches, but at Torre Abbey Sands it occurs, unusually, in the intertidal zone (Devon Wildlife Trust 1995). At Hollicombe, the under-boulder fauna features what is probably the densest population in the south-west of the green sea urchin *Psammechinus miliaris* (Devon Wildlife Trust 1995), with similarly rich under-boulder communities occurring at Saltern Cove. Several of the small coves in this area feature well-developed reefs of the honeycomb worm *Sabellaria alveolata*. The sea bed of the bay is relatively uniform and consists of a muddy sand that supports a diverse burrowing community dominated by bivalves, brittlestars and anemones. A small, yet important,

population of the burrowing red band fish *Cepola rubescens* has been discovered in the bay (Devon Wildlife Trust 1995), which is one of only a handful of sites where the fish has been found inhabiting shallow water. A submerged peat bed is present off Broadsands in the south-west corner of the bay, heavily bored by the common piddock *Pholas dactylus*.

A network of caves, some of which are subtidal, extends from Sharkham Point as far north as Mackerel Cove, though the greatest concentration is present at the base of Berry Head. The deeper caves here extend below the influence of wave action, and their almost constant temperature, reduced salinity and lack of light give rise to an environment that is probably unique in the country (English Nature 1994). Though species records are incomplete, owing to the inaccessibility of the caves, the Devonshire cup coral *Caryophyllia smithii* is found unusually high above mean low water level and there are notable populations of the soft coral *Alcyonium digitatum*. There are rich under-boulder communities at neighbouring Shoalstone Point that are regarded as being of national conservation importance (Devon Wildlife Trust 1995). Further south beyond Sharkham Point the low-lying reefs protruding from the sandy beaches are scoured by mobile sediments, yet they still exhibit good populations of sand-tolerant algae including the rare alga *Gigartina pistillata* (Devon Wildlife Trust 1995).

Typical exposed shore communities are present at the mouth of the River Dart (Moore 1988a). In the deep (20+ m) water at the entrance to the ria (known as 'the Range'), the major sea bed type is muddy sand, with a rich infauna of bivalves, polychaetes and echinoderms. Low-lying rock outcrops in some areas here have a low species diversity, probably because of the silt load of the River Dart and the scouring action of mobile sediment. Several species, such as the shore seaweeds *Bifurcaria bifurcata* and *Drachiella spectabilis*, the soft coral *Alcyonium glomeratum* and the hydroid *Gymnangium montagui,* reach the eastern limit of their distributions in this area (Devon Wildlife Trust 1995; English Nature 1994). The vertical walls of shallow caves west of Mill Bay Cove are colonised by encrusting species typical of surge gullies (Moore 1988a). Inshore of the exposed conditions of the Range there is a rapid transition to very sheltered, reduced salinity conditions inside the inlet. In the narrow channel at the mouth of the Dart, strong tidal streams sweep over beds of pebbles and cobbles, which have a rich covering of sponges, hydroids, anthozoans and bryozoans. Two southern species of sea squirt, *Distaplia rosea* and *Pycnoclavella aurilucens,* are found in high numbers together with the barnacle *Balanus improvisus*.

Start Bay, stretching 14 km from Combe Point to Start Point, has a shoreline characterised by shingle beaches and pebble-scoured rocks, with relatively impoverished communities. The shore at Start Point supports a classic exposed community dominated by barnacles and limpets, while in the sublittoral fringe, a rich tideswept community of anemones, sponges and hydroids is present (Devon Wildlife Trust 1995). The sea bed off Start Point is composed of areas of mobile sand and gravel, interspersed with bedrock outcrops covered in a rich turf of animal species.

Start Point to Rame Head

From Start Point to Prawle Point the cliff-backed shore consists largely of wide, wave-cut platforms with numerous rockpools. The communities here are typical of moderately exposed to exposed conditions, being dominated by limpets *Patella vulgata* and barnacles, particularly *Chthamalus montagui*. From Bolt Head to Bolt Tail, the intertidal strip narrows and steepens. Powell *et al*. (1978) proposed these stretches of exposed shoreline as a site of regional marine biological importance.

By contrast, the shelter provided by the Salcombe-Kingsbridge inlet, one of the West Country's finest natural harbours, gives rise to quite different communities. There is a high diversity of shore and subtidal habitats, associated with correspondingly diverse marine communities. The lower part of the inlet is characterised by rocky shores and sandy bays, while the upper reaches are predominantly intertidal mudflats. Sublittoral sediment areas of muddy sand are particularly rich in burrowing fauna, with large numbers of polychaete worms, bivalves, anemones and crustaceans, including the angular crab *Goneplax rhomboides*. At Tosnos Point, in the Kingsbridge Estuary, sheltered sediment communities were considered by Hiscock (1986) to be of national or possibly international importance. Just to the north of here, at the Saltstone, rich communities are found on the lower shore of muddy shale gravel and stones. The sediment is characterised by numerous polychaetes (including a large population of the peacock worm *Sabella pavonina*) and amphipods, together with larger burrowing species such as the anemones *Cereus pedunculatus* and *Sagartiogeton undatus*. At and just below low water mark in certain sandy areas around Salcombe Harbour, a heart urchin *Echinocardium cordatum* burrowing community is found, together with extensive beds of eelgrass *Zostera marina* (English Nature 1994). Salcombe's Castle Rocks possess an exceptional marine flora, which includes the kelp *Laminaria ochroleuca* (at one of its easternmost recorded locations) and, amongst the red algae, *Gracilaria multipartita*, all three species of *Gigartina,* and *Mastocarpus stellatus*. The whole Salcombe-Kingsbridge ria system is regarded as being of international marine biological importance for both its rocky and its sediment shores (Bishop & Holme 1980) and for the presence of many southern species.

The intertidal zone between Salcombe and Wembury, excluding the estuaries, is characterised by rocky platforms of inclined slates, with small sandy bays and gullies. Rockpools are a key feature of this section, supporting a high diversity of algae including the peacock weed *Cystoceira tamariscifolia*, the brown alga *Bifurcaria bifurcata* and the introduced Japanese seaweed *Sargassum muticum*. Other intertidal communities here are typical of moderately exposed to exposed shores, though local shelter at some sites (e.g. Cunnimall Rocks or Wadham Rocks) has led to the development of a rich under-boulder fauna with abundant crustacea, such as the furrow crab *Xantho incisus*, the squat lobster *Galathea squamifera* and the broad-clawed porcelain crab *Porcellana platycheles*.

Below low water mark off the open coast, rock surfaces are colonised by a dense kelp forest of *Laminaria hyperborea* and *Saccorhiza polyschides*, with the southern ascidian *Distomus variolosus* occasionally being found in the holdfasts ('roots') of the former. Surge gullies are widespread and possess characteristic communities, with vertical walls often being colonised by jewel anemones *Corynactis viridis*.

The extensive area of wave-exposed clean sand between Burgh Island and the mouth of the River Avon contains rich communities dominated by polychaetes such as *Scolelepis*

tridentata, *Nephtys* spp. and *Magelona mirabilis* (Moore 1988b). Sand eels *Ammodytes* spp. are also abundant. The high freshwater input to the Erme Estuary results in the presence of the brackish brown alga *Fucus ceranoides*. The inlet has been substantially infilled, though sediments remain sandy for some distance upstream from the entrance. Further to the west, off Hilsea Point, rock pinnacles drop from 5 to 30 m depth, with kelp fringing their tops and a range of anthozoans such as jewel anemones, soft corals and sea fans growing on the vertical walls (Gubbay 1988).

At Cellars Beach at the mouth of the Yealm Estuary there are extensive eelgrass *Zostera marina* beds colonising fine, clean sand in shallow water. Where eelgrass is absent, areas of sand are particularly rich in burrowing species such as the heart urchin *Echinocardium cordatum* and various species of bivalves, amphipods and polychaetes. Rocky areas on the lower shore have an array of overhangs and caves, colonised by a rich and characteristic fauna. Species more commonly found below low water occur here, such as the anemones *Metridium senile* and *Sagartiogeton undatus* and the sea squirts *Morchellium argus* and *Sidnyum turbinatum* (Hiscock & Moore 1986). In the upper estuary the communities found at 2-3 m depth on cobbles and pebbles are particularly rich, featuring high abundances of hydroids, anemones, keel worms and sea squirts. The estuary was proposed as a site of national marine biological importance by Bishop & Holme (1980).

Wembury was considered to be a site of primary marine biological importance by Powell *et al*. (1978), and it has been a Voluntary Marine Conservation Area since 1981 (Gubbay 1988). Within the bay there are several reefs of slate bedrock, broken into an uneven series of ridges running parallel to the coast. The sheltered northern faces of these ridges (which are generally steep, vertical, overhung or deeply fissured) are also shaded from the sun. This has enabled a rich and diverse gully and crevice fauna to develop on the lower shore (English Nature 1994). In the sublittoral, echinoderms are much in evidence on the sloping slate ridges, with conspicuous species including the common sea urchin *Echinus esculentus*, the starfish *Henricia oculata* and the cotton spinner *Holothuria forskali*. Other sea cucumbers, such as *Pawsonia saxicola* and *Aslia lefevrei*, remain hidden in fissures, while in adjacent areas of clean, coarse sand, the burrowing sea cucumber *Neopentadactyla mixta* can be found. The area around the Mewstone Ledges is the only site within the region where the nationally rare crevice-dwelling brittlestar *Ophiopsila aranea* is known.

Plymouth Sound and its estuaries represent a fine example of an extensive ria system, with a high diversity of both rocky and soft sediment habitats supporting a very rich marine flora and fauna, the whole area being of national marine nature conservation importance (Hiscock & Moore 1986). The steep rocky shores of the mouth of the sound and the adjacent open coast support typical wave-exposed communities, with gullies and overhangs adding to the variety of habitats. In the subtidal, a *Laminaria hyperborea* kelp forest and a wide variety of foliose red algae dominate the shallows, with sponges, anemones, sea squirts and echinoderms also present. The breakwater at the entrance to the sound is formed of limestone blocks and has a dense forest of kelp *Laminaria hyperborea* and *Saccorhiza polyschides*. The kelp *Alaria esculenta*, a northern species found in wave-exposed situations, is rarely found east of Plymouth (Powell *et al*. 1978). Interestingly, the southern kelp *Laminaria ochroleuca* is also found here. To the south of the breakwater, slate bedrock reefs at 12-25 m depth have rich animal-dominated communities featuring several uncommon or rare species. Of particular note are the impressive dense stands of the nationally important pink sea fan *Eunicella verrucosa*. Further offshore, clean sand areas have an infauna featuring polychaetes, amphipods and bivalves, particularly *Dosinia exoleta* and *Abra prismatica* (Hiscock & Moore 1986).

Within the relative shelter of the sound, the limestone shores of the north side (e.g. below the Hoe) and the north-east side (e.g. at Batten Bay) are of particular interest, with low-shore gullies, overhangs, small caves and rich under-boulder communities. The rock here is extensively bored by bivalves (notably *Hiatella arctica*), and overhangs and shaded vertical faces dominated by the sea squirt *Dendrodoa grossularia* are common on the lower shore. Indeed, the communities present at these sites are regarded as being of regional/national conservation importance (Devon Wildlife Trust 1993b). The upper tidal stretch of the River Tamar, from Weir Quay to Calstock Bend, also merits national importance on account of the salinity gradient along its length, with both hard and sedimentary substrata present (Hiscock & Moore 1986). Further downstream, at Torpoint, the shale cobbles and boulders below Ballast Pound support a rich assembly of algae and encrusting animals, also of national importance (Hiscock & Moore 1986). In the subtidal at The Narrows, the strength of the tidal currents leads to a dominance of filter- and suspension-feeding organisms, such as sponges, hydroids, feather stars and sea squirts (Devon Wildlife Trust 1993b). This habitat and its associated community are of national importance, being rarely recorded elsewhere. A deep underwater 'gorge' (the old river channel) with steep rocky sides runs from around Drake's Island to Mallard Shoal. On the north side of Drake's Island an area of muddy sand is colonised by a bed of the eelgrass *Zostera marina* (Hiscock & Moore 1986).

Rame Head to Zone Point

This section of coast provides some spectacular scenery, with sheltered sandy coves hidden between cliffs and exposed rocky headlands; however, marine biological information is generally lacking. Whitsand Bay has a 6 km shoreline of sand and shingle, with gullies carved by strong tides and cross-currents (Davies in prep.). The Looe Estuary exhibits habitats and associated communities of only local marine biological importance (Little 1988). By contrast, the rocky shores of Looe and Portnadler Bays are regarded as being of prime marine biological importance (Powell *et al.* 1978). The extensive but relatively sheltered shores here have allowed the development of rich intertidal communities. The range of habitats present on the shore at Hannafore Point is of special interest, with an extensive series of gullies, overhangs, reefs and rockpools supporting a great variety of plants and animals. Extensive eelgrass *Zostera marina* beds are present in shallow sandy areas between Hannafore Point and Looe Island. The rocky shores on Looe Island support a similar diversity of species to Hannafore Point, with populations of the anemone *Aiptasia mutabilis* and unusual intertidal records of the rare Celtic sea slug *Onchidella celtica* (M. Camplin pers. comm.).

Between Portnadler Bay and Polruan at the mouth of the Fowey Estuary, the exposed rocky shore at the base of the cliffs is relatively inaccessible, with the exception of access

points at Talland Bay and the small harbour at Polperro. At the entrance to the Fowey Estuary rockpools, overhangs and vertical rock are present from the upper shore down to low water level. The barnacles *Chthamalus montagui* and *C. stellatus* are abundant on the upper shore, with *Balanus perforatus* and *Semibalanus balanoides* lower down and the introduced species *Elminius modestus* being recorded frequently at more sheltered sites (Scott & Moore in prep.). At Polruan Point and Mundy Rocks there are caves possessing distinct communities, with limpets, barnacles, gastropods, sponges and anemones present in varying numbers. The communities associated with subtidal habitats in the lower reaches of the estuary are not especially diverse (Scott & Moore in prep.), though there are beds of the eelgrass *Zostera marina* in the fine sand at Polruan Pool. The burrowing anemones *Cereus pedunculatus* and *Sagartiogeton undatus* are present amongst the eelgrass.

In Mevagissey Bay (and to a lesser extent in neighbouring St. Austell Bay), the shell-gravel sea bed has been buried by up to 2 m of china clay waste (a fine mica and quartz rich silt), washed into the bay from nearby workings. Five different benthic communities have been identified within the bay (Knight 1988, in Davies in prep.), their faunal composition and distribution determined by the quantity and nature of the china clay waste.

From Dodman Point to Zone Point the open coast is largely composed of high cliffs, rocky shores and occasional sandy bays. In particular the rocky shores at Hemmick Beach (near Dodman Point) and Portholland provide a wide variety of habitats and associated wildlife (Powell *et al*. 1978). Where studied, the sublittoral rocky sea bed along this stretch of coast is characterised by forests of kelps *Laminaria hyperborea* and *L. ochroleuca*, underlain by a turf of red algae and large numbers of the sea urchin *Echinus esculentus*. In deeper water this community is replaced by an animal-dominated one, with large numbers of the featherstar *Antedon bifida*, dead man's fingers *Alcyonium digitatum* and, locally, populations of the starfish *Marthasterias glacialis* and the sea cucumber *Holothuria forskali* (James 1983, in Davies in prep.). Near-shore sea-bed habitats and communities from this area remain largely undescribed. On the tide-swept bedrock of the open coast to the east of the Fal Estuary, rich anthozoan and sponge communities are present (English Nature 1994).

Offshore

The reefs in Lyme Bay, most of which are between 3-8 km offshore, support rich faunal communities with some conspicuous though rarely encountered Mediterranean-Atlantic species. These include the bryozoan *Pentapora foliacea*, dense stands of the pink sea fan *Eunicella verrucosa*, and a small population of the rare solitary coral *Leptopsammia pruvoti* (at Saw Tooth Ledges); the occurrence of these last two species is of national importance (Devon Wildlife Trust 1993a). The cobbles and small boulders present at Lane's Ground support a rich diversity of sponges, including *Polymastia mamillaris* and the branching sponge *Axinella dissimilis*, with a dense turf of bryozoans, hydroids and tunicates. Large numbers of pink sea fans are present both on the current-swept bedrock of West Tennants and the large boulders at East Tennants, both at about 25 m depth. The reef at Eastern Heads consists of flat bedrock at 18-20 m depth, with occasional large flat-topped boulders. Again, sea fans are conspicuous here, together with the bright yellow sponges *Cliona celata* and *Polymastia boletiformis*. At Beer Home Ground, off Seaton Bay, there are silty mudstone reefs forming short cliffs and ledges. These appear to have a relatively impoverished fauna, compared with the other reefs, with the hydroid *Nemertesia antennina* being the only conspicuous species recorded as abundant (Devon Wildlife Trust 1993a).

Sublittoral sediments within Lyme Bay support an extremely diverse fauna, with over 400 taxa being recorded from a series of grab samples taken in 1994 (Ambios Environmental Consultants 1995). Sea-bed types range through clean sand, muddy sand, sandy gravel and gravel. The most common community is associated with muddy sand and is dominated by the bivalve *Corbula gibba*, the polychaetes *Chaetozone setosa* and *Megelona filiformis* and the amphipod *Bathyporeia tenuipes*. Further offshore, Holme (1966) described the bottom fauna of the English Channel from a series of grab samples. He identified five species/habitat associations, the commonest being boreal offshore sand, muddy sand and gravel associations.

7 km WSW of Bolt Tail lies the East Rutts pinnacle, a rock outcrop which rises from the sea bed at 35 m to just 9 m below the surface. Below the algal-dominated uppermost zone, a dense animal turf of hydroids (*Tubularia* spp.) and jewel anemones *Corynactis viridis* is interspersed with various sponges, including *Axinella damicornis* and *Homaxinella subdola*, red sea fingers *Alcyonium glomeratum* and, interestingly, a colony of the football sea squirt *Diazona violacea*.

The Eddystone Rocks, some 20 km south of Plymouth Sound, are formed of a hard pink granite. Except for the lighthouse rock itself, they rise to 12-15 m below the surface from a level area of sea bed 50-60 m below chart datum. Flat-faced, angular vertical cliffs with overhangs dominate the underwater scenery, colonised by a turf of bryozoans, hydroids, anemones and extensive patches of jewel anemones *Corynactis viridis*. A high proportion of southern (Mediterranean-Atlantic) species is present here, such as the sea fan *Eunicella verrucosa*, the soft coral *Alcyonium glomeratum*, and the sea cucumber *Holothuria forskali*. Similar communities occur off Hands Deep to the north-west of the Eddystone. The sea bed immediately surrounding the Eddystone Rocks ranges from coarse muddy sand to fine gravel, with patches of shell gravel where there is tidal scour. The shell gravels are dominated by bivalves, such as *Clausinella fasciata*, *Lutraria* spp. and *Parvicardium scabrum*, and polychaetes (English Nature 1994). To the south and east, the sea bed is more uniform and composed of clean fine sand.

The offshore sediments of Whitsand Bay are fine sand and mud with infaunal communities dominated by polychaetes but including the sea cucumbers *Leptosynapta inhaerens* and *Trachythyone elongata* and the burrowing prawn *Callianassa subterranea*. Further west, the sediment becomes muddier, being characterised by an '*Echinocardium cordatum - Amphiura filiformis*' (heart urchin/brittlestar) community (Holme 1953, in Davies in prep.).

4.2.3 Human activities

A wide range of fishing activities takes place within the region, many of which may affect sea-bed habitats and communities. Examples that occur within several of the inlets include bag netting, fyke netting (for eels) and seine netting (for salmon) (see also section 9.1), and mussel and clam cultivation (see also section 9.2). In addition, bait digging, collecting winkles by hand and the use of tiles to attract moulting crabs are widespread. There is a trawling exclusion zone over part of the Skerries Bank, enclosing an area between Start Point and the Bell Buoy. Further details of fisheries and mariculture can be found in sections 9.1 and 9.2.

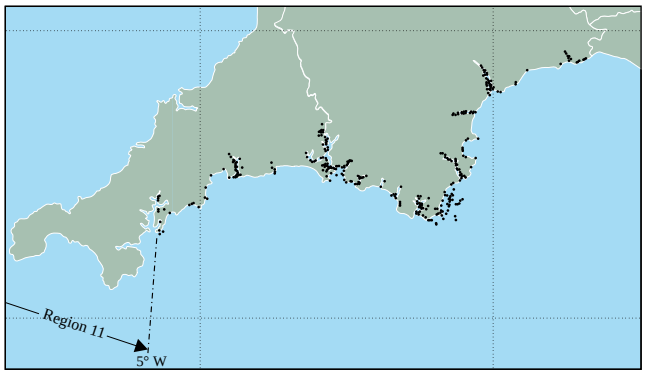
Wembury Voluntary Marine Conservation Area, established in 1981, extends from Gara Point via the Great Mew Stone to Staddon Point, Fort Bovisand. The site lies within the Plymouth Sound SMA and is of importance because of the diversity of its marine life and its accessibility. It has an underwater nature trial. The establishment in 1995 of Looe Voluntary Marine Conservation Area was motivated partly by a 'green tourism' promotion; it embraces almost 5 km of coastline from the Hore Stone, west of Portnadler Bay, to Limmicks in Looe Bay, including the East and West Looe Rivers to their tidal limits. Seawards, the boundary extends to the 10 m depth contour and encompasses Looe Island and the Ranneys.

4.2.4 Information sources used

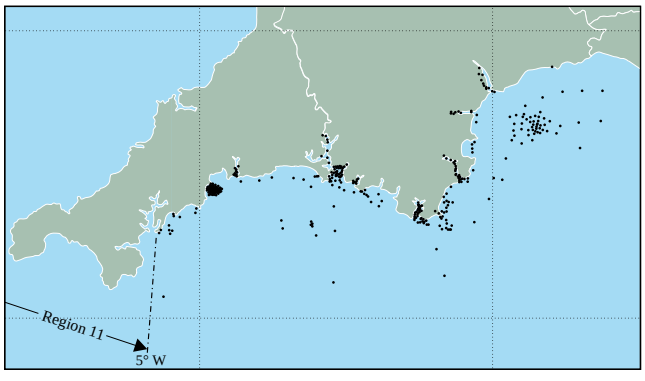
JNCC's Marine Nature Conservation Review (MNCR) team (and their contractors) use a standard recording methodology for both littoral and sublittoral surveys, which includes descriptions of both habitats and their associated communities (see Hiscock 1996). Survey information from other sources may vary considerably in its methodology and coverage. The MNCR *Review of current knowledge* series, in which this region is covered in Davies (in prep.), summarises the results of many previous surveys. Table 4.2.2 and Maps 4.2.2 and 4.2.3 indicate the scale and distribution of marine benthic site survey in the region.

The Scottish Marine Biological Association/Marine Biological Association Intertidal Survey Unit surveyed and assessed the marine biological importance of many littoral sites within the region (Powell *et al*. 1978). The south-west Britain sublittoral survey covered the whole of the South-West Peninsula (Hiscock 1981). Marine inlets in the region were described by the Field Studies Council during the Nature Conservancy Council's study of harbours, rias and estuaries in southern Britain (e.g. River Exe (Dixon 1986), River Teign (Frid 1989), River Dart (Moore 1988a), Salcombe Harbour & Kingsbridge Estuary (Hiscock 1986), Rivers Avon & Erme (Moore 1988b), Plymouth area & the Yealm (Hiscock & Moore 1986), Looe (Little 1988)). Descriptions from these sites have been included in a number of area summaries compiled by Smith & Moore (in prep.) and in a classification of the range of biotopes represented (Moore in prep.). A series of intertidal monitoring studies has been carried out in the western English Channel to study long-term changes, including the effects of the Torrey Canyon oil spill (Southward *et al.* 1995; Hawkins & Southward 1992).

The Devon Wildlife Trust (DWT) holds a wide range of information relevant to the coast and nearshore waters off



Map 4.2.2 Littoral (including tidal river) surveys recorded on the MNCR database (see Table 4.2.2). Source: JNCC.



Map 4.2.3 Near-shore sublittoral surveys recorded on the MNCR database (see Table 4.2.2). Source: JNCC.

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

Littoral	*Near-shore sublittoral*	*Offshore*	*Total*
499	404	0	893

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

Devon. A major marine survey programme was initiated by the DWT in 1991 following the *Rosebay* oil spillage, concentrating on annual littoral and sublittoral surveys within distinct coastal cells. To date, reports have been produced for the Great West Bay area (Devon Wildlife Trust 1995) and Plymouth Sound (Devon Wildlife Trust 1993b). In Cornwall a substantial amount of information, both published and unpublished, is held at the Cornish Biological Records Unit (CBRU), Redruth, as well as by the Cornwall Wildlife Trust. A historical record of conchological studies in Cornwall, together with descriptions of shores and of their molluscan fauna, was provided by Turk (1983). The inaccessibility of much of the foreshore between Lyme Regis and Budleigh Salterton has meant that studies of littoral habitats and communities there have been limited. However, recent work by the Devon Wildlife Trust has helped to redress this. Ladram Bay near Otterton has been extensively studied by Exeter University, though most information remains unpublished.

For many offshore (defined as beyond 3 km or 50 m depth) areas, there is little information available in the public domain on the detailed nature of the sea bed. However, in

Lyme Bay recent survey work has added considerably to current knowledge; for instance, the Devon Wildlife Trust near-shore reefs survey (Devon Wildlife Trust 1993a) and environmental assessment (EA) studies relating to near-shore oil and gas exploration are available (Ambios Environmental Consultants 1995). These EA reports mainly refer to the eastern portion of Lyme Bay (Region 9). General information on bathymetry and sea-bed geology is shown on Admiralty charts and British Geological Survey sediment charts.

4.2.5 Acknowledgements

The author acknowledges the help of JNCC's Marine Nature Conservation Review team (particularly Dr Tim Hill) in compiling and presenting the information given here. The MNCR literature review by Dr Jon Davies (Durlston Head westwards) has been widely consulted. Thanks are also due to Mike Camplin (Devon Wildlife Trust), who provided invaluable first-hand knowledge of the region.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Marine nature conservation issues in England	*Marine Ecologist, Marine Task Force, EN HQ, Peterborough, tel: 01733 340345
Local marine nature conservation issues	*English Nature (Devon and Cornwall Local Team), Okehampton, tel: 01837 55045
Littoral studies at various sites in the south-west, especially within the Exe Estuary	Dr Tegwyn Harris, Department of Biological Sciences, University of Exeter Hatherley Labs., Prince of Wales Road, Exeter, Devon EX4 4PS, tel: 01392 263263
General marine information; extensive library; aquarium	Marine Biological Association of the UK, The Laboratory, Citadel Hill, Plymouth PL1 2PB, tel: 01752 633100
General marine research	Plymouth Marine Laboratory, Prospect Place, West Hoe, Plymouth PL1 3DH, tel: 01752 633100
Coastal and marine information for Devon	Dr Geoff Wigham, Dept. of Biological Sciences, University of Plymouth, Drake Circus, Plymouth PL4 8AA, tel: 01752 600600
Coastal and marine information for Cornwall	Dr Stella Turk, Cornish Biological Records Unit, Trevithick Centre, Trevenson Road, Pool, Redruth, Cornwall TR15 3PL, tel: 01209 710424
Marine conservation issues in Devon & Cornwall	*Joan Edwards, Marine Conservation Officer, Devon Wildlife Trust, Exeter, tel: 01392 79244
Littoral and sublittoral survey records of habitats and species from the south Devon coast	*Marine Survey Officer, Devon Wildlife Trust, Exeter, tel: 01392 79244
Habitats and species from the Cornish coast	*Director of Conservation, Cornwall Wildlife Trust, Truro, tel: 01872 73939
General marine conservation issues in Britain	*Marine Conservation Society, Ross-on-Wye, tel: 01989 566017

*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 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 (layering), which determine the vertical stability of the water column. The distribution of species, here and elsewhere, is influenced directly by salinity, temperature, water flows into the area (section 2.3) and the presence of local benthic (bottom-dwelling) communities (see section 4.2.2). Many of the species of these communities, including commercially important fish and shellfish (see section 5.5 and 5.7), have temporary planktonic larval forms (meroplankton). Tidal fronts (boundary zones between stratified and well-mixed water masses) are likely to be of significant biological importance, since they are usually rich in plankton, which attracts other marine life.
Phytoplankton blooms - transient 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 or have an important economic impact on mariculture, fisheries and tourism. Figure 4.3.1 shows the seasonal cycles of phytoplankton blooms and numbers of copepods present in Region 10 (Warner & Hays 1994).

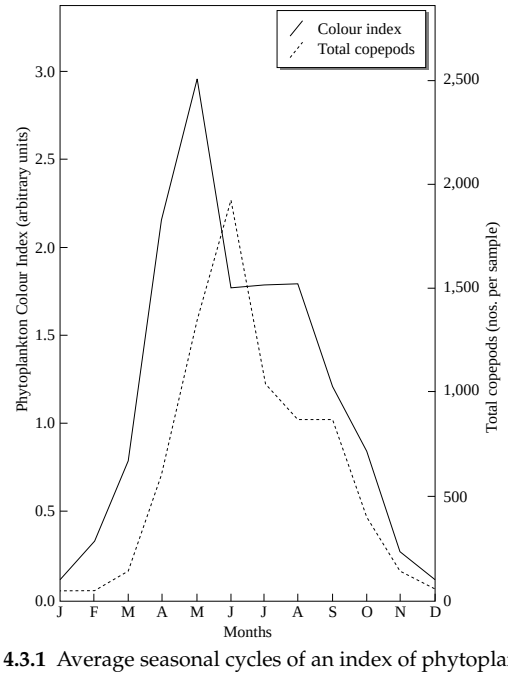
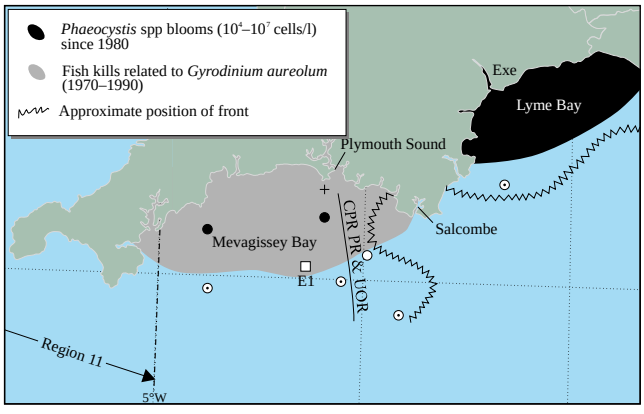


Figure 4.3.1 Average seasonal cycles of an index of phytoplankton colour (a visual estimate of chlorophyll) and the numbers of copepods per sample (approximately 3 m^3 of water filtered), derived from Continuous Plankton Recorder data for 1958-1992. Source: SAHFOS.



Map 4.3.1 Plankton surveys (see Table 4.3.1), the approximate position of 'fronts' (Pingree & Griffiths 1978), and the occurrence of *Phaeocystis* and *Gyrodinium aureolum*. Source: SAHFOS, Oslo & Paris Commissions (1992).

In Region 10, as elsewhere, the plankton has a fundamental role in the food chain of both benthic (sea-bed) organisms (see sections 4.2, 5.4 and 5.5) and fish (see sections 5.7 - 5.9). For both ecosystems the availability of food and nutrients, the survival of larvae, the maintenance of populations and the timing of egg production are highly dependent on the amount of plankton 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 also give early warning of adverse human impacts (for example the effects of eutrophication) and highlight different water masses.

The annual cycle of phytoplankton production in the English Channel (Figure 4.3.1) is similar to that in the Irish Sea, except that the spring bloom commences one month earlier (March-April). This region includes the coastal waters of the western English Channel, ranging in depth between 20-80 m. Mean surface temperature and salinity vary (depending on season) between 8-16 °C and 34.75-35.3 g/kg respectively. During the winter months the water column is mixed homogeneously, but by summer much of Mevagissey Bay and Lyme Bay are stratified, with tidal fronts developing between coastal waters and central English Channel waters (Map 4.3.1).

4.3.2 Important locations and species

The Continuous Plankton Recorder (CPR) surveys (see e.g. Warner & Hays (1994)) show that the planktonic assemblage is made up mainly of neritic (coastal water) species, although southern intermediate (mixed water) species can also be present at certain times of the year.

Detailed surveys of phytoplankton succession in the western Channel have indicated three peaks occurring on an annual basis, reflecting a change in species composition (Boalch 1987; Holligan & Harbour 1977). The spring and autumnal (September) blooms are dominated by diatoms, while dense populations of dinoflagellates dominate

Table 4.3.1 Details of surveys

Identification on Map 4.3.1	*Frequency*	*Period*	*Reference*
CPR: 'PR' route	Monthly	1974-1994	Warner & Hays 1994
UOR	Occasional	1979-1981	Robinson *et al.* 1986
E1 (□)	Occasional	1964-1974	Maddock *et al.* 1981
E1 (□)	Monthly	1975 & 1976	Holligan & Harbour 1977
E1 (□)	Various	1964-1986	Boalch 1987
PS (●)&(□)	Seasonal	1964-1974	Boalch *et al.* 1978
PS (+)	Various	1933-1934	Harvey *et al.* 1935
PS (○)	Weekly	1924-1988	Southward 1980
PS (⊙)	Occasional	July 1977	Holligan *et al.* 1980
Western Channel	Occasional	1958-1960	Southward 1962
Western Channel	Occasional	1974-1975	Pingree *et al.* 1976

Key: CPR: Continuous Plankton Recorder; UOR: Undulated Oceanographic Recorder; E1: International Hydrographic Station; PS: Plankton Station.

between June and August. This succession is related to the degree of thermal stratification in the water column. The zooplankton of this region is typically dominated by small neritic copepods, although some species (e.g. *Paracalanus* spp., *Pseudocalanus* spp.) are relatively scarce in English coastal waters. Weekly sampling of zooplankton between 1924-1988 has indicated a long series of changes involving larger zooplankton (e.g. for fish larvae, a change in dominance of *Sagitta elegans* to *S. setosa*, and fluctuations in *Calanus helgolandicus* numbers) in relation to a climatic oscillation known as the 'Russell Cycle'. These changes in the biological and chemical components of the ecosystem have been reviewed by Southward (1980).

Although the zooplankton season is quite long in English coastal waters, abundance is generally low. Zooplankton species are more abundant in the central English Channel, especially in frontal areas, where euphausiids and *Calanus helgolandicus* dominate. Other commonly found zooplankton include small hydromedusae, amphipods and meroplanktonic larvae of echinoderms, polychaetes, decapods, molluscs and cirripedes. The CPR data shows that a decline in species numbers and a shortening of the growing season occurs from north to south across the western English Channel and that both phyto- and zooplankton undergo marked changes in species occurrence on a seasonal and year-by-year basis, owing to climatic variability (Robinson *et al.* 1986).

4.3.3 Human activities

In this region phytoplankton are of particular importance to the coastal manager because a number of exceptional and toxic blooms have occurred here (Table 4.3.2). These blooms and their effects on fishing in the western English Channel have been reviewed by Boalch (1984). The two most economically detrimental blooms are attributed to the dinoflagellate *Gyrodinium aureolum*, which has caused fish mortalities, and the diatom *Coscinodiscus wailesii*, which produces large amounts of mucilage and impedes fishing operations (by, for example, clogging fishing nets). Blooms of *Phaeocystis* (10^4-10^7 cells/l) have also occurred in this region (Map 4.3.1) (Oslo & Paris Commissions 1992); blooms of this species have been associated with eutrophication in Dutch coastal waters and may result in the accumulation of large banks of foam on beaches, resulting in a visual and olfactory nuisance.

Table 4.3.2 Summary of the distribution of blooms and their possible effects

Species	*Location*	*Possible effect*
Gyrodinium aureolum	Western Channel	Fish and invertebrate mortalities
Phaeocystis	Lyme Bay	Foam-producing species
Noctiluca scintillans	Western Channel	Red tides
Alexandrium tamarense	Fal Estuary	Paralytic Shellfish Poisoning
Coscinodiscus wailesii	Western Channel	Mucilage-producing species

Source: Boalch (1987)

4.3.4 Information sources used

The western part of the English Channel has been studied in detail for more than 75 years, including continuous observations since 1924 at one station (Southward 1980). Much of the work has been carried out by researchers based at the Marine Biological Association (now part of Plymouth Marine Laboratory) using Station E1. Seasonal succession and phyto-zooplankton relationships have been investigated by Holligan & Harbour (1977) and Maddock *et al.* (1981). Boalch *et al.* (1978) measured primary production over a period of eleven years, while Robinson *et al.* (1986) have investigated the relationship between hydrography and plankton using data from the CPR survey. For a list of plankton studies within estuaries of this region (e.g. Plymouth Sound and the Exe and Salcombe Estuaries), see Head (1975). Table 4.3.1 summarises plankton surveys in Region 10, shown on Map 4.3.1.

4.3.5 Further sources of information

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Continuous Plankton Recorder (CPR) survey data	Director, Sir Alister Hardy Foundation for Ocean Science, The Laboratory, Citadel Hill, Plymouth PL1 2PB, tel: 01752 633100
Long-term plankton data, plankton blooms, plankton succession in the western English Channel	Director, Marine Biological Association, Plymouth Marine Laboratory, Citadel Hill, Plymouth PL1 2PB, tel: 01752 633100
Plankton research	Head of Department, Department of Oceanography, Southampton University, University Road, Southampton SO9 5NH, tel: 01703 595000 ext. 3642
Ichthyoplankton	*Director, MAFF Directorate of Fisheries Research, Fisheries Laboratory, Lowestoft, tel: 01502 562244

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

Wembury Bay, near Plymouth, Devon, is a site of notable marine biological importance and has been a Voluntary Marine Nature Reserve since 1981. Crevices in the rocky reefs that form the lower shore are crammed with different life-forms, including seaweeds. One red seaweed, *Bornetia secundiflora*, is nationally rare, and another, *Gigartina pistillata*, is nationally scarce. Photo: Peter Wakely, English Nature.

Chapter 5 Important species

5.1 Terrestrial lower plants

N.G. Hodgetts

5.1.1 Introduction

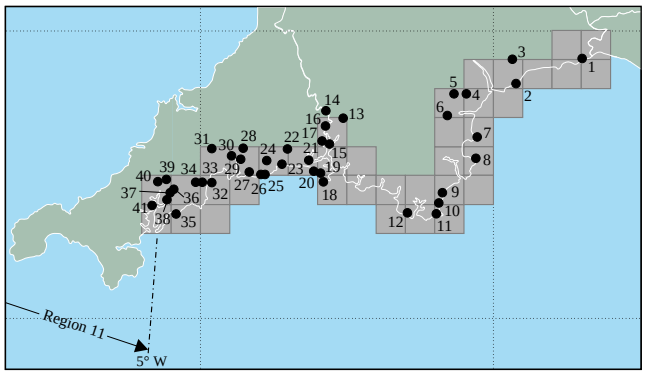
This section covers lichens, bryophytes (mosses and liverworts), stoneworts (a group of freshwater and brackish water algae - the latter are covered in section 5.4) and fungi occurring in the coastal 10 km squares within the boundaries of the region. About 42% of the British bryophyte flora and about 14% of the stonewort flora occur in the region. Similar figures are not available for other groups. The lower plant flora of Region 10 is subtly different from that of the adjacent Region 11 (which includes the north coasts of Devon and Cornwall), though it is less diverse. The equable climate and south-westerly position of this region make it an important area for southern European lower plant species at the northern extremity of their range. There is also a reasonable representation of oceanic species and communities.

There are several sites of national importance for lower plants and one at Torquay of international importance. Like higher plants (see section 5.2), lower plant species tend to occur in characteristic assemblages that are restricted to particular habitats. Particularly important lower plant habitats occurring in the region include calcareous and non-calcareous coastal grassland, woodland and old mine workings and china clay quarries. Other habitats of importance for lower plants represented in the region include wet and dry heathland. There are also many small, 'miscellaneous' sites, such as roadside banks, hedgerows, streams, small gullies, rock crevices, damp grassland etc., which individually do not appear very significant but which collectively comprise a substantial resource in this region.

5.1.2 Important locations and species

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

Important lower plant localities in this region are found in strips of cliff-top grassland, which usually have thin turf with complex vegetation mosaics rich in bryophytes, lichens and higher plants. These often extensive unstable areas are important in maintaining bare ground for colonisation by some of the rare ephemeral lower plants of this habitat. Grassland of this type differs in its species composition according to the geology. Calcareous grassland is usually richer than neutral or acidic grassland, but each type has its own distinctive flora. The cliff tops in the Torquay area are particularly rich in rare calcicolous bryophytes, while cliff tops on the south coast of Cornwall tend to be rich in calcifuge species, many of which are relatively common in



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

Cornwall but rare in Britain as a whole. Exposed rocks within the grassland or heath habitat are often good for southern warmth-loving species of bryophyte and lichen. The area of exposed rock between high water mark and the cliff tops can be important for lichens. Many distinctive species and communities grow on different rock types, including rarities such as *Teloschistes flavicans* and *Roccella fuciformis*. Some lichens are distinctive components of the saxicolous (i.e. rock) vegetation in cliff bird roosts, where the rocks are enriched by bird droppings.

The other major lower plant habitat in the region is woodland, which in some areas supports a flora substantially influenced by proximity to the sea. Some woodlands in the region have a reasonably good representation of oceanic species, although in general the oceanic flora of woods further inland (on the fringes of Dartmoor and Bodmin Moor) is better. Many oceanic species (most notably small desiccation-intolerant liverworts) are almost confined to woodland. Fungi are important as wood decomposers. The epiphytic lichen flora of Slapton Ley is particularly notable, but is believed to have declined since the demise of the elms through Dutch elm disease. Some of the Red Data Book species listed may no longer occur there.

Old mine-workings and china clay quarries are a characteristically Cornish landscape feature and support a unique and specialised lower plant flora. Some bryophytes and lichens are specialists of heavy metal-rich soils and are virtually confined to old lead and copper mines.

Some specialist aquatic species of all lower plants occur where there are streams and rivers.

The area contains a number of threatened species, some of which are given special protection under national and international legislation. These and other Red Data Book (i.e. nationally rare) species, excluding those with a status of

Table 5.1.1 Lower plant sites

*Site no.**	*Site name*	*Grid ref.*	*Protected status*
	Devon		
1	Axmouth-Lyme Regis Undercliffs	SY3090	NNR
2	Otter Estuary	SY0782	SSSI
3	East Devon Pebble Bed Heaths	SY0690	SSSI
4	Great Haldon Heaths	SX9078	SSSI
5	Chudleigh Caves & Woods	SX8678	SSSI
6	River Lemon Valley Woods	SX8471	SSSI
7	Hope's Nose to Walls Hill	SX9463	SSSI
8	Berry Head to Sharkham Point	SX9456	SSSI, part LNR
9	Slapton Ley	SX8244	SSSI
10	Stokenham	SX8141	SSSI
11	Prawle Point & Start Point	SX8037	SSSI
12	Bolt Head to Bolt Tail	SX7037	SSSI
13	Grenofen Wood	SX4870	SSSI
	Cornwall		
14	Clitters Wood, Chilsworthy	SX4272	Not protected
15	Landulph area	SX4361	Not protected
16	Bohetherick-Cotehele Bridge	SX4267	Not protected
17	Kingsmill Bridge, Cornwall	SX4162	Not protected
18	Rame Head area (including Bull Cove)	SX4148	Part SSSI
19	Withnoe Cliffs	SX4051	Not protected
20	Tregantle Down Cliffs	SX3852	Not protected
21	Lynher Estuary	SX3655	SSSI
22	Seaton Valley, south of Hessenford	SX2959	Not protected
23	Millendreath	SX2754	Part NT
24	Catherinepark Wood and Sowden's Bridge	SX2255	Not protected
25	Polperro-Talland Cliffs	SX2150	Part NT
26	Polperro West Cliffs	SX2050	SSSI, part NT
27	West Coombe, Lansallos	SX1651	Part NT
28	Boconnoc Park and Woods	SX1459	SSSI
29	Lerryn Wood	SX1356	Not protected
30	Milltown Wood	SX1057	Not protected
31	Valley at Lavrean Farm, Menadue	SX0359	Not protected
32	Hallane, Black Head	SX0348	Not protected
33	Shepherdshill Wood	SX0048	Not protected
34	Paramoor Wood	SW9848	Not protected
35	Gerrans Bay to Camels Cove	SW9137	SSSI
36	Killiow Brake	SW9045	Not protected
37	Fal & Ruan Estuaries, Mellingoose	SW8944	SSSI
38	Lamorran Wood	SW8842	Not protected
39	Cuskayne, roadside woods	SW8849	Not protected
40	Frogmore, Trevella stream	SW8548	Not protected
41	Cowlands Creek	SW8340	Not protected

Sources: references listed in section 5.1.5 and JNCC's protected sites database. Key: SSSI = Site of Special Scientific Interest; LNR = Local Nature Reserve; NNR = National Nature Reserve; NT = National Trust; *site numbers refer to Map 5.1.1.

Indeterminate, Insufficiently Known or Extinct (out of a total of 137 bryophytes, twelve stoneworts and 177 lichens on the British Red Lists), are listed in Table 5.1.2. In addition, the region holds 57 of the 313 nationally scarce bryophytes, although no nationally scarce species of freshwater stoneworts. There is currently insufficient information to provide regional lists of nationally scarce fungi and lichens.

Table 5.1.2 Red Data Book lower plants

Species	*Locations/habitats*
Liverworts	
Cephaloziella turneri	Roadside and trackside banks, Frogmore, Tregony & Winsworth, Cornwall
*Petalophyllum ralfsii**,**	Thin turf on Walls Hill, Torquay, Devon
Mosses	
*Acaulon triquetrum***,[a]	Cliff-top turf, Torquay, Devon
Amblystegium saxatile	Damp grassy hollow, Menadue, Cornwall
Tortula cuneifolia	Shaded coastal rocks, Torquay and Teignmouth area
Weissia multicapsularis	Acidic soil, south Cornwall and Devon
Stoneworts	
Chara connivens	Calcareous pool at Slapton Ley, Devon
Lichens	
Bacidia incompta	Tree trunks, Littleham and East Allington, Devon
Caloplaca flavorubescens	Epiphytic, South Devon
Cliostomum corrugatum	South Devon
Collema fragrans	Epiphytic, South Devon
Cryptolechia carneolutea	Epiphytic, Slapton Ley, Devon
Parmelia quercina	Nutrient-rich bark, Slapton Ley and the Undercliff west of Lyme Regis, Devon
*Physcia tribacioides***	Tree trunk, Slapton Ley, Devon
*Teloschistes flavicans***	Soar Mill Cove, Malborough, & Widdicombe House, Torcross, Devon
Usnea madeirensis	South Devon

Source: JNCC lower plants database. Key: *protected under Annex II of the EC Habitats & Species Directive and Appendix I of the Bern Convention; **protected under Schedule 8 of the Wildlife & Countryside Act 1981; [a]old records only - further survey work needed.

5.1.3 Human activities

Current factors that may have a bearing on the lower plant flora of the region include urban expansion, road construction programmes and acid rain. Lowering of the water table may have an effect on wetland sites, particularly bogs and wet heath. Some areas are affected by holiday and leisure developments such as caravan sites and golf courses. Cliff-top grassland and heathland are subject to erosion in some places, particularly close to conurbations. The fragile mosaics of thin vegetation may be prone to replacement with coarse grassy swards where there is enrichment from dog excrement etc. Pollution is a general problem but may be aggravated in some areas by agricultural run-off, oil spillages etc. Most of the old derelict mine sites rich in heavy metals are at least potential targets for reclamation.

One site in the region is a National Nature Reserve and is therefore managed for nature conservation. There are a number of management considerations on this and other sites that are important for lower plants. Overgrazing in woodland areas has an effect on the lower plant communities in the long term, as the woods tend to become more senescent (dominated by older trees). On the other hand, undergrazing leads to the development of a thick understorey of shrubs such as holly, and should also be avoided: a balance needs to be struck. Burning of heathland sites is usually damaging to the lower plant communities. Equally damaging, particularly in wet heathland sites, is

scrub invasion, often the result of insufficient or no grazing, which leads to their eventual drying out. However, coastal scrub is often important for lower plants, and any clearance operations should be handled with care. A close species-rich sward with some bare soil should be maintained at important coastal grassland sites: the correct grazing regime, a certain amount of instability and a low level of nutrient input is often desirable to achieve this.

5.1.4 Information sources used

Most of the sites mentioned in this section were selected for protection partly or wholly on the basis of their bryophyte and lichen interest. Many of the sites contain rare and scarce species and qualify for Site of Special Scientific Interest (SSSI) status on the basis of their lower plant flora alone (Hodgetts 1992).

Most important and potentially important coastal lichen sites have been identified in recent surveys (Fletcher 1984; James & Wolseley 1991). However, relatively few of these sites have been comprehensively surveyed, so there are potentially more lichen sites than appear in Tables 5.1.1 and 5.1.2. Data are generally good for bryophytes and the larger lichens but are less complete for fungi, algae and the smaller lichens. Most important bryophyte sites in the region are well documented. The computerised database at the Biological Records Centre (BRC), Monks Wood, and the Lower Plants Database at JNCC include recent records collected over decades by expert bryologists as well as important historical records. In general, Cornwall has better coverage than Devon, although a smaller proportion of the sites have protected status.

Data collation for fungi is still at a relatively early stage, and it is not yet possible to incorporate fungi into criteria for selecting sites for protection, except in rather an *ad hoc* fashion. All British Mycological Society foray data are currently being put onto a computer database at the International Mycological Institute under a JNCC contract.

With the exception of stoneworts, algae are poorly known. No sites are currently selected for protection on the basis of their algae other than stoneworts. Computerised stonewort data are held at BRC and JNCC. More information on other freshwater algae may be available from the Freshwater Biological Association.

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

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Lichens (hard rock coasts)	T. Duke, Sandrock, The Compa, Kinver, Staffs. DY7 6HS, tel: 01384 872798
Lichens (general coastal)	P.W. James, c/o Department of Botany, The Natural History Museum, Cromwell Road, London SW7 5BD, tel: 0171 938 9123
Lichens (woodland, coastal and general: British Lichen Society database)	Dr A. Fletcher, Leicestershire Ecology Centre, Holly Hayes, 216 Birstall Road, Birstall, Leicester LE4 4DG, tel: 0116 2671950
Fungi (British Mycological Society database)	Dr P. Cannon, International Institute of Mycology, Bakeham Lane, Englefield Green, Egham, Surrey TW20 9TY, tel: 01784 470111
Bryophytes (BRC database)	*C.D. Preston, Biological Records Centre, ITE, Monks Wood, Huntingdon, tel: 014873 381
Bryophytes (British Bryological Society herbarium)	A.R. Perry, Department of Botany, National Museum of Wales, Cardiff CF1 3NP, tel: 01222 397951
Lower plants (species status; Red Data Book Database; site register etc.)	*N.G. Hodgetts, JNCC, Peterborough, tel: 01733 62626

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

5.2 Flowering plants and ferns

V.M. Morgan

5.2.1 Introduction

This section describes the importance of the region for vascular plants (i.e. flowering plants and ferns), particularly species that are rare or scarce in Great Britain, occurring in the region's coastal 10 km national grid squares, whether or not they are regarded as 'coastal' species. The region is of national importance for rare and scarce species (Table 5.2.1). Classic British botanical localities in the region include the Torquay coast and Berry Head.

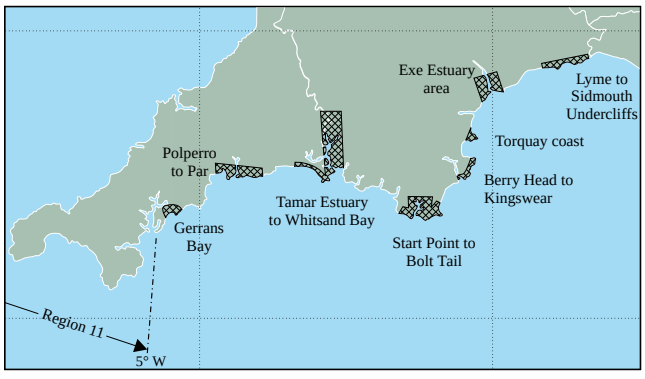
The climate of the region is characterised by mild winters; snow is relatively uncommon and seldom lies long; rainfall is moderate, with an area of lower rainfall around the Exe Estuary (Ivimey-Cook 1985). The mild winters allow a number of species to thrive that are characterised as oceanic-southern, for example wild madder *Rubia peregrina*, whose distribution corresponds with the 4.5°C January isotherm (Ivimey-Cook 1985), sea spurge *Euphorbia paralias* and Bithynian vetch *Vicia bithynica*. Southern continental species are favoured by dry springs and hot summers, especially on chalk and limestone, where the microclimate is often very hot and dry. Examples of such species in the region include squinancywort *Asperula cynanchica* and horseshoe vetch *Hippocrepis comosa* (Ivimey-Cook 1985) and, from other habitats, strapwort *Corrigiola litoralis* and galingale *Cyperus longus* (Matthews 1955). There are also many rarities on Berry Head that are thought to be late-glacial relicts that have been able to persist in a small area that was never covered by forest (Ivimey-Cook 1985).

A number of Britain's most threatened species are present in this region, including eleven that are amongst the 107 listed on Schedule 8 of the Wildlife & Countryside Act (1981). Twenty-seven of the 317 nationally rare (RDB) species listed for Great Britain in the *British Red Data Book of vascular plants* (Perring & Farrell 1983) occur in the region. Of the 254 scarce (i.e. known from up to 100 ten km squares in Great Britain) species in Great Britain, 63 occur in this region (Stewart *et al.* 1994).

Of the nine vascular plant species protected under European law that occur in Britain, one, the endemic (i.e. occurring nowhere else) early gentian *Gentianella anglica*, is found in this region. Shore dock *Rumex rupestris* is Europe's most seriously threatened dock, and the total British population of around 250-300 plants (L. McDonnell pers. comm.) is of international importance.

5.2.2 Important locations and species

Rare species found in the region are listed in Table 5.2.2. Three species - sand crocus *Romulea columnae*, triangular club-rush *Schoenoplectus triqueter* and strapwort - are not found elsewhere in Britain. Some of the more widespread species have their stronghold in south-west England, such as Italian lords-and-ladies *Arum italicum* subsp. *neglectum*, twiggy mullein *Verbascum virgatum* and hairy bird's-foot-trefoil *Lotus subbiflorus*, whereas others occur as outliers of populations centred elsewhere, for example marsh clubmoss *Lycopodiella inundata*, mossy stonecrop *Crassula tillaea* and sea barley *Hordeum marinum*.



Map 5.2.1 Key localities for rare and scarce higher plants. Sites are listed in Table 5.2.2. Source: JNCC rare plants database.

Table 5.2.1 Numbers of rare and scarce higher plant species in coastal 10 km squares of the region*

	*Protected species***	*Other rare (RDB) species*	*Scarce species*
Devon	10	12	55
Cornwall	3	9	36
Region 10	***11***	***17***	***63***

Source: JNCC rare plants database; Stewart *et al.* (1994); BRC database. Key: RDB = Red Data Book; *excludes known introductions and records from before 1970; **listed for special protection in the Wildlife & Countryside Act (1981) or on appropriate annexes of the EC Habitats & Species Directive or the Bern Convention.

Rare and scarce species grow in a wide range of habitats, but of particular importance are limestone grassland, sandy beaches, dunes and estuarine mud. Key localities for the region's rare and scarce species are shown on Map 5.2.1 and listed in Table 5.2.3. In addition to the key localities that are noted for rarities, there are many moderately species-rich sites throughout the region.

5.2.3 Human activities

Activities that have affected plant communities and populations include tourist developments and construction projects, such as sea defences and culverting of streams, which may lead to loss of habitats, affecting such species as shore dock. Agricultural modernisation has affected species such as field eryngo, bladderseed and Vigur's eyebright (FitzGerald 1990). Species of waste ground such as Greek sea-spurrey are at risk from hard-surfacing and the use of herbicides.

In the past, some species have been threatened by collecting, particularly in the era of botanical exchange clubs around the end of the last century, when herbarium specimens were swapped amongst botanists. The precise localities of potentially collectable species such as Plymouth pear and small-flowered tongue-orchid are still kept strictly confidential.

Table 5.2.2 Recorded occurrence of nationally rare (RDB) and/or protected species

Species	*Recorded occurrence in:*			*Key localities*	*Habitat*
	10 km squares in GB	*10 km squares in region*	*No. of sites in region (approx.)*		
Bladderseed *Physospermum cornubiense*	8	2	5	Tamar Estuary to Whitsand Bay	Rough grassy heaths
Broad-fruited cornsalad *Valerianella rimosa*	5	1	1	Exe Estuary area	Arable and rough ground
Early gentian *Gentianella anglica*[1,2]	36	1	1	Lyme Regis to Sidmouth undercliffs	Chalk & dunes
Field eryngo *Eryngium campestre*[1]	10	4	5	Exe Estuary area; Scabbacombe (SX95); Billacombe (SX52); Tamar Estuary to Whitsand Bay	Dry grassland
Four-leaved allseed *Polycarpon tetraphyllum*	13	4	5	Kingswear (SX85); Berry Head to Kingswear; Blackpool (SX84); Bantham (SX64); Tamar Estuary to Whitsand Bay	Sand dunes & walls
Goldilocks aster *Aster linosyris*	7	1	1	Berry Head to Kingswear	Limestone cliffs
Greek sea-spurrey *Spergularia bocconii*	4	1	1	Polperro to Par	Open sandy & gravely places
Heath lobelia *Lobelia urens*	7	2	2	Little Bradley (SX87); Lerryn (SX15)	Damp heaths
Honewort *Trinia glauca*	6	2	5	Torquay area; Berry Head to Kingswear	On dry, stony limestone soils
Little-Robin *Geranium purpureum*	15	2	2	Torquay coast; Plymouth; Gerrans Bay	Open rocky places & hedgebanks
Nit-grass *Gastridium ventricosum*	20	2	2	Berry Head to Kingswear; Little Bradley (SX87)	Basic grassland
Pennyroyal *Mentha pulegium*[1]	15	1	1	Start Point to Bolt Tail	Inundation grassland
Plymouth pear *Pyrus cordata*[1]	3	1	1	Plymouth area	Hedgerows & green lanes
Prostrate toadflax *Linaria supina*	7	2	3	Plymouth; Tamar Estuary to Whitsand Bay; Polperro to Par	Dry, open ground
Purple gromwell *Lithospermum purpurocaeruleum*	13	3	4	Lyme to Sidmouth Undercliffs; Torquay coast	Chalk & limestone cliffs
Sand crocus *Romulea columnae*[1]	1	1	2	Exe Estuary	Short turf on sand
Sea knotgrass *Polygonum maritimum*[1]	4	1	1	Polperro to Par	Sandy beaches
Shore dock *Rumex rupestris*[1,2]	13	6	7	Start Point to Bolt Tail; Ringmore (SX64); Tamar Estuary to Whitsand Bay; Polperro to Par; Gerrans Bay	Damp raised beaches & dune slacks
Slender bird's-foot-trefoil *Lotus angustissimus*	24	8	20	Exe Estuary area; Start Point to Bolt Tail; Plymouth; Tamar Estuary to Whitsand Bay; Polperro to Par; Gerrans Bay	Open grassland
Small-flowered tongue-orchid *Serapias parviflora*[3]	1	1	1	Tamar Estuary to Whitsand Bay	Scrub
Small hare's-ear *Bupleurum baldense*[1]	2	1	1	Berry Head to Kingswear	Open calcareous grassland
Small restharrow *Ononis reclinata*[1]	8	2	3	Torquay coast; Berry Head to Kingswear	Open limestone grassland
A whitebeam *Sorbus anglica*	13	1	2	Whilborough (SX86)	Limestone cliffs & woods
Strapwort *Corrigiola litoralis*[1]	1	1	1	Slapton Ley (SX84)	Sandy lagoon
Toadflax-leaved St. John's-wort *Hypericum linariifolium*	7	1	1	Berry Head to Kingswear	Acid, rocky slopes
Triangular club-rush *Schoenoplectus triqueter*[1]	1	1	1	Tamar Estuary to Whitsand Bay	Banks of muddy estuaries
Vigur's eye-bright *Euphrasia vigursii*	19	2	2	Tamar Estuary to Whitsand Bay; Polperro to Par	Maritime dwarf heath
White rock-rose *Helianthemum apenninum*	6	2	5	Torquay coast; Berry Head to Kingswear	Dry limestone grassland

Source: JNCC rare plants database and rare plant survey reports. Key = [1]listed on schedule 8 of the Wildlife & Countryside Act, 1981; [2]listed on Annexes IIb & IVb of EC Habitats Directive and Annex I of the Bern convention; [3]*Serapias parviflora* is widely considered to have been introduced. Note: figures are for numbers of 10 km squares recorded since 1970, excluding known extinctions. Grid references are given for localities not shown in Map 5.2.1.

Table 5.2.3 Key localities for nationally rare (RDB) and scarce species (records post 1970)

Locality	*Species*	*Status*
Lyme to Sidmouth Undercliffs	RDB: early gentian *Gentianella anglica*, purple gromwell *Lithospermum purpurocaeruleum* Scarce species: white horehound *Marrubium vulgare* plus nine others	SSSI, part NNR
Exe Estuary area	RDB: broad-fruited cornsalad *Valerianella rimosa*, field eryngo *Eryngium campestre*, sand crocus *Romulea columnae*, slender bird's-foot-trefoil *Lotus angustissimus* Scarce species: galingale *Cyperus longus*, the whitebeam *Sorbus devoniensis*, twiggy mullein *Verbascum virgatum*, white mullein *V. lychnitis,* plus fourteen others	Part SSSI, part LNR, part undesignated
Torquay coast	RDB: honewort *Trinia glauca*, little-Robin *Geranium purpureum*, purple gromwell, small restharrow *Ononis reclinata*, white rockrose *Helianthemum apenninum* Scarce species: Autumn squill *Scilla autumnalis*, carrot broomrape *Orobanche minor* var. *maritima*, maidenhair fern *Adiantum capillus-veneris*, the whitebeam *Sorbus porrigentiformis*, twiggy mullein, plus eleven others	Part SSSI, part undesignated
Berry Head to Kingswear	RDB: four-leaved allseed *Polycarpon tetraphyllum*, Goldilocks aster *Aster linosyris*, honewort, nit-grass *Gastridium ventricosum*, small hare's-ear *Bupleurum baldense*, small restharrow, toadflax-leaved St. John's-wort *Hypericum linarifolium*, white rockrose Scarce species: Autumn squill, carrot broomrape, maidenhair fern, twiggy mullein plus ten others	Part SSSI, part LNR, part undesignated
Start Point to Bolt Tail	RDB: pennyroyal *Mentha pulegium*, shore dock *Rumex rupestris*, slender bird's-foot-trefoil Scarce species: Autumn squill, balm-leaved figwort *Scrophularia scorodonia*, carrot broomrape, galingale, twiggy mullein plus seventeen others	Part SSSI, part undesignated
Tamar Estuary (including Plymouth) to Whitsand Bay	RDB: bladderseed *Physospermum cornubiense*, field eryngo, four-leaved allseed, prostrate toadflax *Linaria supina,* shore dock, slender bird's-foot-trefoil, triangular clubrush *Schoenoplectus triqueter*, Vigur's eyebright *Euphrasia vigursii*, Plymouth pear *Pyrus cordata* Scarce species: balm-leaved figwort, carrot broomrape, maidenhair fern, twiggy mullein plus nineteen others	Part SSSI, part undesignated
Polperro to Par	RDB: Greek sea-spurrey *Spergularia bocconii*, prostrate toadflax, sea knotgrass *Polygonum maritimum*, shore dock, slender bird's-foot-trefoil, Vigur's eyebright Scarce species: balm-leaved figwort, long-stalked orache *Atriplex longipes*, maidenhair fern, twiggy mullein plus nineteen others	Part SSSI, part undesignated
Gerrans Bay	RDB: little-Robin, shore dock, slender bird's-foot-trefoil Scarce species: Babington's leek *Allium ampeloprasum* var. *babingtonii*, galingale, maidenhair fern plus eleven others	Part SSSI, part undesignated

Source: JNCC rare plants database; Stewart *et al.* (1994); SSSI citation sheets; BRC database. Key: SSSI = Site of Special Scientific Interest; NNR = National Nature Reserve; LNR = Local Nature Reserve. Note: scarce species may occur near to rather than within some localities.

5.2.4 Information sources used

Both Devon and Cornwall were covered in rare plant surveys between 1985 and 1989, and a series of detailed confidential reports were produced, now held by English Nature and the Joint Nature Conservation Committee (JNCC). Further work has been carried out by English Nature as part of their programme of monitoring. JNCC maintains a database of nationally rare plant species, which includes site records. Members of the Botanical Society of the British Isles (BSBI) have recently finished collecting up-to-date records of scarce species; these data are held at the Biological Records Centre and have been summarised in *Scarce plants in Britain* (Stewart *et al*. 1994). A Red Data Book for Cornwall is in preparation by the Institute of Cornish Studies.

5.2.5 Acknowledgements

Thanks are due to J.H. Barne, D. Bolton, I. Carl, R. FitzGerald, L. McDonnell, R.J. Murphy, M.J. Wigginton, R. Stevens and staff at the Biological Records Centre.

5.2.6 Further sources of information

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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 340345
Database of rare and protected species	*Species Conservation Branch, JNCC Peterborough, tel: 01733 62626
Biological Records Centre for Devon	*Conservation Data Manager, Devon Wildlife Trust, Exeter, tel: 01392 79244
Biological Records Centre for Cornwall	Institute of Cornish Studies, Trevithick Building, Trevenson Road, Pool, Redruth TR15 3PL, tel: 01209 710424
Local BSBI vice-county records	*C.D. Preston, c/o Biological Records Centre, ITE Monk's Wood, tel: 01487 773381

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

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 invertebrate groups in Great Britain (Kirby 1992). This section deals with most insect orders, though not all families, together with a wide range of non-insect invertebrates, known from sites within the coastal 10 km Ordnance Survey grid squares of the region. Lagoonal species are covered in section 5.4.

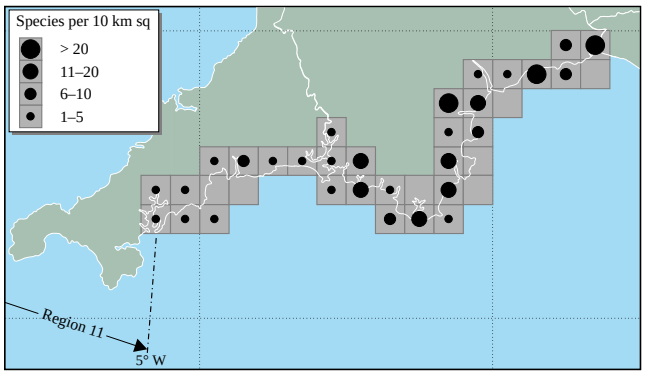
The region is known to support a significant and extensive invertebrate fauna and is nationally important for the conservation of a wide range of invertebrate species. For a few species the only recent British records are from this region, and several other species have a substantial part of their British distribution along this stretch of coast. The region is nationally important for the conservation of many coastal invertebrates that are either restricted to or have a large part of their range within this region, many of which for climatic reasons are at the edge of their range in Britain. Of 358 coastal nationally rare (i.e. Red Data Book (RDB)) and 455 coastal nationally scarce invertebrate species that are listed by Kirby (1994a, b) as known to be associated with coastal habitats, 59 RDB and 108 nationally scarce species have recently been recorded from the region (data from JNCC's Invertebrate Site Register (ISR)). These totals include recent (post 1969) records for ten RDB species of Hymenoptera (bees, wasps and ants). In addition, this region hosts substantial proportions of the British Orthoptera (crickets and grasshoppers). Map 5.3.1 shows the numbers of all nationally rare (RDB) invertebrate species (including Kirby's 'coastal' species and all others) recorded in coastal 10 km squares in the region; Map 5.3.2 shows the recorded distribution of all nationally scarce invertebrates in the region. Note that survey effort has not been equal throughout the region, so actual occurrence may differ from recorded distributions.

Nine species of terrestrial and freshwater pool invertebrates recorded from the region are afforded legal protection under various international directives and conventions or are listed on Schedule 5 of the Wildlife & Countryside Act 1981 (Table 5.3.1).

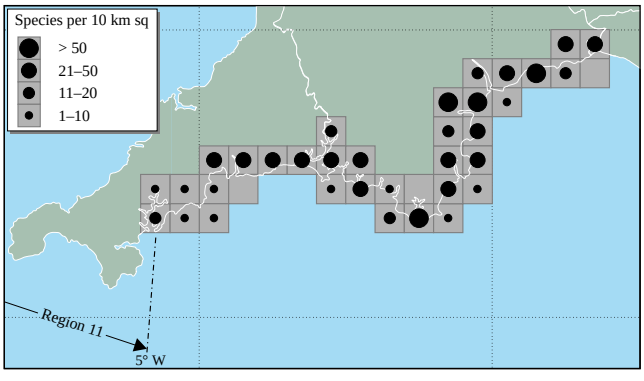
Table 5.3.1 Protected invertebrate species

Species	*Protected status*	*Comments*
Devon		
Southern damselfly *Coenagrion mercuriale*	1, 4	
Stag beetle *Lucanus cervus*	1, 4	
Large blue *Maculinea arion eutyphron*	2, 4, 5	Possibly last recorded 1906
Atlantic stream crayfish *Austropotamobius pallipes*	1, 3, 4, 5**	Present status uncertain
Heath fritillary *Mellicta athalia*	5	Old records only
Barberry carpet *Pareulype berberata*	5	Old record only
Devon and Cornwall		
Marsh fritillary *Euphydryas aurinia*	1, 4	Last recorded 1979 in south Devon and old records only for east Cornwall
Fairy shrimp *Chirocephalus diaphanus*	5*	
High brown fritillary *Argynnis adippe vulgoadippe*	5***	Last recorded 1973

Source: JNCC's Invertebrate Site Register. Key: protected status codes: 1 = Annex II, EC Habitats Directive; 2 = Annex IV, EC Habitats Directive; 3 = Annex V, EC Habitats Directive; 4 = Bern Convention; 5 = Schedule 5, Wildlife & Countryside Act 1981 (excluding Schedule 5 section 9(5): sale only); *Variation of Schedules Order 1988; ** Variation of Schedules Order 1988 but only in respect of section 9(1) so far as it relates to taking in respect of section 9(5); ***Variation of Schedules 5 & 8 Order 1992.



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.



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.

5.3.2 Important locations and species

Table 5.3.2 lists coastal RDB species (after Kirby 1994a, b) recently recorded from the region. The region is probably best known for its cliff habitats, including areas of landslip, coastal woodland and associated maritime grassland. Several of these sites are known to be of national importance for invertebrate conservation, e.g. Sidmouth to Beer Coast,

Table 5.3.2 Coastal Red Data Book (RDB) species with post 1969 records

Species	*Comments*
RDB 1	
Callilepis nocturna	Spider found on a steep sandy bank sparsely vegetated with sedges *Carex* spp. and broad-leaved herbs below sea cliffs. Adults have been found in May and June. Known only from near East Prawle and Start Point, Devon.
Cathormiocerus attaphilus	Small (3 mm) globular weevil living at plant roots; wide range of food plants but apparently favours buck's-horn plantain *Plantago coronopus*. Frequents maritime cliff grassland. Internationally rare; main centres of distribution in south-west Britain. Yealm Estate (Wembury Point SSSI); Stoke Point, Erme Estuary SSSI.
Dibolia cynoglossi	Small (2-3 mm) flea beetle associated with various aromatic herb species, including hemp-nettles *Galeopsis* spp., mints *Mentha* spp., the clary genus *Salvia*, woundworts *Stachys* spp., black horehound *Ballota nigra* and also the hound's-tongue genus *Cynoglossum*. Very rare, scattered old records in southern Britain. Dawlish Warren (undated).
Nomada sexfasciata	Cuckoo bee, a nest parasite of the mining bee *Eucera longicornis* (and possibly *E. tuberculata*). Rare and declining, presently known only from Prawle Point and Start Point, South Devon.
pRDB 1	
Scrobipalpula tussilaginis	Coastal moth associated with sparsely vegetated sand or clay soil from recent cliff slippages. Larvae feed in a blotch mine in a leaf of colt's-foot *Tussilago farfara*. Known from five sites along the south coast of England. Difficult to distinguish from *S. psilella*. Axmouth to Lyme Regis.
RDB 2	
Anchonidium unguiculare	Weevil occurring in sessile oak woodland and on sea cliffs. In leaf litter, moss and at the roots of various plants including sheep's sorrel *Rumex acetosella*, common bird's-foot-trefoil *Lotus corniculatus* and sea campion *Silene maritima*. Adults have been recorded from March to September. Very scarce and known only from Cornwall and South Devon. Erme Estuary SSSI and Stoke Point.
Andrena rosae	Mining bee known from a variety of habitats, including coastal landslips, soft rock cliffs and rough cliff tops. Burrows are probably dug in sparsely-vegetated, sunny areas on light soils. Extremely scarce throughout its range and has apparently declined considerably. Post-1970 records are known from only a handful of sites in E. Cornwall, N. Devon, W. Kent and Pembrokeshire. Milton Combe Valley, near Plymouth.
Andrena simillima	Mining bee typically recorded from coastal landslip sites and soft rock cliffs. Also recorded from a Dorset heathland and Hampshire downland. Patches of sparsely vegetated ground in warm, sunny situations are probably required for nesting. Branscombe Pastures and Kelligerran Head.
Cryptocheilus notatus	Spider-hunting wasp, known from only about a dozen counties in southern England. Nests in burrows of small mammals especially moles. Prey includes spiders of the genera *Agelena*, *Trochusa*, *Tegenaria* and *Drassodes*. Branscombe; New Bridge, Teign Valley; Portlemouth to East Prawle; Prawle Point & Start Point; Prawle Point and Signalhouse Point.
Euodynerus quadrifasciatus	Mason wasp. Rare: Surrey, Dorset and South Devon. At Sidmouth breeds in holes in pebbles on the beach. Prawle Point & Start Point.
Lasioglossum laticeps	Mining bee confined to the coast of Dorset and Devon. Frequenting coastal undercliff and landslips, nesting usually gregariously in clay-like soils. Adults have been noted on common fleabane *Pulicaria dysenterica*, wild carrot *Daucus carota* and ragworts *Senecio* spp. Axmouth to Lyme Regis.
Limonia bezzii	Cranefly associated with coastal lagoons and intertidal gravel with algae *Enteromorpha* spp., in which the larvae probably develop. Dawlish Warren.
Otiorhynchus ligustici	Ground-dwelling weevil. Larvae feed on the roots of various plants, but with a preference for kidney vetch *Anthyllis vulneraria*. There are records from a wide area of Britain but few are recent. Prawle Point & Start Point and The Warren (Bolt Head to Bolt Tail).
Sphecodes spinulosus	Very rare solitary bee, brood parasite of Halictine bees. Host unknown. Known from only about eight counties in southern England. Sidmouth to Beer Coast.
pRDB 2	
Cardiophorus erichsoni	Mottled grey click beetle (9 mm long) living in sandy soil on the coast. Larvae (wireworms) feed on grass roots. Very rare, restricted to Devon and Lundy with small persistent colonies. Mill Bay to Gara Rock, Salcombe Estate and valley behind Inner Hope.
RDB 3	
Andrena proxima	Mining bee known from coastal landslips and soft rock cliffs and inland on heathland, the banks of country lanes and other disturbed situations. Also reported from chalk downland in Kent and Berkshire. Closely associated with the flowers of umbellifers, including cow parsley *Anthriscus sylvestris* and rough chervil *Chaerophyllum tementulum*. Nest burrows are dug in the ground, probably in warm, sunny areas with short turf or sparse vegetation. Extremely scarce species, mostly in S. Devon, the Isle of Wight and Kent. Single records for Bovey Heath and Sidmouth to Beer Coast.
Cathormiocerus myrmecophilus	Weevil, probably feeding on a variety of plants. Larvae probably feed on the roots, while the adults occur at the base. Female reproduces without mating. Coastal cliffs. Whitsand Bay (Rame Head).
Dolichopus andalusiacus	Metallic green fly. Larvae probably develop in damp substrates at the edge of water. Adults found in fens and wet meadows. Mainly recorded from southern England including Slapton Ley.
White spot moth *Hadena albimacula*	On shingle beaches and chalk or limestone cliffs. Larvae feed on Nottingham catchfly *Silene nutans*. Very local on the southern coast, Kent, Hampshire and South Devon. Sidmouth to Beer Coast; Exe Estuary.
Lasioglossum angusticeps	Mining bee known in Britain only from the south coast of England where it nests in coastal soft-rock cliffs. Axmouth to Lyme Regis.

Table 5.3.2 Coastal Red Data Book (RDB) species with post 1969 records (continued)

Species	*Comments*
RDB 3 continued	
Beautiful gothic moth *Leucochlaena oditis*	Frequents grassy slopes and cliffs by the sea. Larva on grasses. Very local in south-west England and Isle of Wight. Hope's Nose - Walls Hill, Prawle Point & Start Point, Slapton Ley.
Limonia goritiensis	Cranefly found on seepages on coastal cliffs and rock faces. Larvae probably develop in damp soil or moss beside seepages. Widely scattered but very local. Found mainly in the north and west, but the localities are very dispersed. Axmouth to Lyme Regis, Branscombe Pastures, Gerrans Bay to Camels Cove SSSI (Nare Head), Hope's Nose to Walls Hill, Lansallos Cliff, Prawle Point & Start Point, Sidmouth to Beer Coast.
Nomada hirtipes	Rare southern cuckoo bee associated with the solitary bee *Andrena bucephala*. Bovey Heath and Sidmouth to Beer Coast.
Ochthebius poweri	Very small black water beetle about 1 mm long. A south-western species restricted to small seepages on cliff faces, particularly those of Red Sandstone. Recorded from cliffs in Devon, Cornwall and Pembrokeshire. Best known locality is the cliffs between Exmouth and Teignmouth.
Solenopsis fugax	Minute ant, nests usually constructed under deep stones and often linked with other ant species such as *Lasius* and *Formica*. Noted on or near the coast in Cornwall, Devon, Somerset, Dorset, Isle of Wight, Kent and Essex. The Warren (Bolt Head to Bolt Tail).
Thereva strigata	Stiletto fly that seems to be associated with hot, south-facing coastal cliffs. Larvae are likely to occur in sandy to sandy-loam soils and are probably predators feeding on a variety of arthropods and earthworms. Branscombe Pastures.
Trapezonotus ullrichi	Rare groundbug confined to the south coast of Devon and Cornwall and of very scattered distribution. Found on the ground amongst short grassland on cliff tops etc. Babbacombe Bay Cliffs.
Truncatellina callicratis	Tiny spire-shaped snail confined to the south coast of England where it occurs in arid situations such as unvegetated screes. Can be abundant in favourable sites. Sidmouth to Beer Coast and Triangle Point.
pRDB 3	
Anthicus scoticus	2-2.5 mm long reddish ant beetle living in strandline refuse, decaying seaweed etc. in saltmarshes. Adults on flowers. Until recently only known from west Scotland, Cumbria and the Isle of Man. Small population has recently been discovered in Kent and Devon. Prawle Point & Start Point.
Lasiacantha capucina	Lacebug that feeds on thyme *Thymus drucei*. Confined to Cornwall and extremely localised even there. Gerrans Bay to Camels Cove SSSI (Nare Head).
RDB I	
Astenus subditus	Rove beetle found in sandy or chalky situations at the roots of grass and in moss etc. Under large, deeply embedded stones high up on a beach at the base of a cliff. Difficult to identify and may be confused with *A. procerus*. Only recorded recently from The Warren (Bolt Head to Bolt Tail).
Medon pocoferus	Rove beetle recorded from coastal shingle around the high-water mark, in fine shingle and rock crevices and under seaweed. Adults have been recorded from March to May and in August. Hallsands.
RDB K	
Bloxworth snout *Hypena obsitalis*	Moth that has recently become resident in Britain. Larva feeds on pellitory-of-the-wall *Parietaria judaica*. Petit Tor Point.
pRDB K	
Actocharis readingi	Tiny (1.5-1.7 mm) yellow rove beetle living among stones and dead seaweed on sandy shores below the high water mark. South-west peninsula only at Blackaterry Point.
Astenus procerus	Rove beetle found in chalky or sandy places near the coast; does occasionally occur inland. Lives in moss, at the roots of grass and amongst other herbage. Stoke Point.

Source: JNCC Invertebrate Site Register. Key: Red Data Book categories: RDB 1 = endangered; RDB 2 = vulnerable; RDB 3 = rare; RDB I = indeterminate; RDB K = insufficiently known; pRDB = proposed species as categorised in e.g. Hyman & Parsons (1992). For further description of RDB categories, see Shirt (1987) and Bratton (1991).

and Bolt Head to Bolt Tail, and many support a range of species with a southern and western distribution. Other areas of coastal cliff and maritime grassland are considered to be of regional importance and with greater recording effort further sites will probably be found to be significantly more important than current data suggest. Other sites of national significance include the complex of heaths and associated habitats of the East Devon Pebble Bed Heaths, and the complex of habitats at Slapton Ley. On available records Dawlish Warren is considered the most significant sand dune system in the region.

The ISR records approximately 180 coastal sites within this region, some of them subsites of larger areas. Several support a number of RDB species, while many are the habitats of a range of nationally scarce species. Table 5.3.3 lists sites of major importance for the conservation of invertebrates. Site selection was based on the range and/or scarcity of species present, the species habitat associations and the amount of the available habitat.

This stretch of coast is nationally important both for the conservation of a range of species and assemblages of species. For instance Marshall & Haes (1988) cite the East Devon Pebble Bed Heaths as one of the twenty best sites in the country for Orthoptera (grasshoppers and crickets) and allied insects with seventeen species recorded. The spider *Callilepis nocturna* has only been found on two sites in Great Britain (both in south Devon) and the six-banded nomad bee *Nomada sexfasciata* has declined to the point where it is currently known from just a single site in south Devon. Ore Stone Rock supports the only long-term British population of the firebug *Pyrrhocoris apterus*. The Bloxworth snout moth *Hypena obsitalis* was recorded as temporarily

Table 5.3.3 Sites important for invertebrate conservation

Site	*Grid ref.*	*Conservation status*
Dorset/Devon		
Axmouth to Lyme Regis	SY3090	NNR
Devon		
Spring Head, Axmouth	SY2790	SSSI
Sidmouth to Beer Coast	SY1988	SSSI, NT (in part), DWT reserve (in part)
River Otter, Harpford	SY0890	SSSI, DWT reserve (in part)
East Devon Pebble Bed Heaths	SY0689	SSSI, DWT reserve (in part)
Exe Estuary (includes Orcombe Rocks)	SX9686	SSSI, NT (in part), DWT reserve (in part), SPA, Ramsar site
Dawlish Warren	SX9879	SSSI, DWT reserve, LNR
New Cross Ponds	SX8674	DWT reserve
Babbacombe Bay Cliffs	SX9265	SSSI
Hope's Nose - Walls Hill	SX9464	SSSI
Ore Stone Rock	SX9663	
Berry Head to Sharkham Point	SX9456	SSSI, LNR
Scabbacombe Head to Ivy Cove	SX9251	NT (in part)
Slapton Ley	SX8242	SSSI
Prawle Point and Start Point (includes Gara Rock to Gammon Head)	SX7936	SSSI, NT (in part)
Portlemouth to East Prawle (includes Mill Bay to Gara Rock)	SX7435	NT
Bolt Head to Bolt Tail (includes Steeple Cove to Off Cove and Bolt Tail to Soar Mill Cove)	SX7136	SSSI, NT
Erme Estuary	SX6248	SSSI
Stoke Point (includes Blackaterry Point)	SX5645	
Plym Forest	SX5258	NT (in part)
Cornwall		
Sheviock Wood	SX3755	
Sharrow Point	SX3952	NT
Portwrinkle Beach	SX3553	
Ethey Woods, Lerryn	SX1356	NT (in part)
Menabilly Woodlands	SX1051	
Dodman Point	SX0039	NT
Nare Head	SW9137	NT
Pendower Beach and Cliff (includes Gerrans Bay to Camels Cove)	SW9038	NT (in part), CWT reserve (in part)

Source: JNCC ISR. Key: LNR = Local Nature Reserve; NNR = National Nature Reserve; NT = National Trust; SPA = Special Protection Area; SSSI = Site of Special Scientific Interest; DWT = Devon Wildlife Trust; CWT = Cornwall Wildlife Trust.

established near Torbay in 1990 (Dobson 1991) and is still present in the area. Several other species have a significant part of their current known British range along this region's coast; examples include the weevils *Anchonidium unguiculare*, *Cathormiocerus attaphilus* and *Otiorhynchus ligustici*, the ground bug *Trapezonotus ullrichi*, the moth *Cydia gemmiferana*, the Devonshire wainscot moth *Mythimna putrescens* and the cuckoo bee *Sphecodes spinulosus*. Two RDB spiders (*Episinus maculipes* and the recently described *Nothophantes horridus*) are found in Plymouth, the only known site for the latter species. The only known British record of the harvest man *Centetostoma bathylipherum* is also from Plymouth. The region also supports a very few subspecies of moths not found outside Great Britain, e.g. Barrett's marbled coronet *Hadena luteago barrettii.*

Invertebrates can be found in the full range of coastal habitats and many require particular microhabitats. Many species are restricted in their distribution because of their specialised habitat demands. Cliff habitats are perhaps the most extensively recorded along this stretch of coast and fall mainly into two categories: hard-rock and soft-rock. Many of the invertebrates occurring in these situations require the warm, sunny and sheltered conditions provided by the south-facing cliffs. On rocky coasts species such as the thrift clearwing *Bembecia muscaeformis* (a moth) can be found. Sparsely vegetated situations can support colonies of the slender-bodied ant *Leptothorax tuberum*, a species that has been found on several sites in the region. The extremely scarce moth *Selania leplastriana* has been found on the cliffs amongst its foodplant, wild cabbage *Brassica oleracea*, at Hope's Nose to Walls Hill. More grassy conditions are suitable for insects such as the grey bush cricket *Platycleis albopunctata.* Cliff paths provide habitat for species that rely on areas of bare ground, for instance many bees and wasps. Where there are wet flushes, populations of the scarlet tiger moth *Callimorpha dominula* can occur, and where there are ephemeral pools the fairy shrimp *Chirocephalus diaphanus*, a protected species, may be found. Soft-rock cliffs and landslips are important habitats for a wide range of invertebrates and these sites often support many species with restricted distributions, such as the cuckoo bees *Sphecodes reticulatus* and *S. spinulosus*, both of which have been found along the Sidmouth to Beer Coast. Calcareous substrates provide conditions for a different range of species, which can include the chalk carpet moth *Scotopteryx bipunctaria*. Seepages and trickles in cliff situations are important for a number of species including the water-beetle *Octhebius poweri*, and carr and woodland can support significant assemblages of species, including for instance the red-tipped clearwing moth *Synanthedon formicaeformis.*

Secluded estuaries, such as the Erme Estuary, support a range of habitats including wooded shores, areas of saltmarsh, freshwater marsh and damp meadows. These sites are often under-recorded but are of considerable potential in terms of invertebrate conservation. Several species of interest are already known from these sites. These include the hoverfly *Platycheirus immarginatus,* which has been found in brackish coastal marshes, and the snail-killing fly *Ectinocera borealis*, normally considered to be a boreo-alpine species, which has been recorded on a sandy shore overhung by oak woodland.

The various stages of dune succession provide a variety of microhabitats, all of which have distinctive elements to their faunas. The pill woodlouse *Armadillidium album* has been recorded at Dawlish Warren. It is typical of the strandline, where it can be found burying itself under driftwood and other strandline litter. The sand dart *Agrotis ripae* is one of a very few species that can survive the harsh conditions found along the unstable fore dunes. The larvae of this moth bury themselves in the sand by day and feed at night on a variety of sandhill plants. The silvery leaf-cutter bee *Megachile leachella*, as with many bees and wasps, is closely associated with wind-blown sand and normally frequents the warm and sunny mid-dunes. In wetter situations, where there are reed-beds, species such as the twin-spotted wainscot moth *Archanara geminipuncta* can occur. Amongst sallow carr, the weevil *Cryptorhynchus lapathi* can be found feeding internally on the branches.

There are few stretches of vegetated shingle along this stretch of coast. However, Slapton Ley supports the only known shingle population of Barrett's marbled coronet *Hadena luteago barrettii*. Behind the shingle bar is the largest freshwater lake in south-west England. Vegetation at the edges of this lake supports a wide range of invertebrates. The nationally declining goat moth *Cossus cossus,* a species often associated with carr, has been recorded, and the snail-killing fly *Pherbelia grisescens*, which appears to prefer mildly brackish conditions, is also present.

Ponds in this part of the country, for instance New Cross Ponds, can support nationally important assemblages of Odonata (dragonflies and damselflies). This complex of ponds was known to support eighteen breeding species between 1975 and 1980 and possibly still does, although more recent data are not available.

There is a significant amount of coastal woodland in this region, of which comparatively little has been surveyed in any depth. However, many scarce and threatened species have been recorded, including a few species usually indicative of ancient broad-leaved woodland, e.g. at Ethy Woods the beetle *Thymalus limbatus* and the weevil *Mesites tardii,* the latter of which is thought to be able to disperse by utilising driftwood. Blomer's rivulet *Discoloxia blomeri* has been found at Sheviock Wood; this moth has a primarily western distribution with a larva that feeds on wych elm *Ulmus glabra*.

The extensive areas of wet and dry heaths of the East Devon Pebble Bed Heaths have many associated habitats, such as raised bog, scrub and woodland. Species such as the ringed carpet moth *Cleora cinctaria* inhabit the lightly wooded heathland. The wood cricket *Nemobius sylvestris* can be found deep in leaf litter in warm sunny clearings, whereas the bog bush cricket *Metrioptera brachyptera* is found in clearings in damp woodland. The plume moth *Buckleria paludum* has been found in the boggier areas; as a larva it feeds on the leaves and dead stems of the insectivorous plant the round-leaved sundew *Drosera rotundifolia*.

5.3.3 Human activities

As for other nature conservation interests the main threats to invertebrate communities in the region include inappropriate management of sites and habitat loss or degradation, such as through the construction of coastal defences on soft-rock cliffs or through the clearing away of organic strandline debris.

Appropriate site management may be vital for maintaining invertebrate interest, since invertebrates occur in the full range of coastal habitats and many require particular microhabitats in a suitable condition, often using subtle features of vegetation structure or areas of bare ground. As invertebrates generally have annual life cycles, the habitat features they utilise must be present in the right condition in each and every year. Site management often overlooks many features that are of importance to invertebrates, many species surviving by default. The management of coastal habitats for invertebrates is covered by Kirby (1992). The effects of mechanical beach-cleaning on invertebrate populations on beaches around Swansea Bay are reported by Llewellyn & Shackley (1996); their discussion has wider relevance.

5.3.4 Information sources used

Most of the data used here come from the ISR, a computerised GB-wide database based on literature searches of entomological journals and those of local naturalist societies, collation of data from local Biological Records Centres and the Biological Records Centre, Monks Wood, and consultation with invertebrate specialists and non-governmental organisations. The Cornwall Biological Records Centre also has a computerised database covering all invertebrate groups. Additional information was gleaned from a range of other reports and reviews, including the *Report & Transactions of the Devonshire Association (Entomological section)*, the *Annual Report of the Caradon Field & Natural History Club*, and *Nature in Devon,* which includes occasional invertebrate-related papers.

As with most regions in Great Britain, the levels of invertebrate recording vary along the coast and between invertebrate groups. A wide range of invertebrate groups have been studied to varying degrees, although it is the popular groups, such as the Lepidoptera (butterflies and moths) that are probably the best known here. This is borne out by Spalding (1992), who stated that the "moths and butterflies have been studied in Cornwall for over a century".

National recording schemes for a range of invertebrate groups contain records from this part of the coast. Most of these schemes are coordinated by specialists with assistance from the Biological Records Centre. Recently commissioned surveys include one by The National Trust for aculeate Hymenoptera at their coastal properties and an English Nature survey of the invertebrate fauna along the coast between Prawle Point and Start Point. In addition to these larger schemes, many groups and individuals hold records of invertebrates for the region. National distribution maps

are available for a wide range of invertebrate groups, including many for which this region is important. For example, the distributions of the butterflies of Devon and south-east Cornwall have recently been mapped. Bristow *et al.* (1993) and Frost & Madge (1991) respectively have published the results of these schemes, the latter based only on records from the mid 1970s to 1989. Other mapping schemes include Haes (1990), who mapped the distribution of the Orthoptera (grasshoppers and crickets) and related insects in south-east Cornwall, and Majerus (1988) and Jackson (1989), who mapped the Coccinelidae (ladybirds).

5.3.5 Acknowledgements

Thanks are due to D. Procter and Dr S. Ball (JNCC) for the provision of the raw data from the ISR and for assistance in producing the maps and tables. Thanks are also due to D. Procter and J.H. Barne (JNCC) and R. Stevens, City of Plymouth Council, for their comments.

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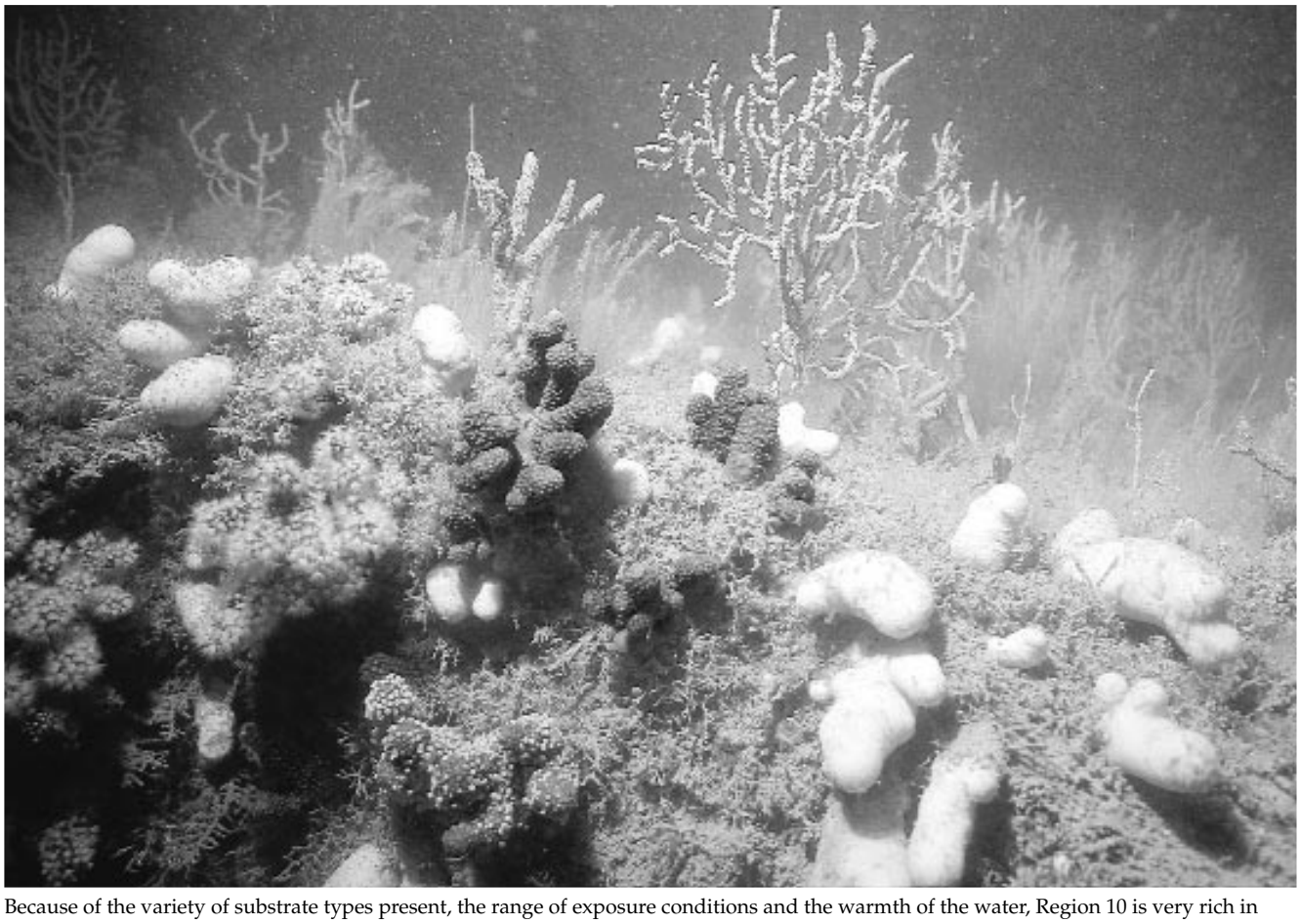
C. Contact names and addresses

Type of information	*Contact address and telephone no*
Occurrence of invertebrates in the region	*Biological Records Centre, Institute of Terrestrial Ecology, Monks Wood, tel: 01487 77338
Invertebrates in the region	*Dr R.S. Key, Dr C.M. Drake and Dr D.A. Sheppard, Invertebrate Zoologists, Lowlands Team, English Nature HQ, Peterborough, tel: 01733 340345
Invertebrate Site Register (ISR): a computerised national inventory of sites of significance to invertebrate conservation; contains records of local, scarce and threatened species of all groups of invertebrates	*Invertebrate Site Register, JNCC Peterborough, tel: 01733 62626
Conservation of butterflies - Devon	K. Bastow, British Butterfly Conservation Society, Devon Branch, 19 Ashmill Court, Bradley Valley, Newton Abbot, Devon TQ12 15Q
Conservation of butterflies - Cornwall	G. Pilkington, British Butterfly Conservation Society, Cornwall Branch, Chapel Cottage, Gooseham Mill, Morwenstow, Cornwall EX23 9PQ
Local biological records centre - Devon	Exeter Biological Records Centre, Royal Albert Memorial Museum, Queens Street, Exeter, Devon EX4 3RX, tel: 01392 265858
Local biological records centre - Cornwall	Cornish Biological Records Unit, Trevithick Building, Trevenson Road, Pool, Redruth, Cornwall TR15 3PL, tel: 01209 710424
Invertebrate interest of National Trust holdings	*The National Trust, Cirencester, tel: 01285 65181
Invertebrate data for the Plymouth area, pre-1980	S. Laming, Plymouth City Museum & Art Gallery, Drake Circus, Plymouth PL4 8AJ, tel: 01752 264878

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



Because of the variety of substrate types present, the range of exposure conditions and the warmth of the water, Region 10 is very rich in nationally rare and scarce sea-bed species. The pink sea fan *Eunicella verucosa* in particular is locally relatively common. It is often found with red sea fingers *Alcyonium glommeratum* and dead man's fingers *A. digitatum*, as shown here. Photo: Keith Hiscock, JNCC.

5.4 Rare sea-bed species

Dr W.G. Sanderson

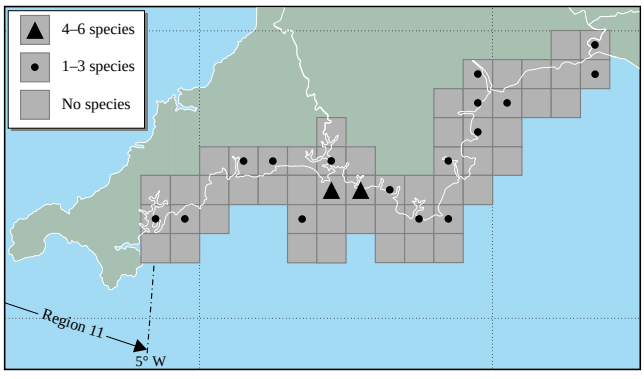
5.4.1 Introduction

This section considers rare and scarce marine benthic (sea-bed) species, excluding fish. The occurrence and distribution of benthic communities is discussed in section 4.2. 'Nationally rare' marine benthic species in this section are those native organisms that occur in eight or fewer of the 10 km squares (of the Ordnance Survey national grid) containing sea within the three-mile territorial limit for Great Britain. 'Nationally scarce' are those that occur in nine to 55 such squares. This methodology and these criteria are analogous to those used for other groups of organisms in British Red Data Books (e.g. Bratton 1991) and by the International Union for Conservation of Nature and Natural Resources (IUCN) (see IUCN Species Survival Commission 1995). The development of the current criteria and the choice of study area for rarity assessment in the marine benthos of Great Britain are discussed in detail by Sanderson (in prep.). Species considered in this chapter are those conspicuous and readily identifiable in the field by the Marine Nature Conservation Review (MNCR) and similar techniques or for which taxonomic or biogeographic experts consider that sufficient data exist on a national basis to warrant their inclusion. Some species classed here as rare or scarce may also be present in waters beyond the study area. Species at the limit of their global distribution (e.g. 'southern' or 'northern' species) may be rare only within Great Britain's territorial seas. Indeed, there are a number of Lusitanian species described here that are at the margins of their range in Region 10. A species described here as 'nationally rare' or 'nationally scarce' is therefore not necessarily endangered, and although without doubt of national interest, the conservation importance of these species may need to be carefully considered. The analysis in this section represents the first attempt to quantify the rarity of marine benthic species in Great Britain and to summarise the known occurrence of rare and scarce species. As either more data become available or populations change, the status of species listed in this chapter will require re-evaluation.

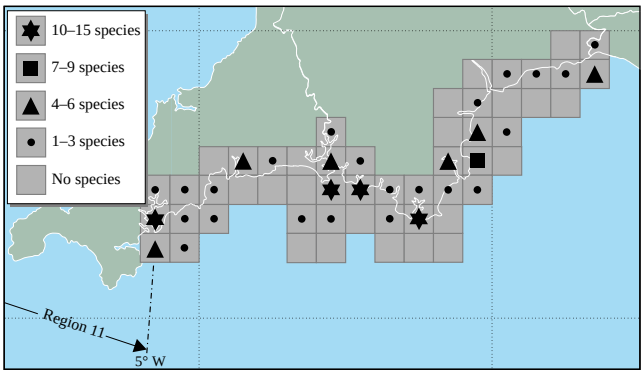
Like other regions in south-west Britain, Region 10 appears to be comparatively rich in nationally rare and scarce species: there are 21 rare and 32 scarce marine benthic species recorded from this region. Maps 5.4.1 and 5.4.2 summarise the current known occurrence. The Torbay, Salcombe, Plymouth Sound and Fal Estuary areas apparently contain more rare and scarce marine benthic species than other parts of the region. This assertion maybe somewhat misleading, however, since survey effort in this region is not uniform. Two of the rare and scarce species in Region 10 are protected under the Wildlife and Countryside Act 1981 and one under the EC Habitats & Species Directive.

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 10, together with their known areas of occurrence. Species names are after Howson (1987).



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



Map 5.4.2 Numbers of scarce marine benthic species recorded in 10 km squares within the 3 mile limit. Distribution may reflect differences in recording effort.

Some nationally rare and scarce species described here are restricted to very specific habitat types in Great Britain that are themselves rare or scarce and in some cases threatened. Such species may therefore be of high nature conservation importance. Within this region certain species are 'nationally rare' or 'scarce' because they are Mediterranean-Atlantic species at the margins of their distribution in Great Britain. It has been argued that populations of many sessile (non-mobile) southern species have a poor capacity for recovery and replace their numbers slowly at the margins of their distribution and are therefore particularly vulnerable to even the most minor, infrequent damage. Communities of southern species have therefore been considered important as reference sites for monitoring the marine environment (Fowler & Laffoley 1993). There are other genetic, ecological and pragmatic arguments for the conservation of populations of species that are rare because they are at the margins of wider distributions (see Hunter & Hutchinson 1994).

None of the species from this region is known to be a common deep-water species, and so it is unlikely that any appear rare simply because their distribution only just includes the generally shallower near-shore sea area that is the focus of this study. Some species, however, will occur to some extent in the waters of Great Britain outside the scope of this report.

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

Species	*Common name*	*Area(s) of occurrence*	*Habitat/associations*	*Comments*	*Useful reference*
Stelletta grubii	Sponge	W. Gammon Head, south to Starehole Bay	On rock, often dark or overhung. Associated with epifaunal organisms. Intertidal to 135 m.	Often obscured by associated epifauna. May well be under-recorded (B.E. Picton pers. comm.).	Ackers *et al.* (1992)
Thymosia guernei	Sponge	Reef near wreck of *Elk* (Plymouth Sound)	Often with *Polydora* or brittle stars. Overhangs & recesses on rock. Sites exposed to flowing water or wave action to about 30 m.	May be a southern species. May have very specific habitat requirements.	Ackers *et al.* (1992)
Axinella damicornis	Sponge	Torbay(?), Dart Estuary, Plymouth Sound	On vertical & horizontal faces at sites of moderate wave action. Sometimes with some silt at sites generally below 20 m.	Southern. Mediterranean species at limit of range.	Ackers *et al.* (1992)
*Adreus fascicularis**	Sponge	Lanes Ground (Lyme Bay)	Sites with strong tidal streams. On rock overlain with silt or sediment. Often half buried in shelly gravel and deeper than 12 m.	Southern. Also Channel Islands and Spain.	Ackers *et al.* (1992)
Tethyspira spinosa	Sponge	Prawle Point to Salcombe	On wave-exposed coasts. Shallow subtidal rock to 60 m+.	South western in British Isles. May be somewhat under-recorded.	Ackers *et al.* (1992)
*Dysidea pallescens**	Sponge	Plymouth Sound	Known from sublittoral rock.	Known from southern British sites. Also Mediterranean. As with all sponges, rarity should be regarded cautiously.	Ackers *et al.* (1992)
Hartlaubella gelatinosa	Hydroid	Yealm Estuary (Steer Point), Plymouth Estuary (Weir Point, Clitters Wood, Royal Albert Pier, Cargreen)	Tolerant of silt & brackish water. Intertidal to 15 m. Often in gentle current.	From Oslo Fjord to Mediterranean & Black Sea. Hydroids are susceptible to under-recording.	Hayward & Ryland (1990)
Laomedea angulata	Hydroid	River Yealm	Often on eel grass. Extreme low water to 8 m.	South coast of England & further south.	Hayward & Ryland (1990)
Parerythropodium coralloides	Soft coral	Durl Rock (Torbay), Outer Plymouth Sound (Hilsea Point, near Mewstone & Knapp Shoal, *Elk* reef, Gull Rock)	Overhangs & crevices out of light. Sheltered from strong wave action. 0-25 m.	Easily overlooked but still probably scarce. Southern. More common in SW Europe & Mediterranean.	Manuel (1988)
Eunicella verrucosa#	Pink sea fan	Near shore reefs between Lyme Regis & Exmouth, Dartmouth (Mewstone & Homestone), Gammon Head, Outer Plymouth Sound area (Hilsea Point, Great Mewstone, Knapp Shoal, *Elk* reef), Rame Head, wrecks of *James Egon Lane* and *Heliops*, south Cornwall (off Dodman Point & Anthony Head, the Whelps, the Bizzies & near the Manacle)	On rocky surfaces, often vertical or overhung. Especially between 20-200 m.	Cautiously regarded as scarce. Southern. SW Europe, the Mediterranean & North Africa. Not uncommon locally. Historically heavily collected in some places in GB. Colonies long lived & slow growing.	Manuel (1988)
Isozoanthus sulcatus	Ginger tiny (anemone)	Off Lyme Regis, Hook Ebb, Churstone Cove, Dart Estuary, Torbay, Gammon Head, Starehole Bay	Silty rock. 0-25 m. Occasional on the shore in pools.	Cautiously regarded as scarce. Southern. Also Atlantic France, Norway & Denmark. Not uncommon locally.	Manuel (1988)

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

Species	*Common name*	*Area(s) of occurrence*	*Habitat/associations*	*Comments*	*Useful reference*
Anthopleura thallia	Glaucus pimplet (anemone)	St. Mawes	Shores exposed to wave action. Mid to lower shore. In pools & gullies, sometimes partially buried by gravel.	Extreme south-westerly species in GB. Can be locally common. Also known from Atlantic France.	Manuel (1988)
Aiptasia mutabilis	Trumpet anemone	Wreck of *Baygitano* and Lanes Ground (Lyme Bay), Babbacombe, Torbay, near Scoble Point (Salcombe), Plymouth Sound, St. George's Island, Percuil River	Overhangs, lower shore pools, but more abundant in shallow subtidal amongst the holdfasts of kelps.	An extreme south-western species in GB. Found south to the Mediterranean.	Hayward & Ryland (1990)
Cataphellia brodricii	Latticed corklet (anemone)	Langstone Reef (near Dawlish), Rame Head	Lower shore & subtidal to 20 m. Under stones, in kelp holdfasts, attached to hard substrata beneath sand.	Southern. Typically low shore in kelp zone. Can be locally common in Devon & Cornwall. Elsewhere northern France.	Manuel (1988)
*Amphianthus dohrnii**	Fan anemone	Plymouth Sound entrance, off Gull Rock	Found on pink sea-fan *Eunicella verrucosa*.	Sporadic occurrence. Also from Scandinavia to the Mediterranean.	Manuel (1988)
*Hoplangia durotrix**	Weymouth carpet coral	Outer Plymouth Estuary (Knapp Shoal)	On rocks in shaded locations. Shallow subtidal.	South-western species. South to Mediterranean.	Manuel (1988)
Balanophyllia regia	Gold & scarlet star coral	Outer Dart Estuary (Castle Point), Outer Plymouth Estuary (Penlee Tunnel), Falmouth	In gullies & overhangs. Occasionally low shore. More often shallow subtidal to 25 m.	Elsewhere Brittany to Mediterranean. Appears to be long lived. Can be locally common.	Manuel (1988)
*Leptopsammia pruvoti**	Sunset coral	Plymouth Sound Entrance ('drop-off')	On rock. Often sheltered from strong current. 10-40 m.	Sporadic southern species. Also SW Europe & Mediterranean.	Manuel (1988)
Amalosoma eddystonense	Echiuran worm	Off Plymouth	Burrows in stony sediments, sand or mud. Also as deep as 4,000 m.	Cautiously regarded as scarce - difficult to collect. May occur in a few more areas. Elsewhere Gulf of Gascony.	Hayward & Ryland (1990)
*Sternaspis scutata**	Bristle worm	Dart Estuary	In sediment.	A Mediterranean species currently known from only two areas in GB.	
*Ophelia bicornis**	Worm	Exe Estuary	Lower shore in loose, mobile sand.	Also Atlantic Europe. Very specific habitat requirements.	Harris (1991a, b)
Alkmaria romijni#	Tentacled lagoon worm	Greenland Bank (Exe Estuary), Waterhead Creek (Kingsbridge Estuary), adjacent to Portscantho (Fal Estuary)	Lagoon-like habitats. Intertidal to a depth of a few metres.	Specific habitat requirements. Elsewhere from Netherlands to Denmark, Baltic & Morocco.	Bratton (1991); Holthe (1986)
Apherusa ovalipes	Amphipod	Ox Point (near Salcombe), Wembury Bay (Yealm Estuary)	Generally amongst subtidal algae.	Mainly southern GB coast. Also Atlantic Europe & North Sea.	Hayward & Ryland (1990)
*Pereionotus testudo**	Amphipod	Mill Bay, Fowey Estuary	Among coralline algae on the low shore and shallow subtidal.	Southern. Also known south to the Mediterranean and the Red Sea.	Hayward & Ryland (1990)
Gammarus chevreuxi	Amphipod	Teign Estuary, west of Westwood (Fowey)	From brackish waters, especially coastal marsh.	Southern. May occur in a few more sites in south-west England than currently recorded.	Hayward & Ryland (1990)
*Microdeutopus stationis**	Amphipod	Yealm sand bar, Newton Ferrers (Yealm Estuary)	Often on holdfasts of kelp *Saccorhiza* spp. Found from 0-50 m.	Southern species. Atlantic Europe. South to the Mediterranean.	Lincoln (1979)

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

Species	*Common name*	*Area(s) of occurrence*	*Habitat/associations*	*Comments*	*Useful reference*
*Circulus striatus**	Sea snail	Lannacombe Beach	Muddy sea-beds to 30 m depth.	Southern species. From SW Britain to Mediterranean.	Graham (1988)
*Steliger bellulus**	Sea slug	Jennycliff Bay (near Plymouth)	Shallow water, sometimes amongst eel grass.	Occurrence scattered from Norway to Mediterranean. Regarded as "exceedingly rare".	Thompson (1988)
Tritonia nilsodhneri	Sea slug	Hilsea Point, Eddystone Reef	Occurs and feeds on *Eunicella verrucosa* in GB.	South-western species. Also known south to Spain. Prone to substantial population fluctuations.	Picton & Morrow (1994)
*Okenia elegans**	Yellow skirt slug	Ore Stone (Torbay), Firestone Bay (Plymouth)	Feeds on the sea squirt *Polycarpa rustica*.	Wide ranging records from Devon to Scandinavia but recent British records are from SW.	Picton & Morrow (1994)
Trapania pallida	Sea slug	The Ramillies	Usually found amongst bryozoans, hydroids & sponges. Rocky subtidal areas in 10-20 m.	Also west Scotland to Atlantic France & Spain	Picton & Morrow (1994)
Atrina fragilis	Fan mussel	Looe, south of Dodman Point	Point of shell downwards in mud, sand & gravel. Shallow subtidal to considerable depth. Sometimes gregarious.	Scattered distribution in GB. Rarely encountered. N. Scotland to Iberian Peninsula. May be declining due to sea-bed disturbance & collecting.	Tebble (1976); Holme (1995)
*Pteria hirundo**	Wing-shell	Off St. Ives	On *Eunicella verrucosa.*	Southern. Also off-shore but rare overall in British seas. Elsewhere south to Iberian Peninsula & Mediterranean.	Hayward & Ryland (1990)
*Lucinella divaricata**	Bivalve	Looe Island	Muddy gravel sand. Intertidal.	Southern. South to the Mediterranean and the Black Sea, Madeira and the Canary Is.	Tebble (1976)
*Acanthocardia aculeata**	Spiny cockle or red nose	Southpool Creek and Paignton (based on beaching of specimens after storm)	Infaunal. Also occurring offshore.	Southern. Also occurring south to Mediterranean and NW Africa.	Hayward & Ryland (1990)
*Callista chione**	Bivalve	Whitsands Bay, Gerrans Bay	In sand. Occurs offshore also (to 100 m).	Southern. Not common offshore.	Hayward & Ryland (1990)
*Ophiopsila aranea**	Brittle star	Outer Plymouth Sound area (Mewstone, 'B' tidal diamond reef, Tinker Shoal, Knapp Shoal, '*Elk* reef')	Crevice dwelling with arms extended.	More common in south Britain. Habitat may be under-recorded to some extent but still probably rare.	Picton (1993)
Pycnoclavella aurilucens	Sea squirt	Various sites in Dart Estuary, Torbay, Gammon Head & Outer Plymouth Sound areas	Current swept rocks at 10-30 m.	Cautiously regarded as scarce. Southern. Also Brittany & perhaps south to Mediterranean.	Hayward & Ryland (1990)
Phallusia mammillata	Sea squirt	Near-shore reefs e.g. Lanes Ground (off Lyme Regis), off Crab Ledge (near Sidmouth), Long Quarry Point (Babbacombe), Shoalstone, Morris Rogue, Shag rock (Torbay), Goodrington, Tosnos Point, Middle Ground, Salt Stone, Snapes Point (Salcombe & Kingsbridge)	On hard substrata with slow to fast water movement. Lower shore to 180 m.	Southern. Seems to occur mainly off southern Cornwall & Devon in GB. Also Spain & Mediterranean.	Hayward & Ryland (1990)

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

Species	*Common name*	*Area(s) of occurrence*	*Habitat/associations*	*Comments*	*Useful reference*
*Gelidium sesquipedale**	Red seaweed	Stoke Point	Upper subtidal. Coasts exposed to severe wave action.	Southern. Restricted in GB to Cornwall & Devon. Elsewhere south to Mediterranean & N. Africa.	Dixon & Irvine (1977)
Gelidiella calcicola##*	Red seaweed	Middle Ground (Salcombe Harbour), Fal Estuary	Normally confined to maerl but on shell in Salcombe Harbour.	Localised in restricted habitat.	Maggs & Guiry (1987)
Lithothamnion corallioides##	Maerl	Falmouth Bay	Forming maerl beds. Associated with rich assemblages of deposit & suspension feeders.	On EC Habitats & Species Directive, Annex Vb. Falmouth has the most extensive living maerl bed in England.	Irvine & Chamberlain (1994)
Gracilaria bursa-pastoris	Red seaweed	Fishcombe (Torbay), Snapes Point (Salcombe), Outer Avon, Erme & Plymouth Estuaries	On stone in sheltered places. Upper subtidal, often with sand deposition.	Southern. Elsewhere widely distributed in warm waters.	Dixon & Irvine (1977)
Gracilaria multipartita	Red seaweed	Salcombe & Kingsbridge Estuary, Outer Yealm & Plymouth Estuary	On stone from upper subtidal to 15 m. Tolerant of sand & silt deposition.	Southern. Probably widely distributed in warm waters.	Dixon & Irvine (1977)
Schmitzia hiscockiana	Red seaweed	Staddon Point Gully (Outer Plymouth Sound)	Wave exposed shores.	Scattered distribution in GB. Restricted habitat. Common at few sites of occurrence. Possibly endemic to the British Isles.	Maggs & Guiry (1985)
Gigartina pistillata	Red seaweed	Man Sands (near Brixham), Salcombe/Bolt Head, Ayrmer Cove, Challaborough, Barricave Beach, Wembury, Dodman Point & Trebetherick Point (Camel)	On stones. Upper subtidal. In pools & occasionally exposed by the tide. Tolerant of some sand cover. Sheltered & slightly wave exposed sites.	South-western species in British Isles.	Dixon & Irvine (1977)
*Bornetia secundiflora**	Red seaweed	Leek Cove (near Salcombe), Bigbury Bay, Wembury Point & Queener Point (Outer Plymouth Sound area)	Boulders & bedrock. Subtidal fringe to 3 m depth. Moderate to exposed sites.	Southern. Occurring south to Morocco & Mediterranean.	Maggs & Hommersand (1993)
*Lophosiphonia reptabunda**	Red seaweed	Next to Ladram Bay near Sidmouth	Intertidal.	Several historic records elsewhere. Currently known at only two sites in GB. Subtropical species also known from African coast.	
Pterosiphonia pennata	Red seaweed	Starehole Bay (near Salcombe)	On muddy bedrock, pebbles & maerl. Moderate to very wave sheltered sites. Extreme low water to 10 m.	Southern. SW Europe & Mediterranean. Wide distribution in Atlantic & Pacific.	Maggs & Hommersand (1993)
Zanardinia prototypus	Brown seaweed	Saltern Cove (Torbay)	Hard substrata. Subtidal to 20 m. Especially on silty rock.	Southern. Subtropical to warm temperate species. Ephemeral species - probably substantial annual fluctuations in population size.	Fletcher (1987)
Padina pavonica	Turkey feather alga or Peacock's tail	Lyme Regis, Sidmouth, Ladram Bay, Budleigh Salterton, Livermead, Shoalston, Goodrington	On hard substrata.	Southern. Ephemeral species - substantial changes in populations with time.	Price *et al*. (1979)

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

Species	*Common name*	*Area(s) of occurrence*	*Habitat/associations*	*Comments*	*Useful reference*
Carpomitra costata	Brown seaweed	Outer Plymouth Sound, the Whelps & the Bizzies (South Cornwall)	On bedrock & boulders. Subtidal to 37 m. Tolerant of some sand cover.	Southern. Probably a summer annual.	Fletcher (1987)
Asperococcus compressus	Brown seaweed	W. Lyme Regis, Ladrum Bay, Exmouth, Teignmouth, Drake's Island	Intertidally on rock & other algae in pools & to 10 m.	Distributed around the British Isles but rare	Fletcher (1987)

Key: * = nationally rare; # = protected under the Wildlife & Countryside Act 1981; ## = maerl or occurs in association with maerl species; (?) = there is reason to believe that the species may no longer exist at this site. Notes: many of the scarce species are only a little more common than the rare species listed; species names after Howson (1987); in the absence of a specific common name the nearest available group name has been used.

5.4.3 Information sources used

The sites of intertidal and subtidal benthic data utilised in this analysis are mapped in section 4.2. In Region 10 some of the available data come from MNCR survey work and earlier NCC-funded surveys. Data are also available from surveys by South West Water, the Scottish Marine Biological Association Intertidal Survey Unit, environmental impact assessments and National Rivers Authority surveys as well as from publications arising from the extensive collections of local marine biological recorders and staff at the Cornish Biological Records Centre and the Universities of Exeter and Plymouth. The Devon Wildlife Trust has recently gathered much useful data, and additional records have also been considered in the present study following personal communications with experts in many taxonomic fields. It has not been possible in this chapter to list all the available literature on which this analysis has been based, but the information reviews and recent papers listed in sections 4.2.6 and 5.4.5 should allow access to most of the available information.

Suitable information in the sublittoral zone of this region is evenly distributed, with only intermittent, small areas of coastal seas lacking information. Intertidal surveys in the region are more patchy, being concentrated in estuaries and sounds.

In some areas within Region 10 records go back to the 1800s, but data from records prior to 1965 have not been used to assess rarity, as they may be out of date. Old records are especially plentiful in this region because the Marine Biological Association established their laboratory in Plymouth in 1884. Indeed, in the vicinity of Plymouth there are old records for many rarely recorded species, for example: the sponge *Adreus fascicularis*, the hydroids *Aglaophenia kirchenpaueri*, *Eudendrium album* and *Obelia bidentata*, the amphipod *Apherusa clevei*, the shrimp *Alpheus macrocheles*, the crabs *Achaeus cranchii* and *Xaiva biguttata*, the bryozoan *Hincksina flustroides*, the urchin *Paracentrotus lividus* and the alga *Polysiphonia foetidissima* (see Marine Biological Association UK 1957; Maggs & Hommersand 1993). The rare hermit crab *Clibanarius erythropus* has been known from Wembury but disappeared from this and other sites in south Cornwall following environmental change or possibly environmental impact (Southward & Southward 1988). It would be valuable to re-survey the sites of old records. Species that are likely to be very under-recorded or overlooked on a national scale have been avoided in the present work.

MNCR survey work uses a consistent methodology to record conspicuous species (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. Inconsistent recording has not, however, seriously reduced the quantity of information available for rarity assessment in this region. The MNCR of Great Britain is at present incomplete but in future will substantially increase the quality and evenness of distribution of the available data. Combined with other surveys, this will almost certainly expand our knowledge of the 'nationally rare' and 'scarce' species in Region 10. Consequently the nationally rare and scarce status of the organisms presented here may require re-evaluation, and in future further species may be added to the list for this region. Populations of species with short life histories, such as ephemeral algae and sea slugs, may be prone to fluctuation from year to year and may require more regular re-evaluation of their occurrence than others.

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Sea squirts	*D.W. Connor, JNCC, Peterborough, tel: 01733 62626
Brown algae	Dr R.L. Fletcher, University of Portsmouth, Marine Laboratory, Ferry Road, Hayling Island, Hants PO1 10DG, tel: 01705 876543
Red algae	Dr C.A. Maggs, School of Biology & Biochemistry, Queen's University of Belfast, Belfast BT7 1NN, tel: 01232 245133

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

5.5 Exploited sea-bed species

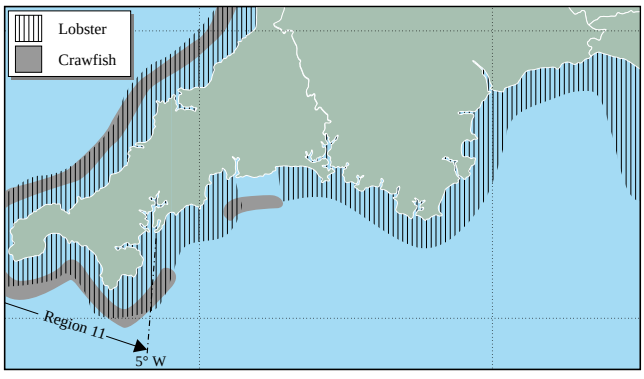
Dr M.G. Pawson & C.F. Robson

5.5.1 Introduction

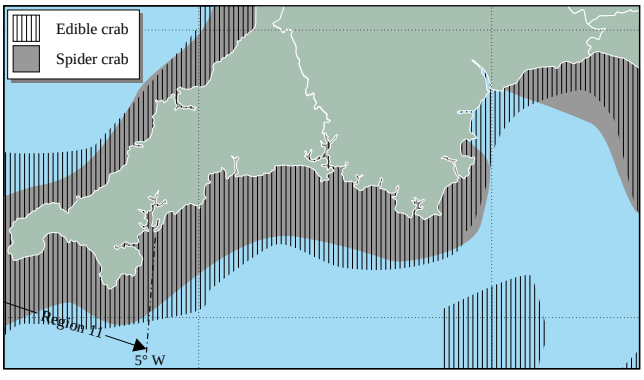
This section describes the distribution of large populations of species that live on, near, or in the bottom sediments of the sea bed (collectively called 'the benthos') and that are routinely exploited, mainly for human food. The exploitation itself is described in sections 9.1 and 9.2. Many of these species also provide an essential food source for other species, such as fish and birds, for example migrant and wintering waders and wildfowl. Most of the species discussed have planktonic larvae; the dispersal of planktonic larvae and the interrelation between populations of the same species can only be inferred from studies on movements of water masses. Their distributions are determined by factors such as water temperature (see section 2.3) and available habitat/substrate type (see also section 4.2). The species described may also be found elsewhere in the region, but in smaller numbers.

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

This region is characterised by important populations of exploited sea-bed species, especially of crustacea such as lobsters, crawfish, spider crabs and edible crabs. There are also scallop and queen scallop grounds offshore and populations of native oysters and mussels in many estuarine areas. There are no exploitable quantities of brown shrimps, deep-water prawns, pink prawns or *Nephrops* in the region.



Map 5.5.1 Distribution of lobster and crawfish. © MAFF.



Map 5.5.2 Distribution of edible crab and spider crab. © MAFF.

Table 5.5.1 Species names

Common name	*Scientific name*
Lobster	*Homarus gammarus*
Edible or brown crab	*Cancer pagurus*
Spider crab	*Maja squinado*
Crawfish, spiny lobster	*Palinurus elephas*
Dublin Bay prawn, scampi, Norway lobster or langoustine	*Nephrops norvegicus*
Deep water prawn (or shrimp - referred to as both)	*Pandalus borealis*
Pink prawn (or shrimp - referred to as both)	*Pandalus montagui*
Brown shrimp	*Crangon crangon*
Cockle	*Cerastoderma edule*
Native oyster	*Ostrea edulis*
Mussel	*Mytilus edulis*
Periwinkle	*Littorina littorea*
Razor shell	*Ensis* spp.
Scallop	*Pecten maximus*
Queen scallop	*Aequipecten opercularis*
Cuttlefish	*Sepia officinalis*
Squid	*Loligo* spp.
Whelk	*Buccinum undatum*
Lugworm	*Arenicola marina*
Ragworm/king ragworm	*Neanthes virens/Hediste diversicolor*
Maerl	*Lithothamnion coralloides* & *Phymatolithon calcareum*

5.5.2 Important locations and species

Crustacea

The broadscale distribution of lobster and crawfish in the region is shown in Map 5.5.1 and spider crabs and edible crabs on Map 5.5.2. Lobsters are distributed along the majority of the region's coastline but are less common for a short stretch of coast between Looe and Fowey. The lobsters are distributed mainly inshore along exposed or rocky shorelines wherever there is suitable habitat, such as rocky reefs with crevices for protection. Spider crabs and edible crabs are found along most of the exposed or rocky shorelines in the region, often on softer sediments - ranging from sand/gravel to rock - than lobsters. From the Channel Islands to Start Point edible crabs are very abundant (Pawson 1995). Juvenile edible crabs tend to be found inshore and adults further offshore (Rees & Dare 1993). The coastal waters of the region form part of their main nursery grounds in the English Channel (Pawson 1995). Crawfish, although present between Gribbin Head and Looe, generally have a more westerly distribution in the UK and are thus more widely distributed in Region 11. Brown shrimps, deep-water prawns, pink prawns and *Nephrops* are not known to occur in exploitable quantities in the region.

Molluscs - inshore and estuarine

The main locations in the region where exploitable populations of native oysters and mussels are found are shown in Map 5.5.3. Cockles are found in the intertidal zones of the small estuaries and other sheltered sites in this region but not in commercially exploitable quantities. There are known exploitable stocks of native oyster in the Exe, Teign, Dart, Salcombe & Kingsbridge Estuaries and in the Lynher and Tamar. Mussels are found in the region, from the mid-shore to the subtidal zone, in water of normal or variable salinity, and in areas exposed to water currents. They attach themselves using 'byssus threads' to bedrock, sand, gravel or pebble substrata or other mussels and empty shells, and have the effect of binding the substratum. Mussels are present in many estuaries in the region, including the Exe, Teign, Dart, Avon, Lynher & Tamar and Fowey. There are also several large mussel beds along the open coast, for example at Whitsand Bay. Periwinkles are present throughout the region on algae growing on rocky shorelines. Razor shells occur in the inshore areas around the region, mainly where the sea bed is clean sand.

Molluscs - offshore

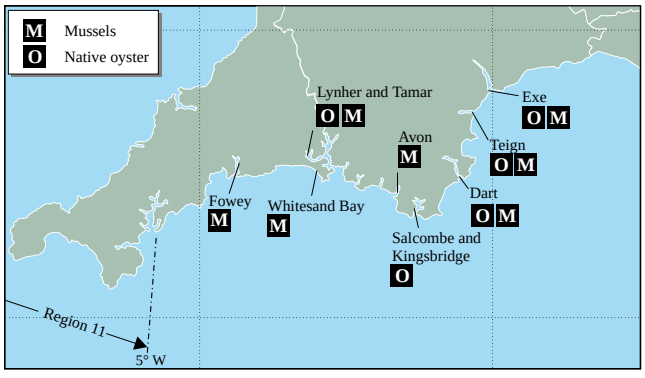
Scallops and queen scallops live on sandy/gravel areas of the sea bed. Scallops have a widespread distribution in the region. Queen scallops are also found in two areas: Lyme Bay westwards towards Sidmouth, and in an area offshore from Start Point westwards, encompassing Eddystone Rocks. Cuttlefish numbers are concentrated in the centre of the Western Channel during the winter and they move into coastal areas during spring and summer. Spawning of cuttlefish occurs from mid-April to mid-May. Squid are found offshore seasonally throughout the region, and move inshore to spawn in the spring. Whelks are widely dispersed throughout the region and, in some areas, have recently begun to attract commercial interest. The broad-scale distributions of scallops and queen scallops in the region are shown in Map 5.5.4.

Polychaetes

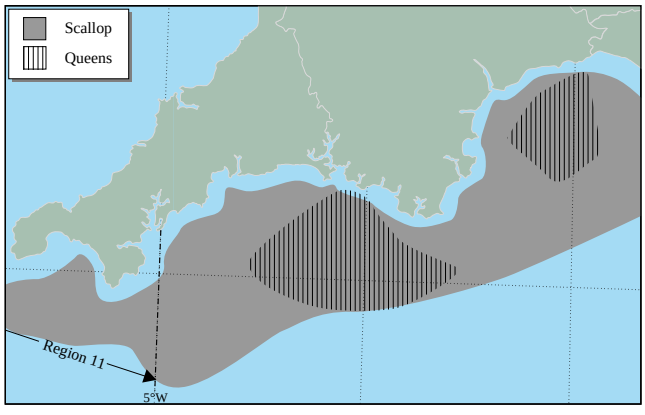
The intertidal and subtidal zones in the region's estuaries (such as the Exe, Salcombe & Kingsbridge, Tamar and the Fowey) support populations of lugworm and ragworm. Lugworms are common in less exposed areas where there is a higher organic content in the substratum. They occur elsewhere in a wide range of sediment types from almost pure mud to clean sand (Davidson *et al.* 1991). Ragworms are usually found in the intertidal and sublittoral in slightly estuarine conditions. They live in burrows in muddy sediments or under rocks and stones. Both ragworm and lugworm are dug for angling bait in several parts of the region (see section 9.1.2).

Others

Maerl is a collective name given to various species of calcareous algae within the Rhodophyta (red seaweeds) that live unattached on the substratum in sheltered areas. The two most common maerl species are both listed under Annex Vb of the EC Habitats & Species Directive (see sections 4.2 and 5.4). The most extensive known beds of living maerl in England and Wales are located in the Fal



Map 5.5.3 Main inshore and estuarine locations of native oysters and mussels. © MAFF.



Map 5.5.4 Main offshore locations of scallops and queen scallops. © MAFF.

Estuary (Cordrey 1996; Tompsett 1996), which is just outside this region, in Region 11. Within Region 10 living specimens of maerl have been reported from Gorran Haven. Dead maerl is dredged from the sea bed for application to soil (see section 5.5.3). Dead maerl covers approximately 30% of the substrate in Lyme Bay east of the Exe Estuary (Devon Wildlife Trust 1995). A particularly significant area is located opposite the mouth of the Otter River and around Otterton Ledge. There are also concentrations of dead maerl that form a wide offshore bank which extends across Falmouth Bay from Rosemullion Point to Gull Rock (east of Nare (Cordrey 1996). The Falmouth Bay area has been surveyed to confirm the distribution of such benthic biotopes (Davies & Sotheran 1995); however, the survey did not cover the area in Region 10 east of Zone Point to Dodman Point.

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. Restrictions are imposed by the authorities who manage the resource and include minimum landing sizes and catch quotas. There are national statutory Minimum Landing Size (MLS) limits for edible crab, lobster, spider crab, *Nephrops*, scallops and velvet crab. The actual size limits may vary between the Sea Fisheries Committees (SFC) that apply them. In addition the Cornwall SFC sets an MLS limit on crawfish and the Devon SFC sets an MLS limit on periwinkles.

Competition between pot and trawling interests off Start Point has led to the introduction of mutually agreed, but voluntary, designated static gear areas, from which trawlers are excluded. These areas change on a seasonal basis and there are also agreed areas designated for potting. Boats fishing for lobster, crawfish and crabs in the Cornwall SFC area must possess a permit issued by them. Although there is no limitation on the number of permits issued, creel fishermen have to submit catch data and other information to the Cornwall SFC.

The overfishing of native oysters caused the traditional industry of dredging to cease in the 1940s in several of the estuaries in the region. However, in the Dart harvesting continued until the 1980s, when contamination from antifouling paint containing tributyltin (TBT) caused the fishery to become uneconomic. Now that the water quality appears to be improving there are plans to re-stock the natural beds in estuaries such as the Dart and Exe (see section 9.2.2).

There has been concern in the region about the effect of the protozoan parasite *Bonamia* on the stocks of native oysters and its possible spread to other areas. For this reason the movement of native oysters is carefully controlled and the Pacific oyster, which is resistant to the parasite, is farmed in preference. Another issue of concern in the region is the introduction of other non-native species, such as the hard-shelled clam, and the effect that their subsequent exploitation has on native species and their habitat.

The effect of scallop dredging on fragile benthic species such as sea fans has recently been investigated (Devon Wildlife Trust 1992).

Maerl is rich in calcium carbonate and dead maerl is dredged by the Cornish Calcified Seaweed Company from the sea bed in Falmouth Bay and further east for liming soil. This extraction is contentious, as live maerl, which is rare and fragile with two species listed in the EC Habitats & Species Directive (see Table 5.4.1), may also be found in the areas made up mostly of dead maerl.

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 embayments (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 MAFF Directorate of Fisheries Research fishery officers and the Devon and Cornwall SFCs on the locations of the species and their fisheries. There is supporting information in the form of catch statistics, for commercial landings, 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 research vessel 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, MAFF Directorate of Fisheries Research (DFR) and the Devon and Cornwall SFCs. Information was also used from Lee & Ramster (1981). Pawson (1995) presents information including distribution maps of selected species (scallops, cuttlefish, lobster, edible crab and spider crab) around the British Isles and has a species-specific bibliography.

5.5.5 Acknowledgements

The authors thank R.C.A. Bannister (Shellfish Resource Group, MAFF DFR, Lowestoft), Stuart Bray (Environment Agency South Western Region), Neil Downes (Devon SFC), Joan Edwards and Mike Camplin (Devon Wildlife Trust), Paul Knapman (English Nature), Mark Tasker (JNCC) and E.J. Derriman (Cornwall SFC) for providing information and commenting on drafts.

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C. Contact names and addresses

Type of information	Contact address and telephone no.
Shellfish stocks and fisheries advice to assist with management and policy decisions for the coastal zone	*Head of Laboratory, MAFF Directorate of Fisheries Research, Fisheries Laboratory, Conwy, tel: 01492 593883
Assessment and provision of advice on the conservation of commercial fish and shellfish stocks	*Director, MAFF Directorate of Fisheries Research, Lowestoft, tel: 01502 562244
General marine research, especially within the Exe Estuary	Department of Biological Sciences, University of Exeter Hatherley Labs., Prince of Wales Road, Exeter, Devon EX4 4PS, tel: 01392 263263
General marine information; extensive library; aquarium	Marine Biological Association of the UK, The Laboratory, Citadel Hill, Plymouth PL1 2PB, tel: 01752 633100
General marine research	Plymouth Marine Laboratory, Prospect Place, West Hoe, Plymouth PL1 3DH, tel: 01752 633100
General marine research	Dept. of Biological Sciences, University of Plymouth, Drake Circus, Plymouth PL4 8AA, tel: 01752 600600
Coastal and marine information for Cornwall	Cornish Biological Records Unit, Trevithick Centre, Trevenson Road, Pool, Redruth, Cornwall TR15 3PL, tel 01209 710424
Survey records of habitats and species from the south Devon coast	*Marine Survey Officer, Devon Wildlife Trust, Exeter, tel: 01392 79244
Habitats and species from the Cornish coast	*Director of Conservation, Cornwall Wildlife Trust, Truro, tel: 01872 73939
Benthic surveys: Marine Nature Conservation Review (MNCR) Database	*Marine Conservation Branch, JNCC, Peterborough, tel: 01733 62626
Marine conservation issues and fisheries	*Fisheries Liaison Officer, English Nature HQ, Peterborough, tel: 01733 340345
Marine Fisheries Task Group papers; marine conservation	*Marine Advisory Officer, Marine Conservation Branch, JNCC, Peterborough, tel: 01733 62626
Marine conservation and issues	*Conservation Officer, RSPB, Sandy, tel: 01767 680551
Marine conservation and issues	*Fisheries Officer, Marine Section, WWF-UK, Godalming, tel: 01483 426444
Marine conservation and issues	*Conservation Officer, Marine Conservation Society, Ross-on-Wye, tel: 01989 566017
Marine conservation and issues	Honorary Secretary, The Marine Forum for Environmental Issues, c/o University College Scarborough, Filey Road, Scarborough YO11 3AZ, tel: 01723 362392
Marine conservation issues in Devon & Cornwall	*Marine Conservation Officer, Devon Wildlife Trust, Exeter, tel: 01392 79244

* 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 (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*), although the smooth newt and great crested newt are virtually absent from Cornwall. Both of Britain's rarest reptiles have been reported in this region: the smooth snake *Coronella austriaca* is known from only a single (1978) record from Devon, and the sand lizard *Lacerta agilis* was introduced in 1994 into a protected site also in Devon, as part of English Nature's sand lizard Species Recovery Programme (Corbett 1994; Whitten 1990).

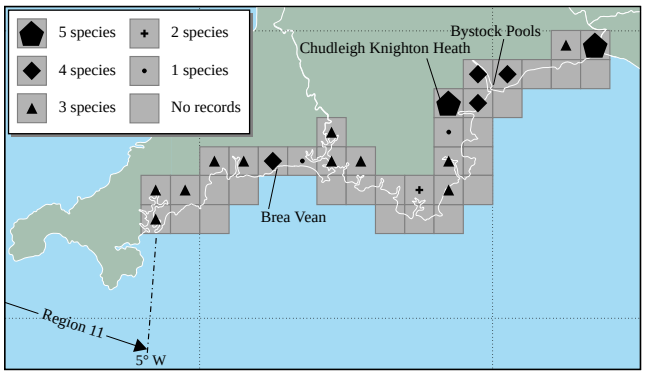
Two alien amphibian species, the edible frog *Rana esculenta* and marsh frog *Rana ridibunda*, have been recorded in the region, the former species in the Plymouth and Fowey areas in the 1970s and at Newton Abbot in the early 1980s, the latter at Teignmouth in the mid 1970s. Since 1990, six leatherback turtles *Dermochelys coriacea* and one other unidentified marine turtle have been recorded either swimming at sea or stranded on the shore of this region. An established population of the introduced species red-eared turtle *Pseudemys scripta-elegans* is reported in the Plymouth area.

The great crested newt, sand lizard, smooth snake and leatherback turtle are totally protected under the Wildlife & Countryside Act 1981, although almost all the species listed are afforded some degree of protection under national and international legislation (Table 5.6.1).

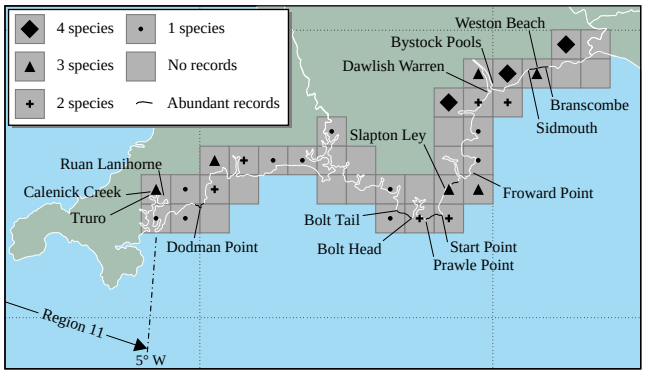
Table 5.6.1 Protected status of amphibians and reptiles occurring in region

Species	*Protection (see footnote)*
Amphibians	
Common frog *Rana temporaria*	1, 2, 3
Common toad *Bufo bufo*	1, 2
Edible frog *Rana esculenta*	1, 2
Marsh frog *Rana ridibunda*	1, 2
Smooth newt *Triturus vulgaris*	1, 2
Palmate newt *Triturus helvetica*	1, 2
Great crested newt *Triturus cristatus*	1, 2, 3
Reptiles	
Slow worm *Anguis fragilis*	1, 2
Common lizard *Lacerta vivipara*	1, 2
Sand lizard *Lacerta agilis*	1, 2, 3
Grass snake *Natrix natrix*	1, 2
Adder *Vipera berus*	1, 2
Smooth snake *Coronella austriaca*	1, 2, 3
Leatherback turtle *Dermochelys coriacea*	1, 2, 3, 4
Red-eared turtle *Pseudemys scripta-elegans*	None

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



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



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

Table 5.6.2 shows the numbers of individual amphibian and terrestrial reptile records in relation to survey effort. The region supports a relatively high diversity of amphibians in a national context. 79% of surveyed 10 km squares support at least three species of amphibian (Map 5.6.1), comparing favourably with Great Britain as a whole (22%), and with the entire British coast (49%) and the North Sea coast (76%). A smaller proportion of 10 km squares in this region (35%) support at least three species of reptile (Map 5.6.2) than in Great Britain as a whole (45%) or the whole coast (43%).

Coastal habitats are essential to the continued existence of Britain's rare amphibians and reptiles. Coastal cliffs, paths and adjacent heathland constitute valuable habitats for adders, slow-worms and common lizards. However, grass snakes are not common in the rugged or dry coastal areas of either Cornwall or Devon, but are more frequently associated with lusher, moister habitats of the river valleys, such as the Exe and Teign in Devon. Most of the amphibians in this region occur in freshwater habitats in the hinterland of the coast, mainly in small agricultural field ponds but also in mineral extraction sites and marshland.

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

		% 10 km squares surveyed for:			*Total no. of individual records*		*Mean no. of individual records per surveyed 10 km square*	
	*Total no. of 10 km squares**	*Any herp. species*	*Amphibians*	*Reptiles*	*Amphibians*	*Reptiles*	*Amphibians*	*Reptiles*
Devon	27	85	52	59	197	102	16.4	6.4
Cornwall	15	80	67	67	66	27	6.6	2.7
Region 10	***42***	***83***	***57***	***62***	***263***	***129***	***10.9***	***4.9***
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, Monks Wood. Key: *total includes squares that are partly in the area, but excludes squares that are exclusively marine.

5.6.2 Important locations and species

Table 5.6.3 lists coastal 10 km squares (two digits) and coastal 1 km OS grid squares (four digits) in which rare and vulnerable species are found and areas that support regionally or nationally important species assemblages (Swan & Oldham 1989) or outstanding populations of widespread species (Maps 5.6.1 and 5.6.2).

Species richness is much higher in Devon than in Cornwall, which is beyond the recorded south-western limit of the distribution ranges of the smooth newt, great crested newt and smooth snake. Hence, the rare species are all found in Devon: the smooth snake and sand lizard both occur in coastal sites just west of the Dorset border and most of the recorded great crested newt breeding sites are to the east of Exeter. The region supports one nationally important amphibian species assemblage, at Chudleigh Knighton Heath, Devon, where all five of the widespread species are reported to breed. Two regionally important amphibian community sites exist, at Bystock Pools and Brea Vean, each of which supports strong populations of four species.

5.6.3 Human activities

Careful management of public access to the coast has limited the extent and impact of tourism, and overall, both amphibians and reptiles have probably benefited from the restriction of development arising from the protected status of a high proportion of the region. Undisturbed, abandoned mineral extraction sites provide good habitat for both amphibians and reptiles along this coastline.

As most of the region's amphibian sites are within the agricultural hinterland of the coast, farming pressures (such as water-body eutrophication), rather than coast-related activities, tend to affect their habitats. However, relative to much of Britain, agriculture in this region is of low intensity

Table 5.6.3 Important areas for rare and vulnerable amphibian and reptile species

Site name	*Grid ref.*	*Habitat*	*Species present*
Devon			
Coast between Sidmouth and Branscombe	SY18	Heathland, grassland, scrub, cliff	Common lizard, slow-worm, grass snake, adder
Weston Beach	SY1688	Scrub, grassland, cliff	Smooth snake (recorded in 1978)
Bystock Pools	SY0384	Heathland, woodland, pools	Common frog, common toad, smooth newt, palmate newt, common lizard, slow-worm, grass snake, adder
Dawlish Warren	SX9878	Sand dunes	Sand lizard (reintroduction site)
Chudleigh Knighton Heath	SX837776	Pond	Common frog, common toad, smooth newt, palmate newt, great crested newt
Froward Point	SX9049	Grassland, woodland, scrub	Common lizard, slow-worm, adder
Slapton Ley	SX8244	Grassland, scrub	Common lizard, slow-worm, adder
Coast between Bolt Tail and Bolt Head; and between Prawle Point and Start Point	SX66-SX73; SX77-SX83	Grassland, scrub, cliff	Common lizard, slow-worm, adder
Cornwall			
Brea Vean	SX214512	Moorland and pools	Common frog, common toad, smooth newt, palmate newt
Dodman Point	SX0040	Mining area	Common lizard, slow-worm
Ruan Lanihorne	SW8942	Grassland, scrub	Common lizard, slow-worm, adder
Calenick Creek	SW8344	Grassland, scrub	Common lizard, slow-worm, grass snake, adder
Truro	SW831433	Railway embankment	Common lizard, slow-worm, adder

Sources: Swan & Oldham (1993a, b), Devon Wildlife Trust, Cornwall Wildlife Trust, English Nature, Perrins (1991).

and few harmful impacts are reported. On the other hand reptile habitat, which is often restricted to a narrow coastal strip, can be further squeezed by agricultural encroachment. Habitats may be at risk from blackthorn and bracken invasion and in some places by proposals for hard coast defences.

A three-year Species Recovery Programme for the sand lizard, begun in 1994, is being implemented by the Herpetological Conservation Trust in partnership with English Nature and the Worldwide Fund for Nature, and a Species Recovery Programme for the smooth snake is also under consideration by English Nature. The background and principles of schemes such as these are outlined in Whitten (1990).

5.6.4 Information sources used

Amphibian and reptile surveying in Britain has been widespread, with 84% of 10 km squares receiving some coverage nationally, although coastal coverage (69% of squares) has been less extensive. For amphibians, the coastline of this region has been surveyed to approximately the same extent as the coast of Britain as a whole in terms of the proportion of 10 km squares where some surveying has been carried out (57% in the region compared with 59% on the British coast), while survey for reptiles has been more extensive (62% in the region compared with 49% on the British coast) (Table 5.6.2).

National distribution data for the widespread terrestrial amphibians and reptiles were provided by the Biological Records Centre (BRC) at Monk's Wood (Arnold 1983, Arnold in prep.). These sources comprise post-1970 species records held by BRC and include all the data collected during the National Amphibian and Reptile Surveys (NARS) undertaken by De Montfort University on behalf of English Nature. The NARS formed the focus of national amphibian and reptile recording during the 1980s and early 1990s (Oldham & Nicholson 1986; Swan & Oldham 1989, 1993a, b). Most of these data were collected through a volunteer, mainly amateur, recorder network. Information on local impacts, habitat associations and important sites was provided by the county wildlife trusts of Cornwall and Devon and by English Nature regional staff. Information on alien species was provided by Henry Arnold of BRC.

Information on the distribution of sand lizards, extracted from the pilot study for the sand lizard Species Recovery Programme (Corbett 1994), and information about the smooth snake was provided by English Nature. Sand lizard and smooth snake populations are regularly monitored by the Herpetological Conservation Trust (HCT) and the British Herpetological Society Conservation Committee (BHSCC).

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

5.6.5 Acknowledgements

The author wishes to thank the following people for providing information: Richard Archer, Henry Arnold, Keith Corbett, Tony Gent, Colin McCarthy, Andrew McDouall and Mark Nicholson.

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C. Contact names and addresses

Type of information	Contact address and telephone no.
Conservation and captive breeding of amphibians and reptiles	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 Co-ordinator, Herpetofauna Groups of Britain and Ireland, c/o HCIL, Triton House, Bramfield, Halesworth, Suffolk IP19 9AE, tel: 0198 684518
National recording schemes and biological data from throughout UK	*Environmental Information Centre, ITE, Monks Wood, Huntingdon, tel: 01487 773381
Species Recovery Programmes	*Dr R. Mitchell, English Nature HQ, Peterborough, tel: 01733 340345
Turtles	Dr Colin McCarthy, Natural History Museum, Cromwell Road, London SW7 5BD, tel: 0171 938 9123
Turtles	Dept. of Oceanography, Southampton University, Highfield, Southampton SO9 5NH, tel: 01703 595000
Designated sites, Devon	*English Nature, Okehampton, tel: 01837 55045
Designated sites, Cornwall	*English Nature, Truro, tel: 01872 262550
Reptiles and amphibians in Region 10	*Devon and Cornwall Amphibian and Reptile Group, c/o Cornwall Wildlife Trust, Truro, tel: 01872 73939
Reptiles and amphibians in Devon	*Devon Wildlife Trust, Exeter, tel: 01392 79244
Reptiles and amphibians in Cornwall	*Cornwall Wildlife Trust, Truro, tel: 01872 73939

* 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 series, 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.

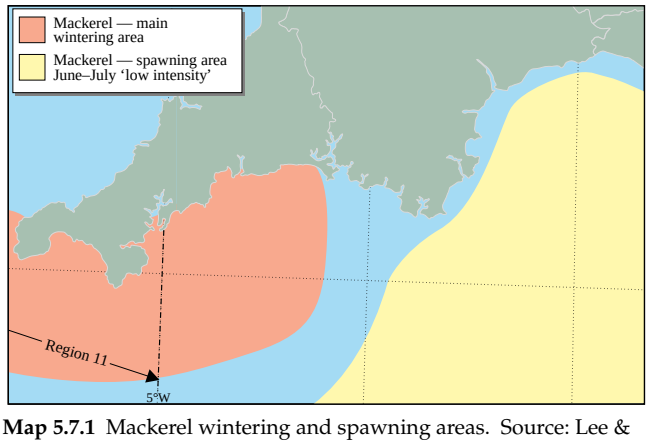
The distribution of exploited sea fish species can be mapped from analysis of catch data. This description of their distribution covers their occurrence at identifiable locations in the region during particular phases of their life history, and Maps 5.7.1 - 5.7.4 show the known spawning and nursery areas 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 (ICES Division VIIe).

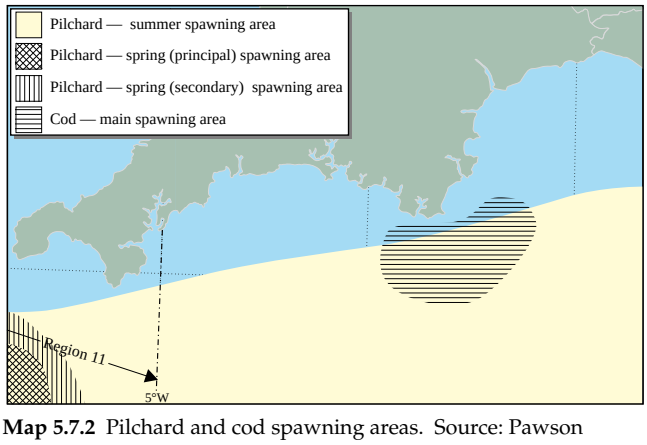
5.7.2 Important locations and species

Of the pelagic species, mackerel is the most abundant off the west coast of Britain. Mackerel spawn throughout the shelf waters of the British Isles, but most prolifically along the edge of the continental shelf and west of the English South-West Peninsula in May and June. They also spawn in a lower density during June and July in the English Channel, including Lyme Bay (Map 5.7.1). Growing juveniles and adults migrate to coastal waters after spawning, where they remain until autumn. Overwintering concentrations are found west of Scotland, west of Ireland and, in this region, off the south coast of Cornwall (Map 5.7.1). Herring are locally abundant around the Cornish coasts, where spawning occurs in estuaries in the spring. The timing of spawning depends on the locality, and the herring larvae drift to shallow nursery areas.

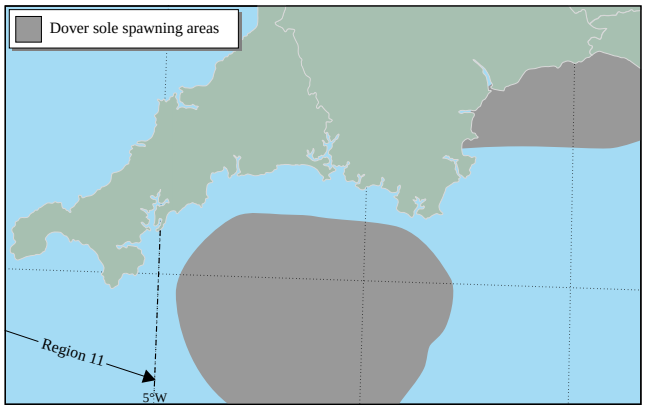
Sprat are widely dispersed throughout the shallower areas of the region and they migrate to offshore spawning



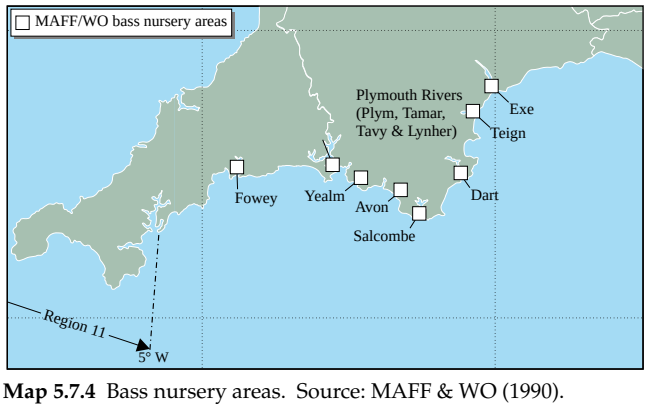
Map 5.7.1 Mackerel wintering and spawning areas. Source: Lee & Ramster (1981). © Crown copyright.



Map 5.7.2 Pilchard and cod spawning areas. Source: Pawson (1995). © Crown copyright.



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



Map 5.7.4 Bass nursery areas. Source: MAFF & WO (1990). © Crown copyright.

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

Species	*Protection measures*
Pelagic species	
Mackerel *Scomber scombrus*	MLS/QM
Horse mackerel *Trachurus trachurus*	MLS/QM
Herring *Clupea harengus*	MLS/QM
Sprat *Sprattus sprattus*	QM
Pilchard *Sardina pilchardus*	No limitation
Demersal species	
Elasmobranchs	
Porbeagle *Lamna nasus*	No limitation
Blue shark *Prionace glauca*	No limitation
Thornback ray *Raja clavata*	No limitation
Spurdog *Squalus acanthias*	No limitation
Gadoids	
Cod *Gadus morhua*	MLS/QM
Whiting *Merlangius merlangus*	MLS/QM
Ling *Molva molva*	No limitation
Pollack *Pollachius pollachius*	MLS/QM
Saithe *Pollachius virens*	MLS/QM
Hake *Merluccius merluccius*	MLS/QM
Flatfish	
Plaice *Pleuronectes platessa*	MLS/QM
Dab *Limanda limanda*	MLS
Dover sole *Solea solea*	MLS/QM
Lemon sole *Microstomus kitt*	MLS
Turbot *Psetta maxima*	MLS
Brill *Scophthalmus rhombus*	MLS
Megrim *Lepidorhombus whiffiagonis*	MLS/QM
Witch *Glyptocephalus cynoglossus*	MLS
Flounder *Platichthys flesus*	MLS
Other demersal fish	
Bass *Dicentrarchus labrax*	MLS
Grey mullets *Chelon labrosus*, *Liza ramada* and *L. aurata*	MLS
Monkfish (angler) *Lophius piscatorius*	QM
Sandeels *Ammodytes* spp.	No limitation
Conger eel *Conger conger*	MLS
John Dory *Zeus faber*	No limitation
Gurnards *Triglidae* spp.	No limitation
Wrasse *Labridae* spp.	No limitation
Red sea bream *Pagellus* spp.	MLS
Red mullet *Mullus surmuletus*	MLS

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

areas around the region's waters. Spawning mainly peaks from April to June and is temperature dependent. Sprats migrate inshore to overwinter, and no clearly defined nursery areas have been identified. Juvenile sprats are often found mixed with young herring (whitebait) in inshore areas.

Horse mackerel (also known as 'scad') are more southerly than other pelagic species, and occur in abundance in UK waters only along the coast of the western English Channel. Horse mackerel spawn mainly along the continental shelf edge between April and July. Lower egg densities are also found over a wider area, including the south eastern sea area of the region (Pawson 1995). Pilchards are also a more southerly pelagic species. The main shoals of pilchards are found along the Western Channel from the Isles of Scilly to the Isle of Wight. Map 5.7.2 shows the pilchard spawning areas in the region. Spawning takes place principally in spring in an area outside the region and offshore from Land's End, but the summer spawning area is more wide ranging and eggs have been found in the region (Map 5.7.2) (Pawson 1995).

Elasmobranch species produce relatively small numbers of live young (10 - 100 per year, but can be fewer in big sharks) or lay large eggs on the sea bed close to their nursery areas. Several species of shark occur sporadically during their summer migrations off the coast. Shark species such as porbeagle, blue shark and spurdog are found in sufficient abundance to be targeted by sea anglers. The thornback ray is also important locally, especially *en route* to its spring spawning grounds in shallow bays around the region. A number of other ray species are distributed patchily in the area.

Of the gadoids, cod is one of the most important exploited fish species in the North Atlantic and is widely distributed in the region. Local fishermen suggest that cod in the area migrate between deep-water wrecks and reefs in the summer and inshore areas in winter (Pawson 1995). There is an aggregation of spawning cod off Start Point, south Devon, which peaks in February (Map 5.7.2). Whiting, also a member of the cod family, is widely distributed around Britain and is abundant in inshore waters along the English Channel. The whiting spawning season is prolonged, from January to July depending on the latitude. Pollack and saithe are less abundant than other gadoids and more locally distributed, with saithe being close to the southern limits of its distribution in the region. Ling spawn mainly along the continental shelf, and an area offshore from the region forms part of this species' nursery area (Pawson 1995). Ling, like pollack and saithe, are commonly found in areas of stony ground, reefs and wrecks. Hake, though not a gadoid, is found in the deeper water of the Celtic Sea and the western English Channel, though the main part of its population lies outside coastal waters towards the edge of the continental shelf, where they spawn.

Plaice and dab are the most abundant flatfish species in the coastal waters of the region, where they occur on sandy areas of the sea bed, with juveniles living close to the shore in nursery areas, gradually moving to deeper water as they mature. The knowledge of plaice spawning areas is obtained from the distribution of newly spawned eggs in spring determined by plankton surveys (Lee & Ramster 1981). Dover sole are present throughout the region and have similar behaviour to plaice and dab, though they are more confined to areas with higher bottom temperatures. Dover sole spawn during the region in early spring (February to April), in a large area offshore between the Lizard peninsula and Start Point and also in Lyme Bay (Map 5.7.3). Turbot and brill are much less abundant than plaice, dab or sole but exhibit similar behaviour. None of the flatfish species undertakes extensive migrations, though their larvae can drift for several weeks from offshore spawning grounds to inshore nursery areas. There may be some interchange between spawning stocks and nursery grounds in this and adjacent regions. In contrast, a more local distribution is recorded for the lemon sole, with an apparently discrete population occurring around the English South-West Peninsula and in the western Channel;

it is assumed that the adults do not make extensive migrations. Flounder 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 coastal movement other than in the egg or larval phase. At the other extreme, both megrim and witch are found in deeper water in this region.

Bass and grey mullet are seasonally abundant inshore and in estuaries in the region, and both species move south and west along the coast in the autumn to overwintering areas. Spawning takes place offshore as the fish return north to feeding grounds in the spring, and in this region there is strong recruitment of stocks, thought to be linked to the warm sea temperatures in spring (Pawson 1992). From June onwards juvenile bass are found extensively in the region's many creeks, estuaries, backwaters and shallow bays (Kelley 1988). Areas such as these have been designated by MAFF as bass nursery areas, with angling restrictions imposed (Map 5.7.4).

Monkfish (angler) spawn in deep water along the continental shelf edge, mainly between March and June, but juveniles and non-spawning adults can be found throughout the western coastal area, even in shallow nearshore waters. Other demersal species of minor importance are conger eel, John Dory and various gurnards and wrasse species. Sandeels are distributed widely throughout the region and provide an important food source for many commercial species. They burrow in coarse sand at night and during the winter; thus, their distribution is 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 extent 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, gear restrictions, bycatch restrictions and quantitative controls on catches of 'pressure stock' species (through catch quota management by the setting of annual Total Allowable Catches (TACs, further explained in section 9.1.3). Two such protection measures are shown in Table 5.7.1, MLS and catch quota management (QM), the latter indicating that the UK has been allocated a portion of the TAC in ICES Division VIIe (which includes Region 10). 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. Under the EU Common Fisheries Policy, an area offshore from the South-West Peninsula and including all the coastal waters of Region 10 has been designated the 'Mackerel Box'. This measure was introduced in order to conserve juvenile mackerel. Within the Mackerel Box there are restrictions on retaining mackerel on board; however, this does not apply to fishermen using handlines or gill nets. A Cornwall Sea Fisheries Committee (SFC) bylaw stipulates a 'minimum taking size' for bass of 37.5 cm.

In order to safeguard the bass fishery in coastal waters, 34 areas in England and Wales have been designated statutory bass nurseries (The Bass (Specified Sea Areas) (Prohibition of Fishing) Order 1990: SI 1990 No. 1156) (Ministry of Agriculture, Fisheries & Food/Welsh Office Agriculture Department 1990). Nursery areas are where juvenile bass are more abundant and are more easily caught, particularly during the summer months. 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 from within nursery areas. There are eight designated bass nursery areas in this region (Table 5.7.2; Map 5.7.4).

Table 5.7.2 MAFF/WO designated bass nursery areas in the region

Name of area	*Duration of closed season*
River Exe	1 May - 31 October
River Teign	1 May - 31 October
River Dart	1 May - 31 December
Salcombe Harbour	1 May - 31 December
River Avon	1 May - 31 December
River Yealm	1 May - 31 December
Plymouth Rivers - Plym, Tamar, Tavy and Lynher	All year
River Fowey	1 May - 31 December

Source: Ministry of Agriculture, Fisheries and Food & Welsh Office Agriculture Department (1990)

Elasmobranch species in the region do not have any protected status. As a result of the relatively long time they take to reach reproductive maturity and the small numbers of young that they produce, they are vulnerable to exploitation.

Spawning and nursery areas may be vulnerable to other activities such as aggregate extraction, sewage sludge disposal, 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 must be taken into account. Other activities, such as sea angling (see section 9.1.2) and seismic activity for oil and gas exploration (Turnpenny & Nedwell 1994), may also have an effect on fish populations.

5.7.4 Information sources used

Whereas the life history of 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 from recorded commercial landing figures. In addition, information is used from research vessel catch data and data from biological sampling during fishing surveys. Data from these surveys on the occurrence of spawning fish and juveniles can be used to identify spawning and nursery

areas. However, this information is sometimes limited, and there may be other areas in addition to those described or shown on the maps where the species might also occur. Research surveys involving plankton sampling, hydrographic studies, fishing and tagging are required to establish the links between spawning groups and specific nursery areas, and between growing juveniles and the adult populations to which they eventually recruit. Lee & Ramster (1981) has been used as a source for the maps. Pawson (1995) shows distribution maps of selected fish and shellfish species around the north-east Atlantic and the British Isles 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 and the regulations for 1996 are given in European Council (1995).

5.7.5 Acknowledgements

The authors thank Paul Knapman (English Nature), E.J. Derriman (Cornwall Sea Fisheries Committee) and Mark Tasker (JNCC) for providing information and for commenting on drafts.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Advice to assist with management and policy for the coastal zone	*Head of Laboratory, MAFF Directorate of Fisheries Research, Fisheries Laboratory, Conwy, tel: 01492 593883
Assessment and provision of advice on the conservation of exploited fish stocks. MAFF fish databases.	*Director, MAFF Directorate of Fisheries Research, Fisheries Laboratory, Lowestoft, tel: 01502 562244
UKDMAP software with maps showing distributions of selected sea fish species and spawning areas	Project Manager, British Oceanographic Data Centre, Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, tel: 0151 652 3950
Marine science research	Director/Librarian, University of Newcastle upon Tyne, Dove Marine Laboratory, Cullercoats, North Shields NE30 4P2, tel: 0191 252 4850
Marine conservation issues and fisheries	*Fisheries Liasion Officer, English Nature HQ, Peterborough, tel: 01733 340345
Marine Fisheries Task Group papers and advice on marine conservation issues	*Marine Advisory Officer, Marine Fisheries Task Group, c/o JNCC, Peterborough, tel: 01733 62626
Marine conservation issues	*Conservation Officer, RSPB, Sandy, tel: 01767 680551
Marine conservation issues	*Fisheries Officer, Marine Section, WWF-UK, Godalming, tel: 01483 426444
Marine conservation issues	*Conservation Officer, Marine Conservation Society, Ross-on-Wye, tel: 01989 566017
Marine conservation issues	Honorary Secretary, The Marine Forum for Environmental Issues, c/o University College Scarborough, Filey Road, Scarborough YO11 3AZ, tel: 01723 362392
Marine conservation issues, Devon	*Marine Conservation Officer, Devon Wildlife Trust, Exeter, tel: 01392 79244
Marine conservation issues, Cornwall	*Director of Conservation, Cornwall Wildlife Trust, Truro, tel: 01872 73939

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

Table 5.8.1 Species and examples of measures for their protection

Species	Protection measures
Atlantic salmon *Salmo salar*	EC Habitats & Species Directive Annexes IIa, Va (freshwater only), close season
Sea trout *Salmo trutta*	Close season
Eel *Anguilla anguilla*	No limitation

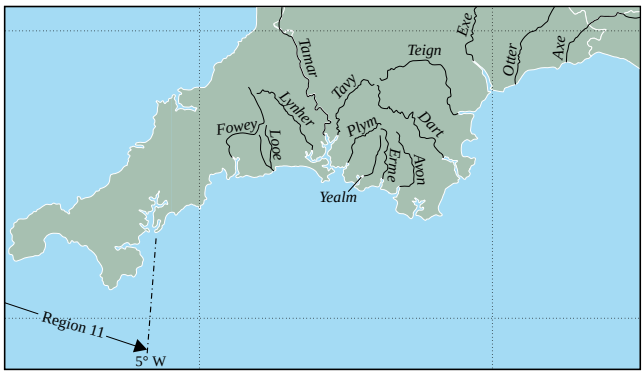
Sources: MAFF and Environment Agency (pers. comm.)

5.8.2 Important locations

Salmon, sea trout and eels have a widespread distribution in the rivers and coastal seas of British waters. 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. They are present in many rivers and the coastal seas of this region (Map 5.8.1). Eels are probably found in all river systems in the region, as elsewhere in Britain. It is highly likely that there are diadromous fish present in the region in other rivers, small tributaries and streams that are not shown on Map 5.8.1.

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 (EA) on 1 April 1996. The South West Region of the EA 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 two Sea Fisheries Committees (SFCs) of the region have powers to support the conservation of salmonid fisheries while exercising their responsibilities towards the regulation of sea fisheries (see section 9.1). However, in estuaries in



Map 5.8.1 Salmon and sea trout rivers. Source: EA.

Cornwall the EA assumes the role of the SFC. The EA uses a variety of techniques, such as netting, electric fishing and monitoring of angling catches, to assess stocks of salmon and sea trout. The 'Fisheries Classification Scheme' allocates fisheries to a quality class on the basis of fish and river habitat data (National Rivers Authority 1994b). 'Salmon Management Plans' are being developed by the EA for key salmon rivers (National Rivers Authority 1996). These plans will form part of the 'Local Environment Action Plans', developed from Catchment Management Plans. The EA constructs fish passes around natural barriers, or makes them passable by fish in other ways. The EA also undertakes physical habitat improvement by, for example, creating pools and adding spawning gravels, riffles and trees for cover.

The effects of exploitation, especially by different catch methods (rod-and-line or nets), is an issue for salmon and sea trout stocks (MAFF/SO 1991). The use of drift nets to target sea fish close to the coast and in estuaries is a potential barrier to migrating salmonids, as is the use of coastal fixed nets. There is particular concern with regard to Irish drift nets, which take approximately 30% of grilse returning to the south-west rivers. As well as rod-and-line, small seine nets are licensed for use in many of the region's rivers (see section 9.1.2) and fyke and elver nets are used to catch eels in tidal or still waters. Net Limitation Orders are applied by the EA to estuarine salmon and sea trout fisheries. These limit the number of nets allowed to fish a particular area. Net Limitation Orders are in place for the following estuaries in the region: Exe, Teign, Dart, Avon, Tavy, Tamar, Lynher and Fowey. The use of nets (apart from putchers and dip nets for eels) is not permitted in any other estuaries. All licences issued by the EA are subject to seasonal and weekly closure times.

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 changing land use, such as the change in flow of rivers from canalisation, and increased siltation. An NRA-funded project used radio tracking equipment on salmon and provided evidence that three weirs along the River Exe constituted significant obstacles to the movement of the fish in the river (EA pers. comm.).

5.8.4 Information sources used

The rivers and coastal areas shown in Map 5.8.1 are those that support net fisheries or have mean annual rod catches in excess of 30 salmon or 100 sea trout, plus some small selected rivers. The information has been derived from the National Rivers Authority published catch statistics of the now Environment Agency (see section 9.1.2). Tributaries and minor rivers with a shared estuary are included under the main river and any remaining rivers are recorded separately in the 'others' category. There are therefore diadromous fish present in other rivers and streams that are not shown on Map 5.8.1. Rivers in the region are shown on the maps in National Rivers Authority (1994a), and the distribution of Atlantic salmon in England and Wales is described in Russell (1989).

The Institute of Freshwater Ecology (part of the Natural Environment Research Council) conducts a programme of research into freshwater habitats and species. Their 'fish counters' yield information on various species of fish, and other studies involve sampling salmon, sea trout and eel from rivers in the UK.

5.8.5 Acknowledgements

The authors thank Stuart Bray (EA South West Region), Mark Tasker (JNCC) and E.J. Derriman (Cornwall Sea Fisheries Committee) for providing information and commenting on 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 Officer, EA South West Region, Exeter, tel: 01392 444000
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.

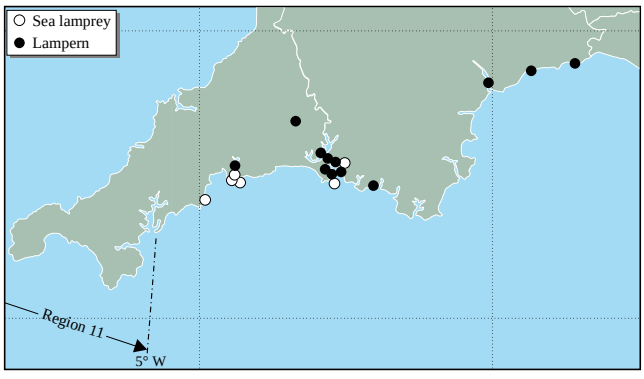
5.9 Fish: other species

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

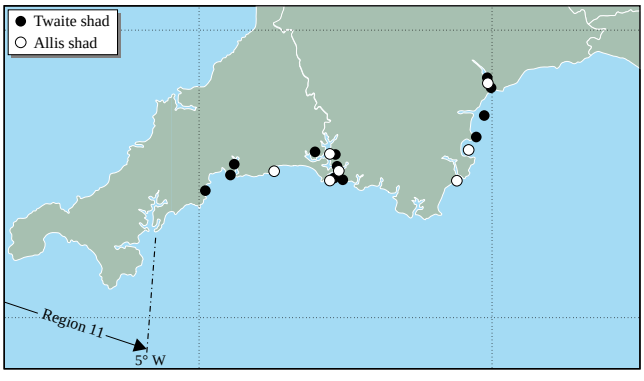
5.9.1 Introduction

The estuaries and coastal waters of this region are amongst the richest and most diverse in the country for fish. There are 181 species of exploited and unexploited fish recorded in the Plymouth Marine Fauna (out of a national total of 336), of which three are hagfish or lampreys (Agnatha), 29 are sharks or rays (elasmobranchs) and 149 are bony fishes (teleosts) (Marine Biological Association 1957). These records include fish caught in the approaches to the English Channel. The species list for the Tamar Estuary and Plymouth Sound is more typical of shore and coastal waters, with 180 fish species being recorded, above the UK regional average of approximately 160. The diversity is attributable to the presence of southern species on the edge of their distribution and ocean vagrants brought in on the North Atlantic Drift.

This region has confirmed records of all seven British marine and estuarine species protected under national, European and international legislation (Table 5.9.1). These include lampern *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus*, sturgeon *Acipenser sturio*, allis shad *Alosa alosa* and twaite shad *Alosa fallax*. These species are considered threatened in UK and European waters (Potts & Swaby pers. comm.).



Map 5.9.1 Distribution records on the British Marine Fishes Database of lampern and sea lamprey. Source: after Potts & Swaby (1993).



Map 5.9.2 Distribution records on the British Marine Fishes Database of allis shad and twaite shad. Source: after Potts & Swaby (1993).

5.9.2 Important locations and species

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

Map 5.9.1 shows the distribution of records of lampern and sea lamprey. Scheduled species, including lamperns, were once recorded as common in the Exe, Axe and Plym, according to Parfitt (in Clarke 1907), and as common in rivers of eastern Cornwall during the spring (Cunningham 1906). Lamperns have been caught during the last five years in the River Plym. Lampreys have been found in the Tamar, but unfortunately they were not recorded to species level (Driver 1992 pers. comm.) and historically have been recorded only as 'in the county' of Cornwall (Clarke 1907). One was found in the stomach of a hake *Merluccius merluccius* caught off Mevagissey (Cunningham 1906), and in 1992 a sea lamprey was found attached to a pollack *Pollachius pollachius* caught in the dockyard area of the Tamar Estuary. Individual sea lamprey have also been seen attached to basking sharks *Cetorhinus maximus* on their spring migrations up the Channel (G.W. Potts pers. obs.).

Table 5.9.1 Scheduled species and protected status

Species	*Wildlife and 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 (1993, pers. comm.). Key: *the sand and common gobies are both very abundant in UK.

Sturgeon used to be taken from the coast of Devon according to Parfitt (Cunningham 1906) and were landed to Plymouth fish market, but in most cases the details of capture are unknown. Cornish records include a sturgeon taken in trammel nets at Mevagissey and one captured at St. Mawes (Clarke 1907). More recent records from the region are listed in Table 5.9.2.

Table 5.9.2 Records of sturgeon from the region

Location	*Numbers*	*Date*
Coast of Devon and Cornwall	1	1953, 1956, 1959, 1971, 1972
Off Brixham	1	1953, 1973, 1975, 1990
Off Dodman Point	1	1953
Off Start Point	1	1969
Mevagissey	1	1971
Eddystone	1	1978
Beer	1	1983
Off Plymouth	1	1990

Source: British Marine Fishes Database.

Map 5.9.2 shows the distribution in the region of records of twaite shad and allis shad. Cunningham (1906) reported as many as 600 allis shad at one time in mackerel seines off Mevagissey. Twelve specimens of allis shad were taken in 1893 in Plymouth Sound (Cunningham 1906) and one was recorded from the Tamar in 1936 (Marine Biological Association 1957). Recent records include three in 1993: one in the weir at Gunnislake on the River Tamar and two from the Fowey Estuary. Twaite shad were formerly recorded at the mouth of the Dart (Cunningham 1906) and sporadically from around south-west coasts (Cunningham 1906; Marine Biological Association 1957). Twaite shad are recorded as having been caught occasionally during routine monitoring of coastal gill nets (Environment Agency South-West Region pers. comm.). More recently there have been records of allis and twaite shad in the Exe; it is thought they may spawn there (Driver pers. comm.), although this has yet to be verified.

The gilthead *Sparus auratus* and triggerfish *Balistes carolinensis* are on the northern edge of their distributions in this region and appear to be increasing in numbers. Both were considered rare visitors at the turn of the century but are now relatively common. Other notable species that occur during the spring and summer months include the basking shark and sunfish *Mola mola*. These are often recorded by yachtsmen and holidaymakers in this region.

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. 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 1993). The dumping of dredged material has been found to have affected fish in the Salcombe and Kingsbridge Estuaries (Little 1987). The region was at one time subjected to intense mining activity, and contamination from mine water occurs from time to time. The china clay works in the St. Austell area have also been shown to have an effect on the coastal waters (Wilson & Connor 1976). 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 1994) (see also section 9.1.2). Other activities such as oil exploration and seismic surveying activity can have an adverse impact on fish (Turnpenny & Nedwell 1994). Dams, weirs and power stations' water intakes can injure or impede migratory fish, which are then unable to reach spawning and feeding grounds. Salmon 'passes' can be built around dams and weirs to allow some selected species to migrate up or down the affected rivers and estuaries.

5.9.4 Information sources used

Surveys in this region are carried out by the Environment Agency (EA), universities and other research institutes. The review of estuarine fish in selected English estuaries (Potts & Swaby 1993), carried out by the Marine Biological Association for English Nature, is included in the British Marine Fishes Database and covers fish in the UK and individual records for this area. Information is being gathered from a variety of sources, including the EA, the Sea Fisheries Committees, anglers and fishermen. The data include published literature, unpublished reports and personal communications from fish biologists. The Marine Biological Association keeps records of fish in the approaches to the English Channel and is the recording centre for the National Rod-caught Fish Committee. MAFF Fisheries Laboratory at Lowestoft has records of species, including non-exploited species, taken during sampling programmes in the English Channel and surrounding area.

5.9.5 Acknowledgements

The authors wish to thank Jane Driver, Environment Agency, and the Cornish Biological Records Unit, Redruth, for their help.

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C. Contact names and addresses

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British Marine Fishes Database	Dr G.W. Potts and S.E. Swaby, Marine Biological Association UK, Citadel Hill, Plymouth PL1 2PB, tel: 01752 633100
Fisheries - England and Wales	*Director, MAFF Directorate of Fisheries Research, Lowestoft, tel: 01502 562244
Maintenance, improvement and development of salmon, sea trout and eel fisheries - England and Wales	*Head of Department, Environment Agency (EA) Fisheries Department, Bristol, tel: 01454 624400
Fish conservation - UK	*Marine Advisory Officer, JNCC, Peterborough, tel: 01733 62626
Fish conservation - England	*Marine Fisheries Officer, EN HQ, Peterborough, tel: 01733 340345
Fish conservation - Devon	*Marine Conservation Officer, Devon Wildlife Trust, Exeter, tel: 01392 79244
Fish conservation - Cornwall	*Director of Conservation, Cornwall Wildlife Trust, Truro, tel: 01872 73939

* 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 (Table 5.10.1), but also divers, grebes and seaduck: in other words, those species reliant for an important part of their life on the marine environment. (Section 5.12.2 includes information on these waterfowl species, where they occur close inshore, especially within estuaries.) Scientific names of all species are given in the tables.

This region is not particularly important for seabirds in numerical terms, but it is close to the southern limit of the breeding ranges of several species. Ten species of seabird breed in the region, three (cormorant, shag and herring gull) in numbers of national importance (more than 1% of their GB populations), but none breed in numbers of international importance. Table 5.10.1 summarises the importance of the region for breeding seabirds.

Table 5.10.1 Overall importance of seabirds breeding in the region

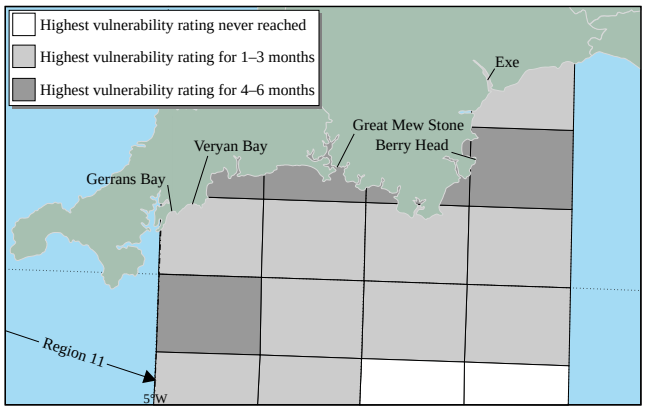
Species	Total	% GB	% Europe
Fulmar *Fulmarus glacialis*	486	<1.0	0
Cormorant *Phalacrocorax carbo*	345	5.1	<1.0
Shag *Phalacrocorax aristotelis*	417	1.1	<1.0
Lesser black-backed gull *Larus fuscus*	11	0	0
Herring gull *Larus argentatus*	2,189	1.4	<1.0
Great black-backed gull *Larus marinus*	163	<1.0	<1.0
Kittiwake *Rissa tridactyla*	2,065	<1.0	<1.0
Guillemot *Uria aalge*	894	<1.0	0
Razorbill *Alca torda*	100	<1.0	0
Puffin *Fratercula arctica*	20	0	0

Sources: figures for Britain from Walsh *et al*. (1995), for Europe from Lloyd *et al*. (1991). Note: regional totals are compiled from the most recent available good-quality counts up to 1994. Counts are all of pairs, except for guillemot, razorbill and puffin, which are counted individually.

Numbers of birds at sea off the region are generally low in comparison with more northern waters of the UK. The greatest concentrations of birds at sea occur in this region outside the breeding period,when concentrations of gannets can occur offshore, and there is immigration by guillemots and razorbills to offshore waters in winter. Numbers of offshore waterfowl do not reach levels of international importance.

5.10.2 Important locations and species

Most breeding seabirds require habitat that is free from predatory mammals, so all colonies are on offshore islands or cliffs. The only colony of national importance in the region is that at the Great Mew Stone, which held 104 pairs of cormorants at the last available count in 1992 (Map 5.10.1). Several other colonies within SSSIs hold regionally important numbers of birds. Most notable among these is



Map 5.10.1 Relative importance of region and adjacent seas for seabirds. Important locations for seabird colonies are named. The grid is of 15'N x 30'W rectangles; see text for explanation of vulnerability ratings. Source: JNCC Seabirds at Sea Team.

the guillemot colony at Berry Head, which is the largest such colony on the coast of southern England. Berry Head is also designated an Area of Special Protection: the designation adds to the protection of breeding birds from disturbance during the breeding season. This applies not only to the cliff, but also to the seas immediately offshore (see section 7.3.4).

At sea, seabird food sources range from zooplankton to small fish and offal from fishing fleets. Habitats that concentrate any of these foods are preferred. Zooplankton can be concentrated in zones where water masses meet, or where tides converge around islands or over some sea-bed features. In winter, Lyme Bay is of considerable importance to guillemots and razorbills. Two sites at Gerrans Bay/Veryan Bay and the Exe support nationally important numbers (exceeding 1% of British totals) of marine-wintering waterfowl (Table 5.10.2). With the exception of the waters immediately adjacent to Berry Head, there are no protected sites at sea in the region. There are no sites of international importance for seaduck or other offshore waterfowl in the region, but the nearshore area between Gribbin Head, near Fowey, and Dennis Head (Helford River: Region 11) supports important numbers of great northern divers (Slade 1995).

Table 5.10.2 Important locations in the region for marine-wintering waterfowl (seaducks, divers and grebes)

Species	*Peak numbers*	*1% GB*	*1% NW Europe*
Exe			
Slavonian grebe *Podiceps auritus*	40	50	50
Common scoter *Melanitta nigra*	400	230	8,000
Red-breasted merganser *Mergus serrator*	158	100	1,000
Gerrans Bay/Veryan Bay			
Black-throated diver *Gavia arctica*	98	50	1,200
Slavonian grebe *Podiceps auritus*	21	50	50

Sources: peak numbers from Lock & Robins (1994), 1% GB from Waters & Cranswick (1993), 1% NW Europe from Rose & Scott (1994). Note: counts are of individuals.

5.10.3 Human activities

The vulnerability of seabirds at sea (Map 5.10.1) to the effects of human activities is calculated from the abundance of birds in the rectangles shown on Map 5.10.1 and a factor derived from the amount of time spent on the water, the overall population size and the rate at which the species recruits new individuals to the population (for a discussion of vulnerability see Carter *et al*. (1993), Williams *et al*. (1994) or Webb *et al*. (1995)).

Seabirds can be particularly affected by marine oil pollution, and spills near the main colonies during the breeding season could be particularly damaging. The risk of accidents from tankers passing the region was highlighted during the *Rose Bay* oil spill, when a tanker was holed in an offshore collision and the resultant pollution affected the birds offshore between Start Point and Plymouth. Concern has also been expressed about the proximity of tanker anchorage off Torquay to the Berry Head colonies. Spills (not only of oil) can also occur from non-tanker shipping movements. The English Channel as a whole is an important route for tankers and other vessels. Entanglement of birds in fishing nets may occur on a small scale.

5.10.4 Information sources used

All seabird colonies in the region were counted between 1984 and 1987. These counts, and all those made since 1969, are held on the JNCC/Seabird Group Seabird Colony Register. Numbers and breeding performance of several species are evaluated annually at Berry Head and Start Point. Surveys of birds at sea in the English Channel have been carried out by JNCC's Seabirds at Sea Team (SAST), and in Lyme Bay by Ambios Ltd. Survey effort from ships by SAST has been greatest off Plymouth and Start Point. In addition, 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. Relatively few surveys have taken place in Lyme Bay, although some specific surveys from small vessels have occurred in the last two years. Coverage, from the land, of most nearshore waters in the region has been patchy, but is better than in many other regions.

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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	*Vertebrate Ecology and Conservation Branch, JNCC, Peterborough, tel: 01733 62626
Nearshore waterfowl	*Wildfowl and Wetlands Trust, Slimbridge, tel: 01453 890333

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

5.11 Other breeding birds

D.M. Craddock & D.A. Stroud

5.11.1 Introduction

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

The numbers and species diversity of breeding waders on saltmarshes and coastal grasslands in the region are low compared to other parts of Britain (Davidson *et al.* 1991), reflecting the limited extent of these habitats. Despite overall low numbers, the region does support a number of breeding waterfowl species with limited or scattered distributions (Gibbons *et al.* 1993). Two sites hold nationally important populations of shelduck *Tadorna tadorna*.

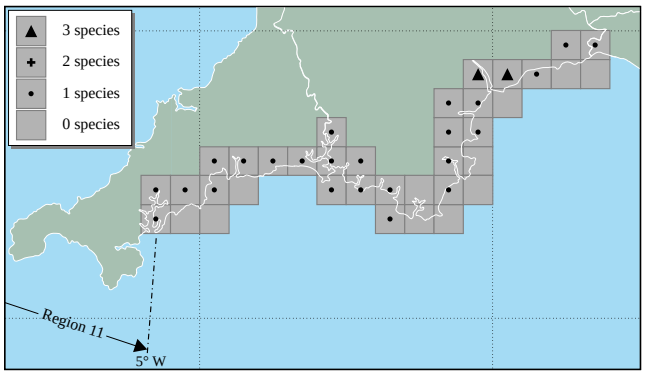
The region, and south-west England generally, is important for breeding passerines (e.g. songbirds) and is nationally important for nightjar *Caprimulgus europaeus* and Dartford warbler *Sylvia undata*, species not typically associated with the coast. It is the last stronghold in England of the cirl bunting *Emberiza cirlus*, has relatively high numbers of stonechat *Saxicola torquata* and is one of the few coastal regions supporting Cetti's warbler *Cettia cetti*.

5.11.2 Important locations and species

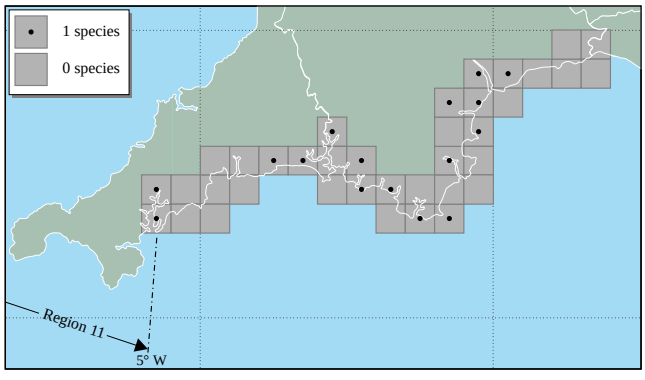
Few locations in the region have significant areas of saltmarsh or lowland wet grassland. As a result, the diversity and numbers of breeding waterfowl are relatively low. Typical wet grassland breeding waterfowl species include teal *Anas crecca*, lapwing *Vanellus vanellus*, redshank *Tringa totanus*, mallard *Anas platyrhynchos* and snipe *Gallinago gallinago* (Map 5.11.1). The most important breeding location in the region for redshank and lapwing is the Exminster and Bowling Green Marshes, at the head of the Exe Estuary, although a large area of saltmarsh in the Lynher Estuary and smaller areas elsewhere also support breeding waterfowl.

Characteristic species that breed on shingle, sand dune and other dry grasslands include ringed plover *Charadrius hiaticula*, oystercatcher *Haematopus ostralegus* and shelduck (Map 5.11.2). The national survey of shelduck in 1992 showed that the Exe and Tamar Estuaries support nationally important numbers of breeding shelduck (Table 5.11.1).

The cirl bunting's population size and range have declined dramatically over the last 50 years, to the point that it is now one of Britain's rarest resident passerines (Smith *et al.* 1992). Usually a bird of lowland agriculture, its main range in Britain is now confined to the coastal strip between Plymouth and Exeter (Gibbons *et al.* 1993). Two other birds not usually associated with the coast, nightjar and Dartford warbler, are found in nationally important numbers on areas of coastal heathland in east Devon. This area is also notable for breeding curlew *Numenius arquata* and hobby *Falco subbuteo* (Pritchard *et al.* 1992). The rias of the region with their steep wooded valleys, for example at Looe, provide nesting habitat for grey heron *Ardea cinerea*, and the cliffs that fringe parts of the coastline support breeding peregrine *Falco peregrinus* (Ratcliffe 1993).



Map 5.11.1 Number of confirmed breeding species characteristic of wet grassland (redshank, snipe, lapwing, teal and mallard) 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).

5.11.3 Human activities

The appropriate agricultural and other management of wet grassland in the region is of crucial importance for their wader populations (see papers in Hötker 1991). Likewise, different grazing regimes on saltmarshes can significantly alter the nest density and breeding success of waders, through effects on vegetation composition and structure (Cadbury *et al.* 1987). Cetti's warblers inhabit dense scrub in damp places, usually adjoining reed beds. The correct management of such coastal reedbeds and associated wetlands is of key importance for the continued survival of their characteristic bird assemblage, including Cetti's warbler. These needs are outlined in detail by Everett

Table 5.11.1 Sites holding at least 45 shelduck

Site	*Total*	*Males*	*Pairs*	*Non-breeding birds*
Tamar Estuary	289	0	0	0
Exe Estuary	169	0	7	18
Axe Estuary	88	0	40	8

Source: WWT national shelduck survey, 1992.

(1989). Human disturbance during the breeding season may have significant effects on bird 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. Active land management for conservation has, in many coastal areas, increased the populations of breeding waterfowl.

Threats from development within south-west England are increasing. In this region proposals around Plymouth and the Plym Estuary may lead to a loss of intertidal areas and increased recreational activity, with associated disturbance (Pritchard *et al*. 1992). The Dartford warbler is found almost exclusively on dry heath. This habitat is threatened through the spread of trees in the absence of grazing (Gibbons *et al.* 1993). Other threats include oil pollution, which can have serious effects on waterfowl where high densities of birds occur.

The death of the last chough *Pyrrhocorax pyrrhocorax* in Cornwall in 1973 also meant its extinction from England. Possible reasons for the decline include increased human disturbance, egg-collecting, trade in live birds, increased competition (Darke 1971; Owen 1989), disease (Bignal *et al.* 1987; Meyer & Simpson 1988) and direct persecution; possibly the greatest impacts on the breeding chough population have arisen from historic changes in land use.

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 x 10 km square level with those recorded in the first breeding bird atlas of 1968-1972 (Sharrock 1976). Whilst these data are one of the best sources for comparisons at county, regional or national scales, care should be taken with their use to assess individual sites or 10 km squares. This is because the tetrad coverage of each 10 km square was not always the same, and since the atlas survey period (1988-1991) distributions of some breeding species may have changed. Between- and within-region comparisons of precise distributions and densities based on coastal 10 x 10 km should be undertaken with caution, as there may be greatly varying amounts of land within each square.

For a number of species, additional extensive survey work has 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 (WWT unpublished)).

5.11.5 Acknowledgements

Thanks are due to Dave Cole, George Boobyer, Dr Andy Brown and Phil Grice for their assistance, K. Curry, Project Explore, for her useful comments and Humphrey Crick and WWT for supplying data.

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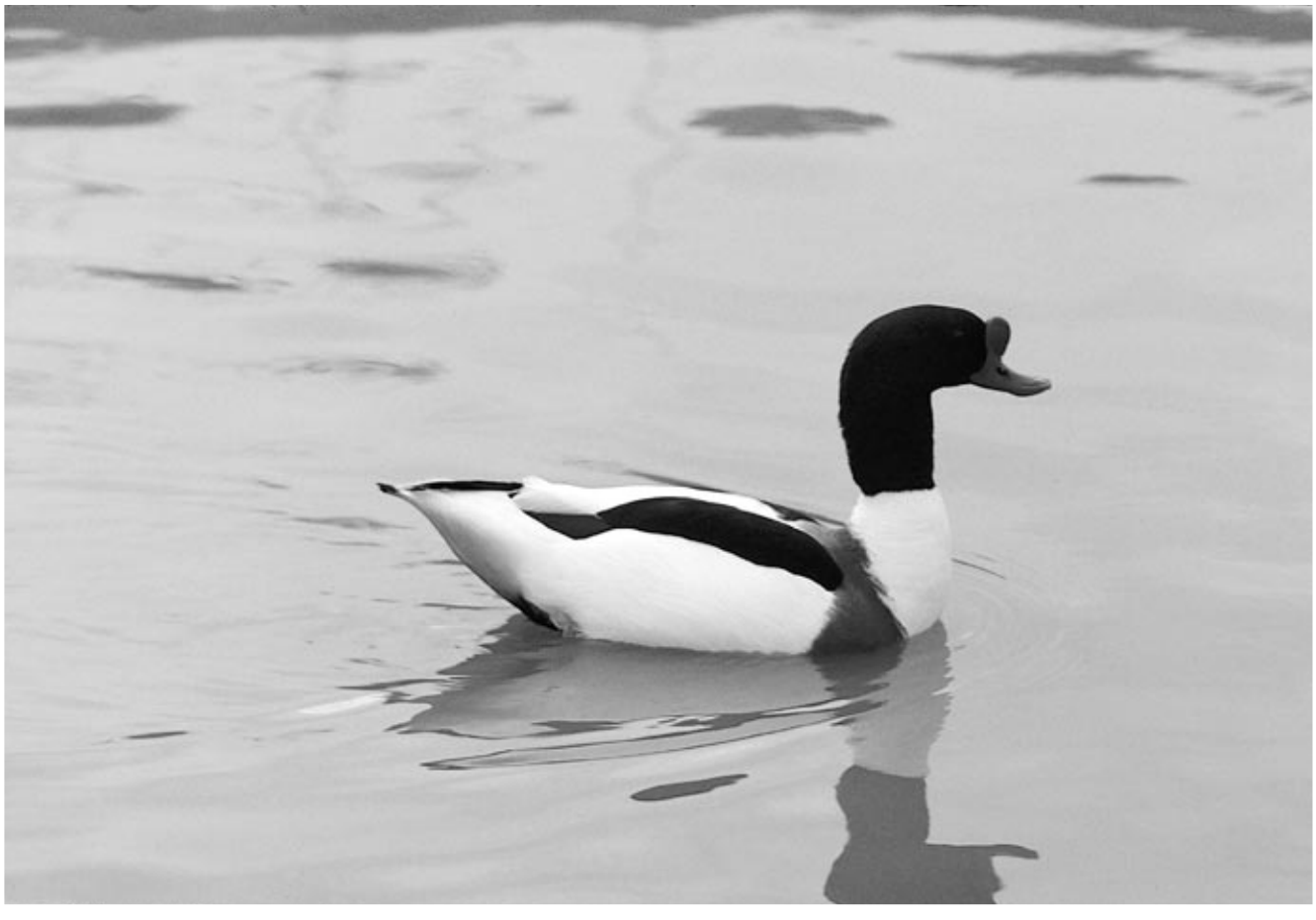
C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Breeding atlas data	*Development Unit, British Trust for Ornithology, Thetford, tel: 01842 750050
Coastal breeding wildfowl data	*Wildfowl & Wetlands Trust, Slimbridge, tel: 01453 890333
Site designations	*Designations Team, English Nature HQ, Peterborough, tel: 01733 340345
RSPB Reserves	*Regional Officer, RSPB South West Regional Office, Exeter, tel: 01392 432691

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



The Tamar Estuary is an important site for wintering waterfowl. Shelduck *Tadorna tadorna* is one of five species, including the avocet *Recurvirostra avosetta* and little egret *Egretta gazetta*, that occur here in nationally important (although not necessarily large) numbers during the winter, when the assemblage can include up to 20,000 birds. Photo: Nick Davidson, JNCC.

5.12 Migrant and wintering waterfowl

D.A. Stroud & D.M. Craddock

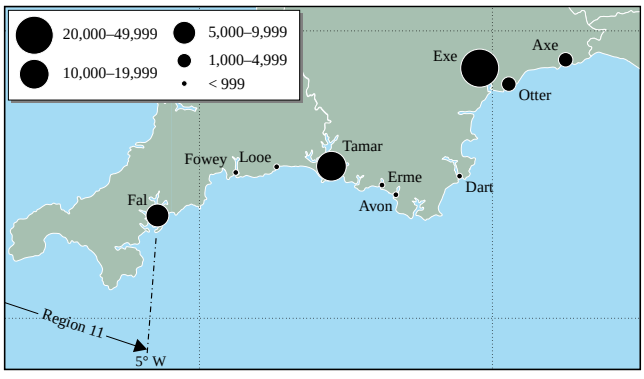
5.12.1 Introduction

This section describes the importance of the region to waterfowl, defined as waders and wildfowl (divers, grebes, ducks, geese and swans together with coot *Fulica atra*). The section notes the occurrence of marine-wintering waterfowl (divers, grebes, seaducks and cormorant *Phalacrocorax carbo*) where they occur close inshore, especially within estuaries; their overall regional distribution, including the importance of offshore areas, is covered in section 5.10.

Of the twelve estuarine areas in the region, the Exe Estuary is of international importance for wintering waterfowl and the Tamar supports nationally (i.e. Great Britain) important numbers of some species (Map 5.12.1). There are ten species of non-breeding waterfowl that occur at levels of national importance on at least one estuary. For some species, sites within the region are amongst the most important in the UK. However, the region holds generally low numbers of over-wintering waterfowl compared with other parts of the UK, although the non-estuarine coast of Cornwall has densities of waders comparable to those of other regions (based on numbers in winter 1984/85).

The mild, southerly climate of this coast means that a number of waterfowl occur here at the northern limit of their winter range, including common sandpiper *Actitis hypoleucos*, greenshank *Tringa nebularia*, green sandpiper *T. ochropus* and avocet *Recurvirostra avosetta*. These species are recorded on only a limited number of sites elsewhere in Britain. The mild climate may also increase the region's importance during periods of severe cold weather, for shores here may remain open as feeding sites when others elsewhere are frozen over. Under these conditions, major influxes of waterfowl may occur from other coastal or inland areas (Ridgill & Fox 1990). Several such important cold weather refuge sites have been identified in the region, including the Otter, Exe, Teign, Dart, Kingsbridge, Avon and Looe (Ridgill & Fox 1990). Table 5.12.1 shows the total January 1993 waterfowl count for the region as a proportion of the coastal totals for England and Great Britain. However, such comparisons can give only an approximation of relative regional importance, since the data are uncorrected for coverage - some areas are better counted than others.

By comparison with densities on estuarine coasts generally and also in the region, and with non-estuarine coasts elsewhere, densities of wintering shorebirds on non-estuarine, non-cliff coasts in the region are very low (Moser & Summers 1987) (Table 5.12.2). The (small) range of wader species occurring here varies greatly with the degree of exposure of the coast and the type of substrate (Moser & Summers 1987).



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

Table 5.12.1 Waterfowl counts in Region 10, England and Great Britain in January 1993

	Total waterfowl count	*Number of sites counted*	*% of count in Region 10*
Coastal sites in Region 10	21,008	11	-
All counted English coastal sites	1,577,388	106	1.3
All counted British coastal sites	2,060,961	214	1.0

Sources: Waters & Cranswick (1993); Rose & Taylor (1993). Note: care should be taken in interpretation as the count coverage varies from country to country and this has not been corrected.

5.12.2 Important locations and species

The varying species composition of the region's wintering waterfowl assemblages (Figure 5.12.1) is determined both within and between sites by habitat characteristics. Sites with extensive areas of saltmarsh or grazing marsh in close proximity to intertidal areas, such as the Exminster and Bowling Green Marshes, at the head of the Exe Estuary,

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

	Number of wader species recorded	*Total number of non-estuarine waders*	*Extent of non-cliff, non-estuarine coast in county (km)*	*Extent of coast surveyed (km)*	*Overall wader density (approx. nos. birds/km coast)*
Devon	14	2,110	242.6	306.4	6.9
Cornwall	14	3,655	272.2	435.7	8.38

Source: from the Winter Shorebird Count - Moser & Summers (1987). Note: county totals include areas outside Region 10. Numbers include only those species surveyed by Moser & Summers in December 1984 and January 1985.

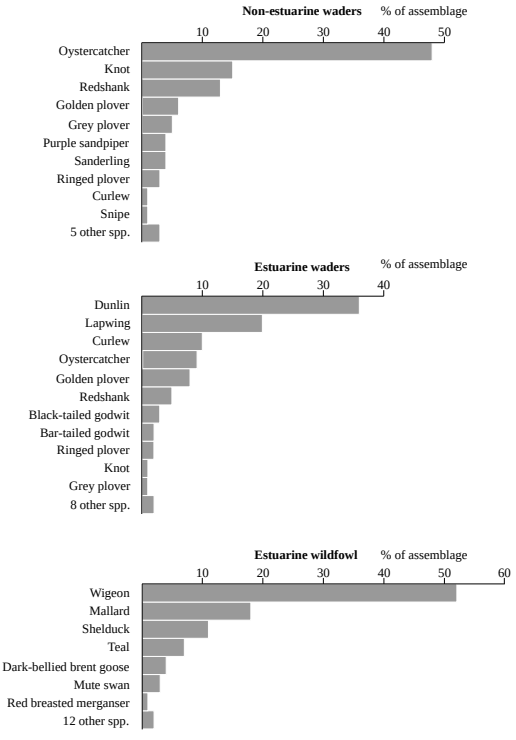


Figure 5.12.1 Relative species composition of non-breeding waterfowl assemblages on coastal areas of the region. Note: figures are for the whole of Devon and Cornwall. Sources: estuarine waterfowl data from Prater (1981), non-estuarine wader data from Moser & Summers (1987).

have large populations of wigeon (Pritchard *et al.* 1992). Where they exist, such areas are also attractive to godwits, lapwing *Vanellus vanellus*, curlew *Numenius arquata*, grey plover *Pluvialis squatarola* and golden plover *Pluvialis apricaria*, as they provide a wide range of feeding opportunities as well as being secure roosting areas. On estuaries, sheltered muddy substrates (such as in the Exe Estuary) are especially attractive to dunlin *Calidris alpina*, whilst sandier estuaries and embayments (such as Dawlish Warren) hold larger numbers of oystercatcher *Haematopus ostralegus*, dark-bellied brent geese *Brant bernicla bernicla*, bar-tailed godwit *Limosa lapponica* and curlew. The Slapton Ley Nature Reserve, the largest natural freshwater system in south-west England, contains extensive reed beds and the largest extent of swamp habitats in Devon and is particularly important for the diversity of birds of passage that occur.

The Exe Estuary is of international importance for regularly supporting over 20,000 wintering waterfowl and has been designated a Special Protection Area (SPA) and Ramsar site (Table 5.12.3). The Exe Estuary also supports nationally important populations of eight species of waterfowl, including a high proportion of the national wintering population of avocet - the second largest population in the UK (Waters & Cranswick 1993). The Tamar Estuary is nationally important for its wintering populations of avocet, shelduck *Tadorna tadorna*, little egret *Egretta gazetta*, black-tailed godwit *Limosa limosa* and dunlin *Calidris alpina*. The Fal Estuary supports nationally important populations of black-tailed godwit *Limosa limosa*. Ringing studies have shown that many of these species (e.g. dunlin and 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).

Other regularly occurring non-breeding waterfowl include shelduck, wigeon *Anas penelope*, mallard *Anas platyrhynchos*, teal *Anas crecca*, dunlin (the most abundant wader in the region - Figure 5.12.1), lapwing, curlew, oystercatcher, turnstone *Arenaria interpres* and black-tailed godwit. Dark-bellied brent geese are present on several of the estuaries in winter, including the Kingsbridge and Exe Estuaries (Cranswick 1993). The numbers of little egret wintering on some of the region's estuaries, such as the Tamar, have increased in recent years in line with the general increase in the species' numbers in southern England.

Table 5.12.3 Wintering** waterfowl numbers on estuaries in the region

Site	*International protected status*	*Five year mean nos. wintering** waterfowl*	*1992/93 peak waterfowl numbers*	*1992/93 peak wildfowl numbers*	*1992/93 peak wader numbers*	*Species occurring at levels of national importance*
Axe	-	1,279	2,480	311	2,169	-
Otter	-	1,076	1,120	1,028	92	-
Dart	-	247	96	96	-	-
Avon	-	776	567	357	210	-
Erme	-	677	608	481	127	-
Exe	SPA & Ramsar	*23,150	21,573	7,038	14,535	Cormorant, dark- bellied brent goose, red-breasted merganser *Mergus serrator*, oystercatcher, avocet, grey plover, dunlin, black-tailed godwit
Tamar	-	11,978	11,940	2,909	9,031	Shelduck, avocet, dunlin, little egret, black-tailed godwit
Looe	-	169	-	-	-	-
Fowey	-	231	298	113	185	-
Fal complex	-	4,832	5,924	971	4,953	Black-tailed godwit

Source: WeBS data from Waters & Cranswick (1993). International protected status follows Pritchard *et al.* (1992). Key: SPA = Special Protection Area; Ramsar = site classified as internationally important under the Ramsar Convention; *sites holding >20,000 waterfowl are of international importance by virtue of absolute numbers; **winter season used by WeBS is November to March for waders and September to March for wildfowl; - = none. Notes: see Waters & Cranswick (1993) for further detail on interpretation of counts and limitations of data. WeBS data above include divers, grebes and cormorants.

On non-estuarine shores, oystercatcher is the most abundant wader species, followed in order of decreasing abundance by knot *Calidris canutus*, redshank *Tringa totanus*, golden plover, grey plover, purple sandpiper *Calidris maritima*, sanderling *Calidris alba*, ringed plover *Charadrius hiaticula*, curlew and snipe *Gallinago gallinago* (Moser & Summers 1987) (Figure 5.12.1).

5.12.3 Human activities

Wintering waterfowl are potentially affected, either directly or indirectly, by a wide range of human activities. Wildfowling occurs, especially in estuaries, although it is generally subject to good regulation (see also section 9.7). The impacts and regulation of wildfowling on National Nature Reserves (NNRs) have been reviewed by Owen (1992). Permit systems generally operate and there is close liaison in the regulation of wildfowling between local shooting clubs, the British Association for Shooting and Conservation (the BASC) and English Nature. Owen (1992) made a number of recommendations for improving the operation of existing schemes to regulate shooting on NNRs. The most popular shooting areas in Region 10 include the Tamar Valley and Kingsbridge area.

Incremental land claim, including barrage schemes, has the potential to further affect waterfowl populations through loss of feeding habitat, although at important sites, SSSI designation allows limitation of such activity. Coastal wind farms in sensitive areas also have the potential to be highly disruptive to wintering waterfowl (Crockford 1992), although there are no such developments in the region at present. Oil pollution is well known as a serious potential threat to wintering waterfowl in areas where high densities of birds occur.

In highly populated areas, disturbance to waterfowl as a result of recreational activities can also have significant effects. Bait digging and shellfish collection from intertidal sediments 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. Further information is needed for this region on the extent of such disturbance, as well as research into the significance of its impact on waterfowl populations, in order to ensure that coastal management planning can best minimise negative impacts.

5.12.4 Information sources used

As with other areas of the UK, migrant and wintering waterfowl are well surveyed by the Wetland Bird Survey (WeBS - organised by the British Trust for Ornithology, the Wildfowl & Wetlands Trust, The Royal Society for the Protection of Birds and the JNCC). This volunteer-based survey collates monthly counts from coastal and inland wetlands throughout the UK. Coastal coverage is generally good for estuaries, although the open coast is not thoroughly surveyed on an annual basis (Waters & Cranswick 1993). The WeBS waterfowl count scheme publishes an extensive annual summary report, the most recent being Cranswick *et al.* (1995), covering the winter season 1992/93. This report summarises species trends, based on counts at wetlands throughout the UK. It also tabulates total waterfowl numbers at all counted estuaries, as well as inland sites. 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 5.12.5. 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. The WeBS waterfowl counts are generally undertaken at high tide, when waterfowl gather in high densities on traditional roosting areas. To complement this information, at selected estuaries WeBS organises low-tide counts to give information on the feeding distributions of waterfowl during the intertidal period. Sites in the region for which such information is already available include the Exe and Erme Estuaries.

The whole UK coastline was surveyed for wintering waders during the Wintering Shorebird Count of 1984/85 (Moser & Summers 1987), and there are current WeBS plans for a repeat national survey, possibly in 1996/97. Such information on the wintering waterfowl of the non-estuarine shore is important to place annual estuaries counts into a wider perspective.

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

Prater (1981) gives useful descriptive accounts of the birds of British estuaries, as well as placing these in a wider national and international context, using data from the period 1969-1975. As in Owen *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.

The dark-bellied brent goose population wintering in the region has been the subject of a long-term national population study undertaken by WWT (e.g. Cranswick 1993).

5.12.5 Further sources of information

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B. Contact names and addresses

Type of information	*Contact address and telephone no.*
RSPB	*South West England Regional Office, Exeter, tel: 01392 432691
High tide and low tide counts of wintering and migrant wildfowl (WeBS)	*Peter Cranswick: WeBS National Organiser (Waterfowl), The Wildfowl & Wetlands Trust, Slimbridge, tel: 01453 890333
High tide counts of wintering and migrant wader (WeBS)	*Ray Waters: WeBS National Organiser (Waders), The British Trust for Ornithology, Thetford, tel: 01842 750050
Low tide counts of wintering and migrant wader (WeBS)	*Julianne Evans: WeBS National Organiser (Low Tide Counts), The British Trust for Ornithology, Thetford, tel: 01842 750050
Site designations	*Ornithologist, EN HQ, Peterborough, tel: 01733 340345
Specific sites (Devon)	*EN, Okehampton, tel: 01837 55045
Specific sites (Cornwall)	*EN, Truro, tel: 01872 262550

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

5.13 Land mammals

Dr C.E. Turtle

5.13.1 Introduction

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

This region is particularly important for bats and supports a number of nationally important species, most of which are vulnerable and declining (Morris 1993). Twelve of the fourteen species of British bat are recorded from this region (Arnold 1993; BRC data). These are the greater horseshoe, lesser horseshoe *Rhinolophus hipposideros* (Map 5.13.1), whiskered *Myotis mystacinus*, natterer's *M. nattereri*, Bechstein's *M. bechsteinii*, Daubenton's *M. daubentonii*, serotine *Eptesicus serotinus*, noctule *Nyctalus noctula*, pipistrelle *Pipistrellus pipistrellus*, barbastelle *Barbastella barbastellus*, brown long-eared *Plecotus auritus* and grey long-eared *P. austriacus*. The greater horseshoe, the lesser horseshoe and the grey long-eared are the most important, owing to their limited national distribution and declining numbers. All bats, the otter *Lutra lutra* and the dormouse *Muscardinus avellanarius* are listed under Schedule 5 of the Wildlife and Countryside Act and Annex II of the Bern Convention (except for the dormouse, which is on Annex III). Four species of bat in the region, the greater horseshoe, lesser horseshoe, Bechstein's and barbastelle, and the otter are listed in Annex II of the EC Habitats and Species Directive as species whose conservation requires the designation of Special Areas of Conservation. Table 5.13.1 summarises the recorded distribution of protected species in the region.

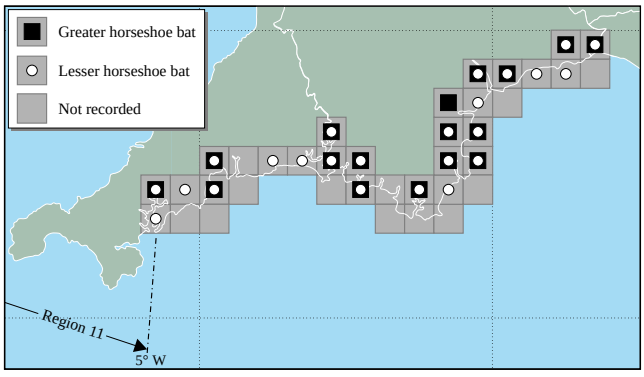
5.13.2 Important locations and species

The otter is associated with semi-aquatic areas, including rivers, lakes and coasts, and is the terrestrial mammal that

Table 5.13.1 Records of protected species distribution

Protected species	*Estimate of importance in region*
Greater horseshoe bat	Occasional
Lesser horseshoe bat	Frequent
Whiskered bat	Rare
Natterer's bat	Occasional
Bechstein's bat	Rare Devon, absent Cornwall
Daubenton's bat	Rare
Serotine bat	Rare Devon, absent Cornwall
Noctule bat	Rare
Pipistrelle bat	Frequent
Barbastelle bat	Rare
Brown long-eared bat	Occasional
Grey long-eared bat	Rare
Dormouse	Occasional
Otter	Frequent

Source: Arnold 1993.



Map 5.13.1 Recorded distribution of the greater and lesser horseshoe bats in coastal 10 km squares. Records from 1975 onwards. Source: Arnold (1993).

uses coastal areas most frequently. It is classed as endangered and is absent from many areas of England (Morris 1993). The south-west is regarded as an important stronghold for otters in England, and data from Arnold (1993) suggest that otters utilise the coast in this region. These populations are proving important for the recovery of the otter in England (Steve Gibson pers. comm.). However, both the 1977-1979 otter survey (Lenton *et al.* 1980) and the 1984-1986 otter survey of England (Strachan *et al.* 1990) found little evidence of otters on the coast in the region. Indeed, there was only one positive record from the 1984-85 survey, near Boswinger, Cornwall (Strachan *et al.* 1990). Lenton *et al.* (1980) noted that very little surveying could be done at coastal sites, because of their inaccessibility or disturbance from people. Recent records of otters from Slapton Ley and the Tamar Estuary and a number of inland records are likely to be connected with coastal activity by otters (H. Marshall pers. comm.). Otters have also been sighted from cliff tops, but these records are difficult to confirm (H. Marshall pers. comm.). Otters are found in the headwaters and upper reaches of the River Fal.

The national bat habitat survey (Walsh & Harris in press) includes coastal habitats and demonstrates that bats utilise the coast for foraging. Bats are likely to find areas of semi-natural habitat of most value for foraging, although shelter and natural features for flightlines are also important. The Devon population of the greater horseshoe is of national importance, being at the northern and western limit of its range. There are several important underground roost sites in Devon (G. Bemment pers. comm.), and a nursery roost is known from an old mine system near Par, Cornwall (J. Page pers. comm.). The lesser horseshoe bat is restricted to the south-west (Arnold 1993), where it is on the northern edge of its range in Europe. The region's coastline is important for this species, which is concentrated along the south-east coast of Devon and is associated particularly with ancient woodlands. English Nature's Bat Sites Register should confirm the important sites in the region. Map 5.13.1 shows the distribution of greater and lesser horseshoe bats in the region.

In Region 10 the dormouse is on the western edge of its range in Europe (Corbet & Harris 1991). It is classified as vulnerable and locally endangered in Britain (Morris 1993).

They are specialist feeders and occur primarily in woodlands but also in edge habitats such as hedgerows and scrub. They are often associated with ancient woodlands with a coppiced hazel understorey and a diverse tree and shrub layer. Isolated areas of suitable habitat are unlikely to hold viable populations if they are less than 20 ha in extent (Bright *et al.* 1994). The preliminary findings of the Great Nut Hunt (Morris *et al.* in press) have shown that dormice occur along the south-east Devon coast. The undercliffs of the coastal National Nature Reserve between Axmouth and Lyme Regis are particularly important for dormice because much of the site is virtually undisturbed woodland and scrub, because of the instability of the cliffs (F. Rush pers. comm.).

5.13.3 Human activities

Parts of the region are under heavy pressure from tourism and the leisure industry, with disturbance mainly concentrated in 'honey pot' areas on the Devon coast, such as the Exe Estuary and Dawlish Warren. The disturbance caused by tourists and water sports may be inhibiting otters from using the coast. In some areas, otters may also be affected by run-off of nitrates from agricultural land. Agricultural intensification, especially the use of pesticides, also has an adverse effect on all bat species. Removing hedgerows and woodland destroys bat roosting and foraging sites as well as reducing shelter: indeed, the loss of any semi-natural habitats will reduce the quality of the environment for most species of bat. The loss of mature hedgerows, particularly those that connect with other woodlands, will also have a severe effect on the dormouse population, as will destruction, fragmentation and inappropriate management of ancient woodlands, including hazel coppice.

5.13.4 Information sources used

There have been no specifically coastal surveys within this region and therefore the value of even the nationally comprehensive surveys, such as those for otters, have their limitations when assessing the importance of this coast. There are no reliable estimates of the numbers of mammals in the region or Britain that could be used to quantify the resource. Using data from Arnold (1993) (although these records are incidental rather than comprehensive), an estimate has been made of the frequency of their occurrence in the region. As a general observation (Morris 1993), mammal surveys are not recorded with the same intensity as botanical ones and the occurrence of mammals within 10 km squares is not enough to establish the status of species. There have been no comprehensive surveys for dormice or for any of the bats, although there are recent records for all of them.

5.13.5 Acknowledgements

Thanks are due to F. Rush, Devon Wildlife Trust, Steve Gibson, JNCC, H. Marshall, Otter Recorder (Devon & Cornwall), G. Bemment, Devon Bat Group, and J. Page, Cornwall Bat Group, for their valuable information and their time. The Biological Records Centre, Monks Wood, provided recent data for the area.

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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.*
National site and species information	*Mammal Ecologist, English Nature HQ, Peterborough, tel: 01733 340345
Biological Records Centre: records of mammal distributions	*ITE Monks Wood, Huntingdon, tel: 01487 773381
Local site and species information in Devon	*English Nature, Okehampton, tel: 01837 55045
Local site and species information in Cornwall	*English Nature, Truro, tel: 01872 262550
Mammal sites in Devon	*Devon Wildlife Trust, Exeter, tel: 01392 79244
Mammal sites in Cornwall	*Cornwall Wildlife Trust, Truro, tel: 01872 73939

Type of information	*Contact address and telephone no.*
Bats	George Bemment, Devon Bat Group, 19 Fore Street, Kingskerswell, Newton Abbot, Devon TQ12 5BT, tel: 01803 874028
Otters in Devon	Hilary Marshall, Otter Recorder, Meadowside, Virginstow, Beaworthy, Devon EX21 5DZ, tel: 01409 211581
Otters in Cornwall	Steve Crummay, St. Agnes - Newquay Countryside Service, tel: 01637 851889
General mammal information	The Mammal Society, 15 Cloisters House, 8 Battersea Park Road, London SW8 4BG, tel: 0171 498 4358

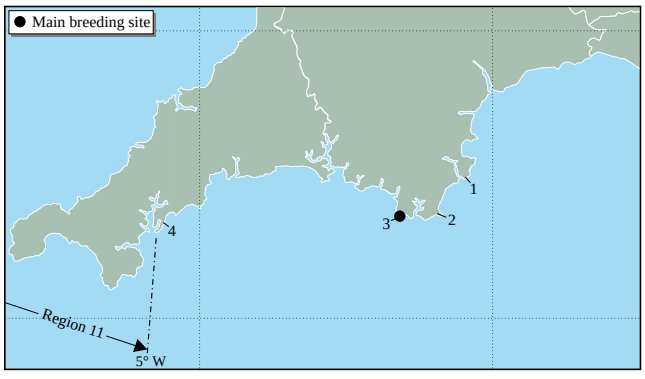
*Starred contact addresses are given in full in the Appendix.

5.14 Seals

C.D. Duck

5.14.1 Introduction

This region holds surprisingly few common seals *Phoca vitulina* or grey seals *Halichoerus grypus* and makes no significant contribution to the UK population of either species (Table 5.14.1). There are few suitable sites in the region where seals may either haul-out or breed; they tend to use remote and inaccessible beaches and islands, and frequently beaches at the rear of sea-caves. Both seal species are listed in the EC Habitats & Species Directive as species whose conservation requires the designation of Special Areas of Conservation (SACs - see also section 7.2).



Map 5.14.1 Grey seal pup production. Sites are listed in Table 5.14.2. Source: Westcott 1993.

5.14.2 Important locations

Grey seals, although not abundant in the region, can be seen along most of the coast, particularly west of Torbay. The one confirmed breeding site in the region is to the west of Salcombe, south Devon. Very few pups are born in the region; annual production is estimated to be less than 0.01% of the GB total. Outside the breeding season, the numbers of grey seals at haul-out sites are unpredictable and may vary greatly from day to day. Regularly used haul-out sites and the one breeding site are shown in Table 5.14.2 and Map 5.14.1.

Reliable sightings of common seals in the region are very rare. A three-day old pup was found at the mouth of the River Erme, Devon, in July 1994. The pup was considered to be abandoned by its mother and was taken to the seal sanctuary at Gweek in Cornwall. The closest regular breeding sites are on the north-west coast of France and the south coast of Eire.

Table 5.14.1 Numbers of grey seals in the region in relation to the rest of GB

Location	*Pup production*	*% of GB total*	*Associated population >1 year old*
Devon (south)	3	0.01	10
Cornwall (south-east)	0	-	0
Region 10	***3***	***0.01***	***10***
GB total	33,850	-	115,000

Source: Westcott (1993).

Table 5.14.2 Grey seal pup production and important haul-out sites

Site	*Grid ref.*	*Main breeding site*	*Important haul-out site*	*Number of pups born*
1 Mew Stone Skerry	SX820364		-	-
2 Sleaden Seal Rock	SX908494		-	-
3 Bolt Tail	SX671392	-		3
4 Middle Stone	SW926365		-	-

Source: Westcott (1993). Key: - = not known. Note: site numbers refer to Map 5.14.1.

5.14.3 Human activities

The coast of the region is quite densely populated in places and there is considerable tourist activity during the summer months. As with other regions in south-west Britain, sightings of seals generate considerable public interest. The effects of human disturbance on seals are unknown. The density of seals in the region is very low and is unlikely to increase to any significant level, given the extent of human presence, tourist activity and the lack of suitable habitat.

5.14.4 Information sources used

On account of the small numbers of seals, there have been very few surveys of the region and existing data are limited. The most recent information forms part of an investigation conducted by Westcott (1993) into the numbers and distribution of grey seals throughout Devon, Cornwall and the Isles of Scilly (but not this region). All the information presented here is derived from those data. Survey techniques include observation from cliff-tops and from boats and swimming into caves using sub-aqua equipment. The remoteness and inacessibility of seals' preferred breeding sites makes surveying extremely difficult. In addition, in this region their breeding season is earlier and more protracted than at colonies in Scotland and elsewhere in England, which adds to the problem of accurately assessing pup production.

5.14.5 Acknowledgements

I am grateful to Stephen Westcott for making available the information he has accumulated since 1990. James Barnett of the National Seal Sanctuary kindly provided information about the common seal pup found in Devon in 1994.

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B. Further reading

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Summers, C.F. 1974. The grey seal (*Halichoerus grypus*) in Cornwall and the Isles of Scilly. *Biological Conservation, 6*: 285-291.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Seals in Devon	*English Nature, Okehampton, tel: 01837 55045
Seals in Cornwall	*English Nature, Truro, tel: 01872 262550
Seals in the region	Stephen Westcott, Hawthorn Cottage, The Vineries, Poljigga, St. Levan, Penzance TR19 6LT tel: 01736 871496
General information, Devon	*Devon Wildlife Trust, Exeter, tel: 01392 79244
General information, Cornwall	*Cornwall Wildlife Trust, Truro, tel: 01872 73939
Seal rehabilitation	National Seal Sanctuary, Gweek, Helston, Cornwall TR12 6UG, tel: 01326 221 361
Seal numbers and distribution around the UK	Callan Duck, Sea Mammal Research Unit, Gatty Marine Laboratory, University of St. Andrews, Fife KY16 8LB, tel: 01334 476161

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

5.15 Whales, dolphins and porpoises

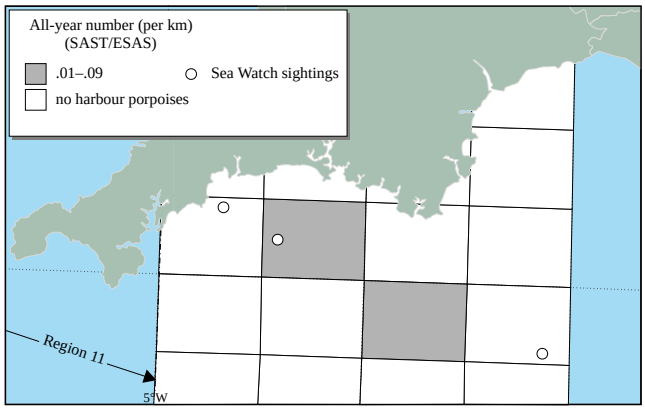
Dr P.G.H. Evans

5.15.1 Introduction

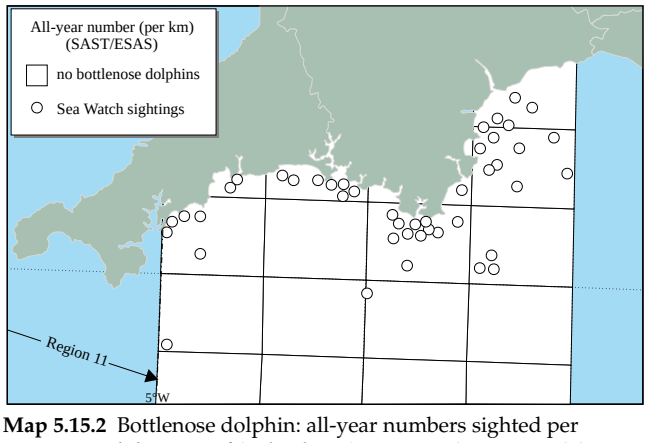
The region is relatively unimportant for cetaceans (whales, dolphins and porpoises), although several cetacean species are seen more regularly in the region than in other areas of the Channel. Thirteen species have been recorded since 1980 along the coasts or in nearshore waters (i.e. within 60 km of the coast) of the region; of these, seven species (a little over 25% of the 27 UK species) are either present in the region throughout the year or have been recorded annually as seasonal visitors.

Generally, the species most frequently recorded in nearshore waters are the bottlenose dolphin *Tursiops truncatus*, common dolphin *Delphinus delphis*, long-finned pilot whale *Globicephala melas* and harbour porpoise *Phocoena phocoena*, with Risso's dolphin *Grampus griseus*, striped dolphin *Stenella coeruleoalba* and killer whale *Orcinus orca* recorded occasionally. The cetacean species recorded further offshore most frequently and in greatest abundance are the long-finned pilot whale and common dolphin; both species appear to be wide-ranging with no specific favoured location. Other cetacean species recorded in the region include sei whale *Balaenoptera borealis*, minke whale *Balaenoptera acutorostrata*, Cuvier's beaked whale *Ziphius cavirostris*, Sowerby's beaked whale *Mesoplodon bidens*, white-beaked dolphin *Lagenorhynchus albirostris* and white-sided dolphin *Lagenorhynchus acutus*. For geographical comparisons of sightings rates for various cetacean species in UK waters, see Evans (1990, 1992) and Northridge *et al.* (1995).

The harbour porpoise and bottlenose dolphin are both listed in Annex II of the EC Habitats & Species Directive as species whose conservation requires the designation of Special Areas of Conservation (SACs - see also section 7.2).



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



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

5.15.2 Important locations and species

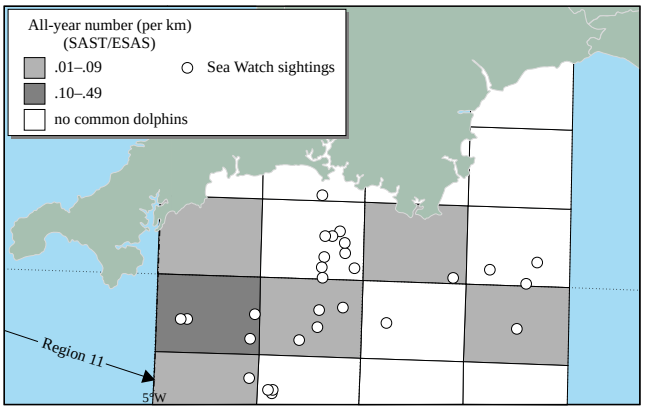
Prominent headlands and enclosed bays are favoured by cetaceans in coastal waters. Small numbers of harbour porpoises are reported between September and December, mainly along the southern Cornish coast (Map 5.15.1). Although rare during the 1980s, bottlenose dolphins have been reported nearshore since 1990 in most months (but particularly between March and August), with many sightings from Falmouth Bay, Gerrans Bay, Megavissey and St. Austell Bays, Whitsand Bay, Bigbury Bay, between Bolt Head and Prawle Point, and in Tor Bay (Map 5.15.2). The common dolphin is a relatively deep-water species recorded mainly offshore, most frequently reported between August and January (Map 5.15.3). Long-finned pilot whales are also seen more frequently in deeper water in the region (Map 5.15.4). Table 5.15.1 summarises recorded sightings of cetacean species in the region.

5.15.3 Human activities

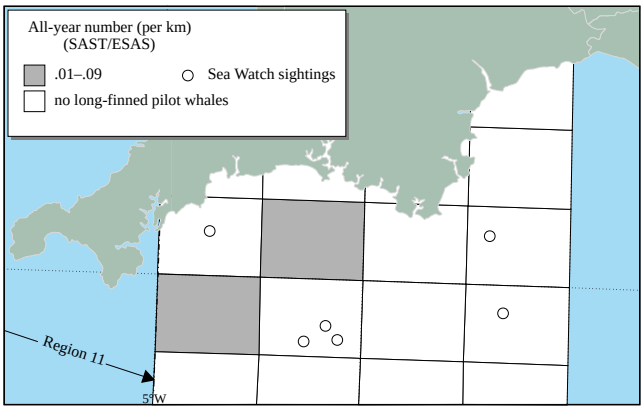
ASCOBANS (Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas) is an international agreement under the Bonn Convention between countries bordering the North and Baltic Seas, with the aim of promoting the conservation of small cetaceans. It was ratified by the UK in 1993. Participating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

Cetaceans in the region face three potential 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).

Several ports along the south Devon and Cornwall coasts have fishing fleets. Most important of these are Brixham and Plymouth, but others include Falmouth, Megavissey, Torquay, Teignmouth and Exmouth. There have been several reports of small cetaceans (mainly common dolphins and long-finned pilot whales in autumn and winter) being killed accidentally in fishing gear, primarily involving gill nets bottom set around wrecks, although bottom trawls and beam trawls may bring up already dead animals. Actual figures on catch levels are not



Map 5.15.3 Common dolphin: all-year numbers sighted per kilometre of Seabirds at Sea survey (source: JNCC SAST/ESAS); and sightings reported to the Sea Watch sighting system (source: Evans (1992)).



Map 5.15.4 Long-finned pilot whale: all-year numbers sighted per kilometre of Seabirds at Sea survey (source: JNCC SAST/ESAS); and sightings reported to the Sea Watch sighting system (source: Evans (1992)).

available. Between January and March of 1992, 118 dolphin carcasses (of which 54 were positively identified as common dolphins) were found stranded on the coast of Cornwall and Devon. Of 38 dolphins examined for cause of death, 30 showed signs associated with incidental capture in fishing gear (Kuiken *et al*. 1994b). Skin lesions characteristic of capture in a small-meshed net and the predominance of recently ingested Atlantic mackerel *Scomber scombrus* and pilchard *Sardina pilchardus* in the stomachs of the dolphins suggested that they had been caught in the trawl or purse seine nets used for these fish. The geographic location of capture is not known but there is an intense multi-national fishery for these two species of fish in the south-west approaches to the English Channel.

Contaminant levels in cetaceans from the region are low, though generally higher than in other regions of the UK. Mean total PCB (25 congeners) levels of nine harbour porpoises sampled from the south coast of England (Sussex to Cornwall) in the period 1988-92 amounted to 31 ppm (Kuiken *et al*. 1994a). Eight common dolphins sampled in 1990-1991 and eleven in 1992 gave mean values of 50 ppm and 31 ppm total PCBs respectively (Kuiken *et al.* 1994b). Trace metal contaminant levels of five common dolphins stranded along the south coast of Devon and Cornwall in 1992 were generally low, only zinc (at 46 ppm) having a mean value exceeding 5 ppm.

Recreational activities (speedboats, jet skis etc.) in the vicinity of Carrick Roads, Plymouth Sound, Salcombe, Start Bay and Torbay and to a lesser extent resorts such as Falmouth, St. Austell, Fowey, Bigbury Bay, Brixham and Exmouth/Exeter pose threats of direct physical damage from collisions and disturbance from the high frequency (>1 kHz) noise generated by these vessels (Evans *et al.* 1992). Heavy shipping may also disturb cetaceans. Sound frequencies produced by ships' engines overlap those used by cetaceans, particularly baleen whales (not resident in or a regular visitor to this region), but also dolphins and porpoises when cavitation of the propeller occurs. Negative responses (vessel avoidance and increased dive times) to such sounds by both bottlenose dolphins and harbour porpoises have been reported by Evans *et al.* (1992, 1994). Other underwater sounds from seismic activities (as part of oil and gas exploration in the Channel) are at lower frequencies (20-500 Hz) and are therefore most likely to affect baleen whales, which communicate primarily at these frequencies. It is possible that porpoises are also affected (Baines 1993), perhaps through changes to the distribution of their fish prey (Evans 1996). A code of conduct for boat users has been produced (Seawatch Foundation & UK Mammal Society 1992).

Table 5.15.1 Cetacean species recorded in the region

Species	*Status, distribution and seasonal occurrence*
Long-finned pilot whale *Globicephala melas*	Present mainly offshore, sometimes in large numbers, particularly in November and December
Harbour porpoise *Phocoena phocoena*	Uncommon, occurring in small numbers in nearshore waters, mainly between October and December
Bottlenose dolphin *Tursiops truncatus*	In recent times, recorded regularly only since 1990 and now the most frequently observed dolphin in nearshore waters, though rarely in groups exceeding ten individuals. Peak numbers and frequency of sightings occur between March and August: this may vary from year to year.
Common dolphin *Delphinus delphis*	The commonest dolphin in the region, occurring mainly offshore. Peak numbers and frequency of sightings between August and December.
Striped dolphin *Stenella coeruleoalba*	Rare, but recorded annually in the Channel in very small numbers, between September and December
Risso's dolphin *Grampus griseus*	Uncommon, occurring in nearshore waters mainly in the months of April and September
Killer whale *Orcinus orca*	Rare, occurring mainly between September and November

5.15.4 Information sources used

Information on cetacean status and distribution comes primarily from the national sightings database (1973-present) maintained by the Sea Watch Foundation (SWF) and the strandings scheme organised by the London Natural History Museum (1913-present). Systematic land-based watches have been carried out at Berry Head and Prawle Point along the south Devon coast. Sea-based coverage is generally better in nearshore waters than offshore, although this is changing following emphasis upon greater all-round coverage using observers aboard fishing vessels. Observations are made monthly from the Plymouth to Santander ferry. Effort has been highest between the months of April and September when sea conditions are also usually best, although several species are most frequently seen in late autumn or early winter. JNCC's Seabirds and Cetaceans at Sea Team (SAST) has only limited survey information on cetaceans in the English Channel. Strandings and sightings data, while helpful in providing some indications of current status of populations, their distribution and migration patterns, do not as yet allow any definite statements to be made about any species.

A major international collaborative programme, the Small Cetaceans Abundance in the North Sea (SCANS) Project (which includes this region), aims to provide an authoritative baseline assessment of abundance based on intensive survey work in summer 1994.

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, N. Fletcher, J. & L. Hingley, R.J. Law, J. Ramster, F. Scampton, C. Speedie, M.L. Tasker, N. Tregenza and A. Webb.

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Tregenza, N. 1992. Fifty years of cetacean sightings from the Cornish coast, SW England. *Biological Conservation, 59:* 65-70.

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 0X1 3PS, tel: 01865 727984
Cetacean sightings & surveys	*Seabirds & Cetaceans Branch, JNCC, Aberdeen, tel: 01224 655700
Cetacean land-based watches	C. Speedie, Sea Trident Ltd, 4 Carlton Place, Teignmouth, Devon TQ14 8AB, tel: 01841 521162
Cetacean organochlorine & heavy metal levels	*Dr R.J. Law, MAFF Directorate of Fisheries Research, Fisheries Laboratory, Burnham-on-Crouch, tel: 01621 782658

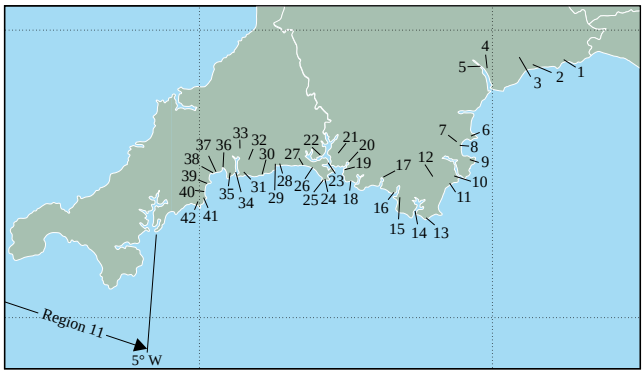
* Starred contact addresses are given in full in the Appendix.

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 be unwittingly 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, gives information on the provisions for safeguarding known and unknown sites, and describes the extent of survey work and how to report new discoveries. Map 6.1.1 shows archaeological locations mentioned in the text, numbered as in Table 6.1.1.



Map 6.1.1 Archaeology: locations mentioned in the text. Site names are listed in Table 6.1.1.

Table 6.1.1 Key to numbered locations on Map 6.1.1

Number	*Location*	*Number*	*Location*
1	Branscombe	22	Saltash
2	Sidmouth	23	Millbrook Lake
3	Hembury	24	Cawsand
4	Topsham	25	Rame Head
5	Exeter	26	Whitsand Bay
6	Torquay	27	Portwrinkle
7	Paignton	28	Millendreath
8	Goodrington	29	Looe
9	Brixham	30	Polperro
10	Dartmouth	31	Polruan
11	Blackpool	32	Lerryn
12	Halwell	33	Lostwithiel
13	Prawle Point	34	Fowey
14	Salcombe	35	Polkerris
15	Bantham	36	Par
16	Bigbury Bay	37	Charlestown
17	Oldaport	38	St. Austell
18	Heybrook Bay	39	Pentewan
19	Mount Batten	40	Mevagissey
20	Cattewater	41	Gorran Haven
21	Plymouth	42	Dodman Point

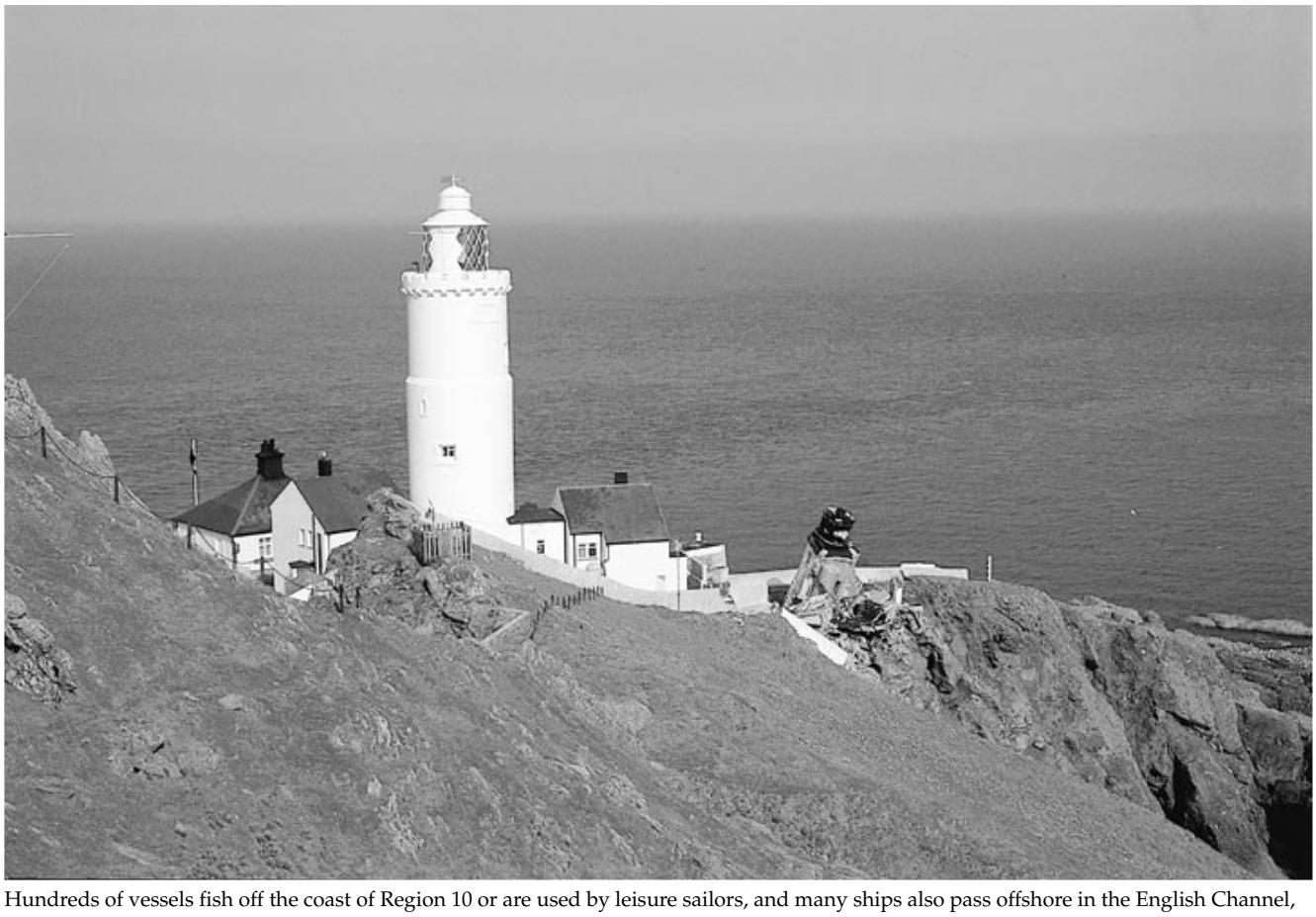
The discrete prehistoric sites in this region must be interpreted within a framework of changing sea levels; the most recent rise, following the end of the last ice age, inundated the former coastal plain and river valleys. Information can be drawn from palaeo-environments, the landscapes of prehistory. These survive as waterlogged peat and forest in intertidal and subtidal zones. Such deposits have been observed at Torre Abbey Sands (Torbay), Goodrington Sands, Blackpool, Bigbury Bay, Millendreath Bay and Readymoney (Fowey) (Johnson & David (1992) provide a list of Cornish sites). Analysis of plant remains helps to reconstruct environments, as changing plant populations reveal patterns of animal husbandry, cultivation or woodland management. Artefacts of Mesolithic to Roman date have been found on the submerged deposits and provide direct evidence of man's presence. The submerged forests and discrete prehistoric sites extend into the sub-tidal zone.

Since the end of the 18th century, with the emergence of resorts such as Sidmouth and Torquay, the region has grown in popularity as a holiday destination. The tourist image of unspoilt countryside belies the level of industrial activity. Minerals including tin, copper, china clay and granite have been mined or quarried for export and, since at least the 16th century, the fishing fleets have served not only home consumption but also export markets. It is no surprise therefore that settlements are now concentrated on the estuaries of rivers, such as the Axe, Exe, Dart, Plym and Fowey, or that small harbours occupy breaks in the cliffs to the west, for example at Polperro, Mevagissey and Gorran Haven. Over the millennia of prehistory the resources of the region were no less available, and the maritime routes no less important, than they are today.

The region is rich in post-Medieval and Modern fortifications and industrial remains linked to maritime activity. The latter include: protective piers, slipways and winches, harbour complexes, pilchard cellars, quarries and mines, lime kilns, lifeboat stations and coastguard look-outs. The missing element of this maritime panorama is the diverse shipping of the past. Hulks of abandoned vessels can be found in the intertidal area, particularly on rivers and estuaries. These are often the remains of undocumented local craft that worked along the coast and inland, but little has so far been done to record this resource (Devon County Council 1995).

Shipwrecks are, however, predicted to be the most numerous site type. Most located shipwrecks around Britain are metal ships that sank in this century. They usually stand proud of the sea bed and can be located by remote sensing equipment. The 16th century Cattewater wreck (Redknap 1984) proves that wooden hulls can survive in the sea bed, while cargoes discovered at Salcombe and in

the Erme Estuary provide information on prehistoric and early historic trade. Records of losses, which show the potential for ship sites to be found, are comprehensive for the 19th century, relatively complete for the 18th, and patchy for the 14th to 17th centuries. For earlier periods it is necessary to examine documentary evidence for sea-borne trade and extrapolate the extent of ship losses by considering the hazards to navigation. This process has then to be extended into the prehistoric period by looking at archaeological evidence for trade and seafaring.



Hundreds of vessels fish off the coast of Region 10 or are used by leisure sailors, and many ships also pass offshore in the English Channel, one of the busiest waterways in the world. However, the rocky shoreline of much of the region is notoriously dangerous for shipping. Lighthouses, such as this at Start Point, have been a feature of the coast for centuries. Photo: Pat Doody, JNCC.

6.2 History and archaeology of the region

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

Flint tools found from the Devonshire valleys of the Axe, Otter, Culm and Exe show that these locations were used by Palaeolithic hunting groups during the last glaciation. Although occupation sites from the Palaeolithic era are rare, Kent's Cavern near Torquay is one of the few surviving in Britain in which flint axes have been found in association with the remains of animals that became extinct over 400,000 years ago. Harpoons and needles dating back to around 12,000 BC found in Kent's Cavern showed that man was once more exploiting the environment as the climate warmed after the last Ice-Age. At this time, early Mesolithic hunter-gatherers used the estuaries and low-lying coastal plains of the region. Mesolithic tools of flint and antler found at submerged sites near Torbay, together with material from sites that today are on cliff edges, such as at Boulberry Down and Rame Head, suggest the existence of occupation. These sites were used prior to the rise in sea level that flooded the coastal plains and severed Britain from Europe. As the coastal plains reduced, more settled methods of subsistence were adopted as cultivation was developed. Above the River Otter at Hembury, spelt (a type of wheat) has been excavated from storage pits constructed by these Neolithic farmers. The tools of the period are characterised by stone axes, and finely crafted and highly polished examples suggest that a special value was placed on these tools. Across Britain the discovery of axes manufactured from the igneous rocks of this region is evidence of extensive communication systems. The more complex structure of communities is also suggested by the construction of communal stone burial monuments, commonly known as long cairns. At High Peak, near Sidmouth, Neolithic occupation of a cliff-top defensive site has been found.

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

Cultural development in the 2nd millennium BC is signified by a change in burial monument, favouring round barrows in place of long cairns. The undeveloped uplands of Dartmoor and Bodmin preserve some of the country's best examples of the field systems and huts used by the contemporary communities. A number of sites lie close to the present cliff top, for example cairns made during field clearance at Branscombe, a possible round barrow at Berry Head, a midden at Mount Batten and two barrows at Dodman Point. Intertidal finds from Torbay may relate to now inundated areas.

New metal-working technology was providing tools and weapons of copper and tin alloy. With Cornwall and Dartmoor among the few north European sources of tin, the region has produced evidence of maritime trade in both manufactures and raw materials. A collection of bronze swords, of French and German origin, from the sea bed at Salcombe has been interpreted as a cargo - one of only two Bronze Age shipwrecks discovered in British waters (Muckelroy & Baker 1979). An unparalleled copper ingot, reminiscent of Bronze Age ingots from the Mediterranean, was recovered off Looe Island (Tylecote 1984).

The technological move to iron-making is traditionally associated with a cultural change in which large social groups occupied hilltops or promontories, such as Berry Cliff Camp near Sidmouth, Berry Head, Hembury, Castle Head at Dartmouth, Mount Batten, Rame Head and Dodman Cliff. The massive surrounding earthworks have given these sites the name of hillforts or cliff castles, but excavation has shown them to be social and trading centres, the focal point of settlement and community. Mount Batten, for example, was an active port.

6.2.3 The Roman province

The Fosse Way marked the limit of the first phase of the Roman occupation of Devon and Cornwall. The siting of a military establishment on the Exe, and possibly a port at Topsham, at the road's southern terminus, underlines the importance of sea transport to supplying the frontier army.

Excavation at Hembury has shown that such fortified sites were subdued and then occupied by the Romans. Finds of Roman date, especially coins, from the vicinity of Sidmouth, Berry Head in Tor Bay, and Berry Hill near Brixham reveal similar continuity of occupation and possibly of trading contact. Tin ingots, at least a dozen of which have been found in Cornwall, are a further indicator of industry and trade. The discovery of contemporary shipwrecks would greatly increase the understanding of the region's maritime trade. A group of pewter flagons from Goodrington Bay, Paignton, coins from Heybrook Bay in Plymouth Sound and seven contemporaneous 3rd century coins found in Whitsand Bay perhaps derive from such shipwrecks.

6.2.4 Roman departure to Norman conquest

The Roman occupation appears to have had little long-term effect on the region. The civilian population had continued to occupy enclosed farming homesteads, which developed into a characteristic layout known as courtyard houses. These are commonly found in areas of Medieval farming. An example with occupation from the 3rd century has also been excavated close to the coast at Trethurgy, St. Austell. In Devon rectilinear enclosures take the place of the round earthworks of Cornwall. Old strategic fortified sites above waterways and estuaries came into use after the Roman withdrawal. Hembury Fort and Bantham Camp at the mouth of the Avon were, for example, occupied during the 5th and 6th centuries.

Oldaport on the River Erme may have served a similar trading function to that hinted at by finds of imported pottery at Hembury and Bantham. Excavations on the site proved inconclusive but the estuary itself has provided

evidence of contemporary trade. Pottery and ingots from an intertidal site may indicate trade from the Mediterranean. Tin ingots from a nearby possible wreck site may be contemporary or older (Oldham *et al.* 1993), which suggests that the tin trade, which had been dominated by Spanish tin in the Roman economy, was regaining importance in the region.

The spread of Christianity is not clearly chronicled. Small monasteries appear to have been a focus for secular settlements. Many lay on communication routes, either along the coast or on river valleys. In addition to religious influences, from the 7th century the region was being drawn under the control of Saxon Wessex. The end of the struggle for an independent British kingdom in Cornwall is marked by the battle of 838. Soon after this date, however, the region was targeted by Viking raids. The defensive system devised by King Alfred for Wessex was based on establishing strongholds, called burghs. In this region these were close to estuaries at Exeter and Halwell; on a tributary of the Tamar at Lydford; possibly at Kingsteignton, which was burnt by the Vikings; and at Oldaport.

6.2.5 Medieval period

Maritime trade was an important factor in the growth of towns in the region. Raw materials provided outward cargoes which were often shipped from high up the estuaries. Slate was carried from Cornwall and Devon to roof Norman castles; the products of silver and lead mines were shipped down the Tamar, and tin was carried from Saltash and Lostwithiel, which were notable ports. Waste material from tin workings was a major factor in the silting of such ports, which as a result were eclipsed in the 13th century by down-river ports such as Dartmouth, Plymouth and Fowey. Exeter secured its place in maritime trade by constructing one of Britain's earliest canals in 1563, which permitted transhipment from Topsham by barge, and, with later improvements, access for sea-going vessels.

In the 15th century the ports of this region were among the foremost in the country: in addition to visits by foreign ships they were home to a growing English shipping interest. Lyme received cargoes from Channel Island ships and Exeter and Dartmouth were particularly notable for their home fleets of balingers and spinaces (Burwash 1969), a class of merchant ship. The appearance, construction and performance of these regional vessels, and others known only from documents, will always be a mystery unless their remains can be discovered and archaeologically investigated. Ports received from Brittany, Biscay and Spain cargoes including salt, canvas, wine, woad, alum, fruit, soap, sugar and almonds, whilst exporting tin and cloth. Engaged in similar trades, Plymouth and Fowey also exported hides, lead and pewter. Coastal trade expanded in the 17th and 18th centuries. The ports received coal from south Wales and the north-east coast and exported a variety of Cornish and Devonshire products, such as cloth, tin and cider, along with re-exports such as Norwegian timber and Portuguese goods.

Coastal salt production, particularly in East Devon, enabled fish to be preserved and fishing to develop into an important economic activity. From the 14th century written sources mention a number of fishing communities including Millbrook Lake, Cawsand Bay, Portwrinkle, Polperro, Polkerris and Mevagissey. The latter, for example, had a stone pier built in 1430 to shelter the fishing boats. The export of cargoes of fish to the Mediterranean is documented from at least the 1570s, when the taxes levied on them were sufficient to pay for a fort at Plymouth (Scantlebury 1993). This date coincides with the construction of special facilities for preserving pilchards known variously as pilchard cellars or palaces. A number were built at Cawsand in the 1580s, though most surviving examples date from the 18th century. In 1785 some 3,500 men were employed annually in the pilchard fishery (Pounds 1944).

Maritime trade, with its direct influence on national prosperity and overseas interests, conferred a strategic importance on the region. Land-based defences on the estuaries and rivers were constructed and strengthened. Dartmouth Castle, for example, was given innovative gun ports during construction in 1481. Henry VIII continued this trend of improvements by upgrading castles and defences around Plymouth Sound and the Dart. Fowey and Polruan also received defences. The former was an early base for pirates and the importance of west country privateering activity under Elizabeth I is well-known. The formal naval dockyard was established at Plymouth in 1691 and a ordnance yard constructed between 1720 and 1724. Plymouth was also the key victualling centre for western squadrons and foreign naval bases during the many conflicts of the 18th century.

6.2.6 Post medieval and modern times

Mineral export and fishing remained the focal economic activities of the region during the 19th century. This is reflected in the character of the ports and harbours, which fall into two groups. The pier ports, so-called after the protective piers, which provide shelter on relatively inhospitable stretches of coast, had no true hinterland, being built either for a single export such as granite or copper ore, or purely as a haven for a fishing fleet. Their location and scale afforded no chance of diversification should their primary function become obsolete. The planned harbours of Charlestown (1791), Pentewan (1818) and Par (1820) were built primarily for the export of china clay. Their entrepreneurial founders set up subsidiary industries such as brick making, lime burning and rope-making. While Pentewan and Par succumbed to silting, which resulted partly from waste carried downstream from tin and china clay works, Charlestown was flushed by the River Par through a specially constructed culvert (Luck 1988). Today china clay remains a staple export for Fowey, Par and Charlestown.

In addition to the pier ports and planned harbours, estuaries such as the Exe, Dart, Tamar and Fowey continued to enjoy maritime activity. Schooners were built at many sites, for employment in the Mediterranean trade, especially the carriage of fruit. The rivers also provided access to rural areas. Upriver quays were used to unload coal from south Wales and limestone from Devon, which were burnt in quayside kilns, for example at Lerryn on the Fowey, to provide lime for improving agricultural land.

Pilchards were the primary catch of the region. They had been exported since the 16th century; the domestic market for pilchards increased in 1859 on the arrival of the

Great Western Railway, which provided rapid transport to inland population centres. In 1870, however, the fishery collapsed, resulting in the decline of many small harbours, although Brixham harbour continued to enjoy a booming fishing industry. Its sailing trawlers were engaged in deep-sea fisheries and worked around the coast of Britain and further afield. The decline of the later steam fleets resulted from losses in the 1914-1918 War and the change to motorised trawlers.

The region's continued importance to British naval strategy is underlined by investment in Plymouth. The Royal William Victualling Yard was built between 1822 and 1832. It was designed and built by Rennie the Younger, who had just completed the massive breakwater for Plymouth, the construction of which he had taken over on the death of his father. Improvements continued in Devonport Dockyard, with, for example, a slipway built in 1774-5 being roofed in timber in the early part of the century. This slipway is one of the few original structures in the dockyard to have survived the Second World War bombing of Plymouth. The ordnance and victualling yards suffered less damage and are noted for the preservation of a number of unique dockyard facilities and architectural features (Coad 1983). In the 1860s a perceived threat from France induced Palmerston to implement extensive defensive works based on coastal forts such as that at Bovisand.

6.3 Human activities

6.3.1 Activities and processes affecting the archaeological resource

The region's archaeological resource does not consist entirely of discrete sites such as intact wrecks. Many sites are scattered. Some sites, including palaeo-environments, are extensive and straddle the terrestrial, intertidal and subtidal zones.

Coastal sites are sensitive to both natural and human influences. The impact of past, large-scale quarrying can be seen at sites such as Mount Batten. Cliff erosion can threaten sites such as promontory forts and field systems, while erosion of sand dunes, such as those at Bantham Hams, both reveals and destroys archaeological deposits.

The decline of the fishing industry has left many small harbours redundant. These are targets for redevelopment to support economic regeneration. Projects to change the use of buildings or encourage access for tourists require skilful planning to permit new activities while retaining the character and fabric of historic buildings and structures. Medieval waterfronts are often located beneath later urban areas. Such sites have been excavated at Exeter. The silting of estuaries means that Medieval quays may also be preserved, possibly beneath dry land, in areas that did not feature in the maritime activity of the last few centuries. Modern engineering, such as flood prevention work at Millendraeth, can similarly divorce structures from their functional setting.

Sites in the intertidal and subtidal zones are also exposed to potentially damaging human activities. Construction of outfalls and sea defences, dredging, ship wash, salvage diving, the use of some types of fishing gear and the activities of individuals, such as bait digging and metal detecting, have all given cause for concern. On the sea bed, incidental recovery of artefacts is often the only indication of an impact on an archaeological site; for instance, capital dredging accidentally recovered the first timbers of the Cattewater wreck (Mortlock & Redknap 1978). Unfortunately, too little survey work on intertidal and subtidal sites has been completed to allow the influence of these diverse activities to be quantified.

6.3.2 Protection of sites, monuments and wrecks

In this region, three statutory designations are intended to protect *in situ* remains of archaeological or historic importance. The Ancient Monuments & Archaeological Areas Act 1979 provides for Scheduled Ancient Monuments (SAMs). The AMAA definition of monument includes sites both on land and in UK territorial waters, including remains of vehicles, vessels and aircraft. In practice, however, scheduling has been applied only above low water mark (Firth 1993). 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.

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

Location	*No. of SAMs*
Devon (south coast)	**161**
East Devon	26
Exeter	0
Teignbridge	20
Torbay	9
South Hams	33
Plymouth	73
Cornwall (part)	**91**
Caradon	50
Restormel (south coast)	34
Carrick (part)	7
Region 10	***252***

Source: English Heritage county lists of Scheduled Monuments, Devon and Cornwall (1994).

There is a published list of criteria for determining the national importance of a monument (DoE 1990). The number of scheduled sites is being increased as a result of a review - the Monuments Protection Programme. In 1990, Cornwall had the greatest number of scheduled sites of any English county (Johnson & Rose 1990). Table 6.3.1 shows the numbers of coastal SAMs in this region.

The Town & Country Planning (Listed Buildings and Conservation Areas) Act 1990 provides for Listed Buildings - buildings considered of special architectural or historic importance. Listed buildings in this region include maritime structures such as elements of the Royal William Victualling Yard, lime kilns and pilchard cellars. 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 (DoE 1994).

The Protection of Wrecks Act 1973 provides for the designation of shipwrecks of national importance for their artistic, archaeological or historic value. Archaeological investigation is permitted only under licence from the Department of National Heritage. 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. Table 6.3.2 shows the seven wrecks that have been designated within the region (Archaeological Diving Unit 1994). However, as fewer than 45 wrecks have been designated for the whole of Britain, their distribution cannot be accepted as a reasonable guide to the total sea-bed resource (see section 6.4).

6.3.3 Key organisations and their responsibilities

English Heritage and the Department of National Heritage are responsible for sites protected under, respectively, the Ancient Monuments & Archaeological Areas Act (1979) and the Protection of Wrecks Act (1973). English Heritage

Table 6.3.2 Historic wrecks designated in the region

Name	*Location*	*Grid ref.*	*Description*	*Designation order*
Cattewater Wreck	Cattewater, Plymouth	SX487535	Merchant ship lost *c.* 1530	1973 No. 1 (1973/1531) 1975 Amendment Order (1975/262)
Church Rocks Wreck	Teignmouth	SX947732	Possibly 16th century	1977 No. 2 (1977/1357)
Moor Sand Wreck	Prawle Point, Salcombe	SX759361	Bronze Age implements	1978 No. 1 (1978/199)
Coronation	Penlee Point, Plymouth	SX439486	90 gun 2nd rate warship lost 1691	1978 No. 2 (1978/321)
Coronation	Penlee Point, Plymouth	SX439486	Offshore section of above	1988 No. 1 (1988/2138)
Erme Estuary Wreck	Erme Estuary	SX609471	Unidentified vessel; artefacts from 16th-18th centuries	1991 No. 1 (1991/1110)
Erme Ingot Site	Erme Estuary	SX606466	Tin ingots cargo	1993 No. 3 (1993/2895)

Source: Department of Natural Heritage; grid references: RCHME.

inspects monuments, assists owners by drawing up management agreements supported by grants and directly manages those monuments in guardianship. It also funds rescue archaeology and related research projects.

The Royal Commission on the Historical Monuments of England (RCHME) has a statutory responsibility for the survey and inventory of archaeological sites in England. It maintains a computerised database of archaeological sites: the National Monuments Record (NMR). In 1992 new Royal Warrants extended the remit of RCHME to the territorial seas and a Maritime Section has since been added to the NMR. RCHME is the lead agency overseeing data standards in local archaeological databases - Sites and Monuments Records (SMRs) - which are usually maintained at local authority level.

Devon and Cornwall County Councils have archaeological officers and maintain SMRs. Plymouth and Exeter City Councils also have archaeologists who, through a reciprocal arrangement with the county SMR, fulfil a role in local development control. The role of SMRs as a source of information for planning authorities was recently confirmed (DoE 1990).

6.3.4 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 SMR, 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 presumption in favour of preservation *in situ* has been extended to Listed Buildings and their settings (DoE 1994).

Planning decisions should take into account more detailed policies, which appear in Development Plans. The Structure Plans of Devon and Cornwall, and the Local Plans of their constituent districts, include general policies relating to archaeology. Further policies and information relating to archaeology appear in a variety of local and/or site management plans. Devon County Council, for example, has produced a Coastal Statement, which includes a chapter on archaeology (Devon County Council 1995), and a strategy for landscapes, which identifies archaeological sites and historic settlements as characteristic features of certain zones. The zones include seventeen coastal areas (Devon County Council 1994). The Cornwall Archaeological Unit (CAU) contributes to the care of archaeological sites within an integrated management approach by contributing to the activities of initiatives such as the Fowey-Lynher and the Dodman-Fal Estuary Countryside Services. Other bodies with responsibilities for managing the coast, such as the National Trust, also often include archaeological considerations in their policies.

For certain types of development (listed in Schedules 1 and 2 to the Town & Country Planning (Assessment of Environmental Effects) Regulations 1988), formal Environmental Assessments may be necessary. This should include information on any effects on the cultural heritage.

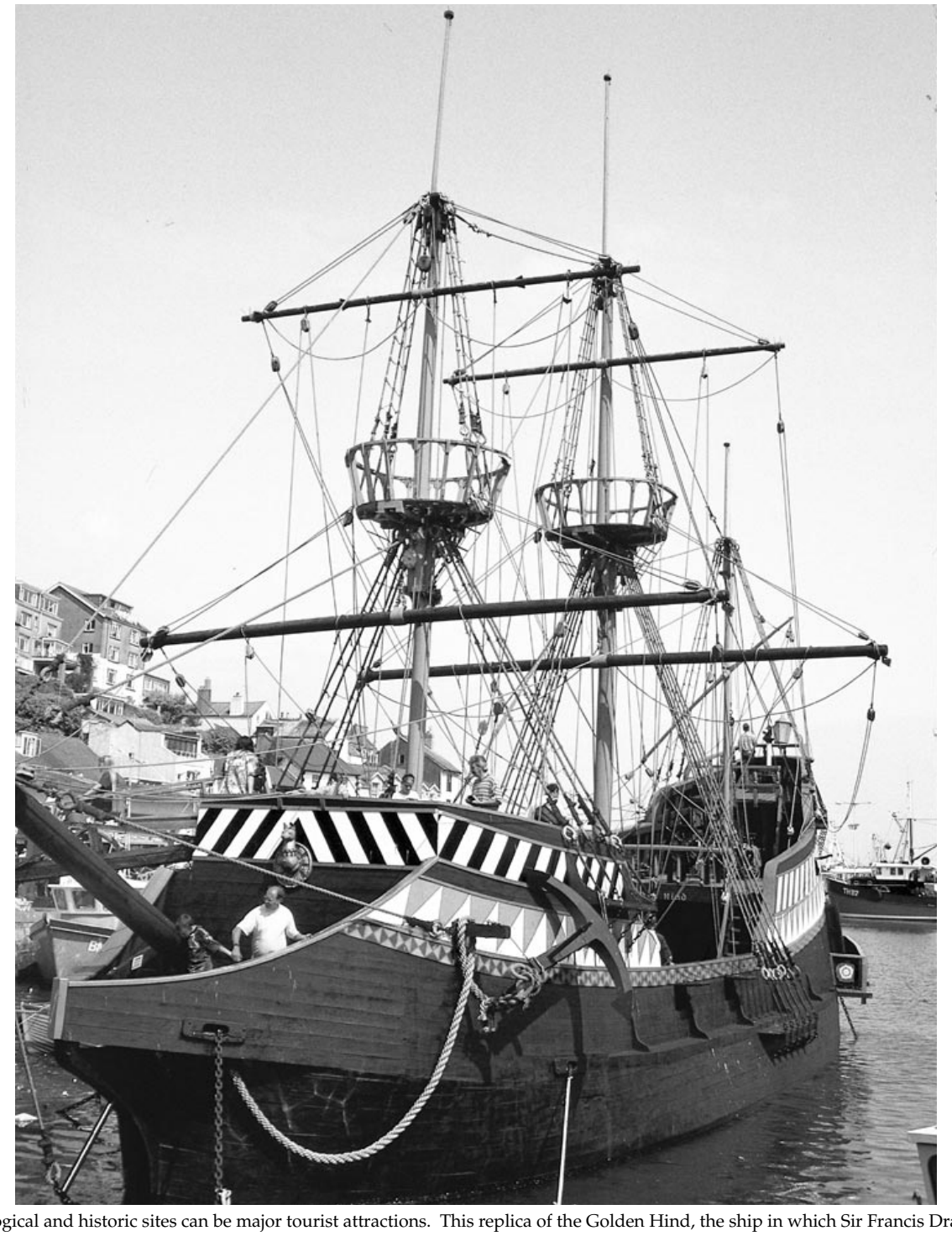
To seaward of low water mark there is a sectoral approach to development control (DoE 1993). Regulation, including requirement for Environmental Assessment, is divided between a range of government departments and agencies. Until recently, the lack of information on the extent of the resource and the absence of a management structure for archaeology in the subtidal zone had precluded its consideration by many local authorities. However, growing awareness of marine archaeology is leading to voluntary consideration of the archaeological resource. Such practice is encouraged by a new *Code of practice for seabed developers* (Joint Nautical Archaeology Policy Committee 1995).

6.3.5 Reporting archaeological information

The Royal Commission on the Historical Monuments of England (RCHME) and the Sites and Monuments Records (SMRs) are the accepted reporting points for new archaeological information, although there is a legal requirement to report archaeological and historical artefacts only when the objects fall within the laws on either Treasure Trove or Salvage. 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 British Museum, the police or the coroner. Should a coroner's inquest then declare the objects Treasure Trove,

the British Museum may retain them and, in return, make an *ex gratia* payment to the finder.

The Merchant Shipping Act 1894 requires any recovered wreck to be reported to the Receiver of Wreck. Wreck is now defined as any ship, aircraft, hovercraft or parts of these, their cargo, or equipment, found in or on the shores of the sea, or any tidal water. The Receiver provides advice and supplies forms for reporting recovered wreck. These include a form which finders may use to volunteer to the RCHME information on the identity and condition of wreck sites. The Receiver advertises reported wrecks, regardless of age, in order that owners may claim their property. After one year, an unclaimed wreck becomes the property of the Crown and is disposed of in order to pay the expenses of the Receiver and any salvage awards. During the statutory year, such items may be lodged with an appropriate museum or conservation facility with suitable storage conditions. There is a policy of offering unclaimed wreck of historic, archaeological or artistic interest to registered museums. Finders are often allowed to keep unclaimed wreck in lieu of a salvage award. The responsibility of the Receiver to the finder, with regard to salvage awards, remains regardless of the historic character of the wreck. Forms for reporting recovered wreck are available from the Receiver. These include a section in which finders may report the location and condition of wreck sites to RCHME.



Archaeological and historic sites can be major tourist attractions. This replica of the Golden Hind, the ship in which Sir Francis Drake circumnavigated the world between 1577 and 1580, is a well known sight in Brixham Harbour. Photo: Pat Doody, JNCC.

6.4 Information sources

6.4.1 Information gathering and collation

The rapid compilation of records for the National Monuments Records - Maritime Section, RCHME, was completed in 1995. The records have been compiled from the Hydrographic Department Wreck Index (see Table 6.4.1). This lists mainly 20th century shipwrecks and unidentified sea-bed obstructions. To these will be added records of shipping casualties and details of finds made by fishermen and divers.

English Heritage and the RCHME have commissioned a project, England's Coastal Heritage, which will inform the development of a strategic approach to survey, recording and management. The latter element is examining the relationship between archaeology and current developments in the management of the coast. Under the project, the Aerial Photographic Unit of RCHME is investigating the feasibility of using aerial photographs for intertidal survey, and Reading University is producing a synthesis of information within the National Monuments Record (NMR), Sites and Monuments Records (SMRs) and published sources.

There has been limited archaeological survey thematically or geographically directed at the coastal land of this region. In Devon site-specific work has occurred at some places, including Bantham Hams, where sand dune erosion is affecting archaeological deposits. The Cornwall Archaeological Unit is considering the need for a coastal audit of Cornwall, but work to date has been confined to a rapid identification survey for RCHME which included the banks of the Tamar from Calstock to Saltash; a Historic Landscape Assessment commissioned by the Countryside Commission and English Heritage included characterisation of the whole coast and survey of fortifications in Plymouth.

Private researchers have compiled records of abandoned and wrecked vessels in the intertidal area (see for example Langley & Small 1988). The SMRs include a small number of intertidal and submerged sites of a terrestrial nature but at present only Devon SMR has begun adding shipwreck sites. About 100 sites for the whole county have been drawn from published sources.

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

County	*Known wrecks*[1]	*Documented casualties*[2]	*Unidentified obstructions*[3]
Devon (south coast)	62	209	98
Cornwall (south coast)	27	303	39
Total	***89***	***512***	***137***

Source: RCHME (October 1994). Key: [1]primarily sites recorded on the Hydrographic Wreck Index; [2]historic records of ship losses; [3]net fasteners etc.

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. The authors are also indebted to Jane Tyson of Reading University, who made available information from the England's Coastal Heritage project.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Scheduled Ancient Monuments; Listed Buildings; designated wreck sites; rescue archaeology; management of monuments in care	Chief Archaeologist, English Heritage, 23 Savile Row, London W1X 1AB, tel: 0171 973 3000
Maritime archaeological sites; *Code of practice for seabed developers* (published by the Joint Nautical Archaeology Policy Committee)	Head of Recording (Maritime), National Monuments Record, Royal Commission on the Historical Monuments of England, National Monuments Record Centre, Kemble Drive, Swindon SN2 2GZ, tel: 01793 414600
Archaeological sites (general)	National Monuments Record, Royal Commission on the Historical Monuments of England, National Monuments Record Centre, Kemble Drive, Swindon SN2 2GZ, tel: 01793 414600
Devon SMR	*SMR Officer, Environment Department, Devon County Council, Exeter, tel: 01392 382266
Cornwall SMR	*SMR Officer, Cornwall Archaeological Unit, Cornwall County Council, Truro, tel: 01872 323606
Historic wreck sites	The Secretary, The Advisory Committee on Historic Wreck, Department of National Heritage, Room 306, 2-4 Cockspur Street, London SW1Y 5DH, tel: 0171 211 6369/6367
Reporting of recovered wreck	Receiver of Wreck, Coastguard Agency, Spring Place, 105 Commercial Road, Southampton S015 1EG, tel: 01703 329474
Reporting of Treasure Trove	The British Museum, Russell Square, Bloomsbury, London W1 3DG, tel: 0171 323 8629 (Medieval to Present), or 0171 323 8454 (Prehistoric to Romano-British)

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

Chapter 7 Coastal protected sites

R.G. 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. Data included in this section were last updated in September 1996, unless otherwise stated.

Statutory protected sites are those notified, designated or authorised under European Directives and/or implemented through British legislation (most notably the Wildlife and Countryside Act 1981) by a statutory body, thereby having recognised legal protection. 'Non-statutory sites' include a wide variety of sites that are not directly protected by legislation but which are recognised by statutory bodies or owned, managed or both by non-statutory organisations for their nature conservation or aesthetic value. Note that the categories of conservation protection (e.g. National Nature Reserve, RSPB Reserve) are not mutually exclusive. In many localities several different types of protected site overlap, since they have been identified for different wildlife and landscape conservation purposes. Patterns of overlap are often complex, since site boundaries for different categories of site are not always the same.

Further explanation of the various site protection mechanisms can be found in Davidson *et al.* (1991). Planning Policy Guidance Note (PPG) 9 - Nature Conservation (DoE 1994) also gives useful summaries of existing site protection mechanisms. It sets out the Government's objectives for nature conservation and provides a framework for safeguarding 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; the most common are Sites 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, which are covered in more detail 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 the Bonn Convention, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), parts of the Birds Directive and parts of the Habitats & Species Directive, are also not covered. For further information, see references in section 7.1.3 A.

This chapter is divided into five sections. A regional summary of all categories of site is given in Table 7.1.1. Section 7.2 covers those site-based protection measures falling under international conventions or European directives. Sites identified under national statute 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 finally, other types of sites (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

The region contains a large proportion by area of the coastal Local Nature Reserves (14%), Areas of Outstanding Natural Beauty (14%) and Heritage Coasts of Britain (10.5%). There are also substantial numbers of coastal Woodland Trust sites (28%), Sensitive Marine Areas (19%) and Voluntary Marine Nature Reserves (18%). 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. In April 1996 a World Heritage Site proposal was submitted for the coastal strip between Orcombe Point, near Exmouth, Devon, to Old Harry Rocks, Dorset, based on the area's remarkable geology and geomorphology.

Table 7.1.1 Summary of site protection in Region 10

	Number of protected sites					*Area covered by site protection*				
	Region	*North Sea coast*	*% of North Sea coast total in region*	*GB coast*	*% of GB coastal total in region*	*Region (ha)*	*North Sea coast (ha)*	*% of North Sea coast total in region*	*GB coast (ha)*	*% of GB coast total in region*
Ramsar sites	1	32	3.1	53	1.9	2,389	172,710	1.4	287,329	0.8
Special Protection Areas	1	44	2.3	78	1.3	2,389	183,468	1.3	306,711	0.8
Possible Special Areas of Conservation	2.5*	50	5.0	111	2.3	n/av	n/av	n/av	n/av	n/av
National Nature Reserves	2	43	4.7	81	2.5	513	35,069	1.5	87,221	0.6
Sites of Special Scientific Interest	45	552	8.2	1,198	3.8	8,123	330,389	2.5	703,844	1.3
Local Nature Reserves	12	69	17.4	94	12.8	1,886	8,731	21.6	13,300	14.2
Areas of Special Protection	1	14	7.1	23	4.3	n/av	n/av	n/av	n/av	n/av
Areas of Outstanding Natural Beauty	4	14.5	27.6	24	16.7	127,900	714,800	17.9	899,900	14.2
Country Parks	2	20	10.0	34	5.9	348	2,943	11.8	4,441	7.8
Geological Conservation Review sites	50	490	10.2	980	5.1	n/ap	n/ap	n/ap	n/ap	n/ap
Heritage Coasts	4.5+	17.5	25.7	45	10.0	161#+	649#	24.8#	1,539#	10.5#
Sensitive Marine Areas	5*+	16.5	30.3	27	18.5	n/av	n/av	n/av	n/av	n/av
Voluntary Marine Nature Reserves	2	9	22.0	13	15.4	n/av	n/av	n/av	n/av	n/av
National Trust sites	65[a]	190[a]	34.2[a]	453[a]	14.3[a]	4,629[a]	17,457[a]	26.5[a]	62,972[a]	7.4[a]
Royal Society for the Protection of Birds reserves	1	53	1.9	81	1.2	96	24,555	0.4	38,680	0.3
The Wildlife Trusts reserves	13	122	10.7	217	6.0	608	10,311	5.9	23,419	2.6
Ministry of Defence sites	5	65	7.7	110	4.5	485	34,449	1.4	53,409	0.9
Woodland Trust reserves	18	35	51.4	64	28.1	154	1,095	14.1	1,458	10.6

Source: JNCC. Key: n/ap = not applicable; n/av = not available; # = lengths (km); *site(s) lying partly within Region 9; half the area has been included in the total; +site(s) lying partly within Region 11; half the area has been included in the total; [a]includes National Trust for Scotland. Notes: site types not currently found in the region: World Heritage (Natural) Sites, Biosphere Reserves, Environmentally Sensitive Areas, Biogenetic Reserves, National Parks, Wildfowl and Wetlands 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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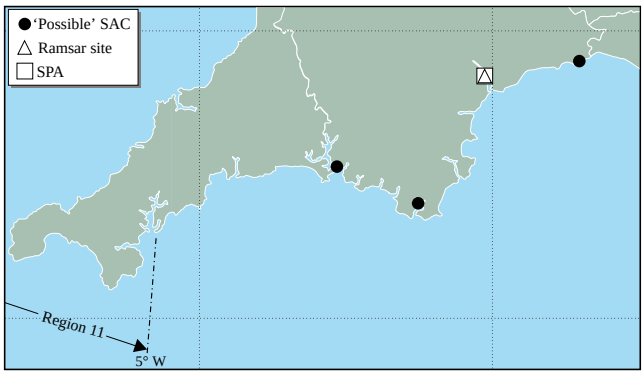
Marren, P.R. 1994. *England's National Nature Reserves.* Newton Abbott, David & Charles.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
World Heritage Site proposal (Orcombe Point, Devon, to Old Harry Rocks, Dorset)	Gordon LePard, County Planning Department, Dorset County Council, County Hall, Dorchester, Dorset DT1 1XJ tel: 01305 251000

7.2 Sites designated under international conventions and directives

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



Map 7.2.1 Ramsar sites, Special Protection Areas and 'possible' Special Areas of Conservation. Source: JNCC.

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 wetlands of international importance and to promote their conservation and 'wise use'. Ramsar sites are thus designated for their waterfowl populations, their important plant and animal assemblages, their wetland interest or a combination of these. There is one coastal Ramsar site (2,389 ha) in Region 10 (Table 7.2.1; Map 7.2.1). Table 7.2.1 summarises the interest for which the site has been designated and sections 5.10, 5.11 and 5.12 describe the importance of the site 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 of the statutory conservation agencies. This designation is implemented through the Wildlife and Countryside Act 1981; all SPAs have first to be notified as SSSIs. There is one coastal SPA (2,389 ha) in Region 10 (Table 7.2.2; Map 7.2.1). Table 7.2.2 summarises the interest of the site, and sections 5.10, 5.11 and 5.12 describe the importance of the site for the region's birds.

7.2.3 Special Areas of Conservation

The designation of Special Areas of Conservation (SACs) is one of the main mechanisms by which the EC Habitats & Species Directive 1992 will be implemented. They are areas identified as outstanding examples of selected habitat types or areas important for the continued well-being or survival of selected non-bird species. 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 Annex VI prohibits some means of capture or killing of mammals and fish. In the UK the Directive will be implemented through the Conservation (Natural Habitats etc.) Regulations 1994. A list of 'possible' SACs was announced by the Government on 31 March 1995. There are two whole and part of one other 'possible' SACs proposed for Region 10 (Table 7.2.3; Map 7.2.1) (see JNCC (1995) for more information).

Table 7.2.1 Ramsar sites

Site name	*No. of sites*	*Grid ref.*	*Area (ha)*	*Date designated*	*Qualifying interest*
Devon					
Exe Estuary		SX9884	2,389	1992	Regularly supports 20,000 waterfowl and 1% of a waterfowl species population
Region 10	***1***		***2,389***		
North Sea coast	35		172,710		
GB coast	58		287,329		
GB whole country	91		387,577		

Sources: JNCC, English Nature. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

Table 7.2.2 Special Protection Areas (SPAs)

Site name	*No. of sites*	*Grid ref.*	*Area (ha)*	*Date designated*	*Qualifying interest*
Devon					
Exe Estuary		SX9884	2,389	1992	Internationally important numbers of wintering dark-bellied brent goose; nationally important numbers of one wintering seabird species and seven wintering wader species
Region 10	***1***		***2,389***		
North Sea coast	54		183,468		
GB coast	93		306,711		
GB whole country	99		304,529		

Sources: JNCC, English Nature. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

Table 7.2.3 Possible Special Areas of Conservation (SACs) in Region 10

Site name	*No. of sites*	*Qualifying interest*
Dorset/Devon	**0.5**	
Sidmouth to West Bay*		Vegetated sea cliffs of the Atlantic and Baltic coasts
Devon	**1**	
South Hams		Greater horseshoe bat *Rhinolophus ferrumequinum*
Devon/Cornwall	**1**	
Plymouth Sound and Estuaries		Shore dock *Rumex rupestris*; estuaries; large shallow inlets and bays; sandbanks which are slightly covered by sea water all the time
Region 10	***2.5***	
North Sea coast	49	
GB	112	

Source: JNCC. Key: *partly within Region 9. 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 Acknowledgements

Thanks are due to Alan Law (JNCC) and Biotopes and International Policy Branches (JNCC).

7.2.5 Further sources of information

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Stroud, D.A., Mudge, G.P., & Pienkowski, M.W. 1990. *Protecting internationally important bird sites. A review of the EEC Special Protection Area network in Great Britain*. Peterborough, Nature Conservancy Council.

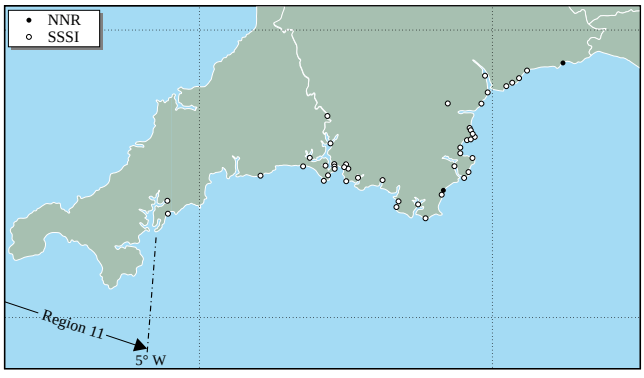
C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Ramsar sites, SPAs, Special Areas of Conservation (Devon)	*Conservation Officer, English Nature, Okehampton, tel: 01837 55045
Special Areas of Conservation (Cornwall)	*Conservation Officer, English Nature, Truro, tel: 01872 262550
Ramsar sites, SPAs	*Regional Officer, RSPB, South-west England Office, Exeter, tel: 01392 432691
Special Areas of Conservation - UK	*European Wildlife Division, DoE, Bristol, tel: 0117 987 8000

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

7.3 Sites established under national statute

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



Map 7.3.1 Coastal National Nature Reserves and Sites of Special Scientific Interest. Sources: English Nature, JNCC. Note: a single symbol may represent more than one site in close proximity.

7.3.1 National Nature Reserves

National Nature Reserves (NNRs) contain examples of some of the most important natural and semi-natural ecosystems in GB. 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 (in this region English Nature) under section 19 of the National Parks and Access to the Countryside Act 1949, or section 35 of the Wildlife and Countryside Act 1981. All NNRs are also Sites of Special Scientific Interest (SSSIs). There are two coastal NNRs (513 ha) in Region 10 (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 and 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 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 45 coastal SSSIs (8,123 ha) in Region 10 (Table 7.3.2; Map 7.3.1). Of the total land mass of Britain, 8.2% is SSSI, as at March 1995.

Of the 45 coastal SSSIs in the region, over three-quarters (79.5%) include intertidal land to mean low water mark, while only around one sixth (15.9%) are purely terrestrial. Over two-fifths were selected at least partly for their biological interest and nearly one half at least partly for their geological or geomorphological interest. Of the total, one fifth have both biological and earth science interest. Examples of a very wide range of habitats and species occur within the SSSIs in this region, the most frequently occurring habitats being saltmarsh, soft sea cliffs, dry grassland and woodland, all of which occur in between 18-23% of sites. SSSIs in the region include many sites of interest for their rare plants, terrestrial invertebrates and breeding seabirds. Further details of SSSIs may be found in the coastal and marine UKDMAP datasets module disseminated by JNCC Coastal Conservation Branch (BODC 1992; Barne *et al.* 1994).

7.3.3 Local Nature Reserves

Local Nature Reserves (LNRs) are 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 twelve LNRs (1,886 ha) in Region 10 (Table 7.3.3; Map 7.3.2).

Table 7.3.1 National Nature Reserves

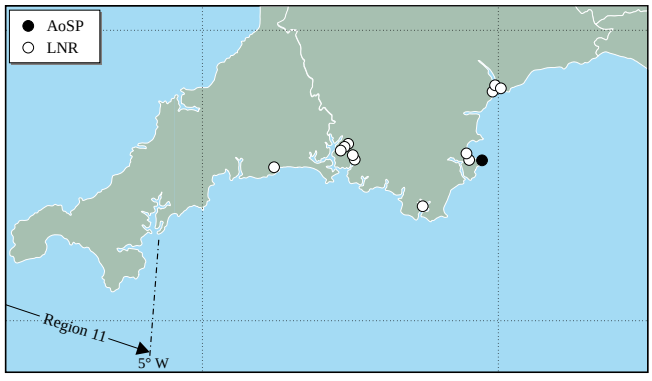
Site name	*No. of sites*	*Grid ref.*	*Area (ha)*	*Date last declared*	*Habitats*
Devon	**2**				
Axmouth-Lyme Regis Undercliffs		SY3290	321	1955	Woodland
Slapton Ley		SX825435	192	1993	Wetland, reedbeds, wet meadow, woodland
Region 10	***2***		***513***		
North Sea coast	43		35,069		
GB coast	81		87,221		
GB whole country	290		196,044		

Sources: English Nature, Devon Wildlife Trust. 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 10

Site name	*No. of sites*	*Grid ref.*	*Area (ha)*	*Date last notified*
Devon	**36**			
Axmouth to Lyme Regis Undercliffs		SY256896	168	1986
Sidmouth to Beer Coast		SY130873	239	1985
Ladram Bay to Sidmouth		SY096847	18	1986
Otter Estuary		SY073830	33	1986
Budleigh Salterton Cliffs		SY060815	11	1985
Exe Estuary		SX980845	2,182	1986
Dawlish Warren		SX985795	207	1984
Dawlish Cliffs		SX960759	9	1986
Southacre Clay Pit		SX853754	92	1974*
Babbacombe Cliffs		SX928662	14	1986
Kents Cavern		SX934641	2	1993
Hope's Nose to Walls Hill		SX932654	65	1986
Meadfoot Sea Road		SX934633	6	1987
Daddyhole		SX927628	4	1988
Dyers Quarry		SX922628	1	1988
Roundham Head		SX898601	4	1986
Saltern Cove		SX895585	13	1985
Berry Head to Sharkham Point		SX937568	68	1986
Scabbacombe		SX916522	8	1986
Froward Point		SX905497	32	1986
Lords Wood		SX874539	21	1986
Slapton Ley		SX826441	219	1984
Prawle Point and Start Point		SX741371	341	1986
Salcombe to Kingsbridge Estuary		SX746406	652	1987
Bolt Head to Bolt Tail		SX666398	229	1986
South Milton Ley		SX685422	16	1984
Erme Estuary		SX623490	431	1986
Wheal Emily		SX541498	0.4	1990
Wembury Point		SX500483	139	1984
Billacombe		SX5254	1.9	1989
Wallsend Industrial Estate		SX493537	1	1991
Faraday Road		SX498542	0.2	1986
Richmond Walk		SX460543	0.2	1992
Western King		SX462533	2	1985
Mount Wise		SX456541	1	1985
Warleigh Point		SX448610	13	1985
Devon/Cornwall	**1**			
Tamar-Tavy Estuary		SX436711	1,441	1991
Cornwall	**8**			
Lynher Estuary		SX375565	687	1988
St. John's Lake		SX430540	279	1986
Kingsand to Sand Point		SX4350	6	1994
Bull Cove		SX422485	1	1988
Eglarooze Cliff		SX349539	31	1986
Polperro West Cliffs		SX202505	31	1986
Gerrans Bay to Camels Cove		SW886370	140	1986
Fal & Ruan Estuary		SW888423	263	1968*
Region 10	***45***		***8,123***	
England	3,813		875,165	
North Sea coast	552		330,389	
GB coast	1,198		703,844	
GB whole country	6,098		1,940,495	

Sources: English Nature, JNCC. Key: *sites notified before the 1981 Wildlife and Countryside Act and not yet renotified are not afforded protection under this Act: these sites may later be renotified. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.



Map 7.3.2 Coastal Local Nature Reserves and Areas of Special Protection. Sources: English Nature, DoE.

Table 7.3.3 Local Nature Reserves

Site name	*No. of sites*	*Grid ref.*	*Area (ha)*	*Date last notified*
Devon	**11**			
The Maer		SY007803	4	1992
Exmouth		SX995815	465	1994
Dawlish Warren		SX985795	216	1983
Sugar Loaf & Saltern Cove		SX895585	16	1973
Berry Head		SX904565	43	1973
Salcombe - Kingsbridge		SX746406	954	1993
Efford Marsh		SX512568	15	1990
Forder Valley		SX508580	59	1990
Woodland Wood Valley		SX470595	30	1990
Whitley Wood		SX477644	25	1993
Budshead Wood		SX462598	15	1990
Cornwall	**1**			
Kilminorth Wood		SX243540	45	1994
Region 10	***12***		***1,886***	
North Sea coast	69		8,731	
GB coast	94		13,300	
GB whole country	396		21,513	

Source: English Nature. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

7.3.4 Areas of Special Protection

Area of Special Protection (AoSP) is a designation replacing Bird Sanctuary Orders under the 1954 to 1967 Protection of Birds Acts, which were repealed and amended under the Wildlife & Countryside Act 1981. Designation aims to prevent the disturbance and destruction of the birds for which the area is identified, by making it unlawful to damage or destroy either the birds or their nests and in some cases by prohibiting or restricting access to the site. There is one AoSP in Region 10 (Table 7.3.4; Map 7.3.2).

7.3.5 Areas of Outstanding Natural Beauty

The primary purpose of the Area of Outstanding Natural Beauty (AONB) designation is to conserve natural beauty, but account is taken of the need to safeguard agriculture, forestry and other rural industries, and the economic and social needs of local communities (Countryside Commission 1994). AONBs are designated, in England by the

Table 7.3.4 Areas of Special Protection (AoSPs)

Site name	*No. of sites*	*Date designated*
Devon	**1**	
Berry Head: No. 1471		1984
No. 1749		1988
Region 10	***1***	
North Sea coast	14	
GB coast	23	
GB whole country	38	

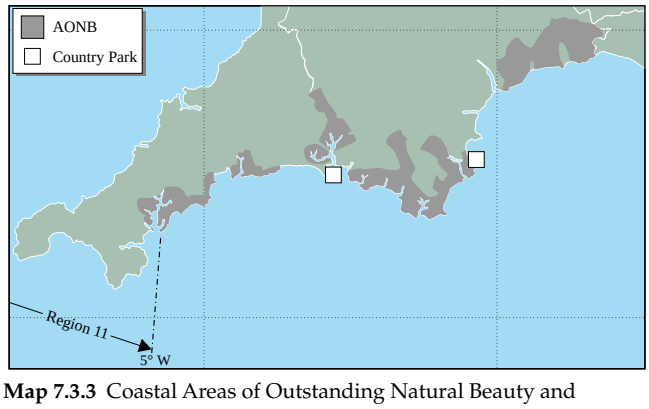
Source: DoE. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

Countryside Commission, under the National Parks and Access to the Countryside Act 1949. In 1995 the total area covered by AONBs (2,123,700 ha) was just over 14% of the countryside of England and Wales. There are four AONBs (127,900 ha) in Region 10 (Table 7.3.5; Map 7.3.3).

Table 7.3.5 Areas of Outstanding Natural Beauty (AONBs)

Site name	*No. of sites*	*Area (ha)*	*Date designated*
Devon	**2**		
East Devon		26,800	1963
South Devon		33,700	1960
Devon/Cornwall	**1**		
Tamar Valley		19,500	1995
Cornwall	**1**		
Cornwall[a]		47,900	1959 1983
Region 10	***4***	***127,900***	
North Sea coast	14.5	714,800	
GB coast	24	899,900	
GB Whole country		2,123,700	

Source: Countryside Commission. Key: [a]comprising several disjunct areas and falling partly in Region 11; 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.



Map 7.3.3 Coastal Areas of Outstanding Natural Beauty and Country Parks. Source: Countryside Commission.

7.3.6 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 declared and managed by local authorities under section 7 of the Countryside Act 1968. There are two coastal Country Parks (348 ha) in Region 10 (Table 7.3.6; Map 7.3.3).

Table 7.3.6 Country Parks

Site name	*No. of sites*	*Grid ref.*	*Area (ha)*	*Date designated/ opened*
Devon	**1**			
Berry Head		SX941565	41	1970
Cornwall	**1**			
Mount Edgcumbe		SX408511-SX455533	307	1975
Region 10	***2***		***348***	
North Sea coast	20		2,943	
GB coast	34		4,441	
GB whole country	281		35,150	

Sources: Countryside Commission, English Nature. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

7.3.7 Acknowledgements

Thanks are due, in particular, to Ray Woolmore (Countryside Commission) and also to Roger Bolt (JNCC), Phillip Biss, Charles Pulteney and Jon Stewart (English Nature), Neale Oliver (DoE) and Paul Johnson (Countryside Commission).

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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, AoSP (Devon)	*Conservation Officer, English Nature, Okehampton, tel: 01837 55045
SSSIs, LNRs (Cornwall)	*Conservation Officer, English Nature, Truro, tel: 01872 262550
Areas of Special Protection - UK	*European Wildlife Division, DoE, Bristol, tel: 0117 987 8000
AONB, Country Park	*Countryside Commission, South West Region, Bristol tel: 0117 973 9966
Coastal and marine UKDMAP datasets	*Coastal Conservation Branch, JNCC, Peterborough, tel: 01733 62626

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

7.4 Sites identified by statutory agencies

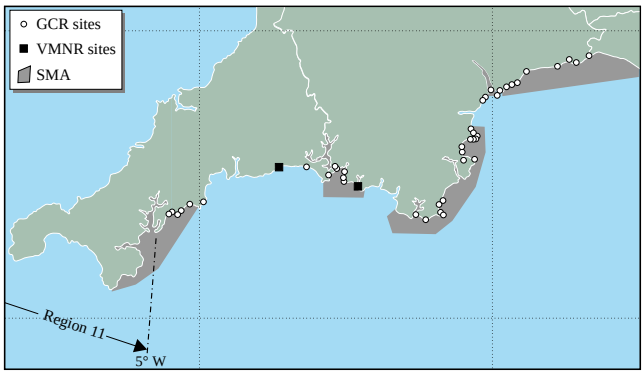
This section covers sites which, although not protected by statute, have been identified by statutory agencies as being of nature conservation or landscape importance.

7.4.1 Nature Conservation Review sites

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. Ratcliff (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. 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 50 coastal GCR Single Interest Localities (SILs) in Region 10 (Table 7.4.1; Map 7.4.1). Detailed scientific accounts of 519 (coastal and inland) GCR SILs have been published or



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

Table 7.4.1 GCR SILs

Site name	*No. of SILs*
Dorset/Devon	**3**
Lyme Regis**	
Pinhay Bay - Fault Corner**	
Axmouth - Lyme Regis	
Devon	**37**
Pinhay Bay	
Culverhole Point	
Hooken Cliff	
East Cliff to White Cliff	
High Peak	
Ladram Bay*	
Otterton Point	
Budleigh Salterton	
Budleigh Salterton*	
Orcombe Rocks	
Dawlish Warren*	
Dawlish	
Coryton's Cove	
Oddicombe	
Long Quarry	
Kent's Cavern	
Hope's Nose (2 SILs)	
Hope's Nose and Thatcher Rock*	
Babbacombe	
Daddy Hole	
Meadfoot Sea Road	
Dyers Quarry	
Roundham Head	
Saltern Cove (2 SILs)	
Shoalstone	
Slapton*	
Start Point - Prawle Point	
Elender Cove to Black Cove	
North Sands Bay, Salcombe	
Jennycliff Bay	
Faraday Road	
Fisons Quarry	
Richmond Walk	
Western King	
Mount Wise	
Cornwall	**10**
Kingsand, Cawsand Beach	
Bull Cove	
Whitsand Bay	
Perhaver	
East Portholland - Long Point - Cadythew Rock	
The Straythe - Nare Head	
The Blouth - Nare Head	
Gerrans Bay	
Pendower	
Shannick Point - Pendower	
Region 10	***50***
North Sea coast	508
GB coast	1,059
GB whole country	3,002

Sources: English Nature, JNCC. Key: *site selected wholly or partly for its coastal geomorphological interest; **part of each of these sites is in Region 9. Note: site names that occur more than once refer to SILs at different grid reference points but with the same name. 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.

are in preparation in nine volumes of a planned 42-volume *Geological Conservation Review* series (Ellis *et al.* 1995).

7.4.3 Heritage Coasts

A Heritage Coast is an area selected for having a coastline of exceptionally fine scenic quality exceeding 1 mile in length, substantially undeveloped and containing features of special significance and interest. This non-statutory protection is agreed between local authorities and (in England) the Countryside Commission, as an aid to local authorities in planning and managing their coastlines. There are four whole, and part of one other, Heritage Coasts (161 km) in Region 10 (Table 7.4.2; Map 7.4.2). Of the English coastline encompassed by Heritage Coasts, 39.5% is protected by the National Trust (Heritage Coast Forum 1993).

7.4.4 Sensitive Marine Areas

Sensitive Marine Areas (SMAs) are non-statutory marine areas that are nationally important and notable for their marine animal and plant communities or which provide ecological support to adjacent statutory sites. They are identified by English Nature, with a further aim of raising awareness and disseminating information to be taken into account in estuarine and coastal management planning. These areas rely on the co-operation of users and local communities for sustainable management, with the help of grant aid. 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). There are four whole and part of two other Sensitive Marine Areas within Region 10 (Table 7.4.3; Map 7.4.1).

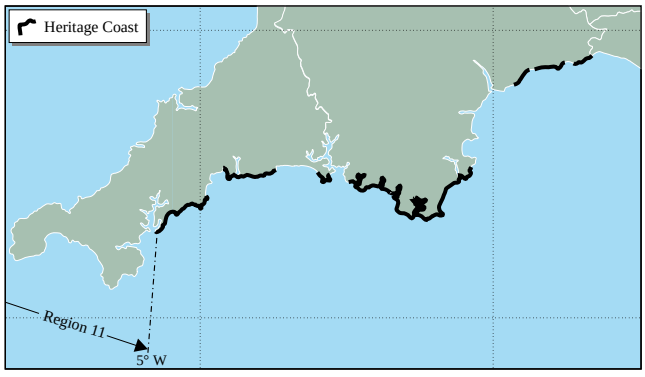
7.4.5 Voluntary Marine Nature Reserves

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 conservation of an important marine biological area to 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 are two VMNRs within Region 10 (Table 7.4.4; Map 7.4.1).

Table 7.4.4 Voluntary Marine Nature Reserves

Site name	*No. of sites*
Devon	**1**
Wembury	
Cornwall	**1**
Looe	
Region 10	**2**
North Sea coast	9
GB coast	13

Source: English Nature, Marine Conservation Society, WWF-UK.



Map 7.4.2 Heritage Coasts. Source: Countryside Commission.

Table 7.4.2 Heritage Coasts

Site name	*No. of sites*	*Grid ref.*	*Length (km)*	*Date designated*
Devon	**2**			
East Devon (county boundary to Budleigh Salterton)		SY332913-SY072829	27	1984
South Devon (Southdown Cliff to Wembury Bay)		SX928543-SX517484	75	1986
Cornwall	**2.5**			
Rame Head		SX433502-SX416503	8	1976
Gribbin Head - Polperro		SX244518-SX087531	24	1976
The Roseland[a]		SX016441-SW843395	27	1986
Region 10	***4.5***		***161***	
North Sea coast	17.5		649	
England & Wales	45		1,539	

Source: Countryside Commission. Key: [a]part of this site is within Region 11; half of the length has been included in the total for Region 10. Note: all these sites are 'completely defined', i.e. they also have a defined landward boundary.

Table 7.4.3 Sensitive Marine Areas

Site name	*No. of sites*	*Date established*
Dorset/Devon	**0.5**	
Lyme Bay[a]		1994
Devon	**3**	
Exe Estuary		1994
Torbay to Start Point		1994
Bolt Tail to Start Point		1994
Devon/Cornwall	**1**	
Plymouth Sound, Tamar, Yealm & Eddystone		1994
Cornwall	**0.5**	
Dodman Point to the Lizard[b]		1994
Region 10	***5***	
North Sea coast	16.5	
England coast	27	

Source: English Nature 1994a. Key: [a]the Dorset part of the Lyme Bay SMA is in Region 9; [b]part of the Dodman Point - Lizard SMA is in Region 11.

7.4.6 Acknowledgements

Thanks are due to Ray Woolmore and Paul Johnson (Countryside Commission), Roger Bolt and Earth Sciences Branch (JNCC), Phillip Biss and Paul Gilliland (English Nature), Sarah Welton (Marine Conservation Society) and Sian Pullen (WWF-UK).

7.4.7 Further sources of information

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C. Contact names and addresses

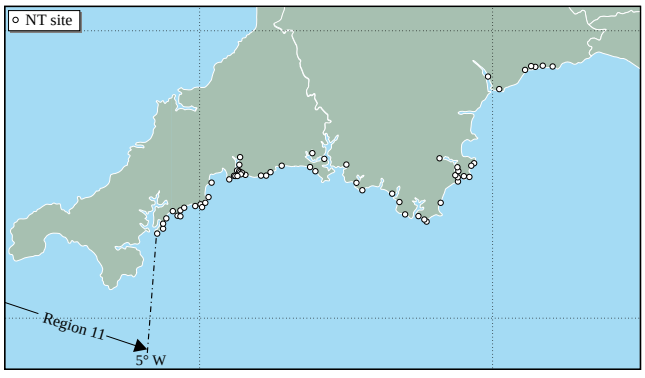
Type of information	*Contact address and telephone no.*
Heritage Coasts	*Countryside Commission, South West Region, Bristol, tel: 0117 973 9966
NCR sites, GCR sites, SMAs, VMNRs - Devon	*Conservation Officer, English Nature, Okehampton, tel: 01837 55045
NCR sites, GCR sites, SMAs, VMNRs - Cornwall	*Conservation Officer, English Nature, Truro, tel: 01872 262550

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

7.5 Other types of protected site

7.5.1 The National Trust

The National Trust is an independent charity that is currently the largest private landowner in Britain. The National Trust owns about 230,000 ha of land in England, Wales and Northern Ireland, and over 200 buildings of outstanding importance. It has also accepted or bought covenants that protect against development for a further 31,600 ha of land and buildings. Many of the tenanted properties have individual intrinsic value; together they protect large areas of unique landscape and countryside. The National Trust has statutory powers to protect its properties, under an Act of Parliament (1907) which declares its holdings of land and buildings inalienable; these properties cannot be sold or mortgaged. In addition, National Trust properties can be protected by bylaws. In 1985 the National Trust relaunched its 1965 campaign 'Enterprise Neptune' to raise funds for the purchase of coastal areas. A total of 850 km of coast are now owned or managed by the National Trust (National Trust 1993). There are 65 National Trust sites (4,629 ha) in Region 10 (Table 7.5.1; Map 7.5.1).



Map 7.5.1 Coastal National Trust sites. Source: National Trust. Note: a single symbol may represent more than one site in close proximity.

7.5.2 The Royal Society for the Protection of Birds

The Royal Society for the Protection of Birds (RSPB) has substantial non-statutory reserve holdings and currently

Table 7.5.1 National Trust sites

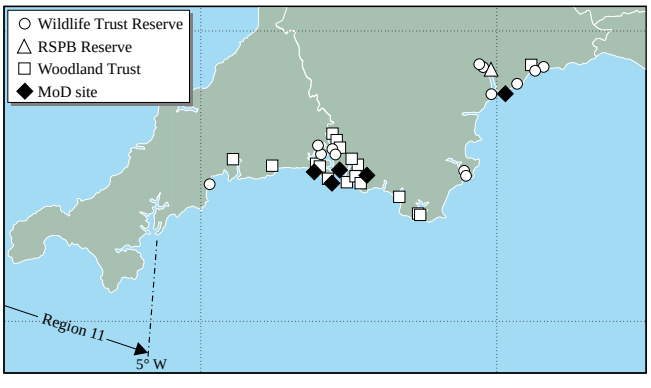
Site name	*No. of sites*	*Grid ref.*	*Area (ha)*	*Date acquired*	*Landform*
Devon	**30**				
Branscombe		SY210880	221	1965-1974	Cliffs, foreshore, beaches and farmland
Coxes Farm		SY176884	54	1991	Coastal farmland
Coombe Wood Farm		SY148880	25	1990	Cliffland and farmland
Southcombe Farm		SY143878	45	1987	Cliff, foreshore and farmland
Salcombe Hill		SY140882	38	1986	Coastal hill
Peak Hill		SY112872	10	1964-1985	Cliff and fields
Orcombe & Prattshayes		SY025808	51	1960	Cliff, foreshore and fields
Lympstone		SX988842	3	1942	Coast
Sharkham Point		SX933547	11	1985	Cliffs and farmland
Southdown Cliffs		SX927540	47	1978	Cliffs and farmland
Coleton Fishacre, Coleton Barton Farm and Woodhuish Farm		SX918500	393	1982	Coastal estate
Higher Brownstone Farm		SX901505	121	1981	Coastal farmland
Hoodown Wood		SX884520	14	1987	Coastal woodland
Long Wood		SX881535	41	1981	Foreshore and woodland
Crownley Wood		SX817563	3	1991	Foreshore and woodland
Dyers Hill		SX878506	5	1974	Coastal woodland
Gallants Bower, Compass Plantation		SX883502	12	1976-1987	Coastal wooded hillside
Little Dartmouth		SX880490	67	1970-1971	Cliffs, beaches and farmland
Beesands Cliff		SX822415	7	1971	Beach and cliff
Prawle Point and Signal House Point		SX773350	29	1966-1985	Headland, cliff and farmland
Gammon Head		SX765355	66	1967-1969	Headland
Portlemouth Down		SX740375	158	1928-1991	Cliffs, sandy coves and farmland
Snapes Point		SX745394	62	1985	Coastal farmland
Bolt Head to Bolt Tail		SX700370	428	1929-1991	Cliffs and farmland
South Milton		SX677415	31	1980-1983	Beach and farmland
Lower Manor & Higher Manor Farms		SX645457	99	1992	Coastal farmland
Clematon Hill		SX655442	3	1938	Coastal hill
Stoke Point		SX550460	149	1987	Cliffs and farmland
Wembury Bay and Yealm Estuary (North and South Banks)		SX530480	234	1938-1991	Foreshore, woodland, cliff, beach and farmland
Saltram House		SX520557	470	1957-1969	Parkland, farmland and woodland

Table 7.5.1 National Trust sites (continued)

Site name	*No. of sites*	*Grid ref.*	*Area (ha)*	*Date acquired*	*Landform*
Cornwall	**35**				
Erth Barton & Erth Island		SX385565	70	1961-1962	Saltings, foreshore and farmland
Antony House		SX418564	27	1961-1965	Parkland
Sharrow Point and Higher Tregantle Cliffs		SX390525	28	1961	Cliffs and farmland
Trethill Cliffs		SX370536	27	1967	Cliffs and farmland
Bodigga Cliff		SX274543	18	1967	Cliff and foreshore
Hore Point		SX236519	59	1980	Farm and cliffland
The Warren		SX217509	16	1945-1948	Cliffs
Chapel Cliff		SX205506	49	1926-1988	Cliff and farmland
Pencarrow Head, Lansallos, Lantic Bay & Lantivet Bay		SX148508	457	1936-1975	Cliff and farmland
St. Saviour's Point		SX123507	3	1926-1972	Headland
Polruan - Townsend Farm		SX135506	53	1991	Coastal farm
Polruan - North Down Field		SX133512	8	1986	Coastal farmland
Pont Pill, Lanteglos		SX135515	42	1955-1977	Creek, foreshore and farmland
Hall Walk, Lanteglos		SX130520	17	1945	Cliff and walk
Penpoll Creek		SX127545	6	1964-1980	Creek
Lerryn Creek		SX135573	49	1959-1989	Creekside and parkland
Station Wood		SX122523	13	1966	Wood and meadow
St. Catherine's Point		SX118509	5	1919-1971	Woodland
Coombe		SX112510	60	1982-1984	Coastal farm
The Gribbin & Polridmouth		SX097496	49	1966-1967	Cliff and farmland
Black Head		SX039479	5	1986	Headland
Bodrugan's Leap		SX027431	1	1946	Headland
Lamledra Farm		SX015414	28	1966	Coastal farmland
Dodman Point		SX000400	112	1919-1966	Headland
Hammick Beach		SW995407	22	1957-1968	Beach and cliffs
Lambsowden Cove		SW982409	28	1969	Coastal farmland
Portloe		SW936394	3	1944-1986	Grazing land
Broom Parc		SW930390	4	1963	Cliff and house
Gull Rock		SW928369	2	1989	Rocky islet
Nare Head		SW916370	184	1931-1981	Headland
Pendower Beach		SW902385	100	1961-1963	Beach and farm
Porthcurnick		SW880360	27	1983-1984	Beach and fields
Tregassick & Trewicne		SW865344	58	1968	Estuary foreshore and farmland
St. Anthony-in-Roseland[a]		SW865325	88	1958-1960	Cliffs, headland, beaches, estuary, and farmland
St. Anthony Head (including Zone Point)[a]		SW846312	14	1959-1985	Headland
Region 10	***65***		***4,629***		
North Sea coast	190		17,404		
England & Wales coast	453		62,918		

Source: National Trust. Key: [a]part of each of these sites is in Region 11; half the area of each has been included in the total for Region 10. 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.

manages over 130 reserves (84,000 ha) in Britain (RSPB 1993). Wherever possible, reserves are purchased, so that the level of safeguard for the wildlife and its habitats is high. Where reserves are leased, the RSPB aims to acquire long leases (longer than 21 years) with appropriate management rights. There is one RSPB site (96 ha) in Region 10 (Table 7.5.2; Map 7.5.2).



Map 7.5.2 Other voluntary and private sites. Sources: Ministry of Defence (MoD), Wildlife Trusts, RSPB, Woodland Trust. Note: a single symbol may represent more than one site in close proximity.

7.5.3 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,

Table 7.5.2 Royal Society for the Protection of Birds reserves

Site name	*No. of sites*	*Grid ref.*	*Area (ha)*	*Date acquired*	*Interest*
Devon	**1**				
Exe Estuary		SX973875 & SX954872	96	1985	Coastal grazing marshes, freshwater ditches; breeding waders and passerines (e.g. songbirds), wintering waterfowl
Region 10	***1***		***96***		
North Sea Coast	53		24,555		
GB coast	82		38,680		

Source: RSPB *in litt*. 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 Wildlife Trusts sites

Site name	*No. of sites*	*Grid ref.*	*Area (ha)*	*Date acquired*
Devon Wildlife Trust	**10**			
Weston Mouth		SY163879	2	1973
Sidmouth Cliffs		SY135875	8	1967
Otter Estuary		SY075824	18	1982
Exe Reedbeds		SX956885	25	1982
Old Sludge Beds		SX952888	5	1977
Dawlish Warren		SX986794	124	1976
Froward Point		SX905495	23	1967
The Grange		SX895503	11	1971
Warleigh Point Wood		SX447610	31	1965
Hangingcliffe Wood		SX427655	3	1972
Cornwall Wildlife Trust	**3**			
Cargreen		SX432630	405	1970
Maybrook Drive, Tincombe		SX417589	1	1986
Ropehaven Cliffs		SX034490	20	1985
Region 10	***13***		***675***	
England	140		8,406	
North Sea Coast	122		10,311	
GB coast	217		23,419	

Sources: Wildlife Trusts (1990 data), Devon Wildlife Trust. 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 7.5.4 MoD sites

Site name	*No. of sites*	*Area (ha)**	*Habitats*	*Protected status*
Devon	**3**			
Straight Point		21	Cliff	
Wembury		60	Cliff	SSSI, AONB
Staddon Heights		47	Cliff	AONB
Cornwall	**2**			
Rame (Pier Cellars)		2	Cliff	AONB
Tregantle		355	Cliff	SSSI
Region 10	***5***	***485***		
North Sea Coast	65	34,449		
GB coast	110	53,409		

Sources: Ministry of Defence, Devon Wildlife Trust. 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. 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.

although both Scotland and the Isle of Man each have a single Trust. The Trusts with coastal sites in the region are the Devon Wildlife Trust and the Cornwall Wildlife Trust. There are nine coastal Wildlife Trust sites (608 ha) in Region 10 (Table 7.5.3; Map 7.5.2).

7.5.4 The Ministry of Defence

As at August 1994, the Ministry of Defence (MoD) owned sites 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 are five coastal MoD sites within Region 10 (Table 7.5.4; Map 7.5.2).

7.5.5 The Woodland Trust

The Woodland Trust was established in 1972 with the aim of conserving, restoring and re-establishing trees (particularly broad-leaved) and woodland plants and wildlife in the United Kingdom. There are eighteen Woodland Trust sites (154 ha) in Region 10 (Table 7.5.5; Map 7.5.2).

Table 7.5.5 The Woodland Trust sites

Site name	*No. of sites*	*Grid ref.*	*Area (ha)*
Devon	**13**		
Page Wood		SY137879	0.4
The Plantation		SX734385	1
Woodcot Wood		SX734384	3
Bantham Copse		SX671439	1
Newton Wood		SX543487	17
Hollacombe Quarry		SX527506	7
Longlands Brake		SX502492	1
Hardwick Wood		SX530555	22
Harwick Wood		SX528554	3
Leigham Wood		SX515576	14
Whitleigh Wood		SX477604	20
Bere Ferrers Copse		SX451637	0.1
Cleaveland Wood		SX436651	2
Cornwall	**5**		
Antony Wood		SX401547	0.1
Benskin's Wood		SX409539	1
Martin's Wood		SX433504	0.1
Trenant Wood		SX246544	28
Milltown & Lantayn Woods		SX108578/ SX110570	33
Region 10	***18***		***154***
North Sea Coast	35		1,095
GB coast	64		1,458

Source: Woodland Trust 1993. 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 author wishes to thank Andrea Firth (MoD), Jo Burgon and Richard Offen (The National Trust), David Williamson (Enterprise Neptune), Bob Scott (RSPB), Mark Pollitt (Wildfowl & Wetlands Trust), Sarah Hawkswell (The Wildlife Trusts) and Nicholas Durston (Woodland Trust) for providing information. Thanks also go to Dr Andy Stevens, City of Plymouth Council, for his useful comments.

7.5.7 Further sources of information

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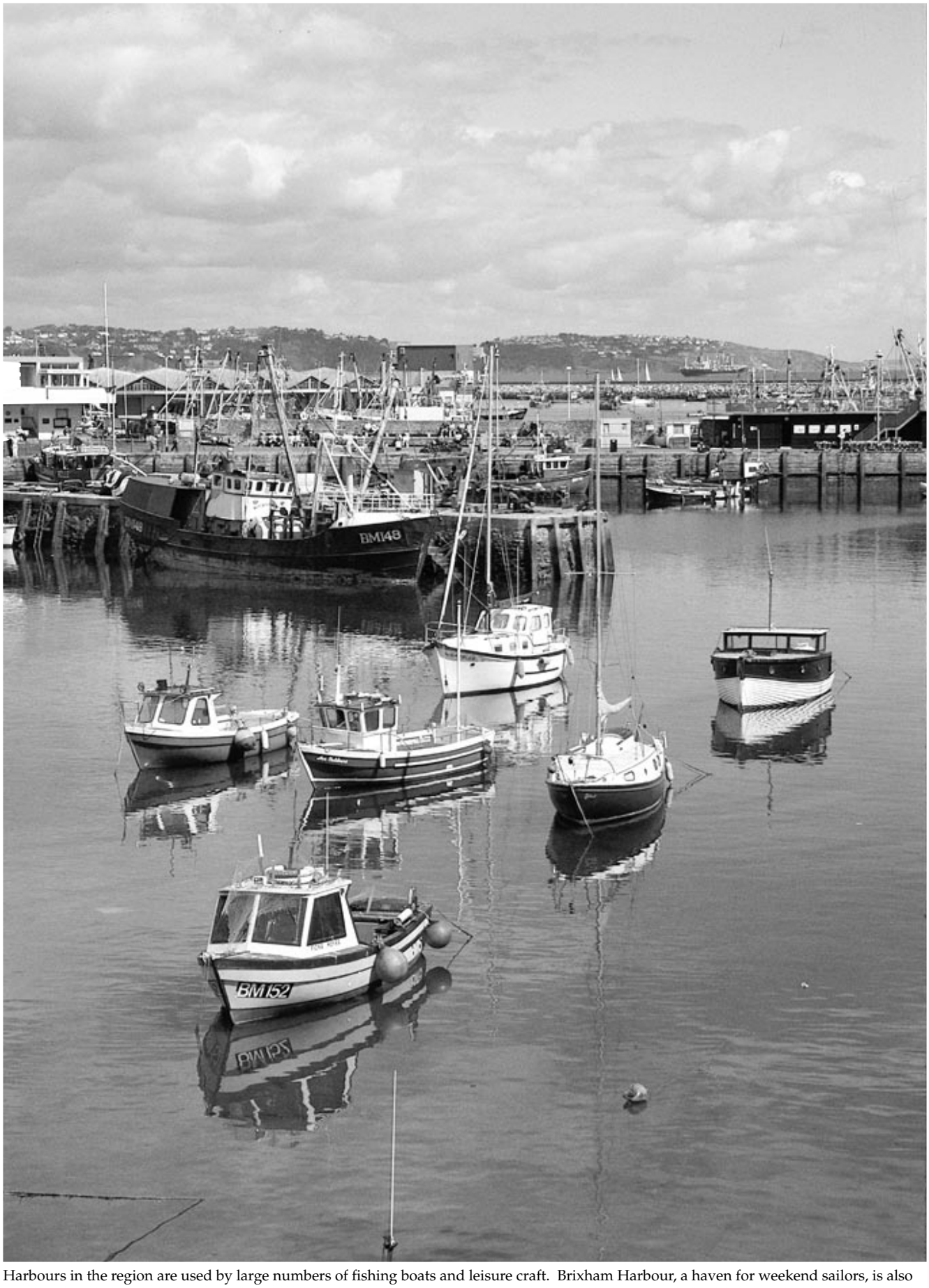
National Trust. 1992. *Properties of the National Trust.* Reading, The National Trust.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
National Trust sites	*Coast and Countryside Adviser, The National Trust, Cirencester, tel: 01285 651818
National Trust sites - Devon	Regional Land Agent, The National Trust, Killerton House, Broadclyst, Exeter EX5 3LE, tel: 01392 881691
National Trust sites - Cornwall	Regional Land Agent, The National Trust, Lanhydrock, Bodmin PL30 4DE, tel: 01208 742481-4
RSPB sites	*Regional Officer, RSPB, South-west England Office, Exeter, tel: 01392 432691
Devon Wildlife Trust sites	*Conservation Officer, Devon Wildlife Trust, Exeter, tel: 01392 79244
Cornwall Wildlife Trust sites	*Conservation Officer, Cornwall Wildlife Trust, Truro, tel: 01872 73939
Woodland Trust sites	The Woodland Trust, Autumn Park, Dysart Road, Grantham, Lincolnshire NG31 6LL, tel: 01476 74297
MoD sites	Conservation Officer, MoD Conservation Office, B2/3, Government Buildings, Leatherhead Road, Chessington, Surrey KT9 2LU, tel: 0181 391 3028/9

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



Harbours in the region are used by large numbers of fishing boats and leisure craft. Brixham Harbour, a haven for weekend sailors, is also one of two 'main ports' in the region, which together land more than 10% of all fish landed to ports in England and Wales each year. Photo: Bill Sanderson, JNCC.

Chapter 8 Land use, infrastructure and coastal defence

M.J. Dunbar, S.J. Everett, S.L. Fowler, J.A. Norton, C.A. Crumpton & M.J. Goodwin

8.1 Introduction

This chapter is divided into three sections: (rural) land use, covering agriculture (especially as it affects important coastal wildlife habitats) and woodland; infrastructure, covering population distribution, industry, ports, harbours and power generation; and coastal defence, including sea defence and coast protection.

Coastal land use in the region is mainly mixed agriculture, with very little industrial or commercial development outside Exeter and Plymouth. The main centres of population in the region are Exeter, Tor Bay (including Torquay, Paignton, Brixham) and Plymouth (including Devonport and Stonehouse). Plymouth is a nationally important centre for marine industries, including docks, boat building and repair yards. The leisure and recreation industry is an important coastal land use and is becoming the major employer in many coastal areas, as other traditional industries decline. The increasing employment opportunities and revenue from leisure and tourism benefit the local economy but are subject to seasonal fluctuation. There are numerous leisure developments and an important holiday area around Tor Bay, while much of the attractive coastline is popular for watersports (see also section 9.7). There are several countryside interpretation and field studies centres.

Most of the region is designated an Objective 5b (promotion of rural development) area under the European Social Fund and is therefore eligible for funding under the EC's structural funds and regional aid programmes. These programmes aim to promote rural diversification, including the economic restructuring of ports that were formerly dependent on fisheries.

The region's estuaries are predominantly rural. However, Plymouth Sound and its tributaries, such as the Plym (illustrated), are heavily developed, fronting the city of Plymouth and the towns of Plymstock, Saltash and Torpoint. Photo: Peter Wakely, English Nature.

8.2 Land use

S.L. Fowler & M.J. Dunbar

8.2.1 Introduction

Agriculture is the dominant (rural) land use in the region, outside the developed areas. Overall, the region is fairly representative of the south coast, rural land use being a mixture of arable and grazing, particularly dairy farming, intermediate between conditions in the important livestock rearing areas of the west coast and those on the arable east coast of Britain. Semi-natural grassland and heath are present in pockets along the coastal fringe, notably along the rockiest sections of coast in the west of the region, but elsewhere agriculture is intensive and most of the grassland beyond the unmanaged coastal fringe is agriculturally improved.

The majority of agricultural land along this coastline is Grade 3, with small areas of higher land classified as Grade 4. There is a significant amount of Grade 1 land adjoining the River Otter and the Exe Estuary. Much of the land on the west side of Plymouth Sound and around the mouth of the Tamar Estuary is Grade 2 (MAFF/WOAD 1979).

Extensive areas of coastal semi-natural habitat are managed by grazing. This is probably the oldest form of saltmarsh management. There are approximately 44,000 ha of saltmarsh in Great Britain, about 31,600 ha of which are grazed, with major concentrations in south-east and north-west England. About half of the total area of saltmarsh in this region is grazed (Burd 1989) (see also section 3.6.3). Figures for stocking densities vary in the UK. However, Doody's 1988 study of saltmarsh management identified levels across the UK ranging from one to six animals per hectare, with grazing usually only taking place from May to September.

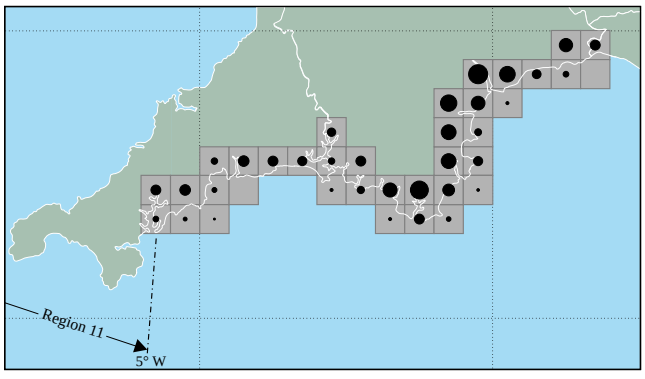
The dunes of England have probably been affected by agriculture for most of their existence (Radley 1994). However, during a recent survey of dune vegetation in England, grazing by domestic stock was recorded at only 34 out of 121 dune sites (Radley 1994). None of the dune sites in the region is grazed.

The majority of the exposed coast is unwooded, but many of the region's numerous rias have stands of woodland along their upper shores, with significant ancient semi-natural woodlands in some locations.

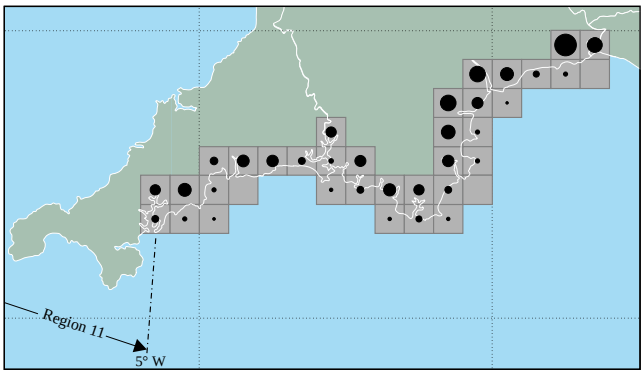
8.2.2 Locations and land uses

Maps 8.2.1, 8.2.2 and 8.2.3 show the distribution in the region of, respectively, tilled land, heavily managed mown/grazed turf and lightly managed meadow/semi-natural grassland. The size of the circles in relation to the squares is proportional to the amount of that land cover type in the 10 km square.

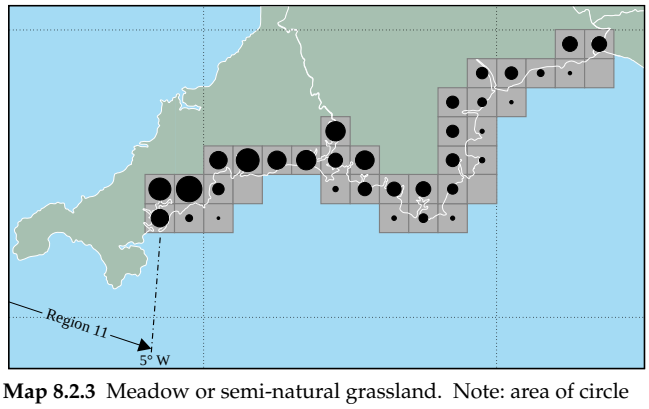
Tilled land with smaller areas of mown or grazed turf predominate in the eastern part of the region as far as the Salcombe area; to the west, where soils are poorer and exposure to the elements is more severe, coastal land is managed less intensively and meadows and semi-natural grassland become more abundant. There has been some land claim for agricultural in the Tamar/Tavy Estuary and particularly on the Exe Estuary, where 830 ha of land have been claimed (see section 3.5.3).



Map 8.2.1 Tilled land. Note: area of circle indicates the area of this land cover type in the 10 km square. Source: Countryside Survey (ITE 1990).



Map 8.2.2 Mown or grazed turf. Note: area of circle indicates the area of this land cover type in the 10 km square. Source: Countryside Survey (ITE 1990).



Map 8.2.3 Meadow or semi-natural grassland. Note: area of circle indicates the area of this land cover type in the 10 km square. Source: Countryside Survey (ITE 1990).

Saltmarshes are grazed mostly in the Tamar Estuary complex and to a lesser extent on the Axe, Dart and Avon Estuaries (Map 8.2.4).

The cliff-side woods of the Axmouth to Lyme Regis Undercliffs National Nature Reserve form the largest extent of woodland on the exposed coast of this region. Table 8.2.1 lists the major woodlands in the region within 500 m of the coast (Map 8.2.5).

Table 8.2.1 Areas of significant woodland within 500 m of the coast (centre grid ref.)

Site no.	*Site name*	*Grid ref.*	*Area of wood (ha)*	*Area of ancient semi-natural woodland (ha)*	*Notes*
	Devon				
1	Lyme Regis to Axmouth Undercliffs	SY3090	250	0	Mostly deciduous, semi-natural; NNR
2*	Haven Ball Wood	SY256907	12	12	
3	Branscombe	SY1988	3	3	
4	East of Broadsands	SX9156	10	0	Replanted ancient woodland
5*	Long Wood	SX881536	34	34	
6*	Lord's Wood	SX872540	17	17	
7*	Ham Copse	SX834580	5	5	
8*	Sharpham Wood	SX832572	14	14	
9*	Halwell Wood	SX752405	10	10	
10	Kingsbridge Estuary	SX7440	6	6	
11	West bank of Kingsbridge Estuary; south-west of Salcombe	SX7238, SX7237	10	5	Three small blocks of ancient woodland
12	East and west banks of River Avon	SX6845, SX6846	5	5	Small blocks of replanted ancient woodland
13	East and west banks of River Erme (upper sections)	SX64, SX65	250	0	Deciduous and replanted ancient woodland, plus more recent plantation
14*	Yarninknowle Wood	SX627503	33	22	
15*	Orcheton Wood	SX625492	20	20	
16*	Wrinkle/Tor Woods	SX625487	45	20	
17*	Holbeton Wood	SX623499	10	8	
18*	Pamflete Wood/+	SX620485	25	9	
19*	Heddon Wood	SX570507	6	6	
20*	Warren Wood	SX556509	15	15	
21*	Crawl/West Woods	SX550498	24	19	
22*	Newton/Court Woods	SX545488	9	9	
23*	Ferry Wood	SX541477	17	17	
24*	South Wembury Wood	SX540490	10	10	
25*	Wembury/Train Woods/+	SX538505	42	42	
26*	Old Coastguard Wood	SX537484	5	5	
27*	Saltram Wood	SX515557	12	12	
28	Banks of River Tavy	SX4765	15	15	
29*	South/Lopwell Woods	SX478648	25	15	
30*	Blaxton Wood	SX469634	28	26	
31*	Maddacleave/+ Woods	SX456695	45	22	
32*	Warleigh Wood	SX450610	25	25	
33*	Hatch/Morwell Woods	SX440710	93	14	
34*	Buttspill Wood	SX438681	8	8	
	Cornwall				
35*	Clarrick/Pigshill Woods	SX441521	17	13	
36	Tamar Estuary, Torpoint	SX4256	n/a	n/a	Small blocks of amenity woodland; linear ancient semi-natural woodland
37*	Bohetherick Wood	SX419680	8	6	
38*	Crosspark/Lifte Woods/+	SX412639	30	13	
39*	Wacker Wood	SX386548	6	6	
40*	Sheviock/Hawks Woods/+	SX373561	57	30	
41	Sheviock Wood (south bank of St. Germans River, Tamar Estuary)	SX3656	40	16	Ancient woodland; about 60% replanted, the remainder semi-natural
42*	Venton/Mill Hill Woods	SX349595	9	5	
43*	St. Martin's Wood	SX254549	15	15	
44*	Trenant/Quayfield/+ Woods	SX250541	14	14	
45	Ria extending north-west and north of Looe	SX2453	>100	50	Ancient woodland, mostly replanted
46*	Kilminorth/+ Woods	SX232545	115	46	
47*	Manely/Lerryn Woods	SX131566	41	28	
48*	Great/Middle/Ethy Woods	SX127568	56	26	
49*	Colvithick Wood	SX123537	27	23	
50*	Woodgate Wood	SX112562	20	20	
51*	Milltown Wood	SX107578	11	11	

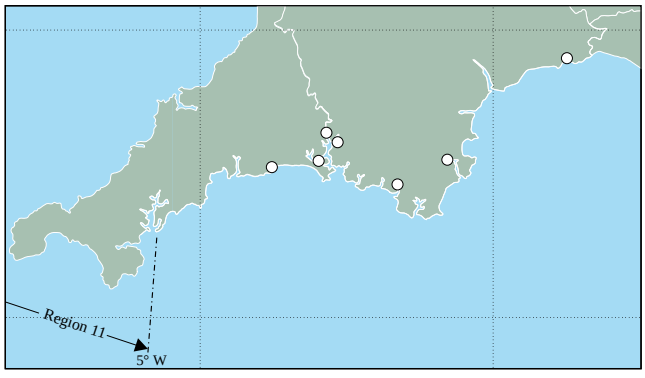
Source: English Nature Ancient Woodland Inventory; Nature Conservancy Council 1986a, b. Note: site numbers are as shown on Map 8.2.5. Key: *site listed in English Nature's Ancient Woodland Inventory (ancient semi-natural woods); /+ = several small sites have been grouped together; n/a = not available.

8.2.3 Information sources used

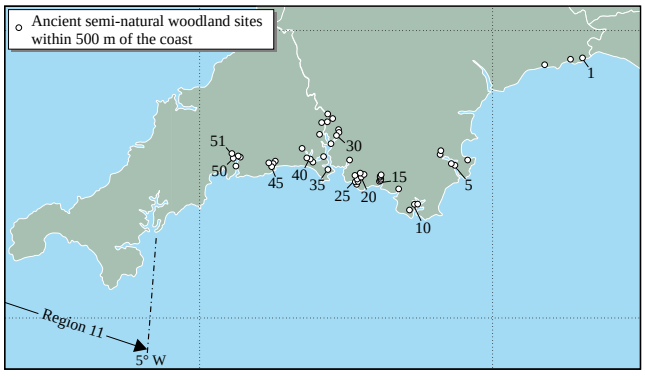
The main source of information for this section was the Countryside Survey 1990 (ITE 1993), which is based primarily on high resolution satellite images. These images show the dominant land cover for each 25 m x 25 m area (pixel) of Great Britain. Land cover is classified into seventeen key types (including tilled land and managed grassland) and field surveys of randomly selected areas were used to check the results. Maps 8.2.1, 8.2.2. and 8.2.3 are derived from printouts of these data from the DoE Countryside Information System. The main limitations of the data derive from errors in classifying areas covered by a mixture of land types and from the form of presentation used in the maps. The Countryside Information System can also provide data on a 1 km square framework. More detailed information on agricultural land use is available from ADAS (for example, information on set-aside targets), Heritage Coast plans and local plans. Sand dune and saltmarsh grazing information for Map 8.2.4 comes from the JNCC's Integrated Coastal Database, and from cited references. Woodland information (Map 8.2.5) was obtained from English Nature's Ancient Woodland Inventory (Spencer & Kirby 1992), which is a detailed source of comparative data for the region, and from 1:50,000 scale Ordnance Survey Landranger maps. The Forestry Commission has afforestation maps that cover the region.

8.2.4 Acknowledgements

Thanks go to Chris Reid, English Nature, for assistance with Ancient Woodland Inventory data.



Map 8.2.4 Saltmarshes with recorded grazing. No sand dune sites in the region are recorded as being grazed by stock. See Maps 3.6.1 and 3.2.1 for distribution of saltmarsh and sand dune sites. Source: JNCC Coastal Database.



Map 8.2.5 Coastal woodland. Numbers refer to Table 8.2.1. Sources: English Nature Ancient Woodland Inventory, Ordnance Survey Landranger maps. © Crown copyright.

8.2.5 Further sources of information

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Whitbread, A.M., & Kirby, K.J. 1992. *Summary of NVC woodland descriptions.* Peterborough, Joint Nature Conservation Committee. (UK Nature Conservation Series, No. 4.)

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Agriculture policy	MAFF, Whitehall Place, London SW1A 2HH, tel: 0171 270 3000
Agriculture - Devon	MAFF Regional Service Centre, Government Buildings, Alphington Road, Exeter, Devon EX2 8NQ, tel: 01392 77951
Agriculture - Cornwall	MAFF Regional Service Centre, Pydar House, Pydar Street, Truro, Cornwall TR1 2XD, tel: 01872 265 400
Land use, agricultural land grades, set-aside (MAFF/ ADAS Land Service)	ADAS, Oxford Spire Business Park, The Boulevard, Kidlington, Oxford OX5 1NZ, tel: 01865 842742
ITE Countryside Survey 1990	*Department of Rural Affairs, DoE, Bristol, tel: 0117 921 8811
ITE Countryside Survey 1990	*Land Use Group, ITE Merlewood, tel: 01539 532264
ITE Countryside Survey 1990	*Environmental Information Centre, ITE Monks Wood, tel: 01487 773381
Inventory of ancient semi-natural woodland	*EN Devon and Cornwall Local Team, Okehampton, tel: 01837 55045
Soil surveys in England and Wales	John Hazelden, Soil Survey and Land Research Centre, Cranfield University, Silsoe College, Bedford MK45 4DT, tel: 01525 863000
Distribution, ownership and management of woodlands	The Forestry Authority, The West Country, The Castle, Exeter, Devon EX6 8HD, tel: 01626 890 666

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

8.3 Infrastructure

S.L. Fowler, J.A. Norton, M.J. Dunbar, C.A. Crumpton & M.J. Goodwin

8.3.1 Introduction

The region has some of the least developed coastline in England. However, there is continuing pressure on remaining areas of semi-natural habitat from the expansion of coastal settlements, for residential purposes or for tourist facilities. This may be damaging to the setting of the seaside towns and villages, as land immediately adjacent to seaside settlements is often an essential component of their visual character (Devon County Council 1995).

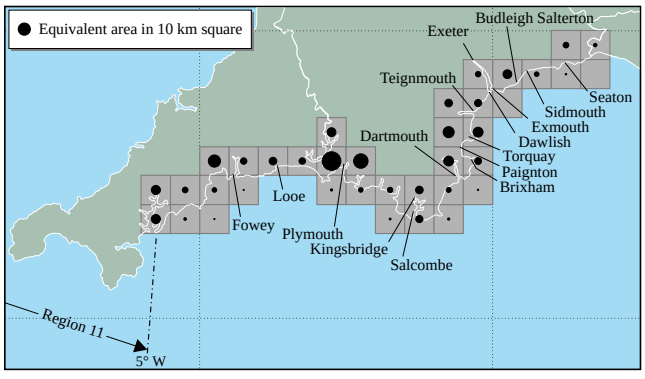
The major centres of population along the coast of the region are Exeter, Plymouth and the Tor Bay coast. These locations are also traditionally the main focus for tourism and holidays, probably because of past reliance on the railway network. With increasing car ownership and the improving road system in the region, tourism has now spread to other parts of the coast.

Major industrial activity in the region is concentrated on the shores of Plymouth Sound and, to a lesser extent, around the city of Exeter. The Plymouth Sound area is of regional and national maritime importance and is the largest merchant and defence shipping centre in the western approaches to the English Channel. It is also of significance for ship building and as a centre of marine scientific activity. As in many coastal industrial areas, a peak period of marine industrial activity in previous years has been followed by the decline of ship building and associated industries (see also Chapter 6). This is a particular problem in the Plymouth area, where the decline is largely a result of military cutbacks. However, this produces opportunities to exploit the maritime heritage for tourism and leisure (see also section 9.7). For example the old Royal William Victualling Yard in Plymouth is a major site with a series of substantial listed buildings that are to be sympathetically redeveloped (Devon County Council 1995). As an Objective 2 industrial region (in industrial decline), Plymouth has qualified for support under the EC's structural funds and regional aid programmes, to support employment growth and invest in a skilled workforce.

8.3.2 Important locations

Residential development

Map 8.3.1 shows the distribution of areas of urban and suburban development in the region. Population figures for locations wholly or partly in the region are given in Table 8.3.1. The three main centres of population are all in Devon, on the Exe Estuary at Exeter and Exmouth, along the coastline of Tor Bay (Torquay, Paignton and Brixham), and around Plymouth Sound (including Plymouth, Devonport, Plymstock, Torpoint and Saltash). Otherwise, development in the region is concentrated around small coastal settlements which may also be resort towns and retirement centres, including Seaton, Sidmouth, Budleigh Salterton, Dawlish, Teignmouth, Dartmouth, Salcombe, Kingsbridge, Looe and Fowey. The populations of these settlements may



Map 8.3.1 Distribution of areas of industrial and residential development. Note: area of circle indicates the area of this land cover type in the 10 km square. Major cities and towns are also shown. Sources: ITE (1993); ITE Monks Wood pers. comm.

be greatly enhanced by summer visitors. Outside the towns the coast is sparsely populated, especially west of Brixham, but also in certain stretches of the east Devon coast.

The current estimate of the population of Devon is almost 1,050,000; of these, approximately 900,000 people live in the coastal cities, towns and parishes, amounting to 89% of the total population of the county. Of the population living near the coast approximately 36% are over 60 years old, many having migrated into the region (Devon County Council 1995). This increase in the retired population, together with the continued demand for waterfront properties, particularly where associated with offices and

Table 8.3.1 Populations wholly or partly in Region 10

	Population
Devon*	1,049,200
East Devon District*	120,300
Seaton	5,000
Sidmouth	12,500
Exmouth	29,000
Exeter*	105,100
Teignbridge District*	112,100
Dawlish	11,000
Teignmouth	13,300
Torbay (Torquay, Paignton & Brixham) Borough*	121,100
South Hams District*	78,500
Dartmouth	6,300
Salcombe	2,400
Kingsbridge	4,200
Plymouth (Plymouth, Devonport, Stonehouse) Borough*	259,000
Cornwall*	477,000
Caradon District*	77,800
Looe	4,500
Restormel District*	88,300
Carrick District*	84,500

Sources: Borough/District figures (mid-1993 population estimates based on 1991 census): Office of Population Censuses and Surveys (1994); others (1981 data): Cook (1993). Key: *whole county/district total, including population inland and/or outside Region 10. Note: towns/cities are shown on Map 1.2.1.

leisure facilities, has resulted in considerable pressure for new residential development along the coast. This has led to the tourist accommodation stock declining over the last decade due to conversions of hotels to other uses, particularly nursing and retirement homes and demolition for residential development. This policy is now being resisted to maintain the viability of the tourism industry in the region. Other areas are being redeveloped to help alleviate this pressure; for example, the old Exmouth docks are being developed as a residential and commercial complex with associated marina berths.

Industrial development, ports and harbours

Industrial activity in south-west England is strongly associated with the region's main centres of population, which are themselves associated with the ports and harbours. There are a considerable number of small fishing ports scattered around this coastline, although the fishing industry has been in serious decline over the past decade or so (see Chapter 7) and today many of the traditional fishing harbours are more important for leisure boating. There are also some extremely important port facilities in the region, notably within Plymouth Sound (Plymouth, Devonport, Millbay) and within the Exe Estuary (Topsham and Exmouth) as well as the nationally important china clay exporting ports of Par and Fowey. In addition, most of the coastal towns have experienced recent light industrial developments.

The most heavily industrialised areas are located around Exeter and Plymouth Sound. The Plymouth area still has important (albeit declining) boat building and repair and other marine industries, associated with its long-established role as a naval base. Plymouth's roll-on roll-off ferry facilities are expected to increase in importance through the expansion of existing services and the introduction of new services as trade to Spain and Portugal increases. Passenger ferries currently run from Plymouth to Roscoff, France, and Santander, Spain.

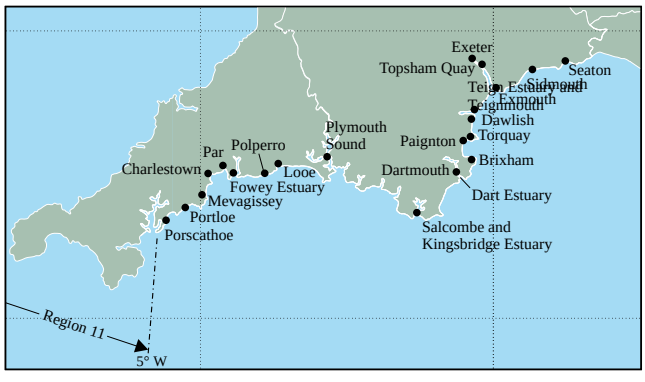
After Plymouth, Exeter is the second largest focus for industrial activity, mainly in the service sector but with some construction and engineering. Exmouth docks are in the process of redevelopment from a working port to a residential and commercial complex with associated marina berths. The other main commercial area, Torbay, has a mixture of service and production industries, but the most important sector is tourism and leisure. Dartmouth is largely leisure-orientated but is also associated with defence infrastructure, as are other smaller ports and inlets in the region.

With the increase in size and draft of modern vessels there has been a tendency, UK-wide, for commercial dock and jetty construction to move to locations where deeper water is available close to shore, to avoid the high costs of large-scale dredging. This has not yet occurred in this region, although there was a proposal in 1989 for a deep-water port at Noss Point, in the Dart Estuary. The natural deep-water harbour of Plymouth Sound has been improved by the construction (in 1841) of a large breakwater to protect the inner anchorage and the approaches to the numerous docks in the area. The harbour requires only a limited amount of maintenance dredging to keep its naval and merchant shipping channels open.

Virtually all the coastal settlements in the region have, or used to have, some kind of harbour or facilities for fishing vessels. Many of the smaller inlets in the region, formerly used primarily by the inshore fishing industry, are now mainly used by recreational craft (see section 9.7) and have only small numbers of fishing vessels, following a national decline in fishing fleet numbers (see also section 9.1). Examples include fishing ports at Seaton, Beer, Sidmouth and Mevagissey, and harbours at Budleigh Salterton, Torquay, Bigbury-on-Sea, Newton Ferrers, Looe, Polperro and Charlestown (St. Austell). Fishing boats are launched from the beach at several places, for example Beer, Sidmouth and Budleigh Salterton.

Fowey and Par are nationally important as the main UK ports for the export of china clay from the extensive inland quarries. The extraction and export of tin and china clay have significantly affected coastal development, water quality and land use in the west of the region, and remain of environmental significance even where the industries are no longer active. For example, in Mevagissey Bay the sea bed has been buried by up to 2 m of china clay waste, which affects the type and distribution of animal life that lives there.

Table 8.3.2 lists the main locations of coastal industry, ports and harbours in the region, as shown on Map 8.3.2.



Map 8.3.2 Population centres (Table 8.3.1), ports and harbours and locations of industrial development (Table 8.3.2)

Power generation

There are no power generating operations on the coast in this region. However, the coasts of Devon and Cornwall have high potential as locations for windfarming, owing to the favourable prevailing wind conditions. A report entitled *Planning for Renewable Energy in Devon* (ETSU 1993) was prepared jointly between Devon County Council and West Devon Borough Council in collaboration with ETSU (Energy Technology Support Unit), on behalf of the DTI. This study looked at the individual renewable energy technologies which appear to offer the best scope and potential in Devon. The main technologies considered included waste combustion, wind, biogas, solar, hydro-electric, landfill gas and tidal barrages. The estimated potential combined output of these technologies in Devon was approximately 220 MW, and it was concluded that 15-20% of Devon's electricity requirements could be met from these sources over the next 10-15 years.

Table 8.3.2 Industrial, port and harbour development

Site name	*Grid ref.*	*Details*
Devon		
Seaton	SY2590	Port and small harbour
Exe Estuary	SX9786	Three boat-building/repair yards
Exmouth	SY0082	Harbour for fishing fleet; docks
Topsham Quay	SX9788	Tidal drying berth; docks
Exeter	SX9590	Exeter Ship Canal (coastal shipping up to 650 gross registered tonnes): owned and operated by Exeter City Council; light manufacturing
Teign Estuary and Teignmouth	SX9573	Small port owned by Teignmouth Harbour Commission, operated by Teignmouth Quay Co Ltd. 70,000 tonnes pa; 7,000 sq. m open storage; 18,600 sq. m covered storage. Principal traffic & facilities: ro-ro, dry bulks including ball clay, grain/feedstuffs, forest products. Principal imports: animal feed. Principal export: ball clay. Three quays and one dock. 460 m of berths.
Torquay	SX9263	Small port and harbour with large marina (440 berths + 60 for visitors) owned and operated by Torbay Harbour Authority. Regular freight services to Channel Islands. Yacht marina.
Brixham	SX9457	Large harbour for fishing fleet; harbour owned and operated by Torbay Borough Council
Dart Estuary	SX8852	Port facilities at Totnes and Kingswear; crab fishing fleet; boat-building yard at Noss Point
Dartmouth	SX8851	Trust port owned and operated by Dart Harbour and Navigation Authority. 305 m length of berthing. Moorings for leisure craft, ship repair/graving (a type of dry dock), lay-up berths, yacht marina & bunkering. Naval college. Three marinas: Darthaven (230 berths + 12 for visitors), Kingswear (10), Dart (80 + 40 visitors).
Salcombe & Kingsbridge Estuary	SX7538	Harbour (450 leisure craft/lay-up berths) at Salcombe owned and operated by Salcombe Harbour Authority. Quay at Kingsbridge: large shell-fishing fleet; boat yards. Boat-building and repair yards at Lincombe and Goodshelter.
Devon/Cornwall		
Plymouth Sound	SX4752	Several major concentrations of dock facilities at the Devonport Royal Naval Dock, Millbay Docks, Mutton Cove and Cattewater. Other dock facilities elsewhere. Imports include refined petroleum products from Milford Haven, coal and bauxite; exports include barley and china clay. New terminal planned for Cattedown. International ferry port. Roll-on roll-off facilities. Proposal for a new load terminal. Ship-building at Royal Naval Dock. Metal industry and oil terminal at Cattewater. Two river management barrages. China clay works on the River Plym. Six marinas taking over 1,000 boats. Cattedown Wharves Ltd: Cattewater Harbour Authority. Principal traffic & facilities: grain/feedstuffs, dry bulks, forest products, oil/petroleum, general cargo, fish; two berths: 171 m length; 4,650 sq. m covered storage. Millbay Docks: Associated British Ports; three berths, 580 m length; 16,000 sq. m open storage; 5,400 sq. m covered storage; ro-ro, vehicles/wheeled cargoes, passengers. Yacht marina. Victoria Wharf: Cattewater Harbour Trust. Three berths, total 285 m length; 5,000 sq. m open storage; 5,000 sq. m covered storage; lo-lo (crane load and unload), grain/feedstuffs, dry bulks, forest products, general cargo. Sutton Harbour: moorings for leisure craft and yacht marina.
Cornwall		
Looe	SX2653	Busy harbour for commerce; fishing fleet and pleasure craft; boat yard
Polperro	SX2251	Small fishing harbour (Polperro Harbour Trustees)
Fowey Estuary	SX1351	Trust port (Fowey Harbour Commissioners). Five berths, 650 m total length. 1,700,000 tonnes p.a. Dry bulks (major china clay exports). Jetties owned by ECC Ports, part of English China Clays plc. Ship repair/graving docks. Exports of granite from Dartmoor. Moorings for leisure craft.
Par	SX0853	Port owned and operated by ECC Ports. 700,000 tonnes p.a. Eight berths. Dry bulks (main port for china clay export) and other liquid bulk. Fishing port.
Charlestown	SX0452	Small port, primarily exporting china clay, operated by Fowey Harbour Commissioners. Grain is another principal traffic. 50,000 tonnes p.a. Open storage of 1,000 sq. m. 225 m length of berths. Ship repair/graving docks, leisure craft moorings, yacht marina.
Mevagissey	SX0244	Harbour for fishing fleet
Portloe	SW9339	Scenic fishing harbour owned and operated by Portloe Harbour Trust. Slipway and winch for small fishing boats and leisure craft up to 7 m.
Portscathoe	SW8736	Very small leisure craft harbour owned and operated by Carrick District Council

Sources: Walker (1996), D'Olivera & Featherstone (1993) and Ordnance Survey Landranger 1:50,000 maps.

8.3.3 Information sources used

A main source of information for this section was the *Devon coastal statement* produced by Devon County Council (1995). Other sources of information for this section included Cook (1993), Buck (in prep.) and Ordnance Survey Landranger 1:50,000 maps. Some of the information on industrial activity and infrastructure may be out of date, as a result of recent local and national declines in industrial activity. 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. Most of the information on ports was derived from Walker (1996). Most information on ferries was derived from 1:50,000 Ordnance Survey Landranger maps and Admiralty Charts. The British Marine Industries Federation, which is the representative body for all types of company involved in the small vessel sector of the marine industry, is an important source of information on local marine industries and activities in the region.

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 computer-assisted 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. Lord Donaldson also records that no records are kept of how many ships use UK port facilities. Under MARPOL (the United Nations' International Convention on the Prevention of Pollution from Ships), the UK must provide port facilities that are "adequate to meet the needs of ships using them and do not cause undue delay to ships". These facilities should prevent ships from discharging oil and other wastes into the sea. However, Lord Donaldson (1994) describes UK facilities as "inadequate". A survey of the quality of UK port reception facilities for the disposal of ship's wastes was carried out by WRC (1995). The Marine Safety Agency also carry out a regular quantification of port reception facilities for the International Maritime Organisation.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Planning development	*Local authorities: see Appendix A.2
Plymouth Chamber of Commerce & Industry	Lyster Court, The Quadrangle Business Centre, 2 Craigie Drive, Plymouth PL1 3JB, tel: 01752 202500
Cornwall Chamber of Commerce & Industry	West Cornwall Enterprise Centre, Cardrew Industrial Estate, Redruth TR15 1SS, tel: 01209 314884
Trading statistics for member ports	British Ports Association, Africa House, 64-78 Kingsway, London WC2B 6AH, tel: 0171 242 1200
Trading statistics for member ports	The UK Major Ports Group Ltd, 150 Holborn, London EC1N 2LR, tel: 0171 404 2008
Marine small craft industry	British Marine Industries Federation, Meadlake Place, Thorpe Lea Road, Egham, Surrey TW20 8HE, tel: 01784 473377
Control of certain maritime activities	International Maritime Organisation, 4 Albert Embankment, London SE1 7SR, tel: 0171 735 7611
Exeter (navigational & canal authority: Exe Estuary & Exeter Ship Canal)	*Exeter City Council, tel: 01392 74306
Ports and harbours	See Appendix A.2
Teignmouth (harbour)	*Harbour Commission, Teignmouth, tel: 01626 772376
Torbay (harbour)	*Borough of Torbay, Torquay, tel: 01803 292429
Dart (harbour)	* Dart Harbour and Navigation Authority, Dartmouth, tel: 01803 832337
Salcombe (harbour)	*Salcombe Harbour Authority, Salcombe, tel: 01548 843791
Plymouth (Cattewater Harbour)	*Cattewater Harbour Commissioners, Plymouth, tel: 01752 665934
Plymouth (Millbay Docks)	*Associated British Ports, Plymouth, tel: 01752 662191
Fowey (harbour)	*Fowey Harbour Commissioners, Fowey, tel: 01726 832471/2
Par (harbour)	*ECC Ports, Par, tel: 01726 817300
Renewable energy	Renewable Energy Enquiries Bureau, Energy Technology Support Unit (ETSU), Harwell, Oxfordshire OX11 0RA, tel: 01235 432450
Wind energy	The Administrator, British Wind Energy Association (BWEA), 89 Kingsway, London WC2B 6RH, tel: 0171 404 3433

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

8.4 Coastal defence

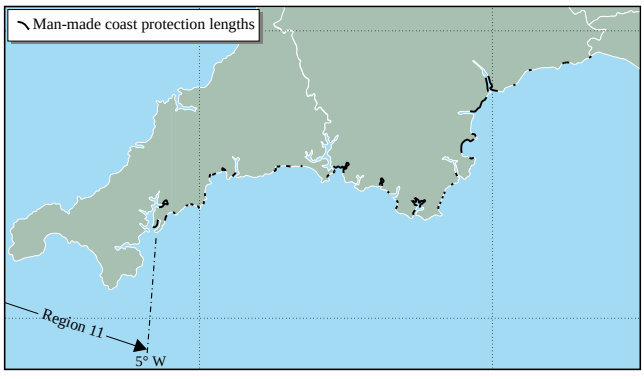
M.J. Dunbar, S.J. Everett, S.L. Fowler & J.A. Norton

8.4.1 Introduction

Coastal defence covers two types of works: coast protection and sea (or flood) defence. Coast protection works prevent or slow the erosion of land and encroachment by the sea. Sea defences protect low-lying land from flooding by the sea or rivers, especially to preserve human life and property in coastal settlements and industrial areas; many lengths were built in the past to protect low-lying agricultural land from flooding by the sea and to allow 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 are owned and maintained privately or by bodies that are not usually responsible for coastal defences, for example the Ministry of Defence (MoD). Works can range from simple wooden groynes installed on beaches to control coastal sediment movement, to major concrete engineering works (berms and seawalls). Some of these forms of coastal defence can provide vital 'toe' support to the base of coastal cliffs.

There are two major sources of current information about coastal works in England: the Coast Protection Survey of England (MAFF 1994) and the Sea Defence Survey of 1991 (NRA 1992). Map 8.4.1 shows coastal works around the region's coast as recorded in the MAFF survey; for detailed information about individual areas, MAFF or the relevant Environment Agency Regional Office should be consulted. Tables 8.4.1 and 8.4.2 show summary results from the Coast Protection Survey. Coastal works in the region tend to be on a small scale (only 15% of the coast is protected against erosion) compared with those in the more developed coastline to the east (Regions 7, 8 and 9), because of the generally stable coastline and the absence of isostatic sinking of the land. Most of the sea defences are in sheltered inlets that have centres of population. Sea defences on the open coast are also generally restricted to built-up areas, particularly coastal resorts such as Torbay. Table 8.4.2 indicates the condition of coastal works in the region as identified in the MAFF survey and the degree of erosion that they are experiencing.

Table 8.4.3 summarises data from the NRA, now the Environment Agency (EA), Sea Defence Survey (NRA 1992).



Map 8.4.1 Locations of coastal works. Source: MAFF 1994 database. See also Table 8.4.4.

Table 8.4.1 Coast protection in Region 10 and in England

Coastline	*Total length (km)*	*Unprotected length (km)*	*Coast protection length (km)*	*% protected*
Region 10	362	307	55	15
England	***2,925***	***2,065***	***860***	***29***

Source: MAFF 1994 database. Note: lengths exclude estuary and harbour shorelines and are given to the nearest km.

There is a relatively short length of defended coast in south Devon and Cornwall compared with south-east England.

8.4.2 Important locations

Table 8.4.4 shows a breakdown of protected lengths of coast in the region by district, from the MAFF Coast Protection Survey. Areas where a large proportion of the shoreline is protected are Teignbridge, Torbay and Plymouth Districts (where about half of the coastline is protected), with rather less in East Devon (about 21%) and remaining districts having between 2% and 7% of their coastline protected.

Estuaries in the east of the region are more heavily defended than those in the west, owing to their lower-lying

Table 8.4.2 Length and condition of coast protection works and state of coastal erosion

Survey area	*Total length of coast***	*Length of coast defended*	*Length of coast suffering significant erosion*	*Proportion of coast defended*	*Proportion of defences requiring work*		*Proportion of coast suffering significant erosion*
	(km)	*(km)*	*(km)*	*(%)*	*Significant work (%)*	*Moderate work (%)*	*(%)*
Taunton Area (Dorset to Wales)*	1,480	146	34	10	2	15	2.3
England	***3,763***	***860***	***134***	***23***	***6***	***29***	***4***

Source: MAFF (1994). Key: *area includes Region 10; figures from Region 10 alone were not available; **estimated whole coast length to nearest km, including estuaries and harbours; see also section 8.4.4.

Table 8.4.3 Ownership of sea (flood) defences (km**)

NRA Region	*NRA*	*Local authority*	*Privately owned*	*Total*
South West*	23	33	24	80
England & Wales*	***805***	***242***	***212***	***1,259***

Source: NRA (1992). Notes: *Region 10 was included in the NRA South-West Region at the time of the survey; figures for the region alone were not available; **lengths have been rounded to the nearest whole km.***Thames Region was omitted from the survey as, being inland, it has no sea defences.

land and softer rock. For example, the Exe Estuary has extensive lengths of embankments and groynes, with coastal works also protecting the railway that runs along both sides of the estuary. Plymouth Sound has very extensive coastal works associated with docks and industries and an extensive breakwater at its entrance.

Table 8.4.4 Lengths* of coast protection works

Council frontage	*Total length (km)*	*Undeveloped** *length (km)*	*Coast protection length (km)****	*% protected*
Devon				
East Devon	48	38	10	21.2
Teignbridge	23	10	13	55.3
Torbay	25	14	11	44.5
South Hams	102	97	5	4.9
Plymouth	16	8	8	51.3
Cornwall				
Caradon	55	52	4	6.6
Restormel (south coast)	45	44	1	2.4
Carrick (south coast)	48	44	3	6.9
Region 10	***362***	***307***	***55***	***15.2***
England whole coast	2,925	2,065	860	29.4
% of English coast totals in region	12.4	14.9	6.4	-

Source: MAFF 1994 database. Key: *rounded to the nearest whole km; **i.e. lacking man-made coast protection; ***excludes inner estuary and harbour coastlines. Note: see Map 8.4.1.

8.4.3 Management

Departmental responsibility for coast protection and sea defence in England lies with MAFF. In England and Wales operational responsibility for coast protection works is generally the responsibility of District Councils under the Coast Protection Act (1949), although other bodies may maintain some stretches of coast protection, for example alongside railway lines. Sea defences were made the responsibility of the NRA (now the Environment Agency - EA) 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. MAFF set up a Coastal Groups Forum in 1991 to promote the formation of coastal groups, to further co-operation between parties responsible for coastal defences, to identify research needs and to promote strategic planning of coastal defences. The forum meets twice a year and includes representatives of the EA and the regional coastal groups, which co-ordinate the work of adjacent coastal defence agencies (see also Chapter 10).

Two non-statutory regional coastal groups have been established to promote co-ordination between coastal defence agencies in the region: the Lyme Bay and South Devon Coastline Group and the Cornwall and Isles of Scilly Coast Protection Group. More detailed information is given in section 10.3.1.

8.4.4 Information sources used

MAFF (1994) have recently published a detailed assessment of the extent and state of repair of coast protection works on the English coast and defence requirements to the end of the century. The survey also identified lengths of unprotected coast that were significantly eroding and where works might be necessary during the ten years following the survey. These detailed data are held by the contractors (Sir William Halcrow & Partners) and MAFF on a Geographic Information System (GIS), from which the information in Tables 8.4.1, 8.4.2 and 8.4.4 and on Map 8.4.1 was extracted. In these tables it is important to distinguish between whole-coast lengths and figures that refer only to coastal lengths included in the survey.

The National Rivers Authority carried out its Sea Defence Survey in 1991 (NRA 1992). The results are held mainly in a proprietary database cross-referenced to maps, and may be viewed at regional Environment Agency offices by prior arrangement. No detailed information from the database was available at the time of writing, so Table 8.4.3, drawn from the published survey, is general in scope. However this is a very accurate and detailed source of information, although now due for updating (by the time of publication, most of the defences classified as in need of significant or moderate works may have been improved or be included in a medium term capital programme).

Summaries of the extent of coast protection and sea defence works in estuaries are available for those sites covered by English Nature's Estuaries Initiative coastal processes reports (Coastal Research Group 1994; Institute of Estuarine and Coastal Studies 1995).

8.4.5 Acknowledgements

Thanks are due to officers of the County Councils, MAFF, the Environment Agency, DoE and English Nature staff.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Departmental responsibility for flood defence and coast protection policy, provision of grants towards capital expenditure by the responsible bodies. Coast Protection Survey of England.	*Ministry of Agriculture, Fisheries and Food (MAFF), Flood and Coastal Defence Division, London, tel: 0171 238 3000
Coast protection and prevention of flooding of non-agricultural land	*District Councils
Co-operation between parties responsible for coastal defences, identification of research needs and promotion of strategic planning of coastal defences	*English Coastal Groups Forum, MAFF Flood and Coastal Defence Division, London, tel: 0171 238 3000
Storm Tide Warning Service	Meteorological Office, London Road, Bracknell, Berkshire RG12 2SZ, tel: 01344 420 242
Flood defence - general	*Environment Agency (EA) HQ, Bristol, tel: 01454 624 400
Flood defence - Devon and Cornwall	*EA South West Region, Exeter, tel: 01392 444 000
Coastal Engineering Advisory Panel	Anne-Marie Ferguson, Institute of Civil Engineers, 1 Great George Street, London SW1P 3AA, tel: 0171 222 7722
Coastal Engineering Research Advisory Committee	International Council for the Exploration of the Sea, Palægade 2-4, DK-1261, Copenhagen K, Denmark
Co-ordination and liaison between agencies undertaking coastal works in south-west England	Regional Engineer, MAFF, Quantock House, Paul Street, Taunton, Somerset TA1 3NX, tel: 01823 337 922
Co-ordination and liaison between agencies undertaking coastal works: Portland Bill to Rame Head	*Lyme Bay and South Devon Coastline Group, M.F. Johnson, Director of Technical Services, South Hams District Council, Totnes, tel: 01803 861234
Co-ordination and liaison between agencies undertaking coastal works: Rame Head to Hartland Point	J.V. Calvert, Cornwall and Isles of Scilly Coast Protection Group, Kerrier District Council, Council Offices, Camborne, Cornwall TR14 8RY, tel: 01209 712941

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

Tourism is hugely important in Region 10 as a major source of revenue and a significant influence on land use and infrastructure. Here at Bigbury Bay, an ingenious vehicle is employed to ferry trippers across the sands at high tide to the aptly-named Pilchard Inn on Burgh Island. Photo: Pat Doody, JNCC.

Chapter 9 Human activities

9.1 Fisheries

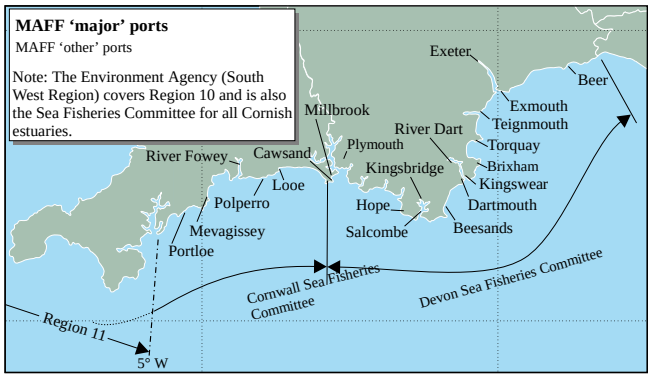
C.F. Robson

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 and several marine shellfish species (demersal fish live on or near the sea bed; pelagic fish tend to be found in midwater) and diadromous species - in this section salmon, sea trout and eels - which spend part of their lives in fresh water and part at sea. The section also covers sea angling and bait collection. For more information about the species concerned, including their scientific names, see sections 5.5, 5.7 and 5.8.

Plymouth and Brixham are the two 'major' fishing ports (as defined by MAFF) in the region, and both have daily fish markets. They and other MAFF-defined ports where fish and shellfish are landed are shown on Map 9.1.1. The fishing fleet in this region comprises two groups: offshore vessels, the majority of which are based in Brixham and Plymouth and which generally spend a number of days at sea and fish beyond the 12 mile limit, and inshore boats, which tend to fish within the 12 mile limit and land their catch every day. These two groups may be further divided into trawlers, beam trawlers, potters, netters and handliners.

In 1992, 4.1% of all recorded landings of fish and shellfish species in Britain (and the Isle of Man) were made in this region, which is below the average for all regions of 5.9%. The total tonnages of pelagic, demersal and shellfish species landed in the region in 1992 represent 5.4%, 2.7% and 4.6% respectively of the British totals. Pelagic species dominate the landings in the region, and the total, although a small percentage of the British figure, is a significant 57.5% of the England and Wales total. The tonnage of pilchard landed in the region represents 100% of the British total and there are also significant landings of horse mackerel (52%) and sprat (16.8%). The region is important for a wide range of shellfish species: the tonnage of squid landed in the region represents 28.9% of the British total and there are also



Map 9.1.1 MAFF-defined fisheries landing ports and Sea Fisheries Committees. © Crown copyright.

significant landings of scallops (19.8%) and crabs (10.7%). A summary of the total landings in 1992 for pelagic, demersal and shellfish species is given in Table 9.1.1.

The majority of all fish landed in the region in 1992 was landed at the main ports of Brixham and Plymouth. Table 9.1.2 summarises landings to these main ports 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.

Three diadromous species - salmon, sea trout and eel - support licensed net and rod-and-line fisheries in the region, the most important of which are for salmon (including grilse, young salmon that have spent less than one winter at sea before maturing) and sea trout. The main method of netting is by using seine nets. As shown in Table 9.1.3, a relatively small percentage of the salmon and grilse recorded as caught in GB is from this region, with a slightly higher percentage of sea trout.

Table 9.1.1 Species group landings in 1992 (tonnes)

Species group	*Region 10*	*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	13,692	184,309	23,809	252,335	7.4	5.4
Demersal	7,344	228,056	81,237	275,460	3.2	2.7
Shellfish	4,876	61,933	55,360	104,912	7.9	4.6
All species	***25,912***	***474,298***	***160,406***	***632,712***	***5.5***	***4.1***

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.). Note: amounts landed are rounded up to the next whole tonne. Calculating the figures in this table was a complex process: refer to section 9.1.4.

Table 9.1.2 Landings[a] of all fish species to Region 10 main ports 1991-1994 (thousands of tonnes)

	1991	*1992*	*1993*	*1994*
Brixham	9.0	7.6	9.0	9.2
Plymouth	9.3	11.1	10.9	12.0
Region 10 main ports	***18.3***	***18.7***	***19.9***	***21.2***
England & Wales	169.0	160.6	165.5	178.7
% of England & Wales total landed in Region 10 main ports	10.8	11.6	12.0	11.8

Sources: MAFF 1994, 1995a, b. Key: [a]landings totals relate to 'nominal live weight', i.e. weight of the whole fish.

Table 9.1.3 Average catch (numbers of fish) of salmon and grilse and sea trout 1989 - 1993

	Salmon and grilse	*Sea trout*
Region 10	6,743	5,042
North Sea coast	196,247	104,789
England & Wales	67,347	76,337
GB	***254,829***	***141,813***
% of North Sea coast total in region	3.4	5.0
% of GB total in region	2.6	3.7

Sources: Scottish Office Department of Agriculture and Fisheries (1990); National Rivers Authority (1991, 1992, 1993, 1994a, b); Scottish Office (1991, 1992, 1993, 1994). Note: calculating the figures in this table was a complex process: refer to section 9.1.4.

9.1.2 The fisheries

Pelagic species

Table 9.1.4 gives the quantities of various pelagic species landed in 1992 in the region, compared with landings nationally. Historically, the pilchard fishery once supported over a third of the Cornish workforce and was extremely important to the economy of the South-West Peninsula. The directed pilchard fishery has been restricted by the 'Mackerel Box' (see below), where there is a 15% mackerel by-catch limit. Pilchards are targeted in winter by drift netters, pair trawlers and purse seiners from Plymouth and Mevagissey and by some visiting boats. Catches are sold to a local processor in Plymouth and the one remaining company in the pilchard curing business.

Purse seining and pair trawling for mackerel are now restricted in the Mackerel Box, which includes all the coastal waters of Region 10 (see section 5.7.3), to conserve mackerel stocks. The traditional mackerel handline fishery takes place in the autumn, when shoals of mackerel move inshore for the winter. This method is popular in the summer with charter boats taking visitors on day trips. Having spawned during spring and early summer, the mackerel feed throughout the summer to build up their food reserves. By the end of the summer their oil content is at its peak, contributing up to 30% of their total body weight; mackerel caught at this time are ideal for processing. Herring and sprats are targeted by midwater single or pair trawling by vessels working out of Brixham, Teignmouth and Exmouth. The sprat fishery begins in late summer, and the local processor in Exmouth often limits the amount of fish each boat can land so as not to exceed demand. The sprats are pickled in brine and exported in barrels. A small-scale herring drift-net fishery involves small open beach boats, from autumn to spring.

Demersal species

Table 9.1.5 gives the quantities of various demersal species landed in 1992 in the region, compared with landings nationally. Smaller inshore vessels that use otter trawls, or are capable of using a beam trawl, land a variety of demersal species throughout the year. Species such as Dover sole, plaice, rays, turbot and monkfish (angler) are most commonly landed from September to March. Otter trawling continues all year, although the catch composition changes as different fish species migrate onto the fishing grounds. Cod and whiting tend to be targeted in winter and flatfish in spring. Since the late 1980s, non-quota species such as red mullet and sea bream have become more important in the summer, as quota restrictions are imposed on flatfish. In 1992 the 'Others' category, which includes these species, made up 27.7% of the British total landed.

Small beam trawlers target flatfish for most of the year,

Table 9.1.4 Pelagic species landings (tonnes) in 1992

Species group	*Region 10*	*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*
Herring	289	74,706	915	85,650	0.4	0.3
Horse mackerel	779	1,374	1,026	1,499	56.7	52.0
Mackerel	6,691	95,366	9,142	150,726	7.0	4.4
Pilchard	4,244	4,244	4,244	4,244	100.0	100.0
Sprat	1,689	8,478	8,478	10,032	19.9	16.8
Whitebait	0	1	1	1	0	0
Others	P	140	3	183	-	-
Total	***13,692***	***184,309***	***23,809***	***252,335***	***7.4***	***5.4***

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.

Table 9.1.5 Demersal species landings (tonnes) in 1992

Species group	*Region 10*	*North Sea coast*	*England & Wales*	*Britain and Isle of Man*	*% of North Sea coast total landed in region*	*% of combined British and Isle of Man total landed in region*
Elasmobranchs						
Dogfish	94	7,449	3,625	13,348	1.3	0.7
Skates and rays	277	3,816	4,142	7,827	7.3	3.5
Gadoids						
Cod	230	53,440	23,530	59,524	0.4	0.4
Haddock	3	49,221	3,706	53,586	0	<0.1
Hake	106	589	1,621	3,620	18.0	2.9
Ling	213	4,594	1,708	6,027	4.6	3.5
Pollack (lythe)	361	1,921	1,734	3,023	18.8	11.9
Saithe	26	11,032	2,284	12,602	0.2	0.2
Whiting	738	36,733	5,088	41,055	2.0	1.8
Whiting, blue	P	6,531	P	6,531	-	-
Flatfish						
Brill	124	317	392	443	39.1	28.0
Dab	123	1,017	456	1,215	12.1	10.1
Dover Sole	803	2,021	2,812	2,876	39.7	27.9
Flounder	62	167	269	273	37.1	22.7
Halibut	P	166	80	194	-	-
Halibut, Greenland	0	119	117	137	0	0
Lemon sole	924	5,004	3,000	5,573	18.5	16.6
Megrim	40	1,379	1,471	4,037	2.9	1.0
Plaice	1,384	20,749	15,970	23,887	6.7	5.8
Turbot	74	561	545	742	13.2	10.0
Other species						
Catfish	0	1,896	557	1,935	0	0
Conger eel	63	99	403	510	63.6	12.4
Gurnard	297	368	589	627	80.7	47.4
Monkfish/angler	322	9,813	3,102	14,678	3.3	2.2
Redfish	0	718	581	774	0	0
Sand eels	0	4,152	P	4,152	0	0
Torsk (tusk)	0	165	13	207	0	0
Witch	2	1,405	192	1,981	0.1	0.1
Others	1,060	2,419	3,151	3,833	43.8	27.7
Fish roes	18	195	99	243	9.2	7.4
Total	***7,344***	***228,056***	***81,237***	***275,460***	***3.2***	***2.7***

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.

although some may switch to scallop dredging during the summer. Gill netters generally fish on rough ground and wrecks (which are inaccessible to trawlers) for cod, pollack, ling, conger, rays and dogfish or use tangle nets for Dover sole, plaice, rays, turbot, brill and monkfish.

Both bass and mullet (in the 'Others' category) are caught in gill nets either drifted or set close to the coast and, when permitted (see section 5.7 for bass nursey areas), in estuaries. Bass are also caught on handlines and longlines set by the smaller boats. French and occasionally Scottish pair trawlers target bass, usually offshore but sometimes as close as 6 miles off this coast. Sandeels are caught in beach seines and light trawl gear, for use as bait in estuaries and harbours.

Shellfish species

Table 9.1.6 gives the quantities of various shellfish species landed in 1992 in the region, compared with landings nationally.

The region supports the largest fishing fleet for edible crab in the UK, based around Kingswear and Salcombe. The traditional 'inkwell' pot is the most commonly used trap, although 'parlour' pots are also used inshore. The fleet comprises both vivier-equipped (with sea-water holding tanks) offshore boats, which set up to 2,000 pots out into the middle of the Channel and often land their catches into France, and smaller inshore boats that set up to 600 pots, usually within a few miles of the coast. Lobsters are targeted along most of the region's coast; the fishery peaks during late summer/early autumn, although pots are still set during the winter in sheltered areas, where they also yield velvet and green crabs. Spider crabs form dense spawning aggregations during spring, when landings can be very high. Spider crabs and crawfish are often caught in tangle nets.

Dredging for both scallops and queen scallops increased through the 1970s as markets were established abroad.

Table 9.1.6 Shellfish* species landings (tonnes) in 1992

Species group	*Region 10*	*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	1,823	9,117	9,453	16,970	20.0	10.7
Lobsters	20	622	504	1,069	3.2	1.9
Mussels	41	4,865	3,488	6,555	0.8	0.6
Nephrops	0	8,368	1,918	19,639	0	0
Periwinkles	0	315	70	1,907	0	0
Queen scallops	P	2,207	2,989	11,273	-	-
Scallops	1,638	4,519	2,589	8,290	36.2	19.8
Shrimps	0	615	563	743	0	0
Squids	579	1,382	919	2,005	41.9	28.9
Whelks	P	1,905	1,535	2,393	-	-
Others	775	1,819	1,831	2,026	42.6	38.3
Total*	***4,876***	***61,933***	***55,360***	***104,917***	***7.9***	***4.6***

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: *excluding landings of farmed shellfish - see section 9.2; 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.

Scallops are harvested mainly from June to August, with the lowest landings occurring in the winter between November and January, partly because of adverse weather conditions in those months and partly because seasonal opportunities exist then in other fisheries. In spring and early summer the quality of the scallops is not as good, owing to spawning, and some boats switch to beam trawling.

Native oysters are harvested by hand in the Salcombe Estuary and were traditionally dredged from several of the estuaries in the region. However many of the stocks were overfished and the industry ceased in the 1940s. Harvesting continued in the Dart Estuary until the 1980s, when boat anti-fouling paint containing tributyltin (TBT) affected the stocks to such an extent that the fishery became uneconomic. There are at present plans to re-stock the beds in the Dart, and perhaps the Exe, with native oysters from the Orkneys (see section 9.2.2). Native oysters have been dredged from the Lynher and Tamar. However, these estuaries are not currently being exploited, because of the reduced water quality in the areas where the oysters are present, which would necessitate them being relayed into cleaner areas before they could be sold. This is possible, but logistical problems such as access and ownership are impeding progress with this fishery.

The natural mussel beds in the Exe, Teign, Dart and Avon Estuaries are re-seeded (see section 9.2.2.) and the resulting larger mussels are collected by non-mechanical methods such as hand-picking or by using rakes. Mussels are also hand picked from the rocks at Whitesand Bay and the Fowey Estuary. The mussels in the Lynher and Tamar are also hand picked. Attempts have been made to reseed mussels from the Lynher and Tamar into areas of better water quality, but with no success to date.

In some inshore areas pink prawns and whelks are targeted using pots. The landings of whelks have increased since 1992, with around 250 tonnes landed in 1994, and this is a fast growing target fishery in this region. Cockles and periwinkles are gathered by hand. Cuttlefish and squid have recently become an important resource to the inshore otter trawling fleet, as scallops and demersal species become scarce and less profitable in the summer.

Diadromous species

The distribution of diadromous fish species in rivers in the region is discussed in section 5.8. The main rivers of interest are the Exe, Teign, Dart, Tamar, Tavy, Lynher, Fowey and Plym (Table 9.1.7). Salmon and sea trout in the region support a seine net fishery, with 74 licences issued in 1993.

Table 9.1.7 Salmon and grilse and sea trout five-year (1989-1993) average catch (as numbers of fish reported), catch methods used and number of net licences issued in 1993

	Salmon & grilse	*Sea trout*	*Method used/net licences issued*
River			
Axe	0	68	Rod
Otter	0	35	Rod
Exe	1,702	41	Rod, seine nets (18)
Teign	1,196	1,441	Rod, seine nets (10)
Dart	1,081	1,010	Rod, seine nets (18)
Avon	33	122	Rod, fixed engine (1)*
Erme	0	48	Rod
Yealm	0	55	Rod
Plym	22	290	Rod
Tavy	401	366	Rod, seine nets (4)
Tamar	1,719	433	Rod, seine nets (15**)
Lynher	305	292	Rod, seine nets (5)
Looe	0	61	Rod
Fowey	285	781	Rod, seine nets (4)
Region 10	***6,743***	***5,042***	***75***

Source: National Rivers Authority (1991, 1992, 1993, 1994a, b). Key: *this licence was not used; in 1995; **includes one net licensed for both the Tamar and the Tavy. Notes: 'sea trout' here includes all migratory trout. 'Nets' are defined as instruments other than rod and line. Rivers with very small recorded catches have been excluded from this table, so the distribution of rod and line fishing may be more widespread than appears here. Map 5.8.1 shows the locations of rivers in this table.

Fyke and elver nets are used in estuaries, such as the Fowey Estuary, to catch migrating adult eels (silver eels) and juvenile eels (elvers) respectively. Table 9.1.7 shows the average numbers of salmon and grilse and sea trout caught in the region's rivers and fisheries in the five years between 1989 and 1993, the methods used to catch them and the numbers of net licences issued in 1993.

Sea angling

Sea angling is a popular sport practised by over two million people in Great Britain (Fowler 1992). The governing body in England is the National Federation of Sea Anglers, which has approximately 570 affiliated clubs with some 33,000 individual members. Sea angling is distinguished from two other types of sport fishing: game fishing for salmon, sea trout, brown and rainbow trout (the first two are covered here) and coarse fishing, which is for freshwater fish species and so is not covered here. Sea angling has three main forms: angling from the shore, inshore fishing within about 5 km of the shore and deep sea fishing. Sea angling occurs in many places in the region, but the main locations are Sidmouth Bay, Exmouth, Dawlish, Teignmouth, Torquay, Paignton, Brixham, Dartmouth, Torcross, Salcombe, Newton Ferrers, Plymouth, Looe, Polperro, Fowey Estuary, Mevagissey and Gorran Haven (Orton 1994). Torquay is famous for wreck fishing, and at Paignton the summer months are considered the best time to fish for a wide range of species. Sea angling at Brixham yields plaice, dab, mackerel and grey mullet from the harbour. Congers and thornback rays are landed at Dartmouth, and Salcombe Estuary is good for bass. The area around Plymouth is good for offshore deep-water fishing, for example near Eddystone Reef, where pollack, conger, ling, whiting, cod, bream and mackerel are taken regularly. Looe is a good all-round sea angling port but is best known for its shark fishing for porbeagle, mako, blue and sometimes thresher shark. Tag and release programmes are operated by shark anglers in conjunction with Plymouth Marine Laboratory. The bass fishery in Seaton Bay attracts many anglers. Fishing boats in the region are becoming more dependent on chartered angling trips for tourists and angling clubs, with some boats also offering pleasure cruises along the coastline. Spearfishing is a popular activity in the south-west, and bass are frequently caught in this way.

Bait collection

Bait collection for sea angling occurs in many areas in the region, although some areas are more prolific than others and may attract commercial collectors (Fowler 1992). Anglers often collect their own bait locally, while commercial collectors travel in teams to suitable shores. Many species are collected in the region, including ragworm, lugworm, peeler crabs (moulting shore crabs), mussels, cockles, limpets and razor shells. 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 at many locations in the region. The Teign Estuary is important for peeler crab collection and also for sandeel seining; like squid and mackerel, sandeel are also used as angling and pot bait. Areas such as Torbay and the Exe, Salcombe & Kingsbridge and Fowey Estuaries experience larger numbers of diggers and some problems have been encountered (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). EU regulations are implemented through UK law (see Way (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. Between 6 and 12 nautical miles from baseline (low water mark) other member states with historic rights also have access, and beyond 12 nautical miles (the limit of the British Territorial Seas) access to vessels from the other member states is limited based on historic fishing rights and to vessels from non-member countries by reciprocal agreements within the European Union.

For the purpose of stock assessment, waters around the UK have been divided into statistical areas by the International Council for the Exploration of the Sea (ICES). The coastal seas around this region are part of Division VIIe (English Channel - West). 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 intended to reflect the maximum level of exploitation that a given stock can sustain. Precautionary TACs are applied to important stocks where there is 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) fixes, for 1996, details of

the national catch quotas for fish and shellfish species for all European countries and certain conditions under which the species may be fished. The annual TACs, UK quotas and 'uptake' for each species in the ICES statistical division in the region are given in MAFF (1994, 1995a, b). European Council Regulation No. 3760/92 (European Council 1992) summarises the CFP, including the proportions by which TACs are allocated as national quotas. Details of 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 Devon Sea Fisheries Committee (DSFC) and the Cornwall Sea Fisheries Committee (CSFC) manage the sea fisheries from the high water mark out to 6 nautical miles from UK baselines (as defined by the Territorial Waters Order in Council 1964, as amended), apart from estuaries in Cornwall, which are regulated by the Environment Agency (EA) (see below). The boundary between these two Sea Fisheries Committees is at Rame Head (Map 9.1.1). DSFC bylaws prohibit boats over 15.24 m (or 50 ft) fishing for sea fish within 3 miles of the coast (although boats of up to 18.29 m are exempt provided that they were fishing before 1991 and were registered in the same ownership). The use of trawl gear has also been prohibited in specified areas to help protect juvenile fish stocks. The protected areas include Start Bay and waters within estuaries. Mesh sizes are also regulated. The DSFC have bylaws which enable the closure of any shellfishery, any bed or part of a bed of shellfish to aid recovery, if they think that it is so severely depleted as to merit such action. A CSFC bylaw prohibits boats over 18.29 m from trawling within 3 miles of the coast. Trawling is also prohibited in certain parts of the CSFC district. Local MAFF Sea Fisheries Inspectorate officers deal with quota management, enforcement of UK and EU fisheries legislation and licensing of fishing vessels.

The EA's South West Region has responsibility to regulate, protect and monitor salmon, sea trout and freshwater eel fisheries from rivers to coastal waters out to the 6 nautical mile limit. The EA are also the Sea Fisheries Committee for all Cornish estuaries. The two Sea Fisheries Committees also have powers to support this conservation of salmonid fisheries whilst exercising their responsibilities towards the regulation of sea fisheries. For example, in 1988 the CSFC introduced a fixed engine bylaw which prohibits the use of nets in many areas (mostly around estuaries) unless they are set 3 m below the water surface. The object is to help protect the passage of salmon and sea trout along the coast.

In England and Wales MAFF's Sea Fisheries Inspectorate is responsible for collecting and the Directorate of Fisheries Research (DFR) Laboratory at Lowestoft for collating information on fish stocks exploited by UK vessels. The MAFF DFR Fisheries Laboratory at Conwy is the Directorate's centre for assessing the implications of non-fisheries activities and coastal zone usage on fish stocks and fisheries. MAFF DFR databases are described in Flatman (1993).

Fishermen's organisations represent fishermen's and boat owners' interests in the fishing industry and are consulted on fisheries management issues and other fisheries related issues.

Regulating Orders are granted in England by MAFF to a responsible body to enable it to regulate the fishery for particular wild stocks of molluscan shellfish species. The specified shellfish stock may be fished only in accordance with the terms of the order and any regulations made under it. There is one Regulating Order in this region (Table 9.1.8), out of nine in Britain covering approximately 215,889 ha (as at July 1995).

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. Issues include the effects on target species as major components in marine ecosystems, the changed availability of food for predators, the effects on non-target species, and effects on species and habitats of nature conservation interest. These issues 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 Marine Fisheries Task 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) affect wildlife and identifies any action needed. 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. The '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. 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 - 9.1.8 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.

Table 9.1.8 Regulating Orders in the region

Title	*Species*	*Location*	*Grid ref.*	*Grantee*	*Approx. area (ha)*	*Expiry date*
River Teign Mussel Fishery Order 1966	Mussels, oysters	Teignmouth	SX920725	Teign Musselmen's Society Ltd	156	2026

Source: MAFF (1995c). Note: Several Orders are listed in Table 9.2.2.

Pelagic, demersal and shellfish species

Statistics given here are for landings recorded in the region, not estimated catches made in the region. Some fish caught in the region may not be landed in the region's ports or even in the UK; other fish are landed in the region but are caught outside it; and until 1993, boats under 10 m were not obliged to register their landings. Vessels are not required to report landings of non-quota species, so the figures for these species are certainly underestimates. 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 and 1994 for England and Wales have also been published in MAFF (1995a, b).

The tonnages of various pelagic, demersal and shellfish species (fresh and frozen) landed by UK vessels at the major ports in England and Wales come from *UK sea fisheries statistics 1991 and 1992* (MAFF 1994): this applies to Plymouth and Brixham, the two 'major ports' in the region. A total for the 'other', smaller, ports (see Map 9.1.1) was provided by the MAFF Fisheries Statistics Unit. These data have been combined to give the figures in the 'Region 10' column for Tables 9.1.1 and 9.1.4 - 9.1.6. The figures in the 'North Sea coast' column in Tables 9.1.1 and 9.1.4 - 9.1.6 were calculated by adding together all the landings data for the ten Coastal Directories regions on the North Sea coast of Great Britain.

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 the 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. Also, SOAEFD publish the weight of fish as 'standard landed weight' (gutted fish with head on), whereas MAFF and IoM DAFF provide 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 sandeels (which are not gutted), so that all the data given represent 'nominal live weight'.

Diadromous species

The Environment Agency reported catches for salmon, grilse and sea trout vary in accuracy from year to year, as they represent only declared catches by individuals with a net or rod licence; in addition, catches themselves fluctuate, and so the relationship between catch and stock is not straightforward. Further, in 1992, the introduction of changes to the catch recording system may have resulted in a temporarily reduced level of recording. Therefore the figures given in Tables 9.1.3 and 9.1.7 should be used only as an indication of the pattern of the catch in the region. The annual publication *Salmonid and freshwater statistics for England and Wales* (National Rivers Authority 1991, 1992, 1993, 1994a, b) contains more detailed information.

Sea angling

In the 84th edition of *Where to fish*, Orton (1994) lists much useful information relating to sea angling, including the locations from which various species of fish can be caught and the facilities available. Orton (1994) also lists contact addresses for fishing clubs in the region and national organisations.

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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9.1.6 Further sources of information

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C. Contact names and addresses

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
Central contact for the local Sea Fisheries Committees; general policy issues	Chief Executive, Association of Sea Fisheries Committees, Buckrose House, Commercial Street, Norton, Malton, North Yorkshire YO17 9HX, tel: 01653 698219
Local inshore fisheries information and advice on bylaws, national and EU legislation	Chief Fisheries Officer and Deputy Clerk, Devon Sea Fisheries Committee, Office 9, Fish Market, Brixham, Devon TQ5 8AW, tel: 01803 854648/882004
Local inshore fisheries information and advice on bylaws, national and EU legislation	Clerk, Cornwall Sea Fisheries Committee, County Hall, Truro, Cornwall TR1 3AY, tel: 01872 322000
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, MAFF Directorate of Fisheries Research, Fisheries Laboratory (Conwy), tel: 01492 593883
Assessment and advice on the conservation of fish stocks exploited by UK vessels. Seals and fisheries	*Director, MAFF Directorate of Fisheries Research, Fisheries Laboratory (Lowestoft), tel: 01502 562244
Shellfish hygiene and fish diseases	Head of Laboratory, MAFF Fish Diseases Laboratory, Barrack Road, The Nothe, Weymouth, Dorset DT4 8UB, tel: 01305 206600
Additional statistics other than those in publications (available from HMSO)	MAFF Fisheries Statistics Unit, Nobel House, 17 Smith Square, London SW1P 3JR, tel: 0171 238 6000
Local fisheries, quota management, licensing of fishing vessels and enforcement, UK and EU legislation, from Fowey to Lyme Regis	District Inspector, MAFF Sea Fisheries Inspectorate, South West District Fisheries Office, Fish Market, The Barbican, Plymouth, Devon PL1 2LU, tel: 01752 228001
National fisheries policy and projects; salmonid and freshwater statistics for England and Wales	Head of Department, Fisheries Department, Environment Agency (EA) Head Office, Rivers House, Waterside Drive, Aztec West, Almondsbury, Bristol BS12 4UD, tel: 01454 624400
Regional information and advice on diadromous fisheries; salmonid and freshwater statistics. Acting Sea Fisheries Committee for Cornish estuaries	Regional Fisheries Officer, EA South West Region, Manley House, Kestrel Way, Exeter EX2 7LQ, tel: 01392 444000

Type of information	Contact address and telephone no.
Research and fishing gear technology	Technical Director, Sea Fish Industry Authority, Seafish Technology Division, Sea Fish House, St. Andrew's Dock, Hull HU3 4QE, tel: 01482 27837
UKDMAP software; mapped fishing areas of selected species, ICES Statistical Division boundaries etc.	Project Manager, British Oceanographic Data Centre, Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, tel: 0151 652 3950
Local representation of fishermen's and boat owners' interests in the fishing industry	Honorary Secretary, South Devon and Channel Shellfishermen's Association Ltd, Leyburn, Torcross, Kingsbridge, Devon TQ7 2TJ, tel: 01548 580446
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
Shellfish production (commercial)	Director, Shellfish Association of the UK, Fishmongers' Hall, London Bridge, London EC4R 9EL, tel: 0171 626 3531
Affiliated angling clubs	Secretary, National Federation of Sea Anglers, 51a Queens Street, Newton Abbot, Devon TQ12 2QJ, tel: 01626 331330
Game fishing	Director, Salmon and Trout Association, Fishmongers' Hall, London Bridge, London EC4R 9EL, tel: 0171 283 5838
Interaction between fisheries and non-fisheries conservation issues	*Fisheries Liaison Officer, English Nature HQ, Peterborough, tel: 01733 340345
Marine Fisheries Task Group paper; interaction between fisheries and non-fisheries conservation issues	*Marine Advisory Officer, JNCC Peterborough, tel: 01733 62626
Interaction between fisheries and non-fisheries conservation issues	*Marine Policy Officer, RSPB HQ, Sandy, tel: 01767 680551
Interaction between fisheries and non-fisheries conservation issues	*Fisheries Officer, WWF-UK, Godalming, tel: 01483 426444
Interaction between fisheries and non-fisheries conservation issues	*Conservation Officer, Marine Conservation Society, Ross-on-Wye, tel: 01989 566017
Interaction between fisheries and non-fisheries conservation issues	Honorary Secretary, The Marine Forum for Environmental Issues, c/o University College Scarborough, Filey Road, Scarborough YO11 3AZ, tel: 01723 362392
Interaction between fisheries and non-fisheries conservation issues	*Marine Conservation Officer, Devon Wildlife Trust, Exeter, tel: 01392 79244

C. Contact names and addresses (continued)

Type of information	*Contact address and telephone no.*
Interaction between fisheries and non-fisheries conservation issues	*Director of Conservation, Cornwall Wildlife Trust, Truro, tel: 01872 73939
Seals and fisheries	Sea Mammal Research Unit, Gatty Marine Laboratory, University of St. Andrews, Fife KY16 8LB, tel: 01334 476161
Seals and fisheries	Susan Joy, Co-ordinator, Wildlife & Countryside Link Seals Group, 15 Park Road, East Grinstead, West Sussex RH19 1DW, tel: 01342 315400

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

9.2 Mariculture

C.F. Robson

9.2.1 Introduction

Mariculture is the cultivation of marine species. In this region there is cultivation of sea trout and shellfish farming for bivalve molluscs, located in the estuaries of south Devon and Cornwall.

9.2.2 Locations and species

Map 9.2.1 shows the location of commercial mariculture areas and the species that are cultivated in the region. Table 9.2.1 lists the main species that are under commercial cultivation in the region and in Great Britain and the Isle of Man. There is currently no cultivation of non-salmonid fish or polychaetes in this region.

Salmonids

Sea trout are cultivated in cages under one of the English China Clay Ports' jetties in the Fowey Estuary (Fowey Harbour Commissioners 1996).

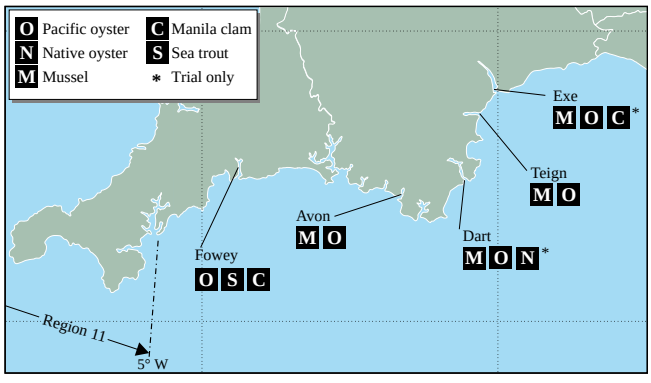
Shellfish

Pacific oysters are cultivated in the region in the Exe, Teign, Dart, Avon and Fowey Estuaries. The Pacific oysters are

Table 9.2.1 Main species cultivated in the region and in Great Britain and the Isle of Man

Species	*Species status*	*Cultivated in region*
Salmonids		
Atlantic salmon *Salmo salar*	Native	
Sea trout *Salmo trutta*	Native	✔
Non-salmonids		
Turbot *Psetta maxima*	Native	
Halibut *Hippoglossus hippoglossus*	Native	
Shellfish: bivalve molluscs		
Common mussel *Mytilus edulis*	Native	✔
Native oyster *Ostrea edulis*	Native	✔
Pacific oyster *Crassostrea gigas*	Un-established introduction	✔
Hard shelled clam *Mercenaria mercenaria*	Non-native	
Manila clam *Tapes philippinarum*	Un-established introduction	✔
Palourde *Tapes decussatus*	Native	
Scallop *Pecten maximus*	Native	
Queen scallop *Aequipecten opercularis*	Native	
Polychaetes		
King ragworm *Neanthes virens*	Native	

Sources: MAFF; Crown Estate Commissioners; La Tene 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.



Map 9.2.1 General locations of mariculture areas and species in culture. Sources: MAFF, Crown Estate Commissioners & La Tene Maps. © Crown copyright.

grown from spat bought in from commercial hatcheries. A variety of cultivation methods are used: in the Exe, Avon and Fowey, the Pacific oysters are put into bags and placed on racks or trestles in the intertidal zone. In the Teign, the 'Parc' system is used whereby the oysters are grown to a certain size in bags, then scattered directly onto the substrate for ongrowing. The bags are placed directly onto the intertidal shore in the Dart. Table 9.2.2 gives the total production of Pacific oysters landed from 1990 onwards from the estuaries in Devon (the Exe, Teign, Dart and Avon); production has shown a steady increase. The Pacific oyster farm at Pont Pill, Fowey Estuary, has been in operation only since April 1995, so no landing figures were available at the time of writing. Problems have been encountered with water quality and the lack of suitable waters in the vincinity for relaying. In the area of the Waddeton Oyster Fishery Order, in the Dart, trials are underway of the cultivation of native oysters alongside the Pacific oysters. Pacific oysters are not currently being cultivated at Salcome, owing to water quality problems introduced through the use of tributyltin (TBT) anti-fouling paint. Water quality is now thought to be improving, which should allow production to start again.

Mussel spat is collected from wild mussel beds and placed (reseeded) on natural beds within estuaries such as the Exe, Teign, Dart and Avon, to allow growth to a marketable size. These mussels are hand-picked or raked from the substrate. Table 9.2.2 gives the total production of mussels landed from 1990 onwards from these areas. The

Table 9.2.2 Total quantities of Pacific oysters and mussels landed from the Exe, Teign, Dart and Avon Estuaries (1990-1995)

Year	*Pacific oysters (tonnes)**	*Mussels (tonnes)**
1990	46	184
1991	49	168
1992	59	1,096
1993	66	274
1994	54	239
1995	62	236

Source: Devon Sea Fisheries Committee. Key: *amounts rounded to the nearest whole tonne.

increase in production in 1992 was due to there being a very good spatfall, which has not occurred since. Within Tor Bay or at Mansands there are plans to establish a system of mussel cultivation using long-lines strung from rafts.

After succesful trials in 1995, Manila clams are being cultivated at Pont Pill in the Fowey Estuary. The hatchery-reared clams are 'seeded' into the intertidal zone and covered with mesh to protect them from predators. Once they have reached marketable size they are collected using rakes. Cultivation trials of Manila clams are also under way in the Exe Estuary.

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. A database of the current hygiene status of shellfish harvesting areas is maintained by MAFF (Fisheries Division, Nobel House, and DFR 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 consent of the owners or managers of the sea bed is required and a lease may be needed before structures for mariculture can be erected on the sea bed. In many areas consent must be sought from the Crown Estate, since it owns or manages 55% of the foreshore and the same proportion of the beds of tidal rivers between mean high and low water in GB, together with virtually the entire territorial sea bed. Of the remainder of the foreshore the majority is owned by the Duchies of Cornwall and Lancaster (the River Erme is privately owned). 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 the cultivation of 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. There is one Several Order in this region (Table 9.2.3), out of 22 in Britain covering a total of approximately 3,299 ha (as at July 1995).

Pacific oysters are currently being cultivated in the area covered by the Waddeton Oyster Fishery Order (see section 9.2.2). The Devon Sea Fisheries Committee aims to take over the fishery when the Order expires and increase the area covered, and include mussels as well as oysters. The Devon Sea Fisheries Committee has applied for a Several Order for the Exe that would cover all molluscan shellfish species.

Mariculture and its effects are limited in this region compared with some other parts of Britain. However, issues relating to the cultivation of marine species are closely linked to marine nature conservation interests, particularly the possible effects on species and habitats of nature conservation interest. These issues for mariculture in general are under consideration by the 'Marine Fisheries Task 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 Marine Fisheries Task 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

Table 9.2.3 Several Orders in the region

Title	*Species covered*	*Grid ref.*	*Location*	*Grantee*	*Approx. area (ha)*	*Year of expiry*
Waddeton Oyster Fishery Order 1972	Oysters	SX867573	River Dart, near Galmpton, Devon	H. Goodson	12	1997

Source: MAFF (1995). Note: Regulating Orders are presented in Table 9.1.8.

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 (MAFF DFR Conwy), Dr P.D. McGovern (Crown Estate, Scotland), Neil Downes (Devon SFC), Paul Knapman (English Nature), Blaise Bullimore (Countryside Council for Wales), Indrani Lutchman (WWF-UK), and Clare Eno and Mark Tasker (JNCC). Thanks also go to R.C.A. Bannister and David Bennett (MAFF DFR), Stuart Bray (Environment Agency (EA) South-West Region), Miran Aprahamian (EA North-West Region), E.J. Derriman and R.G. Teague (Cornwall SFC) and Emma Burfoot (Fowey Harbour Commissioners) for providing information and commenting on drafts.

9.2.5 Further sources of information

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Spencer, B.E., Edwards, D.B., & Millican, P.F. 1991. *Cultivation of Manila clams.* Lowestoft, MAFF. (Directorate of Fisheries Research Laboratory Leaflet, No. 65.)

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
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
Several Orders, mariculture activities and local bylaws	Chief Fisheries Officer and Deputy Clerk, Devon Sea Fisheries Committee, Office 9, Fish Market, Brixham, Devon TQ5 8AW, tel: 01803 854648/882004
Several Orders; mariculture activities and local bylaws	Clerk, Cornwall Sea Fisheries Committee, County Hall, Truro, Cornwall TR1 3AY, tel: 01872 322000
Fisheries and mariculture in England, including Several Orders. Seals and mariculture	MAFF (Aquaculture Division), Nobel House, 17 Smith Square, London SW1P 3JR, tel: 0171 238 5940
Scientific advice: marine fish and shellfish cultivation; advice on management and policy issues for the coastal zone. Interaction between mariculture activities and marine nature conservation issues	*Head of Laboratory, MAFF Directorate of Fisheries Research, Fisheries Laboratory (Conwy), tel: 01492 593883
Bivalve mollusc production areas; classification of shellfish waters and shellfish diseases	Head of Laboratory, MAFF Directorate of Fisheries Research, Fish Diseases Laboratory, Barrack Road, The Nothe, Weymouth, Dorset DT4 8UB, tel: 01305 206600
Technical advice on shellfish purification (depuration)	Sea Fish Industry Authority, Sea Fish House, St. Andrews Dock, Hull HU3 4QE, tel: 01482 27837
Leases	The Crown Estate, Marine Estates, 16 Carlton House Terrace, London SW1Y 5AH, tel: 0171 210 4377
Salmon farming	Director, Scottish Salmon Growers Association, Drummond House, Scott Street, Perth PH1 5EJ, Scotland, tel: 01738 635420
Commercial advice on shellfish	Director, Shellfish Association of the UK, Fishmongers Hall, London Bridge, London EC4R 9EL, tel: 0171 6263531

Type of information	*Contact address and telephone no.*
Interaction between mariculture activities and marine nature conservation issues	*Fisheries Liaison Officer, EN HQ, Peterborough, tel: 01733 340345
Marine Fisheries Task Group paper; interaction between mariculture activities and marine nature conservation issues	*Marine Advisory Officer, JNCC, Peterborough, tel: 01733 62626
Interaction between mariculture activities and marine nature conservation issues	*Coastal Policy Officer, RSPB HQ, Sandy, tel: 01767 680551
Interaction between mariculture activities and marine nature conservation issues	*Fisheries Officer, WWF-UK, Godalming, tel: 01483 426444
Interaction between mariculture activities and marine nature conservation issues	*Conservation Officer, Marine Conservation Society, Ross-on-Wye, tel: 01989 566017
Interaction between mariculture activities and marine nature conservation issues	Honorary Secretary, The Marine Forum for Environmental Issues, c/o University College Scarborough, Filey Road, Scarborough YO11 3AZ, tel: 01723 362392
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Interaction between mariculture activities and marine nature conservation issues - Cornwall	*Director of Conservation, Cornwall Wildlife Trust, Truro, tel: 01872 73939
Seals and mariculture	Sea Mammal Research Unit, Gatty Marine Laboratory, University of St. Andrews, Fife KY16 8LB, tel: 01334 476161
Seals and mariculture	Co-ordinator, Wildlife & Countryside Link Seals Group, 15 Park Road, East Grinstead, West Sussex RH19 1DW, tel: 01342 315400

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

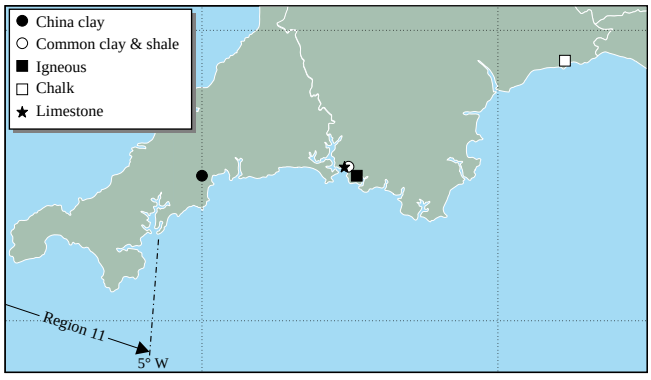
9.3 Quarrying and landfilling

C.A. Crumpton & M.J. Goodwin

9.3.1 Introduction

In this section, quarries are included as coastal if they are less than 2 km inland and landfill sites if they are in a coastal 10 km square. The minerals quarried in the region on a commercial basis are china clay, clay and shale, chalk, limestone and igneous rock. These minerals are put to a variety of uses including for bricks, pipes and tiles (clay); construction and roadstone (clay, igneous rock and limestone); and cement and concrete aggregate (limestone). China clay is used mainly as a coating layer for gloss paper.

Table 9.3.1 presents production levels by whole county, compared with British levels, for the main minerals quarried in the region. For clay and shale, the figure for production in Devon is not available, for commercial reasons. However, 651,000 tonnes were produced from the combined area of Devon, Wiltshire, Avon and Dorset in 1993, accounting for approximately 6% of the British total.



Map 9.3.1 Coastal quarries. Source: BGS (1994). © Crown copyright.

9.3.2 Important locations

In this region there are 21 coastal quarry workings extracting one or more minerals (Map 9.3.1). Of these, china clay is extracted from seventeen quarries and limestone, clay and shale, igneous rock and chalk each from one quarry (Table 9.3.2).

All the china clay workings in Britain are located in Devon or Cornwall - over half of them in Region 10, centred around St. Austell, and the remainder in Region 11. In 1993 approximately 22 million tonnes of waste were created in the production of 2.8 million tonnes of china clay. A percentage of this waste is used as aggregate for road building schemes. For example, during the construction of the new A30/39 Fraddon/Indian Queens bypass, china clay waste made up 30% of the total aggregate content of concreting sand and was widely used for other filling purposes (Cornwall County Council pers. comm.).

During 1994 there was an increase in quarrying activity in Cornwall compared with the previous two to three years; the County Council received eleven applications for minerals extraction and associated operations over the year (South West Regional Aggregates Working Party 1994).

Map 9.3.2 shows the locations 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 9.3.3. Landfill sites in the region are concentrated in the east, near the urban areas of Exeter, Teignmouth, Torquay, Paignton and Dartmouth. The western parts of the region have many fewer, with the exception of the Plymouth area.

Table 9.3.2 Coastal quarries in the region

Location	*Operator*	*Mineral*
Devon		
Seaton	ARC Southwestern	Chalk
Yealmpton	English China Clays Ltd	Igneous
Plymstock	Blue Circle	Clay and shale
Billacombe	English China Clays Ltd	Limestone
Cornwall		
St. Austell	English China Clays Ltd (17 workings)	China clay

Source: British Geological Survey (1994).

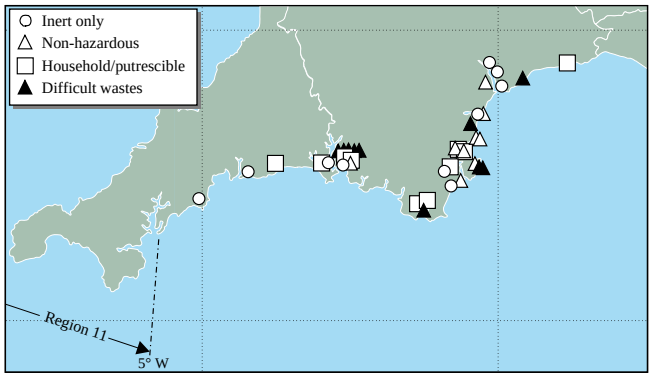
9.3.3 Management

In April 1996 the Environment Agency (EA) came into force, under the 1995 Environment Act. It 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 council, district or national

Table 9.3.1 Minerals production* in Region 10 (1993)

	Chalk		*Igneous*		*Clay & shale*		*China clay*		*Limestone*	
	Tonnes	*% of GB total*	*Tonnes*	*% of GB total*	*Tonnes*	*% of GB total*	*Tonnes*	*% of GB total*	*Tonnes*	*% of GB total*
Devon	65,000	0.7	763,000	1.6	n/a	n/a	428,000	15.0	3,022,000	2.9
Cornwall	0	0	1,922,000	3.9	0	0	2,424,000	85.0	0	0
Region 10	***65,000***	***0.7***	***2,685,000***	***5.5***	***n/a***	***n/a***	***2,852,000***	***100***	***3,022,000***	***2.9***
England	9,076,000	100	24,783,000	50.4	9,883,000	90.7	2,852,000	100	84,123,000	80.0
Great Britain	9,076,000	100	49,209,000	100	10,891,000	100	2,852,000	100	105,885,000	100

Source: Central Statistical Office (1994). Key: n/a = not available; *amounts rounded up to the next whole thousand tonnes.



Map 9.3.2 Coastal landfill sites. Note: a single symbol may represent more than one site in close proximity. See Table 9.3.3. Source: Aspinwall & Co. (1994).

administrative boundaries, to facilitate local accountability. The activities of the EA are grouped under two broad headings: pollution prevention and control, including waste regulation, the work of HMIP and the NRA's work on water quality; and water management, covering the NRA's other functions. However, there is a strong link between these two sets of functions, to ensure the continuing integrity of estuarine and coastal management. Also within the Environment Act 1995 is the requirement for mine operators to give the EA 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 those seeking to avoid their obligations. Landfill site licensing is also the responsibility of the EA.

The demand for aggregate from quarries in Devon has been reduced in the last two to three years by the absence of major road construction in the county and by the County Council's policy of using recycled or secondary materials for highway maintenance and construction. A working party has been set up to develop a highway maintenance recycling policy and monitor national developments.

The Cornwall Minerals Local Plan, released in 1995, sets out a comprehensive range of policies to the year 2011. The major emphasis is on applying the principles of sustainable development to minerals extraction. A heavy emphasis is also placed on using minerals waste as an aggregate and the need for the development of a comprehensive tipping and restoration strategy for the St. Austell china clay area.

9.3.4 Information sources used

Data on quarrying were obtained from the British Geological Survey's *Directory of mines and quarries* (British Geological Survey 1994) and are the most up to date and comprehensive available. Nevertheless these data may be up to three years old and may therefore include information on some operations that have now ceased. In a very small number of cases, exact addresses of quarries were not listed and therefore it was not known if they were coastal.

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 information from the 152 former Waste Regulation Authorities and represents the most up-to-date collection of public information on British waste management currently available.

9.3.5 Further sources of information

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Table 9.3.3 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.	10
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.	9
3 Household/putrescible	Typical contents of a household dustbin and similar wastes of industrial origin wastes. e.g. food processing	10
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 Environment Agency.	10
Total		***39***

Source: Aspinwall & Co. (1994). See Map 9.3.2

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Mines and quarries (British Directory of Mines and Quarries)	Director, British Geological Survey, Keyworth, Nottingham NG12 5GG tel: 0115 936 3100
Landfill sites (Sitefile Digest)	Dr. Ron Moore or Dr. Phil Marsh (senior consultants), Aspinwall & Co., Walford Manor, Baschurch, Shrewsbury SY4 2HH, tel: 01939 262200
Waste regulation, pollution prevention and control	*Environment Agency, South West Region, Exeter, tel: 01392 444000
Local mineral plans	*Minerals Planning Officer, Cornwall County Council, Truro, tel: 01872 322000
Local mineral plans	*Minerals Planning Officer, Devon County Council, Exeter, tel: 01392 382000

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

9.4 Marine aggregate extraction, dredging and solid waste disposal at sea

C.A. Crumpton & M.J. Goodwin

9.4.1 Introduction

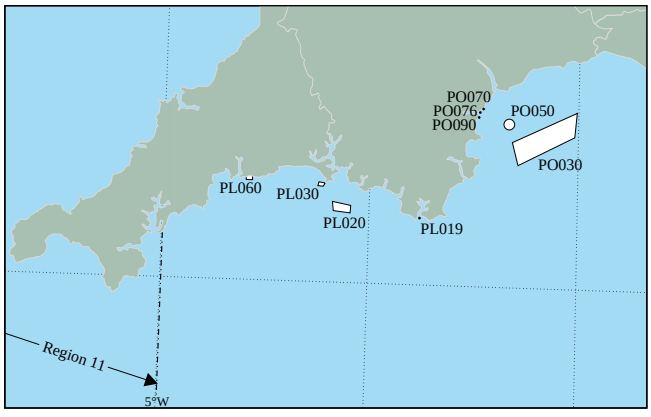
Sand and gravel on the sea bed are important sources of industrial aggregate for end uses such as concrete production, beach replenishment and beach protection. The main market is in the south-east of England. The national demand for aggregate from all sources increased steadily during the 1980s. Aggregates 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 1995).

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 26,122,758 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. There is currently no extraction of aggregate in the region, although the area has been extensively prospected in recent years. Maerl (calcareous red seaweed) is dredged from the sea bed in the region for use for soil conditioning (see section 5.5).

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 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).

The amount of dredged material deposited at sea in the region in 1993 (305,651 tonnes) constituted about 1% of the total deposited around the UK as a whole (29,866,256 tonnes). From 1989 to 1993, a yearly average of 33,000,000 tonnes (wet weight) of dredged material was deposited at sea in England and Wales. Amounts varied between 40,810,718 tonnes (wet weight) in 1989 and 26,086,503 tonnes in 1993 (MAFF 1995).

Other solid materials deposited under licence from MAFF include sewage sludge and solid industrial waste. Some sewage sludges are principally of domestic origin and contain only low levels of metals and other persistent components. Others include industrial inputs, resulting in higher concentrations of contaminants. In terms of sewage disposal, the UK produces some 1.1 million tonnes of dry solids (tds) annually and disposes of approximately 300,000 tds (equivalent to about 11,000,000 wet tonnes) to the sea. A total of 57,421 wet tonnes were deposited at the Lyme Bay and 48,766 wet tonnes at the Plymouth Sound sites in 1993, making a regional total of 106,187 wet tonnes (MAFF 1995). 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 by marine vessels is set to be phased out by 1998. It will have to be replaced by disposal on land, by tipping or incineration.



Map 9.4.1 Solid waste disposal sites at sea - dredged material (see Table 9.4.1) and sewage sludge. Source: MAFF (1994). © Crown copyright.

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 in this region.

9.4.2 Important locations

Marine aggregates dredging

No areas were licensed for aggregates dredging and no aggregate was landed at ports in the region in 1995 (Crown Estate 1996). However, a site with potential for sand and gravel extraction exists as a wedge-shaped area of between 16 nautical miles wide in Lyme Bay in the east and three miles wide in Gerrans Bay to the west. Recent (Holocene) sand deposits mantle much of the sea bed off the south Cornish coast and there are large areas of exposed bedrock. However extensive areas of extractable aggregate resource exist close to the 30 m depth contour, which may in future yield significant quantities (see also section 2.2).

Map 9.4.1 shows the main marine sites used in the region in 1992 and 1993 for the disposal of sewage sludge and dredged material from maintenance dredging; they are listed in Table 9.4.1. Another licensed disposal site exists at Teignmouth Ness (PO076), but it was not used during this period.

Table 9.4.1 Amounts of material disposed of at each licensed site in the region in 1992 and 1993

Site name	*MAFF code (see Map 9.4.1)*	*Waste type*	*Depth*	*Deposited tonnage*	
			(m)	*1992*	*1993*
Devon					
Lyme Bay 1	PO030	Sewage sludge	40	54,026	56,760
Lyme Bay 2	PO050	Sewage sludge	25	1,639	661
Sprey Point	PO070	Maintenance dredging	0-10	41,210	53,320
Bundle Head	PO090	Maintenance dredging	8	11,620	9,100
Bolt Head	PL019	Maintenance dredging	15	2,315	0
Plymouth	PL020	Sewage sludge	50	41,969	48,766
Cornwall					
Rame Head	PL030	Maintenance dredging	25	69,540	92,800
Lantic Bay	PL060	Maintenance dredging	25	144,373	150,431
Region 10				***366,692***	***411,838***

Source: MAFF.

Navigational dredging

Maintenance dredging is carried out at the discretion of the individual harbour authorities and takes place in the Exe Estuary, Teignmouth Harbour, the Dart Estuary, the Salcombe and Kingsbridge Estuary, Plymouth Sound and the Fowey Estuary. Up to 5,000 m^3 of sediment are removed from the Exe Estuary every three years. At Plymouth, since the Lee Moor china clay quarry reduced its sediment input to the estuarine system in the early 1980s, the need to dredge Plymouth Sound has been dramatically reduced. A 'bed-leveller' is now used to remove the peaks of sediment, and this has helped to reduce the required frequency of dredging to an estimated every 10-12 years (Plymouth Harbour Commission pers. comm.). Maintenance dredging at the other locations is less frequent.

Capital dredging has been infrequent in the region, having been undertaken only occasionally in recent years, for example to facilitate recreational water activities at Plymouth Sound. The two major sites of navigational dredging in the region are off Exeter and Plymouth.

9.4.3 Management

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

Marine sand and gravel are extracted by commercial mineral companies under licence from the Crown Estate. Government policy for the provision of aggregates, formulated in 1982 and 1989, has encouraged marine extraction of sand and gravel: Minerals Planning Guidance Note 6 states that "it has a very important role to play in maintaining supplies of aggregate and, as far as possible, its use is to be encouraged" (Crown Estate 1992). The government has announced its intention (as at November 1995) 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. 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 Department of the Environment (1995), which recommends 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).

Aggregate extraction from the sea bed commonly involves using either suction pipes or hoppers. The former method creates long shallow tracks or large round holes several metres deep, depending on whether the pipe is trailed or fixed. The latter method results in localised depressions, the size of which depends on the capacity of the hopper. The biological implications of extraction depend upon the characteristics of the individual area concerned and are potentially far reaching. 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. Where aggregate is overlain by clean sand, it is thought unlikely that long-term damage to benthic fauna will occur (Irish Sea Study Group 1990).

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. In

Plymouth Sound, the need for dredging has been minimised by the reduction of the amount of sediment entering the river from quarrying activities. Plymouth Harbour Commissioners' use of a bed-leveller rather than regular dredging is a voluntary response to the increased awareness of the environmental impacts of dredging and dredged material disposal.

Dredged material 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 1986 and 1987 six and three cases respectively of alleged illegal dumping were investigated in England and Wales (MAFF 1989).

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 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.

9.4.5 Acknowledgements

Thanks are due to the Plymouth Harbour Commissioners, who provided information on 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 aggregate extraction	Marine Manager, Marine Estates (Offshore), The Crown Estate, 16 Carlton House Terrace, London SW1Y 5AH, tel: 0171 210 4377
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
Scientific assessments of dredging and waste disposal, and database of licensed disposal operations at sea	*Head of Laboratory, MAFF Directorate of Fisheries Research, Fisheries Laboratory, Burnham-on-Crouch, tel: 01621 782658
Licensing of disposal at sea in England and Wales	MAFF, Marine Environment Protection Division, Nobel House, 17, Smith Square, London SW1P 3JR, tel: 0171 238 5830
Offshore geoscience data	Director, British Geological Survey, Keyworth, Nottingham NG12 5GG, tel: 01602 363100
Sand and gravel extraction	Director, Sand and Gravel Association (SAGA), 1 Bramber Court, 2 Bramber Road, London W14 9PB, tel: 0171 381 8778
Disposal of dredged material at sea - international	The Oslo and Paris Commissions, New Court, 48 Carey Street, London WC2A 2JE, tel:0171 242 9927
Disposal of dredged material at sea - international	London Convention Secretariat, International Maritime Organisation (IMO), 4 Albert Embankment, London SE1 7SR, tel: 0171 735 7611
Database of licensed disposal operations at sea	*Dr C. Vivian, Marine Environmental Protection Division, Ministry of Agriculture, Fisheries and Food, Fisheries Laboratory, Burnham-on-Crouch, tel: 01621 782658

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

9.5 Oil and gas developments

C.A. Crumpton, M.J. Goodwin & J.H. Barne

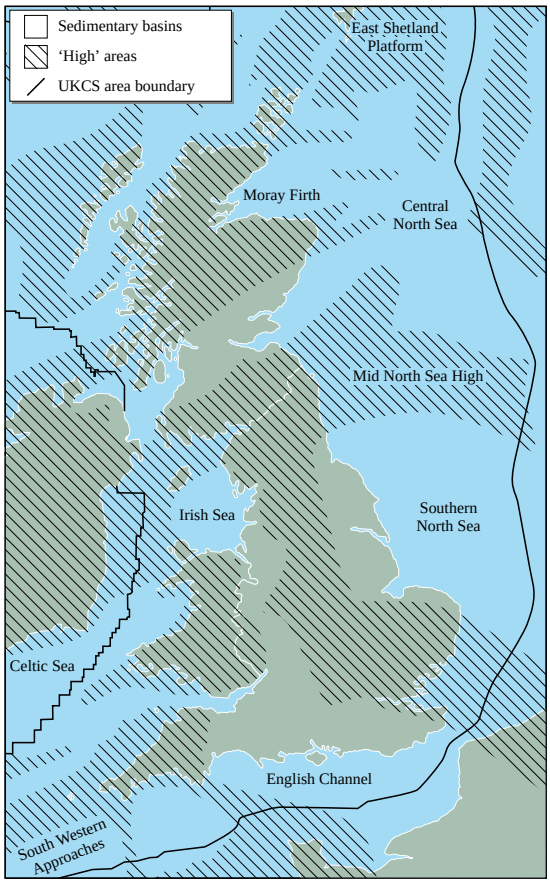
9.5.1 Introduction

This section describes oil and gas exploration and related development in the region; oil and gas infrastructure is described in section 8.3.

Map 9.5.1 shows sedimentary basins and structural 'highs', which determine the distribution of oil and gas deposits. The offshore oil and gas industry is not significant in this region. Related employment and infrastructure is minimal by comparison with Region 9 to the east, which has a high concentration of exploration, production and refining activity. The 17th Offshore Oil and Gas Licensing Round is currently under way. No areas were offered in Region 10 under this round.

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', which include estuaries such as the Exe, Teign and the Tamar complex. Results were announced in March 1996, when 74 blocks were awarded, none of them in this region.

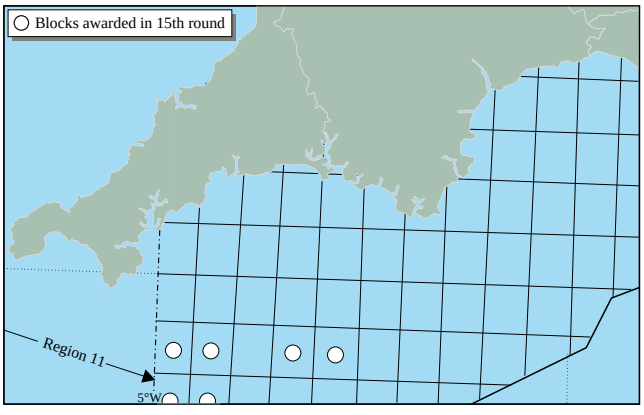
Total UK Continental Shelf (UKCS) oil and gas production in 1995 was a record of some 220 million tonnes of oil equivalent, accounting for around 2% of Gross Domestic Product (DTI 1996). A total of 98 exploration and appraisal wells were drilled in 1995 and seven significant discoveries were announced, none in this region.



Map 9.5.1 UK Continental Shelf (UKCS) sedimentary basins and structural 'highs'. Source: DTI. © Crown copyright.

9.5.2 Important locations

There are no licensed blocks in the region's waters, although several blocks approximately 30 miles offshore have been licensed in the past (Map 9.5.2).



Map 9.5.2 Oil and gas licensing and fields. Source: DTI. © Crown copyright.

9.5.3 Management and issues

Licences are awarded by the Department of Trade and Industry (DTI), in consultation with a wide range of organisations, including government departments, environmental agencies, local groups, local authorities, fishermen's federations and other non-governmental organisations. A range of conditions may be applied, linked to the environmental sensitivity of the block (see Davies & Wilson (1995) for conditions applied to the 16th round). For more recent sets of conditions consult the DTI. The range of potential issues for nature conservation is wide. For example, the potential for oil spills to harm birds and marine and coastal wildlife is well known, especially in sheltered embayments and estuaries (see also sections 5.10, 5.11 and 5.12). There is also a potential risk to seals and dolphins associated with oil-related development (see also sections 5.14.3 and 5.15.3). There is a very small risk of injury to seals in the immediate vicinity of a vessel conducting seismic surveys. The air-gun arrays used in seismic surveys generate high levels of low frequency sound, most of which is outside the known hearing range of seals and is unlikely to disturb them. In the case of cetaceans, results obtained during seismic surveys by Marathon Oil UK Ltd and BHP Petroleum Ltd in the Irish Sea were inconclusive, and experimental evidence for disturbance arising from seismic activities remains lacking (Evans *et al*. 1993). Best practice environmental management guidance for carrying out seismic surveys in areas where marine mammals occur is among environmental issues considered in UKOOA's *Environmental guidelines for exploration operations in near-shore and sensitive areas* (UKOOA 1994).

9.5.4 Information sources used

Most of the data used here come from the DTI's 'Brown Book' (DTI 1996), which should be referred to for further explanation.

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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 Palace Street, London SW1E 5HE, tel: 0171 215 5000
Oil and gas industry issues	Public Relations Officer, UK Offshore Operators Association, 3 Hans Crescent, London SW1X 0LN, tel: 0171 589 5255
Oil transportation and terminals	Technical Adviser, Oil Companies International Marine Forum (OCIMF), 15th Floor, 96 Victoria Street, London SW1E 5JW, tel: 0171 828 7966
General information on the oil industry	Librarian, Institute of Petroleum Library and Information Service, 61 New Cavendish Street, London W1M 8AR, tel: 0171 467 7100
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 St., Northam, Southampton SO14 5QE, tel: 01703 331551
Research into oil pollution	Oil Pollution Research Unit, Fort Popton, Angle, Pembroke, Dyfed SA71 5AD, tel: 01646 641404
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, MAFF DFR, Burnham-on-Crouch, tel: 0162 782658
Local information on the environmental effects of exploration and production - Devon	*Devon Wildlife Trust, Exeter, tel: 01392 79244
Local information on the environmental effects of exploration and production - Cornwall	*Cornwall Wildlife Trust, Truro, tel: 01872 73939
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

C.A. Crumpton & M.J. Goodwin

9.6.1 Introduction

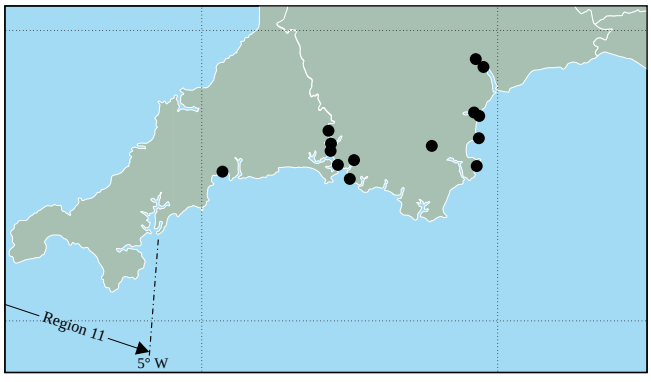
This section summarises information about water quality and effluent discharge from a number of sources. Sewage sludge disposal is covered in section 9.4. Full interpretation of the information base on pollutants and water quality is complex and beyond the scope of this book.

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 reach the sea by airborne means, for example aerosols and rain. Industrial pollutants can enter the marine environment through intentional licensed release or accidentally. Discharges occurring outside the region may also have an effect.

Water quality in the region is generally excellent. There are a large number of domestic sewage outfalls concentrated mainly in Devon, but no major trade discharges. In rural areas quarries, houses, farms and hotels discharge directly to the sea, although the amounts released are very small.

There are 69 bathing waters in this region, as identified under the EC Bathing Water Directive (76/160/EEC). All complied with mandatory standards in 1995, showing a steady improvement year-on-year (Table 9.6.1). The 1995 data for the UK as a whole, assessed by the Department of the Environment (DoE) in accordance with the EC Bathing Water Directive, show a slight increase in compliance with the mandatory standards since 1994: 89% compared with 82%. The Environment Agency (EA) expects a further increase in compliance after the majority of capital schemes being undertaken by the water service companies are completed in 1995. Trend data show that although the percentage of bathing waters consistently complying with the mandatory standards has remained at around 64%, the number consistently failing has reduced. Analysis of media faecal coliform values suggests that the improvement in water quality has been maintained over the last four years.

There are four Blue Flag beaches in the region, representing 12.9% of the UK total of 31 for 1996. The 25 Tidy Britain Group Seaside Award beaches in the region in 1996 represent 12.3% of the UK total of 203. Overall, beach quality in the region is slightly better than average for Great Britain. However, the results of Coastwatch UK's 1994 survey showed an overall deterioration since the previous year (Coastwatch UK 1994). The main items of litter found along the coastline in the region were plastics (including packing straps, can holders, fishing gear and bottles) and sewage related material.



Map 9.6.1 Consented sewage outfalls (see Table 9.6.3). Map shows all outfalls with consented flows greater than 6,000 m^3/day. Source: Environment Agency,

9.6.2 Important locations

All sewage outfalls with consented daily flows greater than 6,000 m^3 are shown on Map 9.6.1 and listed in Table 9.6.3. These represent only a small proportion of the 202 licensed sewage outfalls in the region. By far the majority of both large and small outfalls are in Devon, concentrated around Plymouth and in the east of the region in Devon, where there is urban development along the coastline. Almost all sewage discharged in the region from larger outfalls has had some treatment, mainly primary. Sewage discharged from larger outfalls situated in areas where dispersion is not high, such as Exeter, Totnes and Plympton, receive secondary treatment. In total coastal waters of the region receive less than 200,000 m^3 of sewage daily from large outfalls. There are numerous small outfalls from farms, hotels and quarries but the average daily flow of these is below 50 m^3. There are no significant trade outfalls with consented discharge into the tidal waters of the region.

Summary information about water quality in the region's coastal waters is limited (North Sea Task Force 1993a). However, information is available for a number issues with local relevance within the region. In Devon, for instance, part of the Axe Estuary has been identified as a

Table 9.6.1 Bathing waters survey, 1993, 1994 & 1995

	Pass			*Fail*			*Total*		
	1993	*1994*	*1995*	*1993*	*1994*	*1995*	*1993*	*1994*	*1995*
Region 10	***61***	***60***	***69***	***10***	***9***	***0***	***71***	***69***	***69***
England & Wales	332	347	380	86	72	45	418	419	425
Scotland	18	16	19	5	7	4	23	23	23
N. Ireland	15	15	15	1	1	1	16	16	16
UK	365	376	413	92	81	51	457	458	464

Source: DoE (1993, and pers. comm.); NRA (1993). Note: pass denotes compliance with EC Bathing Water Directive (76/160/EEC): Coliform standards.

Table 9.6.2 Beach quality in the region* compared with national standards in 1994

	% of beaches rated as		
	excellent	*moderate*	*polluted*
Devon	13	49	38
Cornwall	18	39	43
Region 10	***16***	***44***	***41***
England	10	44	46
Wales	7	39	54
Scotland	7	37	56
Great Britain	8	42	50

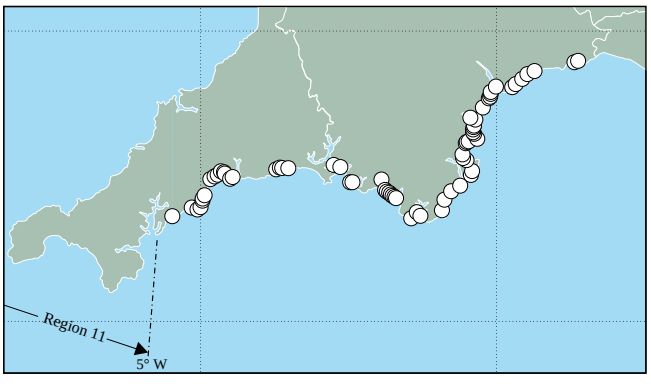
Sources: Coastwatch UK (1994). Key: *includes parts of the coasts of Devon and Cornwall lying in Region 11.

candidate Sensitive Area (Eutrophication) under the EC Urban Waste Water Treatment Directive, owing to the level of discharge from Seaton sewage treatment works, which may result in the waters becoming too organically enriched. The estuary will be monitored in 1995/96 to determine whether the discharges warrant a higher level of treatment. In the Exe Estuary, sewage discharge and run-off from agricultural land have produced elevated nutrient levels in recent years (Exe Estuary Management Plan 1996). Moderately elevated and possibly increasing nutrient levels have also been recorded in the Dart (English Nature pers. comm.). Effluent discharged into the Salcombe/ Kingsbridge Estuary has produced some elevation of nutrient levels in the inner estuary. High concentrations of bacteria are found in the estuary and may pose problems for watersport users and shell fisheries. However, improvements to the sewage system undertaken by South West Water should alleviate these problems (English Nature & South Hams District Council 1994). Water quality in the Tamar Estuary complex is generally good, although in a small upper part of the Plym it is classified as fair. There are high levels of nutrients and locally raised levels of metals, especially around Plymouth (English Nature pers. comm.). High levels of hydrocarbons are associated with the Rame Head dredge disposal site, where spoil from the naval harbour in Plymouth is dumped (North Sea Task Force 1993b). Shipyards at Plymouth have a number of outfalls, although these are for surface water drainage only and are not considered to be potential sources of pollutants.

In Cornwall, water quality is affected mainly by mining activity. Levels of silver in the east Looe Estuary are high (North Sea Task Force 1993b). Management issues identified on the Fowey Estuary are raised levels of heavy metals, discharge of untreated sewage, non-compliance with discharge consents by the Lostwithiel sewage treatment works, private discharge of sewage and eutrophication. Planned improvements to treatment facilities by South West Water should reduce the amount of sewage entering the river (Fowey Harbour Commissioners 1996). In the St. Austell area water quality in a number of smaller coastal riverine stretches is classed as poor. This is mainly the result of increased turbidity caused by inert and non-toxic china clay waste being washed from nearby workings into Mevagissey Bay and to a lesser extent into neighbouring St. Austell Bay. There has been a recorded loss of species richness in part of the Fal, attributed to locally high nutrient levels and very elevated concentrations of metals from mining activity, particularly from drainage water from disused tin mines (English Nature pers. comm.).

Further impacts on water quality, arising from industrial land use, include pollution from port and harbour operations, such as the use of antifouling paint containing tributyltin (TBT) from ships in yards (Langston *et al.* 1990; Waite *et al.* 1991). TBT is known to affect the growth of benthic organisms, and in 1986 legislation was introduced to control its use.

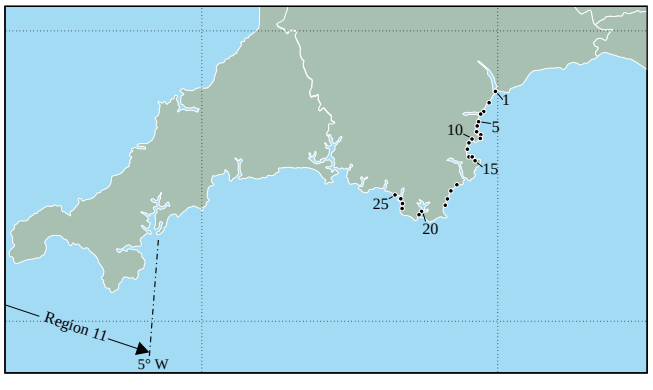
Map 9.6.2 shows the locations of bathing waters in the region identified under the EC Bathing Water Directive (76/160/EEC). All 69 complied with mandatory standards in 1995.



Map 9.6.2 Locations of EC-identified bathing waters. Source: Environment Agency pers. comm. Adapted with permission.

In Devon, results of the Coastwatch UK 1994 survey showed that beach quality in the county was generally around the national average. However, levels of all litter items found in the region were above 1993 levels. Plastic items, such as bottles, packing straps, can holders and fishing gear, and sewage related matter were the most notable problem items. In Cornwall, the beaches surveyed were generally better than the national average.

The four Blue Flag beaches in the region and 25 Tidy Britain Group Premier Seaside Award beaches are listed in Table 9.6.4 and shown on Map 9.6.3.



Map 9.6.3 Award-winning beaches in Region 10. Source: Tidy Britain Group.

9.6.3 Management

In April 1996, the new Environment Agency 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

Table 9.6.3 Sewage outfalls to tidal waters in the region with consented 'dry weather flows' >6,000 m^3 per day

Name of outfall	*Location*	*Grid ref.*	*Type of treatment*	*Max. consented daily dry weather sewage flow (m^3)*
Devon				**174,083**
Milbury Lane	Exminster	SX946876	Primary	6,969
Countess Wear	Exeter	SX940891	Secondary	38,131
Shaldon	Teign Estuary	SX940721	Some	6,000
Teignmouth	Teignmouth	SX960714	Secondary	17,711
Hope's Nose	Torquay	SX949635	Screened (>6 mm)	17,280
Sharkham Point	Brixham	SX938546	Untreated	12,096
Totnes	Totnes	SX807610	Secondary	8,203
Wembury	Wembury Point	SX509483	Some	9,792
Plympton Marsh Mills	Plympton	SX520563	Secondary	18,000
West Hoe	Plymouth	SX471533	Primary	9,800
St. Levan Road	Plymouth	SX445559	Untreated	6,000
Camels Head	Plymouth	SX445571	Primary	11,300
Ernesettle	Ernesettle	SX442602	Primary	12,801
Cornwall				**13,956**
Par Spit	St. Austell Bay	SX073523	Some	13,956
Region 10				***188,039***

Source: NRA, MAFF.

Table 9.6.4 Award-winning beaches in Region 10

No. on Map 9.6.3	*Location*	*Grid ref.*	*TBG/BF**
	Devon		
1	Dawlish Warren	SX9879	TBG
2	Coryton's Cove (Dawlish)	SX9675	TBG
3	Teignmouth Main Beach	SX9472	TBG
4	Ness Cove (Shaldon)	SX9371	TBG
5	Maidencombe	SX9268	TBG
6	Watcombe (Torquay)	SX9267	TBG
7	Redgate (Torquay)	SX9364	TBG, BF
8	Oddicombe	SX9265	TBG, BF
9	Meadfoot	SX9363	TBG, BF
10	Corbyn's Head	SX9063	TGB, BF
11	Paignton	SX8961	TBG
12	Goodrington Sands South	SX8959	TBG
13	Broadsands	SX8957	TBG
14	Elberry Cove	SX9057	TBG
15	Churston Cove	SX9156	TBG
16	Blackpool Sands	SX8547	TBG
17	Strete Gate	SX8345	TBG
18	Torcross	SX8242	TBG
19	Beesands	SX8240	TBG
20	Salcombe North Sands	SX7338	TBG
21	Salcombe South Sands	SX7237	TBG
22	Hope Cove	SX6739	TBG
23	South Milton Sands (Thurlestone)	SX6741	TBG
24	Bantham	SX6643	TBG
25	Challaborough	SX6444	TBG

Source: Tidy Britain Group. Key: *TBG = Tidy Britain Group Seaside Award Scheme; BF = European Blue Flag Award Scheme.

activities are grouped under two broad headings: pollution prevention and control, including waste regulation, the work of HMIP and the NRA's work on water quality; and water management, covering the NRA's other functions. However, there will be a strong link between pollution prevention and control and water management, to ensure continuing integrity of estuarine and coastal 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 (EA) 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 fishery interests. Trade effluent discharges involving scheduled (hazardous) substances must be authorised by the EA 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 (see section 9.6.6). Sewage disposal on land is also controlled by the EA (see section 9.3).

In 1988 all disposal of liquid industrial waste at sea in this region 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 and trade 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', all significant sewage discharges (thus including all those in Table 9.6.3) to coastal waters, where the outfalls serve populations >10,000 (roughly equivalent to 1,800 m^3 per day), and to estuaries, where they serve populations >2,000 (roughly 360 m^3 per day), 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 discharges into 'high natural dispersion areas' are at

Sidmouth; Teignmouth, Dawlish and Exmouth; and Torbay - Sharkham.

A new management tool, the General Quality Assessment (GQA) classification scheme for estuaries and coastal areas, is to be introduced by the EA. 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). Monitoring is carried out by the EA. 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

The Department of the Environment (DoE) Environmental Protection Statistics Division publishes an annual *Digest of environmental protection and water statistics* (DoE 1995), 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 take place over one or two days. The results may therefore be skewed by heavy rain or localised effects at the time of survey. Coastwatch UK and Beachwatch do not sample the whole coastline, 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 EA'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). MAFF (Burnham-on-Crouch) maintains a national database of consented sewage outfalls in England and Wales. Further information on discharges can be obtained from the local offices of the EA, who issue discharge consents and authorisations.

9.6.5 Acknowledgements

Thanks are due to Mrs F.L. Franklin of MAFF Fisheries Laboratory, Burnham-on-Crouch, for sewage outfalls data, Chris Moore of the EA South Western Region for providing information on trade and domestic outfalls, and Alastair Burn, English Nature, for water quality information.

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National Rivers Authority. 1995. *Contaminants entering the sea.* London, HMSO and National Rivers Authority. (Water Quality Series, No. 24.)

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Discharge consents and coastal water quality	*Environment Agency, South Western Region, Exeter, tel: 01392 444000
Water quality and sewage treatment	South West Water Services Ltd, Peninsula House, Rydon Lane, Exeter EX2 7HR, tel: 01392 219666
Beachwatch	*Marine Conservation Society, Ross-on-Wye, tel: 01989 66017
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	Lion House, 26 Muspole Street, 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, MAFF Directorate of Fisheries Research, Fisheries Laboratory, Burnham-on-Crouch, tel: 01621 782658

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

9.7 Leisure and tourism

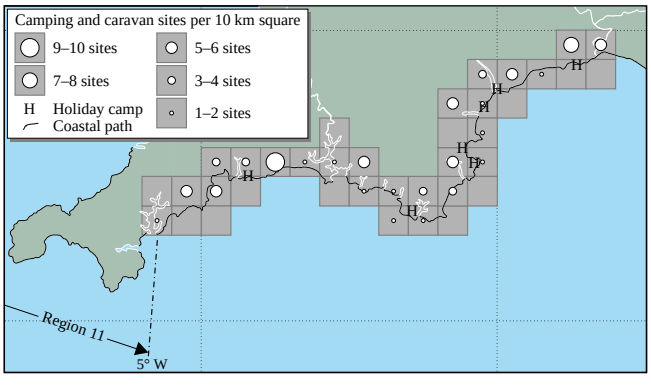
S.L. Fowler, S.J. Everett & M.J. Dunbar

9.7.1 Introduction

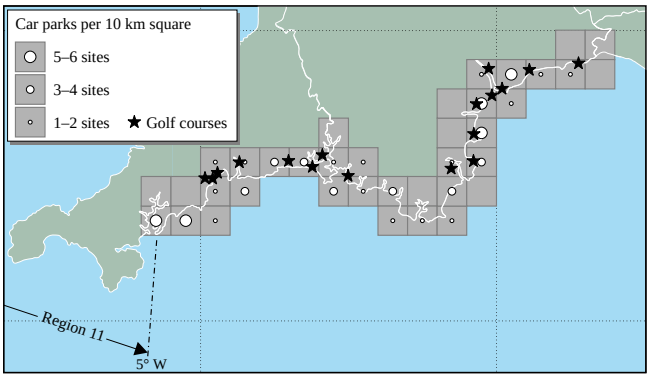
Tourism is a major industry in the region. The south-west's long stretches of attractive undeveloped coastline and good facilities have helped to make it the most important region for domestic tourism in the UK, annually receiving 13 million visitors and generating £1,870 million in revenue. Devon and Cornwall are the main destinations for tourists; Devon alone receives in excess of 3.5 million visitors a year, with Cornwall receiving a similar figure (South West Regional Planning Conference 1994). Over 30 million tourist nights are spent in Devon each year, 80% of which are spent in the coastal region, with Torbay, the country's most popular tourist overnight destination, providing 25% of Devon's 270,000 commercial bed spaces (Devon County Council 1995).

Improved communications, particularly the M5 and arterial routes, have reduced journey times and improved general access to the region, especially to coastal areas. Although the numbers of people seeking a traditional seaside holiday are declining, new growth in the tourist industry has been generated, centred on activity based holidays, owing to the increase in leisure time and the number of short breaks and second holidays taken.

A wide range of land-based leisure activities take place along the coast, including walking (the South West Coast Path runs the entire length of the region), camping, golf, beach recreation and bathing, bird watching, wildfowling, horse riding, angling and rock climbing (Buck in prep.). Many of Devon's 300 tourist attractions are situated on the coast; they range from natural sites, including Kents Cavern, Torquay, to man-made attractions, such as the preserved railway which runs along the Dart Valley. The infrastructure associated with these activities includes car parks, caravan and camp sites, piers, golf courses and paths and trails. Ordnance Survey Landranger maps show 76 caravan parks and 80 campsites (Map 9.7.1), 74 rural car parks and nineteen golf courses (Map 9.7.2) in the coastal 10 km squares in the region. There are also many leisure, outdoor activity and visitor centres, and amusement parks. Holiday parks are numerous and may occupy significant



Map 9.7.1 Number of camping/caravan sites in coastal 10 km squares in the region; locations of holiday camps and long distance coastal footpath. Source: Ordnance Survey Landranger maps. © Crown copyright.

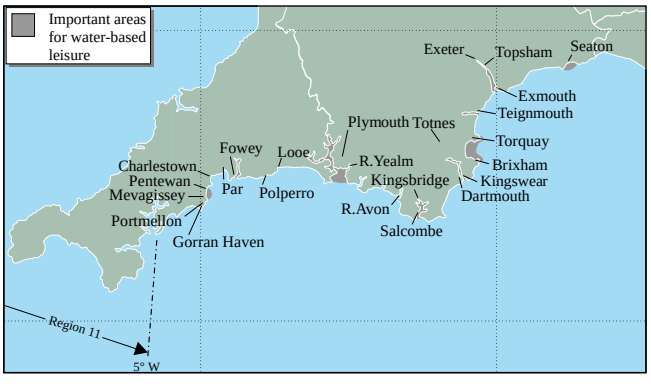


Map 9.7.2 Number of car parks in coastal 10 km squares in the region and coastal golf courses. Source: Ordnance Survey Landranger maps. © Crown copyright.

areas of land and comprise chalets and/or mobile homes, often with centralised facilities such as bars, entertainment complexes and swimming pools. Wildfowling - a traditional coastal activity in the region - is now recreational, although formerly it was commercially practised for food. Targeted coastal species include most ducks, some geese and three waders (only one of which - golden plover *Pluvialis apricaria* - is regularly coastal). Shooting on some coastal sites involves both local wildfowlers and those from further afield.

Water-based recreation is a very important activity in the region, with particular pressures on the south Devon coast (Map 9.7.3), which is one of the most important areas for water-based activity in the UK. The popularity of the newer forms of marine recreation, such as water skiing and the use of personal watercraft, is set to increase. With the continued growth of sailing and power boating in southern England, Devon is experiencing demand for additional mooring and marina facilities.

The sheltered areas of Tor Bay, the Exe, Salcombe and Dart Estuaries and Plymouth Sound are ideal sites for watersports. Peak periods of use are during weekends in the summer months (April - September) and during races



Map 9.7.3 Important locations for land-based leisure. Named locations are listed in Table 9.7.2. Sources: D'Olivera & Featherstone 1993, Sidaway 1991, Buck in prep., tourist brochures and Ordnance Survey Landranger maps. © Crown copyright.

Table 9.7.1 Land-based leisure and tourist facilities

Site	*Grid ref.*	*Notes*
Devon		
Seaton area	SY2490	Picnic site, holiday park, preserved railway, youth hostel, caves, tourist information centre, caravan and campsites and golf course
Sidmouth	SY1287	Museum, observatory, tourist information, caravan and camping sites and golf course
Budleigh Salterton	SY1281	Museum, gardens, holiday centre, tourist information and craft centre
Exe Estuary	SX9882	Historic house, castle, museums (Maritime Museum at Exeter), picnic sites, racecourse, nature reserve, viewpoint, holiday parks, caravan and camping sites, tourist information centre and golf courses
Teignmouth	SX9172	Racecourse, viewpoints, caravan and camping sites, tourist information centre, golf course and pier
Torbay		
Torquay	SX9264	Tourist information centre, abbey, museum, show cave, holiday park, aircraft museum, tourist information centre, caravan and camping sites and golf course
Paignton	SX8960	Zoo, nature reserve, pier and camping and caravan sites
Brixham	SX9356	Tourist information, museum, viewpoint, 3 holiday parks, country Park, Nature Trail, coastguard station, camping sites and golf course
Dart Estuary	SX8851	Tourist information centre, castles, museums, Dart Valley preserved railway, gardens, vineyard, ancient monument, youth hostel, holiday park, caravan and camping sites and golf course
Slapton Ley	SX8243	Nature reserve with field study centre; caravan and camping sites
Kingsbridge and Salcombe Estuary	SX7441	Historic house, tourist information centre, maritime museum, viewpoint vineyard, youth hostel, holiday park; caravan and camping sites
Tamar Valley and Plymouth Sound	SX4357	Preserved railway, historic houses, garden, nature reserves, Marine Biological Association aquarium, ancient monument, Plymouth Hoe and the Barbican, viewpoints, picnic sites, tourist information centre, scuba diving club, golf courses and caravan and camping sites. Drake's Island fortress and outdoor adventure centre.
Cornwall		
Looe	SX2553	Museums, tourist information, zoo, holiday parks, caravan and camping sites and golf course
Polperro	SX2150	Museum and caravan and camping sites
Fowey	SX1251	Tourist information centre, museums, castle, holiday park, scuba diving club, youth hostel and caravan and camping sites
St. Austell	SX0251	Museum, tourist information, caravan and camping sites and golf courses
Mevagissey	SX0145	Museum and caravan and camping sites

Sources: Ordnance Survey Landranger maps and tourist brochures.

and regattas. Activities include yachting, power boat racing, dinghy sailing, canoeing, surfing, windsurfing, diving, water skiing, the use of personal watercraft, rowing and tourist boat trips. Virtually all of the coastal settlements in the region have some kind of harbour or boat facilities. These were formerly used by the inshore fishing industry, but following the national decline in fishing fleet numbers they are now important mainly for tourism and recreational boating use. Consequently the population of the coastal strip is greatly enlarged by visitors during the summer months, with coastal resources and recreational facilities used intensively.

9.7.2 Important locations

Major land- and water-based leisure facilities are concentrated in traditional coastal holiday areas, most of which are in Devon, including Seaton, Sidmouth and Budleigh Salterton, Exmouth and Dawlish on the Exe Estuary, Teignmouth, the Tor Bay area and Salcombe. Table 9.7.1 lists larger locations in the region for land-based leisure and tourism. There are many other visitor attractions and facilities in the region that individually do not cover large areas but which cumulatively contribute significantly to the importance of the region for leisure and tourism.

Most of the important land-based activities in the region rely on the quality of the natural environment, both its beautiful landscape and its diverse wildlife. The south-west is famous for its sandy beaches and mild climate, which allows palm trees and other subtropical plants to grow, and has led to the coastline between Dawlish and Brixham being referred to as the 'English Riviera'. Beaches are important recreational sites and those with good water quality in the region, as indicated by the Reader's Digest *Good Beach Guide*, include Branscombe, Torbay, Blackpool Sands, Slapton Sands, Mill Bay (near Salcombe), South Milton Sands, Thurlestone, Bigbury-on-Sea, Challaborough and Bow Beach (near Gorran Head) (Marine Conservation Society 1994) (see also section 9.6).

There are several important coastal nature reserves in the region, popular locations for bird watchers and naturalists. Slapton Ley National Nature Reserve field studies centre and the visitor centre at Dawlish Warren Local Nature Reserve both provide programmes of guided walks and activities. Sites on the Exe Estuary and the inner Salcombe-Kingsbridge Estuary are also popular with bird watchers. The RSPB run 'avocet cruises' on the River Exe in

the winter months, when the largest numbers of this important population occur. The most popular wildfowling sites include the Tamar Valley and Kingsbridge area. The principal areas used for shooting in the Exe Estuary are at and south of Topsham.

Several important coastal rock climbing locations exist in the region, for example at Berry Head, although bylaws restrict access to certain parts of the cliffs at sensitive times of the year in order to protect nesting seabirds.

The South West Coast Path is Britain's longest National Trail and the second most intensively used. It follows the coast for 560 miles from Poole, Dorset (Region 9), along the whole of the region's coastline and ends at Minehead, Somerset (Region 11).

Table 9.7.2 lists existing and proposed water-based leisure and tourism facilities in the region; important locations are shown on Map 9.7.3.

Most of the estuaries have yacht moorings and some, such as Plymouth Sound and the Dart, have marinas. In 1994 there were ten marinas on the south Devon coast (Devon County Council 1995), three each in Tor Bay and the Dart Estuary and four in Plymouth Sound. In Devon, there are approximately 7,500 moorings at nine main sites and an estimated 2,550 berths (Sidaway 1991). The yacht clubs at Exmouth, Torquay, Brixham, Salcombe and Plymouth regularly hold large regattas, and dinghy sailing is popular in the region, both in estuaries, notably Salcombe and Plymouth Harbour, and on the open sea. Beer, Sidmouth, Axmouth, Teignmouth, River Dart and Salcombe each have a dingy sailing club, while the River Exe, Tor Bay and Plymouth Harbour all have several.

Despite the Exe Estuary's importance in the region for a range of water-based recreational activities, it has generally escaped the large-scale development of water leisure facilities that has taken place on other areas of the south coast, such as The Solent. This is partly due to the presence of the canal and railway line, which runs along most of the water's edge, creating a physical barrier to such development.

Torbay is one of the top ten seaside tourist resorts in the UK (Hutchings 1995) and the focus of many water-based activities in the region, for instance power boat racing. The bay is also popular for parascending from motor boats, water skiing and windsurfing. As with many of the region's other tourist centres, tourist boat trips operate from here.

Other water-based activities in the region include water skiing, which occurs in the Exe and Teign Estuaries, Salcombe, Thurlestone, Jennycliff Bay and Cawsand Bay.

Table 9.7.2 Water-based leisure and tourism facilities

Site	*Grid ref.*	*Description*
Devon		
Axmouth/Beer/Seaton	SY2590	Small harbour, moorings, sailing club and sea angling club
Sidmouth	SY1287	Sailing club and sea angling club
Budleigh Salterton	SY0681	Sea angling club
Exmouth	SY0082	Harbour, 700 moorings; marina proposal, sailing clubs and sea angling club
Exe Estuary	SX9788	Popular for watersports, around 2,500 moorings, marinas at Exeter and large numbers of non-marina moorings, four sailing clubs, rowing club, river and canal cruises and the Exe canal
Teignmouth	SX9573	Harbour, seven dinghy parks on estuary, marina proposal, 1,250 moorings, sailing and sea angling clubs
Torbay		
Torquay	SX9263	Harbour, Torquay Marina, power boating, and rowing, sailing and sea angling clubs
Paignton	SX8961	Small harbour, sailing and sea angling clubs
Brixham	SX9457	Harbour, two marinas (Brixham Marina and Dolphin Haven), sailing and sea angling clubs
Dart Estuary	SX8852	Three marinas (Kingswear, Darthaven and Dart), approx. 2,000 moorings, mainly concentrated at Dartmouth, Totnes, Dittisham and Stoke Gabriel, and rowing, sailing and sea angling clubs
Salcombe & Kingsbridge Estuary	SX7538	Large natural harbour with about 1,900 moorings, dinghy/boat park at Salcombe, sailing and sea angling clubs
Avon Estuary	SX6643	Leisure moorings and sea angling club at Bigbury-on-Sea
Yealm Estuary	SX5547	Large numbers of moorings
Plymouth Sound	SX4752	Four marinas (Queen Anne's Battery, Mayflower International, Millbay, Sutton Harbour), marina proposed at Millbrook, leisure barrage at Millbrook, proposals for two more at Tamarton Creek and Laira, on the River Plym, power boating, rowing, sailing and sea angling clubs, scuba diving training school at Fort Bovisand and diving clubs
Cornwall		
Looe	SX2653	Moorings, quay, Shark Angling Club of Great Britain, water skiing and dinghy sailing club
Polperro	SX2251	Small harbour
Fowey	SX1351	Harbour, 1,400 anchorage/moorings, yacht club, power boating, rowing and sea canoeing clubs
Charlestown	SX0452	Small harbour
Mevagissey	SX0245	Harbour
Portmellon	SX0244	Minor anchorage
Gorran Haven	SX0242	Minor anchorage

Sources: D'Olivera & Featherstone (1993), Sidaway (1991), Buck (in prep.), tourist brochures and Ordnance Survey Landranger maps.

Where there are more exposed beaches windsurfing occurs; sites include Exmouth, Dawlish, Teignmouth, Compass Cove, Blackpool Sands, Slapton Sands, Salcombe, Bigbury Bay, Wembury Bay and Plymouth Sound. Plymouth is a base for coastal rowing clubs, as are the other more sheltered estuaries in the region, including Exeter, Dartmouth and Torquay. Together with Axmouth, Exeter, Exmouth, Paignton, Plymouth is also one of the sites from which sea canoeing is practised. Scuba diving is popular in the region, owing to its clear waters and dramatic underwater scenery. Fort Bovisand, to the east of Plymouth, is one of the country's leading diver training schools, and there are many clubs and diving centres throughout the region.

Amenity barrages in marine inlets and estuaries often impound a lake of water upstream, which can be used for recreational activities at all stages of the tide. Such a leisure barrage exists at Millbrook, where activities include sailing. Barrages are proposed at Tamarton Creek and Laira on the River Plym.

Looe and Fowey are the most important centres for leisure and recreation along the region's Cornish coast. Looe Estuary drains at low tide and has very few moorings but does have a dingy sailing club and is popular for water skiing. Looe is the base for the Shark Angling Club of Great Britain. The Fowey Estuary has up to 1,400 moorings and its yacht club regularly holds large regattas. Dinghy sailing is popular, with clubs at Fowey and Pentewan. As a sheltered estuary, Fowey is also a base for power boat racing, coastal rowing and sea canoeing clubs.

Windsurfing occurs from more exposed beaches, such as St. Austell, while board surfing, more popular in north Cornwall, takes place in Whitsand Bay and from Polkerris, and informally from other beaches.

Angling from the shore is a popular pastime pursued on most of the estuaries in the region. Sea angling is popular, and boat-based trips, including for shark fishing, may be made from many of the region's harbours. Sea anglers tend to use the outer part of the Salcombe-Kingsbridge Estuary during the summer and the inner during the winter months. The River Exe is one of the premier salmon rivers in England, and recognised rod fishing locations exist in the upper reaches of the estuary.

Wildfowling takes place on at least five of the region's estuaries - the Otter, Exe, Teign, Salcombe-Kingsbridge and Plymouth Sound - although at most of them shooting is no longer as intensive as in former years. Much of the shooting is undertaken through wildfowling clubs and associations. In addition, private shoots and some punt gunning occur in Plymouth Sound. Wildfowling is most widespread on the Exe Estuary, where it occurs nearly everywhere except in the bird sanctuary on the west shore. Target species are mostly mallard and wigeon.

9.7.3 Management and issues

The region is a major tourist destination that is highly dependent on British holidaymakers. Despite its existing importance there is a need to stimulate the tourist industry and its infrastructure, which has led the local authorities to seek new sources of funds (e.g. from the European Union, Heritage Lottery and Millenium Funds) for coastal regeneration projects. These projects will need to conserve the natural qualities of the undeveloped coast while also providing facilities, such as heritage centres and wet-weather tourist attractions, which will retain the interest of British holidaymaker. Green tourism initiatives, such as Devon County Council's strategy on action for tourism and the environment on the lower Dart Valley, and South Devon Green Tourism Initiative and Project Explore, in south-east Cornwall, seek to do this by encouraging tourism and recreation that is sustainable and does not degrade the environment. A visitor management strategy which incorporates this philosophy is being prepared by Project Explore for the Fowey Estuary.

Several factors suggest that the region's coast will come under increasing pressure from people seeking leisure opportunities, at a much greater scale than elsewhere in Britain. Factors include improved communication links and the regions' emergence as a popular place to live, as it allows a high quality of life, and the increasing numbers of retired residents. Therefore, recognition of the importance of coastal recreation management is increasing. Future planning will be vital to avoid conflicts between the various interest groups, including local authorities, commerce, recreational users and nature conservation organisations. For example, a recreational management plan has been produced by the South West Coast Path Project, dealing with the usage, condition and development opportunities for the long distance trail.

The desirability of zoning watersports and other activities in some locations is recognised and becoming more important, but zoning may be difficult to implement in many areas. Recreation is a topic within the estuary management plans being prepared throughout the region (see also Chapter 10). Zoning already exists in Tor Bay, where water skiing is restricted to two sites. The use of personal watercraft has been banned from Salcombe Harbour. Designated areas for personal watercraft exist in Tor Bay, Dawlish Warren and Plymouth Sound; they are monitored by the local companies that hire craft. Launching of personal watercraft is possible from many of the beaches in the region, although it is discouraged from those beaches managed by the National Trust. Such leisure activities can potentially disturb nesting birds and overwintering wildfowl and waders, as well as conflicting with other uses of the coast. Dinghy launching in certain areas can potentially damage shore and intertidal vegetation. However, only isolated damage due to recreation has occurred in the region, compared with other south-west coastal sites such as Land's End (Region 11). Increasingly, organisations responsible for recreational activities, for example the British Water Ski Federation, are drawing up codes of practice with guidelines for minimising environmental impact.

The strategic locating of new marinas can help to concentrate water activity and also relieve pressure on more sensitive areas, particular in estuaries. Such developments are best placed in coastal resorts and other sites that are already developed; Exmouth docks are being redeveloped as a residential and commercial complex with associated marina berths (Exe Estuary Project 1996).

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 and Countryside Act 1981. As elsewhere in Britain, much of the wildfowling in Region 10 is operated and managed through wildfowling clubs and syndicates, including the Devon Wildfowling Association (the Exe and Teign Estuaries), the Kingsbridge Pidgeon Shooting Club (the Salcombe-Kingsbridge Estuary), the Tamar Valley Association of Shooting and Conservation (the Tamar and Lynher) and the St. John's Lake Wildfowlers (Plymouth Sound). On the Teign Estuary the shooting rights are held jointly by the Devon Wildlife Trust and the Devon Wildfowling Association. Much wildfowling in the region takes place on areas covered by national and international site protection, including on National Nature Reserves (NNRs), where it is mostly managed through permit systems; around 90% of land used for wildfowl shooting in England is designated as Sites of Special Scientific Interest (SSSIs). Wildfowling on NNRs is reviewed by Owen (1992).

During periods of severe winter weather, disturbance to waterfowl (including non-targeted species) from shooting threatens the birds' survival; at these times national statutory wildfowling bans can be imposed after fourteen days of freezing conditions (voluntary restraint is called for after seven days). Bans are important in this region since it is used by some species as a refuge when weather further east in continental Europe is severe (Ridgill & Fox 1990). Further information on the history and operation of cold-weather shooting bans is given by Stroud (1992).

A more detailed survey of sports activities in the region is provided by South Western Council for Sports and Recreation (1990), along with details of potential conflicts with nature conservation. Key issues include conflicts between different coastal user groups; coastal sewage treatment and pollution; the impact of new marinas; traffic management and car parking; and anti-fouling substances and other chemicals used in boat maintenance and repair.

9.7.4 Information sources used

Published sources of data used are listed in section 9.7.6; many of them contain far more information than has been mentioned here. Other sources used included tourist brochures and Ordnance Survey Landranger maps. Some sources were not up to date and some new facilities such as golf courses may have been omitted. Other sources include the BMIF Annual Marine Industry Statistics (1989-1994). BMIF have also carried out a national survey of boating and water sports participation (Market Research Solutions Ltd 1994). Useful detail is contained in The South Western Council for Sports and Recreation (1990, 1993) publications. In addition to the references cited, some of the information about the distribution and management of wildfowling comes from the NCC's 1989 Estuaries Review data collection (Davidson *et al.* 1991), now held as part of JNCC's integrated coastal database.

A comprehensive listing of contact addresses may be found in *Sport in the south-west* (Sports Council 1995).

9.7.5 Acknowledgements

The authors wish to thank the BASC for help in compiling information on wildfowling and R. Irving for providing other material for this section.

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C. Contact names and addresses

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 x 3011/3015
Tourist Information Centres	
Seaton	The Esplanade, Seaton EX12 2QQ, tel: 01297 21660
Sidmouth	Ham Lane, Sidmouth EX10 8XR, tel: 01395 516441
Budleigh Salterton	Fore Street, Budleigh Salterton EX9 6NG, tel: 01395 445275
Exmouth	Alexandra Terrace, Exmouth EX8 1NZ, tel: 01395 263744
Dawlish	The Lawn, Dawlish EX7 9PW, tel: 01626 863589
Teignmouth	The Den, Sea Front, Teignmouth TQ14 8BE, tel: 01626 779769
Torquay	Vaughan Parade, Torquay TQ2 5JG, tel: 01803 297428
Paignton	The Esplanade, Paignton TQ4 6BN, tel: 01803 558383
Brixham	The Old Market House, The Strand, Brixham TQ5 8AW, tel: 01803 852861
Totnes	The Plains, Totnes TQ9 5EJ, tel: 01803 863168
Dartmouth	The Engine House, Mayors Avenue, Dartmouth TQ6 9YY, tel: 01803 834224
Kingsbridge	The Quay, Kingsbridge TQ7 1HS, tel: 01548 853195
Salcombe (seasonal)	Council Hall, Market Street, Salcombe, tel: 01548 843927/842736
Plymouth	Island House, 9 The Barbican, Plymouth PL1 2LS, tel: 01752 264849
Looe (seasonal)	The Guildhall, Fore Street, East Looe PL13 1AA, tel: 01503 262072
Fowey	The Post Office, 4 Custom House Hill, Fowey PL23 1AA, tel: 01726 833616
Sports and recreation	Sports Council Headquarters, 16 Upper Woburn Place, London WC1H 0QP, tel: 0171 3881277
Sports and recreation - Devon and Cornwall	Sports Council South West Region, Ashlands House, Ashlands, Crewkerne, Somerset TA18 7LQ, tel: 01460 73491
Canoeing	British Canoe Union, Agbolton Lane, West Bridgford, Nottingham NG2 5AS, tel: 0115 982 1100
Diving	British Sub Aqua Club, Telfords Quay, Ellesmere Port, South Wirral, Cheshire L65 4FY, tel: 0151 357 1951

Type of information	*Contact address and telephone no.*
Golf	P. Baxter, English Golf Union, 1-3 Upper King Street, Leicester, Leics. LE1 6XF, tel: 0116 2553042
Sailing, windsurfing and powerboating	Royal Yachting Association, RYA House, Romsey Road, Eastleigh, Hants. SO50 9YA, tel: 01703 629962
Waterskiing	M. Waterman, British Water Ski Federation, South West Regional Committee, 3 Alistair Drive, Yeovil, Somerset BA21 3BT, tel: 01935 78067
Wildfowl and wetlands	*Publicity Officer, Wildfowl and Wetlands Trust, Slimbridge, tel: 01453 890333
Wildfowling (general, including information on affiliated clubs)	Information Officer, The British Association for Shooting and Conservation, Marford Mill, Rossett, Wrexham LL12 0HL, tel: 01244 573000
Wildfowling (general information on wildfowl habitats and conservation)	*Enquiry Officer, RSPB, Sandy, tel: 01767 680551
Wildfowling (the sport)	Press and Information Officer, British Field Sports Society, 59 Kennington Road, London SE1 7PZ, tel: 0171 928 4742
Severe weather wild fowling bans	*Licensing Officer, English Nature HQ, Peterborough, tel: 01733 340345
Small boat movements - Portland	HM Coastguard - Portland, MRSC, Portland, 8 Custom House Quay, Weymouth, Dorset DT4 8BE, tel: 01305 760439
Small boat movements - Straight Point - Dodman Point	HM Coastguard, MRSC Brixham, Kings Quay, Brixham TQ5 9TW, tel: 01803 882704
Small boat movements - Falmouth	HM Coastguard, MRCC Falmouth, Pendennis Point, Castle Drive, Falmouth TR11 4WZ, tel: 01326 317 575
Marine leisure industries; small craft marine industries	British Marine Industries Federation, Meadlake Place, Thorpe Lea Road, Egham, Surrey TW20 8HE, tel: 01784 473 377
Harbour Masters	See Appendix A.2
Cattewater	*Plymouth, tel: 01752 665934
Dart	*Dartmouth, tel: 01803 832337
Exeter	*Exeter, tel: 01392 74306
Fowey	*Fowey, tel: 01726 832471/2
Par	*Par, tel: 01726 817300
Salcombe	*Salcombe, tel: 01548 843791
Teignmouth	*Teignmouth, tel: 01626 772376
Torbay	*Torquay, tel: 01803 292429

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

Coastal management is a major preoccupation in Region 10. The region is one of the most important tourist destinations in the UK and is also of outstanding importance for its beautiful scenery and varied coastal habitats. At Beesands, the seafront dwellings are given vital protection against erosion and flooding by a visually intrusive concrete seawall and rock berm - a traditional, 'hard engineering' solution. Photo: Pat Doody, JNCC

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 10. GB and UK national initiatives without a specific regional focus, notably those led by non-governmental agencies and user groups, are outside its scope. However, as the whole chapter concludes with a list of contacts with a wider involvement or interest in coastal management (section 10.3.3), contact points for some of these organisations are included there. In addition, names and addresses of many contacts are given within the relevant section.

10.1.1 Coastal management in the UK

This section outlines the direction of national policy-making, within which many of the regional initiatives operate. Many, frequently competing, issues and activities affect the coastal environment and inshore waters, making the task of coastal planning and management a very complex one, particularly as numerous different authorities are responsible for particular statutory duties. Coastal management promotes an inter-disciplinary approach to multiple use and conflict resolution between interest groups, "to ensure the long-term future of the resources of the coastal zone through environmentally sensitive programmes, based on the principle of balanced, sustainable use" (Gubbay 1990). Coastal management ensures that all land and sea use issues are co-ordinated, including development, conservation, waste disposal, fisheries, transport, and coastal protection and flood defence. The advantages of this have been recognised by coastal planners in many areas, and several local authorities and other bodies now promote coastal management. However, approaches differ from area to area, with overlap in some places and patchy coverage elsewhere (Earll 1994; King & Bridge 1994).

The House of Commons Environment Committee Second Report (House of Commons 1992), although limited in scope to England and the estuaries it shares with Wales and Scotland, made recommendations for the planning and implementation of coastal management that have had policy and practical implications throughout the UK. Amongst 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 (European Union (EU)-wide) policy initiatives;
- clearer responsibilities for planning and action in the coastal zone, based on a national strategic framework;
- appropriate funding for accountable bodies with responsibilities;
- research into the physical functioning of the coastal zone and associated protection and conservation measures;
- a review of planning mechanisms to allow effective safeguard of the coastal resource;
- monitoring and environmental assessment of coastal activities to assess their impacts;
- the involvement of local communities in coastal management planning;
- the integration of responsibility for coast protection and sea defence under one body;
- better statutory protection for sites of nature conservation importance;
- better provisions for control of marine pollution;
- the need for fisheries activities to take account of marine conservation issues.

Later in 1992, the Department of the Environment and the Welsh Office issued *Planning Policy Guidance: Coastal Planning (PPG 20)*, which made clearer the requirement for planning decisions to take account of environmental and conservation issues.

The Environment Select Committee's recommendations were followed up, in 1993, by the publication of *Development below low water mark: a review of regulation in England and Wales* (Department of the Environment/Welsh Office 1993a), in parallel with the discussion paper *Managing the coast: a review of coastal management plans in England and Wales and the powers supporting them* (Department of the Environment/ Welsh Office 1993b). That same year, The Ministry of Agriculture, Fisheries and Food (MAFF) and the Welsh Office brought out their *Strategy for flood and coastal defence in England and Wales* (MAFF/WO 1993). In this their policy is spelled out: ". . . reducing the risks to people and the developed and natural environment from flooding and coastal erosion by encouraging the provision of technically, environmentally and economically sound and sustainable defence measures." Section 10.3.3 B gives additional notes on the content of these publications.

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 management functions. In 1994 the Department also undertook to highlight good practice in coastal management plans, clarify the interaction of the different elements of coastal management and review relevant bylaw powers. This *Best practice guide* is being prepared by Nicholas Pearson Associates and should be published in 1996. It will set out the basic principles and objectives relating to coastal 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 management interact, including relationships with other strategies. The *Review of bylaw-making powers for the coast* (DoE in prep.) is examining the bylaw powers available to bodies with

responsibilities for the coast and aims to assess whether they meet modern needs. It is also considering the broader relationship between the voluntary principle and other regulatory mechanisms. A final statement on the outcome of the review is expected in 1997.

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.

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 1994, the UK Government published its Regulations to implement the EC Habitats Directive (Department of the Environment/Welsh Office 1994). As they relate to the coast, these regulations provide for single management groups to be set up for whole sites, 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. At the time of writing, discussions are continuing on how these requirements will work in practice (see also section 10.2.7).

10.2 National coastal initiatives with regional elements

10.2.1 Introduction

Partly as a result of developments at a UK and international level, many national bodies are now becoming involved in the promotion of coastal management initiatives, including several with no direct management role through a statutory remit or ownership of coastal land. These include non-governmental organisations with a particular interest in the conservation of the coastal zone: the Marine Conservation Society, World Wide Fund for Nature (UK) and the Royal Society for the Protection of Birds (RSPB) (see section 10.2.4). Only national initiatives that have distinct local elements in the region are described here. Many other diverse interest groups and organisations now have national policies with regard to coastal management and estuaries management, for example the British Association for Shooting and Conservation and the Royal Yachting Association, and their representatives are involved in most local or regional groups or fora, listed in Table 10.3.1. For further information on regionally-led coastal management initiatives, see section 10.3.

10.2.2 National coastal fora

The Coastal Forum (for England)

The Coastal Forum was launched in December 1994; it is chaired and serviced by the Department of the Environment 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 on issues related to the coastal zone in England by a wide range of interested bodies. 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. The Forum intends to produce a *Good practice guide* in 1996.

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 National Rivers Authority, Local Authority Associations, English Nature, Railtrack and Department of the Environment. The English Coastal Groups Forum met three times in 1995.

The Coastal Heritage Network (CoastNET)

Launched in 1996, the Coastal Heritage Network (CoastNET) (formerly the Heritage Coast Forum) provides 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.

10.2.3 English Nature

English Nature organises or participates in a number of national coastal zone management initiatives; major examples are described below (see also section 10.2.7).

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 35 estuary projects under way or proposed in the country, four are under way (one proposed) in this region (Table 10.2.1). 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 (SMA) initiative is set out in *Managing England's marine wildlife* (English Nature 1994) (see also section 7.4.4). Under the initiative, which is modelled on the Estuaries Initiative, English Nature and the managers and users of the marine environment are, with joint funding, developing ways of managing areas of marine wildlife importance, based on voluntary measures used in conjunction with existing regulatory controls. SMAs within the region are Lyme Bay (part of which lies within Region 9), the Exe Estuary, Torbay to the Dart Estuary, Bolt Tail to Slapton, and Plymouth Sound, Tamar and Yealm. Part of the Dodman Point to the Lizard site falls within the region, but most lies within Region 11 to the west.

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, from Portland Bill to Start Point) which lies partly within the region. The trial includes a review of the coastline, adjacent areas, the mechanisms by which the area is regulated and how these may be applied in future, and development of a framework to decide what the management objectives for the area are and how they may be achieved. A strategy will be derived from this review, including the management objectives for the Maritime Natural Area and an action plan for their implementation. Future projects should extend this approach to the other Maritime Natural Areas within this region: Start Point to Porthallow (which includes part of Region 11).

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 co-ordinated management (Rothwell & Housden 1990). The campaign ran for three years. The RSPB Estuaries Inventory project compiled mapped and numerical information on land use and selected human activities for 57 major UK estuaries. In 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).

10.2.5 Shoreline management plans

Shoreline management plans 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 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. Two separate groups are preparing sub-cell Shoreline Management Plans for coastal defence in the region (Table 10.2.2) as at June 1996. Each is managed by a Shoreline Management Group, which comprises the lead authority, other local authority partners within the coastal sub-cell, the Environment Agency, English Nature, MAFF and any other important local organisations. Such groups are also known as Coastal Engineering Groups.

10.2.6 Local Environment Action Plans

The river catchment, which includes estuaries and coastal waters, is the basic water resource management unit (Map 10.2.1). The Environment Agency is building on the success of NRA catchment management plans in providing an integrated strategy for each catchment area. These plans, known as Local Environment Action Plans (LEAPs), deal with a wide range of environmental issues, environmental protection and the enhancement of water, land and air.

Table 10.2.2 Shoreline Management Plans

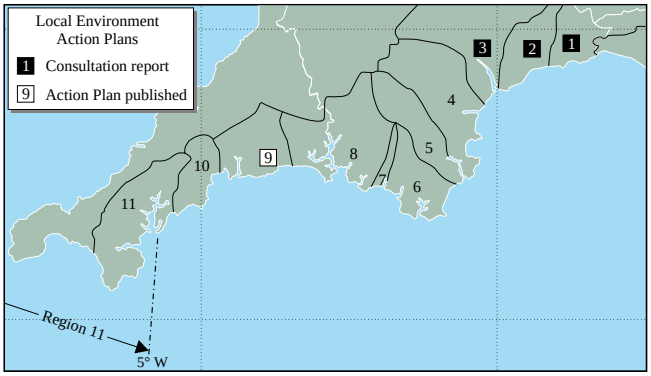
Sub-cell	*Lead organisation in management group*
Portland Bill to Dawlish Warren	*West Dorset District Council, tel: 01305 251010
Dawlish Warren to Start Point	*West Dorset District Council, tel: 01305 251010
Start Point to Rame Head	*West Dorset District Council, tel: 01305 251010
Rame Head to Lizard Point	*Caradon District Council, tel: 01579 341000

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

Table 10.2.1 Coastal management initiatives allied to English Nature Estuaries Initiatives

Initiative name	*Activities*	*Organisations involved*	*Contact address and telephone no.*
Exe Estuary Management Plan	Aims to promote sustainable use of the estuary to yield the greatest benefit to the present population whilst maintaining its potential to meet the needs and aspirations of future generations; improve co-operation and communication; provide for the continued and safe use by watercraft; agree a plan to control the number of moorings; provide adequate and safe navigation; ensure a sustainable fishery; encourage improvement of water quality; promote and adhere to the concept of sustainable development. Draft management framework produced 1994. Public consultation draft produced 1996.	Devon County Council, Exeter City Council, East Devon District Council, English Nature, NRA, Sports Council & the Exe Estuary Users Association	*Richard Butler, Devon County Council, Exeter, tel: 01392 382251
Salcombe Kingsbridge Estuary Environmental Management Plan	Aims to promote the sustainable use of the estuary by managing human activity in a manner that maintains the estuary's potential to meet the needs of future generations; conserve and enhance the nature conservation value; accommodate recreational activity; safeguard the interests of the local economy; encourage membership of the conservation forum; enhance water quality; enhance the landscape; protect features of historic and archaeological significance. Environmental Management Plan produced 1994. Proposes implementation through Conservation Officer, Estuary Forum and zoning policy.	South Hams District Council, Salcombe Harbour Master, South Hams Environment Service, English Nature	*Ken Carter, South Hams District Council, Totnes, tel: 01803 866480
The Waters of Plymouth and the Tamar Basin: a Partnership	Civil Water Management plan (Posford Duvivier Environment 1992). Programme includes appointment of Coastal Officer, reporting to Management Plan Group & Plymouth Civil Waters Management Steering Committee, consultation and drafting of issues report 1994-1995.	Civil Water Management Steering Committee formed from the Port of Plymouth Marine Liaison Committee (see Table 10.3.1). Members: Plymouth City Council, Cornwall and Devon CC, Caradon DC, West Devon BC, English Nature, Countryside Commission, South West Water.	*Coastal Liaison Officer, Planning and Transport, Plymouth City Council, Plymouth, tel: 01752 668000
Fowey Estuarial Management Plan	Issues Report - consultation draft circulated March 1996. Management Plan due April 1997.	Harbour Commissioners, Caradon DC, Cornwall County Council, Countryside Commission, Duchy of Cornwall, Restormel Borough Council, NRA, town and parish councils; fisheries representatives and recreation organisations.	Project Officer, Harbour Office, Fowey, tel: 01726 832471
Falmouth Bay & Estuaries Initiative	Issues report produced. Strategic guidelines and nature conservation overview in preparation. Project due for completion December 1996.	Cornwall CC, South West Water, Port of Truro, Port of Penryn, National Trust, English Nature, Carrick DC	*Coastal Officer, Countryside Service, Cornwall County Council, Truro, tel: 01872 323607

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



Map 10.2.1 River catchment areas for Local Environment Action Plans (LEAPs). Numbers refer to Table 10.2.3. Source: Environment Agency; reproduced by kind permission.

Table 10.2.3 Coastal Local Environment Action Plans (LEAPs) timetable

No. on Map 10.2.1	*Catchment*	*Current state of LEAP*
1	Lim & Axe	Consultation report published
2	Sid & Otter	Consultation report published
3	Exe	Consultation report published
4	Teign	In preparation
5	Dart	In preparation
6	Avon	In preparation
7	Erme	In preparation
8	Tamar Estuary, Tavey, Lynher, Plym & Yealm	In preparation
9	Seaton, Looe & Fowey	LEAP published
10	Parr, Crinnis & St. Austell	In preparation
11	Fal	In preparation

Table 10.2.3 gives a list of catchments where Local Environment Action Plans have been completed, or consultation reports have been issued or will be proposed during the period 1993-98 (NRA 1994). For further information contact the Environment Agency South-West Regional Office (see Appendix A.1).

10.2.7 Designated sites

Discussed in detail in Chapter 7, several statutory and non-statutory designations are also relevant here because they provide a degree of coastal management through their area or site management plans. 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 approved bodies for nature conservation objectives, Heritage Coasts (see below) and possible marine Special Areas for Conservation (see also section 7.1). The National Trust, which has extensive land holdings in the region, has recently been carrying out a review of its Coastal Strategy Plans and has a review of coastal site management plans ongoing.

Heritage Coasts

The defined areas of Heritage Coasts include only the finest sections of undeveloped coast (section 7.4.3). Most Heritage Coast Services (management teams working from within local authorities) in the region are producing or implementing management plans through their respective

Table 10.2.4 Heritage Coast management plans

Heritage Coast	*Aims*	*Organisations involved*	*Contact address*
South Devon Heritage Coast	No formal management plan; managed on an annual rolling programme of work, covering wildlife and landscape conservation, providing for informal recreation and interpretation	Service run jointly by South Hams District Council and Devon County Council. Steering group members also include Countryside Commission, National Trust and Heritage Coast Officer.	*Heritage Coast Officer, South Hams District Council, Totnes, tel: 01803 864499
Rame Head Heritage Coast	Mount Edgcumbe Country Park Management Plan covers much of this Heritage Coast	Part is managed by Mount Edgcumbe Joint Committee, which includes Cornwall County Council and Plymouth City Council.	Park Manager, Mount Edgcumbe House, Cremyll, Torpoint, Cornwall PL10 1HZ, tel: 01752 822236
Gribben Head - Polperro Heritage Coast	Area Management Strategy in preparation	Managed by Fowey - Lynher Countryside Service. Advisory Group includes Cornwall CC, Restormel BC, Caradon DC, Countryside Commission and other local agencies/landowners/ interest groups.	Countryside Officer, Project Explore, SE Cornwall Discovery Centre, Millpool, Looe, Cornwall PL13 2AF, tel: 01503 263266
The Roseland Heritage Coast	Area Management Strategy in preparation	Managed by Dodman - Fal Estuary Countryside Service. Advisory Group includes Cornwall CC, Restormel BC, Carrick DC and other local agencies/landowners/interest groups.	*Countryside Officer, Cornwall County Council, tel: 01872 322000

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

local authorities and associated Advisory Groups (Table 10.2.4). These plans cover coastal Areas of Outstanding Natural Beauty, but larger coastal areas are also included in the remit of the Countryside Management Services that cover the Heritage Coasts. The Coastal Heritage Network (CoastNET - see section 10.2.2) brings together those managing Heritage Coasts.

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 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. Under the Directive marine and terrestrial SACs will have to be managed in a way that secures their 'favourable conservation status'. All possible sites should be managed, on a voluntary basis, as though they were already designated. 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, as appropriate. In 1996 the Department of the Environment published consultation draft guidelines for the preparation and application of management schemes for marine SACs (DoE 1996). At the time of writing, the four country nature conservation agencies are, at the instigation of the Scottish Office, preparing a generic management model for marine SACs, giving an overview of how schemes of management should develop.

10.3 Regional coastal management groups and initiatives

10.3.1 Introduction

There are currently numerous regional coastal management initiatives arising around the coastline under the leadership of local planning, harbours and ports authorities. Other locally-based coastal management initiatives, although not strictly integrated as defined in section 10.1.1, are also under way. These include Coastal Engineering Groups (see section 10.2.5), which are primarily concerned with promoting co-ordination and liaison between organisations undertaking coastal works (section 8.4). In some places wider coastal fora have developed from a range of coastal designations and various management initiatives. For example, the Lyme Bay Forum is a collaborative initiative between Dorset and Devon County Councils, to examine problems and processes which overlap administrative boundaries (see Table 10.3.1 for others). The great value of such fora is that they bring all interest and user groups together and enable issues of concern to be examined from all points of view.

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 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. Their own planning documents (County Structure Plans and Local Plans) also usually pay particular attention to coastal matters, particularly when produced following PPG 20. In 1995 further guidance was forthcoming from the Local Government Management Board on the implementation of local coastal sustainable development strategies, i.e. Local Agenda 21 initiatives) (Local Government Management Board 1995). An important local authority initiative at county level is SWRPCON (South West Regional Planning Conference), which includes Devon and Cornwall (see Table 10.3.1). SWRPCON produced a regional strategy document in 1994, which set out guidelines to assist the local planning authorities in the preparation of strategic plans and policies. The report highlighted three areas of major significance to the south-west: the landscape, the historic environment and the coast (SWRPCON 1994). Port and Harbour Authorities (listed with local planning authorities in Appendix A2) also have a statutory remit to control activities within their areas of authority, which may include coastal waters, and will receive wider powers to manage Special Areas of Conservation under the EC Habitats & Species Directive.

Table 10.3.1 Regional coastal management initiatives

Initiative name	*Scope/aims*	*Organisations involved*	*Contact address*
South West Regional Planning Conference (SWRPCON)	Publication of regional planning guidance 1994. Joint action required by all local planning authorities and agencies to adopt an agreed vision and set priorities; maintain and enhance coastal features; ensure no development on undeveloped parts of coast.	South West County Councils (Dorset, Devon, Cornwall, Wilts., Somerset, Avon & Glos.) and District Councils	Sue Watts, SWRPCON Secretariat, Somerset County Council, County Hall, Taunton TA1 4DY, tel: 01823 333451
Lyme Bay Coastal Forum	Joint initiative addresses major issues affecting Lyme Bay (oil transport and discharge, inshore water quality, coast protection, marine environmental quality, fishing, tourism, policy and management). Provides a forum for discussion and newsletter.	Devon and Dorset County Councils and other organisations, agencies, user groups, voluntary bodies and local authorities with an interest in Lyme Bay	Coastal Policy Officer, Planning Department, Dorset County Council, County Hall, Colliton Park, Dorchester, tel: 01305 224132 or *Engineering and Planning Officer, Environment Department, Devon County Council, Exeter tel: 01392 382000
Lyme Bay and South Devon Coastline Group	Improve co-ordination and liaison between agencies undertaking coastal works		*M.F. Johnson, Director of Technical Services, South Hams District Council, Totnes, tel: 01803 861234
Devon Coast Protection Advisory Group	Improve co-ordination and liaison between agencies undertaking coastal works		*M.F. Johnson, Director of Technical Services, South Hams District Council, Totnes, tel: 01803 861234
Devon Coastal Statement	Coastal fora established for Lyme Bay, North Devon and Falmouth Bay. Statement sets the scene, identifies issues, sets out policies and responsibilities, and provides guidance for local CZM plans.	Devon County Council co-ordinating, contributions invited from all agencies, organisations and authorities in the area	*Devon County Council, tel: 01392 383019
East Devon Coastal Plan	Due 1995; will give direction to the work of the Heritage Coast Service	Devon CC, East Devon District Council, Countryside Commission, East Devon Heritage Coast Service.	East Devon Heritage Coast Service, Divisional Surveyor, Council Offices, Station Rd., Knowle, Sidmouth, Devon EX10 8HL, tel: 01395 515245
Lyme Bay Clean Sweep	South West Water's programme of marine improvement schemes, to meet mandatory standards of the EC Bathing Water Directive. Example of water industry's new integrated approach to catchment management.	South West Water and South West National Rivers Authority	*Environment Agency, South Western Region, Exeter, tel: 01392 444000
Port of Plymouth Area Recreation Study	Covers waters of Plymouth and Tamar Basin. Provides key recommendations and policies for many zones. First published in 1975; reviewed in 1992.	Port of Plymouth Marine Liaison Committee	*Plymouth City Council, Plymouth, tel: 01752 668000
West Devon Borough Local Plan	Final Plan 1994 recommends protection of specialised coastal and estuarine habitats, the aquatic environment, special landscapes and river corridors	West Devon Borough Council	*Planning Department, West Devon Borough Council, Okehampton, tel: 01837 52901
Cornwall and Isles of Scilly Coast Protection Group	Aims to improve co-ordination and liaison between agencies undertaking coastal works.	Cornwall County Council, Caradon, Kerrier, North Cornwall, Penwith and Restormel District Councils	Kerrier District Council, Council Offices, Dolcoath Avenue, Camborne TR14 8RY, tel: 01209 712941

Table 10.3.1 Regional coastal management initiatives (continued)

Initiative name	*Scope/aims*	*Organisations involved*	*Contact address*
Project Explore, incorporating Fowey-Lynher Countryside Service	Sustainable management of coast through public and private sector partnerships, community involvement, conservation and interpretation of countryside and historic sites, green tourism	Caradon District Council, Restormel BC, Cornwall County Council, Countryside Commission, local agencies/landowners/interests	*Fowey-Lynher Countryside Service, Discovery Centre, Millpool, West Looe PL13 2AF, tel: 01503 263266
Towards 2000, Cornwall's Coast & Countryside	Strategy in preparation. Five-year and annual programmes. Integrated management through a network of area countryside services and initiatives.	Cornwall County Council, partner local authorities and agencies	*Cornwall County Council, Truro, tel: 01872 322000
Dodman-Fal Estuary Countryside Service	Area Management Strategy in preparation. Rolling programme of environmental, interpretative and recreation management. Aims for sustainable management of the coast through public and private sector partnerships, community involvement, conservation and interpretation of historic sites.	Cornwall County Council, Countryside Commission, Carrick District Council, Restormel Borough Council, National Trust, landowners, relevant local interests	Dodman-Fal Estuary Countryside Service, Lander Building, Daniell Road, Truro, Cornwall TR1 2DA, tel: 01872 322000

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Halliday, J.E. 1988. Coastal planning and management: the role of the county councils in England and Wales. *Ocean and Shoreline Management, 11:* 211-230.

Heritage Coasts Forum. 1993. *Heritage Coasts in England and Wales - a gazetteer.* Manchester, Heritage Coasts Forum.

Jones, R. 1993. Coastal cell studies - a basis for coastal zone management. *Earth Science Conservation, 32:* 12-15.

National Coasts and Estuaries Advisory Group. 1993. *Coastal planning and management: a good practice guide*. Maidstone, National Coasts and Estuaries Advisory Group.

Nature Conservancy Council. 1990. *Marine Consultation Areas*. Edinburgh, Nature Conservancy Council.

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.

World Wide Fund For Nature UK. In prep. *Coastal management plans.* Godalming, World Wide Fund For Nature UK. (Marine Update No. 18.)

World Wide Fund For Nature UK. In prep. *International commitments to integrated coastal zone management.* Godalming, World Wide Fund For Nature UK. (Marine Update No. 17.)

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 10.3.3 C.

Coastline UK. Newsletter of the National Coasts and Estuaries Advisory group (NCEAG). Aimed at local authority planners. Published by NCEAG.

Coastline. Quarterly magazine of the European Union for Coastal Conservation (EUCC). Intended to establish a pan-European forum on coastal issues, including coastal management. Published by EUCC.

Coastline. The Bulletin of the Parliamentary All Party Coastal Group. Provides information summaries for MPs. Published by the All Party Coastal Group.

CoastNET. The Bulletin of the Coastal Heritage Network. A quarterly publication on all matters concerned with coastal management in the UK. Published by the Coastal Heritage Network.

CZM News. Occasional Newsletter of Eurocoast UK, reporting on projects and developments in the field of coastal zone management. Published by Eurocoast UK.

Marine Scene. Occasional marine newsletter of the statutory conservation agencies in UK. Aimed at marine scientists, and users and regulators of the sea. Published by JNCC.

Wavelength. The Coastal Forum newsletter. Reports the work of the Forum to a wider audience. Published by the Department of the Environment.

National planning/management publications

DoE/Welsh Office. 1992. *Planning policy guidance - coastal planning*. London, HMSO. (PPG 20.) (Recognises the need to define a coastal zone incorporating areas affected by natural near-shore processes. Advises local authorities to consider the impacts of off-shore and on-shore developments within the full coastal zone. Endorses the precautionary approach.)

DoE/Welsh Office. 1993. *Development below Low Water Mark - a review of regulation in England and Wales*. London, HMSO. (Rejects the 1992 Environment Committee's recommendations for the extension of development controls off-shore. Seeks to strengthen existing arrangements to overcome limitations and draw-backs in the present land-use planning system.)

DoE/Welsh Office. 1993. *Managing the coast: a review of coastal management plans in England and Wales and the powers supporting them*. London, HMSO. (Includes proposals for coastal management plans to be based on a voluntary, multi-agency approach, generally led by local authorities.)

Department of the Environment. 1995. *Policy guidelines for the coast.* London, HMSO. (Highlights government coastal policy and summarises essential guidance.)

House of Commons Environment Committee. 1992. *Second report - coastal zone protection and planning*. London, HMSO. (Recommended that coastal zone management be adopted as the framework for all coastal zone planning and management practice in the United Kingdom. Called for a national coastal strategy, a review of the many organisations responsible for the coast, the extension of planning controls offshore, and the establishment of a Coastal Zone Unit in Department of the Environment.)

MAFF. 1994. *Shoreline management plans.* (A procedural guide for operating authorities. 4th draft, July 1994.)

C. Contact names and addresses

(See also Tables 10.2.1, 10.2.2, 10.2.4 and 10.3.1)

Organisation/group	*Activities*	*Contact address and telephone no.*
British Marine Industry Federation	The BMIF Environment Initiative is developing a code of practice for the marine industry and a user outreach programme to educate boat users about their environmental responsibilities. It has also produced a Guidance Note on Planning Policies for the Marine Environment.	BMIF, Meadlake Place, Thorpe Lea Road, Egham, Surrey TW20 8HE, tel: 01784 473377
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, Bristol, tel: 0117 987 8003
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.	Coastal Heritage Network, The Manchester Metropolitan University, St. Augustine's, Lower Chatham Street, Manchester M15 6BY, tel: 0161 247 1067
Coastal Research and Management Group (CR&MG)	Liaison between research workers and managers in the field of coastal ecology. Concentrates on research and management issues relevant to landscape and wildlife conservation along the coastal zone (marine and terrestrial).	*Coastal Research and Management Group (CR&MG), Coastal Conservation Branch, JNCC, Peterborough, tel: 01733 62626
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: Maritime Team, English Nature HQ, Peterborough, tel: 01733 340345 (secretariat)
Countryside Commission	Promotion of policies for Heritage Coasts, and coastal management generally	*National Parks & 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 section 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.	*R. Hathaway, Head of Flood and Coastal Defence Division, MAFF, London, tel: 0171 238 6660
English Nature	Management of designated coastal sites; nature conservation and development planning, Estuaries Initiative, Sensitive Marine Areas, Maritime Natural Areas	*English Nature HQ, Peterborough, tel: 01733 340345
Environment Agency	Catchment management planning, 5-year programme, sea defences, shoreline management plans	*Environment Agency South-Western Region, Exeter, tel: 01392 444000
Eurocoast UK	The Eurocoast Association aims to improve the basis for protection, development and management of the coastal zone. Primarily a communication network.	Eurocoast UK, Burderop Park, Swindon, Wiltshire SN4 0QD, tel: 01793 812479
European Union for Coastal Conservation (EUCC)	International grouping of organisations and individuals with an interest in coastal nature conservation matters, including coastal management. The CR&MG (see above) is the core of the UK branch of EUCC.	European Union for Coastal Conservation (EUCC) Secretariat, PO Box 11059, NL-2301 EB Leiden, tel: +31 71 122900/123952

Addresses and telephone numbers of local planning authorities are given in full in the Appendix, as are * starred contact addresses.

C. Contact names and addresses (continued)

(See also Tables 10.2.1, 10.2.2, 10.2.4 and 10.3.1)

Organisation/group	*Activities*	*Contact address and telephone no.*
Joint Nature Conservation Committee - Coastal Conservation Branch	Information and advice on coastal management initiatives	*JNCC, Peterborough, tel: 01733 866821
Joint Nature Conservation Committee - Marine Conservation Branch	Information and advice on marine issues. Publishes Marine Scene, which summarises marine conservation news from the JNCC, Scottish Natural Heritage, English Nature and the Countryside Council for Wales.	*JNCC, Peterborough, tel: 01733 866833
Les Esturiales Environmental Study Group	International programme for co-operation, the exchange of experience on estuarine management and personal contacts between local authority practitioners in Europe.	Esturiales Environmental Study Group, Professor Graham King, CZM Associates, 2 Newton Villas, Newton, Swansea SA3 4SS, tel: 01792 367552
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	Shoreline Management Plans (mainly aimed at formulating a coast protection strategy)	*MAFF, London , tel: 0171 238 3000
National Coasts and Estuaries Advisory Group (NCEAG)	On behalf of local authorities, provides advice on sustainable management of coastal and estuarine environments; published guide to good practice (NCEAG 1993)	Environment Programme Manager, National Coasts and Estuaries Advisory Group (NCEAG), Environment Programme, Kent County Council, Springfield, Maidstone ME14 2LX, tel: 01622 696180
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 (Devon), Exeter, tel: 01392 881691, or *National Trust (Cornwall), Bodmin, tel: 01208 742481
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.	*D. Huggett, 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.	*World Wide Fund for Nature - UK, Godalming, tel: 01483 426444
The Wildlife Trusts	Has extensive coastal land holdings throughout the UK. Is actively involved in coastal zone initiatives in this region. Manages some voluntary conservation areas. Has extensive experience of coastal interpretation, marine survey and policy work.	Joan Edwards, Marine Conservation Officer, The Wildlife Trusts, The Green, Witham Park, Waterside South, Lincoln LN5 7JR, tel: 01522 544400

Addresses and telephone numbers of local planning authorities are given in full in the Appendix, as are * starred contact addresses.

Appendix

A.1 Frequently cited contact names and addresses

Name	*Contact address and telephone no.*
Statutory bodies	
Countryside Commission HQ	John Dower House, Crescent Place, Cheltenham, Gloucestershire GL50 3RA, tel: 01242 521381
Countryside Commission, South-West Region	Bridge House, Sion Place, Clifton Down, Bristol BS8 4AS, tel: 0117 973 9966
Department of the Environment (DoE), European Wildlife Division/ Dept. of Rural Affairs	DoE, Tollgate House, Houlton Street, Bristol BS2 9DJ, tel: 0117 987 8000
DoE, Water Resources and Marine	Romney House, 43 Marsham Street, London SW1P 3PY, tel: 0171 276 0900
English Nature (EN) HQ	Northminster House, Peterborough PE1 1UA, tel: 01733 340345
English Nature, Devon Local Team	The Old Mill House, 37 North Street, Okehampton, Devon EX20 1AR, tel: 01837 55045
English Nature, Cornwall Local Team	Trevint House, Strangways Villas, Truro, Cornwall TR1 2PA, tel: 01872 262550
Environment Agency (EA) HQ	Rivers House, Waterside Drive, Aztec West, Almondsbury, Bristol BS12 4UD, tel: 01454 624400
Environment Agency, South-West Regional Office	Manley House, Kestrel Way Exeter, Devon EX2 7LQ, tel: 01392 444000
EA Devon Area Office	Manley House, Kestrel Way Exeter, Devon EX2 7LQ, tel: 01392 444000
EA Cornwall Area Office	Sir John Moore House, Victoria Square, Bodmin PL31 1EB, tel: 01280 78301
Institute of Terrestrial Ecology (ITE), Monks Wood	Abbots Ripton, Huntingdon, Cambridgeshire PE17 2LS, tel: 01487 773381
Joint Nature Conservation Committee (JNCC) HQ	Monkstone House, City Road, Peterborough, Cambs. PE1 1JY, tel: 01733 62626
JNCC Seabirds at Sea Team	Seabirds and Cetaceans Branch, Joint Nature Conservation Committee, Dunnet House, 7 Thistle Place, Aberdeen AB1 1UZ, tel: 01224 655700
Ministry of Agriculture, Fisheries and Food (MAFF) Directorate of Fisheries Research (DFR), Fisheries Laboratory, Conwy	Benarth Road, Conwy, Gwynedd LL32 8UB, tel: 01492 593883
MAFF DFR, Fisheries Laboratory, Lowestoft	Pakefield Road, Lowestoft, Suffolk NR33 OHT, tel: 01502 562244

Name	*Contact address and telephone no.*
Statutory bodies (continued)	
MAFF DFR, Fisheries Laboratory, Burnham-on-Crouch	Remembrance Avenue, Burnham-on-Crouch, Essex CM0 8HA, tel: 01621 787200
MAFF, Flood and Coastal Defence Division	Eastbury House, 30/34 Albert Embankment, London SE1 7TL, tel: 0171 238 3000
Coastal fora	
Marine Forum for Environmental Issues	Honorary Secretary, The Marine Forum for Environmental Issues, c/o University College Scarborough, Filey Road, Scarborough YO11 3AZ, tel: 01723 362392
Lyme Bay Coastal Forum	Coastal Policy Officer, Planning Department, County Hall, Colliton Park, Dorset County Council, Dorchester, Dorset DT1 1XJ, tel: 01305 224132
Lyme Bay and South Devon Coastline Group	West Dorset District Council, 58-60 High West Street, Dorchester, Dorset DT1 1UZ, tel: 01305 251010
Wildlife Trusts	
Devon Wildlife Trust	35-37 St David's Hill, Exeter, Devon EX4 4DA, tel: 01392 79244
Cornwall Wildlife Trust	Five Acres, Allet, Truro TR4 9DJ, tel: 01872 73939
National voluntary bodies	
British Trust for Ornithology (BTO)	The Nunnery, Thetford, Norfolk IP24 2PU, tel: 01842 750050
Marine Conservation Society	9 Gloucester Road, Ross-on-Wye, Herefordshire HR9 5BU, tel: 01989 566017
National Trust (NT), Coast and Countryside Adviser	33 Sheep Street, Cirencester, Gloucestershire GL7 1RQ, tel: 01285 651818
NT Devon Region	Killerton House, Broadclyft, Exeter, Devon EX5 3LE, tel: 01392 881691
NT Cornwall Region	Lanhydrock, Bodmin, Cornwall PL30 4DE, tel: 01208 74281
Royal Society for the Protection of Birds (RSPB) HQ	The Lodge, Sandy, Bedfordshire SG19 2DL, tel: 01767 680551
RSPB South-West England Office	10 Richmond Road, Exeter, Devon EX4 4JA, tel: 01392 432691
Wildfowl & Wetlands Trust (WWT) HQ	Slimbridge, Gloucestershire GL2 7BT, tel: 01453 890333
Worldwide Fund For Nature (WWF) - UK	Panda House, Weyside Park, Cattershall Lane, Godalming, Surrey GU7 1XR, tel: 01483 426444

A.2 Local planning authorities; ports and harbour authorities addresses

Authority	*Address*
Caradon District Council	Luxstowe House, Liskeard PL14 3DZ, tel: 01579 341000
Carrick District Council	Carrick House, Pyder Street, Truro TR1 1EB, tel: 01872 78131
Cornwall County Council	New County Hall, Truro TR1 3AY, tel: 01872 322000
Devon County Council	County Hall, Exeter EX2 4QD, tel: 01392 382000
East Devon District Council	Council Offices, Station Road, Knowle, Sidmouth EX10 8HL, tel: 01395 516551
Exeter City Council	Civic Centre, Paris Street, Exeter EX1 1JN, tel: 01392 77888
Plymouth City Council	Civic Centre, Plymouth PL1 2EW, tel: 01752 668000
Restormel Borough Council	Borough Offices, 39 Penwinnick Road, St. Austell PL25 5DR, tel: 01726 74466
South Hams District Council	Follaton House, Plymouth Road, Totnes TQ9 5NE, tel: 01803 861234
Teignbridge District Council	Council Offices, Forde House, Newton Abbot TQ12 4XX, tel: 01626 61101
Torbay Borough Council (& Torbay Harbour)	Town Hall, Torquay TQ1 3DR, tel: 01803 296244
West Devon Borough Council	Council Offices, Kilworthy Park, Drake Road, Tavistock PL19 0BZ, tel: 01822 615911

Port/harbour authorities	*Address*
Exeter (& Exeter Ship Canal; pilotage to Exmouth Docks)	Exeter City Council, Navigational & Canal Authority Exe Estuary, Civic Centre, Paris Street, Exeter EX1 1JN, tel: 01392 74306
Dart	Dart Harbour and Navigation Authority, Dart House, Oxford Street, Dartmouth, Devon TQ6 9AL, tel: 01803 832337
Fowey	Fowey Harbour Commissioners, Harbour Office, Albert Quay, Fowey, Cornwall PL23 1AJ, tel: 01726 832471/2
Par Harbour	ECC Ports Ltd, Par Harbour, Par, Cornwall PL24 2BP, tel: 01726 817300
Plymouth (Cattewater Harbour)	Cattewater Harbour Commissioners, 2 The Barbican, Plymouth PL1 2LR, tel: 01752 665934
Plymouth (Millbay Docks)	Associated British Ports, Port Office, Millbay Docks, Plymouth PL1 3EF, tel: 01752 662191
Salcombe Harbour Authority	South Hams District Council, Harbour Office, Whitestrand, Salcombe, Devon TQ8 8BU, tel: 01548 843791
Teignmouth Harbour	Harbour Commission, 2-5 Orchard Gardens, Teignmouth, Devon TQ14 8DR, tel: 01626 772376
Torbay Harbour	Borough of Torbay, Town Hall, Castle Circus, Torquay, Devon TQ1 3DR, tel: 01803 292429

A.3 Core reading list

There are a number of imporant 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.

Ambios Environmental Consultants. 1995. *Lyme Bay Environmental Study*. A report produced by Ambios Environmental Consultants Ltd on behalf of Kerr-McGee Oil (UK) Plc and Partners. (18 volumes covering the physical environment; subtidal and intertidal benthic ecology; marine vertebrates; terrestrial ecology and environmental quality.)

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

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

Brown, A. 1992. *The UK environment*. London, HMSO.

Buck, A.L. In prep. *An inventory of UK estuaries. 6. Southern England.* Peterborough, Joint Nature Conservation Committee.

Cordrey, L. 1996. *The biodiversity of the south-west: an audit of the south-west biological resource*. Somerset, South West Regional Planning Conference. (A report prepared by RSPB, the County Wildlife Trusts and the SWRPCON.)

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.

Department of the Environment. 1995. *Policy guidelines for the coast*. London, HMSO.

Devon County Council. 1995. *Devon Coastal Statement*. Exeter, Devon County Council.

Devon Wildlife Trust. 1996. *The Great West Bay marine wildlife survey. A report on the marine wildlife resource of the Great West Bay*. Exeter, Devon Wildlife Trust.

Doody, J.P., Johnston, C., & Smith, B. 1993. *The directory of the North Sea coastal margin.* Peterborough, JNCC.

Eno, N.C., *ed*. 1991. *Marine conservation handbook.* 2nd ed. Peterborough, English Nature.

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.

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. *Quality Status Report of the North Sea 1993. Sub-region 9 Assessment Report*. London, UK Department of the Environment, Republique Francaise Ministere de l'Environnement, Institut Français de Recherche pour l'Exploitation de la Mer.

Robinson, A., & Millward, R. 1983. *The Shell book of the British coast*. Newton Abbot, David and Charles.

SWRPCON. 1994. *South West Regional Planning Conference: regional strategy. The landscape, coast and historic environment of the south west*. Somerset, South West Regional Planning Conference.

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

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