JOINT NATURE CONSERVATION COMMITTEE

Coasts and seas of the United Kingdom

Region 4 South-east Scotland: Montrose to Eyemouth

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 sea defence and coast protection, the distribution and importance of the wildlife and habitats of our coasts and seas, including fish and fisheries, and the climate and sea level changes to which they all are subject.

In addition to the value of the information itself, the way the project has been run and the data collected has made an important contribution to the quality of the product. A wide range of individuals and organisations concerned with the conservation and use of the coastal margin have collaborated in collating the information, their variety reflecting the extent of the interplay between the coastal environment and human activities. These organisations included the Ministry of Agriculture, Fisheries and Food, the Scottish Office, the Department of the Environment (Northern Ireland), the Environment Agency, the Countryside Commission, the Welsh Office, the Department of the Environment, 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 & Species Directive. In addition, the reports will make an important contribution to the implementation of the UK Biodiversity Action Plan.

The Earl of Selborne
Chairman, Joint Nature Conservation Committee

How to use this book

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

Structure

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

- **Introduction**: presents the important features of the topic as it relates to Region 4 and sets the region in a national context.
- **Important locations and species**: gives more detail on the features of the region in relation to the topic.
- **Human activities**: describes management and other activities that can have an effect on the resource in the region.
- **Information sources used**: describes the sources of information, including surveys, on which the section is based, and notes any limitations on their use or interpretation.
- **Acknowledgements**
- **Further sources of information**: lists references cited, recommended further reading, and names, addresses and telephone numbers of contacts able to give more detailed information.

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

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

Definitions and contexts

The word 'region' (as in 'Region 4') 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 1 km of Mean High Water Mark, or an offshore area that may extend out to the median line between the UK and neighbouring states. Inland areas of the counties concerned are not included unless specifically stated.

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

The term 'North Sea Coast', as used here, means the coast of Britain from Cape Wrath (longitude 5°W) along the east and south coasts of Britain to Falmouth (again longitude 5°W), and including Orkney and Shetland.

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

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

Throughout the book, the information given is a summary of the best available knowledge. The sites mentioned as important, the numbers and distributions of species, archaeological features discovered and information on all the other elements of the natural and man-made environment are as up-to-date and complete as reasonably practicable at the time of publication (July 1997). 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 volume 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
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Belfast City Council
BHP Petroleum Ltd[1]
Centre for Environment, Fisheries & Aquaculture Sciences
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
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Dorset County Council
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Dumfries and Galloway Regional Council
Dyfed County Council
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North East Fife District Council
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Somerset County Council
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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.

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This collaborative project involved many other staff of JNCC in addition to the project team listed on page 2. They were: Deirdre Craddock, Steve Gibson, Tim Hill, Keith Hiscock, Nick Hodgetts, Alan Law, Becci May, Sonia Palasiuk, Deborah Procter, Bill Sanderson, David Stroud, Mark Tasker, Andy Webb, Martin Wigginton and Lissie Wright. We thank them all for their help and support.

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

The town of North Berwick, on the rugged coast of East Lothian, is a popular centre for leisure and tourism. Home of the East Lothian Yacht Club, it also offers camping and caravan sites, golf courses, two historic castles close by and boat trips to see the seabirds and seals at Fidra Island and Bass Rock. Photo: Coastwatch, 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 undertook to prepare such a compendium of information for the coast of the whole United Kingdom.

This undertaking - the Coastal Directories Project - collates existing information on the United Kingdom and Isle of Man coastal zone to provide national and regional overviews of its natural resources and human activities, and indexes more detailed sources of information. The project uses a broad definition of the coastal margin that encompasses all the main habitats from offshore waters through to dry land, including any habitat forming part of the functioning coastal system; in addition areas of former tidal land now enclosed from the sea and lowland wet grassland alongside tidal rivers are included. At times it can be either unhelpful or impossible to set precise limits on the geographic areas that need to be covered, for example in the marine environment, such as when discussing fisheries or sources of contamination. However, where possible, coverage is of coastal 10 km squares, or sites within 1 km 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.

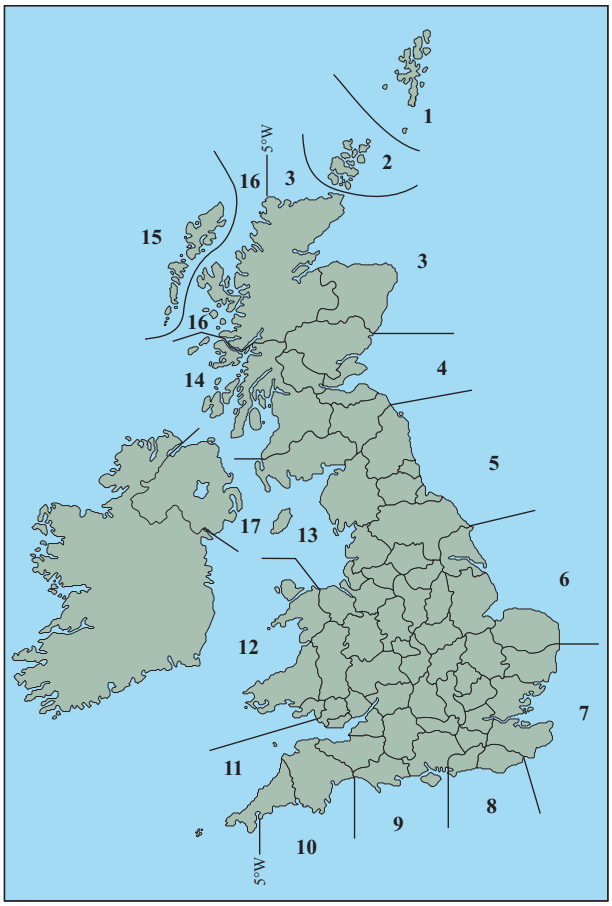
At the second meeting of the NSTF, in 1989, the UK suggested that the North Sea QSR should include consideration of terrestrial habitats and species. This was to involve the collection of information dealing with the coastal margin of the North Sea (defined as being east of longitude 5° West - i.e. from 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, encouraged a more integrated, local approach to management issues. At the same time, as the work on the *Directory of the North Sea coastal margin* proceeded, the emphasis of the approach changed. The main aim had been the collection of information, but gradually the process of working with people to gather the data threw the spotlight more on the benefits of a partnership approach and its value for promoting coastal zone management, with which the Coastal Directories Project became more directly linked.



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 proposed to produce a *West Coast Directory* to cover the remainder of the coast of Great Britain, the Isle of Man and, by later agreement, Northern Ireland, as well as a series of regional volumes to cover the whole coast of the UK. Regions were defined, wherever possible, by the current local or national government coastal boundaries that most closely approximated to the limits of major coastal process cells (see section 2.4), to ensure that pragmatic management requirements were matched by an ecologically coherent information base. Volumes covering 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 resulted in a decision to make the completion of the regional volumes the priority, rather than the overview *West Coast Directory*. At the meeting of the main steering group in February 1996 it was decided not to publish the *West Coast Directory* at all, as it would duplicate material already published in the regional volumes.

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

Interest in the project 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 have met regularly. The main steering group met annually for a seminar: it considered the *Role of the Directories in the development of coastal zone management* (January 1994), the *Use of electronic storage and retrieval mechanisms for data publication* (February 1995) and *The tide turns for coastal zone management: Coastal Directories users*

Table 1.1.1 Coastal Directories Project management structure

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

report back on their experiences (February 1996). In addition the core steering group has also met at least annually.

1.1.4 The contribution of the project to coastal management

At the outset it was agreed that the work should involve as many as possible of the individuals and organisations concerned with the use of the coastal margin, to reflect the complex nature of the habitats and species and the wide-ranging influence of human activities. As the project evolved, the value of this approach 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 1993a) and *Managing the coast* (DoE/Welsh Office 1993b) (note that these reports do not cover Scotland, Northern Ireland or the Isle of Man) and *Scotland's coast: a discussion paper* (Scottish Office Agriculture, Environment and Fisheries Department 1996). 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

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	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	1996
Region 12. Wales: Margam to Little Orme	1995
Region 13. Northern Irish Sea: Colwyn Bay to Stranraer including the Isle of Man	1996
Region 14. South-west Scotland: Ballantrae to Mull	1997
Regions 15 & 16. North-west Scotland: the Western Isles and west Highland	1997
Region 17. Northern Ireland	1997
Electronic editions	
Coastal and marine UKDMAP datasets: Version 2	1994
Regions 3, 5, 6, 9, 10, 11, 12 & 13	1996
Regions 4, 14, 15 & 16, 17	1997
Other regions	Following book publication

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.

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). Electronic editions of the published regional volumes are also 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

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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.

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

B. Further reading

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

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Information about the Coastal Directories project and UKDMAP version	*Communications Manager, JNCC, Peterborough, tel: 01733 62626
Sales outlet for book and electronic 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.

1.2 Introduction to the region

Dr J.P. Doody

1.2.1 Introduction

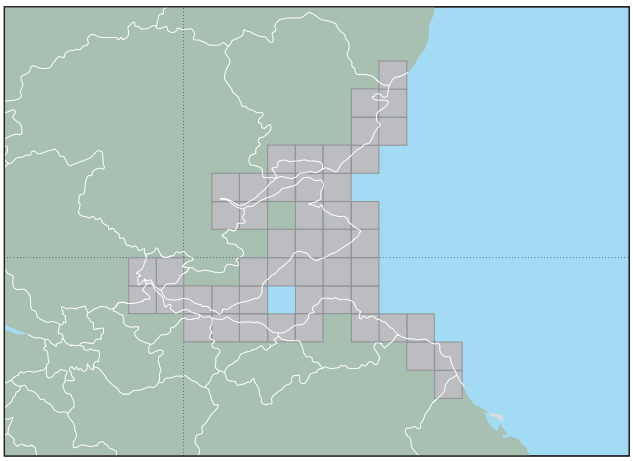
This section gives a brief introduction to the character of the region, its wildlife and the extent of its human use and development, synthesising information presented in Chapters 2 - 10. The main coastal locations are shown on Map 1.2.1. Map 1.2.2 shows the coastal 10 km squares in the region.

Region 4 covers the coastal zone of south-east Scotland southwards from Montrose, including Angus, the City of Dundee, Perth and Kinross, Fife, Clackmannanshire, Stirling, Falkirk, West Lothian, the City of Edinburgh, Midlothian, East Lothian and the Scottish Borders. The coast is 533 km long - 4.5% of the total coastline of Scotland and 2.8% of that of Great Britain. It has a varied geology, for the most part formed of Devonian and Carboniferous rocks (410-290 million years old). In contrast to Region 3 to the north, which has a rugged and open character, this region has a much gentler topography, with the immediate coastal hinterland lying mostly below the 250 m contour. The Firth of Forth, one of the major estuaries in the UK, and the Firth of Tay bring maritime influence many kilometres inland.

Winds at Edinburgh Airport (Turnhouse) are mainly from the west and south-west (>50% of the time) or from the north-easterly sector (>35% of the time). Much of the region is relatively sheltered from gales from the north and, especially, the west. Local topography may have an important influence on onshore breezes, particularly in storms, but its impact is less than on the west coast of Scotland, where the mountains are much closer to the sea. Tidal range is moderate and, at 4 m, typical of much of the Scottish coast. It can rise to 6 m (at Leith and Rosyth) on spring tides, and once in five years a tidal surge generated by weather conditions can be expected to add another 1.5 m to all stages of the tide.

Agricultural use in the region includes intensive arable farming as well as livestock (cattle and sheep) rearing. Dundee and Perth on the Tay and Stirling and Edinburgh on the Forth are the main urban centres, although towns and villages are distributed along much of the coast. Industrial activities include oil refining and storage, coal mining (now largely ceased) and power generation. Fishing, once a major activity, occurs on only a relatively small scale today. Unlike the higher, more rugged landscapes to the north and west, the landscape is not a major tourist attraction, but the sandy beaches, golf courses and historical interest help to sustain a substantial tourism industry.

Map 1.2.1 Rivers, major towns and other coastal locations



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

1.2.2 Structure and landscape

The region lies to the south and east of the Highland Boundary Fault and its rocks are considerably younger than those further north. In the north of the region the cliffed coast is formed of Lower Devonian rocks, which include a variety of sandstones and shales. Rocks of volcanic origin - mainly lavas, which tend to be more resistant to weathering - are interspersed with the sediments, forming headlands such as Scurdie Ness and Red Head, north of Arbroath. Further south, cliffs give way to the sandy shores and dunes of the outer Firth of Tay and the low-lying rock platforms of Fife. Carboniferous rocks make up the bulk of the Fife coast and occur extensively in the Firth of Forth. Until recently, coal-bearing strata here provided the basis for the production of approximately half of Scotland's coal output. Around North Berwick the low-lying coastline has a substantial covering of sand in places such as Aberlady Bay and Tyninghame. Volcanic activity in the Carboniferous Period helped to create many significant landscape features in and around the Firth of Forth, including the Isle of May and Bass Rock. Cliffs reappear where Silurian rocks (440-410 million years old) form the coast, rising to 152 m at the igneous mass of St. Abb's Head, which is the highest point on the east coast of Scotland.

The Firths of Tay and Forth are major features, formed during the inundation of the land by the sea at the end of the last glaciation. Here, as elsewhere along the coast, there are raised beaches which, where they are not obscured by ports, industry and housing, provide evidence of the rapid rise in sea level experienced at the end of the Ice Ages and the subsequent uplift of the land as a result of isostatic adjustment. Cliffs occur at locations such as at Red Head, Meg's Craig, south of Lunan Bay and St. Abb's Head but have limited areas of maritime vegetation because of their relatively sheltered aspect compared with cliffs on exposed sections of coast in the north and west of Scotland (Regions 3 and 15). Elsewhere much of the shoreline is composed of exposed rock platforms with deposits of glacial drift. There are large areas of sand dunes on the outer coast, including the Fife promontory. The sheltered inlets of the region hold extensive mud and sand flats.

1.2.3 The natural environment

The region is home to some important terrestrial animal species, amongst them otters, which occur in several estuaries; numbers appear to be increasing on the northern shore of the Firth of Tay. The region is a stronghold for red squirrels, a nationally declining species that within the UK is now almost confined to Scotland. Although eight out of the nine widespread species of amphibians and reptiles in Great Britain have been recorded, generally their populations are small and their distribution sparse compared with other parts of the UK.

The sea and sea bed

A variety of marine benthic habitats are found in the region, on substrates ranging from rocks to large areas of sand and mud. Most of the rocky habitats are moderately exposed to wave action; there is no oceanic swell and offshore waters are relatively shallow. A higher degree of shelter prevails in enclosed inlets and estuaries, such as the Montrose Basin, the Firths of Tay and Forth and the Eden Estuary, and soft sediments predominate. Off the rocky coasts of Arbroath, Fife and North Berwick the sea bed shelves steeply to 40 m, then more gently to 60 m well offshore. South-east of St. Abb's Head depths reach 60 m much closer to the shore. The nearshore sea bed is largely blanketed in silt and sands, especially around St. Andrews Bay and the Firth of Forth, where it is relatively shallow. There are extensive deposits of glacial sand, and supplies of new sedimentary material from the land are relatively abundant. To the west of North Berwick and off St. Abb's Head tidal currents sweep the bedrock clean in places.

Although the region's sea bed communities have not been as well studied as those in some parts of western Scotland, at least one area is known to be of particular interest for its marine life. The Berwickshire Marine Consultation Area (MCA) extends from Siccar Point (east of Cockburnspath) to Ross Point (just south of Burnmouth) and contains within it the St. Abb's Voluntary Marine Nature Reserve, which extends 1-2 km offshore between St. Abb's Head and Hairy Ness.

The outer stretches of the Montrose Basin, the Firths of Tay and Forth and the Eden Estuary have a range of habitats that include moderately exposed rocky shores, sandy bays and sand flats, whereas the enclosed embayments and inner estuarine areas are much more sheltered and dominated by tidal mudflats. These support large populations but a relatively low diversity of intertidal fauna and flora, typical of estuarine sediments in eastern Scotland. These animals and plants in their turn provide food for many of the waterfowl that use the area and which are especially numerous in winter. Around the north end of the Isle of May vertical stepped cliffs extend to 40 m below chart datum; very dense populations of soft corals and large anemones carpet some of the vertical rock surfaces, while at the base of the cliffs, boulders and cobbles support large numbers of brittlestars, together with encrusting bryozoans and the keel worm.

The headlands of Fast Castle, Souter and St. Abb's, on the coast of the Scottish Borders, are subject to greater wave exposure than much of the adjacent coast. In places very dense populations of mussels and barnacles occur in the littoral fringe. The deep, clear, unpolluted waters offshore

and fast tidal streams that flow around the steeply-shelving hard rock substrates result in a rich variety of benthic flora and fauna including, beneath the canopy of the kelp forest at the base of St. Abb's Head, a dense assemblage of attached animals. Further offshore, at a depth of 25 m, the sea bed is a level plain of tide-swept cobbles and pebbles characterised by hydroids and bryozoans. Other offshore localities within the area include bedrock terraces with large colonies of soft corals and dense brittlestar populations.

The region has records of 154 species of fish. These include all seven of the species protected under national, European and international legislation, although records are sparse. A wide range of exploited fish species, including herring *Clupea harengus*, whiting *Merlangius merlangus*, cod *Gadus morhua*, saithe *Pollachius virens* and various flatfish, spend part or all of their lives in the waters off the region. The Firth of Forth has a small nursery area for juvenile herring (originating from the spawning grounds off the west coast of Scotland) and, in common with the other shallow inlets in the region, is an overwintering ground for sprat *Sprattus sprattus*. The area off the region's southern coast is an important spawning ground for plaice *Pleuronectes platessa* and the Firth of Forth is an important plaice nursery area. The inshore waters bordering this region provide a nursery area for mackerel *Scomber scombrus*, which spawn further offshore in the North Sea. Mussels *Mytilus edulis* are plentiful in the Montrose Basin, along the south shore of the Firth of Tay at Tayport, in the Eden Estuary and along the south shore of the Firth of Forth. Stocks of lobster *Homarus gammarus* are found inshore on rocky substrate; juvenile edible crab *Cancer pagurus* are found on soft substrates within the estuaries, although the adults occur further offshore, and velvet crab *Necora puber* occur throughout the inshore area. Offshore there is a large population of *Nephrops* ('scampi'), and scallops *Pecten maximus* also occur in a large area offshore. The Atlantic salmon *Salmo salar* and sea trout *S. trutta* are present in large numbers in most rivers in the region and are especially abundant in the River Tay.

Both grey seals *Halichoerus grypus* and common seals *Phoca vitulina* occur, mainly in the north of the region. The common seal breeds in the outer Firth of Tay, its main breeding site on the east coast between the Moray Firth and the Tees Estuary; during August some 2% of the Great Britain population is found in the region. The grey seal, which is widespread around Orkney, Shetland, the Western Isles and south-west Wales, breeds in increasing numbers on the north shore of the Isle of May, where approximately 4% of British pups are born. This is one of only three breeding sites on the east coast of mainland Britain, the others being on the Farne Islands (Region 5) and on Scroby Sands off Great Yarmouth (Region 6). In summer large numbers haul out on Buddon Ness, the Abertay and Tentsmuir sands. Six species of cetaceans occur regularly offshore in the region, out of a total of 27 species recorded for the UK. The most frequently observed species in nearshore waters are the harbour porpoise *Phocoena phocoena* and white-beaked dolphin *Lagenorhyncus albirostris*, followed by minke whale *Balaenoptera acutorostrata*, with bottlenose dolphin *Tursiops truncatus*, white-sided dolphin *Lagenorhynchus acutus* and killer whale *Orcinus orca* as less common visitors. White-beaked dolphins, in particular, become numerous between July and September, when mackerel shoals move towards the coast. The leatherback turtle *Dermochelys coriacea* is seen occasionally and is now thought to be present in Scottish waters at certain times of every year.

Large numbers of seabirds, including kittiwakes *Rissa tridactyla*, guillemots *Uria aalge*, puffins *Fratercula arctica* and gannets *Morus bassanus*, are found offshore in the outer Firth of Forth and the Tay, both during the breeding season and immediately afterwards. The Firth of Tay, St. Andrews Bay (the Eden Estuary) and the Forth are especially important for wintering sea ducks. The Firth of Tay holds more than 25,000 eiders *Somateria mollissima,* more than 1% of north-west European populations (i.e. of international importance); St. Andrews Bay holds around 2,500 common scoter *Melanitta nigra*. The Firth of Forth holds at least ten species of wintering waterfowl at levels greater than 1% of the British population, including eider (8,800) and common scoter (1,400).

Estuarine shores (firths)

There are five estuaries in the region (data for St. Cyrus Estuary are included in Region 3 (Cape Wrath to St. Cyrus), although the estuary forms the boundary between Regions 3 and 4). They represent approximately 4% of the estuarine resource in Great Britain, together supporting around 28% (>83,000 birds) of the Scottish waterfowl total in mid-winter (1993 figures), with seven species occurring in internationally important numbers. The Firth of Forth is the most significant area, followed by the Montrose Basin. The Firth of Forth is of international importance for pink-footed goose *Anser brachyrhyncus*, four wintering wader species (knot *Calidris canutus*, bar-tailed godwit *Limosa lapponica*, redshank *Tringa totanus* and turnstone *Arenaria interpres*) and shelduck *Tadorna tadorna*. The Montrose Basin supports internationally important numbers of pink-footed goose, redshank and knot.

Significant areas of saltmarsh are mostly confined to the inner parts of the Tay and Forth Estuaries. Though large on a Scottish scale, these saltmarshes represent only about 2% of the total in Great Britain. An unusual feature of saltmarshes in this region is the extent of swamp communities in the upper marsh zone - more than 75% of the total area of upper marsh swamps in Scotland. This largely reflects the presence of the more than 400 ha of commercially-managed tidal reedbeds in the inner Firth of Tay. This site holds the largest single expanse of reedbed in the UK, supporting breeding water rail *Rallus aquaticus*, large numbers of sedge warblers *Acrocephalus schoenobaenus* and reed buntings *Emberiza schoeniclus*. Such fresh and brackish-water fen communities are of special interest as they are particularly rare further south in Britain. In the Firth of Forth these saltmarsh upper zones have undergone extensive enclosure for industrial use. By contrast, on some sites on the region's outer, rocky shores and boulder beaches, unusual 'beach head' saltmarshes occur, where despite the paucity of sediment a sequence of typical saltmarsh plants occurs across the shore, grading inland into non-maritime vegetation. The region's saltmarshes also have important breeding waterfowl populations, with shelduck and oystercatcher *Haematopus ostralegus* both found at high densities. The Montrose Basin has the highest density of saltmarsh-breeding waders in Britain. There are some generally small but notable areas of coastal wet grassland in the region, often associated with saltmarsh transitions.

Non-estuarine shores

The region includes an estimated 9% of the total area of sand dune in Great Britain, at 70 sites. The dunes, some of them large and varied, are found associated with open shores, bays and hard cliffs. Dune types include cuspate foreland or ness dunes, large examples occurring at Buddon Sands and Tentsmuir, and spit dunes, such as Montrose and St. Andrews West. Bay dunes, which are widespread in the region, are mostly comparatively small sites developed on sand trapped in the shelter of rock headlands. The absence of the extensive hind shore dunes so characteristic of Britain's west coast is a reflection of the relatively sheltered nature of much of the region's coast.

The region is particularly notable for more acidic vegetation community types, including fixed dune grassland, dune lichen communities and dune heath. These reflect the acidic nature of the sand, much of which is derived from glacial material and lacks any significant calcareous shell sand component. Several dune vegetation sub-communities are largely restricted to eastern Scotland, reflecting the cool sub-continental climate. Tentsmuir, Earlshall Muir (between Tayport and Tentsmuir) and Barry Links are all nationally important for their dune vegetation, and Barry Links is included as a candidate Special Area of Conservation (SAC) under the EC Habitats & Species Directive. Some dune systems in the region are important for lower plants, such as bryophytes, lichens and fungi. Generally the region's sand dunes have good invertebrate populations, with Tentsmuir and Earlshall Muir having outstanding assemblages, with many rare or scarce species. Sand dune systems and sand/shingle shores in the region, in particular the Montrose Basin and the inner Firth of Forth, are noted for their breeding ringed plover *Charadrius hiaticula*; they are major breeding sites in the UK for both this species and redshank.

Human impact on the sand dunes of the region has been considerable. In addition to the loss of open dune heath to forestry plantations, the development of dune scrub and self-seeded pine forest has affected several sites. Sea-buckthorn *Hippophae rhamnoides*, planted to help control erosion, is spreading and reducing open dune vegetation, leading to a loss of species diversity, although efforts are under way to limit this spread. Non-intensive agriculture, the creation of golf courses and use by the Ministry of Defence have also reduced the area of semi-natural dune vegetation, although some of these uses may at the same time have prevented continuing or more intensive and damaging development.

Shingle shorelines occur widely throughout the region, although there are no significant shingle structures. Shingle vegetation is limited to a sparse cover of pioneer species, such as scurvygrass *Cochlearia officinalis*, sea mayweed *Tripleurospermum maritimum* and curled dock *Rumex crispus*, at the rear of the fringing beaches.

The region's few but sometimes spectacular cliffs are of high interest for both their landscape and their nature conservation value. In all but a few places they are relatively sheltered from North Sea storms and exposure to salt spray and hence the extent of truly maritime vegetation is limited. Where it does occur, in exposed areas, thrift *Armeria maritima*, sea campion *Silene maritima* and purple milk-vetch *Astragalus danicus* grow alongside typically grassland species. The nationally scarce thyme broomrape *Orobanche alba*, elsewhere known only from a few places in the far south-west of England, the Pennines and North-west Scotland, occurs on cliffs in the region. Narrow strips of shallow soil with maritime grassland vegetation on the low, rocky coasts of the Firth of Forth support the micro-moth *Elachista orstadii*, which is recorded from the mouth of the Abbey Burn at Likim Bay, one of only two localities within the British Isles.

Cliffs are especially important for seabirds, as they provide safe sites for nesting colonies. There are seven internationally important and numerous smaller seabird colonies in the region, each with its own distinctive assemblage of species. In summer the rocky islands and mainland habitats of the Firth of Forth support over 200,000 breeding seabirds of ten species in at least nationally important numbers. The small low-lying islands of the inner and outer Forth together support 470 pairs of cormorants, representing more than 1% of the British and European population. The Isle of May in the outer Firth of Forth has breeding populations of the kittiwake (7,600 pairs), guillemot (17,900 individuals) and large numbers of puffins (20,100 pairs, more than 5% of the British and 1% of the European Union population). Bass Rock has one of the most significant gannet colonies in Britain, with over 39,000 pairs (approx 15% of the world population) in the breeding season. St. Abb's Head also has major seabird populations: 13,670 pairs of kittiwakes, 28,900 guillemots and 1,700 razorbills.

1.2.4 Landscape and nature conservation

The coastline of the region is relatively short compared with that of other regions in the UK, and this results in the region having proportionally fewer designated sites for nature conservation than other, larger, regions. Nevertheless, the value of the area for nature conservation is not well reflected in the number and extent of official designations, the most important of which are summarised in Table 1.2.1. With only two Special Protection Areas (SPAs), the Montrose Basin and the Firth of Forth islands, and one Ramsar site (Montrose Basin), the region has only a small proportion of the UK's sites specially designated for the protection of internationally important birds. However, it does have a number of reserves owned or managed by the Scottish Wildlife Trust and the Woodland Trust. There are also three National Nature Reserves, 51 Sites of Special Scientific Interest and five Local Nature Reserves (LNRs), the latter representing more than a quarter of the total area of LNRs in Britain. Two sites (Barry Links and a marine area off the Berwickshire coast) have been put forward as possible Special Areas of Conservation (SACs) under the EC Habitats & Species Directive. The latter site includes the Berwickshire Marine Consultation Area and the St. Abb's to Eyemouth Voluntary Marine Nature Reserve. In terms of its landscape, too, the region has few designated areas, containing no National Scenic Areas and only three Preferred Conservation Zones; however, more than 62,000 ha are within twelve areas that have Regional Landscape Designations, in this region all Areas of Great Landscape Value.

Table 1.2.1 Summary of main designations

Designation	*No. of sites in region*	*Total area in this region (ha)**	*% of GB coast total in region*
Ramsar sites	1	987	0.3
Special Protection Areas (SPA)	2	1,078	0.3
Possible Special Areas of Conservation	2	n/av	n/av
National Nature Reserves (NNR)	3	649	0.7
Sites of Special Scientific Interest (SSSI)	51	18,586	2.6
Local Nature Reserves (LNR)	5	4,357	28.5
National Trust for Scotland sites	2	488	0.6
RSPB reserves	5	424	1.1
Wildlife Trust reserves	10	2,309	8.9
Regional Landscape Designations	12	62,332	12.3
Preferred Conservation Zones	3	n/av	n/av

Key: *to the nearest whole hectare; n/av = not available.

1.2.5 Human activities, past and present

Human occupation of the region dates back at least 9,000 years; evidence of Mesolithic hunter-gatherers has been found along the coastal fringe of the Rivers Tay and Forth. These rivers, which reach far into the fertile hinterland, were centres for occupation by humans attracted by the abundant estuarine food resources and relative ease of access by land and sea. Much archaeological material from coastlines predating the present shoreline has been lost as a result of erosion. It is thought, however, that farming in the region, including crop cultivation and animal husbandry, dates back to about 4,000 BC. Burial mounds provide the best evidence of human colonisation, and earthen long barrows from this Neolithic period help to establish that cultural influences spread north along the coast from Yorkshire. The development of agriculture continued during the Bronze and Iron Ages and the region has a number of defended sites and settlements from these periods.

The region was never fully subdued by the Romans, although the Antonine Wall between the Clyde and the Forth bisects the region and was manned for a few years. By the 3rd century AD the Romans had all but left. The next several hundred years were marked by the formation of the major Early Historic political units, the Picts to the north of the Forth and the Angles to the South. Eventually, the Picts and Scots were brought together and the modern kingdom emerged, its border on the Tweed first established in 1018.

During the succeding centuries the region, in common with the rest of Britain's North Sea coast, experienced repeated Viking raids, and place names and artefacts show the influence of Norse and Anglian culture. Christianity weathered the pagan influxes and by the 13th century religious houses had become a powerful force in the region's economy. Subsequently the establishment of royal and baronial burghs provided a new focus for mercantile trade and a stimulus for agricultural production. Many of these medieval townscapes have not changed significantly since they were built. The region's coastal settlements developed at different times depending on the availability of harbours, the presence of local raw materials and a willingness for investment. Coal mining and salt manufacture underpinned much of the wealth of the region. Dundee derived much of its prosperity in the 18th century from the linen trade, but towards the middle of the 19th century the city became the centre of the jute industry, a tradition that continues today, as the material is used to make carpets and sacks. Also in the 19th century the whaling industry provided oil for industry. Ships were built at Dundee, including the famous *Discovery*, which was used in Scott's Antarctic exploration and is now moored in the city docks.

The region has been important for sea fisheries, and vessels based in a number of ports in the outer Firth of Forth once operated over a wide range of fishing grounds in the North Sea and north-east Atlantic, but activity has declined during this century. Only small quantities of herring and mackerel are now fished, and the less valuable bottom-living species such as dab and dogfish dominate landings. Today some of the old fishing ports are mainly tourist resorts, and the majority of landings of fish and shellfish species are made to ports such as Pittenweem and Eyemouth. There are no fish or shellfish farms in the region at present. However, the region is important for salmon and sea trout, the River Tay being a major salmon river. On average the region's recorded annual catch of salmon and grilse, by all methods, represents 30% of the British total, and for sea trout the proportion is 19%.

Much of the hinterland of this region is in intensive agricultural use, including some of the most productive land in Scotland. In the southern part of the region, agricultural land stretches to the edge of the cliffs. There is little ancient woodland on the coast, and forestry is limited, the only major plantation on the coast being at Tentsmuir. Some intertidal areas within estuaries such as the Tay have been claimed for industrial and agricultural use; although these areas are large in a Scottish context they are small compared with the area of land claimed in south and east England.

Despite its predominately rural aspect, the region is one of the most populous parts of Scotland, with many settlements located at or near the coast. The largest conurbation is the capital, Edinburgh, with a population of approximately 400,000. Industrial areas in the region have experienced considerable change during the past decade: the closure of coastal coal mines, for example around Kirkcaldy, and the decline in the British shipbuilding and repair industry, coupled with the decimation of the North Sea fisheries and the loss of fisheries-related employment, have led to serious economic difficulties in the region. However, there has been expansion in petrochemical industries along the Forth, such as the large oil refining plant at Grangemouth, and in the industries which support

the offshore oil and gas industry. However, the North Sea oil industry has not had the same impact in this region as it has further north. There are several power stations in the region, including coal-fired ones on the Firth of Forth close to the coal mining area, and a nuclear power station at Torness. Other important industries include electronics and distilleries.

Although the area does not have the wild and remote appeal of the Highlands and Islands, it is nevertheless attractive to tourists. The cultural appeal of Edinburgh, its Festival, the historic legacy of the area, the small fishing villages and the nature conservation sites all contribute to a valuable tourist industry. The region is internationally important for golf tourism, with 50 courses scattered along the coast; even these are unable fully to meet the demand. Courses include the links north of St. Andrews, one of the oldest and most famous golf courses in the world. The area also boasts attractive beaches, especially at Montrose, Lunan Bay and on the East Lothian coast, as for example at Belhaven.

Coastal zone management has as yet received little attention in the region. The Scottish Natural Heritage initiative 'Focus on Firths' aims to promote improved management of the resources of the major Scottish firths and estuaries by stimulating understanding and voluntary co-operation among the various users and statutory authorities. At present, in this region, only the Firth of Forth is included in this initiative.

1.2.6 Acknowledgements

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1.2.7 Further sources of information

A. Further reading

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The coast from Pettico Wick to St. Abb's Head in the Scottish Borders, a Geological Conservation Review site, displays a dramatic section through Silurian rocks, consisting of folded inclined interbedded greywackes (muddy sandstones) and shales. The Silurian rocks are overlain by Lower Devonian rocks and intruded by dykes and sills. Andesitic and basaltic lavas occur towards the base of the sequence. Photo: MNCR, JNCC.

Chapter 2 Geology and physical environment

2.1 Coastal geology

British Geological Survey & J. Sawyer

2.1.1 Introduction

Region 4 is formed from some of the oldest sedimentary rocks on the east coast of Britain. To the north of the region (in Region 3) the geology of the Highlands is dominated by metamorphic rocks, while to the south the sedimentary rocks of England become progressively younger southwards. The coastline of the region includes some spectacular and extensive geological sections that range in age from Silurian to Carboniferous (Map 2.1.1; Table 2.1.1). Both igneous and sedimentary rocks are present. Relatively recent glacial and post-glacial events have left drift deposits along large stretches of the coast. The tectonic history of the region has been particularly dynamic and this has influenced both the deposition and the exposure of the rocks.

2.1.2 Stratigraphy

Montrose - St. Andrews

From just north of Montrose to a point a few kilometres north of St. Andrews the coast is composed mainly of rocks of Lower Devonian age. These rocks, which belong to the Arbuthnott and Garvock Groups, form the south-eastern limb of the Sidlaw Anticline and incline gently to the south-east. They were formed as sediments in non-marine conditions and consist of grey, brownish-grey and red sandstones, shales, flagstones and conglomerate, representing coarse detritus eroded from a mountainous terrain to the north. Formations consisting mainly of lavas are interbedded with the sedimentary formations; these are mainly of basic and intermediate types (olivine basalts and andesites). The lavas are relatively resistant to erosion and form headlands at Scurdie Ness south of Montrose and Red Head north of Arbroath. They also constrict the mouth of

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		Sea-level fluctuations
		Pleistocene	1.8		Series of ice sheets cover the region
	Tertiary (Neogene)	Pliocene	5		
		Miocene	23		
	Tertiary (Palaeogene)	Oligocene	38		
		Eocene	54		
		Palaeocene	65		
Mesozoic	Cretaceous		146		
	Jurassic		208		
	Triassic		245		
Palaeozoic (Upper)	Permian		290		
	Carboniferous	Stephanian			
		Westphalian			
		Namurian			
		Dinantian	360		
	Devonian	Upper	410	Arbuthnott Group	Depression of Midland Valley
		Lower		Garvock Group	Caledonian Orogeny
					Closure of Iapetus Ocean
Palaeozoic (Lower)	Silurian		440		
	Ordovician		505		
	Cambrian		544		
	Precambrian				

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

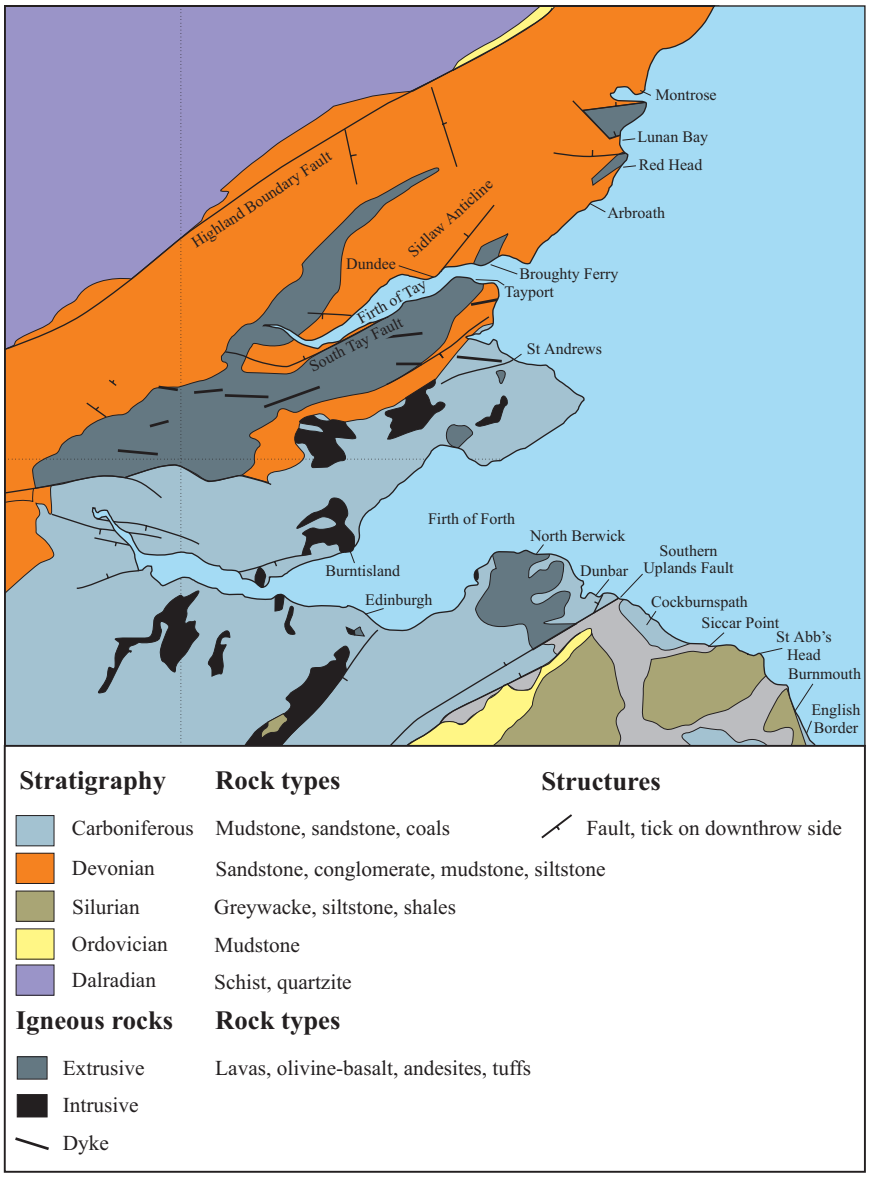
the Firth of Tay between Broughty Ferry and Tayport. In many places the rocks are very well exposed in cliffs and in wave-cut platforms on the foreshore.

In small areas near Montrose and Arbroath and in the upper part of the Firth of Tay, the Lower Devonian rocks are overlain by strata of Upper Devonian age. These consist of red, brown, yellow and white sandstones, which are locally conglomeratic (pebbly), red mudstones and, in the top part of the succession, some thin, rubbly beds of concretionary dolomite. The unconformity at the base of the Upper Devonian rock sequence is particularly well exposed at Whiting Ness, Arbroath.

Both local and extensive drift deposits are present along this stretch of coast. Within Lunan Bay, between Montrose and Arbroath, parts of the cliff are formed of glacial outwash gravels. More extensively, the low-lying coastlines between Arbroath and Broughty Ferry and from a point south of the Tay to St. Andrews are formed of blown sand and raised marine deposits of late-glacial and post-glacial origin.

St. Andrews - Cockburnspath

Rocks of Carboniferous age extend from just north of St. Andrews along the Fife and Lothian coastlines to Cockburnspath. They range from Dinantian to Westphalian in age (Table 2.1.1) and include examples of most of the Scottish Carboniferous sequence. The rocks are predominantly arenaceous (sandy), particularly in the older part of the succession, which is well exposed on the east Fife and East Lothian coasts. Interbedded with the grey and pale buff sandstones are limestones and dark mudstones. Coal seams, bedded ironstones and oil-shales also occur and are characteristic of parts of the sequence. The coastline of the Firth of Forth cuts across the Fife and Midlothian coalfields and the West Lothian oil-shale district, but with a few exceptions the rocks are poorly exposed. Mining activity is now greatly reduced but formerly mines extended offshore from the Fife, Edinburgh and East Lothian coasts (see also section 9.3). Along the Fife coast, glacial till locally forms small cliffs and bays. In places, large erratic boulders of glacial origin are strewn across the intertidal shore platform.



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

Olivine-basalt lavas are interbedded in the sedimentary succession at Burntisland and North Berwick. Numerous igneous intrusions, mainly of basic and intermediate rocks, disrupt the Carboniferous outcrop, and these form most of the prominent coastal features, including all the islands of the Firth of Forth.

Cockburnspath - English border

The Southern Uplands Fault divides the Upper Palaeozoic rocks of the Midland Valley from the Lower Palaeozoic rocks of the Southern Uplands, but where it reaches the coast the Carboniferous (Upper Palaeozoic) rocks cover the Lower Palaeozoic rocks, concealing the fault. The unconformable boundary between the near-horizontal Carboniferous rocks of the Dunbar area and the steeply-dipping Silurian rocks of the Southern Uplands is spectacularly displayed at Siccar Point.

From Siccar Point to Burnmouth the coastline is formed of rocks of Silurian and Devonian age. This part of the coast cuts across the north-eastern end of the Southern Uplands and gives an almost continuously-exposed section through the Silurian rocks. They consist of a sequence of sediments consisting of interbedded greywackes (muddy sandstones) and shales, either vertical or dipping steeply to the north-west. Much of the coastline is cliffed and the folding in the greywackes is clearly displayed. There are numerous dykes and sills of Lower Devonian age, which have intruded the Silurian rocks. In the St. Abb's area Lower Devonian rocks overlie the Silurian rocks. A greywacke-pebble conglomerate at the base of the sequence is overlain by andesitic and basaltic lavas and interbedded tuffs.

Between Burnmouth and the English border rocks of Lower Carboniferous age are exposed on the coast. The sequence is similar to that in Northumberland and consists of pale buff and grey sandstones with interbedded shales and cementstones and a thin limestone in the upper part of the succession.

2.1.3 Structure

The structure of the region is largely the result of major geological events that occurred during the Devonian Period, which shaped the geological environment on a regional scale. Three events are highlighted here: the closure of the Iapetus Ocean (which had been present in Silurian times), the formation and contemporaneous erosion of the Caledonian mountains to the north, and the depression of the Midland Valley. The Lower Devonian rocks between Montrose and St. Andrews were affected by deformations and uplift that occurred during the Caledonian Orogeny; they now dip to the south-east and are in part covered by Upper Devonian Rocks, which were laid down afterwards. The depression of the Midland Valley created a relatively low-lying area and this facilitated the deposition of the Carboniferous sediments now exposed between St. Andrews and Cockburnspath. These strata have also been subsequently folded in places. Between Cockburnspath and the English border are the steeply-dipping Silurian strata, sedimentary rocks that once lay horizontally below the Iapetus Ocean but were upended at the beginning of the Devonian Period as the ocean closed.

2.1.4 Acknowledgements

Thanks are due to George Lees, Sandy MacLennan and Karen Passmore (SNH), Jim Allison (Scottish Tourist Board), L. Scholfield (Perth and Kinross Council), Sheila Harvey (the Crown Estate) and Tom Leatherland (SEPA) for their helpful comments.

2.1.5 Further sources of information

A. Maps

Note that 1:50,000 scale geological sheets are available for much of coast of the region and further information may be obtained from the British Geological Survey, Keyworth, Nottingham.

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McAdam, A.D., & Tulloch, W. 1985. *Geology of the Haddington district.* London, HMSO. (Memoir of the British Geological Survey, Sheet 33W and part of Sheet 41 (Scotland).)

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McManus, J., & Sousby, E. 1993. *Landform inventory of north-east Fife district.* Unpublished report to Scottish Natural Heritage (SE Region).

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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D. Contact names and addresses

Type of information	*Contact address and telephone no.*
Geological information for region and the whole of Britain; 1:50,000 scale map sheets	*Coastal Geology Group, British Geological Survey, Nottingham, tel: 0115 936 3100
Geological Conservation Review (GCR) sites	*Scottish Natural Heritage, Advisory Services, Edinburgh, tel: 0131 447 4784
Geological Conservation Review sites in Angus, Dundee and Perth and Kinross	*SNH, Perth Area Office, Perth, tel: 01738 639746
Geological Conservation Review sites in Fife, Stirling, Clackmannan and Falkirk	*SNH, Stirling Area Office, Stirling, tel: 01786 450362
Geological Conservation Review sites in West Lothian, City of Edinburgh, Midlothian, East Lothian and Scottish Borders	*SNH, Galashiels Area Office, Galashiels, tel: 01896 756652

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

Along the whole of the exposed coast from North Berwick to the English border, the nearshore sea bed is predominantly of bare rock, here including lavas and olivine basalt. The varied under-sea habitats are rich in wildlife, leading these waters to be identified as a Marine Consultation Area and Voluntary Marine Reserve, the only ones in the region. Photo: MNCR, JNCC.

2.2 Offshore geology

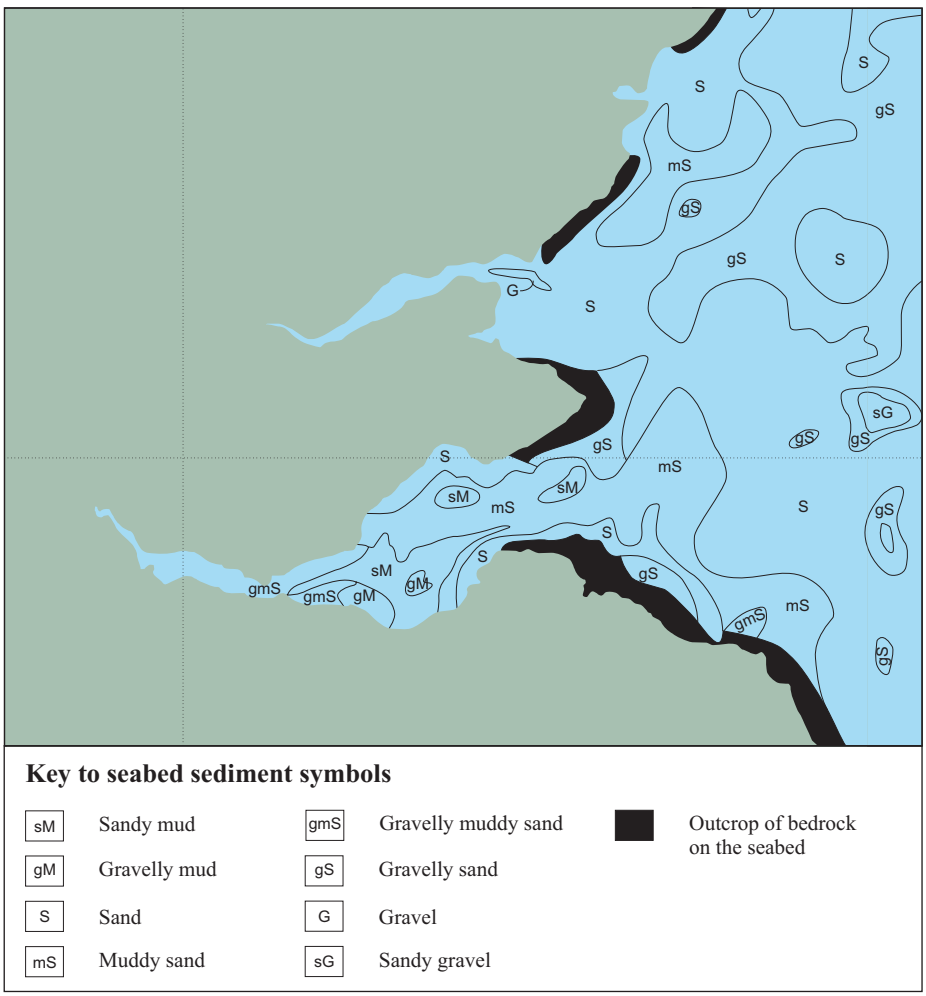
British Geological Survey & J. Sawyer

This section deals briefly with the geology of the rocks and sediments at and below the sea bed. The bulk of the information is shown on the maps, with some additional explanation provided by the text. Sea-bed sediments date from the Quaternary Period, which covers the last 1.6 million years and is divided into the Holocene (the last 10,000 years) and the Pleistocene. Rocks formed before the start of the Quaternary Period (1.8 million years ago) are included by geologists in the category of 'solid geology'. Offshore most solid geology is concealed by sea-bed sediments and palaeovalley infill sediments, but isolated rock outcrops do occur at the sea bed.

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 during the Holocene. The lithology (rock types) and thickness of the sediments have been determined by sampling, high-resolution seismic profiling and sidescan sonar. The sea-bed sediments of the region are shown on Map 2.2.1.

The Firth of Tay contains clean sands and gravels with only small areas of muddy sediments. The gravels are derived from glacial material, winnowed by the strong tidal currents in the estuary, and are of a range of rock types. Along the centre of the Firth of Forth a belt of mud-rich sediments contrasts with the sandy gravels, often with a large component of shell material, that lie close to the northern and southern shores. East of Edinburgh the estuary widens and sandy and gravelly muds cover large areas of the estuary floor. In the outer estuary, fine sediment supplied to the estuary by rivers is deposited by strong tidal currents. These currents scour some parts of the estuary floor, and large areas of rock are exposed on the sea floor along the margins of the outer estuary. Offshore of the mouths of the Tay and the Forth lie two large patches of muddy sand, elongated parallel to the direction of tidal flow, resulting from the transport of mud by tides out of the two estuaries. Seaward of the estuaries, the sea floor is mantled by extensive areas of gravelly sands and clean sands, with low mud content but often with abundant shell fragments. Mega-ripples and sinuous sandbanks occur in this offshore area, sculpted by the strong tidal currents which flow parallel to the coastline.



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

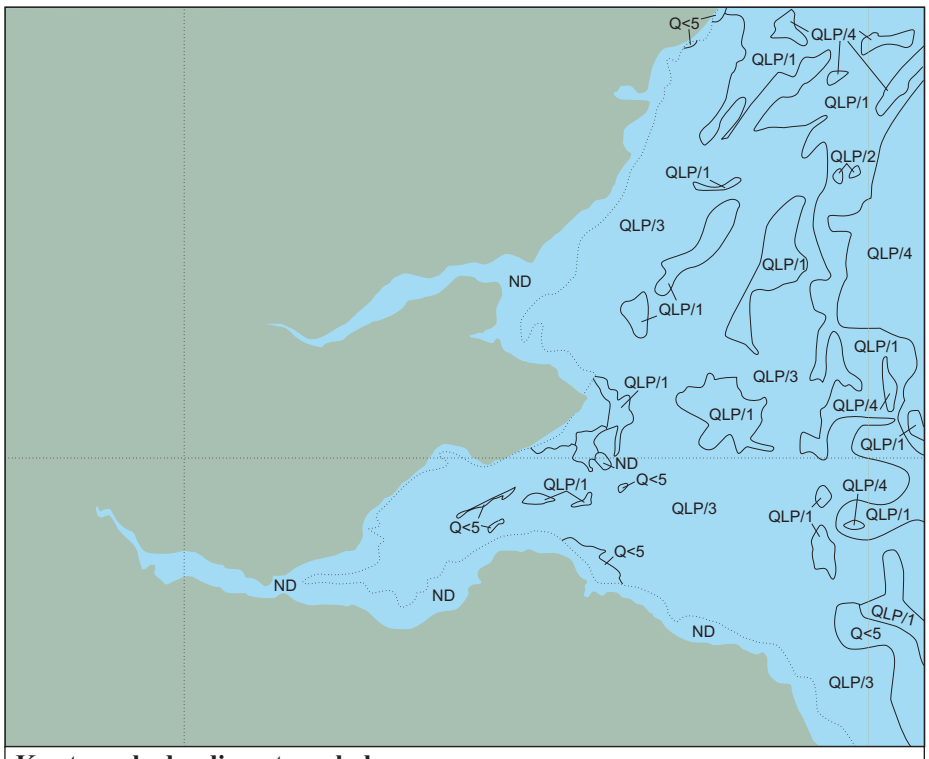
2.2.2 Pleistocene geology

In the British Isles and surrounding seas the Pleistocene was a time of fluctuating sea levels, and ice sheets crossed much of the area on a number of occasions. Both Pleistocene glacial till (boulder clay) and glaciomarine muds occur widely across the sea floor in this region, but they are commonly covered by a thin veneer of Holocene sediments. The glacial sediments are all essentially Late Pleistocene in age, deposited mostly during the last ice advance, but deposition continued into the Early Holocene (Map 2.2.2). The sediments comprise either till (Wee Bankie Formation), pebbly glaciomarine muds (St. Abb's Formation) or sands with interbedded muds and silts (Forth and Marr Bank Formations). The Forth Formation covers much of the sea floor in the Firth of Forth and straddles the Late Pleistocene-Holocene boundary in age. The Wee Bankie Formation forms a unit of variable thickness, ranging from less than 5 m to 40 m, comprising sandy and gravelly glacial till with interbedded fluvial sand and pebbly sand. Coarse sands and gravels occur in places in channels eroded into the pre-Quaternary surface. The glacio-marine muds of the St. Abb's Formation are generally less than 10 m thick, although occasionally reaching 20 m, and lie either on the surface of the Wee Bankie Formation or directly upon bedrock.

2.2.3 Solid (Pre-Quaternary) geology

In the coastal waters of Region 4 the stratigraphy of the sea bed is similar to that existing onshore (Map 2.2.3). The Firth of Tay is underlain mainly by Devonian rocks, comprising reddish-brown siltstones, mudstones and sandstones deposited in terrestrial (alluvial fan), fluvial and lacustrine environments. These rocks, frequently interbedded with volcanics, extend along the coast to the north. The Firth of Forth is underlain by Carboniferous rocks, including a zone of Coal Measures, which extends across the firth at Edinburgh. Elsewhere under the firth, the pre-Coal Measures (Namurian) sandstones and mudstones are largely of deltaic and fluvial origin, although there are coals and marine sediments, including oil-shales and thin limestones. Further offshore, beyond the limits of the Carboniferous and Devonian rocks, Permo-Triassic rocks underlie the sea floor. Most of the Permo-Triassic strata comprise red sandstones, siltstones and mudstones, but they also include evaporite minerals (anhydrite/gypsum/halite), which can be dissolved away while buried underground, causing the disturbance and collapse of overlying beds.

The rocks in this area have been greatly affected by tectonic activity. The Firth of Forth fault is a major zone of geological weakness, and the pre-Coal Measures strata are disrupted by numerous faults.



Key to seabed sediment symbols

QLP	Late Pleistocene to Early Holocene	1	Predominantly till
Q	Quaternary, undivided	2	Predominantly mud
Q<5	Quaternary generally < 5 m thick	3	Predominantly interbedded mud and sand
ND	No data	4	Predominantly sand

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

2.2.4 Acknowledgements

Thanks are due to George Lees, SNH, for his helpful comments on the draft.

2.2.5 Further sources of information

A. Maps

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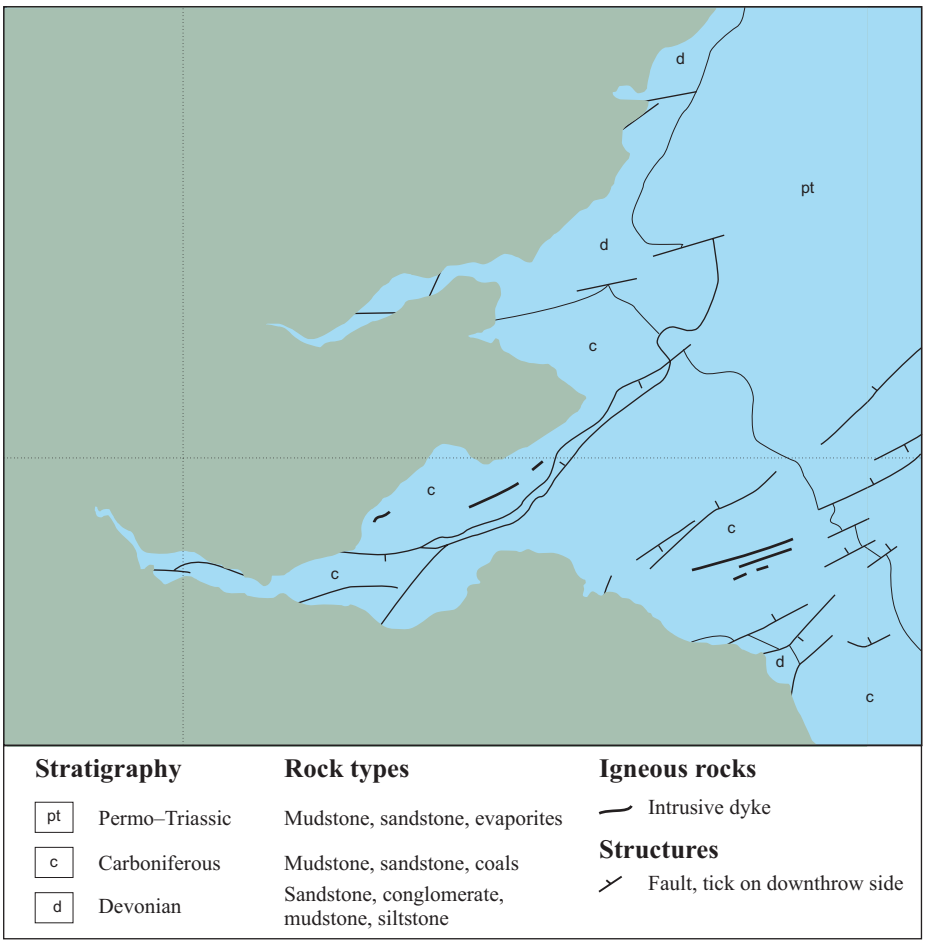


Map 2.2.3 Offshore pre-Quaternary geology. Source: British Geological Survey (1991).

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, Nottingham, tel: 0115 936 3100
UKDMAP 1992. Version 2. United Kingdom digital marine atlas. Oceanographic maps.	*British Oceanographic Data Centre, Birkenhead, tel: 0151 652 3950

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

2.3 Wind and water

British Geological Survey, D. Dales & K. Gilbert

2.3.1 Wind

Predominant wind speeds and directions are influenced by local topography. The Firth of Forth, for example, provides a natural corridor for airflow, so wind directions tend to follow the north-east/south-west axis. The wind rose (average of summer and winter) for the Forth (Figure 2.3.1) indicates not only a dominance of westerly and south-westerly air flows (greater than 50%) but also frequent north-easterly and easterly flows (greater than 35%). These latter are due in part to the development of sea breezes along the North Sea coast. Maps 2.3.1 and 2.3.2 show hourly windspeeds in the region. Mean hourly windspeed exceeded for 75% of the time is 3-3.5 m/s along much of the coast of the region, typical of the east coast of Scotland. The maps show the influence of local topography funnelling the wind along the Firth of Forth. Wind speeds are greater over the open water of the firth, away from the shelter of the land (Harrison 1987).

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. Offshore, the sea bed slopes relatively smoothly from the coast to around 50 m on the Wee Bankie (Map 2.3.3). Within the plain there are a number of banks and deeps ranging in depth between 40 m and 80 m, in which the sea bed is more irregular. Waters less than 20 m deep are limited to the vicinity of the coast, the firths and St. Andrews Bay. The estuaries of the Tay and Forth are shallower, with much of the Firth of Tay being less than 10 m deep. The depth of the Firth of Forth increases to 40-50 m below sea level at its mouth. It contains a number of narrow enclosed channels (not shown on the map), ranging in depth from 30 m to 60 m and aligned parallel to the main axis of the firth.

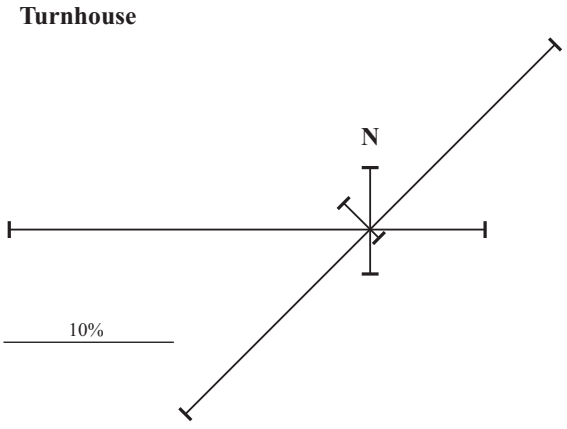
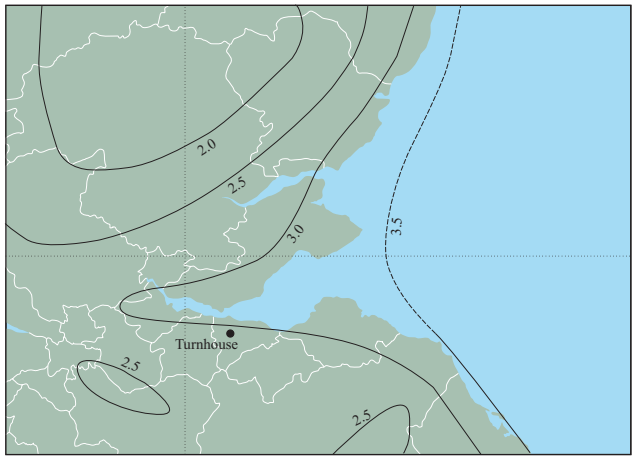
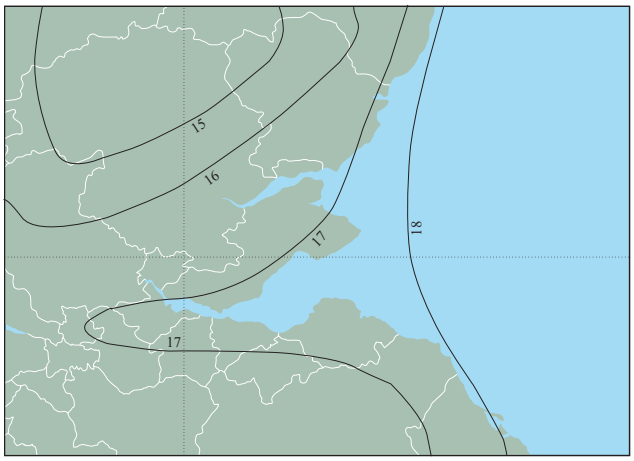


Figure 2.3.1 Wind directions at Turnhouse at 1500 hrs, 1971-80. Average of winter and summer frequencies. Source: Harrison (1987).



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



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

2.3.3 Tidal currents

Maximum tidal currents in the area range from 0.375-1.0 m/s, although in constricted passages they can be considerably faster (Map 2.3.4). The highest values are recorded from the Firth of Tay, where spring tidal currents reach 1 m/s. Tidal currents are responsible for the circulation of sediment within the estuary, resulting in continual movement of the channel.

Tides in the majority of the estuary of the Forth are semi-diurnal, i.e. the tidal peak occurs twice a day (the most common situation elsewhere on UK shores). In the Forth the duration of the flood tide is greater than the ebb, and the ebb flow is correspondingly stronger. Surface water tends to ebb earlier than bottom water, and bottom water flows in on flood tides earlier than surface water. Flood currents are stronger on the north side of the estuary and ebb currents stronger on the south side. A long period of slack water of up to three hours occurs around low water, particularly in the lower reaches of the Forth Estuary. In the innermost part of the estuary the onset of the flood tide is a rapid

event, and a discontinuity in water level, or tidal bore, occasionally develops at the larger spring tides. Upstream of Grangemouth the tidal cycle is more complex because of the local physiography, and 'double' high and low waters occur, known locally as 'lackie' or 'leaky' tides.

2.3.4 Tidal range

Tidal range is the difference between the depth of water found at a location at successive low and high waters. Tidal ranges found along the east coast of the UK are greater than those elsewhere in the North Sea as a result of the rotation of the earth, which deflects the southward tidal flow towards the west, causing water to pile up along the coast, and pushes the northerly ebb to the east. The net results are higher high waters and lower low waters than might otherwise be expected. In the context of the British Isles tidal ranges in the region are of average magnitude. Map 2.3.5 shows that mean spring values are over 4.0 m close to shore, decreasing offshore. Tidal range can be amplified as water is funnelled up narrow channels and firths: this is demonstrated in the Firth of Forth, where at Rosyth the mean spring range is 5.0 m and the maximum predicted spring range is 6.2 m. In the outer part of the Forth the range is about 4.0 m. The interaction of atmospheric pressure, wind and tide can lead to unusually high tides occurring all over the region, known as tidal surges. In this region the height of the tidal surge expected once in 50 years is 1.5 m, while smaller surges occur more frequently.

2.3.5 Wave exposure and sea state

Waves in this region are predominantly generated by winds from the north and east. The coasts north of Arbroath and south-east of North Berwick are exposed to easterly storms, while the inner parts of the Tay and the Forth have more sheltered coastlines. Map 2.3.6 shows the significant wave heights that can be expected to be exceeded for 10% and 75% of the year. In the Firth of Forth near North Berwick the significant wave height exceeds 1.5 m for 10% of the year and 0.5 m for 75% of the year. Along the exposed coastlines to the north and south wave heights are generally slightly greater: the 10% exceedance value lies between 1.5 and 2.0 m and the 75% value between 0.5 and 1.0 m.

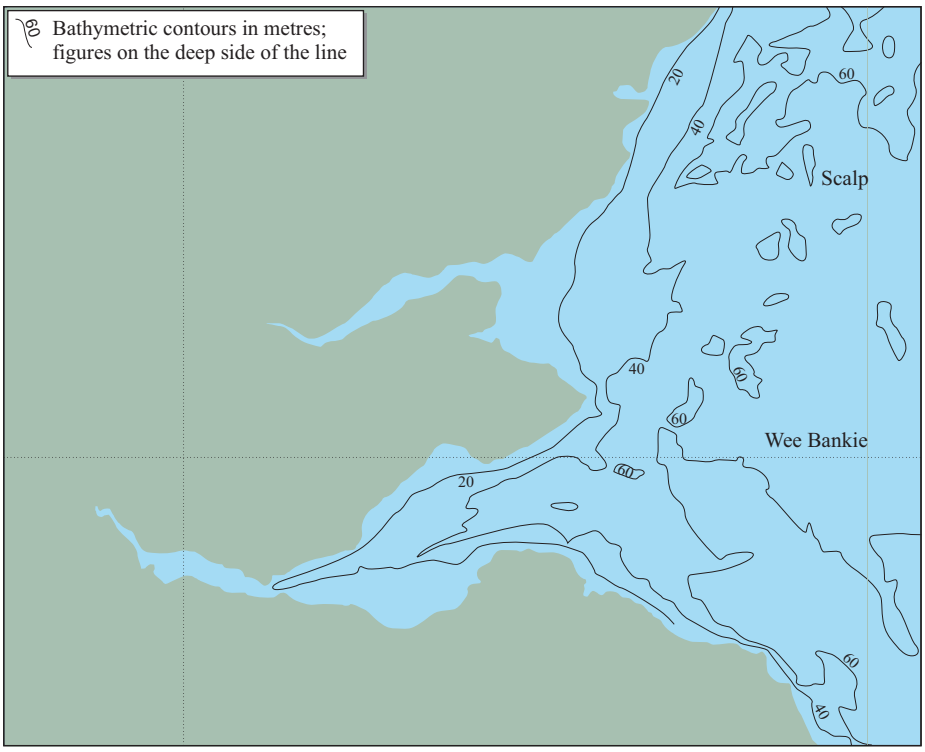
2.3.6 Water characteristics

Water temperature

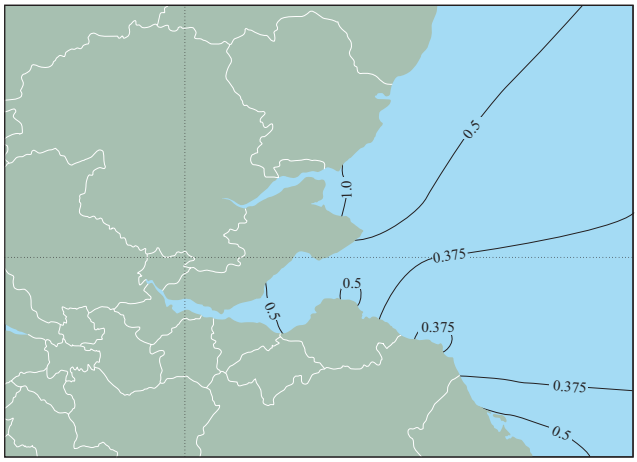
The temperature of surface waters in the outer Firths of Forth and Tay is relatively uniform, averaging 5.5-6.0°C in winter and 13°C in summer. This suggests efficient mixing of river water and sea water into a homogeneous water mass. The sea water is slightly warmer than the river water in winter, but slightly cooler in summer. The mean summer sea surface temperature is shown on Map 2.3.7 (no winter contours from the data source (Lee & Ramster 1981) cross the area of the map). Summer data are for August, which is the month of highest average sea surface temperature; February is the month of lowest average sea surface temperature.

Salinity

Around the coast of the UK, water of greater than 35 g/kg salinity is usually of oceanic origin, while areas where salinity drops below this value show the effect of freshwater input. The mean surface salinity contours in the region for

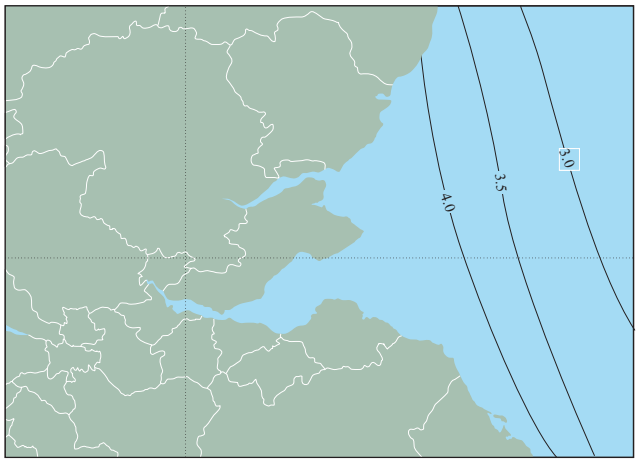


Map 2.3.3 Bathymetry. Source: British Geological Survey (1987).

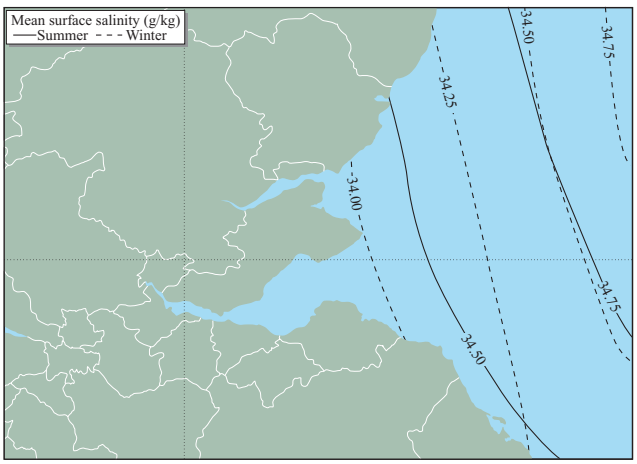


Map 2.3.4 Maximum tidal current speed (m/s) at mean spring tides. Source: Lee & Ramster (1981). © Crown copyright.

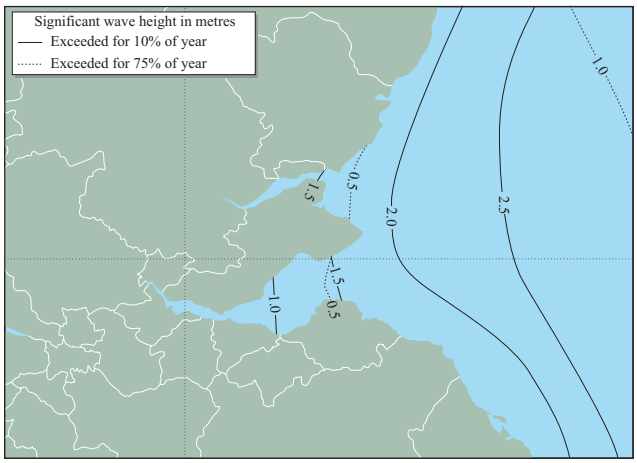
Map 2.3.7 Mean surface water temperature in summer (°C). Source: Lee & Ramster (1981). © Crown copyright.



Map 2.3.5 Tidal range (m) at mean spring tides. 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.



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

summer and winter are shown on Map 2.3.8, based on data for August and February respectively. Data are averaged for the month in question, which has the effect of smoothing out salinity gradients in some areas. The salinity of the sea water in the region is generally only very slightly below that of oceanic water (35 g/kg). The freshwater inflow in the Firth of Tay is proportionally greater than that in the Forth Estuary, with corresponding lower salinities and less mixing of fresh and saline waters. In the Firth of Forth the water is fairly homogeneous to the east of a line from Edinburgh to Kirkcaldy, but upstream of this line salinities have been recorded decreasing progressively from 34 to 28 g/kg (Dyke 1987). At times, however, more saline waters extend further inland. Salinity patterns change with the seasons and may vary from year to year, depending upon the prevalent weather conditions, freshwater discharges into the firth and water circulation within it.

2.3.7 Acknowledgements

Thanks are due to Mark Tasker (JNCC), George Lees, Sandy MacLennan and Karen Passmore (SNH), G. Russell (Institute of Ecology and Resource Management, Edinburgh University) and Alan Burdekin (SOAEFD) for their helpful comments on the draft.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
UKDMAP (United Kingdom digital marine atlas), Oceanographic maps	*British Oceanographic Data Centre, Birkenhead, tel: 0151 652 3950
Monthly, seasonal and annual wind roses	Meteorological Office Marine Enquiry Service, Johnstone House, London Road, Bracknell RG12 2SY, tel: 01344 854979

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

2.4 Sediment transport

British Geological Survey & Scott Wilson Resource Consultants

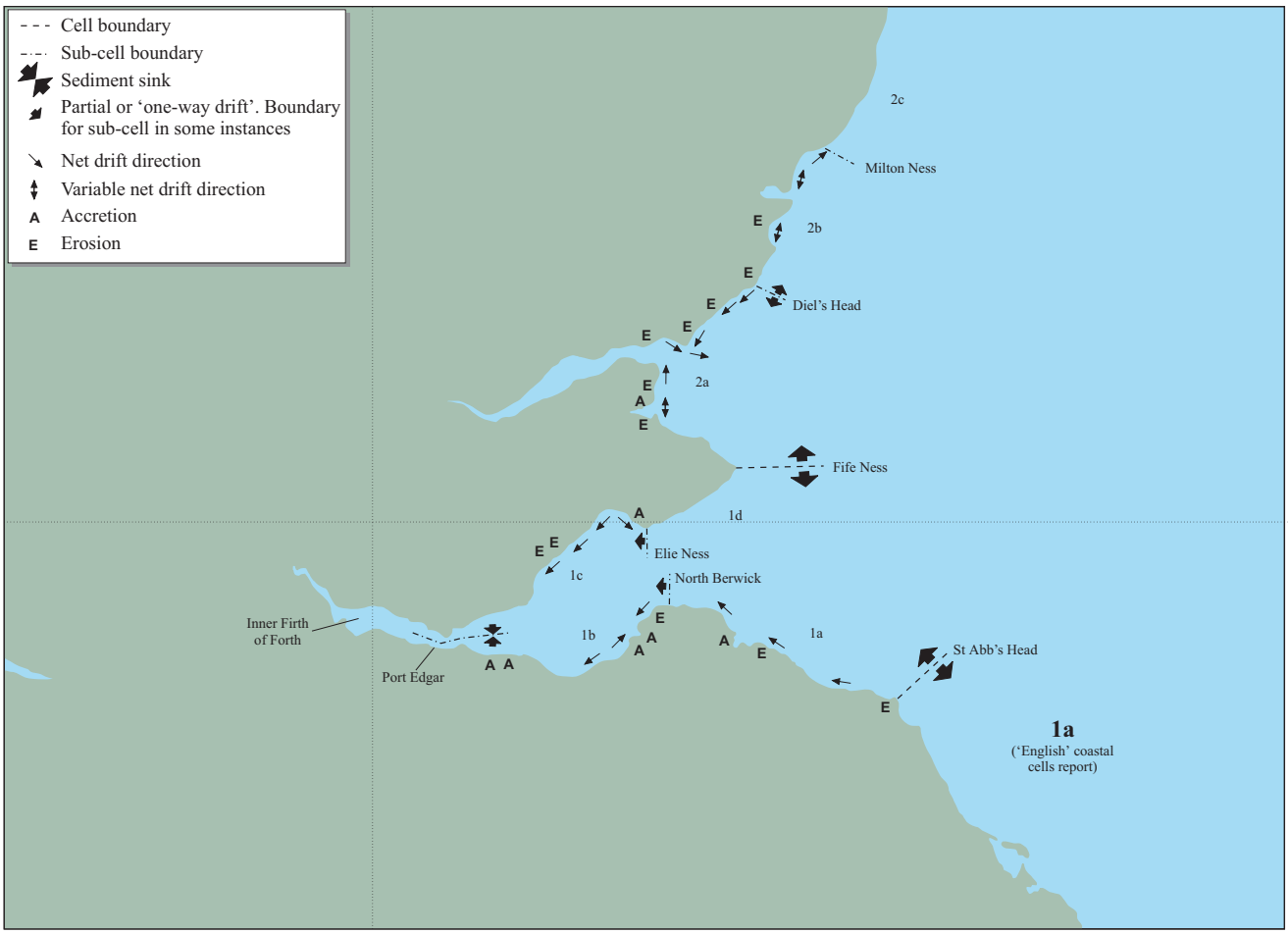
2.4.1 Introduction

Sediment transport is described within the context of coastal cells. These are sections of the coast within which the littoral drift of sand and gravel 'bed load' is largely independent of other cells. HR Wallingford divided the coast of mainland Scotland into seven major littoral cells (HR Wallingford in prep.). In this region, where much of the coast is rocky rather than sedimentary, the character of the coast and the hydraulic climate have also been taken into account in determining cell and sub-cell boundaries. In this region there are parts of three coastal cells, two of which are described in HR Wallingford's Scottish report (HR Wallingford 1995): Cell 2 between Cairnbulg Point (in Region 3) and Fife Ness, and Cell 1 between Fife Ness and St. Abb's Head; and the third is described in the England and Wales report (Motyka & Brampton 1993): Cell 1 between St. Abb's Head and the River Tyne (Region 5). The part of Cell 2 in the region is divided in two sub-cells, 2a and 2b, and the 'Scottish' Cell 1 is divided into four sub-cells, 1a - 1d. Between St. Abb's Head and the English border all the coastline lies within 'English' sub-cell 1a. These sub-cells are described below and are shown on Map 2.4.1. Note that the sediment transport shown on the map is of sand and gravel 'bed load', not suspended sediments.

2.4.2 Description

Sub-Cell 2b: Milton Ness - Diel's Head

This largely undeveloped coastline has hard cliffs between Montrose and Lunan Bay. (North of Milton Ness the character of the coastline changes significantly.) Shores at St. Cyrus are accreting, although the rate is slow. At Montrose, wave-induced longshore drift is northwards. Infilling of the dredged channel at Montrose indicates that this is countered by a southwards tidally-induced drift. Net drift is presently (since 1989) to the north, although historically it has been virtually zero. At Lunan Bay there is little evidence of any net drift, with gross drift depending on wave direction. There is dune erosion at Lunan Bay and Montrose, to such an extent that the golf course at Montrose is now affected.



Map 2.4.1 Sediment transport and coastal cells. Source: HR Wallingford (1995). Adapted with permission from SNH, SOAEFD and Historic Scotland.

Sub-cell 2a: Diel's Head - Fife Ness

The coastline is rocky at both sub-cell boundaries, with coastal elevation decreasing towards the Firth of Tay, where the cliffs are replaced by sandy beaches between Arbroath and St. Andrews. The exact position of the drift divide to the north of Arbroath varies depending on wave direction. Both waves and tidal currents affect sediment transport within this cell. There is a moderate rate of drift, generally towards the Firth of Tay. Wave-induced longshore transport is dominant, although tidal currents are important on the northern coastline of the Tay, particularly around Barry Buddon, where sediment is moved offshore by ebb tides. Tidal currents are responsible for the circulation of sediment within the estuary and for the complex interaction of sediment between the sand bars, the main accretionary area being on the southern side of the estuary in the region of Abertay Sands. Within St. Andrews Bay sediment is transported northwards by wave action. Around the Eden Estuary, the longshore sediment transport direction can vary. There is some cliff erosion to the north of Arbroath and dune erosion is occurring along Monifieth, Tentsmuir and part of St. Andrews Links. There is erosion of the coastal edge in front of the caravan park at Monifieth and at East Haven. Beach erosion, sometimes rapid, occurs sporadically between Carnoustie and Barry Buddon. Accretion of sand is occurring on the sand banks to the north-east of Tentsmuir. There is also accretion on the sand flats in the Eden Estuary and the seaward face of St. Andrews Links.

Sub-cell 1d: Fife Ness - Elie Ness

This rocky, cliffed coastline has few beaches. Erosion of the coastal edge and any longshore transport of beach material is wave-dominated, with tidal currents having little influence. Longshore drift is minimal, owing to the nature of the coastline and the lack of beach material. There is erosion of the Saltpans complex at St. Monance, but little significant accretion within the sub-cell.

Sub-cell 1c: Elie Ness - Forth Estuary

This coastline, which is more sheltered than that to the east, consists largely of rocky shore platforms and cliffs, although there are large sandy expanses at Largo Bay and Burntisland. The net sediment transport is wave-induced. Drift is south-westerly along much of the coast, the result of waves generated in the North Sea, but in Largo Bay drift appears to be to the east, owing to locally-generated wave conditions within the firth. A clockwise rotating current within the bay, although not strong enough to transport sediment on its own, may assist in moving already mobile sediment. The main area of erosion is just to the north of Kirkcaldy, where the coastal margin is being cut back. Sand is accreting at the eastern end of Largo Bay and in the adjacent Shell Bay.

Sub-cell 1b: Port Edgar - North Berwick

There is little littoral interaction between the north and south coasts of the Firth of Forth. The urban frontages of Edinburgh and its satellites occupy much of the western half of this sub-cell, while the eastern half is characterised by sandy beaches, dunes and links areas. A low or moderate wave-induced westerly littoral drift is present, which forms a weak anti-clockwise gyre at Musselburgh and Prestonpans and in the bay between Port Seton and Gosford. There has been slight foreshore erosion at Dalmeny/Queensferry and to the east of Cramond. Long-term beach erosion has occurred at Joppa and Portobello, and dunes in Gullane Bay are being eroded. Accretion is evident on the east side of the causeway to Cramond Island and silt is being deposited at Port Edgar. Steady silt deposition in the approach channels to Leith and Granton harbours is accelerated by easterly winds. Long-term accretion of sand is occurring at Aberlady Bay and Gosford Bay.

Sub-cell 1a: North Berwick - St. Abb's Head

This is a largely undeveloped and predominantly rocky coastline, with hard cliffs at the eastern end. There is a wave-induced westerly littoral drift along this coast, although the rate is low. Beach material may pass into sub-cell 1b at North Berwick but the volumes are likely to be very small. There is erosion along the east sides of some of the bays to the south of Dunbar, but further east, where the coast is cliffed, erosion is only locally significant in some coves. Sand is accreting on the sand bars to the north-west of Dunbar.

'English' sub-cell 1a: St. Abb's Head - Tyne

Here littoral drift is low and intermittent: sand transport is interrupted by rock reefs and headlands. Wave action produces strong seasonal onshore/offshore sand movement, while the tidal currents reinforce southerly sand transport along the beach and nearshore sea bed.

2.4.3 Acknowledgements

Thanks are due to George Lees, Sandy MacLennan and Karen Passmore (SNH), Liz Garson (Falkirk Council), Daniel Owen (RSPB), G. Russell (Institute of Ecology and Resource Management, Edinburgh University), Alan Burdekin (SOAEFD) and Mark Tasker (JNCC) for their helpful comments on the draft.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Coast protection policy; sediment cells	*Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD), Edinburgh, tel: 0131 556 8400
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
Earth science information	*SNH Advisory Services, Earth Science Branch, Edinburgh, tel: 0131 447 4784
Sediment cells	HR Wallingford Ltd., Howbury Park, Wallingford, Oxfordshire OX10 8BA, tel: 01491 835381

*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 changes in sea level are the combined effect of local crustal movements (owing to the removal of the weight of ice since the last glacial period, much of Scotland is rising whereas southern England is sinking) and global rises in sea level, estimated as rising between 1.5 and 2 mm/year. Reviews that attempt to estimate future changes in apparent sea level (e.g. Woodworth 1987) cite the regional and temporal variability shown by tide gauge data as major causes of uncertainty. Shennan (1989) suggests a crustal uplift rate of between 0.5 mm/yr and 2.0 mm/yr for the region. This uplift counteracts the current global rise in sea level, to produce a net rise in sea level along the coast that is probably close to zero (Woodworth 1987). Emery & Aubrey (1985), however, indicate a relative sea level fall of 2-6 mm/year across most of the region (Map 2.5.1).

2.5.2 Flooding in the region

The potential for flooding is high in the low-lying ground around the fringes of the Tay, Eden and Forth Estuaries (taken as land below the 10 m contour on the Ordnance Survey 1:50,000 series maps - see Map 2.5.1). Examples include an area immediately downstream of Kincardine Bridge that is extremely vulnerable and depends on a sea wall for protection at high spring tides, and Perth, where a flood defence scheme is being designed to prevent flooding when high tides coincide with heightened river levels associated with snow melt. Elsewhere the coastline is mostly cliffed or rises rapidly away from the coast.

2.5.3 Acknowledgements

Thanks are due to Mark Tasker (JNCC), Liz Garson (Falkirk Council), Daniel Owen (RSPB), G. Russell (Institute of Ecology and Resource Management, Edinburgh University), Alan Burdekin (SOAEFD) and George Lees (SNH) for comments on the draft.

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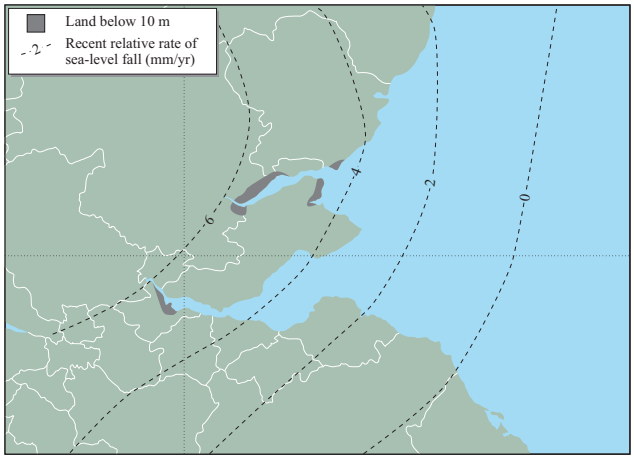

Map 2.5.1 Areas below 10 m above OD and thus susceptible to flooding, and estimated rates of recent relative sea-level fall. Source: OS Landranger maps and after Emery & Aubrey (1985).

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Flood warning	*Scottish Environment Protection Agency (SEPA), East Region HQ, Edinburgh, tel: 0131 449 7296
Flood and coastal defence policy (see also section 8.4)	*Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD), Edinburgh, tel: 0131 556 8400
Review of erosion, deposition and flooding in Great Britain (maps and database)	Minerals Division, Room C15/19, Department of the Environment, 2 Marsham Street, London SW1P 3EB, tel: 0171 276 0900
Tide gauge data	*British Oceanographic Data Centre, Birkenhead, tel: 0151 652 3950

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

2.6 Coastal landforms

Scott Wilson Resource Consultants

2.6.1 Introduction

This region has a varied coastline of cliffs and wide sandy bays, with intertidal mudflats and saltmarsh in sheltered areas. The glaciated hinterland is of low relief compared with the north and west of Scotland. The Firths of Tay and Forth form major indentations in the coastline, but there are also a number of smaller estuarine areas such as Montrose Basin, the Eden and Tyninghame Bay. (The St. Cyrus Estuary forms the border with Region 3 and is described in that volume.)

Map 2.6.1 shows the major coastal landforms of the region. As in the rest of Scotland, many of the coastal features are relicts of a former coastline. The coast of Region 4 was subjected to glacial erosion on more than one occasion during the Quaternary Period. The rock surface was eroded by the passage of ice, and glacial deposits cover most of the land surface inland. Erosional features of former coastlines occur at several different levels and these correspond to various heights of sea level relative to the land surface. On some parts of the coast there are wave-cut rock platforms that have been glaciated and hence evidently pre-date the last glaciation. They have been modified by one or more episodes of subsequent marine erosion.

Scottish Natural Heritage (SNH) are running a comprehensive programme of landscape assessments throughout Scotland, based on the old administrative districts. So far field work for St. Andrews, Dunfermline, Stirling, Clackmannanshire, Falkirk, the Scottish Borders and the River Forth has been completed (David Tildesley & Associates 1995a, b). Work on the Lothians is also nearing completion.

2.6.2 Description

Montrose - Dundee

The River North Esk marks the northern boundary of the region, forming a small estuary where it reaches the sea south of St. Cyrus. Dunes, partly forested, and a sandy foreshore stretch south from the river mouth to Montrose, where a ridge of raised beach gravel constricts the mouth of the River South Esk. Behind the ridge is the large and sheltered tidal Montrose Basin, which is gradually silting up. The river reaches the sea through a narrow channel, which is rocky on its southern side. Most of the coast south

Map 2.6.1 Major coastal landforms. Source: British Geological Survey.

to Arbroath is backed by cliffs with, in places, a rock platform on the seaward side. The cliffs are broken and gullied where there are variations in the resistance of the rocks and where zones of weakness have facilitated erosion. The wide, sandy expanse of Lunan Bay has been created where the valley of the Lunan Water breaches the line of cliffs. The coast between Arbroath and Dundee has one or more raised shorelines with a thin spread of shingle or sand on the cut platform, which may be of rock or glacial till. In some places patches of blown sand or dunes have accumulated on the seaward edge of the raised beach. At Easthaven and Carnoustie there are relict cliffs or back features to the raised beach. Buddon Ness, at the mouth of the Firth of Tay, is a large triangular ness formed of raised beach deposits, flanked around its margins by a broad zone of shingle and sand dunes. The feature appears to be largely stable, although there is erosion on its east side. From Monifieth westwards to Dundee the coastal margin is mostly urbanised; there is little intertidal area to the west of Broughty Ferry until the mudflats of the inner firth alongside Dundee airport.

Firth of Tay - Elie Ness

The Firth of Tay is relatively sheltered, and marine erosion is less evident than on the open coast. South-west of Dundee there is an extensive area of elevated, although still intertidal, mud flat (carse) - the Carse of Gowrie, which is more than 5 km wide at its maximum; much of it has been land claimed over the last 200 years. The southern side of the Firth of Tay, where the land rises more steeply than on the north, has a raised shoreline formed in glacial till and rock, but there are few raised beaches. From Tayport to St. Andrews the coast is low-lying and there has been considerable accretion of coarse sediments. A broad belt of shingle and sand has accumulated on the shoreline, with the Abertay Sands, uncovered at low tide, extending about 7 km out to sea. The sand dunes at Tentsmuir have been almost completely afforested. The Eden Estuary is a wide muddy expanse, partly closed off by the St. Andrews Links, home of the Royal and Ancient Golf Course. From St. Andrews to Elie Ness the coastline is rocky, with a number small coves such as Crail, Anstruther Easter and Pittenweem. As between Arbroath and Dundee, there is a long raised beach with low cliffs or back-features and, in places such as between St. Andrews and Buddo Ness, a rock platform on the foreshore. In places there has been landslipping at the back of the raised beach.

Elie Ness - North Berwick: the Firth of Forth

Within the Firth of Forth there is a range of coastal landforms, with shelter increasing to the west, especially in the Forth Estuary above the narrows at Queensferry. Significant areas of intertidal sand are found at Largo Bay, Burntisland, Drum Sands (around Cramond Island) and Musselburgh, as well as to the east of the urban frontage of the Edinburgh conurbation at Gosford, Aberlady and Gullane Bays, with their dunes and golf links. Mudflats are found at Dalgety Bay and on both sides of the estuary above the Forth Road Bridge, being particularly wide at Torry Bay and Grangemouth. There are short stretches of cliffed coast south of Kirkcaldy and around North Berwick, reflecting the greater resistance to erosion of igneous rocks within the softer sedimentary sequence. The islands in the firth, including Inchkeith and Bass Rock, are formed of similar igneous rocks, as are features such as Arthur's Seat, which contribute to Edinburgh's spectaular setting. Some of the coast south of Kirkcaldy is affected by landslipping and rockfalls. As in the Tay, erosional features tend to be less well-developed in the inner, sheltered parts of the estuary. A large area of carse adjoins the Forth Estuary at Grangemouth. Man-made coastlines occur adjacent to the larger towns, for example at Burntisland, Inverkeithing, Kincardine, Bo'ness and Edinburgh, where the coastal fringe is heavily modified between Granton and Cockenzie.

North Berwick - English border

As far east as Cockburnspath the coast is formed of a variety of rocky shores and tiny sandy bays, with the wide estuarine expanse between Tyninghame and Belhaven, just west of Dunbar. The coast is backed by raised beaches with rock platform or small areas of dune on the seaward side. Beyond Cockburnspath the coast is almost entirely cliffed as far as the English border, which lies about 5 km north of Berwick-upon-Tweed. The cliffs, which reach heights of nearly 200 m between Fast Castle Head and St. Abb's Head, have at their base a rock platform washed by the sea. Breaks in the cliffs occur where the rock is faulted or jointed.

2.6.3 Acknowledgements

Thanks are due to Anne Brown and George Lees (SNH), Allan Brown and G. Moy (Fife Council), G. Russell (Institute of Ecology and Resource Management, Edinburgh University), Daniel Owen (RSPB), Alan Burdekin (SOAEFD) and Mark Tasker (JNCC) for their useful comments on the draft.

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Wright, R. 1981. *The beaches of Tayside.* Edinburgh, Countryside Commission for Scotland. (Unpublished report.)

B. Contact names and addresses

Type of information	*Contact address and telephone no.*
Geomorphological information for region	*Coastal Geology Group, British Geological Survey, Nottingham, tel: 0115 936 3100.
Landscape Assessment Descriptions	*SNH Advisory Services, Landscape Branch, Edinburgh, tel: 0131 447 4784

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

The inner shores of Aberlady Bay are fringed with a broad band of saltmarsh. The vegetation is diverse, with swathes of pink thrift in the mid marsh zone and nationally scarce eelgrasses in the low marsh. The region's intertidal habitats are of great importance for breeding waders and waterfowl, the saltmarshes particularly so for oystercatchers; eastern Scotland is the prime area of the UK for this species. Photo: Pat Doody, JNCC.

Chapter 3 Terrestrial coastal habitats

3.1 Cliffs and cliff-top vegetation

Dr T.C.D. Dargie

3.1.1 Introduction

Geology and geological structure, together with environmental history (past and present marine erosion and glacial processes), determine cliff form. Sea cliffs are generally steep slopes (>15°), but they can show great diversity of form, from very tall vertical or near-vertical cliff faces, through long, steep slopes with a vertical face restricted to the base, to low cliffs with a great variety of local slope forms above an intertidal rock platform. The most distinctive cliff types are consolidated (hard cliffs developed from resistant bedrock) and unconsolidated (soft cliffs developed in easily-eroded materials, including Quaternary deposits such as till (Doody *et al.* 1993)).

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 maritime cliff and cliff-top habitats in Great Britain are bare ground, spray-zone lichen-covered rock, rock crevice, cliff-ledge, sea-bird 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 an undercliff vegetation of scrub, tall herbs and rank grassland, often very close to the sea.

The region has a total cliff length of 55 km (Table 3.1.1; Map 3.1.1), which represents just over 1% of the British resource and is therefore of only modest importance in the national context (Table 3.1.1). Table 3.1.2 summarises the extent of cliffs of different forms in the region.

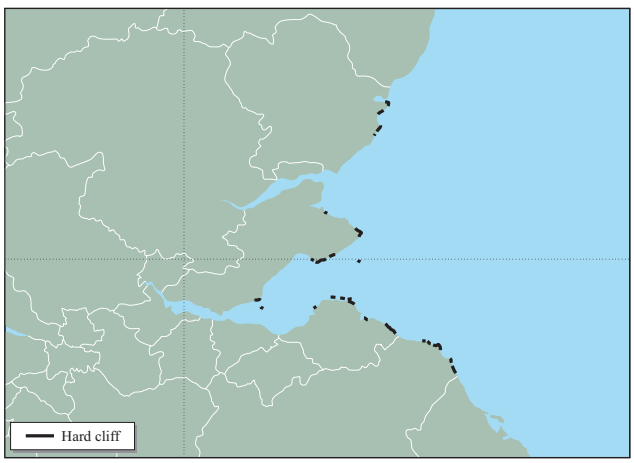
The extensive and diverse cliffs of the region are developed in Carboniferous and Lower Devonian rocks of largely igneous and sedimentary origin. Changes in relative sea level in the late glacial and post-glacial periods have produced relatively low cliffs that usually have a well-developed wave-cut platform at their base and one or more raised beaches, of national importance for determining sea level changes. Hard cliffs predominate in the region and there are relatively few examples of soft types, apart from cases of glacial till overlying cliffed bedrock. Cliffed coast in the region, though restricted in extent, is of great importance in terms of landscape and nature conservation interest. The region's cliffs are diverse and of high scenic value, with examples of low vertical and non-vertical cliffs (some on small islands in the Firth of Forth), headlands, caves and a small number of arches and stacks. In addition, regional cliffs are of major national interest for geological sections covering the Carboniferous and Lower Devonian periods (see sections 2.1 and 2.6). Table 3.1.2 sets the region's resource of different cliff types in a national context.

Table 3.1.1 Region's cliff resource in context

	Total	*% in Region 4*
Angus	8	-
Fife	15	-
East Lothian	7	-
Scottish Borders	28	-
Region 4	***58***	***100***
Scotland	2,373	2.4
North Sea Coast	1,799	3.2
Great Britain	4,059	1.4

Source: JNCC Coastal Resources Database

The full regional extent of cliff-top habitat has not been surveyed, but the relatively sheltered position of the coast from predominant westerly winds restricts heavy spray deposition, allowing a variety of maritime cliff, grassland and heath habitats to flourish. Habitat surveys suggest the following approximate values for the extent of maritime cliff habitats in the region: hard cliff 17 ha, soft cliff 1 ha, cliff crevices and ledges 10 ha, grassland 71 ha, heath 1 ha and bird cliff 10 ha. The overall lateral extent of these habitats is therefore unlikely to be much more than 110 ha, though total area measured to include vertical and near-vertical cliffs would probably increase this value significantly. Much of the region's cliffed coast is notified as Sites of Special Scientific Interest (SSSI): at least sixteen SSSIs, two of them National Nature Reserves (St. Abb's Head, Isle of May), are of primary or secondary cliff biological interest. Headlands with cliffs also provide bay conditions for the formation of many sand dune systems and shelter for bay-head saltmarshes, which are comparatively rare in Britain.



Map 3.1.1 Cliffs and cliff-top habitat (Table 3.1.3). Source: JNCC.

Table 3.1.2 Lengths (km*) of cliff types

Area	*Vertical >20 m height*		*Vertical <20 m height*		*Non-vertical >20 m height*		*Non-vertical <20 m height*	
	Length (km)	*% of total length in Region 4*	*Length (km)*	*% of total length in Region 4*	*Length (km)*	*% of total length in Region 4*	*Length (km)*	*% of total length in Region 4*
Angus	2	-	1	-	5	-	0	-
Fife	2	-	1	-	5	-	7	-
East Lothian	2	-	0	-	5	-	0	-
Scottish Borders	7	-	0	-	21	-	0	-
Region 4	***13***	**-**	***2***	**-**	***36***	**-**	***7***	**-**
Scotland	677	1.9	724	0.3	633	5.7	340	2.1
North Sea Coast	601	2.2	380	0.5	559	6.5	261	2.7
Great Britain	1,325	1.0	818	0.2	1,371	2.6	545	1.3

Source: JNCC Coastal Resources Database. Key: *to the nearest whole km.

3.1.2 Important locations and species

A particularly distinctive feature in the region are the numerous areas of wave-cut rock platform at the cliff foot and a sequence of raised beaches. Outstanding lengths of such coast include Scurdie Ness to Boddin Point and Ethie Haven to Arbroath in Tayside, St. Andrews to Fife Ness and Fife Ness to Elie in Fife, and Cockburnspath to Lamberton in the Scottish Borders. Cliffs in East Lothian are more restricted but are well developed on islands, most notably Bass Rock and the Isle of May. The highest cliffs reach 120 m at Black Bull, between Cockburnspath and Fast Castle Head.

Table 3.1.3 lists the SSSIs in the region that contain maritime cliff habitat. The National Vegetation Classification (NVC) covers twelve maritime cliff communities, though almost all refer to hard cliff habitats (Rodwell in press). Existing information is insufficient to detail the precise regional extent of individual cliff and cliff-top habitats. However, two communities (MC2 thrift *Armeria maritima* - Scots lovage *Ligusticum scoticum* maritime rock-crevice and MC3 thrift - roseroot *Sedum rosea* maritime cliff-ledge) are probably confined to Scotland, and both are present, although probably rare, in the region. The MC5 thrift - sea mouse-ear *Cerastium diffusum* subsp. *diffusum* maritime therophyte (short-lived annual species) type is also recorded in the region and is probably restricted to local patches of thin soil. A number of other NVC communities are likely to be present on cliffs in the region. Maritime heath is an important national feature of cliff-top habitat and is probably very restricted in the region, with the largest extent on the Burnmouth Coast. Maritime cliff grassland is more widespread and extensive, occurring for example at the Isle of May, Anstruther - East Wemyss Coast, Forth Islands, Pease Bay Coast and Burnmouth Coast. No lichen heath of national importance is recorded from the region's cliffs, but the lichen ecology of maritime grassland over limestone at Aberlady Bay is notable and there is also regional lichen interest on wind-cut cliff-top vegetation at St. Abb's Head (Fletcher *et al*. 1984).

In Great Britain nine nationally rare and four nationally scarce species or subspecies of higher plant are found mainly or exclusively on cliffs. Most are restricted to cliff habitats in the south and west of Britain and only one nationally scarce species, thyme broomrape *Orobanche alba*, occurs in the region. Other nationally scarce species more typical of other habitats occur on cliffs in the region: spring sand wort *Minuartia verna*, sea radish *Raphanus maritimus* and Nottingham catchfly *Silene nutans*.

The regional bird fauna of cliffs is outstanding and of national and international importance (Stroud *et al.* 1990). The Forth Islands have been designated as a Special Protection Area for their seabird populations, and the cliffs between Fast Castle Head and St. Abb's Head hold populations at levels indicating international importance (see section 5.10). No systematic survey of invertebrates of cliff and cliff-top habitats has been carried out, but these environments are very diverse and thus can support large numbers of species (Mitchley & Malloch 1991). The snail fauna of Scurdie Ness - Rickle Craig SSSI (Angus) is notable for its diversity. Small numbers of rare (Red Data Book) and scarce invertebrate species have been recorded from the Burnmouth Coast, Barns Ness Coast, St. Abb's Head, Pease Bay Coast, Isle of May, Buckhaven to Anstruther Coast and Arbroath Cliffs, although no site is outstanding.

3.1.3 Human activities

Cliffs are among the least modified of terrestrial habitats, although nationally the cliff-top zone, especially its inner sectors, has been affected by a variety of human impacts, sometimes leading to major habitat loss. At a national scale the most extensive influences on hard cliff vegetation are grazing and burning, the major management techniques for cliff-top habitat (Mitchley & Malloch 1991), but little is known of their role in the region. Cliff-top grassland and heath have been lost to arable use, and grazing has probably converted some coastal heath into grassland and altered the vegetation of cliff-top zonations.

Recreation creates local impacts, with cliffs providing a very important recreational resource for heavily populated areas and holidaymakers. There is a good network of coastal footpaths but few have very heavy usage and only local erosion is present. Most scenic headlands have road access and car parking is provided in many places. Caravan park development on or close to cliffs is common in Fife (Ritchie 1979) and development of one site is known to be responsible for the loss of the nationally scarce thyme broomrape from that site (Ballantyne 1992).

There are no large coastal settlements on cliffs, but several small existing and former fishing ports originally sited in bays have developed up onto their surrounding cliffs; these include Crail, Anstruther, Pittenweem,

Table 3.1.3 SSSIs in the region with maritime cliff habitat

	Site name	*Centre grid ref.*	*SSSI area (ha)*	*Maritime cliff habitat:*	
				type(s)	*area (ha)*
	Angus				
1	St. Cyrus - Kinnaber Links	NO7462	203.8	n/a	n/a
2	Scurdie Ness - Rickle Craig	NO7254	73.1	n/a	n/a
3	Ethie Haven - Whiting Ness Coast	NO6945	153.0	n/a	n/a
	Fife				
4	St. Andrews - Craig Hartle	NO5415	133.4	Hard cliff	0.8
				Heathland	0.1
				Grassland	0.1
				Crevice/ledge	0.1
5	Fife Ness Coast	NO6210	116.9	Hard cliff	1.0
				Grassland	0.4
				Crevice/ledge	0.2
6	Barnsmuir Coast	NO6006	20.4	Hard cliff	0.3
7	Isle of May	NT6599	56.6	Bird cliff	10.8
				Grassland	8.1
				Crevice/ledge	5.1
8	Anstruther - East Wemyss Coast	NT4699	94.4	Hard cliff	0.8
				Soft cliff	0.3
				Grassland	11.6
				Crevice/ledge	3.7
9	Ruddons Point	NO4500	9.4	Grassland	0.1
10	Burntisland - Kircaldy Coast	NT2888	371.8	Hard cliff	2.7
				Grassland	4.3
				Crevice/ledge	1.3
	Edinburgh				
11	Forth Bridge - Granton Shore	NT1878	742.3	Grassland	0.3
12	Inchmickery	NT2080	4.8	Grassland	0.8
	East Lothian				
13	Aberlady Bay	NT4580	866.2	Hard cliff	1.2
				Soft cliff	0.8
				Grassland	1.1
14	Gullane Bay - Broad Sands	NT4784	294.0	Hard cliff	0.1
				Grassland	1.6
				Crevice/ledge	0.1
15	Forth Islands	NT5386	22.5	Hard cliff	3.8
				Grassland	7.7
16	Bass Rock	NT6087	7.7	Hard cliff	3.1
				Grassland	2.4
17	Tyninghame Shore	NT6480	608.3	Hard cliff	1.3
18	Dunbar Coast	NT6679	81.2	n/a	n/a
19	Barns Ness Coast	NT6978	271.3	Hard cliff	3.1
				Grassland	2.4
	Scottish Borders				
20	Pease Bay Coast	NT7871	64.8	Hard cliff	2.8
				Grassland	14.8
				Heathland	0.1
21	Siccar Point	NT8170	5.7	n/a	
22	Fast Castle Head - St. Abb's Head	NT8869	257.3	Grassland	n/a
23	Burnmouth Coast	NT9661	168.7	Grassland	16.7
				Heathland	0.7

Source: SNH. Key: n/a = not available.

St. Monance, Dunbar and Eyemouth. Industrial development from coal mining has occurred on the Fife coast (between East Wemyss and Kirkcaldy) and a nuclear power station is sited behind cliffs at Torness Point (East Lothian). There are few major buildings and structures on cliffs apart from a small number of lighthouses and transmission masts. Much of the cliffed coastline of mainland sites is therefore undeveloped, with agriculture restricting the inner edge of natural and semi-natural habitats for lengthy stretches. The least developed sites are islands, although most of these have buildings and probably supported small populations in the past.

Virtually none of the regional cliff base has been protected by coastal defences and hence natural coastal erosion is prevalent.

3.1.4 Information sources used

One site in the region, between Cockburnspath and Eyemouth, has been mapped by Scottish Natural Heritage using the NVC system (Daly Walton 1996). The NVC data provide a sound baseline for future cliff vegetation studies at the site, and for site management. No other detailed surveys exist for the region and current information is insufficient to detail the regional extent of individual cliff and cliff-top habitats. However, Phase 1 habitat mapping for all of Fife has been carried out on behalf of Fife Council, including survey of the extent of cliff habitats.

3.1.5 Acknowledgements

Assistance with sources was kindly provided by Kathy Duncan (SNH) and Deborah Procter (JNCC). Thanks are also due to John Baxter and Anne Brown (SNH), Liz Garson (Falkirk Council), Dr C.J. Legg, Alistair Hamilton and Heather McHaffie (Institute of Ecology and Resource Management, University of Edinburgh), Allan Brown (Fife Council), Alan Burdekin (SOAEFD) and Mark Tasker (JNCC) for comments on the draft.

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B. Further reading

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

Steers, J.A. 1973. *The coastline of Scotland.* 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 - Scotland	*SNH, Aquatic Environments Branch, RASD, Edinburgh, tel: 0131 554 9797
Flora, fauna, habitat information, site management: Angus, Dundee, Perth & Kinross	*SNH Area Office, Perth, tel: 01738 639746
Flora, fauna, habitat information, site management: Fife, Clackmannanshire, Stirling, Falkirk	*SNH Area Office, Stirling, tel: 01786 450362
Flora, fauna, habitat information, site management: West Lothian, Edinburgh, Midlothian, East Lothian, Scottish Borders	*SNH Area Office, Galashiels, tel: 01896 756652
Advice on national and international policy and cliff conservation	*Earth Science and Coastal Advisor, JNCC, Peterborough, tel: 01733 62626
National Landslide Databank	Rendel Geotechnics, Norfolk House, Smallbrook Queensway, Birmingham B5 4LJ, tel: 0121 627 1777
Invertebrate fauna	*Invertebrate Site Register, Biological Records Centre, ITE Monkswood, tel: 01487 773381

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

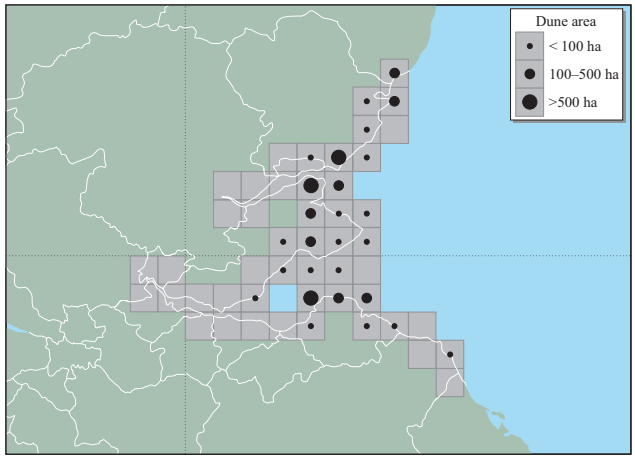
3.2 Sand dunes

Dr T.C.D. Dargie

3.2.1 Introduction

The region's coast contains a large and varied set of sand dune systems associated with open shores, bays and hard cliffs. The region has a total of 70 dune sites, containing an estimated 4,511 ha of vegetated sand and other land cover. Together they represent 9% of the British sand dune resource, for which the region is therefore of moderate importance (Table 3.2.1). (Survey of dunes in Scotland is still in progress and it is not possible to give precise figures on extent of the resource for the region or Scotland, nor, consequently, for the North Sea Coast or Great Britain. An estimate of the dune resource for Scotland, based on a sample set of sites (Dargie 1993), is used here.) Overall in the region there are a small number of very large areas of windblown sand (Barry Links, Tentsmuir to Leuchars, Aberlady Bay) and a large number of much smaller bay dune systems, although the precise size of most sites is unknown (Map 3.2.1). The few large sites and the diverse range of habitats present make the sand dunes of the region of great interest. This is reflected in their inclusion in 38 Sites of Special Scientific Interest (SSSIs) and one National Nature Reserve (Tentsmuir Point) (see also section 7.3).

Some 85 National Vegetation Classification (NVC) communities have been recorded for surveyed Scottish dunes, with a total of 116 types for communities and sub-communities combined (Dargie 1993). Eastern Scotland, including Region 4, is particularly notable for its very large extents of acidic SD12 sand sedge *Carex arenaria* - sheep's fescue *Festuca ovina* - common bent *Agrostis capillaris* fixed dune grassland and SD11 sand sedge - lichen *Cornicularia aculeata* community. The preponderance of these vegetation types reflects the acidic nature of the sand, much of which is derived from former glacial materials and usually lacks a significant calcareous shell sand component. In the past the region also probably held large extents of H11 heather *Calluna vulgaris* - sand sedge dune heath, most of which has now been lost to afforestation or as a result of changes in management. Scotland is also distinctive because a large variety of wetland types (mire, swamp, wet neutral grassland) replace most types of dune slack vegetation found in England and Wales. Only the SD17 silverweed *Potentilla anserina* - common sedge *Carex nigra* slack community is moderately common. Several NVC sub-communities are largely restricted to eastern Scotland, reflecting the cool sub-continental climate and moderate rainfall. It is also important to note that Scottish NVC dune surveys have encountered vegetation types that do not closely resemble published NVC types and which may represent potential additional NVC sub-communities. These include strandline, semi-fixed dune, fixed dune, mire and scrub types (Dargie 1993), with semi-fixed and fixed dune examples in this region at Barry Sands and Tentsmuir. Table 3.2.2 indicates provisional estimates of the extent of the different dune habitats occurring in the region and nationally.



Map 3.2.1 Area of sand dunes in coastal 10 km squares. Source: JNCC.

Table 3.2.1 Region 4 vegetated dune resource⁺ (ha*) in context

	Total area (ha)	*% of total in region*
Region 4	4,511	100
Scotland	31,540	14.3
North Sea Coast	25,356	17.8
GB	***50,200***	***9.0***

Sources: Dargie (1993, 1995), Radley (1994), JNCC. Key: ⁺provisional estimate based on a sample of dunes representing $\simeq 1/3$ of the region's total dune resource; *to the nearest whole hectare. Note: survey data for Scotland are incomplete and therefore totals for Scotland and thus the North Sea Coast and Great Britain are provisional estimates.

3.2.2 Important locations and species

Sand dune sites in the region are listed in Table 3.2.3. Vegetated blown sand is well distributed throughout most of the region, but the most notable concentrations occur at the mouth of the Firth of Tay, which appears to have had a much larger sediment load in post-glacial times than the Firth of Forth.

The largest dunes in the region are cuspate foreland or ness types, formed from sediments delivered from two different directions of offshore current, aided by a predominant offshore wind. This is the situation at Barry Links and Tentsmuir, which are amongst the largest sand dune sites in Britain. Spit dunes develop at the mouths of estuaries from sediments transported downstream by rivers meeting coastal currents carrying further sediment supplies. Large examples include Montrose and St. Andrews West, together with much smaller examples at a further seven sites. The outer ends of spit and ness dunes are very dynamic features and show great variation in rates of extension in response to weather systems and sediment supply by currents (e.g. Tentsmuir Point). Bay dunes are widespread in the region but most are comparatively small systems, developed on sand trapped within the shelter of rock headlands. The most notable large examples of bay dunes include Elie and Largo Bay on the southern Fife coast

Table 3.2.2 Areas* of vegetation types (ha+)

Area	*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*
Angus and Dundee City	0	70	951	380	157	397	57	73	17	0	3
Fife	2	73	738	214	80	80	210	154	3	0	
City of Edinburgh, East Lothian and the Scottish Borders	1	77	40	627	0	13	67	27	0	0	0
Region 4	***3***	***220***	***1,729***	***1,221***	***237***	***490***	***334***	***254***	***20***	***0***	***3***
Scotland	61	4,059	4,125	10,513	2,113	1,095	3,817	5,500	217	41	Rare
North Sea Coast	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Great Britain	340	8,504	4,953	15,228	2,615	2,175	4,114	8,965	836	64	2,406

Sources: Dargie (1993, 1995), Radley (1994), JNCC. Key: *provisional estimate based on a sample of dunes representing ~1/3 of the region's total dune resource; +to the nearest whole hectare; n/a = not available. Note: survey data for Scotland are incomplete and therefore totals for Scotland and thus the North Sea Coast and Great Britain are provisional estimates.

and Gullane to Muirfield in East Lothian. Climbing dunes are sand blown up onto terrain inland and on the edge of the main dune system, forming a variable, but often thin, sand layer over bedrock. Such dunes are rare in the region because they require predominant strong onshore winds; they are confined to the short stretch of west-facing coast between Aberlady Bay and Muirfield. Several dune types can be present in a single site; such complexes occur notably at Aberlady Bay, a cuspate foreland system with extensive climbing dune and a small spit, and at Belhaven Bay, where several spits and a small cuspate foreland have developed. The region lacks one major dune type, the dune hindshore system, which requires strong onshore winds and a good sand supply on an open coast.

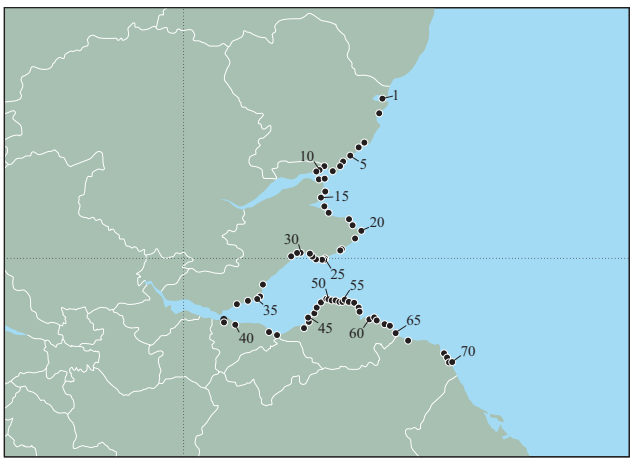
Dune systems in the region develop a water table that influences the vegetation of depressions, forming a distinctive and nationally rare type of wetland termed dune slack. In cuspate forelands slacks form in two ways. First, they develop in depressions in the rear of dune blowouts, which are initiated by storms and migrate across a site. The best examples in the region are at Barry Links, which has some of the best parabolic dune blowout and slack systems on the North Sea Coast of Britain. Secondly, they develop in depressions representing former saltmarsh cut off from tidal inundation by the seaward extension of a low prograding foredune; Tentsmuir Point has the best examples in the region.

In Great Britain, four nationally rare and thirteen nationally scarce higher plants are found mainly or exclusively on dunes. No nationally rare dune species are present in the region, but five nationally scarce species are found: variegated horsetail *Equisetum variegatum*, Baltic rush *Juncus balticus*, seaside centaury *Centaurium littorale*, rush-leaved fescue *Festuca arenaria* and curved sedge *Carex maritima*. Other nationally scarce species more typical of other habitats also occur on dunes in the region, including coralroot orchid *Corallorhiza trifida*, creeping lady's-tresses *Goodyera repens*, sea pea *Lathyrus japonicus* and oyster plant *Mertensia maritima*. Some Red Data Book bryophytes (see also section 5.1) are also associated with the region's dunes, e.g. the mosses *Bryum marratii, B. warneum* and *B. calophyllum*. Montrose (Kinnaber Links, especially the stunted pine plantation on thin sand over shingle) and Tentsmuir are noted for their lichen interest (Fletcher *et al.* 1984).

Detailed studies on animal populations have concentrated on birds. Several sand dune systems are parts of larger estuaries that are important for over wintering wildfowl populations: Montrose Basin, Firth of Tay, Eden Estuary/Tentsmuir/Abertay and the Inner and Outer Firth of Forth (Stroud *et al.* 1990; Davidson *et al.* 1991; Doody *et al.* 1992). Several dune sites are also outstanding in terms of Invertebrate Site Register records, most notably those in the Tentsmuir area (Tayport - Tentsmuir Coast SSSI, Tentsmuir Point, Kinshaldy Coast, Earlshall Muir) and Aberlady Bay (see section 5.3). Several other sites support small numbers of notable and rare invertebrate species (Burnmouth Coast, Barns Ness Coast, Tyninghame Shore, Dunbarnie Links, Barry Links).

3.2.3 Human activities

In general, sand dunes are among the least heavily modified of terrestrial habitats. However, the dune resource of the region is close to heavily populated and industrialised areas and this has inevitably resulted in a diverse range of human impacts leading to major habitat loss, conversion to



Map 3.2.2 Surveyed dune sites (Table 3.2.3). Source: JNCC.

Table 3.2.3 Sand dune sites in Region 4

Site no. on Map 3.2.2	*Site*	*Grid ref.*	*Area (ha)**	*Dune type(s)*	*Survey type*
1	Montrose	NO729590	n/a	Spit, bay	CCS, ITE
2	Lunan Bay	NO692514	n/a	Spit, bay	CCS, ITE
3	Arbroath	NO642405	n/a	Bay	CCS, ITE
4	Elliot	NO622394	n/a	Spit, bay	CCS
5	East Haven	NO592362	n/a	Bay	CCS
6	Carnoustie	NO565343	n/a	Bay	CCS
7	Barry Links (North)	NO559325	n/a	Cuspate foreland	CCS, ITE, NVC
8	Buddon Sands	NO533310	789	Cuspate foreland, spit	CCS, ITE, NVC
9	Monifieth	NO495320	n/a	Bay	CCS
10	Barnhill	NO483314	n/a	Bay	CCS
11	Broughty Ferry	NO472308	n/a	Bay	CCS
12	Tayport - Tentsmuir	NO480280	n/a	Bay, cuspate foreland	CCS, ITE, NVC
13	Tentsmuir Point	NO500283	507	Cuspate foreland, spit	CCS, ITE, NVC
14	Kinshaldy	NO501235	n/a	Cuspate foreland	CCS, ITE, NVC
15	Leuchars	NO493213	n/a	Cuspate foreland, spit	CCS, ITE
16	St. Andrews West	NO500185	n/a	Spit	CCS
17	St. Andrews East	NO518162	n/a	Bay	CCS
18	Airbow	NO594135	n/a	Bay	CCS
19	Cambo	NO603123	n/a	Bay	CCS
20	Balcomie	NO632102	n/a	Bay	CCS
21	Crail	NO611073	n/a	Bay	CCS
22	Anstruther Town	NO565035	n/a	Bay	CCS
23	Anstruther West	NO563031	n/a	Bay	CCS
24	Elie East Links	NT502998	n/a	Bay	CCS
25	Elie Wood Haven	NT497995	n/a	Bay	CCS
26	Elie Centre	NT490999	n/a	Bay	CCS
27	Earlsferry	NT474997	n/a	Bay	CCS
28	Shell Bay	NO461006	n/a	Bay	CCS
29	Largo Bay	NO450017	n/a	Bay	CCS, ITE
30	Largo Town	NO415024	n/a	Bay	CCS
31	Lundin Links	NO405023	n/a	Bay	CCS
32	Leven	NO388010	n/a	Bay	CCS
33	Kirkcaldy	NT282910	n/a	Bay	CCS
34	Kinghorn	NT271868	n/a	Bay	CCS
35	Pettycur	NT269862	n/a	Bay	CCS
36	Burntisland	NT240863	n/a	Bay	CCS
37	Silversands	NT200855	n/a	Bay	CCS
38	Peatdraught	NT156795	n/a	Bay	CCS
39	Fishery Cottage	NT159794	n/a	Bay	CCS
40	Cramond	NT195770	n/a	Bay	CCS
41	Portobello	NT310740	n/a	Bay	CCS
42	Fisherrow	NT340733	n/a	Bay	CCS
43	Seton - Longniddry	NT430763	n/a	Bay	CCS
44	Gosford Bay	NT448785	n/a	Bay	CCS
45	Greencraig Bay	NT445798	n/a	Bay	CCS
46	Aberlady Bay	NT460810	426	Bay, cuspate foreland, spit, climbing dune	CCS, ITE, NVC
47	Gullane	NT475832	n/a	Bay, climbing dune	CCS, ITE
48	Muirfield	NT488848	n/a	Bay, climbing dune	CCS
49	Longskelly	NT505860	n/a	Bay	CCS
50	Yellowcraigs	NT515860	n/a	Bay	CCS, ITE
51	Broadsands	NT525857	n/a	Bay	CCS
52	North Berwick West	NT544857	n/a	Bay	CCS
53	North Berwick East	NT558854	n/a	Bay	CCS
54	Milsey Bay	NT565853	n/a	Bay	CCS
55	Quarrel Sands	NT572856	n/a	Bay	CCS
56	Canty Bay	NT585853	n/a	Bay	CCS
57	Seacliff	NT605845	n/a	Bay	CCS
58	Peffer Sands	NT621826	n/a	Bay	CCS, ITE
59	Ravensheugh Sands	NT626818	n/a	Bay	CCS, ITE
60	Belhaven Bay	NT660786	n/a	Bay, cuspate foreland, spit	CCS, ITE
61	Dunbar Bathe	NT676793	n/a	Bay	CCS
62	Dunbar East	NT682789	n/a	Bay	CCS
63	Whitesands	NT712773	n/a	Bay	CCS
64	Barns Ness	NT725765	n/a	Bay	CCS

Table 3.2.3 Sand dune sites in Region 4 (continued)

Site no. on Map 3.2.2	*Site*	*Grid ref.*	*Area (ha)**	*Dune type(s)*	*Survey type*
65	Thorntonloch	NT753740	n/a	Bay	CCS
66	Pease Bay	NT793710	n/a	Bay	CCS
67	Coldingham Bay	NT917666	n/a	Bay	CCS
68	Linkim	NT925656	n/a	Bay	CCS
69	Callercove	NT935648	n/a	Bay	CCS
70	Eyemouth	NT945645	n/a	Bay	CCS

Sources: Dargie (1993); Ritchie (1979); Ritchie & Mather (1984); Rose (1980); Shaw *et al*. (1983); Wright (1981); RASD, SNH. Key: *to the nearest whole ha; n/a = not available; CCS = Countryside Commission for Scotland (University of Aberdeen beach survey reports); ITE = Institute of Terrestrial Ecology Scottish Coastal Survey; NVC = National Vegetation Classification survey (NCC/JNCC/SNH).

common vegetation lacking dune species, or some other form of significant modification to the nature conservation interest. The primary traditional use of most sites was probably extensive grazing for sheep and cattle, together with rabbit trapping; these uses maintain a diverse range of species-rich vegetation types and invertebrate populations. Apart from rabbit grazing (which fluctuates), dune grazing is now rare in the region and has been replaced by forestry, arable agriculture, military use, residential development, industrial development, recreation and nature conservation.

Forestry has replaced dune heath and slack for much of the blown sand area between Tayport and Leuchars in Fife. This has had several effects, in addition to causing major loss of important dune habitat types. Scarce pine forest plant and invertebrate species have become established, and Forest Enterprise have developed the area for recreation. Tree invasion of the narrow outer fringe of the remaining dune system is a persistent problem, with non-native pines invading dry habitats and birch and alder colonising scarce slack habitat. Attempts to control tree invasion by clearance and goat grazing have not been fully successful and have in turn altered the species composition of the slacks. Other sites with a large proportion of dune area converted to conifer plantation include Charleton and Kinnaber Links (with some positive benefits in terms of lichen interest in planted areas on thin sand over shingle), Tyninghame Links and Belhaven Bay. Smaller conifer plantations are also present at Barry Links, Muirfield and Longskelly. Arable cultivation is present on the inner sands of several bay dune systems in Fife and East Lothian (Earlshall, Aberlady, Longniddry).

Military use of dunes in the region has occurred for more than a century. Barry Links has been used for small-arms training and exercises and considerable numbers of troops use the ranges on an annual basis. Exercises involve the use of pyrotechnics, and fires are a regular occurrence, perhaps contributing to a steady reduction in the extent and quality of dry and wet dune heath on the site (Dargie 1995). A network of surfaced and unsurfaced roads crosses the site, and good liaison between range staff and Scottish Natural Heritage has helped to minimise the impact of vehicular use. Coastal defences (especially tank traps) constructed between 1939 and 1945 are common on beaches. Dunes at Gullane were used in exercises in preparation for the 1944 Normandy landings and were probably initially destabilised as a result. Subsequent coastal erosion and blowout development led to loss by the early 1960s of the entire foredune and outer slack zones, requiring a major programme of dune rehabilitation and visitor management, which has continued to the present day. Dunes at Leuchars have been converted into a major military airfield, involving loss of dune habitats for runway and taxiing surfaces, roads and buildings. There has also been tree planting to screen the military facilities.

Residential development on dunes has occurred in Angus/Perth and Kinross (Montrose, Broughty Ferry, Monifieth, Easthaven), City of Edinburgh and East Lothian (Leith, Musselburgh) and Scottish Borders (Eyemouth). Industrial development has occurred at Musselburgh (ash lagoons for coal-fired power stations) and Thorntonloch (Torness nuclear power station). A few beaches (e.g. Gullane) have been affected by sand and shingle extraction in the past, but probably only on a small scale, although this activity has caused serious erosion elsewhere (Carter *et al.* 1992).

Recreational pressure on the region's dunes is particularly high. Formal car parks, caravan and camp sites are common: Ritchie (1979) records stands for 3,400 caravans on or adjacent to sand dunes in Fife, for example. Holiday camps are present adjacent to dunes at Longniddry and Eyemouth. High visitor numbers are experienced at the John Muir Country Park (Belhaven Bay, Dunbar). In virtually all sites with high visitor numbers there is some very local damage (e.g. the initiation and extension of small blowouts) due to trampling, but dune systems are generally resilient and have coped well with such numbers for several decades. Erosion control using sand fencing, wave barrier fences, dune grass planting, footpath management and re-contouring blown sand at Gullane is particularly well studied (East Lothian County Council 1970; ASH Consulting Group 1994), because in the late 1960s and 1970s it served as a model for erosion management at other sites. Extensive planting of sea-buckthorn *Hippophae rhamnoides* has been a useful aid for managing visitor use of the site, but the plant is invasive and controlling its spread is proving difficult in some localities (e.g. Gullane).

In terms of the land area occupied, golf is the major recreational pursuit on the region's dunes, where there are more than 20 courses. The game probably originated in the region and was initially developed on coastal 'links', the Old Course at St. Andrews being world-famous as the foremost example of this type. Other famous links courses include Carnoustie, Gullane and Muirfield. Golf courses have been associated with both positive and negative impacts on dune ecosystems. One the one hand they have served to constrain residential development, and clubs are

increasingly seeking to improve their courses' value for wildlife. However, conventional golf course management may cause habitat loss and modification to greens and fairways, changes to drainage (including increasing the extent of slack habitat by summer watering, notably at St. Andrews) and modification of rough vegetation. At Aberlady Bay the drainage of wet sands on climbing dunes has probably reduced or eradicated interesting wetlands on higher ground, and an absence of grazing by stock or rabbits has possibly contributed to the development of large areas of rank and species-poor SD9 marram *Ammophila arenaria* - false oat grass *Arrhenatherum elatius* neutral dune grassland on the inner sectors of windblown sand. Golf clubs sometimes carry out engineering works, such as coast protection, that may have an effect on dune communities.

Overall, the region's dune resource makes a major contribution to recreational facilities in the region and careful planning has retained the wildlife value of these areas, at least in the last three or four decades. The quality of the dune resource is reflected in its management for nature conservation at designated sites (e.g. at Tentsmuir NNR, Earlshall Muir SSSI, Eden Estuary LNR, Aberlady Bay LNR, John Muir Country Park), and by the high priority placed on nature conservation elsewhere (e.g. Tentsmuir Forest Park). Serious coastal erosion by storm waves is present at several sites, most notably on both shores of the Eden Estuary, at Montrose and Carnoustie and on the eastern side of Barry Links. A variety of hard and soft engineering techniques have been used in dune environments (ASH Consulting Group 1994). These have included vertical sea walls to protect property (Portobello, Edinburgh) and industrial sites (Torness nuclear power station), massive rock armour walls to low water mark, riprap (Montrose, Carnoustie, Barry Links), groynes (Portobello, Broughty Ferry, Eden Estuary), gabions (Eden Estuary, Carnoustie), beach replenishment (Portobello) and sand trapping/rehabilitation (Gullane and Eden Estuary). The long-term impacts of coast protection measures in the region are uncertain.

3.2.4 Information sources used

Three main sets of surveys cover the region. Dune geomorphology is covered in Aberdeen University beach survey reports, sponsored by the Countryside Commission for Scotland (Ritchie 1979; Rose 1980; Wright 1981; Ritchie & Mather 1984). Three sites have been surveyed using the National Vegetation Classification (NVC) (Rodwell 1991a, 1991b, 1992, 1995, in press) and incorporated into the Sand Dune Vegetation Survey of Great Britain (Dargie 1993). The Sand Dune Vegetation Survey of Great Britain was initiated by the Nature Conservancy Council in 1987 and continued after 1992 by the Joint Nature Conservation Committee on behalf of country conservation agencies. Additional NVC survey of all unsurveyed dunes in Scotland was initiated in 1995. The NVC surveys, all carried out in the summer months, are very detailed and use a consistent methodology. The vegetation is mapped and described, and information on coastal erosion and accretion, atypical vegetation and adjoining land use is also recorded. Individual site reports are available for sites covered in the Sand Dune Vegetation Survey of Great Britain, as well as a national report covering a sample set of sites (Dargie 1993). Completion of the Sand Dune Survey of Scotland is funded by Scottish Natural Heritage and is scheduled to finish in 1998. The region's dune vegetation has also been examined by the Institute of Terrestrial Ecology (ITE) (Shaw *et al.* 1983) for selected areas covering sixteen sites. The vegetation categories employed are broad and are not easily related to the finer detail now available in the NVC (Dargie 1992). No other comprehensive surveys exist for the region, though a small number of sites have specific information on invertebrates (Institute of Terrestrial Ecology 1979). Details of site coverage in completed surveys are given in Table 3.2.3.

3.2.5 Acknowledgements

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Flora, fauna, habitat information, location of site reports, site management - Scotland	*SNH, Aquatic Environments Branch, RASD, Edinburgh, tel: 0131 554 9797
Flora, fauna, habitat information, site management: Angus, Dundee, Perth & Kinross	*SNH Area Office, Perth, tel: 01738 639746
Flora, fauna, habitat information, site management: Fife, Clackmannanshire, Stirling, Falkirk	*SNH Area Office, Stirling, tel: 01786 450362
Flora, fauna, habitat information, site management: West Lothian, Edinburgh, Midlothian, East Lothian, Scottish Borders	*SNH Area Office, Galashiels, tel: 01896 756652
Advice on national and international policy and dune conservation	*Earth Science and Coastal Advisor, JNCC, Peterborough, tel: 01733 62626
Invertebrate fauna	*Invertebrate Site Register, Biological Records Centre, ITE Monkswood, tel: 01487 773381

*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 may have developed on it. Shingle sites where the sand cover is greater than 20 cm in depth 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. This region has no shingle structures (Table 3.3.1), principally because the underlying rocks of the region do not generally weather into shingle-sized fragments. This lack of suitable sediment results in the occurrence of only short lengths of shingle shorelines (Map 3.3.1).

Table 3.3.1 Area of vegetated shingle structures in Region 4

	Area (ha)*
Region 4	***0***
North Sea Coast	4,472
Scotland	672
Great Britain	5,129

Source: Sneddon & Randall (1994). Key: *to the nearest whole ha.

3.3.2 Important locations and species

Table 3.3.2 lists the fringing beaches in the region visited by the author during a national survey of shingle beaches. The only stretches of shingle in the region are in Edinburgh and the Lothians. There are spreads of river-borne pebbles and small boulders at the mouth of the River Esk at Musselburgh. At Aberlady Bay there are mudflats giving way to sand and sandy shingle that contain high levels (over 10%) of shelly material; most of the shingle is formed of volcanic basalt and dolerite from off-lying rocks and skerries (Dargie 1994). Barns Ness has shingle with a sandy matrix, derived from a local limestone outcrop.

Shingle plant communities around Britain are distinctive (Sneddon & Randall 1993a), with some communities being widespread and others limited to a particular region or substrate. In this region the shingle vegetation is limited to a sparse cover of pioneer species at the rear of the fringing beach. Typical species present include common scurvygrass *Cochlearia officinalis*, sea mayweed *Tripleurospermum maritimum* and curled dock *Rumex crispus*. In the sandy shingle at Aberlady Bay, marram *Ammophila arenaria* and sea

Table 3.3.2 Fringing shingle beaches visited

Location	*Grid ref.*	*Length (km)*	*Description*
Musselburgh	NT3474	0.5	Pebbles, small boulders
Aberlady Bay	NT4680	1.0	Sandy shingle, bird-rich
Barns Ness	NT7276	1.5	Sandy shingle, bird-rich

Source: Randall (unpublished survey, early 1980s)

Map 3.3.1 Vegetated fringing shingle beaches.

sandwort *Honkenya peploides* occur, whereas the more silty shingle adjacent to the mudflats has saltmarsh rush *Juncus gerardii as* the dominant species. Barns Ness has some lime-rich turf over shingle, with extensive populations of yarrow *Achillea millefolium* and eyebright *Euphrasia officinalis agg.* Ringed plover *Charadrius hiaticula* and oystercatcher *Haematopus ostralegus* frequent the shingle beaches of this region.

3.3.3 Human activities

Most of the fringing beaches in Scotland have no conservation designations and few are subject to high levels of recreational pressure or building disturbance. Aberlady Bay is a Local Nature Reserve and Site of Special Scientific Interest (SSSI). Barns Ness is an SSSI owned by East Lothian Council. At designated sites such as these, site management takes account of the nature conservation interest and damaging activities can mostly be avoided. A few beaches (e.g. Gullane) have been affected by sand and shingle extraction in the past, but probably only on a small scale, although extraction has caused serious beach erosion elsewhere, outside the region (Carter *et al.* 1992).

3.3.4 Information sources used

The principal vegetated shingle structures of Britain (of which none occur in this region) were surveyed during the NCC's national shingle structures survey carried out between July 1988 and October 1989. This survey used the National Vegetation Classification (NVC), applying a standard methodology (Sneddon & Randall 1993, 1994; Rodwell in press).

Fringing beaches in the region were examined in 1986-1987 as part of the NCC's rare species monitoring scheme (Randall 1989). In this survey fringing beaches were examined qualitatively and features of physical or biological interest were described. JNCC's Coastal Database records lengths of shingle shoreline by 10 km square.

3.3.5 Acknowledgements

Thanks are due to Dr C.J. Legg and Catherine Leach (University of Edinburgh) and Kathy Duncan and John Baxter (SNH) for comments on the draft.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Fauna, flora, habitat information, site management - Scotland	*SNH, Aquatic Environments Branch, RASD, Edinburgh, tel: 0131 554 9797
Flora, fauna, habitat information, site management: Angus, Dundee, Perth & Kinross	*SNH Area Office, Perth, tel: 01738 639746
Flora, fauna, habitat information, site management: Fife, Clackmannanshire, Stirling, Falkirk	*SNH Area Office, Stirling, tel: 01786 450362
Flora, fauna, habitat information, site management: West Lothian, Edinburgh, Midlothian, East Lothian, Scottish Borders	*SNH Area Office, Galashiels, tel: 01896 756652
Flora and birdlife of the region	*Scottish Wildlife Trust, Edinburgh, tel: 0131 312 7765

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

3.4 Coastal lagoons

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

3.4.1 Introduction

Coastal lagoons are pond- or lake-like bodies of saline water of restricted tidal range, either wholly or partially separated from the adjacent sea, but with some influx of sea water. The term is used here to include true lagoons *(sensu* Barnes 1988), i.e. those separated from the sea by a natural sedimentary barrier, as well as other lagoonal areas *(sensu* Thorpe *et al.* in prep.), e.g. isolated percolation pools, sluiced or culverted pools, silled inlets and artificial brackish ponds and coastal pools, of a similarly restricted tidal range and often containing comparable lagoonal species assemblages. Lagoons are commonly shallow, often with varying salinity ranging from above to below normal sea-water levels (35 g/kg). Freshwater systems are not considered here. Lagoons are a nationally rare habitat and a 'priority habitat type' under Annex 1 of the EC Habitats and Species Directive.

The contribution of the region's lagoons to the British lagoonal *(sensu* Barnes 1988) resource as a whole is shown in Table 3.4.1. The single true lagoon, Elliot Links, Angus, totals less than 1 ha, amounting to less than 0.1% of Britain's total lagoonal resource. It was not regarded by Barnes (1989) as being 'especially noteworthy in the national context'. The region is therefore not significant in the national context.

Map 3.4.1 Coastal lagoons.

Table 3.4.1 Lagoon⁺ areas* in Region 4 in context

	Lagoonal area (ha)	*Overall % of GB total*	*% of GB total excl. The Fleet*
Angus, Perth and Kinross and Dundee City	1	<0.1	<0.1
Region 4	1	<0.1	<0.1
North Sea Coast	1,163	92	87
Great Britain	1,261	-	-

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

3.4.2 Important locations and species

Table 3.4.2 summarises the areas and physiography of the lagoonal sites in the region.

True lagoons support only three types of aquatic vegetation, namely stands of green algae *(Chaetomorpha spp., Ulva spp. and Enteromorpha* spp.), of eelgrasses *Zostera* spp. and similar plants (predominantly tasselweeds *Ruppia* spp.) and, much more rarely, of stoneworts (especially *Lamprothamnium* spp.). Much of the area of their beds, however, is bare sediment, devoid of vegetation cover. Fringing stands of common reed *Phragmites australis,* saltmarsh plants and/or sea club-rush *Scirpus maritimus* are usual. Elliot Links lagoon, however, supports no significant aquatic vegetation. The artificial ponds retained behind a sea wall at Skinflats (including Kinneil Kerse) are generally of low salinity, with a restricted estuarine fauna and flora. There are no important plant species associated with the region's lagoonal areas, although the Skinflats area supports a diverse terrestrial flora.

Lagoons possess a characteristic invertebrate fauna that shows little regional variation, even within Europe. In Britain, several of these species are very rare and are protected under the Wildlife & Countryside Act 1981. However, none of these protected species occurs in the region. Elliot Links lagoon has a restricted, low-diversity estuarine assemblage of benthic species (see section 5.4); its planktonic species assemblage, dominated by the opossum shrimp *Neomysis integer,* is relatively rich. The Skinflats site is important for its associated birdlife (see section 5.11).

Table 3.4.2 Lagoonal sites in Region 4

Site	*Grid ref.*	*Area (ha)**	*Type*
Elliot Links	NO620391	1	Natural, estuarine
Skinflats (includes Kinneil Kerse)	NS922830	8	Artificial, estuarine

Key: *to the nearest whole ha.

3.4.3 Human activities

The Elliot Links site and part of the Skinflats site are within Sites of Special Scientific Interest (SSSIs). At designated sites such as these, site management takes account of the nature conservation interest and damaging activities can mostly be avoided.

3.4.4 Information sources used

All potential lagoons in the region were surveyed as part of the national lagoon survey undertaken on behalf of the Nature Conservancy Council (McLusky & Roddie 1984). Detailed reports are available, including habitat maps and species lists. The data are summarised by Barnes (1989), from which the information given here were derived.

3.4.5 Acknowledgements

Thanks are due to Mark Tasker (JNCC), Liz Garson (Falkirk Council) and Alan Burdekin (SOAEFD) for comments on the draft.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Lagoons	*Marine Nature Conservation Review (MNCR) Team, JNCC, Peterborough, tel: 01733 62626
Brackish lagoons in the region	Dr R.S.K. Barnes, St. Catharine's College, Cambridge CB2 1RL, tel: 01223 336606
Lagoons in Scotland	*SNH, Aquatic Environments Branch, RASD, Edinburgh, tel: 0131 554 9797
Skinflats SSSI	J. Sanderson, Callendar House, Callendar Park, Falkirk FK1 1YR

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

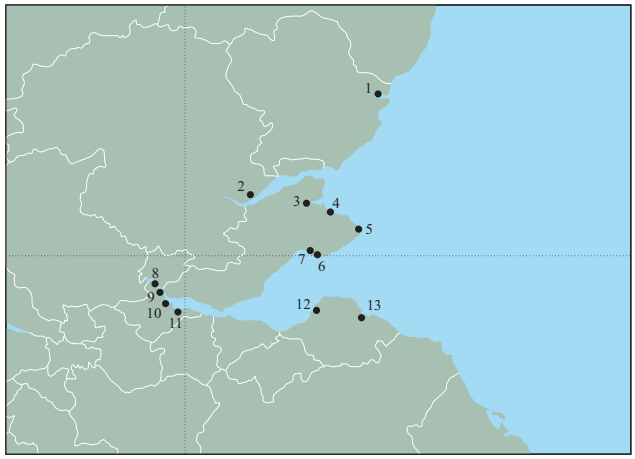
3.5 Wet grassland

Dr H.T. Gee

3.5.1 Introduction

Wet grassland includes both coastal grazing marsh subject to maritime influence and lowland wet grassland adjacent to tidal reaches of estuaries. Coastal grazing marsh is a distinctive habitat consisting of low-lying grassland drained by a series of ditches that may be either brackish or freshwater. Much grazing marsh was formed by the enclosure of saltmarsh behind sea walls. Smaller areas of freshwater grazing marsh have been created landward of natural barriers such as sand dunes or shingle beaches. Wet grassland sites may remain wet throughout the year and may be managed for stock grazing and/or as hay meadow. No national survey exists of wet grassland as here defined, or indeed of coastal grazing marsh or lowland wet grassland separately, so detailed inter-region comparisons are not possible.

Due to the absence of extensive areas of low-lying land adjacent to the coast, there is considerably less lowland wet grassland in Scotland than in the south-east of England, for example. Wet grassland is generally considered to be rare in Scotland (Doody *et al.* 1993) and is often not recognised as an important habitat in Scotland even though sites of conservation value are present throughout the country. There are some generally small areas of wet grassland, brackish and freshwater marshes and fens in the region, and most of the sites discussed in this section are included because of their fen and swamp communities, which are often transitional to saltmarsh (see section 3.6). Many areas in the region that once supported lowland wet grassland, e.g. parts of the Inner Forth, have been subject to land claim for agriculture and/or industry (McLusky *et al* 1992). Information available at present has not given any reason to identify this region as important for wet grassland in either a British or a Scottish context.



Map 3.5.1 Coastal wet grassland sites (Table 3.5.1). Source: SNH.

3.5.2 Important sites and species

The notable wet grassland and fen sites in the region are listed in Table 3.5.1 and shown on Map 3.5.1. Wet grassland habitat in the region is seldom included in Sites of Special Scientific Interest (SSSIs), apart from two areas developed on claimed land behind sea walls, at Skinflats and Kinneil Kerse. Other areas of wet grassland on claimed land are present adjacent to Montrose Basin, the inner Tay Estuary, the Eden Estuary, the inner Firth of Forth and Aberlady Bay.

Species-rich fens are present at the top of a number of beaches, particularly around the Fife coast. Several of these are within designated SSSIs. A number of sites contain species at or near their northern limit on the east coast of Britain. Fine examples of beach-head brackish and non-tidal fens are found within the St. Andrews - Craig Hartle SSSI. Where the transition to non-tidal fens involves freshwater

Table 3.5.1 Coastal wet grassland in Region 4

No. on Map 3.5.1	*Location*	*Grid ref.*	*Conservation status*	*Notes*
1	Montrose Basin	NO6858	Adjacent to SSSI	Saltmarsh around the basin grades to brackish and freshwater marsh in places
2	Inner Tay Estuary	NO2822	Part SSSI	Extensive brackish marsh in upper reaches of estuary; wet grassland on Carse of Gowrie outside SSSI
3	Eden Estuary	NO4719	SSSI	Brackish swamp grades to freshwater marsh and fen
4	St. Andrews - Craig Hartle	NO5415	SSSI	Series of beach-head saltmarshes and brackish fens with transitions to non-tidal fen and freshwater marsh in areas of seepage
5	Fife Ness Coast	NO6210	SSSI	Non-tidal fen to landward of beach-head saltmarsh
6	Ruddons Point	NO4500	Not designated	Ditch-drained wet grassland associated with Cocklemill Burn
7	Dumbarnie Links	NO4501	Adjacent to SSSI	Ditch-drained wet grassland
8	Alloa Inches	NS8692	Not designated	Extensive freshwater marsh and fen communities on islands in the inner Forth
9	Airth & Pow Burn	NS9187	Not designated	Areas of grazed fen and wet grassland on land claim
10	Skinflats	NS9384	Part SSSI	Some areas of wet grassland on claimed land behind sea wall
11	Kinneil Kerse	NS9782	Part SSSI	Some areas of wet grassland on claimed land behind sea wall
12	Aberlady Bay	NT4681	SSSI	Freshwater marsh
13	Tyninghame Bay	NT6480	Not designated	Marsh on claimed land adjacent to Tyne Estuary

Source: SNH. Key: SSSI = Site of Special Scientific Interest.

seepage onto the saltmarsh, species such as knotted pearlwort *Sagina nodosa,* distant sedge *Carex distans* and few-flowered spike-rush *Eleocharis quinqueflora* are present. A range of other fen and swamp types are present in this SSSI and the differences in species composition are partly related to local physico-chemical factors such as alkalinity. Many of these fens are dominated by tall herbs such as meadowsweet *Filipendula ulmaria,* yellow iris *Iris pseudacorus* and hemlock water-dropwort *Oenanthe crocata,* sometimes with associated species such as ragged robin *Lychnis flos-cuculi,* brown sedge *Carex disticha,* northern marsh-orchid *Dactylorhiza purpurella* and the locally rare lesser water-parsnip *Berula erecta.* Another area of fen is dominated by the locally rare lesser pond-sedge *Carex acutiformis* in association with bogbean *Menyanthes trifoliata* and fen bedstraw *Galium uliginosum.* One highly calcareous flush on the SSSI supports a rich flora, including local rarities such as common butterwort *Pinguicula vulgaris,* dioecious sedge *Carex dioica* and marsh lousewort *Pedicularis palustris.*

Similar transitions to non-tidal fresh water fen are present adjacent to the estuarine saltmarshes of the region, e.g. Montrose Basin, Aberlady Bay and the Eden Estuary. Here the tall fen communities are often characterised by hemlock water-dropwort and gipsywort *Lycopus europaeus.*

Little information is available on the important species that coastal wet grassland supports in this region. The wet grassland associated with the larger estuaries, i.e. Montrose Basin, the Tay and the Forth, provide important roosting and feeding habitat for nationally and internationally important populations of wintering waterfowl (see section 5.12), and the Montrose Basin is a Ramsar site - a wetland of international importance for waterfowl - and a Special Protection Area (SPA) for birds (see section 7.2).

3.5.3 Human activities

Nationwide, the major threats to wet grassland and fen are agricultural improvement, conversion to arable use and loss beneath landfill, urban and industrial development. There has been substantial land claim along the major estuaries of the Forth and Tay as well as some of the minor estuaries such as the South Esk (Montrose Basin) and the River Tyne (Tyninghame Bay) (Pye & French 1993). In some parts of the Tay Estuary common reed *Phragmites australis* was actively planted in the 19th century as a coast protection measure and to encourage sediment deposition prior to land claim. Some of the large areas of subsequently claimed wetland adjacent to the Tay Estuary are now under intensive agriculture (Pye & French 1993) and as a result have lost their botanical interest. Substantial land claim, originally for agriculture, took place along the inner Firth of Forth. As with other areas of heavily populated coastline, some of this agricultural land has now been lost under industrial and harbour urban development.

3.5.4 Information sources used

There has been no systematic survey of coastal wet grassland in Scotland, and little information is available. Much of the information presented in this report was gleaned from the SSSI citations provided by the JNCC. Phase I survey plus target notes are available for the marshy grassland at Kinneil Kerse.

3.5.5 Acknowledgements

Thanks are due to Mark Tasker (JNCC), Liz Garson (Falkirk Council), Dr C.J. Legg, Alistair Hamilton and G. Russell (Institute of Ecology and Resource Management, University of Edinburgh), Allan Brown and G.Moy (Fife Council), John Baxter, Kathy Duncan, Karen Passmore and Sandy MacLennan (SNH) and Daniel Owen (RSPB) for their useful comments.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Wet grassland in Scotland	*SNH, Aquatic Environments Branch, RASD, Edinburgh, tel: 0131 554 9797
Flora, fauna, habitat information, site management: Angus, Dundee, Perth & Kinross	*SNH Area Office, Perth, tel: 01738 639746
Flora, fauna, habitat information, site management: Fife, Clackmannanshire, Stirling, Falkirk	*SNH Area Office, Stirling, tel: 01786 450362
Flora, fauna, habitat information, site management: West Lothian, Edinburgh, Midlothian, East Lothian, Scottish Borders	*SNH Area Office, Galashiels, tel: 01896 756652

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

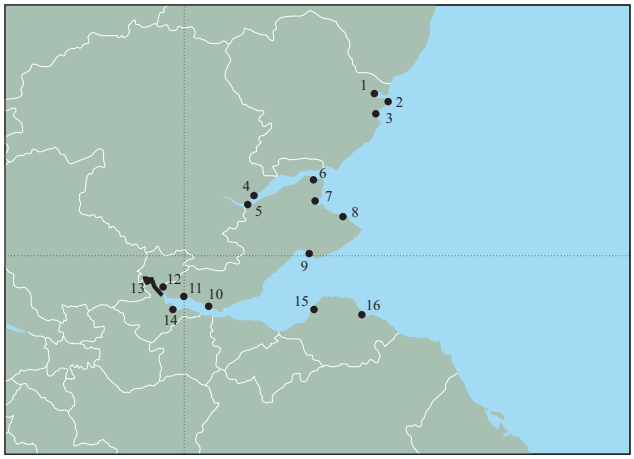
3.6 Saltmarsh

Dr M.I. Hill

3.6.1 Introduction

The total amount of saltmarsh recorded in the region during the national survey (Burd 1989a, b) was 899 ha, representing 4% of that on the North Sea coast, 15% of that in Scotland and 2% of that in Britain (Table 3.6.1). Of this total, approximately 500 ha are in the Firth of Tay and 170 ha in the Firth of Forth. Elsewhere, only the Montrose Basin (River South Esk) contains more than 50 ha. According to the national saltmarsh survey (Burd 1989b), 11% of the region's coastline (56 km) supports saltmarsh. However, saltmarsh is known to be more widespread in the region than the national survey suggests. Areas of saltmarsh vegetation are found throughout the region on shingle beaches and rocky shores, where they form patches on shallow sediments, particularly at the mouths of streams or where there is seepage of fresh water onto the beach. Such 'beach-head' saltmarshes are also found on the west coast of Scotland (Regions 14 and 16).

Saltmarshes in this region are intermediate in character between those of England and those of the rest of Scotland: the proportion of pioneer and low- to mid-marsh vegetation communities, for example, is high compared with other Scottish regions, but low compared with England. This is largely a reflection of the wide low-marsh zones of the saltmarshes of East Lothian, notably Aberlady and Tyninghame Bays. An unusual feature of saltmarshes in this region is the extent of swamp communities in the upper marsh zone (Table 3.6.1). The national survey found that these upper marsh swamps formed more than 50% of the total saltmarsh area, compared with an average of only 5% in Britain as a whole. This is largely due to the more than 400 ha of tidal reedbeds that occur in the inner Firth of Tay. As a result, this region contains more than 75% of the total area of upper marsh swamps in Scotland (see also section 3.5).



Map 3.6.1 Saltmarsh sites (Table 3.6.2). Source: JNCC.

3.6.2 Important sites and species

Saltmarsh in the region takes various forms, including embayment types in estuaries such as Montrose Basin and the Eden Estuary, which have restricted entrances, and fringing marshes in the inner Firth of Tay and the upper Forth Estuary. Saltmarshes in the outer Firth of Tay and the Firth of Forth are mainly of the embayment type, although parts of these saltmarshes have developed behind sheltering rock outcrops and sand spits. 'Beach-head' saltmarshes are widespread in the region, with good examples at Boddin Point to Scurdie Ness, Eden Estuary, Kinkell Harbour - Craig Hartle and Cocklemill Bay. 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 Tay Estuary has a large discharge of freshwater through a comparatively narrow mouth, limiting upstream saline influence. The inner estuary is fringed with brackish and freshwater marshes and freshwater fen communities. The upper estuary supports the largest single expanse of (mainly tidal) common reed *Phragmites australis* swamp in

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

	Spartina	*Pioneer*	*Low-mid*	*Mid-upper*	*Drift-line*	*Upper swamp*	*Transition*	*Wet depression*	*Totals*	*% of total in region*
Angus, Dundee City and Perth and Kinross	0	26	2	37	4	364	43	1	475	-
Fife	<1	5	4	34	2	88	8	<1	144	-
Clackmannanshire, Stirling and Falkirk	<1	8	43	32	4	2	1	0	93	-
West and East Lothian	0	88	53	41	3	1	3	1	190	-
Scottish Borders	0	0	0	<1	0	0	<1	0	<1	-
Region 4	***<1***	***126***	***102***	***143***	***13***	***455***	***54***	***1***	***899***	***-***
Scotland	102	361	499	3,608	63	587	748	2	6,089	15
North Sea Coast	3,461	2,130	8,194	4,772	1,350	1,066	342	2	21,788	4
Great Britain	6,948	3,470	12,353	16,042	1,824	1,475	1,670	2	44,370	2

Source: National Saltmarsh Survey (Burd 1989a, b). Key: *to the nearest whole ha. Sites not surveyed in detail (<4 ha) are included in the Totals column but not in the communities columns.

Table 3.6.2 Main saltmarsh sites surveyed

Site no. on Map 3.6.1	*Location*	*Grid ref.*	*Area (ha)**	*Protected status*
1	Montrose Basin	NO693577	58	Ramsar site, SPA, SSSI, LNR
2	Boddin Point - Scurdie Ness	NO731555	1	SSSI
3	Lunan Burn	NO686514	4	Not designated
	Firth of Tay			
4	Inner estuary north shore	NO270227	374	SSSI, LNR
5	Inner estuary south shore	NO232191	119	SSSI, LNR
6	Tayport	NO470278	5	NNR, SSSI
7	Eden Estuary	NO470195	32	SSSI, LNR
8	Kinkell Harbour - Craig Hartle	NO561152	2	SSSI
	Firth of Forth			
9	Cocklemill Bay	NO459009	9	SSSI
10	Culross Shore	NS991859 + NS976857	3	Not designated
11	Kennetpans	NS919888	2	Not designated
12	Black Devon/Clackmannan Pow	NS902909	6	Not designated
13	Alloa to Grangemouth	NS913876	83	SSSI
14	Grange Burn	NS946826	1	SSSI
15	Aberlady Bay	NT466805	77	SSSI, LNR
16	Tyninghame Shore	NT644797	112	SSSI

Sources: National Saltmarsh Survey (Burd 1989a, b). Key: *to nearest whole ha. Note: table includes all surveyed sites with more than 1 ha of saltmarsh. SSSI = Site of Special Scientific Interest.

the UK. There are associated swamps of sea club rush *Scirpus maritimus* and grey club-rush *Schoenoplectus tabernaemontani* around the fringe of the reedbed. Towards the eastern end of the inner Tay, there are areas of saltmarsh rush *Juncus gerardi* and sea aster *Aster tripolium.* Examples of saltmarsh transitions to freshwater fen and mire also occur at the Eden Estuary and Cocklemill Bay and on the beach-head saltmarshes in the vicinity of Craig Hartle and Fife Ness.

In the upper Forth Estuary (i.e. Alloa to Grangemouth), saltmarshes form a narrow fringe in front of the sea wall and the vegetation has a low diversity of both species and communities. The main saltmarsh communities in the upper Forth are those dominated by common saltmarsh-grass *Puccinellia maritima* and saltmarsh rush, both widespread communities in Britain, but with abundant sea arrowgrass *Triglochin maritima* as a characteristic feature. On the small island of Alloa Inch in the upper Forth several hectares of arable land were more or less abandoned when the seawall was breached in 1992. As a result, most of the island is covered by a tidal reedbed. Reeds are also found at the landward edge of the saltmarsh and fringing the river channel in many parts of the upper Forth. In the lower Forth Estuary, downstream of Bo'ness, saltmarshes are of limited extent, occurring mainly at the heads of bays and around the mouths of streams. Larger and more diverse marshes are found on the north shore at Cocklemill Bay (Dumbarnie Links and Ruddons Point SSSIs) and at Aberlady Bay. The saltmarsh at Tyninghame shore also contains a wide range of plant communities.

Many of the transitional habitats are species-rich, supporting diverse assemblages of plants and invertebrates (see also section 3.5). The large areas of reedswamp found in some of the inner estuaries of the region have substantial conservation value. At the upper edge of saltmarshes, particularly where there is a natural transition to wet grasslands, a vegetation rich in sedges can develop, with glaucous sedge *Carex flacca* as a characteristic species. Where there is a seepage of freshwater from adjacent land, a particularly diverse and interesting flora is found in the upper saltmarsh zone, including stands of saltmarsh flat-sedge *Blysmus rufus* and slender spike-rush *Eleocharis uniglumis.* These two species are northern elements in the British saltmarsh flora and occur mainly on the west coast of Britain from mid-Wales northwards. Whilst neither is regarded as nationally scarce, their extent as a vegetation type in British saltmarshes is limited.

This region lies at the boundary between the north and south saltmarsh floras in Britain. This means that northern species are present and some southern species such as sea wormwood *Artemisia maritima* and hard-grass *Parapholis strigosa* reach their northern limit in the region. Other southern species such as sea-purslane *Halimione portulacoides* and common sea-lavender *Limonium vulgare* are absent. The three British species of eelgrasses *Zostera* spp., all nationally scarce, are present in intertidal and subtidal zones in the region, including Montrose Basin, the Eden Estuary, the lower Forth Estuary and the Firth of Forth.

Saltmarshes and their brackish pools harbour specialist invertebrates, such as the beetle *Heterocerus maritimus,* which burrows into wet mud (section 5.3). High densities of breeding waterfowl, especially waders, use the saltmarshes of the region: Montrose Basin (a Ramsar site wetland of international importance and a Special Protection Area (SPA) for birds) has the highest density of saltmarsh breeding waders in Britain (Davidson *et al.* 1991) and is particularly important for oystercatchers *Haematopus ostralegus* (see also section 5.11). The habitats of particular significance for wintering birds include the saltmarshes of Montrose Basin, the Eden Estuary and the Firths of Tay and Forth (see section 5.12).

3.6.3 Human activities

Erosion of saltmarshes is not a significant problem in this region, where most sites are growing in depth and lateral extent; exceptions are the marshes of the upper Forth, which are showing lateral erosion (Proctor *et al.* 1983).

In some areas there has been substantial land claim of saltmarsh for agriculture and more recently for industry. Areas involved include the inner Tay and Forth Estuaries and Tyninghame Bay. A study of the Forth Estuary (McLusky *et al.* 1992) showed that since the beginning of the 19th century almost 50% of the intertidal area, presumably mostly saltmarsh, has been land claimed. Other activities on saltmarshes include reed-cutting, wildfowling (see section 9.7) and grazing (see also section 8.2). Different grazing regimes on saltmarshes can significantly alter the density and nesting success of breeding waders through effects on vegetation composition and structure (Cadbury *et al.* 1987) (see section 5.11).

Common cord-grass *Spartina anglica* was planted at several locations in the region in the early part of this century, including the Eden and Forth Estuaries. Here it is at the northern limit of its range and, unlike in England and Wales, has not spread: in fact there are no recent records at some sites. Reeds were planted in the Tay Estuary in the 19th century to assist land claim.

3.6.4 Information sources used

Saltmarshes in this region were surveyed in 1984 as part of the national saltmarsh survey by the Nature Conservancy Council. A detailed report (Stace 1987) provides site descriptions and assessments and the results are summarised in Burd (1989a, b). Data presented here are derived from that database. The national saltmarsh survey provided an intermediate level of detail between Phase 1 habitat survey and the National Vegetation Classification (NVC) (e.g. Rodwell in press). It did not include all areas of transition to other habitats such as sand dune and shingle, nor areas of eelgrasses *Zostera* spp. Many small areas of saltmarsh vegetation on beaches were not covered; the national survey therefore indicates only a minimum figure for the extent of saltmarsh in the region.

Detailed surveys of saltmarshes have been carried out in the upper Forth by Proctor *et al.* (1983) and for the whole Fife Coast by Leach & Phillipson (1985). Both surveys used the NVC methodology. Proctor (1987) summarises data for the Firth of Forth as a whole.

3.6.5 Acknowledgements

Thanks are due to Liz Garson (Falkirk Council), Dr C.J. Legg, A. Hamilton and G. Russell (Institute of Ecology and Resource Management, University of Edinburgh), A. Brown and G. Moy (Fife Council), John Baxter, Kathy Duncan, Alan Leitch, Sandy MacLennan and Karen Passmore (SNH) and Mark Tasker (JNCC) for comments on the draft.

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Pye, K., & French, P.W. 1993. *Erosion and accretion processes on British saltmarshes.* London, Ministry of Agriculture, Fisheries and Food.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Data from the National Saltmarsh Survey	*Marine and Coastal Data Custodian, JNCC, Peterborough, tel: 01733 62626
Statutory protected saltmarsh sites; detailed saltmarsh site information; coastal geomorphology	*SNH, Aquatic Environments Branch, RASD, Edinburgh, tel: 0131 554 9797
Flora, fauna, habitat information, site management: Angus, Dundee, Perth & Kinross	*SNH Area Office, Perth, tel: 01738 639746
Flora, fauna, habitat information, site management: Fife, Clackmannanshire, Stirling, Falkirk	*SNH Area Office, Stirling, tel: 01786 450362
Flora, fauna, habitat information, site management: West Lothian, Edinburgh, Midlothian, East Lothian, Scottish Borders	*SNH Area Office, Galashiels, tel: 01896 756652

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

Estuaries are an important element of the region's environment: over 500 km of the region's shores are estuarine, and the major estuaries of the Firths of Tay and Forth dominate the region's history and geography. Both within and outside these huge firths are many lesser estuarine inlets, such as that of the River Tyne, illustrating the same intertidal features at a smaller scale. Photo: MNCR, JNCC.

Chapter 4 Marine and estuarine environments

4.1 Estuaries

Dr N.C. Davidson

4.1.1 Introduction

Estuaries are "partially enclosed tidal areas at least partly composed of soft tidal shores, open to saline water from the sea, and receiving fresh water from rivers, land run-off or seepage" (Davidson *et al*. 1991). They comprise both aquatic (marine, brackish and fresh water) and terrestrial habitats, including adjacent sand dunes, coastal grasslands and maritime heaths. All the estuaries discussed here were covered by the NCC Estuaries Review (Davidson *et al.* 1991) and have at least 2 km of tidal channel or 2 km of shoreline over 0.5 km wide at low tide, either now or historically. This section gives only an overview of the main features of the estuarine resource in Region 4; for further details of habitats, species and human uses and influences refer to relevant sections in Chapters 3, 5 and 9 respectively. Names of estuaries are those used in Davidson *et al* (1991).

Estuaries are a major feature of this coast and contribute substantially to the diversity of coastal habitats. Over 530 km of the region's shoreline is estuarine and the coastal topography of the region is dominated by its two large firths: the Tay and the Forth.

The contribution of the five estuaries in Region 4 (Map 4.1.1) to the wider resource is summarised in Table 4.1.1 (note that the area of the Firth of Forth as defined here includes intertidal and subtidal areas in the inner estuary but only intertidal areas on the outer shores (see Buck 1993)). The 23,056 ha of the region's estuarine area forms 9% of the North Sea resource and 4% of the UK total; the intertidal area in the region making a similar contribution to the nation's estuarine resource. At over 12,000 ha, the Firth of Tay is the largest estuary in the region, followed by the Firth of Forth (8,500 ha). Together they form almost 90% of the region's estuarine area; otherwise only the Eden Estuary exceeds 1,000 ha in total area. These large firths have a complex geomorphological origin, resulting from the effects of glaciation and river erosion

Map 4.1.1 Estuaries. Source: JNCC Estuaries Database.

where large rivers have cut through hard rocks, whilst their hydrodynamics share features with the large coastal plain estuaries further south in Britain. The smaller estuaries in the region are all bar-built, formed where rivers have been diverted by the development of sand and shingle spits.

All the region's estuaries occur where rivers discharge to the sea, and several, notably the Firths of Tay and Forth, have major freshwater inflows into their upper reaches. Tidal ranges in the region (3.7-4.8 m spring tidal range) are typical of those on the North Sea coast. The smaller estuaries in the region drain substantially at low tide, and tidal flats and saltmarshes form over three-quarters of the area of these places. In contrast the Tay and the Forth have major subtidal areas, particularly in their outer parts. Many of the intertidal flats in the region are muddy, deposited either in the shelter of bars or in the more sheltered bays in the larger estuaries. Sandflats occur mainly in the outer, higher-energy parts of the estuaries. By far the largest areas of intertidal sediments are in the Firths of Tay (about

Table 4.1.1 Contributions of Region 4 estuaries to the national resource

Resource	*Regional total*[+]	*North Sea Coast total*	*% North Sea Coast total*	*GB total*	*% GB total*	*UK total*	*% UK total*
Intertidal area (ha)	12,594	136,580	9.2	321,050	3.9	332,350	3.8
Saltmarsh area (ha)	877	20,650	4.2	48,380	1.8	*	*
Total estuarine area (ha)	23,056	258,100	8.9	525,650	4.4	581,290	3.9
Shoreline length (km)	518	5,645	9.2	9,054	5.7	9,727	5.3
Longest channel lengths (km)	134	1,484	9.0	2,461	5.4	2,640	5.1

Sources: Buck (1993); Davidson & Buck (in prep). Key: *areas of saltmarsh were not available for Northern Ireland; [+]areas rounded to the nearest whole ha; lengths rounded to the nearest 1 km.

5,700 ha) and Forth (almost 4,800 ha), but substantial intertidal areas also lie within Montrose Basin and the Eden Estuary. The 877 ha of saltmarsh in the estuaries of the region forms only about 2% of British saltmarshes, a smaller proportion than for the total and intertidal estuarine areas. Over half the region's saltmarsh is within the Firth of Tay, with large areas also in the Firth of Forth and Tyninghame Bay. Tyninghame Bay is notable for the large proportion (28%) of its intertidal area that is saltmarsh.

Major parts of the Montrose Basin and the Firths of Tay and Forth are industrialised, with a long history of major port and industrial use. In the Tay this has focused on the outer northern shore centred on Dundee, but industrialisation is widespread along all the tidal reaches of the Forth. At least part of each estuary in the region is, however, more rural and undeveloped, with natural shorelines in the inner parts of Montrose Basin, the upper parts of the Tay, and the much of the Eden Estuary and Tyninghame Bay.

All the estuaries in this region have substantial geomorphological, wildlife and nature conservation importance, and all are wholly or in large part notified as Sites of Special Scientific Interest. In addition the Tay has a National Nature Reserve, and there are Local Nature Reserves on Montrose Basin, the Eden Estuary and the Forth (see also Chapter 7). Four of the region's estuaries (Montrose Basin, Tay, Eden and Forth) are of international importance for migrant and wintering waterfowl.

4.1.2 Important locations and species

Table 4.1.2 summarises the main physical characteristics of the estuaries in the region.

Montrose Basin, at the southern end of Montrose Bay, is the estuary of the South Esk river. It forms a broad, muddy, predominantly intertidal basin, much of which remains largely unmodified by pollution and land-claim, except around its mouth. The basin is enclosed by a broad spit on which is built the town of Montrose; the estuary discharges through a narrow channel at the southern end of the spit. Montrose Basin is fringed by saltmarsh, has rich sea-bed communities including eelgrass *Zostera* spp. beds, and supports internationally important numbers of wintering waterfowl, notably pink-footed geese *Anser brachyryhnchus*, redshank *Tringa totanus* and knot *Calidris canutus*.

The Firth of Tay is over 50 km long, measured from its upper reaches north of Perth. The combined waters of the Rivers Tay and Earn form the largest single freshwater discharge into the seas around Britain and contribute around one-fifth of the total freshwaters discharged from Britain into the North Sea. Fringing the shores of the inner estuary are one of the largest areas of saltmarsh in eastern Scotland and the largest continuous stand of brackish common reed *Phragmites australis* swamp in Britain. The estuary is important geomorphologically, particularly around its mouth, where the large quantities of sediment carried downstream by the rivers are deposited. The extensive and actively-building bar and spit systems (Barry Links on the north shore and Tentsmuir on the south) support large dune systems with important and diverse plant and invertebrate communities. The Firth of Tay supports internationally important wintering populations of a number of waterfowl species.

The Eden Estuary, lying in the shelter of a northward-building sand spit, has extensive soft mudflats with mussel *Mytilus edulis* and eelgrass beds and diverse saltmarsh communities. To the north of the estuary and on the outer edge of the spit lie broad sandy beaches.

The Forth, with its large deep-water outer firth and sheltered inner estuary, has a narrow tidal channel meandering from its upper tidal limit at Stirling downstream to Alloa, where it opens into a sheltered estuary with extensive fringing mudflats and saltmarshes. The estuary narrows around Queensferry, where the rail and road bridges cross. Further downstream the outer firth is broader and deeper, with tidal mud and sand flats in more exposed bays along both northern and southern shores and a varied shoreline of rocky outcrops, sand and shingle flats, mussel beds and artificial sea walls. The major conurbation of Edinburgh and its suburbs forms a largely artificial part of the southern shoreline. Habitat diversity in the estuary is enhanced by a tidal reed bed at Alloa Inch in the upper reaches, brackish artificial lagoons at Skinflats on the middle estuary, the extensive tidal flat, saltmarsh and sand dune complex of Aberlady Bay in the east of the outer Firth and the species-rich dune grassland at Gullane at the easternmost point of the estuary's southern shore. The estuary is of major wildlife importance, particularly for its wintering waterfowl, for which it is overall of international importance, supporting 25 species in at least nationally important numbers.

Tyninghame Bay, the small estuary of the River Tyne, lies between two rocky headlands on the north-east facing coast of East Lothian. Sheltered by two sand spits, the estuary is predominantly sediment-filled. Saltmarshes form over 20% of the estuary and include zonations from pioneer plant communities to upper saltmarsh, backed by natural shorelines.

Table 4.1.2 Physical characteristics of Region 4 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 %*
85. Montrose Basin	NO6957	Bar-built	842	739	58	21.9	8.0	4.1	12.2
86. Firth of Tay	NO3527	Complex	12,265	5,720	502	170.3	53.7	3.7	53.4
87. Eden Estuary	NO4819	Bar-built	1,041	937	32	27.7	11.1	3.7	10.0
88. Firth of Forth	NT0182	Complex	8,401	4,798	173	272.5	54.8	4.8	42.9
89. Tyninghame Bay	NT6480	Bar-built	507	400	112	25.8	5.9	4.5	21.1

Sources: Buck (1993); JNCC Integrated Coastal Database. Key: *to the nearest whole hectare. Notes: estuary numbers are those used in Davidson *et al.* (1991). 'Geomorphological type' relates to nine estuary categories, described further in Chapter 5.7 of Davidson *et al.* (1991). 'Spring tidal ranges' are for the monitoring station closest to the mouth of the estuary.

4.1.3 Human activities

Estuaries in the region vary greatly in the extent of their urban and industrial use (Table 4.1.3). The Firth of Forth is the most extensively urbanised, with a long history of industrial and port-related modifications to its shoreline, plus major urban areas, notably Edinburgh and Stirling. Industry includes Scotland's largest industrial and petrochemical complex, at Grangemouth, chemical industries at Granton, Mossmorran/Braefoot Bay, Burntisland, Alloa and Cambus, and power stations in the inner estuary at Longannet and Kincardine (although this has been mothballed), on the Fife coast at Methil and Cockenzie and on the East Lothian coast at Torness. Several parts of the firth have port and dock facilities. The inner half of the Firth of Tay is predominantly rural, except for the Perth area close to the upper tidal limit; in the lower firth, urban and industrial shores are concentrated on the northern shore around Dundee, where there are docks, oil-related industry and textile works. Around the mouth of the Montrose Basin are urban and industrial shores but, like the Tay, the inner estuary is rural, as is much of the shoreline of the smaller estuaries in the region.

Land claim has substantially affected several estuaries. In the inner Forth Estuary almost 3,000 ha of estuarine habitats have been claimed since 1900, notably around Grangemouth on the southern shore and Torry Bay and Rosyth on the northern shore. Further substantial areas have been claimed along the outer firth, especially around Edinburgh. Land claim for industry and waste disposal has affected parts of Montrose Basin during this century, and caused the loss of 150 ha of intertidal land from the Firth of Tay between 1800-1900; the inner part of Tyninghame Bay has been embanked for agriculture.

Estuarine water quality is fair to good in the smaller estuaries. The Firth of Forth has a long history of industrial pollution, with major industrial discharges from Grangemouth and other upstream locations, and sewage and industrial discharges around Edinburgh. Substantial improvements in sewage treatment and discharge quality have been made over the last 20 years. Discharges of potentially hazardous persistent pollutants have been eliminated, but despite continuing improvements there are still low concentrations of dissolved oxygen in the upper estuary during spring tides in summer.

Major population centres lie close to most of the region's estuaries, and recreational use of at least part of most estuaries is diverse and at times intensive. A wide variety of informal leisure uses (walking, horse-riding, bird-watching, angling etc.) take place in parts of Montrose Basin, the outer parts of the Tay, the southern shore of the Eden Estuary, parts of the outer Firth of Forth, and Tyninghame Bay, part of which is a Country Park. Sailing and other water sports take place in the outer parts of Montrose Basin and the Tay, outside the mouth of the Eden Estuary and in the inner Firth of Forth. Golf is a major leisure activity bordering the region's estuaries, with the world-famous St. Andrews golf course on the sand spit enclosing the Eden Estuary, Carnoustie on the outer shore of the Firth of Tay, and further links courses at Elie, Balcomie (Crail), Aberlady and Gullane on the Firth of Forth.

Some exploitation of natural resources occurs on all estuaries. Saltmarshes and/or sand dunes are grazed in several parts of the Tay Estuary (where there is also reed-cutting for thatch), Eden Estuary and Firth of Forth. Some bait is dug in Montrose Basin, on the outer shores of the Tay, the outer Eden Estuary and Tyninghame Bay. Bait-digging is intensive on parts of the southern shore of the Firth of Forth, and in this estuary winkles and mussels are hand-gathered from rocky shores. Wildfowling takes place in parts of the Firth of Tay, is widespread on the Firth of Forth, and is undertaken by permit in parts of Montrose Basin, Eden Estuary and much of Tyninghame Bay. There are wildfowling sanctuary areas established in Montrose Basin, the Eden Estuary, Aberlady Bay on the outer Firth of Forth and Tyninghame Bay.

The Forth Estuary Forum is part of Scottish Natural Heritage's major coastal management initiative, 'Focus on Firths'. It aims to promote the protection and better management of the natural resources of the estuary and firth by stimulating understanding and voluntary co-operation among the various users and statutory authorities (see section 10.2.4).

4.1.4 Information sources used

Information in this section comes mainly from JNCC's *An inventory of UK estuaries*, which is being published in six regional volumes along with an introductory and methods volume. Estuaries in Region 4 are included in *Volume 4. North and east Scotland* (Buck 1993). Data presented in the inventory are drawn largely from material collected during 1989-90 (updated to 1993 where appropriate) for the NCC's Estuaries Review (Davidson *et al.* 1991). Saltmarsh data come originally from Burd (1989a, b). 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.

Table 4.1.3 Human uses and water quality in Region 4 estuaries

Estuary	*Centre grid ref.*	*Human use type:*				*Water quality*
		urban	*industrial*	*rural**	*recreational*	
85. Montrose Basin	NO6957	●	○	●	○	A
86. Firth of Tay	NO3527	●	●	●	●	A, B, A
87. Eden Estuary	NO4819	○	○	●	●	B
88. Firth of Forth	NT0182	●	●	○	●	C, B, A, D
89. Tyninghame Bay	NT6480			●	●	A

Sources: Buck (1993); Scottish Development Department (1987); Scottish Office Environment Department (1992). Key: *includes natural resource exploitation. ● = major human use; ○ = minor human use. Water quality: A = good, B = fair, C = poor, D = bad; multiple water quality codes are in downstream sequence.

4.1.5 Acknowledgements

Thanks are due to Mark Tasker (JNCC), Liz Garson (Falkirk Council), G. Russell (Institute of Ecology and Resource Management, University of Edinburgh), G. Moy (Fife Council), Alan Burdekin (SOAEFD), Steve Atkins, Alan Leitch, Karen Passmore and Sandy MacLennan (SNH) and Daniel Owen (RSPB) for their helpful comments on draft texts.

4.1.6 Further sources of information

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Burd, F. 1989b. *The saltmarsh survey of Great Britain. Regional supplement No. 15, south-eastern Scotland.* Peterborough, Nature Conservancy Council. (Unpublished report.)

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

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B. Further reading

A list of selected further reading for each estuary discussed here is given in Buck (1993). Further details of estuaries are in the *Coastal & marine UKDMAP datasets* module (Barne *et al.* 1994), available from JNCC, Peterborough.

Atkins, S.M., Caudwell, C., & Herbert, R. 1992. *Montrose Basin flats: environmental survey 1991.* Edinburgh, Scottish Wildlife Trust.

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SOAEFD. In prep. *Water quality survey of Scotland, 1995.* Edinburgh, Scottish Office.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Integrated Coastal Database: national database of estuaries; coastal habitats; statutory & non-statutory protected sites. Summary data available also in Coastal Directories UKDMAP display version.	*Coastal Data Custodian, JNCC, Peterborough, tel: 01733 62626
Statutory protected sites; detailed wildlife site information; coastal geomorphology. Focus on Firths Initiative & estuary management plans. Numerical and some digitised data.	*Coastal Ecologist, Maritime Unit, Advisory Services, SNH, Edinburgh, tel: 0131 554 9797
RSPB Estuaries Inventory: mapped and numerical information on land use and selected human activities for 57 major UK estuaries. In Region 4 the Inventory covers the Firth of Forth.	*Research Data Manager, RSPB, Sandy, tel: 01767 680551
Forth Estuary Forum	*The Secretary, Forth Estuary Forum, Perth, tel: 01738 444 180
National River Flow Archive: catchments and river flows from upstream gauging stations; interpreted analyses for whole estuaries.	National Water Archive Manager, Institute of Hydrology, Maclean Building, Crowmarsh Gifford, Wallingford, Oxfordshire OX10 8BB, tel: 01491 838800

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

4.2 The sea bed

R.A. Irving

4.2.1 Introduction

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

A variety of marine benthic habitats occur in the region. There are large areas of sedimentary shores, ranging from the wide mudflats of Montrose Basin, the Eden Estuary and the upper reaches of the Tay and Forth Estuaries to the sandy shores of Montrose Bay, Lunan Bay, Barry Buddon, Tentsmuir, Largo Bay, Burntisland, Drum Sands, Gosford Bay, Aberlady Bay, Gullane Bay and Tyninghame. The intervening stretches of coastline are predominantly rocky, with notable stretches from Montrose to Carnoustie, St. Andrews to Elie Ness and Dunbar to the English border. A number of wrecks (ships, aircraft and other solid material) occur off the coast of this region (see also section 6.1). In some sedimentary areas, these wrecks provide hard substrata for opportunistic colonising species that otherwise would not be present. Most mainland rocky shores within this region are moderately exposed; that is, onshore winds are frequent but not prevailing, and there is an absence of oceanic swell and no proximity to deep water. A higher degree of shelter is provided by enclosed inlets and estuaries.

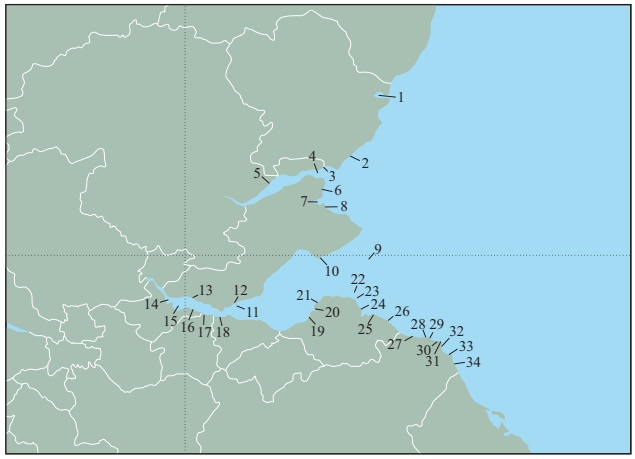
Parts of the region are known to be of particular interest for their marine life. The Berwickshire Marine Consultation Area (MCA - see also section 7.4.3) is the only MCA within this region, extending from Siccar Point (east of Cockburnspath) to Ross Point (just south of Burnmouth). The St. Abb's Voluntary Marine Nature Reserve (VMNR), which extends 1-2 km offshore between St. Abb's Head and Hairy Ness, lies within the Berwickshire MCA (see also section 7.4.4). A wide variety of sea-bed types, together with strong tidal currents and deep rock occurring close inshore, has led to a particularly high diversity of habitats and species in the VMNR.

4.2.2 Important locations and communities

Table 4.2.1 shows the locations of marine interest mentioned in the text (Map 4.2.1). There may be other areas of importance for which there is currently insufficient information on which to base a reliable assessment.

Montrose - Fife Ness

A long sandy beach stretches south from the mouth of the River North Esk to Montrose. The intertidal fauna here is typical of exposed sediments of the north-east of Scotland, with a low species diversity dominated by amphipods and spionid polychaete worms (AURIS Environmental 1991). In Montrose Basin, the estuary of the River South Esk, there is a rich estuarine fauna, dominated by the small mud snail



Map 4.2.1 Locations of particular marine interest (numbers refer to Table 4.2.1)

Hydrobia ulvae, the amphipod *Corophium volutator*, common cockle *Cerastoderma edule*, Baltic tellin *Macoma balthica* and the small sabellid worms *Manayunkia* spp. and *Fabricia*

Table 4.2.1 Sites of marine interest mentioned in the text

No. on Map 4.2.1	*Location*	*Grid ref.*
1	Montrose Basin	NO6958
2	Easthaven	NO5936
3	Monifieth	NO4932
4	Broughty Ferry	NO4730
5	Seaside to Kingoodie	NO2824 - NO3329
6	Tentsmuir Sands	NO5024
7	Eden Estuary	NO4719
8	West Sands, St. Andrews	NO5018
9	Isle of May	NT6599
10	Elie	NT4899
11	Inchcolm	NT1882
12	Braefoot	NT1783
13	Torry Bay	NT0285
14	Skinflats	NS9384
15	Kinneil	NS9782
16	Carriden Bay	NT0281
17	Blackness Bay	NT0679
18	South Queensferry	NT1278
19	Gosford Bay	NT4478
20	Aberlady Bay	NT4681
21	Gullane Bay	NT4783
22	Bass Rock	NT6087
23	Great Car	NT6185
24	St. Baldred's Cradle, Tyninghame	NT6481
25	Dunbar	NT6779
26	Barns Ness	NT7277
27	off Siccar Point	NT8171
28	Fast Castle	NT8671
29	Souter	NT8770
30	Pettico Wick	NT9069
31	St. Abb's Head	NT9169
32	St. Abb's harbour area	NT9267
33	Eyemouth	NT9464
34	Burnmouth	NT9661

sabella (McLusky & Roddie 1982). There are also extensive mussel *Mytilus edulis* beds present, particularly on banks at the eastern end of the basin and along the main drainage channels (Atkins *et al*. 1992). Dwarf eelgrass *Zostera noltii* and narrow-leaved eelgrass *Z. angustifolia* are found within the basin, although there was a marked decline in the cover of eelgrasses within the basin between 1982 and 1991 (Atkins *et al*. 1992).

To the south of Montrose lies the sandy expanse of Lunan Bay. 26 animal species, fifteen of them crustaceans, occur on the beach, with large numbers of the amphipods *Bathyporeia elegans* and *Haustorius arenarius* and the polychaete worm *Scolelepis squamata* (Eleftheriou & Robertson 1988). Bivalve molluscs are virtually absent. Lunan Bay is bounded on either side by impressive sandstone cliffs, at the base of which are shore platforms (known as 'floors'), dotted with rockpools (Bennett & McLeod in prep.).

The River Tay has the largest freshwater inflow of any British river, with a mean flow rate of 198 m^3/s (Williams & West 1975). This has a strong influence on the character of the Firth of Tay, which can be divided into the relatively marine-influenced outer firth (from Broughty Castle/Tayport to Buddon Ness and Tentsmuir); a middle region, between Invergowrie and Broughty Castle, of varying salinity and also of high effluent inputs of domestic sewage and trade waste; and the more freshwater-influenced inner reaches upstream towards Perth. Saline influences only penetrate the estuary as far as Newburgh, even under low-flow conditions (Williams & West 1975). There are extensive mudflats within the firth as a whole, 90% of which are found on the north shore between Kingoodie and Seaside. The south shores range from bedrock to mud (Buller *et al*. 1971). Bedrock outcrops in the littoral zone at just a few places in the firth, mainly on the south shore. Polychaete and oligochaete worms dominate the mudflats of Monifieth Bay, with the amphipod *Bathyporeia pilosa* dominant in places; in general, species diversity increases lower on the shore (Jones *et al*. 1990). The shores of the outer firth are mainly of clean sand.

The overall distribution of sublittoral flora and fauna within the firth is determined primarily by salinity variation and substrate texture, a large part of the bed of the estuary having little or no infauna due to the instability of the coarse sediments found widely within the firth (Khayrallah & Jones 1975). Mussels form the most prominent populations in the middle and outer estuary, densities reaching 13,000 mussels per m^2, often with large numbers of the common starfish *Asterias rubens*. Small areas of eelgrass *Zostera marina* occur in the outer estuary, at Broughty Ferry (Cleator 1993) and Tayport (Khayrallah & Jones 1975). Near the north shore, at Monifieth, a bed of the sugar kelp *Laminaria saccharina* supports a considerable epifauna (Khayrallah & Jones 1975), and the main shipping channel between Monifieth and Broughty Ferry supports a rich diversity of species (Jones *et al*. 1990). These include large encrusting sponge growths, various scaleworms, the amphipods *Parajassa pelagica* and *Ampithoë rubricata* and the sea spider *Nymphon rubrum*.

The sand spits and bars of the Abertay Sands provide protection from wave action for the extensive sandy shore at Tentsmuir Sands. 35 species were recorded on this beach by Eleftheriou & Robertson (1988), polychaete worms, amphipod crustaceans and bivalve molluscs being dominant. Most of the animals were found around mid tide level and below, at densities reaching nearly 3,000 per m^2 at Mean Low Water Springs. The Eden Estuary to the south of Tentsmuir has a large intertidal area of heavy black mud, with firm sand occurring at the High Water Mark and at the mouth of the estuary (Johnston *et al*. 1979). On the southern shore, high densities of the amphipod *Corophium volutator* were recorded from the Edenside Flat, while in the more saline area of Kincaple Flat cockles and Baltic tellins (both bivalves) are widespread. Small amounts of eelgrass are present on Kincaple Flat only, and large numbers of the small sabellid worm *Fabricia sabella* have been recorded here. On the north side of the estuary, between Coble House Point and Shelly Point, the shores are dominated by fucoid seaweeds. There are mussel beds on the banks of the river channel (Johnston *et al*. 1979).

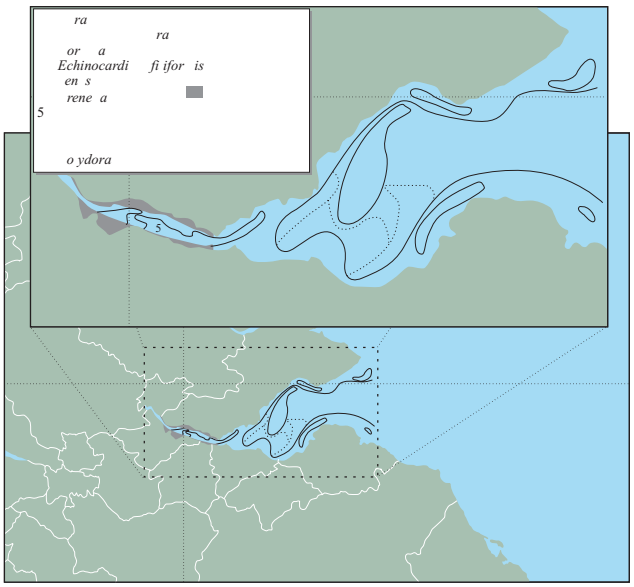
The moderately exposed beach of West Sands runs between the mouth of the Eden Estuary and St. Andrews. Eleftheriou & Robertson (1988) recorded 35 species here, including the polychaete worms *Nephtys cirrosa*, *Spiophanes bombyx* and *Spio filicornis*, the amphipods *Bathyporeia pilosa*, *B. sarsi*, *B. elegans* and *B. guilliamsoniana*, and the bivalves *Tellina* (*Angulus*) *tenuis* and *Donax vittatus*. From St. Andrews eastwards to Fife Ness moderately exposed rocky shores predominate.

The Firth of Forth and Forth Estuary: Fife Ness - Dunbar

The Forth may be considered in three sections, with that from Stirling to Kincardine Bridge as the upper Forth estuary and that between the Kincardine and Forth Bridges as the lower Forth estuary. The outer area, from the Forth Bridges to the seaward limits at Fife Ness and Dunbar, is often considered as the Firth of Forth proper (McLusky 1987). Eight sublittoral faunal associations have been identified within the estuary and firth, their distributions determined predominantly by physical parameters such as salinity, sediment type and bathymetry, on which the effects of urbanisation, industrialisation, dredging and spoil disposal and thermal discharges are superimposed (Elliott & Kingston 1987). Table 4.2.2 shows the sublittoral benthic faunal associations in the Firth of Forth (Map 4.2.2). The richest areas, in terms of numbers of species, are near Inchcolm, at the south of Largo Bay, off Aberlady Bay and off Dunbar.

The coastline of the firth proper is a series of sandy bays and rocky headlands, with some extensive stretches of rocky shores, particularly in the outer parts. In the sandy beach at Gullane Bay, to the north of Aberlady Bay, 46 species of fauna, including 23 crustaceans, seventeen polychaetes and five bivalves have been found. The amphipods *Bathyporeia elegans* and *B. guilliamsoniana* are common, and within the upper beach the polychaetes *Scolelepis squamata* and *Ophelia rathkei* occur in large concentrations (Eleftheriou & Robertson 1988).

On the north coast, from Fife Ness to Elie, shores are predominantly rocky, although clean sand is present in the nearshore sublittoral zone between Fife Ness and Kircaldy. The rocky shores support a variety of algae. Along a 5 km stretch of rocky shore at Elie, there are 136 species of algae, including the kelps *Laminaria digitata*, *L. hyperborea* and *L. saccharina*, the green algae *Enteromorpha intestinalis* and *Cladophora rupestris*, and the red algae *Delesseria sanguinea*, *Membranoptera alata* and *Plumaria elegans* (Wilkinson &



Map 4.2.2 Major sublittoral sediment faunal communities in the Firth of Forth. Source: Elliott & Kingston (1987).

Tittley 1979). In the inner reaches of the firth, the richest shores in terms of algal species are at South Queensferry and Braefoot (Wilkinson *et al*. 1987).

The sublittoral environment of the firth is predominantly sedimentary, apart from the rocky islands of the Isle of May, Inchmickery, Inchkeith and Bass Rock, and shallow areas off the rocky coast at North Berwick. There are several other islands in the firth, of which Cramond Island and Inchcolm are the largest (Bennett & McLeod in prep.). Bass Rock, which lies 5 km north-east of North Berwick, is subject to strong wave action and tidal streams, particularly around its northern tip (Davies 1994). As a result of the wave exposure the splash zone is very extensive, being characterised by black lichens (*Verrucaria* spp.). The green alga *Prasiola stipitata* is common in areas enriched by seabird guano. The mid-shore zone is dominated by mussels and barnacles, with patches of the red algae *Porphyra umbilicalis* and *Callithamnion sepositum* (Davies 1994), while the sublittoral fringe habitats support dense forests of kelp species. Around the island, cliffs extend 15-40 m below chart datum, and dense populations of the soft coral *Alcyonium digitatum* and the anemone *Metridium senile* form a carpet over vertical rock surfaces. At the base of the cliffs, boulders and cobbles support large numbers of brittlestars, together with encrusting bryozoans and the keel worm *Pomatoceros triqueter*. To the north-east of the landing stage a series of submarine gullies with vertical rock faces support a rich variety of solitary and colonial ascidians, sponges and encrusting and erect bryozoans (Davies 1994).

Substrates in the estuary are mainly sedimentary. Sublittoral studies within the estuary have revealed that species diversity increases with salinity, and from shallow to deep water (Elliott 1983). In general, polychaete worms dominate the lower estuary, and oligochaete worms the upper estuary, although certain groups such as tellinid bivalves and spionid polychaetes dominate isolated patches of the estuary bed (see Map 4.2.2). Recent records of the occurrence of eelgrass species within the Forth include Carriden Bay (narrow-leaved eelgrass), Blackness Bay (narrow-leaved and dwarf eelgrass), Gosford Bay (eelgrass) and Belhaven Bay (narrow-leaved and dwarf eelgrass) (Cleator 1993). Low-salinity sites at the head of the estuary are dominated by oligochaetes, but more saline areas are characterised by an impoverished estuarine fauna (McLusky *et al*. 1993). In the lower estuary the mudflats between Carriden and Blackness are dominated by the bivalves Baltic tellin and cockle (McLusky *et al*. 1976), while those at Skinflats, Kinneil and Torry Bay are characterised by the polychaete worm *Manayunkia aesturina*.

From Gin Head, east of North Berwick, to Dunbar the coastline faces north-east and is moderately exposed to wave action. There is a complex mixture of sedimentary

Table 4.2.2 Sublittoral benthic faunal associations present within the Firth of Forth

No. on Map 4.2.2	*Community name*	*Notes & characteristic species*
1	*Abra*	Largest group. The bivalve *Abra nitida* is the characteristic species, with *Abra alba* relatively poorly represented
1a	Impoverished *Abra*	Species-poor version of *Abra* community.
1b	*Corbula* - oligochaetes	Numerically dominated by the bivalve *Corbula gibba* and substantial numbers of oligochaete worms, predominantly *Tubificoides* spp.
2	*Echinocardium - filiformis*	Numerically dominated by the polychaete worm *Pholoe inornata*, with *Echinocardium* represented principally by the heart urchin *E. cordatum*, although *E. flavescens* occasionally recorded. The brittlestar *Amphiura filiformis* also present.
3	*Venus*	Characteristic species include the amphipods *Ampelisca brevicornis*, *Urothoe elegans* and *Ampelisca typica* and the polychaete *Myriochele oculata*. The bivalve *Venus striatula* is an associate species.
4	*Crenella*	Characterised by the bivalves *Crenella decussata*, *Venus ovata* and the amphipod *Metaphoxus fultoni*.
Not shown	*Modiolus*	Horse mussels *Modiolus modiolus* were taken from several stations in the region of the Forth Bridges.
5	Supra-estuarine	Characterised by many marine species, such as the polychaetes *Dodecaceria concharum* and *Neoamphitrite figulus* and the bivalve *Abra alba*, the latter numerically dominant in places.
6	Impoverished supra-estuarine	Similar to above but with very few species and only low numbers.
7	Stressed transition	Confined to fine sediment areas off Kinneil Bay. Fauna extremely impoverished, with the polychaete worms *Nephtys hombergii* and *Eteone longa*.
8	*Polydora* - oligochaete	Found to the west of Kinneil, with the spionid polychaetes *Polydora ligni/ciliata* and *Marenzellaria wireni*, and the oligochaete worms *Tubificoides* spp.

Source: after Elliott & Kingston (1987).

and volcanic rock outcrops, separated by expanses of clean blown sand. The basalt outcrop of Great Car has a mixture of ridges, gullies and flat surfaces, giving rise to a high diversity of communities above low water mark. The extensive rock pools have a rich variety of intertidal organisms characterised by the coralline alga *Corallina officinalis* and the red alga *Mastocarpus stellatus* (Davies 1994). Below low water the steep bedrock extends to only 7 m below chart datum, below which is a level sediment plain where grazing by the sea urchin *Echinus esculentus* and gastropod molluscs limits the growth of the kelp forest, with its lush undergrowth of red algae. Below the kelp, rock surfaces are covered in sand tubes of the polychaete worm *Sabellaria spinulosa* and the solitary ascidian *Ascidiella aspersa* (Davies 1994).

On the northern side of Tyninghame Bay, St. Baldred's Cradle is an outcrop of basalt and Carboniferous limestone, on whose southern side flat rock platforms hold pools with rich assemblages of algal species, including *Corallina officinalis* and green filamentous algae *Cladophora* spp. Narrow-leaved eelgrass has been recorded within the pools on the mid-shore (Davies 1994). On the lower shore of Tyninghame/Belhaven Bay, the clean, medium fine sand is characterised by the polychaete worms *Paraonis fulgens* and *Scolelepis squamata* (Brazier & Murray (1994). Where more stable, muddier sand is present, a more diverse population of polychaetes occurs. The sand continues below low water mark, forming a level plain with few conspicuous species. Infaunal communities are characterised by the tube-building sandmason worm *Lanice conchilega*, razor shells *Ensis* spp. and heart urchins (Davies 1994).

Dunbar to Berwick-upon-Tweed

The section of coast between Dunbar and the English border is predominantly rocky with occasional small sandy bays. For the most part, shores are moderately exposed to wave action, having a northerly or north-easterly aspect, and the complex geology of the area has created a high diversity of intertidal habitats (Davies 1994). For 3 km east of Dunbar, the shores are broad, flat rock platforms, overlain with patches of boulders, which add to the habitat diversity (Davies 1994). Where the rock platforms have been eroded, such as along the stretch of shore from White Sands to Torness, habitat diversity is increased further. On vertical surfaces barnacles and limpets replace fucoid algae as the dominant cover organisms. At Barns Ness the shore has a mix of boulders, cobbles, pebbles and broken bedrock outcrops, and lower shore habitats support a rich assemblage of red algae growing on kelp stipes and adjacent rock surfaces. Rock surfaces are encrusted with keel worms *Pomatoceros triqueter* and encrusting red and brown algae; other conspicuous species include echinoderms - mostly the brittlestar *Ophiothrix fragilis*. Occasional limestone boulders have been extensively bored by piddocks, the boreholes providing a refuge for the brittlestars *Ophiopholis aculeata* and *Ophiactis balli* (Davies 1994).

Approximately 200 m off Siccar Point, at a depth of 14 m, the sea bed is a plain of sand supporting a rich infaunal community with dense populations of razor shells and heart urchins (Davis 1994). Large numbers of the burrowing crab *Corystes cassivelaunus* live on the surface of the sediment. Approximately 4 km offshore, at a depth of 41 m, a level sea bed of muddy gravel with boulders supports large colonies of the soft coral *Alcyonium digitatum* and the large anemones *Urticina eques* and *Bolocera tuediae* (Davies 1994).

The headlands of Fast Castle, Souter and St. Abb's are subject to greater wave exposure than the adjacent coast, with wave surges sending salt spray high up the cliffs. Very dense populations of mussels and barnacles inhabit the mid-shore zone, with a band of the red alga *Mastocarpus stellatus* on the lower shore (Davies 1994). In the sublittoral fringe, wave surge favours the development of a dense forest of the kelp *Alaria esculenta*, with *Laminaria digitata* more common in sheltered areas. At Pettico Wick the cliffs are less steep and the shore comprises a series of bedrock outcrops surrounded by mobile boulders and cobbles. To the west, narrow pools between sandstone ridges support dense algal assemblages. The landward sides of the ridges are more sheltered and support isolated populations of fucoid algae on an otherwise limpet/barnacle-dominated shore (Davies 1994).

Shores in the vicinity of St. Abb's harbour comprise rugged bedrock with many fissures and crevices. To the north of the harbour the shore is sheltered by a series of offshore rock outcrops with well-developed fucoid algal communities on steep and horizontal surfaces (Davies 1994). To the south of the harbour there is no such protection, and upper shore communities are restricted to dense populations of limpets and barnacles with only a few clumps of algae, while on the lower shore a dense turf of the red algae *Laurencia pinnatifida* and *Chondrus crispus* forms a band above the kelp forest. Similar rugged bedrock shores extend south-east from Coldingham Bay to Eyemouth. In the sublittoral, changes in geology, bathymetry and tidal streams have a major influence on community structure: strong tidal streams prevent silt from settling and appear to increase species richness (Davies 1994). For example beneath the canopy of the kelp forest at the base of St. Abb's Head there is a dense assemblage of attached animals, including the colonial ascidians *Diplosoma listerianum* and *Lissoclinum perforatum*, the encrusting bryozoans *Umbonula littoralis* and *Parasmittina trispinosa*, the erect bryozoans *Scrupocellaria scruposa*, *Alcyonidium diaphanum* and *Crisia eburnea*, and the anemone *Sagartia elegans*. Further offshore, at a depth of 25 m, the sea bed comprises a level plain of cobbles and pebbles characterised by hydroids and bryozoans (Davies 1994). Elsewhere, bedrock terraces have large colonies of the soft coral *Alcyonium digitatum* and dense brittlestar populations.

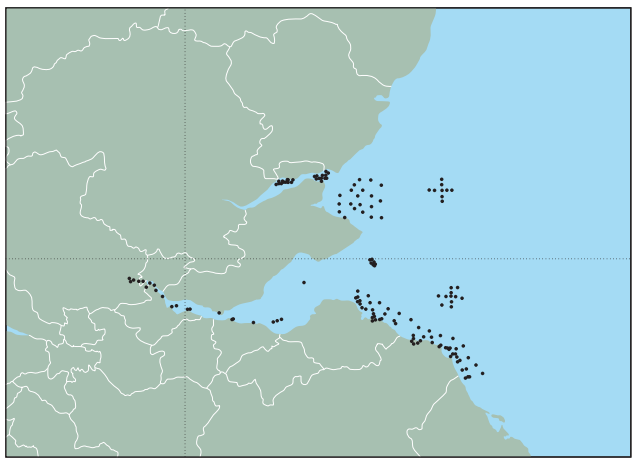
For approximately 3 km to the south of Eyemouth the shores are predominantly vertical, at the base of high cliffs. Further towards Burnmouth the mid-shore is dominated by limpets and barnacles, although where the shore changes to a flat rock platform, fucoids are more apparent. To the north of Berwick there are caves with distinct communities associated with them - encrusting coralline algae, the purse sponge *Grantia compressa* and a red algal turf (mainly of *Plumaria elgans* and *Phyllophora traillii*), which covers vertical walls (Holt 1994). Below low water mark between Eyemouth and Berwick, bedrock gradually gives way to sedimentary plains with mixed cobbles and pebbles. Overall, the biotope diversity here is lower than in surveyed areas further north, although the varied nature of the sea bed results in a high species richness for most habitats (Holt 1994).

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

Far less information is available on benthic habitats and communities from offshore locations, other than that shown on Admiralty charts and British Geological Survey maps. The sublittoral sediments and fauna near Inchcape or Bell Rock, 18 km south-east of Arbroath, have been extensively studied in relation to the disposal of sewage sludge in this area (Hull & Webster 1991). The sediments consist of fine to medium grained sands, and over 300 species have been recorded from the area.

The Isle of May lies 9 km south-east of Crail at the outermost extent of the Firth of Forth. A wide range of wave exposures is found on the predominantly rocky shores. Much of the western side of the island consists of vertical cliffs, which give way to a gradual slope of large boulders at a depth 3 m below chart datum, leading to a cobble and muddy shell gravel plain at 14 m. The eastern side slopes more moderately, with bedrock extending below low water, eventually giving way to a narrow band of boulders at 19 m below chart datum, and then a plain of cobbles or pebbles/shell gravel. The habitats and communities present are not particularly diverse, although they are representative of the biogeographic area (Bennett 1989). Surge caves form an unusual habitat type. Despite the limited range of habitats, the number of littoral species recorded (102) is high (Bennett 1989). Sublittoral communities include kelp forests of *Laminaria hyperborea*, *L. saccharina* and *Saccorhiza polyschides*, bedrock and boulders dominated by the soft coral *Alcyonium digitatum*, communities characterised by the hydroid *Abietinaria abietina*, and brittlestar beds with *Ophiothrix fragilis* and *Ophiocomina nigra*.

Map 4.2.3 Littoral surveys recorded on the MNCR database. Source: JNCC.



Map 4.2.4 Sublittoral surveys recorded on the MNCR database. Source: JNCC.

4.2.3 Human activities

The human activities that affect sea-bed habitats and communities in the region are described in sections 9.1.3 and 9.2.3. Towards the end of the 19th century, Elie, Joppa and Dunbar were considered to be three of the richest localities for algae in the Firth of Forth (Traill 1886, 1888, 1890). Re-survey of these shores (Johnston 1972; Wilkinson & Tittley 1979; Knight & Johnston 1981) revealed that algal diversity at Joppa had fallen dramatically, an effect that was attributed to increased levels of pollution. However, no change in species diversity was found at Elie or Dunbar. Widespread sewage contamination has been reported from Montrose Basin, with increasing nutrient enrichment identified as a potentially serious problem, primarily due to the release of effluent close to the mouth of the estuary on flood tides (Atkins *et al*. 1992). The effects of sewage pollution in the Firth of Tay between Broughty Ferry and Monifieth were investigated by Jones *et al*. (1990), and in Invergowrie Bay by Jones *et al*. (1989). A programme of improving the sewage discharges into the firth around Dundee by collecting the seven major and 40 minor outfalls into several new long outfalls has been underway now for a number of years. Studies relating to sewage pollution within the Firth of Forth are mentioned in section 4.2.4.

In 1984, an artificial reef was constructed 3.4 km south-east of Torness Point, East Lothian, by depositing some 210,000 tonnes of limestone rock onto the natural sea bed substratum (Todd *et al*. 1992) during the construction of the power station (see section 8.4.2). Photographic surveys using a remotely-operated vehicle between 1987 and 1988, and sampling by various methods between 1988 and 1990, indicated that the reef had produced a local enhancement of cod *Gadus morhua* and lobster *Homarus gammarus* populations. Some large invertebrates such as sea urchins *Echinus esculentus*, starfish *Asterias rubens* and encrusting bryozoans had also colonised the reef (Todd *et al*. 1992).

4.2.4 Information sources used

Information on the precise extent of shore and sea bed types in a national context is not yet available. The information used here is predominantly that gathered for the JNCC's Marine Nature Conservation Review (MNCR). The MNCR

Table 4.2.3 Number of surveyed sites in the region recorded on the MNCR database

Littoral	*Near-shore sublittoral*	*Offshore*	*Total*
127	185	20	332

Source: MNCR Field Database 1996. Note: these figures are not comprehensive; additional records exist in sources that were not consulted.

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 (Hiscock 1996). Survey information from other sources may vary considerably in its methodology and coverage. Table 4.2.3 shows the number of sites in the region with marine benthic habitat and species information held on the MNCR database, although this information is not fully comprehensive; Maps 4.2.3 and 4.2.4 show the locations of all littoral and near-shore sublittoral surveys recorded on the JNCC's MNCR database. From 1992 to 1994 the MNCR surveyed littoral and sublittoral sites from North Berwick south to Berwick-upon-Tweed and beyond (Davies 1994; Holt 1994; Brazier & Murray 1994).

The majority of studies in the Firth of Tay have been carried out by the Tay Estuary Research Centre and University of Dundee; other work has been undertaken by the Tay River Purification Board. Much of the published information on the Firth of Tay is contained within volumes covering four symposia held by the Royal Society of Edinburgh (1972, 1975, 1980; McManus 1987). The long-established Gatty Marine Laboratory of St. Andrews University holds records of survey work carried out in the area.

Most marine studies within the estuary and Firth of Forth have taken place since the early 1970s, after the establishment of the Universities of Stirling and Heriot-Watt and the Forth River Purification Board (FRPB), now the East Region of the Scottish Environment Protection Agency (SEPA). This last organisation is engaged in the long-term monitoring of the upper and lower Forth Estuary, with studies involving the monitoring of sediments, macrobenthos, fish and plankton, as well as water quality and oceanographic surveys. Heriot-Watt University's Institute of Offshore Engineering has carried out a number of projects within the firth and elsewhere. Studies within the estuary by Stirling University's Department of Biological and Molecular Sciences are listed in McLusky *et al*. (1991), whilst additional work has been undertaken by Napier University, Edinburgh. A symposium held in 1985 on the natural environment of the estuary and the Firth of Forth brought together available knowledge at the time (McLusky 1987). This has been recently been updated by a conference organised by the Estuarine and Coastal Sciences Association (ECSA). Many investigations in the estuary have been related to pollution, particularly the effect of effluents from point source discharges on the distribution of species, e.g. Anderson *et al*. (1981) or Read (1987). In addition, there have been a number of studies undertaken by university students, e.g. Barnes (1981), Chong (1985) and Cleator (1986). Caldwell (1982) lists algae found within the Kircaldy District, while Norton (1976) lists littoral algae found between North Berwick and Dunbar. Wilkinson *et al*. (1987) mapped and described the algae of the Forth with respect to changing conditions. The fauna of rocky shores in the Firth of Forth, with particular reference to the distribution of Mollusca, is described by Berry & Smith (1987). The sediment shores of the Firth have been described and summarised by Read (1987). A number of monitoring studies, particularly of shores on the southern side of the estuary and firth, have been undertaken on behalf of BP Oil and BP Chemicals, who have industrial complexes at Grangemouth and Bo'ness. Smith *et al*. (1990) provide a list of species recorded from the rocky shore at Easthaven, a popular site for educational field studies. A compilation of marine fauna and flora records of St. Andrews Bay was produced by Laverack & Blackler (1974). Hardy (1993) prepared a checklist of marine algae recorded from the Berwickshire coast, whilst faunal records for the shores of Berwickshire are listed by Hardy & Wheeler (1992).

4.2.5 Acknowledgements

The author acknowledges the considerable help of JNCC's Marine Nature Conservation Review team, particularly Dr Tim Hill and Kate Northen, in compiling and presenting the information given here. The MNCR literature reviews by Teresa Bennett and Colin McLeod (East Scotland: Duncansby Head to Dunbar, in prep.) and by Teresa Bennett and Judy Foster-Smith (South-east Scotland and North-east England: Dunbar to Bridlington, in prep.) have been widely consulted. Thanks are also due to Mark Tasker (JNCC), Tom Leatherland (SEPA), Alan Burdekin (SOAEFD), Karen Passmore and Sandy MacLennan (SNH) and Daniel Owen (RSPB) for comments on the draft.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Marine nature conservation issues in Scotland	*Marine Ecologist, Maritime Unit, Advisory Services, SNH, Edinburgh, tel: 0131 554 9797
MNCR database	*MNCR Team, JNCC, Peterborough, tel: 01733 62626
Offshore benthic studies relating to fisheries	*SOAEFD Marine Laboratory, Aberdeen, tel: 01224 876544
General marine science information	Scottish Association for Marine Science (formerly Scottish Marine Biological Association), Dunstaffnage Marine Laboratory, PO Box 3, Oban, Argyll PA34 4AD, tel: 01631 562244
Shellfish collection (as curios)	Association of Scottish Shellfish Growers, 'Mountview', Ardvasar, Isle of Skye IV45 8RU, tel: 0147 14 324
Benthic information for the Firths of Forth and Tay	*SEPA East Region, Edinburgh, tel: 0131 449 7296

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

4.3 Plankton

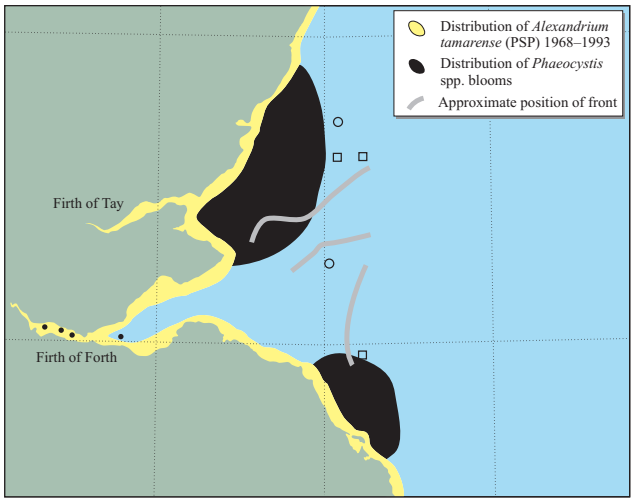
M. Edwards & A.W.G. John

4.3.1 Introduction

Plankton include the bacteria (bacterio-), plant (phyto-) and animal (zoo-) plankton. In temperate continental shelf seas, as in this region, the phytoplankton assemblage is dominated by diatoms and dinoflagellates, and the zooplankton, although containing representatives of most marine animal phyla at some stage, is dominated by crustaceans, principally copepods. The plankton's abundance is strongly influenced by factors such as depth, tidal mixing and temperature stratification, which determine the vertical stability of the water column. The distribution of species, here and elsewhere, is influenced directly by salinity, temperature and water flows into the area (see section 2.3) and by the presence of local benthic (bottom-dwelling) and littoral (shoreline) communities (see also section 2.4). Many of the species of these communities, including commercially important fish and shellfish, have temporary planktonic larval forms (meroplankton). Tidal fronts (boundary zones between stratified and well-mixed water masses) in this region are likely to be of significant biological importance, since they are usually rich in plankton, which attracts other marine life. Phytoplankton blooms (transient, unsustainable growths, usually of a single species and sometimes 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 can be toxic to humans and possibly have an important economic impact on mariculture, fisheries and tourism. However, coastal phytoplankton blooms in south-east Scotland usually consist of less than five dominant species and only rarely of a single species.

Section 2.3 describes the physical environment of the coastal waters of Region 4. There is generally a southerly residual tidal flow down the east coast of Scotland and, where tidal mixing is weakest in summer (e.g. the Firth of Forth), vertical thermal stratification develops. Apart from the Firth of Forth and deeper areas of the North Sea, much of the coastline is dominated by transitional waters containing a number of frontal features (Map 4.3.1).

Owens *et al.* (1990) found high levels of phytoplankton production in the outer Firth of Forth/Tay area in July 1987, possibly due to riverine nutrient input. However, estimated annual primary production for British coastal regions is low (75-79 g C m^{-2} y^{-1}) compared with the central North Sea (100-119 g C m^{-2} y^{-1}) and along the continental coast (199-261 g C m^{-2} y^{-1}) (Joint & Pomroy 1992). Krause & Martens (1990) sampled parts of this region in spring 1986 and winter 1987, finding zooplankton biomass in winter of <10 mg C m^{-3} and in spring of >100 mg C m^{-3}. These figures are reasonably high compared with other parts of the North Sea. Figure 4.3.1 shows the seasonal cycles of phytoplankton production for Region 4, based on a visual estimate of chlorophyll and numbers of copepods per sample. Time series data from the Continuous Plankton Recorder (CPR) survey indicate a general decline in the abundance of phyto- and zooplankton in the region from



Map 4.3.1 Locations of surveys and approximate position of fronts. See Table 4.3.1 for explanation of symbols. Source: SAHFOS and Oslo & Paris Commissions (1992).

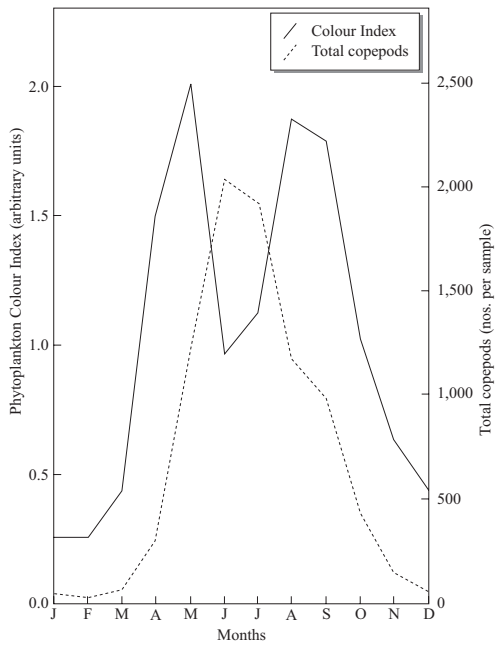


Figure 4.3.1 Average seasonal cycles of an index of phytoplankton colour (a visual estimate of chlorophyll) and of the numbers of copepods per sample (approximately 3 m^3 of water filtered) derived from Continuous Plankton Recorder (CPR) data for 1958-1992. Source: SAHFOS.

1960-1980, similar to that in other shelf waters. After this initial decline, a substantial recovery to average levels occurred through the 1980s, but levels of abundance are decreasing again in the 1990s.

In Region 4, as elsewhere, the plankton has a fundamental role in the food chain of both benthic (sea-bed) and pelagic (water column) wildlife. For both ecosystems, the availability of food and nutrients, larval survival, maintaining populations, and timing of egg production are highly dependent on the amount of phyto/zooplankton

available. Any environmental stress imposed on the plankton will have consequences throughout the food chain and may affect the amount of food available to fish, birds, marine mammals etc. In coastal management, plankton can give early warnings of adverse human impacts (e.g. the effects of eutrophication) and highlight different water masses.

4.3.2 Important locations and species

Evidence from the CPR survey suggests that the phytoplankton assemblage found in this region is fairly typical for north British coastal waters. The spring increase of phytoplankton (mainly diatoms) begins in March and peaks between April and May. The spring bloom is followed by a decline to steady levels in June, with another peak in September, followed by a decline to low winter levels. Diatoms predominate in inshore mixed waters, while dinoflagellates are often more abundant in stratified offshore areas, particularly in summer/autumn (Adams 1987). Although the zooplankton of this region are mainly made up of neritic (coastal water) and intermediate (mixed-water) species, the inflow of Atlantic water down the western edge of the North Sea in late summer/autumn may introduce oceanic species such as the herbivorous salp *Salpa fusiformis* (Fraser 1962). Apart from the Forth Estuary, where estuarine copepods predominate (e.g. *Acartia longiremis* (Taylor 1993)), the main components of the zooplankton appear to be small neritic and intermediate copepods such as *Pseudocalanus elongatus* and *Temora longicornis*. Further offshore, the larger copepod *Calanus finmarchicus* can be very abundant at times. The zooplankton of the Firth of Forth are critical to the survival of certain commercially important fish species, for this Firth is a nursery area for juvenile herring (many of which originate from the spawning grounds of the north and west of Scotland) and an overwintering ground for sprat (Elliott *et al*. 1990).

4.3.3 Human activities

Dinoflagellates are of particular importance to the coastal manager in this region because a number of toxic blooms have occurred, resulting in Paralytic Shellfish Poisoning (PSP). PSP occurs in shellfish and is attributed to the dinoflagellate *Alexandrium tamarense*, which has occurred quite regularly in this region since 1968 (Map 4.3.1).

Studies in the Firth of Forth have identified this area as a possible source for cysts (the resting stages) of *A. tamarense* (Joint & Aiken 1994)); large numbers of cysts in sediments may have the potential to seed a toxic bloom. Not only is this dinoflagellate a hazard to public health and economically detrimental to the shellfish industry, but it has also been associated with mass mortalities of seabirds and sandeels in north-east England (Ayres & Cullum 1978). *Phaeocystis* blooms (10^4-10^7 cells/l) have also occurred in this region (Oslo & Paris Commissions 1992). Such blooms 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.

4.3.4 Information sources used

Surveys in this area (Table 4.3.1) have mainly concentrated on the estimation of chlorophyll *a* and zooplankton standing crop in relation to other parts of the North Sea (Krause & Martens 1990; Adams *et al.* 1976; Owens *et al*. 1990). For a more detailed review of zooplankton, including species composition in the Forth Estuary, see Taylor (1993). The CPR surveys in this region are important because they contain long-term plankton data, which can be used to assess the effects of environmental variability and climatic changes on the marine biota.

4.3.5 Acknowledgements

Thanks are due to Tom Leatherland and Richard Park (SEPA) and Steve Hay and Elspeth Macdonald (SOAEFD) for comments on the draft.

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Table 4.3.1 Details of surveys

Identification on Map 4.3.1	*Frequency*	*Period*	*Reference*
CPR: 'LR' route	Monthly	1959-1978, 1984 to present	Warner & Hays 1994
PS (□)	Occasional	1986 & 1987	Krause & Martens 1990
PS (●)	Monthly	1980-1981	Taylor 1993
PS (○)	Occasional	1987	Owens *et al.* 1990
Forth (sampled by MLA)	Occasional	1974	Adams *et al.* 1976
Forth (sampled by LRPB)	Occasional	1967-1972	Taylor 1983
Forth (sampled by SOAFD)	Occasional	1975-1976	Taylor 1983
Upper Forth Estuary	Occasional	1980 & 1982	Roddie *et al.* 1984
Forth (sampled by FRPB)	Seasonal	1991 to present	Park 1996

Key: CPR: Continuous Plankton Recorder; PS: Plankton samples; MLA: Marine Laboratory Aberdeen; LRPB: Lothians River Purification Board; SOAFD: Scottish Office Agriculture & Fisheries Department (now SOAEFD - Scottish Office Agriculture, Environment & Fisheries Department); FRPB: Forth River Purification Board (now SEPA - Scottish Environment Protection Agency).

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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 633130
Firth of Forth plankton	*SEPA, East Region, Edinburgh, tel: 0131 449 7296
Plankton research	Director, University of St. Andrews Gatty Marine Laboratory, East Sands, St. Andrews, Fife, KY16 8LB, tel: 01334 76161
Plankton research	*Director, SOAEFD, Marine Laboratory, Aberdeen, tel: 01224 876544
Plankton in Scottish waters	Head of Department, University of Stirling, Department of Biological and Molecular Science, Stirling FK9 4LA, tel: 01786 73171

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

The craggy mass of Bass Rock, lying just offshore where the Firth of Forth meets the open sea, is almost entirely covered in nesting seabirds, for which it is a Site of Special Scientific Interest (SSSI). A staggering 40,000 pairs of gannets - 15% of the world total - breed here, ranging for food up to 120 km away, unusually far for this species. In addition, grey seals haul out on the rock and are thought to raise pups there. The rock itself is the remnant of an ancient extinct volcano, as are all the other islands in the Firth. Photo: MNCR, JNCC.

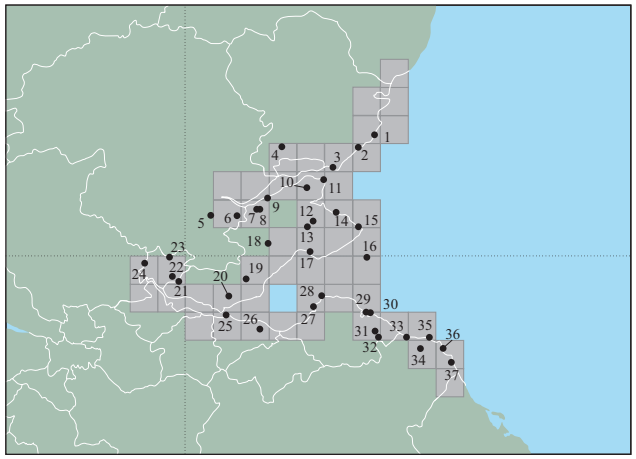
Chapter 5 Important species

5.1 Terrestrial lower plants

N.G. Hodgetts

5.1.1 Introduction

This section covers lichens, bryophytes (mosses and liverworts), freshwater stoneworts (a group of algae; brackish-water species are covered in section 5.4) and fungi occurring in the coastal 10 km squares of the region. About 43% of the British bryophyte flora and about 21% of the stonewort flora occur in the region; corresponding figures are not available for other groups. The lower plant flora is determined by the character of the coast, much of which has open and relatively exposed habitats with extensive cliffs and dunes but little woodland. The dunes (including those with large conifer plantations), cliffs, cliff-top grassland, heath and rocky shores of the region are particularly favoured by lower plants.



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

5.1.2 Important locations and species

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

Dune systems are important for bryophytes, lichens and fungi; some bryophytes and many fungi are dune specialists. As in other regions, wet dune slacks are particularly rich, but the dry dunes of this region and those of Region 3 to the north are also of national significance for their lower plants. Many fungi are mycorrhizal with (i.e. dependent on a close association with the roots systems of) higher plants, with willow *Salix* spp. and marram *Ammophila arenaria* apparently being important associates. Temporarily water-filled dune hollows and calcareous lochs in dune systems support stonewort communities.

Some of the extensive rocky coasts in the region are likely to be rich in lichens, but little survey work has taken place. Many important and potentially-important coastal lichen sites have been identified in recent surveys (Fletcher 1984; James & Wolseley 1991), but few of these sites have been comprehensively surveyed. For example, it is likely that there are areas of lichen interest within the large East Wemyss - Anstruther Coast and Barns Ness Coast SSSIs. On rocky coasts, areas of exposed rock between the high water mark and the cliff-top are very important for lichens. The species composition varies according to the rock type, and some lichens are distinctive components of the vegetation in cliff bird roosts, which are enriched by bird droppings.

Coastal (usually cliff-top) grassland and heath with thin turf can be rich in bryophytes and lichens, which often form complex mosaics. Calcareous grassland is usually richer in species than neutral or acidic grassland. Unstable areas provide bare ground for colonisation by some of the uncommon ephemeral lower plants of this habitat. Exposed rocks here often support southern, warmth-loving species of bryophyte. Volcanic rocks, such as those exposed on Arthur's Seat, can be particularly rich in bryophytes and lichens. Other notable lower plant habitats in the region include small bogs and flushes and extensive areas of heathland, where bryophytes, particularly *Sphagnum* spp., are often dominant or co-dominant and some specialist fungi occur. Many of these sites contain areas of mesotrophic mire or fen and support a varied lower plant flora.

Woodland is not a major resource in the region, but there are a few woodlands of some importance for lower plants, notably in the deeply incised cleughs (steep valleys) of the north-eastern Lammermuir Hills and the coastal valleys of East Lothian and the Scottish Borders.

The region contains a number of threatened species, one of which, the lichen *Caloplaca luteoalba*, is protected under the Wildlife & Countryside Act 1981. Table 5.1.2 lists the Red Data Book (RDB - i.e. nationally rare) species found in the region (out of a total of 139 bryophytes, eleven stoneworts and 177 lichens on the British Red Lists), excluding extinct species. In addition, the region contains 48 out of 375 near-threatened and nationally scarce bryophytes and one of the ten nationally scarce stoneworts (figures for nationally scarce species are provisional). There are also records of the moss *Drepanocladus vernicosus* from several dune slacks in the region. This species is included

Table 5.1.1 Lower plant sites in coastal 10 km squares

Site no. on Map 5.1.1	*Site name*	*Grid ref.*	*Protected status*
1	Whiting Ness to Ethie Haven	NO6843	SSSI
2	Elliot Links	NO6239	SSSI
3	Barry Links	NO5331	SSSI
4	Auchterhouse Hill (part)	NO3539	SSSI
5	Pitkeathly Mires	NO1014	SSSI
6	Torflundie Mire	NO1914	SSSI
7	Lindores Loch	NO2616	SSSI
8	Dunbog Bog	NO2716	SSSI
9	North Fife Heaths	NO3020	SSSI
10	Pickletillem Marsh	NO4424	SSSI
11	Tayport-Tentsmuir Coast	NO5027	SSSI, part NNR
12	Cassindonald Moss	NO4612	SSSI
13	Bankhead Moss	NO4410	SSSI
14	St. Andrews - Craig Hartle	NO5415	SSSI
15	Fife Ness Coast	NO6210	SSSI
16	Isle of May	NT6599	NNR
17	Dumbarnie Links	NO4501	SSSI
18	Star Moss	NO3004	SSSI
19	Camilla Loch	NT2291	SSSI
20	Otterston Loch	NT1685	SSSI
21	Lockshaw Mosses	NS9890	SSSI
22	Craigmad Wood	NS9692	SSSI
23	Dollar Glen	NS9599	SSSI
24	Craig Leith & Myreton Hills	NS8697	SSSI
25	Dalmeny House & Park	NT1578	Not protected
26	Arthur's Seat Volcano	NT2773	SSSI
27	Aberlady Bay	NT4681	SSSI, part LNR
28	Gullane - Broad Sands	NT4985	SSSI
29	Tyninghame Shore	NT6579	SSSI
30	Dunbar Coast	NT6679	SSSI
31	Woodhall Dean	NT6872	SSSI
32	Lammermuir Deans (part)	NT6970	SSSI
33	Pease Bridge Glen	NT7970	SSSI
34	Drone Moss	NT8466	SSSI
35	St. Abb's Head - Fast Castle	NT8770	SSSI, part NNR
36	Coldingham Bay/Yellow Craig	NT9266	Not protected
37	Burnmouth Coast	NT9561	SSSI

Sources: references listed in section 5.1.6 and JNCC's protected sites database. Key: SSSI = Site of Special Scientific Interest; NNR = National Nature Reserve; LNR = Local Nature Reserve.

on Schedule 8 of the Wildlife & Countryside Act and is listed for protection under the EC Habitats & Species Directive. However, recent work has shown that records refer to two species, and further work is necessary before the presence of *D. vernicosus* in Region 4 can be confirmed. There is currently not enough information to provide even provisional regional lists of nationally scarce lichens and fungi.

5.1.3 Human activities

Current issues that may have a bearing on the lower plant flora of the region include road and industrial construction programmes, house building, forestry and holiday and leisure developments. Areas of natural importance may be

Table 5.1.2 Red Data Book lower plants

Species	*Locations/habitat*
Liverworts	
Riccia canaliculata	Near Dumyat & Menstrie, Ochil Hills, West Perthshire
Mosses	
Bryum calophyllum	Barrie Links, Angus; Aberlady Bay, E. Lothian; Tayport - Tentsmuir Coast, Fife
Bryum knowltonii	Barry Links, Angus
Bryum marratii	Barry Links, Angus
Bryum warneum	Barry Links, Angus; Aberlady Bay, E. Lothian; Tayport - Tentsmuir Coast, Fife
Lichens	
Caloplaca luteoalba[a]	Near Lunan Bay, Angus; Auchterhouse Hill, Dundee
Peltigera malacea	Tayport - Tentsmuir Coast, Fife

Source: JNCC. Key: [a]protected under Schedule 8 of the Wildlife & Countryside Act.

under particularly intense pressure in and around the densely-populated city of Edinburgh. Construction of golf courses can be an issue with regard to dune systems and areas of grassland.

Many sites in the region are National Nature Reserves (NNRs) or SSSIs and therefore nature conservation is taken into account in their management. Overgrazing by sheep and deer on moorlands and in woodlands has an effect on lower plant communities in the long term, often causing the replacement of heather with grass communities on the moorland, and the prevention of tree regeneration in woodland. Any insensitive burning of bog and moorland sites is damaging to lower plant communities.

5.1.4 Information sources used

Data for bryophytes and the larger lichens are generally quite good, at least locally (e.g. on the larger dune systems and in close proximity to Edinburgh), but much of the region is under-recorded, particularly outside SSSIs. Data for fungi, algae and the smaller lichens are less complete.

The computerised database at the Biological Records Centre (BRC), Monks Wood, and the Red Data Book database at JNCC include recent records collected over decades by expert bryologists, as well as important historical records. Some important, or potentially important, coastal lichen sites have been identified in recent surveys (Fletcher 1984; James & Wolseley 1991), but as relatively few have been comprehensively surveyed, there may be more than are shown in Table 5.1.1. Data collation for fungi is still at a relatively early stage: all British Mycological Society foray data are currently being put onto a computer database at the International Mycological Institute, under a JNCC contract. Computerised stonewort data are held at BRC and JNCC. More information on freshwater algae may be available from the Freshwater Biological Association.

5.1.5 Acknowledgements

Thanks are due to Allan Brown (Fife Council), Alan Burdekin (SOAEFD), Dr C.J. Legg (Institute of Ecology and

Resource Management, University of Edinburgh) and Kathy Duncan (SNH) for their comments on the draft.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Lower plant sites and species information: Angus, Dundee, Perth & Kinross	*SNH Area Office, Perth, tel: 01738 639746
Lower plant sites and species information: Fife, Clackmannanshire, Stirling, Falkirk	*SNH Area Office, Stirling, tel: 01786 450362
Lower plant sites and species information: West Lothian, Edinburgh, Midlothian, East Lothian, Scottish Borders	*SNH Area Office, Galashiels, tel: 01896 756652
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, Natural History Museum, Cromwell Road, London SW7 5BD, tel: 0171 938 9123
Lichens (woodland and general: British Lichen Society database)	Dr A. Fletcher, Leicestershire Ecology Centre, Holly Hayes, 216 Birstall Road, Birstall, Leicester LE4 4DG, tel: 0116 267 1950
Lichens (general, survey etc.)	A. Fryday, 110 Eastbourne Road, Darlington, County Durham DL1 4ER, tel: 01325 484595
Fungi (general and sand dune)	M. Rotheroe, Conservation Officer, British Mycological Society, Fern Cottage, Falcondale, Lampeter, Dyfed SA48 7RX, tel: 01570 422041
Fungi (general Scottish)	Dr R. Watling, Royal Botanic Garden, 20a Inverleith Row, Edinburgh EH3 5LR, tel: 0131 552 7171

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
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: 01487 773381
Bryophytes (British Bryological Society herbarium)	A.R. Perry, Department of Botany, National Museum of Wales, Cathays Park, Cardiff CF1 3NP, tel: 01222 397951
Bryophytes (general, Scottish)	D.G. Long, Royal Botanic Garden, 20a Inverleith Row, Edinburgh EH3 5LR, tel: 0131 552 7171
Bryophytes (Scottish, lowland)	A.B.G. Averis, 2 Traprain Cottages, Traprain, Haddington, East Lothian EH41 4PY, tel: 01620 860029
Bryophytes (Scottish, upland)	G.P. Rothero, Stronlonag, Glenmassan, Dunoon, Argyll PA23 8RA, tel: 01369 706281
Fife Biological Records Centre	*Fife Nature, Department of Economic Development & Planning, Fife Council, Glenrothes, tel: 01592 414141 ext. 3793
Lower plants (species status; Red Data Book Database; site register etc.)	*N.G. Hodgetts, JNCC, Peterborough, tel: 01733 62626
Freshwater algae	Freshwater Biological Association, The Ferry House, Far Sawrey, Ambleside LA22 0LP, tel: 015394 42468

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

5.2 Flowering plants and ferns

V.M. Morgan

5.2.1 Introduction

This section describes the importance of the region for vascular plants (i.e. flowering plants and ferns), particularly species that are rare or scarce in Great Britain, occurring in the coastal 10 km squares of the region. Rare and scarce species grow in a wide range of habitats, but of particular importance in this region are dunes, saltmarshes and lime-rich habitats. The region is not rich in rare or scarce species and has no 'classic' British botanical localities. However, the rural parts of the region contain large areas of semi-natural vegetation, which, while not notable for rare species, include habitats with good diversity of species, for example long stretches of the Scottish Borders coast (Braithwaite & Long 1990). As a result of the long industrial history of parts of the region there are a number of unusual human-influenced habitats, including those associated with the bings (spoilheaps) left by the coal and oil-shale industries. The numbers of rare and scarce species in the region are shown in Table 5.2.1.

Two of the 317 nationally rare 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 species (i.e. known from 16 to 100 ten km squares) in Great Britain, 31 occur in the region. One species present is among the 107 listed on Schedule 8 of the Wildife and Countryside Act (1981). No internationally protected plant species are known in the region.

5.2.2 Important locations and species

Nationally rare species in the region are listed in Table 5.2.2. Key localities for rare species and/or four or more scarce species are listed in Table 5.2.3 and shown on Map 5.2.1.

A number of different elements, defined by Matthews (1955), are found in the flora. There are few continental or southern continental species in the region; examples are white ramping-fumitory *Fumaria capreolata*, knotted hedge-parsley *Torilis nodosa* and wild liquorice *Astragalus glycyphyllos*. There are even relatively few oceanic southern or western European taxa, such as hard grass *Parapholis strigosa* and hemlock water-dropwort *Oenanthe crocata*. Northern species are better represented: they include continental plants such as coral-root *Corallorhiza trifida*, slender-leaved pondweed *Potamogeton filiformis* and purple milk vetch *Astragalus danicus*, montane species such as creeping lady's tresses *Goodyera repens* and chickweed wintergreen *Trientalis europaea*, and oceanic plants including seaside centaury *Centaurium littorale*, Baltic rush *Juncus balticus* and sea pea *Lathyrus japonicus*. Despite the northern element in the flora, there are few representatives of the arctic/subarctic plants that characterise most other Scottish regions, although Scots lovage *Ligusticum scoticum* and oyster plant *Mertensia maritima* both grow in the region.

The region includes the northern British limit of a number of species, including Nottingham catchfly *Silene nutans*, clustered bellflower *Campanula glomerata* and the rare greater yellow-rattle *Rhinanthus angustifolius*, growing hundreds of miles north of the nearest known other population, in Lincolnshire. A small number of species are at or near the southern limit of their distribution; these include Baltic rush *Juncus balticus* and northern knotgrass *Polygonum boreale*.

One species of note in the region is the rare Welsh groundsel *Senecio cambrensis*, which arose from a hybrid between the native groundsel *S. vulgaris* and the alien Oxford ragwort *S. squalidus*. It is thought that the populations in Edinburgh originated separately from the larger populations in Wales (Ingram & Noltie 1995), but it has not been seen recently and may now be extinct. If still surviving, it is one of only a few endemic (i.e. confined to Great Britain) species occurring in the region, another being Scottish scurvygrass *Cochlearia scotica*, whose taxonomic status is uncertain. There are also a large number of other

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

Table 5.2.1 Number of rare and scarce coastal species in the region

	Protected species	*Other Red Data Book species*	*Scarce species*
Angus	1	0	8
City of Dundee	0	0	7
Perth & Kinross	0	0	4
Fife	0	0	19
Clackmannanshire	0	0	7
Stirling	0	0	1
Falkirk	0	0	5
West Lothian	0	0	2
City of Edinburgh	0	1	7
East Lothian	0	0	7
Scottish Borders	0	0	7
Region 4	***1***	***1***	***31***

Sources: JNCC rare plants database; Stewart *et al.* (1994); BRC database. Note: excludes known introductions, and records from before 1970.

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

Species	Recorded occurrence in: total no. of 10 km squares in GB	no. of coastal 10 km squares in region	no. of sites in region (approx.)	Key localities	Habitat
Greater yellow rattle *Rhinanthus angustifolius**	7	1	1	Firth of Tay area	Tall grassland
Welsh groundsel *Senecio cambrensis*	11	1	1	Edinburgh docks	Waste ground

Source: JNCC rare plants database. Key: *listed on schedule 8 of the Wildlife & Countryside Act 1981. Numbers of 10 km squares = those recorded in GB since 1970, excluding known extinctions. Note: sticky catchfly *Lychnis viscaria* is known from four areas, in Edinburgh and the upper Firth of Tay. Although growing in 'coastal' grid squares, the species is not maritime and is, at most, only indirectly affected by its proximity to the sea. It has therefore been excluded from this chapter.

Table 5.2.3 Key localities for rare and scarce plants

Locality	Species	Habitats	Status
Montrose area	Red Data Book species: none Scarce species: coral-root *Corallorhiza trifida*, curved sedge *Carex maritima*, maiden pink *Dianthus deltoides*, Nottingham catchfly *Silene nutans*, rush-leaved fescue *Festuca juncifolia,* wild cabbage *Brassica oleracea* subsp. *oleracea*	Estuarine basin, mudflats, saltmarsh, base-rich grassland	Part SSSI, part undesignated
Firth of Tay area	Red Data Book species: greater yellow rattle *Rhinanthus angustifolius* Scarce species: Baltic rush *Juncus balticus*, coral-root, creeping lady's tresses *Goodyera repens*, curved sedge, maiden pink, mudwort *Limosella aquatica*, rush-leaved fescue, sea pea *Lathyrus japonicus,* seaside centaury *Centaurium littorale*	Dunes	Part NNR, part SSSI, part undesignated
Edinburgh Docks	Red Data Book species: Welsh groundsel *Senecio cambrensis* Scarce species: none	Urban, industrial	Undesignated
Aberlady Bay to Broad Sands	Red Data Book species: none Scarce species: fen pondweed *Potamogeton coloratus*, maiden pink, rush-leaved fescue, variegated horsetail *Equisetum variegatum*	Dunes, saltmarsh, mudflats, limestone	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.

alien species recorded in the region, a legacy of its long industrial history, which created a number of highly specialised habitats such as spoil tips.

5.2.3 Human activities

Activities that restrict the distribution of species and habitats in the region include industrial and urban development, as for example in Angus (Ingram & Noltie 1981), West Lothian (Muscott 1989) and Edinburgh (Silverside & Jackson 1988); recreation in Berwickshire (Braithwaite & Long 1990); and the construction of sea defences in Falkirk (Stewart 1988). Modern agriculture has affected other habitats and species, through drainage (McKean 1988) and the use of pesticides and fertilisers (Ingram 1981). Successional changes to the vegetation type following a cessation of management have adversely affected some sites (Dargie 1994; Braithwaite pers. comm.); and over-stabilisation and conifer planting have altered some dune systems (C. Sydes pers. comm.).

5.2.4 Information sources

A number of the species and sites have been surveyed by Scottish Natural Heritage, who monitor species and the condition and management of protected sites. Records of nationally rare species are held in JNCC's Rare Plants database. Members of the Botanical Society of the British Isles (BSBI) have recently finished collecting up-to-date records of scarce species; these data are held at the Biological Records Centre and have been summarised in *Scarce plants in Britain* (Stewart *et al.* 1994).

5.2.5 Authors and acknowledgements

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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, data on rare and scarce species, rare plant surveys, licensing and protected species: Angus, Dundee, Perth & Kinross	*SNH Area Office, Perth, tel: 01738 639746
Species on SSSIs and NNRs, other protected areas, data on rare and scarce species, rare plant surveys, licensing and protected species: Fife, Clackmannanshire, Stirling, Falkirk	*SNH Area Office, Stirling, tel: 01786 450362
Species on SSSIs and NNRs, other protected areas, data on rare and scarce species, rare plant surveys, licensing and protected species: West Lothian, Edinburgh, Midlothian, East Lothian, Scottish Borders	*SNH Area Office, Galashiels, tel: 01896 756652
Angus, Dundee, Perth & Kinross and parts of North East Fife Biological Records Centre and Herbarium	Keeper of Natural History, Dundee Museums & Art Galleries, Albert Square, Dundee DD1 1DA, tel: 01382 432069
Fife Biological Records Centre and Herbarium	*Fife Nature, Department of Economic Development & Planning, Fife Council, Glenrothes, tel: 01592 414141 ext. 3793
Stirling Biological Records Centre and Herbarium	Collections Manager, Central Region Records Centre, Smith Art Gallery & Museum, Dumbarton Road, Stirling FK8 2RQ, tel: 01786 471917
Falkirk Biological Records Centre and Herbarium	Principal Officer (Museums), Falkirk Museums, Callendar House, Callendar Park, Falkirk FK1 1YR, tel: 01324 612134
Berwickshire Biological Records Centre and Herbarium	Natural Sciences Officer, Scottish Borders Records Centre, Hawick Museum, Wilton Lodge Park, Hawick, Scottish Borders TD9 7JL, tel: 01450 373457
Lothian region and parts of Falkirk Biological Records Centre and Herbarium	Wildlife Insite (Lothian Biological Records Centre), Records Centre Co-ordinator, Beechmount House, 102 Costorphine Road, Edinburgh EH12 6TZ, tel: 0131 313 4143
Local BSBI vice-county recorders' records	c/o Dr P. Macpherson, Hon. Secretary, Scotland Committee, Botanical Society of the British Isles, 15 Lubnaig Road, Glasgow G43 2RY, tel: 0141 623 0723

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

5.3 Land and freshwater invertebrates

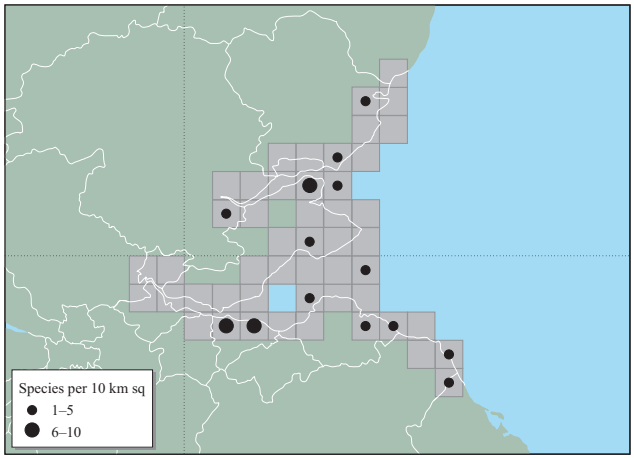
A.P.Foster & M.S.Parsons

5.3.1 Introduction

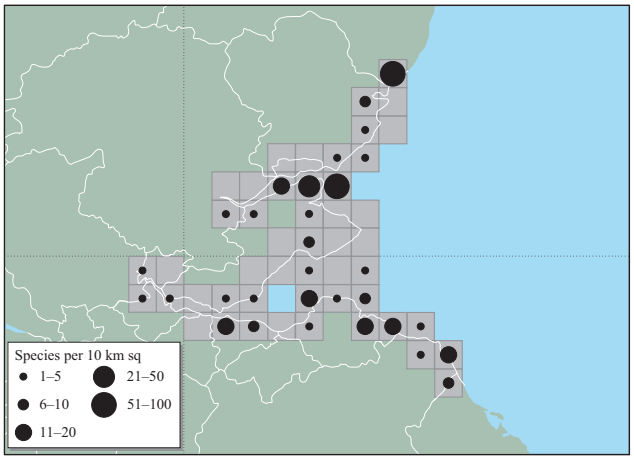
There are over 28,000 species in the better known invertebrate groups in Great Britain (Kirby 1992). This section deals with most insect orders (although not all families), together with a range of non-insect invertebrates, known from sites within the coastal 10 km squares in the region. Lagoonal species are covered in section 5.4.

The region contains sites of major importance for the conservation of invertebrates. Assemblages of species associated with dunes, saltmarsh, coastal grasslands and rocky habitats are well represented in this region. In addition, wetlands such as flushes, boggy moorlands and lochs, with their associated habitats, are home to many scarce species. A few woodland habitats are important for their invertebrate assemblages. Among the most threatened coastal species recorded is the spider *Dictyna major*, which has been reported from Aberlady Bay (although not in recent years) and is extremely scarce in the British Isles. Most scarce invertebrates have exacting habitat requirements in one or more stages of their life histories and many are recorded from only a few localities. Even within individual sites, some taxa are restricted to particular habitats. On dune systems, for example, the fauna of embryo dunes is very different from that of the slacks, with certain scarce species restricted to one or other situation.

The region is known to be nationally important for the conservation of only relatively few invertebrate species. Of the 358 Red Data Book (RDB - nationally rare) and 455 nationally scarce species listed by Kirby (1994a, b) as known to be associated with coastal habitats, ten RDB and 45 nationally scarce species have been recorded from this region. However, some of the scarcest species have not been reported for many years. Many other species of equivalent rank, but not covered by Kirby, also occur. These include, for example, species associated with freshwater wetlands located in the vicinity of the coast. No invertebrates recorded recently from the region are listed on international directives or conventions or the Wildlife & Countryside Act 1981. However, there are 19th century records from a single locality for marsh fritillary butterfly *Eurodryas aurinia* (listed on the Bern Convention).



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: Invertebrate Site Register, Biological Records Centre, ITE Monks Wood.



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: Invertebrate Site Register, Biological Records Centre, ITE Monks Wood.

5.3.2 Important locations and species

The Invertebrate Site Register (ISR) has records from over 90 sites within the region, although a few of these are subsites of much larger statutory nature conservation areas. Nationally rare and scarce species have been recorded at many of the ISR sites. Map 5.3.1 shows the number of RDB species (including Kirby's 'coastal' species and others) and Map 5.3.2 shows the number of nationally scarce species recorded from within 10 km squares in the region. Note that survey effort is not consistent throughout the region, so actual occurrence may differ from recorded distribution. RDB species recorded recently (post-1970) in the region are listed in Table 5.3.1, and Table 5.3.2 lists those sites considered to be of major importance for conservation of invertebrates. Site selection was based on the range and/or scarcity of species present, the species/habitat associations and the amount of available habitat. Many of these sites are either National Nature Reserves (NNR) or Sites of Special Scientific Interest (SSSIs), and other currently under-recorded sites may warrant similar designation on the basis of their invertebrate interest.

The dune systems in the region harbour a wide range of scarce taxa, with Elliot Links and Tentsmuir among the better recorded localities. Among the most threatened species recorded within the region in recent years are the beetles *Trichohydnobius suturalis* and *Arena tabida* and the therevid fly *Dialineura anilis*, each associated with sandy habitats. Many other scarce species are known from the

Table 5.3.1 Coastal RDB invertebrates in Region 4 (post-1970 records)

Species	*Notes*
RDB3	
Limonia (Dicranomyia) goritiensis	A cranefly found on seepages on coastal cliffs and rock faces. Larvae probably develop in damp soil or moss beside such seepages. Widely scattered but very local. Found mainly in the north and west of Britain, but localities very dispersed. Burnmouth Coast SSSI.
pRDB3	
Dialineura anilis	A stiletto fly associated with sand dunes. Larvae probably develop in damp sand at the base of vegetation. Mainly noted from the Welsh coast and the west coast of Scotland; also known from Somerset and Lancashire. Barry Links.
pRDBK	
Arena tabida	Very rare rove beetle associated with sandy habitats on the coast. Only recorded recently from Wales and Scotland. Kinshaldy Coast (Tentsmuir) and Earlshall Muir SSSI.
Bledius erraticus	Small red and black beetle living in burrows in sandy banks at the side of streams. Northern species. Very rare. Aberlady Bay.
Omalium rugulipenne	A rove beetle, found under dead seaweed. Local in England; also known from Scotland but probably rarer in the north of its range. Tentsmuir Point and Dumbarnie Links SSSI.
Trichohydnobius suturalis	A small beetle with larvae probably associated with subterranean fungi. Tayport - Tentsmuir Coast SSSI.

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

region's dunes, including bugs such as *Systellonotus triguttatus*, beetles, for example *Amara fulva,* and a number of strictly coastal moths. Examples of the latter include the coast dart *Euxoa cursoria*, associated with relatively stable dune slacks, and the lyme-grass moth *Photedes elymi*, a foreshore species whose larvae feed on lyme-grass *Leymus arenarius*. Other foreshore species are associated with wet trickles over sand, for example the scarce ground beetle *Bembidion pallidipene*. Strandline debris provides a valuable habitat for many invertebrates.

Saltmarshes, with their brackish pools and bare mud, harbour an array of specialist invertebrates, including many beetles, such as *Heterocerus maritimus,* which burrows into wet mud. Among the better-recorded freshwater wetlands are the Yellow Mires Marsh area of Aberlady Bay, and Morton Lochs, both of which contain nationally scarce water beetles, such as *Agabus labiatus,* and a variety of scarce flies. Even small wetland habitats such as springs and seepages are vital for certain species, such as the soldierfly *Oxycera pardalina* at Pease Bridge coast.

Coastal heaths, such as those at Earlshall Muir, support a good representation of locally distributed heathland insects, including the light knotgrass moth *Acronicta menyanthidis*, whose larvae feed on a variety of dwarf shrubs. Rocky coasts with cliffs and associated grasslands can support important populations of scarce species: the recently discovered micro-moth *Elachista orstadii* has been recorded from the mouth of the Abbey Burn at Likim Bay and at only a few other localities within the British Isles. Assemblages of locally-distributed butterflies are also represented: Burnmouth Coast, for example, has northern brown argus *Aricia artaxerxes*, small blue *Cupido minimus* and the grayling *Hipparchia semele*. A few woodland habitats are of significance for invertebrate conservation. Woodhall Dean is one of the best recorded woodland sites for beetles and contains several scarce species, including some dependent upon fungal growth on trees. The actively-managed Dalmeny Park contains an array of beetles associated with dead or decaying trees. Earlshall Muir supports several scarce weevils, including the RDB *Pissodes validirostris*, that are specialist associates of Scots pine *Pinus sylvestris*.

Table 5.3.2 Sites important for invertebrate conservation

Site	*Grid ref.*	*Status*
Rossie Moor	NO6554	SSSI
Elliot Links	NO6139	SSSI
Tayport - Tentsmuir coast (includes Kinshaldy coast and Tentsmuir Point)	NO5025	NNR/SSSI
Morton Lochs	NO4626	NNR
Earlshall Muir	NO4822	SSSI
Dumbarnie Links	NO4501	SSSI
Dalmeny Park	NT1578	
Duddingston Loch	NT2872	SSSI
Aberlady Bay	NT4581	SSSI/LNR
Tyninghame Shore	NT6480	SSSI
Barns Ness Coast	NT7277	SSSI
Woodhall Dean	NT6872	SSSI
Pease Bay Coast	NT7871	SSSI
St. Abb's Head to Fast Castle	NT8969	SSSI/NNR/ SWT/NTS
Coldingham Bay (including Coldingham Common)	NT9265	
Linkim Bay	NT9265	
Burnmouth Coast	NT9560	SSSI

Key: NNR = National Nature Reserve; SSSI = Site of Special Scientific Interest; LNR = Local Nature Reserve; NTS = National Trust for Scotland; SWT = Scottish Wildlife Trust Reserve.

5.3.3 Human activities

As for other nature conservation interests, the main threats to invertebrate communities include inappropriate management of sites, and direct habitat loss or degradation. Appropriate management of sites may be vital in maintaining their invertebrate interest. Most invertebrates have annual or even shorter life cycles and require specific habitat conditions in which to complete development. Many of the rarest species have poor powers of dispersal and are thus unable to colonise suitable habitat from afar, so it is vital that suitable breeding conditions are retained at sites year after year. Even subtle changes in management,

for example shifts in grazing pressure, can have an influence on the survival of invertebrates, and issues such as the removal of strandline debris may have implications for the survival of certain threatened taxa. The fundamental principals of managing coastal habitats for invertebrates are covered by Kirby (1992).

5.3.4 Information sources used

As with most regions of Britain, the level of invertebrate recording varies over this section of the coast, as well as between the invertebrate groups. A wide range of invertebrate groups has been recorded along this section of coast, although the Lepidoptera (macro and micro-moths and butterflies), Coleoptera (beetles) and Diptera (flies) are probably among the best studied groups. The Mollusca (slugs and snails), Hemiptera (bugs) and Hymenoptera: Symphyta (sawflies) are also well studied. Even so, only a few localities have been investigated in detail.

This section has largely been prepared from data held on the Invertebrate Site Register (ISR), a computerised GB-wide database that, although not comprehensive, includes information from a variety of sources including published literature, national recording schemes, local biological records centres and individual specialists. County-based publications are available for some of the better known groups, for example the butterflies and dragonflies of Fife (Smout & Kinnear 1993, 1994). Entomological bibliographies are also available for certain localities, for instance the Islands in the Firth of Forth (Smith & Smith 1983).

5.3.5 Acknowledgements

Thanks are due to D. Procter and Dr S. Ball (JNCC), for providing raw data from the ISR and for assistance in producing maps. Thanks also go to L. Scholfield (Perth and Kinross Council), Kathy Duncan, Karen Passmore and Sandy McLennan (SNH), Alan Burdekin (SOAEFD) and Mark Tasker (JNCC), for their comments on the draft.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Invertebrate site and species information, Scotland	*SNH Advisory Services, Edinburgh, tel: 0131 554 9797
Invertebrate site and species information: Angus, Dundee, Perth & Kinross	*SNH Area Office, Perth, tel: 01738 639746
Invertebrate site and species information: Fife, Clackmannanshire, Stirling, Falkirk	*SNH Area Office, Stirling, tel: 01786 450362
Invertebrate site and species information: West Lothian, Edinburgh, Midlothian, East Lothian, Scottish Borders	*SNH Area Office, Galashiels, tel: 01896 756652
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, including details of occurrence of invertebrates in the region	*Invertebrate Site Register, Biological Records Centre, ITE Monks Wood, Huntingdon, tel: 01487 773381
Literature-based entomological records	Scottish Insect Records Index, c/o Dr M.R. Shaw, National Museums of Scotland, Chambers Street, Edinburgh EH1 1JF, tel: 0131 225 7534
Information relating to conservation of butterflies and moths	R. Sutcliffe, Butterfly Conservation, Art Gallery & Museum, Kelvin Grove, Glasgow G3 8AG, tel: 0141 305 2660
National recording databank for aquatic Coleoptera, and specific survey information on scarce species in region	Dr G.N. Foster, Balfour-Browne Club, 3 Eglinton Terrace, Ayr KA7 1JJ, tel: 01292 525294
Specialist knowledge of Lepidoptera occurring in the region	Dr M. Young, Dept. of Zoology, University of Aberdeen, Tillydrone Avenue, Aberdeen AB9 2TN, tel: 01224 272000
Angus-based biological records	Angus District Records Centre, Montrose Museum & Art Gallery, Pannure Place, Montrose, Angus DD10 8HE, tel: 01307 465101
Dundee-based biological records	A. Garside, Dundee Records Centre (Naturebase), Dundee Museum & Art Gallery, Albert Square, Dundee, Angus DD1 1DA, tel: 01382 432069
Fife-based biological records	*Fife Nature, Fife Council, Dept. of Economic Development & Planning, Glenrothes, tel: 01592 414141 x3793
Perth-based biological records	Perth & Kinross District Records Centre, Perth Museum and Art Gallery, George Street, Perth, Perthshire PH15LB, tel: 01738 632488

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

5.4 Rare sea-bed species

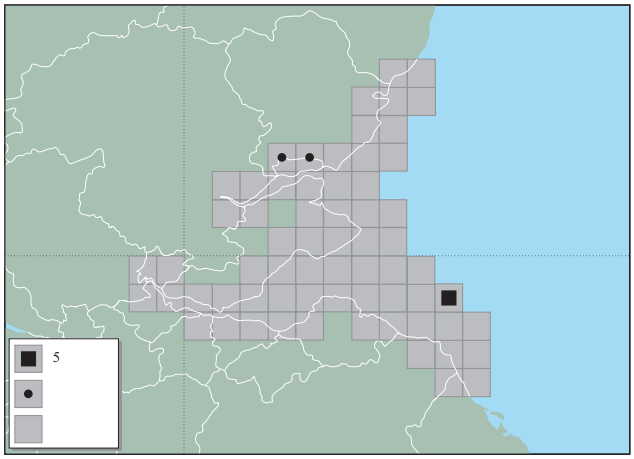
J. Plaza

5.4.1 Introduction

This section considers rare and scarce marine benthic (sea-bed) species, excluding fish. The occurrence and distribution of benthic communities is discussed in section 4.2. 'Nationally rare' marine benthic species in this section are those that occur in one to eight of the 1,546 10 km by 10 km squares (of the Ordnance Survey national grid) which contain sea within the three-mile territorial limit for Great Britain. 'Nationally scarce' species are those that occur in nine to 55 such squares. Three rare and three scarce marine benthic species have been recorded from Region 4. An area north of St. Abb's Head appears to contain more rare and scarce marine benthic species than other areas, but this is likely to be due to the higher level of survey effort in that locality (see section 5.4.3) rather than reflecting a genuine phenomenon. None of the species known to occur in the region is currently protected by statute.

The development of the current criteria and the choice of study area for rarity assessment in the marine benthos of Great Britain are discussed in detail by Sanderson (1996; in press) and are analogous to the criteria and methodologies used for other groups of organisms in British Red Data Books (e.g. Bratton 1991) and by the International Union for Conservation of Nature and Natural Resources (IUCN 1995). Species considered in this chapter are those that are conspicuous and readily identifiable in field surveys by the Marine Nature Conservation Review (MNCR) or similar survey techniques, or for which taxonomic experts consider that sufficient data exist on a national basis to warrant their inclusion. Species that are likely to be grossly under-recorded or overlooked on a national scale have been avoided in the present work. The analysis in this section represents the first attempt to quantify the rarity of marine benthic species and to summarise the known occurrence of rare and scarce species in Great Britain. As more data become available or populations change, the status of species listed in this chapter will require re-evaluation.

Species at the limit of their global distribution (e.g. 'southern' or 'northern' species) may be rare within Great Britain's territorial seas but occur more commonly towards the centre of their biogeographic range. Species described here as 'nationally rare' or 'nationally scarce' are therefore not necessarily endangered globally and, although they are of national interest, their conservation importance needs to be carefully considered. In Britain, populations of many sessile (non-mobile) southern species are thought to be particularly sensitive to environmental impacts because as they approach the margins of their global distribution their capacity to recover from impacts and successfully reproduce after them is progressively diminished. As a result, communities of southern species have been considered important for monitoring the marine environment in the UK (Fowler & Laffoley 1993). An analogous argument may apply to northern species as they approach the southern limit of their biogeographical range (e.g. four of the six rare or scarce species in this region). Other genetic, ecological and pragmatic arguments for the conservation of populations of species that are rare because they are at the margins of wider distributions are summarised by Hunter & Hutchinson (1994). The importance of genetic, species and habitat biodiversity in the UK has recently been the focus of *Biodiversity: the Steering Group report* (Anon. 1995). 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 distributions only just extend into the generally shallower near-shore sea area that is the focus of this study. Some species, however, will occur to some extent in the waters of Great Britain outside the scope of this report.



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

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 4, together with their known areas of occurrence and other key information (Map 5.4.1). Species names, and their order of appearance in the table, are after Howson (1987). Because survey effort in this region has not been uniform (Maps 4.2.3 and 4.2.4), assertions made as to the distribution of rare and scarce species are somewhat artificial and should be regarded with caution. The references cited contain the best available discussion of a species or taxonomic group.

5.4.3 Information sources used

An important starting point for the collection of information and literature on the distribution of rare and scarce species has been the MNCR database (McDonald & Mills 1996), which contains data on species present for more than 10,500 sites around Britain. The bulk of the data reproduced here have been confirmed by critical appraisal of the available scientific literature and through liaison with many eminent marine biologists and experts in taxonomic fields. It has not been possible in this section to list all the available literature on which the present analysis has been based, but the reviews

Table 5.4.1 'Nationally rare' and 'nationally scarce' marine benthic species found in Region 4

Species	*Type of organism*	*Area(s) of occurrence*	*Habitat/associations*	*Comments*	*Useful reference*
Tamarisca tamarisca	A hydroid	Approximately 17 km north of St. Abb's Head	Sublittoral. Substrate apparently unrecorded.	Occurs around GB and north to Arctic. Hydroids are often overlooked.	Hayward & Ryland (1990)
Baldia johnstoni	A polychaete worm	North shore of the Tay Estuary	Clean sand on the low shore	Known only from NE England and SE Scotland. Possibly under-recorded: it is a relatively new species (discovered in 1988) and resembles *Capitella capitata.*	Garwood & Bamber (1988)
*Metopa robusta**	An amphipod	Approximately 17 km north of St. Abb's Head	Unknown	A northern species, previously recorded off the Northumberland coast.	Sars (1895)
*Acanthonotozoma serratum**	An amphipod	Approximately 17 km north of St. Abb's Head	Unknown	A northern species. Only one published record exists in GB for this species.	Moore (1984)
*Paradulichia typica**	An amphipod	Approximately 17 km north of St. Abb's Head	Unknown	A northern species not previously recorded in British waters.	Boeck (1871)
Bugula purpurotincta	A bryozoan	Approximately 17 km north of St. Abb's Head	Low water to shallow sublittoral on shells and hydroids	A northern species. Occurs north through Norway to Spitzbergen.	Hayward & Ryland (1990)

Species names after Howson (1987); in the absence of a specific common name the nearest available group name has been used. Key: *nationally rare. Note: scarce species listed here may be only a little more common than the rare species.

and recent papers listed in sections 4.2.6 and 5.4.5 should allow access to the majority of the available information.

Most of the sites of intertidal and subtidal benthic survey data for this region are mapped in section 4.2. Data on intertidal and subtidal habitats are available mainly as a result of academic research and from water quality and sewage sludge disposal-related interests. The St. Abb's sewage sludge disposal site has been particularly well surveyed on a semi-annual/annual basis since 1978 (Hull & Webster 1991), and the wealth of data generated include the only records in this region for five of the six species in Table 5.4.1. Intensive, long-term monitoring of this type is more likely to record rare or scarce species that, being at the edge of their range, may be ephemeral or sparsely distributed and easily missed.

Some areas in Region 4 have a long history of study, with records from the Gatty Marine Laboratory of St. Andrews University going back to the 1800s. In this analysis, data have not been used from reports prior to 1965, so as to represent currently known occurrence. Old records for various rare and scarce species in Region 4 nevertheless do exist, e.g. for the sea urchin *Strongylocentrotus droebachiensis* and the sea cucumber *Cucumaria frondosa*. Both of these northern species were described as "common on West Sands after storms" (McIntosh (1875), in Laverack & Blackler (1974)), and it is thought that a northward constriction of their ranges may have taken place this century.

MNCR survey work uses a consistent methodology to record conspicuous species (Connor & Hiscock 1996). Not all the data available from surveys in this region are as broad in scope as MNCR surveys and they may not include less common species or those less familiar to a specialist worker. The MNCR of Great Britain is at present incomplete but has substantially increased the quality and evenness of distribution of available data. With further surveys, knowledge of the 'nationally rare' and 'scarce' species in Great Britain will almost certainly expand. Consequently, the nationally rare and scarce status of the organisms presented here may require re-evaluation, and in future 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 require more regular re-evaluation of their occurrence than others.

5.4.4 Acknowledgements

It is a pleasure to acknowledge Dr W.G. Sanderson (JNCC) for his advice, stimulating discussions and input to drafts of this section. The author is grateful for the assistance of the JNCC Marine Nature Conservation Review and the Coastal Directories Project as well as the expert advice of Dr R.N. Bamber, Dr J.M. Baxter, Dr J. Brodie, P.F. Clark, D.W. Connor, Dr M.J. Costello, Dr R.L. Fletcher, Dr J.D. Fish, Dr P.R. Garwood, Dr J.M. Hall-Spencer, Dr T. Harris, Dr P.J. Hayward, Dr T.O. Hill, Dr K. Hiscock, I.J. Killeen, Dr G. Könnecker, J.M. Light, Dr C.A. Maggs, Dr J.D. McKenzie, Prof. P.G. Moore, D. Moss, Prof. T.A. Norton, Dr J.D. Nunn, Dr M. O' Reilly, B.E. Picton, D.R. Seaward, Dr S. Smith, Dr E.C. Southward, I. Tittley, S.M. Turk and Dr R.B. Williams. The author also thanks Dr R.N. Bamber, Dr I.M.T. Dixon, Dr J. Foster-Smith, Dr R. Foster-Smith, L. Heaney, Dr K. Hiscock, Dr D. Moore and Dr D. McLusky for taking time to read and comment on drafts. Access to the MNCR Database at the Joint Nature Conservation Committee, the NIBESRC Database at the Ulster Museum and the ERICA database run by the Cornish Biological Records Unit has been invaluable for the overall analysis.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
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Baldia johnstoni	*Dr R. Bamber, Fawley Aquatic Research Labs Ltd., Southampton, tel: 01703 893513
Amphipods	Dr M. O'Reilly, Scottish Environmental Protection Agency (West), Rivers House, Murray Road, East Kilbride G75 0LA, tel: 01355 238181
Bryozoans	Dr P.J. Hayward, School of Biological Sciences, University College Swansea, Singleton Park, Swansea, West Glamorgan SA2 8PP, tel: 01792 205678
Echinoderms	Dr J.D. Mackenzie, Dunstaffnage Marine Science Laboratory, Scottish Association for Marine Science, PO Box 3, Oban, Argyll PA34 4AD, tel: 01631 566555

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

5.5 Exploited sea-bed species

C.F. Robson

5.5.1 Introduction

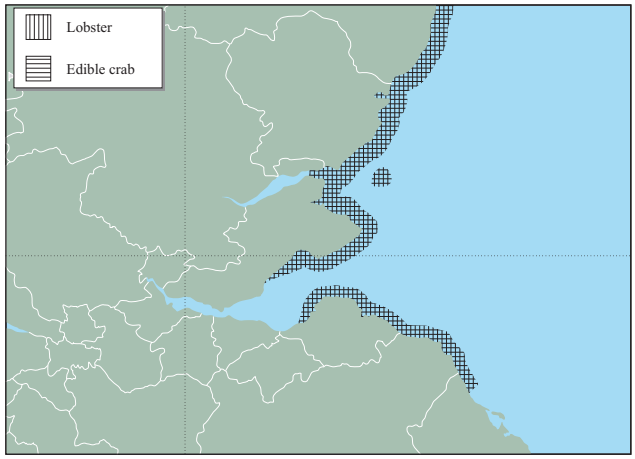
This section describes the distributions of large populations of species that live on, near or in the bottom sediments of the sea bed (collectively called 'the benthos') and that are routinely exploited, mainly for human food. The exploitation itself is described in sections 9.1 and 9.2. Many of these species also provide an essential food source for other species, such as fish and birds, for example seabirds, waders and wildfowl (see also sections 5.10, 5.11 and 5.12). Most of the animal 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 given in Table 5.5.1.

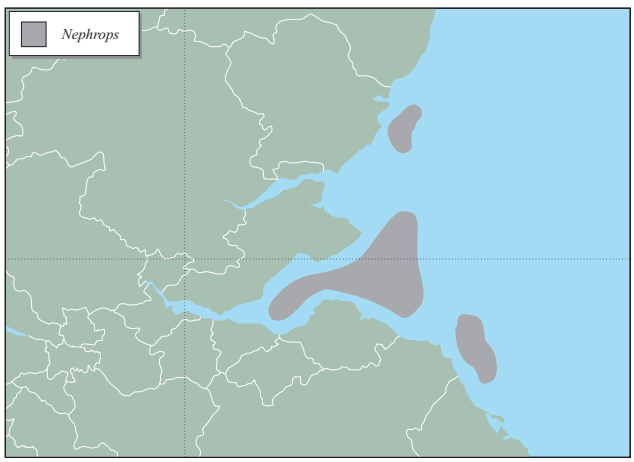
In this region there are important inshore populations of lobster, edible crab and mussels and large offshore populations of *Nephrops* and scallops. There are no known exploitable quantities of native oyster, cockles, spider crab, deep-water prawn, pink prawn, crawfish or queen scallops in the region.

Table 5.5.1 Species names

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



Map 5.5.1 Distribution of crustacea: lobster and edible crab. Source: © SOAEFD.



Map 5.5.2 Distribution of crustacea: *Nephrops*. Source: © SOAEFD.

5.5.2 Important locations and species

Crustacea

Lobster and edible crab are present wherever there is suitable habitat, such as rocky reefs with crevices for protection. This habitat occurs off the coast of the whole region, including around Bell Rock (opposite the Firth of Tay), apart from some of the inner areas of the Firths of Forth and Tay. Edible crabs are often found on softer substrates - ranging from sand/gravel to rock - than lobsters. Juveniles tend to be found inshore and adults further offshore (Rees & Dare 1993). The broadscale distributions of lobster and edible crab in the region are shown on Map 5.5.1. Velvet crabs can be found in the same areas as lobster and edible crabs. The distribution of *Nephrops* is determined by its preference for a sea bed of mud and muddy sand, into which it burrows; in this region there are populations offshore from the Montrose Basin, in the outer Firth of Forth and off St. Abb's Head (Map 5.5.2). Brown shrimp are present in the Forth Estuary. Crawfish

are more abundant on the west coast of Great Britain and so are not common in the region.

Molluscs

Mussels are found around most of the coast 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. On exposed rocky shores mussels are generally small; larger, more exploitable, mussels are mainly confined to sheltered inlets. Mussels attach themselves using 'byssus threads' to sand, gravel or pebble substrata or other mussels and empty shells and have the effect of binding the substratum. Important areas in the region for mussels are the Montrose Basin, the south shore of the Firth of Tay at Tayport, the Eden Estuary and the south shore of the Firth of Forth. Cockles are found in the intertidal mud and sandflats of the estuaries and other sheltered sites in this region. Periwinkles are found on rocky shorelines throughout the region, wherever suitable habitat is present. The native oyster does not occur in exploitable quantities in the region.

Scallops and queen scallops live on sandy/gravelly areas of sea bed. Important populations of scallops are present in a large area off the coast of the region and around the Isle of May (Map 5.5.3). There are no exploitable quantities of queen scallops in the region. Whelks are widely distributed throughout the region, with *Neptunea* being rather more common in the more offshore areas. Concentrations of squid occur seasonally and octopus are also present in the region. Razor shells occur in the inshore areas of the Firths where the sea bed is clean sand. McKay (1992) reports on a survey of potentially exploitable burrowing bivalve molluscs, such as razor shells, and identifies their presence at various sites within the region.

Polychaetes

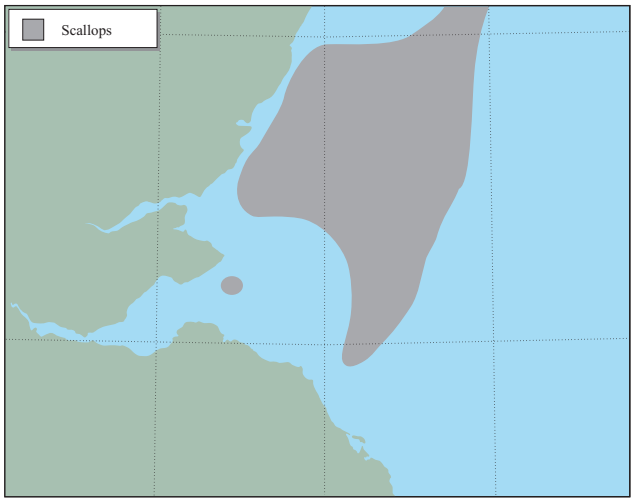
The intertidal and subtidal zones in the region's estuaries support populations of polychaetes, such as the lugworm and ragworm. Lugworms are common in less exposed areas where there is a higher organic content in the substratum. They also occur elsewhere in a wide range of sediment types, from almost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

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 the potential for mariculture in section 9.2. The major issues relating to the exploited sea-bed species in this region are the state of the stocks in relation to the level of exploitation, possible effects of harvesting on non-target species and competition of fisheries with other predators, such as birds.

Nephrops is considered to be a 'pressure stock', which means that it is perceived to be over-exploited. It is subject to catch quota management by the setting of an annual Total Allowable Catch (TAC), which limits landings (see section 9.1.3). The TAC for *Nephrops* effective in Region 4 covers ICES Division IVb (Middle North Sea).

There are full year and seasonal closures on the use of mobile fishing gear (trawl, seine net, dredge (including suction dredging) etc.) made under the Inshore Fishing



Map 5.5.3 Main locations of scallops. Source: © SOAEFD.

(Prohibition of Fishing and Fishing Methods) (Scotland) Order 1989, which was issued in four areas in the region under the Inshore Fishing (Scotland) Act 1984 (Map 9.1.3). In addition, in the Firth of Forth there is a full year general prohibition of fishing. Exceptions from this prohibition are any method of fishing for herring, mackerel and sprats during the full year and fishing for any species of sea fish (except species above) from a fishing boat with an overall length not greater than 55 feet during the full year. Lobster, edible and velvet crabs, *Nephrops* and scallops all have minimum landing sizes (see section 9.1.3).

Scallop fishing in Scotland is the subject of a consultation by SOAEFD. An assessment of the main scallop stocks at the end of 1994 concluded that the state of the stocks, in particular the sustainable rate of exploiting the fisheries in the east and north-east, warranted concern. A weekend ban on fishing for scallops has been proposed in all inshore waters, to prevent fishing effort from increasing. The possible effects on the benthos, feeding birds and shellfish stocks of the harvesting of shellfish species are discussed in some of the publications in section 5.5.6 B.

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 also sections 5.11.3 and 5.12.3 and publications 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 three maps in this section show schematically the known broad-scale distributions of the main species of interest, based on information made available by the SOAEFD Marine Laboratory 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.

Information was also used from Lee & Ramster (1981), and from Pawson (1995), which contains distribution maps of scallops, lobster, edible crab and spider crab around the British Isles and has a species-specific bibliography. McKay (1992) reports on a survey around Scotland of potentially exploitable burrowing bivalve molluscs, including razor shells.

5.5.5 Acknowledgements

The author thanks David McKay (SOAEFD Marine Laboratory, Aberdeen), who provided maps and information for this section, and Derek Murison (SOAEFD Marine Laboratory, Aberdeen), David Donnan (Scottish Natural Heritage) and Mark Tasker (JNCC), for comments on text.

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C. Contact names and addresses

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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, Scarborough, tel: 01723 362392

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

5.6 Amphibians and reptiles

Dr M.J.S. Swan

5.6.1 Introduction

This region supports eight of the nine widespread species of amphibian and terrestrial reptile in the UK: common frog *Rana temporaria*, common toad *Bufo bufo*, smooth newt *Triturus vulgaris*, palmate newt *T. helveticus*, great crested newt *T. cristatus*, slow-worm *Anguis fragilis*, common lizard *Lacerta vivipara* and adder *Vipera berus* (Swan & Oldham 1993a, b). One non-native (European) amphibian species is also reported in this region - the alpine newt *Triturus alpestris* (Herpetofauna Consultants International 1993). The densities of amphibian and, particularly, reptile populations are thought to be extremely low in this region.

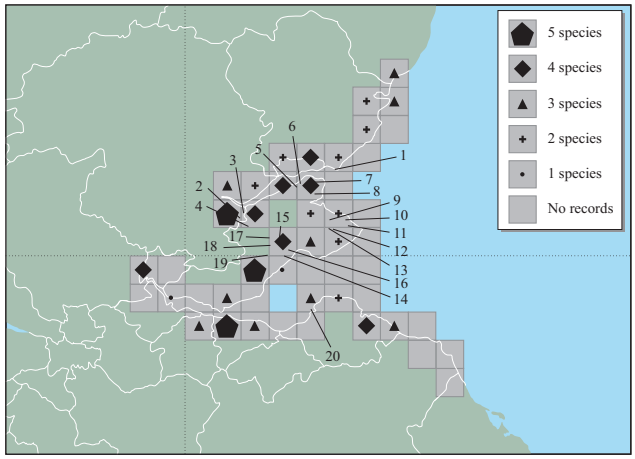
Since 1970, four leatherback turtles *Dermochelys coriacea* have been recorded in the region, three alive but entangled in fishing nets and one dead, stranded on the shore. One other unidentified marine turtle has been recorded swimming at sea. The leatherback turtle is now thought to be resident in Scottish waters at certain times of the year (Brongersma 1972; Langton *et al.* 1996); previously, they were considered to be vagrants.

All of the above native species are afforded some degree of protection or regulation of exploitation under national or international legislation (Table 5.6.1). The great crested newt and leatherback turtle are fully protected under GB legislation through the Wildlife & Countryside Act 1981, and both species are included in Scottish Natural Heritage's 'Species Action Programme' initiative.

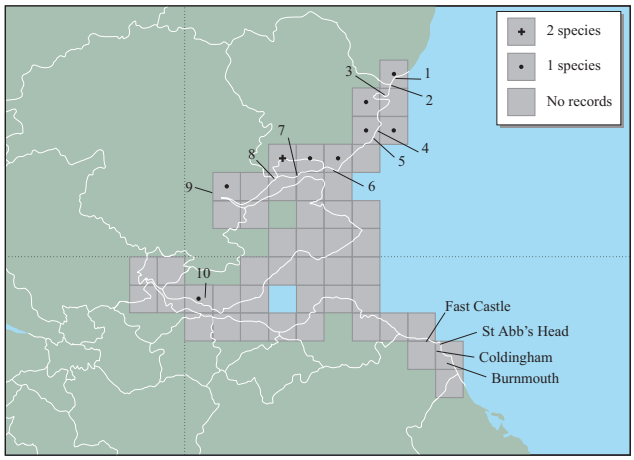
5.6.2 Important locations and species

Table 5.6.2 lists regionally important amphibian breeding sites (Map 5.6.1); and Table 5.6.3 lists sites where reptiles are reported to be relatively abundant in the region. Owing to the paucity of records, particularly of reptiles, these lists are probably far from complete.

Amphibians are uncommon on the coast north of the Firth of Forth: frogs are reported to be more common in upland than lowland areas whereas toads are more prevalent in large water bodies in the lowlands. Newts have not been well recorded here, although the palmate newt is thought to be widespread (Taylor 1990). Throughout this region, frogs, toads and palmate newts are reported to breed in garden ponds. In some districts there may be more suitable habitats for these species in urban areas than rural ones. In Dundee and Angus, suitable amphibian habitat has largely been lost or degraded in the wider countryside but is present on army training areas (amphibians are reported to breed in flooded tank traps). The great crested newt is rare in this region: since 1970 the species has been recorded in north-east Fife, Pitmedden Forest, Kirkcaldy, east and south of Edinburgh and south and east of Dunbar. Pitmedden Forest is the only breeding area in the region north of the Forth to have been confirmed



Map 5.6.1 Sites listed in Table 5.6.2, and numbers of amphibian species recorded in coastal 10 km squares. Distribution may reflect differences in recording effort. Source: Biological Records Centre, ITE Monks Wood.



Map 5.6.2 Sites listed in Table 5.6.3, and numbers of reptile species recorded in coastal 10 km squares. Distribution may reflect differences in recording effort. Source: Biological Records Centre, ITE Monks Wood.

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
Smooth newt *Triturus vulgaris*	1, 2
Palmate newt *Triturus helveticus*	1, 2
Great crested newt *Triturus cristatus*	1, 2, 3
Reptiles	
Slow worm *Anguis fragilis*	1, 2
Common lizard *Lacerta vivipara*	1, 2
Adder *Vipera berus*	1, 2
Leatherback turtle *Dermochelys coriacea*	1, 2, 3, 4

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

Table 5.6.2 Sites with important amphibian species assemblages

Site no. on Map 5.6.1	*Site name*	*Grid ref.*	*Species present*
1	Barry Buddon Ranges	NO5331	Common frog, common toad
2	Turflundie Wood	NO1914	Common frog, common toad, palmate newt, great crested newt
3	Pitmedden Forest	NO2114	Common frog, common toad, palmate newt, great crested newt
4	Auchtermuchty	NO2311	Smooth newt, palmate newt, great crested newt
5	Ghouls Den	NO3823	Common frog, common toad
6	East Links Wood	NO4124	Common frog, common toad
7	Morton Lochs	NO4626	Common frog, common toad, smooth newt, palmate newt
8	Tentsmuir, Earlshall Muir	NO4723	Common frog, common toad
9	Prior Muir Fox Covert	NO5213	Common frog, common toad
10	Burnside Wood	NO5413	Common frog, common toad
11	Kilduncan Farm	NO5712	Common frog, common toad
12	Drumly Farm	NO5510	Common frog, common toad
13	Swinkie Moor	NO5510	Common frog, common toad
14	Cottons Durie	NO3601	Common frog, common toad
15	Clatto Reservoir	NO3607, NO3707	Common frog, common toad, smooth newt, palmate newt
16	Clattobarns Farm	NO3506	Common frog, common toad
17	Kettlehill	NO3207	Common frog, common toad, palmate newt
18	Carriston	NO3204	Common frog, common toad
19	Balgonie Castle	NO3100	Common frog, common toad, smooth newt, palmate newt
20	Aberlady Bay	NT4580	Common frog, common toad, smooth newt

Source: Swan & Oldham 1993a, b

since 1990 (Langton & Beckett 1995). Despite extensive recording along the coast of Fife, amphibians are reported to be common only at Tentsmuir (Smout & Pritchard 1995). Much of the coast of Edinburgh and the Lothians is urban or industrialised, but amphibians have been reported on the less built-up stretches, such as between Carriden (east of Bo'ness) and South Queensferry and west of Aberlady (Hamilton 1978).

Reptile distributions are even more limited. Along the coast of Angus reptiles occur in protected areas such as St. Cyrus, Red Head and Barry Buddon ranges. Common lizards, in particular, are reported at Barry Buddon at the mouth of the Tay in the sand dunes and heathland. Slow worms, common lizards and adders are rare in the coastal parts of Angus but can occasionally be found on landfill sites where vegetation is unmanaged and rank. Reptiles are virtually absent from the coast of Fife.

Along the Scottish Borders coast amphibian and reptile habitats are limited. Arable land extends to the edge of much of the coast and agricultural field ponds are uncommon in the coastal hinterland. Frog and toad (and probably palmate newt) populations survive in coastal nature reserves, and common lizards and slow worms have been observed on cliff tops between Fast Castle and St. Abb's Head, on Coldingham Moor and at Burnmouth. However, the whole coast is poorly recorded for both amphibians and reptiles, so distributions and abundance are largely unknown.

5.6.3 Human activities

Parts of the Firths of Forth and Tay are industrialised and urbanised and have no areas of habitat suitable for amphibians and reptiles. Some of the remaining semi-natural areas, such as Aberlady Bay, are under pressure for recreational purposes. In unpopulated areas, arable agriculture extending right to the edge of the cliffs has eliminated potential reptile habitat, and in the drained and 'improved' coastal hinterland there are few wetlands or farm ponds available as breeding amphibian habitat. Garden ponds in urban areas provide an additional habitat for some species.

5.6.4 Information sources used

Amphibian and reptile surveying in Britain has been extensive, with 84% of 10 km squares receiving some coverage nationally, although only 69% of coastal squares have been surveyed (Table 5.6.4). The recording coverage of this region, in terms of the percentages of 10 km squares sampled, is lower than average, the reptile information being particularly thin. In terms of both the percentages of 10 km squares sampled and the numbers of individual records per 10 km square, survey coverage is inadequate to infer species status and distributions with confidence. Local

Table 5.6.3 Important areas for reptiles

Site no. on Map 5.6.2	*Site name*	*Grid ref.*	*Species present*
1	St. Cyrus NNR	NO7362	Common lizard
2	Kinnaber, Montrose	NO7261	Common lizard
3	South Esk Mouth	NO7257	Common lizard
4	Red Head	NO7047	Slow-worm
5	Prail Castle	NO6946	Slow-worm
6	Barry Buddon Ranges	NO5331	Common lizard
7	Dundee	NO3829	Slow-worm
8	Invergowrie	NO3429	Common lizard
9	Perth	NO1122	Adder
10	Cairneyhill	NT0486	Slow-worm

Source: Swan & Oldham 1993a, b

Table 5.6.4 Records of amphibians and reptiles ('herps') related to survey effort

		% 10 km squares surveyed for:			*Total no. of individual records*		*Mean no. of individual records surveyed per 10 km square*	
	Total no. of 10 km squares	*Any herp. species*	*Amphibians*	*Reptiles*	*Amphibians*	*Reptiles*	*Amphibians*	*Reptiles*
Angus	7	85	71	71	25	13	5.0	2.6
Dundee	4	100	100	33	35	7	8.8	2.3
Perth & Kinross	5	100	100	20	38	2	7.6	2.0
North-east Fife	15	60	60	0	160	0	17.9	0.0
Kirkcaldy	4	75	75	0	82	0	27.3	0.0
Dunfermline	4	75	50	25	5	1	2.5	1.0
Clackmannanshire	3	67	67	0	10	0	5.0	0.0
Stirling	1	100	100	0	9	0	9.0	0.0
West Lothian	2	100	100	0	30	0	15.0	0.0
Falkirk	4	75	50	25	10	1	5.0	1.0
Edinburgh	3	67	67	0	27	0	13.5	0.0
East Lothian	7	57	57	0	14	0	3.5	0.0
Scottish Borders	5	30	20	0	5	0	5.0	0.0
Region 4	***64***	***70***	***67***	***17***	***450***	***24***	***10.7***	***2.2***
North Sea Coast	504	76	66	49	4,141	1,602	12.5	6.5
GB coast	1,124	69	59	49	7,524	3,138	11.3	5.7
GB (coast and inland)	2,862	84	79	66	27,182	8,803	12.1	4.7

Source: Biological Records Centre, Monks Wood

sources suggest, however, that the dearth of reptile records is a reflection of scarcity rather than low recording intensity.

Amphibian survey coverage in this region has been patchy. Fife has been extensively surveyed and Angus, Dundee, Perth, Kinross, Edinburgh and the Lothians have received widespread but unsystematic recording. The Scottish Borders have had scant coverage (Table 5.6.4). Reptile survey effort has been low throughout most of the region, with only 17% of all 10 km squares having received any coverage at all. Angus is a notable exception, with 71% of squares surveyed.

National distribution data for the widespread amphibians and terrestrial reptiles were provided by the Biological Records Centre (BRC) at Monk's Wood (Arnold 1983, 1995). These comprise post-1970 species records held by BRC and include all the data collected during the National Amphibian and Reptile Surveys (NARS) undertaken by De Montfort University on behalf of English Nature. The NARS formed the focus of national amphibian and reptile recording during the 1980s and early 1990s (Oldham & Nicholson 1986; Swan & Oldham 1989, 1993a, b). Most of these data were collected through a volunteer, mainly amateur, recorder network. Currently data are being collated locally at the region's museums and by Fife Nature. Two further reports to Scottish Natural Heritage describe the distribution of the adder (Reading *et al.* 1994) and the great crested newt (Langton & Beckett 1995). SNH also hold lists of great crested newt and other amphibian breeding sites throughout Scotland.

Turtle data and information on the Species Action Programme were provided by Scottish Natural Heritage, the Natural History Museum in London and Langton *et al.* (1996). All strandings and sightings at sea should be reported to the Natural History Museum in London. As part of their Species Action Programme, and in collaboration with the Scottish Office Marine Laboratory and the Scottish Agricultural College Veterinary Service, SNH are appealing for information on turtle sightings in Scottish waters. 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* (SNH 1996).

Information on local impacts, habitat associations and important sites was provided by SNH regional staff, Fife Nature and Biological Record Centre staff at the region's museums.

5.6.5 Acknowledgements

The author wishes to thank the following people for providing information: Henry Arnold, Richard Brinklow, Martin Gaywood, John Harrison, Stewart Pritchard, Kevin Rideout, Mark Simmonds and Ann Marie Smout. Thanks also go to the following for comments on the draft: Karen Passmore and Sandy MacLennan (SNH), Steve Gibson (JNCC), L. Scholfield (Perth and Kinross Council), Allan Brown (Fife Council), Alan Burdekin (SOAEFD) and Daniel Owen, RSPB.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Conservation and captive breeding of amphibians and reptiles, nationally	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: 01986 84518
National recording schemes and biological data from throughout UK	*Environmental Information Centre, ITE Monks Wood, Huntingdon, tel: 01487 773381
Turtles	Dr C. 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
Wildlife Trust sites - Scotland	*Scottish Wildlife Trust, Edinburgh, tel: 0131 312 7765
Turtles in Scotland and Species Action Programme	*Scottish Natural Heritage, Advisory Services, Edinburgh, tel: 0131 554 9797

Type of information	*Contact address and telephone no.*
Reptiles and amphibians in Scotland	Co-ordinator, Scottish Adder Survey, Institute of Terrestrial Ecology, Banchory Research Station, Glassel, Banchory, Grampian Region AB31 4BY, tel: 01330 823434
Reptiles and amphibians in Stirling, Falkirk, Clackmannan and Fife areas	*SNH, Stirling Area Office, Stirling, tel: 01786 450 362
Reptiles and amphibians in Fife	*Fife Nature, Fife Council, Glenrothes, tel: 01592 414141 ext. 3793
Reptiles and amphibians in Dundee & Angus	Biological Records Centre, Dundee Museum, Dundee DD1 1PG, tel: 01382 434000
Reptiles and amphibians in Angus, Perth and Kinross and Dundee City	*SNH, Perth Area Office, Perth, tel: 01738 639746
Reptiles and amphibians in Perth & Kinross	Biological Records Centre, Perth Museum, 78 George Street, Perth PH1 5LB, tel: 01738 632488
Reptiles and amphibians in Scottish Borders	Scottish Borders Biological Records Centre, Hawick Museum, Wilton Lodge Park, Hawick, Scottish Borders TD9 7JL, tel: 01450 373457
Reptiles and amphibians in Scottish Borders and Lothians	*SNH, Galashiels Area Office, Galashiels, tel: 01896 756652
Reptiles and amphibians in St. Abb's Head National Nature Reserve	The Ranger's Cottage, St. Abb's Head NNR, Eyemouth, Berwickshire TD14 5QF, tel: 01890 771443

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

5.7 Fish: exploited sea fish

C.F. Robson

5.7.1 Introduction

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

The distribution of exploited sea fish species can be mapped from analysis of catch data. 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 - 5.7.3 show the known spawning and nursery areas of key species. Barring substantial climate change, stock collapse or other factors, these distributions and relationships will remain stable over several decades.

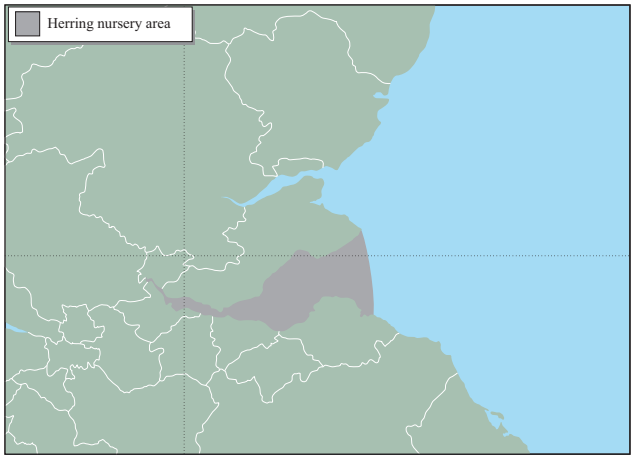
Table 5.7.1 lists the important pelagic and demersal species occurring in the region and give examples of protection measures in this region.

5.7.2 Important locations and species

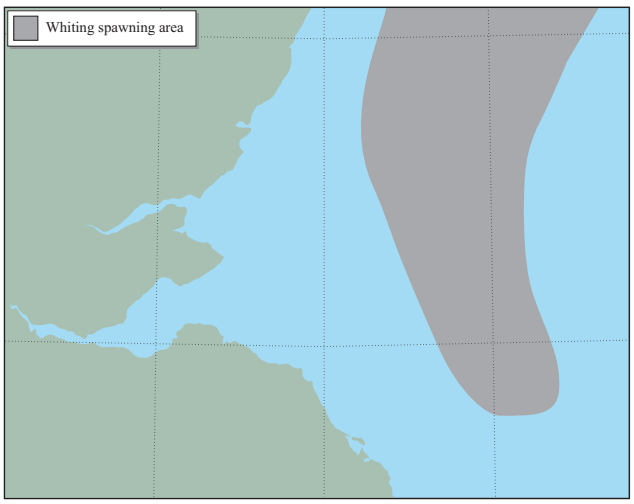
Of the pelagic species, mackerel are widely distributed around Britain and are present in the seas off the region, more commonly in the summer. Mackerel spawn from February to July in areas far offshore of this region in the North Sea. Growing juveniles and adults migrate to coastal waters after spawning, where they remain until autumn. The size of the spawning stock in the North Sea is very low at present and has shown no signs of recovery since its decline in the 1970s. Overwintering concentrations are found west of Scotland, west of Ireland and off Cornwall but not adjacent to this region (Lee & Ramster 1981).

Herring are locally abundant in the summer and autumn in feeding areas throughout the region. There are spawning areas north and south of the region (Lee & Ramster 1981), and herring larvae drift to a shallow nursery area in the Firth of Forth (Map 5.7.1).

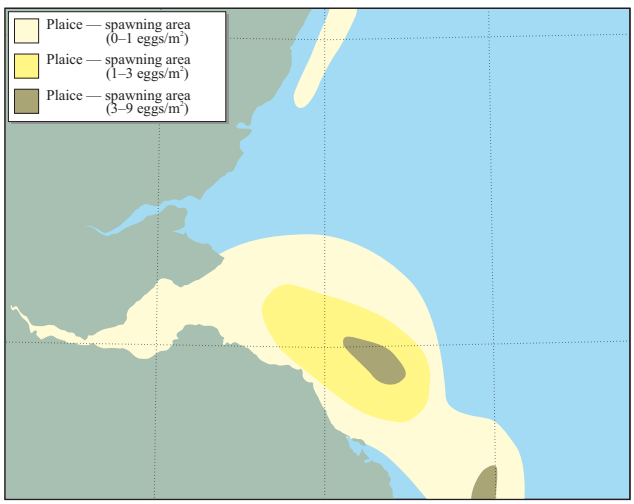
Sprat are found only in the shallower areas of the region between September and March, when they migrate inshore for winter. In summer they are found widely in the North Sea, although recently the stock has been reduced. Although some sprat spawning takes place in coastal waters, they mainly migrate to offshore areas in the North Sea, with spawning peaking between May and July.



Map 5.7.1 Herring nursery area. Source: Lee & Ramster (1981). © Crown copyright.



Map 5.7.2 Whiting spawning area. Source: Lee & Ramster (1981). © Crown copyright.



Map 5.7.3 Plaice spawning areas. Source: Lee & Ramster (1981). © 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
Demersal species	
Elasmobranchs	
Spurdog *Squalus acanthias*	No limitation
Lesser spotted dogfish *Scyliorhinus canicula*	No limitation
Thornback ray *Raja clavata*	No limitation
Cuckoo ray *Raja naevus*	No limitation
Gadoids	
Cod *Gadus morhua*	MLS/QM
Whiting *Merlangius merlangus*	MLS/QM
Haddock *Melanogrammus aeglefinus*	MLS/QM
Norway pout *Trisopterus esmarkii*	QM
Ling *Molva molva*	No limitation
Pollack *Pollachius pollachius*	MLS
Saithe *Pollachius virens*	MLS/QM
Flatfish	
Plaice *Pleuronectes platessa*	MLS/QM
Dab *Limanda limanda*	MLS
Long rough dab *Hippoglossoides platessoides*	No limitation
Dover sole *Solea solea*	MLS/QM
Lemon sole *Microstomus kitt*	MLS
Turbot *Psetta maxima*	MLS
Megrim *Lepidorhombus whiffiagonis*	MLS
Brill *Scophthalmus rhombus*	MLS
Witch *Glyptocephalus cynoglossus*	MLS
Flounder *Platichthys flesus*	MLS
Other demersal fish	
Monkfish (angler) *Lophius piscatorius*	No limitation
Conger eel *Conger conger*	MLS
Gurnards *Triglidae* spp.	No limitation
Sandeels *Ammodytes* spp.	No limitation

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

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

Of the gadoids, cod are distributed in the region in the summer. The North Sea population of cod is self-contained and the cod migrate south in winter to aggregate in large and pronounced spawning areas. Although there are no known cod spawning areas in the region, the North Sea offshore from the region is within the likely limit of possible spawning areas (Lee & Ramster 1981). Whiting are abundant and widely distributed in the region, especially in the inshore waters of the Firth of Forth. The large whiting spawning area east of Scotland is within the region's offshore area (Map 5.7.2). The spawning season is prolonged - from January to July, depending on the latitude - and there are likely to be other spawning areas and nursery areas that have not been identified.

Haddock are widely distributed north of the Firth of Forth and are present in large numbers in the summer and autumn. Spawning takes place between February and May, with a peak in March and April; the main spawning areas are outside the region in the northern North Sea (Lee & Ramster 1981). Norway pout is found in very deep water offshore in the North Sea and is an important target species for the industrial fishery (see also section 9.1). Most Norway pout spawn for the first time at the age of two years, between January and April. Ling, pollack and saithe are present but are locally distributed, particularly around rocky reefs and wrecks.

Plaice, dab and long rough dab are abundant in the region. These species occur on sandy areas of sea bed throughout the region, with juveniles living close to the shore in nursery areas, gradually moving to deeper water as they grow. Much more is known about the life history of the plaice than the dabs. The knowledge of plaice spawning areas is obtained from the distribution of newly-spawned eggs in spring, determined from plankton surveys (Lee & Ramster 1981). The area off the region's southern coast is an important spawning ground for plaice (Map 5.7.3). The Firth of Forth, and in particular areas such as Broad Sands Bay, are important nursery areas for juvenile plaice (Nasir 1985; Poxton & Nasir 1985; Rae 1970). Dab spawn from January to June throughout the North Sea and are locally abundant. The juveniles move to coastal nurseries in the autumn and migrate to deeper water as they grow. Dover sole have a similar lifestyle to plaice and dab but are more confined to areas with higher sea temperatures and are therefore scarce in the northern North Sea. Turbot and brill are much less abundant but have a similar lifestyle to plaice, dab and Dover sole. Turbot spawn from May to August and relatively important spawning grounds are located north of this region offshore of Aberdeen (Rae & Devlin 1972). None of the flatfish species exhibits extensive migrations, though the larvae can drift for several weeks from offshore spawning grounds to inshore nursery areas. There may be some two-way interchange between spawning stocks and nursery grounds in this and adjacent regions. In contrast, a more local distribution is recorded for lemon sole, with an apparently discrete population occurring in the north-western area of the North Sea (Rae 1970). It is assumed that the adults spawn between May and October wherever they are found. Megrim and witch tend to be found only in the deepest water of this region and there are no separate nursery or spawning areas recognised in the North Sea. Flounders migrate in the summer from inshore, estuarine and even riverine nursery areas in the region to spawn up to 30 miles offshore in late winter, and there appears to be little long-shore coastal movement other than in the egg or larval phase.

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 region. Other exploited demersal species of minor importance are conger eel and gurnards. Sandeels are present in the region, and appear to be especially abundant on the series of sand banks that lie about 30-50 km offshore from the region, including the Berwick Bank, Wee Bankie, Scalp Bank and Montrose Bank. The distribution of sandeels is closely associated with well-oxygenated, medium to coarse sand. Sandeels provide an important source of food for many predators, including fish such as

cod and haddock, marine mammals including grey seals and harbour porpoises, and seabirds. Most of the large seabird colonies on the coast of this region appear to be reliant on sandeels during the breeding season (see also section 5.10). Sandeels are a very important target species for industrial fisheries (see also section 9.1). The biology of sandeels and the effects of large-scale industrial fisheries in this area are presently being investigated by an EU funded research programme (EFLIFONS).

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 is determined by environmental conditions at the time of spawning and in the subsequent larval survival, although how these conditions affect fish stocks is not fully understood. Exploitation of fish stocks may increase the extent of these fluctuations.

In Scottish inshore waters the principle tools of fisheries management are the Inshore Fishing (Scotland) Act 1984 and orders issued under it. These give the Secretary of State powers to regulate fishing in specified inshore waters and to prohibit the carriage of specified types of net and the use of mobile gear near fixed salmon nets. There are full year and seasonal closures on the use of mobile fishing gear (trawl, seine net, dredge - including suction dredging - etc.) made under the Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 1989, in four areas in the region (see Map 9.1.3). In addition, in the Firth of Forth there is a full year general prohibition of fishing. Exceptions from this prohibition are any method of fishing for herring, mackerel and sprats during the full year and fishing for any species of sea fish (except these species) from a fishing boat with an overall length not greater than 55 feet during the full year.

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). Two such protection measures are shown in Table 5.7.1: MLS and catch quota management (QM). QM indicates that the UK has been allocated a TAC in the ICES Division that covers Region 4 - Division IVb. 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. There has been no fishery for sprats in this region in recent years because, with the low stock biomass, it has been extremely difficult to take catches of sprat containing less than 10% herring, the maximum bycatch allowed.

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

Spawning and nursery areas may be vulnerable to other activities such as sewage sludge dumping, dredging and dredge spoil disposal and development of infrastructure such as barrages and pipelines. The Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD) is a statutory consultee for, or licenses, activities such as these, in which the distributions of exploited fish populations and their identifiable spawning and nursery areas have to be taken into account. Other activities, such as seismic activity for oil and gas exploration (Turnpenny & Nedwell 1994), may also have an effect on populations.

5.7.4 Information sources used

Whereas the life history of the exploited crustacean and mollusc species can be observed at or near the sites at which they are harvested, the distributions of fish populations can change considerably between juvenile and adult phases and with seasonal migrations. Therefore the information used in this section is based on the distribution and relative abundance of fish species as revealed by fisheries catch statistics obtained from recorded commercial landing figures. In addition, information is used from research vessel catch data and data from biological sampling during fishing surveys. Data from these surveys on the occurrence of spawning fish and juveniles can be used to identify spawning and nursery areas. However, this information is sometimes limited, and there may be other areas in addition to those described or shown on the maps where the species might also occur. Research surveys involving plankton sampling, hydrographic studies, fishing and tagging are required to establish the links between spawning groups and specific nursery areas, and between growing juveniles there and the adult populations to which they eventually recruit. The *Atlas of North Sea fishes* (Knijn *et al.* 1993) gives details of the distribution of fish inferred from otter trawl surveys over three years. Lee & Ramster (1981) has been used as a source for the maps in this section. 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 catch quotas for fish and shellfish species for all European countries, i.e. the Total Allowable Catches (TACs), 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 reviewed annually and the regulations for 1996 were published in European Council (1995).

5.7.5 Acknowledgements

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Assessment and provision of advice on fish stocks in Scotland; marine conservation issues	*SOAEFD Fisheries Research Services, Marine Laboratory, Aberdeen, tel: 01224 876544
Fisheries policy	*SOAEFD Sea Fisheries Division, Edinburgh, tel: 0131 244 6440
UKDMAP software with maps showing distributions of selected sea fish species and spawning areas	*Project Manager, BODC, Birkenhead, tel: 0151 652 3950
Marine conservation issues	*Maritime Unit, SNH Advisory Services, Edinburgh, tel: 0131 554 9797
Marine conservation and fisheries issues specific to the Firth of Forth	*Forth Estuary Forum, Edinburgh, tel: 0131 200 2000
Marine conservation issues	*Marine Advisory Officer, Marine Fisheries Task Group, c/o JNCC, Peterborough, tel: 01733 62626
Marine conservation issues	*Conservation Officer, RSPB, Scottish HQ, Edinburgh, tel: 0131 557 3136
Marine conservation issues	Conservation Officer, WWF Scotland, 1 Crieff Road, Aberfeldy, Perthshire PH15 2BJ tel: 01887 820449 or *Fisheries Officer, 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, Scarborough, tel: 01723 362392

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

5.8 Fish: salmon, sea trout and eels

C.F. Robson

5.8.1 Introduction

Diadromous fish spend part of their lives in fresh water and part at sea. The three fish species covered in this section - the Atlantic salmon *Salmo salar*, sea trout *Salmo trutta* and eel *Anguilla anguilla* - are widespread in British waters and have been recorded in rivers in this region. (Twaite shad, allis shad and sea lamprey are also diadromous but are included in section 5.9.) 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).

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

5.8.2 Important locations

Salmon, sea trout and eels have a widespread distribution in rivers and the coastal seas of British waters. The distribution of salmon and sea trout is controlled by natural factors, such as river levels, by man-made barriers that may limit the extent to which they can go upstream, and by pollution levels. On the North Sea coast, salmon rivers are concentrated in north and north-east Scotland and in the border area with England and are very well represented in this region. The Tay and Tweed are of special significance (Webb 1989; Walker 1990). Sea trout generally have a westerly distribution in Britain. The rivers shown on Map 5.8.1 are the main ones that are known to contain populations of salmon and sea trout. It is highly likely that smaller rivers and tributaries not shown on the map also contain populations. Eels are probably found in all river systems in the region, as elsewhere in Britain.

5.8.3 Human activities

Recent years have provided considerable evidence of a general decline in the catches of salmon and sea trout in the early months of the angling season in a number of major Scottish east coast rivers (Shearer 1985, 1988, 1989; Laughton & Smith 1993). At present, there is no clear explanation for this situation.

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), especially the effects of commercial net operations during migratory phases. Net-and-coble and rod-and-line fishing for salmon (including grilse) and sea trout takes place on the coast, in estuaries, and in rivers. Fixed netting stations operate on the coast, and no part of any net, except warps and moorings, may be set further than 1,300 m from the low water mark. In addition, in Scotland, no nets used to fish for salmon may be designed or constructed to catch fish by enmeshing them. Some netting stations have become uneconomic whilst others have been purchased by bodies such as District Salmon Fishery Boards and the Atlantic Salmon Conservation Trust and closed to reduce exploitation by nets. Drift netting has been an illegal salmon fishing method in Scotland since 1962, but it is still carried out in the adjacent waters of north-east England. More specific concern relating to the state of wild salmon and sea trout stocks has focused on a wide range of potential anthropogenic and natural impacts, such as predation by aquatic mammals and birds. Maitland & Campbell (1992) describe the possible effects of various other issues of relevance to freshwater fish.

There is now compelling evidence that salmon may belong to different genetic populations, each associated with its natal river, and that, in larger rivers at least, sub-stocks may be associated with different parts of the river system (Verspoor *et al.* 1991; Scottish Office Agriculture and Fisheries Department 1992). This aspect of salmonid stock definition is significant for the management of salmon fisheries because of concern regarding genetic interactions between escaped farmed fish and wild stocks (Webb 1991; Webb *et al.* 1991). The pollution of rivers and inshore waters, which is relatively rare and localised in the region, may affect the ability of fish to return to their natal river to spawn.

5.8.4 Information sources used

The *Map of the distribution in Scottish rivers of the Atlantic salmon* Salmo salar *L.* (Gardiner & Egglishaw 1986) and the list of rivers for which the SOAEFD Montrose Field Station collates salmonid catch data were used as a basis for Map 5.8.1.

Under the provisions of the Salmon and Freshwater Fisheries (Protection) (Scotland) Act 1951, data are collected on catches of salmon and sea trout for each salmon fishery. The SOAEFD Montrose Field Station of the Freshwater Fisheries Laboratory collects, collates and publishes these data annually as a *Statistical Bulletin* (Scottish Office 1996). The 'returns' are made through an annual questionnaire

sent to proprietors and occupiers of salmon fishings. A high percentage of the forms sent are returned (>95%).

5.8.5 Acknowledgements

Thanks are due to Allan Brown (Fife Council), Jackie Milne (SOAEFD Montrose Field Station) and David Donnan (Scottish Natural Heritage) for information, advice and comments on drafts.

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Webb, J. 1992. *The behaviour of adult salmon (Salmo salar L.) in the River Tay as determined by radio telemetry.* Aberdeen, Scottish Office Agriculture and Fisheries Department. (Scottish Fisheries Research Report, No. 52.)

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Wild salmon and freshwater fisheries policy; contact details of the Clerks of the Salmon Fishery District Boards	*SOAEFD Division K2, Pentland House, Edinburgh, tel: 0131 244 6230
Collation of salmon and sea trout catch statistics in Scotland	SOAEFD, Freshwater Fisheries Laboratory, Montrose Field Station, 16 River Street, Montrose DD10 8DL, tel: 01674 677070
Research into freshwater fish species, habitats, behaviour and exploitation in Scotland	SOAEFD, Freshwater Fisheries Laboratory, Faskally, Pitlochry, Perthshire PH16 5LB, tel: 01796 472060
Additional fisheries data to that published in the *Statistical Tables* (see section 9.1.4); marine and estuarine fisheries research	*SOAEFD Fisheries Research Services, Aberdeen, tel: 01224 876544
Fish conservation	P.S. Maitland, Fish Conservation Centre, Easter Cringate, Stirling FK7 9QX, tel: 01786 451312
Conservation of wild salmon; salmonid research	Director, The Atlantic Salmon Trust, Moulin, Pitlochry PH16 5JQ, tel: 01796 473439
Inter-government convention regulating salmon fishing on the high seas	Secretary, North Atlantic Salmon Conservation Organisation, 11 Rutland Square, Edinburgh EH1 2AS, tel: 0131 228 2551

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

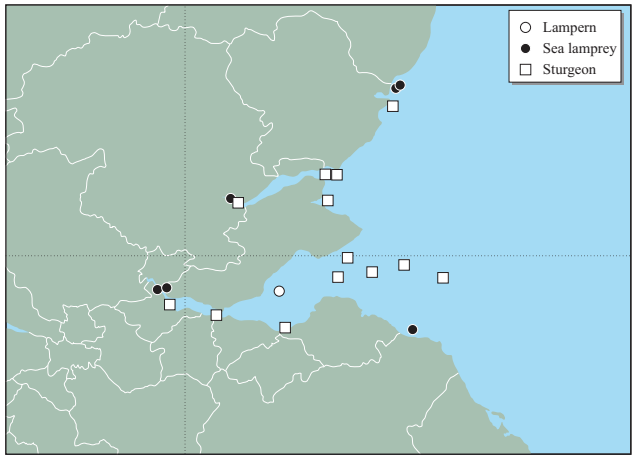
5.9 Fish: other species

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

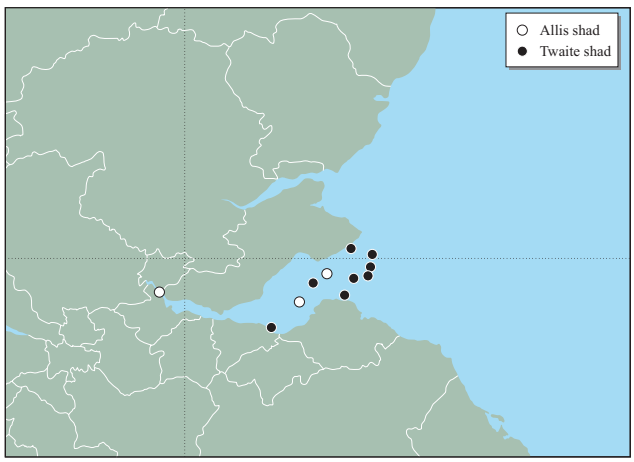
5.9.1 Introduction

There are 154 species of exploited and unexploited fish recorded from this region, comprising three jawless fishes (Agnatha), 23 sharks and rays (elasmobranchs) and 128 bony fishes (teleosts). This region has records of all seven British marine and estuarine species protected under national, European and international legislation (Table 5.9.1). However, these have mostly been individual records of the lampern and sea lamprey, allis and twaite shads and the sturgeon. These species are considered threatened in UK and European waters (Potts & Swaby 1993a). Map 5.9.1 shows the recorded distributions in the region of lampern, sea lamprey and sturgeon, and Map 5.9.2 shows the recorded distributions in the region of allis shad and twaite shad. Recent records of the sturgeon are rare.

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



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



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

5.9.2 Important locations and species

Parnell (1837) listed 125 fish species in the River and Firth of Forth as a whole, with the opah *Lampris guttatus* among the notable and exotic species stranded there (McLusky 1978).

The lampern (river lamprey) was recorded by Parnell (1838) and Rintoul & Baxter (1935) as being frequent in the

Table 5.9.1 Scheduled species and protected status

Species	*Wildlife & Countryside Act (Schedule)*	*EC Habitats & Species Directive (Annex)*	*Bern Convention (Appendix)*	*CITES (Appendix)*
Lampern *Lampetra fluviatilis*		IIa, Va	III	
Sea lamprey *Petromyzon marinus*		IIa	III	
Sturgeon *Acipenser sturio*	5	IIa, Va	III	I
Allis shad *Alosa alosa*	5	IIa, Va	III	
Twaite shad *Alosa falla*		IIa, Va	III	
Common goby *Pomatoschistus microps**			III	
Sand goby *Pomatoschistus minutus**			III	

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

region. Sharman (1963) found considerable numbers at Kincardine, and Maitland *et al.* (1984) recorded them on the intake screens of Kincardine and Longannet power stations. Here, the newly metamorphosed fish were recorded as common in spring and the maturing adults as common in the autumn (Poxton 1987). Parnell (1838), McIntosh (1875) and Rintoul & Baxter (1935) recorded the sea lamprey as 'not uncommon'. The latter found them near the mouths of the Rivers Almond and Esk and off St. Abb's Head. Maitland (1979) did not find any records and suggested they may have ceased breeding in the Forth area. The sturgeon is recorded occasionally in Region 4, but there is no evidence of it breeding there. Parnell (1838) recorded it every few years at Musselburgh and Queensferry, and one specimen was found as far upstream as Alloa. McIntosh (1875) recorded sturgeon as occasional and Sim (1903) described the sturgeon as "long known along the east coast of Scotland", although never in large numbers. These occasional records have been reported by line fishermen, stake netters and trawlermen, who landed sturgeon at Aberdeen market at frequent intervals. Maitland (1979) had no recent records, although he thought it probably occurred from time to time in the Forth Estuary.

There are more records of twaite shad than allis shad in this region. The allis shad was considered rare by Parnell (1838), with only two records, one at Musselburgh and the other at the mouth of the Firth of Forth. Maitland (1979) did not find any records. Parnell (1838) recorded twaite shad entering the Firth of Forth in "tolerable numbers towards the end of July and dozens are then taken in salmon nets at almost every tide". Sim (1903) described twaite shad as not abundant, but frequently taken during the summer by both line and trawl, although he did not distinguish between twaite and allis shad, so his comments could apply to either or both species. Despite the previous numbers Maitland (1979) did not find any recent records of twaite shad.

The smelt (or sparling) *Osmerus eperlanus* was recorded by Parnell (1838) as abundant in the River Forth near Alloa, where he described them being taken in great numbers, especially in the autumn when the fish were small. Larger smelt ascended rivers in March when spawning took place. Sim (1903) recorded smelt as being common in the Firths of Forth and Tay and caught in great quantities in the autumn. Although Maitland (1979) stated that populations have declined over time, monitoring at Longannet Power Station appears to indicate that the species has now satisfactorily re-established itself in the estuary. The Rivers Tay and Forth now support two of the three populations of smelt in Scotland, the other being in the River Cree (Maitland & Smith 1987).

Records of fishes from power stations in Region 4 include 28 species from Cockenzie (Maitland *et al.* 1980), 33 from Kincardine (Sharman pers. comm. in Poxton 1987), and a total of 45 species from a comparative survey between Cockenzie, Kincardine and Longannet (Poxton 1987).

5.9.3 Human activities

Human activities affecting estuaries and adjacent coasts are summarised in Buck (1993); these also affect the abundance and distribution of fish. Nationally, estuaries are used by up to 180 fish species for migration, spawning and feeding and as nursery grounds (Potts & Swaby 1993c). The Forth Estuary is affected by industrial contaminants such as heavy metals (Davies 1981; Costa & Elliott 1991), land claim, organic enrichment and dredging and soil disposal (Costa & Elliott 1991; McLusky *et al.* 1992). Evidence of mercury affecting the marine environment in the region is discussed in Jones *et al.* (1972) and Elliott & Griffiths (1986). In addition, dams, weirs, barrages and abstraction intakes can impede the passage of migratory fish. While salmon 'passes' allow some species to migrate up or down rivers and estuaries, they provide obstacles to the majority of fish, which are unable to reach spawning and feeding grounds further upstream. Urbanisation and the discharge of untreated sewage to the sea and particularly into estuaries results in a reduction in dissolved oxygen to which fish are particularly sensitive. The result is that fish leave the area and do not return until treatment plants reduce the amount of sewage and oxygen levels increase (Potts & Swaby 1993b). The possible effects of fisheries on species is discussed in sections 5.7 and 9.1. Fisheries in the Firth of Forth are discussed in Poxton (1987) and Howard *et al.* (1987) and in the whole region are discussed in Rae (1971), Thomas & Saville (1972) and Costa & Elliott (1991). Sea angling occurs in many places throughout the region (Orton 1996).

5.9.4 Information sources used

Various surveys in which fishes have been recorded have been carried out by the Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD), and some are mentioned in broader studies carried out by Scottish Natural Heritage. The distribution of fish species in the region is not well documented, and although the *Atlas of North Sea fishes* (Knijn *et al.* 1993) gives details of distribution of fish from surveys conducted between 1985-1987, the methods employed (otter trawl) excluded inshore coastal areas.

Information of marine and estuarine fishes is stored in the British Marine Fishes Database, which covers fishes in the UK and individual records for this region. Information is being gathered from a variety of sources including research institutes, fish biologists, anglers and fishermen. The data include published literature, unpublished reports and personal communications from fish biologists.

5.9.5 Acknowledgements

Thanks are due to Scot Mathieson (SEPA) for comments on the draft.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
British Marine Fishes Database	Dr G.W. Potts/S.E. Swaby, Marine Biological Association UK, Citadel Hill, Plymouth PL1 2PB, tel: 01752 633100/600301
Fisheries - Scotland	*SOAEFD Fisheries Research Services, Aberdeen, tel: 01224 876544
Water quality information and fish data	*SEPA, Head Office, Stirling, tel: 01786 457700
Water quality information and fish data	*SEPA, East Region HQ, Edinburgh, tel: 0131 449 7296
Fish conservation. Data obtained from power station screens at Cockenzie, Longannet and Kincardine	P.S. Maitland, Fish Conservation Centre, Easter Cringate, Stirling FK7 9QX, tel: 01786 451312
Fish conservation - UK	*Marine Advisory Officer, JNCC Peterborough, tel: 01733 62626
Fish conservation - Scotland	*Maritime Unit, SNH Advisory Services, Edinburgh, tel: 0131 554 9797

*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 includes information on these waterfowl species where they occur close inshore, especially within estuaries.) Scientific names of all species are given in Table 5.10.1.

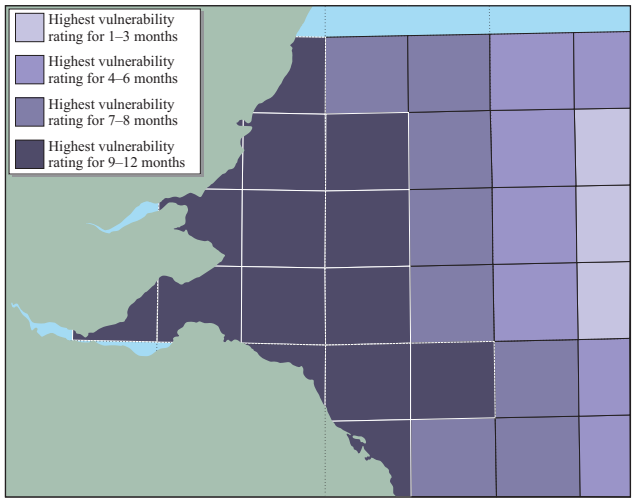
This region is of international importance to ten species (gannet, cormorant, shag, lesser black-backed and herring gull, kittiwake, roseate tern, guillemot, razorbill and puffin), which breed here in numbers greater than 1% of their European populations. A further four species (fulmar and common, arctic and little tern) are present in numbers greater than 1% of their GB population. Eleven colonies are of importance in the national context, with seven of these holding internationally important numbers. Because terns and cormorants can nest at different sites each year, several further sites are of national importance in certain years.

The waters of the Firth of Forth and immediately off the region are of great importance to seabirds throughout the year. The greatest concentrations of birds at sea in this region occur in the period immediately after the breeding season. Numbers of offshore waterfowl reach international importance at three sites in the region, with the Firths of Forth and of Tay being particularly important for seaduck. Map 5.10.1 illustrates the high relative importance of the region's seas for seabirds (see also section 5.10.3).

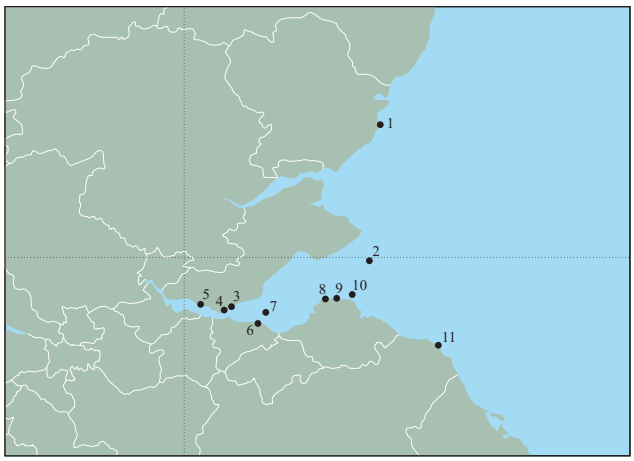
Table 5.10.1 Overall importance of seabirds breeding in the region

Species	*Total*	*% GB*	*% Europe*
Fulmar *Fulmarus glacialis*	5,300	1.0	0.9
Gannet *Morus bassanus*	39,751	19.8	16.5
Cormorant *Phalacrocorax carbo*	526	7.7	4.0
Shag *Phalacrocorax aristotelis*	1,370	3.8	2.6
Black-headed gull *Larus ridibundus*	400	0.2	-
Lesser black-backed gull *Larus fuscus*	8,200	10.0	7.1
Herring gull *Larus argentatus*	21,000	14.0	3.5
Great black-backed gull *Larus marinus*	33	0.2	0.1
Kittiwake *Rissa tridactyla*	39,000	7.9	7.1
Sandwich tern *Sterna sandvicensis*	5	-	-
Roseate tern *Sterna dougalli*	17	24.5	2.3
Common tern *Sterna hirundo*	870	2.0	0.9
Arctic tern *Sterna paradisaea*	580	1.3	0.6
Little tern *Sterna albifrons*	42	1.7	0.3
Guillemot *Uria aalge*	58,900	5.6	4.9
Razorbill *Alca torda*	6,700	4.5	3.7
Puffin *Fratercula arctica*	23,250	5.2	4.9

Sources: figures for Britain from Thompson *et al.* (1995) and for Europe from Lloyd *et al.* (1991) (with some updating). Regional totals are compiled from the most recent available good-quality counts up to 1995. Note: counts are all of pairs, except for guillemot and razorbill, where they are of individuals.



Map 5.10.1 Relative importance of region and adjacent seas for seabirds. Grid is of 15'N x 30'W rectangles; see text for explanation of vulnerability ratings. Source: JNCC Seabirds at Sea Team.



Map 5.10.2 Colonies holding at least 1% of the GB population of any seabird species. Sites are listed in Table 5.10.2. Source: JNCC Seabird Colony Register.

5.10.2 Important locations and species

Breeding seabirds require habitat that is safe from predatory mammals, so most seabirds breed on offshore islands or on cliffs. A total of seven colonies hold numbers of seabirds exceeding 1% of their international population level, with a further four at the equivalent level or higher for their GB populations (Table 5.10.2). The location of these colonies is shown on Map 5.10.2. Further colonies hold regionally important numbers of birds. The region is relatively important for roseate terns: three sites have held colonies over the past five years. Present numbers of Sandwich terns are very low; in most years since 1980, Inchmickery has supported a nationally important colony. Carr Craig has been nationally important for cormorant regularly over this period also.

The feeding areas of birds from colonies are as important

Table 5.10.2 Seabird colonies of at least national importance for particular species

Site no. on Map 5.10.2	*Colony*	*Grid ref.*	*Species*	*Count date*	*Count*	*≥1% EU/GB population*	*Protected status*
1	Red Head	NO705480	Herring gull	1986	2,125	GB	
2	Isle of May	NT655993	Shag	1995	503	EU	SSSI
			Lesser black-backed gull	1994	1,270	EU	
			Herring gull	1994	2,122	GB	
			Kittiwake	1995	7,603	EU	
			Common tern	1994	148	GB	
			Arctic tern	1994	540	GB	
			Guillemot	1993	17,919	EU	
			Razorbill	1993	3,022	EU	
			Puffin	1992	20,106	EU	
3	Inchcolm	NT190825	Lesser black-backed gull	1994	1,669	EU	
			Herring gull	1994	1,615	GB	
4	Haystack	NT177825	Cormorant	1995	97	GB	
5	Rosyth Dockyards	NT105825	Lesser black-backed gull	1990	865	GB	
6	Leith Docks	NT260778	Common tern	1994	499	EU	
7	Inchkeith	NT293829	Cormorant	1995	112	GB	
			Lesser black-backed gull	1994	2,607	EU	
			Herring gull	1994	4,977	GB	
8	Lamb	NT535867	Cormorant	1995	179	EU	
9	Craigleith	NT552870	Cormorant	1995	82	GB	
			Lesser black-backed gull	1994	934	GB	
			Herring gull	1994	2,385	GB	
10	Bass Rock	NT602873	Gannet	1994	39,751	EU	SSSI
11	St. Abb's Head	NT914694	Kittiwake	1995	13,670	EU	SSSI
			Guillemot	1993	28,911	EU	
			Razorbill	1993	1,748	GB	

Source: JNCC/Seabird Group Seabird Colony Register. Key: GB = nationally important; EU = internationally important. Notes: counts are of pairs, except for guillemots and razorbills, which are counted individually. For most species the most recent available good-quality count is presented. For terns (whose numbers may fluctuate markedly from year to year, reflecting inter-colony movements), the highest count from the period 1989-93 is presented. Colonies are as defined by counters contributing to the JNCC/Seabird Group Seabird Colony Register.

to the birds as the colonies themselves. Seabird food ranges from zooplankton to small fish and waste from fishing fleets. Habitats that concentrate any of these foods are preferred. Zooplankton can be concentrated in zones where water masses meet (see Map 4.3.1), or where tides converge around islands or over certain sea-bed features. Many of the species for which the region is important feed on sandeels and other small fish in the summer. Sandeels require well-oxygenated sandy sediment to live in; such conditions occur in several areas in the region. Seaduck and other nearshore waterfowl need relatively sheltered waters and feed on a variety of benthic organisms, including fish, shellfish and invertebrates.

Most of the breeding seabirds in this region do not range further than about 50 km from their colonies; gannets are an exception to this, with some birds feeding up to 120 km from Bass Rock. There is considerable immigration of waterfowl to the region in winter, when three areas support internationally important numbers of waterfowl (Table 5.10.3). Large numbers of eiders, common scoter and goldeneye use the Forth Estuary, St. Andrew's Bay and the Firth of Tay. The outer Firth of Forth and more distant parts of the Firth of Tay/St. Andrew's Bay have not been well counted and so total numbers of birds using these areas are not well known. Most of the scoter occur out of sight of land, as do substantial numbers of divers, cormorants and gulls; these can only be detected by aerial surveys (Webb & Tasker 1988).

5.10.3 Human activities

The vulnerability of seabirds at sea 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. Spills near the main colonies during the breeding season could be catastrophic. Spills can also arise from non-tanker shipping movements; large numbers of seaduck were killed by oil from unknown sources in the outer Tay in both 1968 and 1970. Some birds may become entangled in fishing nets in the region, but the scale at which this occurs is not believed to be great overall. There has been recent controversy over the possible effects of fishing for sandeels, the main prey of seabirds in the region, on the offshore banks (e.g. the Wee Bankie in the Forth), which are used by seabirds for foraging.

5.10.4 Information sources used

All seabird colonies in the region were counted or reappraised between 1984 and 1987. Most Firth of Forth colonies have been re-counted in the past three years.

Table 5.10.3 Numbers of offshore wintering waterfowl in relation to British and north-west European populations

	Peak numbers	*1% GB*	*1% NW Europe*
Tay Estuary			
Eider *Somateria mollissima*	25,150	750	20,000
Goldeneye *Bucephala clangula*	299	170	3,000
Red-breasted merganser *Mergus serrator*	118	100	1,000
Goosander *Mergus merganser*	144	90	1,500
St. Andrew's Bay			
Long-tailed duck *Clangula hyemalis*	456	230	20,000
Common scoter *Melanitta nigra*	2,555	230	8,000
Velvet scoter *Melanitta fusca*	1,642	30	2,500
Forth Estuary			
Red-throated diver *Gavia stellata*	82	50	750
Great crested grebe *Podiceps cristatus*	728	100	?
Red-necked grebe *Podiceps grisegena*	33	?	330
Slavonian grebe *Podiceps auritus*	26	?	50
Cormorant *Phalacrocorax carbo*	808	130	1,200
Scaup *Aythya marila*	205	110	3,100
Eider *Somateria mollissima*	8,785	750	20,000
Long-tailed duck *Clangula hyemalis*	598	230	20,000
Common scoter *Melanitta nigra*	1,403	230	8,000
Velvet scoter *Melanitta fusca*	226	30	2,500
Goldeneye *Bucephala clangula*	2,042	170	3,000
Red-breasted merganser *Mergus serrator*	497	100	1,000

Source: Cranswick *et al*. (1995).

These counts, and all those made since 1979, are held on the JNCC/Seabird Group Seabird Colony Register. Numbers and breeding performance of various species of seabird are evaluated annually at about 25 colonies in the region (Thompson *et al*. 1995). Surveys of birds at sea off this coast have been carried out by JNCC's Seabirds at Sea Team (SAST); survey effort from ships has been greatest in nearshore waters and lowest east of 1°W. 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 (Webb & Tasker 1988). There has been no systematic coverage from the land. The Wetland Bird Survey provided information on offshore waterfowl.

5.10.5 Acknowledgements

Kate Thompson (JNCC) abstracted the Seabird Colony Register records and summarised the information presented here. The Forth Seabird Group has been co-ordinating most recent counts on which the Seabird Colony Register is based. Members of that group and others carried out the counting. Allan Brown (Fife Council), Anne Brown, Karen Passmore and Sandy MacLennan (SNH) and Daniel Owen (RSPB) commented on a draft of this section.

5.10.6 Further sources of information

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B. Further reading

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Greenwood, J.J.D., & Keddie, J.P.F. 1968. Birds killed by oil in the Tay Estuary, March and April 1968. *Scottish Birds, 5*: 189-196.

Kirby, J.S., Evans, R.J., & Fox, A.D. 1993. Wintering seaducks in Britain and Ireland: populations, threats, conservation and research priorities. *Aquatic Conservation: Marine and Freshwater Ecosystems, 3*: 105-137.

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Skov, H., Durinck, J., Leopold, M.F., & Tasker, M.L. 1995. *Important bird areas for seabirds in the North Sea including the Channel and the Kattegat*. Cambridge, BirdLife International.

Stone, C.J., Webb, A., Barton, C., Ratcliffe, N., Reed, T.C., Tasker, M.L., & Pienkowski, M.W. 1995. *An atlas of seabird distribution in north-west European waters.* Peterborough, Joint Nature Conservation Committee.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Seabird colonies	*Coordinator, Seabird Colony Register, JNCC, Aberdeen, tel: 01224 655703
Seabirds at sea	*Seabirds at Sea Team, JNCC, Aberdeen, tel: 01224 655702
Birds database	*Birds Advisor, JNCC, Peterborough, tel: 01733 62626
Monitoring of breeding seabirds on an annual basis; covers 13 islands in the Forth Estuary	Forth Seabird Group, Vane Farm, RSPB Nature Centre, Kinross, Tayside KY13 7LX, tel: 01577 862355
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

R.T. May & A.B. Law

5.11.1 Introduction

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

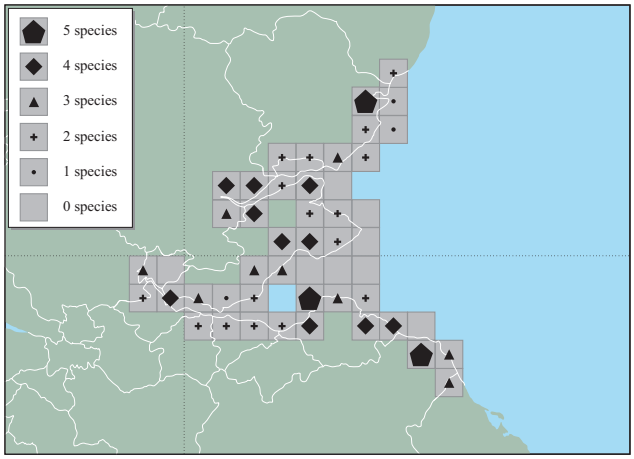
The region's coast is characterised by sandy bays, rocky coast and large estuarine areas. These habitats support widespread and diverse breeding waterfowl assemblages. The saltmarshes and sand dunes of the region are of great importance for their high densities of breeding waterfowl, especially waders (Smith 1983; Davidson 1991; Davidson *et al.* 1991; Maps 5.11.1 and 5.11.2). Montrose Basin has the highest densities of saltmarsh breeding waders in Britain (Davidson *et al.* 1991). Wet grassland in the region also supports diverse assemblages of breeding waterfowl (Map 5.11.3). Numbers of lowland breeding waders, especially those associated with wet grassland areas and saltmarshes, have been declining, not only nationally but also internationally (Hötker 1991), because of habitat loss or degradation. The importance of the region's areas of these habitats for breeding birds is thus likely to increase.

5.11.2 Important locations and species

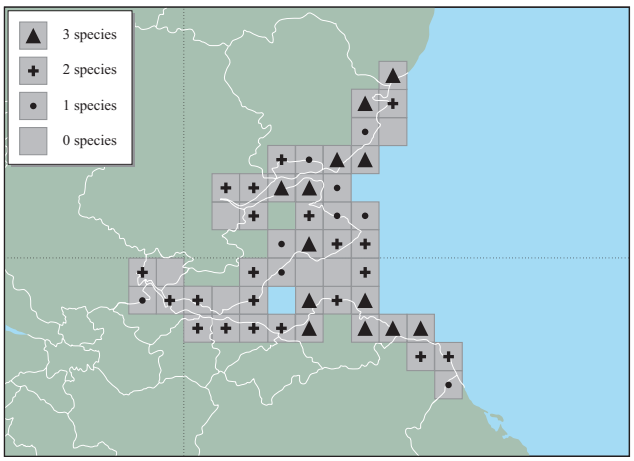
Map 5.11.3 shows the incidence of confirmed breeding in coastal 10 km squares of selected species characteristic of wet grassland (teal *Anas crecca*, lapwing *Vanellus vanellus*, redshank *Tringa totanus*, mallard *Anas platyrhynchos*, snipe *Gallinago gallinago* and pintail *Anas acuta*). More waterfowl species breed in the wet grassland areas around Aberlady Bay in the Forth Estuary and Montrose Basin than anywhere else in the region. Table 5.11.1 indicates the densities of certain breeding waders (oystercatcher *Haematopus ostralegus*, ringed plover *Charadrius hiaticula*, lapwing, curlew *Numenius arquata*, redshank and snipe) on a sample of the region's saltmarshes in 1985. Map 5.11.2 shows overall breeding densities of saltmarsh breeding waders on some estuarine areas on Britain.

Map 5.11.1 shows the incidence of confirmed breeding in coastal 10 km squares of selected waterfowl species characteristic of shingle, sand dunes and dry coastal grassland (ringed plover, oystercatcher and shelduck *Tadorna tadorna*). The sand dune systems and bays of this region provide ideal breeding habitats for these species. Both saltmarsh and sand dunes are important nesting habitats for oystercatcher, which in the UK are most abundant on the east coast of Scotland (Gibbons *et al.* 1993). Breeding ringed plovers nest in sandier areas along the coast (Davidson *et al.* 1991; Prater 1989), especially on Aberlady Bay and other areas on the Forth Estuary and Montrose Basin (Gibbons *et al.* 1993), which are major breeding sites in a national context for both this species and redshank (Table 5.11.2, Map 5.11.4).

The muddy and sandy shores of the Forth and Tay estuaries support one of the main concentrations of shelduck in Scotland (Gibbons *et al.* 1993). The Forth Estuary is a particularly important breeding area for shelduck (Table 5.11.3) and has high numbers in a national context. Large concentrations of eider *Somateria mollissima* occur on the Forth and Tay Estuaries (Gibbons *et al.* 1993) and non-breeding colonies are found on islands in the Firth of Forth.



Map 5.11.1 Number of confirmed breeding species characteristic of shingle, sand dunes and other dry grasslands (ringed plover, oystercatcher and shelduck) in coastal 10 km squares. Source: based on Gibbons *et al.* (1993).



Map 5.11.2 Overall breeding densities of saltmarsh breeding waders on some estuarine areas in Britain. Source: Davidson *et al.* (1991) from data in Prater (1989).

The inner Tay Estuary has one of the largest reedbed areas in Britain along its north shore, supporting nationally important numbers of water rail *Rallus aquaticus* and large numbers of sedge warbler *Acrocephalus schoenobaenus* and reed bunting *Emberiza schoeniclus* (Pritchard *et al.* 1992). The bulk of the coot *Fulica atra* population in Scotland is found in this region (Gibbons *et al.* 1993).

Many of the important areas of breeding bird habitat in the region lie within designated sites such as a National Nature Reserves (NNR) or Sites of Special Scientific Interest (SSSIs), although the sites were not necessarily chosen principally for their breeding bird interest. In addition there are a number of coastal Local Nature Reserves (LNRs)

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

Site	*Oystercatcher (pairs/km²)*	*Ringed plover (pairs/km²)*	*Lapwing (pairs/km²)*	*Curlew (pairs/km²)*	*Redshank peak (nests**/km²)*	*Snipe (pairs/km²)*	*Total wader (pairs/km²)*
Montrose Basin	24	0	31	5	54	0	114
Skinflats	4	0	13	0	36	0	53
Aberlady	0	4	40	0	72	11	124

Source: Allport *et al*. (1986). Key: *other saltmarshes in the region were not surveyed, so this is not a comprehensive listing; **for this table, redshank nest densities are treated as equivalent to pairs densities.

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

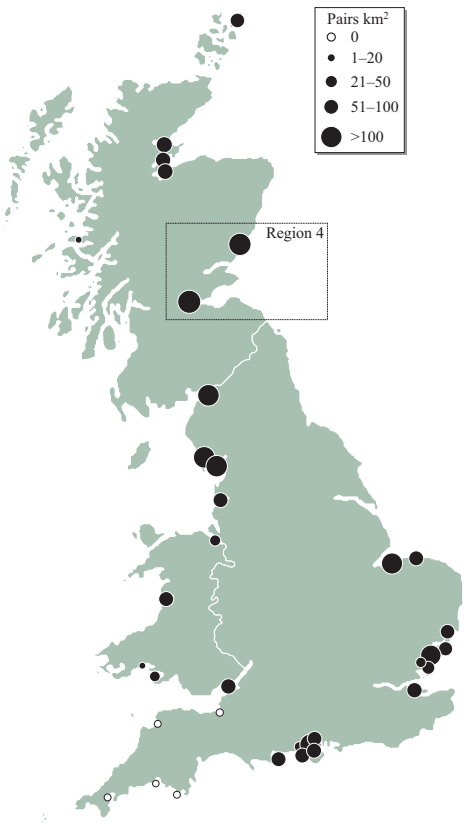
Area	*Pairs (coastal) counted in survey+*	*% GB total counted in survey+*
Fife	26	0.4
East Lothian	96	1.3
West Lothian	1	0.01
*Peebles/Roxburgh/Berwick (Scottish Borders)	13*	0.2
Angus	15	0.2
Region 4	***151***	***2.11***
Scotland	5,002	69.4
GB	7,207	

Source: Prater (1989). Key: *not all coastal; +survey coverage varied between counties, although overall in the region it was generally good.

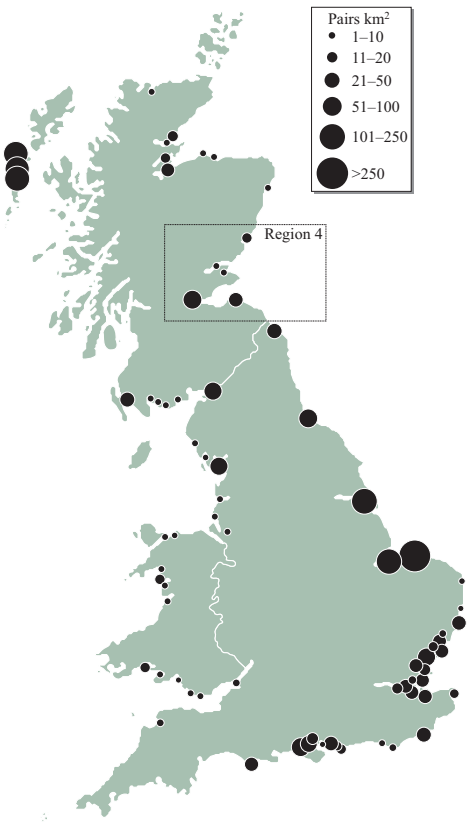
containing sand dune and estuarine habitats. Internationally important sites include a designated Ramsar site and SPA for birds (Montrose Basin), as well as undesignated areas (Forth and Tay estuaries). The RSPB also has reserves within the Forth Estuary, where management specifically for their bird populations provides ideal breeding habitat for a number of species.

5.11.3 Human activities

Incremental land claim along the soft coasts of estuaries and sand dune systems has the potential to affect breeding waterfowl populations through loss of nesting and feeding habitat. The appropriate agricultural and other management (e.g. by winter flooding) of wet grassland in the region (see e.g. Coleshaw 1995; Scholey 1995; Thomas *et al.* 1995) is of crucial importance for their wader



Map 5.11.3 Number of confirmed breeding species characteristic of wet grassland (teal, lapwing, redshank, mallard, snipe and pintail) in coastal 10 km squares. Source: based on Gibbons *et al.* (1993).



Map 5.11.4 Numbers of breeding ringed plover on estuaries in Britain (species also breeds elsewhere along the coast). Source: Davidson *et al.* (1991) from data in Prater (1989).

Table 5.11.3 Sites holding at least 45 shelduck in 1992

Site name	*Total birds*	*Pairs*	*Non-breeding birds*
Montrose Basin	110	55	0
Inner Tay Estuary	124	46	32
Eden Estuary LNR	212	90	22
Forth Estuary	1,016	322	372

Source: S. Delany (pers. comm.). Key: LNR = Local Nature Reserve.

populations (see also papers in Hötker 1991). Likewise, different grazing regimes on saltmarshes can significantly alter the density and nesting success of breeding waders through effects on vegetation composition and structure (Cadbury *et al.* 1987). Human disturbance during the breeding season may have significant effects on breeding success (Pienkowski 1992), although for the birds discussed in this section there are few good assessments of the scale of the problem for this region.

Active land management for conservation in many coastal areas has increased populations of breeding waterfowl. The management of the coastal reedbeds on the Tay Estuary is of key importance for the continued survival of their characteristic bird assemblage. Dumping rubbish in reedbeds has been highlighted as a danger to breeding birds, because it can encourage rats (Pritchard *et al.* 1992).

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 and national scales, care should be taken with their use to assess individual sites or 10 km squares. This is because the coverage of each 10 km square was not always the same, and since the atlas survey period (1988-1991) distributions of some breeding species may have changed. Between- and within-region comparisons of precise distributions and densities based on coastal 10 x 10 km squares should be undertaken with caution, as there may be greatly varying amounts of land within each square.

The coast of this region has not been studied as comprehensively as some other parts of the GB coastline and thus available data may not reflect the true importance of the region for some breeding birds. However for a number of species, extensive survey work has also been undertaken by volunteers. Usually these surveys have been organised as part of wider British surveys (e.g. for ringed plover (Prater 1989) and shelduck (Delany pers. comm.). Breeding shelduck studies on the Firth of Forth have also been carried out by Pienkowski & Evans (1982).

5.11.5 Acknowledgements

Thanks are due to D.A. Stroud and D.M. Craddock (JNCC), Simon Delany and the Wildfowl and Wetlands Trust for use of unpublished shelduck data, and to Mark Tasker (JNCC), Karen Passmore, Alan Leitch and Sandy MacLennan (SNH) and Daniel Owen (RSPB) for their useful comments.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Breeding atlas data and breeding wader data	*Development Unit, British Trust for Ornithology, Thetford, tel: 01842 750050
Breeding bird surveys - north of region	*Regional Officer, RSPB East Scotland Office, Aberdeen, tel: 01224 624824
Breeding bird surveys - south of region	*Regional Officer, RSPB South and West Scotland Office, Glasgow, tel: 0141 945 5224
Coastal breeding wildfowl data	*Wildfowl & Wetlands Trust, Slimbridge, tel: 01453 890333
Site designations	*SNH Advisory Services, Edinburgh, tel: 0131 554 9797

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

5.12 Migrant and wintering waterfowl

R.T. May & A.B. Law

5.12.1 Introduction

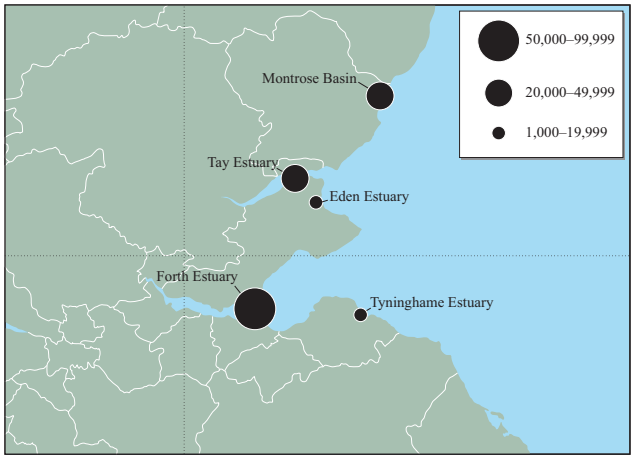
This section describes the importance of the region for waterfowl, defined as waders and wildfowl (divers, grebes, ducks, geese and swans together with coot), during their non-breeding period. The importance of offshore areas for wintering divers, grebes, seaducks and cormorant is outlined in section 5.10 and by Kirby *et al.* (1993). Common and scientific names of species are given in Table 5.12.1.

The region is of great importance for wintering waterfowl in UK and international contexts. Seven species of waterfowl occur in the region at levels of international importance on at least one site and a further 23 species occur at levels of national importance. In total, the region holds, in mid-winter, over 83,000 waterfowl - over a quarter of Scotland's total coastal wintering waterfowl (Table 5.12.2). Note, however, that such comparisons can give only a rough approximation of the relative importance of the region, since the data are uncorrected for coverage: some areas are counted more thoroughly than others. According to the WeBS national survey of wetland sites (Waters *et al.* 1996), four coastal wetland sites in the region (Montrose Basin, Tay, Eden and Forth Estuaries) support nationally important numbers of one or more overwintering waterfowl species, some of them occurring in internationally important numbers. The habitats of particular significance for wintering birds in the region are the large areas of estuarine intertidal flats and saltmarsh. Ringing studies have shown that many species (e.g. dunlin and (on non-estuarine shores) grey plover) demonstrate complex patterns of interchange between sites during the course of a winter, which means that individual sites cannot be considered in isolation (Symonds *et al.* 1984; Davidson *et al.* 1991). The relative importance of the regularly counted wetlands (estuaries and adjacent marshes) in the region is indicated on Map 5.12.1.

There can be considerable distances between birds' feeding and roosting sites (Davidson *et al.* 1991). This is particularly true of greylag goose and pink-footed goose, two species of note in the region. These species are recorded in internationally important numbers on some coastal sites but make more extensive use of lochs and reservoirs further inland, outside the region (for example Cameron Reservoir, Gladhouse Reservoir, Fala Flow, South Tayside Goose Roosts and Westwater Reservoir).

The region can increase in importance during periods of severe cold weather in continental Europe, when there may be influxes of waterfowl from other coastal regions or inland areas (Ridgill & Fox 1990). Locally, some sites also act as cold weather refuges where parts of the estuarine system freeze more slowly than other coastal and inland wetlands and so can provide open-water feeding when other sites are unavailable (Owen *et al.* 1986). For example, in severe weather in 1981/82, waterfowl populations increased substantially on the Forth Estuary (Davidson *et al.* 1991).

The estuaries of the region are also of importance for several species of migratory waterfowl in spring and autumn. The region lies on the principal migratory flyway of the east Atlantic and many birds moving to and from wintering areas on the African, Mediterranean and south-west European coasts to Arctic breeding grounds pass through and stage on the coast here. The extent to which this occurs varies between species, but the region is known to be of particular significance during spring and autumn migration periods for eider, red-breasted merganser and bar-tailed godwit.



Map 5.12.1. Distribution of main estuarine concentrations of wintering intertidal waterfowl (note: waterfowl also winter elsewhere on the coast and offshore). Size of circle proportional to 5-year mean of waterfowl numbers. Source: Waters & Cranswick (1993).

Table 5.12.1 Names of species mentioned in the text

Common name	*Scientific name*
Bar-tailed godwit	*Limosa lapponica*
Common scoter	*Melanitta nigra*
Coot	*Fulica atra*
Cormorant	*Phalacrocorax carbo*
Curlew	*Numenius arquata*
Dunlin	*Calidris alpina*
Eider	*Somateria molissima*
Golden plover	*Pluvialis apricaria*
Goldeneye	*Bucephala clangula*
Goosander	*Mergus merganser*
Great-crested grebe	*Podiceps cristatus*
Grey plover	*Pluvialis squatarola*
Greylag goose	*Anser anser*
Knot	*Calidris canutus*
Lapwing	*Vanellus vanellus*
Long-tailed duck	*Clangula hyemalis*
Mallard	*Anas platyrhynchos*
Oystercatcher	*Haematopus ostralegus*
Pink-footed goose	*Anser brachyrhyncus*
Red-breasted merganser	*Mergus serrator*
Red-throated diver	*Gavia stellata*
Redshank	*Tringa totanus*
Ringed plover	*Charadrius hiaticula*
Sanderling	*Calidris alba*
Scaup	*Aythya marila*
Shelduck	*Tadorna tadorna*
Teal	*Anas crecca*
Velvet scoter	*Melanitta fusca*
Wigeon	*Anas penelope*

Table 5.12.2 Waterfowl counts in Region 4, Scotland and Great Britain in January 1993

Area	*Total waterfowl count in January 1993*	*Number of sites counted*	*% of count in Region 4*
Region 4	***83,473***	***8***	***100***
All counted Scottish coastal sites	299,676	78	27.9
All counted British coastal sites	2,060,961	214	4.1

Source: Rose & Taylor (1993). Note: care should be taken in interpretation as count coverage varies from country to country and the data have not been corrected.

Many parts of the region's coast lie within designated sites such as National Nature Reserves or Sites of Special Scientific Interest (see Chapter 7), many of them selected wholly or partly for their migrant and wintering waterfowl interest, and Montrose Basin is a Special Protection Area and Ramsar site. The RSPB has reserves on the Forth Estuary.

5.12.2 Important locations and species

Montrose Basin, the Tay Estuary, the Firth of Forth and the Eden Estuary each support at least one species of wintering waterfowl at levels of international importance and several species at levels of national importance (Table 5.12.3). The Firth of Forth, Montrose Basin and the Tay Estuary also qualify as of international importance by virtue of each holding over 20,000 waterfowl. The Eden Estuary is also notable for its passage waterfowl, such as eider, red-breasted merganser and bar-tailed godwit and the Tay Estuary supports notable numbers of autumn passage redshank (Pritchard *et al*. 1992).

The Forth is one of the most important estuarine areas for wintering birds in Scotland and is the most significant area in this region in terms of waterfowl diversity and abundance (Bryant 1987; Cranswick *et al*. 1995; Prater 1981; Rose & Taylor 1993). It supports internationally important wintering populations of six species of waterfowl and nationally important populations of a further nineteen species. Large numbers of waders use the extensive areas of intertidal mudflat and saltmarsh, and the shallow bays provide feeding areas for diving seaduck, such as scaup and eider. The sandy bays of the Firth of Forth are used as roost sites by a variety of waterfowl.

The species compositions of assemblages of estuarine and non-estuarine migrant and wintering waterfowl in the region are shown in Figure 5.12.1. Species assemblages vary greatly with the exposure of the coast and the type of substrate (Moser & Summers 1987). On estuaries, the sheltered, muddy substrates are especially attractive to species such as dunlin, whilst sandier areas hold larger numbers of knot and oystercatcher. The non-estuarine areas in this region (predominantly soft cliffs and rocky shores with some sandy stretches) support fewer waders than the estuarine areas, although at very high densities (Table 5.12.4) compared with similar areas in other UK coastal regions (Moser & Summers 1987). On these non-estuarine shores, oystercatcher is the most common wader species, followed by knot, dunlin and curlew (Figure 5.12.1) (Moser & Summers 1987). Seaducks are the principal wildfowl interest of the non-estuarine shores.

5.12.3 Human activities

Wintering waterfowl are potentially affected, either directly or indirectly, by a wide range of human activities. Wildfowling occurs in the region, especially in the estuaries, and is a potential cause of disturbance to waterfowl, although it is generally well regulated (see also section 9.7). The impacts and regulation of wildfowling on National Nature Reserves (NNRs) have been reviewed by Owen (1992). There is generally close liaison in the regulation of wildfowling between local shooting clubs, the British Association for Shooting and Conservation (the BASC) and

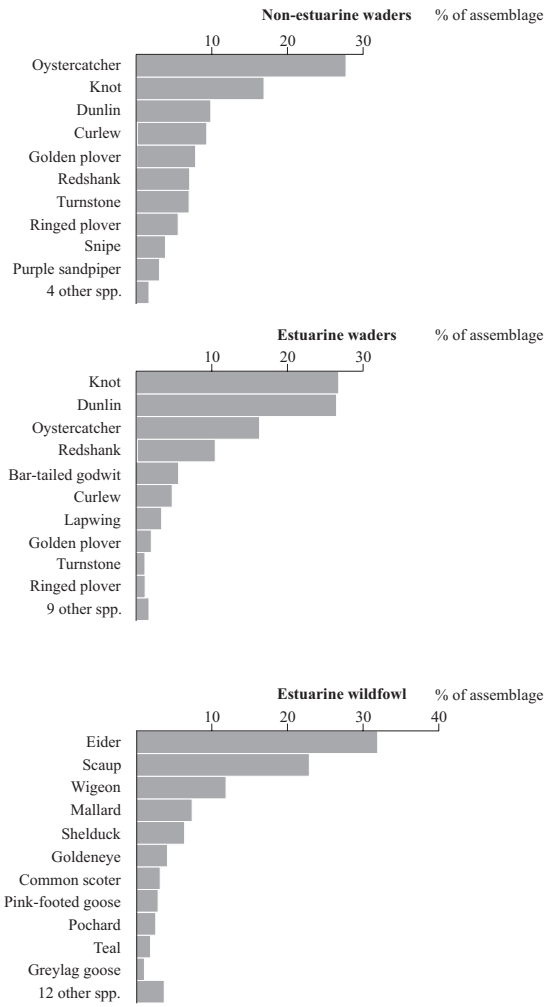


Figure 5.12.1 Relative species composition of non-breeding waterfowl assemblages on coastal areas of the region. Sources: estuarine waterfowl data from Prater (1981), non-estuarine wader data from Moser & Summers (1987).

Table 5.12.3 Wintering waterfowl numbers on on estuaries in the region

Area	*Five year mean nos. wintering waterfowl*[+]	*1994/95 peak waterfowl numbers*[+]	*1994/95 peak wildfowl numbers*[+]	*1994/95 peak wader numbers*[+]	*Species occurring at levels of national or international* importance*[#]
Montrose Basin	53,953	59,465	45,211	14,254	Pink-footed goose*, redshank*, knot*, wigeon, eider
Tay Estuary	20,361	13,492	6,549	6,943	Bar-tailed godwit*, pink-footed goose*, greylag goose*, common scoter, goldeneye, red-breasted merganser, goosander, sanderling
Eden Estuary	16,490	16,359	5,353	11,006	Bar-tailed godwit*, shelduck, oystercatcher, grey plover, common scoter, velvet scoter, black-tailed godwit
Forth Estuary	85,917	79,865	42,798	37,067	Pink-footed goose*, shelduck*, knot*, bar-tailed godwit*, redshank*, turnstone*, great crested grebe, cormorant, red-throated diver, teal, mallard, scaup, eider, long-tailed duck, common scoter, velvet scoter, goldeneye, red-breasted merganser, oystercatcher, ringed plover, grey plover, golden plover, lapwing, curlew, dunlin
Tyninghame Estuary	7,097	7,569	3,216	4,353	-

Sources: [+]Waters *et al*. (1996); [#]Cranswick *et al.* (1995), except pink-footed goose and greylag goose status in the Tay Estuary: C. Mitchell (pers. comm.). Key: *species occurring at levels of international importance. Note: winter season used by WeBS is November to March for waders and September to March for wildfowl; WeBsS data include divers, grebes and cormorants.

Scottish Natural Heritage (SNH) local staff. Owen (1992) made a number of recommendations for improving the operation of existing schemes to regulate shooting on NNRs. Shooting has been restricted at a number of Local Nature Reserves in this region, which has led to an increase in wildfowl numbers, particularly of pink-footed geese (Pritchard *et al*. 1992).

Incremental land claim has the potential to affect waterfowl populations through loss of feeding habitat (McLusky *et al.* 1992), although at important sites SSSI designation provides a planning control mechanism to limit such activity. The Forth Estuary is used for a variety of human uses, including leisure/recreation, fishing, shipping, cooling for electricity generating stations and effluent disposal (Leatherland 1987). The impact of land claim on the intertidal areas of the Forth Estuary is described by McLusky *et al*. (1992). This shows that in recent times almost 50% of the intertidal area of the upper Forth Estuary has been destroyed for a number of purposes, including agriculture, harbours and industrial development. The large-scale loss of habitat on the Forth seems to have reduced the size of some of the shorebird populations that overwinter on the estuary.

Bait digging and shellfish collection from intertidal sediments, as well as other recreational activities, 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 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 research is needed on the extent of disturbance caused by these activities and its significance for waterfowl populations in order to ensure that coastal management planning can minimise negative impacts. Other human activities include oil and industrial pollution, which are serious potential threats to many wintering waterfowl, particularly where high densities of birds occur (Gordon 1987). Coastal windfarm developments in sensitive areas also have the potential to be highly disruptive to wintering waterfowl (Crockford 1992).

5.12.4 Information sources used

As in other areas of the UK, migrant and wintering waterfowl in Region 4 are well surveyed by the Wetland Bird Survey (WeBS - organised jointly by the British Trust for Ornithology, the Wildfowl & Wetlands Trust, the Royal Society for the Protection of Birds and the Joint Nature Conservation Committee). This volunteer-based survey collates monthly counts from coastal and inland wetlands through the UK. Coastal coverage is generally good for estuaries, although the open coast is not thoroughly surveyed on an annual basis (Cranswick *et al*. 1995). The WeBS count scheme publishes an extensive annual

Table 5.12.4 Overall densities of wintering waders on non-estuarine coasts in Region 4

	Number of wader species recorded	*Total number non-estuarine waders*	*Extent of non-cliff, non-estuarine coast in county (km)*	*Extent of coast surveyed (km)*	*Overall density (birds/km coast)*
Borders	7	502	22.0	22.0	22.8
Lothian	12	6,940	40.3	40.3	172.2
Fife	13	4,755	48.8	48.8	97.4
Tayside	13	1,676	42.9	42.9	39.1

Source: Winter Shorebird Count (Moser & Summers 1987).

summary report, the most recent being Waters *et al.* (1996), covering the winter season 1994/95. This report summarises species trends, based on counts at wetlands throughout the UK. It also tabulates counts of total waterfowl numbers at all counted estuaries. It is the primary source of information on wintering and migrant waterfowl in the UK. Copies are available from either of the WeBS National Organisers listed in section 5.12.6B. The annual report can only summarise what are very detailed data, and in summary form such counts may be subject to misinterpretation for a number of reasons. Detailed count data for sites can be provided by WeBS, and inspection of these data is recommended for any planning-related activity. WeBS counts are generally undertaken at high tide, when waterfowl gather in high densities on traditional roosting areas. To complement this information, at selected estuaries, WeBS organises low-tide counts to give information on the feeding distributions of waterfowl during the intertidal period. A summary of the Tay Estuary low-tide count, carried out in 1993/94, is found in Cranswick *et al*. (1995) and low tide counts on the Forth Estuary and Montrose Basin were carried out in 1992/93 (Waters & Cranswick 1993).

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

Although now becoming slightly dated, Owen *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 this should now be supplemented by more recent count information available from WeBS and Davidson *et al.* (1991).

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

There have been a number of more detailed studies of the wintering waterfowl of this region, including studies on pink-footed geese (Fox *et al*. 1989; Newton *et al*. 1990) and studies on the Forth Estuary (Bryant 1987; Hawarth & Bryant 1988; McLusky *et al.* 1992; Symonds *et al*. 1984). Thom (1986) provides a general source on birds of Scotland.

5.12.5 Acknowledgements

Thanks are due to D.A. Stroud, D.M. Craddock and Mark Tasker (JNCC), Allan Brown and G. Moy (Fife Council), G. Russell (Institute of Ecology and Resource Management, Edinburgh University), Alan Leitch, Karen Passmore and Sandy MacLennan (SNH), C. Mitchell (Wildfowl and Wetlands Trust), and Daniel Owen (RSPB) for their useful comments.

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B. Contact names and addresses

Type of information	*Contact address and telephone no.*
High tide and low tide counts of wintering and migrant wildfowl (WeBS)	*Peter Cranswick, WeBS National Organiser (Waterfowl), The Wildfowl & Wetlands Trust, Slimbridge, tel: 01453 890333
High tide counts of wintering and migrant waders (WeBS)	*Ray Waters, WeBS National Organiser (Waders), The British Trust for Ornithology, Thetford, tel: 01842 750050
Low tide counts of wintering and migrant wader (WeBS)	*WeBS National Organiser (Low Tide Counts), The British Trust for Ornithology, Thetford, tel: 01842 750050
Site designations (Scotland)	*SNH, Advisory Services, Edinburgh, tel: 0131 554 9797
Birds in Angus, Perth and Kinross, Dundee City and Fife	*Regional Officer, RSPB East Scotland Office, Aberdeen, tel: 01224 624824
Birds in Stirling, Clackmannan, City of Edinburgh, West and East Lothian and Scottish Borders	*Regional Officer, RSPB South and West Scotland Office, Glasgow, tel: 0141 945 5224

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

5.13 Land mammals

Dr C.E. Turtle & K. Meakin

5.13.1 Introduction

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

The region is important for some of the nationally important mammal species, most of which are vulnerable and declining (Morris 1993). Four species of bat are recorded from the region: Natterer's bat *Myotis nattereri*, Daubenton's bat *Myotis daubentonii*, brown long-eared bat *Plecotus auritus* and pipistrelle *Pipistrellus pipistrellus*. The otter has a stronghold in Scotland, and there are also areas that support significant populations of red squirrels *Scuirus vulgaris*. Wildcat *Felis sylvestris* hybrids have been recorded in parts of the region.

All British bats, the otter, red squirrel and wildcat are listed under Schedule 5 of the Wildlife and Countryside Act. All British bats are listed under Annex II and the red squirrel is listed under Annex III of the Bern Convention. Table 5.13.1 summarises the of distribution of protected species in the region.

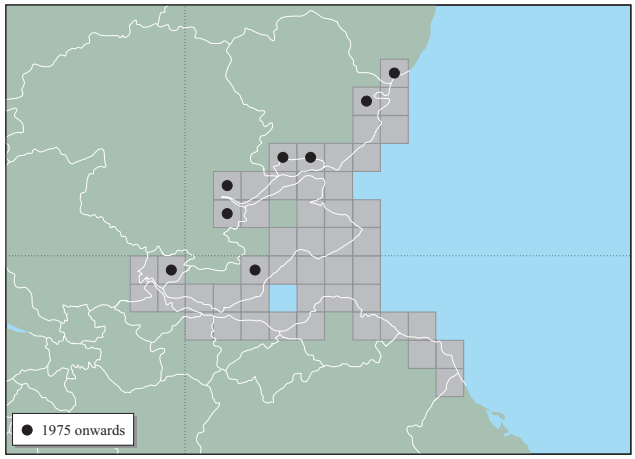
5.13.2 Important locations and species

Scotland is an important stronghold for the otter, which is extinct or endangered over most of mainland Britain (Morris 1993; Harris *et al.* 1995). Otters are the terrestrial mammals that are most associated with the coast, although analysis of habitat preferences recorded during the Otter Survey of Scotland 1991-94 (Green & Green 1997) has shown that otters are markedly less coastal on the east coast of Scotland than on the sheltered, highly dissected west coast. The more exposed topography of the east coast tends to concentrate otter activity on well developed rivers, from which they exploit the coast, particularly where there are suitable sheltered waters and coastal burns (R. Green pers. comm.).

Table 5.13.1 Recorded distribution of protected species distribution

Protected species	*Estimate of importance in region*
Natterer's bat	Rare in Fife, Central & Lothian; absent elsewhere
Daubenton's bat	Absent from Tayside; rare elsewhere
Brown long-eared bat	Absent from Scottish Borders; rare elsewhere
Pipistrelle bat	Occasional in Tayside; frequent elsewhere
Red squirrel	Occasional in Tayside, Fife, Scottish Borders; rare elsewhere
Otter	Frequent in Tayside; rare elsewhere
Wildcat	Rare in Tayside; absent elsewhere

Source: Arnold (1993).



Map 5.13.1 Recorded distribution of the otter by coastal 10 km square. Records from 1975 onwards. Source: Arnold (1993).

Map 5.13.1 shows the recorded regional distribution of the otter by coastal 10 km squares (Arnold 1993).

There is strong evidence that otters are increasing in the region. Successive otter surveys of Scotland (Green & Green 1980, 1987, 1997) have demonstrated a continuing expansion in range, particularly along the north Tayside coast, for which there is now complete survey coverage. There are also reliable accounts of otters spreading into urban areas such as the Water of Leith in Edinburgh (R. Green pers. comm.).

The national bat habitat survey (Walsh & Harris 1996a, b) includes coastal habitats and demonstrates that bats use the coastline for foraging where there is suitable habitat with shelter and flight lines to the feeding areas. Recent records show that Daubenton's bats are present in Tayside, and brown long-eared bats have been confirmed in the coastal region of the Scottish Borders (Haddow & Herman 1995). Sea caves at East Wemyss are known to be used by a small number of pipistrelles as winter roosts (N. Mortimer pers. comm.) and there have been casual observations of bats around the sea caves at St. Abb's Head (A. Panter pers. comm.).

Red squirrels are vulnerable in England and Wales but are locally common in Scotland. Red squirrels are dependent on large conifer plantations with good seed crops and relatively low tree densities. Red squirrels are most unlikely to be present in broadleaved woodlands where grey squirrels are resident. Increased afforestation has led to an expansion in red squirrel range, and they now occupy more 10 km squares in Scotland than they did 50 years ago (Gurnell & Pepper 1993). A compilation of records carried out by Biological Records Centres and the Scottish Wildlife Trust shows that the region is a stronghold for red squirrels, which are widespread in conifer plantations along the coast, such as at Tentsmuir in Fife (Biological Recording in Scotland Campaign (BRISC) unpublished data). Red squirrels have also been recorded from plantations in Angus, Dundee, Perth and Kinross, Fife, Lothian and the Scottish Borders (TGUK 1992). In Tayside

populations still persist in scattered woodlands along river valleys (A. Somerville pers. comm.) and in the landscaped woodlands of estates such as those around Eyemouth and Coldingham in the Scottish Borders (A. Panter pers. comm.).

Wildcats can utilise a variety of habitats, including woodland, moorland, grassland and marsh. In the UK the wildcat is restricted to Scotland and is on the edge of its northerly range in Europe,where the population is diminishing (Easterbee *et al.* 1991). There is some doubt over the true distribution of this species, because of possible hybridisation with feral cats (D. Balharrie pers. comm.). During the 1983-87 wildcat survey no wildcats were recorded in the region, which is at the south-easterly limit of the wildcat's distribution in Scotland (Easterbee *et al.* 1991); although hybrids with domestic cats have been reported from Angus and Deeside (A. Kitchener pers. comm.).

The pine marten is extinct over most of England and Wales (Morris 1993) and the main population is confined to the Scottish Highlands (Verlander 1983). Pine martens are dependent on large, mixed conifer plantations (D. Balharrie pers. comm.). Young forestry plantations with coarse grassland, heather and grass moorland, or grass and scrub rides are a key element, as these habitats support high numbers of field voles, the principal prey item (Gurnell *et al.* 1994). A dead pine marten was found killed on a road at Lunan Bay, Angus, during a recent survey of the pine marten in Scotland (Balharrie *et al*. 1996). Pine martens are unable to survive in solely maritime habitats (D. Balharrie pers. comm.) and this record is not proof of a resident breeding population.

5.13.3 Human activities

The region includes some of the best agricultural land in Scotland, and parts of the coastal strip are heavily populated. Improvements in water quality are allowing otters to expand along river systems, but there are still localised pollution problems from heavy industries around the Firth of Forth and Tay and localised pollution from disused mines and sewage (A. Somerville pers. comm.). Habitat fragmentation is a continuing problem for bats and red squirrels. Inappropriate deciduous woodland planting could further reduce the red squirrel population by facilitating the spread of grey squirrels. Reduced persecution and an increase in forestry plantation have contributed to an expansion in numbers and distribution of the wildcat in Scotland (Morris 1993). Although they are known to use sheltered areas of coast (Easterbee *et al.* 1991), much of the region's coastline is probably too intensively farmed for them and the industrialised central belt of Scotland acts as a barrier to recolonising the south (Easterbee *et al.* 1991). Hybridisation is also more likely here, on the edge of the wildcat's range (A. Kitchener pers. comm.).

5.13.4 Information sources used

There are no reliable estimates of the numbers of mammals in the region that could be used to assess the relative importance of the region in national terms. Using data from Arnold (1993) an estimate has been made for the occurrence of mammals within the coastal area (Table 5.13.1), although these records are incidental rather than comprehensive. As a general observation, 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 (Morris 1993). However, there have been no specifically coastal mammal surveys within this region and there have been no nationally comprehensive surveys for any of the bats. Therefore, even the nationally comprehensive surveys have their limitations when assessing the importance of the coast of this region. A red squirrel survey was carried out in 1991 (TGUK 1992), based on questionnaires sent to all Timber Growers UK members. There have been three systematic otter surveys of Scotland, the first between 1977-79 (Green & Green 1980), a re-survey between 1984-85 (Green & Green 1987) and another between 1991-94 (Green & Green 1997)

5.13.5 Acknowledgements

The authors would like to thank D. Balharrie (SNH), N. Mortimer (Countryside Ranger, Craigtoun Country Park, St. Andrews), R. Green (The Vincent Wildlife Trust), A. Kitchener (National Museum of Scotland), A. Somerville (Scottish Wildlife Trust) and A. Panter (the Borders Bat Group) for their valuable information and their time.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
National site and species	*SNH Advisory Services, Edinburgh, tel: 0131 554 9797
Local site and species	*SNH Area Office, Perth, tel: 01738 639746
Local site and species information: Fife, Clackmannanshire, Stirling, Falkirk	*SNH Area Office, Stirling, tel: 01786 450362
Local site and species information: West Lothian, Edinburgh, Midlothian, East Lothian, Scottish Borders	*SNH Area Office, Galashiels, tel: 01896 756652
Local site and species information	*Conservation Officer, Scottish Wildlife Trust, Edinburgh, tel: 0131 312 7765
Bats	Prof. P. Racey, Scottish Bat Group, Dept of Zoology, University of Aberdeen, Tillydrone Avenue, Aberdeen AB9 2TN, tel: 01224 27200
Bats in the Lothian area	J. Herman, Lothians Bat Group, Natural History Department, National Museum of Scotland, Chambers Street, Edinburgh EH1 1JF, tel: 0131 225 7534
Bats in Dundee and Angus area	R. Brinklow, Angus Bat Group, Dundee Museum, Barrack Street, Dundee DD1 1PG, tel: 01382 23141
Bats in Perth and Kinross area	Mike Taylor, Perth Museum and Art Gallery, 78 George Street, Perth PH1 5LB, tel: 01738 632488
Bats in the Fife area	Keith Cohen, Fife Bat Group, Fife Countryside Ranger Service, Pitcairn Centre, Coull, Glenrothes, Fife KY5 8BA, tel: 01592 741212

Type of information	*Contact address and telephone no.*
Bats in the Borders area	*A. Panter, Borders Bat Group, SNH, Galashiels, tel: 01896 756652
Otters	J. & R. Green, The Vincent, Wildlife Trust Otter Rehabilitation Centre, Barjarg, Girvan, Ayrshire KA26 0RB, tel: 01465 821225
Red squirrels	*SNH HQ, Edinburgh, tel: 0131 447 4784
Red squirrels in Fife	Sarah Warrener, Fife Squirrel Group, FWAG, 33 Castlefield, Cupar, Fife, tel: 01334 656546
Red squirrels in Perth and Kinross	Helen Cole, Perthshire Squirrel Group, National Trust for Scotland, Fagus, Main Street, Killin FK21 8UY, tel: 01567 820988
Red squirrels in Lothians	Harriet Palmer, Lothian Squirrel Group, SAC, West Mains Road, Edinburgh EH9 3JG, tel: 0131 667 1041
Red squirrels in Scottish Borders	Greg MacFarlane, Forestry Authority, North Wheatlands Mill, Wheatlands Road, Galashiels TD1 2HQ, tel: 01896 750222
Wildcats	A. Kitchener, Natural History Department, National Museum of Scotland, Chambers Street, Edinburgh EH1 1JF, tel: 0131 225 7534
General mammal information	The Mammal Society, Unit 15, Cloisters House, Cloisters Business Centre, 8 Battersea Park Road, London SW8 4BG, tel: 0171 498 4358
General mammal information	*Institute of Terrestrial Ecology, Monks Wood, tel: 01487 773381

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

5.14 Seals

C.D. Duck

5.14.1 Introduction

Common (or harbour) seals *Phoca vitulina* may be seen throughout the region but are concentrated in the north. Over 2% of the GB population of common seals are found in the region (Table 5.14.1). Grey seals *Halichoerus grypus* are also present throughout the region. The Isle of May is the only significant breeding site, producing over 4% of pups born in GB (Table 5.14.1). Large numbers of grey seals haul-out on the Abertay and Tentsmuir Sands during the summer.

5.14.2 Important locations

Most common seals in the region can be found at the mouths of the River Tay and the River Eden, with the biggest haul-out sites on the Abertay and Tentsmuir Sands. Smaller haul-out sites include Buddon Ness, off Broughty Ferry, sandbanks in the upper Tay and the south Fife shore and skerries between Seafield and Dalgety Bay in the Firth of Forth (Map 5.14.1; Table 5.14.2). A small number of common seals can be found in the Montrose Basin. The common seal breeds in the outer Firth of Tay, its only breeding site on the east coast between the Moray Forth and the Tees Estuary.

Grey seal breeding and haul out sites in the region are listed in Table 5.14.3 and shown on Map 5.14.2. The only significant grey seal breeding site in the region is the Isle of May, which was the fifth biggest in GB during the 1993 breeding season. Grey seals at the mouth of the River Tay are studied as part of a programme using photo-identification to determine the movements and numbers of grey seals in the North Sea (Hiby 1994). Scientific studies have been carried out on grey seals on the Isle of May since the mid 1980s (Harwood & Wyile 1987; Wyile 1988; Hall *et al.* 1997; Pomeroy *et al.* 1996). These studies have shown that a number of the adult females now breeding at the Isle of May previously bred at the Farne Islands (Harwood & Wyile 1987), implying movement from the Farnes to the Isle of May. During the summer, large numbers of grey seals haul-out at the mouth of the River Tay at Buddon Ness,

Map 5.14.1 Distribution of common seals in the region in August. Size of circle represent the numbers of seals at each location; site numbers refer to Table 5.14.2. Sources: Sea Mammal Research Unit, University of Aberdeen, SNH, SOAEFD.

Abertay and Tentsmuir Sands, with smaller numbers scattered throughout the region, and there is considerable interchange of grey seals between the Abertay and Tentsmuir Sands and the Farne Islands (Hiby 1994). In the Firth of Forth, grey seals haul-out as far upstream as Kincardine Pier. Small numbers of pups are born on Inchcolm, Eyebroughy, possibly on Bass Rock and along the cliff-bound coast by Fast Castle north of St. Abb's Head.

5.14.3 Human activities

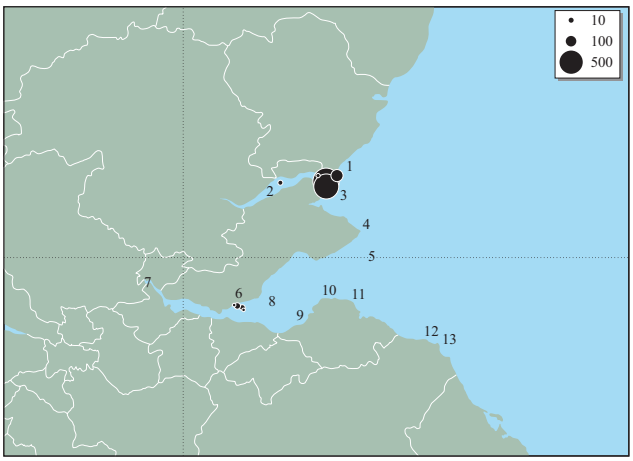
Boat tours that include seal-watching operate out of Crail and Anstruther to the Isle of May, and boats can be chartered to visit seals on Inchcolm.

An intensive, mainly Danish, sandeel fishery has been operating over the Wee Bankie, east of Fife Ness. Sandeels form a major component of grey seal diet at certain times of the year (Hammond *et al.* 1994a, b) and the effects of this fishery on grey seals in the region are not known. Commercial salmon netting occurs in the River Tay and at a

Table 5.14.1 Numbers of common and grey seal in the region in relation to the rest of GB

County	*Common seals*		*Grey seals*		
	Number of seals	*% of GB total*	*Pup production in 1993*	*% of GB total*	*Associated population ≥1 year old*
Dundee, Angus, Perth and Kinross	150	0.6	0	0	0
Fife	500	1.7	1,500	4.4	5,100
East Lothian & Scottish Borders (numbers are estimated)	~10	0.04	<25	<0.07	880
Region 4	***650***	***2.3***	***1,500***	***4.4***	***5,980***
Scotland	26,400	93.1	31,000	91.6	105,300
GB total	28,350	-	33,850	-	155,000

Sources: SMRU, Fife and East Lothian District Councils, Scottish Wildlife Trust, National Trust for Scotland.



Map 5.14.2 Grey seal haul-out sites. Size of circle represents the number of seals at each haul-out location. Site numbers refer to locations in Table 5.14.3. Sources: Sea Mammal Research Unit, University of Aberdeen, SOAEFD.

Table 5.14.2 Common seal numbers in areas regularly surveyed

Site no. on Map 5.14.1	*Area surveyed*	*Grid ref.*	*No. of seals*	*% of region total*
1	Montrose Basin	NO700570	[5-10]	1.6
2	Buddon Ness	NO550300	89	14.2
3	Broughty Ferry	NO490310	64	10.2
4	Upper Tay (Road Bridge to Newburgh)	NO290220-NO410290	53	8.5
5	Abertay and Tentsmuir Sands	NO560290-NO520260	289	46.2
6	Eden Estuary	NO500210	80	12.8
7	South Fife coast and Firth of Forth islands	NT284884-NT180830	[10-20]	[3.2]
8	Aberlady Bay	NT450800	[10]	[3.2]
9	Tantallon	NT598854		
10	Belhaven Bay	NT640800		

Sources: SMRU; Scottish Wildlife Trust, East Lothian District Council. Figures within brackets are estimates.

dwindling number of sites along the Montrose and East Lothian coasts. Catches have declined in recent years and seals in the vicinity of nets are liable to be shot. Objections have been raised by the East Fife fishing lobby to the lack of restrictions on increasing seal, particularly grey seal, populations. In the Montrose Basin Local Nature Reserve seals are protected against shooting by bylaws.

5.14.4 Information sources used

Surveys of common seals on sandbanks in the region are carried out by the Sea Mammal Research Unit (SMRU) in August of alternate years, using conventional aerial photography from a fixed-wing aircraft. Similar surveys of grey seal pup production at the Isle of May are carried out annually. Observations of seals at smaller sites in the Firth of Forth were provided by local reserve rangers, Scottish Natural Heritage and Scottish Wildlife Trust staff.

5.14.5 Acknowledgements

Thanks go to Caroline Gallagher, Pete Kinnear and Ian McGowan (SNH), Neil Clark, Roger Powell and Ian Thomson (East Lothian Council), Bobby Anderson (John Muir Country Park Ranger Service), David Fairlamb (RSPB, Vane Farm), Rick Goater (SWT), Les Hatton (Fife Ranger Service), Kevin Rideout (SWT and NTS) and Ailsa Hall, Paddy Pomeroy and Bernie McConnell (SMRU) for providing information and for commenting on an earlier draft. Thanks are also due to Kathy Duncan, Alan Leitch and John Baxter (SNH), Allan Brown (Fife Council), Alan Burdekin (SOAEFD) and Daniel Owen (RSPB) for their useful comments.

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Table 5.14 3 Grey seal pup production and important haul-out sites

Site no. on Map 5.14.2	*Site*	*Grid ref.*	*Important haul-out site*	*Important breeding site*	*No. of pups born*	*Proportion of Region total*
1	Buddon Ness	NO550300	✓			
2	Upper Tay	NO342273	✓			
3	Abertay and Tentsmuir Sands	NO560290-NO520260	✓			
4	Fife Ness	NO645115				
5	Isle of May	NT660986		✓	1,500	98.6
6	Kincardine Pier	NS928866	✓			
7	Inchcolm and Forth islands	NT180830				
8	Inchkeith	NT290820				
9	Long Craigs, Portobello	NT420765				
10	Eyebroughy and Fidra	NT494863, NT510870				
11	Bass Rock	NO602873			<20	<1.0
12	Fast Castle	NT860710				
13	St. Abb's Head	NT913695				

Sources: SMRU; Fife and East Lothian District Councils.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
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
Seals in Scotland	*Scottish Wildlife Trust, Edinburgh, tel: 0131 312 7765
Seals in Fife	*SNH, Perth Area Office, Perth, tel: 01738 639746
Seals in Angus, Dundee City and Perth and Kinross	*SNH, Stirling Area Office, Stirling, tel: 01786 450362
Seals in Lothians and Scottish Borders	*SNH, Galashiels Area Office, Galashiels, tel: 01896 756652
Seals in Montrose Basin	Scottish Wildlife Trust, Montrose Basin Wildlife Centre, Rossie Braes, Montrose DD10 9TJ, tel: 01764 678773
Seals in the Eden Estuary	Countryside Ranger Service, Craigtoun Country Park, St. Andrews, Fife KY16 8NX, tel: 01334 472151
Seals along the Lothian coast	*East Lothian Council, Department of Leisure and Tourism, Haddington, tel: 01620 827827
Seals between North Berwick and Dunbar	John Muir Country Park Ranger Service, Dunbar Town House, Dunbar, East Lothian EH42 1ER, tel: 01368 863886
Seals around St. Abb's Head	Scottish Wildlife Trust and National Trust for Scotland, The Ranger's Cottage, Eyemouth, Berwickshire TD14 5QF, tel: 01890 771443
Seal rescue and rehabilitation centre	SSPCA, Animal Welfare Centre, Masterton Road, Middlebank, Fife KY11 5QN, tel: 01383 412520
General information on the marine environment	St. Andrews Sea Life Centre, The Scores, St. Andrews, Fife KY16 9AS, tel: 01334 474786
General information on the marine environment	Deep Sea World, North Queensferry, Fife KY11 1JR, tel: 01383 411411
General information on the marine environment	*SNH Advisory Service, Edinburgh, tel: 0131 554 9797

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

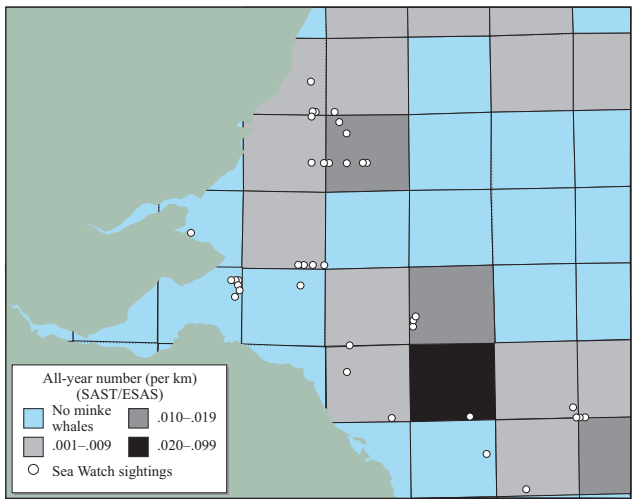
5.15 Whales, dolphins and porpoises

Dr P.G.H. Evans

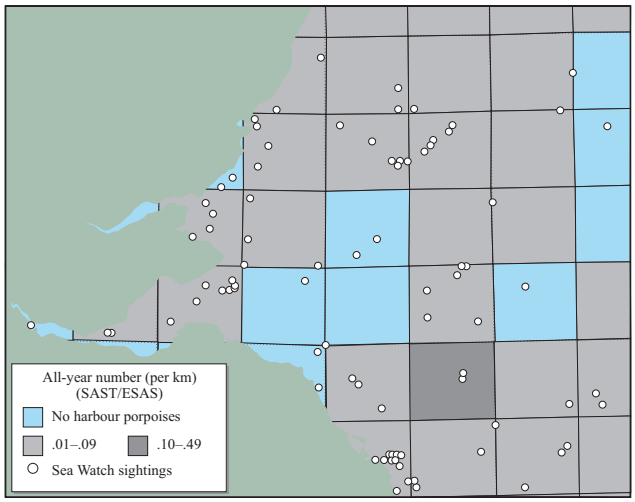
5.15.1 Introduction

The coastal waters of south-east Scotland are moderately rich in cetaceans (whales, dolphins and porpoises), with six species (22% of the 27 total UK species) recorded regularly in the region. The commonest species in nearshore waters (within 60 km of the coast) are the harbour porpoise *Phocoena phocoena* and white-beaked dolphin *Lagenorhynchus albirostris*, followed by minke whale *Balaenoptera acutorostrata*, with bottlenose dolphin *Tursiops truncatus*, white-sided dolphin *Lagenorhynchus acutus* and killer whale *Orcinus orca* as less common visitors to the region. Other cetacean species recorded in the region since 1980 include sperm whale *Physeter macrocephalus*, northern bottlenose whale *Hyperoodon ampullatus*, Sowerby's beaked whale *Mesoplodon bidens*, common dolphin *Delphinus delphis*, Risso's dolphin *Grampus griseus*, and long-finned pilot whale *Globicephala melas*. 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 listed in Annex II of the EC Habitats & Species Directive as species whose conservation requires the designation of Special Areas of Conservation (see also section 7.2).



Map 5.15.1 Minke whale: all-year number sighted per km of Seabirds at Sea survey and sightings reported to the Sea Watch sighting system. Sources: Evans (1992), JNCC Seabirds at Sea Team.



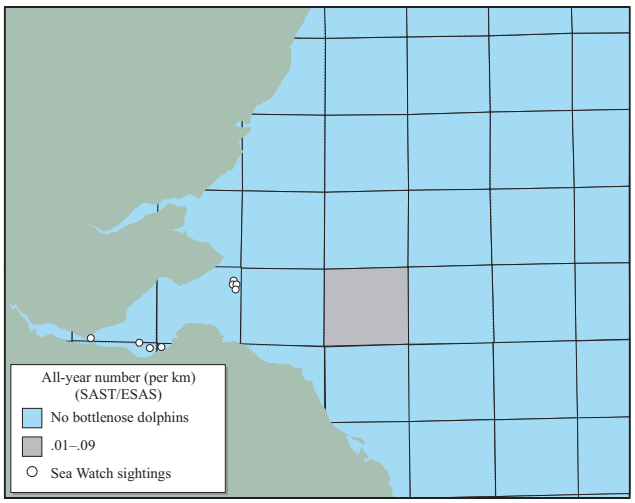
Map 5.15.2 Harbour porpoise: all-year number sighted per km of Seabirds at Sea survey and sightings reported to the Sea Watch sighting system. Sources: Evans (1992), JNCC Seabirds at Sea Team.

5.15.2 Important locations

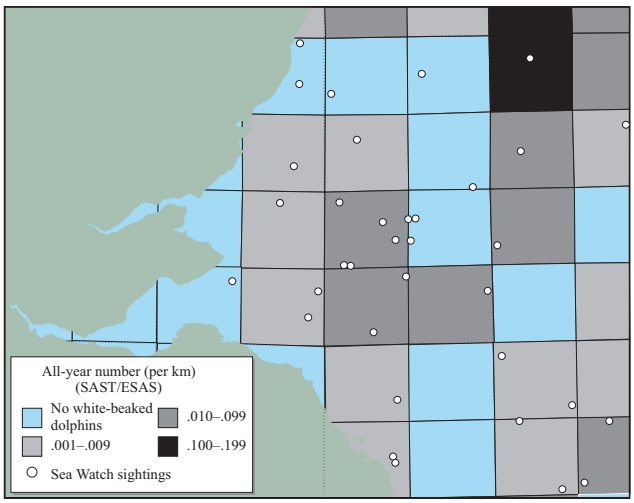
Table 5.15.1 lists the species that occur regularly in the region; Maps 5.15.1 - 5.15.4 show the distribution in the region of minke whale, harbour porpoise, bottlenose dolphin and white-beaked dolphin respectively. Harbour porpoises are recorded in small numbers in most months of the year, but mainly between July and September. Most nearshore sightings are from those locations where systematic watches have been conducted, for example St. Abb's Head and the Isle of May, and it is likely that the species is fairly evenly distributed throughout the region. Harbour porpoises have occasionally been seen upstream of the Forth Bridges. Other cetacean species, such as minke whale and bottlenose and white-beaked dolphins, are sometimes seen in coastal waters, most often from the Isle of May in the Firth of Forth between June and September.

Table 5.15.1 Cetacean species recorded regularly in the region

Species	*Status, distribution & seasonal occurrence*
Minke whale *Balaenoptera acutorostrata*	Small numbers in the Firth of Forth (e.g. around Isle of May) and offshore between June and September
Harbour porpoise *Phocoena phocoena*	Small numbers in nearshore waters along the coasts of Tayside and east Lothian and in the Firth of Forth; most sightings between July and September
Bottlenose dolphin *Tursiops truncatus*	Infrequent in nearshore waters and around Isle of May, mainly between June and September
White-sided dolphin *Lagenorhynchus acutus*	Deep water species recorded generally more than 10 km from the coast; most sightings between July and September
White-beaked dolphin *Lagenorhynchus albirostris*	Commonest dolphin in the region, occurring mainly offshore, mostly between June and September
Killer whale *Orcinus orca*	Infrequent in Firth of Forth between March and June, and occasionally offshore



Map 5.15.3 Bottlenose dolphin: all-year number sighted per km of Seabirds at Sea survey and sightings reported to the Sea Watch sighting system. Sources: Evans (1992), JNCC Seabirds at Sea Team.



Map 5.15.4 White-beaked dolphin: all-year number sighted per km of Seabirds at Sea survey and sightings reported to the Sea Watch sighting system. Sources: Evans (1992), JNCC Seabirds at Sea Team.

Minke whale, killer whale, harbour porpoise, white-beaked dolphin and white-sided dolphin have all been recorded in offshore waters, mainly between July and September. There is little evidence for any particular offshore location being favoured over others.

5.15.3 Human activities

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).

There have been reports from the region of small cetaceans (mainly harbour porpoises, but also white-beaked and/or white-sided dolphins) being killed accidentally in fishing gear (Northridge 1988). A variety of fisheries can result in the accidental capture of cetaceans, but the greatest impact in UK waters appears to come from bottom-set gill nets, including tangle nets and nets set around wrecks, most frequently affecting harbour porpoises and common dolphins. Purse seine and midwater trawling can also lead to bycatches, whilst creel lines sometimes entangle minke whales.

Contaminant levels in cetaceans from the region are poorly known. Mean total PCB levels of 24 harbour porpoises sampled from eastern Scotland amounted to only 4 ppm, but the only animal from this region in the sample, a harbour porpoise stranded in July 1990 on the Fife coast, contained 17.08 ppm total PCB (Kuiken *et al.* 1994). The total DDT in the blubber of two female harbour porpoises stranded in the region during 1992 was 120 ug kg^{-1} in one and 3,060 ug kg^{-1} in the other, and dieldrin levels were 350 ug kg^{-1} and 490 uk kg^{-1} respectively (Wells *et al.* 1994).

Recreational activities (speedboats, jet skis etc.) in the region occur mainly in the inner Firth of Forth and Firth of Tay, although some small boat activity (e.g. powered vessels) takes place at small ports such as North Berwick, Aberdour, Kirkcaldy, St. Andrews, Dundee, Carnoustie, Arbroath and Montrose. Such vessels pose threats of direct physical damage from collisions as well as disturbance from the high frequency noise they generate (Evans *et al.* 1992). Heavy shipping may also disturb cetaceans, but most of the sound produced by vessels with large engines is at frequencies below 1 kHz, thus overlapping more with minke whales (and other baleen whale species not resident in or regular visitors to this region) than with dolphins and porpoises (Evans 1987, 1996). However, vessels can also generate high-frequency (>1 kHz) sound overlapping the frequencies used by small cetaceans, and vessel avoidance and increased dive times by bottlenose dolphins and harbour porpoises have been reported by Evans *et al.* (1992, 1994).

Underwater sounds from seismic activities connected with oil and gas exploration in the North Sea involve lower frequencies and therefore are most likely to affect baleen whales, which communicate primarily at these frequencies (20-500 Hz). Nevertheless recent studies indicate that other cetaceans may also be disturbed by seismic surveying, as they are sighted less frequently, either acoustically or visually, during seismic surveys (Goold 1996). It is possible that porpoises are affected (Baines 1993), perhaps indirectly by changing the distribution of their fish prey (Evans & Nice 1996).

ASCOBANS (Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas) is an international agreement between countries bordering the North and Baltic Seas that promotes 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.

A code of conduct for boat users has been produced (Sea Watch Foundation and UK Mammal Society 1992) and Scottish Natural Heritage has a dolphin awareness scheme for Scotland, although this currently concentrates on the Moray Firth.

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) (Evans 1992) and the strandings scheme organised by the Natural History Museum in London (1913-present), run within Scotland by SAC Veterinary Investigation Centre, Inverness (Sheldrick *et al*. 1994). Systematic land-based watches have been carried out by the wardens of the Isle of May bird observatory and at St. Abb's Head, Scottish Borders. Offshore effort-related data have been collected by NERC and SOAFD research vessels, merchant ships and yachts, and by JNCC's Seabirds at Sea Team as part of seabird surveys of the North Sea, mainly between 1979 and 1986 (Northridge *et al*. 1995). Coverage is generally better in nearshore waters than offshore and effort has been highest between the months of April and September when sea conditions tend to be best.

A major international collaborative programme, the Small Cetacean Abundance in the North Sea (SCANS) project, has aimed to provide a baseline assessment of abundance from intensive survey work in July 1994 (Hammond *et al*. 1995). No SCANS surveys were undertaken in the Firth of Forth, although surveys were conducted further offshore. Porpoises were sighted regularly from the Firth of Forth into the North Sea; no white-beaked dolphins were sighted and only one white-sided dolphin; small numbers of minke whales were sighted regularly east of the Firth of Tay and east-north-east of Berwick.

In his dietary studies during the 1960s, involving set gill nets for cod, Rae (1965, 1973) made use of bycaught porpoises, mainly from the ports of Montrose, Johnshaven and Arbroath.

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 C.J. Camphuysen, I. Cumming, M.P. Harris, P.K. Kinnear, P. Lawrence, M. Leopold, M. Tasker, S. Wanless, A. Webb and B. Zonfrillo. Thanks also go to Anne Brown, Kathy Duncan and John Baxter (SNH), G. Russell (Institute of Ecology and Resource Management, Edinburgh University) and John Hisleys (SOAEFD) for comments on the draft text.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Cetacean strandings	Dr D. George/A. Muir, Natural History Museum, Cromwell Road, London SW7 5BD, tel: 0171 938 8861.
Cetacean strandings, Scotland	Scottish Strandings Coordinator, SAC Veterinary Services, Drummond Hill, Inverness, tel: 01463 243030
Cetacean sightings & surveys	Dr P.G.H. Evans, Sea Watch Foundation, c/o Dept. of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, tel: 01865 727984
Cetacean sightings & surveys	*Seabirds & Cetaceans Team, JNCC Aberdeen, tel: 01224 655702
Cetacean organochlorine & heavy metal levels	Dr R.J. Law, Centre for Environment, Fisheries & Aquaculture Sciences, Burnham-on-Crouch Laboratory, Remembrance Avenue, Burnham-on-Crouch, Essex CM0 8HA, tel: 01621 787200
Bottlenose dolphin studies	Dr P. Thompson/B. Wilson, University of Aberdeen, Department of Zoology, Lighthouse Field Station, George Street, Cromarty IV11 8YJ, tel: 01381 600548
SCANS Project	*European Wildlife Division, Department of the Environment, Bristol, tel: 0117 987 8000
General information on the marine environment	*Maritime Unit, SNH, Advisory Services, Edinburgh, tel: 0131 554 9797

*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.

The rivers Tay and Forth reach deep into fertile areas. They are central to the intensive settlement of this lowland region, providing routeways for the earliest colonists and later the spread of ideas and technology. They also gave access to marine resources, whether shellfish, fish and seabirds as food or salt and seaweed as raw materials, and acted as maritime highways through which commerce could develop. The sea routes were also of strategic importance during tribal power struggles of the Early Medieval period and later conflicts between Scotland and England. In more recent centuries the coal deposits of Fife and the Lothians have provided both a stimulus to industry and a commodity for export. The development of road and rail transport on north-south routes encouraged important engineering solutions to the bridging of the east-west rivers.

The diversity and long history of human activity in the region has left it with some outstanding monuments, although in Fife and Tayside the range of prehistoric monuments is in some respects more restricted than in other parts of Scotland (Walker & Ritchie 1987). However, intensive land-use and urban development prejudice the

Map 6.1.1 Archaeology: locations mentioned in the text.

survival of archaeological remains. Modern agricultural methods, for example, can obliterate evidence of early fields and prehistoric settlements. The development of modern dock complexes, such as those at Leith, obscures the earlier shorelines used by fishermen and merchants. Medieval ports are sealed beneath modern cities; excavations at Perth have produced some of the most important evidence for Medieval towns in Scotland.

Changes in sea level complicate the task of tracing coastal communities into prehistory. Following the last ice age, sea level rise before 6,600 BP inundated areas of human habitation (Woodman 1989). In contrast, the subsequent uplift of land has placed some evidence of coastal activity inland on the raised beaches of the Forth and Tay (Price 1982). Just as archaeological evidence is not confined to standing monuments, so it is not confined to dry land, and finds of former land sites may be anticipated on the sea bed. Here conditions provide the best opportunities for the preservation of organic materials.

Shipwrecks are the most commonly recognised sea-bed sites. Written accounts tell of many ship losses. The records are comprehensive for the 19th century, relatively complete for the 18th, and patchy for the 14th to 17th centuries. When records of individual losses are scarce, documentary evidence for sea-borne trade and hazards to navigation can indicate the levels of shipping loss. The potential sea-bed resource may be inferred from this. For example, the construction of a light on the Isle of May in the 17th century was an early response by shipowners and merchants to the high financial penalties suffered as a result of heavy shipping losses in the Forth. Comparable inferences can be made for the prehistoric period by looking at archaeological evidence for trade and seafaring.

St. Andrews, Fife, has had a long and turbulent history, reflecting its position on the open North Sea coast, where it was the target of Viking raids for centuries. Its monastery, founded by early Pictish Christians, was a destination for pilgrims in mediaeval times, and the well-planned burgh still forms the heart of the town today. Photo: MNCR, JNCC.

6.2 History and archaeology of the region

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

Flint tools, middens and hearths of Mesolithic hunter-gatherers have been found in the Forth and Tay river valleys. A dugout from Friarton, Perth, is probably contemporary. Sites such as large shell mounds at Grangemouth show that marine resources of fish, waterfowl and seabirds were seasonally exploited. With the exception of sites on the Inner Hebrides (Regions 14 and 16), Morton, Tentsmuir, provides the main dating evidence for the earliest habitation in Scotland. The excavations revealed foundations of light shelters, hearths and middens on a site that was probably then on the coast. Possible campsites have also been found at Dundee and Broughty Ferry.

This region adopted crop cultivation and animal husbandry by about 4,000 BC. The technology probably spread northwards along the coast from Yorkshire (Ritchie & Ritchie 1985). Such cultural contact is suggested by the burial monuments of this Neolithic period. These are earthen long barrows, which are found in East Lothian and in Scottish Borders. North of the Forth they were either less widely adopted or have suffered greater destruction. Cultivation, animal husbandry and hunter-gathering clearly co-existed. Henge monuments are a distinctive feature of the region. These circular ditched enclosures, sometimes associated with timber circles and groups of standing stones, probably served a ceremonial and ritual function and point to a high level of social organisation. Reassessment of the early henge at Balfarg places it in a group with the Stones of Stenness in Orkney.

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

During the 3rd and 2nd millennium BC new influences came into play. The economic structure is not known, but farming intensified and the construction of henges and the use of communal barrows for burial declined. The numerous hut-circles and field systems in Perthshire probably date to this period and represent farming settlements. Tools, implements, adornments and weapons manufactured by specialist craftsmen indicate a society with surplus produce for exchange. A bronze dagger from a burial mound at Collessie, Fife, is Scotland's earliest dated metalwork. Hoards of scrap bronze from Duddingston Loch and Arthur's Seat, Edinburgh, are seen as evidence of smiths working nearby. Moulds found at Traprain Law were used for casting distinctive bronze swords, examples of which have been found around the Forth. By 600 BC iron had been added to the smiths' materials, and the site has yielded iron copies of objects commonly made in the Bronze Age.

The importance of controlling fertile areas led to the construction of defended sites and settlements. Around the Forth there are a few possible Atlantic Roundhouses, sites normally associated with the far north and west of Scotland (Regions 15 and 16). However, the most common defensive structure in this region is the hill-fort with ramparts of earth or stone or, as at Abernethy, stone interlaced with timber. Traprain Law, overlooking the Forth, is an unusually large example of a hillfort. A concentration of forts on the south coast of the Forth, such as Earns Heugh, may represent the strongly defended northern frontier of the Votadini tribe. To the south are a large number of smaller forts each enclosing less than a hectare, and other defended settlements.

Crouched inhumations in cists (stone burial chambers that were once buried under an earth heap) dated to the 1st or 2nd centuries AD have been found at, for example, Granton. However, in this region an unusual multiple internment at Lochend, Dunbar, comprised a large cist containing 21 individuals. This burial, which has been dated to the Iron Age, is paralleled only by a Neolithic communal cist at Sumburgh, Shetland (Hedges 1980), and by an Iron Age cist at Beadnell, Northumberland.

6.2.3 The Roman and early Medieval periods

This region was never drawn completely into the Roman province of southern Britain, and Roman remains arise from major military campaigns directed against the native tribes. Unaffected by the additions and alterations that followed the urbanisation and civilianisation of military centres in England, these sites reflect with clarity the operation of the Roman Army in hostile territory. In 79 AD harassment by tribes from the Tay precipitated a determined attempt to pacify Scotland. Initially the minimal resistance in the lowlands enabled Dere Street to be extended to the Forth at Inveresk, but further progress demanded an innovative fleet-backed strategy. Attempts were made to establish a northern frontier in the region, the boldest being a 1st-century line of forts from the Tay to the Clyde (Maxwell 1989). Then, in 142 AD, the Antonine Wall, which was of turf, bisected Scotland between the Forth and the Clyde. For a time this cut off the northern tribes from the Votadini and Selgovae to the south. Remains include the forts and settlements at Cramond, Carriden and Inveresk.

The population was never romanised, as is shown by hillforts and palisaded settlements south of the Forth and documented intermittent attacks on the Roman province. Further campaigns in the 3rd century involved a new military base on the Tay at Carpow and the refortification of an old base at Cramond. However, in a concerted attack involving the Picts, the permanent frontier on the Tyne - Solway line was overrun and Roman presence in the region effectively ceased.

From this time the region was a melting pot. In simple terms there were territorial struggles between the Picts and the Northumbrians. The Picts also conflicted with the Scots, whose kingdom lay in Argyll. Eventually, under Kenneth MacAlpine, the Picts and Scots were brought together, probably partly in response to Viking raids. As the Scots became dominant the modern kingdom emerged, its border on the Tweed first established in 1018. The archaeological remains from this period are scant and difficult to interpret.

Aerial photographic survey has shown souterrains, underground structures perhaps for storage, to be very

numerous north of the Tay and in Fife, often associated with settlements. The Picts are known mainly from secondary historic references to their warfaring, and the name has become linked with particular types of archaeological evidence. Placenames with the 'Pit' element are indicators of Pictish settlement spreading south of the Forth. Expansion of Anglicised Northumbria is also seen in place-names; the element 'ingham' appears on rivers and along the coast, for example at Coldingham and Tyninghame. Anglian-type timber halls at Doon Hill and Dunbar confirm this northern presence. Excavated artefacts demonstrate links between these settlements and the ecclesiastical centres of Durham and York. Christian influence can be seen in carved stones, characteristic of 8th century Pictland, and early Christian establishments including St. Vigeans, Brechin, Abernethy, St. Andrews and the Isle of May. Such coastal sites were easy targets for pagan Viking raiders, who won a decisive victory at Fortiu in 839. The possibility of scattered Scandinavian settlement is indicated by Norse-derived place-names throughout the region, some Scandinavian finds such as Viking pagan graves, Viking hoards at Lindores, Fife, and Cockburnspath (Graham-Campbell 1995), and hog-backed tombstones (although those from Inchcolm and Tyninghame show English influence (Ritchie 1995)).

6.2.4 Medieval to modern times

In the 11-13th centuries Scotland began to adopt European ideas. The monarchy and nobility endowed religious establishments such as Arbroath Abbey, the monastery at Balmerino and the Abbeys of Inchcolm and Coldingham; some, like the priories at St. Andrews and on the Isle of May, continued on traditional Christian sites. Travel was a feature of religious life: the Trinitarians at Dunbar served pilgrims *en route* for St. Andrews, and Queen Margaret established the crossing for them at Queensferry. A scallop shell was placed as a pilgrim badge in the mouth of a man buried on May - a unique find in Scotland. The religious houses were powerful forces in the economy. Sea fishing was undoubtedly stimulated by ecclesiastical needs: Arbroath was endowed with fisheries and saltpans, vital for preserving food. The new monastery at Pittenweem obtained revenue from a levy on fishing boats using their harbour on the Isle of May. The range of monastic imports is clear from excavated pottery, and in later years their lands produced wool, the major Scottish export.

The establishment of royal and baronial burghs provided new centres for mercantile trade and stimulated agricultural production beyond the subsistence economy. Knowledge of Medieval towns in the region is derived from excavations in Perth, Edinburgh, St. Andrews and some smaller burghs. These produced details of street layout, building fabric and sequence, craftsmens' work-shops and, through analysis of faunal remains, the interface between urban consumption and rural producers. In Perth, waterlogged deposits, which preserved organic materials such as leather, raise the quality of the resource of archaeological evidence. Timber elements of the 12th century waterfront were also discovered. It was replaced by a stone quay in the 1530s and, in the 19th century, by new docks downstream at Friarton. Archaeological evidence for the domestic economy and foreign trade challenge some concepts of Medieval Scotland derived from documentary evidence (Yeoman 1995).

The region's coastal burghs flourished at different times. Many townscapes have not changed since first built, and harbours, in particular, reflect periods of prosperity and investment. In the 16th century, for example, Crail dominated the Fife coast and was an international port but was later eclipsed by Pittenweem. The latter exported fish, coal and salt, and excavation has produced pottery that demonstrates the range of incoming trade. Further along the Fife coast, Elie developed in the 18th and 19th centuries, once the controlling lairds invested in the harbour and constructed large granaries; St. Monans and Anstruther both benefited from the herring boom, the latter town widening its industrial and commercial role.

Dundee's 18th century prosperity derived from linen, which was followed in the 19th century by the jute trade. Its port should be seen in conjunction with preserved jute mills. The docks ranged along the Tay and surviving features include impressive ranges of transit sheds. Leith, the port of Edinburgh, demonstrates the evolution of facilities: from the river waterfront, with narrow tofts (homesteads) and multistorey warehouses, to the first docks (now infilled), supplemented by the larger Victoria Dock, to the huge Albert and Edinburgh docks, with surviving hydraulic crane, rail systems and transit sheds, the whole within the massive outer harbour arms and land claimed from the firth.

In contrast, the open harbour at Granton was built in the 19th century specifically for the export of coal, its facilities latterly designed for steamships. The port also provided a rail ferry link prior to the construction of the Forth rail bridge. Coal in the Lothians and Fife stimulated local industries. On the coast the coal was important for both saltmaking and limeburning. Saltmaking had flourished in the 17th century, providing an export commodity. A saltworks excavated at St. Monans demonstrates the extent of large facilities in the late 18th century. These included wooden rails for transport from the coal mines and to the harbour. In the same period the largest limekiln complex, comprising nine kilns, was constructed by the Earl of Elgin at Charlestown.

Much of Leith's prosperity was derived from supplying convoys and naval escorts during the napoleonic wars of the 18th and 19th centuries. Coastal fortifications are a feature of this region. Structures include royal castles overlooking the burghs, defended residences such as the characteristic towerhouses including Claypotts Castle and Huntingtower Castle, early artillery works, once seen at Leith and surviving at Ravenscraig, Dunbar and Eyemouth, and later fortifications such as the tower house modified as a battery at Broughty Ferry and the Martello Tower at Leith.

Impressive lighthouses also stand guard over the coast and rival the engineering of harbour works. A coal-fired light placed on the Isle of May in 1635 was one of Scotland's first lighthouses. It was, however, the work of the Stevenson family, engineers to the Northern Lighthouse Board (founded 1785), which established Bell Rock, with its signal stations at Arbroath, Isle of May, Inchkeith, Bass Rock, Barns Ness and St. Abb's Head (Muir 1978).

Victorian engineering flair was also applied to the land-based infrastructure. The need for north-south routes to cross the east-west estuaries has given the region a number of important bridges, including the Forth Railway Bridge, the first major engineering structure in the world to be made entirely of steel (1882-1890).

6.3 Human activities

6.3.1 Integrated management

The archaeological resource is now being considered within mechanisms for the management of the Scottish coastal zone. The man-made heritage is included in *Scotland's coast: a discussion paper* (Scottish Office 1996). Historic Scotland has established links with Scottish National Heritage and comparable national bodies and liaises with coastal zone management bodies as they are formed. In addition, it is working with the Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS) to develop the archaeological database, initially by rapid survey, for the coastal zone. Where possible this is being implemented within the framework of projects created by the Focus on Firths initiative. Within the Forth Estuary Forum a Built and Archaeological Heritage Topic Group provides expert advice for the Management Group. The Topic Group is investigating issues and information relating to mankind's past in the project area and identifying ways to resolve conflicts.

Coastal zone management can also present opportunities for curation of the archaeological resource at a site-specific level. In Fife the development of the Bridge to Bridge Coastal Path has created a demand for interpretation of the man-made heritage. At St. Monans this has given rise to a project involving information retrieval by excavation, preservation of remains by constructing defences against coastal erosion, and interpretation. The Borders Regional Archaeology Service is initiating a Heritage Interpretation Programme to develop visitor interest in the Region's nature and history through accessible sites. This will include interpretation of coastal archaeological sites.

6.3.2 Activities and processes affecting the archaeological resource

The archaeological resource does not consist entirely of discrete sites such as intact wrecks, and many sites are scattered. Some sites, including palaeoenvironmental deposits, can be extensive, stretching from the terrestrial zone across the intertidal area and on to the sea bed. Archaeological sites and landscapes in the intertidal and subtidal zones are vulnerable to engineering works such as sea defences, coast protection, sewage outfalls, pipe and cable-laying, and the construction of harbour works and new maritime facilities, such as marinas. The need to consider the archaeological resource during the planning stage of land developments is recognised (see section 6.3.5).

The redevelopment of redundant dock areas requires skilful planning to preserve the fabric and setting of historic structures. The old East and West Dock at Leith, for example, have been entirely buried and a large part of the west harbour at Granton infilled for industrial and office building. Such docks are, themselves, of historic importance both as engineering works and as maritime locations. The conservation of buildings can be achieved through sympathetic re-use, e.g. the complex of harbour-side buildings occupied by the Anstruther Fishing Museum (Prescott 1991), the housing of a local heritage centre and restaurant in part of the still working fish market at Newhaven, and the various new uses found for jute mills within the Blackness Industrial Improvement Area, Dundee (Pound 1991).

Erosion has been identified by Historic Scotland as a long-term serious threat to Scottish archaeological sites. Soft engineering solutions to erosion can aid preservation of archaeological sites provided their location and status is known and considered during project planning. However, a review (Ashmore 1994) made apparent the almost total lack of coastal survey in this region. It specifically highlighted the lack of Sites and Monuments Records for Tayside and Lothian as an impediment to the effective targeting of future work. Nevertheless, in early 1996 audit surveys were undertaken between Dunbar and Fife Ness and on the Fife coast of the Tay, and specific coast defence projects have been undertaken to protect the archaeological sites of Wemyss Caves and St. Monans saltpans.

Land sites are vulnerable to destruction by agricultural machinery. The effects are so great that it has been said that, in fertile areas of the lowlands, "most sites have been ploughed flat" (Hanson & Macinnes 1991). Aerial photography is, therefore, an important tool for identifying sites in this region. The need for subsequent investigation as a prerequisite to evaluating the merit of sites is embodied in the decision of the former Fife Regional Council to list all cropmarks as Archaeological Sites and Areas of Regional Importance (see section 6.3.5).

6.3.3 Protection of sites, monuments and wrecks

The White Paper *This common inheritance* (DoE *et al.* 1990) expressed the government's commitment to preserving and enhancing the archaeological heritage. Remains are non-renewable and "the primary policy objectives are that they should be preserved wherever feasible and that, where this proves not to be possible, procedures should be in place to ensure proper recording before destruction, and subsequent analysis and publication" (Scottish Office 1994a). The development planning system provides the main policy framework for achieving this objective (see section 6.3.5).

In Scotland three statutes provide for protection of *in situ* remains of archaeological or historic importance. The Ancient Monuments & Archaeological Areas Act 1979 (AMAA) provides for Scheduled Ancient Monuments (SAMs), the Planning (Listed Buildings and Conservation Areas) Act 1990 provides for Listed Buildings and Conservation Areas, and the Protection of Wrecks Act 1973 allows designation of shipwrecks of archaeological, historic or artistic importance.

The legislative arrangements, controls on works and criminal offences related to SAMs are described in Planning Advice Note 42, which also includes the non-statutory list of criteria for determining the national importance of sites

prior to scheduling (Scottish Office 1994b). In general, works affecting a SAM require the prior written consent of Historic Scotland. The AMAA definition of a monument includes sites both on land and in UK territorial waters, including remains of vehicles, vessels and aircraft. Although wreck sites have yet to be scheduled, Historic Scotland has scheduled sites that extend across the intertidal zone. The number of SAMs in Great Britain has been increasing at the rate of 300 a year since 1993. Table 6.3.1 shows the numbers of coastal Scheduled Ancient Monuments in the region and in Scotland and Great Britain as a whole.

The Town & Country Planning (Listed Buildings and Conservation Areas) Act 1990 provides for buildings considered of special architectural or historic importance to be designated as Listed Buildings. Historic Scotland has published detailed guidance on the treatment of Listed Buildings, for which controls are generally exercised via the local authority. There is a presumption against the destruction of listed buildings and the prior consent of the Secretary of State is required for any works which will alter, damage or destroy a Listed Building. Conservation Areas are usually applied to urban areas to protect the historic environment. In 1990 the preservation of jute mills in the Blackness area of Dundee was underwritten by its designation as a Conservation Area.

The Protection of Wrecks Act 1973 provides for the designation of Historic Wreck Sites - any shipwrecks of importance for their archaeological, historical or artistic interest (Archaeological Diving Unit 1994). There are no standard criteria for designation, but Historic Scotland receives guidance from the Advisory Committee on Historic Wreck. Except under licence from Historic Scotland it is illegal to tamper with or remove material, to use diving or salvage equipment, or to deposit anything that may damage or obliterate the wreck (Archaeological Diving Unit 1994). Sites may be visited on behalf of Historic Scotland by the Archaeological Diving Unit, which is contracted by the Department of National Heritage to provide field inspection throughout the UK. The National Monuments Record (Maritime Section) for Scotland and the newly formed maritime aspect of the Fife Council Sites and Monuments Record contain information on wreck sites within the region. No wrecks have been designated in this region; however, as fewer than 45 wrecks have been designated for the whole of Britain, their distribution cannot be regarded as an accurate guide to the total sea-bed resource of potential Historic Wreck Sites.

Table 6.3.1 Numbers of Scheduled Ancient Monuments (SAMs) in Region 4 coastal 10 km squares

Area	*No. of SAMs*
Angus	76
City of Dundee	26
Perth & Kinross	27
North East Fife	78
Kirkaldy	20
Dunfermline	32
Clackmannanshire	15
Falkirk	27
Stirling	9
City of Edinburgh	41
West Lothian	8
East Lothian	133
Berwickshire (now part of Scottish Borders)	46
Region 4	***538***
Scotland (whole country)	5,300
GB (whole country)	21,000

Source: Historic Scotland (1995); Breeze (1993).

6.3.4 Key organisations and their responsibilities

Historic Scotland (HS) executes the responsibility of the Secretary of State in respect of the protection, management and interpretation of the built heritage (i.e. ancient monuments, archaeological sites and landscapes, historic buildings, parks and gardens, and designed landscapes). HS compiles and amends the Schedule of Ancient Monuments and the statutory lists of buildings of special architectural or historic interest. HS also has responsibility for wreck sites designated under the Protection of Wrecks Act 1973.

The Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS) has responsibility for survey and inventory of archaeological sites. It maintains a database of archaeological sites known as the National Monuments Record Scotland (NMRS). In 1992 a new Royal Warrant extended its remit to the territorial seas. The Commission has compiled an initial maritime section of the NMRS. Local Authorities have 'far reaching powers, both statutory and discretionary . . . to deliver a conservation service' (Historic Scotland 1996a). The cornerstone of their work under the development control system is the Sites and Monuments Record (SMR) - an inventory of all known archaeological features in their area and the main source of information at a local level; the RCAHMS is the lead agency for SMRs. Local council archaeologists fulfil a curatorial role in respect of archaeological sites. This is achieved primarily through the planning system, but their archaeology services perform a range of tasks to protect and promote the heritage of Region 4.

The Scottish Institute for Maritime Studies at St. Andrews University is the only formally constituted academic department in Scotland concentrating on maritime heritage. It undertakes and supervises research and is involved in fieldwork.

6.3.5 Development control

To landward of low water mark, archaeology is considered within the unified system of development control provided by the planning system (see section 10.3.4). National Planning Policy Guidance Note 5 (Scottish Office 1994a) explains the regard that should be accorded to archaeological remains. In essence there is a presumption in favour of preservation *in situ* because "the primary policy objectives are that they shoud be preserved wherever possible". 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 "procedures should be in place to ensure proper recording before destruction, and subsequent

analysis and publication". Account must be taken of sites with regional or local significance and of other sites and finds recorded in the SMR. Specific guidance is also available on the treatment of SAMs within the planning system (Scottish Office 1994b).

In general, the safeguards for archaeological remains provided by the planning system do not extend below low water mark. Without an appropriate management structure it has been difficult to facilitate consideration of archaeology by the many authorities involved in the sectoral regulation of the marine zone. However, growing awareness of marine archaeology is leading to voluntary consideration of the archaeological resource. This has been stimulated by the development of databases of sea-bed sites and by initiatives such as the *Code of practice for seabed developers* (Joint Nautical Archaeology Policy Committee 1995).

The Structure Plans for the previous Fife and Borders Regional Councils include general archaeological policies. The former lists over 900 Archaeological Sites and Areas of Regional Importance, with accompanying maps. These sites were identified in 1992 (Fife Regional Council 1992) and the list is currently being revised and updated.

6.3.6 Reporting archaeological information

The Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS) and Council Archaeological Service Sites and Monuments Records (SMRs) are the accepted reporting point for new archaeological information. Information and enquiries concerning Scheduled Monuments and Historic Wrecks should be directed to Historic Scotland. Those concerning Listed Buildings should be directed to the Planning Service of the local authority.

In Scotland the law of *bona vacantia* (encompassing Treasure Trove) stipulates that all finds of objects whose original owner or rightful heir is unknown are the property of the Crown and can be claimed by the Crown. This law applies throughout the land and extends to low water mark and harbour waters (thereby overlapping in scope with some maritime legislation); it applies to all objects, irrespective of their raw material or original circumstances of deposition. Finders are legally obliged to report all finds, ultimately to the Queen's and Lord Treasurer's Remembrancer at the Crown Office; this can be done *via* the Treasure Trove Advisory Panel Secretariat (at the National Museums of Scotland) or the local museum, local authority archaeologist, the police or the Procurator Fiscal.

Finds from excavations funded by Historic Scotland, made casually on monuments in care, or from excavation undertaken with Scheduled Monument Consent, if not claimed by the Crown, go before the Finds Disposal Panel, which determines to which museum they should go (Historic Scotland 1994).

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

6.4 Information sources

6.4.1 Information gathering and collation

A review of coastal survey in the terrestrial and intertidal zones was produced by Historic Scotland in advance of preparing policy (Ashmore 1994). Historic Scotland have now produced a specification for coastal zone assessment surveys that sets out a standard level for future survey (Historic Scotland 1996b).

A three-year research project, Maritime Fife, has been set up by Fife Council within the Scottish Institute of Maritime Studies. Its long-term aim is to carry out historical research and fieldwork to provide an archive and database on the maritime activities and sites of Fife, with the specific aim of updating the intertidal and sea-bed data held by the Council SMR. The initial phase of the project has been undertaken with consortium funding from local authorities and national heritage bodies. This desk-top exercise has drawn on published and archive sources and the knowledge of local individuals, to increase the number of recorded sites and to provide a firm basis for developing conservation policies.

Historic Scotland has funded a rapid survey of the coast to provide archaeological data for the management initiatives arising from the Forth Estuary Forum. The rapid field survey from Kincardine to Fife Ness examined the intertidal area and a 50-100 m strip of land at the coast edge. The work has been completed in association with the Maritime Fife project, who have been commissioned to complete the Fife Survey from Fife Ness to Newburgh. The need for parallel sea-bed survey is recognised.

Until recently coastal survey around the Tay has been very limited. However, the potential of coastal sites was highlighted in 1992 by a trial excavation at Montrose, which showed the potential for information on the Medieval town and on the rural land-use that preceded urban growth to be recovered (Sheriff 1992). In 1996 the south shore of the Tay was investigated within the Maritime Fife project.

The Lothians and Scottish Borders are similarly lacking in targeted coastal survey. However, specific coastal sites, such as areas adjacent to Dunbar and Eyemouth Harbours, have been excavated (Perry *et al.* in press; Dixon 1986). A further scheme in Eyemouth, to include the excavation, preservation and interpretion of the Eyemouth Artillery Fort, is being considered.

The initial compilation of the National Monuments Record Scotland - Maritime Section by The Royal Commission on the Ancient and Historical Monuments of Scotland has drawn on entries within the Wreck Index of the Hydrographic Department, which is maintained as an aid to publishing Admiralty Charts for navigation. It contains mainly metal wrecks that are proud of the sea bed and have been identified by remote sensing, plus last position reports of 20th century shipping casualties. RCAHMS record is linked to a Geographic Information System (GIS), and incorporation of environmental data on sea-bed deposits should help to indicate areas of likely preservation.

Table 6.4.1 indicates the numbers of sites in Region 4 listed in the National Monuments Record - Maritime Section, Scotland.

Table 6.4.1 Initial records* entered in the National Monuments Record - Maritime Section, Scotland

Area	*No. of sites*
Tayside (now Dundee, Angus, Perth and Kinross)	32
Fife	110
Lothians (now West, Mid and East Lothian and City of Edinburgh)	100
Borders (now Scottish Borders)	30
Region 4	***272***
Scotland	1,540

Source: RCAHMS (June 1995 data). Key: *from the Hydrographic Department Wreck Index, including known wrecks and unidentified obstructions.

6.4.2 Acknowledgements

Thanks are due to the staff from all the organisations mentioned in the text who provided information and advice.

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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	Principal Inspector of Monuments, Historic Scotland, Longmore House, Salisbury Place, Edinburgh EH9 1SH, tel: 0131 668 8650
National Monuments Record of Scotland	Royal Commission on the Ancient & Historical Monuments of Scotland, National Monuments Record of Scotland, John Sinclair House, 16 Bernard Terrace, Edinburgh EH8 9NX, tel: 0131 662 1456
Reporting of recovered wreck in Britain	Receiver of Wreck, Coastguard Agency, Spring Place, 105 Commercial Road, Southampton SO15 1EG, tel: 01703 329474
Maritime archaeological survey	The Secretary, Scottish Institute for Maritime Studies, University of St. Andrews, St. Andrews, Fife KY16 9AL, tel: 01334 462916
A code of practice for seabed developers	Joint Nautical Archaeology Policy Committee, Head of Recording (Maritime Section), National Monuments Record, Royal Commission on the Historical Monuments of England, National Monuments Record Centre, Kemble Drive, Swindon SN2 2GZ, tel: 01793 414713
Angus SMR	Museum Curator, Montrose Museum, Panmure Place, Montrose DD10 8HE, tel: 01674 673232
City of Dundee SMR	Planning Officer, Policy and Design Division, Planning and Transportation Department, City of Dundee Council, Floor 16, Tayside House, Crichton Street, Dundee DD1 3RB, tel: 01382 433414
Perth and Kinross SMR	Human History Officer, Perth Museum and Art Gallery, 78 George Street, Perth PH1 5LB, tel: 01738 632488
Fife SMR	*Archaeology Officer, Planning Service, Fife Council, Glenrothes, tel: 01592 414141
Stirling and Clackmannanshire SMR	*Archaeology Officer, Environmental Services, Stirling Council, Stirling, tel: 01786 443322
Falkirk SMR	Keeper of Archaeology and Local History, Falkirk Museums, Callendar House, Callendar Park, Falkirk FK1 1YR, tel: 01324 503770
West Lothian SMR	Conservation and Design, West Lothian Council, Council Buildings, Linlithgow EH49 7EZ, tel: 01506 775279
City of Edinburgh SMR	*City Archaeologist, Archaeologist Service, Department of Recreation, City of Edinburgh Council, Edinburgh, tel: 0131 558 1040
East Lothian SMR	*Environment Department, East Lothian Council, Haddington, tel: 01620 827827
Scottish Borders SMR	*Principal Planning Officer (Heritage), Planning and Development Department, Scottish Borders Council, Melrose, tel: 01835 824000
Information on, and reporting of, Treasure Trove	Archaeology Department, National Museums of Scotland, Queen Street, Edinburgh EH2 1JD, tel: 0131 2257534
Maritime Fife	Research and Education, Scottish Institute for Maritime Studies, University of St. Andrews, St. Andrews, Fife KY16 9AL, tel: 01334 462 916
Castle Park site, Dunbar	Post Excavation Manager, Scottish Trust for Urban Archaeology, 55 South Methven Street, Perth PH1 5NX, tel: 01738 622393

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

Chapter 7 Coastal protected sites

J. Plaza & 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 are correct as at January 1997, unless otherwise stated.

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

Further explanation of the various site protection mechanisms can be found in Davidson *et al.* (1991). Planning Policy Guidance Note (PPG) 9 - Nature Conservation (DoE 1994), although dealing specifically with planning policy in England, also gives useful summaries of some of the existing site protection mechanisms found in Scotland. 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 statutory framework for site protection in Scotland is set out in Scottish Office Circular 6/90/95 (Scottish Office 1995). The Scottish Office is currently preparing two National Planning Policy Guidance (NPPG) notes: one on natural heritage and one on coastal matters. They are currently in draft format and may be ready by 1997.

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

Non-site based measures contained in conventions and directives aimed at broad species and habitat protection, such as the Bonn Convention, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), parts of the EC Birds Directive and parts of the EC Habitats & Species Directive, are also not covered. For further information, see references in section 7.1.3 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; and finally, other types of site (i.e. those identified, owned or managed by charities, trusts etc.) are described in section 7.5. For each category of protected site, a list of coastal sites is given (clockwise around the coast), showing their type, area/length and location, with an accompanying map. Each section concludes with further information sources and contact points relevant to the region.

7.1.2 Importance of the region

Region 4 has a relatively short coastline compared with other regions in the UK, apart from those on the south coast of England, and this is reflected in the small total extent of many of the protected coastal sites designations when compared with British totals. Nevertheless, the region contains approximately a quarter of Britain's Local Nature Reserves by area (29%), and approximately one sixth of the Country Parks (15%). Other site designations that are

Table 7.1.1 Summary of site protection in Region 4

	Number of protected sites					*Area* covered by site protection*				
	Region	*North Sea Coast*	*% of North Sea Coast total in region*	*GB coast*	*% of GB coast total in region*	*Region (ha)*	*North Sea Coast (ha)*	*% of North Sea Coast total in region*	*GB coast (ha)*	*% of GB coast total in region*
Ramsar sites	1	37	2.7	61	1.6	987	189,145	0.5	343,524	0.3
Special Protection Areas	2	60.5	3.3	99	2.0	1,078	199,727	0.5	363,103	0.3
Possible Special Areas of Conservation	2	49	4.1	112	1.8	n/av	n/av	n/av	n/av	n/av
National Nature Reserves	3	43	7.0	80	3.8	649	35,830	1.8	87,916	0.7
Sites of Special Scientific Interest	51	557	9.2	1,208	4.2	18,586	335,607	5.5	716,548	2.6
Local Nature Reserves	5	73	6.8	98	5.1	4,357	10,710	40.7	15,279	28.5
Areas of Special Protection	1	14	7.1	23	4.3	n/av	n/av	n/av	n/av	n/av
Country Parks	1	24	4.2	38	2.6	675	3,130	21.6	4,608	14.6
Geological Conservation Review sites	47	551	8.5	1,096	4.3	n/ap	n/ap	n/ap	n/ap	n/ap
Marine Consultation Areas	1	6	16.7	29	3.4	4,838	8,609	56.2	111,896	4.3
Voluntary Marine Nature Reserves	1	9	11.1	14	7.1	n/av	n/av	n/av	n/av	n/av
Regional Landscape Designations	12	39	30.8	63	19.0	62,332	73,726	84.5	508,067	12.3
Preferred Conservation Zones	3	17	17.6	22	11.1	n/av	n/av	n/av	n/av	n/av
The National Trust & The National Trust for Scotland sites**[a]	2	191[a]	1.1	453[a]	0.4	488	18,610	2.6	64,127	0.6
Royal Society for the Protection of Birds reserves	5	53	9.2	82	5.9	424	24,610	1.7	39,660	1.1
The Wildlife Trusts reserves[b]	10	145	6.9	241	4.1	2,309	11,574	19.9	25,884	8.9
Ministry of Defence sites	4	65	6.2	110	3.6	2,402	34,449	7.0	53,409	4.5
Woodland Trust properties	4	36	11.1	71	5.6	138	1,104	12.5	1,584	8.7

Source: JNCC (October 1996 Ramsar/SPA data). Key: n/ap = not applicable; n/av = not available; *to the nearest whole hectare; **natural heritage interest sites only; [a]includes National Trust sites for England and Wales; [b]in this region all Scottish Wildlife Trust reserves. Notes: site types not currently found in the region: World Heritage (Natural) Sites, Biogenetic Reserves, Biosphere Reserves, National Scenic Areas, Areas of Special Protection, Marine Nature Reserves, Wildfowl & Wetlands Trust sites, John Muir Trust sites. In this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

extensive in Region 4 are the Regional Landscape Designations (12%), Wildlife Trust Reserves (9%) and Woodland Trust Properties (9%). The region contains only a small proportion by both area and number of Special Protection Areas, Ramsar sites, National Trust for Scotland Sites and RSPB sites. 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.

7.1.3 Further sources of information

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7.2 Sites designated under international conventions and directives

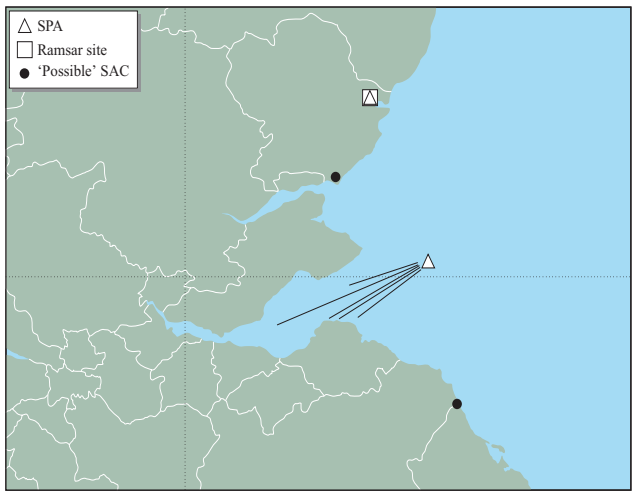
This section describes those types of site designated under international conventions to which the UK is a contracting party and sites designated under UK statute to implement EC Directives concerning wildlife and habitat conservation. Sites protected by domestic legislation only are covered in section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

7.2.1 Wetlands of international importance (Ramsar sites)

Ramsar sites are statutory areas designated by the UK government on the advice of the conservation agencies under the Ramsar Convention (the Convention on wetlands of international importance especially as waterfowl habitat). Contracting parties (of which the UK is one) are required to designate at least one wetland of international importance and to promote their conservation and 'wise use'. Ramsar sites are designated for their waterfowl populations, their important plant and animal assemblages, their wetland interest or a combination of these. There is one coastal Ramsar site (987 ha) in Region 4 (Table 7.2.1; Map 7.2.1). Table 7.2.1 summarises the interest for which the site has been designated, and sections 5.11 and 5.12 describe the importance of the site for the region's birds. Designation of Ramsar sites is an ongoing process and further sites in the region may be announced in the future.

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



Map 7.2.1 Ramsar sites, Special Protection Area and 'possible' Special Areas of Conservation. Source: JNCC, SNH, Pritchard *et al.* (1992).

through the Wildlife and Countryside Act 1981; all SPAs have first to be notified as Sites of Special Scientific Interest. There are two coastal SPAs (1,078 ha) in Region 4 (Table 7.2.2; Map 7.2.1). Table 7.2.2 summarises the interest of these sites, and sections 5.10, 5.11 and 5.12 describe the importance of these sites for the region's birds. Designation of SPAs is an ongoing process and further sites may be announced in the future.

7.2.3 Special Areas of Conservation

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

Table 7.2.1 Ramsar sites

Site name	*No. of sites*	*Grid ref.*	*Area (ha)**	*Date designated*	*Selection criteria used*
Angus	**1**				
Montrose Basin		NO685580	987	1995	1% of a waterfowl species population, regularly supports more than 20,000 waterfowl, representative wetland common to more than one biogeographical region, a specific type of rare or unusual wetland for a biogeographical area
Region 4	***1***		***987***		
North Sea Coast	37		189,145		
GB coast	61		343,524		
GB whole country	103		357,911		

Sources: JNCC October 1996 data; SNH. Key: *to the nearest whole hectare. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

Table 7.2.2 Special Protection Areas (SPAs)

Site name	*No. of sites*	*Grid ref.*	*Area (ha)**	*Date designated*	*Selection criteria used*
Angus	**1**				
Montrose Basin		NO685580	987	1995	Internationally important numbers of wintering pink-footed goose *Anser brachyrhynchus*, knot *Calidris canutus* and redshank; nationally important numbers of wintering wigeon *Anas penelope*, eider *Somateria mollissima* and oystercatcher *Haematopus ostralegus*; regularly supports over 20,000 wintering waterfowl
Fife/Lothian	**1**				
Firth of Forth Islands (includes Inchmickery, Isle of May, Fidra, The Lamb, Craigleith and Bass Rock)		NT207805	91	1990	Internationally important for breeding gannets *Sula bassana*, cormorants *Phalacrocorax carbo*, kittiwake *Rissa tridactyla*, guillemot *Uria aalge*, razorbill *Alca torda*, sandwich tern *Sterna sandvicensis*, common tern *S. hirundo*, roseate tern *S. dougalli*, shag *Phalacrocorax aristotelis*, and lesser black-backed gulls *Larus fuscus*; nationally important for breeding gulls
Region 4	***2***		***1,078***		
North Sea Coast	60.5		199,727		
GB coast	99		363,103		
GB whole country	137		495,852		

Sources: JNCC October 1996 data; SNH; Pritchard *et al.* (1992). Key: *to the nearest whole hectare. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

and species; Annex IV prohibits the taking of certain species; Annex V requires the taking of certain species to be monitored; and Annex VI prohibits some means of capture or killing of mammals and fish. In the UK the Directive is implemented through the Habitats etc. Regulations 1994 (DoE 1994; Scottish Office 1995). A list of possible SACs was announced by the Government on 31 March 1995. There are two possible SACs in Region 4, from a total of 112 such sites in GB (Table 7.2.3; Map 7.2.1) (see JNCC (1995) for more information). Designation of SACs is an ongoing process and further sites may be announced in the future.

7.2.4 Acknowledgements

Thanks are due to Alan Law and Mark Tasker, JNCC.

7.2.5 Further sources of information

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Table 7.2.3 Possible Special Areas of Conservation (SACs)

Site name	*No. of sites*	*Qualifying interest*
Angus/Dundee City	**1**	
Barry Links		Decalcified fixed dunes with crowberry *Empetrum nigrum*. Embryonic shifting dunes. Eu-atlantic decalcified fixed dunes (Calluno-Ulicetea). Humid dune stacks. Shifting dunes along the shoreline with marram *Ammophila arenaria* (white dunes).
Scottish Borders	**1**	
Berwickshire and north Northumberland coast		Grey seal *Halichoerus grypus*. Mudflats and sandflats not covered by seawater at low tide. Reefs. Submerged or partially submerged sea caves.
Region 4	***2***	
North Sea Coast	49	
GB	112	

Sources: JNCC, SNH. 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.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Ramsar sites, SPAs, Special Areas of Conservation (Perth and Kinross; Angus; Dundee City)	*SNH, Perth Area Office, Perth, tel: 01738 639746
Ramsar sites, SPAs, Special Areas of Conservation (Stirling and Fife)	*SNH, Stirling Area Office, Stirling, tel: 01786 450362
Ramsar sites, SPAs, Special Areas of Conservation (Scottish Borders)	*SNH, Galashiels Area Office, Galashiels, tel: 01896 756652
Ramsar sites, SPAs (Angus and Fife)	*Regional Officer, RSPB East Scotland Office, Aberdeen, tel: 01224 624824
Ramsar sites, SPAs (Stirling, Lothian and Scottish Borders)	*Regional Officer, RSPB South and West Scotland Office, Glasgow, tel: 0141 945 5224
Special Areas of Conservation	*Department of the Environment (DoE), European Wildlife Division, Bristol, tel: 0117 987 8000

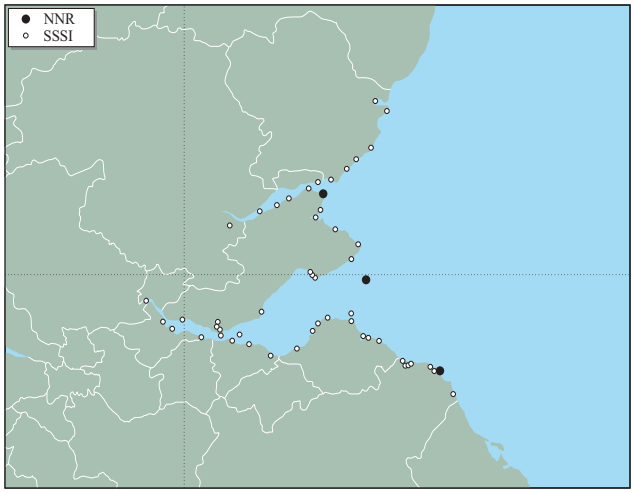
*Starred contact addresses are given in full in the Appendix.

7.3 Sites established under national statute

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

7.3.1 National Nature Reserves

National Nature Reserves (NNRs) contain examples of some of the most important natural and semi-natural ecosystems in Great Britain. They are managed to conserve their habitats, providing special opportunities for scientific study of the habitats, communities and species represented within them (Marren 1994). They are declared by the country agencies under section 19 of the National Parks and Access to the Countryside Act 1949, or section 35 of the Wildlife and Countryside Act 1981. All NNRs are also Sites of Special Scientific Interest (SSSIs). There are three coastal NNRs (649 ha) in Region 4 (Table 7.3.1; Map 7.3.1).



Map 7.3.1 Coastal National Nature Reserves (NNRs) and Sites of Special Scientific Interest (SSSIs). Note: a single symbol may represent more than one site in close proximity. Source: SNH, JNCC.

7.3.2 Sites of Special Scientific Interest

Sites of Special Scientific Interest (SSSIs) are notified under the Wildlife & Countryside Act 1981. They are intended to form a national network of areas, representing in total the parts of Britain in which the natural features, especially those of greatest value to wildlife and earth science conservation, are most highly concentrated or of highest quality. Each SSSI represents a significant fragment of the much-depleted resource of wild nature remaining in Britain. Within the area of an SSSI the provisions of the Wildlife & Countryside Act 1981 and its 1985 amendments aim to limit or prevent operations that are potentially damaging to the wildlife interest of the area. There are 51 coastal SSSIs (18,586 ha) in Region 4, as at November 1996 (Table 7.3.2; Map 7.3.1). About 8% of the total land mass of Britain is SSSI, as at November 1996.

Nearly all the SSSIs in the region (92%) have some intertidal land, while only 8% are purely terrestrial. Three-quarters of the SSSIs were selected at least partly for their biological interest and over half (57%) at least partly for their earth science (geological or geomorphological) interest. Of the total, nearly one-quarter 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 tidal flats, hard rock sea cliffs, saltmarshes, sand dunes, dry grasslands, vegetated shingle, woodland and freshwater marshes, these habitats occurring in 15-44% of sites. SSSIs in the region include several sites of interest for their reptiles, terrestrial invertebrates, breeding seabirds and wildfowl and nationally important migrating/wintering bird populations. Further details of SSSIs may be found in the *Coastal and marine UKDMAP datasets* module disseminated by JNCC Coastal Directories Team (BODC 1992; Barne *et al.* 1994).

Table 7.3.1 National Nature Reserves

Site name	*No. of sites*	*Grid ref.*	*Area (ha)**	*Date last declared*	*Habitats*
Fife	**2**				
Tentsmuir Point		NO510275	515	1954	Intertidal flats, accreting sand dunes, lowland heath, dune slack and fen
Isle of May		NT655995	57	1956	Cliffs, breeding seabirds, grey seal *Halichoerus grypus* colony
Scottish Borders	**1**				
St. Abb's Head		NT914689	77	1984	Cliffs, breeding seabirds
Region 4	***3***		***649***		
North Sea Coast	43		35,830		
GB coast	80		87,916		
GB whole country^{+}	288		195,531		

Source: SNH. Key: *to the nearest whole hectare; $^{+}$1995 data. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

Table 7.3.2 SSSIs in Region 4

Site name	*No. of sites*	*Grid ref.*	*Area (ha)**	*Date last notified*
Angus	**6**			
Montrose Basin		NO685580	889	1986
Rickle Craig - Scurdie Ness		NO727545	73	1987
Whiting Ness - Ethie Haven		NO670428	153	1989
Elliot Links		NO620390	29	1985
Easthaven		NO588356	1	1989
Barry Links		NO532319	1,041	1985
Dundee City	**1**			
Monifieth Bay		NO485313	213	1985
Perth and Kinross	**2**			
Carey		NO174170	2	1990
Inner Tay Estuary		NO280220	5,400	1985
Fife	**18**			
Flisk Wood		NO335236	63	1984
Balmerino - Wormit Shore		NO380257	85	1989
Tayport - Tentsmuir Coast		NO452294	1,048	1984
Earlshall Muir		NO485220	432	1983
Eden Estuary		NO475195	1,161	1990
St. Andrews - Craig Hartle		NO545152	133	1989
Fife Ness Coast		NO625107	117	1987
Barnsmuir Coast		NO602060	20	1984
Isle of May		NT655995	57	1985
East Wemyss - Anstruther Coast		NT465997	530	1991
Ruddons Point		NO457006	9	1984
Dumbarnie Links		NO451017	40	1982
Burntisland - Kirkcaldy Coast		NT280885	372	1989
Ferry Hills		NT124834, NT123822, NT126815, NT128811	28	1992
Carlingnose		NT134806	6	1988
Torry Bay		NT005855	620	1991
Longcraig Island		NT125802	2	1996
St. Margaret's Marsh		NT116816	26.4	1996
Clackmannanshire	**1**			
Alloa Inches		NS865920	316	1988
Falkirk	**2**			
Skinflats		NS932845	543	1988
Kinneil Kerse		NS970825	764	1988
West Lothian	**1**			
Blackness Bay		NT067795	190	1987
City of Edinburgh	**3**			
Forth Bridge - Granton Shore		NT180785	742	1986
Inchmickery		NT207805	5	1985
Wardie Shore		NT238772	12	1987
East Lothian	**10**			
Leith - Prestonpans		NT315736	287	1986
Gosford Bay - Port Seaton		NT405760	318	1984
Aberlady Bay		NT465815	866	1983
Gullane - Broad Sands		NT479841	294	1983
Forth Islands		NT513868	23	1983
Bass Rock		NT602873	8	1983
North Berwick Coast		NT601848	180	1984
Tyninghame Shore		NT640800	608	1984
Dunbar Coast		NT661793	81	1984
Barns Ness Coast		NT696781	271	1984
Scottish Borders	**7**			
Pease Bay Coast		NT781718	65	1986
Pease Bridge Glen		NT792701	12	1986
Old Cambus Quarry		NT806705	2	1989
Siccar Point		NT811709	6	1987
St. Abb's Head - Fast Castle		NT880699	257	1986
Coldingham Loch		NT895685	17	1985
Burnmouth Coast		NT960610	169	1986
Region 4	***51***		***18,586***	
North Sea Coast	557		335,607	
GB coast	1,208		716,548	
GB whole country^{+}	6,095		1,940,483	

Source: SNH. Key: *to the nearest whole hectare; $^{+}$1995 data. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

7.3.3 Local Nature Reserves

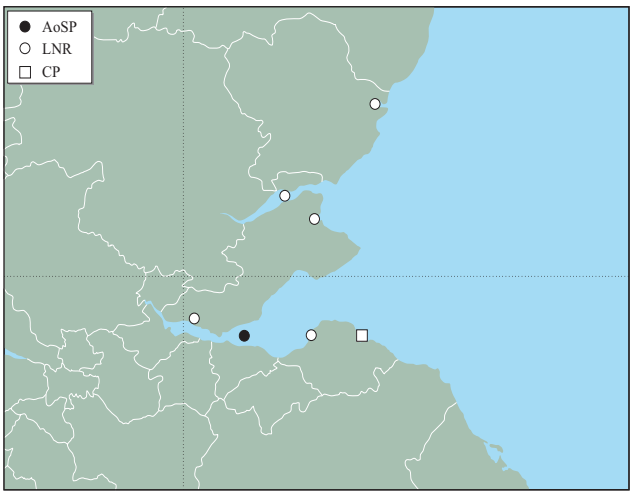
Local Nature Reserves (LNRs) are designated by local authorities under section 21 of the National Parks and Access to the Countryside Act 1949, for the same purposes as NNRs but because of the local rather than the national interest of the site and its wildlife. Under this Act local authorities have the power to issue bylaws to protect the LNR. There are five LNRs (4,357 ha) in Region 4 (Table 7.3.3; Map 7.3.2).

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 and Countryside Act 1981. Designation aims to prevent the disturbance and destruction of the birds for which the area is identified, by making it unlawful to damage or destroy either the birds or their nests and in some cases by prohibiting or restricting access to the site. There is one AoSP in Region 4, at Inchmickery (Table 7.3.4; Map 7.3.2).

7.3.5 Country Parks

Country Parks are primarily intended for recreation and leisure opportunities close to population centres and do not necessarily have any nature conservation interest. Nevertheless, many are in areas of semi-natural habitat and so form a valuable network of locations at which informal recreation and the natural environment co-exist. They are statutorily declared and managed by local authorities under section 7 of the Countryside Act 1968. There is one coastal Country Park (675 ha) in Region 4 (Table 7.3.5; Map 7.3.2).



Map 7.3.2 Coastal Area of Special Protection (AoSP), Local Nature Reserves (LNR) and Country Park (CP). Source: SNH, DoE, Countryside Commission for Scotland (1985).

Table 7.3.3 Local Nature Reserves

Site name	*No. of sites*	*Grid ref.*	*Area (ha)**	*Date designated/ opened*
Angus	**2**			
Montrose Basin		NO695580	1,024	1991
Inner Tay Estuary		NO349290	1,176	1996
Fife	**2**			
Eden Estuary		NO475195	891	1977
Torry Bay		NT005855	683	1996
East Lothian	**1**			
Aberlady Bay		NT460810	582	1952
Region 4	***5***		***4,357***	
North Sea Coast	73		10,710	
GB coast	98		15,279	
GB whole country+	396		21,513	

Source: SNH. Key: *to the nearest whole hectare; +1995 data. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

Table 7.3.4 Areas of Special Protection (AoSPs)

Site name	*No. of sites*	*Date designated*
Inchmickery, No. 119 (S.3), Lothian		1963
Region 4	***1***	
North Sea Coast	14	
GB coast	23	
GB whole country	38	

Source: DoE European Wildlife Division. 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 7.3.5 Country Parks

Site name	*No. of sites*	*Grid ref.*	*Area (ha)**	*Date designated/ opened*
East Lothian	**1**			
John Muir		NT640800	675	1976
Region 4	***1***		***675***	
North Sea Coast	24		3,130	
GB coast	38		4,608	
GB whole country+	281		35,150	

Source: Countryside Commission for Scotland (1985). Key: *to the nearest whole hectare; +1995 data. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

7.3.5 Acknowledgements

Thanks are due to Roger Bolt and Mark Tasker, JNCC, Kathy Duncan and Natasha O'Connel, Scottish Natural Heritage, and Neale Oliver, DoE, for their helpful comments.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
NNRs, SSSIs (Perth and Kinross; Dundee City; Angus)	*SNH, Perth Area Office, Perth, tel: 01738 639746
NNRs, SSSIs (Stirling; Clackmannanshire; Fife)	*SNH, Stirling Area Office, Stirling, tel: 01786 450362
NNRs, SSSIs (Falkirk; Lothian; Scottish Borders)	*SNH, Galashiels Area Office, Galashiels, tel: 01896 756652
Local Nature Reserves (Angus)	*Angus Council, Forfar, tel: 01307 461460
Local Nature Reserves (Stirling)	*Stirling Council, Stirling, tel: 01786 443322
Local Nature Reserves (Fife)	*Fife Council, Glenrothes, tel: 01592 414141
Local Nature Reserves Country Park (East Lothian)	*East Lothian Council, Haddington, tel: 01620 827827
Local Nature Reserves (Scottish Borders)	*Scottish Borders Council, Melrose, tel: 01835 824000

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

Tentsmuir National Nature Reserve (NNR), Fife, at over 500 ha, contains one of the largest areas of sand dune in Scotland. The outer end of this system, a prograding ness, is very dynamic, varying in form according to weather and tidal conditions. Much of the inner dune area has been afforested, and self-sown trees have spread beyond the forest boundary. Photo: Pat Doody, JNCC.

7.4 Sites identified by statutory agencies

This section covers sites which, although not protected by statute, have been identified by statutory agencies as being of nature conservation or landscape importance.

7.4.1 Nature Conservation Review sites

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

7.4.2 Geological Conservation Review sites

Geological Conservation Review (GCR) sites are non-statutory sites identified as having national or international importance for earth science. As such, it is intended that most GCR sites will eventually be notified as SSSIs. The GCR selection process describes and assesses key sites in the context of their geology, palaeontology, mineralogy or geomorphology; GCR sites are the earth science equivalent of NCRs. There are 47 coastal GCR sites in Region 4 (Table 7.4.1; Map 7.4.1). Detailed scientific accounts of coastal and inland GCR sites are contained in volumes of a planned 42-volume *Geological Conservation Review* series (see e.g. Ellis *et al.* 1996). Twelve of these volumes have been published to date.

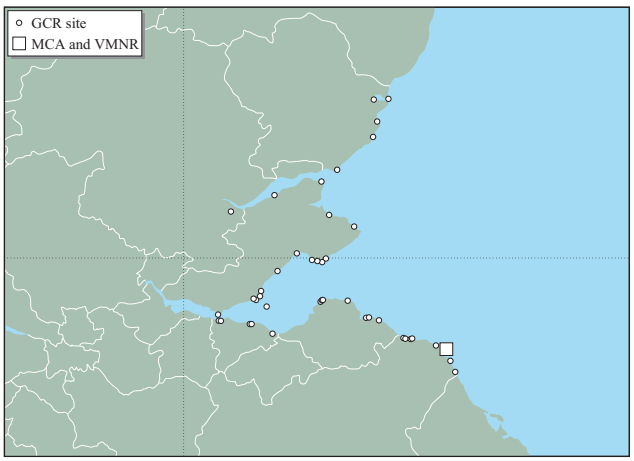
7.4.3 Marine Consultation Areas

The non-statutory Marine Consultation Area (MCA) designation identifies areas considered by Scottish Natural Heritage to deserve particular distinction in respect of the quality and sensitivity of the marine environment within them. Their selection encourages coastal communities and

Table 7.4.1 GCR Sites

Site name	*No. of sites*
Angus	**6**
Maryton	
Scurdie Ness	
Scurdie Ness to Usan Harbour	
Black Rock to East Comb	
Whiting Ness	
Barry Links	
Perth and Kinross	**1**
Carey	
Fife	**18**
Balmerino - Wormit	
Tentsmuir	
East Sands - Buddo Ness	
Randerston Coast	
Elie Ness	
Elie - Anstruther	
Kincraig Point	
East Fife Coast	
Ardross Castle	
East Wemyss to Buckhaven Coast	
Inchkeith	
Kinghorn Coast	
Invertiel	
Kingswood	
Abden	
Pettycur	
Burntisland - Kinghorn Coast	
North Queensferry (A90) Road Cuttings	
City of Edinburgh	**7**
Queensferry Shore	
Joppa Shore (2 sites)	
Wardie Shore	
South Queensferry - Hound Point	
Granton Shore	
Wardie	
East Lothian	**6**
Cheese Bay	
North Berwick Coast	
Weak Law	
Dunbar (2 sites)	
Barns Ness Coast	
Scottish Borders	**9**
Cove	
Oxroad Bay	
Hawks Heugh	
Old Cambus Quarry	
Siccar Point	
St. Abb's Head	
Pettico Wick to St. Abb's Harbour	
Lennel Braes	
Burnmouth	
Region 4	***47***
North Sea Coast	551
GB coast	1,096
GB whole country	3,025

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



Map 7.4.1 Coastal Geological Conservation Review (GCR) sites, Marine Consultation Area (MCA) and Voluntary Marine Nature Reserve (VMNR). Note: a single symbol may represent more than one site in close proximity. Source: JNCC, SNH, Marine Conservation Society, WWF (UK), NCC (1990).

Table 7.4.2 Marine Consultation Areas

Site name	*No. of sites*	*Area (ha)**	*Date established*
Scottish Borders	**1**		
Berwickshire		4,838	1986
Region 4	***1***	***4,838***	
North Sea Coast	6	8,609	
Scotland	29	111,896	

Source: NCC (1990). Key: *to the nearest whole hectare.

management bodies to be aware of marine conservation issues in the area. There is one MCA (4,838 ha) in Region 4 (Table 7.4.2; Map 7.4.1).

7.4.4 Voluntary Marine Nature Reserves

Voluntary Marine Nature Reserves (VMNRs) (also called voluntary marine conservation areas or voluntary marine wildlife areas) may be set up by representatives of the users of a subtidal area or an area of shore in order to initiate management of that area. Management may have a variety of purposes, from conservation of a marine biologically important area to educational use. 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. The single VMNR in Region 4 is the only one in Scotland (Table 7.4.3; Map 7.4.1).

7.4.5 Regional Landscape Designations

Regional Landscape Designations (RLDs) provide a mechanism whereby Scottish planning authorities can identify sites where there should be a strong presumption against development (Cobham Resource Consultants 1988). The designation recognises that these scenic areas have considerable unexploited potential for tourism and therefore for benefiting local economies. Local circumstances and the absence of central guidance since 1962 means that regional landscape designations vary in title, scale and objectives from one planning authority to another (Cobham Resource Consultants 1988), such that there are at least five types of RLD. The area of many of these sites is not available.

There are twelve areas covered by RLDs that include areas somewhere within the coastal zone in Region 4 (Table 7.4.4; Map 7.4.2); all are known as Areas of Great Landscape Value (AGLV). There has been no monitoring or further comprehensive study of the number of RLDs since the study by Cobham Resource Consultants (1988).

Table 7.4.3 Voluntary Marine Nature Reserves

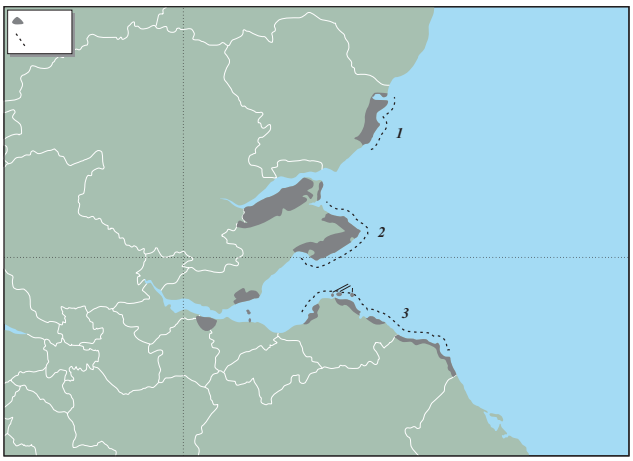
Site name	*No of sites*
Scottish Borders	**1**
St. Abb's Head	
Region 4	***1***
North Sea coast	9
GB coast	14

Source: SNH.

Table 7.4.4 Regional Landscape Designations (RLDs)

Identification on Map 7.4.2	*Site name*	*No. of sites*	*Area (ha)**
	Angus	**1**	
a	Lunan Bay and Coast		3,258
	Fife	**4**	
b	Tay Coast		17,599
c	Tentsmuir Shore		17,595
d	East Neuk Coast		13,837
e	Burntisland Coastal Area		3,620
	West Lothian	**1**	
f	Hopetoun Coastline		875
	City of Edinburgh	**1**	
g	Crammond Isle, Cow and Calves and Inchmickery		<100
	East Lothian	**4**	
h	Longniddry to Dirleton Coastline		1,615
i	Islands of Bass Rock,Craigleith and the Lamb		251
j	Dunbar to Dunglass Burn Coastline		785
k	North Berwick to Tyninghame Coastline		1,555
	Scottish Borders	**1**	
l	Berwickshire Coastline		1,232
	Region 4	***12***	~ 62,332
	North Sea Coast	39	n/a
	Scotland coast	63	n/a
	Scotland whole country	178	n/a

Sources: Cobham Resource Consultants (1988), SNH. Key: *to the nearest whole hectare; n/a = not available. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.



Map 7.4.2 Coastal Regional Landscape Designations (RLD), Preferred Conservation Zones (PCZs) (listed in Table 7.4.5). Source: Cobham Resource Consultants (1988), Scottish Development Department (1974).

7.4.6 Preferred Conservation Zones (PCZ)

Created in the 1970s, Preferred Conservation Zones (PCZs) are non-statutory coastal areas in Scotland, of particular national, scenic, environmental or ecological importance, in which major new oil- and gas-related developments would in general be inappropriate or would have a socio-economic impact on a small community, and would only be justified in exceptional circumstances (see also section 9.5). They are areas with a distinctive aesthetic appeal, heritage and character, where tourism and recreation take priority over major industrial processes. PCZs are the opposite of Preferred Development Zones. In Region 4 there are three PCZs (Table 7.4.5; Map 7.4.2). This compares with 22 PCZs on the Scottish mainland and larger islands, and numerous potential PCZs around the smaller islands (only the larger islands have defined PCZs) (Scottish Development Department 1974). The principles of PCZs were incorporated into local development plans.

Table 7.4.5 Preferred Conservation Zones (PCZs)

Site no. on Map 7.4.2	*Location*	*No. of sites*
	Angus	**1**
1	North of Arbroath - South of Montrose	
	Fife	**1**
2	Lundin Links - Tentmuir	
	Scottish Borders/East Lothian	**1**
3	St. Abb's - Longniddry	
	Region 4	***3***
	North Sea Coast	17
	Scotland	22

Source: Scottish Development Department (1974).

7.4.7 Acknowledgements

Thanks are due to Roger Bolt, JNCC, and Donald Balsillie, Kathy Duncan and Natasha O'Connel, Scottish Natural Heritage.

7.4.8 Further sources of information

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
NCR sites, GCR sites (Perth and Kinross; Angus)	*SNH, Perth Area Office, Perth, tel: 01738 639746
NCR sites, GCR sites (Stirling and Fife)	*SNH, Stirling Area Office, Stirling, tel: 01786 450362
NCR sites, GCR sites, MCA, VMNR (Lothian and Scottish Borders)	*SNH, Galashiels Area Office, Galashiels, tel: 01896 756652
PCZs, RLDs (Angus)	*Angus Council, Forfar, tel: 01307 461460
PCZs RLDs (Stirling)	*Stirling Council, Stirling, tel: 01786 443322
PCZs, RLDs (Fife)	*Fife Council, Glenrothes, tel: 01592 414141
PCZs, RLDs (East Lothian)	*East Lothian Council, Haddington, tel: 01620 827827
PCZs, RLDs (City of Edinburgh)	*City of Edinburgh Council, Edinburgh, tel: 0131 200 2000
PCZs, RLDs (West Lothian)	*West Lothian Council, Livingston, tel: 01506 777000
PCZs, RLDs (Scottish Borders)	*Scottish Borders Council, Melrose, tel: 01835 824000

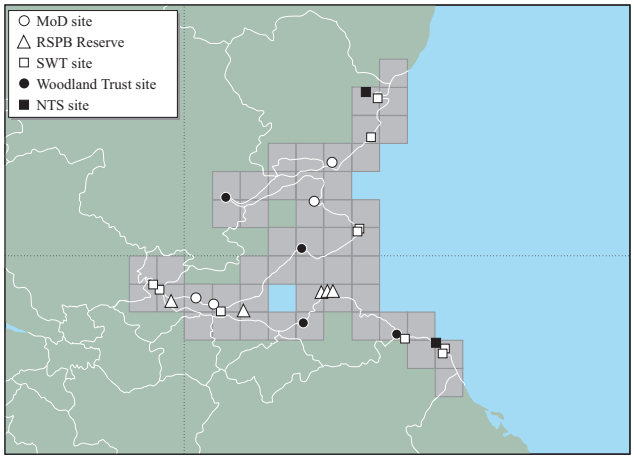
*Starred contact addresses are given in full in the Appendix.

Elie Ness to Anstruther Geological Conservation Review site, Fife, is one of a few places on the coast of the Firth of Forth where the Scottish Carboniferous coal seams, ironstones and oil shales are exposed on the surface. The coal was once extensively mined, underpinning the region's prosperity, although now it has been supplanted by oil and gas. Photo: Pat Doody, JNCC.

7.5 Other types of protected site

7.5.1 The National Trust for Scotland

The National Trust for Scotland is a charitable organisation, established in 1931 (National Trust for Scotland Order Confirmation Act 1935) to promote the permanent preservation of Scotland's heritage of fine buildings, beautiful landscape and historic places, and to encourage public enjoyment of them. The Trust now has over 100 properties in its care, including over 40,500 ha of countryside, from forest, mountains and moorland to the coast (National Trust for Scotland 1996). The National Trust for Scotland practises active conservation and management of its land. Land that is not owned by the Trust can be protected by a Conservation Agreement under power given to the National Trust for Scotland by a 1938 Act of Parliament. Conservation Agreements are entered into voluntarily by landowners who wish their land to come under a form of protection short of full Trust ownership. There are two National Trust for Scotland sites of natural heritage interest on the coast of Region 4 (Table 7.5.1; Map 7.5.1)



Map 7.5.1 Other types of coastal protected site. Source: JNCC, National Trust for Scotland (NTS), RSPB, Scottish Wildlife Trust (SWT), Ministry of Defence (MoD), Woodland Trust.

7.5.2 The Royal Society for the Protection of Birds

The Royal Society for the Protection of Birds (RSPB) has substantial non-statutory reserve holdings and currently manages over 140 reserves (97,000 ha) in Britain (S. Gilbert pers. comm.). Wherever possible, reserves are purchased, so that the level of safeguard for the wildlife and their habitats is high. Where reserves are leased, the RSPB aims to acquire long leases (longer than 21 years) with appropriate management rights. There are five coastal RSPB reserves (424 ha) in Region 4 (Table 7.5.2; Map 7.5.1).

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, although both Scotland and the Isle of Man each have a single Trust. The Scottish Wildlife Trust owns, leases and manages (by agreement with owners) over 80 nature reserves (more than 15,000 ha). There are ten coastal Scottish Wildlife Trust sites (2,309 ha) in Region 4 (Table 7.5.3; Map 7.5.1).

7.5.4 The Ministry of Defence

As at August 1994, the Ministry of Defence (MoD) owned, leased or used under licence landholdings covering some 320 km of coastline around the UK, not all of it significant for its nature conservation value. The MoD gives high priority to nature conservation on the Defence Estate, subject to the overriding importance of military training. The restrictions to public access on some sites mean that they can be amongst the most undisturbed areas of wildlife habitat in the region. There are four coastal MoD sites (2,402 ha) in Region 4 (Table 7.5.4; Map 7.5.1).

Table 7.5.1 National Trust for Scotland sites

Site name	*No. of sites*	*Grid ref.*	*Area (ha)**	*Date acquired*	*Landform*
Angus	**1**				
House of Dun		NO665587	342	1980-86	Coastal estate
Berwickshire	**1**				
St. Abb's Head		NT917690	146	1980-87	Coastal headland
Region 4	***2***		***488***		
Scotland coast	20		25,170		
North Sea Coast**	191		18,610		
GB coast**	453		64,127		

Sources: National Trust for Scotland, JNCC. Key: *to the nearest whole hectare; **includes National Trust sites in England (and Wales). Note: in this table only sites of natural heritage interest have been included. Any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

Table 7.5.2 Royal Society for the Protection of Birds reserves

Site name	*No. of sites*	*Grid ref.*	*Area (ha)**	*Date acquired*	*Interest*
Falkirk	**1**				
Skinflats		NS930840	413	1976	Estuarine mudflat, ungrazed saltmarsh - wintering and migrating waterfowl including pink-footed geese *Anser brachyrhynchus*, shelduck *Tadorna tadorna*, dunlin *Calidris alpina* and knot *Calidris canutus*.
East Lothian	**3**				
Fidra Islands - Lamb		NT494863	-	1988	Rocky unvegetated islet, breeding seabirds including cormorant *Phalacrocorax carbo*
Fidra Islands - Fidra		NT513868	-	1988	Rocky coastline and cliffs with maritime grassland-breeding seabirds
Fidra Islands - Eyebroughy		NT535866	7	1988	Exposed bare rock, sand bar with breeding seabirds including cormorant, moulting eider *Somateria mollissima*
City of Edinburgh	**1**				
Inchmickery		NT207806	4	1961	Rocky shore, low cliffs, sand/shingle beach, overgrown coastal grassland, wartime fortifications with breeding gulls and terns including roseate tern *Sterna dougalli*
Region 4	***5***		***424***		
North Sea Coast	53		24,610		
GB coast	82		39,660		

Sources: RSPB (1994; *in litt*.). Key: *to the nearest whole hectare. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

Table 7.5.3 Wildlife Trusts sites

Site name	*No. of sites*	*Grid ref.*	*Area (ha)**	*Date acquired*
Angus	**2**			
Montrose Basin		NO694576	1,013	1976
Seaton Cliffs		NO667416	11	1975
Fife	**3**			
Fife Ness		NO636097	1	1995
Kilminning Coast		NO633090	9	1985
Long Craig Island		NT125802	2	1987
Clackmannanshire	**2**			
Alloa Inches		NS865920	50	1996
Cambus Pools		NS843937	6	1995
Scottish Borders	**3**			
Pease Dean		NT790705	32	1988
St. Abb's Head		NT914688	97	1977
St. Abb's Marine Reserve		NT920700	1,030	1984
Region 4	***10***		***2,309***	
Scotland#	26		13,805	
North Sea Coast	145		11,574	
GB coast	241		25,884	

Source: Scottish Wildlife Trust (1996). Key: *to the nearest whole hectare; # all Scottish Wildlife Trust. Notes: 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*
Angus	**1**			
Barry Buddon		1,177	Sand dunes	SSSI
Fife	**3**			
Leuchars		392	Sand, mud, shingle	SSSI
Rosyth		520	Harbour, rock	No designation
Crombie		312	Rock, mud, shingle	No designation
Region 4	***4***	***2,402***		
North Sea Coast	65	34,449		
GB coast	110	53,409		

Source: Ministry of Defence. Key: *all areas are approximate and include land leased or used under licence; SSSI = Site of Special Scientific Interest. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

7.5.5 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 four Woodland Trust sites (138 ha) in Region 4 (Table 7.5.5; Map 7.5.1).

7.5.6 Acknowledgements

The authors wish to thank Andrea Firth (MoD), Dr J. Fenton (National Trust for Scotland), Bob Scott and Steve Gilbert (RSPB), Dr A. Somerville (Scottish Wildlife Trust) and the Woodland Trust.

Table 7.5.5 The Woodland Trust sites

Site name	*No. of sites*	*Grid ref.*	*Area (ha)**
Angus	**1**		
Moncreiffe Hill Wood		NO130200	135
Fife	**1**		
Largo Serpentine		NO425029	1
E. Lothian	**1**		
Seton Dean		NT426755	1
Scottish Borders	**1**		
Fairbairn Copse		NT780719	1
Region 4	***4***		***138***
North Sea Coast	36		1,104
GB coast	72		1,584

Source: Woodland Trust (1996). Key: *to the nearest whole hectare. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

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Royal Society for the Protection of Birds. 1996. *Nature reserves - information for visitors.* Sandy, Royal Society for the Protection of Birds.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
National Trust for Scotland sites	*The National Trust for Scotland, Edinburgh, tel: 0131 226 5922
RSPB sites (Angus and Fife)	*Regional Officer, RSPB East Scotland Office, Aberdeen, tel: 01224 624824
RSPB sites (Stirling, Lothian and Scottish Borders)	*Regional Officer, RSPB South and West Scotland Office, Glasgow tel: 0141 945 5224
Scottish Wildlife Trust sites	*Scottish Wildlife Trust, Edinburgh, tel: 0131 312 7765
The 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 Appendix.

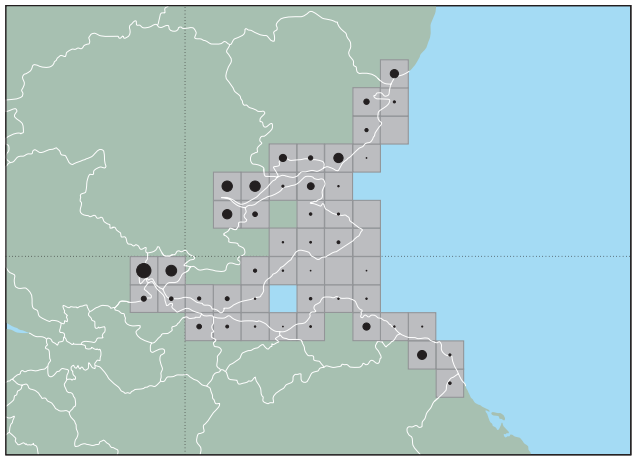
Chapter 8 Land use, infrastructure and coastal defence

S.J. Everett

8.1 Introduction

This chapter is divided into three sections: (rural) land use, covering agriculture (especially as it affects important coastal wildlife habitats) and woodland; infrastructure, covering population distribution, industry, ports, harbours, ferries, pipelines, cables and power generation; and coastal defence, including sea defence and coast protection.

Most of the coastal fringe of this region is agricultural or urban, and there are only small areas of non-coastal semi-natural habitat, including woodland, heath, bog and moor (Map 8.1.1), although there are a few large areas of conifer plantation. The greatest part of the coastal hinterland is in agricultural use and contains Scotland's most productive farmland. The population and industry of the region is concentrated around the Firths of Tay and Forth, with Arbroath, Dundee, Kircaldy and Edinburgh being among the main centres. Perth and Stirling are sited at the heads of the firths, while Dunfermline and Falkirk are set back a little from the coast. The Firth of Forth has Edinburgh (Scotland's capital city), the major petrochemical complex and port of Grangemouth, the dockyards and industrial areas of the Forth Bridgehead area and a large number of small towns lining its shores: these are some of the most significant urban and industrial areas in Scotland. By contrast, most of the open coast is only sparsely populated.



Map 8.1.1 Area of heath, bog and moor in coastal 10 km grid squares. Note: area of circle indicates the area of this land cover type in the 10 km square. Sources: Countryside Survey (1990), ITE Monks Wood.

Away from the urbanised and industrialised inner firths, the coastal zone of this region is mostly under intensive agriculture right to the limit of tidal habitats, with few areas of woodland, moor or bog. Its sandy bays, such as Shell Bay near Earlsferry on the north shore of the Firth of Forth, are popular for caravan sites, and the region is famous for golf tourism, with more than 50 golf courses, many on sand dune systems. Photo: Pat Doody, JNCC.

8.2 Land use

S.J. Everett

8.2.1 Agriculture

Region 4 contains almost all the Prime Quality Land occurring on Scotland's coast. Fifty-seven percent of the land adjacent to the coast in the region is Class 2 or 3, while 24% is urban (G. Russell pers. comm.). Map 8.2.1 illustrates the large area of tilled land in the coastal 10 km squares of the region, occurring particularly in Angus, Fife, East Lothian and the Scottish Borders. A small amount of the important soft fruit growing in Angus occurs on the coast. Maps 8.2.2 and 8.2.3 show that this region has little mown or grazed turf or meadows, except in areas around the upper reaches of the Forth and Tay Estuaries.

As with most coastal regions in Scotland, Region 4 has experienced rural decline and loss of employment in the agricultural sector, which together have encouraged rural depopulation, although this has been a more serious problem in the interior upland areas than on the coast. The Scottish Borders has been designated an Objective 5b rural area under the European Union's structural funds and regional aid programmes and is eligible for development funding. This objective aims to promote rural diversification, including the restructuring of fishing ports.

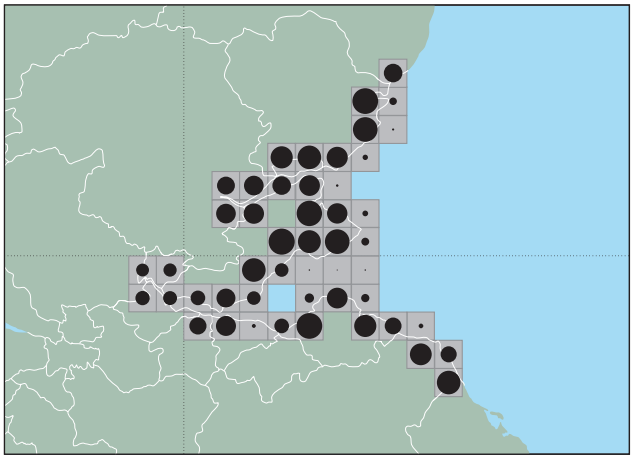
Grazing of stock on saltmarshes surveyed as part of the national saltmarsh surveys (Burd 1989) is illustrated on Map 8.2.4. None of the sand dune sites included in the national sand dune survey (Dargie 1993) in this region was found to be grazed, although grazing is known from other dune sites (see section 3.2).

8.2.2 Woodland and forestry

This region has few large areas of coastal woodland, although in certain areas, such as along the south side of the Firth of Tay and on the shores of the Forth as far east as Cockburnspath, there are scattered small woodlands in the coastal zone. Of these only a few small areas have been identified as 'ancient' or 'long-established semi-natural' in Scottish Natural Heritage's Ancient Woodlands Inventory. The only large commercial plantation is on the dunes at Tentsmuir, although there are small areas of conifer plantation on other coastal dunes, for example at Kinnaber and Barry Links. Local authority plans identify the coast as a 'sensitive' area, where afforestation is generally discouraged except for amenity, landscape and nature conservation purposes.

The coastal area along the south bank of the Firth of Forth in West Lothian lies within the area of the 'Central Scotland Forest', an initiative established to promote woodland planting between the urban conglomerations of Edinburgh and Glasgow. There is a similar initiative in Fife: the West Fife Woodlands Initiative.

Areas of woodlands >5 ha shown on 1:50,000 Ordnance Survey maps are shown on Map 8.2.6 and listed in Table 8.2.1. In addition the region holds a number of areas of ancient semi-natural woodland >5 ha listed in Scottish Natural Heritage's Ancient Woodland Inventory. These are shown on Map 8.2.6.



Map 8.2.1 Tilled land. Note: area of circle indicates the area of this land cover type in the 10 km square. Sources: Countryside Survey (1990), ITE Monks Wood.

8.2.3 Information sources used

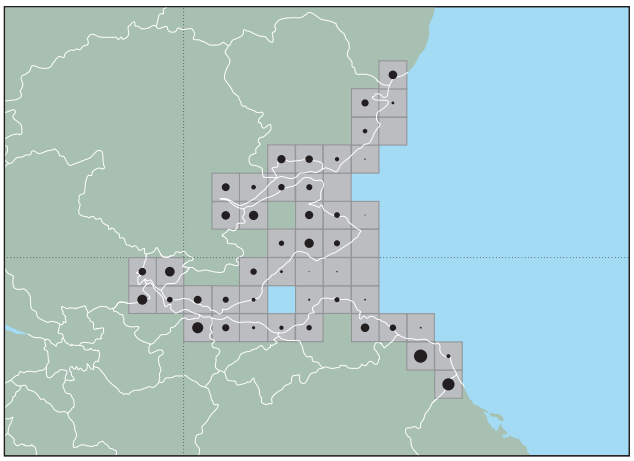
The four main sources of information for this section were the Countryside Survey 1990 (ITE 1993), land use capability data from the Macaulay Land Use Research Institute, Ordnance Survey Landranger maps and the Scottish Natural Heritage Ancient Woodland Inventory.

The Countryside Survey 1990 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. These are 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 8.1.1, 8.2.1, 8.2.2, and 8.2.3 are derived from these data, which are held in the DoE Countryside Information System. The main limitations of these data are derived from errors in classifying areas covered by a mixture of land types. The Countryside Information System can provide data on a 1 km square framework, but this level of detail was not considered appropriate here.

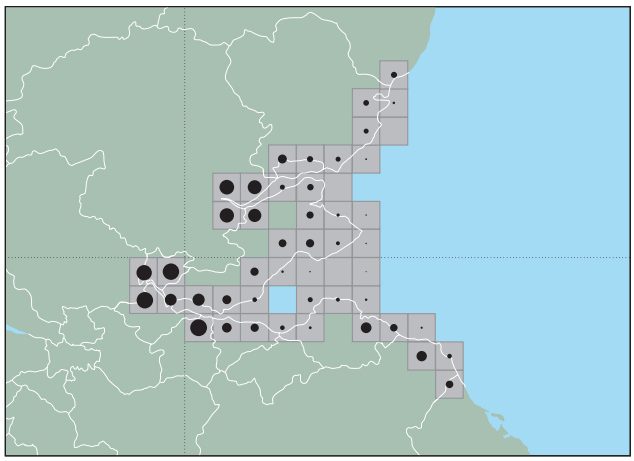
Information on coastal woodland was obtained from 1:50,000 scale Ordnance Survey Landranger maps and the Ancient Woodland Inventory held by Scottish Natural Heritage. The Countryside Survey 1990 (ITE 1993) is also a source of information on woodlands, but the broad-leaved category includes some deciduous conifer trees, such as larch.

8.2.4 Acknowledgements

Thanks are due to John Kupiec (SNH), for providing ancient woodland data, and to Robin Fuller (ITE) for Land Cover data. Thanks also go to Mark Tasker (JNCC), G. Russell (Institute of Ecology and Resource Management, University of Edinburgh), Allan Brown and G. Moy (Fife Council), Anne Brown, Kathy Duncan, Alan Leitch, Sandy MacLennan and Karen Passmore (SNH), Alan Burdekin (SOAEFD) and Daniel Owen (RSPB) for their useful comments on the drafts.



Map 8.2.2 Area of mown/grazed turf in coastal 10 km grid squares. Note: area of circle indicates the area of this land cover type in the 10 km square. Sources: Countryside Survey (1990), ITE Monks Wood.

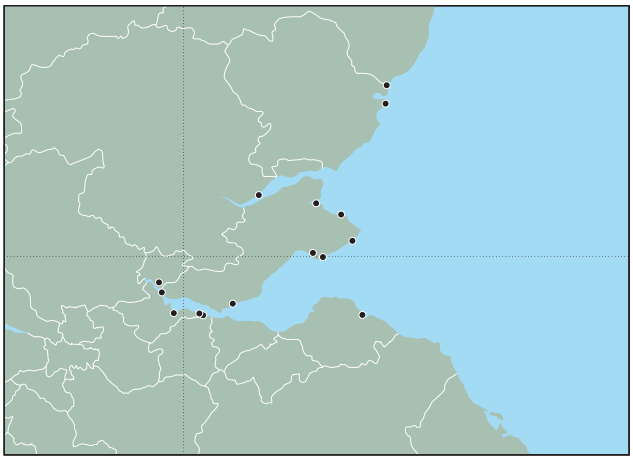


Map 8.2.3 Area of meadow or semi-natural grassland (ITE 1993) in coastal 10 km^2 grid squares. Note: area of circle indicates the area of this land cover type in the 10 km square. Sources: Countryside Survey (1990), ITE Monks Wood.

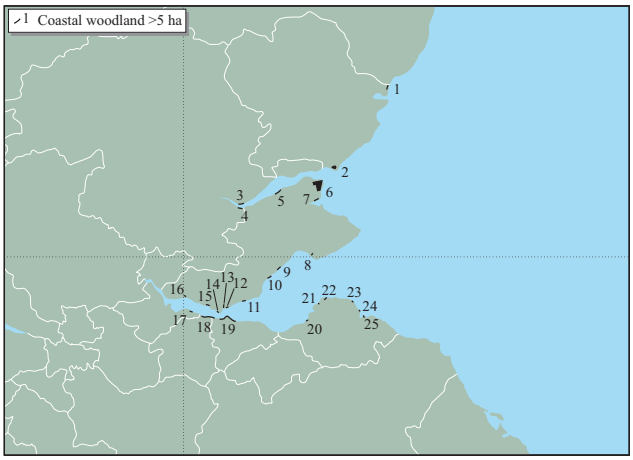
Table 8.2.1 Areas of significant coastal forestry and woodland

Site no. on Map 8.2.5	*Location*	*Grid ref.*	*Details*
1	Charleton and Kinnaber Links, Montrose Bay	NO7261-NO7360	>40 ha conifers, some on sand dunes
2	Barry Links	NO5332	Woodland and scrub on golf course
3	Paddockmuir Wood	NO2119, NO2120	>30 ha broad-leaved; includes long-established woodland of plantation origin
4	West of Newburgh	NO2218	*c.* 20 ha deciduous
5	South shore, Firth of Tay	NO3223	Narrow steep woodland extending for *c.* 5 km; listed on Ancient Woodland Inventory
6	Tentsmuir Forest, Morton Links	NO5025	>1,400 ha conifer afforestation on sand dunes plus small area of broad-leaved woodland and scrub
7	Reres Wood, near Leuchars, Fife	NO4821	*c.* 80 ha conifers on sand dunes
8	St. Ford Links, near Earlsferry, Fife	NO4600	>10 ha coniferous
9	Coaltown (Wemyss)	NT3396	>5 ha broad-leaved
	Blair Point/Wemyss	NT3194	>20 ha narrow steep woodland (broad-leaved, long-established plantation origin)
10	North-east of Kirkcaldy	NT2992	>10 ha woodland
11	Silversands Bay	NT2085	6 ha ancient broad-leaved woodland
12	Dalgety Bay, north shore, Firth of Forth	NT1683-NT1884	*c.* 40 ha broad-leaved in scattered strips abutting shore; long-established plantation origin
13	St. David's Harbour (Letham Hill Wood), Firth of Forth	NT1482	*c.* 20 ha
14	Cult Ness	NT1281	*c.* 5 ha
15	Charlestown	NT0783	*c.* 15 ha broad-leaved
16	Low Valleyfield	NT0086	*c.* 10 ha broad-leaved
17	Muirhouses	NT0280	16 ha broad-leaved (long-established semi-natural) over 2 km beside shore
18	Wester Shore Wood to South Queensferry	NT0579-NT1078	40 ha coniferous and mixed woodland
19	South Queensferry to Edinburgh	NT1378-NT1877	Extensive areas of broad-leaved and mixed woodland in coastal strip and associated with Dalmeny Park
20	Gosford Bay	NT4477-NT4479	Woodland associated with Gosford House
21	Black Rocks	NT4884	*c.* 20 ha coniferous
22	Longskelly	NT5085	>70 ha mixed and coniferous
23	Gar Rocks	NT6084	Narrow strip of broad-leaved woodland on top of cliff
24	Tyninghame Links	NT6380	>25 ha on headland
25	West Barns	NT6479	>20 ha coniferous

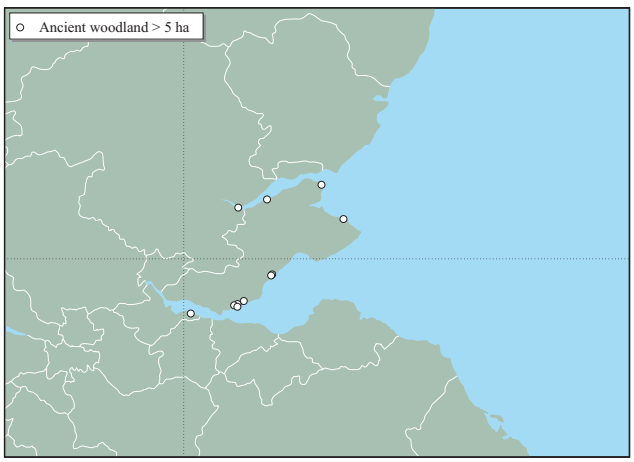
Source: Ordnance Survey 1:50,000 maps and Scottish Natural Heritage Ancient Woodland Inventory.



Map 8.2.4 Grazing on saltmarsh. Source: JNCC integrated coastal database.



Map 8.2.5 Areas of coastal woodland >5 ha (semi-natural and planted) (Table 8.2.1). Sources: Ordnance Survey Landranger maps. © Crown copyright.



Map 8.2.6 Areas of coastal ancient semi-natural woodland >5 ha. Source: Scottish Natural Heritage Ancient Woodland Inventory database.

8.2.5 Further sources of information

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Agricultural policy in Scotland	*Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD), Pentland House, Edinburgh, tel: 0131 556 8400
Land use (agricultural and forestry land capability information. Handbooks and maps) in Scotland.	Macaulay Land Use Research Institute, Craigiebuckler, Aberdeen AB9 2QJ, tel: 01224 318611
ITE Countryside Survey 1990	*Land Use Group, ITE Merlewood, tel: 01539 532264, or *Environmental Information Centre, ITE Monks Wood, tel: 01487 773381
Crofting	Crofters Commission, 4/6 Castle Wynd, Inverness IV2 3EQ, tel: 01463 237231
Forestry policy (GB)	The Forestry Commission of Great Britain, 231 Corstorphine Road, Edinburgh EH12 7AT, tel: 0131 334 0303
Distribution, ownership, management of woodlands - Scotland	Forestry Authority, Scotland National Office, Portcullis House, 21 India Street, Glasgow G2 4PL, tel: 0141 248 3931
Distribution, ownership, management of woodlands - Perth	Forestry Authority, Perth Conservancy, 10 York Place, Perth PH2 8EP, tel: 01738 442830
Distribution, ownership, management of woodlands - Lothian and Borders	Forestry Authority, Lothian and Borders Conservancy, North Wheatlands Mill, Wheatlands Road, Galashiels TD1 2DQ, tel: 01896 750222
Crown agricultural and forestry estates	Crown Estate, 10 Charlotte Square, Edinburgh EH2 4DR, tel: 0131 226 7241
Coastal woodlands of nature conservation significance - Scotland ancient woodlands GIS database	*SNH Advisory Services, Edinburgh, tel: 0131 554 9797
Coastal woodlands of nature conservation significance - Angus, Dundee City, Perth and Kinross Area	*SNH, Perth Area Office, Perth, tel: 01738 639746
Coastal woodlands of nature conservation significance - Fife, Stirling, and Clackmannan Area	*SNH, Stirling Area Office, Stirling, tel: 01786 450362
Coastal woodlands of nature conservation significance - West Lothian, City of Edinburgh, East Lothian and Scottish Borders Area	*SNH, Galashiels Area Office, Galashiels, tel: 01896 756652

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

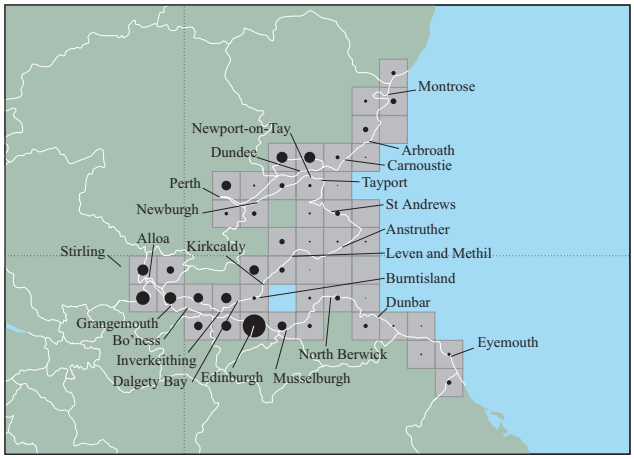
8.3 Infrastructure

S.L.Fowler, S.J. Everett & Scott Wilson Resource Consultants

8.3.1 Introduction

This section summarises the infrastructure of the region, including population distribution, industry (including oil refining), ports, harbours, ferries and power generation, and land claim for these developments. Oil and gas exploration and development are covered in section 9.5.

The majority of Scotland's industry and residential development is located on its coast, with this region holding many of the country's most significant urban and industrial areas, located primarily along the shores of the Firth of Forth and in the cities of Dundee and Stirling. The industrial areas have experienced considerable change during the past twenty years. The closure of coastal coal mines (e.g. around Kirkcaldy) and the decline in the British shipbuilding and repair industry, coupled with the decline of the North Sea fisheries, have led to economic difficulties in the region. However, there has been notable expansion in the petrochemical industries situated in the Firth of Forth, and in the industries that support the offshore oil and gas industry. Nevertheless many of the urban areas still qualify for special development aid under the European Union's structural funds and regional aid programmes.



Map 8.3.1 Urban, suburban and rural development. Note: area of circle indicates the combined area of these land cover types in the 10 km square. Towns and cities are also shown. Sources: Countryside Survey (1990); ITE Monks Wood.

8.3.2 Important locations

Residential development

Although much of the open coastline is sparsely populated, Region 4 is the most heavily populated of all the Scottish regions, with the exception of the Glasgow area. The populations of all the major cities and towns in the region are shown in Table 8.3.1. Map 8.3.1 shows the locations of major centres of population in the region.

The coastline of Angus is, for the most part, sparsely populated apart from the towns of Montrose and Arbroath. Carnoustie, although primarily a resort town, has been subject to recent expansion of its residential areas primarily for commuter housing serving Dundee. Dundee itself, located on the north bank of the Tay, is Scotland's fourth largest city but continues to experience population decline. As a consequence, strategic planning policies for Dundee aim to promote urban renewal. Perth, located at the head of the Tay Estuary, is the main residential and employment centre in Perth and Kinross District and is an important historic centre. The south shore of the Firth of Tay is sparsely populated and there are only minor settlements (e.g. Newburgh, Newport-on-Tay and Tayport, with a combined population of *c.* 10,000 inhabitants). St. Andrews is an ancient university town, resort and golfing centre. The small fishing villages of the East Neuk of Fife (Crail, Kilrenny, Anstruther, Pittenweem, St. Monans and Elie) have been protected through planning policies that limit modern urban expansion and are now important localities for tourism.

Leven, Methil and Kirkcaldy have recently expanded, but most new development has occurred away from the coast. Kirkcaldy is a major settlement, sufficiently close to Edinburgh to serve as a dormitory town. Development with residential and industrial uses is resulting in a significant expansion in the Dalgety/Inverkeithing area (projected population 10,000).

At the head of the Firth of Forth are the population centres of Alloa, Stirling, Grangemouth and Bo'ness. Grangemouth and Bo'ness are major industrial centres for

Table 8.3.1 Coastal centres of population in Region 4

Location	*Population**
Montrose	12,000
Arbroath	24,000
Carnoustie	9,000
Dundee	166,000
Perth	42,000
Newburgh	2,000
Newport-on-Tay	4,000
Tayport	3,000
St. Andrews	11,000
Anstruther	3,300
Leven & Methil	9,000
Kirkcaldy	145,000
Burntisland	6,000
Dalgety Bay	10,000
Inverkeithing	6,000
Alloa	26,000
Stirling	39,000
Grangemouth	22,000
Bo'ness	15,000
Edinburgh and Leith	421,000
Musselburgh	19,000
North Berwick	5,000
Dunbar	6,000
Eyemouth	3,000

Source: Cook (1993). Key: *to the nearest thousand.

the region. Edinburgh, Scotland's capital city, is the largest residential centre in the region, with a population of 421,000 and an urban frontage on the coast of some 12 km, between Granton and Joppa. To the east, the coast has four small towns: Musselburgh, North Berwick, Dunbar and Eyemouth.

Industry

Industrial development is concentrated alongside key locations in the sheltered waters of the Firths of Tay and Forth. Much of the region has suffered a decline in its manufacturing sector, which, coupled with the closure of most of the region's coalfields and the running down of the Rosyth naval base, has led to urban decline and high unemployment in some of the traditional industrial areas. As a result, most of the major employment centres (except Edinburgh) lie within designated Development Areas or areas with Intermediate Assisted or Assisted Area status. These locations have also been designated as Objective 2 (industrial) areas by the European Commission and therefore qualify for support under the European Structural Fund and Regional Aid programmes. Centres identified as being in need of economic regeneration and given special status include Arbroath, Dundee, Newport-on-Tay, Tayport and the towns along the north shore of the Forth between Leven and Alloa, as well as Grangemouth and Bo'ness on the south shore. Councils around the Forth qualify for EU support under the 'Rechar' initiative (aimed at promoting economic regeneration in former coal-mining areas).

Montrose and Arbroath are important local employment centres that have benefited from oil-related development. Montrose has seen recent expansion in the pharmaceutical industry and is a supply base for the North Sea oil industry. Arbroath was originally a major fishing port but now has engineering, electronics and textile industries, as well as being a coastal resort. Both towns have been identified as locations for future economic development. Dundee and Perth are regionally important centres for industry and business, with Perth having been identified by the Scottish Office as an area for regional economic growth.

The main concentration of industry in the region is in the Forth Estuary. The inner area (upstream from the bridges) has lost about 50% of its former intertidal area as a result of land-claim during the past 200 years, partly for agriculture but mainly to industry. The Levenmouth area, including Methil Docks, formerly a major industrial area, has been targeted for urban regeneration projects through the Levenmouth Area Initiative. Kirkcaldy is a major service centre that has experienced economic difficulties since the closure of its coal mines. As a result the Kirkcaldy Initiative has been established to promote urban regeneration, strengthen its transport network and promote economic development. Burntisland has a large harbour and docks and a chemical industry and is also a resort. The industrial area located between Braefoot Bay and Rosyth includes the oil terminal at Braefoot Bay, which serves the Shell/Exxon chemical plant at Mossmorran, industrial areas at Dalgety Bay and Inverkeithing, and the Rosyth Naval Base and nuclear establishment (currently being running down, but to be redeveloped for mixed use under the Rosyth 2000 Initiative).

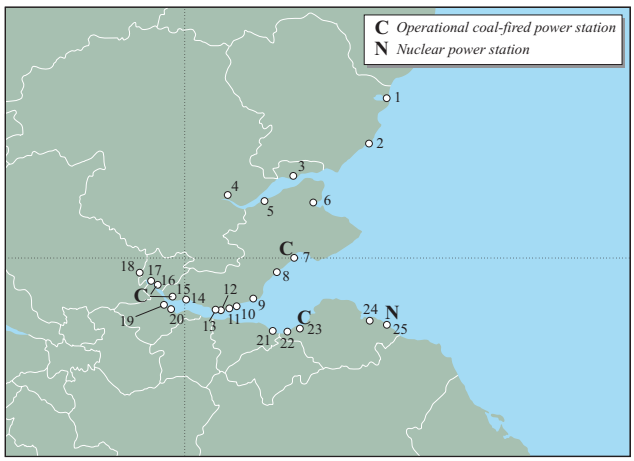
The most heavily industrialised coastal area in the region is located at Grangemouth on the south bank of the Firth of Forth. The combined oil and chemical complex here is the largest in Scotland and accounts for 8% of Scottish gross domestic product. Nearly 300 ha of land was identified in the early 1990s for new developments and for the expansion of the petrochemical complex, including a projected £1 billion plan to expand BP's refining and chemicals capacity in the area. BP has also invested in additional facilities at Grangemouth Docks for the handling of hazardous bulk liquid cargoes. The Central Region Structure Plan (Central Regional Council 1994) notes that there are significant opportunities for the development of new chemical plants on redevelopment sites within the existing complex, although the disposal of chemical waste is a recurring problem. Plans for further land-claim and a new marine terminal at Kinneil were turned down on appeal, and a decision was made by the Secretary of State not to permit further land claim through tipping of domestic and trade waste. However, the south-west part of the site remains as a National Planning Guideline site for petrochemical development. Grangemouth is also a major site for shipbuilding and repair, with an oil tanker terminal projected. As well as the oil refinery (which has a pipeline to Hound Point Jetty, South Queensferry), there is deepwater anchorage for tankers, petroleum, chemical and pharmaceutical industries, marine engineering, electronics and electrical industries. To the east of Grangemouth, coastal industry is located at Bo'ness and Edinburgh. Musselburgh, a short distance to the east of Edinburgh, has a small harbour where extensive intertidal areas have been lost by the establishment of ash lagoons.

On the open coast, North Berwick and Dunbar are traditional fishing ports, now resorts, with associated small industries. The most significant industrial sites on this section of coast are the cement works at Oxwell Mains and Torness nuclear power station.

Table 8.3.2 lists locations of industrial infrastructure in the region (Map 8.3.2).

Communications

It has been proposed to build a second road crossing across the Firth of Forth at Queenferry alongside the existing Forth Road Bridge. This proposal has been delayed indefinitely



Map 8.3.2 Industrial infrastructure (Table 8.3.2) and operational coastal power stations (Table 8.3.4). Sources: Ordnance Survey Landranger maps; Scottish Power plc. © Crown copyright.

Table 8.3.2 Major areas of coastal industrial development

No. on Map 8.3.2	*Location*	*Grid ref.*	*Details*
1	Montrose	NO7057	Boat building, rope manufacturing and chemical industry, North Sea oil supply base, fishing port
2	Arbroath	NO6441	Engineering and textile industries
3	Dundee	NO4130	Major industrial area; offshore fabrication (oil rig/platform renovation yard), small oil refinery, land claim for dock and airport, gas jetty, other jetties; engineering and manufacturing industries, including scrap metal merchant and textile dyeing works
4	Perth	NO1123	Dyeing and textiles industry, food and drink industry including whisky distilling, financial centre
5	Newburgh	NO2318	Light industry
6	Guardbridge	NO4519	Paper mill on River Eden
7	Methil	NO3700	Coal-fired power station, large docks
8	Kirkcaldy	NT2892	Engineering works
9	Burntisland	NT2385	Major industrial works
10	Braefoot Bay, Aberdour	NT1883	Oil terminal, jetties, piers serving Shell and Exxon chemical works at Mossmorran
11	Dalgety Bay	NT1583	New town and industrial estate
12	Inverkeithing	NT1282, NT1382	Ship breaking, paper mill, industrial developments
13	Rosyth	NT0982	Manufacturing and technical support to the Ministry of Defence as well as overseas markets. 4 large dry docks for ships up to 300 m. A shiplift for up to 1,500 tonnes.
14	Preston Island, Culross (Valleyfield Lagoon)	NT0085	>1,800 ha land claim in Torry Bay, fly ash lagoon
15	Longannet Point/Castle Bridge complex	NS9485, NT9486	Coal-fired power station, land claim; colliery
16	Kincardine	NS9288	Coal-fired power station (mothballed) with ash lagoons, land claim
17	Alloa	NS8892	Distillery, warehousing, industrial estate
18	Stirling		Engineering and textiles
19	Grangemouth	NS9483	>500 ha industrial area and the main Forth port with oil refinery, petrochemical and pharmaceutical works; ship building and repair, marine engineering, electronics and electrical industries
20	Bo'ness	NS9981	Foundries and timber yards; land claim
21	Edinburgh	NT2070	Major industrial sites with gas works and other industry; land claim, chemical and gas works at Granton
22	Musselburgh	NT3473	>50 ha land claim for ash lagoons; manufacturing centre; paper making
23	Cockenzie	NT3975	Coal-fired power station
24	Oxwell Mains	NT7076	Cement works
25	Torness Point	NT7475	Nuclear power station (advanced gas-cooled)

Sources: Ordnance Survey Landranger maps and local authority planning documents

until other transport options have been considered. At Kincardine the bridge built in 1936 is reaching the end of its life, and with an increase predicted in traffic flows an upgrading of the crossing is deemed necessary. In January 1997 government approval was given for a new £50 million crossing. When the new crossing opens (expected in 2004) the existing, structurally weak, bridge will be given a £15 million refurbishment, effectively doubling traffic capacity across the river.

Ports and harbours

Major ports in the region are located at Montrose, Dundee, Methil, Kirkcaldy, Grangemouth and Leith. Many of the region's traditional ports have fallen into decline or disuse, owing to industrial decline and the diversion of passenger traffic to air transport and freight to road or rail routes (particularly with the construction of the Forth Bridges) and redirection of commercial shipping to new harbours closer to main shipping routes. Owing to the increase in size and draft of modern vessels, there has been a tendency for new dock and jetty construction to move to more open coast locations and purpose-built ports where deeper water is available close to shore, avoiding the high costs associated with large-scale capital and maintenance dredging. Most of the numerous small harbours in the region have therefore fallen into decline and are now used primarily by recreational craft for yachting and sea angling, with only a small amount of commercial fishing. Virtually all the small open-coast towns in the region were originally important fishing centres with their own harbours. The collapse of the herring fisheries and the change to larger modern fishing vessels caused many of these harbours to close. Present-day major harbours are listed in Table 8.3.3, with their main activities (Map 8.3.3). Major shipping routes are shown on Map 8.3.4.

Most of the small ports, harbours and piers along the north shore of the Tay Estuary are no longer used by commercial shipping, but Perth still has a thriving port taking ships of up to 1,000 tonnes. Edinburgh has two harbours, at Granton and Leith Docks, the latter being the major port for the city. The Forth Ports plc is the owner of

Table 8.3.3 Ports and harbours

No. on Map 8.3.3	*Port*	*Notes*
1	Montrose	Major port with container, lo-lo (crane load on and off) and ro-ro (roll on, roll off) facilities and over 1,000 m of quayside (two quays, eleven berths), owned by Montrose Port Authority. Principal import commodities: paper and woodpulp (destined for paper-making centres at Aberdeen and Fife). Principal exports: grain, scrap metal and oats. The purpose-built Ferryden Oil Supply Base, which also services commercial shipping, is located to the south of the port. It also handles other bulk and general cargo and is an offshore supply base, fishing port and recreational harbour. Port handling includes dry bulks, grain/feedstuffs, fruit/vegetables, forest products, liquid bulk, offshore supply, general cargo, project cargo. 16 ha open storage.
2	Arbroath	Recreational harbour owned and operated by Angus Council
3	East Haven	Harbour
4	Broughty Ferry	Piers, harbour, lifeboat station, mooring facilities and slipway
5	Dundee	Trust Port covering *c.* 300 ha; 1,672 m of riverside wharves, including nine wharves, two docks and deep water anchorages, handling 1,017,642 tonnes p.a.; bulk and general cargo, including jute, grain, fertilisers, cement, salt, coal, steel, textiles, oil-related cargoes and large quantities of forest products; container, ro-ro, dry dock and ship repair facilities; receives cruise liners and carries out offshore fabrication for the North Sea oil industry. 8.4 ha covered storage.
6	Perth	Small port owned and operated by Perth and Kinross Council, primarily handling imports of animal feedstuffs; lo-lo, dry bulks, hazardous cargoes, forest products, non-petroleum liquid bulk, general cargo; 1.75 ha open storage; 2.4 ha covered storage.
7	Newburgh	Piers and jetties on waterfront
8	Tayport	Harbour
9	St. Andrews	Small recreational harbour with local crab/lobster fishery
10	Crail	Harbour
11	Anstruther Easter and Cellardyke	Harbours and lifeboat station, owned by Fife Council; maximum vessel size 8 m beam, 4.5 m draft.
12	Pittenweem	Municipal harbour owned and operated by Fife Council. Major fishing port on the Forth.
13	St. Monans	Harbour owned and operated by Fife Council
14	Elie	Harbour
15	Methil	Large commercial port and docks owned and operated by Forth Ports plc; dry bulks, grain/feedstuffs, forest products, offshore supply, general cargo, project cargo, fish; two docks; 713 m length of berths; 200,000 tonnes p.a.; *c.* 1.5 ha storage.
16	Dysart	Small harbour
17	Kirkcaldy	Harbour (two small basins at Port Brae); very minor commercial traffic
18	Kinghorn	Pettycur harbour and pier, owned and operated by Fife Council
19	Burntisland	Port owned and operated by Forth Ports plc, handling *c.* 500,000 tonnes p.a. dry bulk, grain/feedstuffs, non-petroleum liquid bulk, offshore supply, general and project cargo; harbour; *c.* 1.5 ha storage
20	Aberdour	Small harbour owned by Fife Council and leased to local boat club. Vessels up to 5 m beam, 3 m draft.
21	Braefoot Bay	Operated by Shell UK/Exxon Chemicals, supervised by Forth Ports plc; oil terminal, jetties, piers; two berths; docking for oil/petroleum products and other liquid bulks
22	Inverkeithing	Large harbour
23	North Queensferry	Long piers, harbour, owned and operated by Fife Council; moorings for leisure craft operated by boat club; lay up berths
24	Rosyth Royal Dock Yard	Babcock Rosyth Defence, offers comprehensive engineering, manufacturing and technical support to the Ministry of Defence as well as overseas markets. Four large dry docks for vessels up to 300 m. A shiplift for up to 1,500 tonnes. Currently employs about 3,500.
25	Limekilns and Charlestown	Piers, harbours on Forth shore
26	Longannet Point	Jetty serving power station
27	Kincardine	Swing-bridge, piers, jetty serving power station
28	Grangemouth	Major docks for shipbuilding and repair, owned and operated by Forth Ports plc; port handling lo-lo, ro-ro, vehicles/wheeled cargoes, dry bulks/grains/feedstuffs, fruit/vegetables, refrigerated products, hazardous cargoes, forest products, oil/petroleum, other liquid bulk, general cargo, project cargo (heavy lift); approx 8,500,000 tonnes p.a.; 20 berths: 2,350 m total length; large areas of open storage; 1.9 ha covered storage; ship repair/graving; lay up berths; six private jetties.
29	Hound Point terminal	Two berths, owned by Forth Ports plc, operated by BP (leased); oil/petroleum
30	Bo'ness	Harbour and dock
31	Port Edgar, Queensferry	Harbour, piers, breakwater; marina; >20 ha
32	Queensferry	Small harbour, piers
33	Granton Harbour	Large (*c.* 50 ha) harbour, owned and operated by Forth Ports plc; very little commercial traffic (2,000 tonnes p.a.): ro-ro, grain/feedstuffs, general cargo.

Table 8.3.3 Ports and harbours (continued)

No. on Map 8.3.3	*Port*	*Notes*
34	Leith Docks	Very large (>250 ha) docks complex owned and operated by Forth Ports plc; 20 berths, 5,445 m length; bulk commodities, ro-ro, vehicles/wheeled cargoes, passengers, dry bulks, grain/feedstuffs, fruit/vegetables, forest products, oil/petroleum & other liquid bulk, offshore, general cargo, project cargo, coal; cruise liner traffic; some waterfront redevelopment (more planned); 2,000,000 tonnes p.a.; approx. 25 ha open storage; 1.7 ha covered storage; leisure moorings; ship repair/graving docks.
35	Newhaven	Small harbour
36	Musselburgh	Small harbour
37	Cockenzie & Port Seton	Two harbours, pier
38	North Berwick	Small harbour
39	Dunbar	Harbour and lifeboat station operated by East Lothian Council
40	Skateraw Harbour	Small natural harbour
41	Torness Point	Breakwater and harbour
42	St. Abbs	Small harbour
43	Eyemouth	Harbour in estuary, pier
44	Burnmouth	Small harbour

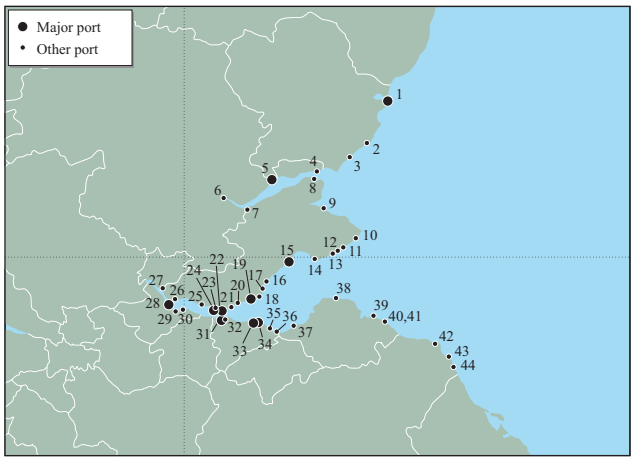
Sources: British Ports Association (1994), D'Oliveira & Featherstone (1994), Walker (1996) and Ordnance Survey Landranger maps.

seven ports within this region: Dundee, Methil, Kirkcaldy, Burntisland, Grangemouth, Granton and Leith. Forth Ports also owns the Hound Point terminal and jetty (operated by BP) and supervises the Braefoot terminal. Cargos handled at the Forth Ports include oil, petrochemicals, unitised general and dry bulk cargo. Grangemouth is the most important commercial port in the east of Scotland and is critical to the functioning of the adjacent oil and petrochemical complex. Facilities at the port are being upgraded. A considerable amount of shipping movement is associated with the Forth Bridges area, where the former Rosyth naval base is located. The Defence Evaluation and Research Agency conducts tests on scale models, decommissioned and operational naval vessels as part of ongoing research into the behaviour of naval structures and equipment subjected to underwater explosion loading. The DRA has four sites on the Forth, licensed by the Scottish Development Department, at Rosyth, Society Bank, Blackness and Oxcars. There are still fifteen active fishing ports in and around the Firth of Forth. Coastal villages east of Largo Bay were formerly notable fishing centres, Pittenweem and Anstruther still being important for fishing. The smaller ones such as Crail, Cellardyke, St. Monans and Elie are generally only used by a few inshore fishing vessels working for lobster and crab.

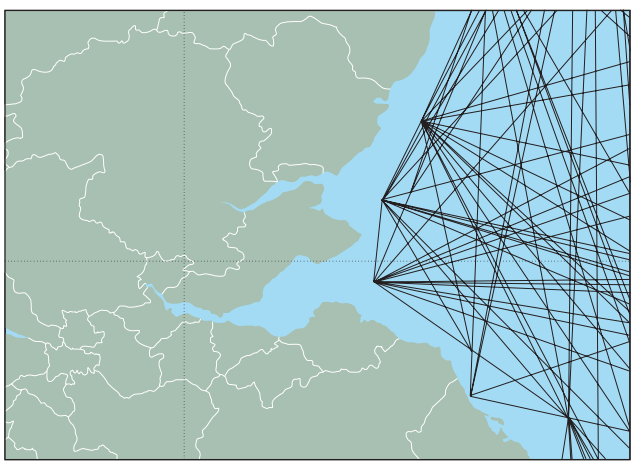
Following the decline of the ship-repair and shipbuilding industry there has been a nationwide trend for the redevelopment of former dockland sites for leisure and commerce. There has been a major dockland redevelopment scheme in Dundee, and redevelopment is planned at Granton Harbour and at Leith, where some commercial waterfront redevelopment has alrady been carried out. In 1994 the Eyemouth Harbour Trust received a £2.8 million grant towards the cost of a new harbour basin and fish market. Construction work for this has recently commenced.

Power generation

Competition in the electricity generating industry has been intense since privatisation in 1990. This has stimulated some diversification, which has been further encouraged by guidelines such as the government's Scottish Renewables Order (SRO), introduced under the 1989 Electricity Act, and the EC's 1988 Directive on Large Combustion Plant.



Map 8.3.3 Ports and harbours. Sources: Walker (1996) and others.



Map 8.3.4 Shipping routes. Source: COAST database, held by Dovre Safetec Ltd.

Although the number of power producers has increased since privatisation, conventional power production is still largely controlled by two companies in Scotland: Scottish Power plc in southern Scotland and Scottish Hydro-electric plc in northern Scotland.

Power is produced by conventional and nuclear plants within 2 km of the coast in Region 4. From these plants, the region produces approximately 9% of the UK's conventionally produced power and approximately 10% of the total nuclear produced power. There are four conventional power stations on the region's coast (Table 8.3.4), three of which are operational (Map 8.3.2). The Methil fluidised bed (coal/slurry fired) power station has a capacity of 57 megawatts (MW). The coal fired stations at Longannet, Kincardine (mothballed) and Cockenzie have capacities of 2,304 MW, 375 MW and 1,152 MW respectively. The combined output from Longannet and Cockenzie represents the bulk of Scottish Power's electricity production.

Table 8.3.4 Coastal power installations in region 4

Location	*Fuel*	*Power producing capacity (MW)*	*Notes*
Methil	Coal	57	2 x 30 MW units, fluidised bed
Longannet	Coal	2,304	4 x 600 MW reheat units
Kincardine	Coal	375	Mothballed
Cockenzie	Coal	1,152	4 x 300 MW generating units
Torness	Nuclear	1,250	Two Advanced Gas Cooled (AGR) reactors

Source: Scottish Power plc; Electricity Association

Approximately one-fifth of the UK's electricity is currently produced by nuclear power. This is produced by thirteen power stations (eleven owned by Nuclear Electric plc and two by British Nuclear Fuels Ltd.). There is one nuclear power station in the region, at Torness, 8 km south-east of Dunbar. The plant's two reactors, which are of the advanced gas cooled (AGR) type, came on line in 1988 and have a combined capacity of 1,250 MW.

The generation of electricity through the use of non-fossil fuels is encouraged through the Scottish Renewables Obligation (SRO). Under the scheme renewables will account for 30 to 40 MW of Scotland's present capacity of 12,000 MW. The first round of the scheme approved twelve wind generating projects, fifteen hydro developments, two waste-to-energy schemes and one biomass power station in Scotland. There are no current proposals for renewable energy installations in the region under the SRO. An additional round of projects will be published in 1997.

8.3.3 Information sources used

Sources of information on residential development included Cook (1993), the 1991 census, Ordnance Survey Landranger 1:50,000 maps and strategic planning documents published by the former regional councils of Tayside, Fife, Central and Lothian Regions. The Office of Population Censuses and Surveys published 1991 census data on a district basis and population estimates for subsequent years based on those data (e.g. Registrar General Scotland 1995). 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. Sources of information on industrial infrastructure were Cook (1993), Ordnance Survey Landranger 1:50,000 maps and local authority strategic planning documents. Map 8.3.1 is adapted from the ITE (1993) Countryside Survey database, which is derived from 1990 satellite imagery. Most of the information on British Ports Association ports was derived from British Ports Association (1994) and Walker (1996). Data regarding the output capacity of power stations in the region were obtained from Scottish Power plc and the Electricity Association.

Lord Donaldson (1994) records that there is virtually no clear information available on where ships go within UK waters. The Department of Transport, UK Offshore Operators Association and the Health and Safety Executive have addressed this issue by jointly funding a project to produce a ship traffic database (COAST) which provides details of 3,500 shipping routes across the UK continental shelf, giving the number of vessels and their distribution by ship, type, age and flag. Map 8.3.4 reproduces an extract from this database. Under MARPOL (the United Nations' International Convention on the Prevention of Pollution from Ships), the UK must provide port facilities that are "adequate to meet the needs of ships using them and do not cause undue delay to ships". These facilities should prevent ships from discharging oil and other wastes into the sea. However, Lord Donaldson (1994) describes UK facilities as "inadequate". The UK government has commissioned a survey of all UK port reception facilities for the disposal of ships' wastes (Waste Regulation Council 1995). In 1994 the European Sea Ports Organisation (ESPRO) issued an *Environmental code of practice* (European Sea Ports Organisation 1994).

8.3.4 Acknowledgements

Shipping routes on Map 8.3.4 are reproduced from the COAST database, developed and held by Dovre Safetec Ltd. Thanks are due to L. Scholfield (Perth and Kinross Council), Mark Tasker (JNCC), Tom Leatherland (SEPA), D.W. Moore (Esso Exploration and Production UK Limited), Anne Brown, Sandy MacLennan and Karen Passmore (SNH), Alan Brown and G. Moy (Fife Council) and Catherine Leach and G. Russell (Institute of Ecology and Resource Management, University of Edinburgh) for their useful comments on drafts.

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Technica. 1985. *Shipping routes in the area of the United Kingdom continental shelf*. London, HMSO.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Planning developments	
Angus	Council, Forfar, tel: 01307 461460
Dundee	*Dundee City Council, Dundee, tel: 01382 434000
Perth and Kinross	*Perth and Kinross Council, Perth, tel: 01738 475000
Fife	*Fife Council, Glenrothes, tel: 01592 414141
Clackmannanshire	*Clackmannanshire Council, Alloa, tel: 01259 450000
Stirling	*Stirling Council, Stirling, tel: 01786 443322
Falkirk	*Falkirk Council, Falkirk, tel: 01324 506070
West Lothian	*West Lothian Council, Livingstone, tel: 01506 777000
City of Edinburgh	*City of Edinburgh Council, Edinburgh, tel: 0131 200 2000
Midlothian	*Midlothian Council, Dalkeith, tel: 0131 663 2881
East Lothian	*East Lothian Council, Haddington, tel: 01620 827827
Scottish Borders	*Scottish Borders Council, Melrose, tel: 01835 824000

Type of information	*Contact address and telephone no.*
Economic and urban development policy including European Funds (Scotland)	*The Scottish Office Development Department, tel: 0131 556 8400
Ports	
British Ports Association	Africa House, 64-78 Kingsway, London WC2B 6AH, tel: 0171 242 1200
The UK Major Ports Group Ltd	150 Holborn, London EC1N 2LR, tel: 0171 404 2008
European Sea Ports Association (ESPRO)	Avenue Michel-Ange 68, B-1040 Brussels, Belgium, tel: +32 2 736 34 63, fax: +32 2 736 63 25
Port reception facilities	Marine Safety Agency, Spring Place, 105 Commercial Road, Southampton SO15 1EG, tel: 01703 329100
Montrose Port Authority	*Ferryden, Montrose, tel: 01674 672302
Dundee Port Authority	*Dundee, tel: 01382 224121
Perth Harbour	*Perth, tel: 01738 624056
Forth	*Forth Ports plc (Forth Ports Authority), Edinburgh, tel: 0131 554 6473

C. Contact names and addresses (continued)

Type of information	*Contact address and telephone no.*
Power generation	
Energy production - general	*Education and Industry Department, Energy Division, Scottish Office, Victoria Quay, Edinburgh, tel: 0131 244 7140
Energy production - general	Secretary, Institute of Energy, 18 Devonshire Street, London W1N 2AU, tel: 0171 580 7124
Energy production - general	Department of Energy, 1, Palace Street, London SW15 5HE, tel: 0171 238 3000
Energy production - general	Secretary, Institute of Energy, 18 Devonshire Street, London W1N 2AU, tel: 0171 580 7124
Energy production - general	The Electricity Association Services Ltd., 30 Millbank, London SW1P 4RD, tel: 0171 9635700
Conventional power production	Generation Wholesale Division, Scottish Power plc, Cathcart House, Spean Street Glasgow G44 4BE, tel: 0141 637 7177
Conventional power production, further details of power stations	Public Information Officer, National Power plc, Senator House, 85 Queen Victoria Street, London EC4V 4DP, tel: 0171 454 9494
Nuclear power production	Scottish Nuclear Ltd., Torness Power Station, Dunbar, East Lothian EH42 1QS, tel: 01368 863500 (freephone number: 0800 250255)
Nuclear issues - general	Secretary General, British Nuclear Forum, 22 Buckingham Gate, London SW1E 6LB, tel: 0171 828 0166
Radioactive waste disposal	*SOAEFD, Victoria Quay, Edinburgh, tel: 0131 244 4042
Radioactive discharges	Information Officer, National Radiological Protection Board (NRPB), Chilton, Didcot, Oxfordshire OX11 0RQ, tel: 01235 831600
Renewable energy	Secretary, Energy Technology Support Unit (ETSU), Renewable Energy Enquiries Bureau, Harwell, Oxfordshire OX11 0RA, tel: 01235 432450
Renewable energy (SRO-2 list)	Office for Electricity Regulation, Regent Court, 70 West Regent Street, Glasgow G2 2QZ, tel: 0141 331 2678
Renewable energy - Scotland	*Scottish Office, Energy Efficiency Office, Victoria Quay, Edinburgh, tel: 0131 244 1200
Renewable energy potential report for Scotland	Highlands and Islands Enterprise, Bridge House, 20 Bridge Street, Inverness IV1 1QR, tel: 01463 234171
Wind energy - general	British Wind Energy Association, 42 Kingsway, London WC2B 6EX, tel: 0171 404 3433
Wind farms - Scotland	British Wind Energy Association - Scottish Branch, National Wind Turbine Centre, National Engineering Laboratory, East Kilbride, Glasgow G75 0QU, tel: 013552 72068
Wave and hydro power	Project Director, Energy Systems Group, Coventry Polytechnic, Dept of Electrical, Electronic and Systems Engineering, Priory Street, Coventry CV1 5FB, tel: 01203 838861

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

8.4 Coastal defence

S.L. Fowler & S.J. Everett

8.4.1 Introduction

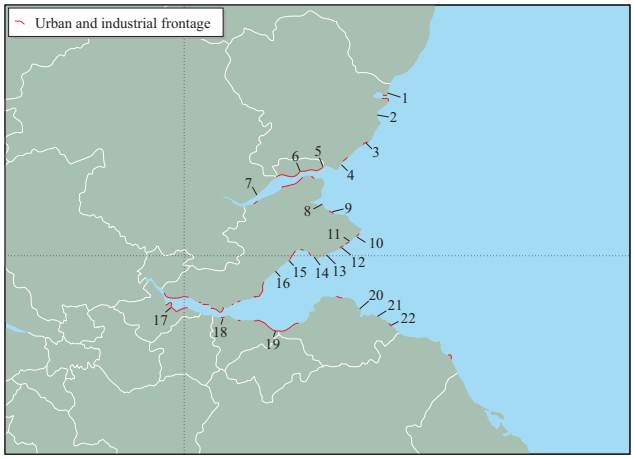
Coastal defence covers two types of works: coast protection and sea (or flood) defence. Coast protection works prevent or slow the erosion of land and encroachment by the sea. Sea defences protect low-lying land from flooding by the sea or rivers, especially to protect human life and property in coastal settlements and industrial areas; in the past some were built to protect 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 when 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). Because of this complexity this section describes coastal defence works in general around the coast, irrespective of the purpose for which they were constructed. The works range from simple wooden groynes installed on beaches to control coastal sediment, 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. Also, because the information used here comes from several sources compiled according to different rationales, detailed inter- and intra- regional comparisons are not practicable (see also section 8.4.4).

In the UK, coastal works are most widely distributed along eroding coasts with relatively soft geological formations, or very low-lying, sinking coastal land. They are therefore particularly predominant in south and south-east England. The risk of coastal erosion or flooding in this region is only very localised, because of the upward isostatic movement of land in the north of Britain (see also section 2.5). Storm surges, particularly when combined with high spring tides and/or heavy rain causing peak river flows, are the major flooding threat to low-lying coastal areas; in the seas around the UK storms are expected to increase in frequency as a result of climate change.

Compared with the south of Britain this region has few coastal works; in this region they are built mainly to protect coastal settlements, industrial areas, golf courses and dunes.

8.4.2 Important locations

Table 8.4.1 summarises information on coastal defences in the region (Map 8.4.1). The open coast is not heavily defended, although there is localised erosion, particularly where there are coastal dunes (e.g. at Lunan Bay, Montrose and Tentsmuir - see section 3.2). Hard coastal defences are mostly associated with the coastal towns and harbours (e.g. the fishing villages on the Angus coast), golf links, power stations (e.g. at Torness) and the urban and industrial developments within the inner Firth of Forth. The coastline of Angus has experienced prolonged erosion since the late 1980s, with the main problem area being north of the seawall at Montrose, but work has also been carried out at Carnoustie, on the east side of Barry Links and north of the Dighty Water (all during the 1990s). There are serious



Map 8.4.1 Locations of coastal works (Table 8.4.1). Sources: HR Wallingford (1995), OS Landranger maps.

coastal erosion problems along the Fife coastline from Kirkaldy to Burntisland. The principal settlements affected are East Wemyss, West Wemyss and Dysart, where loss of property and infrastructure along the frontage is possible in the absence of coast protection measures. Emergency armouring undertaken since 1994 has withstood the most recent storms.

8.4.3 Management

Legislation relating to the carrying out of flood or sea defence works is included in the Water Resources Act (1991) and the Land Drainage Act (1991). Departmental responsibility for flood defence and coast protection lies with the Scottish Office Agriculture, Environment and Fisheries Department. Under the Coast Protection Act (1949), councils have discretionary powers as coast protection authorities in Scotland to protect land from erosion and encroachment and to prevent flooding of non-agricultural land.

A coast protection group that used to operate in the former Tayside Region is to be re-formed, with the cooperation of the new unitary authorities (see also Chapter 10). Coastal erosion is a key concern in Fife. Since coal pits closed and the dumping of mine waste ceased, many beaches have become deprived of the material that once protected them. To deal with this issue, Fife Council has established a Coastal Officers Group to evaluate a twenty-year strategy (CoastNET 1996). The Forth Estuary Forum, which is part of the Firths Initiative (see also Chapter 10), has also established a coastal defence topic group, which will contribute to the management strategy for the Firth of Forth.

8.4.4 Information sources used

HR Wallingford are conducting a study on coastal process cells in Scotland (HR Wallingford 1995), co-sponsored by

Table 8.4.1 Coastal defence works

No. on Map 8.4.1	*Location*	*Grid ref.*	*Details*
1	Montrose Beach	NO7462-NO7356	Sea wall with rock armour. Visitor management and boardwalks on dunes next to Montrose South Beach. Main area of erosion is the golf course links (on dunes) to the north of the Montrose seawall.
2	Lunan Bay	NO6951	Localised gabion and tank trap protection at the south end of Lunan Bay
3	Arbroath Harbour	NO6440	Concrete seawalls
4	Carnoustie - Barry Links	NO5634-NO5430	The central beach at Carnoustie is protected by rock armour or gabion mattress revetment. Some old tank traps immediately north of the central beach. Dune retreat up to 10 m per year at Barry. The rock armour revetment south of the Barry Burn has been breached. Rock armour on the face of the dunes to their full height of 7-10 m recently upgraded.
5	Monifieth - Broughty Ferry	NO5032-NO4630	Rock armour revetments protect the central area at Traill Drive and immediately to the east. West of this revetment the private caravan site has suffered extensive erosion (approx. 10-15 m since 1987). The main groyne field is east of the caravan site almost down to the Dighty Water. There is another extensive groyne field west of the rock armour revetment west of the Dighty Water. The remainder of Broughty Ferry west of the beach is protected by stone walls or a stone pitched revetment.
6	Dundee	NO3929	Docks, airport, road and rail frontages provide protection
7	Firth of Tay	NO3026, NO2125	Two breakwaters 1 km and 0.7 km long extending from north bank of Tay (Dog Bank); 2 breakwaters *c.* 200 m long extending from north bank of Tay (Errol). Approximately 3 km of clay embankment (sea defence) protecting low-lying fields.
8	St. Andrews golf links/ Eden Estuary	NO4918	Erosion threatens the golf courses and has led to a succession of coastal defence works. Gabion baskets used on west side, planting of marram grass on west side.
9	St. Andrews city and East Sands	NO5116	Cliff stabilisation using nylon fabric; sea wall
10	Crail	NO6107	Sea wall and harbour defences; coastal footpath affected by wave attack
11	Anstruther	NO5603	Sea wall and harbour defences
12	Pitttenweem	NO5502	Sea wall and harbour defences; stabilisation of cliff face
13	St. Monance	NO5201	Sea wall and harbour defences
14	Wood Haven, Elie	NT4999	Piecemeal coastal defences include concrete sea walls and gabions, including anti-tank blocks, which protect the soft sediments of the cliff formation and the road and buildings landward. Erosion is relatively rapid and the cliff above the sea defences has slumped.
15	Methil/Buckhaven	NT3597	Rock revetment at Methil; 'rip-rap' scheme (rocks on top of fabric) at Buckhaven to protect housing
16	East Wemyss	NT3496	Rock groynes and revetments are present at West Wemyss; the main area of erosion is between Dysart and East Wemyss
17	Falkirk District		Virtually all of the Falkirk District frontage onto Forth Estuary is claimed and embanked
18	South Queensferry	NT1278	Sea walls of concrete and masonry
19	Edinburgh: Cramond to Cockenzie	NT1977-NT4075	Rock armouring and concrete revetments protect parts of the coast between Cramond and Granton. Sloping revetment at Silverknowes. Rip-rap armour facing protects the land claim at Granton Point. Sea walls along the developed Edinburgh coastline from Granton to Cockenzie. Long-term beach erosion at Joppa/Portobello beaches controlled by wooden groynes and artificial nourishment in 1974 and 1990. Concrete sea walls with aprons of concrete armour units front the land claim and ash lagoons at Cockenzie.
20	Tyne Sands	NT6380	Anti-tank blocks
21	Dunbar, White Sands	NT7078	Erosion below golf course; rubble facing the backshore slope
22	Torness power station	NT7475	Rock revetment and breakwater. Artificial reef: project is a collaboration between the Scottish Office Agriculture Environment and Fisheries Department (SOAEFD), the Marine Laboratory (Aberdeen) and the University of St. Andrews. Made of material licensed to be disposed of at sea prior to the construction of the reactor at Torness Point. 210,000 tonnes of spoil was used to construct an artificial reef 3.4 km to the south-east of Torness Point at a depth of about 20 m below chart datum.

Sources: HR Wallingford (1995), Ordnance Survey Landranger maps, ASH Consulting Group (1994) and pers. comms. from Angus Council, Fife Council, Perth and Kinross Council, City of Edinburgh Council and Falkirk Council. Note: table includes only those sites identified in HR Wallingford (1995).

Scottish Natural Heritage, the Scottish Office Environment Department and Historic Scotland. Phase one, a broad delineation and description of cells, is now complete and is to be followed by a further two years' work to provide a comprehensive description of the cells. This study will set out for the first time a framework for management of coastal areas in Scotland and could be used as the basis for setting up coastal engineering groups of the type established in England and Wales. Coastal defence works in Scotland are also dealt with in the *Review of Scottish coastal issues* (Burbridge & Burbridge 1994).

ASH Consulting Group (1994) gives details of case studies for the Eden Estuary and Wood Haven, Elie. The Scottish Office have published a discussion paper on general coastal strategy, including coastal defence (SOAEFD 1996).

8.4.5 Acknowledgements

Thanks are due to Mark Tasker (JNCC), Anne Brown, George Lees and Alan Leitch (SNH), G. Russell (Institute of Ecology and Resource Management, University of Edinburgh) and Alan Burdekin (SOAEFD) for comments on the draft. Thanks also go to Angus, Perth & Kinross, Fife, Falkirk and City of Edinburgh Councils for information on coast protection.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Flood defence and coast protection policy, grants towards capital expenditure	*The Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD), Edinburgh, tel: 0131 556 8400
Coast protection and flood defence - Angus	*Angus Council, Forfar, tel: 01307 461460
Coast protection and flood defence - Dundee	*Dundee City Council, Dundee, tel: 01382 434000
Coast protection and flood defence - Perth and Kinross	*Perth and Kinross Council, Perth, tel: 01738 475000
Coast protection and flood defence - Fife	*Fife Council, Glenrothes, tel: 01592 414141
Coast protection and flood defence - Clackmannanshire	*Clackmannanshire Council, Alloa, tel: 01259 450000
Coast protection and flood defence - Stirling	*Stirling Council, Stirling, tel: 01786 443322
Coast protection and flood defence - Falkirk	*Falkirk Council, Falkirk, tel: 01324 506070
Coast protection and flood defence - West Lothian	*West Lothian Council, Livingston, tel: 01506 777000
Coast protection and flood defence - City of Edinburgh	*City of Edinburgh Council, Edinburgh, tel: 0131 200 2000
Coast protection and flood defence - Midlothian	*Midlothian Council, Dalkeith, tel: 0131 663 2881
Coast protection and flood defence - East Lothian	*East Lothian Council, Haddington, tel: 01620 827827
Coast protection and flood defence - Scottish Borders	*Scottish Borders Council, Melrose, tel: 01835 824000
Storm Tide Warning Service	Meteorological Office, Johnstone House, London Road, Bracknell, Berkshire RG12 2SZ, tel: 01344 420242
Coastal Engineering Advisory Panel	Anne Ferguson, Institute of Civil Engineers, Great George Street, London SW1P 3AA, tel: 0171 222 7722
Forth Estuary Forum, Coastal Defence Topic Group	George Lees, Coastal Defence Topic Group, Scottish Natural Heritage, Edinburgh, tel: 0131 554 9797
National Landslide Databank	Rendel Geotechnics, Norfolk House, Smallbrook Queensway, Birmingham B5 4LJ, tel: 0121 627 1777
Coastal protection: Firth of Tay	*B. Wallace, Angus Council, Forfar, tel: 01307 461460

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

The Firth of Forth is the location for most of the region's residential and industrial development: more than half the region's population live and work here. The largest trade effluent discharges in the region come from the Rosyth Royal Dockyard and the chemical works, oil refinery and other petrochemical works at Grangemouth. Although treatment has been improved in recent years, all sewage and trade effluent outfalls to the estuary and Firth of Forth (and other specified areas) will have to meet new minimum standards of treatment by the year 2005. Photo: Coastwatch, JNCC.

Chapter 9 Human activities

9.1 Fisheries

D. Murison & 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 do not) and diadromous fish (which spend part of their lives in fresh water and part at sea - in this section salmon, sea trout and eels). The section also covers sea angling and bait collection. For more information about the species concerned, including their scientific names, see sections 5.5, 5.7 and 5.8.

The locations of the main fishing ports in the region where landings are recorded by SOAEFD, and the Scottish Sea Fisheries Districts in the region, are shown on Map 9.1.1. The ports where the most fish are landed in the region are Pittenweem and Eyemouth.

In 1992, 2.1% of all recorded landings of fish and shellfish species in Britain and the Isle of Man were made in this region. The total tonnages of pelagic, demersal and shellfish species landed in the region represent <0.1%, 3.7% and 3.2% respectively of the British totals. Of the demersal fish (the species group with the largest totals), landings of some species, such as dab (17.1%), dogfish (8.4%), lemon sole (7.8%) and pollack (7.0%), represent more significant proportions of the species' combined British and Isle of Man total recorded landings. A summary of the totals for pelagic, demersal and shellfish species is given in Table 9.1.1.

Table 9.1.2 summarises landings to the main ports in Region 4 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 is based.

Three diadromous species - salmon, sea trout and eel - support fisheries in the region, the most important of which

Map 9.1.1 Fishing ports and Scottish Sea Fisheries Districts. Source: SOAFD (1995a). © Crown copyright.

are for salmon (and grilse, which are salmon that have spent not more than one winter at sea before maturing) and sea trout. In the Scottish Salmon Fishery Statistical Districts in the region (Map 9.1.2), salmon (including grilse) and sea trout support rod-and-line and net-and-coble fisheries from rivers. The salmon fishery has a long-standing tradition in several rivers in the region, as many of them support large stocks of salmon and sea trout. As shown in Table 9.1.3, a very large percentage of the Great Britain recorded catch of salmon and grilse and sea trout is from this region, although the percentage for sea trout is not quite as high as that for salmon and grilse.

Table 9.1.1 Species group landings in 1992 (tonnes)

Species group	*Region 4*	*North Sea Coast*	*Scotland*	*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	61	184,309	227,669	252,335	<0.1	<0.1
Demersal	10,099	228,056	193,914	275,460	4.4	3.7
Shellfish	3,305	61,933	46,112	104,917	5.3	3.2
All groups	***13,465***	***474,298***	***467,695***	***632,712***	***2.8***	***2.1***

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.). Notes: amounts landed are rounded up to the next whole tonne. Figures are given in 'nominal live weight' i.e. weight of the whole fish. 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 4 fisheries main ports 1991 - 1994 (thousands of tonnes)

	1991	*1992*	*1993*	*1994*
Pittenweem	2.0	2.5	3.0	1.8
Eyemouth	4.8	6.8	6.4	4.1
Region 4 main ports	***6.8***	***9.3***	***9.4***	***5.9***
Scotland	458.4	467.7	491.8	487.8
% of Scottish total landed in Region 4 main ports	1.5	2.0	1.9	1.2

Sources: Ministry of Agriculture, Fisheries and Food (1995b). Key: [a]landings totals relate to 'nominal live weight', i.e. weight of the whole fish. Note: calculating the figures in this table was a complex process: refer to section 9.1.4.

Table 9.1.3 Average annual catch (numbers of fish) of salmon and grilse and sea trout 1989 - 1993

Totals	*Salmon and grilse*	*Sea trout*
Region 4	76,842	26,972
North Sea Coast	196,247	104,789
Scotland	187,481	65,468
GB	***254,829***	***141,813***
% of North Sea Coast total in region	39.0	25.4
% of GB total in region	29.9	18.8

Sources: Scottish Office Department of Agriculture and Fisheries (1990); National Rivers Authority (1991, 1992, 1993, 1994a, b) and Scottish Office (1991, 1992, 1993, 1994). Note: calculating the figures in this table was a complex process: refer to section 9.1.4.

9.1.2 The fisheries

Pelagic species

Table 9.1.4 gives the quantities of various pelagic species landed in the region in 1992, compared with landings nationally. In the past there was a viable sprat fishery in the Firth of Forth. However, reduced availability of sprat and restrictions on herring bycatch in recent years have meant that fishing effort for sprat is virtually non-existent in this region. The decline in North Sea sprat spawning stocks is possibly due to a succession of years of poor recruitment to the stock, accompanied by an increase in fishing. Small quantities of herring and mackerel are landed using drift nets and handlines.

Map 9.1.2 Scottish Salmon Fishery Statistical Districts and Regions. Source: Scottish Office (1994). © Crown copyright.

Demersal species

Table 9.1.5 gives the quantities of various demersal species landed in 1992 in the region, compared with landings nationally. Demersal fish are targeted by inshore otter trawlers, large offshore trawlers and seine netters. However the amount of effort is dependent on the time of year and the status of the *Nephrops* fishery, of which demersal fish are a significant by-catch. The inshore trawlers often work in pairs and land varying proportions of cod, haddock, whiting, plaice and lemon sole, depending on the locality and season. Plaice, dab, turbot and skates and rays are caught in larger quantities between spring and autumn. Gill netting for demersal species takes place in the region north of Arbroath, where trawlers are prohibited from fishing close to shore (see section 9.1.3). During the winter nets are set for cod, also yielding whiting, saithe, pollack and dogfish. Danish fishermen have historically fished for

Table 9.1.4 Pelagic species landings in 1992 (tonnes)

Species	*Region 4*	*North Sea Coast*	*Scotland*	*Britain and Isle of Man*	*% of North Sea Coast total landed in region*	*% of combined British and Isle of Man total landed in region*
Argentines	0	137	180	180	0	0
Herring	29	74,706	83,879	85,650	<0.1	<0.1
Horse mackerel	0	1,374	473	1,499	0	0
Mackerel	32	95,366	141,583	150,726	<0.1	<0.1
Pilchard	0	4,244	0	4,244	0	0
Sprat	0	8,478	1,554	10,032	0	0
Whitebait	0	1	0	1	0	0
Others	0	3	0	3	0	0
Total	***61***	***184,309***	***227,669***	***252,335***	<0.1	<0.1

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.). Notes: amounts landed are rounded up to the next whole tonne. Figures are given in 'nominal live weight' i.e. weight of the whole fish. Calculating the figures in this table was a complex process: refer to section 9.1.4.

Table 9.1.5 Demersal species landings in 1992 (tonnes)

Species	*Region 4*	*North Sea Coast*	*Scotland*	*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	1,116	7,449	9,657	13,348	15.0	8.4
Skates and rays	72	3,816	3,670	7,827	1.9	0.9
Gadoids						
Cod	2,260	53,440	35,898	59,524	4.2	3.8
Haddock	3,284	49,221	49,867	53,586	6.7	6.1
Hake	4	589	1,993	3,620	0.7	0.1
Ling	107	4,594	4,318	6,027	2.3	1.8
Pollack (lythe)	213	1,921	1,285	3,023	11.1	7.0
Saithe	94	11,032	10,310	12,602	0.9	0.7
Whiting	1,317	36,733	35,923	41,055	3.6	3.2
Whiting, blue	0	6,531	6,531	6,531	0	0
Flatfish						
Brill	P	317	50	443	-	-
Dab	208	1,017	759	1,215	20.5	17.1
Dover sole	10	2,021	57	2,876	0.5	0.3
Flounders	0	167	4	273	0	0
Halibut	2	166	114	194	1.2	1.0
Halibut, Greenland	0	119	20	137	0	0
Lemon sole	434	5,004	2,566	5,573	8.7	7.8
Megrim	6	1,379	2,566	4,037	0.4	0.1
Plaice	704	20,749	7,902	23,887	3.4	2.9
Turbot	8	561	196	742	1.4	1.1
Other species						
Catfish	79	1,896	1,378	1,935	4.2	4.1
Conger eel	P	99	107	510	-	-
Gurnard	0	368	32	627	0	0
Monkfish/angler	125	9,813	11,557	14,678	1.3	0.9
Redfish	1	718	193	774	0.1	0.1
Sand eel	0	4,152	4,152	4,152	0	0
Torsk (tusk)	5	165	194	207	3.0	2.4
Witch	35	1,405	1,789	1,981	2.5	1.8
Others	8	2,419	682	3,833	0.3	0.2
Fish roes	7	195	144	243	3.6	2.9
Total	***10,099***	***228,056***	***193,914***	***275,460***	***4.4***	***3.7***

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. Notes: amounts landed are rounded up to the next whole tonne. Figures are given in 'nominal live weight' i.e. weight of the whole fish. Calculating the figures in this table was a complex process: refer to section 9.1.4.

sandeels in the region, around sand banks at the mouth of the Firth of Forth, such as on Wee Bankie, Marr Bank and Scalp Bank.

Shellfish species

Table 9.1.6 gives the quantities of various shellfish species landed in 1992 in the region, compared with landings nationally.

The main shellfish fishery in this region, as in Scotland as a whole, is for *Nephrops*. The majority of the inshore trawler fleet target *Nephrops* for most of the year between 3 and 20 miles offshore. However the peak season is in the summer and autumn, when many visiting trawlers from the west coast also join the fishery.

The other major shellfish fishery that takes place in the region is dredging for scallops. Scallops have been fished extensively close in to the Fife shore from Elie to Fife Ness. Enhanced catching opportunities here, together with reduced catch rates and seasonal closures in some other areas, have made this region popular for scallop dredgers. Thus the scallop fisheries in the region attract vessels from other Scottish regions and from England and the Isle of Man during the summer months.

Creel fisheries for lobster and edible crab operate throughout the region, the former being of relatively high value. Good catches of edible crab occur from spring to autumn, the fishery being concentrated on offshore boulder, gravel and sand substrates. Lobster landings are highest between May and September, the fishery operating close inshore on rocky substrates. In recent years, small landings of velvet crabs have also been made from the inshore grounds.

The Firth of Forth native oyster beds were once some of

the largest in Scotland and supported an important shellfishery (Harding 1996). The amounts taken by the fishery began to decline at the end of the 19th century and the fishery was subsequently closed early in the 20th century. Harding (1996) explored the feasibility of reintroducing the native oyster into the Firth of Forth, in order to re-establish the fishery. Mussels also form a large fishery in the region. They are collected from the Montrose Basin for re-laying and ongrowing in other areas outside the region, for example on the west coast of Scotland. Periwinkles are gathered by hand from rocky coasts throughout the region.

Diadromous species

The distribution of diadromous fish species in rivers in the region is discussed in section 5.8 and shown on Map 5.8.1. Net-and-coble and rod-and-line fishing for salmon (including grilse) and sea trout is permitted on the coast, in estuaries, and in rivers. Fixed engines (stake nets and bag nets) can be used only outside estuary limits. In practice, all diadromous net fisheries in the region operate in estuaries or in rivers, rather than on the open coast; there are currently no fixed netting stations in operation. Some stations became uneconomic; others were purchased by the Atlantic Salmon Conservation Trust and closed to protect the interests of the rod-and-line sport angling sector. Table 9.1.7 shows the average numbers of salmon and grilse and sea trout caught in the region's Statistical Districts (Map 9.1.2) in the five years between 1989 and 1993. In order to protect commercial confidentiality, the reported catches for each Scottish Statistical District are published without any indication of catch method.

Sea angling

Sea angling is distinguished from two other types of sport fishing: game fishing for salmon, sea trout, brown and rainbow trout (the first two are covered above) and coarse fishing, which is for freshwater fish species and so is not covered here. Sea angling has three main forms: angling from the shore, inshore fishing within about 5 km of the shore and deep sea fishing. It is a popular sport practised by over two million people in Great Britain (Fowler 1992). The governing body in Scotland is the Scottish Federation of Sea Anglers, which has approximately 64 affiliated clubs and approximately 200 additional personal members, who are not always members of affiliated clubs. Orton (1996) lists contact addresses for fishing clubs in the region and national angling organisations.

In Region 4, sea angling charter vessels operate from small ports such as Arbroath. Angling occurs from rocks, piers and boats at Easthaven, Carnoustie and Broughty Ferry; at Dunbar, in the south of the region, there is excellent rock, pier and boat fishing for mackerel, cod, saithe, whiting and flatfish such as dab, plaice and flounder. Orton (1996) gives information on these sea fishing stations in the region and the facilities available.

Bait collection

Bait collection for sea angling occurs in many areas in the region, although some areas are more prolific than others and may attract commercial collectors. Anglers often collect their own bait locally, while commercial collectors travel in teams to suitable shores. Many species are collected, including ragworm, lugworm, peeler crabs (moulting shore crabs), mussels, cockles, limpets 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 on the shore are digging and boulder turning. Bait digging, especially for lugworms, is carried out over the lower part of muddy and sandy shores around the time of low water. Fowler (1992) identified that the exploitation of bait species was taking place at many locations in the region, including Montrose Basin, Eden Estuary, Torry Bay, Blackness, Almond Estuary, Port Seaton, Musselburgh, Aberlady Bay, Gullane Bay, along the North Berwick coast, Tynemouth, Barns Ness and Eyemouth Bay.

Table 9.1.6 Shellfish landings* in 1992 (tonnes)

Species	*Region 4*	*North Sea Coast*	*Scotland*	*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	2,546	32,047	0	0
Crabs	176	9,117	7,501	16,970	1.9	1.0
Lobsters	82	622	564	1,069	13.2	7.7
Mussels	582	4,865	3,067	6,555	12.0	8.9
Nephrops	1,947	8,368	17,707	19,639	23.3	9.9
Periwinkles	206	315	1,837	1,907	65.4	10.8
Queen scallops	0	2,207	5,518	11,273	0	0
Scallops	230	4,519	5,068	8,290	5.1	2.8
Shrimps	0	615	180	743	0	0
Squids	80	1,382	1,071	2,005	5.8	4.0
Whelks	2	1,905	858	2,393	0.1	<0.1
Others	0	1,819	195	2,026	0	0
Total*	***3,305***	***61,933***	***46,112***	***104,917***	***5.3***	***3.2***

Sources: Ministry of Agriculture, Fisheries and Food (1994); Scottish Office Agriculture and Fisheries Department (1993); Isle of Man Department of Agriculture, Fisheries and Forestry (pers. comm.). Key: *excluding landings of farmed shellfish - see section 9.2. Notes: amounts landed are rounded up to the next whole tonne. Calculating the figures in this table was a complex process: refer to section 9.1.4.

Table 9.1.7 Salmon and grilse and sea trout five-year (1989-1993) average catch (numbers of fish reported to SOAEFD)

Scottish Salmon Fishery Statistical District	*Salmon & grilse*	*Sea trout*
North Esk & Bervie[a]	13,708	3,016
South Esk	10,500	7,932
Tay	33,814	5,362
Forth	2,738	1,888
Tweed	16,082	8,774
Region 4	76,842	26,972

Source: Scottish Office Department of Agriculture and Fisheries (1990); Scottish Office (1991, 1992, 1993, 1994). 'Sea trout' here includes all migratory trout. Key: [a]Statistical District covers the two named Salmon Fishery Districts, including part of Region 3.

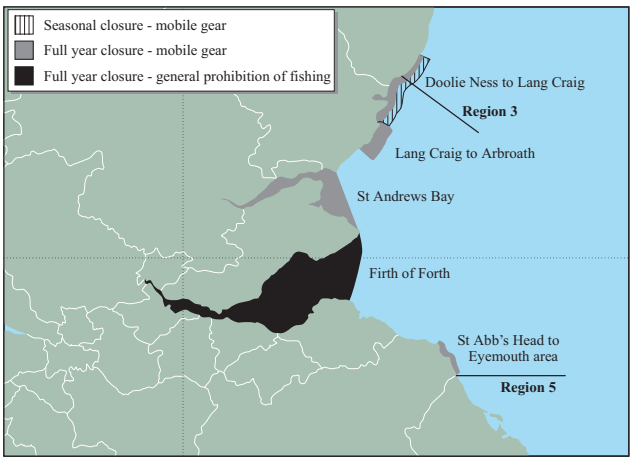
9.1.3 Management and issues

Responsibility for the management of fisheries in coastal waters rests with the Commission for the European Union (EU), who delegate it to member states under the Common Fisheries Policy (CFP). European Council regulations are implemented through UK law, 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 the requirements of the CFP.

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, the UK coastal waters have been designated by the International Council for the Exploration of the Sea (ICES) into statistical areas. The coastal seas around this region is part of one 'division': Division IVb (Middle North Sea). ICES provides scientific advice on the management of all the important commercial species of fin fish and some shellfish stocks in all areas of the north-east Atlantic. This work is summarised in the annual report of the Advisory Committee for Fisheries Management, which is responsible for providing scientific advice on TACs and other conservation measures to the international fisheries commissions, including the EU. The TAC is a fishery management tool which may, amongst other management needs, take account of the maximum level of exploitation that a given stock can sustain. Precautionary TACs are applied to important stocks where there are not enough scientific data to make an analytical assessment. Once the TACs are set for each stock they are divided between member states in the form of catch quotas. European Council Regulation No. 3074/95 (European Council 1995) fixes, for 1996, details of the catch quotas for fish and shellfish species for all European countries and certain conditions under which the species may be fished. The TACs, UK quotas and 'uptake' for 1995 for each species in the ICES statistical division in the region are given in SOAEFD (1996a), which is published annually. European Council Regulation No. 3760/92 (European Council 1992) summarises the CFP, including the proportions by which TACs are allocated as national quotas. Information on minimum landing sizes and whether an annual quota applies in the region for the important pelagic and demersal species is given in Table 5.7.1.

In Scotland the administration and management of sea fisheries is carried out by the Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD) in accordance with the CFP of the European Union. Research relating to the CFP and other fisheries management requirements is carried out by the SOAEFD Marine Laboratory, Aberdeen. The District Office in each of the three Sea Fisheries Districts partly or wholly within the region (Map 9.1.1) collects data on landings at all ports in that district. Administration and enforcement of sea fisheries legislation within Sea Fisheries Districts is the responsibility of the Sea Fisheries Inspectorate branch of the Scottish Fisheries Protection Agency, which operates the Fisheries Protection Fleet and aircraft. In Scottish inshore waters (to 6 miles from baselines), the principal instrument of fisheries management is the Inshore Fishing (Scotland) Act 1984. This gives the Secretary of State powers to regulate fishing in specified inshore waters and to prohibit the carriage of specified types of net and the use of mobile gear near fixed salmon nets. Map 9.1.3 and Table 9.1.8 show the full year and seasonal closures on the use of mobile fishing gear (trawl, seine net, dredge (including suction dredging) etc.) in four areas wholly or partly in the region,



Map 9.1.3 Full year and seasonal closures on the use of mobile fishing gear and general prohibition of fishing (see Table 9.1.8). Note: this map is for illustrative purposes only. For further information, see source. Source: Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 1989. © Crown copyright.

Table 9.1.8 Full year and seasonal closures on the use of mobile fishing gear*

Sea area within which prohibition applies	*Full year closure or seasonal closure*	*Type of prohibition*	*Areas of waters within:*	*Method of fishing for species of sea fish excepted from prohibition and period of exception*
Doolie Ness to Lang Craig+	Full year	Mobile gear	1/2 nautical mile from mean high water	-
	Seasonal (closed October to March inclusive)	Mobile gear	Between 1/2 and 1 nautical mile from mean high water	-
Lang Craig to Arbroath	Full year	Mobile gear	2 nautical miles from mean high water	-
St. Andrews Bay	Full year	Mobile gear	See Map 9.1.3	-
Firth of Forth	Full year	General prohibition of fishing	See Map 9.1.3	(a) Any method of fishing for herring, mackerel and sprats during full year (b) Fishing for any species of sea fish (except species above) from a fishing boat with an overall length not greater than 55 feet during full year
St. Abb's to Eyemouth Area	Full year	Mobile gear	1 nautical mile from mean high water	-

Source: the Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 1989. Key: *includes trawl, Danish seine or similar net, purse seine, ring net or dredge, including suction dredge (designed to raise fish, shellfish or other material from the sea bed using a solids pump or air lift, or water jets to dig into the sea bed); +partly in Region 3.

made under the Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 1989, issued under the Inshore Fishing (Scotland) Act 1984. In addition in the Firth of Forth there is a full year general prohibition of fishing, for vessels of 55 feet or over in length (exceptions are listed in Table 9.1.8).

The Sea Fisheries (Wildlife Conservation) Act 1992 gives SOAEFD limited scope to have due regard for wider environmental interests when managing fisheries and permits the restriction of time that a fishing vessel can spend at sea. Fisheries managers have been given environmental responsibilities under the Environment Act 1995 and the Conservation (Natural Habitats etc.) Regulations 1994. There are a total of nine Regulating Orders in Britain covering approximately 215,889 ha (as at July 1995) (MAFF 1995a). While Regulating Orders do not presently apply in Scotland, the Scottish Office issued a consultation paper in December 1994 reviewing its policy on Several and Regulating Orders. Regulating Orders can be granted under the Sea Fisheries (Shellfish) Act 1967 by SOAEFD to a responsible body to enable it to regulate the natural fishery via regulations and restrictions and to levy tolls or royalties. Several Orders are discussed in more detail in section 9.2.3.

Fishermen's Organisations, such as the Scottish Fishermen's Federation, the Firth of Forth Fishermen's Association, the Eyemouth and District Fishermen's Association and the Fife Fishermen's Association, represent fishermen's and boat owners' interests in the fishing industry and are consulted on fisheries management issues and other fisheries-related issues. The Unitary Councils have a role in providing infrastructure and support to the fishing industry.

The Salmon Fishery Statistical Districts (composed of one or more Fishery Administrative Districts) in the region are shown on Map 9.1.2 and listed in Table 9.1.7. In Scotland there is no public right to fish for salmon, and exclusive rights for each stretch of river are privately owned. Coastal and estuarine fisheries are similarly governed by heritable titles. Within District Salmon Fishery Board areas there may be associations of those concerned with a fishery, such as the proprietors, tenants, gillies and anglers.

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. 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 5.5.3, 5.7.3 and 5.8.3.

9.1.4 Information sources used

Inshore fisheries review of England, Scotland and Wales, 1992/1993 (Gray 1994) has been used in compiling this section. Gray (1994) describes the different types of fishing gear used inshore and any related restrictions. It also 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) and specifically for Scotland in Cleator & Irvine (1994). Figures given in Tables 9.1.1 - 9.1.7 come from various sources: MAFF, NRA (now the Environment Agency), SOAEFD and Isle of Man Department of Agriculture, Fisheries and Forestry (IoM DAFF); their interpretation is described below.

Information on the number and size of fishing vessels (i.e. under 10 m length; 10 m and over) based in the region may be obtained from *The Scottish fishing fleet at December 1995* (SOAEFD 1996b). Numbers of full-time and part-time fishermen resident in Sea Fisheries Districts within the region are also given in this annual publication. Trends in fish landings (tonnage and value) at Scottish ports are decribed in detail in MacKay & Adam (1995).

Pelagic, demersal and shellfish species

Statistics given in this section are for landings recorded in the region, as distinct from fish catches taken. Choice of landing port reflects a combination of operational factors, such as market prices, distance from the fishing grounds and the location of fishermen's weekend bases. Consequently, locally-based vessels may land catches at ports in other regions. Conversely, because of the higher prices often obtainable at markets in this region, vessels based outside the region frequently land their catches at ports within the region. Some fish caught may have been discarded before landing. 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 Scotland are published annually and for 1993, 1994 and 1995 are available in SOAFD (1994, 1995) and SOAEFD (1996a).

Statistics for the Scottish Sea Fisheries Districts are based on *Scottish sea fisheries statistical tables,* published annually by the Scottish Office Agriculture, Environment and Fisheries Department (formerly the Scottish Office Agriculture and Fisheries Department) (SOAFD 1993). The contributions to fish and shellfish landings by Scottish vessels in the part of the Arbroath Sea Fisheries District within Region 4 were provided by SOAEFD.

The landings for the Sea Fisheries Districts have been combined to give the figures in the 'Region 4' column for Tables 9.1.1 and 9.1.4 - 9.1.6. The figures in the 'North Sea Coast' column 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 'Scotland' column of these tables were calculated by adding together all of the SOAEFD data for Scotland, and those in the 'Britain and Isle of Man' column by combining MAFF, SOAEFD and IoM DAFF data. Because these organisations do not use the same categories, landings in some of their categories have been added to the 'others' rows in the tables in this section. Also, SOAEFD publish the weight of fish as 'standard landed weight' (gutted fish with head on), whereas MAFF and IoM DAFF publish them as 'nominal live weight' (whole fish). These two are the same for pelagic and shellfish species, but converted data from SOAEFD were used for all demersal species, apart from sandeels (which are not gutted), so that all the data presented are as 'nominal live weight'.

The Forth Estuary Forum paper on fisheries (Forth Estuary Forum in prep.) outlines the history of fishing in the Firth of Forth and overviews the current situation and other fisheries issues.

Diadromous species

The data for the Scottish Salmon Fishery Statistical Districts are based on returns made in response to an annual questionnaire sent to proprietors and occupiers of salmon fishings under the provisions of section 15 of the Salmon and Freshwater Fisheries (Protection) (Scotland) Act 1951, as amended by the Salmon Act 1986. Over 95% of the forms sent out in 1992 were returned. The figures presented are the reported catch and no allowance is made for inaccuracies, non-returns or gaps in the roll of proprietors and occupiers. Therefore the figures given in Table 9.1.7 should be used only as an indication of the pattern of the catch in the region. In order to protect commercial confidentiality, the reported catches for each District are published without an indication of catch method. The *Statistical Bulletin* for Scottish salmon and sea trout lists catch returns for each individual Salmon Fishery Statistical District (Map 9.1.2) and is published annually (SODAF 1990; SO 1991-1996).

Sea angling

In the 85th edition of *Where to fish*, Orton (1996) lists much useful information relating to angling, including the locations from which various species of fish can be caught.

Bait collection

Bait collection is discussed by Fowler (1992), who presents results from a survey around the coast of Britain in 1985.

9.1.5 Acknowledgements

The author thanks the following members of the 'Fisheries Working Group' for their contributions and comments, which enabled the production of this section: Stephen Lockwood (CEFAS), Mike Pawson (CEFAS), Miran Aprahamian (Environment Agency North-West Region), Bill Cook (North Wales and North Western Sea Fisheries Committee (SFC)), Phil Coates (South Wales SFC), Russell Bradley (Association of SFCs), Neil Downes (Devon SFC), Paul Knapman (English Nature), Blaise Bullimore (Countryside Council for Wales), Indrani Lutchman (WWF-UK), Clare Eno (JNCC) and Mark Tasker (JNCC). Thanks also go to Allan Brown (Fife Council), Alan Burdekin (SOAEFD), Daniel Owen (RSPB), David Donnan (Scottish Natural Heritage), Jim Kinnear (SOAEFD Marine Laboratory) and Rory Sumerling (JNCC) for providing a great deal of information specific to this region and for checking drafts and maps.

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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 45 331 57092
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
Statistics on sea fish landings in Scotland. Analysis and dissemination of data and statistics on vessels in the Scottish fishing fleet.	*SOAEFD Division J4, Pentland House, Edinburgh, tel: 0131 556 8400 or 0131 244 6441
International fisheries policy for Scotland. Fisheries conservation including quota policy.	*SOAEFD Division J1, Pentland House, Edinburgh, tel: 0131 556 8400 or 0131 244 6440
Domestic fisheries policy for Scotland. Inshore and shellfisheries management - including Regulating Orders, enforcement and environmental aspects	*SOAEFD Division J2, Pentland House, Edinburgh, tel: 0131 556 8400 or 0131 244 6440
Marine and estuarine fisheries research in Scottish waters; interaction between fisheries and non-fisheries conservation issues in Scotland; seals and fisheries	*SOAEFD Fisheries Research Services, Marine Laboratory, Aberdeen, tel: 01224 876544
Diadromous fish and fisheries information	SOAEFD Freshwater Fisheries Laboratory, Montrose Field Station, 16 River Street, Montrose, Angus DD10 8DL, tel: 01674 677070
Wild salmon and freshwater fisheries policy; contact details for the Clerks of the District Salmon Fishery Boards	*SOAEFD Division K2, Pentland House, Edinburgh, tel: 0131 556 8400 or 0131 244 6231
Scottish Office publications sales	HMSO, 71-73 Lothian Road, Edinburgh EH3 9AZ, tel: 0131 479 3141
Research and development, marketing and training for the fishing industry	Sea Fish Industry Authority, 18 Logie Mill, Logie Green Road, Edinburgh EH7 4HG, tel: 0131 558 3331
Representation of fishermen's and boat owners' interests in the Scottish fishing industry	Scottish Fishermen's Federation, 16 Bon Accord Crescent, Aberdeen AB1 2DE, tel: 01224 582583
Representation of fishermen's and boat owners' interests in the Firth of Forth	Firth of Forth Fishermen's Association, 1 Sealstrand, Dalgety Bay, Fife KY11 5NG, tel: 01383 824263
Representation of fishermen's and boat owners' interests in and around Eyemouth	Eyemouth and District Fishermen's Association, Dundee House, Harbour Road, Eyemouth, Berwickshire TD14 5JB, tel: 018907 50231
Representation of fishermen's and boat owners' interests in Fife	Fife Fishermen's Association, 10 Newgrange Park, Pittenweem, Fife KY10 2QT, tel: 01333 311776
Shellfish production (commercial)	Director, Shellfish Association of the UK, Clerk, Fishmongers Hall, London Bridge, London EC4R 9EL, tel: 0171 626 3531
Affiliated sea angling clubs	Secretary, Scottish Federation of Sea Anglers, Administrator Caledonia House, South Gyle, Edinburgh EH12 9DQ, tel: 0131 317 7192
Game fishing	Director, Salmon and Trout Association, (Scottish Branch), Administrator, 10 Great Stuart Street, Edinburgh, EH3 7TN, tel: 0131 225 2417
Interaction between fisheries and non-fisheries conservation issues	*Fisheries Officer, JNCC Peterborough, tel: 01733 62626
Interaction between fisheries and non-fisheries conservation issues	*Maritime Unit, SNH, Advisory Services, Edinburgh, tel: 0131 554 9797
Interaction between fisheries and non-fisheries conservation issues specific to the Firth of Forth	*Forth Estuary Forum, The Secretary, Redgorton, Perth, tel: 01738 444180
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	Conservation Officer, WWF Scotland, 1 Crieff Road, Aberfeldy, Perthshire PH15 2BJ tel: 01887 820449, and *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, Scarborough, tel: 01723 362392
Seals and fisheries	Co-ordinator, Wildlife & Countryside Link Seals Group, 15 Park Road, East Grinstead, West Sussex RH19 1DW, tel: 01342 315400
Seals and fisheries	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.

9.2 Mariculture

C.F. Robson

9.2.1 Introduction

Mariculture is the cultivation of marine species. There is currently no mariculture occurring in this region. Shellfish farming in Scotland has developed significantly in the last ten years, but the number of active shellfish companies has decreased slightly since its peak in 1990.

9.2.2 Locations and species

Table 9.2.1 lists the main species that are under commercial cultivation in Great Britain and the Isle of Man, although not in this region.

Pacific oysters used to be cultivated in the Firth of Forth, but these sites, along the south shore of the Firth, are no longer active. In 1991 1,000 Pacific oysters from the Forth were sold for human consumption. Harding (1996) explores the feasibility of reintroducing the native oyster into the Firth of Forth in order to re-establish the fishery, which might involve some maricultural activity.

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 the Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD), following sampling carried out by the Port Health Authority or Local Authority. Samples of live shellfish are submitted to SOAEFD Marine Laboratory for bacteriological examination and, depending on the resulting category (A - D), restrictions and further treatment may apply before human consumption is permitted. Samples are taken regularly and the classification can change. Shellfish must also meet the 'End Product Standard', to which all live bivalves intended for immediate human consumption must comply.

The consent of the owners or managers of the sea bed is required and a lease may be needed, applications for which must go through an extensive consultation process, before structures for mariculture can be erected on the sea bed. In many areas a lease must be sought from the Crown Estate, since it owns or manages about 55% of the foreshore and the same proportion of the beds of tidal rivers between mean high and low water springs in Scotland (as opposed to mean high and low water in England and Wales), together with virtually the entire territorial sea bed. These leases are controlled through a formal consultation procedure involving a range of interested bodies including local authorities, the Scottish Environment Protection Agency (SEPA), SOAEFD and Scottish Natural Heritage (Crown Estate 1987, 1989a, 1989b). Details of all salmonid and shellfish cultivation leases in this region are held by the Crown Estate in Edinburgh. If the intended structures are potentially hazardous to navigation the Department of Transport must also issue a consent. If they are to be above mean low water spring mark, planning permission must be sought from the local authority, who will take nature conservation and landscape considerations into account. SEPA and local authorities are responsible for processing consents to discharge from fish and shellfish farms; they hold details of the consents issued to operational sites and site monitoring records. The development of a control policy for fish farming is discussed in Smith & Haig (1991).

Several Orders are granted under section 1 of the Sea Fisheries (Shellfish Act) 1967 and are administered in Scotland by SOAEFD. Several Orders take precedence over the public right to fish and are granted to an individual, a co-operative or a responsible body to cultivate the sea bed within a designated area of water and to protect, conserve and enhance a fishery for named molluscan shellfish species. There are no Several Orders in this region, out of 22 in Britain covering a total of approximately 3,299 ha (as at July 1995) (MAFF 1995). There are consultations proceeding to extend the Act to cover Crustacea as well as molluscs.

The Scottish Salmon Growers Association and the Association of Scottish Shellfish Growers are trade associations which act as information sources for the mariculture industry in Scotland, encourage research and act as consultees on relevant issues.

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

Table 9.2.1 Main species that are cultivated in Great Britain

Species	*Species status*
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 clams *Mercenaria mercenaria*	Non-native
Manila clams *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: The Crown Estate & Scottish Office Agriculture and Fisheries Department (pers. comms.), La Tene Maps (1995a, b).
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.

Britain and for the importation and 'deposit' of molluscan shellfish and lobsters, under the EC Fish Health Directive (Directive 91/67). The regulations list 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 only be made from areas of equal or better health status, and imports of Pacific oysters are subject to screening for species contamination. Imports from non-EU countries can only be made under licence, and enter through designated border inspection posts. Fish farming and shellfish farming businesses in Scotland are required to register with SOAEFD within two months of starting operations, under the Registration of Fish Farming and Shellfish Farming Businesses Order 1985, with a view to preventing the spread of disease. Diagnosis, collation of information and research on fish- and shellfish-related diseases in Scotland is carried out by SOAEFD Marine Laboratory.

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. For instance, the intensification of mussel farming has enhanced the potential for eider ducks, which feed on mussels, increasingly to predate the farmed shellfish, causing a conflict between interests in the area. Advice on precautions against eider duck predation of mussel farms is outlined in Galbraith (1992). Bird-scaring devices and human presence on the farms may be effective deterrents.

As in agriculture, efficient mariculture operations depend on intensive production methods (i.e. at greater than natural population densities), requiring high water quality. The maintenance of the coastal marine environment in an uncontaminated and fully functional state is recognised as an important objective shared by mariculturists and other users of the coastal zone. The presence of fish farming operations in the sea may lead to some interactions between husbandry procedures and the environment. There has been active research and monitoring in Scotland and other northern European countries where salmon farming has developed as the primary form of mariculture. Interactions that give rise to expressions of concern are associated with: the siting and appearance of fish farms, effects on water quality, the sea bed, benthic communities and wildlife (fish predators), opportunities for exchange of pathogens and parasites between wild and farmed fish, the use of chemicals to treat sea lice, the use of antibiotics and their persistence in sediments and the potential for genetic interactions between wild fish and escaped farmed fish. All shellfish species cultivated in Scotland depend on natural food supplies and receive no therapeutic (chemical) treatments for disease or parasites. The high water quality requirement for shellfish farming has, occasionally, led to some concern regarding the impact of certain pollutants in the marine environment.

9.2.4 Acknowledgements

Thanks go to Derek Murison and David Fraser (SOAEFD Marine Laboratory), David Donnan (Scottish Natural Heritage), Professor Paul Read (Napier University), Jim Buchanan (Association of Shellfish Growers), G. Russell (University of Edinburgh), Sheila Harvey (The Crown Estate, Scotland) and Rory Sumerling (JNCC) for commenting on the text.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Fish and shellfish farming policy, disease control, Several Orders in Scotland	*SOAEFD, Division K4, Edinburgh, tel: 0131 244 6224 or 0131 556 8400
Research into fish and shellfish cultivation in Scotland, *Salmon Farming* journal, interaction between mariculture activities and marine nature conservation issues	*SOAEFD Fisheries Research Services, Marine Laboratory, Aberdeen, tel: 01224 876544
Leases	The Crown Estate, 10 Charlotte Square, Edinburgh EH2 4DR, tel: 0131 226 7241
Discharge consents and water quality	*Scottish Environment Protection Agency (SEPA), East Region HQ, Edinburgh, tel: 0131 449 7296
Market research and technical advice on shellfish purification (depuration)	Sea Fish Industry Authority, 18 Logie Mill, Logie Green Road, Edinburgh EH7 4HG, tel: 0131 558 3331
Salmon farming	Director, Scottish Salmon Growers Association, Drummond House, Scott Street, Perth PH1 5EJ, tel: 01738 635420
Shellfish farming	Association of Scottish Shellfish Growers, The Old Parsonage, 2 Manse Road, Roslin, Midlothian EH25 9LS, tel: 0131 440 2116
Commercial advice on shellfish	Director, Shellfish Association of the UK, Fishmongers Hall, London Bridge, London EC4R 9EL, tel: 0171 626 3531
Interaction between mariculture activities and marine nature conservation issues	*Aquatic Environments Branch, RASD, SNH, Edinburgh, tel: 0131 554 9797
Interaction between mariculture activities and other issues specific to the Firth of Forth	*Forth Estuary Forum, The Secretary, Redgorton, Perth, tel: 01738 444180
Interaction between mariculture activities and marine nature conservation issues	*Fisheries Officer, JNCC Peterborough, tel: 01733 62626
Mariculture and marine nature conservation issues	*Coastal Policy Officer, RSPB HQ, Sandy, Beds., tel: 01767 680551
Mariculture and marine nature conservation issues	Conservation Officer, WWF Scotland, 1 Crieff Road, Aberfeldy, Perthshire PH15 2BJ tel: 01887 820449, and *Fisheries Officer, WWF-UK, Godalming, tel: 01483 426444
Mariculture and marine nature conservation issues	*Conservation Officer, Marine Conservation Society, Ross-on-Wye, tel: 01989 566017
Seals and mariculture	Co-ordinator, Wildlife & Countryside Link Seals Group, 15 Park Road, East Grinstead, West Sussex RH19 1DW, tel: 01342 315400
Seals and mariculture	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.

9.3 Quarrying and landfilling

S.L. Bell & N.J. Stephenson

9.3.1 Introduction

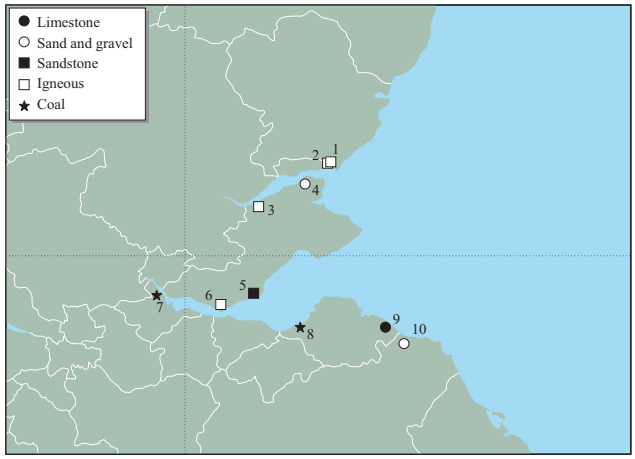
In this section, quarries are included as coastal if they are less than 2 km inland and landfill sites if they are in a coastal 10 km square. The minerals quarried in the region on a commercial basis are sand and gravel, sandstone, limestone and the 'igneous' rocks Andesite and Dolerite. Coal is also mined in this region. These minerals are put to a variety of uses. The sand and gravel are used for construction purposes, including concrete mix, coating and fill. The 'igneous' rock provides aggregate for road construction and building stone. Limestone from the region is used in cement production. The coal is used to fuel local power stations. Table 9.3.1 presents production levels for the whole of local authority areas represented in the region, compared with British levels, for the main minerals quarried in the region. Owing to the relatively small number of operators in Region 4, figures for the regional production of certain minerals are not available, as this could compromise the commercial confidentiality of the operations.

According to the Scottish Office (pers. comm.), there are three major coastal landfill sites currently operational in Scotland. Of these, two occur within Region 4: Riverside (Dundee) and Kinneil Kerse (Falkirk).

9.3.2 Important locations

The coastal quarries in Region 4, including the region's two coastal coal mines, are listed in Table 9.3.2 and shown on Map 9.3.1. Four of the quarries extract 'igneous' rock, two sand and gravel, one limestone and one sandstone.

In order to minimise transport costs, quarries are usually developed close to their markets. The majority of minerals quarried in the region are used to meet demand from within the region. It has been estimated that 89% of Scottish aggregates are used in Scotland, with 78% remaining within the region of origin. Table 9.3.3 illustrates the degree to which this is true in Region 4 compared with in Scotland as a whole.



Map 9.3.1 Coastal quarries (Table 9.3.2). Sources: BGS (1994), SNH. © Crown copyright.

The limestone quarry at Dunbar is one of only two locations in Scotland where limestone for cement is mined (Scottish Office 1994). Coal from the Tranent mine is used to power the nearby Cockenzie Power Station.

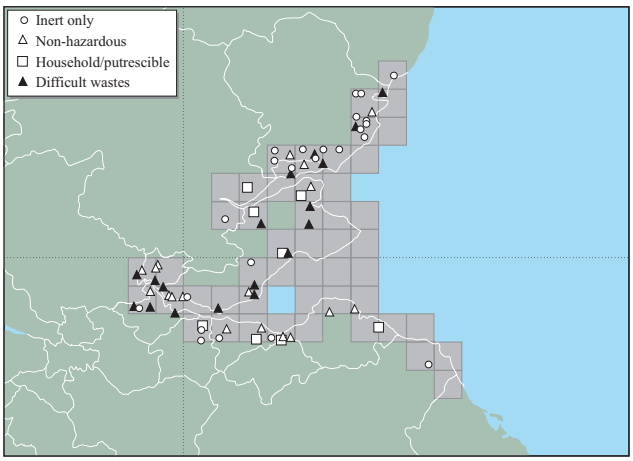
Map 9.3.2 shows the location of coastal landfill sites in Region 4 that were operational in 1994, according to Aspinwall's Sitefile Digest (Aspinwall 1994); the status codes are defined in Table 9.3.4.

The two major coastal landfill sites in the region, at Riverside, to the west of Dundee, and Kinneil Kerse, between Grangemouth and Bo'ness, both have a potentially limited life. Riverside is used mainly for ash disposal from Dundee District Council's incinerator. Tipping at Kinneil Kerse has formed a lagoon, which now has a high nature conservation value for birds and is notified as a Site of Special Scientific Interest (SSSI). In addition to these two sites, there are two locations where pulverised fuel ash is landfilled, near Valleyfield and Musselburgh. These take ash from the Longannet and Cockenzie power stations respectively. Fuel ash has also been used for land claim in this area.

Table 9.3.1 Minerals production in Region 4* (1993) (thousands of tonnes)

Local Authority unit	*Limestone*		*Sand & gravel*		*Sandstone*		*Igneous rock*	
	Tonnes	*% of GB total*	*Tonnes*	*% of GB total*	*Tonnes*	*% of GB total*	*Tonnes*	*% of GB total*
Tayside (now Angus, Dundee City, Perth and Kinross)	1,216[a]	1.1	1,285	1.6	0	0	877	<1
Fife	0	0	1,221	1.5	2	<1	1,598	3.2
Central (now Clackmannan, Stirling and Falkirk)	0	0	n/a	n/a	0	0	887	<1
Lothian (now City of Edinburgh and West, Mid and East Lothian)	a	a	629	0.8	0	0	1,424	2.9
Borders (now Scottish Borders)	0	0	472	<1	0	0	1,132	2.3
Region 4	***1,216***	***1.1***	***3,607***	***4.5***	***2***	***0.02***	***5,918***	***12.0***
Scotland	1,432	1.4	11,359	14.3	1,716	14.2	20,806	42.3
Great Britain	105,885	100	79,380	100	12,100	100	49,209	100

Source: Central Statistical Office (1994). Key: *figures are for production in the Local Authority unit(s) as a whole, not just the coastal zone; n/a = not available; [a]includes production from former Tayside, Lothian, Strathclyde and Dumfries & Galloway.



Map 9.3.2 Coastal landfill sites. Note: a single symbol may represent more than one site in close proximity. Source: Aspinwall (1994).

9.3.3 Management

Planning for Mineral Extraction in Scotland is guided by National Planning Policy Guideline No. 4 *Land for mineral working* (Scottish Office 1994). This notes that land-based sources provide the main supplies of aggregates in Scotland. Planning Authorities are requested to maintain a minimum of a ten-year 'landbank' for minerals, i.e. a stock of planning permissions for the winning and working of minerals.

In Scotland demand for aggregates is anticipated to rise to around 370-440 million tonnes in the next twenty years (Scottish Office 1996). The potential role of coastal superquarries (which could produce in excess of 5 million tonnes per year) in meeting this demand has been identified. In a 1992 report (Whitbread & Marsay 1992) the Department of the Environment found no reasonable prospects for superquarry development along the coastlines of England and Wales, and speculated that there may be scope for five superquarries in Scotland, with the greatest potential being found on the north and west coasts. Regions considered suitable for the development of superquarries are listed in Scottish Office (1994). These are the north coast of Highland region (Regions 3 and 16), Shetland (Region 1) and the Western Isles (Region 15). However, Scottish Office (1994) notes that no more than four sites should be identified by 2009, and the south-east of Scotland is not identified as a likely target area for any of them.

Local Authorities are required to develop local minerals subject plans. Such a plan was developed for Perth & Kinross over a decade ago and is currently being reviewed. A local minerals plan was developed for North East Fife in 1994 and has been inherited by the new Fife Authority. A similar plan is being developed for the Scottish Borders area, with a draft expected by late autumn 1996. Policies relating to mineral extraction are also included within the relevant structure and general local plans.

Guidelines relevant to applications to extract coal are the Coal Industry Act 1994 and NPPG4. Under the Coal Industry Act, the Coal Authority is responsible to the Department of Trade and Industry for the regulation of the coal industry and the issue of licences for coal extraction.

The Scottish Environment Protection Agency (SEPA) came into force in April 1996 as a result of the Environment Act 1995. SEPA integrates the functions of these former authorities: Her Majesty's Industrial Pollution Inspectorate (HMIPI), the local waste regulatory authorities and the

Table 9.3.2 Coastal quarries and coal mines in Region 4

Site no. on Map 9.3.1	*Location*	*Operator*	*Mineral*
1	Dundee	D. Geddes (Contractors) Ltd.	'Igneous' (Andesite)
2	Dundee	Bruntcliffe Aggregates plc	'Igneous' (Andesite)
3	Newburgh	Bruntcliffe Aggregates plc	'Igneous' (Andesite)
4	Newport on Tay	RMC - Scottish Aggregates	Sand & gravel
5	Newbigging	Scottish Natural Stones Ltd.	Sandstone
6	Inverkeithing	Cruicks Quarry, Tilcon Holdings Ltd (active) Prestonhill Quarry, Tarmac (dormant)	'Igneous' (Dolerite)
7	Falkirk	Hillfarm Coal Co. Ltd.	Coal
8	Tranent	Amec Mining Ltd/British Coal Opencast	Coal
9	Dunbar	Blue Circle	Limestone
10	Cockburnspath	Kinegar Sand & Gravel	Sand & gravel

Source: BGS (1994)

Table 9.3.3 Minerals produced/imported in Region 4 in 1989 (thousands of tonnes)

Area	*Production*	*Amount retained in area*	*% retained*	*Imports to area*
Angus, Dundee City, Perth and Kinross	2,551.9	2,149.5	84	482.1
Fife	3,385.4	2,590.2	77	252.6
Clackmannan, Stirling and Falkirk	1,886.1	1,136.1	60	314.3
City of Edinburgh and Lothians	2,033.2	1,757.8	87	1,281.4
Scottish Borders	1,304.8	688.7	53	64.5
Scotland	28,219.6	21,847	89	n/a

Source: Scottish Office (1989). Key: n/a = not available.

Table 9.3.4 Status of coastal landfill sites in Region 4

Status code	*Definition*	*No. of sites in region*
1 Inert only	Uncontaminated excavated natural earth materials, and uncontaminated brick rubble and concrete with similar properties to natural earth materials.	26
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.	19
3 Household/putrescible	Typical contents of a household dustbin and similar wastes of industrial origin e.g. food processing wastes.	8
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 SEPA.	21
Total		*74*

Source: Aspinwall & Co. (1994). Note: status codes are as shown on Map 9.3.2

River Purification Boards (RPBs). The activities of the agency are grouped under two broad headings: pollution prevention and control, and water management, but there will be a strong link between the two to ensure the continuing integrity of estuarine and coastal management. Waste management licences were introduced by the 1990 Environmental Protection Act to replace the disposal site licences previously required by the 1974 Control of Pollution Act. SEPA is required to maintain a public register of waste management licences for private sites in its area and a register of resolutions referring to its own sites. Also within the Environment Act is the requirement for mine operators to give the agency at least six months' notice of their intention to abandon a mine, in order that steps can be taken to avoid future pollution from minewater. Also relevant to quarrying and landfilling are the provisions relating to producer responsibility for waste. These 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.

9.3.4 Information sources used

Data on quarrying were obtained from the British Geological Survey's *Directory of Mines and Quarries* (BGS 1994), the Scottish Office *Survey of aggregate working in Scotland* (Scottish Office 1989), and the Central Statistical Office's *Business Monitor (Minerals)* (Central Statistical Office 1994), and are the most up to date and comprehensive available. Additional information can also be gained from NPPG4 *Land for mineral working* (Scottish Office 1994), and reports of surveys prepared prior to the production of Regional Plans. Data for quarrying in BGS (1994) may be up to three years old and may therefore include information on some operations that have now ceased. Statistics for mineral extraction are usually presented on a county basis, making it difficult to identify both how much had been won from a particular area and how much of this was obtained from sites adjacent to the coast.

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 Waste Regulation Authorities (now included in SEPA) and represents the most up-to-date collection of public information on British waste management available. The Scottish Environment Protection Agency (SEPA) is in the process of compiling up-to-date information about the location of landfill sites. The Hazardous Waste Inspectorate produced summary statistics of waste disposal in Scotland between 1991-1992. Public registers detailing waste disposal licences were kept by Local Authorities until April 1996. These have been passed to SEPA, who now hold responsibility for issuing licences and maintaining the public register. No standard format for the public register was prescribed, and differing levels of data are readily available from each of the different local authority areas.

9.3.5 Acknowledgements

Thanks are due to Mark Tasker (JNCC), Allan Brown (Fife Council), Alan Burdekin (SOAEFD) and Kathy Duncan (SNH) for their useful comments.

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Scottish Office. 1994. *The Scottish environment - statistics, No. 4 1993.* Edinburgh, Government Statistical Service.

C. Contact names and addresses

Type of information	*Contact address & telephone no.*
Scottish Environment Protection Agency	*SEPA, East Region, Edinburgh, tel: 0131 449 7296 *SEPA Head Office, Stirling, tel: 01786 457700
Local plans and minerals policies: Angus	*Angus Council, Planning Department, Forfar, tel: 01307 461460
Local plans and minerals policies: Dundee	*Dundee City Council, Planning Department, Dundee, tel: 01382 434000
Local plans and minerals policies: Perth & Kinross	*Planning Department, Perth & Kinross Council, Perth, tel: 01738 475000
Local plans and minerals policies: Fife	*Planning Service, Fife Council, Glenrothes, tel: 01592 414141
Local plans and minerals policies: Clackmannanshire	*Clackmannanshire Council, Alloa, tel: 01259 450000
Local plans and minerals policies: Stirling	*Planning Department, Stirling Council, Stirling, tel: 01786 443322
Local plans and minerals policies: Falkirk	*Planning Department, Falkirk Council, Falkirk, tel: 01324 506070
Local plans and minerals policies: West Lothian	*Planning Department, West Lothian Council, Council Headquarters, Livingston, tel: 01506 777000
Local plans and minerals policies: Edinburgh	*Planning Department, City of Edinburgh Council, Edinburgh, tel: 0131 200 2000
Local plans and minerals policies: East Lothian	*East Lothian Council, Planning Department, Haddington, tel: 01620 827827
Local plans and minerals policies: Borders	*Planning Department, Scottish Borders Council, Melrose, tel: 01835 824000
Landfill database and Sitefile Digest	Aspinwall & Co., Walford Manor, Baschurch, Shrewsbury SY4 2HH, tel: 01939 262200
General information on Scottish mining	British Geological Survey - Scottish Office, Murchison House, West Mains Road, Edinburgh EH9 3LA, tel: 0131 667 1000
Mines and quarries (British Directory of Mines and Quarries)	*British Geological Survey, Nottingham, tel: 0115 936 3100

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

9.4 Marine aggregate extraction, dredging and solid waste disposal at sea

S.L Bell & N.J. Stephenson

9.4.1 Introduction

Sand and gravel on the sea bed are important sources of industrial aggregate for concrete production, road construction, building and, increasingly, for beach replenishment and soft coastal defences. The main market is in the south-east of England. Marine aggregates form a significant part of the total demand for sand and gravel in Britain, each year accounting for 15% of the national total requirement (Crown Estate 1992). In 1995, a total of 26,122,758 tonnes of aggregate were landed from British waters. This figure includes approximately 6.8 million tonnes of aggregate that were dredged in Great Britain but exported to landing ports abroad. 5.2 million tonnes were dredged specifically for contract fill and beach nourishment. There is some interest in gravel extraction from the east coast of Scotland, and a licence for gravel extraction has been granted in Spey Bay (Region 3). There is currently only limited commercial extraction of aggregate from Region 4, from the River Tay.

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. The majority of dredged material, which can range in composition from silts to boulder clay and rock, is disposed of at sea. Some dredged material is also used for land claim and increasingly for 'soft' coastal defences such as beach recharge. Thereafter, maintenance dredging is the regular dredging of existing ports and their approaches to maintain safe navigation. Since 1988 there have been fluctuations in the wet tonnage of dredged material deposited in the seas off Scotland, from 2,109,114 tonnes in 1990 to 4,026,861 tonnes in 1992 and back down to 2,025,525 tonnes in 1993 (MAFF 1995). The total quantity of dredged material deposited in the region in 1994 (1,153,377 tonnes) constituted 3.2% of the total dredged material deposited at offshore sites in the UK in 1994 (35,962,835 tonnes) (Table 9.4.1)

The UK currently produces some 1.1 million tds (tonnes of dry solids) of sewage sludge annually and disposes of approximately 300,000 tds to the sea. Sewage sludge has been disposed of at sea since the early 1900s, and disposal from ships currently accounts for 74% of Scotland's sewage sludge disposal. In 1994 some 327,510 tonnes were deposited at two sites in this region, representing >1% of the total dredged material deposited at offshore sites in the UK in 1994 (Table 9.4.1). However, under the Urban Waste Water Treatment Directive (91/271/EEC) all sewage sludge disposal by marine vessels is to be phased out by 1998. It will have to be replaced by disposal on land, by tipping or incineration. UK sewage sludge production is set to increase dramatically over the next decade, to a predicted 3.3 million tds by 2006.

Map 9.4.1 Sites of licenced disposal of dredged materials and sewage sludge at sea in 1994. Source: SOAEFD Marine Laboratory.

9.4.2 Important locations

Marine aggregates dredging

Very little aggregate was extracted under licence in Scottish waters or landed in Scottish ports in 1995. In that year Region 4 had only one aggregate extraction site operational: RMC Scottish Aggregates exploited sand resources on a small scale on the south side of the River Tay (Crown Estate 1996). The sea bed of Region 4 has received only limited prospecting interest, and whilst there is resource potential

Table 9.4.1 Material licensed and disposed of at sea in Region 4 (1994)

	Licences issued	*Sites under licence*	*Sites used*	*Wet tonnage deposited*
Dredged material	12	11	11	1,153,377
Sewage sludge	2	2	2	327,510
Region 4	***14***	***13***	***13***	***1,480,887***
Scotland	23	28	22	1,822,053
UK	134	120	98	35,962,835

Source: MAFF pers. comm. Note: licences may commence at any time and generally last for one year.

present in certain locations (e.g. Scalp Bank), opposition from fishermen has discouraged exploration.

Navigational dredging

Dredging of some of the major channels and harbour areas in the Forth is virtually continuous, and dredged material disposal at sea occurs throughout the year. Other harbour areas are dredged infrequently, often only annually.

Solid waste disposal

Table 9.4.2 lists the main marine locations used for the disposal of dredged material and sewage sludge in Region 4 in 1994 (Map 9.4.1). The largest amount of dredged material is deposited at a licensed site off Bo'ness. In 1993/4 over 824,000 tds were disposed of at this site. There are two sewage sludge disposal sites within the region. Both sites receive sludge produced from the East Lothian - Edinburgh area. When sewage sludge disposal at sea ceases in 1998, sludge produced from Edinburgh will be incinerated.

Ammunition dump sites

There are two ammunition dump sites off the Isle of May, now disused. Local *Nephrops* trawlers regularly fish on the grounds east of the Isle of May, including in the vicinity of the dump sites, and claim they often trawl up munitions, believed to be cordite, which are either returned to the sea or landed and dealt with by the proper authorites. Creel vessels also work the ground off the Isle of May and are thought to venture into the dump sites. They are unlikely to raise significant quantities of munitions by this method of fishing. It is unlikely that the dumped material could be moved from the dump sites by water circulation/tidal influences alone.

9.4.3 Management and issues

Marine aggregates dredging

All dredging activities have short-term, localised effects, such as the removal of material and organisms, but long-term effects on, say, fish stocks or morphology are much more difficult to assess, owing to the difficulty of determining which effects are the result of dredging and which the result of the many other factors operating (Doody *et al*. 1993).

Marine sand and gravel are extracted by commercial mineral companies under licence from the Crown Estate. Aggregates from terrestrial sources are insufficient to meet UK demand (Doody *et al.* 1993), and dredging for marine aggregates tends to arouse less controversy than terrestrial extraction. So government policy for the provision of aggregates, formulated in 1982 and 1989, has encouraged marine extraction of sand and gravel. 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). The Scottish Office is currently considering changing 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 Scottish Office (Crown Estate 1994). As part of this process SOAEFD undertakes a comprehensive assessment of the potential effect of the new aggregate extraction areas on the marine environment, on commercial fisheries and fisheries operations. 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. A consultation exercise outlining options for a new system in Scotland was undertaken by the Scottish Office. No statement of intent has yet been issued.

Aggregate extraction from the sea bed commonly involves using suction pipes or bucket dredgers. Short- or long-term changes in sediment deposition can result, as well as inevitable changes in the topography of the bed. The biological implications of extraction depend upon the characteristics of the individual area concerned. In general, the principal biological impact of marine aggregate extraction is the disturbance and removal of benthic infauna and epifanuna and alteration of the substrate upon which colonisation depends. Disturbance of muddy material in order to access underlying aggregate can destroy feeding grounds for flatfish through the displacement of muddy

Table 9.4.2 Licensed disposal of dredged material at sea, 1994 (tonnes of dry solids (tds))

MAFF code (Map 9.4.1) deposited	*Location*	*Waste type*	*Depth (m)*	*Tonnes*
FO010	Montrose	Maintenance dredging	25	175,800
FO020	Arbroath	Maintenance dredging	25	18,581
FO021	Firth of Tay (East)	Maintenance dredging	5	38,736
FO023	Newcome Buoy	Maintenance/capital dredging	10	2,051
FO025	Tay Bridge	Maintenance dredging	2.5	3,890
FO038	Narrow Deep B	Maintenance dredging	25	18,070
FO041	Oxcars Main	Maintenance/capital dredging	10	50,602
FO044	Bo'ness	Maintenance dredging	7.5	824,619
FO048	Methil	Maintenance dredging	15	2,085
FO051	Pittenweem	Maintenance dredging	31	18,943
FO030	Bell Rock (summer)	Sewage sludge	54	139,467
FO050	St. Abb's Head (winter)	Sewage sludge	60	188,043

Source: MAFF pers. comm. Note: sites not licensed in 1994 may be used in other years.

sand fauna. If an area is used by fish for spawning, for which a stable bed is required, egg laying can be disrupted. Where the remnant substrate is identical to the superficial sediments, disturbance is unlikely to be permanent and the extraction area will be recolonised. Licences are generally only granted where these conditions are fulfilled (Campbell 1993).

Navigational dredging

Navigational dredging is the responsibility of individual harbour authorities and is carried out as required, although a licence from SOAEFD is required for disposal of the dredged material offshore.

Solid waste (including dredged material) disposal

The primary legislation in force to control the disposal of solid waste, including 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 solid wastes and dredged material at sea. In this region, licences to deposit solid wastes, including sewage sludge and dredged material, at sea are issued by the Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD) under the Food and Environment Protection Act 1985. Each licence is subject to certain conditions, which have become more stringent in the last few years. 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, either by disposal on land, by incineration, or by an alternative beneficial use being found for the material. It is possible that illegal dumping of material occurs from time to time.

Blanketing of the sea bed is the main impact of dumping dredged material. Benthic flora may be killed when the input rate is significantly greater than the natural sedimentation rate, through the prevention of respiration and feeding (Kenny & Rees 1994). Other impacts include the localised elevation of metal levels, caused by the disturbance of industrial waste and effluent discharged into the rivers from which the dredged material originated. Some sewage sludges are principally of domestic origin and contain low levels of metals and other persistent components. Others include industrial inputs, resulting in higher concentrations of contaminants, which can affect marine organisms. Localised increases in water column turbidity, which are often caused by dumping of all kinds of solid waste, may interfere with fish migration, but only on a temporary basis. Changes in sediment particle size can result in changes in benthic flora and fauna which, whilst not damaging *per se*, can affect the distribution of higher animals by altering the food chain. Shallows over banks of sediment can also be created, which could be a navigation hazard (Irish Sea Study Group 1990).

9.4.4 Information sources used

The statistics on marine aggregate extraction relate to royalty returns to the Crown Estate (as owners of the foreshore and sea bed) for 1994. The information on disposal of dredged material is derived from licences granted by SOAEFD.

9.4.5 Acknowledgements

Thanks are due to the Crown Estate, and in particular Sheila Harvey, for information on marine aggregate extraction in the region, to Dr C. Vivian (MAFF, Burnham-on-Crouch), who provided information on solid waste disposal and sewage sludge disposal at sea, and Laura Goodwin (Marine Laboratory, Aberdeen) for marine disposal site information. Thanks also go to Mark Tasker (JNCC), Derek Saward (SOAEFD), Kathy Duncan and John Baxter (SNH), Alan Burdekin (SOAEFD) and Daniel Owen (RSPB) for their comments.

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Scottish Office. 1996. *Scotland's coasts. A discussion paper.* Edinburgh, Scottish Office Agriculture, Environment and Fisheries Department.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Marine aggregate extraction licensing	The Crown Estate, Marine Estates (Scotland), 10 Charlotte Square, Edinburgh EH2 4DR, tel: 0131 226 7241
Offshore geoscience data including 1:250,000 maps of geology of coastline	*Director, British Geological Survey, Nottingham, tel: 0115 936 3100
Marine resource management (managing agents offshore for the Crown Estate)	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, Centre for Environment, Fisheries & Aquaculture Sciences, Burnham-on-Crouch Laboratory, Remembrance Avenue, Burnham-on-Crouch, Essex CM0 8HA, tel: 01621 782658
Scientific assessments of dredging and waste disposal and licensing of disposal at sea	*SOAEFD, Fisheries Research Services, Aberdeen, tel: 01224 876544
Marine sand and gravel extraction	British Marine Aggregate Producers Association (BMAPA) and British Aggregate Construction Materials Industries (BACMI), 156 Buckingham Palace Road, London SW1 9TR, tel: 0171 730 8194
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
British Ports Federation	Technical Manager, British Ports Federation, 7th Floor Victoria House, Vernon Place, London WC1B 4LL, tel: 0171 242 1200

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

9.5 Oil and gas developments

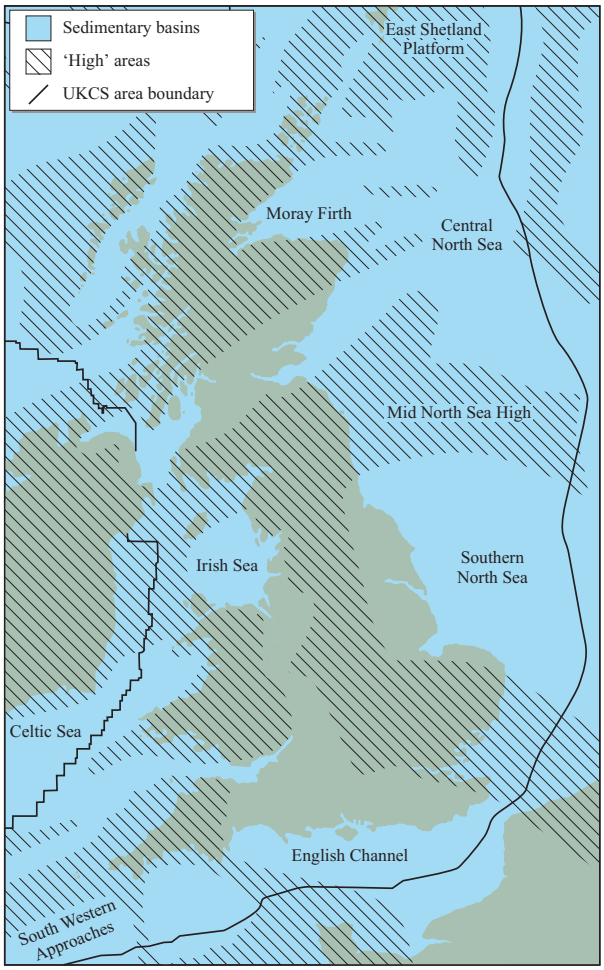
S.L. Bell & N.J. Stephenson

9.5.1 Introduction

This section describes oil and gas exploration and related development in the region. Map 9.5.1 shows the sedimentary basins and structural 'highs' around the UK Continental Shelf, which determine the distribution of oil and gas deposits. There is little exploration activity in this region, although it is an important location for processing.

In the 17th Offshore Oil and Gas Licensing Round (1997), no blocks in this region were awarded exploration licences. In July 1995 the 7th Landward Round for oil and gas exploration was announced, under which applications were invited for licences covering both land and certain inshore 'watery areas'. Results were announced in March 1996, when 74 blocks were awarded, although none in this region. The 8th Landward Round is imminent.

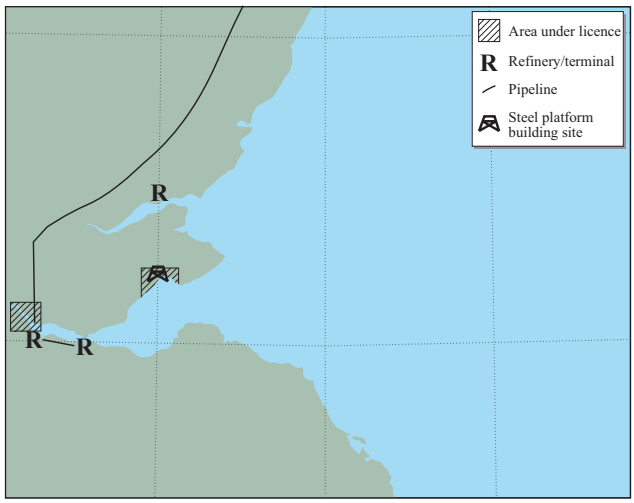
Total UK Continental Shelf (UKCS) oil and gas production in 1995 was a record of some 220 million tonnes of oil equivalent, and accounted for some 2% of Gross Domestic Product (DTI 1996). A total of 98 exploration and appraisal wells were drilled in 1995, and seven significant discoveries were announced, although none in this region.



Map 9.5.1 UK Continental Shelf (UKCS) sedimentary basins and structural 'highs'. Source: DTI (1994). © Crown copyright.

9.5.2 Important locations

Map 9.5.2 shows the locations of oil and gas related activity in the region. Two onshore areas were noted as being under licence in January 1996 (DTI pers. comm.), one near Methil and the other near Stirling. Existing petro-chemical related industry includes a small oil refinery in the dock area of Dundee, a relatively small-scale gas separation plant at Milton of Balgonie near Methil, a platform building yard at Methil, a gas terminal and exporting facilities at Braefoot Bay (Mossmorran), oil refinery and petro-chemical facilities at Grangemouth, oil reception terminals at Grangemouth and Dalmeny (Hound Point), and oil/gas separation facilities at Dalmeny. BP, Shell and Esso all have interests in the area. In the Firth of Forth, off the Fife coast, there are anchorages for tankers and for laying up oil exploration rigs.



Map 9.5.2 Oil and gas exploration licensed areas and infrastructure. Source: DTI (1994). © Crown copyright.

9.5.3 Management and issues

Licences are awarded by the Department of Trade and Industry, following 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. Davies & Wilson (1995) describe the 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). Comprehensive oil spill contingency plans exist for both the Tay and Forth Estuaries. The Tay plan,

known as 'Tayclear', is currently under review. The Forth plan is known as 'Clearwater Forth'. There are also plans specific to Hound Point and Grangemouth oil refinery.

Concern has been expressed about the potential risk to seals and dolphins from oil-related activities in the region. 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 from fieldwork 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). Nevertheless recent studies indicate that cetaceans may be disturbed by seismic surveying, as they are sighted less frequently, either acoustically or visually, during seismic surveys (Goold 1996). Best practice environmental management guidance for carrying out seismic surveys in areas where marine mammals occur, without compromising safety or operational viability, is among environmental issues considered in UKOOA's *Environmental guidelines for exploration operations in near-shore and sensitive areas* (UKOOA 1994).

Planning guidance issued by the Scottish Office has safeguarded sites for future petrochemical development. The 1981 National Planning Guidelines identified Kinneil Kerse, on the coast, and Mossmorran, which now has a coastal component. These sites were confirmed by NPPG2 in 1993.

9.5.4 Information sources used

Many of the data used here come from the DTI's 'Brown Book' (DTI 1996), which should be referred to for further explanation. It is updated annually. Supplementary data was obtained from the Scottish Office.

9.5.5 Acknowledgements

Thanks are due to Mark Tasker (JNCC), Derek Saward and Alan Burdekin (SOAEFD), D.W. Moore (Esso Exploration and Production UK Ltd) and Kathy Duncan and John Baxter (SNH) for their useful comments.

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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 (UKOOA), 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 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
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
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
Oil spill contingency plans	*SEPA East Region HQ, Edinburgh, tel: 0131 449 7296
Oil spill contingency plans	Forth Ports plc, Tower Place, Leith, Edinburgh EH6 7DB, tel: 0131 554 6473

Type of information	Contact address and telephone no.
Licensing the use of dispersants for oil spill - Scotland	*Marine Environment and Wildlife Branch, SOAEFD, Pentland House, Edinburgh, tel: 0131 556 8400
Scientific assessments of oil dispersants and effects of gas and oil exploitation on the marine environment	*SOAEFD Marine Laboratory, Aberdeen, tel: 01224 876544
Response (privately-funded) to oil spills worldwide	Oil Spill Response, Oil Spill Service Centre, Lower William Street, Northam, Southampton SO14 5QE, tel: 01703 331551
Research into oil pollution	Oil Pollution Research Unit, 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 environmental effects of exploration, production and oil spills	*Marine Advisor, JNCC, Peterborough, tel: 01733 62626, or JNCC, Aberdeen, tel: 01224 655701
Advice on environmental effects of exploration, production and oil spills	*Maritime Unit, Advisory Services, SNH, Edinburgh, tel: 0131 554 9797
Local information on the environmental effects of exploration and production	*Scottish Wildlife Trust, Edinburgh, tel: 0131 312 7765
Information on the environmental effects of exploration and production	*WWF - UK, Godalming, tel: 01483 426444
Oil and gas licensing in Scotland	*Scottish Office, Development Department, Edinburgh, tel: 0131 556 8400

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

9.6 Water quality and effluent discharges

S.L. Bell & N.J. Stephenson

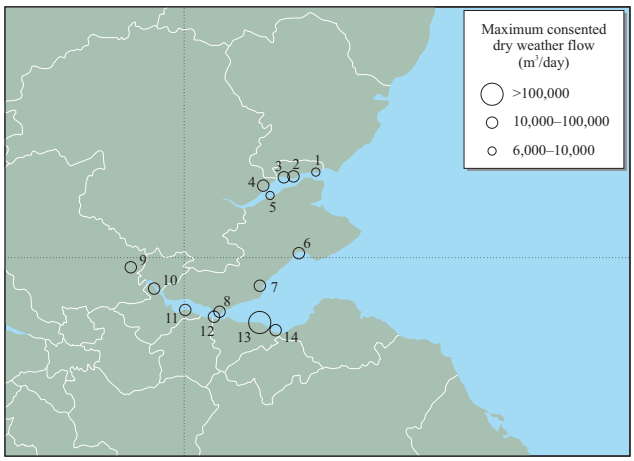
9.6.1 Introduction

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.

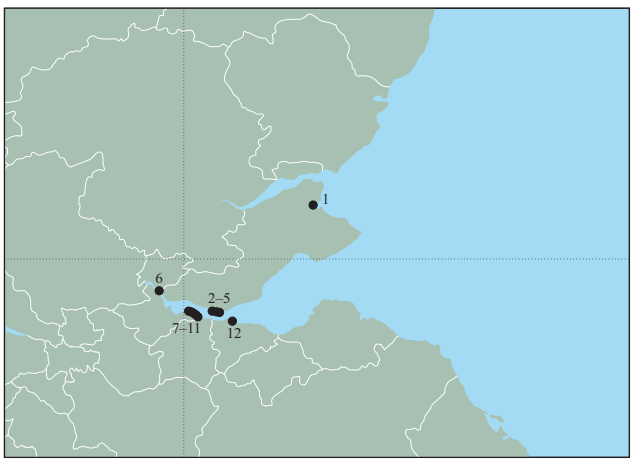
Waste products and effluents containing contaminants reach the marine environment in this region in a number of ways: sewage, agricultural run-off and trade effluents are discharged from outfalls into rivers or directly into the sea, and contaminants can reach the sea by airborne means, for example aerosols and rain. Industrial pollutants can enter the marine environment under licensed discharge or by accidental release. Discharges occurring outside the region may also have a detrimental effect on coastal water quality. Abstraction of water in Region 4 is not a major concern for water quality; however East of Scotland Water have plans to abstract, by approximately the year 2020, 450 million litres/day from the upper tidal limit of the Tay at Perth, to be piped to central Scotland to meet increasing demand there.

The coastal water quality in the region is generally good or excellent (Table 9.6.1). The greatest length of coast adjacent to unsatisfactory or seriously polluted water is found in the Forth area, where 40% of waters in the Forth Estuary are affected by sewage discharges. However, there have been continuing improvements in estuarine water quality in the River Forth, the result of the introduction and upgrading of sewage treatment works. Table 9.6.2 shows the total numbers of sewage (Map 9.6.1) and trade (Map 9.6.2) outfalls in the region. The majority of sewage outfalls in the region are extremely small, being from domestic septic tanks.

Overall, beach quality in the region is poorer than average for Great Britain (Coastwatch UK 1994). The results for 1994 showed a moderate increase in quality of coastline in Fife between 1993 and 1994, and a downturn in quality for coastline in the Lothians over the same time period (Table 9.6.3). No beaches in former Tayside or Central Regions were monitored. The main items of litter found along the coastline in this region were sanitary items, cans, plastic bottles, paper drinks containers, glass items, potentially hazardous containers, and packing straps. Medical waste, including syringes and needles, is an increasing problem, the source of which is not known (McGilvray 1994). In Region 4 there are eleven bathing waters identified under the EC Bathing Water Directive (76/160/EEC) (Map 9.6.3). All complied with mandatory standards in 1996 (Table 9.6.4), as in the previous three years. There are only two European Blue Flag beaches in Scotland, both in this region. The six Tidy Britain Group



Map 9.6.1 Sewage effluent outfalls with consented daily flows >6,000 m³ (Table 9.6.5). Sources: River Purification Boards.



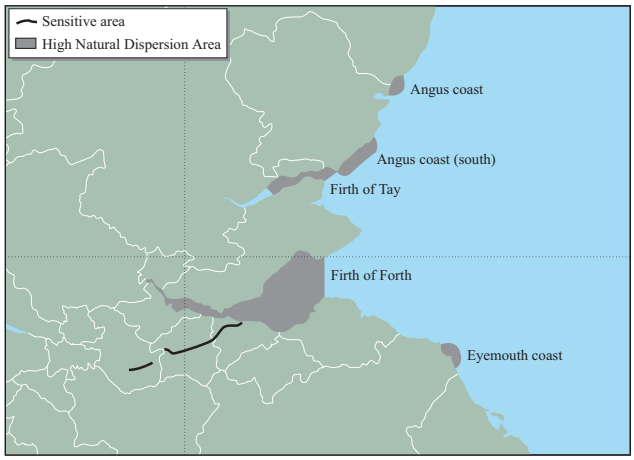
Map 9.6.2 Trade effluent discharges with consented daily flows >6,000 m³ (Table 9.6.6). Source: SEPA.

Table 9.6.1 Quality classification of coastal waters 1994/5

			Quality class		
River Purification Authority area*	*Excellent (km)*	*Good (km)*	*Unsatisfactory (km)*	*Seriously polluted (km)*	*Total*
Tay	53.3	22.7	5.5	0	81.5
Forth	32.5	78.3	56.7	20.8	188.3
Tweed	43.1	0.7	0.2	0	44.0

Sources: Tay River Purification Board (1995); Forth River Purification Board (1995); Tweed River Purification Board (1995) Key: *now replaced by the Scottish Environment Protection Agency (SEPA).

Map 9.6.3 EC identified bathing waters: results of 1996 sampling. Source: SEPA.



Map 9.6.4 High Natural Dispersion Areas identified in connection with the EC Urban Waste Water Treatment Directive.

Seaside Award beaches in the region in 1996 represent 38% of the Scottish total of 16 and 3% of the UK total of 210.

9.6.2 Important locations

The fourteen sewage outfalls in the region with consented dry weather flows greater than 6,000 m^3 per day are listed in Table 9.6.5 (Map 9.6.1). Several stretches of the coastline and estuaries in Region 4 have been identified as High Natural Dispersion Areas (HNDAs): the Angus coast, the Firth of Tay, the Firth of Forth, and the Eyemouth coast (Map 9.6.4). These are considered to be less sensitive areas under the Urban Waste Water Treatment Directive (UWWTD) (91/271/EEC) (see section 9.6.3). Outfalls that will require upgraded treatment under the UWWTD are identified in Table 9.6.5.

In Region 4, coastal industrial development and its associated effluent discharges and potential for contamination are concentrated around the Firth of Forth. The only significant trade outfall north of the Firth of Forth is the paper mill at Guardsbridge, which discharges into the Eden Estuary. Since the construction of a treatment plant in 1992, the quality of the effluent entering the estuary has improved dramatically (Clelland in prep.). Within the Firth of Forth there are a number of sources of trade effluent. The upper reaches of the Forth have suffered low levels of oxygen for many years, but this has been improved recently by the biological treatment of the effluent from the Quest factory at Alloa (Griffiths in prep.). The largest trade discharges in the region are associated with the Rosyth Royal Dockyard, and the chemical works, oil refinery and other petrochemical works at Grangemouth. Discharges have been subject to improved treatment in recent years, for example biological treatment of process water at the BP refinery, in-plant works at BP chemicals, and the biological treatment facilities that are under contruction at Zeneca plc (Griffiths in prep.). Nuclear establishments in the region are located at Rosyth and Torness (Scottish Nuclear); Rosyth houses several decommissioned nuclear submarines. There is also evidence of radioactive contamination at Donibristle, where remains of World War II aircraft instrument dials have been detected on the shore at Dalgety Bay. Despite recent reductions in the amount of persistent substances entering the Forth, there is an historical legacy of such substances in sediments around Grangemouth and Inverkeithing (Griffiths in prep.). Whilst the input of contaminants to the Forth from point sources has decreased (Forth Estuary Forum 1996), the input from diffuse sources has increased. Rivers represent the most significant source of contaminants. Levels of nitrate in the River Tyne have

Table 9.6.2 Numbers of trade and sewage outfalls by *River Purification Board area 1994/95

	Sewage	*Trade*	*Total*
Tay	159	38	197
Forth	182	190	372
Tweed	88	50	138
Region 4	***429***	***278***	***707***

Sources: Tay River Purification Board (1995); Forth River Purification Board (1995); Tweed River Purification Board (1995). Key: *now replaced by the Scottish Environment Protection Agency.

Table 9.6.3 Beach quality in the region (1993)

	% of beaches rated as:		
Area	*excellent*	*moderate*	*polluted*
Fife	3	49	48
Lothians	0	33	67
England	10	44	46
Wales	7	39	54
Scotland	7	37	56
Great Britain+	***8***	***42***	***50***

Source: Coastwatch UK (1994).

Table 9.6.4 EC designated bathing waters survey (1996)

	Pass	*Fail*	*Total*
Region 4	***11***	***0***	***11***
England & Wales	386	47	433
Scotland	21	2	23
N. Ireland	16	0	16
UK	423	49	472

Sources: SEPA (pers. comm.), Environment Agency (1997), DoE (NI) pers. comm. Note: pass denotes compliance with Bathing Water Directive (76/160/EEC) mandatory coliform standards.

Table 9.6.5 Sewage effluent outfalls to tidal waters in the region with consented dry weather flows >6,000 m³ per day

Site no. on Map 9.6.1	*Location*	*Outfall*	*Grid ref.*	*Treatment*	*Maximum dry weather flow (m³/day)*	*Comments*
1	Dundee	Stannergate Reclamation Sewer Outfall	NO438309	Unknown	6,912	Meets UWWTD requirements
2	Dundee	Eastern Wharf (Interceptor) Sewer Outfall	NO420306	Unknown	9,936	Meets UWWTD requirements
3	Dundee	King George V Wharf Sewer Outfall	NO417305	Unknown	10,368	Meets UWWTD requirements
4	Dundee	Invergowrie/Riverside Drainage Scheme	NO380284	Unknown	34,214	Meets UWWTD requirements
5	Newburgh	Newburgh	Unknown	Reed bed	8,640	New reed bed planted 96/97
6	Leven	Leven Valley Sewer Outfall	NO384002	Preliminary	67,000	New primary treatment works being constructed for UWWTD
7	Kircaldy	Kircaldy Sewage Works	NT293916	Preliminary (screened)	20,000	Primary treatment required for UWWTD
8	North Queensferry	Dunfermline Sewage Treatment Works	NT127804	Primary	24,750	Secondary treatment required for UWWTD
8	Stirling	Stirling	NS808935	Secondary (activated sludge)	23,000	Meets UWWTD requirements
10	Alloa	Alloa Sewage Treatment Works	NS886918	Secondary (activated sludge)	43,200	Meets UWWTD requirements
11	Grangemouth	Kinneil Kerse	NS963813	Primary	25,143	New secondary tratment works required for UWWTD
12	South Queensferry	South Queensferry Sewage Treatment Works (New)	NT118795	Preliminary (screened)	10,400	Primary treatment required for UWWTD
13	Leith	Edinburgh Sewage Treatment Works	NT295787	Primary	1,440,300	Secondary treatment may be required for UWWTD
14	Musselburgh	Wallyford Sewage Treatment Works	NT364738	Primary	68,250	Meets UWWTD requirements

Source: SEPA pers. comm.

increased by 250% in the last 30 years, a trend that has been linked to the increased use of fertiliser on agricultural land (Forth Estuary Forum 1996). Urban sources of diffuse pollution include storm overflows and contaminated surface water from roads, industrial estates and housing schemes. Pollutants include oil, dust containing metals, and some herbicides. In addition to these landward sources of pollution, a variety of contaminants enter the sea from ships (Forth Estuary Forum 1996). Table 9.6.6 lists the twelve larger trade effluent outfalls in the region, i.e. those with a consented daily effluent flow in excess of 6,000 m³ per day (Map 9.6.2).

Bathing waters in the region identified under the EC Bathing Water Directive (76/160/EEC), all of which complied with mandatory standards in 1995, are Montrose, Arbroath, Carnoustie, West Sands (St. Andrews), Pettycur (Kinghorn), Silversands (Aberdour), Gullane, Yellowcraigs, Milsey Bay (North Berwick), Belhaven (Dunbar) and Pease Bay (Map 9.6.3). Carnoustie failed UK regulations but

Table 9.6.6 Trade effluent outfalls in the region with consented daily flows >6,000 m³ per day

No. on Map 9.6.2	*Location*	*Grid ref.*	*Outfall*	*Consented flow (m³/day)*
1	Guardbridge	NO452195	Guardbridge Paper Mill	8,730
2	Inverkeithing	NT131823	Caldwells Mill	7,000
3	Rosyth	NT108818	Rosyth Royal Dockyard - Bypass & Interceptor	81,216
4	Rosyth	NT100821	Rosyth Royal Dockyard - King James IV, Barton Road	17,280
5	Rosyth	NT099821	Rosyth Royal Dockyard - Caledonia Road	7,776
6	Alloa	NS886918	Quest Glenochil Yeast Factory	7,860
7	Grangemouth	NS944842	Zeneca plc	20,000
8	Grangemouth	NS951821	BP Refinery Discharge	20,400
9	Grangemouth	NS953822	BP Refinery Ballast Water	15,600
10	Grangemouth	NS956818	BP Chemicals Combined Discharge	20,000
11	Bo'ness	NT001831	BP Kinneil Gas Separation	19,100
12	Dalmeny	NT158799	BP Dalmeny Discharge	50,000

Source: SEPA

complied with the Directive. The only two Blue Flag beaches in Scotland in 1996 are located in the region, at St. Andrews and Aberdour. The six Tidy Britain Seaside Award beaches in the region in 1996 were West Sands (St. Andrews), Kingsbarns, Elie, Silversands (Aberdour), Gullane Bents (Gullane), and Belhaven Bay (Dunbar).

9.6.3 Management and issues

Responsibility for coastal water quality in the regions lies with the Scottish Environment Protection Agency (SEPA), which became operational in April 1996. The activities of SEPA are grouped under two broad headings: pollution prevention and control, including the functions of the former waste regulatory authorities, the work of Her Majesty's Industrial Pollution Inspectorate (HMIPI) and the regional River Purification Boards' (RPBs) work on water quality; and water management, covering the RPBs' other functions. There is 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. The primary statute in Scotland is the Control of Pollution Act 1974. Discharge consents from'prescribed processes', including trade effluent, are authorised by SEPA under the Environmental Protection Act 1990. Discharges from nuclear installations are licensed under the Radioactive Substances Act 1993 by SEPA. Environmental Quality Standards (EQSs) for many of the substances are specified in the Environmental Protection (Prescribed Processes etc.) Regulation 1991. The EQSs may be set by the EU (under the Dangerous Substances Directive 76/464/EEC and Framework Directive 86/280/EEC) or nationally (DoE Circular 7/89, March 1989).

From early 1993, all authorised disposal of liquid industrial waste directly into the sea around the UK ceased, in accordance with the Ministerial Declarations of the 2nd and 3rd North Sea Conferences. Under the Urban Waste Water Treatment Directive (91/271/EEC), except in 'high natural dispersion areas', all significant sewage discharges 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 authorities, show that there will be no adverse effects on the environment.

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 of bathing waters is carried out by SEPA. Beaches are tested regularly to assess whether they have met the 'mandatory' or more stringent 'guideline' standards. Any measures required to improve the quality of the waters are a matter for the dischargers of industrial effluent and East of Scotland Water (in Region 4), in their role as sewerage authority. Under the terms of the Environmental Protection Act 1990, the quality (with respect to litter and facilities etc.) of bathing beaches is the responsibility of local authorities. Secondly, there is the European Blue Flag Award Scheme for beaches that meet the EU guideline standards of beach and water quality, as well as certain land-based criteria. Thirdly, there is the Tidy Britain Group Seaside Award Scheme, designed to complement the Blue Flag scheme, for beaches that meet the minimum standards of beach and water cleanliness and selected land-based criteria but not the Blue Flag standard. Finally there are the annual litter surveys of Coastwatch UK and Beachwatch, both of which employ volunteers to survey lengths of coastline for litter and other signs of pollution. Coastwatch UK is organised by Farnborough College of Technology and Beachwatch by Readers Digest and the Marine Conservation Society.

Radioactive wastes emanate from nuclear power stations and reprocessing facilities (e.g. Sellafield (Region 13) - the major contributor of radioactivity in British waters), though small amounts may also derive from hospitals and research establishments, discharging to rivers. Low levels of radioactive waste in the North Sea have been traced to discharges from Sellafield, which disperse up the west coast of Scotland and through the Pentland Firth.

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. MAFF (Directorate of Fisheries Research, Lowestoft, now Centre for Environment, Fisheries and Aquaculture Science (CEFAS)) publishes two annual Aquatic Environment Monitoring Reports (AEMR). One reports on radioactivity in the marine environment (e.g. MAFF 1994), the other on non-radioactive pollution and waste disposal operations at sea (e.g. MAFF 1995).

Monitoring of water quality in the region is carried out by SEPA and SOAEFD, with SEPA concerned mainly with point sources of contamination from outfalls in the nearshore environment. The interests of SOAEFD lie with the disposal of sewage sludge and dredge spoil further offshore, and their possible effects on fisheries, and they carry out a wide range of sampling work associated with this. SEPA and SOAEFD contribute to the National Marine Monitoring Plan, which monitors a wide range of listed chemicals in water, biota and sediments, at a range of frequencies which decreases from the estuarine to the offshore environment.

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 in a region, owing to a shortage of volunteers. The results may therefore sometimes be unrepresentative because of the small sample size.

Other information sources available include the RPB's

Annual Reports (to be replaced by SEPA reports) and the Scottish Office Water Quality Series reports (e.g. Scottish Office 1991). Further information on discharges can be obtained from the local offices of the SEPA, who issue discharge consents and authorisations.

9.6.5 Acknowledgements

Thanks are due to Tom Leatherland (SEPA) and the staff of SEPA East Region based in Perth, Edinburgh and Galashiels for outfall data, and to Mark Tasker (JNCC), Alan Burdekin (SOAFD) and Daniel Owen (RSPB) for comments on the draft text.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Pollution control & water quality information, sewage pipeline outfalls and waste regulation	*SEPA East Region HQ, Edinburgh, tel: 0131 449 7296
Beachwatch	*Marine Conservation Society, Ross-on-Wye, tel: 01989 566017
Coastwatch UK	Project Officer, Coastwatch UK, Farnborough College of Technology, Boundary Road, Farnborough, Hampshire GU14 6SB, tel: 01252 377503
Tidy Britain Group Seaside Awards	Lion House, 26 Muspole Street, Norwich NR3 1DJ, tel: 01603 762888
Aquatic environmental research and monitoring related to radioactivity in the aquatic environment, non-radioactive waste disposal at sea; consented outfalls database	*SOAEFD Fisheries Research Services, Marine Laboratory, Aberdeen, tel: 01224 876544

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

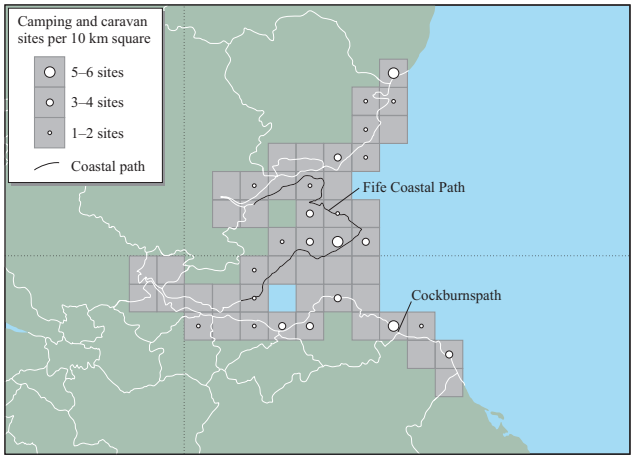
9.7 Leisure and tourism

S.J. Everett

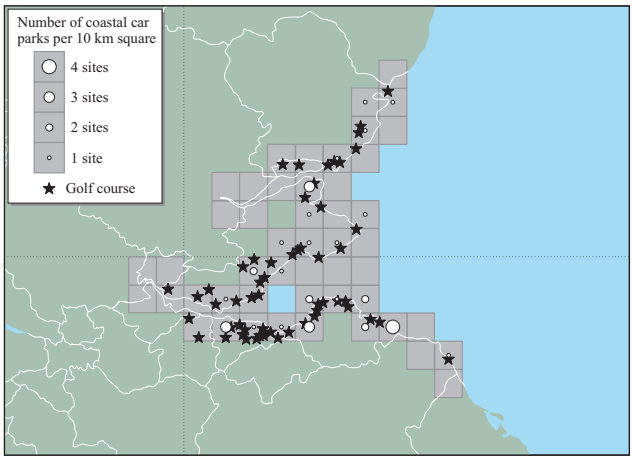
9.7.1 Introduction

This region is of national importance to the Scottish tourist industry by virtue of its location within the most populous region of Scotland, including its capital city, Edinburgh. Much of the open coastline is attractive and reasonably accessible, and there are many fine sandy beaches backed by sand dunes, although the area is not highly developed for beach-based tourism compared with other parts of the UK. A wide range of land-based leisure activities take place along the coast, including walking, camping, golf, beach recreation, bird watching, wildfowling, horse riding, angling and, increasingly, the use of motorised vehicles on beaches and dunes. The most important examples of land-based leisure infrastructure on the coast are caravan parks and campsites, rural car parks (which provide the access points necessary for most land and water-based leisure activities), leisure parks and golf courses. There are 63 caravan parks and campsites (Map 9.7.1) and 36 coastal car parks (Map 9.7.2) in coastal 10 km squares in the region (Ordnance Survey 1995; Ordnance Survey Landranger maps). Wildfowling is a traditional coastal activity in the region.

This region is of international significance for golf tourism, and there are 52 golf courses along the coast (Map 9.7.2). The use of the coast for leisure and sport has been the subject of a project undertaken by the Scottish Sports Council, which maintains a database of leisure and sporting activity around the Scottish coast. Map 9.7.3 shows the number of sports sites in the region within 10 km squares of the coast. The Council has identified the Firth of Forth and its environs as being the most intensively used area for coastal recreation in the region.



Map 9.7.1 Number of camping/caravan sites in coastal 10 km squares in the region. Sources: Ordnance Survey & Hamlyn (1995), Ordnance Survey Landranger maps. © Crown copyright.



Map 9.7.2 Coastal golf courses and numbers of public car parks in coastal 10 km squares in the region; coastal paths in the region. Sources: Ordnance Survey and Hamlyn (1995), Ordnance Survey Landranger maps. © Crown copyright.

9.7.2 Important locations

The main coastal towns that are popular for tourism include Montrose, Arbroath, Carnoustie, Dundee, St. Andrews, Crail, Anstruther, Leven, Kirkcaldy, Burntisland, Musselburgh/Longniddry, Dunbar, North Berwick and Eyemouth. There are notable concentrations of golf courses along the Angus coast, in the East Neuk of Fife and along the coast of East Lothian (Map 9.7.2). This part of the Scottish coast holds several championship golf courses, such as those at Carnoustie, Barry Links and St. Andrews. Dundee is promoted as a tourist destination and as a focus for the area's championship golf courses. Edinburgh, the capital city, is Scotland's prime tourist destination, but tourist activities are predominantly city- rather than coastal-based. However, a coastal camping/caravan site, a golf course and several coastal car parks are located at Cramond, to the west of the city. Seton Sands, to the east of Edinburgh, hosts several large caravan parks.

There is a major footpath in the region in the Scottish Borders, where the Southern Upland Way starts at Cockburnspath and crosses Scotland to Portpatrick in Galloway. There is no strategic footpath network in the region, although some local councils have developed coastal path initiatives. An initiative is underway in Fife, the Fife Coastal Footpath, to create a coastal walk from the Forth Road Bridge at North Queensferry to the Tay Bridge at Tayport. This is supported by Fife Enterprise and Fife Council, with support from the European Regional Development Fund. At present only 22 of the 78 miles of this footpath exist. Map 9.7.1 shows the locations of these coastal paths.

Nature conservation tourism is continuing to expand nationally, a trend which is reflected in this part of Scotland. Key locations include the Nature Reserve at Aberlady Bay, St. Abb's Head (also a popular area for scuba diving and snorkelling because of the excellent diving conditions) and the Forth Islands. Boat trips operate from Anstruther to the Isle of May and from North Berwick to Bass Rock and Fidra Island, for bird and seal watching as well as for the historic

interest of these locations. In 1995 the Isle of May received 5,000 visitors.

Table 9.7.1 lists the locations of land-based leisure infrastructure in the region.

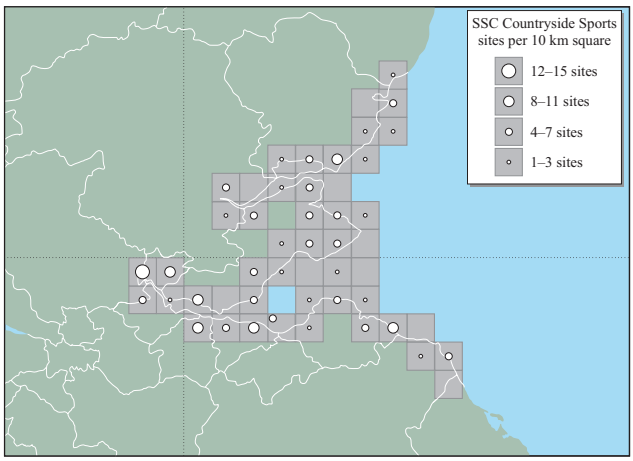
Although water-based recreation is not as highly developed in this region as in some others, there is still a great deal of activity. Table 9.7.2 lists the locations of water-based leisure and tourism facilities in the region (Map 9.7.4). Redevelopment of redundant waterfronts has been taking place throughout the UK, as traditional boat-building and repair industries have declined. In Dundee, the waterfront area has been developed for leisure, tourism and as a conference centre, and there has been some redevelopment at Leith Docks (mainly commercial).

The only significant marina in the region is located in the Firth of Forth at South Queensferry (Port Edgar), although Granton has a number of new pontoons in addition to a large number of moorings. There is a proposal to build a marina at Inverkeithing (Caledonia Partnership). Only limited use is made of the upper Forth Estuary, by a rowing club and local canoeists, and considerable stretches of the Forth coastline are relatively inaccessible. Most of the small harbours on the open coast have slipways and provide for casual recreational craft visiting the area, but on only a very

Table 9.7.1 Land-based leisure and tourism facilities and coastal wildlife sites that are publicised nationally

Site	*Grid ref.*	*Notes*
Montrose	NO7258	Camp sites; golf courses; tourist information centre; museum
Brechin	NO6060	Camping and caravan site; steam railway
Arbroath	NO6441	Camping and caravan site; golf courses; museum; tourist information centre
Lang Craig	NO7048	Viewpoint
Carnoustie	NO5635	Camping and caravan sites; golf courses (includes Barry Links); country park; tourist information centre; picnic site
Eden Estuary	NT4819	Local Nature Reserve; hides; visitor centre at Guardbridge
Isle of May	NT6599	National Nature Reserve; boat trips around the island and landing by permission; bird observatory with hostel accommodation in disused lighthouse
Kilminning Coast	NO6309	Scottish Wildlife Trust Reserve; access by footpath
Dundee (N)	NO3931	Golf courses; tourist information centre; museum; wildlife park; country park; picnic site
Carse of Gowrie	NO2628	Camping and caravan site
Newburgh	NO2318	Museum
Newport-on-Tay	NO4228	Caravan site; golf courses; picnic site (Tentsmuir Forest)
St. Andrews	NO5117	Camping and caravan sites; golf courses (St. Andrews); country park; tourist information centre; museums; aquarium
Balcomie	NO6310	Golf course
Crail	NO6108	Camping and caravan sites; tourist information; picnic site; museum
Kilrenny/Anstruther	NO5804	Camping and caravan sites; golf course; tourist information centre; picnic site
Largo Bay	NO4203	Camping and caravan sites; golf courses (includes Lundin Links)
Leven	NO3801	Caravan sites; golf course; tourist information centre
Dysart	NT3093	Museum
Kirkcaldy	NT2892	Camping and caravan sites; golf courses; tourist information centre; museum
Kinghorn	NT2787	Caravan site and golf course
Burntisland	NT2386	Camping and caravan site; golf courses; tourist information centre
Inverkeithing	NT1383	Golf courses; museums
North Queensferry	NT1380	'Deep Sea World' aquarium
Dunfermline	NT1087	Golf courses; abbey: museums; tourist information centre
Culross	NS9986	16th and 17th century village (National Trust)
Kincardine	NS8893	Golf course
Grangemouth	NS9381	Golf courses; museums
Bo'ness	NS9881	Bo'ness and Kinneil Railway
Linlithgow	NT0077	Camping and caravan site; golf courses; country park; palace
Queensferry	NT1378	Golf courses; picnic site; museum, Blackness Castle, Hopetoun House, House of Binns; Dalmeny House
Edinburgh	NT2674	Major tourist centre (capital city); Edinburgh Castle, Palace of Holyroodhouse, Scott Monument, great houses, various tourist attractions; Hillend (Europe's largest artificial ski slope); camping and caravan sites; golf courses
Musselburgh	NT3573	Camping and caravan sites; golf courses; tourist information centre; museum
Longniddry	NT4376	Camping and caravan sites; golf courses; includes large static holiday (caravan) parks at Seaton Sands, Gosford House
Aberlady Bay	NT4780	Local Nature Reserve and golf courses
North Berwick	NT5585	Camping and caravan sites; golf courses; tourist information centre, Dirleton and Tantallon Castles
Dunbar	NT6879	Camping and caravan sites; golf courses; John Muir Country Park; tourist information centre
Thorntonloch	NT7574	Camping and caravan sites; picnic site
Bass Rock	NT6087	Daily sailings from North Berwick around rock, landing by permission
Pease Bay	NT7971	Nature trail (Scottish Wildlife Trust); caravan site
St. Abb's Head	NT9169	Visitor centre and car park (Scottish Wildlife Trust and National Trust)
St. Abb's - Eyemouth	NT9267-NT9464	Camping and caravan sites; golf course; tourist information centre; Hoseasons Holiday Park (caravan site) at Old Forth Point

Source: Ordnance Survey and Hamlyn (1995)



Map 9.7.3 Numbers of Countryside Sports Database sites within coastal 10 km squares. Source: Scottish Sports Council.

Map 9.7.4 Locations for water-based leisure (Table 9.7.2). Sources: D'Oliveira & Featherstone (1994), Tourist Offices.

small scale. There are a number of RYA-affiliated yacht and boat clubs in this region, listed in Table 9.7.3 (Map 9.7.5).

Surfing and sailboarding occur around the open coast: St. Andrews, Elie, Gosford Bay and Gullane Bents are popular areas in the region. Waterskiing is known to take place on the Firth of Tay at Broughty Ferry and on the Firth of Forth at Aberdour, Blackness, Cramond, Portobello and Prestonpans. Sand-yachting is practised at West Sands, St. Andrews.

Wildfowling occurs in this region at Montrose Basin, several areas on the Tay, the Eden Estuary and in various places around the Firth of Forth, including Torry Bay, Aberlady Bay and the John Muir Country Park near Dunbar (Davidson *et al.* 1991). Active clubs recorded in the region included the Montrose District Wildfowling Club, the Eden Wildfowlers Association, the East Lothian Wildfowl Club, the Forth Valley Wildfowling Club and Dunbar Wildfowlers. Targeted species include greylag goose *Anser anser* and pink-footed goose *A. brachyrhynchus*, wigeon *Anas penelope*, teal *A. crecca*, mallard *A. platyrhynchus* and goldeneye *Bucephala clangula*.

9.7.3 Management and issues

Tourism planning and policy in the region are overseen by local councils and the Area Tourist Boards. The Scottish Tourist Board is the agency responsible for the marketing of tourism in Scotland, with Scottish Enterprise responsible for tourist development. The Scottish Sports Council is the national body responsible for the promotion of sport and physical recreation in Scotland, and Scottish Natural Heritage has a statutory duty to facilitate the enjoyment of the countryside and to promote recreation with regard to the conservation of Scotland's natural heritage.

National planning guidance (Scottish Office 1995) on sport and recreation has been drafted but does not apply to some forms of recreation, particularly those that occur below low water mark. Local authority policies and regional planning guidance recognise the need to conserve the natural qualities of the undeveloped coast whilst at the same time developing and managing the leisure and tourism industry. Local policies in Region 4 aim to support and develop the range of leisure facilities that are currently available, with particular emphasis on the golfing industry, redevelopment of redundant dockland sites, informal countryside recreation and the promotion of off-peak tourism. Effective planning policies are in place to protect important settlement boundaries in some key tourist areas, such as those of the small fishing villages of south-east Fife. A Tourist Management Plan for St. Andrews has been established, to develop long-term benefits from tourism for St. Andrews and the surrounding area.

Recreational use of the Firth of Forth is currently being investigated by the Tourism and Recreation Topic Group of the Forth Estuary Forum. The Group's report (Forth Estuary Forum 1996) lists a wide range of water-based and land-based activities in the area, from golfing to horse-riding, bird-watching, personal water-crafting, angling and sailing. The Forum has concluded that most recreation and tourism-related activities do not unduly conflict with other user interests in the area, although some of the popular tourist and recreational sites in the region are under pressure during the high season.

Golf provides a major focus for tourism and leisure in this region, and in some areas demand for golfing facilities is outstripping supply. For example, an 'unmet demand for golf ' has been identified within Dundee City and in the Carse of Gowrie (Tayside Regional Council 1994). The

Map 9.7.5 RYA affiliated yacht and boat clubs (excludes University Clubs and Cruising Clubs and Associations). Site numbers refer to Table 9.7.3. Source: Royal Yachting Association (1996).

Table 9.7.2 Water-based leisure and tourism infrastructure*

Site	*Grid ref.*	*Facilities*
Montrose	NO7157	Port; yacht berths adjacent to North Quay
Arbroath	NO6440	Yacht berths in North Dock; boatyard
Broughty Ferry	NO4630	Anchorage offshore
River Tay: W of Tay Road Bridge (north bank)	NO4029	Anchorage
Inchyra	NO1820	Anchorage
Newburgh	NO2318	Anchorage
Perth	NO1222	Anchorage and water ski club
Balmerino	NO3525	Anchorage offshore
Woodhaven	NO4026	Anchorage
West Newport	NO4127	Anchorage
Tayport	NO4529	Moorings; yacht berths in harbour (North Quay); boatyard
St. Andrews	NO5017	Yacht berths in harbour
Crail	NO6107	Anchorage in harbour
Anstruther	NO5603	Yacht berths in harbour
Isle of May	NT6599	Anchorage off Tarbet; landing at Kirk Haven
St. Monance	NO5201	Anchorage in harbour
Elie	NT4999	Anchorage in harbour
Largo	NT4002	Mooring facilities
Methil Docks	NO3799	Yacht berths in No. 2 Dock
Kinghorn	NT2686	Mooring facilities
Kirkcaldy	NT2891	Berthing permitted (East Pier in outer harbour)
Burntisland Docks	NO2385	Industrial docks
Inchcolm	NT1882	Landing at jetty east of Abbey
Aberdour	NT1985	Anchorage and temporary berths in harbour; Aberdour Boat Club
Dalgety Bay	NT1782	Mooring facilities
Limekilns	NT0882	Mooring facilities
Charlestown	NT0683	Mooring facilities in harbour
North Queensferry	NT1280	North Queensferry Yacht Marina (15+ berths); anchorage immediately east of Forth Railway Bridge
South Queensferry (Port Edgar)	NT1178	Port Edgar Marina (308+ moorings in harbour); boatyard and chandlery
South Queensferry Harbour	NT1378	Mooring facilities
Granton Docks, Edinburgh (Port of Leith)	NO2377	Yacht berths without facilities and numerous yacht moorings in East Harbour; Royal Forth Yacht Club; Forth Corinthian Yacht Club
Fisherrow	NT3373	Pleasure craft harbour; berthing on East Pier; Fisherrow Yacht Club
North Berwick	NT58	Anchorage in harbour; East Lothian Yacht Club
Cockenzie	NT3975	Mooring facilities
Dunbar	NT6779	Yacht berths; anchorage offshore at Castle Rocks
Eyemouth	NT9464	Anchorage in bay; yacht berths in harbour

Sources: D'Oliveira & Featherstone (1994), Forth Estuary Forum (1996). Key: *see also Table 8.3.3 (Ports and harbours).

Scottish Office has estimated a significant demand for new golf course facilities in the Forth Valley and new courses are likely to be proposed along the coast; however, the recent discussion paper *Scotland's coast* (SOAEFD 1996) states that 'scope for introducing new coastal courses is now fairly limited'.

Some of the land-based leisure developments in the region have had significant effects on coastal habitats. The establishment of golf courses on dunes has reduced the area of semi-natural vegetation at some sites in the region. Sand dune systems have also been affected by car parks and campsites, as well as by pressure from visitors. ASH Consulting Group (1994) has identified a number of locations where specific tourist activities and facilities have caused coastal erosion and where management to halt or reduce erosion has had to be undertaken. Some of the conflicts between nature conservation and golfing interests in key locations are being resolved through the establishment of a partnership approach between nature conservation bodies and golfing enterprises and as a result of new environmental management initiatives agreed by members of the national and European golfing organisations, including the European Golf Union. The Royal and Ancient Golf Club of St. Andrews has been a key organisation leading the debate on British golf course management, and Linlithgow Golf Club was a demonstration site under a recent Europe-wide initiative developing an environmental management programme for golf courses (European Golf Association Ecology Unit 1996).

Although water-based recreation has developed enormously over the last 25 years it is not highly developed in south-east Scotland. Although no very significant conflicts have yet been identified, such activities could be regulated by zoning schemes in the future (e.g. around the Forth islands) if problems do become apparent (Forth Estuary Forum 1996). Although disturbance to birds from recreational boating in the Firth of Forth is not a serious problem, since most yachting along the Forth is either racing or day sailing, the landing of craft on the Forth Islands has been identified as a concern and requires monitoring. However, landing safely on the islands requires skill and the relevant pilot clearly states the need to avoid nesting sites in the breeding season.

The representative body for sport shooting in the UK is

Table 9.7.3 Yacht and Boat Clubs in Region 4

Site no. on Map 9.7.5	*Name of Club*
1	Montrose Sailing Club
2	Royal Tay Yacht Club (Broughty Ferry)
3	Dundee Corinthian Boating Club
4	Dundee Sailing Club
5	Perth Sailing Club
6	Loch Tay Racing Club (Perth)
7	Newburgh Sailing Club
8	St. Andrews Sailing Club
9	Elie and Earlsferry Sailing Club
10	Largo Bay Sailing Club
11	Kinghorn Sailing Club
12	Burntisland Sailing Club
13	Aberdour Yacht Club
14	Dalgety Bay Sailing Club
15	Queensferry Boat Club
16	Upper Forth Boat Club (Bo'ness)
17	Blackness Yacht Club
18	Port Edgar Yacht Club (South Queensferry)
19	Cramond Boat Club
20	Royal Eastern Yacht Club (Cramond)
21	Forth Corinthian Yacht Club (Granton)
22	Royal Forth Yacht Club (Granton)
23	Fisherrow Yacht Club (Musselburgh)
24	Prestonpans Yachting and Boating Club
25	East Lothian Yacht Club (North Berwick)
26	Dunbar Sailing Club

Source: Royal Yachting Association (pers. comm.). Note: includes only RYA-affiliated clubs and does not include Universities or Cruising Clubs and Associations.

the British Association for Shooting and Conservation (the BASC). Targeted wildfowling species and shooting seasons are regulated through the Wildlife & Countryside Act 1981. Depending on the ownership of the land, the adminstrative regime varies considerably, with permit systems operating on most estuaries to limit the area involved, the numbers of wildfowlers and the months and times of day when wildfowling is allowed. 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). Further information on the history and operation of cold-weather shooting bans is given in Stroud (1992).

9.7.4 Information sources used

Sources of information used in this section are listed in section 9.7.6 A; many of them contain far more information than has been mentioned here. Other sources include tourist brochures and information derived from Ordnance Survey 1:50,000 Landranger maps, Ordnance Survey and Hamlyn (1995), a nautical almanac (D'Oliveira & Featherstone 1994) and Topic Group Papers from the Forth Estuary Forum (1996). It is not possible to gauge the scale of some facilities from the information that was available for this review. The maps and tables are therefore only indicative of the distribution of leisure and tourism in the region. The Royal Yachting Association provided information on the location of sailing clubs from their database.

9.7.5 Acknowledgements

Thanks are due to Vicki Eachus (University of Edinburgh) for supplying data from the Scottish Sports Council database and for comments on a draft of the text. Thanks also go to G. Russell (Institute of Ecology and Resource Management, University of Edinburgh), Kathy Duncan, Sandy MacLennan and Karen Passmore (SNH), Allan Brown and G. Moy (Fife Council), Alan Burdekin (SOAEFD), the Royal Yachting Association and Mark Tasker (JNCC).

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Tourist information service - GB	Commercial Information Library, British Tourist Authority, Thames Tower, Black's Road, Hammersmith, London W6 9EL, tel: 0181 846 9000 x 3011/3015
Tourist information service - Scotland	Scottish Tourist Board, 23 Ravelstone Terrace, Edinburgh EH4 3EU, tel: 0131 332 2433
Tourist Information Centres open all year	
(There are also seasonal offices at Montrose, Brechin, Carnoustie, Perth (Inveralmond), Crail, Anstruther, Forth Road Bridge, Stirling (Pirnhall), Kincardine Bridge, Bo'ness, Musselburgh and Eyemouth.)	Market Place, Arbroath DD11 1HR, tel: 01241 872609
	4 City Square, Dundee DD1 3BA, tel: 01382 434664
	45 High Street, Perth PH1 5TJ, tel: 01738 638353
	70 Market Street, St. Andrews KY16 9NU, tel: 01334 472021
	Rothes Square, Kingdom Centre, Glenrothes KY7 5NX, tel: 01592 754954
	The Beehive, Durie Street, Leven KY8 4HE, tel: 01333 429464
	19 Whytescauseway, Kirkcaldy KY1 1XF, tel: 01592 267775
	13/15 Maygate, Dunfermline KY12 7NE, tel: 01383 720999
	Mill Trail Visitor Centre, Alva FK12 5EN, tel: 01259 769696
	Dumbarton Road, Stirling FK8 2LQ, tel: 01786 475019
	2-4 Glebe Street, Falkirk FK1 1HX, tel: 01324 620244
	Burgh Halls, The Cross, Linlithgow EH49 7EJ, tel: 01506 844600
	Edinburgh and Scotland Information Centre, 3 Princes Street, Edinburgh EH2 2QP, tel: 0131 557 1700
	Tourist Information Desk, Edinburgh Airport EH12 9DN, tel: 0131 333 2167
	The Library, White Hart Street, Dalkeith EH22 1AE, tel: 0131 660 6818
	Quality Street, North Berwick EH39 4HJ, tel: 01620 892197
	A1 by East Linton, Pencraig EH41 3SB, tel: 01620 860063
	143 High Street, Dunbar EH42 1ES, tel: 01368 863353
Local tourism development, planning and promotion - Area Tourist Boards	Angus and City of Dundee Tourist Board, 4 City Square, Dundee DD1 3BA, tel: 01382 434281
	Perthshire Tourist Board, Lower City Mills, West Mill Street, Perth PH1 5QP, tel: 01738 627958
	Kingdom of Fife Tourist Board, 7 Hanover Court, North Street, Glenrothes KY7 5SB, tel: 01592 750066
	Edinburgh and Lothians Tourist Board, 4 Rothesay Terrace, Edinburgh EH3 7RY, tel: 0131 557 2727
	Scottish Borders Tourist Board, 70 High Street, Selkirk TD7 4DD, tel: 01750 20555
Sports facilities including GIS-based maps of sea and land-based sporting activities	Scottish Sports Council, Caledonia House, South Gyle, Edinburgh EH12 9DQ, tel: 0131 317 7200
Tourism and recreation in the Forth Estuary	*Forth Estuary Forum Project Officer, Scottish Natural Heritage, Perth, tel: 01738 444177

C. Contact names and addresses (continued)

Type of information	*Contact address and telephone no.*
Marine leisure industries; small craft industries	British Marine Industries Federation, Meadlake Place, Thorpe Lea Road, Egham, Surrey TW20 8HE, tel: 01784 473377
Wildfowl and wetlands	*Publicity Officer, Wildfowl & Wetlands Trust, Slimbridge, tel: 01453 890333
Wildfowling (general, including details of affiliated clubs)	Conservation & Training Officer, The British Association for Shooting and Conservation, Trochry, Dunkeld, Perthshire PH8 09Y, tel: 01350 723226
Wildfowling (general information on wildfowl, habitats and conservation)	*Enquiry Officer, RSPB HQ, Sandy, tel: 01767 680551
Wildfowling (the sport)	Press and Information Officer, British Field Sports Society, 59 Kennington Road, London SE1 7PZ, tel: 0171 928 4742
Severe weather wildfowling bans	*Licensing Officer, SNH, Advisory Services, Edinburgh, tel: 0131 554 9797
Leisure activities	
Camping	Secretary, The Camping and Caravanning Club (Scottish Region), 70 Douglas Road, Longniddry, East Lothian EH32 0LJ, tel: 01875 853292
Canoeing - Britain	British Canoe Union, Agbolgon Lane, Westbridgford, Nottingham NG2 5AS, tel: 0115 982 1100
Canoeing - Scotland	Administrator, Scottish Canoe Association, Caledonia House, South Gyle, Edinburgh EH12 9DQ, tel: 0131 317 7314
Field sports	Secretary, British Field Sports Society (Scottish Branch), Green Burns, Coupar, Angus PH13 9HA, tel: 01828 27015
Golf	Secretary, Scottish Golf Union, The Cottage, 181a Whitehouse Road, Edinburgh EH4 6BY, tel: 0131 339 7546
Horseriding	Secretary, The Trekking and Riding Society of Scotland, Boreland, Fearnan, Aberfeldy PH15 2PG, tel: 01887 830606
Jet skiing	UK Jet Ski Association, Goodwood Road, Boyatt Road Industrial Estate, Eastleigh, Hants. SO5 4NT, tel: 01703 601684
Sub Aqua	Scottish Sub Aqua Club, Cockburn Centre, 40 Bogmoor Place, Glasgow G51 4TQ, tel: 0141 425 1021
Surfing	Secretary, Scottish Surfing Federation, 20 Strichen Road, Fraserburgh AB43 5QZ, tel: 01346 513736
Water skiing	Scottish Water Ski Association, Development Officer, Scottish Water Ski Centre, Town Loch, Town Hill, Dunfermline KY12 0HT, tel: 01383 620123
Wind surfing - Scotland	Secretary, Scottish Windsurfing Association, c/o Royal Yachting Association, Scotland, Caledonia House, South Gyle, Edinburgh EH12 9DQ, tel: 0131 317 7388
Wind surfing - GB	British Windsurfing Association, 86, Sinah Lane, Hayling Island, Hants. PO11 9JX, tel: 01705 468182
Board sailing	UK Board Sailing Association, PO Box 28, Fareham, Hants PO14 3XD, tel: 01329 664779
Yacht harbours	The Yacht Harbour Association, Hardy House, Somerset Road, Ashford, Kent TN24 8EW, tel: 01303 814434
Yachting	Honorary Secretary, Royal Yachting Association, Scotland, Caledonia House, South Gyle, Edinburgh EH12 9DQ, tel: 0131 317 7388
Information on environmental affects of leisure activities	*SNH, Advisory Services, Edinburgh, tel: 0131 447 4784
Harbour Masters	*See Appendix A.2

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

Chapter 10 Coastal management

S.L. Fowler

10.1 Introduction

This chapter describes national (section 10.2) and local and regional (section 10.3) coastal management initiatives taking place wholly or partly within Region 4. GB and UK national initiatives without a specific regional focus, notably those led by non-governmental agencies and user groups, are outside the scope of this chapter. However, as the whole chapter concludes with a list of contacts with a wider involvement or interest in coastal management (section 10.3.6), contact points for some of these organisations are included there.

10.1.1 Coastal zone management in the UK

This section outlines the direction of UK 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 zone management ensures that all land and sea use issues are co-ordinated, including development, conservation, waste disposal, fisheries, transport, 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 zone management. However, approaches differ from area to area around the UK, 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 zone management, incorporating maritime land, sea and intertidal areas;
- a review of existing legislation;
- the need for international (EU-wide) policy initiatives;
- clearer responsibilities for planning and action in the coastal zone, based on a national strategic framework;
- appropriate funding for accountable bodies with responsibilities;
- research into the physical functioning of the coastal zone and associated protection and conservation measures;
- a review of planning mechanisms to allow effective safeguard of the coastal resource;
- monitoring and environmental assessment of coastal activities to assess their impacts;
- the involvement of local communities in coastal zone management planning;
- the integration of responsibility for coast protection and sea defence under one body;
- better statutory protection for sites of nature conservation importance;
- better provisions for control of marine pollution;
- the need for fisheries activities to take account of marine conservation issues.

Strategic planning guidelines for the Scottish coast were first set out in Scottish Development Department (1974), based on a series of maps published in Skinner (1974). These guidelines were updated by Scottish Development Department (1981) to cover most of the major developments for port, industrial and power generation purposes. More recently, the Scottish Office has commissioned a review of Scottish coastal issues (Burbridge & Burbridge 1994). This review urges the development of new coastal planning policies and guidelines to deal with the integration of coastal resource-based activities at the local and regional level. The report suggests that these should support planning authorities in dealing with planning applications and advise on the production of local and regional coastal management plans and strategies. It also suggests the promotion of a national strategy for the sustainable development and management of coastal land and water resources.

The Burbridge report of 1994 has since been followed up with the publication of a discussion paper *Scotland's coasts* (Scottish Office Agriculture, Environment and Fisheries Department 1996). This provides a summary of Scottish coastal issues and identifies a range of actions that should be taken or investigated for the purposes of achieving sustainable management of the coast and its resources. The government proposed the establishment of a Scottish Coastal Forum, similar to those that have already been established in England and Wales (Scottish Office Agriculture, Environment and Fisheries Department 1996). The Scottish Coastal Forum was announced in November 1996 and comprises representative bodies with a major interest or responsibility in coastal zone issues; it will provide a national context for coastal zone management planning.

In 1994, the UK Government published its Regulations to implement the EC Habitats & Species Directive (Department of the Environment 1994). In Scotland, the

EC Habitats & Species Directive is implemented in accordance with Scottish Office Environment Division Circular 6/90/95 (Scottish Office 1995). 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).

In 1995 the European Commission adopted the *Communication on integrated management of coastal zones* (COM/511/95), which sets out proposals for EU funding for demonstration programmes of coastal zone management. The strategy is to be based on the principles of sustainability and sound ecological and environmental practice, but will have no legal standing. In February 1996 the European Commission published a *Demonstration programme on integrated management of coastal zones* (European Commission Services 1996), intended as a spur to urgent co-operative action for Europe's coast.

In 1995 the Local Government Management Board (LGMB) issued 'Roundtable Guidance' on the implementation of Local Agenda 21 on the coast (LGMB 1995).

10.2 National coastal initiatives with regional elements

10.2.1 Introduction

Partly as a result of developments at a UK and international level, many national bodies, including several with no direct management role through a statutory remit or ownership of coastal land, are now becoming involved in the promotion of coastal management initiatives. These include non-governmental organisations with a particular interest in the conservation of the coastal zone, such as CoastNET (the Coastal Heritage Network), the Marine Conservation Society, World Wide Fund for Nature (UK) and the Royal Society for the Protection of Birds (see section 10.2.6). The National Trust for Scotland has recently been carrying out a complete review of its Coastal Strategy Plans and has an ongoing review of coastal site management plans. 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. Regionally-led coastal management initiatives are dealt with in section 10.3.

10.2.2 The Scottish Coastal Forum

The Scottish Coastal Forum, which was put forward in the discussion paper *Scotland's coasts* (Scottish Office 1996), was announced in November 1996. A wide range of organisations with interests in coastal matters will be invited to participate in the Scottish Coastal Forum, including representatives from the Association of Shellfish Growers, Confederation of British Industry Scotland, CoastNET, Convention of Scottish Local Authorities, Crown Estate, Highlands and Islands Enterprise, Scottish Enterprise, Scottish Environment Protection Agency, Scottish Fishermen's Federation, Scottish Natural Heritage, Scottish Salmon Growers' Association, Scottish Sports Council, Scottish Tourist Board, Scottish Wildlife and Countryside Link and the Scottish Office. The Forum will provide a focus for coastal issues as well as a national context for the work of local coastal forums, such as the Forth Estuary Forum.

10.2.3 Scottish Environment Protection Agency (SEPA)

The Scottish Environment Protection Agency (SEPA) was established under the Environment Act 1995. It carries out the functions of the former River Purification Boards with respect to water resources, water pollution, enforcement of legislation in relation to releases of substances into the environment and flood warning systems. It has also been assigned the waste regulation and disposal functions formerly the responsibility of the local authorities and other functions with respect to pollution control, and must be consulted over land drainage proposals to controlled waters. It does not, however, have responsibilities for flood and coastal defence, unlike the Environment Agency (England and Wales). This remains with the local authorities in Scotland. Unlike England and Wales, there is no system of river catchment management planning operational in Scotland (Macaulay Land Use Research Institute 1995), although there is widespread support from conservation bodies that this approach should be pursued.

10.2.4 Scottish Natural Heritage

Focus on Firths

The major national coastal management initiative currently under way in Scotland is 'Focus on Firths', instigated by Scottish Natural Heritage (SNH). It aims to promote the protection and better management of the natural resources of the major Scottish estuaries and firths by stimulating

understanding and voluntary co-operation among the various users and statutory authorities. A local management forum will be set up for each site, made up of statutory, industrial, voluntary agencies' and community representatives as appropriate, to develop proposals for its sustainable management. In Scotland there are currently five coastal zone management initiatives, three of which, covering the Solway Firth, the Firth of Forth and the Moray Firth, are included in the Focus on Firths Initiative; the other two, for the Cromarty Firth and the Firth of Clyde, are partly funded by SNH under that initiative. A proposal for a Tay project is under development.

10.2.5 CoastNET: the Coastal Heritage Network

CoastNET was established in 1995 to link individuals and organisations working for the sustainable management of the coastal and marine environment, building on the achievements of its predecessor, the Heritage Coast Forum. CoastNET aims to provide a network for coastal managers and field staff on the UK coast, to improve the ways in which the coastal heritage of the UK is managed, and to ensure that the practical experience of coastal managers and field staff contributes to the formulation of policy for the coastal zone. CoastNET is a membership body open to all those with an interest in the practical management of the UK coastline. It recently (November 1996) held a national workshop for coastal managers in Scotland (CoastNET 1997).

10.2.6 Royal Society for the Protection of Birds

In 1990, the Royal Society for the Protection of Birds (RSPB) launched a national campaign to promote the importance of estuaries in the UK and the need for coordinated management (Rothwell & Housden 1990). The campaign ran for three years. The RSPB Estuaries Inventory project compiled mapped and numerical information on land use and selected human activities for 57 major UK estuaries, including in this region the Firth of Forth. 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).

10.2.7 Designated sites

Site designations are discussed in detail in Chapter 7. However, several statutory and non-statutory designations are also relevant here because they provide a degree of coastal zone 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 in this region include nature reserves, which are managed for nature conservation objectives by Scottish Natural Heritage, the Scottish Wildlife Trust, the National Trust for Scotland, local authorities, the RSPB and other bodies. The Natural Heritage (Scotland) Act 1991 makes provision for the designation of Natural Heritage Areas (NHAs), which will cover extensive areas of land within which nature conservation, landscapes and cultural interests will be managed under a single integrated management plan to be approved by the Secretary of State. No NHAs have been designated yet. Of particular interest because of their specific requirement for wide consultation are Marine Special Areas of Conservation (SACs) and Marine Consultation Areas (see also sections 7.2.3 and 7.4.3).

Special Areas of Conservation (SACs)

Under the EC Habitats & Species Directive 1992, a list of 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). A list of possible sites on which consultations will be carried out was published in March 1995. Marine SACs may include intertidal areas, subtidal areas and/or lagoonal areas; terrestrial SACs may include important coastal maritime habitats such as lagoons, saltmarshes or sand dunes. Under Scottish Office Environment Division Circular 6/90/95 (Scottish Office 1995), marine and terrestrial SACs will have to be managed in a way that secures their 'favourable conservation status'. A range of bodies and individuals will be involved, including all 'relevant and competent authorities', e.g. local authorities, the Scottish Environment Protection Agency (SEPA), ports and harbour authorities, Sea Fisheries Committees, Scottish Natural Heritage and Scottish Office Agriculture Environment and Fisheries Department, as well as owners and occupiers of foreshore land and representatives of those who rely on marine areas for their livelihood or for recreation. Management will be coordinated through an agreed management scheme, backed by existing statutory measures. The Department of the Environment has drafted guidance (DoE/WO 1996) on the preparation and application of management schemes for SACs. 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 (Laffoley in prep.).

Marine Consultation Areas

This non-statutory designation is used by Scottish Natural Heritage to indicate important marine sites and stimulate consultation over developments there (NCC 1990). There is one Marine Consultation Area in the region, extending along the coast around St. Abb's Head.

10.3 Regional coastal management groups and initiatives

10.3.1 Introduction

The Government has stated its support for the encouragement of more local coastal fora along the lines of the Focus of Firths Initiatives (The Scottish Office 1996). There is currently only one such project in south-east Scotland, the Forth Estuary Forum. Table 10.3.1 lists the coastal management initiatives in the region.

Forth Estuary Forum

The Forth Estuary Forum was established in 1993 by a large number of public and private sector organisations with a direct interest in promoting the wise and sustainable use of the Firth of Forth. Over 200 organisations are represented on the Forum, including local authorities, industry, recreation and conservation bodies. Activities are currently directed by a Management Group representing the founder organisations, with the administrative and financial support currently provided by Scottish Natural Heritage under its 'Focus on Firths' initiative.

Ten topic groups have been established within the Forum to address specific issues: Nature Conservation, Coastal Defence, Marine and Coastal Pollution, Economic Development, Tourism and Recreation, Built and Archaeological Heritage, Fisheries, Landscape and Amenity, Information and Research, and Awareness and Education. Each group is charged with researching and producing topic papers for their area, to be combined to create a Forth Estuary Management Strategy by 1998. Each paper will provide, in concise and usable form, information on issues and opportunities in the Forth, identifying relevant development constraints and suggesting appropriate policy options and priorities.

The Forum is beginning to initiate the implementation of some of the management recommendations that the various groups are proposing in their reports, and over the next few years many initiatives and projects are hoped to be developed as a direct result. Already considerable work has been undertaken to raise awareness and understanding around the Forth, with projects ranging from workshops with local communities, marine litter campaigns, and the use of educational tools such as the Internet.

10.3.2 Coastal (engineering) groups

There are no formal coastal (engineering) groups in Scotland. HR Wallingford have recently carried out a study on coastal process cells in Scotland (HR Wallingford 1995), co-sponsored by Scottish Natural Heritage, the Scottish Office Environment Department and Historic Scotland. This study aims to set out for the first time a framework for management of coastal areas in Scotland and could be used to set up new coastal management initiatives, such as the coastal (engineering) groups established in England and Wales. HR Wallingford are also producing a series of eleven regional reports, summarising coastal processes for each of the coastal cells in Scotland. Coastal engineering groups are often coordinated by local authorities to integrate coastal defence work and exchange technical information about coastal defence. It is anticipated that new coastal groups will be established by the new unitary authorities on the basis of the coastal cell work carried out by HR Wallingford (1995).

Table 10.3.1 Regional coastal management initiatives

Initiative name	*Scope/aims*	*Organisations involved*	*Contact details*
Forth Estuary Forum	Promotes integrated management of the natural resources of the Forth Estuary	Membership includes over 200 bodies, such as statutory, industrial, voluntary groups and community representatives	*Project Manager, Forth Estuary Life Project, City of Edinburgh Council, tel: 0131 200 2000
Coastal engineering groups	Liaises over the construction and repair of coastal works and exchanges technical information	Unitary authorities and other organisations such as Scottish Natural Heritage, Ministry of Defence and port/harbour authorities	*W. Wallace, Angus Council, Forfar, tel: 01307 461460 *G. Moy, Fife Council, Glenrothes, tel: 01592 414141
Fife Coast Watch	Encourages local groups in Fife to adopt their local coastline and carry out litter surveys	Fife Council and local Community Councils	*Alan Brown, Fife Council, Glenrothes, tel: 01592 416498
St. Abb's Head Voluntary Marine Reserve	Aims to conserve the outstanding biological richness of its coastal waters and to encourage educational and responsible recreational use alongside a traditional fishery, to the mutual benefit of all	Scottish Nuclear, Scottish Natural Heritage and Scottish Wildlife Trust	Fiona Croach, St. Abb's Head Voluntary Marine Reserve Warden, Wellridge, The Boga, Coldingham, Berwickshire PD14 5ND, tel: 018907 71273
Berwickshire Marine Consultation Area	Identification indicating importance of site and highlighting need for consultation over developments	Scottish Natural Heritage (see also organisations involved with St. Abb s Head VMR above)	*Scottish Natural Heritage, National Strategy, Edinburgh, tel: 0131 447 4784

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

10.3.3 Shoreline Management Plans

Scottish Natural Heritage is encouraging the creation of Shoreline Management Plans (SMPs), which 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 1994). In Scotland, where relative sea level is static or falling, such SMPs are generally only appropriate on the eastern shores, where there are extensive tracts of low-lying coastal land. Two such projects are underway in the region: Fife Council is formulating a shoreline management plan within their administrative boundaries and the Coastal Defence Topic Group of the Forth Estuary Forum will be publishing their Topic Group Paper in 1997.

10.3.4 Unitary authorities and port/harbour authorities

The maritime local planning authorities are key organisations in coastal zone management initiatives. Local planning authorities in the region have published regional and district-wide local plans, which provide the statutory planning framework for development control purposes. In many cases these plans are supplemented by regular reviews, monitoring documents and survey reports covering a variety of topics. Note that local government in Scotland was reorganised in 1996, and most of the documents were produced by the former regional councils and second-tier authorities. Port and Harbour Authorities have a statutory remit to control activities within their areas of authority, which may include coastal waters. They receive wider powers to manage Special Areas of Conservation under the EC Habitats & Species Directive.

Fife has several local coastal initiatives, including the Fife Coastal Path (see section 9.7.2), the East Neuk Maritime Heritage Project, which is based upon the fishing villages of south-east Fife, and the Fife Coast Watch, which is an initiative to encourage local groups to adopt their local coastline and carry out litter surveys.

10.3.5 Acknowledgements

Thanks are due to L. Scholfield (Perth and Kinross), Mark Tasker (JNCC), Tom Leatherland (SEPA), Steve Atkins (SNH) and Alan Burdekin (SOAFD) for their helpful comments on the drafts.

10.3.6 Further sources of information

A. References cited

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Earll, R.C., *ed.* 1994. *Statutory and non-statutory plans in the estuarine and coastal environment. Overlapping plans - is this an issue?* Kempley, Gloucestershire, Marine Environmental Management and Training. (Unpublished report of a meeting held in July 1994.)

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Gubbay, S. 1990. *A future for the coast? Proposals for a UK coastal zone management plan.* Ross-on Wye, World Wide Fund For Nature. (Unpublished report by the Marine Conservation Society.)

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B. Further reading

Included in the following list of references are items relating to England and Wales that may be of interest to individuals and organisations involved in coastal management in Scotland.

Bown, D. 1988. *Coastal development: a planner's view.* Paper presented to the Council for the Protection of Rural Wales (CPRW) Annual Study Conference (unpublished).

Coastal Heritage Forum. 1995. *Heritage Coasts: a guide for councillors and officers.* Manchester, Coastal Heritage Forum.

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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 10.3.6C.

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.

Forth Estuary Forum. Quarterly newsletter on matters concerned with the Forth Estuary Forum. Published by the Forth Estuary Forum, Battleby, Perth.

Marine Scene. Occasional marine newsletter of the statutory conservation agencies in UK. Aimed at marine scientists, and users and regulators of the sea. Published by JNCC.

Marine Update. A briefing to highlight World Wide Fund For Nature's work in marine conservation. Published by WWF.

Wavelength. The (English) Coastal Forum newsletter. Reports the work of the Forum to a wider audience. Published by the Department of the Environment.

National planning/management publications

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.)

Local Government Management Board. 1995. *Local Agenda 21: roundtable guidance. Action on the coast*. Luton, Local Government Management Board.

Scottish Office. 1995. *Nature conservation: implementation in Scotland of the EC Directives on the conservation of natural habitats and of wild flora and fauna, and the conservation of wild birds: the conservation (natural habitats, etc.) regulations 1994.* Edinburgh, Scottish Office Environment Division, Rural Affairs Department. (Circular 6/90/95.)

Scottish Office. 1995. *Scottish Office National Planning Policy Guidelines - planning and flooding.* Edinburgh, Scottish Office. (NPPG7.)

C. Contact names and addresses

(See also Table 10.3.1.)

Organisation/group	Activities	Contact address and telephone no.
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. Augustines, Lower Chatham Street, Manchester M15 6BY, tel: 0161 247 1067
Coastal Technical Officers Group	The coastal group of the statutory conservation agencies (English Nature, Scottish Natural Heritage, Countryside Council for Wales, Department of the Environment for Northern Ireland, Joint Nature Conservation Committee and the Countryside Commission)	Coastal Technical Officers Group: Maritime Team, English Nature, Northminster House, Peterborough PE1 1UA, tel: 01733 455000
Eurocoast UK	The Eurocoast Association aims to improve the basis for protection, development and management of the coastal zone. Primarily a communication network.	Eurocoast UK Secretariat, Dept of Maritime Studies & International Transport, UWCC, PO Box 907, Cardiff CF1 3YP, tel 01222 874271
European Union for Coastal Conservation (EUCC)	International grouping of organisations and individuals with an interest in coastal nature conservation matters, including coastal management	European Union for Coastal Conservation (EUCC) Secretariat, P.O. Box 11059, NL-2301 EB Leiden, tel: +31 71 122900/123952
European Union for Coastal Conservation-United Kingdom (EUCC-UK)	UK membership network affiliated to EUCC, providing focus for information exchange about European-level coastal conservation issues	EUCC, c/o 5 Green Lane, Brampton, Huntingdon, Cambridgeshire PE18 8RE, tel: 01480 457624
Joint Nature Conservation Committee - Geology/Coastal Advisor	Advice and information on coastal conservation in Great Britain as a whole and internationally	*JNCC, Peterborough, tel: 01733 62626
Joint Nature Conservation Committee - Marine Advisor	Advice and information on marine nature conservation in Great Britain as a whole and internationally	*JNCC, Peterborough, tel: 01733 62626
JNCC Marine Nature Conservation Review	Project to extend knowledge of benthic marine habitats, communities and species in Great Britain and identify sites and species of nature conservation importance; producing a series of 15 reports *(Coasts and seas of the United Kingdom. MNCR series)* on a coastal sector basis, as well as more detailed area summaries.	*JNCC, Peterborough, tel: 01733 62626
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, Swansea Institute of Higher Education, Faculty of Leisure and Tourism, Mount Pleasant Campus, Swansea SA1 6ED, tel: 01792 456326
Marine Conservation Society	Provides advice and supports local coastal management initiatives: runs grant-aided coastal management workshops and courses for coastal managers; promotes the establishment of voluntary coastal groups.	*Marine Conservation Society, Ross-on-Wye, tel: 01989 566017

C. Contact names and addresses (continued)

(See also Table10.3.1.)

Organisation/group	Activities	Contact address and telephone no.
Marine Forum	National network provides forum for discussion of marine issues relating to the seas around UK. Members include governmental and non-governmental organisations and individuals. Occasional seminars are held, covering a range of topics including coastal management.	*Honorary Secretary, Marine Forum for Environmental Issues, Scarborough, tel: 01723 362392
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.	Alan Inder, Secretary, National Coasts and Estuaries Advisory Group (NCEAG). Hampshire County Council, The Castle, Winchester SO23 8UJ, tel: 01962 846749
National Trust for Scotland	Has coastal land holdings in the region (see section 7.5.1) and plans to extend its Enterprise Neptune project to Scotland (purchase and management of coastal land for nature conservation, landscape and public enjoyment).	*Edinburgh, tel: 0131 226 5922
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.	*D. Huggett, Coastal Policy Officer, RSPB HQ, Sandy, tel: 01767 680551, and *Scottish HQ, RSPB, Edinburgh, tel: 0131 557 3136
Scottish Coastal Forum	Launched 1996 to provide a national context for coastal issues. Chaired by the Chairman, North West Region, Scottish Natural Heritage.	*M. Wright, The Secretariat, Scottish Coastal Forum, SOAEFD, Pentland House, Edinburgh, tel: 0131 244 6038
Scottish Environment Protection Agency (SEPA)	Carries out the function of the former river purification authorities with respect to water resources, water pollution, enforcement of legislation in relation to releases of substances into the environment and flood warning systems. Also carries out the functions of the former waste regulation and disposal authorities, and other functions with respect to pollution control, and must be consulted over land drainage proposals to controlled waters.	*Scottish Environment Protection Agency (SEPA), East Region HQ, Edinburgh, tel: 0131 449 7296
Scottish Office Development Department	Coastal policy and planning. Preparation of Rural White Paper.	*Dr C. Murphy, Room 6/61, Scottish Office Development Department, New St. Andrew's House, Edinburgh, tel: 0131 244 4807
Scottish Office Agriculture, Environment and Fisheries Department	Departmental responsibility for flood defence and coast protection. May establish group to co-ordinate the work of local authorities.	*A.S. Burdekin, SOAEFD European Environment and Engineering Unit, Victoria Quay, Edinburgh, tel: 0131 556 8400
Scottish Natural Heritage	Focus on Firths, Marine Consultation Areas, coastal cells in Scotland	*Focus on Firths Project Manager, SNH (Advisory Services), Edinburgh, tel: 0131 447 4784
World Wide Fund for Nature (UK)	Provides funding for research and publications on marine conservation and coastal management.	*Panda House, Godalming, tel: 01483 426444

Addresses and telephone numbers of local planning authorities are given in full in the Appendix, as are *starred contact addresses.

Appendix

A.1 Frequently cited contact names and addresses

Name	*Contact address and telephone no.*
Statutory bodies	
British Oceanographic Data Centre - NERC (BODC), Proudman Oceanographic Laboratory	Bidston Observatory, Birkenhead, Merseyside L43 7RA, tel: 0151 653 8633
Department of the Environment (DoE), European Wildlife Division/ Dept. of Rural Affairs	DoE, Room 9/03B, Tollgate House, Houlton Street, Bristol BS2 9DJ, tel: 0117 987 8000
Fife Enterprise	Kingdom House, Saltire Centre, Glenrothes, Fife KY6 2AQ, tel: 01592 623000
Institute of Terrestrial Ecology (ITE), Monks Wood	Abbots Ripton, Huntingdon, Cambs. PE17 2LS, tel: 01487 773381
ITE, Merlewood	Institute of Terrestrial Ecology, Windermere Road, Grange-over-Sands, Cumbria LA11 6JU, tel: 01539 532264
Joint Nature Conservation Committee (JNCC), Headquarters	Monkstone House, City Road, Peterborough, Cambs. PE1 1JY, tel: 01733 62626
JNCC, Seabirds and Cetaceans Team	Seabirds and Cetaceans Team, Joint Nature Conservation Committee, 11 Dunnet House, 7 Thistle Place, Aberdeen AB10 1UZ, tel: 01224 655702
Scottish Environment Protection Agency (SEPA), Head Office	Erskine Court, The Castle Business Park, Stirling FK9 4TR, tel: 01786 457700
SEPA East Region HQ	Clearwater House, Heriot-Watt Research Park, Avenue North, Riccarton, Edinburgh EH14 4AP, tel: 0131 449 7296
Scottish Natural Heritage (SNH), National Strategy	12 Hope Terrace, Edinburgh EH9 2AS, tel: 0131 447 4784
SNH, Advisory Services	Bonnington Bond, 2 Anderson Place, Edinburgh EH6 5NP, tel: 0131 554 9797
SNH, Perth Area Office (Angus, Dundee, Perth & Kinross)	55 York Place, Perth PH2 8EH, tel: 01738 639746
SNH, Stirling Area Office (Fife, Clackmannanshire, Stirling, Falkirk)	The Beta Centre, Innovation Park, University of Stirling, Stirling FK9 4NF, tel: 01786 450362
SNH, Galashiels Area Office (West Lothian, Edinburgh, Midlothian, East Lothian, Scottish Borders)	Andersons Chambers, Market Street, Galashiels TD1 3AF, tel: 01896 756652

Name	*Contact address and telephone no.*
Statutory bodies (continued)	
Scottish Office Development Department	Victoria Quay, Edinburgh EH6 6QQ, tel: 0131 556 8400
Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD)	Pentland House, 47 Robb's Loan, Edinburgh EH14 1TY, tel: 0131 556 8400
SOAEFD European Environment and Engineering Unit	Victoria Quay, Edinburgh EH6 6QQ, tel: 0131 556 8400
SOAEFD Marine Laboratory	Fisheries Research Services, PO Box 101, Victoria Road, Aberdeen AB11 9DB, tel: 01224 876544
Wildlife Trusts	
Scottish Wildlife Trust HQ	Cramond House, Kirk Cramond, Cramond Glebe Road, Edinburgh EH4 6NS, tel: 0131 312 7765
National voluntary bodies	
The British Trust for Ornithology	The Nunnery, Thetford, Norfolk IP24 2PU, tel: 01842 750050
Marine Conservation Society	9 Gloucester Road, Ross-on-Wye, Herefordshire HR9 5BU, tel: 01989 566017
The National Trust for Scotland	5 Charlotte Square, Edinburgh EH2 4DU, tel: 0131 226 5922
Royal Society for the Protection of Birds (RSPB) HQ	The Lodge, Sandy, Bedfordshire SG19 2DL, tel: 01767 680551
RSPB, Scottish HQ	17 Regent Terrace, Edinburgh EH7 5BN, tel: 0131 557 3136
RSPB, East Scotland Office	10 Albyn Terrace, Aberdeen AB1 1YP, tel: 01224 624824
RSPB, South and West Scotland Office	Unit 31, West of Scotland Science Park, Kelvin Campus, Glasgow G20 0ST, tel: 0141 945 5224
The Wildfowl & Wetlands Trust (WWT), HQ	Slimbridge, Gloucestershire GL2 7BT, tel: 01453 890333
Worldwide Fund For Nature - UK (WWF-UK)	Panda House, Weyside Park, Cattershall Lane, Godalming, Surrey GU7 1XR, tel: 01483 426444
WWF Scotland	1 Crieff Road, Aberfeldy, Perthshire PH15 2BJ, tel: 01887 820449
Others	
British Geological Survey	Keyworth, Nottingham NG12 5GG, tel: 0115 936 3100

Name	*Contact address and telephone no.*
Others (continued)	
Forth Estuary Forum	*The Project Manager, Forth Estuary Life Project, The City of Edinburgh Council, 1 Cockburn Street, Edinburgh EH1 1BL, tel: 0131 200 2000

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Others (continued)	
Marine Forum for Environmental Issues	c/o University College of Scarborough, Filey Road, Scarborough, Yorkshire YO11 3AZ, tel: 01723 362392

A.2 Local planning authorities; port and harbour authorities

Name	*Contact address and telephone no.*
Angus Council	Council Headquarters, The Cross, Forfar DD8 1BX, tel: 01307 461460
Dundee City Council	21 City Square, Dundee DD1 3BY, tel: 01382 434000
Perth and Kinross Council	PO Box 77, 1 High Street, Perth PH1 5PH, tel: 01738 475000
Fife Council	Fife House, North Street, Glenrothes KY7 5LT, tel: 01592 414141
Clackmannanshire Council	Greenfield, Alloa FK10 2AD, tel: 01259 450000
Stirling Council	Viewforth, Stirling FK8 2ET, tel: 01786 443322
Falkirk Council	Municipal Buildings, Falkirk FK1 5RS, tel: 01324 506070
West Lothian Council	West Lothian House, Almondvale, Livingston EH54 6QG, tel: 01506 777000
Midlothian Council	Midlothian House, Buccleuch Street, Dalkeith EH22 1DJ, tel: 0131 663 2881

Name	*Contact address and telephone no.*
East Lothian Council	Council Buildings, Haddington, East Lothian EH41 3HA, tel: 01620 827827
City of Edinburgh Council	City Chambers, High Street, Edinburgh EH1 1YG, tel: 0131 200 2000
Scottish Borders Council	Council Headquarters, Newtown St. Boswells, Melrose TD6 0SA, tel: 01835 824000
Ports	
Montrose Port Authority	South Quay, Ferryden, Montrose, Angus DD10 9SL, tel: 01674 72302
Dundee Port Authority	Harbour Chambers, Dock Street, Dundee DD1 3HW, tel: 01382 224121
Perth Harbour	Lower Harbour, Fairton Road, Perth PH2 8BH, tel: 01738 24056
Forth Ports plc (Forth Ports Authority)	Tower Place, Leith, Edinburgh EH6 7DB, tel: 0131 554 6473

A.3 Core reading list

There are a number of publications that either provide information on a variety of topics covered in these regional reports (and so are frequently referred to) or give a good overview of regional and national information on coasts and seas. They are listed below.

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

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Forth Estuary Forum. 1996. *Coastal and Marine Pollution Topic Group Paper*. Perth, Forth Estuary Forum.

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Lee, A.J., & Ramster, J.W. 1981. *Atlas of the seas around the British Isles.* Lowestoft, MAFF.

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Steers, J.A. 1964. *The coastline of Scotland*. Cambridge, Cambridge University Press.

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