JOINT NATURE CONSERVATION COMMITTEE

Coasts and seas of the United Kingdom

Region 3 North-east Scotland: Cape Wrath to St. Cyrus

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

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

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Contents

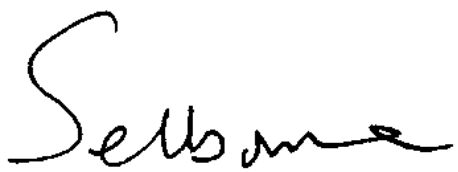
Foreword

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

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

In addition to the value of the information itself, the way the project has been run and the data collected has made an important contribution to the quality of the product. A wide range of individuals and organisations concerned with the conservation and use of the coastal margin have collaborated in collating the information, their variety reflecting the extent of the interplay between the coastal environment and human activities. These organisations included the Ministry of Agriculture, Fisheries and Food, the Scottish Office, the National Rivers Authority, the Countryside Commission, the Welsh Office, the Department of the Environment, the Department of the Environment (Northern Ireland), 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 the region and sets the region in a national context.
- **Important locations and species**: gives more detail on the region's features in relation to the topic.
- **Human activities**: describes management and other activities that can have an effect on the resource in the region.
- **Information sources used**: describes the sources of information, including surveys, on which the section is based, and notes any limitations on their use or interpretation.
- **Acknowledgements**
- **Further sources of information**: lists references cited, recommended further reading, and names, addresses and telephone numbers of contacts able to give more detailed information.

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

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

Definitions and contexts

The word 'region' (as in 'Region 3') is used throughout this book to refer to the coastal and nearshore zone, broadly defined, between the two points given in the title of this book. The area covered varies between chapter sections, depending on the form in which data is available. Coverage is usually either coastal 10 km squares, sites within one kilometre of Mean High Water Mark, or an offshore area that may extend out to the median line between the UK and neighbouring states. Inland areas of the districts concerned are not included unless specifically stated.

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

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

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

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

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

Acknowledgements

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

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

Notes

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

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

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

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

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

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

Chapter 1 Overview

1.1 The Coastal Directories Project

Dr J.P. Doody

1.1.1 Introduction

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

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

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

The relationships between the many and varied components of the coastal zone, that is, between the physical functioning of the zone, its biological components and the human activities that take place there, are complex. With this in mind, a wide-ranging approach to collating coastal information has been adopted in the project; information has been drawn from many sources, from national databases and nation-wide published surveys to the personal observations of field specialists and the newsletters of amateur societies. The approach has also served to highlight the interactions and interdependence between the environmental components (and between the various bodies and individuals) involved. This should help to ensure that users of the information develop policies and adopt strategies that secure the integrated, sustainable use and management of the coastal zone while maintaining biological diversity - a key element of Agenda 21 of the Rio Earth Summit in 1992.

1.1.2 Origins and early development of the project

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

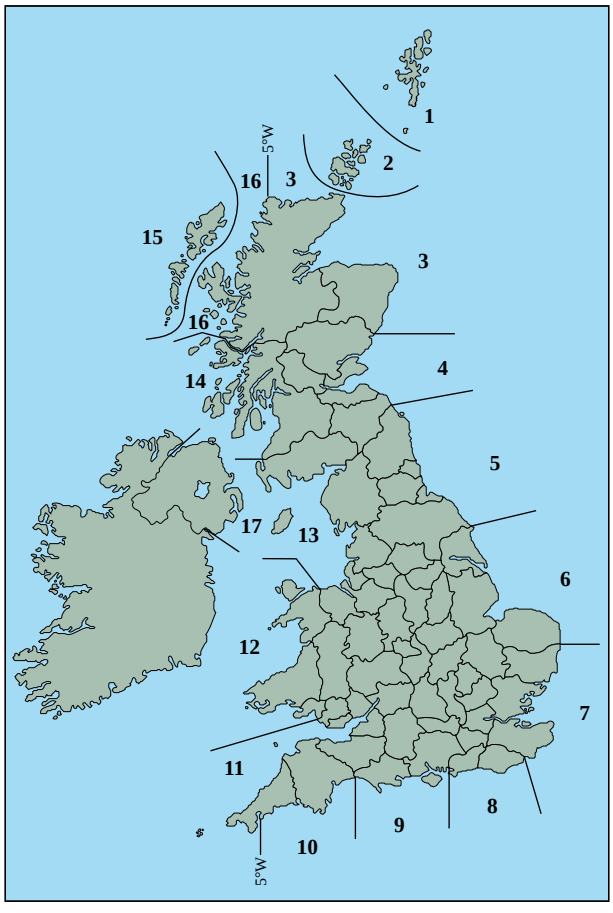
At the second meeting of the NSTF, in 1989, the UK suggested that the North Sea QSR should include consideration of terrestrial habitats and species. This was to involve the collection of information dealing with the coastal margin of the North Sea (defined as being east of longitude 5° West - i.e. from 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), 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 and published their report on *Coastal zone protection and planning* in March 1992 (House of Commons Environment Committee 1992). This report, together with initiatives at UK and European levels, encouraged a more integrated, local approach to management issues. At the same time, as the work on the *Directory of the North Sea coastal margin* proceeded, the emphasis of the approach changed. The main aim had been the collection of information, but gradually the process of working with people to gather the data threw the spotlight more on the benefits of a partnership approach and its value for promoting coastal zone management, with which the Coastal Directories Project became more directly linked.



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 of the coastline. Regions were defined, wherever possible, by the current local or national government coastal boundaries that most closely approximated to the limits of major coastal process cells (see section 2.4), to ensure that pragmatic management requirements were matched by an ecologically coherent information base. Volumes covering seventeen regions have been or are now being prepared: the areas that they cover are shown in Map 1.1.1. Regions 1 - 10 cover the area of the *Directory of the North Sea coastal margin*; Regions 11 - 17 deal with the west coast of the United Kingdom and the Isle of Man. These regional volumes provide a more detailed level of information than the *Directory of the North Sea coastal margin*, to help set each region in a national context and facilitate the preparation of regional plans. Discussions in the main steering group (see below) have resulted in a decision to complete the regional volumes instead of the *West Coast Directory,* in order to avoid duplication of material.

Table 1.1.1 Coastal Directories project management structure

Group	*Role*	*Undertaken by*
JNCC Coastal Conservation Branch (CCB)	Day to day management	Head of CCB, project coordinators
Project management board	Liaison & executive decisions	Country conservation agencies (English Nature, Scottish Natural Heritage, Countryside Council for Wales), JNCC Coastal Conservation Branch, Department of the Environment (Northern Ireland)
Core steering group	Steer work, provide information and support	See page 2
Main steering group (includes, 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

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

Interest in the project has been reflected in the level of sponsorship that the project has received and in the commitment shown by members of the steering groups, which meet regularly. The main steering group meets annually for a seminar: so far it has considered the *Role of the Directories in the development of coastal zone management* (January 1994), and the *Use of electronic storage and retrieval mechanisms for data publication* (February 1995); in addition the core steering group also meets at least annually.

1.1.4 The contribution of the project to coastal management

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

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

It has also been recognised that the summary information in the regional volumes is valuable in preparing and assessing applications for oil and gas licensing around the coastal margin. An injection of funds from the United Kingdom Offshore Operators Association (UKOOA) made possible the early production of draft regional reports for most of the potential licensing areas in the 16th Offshore Oil and Gas Licensing Round in 1994.

1.1.5 Outputs

The regional volumes are being published as hardback books. In addition a first release of coastal conservation

Table 1.1.2 (Provisional) titles and publication dates of products of the Coastal Directories Project

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

data, covering national surveys of terrestrial habitats and coastal Sites of Special Scientific Interest (SSSIs), and a second release of marine conservation data, covering marine benthic surveys, have been published in electronic format (Barne *et al.* 1994) compatible with UKDMAP, the electronic atlas developed by the British Oceanographic Data Centre, Birkenhead (BODC 1992). Other forms of electronic publication are now being evaluated, and electronic editions of the published Regions 12, 5, 6, 13 and 9 are now available. The current position on the publication of book and electronic editions is shown in Table 1.1.2.

1.1.6 Further sources of information

A. References cited

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

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

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

B. Further reading

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

Department of the Environment. 1995. *Policy guidelines for the coast.* London, HMSO.

C. Contact names and addresses

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

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

Along the north coast of Banff and Buchan, rugged cliffs of Devonian Old Red Sandstone shelter scattered fishing harbours between their mighty shoulders. The tiny village of Pennan, tucked in a cleft in the treeless, wind-scoured plateau, is typical of this part of the region. Photo: Pat Doody, JNCC.

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 reigion, and Map 1.2.3 shows the local authority areas operative from 1 April 1996.

Region 3 covers the major part of the coastline of north-east Scotland, excluding Shetland (Region 1) and Orkney (Region 2). The coast is 1,151 km long - 9.8% of the total coastline of Scotland and 6.1% of that of Great Britain. The northernmost coast of the region is exposed to the gales of the North Atlantic, has a varied geology and is composed of predominantly cliffed landscapes. The area has a rugged and open character and is a regular tourist destination for those wishing to experience its scenic beauty and associated wildlife. South from Duncansby Head the coast is also cliffed, with some spectacular stretches, but broken in several places by flatter landscapes, particularly those associated with the inlets and sand dunes of the Moray Basin and the east coast of Grampian Region. The whole region is relatively free from human infrastructure development, except that in the Cromarty Firth associated with the oil industry, and the only major population centres are Inverness and Aberdeen.

1.2.2 Structure and landscape

The rocks of this region include some of the oldest in Britain (from the Precambrian era, >590 million years old). There are important coastal areas of Cambro-Ordovician limestone around Durness. Rocks of Devonian age (Old Red Sandstone, some 400 million years old) predominate in Caithness and around the Moray Firth. Both this rock group and the Precambrian rocks are resistant to erosion, giving rise to the spectacular coastal cliffs of this part of Britain. Younger rocks do occur: the sedimentary basin of the Moray Firth was formed in Jurassic times (approximately 200 million years ago). The nature of the rock and the distribution of the more recent glacial features and deposits largely determine the present-day landscape of the hinterland, which is open and has extensive areas of peat (the Flow Country) and moor.

The coastline can be described according to its solid geology and its degree of exposure to climatic and tidal influences. There are three distinctive zones. The hard rocks of the north coast of Sutherland and the Old Red Sandstone of Caithness are the most exposed to the Atlantic Ocean and the North Sea. Together with the predominantly cliffed coastline from Portknockie to Fraserburgh on the north Grampian coast, these areas are exposed to the full force of winter storms. These conditions allow few opportunities for accretionary habitats such as sand dunes to develop, except in the shelter of kyles (narrow straights) and bays. West from Portknockie, the Outer Moray Firth is less exposed, though there are still tidal and storm effects, which have moved shingle and sandy sediments to create the extensive sand and shingle formations on either side of the Firth. The sheltered inlets of the firths (Dornoch, Cromarty and the Inner Moray Firth and Beauly Firth) have a much lower energy environment, in which wave attack is reduced and intertidal mudflats and saltmarshes can develop.

The land shelves steeply into the sea off the north-facing coasts of Sutherland, Caithness, and Banff and Buchan. The nearshore sea bed is largely blanketed in sands and gravels, except where tidal currents sweep the bedrock clean, such as along the western stretch of the north coast of Highland Region, in the Pentland Firth, and at a few locations along the north side and extensively along the south side of the Outer Moray Firth. Offshore, deposits of glacial sand and gravel predominate, such as at Smith Bank and West Bank, and within the Moray Firth they help to define its gently sloping sea bed. Supplies of new sedimentary material from the land are very limited.

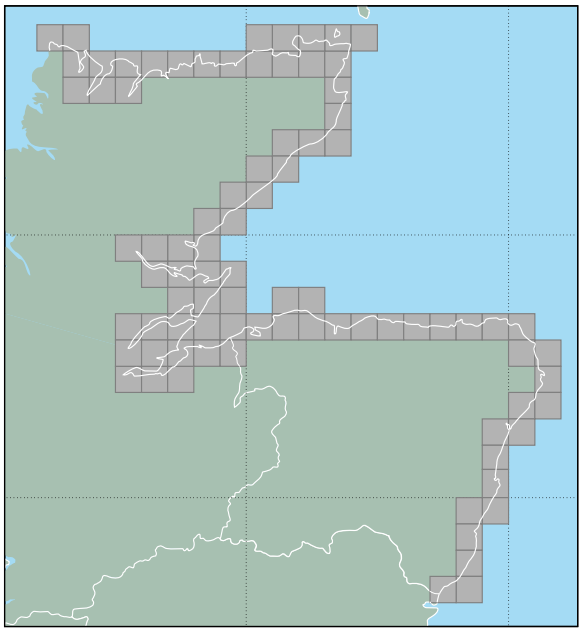
1.2.3 The natural environment

The sea and sea bed

The rocky shores of Caithness and north Grampian are rich in marine wildlife, and Whiten Head and Loch Eriboll appear to contain more rare and scarce benthic species than other parts of the region. One rare and five scarce marine benthic species occur in the region, an unremarkable total for regions in the UK. However, four of these species are North Atlantic/sub-Arctic species and one is a southern species, at the edge of their range of distribution. All are sessile and occur on rock. Loch Eriboll, the only large deep-water sea loch on the north coast of Scotland, is a Marine Consultation Area; the inner part is dominated by boulder, shingle and gravel shores, the outer by rocky substrate. The more exposed offshore areas harbour a kelp forest, below which a rich variety of sponges, ascidians, hydroids and bryozoans occur. The Moray Firth has a range of habitats, which include rocky shores and sandy bays. In the inner marine inlets, such as Loch Fleet, diverse but predominantly sedimentary shores support a rich flora and fauna. Loch Fleet is thought to be of national marine biological importance.

The region contains a large number of the non-exploited fish species present in Great Britain (166 of a national total of 336). These include all seven of the species protected under national, European and international legislation, although most records are of the lampern and sea lamprey, allis and twaite shads and the sturgeon. In addition, populations of a wide range of exploited fish species spend part or all of their lives in the waters off the region, including large numbers of herring, whiting, haddock and various flatfish. Stocks of lobster, edible crab, velvet crab, mussels and cockles occur inshore and there are large offshore distributions of *Nephrops*, scallps and deep water prawns. The Atlantic salmon and sea trout are present in most rivers in the region.

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



Map 1.2.2 National grid 10 km x 10 km squares included as 'coastal' for this region.

Map 1.2.3 Local authority areas in the region operative from 1 April 1996.

Both grey and common seals occur in the region. The common seal breeds in relatively large numbers in the Moray Firth, and the grey seal, more usually found in Orkney, Shetland, the Outer Hebrides and south-west Wales, breeds in small numbers on the north-east coast and the Outer Moray Firth. Six species of cetaceans occur regularly offshore in the region, out of a total of sixteen species recorded here. Off the north coast, between Cape Wrath and Faraid Head, harbour porpoises and bottlenose dolphins are especially common between July and October. The Pentland Firth is also an important area for these species, and minke whale, killer whale and long-finned pilot whale are also recorded regularly. White-beaked dolphins also occur annually, becoming numerous between July and September, when mackerel shoals move towards the coast. The resident population of bottlenose dolphins in the Inner Moray Firth numbers over 100 individuals; it is considered to be of national importance as one of only two such populations in the UK. On this account the Inner Moray Firth has been selected as a possible Special Area of Conservation under the EC Habitats & Species Directive.

During the breeding season, and to a lesser extent throughout much of the rest of the year, large numbers of seabirds, including kittiwake, guillemots and razorbill from the colonies on the Caithness cliffs, are found offshore in the Outer Moray Firth. Numbers are particularly large because of the rich supplies of prey offshore over the Smith Bank, including large populations of sandeels. The waters off north-east Grampian are also important as they are a moulting area for auks in the autumn. Shags and fulmars also occur offshore in large concentrations, and puffins are found within some 60-100 km of the coast off Aberdeen.

Estuarine shores (firths)

The region's estuaries represent approximately 6% of the estuarine resource in Great Britain and include fifteen estuaries identified in the Estuaries Review (Davidson *et al.* 1991). The Moray Basin and its associated inner firths (Moray, Loch Fleet, Dornoch, Cromarty and Beauly Firths and Findhorn Bay) form an exceptionally important sequence of habitats and support sixteen species of wintering waterfowl in internationally important numbers, making these inlets, and the wetland of the Loch of Strathbeg, of international importance for wintering waterfowl. The Moray Firth is of international importance for wintering seaduck and holds 15% of the national population of wintering red-breasted mergansers. By contrast, other tidal inlets, such as the Kyle of Tongue on the north coast, are smaller, sandier and support fewer marine invertebrate prey for wintering birds.

Saltmarshes of any size are mostly confined to the Inner Moray Firth and its smaller inlets. Though large on a Scottish scale, these saltmarshes represent less than 3% of the total in Great Britain. However, those associated with the sand dunes of Morrich More and Dornoch Point and behind the Culbin Shingle Bar are rich in upper saltmarsh communities and transitions to sand dune. The upper marsh turf includes numbers of important species with a northern distribution, such as saltmarsh flat-sedge *Blysmus rufus*, seaside centaury *Centaurium littorale*, long-bracted sedge *Carex extensa* and Baltic rush *Juncus balticus*. The region also supports the only British populations of the estuarine sedge *Carex recta*, in the Dornoch and Moray Firths.

Compared with sites in England and Wales, the upper saltmarsh zone throughout the region is relatively free from destruction by enclosure, so at many sites there are transitions to other vegetation tyoes. These are particularly well developed at a number of sites where saltmarsh communities occur in virtually sediment-free locations on rocky shores and boulder beaches. Despite the paucity of sediment, a sequence of typical saltmarsh plants occurs across the shore in response to tidal inundation, grading imperceptibly into non-maritime vegetation. Sites that have freshwater inflows from the land develop fen communities, which have a wide range of species and are of special interest.

Common cord-grass *Spartina anglica* occurs at only one location in the region, in the Cromarty Firth, where it was planted in 1946. This colony has expanded only very slowly, and climatic conditions in the region suggest that the species will not spread as it has done in England and Wales. It is not a significant factor in saltmarsh development in the region.

The region has important breeding waterfowl populations, with redshank, oystercatcher and curlew all found at high densities on saltmarshes, particularly in the Moray Basin. Densities range from 50 to 100 pairs/km², and the numbers of birds represent a significant proportion of the populations of the east coast of Scotland.

Non-estuarine shores

The coast of Region 3 has nationally and internationally important examples of sea cliffs, sand dunes and shingle structures. The extensive accretionary habitats of the Outer Moray Firth include Culbin Sands, the largest expanse of blown sand in Britain, and the Culbin Shingle Bar, which is regarded as the most natural shingle structure in the country. Morrich More is an outstanding site for its coastal landforms, with major sand dunes and saltmarshes of national and international significance.

The region's spectacular cliffs are of high interest for both landscape and nature conservation. In many exposed places, particularly on the north coast, salt spray is blown onto and over the cliff and cliff tops, creating some of the best and most extensive examples of maritime cliff crevice vegetation in Great Britain. In a few extreme situations, the extent of salt spray deposition is such that saltmarsh communities have formed high on the cliff top, particularly around the edge of geos (small gullies), where the sea water is forced up and over the cliff through fissures in the rock. The north coast of the region has some of the best examples of maritime heath vegetation in Britain. The endemic, nationally scarce Scottish primrose *Primula scotica* is present at a number of locations throughout the region, such as at Strathy Point, on the north coast of Sutherland, where it occurs in abundance in cliff-top grassland and heathland.

The region is internationally important for breeding seabirds. Boundaries between colonies are often indistinct, although sixteen colonies holding more than 1% of a species' total population in the European Union can be defined, plus a further eleven colonies that are important at the Great Britain level. In total there are nine species that exceed 1% of the European population and a further six with nationally important numbers. Kittiwakes and guillemots are the most numerous species, with approximately 190,000 and 125,000 breeding pairs (40% and 25% of the Great Britain populations) respectively in the region. Kittiwake numbers exceed 10% of the European population and those of guillemot and razorbill exceed 5%. Cliffs are especially important for seabirds, as nesting colonies on them are relatively safe from predation. Two cliff sites, at Cape Wrath and Fowlsheugh, have been designated as Special Protection Areas under the EC Birds Directive as holding seabird colonies of international importance, and a number of others are of equivalent status, such as that at Troup Head.

The region includes a high proportion (25%) of the total area of sand dune in Great Britain. The combination of abundant glacial deposits and the exposed nature of the coast has facilitated the growth of a number of large systems. These include two of the ten largest areas of wind-blown sand in Great Britain, at Culbin and Morrich More (*c.* 3,100 ha and 1,240 ha respectively). The former site, which was a mass of moving sand at the turn of the century, has been extensively forested with pine plantations designed to prevent sand movement. Areas of open dune are now very limited. This has led to changes in the water table, affecting the development of the important and characteristic wet dune slack vegetation. Morrich More, by contrast, remains virtually free from afforestation and is protected by the presence of a Ministry of Defence target range for aerial bombardment. This site is one of the top four dune sites in Britain and includes some of the best examples of dune heath. A rich saltmarsh/dune transition at the site has unfortunately been damaged recently through the construction of an oil pipeline fabrication facility, the long-term effects of which are not known. Generally the region's saltmarsh and sand dune habitats, especially at Culbin and St. Cyrus, are of significance for invertebrates, probably because they are relatively undisturbed and still retain transitional habitats, rare features elsewhere in Great Britain.

The region holds a further six dune sites, two of them large (Dunnet Bay (690 ha) and Sands of Forvie (763 ha)), recognised as being of national importance for their vegetation. The former site is an example of a machair system and has a rich calcareous vegetation, whilst the latter is an acid dune with excellent examples of dune heath. Both are National Nature Reserves. Two of the other dune systems, at Durness and Invernaver National Nature Reserves, have developed partly as a result of sand being blown up and over the cliff, resulting in the formation of 'climbing dunes'. These support an Arctic-Alpine flora, including mountain avens *Dryas octopetala*, of significance in a European context because here it occurs at sea level. The wet dune slacks in the region include several rare mosses. The dunes at the Sands of Forvie are home to the largest breeding population of eider ducks in Great Britain. The young collect in large crèches in the Ythan Estuary towards the end of the summer. Sand dune systems in the region are also noted for breeding ringed plover *Charadrius hiaticula*, oystercatcher *Haematopus ostralegus* and shelduck *Tadorna tadorna*.

Shingle shorelines occur extensively around the coast of the region. These shores include some of the most important populations of the rare northern species oyster plant *Mertensia maritima*. The shingle material is mainly derived from glacial deposits, though at the mouth of the River Spey there are extensive riverine shingle banks that extend onto the coast. Two of the most important shingle structures in Great Britain occur within the region - Culbin Shingle Bar and the Kingston Shingle (at the mouth of the River Spey). The former is the best example of a naturally developing shingle bar, with virtually undisturbed sequences of shingle ridge vegetation. Unlike all the other nationally important sites, including the Kingston Shingle, it shows no surface destruction as a result of human activity. The Kingston site is a remnant of an extensive, now largely afforested shingle/dune system. Despite surface shingle extraction, it supports some very important plant communities; in the excavated hollows a shingle slack community containing the rare coralroot orchid *Corallorhiza trifida* is present, and drier areas support dry heath

communities with juniper *Juniperus communis*.

The region is particularly important for two mammal species: the otter, which is especially numerous along the coast, and the wildcat. Pine martens and red squirrels are found in the region's conifer plantations, in particular those of the Culbin Sands. Although eight out of the nine widespread species of amphibians and reptiles in Great Britain have been recorded in the region, only three species of amphibian - common frog, common toad and palmate newt - and one species of reptile - common lizard - are known to be widespread throughout the region.

1.2.4 Landscape and nature conservation

The value of the area for nature conservation is reflected in the number and extent of the official designations, such as Sites of Special Scientific Interest and National Nature Reserves. The total number of sites and the area of the main designations are given in Table 1.2.1. With only four Special Protection Areas (SPAs) and two Ramsar sites, the region has only a small proportion of the internationally important sites specially designated for the protection of birds, for which the region is nonetheless of major importance. However, it does have a number of RSPB reserves - around the average proportion, by area, for coastal regions in Great Britain. In addition to sites listed in Table 1.2.1 there are two National Scenic Areas (NSA), a designation used only in Scotland, and nine sites have been put forward as possible Special Areas of Conservation under the EC Habitats and Species Directive.

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*
Sites of Special Scientific Interest (SSSI)	71	35,977	5.1
National Nature Reserves (NNR)	6	2,989	3.4
Ramsar sites	2	680	0.2
Special Protection Areas (SPA)	4	1,195	0.4
Local Nature Reserves (LNR)	1	36	0.3
National Trust for Scotland sites	0	0	0
Wildlife Trust sites	4	1,359	5.8
RSPB reserves	7	2,485	6.4

1.2.5 Human activities, past and present

Human occupation of the region dates from at least 7,000 BP, when scattered settlements existed along the coastal fringe and sea routes were of major importance. The Sands of Forvie have yielded flint and bone tools of this period, although much archaeological material from coastlines predating the present shore has been lost as a result of erosion, and some might have indicated an earlier date for human occupation of the region. It is thought that farming in the region dates back to around 6-5,500 BP, and although most of the land was used for grazing, examples of tilled ridge and furrow agriculture can be seen. Burial mounds provide the best evidence of human colonisation and use.

The occurrence in the region of extensive mobile sand dune systems has resulted in historic times in the loss or abandonment of settlements, such as the village of Forvie, abandoned in 1413 after being overwhelmed by sand, and the gradual loss of agricultural land at Culbin around 1695. Today, the region is one of the most sparsely populated in Great Britain, with most settlements located at or near the coast. The largest conurbation is Aberdeen (population c. 200,000). Although there are local concentrations of tourism and associated facilities, the pressures they put on coastal habitats are also relatively localised. Particular problems have occurred at, for example, Durness, where a new golf course has been built within some of the richest expanses of maritime cliff and sand dune vegetation in Britain. Although some areas of coastal land within estuaries have been enclosed for agricultural use, they represent only minor incursions compared with land-claim in estuaries in other regions. The shores of the Moray Firth are the exception: land there has been claimed for agricultural use, including for intensive livestock production. Oil-related and other developments within the Cromarty Firth have resulted in the land-claim of some 284 ha of intertidal land.

The North Sea offshore oil industry is a recent development that has had a major positive impact on the economy of the region. Aberdeen and the Dornoch and Cromarty Firths are the two most important locations in Scotland for oil-related development. The housing stock around Aberdeen has expanded greatly, as has the population itself, and increased employment opportunities and thus income for a time turned Aberdeen into a latter-day 'gold-rush' city, although the effects are now waning. The oil and gas industry has resulted in increased industrial and service activity in Inverness and other towns throughout the region. Other industrial developments in the area are limited to those associated with trading ports, the whisky distilleries and fisheries.

Very little of the hinterland in the north is in intensive agricultural use, most being either unsuitable or economically non-viable for this purpose. Small communities along the coast cultivate land for a variety of crops, particularly on the better-drained soils associated with the areas of blown sand, as found on some of the older parts of Morrich More. Elsewhere the majority of land, including the coastal fringe, is used for sheep grazing. Near Thurso and Wick in the north and Easter Ross or the Moray coast there is more intensive use of the land, including arable farming. There are extensive afforested stretches in the region, especially around the Dornoch, Cromarty and Moray Firths. As a result, the timber processing industry is expanding and a concentration of forestry-related industries exists.

The region is the most important in Britain and the Isle of Man in relation to sea fisheries, and vessels based in the region operate over a wide range of fishing grounds in the North Sea and north-east Atlantic. 33.6% of all British and Isle of Man landings (demersal, pelagic and shellfish species) are made to the region's ports, notably Peterhead, which has one of the busiest fish markets in Europe. Around half of the recorded British and Isle of Man demersal catch is landed in the region. The region, especially the Rivers Spey and Dee, is also highly important for the fishery for diadromous species (fish that migrate

from fresh to sea water or *vice versa* to spawn). The region's average total annual recorded catch of salmon and grilse, by all methods, represents nearly a third (28.9%) of the British total and nearly two-fifths (37.7%) of the 'North Sea coast' total. The equivalent catch of sea trout amounts to one-sixth (16.6%) of the British total and nearly a quarter (22.6%) of the 'North Sea coast' total.

This wild and remote area of Britain has a unique appeal for tourists, who come here for outdoor pursuits such as climbing and sailing. In addition, there is an unusually high density of international standard golf courses on the east coast of Highland and Grampian Regions, and golf is a major leisure pursuit in the region. The resident bottlenose dolphin population of the Inner Moray Firth is a popular tourist attraction.

Coastal zone management is as yet only patchy in the region. The major national coastal management initiative currently under way is the 'Focus on Firths', instigated by Scottish Natural Heritage. 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 cooperation among the various users and statutory authorities. The Moray Firth Project, part of the Focus on Firths initiative, covers the whole area of the Moray Basin, from Duncansby Head in the north to the inner firths of the south-west and Fraserburgh in the east. It was initiated in August 1991 with the collation and synthesis of biological and environmental data on the marine and coastal environment of the firth, their human use and the impacts of these uses, as summarised in the *Moray Firth review* (Harding-Hill 1993), a major source of information for much of this region.

1.2.6 Further sources of information

A. References cited

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B. Further reading

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The region's large firths display a great variety of landscapes between their outer, exposed shores and their tranquil wooded interiors. The alder woods at the Mound, Loch Fleet, are the largest in any estuary in Britain and are the reason for the site's selection as a possible Special Area of Conservation under the EC Habitats & Species Directive. Photo: Pat Doody, JNCC.

Chapter 2 Geology and physical environment

2.1 Coastal geology

British Geological Survey

2.1.1 Introduction

The coast of Scotland between Cape Wrath and St. Cyrus is formed from a variety of metamorphic, sedimentary and igneous rocks that range in age from Precambrian to Jurassic, although most are older than the Carboniferous (about 360 million years). It contains a number of important geological features, including the Precambrian and Cambro-Ordovician exposures around Cape Wrath and Durness, the Moine Thrust Zone (a major fault zone where older rocks have been pushed over younger ones), exposures of Moinian and Dalradian rocks and coastal sections of Old Red Sandstone (Table 2.1.1 and Map 2.1.1). The coastline of the region can broadly be divided into three sections. West of the Moine Thrust Zone lie the oldest rocks in the region: these are predominantly Precambrian but with some covering of Lower Palaeozoic rocks. Between the Moine Thrust Zone and the Highland Boundary Fault the geology is dominated by old, metamorphosed sequences of the Central Highland Division (thought to be equivalent to the Moinian) and Dalradian rocks, overlain by Middle and Upper Old Red Sandstone in Caithness and around the Moray Firth to Spey Bay. South of the Highland Boundary Fault the coastline is formed of Lower Old Red Sandstone with associated lava and tuff (volcanic ash).

2.1.2 Stratigraphy

Cape Wrath - Melvich

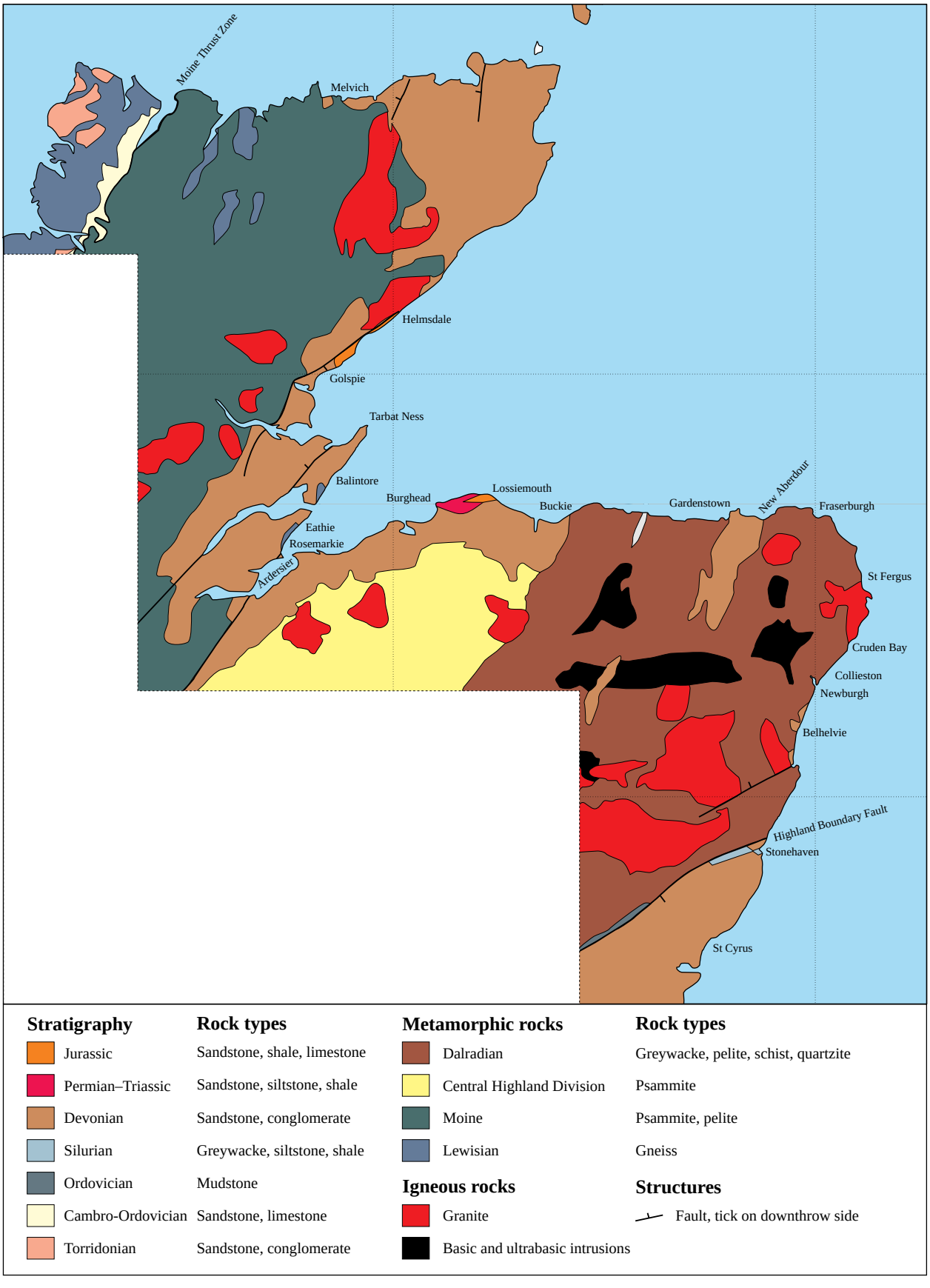
The oldest rocks are found in the extreme north-west of the region and belong to the Archaean-Middle Proterozoic (i.e. early Precambrian) Lewisian Complex. They comprise crystalline acid gneiss enclosing basic and ultrabasic bodies. Resting on the eroded surface of the Lewisian Complex are remnants of the Torridonian, a sequence of late Precambrian sandstones and conglomerates. Together, these Precambrian rocks form the bulk of the coast between Cape Wrath and Loch Eriboll. To the east of the Kyle of Durness they are overlain in places by a sequence of Cambro-Ordovician sediments: the basal part of the sequence, well seen in the Loch Eriboll area, is largely of quartzite, but higher strata are dominated by fossiliferous limestone (the Durness Limestone), which is well exposed around Durness.

These so-called 'foreland' rocks are separated from the Caledonian Orogenic Belt to the east by the Moine Thrust Zone, a 3 km-wide belt of almost horizontal faults (thrusts), composed of wedges of Lewisian and Cambrian rocks, which meets the coast immediately east of Loch Eriboll. The

Table 2.1.1 Geological column

Era	*Period*	*Epoch*	*Age of start (million yrs)*	*Stratigraphic units mentioned in the text*	*Significant geological events*
Cenozoic	Quaternary	Holocene	0.01		Rapid sea-level rise
		Pleistocene	1.6		Glaciations
	Tertiary (Neogene)	Pliocene	5.1		
		Miocene	25		
	Tertiary (Palaeogene)	Oligocene	38		
		Eocene	55		
		Palaeocene	65		
Mesozoic	Cretaceous		144		
	Jurassic		213		
	Triassic		248		
Palaeozoic (Upper)	Permian		286		
	Carboniferous		360		
	Devonian		408	Old Red Sandstone	Caledonian earth movements
Palaeozoic (Lower)	Silurian		438		
	Ordovician		505	Dalradian ?	
	Cambrian		590	Durness Limestone, Dalradian	
Precambrian				Dalradian, Torridonian, Moine, Central Highland Division, Lewisian	

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



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

rocks to the east of the zone have been pushed over the foreland rocks.

The Caledonian Orogenic Belt consists of two suites of Precambrian metamorphic rocks, the Moine and Dalradian, which together form extensive areas of the Scottish Highlands. The Moine, which dominates the north coast between the Moine Thrust Zone and Melvich Bay, comprises a relatively uniform series of quartzites (sandstones) with a subordinate component of metamorphosed siltstones and limestones. Amphibolites (metamorphosed basic intrusions) are also present, especially in the Bettyhill area. Patches of Lewisian gneiss, representing rocks that were folded or faulted into the surrounding Moine rocks, are common around the Kyle of Tongue, the most extensive occupying a 3 km stretch of the coast west of Torrisdale Bay. Partial melting of Moinian rocks is very evident between Kirtomy and Strathy Points.

Melvich - Buckie

Except for sections of Moinian rocks in the inner Dornoch and Beauly Firths, and possible Lewisian rocks around Rosemarkie, the entire coastline of Caithness and the Moray Firth from Helmsdale to Buckie is composed of sedimentary rocks. These are mostly Old Red Sandstone (of Devonian age), comprising lake and river sediments of the Orcadian Basin. Caithness is dominated by Middle Old Red Sandstone flagstones containing abundant fish remains. Between Berridale and Helmsdale, and at Sarclet, the flagstones rest on Lower Old Red Sandstone fluviatile (river) sandstone and conglomerate, but at Red Point on the north coast the Middle Old Red Sandstone overlaps onto Moinian basement rocks. By contrast the Middle Old Red Sandstone south of Golspie is entirely fluviatile, with coarse red sandstone and conglomerate dominating the coastline of the Inner Moray Firth between Tarbat Ness and Ardersier. The Middle Old Red Sandstone also crops out extensively on both sides of the Dornoch Firth and forms small sections of the coast in Spey Bay and from Gardenstown to New Aberdour. Somewhat finer-grained pink and yellow sandstones, which are assigned to the Upper Old Red Sandstone, underlie the coast between Loch Fleet and Tarbat Ness, the west side of Nigg Bay, from Ardersier to Burghead and from Lossiemouth to the mouth of the Spey.

Small outliers of Mesozoic rocks form the youngest strata within this section of coast, and indeed the region. The most extensive, occupying a 30 km strip in the Helmsdale - Golspie area, comprises a succession that is principally Jurassic in age, but which includes a basal sequence of Triassic mudstones and sandstones. The lower part of the Jurassic includes thin coals. Above this are shales, sandstones and boulder beds (the latter including the 'fallen stack of Portgower'), which were deposited on the downthrow side of the Helmsdale Fault, which was active while deposition was taking place. Upper Permian and Triassic sandstones (New Red Sandstone), with local areas of cherty rock, occupy the coast between Burghead and Lossiemouth. Mesozoic rocks include limited exposures of fine-grained Middle-Upper Jurassic rocks at Balintore and Eathie, in the vicinty of the Lewisian rocks.

Buckie - Stonehaven

The Dalradian Supergroup, which forms most of the coast of Grampian between Buckie and Stonehaven, represents a much more varied assemblage than the Moine, particularly in its lower and middle parts, and is considered to range between approximately 700 and 500 million years in age. It is divided into four groups, three of which are exposed on the coast of this region. Coastal exposures of Lower Dalradian (Appin Group) rocks are confined to the section between Buckie and Sandend Bay, where the principal lithologies seen are quartzite, altered siltstone, limestone and calc-silicate rock. The Middle Dalradian (Argyll Group) is essentially similar, although limestone is not so prevalent and the upper part is dominated by metagreywacke (an impure sandstone). In the Portsoy area the sequence also includes gneiss and serpentinite. Rocks of the Middle Dalradian form three sections of the Grampian Region coast: Sandend Bay to Boyne Bay, Fraserburgh to St. Fergus and Newburgh to Aberdeen. The Upper Dalradian (Southern Highland Group) is a more monotonous sequence of metagreywacke and pelite (metamorphosed siltstone), which outcrops on the coast between Boyne Bay and Fraserburgh, around Collieston and south of Aberdeen.

Although large masses of Caledonian intrusive rocks occur extensively within the Moine and Dalradian rocks, only a few are present on the coast. The largest of these is the Peterhead Granite, which has a coastal outcrop of around 20 km between St. Fergus and Cruden Bay. Basic and ultrabasic rocks of the Belhelvie mass dominate a 2.5 km wide coastal strip 10 km north of Aberdeen, whilst 4 km south of the city a body of granite is exposed in the coastal cliffs for 2 km.

Stonehaven - St. Cyrus

The Highland Boundary Fault, which meets the coast at Stonehaven, separates the relatively uplifted Dalradian succession from the younger rocks of the Central Valley of Scotland. South of the fault the coastline as far as St. Cyrus is composed of Lower Old Red Sandstone, which includes layers of ash and lava produced by contemporaneous volcanic activity.

2.1.3 Structure

The Moine Thrust Zone represents a major geological 'suture' between the Lewisian and Torridonian rocks with their Lower Palaeozoic cover to the west, and the metamorphosed Moine sediments to the east. The southern edge of the Caledonian Orogenic Belt is defined by the WSW/ENE trending Highland Boundary Fault, which intersects the coast just north of Stonehaven. The other main Late Caledonian faults, with the exception of the north/south-trending Brough Fault just east of Dunnet Head in Caithness, have NE/SW trends. Most significant of these is the Great Glen Fault, which passes into the Moray Firth at Inverness and which developed as a transcurrent fault (i.e. a vertical fault plane enabling mainly horizontal rock movement) during the Caledonian orogeny. To the north-west and parallel to the Great Glen Fault are the Strath Glass Fault and the Helmsdale Fault. The former cuts the shore at the head of the Cromarty Firth, reappears on land near Invergordon and finally disappears under the North Sea on the southern shore of the Dornoch Firth. The latter crosses the Dornoch Firth north-west of Edderton, then reappears on the coast 3 km north-east of Helmsdale.

2.1.4 Further sources of information

A. Maps

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

British Geological Survey. 1989. *Sutherland.* Sheet 58°N-06W°, Solid geology. 1:250,000 series. Keyworth.
British Geological Survey. 1982. *Caithness.* Sheet 58°N-04W°, Solid geology. 1:250,000 series. Keyworth.
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B. Further reading

Section 7.4 lists the Geological Conservation Review (GCR) sites occurring in the region. Detailed descriptions of GCR sites in the region can be found in volumes of the Geological Conservation Review.

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Johnstone, G.S. 1966. *British regional geology: the Grampian Highlands.* 3rd ed. London, HMSO.
Johnstone, G.S., & Mykura, W. 1989. *British regional geology: the Northern Highlands of Scotland.* 4th ed. London, HMSO.
Sissons, J.B. 1967. *The evolution of Scotland's scenery.* Edinburgh, Oliver and Boyd.
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.*
Geological information for Region 3 and the whole of Britain; 1:50,000 scale map sheets	Coastal Geology Group, British Geological Survey, Keyworth, Nottingham NG12 5GG, tel: 0115 936 3100
Geological Conservation Review sites in Highland	*SNH North-west Region Head Office, Inverness, tel: 01463 239431
Geological Conservation Review sites in Grampian	*SNH East Grampian Area Office, Aberdeen, tel: 01224 312266

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

2.2 Offshore geology

British Geological Survey

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

2.2.1 Holocene sea-bed sediments

Sea-bed sediments are defined here as the unconsolidated sediments at sea bed laid down since the sea transgressed across the area during the early Holocene. The lithology (rock-types) and thickness of the sediments have been determined by sampling, high resolution seismic profiling and sidescan sonar.

The distribution of sea-bed sediments in this region reflects both the glacial history of the area and the present hydrodynamic regime. Present sediment input from the land is small, much of the material carried to the sea by rivers being derived from peat deposits. Most sea-bed sediments are reworked from older, particularly Pleistocene, deposits.

Gravels and sandy gravels are concentrated in three coastal zones up to 15 km wide: between Cape Wrath and Dunnet Head; between the eastern end of the Pentland Firth and Helmsdale; and between Lossiemouth and Peterhead (Map 2.2.1). Gravels also occur in the outer Moray Firth, centred on Smith Bank and West Bank. Some of these gravels have a very high shell content. A belt of muddy sands extends eastwards from the estuaries in the Inner Moray Firth, but sandy sediments surround the gravel banks further offshore. Carbonate sands occur offshore between Buckie and Banff.

Strong currents flow through the Pentland Firth; as a result, sediment cover is patchy, and there are rock outcrops at the sea bed. Sandbanks and sandwave fields occur to the west and south-east of the Pentland Firth and in the inner part of the Moray Firth.

2.2.2 Pleistocene geology

During the late Devensian glaciation, ice spread into the Moray Firth and diverged northwards towards Caithness and the Orkney Isles as well as eastwards approximately parallel to the present day Grampian coast. A blanket of glacier-derived sediments was deposited over most of the floor of the firth (Map 2.2.2), but Pleistocene sediments are thin or absent from the Pentland Firth. They are also absent between Wick and Brora and in an area just north of Peterhead, where bedrock is exposed along the coast. Grey pebbly tills (boulder clays) of Middle Devensian age occur in the eastern Moray Firth. In the Inner Moray Firth the late Devensian till comprises grey or brown muddy sands and sandy clays. Off the Aberdeenshire coast Pleistocene deposits vary from soft red-brown, grey-brown and pink-grey muds, to compact grey clays with scattered pebbles, which probably represent glacial tills. The soft muds at the top of the sequence are of Late Devensian/Early Flandrian age, and were deposited during the decay phase of the last ice sheet in the region.

2.2.3 Solid (pre-Quaternary) geology

Rocks formed before the start of the Quaternary Period (1.6 million years BP) are included by geologists in the category of 'solid geology' (Map 2.2.3). In most areas offshore, bedrock is concealed by sea-bed sediments and infill sediments (Maps 2.2.1 and 2.2.2), but isolated outcrops may occur. Moine and Lewisian metamorphic rocks crop out on the sea floor off the north coast of Sutherland. Jurassic and Cretaceous strata, exposed on the coast in the vicinity of Helmsdale, underlie Quaternary deposits across much of the floor of the Moray Firth.

Devonian (Old Red Sandstone) and Permo-Triassic (New Red Sandstone) rocks extend offshore along the coastal margin of the Moray Firth south and east of Golspie, covering most of the Dalradian rocks seen onshore, except in the section between Aberdeen and Stonehaven. These strata comprise sandstones, conglomerates, mudstones and cherts deposited in continental, often fluvial environments. The Devonian rocks in the Inner Moray Firth have been displaced by the Great Glen Fault: rocks to the north-west of the fault have moved north-east.

2.2.4 Further sources of information

A. Maps

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British Geological Survey. 1984. *Moray-Buchan.* Sheet 57°N-04°W, sea bed sediments and Quaternary geology. 1:250,000 series. Keyworth, BGS.

British Geological Survey. 1984. *Peterhead.* Sheet 57°N-02°W, sea bed sediments. 1:250,000 series. Keyworth, BGS.

British Geological Survey. 1986. *Peterhead.* Sheet 57°N-02°W, Quaternary geology. 1:250,000 series. Keyworth, BGS.

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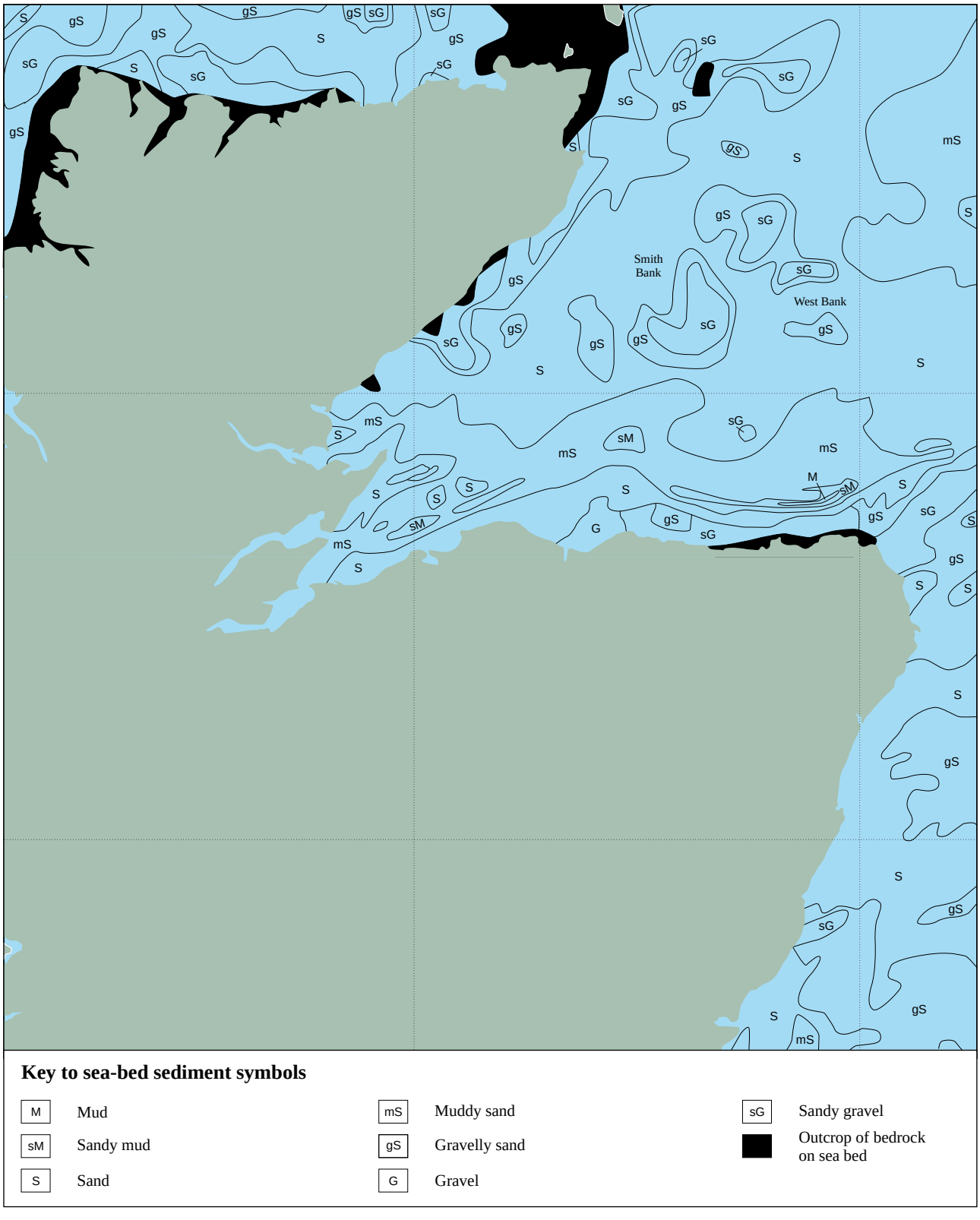
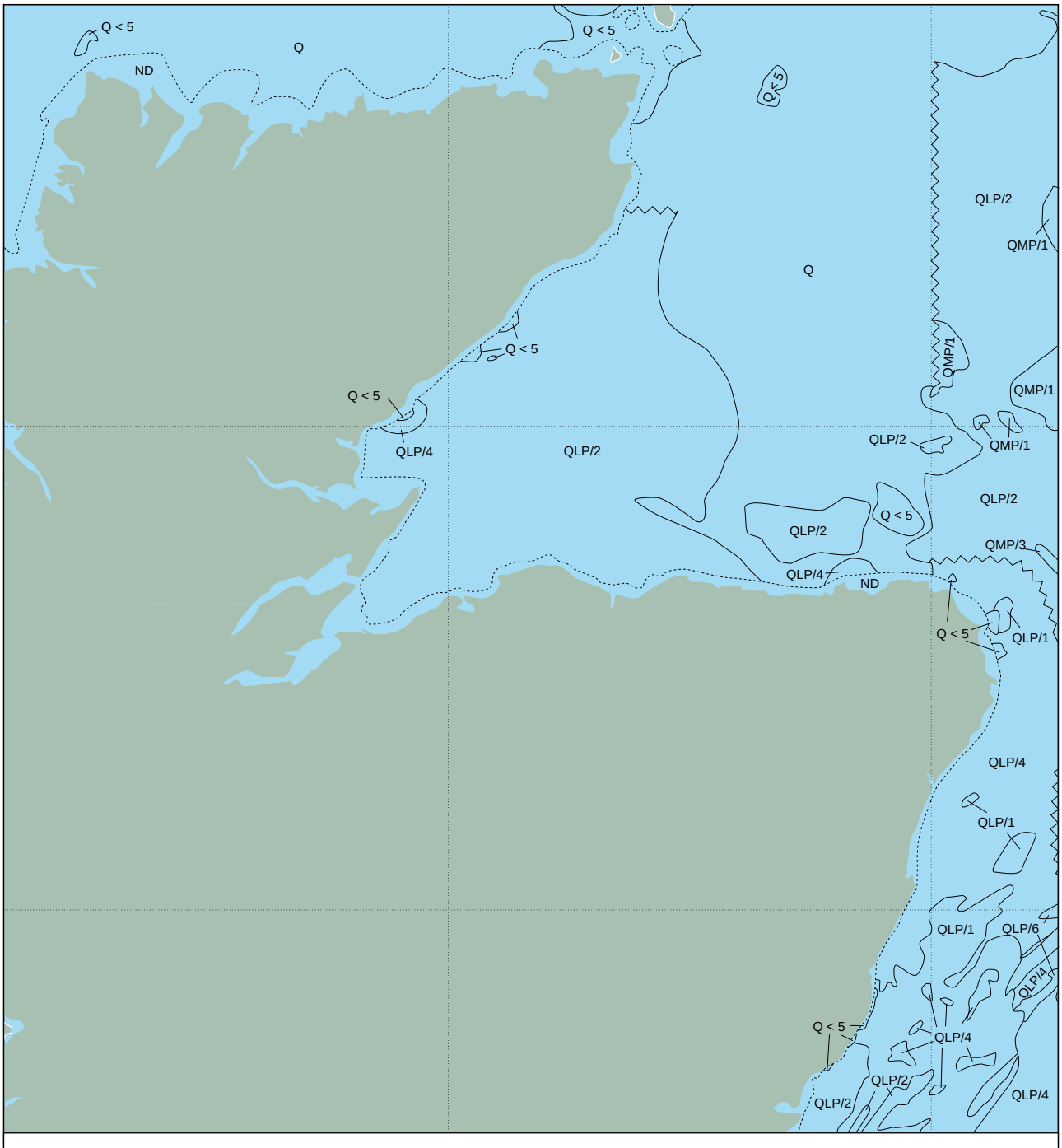
Folk, R.L. 1954. The distinction between grain-size and mineral composition in sedimentary rock nomenclature. *Journal of Geology, 62:* 344-359.



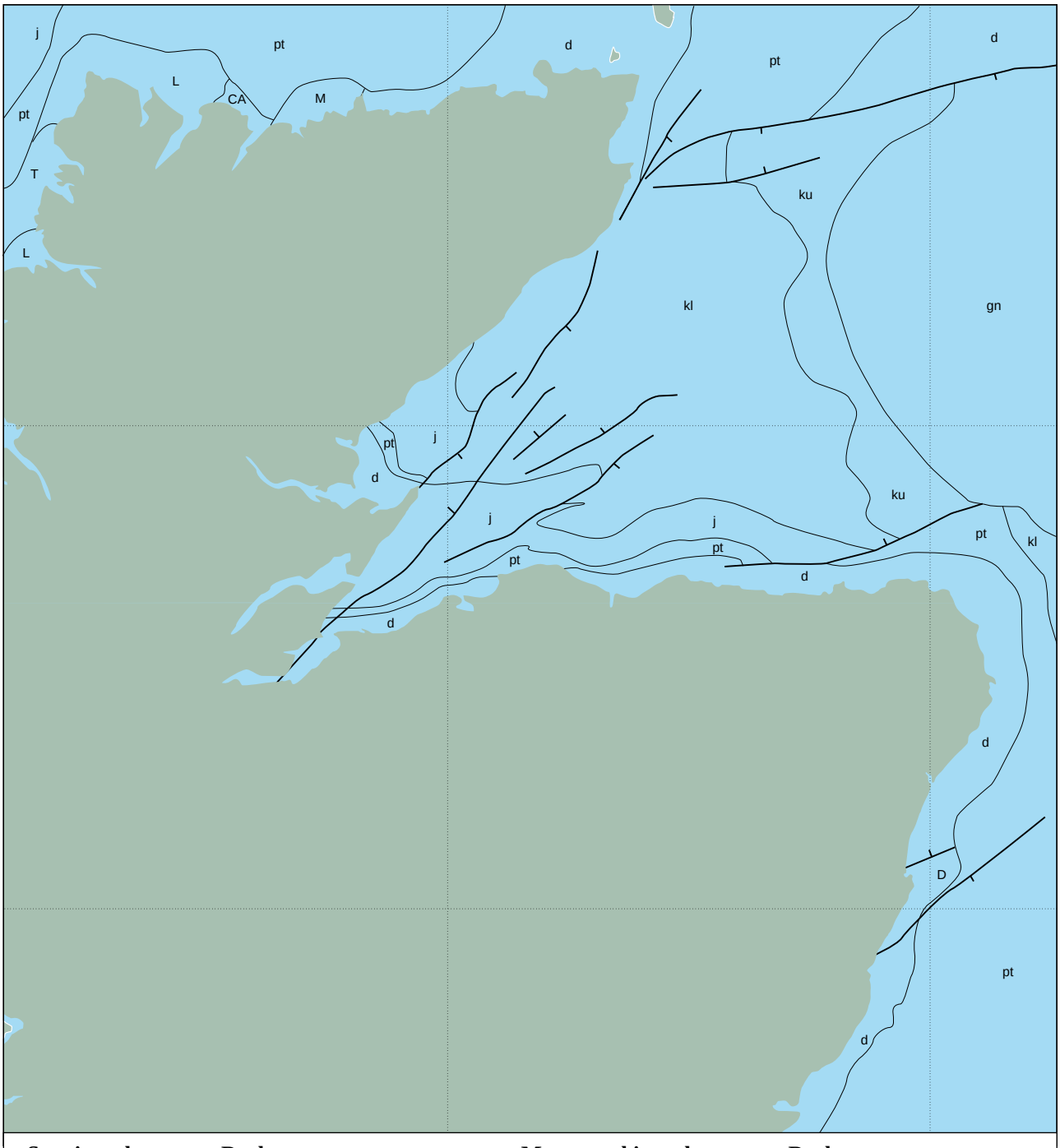
Map 2.2.1 Sea-bed sediments. Source: British Geological Survey (1991); sediment classification modified after Folk (1954).



Key to sea-bed sediment symbols

QLP	Late Pleistocene to Early Holocene	1	Predominantly till		Boundary uncertain
QMP	Middle Pleistocene	2	Predominantly mud		
Q	Quaternary, undivided	3	Predominantly interbedded mud and sand		
Q<5	No significant Pleistocene cover (< 5 m thick)	4	Predominantly sand		
ND	No data; broken line shows seaward limit	5	Predominantly gravel		
		6	Predominantly incision and channel deposits		

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



Stratigraphy		Rock types
gn	Tertiary	Clay, sand
ku	Upper Cretaceous	Chalk
kl	Lower Cretaceous	Shale, siltstone, sandstone
j	Jurassic	Sandstone, shale, limestone
pt	Permian–Triassic	Sandstone, siltstone, shale
d	Devonian	Sandstone, conglomerate
CA	Cambro-Ordovician	Sandstone, limestone
T	Torridonian	Sandstone

Metamorphic rocks		Rock types
D	Dalradian	Greywacke, pelite, schist, quartzite
M	Moine	Psammite, grit, pelite
L	Lewisian	Gneiss

Structures

Fault, tick on downthrow side

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

C. Further reading

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Pantin, H.M. 1991. *The sea-bed sediments around the United Kingdom: their bathymetric and physical environment, grain size, mineral composition and associated bedforms.* Keyworth, British Geological Survey. (BGS Research Report SB/90/1.)

D. Contact names and addresses

Type of information	*Contact address and telephone no.*
Geological information for Region 3 and the whole of Britain	Coastal Geology Group, British Geological Survey, Keyworth, Nottingham NG12 5GG, tel: 0115 936 3100
UKDMAP 1992. Version 2. United Kingdom digital marine atlas. Oceanographic maps.	British Oceanographic Data Centre, Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, tel: 0151 652 3950

2.3 Wind and water

British Geological Survey

2.3.1 Wind

The local climate along the coast depends to a large extent on the degree of shelter from winds from the north and east. The Inner Moray Firth area between Dornoch and Elgin has a relatively sheltered climate. North of Dornoch and east of Elgin the climate becomes more rigorous owing to increasing exposure to wind (Maps 2.3.1 and 2.3.2). The low-lying Caithness plateau has a climate more similar to the Orkney Islands than to the Inner Moray Firth.

Wind strength is markedly affected by local topography. Over land wind speeds are lower than over the sea, because of the greater wind resistance of the ground. Both the strength of the winds and the frequency of certain wind directions show considerable variation, although winds are predominantly from the south and west (Figure 2.3.1). On average, thirteen days of gales per year can be expected at Wick and over the more exposed parts of the Moray Coast. On 13 February 1989 Fraserburgh experienced the highest wind gust speed (123 knots - 142 mph) ever recorded at a low-level site in Britain.

Föhn (warm, dry) winds sometimes blow in the Moray Firth region. As the south-westerly winds pass over high ground inland they deposit some of their moisture on the high ground and then become warmer and drier on their descent towards the Moray Firth coast. High winter temperatures have been recorded in the Moray Firth as a result of these winds.

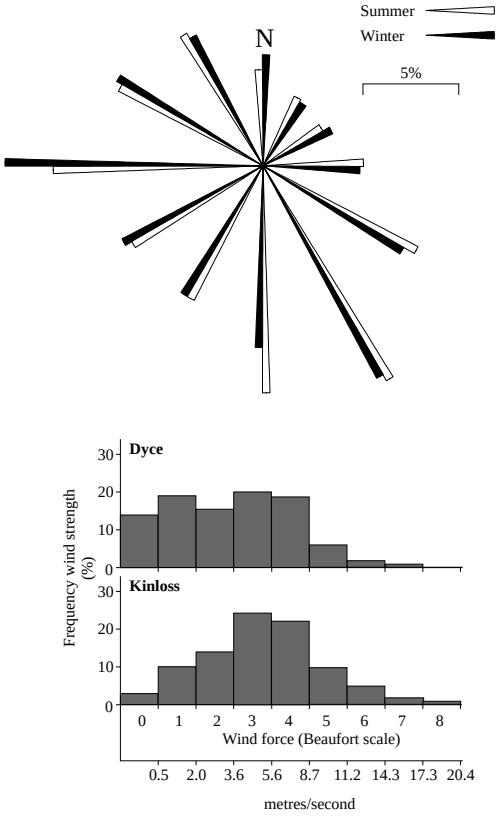
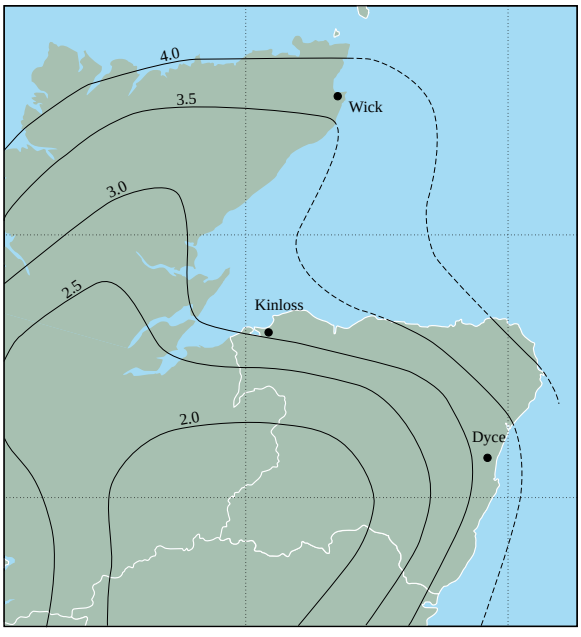


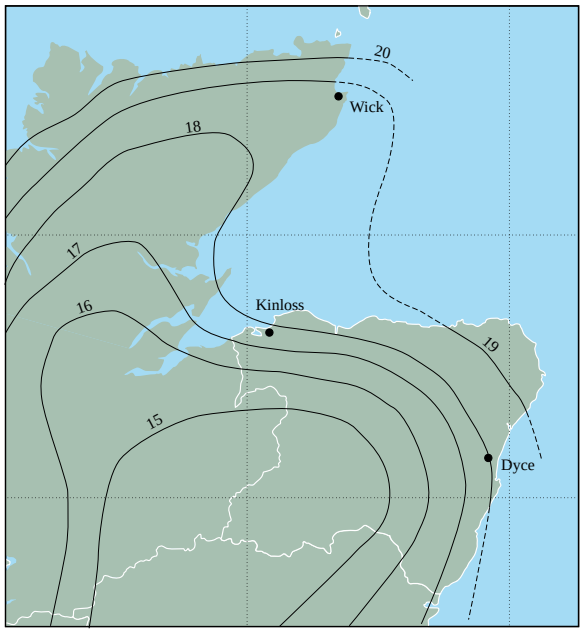
Fig 2.3.1 Wind directions at Wick, 1968 (from Ritchie & Mather 1970), and frequencies of wind strengths at Dyce and Kinloss (from Ritchie *et al.* 1978).



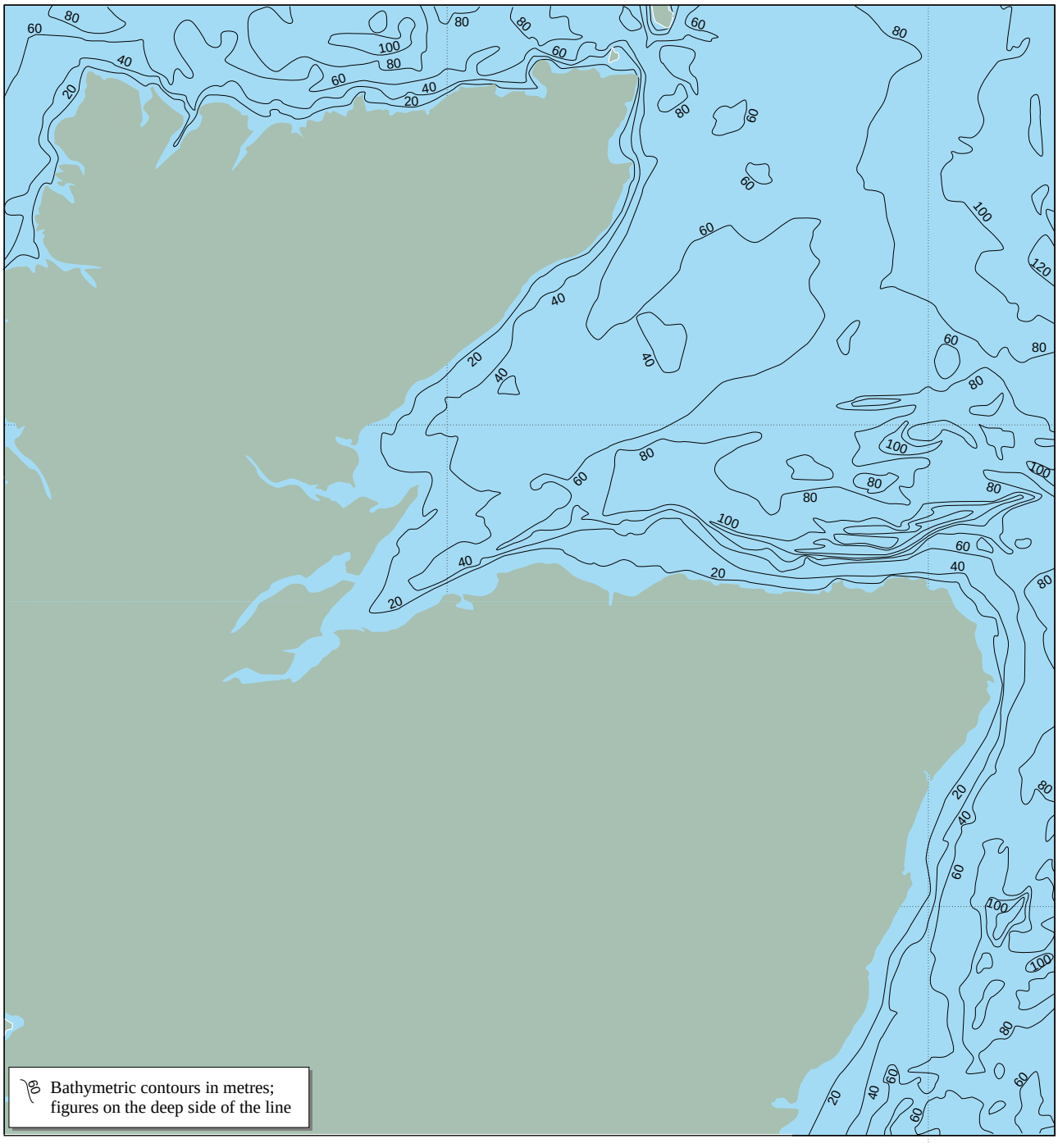
Map 2.3.1 Hourly mean windspeed (in m/s) exceeded for 75% of the time: 1965-1973. Source: Caton (1976).

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.



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



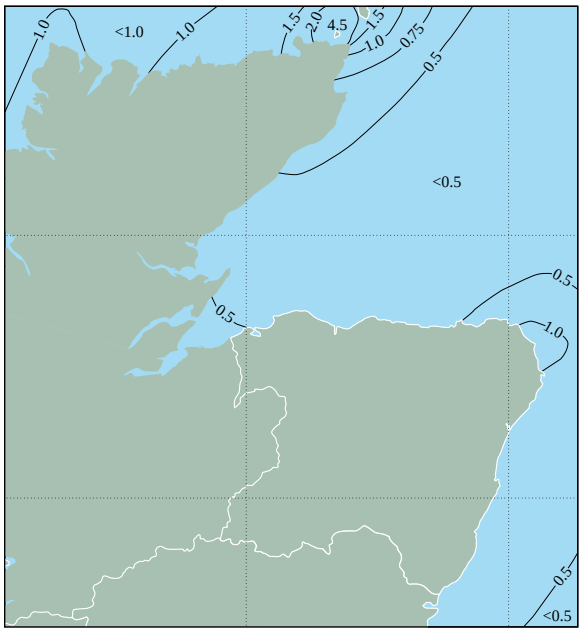
Map 2.3.3 Bathymetry. Source: British Geological Survey (1987).

In the areas between Cape Wrath and Helmsdale and between Buckie and Peterhead, the sea floor slopes from the coast to 60 m depth by about 5-10 km offshore (Map 2.3.3) and the nearshore sea-bed topography is often irregular. In the Inner Moray Firth the smoother sea floor slopes more gently from the coast, except for a narrow north-east-trending channel, which is the continuation of the Beauly and Ness valleys from Inverness. In the outer Moray Firth the sea floor gradually deepens eastwards, locally reaching more than 120 m. There are, however, several banks in the outer Moray Firth which rise 30 m to 40 m above the surrounding sea bed.

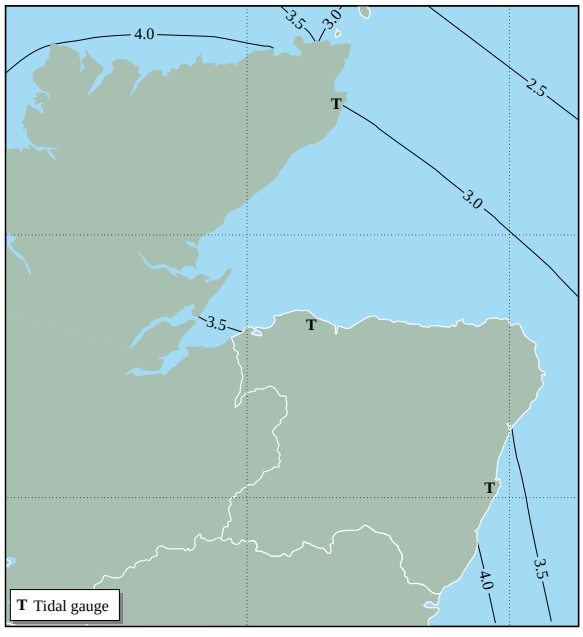
South of Peterhead the sea bed slopes consistently and relatively steeply to more than 60 m depth where it levels out, although off Aberdeen depths of over 120 m are found only about 25 km offshore.

2.3.3 Tidal currents

In the Atlantic Ocean tidal currents are very weak, but as the tidal wave reaches the shallower areas of the UK continental shelf the speed of tidal currents increases greatly. This effect is particularly noticeable where the tide is forced through narrow channels, as for example in the Pentland Firth between the mainland coast and the Orkney Islands, where



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



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

tidal currents reach 4.5 m/s (Map 2.3.4).

Tidal flows are relatively weak within the Inner Moray Firth, attaining speeds of only 0.5 m/s, because the tidal waves cross the entrance of the firth in a south-easterly direction rather than being directed into it. Tidal current speeds are highest at the northern end of the firth, reaching approximately 1.5 m/s at Duncansby Head.

Local coastal irregularities distort the tidal cycle in the Moray Firth; one such feature operates locally between Cullen and Kinnairds Head (near Fraserburgh) on the southern coast, extending offshore for about 13 km. The southerly flood tide is deflected eastwards as it approaches the coast, while the area is 'sheltered' from a northerly or westerly flowing ebb current because of the curvature of the coastline beyond Kinnairds Head. The area therefore experiences easterly flood currents that are not cancelled by westerly ebb currents. An easterly flow runs for 9 hours on each tidal cycle and the flow is insignificant for the remaining 3 hours.

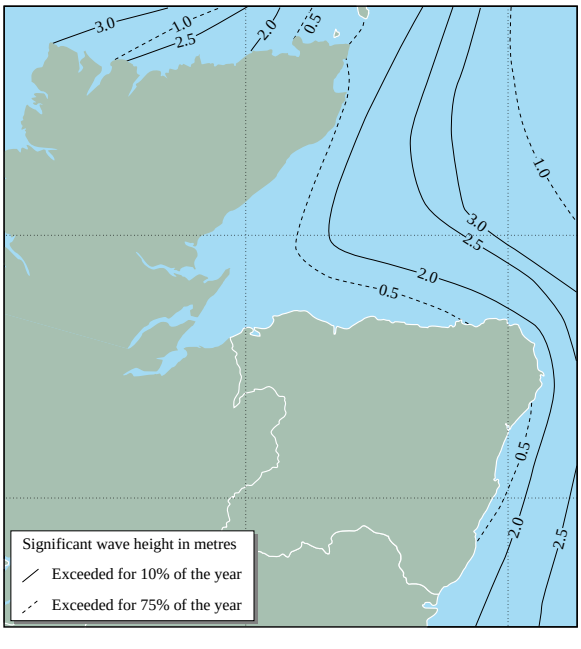
South of Kinnairds Head tidal currents are greater than in the Moray Firth, with values that are typical of the open coast of northern Britain. Values in the southern North Sea, English Channel and Irish Sea are higher because of the constricting effect of the surrounding coastlines.

2.3.4 Tidal range

In the Moray Firth the mean spring tidal range is approximately 3 m except in the inner firths, where it rises to approximately 3.5 m (Map 2.3.5). The north coast of Scotland experiences more influence from the North Atlantic tidal mechanisms and has a tidal range of about 4.0 m. South of Rattray Head, water movement is influenced by the tidal regime of the North Sea and has a tidal range at mean spring tides of between 3.5 and 4 m.

2.3.5 Wave exposure and sea state

Map 2.3.6 shows the significant wave heights that can be expected to be exceeded for 10% and 75% of the entire year. For example, in the outer part of the Moray Firth the significant wave height exceeds a value between 2 and 2.5 m for 10% of the year and exceeds a value of between 0.5 m to 1 m for 75% of the year. Heights are greatest at Cape Wrath, which receives high-energy Atlantic waves passing north of the Outer Hebrides, but they diminish eastwards along the north coast of Scotland, reaching a minimum in the Pentland Firth, where the Orkney Islands help to provide shelter. From Dunnet Head southwards wave heights are relatively constant on the open coast (i.e down to Lybster



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

and again to the south of Kinnairds Head) but they are considerably less in the sheltered and east-facing Moray Firth.

2.3.6 Water characteristics

Water temperature

The mean sea surface temperatures for summer and winter are shown on Map 2.3.7. The data shown are for August and February, which are the months of, respectively, highest and lowest average sea surface temperature. The north coast of Scotland is influenced by the North Atlantic Drift current, which carries oceanic water north and east through the Faroe - Shetland Channel to the Norwegian coast. This flow exerts a relative warming influence in winter and a cooling influence in summer. Average temperatures along the north coast are 12.5-13°C in summer and 6.5-7°C in winter. In summer the waters of eastern Caithness, along with the central Moray Firth, are the coldest coastal waters of mainland Britain, averaging less than 12.5°C, whereas in winter this area has warmer water than any coastal part of the North Sea north of the Thames Estuary (> 6°C). Within the inner Moray Firth and to the south of Kinnairds Head this mitigating effect is less apparent in both summer and winter.

Salinity

The term salinity is used to describe the total weight of dissolved salts present in seawater, and is expressed in g/kg. The salinity of the sea to the north of the Sutherland-Caithness coast between Cape Wrath and the Pentland Firth is slightly below that of normal sea water (35 g/kg), owing to the mixing of Atlantic water with low-salinity coastal waters (Map 2.3.8). A belt of low salinity water extends along the coast of the Inner Moray Firth and its southern shore, reflecting freshwater inflows from the Scottish hinterland. The change in salinity along the firth is clearly shown by the winter pattern of isohaline contours. Mixing of freshwater and oceanic water in the outer firth is facilitated by relatively strong tidal and wind-driven currents. The low-salinity coastal water extends further out into the Moray Firth in the first half of the year, whereas later in the year it becomes mixed with inflowing saline water (Harding-Hill 1993), which is reflected on the map by the bending into the firth of the summer 34.75 isohaline. South of Kinnairds Head salinity is slightly lower in both summer and winter.

2.3.7 Further sources of information

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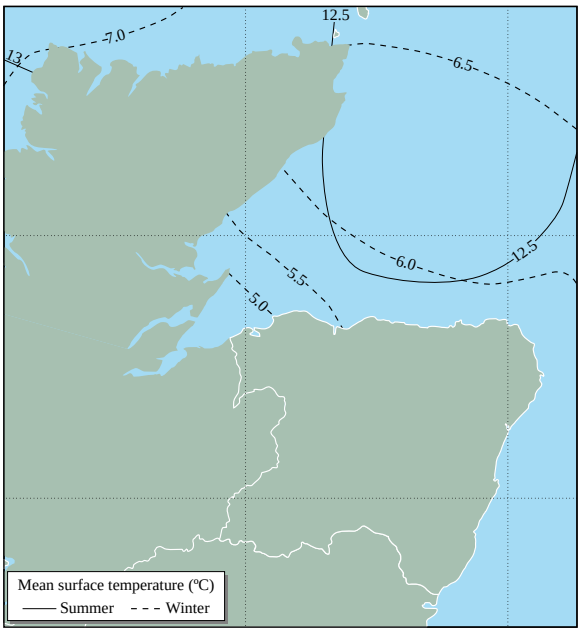
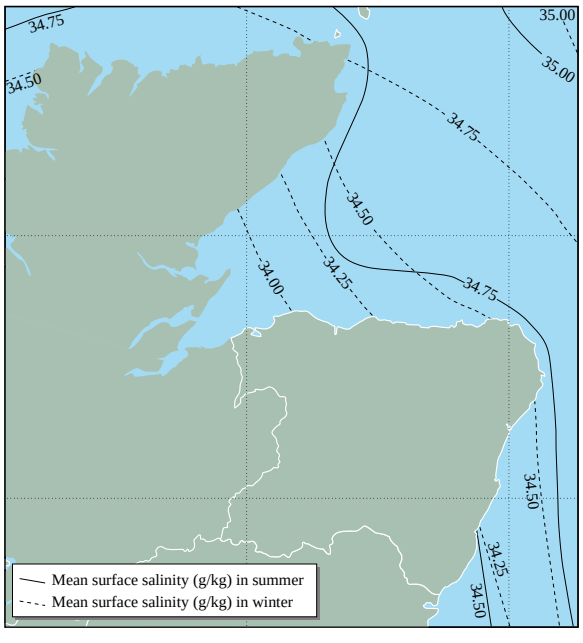
Sager, G., & Sammler, R. 1968. *Atlas der Gezeitenströme für die Nordsee, den Kanal und die Irische See*. Rostock, Seehydrographischer Dienst der DDR.



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



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

B. Further reading

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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, Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, tel: 0151 652 3950
Monthly, seasonal and annual windroses	Meteorological Office Marine Enquiry Service, Johnstone House, London Road, Bracknell RG12 2SY, tel: 01344 854979

Region 3 is famous for its exceptionally large and varied sand dune sites, which together comprise nearly half of the sand dunes on the UK's North Sea coast. At the Loch of Strathbeg, south-east of Fraserburgh, tidal currents flowing south meet northward wave-induced drift; shingle and sand deposited across the mouth of the stream obstructed its exit, creating an internationally important wetland.
Photo: Pat Doody.

2.4 Sediment transport

British Geological Survey

2.4.1 Description

Sediment transport is described within the context of coastal cells and sub-cells. These divide the coastline into sections within which sediment erosion and accretion are inter-related and largely independent of other cells. HR Wallingford (in prep.) have divided the coast of mainland Scotland into seven major littoral cells. The region includes two entire coastal cells: Cell 4, stretching from Cape Wrath to Duncansby Head and Cell 3, from Duncansby Head to Cairnbulg Point, as well as part of Cell 2, which reaches from Cairnbulg Point to Fife Ness (Region 4). Cell 3 is divided into seven sub-cells, 3a - 3g, and the part of Cell 2 in the region is divided into two sub-cells, 2c and 2d. These cells and sub-cells are described below and 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. In this region, with the exception of the central part of the outer Moray Firth between Lothbeg Point and Portknockie, there is little evidence of littoral drift or sediment accretion because the coastline is predominantly rocky and resistant to erosion, and so sediment supply is limited. The coasts of the region are subject to a wide range of wave and tidal energies, these being dependent on the orientation and morphology of each coastal sector.

Cell 4: Cape Wrath to Duncansby Head

This cell has a rocky coastline with pocket sandy beaches and larger intertidal sand flats at Durness, Tongue and Torrisdale. There is a larger beach at Dunnet Bay. Beaches are generally formed of offshore glacial deposits. Beach and cliff erosion are generally minor, although dune erosion is evident at Dunnet. Accretion is minor, as is longshore drift.

Sub-cell 3g: Duncansby Head to Lothbeg Point

Littoral processes are wave-dominated. Little erosion is evident in this predominantly cliffed sub-cell and there is little significant longshore drift. There is some accretion at Sinclair's Bay.

Sub-cell 3f: Lothbeg Point to Tarbat Ness

The Dornoch Firth has complex currents and patterns of drift: net drift is mainly southward to the north of the firth, and eastward to the south of it. There is both accretion and erosion in different parts of Morrich More. Elsewhere Tain, the Cuthill and Dornoch Links and Golspie are all suffering erosion, but there is accretion at Dornoch Point and to the south of Golspie.

Sub-cell 3e: Tarbat Ness to Chanonry Point

Wave action causes low rates of erosion along this coast, and there is some southward littoral drift evident at Rosemarkie.

Sub-cell 3d: Inner Moray Firth - Chanonry Point to Fort George

There is little erosion or accretion in this sub-cell, although wave action within the firth causes some sediment transport and erosion.

Sub-cell 3c: Fort George to Branderburgh

Strong westerly wave-induced drift of sand and shingle occurs in this sub-cell. Some erosion is taking place in Burghead Bay, along parts of the Culbin frontage, and at the eastern end of Whiteness Spit. Accretion is taking place at the Nairn Harbour breakwater and at the western end of Whiteness Head.

Sub-cell 3b: Branderburgh to Portknockie

Wave-induced westerly drift occurs throughout this sub-cell, resulting in the long Portgordon to Lossiemouth shingle ridge, which is cut by the River Spey. Sand is accreting at Lossiemouth, although there is also localised dune erosion there.

Sub-cell 3a: Portknockie to Cairnbulg Point

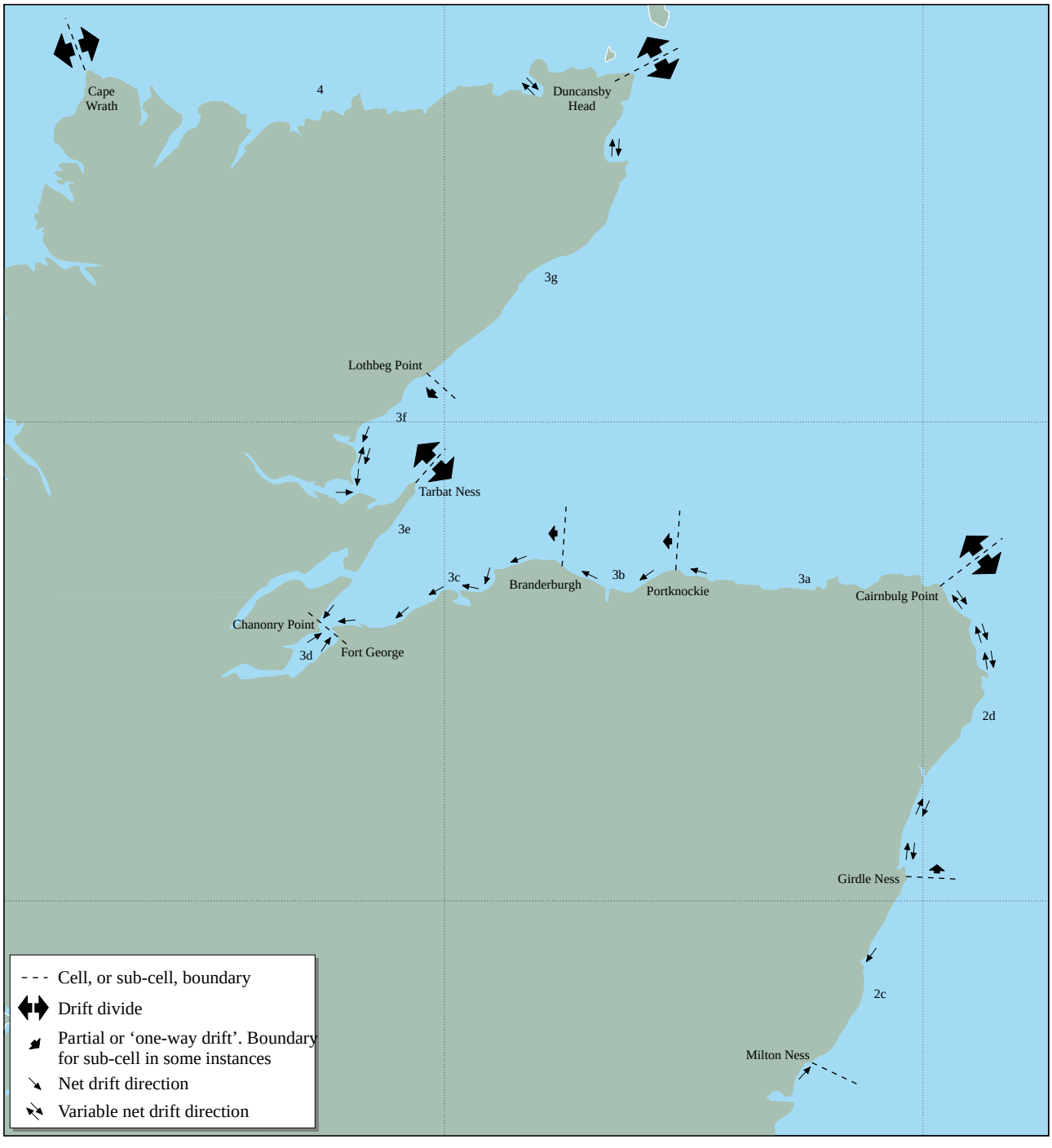
The sub-cell has many small beaches that tend to be isolated from each other. A low rate of erosion occurs on nearly all the frontal dune systems. There is little accretion and little evidence of significant longshore drift.

Sub-cell 2d: Cairnbulg Point to Girdle Ness

Nett littoral drift is low, as northward wave-induced drift is generally cancelled-out by southward tidal currents. River flows add another dimension of complexity. Dune erosion has taken place at Balmedie, Blackdog and St. Combs. There is slight accretion within the dune systems around Scotstown and Rattray Heads.

Sub-cell 2c: Girdle Ness to Milton Ness

Cliff retreat, although evident at Nigg Bay, occurs only slowly along this sub-cell. There are no areas of significant accretion, and no significant nett littoral drift. Slow accretion is taking place at St. Cyrus.



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

2.4.2 Further sources of information

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Institute of Estuarine and Coastal Sciences. 1995. *SNH Focus on Firths. Coastal landforms, processes and management options. III. The Dee, Don and Ythan Estuaries*. Edinburgh, Scottish Natural Heritage.

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 244 0213
Sediment cells	HR Wallingford Ltd, Howbury Park, Wallingford, Oxfordshire OX10 8BA, tel: 01491 835381
Review of erosion, deposition and flooding in Great Britain	Minerals Division, Room C15/19, Department of the Environment, 2 Marsham Street, London SW1P 3EB, tel: 0171 276 0900

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

2.5 Sea-level rise and flooding

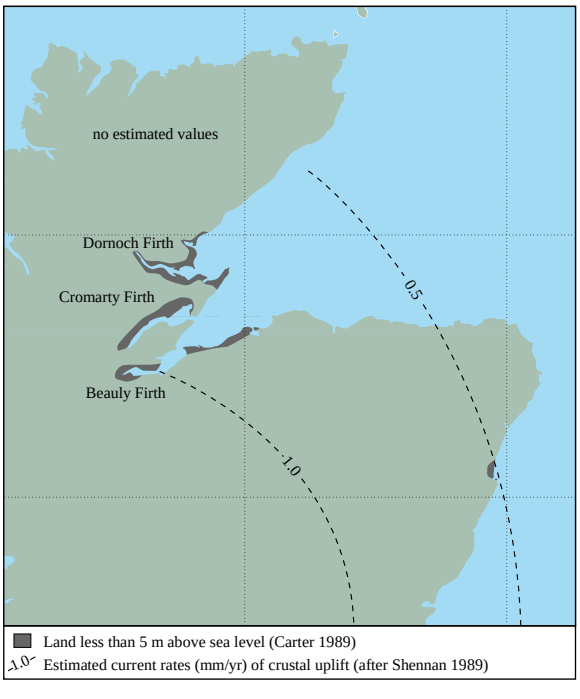
British Geological Survey

2.5.1 Sea-level changes in the region

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

There are a number of detailed studies of the evidence for sea-level rise and crustal movement in Britain (e.g. Shennan (1989), Carter (1989), Woodworth (1987) and Emery & Aubrey (1991)). According to Shennan (1989), crustal uplift at Aberdeen is occurring at a rate of 0.5-1 mm per year. Set against this, Woodworth (1990) suggests that global rates of sea level rise over the past century have been in the order of 1-2 mm per year. He found that relative sea level at Aberdeen was rising at a rate about 1.3 mm/year slower than at Newlyn (Cornwall: Region 11) (Woodworth 1987), and this discrepancy was attributed to the uplift of the Aberdeen station compared with a possible relative subsidence of the Newlyn station. However, the tide gauge data were complex, with inexplicably greater rises during the early part of the century than the later. The regional and temporal variability shown by the tide gauge data clearly identifies difficulties in estimating precise future changes in sea level.

Areas of possible flooding across the coasts of the region are few compared with southern and eastern parts of Britain. The low-lying areas surrounding the Dornoch, Cromarty and Beauly Firths are liable to flooding, especially when high tides coincide with high river levels (Map 2.5.1). Parts of urban Aberdeen are also low-lying and could experience flooding.



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

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Flood and coastal defence policy (see also section 8.4)	*Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD), Edinburgh, tel: 0131 244 0213
Review of erosion, deposition and flooding in Great Britain (maps and database)	Minerals Division, Room C15/19, Department of the Environment, 2 Marsham Street, London SW1P 3EB, tel: 0171 276 0900
Tide gauge data	British Oceanographic Data Centre, Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, tel: 0151 652 3950

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

2.6 Coastal landforms

British Geological Survey

2.6.1 Description

The coast of Scotland between Cape Wrath and St. Cyrus contains a wide diversity of landscapes, ranging from high rocky cliffs to extensive tracts of broad sandy beach (Map 2.6.1), and includes some of the wildest and most spectacular coastlines in Britain.

Cape Wrath - Helmsdale

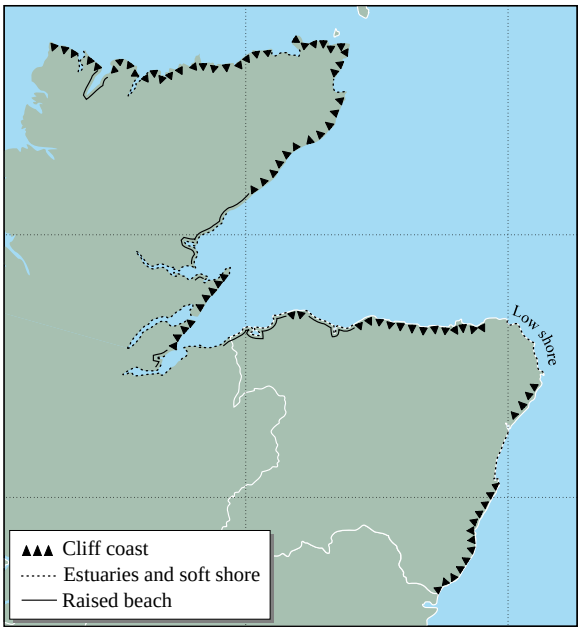
Practically the entire northern section of the coast as far south as Helmsdale is cliffbound, and variations in coastal morphology are closely related to changes in bedrock (see section 2.1.1). For instance, some of the tallest cliffs on mainland Britain are cut in Torridonian Sandstone immediately east of Cape Wrath, where they drop vertically from heights in excess of 180 m. In contrast the nearby Lewisian gneiss forms gentler slopes. The Cambrian limestone cliffs in the Durness area contain notches, benches and caves, cut when the sea level was higher than today; the latter include Smoo Cave, one of the best known features on the north coast.

The western part of the north coast is cut by three large inlets, extending 10-12 km inland, which display contrasting features. The Kyle of Durness and the Kyle of Tongue are extremely shallow, with sand flats exposed at low water. In contrast the subsea slopes of Loch Eriboll are steep and much of the sea bed lies more than 30 m below sea level. The shores of Loch Eriboll contain many examples of raised beaches and fossil cliffs, and, on the eastern side, Ard Neackie is joined to the shore by a raised tombolo (neck of sand and shingle).

Between the Kyle of Tongue and Melvich Bay the coastline is notably serrated, reflecting the great variation of lithologies found as the coast cuts across the layers of Moinian rocks. The larger bays have been cut in softer rock such as sandstone, or in well-jointed granite. East of Melvich Bay, where sandstone predominates, the shoreline is more uniform, with minor indentations caused by local erosion along the lines of joints, faults or dykes. Large breaks in the cliffs occur at Dunnet and Sinclair Bays, where there are fringing sand dunes up to 15 m high. A broad 'bench' has been cut by wave action at the base of the sandstone cliffs on the northern coast of Caithness, but this feature is largely absent from the east coast. There are a number of small islands off the north coast, the largest being Stroma. Elsewhere offshore features are confined to stacks, the most celebrated of which are at Duncansby and include one that is higher than the adjacent cliffs.

Helmsdale - Peterhead

There is a marked change in coastal morphology where the Helmsdale Fault runs out to sea, the cliffs giving way to a low platform cut in Mesozoic rocks with a number of particularly well-developed raised beaches. There are raised beaches of two ages on the shoreline of the Moray Firth, a late-glacial set and a post-glacial set, both of which have since become tilted upwards from the south-west as a result of glacial unloading and consequent uplift inland. Both sets are present in the Golspie area and around Inverness.



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

The coast of the Moray Firth between Golspie and Portgordon consists of sand and shingle spits and barriers, extensive sandy forelands and sandy marshes; all of these are associated with the present beaches or the post-glacial raised beaches. The coastline is backed in some places by extensive glacial deposits and in others by the lines of former cliffs, some of which are cut in the shingle of late-glacial raised beaches. Loch Fleet and the Dornoch Firth are partially obstructed by spits and the Inner Moray Firth is shut off from the open sea by the forelands of Fortrose and Fort George. There are long stretches of high coast on the Black Isle and the Tarbat peninsula, broken at Munlochy and the entrance to the Cromarty Firth by deep valleys. The linearity of this section of coast shows the effect of the Great Glen Fault on the coastal landscape.

The coast around Nairn is characterised by extensive spits, which have developed as a result of a westward movement of sand and shingle. The largest of these, known as The Bar, is over 7 km long and encloses substantial areas of saltmarsh (see sections 3.3 and 3.6). The Bar lies off the Culbin Sands, a large area of dune that is now largely afforested. There are sandstone cliffs between Hopeman and Lossiemouth in what is otherwise a 'soft' length of coast.

At Portgordon the old cliffs behind the beach merge with the present sea-cliffs and continue as far as Rosehearty, generally fronted by a rocky platform. The coastal area is plateau-like, and the cliffs, which range in height from 30 to 90 m, are mostly cut in Dalradian rocks. Old Red Sandstone forms short stretches containing large caves and cut in places by deep ravines. West of Rosehearty the cliff level falls, giving a low shore that extends to Peterhead. Initially

this comprises a rocky platform, but east of Fraserburgh it gives way to sandy beach with low outcrops of Dalradian rocks. Between St. Combs and the mouth of the River Ugie the beach is backed by an extensive area of dunes behind which lies the Loch of Strathbeg.

Peterhead - St. Cyrus

At Peterhead the sandy beach is replaced by a rocky platform, which gives way at Boddam to precipitous cliffs cut in red granite. The granite is well jointed giving rise to many stacks and caves and, at the Bullers of Buchan, a famous blowhole. The cliffs continue to Hackley Head, beyond which the rocky shore disappears below the Sands of Forvie, a large area of spit sand dunes at the mouth of the Ythan Estuary. Dune-backed sandy beaches characterise the coast southwards to Aberdeen.

Between the mouth of the Dee and the Highland Boundary Fault the coast is again dominated by rugged cliffs up to 30 m high, with numerous stacks and caves. The one major indentation, Nigg Bay, is carved out of glacial deposits. South of the fault the coastline is composed almost entirely of Old Red Sandstone cliffs. There are a few beaches, for example at Stonehaven and Inverbervie, which are mainly composed of shingle. There are no raised beaches or significant glacial deposits.

2.6.2 Further sources of information

A. Further reading

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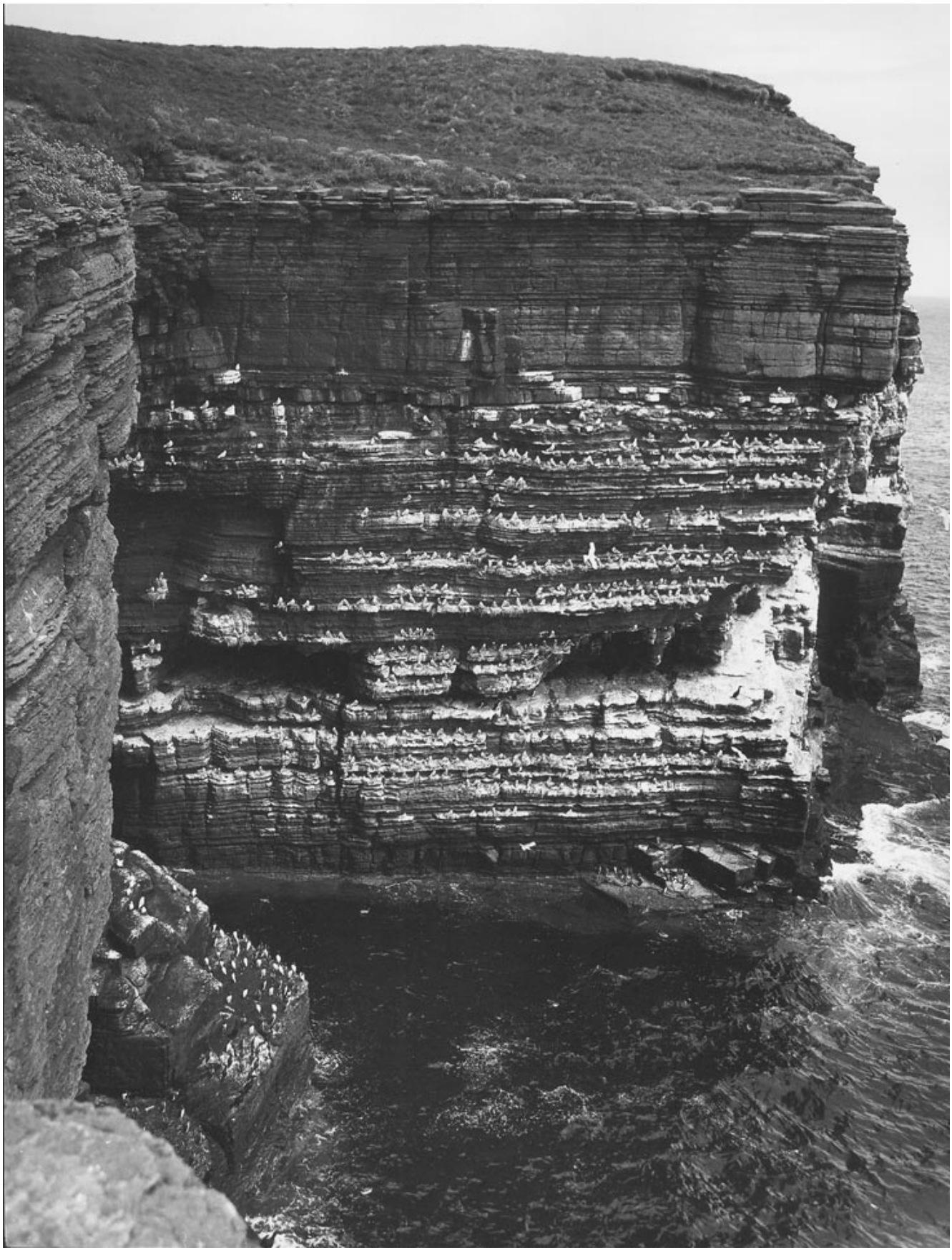
B. Contact names and addresses

Type of information	*Contact address and telephone no.*
Coast protection policy; sediment cells	*Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD), Edinburgh, tel: 0131 244 0213
Geomorphological information for region	Coastal Geology Group, British Geological Survey, Keyworth, Nottingham NG12 5GG, tel: 0115 936 3100

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



Cliffs in the region, and especially along the north shore of the Outer Moray Firth, hold internationally important numbers of several seabird species. Ledges in the spectacular vertical sandstone cliffs at Skirza Head support a mixed breeding colony predominantly of kittiwakes, with fulmars, cormorants, guillemots and herring gulls. Such mixed colonies are characteristic of the region.
Photo: Peter Wakely, English Nature.

Chapter 3 Terrestrial coastal habitats

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

Montane habitats in the region are particularly important for lower plants, which often become dominant in the harsh conditions prevalent at high altitudes (see also section 5.1). High altitude calcareous rocks, scarce in Britain, support very characteristic bryophyte and lichen communities, including many species with their centre of distribution in the Alps. An additional feature of the region is the juxtaposition of arctic-alpine lower plant communities and coastal communities, most notably in the area of Ben Hope (Sutherland), where the lower plant interest is further increased by the outcropping of basic rock at high altitude. Ben Hope is the most northerly outpost in Britain for calcicolous arctic-alpine lower plant communities. Other locations of montane habitat important for lower plants include Invernaver and Ben Hutig, both also in Sutherland. One feature that is particularly characteristic and confined to the most exposed northern coasts of Britain is the presence of montane heathland at sea level, often on wind-blown shell sand (see also section 5.2). Such heaths are widespread in the northern part of the region, with a few occurrences in the more exposed parts of the east coast. Montane heathland plant species can survive at sea level in these places because of the humidity, low temperatures and high degree of exposure.

The freshwater lochs close to the region's coast, such as the Durness lochs (Loch Croispol, Loch Borralie and Loch Caladail), are of particular importance, especially for rare and scarce flowering plants (see also section 5.2). The Durness lochs are a candidate Special Area of Conservation (SAC) under the EC Habitats & Species Directive and are the northernmost examples of lakes on limestone substrate in the UK; in addition they hold populations of a nationally rare fish, the Arctic char. The nationally rare Shetland pondweed *Potamogeton rutilus* (occurring in the Moray Firth area) is known to have declined in western Europe and has been considered as a candidate for protection under the Bern Convention, although it is as yet unprotected. Amphibians are likely to be abundant in the region's coastal freshwater bodies, although they have been very under-recorded in this region (see also section 5.6). The numerous small water-bodies just inland from the coast of Caithness probably support significant numbers of frogs, toads and palmate newts. Scotland is Britain's stronghold for otters, which occur throughout the coast of Highland and most of Grampian Regions, particularly associated with aquatic areas including freshwater lochs.

Actively growing blanket bog is a priority habitat for protection under the EC Habitats & Species Directive. The UK holds the entire European resource, and the Flow Country of Caithness and Sutherland contains a very large proportion of the total. This huge tract of peat, which dominates almost the whole of the interior of these two districts, extending in many places to within coastal 10 km squares, is considered to be "unique and of global significance". It is more than three times as large as any other peatland area in either Britain or Ireland. Important locations in the coastal 10 km squares of the region include Strathy Bogs (Sutherland), Stroupster Peatlands and Loch Calium Floes (Caithness), Pitmaduthy Moss (Ross & Cromarty), and Red Moss of Netherley (Kincardine & Deeside). Other, smaller areas of bog of various types, all of them of conservation significance, also occur in the region. Blanket bogs are important for a wide range of rare and scarce species, including lower plants, for which they are of international importance. Many species of *Sphagnum* and other associated bryophytes occur in them. The scarce bog orchid *Hammarbya paludosa*, which occurs in the region, is thought to have declined by over 80% in its few other localities in Europe. Bogs in the vicinity of the coast contain populations of many invertebrate rarities, including assemblages of boreal or arctic species (see also section 5.3).

There is little ancient semi-natural woodland on the region's coast. Nevertheless, invertebrates associated with various woodland habitats are well represented here; many of these species are restricted to Scotland. Amongst the rare species are several associated with pine and birch woods. Important woodlands for invertebrates include birches at Drummondreach Wood, pinewoods at Lossiemouth, aspens at Torboll Woods and conifer plantations on the dune system at Morrich More, which are also rich in lichens and bryophytes, including rarities. Some of the scrubby hazel wood in the north-west is valuable for its lower plant communities, including oceanic species. Inland from the coast remnants of the indigenous Scots pine forest - Caledonian forest - occur throughout Grampian. This too is a priority habitat under the EC Habitats & Species Directive, and the Scottish examples are distinctive and extremely important in a European context. Coastal 10 km-square instances include Amat Woods, west of Bonar Bridge on the Dornoch Firth, which is a candidate SAC as the most northerly pinewood in Britain, and woods in Strathspey (also a candidate SAC), on the south side of the Moray Firth. Caledonian forest is important for its characteristic assemblages of associated species of higher plants, lichens and bryophytes, invertebrates and birds, including the endemic Scottish crossbill, the capercaillie and black grouse. The woodlands of this region are an important habitat for the wildcat, which in Britain is restricted to Scotland, and for pine martens and red squirrels, which are reduced to relict populations in England and Wales (see also section 5.13). The wildcat is recorded from virtually all the Highland Region coast and is common in the northern area of Grampian. Red squirrels are dependent on large conifer plantations, such as are found in Grampian Region, in Roseisle and Culbin Forests, for example. Pine martens too are dependent on large, mixed conifer plantations. On the coast they are mainly associated with forest plantations in the Lybster and Bonar Bridge areas.

3.1 Cliffs and cliff-top vegetation

Dr T.C.D. Dargie

3.1.1 Introduction

Geology and geological structure, together with past environmental history (marine erosion past and present, and glacial processes), determine cliff form. The most distinctive cliff types are consolidated (hard cliffs developed from resistant bedrock) and unconsolidated (soft cliffs developed in easily-eroded materials, including unconsolidated Jurassic shales and Quaternary deposits).

The coast between Cape Wrath and the Grampian/Tayside boundary contains a large, diverse and spectacular length of cliff and cliff-top habitat. The only coastline in the region with a limited extent of cliffs is the Inner Moray Firth. The region has a total cliff length of 387.5 km (Table 3.1.1 and Map 3.1.1), representing 9.5% of the British resource, and is of high importance in the national context.

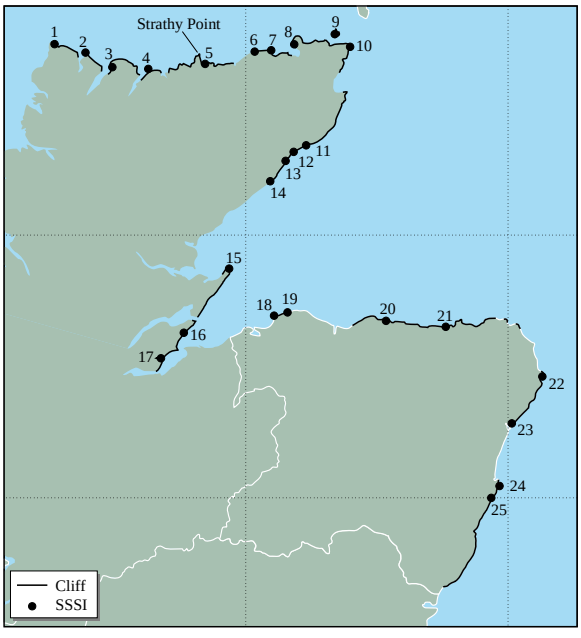
Table 3.1.1 Region's cliff resource in context

	Total	*% in Region 3*
Highland (east of 5° west)	279.0	-
Grampian	108.5	-
Region 3	***387.5***	-
Scotland	2,455.2	15.8
North Sea coast	1,817.0	21.3
Great Britain	4,060.7	9.5

Source: JNCC Coastal Resources Database

The extensive and diverse cliffs of the region are determined by many lithologies, with granite, limestone and sandstone the commonest types. Hard cliffs predominate in the region and there are relatively few examples of soft types; the few that occur are of glacial till overlying cliffed bedrock. Tall vertical cliffs, steep non-vertical types, headlands, caves, geos, blowholes and stacks are all common in the region and there are also cliffed islands (largely restricted to the north coast of Sutherland and Caithness). Table 3.1.2 summarises the extent of cliffs of different forms in the region.

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



Map 3.1.1 Cliffs and cliff-top habitat. Marked sectors have >90% cliffed coast. Numbered sites are SSSIs listed in Table 3.1.3. Source: JNCC Cliffs Database.

around headlands. The major natural and semi-natural cliff and cliff-top habitats in Great Britain are bare ground, spray-zone lichen-covered rock, rock crevice, cliff-ledge, 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 undercliff vegetation of scrub, tall herb and rank grassland, often very close to the sea. Such cliffs are rare in the region and undercliff vegetation is probably very restricted (examples are present at Collieston, Gordon District). The full regional extent of cliff-top habitat has not been surveyed. However, the exposure of the coast to northerly and easterly winds and heavy spray deposition allows maritime cliff grassland and heath to develop extensively. The overall extent of these habitats is perhaps the largest in any region in Britain.

The National Vegetation Classification (NVC - Rodwell in prep.) covers twelve maritime cliff communities, though

Table 3.1.2 Lengths (km) of cliff types

	Vertical >20 m height		*Vertical <20 m height*		*Non-vertical >20 m height*		*Non-vertical <20 m height*	
Area	*Length (km)*	*% of total length in Region 3*	*Length (km)*	*% of total length in Region 3*	*Length (km)*	*% of total length in Region 3*	*Length (km)*	*% of total length in Region 3*
Highland (east of 5° west)	110.5	-	48	-	78	-	42.5	-
Grampian	48	-	1.5	-	55	-	4	-
Region 3	158.5	-	49.5	-	133	-	46.5	-
Scotland	662.9	23.9	725.4	6.8	724	18.4	342.9	13.6
North Sea coast	604.5	26.2	382	13.0	570	23.3	260.5	17.9
Great Britain	1,327.9	11.9	817.9	6.1	1,378.5	9.7	541.9	8.6

Source: JNCC Coastal Resources Database

almost all refer to hard cliff habitats, of which two are probably confined to Scotland (MC2 thrift *Armeria maritima* - Scots lovage *Ligusticum scoticum* maritime rock crevice, MC3 roseroot *Sedum rosea* - thrift *Armeria maritima* cliff ledge. Both are present in the region. Eight out of twelve NVC cliff communities are present in the region, with common types perhaps having their highest frequency in Britain here. In Great Britain nine nationally rare and four nationally scarce species or subspecies of higher plant are found mainly or exclusively on cliffs. Most, however, are restricted to cliff habitats in the south and west of Britain, with comparatively few present in the region (see also section 5.2).

The scenic contribution of cliffs within the region is outstanding. A few sectors of the region's cliffs, notably around Cape Wrath, are very inaccessible and are perhaps the best examples of wilderness coast on the British mainland. Although none of these cliffs is within a National Scenic Area, many are within Areas of Greater Landscape Value (see also sections 7.3.4 and 7.4.4).

3.1.2 Important locations and species

Vertical cliff forms are extensive, with many outstanding examples along the north coast of Sutherland and Caithness. The highest vertical cliffs reach 190 m at Clo Mor, east of Cape Wrath. Non-vertical forms are also common, with extensive coastal grassland on the higher parts. Notable examples are long sectors of the eastern Caithness coast, the cliffs of the southern side of the outer Moray Firth, and the coast north and south of Aberdeen. Narrow raised beaches are present at the foot of cliffs around the Black Isle and Tarbat Ness in the Moray Firth.

Dickie's bladder-fern *Cystopteris dickieana* is a national rarity present in sea caves in Kincardine and Deeside (the only remaining British location for this arctic and montane fern), and one nationally scarce species is present in the region: yellow-vetch *Vicia lutea*. Other nationally rare and scarce species more typical of other habitats also occur on cliffs. One such nationally rare species (purple oxytropis *Oxytropis halleri*) and three nationally scarce species (Scottish primrose *Primula scotica*, spring cinquefoil *Potentilla tabernaemontani* and wild cabbage *Brassica oleracea*) are present in the region. Maritime heath is an important national feature of cliff-top habitat and is probably very extensive on most cliffed coast in the region. Arctic-alpine species are present in some north Sutherland and Caithness maritime heaths, the core area for this distinctive vegetation type in Britain.

Maritime cliff grassland and heath habitats are included in the citations of 25 Sites of Special Scientific Interest (SSSIs) (Table 3.1.3 and Map 3.1.1). The Strathy Point coast, Sutherland (not an SSSI), is also recognised as important for its botanical interest (Doody, Johnston & Smith 1993). No lichen heath of national or regional importance is recorded for regional cliffs (Fletcher *et al*. 1984).

The regional bird fauna of cliffs is of national and international importance. Seabird numbers, either in total or for individual species, reach levels of international importance at six sites (all SSSIs): Cape Wrath; Caithness Cliffs; Troup, Pennan and Lion Heads; Buchan Ness to Collieston coast; and Fowlsheugh (Stroud *et al.* 1990) (see also section 5.10). Several other sites are of national importance for seabirds and are designated as SSSIs: Eilean nan Ron, Red Point Coast, Dunnet Head, Stroma, and Berriedale Cliffs. No systematic survey of invertebrates in cliff and cliff-top habitats has been carried out in the region but these environments have a rich habitat diversity and thus can be expected to support large numbers of species (Mitchley & Malloch 1991). A few cliffs in the region are known to have good invertebrate lists, including several notable and rare (Red Data Book) species: Muchalls Coast (Grampian), Eriboll SSSI and Cape Wrath - Durness SSSI (all Highland) are regionally important cliff locations in the JNCC's Invertebrate Site Register (see also section 5.3); however their known overall interest is low compared with that of cliffs in regions further south, and they probably require further detailed study.

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). Although little is known of its role in the region, grazing is common in many areas and few sites have low grazing pressure. Much of the cliffed coast is developed for agriculture, especially crofting in Highland Region, and this has resulted in the

Table 3.1.3 Region 3 biological SSSIs noted for their cliff and cliff-top habitat

Site no. on Map 3.1.1	*Location*	*Grid ref.*
1	Cape Wrath	NC260740
2	Durness	NC380670
3	Eriboll	NC445570
4	Eilean nan Ron	NC638655
5	Red Point Coast	NC930657
6	Ushat Head	ND035710
7	Holborn Head	ND073712
8	Dunnet Head	ND207713
9	Stroma	ND350780
10	Duncansby Head	ND397710
11	Castle of Old Wick to Craig Hammell	ND371489
12	Craig Hammell to Sgaps Geo	ND362464
13	Sgaps Geo to Dunbeath	ND297371
14	Berriedale Cliffs	ND158280
15	Tarbat Ness	NH949879
16	Rosemarkie to Shandwick Coast	NH744586
17	Munlochy Bay	NH672528
18	Masonshaugh	NJ120693
19	Clashach to Covesea	NJ167704
20	Cullen to Stakeness Coast	NJ574669
21	Gamrie and Pennan Coast	NJ824673
22	Bullers of Buchan Coast	NK110380
23	Collieston to Whinnyfold Coast	NK060310
24	Cove	NJ954005
25	Fowlsheugh	NO881799

Source: JNCC integrated coastal database. Note: other cliff SSSIs in the region have been notified for their geological interest (see section 7.3.2).

conversion of some coastal heath and grassland into improved grassland. Footpaths have heavy usage in a few parts of the region and local erosion is present. Large coastal settlements on cliffs are rare and the only major industrial development in the region is the nuclear power research establishment at Dounreay in Caithness. Military shelling and bombing of cliffs takes place over a relatively small area at Clo Mor, east of Cape Wrath. There is little caravan park development close to cliffs and there are few car parks. In general visitor erosion and residential development have caused very little local habitat loss or vegetation disturbance. Other activities include tourism, particularly at ancient and medieval sites, such as Dunnottar Castle and Slains Castle (see also section 9.7).

Many cliffs in the area have the remains of Second World War defences on them, e.g. Soutars at Cromarty. Historic Scotland are currently undertaking a survey of these with a view to scheduling some for their historic interest (see also Chapter 6). Virtually none of the cliffs in the region have coast protection works at their base, and hence natural coastal erosion is prevalent. Localised, relatively minor cliff recession problems occur along this coast. Notable areas include Dunbeath to Helmsdale on the Sutherland coast, Cullen to Gardenstown on the north Grampian coast, and Stonehaven, where the east coast railway is at risk (Jones & Lee 1994).

Most cliffed sections are in Preferred Coastal Conservation Zones or Coastal Protection Zones (Moray), areas in which there is a presumption against development (see also section 7.4.5).

3.1.4 Information sources used

Three regional sites have been mapped using the NVC system (Cooper 1988a, b, c): Fowlsheugh (Kincardine and Deeside), Troup Head (Banff & Buchan) and Duncansby Head (Caithness). NVC surveys use a reliable, consistent methodology yielding very detailed information (Rodwell in prep.). The vegetation is mapped and described, and information on coastal erosion and accretion, atypical vegetation and adjoining land use is also recorded. The data represent a sound baseline for future cliff vegetation studies and both strategic and local management of the cliff resource. No other detailed surveys exist for the region apart from those of the extent of different habitats in SSSIs. Existing information is insufficient to detail the regional extent of individual cliff and cliff-top habitats.

3.1.5 Acknowledgements

Assistance with sources was kindly provided by Scottish Natural Heritage and JNCC's Coastal Conservation and Species Conservation Branches. Thanks are due to Belinda Millar, Grampian Regional Council, for her useful comments. Thanks also go to Rendel Geotechnics for information on cliff erosion.

3.1.6 Further sources of information

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B. Further reading

Further details of coastal habitat sites, including cliffs, are available on the *Coastal & marine UKDMAP datasets* module disseminated by JNCC Coastal Conservation Branch, Peterborough (Barne *et al.* 1994).

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

Urquhart,U.H., & Gimingham, C.H. 1979. *Maritime heath in northern Scotland.* Edinburgh, Nature Conservancy.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Flora, fauna, habitat information, location of site reports, site management	*Coastal Ecologist, Aquatic Environments Branch, SNH, Edinburgh, tel: 0131 554 9797
Advice on national and international policy and cliff conservation	*Coastal Conservation Branch, JNCC, Peterborough, tel: 01733 62626
Cliff erosion	Rendel Geotechnics, Norfolk House, Smallbrook Queensway, Birmingham B5 4LJ, tel: 0121 627 1777
Invertebrate fauna	*Invertebrate Site Register (ISR), Species Conservation Branch, JNCC, Peterborough, tel: 01733 62626

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

3.2 Sand dunes

Dr T.C.D. Dargie

3.2.1 Introduction

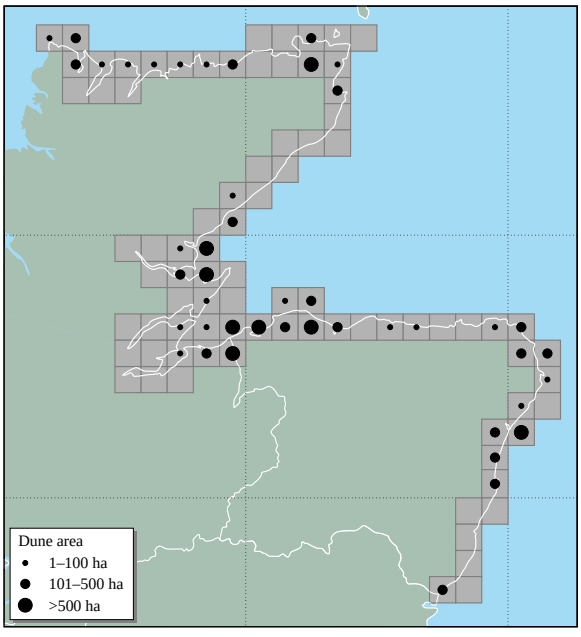
The region contains an exceptionally large and varied set of sand dune systems, with a total of 83 dune and machair sites and an estimated 12,329 ha of vegetated sand and other land cover (including car parks etc.). They make up an estimated 39% of the dune resource for Scotland, 49% of that of the North Sea coast and 25% of all British dunes, the largest percentage for any region. Vegetated sand dunes in the region are therefore clearly of great importance in the national context (Table 3.2.1). The overall distribution of vegetated sand dunes in the region is shown in Map 3.2.1, with major concentrations in north-east Highland, around the Moray Firth and the Fraserburgh - Aberdeen coast.

Some 80 NVC (National Vegetation Classification) communities have so far been recorded for Scottish dunes, with a total of 110 types for communities and sub-communities combined, out of 90 communities and 156 sub-communities recorded for all England, Scotland and Wales, not all of them exclusive to dunes. Dunes thus show great habitat diversity, involving many types of vegetation (Rodwell in prep.). Scotland is particularly notable in having the largest national area of all sand dune NVC vegetation types combined, especially in terms of the extent of semi-fixed dune (SD7 marram *Ammophila arenaria* - red fescue *Festuca rubra* community), fixed calcareous dune grassland (SD8 red fescue *Festuca rubra* - lady's bedstraw *Galium verum* community), acidic dune grassland (SD12 sand sedge *Carex arenaria* - sheep's fescue *Festuca ovina* - common bent *Agrostis capillaris* community), lichen-rich dune (SD10 sand sedge *Carex arenaria* - lichen *Cornicularia aculeata* community) and dune heath (H11 sand sedge *Carex arenaria* - heather *Calluna vulgaris* community). Scottish dunes also have a large area of wet heath, mire and swamp habitat (*c.* 3,800 ha). Some NVC surveys suggest that vegetation types in parts of Scotland are anomalous to the NVC system and new NVC community types might be required to accommodate this variation. Poor conifer growth after planting at Culbin (Lusby 1990) and Littleferry has allowed vegetation similar to native pine woodland (NVC community W18 Scots pine *Pinus sylvestris* - feather moss *Hylocomium splendens*) to develop. The NVC dune vegetation and other vegetation types can be aggregated into eleven groups, which represent the major dune habitats (Table 3.2.2). No nationally rare species confined to dunes are found in Scotland.

Table 3.2.1 Region 3 vegetated dune resource[a] in context

	Total area (ha)	*% of total in Region 3*
Highland east of 5°W	5,307	43.0
Grampian	7,022	57.0
Region 3	***12,329***	***100***
Scotland	31,540	39.1
North Sea Coast	25,356	48.6
GB	50,200	24.5

Sources: Dargie (1993, 1995), Radley (1994), JNCC Coastal Resources Database. Key: [a]all figures have been rounded to the nearest whole hectare. Note: totals for Scotland and therefore Great Britain are provisional estimates.



Map 3.2.1 Areas of sand dune by coastal 10 km square. Source: JNCC Sand Dune Database.

The large extent and diverse range of dune types make the sand dunes of the region of great interest. This is reflected in eleven Site of Special Scientific Interest (SSSI) designations and four National Nature Reserves (NNRs) (see also sections 7.3.1 and 7.3.2). The total area of dune vegetation of SSSI status is probably *c.* 7,080 ha (*c.* 57% of the regional dune extent). Several sites fall within National Scenic Areas (see also section 7.3.4).

3.2.2 Important locations and species

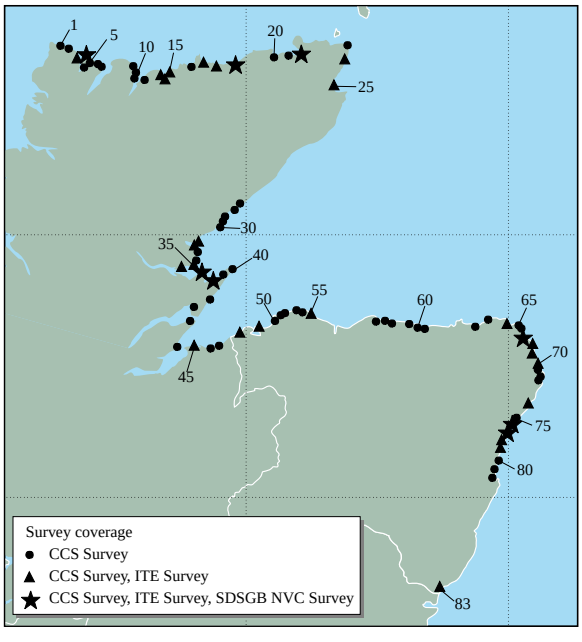
The distribution of sites of vegetated blown sand shows contrasts between scattered small areas (with the exception of Dunnet Bay) along the northern Sutherland and Caithness coast and a major concentration on the Inner Moray Firth, with an intermediate pattern on the eastern Grampian coast. The size of most sites is unknown but the region contains four very large dune systems: Dunnet Bay (690 ha), Sands of Forvie (763 ha), Morrich More (1,240 ha) and Culbin Sands (*c.* 3,100 ha, the largest site in Britain). The majority of sites are small bay dunes on the north coast, developed upon sand trapped within the shelter of rock headlands. The largest of these bay dune systems is Dunnet Bay, which also contains grassland of subdued relief, forming a dune plain termed machair (Ritchie 1976). Such machair is an exposed form of hindshore dune, developed above beaches with a good sand supply and an onshore prevailing wind which drives sand inland (Ranwell & Boar 1986). A further feature of bay dunes on the northern Sutherland and Caithness coast is sand blown up steep slopes, forming a thin layer of climbing dune. Underlying geology is a strong influence and the Durness limestone of

Table 3.2.2 Areas of dune vegetation types (ha) [a]

	Strand and embryo dune	*Mobile and semi-fixed dune*	*Acidic fixed dune grass-land*	*Neutral and calcareous fixed dune grassland*	*Dune heath and bracken*	*Dune slack*	*Other dune wetland*	*Dune woodland and scrub*	*Trans-itions to salt-marsh*	*Trans-itions to mari-time cliff*	*Other land cover*
Highland east of 5°W	7	130	54	665	406	91	150	200	200	3	rare
Grampian	7	312	170	181	312	35	64	3,500	0	1	rare
Region 3	***14***	***443***	***224***	***846***	***718***	***125***	***214***	***3,700***	***200***	***4***	***rare***
Scotland	61	4,059	4,125	10,513	2,113	1,095	3,817	5,500	217	41	587
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 Coastal Resources Database. Key: [a] all figures have been rounded to the nearest whole hectare; n/a = not available. Note: totals for Scotland and therefore Great Britain are provisional estimates.

the Kyle of Durness and Torrisdale Bay/Invernaver have unique montane grassland and heath types developed on climbing dunes at very low altitudes. Spit dunes are also common, usually developing at the mouths of estuaries. Large examples are developed at the mouth of the Ythan Estuary (Sands of Forvie), Dornoch Firth (Dornoch Point) and Loch Fleet (Littleferry Dunes and Coul Links), with a smaller example at Findhorn. Strong currents on the southern Moray Firth coast also form spits or offshore islands at Whiteness Head and Culbin, without an active river influence. Ness or foreland dunes (e.g. Morrich More, Cuthill to Dornoch) are rare in the region, developing on shores with sand supply from two directions and gradually extending (prograding) seawards. Morrich More is a very large site developing in association with large extents of saltmarsh behind an offshore island and bar (Smith & Mather 1973). The very extensive sand dunes of Culbin are developed on a ness/foreland system of shingle ridges but most typical dune vegetation and bare sand have been replaced by conifer afforestation. Parabolic dunes at Culbin, stabilised by forestry, are the largest in Europe (Comber, Hansom & Fahy 1993). Vegetated sand dune sites in the region are listed in Table 3.2.3 and shown on Map 3.2.2.



Map 3.2.2 Surveyed dune sites. Numbers refer to Table 3.2.3. Source: JNCC Sand Dune Database.

In the region calcareous dunes are largely restricted to the machairs of the north coast, with acidic dune grasslands predominating elsewhere, often with extensive lichen dune and dune heath. Several of the region's dune systems are rich in bryophytes, and lichen diversity is particularly high (Fletcher *et al*. 1984; Fryday 1992). Balnakeil Bay and Dunnet Bay are recognised as important sites for machair lichens. For acidic substrates Culbin is outstanding for lichens, for which Sands of Forvie, Cuthill, Littleferry Dunes, Coul Links and Whiteness Head are also of great interest. New NVC SD7 and SD12 types might be needed to cover two vegetation communities found in this region: one rich in feather mosses (e.g. *Hylocomium splendens*), the other comprising dune scrub with juniper *Juniperus communis communis* (Dargie 1993). All five nationally scarce dune species found in Scotland occur in the region: seaside centaury *Centaurium littorale*, variegated horsetail *Equisetum variegatum*, Baltic rush *Juncus balticus*, rush-leaved fescue *Festuca juncifolia* and curved sedge *Carex maritima*.

The larger dune systems in the region develop a watertable which influences the vegetation of depressions, forming a distinct and nationally rare type of wetland termed dune slack. In machair and large spit dune systems slacks form in depressions in the rear of parabolic dune blowouts, which are initiated by storms and migrate across a site. The best regional examples are at Sands of Forvie (Landsberg 1955; Spiller 1980). Ness/foreland slacks usually develop from saltmarsh isolated from tidal influence by developing dunes, and young examples show strongly brackish characteristics, e.g. at Morrich More (Dargie 1989). Large bay dunes often develop a slack termed a winter loch behind the outer dune ridge. In some cases open water is present all year: the Loch of Strathbeg is the largest dune freshwater system in Britain.

Dune water bodies support internationally significant bird numbers at Loch of Strathbeg, with foreshore areas equally important at Loch Fleet, Lower Dornoch Firth, the Moray Firth (Munlochy Bay to Findhorn Bay) and Sands of Forvie (Stroud, Mudge & Pienkowski 1990). JNCC's Invertebrate Site Register indicates that Culbin and St. Cyrus are outstanding sites, with Loch Fleet (Littleferry and Coull), Morrich More, Invernaver, Lossiemouth, Findhorn and Sands of Forvie all of high interest (see also section 5.3).

Table 3.2.3 Sand dune sites in region

Site no.[a]	*Name*	*Grid ref.*	*Area (ha)*[b]	*Conservation status*	*Dune type*	*Survey type*
1	Kervaig Bay	NC292728			Bay, machair, climbing	CCS
2	Keoldale	NC382662			Bay, machair	CCS
3	Kyle of Durness	NC370680			Bay, machair, climbing	CCS, ITE
4	Balnakeil Bay	NC393694	166		Bay, machair, climbing	CCS, ITE, SDSGB
5	Creag Thairbe	NC406685			Bay	CCS
6	Sango Bay	NC409675			Bay	CCS
7	Sangobeg	NC428662			Bay	CCS
8	Traigh Allt Chailgeag	NC443655			Bay	CCS
9	Achininver	NC574650			Bay, machair	CCS
10	Talmine	NC586627			Bay	CCS
11	Melness	NC588606			Bay, machair	CCS
12	Coldbackie	NC610603			Bay	CCS
13	Torrisdale Bay	NC690619		NSA	Bay	CCS, ITE
14	Invernaver	NC700615		NNR, NSA, SSSI	Bay, climbing	CCS, ITE
15	Farr Bay	NC713625			Bay, machair, climbing	CCS, ITE
16	Armadale	NC793646			Bay, machair, climbing	CCS
17	Strathy	NC836661			Bay, machair	CCS, ITE
18	Melvich	NC885651			Bay, machair	CCS, ITE
19	Sandside Bay	NC963653	80	SSSI	Bay, machair	CCS, ITE, SDSGB
20	Thurso Bay	ND115687			Bay	CCS
21	Murkle Bay	ND170693			Bay	CCS
22	Dunnet Bay	ND215695	690	NNR, SSSI	Bay, machair	CCS, ITE, SDSGB
23	Sannick	ND397736			Bay	CCS
24	Freswick	ND377675			Bay, climbing	CCS, ITE
25	Sinclair's Bay	ND340580			Bay, spit	CCS, ITE
26	Kilmote	NC978111			Bay	CCS
27	Crakaig	NC961098			Bay	CCS
28	Kintradwell	NC920072			Bay	CCS
29	Brora Dalchalm	NC915055			Bay	CCS
30	Brora South	NC905033			Bay	CCS
31	Littleferry to Golspie	NH820970		SSSI, SWT	Spit, bay	CCS, ITE
32	Coul Links	NH815947		SSSI, SWT	Spit, bay	CCS, ITE
33	Embo	NH818930			Bay	CCS
34	Dornoch North	NH807905			Bay	CCS
35	Dornoch South	NH805890		NSA, SSSI	Spit	CCS, ITE
36	Cuthill Links	NH754875		NSA, SSSI	Relict, bay	CCS, ITE
37	Morrich More	NH835857	1,240	NSA, SSSI	Island, ness/foreland	CCS, ITE, SDSGB
38	Inver to Arboll	NH875828	28		Bay, spit	CCS, ITE, SDSGB
39	Portmahomack	NH915844			Bay	CCS
40	Wilkhaven	NH946872			Bay	CCS
41	Balintore	NH860753			Bay	CCS
42	Nigg	NH800723			Climbing	CCS
43	Cromarty	NH784673			Bay	CCS
44	Rosemarkie	NH738576			Bay	CCS
45	Whiteness Head	NH803587		SSSI	Spit	CCS, ITE
46	Nairn West	NH860568			Bay	CCS
47	Nairn East	NH895576			Bay	CCS
48	Culbin	NH980630		SSSI	Island, spit, ness/foreland	CCS, ITE
49	Findhorn	NJ050648			Spit	CCS, ITE
50	Burghead Bay	NJ110680			Bay	CCS
51	Cummingstown	NJ132693			Bay	CCS
52	Hopeman	NJ143698			Bay	CCS
53	Covesea	NJ195713			Bay	CCS
54	Stotfield	NJ224709			Bay	CCS
55	Lossiemouth East	NJ250696			Bay	CCS, ITE
56	Cullen Bay	NJ500677			Bay	CCS
57	Findlater	NJ537673			Bay	CCS
58	Sandend	NJ557662			Bay	CCS
59	Whyntie Head	NJ630660			Bay	CCS
60	Boyndie Bay	NJ671647			Bay	CCS
61	Banff Bay	NJ695641			Bay	CCS
62	New Aberdour	NJ886647			Bay	CCS
63	Rosehearty	NJ935676			Bay	CCS
64	Fraserburgh Bay	NK010654			Bay, spit	CCS, ITE
65	Inverallochy	NK050645			Bay	CCS
66	St. Combs	NK053637			Bay	CCS

Table 3.2.3 Sand dune sites in region (continued)

Site no.[a]	*Name*	*Grid ref.*	*Area (ha)*[b]	*Conservation status*	*Dune type*	*Survey type*
67	Strathbeg	NK080597	450	RSPB, SSSI	Spit, bay	CCS, ITE, SDSGB
68	Rattray Head	NK104580			Bay	CCS, ITE
69	Rattray Bay	NK104550			Bay	CCS, ITE
70	Kirkton	NK119506			Bay	CCS, ITE
71	Ugie to Lunderton	NK117490			Bay	CCS
72	Peterhead	NK124452			Bay	CCS
73	Sandford Bay	NK123438			Bay	CCS
74	Cruden Bay	NK084350			Bay	CCS, ITE
75	Collieston	NK040285			Bay	CCS
76	Sands of Forvie	NK020270	763	NNR, SSSI	Spit, bay, climbing	CCS, ITE, SDSGB
77	Foveran to Drums	NK003233		SSSI	Bay, spit	CCS, ITE, SDSGB
78	Menie to Pettens	NJ990205		SSSI	Bay	CCS, ITE
79	Balmedie	NJ978177			Bay	CCS, ITE
80	Blackdog to Murcar	NJ965135			Bay	CCS
81	Bridge of Don	NJ956105			Bay	CCS
82	Aberdeen	NJ953070			Bay	CCS
83	St. Cyrus	NO753644		NNR, SSSI	Bay, spit	CCS, ITE

Sources: Dargie (1993); Mather & Ritchie (1978); Ritchie & Mather (1969, 1970, 1984); Ritchie, Smith & Rose (1978); Smith & Mather (1973); Research and Advisory Services Directorate, Scottish Natural Heritage. Key: [a]see Map 3.2.2; [b]all figures have been rounded to the nearest whole hectare; NNR = National Nature Reserve; NSA = National Scenic Area; RSPB = Royal Society for the Protection of Birds Reserve; SSSI = (Biological) Site of Special Scientific Interest; SWT = Scottish Wildlife Trust Reserve; CCS = Countryside Commission for Scotland (University of Aberdeen beach reports); ITE = Institute of Terrestrial Ecology Scottish Coastal Survey; SDSGB = NCC's Sand Dune Survey of Great Britain.

3.2.3 Human activities

In general, sand dunes are amongst the least heavily modified of terrestrial habitats. Conservation is now a major activity in many locations, with many sites having one or more designations or forms of planning control (Table 3.2.3). However, the inner edge of many sand dune sites in the region has been affected by a variety of human impacts, sometimes leading to major habitat loss or conversion to vegetation that is common and lacks typical dune species (Doody 1989). The most notable case is the loss of a large dune area to afforestation at Culbin. Industrial development has destroyed the coastal edge of dunes at Nigg, and pipeline fabrication yards impact locally on dunes at Sinclair's Bay and Morrich More. Gas pipeline landfalls are routed through dunes at Cruden Bay and Rattray Bay. However, the total area of damage to dune habitat from such development is low. Recreational development has encroached on many sites, and car parks, caravan and camp sites and golf courses are very common (Harding-Hill 1993). A total of 26 sites contain golf courses, but most cause little damage, though the course at Durness is routed through rare habitats and has created concern (Evans 1987). Military use is present on several sites (notably Morrich More), but the total area of impact and damage is slight (Hansom & Leafe 1990). Heavy visitor pressure has been present for at least two decades at Sango Bay, Dunnet Bay, Dornoch South, Nairn West, Nairn East, Findhorn, Stotfield, Peterhead, Bridge of Don, Aberdeen and St. Cyrus, but severe problems of widespread erosion, vegetation trampling or dune destabilisation are rare. Most dune sites are grazed by stock on an extensive scale, which maintains biological diversity, though winter feeding and consequent grassland improvement have occurred at Loch of Strathbeg. Uncontrolled rabbit grazing is common on most dunes and causes local erosion at a few sites (e.g. Farr Bay). Re-seeding and fertiliser addition have modified some vegetation at Dunnet Bay and Loch of Strathbeg. At the latter, sand is being removed from the beach in four 1 km squares and from dunes in three. Findhorn has recently required major coastal defences to protect residential and recreational development, with some fear that new groynes will reduce sediment supply to Culbin and enhance rates of erosion to parts of the SSSI frontage (ASH Consulting Group 1994). Rock riprap has been placed along most of the dune edge at Dornoch North beach. Coastal zone management issues in the Moray Firth are being examined by Scottish Natural Heritage as part of the Focus on Firths initiative (see also Chapter 10).

3.2.4 Information sources used

Three main sets of surveys cover the region. Seven sites have been surveyed as part of the Sand Dune Survey of Great Britain (Dargie 1993) using the National Vegetation Classification (NVC) (Rodwell 1991a, 1991b, 1992, 1995, in prep.). This work was initiated by the Nature Conservancy Council in 1987 and was continued after 1992 by the Joint Nature Conservation Committe on behalf of country nature conservation agencies. NVC surveys use a reliable, consistent methodology yielding very detailed information (Rodwell in prep.). The vegetation is mapped and described, and information on coastal erosion and accretion, atypical vegetation and adjoining land use is also recorded. The data represent a sound baseline for future dune vegetation studies and both strategic and local management of the dune resource. A national report for Scotland (Dargie 1993) is available, which synthesises all site information and discusses regional trends. Scottish Natural Heritage has commissioned a project to complete the NVC survey of Scottish dunes by 1998; until then it is not possible to give accurate figures on extent for either the North Sea coast or

Great Britain. An estimate of dune habitats for Scotland is used in Table 3.2.1, based on a sample set of sites (Dargie 1993).

Dune geomorphology is covered in beach reports for all beaches in Scotland, sponsored by the Countryside Commission for Scotland (Ritchie & Mather 1969, 1970, 1984; Ritchie, Smith & Rose 1978; Smith & Mather 1973). Ecological content is limited but information on site use, especially for recreation, is detailed and forms a good baseline for the survey date.

At selected sites, vegetation has been examined by the Institute of Terrestrial Ecology (ITE) (Shaw, Hewett & Pizzey 1983). Unfortunately the computer-based study lacked the precision of more modern vegetation description systems such as the NVC. No mapping was done and the extent of vegetation types is unknown. A useful descriptive site account is included and species records for each site are available.

3.2.5 Acknowledgements

Assistance with sources was kindly provided by Research and Advisory Services Directorate of Scottish Natural Heritage and JNCC's Species Conservation Branch.

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B. Further reading

Further details of coastal habitat sites, including sand dunes, are available on the *Coastal & marine UKDMAP datasets* module disseminated by JNCC Coastal Conservation Branch, Peterborough (Barne *et al.* 1994).

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C. Contact names and addresses

Type of information	*Contact address and telelphone no.*
Flora, fauna, habitat information, location of site reports, site management - Scotland	*Coastal Ecologist, Aquatic Environments Branch, SNH, Edinburgh, tel: 0131 554 9797
Issues, coastal zone management initiatives	*Project Officer, Moray Firth Initiative, Scottish Natural Heritage, Inverness, tel: 01463 712221
Advice on national and international policy and dune conservation	*Coastal Conservation Branch, JNCC, Peterborough, tel: 01733 62626

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

3.3 Vegetated shingle structures and shorelines

Dr R.E. Randall

3.3.1 Introduction

Shingle means sediments larger than sand but smaller than boulders: that is, between 2 mm - 200 mm in diameter. Where the coast features shingle, it is often mixed with large amounts of sand, or else sand dunes have developed on it. Shingle sites include both simple fringing beaches and also more complex structures where the shingle is vegetated yet not buried by more than 20 cm of sand (e.g. the Dornoch coast, Culbin Bar east). Shingle sites where the sand cover is greater than 20 cm in depth are covered in section 3.2.

Considerable stretches of the coast of this region are bordered by large shingle, but the geomorphology of the coastline precludes the formation of major shingle structures other than in the Dornoch and Moray Firths (Ritchie & Mather 1970). Shingle plant communities around Britain are distinctive (Sneddon & Randall 1993a), with some communities being widespread and others limited to a particular region or substrate. The region as a whole has a wide representation of shingle vegetation communities, and is important in a Scottish context for the extent of its vegetated shingle habitat (Table 3.3.1). It contains two of the best examples of vegetated shingle structures in Britain, at Culbin Bar and Kingston. Kingston is second only to Dungeness, Kent, in terms of its importance to the vegetated shingle resource in Britain today. In addition the region contains some of the more significant wrack-matrix (i.e. where dead seaweed and other detritus forms a significant proportion of the growing medium) fringing beaches on which oyster plant *Mertensia maritima* is found. The sites on the north Grampian coast are significant in having five representative north-eastern communities indicative of drier, relatively undisturbed conditions (Sneddon 1992). These lowland heath communities are rich in mosses and lichens and are unique to the shingle of this area. This region also contains seven representative northern communities, including damp shingle woodlands and lichen-ling heaths at Kingston and scrubby grasslands at several sites where high rainfall is balanced by the free-draining nature of the shingle substrate. The sandy nature of the matrix at several north Scottish sites is strongly represented in the vegetation. Cuthill Links is a classic site at the sandy extreme of the stabilized shingle spectrum.

The most important plant species on shingle in this region is the nationally rare oyster plant, on damper, wrack-rich shingle foreshores. The endemic Scottish scurvygrass *Cochlearia scotica* is frequently present in salt-laden sites on the north coast, as is Scots lovage *Ligusticum scoticum*, a plant restricted in Britain to Scottish and north Irish cliffs and shingle.

Table 3.3.1 Area of vegetated shingle structures in Region 3

	Area (ha)
Highland	112
Grampian	127
Region 3	***239***
North Sea Coast	4,472.3
Scotland	672.6
Great Britain	5,129.1
% North Sea Coast total in region	5.3
% Scotland total in region	35.5
% GB total in region	4.7

Source: Sneddon & Randall (1994)

3.3.2 Important locations and species

The major shingle sites in the region are shown on Map 3.3.1 and are listed in Tables 3.3.2 and 3.3.3.

In Highland Region west of Bettyhill, most beaches are either rock and boulder beaches or sand systems, as at Bettyhill, but eastwards to Duncansby Head there is a series of small bays, such as at Kirtomy, Dounreay, Castle of Mey and John O'Groats (Table 3.3.3), containing large shingle with a matrix of coarse sand and/or organic matter. South from Duncansby Head the bays at Noss and Dunbeath have very coarse shingle with organic matter among boulders. At the mouth of Berriedale Water, Dunbeath, the shingle has a matrix of sand and organic matter and from Golspie southwards the sand content increases markedly. Cuthill Links is an area of raised fossilised shingle ridges with a major sand component.

In Grampian Region there is an extensive sandy shingle spit with saltmarsh to landward at Whiteness Head (Currie 1974; Pizzey 1973) and the aeolian sand influences remain important eastwards to Culbin Bar, which is dominated by dunes to the east (Fuller 1975). The Culbin shingle bar is almost completely natural, unlike the other major areas of shingle (in south-east Britain), where human activities have had a major influence on all sites (Fuller 1975). The Kingston Shingles are part of the Speymouth vegetated

Map 3.3.1 Vegetated shingle structures and fringing shingle beaches

Table 3.3.2 Surveyed shingle structures

Site name	*Grid ref.*	*Site type*	*Area surveyed (ha)*[a]	*Conservation status*	*Human activities*
Highland					
Cuthill Links	NH750860	Raised sandy shingle ridge foreland extraction; road building and rabbit grazing	40	SSSI	Past gravel
Whiteness Head	NH820570	Multiple ridge sandy shingle spit	45	SSSI	None
Culbin Bar	NH9260	Barrier island complex multiple ridge extraction and light rabbit grazing	27	SSSI/RSPB	Past gravel
Grampian					
Kingston Shingles	NJ325660	Spit & raised beach system	127	SSSI	Military use, forestry and some grazing
Region 3			***239***		

Source: Sneddon & Randall (1994). Key: SSSI = Site of Special Scientific Interest; RSPB = Royal Society for the Protection of Birds reserve; [a] all figures have been rounded to the nearest whole hectare.

Table 3.3.3 Fringing shingle beaches (late 1980s survey)

Site name	*Grid ref.*	*Length (km)*	*Site type*
Kirtomy	NC7464	0.5	Coarse sandy shingle
Dounreay	NC9867	<0.5	Coarse sandy shingle
Mey	ND2974	1.0	Sandstone shingle and shell
John O'Groats	ND3773	2.5	Sandstone shingle and shell
Noss	ND3853	2.0	Sandstone shingle and shell
Dunbeath	ND1629	6.0	Sandstone shingle and shell
Golspie	NH8399	0.5	Gravel and blown sand
Nigg	NH7573	0.5	Sandy shingle
Alness	NH6368	1.0	Gravel and sand
Moray Firth	NH7855	2.5	Sandy shingle
Kingsteps	NH9258	2.0	Shingle and sand
Findhorn	NJ0465	0.5	Shingle spit
Covesea	NJ1770	0.5	Shingle and wrack
Logie Head	NJ1770	1.0	Shingle, cobble
Whitehills	NJ6365	1.5	Coarse sand, shingle, cobble
Aberdour Coast	NJ8864	2.0	Coarse sand, shingle, cobble
Strathbeg	NK0759	0.5	Paramaritime shingle

Source: Randall (unpublished late 1980s survey data).

shingle complex of raised beaches, which are thought to have originated about 8,000 years ago (Steers 1973). Although afforestation and excavation have altered the surface over much of the site, the shingle still retains natural and important vegetation. This large site has extensive spreads of pure shingle, with flooded hollows resulting from extraction, vegetated slacks, a stream, transition to saltmarsh, reafforestation and military activity. East of Kingston there are several coarse sand, shingle and cobble bayhead beaches often rich in wrack. Examples were examined at Logie Head, Whitehills and Aberdour. On the east Grampian coast shingle is uncommon, but at Strathbeg there is an interesting paramaritime shingle shore along the border between Loch of Strathbeg and the adjacent dunes.

Because many of the beaches of this region outside the firths are exposed to a high energy environment, pioneer vegetation is sparse, except where offshore rocks provide some protection. In more sheltered sites a northern community is often present, with spear-leaved orache *Atriplex prostata,* Babington's orache *A. glabriuscula,* sea mayweed *Tripleurospermum maritimum*, cleavers *Galium aparine,* common scurvygrass *Cochlearia officinalis* or Scottish scurvygrass and sea sandwort *Honkenya peploides;* damper wrack-rich sites often contain oyster plant. A widespread secondary pioneer community is dominated by sea mayweed and curled dock *Rumex crispus*, with English stonecrop *Sedum anglicum* and sea couch *Elymus pycnanthus*. In the more sandy locations this community often contains sea sandwort and sea mouse-ear *Cerastium diffusum*. At Kingston the influence of saline incursions results in the slacks in a community of red fescue *Festuca rubra,* with thrift *Armeria maritima,* sea plantain *Plantago maritima* and other salt tolerant herbs. Highly stable sandy shingle, as at Whiteness and Culbin, has a cover of fescue sward, rich in the mosses *Dicranum scoparium* and *Hypnum cupressiforme*, the lichens *Cladonia* spp. and *Peltigera canina,* and gorse *Ulex europaeus*. More commonly, where there is grazing or other light disturbance, the fescue sward is herb-rich, with fewer lichens, and as conditions become more sandy there is a greater presence of marram *Ammophila arenaria* and sand sedge *Carex arenaria.* Yorkshire-fog *Holcus lanatus* or common bent *Agrostis capillaris* and burnet rose *Rosa pimpinellifolia* or bramble *Rubus fruticosus* are the precursors to heathland communities. The commonest heathland community on eastern Scottish shingle is dominated by heather *Calluna vulgaris*, bell heather *Erica cinnerea* and the lichen *Hypogymnia physodes*, but with other bryophytes and lichens forming a major component of the community. Drier conditions lead to a simpler heather - crowberry *Empetrum nigrum* - lichen *Cladonia impexa* heath, whereas wetter conditions result in soft-rush *Juncus effusus* or soft-rush - goat willow *Salix cinerea* assemblages. In the very wettest slacks at Kingston, common reed *Phragmites australis* marsh, with water mint *Mentha aquatica*, yellow iris *Iris pseudacorus* and marsh willowherb *Epilobium palustre*, is present. Also found at Kingston are gorse or blackthorn *Prunus spinosa* scrub, sometimes with invasions of juniper *Juniperus communis* or Scots pine *Pinus sylvestris*.

None of the shingle structures of this region is known for its faunal associations, though lack of disturbance at

some sites, such as Loge Head and Culbin Bar, make them important as roosting sites for coastal birds. Rabbits and hares influence the vegetation in most locations.

3.3.3 Human activities

Most of the fringing beaches of Highland and Grampian have no conservation designations and few are subject to high levels of recreational pressure or building disturbance. The four major shingle structures, however, are all Sites of Special Scientific Interest (SSSIs), as is the Aberdour coast. The construction of the nuclear reactor at Dounreay has reduced the extent of vegetated shingle at that location, as has laying power cables to the Beatrice oilfield from Dunbeath. The Noss Head shingle has been 'preserved' and oyster plant has been sown by a local enthusiast since 1978. Cuthill has seen a major loss of shingle with the construction of the A9 link, and there is now a great potential for increased recreational pressure on what was once a remote site. Former gravel extraction has now ceased. Whiteness was extensively grazed and gravel was extracted in the past, but current human activity is low, and there is no grazing by domestic stock. Culbin needs little active management, though there is a potential problem with seeding of Scots pine from the plantation on the mainland. Here too there is currently no grazing by domestic stock. Kingston has been greatly disturbed in the past by shingle excavation, military activity, dumping and landscaping, but this disturbance has resulted in a rich variety of plant communities. Current activities include cattle grazing of 12 ha at the rear of the site and afforestation at a pine plantation on the western part of the site. The south-eastern corner of the site is used as a vehicle dump. The effects of vehicular access and parking on the vegetation of the shingle are locally severe. Despite these activities the site as a whole is the most important vegetated shingle structure in Scotland.

3.3.4 Information sources used

Not all shingle sites are vegetated, especially not those on exposed high-energy coasts or where disturbance is great. Unvegetated sites have not been surveyed. All the major vegetated shingle structures of the region were surveyed during the Nature Conservancy Council (NCC)'s 1989 national shingle structure survey, which used the National Vegetation Classification (NVC) framework (Sneddon & Randall 1993, 1994; Rodwell in prep.). Not all shingle sites fall into the category of shingle structures, but many of the fringing beaches in this region were examined in 1986-1987 as part of the NCC's rare species monitoring scheme (Randall 1988). These sites were only examined qualitatively, except for data on oyster plants. The information became the basis of the geographical variation data published in Randall (1989).

Culbin Bar has been a source of interest to geomorphologists and ecologist over many years and has been repeatedly resurveyed during this century (e.g. Patton & Stewart 1917; Steers 1937; Fuller 1975).

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B. Further reading

Further details of coastal habitat sites, including shingle structures and shorelines, are available on the *Coastal & marine UKDMAP datasets* module disseminated by JNCC Coastal Conservation Branch, Peterborough (Barne *et al.* 1994)

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Webster, M.M. 1978. *Flora of Moray, Nairn and east Inverness.* Aberdeen, University Press.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Shingle sites - Whiteness, Highland Region, north & east coasts	*Area Officer, Scottish Natural Heritage, Inverness, tel: 01463 712221
Shingle sites - Highland Region coasts	*Area Officer, Scottish Natural Heritage, Golspie, tel: 01463 712221
Shingle sites - Kingston Shingles/Culbin, Grampian north coast	*Area Officer, Scottish Natural Heritage, Elgin, tel: 01463 712221
Strathbeg shingle	Warden, Loch of Strathbeg, The Lythe, Crimongate, Lonmay, Fraserburgh AB4 4UB
Shingle sites in the region	*Scottish Wildlife Trust, Alness, tel: 01349 883316

* 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, virtually tideless bodies of saline water either wholly or partially separated from the adjacent sea, but with some influx of sea water. The term is used herein to include true lagoons, i.e. those separated from the sea by a natural sedimentary barrier, and also artificial brackish ponds and coastal pools, of a similarly restricted tidal range and often containing comparable lagoonal wildlife. Lagoons are commonly shallow, often with a varying salinity ranging from above to below that of normal sea water (35 g/kg). Freshwater systems are not considered here.

This chapter summarises the coastal lagoons of the region. The single natural lagoon, Annochie Lagoon, Grampian, totals 3 ha, which is 0.4% of Britain's total natural lagoonal resource (1% of that resource if The Fleet, Dorset - by far Britain's largest lagoon, comprising nearly 70% of the total resource - is excluded). Annochie Lagoon is not included in that part of the national lagoonal resource that was regarded by Barnes (1989) as being "especially noteworthy in the national context".

The cliff morphology of most of the coastline of the region precludes lagoon formation. The only other features approaching lagoon-like status are a small number of estuaries with restricted mouths, for example Loch Fleet, Highland (NH790962), and Findhorn Bay, Grampian (NJ041626). None of these sites represents an important lagoonal habitat. The only other sites of apparently appropriate morphology are restricted-mouth side pools off larger lochs, e.g. Lochs Havurn (NC397544) and Sian (NC447632) (off Loch Eriboll, Highland), and a few saline pools behind sea walls (e.g. Muirtown Pool, Inverness, Highland), some of which have been surveyed recently by the JNCC's Marine Nature Conservation Review (MNCR) team. The region is therefore not significant in the national context. The scale of the contribution of the lagoons of the region to Britain as a whole is shown in Table 3.4.1.

Table 3.4.1 Lagoonal areas for region in context

Region	*Lagoonal area (ha)[a]*	*Overall % of GB total*	*% of GB total excl. The Fleet*
Highland	9	<1	1
Grampian	3	<1	<1
Region 3	***12***	***1***	***2***
North Sea Coast	1,163	92	87
Great Britain	1,261	-	-

Key: [a]areas have been rounded to the nearest whole hectare.

Exceptionally for the North Sea coast, there are no nationally noteworthy (*sensu* Barnes 1989) lagoonal areas in the region (Table 3.4.2).

Lagoons are a nationally rare habitat and a 'priority habitat type' under Annex 1 of the EC Habitats & Species Directive. Therefore, although the region's lagoonal resource is not significant nationally in terms of its extent, the habitat type is of national and international importance wherever it occurs and in whatever quantity.

Map 3.4.1 Coastal lagoons and sites mentioned in the text

Table 3.4.2 Nationally noteworthy lagoonal areas for region and country

Region	*Lagoonal area (ha)[a]*	*Overall % of GB total*	*% of GB total excl. The Fleet*
Region 3	***0***	***0***	***0***
North Sea coast	521	96	63
Great Britain	545	-	-

Source: Barnes (1989). Key: [a]areas have been rounded to the nearest whole hectare.

3.4.2 Important locations and species

Map 3.4.1 shows the location of the Annochie Lagoon and other sites mentioned herein; Table 3.4.3 lists the areas of surveyed sites. Notable amongst the restricted estuaries is the well-studied Loch Fleet, Highland, with a diverse estuarine to fully-marine fauna (see also section 4.2).

True lagoons support only three types of aquatic vegetation, namely stands of green algae (*Chaetomorpha* spp., *Ulva* spp. and *Enteromorpha* spp.), of sea-grasses 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 in the form of bare sediment, devoid of vegetation cover. Fringing stands of reeds *Phragmites* spp., saltmarsh plants and/or sea club-rush *Scirpus maritimus* are usual. No significant lagoonal vegetation types occur within the region, although a

Table 3.4.3 Lagoons surveyed

Name	*Grid ref.*	*Area (ha)*[a]	*Type*
Highland			
Loch Havurn	NC397544	5	Loch head pool
Alness Point	NH653677	2	Marsh pool
Muirtown Pool	NH650466	2	Sluiced pool
Grampian			
Annochie Lagoon	NK107533	3	Restricted estuary

Sources: Barnes (1989); Smith (1984). Key: [a]areas have been rounded to the nearest whole hectare.

number of sites support tasselweeds, eelgrasses *Zostera* spp. and *Chaetomorpha* spp,, and no important plant species are recorded for this habitat in the region.

Lagoons possess a characteristic invertebrate fauna that shows little regional variation, even within Europe. In Britain, several of these species are very rare and are protected under the Wildlife & Countryside Act 1981. None of these protected species, nor any other significant lagoonal species, occurs in the region, although the brackish conditions in a few of the surveyed sites support the lagoonal mud snail *Hydrobia ventrosa* and the lagoonal cockle *Cerastoderma glaucum*. Another species of lagoon-like habitats, *Hydrobia neglecta*, is recorded from Muirtown Pool, Highland.

3.4.3 Human activities

Little active management is applied to the lagoons of the region. Loch Fleet is part of a National Nature Reserve and an SSSI of ornithological interest.

3.4.4 Information sources used

The potential lagoons in the region were surveyed as part of the Nature Conservancy Council's national lagoon survey. A detailed report of these surveys is available, including maps of the habitats and species lists. The data are summarized in Barnes (1989), from which the data given here are derived. Other saline pools were surveyed more recently by the JNCC's Marine Nature Conservation Review (MNCR) team. Reports on these surveys are currently in preparation; these surveys looked in some detail at sub-littoral habitats within the lagoons. Information on the restricted estuaries and harbours was collated by Smith (1984), principally for their molluscan fauna. Smith (1984) includes reference to other surveys covering the quasi-lagoonal habitats (e.g. Holme *et al.* 1980).

3.4.5 Acknowledgements

We are grateful for information supplied by Dr S. Smith and by Dr R. Covey of the MNCR Team.

3.4.6 Further sources of information

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B. Further reading

Further details of coastal habitat sites are available on the *Coastal & marine UKDMAP datasets* module disseminated by the JNCC (Barne *et al.* 1994). Further details of lagoons and quasi-lagoonal features are available on the *UKDMAP datasets* module disseminated by the British Oceanographic Data Centre (BODC 1992).

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

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Saline lagoons in the region	*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	*Aquatic Environments Branch, Scottish Natural Heritage, Edinburgh, tel: 0131 554 9797

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

3.5 Wet grassland

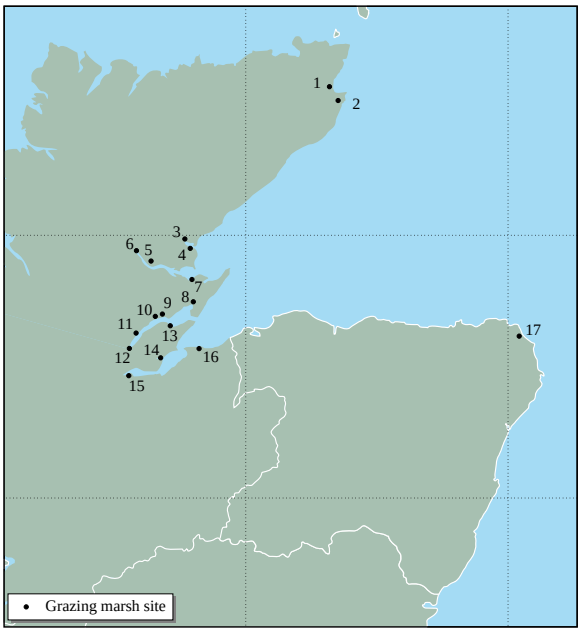
Dr H.T. Gee

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. 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. Regional information is available only for coastal grazing marsh, to which discussions in this section are restricted.

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.

Grazing marsh is generally considered to be a rare habitat in Scotland (Doody *et al.* 1993). Most grazing marshes in the region are around the estuaries of the inner Moray Firth (Map 3.5.1). No figures exist for the total area of grazing marsh in this region; however, their total extent is thought to be small and not to make a significant contribution to the coastal habitats of the region. Information available at present has not given any reason to identify this region as important for this habitat in either a British or a Scottish context.



Map 3.5.1 Coastal grazing marsh sites (numbers refer to Table 3.5.1). Source: SNH; Scott & Law (1984); Scott (1985).

3.5.2 Important locations and species

Land claim of saltmarsh and coastal freshwater marsh for agricultural uses (chiefly for pasture) has occurred on a small scale at several locations. No sites containing ditch-drained coastal pasture have been identified along the north coast of Scotland; on the east coast of Highland Region, however, grazing marsh or similar ditch-drained pasture is present alongside most major and some smaller estuaries. Of particular note are reclaimed pasture on the Wick and Wester Rivers in Caithness and at locations around the Dornoch, Cromarty, Beauly and Moray Firths. Sites such as Udale Bay and Mulochy Bay on the Cromarty Firth have associated freshwater marshes under agricultural use, and the Carse of Delnies at Whiteness Head also has a complex of drainage ditches. The major area of grazing marsh on land claim in Grampian Region is adjacent to the Loch of Strathbeg RSPB reserve. Much of this grazing marsh has now been converted to improved pasture. Table 3.5.1 lists grazing marsh sites in this region.

As in many other areas of the UK, grazing marsh (and wet grassland generally) is recognised as being of value for birds, notably for breeding and wintering waders and wildfowl (Davidson 1991). The Carse of Bayfield on the north-east side of Nigg Bay (Cromarty Firth SSSI) and the grazing marshes of the Beauly Firth, Munlochy Bay and the Loch of Strathbeg are of recognised importance for wintering greylag *Anser anser* and pink-footed geese *A. brachyrhynchus*. The Beauly Firth now also supports a large late-summer moulting population of the alien species Canada goose *Branta canadensis*, a moult migration that has developed over the last few decades (Owen *et al.* 1986). In this region of Scotland, coastal grazing marsh is known to support good numbers of breeding waders on the Kyle of Sutherland and probably does so elsewhere. Otters *Lutra lutra* are also known to be present on the Kyle of Sutherland.

The grazing marsh in the Wick River SSSI supports nationally important sedge communities, including the nationally rare estuarine sedge *Carex recta* (also known as the Wick sedge). Perring & Farrell (1977) note that it is known from only six locations in the British Isles, all in the Highland Region and including the Kyle of Sutherland SSSI, where the ditches support a range of fen and wet grassland communities. At both these sites *C. recta* is found in association with the closely related and uncommon water sedge *Carex aquatilis*, with which it hybridises at Wick River to form *Carex* x *grantii*, for which this is the only known British site.

3.5.3 Human activities

Throughout Highland and Grampian Region there has been little land claim from the sea. Much of what has been claimed is concentrated around the Cromarty and Beauly Firths but there are smaller patches around the Wick River (Caithness), the Kyle of Sutherland and Loch Fleet (Sutherland) and Loch of Strathbeg (Aberdeen). Some claimed areas are still managed as grazing marsh, but other areas have been converted to arable use, particularly on the north side of the Beauly Firth. Surviving areas of grazing marsh have been affected by the same problems of intensification of farming or conversion to arable use observed elsewhere in Britain. Only in the Cromarty Firth

Table 3.5.1 Grazing marsh sites in Region 3

No.	*Site*	*Grid ref.*	*Conservation status of grazing marsh*	*Notes*
	Highland			
1	River of Wester	ND339577		Adjacent to river
2	Wick River	ND350514	SSSI	Coastal grazing marsh
3	Mound Alderwoods	NH765990	NNR, SSSI	Land claim mostly colonised by carr woodland
4	Skelbo	NH732885		Ditch-drained pasture adjacent to the Dornoch Firth
5	Bonar Bridge	NH607911		Ditch-drained improved pasture
6	Kyle of Sutherland Marshes	NH515990	SSSI	Alongside inner reaches of the estuary
7	Tain	NH786824		Coastal fresh and brackish marshy grassland (partly ditch-drained)
8	Nigg Bay	NH770710		Land-claimed pasture adjacent to Cromarty Firth
9	Alness Dalmore	NH660682		Ditch-drained land claim
10	Balconie Point	NH626654		Grazing marsh on former saltmarsh and ditch-drained pasture
11	Dingwall Bay	NH556591	Within SSSI	Coastal grazing marsh
12	Conon Islands	NH552570	Adjacent to SSSI	Coastal grazing marsh
13	Udale Bay	NH707658	NNR	Coastal freshwater marsh
14	Munlochy Bay	NH675528	SSSI, LNR	Coastal freshwater marsh
15	Beauly Firth	NH558470	Adjacent to SSSI	Grazing marsh
16	Whiteness Head	NH790580		Carse of Delnies ditch-drained; some grazing marsh on former saltmarsh
	Grampian			
17	Loch of Strathbeg	NK070602	Adjacent to RSPB Reserve	Coastal grazing marsh

Sources: Scottish Natural Heritage; Scott & Law 1984; Scott 1985. Key: SSSI = Site of Special Scientific Interest; RSPB = Royal Society for the Protection of Birds; NNR = National Nature Reserve; LNR = Local Nature Reserve. Note: site numbers refer to Map 3.5.1.

has industrial development had any significant impact on the extent of grazing marsh.

3.5.4 Information sources used

There are almost no survey data for grazing marsh sites in the region. The absence of data emphasises both the limited extent of the habitat and its limited perceived conservation value within north-east Scotland. In this region grazing marsh on claimed land is rarely included within estuarine SSSIs or designated in its own right. Two exceptions are the Wick River SSSI in Caithness and the Kyle of Sutherland Marshes SSSI. Other wet grassland in SSSIs is thought to be widespread and abundant. However, there has been no survey of the total wet grassland resource comparable to that undertaken in England for English Nature. The surveys of saltmarsh sites in Highland Region undertaken by Scott & Law (1984) and Scott (1985) provide some information on adjacent land use and site maps, both of which were useful in identifying ditch-drained pasture and claimed land adjacent to coastal sites. Around the Loch of Strathbeg, grazing marsh on land claim, much now converted to improved pasture, has been surveyed for breeding and roosting waders and wildfowl by the RSPB.

3.5.5 Acknowledgements

Thanks are due to staff of the SNH area offices for providing information on coastal grazing marsh in their districts.

3.5.6 Further sources of information

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

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Wet grassland in Scotland	*Aquatic Environments Branch, Scottish Natural Heritage, Edinburgh, tel: 0131 554 9797
Wet grassland in north-east Scotland	*Area Officer, Scottish Natural Heritage, Aberdeen, tel: 01224 312266
Wet grassland in Caithness and Sutherland	*Area Officer, Scottish Natural Heritage, Golspie, tel: 01408 633341
Wet grassland around Cromarty Firth	*Area Officer, Scottish Natural Heritage, Dingwall, tel: 01349 865333
Wet grassland around the Moray Firth	*Area Officer, Scottish Natural Heritage, Nairn, tel: 01497 810477

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

3.6 Saltmarsh

Dr M.I. Hill

3.6.1 Introduction

There are 1,317 ha of saltmarsh in Region 3, representing 6% of the saltmarsh on the North Sea coast of Britain, 22% of that in Scotland and 3% of the British resource (Table 3.6.1). The part of Highland in Region 3 contains far more saltmarsh than Grampian, as it contains the Dornoch, Cromarty, Beauly and Inner Moray Firths. 6% of the coastline (at Mean High Water) of the whole Highland Region and 4% of the coastline of Grampian support saltmarsh. Some saltmarsh has been claimed for industry and agriculture, but this has been less widespread than in much of Britain. Although the total area is relatively small, the region's saltmarshes are of interest because, compared with Britain as a whole, there is a high percentage of mid to upper marsh communities in saltmarshes in the region: they make up 61% of the saltmarsh area, compared with 36% on average in GB. The national saltmarsh survey recorded the main mid to upper marsh vegetation types as saltmarsh rush *Juncus gerardii* and a mixture of common saltmarsh grass *Puccinellia maritima* and red fescue *Festuca rubra*. The proportion of low to mid marsh communities is correspondingly low. Transitions from saltmarsh to other habitats, such as dune, fen, grassland and mire, occupy a relatively high percentage of the area.

Saltmarshes in the region mainly show net accretion or stability. Erosion is reported at only a few sites, including Nigg Bay on the north (and more exposed) shore of the Cromarty Firth. Most sites are grazed, although there are some exceptions, such as Culbin Sands and Findhorn Bay.

3.6.2 Important locations and species

The main sites (i.e. those larger than 1 ha of saltmarsh) surveyed during the national survey are shown on Map 3.6.1 and listed in Table 3.6.2.

The main saltmarshes are associated with the Dornoch, Cromarty, Beauly and Inner Moray Firths. The firths contain a variety of saltmarshes, including embayment, fringing and loch head types, although the marshes comprise only a small proportion of the intertidal area. The Dornoch Firth also has back-barrier marshes, which have developed in the shelter of sand bars, most notably at Morrich More, where a substantial area (200 ha) is of high geomorphological and ecological interest (Pye & French 1993). In the outer section of the Moray Firth, saltmarsh is present in sheltered areas, mostly behind sand and shingle spits: for example, Spey Bay, Findhorn Sands, Culbin Sands and Whiteness. The Culbin Sands/Findhorn complex is particularly important for the extent and diversity of its saltmarsh habitats, which total over 300 ha. Elsewhere, i.e. the north coast of Sutherland, Caithness, and the coast between Montrose (Region 4) and Fraserburgh, there are small saltmarshes, mostly less than 10 ha, at loch heads and in bays and river mouths. Stands of saltmarsh vegetation are also present on raised beaches, for example within the Cullen to Stakeness Coast Site of Special Scientific Interest (SSSI). An example of a relict area of saltmarsh within a site that is no longer tidal is provided by the Mound Alderwoods SSSI, Sutherland. This site, at the head of Loch Fleet, is now mainly alder carr and fen.

Map 3.6.1 Saltmarsh sites. Source: JNCC Saltmarsh Database.

Most saltmarshes in the region are within SSSIs (see also section 7.3.2). SSSIs containing saltmarsh are listed in Table 3.6.3.

Saltmarshes in the region generally have a sandy substrate and are grazed, greatly influencing the vegetation type. A typical zonation is from a pioneer zone of glasswort *Salicornia* spp. to a low-mid marsh of common saltmarsh-

Table 3.6.1 Areas (ha)[a] of saltmarsh communities in region compared to national totals

	Spartina	*Pioneer*	*Low-mid*	*Mid-upper*	*Drift-line*	*Upper swamp*	*Transition*	*Wet depression*	*Total*	*% of total in region*
Highland	2	182	47	659	1	30	137	0	1,057	80.3
Grampian	0	7	52	150	11	12	30	<1	260	19.7
Region 3	***2***	***188***	***99***	***809***	***11***	***41***	***167***	***<1***	***1,317***	***100***
North Sea coast	3,461	2,130	8,194	4,772	1,350	1,066	342	2	21,788	6
Scotland	102	361	499	3,608	63	587	748	2	6,089	22
GB	6,948	3,470	12,353	16,042	1,824	1,475	1,670	2	44,370	3

Source: National Saltmarsh Survey (Burd 1989a-c). Key: [a] all figures have been rounded to the nearest whole hectare.

Table 3.6.2 Main saltmarsh sites surveyed

Name	*Grid ref.*	*Area (ha)**
Kyle of Durness	NC355630	6
Loch Eriboll	NC435613	5
Kyle of Tongue	NC554536	8
Torrisdale Bay	NC681614	11
Melvich	NC890645	4
River of Wester	ND339577	8
Wick River	ND350514	11
Loch Fleet	NH803974	41
Dornoch Firth and Morrich More	NH732885 & NH855835	400
Cromarty Firth	NH800737	227
Inner Moray and Beauly Firths	NH570470	132
Whiteness Head	NH825573	49
Nairn	NH910580	13
Culbin	NH950612	203
Findhorn Bay	NJ035618	118
Lossiemouth	NJ245695	2
Spey Bay	NJ344653	22
Stakeness	NJ645658	7
Fraserburgh Bay	NK022648	2
Strathbeg	NK070602	16
Ythan Estuary	NK007284	25
St. Cyrus	NO744635	4

Source: National Saltmarsh Survey (Burd 1989a-c). Key: *areas have been rounded to the nearest whole hectare. Note: this table contains only sites with more than 1 ha of saltmarsh. Some sites are amalgamations of sites in Burd (1989a).

grass *Puccinellia maritima* and a mid-upper marsh of red fescue, saltmarsh rush, sea milkwort *Glaux maritima* and thrift *Armeria maritima.* In the National Vegetation Classification (NVC) this mid-upper marsh would be Juncetum gerardii, with three subcommunities well distributed in the region: red fescue - sea milkwort, autumn hawkbit *Leontodon autumnalis* and glaucous sedge *Carex flacca* subcommunities. In some marshes, common saltmarsh-grass is the primary colonist. Upper marsh swamps of sea club-rush *Scirpus maritimus* and common reed *Phragmites australis* are present at some sites, such as at the head of the Beauly and Cromarty Firths, and usually where grazing is light. At the head of the Beauly and Cromarty Firths are transitions from saltmarsh and upper marsh swamps to fen, alder/willow carr and woodland. Common cord-grass *Spartina anglica* is only a minor component of saltmarshes in this region and reaches its northern limit on the North Sea coast at the Cromarty Firth. Eelgrass *Zostera* spp. is present in intertidal and subtidal zones at many sites and is particularly abundant in the Dornoch, Cromarty, Beauly and Inner Moray Firths. Probably the largest area (1,200 ha) of dwarf eelgrass *Z. noltii* and narrow-leaved eelgrass *Z. angustifolia* in Britain is found in the Cromarty Firth. Beaked tasselweed *Ruppia maritima* is found with dwarf eelgrass and glasswort on the intertidal flats of the Cromarty Firth and also in the river of Wester, Caithness. Natural transitions between saltmarsh and other habitats are widespread and varied, containing uncommon plants and other diverse vegetation. Transitions to dune, dune grassland and dune heath are of particular interest, with good examples at Morrich More and Culbin Sands/Findhorn. Saltmarsh grading into fen occurs at several sites, especially the upper reaches of the firths and in the Wick River. Transitions to mire and wet heath are found mainly on the north coast, whilst those to neutral or marshy grasslands, with soft rush *Juncus effusus* and yellow flag *Iris pseudacorus*, are found throughout.

Two NVC saltmarsh communities of very limited extent in Britain are found in the region: saltmarsh flat-sedge *Blysmus rufus* and slender spike-rush *Eleocharis uniglumis* saltmarsh. Both are characteristic of wet depressions in the upper marsh. The Red Data Book species estuarine sedge

Table 3.6.3 SSSIs containing saltmarsh in region

Name	*Grid ref.*	*Other designations*
Highland		
Durness	NC380670	pSAC
Invernaver	NC685605	Part NNR, pSAC
Loch Fleet	NH800960	
Mound Alderwoods	NH765990	NNR
Dornoch Firth	NH760860	pSAC
Morrich More	NH830840	pSAC
Cromarty Firth	NH650670	Part NNR
Conon Islands	NH552570	
Munlochy Bay	NH672528	
Beauly Firth	NH580480	
Whiteness Head	NH790580	
Highland and Grampian		
Culbin Sands, Forest and Findhorn	NH990625	
Grampian		
Spey Bay	NJ325660	pSAC
Cullen to Stakeness Coast	NJ574669	
Rosehearty to Fraserburgh Coast	NJ967675	
Loch of Strathbeg	NK075590	
Sands of Forvie and Ythan Estuary	NK020275	NNR, pSAC, BR
Garron Point	NO887874	
St. Cyrus and Kinnaber Links	NO745630	Part NNR

Source: JNCC Integrated Coastal Database. Key: NNR = National Nature Reserve, pSAC = possible Special Area of Conservation (Habitats & Species Directive), BR = Biogenetic Reserve.

Carex recta is found only in north-east Scotland, and saltmarsh swamps in this region are one of its main locations. The hybrid of this species with the water sedge *Carex aquatilis* (*C. recta x C. aquatilis = C. x grantii*) is found in the Wick River, Caithness (see also section 3.5.2). Nationally scarce species found on the upper edge of saltmarshes in the region are seaside centaury *Centaurium littorale*, Scottish scurvygrass *Cochlearia scotica*, the eyebright *Euphrasia foulaensis* and Baltic rush *Juncus balthicus* (Stewart *et al.* 1994). The three species of *Zostera* are considered nationally scarce.

As elsewhere, saltmarshes in this region provide roosting sites for shorebirds and food for wildfowl. The *Zostera* beds of the Firths are important feeding grounds for species such as wigeon *Anas penelope*, pintail *A. acuta*, teal *A. crecca*, greylag goose *Anser anser* and whooper swan *Cygnus cygnus* (see also section 5.12).

There is little information on terrestrial invertebrates of saltmarshes in this region. Generally, the fauna is most diverse in upper marsh zones, where pools, seepages, driftline debris and tall vegetation are found. The best sites are therefore usually ungrazed or show transitions to other habitats. The ungrazed saltmarshes and brackish seepage areas of Culbin Sands and Findhorn Bay have many rare species associated with them and are particularly important for water beetles. Records are summarised in the Site Management Brief (Scottish Natural Heritage undated) and include the RDB2 (i.e. vulnerable) water beetle *Ochthebius lenensis* and the notable spider *Pardosa purbeckiensis* (see also section 5.3).

3.6.3 Human activities

The main uses of the saltmarshes in this region are grazing, turf-cutting and wildfowling. Saltmarshes on the east coast tend to be less heavily grazed. The saltmarsh at Morrich More has military use as a bombing range. Some marshes have been partly reclaimed for agriculture or industry, especially in the Cromarty and Moray Firths. Some of the saltmarshes, particularly the smaller ones, have been damaged by tipping of waste materials. The saltmarshes at Nigg Bay and Morrich More have been reduced in extent as the result of oil-related developments (see also section 5.3.3).

3.6.4 Information sources used

Saltmarshes were surveyed in 1984-85 as part of the NCC's national saltmarsh survey. The survey reports (Scott & Law 1984; Scott 1985a, b; Urquhart 1985) provide detailed site descriptions and assessments. The results and areas of plant communities are summarised in Burd (1989a-c). 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: Rodwell in press). It did not include all areas of transition to other habitats, such as sand dune, shingle and freshwater marsh. Saltmarsh vegetation in non-tidal, land-claimed marshes and areas of eelgrass were not covered.

There are a few other surveys of saltmarshes in the region, mostly covering parts of the Firths. Examples include: Morrich More (using the NVC (Dargie 1988)); Mound Alderwoods (with a small area of saltmarsh in the NVC survey); the cord-grass communities of the Cromarty Firth (Smith 1982); eelgrass beds in the Moray and Cromarty Firths (Rodwell in press); saltmarshes and seagrasses of the Beauly and Moray Firths (summarised in Highland Regional Council 1990); and St. Cyrus (Gimingham 1953). The Culbin Sands, Forest & Findhorn Bay SSSI management brief describes the saltmarsh communities of this site (Scottish Natural Heritage undated). A survey of the distribution of dwarf eelgrass and narrow-leaved eelgrass at Culbin Sands and Findhorn Bay was carried out in 1991 (Scottish Natural Heritage undated).

3.6.5 Acknowledgements

Staff of Scottish Natural Heritage kindly provided reference material.

3.6.6 Further sources of information

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B. Further reading

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

Adam, P. 1990. *Saltmarsh ecology*. Cambridge, Cambridge University Press.

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

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

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Data from the National Saltmarsh Survey	*Coastal Conservation Branch, JNCC, Peterborough, tel: 01733 62626
Statutory protected saltmarsh sites; detailed saltmarsh site information; coastal geomorphology	*Marine Conservation Officers/Coastal Ecologist Aquatic Environments Branch, SNH, Edinburgh, tel: 0131 554 9797
Saltmarsh in north-east Scotland	*Area Officer, Scottish Natural Heritage, Aberdeen, tel: 01224 312266
Saltmarsh in Caithness and Sutherland	*Area Officer, Scottish Natural Heritage, Golspie, tel: 01408 633341
Saltmarsh around Cromarty Firth	*Area Officer, Scottish Natural Heritage, Dingwall, tel: 01349 865333
Saltmarsh around the Moray Firth	*Area Officer, Scottish Natural Heritage, Nairn, tel: 01497 810477

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

The vast sandy ness at Morrich More, on the southern lip of the Dornoch Firth, is backed by large tracts of saltmarsh and wet grassland. This kind of site, where the sand dunes are advancing seaward in a cone-shaped foreland, is very unusual in Britain; Morrich More is a possible Special Area of Conservation under the EC Habitats and Species Directive. Photo: Pat Doody, 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 are covered by the NCC Estuaries Review (Davidson *et al.* 1991) and have at least 2 km of tidal channel or 2 km of shoreline over 0.5 km wide at low tide, either now or historically. This section gives an overview of the main features of the estuarine resource in Region 3; for further details of habitats, species and human uses refer to relevant sections in Chapters 3, 5 and 9 respectively.

The contribution of Region 3 estuaries to the wider resource is summarised in Table 4.1.1. Overall the fifteen estuaries in Region 3 (Map 4.1.1) form 6.4% by area of the total UK estuarine resource and 14.3% of the British North Sea resource. Many have substantial subtidal areas in their outer parts, although overall Region 3 estuaries make a relatively small contribution to the national intertidal resource: only 10.9% of the British North Sea intertidal area. This is in part because most estuaries in the region have little or no saltmarsh: estuarine saltmarshes in the region form only 6.1% of the British North Sea saltmarsh area. Since many Region 3 estuaries are long and relatively narrow, the total length of estuarine shoreline in the region is great: over 770 km (13.6% of the British North Sea total).

Map 4.1.1 Estuaries. Source: JNCC Estuaries Database.

4.1.2 Important locations and species

The fifteen estuaries on the mainland coast of north and north-east Scotland vary greatly in size, geomorphological origin and extent of human use, and include some of the least human-influenced estuaries in the UK. The estuaries range from the small (<2,000 ha in total area), remote and unspoilt sediment-filled glacial basins (fjards) on the north coast of Highland region, through the large and geomorphologically complex Dornoch, Cromarty and Moray Firths, with hydronamics similar to coastal plain estuaries, to the very small, mostly bar-built estuaries on the depositional east coast of Grampian. Largest estuaries in the region are the Dornoch, Cromarty and Moray Firths, each with total areas of 9,000-12,000 ha and intertidal areas of 3,500-5,000 ha. (Note that the outer, deep-water part of

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

Resource	*Regional total (ha/km)*	*North Sea Coast total (ha/km)*	*% North Sea Coast total*	*GB total (ha/km)*	*% GB total*	*UK total (ha/km)*	*% UK total*
Intertidal area	14,930	136,580	10.9	321,050	4.6	332,350	4.5
Saltmarsh area	1,270	20,650	6.1	48,380	3.1	*	*
Total estuarine area	36,930	258,100	14.3	525,650	7.0	581,290	6.4
Shoreline length	770	5,650	13.6	9,050	8.5	9,730	7.9
Longest channel lengths	177	1,480	11.9	2,460	7.2	2,640	6.7

Sources: Buck (1993); Davidson & Buck (in prep). Key: *areas of saltmarsh were not available for Northern Ireland and so estuarine saltmarsh area comparisons are not made for the UK; [a]areas rounded to the nearest 10 ha; lengths rounded to the nearest 1 km.

Table 4.1.2 Physical characteristics of Region 3 estuaries[a]

Estuary	*Centre grid ref.*	*Geomorph-ological type*	*Total area (ha)*	*Inter-tidal area (ha)*	*Salt-marsh (ha)*	*Shore-line length (km)*	*Main channel length (km)*	*Spring tidal range (m)*	*Sub-tidal (%)*
Highland									
66. Kyle of Durness	NC3766	Fjard	1,328	561	6	28.9	12.7	4.0	57.8
67. Kyle of Tongue	NC5858	Fjard	1,818	422	8	37.2	14.2	4.3	76.8
68. Torrisdale Bay	NC6962	Fjard	200	139	11	9.8	2.9	4.3	30.5
69. Melvich Bay	NC8964	Fjard	78	33	4	6.9	3.0	4.3	57.7
74. Loch Fleet	NH7996	Bar-built	695	522	34	20.7	6.6	4.0	24.9
75. Dornoch Firth	NH7087	Complex	11,663	4,397	400	284.5	42.8	3.4	62.3
76. Cromarty Firth	NH6667	Complex	9,232	3,642	227	120.5	32.7	3.7	60.6
Highland/Grampian									
77. Moray Firth	NH7152	Complex	11,150	4,783	516	169.6	32.3	4.1	57.1
Grampian									
78. Lossie Estuary	NJ2470	Bar-built	56	30	2	13.3	4.4	4.1	46.4
79. Spey Bay	NJ3465	Bar-built	49	29	22	4.9	0.9	3.4	40.8
80. Banff Bay	NJ6964	Embayment	102	16	1	8.6	2.8	3.1	84.3
81. Ythan Estuary	NK0026	Bar-built	282	201	25	28.2	10.9	3.7	28.7
82. Don Estuary	NJ9509	Bar-built	23	9	1	5.5	2.4	3.7	60.9
83. Dee Estuary	NJ9405	Bar-built	97	7	0	18.7	5.8	3.7	92.8
Grampian/Tayside									
84. St. Cyrus	NO7362	Bar-built	156	136	8	12.8	2.1	4.1	12.8

Sources: Buck (1993); JNCC Integrated Coastal Database. Key: [a]areas rounded to the nearest whole hectare. Notes: estuary numbers are those used in Buck (1993). 'Geomorphological type' relates to nine estuary categories, described further in Chapter 5.7 of Davidson *et al.* (1991) and Chapter 4.5 of Davidson & Buck (in prep.). 'Spring tidal ranges' are for the monitoring station closest to the mouth of the estuary. Subtidal includes tidal channels remaining water-filled at mean low water. The St. Cyrus Estuary forms the boundary between Grampian and Tayside (Region 4).

the Moray Firth is not included in the estuary site in this section.) Elsewhere only the Kyles of Durness and Tongue exceed 1,000 ha in total area. The six estuaries wholly on the Grampian coast are all small, all being less than than 300 ha in total area. Table 4.1.2 lists the estuaries in the region and summarises their main physical characteristics.

The north Highland estuaries are mostly sand-filled inlets with limited freshwater inflow and substantial subtidal zones in their outer parts. Outer shorelines are often rocky and land shelves steeply into the estuaries, so most of the shoreline is natural. Parts of these estuaries are bordered by important areas of calcareous maritime grassland and heath, some areas supporting the nationally scarce endemic Scottish primrose *Primula scotica*. Further south there are mudflats in the sheltered parts and upper tidal reaches of the large firths and smaller bar-built estuaries. Here the Ythan Estuary has nationally important sand dune systems (see also section 3.2) and Spey Bay is closed by the nationally important Kingston Shingles (see also section 3.3). A major feature of many Region 3 estuaries is the large proportion of subtidal habitats, particularly in the outer deep-water parts of the major firths (see also section 4.2); such areas have considerable importance for inshore seabirds, waterfowl and cetaceans (see also sections 5.10, 5.11, 5.12 and 5.15).

4.1.3 Human activities

Numbers of people living around the northern estuaries in the region are small, but there is increasing urbanisation of estuarine shores towards the south of the region, these being most extensive around Banff Bay and the Dee Estuary, whose tidal reaches lie within Aberdeen (see also section 8.3). Related to this urbanisation, shorelines in the south of the region have more coastal defences than the more northern estuaries. Similarly, northern estuaries have a very low intensity of recreational use, with intensity and diversity of recreation increasing around estuaries near large population centres, notably the Don and Dee Estuaries and the outer parts of the Ythan Estuary. Wildfowling is extensive on the larger firths and on estuaries such as the Ythan (see also section 9.7). Other natural resource exploitation is generally limited to sand dune and saltmarsh grazing and some bait-collection, but there are also salmon and/or sea trout fisheries associated with some estuaries, notably at Torrisdale Bay, Moray Firth, Spey Bay, Ythan Estuary and St. Cyrus (see also section 9.1).

Estuarine water quality is good throughout the region, except in a canalised part of the Lossie Estuary, the Don Estuary and the lower part of the Ythan Estuary, an estuary where eutrophication and spreading algal blooms occur. Tidal ranges in this region are generally small compared with those on many parts of the UK coastline. Only eight estuaries - Kyle of Durness, Kyle of Tongue, Torrisdale Bay, Melvich Bay, Loch Fleet, Moray Firth, Lossie Estuary and St. Cyrus Estuary - are macrotidal (i.e. their spring tidal range exceeds 4 m), although the largest spring tidal ranges, on the north Highland coast, are only 4.3 m. The other seven estuaries are mesotidal (i.e. 2-4 m tidal range).

Compared with estuaries further south in Britain, there has been relatively little land-claim in this region, although the lower Dee Estuary has been substantially altered by dock construction, the upper parts of Loch Fleet were closed by embankment in the early 19th century, and road and bridge schemes have altered small parts of several estuaries.

Table 4.1.3 Human influences and water quality on Region 3 estuaries

Estuary	*Centre grid ref.*	*Human use type*				*Water quality*
		urban	*industrial*	*rural**	*recreational*	
Highland						
66. Kyle of Durness	NC3766			●	○	1
67. Kyle of Tongue	NC5858			●	○	1
68. Torrisdale Bay	NC6962			●	○	1
69. Melvich Bay	NC8964			●	○	1
74. Loch Fleet	NH7996			●	○	1
75. Dornoch Firth	NH7087	○	○	●	○	1
76. Cromarty Firth	NH6667	○	●	○	○	1
Highland/Grampian						
77. Moray Firth	NH7152	○	○	●	○	1
Grampian						
78. Lossie Estuary	NJ2470	○		●	○	(2), 1
79. Spey Bay	NJ3465	○		●	○	1
80. Banff Bay	NJ6964	●		○	○	1
81. Ythan Estuary	NK0026			●	●	1, 2
82. Don Estuary	NJ9509	○	○		●	2
83. Dee Estuary (Grampian)	NJ9405	●	●		○	1
Grampian/Tayside						
84. St. Cyrus	NO7362			●	○	1

Sources: Buck (1993), Scottish Development Department (1987). Key: *includes natural resource exploitation; ● = major human use; ○ = minor human use. Multiple water quality codes are in downstream sequence; brackets indicate a water quality found in only a small part of the estuary.

Oil and gas-related construction has, however, more recently affected parts of the Dornoch, Moray and Cromarty Firths, the last also having a major metal industry complex. The recent construction of an oil pipeline fabrication site has cut across saltmarsh-sand dune transitions on the nationally important Morrich More (Dornoch Firth). Table 4.1.3 summarises human uses and water quality on estuaries in the region.

4.1.4 Information sources used

This chapter is summarised chiefly from JNCC's *An inventory of UK estuaries*, which is being published in six regional volumes along with an introductory and methods volume. All estuaries in Region 3 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 (1989), whose surveys did not cover saltmarshes of <0.5 ha.

Hydrological data, e.g. catchment areas and river flows, are available for some but not all estuaries as defined here. Catchment areas and river flows are summarised in a five-year catalogue of river flow gauging stations (Marsh & Lees 1993), but note that for whole estuary data further interpretation is usually necessary.

4.1.5 Acknowledgements

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

4.1.6 Further sources of information

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

Scottish Development Department. 1987. *Water quality survey of Scotland 1985.* Edinburgh, HMSO.

B. Further reading

Further details of estuaries are in the *Coastal & marine UKDMAP datasets* module (Barne *et al.* 1994), available from JNCC Coastal Conservation Branch, Peterborough. A list of selected further reading for each estuary discussed in section 4.1 is given in Buck (1993) (above).

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

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

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
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 Conservation Branch, Joint Nature Conservation Committee, Peterborough, tel: 01733 62626
Statutory protected sites; detailed wildlife site information; coastal geomorphology. Firths Initiative & estuary management plans. Numerical and some digitised data.	*Marine Conservation Officers/Coastal Ecologist, Aquatic Environments Branch, 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	*Estuaries Inventory Project Officer, RSPB, Sandy, tel: 01767 680551
National River Flow Archive: catchments and river flows from upstream gauging stations; interpreted analyses for whole estuaries	National Water Archive Manager, Institute of Hydrology, Maclean Building, Crowmarsh Gifford, Wallingford, Oxfordshire OX10 8BB, tel: 01491 838800
Moray Firth Project	*Rachael Harding-Hill, Moray Firth Project Officer, Scottish Natural Heritage, Ardconnel Terrace, Inverness, tel: 01463 712221
Ecology of the Ythan Estuary	Dr D. Raffaelli, Culterty Field Station, Aberdeen University Department of Zoology, Newburgh, Ellon, Aberdeenshire AB41 0AA, tel: 01358 789631

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

4.2 The sea bed

R.A. Irving

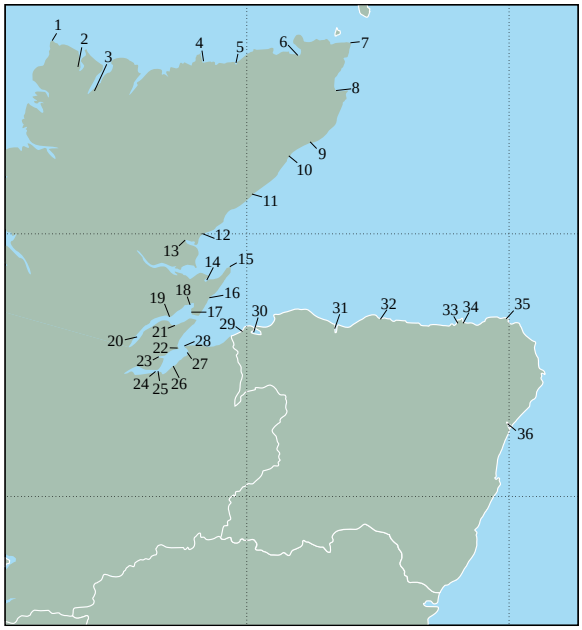
4.2.1 Introduction

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. Information on the precise extent of littoral (between tides) and sublittoral (below tides) habitat types in a national context is not yet available.

The north and north-east coasts of Scotland face away from the prevailing winds and are less exposed than those of, for instance, Orkney or Shetland. The shores of the north coast of Scotland are predominantly rocky and backed by cliffs, interrupted by the occasional sandy beach. Loch Eriboll is the only large deep-water sealoch on the north coast of Scotland and is also the only Marine Consultation Area in the region (Nature Conservancy Council 1990) (see also section 10.2). The Pentland Firth is subject to very strong tidal streams (9 knots or 4.5 m/s), resulting in specialised benthic communities. The Moray Firth coastline comprises a mix of rocky shores, sandy bays and a number of large sheltered firths. Parts of these shores are regarded as being of regional marine biological importance on account of their relatively rich communities. Three of the sheltered inlets (Loch Fleet, Nigg Bay in Cromarty Firth, and Munlochy Bay in Inverness Firth) were all proposed by Bishop & Holme (1980) as being of national marine biological importance. Far less is known of the near-shore sublittoral zone and no areas to date have been highlighted as being of particular importance for their marine habitats or communities. However, this may simply indicate a lack of survey data. Further offshore, a large number of benthic surveys have been carried out, many of them commissioned by the fishing and oil industries, although the reports of several of these surveys are confidential.

Littoral substrates in the region are varied. Along much of the north and north-east coast of this region, south to Helmsdale, rocky shores are common. They are mostly of bedrock, but boulders are also present in some places. Littoral rock is found from Tarbat Ness to Balintore; from Buckie to Fraserburgh; from Boddam to Collieston; and from Aberdeen south to St. Cyrus. Sedimentary areas include, along the north and north-east coast, the Kyles of Durness and Tongue; several small bays and Dunnet Bay; the large Firths and muddy inlets of the Moray Firth; Culbin Sands and Burghead Bay; Fraserburgh Bay and the sands either side of Rattray Head; and the extensive Sands of Forvie and Balmedie Beach to the north of Aberdeen. Some shingle beaches are present too, particularly in Spey Bay.

Sublittorally, the extent of rock has been documented at only a few specific sites. In most areas where littoral rock occurs, the rock also extends beyond the low water mark. The depth at which this eventually gives way to sediment varies, though sediment is likely to occur off sandy bays. Sand and mixed sediments also predominate further offshore. A number of wrecks (of ships, aircraft and other solid material) occur off the coast of this region, as elsewhere. In some largely sedimentary areas, the hard substrata these objects represent provide discrete new habitats for opportunistic colonising species that otherwise would not be present (see also section 5.4).



Map 4.2.1 Locations of particular marine interest (Table 4.2.1)

4.2.2 Important locations and communities

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

Cape Wrath to Duncansby Head

The cliffs at Cape Wrath extend into the sublittoral, forming vertical and very steep bedrock slopes with numerous surge gullies. Associated with these exposed habitats are communities rich in sea squirts and sponges (e.g. *Dendrodoa/Clathrina*) (Dipper 1981). The Kyle of Durness is a shallow inlet with large areas of intertidal sand, bounded by shingle, boulders and bedrock (at the seaward end). Typical sheltered muddy communities are present (dominated by amphipod and polychaete species), together with the fucoid alga *Fucus ceranoides* (Jones 1975a). Well-developed beds of large mussels *Mytilus edulis* are present at the entrance to the inner Kyle. Large boulders, and bedrock with crevices, gullies, overhangs and caves, occur at most sites surveyed, giving way to pebbles, clean sand or mud with increasing depth (Glasgow University Exploration Society 1975). Laminarian kelps extend down to a maximum depth of 23 m below chart datum, with *Alaria esculenta* present at exposed sites and *Saccorhiza polyschides* at sheltered sites. Common animal species include dead man's fingers *Alcyonium digitatum*, the feather star *Antedon bifida*, the dahlia anemone *Urticina felina* and scallops *Pecten maximus* (Glasgow University Exploration Society 1975). The outer region of neighbouring Loch Eriboll comprises

Table 4.2.1 Sites of marine interest mentioned in the text

No. on Map 4.2.1	*Location*	*Grid ref.*
	Highland	
1	Cape Wrath	NC2675
2	Kyle of Durness	NC3766
3	Loch Eriboll	NC45-NC46
4	Strathy Beach	NC8366
5	Sandside Beach	NC9665
6	Dunnet Beach	ND2169
7	Duncansby Head	ND4073
8	Sinclair's Bay	ND3456
9	Clyth Ness	ND2635
10	Dunbeath	ND1629
11	Helmsdale	ND0315
12	Golspie	NC8300
13	Loch Fleet	NH7897
14	Inver Bay	NH8683
15	Tarbat Ness	NH9587
16	Balintore	NH8675
17	Balnabruaich	NH7869
18	Nigg Bay	NH7771
19	Invergordon	NH7068
20	Cromarty Firth	NH5860
21	Udale Bay	NH7165
22	Chanonry Point	NH7555
23	Munlochy Bay	NH6753
24	Kessock	NH6647
25	Longman Point	NH6647
26	Alturlie Point	NH7149
27	Ardersier	NH7755
28	Fort George	NH7656
	Grampian	
29	Culbin Bars	NH9763
30	Findhorn Bay	NJ0463-NJ0563
31	Spey Bay	NJ3465
32	Cullen Bay	NJ5167
33	Gardenstown	NJ8065
34	Pennan	NJ8465
35	Fraserburgh	NK0067
36	Ythan Estuary	NK0028

predominantly bedrock shores, and the inner area is characterised by boulder, shingle and gravel shores (Jones 1975b). The bedrock shores are dominated by barnacle and mussel communities, while the more sheltered shores support fucoid-dominated communities. Shores on the west coast of the sea loch display a wider range of habitats than those on the east, on account of the former's greater variation in wave exposure. At the entrance and in the loch itself, a diverse range of sublittoral habitats and communities occurs (Moss 1986). In the outer loch, below the kelp *Laminaria hyperborea* forest, rich communities of sponges, ascidians, hydroids and bryozoans dominate vertical and steep-sided bedrock. A wide variety of foliose and encrusting algae are found on cobbles and pebbles throughout the loch. Sparse patches of maerl, an unusual calcareous alga, occur in hollows in areas of muddy sand. Soft mud present in the deeper parts of the loch supports populations of the sea pen *Virgularia mirabilis* and the burrowing Norway lobster *Nephrops norvegicus*.

The exposed rocky shores of the north coast of Caithness are distinguished by the presence of a well-developed zone of blue-green algae and red algae *Porphyra* spp. on the upper shore, a mid-shore zone of mussels and the limpet *Patella ulyssiponensis,* and belts of the brown algae *Fucus vesiculosus*, *F. linearis* and *Himanthalia elongata* (Lewis 1954). Duncansby Head appears to act as a distribution boundary for certain intertidal 'southern' species that do not occur on the east coast. These include the upper shore barnacle *Chthamalus montagui*, the gastropod *Littorina neritoides*, the mid to lower shore topshell *Gibbula umbilicalis* and the limpet *Patella aspersa* (Bartrop *et al*. 1980).

The Moray Firth (Duncansby Head to Rattray Head): the open coast

The Moray Firth extends from Duncansby Head in the north, taking in the Beauly Firth in the south-west, to Fraserburgh in the south-east. The open coastline ranges from high cliffs and rocky shores to sweeping sandy beaches. The coast between Duncansby Head and Golspie is predominantly rocky and largely unbroken, with Sinclair's Bay north of Wick being the only major indentation. Beaked tasselweed *Ruppia maritima* is found with dwarf eelgrass *Zostera noltii* and glasswort *Salicornia* spp. on the intertidal flats in the River of Wester, Caithness (Fox *et al.* 1986). The predominantly rocky shores between Dunbeath and Ballintore are similar to those between Aberdeen and the Firth of Tay, i.e. dominated by barnacles and mussels, with fucoid algal cover being sparse. However, this type of shore on the north side of the Moray Firth is generally poorer in species compared with examples on the south side (Smith 1981). Rocky shores at Helmsdale, Tarbat Ness, Cullen, Gardenstown and Pennan are of conservation interest (Bartrop *et al*. 1980). All are exposed or moderately exposed to wave action and support a moderately rich fauna typical of rocky shores within the Moray Firth. In the Inner Moray Firth, the coast south of Tarbat Ness is the only continuous length of rocky shore in over 150 km of sedimentary coastline, with a mixture of rock types and a very extensive kelp forest, off Balnabruaich. Along this stretch, the middle- and lower-shore zones include a range of habitats, including boulders, cobbles, overhangs, rockpools and inclined bedrock, all of which support rich intertidal communities.

The south coast of the Moray Firth from Fort George to Fraserburgh comprises a sequence of sandy bays (more common in the western part) and rocky shores, often backed by cliffs. The sedimentary shore at Culbin Bar, which is of geomorphological interest and regional marine biological importance, is moderately exposed and features a rich eelgrass *Zostera* spp. bed (Bartrop *et al*. 1980). Also of geomorphological interest is the shifting delta of the River Spey at Spey Bay, which forms part of the largest shingle complex in Scotland. The rocky ridges and pools of Cullen Bay display a moderately rich fauna and flora, and further to the east at Gardenstown the extensive rocky shore area has large populations of many common intertidal species, with a well developed flora of red algae (Bartrop *et al*. 1980). The shallow sublittoral zone of the Moray Firth is considered to lack habitat diversity (Earll 1983).

The marine inlets of the Moray Firth

Sedimentary shores considered representative of the Moray Firth inlets and of regional marine biological importance include Loch Fleet, the lower Cromarty Firth, Munlochy Bay, Ardersier and Findhorn Bay (Bartrop *et al*. 1980). All of these sites are sheltered from wave action. Loch Fleet is a small, shallow loch with predominantly sedimentary shores.

The invertebrate fauna is dominated by oligochaete and polychaete worms, amphipods and bivalves (Wells & Boyle 1975). The variety of substrata and habitats leads to a species richness unusual in the Moray Firth, making it possibly of national marine biological importance (Bishop & Holme 1980). Dornoch Firth consists of a series of generally shallow basins and narrows extending into the narrow Kyle of Sutherland. The littoral invertebrate fauna is similar to that of Loch Fleet (Wells & Boyle 1973). The sublittoral sediment fauna includes species characteristic of sandy substrata (Hunter & Rendall 1986). Extensive mussel beds occur in the middle of Dornoch Firth.

Cromarty Firth is a long, natural harbour which, since the 1970s, has served as an anchorage for oil platforms. It is estuarine in nature above Invergordon, but seaward of this point the salinity is stable and the water deep, reaching about 50 m at the entrance to the Firth, where strong tidal streams occur. Probably the largest area (1,200 ha) of dwarf eelgrass and narrow-leaved eelgrass *Z. angustifolia* in Britain is found on the intertidal flats in the Cromarty Firth, where beaked tasselweed and glasswort also occur (Fox *et al*. 1986). On the north side of the firth, Nigg Bay has a rich invertebrate fauna, reflecting the diversity of sediment types present within the bay. It is biologically similar to other bays within the Moray Firth (Raffaelli & Boyle 1986), and is a site of possible national marine biological importance (Bishop & Holme 1980). Within the fouling communities on the Nigg Terminal jetty, mussels and algae dominate the upper parts, with barnacles, tubeworms, anemones, soft corals and hydroids being present lower down (Picken 1986).

Inverness Firth is bounded by sediment shores, with strong tidal streams occurring around Chanonry Point at its mouth. On the south shore, Udale Bay is possibly of marine biological importance (Bishop & Holme 1980). Munlochy Bay has an intertidal area of boulder and cobble slopes bordering mudflats, where extensive stands of the seagrasses *Zostera* spp. and beaked tasselweed provide valuable feeding for overwintering wildfowl and waders. It is considered to be a site of national marine biological importance (Bishop & Holme 1980). The Beauly Firth has extensive intertidal mudflats of ornithological importance. The most common seagrass within the firth is narrow-leaved eelgrass, though dwarf eelgrass and beaked tasselweed also occur (Fox *et al*. 1986). Much of the basin consists of muddy sand with a rich infauna, though towards the entrance, at Kessock, the sea bed is stony, with a greater diversity of epifaunal species, including the hydroid *Dynamena pumila* colonised by the diminutive mussel *Musculus discors* (Hunter & Rendall 1986). The communities from the extensive muddy sandflats at Findhorn Bay are regarded as being typical for the region (Bartrop *et al*. 1980), being dominated by polychaetes (lugworm *Arenicola marina*, ragworm *Hediste diversicolor* and *Scoloplos armiger*), amphipods (*Bathyporeia* spp. and *Corophium volutator*), and bivalves (cockles *Cerastoderma edule*, mussels *Mytilus edulis* and Baltic tellin *Macoma balthica*).

Fraserburgh to St. Cyrus

The littoral zone of this sector comprises a mixture of extensive stretches of sand, interspersed with rocky shores backed by cliffs, about which little has been published. The sea bed off Aberdeen is mostly muddy to fine or coarse sand, with a fauna dominated by bivalves and polychaetes (McIntyre 1958).

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

The North Sea has been divided by Adams (1987) into seven ecological subdivisions, of which the 'north British coastal' and the 'northern' and 'central offshore' sectors (to the north and south of the 100 m depth contour repectively) are relevant here. In the Outer Moray Firth, within the north British coastal sector, sediments vary from sandy mud to gravel, and the fauna is numerically dominated by the burrowing sea urchin *Echinocyamus pusillus* and in terms of biomass by polychaete and mollusc species. The Beatrice Oilfield, approximately 25 km due east of Helmsdale, lies at the south-west corner of the Smith Bank, where sea bed depths are in the region of 50 m. The coarse sandy sediments here support an infauna dominated by the bivalve *Moerella pygmaea,* the polychaete *Ophelia borealis* and the heart urchin *Echinocyamus pusillus* (Sphere Environmental Consultants 1977). To the north and west of the Smith Bank, the finer sand is dominated by the bivalves *Fabulina fabula* and *Angulus tenuis*, the scaphopod *Antalis entalis* and the sea pen *Virgularia mirabilis*.

In the northern offshore sector, Eleftheriou & Basford (1989) found that polychaetes dominated the benthic infauna, with 188 species representing 46% of the total fauna. Crustaceans represented 27% (109 species) and molluscs, mostly bivalves, represented 20% (80 species). The most abundant taxa was the polychaete *Thyasira* species complex. The species richness (for both polychaetes and the total infauna in general) was found to be higher in the 120-140 m depth zone than in the surrounding shallower or deeper areas. In a survey of the epifauna undertaken at the same time (1980-1985) (Basford *et al*. 1989), the most frequently recorded of the 196 taxa found were echinoderms, particularly the starfishes *Asterias rubens* and *Asteropecten irregularis* and the heart urchin *Echinocardium flavescens*.

The Forties Oilfield lies 175 km north-east of Aberdeen in depths of 100-125 m. Hartley (1984) found sediments varying from medium sand to very fine sand, with the sandy muds being characterised by the presence of dense populations of large foraminiferans, e.g. *Astrorhiza arenaria* and *Saccammina sphaerica*. Otherwise, polychaetes comprised about 35% of the taxa and 50% of the individuals at each of the 25 stations sampled in 1978.

4.2.3 Human activities

A number of activities that affect marine benthic habitats and communities take place within this region (see also Chapter 9). Of particular relevance to the offshore benthos are the impacts associated with oil and gas installations and commercial fishing operations within the North Sea. Closer to the coast, commercial cockle harvesting takes place at Inver Bay and at a number of other sites within the Moray Firth (see also section 9.1).

Within enclosed firths and bays, there has been concern in recent years regarding the spread of green algae over mudflats, encouraged by artificial nutrient enrichment. An increase in nitrogen levels in the River Ythan has been associated with increases in the biomass of the green algae *Enteromorpha* spp., which are blanketing out mudflats and adversely affecting numbers of the amphipods *Corophium* spp., the main prey organism of most fish and shorebirds in

the estuary (Raffaelli *et al*. 1989). The Ythan Estuary is one of only two coastal sites in the UK (the other being Langstone Harbour in Hampshire - Region 9) identified in 1992 by the Department of the Environment as exhibiting problems associated with eutrophication (nutrient enrichment) (OSPARCOM 1992) (see also section 9.6).

4.2.4 Information sources used

The numbers and distribution of sites that have been surveyed in this region are given in Table 4.2.2 (MNCR surveys) and Maps 4.2.2 and 4.2.3 (MNCR and other surveys). Few sublittoral sites have been surveyed in this region by either the former Nature Conservancy Council or JNCC's Marine Nature Conservation Review (MNCR) team. Bennett & Covey (in prep.) and Bennett & McLeod (in prep.) review the current knowledge of marine surveys in this region. The MNCR team use a standard recording methodology for both littoral and sublittoral surveys, which includes descriptions of both habitats and their associated communities (see Hiscock 1990).

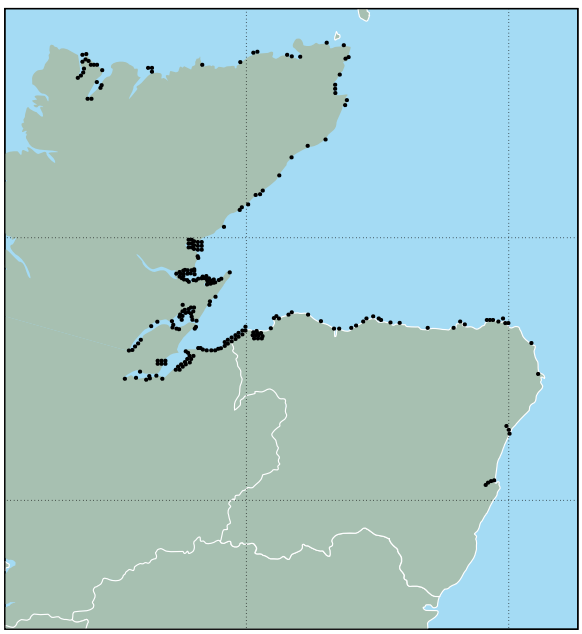
Table 4.2.2 Number of surveyed sites in the region recorded on the MNCR database

Littoral	*Near-shore sublittoral*	*Offshore*	*Total*
386	60	0	446

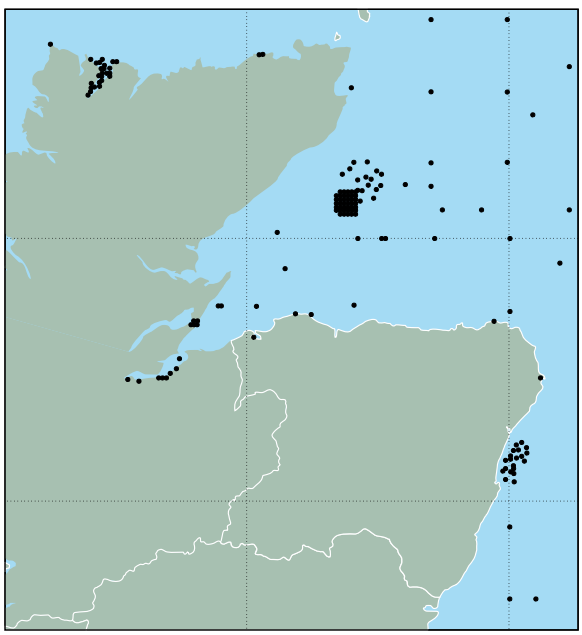
Source: MNCR Field Database 1994. Note: these figures are not comprehensive; additional records exist in sources that were not consulted.

The north Sutherland coast has received little attention from marine biologists, so information on littoral and sublittoral habitats and communities is scant. Since 1971, the rocky shores at Dounreay have been part of a monitoring programme to study the annual differences in recruitment of limpets and barnacles around Great Britain (Bowman 1978). A number of north Sutherland's rocky shores were studied by Lewis (1957), who compared species zonation and distributions on exposed and sheltered shores. Existing information on the coastal habitats of north Caithness was reviewed by Scott *et al*. (1985), including that for the sublittoral zone, as part of the proposal to build the European Demonstration Reprocessing Plant at Dounreay.

Intertidal higher plants, such as the seagrasses *Zostera* spp. and *Ruppia* spp., found at a number of sites within the Moray Firth, have been monitored by the University of Aberdeen, Department of Geography (see 1981 for last known report in study), the distribution and extent of each species being given by Fox *et al*. (1986). A survey of the distribution of dwarf eelgrass and narrow-leaved eelgrass at Culbin Sands and Findhorn Bay was carried out in 1991 (Scottish Natural Heritage undated). A review of the status of all eelgrass species in Scottish coastal waters has recently been prepared (Cleator 1993). A major rocky shore monitoring programme in the Moray Firth was initiated in 1981 by Sphere Environmental Consultants Ltd. (1981) on behalf of Britoil. A total of 34 shores between Duncansby Head and Fraserburgh were selected, and the 36 separate reports resulting from the work were summarised by Terry & Sell (1986). The fauna of the sediment shores between Alturlie Point and Findhorn Bay was surveyed by Wells & Boyle (1974). A number of studies of the Cromarty Firth's intertidal fauna have been carried out, particularly in Nigg and Udale Bays (e.g. Anderson 1971; Raffaelli & Boyle 1986; Rendall & Hunter 1986), and of the sublittoral fauna by Hunter & Rendall (1986). Hunter & Rendall (1986) also provide a description of sublittoral communities within the Moray Firth, with additional data at its entrance deriving from an MNCR training exercise in May 1992 (MNCR unpublished data). A littoral survey of Munlochy Bay was undertaken in 1977 on behalf of the NCC (Boyle & Goodman 1977). The Highland River Purification Board (now part of the Scottish Environment Protection Agency - SEPA) have carried out studies of Inverness Firth's intertidal fauna (Rendall & Hunter 1986) and its sublittoral fauna



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



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

(Hunter & Rendall 1986), particularly in relation to a sewer outfall at Longman Point.

The marine algae of Grampian Region were recorded in 1975 (Wilkinson 1979). Little has been published about the shores or nearshore sublittoral zone from Fraserburgh to St. Cyrus, though the shores in the vicinity of Aberdeen have provided opportunities for investigations (mostly of individual species) by students of Aberdeen University. Eleftheriou (1964) studied the invertebrate fauna of the Dee Estuary. The sediments and benthic fauna of fishing grounds off Aberdeen and in the northern part of the Moray Firth were surveyed by McIntyre (1958). The Ythan Estuary has been intensively studied by the University of Aberdeen, a full list of publications and theses having been compiled recently (University of Aberdeen, Department of Zoology 1992). The estuary's invertebrate populations have been widely investigated in relation to the feeding habits of certain bird species. Long-term changes in nutrients, weed mats and shorebirds have also been studied (Raffaelli *et al*. 1989).

Much of the pre-1970s offshore survey work was related to the fishing industry. Indeed, since the turn of the century, the Scottish Office Agriculture, Environment and Fisheries Department marine laboratory at Aberdeen has carried out extensive survey work throughout the northern North Sea. Major studies of the offshore benthic environment and benthos of the northern North Sea were conducted by Eleftheriou & Basford (1989) and Basford *et al*. (1989, 1990). Since the early 1970s, the development of the North Sea oil industry has provided the impetus for numerous studies, both ongoing monitoring projects and site-specific environmental impact assessments. An initial survey of the benthic fauna around the Beatrice oilfield was carried out by Sphere Environmental Consultants (1977). Further work on the benthic fauna of Smith Bank has been undertaken (e.g. Hartley & Bishop 1986). The benthos of the Forties oilfield has been monitored by the Oil Pollution Research Unit (Hartley 1984), initiated in 1975. Other studies relate to pollution, from pipeline discharges and offshore sewage dumping. Detailed descriptions of offshore benthic sea bed types and their associated communities in the northern North Sea are given by Basford *et al.* (1989, 1990) and Eleftheriou & Basford (1989).

4.2.5 Acknowledgements

The author acknowledges the help of JNCC's Marine Nature Conservation Review team (particularly Dr Tim Hill) in compiling and presenting the information given here. The MNCR literature reviews by Teresa Bennett and Roger Covey (Cape Wrath to Duncansby Head) and by Teresa Bennett and Colin McLeod (Duncansby Head to Dunbar) have been widely consulted.

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Wood, E., *ed*. 1988. *Sea life of Britain and Ireland*. London, Immel. (Marine Conservation Society.)

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Marine nature conservation issues in Scotland	*Dr John Baxter, Aquatic Environments Branch, SNH, Edinburgh, tel: 0131 554 9797
MNCR database	*MNCR Team, JNCC, Peterborough, tel: 01733 62626
Offshore benthic studies relating to fisheries	Scottish Office Agriculture & Fisheries Department, Marine Laboratory, PO Box 101, Victoria Road, Aberdeen AB9 9DB, 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
Various research projects	Department of Zoology, University of Aberdeen, Tillydrone Avenue, Aberdeen AB9 2TN, tel: 01224 272858
Ecology of the Ythan Estuary; estuarine studies; North Sea benthos, etc.	Culterty Field Station, Aberdeen University Department of Zoology, Newburgh, Ellon, Aberdeenshire AB41 0AA, tel: 01358 789631
Sea bed surveys and information	Aberdeen University Marine Studies Ltd., AURIS Business Centre, 23 St. Machar Drive, Old Aberdeen, Aberdeen AB2 1RY, tel: 01224 272853

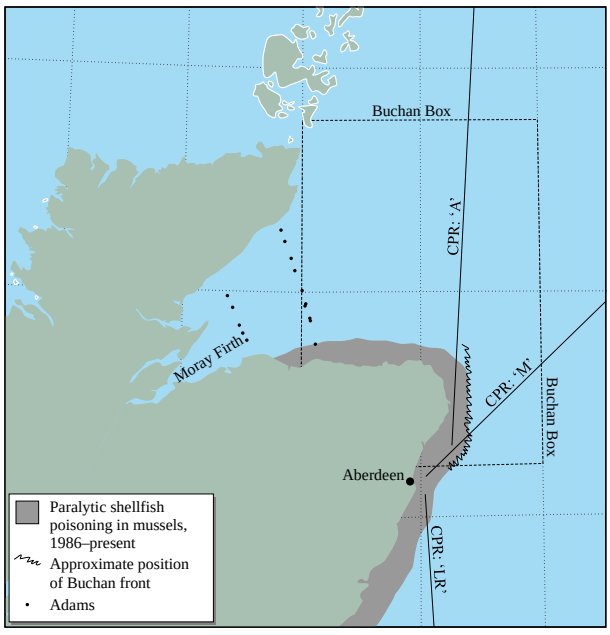
* Starred contact addresses are given in full in the Appendix.

4.3 Plankton

M. Edwards & A.W.G. John

4.3.1 Introduction

Plankton include the bacteria (bacterio-), plant (phyto-) and animal (zoo-) plankton. In temperate continental shelf seas, as in this region, the phytoplankton assemblage is dominated by diatoms and dinoflagellates, and the zooplankton, although containing representatives of most animal phyla at some stage, is dominated by crustaceans, principally copepods. The plankton's abundance is strongly influenced by factors such as depth, tidal mixing and temperature stratification, which determine the vertical stability of the water column. The distribution of species, here and elsewhere, is influenced directly by salinity, temperature and water flows into the area (see section 2.3) and by the presence of local benthic (bottom-dwelling) communities (section 4.3.2). Many of the species of these communities, including commercially important fish and shellfish (sections 5.5 and 5.7), have temporary planktonic larval forms (meroplankton). Tidal fronts (boundary zones between stratified and well-mixed water masses) in the region (Map 4.3.1) are likely to be of significant biological importance, since they are usually rich in plankton, which attracts other marine life. Phytoplankton blooms are a normal feature in the seasonal development of plankton. Some blooms (transient, unsustainable growths, usually of single species and often associated with a visible discolouration of the water) may reach exceptional proportions (>10^6 cells/l) or contain species (principally dinoflagellates) that can be toxic to humans and possibly have an important economic impact on mariculture, fisheries and tourism. Figure 4.3.1 shows the seasonality of phytoplankton blooms and of the numbers of copepods present in the region's waters.



Map 4.3.1 Plankton surveys (see Table 4.3.1), the approximate position of 'fronts' and the occurrence of paralytic shellfish poisoning. Source: SAHFOS.

In Region 3, as elsewhere, the plankton has a fundamental role in the food chain of both benthic (sea-bed) organisms (see sections 4.2 and 5.4) and fish (see sections 5.5 and 5.7-5.9). 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 also give early warning of adverse human impacts (for example the effects of eutrophication) and highlight different water masses.

4.3.2 Important locations and species

The Continuous Plankton Recorder (CPR) surveys (see e.g. Warner & Hays 1994) show that the planktonic assemblage is mainly made up of northern intermediate (mixed water) and neritic (coastal water) species; however, the inflow of Atlantic water down the western edge of the North Sea in late summer/autumn can introduce oceanic species such as *Salpa fusiformis* (Fraser 1962). The spring increase of phytoplankton begins in March, with diatoms, predominantly *Chaetoceros* spp. and *Rhizosolenia* spp., reaching a peak in May. After the diatom peak in May, dinoflagellates, particularly *Ceratium furca* and *Ceratium* spp., show a steady increase through the summer. The timing of the spring bloom is earlier here than it is to the

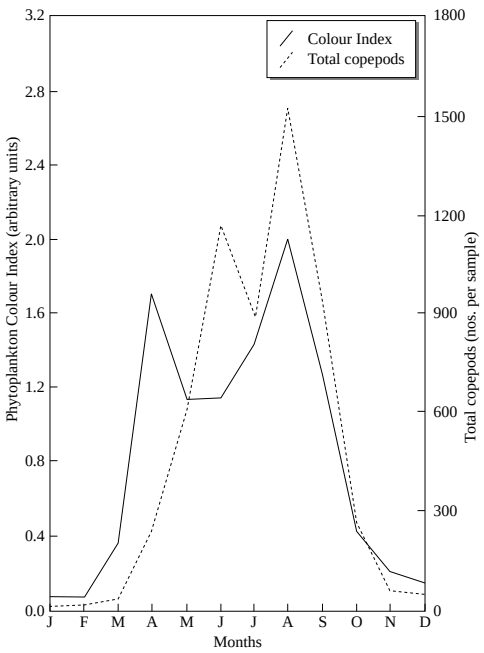


Figure 4.3.1 Average seasonal cycles of an index of phytoplankton colour (a visual estimate of chlorophyll) and of the numbers of copepods per sample (approximately 3 m^3 of water filtered), derived from Continuous Plankton Recorder data for 1958-1992. Source: SAHFOS.

Table 4.3.1 Details of surveys

Identification in Map 4.3.1	*Frequency*	*Period*	*Reference*
CPR: 'A' route	Monthly	1938 to present	Warner & Hays 1994
CPR: 'M' route	Monthly	1938-1966, 1984 to present	
CPR: 'LR' route	Monthly	1959-1978, 1984 to present	
Adams	Monthly	1981	Adams & Martin 1986
Buchan front	Occasional	1985	Kiørboe *et al.* 1988
Buchan Box	Occasional	1953	Glover 1957
Buchan Box	Weekly	1957-1974	Bainbridge *et al.* 1978
Moray Firth and north North Sea (sampled by MLA)	±Monthly	1960-1974	Adams *et al.* 1976

Key: CPR: Continuous Plankton Recorder; MLA: Marine Laboratory, Aberdeen.

north of this region, but the overall abundance and duration of phytoplankton is lower than in the central and southern North Sea. The main components of the zooplankton are small copepods, such as *Pseudocalanus elongatus*, *Acartia clausi* and *Temora longicornis*, and the larger copepod *Calanus finmarchicus*. Copepod numbers start increasing by March, reaching maximum numbers between May and August (2.0 g dry weight/100 m^3); after September copepod numbers decrease to low winter levels (0.3 g dry weight/100 m^3 (Adams 1987)). The overall abundance of copepods in this region is quite high compared with other areas, but the seasonal duration is much shorter than in the southern North Sea. Copepods are the group with the highest diversity in the zooplankton, with overall zooplankton biodiversity increasing towards the open sea. Other commonly-found zooplankton include the chaetognath (arrow worm) *Sagitta elegans* (a species indicative of oceanic water masses), small hydromedusae, amphipods and meroplanktonic larvae of echinoderms, polychaetes, decapods, molluscs and cirripedes. The zooplankton of this region are critical to the survival of important fish species (e.g. herring), which spawn in this region or migrate through the area as larvae and pelagic adults.

A pronounced tidal front (the Buchan front) is found in a transitional zone off Buchan and the Aberdeenshire coast, where shallow coastal water meets deeper, seasonally stratified North Sea water (Map 4.3.1) (Kiørboe *et al*. 1988). In autumn 1985, after a storm event, there was enhanced phytoplankton production (up to 550 mg C m^{-2} d^{-1}), followed rapidly by enhanced grazing and secondary production in copepods (Kiørboe *et al*. 1988). Richardson *et al.* (1986) also found patches of raised chlorophyll and primary production in the mixed and transitional zones in the same area.

4.3.3 Human activities

Dinoflagellates are of particular importance to the coastal manager in Region 3 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 off the coast of north-east Scotland since 1968 (Map 4.3.1). 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).

4.3.4 Information sources used

This region has undergone numerous plankton surveys because of its proximity to the SOAEFD Marine Laboratory in Aberdeen. Data have been collected since the 1920s on plankton indicator species and the variability of plankton assemblages. Particular attention has been paid to the plankton's importance for the herring fishery, and especially to the copepod *Calanus finmarchicus*, which makes up a high proportion of the herring's diet (Glover 1957; Bainbridge *et al.* 1978). The Continuous Plankton Recorder (CPR) surveys in this region are important because they amass long-term plankton data which can be used to assess the effects of environmental variability and climatic changes on the marine biota. Dodge (1989, 1995) studied diversity and seasonality of dinoflagellates from north Sunderland.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Continuous Plankton Recorder (CPR) survey data	Director, Sir Alister Hardy Foundation for Ocean Science, The Laboratory, Citadel Hill, Plymouth PL1 2PB, tel: 01752 633100
Plankton research	*Director, SOAEFD Marine Laboratory, Aberdeen, tel: 01224 876544
Ichthyoplankton	*Director, MAFF Directorate of Fisheries Research, Fisheries Laboratory, Lowestoft, tel: 01502 562244
Marine research	Head of Department, Department of Zoology, University of Aberdeen, Tillydrone Avenue, Aberdeen AB9 2TN, tel: 01224 272858

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

Chapter 5 Important species

5.1 Terrestrial lower plants

N.G. Hodgetts

5.1.1 Introduction

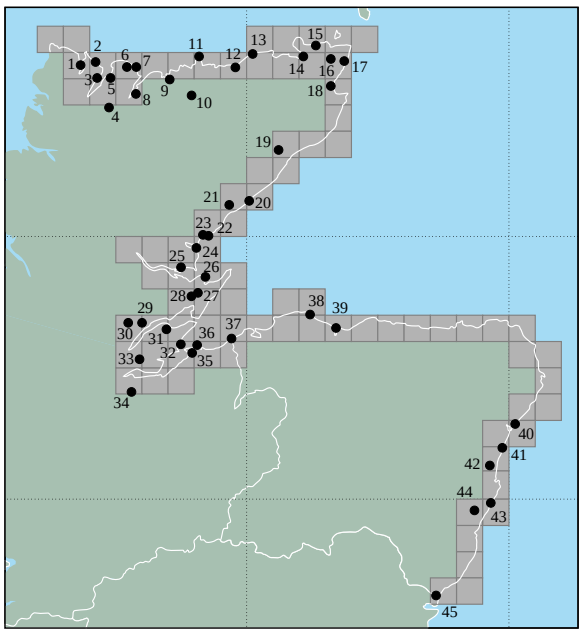
This section covers lichens, bryophytes (mosses and liverworts), stoneworts (a group of freshwater and brackish water algae - the latter are covered in section 5.4) and fungi occurring in the coastal 10 km squares within the boundaries of the region. Much of this region is characterised by its open and exposed coastal habitats, with little woodland or sheltered terrain but extensive cliffs and dune systems, many of them important for lower plants. An additional feature of the region is the juxtaposition of arctic-alpine lower plant communities and coastal communities, most notably in the area of Ben Hope, where the lower plant interest is further increased by the outcropping of basic rock at high altitude within the coastal region. Particularly important lower plant habitats in the region include dune systems; hard rock coasts with important lichen populations; coastal cliff-top grassland and heath; montane habitats; and, around the edge of the 'Flow Country', coastal mires.

Many of the sites in this region are important for their extent, and for the occurrence of northern and continental elements unusual in Britain. About 54% of the British bryophyte flora and about 28% of the stonewort flora occur in the region. Similar figures are not available for other groups. The extensive dune systems, including the sites where planted conifers cover large areas, are rich in lichens and bryophytes. As in other regions, wet dune slacks are very important, but in this region the dry dunes are perhaps more important than they are elsewhere. There are also several calcareous lochs with fenny ground around them associated with the dune systems. The extensive blanket bogs that impinge upon the north of the region are of international importance, with many species of *Sphagnum* and other associated bryophytes occurring there. Ben Hope is the northernmost outpost in Britain for calcicolous arctic-alpine lower plant communities. Some of the rocky coasts in the region are likely to be rich in lichens, but little survey work has taken place.

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 (Map 5.1.1). Many are large, in which case the grid reference given refers to a reasonably central point. It is likely that many important sites are omitted because of the scanty knowledge of lower plants in many parts of this region.

Like higher plants, lower plant species tend to occur in characteristic assemblages that are found in particular



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.

habitats. A number of the region's habitats are particularly favoured by lower plants. For example, a wide diversity of lichens and bryophytes, including oceanic species, live in hazel scrub-woodland characteristic of the north-west region. Dune systems are important for bryophytes, lichens and fungi; indeed some bryophytes and many fungi are dune specialists. Many of the fungi are dependent on an association with the roots of higher plants, especially willow and marram grass, and may aid dune stabilisation. Temporarily water-filled dune hollows and calcareous lochs in dune systems can be important for stoneworts. Bryophytes, particularly *Sphagnum*, are often dominant or co-dominant in bogs and flushes, and some specialist fungi may also occur. There are sometimes important stonewort communities where there is some open water associated with the site. The area of exposed rock between high water mark and the cliff tops is very important for lichens. Many distinctive species and communities grow on different rock types. Some lichens are distinctive components of the saxicolous vegetation in cliff bird roosts, where the rocks are enriched by bird droppings. Important areas of coastal (usually cliff-top) grassland and heath usually have thin turf with complex vegetation mosaics rich in bryophytes, lichens and higher plants. The often extensive unstable areas are important in maintaining bare ground for colonisation by some of the rare ephemeral lower plants of this habitat.

Table 5.1.1 Lower plant sites in coastal 10 km squares

Site no.	Site name	Grid ref.	Protected status
	Sutherland		
1	Durness (Balnakeil Bay)	NC3766	SSSI
2	Smoo Cave	NC4267	SSSI
3	Eriboll	NC4361	SSSI
4	Ben Hope	NC4750	SSSI
5	Inverhope	NC4861	SSSI
6	Ben Hutig	NC5465	SSSI
7	Portvasgo Cliffs	NC5865	Not protected
8	Creag an t-Tralghean area	NC5755	Not protected
9	Invernaver	NC7061	SSSI, part NNR
10	Strathy Bogs	NC7954	SSSI, part NNR
11	Strathy Point	NC8269	Not protected
	Caithness		
12	Sandside Bay	NC9665	SSSI
13	Ushat Head	ND0270	SSSI
14	Dunnet Links	ND2169	NNR
15	Loch of Mey	ND2773	Not protected
16	Stroupster Peatlands	ND3368	SSSI
17	Freswick Bay	ND3867	Not protected
18	Keiss Links	ND3358	Not protected
19	Loch Calium Floes	ND1233	SSSI
	Sutherland		
20	Garbh Allt	ND0113	SSSI
21	Loth Gorge	NC9411	SSSI
22	Carrol Rock	NC8400	SSSI
23	Golspie Burn	NC8301	Not protected
24	Loch Fleet (Ferry & Coul Links)	NH8096	SSSI
25	Dornoch Firth (Cuthill Links)	NH7588	SSSI
Ross & Cromarty			
26	Morrich More	NH8485	SSSI
	Ross & Cromarty (continued)		
27	Calrossie	NH7978	SSSI
28	Pitmaduthy Moss	NH7877	SSSI
29	Black Rock Gorge	NH5966	SSSI
30	Allt nan Caorach	NH5467	SSSI
31	Craigroy Burn	NH6864	SSSI
32	Rosemarkie to Shandwick Coast	NH7458	SSSI
33	Monadh Mor	NH5853	SSSI
	Inverness		
34	Moniack Gorge	NH5540	SSSI
35	Ardersier Glacial Deposits	NH7856	SSSI
	Nairn		
36	Whiteness Head	NH8058	SSSI
	Moray & Nairn		
37	Culbin Sands, Forest & Findhorn Bay	NH9260	SSSI
	Moray		
38	Dunes near Lossiemouth	NJ2470	Not protected
39	Spey Bay	NJ3465	SSSI
	Gordon		
40	Sands of Forvie & Ythan Estuary	NK0327	NNR
41	Balmedie	NJ9818	Not protected
	Aberdeen		
42	Scotstown Moor	NJ9311	SSSI
	Kincardine & Deeside		
43	Findon Moor	NO9497	SSSI
44	Red Moss of Netherley	NO8694	SSSI
45	St. Cyrus & Kinnaber Links	NO7463	NNR

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

Calcareous grassland is usually richer in lower plants than neutral or acidic grassland. Exposed rocks in this habitat are often good for southern warmth-loving species of bryophyte. Lower plants often become dominant in the harsh conditions prevalent at high altitudes, and they are therefore important elements in the ecology of mountains. High altitude calcareous rocks, scarce in Britain, support very characteristic bryophyte and lichen communities, including many species with their centre of distribution in the Alps.

The region contains a number of threatened species, some of which are given special protection under national and international legislation. Species protected under Annex II of the EC Habitats & Species Directive and Appendix I of the Bern Convention and occurring in the region are *Buxbaumia viridis* (moss), on a rotten conifer log in a ravine woodland, and *Drepanocladus vernicosus* (moss), in coastal flushes at scattered sites. Species protected under Schedule 8 of the Wildlife & Countryside Act 1981 and occurring in the region are *Bryoria furcellata* and *Caloplaca luteoalba* (both lichens). Red Data Book species occurring in the region, out of a total of 137 bryophytes, twelve stoneworts and 179 lichens on the British Red Lists, excluding those that are extinct or for which insufficient information exists, are listed in Table 5.1.2. (These RDB species totals are lower than those given in previously published volumes of this series, as IUCN Red List category definitions have since changed.) For fungi there is insufficient information for a comprehensive count.

5.1.3 Human activities

The impact of human activities has not been as great as in many more southerly areas, owing to the remoteness of many parts of this sparsely-populated region. Current issues that may have a bearing on the lower plant flora of the region include mineral extraction, road construction programmes, water management, crofting, forestry, fish farming, peat extraction and acid rain. Lowering of the water table and drainage may have an effect on wetland sites, particularly in the south-east of the region. Some dune areas may be affected by holiday and leisure developments, such as caravan sites and golf courses. Cliff-top grassland and heathland and hill paths may be subject to erosion in some places. Pollution may be aggravated in some areas by new power stations, seepage from domestic or agricultural sites, oil spillages etc.

Table 5.1.2 Red Data Book lower plants

Species	*Locations/habitat*
Lichens	
Bacidia incompta	Tree near Inverbervie, Kincardine & Deeside (unlocalised record)
Bryoria furcellata	Morrich More area, Easter Ross (untraced record, presumably on conifer branches)
Caloplaca luteoalba	Brora area, Sutherland (untraced record, presumably on elm bark)
Cladonia botrytes	On pine stumps, Nairn (unlocalised record)
Cladonia uncialis subsp. *uncialis*	Dunes at Culbin, Moray, & Cuthill & Ferry Links, Sutherland
Lecanactis amylacea	On ancient oak, Moray (unlocalised record)
Lecidea antiloga	On dead pine cones and loose bark, Culbin Forest, Nairn/Moray
Lecidea erythrophaea	On hazel south of Tongue, Sutherland
Leptogium saturninum	On aspen in ravine near Loch Fleet, Sutherland
Micarea assimilata	Coastal heath near Aberdeen (unlocalised record)
Peltigera malacea	Shady track in pine plantation, Culbin Forest, Moray
Pertusaria glomerata	On mosses in Ben Hope area, Sutherland (unlocalised record)
Pyrenula coryli	On hazel, Invernaver NNR, Sutherland
Umbilicaria spodochroa	Boulders by Loch Eriboll, Sutherland (only British site)
Mosses	
Brachythecium erythrorrhizon	Calcareous dunes, Invernaver, Sutherland (only British site)
Bryum calophyllum	Calcareous dune slacks, Lossiemouth, Moray
Bryum knowltonii	Calcareous dune slacks near Tain, Ross & Cromarty
Bryum marratii	Calcareous dune slacks at scattered localities
Bryum neodamense	Wet calcareous ground, Loch of Mey, Caithness
Bryum warneum	Calcareous dune slacks, Lossiemouth, Moray
Buxbaumia viridis	Rotten conifer log, ravine woodland
Drepanocladus vernicosus	Coastal flushes, scattered sites
Grimmia ovalis	Coastal rock near Bonar Bridge, Sutherland
Pseudoleskeella nervosa	Calcareous rocks on Ben Hope, Sutherland

Source: JNCC lower plants database

Many of the larger and more important sites in the region are National Nature Reserves (NNRs) or Sites of Special Scientific Interest (SSSIs) and therefore nature conservation is taken into account in their management. Any insensitive burning of bog and moorland sites is damaging to the lower plant communities. Dune slacks important for bryophytes should be maintained in a damp and open condition, with a close herb- and bryophyte-rich sward. Similarly, a close species-rich sward with bare soil should be maintained at important coastal grassland sites: a certain amount of instability and a low level of nutrient input is often desirable to achieve this. Areas of hazel scrub and even areas of planted conifers on dunes may be important for their lower plants, and conservation programmes should take this into account.

5.1.4 Information sources used

Data for bryophytes and the larger lichens are adequate in the north of the region (although substantial work remains to be done) but less so in the south. Data are less complete for fungi, algae and the smaller lichens. Most of the protected sites in Table 5.1.1 were selected for conservation designation partly on the basis of their bryophyte and lichen interest. Some contain rare and scarce species and qualify for SSSI status on the basis of their lower plant flora alone (Hodgetts 1992).

Some of the most important bryophyte sites in the region are well documented, but survey work has tended to be targeted at specific well-known sites such as Ben Hope, Invernaver etc. 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. There are vast tracts of ground that are under-recorded or unknown as regards bryophytes, most notably the extensive blanket bogs of the region and many of the freshwater lochs and associated wetlands. The country near the coast between Aberdeen and Inverness is also poorly known for this group of species.

Most of the known important and potentially important coastal lichen sites have been identified in recent surveys (Fletcher 1984; James & Wolseley 1991). However, relatively few of these sites have been comprehensively surveyed for lichens. There are potentially more lichen sites than appear in Table 5.1.1. In particular, there are long stretches of rocky coast in Caithness and Sutherland that are under-recorded or unknown, and the coast between Aberdeen and Inverness is well-known only at certain sites, such as Culbin Sands. Many of the sites in Table 5.1.1 have only rather inadequate information for lichens, particularly microlichens. However, many of the larger and more well-known sites have had at least some degree of lichen survey in recent years.

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

With the exception of stoneworts, algae are poorly known. Sites are not currently selected for conservation designation on the basis of algae except for stoneworts. Computerised stonewort data are held at BRC and JNCC. More information on other freshwater algae may be available from the Freshwater Biological Association.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Lichens (hard rock coasts)	T. Duke, Sandrock, The Compa, Kinver, Staffs DY7 6HS, tel: 01384 872798
Lichens (general coastal)	P.W. James, c/o Department of Botany, The Natural History Museum, Cromwell Road, London SW7 5BD, tel: 0171 938 9123
Lichens (woodland and general: British Lichen Society database)	Dr A. Fletcher, Leicestershire Ecology Centre, Holly Hayes, 216 Birstall Road, Birstall, Leicester LE4 4DG, tel: 0116 2671950
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
Fungi	Dr P. Kirk, International Institute of Mycology, Bakeham Lane, Englefield Green, Egham, Surrey TW20 9TY, tel: 01784 470111
Bryophytes (general Scottish)	D.G. Long, Royal Botanic Garden, 20a Inverleith Row, Edinburgh EH3 5LR, tel: 0131 5527171
Bryophytes (Scottish, lowland)	A.B.G. Averis, 2 Traprain Cottages, Traprain, Haddington, East Lothian EH41 4PY, tel: 01620 860029
Bryophytes (Scottish, upland)	G.P. Rotheroe, Stronlonag, Glenmassan, Dunoon, Argyll PA23 8RA, tel: 01369 706281
Bryophytes (British Bryological Society herbarium)	A.R. Perry, Department of Botany, National Museum of Wales, Cathays Park, Cardiff CF1 3NP, tel: 01222 397951
Bryophytes (BRC database)	*C.D. Preston, Biological Records Centre, ITE, Monks Wood, Huntingdon, tel: 01487 773381
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 region's coastal 10 km national grid squares, whether or not they are regarded as 'coastal' species. Rare and scarce species grow in a wide range of habitats, but of particular importance in the region are rocky cliffs and grassland, bogs, marshes, clean lakes and sand dunes. Much of the coast has been relatively little affected by development, so suites of plant communities, such as saltmarsh, grazing marsh and dunes, are more or less intact. This is important for maintaining plant biodiversity in key localities.

The climate of the region varies from the hyper-oceanic, highly exposed north-west, with 150 cm precipitation per year (Kenworthy 1976), to relatively mild, dry parts such as the Moray Firth, where rainfall is locally as low as 65 cm per year (McCallum Webster 1978). The east coast generally has a lower rainfall as it is sheltered by the Highlands from rain-bearing westerly and south-westerly winds, but in spring and early summer south-easterly winds often bring low cloud and rain known as 'haar'. One feature that is particularly characteristic and confined to the most exposed northern coasts of Britain is the existence of montane heathland at sea level, often on wind-blown shell sand. Such heaths are widespread in the northern part of the region, with a few occurrences in more exposed parts of the east coast. Species typically confined to high altitudes can survive at lower altitudes in these parts of the region as a result of the extreme conditions of humidity, temperature and exposure. Montane species of such heathland include mountain avens *Dryas octopetala*, twinflower *Linnaea borealis*, dwarf willow *Salix herbacea*, mountain bearberry *Arctostaphylos alpinus* and yellow saxifrage *Saxifraga aizoides*.

Probably as a result of the relatively equable climate of the Moray Firth area, a number of species reach the northern limits of their British distribution in this part of the region, often as outliers of distributions centred far to the south. Examples include maiden pink *Dianthus deltoides*, smooth cat's-ear *Hypochoeris glabra* and spring cinquefoil *Potentilla tabernaemontani*. Conversely, a number of truly northern scarce species have their stronghold in the region, such as oyster plant *Mertensia maritima*, which may be increasing in Banff and Buchan District (Welch 1993), creeping lady's-tresses *Goodyera repens* and Baltic rush *Juncus balticus*.

The region contains relatively few rare or scarce higher plants (Table 5.2.1). Of the 317 rare species listed for Great Britain in the *British Red Data Book of vascular plants* (Perring & Farrell 1983), ten are found within this region. Of the 254 scarce (i.e. known from up to 100 ten km squares) species in Great Britain, 61 occur in the region (Stewart *et al.* 1994). Of the 107 species protected under the Wildlife and Countryside Act (1981), three occur in the region. At least two of the region's uncommon species, the rare Shetland pondweed *Potamogeton rutilus* and the scarce bog orchid *Hammarbya paludosa*, are known to have declined in western Europe and have been considered as candidates for protection under the Bern Convention, although neither is as yet protected. Bog orchid is thought to have declined by over 80% in Ireland, Denmark, Belgium and the Netherlands (Morgan & Leon 1990). The only internationally protected species in the region is the Killarney fern *Trichomanes speciosum*, which is listed on the EC Habitats & Species Directive and the Bern Convention. The fern has two forms: the larger, vascular form is extremely rare and is not found in the region. The tiny, non-vascular form resembles a liverwort and has recently been discovered to be relatively widespread, being known from over 80 ten km squares in Great Britain, of which three are in the region. It is expected that more sites will be found (F. Rumsey pers. comm.).

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

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

	Protected species	*Other Red Data Book species*	*Scarce species*
Sutherland	2	3	38
Caithness	1	4	22
Ross & Cromarty	0	3	27
Inverness	0	2	13
Nairn	0	1	13
Moray	1	1	16
Banff & Buchan	0	0	9
Gordon	0	0	8
Aberdeen City	1	0	1
Kincardine & Deeside	0	0	4
Region 3	***3***	***10***	***61***

Source: JNCC rare plants database; Stewart *et al.* (1994; 1993 draft used); BRC database. Key: *excludes known introductions and records from before 1970. Note: eyebrights *Euphrasia spp.* are included as scarce species, although some may be rare.

5.2.2 Important locations and species

The key localities in the region noted for rarities and/or scarce species are shown on Map 5.2.1 and listed in Table 5.2.2.

Table 5.2.3 lists the recorded occurrence of nationally rare species in the region.

The region contains a remarkable number of endemic (i.e. confined to Britain) taxa, of which the most important is Scottish primrose *Primula scotica*, one of only five endemics in Great Britain whose status as a species is undisputed. Scottish primrose is scarce, having been recorded from only 30 ten km squares in Great Britain, but it has recently been found to be more abundant within the region than previously thought (Cowie *et al.* 1994). Region 3 is an important stronghold of this species, holding a significant proportion of the known world population. The region also holds the entire world population of the endemic and rare Scottish small-reed *Calamagrostis scotica*, considered by Stace (1991) to be 'probably' distinct from narrow small-reed *C. stricta*. Other endemic plants include Scottish scurvygrass *Cochlearia scotica*; a mouse-ear *Cerastium fontanum* subsp. *scoticum*; and a number of species of eyebright *Euphrasia*. The latter are difficult to differentiate and the species are so little studied that their up-to-date distributions are not known, but the following occur and are thought to be rare or scarce: *E. foulaensis, E. heslop-harrisonii, E. marshallii, E. ostenfeldii* and *E. rotundifolia*. One rare species, estuarine sedge *Carex recta*, is known from nowhere else in Britain. The occurrence of thick swards of mountain avens *Dryas octopetala* on wind-blown sand is thought to be unique in Europe and so these populations are of international significance (Currie 1994).

5.2.3 Human activities

Agriculture and forestry have had a significant effect on the flora of the region, which includes some of Scotland's most afforested counties (McCallum Webster 1978). A number of dune systems have been afforested, for example in Dornoch Firth (Duncan 1980). Drainage for agriculture has affected more fertile areas such as the Black Isle (NH75), with impacts on woodland and aquatic habitats (Duncan 1980). Agricultural run-off also affects aquatic species such as alpine rush *Juncus alpinus* (Duncan 1980) and Shetland pondweed, which is strongly dependent on unpolluted water (Morgan & Leon 1990). Most of the region is unaffected by construction projects, as development is not widespread, although the laying of pipelines has affected some habitats (Duncan 1980).

In the past, some plants, particularly species such as rock cinquefoil *Potentilla rupestris* and Dickie's bladder-fern *Cystopteris dickieana*, have been threatened by collecting. The exact location of the latter species, which has recently been discovered in several new localities in Scotland (Tennant 1996), is confidential as a precaution against further collecting, as unusual ferns are still sought by collectors. Few other rare species are now threatened by collecting.

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

	Recorded occurrence in:				
Species	***total no. of 10 km squares in GB***	***no. of coastal 10 km squares in region[2]***	***no. of sites in region (approx.)***	***Key localities***	***Habitat***
Scottish small-reed *Calamagrostis scotica*	1	1	1	Thurso to John o' Groats	Bogs
Narrow small-reed[1] *Calamagrostis stricta*	15	2	Not known	Thurso to John o' Groats	Bogs and marshes
Estuarine sedge *Carex recta*	4	4	4	Wick River, Dornoch & Moray Firths	Estuarine and lower reaches of rivers
Dickie's bladder-fern *Cystopteris dickieana*[3]	4	1	1	Near Aberdeen	Caves
Holy-grass *Hierochloë odorata*	13	1	3	Thurso to John o' Groats	Wet grassland
One-flowered wintergreen *Moneses uniflora*	12	5	7	Loch Fleet area; Culbin Forest area; Roseisle Forest (NJ16)	Pinewoods
Purple oxytropis *Oxytropis halleri*	10	2	14	Tongue Bay to Melvich Bay; Cromarty Firth area	Blown sand and calcareous cliffs
Shetland pondweed *Potamogeton rutilus*	10 §	2	2	Dornoch Firth area; Moray Firth area	Clean lakes
Rock cinquefoil *Potentilla rupestris*[3]	4	1	1	Dornoch Firth area	Dry basic rocks
Highland saxifrage *Saxifraga rivularis*	16	1	1	Cromarty Firth area	Wet mountain rocks
Killarney fern *Trichomanes speciosum*[3]	>80	3	4	Lossiemouth, Loch Fleet area, Berrie Dale, Thurso to John o' Groats	Damp, shady places

Sources: JNCC rare plants database and rare plant survey reports. Key: [1]*Calamagrostis stricta* is a candidate Red Data Book species; the figures given are provisional; [2]number recorded since 1970, excluding known extinctions; [3]= listed on Schedule 8 of the Wildlife & Countryside Act (1981). Note: eyebrights *Euphrasia* spp. are excluded from this table as up-to-date information about their status is not available. Grid references are given for localities not shown on Map 5.2.1.

Table 5.2.2 Key localities for rare and scarce plants (records post 1970)

Locality	*Status*	*Species*
Cape Wrath to Durness	Part SSSI, part undesignated	No Red Data Book species Scarce species: Baltic rush *Juncus balticus*, curved sedge *Carex maritima*, dark-red helleborine *Epipactis atrorubens*, eyebrights *Euphrasia foulaensis*, *E. marshallii* & *E. rotundifolia*, rock sedge *Carex rupestris*, Scottish primrose *Primula scotica* plus three other scarce species
Loch Eriboll & Ben Hutig	Part SSSI, part undesignated	No Red Data Book species Scarce species: alpine lady-fern *Athyrium distentifolium*, Baltic rush, bog hair-grass *Deschampsia setacea*, curved sedge, dark-red helleborine, eyebrights *Euphrasia foulaensis*, *E. marshallii* & *E. ostenfeldii*, pyramidal bugle *Ajuga pyramidalis*, rock sedge, russet sedge *Carex saxatilis*, Scottish primrose, small adder's-tongue *Ophioglossum azoricum*, thyme broomrape *Orobanche alba* plus three other scarce species
Tongue Bay to Melvich Bay	Part SSSI, part NNR, part undesignated	Red Data Book species: purple oxytropis *Oxytropis halleri* Scarce species: Baltic rush, curved sedge, dark-red helleborine, eyebrights *Euphrasia foulaensis*, *E. heslop-harrisonii*, *E. marshallii* & *E. rotundifolia*, lady's-mantle *Alchemilla wichurae*, mouse-ear *Cerastium fontanum* subsp. *scoticum*, pyramidal bugle, rock sedge, Scottish primrose, small adder's-tongue plus five other scarce species
Thurso to John o' Groats	Part SSSI, part undesignated	Red Data Book species: Killarney fern *Trichomanes speciosum* (gametophyte), holy-grass *Hierochloe odorata*, narrow small-reed *Calamagrostis stricta*, Scottish small-reed *Calamagrostis scotica* Scarce species: Baltic rush, curved sedge, eyebright *Euphrasia foulaensis*, northern knotgrass *Polygonum boreale*, pyramidal bugle, Scottish primrose plus three other scarce species
Wick River	Part SSSI, part undesignated	Red Data Book species: estuarine sedge *Carex recta* Scarce species: Baltic rush, curved sedge, lady's-mantle, Scottish primrose plus one other scarce species
Loch Fleet area	Part SSSI, part NNR	Red Data Book species: Killarney fern (gametophyte), one-flowered wintergreen *Moneses uniflora* Scarce species: bog hair-grass, least waterlily *Nuphar pumila*, pyramidal bugle, seaside centaury *Centaurium littorale*, spring quillwort *Isoetes echinospora*, twinflower *Linnaea borealis* plus two other scarce species
Dornoch Firth area	Part SSSI, part undesignated	Red Data Book species: estuarine sedge, rock cinquefoil, Shetland pondweed *Potamogeton rutilus* Scarce species: Baltic rush, bog hairgrass, curved sedge, eyebright *Euphrasia foulaensis*, pyramidal bugle, spring quillwort plus one other scarce species
Cromarty Firth area	Part SSSI, part NNR, part undesignated	Red Data Book species: Highland saxifrage *Saxifraga rivularis*, purple oxytropis Scarce species: Baltic rush, bog hair-grass, pyramidal bugle, Scottish scurvygrass *Cochlearia scotica*, small cow-wheat *Melampyrum sylvaticum*, small cranberry *Vaccinium microcarpum*, plus four other scarce species
Moray Firth area	Part SSSI, part undesignated	Red Data Book species: estuarine sedge, Shetland pondweed Scarce species: Baltic rush, bog hairgrass, early orache *Atriplex praecox*, northern knotgrass, purple ramping-fumitory *Fumaria purpurea*, seaside centaury, plus nine other scarce species
Culbin Forest area	SSSI	Red Data Book species: one-flowered wintergreen Scarce species: sea centaury, coralroot orchid *Corallorhiza trifida*, Scottish scurvygrass, eyebright *Euphrasia foulaensis*, Baltic rush, pillwort *Pilularia globulifera*, twinflower *Linnaea borealis*, plus four other scarce species
Spey Bay	SSSI	No Red Data Book species Scarce species: alpine pearlwort *Sagina saginoides*, Baltic rush, twinflower plus five other scarce species
Ythan Estuary area	Part SSSI, part NNR, part undesignated	No Red Data Book species Scarce species: Baltic rush, curved sedge, mudwort *Limosella aquatica*, rush-leaved fescue *Festuca juncifolia*, Scottish scurvygrass plus three other scarce species

Source: JNCC rare plants database; Biological Records Centre (BRC) database; Stewart *et al.* (1994); SSSI citation sheets. Key: SSSI = Site of Special Scientific Interest; NNR = National Nature Reserve. Note: key localities are those with important populations of rare species and/or six or more scarce species. Scarce species may occur near to rather than within some localities. Only those scarce species known from up to 60 ten km squares are listed by name.

5.2.4 Information sources used

Species monitoring and monitoring of the condition and management of certain Sites of Scientific Interest (SSSIs) and National Nature Reserves (NNRs) is conducted by Scottish Natural Heritage (SNH), who hold reports. The JNCC maintains a database of nationally rare plant species, which includes site records. Members of the Botanical Society of the British Isles (BSBI) have recently finished collecting up-to-date records of scarce species; these data are held at the Biological Records Centre and have been summarised in *Scarce plants in Britain* (Stewart *et al.* 1994).

5.2.5 Acknowledgements

Thanks are due to J.H. Barne, C. Minto, M.A. Palmer, R. Rayner, M.J. Wigginton, F. Rumsey, R. Scott and staff at the Biological Records Centre.

5.2.6 Further sources of information

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Tennant, D.J. 1996. *Cystopteris dickieana* R. Sim in the central and eastern Scottish Highlands. *Watsonia, 21*(1)*:* 135-139.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Caithness & Sutherland - species on SSSIs and NNRs, other protected areas, data on distribution of rare and scarce species, rare plant surveys, licensing and protected species	*Conservation Officer, SNH Caithness & Sutherland Area, Golspie, tel: 01408 633602
Ross & Cromarty and Inverness area - species on SSSIs and NNRs, other protected areas, data on distribution of rare and scarce species, rare plant surveys, licensing and protected species	*Conservation Officer, SNH Ross & Cromarty and Inverness Area Office, Dingwall, tel: 01349 865333
Strathspey area - species on SSSIs and NNRs, other protected areas, data on distribution of rare and scarce species, rare plant surveys, licensing and protected species	*Conservation Officer, SNH Strathspey Area, Aviemore, tel: 01479 810477
East Grampian area - species on SSSIs and NNRs, other protected areas, data on distribution of rare and scarce species, rare plant surveys, licensing and protected species	*Conservation Officer, SNH East Grampian Area, Aberdeen, tel: 01224 312266
Caithness & Sutherland Biological Records Centres and herbarium	Assistant Curator (North), Regional Museums Service, Bruce Building, Sinclair Terrace, Wick KW1 5AB, tel: 01955 605744
Other parts of Highland Region Biological Records Centres and herbarium	Assistant Curator (Natural Science), Inverness Museum & Art Gallery, Castle Wynd, Inverness IV2 3ED, tel: 01463 237114
Local BSBI vice-county 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, though not all families, together with a wide range of non-insect invertebrates, known from sites within the coastal 10 km Ordnance Survey grid squares of the region. Lagoonal species are covered in section 5.4.

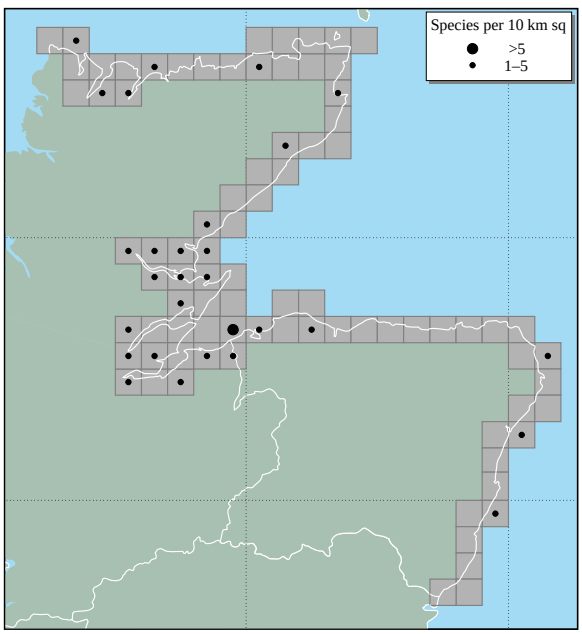
The region is known to be nationally important for the conservation of only a very few invertebrate species, but these include some that are confined to this region. Of the 358 coastal Red Data Book (RDB - nationally rare) and 455 coastal nationally scarce invertebrate species that are listed by Kirby (1994a, b) as known to be associated with coastal habitats, only three RDB and 26 nationally scarce species have been recorded from this region (data from the JNCC's Invertebrate Site Register (ISR)). Other species of equivalent rank, but not covered by Kirby, also occur within the region. These include, for example, species associated with woodland habitats, especially pine and birch associated species, and those confined to wet and boggy habitats. No species recorded in this region has statutory protection.

5.3.2 Important locations and species

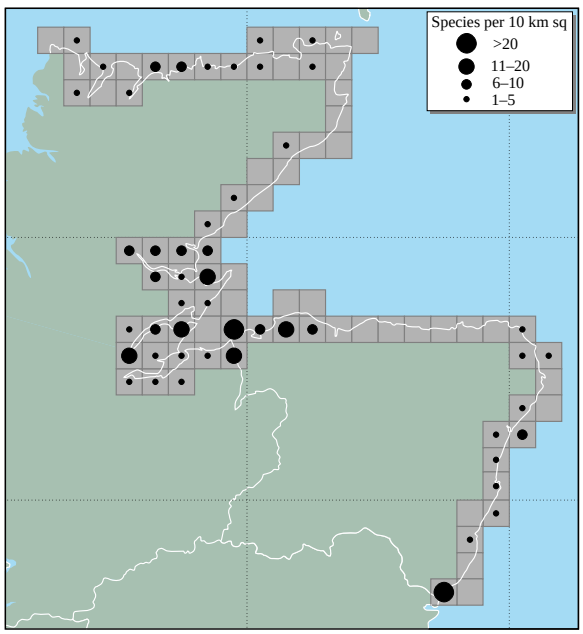
Coastal RDB species as defined by Kirby (1994a, b) are listed in Table 5.3.1. Map 5.3.1 shows the numbers of all nationally rare (RDB) invertebrate species (including Kirby's 'coastal' species and all others) recorded in coastal 10 km squares in the region; Map 5.3.2 shows the recorded distribution of all nationally scarce invertebrates in the region. Note that survey effort has not been equal throughout the region, so actual occurrence may differ from recorded distributions.

The ISR has records from 133 sites within this region, some of them subsites of larger areas. Many sites support RDB invertebrates and many are the habitats of a range of nationally scarce species. Table 5.3.2 lists sites that are considered to be particularly important for invertebrate conservation, mainly on the basis of data from the ISR, including data on the range and/or scarcity of species present, the species/habitat associations and the amount of the available habitat. Many other localities in the region are potentially of similar significance, but the current lack of data prohibits their inclusion here.

Overall, sand dunes are one of the best recorded habitats in this region, and a good range of dune-associated species are known, including many scarce and threatened taxa. Macro-moths are particularly well represented in dune systems of the region. Most of the dune systems in the region harbour populations of scarce species, though few localities are recorded in detail. Two exceptions are the Culbin Sands - Findhorn Bay area and St. Cyrus National Nature Reserve (NNR), for which the Lepidoptera are well known. Examples of nationally scarce species are the coast dart moth *Euxoa cursoria*, which occurs widely in the region, and the lyme grass moth *Photedes elymi*, which reaches its northern limit at Lossiemouth. The former is associated with mature and more stable dunes, the latter with the foredune areas. The cranefly *Tipula nodicornis* is found in areas of sparse vegetation within sand dunes in the Dornoch



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



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

Table 5.3.1 Coastal Red Data Book (RDB) species in Region 3

Species	*Notes*
RDB2	
Ochthebius lenensis	Small water beetle found in saltmarsh pools. In Britain known only from saltmarshes around the Moray Firth on the north-east coast of Scotland. Vulnerable to development of coastal sites and the erosion of saltmarshes. Recorded from Beauly Firth SSSI*, Redcastle*, Castle Stuart (Petty Bay), Culbin Sands and Forest and Findhorn Bay SSSI, and Kirkhill Saltmarsh.
RDB3	
Limonia goritiensis	Cranefly found on seepages on coastal cliffs and rock faces. Biology unknown, although larvae probably develop in damp soil or moss beside such seepages. Widely scattered but very local. Found mainly in the north and west, but the localities are very dispersed. Recorded from Sands of Forvie/Ythan Estuary.
Tipula nodicornis	Cranefly confined to partially vegetated sand or shingle, such as on river banks and coastal dunes or shingle. Yellowish larvae develop in sandy soil. All known localities are Scottish and include a wide scatter of sites on the east coast and in the Spey Valley. Recorded from Culbin Sands and Forest & Findhorn Bay SSSI, Dornoch Firth SSSI, Loch Fleet SSSI and Morrich More SSSI.
Proposed RDB K	
Omalium rugulipenne	Rove beetle found under dead seaweed. Local in England; also known from Scotland but probably rarer in the north of its range. Recorded from Cromarty Firth SSSI, Findhorn and Lossiemouth dunes*.
Bledius erraticus	Small red and black burrowing beetle living in burrows in sandy banks at the side of streams. Northern species. Very rare. Recorded from Culbin Sands and Forest & Findhorn Bay SSSI*.

Source: JNCC Invertebrate Site Register. Key: Red Data Book categories: RDB2 = vulnerable; RDB3 = rare; RDB K = insufficiently known; *= old records (before approx. 1970); SSSI = Site of Special Scientific Interest. For further description of RDB categories, see Shirt (1987) and Bratton (1991).

and Moray Firths, and also occurs in the Spey valley along sandy inland river banks - a habitat type frequented by a number of other dune rarities.

Saltmarshes hold populations of many rare invertebrates, those around the Moray Firth being of particular note. The water beetle *Ochthebius lenensis* lives in saltmarsh pools in the Moray Firth and is not known from elsewhere in Great Britain. Another scarce saltmarsh species present is the water beetle *Helophorus fulgidicollis*. Bogs and small lochs in the vicinity of the coast contain populations of many rarities, including assemblages of boreal or arctic species.

Coastal cliff habitats have characteristic species, but so far this habitat appears to have been poorly recorded, and many locally distributed rocky coast species may yet be discovered. Invertebrates associated with various woodland habitats are well represented in the vicinity of the coast. Many of them are restricted to Scotland, including the beetle *Bolitophagus reticulatus*, which lives in *Fomes* fungi on birch at Drummondreach Wood, the weevil *Pissodes validirostris* (a pine associate) at Lossiemouth, and the hoverfly *Hammerschmidtia ferruginea*, a species associated with decaying aspen trees, from Torboll Woods. Species confined to this region include the micro-moths *Parornix alpicola* and *P. leucostola*, which in Britain are found on just a few coastal hillsides in Sutherland, and the rare water beetle *Oreodytes alpinus*, which was recently discovered in mire habitats in Caithness (Foster & Spirit 1986).

5.3.3 Human activities

Appropriate site management may be vital for maintaining invertebrate interest, since invertebrates occur in the full range of coastal habitats and many require particular microhabitats, often relying on subtle features of vegetation structure or areas of bare ground. As most invertebrates have annual or even shorter life cycles, the habitat features they utilise must be present in the right condition in each and every year. 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. Site management often overlooks many features that are of importance to invertebrates, many species surviving by default. Further threats to invertebrate communities are direct habitat loss or degradation, for example the loss of saltmarshes in the Moray Firth through oil-related developments (see also section 3.6.3). The management of coastal habitats for invertebrates is covered by Kirby (1992).

5.3.4 Information sources used

As with most regions in Great Britain, the level of invertebrate recording varies over this section of the coast, as well as between the various invertebrate groups. A wide range of invertebrate groups have been studied to varying degrees, although the macro-moths and water beetles are probably among the best studied groups: even for them only a few localities are recorded in detail.

Many of the data referred to here come from the Invertebrate Site Register (ISR), a computerised GB-wide database that, although not comprehensive, includes information from many sources, specialists and surveys, as well as from the literature (such as entomological journals and the dune and machair survey by the Institute of Terrestrial Ecology (1979)) and local biological records centres. Although there has not been a major trawl for data in Scotland for some years, the ISR is the most complete data set available on scarcer species occurring in the region. Published county lists are available for certain groups (see e.g. Rosie 1976).

National distribution maps are available for a wide range of invertebrate groups; most are derived from national recording schemes co-ordinated through the

Table 5.3.2 Sites important for invertebrate conservation

Site	*Grid ref.*	*Status*
Highland		
Cape Wrath	NC2674	SSSI
Foinaven	NC3250	SSSI
Durness	NC3867	SSSI
Beinn Spoinnaidh	NC35	
Eriboll	NC4357	SSSI
Loch Hope	NC4654	
Garbh Chnoc	NC5457	
Invernaver	NC6960	NNR/SSSI
Farr Bay	NC7162	
Loch Nam Breac Beag	NC8160	
Broubster Leans	ND0361	SSSI
Holborn Head	ND092709	SSSI
Loch of Muirs	ND203734	
Glen Loth Lochan	NC9416	
Loch Brora	NC8409	
Golspie Burn	NC8301	
Mound Alderwoods	NH7698	NNR
Torboll Woods	NH7498	SSSI
Loch Fleet	NH8196	SSSI/County Trust reserve
Dornoch Firth	NH7487	SSSI
Ledmore Wood	NH6689	SSSI
Migdale Rock	NH6591	SSSI
Kyle of Sutherland Marshes	NH5199	SSSI
Carbisdale Castle	NH5795	
Easter Fearne	NH6586	SSSI
Tain golf course	NH7982	
Morrich More	NH8384	SSSI
Pitmaduthy Moss	NH7777	SSSI
Kindeace Moor	NH7474	
Kinrive - Strathrory	NH7076	SSSI
Alness	NH6569	
Cromarty Firth	NH56	SSSI
Conon Islands	NH5557	SSSI
Loch Ussie	NH5057	SSSI
Monadh Mor	NH5853	SSSI
Drummondreach Wood	NH5857	SSSI
Dam Wood	NH6457	SSSI
Brealangwell Woods	NH6863	SSSI
Beauly Firth	NH54	SSSI
Petty Bay	NH7349	
Nairn	NH8856	
Grampian		
Culbin Sands/Forest & Findhorn Bay	NH9962	SSSI/RSPB reserve
Darnaway Forest	NH9952	
Lossiemouth Shore	NJ2668	
St. Fergus Dunes	NK1054	
Sands of Forvie & Ythan Estuary	NK0227	NNR/SSSI
Muchalls coast	NO8991	
Skatie Shore	NO8988	
St. Cyrus	NO7463	NNR/SSSI

Key: NNR - National Nature Reserve, RSPB - Royal Society for the Protection of Birds, SSSI - Site of Special Scientific Interest.

Biological Records Centre at Monks Wood. Published examples that cover some of the scarce coastal species occurring in this region include distribution maps for the water beetle *Ochthebius lenensis* (Foster 1990) and the cranefly *Tipula nodicornis* (Stubbs 1992). Other scarce species (not strictly coastal but with significant populations at coastal localities) are also mapped and include, for example, the Kentish glory moth *Endromis versicolor* (Heath & Emmet 1991) and the micro-moth *Stigmella dryadella* (Heath 1976).

5.3.5 Acknowledgements

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

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Invertebrate site and species information	*Dr D. Phillips, Scottish Natural Heritage, 12 Hope Terrace, Edinburgh, tel: 0131 447 4784
Occurrence of invertebrates in the region	*Biological Records Centre, Institute of Terrestrial Ecology, Monks Wood, tel: 01487 77338
Invertebrate Site Register (ISR): a computerised national inventory of sites of significance to invertebrate conservation; contains records of local, scarce and threatened species of all groups of invertebrates.	*Invertebrate Site Register, JNCC, Peterborough, tel: 01733 62626
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
County-based biological records centre	*J.W. Robertson, Director of Leisure and Recreation Department, Caithness Biological Records Centre, Caithness District Council, Wick, tel: 01955 603761
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
National recording databank for aquatic Coleoptera, and specific survey information on scarce species in region	Balfour-Browne Club/ Dr G.N. Foster, 3 Eglinton Terrace, Ayr KA7 1JJ, tel: 01292 260 064

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

5.4 Rare sea-bed species

Dr W.G. Sanderson

5.4.1 Introduction

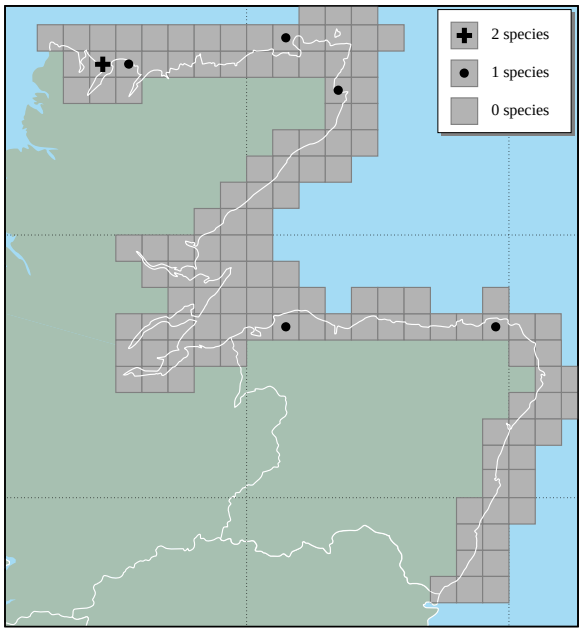
This section considers rare and scarce marine benthic (sea-bed) species, excluding fish. The occurrence and distribution of benthic communities is discussed in section 4.2. 'Nationally rare' marine benthic species in this section are those native organisms that occur in eight or fewer of the 10 x 10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

One rare and five scarce marine benthic species have been recorded from Region 3. The area around Loch Eriboll apparently contains more rare and scarce marine benthic species than other areas in the region. This observation should, however, be regarded with caution, since survey effort in Region 3 has been uneven. None of the species known to occur in the region is currently protected by statute.

5.4.2 Important locations and species

Rare and scarce species in the region are shown in Table 5.4.1. Species are listed in taxonomic order; names follow Howson (1987). Map 5.4.1 shows the known distribution of important locations for rare and scarce benthic species.

Within this region certain species are nationally rare or scarce because they are northern (i.e. North Atlantic/sub-arctic) species at the margins of their distribution in the British Isles. It has been argued that populations of many



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

sessile (non-mobile) southern species have a poor capacity for recovery and replace their numbers slowly at the margins of their distribution and are therefore particularly vulnerable to even the most minor, infrequent damage. Communities of southern species have therefore been considered important as reference sites for monitoring the marine environment (Fowler & Laffoley 1993). This argument may also be applicable to northern species at the limits of their ranges in Region 3. Other genetic, ecological and pragmatic arguments for the conservation of species that are rare because they are at the margins of wider distributions have been summarised elsewhere (see Hunter & Hutchinson 1994). None of the species from this region is known to be a common deep-water species, and so it is unlikely that any appear rare simply because their distribution only just includes the generally shallower near-shore sea area that is the focus of this study. Some species, however, will occur to some extent in the waters of Great Britain outside the scope of this report.

5.4.3 Information sources used

The sites of intertidal and subtidal benthic survey data used in this analysis have been mapped in section 4.2. The shores of north Scotland have received little attention from marine biologists except for Nature Conservancy Council (NCC)-funded surveys and surveys, commencing in the 1970s, by the Rocky Shore Surveillance Group. As Maggs (1986) observed, algae of the north-east coast of Scotland are virtually unstudied. In the Moray Firth more data exist on intertidal and subtidal habitats, mainly as a result of fisheries and oil industry-related interests. For certain

Table 5.4.1 Nationally rare* and scarce marine benthic species found in Region 3

Species	*Type of organism*	*Area(s) of occurrence*	*Habitat/associations*	*Comments*	*Useful reference*
Parazoanthus anguicomus	A cluster anemone	Whiten Head/Loch Eriboll approaches, Dunnet Head	On organic surfaces such as sponges and corals as well as stones, from 20 - 400 m	Northern species at its southern limit in GB. Occurs in wide range of depths, and may not be scarce in deeper water.	Manuel (1988)
Phellia gausapata	A sea anemone	Near Wick (type locality)	On rocks, particularly amongst kelp, but occurs to 30 m. Often in aggregations.	Northern species. Known from north and west Scotland and south to N. Ireland.	Manuel (1988)
*Cylindroporella tubulosa**	A sea mat	Loch Eriboll	Encrusting shells, stones and algae within a wide depth range.	Circumpolar species at southern limit of range in GB.	Hayward & Ryland (1979)
Callophyllis cristata	A red seaweed	Kinnaird Head	Sheltered to moderately wave exposed shores. Shallow subtidal to 30 m. Often on kelp.	Probably more common than records suggest but still scarce. Circumpolar species at southern limit of range. Also from south and west Scotland and North Sea.	Irvine (1983)
Schmitzia hiscockiana	A red seaweed	Whiten Head/Loch Eriboll	Very wave exposed shores	Scattered occurrence over a wide area in GB. Can be locally common.	Maggs & Guiry (1985)
Asperococcus compressus	A brown seaweed	Near Burghead	On other algae and rock in intertidal pools and to 10 m depth	A southern species near the northern limit of its range in this region. Very scattered occurrence. Populations may fluctuate considerably.	Fletcher (1987)

Note: species names after Howson (1987). None of these species has a specific common name: therefore the nearest available group name is given. Most of the scarce species are only a little more common than the rare species listed.

groups, such as molluscs, the paucity of available data in Region 3 has to some extent been compensated for by the recording efforts of organisations like the Conchological Society (see e.g. McKay & Smith 1979). Additional records have been gathered following personal communications with experts in many 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 information reviews and recent papers listed in sections 4.2.6 and 5.4.5 should allow access to the majority of the available information.

Some areas within Region 3 have a long history of study, with records going back to the 1800s. Whereas every effort has been made to obtain biogeographic data for rarity assessment in the present study, data from reports more than thirty years old have not been used. There are, however, additional but old records for various rarities in Region 3, including the only British record for the sea mat *Porella alba* (Wick). The nationally scarce brown alga *Fucus distichus* is a northern species at the southern limit of its range in the UK. However, due to taxonomic changes, it is unclear whether records from Holborn Head, Lower Dounreay, MacDuff and Fraserburgh are *F. distichus* or *F. evanescens* (Powell 1957; Rice & Chapman 1985). It would be valuable to reconfirm some of these records.

MNCR survey work uses a consistent methodology to record conspicuous species (Hiscock 1990). Not all the data available from surveys in this region are as broad in scope as MNCR surveys and they may not include less common species or those less familiar to a specialist worker. Variable recording has undoubtedly reduced the quantity of information available for rarity assessment in the region. The MNCR of Great Britain is at present incomplete but in future will substantially increase the quality and evenness of distribution of the available data. Combined with other surveys, this will almost certainly expand our knowledge of the 'nationally rare' and 'scarce' species in Region 3. 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 the region. Populations of species with short life histories, such as ephemeral algae and seaslugs, may be prone to fluctuation from year to year and may require more regular re-evaluation of their occurrence than others.

5.4.4 Acknowledgements

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Sea anemones	B.E. Picton, BioMar, Environmental Science Unit, University of Dublin, Trinity College, Dublin 2, Republic of Ireland, tel: 00353 16772941
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Red seaweeds	Dr C.A. Maggs, School of Biology & Biochemistry, Queen's University of Belfast, Belfast BT7 1NN, tel: 01232 245133
Brown seaweeds	Dr F.L. Fletcher, University of Portsmouth, Marine Laboratory, Ferry Road, Hayling Island, Hants. PO11 0DG, tel: 01705 876 543

5.5 Exploited sea-bed species

C.F. Robson

5.5.1 Introduction

This section describes the distribution of large populations of species that live on, near, or in the bottom sediments of the sea bed (collectively called 'the benthos') and that are routinely exploited, mainly for human food. The exploitation itself is described in sections 9.1 and 9.2. Many of these species also provide an essential food source for other species, such as fish and birds, for example seabirds, migrant and wintering waders and wildfowl (see also sections 5.10, 5.11 and 5.12). Most of the species discussed have planktonic larvae; the dispersal of planktonic larvae and the interrelation between populations of the same species can only be inferred from studies on movements of water masses. Their distributions are determined by factors such as water temperature (see section 2.3) and available habitat/substrate type (see also section 4.2). The species described may also be found elsewhere in the region, but in smaller numbers.

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

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

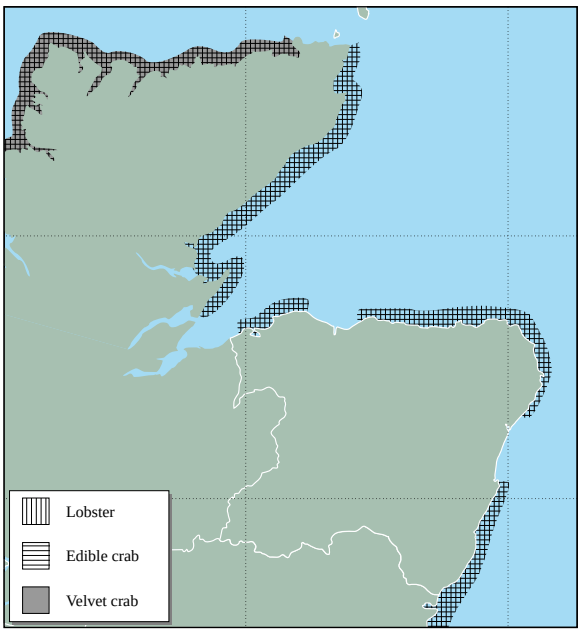
5.5.2 Important locations and species

Crustacea

The broadscale distributions of lobster, edible crab and velvet crab in the region are shown in Map 5.5.1 and of *Nephrops* and deep-water prawns in Map 5.5.2. Lobster, edible crab and velvet crabs are distributed in the region wherever there is suitable rocky habitat. 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).

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	*Neanthes virens* & *Hediste diversicolor*



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

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 is a population offshore that stretches from the Fladen Ground (a major new offshore *Nephrops* fishing ground) into the Southern Trench in the Moray Firth. Deep-water prawns are also found in the Fladen Ground.

Stocks of brown shrimp are present in the Dornoch and Cromarty Firths and a population of pink prawns has been identified in the south-eastern area of the Moray Firth (Harding-Hill 1993). Crawfish are a western species and are thus not common in the region.

Molluscs - inshore and estuarine

The main locations where exploitable populations of cockles and mussels are found in the region are shown on Map 5.5.3. Cockles are found in the intertidal mud and sandflats of the estuaries and other sheltered sites in this region. The main locations of significance are the Kyle of Tongue, Dornoch Firth, Cromarty Firth, Culbin Bay, Findhorn Bay and the Ythan Estuary. 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

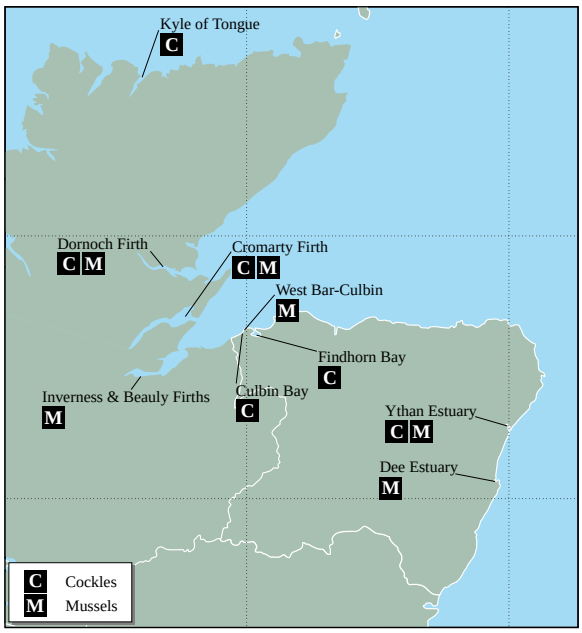
pebble substrata or other mussels and empty shells, and have the effect of binding the substratum. Important areas in the region for mussels include the Dornoch, Cromarty and Inverness and Beauly Firths, the West Bar at Culbin and the Ythan and Dee Estuaries. Periwinkles are found on rocky shorelines throughout the region, wherever suitable habitat is present. The native oyster does not occur in exploitable quantities in the region.

Molluscs - offshore

Scallops and queen scallops live on sandy/gravelly areas of sea bed. Important populations of scallops are present in a small area off the north coast of the region and are widely distributed in the Moray Firth and off the east coast. The broad scale distribution of scallops in the region is shown in Map 5.5.4. 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 in the Moray Firth and octopus are also present in the region. Razor shells occur in the inshore areas of the Moray Firth 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).

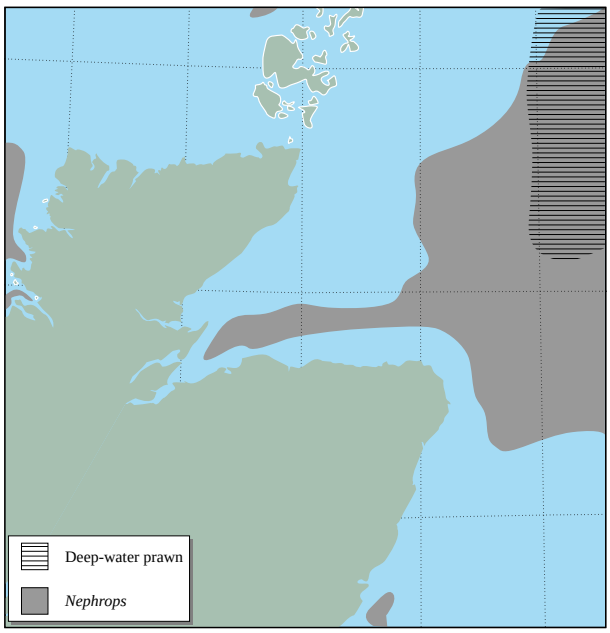


Map 5.5.3 Main inshore and estuarine locations of cockles and mussels. © SOAEFD.

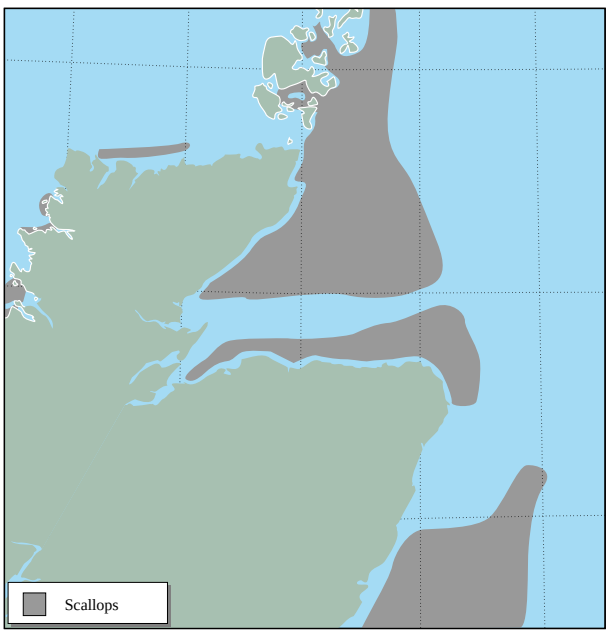
5.5.3 Human activities

The exploitation by fisheries of the species covered in this section is described in detail in section 9.1, and by mariculture in section 9.2. 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 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



Map 5.5.2 Distribution of crustacea: *Nephrops* and deep-water prawn. © SOAEFD.



Map 5.5.4 Main locations of scallops. © SOAEFD.

9.1.3). The TAC for *Nephrops* effective in Region 3 covers ICES Divisions VIa (West of Scotland), IVa (Northern North Sea) and 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 (Prohibition of Fishing and Fishing Methods) (Scotland) Order 1989, which was issued in eight areas in the region under the Inshore Fishing (Scotland) Act 1984 (Map 9.1.3). Exceptions from these prohibitions are that only dredging (but not suction dredging) is allowed for mussels in the Dornoch Firth and for cockles and mussels in the Cromarty and Inverness Firths. Lobster, edible and velvet crabs, *Nephrops* and scallops all have a minimum landing size (section 9.1.3) and the Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD) is considering the proposal to introduce a closed season for creel fishing for crustacea in waters around Scotland.

The exploitation of cockles in this region has led to concern about sustainable exploitation and impacts on wildlife. During 1994 an amendment was made to the Inshore Fishing (Scotland) Act 1984 during 1994 to allow the use of tractor dredges to be controlled by the Act. An order was subsequently issued prohibiting the use of tractor dredges for cockles on all foreshores in Scotland. Scottish Natural Heritage considered that some areas of high natural heritage interest were still vulnerable to vessel-based cockle fishing, and Nature Conservation Orders (NCOs), made under the Wildlife and Countryside Act 1981, have been obtained for the following areas: Loch Fleet, Dornoch and Cuthill Sands; Morrich More (the NCO excludes mussels at this site) and Dornoch Firth; Nigg and Udale Bays; and Culbin Sands and Findhorn Bay. These NCOs prohibit all commercial collection of invertebrates (molluscs, crustacea and annelid bait species), including dredging for cockles; they may be revoked if, under fisheries legislation, prohibition of vessel-based dredging as well as tractor based dredging is introduced in these areas.

Bait collection, especially the digging of 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). The commercial collection of bait species is prohibited in the four areas covered by NCOs, described above. Bait collection in the region is described in section 9.1.2.

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 there was concern over the state of the stocks, in particular the sustainable rate of exploiting the fisheries in the east and north-east. 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.

5.5.4 Information sources used

The four maps in this section show schematically the known broad-scale distributions of the main species of interest, based on 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 commercial landing statistics, samples and surveys (see sections 9.1 and 9.2). 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 stage, 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. The Moray Firth Review (Harding-Hill 1993) includes information on the distribution and abundance of exploited shellfish species.

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) and David Donnan (Scottish Natural Heritage) for comments on text.

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

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Marine and estuarine research on exploitable species	SOAEFD Fisheries Research Services, Marine Laboratory, PO Box 101, Victoria Road, Aberdeen AB9 8DB, tel: 01244 876544
Benthic surveys; Marine Conservation Branch Database	*Marine Conservation Branch, JNCC, Peterborough, tel: 01733 62626
Marine conservation issues	*Aquatic Environments Branch, SNH, HQ, Edinburgh, tel: 0131 554 9797
Marine conservation issues	*Marine Advisory Officer, Marine Fisheries Task Group, c/o JNCC, Peterborough, tel: 01733 626267
Marine conservation issues	*Conservation Officer, RSPB, Sandy, tel: 01767 680551
Marine 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
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

Eight of the nine widespread British species of amphibian and terrestrial reptile and one species of marine turtle have been recorded in this region since 1970. These are the 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*, adder *Vipera berus* and the leatherback turtle *Dermochelys coriacea*.

In Inverness, Moray, Nairn, and Kincardine & Deeside, at least 50% of 10 km squares surveyed for amphibians were shown to support three or more species (Map 5.6.1), compared with 59% nationally and 56% around the whole British coast. Three of the five widespread amphibian species - common frog, common toad and palmate newt - are present throughout the region. Smooth newts and great crested newts are much rarer, with only five and eight records, respectively. Furthermore, there is some doubt over newt species identification at some sites. There is also uncertainty as to whether the great crested newt populations have resulted from natural colonisation since the last Ice Age, or whether, as is rumoured, they were introduced into highland estates during the 19th century.

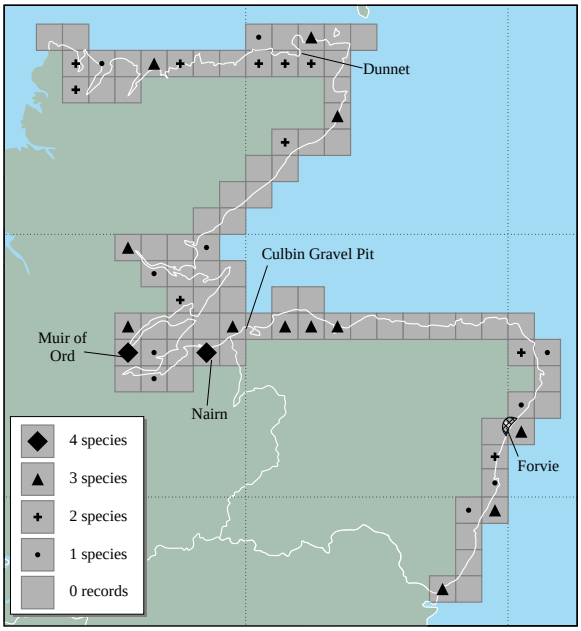
The great crested newt and the leatherback turtle are totally protected under the Wildlife & Countryside Act 1981, although all the species listed are afforded some degree of protection under national and international legislation (Table 5.6.1).

Only in Caithness were all three reptile species recorded in one 10 km square (Map 5.6.2). The current reptile records indicate the common lizard to be the only species present throughout the region; all but one of the records of the other two species (slow worm and adder) are restricted to Sutherland, Caithness and Ross & Cromarty. Reptiles are virtually absent from the coast between Nairn and Kincardineshire, owing to human population and recreation pressures and infrastructure, and intensive agriculture, which extends to the very edge of the coast. However, reptiles are reported in some protected semi-natural areas:

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 helvetica*	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

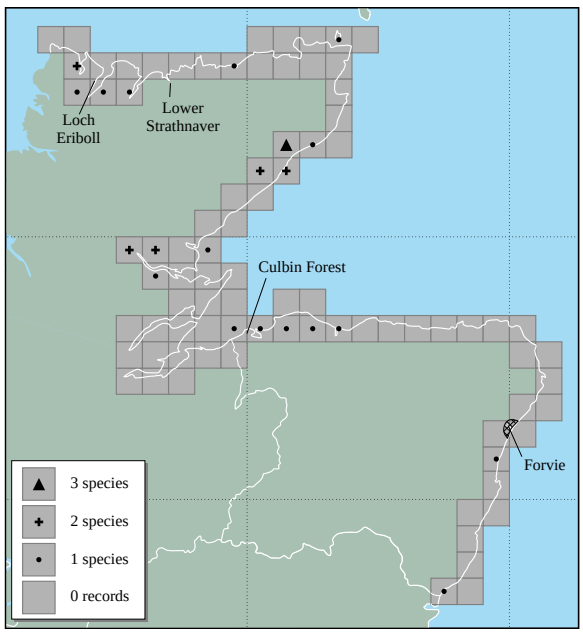
Key: 1 = Wildlife & Countryside Act (1981); 2 = Bern Convention (1979) ; 3 = EC Habitats & Species Directive (1992); 4 = CITES Convention.



Map 5.6.1 Numbers of amphibian species recorded in coastal 10 km squares and key locality for amphibians (cross-hatched). Distribution may reflect difference in recording effort. Source: Biological Records Centre, ITE Monks Wood.

for example, the sand dunes of Culbin Sands and the Sands of Forvie both support common lizards.

Table 5.6.2 shows the number of post-1970 amphibian and reptile records in relation to survey effort. The



Map 5.6.2 Numbers of reptile species recorded in coastal 10 km squares and key locality for reptiles (cross-hatched). Distribution may reflect difference in recording effort. Source: Biological Records Centre, ITE Monks Wood.

Table 5.6.2 Records of amphibians and reptiles related to survey effort

		% 10 km squares surveyed for:			*Total no. of individual records:*		*Mean no. of individual records per surveyed 10 km square*	
	*Total no. of 10 km squares**	*Any herp. species*	*Amphibians*	*Reptiles*	*Amphibians*	*Reptiles*	*Amphibians*	*Reptiles*
Sutherland	24	54	38	42	34	30	3.8	3.0
Caithness	18	67	39	33	31	27	4.4	4.5
Ross & Cromarty	19	44	39	17	32	7	4.6	2.3
Inverness	5	40	40	0	17	0	8.5	0.0
Nairn	3	67	67	33	20	2	10.0	2.0
Moray	10	50	40	50	43	9	10.8	1.8
Banff & Buchan	11	27	27	0	4	0	1.3	0.0
Gordon	4	75	75	25	13	1	4.3	1.0
Aberdeen	3	100	100	33	12	1	4.0	1.0
Kincardine & Deeside	6	50	50	17	11	5	3.7	5.0
Region 3	***86***	***63***	***50***	***33***	***217***	***82***	***5.0***	***2.9***
North Sea coast	504	76	66	49	4,141	1,602	12.5	6.5
GB coast	1,124	69	59	49	7,524	3,138	11.3	5.7
Great Britain (coast and inland)	2,862	84	79	66	27,182	8,803	12.1	4.7

Sources: Biological Records Centre, Monks Wood. Key: *total includes squares that are partly in the region, but excludes squares that are exclusively marine.

amphibians, newts in particular, have been very under-recorded in this region. Considering the high density of water-bodies in coastal areas of Caithness, for example, it is unlikely that amphibian status is as low as the available data suggest.

5.6.2 Important locations and species

Table 5.6.3 lists coastal sites in which great crested newts are recorded and areas that support regionally or nationally important assemblages, or outstanding populations, of widespread species. However, it is unlikely that this table represents an exhaustive list of the region's best amphibian or reptile sites, as survey coverage has been inadequate.

Coastal habitats are important for the conservation of Britain's reptiles; undisturbed sand dunes, maritime heath and cliff-tops, in which this region is rich, provide essential habitat for the three species. The dune slacks constitute important breeding habitat for amphibians, while the numerous small water-bodies just inland from the coast of Caithness probably support significant numbers of frogs, toads and palmate newts. Mineral extraction sites can also provide suitable amphibian and reptile habitat in this region (e.g. Culbin Gravel Pit).

Since 1970, eleven leatherback turtles *Dermochelys coriacea* have been sighted at sea off the coast of this region. Eight were seen swimming freely, and three that had been netted accidentally in fishing gear were released unharmed (Langton *et al.* in press).

Table 5.6.3 Important areas for reptiles and amphibians

Site name	*Grid ref.*	*Species present/site significance*
Sutherland		
Dunnet	ND222702	Regionally important amphibian species assemblage**
Loch Eriboll*	NC4059	Common lizard
Lower Strathnaver*	NC7157	Slow-worm, adder
Ross & Cromarty		
Muir of Ord	NH530501	Great crested newt
Moray/Nairn		
Nairn	NH864503	Great crested newt
Culbin gravel pit	NH995619	Regionally important amphibian species assemblage**
Culbin Forest*	NH9761	Common lizard
Gordon		
Forvie NNR	NK037293, NK037293	Regionally important amphibian species assemblage**
Forvie NNR*	NK0024	Common lizard

Sources: Swan & Oldham (1993a, b), Scottish Natural Heritage. Key: *location of frequent sightings of widespread reptile species; **containing common frog, common toad and palmate newt.

5.6.3 Human activities

The encroachment of agriculture, human settlements and recreational pressures have reduced and degraded valuable coastal habitats and their hinterlands in Grampian Region. Oil-related developments may also have resulted in the loss of important habitats, such as marshes, under oil terminals and rig construction sites. However, in the more remote and undisturbed areas of Highland Region, it is likely that both amphibian and reptile status is relatively high.

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 5.6.2). 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. This problem is being addressed by the Highland Biological Recording Group (HBRC), who are currently undertaking systematic herpetofaunal recording in Highland Region. Note that some records recently collated by HBRC are not included in the tables and figures in this section.

National distribution data for amphibians and terrestrial reptiles were provided by the Biological Records Centre (BRC) at Monk's Wood (Arnold 1983, 1995). These sources comprise post-1970 species records held by BRC and include all the data collected during the National Amphibian and Reptile Surveys (NARS) undertaken by De Montfort University on behalf of English Nature. The NARS formed the focus of national amphibian and reptile recording during the 1980s and early 1990s (Oldham & Nicholson 1986; Swan & Oldham 1989, 1993a, b). Many of these data were collected through a volunteer, mainly amateur, recorder network. 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 information was provided by the Natural History Museum (McCarthy pers. comm.), Southampton University (Mallinson pers. comm.), and Scottish Natural Heritage (Langton *et al.* in press). All sightings at sea and strandings should be reported to the Natural History Museum in London. Concise information on turtle identification, reporting of sightings, UK legislation and instructions on what to do with turtles caught in fishing gear is contained in *The turtle code* (Nature Conservancy Council 1990). The conservation of marine turtles in Scottish waters is being addressed in the SNH Species Action Programme. For further information, contact SNH Research and Advisory Services Directorate in Edinburgh.

5.6.5 Acknowledgements

Thank are due to the following people for information and comments on the draft: Henry Arnold, Ray Collier, Cathy Duncan, Keith Corbett, Vincent Fleming, Martin Gaywood, Bob Laing, Stephen Moran and Rob Raynor.

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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
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
Highland Region Biological Recording Group	*Ray Collier, Scottish Natural Heritage, North West Region, Inverness, tel: 01463 712221, or Stephen Moran, Inverness Museum & Art Gallery, Castle Wynd, Inverness IV2 3ED, tel: 01463 237114
Designated sites - Highland Region	*Scottish Natural Heritage, North West Region, Inverness, tel: 01463 239431
Designated sites - Grampian Region	*Scottish Natural Heritage, North East Region, Aberdeen, tel: 01224 642863
Forvie NNR information	*Scottish Natural Heritage, Sands of Forvie NNR, Ellon, tel: 0135887 330
North-east Scotland Amphibian and Reptile Group	Herpetofauna Groups of Britain, North-east Scotland representative, c/o Culterty Field Station, University of Aberdeen, Newburgh, Ellon, Aberdeen AB41 0AA, tel: 01358 789631

* 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 - 5.7.5 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.

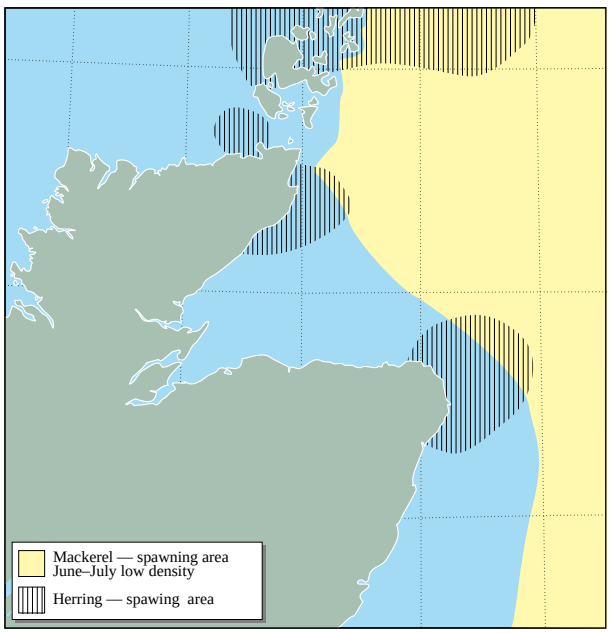
Table 5.7.1 lists the important pelagic and demersal species occurring in the region and give examples of protection measures in this region.

5.7.2 Important locations and species

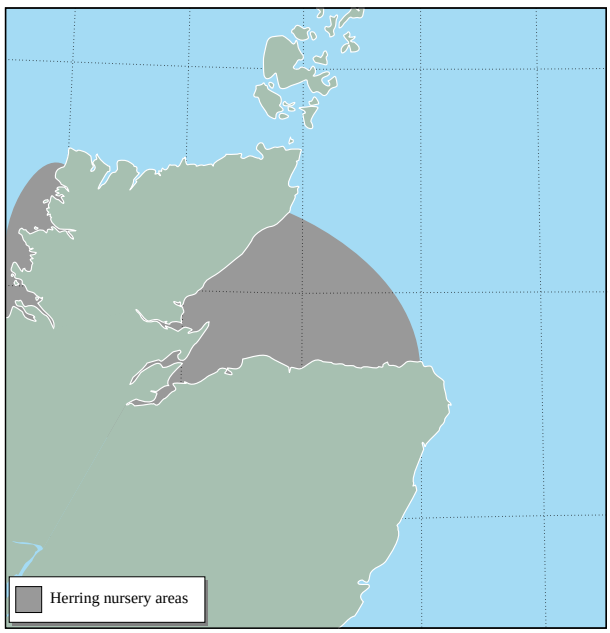
Of the pelagic species, mackerel are widely distributed around Britain and are present in the seas off the region, more commonly in the summer. Mackerel spawn from February to July in areas offshore of this region (Map 5.7.1). Growing juveniles and adults migrate to coastal waters after spawning, where 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. The spawning areas in the region are shown in Map 5.7.1. Although some herring larvae drift to shallow nursery areas in the Moray Firth (Map 5.7.2), most herring larvae produced in this area drift across the North Sea to the nursery grounds off the Danish coast. Studies on young herring in the Moray Firth indicate that the Moray Firth may also be a nursery ground for west coast herring (Heath & MacLachlan 1986).

Sprat are found only in the shallower areas of the region between September and March, when they migrate inshore to overwinter. In summer they are found widely in the North Sea. Although some sprat spawning takes place in coastal waters, they mainly migrate to offshore areas with spawning peaking between May and July. Within the region these sprat spawning areas are off the north coast of Sutherland and Caithness and offshore to the east (Lee & Ramster 1981). There is some evidence that, like herring, the sprat found in the Moray Firth in winter may be more



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



Map 5.7.2 Herring nursery areas. Source: Lee & Ramster (1981). © Crown copyright.

closely linked with the west coast stocks than to those in the North Sea.

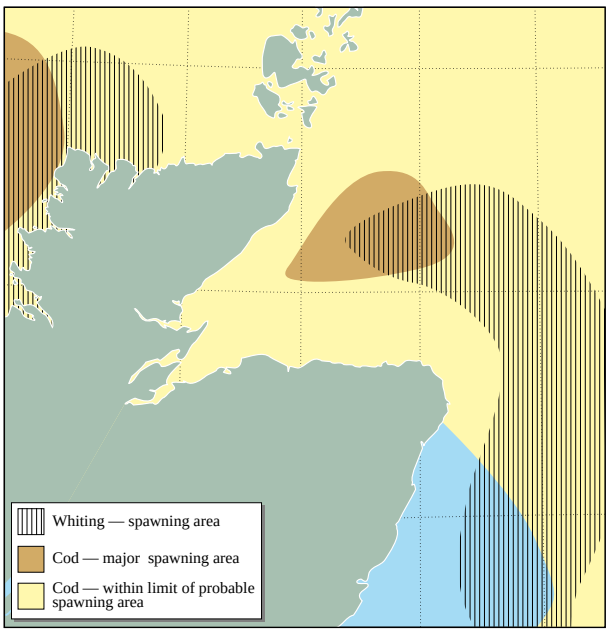
Elasmobranch species produce relatively small numbers of live young (10 -100 per year, but can be fewer in large shark species) or eggs on the sea bed close to their nursery areas. Several species of elasmobranch, such as the spurdog, lesser-spotted dogfish, thornback ray and cuckoo ray, occur sporadically.

Of the gadoids, cod are widely 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. Spawning peaks during February and occurs in the region in a large area in the Outer Moray Firth (Map 5.7.3). Whiting are abundant and widely distributed in the region, especially in inshore waters. The large whiting spawning area east of Scotland is within the region's offshore area and reaches into the Moray Firth (Map 5.7.3). 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.

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
Demersal species - 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/QM
Saithe *Pollachius virens*	MLS/QM
Demersal species - 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
Brill *Scophthalmus rhombus*	MLS
Megrim *Lepidorhombus whiffiagonis*	MLS/QM
Witch *Glyptocephalus cynoglossus*	MLS
Flounder *Platichthys flesus*	MLS
Other demersal fish	
Monkfish (angler) *Lophius piscatorius*	QM
Conger eel *Conger conger*	MLS
Gurnards *Triglidae* spp.	No limitation
Sandeels *Ammodytes* spp.	No limitation

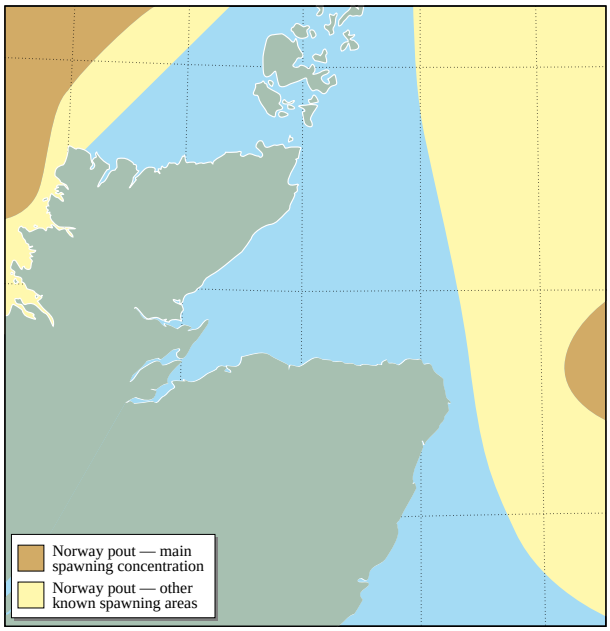
Source: European Council (1986, 1995). Key: MLS = minimum landing size; QM = catch quota management.



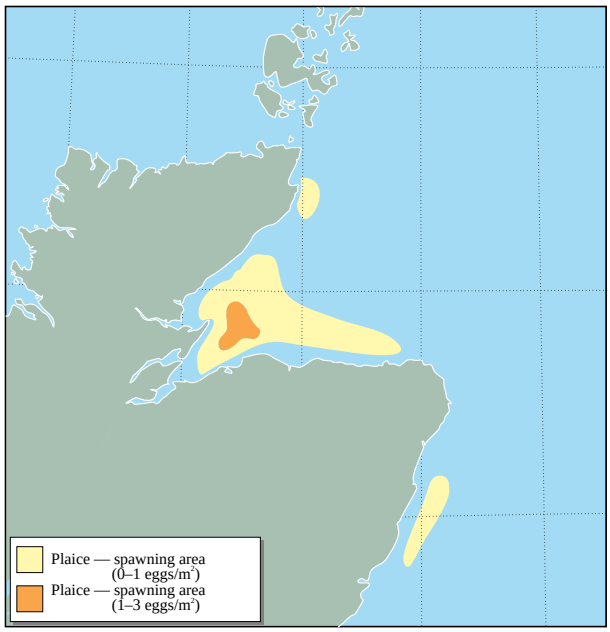
Map 5.7.3 Cod and whiting spawning areas. Source: Lee & Ramster (1981). © Crown copyright.

Haddock are widely distributed in the region 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 deeper water (Lee & Ramster 1981). There are no recognised nursery areas, as juvenile haddock are widely distributed around the North Sea (Doody *et al.* 1993), with fewer in the Moray Firth than elsewhere. Norway pout is found in very deep water offshore in the region 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 (Map 5.7.4). Ling, pollack and saithe are less abundant than haddock and Norway pout and more 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 Moray Firth is the most important spawning ground for plaice in the northern North Sea (Map 5.7.5) (Hopkins 1986). Burghead Bay and Spey Bay (in the Moray Firth) and Aberdeen Bay are important nursery areas in the region for juvenile plaice (Rae 1970). Dab spawn from January to June throughout the North Sea and are locally abundant (North Sea Task Force 1993). 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 offshore of Aberdeen (Rae & Devlin 1972). None of the flatfish species exhibits extensive migrations, though the larvae can drift for several weeks



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



Map 5.7.5 Plaice spawning areas. Source: Lee & Ramster (1981). © Crown copyright.

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). This area includes the Outer Moray Firth, where juveniles have also been found (North Sea Task Force 1993); it is one of the main spawning areas for lemon sole in the northern 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 (Lee & Ramster 1981) and provide an important food source for many exploited species. Their distribution is associated with that of the coarse sand that they burrow into.

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 eight areas in the region (see Map 9.1.3). The Inshore Fishing Act is reviewed on a triennial basis, and at the time of writing a review was underway.

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 one or more of the three ICES Divisions that cover Region 3 - Divisions VIa, IVa and 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 the Moray Firth 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. They 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 dumping 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 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 from otter trawl surveys over two 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. *The Moray Firth review* (Harding-Hill 1993) includes information on the distribution and abundance of exploited fish species.

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 are published in European Council (1995).

5.7.5 Acknowledgements

Thanks go to the following for their advice and for commenting on drafts: David McKay and Derek Murison (Scottish Office Agriculture, Environment and Fisheries Department, Marine Laboratory) and David Donnan (Scottish Natural Heritage).

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

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Assessment and provision of advice on fish stocks in Scotland; marine conservation issues	SOAEFD Fisheries Research Services, Marine Laboratory, PO Box 101, Victoria Road, Aberdeen AB9 8DB, tel: 01224 876544
UKDMAP software with maps showing distributions of selected sea fish species and spawning areas	Project Manager, British Oceanographic Data Centre, Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, tel: 0151 652 3950
Marine conservation issues	*Aquatic Environments Branch, SNH HQ, Edinburgh, tel: 0131 554 9797
Marine conservation issues	*Marine Advisory Officer, Marine Fisheries Task Group, c/o JNCC, Peterborough, tel: 01733 62626
Marine conservation issues	*Conservation Officer, RSPB, Sandy, tel: 01767 680551
Marine conservation issues	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 spend part of their lives in fresh water and part at sea. The three fish species covered in this section - the Atlantic salmon, sea trout and eel - are widespread in British waters and have been recorded in rivers in this region. 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. (Twaite shad, allis shad and sea lamprey are also diadromous but are included in section 5.9.) Sea trout and brown trout are the same species, but the latter is a freshwater form and is therefore not covered in this section. Information on the life-cycles of these fish can be found in Jones (1959), Mills (1971, 1989), Moriarty (1978), Shearer (1992), Sinha & Jones (1975) and Tesch (1977). Table 5.8.1 lists some of the protection measures for salmon, sea trout and eels in the region.

Table 5.8.1 Species and examples of measures for their protection

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

Source: SOAEFD (pers. comm.)

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. 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) (see also section 9.1.3), especially the effects of commercial net operations during migratory phases. Drift netting has been an illegal salmon fishing method in Scotland since 1962, but 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; SOAFD 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 the Salmon Fishery Districts. The SOAEFD Montrose Field Station of the Freshwater Fisheries Laboratory collates these data for the

Salmon Fishery Statistical Boards, which are composed of one or more Fishery Districts (see section 9.1.4 and Map 9.1.2). 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 (>90%).

5.8.5 Acknowledgements

Thanks go to Derek Murison (SOAEFD Marine Laboratory, Aberdeen) and David Dunkley (SOAEFD Montrose Field Station) for information and advice.

5.8.6 Further sources of information

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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, 47 Robb's Loan, Edinburgh EH14 1TY, 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 9.4.4). Marine and estuarine fisheries research.	SOAEFD Fisheries Research Services, Marine Laboratory, PO Box 101, Victoria Road, Aberdeen AB9 8DB, tel: 01224 876544
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

5.9 Fish: other species

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

5.9.1 Introduction

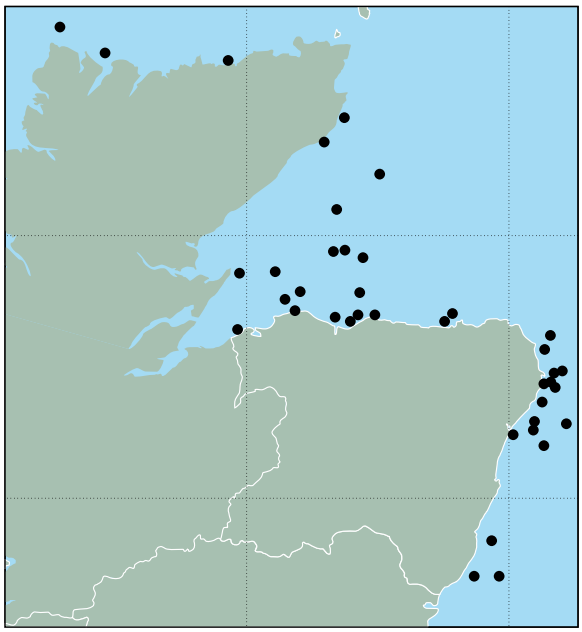
There are 166 species of exploited and unexploited fish recorded from this region, comprising three jawless fishes (Agnatha), 27 sharks and rays (elasmobranchs) and 136 bony fishes (teleosts) (based on the fish species list from Wick to Edinburgh (Sim 1903)). This region has records of all seven British 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). Maps 5.9.1 and 5.9.2 show the recorded distributions in the region of stugeon and twaite shad respectively.

5.9.2 Important locations and species

The lampern was often found in the Spey and Lossie (Gordon 1852) and was found in most of the rivers and streams along the coast (Sim 1903). The sea lamprey was noted by Gordon (1852), when a large specimen (83 cm) was obtained from Lossiemouth in 1849. However, it was described as 'fairly common' all along the east coast and was caught in all seasons of the year (Sim 1903). Sturgeon records (Map 5.9.1) date back to 1833 near Findhorn and were noted again in 1833, 1836 and 1844 on the south side of the Moray Firth (Gordon 1852). It has long been known along the east coast, although never in large numbers, and has been caught by line fishermen, in stake nets, but most frequently by trawlers, who brought them into the Aberdeen market (Sim 1903) and other commercial ports. Twaite shad (Map 5.9.2) were not considered abundant but were taken frequently during the summer along the coasts of Kincardine, Aberdeen, Banff and Moray shires. However, at that time, allis shad were not distinguished from twaite shad (Sim 1903). Although not considered threatened in British waters, a study of the distribution and abundance of the sand goby in the Ythan Estuary was carried out by Healy (1971).

A sublittoral survey of Loch Eriboll (Moss 1986) identified twelve fish species, including pogge *Agonus cataphractus*, ballan *Labrus bergylta* and cuckoo wrasse *Labrus mixtus*, the butterfish *Pholis gunnellus*, the common skate *Raja batis* and the leopard-spotted goby *Thorogobius ephippiatus*. There have been few studies on non-exploited fish in the Moray Firth; even the zooplankton survey on the Cromarty Firth lists only sandeel, dragonets *Callionymus* spp. and dab *Limanda limanda* eggs (Craig & Adams 1967). Fish found in the near surface (1 m) of the sea have been studied in areas from Aberdeen to off Shetland in 1977 and 1978 (Hislop 1979). The most abundant species were rocklings (Gadidae), members of the herring family (Clupeidae) and three-spined sticklebacks *Gasterosteus aculeatus*, with sixteen species represented.

In the Ythan Estuary, although many other fish have been reported as visiting the mudflats, only the common goby, the flounder *Platichthys flesus* and plaice *Pleuronectes platessa* are mentioned in Healy (1971). Fish as food for cormorants and shags in the Dee Estuary were studied, with sixteen species identifed, including members of the flatfishes, cod, herring and salmon families (Rae 1969).

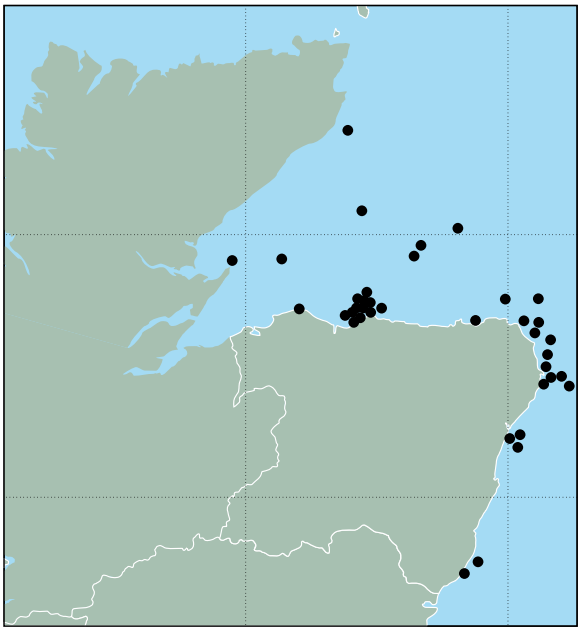


Map 5.9.1 Distribution records on the British Marine Fishes Database of sturgeon. Source: after Potts & Swaby (1993a).

Table 5.9.1 Scheduled species and protected status

Species	*Wildlife and Countryside Act (Schedule)*	*EC Habitats & Species Directive (Annex)*	*Bern Convention (Appendix)*	*CITES (Appendix)*
Lampern *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 (1993b). Key: *the sand and common gobies are both very abundant in UK.



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

Flatfishes make up the bulk of the food of cormorants, with common eel *Anguilla anguilla* and small gadoids next in importance. Shags, however, showed a preference for small gadoids, particularly whiting *Merlangius merlangus* and saithe *Pollachius virens* (Rae 1969).

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

5.9.3 Human activities

Human activities affecting estuaries and adjacent coasts are summarised in Buck (1993); these activities affect the abundance and distribution of fish. Nationally, estuaries are used by up to 180 fish species for migration, spawning, feeding and as nursery grounds (Potts & Swaby 1993b). Industrial development and agricultural pollution have been shown to have a detrimental effect on the estuarine environment, in particular through heavy metals in the water (Davies 1981; McKie 1983). There is concern about the effects of oil pollution on the macrobenthos in the Moray Firth (Hartley & Bishop 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). Fisheries in the Inverness Firth, Beauly Firth and Moray Firth are discussed in Saville (1970) and Hopkins (1986). The possible effects of fisheries on species is discussed in sections 5.7 and 9.1. Sea angling occurs in many places throughout the region (Orton 1994) (see section 9.1.2).

5.9.4 Information sources used

The fish of the north Highlands and Grampian coasts have not been studied as a single unit, and apart from historical fish lists, studies have produced only small and incomplete species lists. 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 and covers UK fishes and individual records for this area. Information is being gathered from a variety of sources including research institutes, fish biologists, anglers and fishermen. The data include published literature and unpublished reports, as well as personal communications from fish biologists.

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Tilbrook, P.J. 1986. Nature conservation in the Moray Firth. *Proceedings of the Royal Society of Edinburgh, 91B:* 13-25.

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, Marine Laboratory, PO Box 101, Victoria Road, Aberdeen AB9 8DB, tel: 01224 876544
Fish conservation - UK	*Marine Advisory Officer, JNCC Peterborough, tel: 01733 62626
Fish conservation - Scotland`	*Aquatic Environments Branch, SNH HQ, 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, but also divers, grebes and seaduck: in other words, those species reliant for an important part of their life on the marine environment (Table 5.10.1). (Section 5.12.2 includes information on these waterfowl species, where they occur close inshore, especially within estuaries.) Scientific names of all species are given in the tables.

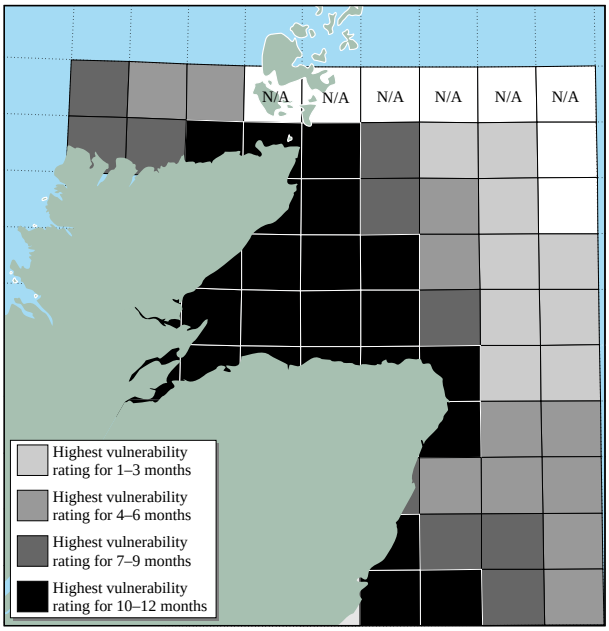
This region is internationally important for seabirds and is amongst the most important in Europe for offshore seabirds. The region is especially important for its cliff-nesting seabirds. Nine species are present in numbers equal to or exceeding 1% of their European populations and a further six species exceed nationally important levels (Table 5.10.1). Of particular note is the kittiwake population, whose numbers exceed 10% of the European population, and the two larger auks (guillemot and razorbill), which are present in numbers exceeding 5% of this level.

Areas at sea are of great importance to seabirds (Map 5.10.1). The Moray Firth holds vulnerable concentrations of birds virtually throughout the year (Stone *et al*. 1995; Carter *et al*. 1993) and is internationally important for seaduck, while the Inner Moray Firth is the most important wintering site for seaduck in Britain. The area immediately off the Caithness cliff breeding colonies is of particularly high importance, and many birds from here, e.g. kittiwake, guillemot and razorbill, commute offshore to feed over the Smith Bank (see Map 2.2.1). These waters support the largest year-round concentration of shags in British waters. The waters off Grampian are of particular importance to moulting auks in the early autumn and support high densities of fulmars for much of the year. The southern coast of the Moray Firth is especially important for herring gulls throughout the year. During the autumn, puffins are

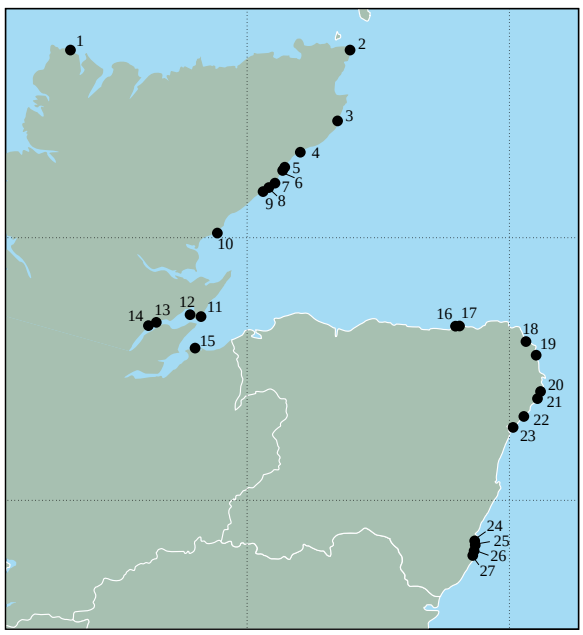
Table 5.10.1 Overall importance of seabirds breeding in the region

Species	*Total*	*% GB*	*% Europe*
Fulmar *Fulmarus glacialis*	57,716	10.7	1.0
Gannet *Morus bassanus*	278	<1.0	<1.0
Cormorant *Phalacrocorax carbo*	553	8.1	<1.0
Shag *Phalacrocorax aristotelis*	4,701	12.9	3.8
Arctic skua *Stercorarius parasiticus*	5	<1.0	<1.0
Great skua *Catharacta skua*	4	<1.0	<1.0
Black-headed gull *Larus ridibundus*	1,835	1.1	<1.0
Common gull *Larus canus*	362	<1.0	<1.0
Lesser black-backed gull *Larus fuscus*	403	<1.0	<1.0
Herring gull *Larus argentatus*	31,402	20.9	1.8
Great black-backed gull *Larus marinus*	1,780	9.7	2.1
Kittiwake *Rissa tridactyla*	193,216	39.3	11.1
Sandwich tern *Sterna sandvicensis*	515	3.7	<1.0
Common tern *Sterna hirundo*	1,283	10.1	1.4
Arctic tern *Sterna paradisaea*	1,560	3.6	<1.0
Little tern *Sterna albifrons*	24	1.0	<1.0
Guillemot *Uria aalge*	253,563	24.2	8.4
Razorbill *Alca torda*	31,305	21.3	5.1
Black guillemot *Cepphus grylle*	2,451	6.5	2.4
Puffin *Fratercula arctica*	10,702	1.2	<1.0

Sources: regional totals are compiled from the most recent available good-quality counts up to 1993; figures for Great Britain are from Walsh *et al*. (1995); those for Europe are from Lloyd *et al*. (1991). Note: counts are of pairs, except for guillemots, razorbills, black guillemots and puffins, which are counted individually. Regional totals of terns have been calculated using 1993 colony counts, or the most recent available counts, to minimise possible double counting.



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.

concentrated over the area of the Buchan front, some 60-100 km off the coast of Aberdeenshire (see Map 4.3.1). Cape Wrath and Fowlsheugh are Special Protection Areas under the EC Birds Directive (see also section 7.2.3) and several other sites are of equivalent standing; their associated feeding areas are equally important.

5.10.2 Important locations and species

Much of the coastline of this region is colonised by seabirds, and on some sections, such as the east Caithness cliffs, colonies are more or less contiguous. Boundaries between 'colonies' in these areas are imprecise, making evaluation difficult. Of the colonies, sixteen hold numbers of seabirds at or above 1% of the total European Union population for that species and a further eleven colonies are important at the Great Britain level (Table 5.10.2, Map 5.10.2). Clo Mor, West Gotten - Sturr Ruadh and Fowlsheugh hold more than one population of international importance. The birds' feeding areas are as important as the colonies themselves. Little research has been carried out to determine feeding areas or general ranges, but the waters of the Greater Moray Firth and the nearshore waters off eastern Grampian are of particular importance. Most colonies are located on the cliffs that characterise much of the coast of the area,

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

Site no.*	*Colony*	*Grid ref.*	*Species*	*Count date*	*Count*	*≥1% EU/GB population*	*Protected status*
	Highland						
1	Cape Wrath/Clo Mor	NC330730	Great black-backed gull	1988	250	EU	SPA
			Kittiwake	1988	9,660	EU	
			Guillemot	1988	13,665	EU	
			Razorbill	1988	1,800	EU	
			Puffin	1988	5,870	GB	
2	Duncansby lighthouse - Kiln of Flux	ND404727	Guillemot	1986	11,180	GB	SSSI
3	Stock O'Brough - Ashy Geo	ND357450	Razorbill	1986	1,934	EU	SSSI
4	Stack of Occumster - Uamh Ron	ND220333	Herring gull	1986	2191	GB	SSSI
5	West Gotten - Sturr Ruadh	ND148268	Kittiwake	1986	5,054	GB	SSSI
			Guillemot	1986	15,564	EU	
			Razorbill	1986	3,277	EU	
6	Dunbeath -Berriedale	ND141260	Black guillemot	1985	472	EU	SSSI
7	Leac Gheal - Bochailean	ND112210	Guillemot	1986	36,000	EU	SSSI
8	Sron Mhor - The Needle	ND085195	Shag	1986	382	GB	SSSI
9	Berriedale - Helmsdale	ND068180	Black guillemot	1985	376	GB	SSSI
10	Brora	NC901005	Little tern	1992	25	GB	SSSI
11	North Sutor	NH830699	Cormorant	1993	251	EU	None
12	Nigg oil terminal	NH793705	Common tern	1993	384	GB	SSSI
13	Alness Bay & Point	NH656678	Common tern	1989	190	GB	SSSI
14	Evanton - Deephaven	NH630666	Common tern	1989	170	GB	SSSI
15	Arderseir	NH810578	Common tern	1992	350	GB	None
	Grampian						
16	Troup Head	NJ820668	Kittiwake	1992	13,867	EU	SSSI
			Guillemot	1992	10,553	GB	
17	Lion's Head	NJ830665	Kittiwake	1992	12,557	EU	SSSI
18	Loch of Strathbeg	NK080595	Sandwich tern	1993	515	EU	Ramsar; SPA
19	St. Fergus	NK095540	Common tern	1991	177	GB	None
			Arctic tern	1989	542	GB	
20	Hare Craig - Cats Bank	NK125405	Kittiwake	1992	7,009	EU	None
21	Bullers of Buchan	NK110380	Shag	1992	430	GB	SSSI
			Kittiwake	1992	6,978	EU	
22	Whinnyfold cliffs	NK075325	Kittiwake	1986	4,903	GB	SSSI
23	Sands of Forvie	NK030270	Sandwich tern	1990	1,126	EU	SSSI
			Common tern	1989	265	GB	
			Little tern	1992	41	GB	
24	Tremuda Bay - Old Hall Bay	NO881832	Kittiwake	1992	7,040	EU	None
25	Turturra Heughs	NO881821	Kittiwake	1992	8,593	EU	SSSI
26	Fowlsheugh	NO880807	Kittiwake	1992	34,871	EU	SPA
			Guillemot	1992	59,910	EU	
			Razorbill	1992	6,830	EU	
27	Swallow Cove - Crawton	NO877792	Kittiwake	1992	8,310	EU	SSSI

Source: JNCC/Seabird Group Seabird Colony Register. Key: *site numbers are as shown on Map 5.10.2. GB = nationally important; EU = internationally important; SSSI = Site of Special Scientific Interest; SPA = Special Protection Area. Notes: counts are of pairs, except for guillemots, razorbills, black guillemots and puffins, 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 those defined by the counters who contributed to the JNCC/Seabird Group Seabird Colony Register.

although some important non-cliff sites, such as the Loch of Strathbeg and the Sands of Forvie, are important for ground-nesting birds. This latter site supports the largest breeding concentration of eiders in Great Britain.

The waterfowl using sites in the region during winter are also of considerable importance. There have been no recent comprehensive surveys of nearshore seabirds in the region, but the only sites thought to hold large concentrations are those listed in Table 5.10.3. Of these six sites, each holding wintering birds in numbers exceeding 1% of their national populations, the Moray Firth is by far the most important. It holds an internationally important flock of red-breasted mergansers that amounts to about 15% of the national total for this species, and nine other species reach nationally important levels, making this site the most important area for wintering seaduck in Britain. Two sites on the east coast of Grampian - the Ythan Estuary and Don Mouth to Blackdog - are important for eider.

At sea, 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 seabed 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. The seaduck and other nearshore waterfowl need relatively sheltered waters and feed on a variety of benthic organisms, including fish, shellfish and invertebrates. In general, divers and seaduck tend to occur in areas with less than about 20 m water depth.

Table 5.10.3 Important locations in the region for marine-wintering waterfowl (seaducks, divers, grebes and cormorant)

	Peak numbers	*1% GB GB*	*1% NW Europe*
Dornoch Firth			
Scaup *Aythya marila*	201	110	3,100
Cromarty Firth			
Slavonian grebe *Podiceps auritus*	27	4	50
Scaup *Aythya marila*	206	110	3,100
Goldeneye *Bucephala clangula*	172	170	3,000
Red-breasted merganser *Mergus serrator*	256	100	1,000
Moray Firth			
Red-throated diver *Gavia stellata*	350	50	750
Black-throated diver *Gavia arctica*	13	7	1,200
Cormorant *Phalacrocorax carbo*	278	130	1,200
Scaup *Aythya marila*	139	110	3,100
Long-tailed duck *Clangula hyemalis*	9,071	230	20,000
Common scoter *Melanitta nigra*	4,649	230	8,000
Velvet scoter *Melanitta fusca*	618	30	2,500
Goldeneye *Bucephala clangula*	779	170	3,000
Red-breasted merganser *Mergus serrator*	1,515	100	1,000
Goosander *Mergus merganser*	573	90	1,500
Loch of Strathbeg			
Cormorant *Phalacrocorax carbo*	139	130	1,200
Goldeneye *Bucephala clangula*	178	170	3,000
Ythan Estuary			
Eider *Somateria mollissima*	1,860	750	20,000
Don Mouth to Blackdog			
Eider *Somateria mollissima*	1,580	750	20,000

Sources: peak numbers from Waters & Cranswick (1993), Kirby *et al.* (1993), Owen *et al.* (1986) and Birds Database; 1% GB from Waters & Cranswick (1993), 1% NW Europe from Rose & Scott (1994). Notes: counts are of individuals. Some of these populations occur within estuaries discussed in section 5.12.

5.10.3 Human activities

Seabirds can be particularly affected by marine oil pollution, and spills near the main colonies during the breeding season could be particularly damaging. There have been concerns that offshore oil exploration in the area will add to the risk of oil spill, but so far there have been no major incidents. Spills can also occur from non-tanker shipping movements. A major shipping route passes through the Pentland Firth adjacent to the region. Large numbers of auks have been killed in the past in fixed salmon nets along the Buchan Ness - Collieston coastline (Pritchard *et al.* 1992).

Seabird vulnerability 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)).

Most breeding seabirds require habitat that is free from predatory mammals, hence nearly all colonies are on offshore islands, cliffs or remote parts of saltmarshes. The large gulls appear to be able to tolerate more disturbance by mammals than the smaller seabird species. However, there have been declines in numbers of herring gulls in the region, which have been attributed to increased levels of predation by foxes. The cliffs of the region make relatively safe nesting sites, but increased levels of ground predation would adversely affect ground-nesting species. This is a particular problem at Sands of Forvie, where predation by foxes, gulls and crows has caused virtual extinction of the tern colony.

5.10.4 Information sources used

All seabird colonies in the region were counted between 1984 and 1987. These counts, and all those made since 1969, are held on the JNCC/Seabird Group Seabird Colony Register. Numbers and breeding performance of several species are evaluated annually at several colonies in the region, including Fowlsheugh, Sands of Forvie and the North Sutor of Cromarty. Until very recently, annual assessments were made of breeding performance and population changes of seabirds on the Caithness cliffs by the Royal Society for Protection of Birds. Since 1979, surveys of birds at sea off the region have been carried out by JNCC's Seabirds at Sea Team (SAST), whose effort from ships has been relatively even. A special study of the Moray Firth was made by Mudge *et al.* (1984) in the early 1980s. Waters at 2 km and 5 km from the shore have been surveyed from the air by SAST, on a bi-monthly basis over one year. Coverage, from the land, of most nearshore waters in the region has been generally poor away from the key areas of the Moray

Firth and off the east coast of Grampian (see Benn (1985) for review).

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Harding-Hill, R. 1993. *The Moray Firth review*. Inverness, Scottish Natural Heritage.

Prater, A.J. 1981. *Estuary birds of Britain and Ireland*. Calton, Poyser.

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

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

5.11 Other breeding birds

D.M. Craddock & D.A. Stroud

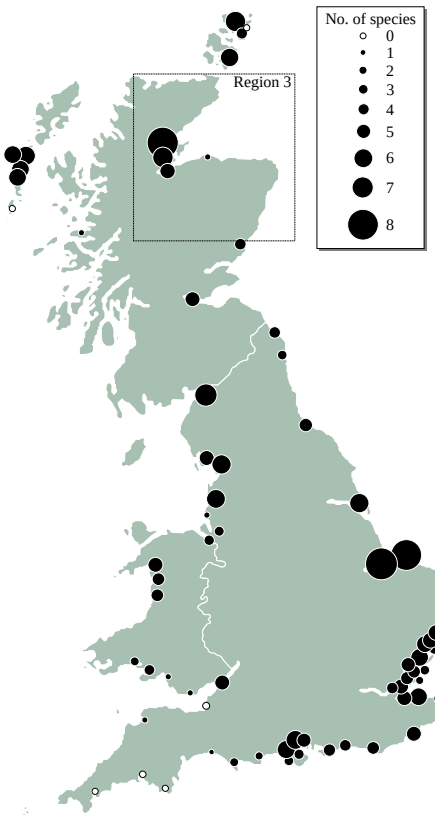
5.11.1 Introduction

The section outlines the importance of the coast 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 physical nature of this coastline is varied and this determines the distribution of the breeding bird assemblages that occur. Large stretches of the coast are cliff-bound, especially along the northern coastline of Sutherland and the coast of Caithness. In these areas, breeding birds typical of soft coastlines are restricted in occurrence. In contrast, the sheltered nature of the firths of the Moray Basin (Loch Fleet, Dornoch Firth, Cromarty Firth and the Inner Moray Firth) and their saltmarshes make this an important area for breeding waders and other waterfowl. This region also contains extensive areas of intertidal sands and mud-flats, which provide important feeding areas for breeding waterfowl, and sand dune systems holding breeding shelduck *Tadorna tadorna* and large eider duck *Somateria mollisima* populations, as well as an assemblage of passerine (e.g. songbird) species. Further south in Grampian, low cliffs and rocky coasts predominate, although there are also some important sand-dune complexes and a few small estuaries.

Compared with elsewhere in Britain, the Moray Basin saltmarshes and grasslands have a very diverse breeding wader assemblage (Map 5.11.1) and high overall breeding wader density (Table 5.11.1) (Davidson 1991; Davidson *et al.* 1991). Maps 5.11.2 and 5.11.3 show the incidence of confirmed breeding in coastal 10 km squares of selected species characteristic of two typical habitat types: wet grassland (teal *Anas crecca*, lapwing *Vanellus vanellus*, redshank *Tringa totanus*, mallard *Anas platyrhynchos*, snipe *Gallinago gallinago* and pintail *Anas acuta*); and shingle, sand dune and other dry grassland (ringed plover *Charadrius hiaticula*, oystercatcher *Haematopus ostralegus* and shelduck).

Wet grassland, although limited in extent, contains small but significant numbers of breeding waders along parts of the coastline. The coastal wetlands of the Moray Basin are collectively of international importance for breeding waterfowl, particularly waders (Pritchard *et al.* 1992). Numbers of lowland breeding waders, especially those



Map 5.11.1 Numbers of different breeding waders on estuaries in Britain (waders also breed elsewhere along the coast). Source: Davidson *et al.* (1991).

associated with wet grassland areas and saltmarshes, have been declining, not only nationally but also internationally (Hötker 1991). The importance for breeding birds of remaining areas of these habitats in the region is thus likely to increase.

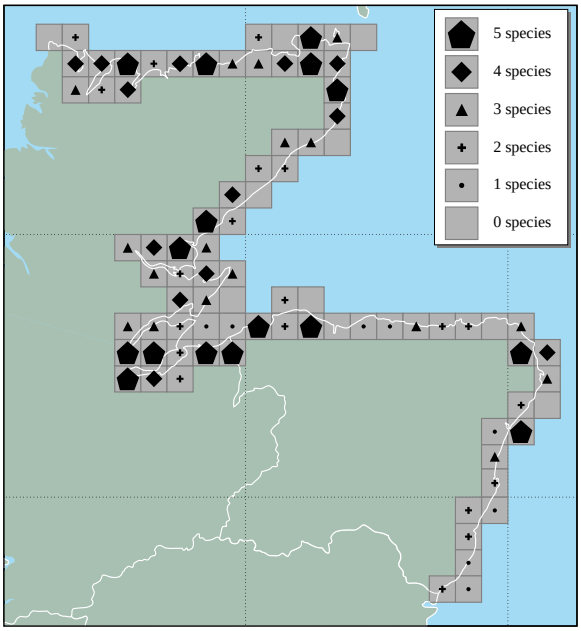
5.11.2 Important locations and species

The Inner Moray, Dornoch and Cromarty Firths hold notable densities of saltmarsh-breeding redshank and oystercatcher (Table 5.11.1). Although curlew *Numenius*

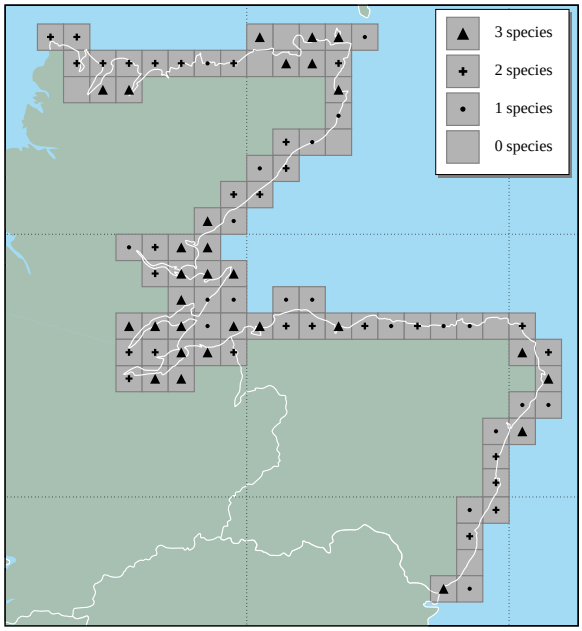
Table 5.11.1 Densities of breeding waders on a sample of saltmarshes surveyed in 1985*

Site	*Oystercatcher (pairs/km²)*	*Ringed plover (pairs/km²)*	*Lapwing (pairs/km²)*	*Curlew (pairs/km²)*	*Dunlin (pairs/km²)*	*Redshank (pairs/km²)*	*Total waders (pairs/km²)*
Sutherland							
Dornoch Point	12	2	7	2	2	28	53
Morrich More	12	-	5	4	-	54	75
Nigg Bay	21	3	4	-	-	19	47
Udale Bay	9	9	-	-	-	3	21
Conon Island	3	-	3	6	3	49	64
Beauly Firth	18	-	4	-	-	40	62
Culbin	19	-	-	-	-	7	26
Findhorn	14	-	-	2	-	33	49

Source: Allport *et al.* (1986). Key: *other saltmarshes in the region were *not* surveyed, so this is not a comprehensive listing.

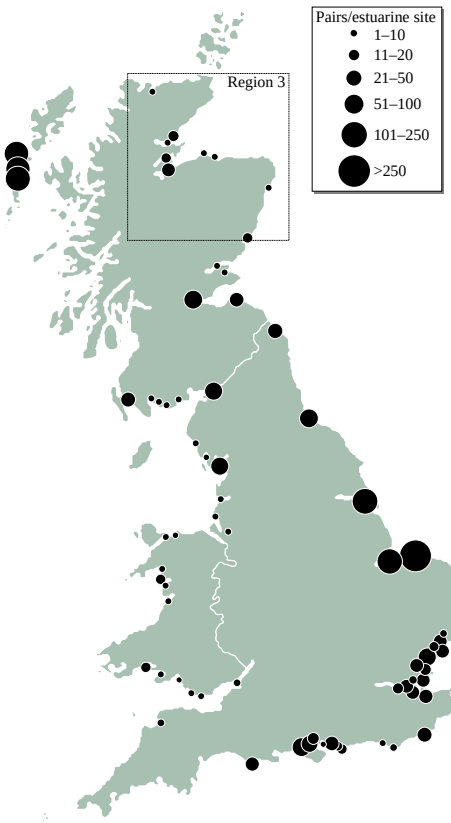


Map 5.11.2 Number of confirmed breeding species characteristic of wet grassland (redshank, snipe, lapwing, mallard, teal and pintail) in coastal 10 km squares. Source: based on Gibbons, Reid & Chapman (1993).



Map 5.11.3 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, Reid & Chapman (1993).

arquata is not principally a coastal breeding wader, the breeding densities on saltmarshes in these firths are amongst the highest in Britain. Breeding ringed plovers nest in the sandier parts of these estuarine systems and elsewhere along the coast (Davidson *et al.* 1991; Prater 1989) (Table 5.11.2; Map 5.11.4). Although their principal coastal stronghold is in the southern islands of the Outer Hebrides, small numbers of dunlin *Calidris alpina* also breed on the Dornoch and Cromarty Firths (Davidson *et al.* 1991) (Table 5.11.1).



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

	Pairs (coastal) counted in survey	*% GB total counted in survey*
Highland	590*	8.2
Grampian	62	0.9
Region 3	***652***	***9.1***
Scotland	5,002	69.4
GB total	***7,207***	

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

The densities of breeding shelduck are significant in a Scottish and North Sea Coast context (Davidson *et al.* 1991). Table 5.11.3 summarises breeding shelduck populations holding more than 45 birds counted in Delany's 1992 survey

Table 5.11.3 Sites holding at least 45 shelduck in 1992

Site	*Total*	*Males*	*Pairs*	*Non-breeding birds*
Cromarty Firth	272	0	76	40
Dornoch Firth	202	11	40	112
Moray Firth	134	17	26	65
Findhorn Bay	116	n/k	n/k	n/k
Beauly Firth	101	2	24	51

Source: S. Delany (pers. comm.). Key: n/k = not known.

(S. Delany pers. comm.), which highlighted the importance of the soft coastline for this species. Two sites on the east coast of Grampian - the Ythan Estuary (Sands of Forvie NNR) and Don Mouth to Blackdog - are important for eider.

Breeding peregrine *Falco peregrinus* occur along most of the north-east Scottish coast, where they prey on seabirds and rock doves *Columba livia* (Gibbons *et al.* 1993). Numbers are significant in both national and Scottish contexts. Parts of the coast are also of national note because they hold the entire British breeding population of Temminck's stint *Calidris temminckii*.

There are a number of coastal SSSIs within the region containing cliff, sand dune and estuarine habitats, and additionally there are RSPB reserves along several stretches of coast (e.g. Udale Bay, Culbin Sands and Loch of Strathbeg), although these have generally been acquired because of their importance for breeding seabirds or wintering waterfowl.

5.11.3 Human activities

Incremental land claim along the soft coasts of estuarine and sand dune systems, although an uncommon occurrence in the region, has the potential to affect breeding waterfowl populations through loss of nesting and feeding habitat; at important sites SSSI designation can limit such activity. The appropriate agricultural and other management of wet grassland in the region is of crucial importance for their wader populations (see papers in Hötker 1991). Likewise, different grazing regimes on saltmarshes can significantly alter the density and nesting success of breeding waders, through effects on vegetation composition and structure (Cadbury *et al.* 1987). Human disturbance during the nesting season can have significant effects on birds' 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.

Oil pollution is well known as a serious potential threat to waterfowl where high densities of birds occur. In areas of the highest risk, however, such as in the Dornoch and Cromarty Firths, there are well-developed contingency plans for dealing with accidental spillages; there have been no major incidents so far.

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

The coast of north-east Scotland is generally poorly monitored, and consequently confirmed breeding records for some species are hard to obtain. Thus available data may not reflect the true importance of the region for some breeding birds. However, for a number of species, additional extensive survey work has been undertaken by volunteers. Usually these surveys have been organised as part of wider British surveys (e.g. for ringed plover (Prater 1989) and shelduck (S. Delany pers. comm.)). Long-term studies of the population dynamics of shelduck (Patterson 1982) and eider ducks (Baillie 1981) have been a significant part of detailed research on the ecological processes of the Ythan Estuary by the University of Aberdeen's field station at Culterty (Gorman & Raffaelli 1983; University of Aberdeen 1992). Buckland *et al.* (1990) provide a comprehensive summary of the status of each breeding bird species in north-east Scotland (Grampian Region).

5.11.5 Acknowledgements

Thanks are due to Simon Delany at the Wildfowl & Wetlands Trust for results of the 1992 breeding shelduck survey, Humphrey Crick (BTO), Dave Cole and George Boobyer (JNCC), Cathy Duncan (SNH), Highland Regional Council and Ian Francis (RSPB).

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
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Coastal breeding wildfowl data	*Wildfowl & Wetlands Trust, Slimbridge, tel: 01453 890333
Site designations	*SNH HQ, Edinburgh, tel: 0131 554 9797
Breeding bird surveys	*Regional Officer, RSPB North Scotland Office, Etive House, Inverness, tel: 01463 715000
Ecology of the Ythan Estuary	Dr D. Raffaelli, Culterty Field Station, Aberdeen University Department of Zoology, Newburgh, Ellon, Aberdeenshire AB41 0AA, tel: 01358 789631

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

5.12 Migrant and wintering waterfowl

D.A. Stroud & D.M. Craddock

5.12.1 Introduction

This section describes the importance of the region for waterfowl, defined as waders and wildfowl (divers, grebes, ducks, geese and swans together with coot *Fulica atra*). The importance of offshore areas for wintering divers, grebes, seaducks and cormorant *Phalacrocorax carbo* is outlined in section 5.10.

This region is not one of the most important areas of coastal Britain for wintering waterfowl, although certain areas and sites are of international and national importance, both individually and collectively, and overall the region holds almost a quarter (>73,000) of Scotland's coastal wintering waterfowl (Table 5.12.1). Note, however, that these figures give only a rough guide to the relative importance of the region, since the data are uncorrected for coverage: some areas are better counted than others.

The physical nature of the coastline determines the assemblages and distribution of wintering waterfowl occurring. Large stretches of the coast are cliff-bound, especially along the northern coastline of Sutherland and Caithness. Along this coast, estuaries are small and hold small numbers of wintering waterfowl. However, the sheltered nature of the firths of the Moray Basin (Loch Fleet, Dornoch Firth, Cromarty Firth and the Inner Moray Firth) makes them of major international importance for their wintering waterfowl populations, and this area is the most northerly major wintering area for waterfowl in Europe (Swann & Mudge 1989). Thus the conservation of these populations is important for maintaining the natural distributions of many species. Ringing studies in the Moray Basin (Symonds & Langslow 1986) have shown that the use made by wintering waders (e.g. dunlin *Calidris alpina* and redshank *Tringa totanus)* of suites of sites during the course of a winter follows complex patterns of interchange, which means that individual sites cannot be considered in isolation (Davidson *et al.* 1991).

The coastline, and especially the estuaries of the region, is of importance for migrant waterfowl in spring and autumn. The region lies on a major migratory flyway and many birds moving to and from wintering areas on the African, Mediterranean and south-west European coasts and arctic breeding grounds pass through and stage on the coast here. The extent to which this occurs varies between species, but it emphasises the international responsibility for the conservation of these areas and their migrant waterfowl populations.

5.12.2 Important locations and species

Five coastal wetlands (Inner Moray Firth, Loch of Strathbeg, Dornoch Firth, Cromarty Firth and the Ythan Estuary) are individually internationally important for their wintering waterfowl populations (Table 5.12.2). However, the coastal wetlands of the Moray Basin comprise an integrated ecological unit, as reflected through waterfowl movements (Symonds & Langslow 1986). As well as being of international importance for wintering populations of several species of waterfowl, the Inner Moray Firth, Loch of Strathbeg and the Dornoch and Cromarty Firths all also hold over 20,000 waterfowl (Table 5.12.2). The Inner Moray Firth is of particular note, holding populations of fifteen species at levels of international (five species) or national (ten species) importance. The Beauly Firth now also supports a large late-summer moulting population of the alien species Canada goose *Branta canadensis*, a moult migration that has developed over the last few decades (Owen *et al.* 1986).

Sites with extensive areas of saltmarsh or grazing marsh in close proximity to intertidal areas, such as the firths of the Moray Basin, typically have large populations of wigeon *Anas penelope*. Such areas are also attractive to lapwing *Vanellus vanellus*, curlew *Numenius arquata* and golden plover *Pluvialis apricaria*, as they provide a wide range of feeding opportunities. Sheltered, muddy substrates are especially attractive to dunlin, whilst sandier estuaries and embayments hold larger numbers of geese, oystercatcher *Haematopus ostralegus* and curlew. The Moray Basin is important for seaduck: common scoter *Melanitta nigra*, goldeneye *Bucephala clangula*, long-tailed duck *Clangula hyemalis* and scaup *Aythya marila* occur offshore in important numbers in the Moray, Cromarty and Dornoch Firths (Kirby *et al.* 1993) (see also section 5.10).

At regularly counted estuaries (Map 5.12.1), a range of different wintering waterfowl assemblages occur, determined by habitat characteristics. Seven species of non-breeding waterfowl occur at levels of international importance on at least one estuary, and a further ten species (Table 5.12.2) occur at levels of national (i.e. Great Britain) importance. Of particular significance are the numbers of some duck species: the Inner Moray Firth is the most important site in the UK for both goosander *Mergus merganser* and red-breasted merganser *M. serrator*; indeed, it is the only internationally important site in the UK for the latter (Aspinall & Dennis 1988; section 5.10). Of particular note are the significant numbers of pink-footed *Anser brachyrhynchus* and Icelandic greylag geese *A. anser* on the

Table 5.12.1 Waterfowl counts for the region, Scotland and Great Britain in January 1993

	Total waterfowl count in January 1993	*Number of sites counted*	*% of count in Region 3*
Coastal sites in Region 3	73,355	5	-
All counted Scottish coastal sites	299,676	78	24.5
All counted British coastal sites	2,060,961	214	3.5

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

Table 5.12.2 Wintering waterfowl numbers on estuaries in the region

Site	*Site protection status*	*Five year mean numbers wintering waterfowl*[a,b]	*1992/93 peak waterfowl numbers*[a,b]	*1992/93 peak wildfowl numbers*[a]	*1992/93 peak wader numbers*[b]	*Species occurring at levels of national or international importance*
Kyle of Durness	Possible SAC	90	n/a	n/a	n/a	n/a
Kyle of Tongue	None	600	n/a	n/a	n/a	n/a
Torrisdale Bay	SSSI	42	n/a	n/a	n/a	n/a
Loch Fleet complex	SSSI	9,169	7,503	3,862	3,641	n/a
Dornoch Firth (inc. Loch Eye)	Possible SAC (Ramsar/SPA)	**29,243	31,577	21,072	10,505	Greylag goose*, wigeon*, teal, curlew, scaup, bar-tailed godwit
Cromarty Firth	SSSI	**27,518	22,544	13,452	9,092	Greylag goose*, whooper swan*, redshank*, wigeon*, pink-footed goose*, bar-tailed godwit*, red-breasted merganser, goldeneye, scaup, curlew
Inner Moray Firth	Possible SAC	**49,308	50,926	22,144	28,782	Redshank*, bar-tailed godwit*, greylag goose*, red-breasted merganser*, wigeon*, goldeneye, goosander, scaup, oystercatcher, curlew, dunlin, teal, whooper swan, long-tailed duck, common scoter
Lossie Estuary	None	1,314	1,681	860	821	n/a
Spey Estuary	Possible SAC	329	839	795	44	n/a
Banff Bay	None	550	n/a	n/a	n/a	n/a
Loch of Strathbeg	Ramsar/SPA	**39,812	37,691	37,691	n/a	Whooper swan*, pink-footed goose*, greylag goose*, teal
Ythan Estuary	SSSI	9,971	10,663	2,855	7,808	Eider
Don Estuary	None	606	792	263	529	n/a
Dee Estuary	None	1,031	2,052	881	1,171	n/a

Source: WeBS data from Waters & Cranswick (1993) (data from Cranswick *et al.* (1995) were not available when this section was compiled). Key: *species occurring at levels of international importance; **internationally important site by virtue of holding ≥20,000 waterfowl; [a]includes divers, grebes and cormorants; [b]includes grey heron; n/a = not available; SAC = Special Area of Conservation under the EC Habitats & Species Directive. Notes: see Waters & Cranswick (1993) for further detail on interpretation of counts and limitations of data. The winter season used by WeBS is November to March for waders and September to March for wildfowl.

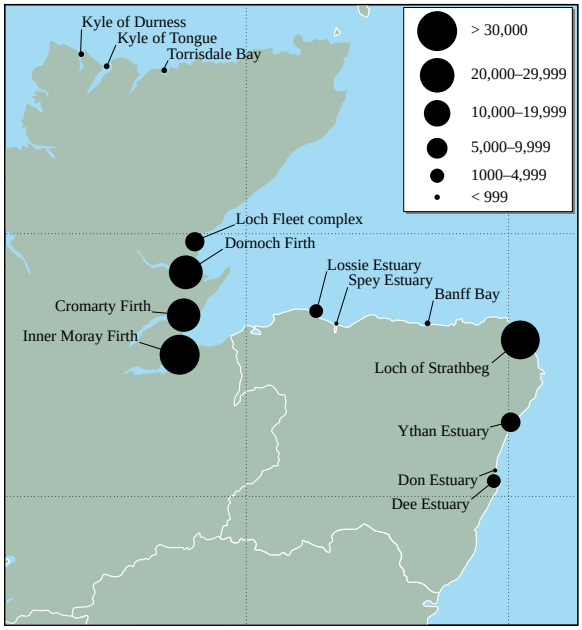
firths of the Moray Basin, as well as the Loch of Strathbeg. These birds tend to roost on undisturbed intertidal areas and lochs, feeding on surrounding agricultural land. Other herbivorous wildfowl include wigeon *Anas penelope,* which occur in internationally important numbers in the Moray Basin and at the Loch of Strathbeg, and whooper swan *Cygnus cygnus,* which occur in internationally important numbers at the latter site. Other regularly occurring waterfowl include teal *Anas crecca*, mallard *A. platyrhynchos*, shelduck *T. tadorna*, dunlin, bar-tailed godwit *Limosa lapponica*, lapwing, curlew, golden plover, redshank and eider *Somateria mollissima* (Figure 5.12.1).

Wader species occurring on non-estuarine coasts vary greatly with exposure and type of substrate. In this region densities of wintering shorebirds in these areas tend to be low to moderate compared with densities on such coasts in other regions of Great Britain (Moser & Summers 1987; Webb 1988). There are significantly higher densities on the coast of Grampian than on the more exposed coast of Highland Region (Table 5.12.3). On the non-estuarine shores of Grampian and Highland, oystercatcher *Haematopus ostralegus* is the most abundant wader species, followed in order of decreasing abundance by knot *Calidris canutus*, redshank, ringed plover *Charadrius hiaticula*, curlew, purple sandpiper *Calidris maritima* and golden plover (Moser & Summers 1987; Figure 5.12.1). Although not all sections have been regularly monitored, the rocky shoreline of the region is of importance for several wintering wader species. Streches of the coastline are of international importance for both purple sandpiper and turnstone *Arenaria interpres* (Webb 1988). The region is of considerable significance during autumn migration periods for curlew sandpiper *Calidris ferruginea*.

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 estuaries, although it is generally subject to good regulation (see also section 9.7). Owen (1992) made a number of recommendations for the improvement of the operation of existing schemes to regulate shooting on NNRs. Incremental land claim, e.g. for oil and gas installation construction, has the potential to further affect waterfowl populations through loss of feeding habitat, although at important sites, SSSI designation provides a mechanism that can limit such activity. Coastal windfarm developments in sensitive areas also have the potential to be highly disruptive to wintering waterfowl (as reviewed by Crockford 1992), although there are no such developments in the region at present (but see section 8.3).

Bait digging and shellfish collection from intertidal sediments, as well as other forms of recreational activities,



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).

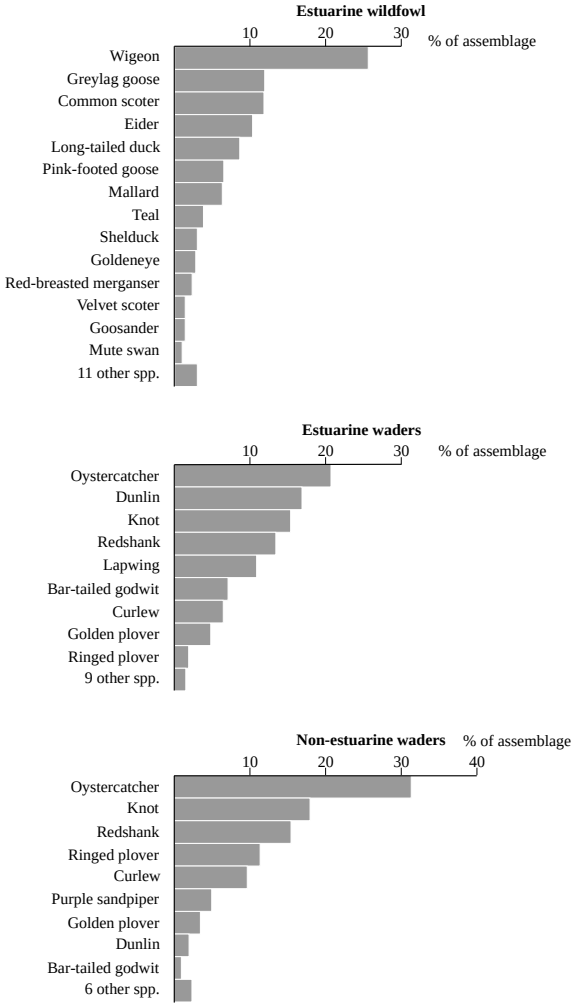


Figure 5.12.1 Relative species composition of non-breeding waterfowl assemblages on coastal areas of the region. Source: etuarine waterfowl data from Prater (1981), non-estuarine wader data from Moser & Summers (1987).

are potentially disruptive and may prevent waterfowl using feeding areas (e.g. Scott (1989) and Keller (1991) on the Ythan Estuary). The significance of these activities varies not only from site to site (in relation to intensity and size/topography of site) but also with the time of year (Davidson & Rothwell 1993a, b, 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 population, in order to ensure that coastal management planning can best minimise negative impacts.

Oil pollution is well known as a serious potential threat to wintering waterfowl in areas where high densities of birds occur, and there have been past oil pollution incidents in the Moray Firth. In areas of the highest risk, however, such as in the Dornoch and Cromarty Firths (where there are oil terminals), there are well-developed contingency plans for dealing with accidental spillages.

5.12.4 Information sources used

As with other areas of the UK, migrant and wintering waterfowl are well surveyed by the Wetland Bird Survey (WeBS - organised by the British Trust for Ornithology, the Wildfowl & Wetlands Trust, the Royal Society for the Protection of Birds and the JNCC). This volunteer-based survey collates monthly counts from coastal and inland wetlands through the UK. Coastal coverage is generally good for north-eastern Scottish estuaries, although the open

Table 5.12.3 Overall densities of wintering waders on non-estuarine coasts in Region 3

	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)*
Grampian	14	10,342	240.7	222.4	46.5
Highland	15	17,637	2,183.3	1,801.2	9.8

Source: Winter Shorebird Count - Moser & Summers (1987); Webb (1988). Note: Highland data are for whole Highland Region including the west coast (Region 16).

coast is not thoroughly surveyed on an annual basis (Waters & Cranswick 1993). The WeBS waterfowl count scheme publishes an extensive annual summary report, the most recent being Cranswick *et al.* (1995), covering the winter season 1993/94. This report summarises species trends, based on counts at wetlands throughout the UK. It also tabulates counts of total waterfowl numbers at all counted estuaries. It is the primary source of information on wintering and migrant waterfowl in the UK. Copies are available from either of the WeBS National Organisers listed in section 5.12.6. The annual report can only summarise what are very detailed data, and in summary form such counts may be subject to misinterpretation for a number of reasons. Detailed count data for sites can be provided by WeBS, and inspection of these data is recommended for any planning-related activity. WeBS counts are generally undertaken at high-tide when waterfowl gather in high densities on traditional roosting areas. To complement this information, at selected estuaries WeBS organises low-tide counts to give information on the feeding distributions of waterfowl during the intertidal period. The only sites in the region at which such information is already available are the Ythan Estuary, Loch Fleet, and the Inner Moray, Cromarty and Dornoch Firths (Symonds & Langslow 1985, 1986).

The whole UK coastline was surveyed for wintering waders during the Winter Shorebird Survey of 1984/85 (Moser & Summers 1987; Webb 1988), and there are current WeBS plans for a repeat national survey, possibly for 1996/97, subject to funding availability. Information on the wintering waterfowl of the non-estuarine shore is important for placing annual estuaries counts in a wider perspective.

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

Prater (1981) gives useful descriptive accounts of the birds of Scottish 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) and Buck (1993).

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

There have been a number of more detailed studies of the wintering waterfowl of the region: the Dee Estuary (Bell 1989), Loch of Strathbeg (Bell 1981) and Moray Basin (Symonds & Langslow 1985, 1986). Also, detailed research has been undertaken on the bird populations and ecological processes of the Ythan Estuary, through the University of Aberdeen's field station at Culterty (Gorman & Raffaelli 1983; University of Aberdeen 1992). The RSPB have also been involved in monitoring projects around the Moray Firth. Additionally, *The birds of north-east Scotland* (Buckland *et al.* 1990) gives a comprehensive systematic account of all birds in Grampian. As well as the very detailed information on each species, there are valuable review chapters on wintering wildfowl and coastal birds, both of which are useful starting points for further reading.

5.12.5 Acknowledgements

We would like to thank Peter Cranswick (WWT), Highland Regional Council and Ian Francis (RSPB) for comments.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
High tide and low tide counts of wintering and migrant wildfowl (WeBS)	*Peter Cranswick: WeBS National Organiser (Waterfowl), The Wildfowl & Wetlands Trust, Slimbridge, tel: 01453 890333
High tide counts of wintering and migrant wader (WeBS)	*Ray Waters: WeBS National Organiser (Waders), The British Trust for Ornithology, Thetford, tel: 01842 750050
Low tide counts of wintering and migrant wader (WeBS)	*Julianne Evans: WeBS National Organiser (Low Tide Counts), The British Trust for Ornithology, Thetford, tel: 01842 750050
Site designations (Scotland)	*SNH, Edinburgh, tel: 0131 554 9797
Birds in Highland	*RSPB North Scotland Office, Inverness, tel: 01463 715000
Birds in Grampian	*RSPB East Scotland Office, Aberdeen, tel: 01224 624824
Ecology of the Ythan Estuary	Dr D. Raffaelli, Culterty Field Station, Aberdeen University Department of Zoology, Newburgh, Ellon, Aberdeenshire AB41 0AA, tel: 01358 789631

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

5.13 Land mammals

Dr C.E. Turtle

5.13.1 Introduction

This section covers mammals that occur in the coastal 10 km squares in the region, concentrating on those that are truly coastal, such as 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.

Scotland (and thus also this region) is nationally important for two mammals: the otter and the wildcat *Felis silvestris*. The otter has a stronghold in Scotland and the wildcat is restricted to Scotland. The region is also of national significance for pine martens *Martes martes* and red squirrels *Sciurus vulgaris*. These species are declining in both distribution and numbers throughout Great Britain and are reduced to relict populations in England and Wales. Only four of the fourteen species of British bat are recorded (Arnold 1993). Three populations; the pipistrelle *Pipistrellus pipistrellus*, brown long-eared *Plecotus auritus* and Natterer's *Myotis nattereri* are classed as vulnerable in Europe, whilst the Daubenton's *Myotis daubentonii* is not threatened at present (Stebbings & Griffith 1986).

All British bats, the otter, pine marten, wildcat and red squirrel are listed under Schedule 5 of the Wildlife and Countryside Act, and the wildcat is listed under Schedule 6 also. All British bats are listed under Appendix II and the red squirrel is listed under Appendix III of the Bern Convention. Table 5.13.1 summarises the recorded distribution of protected species in the region.

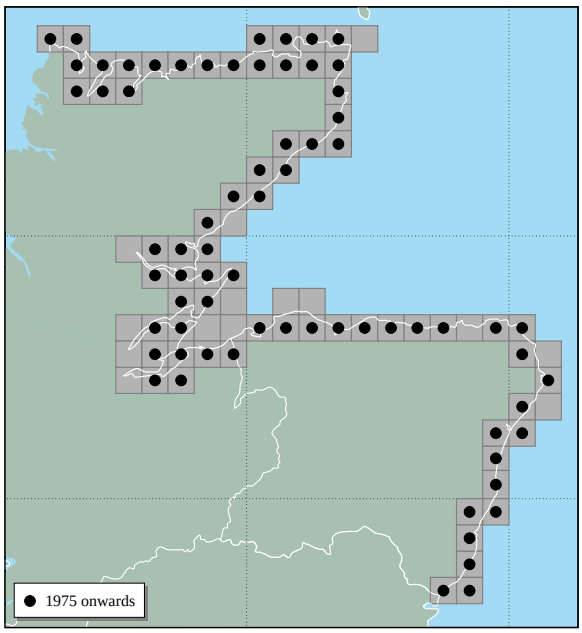
Table 5.13.1 Records of protected species distribution

Protected species	*Estimate of importance in region*
Natterer's bat	Rare
Daubenton's bat	Rare
Pipistrelle bat	Frequent
Brown long-eared bat	Rare
Red squirrel	Rare
Pine marten	Rare
Otter	Common; part of stronghold of the British population
Wildcat	Frequent; restricted to Scotland

Source: Arnold (1993)

5.13.2 Important locations and species

The British stronghold for otters is Scotland, where they occur throughout the coast of Highland and most of Grampian Regions (Map 5.13.1) and elsewhere, although they are classed as vulnerable on the Scottish coasts and islands (Morris 1993). There is evidence that there are not as many otters on the Grampian coast as on the Highland coasts, probably owing to the lower availability of suitable habitat, although a possible contributing factor is that centres of human population in Grampian increase pollution, disturbance and road mortality (R. Green pers. comm). Otters are associated with semi-aquatic areas,



Map 5.13.1 Recorded distribution of the otter by coastal 10 km square. Records from 1960 onwards. Source: Arnold (1993).

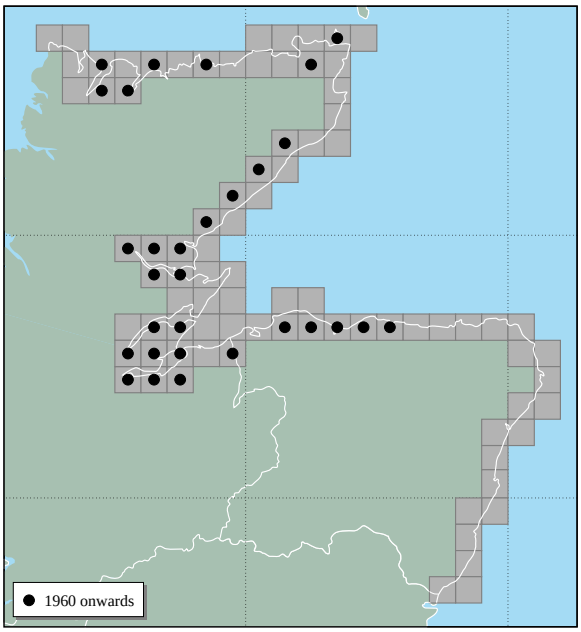
including rivers, lakes and coasts, and is the terrestrial mammal most closely associated with the coast. Otters will use all coastal habitats, although food is less available on long sandy beaches, saltmarshes and exposed cliff headlands than in sheltered rocky inlets (R. Green pers. comm.). Their use of the coastline will depend on the sex of the animal, the time of year and food supplies.

The national bat habitat survey (Walsh & Harris in prep.) includes coastal habitats and demonstrates that bats use the coast for foraging, where there is suitable habitat with shelter and flightlines to the feeding areas. The four species found in this region are recorded throughout Britain except in the Outer Hebrides and Shetland, and so are here on the northerly edge of their European range.

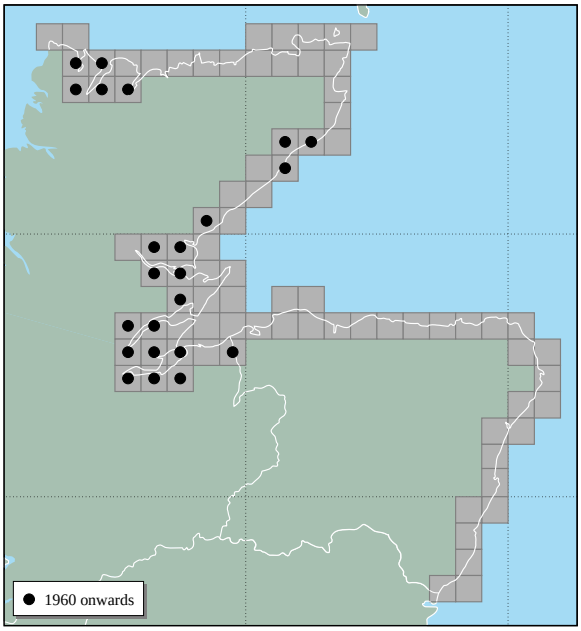
The red squirrel is widespread in Scottish woodlands but extinct over much of England and Wales (Morris 1993). There are only a few recent records of red squirrels from the Highland coast, from around Helmsdale. There are more frequent records from the Grampian Region, associated with wooded areas of the coast, such as Roseisle and Culbin forest, although there is strong evidence of decline (Arnold 1993).

There are few records for the pine marten within this region, and it is extinct over most of England and Wales (Velander 1983). Pine martens are dependent on large, mixed conifer plantations (although the more mature plantations are less valuable) and they are unable to survive in solely coastal habitats (D. Balharry pers. comm.). Their distribution in this region is similar to that of the red squirrel in that they are mainly associated with forest plantations in the Lybster and Bonar Bridge areas (Map 5.13.2).

The wildcat is recorded from virtually all the Highland Region coast and is also common in the northern area of Grampian (Map 5.13.3). Wildcats can utilise a variety of



Map 5.13.2 Recorded distribution of the pine marten by coastal 10 km square. Records from 1960 onwards. Source: Arnold (1993).



Map 5.13.3 Recorded distribution of the wildcat by coastal 10 km square. Records from 1960 onwards. Source: Arnold (1993).

habitats, including woodland, moorland, grassland and marsh, and are known to use the coast, although they prefer sheltered areas (Easterbee *et al.* 1991). In the UK the wildcat is restricted to Scotland and is here on the northerly edge of its range in Europe, where the population is diminishing (Easterbee *et al.* 1991). The recently recorded increased densities in the Grampian areas are likely to be related to the increase in hybridisation with the feral cat populations associated with the denser urban areas.

5.13.3 Human activities

Increased human use of the area is likely to affect otters, especially where it occurs along the shores of lochs. There are few industrial areas within this region; however those in the southern end of the Grampian area may contribute to a decline in water quality, affecting food supplies for otters. This, together with the increase in roads and general disturbance, may limit the otter population in the region. Morris (1993) also reports that fish farming, particularly salmon farming, may affect the water quality by organic enrichment. The use of lobster and crab creels causes otter deaths (Jefferies *et al*. 1984), and this will be significant in areas where these traps are used extensively. The Vincent Wildlife Trust supplies free otter guards to fyke-netters, and they have proved very successful (R. Green pers. comm.). Oil spills cause otter deaths (Jenkins 1980); the gravity of spills will depend on their size and the size of the otter populations.

The hybridisation of wildcats and feral cats is likely to increase as the numbers of domestic cats tend to grow in line with the human population. This hybridisation may cause problems in determining the true distribution of this species, through difficulties in identification (D. Balharry pers comm.). Wildcats and pine martens are occasionally accidentally killed by predator and pest control measures.

Both pine martens and red squirrels inhabit the forestry plantations of the region, and any fall in the rate of conifer planting that changes the proportion of young trees in these forests could affect these mammals. Red squirrels are now largely dependent on extensive conifer plantations with good seed crops and relatively low tree densities. Nationally in broad-leaved woodlands their distribution is negatively correlated to that of the grey squirrel, since grey squirrels have a competitive advantage over reds in this habitat. However, no coastal records for grey squirrels exist in this region. The continued survival here of the red squirrel may be threatened unless grey squirrels are actively excluded from the region.

5.13.4 Information sources used

There are no reliable estimates of the numbers of mammals in the region or in Britain that can be used to quantify the resource. However, it is known that the stronghold of the British otter population is in Scotland. The numbers of wildcat, red squirrel and pine marten occurring in the coastal region are likely to be a low percentage of their overall numbers. An estimate has been made for the occurrence of mammals within the coastal area (Table 5.13.1) using the data from Arnold (1993), although these records are incidental rather than comprehensive. As a general observation (Morris 1993), mammal surveys are not recorded with the same intensity as botanical ones, and the occurrence of mammals within 10 km squares is not enough to establish the status of species. However, the data for all the nationally important mammal species discussed confirm their presence in this region.

The otter and wildcat are the only mammals to have been surveyed on a systematic basis, although the second otter survey of Scotland did not cover the Highland Region (Green & Green 1987). There have been three otter surveys of Scotland: in 1977-1979 (Green & Green 1980), in 1984-1985 (Green & Green 1987) and 1991-1993 (Green & Green in

press). These surveys have established the importance of coastal areas for the otter population. It is difficult to establish the significance of the wildcat records because of the possibility of hybridisation. The 1980-1982 survey of pine marten (Velander 1983) covered few of the coastal areas of this region, but did demonstrate the importance of scattered coastal sites. There have been no comprehensive surveys for the bats, although there are recent records of each of the four species that occur. The absence of bat data makes it difficult to establish the value of the coast for bats, although as most are vulnerable, any coastal sites with bat roosts will be important. A red squirrel survey was undertaken for the Timber Growers UK (1992) and demonstrates the importance of scattered coastal sites.

5.13.5 Acknowledgements

Thanks are due to all those people mentioned in the text for contributing information and time.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
National site and species information	*SNH HQ, Edinburgh, tel: 0131 447 4784
Local site and species information	*Scottish Wildlife Trust, Conservation Officer, Edinburgh, tel: 0131 312 7765
Bats	Scottish Bat Group, Prof P. Racey, Dept of Zoology, University of Aberdeen, Tillydrone Avenue, Aberdeen AB9 2TN, tel: 01224 272000
Bats in the Strathspey area	*Malcolm Currie, SNH Strathspey Area Office, Aviemore, tel: 01479 810477
Otters	Jim and Rosemary Green, The Vincent Wildlife Trust Otter Rehabilitation Centre, Barjarg, Barr Hill, Girvan, Ayrshire KAS26 0RB, tel: 01465 821225
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

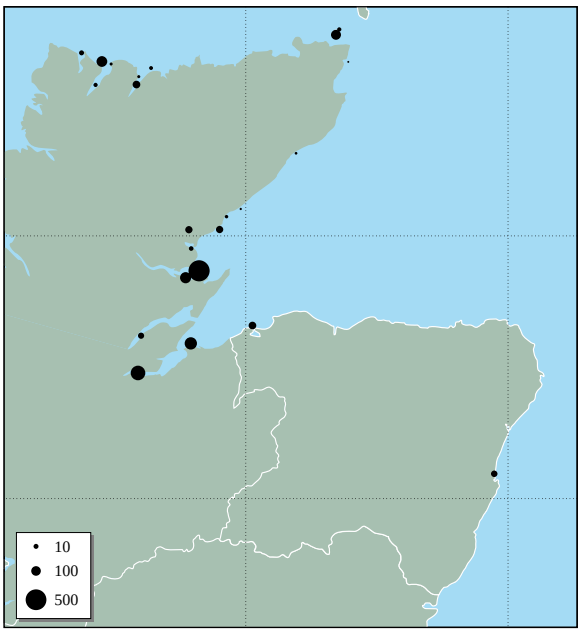
5.14.1 Introduction

This region holds approximately 5% of the GB common seal *Phoca vitulina* population. Grey seals *Halichoerus grypus* can be seen at any time of year throughout the region and account for approximately 5% of the grey seal pups born in Great Britain (Table 5.14.1). Relatively few seals of either species are found along the Grampian coast. During the summer, large numbers of seals of both species haul-out in the outer Dornoch Firth.

5.14.2 Important locations

Common seals can be seen throughout the region but are concentrated in the Inner Moray Firth between Brora and Findhorn Bay, with smaller groups between Cape Wrath and Loch Eriboll, around Tongue Bay and the Kyle of Tongue, on Stroma and along the Helmsdale coast. There is a small common seal haul-out site on Don Island near the mouth of the River Don in Aberdeen and a winter haul-out site at the mouth of the River Ythan. In the Inner Moray Firth common seals haul-out during the summer onto sandbanks; elsewhere in the region, haul-out sites are usually on rocky shores and skerries. The numbers of common seals at sites in the region in early August are given in Table 5.14.2 (Map 5.14.1). In this table a number of small groups have been integrated with larger groups for clarity.

Greys seals breed on isolated rocky shores and islands and frequently in caves. Their main breeding sites are along the mainland coast south and east of An Ceann Geal (Whiten Head) by Loch Eriboll, on Stroma and frequently in caves along the Helmsdale coast. There are smaller breeding groups on the islands at the mouth of Loch Eriboll, on the Rabbit Islands and Eilean nan Ron off Tongue Bay. Pups have been recorded, very occasionally, at Pennan Head, Rattray Head and Catterline on the Grampian coast. Grey seal breeding sites are listed in Table 5.14.3, with numbers of pups born (Map 5.14.2).



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

5.14.3 Human activities

The Cromarty and Inverness Firths and the area to the east of the region are used extensively by the offshore oil and gas production industry. Seismic surveys have recently been carried out off the Helmsdale coast, but seals are unlikely to be affected by them unless they happen to be in the vicinity of the seismic air-gun arrays. Seals are always susceptible to contamination from spilled oil, but particularly during their moulting and breeding seasons. The overall effects of petroleum operations on marine mammals have been reviewed by Richardson *et al.* (1989).

There are important rod and line and fixed-net salmon fisheries in the region (Harding-Hill 1993). Seals visiting fixed nets at the mouths of important salmon and sea-trout rivers are liable to be shot. There are fish-farms sited in Loch Eriboll (Sea Mammal Research Unit (SMRU) data), the Cromarty Firth and the Inverness Firth (Harding-Hill 1993).

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

County	*Common seals*		*Grey seals*		
	No. of seals (to nearest 50)	*% of GB total*	*Pup production (to nearest 50)*	*% of GB total*	*Associated population >1 year old*
North and east Highland	1,500	5.3	1,600	4.7	5,400
Grampian	5*	0	0	0	0
Region 3	***1,500***	***5.3***	***1,600***	***4.7***	***5,400***
Scotland	26,400	93.1	31,000	91.6	105,300
GB total	28,350		33,850		115,000

Sources: Sea Mammal Research Unit (SMRU), University of Aberdeen, SOAEFD, SNH, University of Aberdeen (Lighthouse Field Station, Cromarty). Key: *actual numbers.

Table 5.14.2 Common seal numbers* in areas regularly surveyed

Area surveyed	*Grid ref.*	*No. of seals**	*% of region total*
Cape Wrath to Strathy Point	NC256750-NC828699	200	13.6
Strathy Point to Duncansby Head	NC828699-ND406733	0	0
Stroma	ND355775	100	7.8
Duncansby Head to Dornoch	ND406733-NH808898	100	7.1
Dornoch to Findhorn Bay	NH808898-NJ043649	1,050	69.5

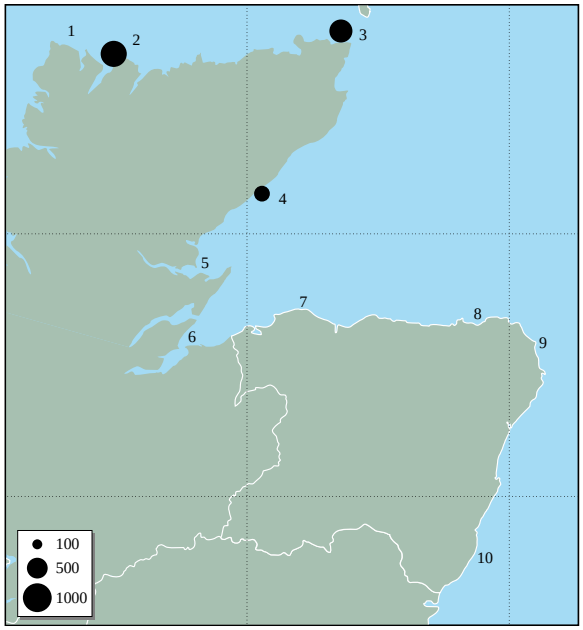
Sources: SMRU; University of Aberdeen, SOAEFD, SNH, University of Aberdeen (Lighthouse Field Station, Cromarty). Key: *to nearest 50.

SSSIs have been designated in all the inner Firths of the region, affording seals a measure of indirect protection. In particular, the Cromarty Firth SSSI is designated with particular reference to the common seal haul-out there. Indirect protection may also be afforded to the breeding site at Rattray Head by virtue of the RSPB reserve there.

5.14.4 Information sources used

In general, common seals are surveyed in August during their annual moult, when the greatest and most consistent numbers of seals can be counted. The coast from Cape Wrath to Duncansby Head was surveyed by SMRU in August 1991 and from Duncansby Head to Dornoch, including Stroma, in August 1993, as part of a survey of common seals around Scotland. Rocky shore sites such as these are surveyed regularly from a helicopter using a thermal imaging camera. Boat and ground surveys of both species of seals in the Inner Moray Firth, from Loch Fleet to Findhorn Bay, are conducted regularly between June and August, since 1987, by the Lighthouse Field Station, Cromarty, University of Aberdeen (Thompson *et al.* 1994). SMRU also conduct aerial surveys of this area, using conventional aerial photography from a fixed-wing aircraft, in August of alternate years.

Grey seal population estimates are based on pup production data because the numbers of grey seals at haul-out sites outside the breeding season are unpredictable and can vary greatly from day to day. For comparability with



Map 5.14.2 Grey seal pup production. Size of circle represents the number of pups born along the section of coast. Numbers refer to locations in Table 5.14.3. Sources: Sea Mammal Research Unit, University of Aberdeen, SOAEFD.

regions elsewhere in Great Britain, the information supplied here refers mainly to grey seal numbers and their distribution during the breeding season. Conventional aerial photographic surveys of grey seal breeding colonies round Loch Eriboll and on Stroma are conducted annually by SMRU, and boat surveys of breeding sites on the Helmsdale coast are conducted in alternate years jointly by SOAEFD, Aberdeen University and SMRU, as this stretch of cliff-bound and cave-ridden coast is unsuitable for aerial photography. Pup production is estimated using counts from boat surveys plus some aerial photographs. SOAEFD monitor the haul-out site at Catterline monthly. The Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD) holds information about licences to kill seals.

Table 5.14.3 Grey seal pup production and important haul-out sites

Site no.	*Site*	*Grid ref.*	*Main breeding site*	*Important haul-out site*	*No. of pups born**
1	Cape Wrath	NC315745		✓	None
2	Loch Eriboll	NC482625 - NC540682	✓		700
3	Stroma	ND355775	✓		650
4	Helmsdale Coast	ND030150 - ND125231	✓		250[1]
5	Dornoch Firth	NH825865		✓	None
6	Ardersier	NH785585		✓	None
7	Halliman Skerries	NJ202720		✓	None
8	Pennan Head	NJ870660		✓	Not known
9	Rattray Head	NK110580		✓	Not known
10	Catterline	NO870780		✓	Not known

Sources: SMRU, SOAEFD, University of Aberdeen (Lighthouse Field Station, Cromarty). Key: *to nearest 50; [1]pup production estimated from single count. Note: site numbers refer to Map 5.14.2.

5.14.5 Acknowledgements

Thanks are due to Leslie and Paul Burren; Dave Clem and PLM Helicopters; Paul Thompson, Jacky Houseman and Graham Pierce of Aberdeen University; Noel Smart of Joseph Johnston & Sons Ltd.; Bob Davis and Brian Lightfoot of SNH; John Hislop of SOAEFD; and Jim Dunbar of the RSPB, for kindly providing information. Thanks also go to Paul Thompson, John Hislop (SOAEFD), Mark Tasker (JNCC) and Ailsa Hall (SMRU) for commenting on the manuscript, and to John Barne, JNCC, for facilitating the gathering of this information.

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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 Highland Region	*SNH, North-west Region, Inverness, tel: 01463 239431
Seals in Grampian Region	*SNH, North-east Region, Aberdeen, tel: 01224 642863
Seals at Rattray Head	The Warden, Loch of Strathbeg RSPB Reserve, The Lythe, Crimongate, Lonmay, Fraserburgh AB43 4UB, tel: 01346 532017
Seals in the Inner Moray Firth	University of Aberdeen, Department of Zoology, Lighthouse Field Station, George Street, Cromarty IV11 8YJ, tel: 01381 600548
Seals and fisheries	SOAEFD Marine Laboratory, Victoria Road, Aberdeen AB9 9DB, tel: 01224 876544
Seals in Scotland	*Scottish Wildlife Trust, Edinburgh, tel: 0131 312 7765

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

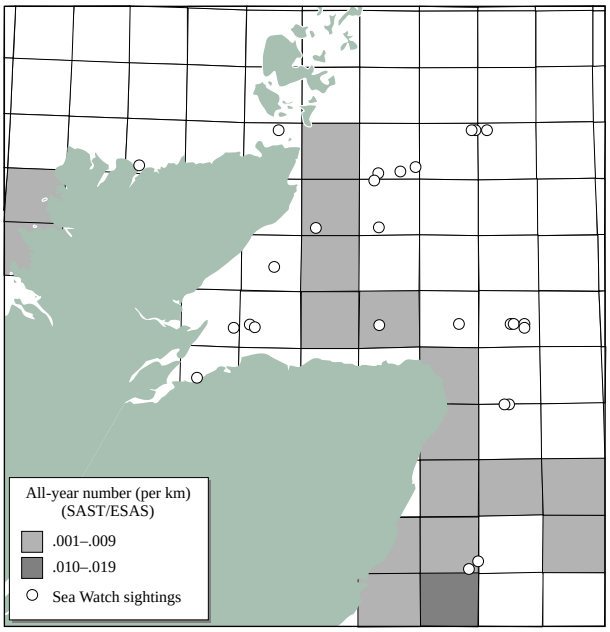
5.15 Whales, dolphins and porpoises

Dr P.G.H. Evans

5.15.1 Introduction

The region is comparatively rich in cetaceans (whales, dolphins and porpoises), with over 30% (eight out of 26 species) of the UK cetacean fauna recorded regularly since 1980. The commonest species in nearshore waters (within 60 km of the coast) are the harbour porpoise *Phocoena phocoena* and bottlenose dolphin *Tursiops truncatus*, then minke whale *Balaenoptera acutorostrata* and white-beaked dolphin *Lagenorhynchus albirostris*. White-sided dolphin *Lagenorhynchus acutus*, killer whale *Orcinus orca* and long-finned pilot whale *Globicephala melas* occur mainly offshore, with Risso's dolphin *Grampus griseus* recorded most often in the Pentland Firth north to Orkney. The Moray Firth is of national importance for its bottlenose dolphin population of between 100 and 200 individuals (although precise numbers are difficult to determine, since the extent of movement in and out of the region is not well known); some individuals are present in several months of the year (Wilson *et al.* 1994; Lewis & Evans 1993). The only other resident population of this species known for Britain occurs in Cardigan Bay (west Wales - Region 12), although the species has also been recorded repeatedly since 1992 off south-west England (Regions 9, 10 and 11), and there are sizeable populations around Ireland. 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 (SACs - see also section 7.2).



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

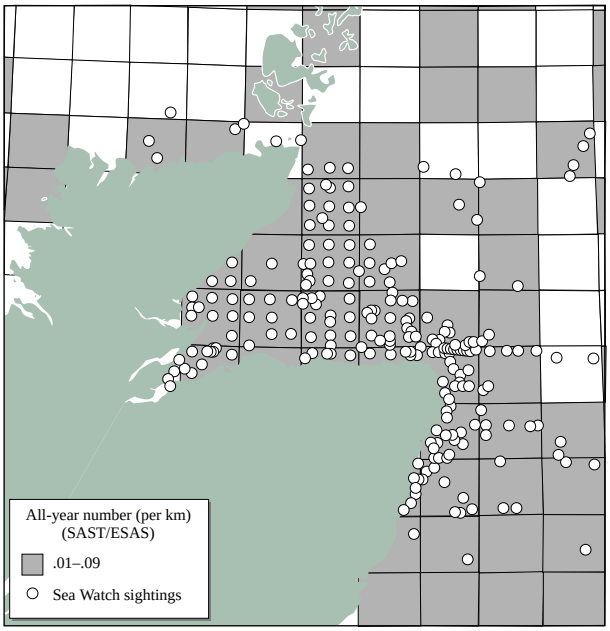
5.15.2 Important locations and species

Table 5.15.1 lists the species resident or regularly occurring in Region 3. Other cetacean species recorded in the region include humpback whale *Megaptera novaeangliae*, sperm whale *Physeter macrocephalus*, beluga *Delphinapterus leucas*, northern bottlenose whale *Hyperoodon ampullatus*, Sowerby's beaked whale *Mesoplodon bidens*, common dolphin *Delphinus delphis*, striped dolphin *Stenella coeruleoalba* and the false killer whale *Pseudorca crassidens*.

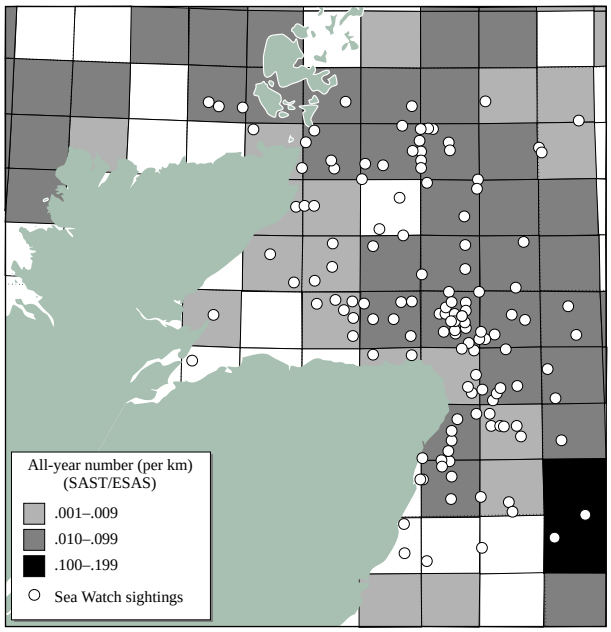
Currents passing through sounds and around headlands tend to bring in cetacean prey such as herring (Richardson *et al.* 1986b). Such topographical features in this region include prominent headlands at Cape Wrath, Strathy Point, Dunnet Head, Duncansby Head, Noss Head, Tarbat Ness, Chanonry Point/Fort George, Kinnaird Head, Rattray Head and Peterhead. In addition, strong tidal currents flow into the Dornoch, Cromarty, Inverness and Beauly Firths from the shallow basin of the Moray Firth, while the Pentland Firth has one of the strongest tidal currents in the UK. Several of those areas are favoured by cetaceans (Evans

Table 5.15.1 Cetacean species recorded in the region

Species	*Status, distribution and seasonal occurrence*
Minke whale	Small numbers offshore in the northern North Sea, coming closer to the coast off north Scotland and into the Moray Firth, particularly between July and October
Harbour porpoise	Fairly common in nearshore waters throughout the region; sightings mainly between July - February
Bottlenose dolphin	Common in nearshore waters of the Moray Firth, particularly at the entrances to Cromarty Firth (around North & South Sutors), Inverness Firth (Chanonry Point & Fort George), and Beauly Firth (North & South Kessock); sightings all year, mainly July - October.
White-sided dolphin	Deep water species: mainly more than 10 km from the coast, and only rarely in nearshore waters, generally between July and September
White-beaked dolphin	Most common dolphin off the north coast of Scotland and offshore in the northern North Sea; sightings mainly between June and September (particularly August)
Risso's dolphin	Annually, mainly off the north Caithness coast and in the Pentland Firth, between April and September (mainly after July)
Killer whale	Annually in the northern North Sea, mainly between June and September, occasionally coming close to the coast anywhere in the region
Long-finned pilot whale	Common and widely distributed offshore in the northern North Sea throughout the year, occasionally coming into coastal waters; sightings mainly between June and January



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



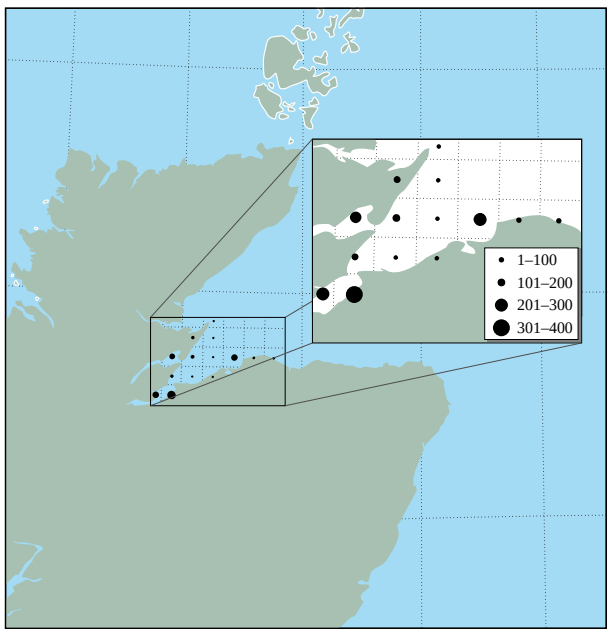
Map 5.15.3 Minke whales: all-year number sighted per kilometre of Seabirds at Sea survey (source: JNCC: SAST/ESAS); and sightings reported to the Sea Watch sighting system (source: Evans (1992)).

1992; Lewis & Evans 1993). High primary productivity exists between Dunnet Head and Rora Head, Hoy; north-east from Noss Head, Wick; and from Kinnaird Head north-eastwards and then south, between 30-54 km off the Aberdeen coast (Pingree & Griffiths 1978; Richardson *et al.* 1986a) and may help account for cetacean sightings in these areas.

Harbour porpoises are fairly common throughout the year in the nearshore waters between Cape Wrath and Faraid Head, around Dunnet Head and Dunscansby, and in the Pentland Firth, with greatest numbers between July and October (Map 5.15.1). When mackerel shoals move towards the coast during late summer (July - September), white-beaked dolphins may occur nearshore in large numbers (Map 5.15.2). Minke whale (July - October), Risso's dolphin (July - September), killer whale (June - September) and long-finned pilot whale (November - January) are regularly observed in the more easterly of these locations. Harbour porpoises are widely distributed in the offshore waters of the Outer Moray Firth, with peak numbers occurring between July and October; minke whales also occur here regularly (Map 5.15.3), particularly between July and October.

A community of bottlenose dolphins is resident in the region, particularly frequenting nearshore waters around the Sutors of Cromarty at the entrance to the Cromarty Firth, Chanonry Point and Fort George at the entrance to Inverness Firth, and North and South Kessock at the entrance to Beauly Firth (Map 5.15.4). Numbers recorded are highest between May and September. Harbour porpoises are also present in the Inner Moray Firth in small numbers throughout the year, but with peak numbers between July and November. Evidence has recently been collected confirming that some bottlenose dolphins cause physical injury to harbour porpoises in the Moray Firth (Ross pers. comm.). Between July and October, minke whales are also reported entering the central portion of the Inner Moray Firth.

Along the Grampian coast (Nairn to Montrose) harbour porpoises are present throughout the year, with peak numbers between July and February. Bottlenose dolphins are recorded at several localities along the coast, such as in the vicinity of Findhorn Bay, Burghead, Lossiemouth and Portnockie. Most sightings and largest groups have been between July and October, but there has been relatively poor survey coverage in this area in winter. White-beaked dolphins are also seen occasionally close to the coast, but are more common offshore, with largest numbers seen between July and September.



Map 5.15.4 Distribution of bottlenose dolphins in the Moray Firth 1990-1992. Number of sightings per 1,000 km travelled (from dedicated cruises). Source: Evans (1992).

5.15.3 Human activities

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

Cetaceans in the region face three 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 and the increasing number of boat-based dolphin watching trips). Set net fisheries for salmon exist all around the Moray Firth and Grampian coasts, and these are reported occasionally to capture both harbour porpoises and bottlenose dolphins (Northridge 1988; Sea Watch unpublished data). Gill netting, pair-trawling and seining all take place in the region and result in a cetacean by-catch (mainly harbour porpoise, white-beaked dolphin and white-sided dolphin), although no details exist of numbers taken (Northridge 1988).

Contaminant levels in cetaceans from the region are relatively low. Mean total PCB (25 congeners) levels of 24 harbour porpoises sampled from eastern Scotland (Berwick-upon-Tweed to Strathy Point, Caithness) in 1988-92 amounted to 4 ppm (Kuiken *et al.* 1994). Possible causes of skin lesions present on individual Moray Firth bottlenose dolphins are untreated sewage, pathogens and toxic compounds (Thompson & Hammond 1992).

Recreational activities (speedboats, jet skis etc.) near localities such as Fortrose and Inverness pose threats of direct physical damage from collisions and disturbance from the high frequency (>1 kHz) noise generated by these vessels (Evans *et al.* 1992). Heavy shipping may also disturb cetaceans. Sound frequencies produced by ships' engines overlap those used by cetaceans, particularly baleen whales (Evans 1987) but also dolphins and porpoises when propellers are damaged. Evans *et al.* (1992, 1994) have reported negative responses (vessel avoidance and increased dive times) to such sounds by both bottlenose dolphins and harbour porpoises. Other underwater sounds from seismic activities (connected with oil and gas exploration in the North Sea) involve lower frequencies and are therefore most likely to affect baleen whales, which communicate primarily at these frequencies (20-500 Hz), although Baines (1993) reported a possible temporary effect on the presence of porpoises around Strumble Head, Dyfed (Region 12). A dolphin awareness scheme with a code of conduct and a boat operators accreditation scheme have been produced by Scottish Natural Heritage for the Moray Firth. A code of conduct for boat users has been produced by Seawatch Foundation & UK Mammal Society (Seawatch Foundation & UK Mammal Society 1992).

5.15.4 Information sources used

Information on cetacean status and distribution comes primarily from the national sightings database (1973-present) maintained by the Sea Watch Foundation (SWF) and the strandings scheme organised by the Natural History Museum, London (1913-present), run within Scotland by SAC Veterinary Investigation Centre, Inverness. Systematic land-based watches have been carried out by members of Friends of the Moray Firth, Tain Field Club and other volunteers contributing to the Sea Watch monitoring scheme. Offshore effort-related data have been collected since 1989 during bottlenose dolphin studies in the Greater Moray Firth by B. Wilson and P. Thompson from Aberdeen University Field Station, Cromarty (Wilson *et al.* 1994); between 1989-1992 by P.G.H. Evans from Oxford University (Lewis & Evans 1993); as part of seabird surveys of the North Sea by JNCC's Seabirds at Sea team, mainly between 1979 and 1986 (Northridge *et al.* 1995); by the RSPB, between 1982 and 1983 (Mudge *et al.* 1984); and by various merchant vessels and sailing boats contributing to the Sea Watch monitoring scheme. Coverage is generally better in nearshore waters than offshore, particularly in the Inner Moray Firth, with effort highest between April and September, when sea conditions also tend to be best. Strandings and sightings data, while helpful in providing some indications of current status of populations, their distribution and migration patterns, do not as yet allow any definite statements to be made about any species.

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

5.15.5 Acknowledgements

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
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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 Branch, JNCC Aberdeen, tel: 01224 655700
SCANS Project	*European Wildlife Division, Department of the Environment, Bristol, tel: 0117 987 8000
Cetacean strandings, Scotland	Henry Ross, Scottish Strandings Coordinator, SAC Veterinary Services, Drummond Hill, Inverness, tel: 01463 243030
Cetacean organochlorine & heavy metal levels	*Dr R.J. Law, Directorate of Fisheries Research, MAFF Fisheries Laboratory, Burnham-on-Crouch, tel: 01621 782658
Bottlenose dolphin studies	Dr P. Thompson/M. Wilson, University of Aberdeen, Department of Zoology, Lighthouse Field Station, George Street, Cromarty IV11 8YJ, tel: 01381 600548
Conservation issues facing cetaceans in Moray Firth	Lynn & Peter Macdonald, Friends of the Moray Firth, 4 Craig View, Findochty, Grampian Region, tel: 01542 833867
Cetacean pathology	Dr J.R. Baker, Veterinary Field Station, 'Leahurst', Neston, Wirral, Cheshire L64 7TE, tel: 0151 794 6120

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

Chapter 6 History and archaeology

A. Gale & V. Fenwick

6.1 Introduction

The physical remains of the human past - archaeological evidence - are an integral and irreplaceable part of the coastal resource. Archaeological sites, whether discrete or part of wider landscapes, are fragile, and those not yet located can unwittingly be destroyed. The distribution of known sites is biased by the uneven spread of survey work, and the discovery and scientific investigation of new sites is vital to developing a full picture of the past. This chapter provides an introduction to the archaeology of the region, 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.

This region lies closer to the coast of Norway than to London. Sea communication with Scandinavia, the Baltic and northern Europe is a constant backdrop to its archaeology and history. The physical barriers to inland communication have sustained the remoteness and individuality of many areas. Additionally, areas not suited to modern agriculture or development have preserved archaeological sites. These range from extant and ruined structures, such as castles or prehistoric enclosures and buildings, to scatters of flint tools and the waste from their fabrication. Many sites are buried or survive only to ground level, and some are known only from documentary sources or aerial photographs. In general, visible monuments are made of stone or earth, and it is only excavation that reveals the degree to which timber was used.

Changes in the coastline can distort the original relationship of sites to the sea. In about 1720, for example, a storm sealed the entrance to Rattray, ending its life as a port and forming the Loch of Strathbeg. The processes of coastal change mean that the intertidal zone now encompasses sites originally on dry land, such as the Iron Age brochs (stone towers) at Keiss. Other sites are functionally specific to the intertidal area. These include the 20th century anti-tank blocks that are a feature of low-lying sandy coastlines, such as the southern end of Sinclair Bay, stone fish traps and, from Portsoy southwards, post-Medieval saltworking sites, which used rock-cut tanks for collecting seawater.

Complex changes in sea and land level mean that palaeo-environments may be discovered both on land and in the sea. These landscapes of history and prehistory can be preserved under mobile sand dunes or beneath marine sediments. They are commonly exposed as peat or submerged forest by erosion in the intertidal zone of estuarine areas. The sea bed has, therefore, the potential to contain many sites of a terrestrial nature.

Shipwreck sites are, however, the most numerous known sea-bed sites. Written accounts show that the hazards of this region caused thousands of shipwrecks. Records of losses, which show the potential for ship sites to be found, are comprehensive for the 19th century, relatively complete for the 18th, and patchy for the 14th to 17th centuries. For earlier periods it is necessary to examine documentary evidence for sea-borne trade and extrapolate the opportunities for ship losses by considering the hazards to navigation. This process has then to be extended into the prehistoric period by looking at archaeological evidence for trade and seafaring.

Map 6.1.1 Archaeology: locations mentioned in the text.

6.2 History and archaeology of the region

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

During the last Ice Age Scotland was covered by massive ice sheets, which depressed the land. Lower sea levels meant that large areas of the present North Sea were dry land. By *c.* 12,000 BP the ice had cleared, but there is no evidence for the presence of groups of Mesolithic hunter-gatherers until 7-6,000 BP. Their flint and bone tools are found mainly on the coast, for example in the sand dune systems of Forvie. The present coastline was created *c.* 6,500 BP by the uplift of land relieved from the weight of ice-sheets. The previous coastline and evidence of habitation may, however, have been submerged during a marine transgression some 2,000 years earlier (Woodman 1989). A flint implement, possibly related to such a land surface, has been recovered from the North Sea.

The introduction of farming techniques - the cultivation of barley and wheat and animal husbandry - has been attributed to Neolithic incomers from north-west Europe *c.* 6,000 BP. Evidence of farming has come from excavated sites such as Boghead Mound, Fochabers, Grampian. However, the most commonly identified sites of this period are burial monuments. The Clava Cairns of Inverness-shire have given their name to a type of burial chamber unique to Scotland, while Grampian has Britain's prime examples of recumbent stone circles, a form of monument that also played a part in funerary practices. Parallels have been drawn firstly between stone monuments of Highland Region and south-west Scotland, and secondly between those of Grampian and eastern England. Although these standing funerary or ritual monuments can suggest aspects of cultural differentiation in the Neolithic population, only the excavation of reduced or buried sites, such as that of a timber hall at Balbridie near Banchory, can provide evidence of domestic buildings and life.

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

While there are many agricultural settlements located on the upland areas of Sutherland and Inverness-shire, burial monuments remain the most commonly known type of site from the Bronze Age. In addition, well-preserved rows of small standing stones, such as those at Clyth, Yarrows and Garrywhin, are a special feature of Sutherland and Caithness, not found elsewhere in Scotland. Metal and ceramic artefacts hint at the cultural links of the communities, by demonstrating contact overseas, with Ireland and the Netherlands.

Iron became a utilitarian material from *c.* 600 BC. It is possible that a reduction in the area of cultivated land coincided with adoption of defended settlements. To the north of the Moray Firth, brochs (stone towers) predominate, such as at Dun na Maigh. Brochs, with limited internal space, are believed to have provided secure strongholds for small, possibly family, groups. To the south, such as at Cullykhan, promontory forts built of stone on a timber framework are the norm. These larger enclosures may have been used by tribal groupings.

6.2.3 The Roman and early Medieval periods

The province and militarised zone of Roman-occupied Britain lay well to the south, and Roman activity in the far north of Scotland was confined to brief campaigns. A line of marching camps extended up the eastern coastal plain at least as far as Keith. Supplies and arms were brought up by the accompanying fleet, which circumnavigated Britain. However, despite achieving a great military victory, a full occupation did not follow. Although there seems to have been little impact on the native population in this region, artefacts from settlements suggest exchange with the Roman territories, probably by sea (Robertson 1970).

From the 3rd century the seafaring and naval battles of the tribes known as Picts are recorded. Their story has been deduced from the incomparable legacy of their stone carvings; the names of kings and battles; and their links with Christianity in Ireland, the Kingdom of Dalriada in Strathclyde, and Northumbria (Close-Brooks 1986). Their submission to Scottish domination may have been hastened by the threat of Norse raids, which began in the 8th century.

Archaeological evidence for Pictish and Norse settlements is scarce, with rare excavation opportunities occurring at Huna, Freswick and Keiss. The large and strategically placed promontory fort at Burghead became a centre of Pictish power, perhaps with an anchorage for fleet operations. Continuity of occupation is similarly apparent at Cullykhan, which remained in use up to the Medieval period. The small castle known as the Old Man of Wick is of Norse construction.

Christian sites are often associated with the voyages of early saints, for example St. Mary's Chapel, Crosskirk, and St. Drostan's Chapel, Tain. Carved cross slabs include examples at Farr, Creich, Edderton, Shandwick, Nigg and Rosemarkie.

6.2.4 Medieval period

Norse control of the Caithness area was maintained from Orkney. Local chieftains continued to use strategic coastal sites, from the late 13th century constructing their characteristic tower houses or castles. The Scottish kings, however, gradually extended their domination during the 12th and 13th centuries, completing the unification of their territory by the early 14th century. They granted rights to create burghs, or towns, which despite their small size became the pivots of commercial activity (Simpson 1972). Banff, Portsoy, Peterhead, Spynie and Aberdeen all engaged in continental trade. Some burghs were failures; for instance Rattray and Spynie were cut off from the sea by silting.

6.2.5 Modern times

In the late 17th century larger fishing boats with greater range provided a stimulus for a Scottish-based industry. Fishing bases were established at, for example, Portknockie (1677) and Findochty (1716). Special ice-houses were built, as in Spey Bay at the mouth of the most important salmon river. The Highland Clearances of the 18th century and associated investment further shaped the settlement of the region. As an alternative to crofting, fishing was seen to provide both a means of subsistence and an opportunity for industry. The population was moved to new villages such as Lybster and Embo. The British Fisheries Society created a number of new towns in Scotland, and it was under their auspices in 1803 that Telford built a new harbour at Wick, which provided the only shelter between Scrabster and Cromarty.

New industries and agricultural improvement created a demand for shipping. Stone, slate and ironstone were quarried for export and local use. Granite exported from Aberdeen was used for major engineering works, such as harbour and dock construction at Newcastle-upon-Tyne and Hull. In 1825 exploitation of Old Red Sandstone in Caithness was facilitated by the construction of a harbour at Castlehill. Thurso was also active in this trade. Land improvement required the import of coal to burn lime and to fire clay pipes for use as land-drains, and dung, bark, bones and guano were applied as fertilisers.

The east coast was traditionally active in trade with Scandinavia and the Baltic. The establishment of linen mills created a new demand for flax, alongside the iron and timber products from that region. Despite these new demands the bulk of Scottish trade remained coastal. Fishing boats were often the chief beneficiaries of small harbour works. The industry was important to larger ports such as Aberdeen. Albert Basin, which still harbours the fishing fleet, was created by training the River Dee in the 1870s and 80s, and a fishmarket was built in 1888. The increased amount of shipping had prompted the creation, in 1786, of the Northern Lighthouse Trustees, to establish lighthouses. Cape Wrath (1828), Dunnet Head (1831) and Girdle Ness (1833) were among the early works of Robert Stevenson (Mair 1978).

The region continued to be of strategic importance in the 20th century. Pill boxes and anti-tank blocks on gently shelving beaches are a reminder of this. Loch Eriboll provided deep anchorage for the Home Fleet in the 1914-1918 and 1939-1945 wars. The Naval Base at Invergordon closed only in 1956. In the latter decades of this century oil and gas exploitation has provided a new stimulus to maritime activity. In time this, too, will form part of the archaeological landscape.

6.3 Human activities

6.3.1 Integrated management

Highland Council are progressing integrated coastal zone management initiatives (see also section 10.3.4). A project to plot the maritime archaeology of the region's coast is one element of the integration of archaeology with other planning and management concerns. The provision for visitors has afforded interpretation and management opportunities for diverse sites, such as the clearance village of Badbea and the sandstone-quarrying complex at Castletown.

6.3.2 Activities and processes affecting the archaeological resource

It is important to remember that the resource does not consist entirely of discrete sites such as intact wrecks. Many sites are scattered and palaeo-environments can be extensive, stretching across terrestrial, intertidal and subtidal zones. In areas that have not received intensive archaeological survey it is vital to recognise the archaeological potential of environments in which preserved remains might be anticipated. Nationally, Historic Scotland has identified coastal erosion as a prime threat to archaeological sites (Ashmore 1994).

New development can affect archaeological sites. Studies such as the Moray Firth Review (Harding-Hill 1993) identified activities that require shoreline installations. These include aggregates and mineral extraction, oil and gas exploitation, shipping, and military uses. The effects on the archaeological resource of these and other developments, such as sewage outfalls, that cross the intertidal zone have yet to be evaluated. Change of site use can have implications for the retention and maintenance of historic maritime features. For instance, a study commissioned by Highland Regional Council found that the majority of fishing harbours, predominantly of 18th or 19th century construction, are functioning below capacity and now serve the recreation market (Groome 1994).

Rural land use also has implications for archaeological sites. Effects can be mitigated by cooperation between land-users and archaeologists. The regulation of afforestation has created opportunities to enhance the presentation of the archaeological resource (Highland Regional Council 1992).

Few sub-tidal sites have been surveyed and so it is difficult to gauge the influence that activities may have on the archaeological resource. Clearly some activities may directly damage or destroy sites, for example salvage diving, dredging for navigation or aggregates, ship wash or the use of fishing gear that is in contact with the sea bed. Chemical or physical changes to the sea bed or water column may also alter the equilibrium of remains that are in a sensitive state of preservation.

6.3.3 Protection of sites, monuments and wrecks

In this region, three statutory designations have been applied to protect *in situ* remains of archaeological or historic importance. The Ancient Monuments & Archaeological Areas Act 1979 (AMAA) provides for Scheduled Ancient Monuments (SAMs), and the Planning (Listed Buildings and Conservation Areas) Act 1990 provides for Listed Buildings and Conservation Areas.

There are published lists of criteria for determining the national importance of a monument (Scottish Office Environment Department 1994b). The AMAA definition of a monument includes sites both on land and in UK territorial waters, including remains of vehicles, vessels and aircraft. Prior written consent is necessary from Historic Scotland for any works that will destroy, damage, repair or remove such a monument. Scotland has precedents for scheduling underwater remains and there is no bar to using this designation for wreck sites in order to cater for visitor access while providing protection (N. Fojut pers. comm.). In practice, however, in this region scheduling has only been applied above low water mark.

The numbers of coastal Scheduled Ancient Monuments in the region and nationally are given in Table 6.3.1. Current review programmes are increasing the numbers of Scheduled Monuments in Britain; in Scotland the increase is around 300 monuments per year. Scheduled Monuments represent only a small number of the total known archaeological sites. Sites and Monuments Records - archaeological databases maintained at regional level - are a key source of information on sites of local and regional significance.

Buildings considered of special architectural or historic importance may be Listed. There is now a presumption against the destruction of Listed Buildings, and consent is required prior to any demolition, alteration or extension. Listed Buildings in the region include maritime structures such as warehouses and lighthouses. Conservation Areas

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

Area	*No. of SAMs in region*
Caithness	225
Sutherland	103
Banff & Buchan	46
Aberdeen	14
Gordon	8
Kincardine & Deeside	36
Moray	26
Inverness	31
Ross & Cromarty	126
Region 3	***615***
Scotland (whole country)*	5,300
GB (whole country)	21,000

Sources: Breeze (1993); Historic Scotland (1995). Note: except where marked*, totals are of all sites occurring in 10 km x 10 km squares of the national grid that include sea, as shown on Ordnance Survey 1:50,000 series maps.

are usually applied to urban areas to protect the historic environment. However, Hill of Warehouse/Yarrows, Caithness, a fossilised landscape, has been recommended for designation as a Rural Conservation Area (Highland Regional Council 1990).

Shipwrecks of archaeological or historic importance can be designated under the Protection of Wrecks Act 1973, although the Act has not been used in this region (Archaeological Diving Unit 1994). Fewer than 45 wrecks have been designated for the whole of Britain, and their distribution cannot be accepted as a reasonable guide to the total sea-bed resource. Information on shipwrecks in the region is contained in the Sites and Monuments Record (SMR) for Highland and in the National Monuments Record (Maritime Section) for Scotland, maintained by the Royal Commission on the Ancient and Historical Monuments of Scotland.

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 the survey and inventory of archaeological sites. It maintains an index of terrestrial sites as part of its National Monuments Records Scotland (NMRS). In 1992 new Royal Warrants extended their remit to the territorial seas. The Commission has established NMR Maritime Sections. It is also the lead agency responsible for the local databases or archaeological sites known as Sites and Monument Records (SMRs), maintained by local Councils, whose archaeologists fulfil a curatorial role in respect of archaeological sites. This is achieved primarily through the planning system, but responsibility is also taken for other aspects of management and interpretation.

The Scottish Institute for Maritime Studies at the University of St. Andrews is the only formally constituted academic department in Scotland concentrating on maritime heritage. It undertakes and supervises research and is involved in fieldwork. The Scottish Trust for Underwater Archaeology is a charitable body that aims to further the study of sunken settlements and drowned landscapes. It is involved in education, research and survey.

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 Environment Department 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". Specific guidance is also available on the treatment of SAMs within the planning system (Scottish Office Environment Department 1994b). Archaeology is also one of the considerations for significant developments when Environmental Assessment is required under the Town & Country Planning (Environmental Assessment) (Scotland) Regulations 1988.

Planning decisions should take into account the more detailed policies which appear in Development Plans. The Structure Plans for Highland and Grampian include general archaeological policies. In addition, the commitment in Highland to prepare a regional Conservation Strategy includes a re-assessment of the heritage resource and its conservation value. Further information related to archaeology appears in a variety of policy documents, guidelines and management plans. For example, the former Highland Regional Council's *Indicative forestry strategy and survey* (Highland Regional Council 1992) describes the consideration that should be give to archaeological sites and their settings, and the benefits of integrating forestry development with reconstruction of historic landscapes.

To seaward of low water mark there is a sectoral approach to development control, although many functions fall within the remit of the Scottish Office. Regulation, including the need for Environmental Assessment, is divided between a range of government departments and agencies. Until recently consideration of archaeology was precluded by the dearth of information on the extent of the resource and the absence of a management structure in the subtidal zone. However, growing awareness of marine archaeology and the development of the NMRS Maritime Section should encourage closer consideration of the marine resource. Seabed developers can now obtain guidance from a *Code of practice for seabed developers* (Joint Nautical Archaeology Policy Committee 1995).

6.3.6 Reporting archaeological information

The Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS) and the 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 Building Control Departments of local authorities.

In Scotland the combination of laws on Treasure Trove and *Bona Vacantia* ('lost property') means that, in effect, all antiquities found on land can be claimed by the Crown (Longworth 1993). "It is important to report anything that might be claimed. Some things should always be reported: objects and coins of gold and silver, and other hoards of coins and things, in pots or loose" (National Museums of

Scotland undated). Reports should be made to a museum, the police or the Procurator Fiscal. The Treasure Trove Panel advises the Crown as to which items should be claimed as Treasure Trove. It also advises to which institution they should go and the reward to be made to the finder. Further advice is available from the National Museums of Scotland.

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 what museum they should go (Historic Scotland 1994).

The Merchant Shipping Act 1894 requires any recovered wreck to be reported to the Receiver of Wreck. Wreck is now defined as any ship, aircraft or hovercraft or parts of these, their cargo or equipment, found in or on the shores of the sea, or any tidal water. The Receiver provides advice and supplies forms for reporting recovered wreck. These include a form which finders may use to volunteer to the 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. Finders are often allowed to keep unclaimed wreck in lieu of a salvage award. There is a policy of offering unclaimed wreck of historic, archaeological or artistic interest to registered museums. During the statutory year, such items may be lodged with an appropriate museum or conservation facility with suitable storage conditions. The responsibility of the Receiver to the finder, with regard to salvage awards, remains regardless of the historic character of the wreck.

6.4 Information sources

6.4.1 Information gathering and collation

Caithness has been the subject of an early coastal survey in which a 100 m strip of coastal land was fieldwalked. This doubled the number of recorded archaeological sites (Batey 1983). A review of coastal survey in 1993 showed that there had been little further specifically coastal work (Ashmore 1994), and terrestrial survey is known to have focused primarily on Caithness and Sutherland (Highland Regional Council 1990). Some coastal sites have been covered incidentally by surveys such as those by RCAHMS in advance of afforestation.

In 1994 Highland Regional Council completed a six month project to create a foundation maritime SMR (Groome 1994). This addressed both the intertidal area and the sea bed and drew on archives, museums, the Wreck Index of the Hydrographic Department, and information from dive clubs and local researchers. The Wreck Index had already built up detailed records for shipwrecks in the Pentland Firth. Published works for other areas indicate the archaeological potential of the region's coast. It has been estimated, for example, that around 1,200 shipping casualties occurred between Duncansby Head and Tod Head, with concentrations in the approaches to Aberdeen and Wick and on the lee shore of north-east Aberdeenshire (Ferguson 1991).

RCAHMS has compiled an initial Maritime Section for the NMRS. This has drawn on entries within the Wreck Index of the Hydrographic Department, which is maintained as an aid to publishing Admiralty Charts for navigation. The index contains mainly metal wrecks that stand proud of the sea bed and which have been identified by remote sensing, as well as 'last position' reports of 20th century shipping casualties. A total of 206 records for Highland Region and 192 for Grampian have been transferred to the NMRS Maritime Section. RCAHMS will develop their records using documentary accounts of ship losses and reports from field observations.

6.4.2 Acknowledgements

Thanks are due to the staff of all the organisations mentioned in the text who gave their time to provide information. I am also indebted to Deanna Groome (Project Officer, Highland Region Maritime Project) for detailed information.

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Shepherd, I. 1986. *Exploring Scotland's heritage, Grampian.* Edinburgh, RCAHMS, HMSO.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Scotland: 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 S015 1EG, tel: 01703 329474
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
Grampian SMR	Regional Archaeologist, Economic Development and Planning Department, Aberdeenshire Council, Woodhill House, Westburn Road, Aberdeen AB9 2LU, tel: 01224 664723
Highland SMR	Regional Archaeologist, Department of Libraries & Leisure, Highland Council, The Old School, High Street, Clachnaharry, Kinmylies, Inverness IV3 6RB, tel: 01463 711176
Maritime archaeological survey	The Secretary, Scottish Institute for Maritime Studies, University of St. Andrews, St. Andrews, Fife KY16 9AL, tel: 01334 462916

Smoo Caves, at the head of Smoo Geo, Cape Wrath, are only one of a host of stunning natural features on a coast protected for much of its length by a variety of landscape and nature conservation designations, including Area of Great Landscape Value and Preferred Conservation Zone. Photo: Keith Hiscock, JNCC.

Chapter 7 Coastal protected sites

R.G. Keddie

7.1 Introduction

7.1.1 Chapter structure

This chapter incorporates statutory and non-statutory site protection mechanisms operating at international, national and local level, including those administered by voluntary bodies and other organisations who own land. It covers only the various types of site protection mechanisms currently found within this region, giving a brief explanation for each category. For the purposes of this chapter, any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as 'coastal'. Where a site straddles the boundaries of two Coastal Directories Project regions and there is no easy way of calculating the percentage of the site lying in each, the site area has been halved, one half being included in each region. Data included in this section are correct as at August 1995, unless otherwise stated.

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

Further explanation of the various site protection mechanisms can be found in Davidson *et al.* (1991). Planning Policy Guidance Note (PPG) 9 - Nature Conservation (DoE 1994) also gives useful summaries of existing site protection mechanisms. It sets out the Government's objectives for nature conservation and provides a framework for safeguarding the natural heritage under domestic/international law, emphasises the importance of both designated sites and undesignated areas for nature conservation, advises that potential Special Protection areas (SPAs) and candidate Special Areas of Conservation (SACs) should be treated similarly to classified SPAs and designated SACs, and deals with the treatment of nature conservation issues in development plans. It also includes copies of the Ramsar Convention, the EC Birds Directive and the EC Habitats & Species Directive (including lists of important species and habitat types). The statutory framework for site protection is set out in the Habitats etc. Regulations 1994.

The following types of protected site have not been included in this chapter:

- archaeological designations and protected sites (covered in Chapter 6);
- 'Sites of Importance for Nature Conservation' (SINCs), a general term for the variously-named non-statutory sites identified by local authorities and wildlife trusts as having special local value for nature conservation but not currently managed for nature conservation; in this region the most commonly used term is Site of Nature Conservation Importance. For more information, see Collis & Tyldesley (1993).

Non-site based measures contained in conventions and directives aimed at broad species and habitat protection, such as in the Bonn Convention, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), parts of the EC Birds Directive and parts of the EC Habitats & Species Directive, are also not covered. For further information on these, 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 statutes are discussed in section 7.3, whereas section 7.4 covers sites without statutory protection but which are identified, owned or managed by statutory bodies; and finally, other types of site (i.e. those identified, owned or managed by charities, trusts etc.) are described in section 7.5. For each category of protected site, a list of coastal sites is given (clockwise around the coast), showing their type, area/length and location, with an accompanying map. Each section concludes with further information sources and contact points relevant to the region.

7.1.2 Importance of the region

The region contains a large proportion by area of Britain's Woodland Trusts properties (49%) (due to the presence of one large site), Biogenetic Reserves (26%), Scottish Wildlife Trust (SWT) reserves (6%) (Loch Fleet), Ministry of Defence (MoD) sites (7%) and Royal Society for the Protection of Birds (RSPB) reserves (6%), together with substantial numbers of Preferred Conservation Zones, Regional Landscape Designation sites and National Nature Reserves, although only a small proportion by both area and number of Special Protection Areas, Ramsar sites and Local Nature Reserves. Table 7.1.1 summarises site protection in the region, showing the numbers and areas of each type of site and comparing these with North Sea coast and British (whole country coast) totals.

Table 7.1.1 Summary of site protection in Region 3

	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*
Biogenetic Reserves	1	4	25.0	5	20.0	973	2,477	39.3	3,777	25.8
Ramsar sites	2	35	5.7	58	3.4	680	172,710	0.4	286,168	0.2
Special Protection Areas	4	54	7.4	93	4.3	1,195	184,442	0.6	307,685	0.4
Possible Special Areas of Conservation	9	51	17.6	112	8.0	n/av	n/av	n/av	n/av	n/av
National Nature Reserves	6	41	14.6	79	7.6	2,989	34,556	8.6	86,708	3.4
Sites of Special Scientific Interest	71	549	12.9	1,183	6.0	35,977	330,377	10.9	700,780	5.1
Local Nature Reserves	1	69	1.4	93	1.1	36	8,731	0.4	13,300	0.3
National Scenic Areas	2	4	50.0	27	7.4	26,000	52,400	49.6	745,800	3.5
Country Parks	1	20	5.0	34	2.9	75	2,943	2.5	4,441	1.7
Geological Conservation Review sites	61	490	12.4	978	6.2	n/ap	n/ap	n/ap	n/ap	n/ap
Marine Consultation Areas	1	6	16.7	29	3.4	3,240	8,609	37.6	111,896	2.9
Regional Landscape Designations	24	38	63.2	62	38.7	n/av	n/av	n/av	n/av	n/av
Preferred Conservation Zones	11	17	64.7	27	40.7	n/av	n/av	n/av	n/av	n/av
Royal Society for the Protection of Birds reserves	7	53	13.2	82	8.5	2,485	24,548	10.1	38,680	6.4
The Wildlife Trusts reserves	4	123	3.3	216	1.9	1,359	10,312	13.1	23,420	5.8
Ministry of Defence sites	9	65	13.8	110	8.2	3,754	34,449	10.9	53,409	7.0
Woodland Trust properties	1	35	2.9	64	1.6	711	1,095	64.9	1,458	48.8

Source: JNCC (May 1996 Ramsar/SPA data). Key: n/ap = not applicable, n/av = not available. Notes: site types not currently found in the region: World Heritage (Natural) Sites, Biosphere Reserves, Wildfowl & Wetlands Trust sites, Areas of Special Protection, Marine Nature Reserves, John Muir Trust sites, National Trust for Scotland properties, Voluntary Marine Nature Reserves. In this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

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7.2 Sites designated under international conventions and directives

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

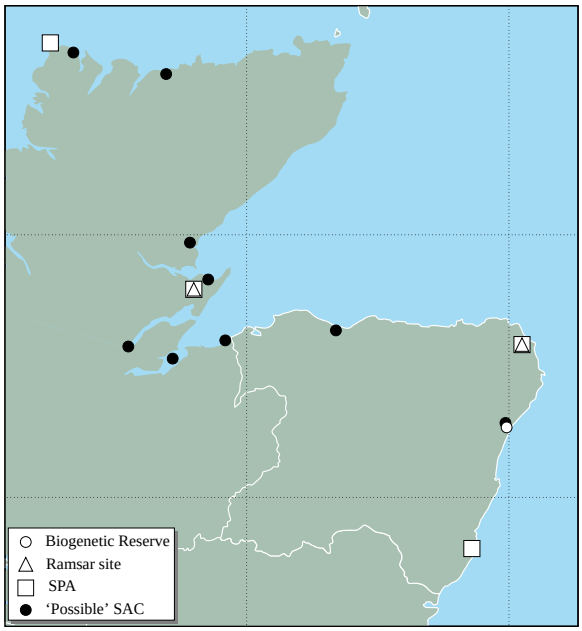
7.2.1 Biogenetic Reserves

In 1973 the European Ministerial Conference on the Environment recommended that a European network of reserves to conserve representative examples of European flora, fauna and natural areas be established. All sites in the UK are existing Sites of Special Scientific Interest (SSSIs), and most are also National Nature Reserves. All five of the coastal Biogenetic Reserves in Britain are designated for their heathland interest. There is one Biogenetic Reserve (973 ha) in Region 3, at Forvie (Table 7.2.1 and Map 7.2.1). In 1992 there were eighteen sites declared in Europe: eleven heathland and seven dry grassland reserves (data provided by International Branch, JNCC).

Table 7.2.1 Biogenetic Reserves

Site name	*No. of sites*	*Grid ref.*	*Area (ha)*	*Date designated*
Grampian	**1**			
Forvie		NK020275	973	1992
Region 3	***1***		***973***	
North Sea Coast	4		2,477	
GB coast	5		3,777	

Sources: JNCC, Scottish Natural Heritage. 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 7.2.1 Coastal Biogenetic Reserve, Ramsar sites (May 1996), Special Protection Areas (May 1996) and 'possible' Special Areas of Conservation (November 1995). Sources: JNCC, SNH.

7.2.2 Wetlands of international importance (Ramsar sites)

Ramsar sites are statutory areas designated by the UK government on the advice of the conservation agencies under the Ramsar Convention (the Convention on wetlands of international importance especially as waterfowl habitat). Contracting parties (of which the UK is one) are required to designate 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 are two coastal Ramsar sites (680 ha) in Region 3 (Table 7.2.2 and Map 7.2.1). Table 7.2.2 summarises the interest for which the sites

Table 7.2.2 Ramsar sites

Site name	*No. of sites*	*Grid ref.*	*Area (ha)*	*Date designated*	*Selection criteria used*
Highland	**1**				
Loch Eye		NH831798	195	1986	1% of a waterfowl species population
Grampian	**1**				
Loch of Strathbeg		NK0759	485	1995	Regularly supports over 20,000 wildfowl
Region 3	***2***		***680***		
North Sea Coast	35		172,710		
GB coast	58		286,168		
GB whole country	99		304,527		

Sources: JNCC May 1996 data; 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.

Table 7.2.3 Special Protection Areas (SPAs)

Site name	*No. of sites*	*Grid ref.*	*Area (ha)*	*Date designated*	*Selection criteria used*
Highland	**2**				
Cape Wrath (Clo Mor)*		NC260740	507*	1996	Internationally important numbers of breeding great black-backed gull, kittiwake, guillemot & razorbill; nationally important numbers of breeding puffin
Loch Eye		NH831798	195	1986	Regularly supports over 20,000 wintering waterfowl
Grampian	**2**				
Loch of Strathbeg		NK0759	485	1995	Regularly supports over 20,000 wintering waterfowl
Fowlsheugh		NO881799	8	1992	Internationally important numbers of breeding kittiwake and guillemot; nationally important numbers of razorbills
Region 3	***4***		***1,195***		
North Sea Coast	54		184,442		
GB coast	93		307,685		
GB whole country	126		439,633		

Sources: JNCC June 1996 data; SNH; Pritchard *et al.* (1992). Key: *site overlaps boundary with Region 16; half the total area has been included here. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

have been designated, and sections 5.11 and 5.12 describe the importance of the sites for the region's birds.

7.2.3 Special Protection Areas

The 1979 EC Directive on the Conservation of Wild Birds (the Birds Directive) requires member states to take conservation measures particularly for certain rare or vulnerable species and for regularly occurring migratory species of birds. In part this is achieved through the designation of statutory Special Protection Areas (SPAs) by the UK government on the advice of the statutory conservation agencies. This designation is implemented through the Wildlife and Countryside Act 1981; all SPAs have first to be notified as Sites of Special Scientific Interest. There are four coastal SPAs (1,195 ha) in Region 3 (Table 7.2.3 and Map 7.2.1). Table 7.2.3 summarises the interest of these sites, and sections 5.10, 5.11 and 5.12 describe the importance of these sites for the region's birds.

7.2.4 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 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 (Scottish Office 1995). A list of possible SACs was announced by the Government on 31 March 1995. There are nine possible SACs in Region 3, from a total of 111 such sites in GB (Map 7.2.1 and Table 7.2.4) (see JNCC (1995) for more information).

7.2.5 Acknowledgements

Thanks are due to Alan Law (JNCC).

7.2.6 Further sources of information

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Table 7.2.4 Possible Special Areas of Conservation (SACs)

Site name	*No. of sites*	*Qualifying interest*
Highland	**6**	
Durness		Alpine calcareous grasslands. Fixed dunes with herbaceous vegetation (grey dunes). Hard oligo-mesotrophic waters with benthic vegetation of mosses *Chara* spp. formations. Limestone pavements.
Invernaver		Decalcified fixed dunes with crowberry *Empetrum nigrum*. Dunes with downy willow *Salix arenaria*. Eu-atlantic decalcified fixed dunes (Calluno-Ulicetea). Fixed dunes with herbaceous vegetation (grey dunes).
Mound Alderwoods		Residual alluvial forests (Alnion glutinoso-incanae)
Dornoch Firth and Morrich More		Atlantic salt meadows (Glauco-Puccinellietalia). Decalcified fixed dunes with crowberry. Dune juniper *Juniperus* spp. Embryonic shifting dunes. Eu-atlantic decalcified fixed dunes (Calluno-Ulicetea). Humid dune slacks. Glasswort *Salicornia* spp. and other annuals colonising mud and sand. Shifting dunes along the shoreline with marram *Ammophila arenaria* (white dunes).
Conon Islands		Residual alluvial forests (Alnion glutinoso-incanae)
Moray Firth		Bottlenose dolphin *Tursiops truncatus*
Highland/Grampian	**1**	
Culbin Bar		Perennial vegetation of stony banks
Grampian	**2**	
Lower River Spey/Spey Bay		Perennial vegetation of stony banks. Residual alluvial forests (Alnion glutinoso-incanae).
Sands of Forvie		Decalcified fixed dunes with crowberry. Embryonic shifting dunes. Eu-atlantic decalcified fixed dunes (Calluno-Ulicetea). Humid dune slacks. Shifting dunes along the shoreline with marram (white dunes).
Region 3	***9***	
North Sea Coast	51	
GB	111	

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 (Highland)	*SNH, North-west Region Office, Inverness, tel: 01463 239431
Ramsar sites, SPAs, Special Areas of Conservation (Grampian)	*SNH, North-east Region Office, Aberdeen, tel: 01224 642863
Ramsar sites, SPAs (Highland)	*Regional Officer, RSPB, Inverness, tel: 01463 715000
Ramsar sites, SPAs (Grampian)	*Regional Officer, RSPB, Aberdeen, tel: 01224 624824
Special Areas of Conservation	*Department of the Environment (DoE), European Wildlife Division, Bristol, tel: 0117 987 8000

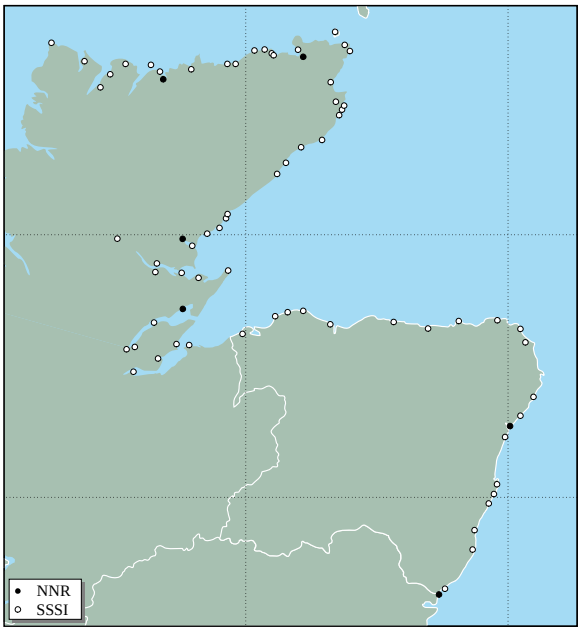
*Starred contact addresses are given in full in the Appendix.

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 six coastal NNRs (2,989 ha) in Region 3 (Table 7.3.1 and 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. Sources: SNH, JNCC.

7.3.2 Sites of Special Scientific Interest

Sites of Special Scientific Interest (SSSIs) are notified under the Wildlife and Countryside Act 1981. They are intended to form a national network of areas, representing in total the parts of Britain in which the natural features, especially those of greatest value to wildlife 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 71 coastal SSSIs (35,977 ha) in Region 3, as at September 1995 (Table 7.3.2 and Map 7.3.1). 8.07% of the total land mass of Britain is SSSI, as at September 1994.

Nearly all the SSSIs in the region (94%) have some intertidal land, while only 6% are purely terrestrial. Three-quarters of the SSSIs were selected at least partly for their biological interest and over half (55%) at least partly for their earth science (geological or geomorphological) interest. Of the total, nearly one-third 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

Table 7.3.1 National Nature Reserves

Site name	*No. of sites*	*Grid ref.*	*Area (ha)*	*Date last declared*	*Habitats*
Highland	**4**				
Invernaver		NC685605	552	1960	Blown sand, montane and maritime communities, juniper scrub
Dunnet Links		ND220690	465	1985	Dune links, marsh, grassland, fens and heathland
Mound Alderwoods		NH765990	267	1966	Estuary, alder woodland, fen
Nigg & Udale Bays		NH765715	640	1977	Intertidal mud and sandflats, eelgrass beds
Grampian	**2**				
Forvie		NK020275	973	1959	Sand dunes, foreshore, estuarine spit, dune heath, slacks, rough pasture, cliffs
St. Cyrus		NO745630	92	1962	Sandy foreshore, salt marsh, dunes, dune pasture and cliff
Region 3	***6***		***2,989***		
North Sea Coast	41		34,556		
GB coast	79		86,708		
GB whole country	288		195,531		

Source: 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.

Table 7.3.2 SSSIs in Region 3

Site name	*No. of sites*	*Grid ref.*	*Area (ha)*	*Date last notified*
Highland	**48**			
Cape Wrath		NC260740	1,014	1990
Durness		NC380670	1,997	1990
Eriboll		NC445570	1,770	1987
Inverhope		NC482618	48	1986
Ben Hutig		NC542655	2,680	1990
Eilean Nan Ron		NC638655	175	1986
Aird Torrisdale		NC673631	178	1975
Invernaver		NC685605	630	1987
Armadale Gorge		NC795640	87	1984
Red Point Coast		NC930657	171	1986
Sandside Bay		NC965655	77	1986
Ushat Head		ND035710	46	1984
Holborn Head		ND073712	128	1984
Pennylands		ND102695	20	1988
River Thurso		ND109656	52	1989
Dunnet Links		ND220690	776	1985
Dunnet Head		ND207713	91	1985
Stroma		ND350780	140	1983
John o' Groats		ND380735	1	1987
Duncansby Head		ND397710	83	1985
Loch of Wester		ND325592	69	1984
Lower Wick River		ND347515	42	1985
Long Berry Coast		ND377498	9	1988
Castle of Old Wick		ND371489	25	1985
Craig Hammel to Sgaps Geo		ND362464	72	1985
Dunbeath to Sgaps Geo		ND297371	146	1985
Berriedale Cliffs		ND158280	234	1984
Ousdale Burn		ND073190	42	1979
Helmsdale Coast		NC929077	148	1986
Garbh Allt		ND011138	6	1988
Ballinreach Coastal Gorges		NC932087	8	1984
Inverbrora		NC906033	56	1988
Dunrobin Coast		NC856008	5	1983
Mound Alderwoods		NH765990	292	1986
Loch Fleet		NH800960	1,238	1984
Ledmore Wood		NH664891	95	1984
Kyle of Sutherland Marshes		NH515990	404	1988
Dornoch Firth		NH760860	3,577	1985
Easter Fearn		NH658868	82	1984
Morrich More		NH830840	2,975	1987
Tarbat Ness		NH949879	60	1985
Cromarty Firth		NH650670	3,585	1988
Conon Islands		NH552570	171	1985
Drummondreach Wood		NH582575	15	1984
Rosemarkie to Shandwick Coast		NH744586	451	1987
Munlochy Bay		NH672528	267	1985
Beauly Firth		NH580480	2,062	1988
Whiteness Head		NH790580	412	1983
Grampian	**23**			
Culbin Sands, Forest & Findhorn Bay		NH990625	4,916	1984
Masonshaugh		NJ120693	37	1986
Clashach - Covesea		NJ167704	23	1989
Lossiemouth Shore		NJ228711	8	1989
Spey Bay		NJ325660	492	1986
Cullen to Stakeness Coast		NJ574669	348	1985
Whitehills to Melrose Coast		NJ702645	94	1990
Gamrie to Pennan Coast		NJ824673	322	1985
Rosehearty to Fraserburgh Coast		NJ967675	139	1989
Cairnbulg to St. Combs Coast		NK053641	55	1989
Loch of Strathbeg		NK075590	983	1985
Bullers of Buchan Coast		NK110380	109	1984
Collieston to Whinnyfold Coast		NK060310	104	1985
Sands of Forvie & Ythan Estuary		NK020275	976	1984
Foveran Links		NK000225	203	1984

Table 7.3.2 SSSIs in Region 3 (continued)

Site name	*No. of sites*	*Grid ref.*	*Area (ha)*	*Date last notified*
Grampian (continued)				
Nigg Bay		NJ966045	5	1984
Cove		NJ954005	10	1983
Findon Moor		NO941974	26	1985
Garron Point		NO887874	60	1989
Fowlsheugh		NO881799	8	1983
Crawton Bay		NO879796	9	1990
Milton Ness		NO769649	26	1990
St. Cyrus & Kinnaber Links		NO745630	312	1989
Region 3	***71***		***35,977***	
North Sea Coast	549		330,377	
GB coast	1,183		700,781	
GB whole country	6,095		1,940,483	

Source: 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.

frequently occurring habitats being tidal flats, hard rock sea cliffs, saltmarshes, sand dunes, dry grasslands, maritime heaths, wet flushes and freshwater marshes, these habitats occurring in 17-41% of sites. SSSIs in the region include many sites of interest for their rare and lower plants, terrestrial invertebrates, breeding seabirds and wildfowl or 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 Conservation Branch (BODC 1992; Barne *et al.* 1994).

7.3.3 Local Nature Reserves

Local Nature Reserves (LNRs) are designated by local authorities under section 21 of the National Parks and Access to the Countryside Act 1949, for the same purposes as NNRs but because of the local rather than the national interest of the site and its wildlife. Under this Act local authorities have the power to issue bylaws to protect the LNR. There is one LNR (36 ha) in Region 3 (Table 7.3.3 and Map 7.3.2).

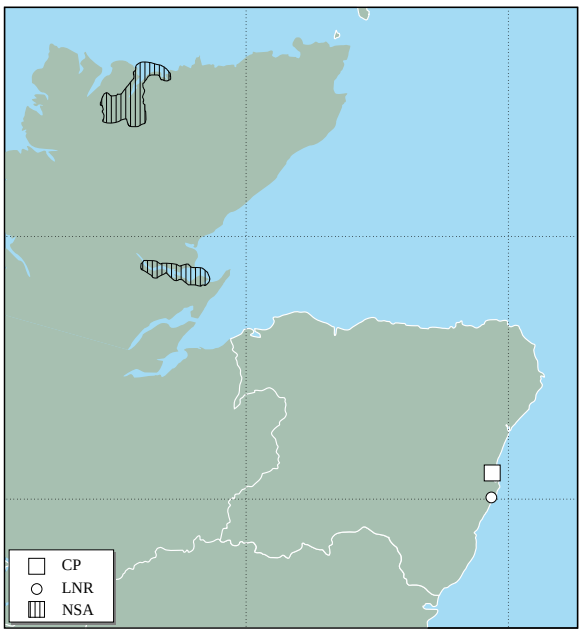
Table 7.3.3 Local Nature Reserves

Site name	*No. of sites*	*Grid ref.*	*Area (ha)*	*Date designated/ opened*
Grampian	**1**			
Donmouth		NJ948094	36	1992
Region 3	***1***		***36***	
North Sea Coast	69		8,731	
GB coast	94		13,300	
GB whole country	396		21,513	

Source: 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.

7.3.4 National Scenic Areas

National Scenic Areas (NSAs) are designated by Scottish Natural Heritage as the best of Scotland's landscapes, deserving special protection in the nation's interest. This designation replaces two earlier categories of importance for scenic interest, which served to fulfil some of the approaches embodied in the National Park and Area of Outstanding Natural Beauty designations in England and Wales. The seaward boundary of NSAs is the same as that for planning purposes in Scotland, i.e. mean low water of spring tides. Special development control measures for the 40 NSAs in Scotland were introduced by the Scottish Development Department in 1980. There are two NSAs (26,000 ha) within Region 3 (Table 7.3.4 and Map 7.3.2).



Map 7.3.2 Coastal Local Nature Reserve (LNR), Country Park (CP) and National Scenic Areas (NSA). Sources: SNH, Countryside Commission for Scotland (1985, 1978).

Table 7.3.4 National Scenic Areas

Site name	*No. of sites*	*Area (ha)*	*Date designated*
Highland	**2**		
Kyle of Tongue		18,500	1980
Dornoch Firth		7,500	1980
Region 3	***2***	***26,000***	
North Sea Coast	4	52,400	
GB coast	27	745,800	

Sources: Countryside Commission for Scotland (1978), 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.

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 (75 ha) in Region 3 (Table 7.3.5 and Map 7.3.2).

Table 7.3.5 Country Parks

Site name	*No. of sites*	*Grid ref.*	*Area (ha)*	*Date designated/ opened*
Grampian	**1**			
Balmedie		NJ976182	75	1983
Region 3	***1***		***75***	
North Sea Coast	20		**2,943**	
GB coast	34		4,441	
GB whole country	281		35,150	

Source: Countryside Commission for Scotland (1985). Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

7.3.6 Acknowledgements

Thanks are due to Roger Bolt (JNCC), Kathy Duncan and Natasha O'Connel (Scottish Natural Heritage) and Neale Oliver (DoE).

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Nature Conservancy Council. 1984. *Nature conservation in Great Britain.* Peterborough.

Nature Conservancy Council. 1989. *Guidelines for selection of biological SSSIs.* Peterborough.

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

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
NNRs, SSSIs, NSAs (Highland)	*SNH, North-west Region Office, Inverness, tel: 01463 239431
NNRs, SSSIs, NSAs (Grampian)	*SNH, North-east Region Office, Aberdeen, tel: 01224 642863
NSAs (Highland)	*Highland Council, Inverness, tel: 01463 234121
NSAs (Grampian)	*Aberdeenshire Council, Aberdeen, tel: 01224 665106
Coastal and marine UKDMAP datasets	*Coastal Conservation Branch, JNCC, Peterborough, tel: 01733 62626

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

7.4 Sites identified by statutory agencies

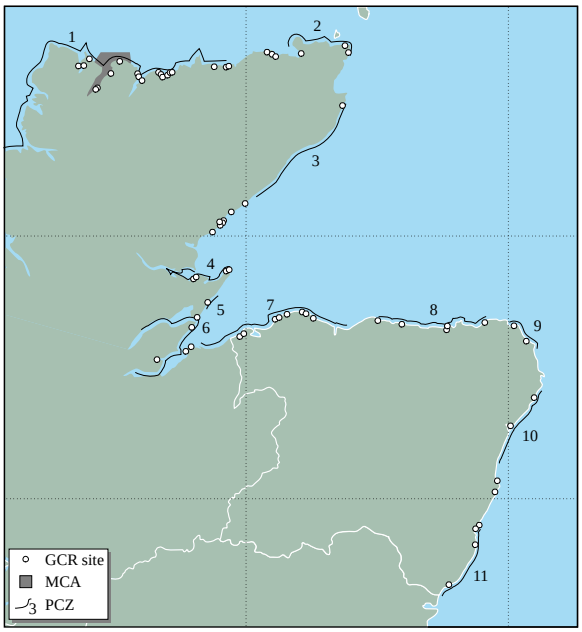
This section covers sites which, although not protected by statute, have been identified by statutory agencies as being of nature conservation or landscape importance.

7.4.1 Nature Conservation Review sites

Nature Conservation Review (NCR) sites are non-statutory sites that are the best representative examples of wildlife habitat; for some coastal sites, for example estuaries, all sites that were above a critical standard of nature conservation importance were selected. 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. The GCR selection process



Map 7.4.1 Coastal Geological Conservation Review (GCR) sites, Marine Consultation Area (MCA) and Preferred Conservation Zones (PCZs) (listed in Table 7.4.4). Note: a single symbol may represent more than one site in close proximity. Sources: JNCC, SNH, NCC (1990).

Table 7.4.1 GCR Single Interest Locations

Site name	*No. of SILs*
Highland	**35**
Balnakeil	
Faraid Head	
Durness	
Eriboll	
Lochan An Druim	
An t-Sron	
Cleit An t-Seabhaig	
Strathan Skerray - Skerray Bay	
Torrisdale Bay and Invernaver*	
Drumhollistan	
Red Point	
Holborn Head Quarry	
Pennyland	
Pennyland to Castlehill	
Dunnet Bay*	
John o' Groats	
Duncansby to Skirza Head*	
Wick Quarries, South Head	
Helmsdale	
Culgower Bay	
Brora (4 SILS)	
Dunrobin Coast Section	
Morrich More (2* SILS)	
Tarbat Ness (2 SILS)*	
Cadh'-an-Righ	
Cromarty and Rosemarkie Inliers	
Eathie Fishing Station	
Munlochy Bay	
Ardersier	
Whiteness Head*	

Site name	*No. of SILs*
Highland/Grampian	**2**
Culbin (2* SILS)	
Grampian	**24**
Masonhaugh (2 SILS)	
Clashach - Covesea	
Lossiemouth Shore	
Lossiemouth, East Quarry	
Spey Bay*	
Cullen	
Cullen - Troupe Head, Banffshire Coast	
Boyne Quarry	
Castle Hill	
Den of Findon	
Rosehearty - Fraserburgh	
Cairnbulg to St. Combs	
Strathbeg*	
Bullers of Buchan*	
Forvie*	
Bay of Nigg	
Coast north of Cove Bay	
Garron Point	
Garron Point to Slug Head	
The Toutties	
Crawton Bay (2 SILS)	
Milton Ness	
Region 3	***61***
North Sea Coast	490
GB coast	978
GB whole country	3,002

Sources: SNH, JNCC. Key: *sites selected wholly or partly for their coastal geomorphological interest. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

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 61 coastal GCR Single Interest Locations (SILs) in Region 3 (Table 7.4.1 and Map 7.4.1). Detailed scientific accounts of 519 (coastal and inland) GCR SILs are contained in nine volumes, published or in preparation, of a planned 42-volume *Geological Conservation Review* series (see e.g. Ellis *et al.* 1995).

7.4.3 Marine Consultation Areas

The non-statutory Marine Consultation Area 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 management bodies to be aware of marine conservation issues in the area. There is one Marine Consultation Area (3,240 ha) in Region 3 (Table 7.4.2 and Map 7.4.1).

Table 7.4.2 Marine Consultation Areas

Site name	*No. of sites*	*Area (ha)*	*Date established*
Highland	**1**		
Loch Eriboll		3,240	1990
Region 3	***1***	***3,240***	
North Sea Coast	6	8,609	
Scotland	29	111,896	

Source: NCC (1990).

7.4.4 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.

In Region 3 there are 24 areas covered by RLDs that include areas somewhere within the coastal zone (Table 7.4.3 and Map 7.4.2). They are known as Areas of Great Landscape Value (AGLV) in Highland and Areas of Regional Landscape Significance (ARLS) in Grampian. The area of many of these sites is not available. There has been no monitoring or further comprehensive study of the number of RLDs since the study by Cobham Resource Consultants (1988).

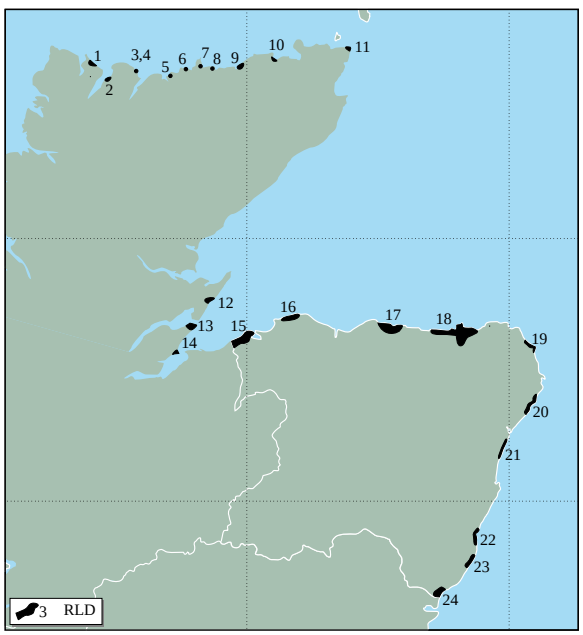
7.4.5 Preferred Conservation Zones (PCZ)

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

Table 7.4.3 Regional Landscape Designations (RLDs)

*Site no.**	*Site name*	*No. of sites*	*Area (ha)*
	Highland	**14**	
1	Smoo Caves		<100
2	Loch Eriboll		<100
3	Achininver		n/a
4	Midfield		n/a
5	Farr		n/a
6	Armadale Bay		n/a
7	Strathy Bay		n/a
8	Melvich Bay		n/a
9	Sandside Bay		<100
10	Holborn Head		<100
11	Duncansby Head		<100
12	Shandwick Beach		<100
13	Sutors of Cromarty		<100
14	Rosemarkie Burn		<100
	Grampian	**10**	
15	Culbin		2,181
16	Burghead/Branderburgh		n/a
17	Cullen/Portsoy		524
18	Macduff/Quarryhead		3,325
19	Rattray		920
20	Longhaven/Cruden Bay		628
21	Collieston/Balmedie		1,212
22	Downies/Stonehaven		312
23	Stonehaven/Todhead Point		563
24	St. Cyrus		224
	Region 3	***24***	***n/a***
	North Sea Coast	38	n/a
	Scotland coast	63	n/a
	Scotland whole country	178	n/a

Sources: Cobham Resource Consultants (1988), SNH. Key: *site number is as shown on Map 7.4.2; 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). Sources: Cobham Resource Consultants (1988), Scottish Development Department (1974).

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 3 there are eleven PCZs (Table 7.4.4 and Map 7.4.1). This compares with 22 PCZs on the Scottish mainland and numerous potential PCZs around the islands (only the larger islands have defined Preferred Conservation Zones).

Table 7.4.4 Preferred Conservation Zones (PCZs)

Site no.[a]	*Location*
	Strathclyde/Highland
1	Machrihanish - Dounreay
	Highland
2	Dunnet Bay - Brough Head
3	South Head - Helmsdale
4	Dornoch - Tarbat Ness
5	The North Sutor
6	The Black Isle
	Highland/Grampian
7	Whiteness Head - Portgordon
	Grampian
8	Portnockie - Rosehearty
9	Fraserburgh Bay - St. Fergus
10	Bullers of Buchan - River Don
11	Dunnottar - River North Esk

Source: Scottish Development Department (1974). Key: [a]site number shown on Map 7.4.2.

7.4.6 Acknowledgements

Thanks are due to Roger Bolt (JNCC) and Donald Balsillie, Kathy Duncan and Natasha O'Connel (Scottish Natural Heritage).

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
NCR sites, GCR sites, MCA (Highland)	*SNH North-west Region Head Office, Inverness, tel: 01463 239431
NCR sites, GCR sites (Grampian)	*SNH North-east Region Head Office, Aberdeen, tel: 01224 642863
PCZs (Highland)	*Highland Council, Inverness, tel: 01463 702000
PCZs (Grampian)	*Grampian Regional Council, Aberdeen, tel: 01224 665106

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

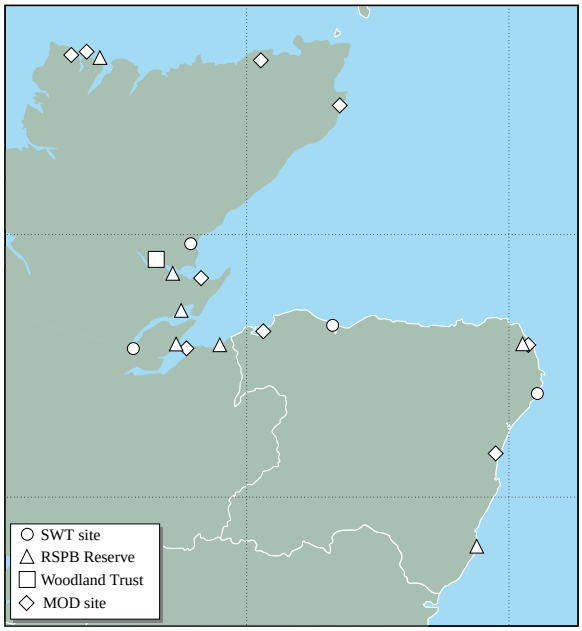
7.5 Other types of protected site

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) for the purpose of promoting 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 1993). The National Trust for Scotland practises active conservation and management of its land. There are no National Trust for Scotland owned sites on the coast of Region 3.

7.5.2 The Royal Society for the Protection of Birds

The Royal Society for the Protection of Birds (RSPB) currently manages over 130 reserves (84,000 ha) in Britain (RSPB 1993). Wherever possible, reserves are purchased, so that the level of safeguard for the wildlife and their habitats is high. Where reserves are leased, the RSPB aims to acquire long leases (longer than 21 years) with appropriate management rights. There are seven RSPB reserves (2,485 ha) in Region 3 (Table 7.5.1 and Map 7.5.1).



Map 7.5.1 Other types of coastal protected site. Sources: Ministry of Defence (MoD), Scottish Wildlife Trust (SWT), RSPB, Woodland Trust.

Table 7.5.1 Royal Society for the Protection of Birds reserves

Site name	*No. of sites*	*Grid ref.*	*Area (ha)*	*Date acquired*	*Interest*
Highland	**4**				
Eilean Hoan		NC445675	40	1979	Low-lying limestone island with grazing sheep, breeding seabirds including storm petrels and Arctic terns; wintering barnacle geese
Edderton Sands		NH7284	87	1989	Intertidal mudflats with eelgrass *Zostera* spp., grazed saltmarsh, wintering and migrating wildfowl and waders, including wigeon and scaup
Nigg & Udale Bays		NH797738	432	1989	Mudflats, eelgrass, saltmarsh, grazing marsh and scrub, wildfowl, wintering waders, roosting waterfowl
Fairy Glen		NH735579	5	1989	Glen, burn, broad-leaved woodland with woodpeckers, treecreepers, passerines and raptors
Highland/Grampian	**1**				
Culbin Sands		NH901573	862	1977	Sandflats, saltmarsh, shingle bars and spits, sand dunes (mostly afforested), wintering waders and wildfowl, breeding waders and terns
Grampian	**2**				
Loch of Strathbeg		NK057581	1,048	1973	Large shallow freshwater loch, fen, marsh, saltmarsh, woodland and sand dunes, migrant and breeding waterfowl, migrant waders, breeding terns, rails and passerines
Fowlsheugh		NO876805	11	1968	Red sandstone grass-topped cliffs, colonies of nesting seabirds, nesting passerines
Region 3	***7***		***2,485***		
North Sea Coast	53		24,548		
GB coast	82		38,680		

Sources: RSPB (1994; *in litt.*). Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

7.5.3 The Scottish Wildlife Trust

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. There are four coastal Wildlife Trust sites (1,359 ha) in Region 3 (Table 7.5.2 and Map 7.5.1).

Table 7.5.2 Wildlife Trusts sites

Site name	*No. of sites*	*Grid ref.*	*Area (ha)*	*Date acquired*
Highland	**2**			
Loch Fleet		NH794965	1,163	1970
Drummondreach Oakwood		NH581574	19	1977
Grampian	**2**			
Spey Bay		NJ330658	127	1991
Longhaven Cliffs		NK115394	50	1986
Region 3	***4***		***1,359***	
Scotland	26		13,805	
North Sea Coast	123		10,312	
GB coast	216		23,420	

Source: Scottish Wildlife Trust (1994). 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 7.5.3 MoD sites

Site name	*No. of sites*	*Area (ha)**	*Habitats*	*Protected status*
Highland	**6**			
Cape Wrath		1097	Rock/cliff	SPA, SSSI
Faraid Head		21	Rock/cliff	SSSI
Wick		19	Rock/shingle	SSSI
Lybster		51	Rock	No designation
Tain		1044	Grass/sand/ saltmarsh	SSSI
Fort George		558	Sand/shingle	SSSI
Grampian	**3**			
Kinloss		710	Sand/reeds	No designation
Crimond		196	Grass/reeds	No designation
Blackdog		58	Sand dunes	No designation
Region 3	***9***	***3,754***		
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; SPA = Special Protection Area. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

7.5.4 The Ministry of Defence

As at August 1994, the Ministry of Defence (MoD) owned, leased or used under licence landholdings covering some 320 km of coastline around the UK, not all of it significant for its nature conservation value. The MoD gives high priority to nature conservation on the Defence Estate, subject to the overriding importance of military training. The restrictions to public access on some sites mean that they can be amongst the most pristine areas of wildlife habitat in the region. There are nine coastal MoD sites (3,754 ha) in Region 3 (Table 7.5.3 and Map 7.5.1).

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 is one Woodland Trust site (711 ha) in Region 3 (Table 7.5.4 and Map 7.5.1).

Table 7.5.4 The Woodland Trust sites

Site name	*No. of sites*	*Grid ref.*	*Area (ha)*
Highland	**1**		
Ledmore & Migdale Woods		NH660900	711
Region 3	***1***		***711***
North Sea Coast	35		1,095
GB coast	64		1,458

Source: Woodland Trust (1993). Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

7.5.6 Acknowledgements

The author wishes to thank Andrea Firth (MoD), Dr J. Fenton (National Trust for Scotland), Bob Scott (RSPB), Dr A. Somerville (Scottish Wildlife Trust) and the Woodland Trust.

7.5.7 Further sources of information

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
National Trust for Scotland sites (none in this region)	*The National Trust for Scotland, Edinburgh, tel: 0131 226 5922
RSPB sites (Highland)	*Regional Officer, RSPB North Scotland Office, Inverness, tel: 01463 715000
RSPB sites (Grampian)	*Regional Officer, RSPB East Scotland Office, Aberdeen, tel: 01224 624824
Scottish Wildlife Trust sites	*Dr Kenny Taylor, Scottish Wildlife Trust (Northern Office), Dingwall, tel: 01349 877625
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.L. Fowler, S.J. Everett & J.A. Norton

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 and power generation; and coastal defence, including sea defence and coast protection. Oil and gas exploration and production are covered in section 9.5.

The long coastline of this region is for the most part thinly populated, the only major centres of population being at Inverness and Aberdeen. The north and east coasts of Highland are largely remote, with small crofts and extensive livestock farming on what is largely poor quality land. Along the coastline of Grampian, which is more intensively exploited and settled, transport and communications infrastructure is much better developed; however the coast is still essentially rural. Forestry is an important activity, with coastal forestry concentrated around the more sheltered shores of the firths that lead into the Moray Firth. This region is one of the most heavily afforested coastal regions in Britain, with extensive commercial conifer plantations, including some on sand dunes.

Fisheries, fish farming, distilleries and tourism are important industries in the more remote areas, with activity concentrated around the major ports and centres of population, particularly on the sheltered shores of the Moray and Cromarty Firths (for example at Alness and Invergordon) and at Aberdeen. Significant areas are eligible for development funding under the European Union's structural funds and regional aid programmes for Objective 5b areas. These programmes aim to promote rural diversification, including the restructuring of fisheries ports.

The most important regional ports and harbours - Cromarty, Peterhead and Aberdeen - are small in extent compared with the major ports of England. Oil-related engineering has become an important industry in the region since the development of the North Sea oil and gas fields, especially in parts of the Inner Moray Firth and at Aberdeen. Highland Council is the biggest single employer in the northern part of the region, with the experimental nuclear establishment at Dounreay another major employer.

Of the Moray Firth coastline, which is 823 km in length between Duncansby Head and Fraserburgh (including the inner firths), Harding-Hill (1993) classifies 15.1% as urban, 6.4% as arable, 10.5% as woodland and 5.0% as being in recreational use.

Nigg Bay in the Cromarty Firth is a centre for oil-related industry, for which the region is of high importance in the UK. The town has facilities for oil rig construction, conversion, inspection and repair and oil field support, and there is a large oil terminal (pictured) connected by pipeline to the Beatrice Oilfield in the Outer Moray Firth. Much of this infrastructure is built on claimed formerly intertidal land. Photo: Pat Doody, JNCC.

8.2 Land use

S.L. Fowler & M.J. Dunbar

8.2.1 Introduction

There is a high proportion of semi-natural vegetation along parts of the Highland coast, where crofting and extensive livestock keeping predominate. Small crofting communities are common on the north Highland coast, although many villages were abandoned during the Clearances of the 19th century. Highland Council has established a Consultative Committee on Crofting to promote initiatives for crofting, which is important in sustaining populations in the remote rural areas. Inland from the coast the hinterland is mainly occupied by heath, bog, moor, rough pasture and forest. The coast of the former Grampian Region is also generally rocky with small farms and crofts. Some of the most fertile agricultural landscapes of Scotland lie a little way inland.

The dunes of Scotland, including those in this region, have probably been affected by agriculture, mostly grazing, for most of recorded history (Dargie 1993), although Scottish dunes are otherwise among the least disturbed in Britain. The characteristic semi-natural vegetation of most stable dunes is grassland; moderate to heavy grazing by rabbits, deer, sheep and cattle maintains a low grass sward and allows a variety of species to develop. In the absence of grazing, many areas of sheltered dune would probably have developed into scrub - as at Morrich More - or woodland.

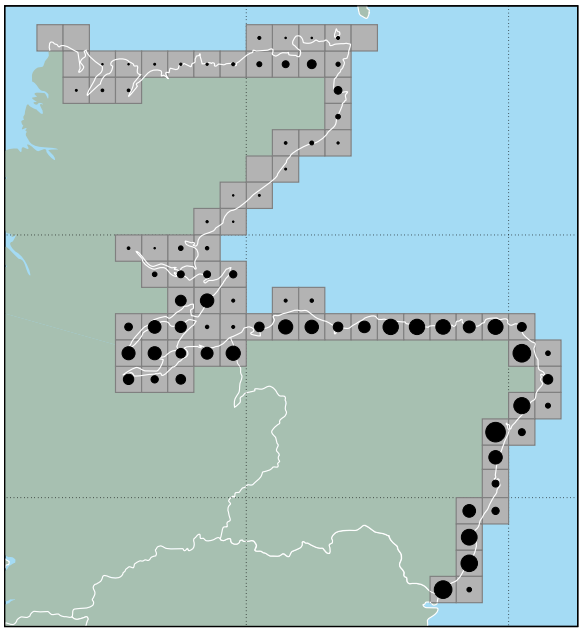
The oldest form of saltmarsh exploitation by man is probably its development for agriculture (Doody 1988). In Scotland, transitions from saltmarsh to non-maritime vegetation are more common than in other areas of Britain, largely owing due to the predominance of grazing and the relatively low incidence of land claim. Small marshes at the heads of lochs tend to be heavily grazed.

There are many fewer ancient woodlands in this region than on the west coast of Scotland, a result of the greater accessibility of the land, leading to agricultural use, and the drier climate, which does not favour regeneration, and the prevalence of conifer plantations. Ancient broadleaved woodland is generally restricted on the coast to sheltered areas such as the Kyle of Tongue and the Dornoch and Beauly Firths, with the open coast contributing only a few sites. No major areas of coastal ancient woodland exist on the Grampian coast, other than belts of woodland along burn and river valleys, for example at Kingston, Cullen and Banff.

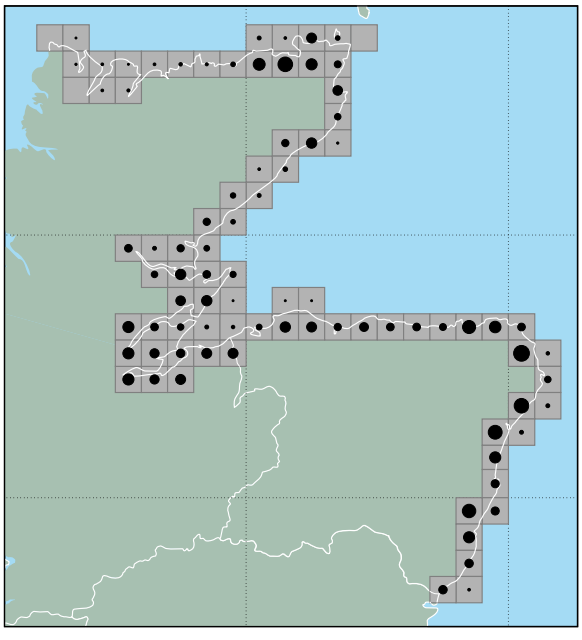
Conifer plantations on sand dunes are characteristic of this region, and there are examples of large upland plantations approaching the coast, for example around the Dornoch Firth.

8.2.2 Locations and land uses

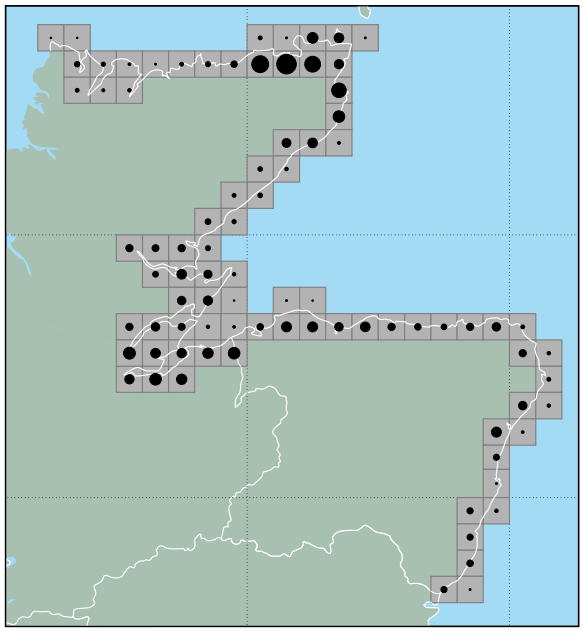
Map 8.2.1 shows that tilled land is concentrated around the Inner Moray Firth and on the Grampian coast, with smaller areas farmed around Thurso and Wick. In other parts of the region there is very little arable land. Mown or grazed turf (Map 8.2.2) is concentrated around Thurso, on the Cromarty and Beauly Firths, along the east coast of Grampian and, to a lesser extent, around the shores of the Outer Moray Firth. Meadow and semi-natural grassland in the region (Map 8.2.3) is most extensive around Thurso and the firths, and on some parts of the north and east coast of Grampian. In the north-east, around Thurso and Wick, where the land is flatter and more suitable for arable use (Grade 3), agriculture is more prevalent, with many small farms. Further down the east coast of Highland Region, coastal



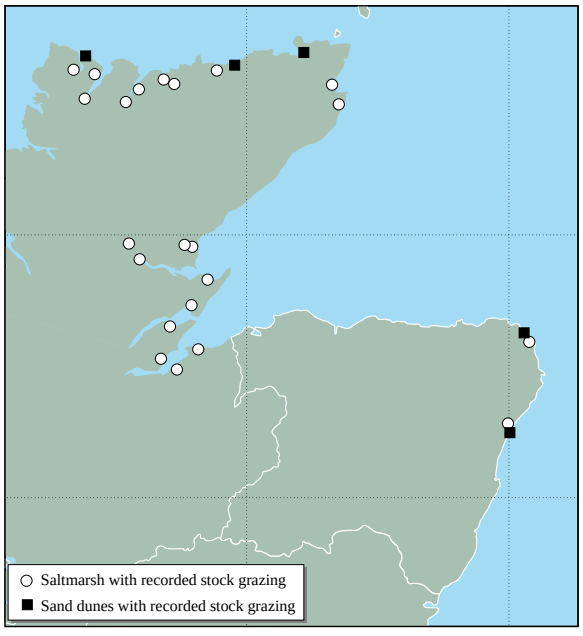
Map 8.2.1 Tilled land. Note: area of circle indicates the area of this land cover type in the 10 km square. Sources: Countryside Survey (1990), ITE Monks Wood.



Map 8.2.2 Mown/grazed turf. Note: area of circle indicates the area of this land cover type in the 10 km square. Sources: Countryside Survey (1990), ITE Monks Wood.



Map 8.2.3 Meadows, verges and low intensity amenity grasslands and semi-natural cropped swards, not maintained as short turf. Note: area of circle indicates the area of this land cover type in the 10 km square. Sources: Countryside Survey (1990), ITE Monks Wood.



Map 8.2.4 Saltmarshes and sand dunes with recorded grazing. See Maps 3.6.1 and 3.2.1 for distribution of saltmarsh and sand dune sites. Source: JNCC Coastal Database.

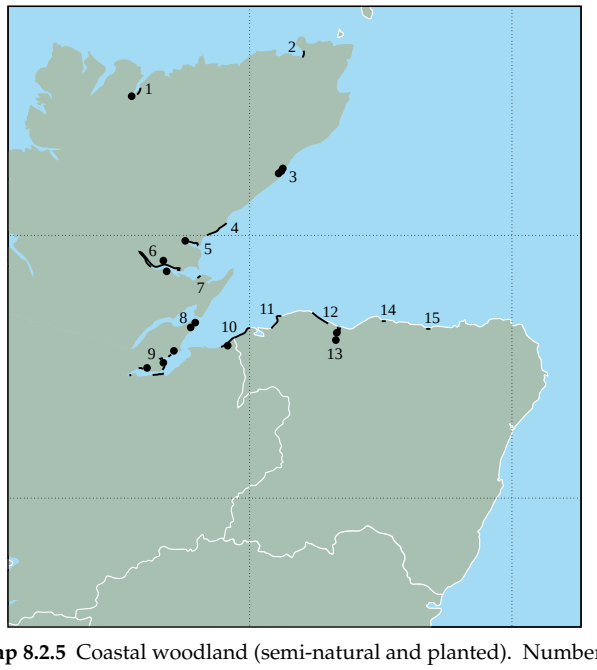
land becomes steeper, with a mixture of small farms and crofting communities, but very little arable land. There are, however, areas of prime agricultural land in the belts of low-lying land along the sheltered shores of the Dornoch, Cromarty and Beauly Firths.

Dargie (1993) concluded that stock grazing was the most important land use at the sand dune sites surveyed in the National Sand Dune Survey (Map 8.2.4). Stock grazing is managed as large private enterprises, or as crofter grazing, usually at low intensity, but intensive management is carried out at Loch of Strathbeg. Some areas of dune have been converted to 'improved' grassland.

Saltmarsh grazing in this region occurs mostly around the Dornoch, Cromarty, Beauly and Moray Firths, but also along the north coast of Highland and at Loch Fleet, Culbin, Strathbeg and the Ythan Estuary (Map 8.2.4). There are 1,317 ha of saltmarsh in the region (Burd 1989), of which 487 ha (37%) are grazed, representing around 1% of the total saltmarsh area (44,000 ha) and 1.5% of the grazed saltmarsh (31,600 ha) in Great Britain.

Areas of ancient semi-natural woodland are listed in Table 8.2.1 and shown on Map 8.2.5. The ancient woodland sites are those held on the Scottish Natural Heritage geographical information system whose central grid references are within 500 m of coast and which have more than 5 ha of semi-natural vegetation. The very few areas of coastal woodland on the north coast of Highland Region are generally restricted to the sheltered shores of some of the sealochs, such as the Kyle of Tongue, and the UK's most northerly example of conifer plantation on sand dunes occurs on the Links of Dunnet, east of Thurso. There are also a few narrow bands of woodland or plantation in some of the burns running to the east coast of Highland Region, such as at Berriedale, although these do not extend right down to the shore. At Mound Alderwoods NNR the upper part of Loch Fleet has been enclosed by an embankment, and natural alder and willow woodland has developed on the site of the former estuary. It is a 'possible' Special Area of Conservation (SAC) under the EC Habitats & Species Directive. At the head of Cromarty Firth the Conon Islands support residual alluvial alderwoods and are a possible SAC.

Significant areas of afforestation are listed in Table 8.2.1 and shown on Map 8.2.5. There are extensive conifer plantations close to the coastline around the Dornoch and Moray Firths, for example near Golspie (including plantations on the coast at Dunrobin Castle) and on low-lying land around Loch Fleet, such as Ferry Links. The shores of the Dornoch Firth have large areas of woodland, including semi-natural deciduous woodland (such as at Ledmore Wood on the north shore, near Spinningdale) and



Map 8.2.5 Coastal woodland (semi-natural and planted). Numbers refer to Table 8.2.1. Source: Ordnance Survey Landranger maps. © Crown copyright.

Table 8.2.1 Areas of significant coastal forestry and woodland

*Site no.**	*Location*	*Grid ref.*	*Details*
	Highland		
1	Kyle of Tongue	NC5755	200 ha mixed in several stands on eastern shore
2	Links of Dunnet	ND220700	100 ha conifer plantation
3	Berriedale	ND1122	Ancient woodland in river valleys
4	Dunrobin Wood	NC875015	1,000 ha conifer plantation
5	Balblair Wood and Ferry Links, Loch Fleet, Mound Alderwoods	NH895975, NH810964	300 ha conifer plantations, ancient woodland - alder and willow
6	Dornoch Firth woodlands	NH68	>1,000 ha mixed along shores of firth; some ancient woodland
7	Cnocan Mealbhain, Morrich More	NH805835	150 ha conifer plantation on dunes
8	Cromarty		Small areas of ancient woodland at Sutors of Cromarty and Eathie
9	Munlochy Bay and Beauly Firth	NH64	Small areas of conifer plantation and broad-leaved
	Grampian		
10	Culbin Forest	NH9861	30,000 ha conifer plantation on dunes
11	Roseisle Forest	NJ1166	600 ha conifer plantation.
12	Lossie Forest	NJ2767	1,000 ha conifer plantation.
13	The Links, Spey Bay	NJ3664, NJ3462	50 ha conifer plantation on links; ancient woodland in Spey valley
14	Cullen	NJ5066	Amenity woodland in river valley
15	Banff	NJ6862	Amenity woodland in river valley

Source: Ordnance Survey 1:50,000 Landranger maps, SNH. Key: *site numbers shown on Map 8.2.5.

extensive conifer plantations, particularly around the upper sections of the estuary. South of the firth, a large area of the dune system at Morrich More has been planted with Scots pine. The Cromarty Firth, by contrast, has only a few areas of woodland actually on the coast, although many large conifer plantations lie not far inland, as is also the case for the Inner Moray Firth. Around Munlochy Bay and the Beauly Firth the coast is generally well-wooded with many small areas of planted woods and shelterbelts, both broadleaved and coniferous, abutting the coast. Further east along the shore of the Moray Firth and extending into Grampian are three extensive areas of conifer plantation: Culbin Forest, which lies between Nairn and Findhorn, much of it on sand dunes; Roseisle Forest between Findhorn and Burghead; and Lossie Forest, which borders the estuary of the River Lossie and extends almost to Kingston, where there has been some conifer planting on the links east of the River Spey.

8.2.3 Information sources used

The main source of information for this section was the Countryside Survey 1990 (ITE 1993), which is based primarily on high resolution satellite images. These images show the dominant land cover for each 25 m x 25 m area (pixel) of Great Britain. 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 8.2.1, 8.2.2 and 8.2.3 are derived from this data 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, and from the form of presentation used in the maps. The Countryside Information System can provide data on a 1 km square framework, but this level of detail was not considered appropriate here. More detailed information on agricultural land use and grades (for example, information on set-aside targets) is available from SOAEFD and local plans. Sand dune and saltmarsh grazing information for Map 8.2.4 comes from the JNCC's Integrated Coastal Database and from cited references.

Woodland information (Map 8.2.5) was obtained from the 1:50,000 scale Ordnance Survey Landranger maps, which differentiate between coniferous, mixed and broad-leaved woodland, and from the Scottish Natural Heritage Geographic Information System (GIS) data on ancient woodlands. The Forestry Authority has afforestation maps that cover the region.

8.2.4 Acknowledgements

Thanks go to John Kupiec, SNH, for providing ancient woodland data.

8.2.5 Further sources of information

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Land use and agricultural land grades, set aside	*SOAEFD, Edinburgh, tel: 0131 244 6001
Land use information	Macaulay Land Use Research Institute, Craigbuckler, Aberdeen AB9 2QJ, tel: 01224 318611
ITE Countryside Survey 1990	*Department of Rural Affairs, DoE, Bristol, tel: 0117 987 8000, or *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
Crown agricultural and forestry estates	Crown Estate Commissioners, 10 Charlotte Square, Edinburgh EH2 4DR, tel: 0131 226 7241
Distribution, ownership, management of woodlands - Highland	Forestry Authority, Highland Conservancy, Woodlands, Fodderty Way, Dingwall, Ross-shire IV15 9XB, tel: 01349 862144
Distribution, ownership, management of woodlands - Grampian	Forestry Authority, Grampian Conservancy, Ordiquhill, Portsoy Road, Huntly AB54 4SJ, tel: 01466 794542
Ancient woodlands GIS database	*SNH HQ, Edinburgh, tel: 0131 447 4784
Coastal woodlands of nature conservation significance	*SNH North West Region, Inverness, Highland tel: 01463 239431

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

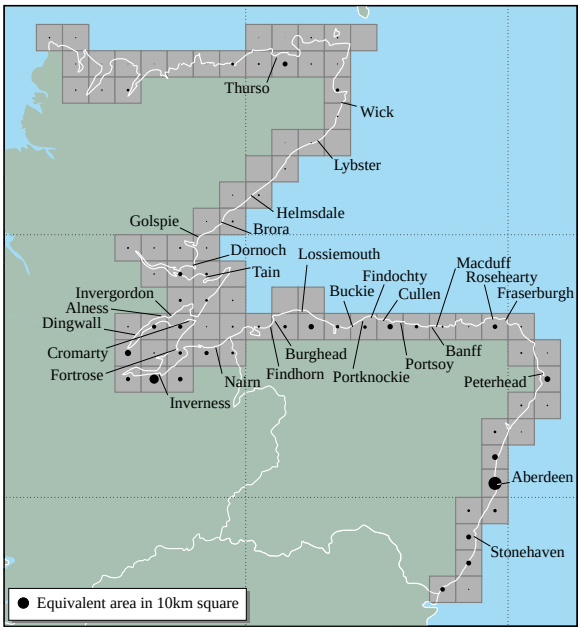
8.3 Infrastructure

S.L. Fowler

8.3.1 Introduction

Highland is one of the most sparsely populated large areas of Britain, with a total population of only about 207,000 (Registrar General Scotland 1995), much of this located close to the long coastline. The north and east coasts of Highland have a scattering of small crofting and farming communities, with only a few larger towns. Most of the coastal population is concentrated in the more sheltered areas of the firths, where the population is expected to continue to increase, particularly around Inverness - one of the fastest-growing areas of Scotland.

Grampian (population 528,000) is rather more densely populated than Highland, both inland and on the coast, with the main population centre being the city of Aberdeen. The other coastal settlements mostly have their origin as fishing villages, but some of the smaller settlements have since become more dependent on tourism, while the larger ports have either retained their importance as fishing centres or have expanded to service the North Sea oil and gas industry.



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. Source: Countryside Survey (1990); ITE Monks Wood.

8.3.2 Important locations

Residential development

Residential development in the region is concentrated around the Inner Moray Firth and along the Grampian coast, particularly Aberdeen. Since 1971, the region's housing stock has increased by over one third, to which the North Sea oil boom has made a significant contribution. Centres of population are listed in Table 8.3.1 and shown on Map 8.3.1.

The only sizeable centre of population on the northern coast of Highland is the market town of Thurso. Thurso has expanded with the development of Dounreay nearby, although fewer people are expected to be employed at this nuclear energy complex in future. The Moray Firth is a significant centre of activity, with about 120,000 people living around its shores. Situated on its outer northern shore is Wick, formerly a busy herring port, and a number of smaller fishing villages, including Lybster and Helmsdale. Towns and villages on or near the shores of the Highland firths include Brora, Golspie, Dornoch and Tain (the latter two slightly set back from the Dornoch Firth shore), the port and industrial town of Invergordon, plus Alness and Dingwall, on the Cromarty Firth, Cromarty and Fortrose on the Black Isle shore, and Inverness and Nairn. Inverness is the major settlement, situated at the opening of the Beauly Firth into the Inner Moray Firth. More than 3,000 new houses have been built in Inverness since 1978, and demand for a further 4,000 is projected by the end of the century.

With a population of 200,000, Aberdeen is the largest population centre in the region. There are many other relatively small coastal towns and villages on the Grampian coast, the largest being Fraserburgh and Peterhead.

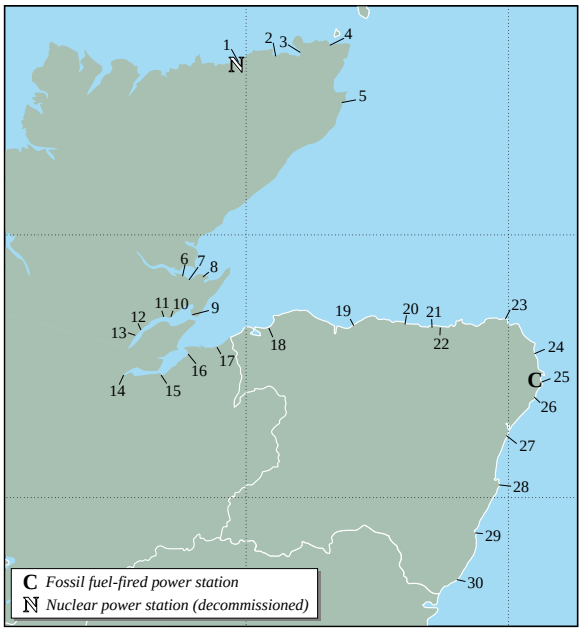
Table 8.3.1 Centres of population in Region 3

Location	*Population*
***Highland**	**207,500**
Thurso	9,000
Wick	8,700
Alness	5,900
Dingwall	5,000
Inverness	43,000
***Grampian**	**532,500**
Lossiemouth	7,300
Buckie	8,400
Fraserburgh	13,000
Peterhead	17,000
Aberdeen	200,000
Stonehaven	8,000

Sources: Cook (1993), except *mid-1994 population estimates (Registrar General Scotland 1995)

Industry

Historically, apart from those activities associated with trading ports, naval yards, whisky distilleries and fisheries, this coastline had very little industrial use. Industrial activity in the region has generally been concentrated alongside the sheltered waters of the firths in Highland, and in the Dee Estuary in Grampian (Grampian has few other deep, sheltered inlets). The development of the North Sea oil and gas fields in the 1970s led to the expansion of associated infrastructure, engineering works and industries. Some of the oil and gas related industries, such as oil terminals and rig or pipeline fabrication/coating yards,



Map 8.3.2 Industrial infrastructure and coastal power stations. Numbers refer to Table 8.3.2. Source: Ordnance Survey Landranger maps. © Crown copyright.

have occupied large areas of coastal land or have required land claim. In total, about 8 km^2 of land on the coast of the region is in industrial use of some kind, mainly related to oil and gas production, fishing and distilling. Other industrial areas in the region extend to around 5-25 ha at most. Significant industries are listed in Table 8.3.2 and the main industrial areas are shown on Map 8.3.2.

There is very little industry in the north of Highland. The Dounreay Nuclear Site near Thurso (operated by British Nuclear Fuel Ltd (BNFL) and the United Kingdom Atomic Energy Authority (UKAEA)) has had experimental fast breeder reactors and associated fuel processing plants in operation for over 30 years. Oil-related activity in Highland includes a pipeline fabrication/coating plant in Sinclair Bay, north of Wick, and a service base for offshore oil platforms at Wick.

More widespread industrial use is made of the north coast of the Moray Firth, which in Scotland is second only to the Aberdeen area for its importance for oil-related development. Little industrial activity occurs in the Dornoch Firth, except for the pipeline fabrication and coating yard at Morrich More. The Cromarty Firth is more heavily industrialised, with Nigg, Invergordon and Evanton having facilities ranging from shipping of general and bulk cargo to oil field support and oil rig conversion, inspection and repair. Some of this infrastructure has needed considerable areas of land claim, for example at Nigg Bay. The Invergordon Enterprise Zone, designated from October 1983 to October 1993, comprised two separate areas on the northern shore of the Cromarty Firth: 24 ha at Invergordon and 36 ha at Alness. This designation aimed to restore private sector activity to the zones by providing automatic planning permission for a range of industrial uses, removing tax burdens, relaxing various administrative controls, waiving rates and providing special capital allowances for the construction of buildings. Areas at Alness/Invergordon and Dingwall have been identified as simplified planning zones under the Town & Country Planning (Simplified Planning Zones) (Scotland) Regulations 1987, allowing certain specified types of development, so far including business, industrial and commercial use, to be regarded as having 'deemed planning consent'.

There is some industrial activity and land claim around the city of Inverness, on the Inner Moray Firth, and a large oil platform construction yard at Whiteness Head. Highland Council has a policy to promote the timber processing industry and a concentration of forestry-related industries exists around the Cromarty and Moray Firths, with seven sawmills and (at Inverness) a board mill.

The north-facing Grampian coast has very little industry other than small distilleries and industries associated with small fishing ports, such as boat building or repairs and net-making. There is a large gas terminal on the east coast behind the dunes at St. Fergus. Just to the south lies the major North Sea fishing port of Peterhead, which has one of the busiest fish markets in Europe and some light industry, plus a large oil-fired power station (see Power generation, below). Aberdeen, which lies on the shores of the Dee Estuary, is a traditional fishing port that has expanded rapidly with the development of the North Sea oil and gas fields. It is also the only major settlement in Grampian that has scope for port development. Apart from the harbour, which services the North Sea oil fields, other industrial activities on the estuary include a boat-building/repair yard and a fish processing plant. The city and its suburbs now also have some large areas of new light industry, mainly developed away from the waterfront.

Ports and harbours

Major port and harbour developments in the region were originally located in the main sheltered estuaries and firths. Some, such as Aberdeen, started out primarily as fishing ports, then gradually became more important for shipping (and related land transport) associated with industrial and commercial purposes. Others, like parts of the Cromarty Firth, have only recently been developed by the North Sea oil industry, although certain ports such as Invergordon have had a long tradition as naval ports. Due 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. This avoids the high costs associated with large-scale capital and maintenance dredging. Most of the numerous very small harbours in the region have fallen into decline as fishing and shipping industries have changed to larger vessels, which can operate from only a few of the larger harbours. The small harbours are now used primarily by recreational craft (for yachting and sea angling), with only a small amount of commercial fishing. Present day major harbours are shown on Map 8.3.3 and listed in Table 8.3.3, with their main activities. In addition to these sites there are 136 piers and jetties, 71 slips and 25 hards in the region. For more information on fishing ports see section 9.1.

Scrabster, near Thurso, is the main port in the north for commercial fishing and sea-angling, with fish worth over £15 million landed in 1993, and the base for the P&O ferry to Orkney. The old harbour at Thurso is a municipal port managed by Highland Council but is now little used. The council acts as the port authority for several other municipal ports and owns and operates numerous harbours, piers,

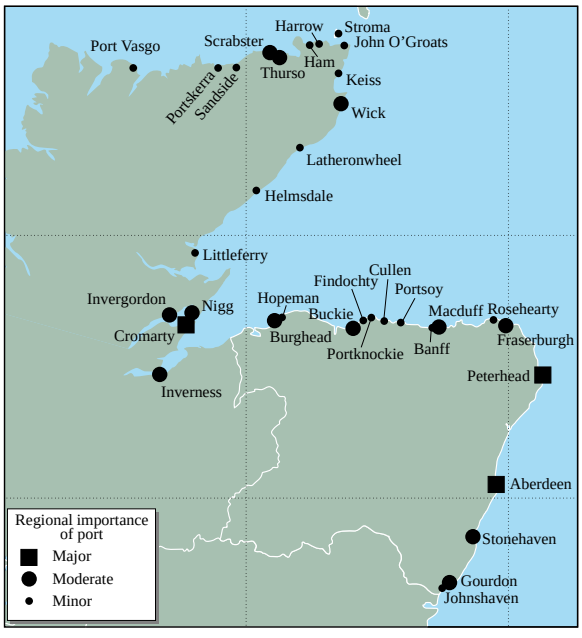
Table 8.3.2 Major areas of coastal industrial development

*Area no.**	*Site/area*	*Grid ref.*	*Details*
	Highland		
1	Dounreay	NC9967	150 ha: experimental nuclear reactor (BNFL & UKAEA) and fuel reprocessing plants
2	Thurso	ND1168	10 ha: small amount of local fisheries-associated industries; small ferry port at Scrabster
3	Castlehill/Castletown	ND1968	Flagstone industry
4	Gills	ND3272	Pier; oil terminal construction
5	Sinclair Bay, Wick	ND3667	Large pipeline fabrication/coating yard; service base
5	Wick	ND3650	10 ha: small amount of local fisheries-associated industries; offshore service base; pipeline coating yards
6	Morangie	NH7683	5 ha distillery
7	Tain	NH7882	Small fish processing plant
8	Morrich More	NH8382	Pipeline fabrication and coating yard
9	Nigg	NH7969	80 ha: large industrial complex including a large oil platform fabrication yard and a graving dock (a type of dry dock), on land claim
10	Nigg	NH7970	50 ha: large oil terminal and storage on intertidal land claim
10	Invergordon	NH7269	130 ha: large industrial jetty & dry dock; conveyor from aluminium smelter (closed 1993). 20 ha distillery just inland. Pipeline coating yards.
11	Invergordon	NH7068	24 ha Simplified Planning Zone (previously Enterprise Zone); land claim
11	Dalmore	NH6668	20 ha distillery (plus one a short distance inland)
12	Alness	NH6565	36 ha Enterprise Zone, Simplified Planning Zone
12	Alness/Dingwall areas	NH5458, NH5356	Sawmills
12	Evanton	NH6266	30 ha industrial estate, 1 km inland
13	Evanton	NH6266	Disused airport & long pier, used for large pipeline fabrication and coating yard
13	Dingwall	NH5458	Enterprise Zone, Simplified Planning Zone; industrial estate
14	Dingwall/Beauly area	NH5346, NH6145	Fish processing: one small, one large site
14	Beauly/Drumchardine areas	NH5346	Sawmills
15	Inverness	NH62	Industrial estates, airport, important light engineering industry, board mill, fish processing plants
16	Ardersier	NH8157	40 ha large oil platform construction yard
17	Nairn	NH8857	Light industry associated with traditional fishing centre including one large and one small fish processing site; sawmills
	Grampian		
18	Kinloss, Findhorn Bay	NJ0561	5 ha sewage works
19	Buckie	NJ4366	20 ha: fish market, cargo trade, boat building, marine and electronic servicing
20	Sandend Bay, Portsoy	NJ5665	5 ha distillery
21	Boyndie Bay, Banff	NJ6664	5 ha distillery
22	Macduff	NJ7064	5 ha ship repair yard, boat building & net making, 5 ha distillery
23	Fraserburgh	NK0065	Important fishing port, 10 ha industrial estate
24	St. Fergus	NK1054	120 ha large gas terminal behind dunes, natural gas pipeline, landfill
25	Peterhead	NK1244	Light industry; major North Sea fishing port/commercial port
26	Furrah Head, Peterhead	NK1243	20 ha power station (1,294 MW)
26	Cruden Bay	NK0935	Landfall for oil pipeline
27	Newburgh, Ythan Estuary	NK0025	Small shot-blasting works
28	Bridge of Don, Aberdeen	NJ9510	40 ha exhibition site, industrial estate inland
29	Aberdeen city and estuary	NJ90	Boat-building/repair yard, fish processing plant and large areas of light industry, mainly developed away from the coast (see also Table 8.3.3)
29	Stonehaven	NO8785	Traditional centre for fishing gear manufacture, 5 ha distillery on the Cowie Water, inland from Stonehaven Bay
30	Gourdon	NO8270	Marine engineering, harbour services, fish market

Source: Ordnance Survey 1:50,000 maps. Key: *area number is as shown on Map 8.3.2.

slips and jetties throughout the region. Wick is managed by a private harbour trust and used to be the busiest herring port in Europe, while John O'Groats and Helmsdale still have active shellfishing fleets. Most of the traditional fishing harbours are used for recreational activities, unless otherwise noted in Table 8.3.3. Several other smaller harbours exist along the north Highland coast, at Port Vasgo, Portskerra, Sandside, Ham, Harrow, Island of Stroma and Keiss. Along the east-facing coast are the small harbours of Scarlet Haven, Lathronwheel and Littleferry.

The former Dornoch Firth ferry crossing at Meikle Ferry has been replaced by a bridge carrying the A9. Cromarty Firth is a trust port with a port authority controlling all activity in the firth, from just below the road bridge at Findon to Fairway Buoy about 4 km from the shore, the harbours at Invergordon and Cromarty and shipping at Nigg, but not the large jetty at Saltburn, which is owned by British Alcan. Main functions of the Cromarty Firth trust port include shipping of general and bulk cargo, acting as an oil field support base, and oil rig conversion, inspection, repair and



Map 8.3.3 Ports and harbours. Sources: various.

lay up. There is a freight only 'ro-ro' (roll-on, roll off) service between Invergordon and Kirkwall (Orkney - Region 2). Inverness port, run by a harbour trust, has oil-related, general cargo and grain traffic, and has crane loading and some yacht facilities. The entrance to the Caledonian canal in the Beauly Firth is an important navigational facility.

The many small fishing harbours in Grampian include some fishing settlements with piers in small sheltered inlets. Aberdeenshire Council and Moray Council own and operate thirteen municipal ports. These include the general cargo and fishing ports of Burghead, Buckie and Macduff, the fishing and recreational harbours of Stonehaven and Gourdon, and the smaller harbours of Banff, Cullen, Findochty, Hopeman, Johnshaven, Portknockie, Portsoy and Rosehearty, which are now used mainly for recreational purposes. The other harbours in the area have their own authority or other local controlling body.

In 1994 Fraserburgh Harbour Commissioners received a £3.6 million aid package from the Scottish Office Agriculture and Fisheries Department for deepening the main entrance channel and the outer Balaclava Harbour. This will allow vessels in and out of the harbour at all states of the tide. Peterhead is a trust port where the Bay Authority handles harbourage for North Sea oil-related traffic, and Peterhead Harbour Authority manages the largest European fish market and the premier UK fish handling port, which also deals with general cargo. Aberdeen Harbour Board manages the principal commercial and passenger port for north-east Scotland. It is a trust port and has offshore oil and gas support facilities and a fishing harbour, and has facilities for bulk cargo, 'ro-ro' and heavy loads. There are domestic and international passenger terminals, for ferry routes to Shetland, Orkney and Scandinavia.

Major shipping lanes in the region run through the narrow Pentland Firth (although a voluntary tanker exclusion zone exists and very large vessels pass to the north of Orkney), parallel to the east coast of Highland and the Grampian coast and offshore across the entrance to the Moray Firth. There are no major traffic separation schemes in the region (Technica 1985).

Power generation

Intense competition has arisen since privatisation in 1990, and the majority of electricity in Scotland is now produced by Scottish Power, Scottish Hydro-Electric and Scottish Nuclear. In this region, power is generated from hydro and fossil fuel. The only operational power station on the coast is the conventional power station at Peterhead, which is ideally situated to take advantage of oil and gas piped from fields in the North Sea (see also section 9.5). Its production capacity of 1,294 MW represents approximately 12% of Scotland's total power production capacity of 10,456 MW (Scottish Power, Scottish Hydro-Electric and Scottish Nuclear pers. comm.). This combined figure for power production includes all methods of power generation plus a small amount of power produced by Scottish Power in the north-east of England (Region 5).

The UK Atomic Energy Authority's site on the coast at Dounreay no longer produces electricity but acts as a repository for spent radioactive material from its decommissioned fast breeder reactors. It also processes its own waste and some from overseas, where it is afterwards returned (UK Atomic Energy Authority pers. comm.). Dounreay also carries out de-scaling for the oil industry, removing radioactive material from used drilling equipment. Details of all radioactive waste disposal can be obtained from the Scottish Office Agriculture, Environment and Fisheries Department (Scottish Office Environment Department 1993). Map 8.3.2 shows the location of Peterhead power station and the decommissioned nuclear power station at Dounreay.

No power is produced commercially from wind energy or other renewables on this region's coastline, although wind farms have been proposed close to Helmsdale. There is less scope for wind farming on this coast than on the west coast of Britain because Britain's prevailing wind direction is south-westerly. An assessment of the potential for renewable energy in Scotland has been produced by a group of bodies, including Hydro-Electric, Scottish Power, the Scottish Office, Scottish Enterprise and the Department of Trade and Industry (DTI 1994). A report from the Energy Technology Support Unit outlines the major potential for power generation from tidal stream power in the Pentland Firth (see DTI 1994). In 1995 the first-ever commercial wave power plant and the first wave power device capable of mass manufacture, the OSPREY (ocean swell powered renewable energy), was installed off Dounreay in Caithness; it sank, owing to a design fault.

8.3.3 Information sources used

Sources of information for the section on residential development included Cook (1993), Buck (1993), the 1991 census and Ordnance Survey Landranger 1:50,000 maps. It is not always clear from these sources whether infrastructures are still in use, and therefore some of the information in this section may be out of date. The Office of Population Censuses and Surveys publishes 1991 census data on a district basis and population estimates for subsequent years based on those data (e.g. 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.

Table 8.3.3 Ports and harbours

Port	*Grid ref.*	*Details*
Highland		
Scrabster	ND1070	Fishing port, ferry to Orkney
Castlehill/Castletown	ND1968	Harbour servicing the flagstone quarries/industry
John O'Groats	ND3873	Fishing port; summer passenger ferry to Burwick, Orkney
Ackergill, Sinclair Bay	ND3554	Harbour
Broadhaven, Wick	ND3650	Harbour
Lybster	ND2434	Small harbour
Dunbeath	ND1629	Small harbour
Helmsdale	ND0315	Fishing and angling harbour
Brora	NC9103	Small harbour
Portmahomack	NH9184	Small fishing harbour
Balintore	NH8675	Small fishing and leisure harbour, salmon netting base
Nigg Ferry	NH7968	Car ferry to Cromarty
Invergordon	NH7168	Large harbour
Cromarty	NH7867	Ferry to Nigg, small harbour
Fortrose	NH7256	Small recreational harbour
Avoch	NH7055	Small harbour
Clachnaharry, Inverness	NH6446	Training walls at entrance to Caledonian Canal
Inverness	NH6745	Harbour with crane loading, container and ro-ro facilities, for oil-related, general cargo & grain traffic
Nairn	NH8857	Recreational harbour
Grampian		
Findhorn	NJ0364	Small recreational harbour
Burghead	NJ1069	Freight port exports bulk timber & malt to continent, imports sawn timber from Scandinavia
Hopeman	NJ1470	Recreational harbour
Lossiemouth	NJ2371	Fishing and commercial harbour
Portgordon	NJ3964	Recreational harbour
Buckie	NJ4366	Fishing and freight port; exports/imports of barley, timber, animal feed and salt
Findochty	NJ4668	Recreational harbour
Portknockie	NJ4868	Fishing and recreational harbour
Cullen	NJ5167	Recreational harbour
Portsoy	NJ5966	2 harbours - commercial and recreational
Whitehills	NJ6565	Fishing harbour
Banff	NJ690647	Recreational harbour
Macduff	NJ7064	Cargo & fishing port; exports/imports of barley, fertilisers, maize, distillers' dark grain and coal
Gardenstown	NJ7964	Recreational and fishing harbour
Rosehearty	NJ9367	Recreational and fishing harbour
Sandhaven	NJ9667	Recreational harbour
Fraserburgh	NK0067	Large fishing and commercial harbour
Cairnbulg	NK0365	Fishing and recreational boathaven
Peterhead	NK1346	Large fishing and commercial harbour
Peterhead Bay	NK1345	Large commercial oil-related harbour
Boddam	NK1342	Recreational harbour
Cruden Bay	NK0935	Recreational & fishing harbour
Collieston	NK0428	Recreational harbour
Aberdeen	NJ9505	Principle commercial and passenger ferry port for north-east Scotland, domestic and international passenger terminals for ferry departures to Shetland, Orkney and Scandinavia, busy fishing harbour, offshore oil, gas support and bulk cargo facilities, 'ro-ro' and heavy loads
Cove, Aberdeen	NJ9500	Small fishing harbour
Stonehaven	NO8785	Large recreational harbour
Catterline	NO8778	Small fishing and recreational harbour
Gourdon	NO8271	Fishing and recreational harbour
Johnshaven	NO7967	Fishing harbour (shellfish)

Sources: various. Note: larger sites are shown on Map 8.3.3; see also Map 9.1.1 for fishing ports.

Sources of information for industrial infrastructure were Cook (1993), Harding-Hill (1993), Ordnance Survey Landranger 1:50,000 maps, Grampian Regional Council (1992a, b, 1995) and Highland Regional Council (1989). Map 8.3.1 is adapted from the ITE (1993) Countryside Survey database, which is derived from 1990 satellite imagery. Areas represent land cover types 'urban' and 'suburban/rural development' (see notes in section 8.2.3).

Most information on ferries was derived from 1:50,000 Land Ranger Ordnance Survey maps. That on ports was derived mainly from the two national handbooks: British Ports Federation (BPF) (undated) and Sutton (1989), which may be incomplete or out of date, plus Grampian Regional Council (1995). In 1991 the BPF was replaced by the British Ports Association and the UK Major Ports Group. Lord Donaldson (1994) records that there is virtually no clear

information available on where ships go within UK waters, and that no records are kept of how many ships use UK port facilities. Under MARPOL (the United Nations' International Convention on the Prevention of Pollution from Ships), the UK must provide port facilities that are "adequate to meet the needs of ships using them and do not cause undue delay to ships". These facilities should prevent ships from discharging oil and other wastes into the sea. However, Lord Donaldson (1994) describes UK facilities as "inadequate". The UK government commissioned a survey of all UK port reception facilities for the disposal of ship's wastes (Waste Regulation Council 1995).

8.3.4 Acknowledgements

Thanks go to Scottish Power, Scottish Hydro-Electric, the UK Atomic Energy Authority and Scottish Nuclear for providing useful information.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Planning developments	
Highland	*Highland Council, tel: 01463 702000
Moray	*Moray Council, Elgin, tel: 01343 543451
Aberdeenshire	*Aberdeenshire Council, Aberdeen, tel: 01224 665106
Aberdeen City	*Aberdeen City Council, tel: 01224 522502
Economic development, redevelopment / renewal	*Highlands and Island Enterprise, Inverness, tel: 01463 234171/ 244469
European Regional Development Funds	Department of Trade and Industry, Regional Policy Division, Room 317, Kingsgate House, 66-74 Victoria Street, London SW1E 6SW, tel: 0171 215 8594
Enterprise Zones	SOAEFD, Planning Division, Victoria Quay, Edinburgh EH6 6QQ, tel: 0131 244 4082
International Maritime Organisation	4 Albert Embankment, London SE1 7SR, tel: 0171 735 7611
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
Port reception facilities	Marine Safety Agency, Spring Place, 105 Commercial Road, Southampton SO15 1EG, tel: 01703 329100
Ports	
Cromarty Firth Port Authority	*Port Office, Invergordon, tel: 01349 852308
Inverness Harbour Trust	*Inverness, tel: 01463 233291
Peterhead Bay Authority	*Harbour Office, Peterhead, tel: 01779 74020
Peterhead Harbour	*Harbour Office, Peterhead, tel: 01779 474281/2/3
Ports owned by Moray Council (Buckie, Burghead, Cullen, Findochty, Hopeman and Portknockie)	*Moray Council, Elgin, tel: 01343 543451
Ports owned by Aberdeenshire Council (Banff, Gourdon, Johnshaven, Macduff, Portsoy, Rosehearty and Stonehaven)	*Aberdeenshire Council, Aberdeen, tel: 01224 276276
Aberdeen Harbour Board	*Harbour Office, Aberdeen, tel: 01224 592571
Power generation	
Conventional power production, further details of power stations	Corporate Communications Officer, PowerGen plc, Westwood Way, Westwood Business Park, Coventry CV4 8LG, tel: 01203 424000

Type of information	*Contact address and telephone no.*
Power generation (continued)	
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
Renewable energy potential report for Scotland	*Highlands and Island Enterprise, Inverness, tel: 01463 234171
Renewable energy	Secretary, Energy Technology Support Unit (ETSU), Renewable Energy Enquiries Bureau, Harwell, Oxfordshire OX11 0RA, tel: 01235 432450
General information on wind farms	British Wind Energy Association - Scottish Branch, National Wind Turbine Centre, National Engineering Laboratory, East Kilbride, Glasgow G75 0QU, tel: 013552 72068
Radioactive waste disposal (statistical bulletin on radioactive waste disposal)	Scottish Office Agriculture, Environment and Fisheries Department, New St. Andrews House, Edinburgh EH1 3TG, tel: 0131 244 4042
Dounreay Nuclear Establishment	UKAEA, Dounreay, Thurso, Caithness KW14 7TZ, tel: 01847 804000
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
Radioactive discharges	Information Officer, National Radiological Protection Board (NRPB), Chilton, Didcot, Oxfordshire OX11 0RQ, tel: 01235 831600
Nuclear issues - general	Secretary-General, British Nuclear Forum, 22 Buckingham Gate, London SW1E 6LB, tel: 0171 828 0166
Energy production general	Education and Industry Department, Energy Division, Scottish Office, Victoria Quay, Edinburgh EH6 6QQ, tel: 0131 244 7140
Energy production general	Secretary, Institute of Energy, 18 Devonshire Street, London W1N 2AU, tel: 0171 580 7124

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

8.4 Coastal defence

S.L. Fowler

8.4.1 Introduction

Coastal defence covers two types of works: coast protection and sea (or flood) defence. Coast protection works prevent or slow the erosion of land and encroachment by the sea. Sea defences protect low-lying land from flooding by the sea or rivers, especially to preserve human life and property in coastal settlements and industrial areas; many lengths were built in the past to protect low-lying agricultural land from flooding by the sea and to allow agricultural improvement and drainage. It is sometimes difficult to differentiate between the two different categories of coastal works, particularly where they protect against both erosion and flooding, or are owned and maintained privately or by bodies that are not usually responsible for coastal defences, for example the Ministry of Defence (MoD). Because of the complexity of distinguishing between coast protection and sea defence works in this region, 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 movement, to major concrete engineering works (berms and seawalls). Some of these forms of coastal defence can provide vital 'toe' support to the base of coastal cliffs. 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). Rising sea levels from climate change and increasing frequency of storm conditions in the Atlantic and North Sea are increasing the future potential for erosion and flooding on the north coast of Scotland and decreasing the expected useful life of coastal works. 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.

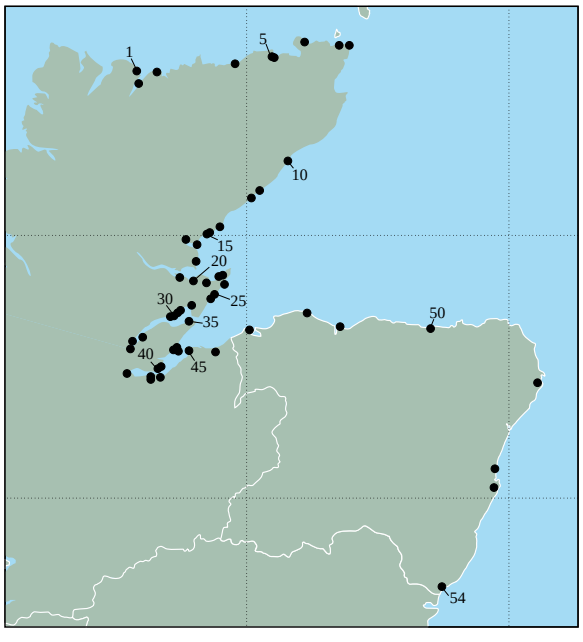
In Scotland coastal works are not uncommon on inhabited parts of the coastline, but they tend to be small in scale; for instance, many links golf courses have some form of protection. Compared with the south of Britain, this region has only a few coastal works. They are mainly built to protect coastal settlements, industrial areas, bridges, road and rail embankments, golf links and historical sites from erosion or flooding.

8.4.2 Important locations

Highland Council has recently identified 30 'complete' protection schemes, two locations where erosion has been reported but no action is possible, two locations where erosion is being monitored, and nine partial protection schemes where monitoring is continuing (Table 8.4.1; Map 8.4.1). Also shown on Map 8.4.1 and Table 8.4.1 are locations of coastal works listed in Buck (1993). The softer shores of the Moray Firth (approximately between Golspie and Burghead) comprise the most heavily protected stretch of coast in the region. In the Moray Firth as a whole, Harding-Hill (1993) records a total length of 160.9 km of coast occupied by linear structures (17.5% of the coastline) and 0.8 km (0.1%) by groynes. These figures include the linear defences associated with the bridges across the Dornoch, Cromarty and Beauly Firths. The road causeway across the Kyle of Tongue on the north Highland coast also incorporates some linear defences. Sites where coastal defence techniques are known to have been used or a perceived coastal erosion problem exists include one site of coastal erosion at Culbin Sands in Moray, five areas of coastal works in Banff and Buchan, two areas of coastal works in Aberdeen and one site of erosion, at Nigg Bay, Aberdeen (ASH Consulting Group 1994).

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 1994. In this region, departmental responsibility for flood defence and coast protection lies with the Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD). The councils in Scotland have powers as coast protection authorities under the Coast Protection Act (1949) to protect land from erosion and encroachment and to prevent flooding of non-agricultural land. Highland Council wishes



Map 8.4.1 Locations of coastal works in Region 3. Numbers refer to Table 8.4.1. Sources: Highland Regional Council pers. comm.; Grampian Regional Council pers. comm.; Buck 1993; OS Landranger maps.

Table 8.4.1 Coastal works in Region 3

No.	*Location*	*Grid ref.*	*Notes*
1	Talmine	NC5862	Partial protection; monitoring ongoing
2	Kyle of Tongue Bridge	NC5659-NC5858	Linear defences
3	Skerray burial ground	NC6663	Partial protection; monitoring ongoing
4	Fresgoe House at Reay	NC9566	Complete protection scheme
5	Scrabster	ND1070	Partial protection; monitoring ongoing
6	Thurso	ND1168	Partial protection; monitoring ongoing
7	Brough	ND2174	Complete protection scheme
8	Huna	ND3673	Complete protection scheme
9	John o' Groats	ND3873	Complete protection scheme
10	Dunbeath	ND1629	Complete protection scheme
11	Helmsdale	ND0215	Complete protection scheme
12	Portgower	ND0013-ND0113	Complete protection scheme
13	Brora	NC9003-NC8701	Complete protection scheme
14	Dunrobin Castle	NC8500	Partial protection; monitoring ongoing
15	Golspie	NH8399	Partial protection; monitoring ongoing
16	Littleferry	NH8095	Complete protection scheme
17	Cambusmore	NH7797	Sea wall
18	Dornoch golf course	NH8090	Complete protection scheme
19	Dornoch Firth Bridge	NH7484-NH7486	Linear defences
20	Tain golf course	NH7982	Complete protection scheme
21	Inver	NH8682	Complete protection scheme
22	Balnabruach	NH9084	Complete protection scheme
23	Portmahomack	NH9184	Complete protection scheme
24	Rockfield	NH9282	Partial protection; monitoring ongoing
25	Hilton of Cadboll	NH8776	Complete protection scheme
26	Balintore	NH8675	Partial protection; monitoring ongoing
27	Nigg Bay	NH8073	Sea wall
28	Barbaraville	NH7472	Complete protection scheme
29	Balintraid	NH7370	Complete protection scheme
30	Saltburn	NH7269	Complete protection scheme
31	Invergordon	NH7068	Complete protection scheme
32	Dingwall	NH5558	Complete protection scheme
33	Conon-Bridge	NH5455	Complete protection scheme
34	Cromarty Firth Bridge	NH5960-NH5862	Linear defences
35	Cromarty	NH7867	Complete protection scheme
36	Rosemarkie, Kincordie housing development	NH7357	Complete protection scheme
37	Chanonry Point golf club	NH7455	Partial protection; monitoring ongoing
38	Fortrose	NH7256	Complete protection scheme
39	Kilmuir	NH6749	Complete protection scheme
40	Kessock Bridge	NH6746-NH6647	Linear defences
41	North Kessock	NH6447	Complete protection scheme
42	Tarradale	NH5548	Sea wall
43	Clachnaharry	NH6446	Complete protection scheme
44	Inverness	NH6746	Complete protection scheme
45	Ardersier	NH7855	Complete protection scheme
46	Nairn golf course	NH8555	Complete protection scheme
47	Findhorn	NJ0364	Linear defence
48	Lossie Estuary	NJ2567	Linear defences
49	Spey Bay	NJ3465	Linear defences
50	Banff Bay	NJ6964	Linear defences
51	Peterhead	NK1244	Defences monitored
52	Don Estuary	NJ9509	Linear defences
53	Dee Estuary	NJ9202	Linear defences
54	St. Cyrus	NO7564	Linear defences

Sources: Highland Regional Council pers. comm.; Grampian Regional Council pers. comm.; OS Landranger maps; Buck 1993. Note: numbers refer to Map 8.4.1.

to increase its annual spend on sea defences from £120,000 to £250,000 to take account of increasing erosion rates, which may be due to increased storminess and wave height. Other councils have programmes of new capital coastal works and maintenance of existing defences. Several methods of beach protection have been proposed for an area of coast at the mouth of the Spey as emergency protection for housing; all the proposed methods have the potential to affect the natural dynamics of the coastal system. This weak spot is one of the main 'problem areas' on this part of the coast and is monitored annually by the council. There are also some coast defence problems at Peterhead, which are being monitored and dealt with by the council. Grampian Regional Council has also regularly monitored existing defences, particularly in problem areas.

There are no formal regional coastal (engineering) groups in Scotland (see section 10.2). However a shoreline management plan, analogous to those in preparation in

England and Wales, is currently being prepared by HR Wallingford for a consortium headed by Highland Council, covering the coastline of the Inner Moray Firth eastwards to Burghead (HR Wallingford 1995). One recommendation of the plan is the formation of a coastal research group.

8.4.4 Information sources used

The main areas of coastal erosion and protection schemes in Highland were mapped by the Regional Council in December 1992. Grampian Regional Council were preparing a list of coastal defences in the region for entry to a database. Further information is now available from the Moray, Aberdeenshire and Aberdeen City Councils.

Hydraulics Research are conducting 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. 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 to set 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).

The Scottish Office has not undertaken any overall review of coastal works (whether policies, location or requirements), although they have published a discussion paper regarding a general coastal strategy (SOAEFD 1996).

ASH Consulting Group (1994) has provided a list of some sites where coastal defence techniques are known to have been used or a coastal erosion problem is perceived.

8.4.5 Acknowledgements

The assistance of the Councils and Harbour Authorities is gratefully acknowledged. Thanks are also due to Dr George Lees, Scottish Natural Heritage, for his useful comments.

8.4.6 Further sources of information

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

B. Further reading

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Swash, A.R.H., Leafe, R.N., & Radley, G.P. 1995. Shoreline management plans and environmental considerations. *In: Directions in European coastal management*, ed. by M.G. Healy and J.P. Doody, 161-167. Cardigan, Samara Publishing Ltd.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Flood defence and coast protection policy, grants towards capital expenditure	*Scottish Office Agriculture, Environment and Fisheries Department, Edinburgh, tel: 0131 244 4042
Coast protection and flood defence - Highland	*Highland Council, Inverness, tel: 01463 702000
Coast protection and flood defence - Moray	*Moray Council, Elgin, tel: 01343 543451
Coast protection and flood defence - Aberdeenshire	*Aberdeenshire Council, Aberdeen, tel: 01224 682222
Coast protection and flood defence - Aberdeen City	*Aberdeen City Council, tel: 01224 276276
Storm tide warning service	Meteorological Office, Johnstone House, London Road, Bracknell, Berkshire RG12 2SZ, tel: 01344 420242
Coastal Engineering Research Advisory Committee	International Council for the Exploration of the Sea, Palægade 2-4, DK-1261, Copenhagen K, Denmark
Coastal Engineering Advisory Panel	Anne-Marie Ferguson, Institute of Civil Engineers, Great George Street, London SW1P 3AA, tel: 0171 222 7722

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

The rivers and coastal waters of the region are amongst the most important in the UK for salmon, grilse and sea trout catches. More than a third of all recorded salmon catches on the North Sea coast are landed here. The picture shows stake nets set for salmon, off the mouth of the River North Esk, St. Cyrus. Photo: Pat Doody, JNCC.

Chapter 9 Human activities

9.1 Fisheries

D. Murison & C.F. Robson

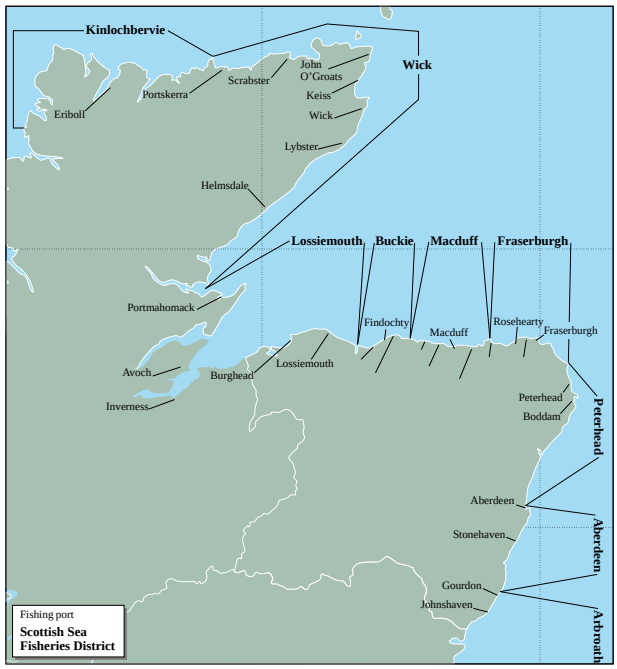
9.1.1 Introduction

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 in Map 9.1.1. The ports where the largest landings are made are Faserburgh, Peterhead and Aberdeen.

The region is of major national importance for its fisheries. In 1992, 33.4% of all recorded landings of fish and shellfish species in Britain and the Isle of Man were made in this region, a higher percentage than for any other region. The total tonnages of pelagic, demersal and shellfish species landed in the region represent 25.8%, 49.1% and 10.1% respectively of the British totals. Of the demersal fish (the species group with the largest totals), landings of some species, notably gadoids such as haddock (73.7%), saithe (65.8%) and whiting (70.4%), represent even higher proportions of the British totals for these species. A summary of the totals for pelagic, demersal and shellfish species is given in Table 9.1.1.

Approximately 88% of all fish landed in the region in 1992 was landed in the fisheries districts of Fraserburgh, Peterhead and Aberdeen. Table 9.1.2 summarises landings to these districts 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.



Map 9.1.1 Fishing ports and Scottish Sea Fisheries Districts. Source: SOAFD (1995a). © Crown copyright.

Three diadromous species - salmon, sea trout and eel - support fisheries in the region, the most important of which are for salmon (and grilse, which are salmon that have spent not more than one winter at sea before maturing) and sea trout. The famous fishing rivers of the Spey and Dee are in the region. In the Scottish Salmon Fishery Statistical Districts in the region (Map 9.1.2), salmon (including grilse) and sea trout support rod-and-line fisheries from rivers, as well as netting stations along the coast. As shown in Table 9.1.3, a very large percentage of the Great Britain recorded catch of salmon and grilse is from this region, although the percentage for sea trout is not quite as high.

Table 9.1.1 Species group landings in 1992 (tonnes)

Species group	*Region 3*	*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	65,143	184,309	227,669	252,335	35.3	25.8
Demersal	135,231	228,056	193,914	275,460	59.3	49.1
Shellfish	10,636	61,933	46,112	104,917	17.2	10.1
All species	***211,010***	***474,298***	***467,695***	***632,712***	***44.5***	***33.4***

Source: Ministry of Agriculture, Fisheries and Food (1994); Scottish Office Agriculture and Fisheries Department (1993); Isle of Man Department of Agriculture, Fisheries & Forestry (pers. comm.). Note: amounts landed are rounded up to the next whole tonne. 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 3 main fisheries districts 1991 - 1994 (thousands of tonnes)

	1991	*1992*	*1993*	*1994*
Fraserburgh	27.0	32.2	40.9	31.4
Peterhead	130.2	121.2	130.5	129.4
Aberdeen	36.0	32.5	36.0	35.0
Region 3 main districts	***193.2***	***185.9***	***207.4***	***195.8***
Scotland	458.4	467.7	491.8	487.8
% of Scottish total landed in Region 3 main districts	42	40	42	40

Sources: MAFF 1994, 1995a, b. Key: [a]landings totals relate to 'nominal live weight', i.e. weight of the whole fish.

Table 9.1.3 Average catch (numbers of fish) of salmon and grilse and sea trout 1989 - 1993

Totals	*Salmon and grilse*	*Sea trout*
Region 3	74,128	23,192
North Sea coast	196,247	104,789
Scotland	187,481	65,468
GB	***254,829***	***141,813***
% of North Sea coast total in region	37.7	22.6
% of GB total in region	28.9	16.6

Source: 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

Traditionally, the fishing fleets from ports in the region travelled widely around the British Isles and adjacent waters in search of fish. Vessels from Aberdeen formerly participated in the distant water fisheries off Iceland and the Faroe Islands, while vessels fishing for herring and mackerel once fished off East Anglia and in the western English Channel. Present-day, largely inshore, fishing activity is summarised below.

Pelagic species

Table 9.1.4 gives the quantities of various pelagic species landed in the region in 1992, compared with landings nationally. Large purse-seiners and pelagic trawlers based

Map 9.1.2 Scottish Salmon Fishery Statistical Districts. Source: Scottish Office (1994). © Crown copyright.

at ports within the region participate in the North Sea and west coast herring and west coast mackerel fisheries, landing most of their catch at Peterhead, Fraserburgh and Aberdeen. The region is important for fish processing, and species such as argentines - used for producing fish-based products such as fish meal - are landed to the larger ports where these facilities are based. Nearly half (42.3%) of the recorded British total herring landings are made into the region, and landings of mackerel are also high. Fraserburgh is also the base for a modest handline fishery from small boats for mackerel. A sprat fishery previously existed on the inshore grounds of the Moray Firth and off the Aberdeenshire coast. However, reduced availability of sprat and restrictions on herring bycatch in recent years have meant that fishing effort is reduced. 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.

Table 9.1.4 Pelagic species landings in 1992 (tonnes)

Species group	*Region 3*	*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*
Herring	36,268	74,706	83,879	85,650	48.5	42.3
Horse mackerel	0	1,374	473	1,499	0	0
Mackerel	28,748	95,366	141,583	150,726	30.1	19.1
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	***65,143***	***184,309***	***227,669***	***252,335***	***35.3***	***25.8***

Source: Ministry of Agriculture, Fisheries and Food (1994); Scottish Office Agriculture and Fisheries Department (1993); Isle of Man Department of Agriculture, Fisheries & Forestry (pers. comm.). Note: amounts landed are rounded up to the next whole tonne. 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 group	*Region 3*	*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	4,120	7,449	9,657	13,348	55.3	30.9
Skates and rays	1,558	3,816	3,670	7,827	40.8	19.9
Gadoids						
Cod	27,201	53,440	35,898	59,524	50.9	45.7
Haddock	39,492	49,221	49,867	53,586	80.2	73.7
Hake	404	589	1,993	3,620	68.6	11.2
Ling	3,005	4,594	4,318	6,027	65.4	49.9
Pollack (lythe)	890	1,921	1,285	3,023	46.3	29.4
Saithe	8,286	11,032	10,310	12,602	75.1	65.8
Whiting	28,910	36,733	35,923	41,055	78.7	70.4
Whiting, blue	2,961	6,531	6,531	6,531	45.3	45.3
Flatfish						
Brill	30	317	50	443	9.5	6.8
Dab	406	1,017	759	1,215	39.9	33.4
Dover sole	8	2,021	57	2,876	0.4	0.3
Flounders	P	167	4	273	-	-
Halibut	81	166	114	194	48.8	41.8
Halibut, Greenland	2	119	20	137	1.7	1.5
Lemon sole	1,808	5,004	2,566	5,573	36.1	32.4
Megrim	1,064	1,379	2,566	4,037	77.2	26.4
Plaice	5,453	20,749	7,902	23,887	26.3	22.8
Turbot	123	561	196	742	21.9	16.6
Other species						
Catfish	1,217	1,896	1,378	1,935	64.2	62.9
Conger eel	15	99	107	510	15.2	2.9
Gurnard	6	368	32	627	1.6	1.0
Monkfish/angler	6,511	9,813	11,557	14,678	66.4	44.4
Redfish	112	718	193	774	15.6	14.5
Sand eel	0	4,152	4,152	4,152	0	0
Torsk (tusk)	113	165	194	207	68.5	54.6
Witch	1,203	1,405	1,789	1,981	85.6	60.7
Others	159	2,419	682	3,833	6.6	4.1
Fish roes	93	195	144	243	47.7	38.3
Total	***135,231***	***228,056***	***193,914***	***275,460***	***59.3***	***49.1***

Source: Ministry of Agriculture, Fisheries and Food (1994); Scottish Office Agriculture and Fisheries Department (1993); Isle of Man Department of Agriculture, Fisheries & Forestry (pers. comm.). Key: P = species landed in the region in small quantities (here <0.5 tonnes); - = % not calculated. Note: amounts landed are rounded up to the next whole tonne. 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.

Demersal species

Table 9.1.5 gives the quantities of various demersal species landed in 1992 in the region, compared with landings nationally. Otter trawl, demersal pair trawl and seine net are the main methods used. Gadoid species such as cod, haddock, whiting and saithe are the main species targeted and landed at ports within the region, from fisheries covering much of the northern North Sea and off the north-west of Scotland. The few distant-water trawlers based at Aberdeen still participate in the cod fisheries along the northern Norwegian coast, while throughout the area small vessels (<10 m length) use handlines to fish for cod on inshore grounds. Smaller quantities of flatfish (mainly plaice and lemon sole), rays and dogfish are also landed. A small number of beam trawlers based at ports in the area fish for flatfish (mainly plaice) on various grounds in the North Sea. In recent years an important fishery for monkfish (angler fish) and deep water flatfish (megrim and witch) has developed. This fishery is pursued on grounds in the northern North Sea and along the continental shelf edge to the north and west of Scotland.

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*. Vessels fishing for *Nephrops* from ports within the area work grounds in the Southern Trench (Moray Firth) and more distant grounds in the Fladen Grounds, Buchan Deeps and off the Coup (Orkney).

The other major shellfish fishery that takes place in the region is dredging for scallops. Scallops have been fished from the Moray Firth for 25 years, but in the past few years the fishery has been extended to grounds off Stonehaven

Table 9.1.6 Shellfish landings* in 1992 (tonnes)

Species	*Region 3*	*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	135	26,199	2,546	32,047	0	0.4
Crabs	295	9,117	7,501	16,970	3.0	1.7
Lobsters	23	622	564	1,069	2.6	2.2
Mussels	2,388	4,865	3,067	6,555	0	36.4
Nephrops	4,953	8,368	17,707	19,639	0.3	25.2
Periwinkles	21	315	1,837	1,907	1.3	1.1
Queen scallops	0	2,207	5,518	11,273	2.4	0
Scallops	1,836	4,519	5,068	8,290	11.8	22.1
Shrimps	116	615	180	743	0	15.6
Squids	535	1,382	1,071	2,005	4.8	26.7
Whelks	216	1,905	858	2,393	9.7	9.0
Others	118	1,819	195	2,026	0	5.8
Total*	***10,636***	***61,933***	***46,112***	***104,917***	***1.9***	***10.1***

Source: Ministry of Agriculture, Fisheries and Food (1994); Scottish Office Agriculture and Fisheries Department (1993); Isle of Man Department of Agriculture, Fisheries & Forestry (pers. comm.). Key: *excluding landings of farmed shellfish - see section 9.2. Note: 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.

and Montrose. The scallop fisheries in the region attract large numbers of vessels from other Scottish regions and from England and the Isle of Man during the summer months.

Creel fisheries for lobster, edible crab and velvet crab operate throughout the region. The lobster and velvet crab fisheries are largely on rocky areas generally very close inshore, while the edible crab fisheries concentrate on softer substrates in slightly deeper water.

Molluscan fisheries include a large mussel fishery in the Dornoch Firth, a razor shell fishery in the Moray Firth, and periwinkle gathering, which is carried out throughout the region. In the past, several other small molluscan fisheries have taken place in the region, such as cockle gathering in the Cromarty and Dornoch Firths and Culbin Bay.

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, most diadromous fisheries in the region operate in estuaries or in rivers, rather than the open coast. Table 9.1.7 shows the average numbers of salmon and grilse and sea trout caught in the region's statistical districts 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 an 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 is the Scottish Federation of Sea Anglers, which has approximately 64 affiliated clubs and approximately 200 additional personal members, who are

Table 9.1.7 Salmon and grilse and sea trout five-year (1989-1993) average catch (as numbers of fish reported to SOAEFD)

Scottish Salmon Fishery Statistical District	*Salmon & grilse*	*Sea trout*
Hope & Grudie[a]	416	662
Naver & Kinloch[a]	2,025	39
Halladale & Strathy[a]	6,849	31
Thurso & Forss[a]	5,441	12
Berriedale to Wick[b]	1,314	30
Helmsdale	1,930	492
Fleet & Brora[a]	522	340
Kyle of Sutherland	8,420	410
Conon & Alness[a]	4,038	587
Beauly	1,305	227
Ness	1,889	398
Nairn	194	203
Findhorn	3,567	190
Lossie	1,012	917
Spey	15,080	9,816
Deveron	3,042	1,286
Ugie	351	1,490
Ythan	2,970	2,290
Don	2,742	880
Dee (Aberdeen)	11,021	2,894
Region 3	***74,128***	***23,192***

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; [b]Statistical District covers the two named Salmon Fishery Districts plus those in between. See also Map 9.1.2. Data for the North Esk and Bervie District, part of which is in this region, are given in Region 4.

not always members of affiliated clubs. Orton (1994) lists contact addresses for fishing clubs in the region and national angling organisations.

In Region 3, sea angling occurs in many places. From Wick, for example, angling is mostly for conger, pollack, saithe, cod, haddock, mackerel and flatfish, with the best months being from June to September. There is excellent sea angling for cod off Noss Head. Portmahomack and off the Easter Ross coast have good sea angling for cod, ling and pollack and two charter vessels take anglers to the wrecks and reefs offshore. The Moray Firth is a popular area for sea angling, most of which occurs from the two piers at Nairn harbour, but also from the two charter vessels operating out of Nairn. Lossiemouth has notable sea trout angling off its east and west beaches. Excellent angling is to be had from rocks at Aberdeen, for cod, saithe, mackerel, whiting, haddock and flatfish species. Stonehaven also has good fishing from rocks for haddock, flounder and mackerel. Orton (1994) also gives information on further sea fishing stations in the region, the facilities available and potential catch species.

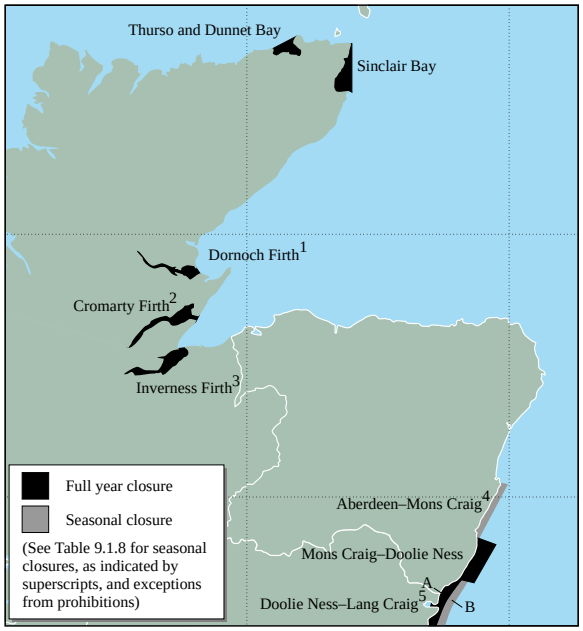
Bait collection

Bait collection for sea angling occurs in many areas in the region, although some areas are more prolific than others and may attract commercial collectors. Anglers often collect their own bait locally, while commercial collectors travel in teams to suitable shores. Many species are collected, including ragworm, lugworm, peeler crabs (moulting shore crabs), mussels, cockles, limpets 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 Scrabster, Loch Fleet, Cromarty and Beauly Firths, Moray Firth, Banff Harbour and the Ythan Estuary. At the time of the survey (1985) this was mainly occasional non-commercial exploitation, but the commercial collection of bait species has recently been prohibited from four areas in the region as part of a Nature Conservation Order (see section 5.5.3 for a list of sites and further details).

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



Map 9.1.3 Full year and seasonal closures on the use of mobile fishing gear. 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.

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 are part of three 'divisions': Divisions VIa (West of Scotland), IVa (Northern North Sea) and 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

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*	*Areas of water within:*	*Exceptions to prohibition*
Thurso and Dunnet Bay	Full year	Embayments	None
Sinclair Bay	Full year	Embayments	None
Dornoch Firth	Full year	Embayments	[1]Dredging (except suction dredging for mussels)
Cromarty Firth	Full year	Embayments	[2]Dredging (except suction dredging for cockles and mussels)
Inverness Firth	Full year	Embayments	[3]Dredging (except suction dredging for cockles and mussels)
Aberdeen to Mons Craig	[4]Seasonal (closed October to March inclusive)	1/2 nautical mile from mean high water	None
Mons Craig to Doolie Ness	Full year	2 nautical miles from mean high water	None
Doolies Ness to Lang Craig	[5]A: full year	1/2 nautical mile from mean high water	None
	[5]B: seasonal (closed October to March inclusive)	Between 1/2 and 1 nautical mile from mean high water	None

Source: the Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 1989. Note: superscript numbers refer to those on Map 9.1.3. Key: *mobile fishing gear includes gear such as a trawl, Danish seine or similar net, purse seine, ring net or dredge, including suction dredge. A suction dredge is 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.

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 1994 for each species in the three ICES statistical divisions in the region are given in SOAFD (1995a), 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 nine 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 3 miles from baselines), the principle 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 eight areas in the region, made under the Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 1989, issued under the Inshore Fishing (Scotland) Act 1984.

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. There are currently no Regulating Orders in Scotland, compared with a total of nine in Britain covering approximately 215,889 ha (as at July 1995) (MAFF 1995c). 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.

Fishermen's Organisations, such as the Scottish Fishermen's Federation, 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, such as Highland Council, have a role in providing infrastructure and support to the fishing industry (Hooper & MacDiarmid 1991). Similarly Highlands and Islands Enterprise helps to develop and supports the fishing industry (Highlands and Islands Enterprise 1993).

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. The list does not include North Esk and Bervie District, the data for which are given in Region 4. 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, such as the Dee Salmon Fishing Improvement Association; this has produced the *Dee salmon action plan* and the *Dee conservation code*, which are supported by 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 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 1994* (SOAFD 1995b). Numbers of full-time and part-time fishermen resident in Sea Fisheries Districts within the region are also given in this annual publication.

Pelagic, demersal and shellfish species

Statistics given in this section are for landings recorded in the region in 1992, not estimated catches made in the region. 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 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 and 1994 are available in SOAFD (1994, 1995a).

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 Kinlochbervie and Arbroath Sea Fisheries District within Region 3 were provided by SOAEFD.

The landings for the Sea Fisheries Districts have been combined to give the figures in the 'Region 3' 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'.

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 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 catches for each individual Salmon Fishery Statistical District (Map 9.1.2) and is published annually (SOAFD 1990; SO 1991-1995).

Sea angling

In the 84th edition of *Where to fish*, Orton (1994) lists much useful information relating to angling, including the locations from which various species of fish can be caught.

Bait collection

Bait collection is discussed by Fowler (1992), who presents results from a survey around the coast of Britain in 1985.

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 (MAFF DFR), Mike Pawson (MAFF DFR), 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 David Dunkely (SOAEFD Montrose Field Station), David McKay (SOAEFD Marine Laboratory) and David Donnan (Scottish Natural Heritage) 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	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, PO Box 101, Victoria Road, Aberdeen AB9 8DB, 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, 731 Lothian Road, Edinburgh EH3 AA2, tel: 0131 228 4181
Research and fishing gear technology	Sea Fish Industry Authority, 18 Logie Mill, Logie Green Road, Edinburgh EH7 4HG, tel: 0131 5583331
Representation of fishermen's and boat owners' interests inthe Scottish fishing industry	Scottish Fishermen's Federation, 16 Bon Accord Crescent, Aberdeen AB1 2DE tel: 01224 582583
Shellfish production (commercial)	Director, Shellfish Association of the UK, Clerk, Fishmongers Hall, London Bridge, London EC4R 9EL, tel: 0171 6263531
Affiliated sea angling clubs	Secretary, Scottish Federation of Sea Anglers, Caledonia House, South Gyle, Edinburgh EH12 9DQ, tel: 0131 7177192
Game fishing	Director, Salmon and Trout Association, Fishmongers Hall, London Bridge, London EC4R 9EL, tel: 0171 2835838
Interaction between fisheries and non-fisheries conservation issues	*Marine Advisory Officer, Marine Fisheries Task Group, c/o JNCC, Peterborough, tel: 01733 62626
Interaction between fisheries and non-fisheries conservation issues	*Aquatic Environments Branch, SNH HQ, Edinburgh, tel: 0131 554 9797
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, c/o University College Scarborough, Filey Road, Scarborough YO11 3AZ, 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. In this region mariculture occurs in Loch Eriboll, Kyle of Tongue, Dornoch Firth, Cromarty Firth and the Inner Moray Firth.

9.2.2 Locations and species

Map 9.2.1 shows the location of commercial mariculture areas and the species that are cultivated in the region. Table 9.2.1 lists the main species that are under commercial cultivation in the region and in Great Britain and the Isle of Man. There is currently no cultivation of polychaetes in the region.

Table 9.2.1 Main species that are cultivated in the region and in Great Britain

Species	*Species status*	*Cultivated in region?*
Salmonids		
Atlantic salmon *Salmo salar*	Native	✔
Sea trout *Salmo trutta*	Native	
Non-salmonids		
Turbot *Psetta maxima*	Native	
Halibut *Hippoglossus hippoglossus*	Native	
Shellfish: bivalve molluscs		
Common mussel *Mytilus edulis*	Native	✔
Native oyster *Ostrea edulis*	Native	
Pacific oyster *Crassostrea gigas*	Un-established introduction	✔
Hard shelled 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: Crown Estates Commissioners & SOAEFD (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.

Salmonids

There are three salmonid farm sites within the region, in Loch Eriboll, South Sutor (Cromarty) and Avoch Bay (Inner Moray Firth) (Map 9.2.1). These sites produced approximately 1,000 tonnes in 1992, out of a total of 13,980 tonnes in Highland Region (SOAEFD pers. comm.). There may also be other sites that are leased for salmon farming but not currently used for cultivation. Table 9.2.2 shows the production of salmon in Highland compared with the whole of Scotland; both have shown steady increases in production since 1992 (SOAFD 1995a).

Map 9.2.1 General location of mariculture areas and species in culture. Sources: Crown Estates Commissioners (pers. comm.), SOAEFD (pers. comm.), La Tene Maps (1995a, b).

Table 9.2.2 Employees and annual production (tonnes) in 1994 of salmon at sea sites

	No. of staff	*Annual production*
Region 3 (Highland)	466	25,003
Scotland	1,245	64,066

Source: SOAFD 1995a. Notes: number of staff includes full time and part time staff. Highland also includes important salmon farming areas outside Region 3.

Highland as a whole produces the greatest tonnage of salmon in Scotland, but most production occurs outside this region in the west coast sea lochs (Regions 15/16).

Shellfish

Shellfish farming in Scotland has developed significantly in the last ten years, but the number of active shellfish companies has now decreased slightly since its peak in 1990. The distribution of the shellfish farm sites and the species farmed in the region are shown on Map 9.2.1. A total of 206 tonnes of mussels were harvested from the Dornoch Firth from the 'relaying' of mussel beds with spat in 1992, and 500 tonnes were 'redeposited'. At the Udale Bay site in the Cromarty Firth the mussels are cultivated on ropes. The Pacific oyster farm in Loch Eriboll produced 0.3 tonnes of Pacific oysters in 1992. Table 9.2.3 shows the results of the 1994 SOAEFD survey of shellfish companies. There may also be other sites that are leased for shellfish farming but not currently used for cultivation.

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 the 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.

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 licence must be sought from the Crown Estate Commissioners (CEC), since it owns or manages 55% of the foreshore and the same proportion of the beds of tidal rivers between mean high and low water in Great Britain, together with virtually the entire territorial sea bed. These licences 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 CEC at their office in Edinburgh. If the intended structures are potentially hazardous to navigation the Department of Transport must also authorise their construction. If they are to be above mean low water 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.

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 a named molluscan shellfish species; none has been granted in this region, although one application, for scallops, is being considered for Loch Eriboll (SOAEFD pers. comm.). 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 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. Registration of fish farming and shellfish farming businesses in Scotland with SOAEFD within two months of starting operations is required by 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 created the potential for eider ducks, which feed on mussels, increasingly to predate the farmed shellfish, causing a conflict between interests in the area. This can be minimised if shellfish farmers take the precautions outlined in Galbraith (1992).

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. This subject is an active research and monitoring area in Scotland and other northern European

Table 9.2.3 Scottish shellfish companies 1994 production* (weight of shellfish in tonnes)

	No. of companies	*No. of staff*	*Pacific oysters*	*Native oysters*	*Mussels*	*Queen scallops*	*Scallops*
Region 3 (Highland)	83	131	24	<1	211	38	26
Scotland	196	337	273	14	728	68	48

Source: SOAFD 1995b. Key: *'production' is that for sale for the table, or for ongrowing by other companies. Note: except for mussels, which are recorded in tonnes, the following average weights of individuals have been used to convert numbers of individuals to (next whole) tonnes: Pacific and native oyster - 80 g, queen scallop - 40 g, scallop - 120 g. Number of staff includes full time, part time and casual staff. Highland also covers an area outside Region 3.

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, 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 Dr P.D. McGovern (Crown Estate), Colin Wishart (Highland Council), Derek Murison (SOAEFD) and David Donnan (Scottish Natural Heritage) 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, Pentland House, 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, PO Box 101, Victoria Road, Aberdeen AB9 8DB, tel: 01224 876544
Leases	The Crown Estate Commissioners, Crown Estate Office, 10 Charlotte Square, Edinburgh EH2 4DR, tel: 0131 226 7241
Discharge consents and water quality	*Scottish Environment Protection Agency (SEPA), North Region HQ, Dingwall, tel: 01349 862021
Market research and technical advice on shellfish purification (depuration)	Sea Fish Industry Authority, 18 Logie Mill, Logie Green Road, Edinburgh EH7 4HG, tel: 0131 5583331
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 6263531
Interaction between mariculture activities and	*Aquatic Environments Branch, SNH HQ, Edinburgh, tel: 0131 554 9797
Interaction between mariculture activities and marine nature conservation	*Marine Advisory Officer, Marine Fisheries Task Group, c/o 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

C.A. Crumpton & M.J. Goodwin

9.3.1 Introduction

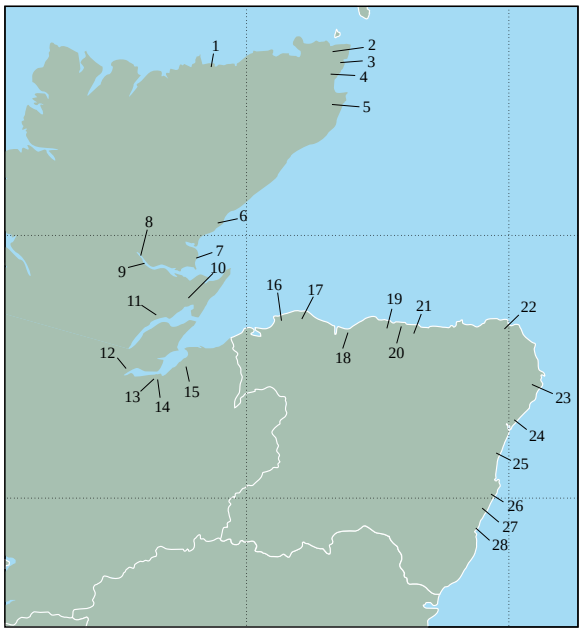
In this section, quarries are included as coastal if they are less than 2 km inland, and landfill sites if they are in a coastal 10 km square. The minerals quarried in the region on a commercial basis are sand and gravel, sandstone, igneous rock and limestone. These minerals have a variety of uses, including concrete mix, roadstone and other constructional uses.

Table 9.3.1 presents production levels by whole local authority region, compared with British levels, for the main minerals quarried in Region 3. The sand and gravel and crushed rock industry in Scotland produces over 30 million tonnes of material annually for the construction industry (Scottish Office 1995). The environmental implications of this economically significant level of production are increasingly being recognised, highlighted by their discussion (for England) in Minerals Planning Guidelines (MPG) 6 (Department of the Environment 1994).

Because of the bulkiness of the product, aggregate is normally produced locally, to keep distribution costs down. Aggregate is, however, also produced from the region on a much larger scale for export to south-east England and other areas. Interest is growing in developing, within the rest of the north of Scotland, large-scale coastal quarries similar to the Glensanda Quarry (Region 16) (Highland Regional Council 1992), but none is planned for this region.

9.3.2 Important locations

Approximately one third of the mineral workings in Highland and Grampian are located on the coast, with aggregate the main resource exploited. There are 28 coastal quarries in this region (Table 9.3.2; Map 9.3.1). They extract igneous rock (eleven quarries), sandstone (four), sand and gravel (seventeen), limestone (one) and gneiss (one). Sand and gravel extraction occurs throughout the region. The only metamorphic rock quarry in the region is at the head of the Dornoch Firth. Most of Region 3's sandstone extraction occurs in north-east Highland, with one quarry in Grampian. All igneous rock extraction and the only limestone quarry in the region are in Grampian. Grampian is the second busiest region in Scotland in terms of numbers of aggregate workings - 19.3% of the total number in



Map 9.3.1 Coastal quarries. Numbers refer to Table 9.3.2. Sources: BGS (1994), Highland Regional Council, SNH. © Crown copyright.

Scotland. Of equal importance are the fourteen sites (four in Highland and ten in Grampian) held for future use in the region - 35% of the number held in Scotland as a whole.

Map 9.3.2 shows the location of the region's currently used coastal landfill sites, according to Aspinwall's Sitefile Digest (Aspinwall 1994); the status codes are defined in Table 9.3.3. Most coastal landfill sites are clustered around centres of population and industry, such as Peterhead and Aberdeen, but they are more dispersed along the north-facing Grampian coast and the Highland coast.

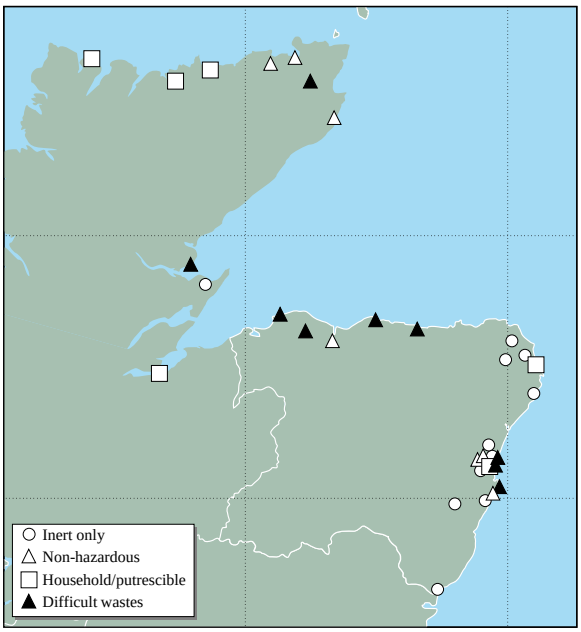
9.3.3 Management

The British Geological Survey estimates that, in the period 1992-2006, demand for land-won aggregates in England will be about 3.1 billion tonnes, of which 1.2 billion tonnes will comprise sand and gravel and 1.9 billion tonnes crushed rock (BGS 1995). A further 1.1 billion tonnes is expected to be derived from imports into England from Scotland and

Table 9.3.1 Minerals production* in Region 3 (1993)

	Limestone		*Sand & gravel*		*Igneous rock*		*Sandstone*	
	Tonnes	*% of GB total*	*Tonnes*	*% of GB total*	*Tonnes*	*% of GB total*	*Tonnes*	*% of GB total*
Highland	79,000	<0.1	1,173,000	1.3	5,450,000	11.1	196,000	1.6
Grampian	136,000	<0.1	1,876,000	2.1	1,543,000	3.1	202,000	1.7
Region 3	***215,000***	***0.2***	***3,049,000***	***3.4***	***6,993,000***	***14.2***	***398,000***	***3.3***
Scotland	1,432,000	1.4	11,359,000	12.7	20,806,000	42.3	1,716,000	14.2
Great Britain	105,885,000		89,470,000		49,209,000		12,100,000	

Main source: Central Statistical Office (1994). Key: *amounts rounded up to next whole thousand tonnes.



Map 9.3.2 Coastal landfill sites. Source: Sitefile Digest (Aspinwalls 1994).

Wales, or from marine sources, or from secondary and recycled materials. These figures, if realised, would represent a significant shift in production since the late 1980s, from onshore quarrying towards the use of imported and secondary materials. In order to help meet the extra demand, the development of a number of large coastal quarries is envisaged, although none is planned for this region.

In April 1996, the Scottish Environment Protection Agency (SEPA) came into operation, under the Environmental Protection Act. The region falls entirely within SEPA North Region, which follows the southern county boundaries of Highland and Aberdeenshire. The regional head office is at Dingwall, with area offices at Thurso, Elgin, Fraserburgh and Aberdeen. In general terms the Agency's boundaries follow political boundaries, to facilitate local accountability. The roles of the local Waste Regulatory Authorities, HM Industrial Pollution Inspectorate and the River Purification Boards (RPBs) have been subsumed into the new agency, which offers industry the advantage of dealing with only one regulatory body for most environmental matters. The activities of the new agency are grouped under two broad headings: pollution prevention and control, including waste regulation, the work of HMIPI and the RPBs' work on water quality; and

Table 9.3.2 Coastal quarries in Region 3

*Site no.**	*Location*	*Operator*	*Mineral*
	Highland		
1	Melvich	Evered Bardon - John Fyfe Ltd.	Sand and gravel
2	Skirza	A. Sinclair and Sons	Sandstone
3	Wester Keiss	A. Dunnet	Sand and gravel
4	Killimster	Gunns (Lybster) Ltd.	Sandstone
5	Thrumster	Star Quarry Products	Sandstone
6	Golspie	Edward Mackay Ltd.	Sand and gravel
7	Dornoch	Alastair Mackay Ltd.	Sand and gravel
8	Invershin	Wimpey Ashphalt	Sand and gravel
9	Ardchronie, Ardgay	Evered Bardon - John Fyfe Ltd.	Metamorphic (gneiss)
10	Kildary	Morrison Construction Ltd.	Sand and gravel
11	Alness	P. Munro	Sand and gravel
12	Beauly	Evered Bardon - John Fyfe Ltd.	Sand and gravel
13	Alturlie, Dalcross	Wimpey Asphalt	Sand and gravel
14	Morayhill	Wimpey Asphalt	Sand and gravel
15	Croy	Bruntcliffe Aggregates	Sand and gravel
	Grampian		
16	Hopeman	Moray Stonecutters	Sandstone
17	Lossiemouth	Morrison Construction Ltd.	Sand and gravel
18	Buckie	Peter Gauld and Co.	Igneous
19	Boyndie	Boyne Bay Lime Co. Ltd	Limestone
20	Macduff	Lovie Ltd.	Igneous
21	Longmanhill	R. Bremner	Igneous
22	Fraserburgh	A. Davidson and Sons	Sand and gravel
22	Fraserburgh	Lovie Ltd.	Sand and gravel
22	Fraserburgh	Watermill Aggregates (Broomhead)	Sand and gravel
22	Fraserburgh	Watermill Aggregates (Concraigs)	Igneous
23	Peterhead	J.H. Connon Ltd.	Igneous
23	Peterhead	Thunderton Quarry Co.	Igneous
24	Cruden Bay	Stoneyhill Quarries Ltd.	Igneous
25	Balmedie	Grampian Regional Council	Igneous
26	Cove	Leith Transport (Aberdeen) Ltd.	Igneous
27	Findon	J.H. Connon Ltd.	Igneous
28	Stonehaven	Barras Hill Quarry Ltd.	Igneous
28	Stonehaven	Bruce Plant Ltd. (Lochburn)	Sand and gravel
28	Stonehaven	Bruce Plant Ltd. (Ury)	Sand and gravel

Source: BGS (1994), Highland Regional Council, SNH. Key: *shown on Map 9.3.1.

Table 9.3.3 Status of the region's coastal landfill sites

Status code	*Definition*	*No. in region*
1 Inert only	Uncontaminated excavated natural earth materials, and uncontaminated brick rubble and concrete with similar properties to natural earth materials.	11
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.	7
3 Household/putrescible	Typical contents of a household dustbin and similar wastes of industrial origin e.g. food processing wastes.	6
4 Difficult wastes	Any wastes which require particular handling techniques at the disposal site, e.g. vehicle tyres, dry feathers, animal carcasses. They are not the same as Special Wastes, which are toxic and require pre-notification of disposal to the Waste Regulation Authority.	9
Total		***33***

Source: Aspinwall & Co. (1994). Note: status codes are as shown on Map 9.3.2.

water management, covering the RPBs' other functions. A strong link between pollution prevention and control, and water management, is being maintained to ensure continuing integrity of estuarine and coastal management. Landfill site licensing is now the responsibility SEPA, and SEPA is required to maintain public registers of waste management licences and resolutions. Waste management licences were introduced by the 1990 Environmental Protection Act to replace the disposal site licences previously required under the 1974 Control of Pollution Act. Also within the Environmental Protection 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 on 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 1994* (BGS 1994) and are the most up-to-date comprehensive data currently available. In a small number of cases, exact locations of quarries were not listed and therefore it was not known if they were coastal. Data for quarrying in the BGS Directory of Mines and Quarries may be up to three years old and may therefore include information on some operations that have now ceased. More up-to-date information for Highland was provided by Highland Regional Council.

The data for landfilling were provided by Aspinwall & Co. from their Sitefile Digest on waste treatment and disposal. At the time of writing this contained regularly updated information from the 152 Waste Regulation Authorities (WRAs) and represented the most up-to-date collection of public information on British waste management currently available.

9.3.5 Acknowledgements

Thanks go to Dr Ron Moore and Susan Morley (Aspinwall and Co.) for providing information from the Sitefile Digest, and Colin Wishart, Highland Regional Council, for data on quarrying activity.

9.3.6 Further sources of information

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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 and telephone no.*
Landfill database and Sitefile Digest	Aspinwall & Co.,Walford Manor, Baschurch, Shrewsbury SY4 2HH, tel: 01939 262200
Mines and quarries (British Directory of Mines and Quarries)	Director, British Geological Survey, Keyworth, Nottingham NG12 5GG, tel: 0115 936 3393
General information on Scottish mining	British Geological Survey - Scottish Office, Murchison House, West Mains Road, Edinburgh EH9 3LA, tel: 0131 667 1000
Scottish Environment Protection Agency	*SEPA, North Region HQ, Dingwall, tel: 01349 862021
General information on mining and minerals planning: Highland	*Director of Planning, Highland Council, Inverness, tel: 01463 702831
Minerals planning: Morayshire	*Mineral Planning Officer, Moray Council, Elgin, tel: 01343 543451
Minerals planning: Aberdeenshire	*Mineral Planning Officer, Aberdeenshire Council, Aberdeen, tel: 01224 665219

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

9.4 Marine aggregate extraction, dredging and solid waste disposal at sea

C.A. Crumpton & M.J. Goodwin

9.4.1 Introduction

No dredging for marine aggregates currently takes place in the region. Generally, prospecting for sand and gravel deposits in Scotland's waters has been unpromising, with only limited reserves being located, although some good quality gravels in shallow waters have been reported from reconnaissance surveys. Also, there is a lack of local demand for marine-based resources, local requirements being adequately met from land-based supplies. British Geological Survey sea-bed sediment sheets give an overview of potential resources, but in the absence of detailed company prospecting, these have not been verified. In Britain as a whole, marine aggregates satisfy an increasing part of the total demand for sand and gravel, each year accounting for 15% of the national total requirement (Crown Estate 1994). The main market is in the south-east of England. No aggregate was extracted under licence from the Crown Estate in Scottish waters or landed in Scottish ports in 1993 (Crown Estate 1995).

Navigational dredging is of two types: capital dredging and maintenance dredging. Capital dredging refers to the one-off removal of sediment, chiefly when deepening shipping channels and during the construction of new dock facilities. Thereafter, maintenance dredging is the regular dredging of existing ports and their approaches to maintain safe navigation. The majority of dredged material, which can range in composition from silts to boulder clay and rock, is deposited at sea, although dredged material is used for land claim and increasingly for beach recharge. 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). In 1993 dredged material deposited in the region (496,795 tonnes) constituted 1.6% of the total dredged material deposited around the UK as a whole (Table 9.4.1). This compares with 3.2% for 1992 when 935,897 tonnes were deposited in the region and 29,161,946 tonnes around the UK as a whole.

The UK produces some 1.1 million tonnes of (sewage sludge) dry solids (tds) annually and disposes of approximately 300,000 tds (equivalent to about 10,000,000 wet tonnes) to the sea. Dumping from ships currently accounts for 75% of Scotland's sewage sludge disposal, none of which originates from this region.

9.4.2 Important locations

Marine aggregates dredging

Only one offshore aggregate production area, to the north of Spey Bay, is licensed in the region; however the licence has never been taken up. The Moray Firth is one of the three sections of Scotland's coast that contain the greatest potential for aggregate reserves.

Navigational dredging

Maintenance dredging takes place in the Moray and Cromarty Firths on a small scale and usually infrequently. However, regular dredging does occur on a five-yearly basis around Invergordon Service Base and, in alternate years, at Nigg. Minor dredging activity occurs on the Dee Estuary, Spey Bay and Banff Bay, although it is infrequent at the latter two sites (Table 9.4.2). No capital dredging projects are under way or planned in the region.

Table 9.4.1 Dredged material licensed and disposed of at sea in 1993

	Licences issued	*Sites under licence*	*Sites used*	*Tonnes licensed*	*Wet tonnage deposited*
Region 3	5	6	6	700,000	496,795
Scotland	26	46	22	3,174,050	2,025,525
UK	***143***	***146***	***110***	***70,245,516***	***29,866,256***

Source: MAFF. Note: licences may commence at any time and generally last for one year.

Table 9.4.2 Locations in the region where maintenance dredging occurs

Location	*Comments*
Cromarty Firth	15,000 m^3 removed every five years from around Invergordon Service Base; 2,000 m^3 removed every other year at Nigg; deep water access to Alness Bay dredged
Moray Firth	Infrequent dredging of shipping channels at Whiteness Head and in River Ness; Nairn Harbour dredged to maintain access every 10-15 years
Spey Bay	Infrequent sediment extraction for coastal protection purposes; also very small amounts removed to keep salmon pools clear
Banff Bay	Banff Harbour dredged on an *ad hoc* basis to maintain access
Dee Estuary	Harbour entrance dredged annually

Source: SOAFD

Dredged material disposal

In both 1993 and 1994, more dredged material was deposited at the disposal site off Aberdeen than at any other licensed site in the region (Table 9.4.3; Map 9.4.1).

9.4.3 Management and issues

All dredging activities have short-term, localised effects, such as the removal of material and organisms, but long-term effects on, say, fish stocks or morphology are much more difficult to assess, owing to the difficulty of determining which effects are the result of dredging and which the result of the many other factors operating (Doody *et al*. 1993).

Marine aggregates dredging

Marine sand and gravel are extracted by commercial mineral companies under licence from the Crown Estate. 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).

Navigational dredging

Navigational dredging is the responsibility of individual harbour authorities, although a licence from SOAEFD is required for the disposal of dredged material offshore (see below).

Map 9.4.1 Sites of licensed disposal of dredged materials at sea used in 1992 and 1993 (see Table 9.4.3). Source: MAFF (1995). © Crown copyright.

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

Table 9.4.3 Dredged material disposed of at licensed sites in the region in 1993 and 1994

	MAFF code (see Map 9.4.1)	*Dredging waste type*	*Depth*	*Deposited tonnage*	
			(m)	**1993**	**1994**
Scrabster	FI005	Capital	56	0	0
Helmsdale	CR020	Maintenance	30	0	21,990
Sutors	CR019	Capital/Maintenance	50	84,306	0
Evanton	CR024	Capital	22	0	0
Inverness B	CR026	Capital	38	0	0
Whiteness Sands B	CR023	Maintenance	<2	0	0
Burghead	CR030	Maintenance	18	28,026	24,475
Lossiemouth	CR031	Maintenance	21	0	0
Buckie	CR040	Maintenance	18	19,604	3,500
MacDuff	CR050	Maintenance	26	1,794	7,854
Fraserburgh	CR060	Capital	35	0	0
Peterhead	CR070	Maintenance	37	0	0
North Buchan Ness	CR080	Maintenance	50	2,400	2,240
Aberdeen	CR110	Capital/Maintenance	40	360,665	320,676
Region 3				***496,795***	***380,735***

Source: MAFF

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 in relation to other methods of disposal over the next decade, to a predicted 3.3 million tds by 2006. Under the Urban Waste Water Treatment Directive (91/271/EEC), all sewage sludge disposal by marine vessels is set to be phased out by 1998. It will have to be replaced by disposal on land, by tipping or incineration.

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. MAFF's (1995) report on the aquatic environment gives details of the effects of the disposal of dredged material and other kinds of waste off the region's shores.

9.4.5 Acknowledgements

Thanks are due to the Crown Estate Commissioners for information on marine aggregate extraction in the region, and to Chris Vivian of MAFF for information on dredged material disposal.

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Scottish Office. 1994. *Land for mineral working.* Edinburgh. (National Planning Policy Guideline (NPPG) 4.)

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Marine aggregate extraction licensing	Crown Estate Commissioners, Marine Estates (Scotland), 10 Charlotte Square, Edinburgh EH2 4DR, tel: 0131 226 7241
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
Offshore geoscience data including 1:250,000 maps of geology of coastline	Director, British Geological Survey, Keyworth, Nottingham NG12 5GG, tel: 01602 363100
Licensing of disposal at sea	*SOAEFD, Edinburgh, tel: 0131 244 6203 or 0131 244 6001
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
Sand and gravel extraction	Sand and Gravel Association (SAGA), 1 Bramber Court, 2 Bramber Road, London W14 9PB, tel: 0171 381 8778
Disposal of dredged material at sea - international	The Oslo and Paris Commissions, New Court, 48 Carey Street, London WC2A 2JE, tel: 0171 242 9927
Disposal of dredged material at sea - international	London Convention Secretariat, International Maritime Organisation (IMO), 4 Albert Embankment, London SE1 7SR, tel: 071 735 7611
Scientific assessments of dredging and waste disposal, and database of licensed disposal operations at sea	*Head of Laboratory, MAFF Directorate of Fisheries Research, Fisheries Laboratory, Burnham-on-Crouch, tel: 01621 782658

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

9.5 Oil and gas developments

C.A. Crumpton, M.J. Goodwin & J.H. Barne

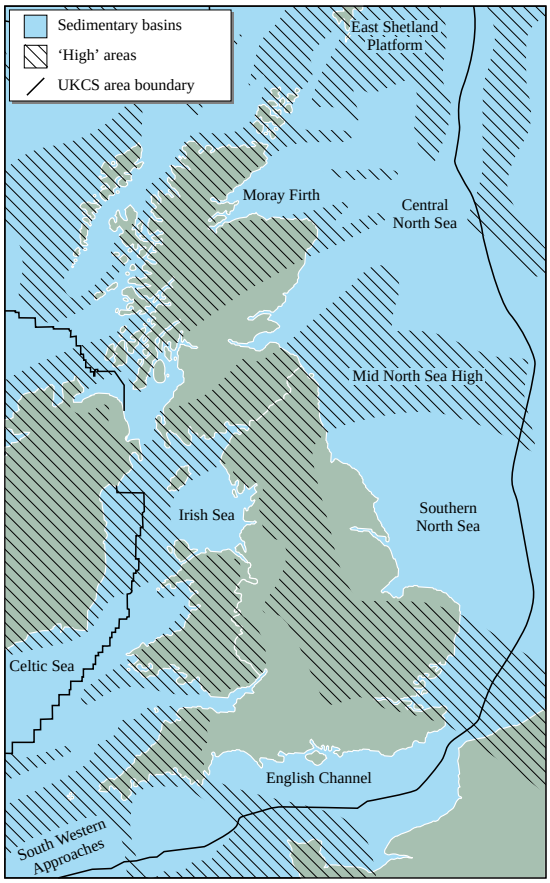
9.5.1 Introduction

This section describes oil and gas exploration and related development in the region; oil and gas infrastructure is described in section 8.3.

Map 9.5.1 shows sedimentary basins and structural 'highs', which determine the distribution of oil and gas deposits. This region is of continuing importance to the oil and gas industry. Although most of the oil and gas fields lie well over 100 km offshore in the Central North Sea Basin, there is sustained interest on the part of oil companies in areas nearer shore. Onshore installations and infrastructure continue to have an effect on the coastal economy, especially around the Cromarty Firth, Peterhead and Aberdeen. Currently the only oilfield in production near to shore in this region is the Beatrice Field in the Outer Moray Firth, some 20 km offshore. Further east, the Captain field is under development.

The 17th Offshore Oil and Gas Licensing Round is currently under way. No areas were offered in Region 3 under this round. In July 1995 the 7th Landward Round for oil and gas exploration was announced, under which applications were invited for licences covering both land and certain inshore 'watery areas', which include estuaries such as the Dornoch, Cromarty and Inner Moray Firths. Results were announced in March 1996, when 74 blocks were awarded, none of them in this region.

Total UK Continental Shelf (UKCS) oil and gas production in 1995 was a record of some 220 million tonnes of oil equivalent, and accounted for around 2% of Gross Domestic Product (DTI 1996). A total of 98 exploration and appraisal wells were drilled in 1995 and seven significant discoveries were announced, none in this region.



Map 9.5.1 UK continental shelf (UKCS) sedimentary basins and structural 'highs'. Source: DTI (1994). © Crown copyright.

9.5.2 Important locations

Map 9.5.2 shows blocks under licence in the region, as at January 1996, along with onshore installations and pipelines. Table 9.5.1 shows details of the fields of the region. In the Moray Firth nine exploration wells and five appraisal wells were drilled in 1995, a level of activity comparable with 1994.

There are two oil terminals receiving crude oil from the North Sea within this region (Map 9.5.2). Oil comes ashore at Cruden Bay from fields in the Central North Sea (Forties, Brae, Montrose, Balmoral, Buchen, Glamis, Arbroath, Miller, Bruce, Everest, Lomond, Toni and Tiffany) and is piped overland to the terminal at Hound Point, West Lothian. In 1993 the terminal received 20 million tonnes of crude oil (28% of the total UKCS receipts) and exported 8.1 million tonnes (16.7% of the total UKCS exports). The Nigg Bay terminal in the Cromarty Firth receives oil from the Beatrice oil field in the Outer Moray Firth. In 1995, receipts amounted to 0.47 million tonnes (DTI 1996).

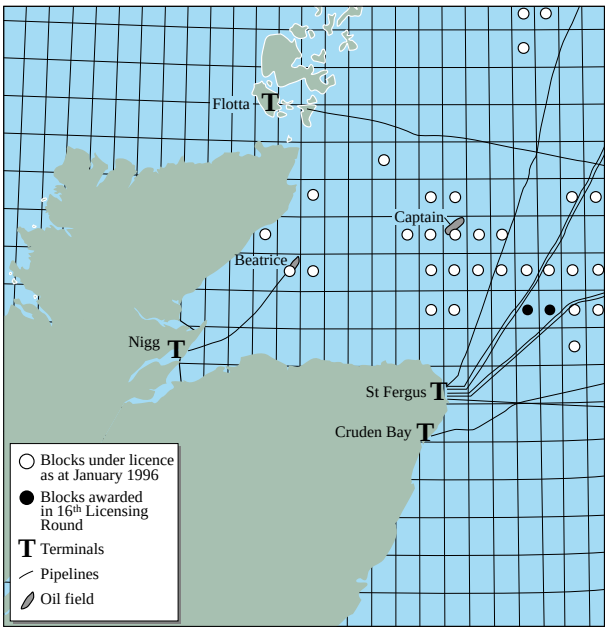
Two gas terminals at St. Fergus take supplies from the twin Frigg pipelines, the Far North Liquids and Associated Gas System (FLAGS: from the Brent field) and the Fulmar and Miller pipelines. A third terminal takes supplies from the Scottish Area Gas Evacuation (SAGE) pipeline from the Beryl A platform.

British Gas (Scotland) are installing a 273 mm diameter natural gas pipeline in a pre-dredged trench in the Inner Moray Firth across the Kessock Narrows from Longman Point to north of Craigton and across the Cromarty Firth near the Cromarty Bridge, for the distribution of natural gas to users.

Table 9.5.1. Oil and gas fields in Region 3

Field	*Oil or gas*	*Production or development*	*Production start*	*Recoverable reserves originally present*
Beatrice	Oil	Production	1981	21.0 million tonnes
Captain	Oil	Development	Estimated December 1996	44.5 million tonnes

Source: DTI 1996



Map 9.5.2 Oil and gas licensing, fields and infrastructure. Source: DTI (1994). © Crown copyright.

9.5.3 Management and issues

Licences for oil and gas exploration are awarded by the Department of Trade and Industry, in consultation with a wide range of organisations, including government departments, environmental agencies, local groups, local authorities, fishermen's federations and other non-governmental organisations. A range of conditions may be applied, linked to the environmental sensitivity of the block (see Davies & Wilson (1995) for conditions applied to the 16th round). For more recent sets of conditions consult the DTI.

The range of potential issues for nature conservation is wide. For example, the potential for oil spills to harm birds and marine and coastal wildlife is well known, especially in sheltered embayments and estuaries (see also sections 5.10. 5.11 and 5.12). Concern has been expressed particularly about the potential risk to seals and dolphins of oil-related developments in the region (see also sections 5.14.3 and 5.15.3). There is a very small risk of injury to seals in the immediate vicinity of a vessel conducting seismic surveys. The air-gun arrays used in seismic surveys generate high levels of low frequency sound, most of which is outside the known hearing range of seals and is unlikely to disturb them. In the case of cetaceans, results obtained during seismic surveys by Marathon Oil UK Ltd and BHP Petroleum Ltd in the Irish Sea were inconclusive, and experimental evidence for disturbance arising from seismic activities remains lacking (Evans *et al*. 1993).

9.5.4 Information sources used

Most of the data used here come from the DTI's 'Brown Book' (DTI 1996), which should be referred to for further explanation. Pipelines are shown on Admiralty Charts.

9.5.5 Acknowledgements

Thanks are due to Colin Macduff-Duncan, Esso, for assistance with this section.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Oil and gas developments	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
Licensing the use of dispersants for oil spill - Scotland	*Marine Environment and Wildlife Branch, SOAEFD, Pentland House, Edinburgh, tel: 0131 244 6232
Scientific assessments of oil dispersants and effects of gas and oil exploitation on the marine environment	*Head of Laboratory, MAFF DFR, Fisheries Laboratory, Burnham-on-Crouch, tel: 01621 782658
Oil spillages: government body carrying out pollution control at sea	Marine Pollution Control Unit, Spring Place, 105 Commercial Road, Southampton SO15 1EG, tel: 01703 329484
Response (privately-funded) to oil spills worldwide	Oil Spill Response, Oil Spill Service Centre, Lower William Street, Northam, Southampton SO14 5QE, tel: 01703 331551
Research into oil pollution	Oil Pollution Research Unit, Fort Popton, Angle, Pembroke, Dyfed SA71 5AD, tel: 01646 641404
Advice on oil pollution strategies worldwide	International Tanker Owner's Pollution Federation Ltd, Staple Hall, Stonehouse Court, 87-90 Houndsditch, London EC3A 7AX, tel: 0171 621 1255
Advice on oil spill control equipment	British Oil Spill Control Association (BOSCA), 4th Floor, 30 Great Guildford Street, London SE1 0HS, tel: 0171 928 9199
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

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

9.6 Water quality and effluent discharges

C.A. Crumpton & M.J. Goodwin

9.6.1 Introduction

This section summarises information about water quality and effluent discharge from a number of sources. Sewage sludge disposal is covered in section 9.4. Full interpretation of the information base on pollutants and water quality is complex and beyond the scope of this book.

Waste products and effluents containing contaminants reach the marine environment in this region in a number of ways: sewage, agricultural run-off and trade effluents are discharged from outfalls into rivers or directly into the sea, and contaminants can reach the sea by airborne means, for example aerosols and rain. Industrial contaminants can enter the marine environment through intentional licensed release or accidentally. In common with other parts of the UK coast, coastal waters in the region receive sewage and trade effluent directly from both large and small outfalls. Discharges occurring outside the region may also have an effect. At the time of writing information was not held centrally about the amount of sewage discharged. There are 85 sewage outfalls, 49 storm drains and ten sources of industrial effluent in the region. The largest trade discharges in the region are associated with the Atomic Energy Authority's site at Dounreay, which now acts as a depository for spent radioactive material. Also significant is the discharge of effluent from oil related operations (see also section 9.5). Between 1980 and 1990 there were an average of about 600 oil spill incidents per year reported in UK waters, of which about one-third were from offshore oil installations in the North Sea. About 20 per year on the east Scottish coast required clean-up operations (Advisory Committee on the Protection of the Sea, quoted in Brown (1992)). Other industries discharging effluent into the region's coastal waters are whisky distilling, woollen goods manufacturing, sand and gravel quarrying, fish farming and fish processing.

The water quality of the region's coastline is some of the best in Great Britain and is generally better than that off the coasts of southern Scotland (Regions 4 and 14), owing to the absence of sewage sludge dumping and the lower levels of industrialisation and subsequent effluent discharge. The region's smaller human coastal population also reduces the level of domestic sewage inputs to coastal waters. There are 23 bathing waters in Scotland, as identified under the EC Bathing Water Directive (76/160/EEC). Of these, sixteen (about 70%) complied with mandatory standards in 1994, including all of the region's four EC bathing waters (Scottish Office 1994) (Table 9.6.1). Trend data show that although the national percentage of bathing waters consistently complying with the mandatory standards has remained at around 64%, the number consistently failing has come down. Analysis of median faecal coliform values suggests that the improved water quality has been maintained over the last four years.

Overall, beach quality in the region, as in the UK generally, is poor. Only 13% of the beaches in the region were rated as 'excellent' in the Coastwatch 1994 survey, which covered 132 km of the coastline. However, results in all categories (excellent, moderate, polluted) were better in Region 3 as a whole than in Scotland or Great Britain (Table 9.6.2). Beaches in Highland attained much better results than the national average, although Grampian beaches were generally slightly below average.

None of the seventeen beaches awarded Blue Flags in 1994 in the UK was in this region, or indeed in Scotland. Out of the 162 Tidy Britain Group Seaside Award beaches in 1994, only six were in the region (Tidy Britain Group 1995).

Table 9.6.1 Bathing waters survey, 1994 & 1995

	Pass		*Fail*		*Total*	
	1994	***1995***	***1994***	***1995***	***1994***	***1995***
Highland	*1*	*1*	*0*	*0*	*1*	*1*
Grampian	*3*	*3*	*0*	*0*	*3*	*3*
Region 3	***4***	***4***	***0***	***0***	***4***	***4***
England & Wales	347	380	72	45	419	425
Scotland	16	19	7	4	23	23
N. Ireland	15	15	1	1	16	16
UK	376	413	81	51	457	464

Source: DoE (pers. comm.); Scottish Office (1994); SEPA pers. comm. Note: pass denotes compliance with Bathing Water Directive (76/160/EEC): Coliform standards.

Table 9.6.2 Beach quality in the region compared with national standards in 1993/1994

Area	*% of beaches rates as:*					
	excellent		*moderate*		*polluted*	
	1993	**1994**	**1993**	**1994**	**1993**	**1994**
Highland*	21	20	25	56	54	24
Grampian	4	6	43	43	53	51
Region 3*	***8***	***13***	***38***	***50***	***53***	***38***
Scotland	7	7	37	37	56	56
Great Britain	8	8	42	42	50	50

Source: Coastwatch UK (1994). Key: *includes the whole of Highland, part of which lies in Region 16.

9.6.2 Important locations

Table 9.6.3 lists the seventeen sewage outfalls in the region whose consented daily flows (see section 9.6.3) are in excess of 3,000 m^3 or which serve populations of more than 3,000 people (Map 9.6.1), with their locations and the type of discharge. By far the largest outfall is at Aberdeen.

Table 9.6.4 lists major sources of trade effluent in the region, with their maximum consented output (Map 9.6.1). The coastal waters of the region receive more than 970,000 million m^3 of consented trade effluent from these larger outfalls alone. By far the largest volume of trade effluent is cooling water from Dounreay, amounting to a consented daily flow of nearly 1 million m^3. The greatest number (approximately one third) of large trade effluent outfalls to the region's coastal waters serve the whisky distilling industry (Highland River Purification Board (RPB) and North East RPB pers. comm.).

Table 9.6.3 Significant sewage outfalls to tidal waters in the region*

Number on Map 9.6.1	*Location*	*Grid ref.*	*Type of discharge*	*Consented daily flow (m^3)*	*Population equivalent*	*Comments*
	Highland					
2	Thurso	ND118695	Domestic	No limit	9,200	
3	Wick	ND384508	Domestic	n/a	6,000	
5	Tain	NH778828	Domestic	n/a	4,000	
8	Invergordon	NH690679	Domestic	n/a	8,500	
10	Alness	NH666677	Domestic	n/a	6,000	
11	Dingwall	NH560585	Domestic	n/a	6,200	
12	Conon Bridge	NH551564	Domestic	n/a	4,000	
13	Inverness	NH666474	Domestic	n/a	40,000	
14	Culloden	NH705479	Domestic	n/a	8,000	
15	Nairn	NH893583	Domestic	n/a	7,980	
	Grampian					
16	Forres	NJ039595	Domestic	n/a	10,000	
17	Kinloss	NJ059617	Domestic	n/a	4,020	
19	Lossiemouth sewage outfall	NJ246717	Domestic and trade effluent	25,920		Screening and grit removal
20	Banff (Harbour) sewage outfall	NJ690644	Domestic, trade effluent and surface water	4,320		Screening
21	Fraserburgh sewage outfall	NJ980672	Sewage and trade effluent with waterworks sludge	11,232		Raw
22	Abercrombie Jetty sewage outfall	NJ959057	Sewage	4,450		None
22	Aberdeen sewage outfall	NJ985041	Domestic and trade effluent	544,320		Screening and grit removal

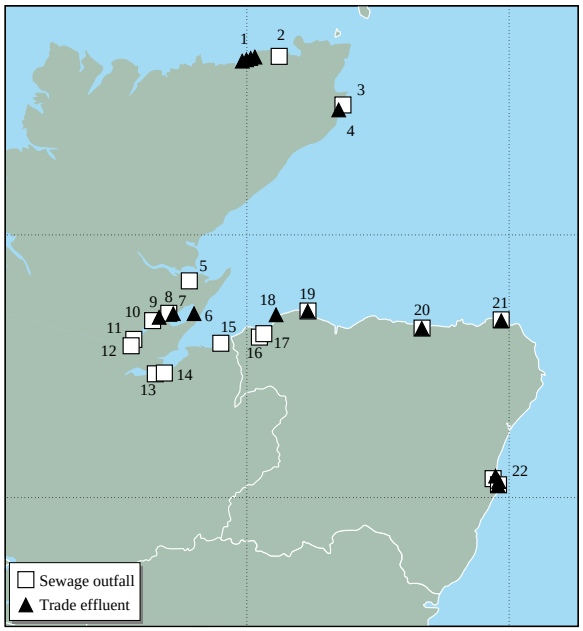
Source: Highland RPB, North East RPB (pers. comm.). Key: *outfalls included in this table are those with a consented daily flow of at least 3,000 m^3 or serving populations greater than 3,000; n/a = not available. Note: the different sources used collate data according to different criteria.

Table 9.6.4 Trade effluent outfalls to tidal waters with consented daily flow >500 m^3

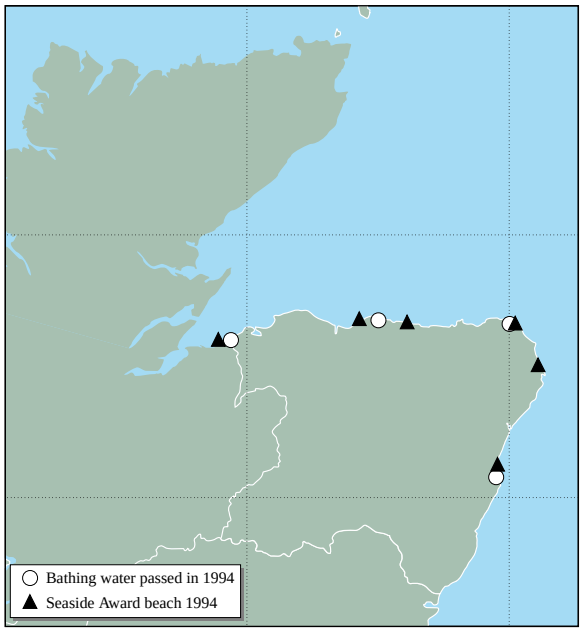
Number on Map 9.6.1	*Owner*	*Location*	*Grid ref.*	*Type of treatment*	*Consented daily flow (m^3)*	*Type of effluent*
	Highland					
1	AEA	Dounreay	NC987674	n/a	755	n/a
1	AEA	Dounreay	NC981674	n/a	1,400	n/a
1	AEA	Dounreay	NC981676	n/a	900	n/a
1	AEA	Dounreay	NC981671	n/a	920,000	Cooling water
4	J.G. Stodart	Pulteney	ND368502	n/a	800	Brewing and distilling
6	BP Exploration	Nigg	NH786688	n/a	19,000	Petroleum refining
7	Invergordon Distillers Ltd	Invergordon	NH717690	n/a	10,000	Brewing and distilling
9	United Distillers Teaninich Process	Alness	NH667677	n/a	656	Brewing and distilling
	Grampian					
18	Grampian Regional Council	Burghead	NJ103699	n/a	9,165	Brewing and distilling
22	United Fish Products	Aberdeen	NJ967046	None	4,800	Condensate and cooling water, temperature 40°C
22	Scotoll Services	Aberdeen	NJ963061	None	3,300	Trade effluent and surface water

Source: Highland RPB, North East RPB (pers. comm. 1995). Key: n/a = not available. Note: the different sources used collate data according to different criteria. Some outfalls discharging trade effluent are included in Table 9.6.3.

Although the water quality in the region is generally good, the Ythan Estuary is one of only two coastal sites in the UK (the other being Langstone Harbour in Region 9) identified in 1992 by the Department of the Environment as exhibiting problems associated with eutrophication (nutrient enrichment) (OSPARCOM 1992). The Ythan is the also only estuary in Scotland that is proposed as a Nitrate Vulnerable Zone under the EC Nitrates Directive (91/676/EEC). Mathieson & Atkins (1995) suggest improvements in the storage and application of slurry and fertiliser on land in the catchment area, although the Scottish Office already promotes a Code of Good Agricultural Practice, which addresses the issue. Nutrient enrichment considered to result largely from agricultural run-off also occurs to the waters of other estuaries in the region, notably the Don (Balls 1993). Levels of certain



Map 9.6.1 Consented sewage and trade effluent outfalls. Map shows all outfalls with consented flow greater than 500 m^3/day. Sources: River Purification Boards.



Map 9.6.2 EC bathing waters: results of 1994 sampling of EC-identified bathing waters; and Tidy Britain Group Seaside Award beaches. Sources: SO (1994) and Tidy Britain Group (1995).

organochlorines, pesticides and aromatic hydrocarbons are four to ten times higher in the sediments of the Inner compared to the Outer Moray Firth (SOAFD Marine Laboratory 1993). The Cromarty Firth is also regarded as potential source of organic contaminants to the North Sea. Small amounts of radioactivity are discharged from Dounreay. Other areas in this region that have been monitored for contaminant input to the North Sea include the Beatrice oil platform and the Nigg oil terminal. Radioactive discharges from Sellafield (Region 13), which enter the sea from outlets in north-west England, are traceable as Caesium-137 for many years and over long distances. This radionuclide is carried northwards around the region's coast to the North Sea, arriving at the Norwegian coast about five years after discharge.

The region's EC designated bathing waters are located at Nairn (East Beach), Cullen, Fraserburgh and Aberdeen (Map 9.6.2) (SO 1994). The six Tidy Britain Group Seaside Award beaches in the region in 1994 were at Nairn Central, Sandend, Inverboyndie, Fraserburgh, Cruden Bay and Balmedie (Map 9.6.2) (Tidy Britain Group 1995). Overall in the region, sewage was a perceived as the main threat to beach quality, particularly in Grampian, where only erosion was seen as more important (Coastwatch UK 1994). The main items of litter found along the coastline in this region are plastics (including fishing gear and bottles), cans and paper. Household furnishings and refuse were found at levels above the national average in Grampian, but well below those levels in Highland. Sewage and sanitary materials are also present (Coastwatch UK 1994).

9.6.3 Management and issues

In April 1996, the new Scottish Environment Protection Agency (SEPA) became operational. The new agency integrates the functions of Her Majesty's Industrial Pollution Inspectorate (HMIPI), the local waste regulatory authorities and the regional River Purification Boards (RPBs). The activities of the new agency are grouped under two broad headings: pollution prevention and control, including waste regulation, the work of HMIPI and the 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 and discharges from nuclear installations, are authorised by SEPA under the Environmental Protection Act 1990. Environmental Quality Standards (EQSs) for many of these prescribed 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 companies, show that there will be no adverse effects on the environment. In this region these high natural dispersion areas include

Thurso Bay, Wick Bay, Cromarty Firth and Moray Firth (Burghead/Lossiemouth), and off the Buckie Coast, Banff Coast, Fraserburgh Coast and Aberdeen Coast.

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), now carried out by SEPA. Any measures required to improve the quality of the waters are a matter for the dischargers of industrial effluent or the sewerage authorities. Under the terms of the Environmental Protection Act 1990, the quality of bathing beaches is the responsibility of councils. Secondly, there is the European Blue Flag Award Scheme for beaches that meet the EC guideline standards of beach and water quality, as well as certain land-based criteria. Thirdly, there is the Tidy Britain Group Seaside Award Scheme, designed to complement the Blue Flag scheme, for beaches that meet the minimum standards of beach and water cleanliness and selected land-based criteria but not the Blue Flag standard. Finally there are the annual litter surveys of Coastwatch UK and Beachwatch, both of which employ volunteers to survey lengths of coastline for litter and other signs of pollution. Beachwatch is organised by Readers Digest and the Marine Conservation Society.

9.6.4 Information sources used

The Department of the Environment (DoE) Environmental Protection Statistics Division publishes an annual *Digest of environmental protection and water statistics* (DoE 1995), which provides detailed national statistics on aspects of environmental protection, including coastal and marine waters, radioactivity, waste and recycling, and wildlife. MAFF (Directorate of Fisheries Research, Lowestoft) publishes two annual Aquatic Environment Monitoring Reports (e.g. MAFF 1994; MAFF 1995). One reports on radioactivity in the marine environment, the other deals with non-radioactive pollution and waste disposal operations at sea. Radioactive discharges from Dounreay are amongst those monitored by MAFF (e.g. Baxter & Camplin 1993). Subregional report 3a of the North Sea Quality Status Report (SOAFD 1993) includes information on water quality in this region, including information for a number of locations on levels of metals, organics, nutrients and radioactivity in biota (for example fish) and sediments, as well as in sea and estuarine water.

Schemes such as the Tidy Britain Group Seaside Award and the European Blue Flag are monitored during the year previous to the publication of their results. Monitoring of the EC Bathing Waters and other beaches under schemes such as Coastwatch UK and Beachwatch take place over one or two days. The results may therefore be skewed by heavy rain or localised effects at the time of survey. Coastwatch UK and Beachwatch do not sample the whole coastline in their region, owing to a shortage of volunteers. The results may therefore sometimes be unrepresentative because of the small sample size.

Further information on water quality and effluent discharges can be obtained from the regional and area offices of SEPA (see section 9.6.6 C and Appendix A.1).

9.6.5 Acknowledgements

Thanks are due to Colin Craig, SEPA North Region, Mike Davidson, SEPA North Region East Division, and Highland and North East RPBs for providing water quality and effluent data.

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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 North Region, Dingwall, tel: 01349 862021
Pollution control & water quality information, sewage pipeline outfalls and waste regulation	*SEPA North Region East Division, Aberdeen, tel: 01224 248338
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
Beachwatch	*Marine Conservation Society, Ross-on-Wye, tel: 01989 66017
Coastwatch	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

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

9.7 Leisure and tourism

S.L. Fowler

9.7.1 Introduction

The coast of the region is an important tourist destination for visitors interested in its wild natural scenery, unspoilt coastal environment and outdoor sports, including walking and golf. In a national context, golfing is probably the most important recreational activity undertaken in the region, with an unusually high density of international standard golf courses on the east coast of Highland and the Grampian coast. The Countryside Sports Database, held by the Scottish Sports Council (SSC), lists records of sport and recreation sites in the coastal 10 km squares of Highland and Grampian. The activities recorded are cross country running (at two sites), surfing (33), sea angling (three), sailing (twelve), orienteering (32), horse riding (25), board sailing (ten), canoeing (four), cycling (three), motor sports (one), waterskiing (two), rowing (two), shooting (47), field archery (two), hang gliding (one), light aviation (three) and power boating (four). Note that coverage in the database is not systematic; also, more than one activity may occur at a site. Table 9.7.1 indicates the distribution of leisure activity in the region, in terms of the number of sites at which one or more such activities are taking place.

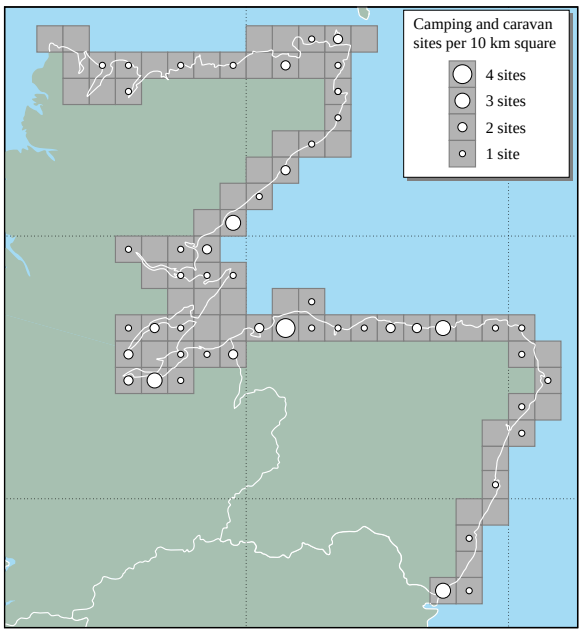
According to Scottish Tourist Board figures, more than 11 million tourists took overnight trips in Scotland as a whole in 1995, spending over £2.1 billion and supporting around 8% of all employment. None of the top fifteen tourist attractions was in this region, although Grampian, and the Highlands and Islands as a whole (which includes Regions 1, 2, 15 and 16), attracted 2.6 million trips from British tourists and an estimated 700,000 trips from overseas tourists.

A range of land-based leisure activities take place along the coast of this region, including golf, walking, camping, some beach recreation, bird and dolphin watching, wildfowling and horse riding. Land-based and beach leisure uses are much more limited in extent here than along the more heavily populated and popular holiday coasts further south. The most important examples of land-based leisure infrastructure on the coast are golf courses, caravan parks, campsites and car parks, which all tend to be concentrated on the sheltered coasts of the firths. 73 caravan parks and/or campsites are shown adjacent to the coast on Ordnance Survey Landranger maps. The campsites are at a relatively low density and tend to be small, with few facilities. There are 34 coastal golf courses in the region and a total of 59 coastal car parks. Car parks provide the access points necessary for most land- and water-based leisure activities; however, because of the relatively low incidence of recreational pressures on the coast, current provision of coastal car parking facilities is generally adequate to meet demand. Locations of land-based leisure infrastructure are marked on Maps 9.7.1 and 9.7.2.

Table 9.7.1 Number of sites at which one or more recreational activities are taking place

District	*No. of sites*
Highland	**82**
Sutherland	11
Caithness	30
Ross & Cromarty	15
Inverness	16
Nairn	10
Grampian	**104**
Moray	51
Banff & Buchan	24
Gordon	5
Aberdeen	17
Kincardine & Deeside	7
Region 3	***186***

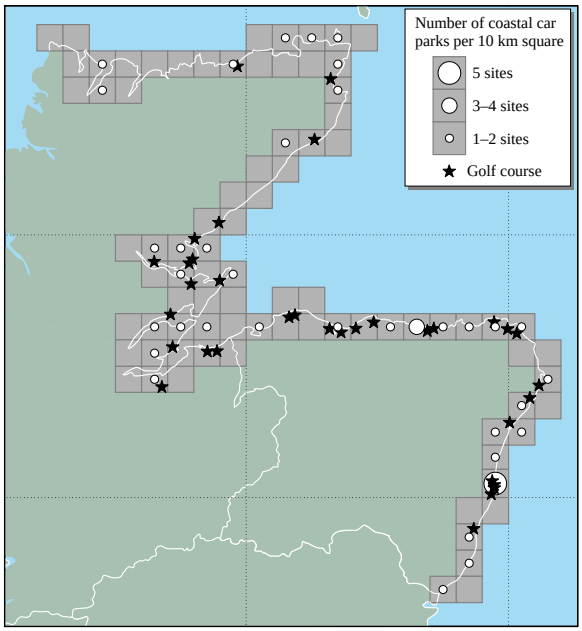
Source: Scottish Sports Council Countryside Sports Database



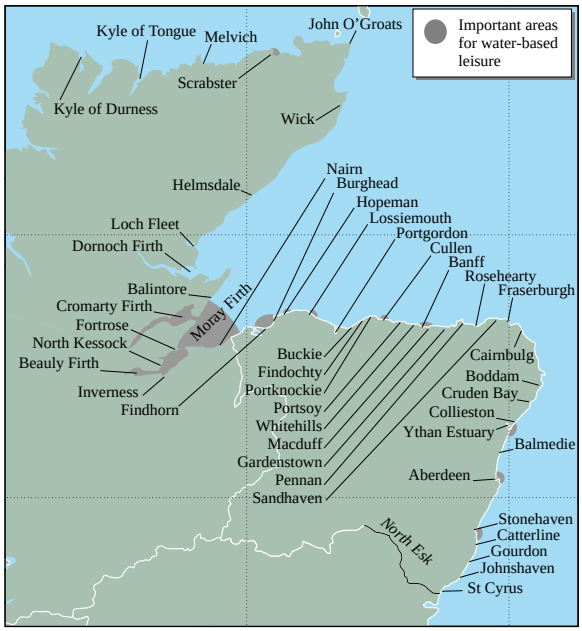
Map 9.7.1 Number of camping/caravan sites in coastal 10 km squares in the region. Source: Ordnance Survey Landranger maps. © Crown copyright.

Wildfowling - a traditional coastal activity in the region - is now recreational, although formerly it was commercially practised for food. Targeted coastal species include most ducks, some geese and three waders (only one of which - golden plover *Pluvialis apricaria* - is regularly coastal); in Region 3 it is usually wigeon, greylag geese and mallard that are targeted. In this region especially, shooting on some coastal sites involves both local wildfowlers and those from further afield, including England.

The main significance of the region for water sports and leisure is derived from the unspoilt coastal and marine environment. However, the local population is sparse and tourism activity is low in comparison with areas further south. The most important area is the Moray Firth, with its sheltered waters and good water sports facilities. The main activities undertaken at sea along the coast are sailing, water-skiing, sea angling, swimming, surfing and scuba diving. Dolphin watching is popular in the Moray Firth, both as an informal land-based activity and recently from numerous organised boat trips. Infrastructure developments for water-based leisure activities in the region



Map 9.7.2 Number of car parks in coastal 10 km squares in the region; locations of coastal golf courses. Source: Ordnance Survey Landranger maps. © Crown copyright.



Map 9.7.3 Locations for water-based leisure (see Table 9.7.1). Sources: Tourist Offices.

include marinas, yacht moorings, dinghy parks, launching slips and water sports centres. Most of these are concentrated in the sheltered waters of the firths and near centres of population. Limited facilities (primarily recreational craft moorings) are also found in most of the small fishing ports and harbours around the coastline.

9.7.2 Important locations

Highland has little formal land-based coastal activity. Dolphin watching occurs at several locations within the Moray Firth, from Cromarty to Nairn. There is a pony trekking centre at Melvich, east of Strathy Point, and horse riding occurs along the long stretches of sandy beaches at places such as Dornoch. There are many coastal paths in the region, for example around Sandside Bay, John o' Groats and Duncansby Head. The Highland Regional Ranger Service organise guided walks in areas such as Durness. Tongue and Golspie are bases for hill walking inland. Bird watching takes place at many coastal locations, including the cliffs at Duncansby Head and in estuaries including Nigg Bay, Cromarty Firth and Beauly Firth.

Grampian has the only coastal amusement park and both the two leisure centres identified within the region, at the Beach Boulevard and Promenade, in Aberdeen. The long-distance Speyside Way starts from the coast at Spey Bay, heading inland, and there are shorter coastal walks from Spey Bay to Portgordon and on cliff tops from Portnockie, Portsoy, Nigg Bay to Cove Bay south of Aberdeen, and Inverbervie to Johnshaven. Bird watching takes place at many coastal locations, including the cliffs at Troup Head and Fowlsheugh, south of Stonehaven, the Loch of Strathbeg and in estuaries including Findhorn Bay and the River Ythan. Sand yachting and horse riding occur along the long stretches of sandy beaches at Fraserburgh.

Water-based leisure-related infrastructure is listed in Table 9.7.2 (Map 9.7.3); there are also other small recreational harbours, including Lybster, Dunbeath, Brora and Avoch, most of which have launching slips for recreational use. Winsurfing is the most popular water-based activity in the region. The Moray Firth is the main area in which sailing (including yachting, dinghy sailing and wind-surfing) is pursued. The few sailing centres present in the region are mainly concentrated here, with marinas at Inverness and Lossiemouth (Harding-Hill 1993). Wind-surfing takes place in Findhorn Bay, the Ythan Estuary and at Hopeman; there is some water-skiing in the Dornoch Firth and Ythan Estuary; sea angling occurs at Scrabster, Fraserburgh and Gourdon; scuba diving is popular on rocky coasts, including the Kyle of Durness; and a small amount of surfing occurs, particularly at Lossiemouth East beach. Swimming from beaches is not a very common activity, but occurs at Coldbackie (near Tongue), Fortrose, Moray Firth, Nairn, Lossiemouth, Cullen, Rattray Head, Balmedie Sands, Stonehaven and St. Cyrus. Boat trips can also be taken along some sections of the coast, including from Skerray and John o' Groats, and daily dolphin watching excursions depart from Inverness. There is a dolphin and seal interpretation centre at North Kessock.

Wildfowling takes place on at least six of the region's estuaries: Loch Fleet, Dornoch Firth, Cromarty Firth, Inner Moray Firth, Spey Bay and Ythan Estuary. There are a number of wildfowling clubs and syndicates active in the region, but in Loch Fleet and the Dornoch Firth, for instance, there are privately-owned shooting rights, and the latter site is shot over by individuals by agreement with the estates. There is only a very low level of shooting activity at Loch Fleet, except of stocked mallards in Mound Alderwoods National Nature Reserve (NNR). The north shore of the Dornoch Firth is shot over privately, but the south side has open access to the public, which can lead to friction among users and excessive disturbance of the birds. Seaboard Sporting Gun Club shoot in Nigg Bay, although there is also some non-club activity. The most important site for wildfowling in the region is the Inner Moray Firth, where, in

Table 9.7.2 Locations of water-based leisure infrastructure

Site (see Map 9.7.3)	*Grid ref.*	*Description*
Highland		
Scrabster	ND0970	Sailing club, sea angling centre
Wick	ND3751	Harbour
Helmsdale	ND0315	Small harbour, sea angling
Balintore	NH8675	Small harbour, fishing, yacht pontoon
North Kessock	NH6547	Watersports centre and slipway
Fortrose	NH7256	Chanonry Sailing Club
Inverness	NH6645	Yacht moorings, marina and cruiser base on Caledonian Canal
Nairn	NH8857	Yacht pontoons in harbour
Grampian		
Findhorn	NJ0364	Yacht moorings and slipway
Burghead	NJ1169	Harbour
Hopeman	NJ1470	Harbour - recreational use
Lossiemouth	NJ2471	Harbour and marina, 46 berths
Portgordon	NJ3964	Harbour - recreational use
Buckie	NJ4265	Harbour - recreational use
Findochty	NJ4567	Recreational harbour, watersports club, >100 moorings, slipway
Portknockie	NJ4968	Harbour, slipway, pleasure craft moorings
Cullen	NJ5167	Recreational harbour, 15 moorings, slipway
Portsoy	NJ5966	2 harbours, 20+ regular users including pleasure craft
Whitehills	NJ6665	Harbour
Banff	NJ6964	Recreational harbour, slipway, 50+ moorings, dinghy park
Macduff	NJ7064	Yacht moorings and slipway
Gardenstown	NJ7964	Harbour: fishing and recreation; slipway
Pennan	NJ8465	Very small recreational harbour
Rosehearty	NJ9367	Harbour, slipway, 20 boats including pleasure craft
Sandhaven	NJ9667	Harbour - recreational use
Fraserburgh	NJ9968	Large fishing port, very good shelter but minimal yacht facilities
Cairnbulg	NK0365	Boathaven (fishing and recreation)
Boddam	NK1342	Harbour - recreational use
Cruden Bay	NK0935	Harbour - recreation & fishing
Collieston	NK0428	Harbour - recreational use
Stonehaven	NO8785	Large recreational harbour, 140 yacht moorings, slipway
Catterline	NO8778	Small harbour, fishing/recreation
Gourdon	NO8270	Harbour, fishing & pleasure craft (20 moorings)
Johnshaven	NO7967	Harbour, fishing & some pleasure craft

Source: Buck (1993), D'Olivera & Featherstone (1993) and miscellaneous publications, e.g. tourist brochures. Note: there are many other areas with small numbers of leisure moorings, and most coastal towns have slipways for leisure craft.

addition to the many unafilliated gun clubs, four BASC-afilliated clubs operate. Wildfowling occurs here by agreement with landowners or under a common right on the foreshore; shooting is particularly prevalent in Findhorn Bay and the Culbin shore. In Spey Bay and the Ythan Estuary public wildfowling is permitted on the foreshore.

9.7.3 Management and issues

Some of the land-based leisure developments in the area have had significant effects on coastal habitats, for example the links golf course developments on dunes, which have reduced the area of semi-natural vegetation at these sites. Sand dune systems have also been affected by car parks and campsites. 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. These include sites in Highland at Red Point near Reay (where large sand dune systems on two sites have been damaged by car parking on machair, path erosion and trampling), and at Morrich More (where erosion of afforested sand plain has occurred), and, in Grampian, at Culbin Sands (erosion of afforested dunes) and Sandend Bay (where stabilisation techniques and fencing on dunes have been implemented).

There are concerns about possible effects on dolphins of boats taking people out to watch them in the Moray Firth. Scottish Natural Heritage have drawn up a voluntary code of conduct for boat operators (Scottish Natural Heritage/ Scottish Wildlife Trust 1995) and are monitoring the situation.

The representative body for sport shooting in the UK is the British Association for Shooting and Conservation (the BASC). The BASC has 19,000 wildfowling members, mostly in 200 affiliated wildfowling clubs. The region's ten wildfowling clubs with 480 members represent only 2% of total BASC membership. Targeted wildfowling species and shooting seasons (the open season for coastal wildfowling varies from species to species, but mainly occurs between 1 September to 20 February) are regulated through the Wildlife and Countryside Act 1981. During periods of severe winter weather, disturbance to waterfowl (including non-quarry species) from shooting threatens the birds' survival (Bell & Fox 1991); at these times statutory wildfowling bans can be imposed after fourteen days of freezing conditions (voluntary restraint is called for after seven days).

As elsewhere in Britain, much of the wildfowling in Region 3 is operated and managed through wildfowling clubs and syndicates. Much takes place on areas covered by national and international site protection, including on several National Nature Reserves (NNRs) and Sites of Special Scientific Interest (SSSIs); wildfowling on NNRs is reviewed by Owen (1992). In this region in particular the sites at which open access for shooting is allowed draw large numbers of wildfowlers from considerable distances. This has raised questions of both conservation and competition with local guns in the past, as has the legal status of the rumoured occurrence of punt gunning in the Cromarty Firth and Ythan Estuary.

9.7.4 Information sources used

Published sources of data used are listed in section 9.7.6 A; many of them contain far more information than has been mentioned here. Other sources used included tourist brochures and Ordnance Survey Landranger maps. Some sources were not up to date and some new facilities such as golf courses may have been omitted. Other sources include the British Marine Industries Federation (BMIF) Annual Marine Industry Statistics (1989-1994). BMIF have also carried out a national survey of boating and water sports participation (Market Research Solutions Ltd. 1994). In addition to the references cited, some of the information about the distribution and management of wildfowling comes from the NCC's 1989 Estuaries Review data collection (Davidson *et al.* 1991), now held as part of JNCC's integrated coastal database.

9.7.5 Acknowledgements

Thanks go to the BASC for help in compiling information on wildfowling and R. Irving for providing other material for this section. Marsailidh Chisholm and John Crawford kindly provided data from the Scottish Sports Council database, and Duncan Stewart of the Scottish Tourist Board provided visitor information. Thanks are also due to Colin Wishart of Highland Council for his comments.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Tourist information service	Scottish Tourist Board, 23 Ravelstone Terrace, Edinburgh EH4 3EU, tel: 0131 332 2433
Tourist Information Centres open all year (There are seasonal offices at Durness, Bettyhill, Thurso, John o' Groats, Helmsdale, Strathpeffer, Nairn, Forres, Buckie, Cullen, Banff, Fraserburgh, Peterhead and Stonehaven.)	Whitechapel Road, Wick, Caithness KW1 4EA, tel: 01955 2596 The Square, Dornoch, Sutherland IV25 3SD, tel: 01862 810400 Castle Wynd, Inverness IV2 3BJ, tel: 01463 234353 17 High St., Elgin IV30 1EG, tel: 01343 542666 St. Nicholas House, Broad St., Aberdeen AB9 1DE, tel: 01224 632727
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
Water quality of bathing beaches - UK	*Marine Conservation Society, Ross-on-Wye, tel: 01989 566017
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 PH8 0DY, tel: 01350 723 226
Wildfowling (general information on wildfowl, habitats and conservation)	*Enquiry Officer, RSPB HQ, Sandy, tel: 01767 680551
Severe weather wildfowling bans	*Licensing Officer, SNH HQ, Edinburgh, tel: 0131 447 4784
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, West Bridgford, Nottingham NG2 5AS, tel: 0115 9821100
Canoeing - Scotland	Administrator, Scottish Canoe Association, Caledonia House, South Gyle, Edinburgh EH12 9DQ, tel: 0131 317 7314
Caving	Grampian Speleological Group, 8 Scone Gardens, Edinburgh EH8 7DQ, tel: 0131 661 1123
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 Trecking and Riding Society of Scotland, Boreland Riding Centre, Fearnan, Aberfeldy PH15 2PG, tel: 01887 830274
Sub Aqua – Britain	British Sub Aqua Club (Scottish Federation), 1 Henderson Place, Edinburgh EH3 5PJ
Sub Aqua – Scotland	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
Water skiing	Scottish Water Ski Association, Development Officer, Scottish Water Ski Centre, Town Loch, Town Hill, Dunfermline, tel: 01383 620123
Wildfowling (the sport)	Press and Information Officer, British Field Sports Society, 59 Kennington Road, London SE1 7PZ, tel: 0171 928 4742
Wind surfing – Scotland	Secretary, Scottish Windsurfing Association, c/o Royal Yachting Association, Scotland, Caledonia House, South Gyle, Edinburgh EH12 9DQ, tel: 0131 317 7388
Windsurfing – Britain	British Windsurfing Association, 86, Sinah Lane, Hayling Island, Hants. PO11 9JX, tel: 01705 468182
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
Marine leisure industries; small craft marine industries	British Marine Industries Federation, Meadlake Place, Thorpe Lea Road, Egham, Surrey TW20 8HE, tel: 01784 473377
Harbour Masters	See Appendix A.2
Aberdeen	*Aberdeen, tel: 01224 592571
Cromarty	*Invergordon, tel: 01349 852308
Inverness	*Inverness, tel: 01463 233291
Peterhead	*Peterhead, tel: 01779 74281/2/3

* 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 3. 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 10.3.6C), contact points for some of these organisations are included there. In addition, names and addresses of regional contacts are given in section 10.3.4.

10.1.1 Coastal 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 management ensures that all land and sea use issues are co-ordinated, including development, conservation, waste disposal, fisheries, transport, and coastal protection and flood defence. The advantages of this have been recognised by coastal planners in many areas, and several local authorities and other bodies now promote coastal management. However, approaches differ from area to area, with overlap in some places and patchy coverage elsewhere (Earll 1994).

The House of Commons Environment Committee Second Report (House of Commons 1992), although limited in scope to England and the estuaries it shares with Wales and Scotland, made recommendations for the planning and implementation of coastal management that have had policy and practical implications throughout the UK. Amongst the Environment Committee's recommendations were:

- the endorsement of an integrated approach to coastal management, incorporating maritime land, sea and intertidal areas;
- a review of existing legislation;
- the need for international (EU-wide) policy initiatives;
- clearer responsibilities for planning and action in the coastal zone, based on a national strategic framework;
- appropriate funding for accountable bodies with responsibilities;
- research into the physical functioning of the coastal zone and associated protection and conservation measures;
- a review of planning mechanisms to allow effective safeguard of the coastal resource;
- monitoring and environmental assessment of coastal activities to assess their impacts;
- the involvement of local communities in coastal 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 the 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 both 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. A Scottish Office coastal strategy discussion paper was published in early 1996, entitled *Scotland's coasts*.

The European Commission was asked by the Council of the EU to propose a strategy for the whole of the Community coast before the end of 1994. The initial response was to adopt the *Communication on integrated management of coastal zones* (COM/511/95), which sets out proposals for EU funding for demonstration programmes of coastal management. The strategy is to be based on the principles of sustainability and sound ecological and environmental practice, but will have no legal standing. In February 1996 the European Commission published a *Demonstration programme on integrated management of coastal zones* (European Commission Services 1996), intended as a spur to urgent co-operative action for Europe's coast.

In Scotland, the EC Habitats & Species Directive will be 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 10.2.6).

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 the Marine Conservation Society, World Wide Fund for Nature UK and the Royal Society for the Protection of Birds (RSPB) (see section 10.2.5). Only national initiatives that have distinct local elements in the region are described here. Many other diverse interest groups and organisations now have national policies with regard to coastal management and estuaries management, for example the British Association for Shooting and Conservation and the Royal Yachting Association, and their representatives are involved in most local or regional groups or fora, listed in Table 10.3.1. Regionally-led coastal management initiatives are dealt with in section 10.3.

10.2.2 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). Unlike England and Wales, there is no system of river catchment management planning operational in Scotland, although there is widespread support from conservation bodies that this approach should be pursued.

10.2.3 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. Four projects are already running, including one in this region, for the Moray Firth (see section 10.3.1 and Table 10.3.1), whilst another project is expected in the near future for the Tay Estuary. A similar project, although not initiated under the Focus on Firths, covers the Cromarty Firth.

10.2.4 Coastal (engineering) groups and national coastal fora

There are no formal coastal (engineering) groups in Scotland, and no Scottish Coastal Forum (the Coastal Forum established by the Department of the Environment is solely for England). Hydraulics Research have recently carried out a study on coastal process cells in Scotland (HR Wallingford 1995: draft report), 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. The final report is due in August 1996. HR Wallingford are also producing a series of eleven regional reports, summarising coastal processes for each of the coastal cells in Scotland.

10.2.5 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 has compiled mapped and numerical information on land use and selected human activities for 57 major UK estuaries. In 1994, the RSPB launched its 'Marine Life' campaign, which aims to increase awareness of the problems facing the marine environment and its wildlife, including pollution, fisheries and shipping safety. It has recently published a *Review of coastal zone management powers* (RSPB 1995). RSPB (1993) reviews strategic planning and management initiatives in part of the region.

10.2.6 Designated sites

Site designations are discussed in detail in Chapter 7. However, several statutory and non-statutory designations are also relevant here because they provide a degree of coastal management through their area or site management plans. These often tend to focus strongly on the conservation of landscapes, buildings and/or habitats and species, rather than on wider and more integrated coastal issues, although in management planning for some sites a focus on visitor use and community involvement is important. Designated sites include nature reserves,

managed by Scottish Natural Heritage, the Scottish Wildlife Trust, local authorities, the RSPB and other bodies for nature conservation objectives and National Scenic Areas managed for a broader range of conservation and recreational objectives.

Marine Special Areas of Conservation (SACs)

Under the EC Habitats 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 7.2.4). A list of possible sites on which consultations will be carried out was published in March 1995. Marine SACs may include intertidal areas and/or subtidal areas; terrestrial SACs may include important coastal maritime habitats such as lagoons, saltmarshes or sand dunes. 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, ports and harbour authorities and Scottish Natural Heritage, as well as owners and occupiers of foreshore land and representatives of those who rely on marine areas for their livelihood or for recreation (Scottish Natural Heritage 1995). Management will be coordinated through an agreed management scheme, backed by existing statutory measures. 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 classification, similar to English Nature's 'Sensitive Marine Area' identification, is used by Scottish Natural Heritage to indicate important sites and stimulate consultation over developments there (NCC 1990). There is one Marine Consultation Area in the region: Loch Eriboll (see also section 7.4.3).

10.3 Regional coastal management groups and initiatives

10.3.1 Introduction

There are currently numerous new regional coastal zone management (CZM) initiatives arising around the coastline under the leadership of local planning, harbours and ports authorities. Additionally, a number of the local or regional CZM projects (Table 10.3.1) are part of national initiatives under organisations such as the statutory nature conservation agencies or non-governmental bodies. Other locally-based coastal management initiatives, although not strictly integrated as defined in section 10.1.1, are also underway. These include management plans for protected areas of coast, ranging from National Nature Reserves, managed by Scottish Natural Heritage for nature conservation objectives, to non-statutory Marine Consultation Areas and the proposed Special Areas of Conservation (under the EC Habitats & Species Directive), which will require the participation of a range of bylaw-making authorities for successful management. A further initiative is the establishment by the District Council of local environmental forums throughout Ross and Cromarty, to take an active role in protecting and enhancing beaches and coastlines. Table 10.3.1 lists regional coastal management initiatives.

10.3.2 The Moray Firth Project

The Moray Firth Project, part of the Scottish Natural Heritage 'Focus on Firths', covers the whole area of the Moray Basin, from Duncansby Head in the north to the inner firths of the south-west, and to Fraserburgh in the east. It was initiated in August 1991 with the collation and synthesis of biological and environmental data on the marine and coastal environment of the firth. The human use of these resources and their impact were also considered and presented in *The Moray Firth review* (Harding-Hill 1993), a major source of information for much of this region.

The project aims to promote integrated management of the Moray Firth in order to secure the sustainable use of its natural resources through consultation, co-operation and example. Over the next ten years the project will progressively lead to the preparation, production and implementation of multi-disciplinary management plans for appropriate areas, which have the widespread understanding and support of key groups. A Moray Firth Project information sheet (Scottish Natural Heritage 1993) provides more information on the two different approaches envisaged. One approach aims to develop and deliver a series of themed projects to meet future requirements for the effective and sensitive management of natural resources in the firth, and the other seeks to stimulate local fora and management plans to involve and accommodate key users and interested parties.

10.3.3 Other coastal fora

In some places coastal fora have developed in response to a range of coastal designations and various management initiatives. There are several of these operating in the region, including the Inner (Moray) Firth Environmental Forum, Cromarty Firth Liaison Group and the Ythan Study Group, with others likely to be established. The great value of these fora is that they bring all interest and user groups together and enable issues of concern to be examined from all points of view (Table 10.3.1).

10.3.4 Local planning authority and port/harbour initiatives

The maritime local planning authorities are involved in most, if not all, of the major coastal management initiatives

described in this chapter (Table 10.3.1) and are beginning to instigate their own, not least through their planning documents. Local planning authorities in the region have published regional, district and local plans, which provide the statutory planning framework for development control purposes. In most cases these plans are supplemented by regular reviews, monitoring documents and survey reports covering a variety of topics. Port and harbour authorities (see Appendix A.2) also have a statutory remit to control activities within their areas of authority, which may include coastal waters.

10.3.5 Acknowledgements

The assistance of the staff of the former Regional and District Councils, Cromarty Firth Port Authority, RSPB and Scottish Natural Heritage is gratefully acknowledged. Thanks are due to Dr Alastair Somerville, Scottish Wildlife Trust, for his helpful comments.

Table 10.3.1 Regional coastal management initiatives

Initiative name	*Scope/aims*	*Organisations involved*	*Contact details*
Moray Firth Project	Promotes the protection and better management of the natural resources of the firth, by stimulating understanding and co-operation among users and statutory authorities	Scottish Natural Heritage (part of SNH 'Focus on Firths' Initiative) and consultees	*Moray Firth Project Officer, SNH, Inverness, tel: 01463 712221
Loch Eriboll Marine Consultation Area	Non-statutory identification indicating importance of site and highlighting need for consultation over developments	Scottish Natural Heritage	*SNH, Edinburgh, tel: 0131 447 4784
Inner (Moray) Firth Environmental Forum	Discussion group based on local community, concerned with the wise management of coastal wildlife and natural resources	Scottish Wildlife Trust, SNH and participants	*Northern Officer, Scottish Wildlife Trust, Dingwall, tel: 01349 877625
Cromarty Firth Liaison Group	Forum for discussing impacts affecting the Firth and encouraging best practice. Aims to prepare a management plan for the Firth.	Cromarty Firth Port Authority, Ross and Cromarty Enterprise, Crown Estates Commission, Scottish Office Marine Laboratory, SNH, RSPB, SEPA, Highland Council	*Captain Peter Taylor, Cromarty Firth Port Authority, Invergordon, tel: 01349 852308
Ythan Study Group	Forum convened by North East River Purification Board (now part of SEPA). Covers all issues relevant to the Ythan Estuary, river catchment, and Sands of Forvie NNR, but specifically aimed at eutrophication. (Includes research, fisheries, sewage, nitrate runoff, predator control etc.) Area designated as a nitrate-vulnerable zone.	SEPA, local authorities, NGOs, landowners, SNH, RSPB, SOAEFD, Culterty Field Station of Aberdeen University (about 20 participants)	*Dr Clare Scanlon (YSG Secretary), SEPA, Aberdeen, tel: 01224 248338
Moray Firth Geographic Information System (GIS) Research Project	Research project to create a GIS of the Greater Moray Firth area (Wick - Beauly - Fraserburgh triangle) including the coastal margins, with a view to utilising this spatial database in environmental management applications	University of Aberdeen (funded by Aberdeen University Development Trust and SNH)	R. Wright, Project Supervisor, Department of Geography, University of Aberdeen, Elphinstone Road, Aberdeen AB9 2UF, tel: 01224 272328
Burghead to the Inner Moray Firth Shoreline Management Plan	Coastal defence plan assessing environmental impacts of proposals (including soft defence and 'do nothing' options)	Highland Council	*Colin Wishart, Planning Department, Highland Council, Inverness, tel: 01463 702000
Banff and Buchan Coastal Strategy (1986)	Coastal study incorporating special project areas and strategy published in 1986. Now incorporated into Local Plan. Considers managing coastline with respect to defences, conservation, recreation. Revised Local Plan 1994.	Aberdeenshire Council North	*Deborah Burroughs, Planning Department, Aberdeenshire Council North, Banff, tel: 01261 813200

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

10.3.6 Further sources of information

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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.

Banff and Buchan District Council. 1994. *Banff and Buchan coastal strategy.* Banff.

Bown, D. 1988. *Coastal development: a planner's view.* Paper presented to CPRW Annual Study Conference (unpublished).

Coastal Heritage Forum. 1995. *Heritage Coasts: a guide for councillors and officers.* Manchester.

Department of the Environment/Welsh Office. 1992. *Planning policy guidance - coastal planning*. London, HMSO (PPG 20).

Department of the Environment/Welsh Office. 1993a. *Development below low water mark: a review of regulation in England and Wales.* London, HMSO.

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

Department of the Environment/Welsh Office. 1994. *The conservation (natural habitats etc.) Regulations.* London, HMSO (SI 2716).

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Gubbay, S. 1994. *Seas: the opportunity. Working together to protect our marine life*. Sandy, Royal Society for the Protection of Birds.

Jones, R. 1993. Coastal cell studies - a basis for coastal zone management. *Earth Science Conservation, 32:* 12-15.

King, G., & Bridge, L. 1994. *Directory of coastal planning and management initiatives in England.* Maidstone, National Coasts and Estuaries Advisory Group.

Ministry of Agriculture, Fisheries and Food/Welsh Office/ Association of District Councils/English Nature/National Rivers Authority. 1994. *Shoreline management plans: a guide for coastal defence authorities.* London, MAFF (PB2197).

Ministry of Agriculture, Fisheries and Food/Welsh Office. 1993. *Strategy for flood and coastal defence in England and Wales.* London, MAFF.

National Coasts and Estuaries Advisory Group. 1993. *Coastal planning and management: a good practice guide*. Maidstone, National Coasts and Estuaries Advisory Group.

Rendel Geotechnics. 1994. *Coastal planning and management: a review*. London, HMSO. (Report for the Department of the Environment.)

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Scottish Wildlife and Countryside Link. 1993. *All at sea? Coastal zone management, the case for Scotland*. Perth, Scottish Wildlife and Countryside Link.

World Wide Fund For Nature UK. 1994. *Coastal management plans.* Godalming, World Wide Fund For Nature UK. (Marine Update No. 18.)

World Wide Fund For Nature UK. 1994. *International commitments to integrated coastal zone management.* Godalming, World Wide Fund For Nature UK. (Marine Update No. 17.)

Newsletters

Many national statutory, non-governmental and scientific bodies are now producing publications or newsletters on the subject of coastal management. These provide either information on particular local or national initiatives (such as the statutory or non-governmental organisations' estuaries and firths initiatives) or general information on a range of coastal news (for example the newsletters of Eurocoast UK and the European Union for Coastal Conservation). Some of these publications are listed below. Addresses of those publishing the newsletters are given in section 10.3.6C.

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.

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.

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.)

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.)

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. While the network builds on the previous work of the Heritage Coast Forum and still links the 45 Heritage Coasts, it has a much wider UK and coastal management remit.	CoastNET (Coastal Heritage Network), Centre for Environmental Interpretation, Manchester Metropolitan University, St. Augustine's, Lower Chatham Street, Manchester M15 6BY, tel: 0161 247 1067
Coastal Research and Management Group (CR&MG)	Liaison between research workers and managers in the field of coastal ecology. Concentrates on research and management issues relevant to landscape and wildlife conservation along the coast zone (marine and terrestrial).	*Coastal Research and Management Group (CR&MG), Coastal Conservation Branch, JNCC, Peterborough, tel: 01733 62626
Coastal Technical Officers Group	The coastal group of the statutory conservation agencies (English Nature, Scottish Natural Heritage, Countryside Council for Wales, Department of the Environment for Northern Ireland, Joint Nature Conservation Committee and the Countryside Commission)	*Coastal Technical Officers Group, Maritime Team, English Nature, Northminster House, Peterborough PE1 1UA, tel: 01733 340345 (secretariat)
Eurocoast UK	The Eurocoast Association aims to improve the basis for protection, development and management of the coastal zone. Primarily a communication network.	Eurocoast UK, Burderop Park, Swindon, Wiltshire SN4 0QD, tel: 01793 812479
European Union for Coastal Conservation (EUCC)	International grouping of organisations and individuals with an interest in coastal nature conservation matters, including coastal management. The CR&MG (see above) is the core of the UK branch of EUCC.	European Union for Coastal Conservation (EUCC), Secretariat, PO Box 11059, NL-2301 EB Leiden, tel: +31 71 122900/123952
Joint Nature Conservation Committee - Coastal Conservation Branch	Information and advice on coastal management initiatives	*JNCC, Peterborough, tel: 01733 62626
Joint Nature Conservation Committee - Marine Conservation Branch	Information and advice on marine issues. Publishes Marine Scene, which summarises marine conservation news from the JNCC, Scottish Natural Heritage, English Nature and the Countryside Council for Wales.	*JNCC, Peterborough, tel: 01733 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, CZM Associates, 2 Newton Villas, Newton, Swansea SA3 4SS, tel: 01792 367552
Marine Conservation Society	Provides advice and supports local coastal management initiatives: runs grant-aided coastal management workshops and courses for coastal managers; promotes the establishment of voluntary coastal groups.	*Marine Conservation Society, Ross-on-Wye, tel: 01989 566017

C. Contact names and addresses (continued)

(See also Table 10.3.1.)

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, c/o University College Scarborough, Filey Road, Scarborough YO11 3AZ, 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 (NCEAG 1993)	Environment Programme Manager, National Coasts and Estuaries Advisory Group (NCEAG), Kent County Council, Springfield, Maidstone ME14 2LX, tel: 01622 696180
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
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.	*SEPA North Region HQ, Dingwall, tel: 01349 862021
Scottish Office Development Department	Coastal policy and planning. Preparation of Rural White Paper.	Dr Cath Murphy, Room 6/61, Scottish Office Development Department, New St. Andrew's House, Edinburgh EH1 3TG, tel: 0131 244 4807
Scottish Natural Heritage	Focus on Firths, Marine Consultation Areas, coastal cells in Scotland	*Focus on Firths Project Manager, SNH, Edinburgh, tel: 0131 447 4784
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.	Alastair Moir, SOAEFD, 27 Perth Street, Edinburgh EH3 5RB, tel: 0131 244 4042
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	
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
Highlands and Islands Enterprise	Bridge House, 20 Bridge Street, Inverness IV1 1QR, tel: 01463 234171
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 at Sea Team	Seabirds and Cetaceans Branch, Joint Nature Conservation Committee, Dunnet House, 7 Thistle Place, Aberdeen AB1 1UZ, tel: 01224 655700
Scottish Environment Protection Agency (SEPA), Head Office	Erskine Court, The Castle Business Park, Stirling FK9 4TR, tel: 01786 457700
SEPA North Region HQ	Graesser House, Fodderty Way, Dingwall IV15 9XB, tel: 01349 862021
SEPA North Region East Division	Greyhope House, Greyhope Road, Torry, Aberdeen AB11 9RD, tel: 01224 248338
Scottish Natural Heritage (SNH), HQ	12 Hope Terrace, Edinburgh EH9 2AS, tel: 0131 447 4784
SNH Caithness and Sutherland Area Office	Main Street, Golspie, Sutherland KW10 6TG, tel: 01408 633602
SNH Caithness and Sutherland Area Office (Annex)	Old Bank Road, Golspie, Sutherland KW10 6RS, tel: 01408 633341
SNH East Grampian Area Office	48 Queen's Road, Aberdeen AB1 6YE, tel: 01224 312266
SNH Elgin Sub Area Office	32 Reidhaven Street, Elgin, Morayshire IV30 1QH, tel: 01343 541551
SNH North-east Region Head Office	Wynne-Edwards House, 17 Rubislaw Terrace, Aberdeen AB1 1XE, tel: 01224 642863
SNH North-west Region Head Office	Fraser Darling House, 9 Culduthel Road, Inverness IV2 4AG, tel: 01463 239431
SNH Research & Advisory Division	2 Anderson Place, Edinburgh EH6 5NP, tel: 0131 447 4784

Name	*Contact address and telephone no.*
Statutory bodies (continued)	
SNH Ross and Cromarty and Inverness Area Office	Fodderty Way, Dingwall Business Park, Dingwall IV15 9XB, tel: 01349 865333
SNH Strathspey Area Office	Achantoul, Aviemore, Inverness PH22 1QD, tel: 01479 810477
Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD)	Pentland House, 47 Robb's Loan, Edinburgh EH14 11Y, tel: 0131 244 6203 or 0131 244 6001, and Interim Civil Engineering Unit: Victoria Quay, Edinburgh EH6 6QQ, tel: 0131 244 0213
SOAEFD Environment Department	New St. Andrew's House, Edinburgh EH1 3TG, tel: 0131 244 4042
SOAEFD Marine Laboratory	Fisheries Research Services, PO Box 101, Victoria Road, Aberdeen AB9 8DB, tel: 01224 876544
Wildlife Trusts	
Scottish Wildlife Trust HQ	Crammond House, Kirk Crammond, Crammond Glebe Road, Edinburgh EH4 6NS, tel: 0131 312 7765
Scottish Wildlife Trust (Northern Office)	Easter Brae, Culbockie, Dingwall, Ross-shire IV7 8JU, tel: 01349 877625
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 North Scotland Office	Etive House, Beechwood Park, Inverness IV2 3BW, tel: 01463 715000
RSPB East Scotland Office	10 Albyn Terrace, Aberdeen AB1 1YP, tel: 01224 624824
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
Others	
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	*Address and telephone no.*
Aberdeen City Council	Town House, Aberdeen AB9 1FY, tel: 01224 522502
Aberdeen Harbour Board	Harbour Office, 16 Regent Quay, Aberdeen AB9 1SS, tel: 01224 592571
Cromarty Firth Port Authority	Port Office, Shore Road, Invergordon, Ross-shire IV18 0HD, tel: 01349 852308
Aberdeenshire Council, Head Office	Woodhill House, Westburn Road, Aberdeen AB9 2LU, tel: 01224 665106
Highland Council, Head Office	Regional Buildings, Glenurquhart Road, Inverness IV3 5NX, tel: 01463 702000
Inverness Harbour Trust	23 Academy Street, Inverness IV1 1JN, tel: 01463 233291
Moray Council Head Office	District Headquarters, High Street, Elgin IV30 1BX, tel: 01343 543451
Peterhead Bay Authority	Harbour Offices, West Pier, Peterhead, Aberdeenshire AB4 6DZ, tel: 01779 74020
Peterhead Harbours	Harbour Office, Peterhead, Aberdeenshire AB4 6DN, tel: 01779 74281/2/3

A.3 Core reading list

There are a number of imporant publications that either provide information on a variety of topics covered in these regional reports (and so are frequently referred to) or give a good overview of regional and national information on coasts and seas. They are listed below.

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

British Oceanographic Data Centre. 1992. *UKDMAP (United Kingdom digital marine atlas).* Birkenhead, BODC (Computer software.).

Brown, A. 1992. *The UK environment*. London, HMSO

Buck, A.L. 1993. *An inventory of UK estuaries. 4. North and east Scotland.* Peterborough, Joint Nature Conservation Committee.

Burbridge, P.R., & Burbridge, V. 1994. *Review of Scottish coastal issues*. Edinburgh, Scottish Office.

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

Donn, S., & Wade, M. 1994. *UK directory of ecological information.* Chichester, Packard.

Doody, J.P., Johnston, C., & Smith, B. 1993. *The directory of the North Sea coastal margin.* Peterborough, JNCC.

Eno, N.C., *ed*. 1991. *Marine conservation handbook.* 2nd ed. Peterborough, English Nature.

Gubbay, S. 1988. *A coastal directory for marine conservation.* Ross-on-Wye, Marine Conservation Society.

Harding-Hill, R. 1993. *The Moray Firth review*. Inverness, Scottish Natural Heritage.

Lee, A.J., & Ramster, J.W. 1981. *Atlas of the seas around the British Isles.* Lowestoft, MAFF.

North Sea Task Force. 1993. *North Sea Quality Status Report 1993*. London; Oslo and Paris Commissions.

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

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

Scottish Office Agriculture and Fisheries Department Marine Laboratory. 1993. *North Sea Subregion 3a assessment report*. Edinburgh, SOAFD.

Steers, J.A. 1964. *The coastline of Scotland*. Cambridge, Cambridge University Press.

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