JOINT NATURE CONSERVATION COMMITTEE

Coasts and seas of the United Kingdom

Region 2 Orkney

edited by
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Contents

Foreword

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

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

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

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

The Earl of Selborne
Chairman, Joint Nature Conservation Committee

How to use this book

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

Structure

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

- **Introduction**: presents the important features of the topic as it relates to Region 1 and sets the region in a national context.
- **Important locations and species**: gives more detail on the features of the region in relation to the topic.
- **Human activities**: describes management and other activities that can have an effect on the resource in the region.
- **Information sources used**: describes the sources of information, including surveys, on which the section is based, and notes any limitations on their use or interpretation.
- **Acknowledgements**
- **Further sources of information**: lists references cited, recommended further reading, and names, addresses and telephone numbers of contacts able to give more detailed information.

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

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

Definitions and contexts

The word 'region' (as in 'Region 2') is used throughout this book to refer to the coastal and nearshore zone, broadly defined, for the area given in the title of this book. The area covered varies between chapter sections, depending on the form in which data are available. Coverage is usually either coastal 10 km squares, sites within 1 km of Mean High Water Mark, or an offshore area that may extend out to the median line between the UK and neighbouring states.

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

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

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

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

Throughout the book, the information given is a summary of the best available knowledge. The sites mentioned as important, the numbers and distributions of species, archaeological features discovered and information on all the other elements of the natural and man-made environment are as 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 volume is one of a series of products from the Coastal Directories Project of the JNCC. The compilation and publication of the series has been made possible by generous contributions from the members of the Coastal Directories Funding Consortium, listed below:

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

Notes

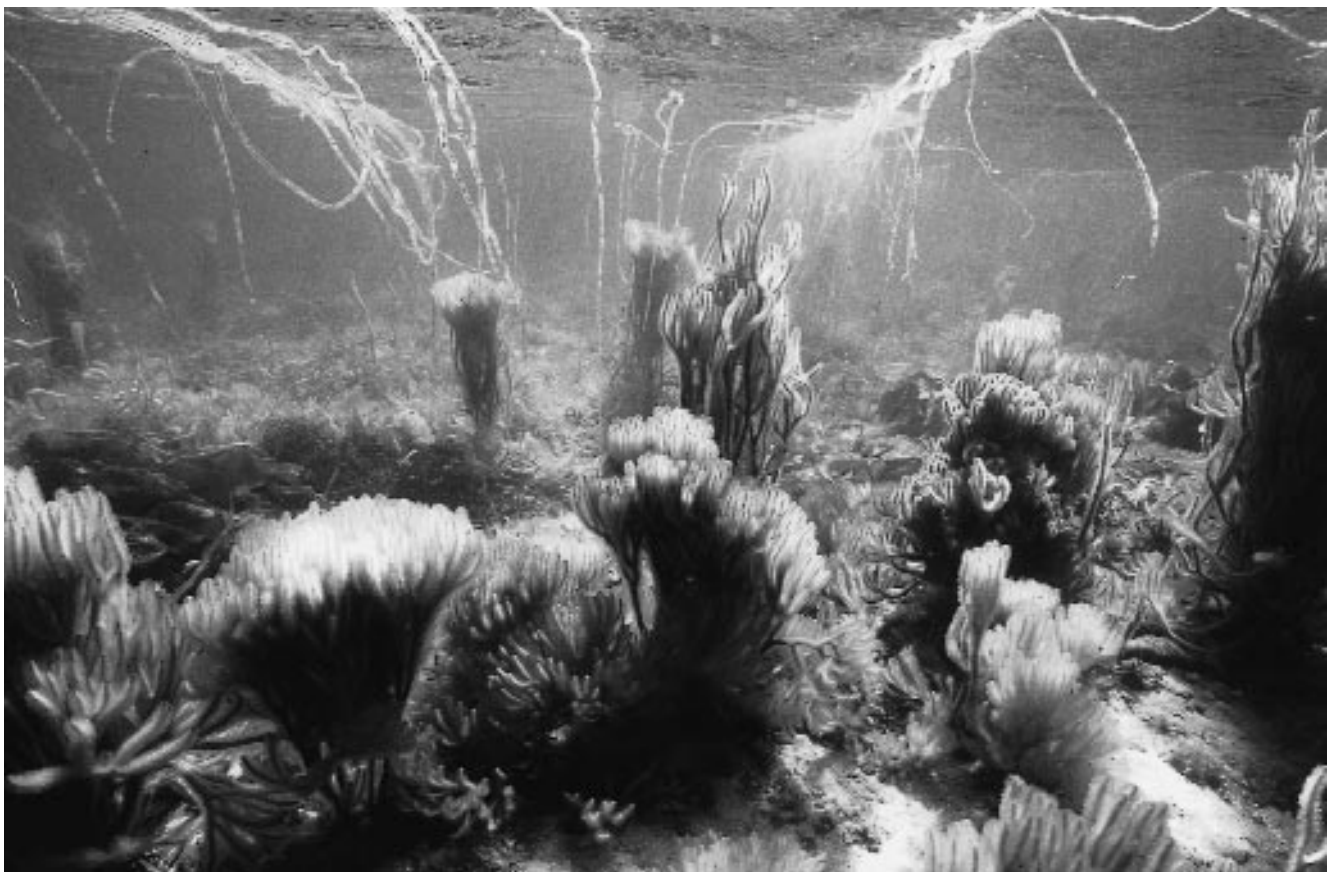
[1]Funding from these companies was given to the Cardigan Bay Forum to fund the supply of information to the Project.

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

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

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 who contributed 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 given their time to comment on drafts:

Gordon Adams, Scottish Tourist Board; Patrick Ashmore, Historic Scotland; Stephen Atkins, Scottish Natural Heritage; John Baxter, Scottish Natural Heritage; David Donnan, Scottish Natural Heritage; Alexander Downie, Scottish Natural Heritage; Sheila Harvey, The Crown Estate; Julian Hunter, Scottish Environment Protection Agency; George Lees, Scottish Natural Heritage; Eric Meek, Royal Society for the Protection of Birds; Clive Mitchell, Scottish Natural Heritage; Diana Murray, Royal Commission on the Ancient and Historical Monuments of Scotland; Eleanor Murray, Joint Nature Conservation Committee; John Orr, Orkney Islands Council; Daniel Owen, Royal Society for the Protection of Birds; R.D. Pringle, Historic Scotland; Chris Sydes, Scottish Natural Heritage; and Chris Vivian, Centre for Environment, Fisheries and Aquaculture Sciences.



The undersea environment of Orkney is exceptionally rich and diverse. At Otters Wick, north Sanday, a green alga forest of *Codium* sp. flourishes with many other algae, including translucent ribbons of the bootlace weed *Chorda filum*. Lush growths of sponges, ascidians, bryozoans and hydroids grow on the algae. Photo: Marine Nature Conservation Review, JNCC.

Chapter 1 Overview

1.1 The Coastal Directories Project

Dr J.P. Doody

1.1.1 Introduction

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

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

This undertaking - the Coastal Directories Project - collates existing information on the United Kingdom and Isle of Man coastal zone to provide national and regional overviews of its natural resources and human activities, and indexes more detailed sources of information. The project uses a broad definition of the coastal margin that encompasses all the main habitats from offshore waters through to dry land, including any habitat forming part of the functioning coastal system; in addition areas of former tidal land now enclosed from the sea and lowland wet grassland alongside tidal rivers are included. At times it can be either unhelpful or impossible to set precise limits on the geographic areas that need to be covered, for example in the marine environment, such as when discussing fisheries or sources of contamination. However, where possible, coverage is of coastal 10 km squares, or sites within 1 km of Mean High Water Mark, or (for marine topics) from the landward limit of high tides out to the median line between the UK and neighbouring states. Areas inland of these limits are not included unless specifically stated.

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

1.1.2 Origins and early development of the project

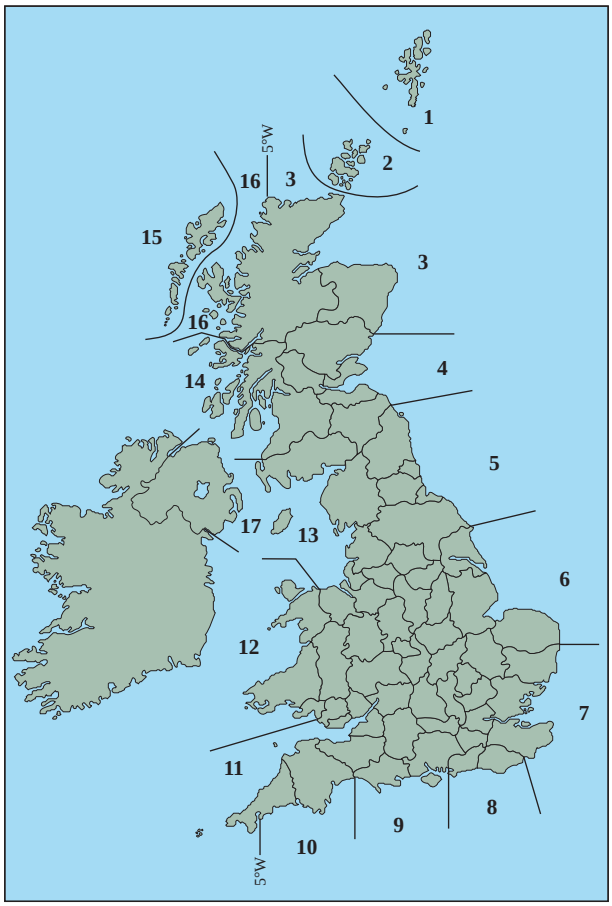
The concept of providing integrated coastal information took a long time to evolve into the Coastal Directories Project. As early as 1984, the need for such data was acknowledged at the first International Conference on the Protection of the North Sea. In 1987, recognising the significant gaps that existed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

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

The principal aims of the *Directory* were to produce "a comprehensive description of the North Sea coastal margin, its habitats, species and human activities, as an example to other North Sea states" (North Sea Task Force 1993), and thus to help to ensure that terrestrial habitats and species were considered in the QSR. In this it succeeded, and the QSR, also published in 1993, included descriptions of terrestrial habitats and species in several of the sub-regional reports, together with comments on the human impacts on the ecosystems.

The North Sea Task Force was wound up in December 1993, following completion of the *North Sea QSR*, and its work is now carried on by a new Assessment and Monitoring Committee (ASMO), under the 1992 Convention for the Protection of the Marine Environment of the North East Atlantic (the OSPAR Convention). This convention requires that assessments similar to the North Sea QSR be produced for all the constituent parts of the north-east Atlantic, and for that area as a whole, by the year 2000. The Celtic Seas, including the Irish Sea and the west coast of Britain, are one of the first areas to be subject to assessment.

In the UK during the period 1990 - 1993 there was a considerable upsurge of interest in the principles of coastal management. For example, between November 1991 and February 1992 the House of Commons Environment Committee examined the issues for England 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 coast of the UK. Regions were defined, wherever possible, by the current local or national government coastal boundaries that most closely approximated to the limits of major coastal process cells (see section 2.4), to ensure that pragmatic management requirements were matched by an ecologically coherent information base. Volumes covering seventeen regions have been 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, including Northern Ireland. These regional volumes provide a more detailed level of information than the *Directory of the North Sea coastal margin*, to help set each region in a national context and facilitate the preparation of regional plans. Discussions in the main steering group (see below) in January 1994 resulted in a decision to make the completion of the regional volumes the priority, rather than the overview *West Coast Directory*. At the meeting of the main steering group in February 1996 it was decided not to publish the *West Coast Directory* at all, as it would duplicate material already published in the regional volumes.

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

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

Table 1.1.1 Coastal Directories project management structure

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

management: Coastal Directories users report back on their experiences (February 1996). In addition the core steering group has been meeting at least annually. The final meeting in February 1997 discussed future options for developing the project, including the possibility of providing access to the information in the form of a multi-media CD-ROM. Consideration is being given to producing a companion volume to the North Sea Directory for the Celtic Seas. In addition the core steering group met at least annually.

1.1.4 The contribution of the project to coastal management

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

Increasingly, the regional volumes are seen as providing essential information to inform the development of coastal zone management policy at a national level. They provide information that complements the approach currently being promoted by a range of government reports. These include PPG 20: *Planning Policy Guidelines: coastal planning* (DoE/Welsh Office 1992), the *Policy guidelines for the coast* (DoE 1995) and the two consultation documents that followed up the House of Commons Environment Committee report: *Development below low water mark* (DoE/Welsh Office 1993a), *Managing the coast* (DoE/Welsh Office 1993b) (note that these reports do not cover Scotland, Northern Ireland or the Isle of Man) and *Scotland's coast: a discussion paper* (Scottish Office Agriculture, Environment and Fisheries Department 1996). MAFF too has promoted the setting up of flood and coastal defence 'coastal cell groups', to encourage sustainable shoreline management.

It has also been recognised that the summary information in the regional volumes is valuable in preparing and assessing applications for oil and gas licensing around the coastal margin. An injection of funds from the United

Table 1.1.2 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	1997
Region 2. Orkney	1997
Region 3. North-east Scotland: Cape Wrath to St. Cyrus	1996
Region 4. South-east Scotland: Montrose to Eyemouth	1997
Region 5. North-east England: Berwick-on-Tweed to Filey Bay	1995
Region 6. Eastern England: Flamborough Head to Great Yarmouth	1995
Region 7. South-east England: Lowestoft to Dungeness	due 1997
Region 8. Sussex: Rye Bay to Chichester Harbour	due 1997
Region 9. Southern England: Hayling Island to Lyme Regis	1996
Region 10. South-west England: Seaton to the Roseland Peninsula	1996
Region 11. The Western Appproaches: Falmouth Bay to Kenfig	1996
Region 12. Wales: Margam to Little Orme	1995
Region 13. Northern Irish Sea: Colwyn Bay to Stranraer including the Isle of Man	1996
Region 14. South-west Scotland: Ballantrae to Mull	1997
Regions 15 & 16. North-west Scotland: the Western Isles and west Highland	1997
Region 17. Northern Ireland	1997
Electronic editions	
Coastal and marine UKDMAP datasets: Version 1	1994
Regions 3, 5, 6, 9, 10, 11, 12, 13	1996
Regions 1, 2, 4, 7, 8, 14, 15 & 16, 17	Following book publication

Kingdom Offshore Operators Association (UKOOA) made possible the early production of draft regional reports for most of the potential licensing areas in the 16th Offshore Oil and Gas Licensing Round in 1994.

1.1.5 Outputs

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

1.1.6 Further sources of information

A. References cited

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

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

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

Doody, J.P., Johnson, C., & Smith, B. 1993. *Directory of the North Sea coastal margin.* Peterborough, Joint Nature Conservation Committee.

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

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

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

B. Further reading

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

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 UKDMAP	*Coastal Data Custodian, JNCC, Peterborough, tel: 01733 62626
Sales outlet for book and electronic editions of the regional volumes, the Directory of the North Sea coastal margin, and other JNCC publications	NHBS Ltd, 2-3 Wills Road, Totnes, Devon TQ9 5XN, tel: 01803 865913

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

1.2 Introduction to the region

Dr J.P. Doody

1.2.1 Introduction

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

Orkney comprises some 90 islands and skerries, including Sule Stack and Sule Skerry. The number of the islands helps explain the relatively great length of its coastline - 881 km, 7.5% of the total coastline of Scotland and 4.7% of that of Great Britain. The whole of the coast is exposed to the gales of the North Atlantic and little, if any, of the land is free from maritime influence. Although from the air the islands appear flat and fertile by comparison with Shetland (Region 1), there are significant cliffed coasts, including some that are important because of their degree of exposure to the gales of the Atlantic and the North Sea. The region is more densely populated and agriculture is more widespread than in Shetland, reflecting the greater fertility of the soil. The islands are cultivated and surprisingly productive considering the northern latitude and degree of exposure. Agricultural use includes livestock rearing, mostly beef cattle and to a lesser extent sheep, as well as some arable farming. Despite the prevalence of agriculture, considerable areas of semi-natural habitats remain, especially in undrained areas. Because much of the coast is very exposed to the wind, tides and sea spray of the Atlantic Ocean and the North Sea, the region has some of the most extensive areas of maritime vegetation in the UK.

The waters around the islands are clear and relatively shallow, and their varied exposure to waves and strong tidal streams results in a diverse marine and sea-bed flora and fauna.

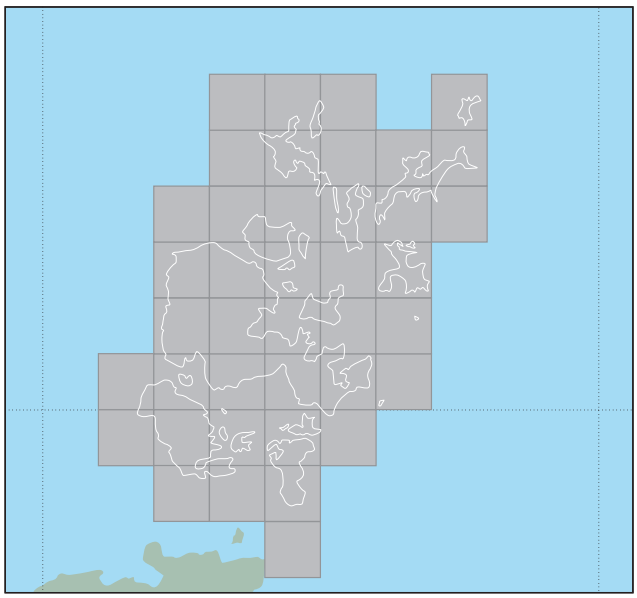
1.2.2 Structure and landscape

The Orkney Islands are mostly composed of sedimentary rocks of Devonian age (410-360 million years ago), predominantly Middle and Upper Old Red Sandstone. In a few places there are older metamorphic rocks, and younger dykes (mostly of Carboniferous age) are also present. The nature of the rock, and the glacial features and deposits left by the ice advances of the Pleistocene, help to determine the present-day landscape of the coast and hinterland.

The channels between the islands are relatively shallow, often less than 20 m, although in North Sound between Westray and Sanday the depth approaches 40 m. The sea floor slopes away steeply from the west of Mainland and from the south-west of Hoy, but more gently to the north and east of the islands. North-west of the islands water depths exceed 180 m in the Noup Basin. Offshore, sands and gravels predominate on the sea bed, those off the north and east coasts having a high shell content. The tidal range during mean springs varies between 2.5 and 3.0 m, although in certain weather conditions tidal surges of between 1.25 m and 1.5 m can occur. Tidal currents in open water range from 1.0 to 2.0 m/s but due to the complex tidal interactions between the islands, some areas such as Hoy Sound and the Pentland Firth can have currents up to 4.5 m/s. Recent relative sea-level trends suggest a net fall in sea level along the coast of 1-3 mm/year (measured at Lerwick and Aberdeen).

Wind from the west and south-east is one of the most significant features of the Orkney climate, and gales are frequent, occurring on 29 days of an average year. The winter months from October to March are the windiest. In the sheltered inlets of the region the lower energy environment allows the formation of intertidal mud and

Map 1.2.1 Major towns, islands and other locations



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

sand flats, although nowhere are they particularly extensive: there are only four significant estuarine areas. Cliffs occupy some 247 km, which represents 28% of the coastline of Orkney and 6% of the British resource. High cliffs, such as St John's Head on Hoy, are present on the west coast of Mainland, Hoy and Westray. These have near-vertical faces, and classic examples of stacks have developed in a few places, notably at Yesnaby and the Old Man of Hoy. The east coasts of the islands also have some fine cliffs, such as those around South Ronaldsay. There are several important areas of sand dune, such as that on the island of Sanday.

1.2.3 The natural environment

The sea and sea bed

The character of marine communities in Orkney is determined by the nature of the substrate and the degree of exposure to tidal and wave movement and water depth and clarity. Waters around the islands are clear, unpolluted and less than 60 m deep, although off the west coast of Mainland, Hoy and the south coast of South Ronaldsay the sea bed shelves away relatively steeply. The sea bed between the islands consists of bedrock, boulders, gravel, sand and occasional deposits of mud, while in tide-scoured sounds it is bedrock, shell gravel or sand. Shores are predominantly composed of bedrock or boulders, with sand in the bays. There are extensive shallow sublittoral areas and varied degrees of wave exposure in Orkney, because of the physiography of the islands.

Sublittoral shores are often dominated by kelps, which in the clear waters may grow down to depths of 20-30 m. In areas moderately sheltered from waves, a thin layer of silt may cover the rocks and boulders, supporting additional lush growths of sponges, ascidians, bryozoans and hydroids. The strong tidal streams that occur within the Pentland Firth and around the northern islands help to support rich, animal-dominated sea-bed communities. In the centre of Eynhallow Sound, for example, tide-swept bedrock below the lush kelp forest has a dense animal turf dominated by soft coral and bushy bryozoans, along with numerous sponges. Strong tidal streams in the Wyre Sound support extensive maerl beds. The wrecks in Scapa Flow offer hard substrata on a sea bed that is largely sedimentary, providing habitats for opportunistic colonising species. The rocky west coast has exposed communities of barnacles and mussels, and limpets and winkles are widespread. A number of intertidal invertebrates reach the northern limit of their distribution around the islands, and three nationally rare and five nationally scarce marine benthic species have been recorded, concentrated around Scapa Flow and the brackish water bodies of Mainland. None of these species is currently protected under the Wildlife & Countryside Act 1981.

Although the fish fauna of the Orkney Islands is not well documented, a total of 108 fish species have been recorded. This includes published records of three British marine and estuarine species protected under national, European and international legislation: sea lamprey *Petromyzon marinus*, sturgeon *Acipenser sturio* and sand goby *Pomatoschistus minutus*. Orkney supports populations of exploited species sea-bed such as lobster, edible crab, velvet crab, squat lobster, *Nephrops*, cockles, mussels, scallops and queen scallops. Exploited fish species such as haddock and whiting are abundant and widely distributed in the region. The area to the west of Orkney is a main spawning area for Norway pout. There are many sea lochs or lagoons (such as Loch of Stenness) and burns containing populations of sea trout.

Common seals *Phoca vitulina* are abundant, with Orkney holding over 27% of the British population. They can be seen at all times of the year and are distributed throughout the island group, except on steep, exposed shores. Grey seals *Halichoerus grypus* may also be seen regularly anywhere in the region: there are a number of colonies, some large, which together produce over 32% of the grey seal pups born in GB, a figure second only to the Western Isles (Region 15). The cetacean fauna (whales, dolphins and porpoises) of the Orkney Islands is one of the richest around Britain. Seventeen species of cetacean have been recorded along the coasts or in nearshore waters (within 60 km of the coast) of the region since 1980. Of these, seven species (26% of the 27 UK species) are either present throughout the year or recorded annually as seasonal visitors. The commonest species in nearshore waters are the harbour porpoise *Phocoena phocoena*, white-beaked dolphin *Lagenorhynchus albirostris*, white-sided dolphin *Lagenorhynchus acutus*, Risso's dolphin *Grampus griseus*, killer whale *Orcinus orca*, long-finned pilot whale *Globicephala melas* and minke whale *Balaenoptera acutorostrata*. Some 1,100 barnacle geese *Branta leucopsis* (more than 1% of the Greenland population) winter in the southern part of Scapa Flow.

Estuarine shores

The 2,250 ha of the region's total estuarine area is less than 1% of that on the UK North Sea Coast and only 0.4% of that for the whole UK. Nevertheless, although relatively small by national standards, the four estuaries of Region 2 add greatly to its coastal diversity, notably through the presence of sand- and mudflats and saltmarshes. Orkney's estuaries are strongly marine influenced, with freshwater input limited to small streams and seepages. Exposed tidal flats are formed mostly of sand and shingle, and mudflats are restricted to the most sheltered inner parts of the shore, where there are small areas of fringing saltmarshes. These represent less than 1.5% of the total area of saltmarsh in Scotland. In common with other saltmarshes of northern Britain and in the absence of significant areas of land claim, upper marsh communities and transitions to non-tidal vegetation are present, although these are limited in extent because of the virtually sediment-free conditions on the rocky shores and boulder beaches. Estuarine shores support breeding waders and wildfowl populations, and there are also small gull and tern breeding colonies. The wintering waterfowl population is diverse, though not large. There is little human use of Orkney's estuaries, which have only small and scattered settlements around them. There are a number of saline lagoons in the region, although the only one of any size is the Loch of Stenness, the largest area of lagoon habitat in Scotland. It has been identified as a potential Special Area of Conservation under the EC Habitats & Species Directive.

Non-estuarine shores

The region includes a moderate proportion (6%) of the total area of sand dune in Great Britain, contained within 84 sites,

most of them small and associated with open shores and bays. Overall there is an estimated 2,961 ha of vegetated sand dune, including some important areas of distinctive wet dune vegetation, for example on the island of Sanday. Such areas contain the scarce curved sedge *Carex maritima*. Bay dunes are by far the dominant type in the region, developed within the shelter of rocky headlands. These and the shell-rich dunes support neutral to calcareous grassland, often heavily grazed. As in other parts of northern and western Scotland, dunes in Orkney are notable for the very large extents of species-rich grazed dune grassland. Although survey effort has been very limited, it is likely that the machair areas are rich in lower plant interest, including rare and scarce species. Beaches, machair and sandhills in the region support a number of scarce terrestrial invertebrates, including the scarce fly *Rhamphomyia morio*, the locally-distributed dark green fritillary butterfly *Argynnis aglaja*, the archer's dart moth *Agrotis vestigialis* and one of the few British records of the sawfly *Nematus stichai*. Orkney's sandy beaches are important for migrant and wintering wildfowl, particularly purple sandpiper *Calidris maritima*, curlew *Numenius arquata* and redshank *Tringa totanus*, and the machair provides breeding habitat for the corncrake *Crex crex*. The dunes can also be densely populated by rabbits, which on Sanday have helped produce a close-cropped grassland with bare sand. Some sites have been damaged by beach sand and shingle extraction, which can lead to erosion. The Bay of Skaill, close to the famed Skara Brae archaeological site, has a serious erosion problem that may be the effect of storm wave action. Such effects are common on exposed sites and there is anecdotal evidence of a slow retreat inland of the outer dune edge.

Shingle beaches are often bay-head features and may be associated with stream outlets or be barriers to lochans. The vegetation is influenced by the sandy nature of the matrix at most of the sites and the accumulation of wrack. Where stable shingle is present over large areas a wide variety of species occur, which may include Scots lovage *Ligusticum scoticum*, the nationally scarce oysterplant *Mertensia maritima* and crustose and foliose lichens, especially where the shingle is undisturbed. Shingle beaches in Orkney are important for migrant and wintering waders, especially turnstone *Arenaria interpres*.

The region's sometimes spectacular cliffs are of great interest for both their landscape and nature conservation value. The highest vertical cliffs reach 335 m at Hendry's Hole on the west coast of Hoy. In most places the cliffs are exposed to the full force of the Atlantic and North Sea gales, and exposure to salt spray may blow inland for some distance, even on relatively high cliffs such as those at Yesnaby, north of Stromness. Away from the cliff edge, maritime heath with the nationally rare endemic Scottish primrose *Primula scotica* may occur; Stromness Heaths and Coast (Yesnaby) has been identified as a potential Special Area for Conservation under the EC Habitats & Species Directive for cliff vegetation. Several notable or local invertebrate species have important populations on the sea cliffs of the region. A leaf beetle known only from Scotland, *Chrysolina crassicornis*, which inhabits cliff tops, maritime dry grassland and sandy hills, has been recorded in this region at Yesnaby.

Orkney has many internationally-important sites for breeding seabirds, with 23 colonies holding more than 1% of a species' total population in the European Union. There are a further three colonies that are important at the Great Britain level. Guillemots (183,000 birds, about 4% of the European population), fulmar (>84,000 pairs), kittiwakes (64,000 pairs) and puffin (51,000 pairs) are the most numerous species. Cliffs are especially important for seabirds, as nesting colonies on them are relatively safe from predation. Marwick Head, for example, has some 36,000 guillemots and 7,000 pairs of kittiwakes. Great and arctic skuas also nest on the islands. Sule Skerry has internationally important numbers of breeding puffins, storm petrels, guillemots and shags and Sule Stack supports internationally important numbers of gannets. Five sites in the region have been designated as Special Protection Areas on the basis of their seabird colonies.

Orkney has good examples of montane vegetation occurring at or near sea level, a characteristic feature of the most exposed coasts of northern Britain. Species found here that are typically confined to high altitudes further south include alpine bearberry *Arctostaphyllos alpinus*, alpine meadow-rue *Thalictrum alpinum* and moss campion *Silene acaulis*. Hoy, with its alpine and sub-alpine heaths, north Atlantic wet heaths with *Erica tetralix* and petrifying springs with tufa formations, has been identified as a potential Special Area of Conservation under the EC Habitats & Species Directive. Orkney's lochs and lochans are a major breeding stronghold for the red-throated diver *Gavia stellata* and pintail *Anas acuta*, supporting over 50% of the British population of the latter. The common toad *Bufo bufo* is the only amphibian species officially recorded as having bred on Orkney, although introduced common frogs *Rana temporaria* appear to have become established. Other recent introductions include the palmate newt *Triturus helveticus*, slow-worm *Anguis fragilis* and common lizard *Lacerta vivipara*, though their survival has not been confirmed. The otter is common on the coastal and inland waters of many of the islands. Nationally important breeding populations of the hen harrier *Circus cyaneus* (possibly as much as 20% of the British total) and the short-eared owl *Asio flammeus* breed on the inland heaths and bogs; their prey include the endemic Orkney vole *Microtus arvalis*.

1.2.4 Landscape and nature conservation

Owing to its small size (only approximately 0.6% of Great Britain's land surface area), Orkney contains only a small proportion by area of many types of coastal protected sites in Great Britain. Nevertheless, Orkney contains a relatively high proportion of certain categories of protected site. For example, the region is notable in that it contains 20.4% of the area of Great Britain's RSPB reserves. Other site designations that are well represented in Orkney are Sites of Special Scientific Interest (2.3% by area of the national total), National Scenic Areas (2% of Great Britain's total) and Local Nature Reserves (1.6% of the total area in Great Britain). Orkney is one of the few regions in Britain that lacks Ramsar sites and National Trust/National Trust for Scotland sites. It is the only region with no National Nature Reserves. The total numbers and areas of the main designated sites are given in Table 1.2.1.

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*
Special Protection Areas	5	806	0.2
Possible Special Areas of Conservation	3	n/a	n/a
Sites of Special Scientific Interest	26	16,743	2.3
Local Nature Reserves	1	244	1.6
National Scenic Areas	1	14,800	2.0
Royal Society for the Protection of Birds reserves	11	8,132	20.4
The Wildlife Trusts	2	83	0.3

Source: JNCC (October 1996 SPA data). Key: n/a = not available.

1.2.5 Human activities, past and present

The greater part of the Orcadian past, even down to the Viking Age, is largely undocumented. However, the prehistoric monuments of Orkney constitute a complex unsurpassed elsewhere in Britain. A large number of Orcadian sites have been discovered as a result of coastal erosion, and others may lie in the intertidal or sub-tidal zones.

Flint scatters attest the presence of hunter-gathers in Orkney, but the first known substantial structures were built by farmers about 3500 BC. Marine erosion has exposed a few intertidal Neolithic settlements that were originally inland, and many of these are in a good state of preservation. The settlement at Skara Brae was probably inhabited for about 600 years in all, some time between 5,100 years and 4,300 years ago, when it was overwhelmed by sand, only to be exposed by a storm in AD 1850. This is probably the best of a wide range of internationally important ancient monuments in the region, which include burial monuments and chambered cairns, some of the most common Neolithic structures found in both Orkney and Shetland. During the Iron Age substantial dry-stone houses were built, including tall towers (brochs) that date at the latest from the first century AD, around which settlements grew up. By the 7th or 8th century AD these settlements were part of the Pictish domain. In the late 8th century Orkney began to be settled by the Vikings; thereafter political control remained with the Earls of Orkney, who were Scandinavians until 1241. From the early 13th century Scottish influence over the islands increased and in 1468 Orkney was formally passed to Scotland.

The original locations for the main port and town developments on Orkney are Stromness and Kirkwall, on Mainland, although there are many smaller harbours and jetties on the other islands. Most of these started out primarily as fishing harbours, the larger ones also being used for importing and exporting goods and for inter-island ferry traffic. The main centres of population are still Kirkwall and Stromness on Mainland; the other half of the population is widely distributed over the other islands. The indented nature of the coastline and small size of the islands means that none of the 20,000 population lives far from the coast. The predominant land use on Orkney is agriculture, with the oil industry, fisheries and fish farming also important.

It is thought that commercial fishing may have begun during the Viking period, but it was the Dutch in the 17th century who harvested the local cod fisheries on a large scale. By the 19th century huge herring shoals attracted fishing vessels from Scotland and elsewhere and by the 20th century the islands were host to hundreds of boats during the season. Today, Kirkwall and Stromness are the two principal fishing ports in Orkney. Other islands supporting commercial fishing boats are Sanday, Westray, Stronsay, Rousay, South Ronaldsay and Hoy. Orkney supports a modern offshore trawling fleet, the majority of the boats being based on Westray. They target demersal fish species, and work the creel fishery, mainly for lobsters and crabs but also targeting velvet crab, shore crab and whelks. Other shellfish species, such as *Nephrops*, scallops and queen scallops, are also fished. The 797 tonnes of crabs landed in Orkney represent 4.7% of the British and Isle of Man total, and there are also significant landings of lobsters (11.9%) and whelks (8.2%). Salmon and shellfish (mainly mussel) farms have become an important feature of the local economy. Orkney produces about 2.7% of Scotland's farmed salmon.

The huge natural harbour of Scapa Flow has long been an important sheltered anchorage, able to accommodate very large vessels. In this century Orkney has played an essential role in the defence of Britain, providing an essential fleet base in the two World Wars. It is well known for its shipwrecks from both wars, with those of the German High Seas Fleet scuttled in 1919 being the most famous. Seven of the 74 ships originally sunk still lie below the surface, and these, together with HMS *Royal Oak,* which was torpedoed in Scapa Flow in 1939 with the loss of 800 lives, provide an important underwater legacy.

Though Orkney was rather less affected than Shetland by developments associated with the North Sea oil industry in the 1970s, an oil-handling terminal was constructed on the island of Flotta within Scapa Flow. In 1994 the port ranked as the ninth most important in the UK, a reflection of the volume of oil-related traffic. The current level of port activity will increase in the near future because the terminal won the contract to take oil from the Foinaven field, currently under development west of Shetland. It is expected this will increase the throughput of trade at Flotta by at least 25%.

Most of the coastal land in Orkney is low-lying and relatively fertile. Agricultural activities, including conversion of rough pasture and heath (including the rare 'maritime heath') to arable use and 'improved' grazing, have resulted in a decline in the populations of some rare plant species, including the Scottish primrose. Despite these changes, the islands of Hoy and Rousay, along with some of the higher ground and the west coast of Westray, are still largely under rough grazing, a land use that generally retains the wildlife and landscape value of the land. There has been a long history of making use of seaweed in Orkney. Washed-up kelp plants (most commonly *Laminaria hyperborea*, known as 'tangles'), were collected from beaches and burnt in pits. The product, rich in potash and soda, was used not only as a fertiliser but also in the glass and soap industries and as a source of iodine. Another valuable natural resource is maerl, an unusual calcareous seaweed which forms extensive beds around the islands. Crushed maerl can be used as a seawater filter in the marine aquarium trade, although it has also been used as a fertiliser/soil conditioner in the past. The sustainability of limited exploitation is currently being assessed.

The region has a wide variety of relatively low-intensity informal recreation, including walking, bird-watching, angling and horse-riding. Scapa Flow is a popular site for scuba diving. Kirkwall and the sheltered waters of Scapa Flow are renowned for sea angling for species such as skate, halibut, ling, plaice, pollack, mackerel and haddock. Sea lochs, such as the Loch of Stenness, are important for sea trout, while brown trout are fished in the freshwater lochs, for example Loch Harray.

Coastal zone management is as yet only patchy in the region. The major coastal management initiative currently under way in Scotland is '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 co-operation among various users and statutory authorities. There are no Focus on Firths initiatives in Orkney, but in the Wide Firth and Scapa Flow the Orkney Islands Council has unifying powers, fulfilling other roles such as that of Harbour Authority and issuing works licences for structures on the sea bed (such as salmon farming cages). As a result it is already able to undertake integrated coastal zone management on a statutory basis, rather than relying on voluntary co-operation.

1.2.6 Acknowledgements

Thanks are due to Eric Meek (RSPB), John Orr (Orkney Islands Council) and Patrick Ashmore and Dr R.D. Pringle (Historic Scotland) for comments on the draft text.

1.2.7 Further sources of information

A. Further reading

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The west coast of Mainland is dominated by high cliffs, which characteristically have vertical or nearly vertical faces, as here at Marwick Head. This is partly a function of the horizontal bedding of the sedimentary rocks, including Middle Old Red Sandstone, which makes up most of Orkney's 90 islands and skerries. Photo: David Stroud, JNCC.

Chapter 2 Geology and physical environment

2.1 Coastal geology

British Geological Survey & Scott Wilson Resource Consultants

2.1.1 Introduction

In common with the north-east of Scotland and parts of the coastline of south-west England and Wales, the Orkney archipelago is formed largely of Middle and Upper Old Red Sandstone rocks of Devonian age. Locally, older sedimentary rocks, basement igneous and metamorphic rocks, as well as younger lavas, volcanic plugs and numerous dykes (mostly of Carboniferous age) are present. The geology of the region is summarised in Table 2.1.1 (Map 2.1.1).

2.1.2 Stratigraphy and structure

The Middle Old Red Sandstone makes up most of Orkney's 90 islands and skerries. This includes the majority of the coast of Westray, Rousay, Eday, North Ronaldsay, Sanday, Stronsay, Shapinsay, Mainland, Burray and South Ronaldsay. In order of decreasing age these rocks have been divided into the Stromness Flags, the Rousay Flags and Eday Beds. The first two groups comprise mainly rhythmic sequences of grey and black siltstone and mudstones alternating with thin beds of sandstone. The Eday Beds comprise yellow and red sandstone separated by Eday Flags and Eday Marls. Fossilised fish remains are found in all three groups and are particularly abundant and well preserved in the Sandwick Fish Bed. On Mainland, in a 3 km stretch from the Ness of Stromness to Warebeth, the typical sequence of the Stromness Flags can be seen. About halfway along this stretch, at Noust of Nethertown, the Sandwick Fish Bed is exposed. Further round the coast, towards Yesnaby, the junction between Moinian metamorphic rocks and the only outcrop of Lower Old Red Sandstone on Orkney, known as the Yesnaby Sandstone Group, can be seen. The Eday Flags are thickest and best developed around Deerness on Mainland. Nearby, at Port of Ayre, basalt lavas in the Eday Beds are exposed. South of here, at Croo Stone at the north-east corner of South Ronaldsay, one of Orkney's most interesting volcanic vents can be seen at low tide. This volcanic vent is bounded and cut by dykes. Excellent exposures of the Eday Beds can be seen around the coast of Eday. On the south-west coast, for instance, a continuous sequence from sandstone, through flagstone (fissile micaceous sandstone) and back into sandstones are exposed.

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 rise in sea level
		Pleistocene	1.8		Series of ice sheets cover the region
	Tertiary (Neogene)	Pliocene	5		
		Miocene	23		
	Tertiary (Palaeogene)	Oligocene	38		
		Eocene	54		Early Tertiary opening of the North-east Atlantic; volcanism
		Palaeocene	65		
Mesozoic	Cretaceous		146		
	Jurassic		208		Sedimentation
	Triassic		245		
Palaeozoic (Upper)	Permian		290		
	Carboniferous		360		Variscan Orogeny
	Devonian		410	Old Red Sandstone	
Palaeozoic (Lower)	Silurian		440		Caledonian Orogeny
	Ordovician		505		
	Cambrian		544		
	Precambrian	Dalradian			
		Moine			
		Lewisian			

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

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

Orkney's youngest rocks are exposed on the west coast of Hoy. They consist of pink and yellow sandstones underlain by lavas and tuffs. These are generally quoted as being part of the Old Red Sandstone sequence (Devonian age) but there is radiometric evidence to suggest they are of Carboniferous age. A famous sea stack, the Old Man of Hoy, is cut out of these sandstones. It lies about 2 km to the north of Rora Head on the west coast of Hoy where it stands on a plinth of lava which rests uncomformably on Stromness Flags.

Structurally these sedimentary rocks are disposed in a shallow synclinal basin. However, the near-horizontal strata are disrupted by faults aligned to the north-east, north-north-east and north-west. Near-vertical jointing is ubiquitous and to a large extent has controlled the trends of dykes.

2.1.3 Further sources of information

A. Maps

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Geological information for Region 2 and the whole of Britain; 1:50,000 scale map sheets	*Coastal Geology Group, British Geological Survey, Nottingham, tel: 0115 936 3100
Geological Conservation Review (GCR) sites in the region	*Conservation Officer, SNH Orkney Office, Kirkwall, tel: 01856 875302

*Starred contacted addresses are given in full in the Appendix

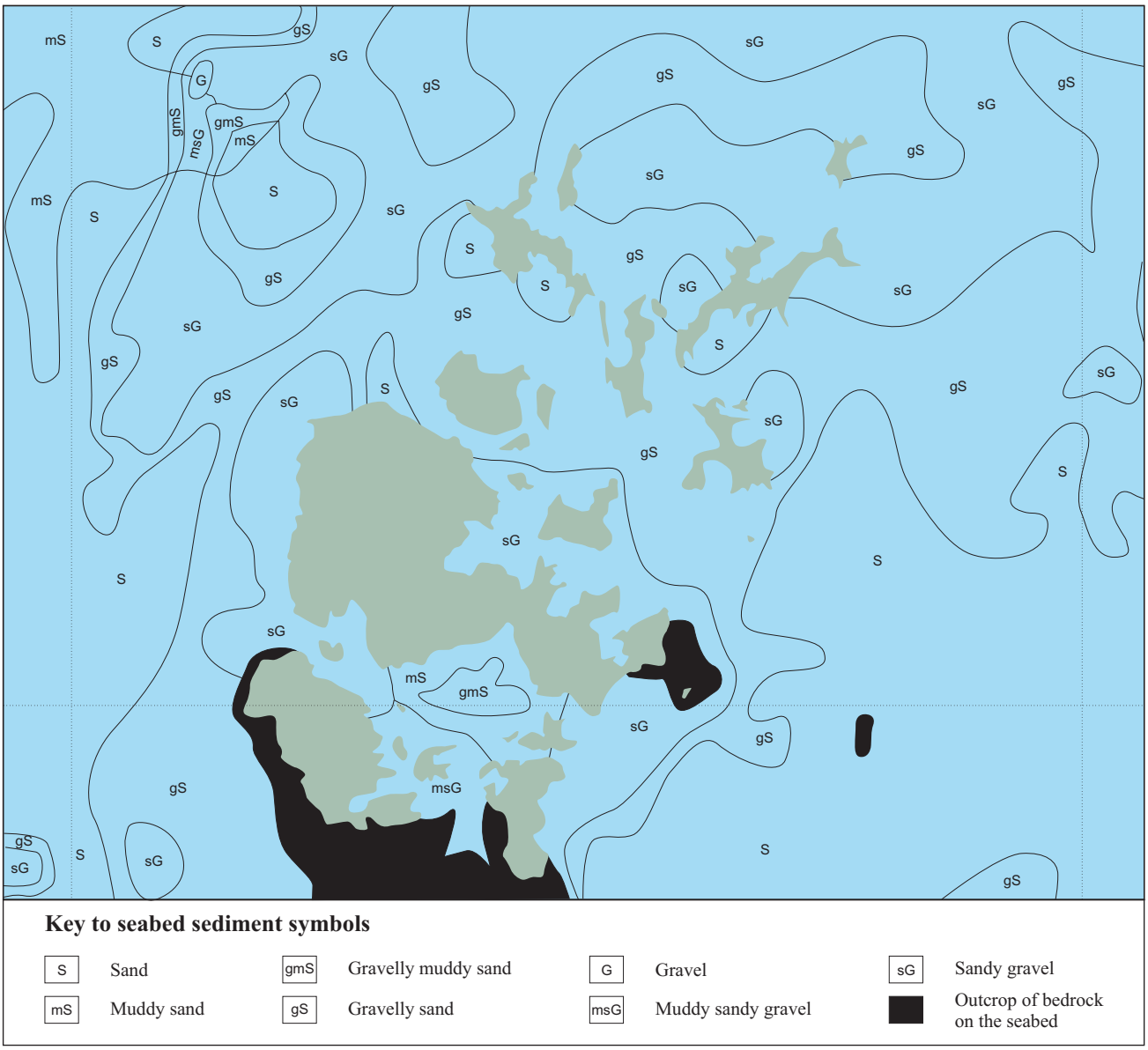
2.2 Offshore geology

British Geological Survey & Scott Wilson Resource Consultants

This section deals briefly with the geology of the rocks and sediments at and below the sea bed. The bulk of the information is shown on the maps, with some additional explanation provided by the text. Sea-bed sediments are defined here as the unconsolidated sediments at sea bed laid down since the sea transgressed across the area following the early Holocene rise in sea level. The Quaternary Period covers the last 1.8 million years and is divided into the Holocene (the last 10,000 years) and the Pleistocene. Holocene sediments form a more superficial and locally mobile veneer over the relatively immobile Pleistocene sea-bed sediments. 'Solid geology' refers to rocks of pre-Quaternary age, which in Britain are separated from the overlying Quaternary sediments by a marked dividing line. The lithology (rock types) and the thickness of the sediments has been determined by sampling, high resolution seismic profiling and sidescan sonar.

2.2.1 Holocene sea-bed sediments

Sea-bed sediments are shown on Map 2.2.1. Sands and gravels notable for their high biogenic carbonate content form the sea-bed sediments around the Orkney Islands. Much of the gravel around the islands, particularly to the north and east, is composed predominantly of shell debris. These carbonate deposits reflect the rich littoral and sublittoral fauna that exists around the Orkney Islands. Between the main islands the sea bed is swept by strong tidal currents. Within these channels, the sediments are thin and patchy, comprising shell-gravels, coarse sand or rock debris; the mud content of the sediments is extremely low.



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

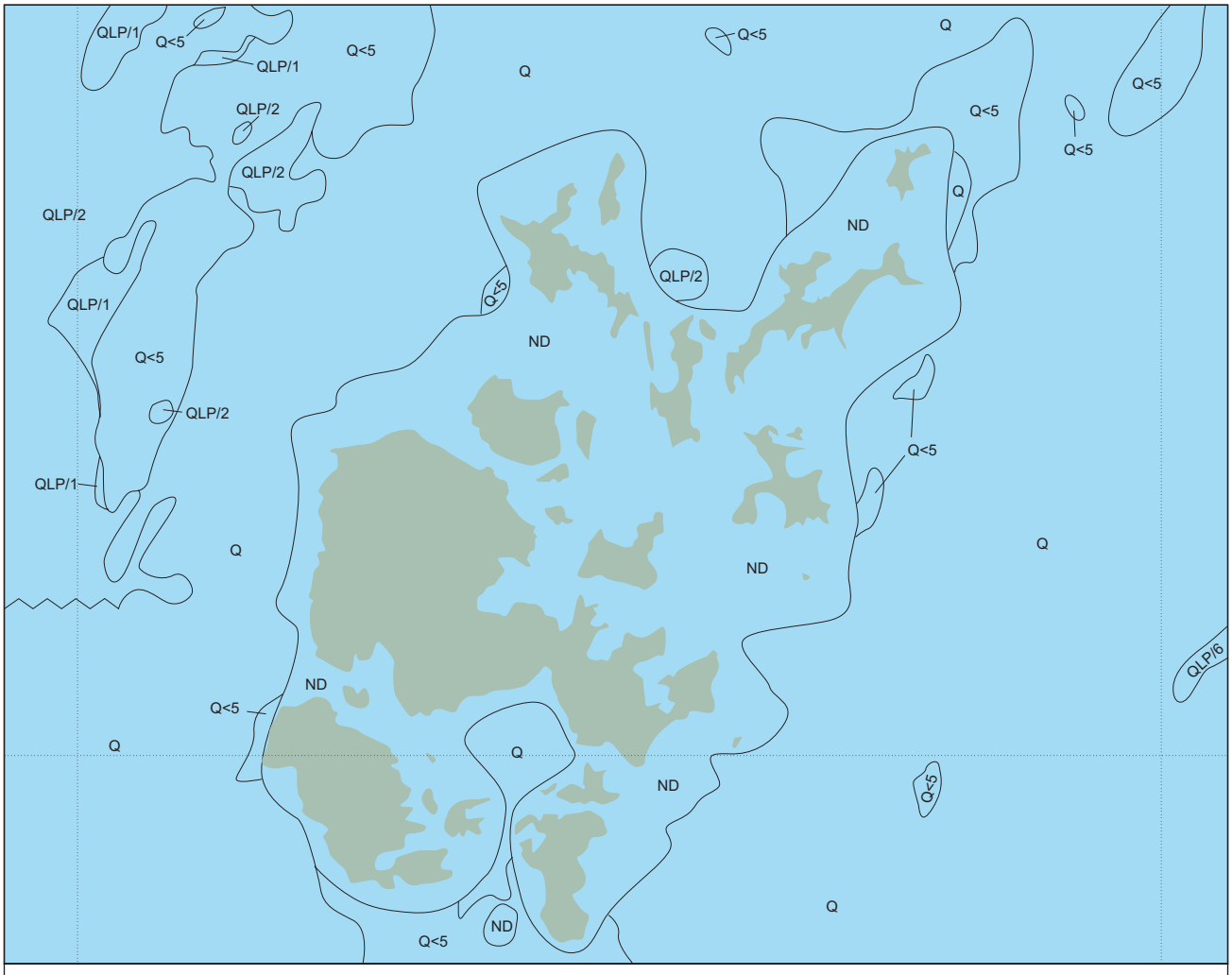
Fine sands are found in sheltered firths or bays. The floor of Scapa Flow is covered by a variety of sediments from mud to rock debris. East of Mainland and to the south of the Orkney Islands, bedrock outcrops occur on the sea bed.

2.2.2 Pleistocene geology

There are no data available for close inshore, but till-like deposits, commonly less than 5 m thick, occur around the Orkney Islands (Map 2.2.2). Thicker deposits occur in the Stormy Bank Basin, south-west of Hoy, where 50 m of Quaternary sediments occur locally. The age of these deposits is unknown, but they are thought to be Devensian or early Flandrian. Further away from Orkney, to the north-west, late Pleistocene deposits of till and mud occur.

2.2.3 Solid (pre-Quaternary) geology

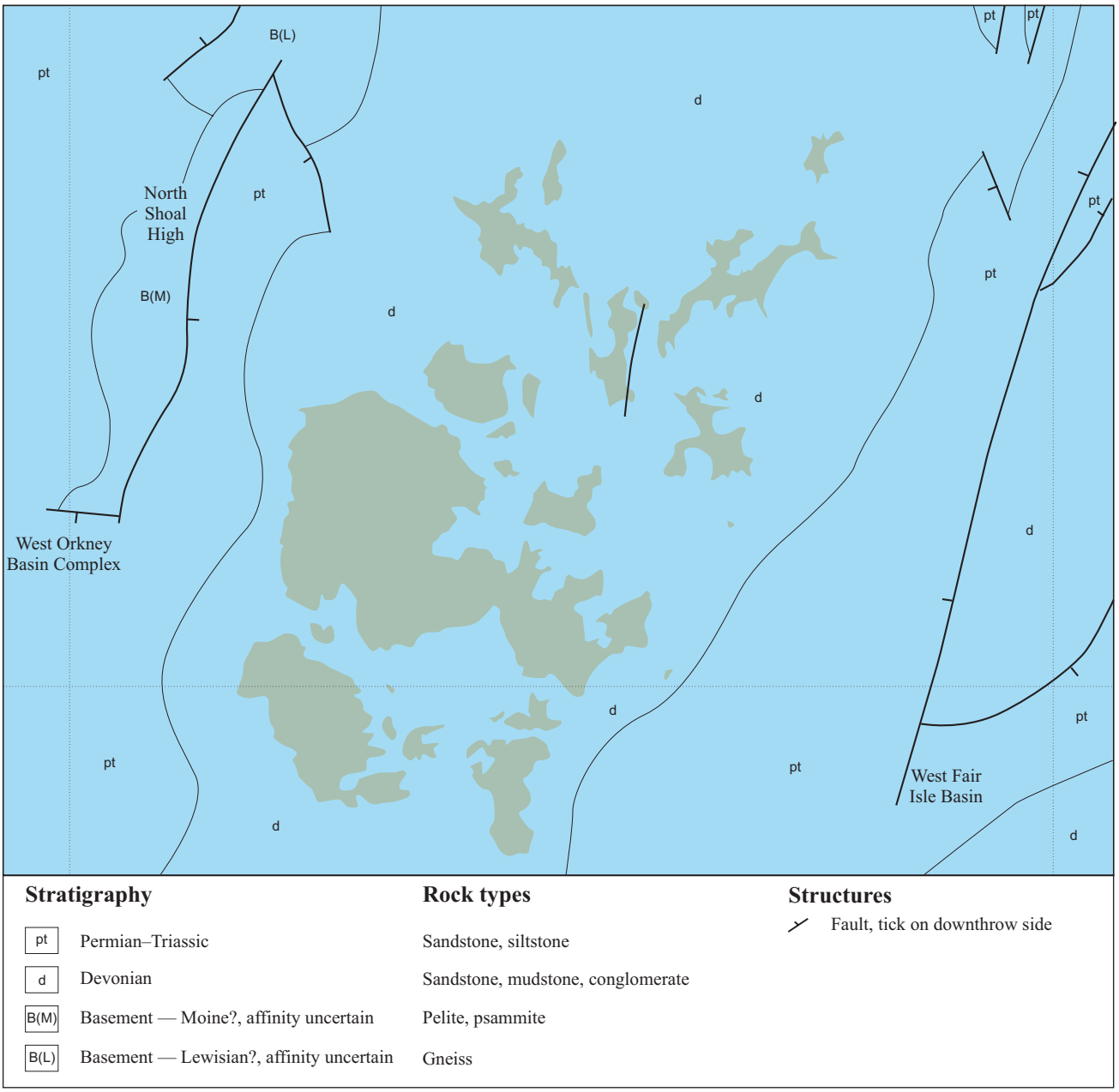
The Orkney Islands and inshore waters are underlain by the Shetland platform, which is composed largely of Middle Devonian rocks (Map 2.2.3). These rocks consist of sandstones, flagstones (fissile micaceous sandstones), conglomerates and shales that are comparable to rock sequences found onshore. Offshore, most solid geology is concealed by sea bed sediments, but rock outcrops do occur at the sea bed south of Orkney and locally elsewhere. Permian and Permo-Triassic rocks crop out on the sea bed in the West Fair Isle Basin and in the West Orkney Basin Complex. An inlier of basement metamorphosed rocks, comprising sandstones, siltstones and shales, as well as mylonites and amphibolites, crops out on North Shoal High.



Key to seabed sediment symbols

QLP	Late Pleistocene to Early Holocene	1	Predominantly till
Q	Quaternary, undivided	2	Predominantly mud
Q<5	Quaternary generally < 5 m thick	6	Predominantly incision and channel deposits
ND	No data		

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



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

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D. Contact names and addresses

Type of information	*Contact address and telephone no.*
Geological information for region and the whole of Britain	*Coastal Geology Group, British Geological Survey, Nottingham, tel: 0115 936 3100
Geological information for region	*SNH, Earth Science Branch, Advisory Services, Edinburgh, tel: 0131 554 9797
UKDMAP 1992. Version 2. United Kingdom digital marine atlas. Oceanographic maps.	*British Oceanographic Data Centre, Birkenhead, tel: 0151 653 8633

*Starred contact addresses are given in full in the Appendix

2.3 Wind and water

British Geological Survey & Scott Wilson Resource Consultants

2.3.1 Wind

Strong winds are perhaps the most significant feature of the Orkney climate. Prevailing winds are from between west and south-east for 60% of the year (Figure 2.3.1). Winds greater than 8 m/s occur for over 30% of the year and gales occur on an average of 29 days per year (Jones 1975). The windy months are October-March while the months of June, July and August are relatively calm, although dead calm prevails for only 0.6% of the year. Wind contour maps for Orkney are not available. However, during the period 1965-1973 an hourly mean wind speed of around 4 m/s was exceeded for 75% of the time, with hourly mean wind speeds of around 21 m/s exceeded for 0.1% of the time (Caton 1974). These are among the highest such figures in Britain.

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. The channels between the islands and the firths and sounds are relatively shallow, often less than 20 m deep (Map 2.3.1). The sea floor slopes away steeply from the west of Mainland and from the south-west of Hoy, but sea floor gradients are much gentler to the north and east of the Orkney Islands. North-west of the islands, water depths exceed 180 m in the Noup Basin.

2.3.3 Tidal currents

The tides around Orkney are the result of the interaction of two independent tidal systems, in the North Atlantic and the North Sea. The tidal waves of both systems have anti-clockwise rotations and the systems reach the Orkney coastline with similar strengths but moving in opposition, the northward-moving Atlantic wave peak arriving some 2-3 hours before the southward-travelling North Sea wave. This produces a net flow of water from west to east and complex interactions among the island sounds and in Scapa Flow. Tidal streams are very weak in the Atlantic Ocean, but as the tidal wave reaches the shallower areas of the UK continental shelf the magnitude of the tidal streams increases greatly. This effect is particularly noticeable where the tide is forced through the narrow channel of the Pentland Firth between Orkney and mainland Scotland. Map 2.3.2 shows the maximum tidal current speeds for the region. The speed of most tidal streams around Orkney ranges between 1.0 and 2.0 m/s. However, owing to the complexity of tidal interactions, some areas, such as Hoy Sound and the Pentland Firth, are subject to considerably higher velocities (up to 4.5 m/s).

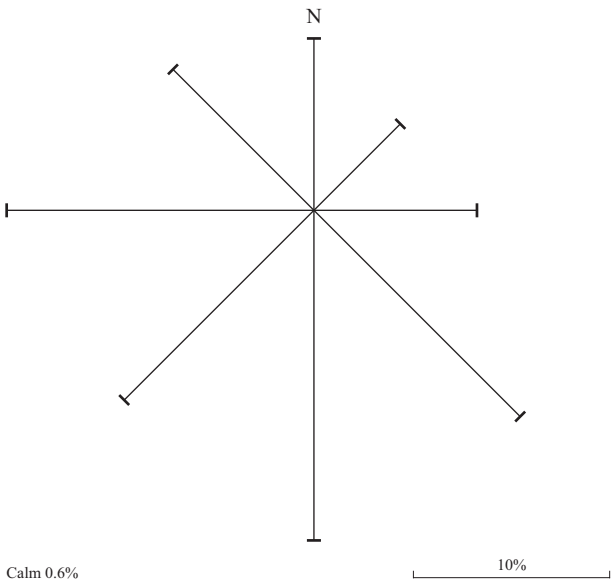


Figure 2.3.1 Wind directions, Kirkwall. Source: Jones (1975).

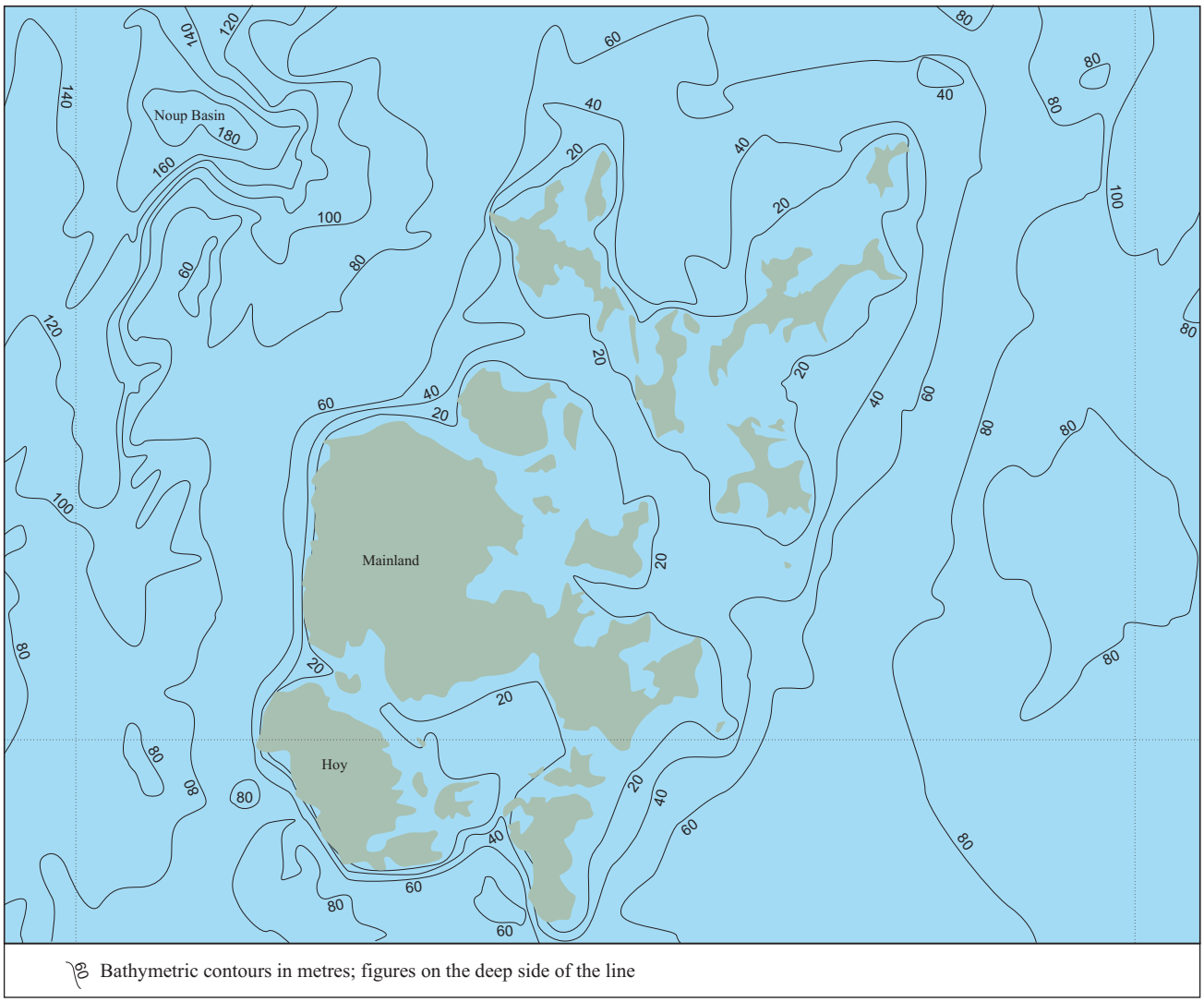
2.3.4 Tidal range

Map 2.3.3 shows the tidal ranges for mean spring tides, the greatest ranges to be found in calm conditions. The tidal range at mean spring tides varies between 2.5 and 3.0 m. Variations occur in the tidal estuaries and bays. Exceptionally, the interaction of atmospheric pressure, wind and tide can lead to the occurrence of an unusually high tidal range, called a tidal surge. In Orkney tidal surges of between 1.25 m and 1.5 m occur on average once in every 50 years. Smaller surges occur more frequently.

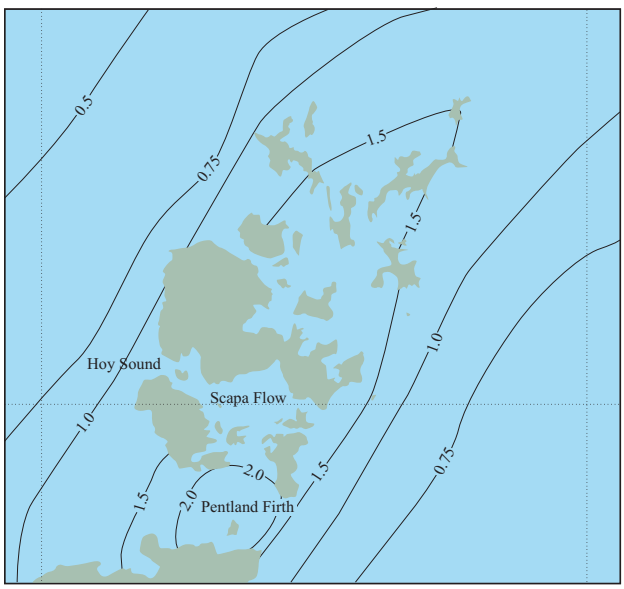
2.3.5 Wave exposure and sea state

The west coast of the Orkney archipelago is exposed to long swells of the North Atlantic and generally has only narrow intertidal areas. There are, however, many sheltered inlets. The east coast is more sheltered and less frequently exposed to large, powerful waves. Wave period (the time between successive waves) is significant when considering sea state and exposure. Close to the coast, and especially within the surf zone, waves can appear to be more frequent because of the effect of refraction from the shore. More powerful waves, such as those created in oceans, have a great deal of energy in them even when refracted by the shore and returning. In an area protected from direct exposure to powerful ocean waves, such as the east coast of Orkney, the dominant period between waves can be longer than in adjacent, exposed seas. The seas of the region have a mean wave period of about 4-6 seconds.

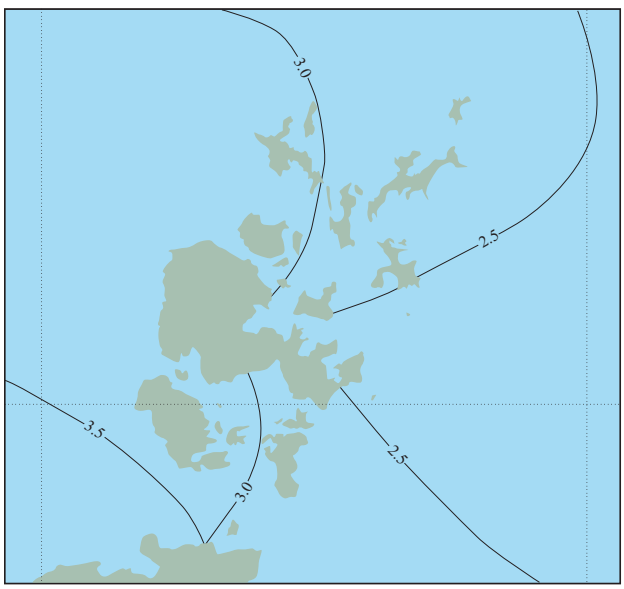
Map 2.3.4 shows the significant wave heights that can be expected to be exceeded for 10% and 75% of the entire year. For example, immediately to the east of Orkney the significant wave height exceeds 0.5 m for 75% of the year, and 1.5 m for 10% of the year, while close to the west of Orkney the significant wave height exceeds 1.0 m for 75% of the year.



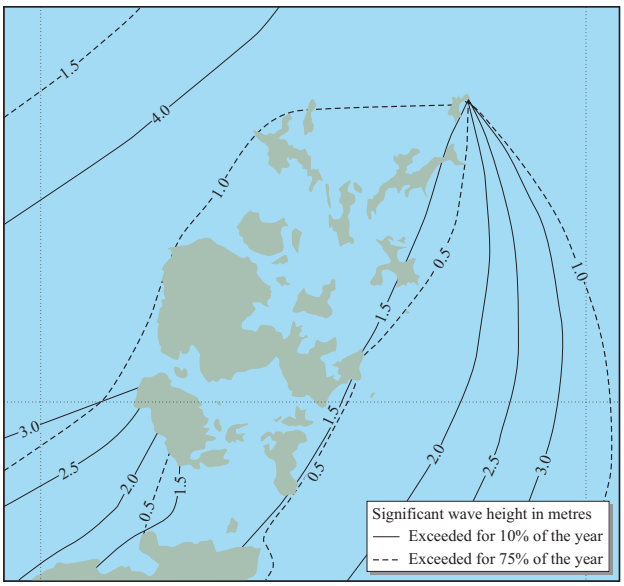
Map 2.3.1 Bathymetry. Source: British Geological Survey (1987).



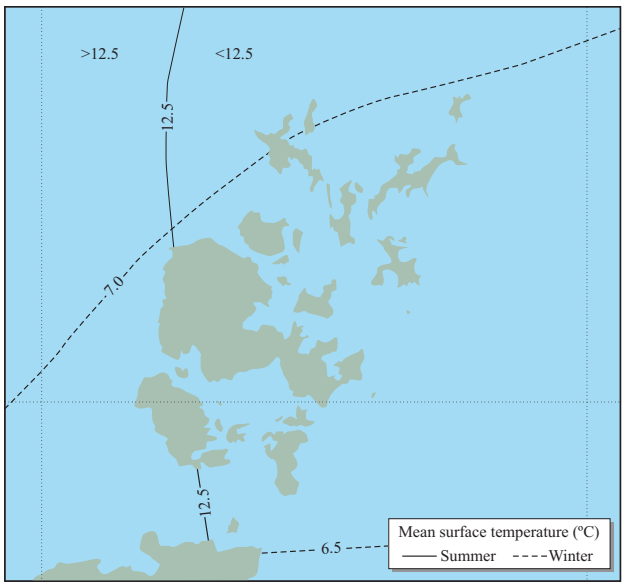
Map 2.3.2 Maximum tidal current speed (in m/s) at mean spring tides. Source: Sager & Sammler (1968).



Map 2.3.3 Tidal range (m) at mean spring tides. Source: Lee & Ramster (1981). © Crown copyright.



Map 2.3.4 Significant wave height (m) exceeded for 10% and 75% of the year. Source: Draper (1991).



Map 2.3.5 Mean surface water temperature in summer and winter (°C). Source: Lee & Ramster (1981). © Crown copyright.

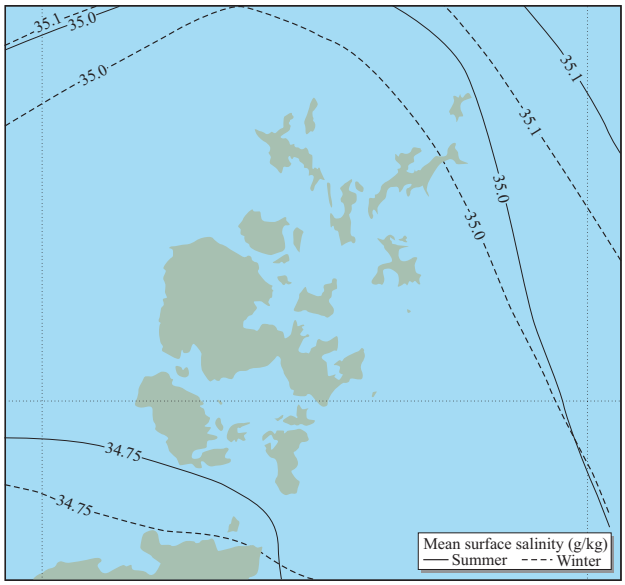
2.3.6 Water characteristics

Water temperature

Sea surface temperatures around Orkney are influenced by the the North Atlantic Drift current, which carries oceanic water north and east through the Faroe - Shetland Channel and the Fair Isle Channel into the North Sea and to the Norwegian coast (Turrell 1992). This flow exerts a relative warming influence in winter, when sea temperatures around the Orkney Isles remain relatively mild, averaging 6.5-7.0°C under its moderating influence; in summer, average temperatures rise to 12.0-12.5°C. The mean monthly sea surface temperatures for summer and winter are shown on Map 2.3.5. The summer isotherms are for August, the month with the warmest average sea surface temperatures, and the winter isotherms are for February, which has the coldest average sea surface temperatures.

Salinity

The salinity of the seas surrounding Orkney remains essentially constant throughout the year, averaging between 34.75 and 35.0 g/kg, very close to that of normal sea water (35g/kg). There is some dilution of Atlantic Ocean water by fresh water from the Scottish mainland. The mean surface salinities for summer and winter, based on data for August and February respectively, are shown on Map 2.3.6. Data are averaged for the month in question, which has the effect of smoothing out the salinity gradients in some areas.



Map 2.3.6 Mean surface salinity of seawater in summer and winter in g/kg of total dissolved salt. Source: Lee & Ramster (1981). © Crown copyright.

2.3.7 Further sources of information

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C. Contact names and addresses

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

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

2.4 Sediment transport

British Geological Survey & Scott Wilson Resource Consultants

2.4.1 Introduction

Sediment transport is described in the context of coastal cells and sub-cells (Motyka & Brampton 1993; HR Wallingford 1995). These are sections of the coast within which sediment erosion and accretion and the littoral drift of sand and gravel 'bed load' is largely independent of other cells.

The coast of Orkney is very complex, with numerous enclosed and deeply indented bays that interact little with each other and could therefore each be identified as a separate sub-cell. However, as it would be impractical to draw up a management plan for each of them, HR Wallingford (1995) have grouped many of these small bays together and defined the cells with consideration of the general orientation of the coastline, its physical character and its hydraulic environment. Thus, four sub-cells have been identified around Orkney (Map 2.4.1).

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

Sub-cell 10a: Costa Head to Mull Head (anticlockwise)

This sub-cell has an undeveloped coastline with few beaches. The coastline is predominantly rocky and exposed to harsh wave conditions. There is little documented detail on sediment transport patterns, apart from an east to west movement depositing sand against the eastern side of the Churchill Barriers that connect the islands of South Ronaldsay, Burray, Glimps Holm and Lamb Holm to Mainland (HR Wallingford 1995). Sand is accreting to the east of the Churchill Barriers, particularly against Causeway No. 4, and along the northern shoreline of Weddel Sound at Causeway No. 3. Wave processes dominate littoral transport, with much of this sub-cell exposed to high energy wave conditions. The extremely high flood and ebb currents that occur in almost all of the straits between islands decrease inshore, and it is unlikely that tidal currents have any direct effect on moving beach material. However, the strength of the currents at peak flows is such that significant movement of material on the sea bed can occur.

Long-term coastal edge retreat is occurring on most of the beach areas, most notably at the Bay of Skaill. Cliff erosion occurs and is more noticeable along the till cliffs, although the sandstone cliffs are being eroded by both wave and wind action. No rates of retreat are available, but the problem is probably much worse in Orkney than in many parts of mainland Scotland, due to the slabby nature of the rocks. Extraction of beach material has also had a detrimental effect on a number of beach areas, particularly at Bay of Skaill, Sandside and Bu Links on Burray (Mather *et al.* 1974).

Sub-cell 10b: Scapa Flow

This sub-cell has been defined separately because the wave climate is much less severe than that found on the more exposed parts of the coast. Although current speeds are high in the straits between islands and off rocky headlands, they are much lower in the indented bays and hence have little impact on the beaches. The Churchill Barriers have blocked off sediment transported through Water and Weddel Sounds into Scapa Flow, which formerly could have eventually found its way onto the beaches within Scapa Flow. There is little significant beach erosion within the sub-cell, and only very slight accretion at the western end of the beach at Scapa.

Sub-cell 10c: Mull Head to Costa Head (anticlockwise)

This sub-cell has numerous large sheltered bays, fringed with pocket and bay-head beaches. Although the main beaches are relatively sheltered, wave action is still the dominant factor in the movement of beach material, for example the transport of material into Deer Sound, and the development of spit features at Mill Sand and Mirkady Point. Littoral drift, where it occurs, is low; however, strong tidal action is responsible for moving sediment in an easterly direction within Eynhallow Sound, with Aiker Ness acting as a groyne, trapping material at Evie. There is little significant natural erosion within the sub-cell. However, sand is accreting at Evie and possibly within Deer Sound.

Sub-cell 10d: Northern islands

This sub-cell consists of numerous islands, each of which can be considered as an individual cell. The littoral processes are likely to be wave dominated, although this will depend on the orientation of the beaches and the amount of shelter provided by other islands. There is unlikely to be any significant net longshore drift or interchange of beach sediments. Although tidal currents are again very strong on both ebb and flood tides, it is unlikely that such currents directly affect beach areas. There is little long-term erosion within this sub-cell; however, wind and sheep grazing have a major influence on a number of dune areas. No significant accretion is occurring within the sub-cell.

2.4.2 Acknowledgements

Thanks are due to Eric Meek (RSPB) and Mark Tasker (JNCC) for commenting on the draft text.

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Stride, A.H., *ed*. 1982. *Offshore tidal sands*. London, Chapman & Hall.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Coast protection policy; sediment cells	*The Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD), Edinburgh, tel: 0131 556 8400
Review of erosion, deposition and flooding in Great Britain (maps and database)	Minerals Division, Room C15/19, Department of the Environment, 2 Marsham Street, London SW1P 3EB, tel: 0171 276 0900
National Landslide Databank	Rendel Geotechnics, Norfolk House, Smallbrook Queensway, Birmingham B5 4LJ, tel: 0121 627 1777
Coastal defence, sediment cells, erosion and deposition	*SNH, Earth Science Branch, Advisory Services, Edinburgh, tel: 0131 554 9797
Sediment cells	HR Wallingford Ltd., Howbury Park, Wallingford, Oxfordshire OX10 8BA, tel: 01491 835381

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

2.5 Sea-level rise and flooding

British Geological Survey

2.5.1 Sea-level changes in the region

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

Woodworth (1987) suggests that the current trend is a net fall in sea level along the coast of north-east Scotland of 1-3 mm/year (measured at Lerwick and Aberdeen). This is in reasonable agreement with Emery & Aubrey (1985), who indicate a relative sea level fall of 2-4 mm/year across most of the region.

2.5.2 Flooding in the region

The potential for flooding in the region is low, and is confined to a few of the dune-backed coastal fringes (Map 2.5.1).

Map 2.5.1 Low-lying areas susceptible to flooding. Source: after Emery & Aubrey (1985).

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Flood defence	*Orkney Islands Council, see Appendix A.2
Flood warning	*SEPA, Northern Region, Dingwall, tel: 01349 862021
Flood and coastal defence policy (see also section 8.4)	*SOAEFD, Edinburgh, tel: 0131 556 8400
Sea-level rise and flooding information for region	*SNH, Earth Science Branch, Advisory Services, Edinburgh, tel: 0131 554 9797
Review of erosion, deposition and flooding in Great Britain (maps and database)	Minerals Division, Room C15/19, Department of the Environment, 2 Marsham Street, London SW1P 3EB, tel: 0171 276 0900
Tide gauge data	*British Oceanographic Data Centre, Birkenhead, tel: 0151 653 8633

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

2.6 Coastal landforms

British Geological Survey & Scott Wilson Resource Consultants

2.6.1 Description

The region comprises a large number of islands and consequently has a relatively long coastline. In general, Orkney has a more subdued topography in comparison with Shetland (Region 1), but there are significant cliffed coasts, particularly along the western shores of some of the islands. High cliffs, low rocky shores, sandy beaches and 'ayres' - sand or shingle spits - are distinctive features of the Orkney landscape.

There are impressive cliffs on the west coast of Westray, and at Noup Head in the far north-west of the island the cliffs extend five miles along the shore. At Aikerness in the north of Westray there is a storm beach formed of blocks torn from the cliffs, with a rocky platform behind. In contrast to the west of the island, much of the eastern coastline is low-lying and rocky, with a series of more sheltered bays and numerous geos - long, narrow openings along joints or faults in the rocks - particularly along the south-eastern coast. A prominent feature of the south coast is the sheltered Bay of Tuquoy, with its extensive intertidal flats, saltmarsh, sand dunes and large areas of dune pasture. East of Westray is Papa Westray, a small low-lying island with geos along its predominantly rocky shoreline.

The island of Eday has a series of ridges and escarpments, and it differs from many of the northern islands in having large areas of peat-covered hill land. Formed of red and yellow rocks of Middle Old Red Sandstone, there are sheer cliffs at Red Head in the far north of the island, overlooking the small neighbouring island of the Calf of Eday. Much of Eday is flanked by rocky shoreline, but with sandy beaches backed by dunes in small bays such as Mill Bay, Bay of London and Bay of Greentoft. On the western shore at Sands of Mussetter and Sands of Doomy there are long stretches of fine beaches and sand dunes.

Much of Sanday is low-lying, and in contrast to much of Orkney, the island has sweeping bays with considerable expanses of white sandy beaches. In the north the rocky islands of the Holms of Ire extend 2 km northwards from the island, connected by shingle tombolos; a similar series of rocky outcrops occur to the east, at the Riv. Further east at Whitemill Bay there is a significant area of sand dunes backed by machair. Otters Wick is the largest of the three estuarine inlets on Sanday, with its tidal flats sheltered by the spits of Lama Ness and Colli Ness. The peninsula of Northwall to the east is low-lying, with several lochs, and its shoreline has long lengths of rocky shore and wide sandy bays. The estuarine inlet of Cata Sand on the east coast forms an intertidal sandflat with fringing saltmarshes and is enclosed by a long, sand-covered, shingle spit that links Tres Ness to the main island. Cata Sand is flanked by dunes. On the south coast of the island beaches are present in the shelter of rocky headlands, including the estuarine inlet of Kettletoft Bay and the white sandy beach of Backaskaill Bay. The west coast of Sanday is predominantly rocky.

To the north-east, the small island of North Ronaldsay has a rocky foreshore; areas of marshland and grazed dunes flank the sandy beach at Linklet Bay in the east. South of Sanday, the island of Stronsay has beaches in the more sheltered bays, and long stretches of rocky shoreline. In the north of the island, Huip Ness shelters the silled lagoonal inlet of Oyce of Huip. Mill Bay is the largest bay on the east coast and has an extensive sandy beach backed by sand dunes and machair. The south-east coast of Stronsay is predominantly rocky, with numerous geos. In the south-west of the island, Straenia Water is impounded by a 50 m wide boulder beach that extends for over 3 km along the shore of the island.

The north coast of Shapinsay is dominated by the wide expanse of Veantrow Bay, which has a narrow fringe of intertidal flats. Here there is a storm beach or 'ayre' that separates Lairo Water from the sea; similarly, the Ouse nearby is partially enclosed by the same storm beach and sand spits. Apart from a small sandy beach at Sandgarth, the eastern and southern shores of the island are rocky, with many geos and caves. The western shore of the island has narrow intertidal flats, and a storm beach separates Vasa Loch from the sea.

The generally steeper landscape of Rousay slopes down to the shore, which forms a virtually continuous narrow, rocky coastline. At Sacquoy Head in the north, high-level storm beaches are present and there are geos and rock arches scattered around the coastline. Maritime heaths have developed in the north-west of Rousay.

The coastline of Mainland takes a variety of forms. Local areas of weakness in the cliff line have resulted in the formation of small geos and caves along the north coast, such as Ramly Geo and Clay Geo (Steers 1973). The Deerness peninsula in the east is bounded by cliffs, around the base of which is a wave-cut rock platform. In the shelter of the peninsula lies the largest estuarine inlet in Orkney, Deer Sound and St Peter's Pool. Within the Sound there are several hooked shingle spits that extend seawards from the coast and shelter the inner bays. The bay of St Peter's Pool comprises largely intertidal sandflats with shingle areas; here, and in the sand and shingle bay of Mill Sand and on the muddy sand of Suckquoy, there are small saltmarshes. The south coast of Mainland abuts the sheltered waters of Scapa Flow, and the shore here is mostly rocky, interspersed with small sandy bays. The west coast of Mainland is dominated by high cliffs, which characteristically have near-vertical faces. This is partly a function of the near-horizontal bedding of the rocks, which, in places, has allowed the development of classic examples of stacks, notably at Yesnaby, and arches, such as at Hole o' Row on the south side of the Bay of Skaill. There are also many geos and caves along the west coast of Mainland.

South of Mainland are Burray and South Ronaldsay. There are fine cliffs around South Ronaldsay and those near Windwick are thought to be fossil cliffs (Steers 1973). Of scientific interest are the widespread occurrences of cemented blown sand (aeolianite) and the less common cemented beach sand, both of which are recorded only rarely in high latitudes (Roberts *et al.* 1972). Examples of the former can be found at Newark Bay in South Ronaldsay and the latter at Bu in Burray. Dam-like shingle ridges, known as oyces, also occur; a good example can be seen at Echnaloch in Burray.

Map 2.6.1 Major coastal landforms.

In contrast to much of Orkney, Hoy comprises steep-sided hills. The east coast is rocky, indented with a series of small bays that have beaches of sand and/or shingle. In the south of the island a sand/shingle ayre (spit) joins the island of South Walls to Hoy, which, like Hoy, has numerous geos along its coast. The west coast of Hoy is truncated abruptly by sea cliffs; at Little Rack Wick the sandstone cliffs are undercut by spectacular sea caves. As on the west coast of Mainland, the cliffs here have near-vertical faces; at St John's Head they reach a height of 335 m. Of particular note is the Old Man of Hoy, a sea stack of sandstone that towers 137 m high; a similar pinnacle of rock is present south of St John's Head.

2.6.2 Further sources of information

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Scottish Natural Heritage. In prep. *Landscape assessment of Orkney.* Edinburgh, Scottish Natural Heritage.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Coastal protection; sediment cells	*Scottish Office Agriculture, Environment & Fisheries Department, (SOAEFD), Edinburgh, tel: 0131 556 0213
Sea defence	Local authorities: see Appendix A2
Geomorphology of the region	*SNH, Earth Science Branch, Advisory Services, Edinburgh, tel: 0131 554 9797
Geomorphological information for region, 1:50,000 scale 'solid' and 'drift' maps	*British Geological Survey, Coastal Geology Group, Nottingham, tel: 0115 936 3100

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

Orkney's youngest rocks, pink and yellow sandstones underlain by lavas and tuffs, make up the cliffs on the west coast of Hoy. Numerous deep sea caves have formed as a result of the vertical jointing of the rocks; inside them, every surface is smothered in a dazzling array of jewel-bright plants and sea creatures. Photo: Marine Nature Conservation Review, JNCC.

Chapter 3 Terrestrial coastal habitats

3.1 Cliffs and cliff-top vegetation

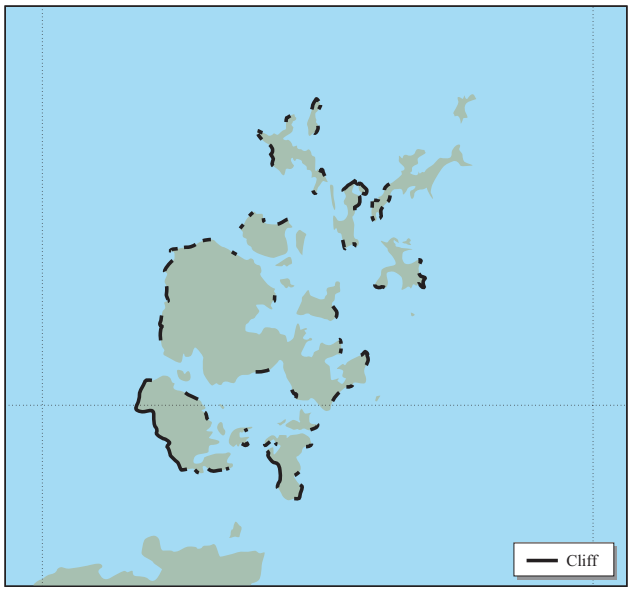
Dr T.C.D. Dargie

3.1.1 Introduction

Geology and geological structure, together with environmental history (marine erosion past and present, plus glacial processes) determine cliff form. Sea cliffs are generally steep slopes (>15°), but they can show great diversity of form, from very tall vertical or near-vertical cliff faces, through long, steep slopes with a vertical face restricted to the base, to low cliffs with a great variety of local slope forms above an intertidal rock platform. The major contrast is between hard cliffs developed from resistant bedrock, and soft cliffs developed in easily-eroded materials, including Quaternary deposits such as till, head and slope colluvium (Doody *et al.* 1993). Hard cliffs are predominant in the region and there are relatively few examples of soft types apart from cases of glacial till overlying cliffed bedrock.

The soils and vegetation of cliffs and cliff-tops are closely related to slope angle, soil type and salt spray deposition, with much local variability possible with changing exposure around headlands. The major natural and semi-natural maritime cliff and cliff-top habitats in Great Britain are bare ground, spray-zone lichen-covered rock, rock crevice, cliff-ledge, sea-bird colony, perched saltmarsh, maritime grassland and maritime heath. Very sheltered cliffs and cliff-top sectors that receive little salt spray input are not here treated as coastal habitats. Soft cliffs on sheltered coasts can develop an undercliff vegetation of scrub, tall herbs and rank grassland, often very close to the sea.

The coast of the Orkney Islands contains a large, diverse and spectacular length of cliff and cliff-top habitat. The region has a total cliff length of 247 km (Table 3.1.1), which represents 6% of the British resource and is therefore of moderate importance in the national context. Sectors of the region's coast that are more than 90% cliffed are shown on Map 3.1.1. The extensive and diverse cliffs of the region are developed in Old Red Sandstone bedrock, often forming high cliffs with notable precipice, ledge, gully and stack components. Vertical forms are most extensive, with many outstanding lengths along the western coast of Hoy, West Mainland, Rousay, Westray and Papa Westray. The highest vertical cliffs reach 335 m at Hendry's Hole on the west coast of Hoy, a short distance north of the Old Man of Hoy.



Map 3.1.1 Cliffs and cliff-top habitat. Marked sectors have >90% cliffed coast. Source: JNCC Cliffs Database.

The scenic contribution of cliffs within the region is outstanding. Tall vertical cliffs, steep non-vertical types, headlands, caves, geos, blowholes, arches and stacks are all common. The Hoy and West Mainland National Scenic Area includes the most spectacular examples of cliffed coast, including the Old Man of Hoy, which is one of the most famous sea stacks in Britain.

Table 3.1.1 Lengths (km*) of cliff types

	Vertical >20 m height		*Vertical <20 m height*		*Non-vertical >20 m height*		*Non-vertical <20 m height*		*Total*	
	Length (km)	*% of total length in Region 2*	*Length (km)*	*% of total length in Region 2*	*Length (km)*	*% of total length in Region 2*	*Length (km)*	*% of total length in Region 2*	*Length (km)*	*% of total length in Region*
Region 2	***84***	***34***	***84***	***34***	***14***	***6***	***65***	***26***	***247***	-
Scotland	663	27	725	30	724	29	343	14	2,373	10.4
North Sea Coast	604	33	382	21	570	31	261	15	1,799	13.7
Great Britain	1,327	33	817	20	1,376	34	541	13	4,059	6.0

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

3.1.2 Important locations and species

The National Vegetation Classification (NVC) covers twelve maritime cliff communities, although nearly all refer to to hard cliff habitats. Vegetation on Scottish cliffs is strongly zoned according to sea spray deposition, soil depth, soil moisture and the influence of grazing (Rodwell in press). Two distinctively northern community types (MC2 thrift *Armeria maritima* - Scot's lovage *Ligusticum scoticum* maritime rock-crevice, MC3 thrift - roseroot *Sedum rosea* maritime cliff-ledge) are confined to Scotland and both are recorded in the region, though they are probably rare. Three more communities occur that are widespread on cliffs elsewhere in Britain: MC8 red fescue *Festuca rubra* - thrift maritime grassland, MC9 red fescue - Yorkshire-fog *Holcus lanatus* maritime grassland, and MC10 red fescue - plantain *Plantago* spp. maritime grassland. The MC8 type tends to occupy much of the outer heavy spray zone; further inland either MC9 (ungrazed cliffs) or MC10 (grazed cliffs) is dominant according to stock management. Further inland still there is a zone of maritime heath (H7 heather *Calluna vulgaris* - spring squill *Scilla verna* heath, changing inland to H10 heather - bell-heather *Erica cinerea* heath), which grades into more typical inland habitats with little evidence of a salt spray influence. Cliff-top areas receiving heavy salt spray deposition can also have a form of perched saltmarsh (SM16 *Festuca rubra* saltmarsh) with saltmarsh rush *Juncus gerardi* and sea-milkwort *Glaux maritima.* These vegetation types are confined to exposed sea cliffs receiving sea spray inputs and are absent from more sheltered cliff lengths. The full regional extent of cliff-top habitat has not been surveyed, but the exposure of the coast to westerly winds and heavy spray deposition allows maritime cliff, grassland and heath to develop extensively. Soft, sheltered cliffs are rare in the region, and undercliff vegetation is probably absent.

In Great Britain nine nationally rare and four nationally scarce species or subspecies of higher plant are found mainly or exclusively on cliffs. Most are restricted to cliff habitats in the south and west of Britain and only one nationally scarce species is present in Orkney, Scottish primrose *Primula scotica*. Populations of this British endemic have been declining for more than a century and the species is thought to have been lost from half of its nineteenth century sites in Orkney. The overall dearth of rare and scarce species is probably in part the result of the achipelago's isolation and Britain's northwards-decreasing lowland rare plant biodiversity.

Maritime heath is an important national feature of cliff-top habitat and is probably very extensive on most cliffed coasts in the region. Four SSSIs are designated with this habitat as a key or subsidiary interest: Stromness Heaths & Coast (Mainland), North Hill (Papa Westray), West Westray and Rousay. Ward Hill Cliffs SSSI (South Ronaldsay) is a sheltered east-facing cliff with rare coastal tall-herb vegetation grading inland to lichen heath. No lichen heath of national importance is recorded for regional cliffs (Fletcher *et al*. 1984), but the lichen flora of the area has probably not been fully evaluated.

The regional bird fauna of cliffs is outstanding and of national and international importance. Seabird numbers, either in total or for individual species, are sufficiently high at five sites to warrant Special Protection Area status: North Hill (Papa Westray), West Westray, Copinsay, Marwick Head, and Sule Skerry and Sule Stack (Stroud *et al.* 1990). No systematic survey of invertebrates in cliff and cliff-top habitats has been carried out but these environments have a rich habitat diversity and thus can support large numbers of species (Mitchley & Malloch 1991), though mainly in the south of Britain. No cliffs in the region have a good invertebrate list that includes many notable and rare (Red Data Book) species, though small numbers are recorded for Stromness, Dennis Head and North Hill SSSIs. These sites are therefore regionally important cliff locations in the Invertebrate Site Register, but their interest is very low compared with that of cliffs in regions further south, and most cliffs in the region probably require further study.

3.1.3 Human activities

Cliffs are among the least modified of terrestrial habitats, although in parts of Britain the cliff-top zone, especially its inner sectors, has been affected by a variety of human impacts, sometimes leading to major habitat loss. In Orkney, cliff-top habitats have been moderately affected by agricultural development, since the soils are suitable for both grazing and arable cultivation. All-year grazing has converted some coastal heath into grassland and altered the zonation of cliff-top vegetation. Arable cultivation has destroyed natural and semi-natural habitats in some cliff-top zones. At a national scale the most extensive influences on hard cliff vegetation are grazing and burning, the major management techniques for cliff-top habitat (Mitchley & Malloch 1991), but little is known of their role in the region. Not all grazing is harmful for cliff vegetation, and heavy winter grazing by sheep followed by no summer grazing has produced a dramatic increase in the population of Scottish primrose on South Walls in a field experiment operated by local farmers and supported by the Scottish Wildlife Trust, Scottish Natural Heritage and the World Wide Fund for Nature (WWF-UK). There are a few footpaths with heavy usage, but erosion has occurred in only a few places. There are few coastal settlements on cliffs, and the only major buildings or structures are very small numbers of lighthouses and transmission masts. There is no caravan park development close to cliffs and there are few formal car parks. Apart from sheep grazing and arable cultivation, human impacts are therefore minimal in the region. Virtually none of the regional cliff base has been protected by coastal defences and hence natural coastal erosion can occur.

3.1.4 Information sources used

Cliffs at Yesnaby, west Mainland, were first surveyed using the NVC system by Cooper (1988), and further NVC survey has since been extended to the remainder of the Stromness Heaths and Coast candidate Special Area of Conservation (SAC). The 1988 survey covered 8 km of cliffs in Orkney, but this is only a small proportion (3%) of the total cliff length in the region. No detailed survey information therefore exists for most of the region's cliff resource. The NVC survey was part of a pilot study involving thirteen cliff sectors in various parts of Britain to assess the feasibility of mapping all cliff habitat. The reports include site descriptions, areas of NVC community types, vegetation

maps, block diagrams, quadrat information and target notes. All surveys were carried out in the summer of 1987 and use a consistent methodology. The data provide a sound baseline for future cliff vegetation studies and local management of the cliff resource.

No other detailed surveys have been carried out for cliffs in the region and existing information is insufficient to detail the regional extent of individual cliff and cliff-top habitats.

3.1.5 Acknowledgements

Assistance was kindly provided by Alison Skene (SNH, Orkney), Andrew Douse (SNH, Edinburgh) and Deborah Procter (JNCC).

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

Steers, J.A. 1973. *The coastline of Scotland.* Cambridge, Cambridge University Press.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Flora, fauna, habitat information	*SNH, Maritime Unit, Advisory Services, Edinburgh, tel: 0131 554 9797
Site management	*SNH, Kirkwall, Orkney, tel: 01856 875302
Cliff conservation	*Geology/Coastal Advisor, JNCC, Peterborough, tel: 01733 62626
National Landslide Databank	Rendel Geotechnics, Norfolk House, Smallbrook Queensway, Birmingham B5 4LJ, tel: 0121 627 1777
Invertebrate fauna	*Species Advisor, JNCC, Peterborough, tel: 01733 62626

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

3.2 Sand dunes

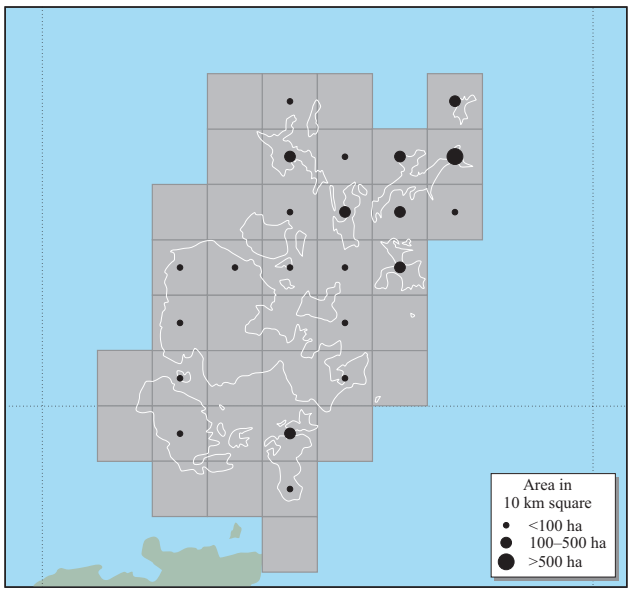
T.C.D. Dargie

3.2.1 Introduction

The coast of Orkney contains many small and varied sand dune systems, largely associated with bays and open coast. The region has a total of 84 dune sites containing an estimated 2,961 ha of vegetated sand and other land cover (JNCC Coastal Resources database). Together they represent nearly 6% of the British sand dune resource (Table 3.2.1), for which the region is therefore of moderate importance. The precise size of the sites is unknown but most are small. Vegetated blown sand (Map 3.2.1) is widely distributed around the archipelago, either within bay dunes with a local sand supply or on more open coast behind shingle, or below cliffs.

The major dune habitats are strand and embryo dune; mobile and semi-fixed dune; acidic fixed dune grassland; neutral and calcareous fixed dune grassland; dune heath; dune slack; other dune wetland; dune woodland and scrub; transitions to saltmarsh; transitions to maritime cliff; other vegetation; and other land cover (e.g. bare ground, car park, caravan park). All, apart from dune woodland and scrub, are likely to be present in the region. On the basis of a survey of a sample of dune sites in the region (Dargie 1993), an estimate of their extent in the region is used here to allow some form of GB context to be indicated (Table 3.2.2).

Some 85 National Vegetation Classification (NVC - Rodwell in press) communities have been recorded for surveyed Scottish dunes, with a total of 116 types of communities and sub-communities combined (Dargie 1993). Strandlines are usually characterised by the SD2 sea rocket *Cakile maritima* - sea sandwort *Honkenya peploides* community. Further up the beach occasional areas of SD4 sand couch *Elymus farctus* embryo dunes are found, often merging with SD5 lyme-grass *Leymus arenarius* and SD6 marram *Ammophila arenaria* mobile dune, which are rapidly stabilised in a moist climate with moderate inblow of beach sand, forming SD7 marram - red fescue *Festuca rubra* semi-fixed dune. Northern and western Scotland are particularly notable for very large extents of species-rich grazed dune, SD8 red fescue - lady's bedstraw *Galium verum* fixed grassland, which replaces SD7 semi-fixed dune under grazing and can extend inland for a great distance. Dune vegetation in Scotland is distinctive because a large variety of wetland types (mire, swamp, wet neutral grassland) replace most types of dune slack vegetation found in England and Wales. Only the SD17 silverweed *Potentilla anserina* - common sedge *Carex nigra* slack community is moderately common. Several NVC sub-communities are largely restricted to western and northern Scotland and reflect a cool oceanic climate with high rainfall. Scottish



Map 3.2.1 Areas of vegetated sand dune by coastal 10 km square. Source: JNCC Coastal Resources Database.

Table 3.2.1 Region 2 vegetated dune resource[a] in context

	Total area (ha)	*% of total in region*
Region 2	2,961*	-
Scotland	31,540+	9.4
North Sea Coast	25,356+	11.7
GB	***50,200+***	***5.9***

Sources: Dargie (1993, 1995), Radley (1994), JNCC Coastal Database. Key: [a]to the nearest whole hectare; *provisional estimate based on a sample of dunes representing 44.6% of the regional resource; +totals for Scotland and thus Great Britain and the North Sea Coast are provisional estimates.

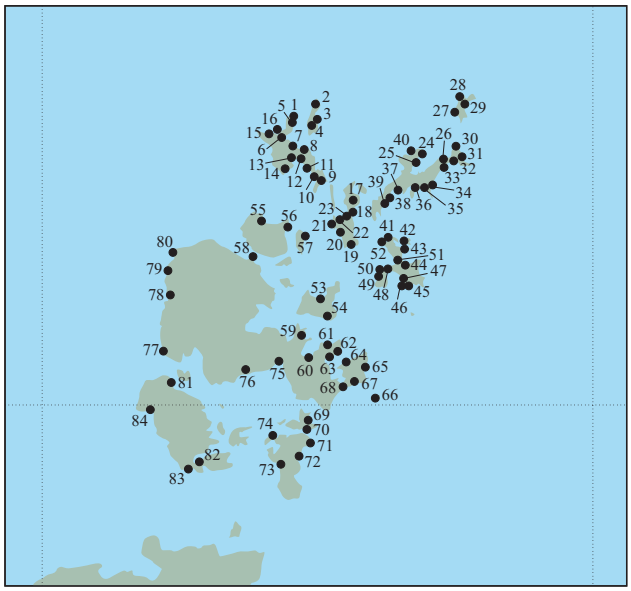
Table 3.2.2 Areas (ha*) of dune vegetation in the region**

	Strand and embryo dune	*Mobile and semi-fixed dune*	*Acidic fixed dune grassland*	*Neutral and calcareous fixed dune grassland*	*Dune heath and bracken*	*Dune slack*	*Other dune wetland*	*Dune woodland and scrub*	*Transitions to saltmarsh*	*Transitions to maritime cliff*	*Other land cover*
Region 2	***6***	***481***	***39***	***1,387***	***21***	***102***	***901***	***0***	***20***	***4***	***Rare***
Scotland+	61	4,059	4,125	10,513	2,113	1,095	3,817	5,500	217	41	Rare
North Sea Coast	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
GB	340	8,504	4,953	15,228	2,615	2,175	4,114	8,965	836	64	2,406

Sources: Dargie (1993), Dargie (1995), Radley (1994), JNCC Coastal Resources Database. Key: *to the nearest whole hectare; **provisional estimate based on a sample of dunes; +figures for Scotland and hence the North Sea Coast and GB are provisional estimates; n/a = not available.

NVC dune surveys have encountered some strandline, semi-fixed dune, fixed dune, mire and scrub vegetation that does not closely resemble published NVC types and which may represent potential new NVC sub-communities (Dargie 1993).

The extent of dune in the region is due to relatively shallow waters within the archipelago and the presence of sufficient glacial till, eroded sandstone and shell sand to nourish the many beaches present. The habitat is an important component of the Orcadian landscape and is especially common in the northern islands of the group, where most of the sand is concentrated (Map 3.2.1). There are eight sites within biological SSSI designations and three fall within the Hoy and West Mainland National Scenic Area, where the dune fringe is in startling contrast to adjacent habitats (agricultural grassland, maritime cliff, moorland, peatland and open water), adding a distinctive component to the landscape.



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

3.2.2 Important locations and species

Table 3.2.3 lists the sand dune sites in the region (Map 3.2.2). Most sand is found on the northern islands. The largest sites are on Sanday and further extensive sand areas are

Table 3.2.3 Sand dune sites in region

No. on Map 3.2.2	*Location*	*Grid ref.*	*Dune type*	*Conservation status*	*Survey type*
	Westray/Papa Westray				
1	Bay of Skaill	HY458515	Bay dune and machair		CCS
2	Northwick	HY500537	Bay dune		CCS
3	Southwick	HY500514	Bay dune		CCS
4	Bay of Moclett	HY491497	Bay dune and machair		CCS
5	The Ouse	HY451509	Spit, bay dune		CCS
6	Pierowall	HY439485	Bay dune		CCS
7	Bay of Brough	HY455473	Bay dune and machair		CCS
8	Bay of Swartmill	HY480461	Bay dune		CCS
9	Sands of Woo	HY512408	Bay dune		CCS
10	Bay of Tafts	HY500416	Bay dune and machair		CCS
11	Wasbist	HY488425	Bay dune		CCS
12	Garth	HY470448	Bay dune and machair		CCS
13	Bay of Tuquoy	HY455450	Spit, bay dune		CCS
14	Mae Sand (Westray)	HY443427	Bay dune and machair		CCS
15	Bay of Noup	HY412490	Bay dune and machair		CCS
16	Grobust	HY430496	Bay dune and machair		CCS
	Eday				
17	Mill Bay (Eday)	HY570360	Bay dune		
18	Bay of London	HY563342	Bay dune and machair		CCS
19	Bay of Greentoft	HY560289	Bay dune		CCS
20	Sandyland	HY544311	Bay dune		CCS
21	Sealskerry Bay	HY533321	Bay dune and machair		CCS
22	Sands of Mussetter	HY545333	Bay dune and machair		CCS
23	Sands of Doomy	HY555340	Bay dune and machair		CCS
	Sanday & North Ronaldsay				
24	Whitemill Bay	HY690464	Bay dune and machair		CCS
25	Otterswick	HY684442	Bay dune and machair		CCS
26	Bay of Sandquoy	HY740447	Bay dune and machair	SSSI	CCS
27	South Bay	HY754525	Bay dune and machair		CCS
28	Linklett Bay	HY768545	Bay dune and machair		CCS
29	Northness	HY768529	Bay dune and machair		CCS
30	Bay of Sowerdie	HY761461	Bay dune and machair		CCS
31	Bay of Scuthvie	HY763446	Bay dune and machair		CCS
32	Bay of Lopness (East)	HY750442	Bay dune and machair	SSSI	CCS
33	Bay of Lopness (West)	HY730437	Bay dune and machair	SSSI	CCS

Table 3.2.3 Sand dune sites in region (continued)

No. on Map 3.2.2	*Location*	*Grid ref.*	*Dune type*	*Conservation status*	*Survey type*
	Sanday & North Ronaldsay (continued)				
34	Bay of Newark	HY708400	Tombolo, machair hindshore	SSSI	ITE, CCS
35	Tresness Bay	HY696390	Spit, machair	SSSI	CCS
36	Sty Wick	HY685393	Tombolo, bay dune and machair	SSSI	CCS
37	Backskaill Bay	HY645393	Bay dune and machair		CCS
38	Doun Helzie North	HY627367	Bay dune and machair, climbing dunes		ITE, CCS
39	Doun Helzie South	HY620360	Bay dune and machair, climbing dunes		ITE, CCS
40	Scar	HY672454	Bay dune and machair		CCS
	Stronsay				
41	Sands of Odie	HY628297	Bay dune and machair		CCS
42	Papa Stronsay	HY660297	Spit, bay dune and machair		CCS
43	Cumley Bay	HY654279	Bay dune		CCS
44	Mill Bay (Stronsay)	HY657260	Bay dune and machair		CCS
45	Sand of the Crook	HY663213	Bay dune and machair		CCS
46	Bight of Scarma	HY655217	Bay dune and machair		CCS
47	Inganoust	HY657224	Bay dune		CCS
48	Sand of Rothiesholm	HY630244	Bay dune and machair		CCS
49	Bay of Bomasty	HY617237	Bay dune		CCS
50	Bight of Baywest	HY617241	Bay dune		CCS
51	St Catherines Bay	HY645262	Bay dune and machair		CCS
52	Stursy	HY620294	Bay dune		CCS
	Shapinsay				
53	Veantrow Bay	HY505192	Bay dune and spit		CCS
54	Bay of Sandgarth	HY520157	Bay dune and machair		CCS
	Rousay				
55	Saviskaill	HY402335	Bay dune		CCS
56	Scrimpo	HY455323	Bay dune and machair		CCS
57	Mae Banks (Egilsay)	HY480304	Bay dune and machair		CCS
	Mainland, South Ronaldsay				
58	Sands of Evie	HY377263	Bay dune and machair		CCS
59	Bay of Meil	HY476120	Bay dune and machair		CCS
60	Sands of Wideford	HY475087	Bay dune		CCS
61	Redbanks	HY528107	Bay dune		CCS
62	Sand of Ness	HY540094	Bay dune		CCS
63	Sand of Beeman	HY529091	Bay dune		CCS
64	Sand of Ouse	HY550073	Bay dune and machair		CCS
65	Sandside Bay	HY589068	Bay dune and machair		CCS
66	Copinsay	HY607016	Bay dune	SSSI	CCS
67	Newark Bay	HY570043	Bay dune		CCS
68	Dingyshowe	HY550034	Bay dune		CCS
69	Burray Links	ND488970	Bay dune and machair		CCS
70	Ayre of Cara	ND479952	Bay dune		CCS
71	Honeysgeo	ND488932	Bay dune		CCS
72	Newark Bay	ND463899	Bay dune and machair		CCS
73	Sandwick	ND434892	Bay dune		CCS
74	Sand of Wright	ND424936	Bay dune		CCS
75	Scapa Bay	HY440087	Bay dune		CCS
76	Waulkmill Bay	HY380067	Spit	SSSI	CCS
77	Warebeth	HY234088	Bay dune and machair	NSA, SSSI	CCS
78	Bay of Skaill	HY235195	Bay dune and machair		CCS
79	Marwick	HY227243	Bay dune and machair		CCS
80	Birsay	HY243274	Bay dune and machair		CCS
	Hoy				
81	Bay of Creekland	HY236045	Bay dune and machair	NSA	CCS
82	The Ayre	ND288893	Bay dune		CCS
83	Melberry	ND265887	Bay dune and machair		CCS
84	Rackwick	ND205985	Bay dune and machair	NSA	CCS

Sources: Mather *et al.* (1974); Shaw *et al.* (1983); Research and Advisory Services Directorate, Scottish Natural Heritage. Key to conservation status: SSSI = Site of Special Scientific Interest; NSA National Scenic Area. Key to survey type: CCS = Countryside Commission for Scotland (University of Aberdeen reports); ITE = Institute of Terrestrial Ecology Scotttish Coastal Survey.

present on Stronsay, Eday, Westray and North Ronaldsay. Amongst the southern islands only South Ronaldsay has a large area of vegetated sand.

Bay dunes are by far the dominant type in the region (Table 3.2.3), developed upon sand trapped within the shelter of rock headlands. A most unusual feature of Orkney bay dunes is the dunes that have developed since the construction of the Churchill Barriers of Scapa Flow in the Second World War. Opposing currents in narrow straits between islands also allow shingle and sand tombolo features to form, and several examples occur in the region. Climbing dunes are an uncommon type that develops when sand is blown up onto terrain inland, on the edge of a main dune system, forming a variable but often thin sand layer over bedrock. In this region there are climbing dunes at both North and South Doun Helzie. The largest British dunes are hindshore types, developed above beaches with a good sand supply and an onshore prevailing wind, which drives sand inland as one or more dune ridges or as mobile parabolic dunes. This type is rare in the region. However, Orkney has a distinctive hindshore variant termed machair (Ritchie 1976), which in Orkney comprises an inland dune plain of variable extent and form (e.g. Mather *et al.* 1974) that can extend inland for 1 km behind outer bay dune foredunes The machair plain is the result of the very high average windspeeds, some of the highest affecting British coastal dunes, conditions that apply at many regional sites. Spit dunes generally develop at the mouths of estuaries or in areas of strong inshore currents, and a few small examples are present.

The dune systems in the region develop a watertable that influences the vegetation of depressions, forming distinctive and nationally rare types of wetland termed damp machair and dune slack. These are commonest in depressions behind an outer foredune ridge or shingle beach with a thin blown sand cover. Dunes are a sufficient barrier to drainage in places to form small areas of standing water termed machair lochs.

In Great Britain, four nationally rare and thirteen nationally scarce higher plants are found mainly or exclusively on dunes. However, most are species restricted to sites in southern Britain. No nationally rare dune species is present in the region, and only one nationally scarce species is present: curved sedge *Carex maritima,* which has an arctic-alpine distribution. Two other nationally scarce species more typical of other habitats occur on dunes in the region: oysterplant *Mertensia maritima,* which is more typical of shingle, and Scottish primrose *Primula scotica,* which is commoner on sea cliffs. The lichen flora has not been closely examined (Fletcher *et al.* 1984).

There have been no detailed studies on the animal populations of regional sand dune systems. No dune site is outstanding in terms of Invertebrate Site Register records, but a few dune systems (Waulkmill SSSI, Melberry Dunes, Burray Sandhills) have a very few notable species.

3.2.3 Human activities

In general, sand dunes are among the least heavily modified of terrestrial habitats. Very little of the regional dune resource has been affected by human impacts leading to major habitat loss or conversion to common vegetation lacking dune species. The primary use of most sites is as extensive grazing for sheep and cattle, and the early 1970s site reports by Mather *et al.* (1974) do not cite any cases of overgrazing contributing to wind erosion and blowout development. Military use has left old buildings and concrete foundations in some sites and, as already mentioned, has allowed narrow lengths of new dunes to be created beside the Churchill barriers of Scapa Flow. Several sites have been affected by sand and shingle extraction from within dunes, with major impacts in the early 1970s at Evie, Burray Links, Melberry Links and Scrimpo (Mather *et al.* 1974). Non-coastal sources of building sand are rare in Orkney and initial heavy extraction occurred in the periods 1914-1918 and 1939-1945 for military defences, with a second phase in the early 1970s for oil-related development. The exact number of sites affected by extraction is uncertain and the scale of impact is also unclear, although site descriptions by Mather *et al.* (1974) cite several examples of old sand pits that have been sucessfully recolonised by dune vegetation. Several sites have been damaged through sand extraction, such as Bay of Skaill (Mainland), Bu of Burray (Burray), Newark Bay (South Ronaldsay), Mae Sand (Westray) and Sand of Rothiesholm (Stronsay). Very recently, there have been proposals to extract sand from beaches at the Churchill Barriers, the only examples of major recent accretion in Orkney. Beach sand and shingle extraction in Orkney has only been on a small scale, although it has caused serious erosion elsewhere (Carter *et al.* 1992).

Recreational pressure on regional dunes is relatively low. Formal car parks, caravan and camp sites are rare and damage due to visitor trampling and erosion is virtually absent (Mather *et al.* 1974), with the only area recording any serious impact located at Bay of Skaill, close to the famed Skara Brae and Dingieshowe (Mainland). Trampling on paths here is exacerbating dune erosion and at Dingieshowe is also creating blowouts. Coastal erosion by storm waves is common on exposed sites where there is anecdotal evidence of a slow retreat inland of the outer dune edge. Serious coastal erosion is present at the Bay of Skaill, where it threatens the Skara Brae archaeological site, generating proposals for large new coastal defences, which have been subject to environmental assessment. Dunes in more sheltered situations had wide bands of strand-line vegetation in the early 1970s, suggesting that slight accretion or a static coastal edge was present.

3.2.4 Information sources used

Two main sets of surveys cover the region. Dune geomorphology is covered in Aberdeen University beach reports sponsored by the Countryside Commission for Scotland (Mather *et al.* 1974). Vegetation has been examined by the Institute of Terrestrial Ecology (ITE) (Shaw *et al.* 1983) for selected areas covering three sites: Bay of Newark, Doun Helzie North and Doun Helzie South. The vegetation categories employed are broad and are not easily related to the finer detail available in the National Vegetation Classification (NVC) (Dargie 1992). No sites in Orkney were surveyed as part of the Sand Dune Survey of Great Britain (Dargie 1993), a study using the NVC (Rodwell 1991a, 1991b, 1992, 1995, in press). NVC surveys, all carried out in the summer months, are very detailed and use a consistent methodology. The vegetation is mapped and described, and

information on coastal erosion and accretion, atypical vegetation and adjoining land use is also recorded. Individual site reports are available for sites covered in the Sand Dune Vegetation Survey of Great Britain, as well as a national report covering a sample set of sites (Dargie 1993). A quadrat-based survey similar to the NVC standard has been completed for south-central Sanday (Shimwell 1985), and NVC fieldwork and mapping of all dune vegetation in Orkney was completed by Scottish Natural Heritage in September 1996, with publication of the results expected in late 1997.

3.2.5 Acknowledgements

Assistance with sources was kindly provided by Andrew Douse and Kathy Duncan (SNH) and Alison Skene (SNH) and Deborah Procter (JNCC). Thanks are also due to John Orr (Orkney Islands Council) for his helpful comments on the draft text.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Flora, fauna, habitat information, site management - Scotland	*SNH, Maritime Unit, Advisory Services, Edinburgh, tel: 0131 554 9797
Flora, fauna, habitat information, site management - Orkney	*Area Officer, SNH, Kirkwall, tel: 01856 875302
National and international policy and advice on dune conservation	*Geology/Coastal Advisor, JNCC, Peterborough, tel: 01733 62626
Invertebrate fauna	*Invertebrate Site Register, Species Advisor, JNCC, Peterborough, tel: 01733 62626

*Starred contact addresses are given in full in the Appendix

3.3 Vegetated shingle structures and shorelines

Dr R.E. Randall

3.3.1 Introduction

Shingle means sediments larger than sand but smaller than boulders, that is, between 2-200 mm diameter. This region has no major shingle structures (except the man-made Churchill Barriers), but there are considerable lengths of shingle shoreline, including spits (ayres) and barrier beaches as well as extensive fringing bay-head beaches, mainly composed of Old Red Sandstone sediments and associated volcanics (Berry 1985). The sites where these occur are shown on Map 3.3.1. Despite their great interest and importance, shingle sites in Orkney were not covered in the GB survey of vegetated shingle structures (Sneddon & Randall 1993, 1994), mainly because of their small size. Consequently no comparisons can be made between the extent of the resource in the region and that in Scotland, the North Sea Coast or Great Britain as a whole.

Map 3.3.1 Shingle beaches mentioned in the text.

3.3.2 Important locations and species

This region contains good examples of fringing beaches in a cool, damp environment. Those fringing beaches exposed to high energy situations have large-sized shingle grading to boulders. The lower energy sites frequently have good examples of wrack matrix in shingle.

Many of the Mainland and Shapinsay shingle beaches are barriers to lochans or bay head features, frequently associated with stream outlets and which have wet shingle as a result, such as at Newark Bay, Honeysgeo, Sand of the Crook and Backaskaill Bay. Shingle on Hoy is limited to the high-energy beach at Tor Ness on the Pentland Firth. Similar west-facing beaches occur at Bay of Skaill on Mainland and Bay of Kirbist, Westray.

The sandy nature of the matrix at most of the northern island sites is strongly reflected in the vegetation, and this is also true of several sites in South Ronaldsay. Accumulations of wrack influence the vegetation wherever sites are protected by offshore rocks and skerries or marine currents are particularly suitable. The three sites on the uninhabited isles of the Calf of Cava, Auskerry and Swona are particularly important because of their lack of disturbance and, in the cases of Auskerry and Swona, their large populations of the nationally scarce oysterplant *Mertensia maritima*. Details of the sites are given in Table 3.3.1.

Shingle plant communities vary considerably from region to region in Britain (Sneddon & Randall 1993, 1994), with some communities being widespread and others limited to a particular region or substrate. Along much of the Orkney shoreline areas of loose cobbles and boulders among outcrops of solid rock are common. Where the rock platform is nearly flat the accretions tend to be finer shingle, whereas on steeper rock larger sediments occur. These habitats carry a sparse flora of sea mayweed *Tripleurospermum maritimum*, orache *Atriplex* spp., curled dock *Rumex crispus trigranulatus* and, in sandier locations, silverweed *Potentilla anserina* and lyme-grass *Leymus arenarius*. These areas are often enriched with organic debris from seaweeds, especially *Laminaria* spp., known as wrack. Where shingle is present over larger areas and is more stable, sea campion *Silene maritima*, perrenial sow-thistle *Sonchus arvensis*, cleavers *Galium aparine*, Scot's lovage *Ligusticum scoticum* and occasionally the nationally scarce oysterplant (Randall 1988) may be found. Greater stability occurs on storm beaches, barrier beaches, spits and bars, where sandstone cobbles and shingle can also have red fescue *Festuca rubra*, false oat-grass *Arrhenatherum elatius*, common nettle *Urtica dioica*, field forget-me-not *Myosotis arvensis*, thrift *Armeria maritima* and skullcap *Scutellaria galericulata*. This stable shingle normally has a rich development of crustose and foliose lichens, especially *Cladonia* spp. Backshore shingle vegetation, further from maritime influences, is dominated by false oat-grass and common couch *Elymus repens*, with hogweed *Heracleum sphondylium*, curled dock, meadow vetchling *Lathyrus pratensis*, silverweed and cleavers.

Enrichment of the shingle habitat occurs where seals haul out or large numbers of birds nest or roost (Bullard & Goode 1975). This results in a community of sea mayweed, curled dock, common mouse-ear *Cerastium fontanum*, procumbent pearlwort *Sagina procumbens*, white clover *Trifolium repens*, sea plantain *Plantago maritima*, red fescue and annual meadow-grass *Poa annua*.

The most important plant species on shingle in this region is the nationally scarce oysterplant, which grows on damper wrack-rich shingle foreshores (Randall 1988). This species is declining over much of its range but seems to be increasing in Orkney, where over 50% of the British population occurs in 21 separate locations. Scot's lovage is restricted in Britain to Scottish and north Irish cliffs and shingle.

Some of the higher shingle ridges, particularly on the smaller islands (e.g. Corn Holm), are nesting sites for fulmars *Fulmarus glacialis*, which nest on the ground

Table 3.3.1 Fringing shingle beaches

Location	*Grid ref.*	*Length of shoreline (km*)*	*Description*
Westray			
Bay of Tuquoy	HY4744	0.5	Bay head sandy shingle spit
Bay of Kirbist	HY4243	0.5	Raised shingle and boulders above rock platform
Sanday			
Otters Wick (Lama Ness to Tor Ness)	HY6743	1.5	Mid bay barrier and storm beach
Bay of Lopness	HY7544	0.5	Raised beach of large shingle behind sandy foreshore
Tres Ness	HY7038	0.5	Sandy shingle promontory
Backaskaill Bay (outlet stream of Bea Loch)	HY6538	0.5	Sandy shingle
Holms of Ire	HY6545	0.5	Shingle among rocks
Stronsay			
Papa Stronsay	HY6629	1.0	Sandy shingle tombolo
Auskerry	HY6716	1.0	Coarse shingle among rocks
Sand of the Crook (Lea Shun)	HY6621	0.5	Sandy shingle barrier beach
Bight of Matpow	HY6425	0.5	Large shingle behind sandy foreshore
Shapinsay			
Bay of Sandgarth	HY5115	1.5	Bay head storm beach
Balfour	HY4816	1.0	Sandy shingle beach at mouth of loch outlet stream
Mainland, South Ronaldsay, Burray			
Bay of Firth	HY3815	0.5	Shingle and wrack at stream mouth protected by skerries
Kirkwall	HY4411	0.5	Bay head barrier beach between loch and sea
Deer Sound (Loch of Tankerness)	HY5108	2.0	Mid bay spit and barrier system below loch
Newark Bay (Mainland)	HY5604	1.0	Sandy shingle foreshore
Corn Holm	HY5901	0.5	Gravel and sand over rock platform
Honeysgeo	ND4893	0.5	Sandy shingle fringing beach
Manse Bay	ND4791	0.5	Large pebbles with shelly sand matrix
Newark Bay (South Ronaldsay)	ND4690	0.5	Shingle and cobble foreshore with sand matrix
Burwick	ND4483	0.5	Sandy shingle foreshore
Swona	ND3985	1.0	Shingle with wrack matrix among rocks
St Margaret's Hope	ND4493	0.5	Sand and shingle among rocks
Burray	ND4797	0.5	Man-made shingle barrier with sand and concrete
Glimps Holm	ND4799	0.5	Sand and shingle among rocks
Sandoyne	HY4601	0.5	Medium shingle with 'wrack'
Scapa Bay	HY4308	0.5	Sandy shingle bay head beach by stream
Swanbister Bay	HY3605	0.5	Shingle and wrack at stream mouth
Bay of Skaill	HY2319	0.5	Large shingle and cobbles with sandy matrix
Hoy			
Calf of Cava	HY3200	0.5	Fringing storm beach
Tor Ness	ND2588	1.0	Large shingle and cobble beach of Hoy sandstone

Key: *to the nearest 0.5 km.

(instead of on cliffs) in the absence of predators. Arctic tern *Sterna paradisaea* commonly breed on the shingle, and there is a very large colony on Swona. Sometimes colonies have common tern *Sterna hirundo* among them. Ringed plover *Charadrius hiaticula* are also widespread on shingle sites.

3.3.3 Human activities

Corn Holm is part of the RSPB bird reserve at Copinsay (also a Special Protection Area (SPA)), but most of the Orkney fringing shingle beaches have no conservation status. There is some shingle extraction for local use at Bight of Matpow and agricultural tractor or fishing boat disturbance in several locations, e.g. Burwick and Newark Bay. The Bay of Skaill is a popular recreational and archeological site. Many of the sandy shingle areas are heavily grazed by the uncontrolled rabbit population and stock grazing by sheep and cattle influences the shingle communities on all the inhabited islands. Swona has a small population of semi-feral cattle which graze extensively over the island. The Churchill Causeway No. 4 has resulted in a build up of sandy shingle around concrete blocks at both the Burray and South Ronaldsay ends. This causeway has become a major site for oysterplant. Oil pollution is a potential problem at all sites around Scapa Flow as a result of pollution incidents around Flotta terminal and continuing seepage from the hulk of the HMS *Royal Oak.* Individual plants, as well as bird and invertebrate life, may be affected.

3.3.4 Information sources used

The fringing shingle beaches in the region were examined by the author in 1986-1987 as part of the Nature Conservancy Council's rare species monitoring scheme (Randall 1988). Shingle fringing beaches surveyed in the NCC rare species survey were examined only quantitatively, with the exception of data on oysterplants, and target notes were used to describe features of interest, both physical and biological. This information became the basis of the geographical variation data published in Randall (1989). The area is described geomorphologically by Ritchie *et al.* (1974) and Steers (1973).

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C. Contact names and addresses

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Flora, fauna, habitat information, site management - Orkney	*Area Officer, SNH, Kirkwall, tel: 01856 875302

*Starred contact addresses are given in full in theAppendix

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 here to include true physiographic lagoons, i.e. those wholly or partially separated from the sea by a natural sedimentary barrier, and also silled inlets and artificial brackish ponds and coastal pools, of a similarly restricted tidal range and often containing a comparable lagoonal wildlife. Lagoons are commonly shallow, often with varying salinity ranging from above to below that of normal sea water (35 g/kg). Freshwater systems are not considered, nor are fully-flushed tidal pools. There are no true lagoons (*sensu* Barnes 1988) in the region, and the habitat is rare throughout Britain (Table 3.4.1).

Table 3.4.1 Lagoonal areas for region in context

Region	*Lagoonal area (ha*)*	*Overall % of GB total*	*% of GB total excl. The Fleet*
Region 2	0	0	0
North Sea Coast	1,163	92	87
Great Britain	***1,261***		

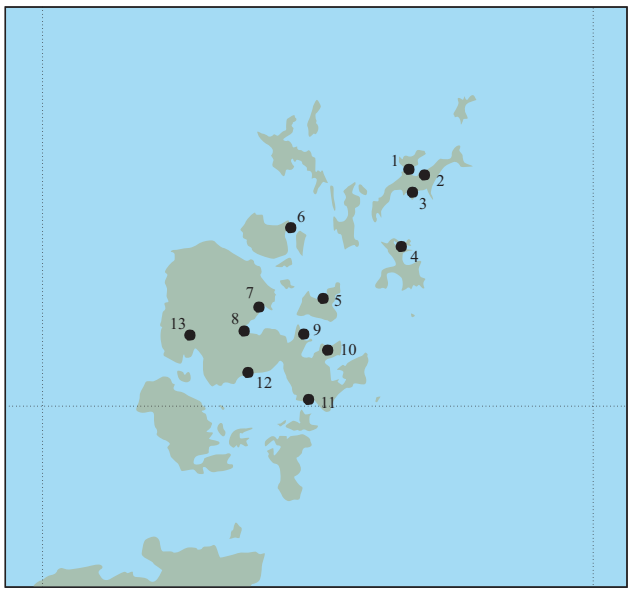
Source: Barnes (1988). Key: *to the nearest whole hectare.

Other definitions of 'lagoon' and 'lagoonal' are also current. Throughout the Orkney Islands there are a few percolation pools and a number of small lochs with restricted mouths and silled inlets. In addition there are a number of small 'lagoons' or 'oyces' separated from the adjacent sea by shingle ridges. Many, particularly where fed by a stream discharge such as at Waulkmill Bay, Scapa Flow, are temporary features in progression to saltmarsh. In the northern islands are a number of storm-beach-retained oyces without streams, which in turn revert to open coast on loss of the storm barrier. The Loch of Stenness is a large, silled brackish pond connected by a restricted channel to Scapa Flow and by sluice to the freshwater Loch of Harray, and consequently supports habitat ranging from sheltered marine through estuarine to freshwater, with associated communities. It represents a significant lagoonal habitat owing to its large size. Such sites have recently been described as 'lagoonal' by Thorpe (in prep.). Table 3.4.2 indicates the relative importance of the region if these lagoonal areas (*sensu* Thorpe in prep.) are included.

Table 3.4.2 Lagoonal* areas^{+} for region in context

Region	*Lagoonal area (ha)*	*Overall % of GB total*	*% of GB total excl. The Fleet*
Region 2	***648***	***24***	***30***
North Sea Coast	1,819	68	62
Great Britain	2,658		

Key: $^{+}$to the nearest whole hectare; *including areas classified as 'lagoonal' by Thorpe (in prep.).



Map 3.4.1 Lagoonal areas mentioned in the text (Table 3.4.4.)

Exceptionally for the North Sea Coast, there are no nationally noteworthy (*sensu* Barnes 1989) lagoonal areas in the region (Table 3.4.3).

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.

3.4.2 Important locations and species

Table 3.4.4 lists the lagoons and lagoonal areas in the region (Map 3.4.1).

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 common reed *Phragmites australis*, saltmarsh plants and/or sea club-rush *Scirpus maritimus* are usual. Tasselweeds are found at many inlet and percolation pool

Table 3.4.3 Nationally noteworthy lagoonal areas for region and country

	Lagoonal area (ha^{+})	*Overall % of GB total*	*% of GB total excl. The Fleet*
Region 2	0	0	0
North Sea Coast	521	96	63
Great Britain	***545***	-	-

Source: Barnes (1989). Key: $^{+}$to the nearest whole hectare.

Table 3.4.4 Lagoons and lagoonal areas

Site no. on Map 3.4.1	*Location*	*Grid ref.*	*Area (ha+)*	*Type*
1	Quivals Loch, Sanday	HY671419	1	Culverted pool
2	Point of Nevin Pool, Sanday	HY684421	1	Silled inlet
3	Little Sea Pool, Sanday	HY669398	1	Culverted pool
4	Oyce of Huip, Stronsay	HY642298	31	Silled inlet
5	The Ouse at Ling Holm, Shapinsay	HY503192	15	Restricted inlet
6	Bay of Ham Lochan, Rousay	HY453323	1	Percolation pool
7	Oyce of Isbister, Mainland	HY392182	8	Silled inlet
8	The Ouse, Mainland	HY359143	11	Restricted inlet
9	Loch of Carness	HY465137	n/a	Non-tidal oyce
10	Long Ayre Inlet, Mainland	HY499098	10	Silled inlet
11	Loch of Ayre, Mainland	HY470012	7	Culverted pool
12	Skaith, Waulkmill Bay	HY375066	n/a	Non-tidal, stream-fed oyce
13	Loch of Stenness, Mainland	HY285128	562	Restricted silled inlet

Key: +to the nearest whole hectare.

sites, while *Chaetomorpha* spp. occur in smaller pools on Sanday. The aquatic vegetation of the non-tidal coastal oyces is predominantly of freshwater species such as pondweeds *Potamogeton* spp.; the rarer spiral tasselweed *Ruppia spiralis* is recorded from the Loch of Carness. Brackish water-crowfoot *Ranunculus baudotii* is common. The brackish fucoid *Fucus ceranoides* is abundant in places in the Loch of Stenness, with some interspersed tasselweeds.

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 occurs in the region, although the presence of the lagoonal snails *Hydrobia ventrosa* and *H. neglecta* and the lagoonal cockle *Cerastoderma glaucum* at The Ouse is notable. The Loch of Stenness has a predominantly estuarine-marine fauna and (with Loch of Harray) supports important overwintering bird populations, as well as otters *Lutra lutra.*

3.4.3 Human activities

No known ecological management exists for the saline ponds in the region. The Loch of Stenness is within an SSSI designated for its botanical and ornithological interest and is used for recreational fishing. There is potential pressure on all marine inlets from salmon farming.

3.4.4 Information sources used

The saline pools of the region were surveyed recently by the Joint Nature Conservation Committee's Marine Nature Conservation Review (Thorpe in prep.); these surveys looked in some detail at sub-habitats within the lagoons. Information on restricted estuaries and lochs was collated by Smith (1984), principally for their molluscan fauna, and includes reference to other surveys covering the quasi-lagoonal habitats of the region. Earlier reports on the vegetation of coastal oyces were given by Bullard (1972).

3.4.5 Acknowledgements

We are grateful to Roger Covey for discussions on the sites and to David Connor and Kath Thorpe of the MNCR for permission to use information from Thorpe (in prep).

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Flora, fauna, habitat information, site management: Orkney	*SNH, Kirkwall, tel: 01856 875302
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3.5 Wet grassland

Dr H.T. Gee

3.5.1 Introduction

This section covers lowland wet grasslands, fens and swamps in coastal locations. Coastal grazing marsh, formed by the land claim of saltmarsh for agriculture, is absent from Orkney since saltmarshes are small and land claim has been minimal. No national survey of wet grassland, or coastal grazing marsh separately, has been carried out, so detailed inter-regional comparisons are not possible.

Low rocky shores form over two thirds of the Orkney coastline and areas of wet grassland and associated habitats are small. Within the low-lying areas, farmed land often extends to the high water mark and agricultural improvement has further reduced the extent of coastal marshes. Small areas of brackish or freshwater marsh, wet grassland and fen are found frequently at the landward edge of saltmarshes in Orkney (see section 3.6). Parts of the machair that lie close to the water table also support areas of wet pasture and marsh (see section 3.2). This habitat is the most extensive and interesting type of wet grassland around the coasts of Orkney.

Map 3.5.1 Lowland wet grassland: locations mentioned in the text.

3.5.2 Important sites and species

The locations of areas of lowland wet grassland in the region are shown on Map 3.5.1. Two Sites of Special Scientific Interest (SSSIs) on Orkney, Waulkmill Bay and Central Sanday, contain areas of wet grassland and freshwater marsh at the landward edge of saltmarsh. At Waulkmill Bay, the burn draining from the Loch of Kirkbister flows to the bay through a series of channels surrounded by freshwater marsh. The saltmarsh is also fringed by a zone of yellow iris *Iris pseudacorus* swamp.

The machair within the Central Sanday SSSI contains wetland areas, with species such as jointed rush *Juncus articulatus*, grass-of-Parnassus *Parnassia palustris*, lesser clubmoss *Selaginella selaginoides* and curved sedge *Carex maritima*. Similar habitats are found in the machair at Northwall, also on Sanday, where the vegetation is particularly diverse. The shoreline in the bays of Little Sea (Kettletoft Bay) and Cata Sand has areas of fresh and brackish marsh and wet pastures managed as hay meadows; these grade into saltmarsh vegetation. There are also areas of low-lying wet pasture adjacent to the lochs of Harray and Stenness on Mainland, the latter having a significant brackish influence.

Orkney is famed for its birds and is of national and international importance for the breeding and wintering wildfowl and waders it supports. The low-lying wet grassland is of importance for its breeding waders. Surveys have shown good numbers of waders, such as lapwing *Vanellus vanellus*, oystercatcher *Haematopus ostralegus*, snipe *Gallinago gallinago*, curlew *Numenius arquata* and redshank *Tringa totanus*. Outside the breeding season, the lowland wet grasslands of Orkney are noted for the numbers of curlew they support. It is estimated that between one fifth and one quarter of all curlew wintering in the British Isles are on Orkney, particularly on the wet grasslands (Meek 1985).

3.5.3 Human activities

Coastal wetlands in Orkney have been damaged in the past by agricultural improvements such as draining, ploughing and re-seeding. Measures to conserve these habitats are now contained in SOAEFD agri-environment schemes: the Habitats Scheme and Scottish Countryside Premium scheme.

3.5.4 Information sources used

Their small and fragmented areas mean that there are few botanical survey data for lowland wet grasslands and associated wetlands in Orkney. The detailed study by Shimwell (1985a) in south-east Sanday is a notable exception. Some information on other coastal wetlands is contained in the saltmarsh survey of Orkney (Shimwell 1985b, c). Data on birds are more comprehensive and are contained in several survey reports (Gray *et al.* 1994a, b, c; Whyte *et al.* 1995).

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Flora, fauna, habitat information, site management - Orkney	*SNH, Kirkwall, tel: 01856 875302

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Much of the coastline of Orkney is exposed, restricting saltmarshes to a few sites that provide some shelter, such as at Bay of Carness, Mainland (pictured). Most of the larger marshes are found within an ouse (or oyce), a shallow bay partially closed and protected by a sand or shingle bar. The many smaller sites tend to be at the heads of beaches within embayments. Photo: Pat Doody, English Nature.

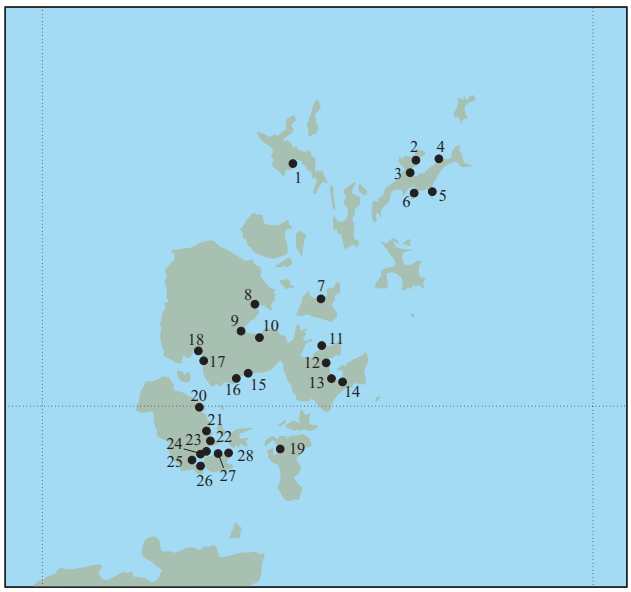
3.6 Saltmarsh

Dr M.I. Hill

3.6.1 Introduction

Saltmarsh in Orkney covers 76 ha (Burd 1989a, b). This is 1.3% of the resource in Scotland, 0.4% of that on the North Sea coast of Britain and 0.2% of the British resource (Table 3.6.1). Although the total area is small, it is distributed at many sites, widely scattered around the coastline; only two sites are larger than 5 ha. 3.5 km of the coastline (at mean high water) supports saltmarsh, less than 0.4% of the length of the coastline (JNCC Coastal Database).

The erosion or accretion status of Orkney saltmarshes varies, with some sites showing lateral erosion and some seaward spread (Pye & French 1993). Most sites appear to receive little tide-borne sediment. Overall, the picture is one of stability, with marshes showing only slow changes in extent or morphology. As a result, most of the saltmarsh comprises higher saltmarsh vegetation types. Table 3.6.1 shows that, in the national survey, 67% of Orkney's saltmarsh was classed as mid-upper marsh and a further 23% as upper marsh (driftline, upper swamp, transitions and wet depressions).



Map 3.6.1 Saltmarsh sites (numbers refer to Table 3.6.2). Source: JNCC Coastal Database.

3.6.2 Important sites and species

Saltmarshes in Orkney are concentrated in three main areas: the sheltered bays and strands of Scapa Flow (particularly on Hoy), the north-east coast of Mainland, and the island of Sanday. Much of the coastline is exposed, restricting saltmarshes to a few sites that provide some shelter. Most of the larger marshes are found within an ouse (or oyce), a shallow bay partially closed and protected by a sand or shingle bar. The many smaller sites tend to be at the heads of beaches within embayments, either at the mouths of streams or at the base of cliffs from which drainage water seeps onto the beach. Some saltmarshes are enclosed behind man-made barriers such as roads, with tidal water entering through a narrow channel. In addition to these sites, vegetation showing many similarities to saltmarsh is widespread on intertidal rock platforms, reefs and low cliffs (Berry 1985).

The more important saltmarsh sites in Orkney in nature conservation terms are the larger examples, which tend to be structurally and botanically the most diverse. The best sites are: Tor Ness & Quivals Creek, Cata Sand, Little Sea (all Sanday); the Ouse at Finstown, Swarsquoy, Bay of Suckquoy, Waulkmill Bay, Cummi Ness and Bridge of Waithe (all on Mainland), and the Ouse at Veantrow Bay on Shapinsay (Shimwell 1985a, b). Sites with more than 0.5 ha of saltmarsh are listed in Table 3.6.2 (Map 3.6.1); there are a further ten sites <0.5 ha, covering a total of approximately 3 ha. Only a few SSSIs, such as Central Sanday and Waulkmill Bay, contain significant areas of saltmarsh.

Saltmarshes of Orkney are characterised by a limited number of plant communities but a high species diversity in the upper marsh, owing to the influence of freshwater seepage, plus some natural transitions to non-tidal areas. Several widespread British saltmarsh species are absent because Orkney lies beyond the northern limit of their

Table 3.6.1 Areas (ha) of saltmarsh communities at sites (>0.5 ha) in Region 2 in context

	Spartina	*Pioneer*	*Low-mid*	*Mid-upper*	*Driftline*	*Upper swamp*	*Transition*	*Wet depression*	*Total*	*% of region total*	*% of area total in region*
Mainland	0	0.1	1.9	23.5	2.0	0	4.7	0.1	32.3	42.2	-
Sanday	0	2.1	0.5	10.6	2.3	0	4.2	0	19.7	25.8	-
Hoy	0	0	1.5	12.8	1.5	0	0.7	0	16.5	21.6	-
Shapinsay	0	0	0.7	1.8	0.5	0	<0.1	0	3.1	3.9	-
South Ronaldsay	0	<0.1	0.7	1.9	0.6	0	0	0	3.2	4.2	-
Westray	0	0	0.4	0.3	0.2	0.5	0.3	0	1.7	2.2	-
Region 2	***0***	***2.3***	***5.7***	***50.9***	***7.1***	***0.5***	***10.0***	***0.1***	***76.5***	**-**	**-**
Scotland	102	361	500	3,608	63	587	748	2	6,089	-	1.3
North Sea Coast	3,461	2,130	8,194	4,772	1,350	1,066	342	2	21,788	-	0.4
Great Britain	6,948	3,470	12,353	16,042	1,824	1,475	1,670	2	44,370	-	0.2

Source: National Saltmarsh Survey (Burd 1989a, b). Note: sites not included total 3 ha in area.

Table 3.6.2 Main saltmarsh sites

No. on Map 3.6.1	*Location*	*Grid ref.*	*Area (ha)*
	Westray		
1	Bay of Tuquoy	HY452451	1.7
	Sanday		
2	Lamma Ness Oyce	HY681438	3.0
3	Tor Ness + Quivals Creek	HY674424, HY668422	2.6
4	Black Rock Marsh, Otters Wick	HY697423	1.3
5	Cata Sand	HY698413	7.3
6	Little Sea	HY671396	6.4
	Shapinsay		
7	The Ouse, Veantrow Bay	HY506187	3.0
	Mainland		
8	Oyce of Isbister	HY392184	2.6
9	The Ouse, Finstown	HY356143	1.9
10	Oyce of Rennibister	HY396123, HY388127	1.0
11	Swarsquoy	HY500094	2.7
12	Mill Sand	HY515084, HY515074	2.4
13	Bay of Suckquoy	HY523043	4.1
14	Sandi Sand	HY545035, HY356044	1.0
15	Waulkmill Bay	HY376065	9.0
16	Swanbister Bay	HY364054, HY356044	1.8
17	Clestrain Sand	HY290068-HY296052	1.0
18	Bridge of Waithe + Cummi Ness	HY282113-HY283105	4.9
	South Ronaldsay		
19	Oyce of Quindry	ND435925	3.2
	Hoy		
20	Lyrawd Bay	ND291987	0.6
21	Mill Bay	ND300954, ND301951	2.3
22	Ore Bay	ND305939	0.7
23	Little Ayre	ND305919	2.6
24	Quoys	ND283912, ND301917	3.4
25	Saltness, North Bay	ND275898	1.7
26	The Ayre	ND286892, ND295898	1.7
27	Wyng Strand	ND320912	1.3
28	Myre Bay	ND331912	2.0

Source: National Saltmarsh Survey (Burd 1989a, b). Note: includes all sites >0.5 ha

distribution; these include sea-purslane *Halimione portulacoides*, sea wormwood *Artemisia maritima*, common sea-lavender *Limonium vulgare* and all species of cord-grass *Spartina*.

A typical saltmarsh zonation in the region comprises only small areas of pioneer and low-mid marsh. The main pioneer species is annual sea-blite *Suaeda maritima*, and the low-mid marsh zone is usually a species-poor common saltmarsh-grass *Puccinellia maritima* community. The dominant species in the mid to upper marsh are saltmarsh rush *Juncus gerardi* and common saltmarsh-grass; other widespread species are sea-milkwort *Glaux maritima*, thrift *Armeria maritima*, common scurvygrass *Cochlearia officinalis*, spear-leaved orache *Atriplex prostrata*, autumn hawkbit *Leontodon autumnalis*, greater sea-spurrey *Spergularia media*, sea plantain *Plantago maritima*, red fescue *Festuca rubra* and sea arrowgrass *Triglochin maritima*. The main mid-upper marsh vegetation types are common saltmarsh-grass saltmarsh and red fescue saltmarsh. The characteristic driftline species is common couch *Elymus repens*.

Upper marsh swamps are uncommon and are associated mainly with freshwater inflows. On the upper levels of the saltmarsh, in wet depressions and where it is flushed with freshwater, there are stands of saltmarsh flat-sedge *Blysmus rufus*, very occasionally with slender spike-rush *Eleocharis uniglumis*. These two species are both northern elements in the British saltmarsh flora, found mainly on the west coast of Britain from mid-Wales northwards, and whilst neither is nationally scarce as a species, their extent as vegetation types on British saltmarshes is very limited. There are several sites with this vegetation on Orkney, but it is less widespread than on the north-west coast of Scotland, in the Western Isles or in Shetland. At the landward edge of the saltmarshes are transitions to other habitats such hay meadows, wet grasslands, freshwater marsh, shingle, dune pasture and low cliffs. Such areas are often of particular ecological interest, having a high diversity of both plants and invertebrates.

Two of the three British species of eelgrass, *Zostera marina* and narrow-leaved eelgrass *Zostera angustifolia*, both nationally scarce, are present in intertidal and subtidal zones in the region (Stewart *et al.* 1994). Another nationally scarce species found on the saltmarshes is the eyebright *Euphrasia foulaensis*.

3.6.3 Human activities

The Orkney saltmarshes have experienced less human interference and land claim than saltmarshes elsewhere in much of Britain. In some places the upper fringes of saltmarsh have been affected by agricultural improvement, such as reseeding and drainage, resulting in a clear boundary between saltmarsh and pasture. Generally, saltmarshes in Orkney at present experience few threats from man's activities, although some sites have been affected by tipping. Some saltmarshes are found in situations where flooding by tidal waters is through a narrow or restricted entrance; they are therefore particularly vulnerable to changes in their tidal regime through drainage works or the construction of culverts and embankments.

3.6.4 Information sources used

Saltmarshes in the region were surveyed in 1985 and the survey reports give maps of the extent of saltmarsh at each site and descriptions (Shimwell 1985a, b). In addition, quadrats were recorded from different vegetation types at most sites and allocated to communities under the National Vegetation Classification. Total areas of NVC communities were calculated. The data from 28 sites exceeding 0.5 ha in area were incorporated into the national saltmarsh survey and the areas of major plant communities for these sites are summarised in Burd (1989a, b). Data presented here are derived from that database.

3.6.5 Acknowledgements

Thanks to staff at Scottish Natural Heritage who kindly provided information and reference material.

3.6.6 Further sources of information

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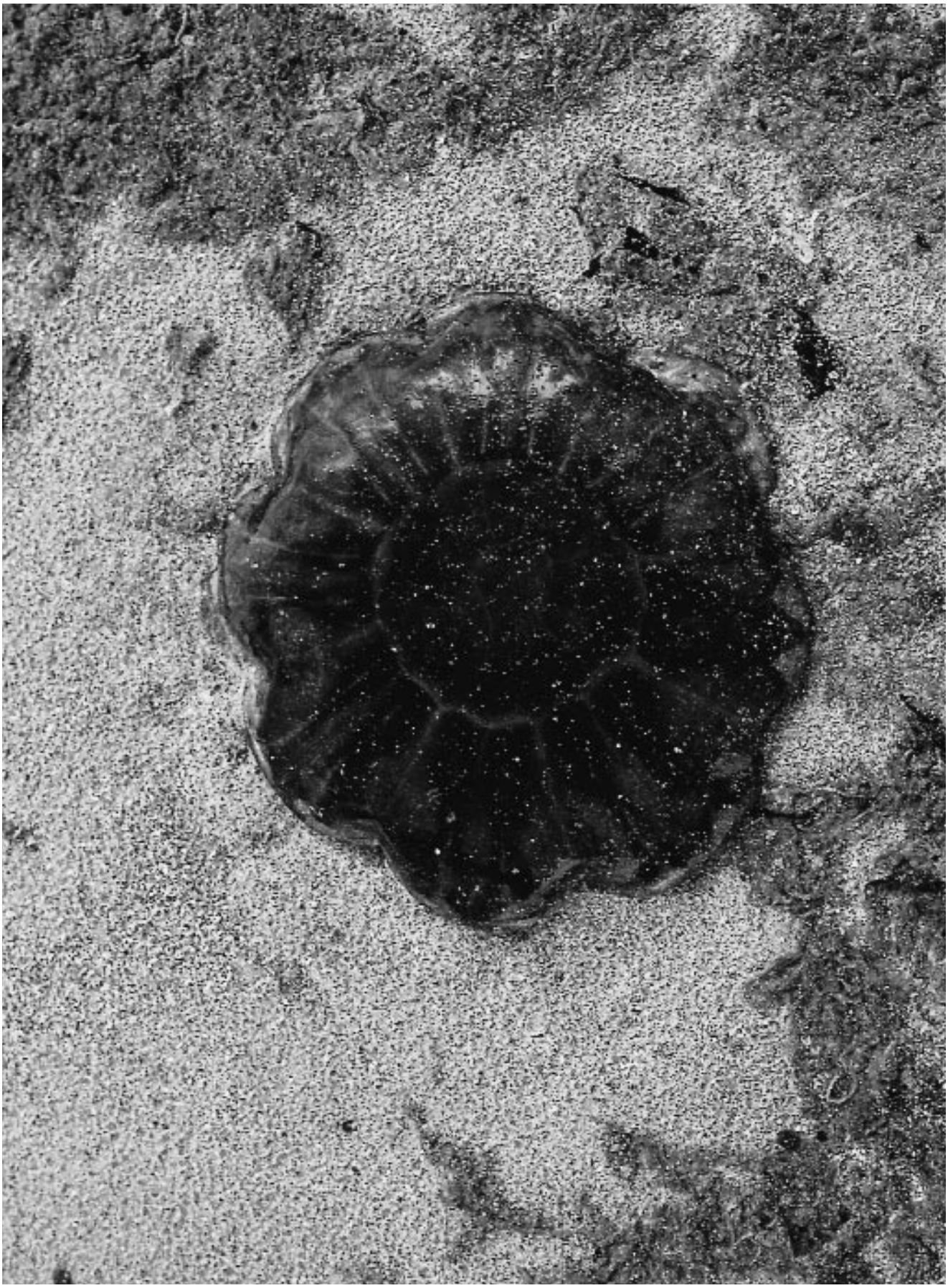
British Oceanographic Data Centre. 1992. *United Kingdom digital marine atlas. User guide. Version 2.0*. Birkenhead, Natural Environment Research Council, British Oceanographic Data Centre.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Data from National Saltmarsh Survey	*Geology/Coastal Advisor, JNCC, Peterborough, tel: 01733 62626
Flora, fauna, habitat information, site management - Scotland	*SNH, Maritime Unit, Advisory Services, Edinburgh, tel: 0131 554 9797
Flora, fauna, habitat information, site management - Orkney	*Area Officer, SNH, Kirkwall, tel: 01856 875302

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



Between the Orkney islands the relatively sheltered waters teem with life, including the compass jellyfish *Chrysaora hysoscella,* which takes its name from its body markings and gives a painful sting. This individual, the size of a dinner plate, ended up stranded on one of the many sandy beaches on Sanday. Photo: Pat Doody, English Nature.

Chapter 4 Marine and estuarine environments

4.1 Estuaries

Dr N.C. Davidson

4.1.1 Introduction

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

The four sheltered and partly sediment-filled inlets in Orkney (Map 4.1.1) form only a small proportion of the coastline of the region but add to the region's coastal diversity, notably through the presence of sandflats, mudflats and saltmarshes. The contribution to the wider resource of the four estuaries in Region 2 is summarised in Table 4.1.1. Only 52 km (5.9%) of the region's shoreline is estuarine, and the region's 2,250 ha total estuarine area is only 0.9% of the North Sea Coasts's estuarine area and only 0.4% of that of the UK. Similarly small proportions of national intertidal and saltmarsh areas, and shoreline and channel lengths, are present in the region.

The Orkney estuaries are strongly marine influenced, with freshwater input limited to small streams and seepages. The inner parts of the estuaries drain at low tide, revealing tidal flats formed mostly of sand and shingle. Areas of mud are very small and restricted to the most sheltered inner parts of the shore, where there are some areas of fringing saltmarshes. Outer parts of the estuaries

Map 4.1.1 Estuaries. Source: JNCC Estuaries Database.

are mostly subtidal and have predominantly rocky shores. Estuaries in the region are bar-built or fjardic (shallow sediment-filled glacial basins), the fjards also showing further bar-built characteristics with the development of sand and shingle spits. In three estuaries, the sheltered inlet lies behind a narrow shingle and sand spit linking a rocky island to the main shore.

4.1.2 Important locations and species

Table 4.1.2 lists the estuaries in the region and summarises their main physical characteristics. None of the Orkney

Table 4.1.1 Contributions of Region 2 estuaries to the national resource

Resource+	*Regional total*	*North Sea Coast total*	*% North Sea Coast total*	*GB total*	*% GB total*	*UK total*	*% UK total*
Intertidal area (ha)	941	136,580	0.7	321,050	0.3	332,350	0.3
Saltmarsh area (ha)	25	20,650	0.1	48,380	0.1	*	*
Total estuarine area (ha)	2,249	258,100	0.9	525,650	0.4	581,290	0.4
Shoreline length (km)	52	5,645	0.9	9,054	0.3	9,727	0.3
Longest channel lengths (km)	12	1,484	0.8	2,461	0.5	2,640	0.4

Sources: Buck (1993); Davidson & Buck (in prep). Key: +areas rounded to the nearest whole hectare; lengths rounded to the nearest whole km; *areas of saltmarsh were not available for Northern Ireland. Some saltmarsh may occur outside estuaries as defined in this section (see section 3.6).

estuaries is large, the largest being Deer Sound & Peter's Pool, at almost 1,300 ha. Otters Wick has a total area of just over 500 ha; the other two are each less than 250 ha in total area. None of the estuaries is industrialised: all are rural and surrounded by farmland, with some areas of dunes and machair grasslands. These areas support breeding waders and wildfowl populations, and there are small gull and tern *Sterna* sp. breeding colonies associated with each estuary. Cata Sand and Kettletoft Bay both lie within the Central Sanday Site of Special Scientific Interest (SSSI).

At over 500 ha Otters Wick is the largest of the three estuarine inlets on Sanday. It is sheltered by the peninsulas of Burness and Northwall, with its inner part further sheltered by the spits Lama Ness and Colli Ness. Here there are tidal flats formed chiefly of sand and shingle, and three small areas of saltmarsh have developed in these inner parts of the inlet; the outer southern shore is rocky. Otters Wick has a more diverse wintering waterfowl population than other Orkney estuaries, the most common species being dunlin *Calidris alpina*, bar-tailed godwit *Limosa lapponica* and turnstone *Arenaria interpres*. In summer it has small breeding seabird colonies, as well as breeding waders and wildfowl on its sand and shingle beaches, saltmarshes and adjacent grasslands.

On the south-east coast of Sanday, Cata Sand is a lagoonal inlet enclosed to the east by the long sand and shingle spit linking Tres Ness to the main island. This sand-covered spit is a marram-dominated dune system, with dry and wet machair on blown shell-sand to landward. The mouth of the Cata Sand inlet is further narrowed by a second spit developed from the western shore. At low tide Cata Sand drains almost completely to form an intertidal sandflat with fringing saltmarshes in the inner parts, the largest being around the small freshwater inflow at Canker. Small numbers of wintering waders, chiefly dunlins, feed on the sandflats, and the inlet has small colonies of breeding gulls and terns.

Kettletoft Bay has formed behind the sand and shingle spit joining Els Ness to Sanday. The small inner bay of Little Sea is separated by two small shingle spits from the outer Kettletoft Bay, which has mostly rocky shores. At low tide Little Sea is a sandflat with fringing saltmarsh, supporting small numbers of wintering waders, mostly bar-tailed godwits and turnstones, and there are small numbers of breeding terns and waders around the inlet in summer.

Deer Sound & Peter's Pool, on Mainland, is the largest estuarine inlet on the islands. The outer, chiefly subtidal, part of the system, Deer Sound, is sheltered behind Deerness. At its south, the inner bay of St Peter's Pool is closed at its southern point by the narrow Dingieshore, a stable sand spit that links Deerness to the main island. St Peter's Pool is mostly intertidal sandflat with shingle areas around its mouth. There are small saltmarshes here and in two other small bays, on the sand and shingle of Mill Sand and the muddy sand of Suckquoy. Freshwater inflow to the inlet is chiefly through small streams flowing into the Bay of Suckquoy and Mill Sand. Small numbers of several waterfowl species breed on the grasslands around the inlet.

4.1.3 Human activities

There is little human use of these remote estuaries, which have only small and scattered settlements around them. Some dune grassland is grazed, small-scale extraction of sand and shingle occurs on Cata Sand and Kettletoft Bay, and some wildfowling occurs on all the estuaries. There is lobster and crab potting and cockling in Kettletoft Bay, Deer Sound & Peter's Pool and Otters Wick. Mussels, oysters and scallops are cultivated in Deer Sound & Peter's Pool. Very low intensity informal recreation (walking, bird-watching, angling, horse-riding) takes place, mostly around Deer Sound & Peter's Pool. Table 4.1.3 summarises human use of Orkney's estuaries.

4.1.4 Information sources used

This section is summarised chiefly from JNCC's *An inventory of UK estuaries* (Buck 1993). Data presented in the inventory are drawn largely from material collected during 1989-90 (updated to 1993 where appropriate) for the NCC's Estuaries Review (Davidson *et al.* 1991). Saltmarsh data come originally from Burd (1989a, b), whose surveys covered mostly saltmarshes of >0.5 ha.

4.1.5 Acknowledgements

Thanks are due to Eric Meek (RSPB) for helpful comments on draft texts.

Table 4.1.2 Physical characteristics of Region 2 estuaries

Estuary	*Centre grid ref.*	*Geomorphological type*	*Total area (ha*)*	*Inter--tidal area (ha*)*	*Saltmarsh (ha*)*	*Shoreline length (km)*	*Main channel length (km)*	*Spring tidal range (m)*	*Sub-tidal %*
Orkney									
70. Otters Wick	HY6843	Fjard	553	310	5	12	2.6	2.8	43.9
71. Cata Sand	HY7041	Bar-built	218	204	7	7.9	1.3	2.8	6.4
72. Kettletoft Bay	HY6739	Fjard	191	122	6	6.7	1.9	2.8	36.1
73. Deer Sound & Peter's Pool	HY5404	Fjard	1,287	305	7	25.4	6.4	3.2	76.3

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

Table 4.1.3 Human uses of Region 2 estuaries

Estuary	*Centre grid ref.*	*Human use type*			
		urban	*industrial*	*rural**	*recreational*
Orkney					
70. Otters Wick	HY6843			●	
71. Cata Sand	HY7041			●	
72. Kettletoft Bay	HY6739			●	
73. Deer Sound & Peter's Pool	HY5404			●	❍

Source: Buck (1993). Key: * includes natural resource exploitation. ● = major human use; ❍ = minor human use.

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Scottish Office Environment Department. 1992. *Water quality survey of Scotland 1990.* Edinburgh, HMSO.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Coastal Database: national database of estuaries; coastal habitats; statutory & non-statutory protected sites.	*Marine & Coastal Data Custodian, JNCC, Peterborough, tel: 01733 62626
Statutory protected sites; detailed wildlife site information; coastal geomorphology. Firths Initiative & estuary management plans. Numerical and some digitised data.	*SNH, Maritime Unit, Advisory Services, Edinburgh, tel: 0131 554 9797

*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.

The configuration of the 70 islands and skerries which make up the Orkney Islands gives rise to a wide range of wave exposure on the shores and shallow sublittoral, varying from very sheltered between the islands to very exposed on the west coast. The islands are influenced by the North Atlantic Drift, which carries warm water northwards along the west coast of Britain. This helps to prevent extreme temperature fluctuations, which, together with the relatively damp atmosphere, allows the development of diverse littoral communities (Jones 1975). Strong tidal streams occur within the Pentland Firth and around the northern islands, with speeds of up to 9 knots (4.5 m/s) on the flood tide in the Pentland Firth (Jones 1975). There is a residual tidal movement of water in a clockwise direction around the islands.

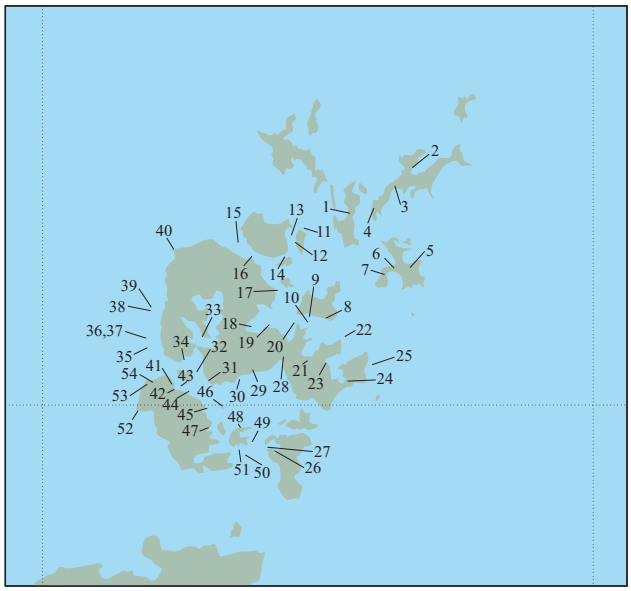
The islands are bounded by the 60 m depth contour, which lies within 3 km off the west coast of Mainland, Hoy and the south coast of South Ronaldsay. The sea bed between the islands consists of bedrock, boulders, gravel, sand and occasional deposits of mud, while the substrata of the tide-scoured sounds are bedrock, shell-gravel or sand. Table 4.2.1 shows the relative proportions of different shore types in Orkney. Most shores are composed of bedrock or boulders, supporting predominantly seaweeds and/or barnacles, with sand in the bays. Beaches have clean sediment with a low organic content, as rivers in Orkney are small and carry a low burden of sediment to the sea (Mykura 1976). Information on the precise extent of shore (littoral) and sublittoral (below low water mark) habitat types in a national context is not yet available.

Orkney lies on a biogeographical boundary between the generally richer marine life of western Britain and the less diverse marine life of the North Sea region. The algal communities on Orkney are well-developed compared with

Table 4.2.1 Proportions of different shore types found in Orkney

Shore type	*Coastline length (km)*	*Proportion of total coastline (%)*
Very exposed shores	120	14
Barnacle-dominated shores	149	17
Barnacle/fucoid-dominated shores	70	8
Fucoid-dominated shores	207	24
Wrack *Ascophyllum* spp.-dominated shores	177	21
Sandy shores	101	12
Shingle shores	32	4

Source: adapted from Baxter *et al.* (1985).



Map 4.2.1 Locations of marine benthic interest (numbers refer to Table 4.2.2).

those in Shetland (Region 1) (Irvine 1974). Orkney's marine algae include elements of northern, east coast and west coast flora, with a number of species reaching the limit of their distribution on the islands (Maggs 1986). Approximately 390 alga species have been listed for the islands (Wilkinson 1975). Several intertidal invertebrates also reach their northern limits of distribution at the islands, including the barnacle *Chthamalus stellatus* and the gastropod *Gibbula umbilicalis* (Baxter *et al.* 1985).

Scapa Flow, one of the finest natural harbours in the world, is well known for its shipwrecks from both World Wars. Such wrecks offer hard substrata on a sea bed that is largely sedimentary, providing new habitats for opportunistic colonising species that otherwise would not be present.

4.2.2 Important locations and communities

Table 4.2.2 lists the locations of marine interest mentioned in the text (Map 4.2.1).

Westray, Papa Westray, Sanday, North Ronaldsay, Eday, Stronsay, Rousay, Egilsay and Shapinsay

Little information is available on the shores and near-shore areas around most of Orkney's northern isles. The whole island of North Ronaldsay is enclosed by a sea wall intended to keep sheep from straying inland. Consequently, it is likely that they have a severe impact on shore vegetation. The shoreline is a storm-beach formed of slabs and boulders, with occasional patches of gravel and some areas of sand (Rendall 1954). Many of the sandstone boulders are riddled by the rock borer *Hiatella arctica*. The rocky west coast of the island has exposed communities of

Table 4.2.2 Locations of marine interest mentioned in the text

No. on Map 4.2.1	*Location*	*Grid ref.*
	Eday	
1	Bay of London	HY5634
	Sanday	
2	Bay of Stove	HY6743
3	Backaskaill Bay	HY6439
4	Otters Wick	HY6035
	Stronsay	
5	Mill Bay	HY6625
6	St Catherine's Bay	HY6425
7	Sand of Rothiesholm	HY6324
	Shapinsay	
8	Bay of Sandgarth	HY5115
9	Helliar Holm	HY4815
10	Head of Work, The String	HY4814
	Egilsay	
11	Smithy Sound	HY4732
12	The Hubbet	HY4628
	Rousay	
13	Rousay Sound	HY4530
14	Wyre Sound	HY4427
15	Eynhallow	HY3628
16	Eynhallow Sound	HY3827
	Mainland	
17	Bay of Puldrite	HY4218
18	Bay of Firth,	HY3814
19	Quanterness	HY4114
20	Car Ness	HY4614
21	Inganess Bay	HY4708
22	Rerwick Head	HY5412
23	Mill Sands	HY5107
24	St Peter's Pool	HY5504
25	The Gloup, Deerness	HY5907
	South Ronaldsay	
26	Widewall Bay	ND4292
27	Hoxa Head	ND4092
	Mainland	
28	Scapa Bay	HY4408
29	Waulkmill Bay	HY3706
30	Swanbister Bay	HY3504
31	Houton Head	HY3003
32	Clestrain Sound, Mainland/Gaemsay	HY2805
33	Loch of Stenness	HY2812
34	Cairston Roads, off Stromness	HY2608
35	Black Rock	HY2110
36	Neblonga	HY2111
37	North Gaulton Castle	HY2111
38	Inga Ness	HY2115
39	Brough of Bigging	HY2116
40	Skipi Geo	HY2428
	Hoy	
41	Bay of Creekland	HY2304
42	Bay of Quoys	HY2403
43	Burra Sound, Hoy/Graemsay	HY2503
44	Nose of Bring, Bring Deeps	HY2702
45	Greenhead	ND3099
46	Calf of Cava,	HY3200
47	Mill Bay	ND3095
	Flotta	
48	N. side of Flotta	ND3595
49	Sound of Hoxa	ND3892
50	Switha	ND3690
51	Switha Sound	ND3591
	Hoy	
52	Rora Head	ND1799
53	Kame of Hoy	HY1904
54	Bay of the Tongue	HY2004

barnacles, particularly *Semibalanus balanoides,* and mussels *Mytilus edulis*.

The sandy shore at Otters Wick on the north side of Sanday is dominated by polychaete worms, especially *Manayunkia aesturina* and *Pygospio elegans* (Atkins *et al*. 1985). The beach at Backaskaill Bay on the south coast of Sanday has a good range of bivalve species (Rendall 1954). On the opposite side of the island, at the Bay of Stove, a typical Orkney beach in terms of both species diversity and densities, there are large numbers (>100/m^2) of the sandmason worm *Lanice conchilega* on the low shore. The beach is generally dominated by amphipods, especially *Bathyporeia* spp., with the amphipod *Pontocrates arenarius* an important constituent of the middle and lower shore (Atkins *et al*. 1985). In Sanday Sound between Sanday and Stronsay, *Laminaria saccharina* dominates the kelp beds (Walker 1950). On Eday, the small sandy Bay of London on the island's east coast is very similar to Bay of Stove on Sanday, although with far fewer sandmason worms (Atkins *et al*. 1985). On Stronsay, the bivalve molluscs at Mill Bay, the Sand of Rothiesholm and St Catherine's Bay are very varied (Rendall 1954).

Near Shapinsay an interesting flattened growth form of maerl known as 'medallions' occurs to the south of the Bay of Sandgarth, at 19-20 m depth, possibly indicative of greater water movement here (Murray *et al*. in prep.) (Map 4.2.2). To the east of Helliar Holm on the southern side of Shapinsay there are beds of horse mussel *Modiolus modiolus* below a fringing kelp forest (Murray *et al*. in prep.). Such beds probably occur throughout the deeper sections of Shapinsay Sound. Off the headlands of Car Ness and Head of Work, on the southern side of the narrows ('The String') between Mainland and Shapinsay, vertical bedrock surfaces between 5-13 m depth support rich communities of ascidians, hydroids and sponges, such as *Esperiopsis fucorum* and *Pachymatisma johnstonia*.

Though Rousay's rocky shores on its west coast are very exposed to wave action, the majority of shores within Eynhallow, Wyre and Rousay Sounds are moderately exposed, being of gently-sloping broken bedrock and stable boulders. These shores are dominated by fucoid algae, with the kelp *Laminaria digitata* in the sublittoral fringe (Murray *et al*. in prep.). There is an extensive area of intertidal tide-swept, medium-sized boulders at Smithy Sound, between Kili Holm and the northern tip of Egilsay, with very rich underboulder communities, with encrusting sponges and ascidians (Murray *et al*. in prep.). The Hubbet on the west coast of Egilsay is a long, almost land-locked inlet of the sea

Map 4.2.2 Locations of maerl in Orkney recorded on the MNCR database.

with saltmarsh at its head and a muddy sandy beach towards its seaward end. A green alga *Codium* sp. occurs here in profusion (McMillan 1972), in a dense canopy of algae on cobbles, including the bootlace weed *Chorda filum*, sea oak *Halidrys siliquosa* and the cape form of *Laminaria digitata* (Murray *et al*. in prep.). All of the algae have lush growths of sponges, ascidians, bryozoans and the small hydroid *Clava multicornis* attached to them.

Despite being similar in physiographic character, the sea bed habitats (and their associated communities) of Eynhallow, Wyre and Rousay Sounds are quite different from each other (Murray *et al*. in prep.). Eynhallow Sound is largely characterised by tide-swept bedrock platforms; Wyre Sound comprises dense maerl and maerl gravel; and Rousay Sound is essentially sediment-dominated, with patches of boulders, cobbles, maerl gravel and sand. Areas of maerl are concentrated on the north-west of Rousay Sound as well as within Wyre Sound (Map 4.2.2). Smaller areas of maerl occur on the north-east of Rousay Sound (off Egilsay) and off the east side of Wyre (Foster-Smith & Davies 1993). Living maerl (primarily *Phymatolithon calcareum*) occurs at depths ranging between 5-20 m in these areas, often where there is enhanced current. Occasionally, as in Wyre Sound, the maerl is piled into waves running perpendicular to the current (Murray *et al*. in prep.). Most shores of Shapinsay are rocky, with sandstone bedrock steps, boulders and gullies supporting typical species. These substrates continue below low water, grading to mixed sediment. There is also maerl in Veantrow Bay on the north coast of Shapinsay, often in association with sugar kelp *Laminaria saccharina* (Foster-Smith & Davies 1993). Perhaps as much as 48,194 tons of 'tangle' (washed up stipes of kelp) is present on the north coast of Shapinsay, made up of *L. hyperborea* (15%), *L. digitata* (14%), *L. saccharina* (70%) and *Saccorhiza polyschides* (1%) (Walker 1950).

In the centre of Eynhallow Sound, tide-swept bedrock below the lush kelp forest has a dense faunal turf, dominated by the soft coral *Alcyonium digitatum* and the bushy bryozoans *Securiflustra securifrons* and *Flustra foliacea* (Murray *et al*. in prep.). Hydroid communities there are characterised by *Abietinaria abietina*, *Nemertesia antennina* and the bottle-brush *Thuiaria thuja*, a species with a northern distribution. Numerous sponges are associated with the turf, including massive growths of *Myxilla incrustans*, *Cliona celata*, *Pachymatisma johnstonia* and the smaller *Suberites ficus*. To the east of the small island of Eynhallow, there is a large expanse of medium and fine sand with various bivalves and areas of eelgrass *Zostera marina*, interestingly with occasional dabberlocks *Alaria esculenta* kelp plants (usually found in more exposed situations).

Mainland and South Ronaldsay (including Scapa Flow)

At the sheltered Bay of Puldrite on the north-east coast of Mainland, flat boulder slabs occur in the shallow sublittoral in amongst coarse sand with shell fragments (Earll, in Dipper 1984). There are scattered sugar kelp *Laminaria saccharina* plants and some *L. hyperborea*, and the bootlace weed *Chorda filum* is common. The slabs are encrusted with coralline algae and keelworms *Pomatoceros* spp., and there is a rich under-boulder fauna. Species present in the sediment include scallops *Pecten maximus*, razor shells *Ensis* spp. and tubeworms.

As on Shapinsay, most shores of Wide Firth are rocky, with sandstone bedrock steps, boulders and gullies supporting typical species. These substrates continue below low water, grading to mixed sediment. In the central part of Wide Firth the sea bed is sand mixed with live and dead maerl and occasional cobbles. The habitat is tide-swept and has high numbers of the tubeworm *Sabella pavonina*, together with razor shells *Ensis arcuatus*, anemones *Cerianthus lloydii* and the unusual tubeworm *Chaetopterus variopedatus*. On the western side of the Bay of Firth, soft flocculent mud overlies cobbles and pebbles, supporting very dense polychaete worm tubes, overlain by a mat of the red algae *Trailliella* and *Polyides rotundus*. Amongst this algal mat are various species of ascidians, colonies of the sponge *Esperiopsis fucorum* (more usually seen encrusting bedrock and boulders) and large numbers of the sea cucumber *Oncus planci*. At Quanterness, live maerl and maerl gravel is present between boulders at 5 m depth (Murray *et al*. in prep.). In sheltered areas, such as Inganess Bay, fine sands predominate, with mud in the Bay of Firth, while in more tide-swept areas, such as The String, mixed cobbles, pebbles and gravel occur (Murray *et al*. in prep.). In Inganess Bay, as in other bays lining Shapinsay Sound, shallow sediments of stable fine sand support a rich burrowing fauna of sabellid worms, the brittlestar *Amphiura filiformis* and anemones *Edwarsia* spp. With increased depth at the entrance to the bays, fine sediment gives way to maerl.

Deer Sound on the eastern tip of Mainland essentially comprises three basins, ranging from a deep, wave-exposed outer basin to a shallow, very sheltered inner basin. The shores lining the Sound are of cliffs on the outer part leading to stepped rocky platforms, particularly on the west side, which extend below low water to a depth of about 10 m. There are also sheltered areas of sediment such as at Mill Sands, Bay of Suckquoy and St Peter's Pool. The shores of the outer basin support communities typical of wave-exposed conditions, with barnacles, limpets and bladderwrack *Fucus vesiculosus* on the midshore, and thongweed *Himanthalia elongata* dominating the low shore (Murray *et al*. in prep.). Where there is less exposure, knotted wrack *Ascophyllum nodosum* and serrated wrack

Fucus serratus occur. Muddy fine sand in the intertidal of the middle and inner basins features dense populations of lugworms *Arenicola marina* and, particularly at Mill Sands and St Peter's Pool, cockles *Cerastoderma edule* (Atkins *et al*. 1985). These cockle populations are interesting in that individuals grow to extremely large sizes (up to 76 mm long) compared with cockles on the west coast of Scotland and elsewhere (McMillan 1971). Beds of eelgrass are also present on the low shore here and extend into the shallow sublittoral, the plants being mixed with bootlace weed *Chorda filum*. The leaves of the eelgrass plants support the ascidians *Ascidia mentula* and *Ascidiella aspersa* (Murray *et al*. in prep.).

Shallow sublittoral rock within Deer Sound extends to 10 m depth, where it gives way to a sediment plain. The stepped bedrock has a covering of kelp with an understorey of other algae such as *Trailliella intricata* and *Desmerestia* spp., with barnacles *Balanus crenatus* and ascidians on vertical surfaces (Murray *et al*. in prep.). Off Rerwick Head, where tidal streams have an influence on the communities, dense growths of the soft coral *Alcyonium digitatum* and the keelworm *Pomatoceros triqueter* are found. Of particular interest are the caves found on the west coast of Deer Sound and on the east coast of Deerness, some of which are up to 15 m in length. The communities present on the vertical walls resemble those of surge gullies, with dense cover of the ascidian *Dendrodoa grossularia*, often associated with the sponges *Clathrina coriacea* or *Leucosolenia complicata* (Murray *et al*. in prep.). One such cave on the Deerness coast, The Gloup, is now open to the sky and is a popular site for tour boats.

Benthic sediments vary within Scapa Flow, resulting in an uneven distribution of species (Jones *et al*. 1988). The sediment shores have a reduced species diversity and abundance compared with beaches on Hoy (Atkins *et al*. 1985). Sediments in the north-eastern area of Scapa Flow are fine and support fewer species and individuals compared with other parts. In the east, sediments are coarse and support the greatest species diversity. The low shore at Scapa Bay is dominated by polychaete worms and at Waulkmill Bay the midshore is polychaete-dominated, although amphipods *Bathyporeia* spp. dominate the lower shore. 37 species, a high number, occur at Swanbister Bay but population densities are low. The midshore here is dominated by the polychaete worms *Pygospio elegans* and *Manayunkia aesturina*. The low shore is dominated by amphipods *Bathyporeia* spp. and *Ampelisca* spp., which together comprise more than 80% of the fauna at this level on the shore (Atkins *et al*. 1985). In the more sheltered sites within Scapa Flow, boulder slopes give way to plains of finer sediment (mostly muddy sand). On boulders and other hard substrata in the shallows, kelp plants are smaller and less dense than off the west coasts, with fewer epiphytic algae. There are huge numbers of urchins in Scapa Flow, one Underwater Conservation Society dive recording 1,000 individuals (mostly within the kelp forest) at a semi-exposed site off Hoxa Head, on the north-west of South Ronaldsay, the greatest number seen during one dive (Dipper 1984). A total of 35 species have been recorded from the beach at Widewall Bay, South Ronaldsay, but population densities are generally low. Unusually, the greatest densities of individuals occur high up on the shore; the low shore supports beds of eelgrass (Atkins *et al*. 1985). South and west-facing shores of the island are very exposed and are dominated by a barnacle and mussel community (Baxter *et al*. 1985). Within Scapa Flow there are beds of horse mussels, with an associated faunal community featuring barnacles, small hydroids, keel worms *Pomatoceros triqueter* and the ascidians *Ciona intestinalis*, *Dendrodoa grossularia*, *Corella parallelogramma*, *Botrylloides leachi* and *Botryllus schlosseri* (Dipper 1984). Several of the sublittoral species were first recorded in Orkney in Dipper (1984). These include the massive form of the yellow boring sponge *Cliona celata*, the jewel anemone *Corynactis viridis*, the Devonshire cup coral *Caryophyllia smithii*, the white anemone *Actinothoë sphyrodeta* and the starfishes *Stichastrella rosea* and *Marthasterias glacialis*. Off Houton Head, the whelks *Buccinum undatum* and *Neptunea antiqua* are common on the gradually-sloping sea bed of fine muddy sand (Dipper 1984). Dense beds of maerl carpet the edges of Clestrain Sound and the sea bed at Cairston Roads, bordering on Hoy Sound (Murray *et al*. in prep.) (Map 4.2.2).

Loch of Stenness is a shallow, brackish-water loch in south-west Mainland, connected to the sea by a narrow entrance at the Bridge of Waithe and to Loch Harray via a sluice gate at Brodgar. It has a distinct salinity gradient (Palmer 1980) and a range of sheltered marine, brackish and freshwater communities and species. The loch is predominantly sedimentary; the lagoon basin floor is soft mud and the shoreline is of muddy sediments with sand and gravel grading into pebbles, cobbles and boulders. The soft sublittoral mud supports large numbers of burrowing worms and mats of green algae, with the bivalve *Mya arenaria* and the snails *Littorina rudis* and *L. littorea* on the mud surface. Littoral boulders are dominated by filamentous green algae or fucoid algae, the brackish seaweed *Fucus ceranoides* being abundant in places. Submerged boulders in more saline areas of the loch support clumps of mussels, the seaweed *Fucus serratus* and a few species of foliose red and filamentous green algae. Loch of Stenness has been proposed as a Special Area of Conservation under the EC Habitats & Species Directive (see section 7.2.2) on account of its lagoonal interest.

The west-facing coast of Mainland and its sublittoral habitats and communities, especially at Black Rock, Inga Ness, Brough of Bigging and Skipi Geo, are similar to those of western Hoy. Shores are very exposed to wave action and bedrock extends into deep water close inshore. To the west of Neblonga, scoured bedrock steps at 36 m depth support patchy growths of the bryozoan *Flustra foliacea*, the brittlestar *Ophiocomina nigra* and dahlia anemone *Urticina felina* (Murray *et al*. in prep.). Fissured vertical surfaces support the brittlestar *Ophiopholis aculeata*, encrusting bryozoans and keelworms *Pomatoceros triqueter*. Caves are a major feature of this section of the coast, supporting communities similar to those found in surge gullies. The outer walls of those around North Gaulton Castle are covered in sheets of the encrusting sponges *Halichondria panicea*, *Esperiopsis fucorum* and *Myxilla incrustans*, together with unusually high numbers of the ascidian *Molgula citrina*. Sponges dominate the middle sections of the caves, with barnacles *Balanus crenatus* and spirorbid worms present in the innermost areas (Murray *et al*. in prep.).

Hoy and Flotta

On the north-east shore of Hoy, the low shore at Bay of Creekland is dominated by polychaetes (Atkins *et al*. 1985).

The neighbouring Bay of Quoys is the most interesting of the fourteen sandy shores surveyed by Atkins *et al*. (1985). The beach is extremely sheltered yet has relatively coarse sediment in the low shore region. Whilst other shores are dominated by the polychaete worms *Pygospio elegans* and *Capitella capitata*, the beach here has large numbers of the polychaetes *Leiochone* (= *Clymenura*) *johnstoni* and *Euclymene* (= *Praxillella*) *affinis*, together with a diverse assemblage of amphipods and the normally subtidal *Polydora* (= *Pseudopolydora*) *antennata*. The Bay of Quoys, Bay of Creekland and Mill Bay all have high species diversity (more than 35 species per site) and high densities of individuals (Atkins *et al*. 1985).

The sea bed in the centre of the southern end of Burra Sound, where shallow tide-swept sand occurs at 11 m depth, is extensively burrowed by the heart urchin *Echinocardium cordatum* and the razor shell *Ensis arcuatus*. Dense beds of the eelgrass occur in the shallower water (Murray *et al*. in prep.). The sea bed off north-east Hoy, at the Nose of the Bring, is semi-exposed and gently sloping, with boulders overlying bedrock, giving way to muddy sand and clean sand (Dipper 1984). Particularly large kelp *Sacchoriza polyschides* plants (over 5 m long) grow on the boulders and scallops *Pecten maximus* on the sediment. Further east, at Greenhead, a steep boulder slope extends from low water to 6 m depth, where there is a muddy plain. Boulders on the north side of the island of Flotta are entirely dominated by the algae *Codium fragile* and *Chorda filum*. However, at the nearby Calf of Cava and off the Nose of Bring off east Hoy, *Sacchoriza polyschides* is the dominant kelp, together with sugar kelp *Laminaria saccharina,* which is found throughout Scapa Flow. Grazing of algae by sea urchins *Echinus esculentus* strips extensive areas of the rock surfaces bare, apart from a covering of encrusting coralline algae. Off Scad Head on east Hoy, below 16 m depth, muddy sand is burrowed by the echiuran worm *Amalosoma eddystonense* (Murray *et al*. in prep.). At depths greater than 20 m, the sea pen *Virgularia mirabilis* occurs alongside *A. eddystonense*, together with the tubeworm *Chaetopterus variopedatus*. At sites where currents are strong, such as the Sound of Hoxa on the south side of Scapa Flow, a rich turf of hydroids and bryozoans occurs with dense growths of the soft coral *Alcyonium digitatum* (Dipper 1984). The clean, coarse sand is characterised by the burrowing sea cucumber *Neopentadactyla mixta* and, in deeper water, the brittlestar *Ophiocomina nigra*. A little further to the south, at Switha, the steeply sloping, stepped bedrock has a kelp *Laminaria hyperborea* forest that extends to 20 m depth and supports dense growths of the soft coral *Alcyonium digitatum* (Dipper 1984). The site is exposed to wave action and strong tidal currents. Maerl is present within Switha Sound (Dipper 1984).

The west coast of Hoy is similar to west-facing coasts on Mainland. The shores are predominantly very exposed bedrock and/or large boulders, backed by sheer cliffs, and are dominated by barnacles with occasional clumps of the brown alga *Fucus distichus* and the red alga *Palmaria palmata* (Murray *et al*. in prep.). The lower shore is characterised by bushy growths of *Corallina officinalis*, encrusting coralline algae, dabberlocks and mussels. Bedrock and boulders continue into the sublittoral, often as steep or vertical cliffs, with caves, crevices, overhangs and gullies. A kelp *Laminaria hyperborea* forest grows to 20 m depth, extending as kelp park to 29 m (Dipper 1984), though dabberlocks also occurs in places. There is a lush understorey of red foliose algal species and heavy epiphytic growths on the kelp stipes. On vertical bedrock, the sponges *Pachymatisma johnstoni* and *Clathrina coriacea*, the soft coral *Alcyonium digitatum* and the colonial ascidian *Botryllus schlosseri* all occur. Ballan wrasse *Labrus bergylta* and lumpsucker *Cyclopterus lumpus* feed amongst the kelp forest (Dipper 1984). In areas of increased current flow, such as Rora Head, there are increased densities of attached species, with dense coverings of the bryozoan *Flustra foliacea* and the soft coral *Alcyonium digitatum* being found to depths of 39 m (Murray *et al*. in prep.). Where there is sediment in these exposed locations it is clean coarse sand, often thrown up into ridges. A number of west-coast sites, including Kame of Hoy and the nearby Bay of the Tongue, have similar sublittoral habitats and communities (Dipper 1984).

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

Far less information is available on benthic habitats and communities from offshore locations, other than that shown on Admiralty charts and British Geological Survey maps. However, surveys have shown that to the east of Orkney sediments increase from coarse to very coarse material between Orkney and Shetland (Basford *et al.* 1990). The echinoids *Cidaris cidaris* and *Echinus acutus,* low densitities of the starfish *Asteria rubens* and the polychaete worm *Hyalinoecia tubicola* were recorded offshore in a benthic survey that used a trawl and headline camera (Dyer *et al.* 1982). In addition, the brittlestars *Ophiura texturata* and *Ophiopholis aculeata* were recorded by a trawl survey to the south-east and north-east of the region respectively, and the echinoid *Spatangus pupureus* offshore to the east (Basford *et al.* 1989). The hermit crab *Pagurus bernhardus* is widespread to the east of Orkney.

4.2.3 Human activities

There has been a long history of making use of seaweed in Orkney. Washed-up stipes of kelp plants (most commonly *Laminaria hyperborea*, known locally as 'tangles'), have been collected from beaches and burnt in pits to make 'kelp'. This product, rich in potash and soda, was used as a fertiliser, in the glass and soap industries and as a source of iodine (Johnston 1985). Small-scale collection of seaweed (mostly *Laminaria* spp. but also knotted wrack *Ascophyllum nodosum*) for the alginate industry continues today, amounting to several hundred tonnes (dry weight) per annum (Bennett & Covey in prep.). Johnston (1985) and the Institute of Offshore Engineering (1986), amongst others, have outlined the potential for revitalising the seaweed industry.

Another natural resource that is in demand is maerl, an unusual calcareous seaweed that can form extensive beds. Crushed maerl is traditionally used as a soil fertilizer and conditioner, although there is now a growing trade for maerl as a filter in the marine aquarium trade and in the treatment of effluents (see section 5.5.3). In 1993 an application was submitted to extract maerl from Rousay Sound. Permission was given in 1996 to extract a limited amount of maerl from Wyre Sound, rather than Rousay Sound, with an ongoing programme to monitor the sustainability of the extraction.

Most commercial fishing in Orkney is undertaken inshore for crustacea, particularly lobster *Homarus gammarus* and crab *Cancer pagurus* (see section 9.1). During the 1980s a new fishery for scallops *Pecten maximus* began. Razor clams *Ensis arcuata* and *E. siliqua*, locally referred to as 'spoots', are traditionally taken by hand on a small scale.

Though Orkney was rather less affected than Shetland by developments associated with the North Sea oil industry in the 1970s, an oil-handling terminal was constructed on the island of Flotta within Scapa Flow. This led to an environmental assessment of the littoral fauna and flora, and of sublittoral benthic sediments and fauna (Jones & Stewart 1974). An independent monitoring programme of Scapa Flow was subsequently set up by the Orkney Marine Biology Unit of Dundee University on behalf of Orkney Islands Council (e.g. Jones *et al*. 1982). In addition, environmental impact assessments were undertaken by consultants (e.g. Cairns & Associates 1973; Cairns & Partners 1975).

4.2.4 Information sources used

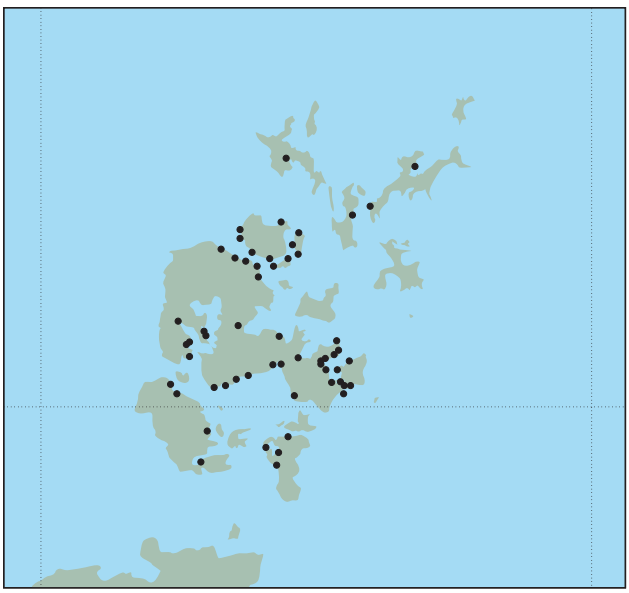
Compared with, say, Shetland, relatively few detailed studies of marine habitats and communities have been undertaken in Orkney. Most of the marine biological studies prior to about 1970 concentrated on listing species present, rather than describing habitats and communities (Bennett & Covey in prep.). Table 4.2.3 shows the numbers of sites in the region with marine benthic habitat and species information held on the JNCC's Marine Nature Conservation Review (MNCR) database; and Maps 4.2.3 and 4.2.4 show, respectively, littoral and near-shore sublittoral surveys recorded on the MNCR database, although the database may not have detailed information for all these sites. The JNCC's MNCR team (and their contractors) use a standard recording methodology for littoral and sublittoral surveys, which includes descriptions of habitats and their associated communities (Hiscock 1996). Survey information from other sources varies considerably in its methodology and coverage.

A symposium on the natural environment of Orkney was held in 1974 (Goodier 1975) and included a number of papers relevant to the marine environment. Ten years later, a symposium on the marine biology of Orkney was held in Edinburgh (Jones 1985). Wilkinson (1975) lists the marine algae that have been recorded in the islands. All records of marine Mollusca for Orkney (from shore surveys and dredging) were brought together by Rendall (1956); the molluscs of Copinsay were recorded by Smith (1973). Johnston (1977) undertook a monitoring programme of the marine environment within Scapa Flow from 1975-1977, linked with the discharge of effluent from the Flotta terminal. Atkins *et al*. (1985) described the biological characteristics of fourteen sediment shores scattered throughout the islands, whilst Baxter *et al*. (1985) assessed long-term changes in rocky shore communities over a period of nine years. Members of the Underwater Conservation Society carried out a number of dives within Scapa Flow and off the west side of Mainland and off north Hoy in 1978 and 1979 (Dipper 1984). Jones *et al*. (1988) undertook a benthic survey of Scapa Flow in 1986 using a grab.

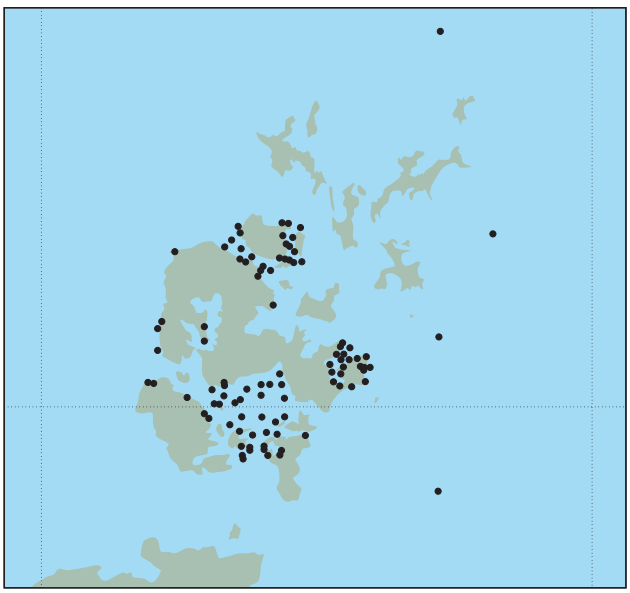
The MNCR team are in the process of carrying out a number of surveys. At present (November 1996), information on littoral and sublittoral habitats and communities is currently being prepared for the following areas: north-west Hoy and south-west Mainland; Hoy Sound and Bring Deeps (Hoy/Mainland); Eynhallow, Wyre and Rousay Sounds (Rousay); Wide Firth & Shapinsay Sound (Shapinsay/Mainland); and Deer Sound (Mainland) (Murray *et al*. in prep.). A remote acoustical survey of Rousay Sound and Wyre Sound using RoxAnn analysis was undertaken by the BioMar team from Newcastle University on behalf of Scottish Natural Heritage (Foster-Smith & Davies 1993), as part of an exercise in mapping maerl beds in the area.

4.2.5 Acknowledgements

The author acknowledges the help of JNCC's Marine Nature



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



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

Table 4.2.3 Numbers of sites with marine benthic habitat and species information held on the MNCR database

Littoral	*Near-shore sublittoral*	*Offshore*	*Total*
45	146	0	187

Note: figures are not comprehensive; additional records may exist in sources that were not consulted. Littoral and sub-littoral records at the same place are counted only once in the total.

Conservation Review team (particularly Tim Hill, David Connor and Eleanor Murray) in compiling and presenting the information given here. The MNCR literature review by Teresa Bennett and Roger Covey (in prep.) has been widely consulted. Thanks are also due to John Orr (Orkney Island Council), Mark Tasker (JNCC), and David Donnan (SNH) for comments on the draft text.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Marine nature conservation issues in Scotland	*SNH, Aquatic Environments Branch, Advisory Services, Edinburgh, tel: 0131 554 9797
Marine nature conservation issues in Orkney	*SNH, Kirkwall, tel: 01856 875302
MNCR database	*MNCR Team, JNCC, Peterborough, tel: 01733 62626
Coastal water quality and surveys	*SEPA Northern Region HQ, Dingwall, tel: 01349 862021
Information on marine biological issues - Scotland	Dr Allan M. Jones, Dept. of Biological Sciences, University of Dundee, Environmental Marine Unit, Millers Wind, Dundee DD1 4HN, tel: 01382 223181
Information on marine biological issues - Orkney	Alex Simpson, Orkney Marine Biology Unit, Harbour Authority Building, Scapa, Orkney KW15 1SD, tel: 01856 876070
Marine biological studies, especially commercial harvesting of kelp	Dept. of Civil and Offshore Engineering, Heriot-Watt University, Riccarton, Edinburgh EH14 4AS, tel: 0131 449 5111
Marine biological studies, especially commercial harvesting of kelp	International Centre for Island Technology, Old Academy, Stromness, Orkney KW16 3AW, tel: 01856 850605

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

4.3 Plankton

M. Edwards & A.W.G. John

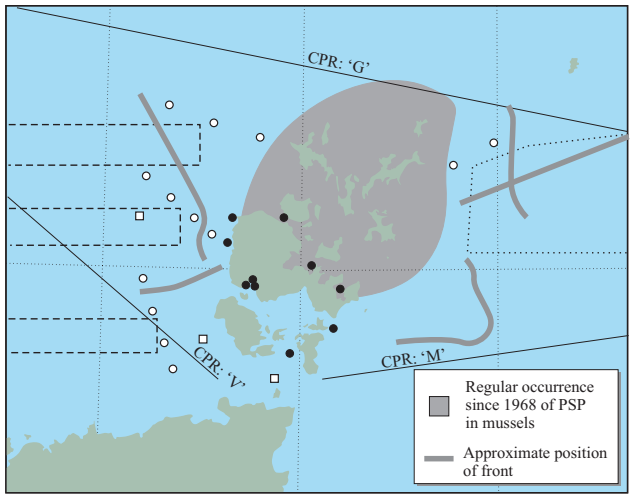
4.3.1 Introduction

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

In Region 2, as elsewhere, the plankton has a fundamental role in the food chain of both benthic (sea-bed) and pelagic (water column) wildlife. For both ecosystems, the availability of food and nutrients, larval survival, maintaining populations, and timing of egg production are highly dependent on the amount of phyto/zooplankton available. Any environmental stress imposed on the plankton will have consequences throughout the food chain and may affect the amount of food available to fish, birds, marine mammals etc. In coastal management, plankton can give early warnings of adverse human impacts (e.g. the effects of eutrophication) and highlight different water masses.

Mean surface temperature and salinity around the Orkney Islands vary (depending on season) between 7-13°C and 34.5-35.1 g/kg, respectively. Northern parts of this region are bounded by the Scottish Coastal/Fair Isle current system, which brings a variable influx of mixed coastal and Atlantic water into the North Sea. This region is marked by persistent offshore fronts and transitional areas, which develop between vertically mixed and stratified waters around the Orkney Islands (Map 4.3.1).

Krause & Martens (1990) sampled parts of this region in spring 1986 and winter 1987, finding a zooplankton biomass in winter of <10 mg C m^{-3} and in spring of between 20-100 mg C m^{-3}. Figure 4.3.1 shows the seasonal cycles of an index of phytoplankton colour (a visual estimate of chlorophyll) and numbers of copepods per sample (approximately 3 m^3 of water filtered) derived from



Map 4.3.1 Locations of surveys and approximate position of fronts.

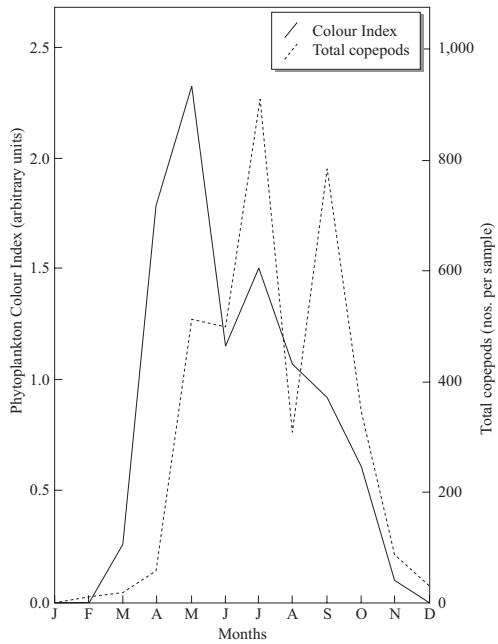


Figure 4.3.1 Average seasonal cycles of an index of phytoplankton colour (a visual estimate of chlorophyll) and of the numbers of copepods per sample (approximately 3 m^3 of water filtered), derived from Continuous Plankton Recorder data for 1958-1992. Source: H. Hunt, SAHFOS.

Continuous Plankton Recorder (CPR) data for 1958-93 for Region 2.

4.3.2 Important locations and species

Although the zooplankton in this region is mainly made up of neritic (coastal water) and intermediate (mixed water) species, the inflow of Atlantic water southwards along the western edge of the North Sea (in late summer/autumn)

may introduce oceanic species such as the herbivorous salp *Salpa fusiformis* (Fraser 1962). Compared with other coastal waters of the North Sea, this region generally contains a higher proportion of intermediate and northern/boreal species (Adams 1987). Evidence from the CPR survey suggests that the phytoplankton found in this region are fairly typical for north British coastal waters. The spring increase of phytoplankton (mainly diatoms) begins in March and peaks between April and May (Figure 4.3.1). The spring bloom is followed by a decline in June to steady levels, until another peak in September. The dinoflagellates (particularly *Ceratium* spp.) show a steady rise through summer (May to August) and then a decline to winter levels by November. Diatoms tend to predominate in inshore mixed waters, while dinoflagellates are often more abundant in stratified offshore areas (particularly in summer/autumn) (Adams 1987). The main component of the zooplankton appear to be small copepods such as *Pseudocalanus* spp., *Acartia clausi, Temora longicornis* and *Oithona similis*. During summer and late autumn *Sagitta elegans* and the ctenophore *Pleurobrachia pileus* appear to be quite common. Other commonly-found zooplankton include small hydromedusae such as *Aglantha digitale*, the amphipod *Parathemisto* spp. and numerous meroplanktonic species. Larger copepods such as *Calanus* spp. are not normally dominant in this area, although in late summer/autumn they may be found in offshore areas, with *Metridia lucens* and euphausiids. 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. Studies by Nellen & Schadt (1992) found that fairly large fluctuations in zooplankton taxa occur in this region, indicating that environmental conditions differ from year to year. However, overall variability in the zooplankton biomass is low, indicating a relatively stable ecosystem.

4.3.3 Important features

High levels of chlorophyll (>150 mg m^{-3}) were recorded in an area east of Orkney, within and adjacent to the Fair Isle current (Dooley 1987). The production in this area is largely dependent on the current strength and the role of frontal features controlling the degree of nutrient supply and water column stability. Dinoflagellates are of particular importance to the coastal manager in this region because a number of toxic blooms have occurred, resulting in Paralytic Shellfish Poisoning (PSP). PSP occurs in shellfish and is attributed to the dinoflagellate *Alexandrium tamarense*, which has occurred regularly since 1968 (Map 4.3.1).

4.3.4 Information sources used

The waters around Orkney have undergone numerous plankton surveys in the past by the Marine Laboratory in Aberdeen. Plankton data on indicator species and the variability of plankton assemblages have been collected since the 1920s. This region has received particular attention, owing to the importance to the herring fishery of plankton (particularly *Calanus finmarchicus*), which constitutes a high percentage of the herring's diet (Bainbridge 1978). Since 1967 the larval herring stock (ichthyoplankton) has been investigated by various European countries; during the early 1980s these data were further analysed to include overall zooplankton abundance and taxonomical composition (Nellen & Schadt 1992). The CPR surveys in this region are important because they contain long-term plankton data, which can be used to assess the effects of environmental variability and climatic changes on the marine biota.

4.3.5 Further sources of information

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Table 4.3.1 Details of surveys

Identification on Map 4.3.1	*Frequency*	*Period*	*Reference*
CPR: 'G', 'M' & 'V' routes	Monthly	Various years, 1948 to present	Warner & Hays 1994
Orkneys (sampled by MLA)	±Monthly	1961-1974	Adams *et al.* 1976
LHD (○)	Occasional	1986	Heath & Rankine 1988
PS (□)	Occasional	1986 & 1987	Krause & Martens 1990
PS (.....)	Occasional	July 1979	Dooley 1987
PS (----)	Occasional	1973	Aiken *et al.* 1977
Orkneys	Weekly	1957-1974	Bainbridge *et al.* 1978
Whole region	Occasional	1967-1989	Nellen & Schadt 1992
PS (●)	Occasional	1973	Wilkinson 1975

Key: CPR = Continuous Plankton Recorder; MLA = Marine Laboratory, Aberdeen; LHD = Larval herring data; PS = Plankton samples.

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Turrell, W.R., Henderson, E.W., Slesser, G., Payne, R., & Adams, R.D. 1992. Seasonal changes in the circulation of the northern North Sea. *Continental Shelf Research, 12*: 257-287.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
CPR survey data	Director, Sir Alister Hardy Foundation for Ocean Science, The Laboratory, Citadel Hill, Plymouth PL1 2PB, tel: 01752 633130
Plankton research	Director, Dunstaffnage Marine Laboratory, PO Box 3, Oban, Argyll PA34 4AD, tel: 01631 562244
Ichthyoplankton	Director, Centre for Environment, Fisheries and Aquaculture Sciences, Pakefield Road, Lowestoft, Suffolk NR33 OHT, tel: 01502 562244
Information on plankton in Scotland	*SNH Maritime Unit, Advisory Services, Edinburgh, tel: 0131 554 9797
Plankton research	*SOAEFD, Marine Laboratory, Aberdeen, tel: 01224 876544
General	Head of Department, Department of Zoology, University of Aberdeen, Tillydrone Avenue, Aberdeen AB24 2TZ, tel: 01224 272858

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

Chapter 5 Important species

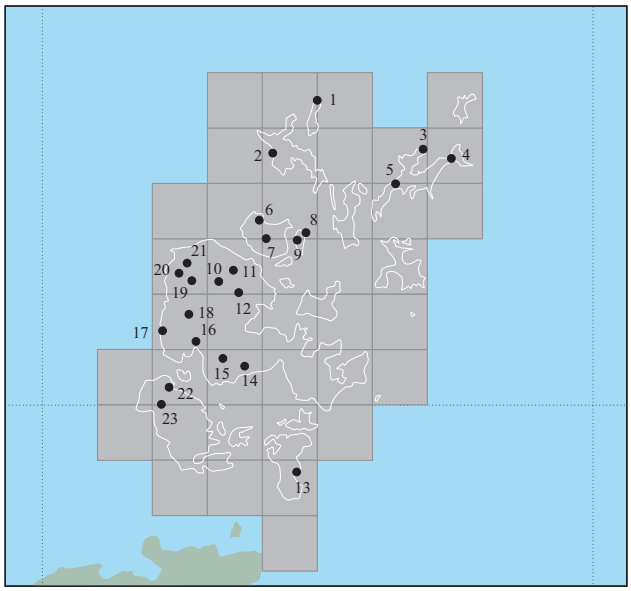
5.1 Terrestrial lower plants

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 Orkney. The geology, exposed position and history of Region 2 means that there is less variety of habitat than in either the western Scottish regions (14, 15 and 16) or in Shetland (Region 1). About 31% of the British bryophyte flora and about 38% of the stonewort flora occur in this area. Figures are not available for other groups.

Most of the region is not of great interest for bryophytes and lichens. Although remote, parts of the region are moderately densely populated; the geology (mainly Old Red Sandstone) gives most of the topography a soft aspect with few outcropping rocks, except on Hoy; the often rich soil means that many areas are under a fairly intensive agricultural regime; and there is very little woodland. The principal lower plant interest of the region probably centres on the stoneworts, which are very well represented in the many freshwater and brackish lochs. Other areas are not entirely without interest, however, and acid rocks, heathlands and mires support some valuable lower plant communities (including some oceanic species), though these are not as rich as in the Western Isles (Region 15).



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

5.1.2 Important locations and species

Table 5.1.1 lists all the sites in the region that are known to be important for lower plants and that have had at least some degree of survey work. Locations are shown on Map 5.1.1. Some sites are large, in which case the grid reference given refers to a reasonably central point. Most of the sites are listed on the basis of their bryophyte and stonewort interest. Some of the sites contain rare and scarce species and qualify for SSSI status on the basis of their lower plant flora (Hodgetts 1992).

Like higher plants, lower plants tend to occur in characteristic assemblages that are found in particular habitats. The extensive coastal hard rock cliffs of the region probably support characteristic lichen assemblages, the species composition of which varies according to geology. However, these have not been surveyed. Similarly, the machair and dunes on Sanday and elsewhere may well be rich in lichens and/or bryophytes, but there is no survey information on these. Coastal (usually cliff-top) grassland and heath with thin turf can frequently be rich in bryophytes, lichens and higher plants, the communities often forming complex mosaics. Unstable areas are important in maintaining bare ground for colonisation by some of the uncommon ephemeral lower plants.

Hoy has extensive and varied areas of moorland, including some calcareous areas, and is unusual in that continental (inland) lichen communities occur in close proximity to oceanic bryophyte communities. In places there is a limited development of the 'mixed hepatic mat' community (Ratcliffe 1968), as on Ward Hill, where the large, oceanic leafy liverwort *Plagiochila carringtonii* has been found. However, in general, the oceanic flora of Orkney is less rich than in western Scotland (Region 16). There is hardly any woodland and little scrub, the only natural woodland remaining being at Berriedale, on Hoy, where rowan, birch, aspen and hazel grow. This can support a limited epiphytic flora of mosses and lichens that are generally common on the west coast of Scotland.

Wet heathland and bogs in Orkney may be rich in lower plants, including oceanic species. The Loch of Isbister and the Loons is the best basin mire development in the region. The Orkney islands are rich in freshwater lochs, and these, where they have escaped the influence of eutrophication and pollution, often contain rich communities of aquatic plants. Stoneworts are particularly characteristic of these communities. Several stoneworts are confined to slightly brackish lochs, such as *Chara baltica*, *C. canescens* and *Tolypella nidifica*, which all occur in Orkney. The Loch of Stenness, on Mainland, is perhaps the most well-known and important site in the region for brackish water stoneworts (see section 5.4).

Table 5.1.1 Important lower plant sites in Orkney

No. on Map 5.1.1	*Site name*	*Grid ref.*	*Protected status*
1	North Hill, Papa Westray	HY5055	SSSI
2	West Westray	HY4246	SSSI
3	Loch of the Riv, Sanday	HY6846	Not protected
4	Northwall, Sanday	HY7444	SSSI
5	Bea Loch, Sanday	HY6540	Not protected
6	Loch of Wasbister, Rousay	HY3933	Not protected
7	Rousay	HY4031	SSSI
8	Loch of Watten, Egilsay	HY4731	Not protected
9	Quarry NE of North Toft, Egilsay	HY4630	Not protected
10	Glims Moss & Durka Dale, Mainland	HY3123	SSSI
11	Mid Hill, Mainland	HY3324	Not protected
12	West Mainland Moorlands	HY3521	SSSI
13	Ward Hill Cliffs, South Ronaldsay	ND4688	SSSI
14	Loch of Kirbister, Mainland	HY3607	Not protected
15	Orphir & Stenness Hills, Mainland	HY3308	SSSI
16	Lochs of Harray & Stenness, Mainland	HY2812	SSSI
17	Stromness Heaths & Coast, Mainland	HY2213	SSSI
18	Mill Dam of Rango, Mainland	HY2618	SSSI
19	Loch of Banks, Mainland	HY2723	SSSI
20	Loch of Isbister & The Loons, Mainland	HY2524	SSSI
21	Loch of Boardhouse, Mainland	HY2625	Not protected
22	South Dam, Hoy	HY2303	Not protected
23	Hoy	HY2201	SSSI

Sources: references listed in section 5.1.5 and JNCC's Red Data Book Database. Key: SSSI = Site of Special Scientific Interest.

The region contains very few threatened species, according to the information currently available, and out of a total of 139 bryophytes, eleven stoneworts and 177 lichens on the British Red Lists, excluding extinct species, only one is present in Orkney (Table 5.1.2). For fungi there is insufficient information for a comprehensive count. In addition, the region contains fourteen out of 375 near threatened and nationally scarce bryophytes (provisional estimate). There are four near threatened and nationally scarce stoneworts in the region, *Chara aspera*, *C. curta*, *C. rudis* and *Tolypella glomerata*. There is currently not enough information to provide even provisional regional lists of near threatened and nationally scarce lichens and fungi. However, a number of nationally scarce lichens are known to occur in the islands, including *Alectoria sarmentosa* subsp. *vexillifera*, *Caloplaca cerinella*, *C. ochracea*, *Catapyrenium cinereum*, *Cladonia fragilissima*, *Lecidea confluens*, *Psorotichia schaereri*, *Schaereria fuscocinerea*, *Strigula taylorii* and *Toninia lobulata* (Hitch 1985; Dalby pers. comm.).

Table 5.1.2 Red Data Book lower plant species in Region 2

Species	*Location/habitat*
Lichen *Peltigera scabrosa*	On acidic soil, Mid Hill, Mainland

Source: JNCC Lower Plants Database

5.1.3 Human activities

Current issues that may have a bearing on the lower plant flora of this region include agricultural development, road construction, fish farming and industrial development. Over-grazing has an effect on the lower plants in Orkney, as it does throughout the highlands and islands of Scotland. Eutrophication of the freshwater lochs through increasing application of fertiliser and manure is certain to affect stonewort communities. The recent survey (Stewart 1995) showed that several of the lochs (e.g. Loch of Swannay) have a substantial growth of filamentous algae, probably owing to agricultural pollution. Other forms of agricultural and industrial pollution can seriously affect lower plants, particularly epiphytes. Oil spillages are a potential threat to coastal lichens. Some sites are SSSIs and therefore nature conservation is taken into account in their management.

5.1.4 Information sources used

Owing to the remoteness of the Orkney islands, and the general perception that they are unlikely to prove very rewarding, survey work has been patchy and incomplete. However, old records by Hooker and others of interesting and rare species seem to indicate that this view of the islands may be unjustified. The computerised database at the Biological Records Centre (BRC), Monks Wood, and the Red Data Book database at JNCC include records collected over decades by expert bryologists as well as important historical records. Some important, or potentially important, coastal lichen sites have been identified in recent surveys (Fletcher 1984; James & Wolseley 1991), but none in Orkney has been comprehensively surveyed. Data for all groups of lower plants are rather poor in the region, with the exception of stoneworts, and there are likely to be further sites in the region that have a rich lower plant flora. For example, Central Sanday SSSI can be expected to support interesting plants on the machair, but no information is available. Recent work by Stewart (1995) has clarified the status of many of the stoneworts of the islands. Data collation for fungi is still at a relatively early stage.

All British Mycological Society foray data are currently being put onto a computer database at the International Mycological Institute under a JNCC contract. Computerised stonewort data are held at BRC and JNCC. More information on freshwater algae may be available from the Freshwater Biological Association.

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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 (general, survey, etc.)	A. Fryday, 110 Eastbourne Road, Darlington, Co. Durham DL1 4ER, tel: 01325 484595
Lichens (woodland and general: British Lichen Society database)	Dr A. Fletcher, Leicestershire Ecology Centre, Holly Hayes, 216 Birstall Road, Birstall, Leicester LE4 4DG, tel: 0116 267 1950
Lichens (Orkney)	Dr D.H. Dalby, 132 Gordon Road, Camberley, Surrey GU15 2JQ, tel: 01276 21230
Fungi (general and sand dune)	M. Rotheroe, British Mycological Society, Fern Cottage, Falcondale, Lampeter, Dyfed SA48 7RX, tel: 01570 422041
Fungi (general)	Dr R. Watling, Royal Botanic Garden, Inverleith Row, Edinburgh EH3 5LR, tel: 0131 552 7171
Fungi (British Mycological Society database)	Dr P. Cannon, International Mycological Institute, Bakeham Lane, Egham, Surrey TW20 9TY, tel: 01784 470111
Bryophytes & lichens (general and epiphytic)	Dr F. Rose, Rotherhurst, 36 St. Mary's Road, Liss, Petersfield, Hampshire, tel: 01730 893478
Bryophytes (BRC database)	*C.D. Preston, Biological Records Centre, ITE, Huntingdon, tel: 01487 773381
Bryophytes (British Bryological Society herbarium)	A.R. Perry, Department of Botany, National Museum of Wales, Cathays Park, Cardiff CF1 3NP, tel: 01222 397951
Bryophytes (general)	D.G. Long, Royal Botanic Garden, Inverleith Row, Edinburgh EH3 5LR, tel: 0131 552 7171
Bryophytes (lowland)	A.B.G. Averis, 2 Traprain Cottages, Traprain, Haddington, East Lothian EH41 4PY, tel: 01620 860029
Bryophytes (upland)	G.P. Rothero, Stronlonag, Glenmassan, Dunoon, Argyll PA23 8RA, tel: 01369 706281
Freshwater algae	Freshwater Biological Association, The Ferry House, Far Sawrey, Ambleside LA22 0LP, tel: 015394 42468
Conservation of lower plants, protected sites - Scotland	*SNH Maritime Unit Advisory Services, Edinburgh tel: 0131 554 9797
Conservation of lower plants, protected sites - Orkney	*SNH Orkney Office, Kirkwall, tel: 01856 875302
Lower plants (species status; Red Data Book Database; site register etc.)	*N.G. Hodgetts, JNCC, Peterborough, tel: 01733 62626

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

5.2 Flowering plants and ferns

V.M. Morgan

5.2.1 Introduction

This section describes the importance of vascular plants (i.e. flowering plants and ferns), particularly species that are rare or scarce in Great Britain. The region is not rich in rare or scarce species (Table 5.2.1) and there are no 'classic' British plant localities such as are found in Shetland (Region 1) or the Inner Hebrides (Region 14). Although agriculture is intensive on most islands, considerable areas of semi-natural habitat remain in undrained areas and along the more than 800 km of coastline (Bullard & Goode 1975).

Table 5.2.1 Number of rare and scarce species in Region 2

	Protected species	*Other Red Data Book species*	*Scarce species*
Region 2	0	2	19

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

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.

The climate is equable considering the northerly latitude, ameliorated by the warm waters of the North Atlantic Drift, and is described by Birse (1971) as 'hyperoceanic'. Although compared with parts of mainland Scotland snow rarely lies long in Orkney and winters are mild, they are extremely windy, with frequent gales of salt-laden winds. The growing season lasts five to six months, with long hours of daylight in midsummer (Berry 1985). Geologically as well as floristically the islands have a strong affinity with adjacent parts of Caithness, with much Old Red Sandstone and smaller areas of granite and gneiss. Shell-rich sand beaches and dunes also occur. There is some fellfield (areas of rock debris) which in the manner of their weathering show affinities with Shetland, although the substrate is different and there are fewer species.

A number of different elements defined by Matthews (1955) are found in the flora. Elements that are well represented include continental northern (for example eared willow *Salix aurita*, long-stalked pondweed *Potamogeton praelongus*, marsh violet *Viola palustris*), northern montane (holy-grass *Hierochloë odorata*, pyramidal bugle *Ajuga pyramidalis*, wintergreen chickweed *Trientalis europaea*), arctic-subarctic (dwarf cornel *Cornus suecica*, oysterplant *Mertensia maritima*, Scots lovage *Ligusticum scoticum*) and arctic-alpine (bearberry *Arctostaphyllos uva-ursi*, trailing azalea *Loiseleuria procumbens*, yellow saxifrage *Saxifraga aizoides*). Unsurprisingly for the latitude, southern elements are less well represented, but some do occur. For example the Mediterranean element includes sea fern-grass *Desmazeria marina*; the continental southern is represented by buck's-horn plantain *Plantago coronopus*; and oceanic elements include southern species such as long-bracted sedge *Carex extensa* and sea pearlwort *Sagina maritima*. The existence of montane vegetation at low altitudes is a characteristic feature of the most exposed northern coasts of Britain and good examples are found in the region. Species that typically are confined to high altitude further south but grow here at or near sea-level include alpine bearberry *Arctostaphyllos alpinus*, alpine meadow-rue *Thalictrum alpinum* and moss campion *Silene acaulis*. The islands are a northern stronghold within Britain of a number of species, including curved sedge *Carex maritima*, limestone bedstraw *Galium sterneri*, flat-stalked and slender-leaved pondweeds *Potamogeton friesii* and *P. filiformis* and oysterplant, whose largest and most important British populations are in Orkney (Stewart 1994).

5.2.2 Important locations and species

Key localities that support important populations of holy-grass, oysterplant or Scottish primrose *Primula scotica*, or important plant assemblages and mosaics of vegetation, are listed in Table 5.2.2 (Map 5.2.1). In addition to these key localities, there are a number of sites with small populations of a single rare species or with species-rich vegetation.

Rare species in the region are listed in Table 5.2.3. There are no protected species, but out of approximately 290 extant species that are likely to be included in the next edition of the rare plants Red Data Book (Wigginton in prep.), two occur in the region. Both species (the eyebright *Euphrasia heslop-harrisonii* and holy-grass) are classified as 'Lower-risk-near threatened' under the IUCN Red List Categories. Of the 254 scarce species (i.e. known from 16 to 100 ten km squares) in Great Britain, nineteen occur in the region.

Probably the most important plant species on the islands is Scottish primrose. It is endemic (confined) to Scotland, where it grows in Orkney, Sutherland and Caithness. Other species endemic to Scotland are the eyebrights *Euphrasia heslop-harrisonii* and the taxonomically difficult *E. marshallii*. Purple ramping-fumitory *Fumaria purpurea*, also present in

Table 5.2.2 Key localities for rare and scarce species

Locality	*Status*	*Species*
West Westray	Part SSSI, part undesignated	Red Data Book species: none Scarce species: curved sedge *Carex maritima*, limestone bedstraw *Galium sterneri*, oysterplant *Mertensia maritima*, Scottish primrose *Primula scotica*
North Papa Westray	Part SSSI, part undesignated	Red Data Book species: none Scarce species: limestone bedstraw, Scottish primrose
East Sanday	Part SSSI, part undesignated	Red Data Book species: none Scarce species: curved sedge, limestone bedstraw, oysterplant
Corn Holm and Copinsay	SSSI	Red Data Book species: none Scarce species: oysterplant
Rousay and Egilsay	Part SSSI, part undesignated	Red Data Book species: holy-grass *Hierochloë odorata* Scarce species: alpine bearberry *Arctostaphyllos alpinus*, curved sedge, the eyebright *Euphrasia foulaensis*, limestone bedstraw, oysterplant, round-leaved wintergreen *Pyrola rotundifolia* subsp. *rotundifolia*, Scottish primrose, shady horsetail *Equisetum pratense*
Swona	Part SSSI, part undesignated	Red Data Book species: the eyebright *Euphrasia heslop-harrisoni* Scarce species: oysterplant
Stromness Heaths and Coasts	SSSI	Red Data Book species: none Scarce species: the eyebright *Euphrasia marshallii*, limestone bedstraw, oysterplant, Scottish primrose
Hoy	Part SSSI, part undesignated	Red Data Book species: none Scarce species: alpine bearberry, curved sedge, mountain avens *Dryas octopetala*, Scottish primrose, small adder's tongue *Ophioglossum azoricum*

Sources: Rare Plants Database; Stewart *et al.* (1994); E.R. Bullard pers. comm.; SSSI citation sheets; BRC database. Key: SSSI - Site of Special Scientific Interest.

Table 5.2.3 Recorded occurrence of rare taxa since 1970, excluding known introductions and extinctions

Species	*Occurrence in total no. of 10 km squares in GB*	*Occurrence in no. of coastal 10 km squares in region*	*Approx. no. of sites in region*	*Key localities*	*Grid ref.*	*Habitat*
Eyebright *Euphrasia heslop-harrisonii*	10	2	4	Herston, Swona	ND49	Short turf on well-drained banks near the sea
Holy-grass *Hierochloë odorata*	16	3	3	Carness, Egilsay Near Swanbister, Mainland	HY30 HY41	Marshes by lochs. Always near sites of Norse churches, hence considered doubtfully native.

Source: JNCC Rare Plants Database; Bullard (1995; pers. comm.).

the region, is endemic to Britain and Ireland. Table 5.2.4 shows the recorded occurrence of scarce taxa since 1970, excluding known introductions and extinctions.

5.2.3 Human activities

Agricultural activities, including conversion to arable, grassland 'improvement' and heather burning, have affected many habitats and reduced the extent of heathland, with consequent decline in populations of Scottish primrose, juniper *Juniperus communis*, stags-horn clubmoss *Lycopodium clavatum* and alpine clubmoss *Diphasiastrum alpinum* (Berry 1985). In contrast to most of the Scottish regions, many of which are affected by over-grazing, there is very little hill-grazing in Orkney, although some of the islands are very heavily grazed. Too little grazing, as for example where cliff-tops are fenced to protect stock from falls, can damage some grassland and heath; where combined with nutrient run-off from adjacent pasture, this can result in the growth of rank tall vegetation comprising common species (E.R. Bullard pers. comm.).

There is a long tradition of muirburn (heather burning) in the islands, but in recent years wet weather during the burning season has prevented significant damage. Some habitats have been affected by sand and peat extraction and roadside verge mowing (E.R. Bullard pers. comm.).

5.2.4 Information sources used

A number of the habitats, species and sites discussed have

Table 5.2.4 Recorded occurrence of scarce species since 1970, excluding known introductions and extinctions

Species	*Occurrence in total no. of 10 km squares in GB*	*Occurrence in no. of coastal 10km squares in region*	*Habitat*
Alpine bearberry *Arctostaphyllos alpinus*	78	3	Dry heath
Alpine meadow-grass *Poa alpina*	44	1	Calcareous rocks
Curved sedge *Carex maritima*	41	13	Wet sandy places
An eyebright *Euphrasia foulaensis*	41	13	Damp, grazed turf and stony places
An eyebright *Euphrasia marshallii*	15	1	Rocks and eroding cliff edges
An eyebright *Euphrasia ostenfeldii*	21	1	Exposed, well drained places
Mountain avens *Dryas octopetala*	74	1	Alkaline rocks
Northern knotgrass *Polygonum boreale*	19	12	Bare ground and beaches
Northern marsh yellow-cress *Rorippa islandica*	17	10	Damp margins of pools and lochs
Oysterplant *Mertensia maritima*	100	16	Exposed beaches
Purple ramping-fumitory *Fumaria purpurea*	43	11	Disturbed ground
Pyramidal bugle *Ajuga pyramidalis*	53	1	Free draining sunny slopes
Round-leaved wintergreen *Pyrola rotundifolia* subsp. *rotundifolia*	42	2	Damp, calcareous places
Scottish primrose *Primula scotica*	31	11	Grassland, heath and rock outcrops
Shady horsetail *Equisetum pratense*	89	1	Sloping sites on silt or sand
Slender-leaved pondweed *Potamogeton filiformis*	88	22	Shallow mesotrophic or eutrophic lochs
Small adder's tongue *Ophioglossum azoricum*	24	8	Well drained maritime turf
Spiral tasselweed *Ruppia cirrhosa*	46	1	Soft sediments in brackish water
Whortle-leaved willow *Salix myrsinites*	50	1	Rock outcrops

Source: JNCC Rare Plants Database; BRC Rare Plants Database; Stewart *et al.* (1994).

been surveyed by Scottish Natural Heritage, including Scottish primrose (Jackson & Reynolds 1985) and areas of maritime heath (Harris 1992). Records of Red Data Book species are held in JNCC's Rare Plants Database. Between 1990 and 1992 members of the Botanical Society of the British Isles (BSBI) collected 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). The BSBI vice-county recorder, E.R. Bullard, keeps plant records, has published a checklist and is working on a full *Flora* for Orkney.

5.2.5 Acknowledgements

Thanks are due to E.R. Bullard, L. McTeague, J. Milne, C. Sydes, M. Wigginton and staff at the Biological Records Centre.

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Stace, C. 1991. *New flora of the British Isles*. Cambridge, Cambridge University Press.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Species in SSSIs and NNRs, other protected areas, data on rare and scarce species, rare plant surveys, licensing and protected species.	*SNH, Maritime Unit Advisory Services, Edinburgh, tel: 0131 554 9797
Species in protected sites - Orkney	*SNH Orkney Office, Kirkwall, tel: 01856 875302
Biological Records Centre (under development)	*Orkney Field Club, c/o SNH, Northern Isles Area, Orkney Office, Kirkwall, tel: 01856 875302
Local BSBI vice-county recorders' records	c/o Dr P. Macpherson, Hon. Secretary, Scotland Committee, Botanical Society of the British Isles, 15 Lubnaig Road, Glasgow G43 2RY

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

The varied range of coastal habitats in Orkney provides niches for many different kinds of invertebrate, including a number of species that are rare or uncommon. Isopods (woodlice), a very ancient group, prefer cool, damp, shady conditions, such as are found in debris and rocks at the tops of beaches, where they feed on decaying matter. Photo: Pat Doody, English Nature.

5.3 Land and freshwater invertebrates

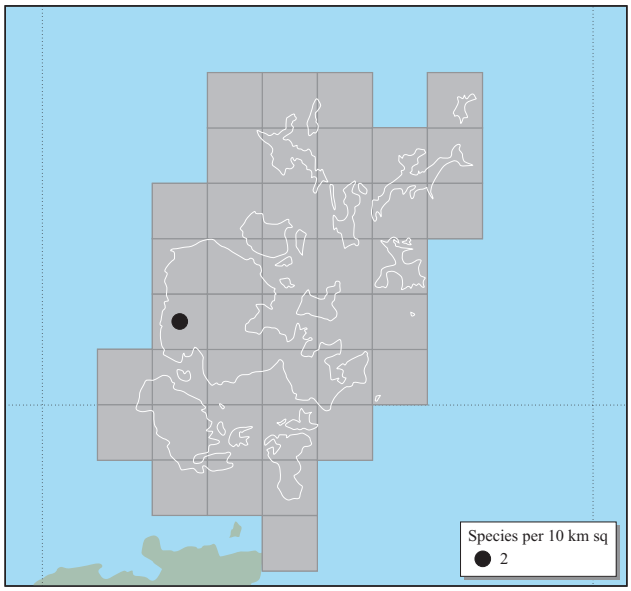
A.P. Foster & M.S. Parsons

5.3.1 Introduction

There are over 28,000 species in the better known groups of invertebrates in Great Britain (Kirby 1992). This section covers most orders (although not all families) of terrestrial and fresh- and brackish-water macro-invertebrates reported from the coastal 10 km squares within the region. Lagoonal species are covered in section 5.4.

Compared with most other areas of the British Isles, the invertebrate fauna of Orkney is poorly documented (with certain exceptions such as the macro-moths (Lepidoptera)). Even so, JNCC's Invertebrate Site Register (ISR) records six nationally rare (Red Data Book (RDB)) and a further 26 nationally scarce species from coastal sites within the region, though only a few of these are strictly coastal in terms of their national distribution. Many more scarce or threatened invertebrates can be predicted to occur within the islands. Subspecies of certain macro-moths are unique to Orkney.

No invertebrates reported from the region are listed on international directives or conventions or the Wildlife & Countryside Act 1981.



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

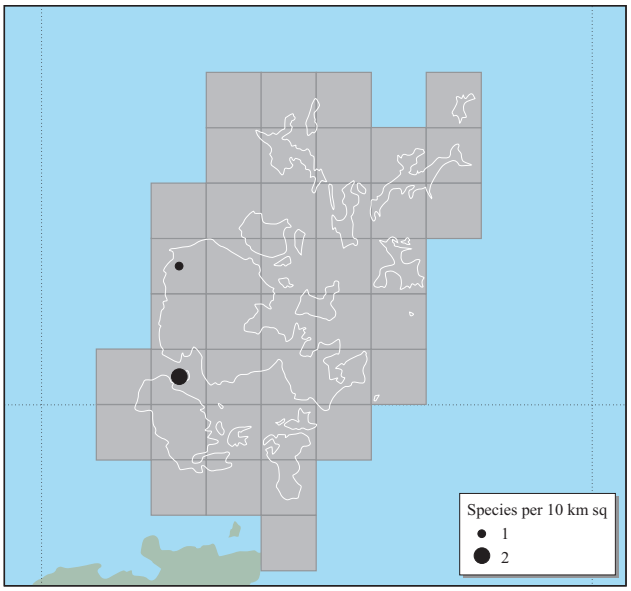
5.3.2 Important locations and species

The RDB and 'notable' species defined as coastal by Kirby (1994a, b) are listed in Table 5.3.1. Map 5.3.1 illustrates the number of RDB species recorded from each 10 km square and Map 5.3.2 shows the recorded distribution in the region of the nationally scarce species. Note that survey effort has not been not consistent throughout the region, so actual occurrence may differ from the recorded distribution, and there may be many other species of significance present. Among the most threatened species recorded are, from Yesnaby, the leaf beetle *Chrysolina crassicornis*, an insect of coastal grasslands that feeds on sea plantain *Plantago maritima* (Owen 1993) and is known only from Orkney, Shetland and western Argyll; and, from Loch Harray (one of

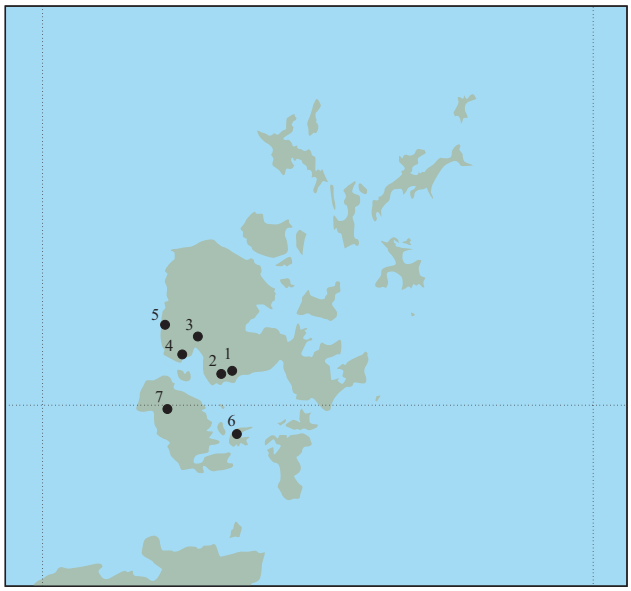
Table 5.3.1 Coastal Red Data Book (RDB) and nationally scarce species recorded in Region 2

Species	*Status*	*Notes*
Ylodes reuteri	RDB 2	A caddis fly associated with brackish waters. Known from marsh sites in East Anglia, the Thames marshes, Spurn and Orkney. Apart from Loch Harray and Spurn, the breeding sites are not known. Loch Harray may eventually become enriched and the construction of a barrage may alter its salinity regime, so this species could disappear from there. Recorded in this region from Lochs of Harray and Stenness SSSI.
Chrysolina crassicornis	pRDB 2	A leaf beetle recorded from cliff tops, dry grassland and sandy hills in maritime situations. Plant-eating, associated with plantains *Plantago* spp. and perhaps toadflaxes *Linaria* spp. Egg-laying onto sea plantain *P. maritima* has been observed. Larvae feed externally on the foodplant during summer. Known only from Scotland; recorded in this region from Yesnaby.
Tropiphorus terricola	Nationally scarce	Brown weevil. Plant-eating, most often associated with dog's mercury *Mercurialis perennis* in woodland. Also recorded from flushed wetlands and dry grassland on chalk and sand dunes. Widespread but local. Recorded in this region from Hoy.
Chestnut-coloured carpet moth *Thera cognata*	Nationally scarce	Moorland, sea-cliffs and limestone hills; the larva feeds on juniper *Juniperus communis*. Local in central and northern Scotland, the Hebrides, Co. Durham, Cumbria and parts of Wales. Recorded in this region from Hoy.
Aphrosylus raptor	Nationally scarce	A coastal fly. The larvae are carnivorous and have been recorded from the littoral zone. Pupae form a cocoon. Adults are found close to the shore; male feelers are silvered on one face and give the appearance of tiny signal lamps as they run across wet rocks. Recorded in this region from Birsay.

Source: JNCC (after Kirby 1994a, b). Key: Red Data Book categories: RDB2 = vulnerable; pRDB 2 = proposed species as categorised in e.g. Hyman & Parsons (1994); Nationally scarce: = notable (see e.g. Parsons 1993). For further description of RDB categories, see Shirt (1987) and Bratton (1991).



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.



Map 5.3.3 Sites known to be of importance for the conservation of invertebrates in Orkney.

Table 5.3.2 Sites known to be of importance for the conservation of invertebrates in Orkney

Site no. on Map 5.3.3	*Site*	*Grid ref.*	*Conservation status*
1	Orphir & Stenness Hills	HY3305	SSSI
2	Hill of Dale	HY3205	
3	Lochs of Harray and Stenness	HY2812	SSSI
4	Stromness	HY2509	
5	Stromness Heaths and Coast (includes Yesnaby)	HY2215	SSSI
6	Burray Sandhills	ND4897	
7	Hoy SSSI (includes Berrie Dale)	HY2001	SSSI

Key: SSSI = Site of Special Scientific Interest

only two confirmed British localities were the species is known to breed), the caddis fly *Ylodes reuteri*, the larvae of which are aquatic and require slightly brackish water.

Three moths have subspecies unique to Orkney: the juniper carpet *Thera juniperata orcadensis*, which is described from, and is apparently unique to, Hoy; the netted pug moth *Eupithecia venosata ochraceae*; and the ingrailed clay *Diarsia mendica orkneyensis*. The weevil *Apion ryei* (which may only be a form of a widespread species), a herbivore feeding on red clover *Trifolium pratense*, is currently unknown outside of the British Isles, where it is restricted to Orkney and the Outer Hebrides (Region 15).

The ISR has records from over 40 sites within the region, although a few of these are subsites of much larger statutory nature conservation areas. Nationally rare and nationally scarce species have been recorded at many of the ISR sites. Table 5.3.2 lists those sites currently considered to be of importance for the conservation of invertebrates (Map 5.3.3). Because of the low level of recording within the region many other sites of significance, as yet undetected, may be present. Site selection was based on the range and/or scarcity of species present, the species habitat associations, the amount of available habitat and level of recording. Some of these sites are of SSSI status and other currently under-recorded sites may also warrant designation. Many other localities in the region have the potential to be of significant interest for coastal invertebrate communities, but the current lack of data prohibits their inclusion here.

Boggy habitats, which are widespread in coastal districts within the region, accommodate a number of scarce or threatened species. Examples include, from the Stromness area, the leaf beetle *Hydrothassa hannoveriana*, which feeds on marsh marigold *Caltha palustris* but favours plants growing in boggy situations with plenty of moss; and, from a blanket bog within Hoy SSSI, the cranefly *Tipula limbata*, which probably has soil-dwelling larvae. The large heath butterfly *Coenonympha tullia*, which has a very localised distribution in Great Britain, is also known from the blanket bogs on the islands. Within these areas, open water habitats are also of significance and contain species such as the scarce water beetles *Coelambus novemlineatus* and *Potamonectes griseostriatus*. Furthermore, nationally scarce species that feed on dwarf shrubs on moorland areas are recorded from the region. These include a good representation of the larger moths such as the Manchester treble-bar *Carsia sororiata*, whose larvae feed on bilberry *Vaccinium myrtillus*; and the northern dart *Xestia alpicola*, whose larvae feed on crowberry *Empetrum nigrum*. Beaches of shell sand or pebbles provide habitat for the scarce fly *Rhamphomyia morio*, a predator of other small invertebrates, which has been recorded from a number of localities. Species of note recorded from machair and sandhill habitats within the region include the locally distributed dark green fritillary butterfly *Argynnis aglaja*, from Burray sandhills, the archer's dart moth *Agrotis vestigialis*, and one of the few British records for the sawfly *Nematus stichai*.

5.3.3 Human activities

The main threats to invertebrate communities include inappropriate management of sites and direct habitat loss or degradation. Appropriate management of sites may be vital in maintaining their invertebrate interest. Most invertebrates have life cycles lasting for one year or less and require specific conditions in which to complete development. This, compounded by the fact that many of the rarest species have poor powers of dispersal, and are thus unable to colonise suitable habitat from afar, makes it vital that suitable breeding conditions are retained at sites year after year. Even subtle changes in management, for example shifts in grazing pressure, can have an influence on the survival of invertebrates. Species such as the caddis fly *Ylodes reuteri* may be threatened by the nutrient enrichment of Loch Harray, or a change in the salinity regime through the construction of a barrage (Wallace 1991). Drainage of boggy habitats probably represents one of the major threats to invertebrate communities in the coastal areas of this region. Sand extraction, for example at Bu of Burray, threatens prime habitat for the dark green fritillary and other locally important species that are at the edge of their range. The fundamental principles of managing coastal habitats for invertebrates are covered by Kirby (1992).

5.3.4 Information sources used

This section has been prepared largely from data held on the Invertebrate Site Register (ISR), a computerised database that, although not comprehensive, includes data from a variety of sources including published literature, national recording schemes and individual specialists.

The level of recording around the region varies considerably, with only a few areas having been studied in any detail. Even so, RDB and nationally scarce species are reported. Assemblages of species associated with coastal grasslands and boggy habitats are well represented, though the level of recording within species groups varies considerably. Most of the better known invertebrate groups have been recorded in Orkney, though information on most is sparse. The moths and butterflies and beetles are probably among the best studied groups; publications such as Lorimer (1983) cover the butterflies and moths, and Balfour-Browne (1948) covers the water beetles, reflecting the attention given to these groups. Other taxa in the ISR data set include flies and sawflies. Smith & Smith (1983) provide an entomological bibliography for Orkney.

5.3.5 Acknowledgements

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

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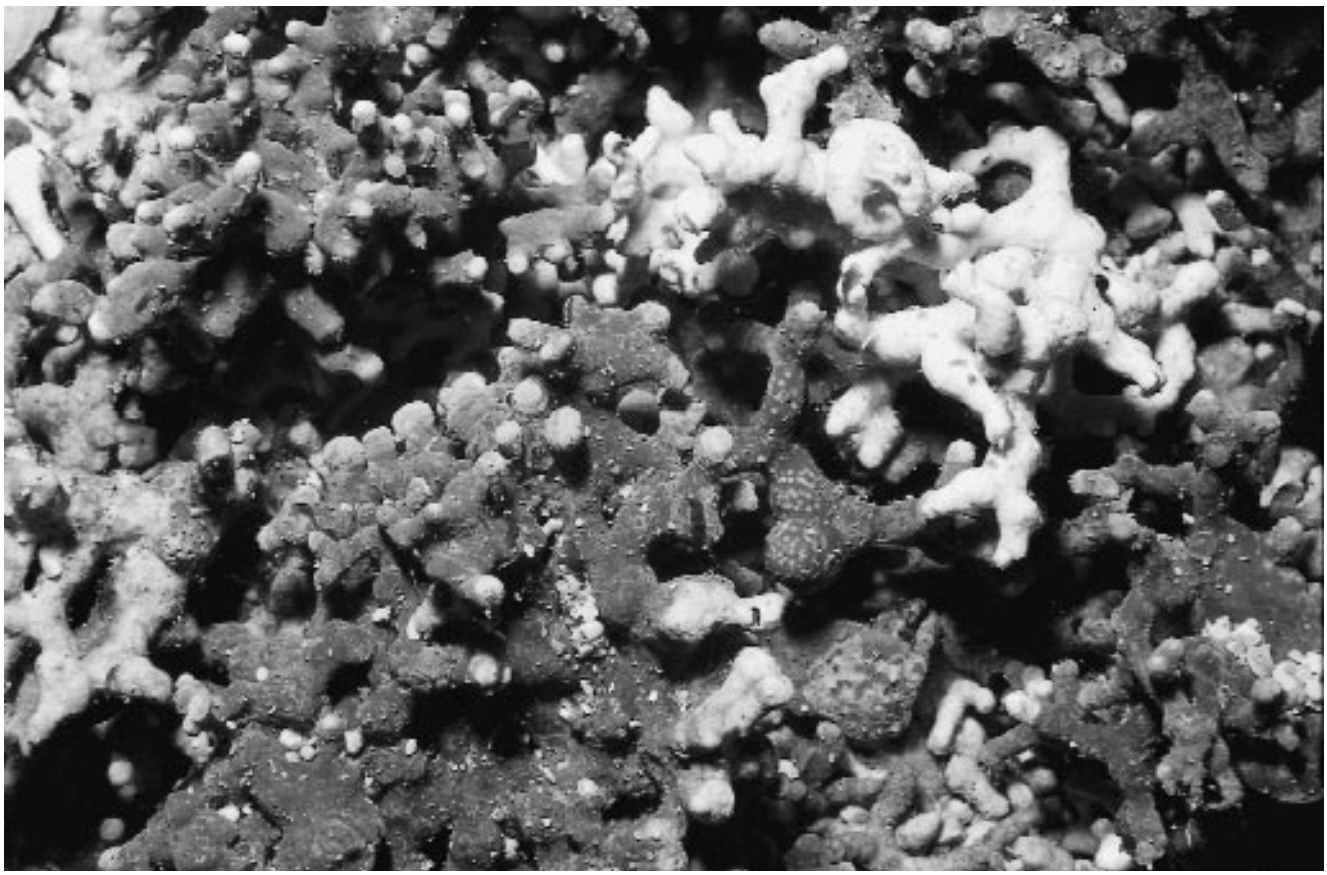
Thomson, G. 1980. *The butterflies of Scotland. A natural history*. London, Croom Helm.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Occurrence of invertebrates in Britain and Ireland	*Biological Records Centre, ITE Monks Wood, tel: 01487 773381
Management of sites for invertebrate interest	*Invertebrate zoologist, SNH, Advisory Services, Edinburgh, tel: 0131 554 9797
Invertebrate Site Register (ISR): computerised inventory of sites of signficance to invertebrate conservation; contains records of local, scarce and threatened species of all groups of non-marine invertebrates	*Invertebrate Site Register, JNCC, Peterborough, tel: 01733 62626
Literature-based entomological records	Scottish Insect Records Index, Royal Museum of Scotland, Chambers Street, Edinburgh EH1 1JF, tel: 0131 225 7534

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



The sea bed of Wyre Sound is covered in dense pink maerl (an unusual group of coraline algae) and dead maerl gravel. Living maerl (primarily *Phymatolithon calcareum* – pictured) occurs here at depths ranging from 5-20 m, often where the current is strongest. Occasionally, the maerl is piled into waves by the current. Photo: Marine Nature Conservation Review, JNCC.

5.4 Rare sea-bed species

J. Plaza

5.4.1 Introduction

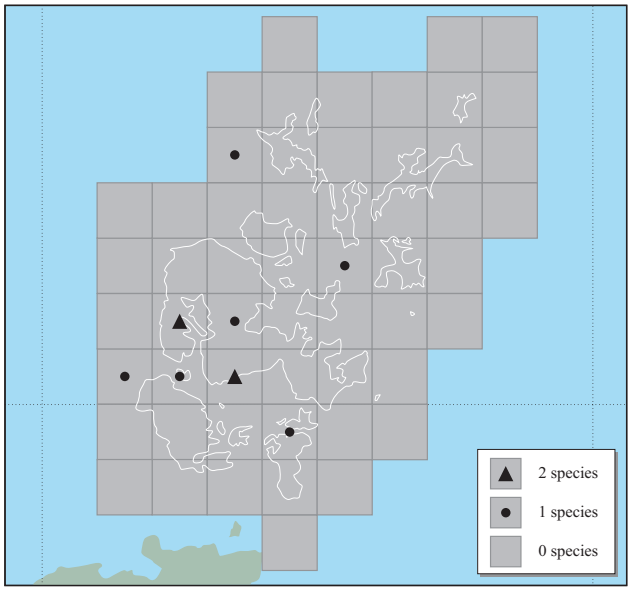
This section considers rare and scarce marine benthic (sea-bed) species, excluding fish. 'Nationally rare' marine benthic species in this section are those that occur in eight or fewer of the 1,546 10 km by 10 km squares (of the Ordnance Survey national grid) that contain sea within the three-mile territorial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

The development of the current criteria and the choice of study area for rarity assessment in the marine benthos of Great Britain are discussed in detail by Sanderson (1996, 1997) and are analogous to the criteria and methodologies used for other groups of organisms in British Red Data Books (e.g. Bratton 1991) and by the International Union for Conservation of Nature and Natural Resources (IUCN 1995). Species considered in this chapter are those that are conspicuous and readily identifiable in field surveys by the Marine Nature Conservation Review (MNCR) or using similar survey techniques, or for which taxonomic experts consider that sufficient data exist on a national basis to warrant their inclusion. Species that are likely to be grossly under-recorded or overlooked on a national scale have been avoided in the present work.

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

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

Three nationally rare and five nationally scarce marine benthic species have been recorded from Orkney. These species appear to be concentrated around Scapa Flow and the brackish water bodies of Mainland, areas which have been relatively well studied compared with the rest of the archipelago. Of the eight rare and scarce species recorded in Orkney none is currently protected under the Wildlife & Countryside Act 1981.



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

5.4.2 Important locations and species

Table 5.4.1 lists the rare and scarce marine benthic species that have been recorded in Orkney, together with their known areas of occurrence and other key information. Map 5.4.1 summarises their current known occurrence. As survey effort in this region has not been uniform (see Maps 4.2.3 and 4.2.4), assertions made as to the distribution of rare and scarce species in Orkney are somewhat artificial and should be regarded with caution.

Of the eight species in Table 5.4.1, two (the lagoon snail *Hydrobia neglecta* and the bird's nest stonewort *Tolypella nidifica*) live in brackish waters, and have been found on Mainland. These are examples of species that are rare or scarce by virtue of their dependence on habitats that are themselves uncommon, in this case coastal lagoons. Coastal lagoons are susceptible to both natural and anthropogenic changes and constitute a 'priority habitat type' under Annex 1 of the EC Habitats & Species Directive.

None of the species in Table 5.4.1 is known to be a common deep-water species, and so it is unlikely that any appear rare simply because their distribution barely extends into the shallower near-shore area that is the focus of this study. Some of them will, however, occur to some extent in the waters of Great Britain outside the scope of this report.

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

Species	*Type of organism*	*Area(s) of occurrence*	*Habitat/ associations*	*Comments*	*Useful reference*
*Sycandra utriculus**	A sponge	Churchill Causeway (Scapa Flow)	Hangs vertically from point of attachment; possibly a sheltered area specialist.	Thought to be a northern species. The only two recent records for the British Isles are from Orkney. Had previously been recorded from Shetland (Region 1) and the Faroes.	Ackers *et al.* (1992)
Amalosoma eddystonense	An echiuran worm	Hoy Sound	Buried quite deep in sublittoral muddy gravels.	Difficult to sample, but still probably scarce.	Hayward & Ryland (1990)
*Leptochiton scabridus**	A chiton	Rousay Sound	On stones in coarse sand. Recently from maerl bed.	Thought to be southern but recent record from maerl may indicate that it occurs more widely (Baxter pers. comm.).	Jones & Baxter (1987)
Hydrobia neglecta	Lagoon snail	Oyce of Isbister, The Ouse (Mainland)	In hyposaline lagoons, salinity usually above 10 g/kg NaCl. Found with the algae *Enteromorpha* spp. and seagrasses.	Only recently distinguished from other *Hydrobia* spp. so may be under-recorded.	Cherril & James (1985)
Atrina fragilis	Fan mussel	Scapa Flow	A large bivalve which protrudes from mud, sand and gravel. Shallow subtidal to considerable depths. Sometimes gregarious.	Widely distributed in GB but rarely encountered. North Scotland to Iberian Peninsula. May have declined owing to sea-bed disturbance and collection.	Tebble (1976); Woodward (1985)
Cucumaria frondosa	A sea-cucumber	Hoy Sound	In subtidal areas of mixed rock and sediment.	A northern species occurring in Shetland (Region 1) and Orkney, with possible old records as far south as Clyde. Range may have retracted northwards this century.	Picton (1993)
Fucus distichus (as *Fucus distichus anceps*)	A brown seaweed	North-west Hoy	Inhabits the upper part of very exposed shores.	Northern species that has undergone taxonomic reassessment, and exact distribution is therefore unclear.	Rice & Chapman (1985)
*Tolypella nidifica**	Bird's nest stonewort	Loch of Stenness	In shallow brackish water ranging from 2-18 g/kg NaCl. Grows on sandy substrates to a depth of 10 m.	Most frequent in the Baltic Sea, but also found around the North Sea.	Stewart & Church (1992)

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

5.4.3 Information sources used

An important starting point for the collection of information and literature on the distribution of rare and scarce species has been the MNCR database (McDonald & Mills 1996), which contains data on species present for more than 10,500 sites around Britain. The bulk of the data reproduced here have been confirmed by critical appraisal of the available scientific literature and through liaison with many eminent marine biologists and experts in taxonomic fields. It has not been possible in this section to list all the available literature on which this analysis has been based, but the information reviews and recent papers listed in sections 5.4.5 and 4.2.6 and in Bennet & Covey (in prep.) should allow access to the majority of the available information.

Prior to the 1970s, the majority of published scientific

literature on Orkney had arisen as a result of academic research by universities and amateur naturalists and consisted largely of species lists, often focusing on seaweeds or molluscs. Compared with Shetland the amount of effort expended and information collected was, and remains, modest. The development of the North Sea oil fields and siting of an oil terminal at Flotta, in Scapa Flow, led to the creation of the Orkney Marine Biological Unit, which conducted biological research focusing mainly on Scapa Flow until 1991 (Simpson pers. comm.). Conservation agencies, particularly the Nature Conservancy Council and two of its successors, the JNCC and Scottish Natural Heritage, have played an increasing role in exploring the habitats, fauna and flora present in Orkney in recent years (e.g. Dipper 1984). In this context recent surveys undertaken as part of the Marine Nature Conservation Review (Murray *et al.* in prep.) have been particularly useful as they put the focus for the first time on subtidal areas outside Scapa Flow, providing a much broader level of knowledge for Orkney's marine habitats and species.

Perhaps as a result of the relatively low number of studies undertaken in Orkney in the past, no old (pre-1965) records of species presently considered nationally rare or scarce using the present criteria have been found during the course of this study, except for the alga *Fucus evanescens* (as *Fucus distichus edentatus, sensu* Powell) and an additional record for the fan mussel *Atrina fragilis*.

MNCR survey work uses a consistent methodology to record conspicuous species (Connor & Hiscock 1996). Not all the data available from surveys in this region are as broad in scope as those from MNCR surveys and they may not include less common species or those less familiar to a specialist worker. The MNCR of Great Britain is at present incomplete but nevertheless has already substantially increased the quality and evenness of distribution of the available data. Combined with other surveys, completion of the MNCR will almost certainly expand our knowledge of the 'nationally rare' and 'scarce' species in Orkney. Consequently, the nationally rare and scarce status of the organisms presented here may require re-evaluation and in future species may be added to the list for this region. Populations of species with short life histories, such as ephemeral algae and sea slugs, may require more regular re-evaluation of their occurrence than others.

5.4.4 Acknowledgements

The expert advice of a large number of people has been indispensable in undertaking this regional analysis. The author would like to thank all of these, in particular Dr W.G. Sanderson and other members of the Marine Nature Conservation Review team. The following kindly read and commented on drafts of this section: D. Connor, Dr D. Donnan, members of Scottish Natural Heritage's Aquatic Environments team, N. Grist, Dr K. Hiscock, Dr A.M. Jones, Dr J.D. Mckenzie, Mr A. Skene and Ms A. Skene; their assistance was much appreciated. Access to the MNCR Database at the Joint Nature Conservation Committee, the NIBESRC Database at the Ulster Museum and the ERICA database run by the Cornish Biological Records Unit has been invaluable for the overall analysis.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Lagoons and lagoon-type habitats	Dr R.S.K. Barnes, Department of Zoology, Downing Street, Cambridge CB2 3EJ, tel: 01223 336606
Sponges	B.E. Picton, Ulster Museum Botanic Gardens, Belfast BT9 5AB, tel: 01232 383146
Amphipods	Prof. P.G. Moore, University Marine Biological Station, Millport, Isle of Cumbrae KA28 0EG, tel: 01475 350581
Crabs	P.F. Clark, Department of Zoology, Natural History Museum, Cromwell Road, London SW7 5BD, tel: 0171 938 9123
Molluscs	Dr S. Smith, Woodleigh, Townhead, Hayton, Carlisle, Cumbria CA4 9HJ
Echinoderms	Dr J.D. Mackenzie, Dunstaffnage Marine Science Laboratory, Scottish Association for Marine Science, PO Box 3, Oban, Argyll PA34 4AD
Brown seaweeds	Dr R.L. Fletcher, University of Portsmouth, Marine Laboratory, Ferry Road, Hayling Island, Hants. PO11 0DG, tel: 01705 876 543
Stoneworts	Dr N. Stewart, Kingfishers, Kingfisher House, 16 Stour Court, Sandwich, Kent CT13 9FY, tel: 01304 613382

5.5 Exploited sea-bed species

C.F. Robson

5.5.1 Introduction

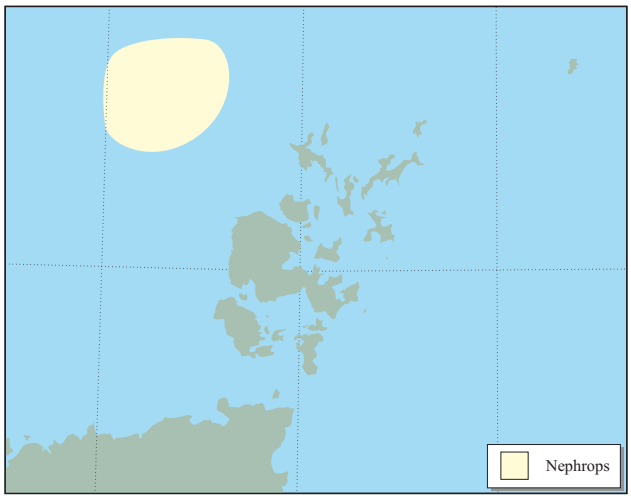
This section describes the distribution of large populations of species that live on, near, or in the bottom sediments of the sea bed (collectively called 'the benthos') and that are routinely exploited, mainly for human food. The exploitation itself is described in sections 9.1 and 9.2. Many of these species also provide an essential food source for other species, such as fish and birds, for example seabirds, waders and wildfowl. Most of the species discussed have planktonic larvae; the dispersal of planktonic larvae and the interrelation between populations of the same species can only be inferred from studies on movements of water masses. Their distributions are determined by factors such as water temperature (see section 2.3) and available habitat/substrate type (see also section 4.2). The species described may also be found elsewhere in the region, but in smaller numbers. All species apart from *Nephrops* are referred to by their common names in the text. The scientific names of the species are given in Table 5.5.1.

Orkney's waters hold exploitable quantities of lobster, edible crab, velvet crab, squat lobster, *Nephrops*, cockles, mussels, scallops and queen scallops.

5.5.2 Important locations and species

Crustacea

Lobster, edible crab and velvet crab are distributed inshore throughout Orkney's waters wherever there is suitable rocky habitat. Edible crabs are more often found on softer sediments - ranging from sand/gravel to rock - than lobsters. Juveniles tend to be found inshore and adults further offshore (Rees & Dare 1993). Crawfish are a westerly species and although found in the region they are less common than lobster or crab. Squat lobsters are present, being commoner on coarser substrates. The broad-scale distribution of *Nephrops* north-west of Orkney is shown on Map 5.5.1. The distribution of *Nephrops* is determined by its preference for a sea bed of mud and muddy sand, into which it burrows; in this region there are populations in the deeper waters north-west of Mainland.



Map 5.5.1 Distribution of *Nephrops*. © SOAEFD.

Table 5.5.1 Species names

Common name	*Scientific name*
Lobster	*Homarus gammarus*
Edible or brown crab	*Cancer pagurus*
Velvet crab	*Necora puber*
Squat lobster	*Munida rugosa*
Crawfish, spiny lobster	*Palinurus elephas*
Cockle	*Cerastoderma edule*
Mussel	*Mytilus edulis*
Native oyster	*Ostrea edulis*
Periwinkle	*Littorina littorea*
Scallop	*Pecten maximus*
Queen scallop	*Aequipecten opercularis*
Whelk	*Buccinum undatum* & *Neptunea antiqua*
Razor shell	*Ensis* spp.
Cephalopods (octopus and squid)	*Eledone cirrhosa* & *Loligo forbesii*
Lugworm	*Arenicola marina*
Ragworm/king ragworm	*Neanthes virens* & *Hediste diversicolor*
Algae, for example knotted wrack & kelp	*Ascophyllum nodosum* & *Laminaria* spp.
Maerl	*Lithothamnion coralloides* & *Phymatolithon calcareum*

Molluscs

Cockles are found in the intertidal mud and sandflats of sheltered sites in this region, such as at Mill Sands and St Peter's Pool in Deer Sound on the eastern tip of Mainland (Atkins *et al*. 1985). Individual cockles from this location are reported to grow extremely large (up to 76 mm long) compared with individuals from other populations, such as on the west coast of Scotland (Regions 14 and 16) (McMillan 1971). This appears to be the result of an unusual combination of rapid growth rates and extreme longevity (Atkins *et al*. 1985). Mussels are found from the mid shore to the subtidal zone in water of normal or variable salinity and in areas exposed to water currents. Mussels are found around the coast of Orkney, in sea lochs and in shallow brackish-water lochs, such as the Loch of Stenness, near Stromness. On exposed rocky shores mussels are generally small, whereas larger (and thus more exploitable) mussels are confined mainly to sheltered inlets such as sea lochs. 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. Periwinkles are found in abundance on rocky shorelines throughout the region, wherever suitable habitat is present. The native oyster does not occur in exploitable quantities in the region.

Scallops and queen scallops live on sandy/gravelly areas of sea bed. Important populations of scallops and

queen scallops are present in many areas of the region; however, queen scallops are not as widely distributed as scallops, being located in exploitable quantities only in Scapa Flow. The broad-scale distributions of scallops and queen scallops around Orkney are shown in Maps 5.5.2 and 5.5.3 respectively. Other potentially exploitable burrowing bivalve molluscs are present at various sites (McKay 1992), for example razor shells, which occur in inshore areas where the sea bed is clean sand. Whelks are widely distributed. Concentrations of squid occur seasonally in the region and octopus are also present.

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 occur elsewhere in a wide range of sediment types from almost pure mud to clean sand (Davidson *et al.* 1991).

Others

Seaweeds such as the knotted wrack and kelp are common on the sheltered shores of Orkney, especially in sea lochs (Maggs 1986). Maerl is a collective name given to various species of calcareous red seaweeds that live unattached to the substratum in sheltered subtidal areas. The two most common maerl species, *Lithothamnium coralloides* and *Phymatolithon calcareum*, are both listed on Annex Vb of the EC Habitats & Species Directive (see section 5.4). Live maerl and maerl gravel are widely distributed around Orkney (see Map 4.2.2). For example, maerl is present within Switha Sound (Dipper 1984) and dense beds have also been recorded from the edges of Clestrain Sound and at Cairston Roads, bordering on Hoy Sound (Murray *et al.* in prep.). The sea bed in Wyre Sound is composed of dense maerl and maerl gravel, and areas of maerl are also present in Rousay Sound (Foster-Smith & Davies 1993). Living maerl (primarily *Phymatolithon calcareum*) occurs at depths between 5-20 m in these areas, often where there are strong currents. Commonly, the maerl covers about 50% of the sediment surface, but this rises to 90-100% in small areas of strong currents (such as north-west of Rousay Sound).

5.5.3 Human activities

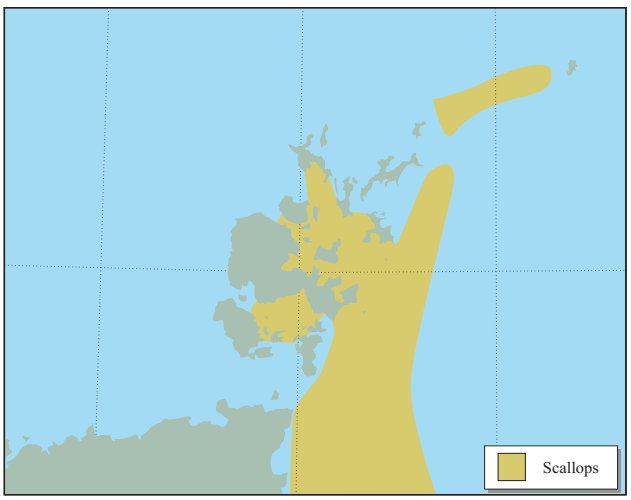
The exploitation by fisheries of the species covered in this section is described in detail in section 9.1, and by mariculture in section 9.2. The major issues relating to the exploited sea-bed species in this region are the state of stocks in relation to the levels of exploitation, possible effects of harvesting on non-target species and competition of fisheries with other predators such as birds.

Nephrops is considered to be a 'pressure stock', which means that it is perceived to be over-exploited (Anon. 1995). It is subject to catch quota management by the setting of an annual Total Allowable Catch (TAC), which limits landings (see section 9.1.3). The TAC for *Nephrops* effective in Region 2 covers ICES Division IVa (Northern North Sea).

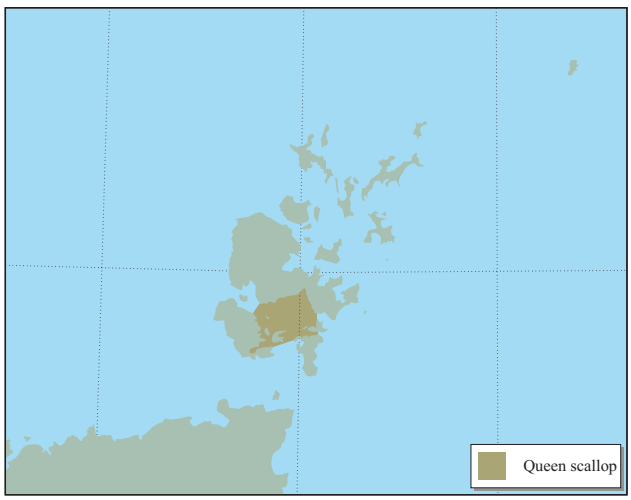
There is a seasonal closure on fishing for crustacea made under the Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 1989. This was issued under the Inshore Fishing (Scotland) Act 1984 and is applicable in Scapa Flow; it bans all fishing for crustacea from 1 June to 15 September in order to restrict the high level of fishing intensity and to conserve stocks (Table 9.1.5; Map 9.1.2). Lobster, edible and velvet crabs, *Nephrops* and scallops are also subject to minimum landing sizes in Orkney (see also section 9.1.3). SOAEFD conducts triennial reviews of inshore fishing legislation under the Inshore Fishing (Scotland) Act 1984. The most recent review was completed in 1996, when the seasonal ban in Scapa Flow was extended from fishing for lobster to cover fishing for all species of crustacea.

Scallop fishing in Scotland is currently 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 whether the rate of exploitation of the fisheries in the east and north-east of Scotland was sustainable. A weekend ban on fishing for scallops from May until September has been proposed in all inshore waters. The possible effects on the benthos, feeding birds and shellfish stocks of harvesting shellfish species are discussed in some of the publications listed in section 5.5.6 B.

Bait collection is not an intensive activity in the region (see section 9.1.2). Bait collection, especially the digging of polychaetes, can have major localised effects on intertidal habitats and communities and can also cause disturbance to



Map 5.5.2 Distribution of scallops. © SOAEFD.



Map 5.5.3 Distribution of queen scallops. © SOAEFD.

birds when they are concentrated in estuaries and embayments (see sections 5.11.3 and 5.12.3 and publications listed in section 5.5.6 B).

Stranded kelp plants were traditionally collected from beaches and burnt in pits to make a product locally known as 'kelp'. This product, which is rich in potash and soda, was used for agricultural purposes such as fertilising crofts, as animal feed, in the glass and soap industries and as a source of iodine (Johnston 1985). The small-scale collection of stranded knotted wrack and kelp for the alginate industry continues today, amounting to several hundred tonnes (dry weight) collected per year (Bennett & Covey in prep.). Johnston (1985) and Institute of Offshore Engineering (1986) have studied the potential of seaweed harvesting in Orkney and outlined the potential for revitalising this industry. The impact of kelp harvesting is detailed in Wilkinson (1995).

In July 1996 a favourable Government View (with conditions) was given to extract 20,000 m^3 of maerl gravel over five years from Wyre Sound (between Rousay and Wyre Islands). One of the conditions of the Government View is the establishment of a monitoring programme, which Scottish Natural Heritage has started. This monitoring programme will be continued by the applicants over a period of six years. Maerl can be used as a seawater filter in the marine aquarium trade, and it has been used as a fertiliser/soil conditioner in the past.

5.5.4 Information sources used

The maps in this section show schematically the known broad-scale distributions of the main species of interest, based on information made available from 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. These data provide some information about the location of spawning and nursery areas. 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 of potentially exploitable burrowing bivalve molluscs, such as razor shells, and identifies their presence at various sites within Orkney.

5.5.5 Acknowledgements

The author thanks David McKay (SOAEFD Marine Laboratory), who provided maps and information for this section, and David Donnan (SNH) and Mark Tasker (JNCC) for commenting on drafts.

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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, Aberdeen, tel: 01244 876544
Benthic surveys; MNCR Database	*MNCR JNCC, Peterborough, tel: 01733 62626
Marine conservation issues	*Aquatic Environments Branch, SNH, HQ, Edinburgh, tel: 0131 554 9797
Marine conservation issues	*Fisheries Officer, JNCC, Peterborough, tel: 01733 62626
Marine conservation issues	*Conservation Officer, RSPB, Sandy, tel: 01767 680551
Marine conservation issues	*Conservation Officer, WWF Scotland, Aberfeldy, 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

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

5.6 Amphibians and reptiles

Dr M.J.S. Swan

5.6.1 Introduction

Of the nine widespread species of amphibian and terrestrial reptile in the UK, the common toad *Bufo bufo*, is the only amphibian species thought to be native to Orkney. However, common frogs *Rana temporaria* have recently been introduced and have become established in the region. Other recently introduced herpetofauna, whose survival is not confirmed, include the palmate newt *Triturus helveticus*, slow-worm *Anguis fragilis* and common lizard *Lacerta vivipara*. Since 1970, thirteen leatherback turtles *Dermochelys coriacea* - seven alive and six dead - have been recorded either swimming at sea or stranded on the shores of Orkney. The leatherback turtle is now thought to be resident in Scottish waters at certain times of the year (Brongersma 1972; Langton *et al.* 1996); previously, they were considered to be vagrants.

All of the above species are subject to some legislative protection or regulation (Table 5.6.1). The leatherback turtle is totally protected under UK legislation and is of international conservation significance. It is also included in Scottish Natural Heritage's 'Species Action Programme'.

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

Species	*Protection (see footnote)*
Amphibians	
Common frog *Rana temporaria*	1, 2, 3
Common toad *Bufo bufo*	1, 2
Palmate newt *Triturus helvetica*	1, 2
Reptiles	
Slow worm *Angius fragilus*	1, 2
Common lizard *Lacerta vivipara*	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.

5.6.2 Important locations and species

Common toads breed in lochans and deep flooded quarries, but are also found in smaller sites, such as roadside ditches. In the late eighteenth century they were recorded as common and widespread throughout the islands. Their distribution range has since contracted considerably, and the species is now largely confined to Hoy and west Mainland.

The original introductions of common frogs are thought to have been tadpoles, released after being used as teaching aids in schools. The species has been present for less than 50 years and most introductions appear to have occurred since 1980 and are still continuing. There are breeding populations on Mainland - in the Tankerness area and around Kirkwall - and on Rousay and Egilsay. The main types of water-body used by the frogs are lochans, flooded quarries and garden ponds.

5.6.3 Human activities

Common toads have declined significantly. The putative causes are associated with changing agricultural practices and include land drainage, grassland improvement and an increase in arable cropping. The introduction of hedgehogs, considered by some to be predators of amphibians, may also have had a deleterious effect (C. Booth pers. comm.).

The extent to which marine turtles are threatened by human activities is largely unquantifiable. Only those stranded, injured by propellors or entangled in fishing gear are ever seen and few carcasses are investigated by post-mortem examination to establish the cause of death. Elsewhere, turtles are known to have died as a result of ingesting marine debris (e.g. plastic bags, oil, tar etc.) (Langton *et al.* 1996). Turtles are unlikely to be killed deliberately in British waters.

Concise information on turtle identification, reporting of sightings, UK legislation and instructions on what to do with turtles caught in fishing gear is contained in the *Turtle code*, an advice sheet produced by SNH (SNH 1996). All sightings at sea and strandings should be reported to Scottish Natural Heritage in Edinburgh and to the Natural History Museum in London.

5.6.4 Information sources used

The toad distribution data were provided by the Biological Records Centre (BRC) at Monk's Wood (Arnold 1983, 1995). Not all of the amphibian or reptile survey information available is held at the national Biological Records Centre (BRC) at Monk's Wood: much of the information in this section is from local sources. Local amphibian and reptile records are published as an appendix to the *The mammals of Orkney* (Booth & Booth 1994). Additional records are published, and species distributions reviewed, annually in the Orkney Field Club Bulletin. Turtle data and information were supplied by the Natural History Museum and Langton *et al.* (1996).

5.6.5 Acknowledgements

The author wishes to thank the following people for providing information and for comments on the draft text: Henry Arnold, Chris Booth, Martin Gaywood, Steve Gibson, Colin McCarthy, Elizabeth McTeague and Mark Tasker.

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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: 0171 722 3333
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 Froglife, Triton House, Bramfield, Halesworth, Suffolk IP19 9AE, tel: 01986 784518
Amphibians and reptiles in Scotland	Institute of Terrestrial Ecology, Banchory Research Station, Glassel, Banchory, Grampian Region AB31 4BY, tel: 01330 823434
Turtles in Scotland and Species Action Programme	*Scottish Natural Heritage, Advisory Services, Edinburgh, tel: 0131 554 9797
Turtles in GB	Dr Colin McCarthy, Natural History Museum, Cromwell Road, London SW7 5BD, tel: 0171 938 9123
Turtles in GB	Oceanography Department, Oceanography Centre, University of Southampton, Empress Dock, European Way, Southampton SO14 3ZH; tel: 01703 595000
Amphibians and marine reptiles in Region 2	*SNH Orkney Office, Kirkwall, tel: 01856 875302
Collection of turtle data - Orkney	Orkney Field Club, c/o 34 High Street, Kirkwall, Orkney KW15 1AZ, tel: 01856 872883

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

5.7 Fish: exploited sea fish

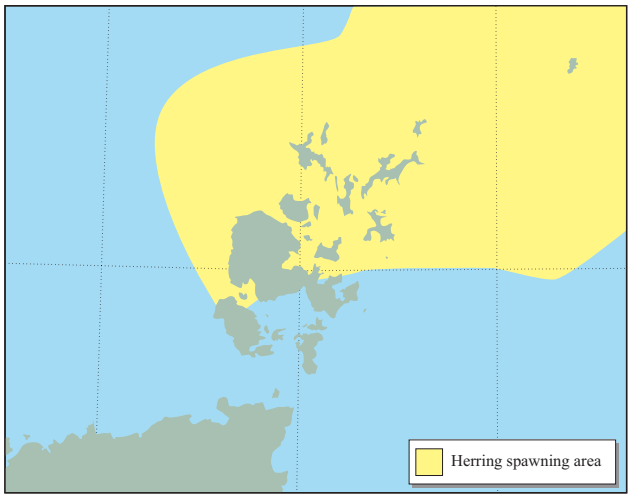
C.F. Robson

5.7.1 Introduction

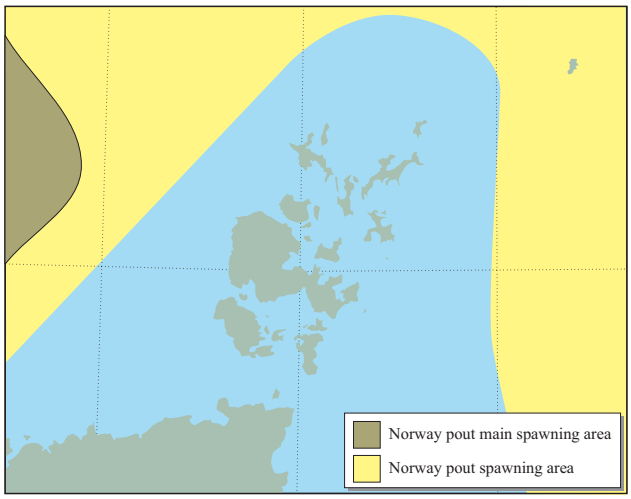
This section describes the distribution of sea fish that are of interest because they are exploited by people, mainly for food. Their exploitation by fisheries is described in section 9.1. Sea fish described as pelagic are most commonly found in shoals swimming in midwater; they typically make extensive 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'. 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 in some cases may 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 and 5.7.2 show the known spawning areas of two key species, herring and Norway pout. 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 main pelagic and demersal species occurring off Orkney and gives examples of protection measures in this region.



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



Map 5.7.2 Norway pout spawning areas. Source: Lee & Ramster (1981). © Crown copyright.

5.7.2 Important locations and species

Of the pelagic species, mackerel are widely distributed around Britain and are present in the seas off Orkney. Mackerel found in this region may originate from both the North Sea and western stocks. Since the decline of the North Sea stock in the late 1960s and early 1970s, however, the mackerel found around Orkney have originated predominantly from the western stock. During the northward feeding migration of the western stock a small proportion of the population enter the coastal waters around Orkney, arriving in May/June, where they spawn. Most of the population keeps on migrating north-eastwards, along the shelf edge. Mackerel remain in the region throughout the summer months. The highest numbers, however, are found in the late summer and autumn (August - October), when the return migration to the south-west takes place. In the late 1970s and early 1980s a large proportion of the western stock migrated through the Pentland Firth and around the north of Orkney. In more recent years, however, the migration has taken place in offshore waters further west.

Herring used to be locally abundant in the summer and autumn in feeding areas throughout the region, but the stock is currently very low. The spawning areas in the north of Orkney are shown on Map 5.7.1. Sprats spawn in waters around Orkney in the early summer, peaking between May and July (Lee & Ramster 1981).

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 spurdog, lesser-spotted dogfish, thornback ray and cuckoo ray, occur sporadically in Orkney's waters.

Of the gadoids, cod are widely distributed off Orkney in the summer; spawning peaks during February. Whiting are abundant and widely distributed off Orkney, especially in inshore waters. The spawning season is prolonged - from January to September, depending on the latitude - and although there are no known spawning areas in the region there are likely to be spawning areas that remain to be identified. Blue whiting are generally found beyond the continental shelf edge of the British Isles; however, in

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

Species	*Protection measures*
Pelagic species	
Mackerel *Scomber scombrus*	MLS/QM
Horse mackerel *Trachurus trachurus*	MLS/QM
Herring *Clupea harengus*	MLS/QM
Sprat *Sprattus sprattus*	QM
Demersal species	
Elasmobranchs	
Spurdog *Squalus acanthias*	No limitation
Lesser spotted dogfish *Scyliorhinus canicula*	No limitation
Thornback ray *Raja clavata*	No limitation
Cuckoo ray *Raja naevus*	No limitation
Gadoids	
Cod *Gadus morhua*	MLS/QM
Whiting *Merlangius merlangus*	MLS/QM
Blue whiting *Micromesistius poutassou*	QM
Haddock *Melanogrammus aeglefinus*	MLS/QM
Norway pout *Trisopterus esmarkii*	QM
Ling *Molva molva*	MLS
Saithe *Pollachius virens*	MLS/QM
Flatfish	
Plaice *Pleuronectes platessa*	MLS/QM
Dab *Limanda limanda*	MLS
Long rough dab *Hippoglossoides platessoides*	No limitation
Dover sole *Solea solea*	MLS/QM
Lemon sole *Microstomus kitt*	MLS
Turbot *Psetta maxima*	MLS
Brill *Scophthalmus rhombus*	MLS
Megrim *Lepidorhombus whiffiagonis*	MLS
Witch *Glyptocephalus cynoglossus*	MLS
Halibut *Hippoglossus hippoglossus*	
Flounder *Platichthys flesus*	MLS
Other demersal fish	
Monkfish (angler) *Lophius piscatorius*	No limitation
Conger eel *Conger conger*	MLS
Gurnards *Triglidae* spp.	No limitation
Sandeels *Ammodytes* spp.	No limitation

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

February considerable quantities of blue whiting occur in the deep channel north and north-east of Orkney. They migrate south for spawning, which peaks in mid-April, and in May they start to move northwards again. Haddock are widely distributed in the region and are present in large numbers in the summer and autumn. Spawning takes place from March to mid-May; the main spawning area is north-east of the region around Shetland. There are no recognised nursery areas, as juvenile haddock are widely distributed. Norway pout are found all around the region, mainly in the north. Many Norway pout spawn for the first time at the age of two years, between January and April. The area to the west of Orkney is a main spawning concentration of Norway pout and they also spawn in other waters off Orkney (Map 5.7.2). Ling 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 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 commercially-exploited plaice than the dabs. Plaice are fairly abundant in some coastal waters of Orkney (Rae 1970). There are no known plaice spawning areas, as determined from plankton surveys, in the region (Lee & Ramster 1981). Dab spawn from January to June and the juveniles move to coastal nurseries in the autumn and migrate to deeper water as they grow. Long rough dab are also widespread in the region (Rae 1970).

Dover sole have a similar lifestyle to plaice and dab but are more confined to areas with higher sea temperatures and are therefore mainly absent from this region. Turbot and brill have a similar lifestyle to plaice and dab but are much less abundant than them. Turbot spawn from May to August (Rae & Devlin 1972). None of the flatfish species exhibits extensive migrations, though the larvae can drift for several weeks from offshore spawning grounds to sandy inshore nursery areas. There may be some interchange, either way, between spawning stocks and nursery grounds in this and adjacent regions. Lemon sole are widespread in the Northern North Sea, including the region, and favour deeper water than plaice, with rocky or boulder-strewn sea bed alternating with rough gravel (Rae 1970). It is assumed that lemon sole spawn wherever they are found, beginning in May and ending in October. Megrim are found at a greater depth than most other flatfish species and are found mainly along the edge of the deeper water north-west of Orkney. In the North Sea the principal areas for witches includes the area east of Orkney. There are no separate megrim or witch nursery or spawning areas recognised in the region. Halibut is a comparatively rare, deep-water flatfish species which occurs most frequently in the Northern North Sea. Flounders migrate in the summer from inshore nursery areas in the region to spawn 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 waters off Orkney. Other exploited demersal species of minor importance are conger eel and gurnards. Sandeels are present in the region and provide an important food source for many exploited species. Their distribution is associated with 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 by 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. Severely over-exploited stocks (for example mackerel and cod) may be below the level at which the amount of spawn produced could replenish the stock in one year.

In Scottish inshore waters (to 6 nautical miles from baselines) the principal 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. There is a seasonal closure 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 the region (Table 9.1.5; Map 9.1.2). This bans the use of mobile gear from Berry to Costa Head in the west of Orkney from May to September (inclusive) and was designed to protect recognised nursery areas. SOAEFD conducts triennial reviews of inshore fishing legislation under the Inshore Fishing (Scotland) Act 1984. The most recent review was completed in 1996.

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 presented in Table 5.7.1: MLS and catch quota management (QM), which indicates that the UK has been allocated a TAC in the ICES Division that cover Region 2 - Division IVa. 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. The economy of Orkney is greatly dependent on the fishing industry and thus fishing effort is restricted by the European Council in an area known as the 'Shetland Box', which includes Orkney. The number of visiting boats allowed to fish within this area is limited through the 'Shetland Box licensing scheme'.

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

Spawning and nursery areas may be vulnerable to other activities such as effluent discharge and development of infrastructure such as pipelines. SOAEFD is a statutory consultee for, or licenses, activities such as these, in which the distributions of exploited fish populations and their identifiable spawning and nursery areas have to be taken into account. Other activities, such as seismic activity for oil and gas exploration (Turnpenny & Nedwell 1994), may also have an effect on populations.

5.7.4 Information sources used

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

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

5.7.5 Acknowledgements

The author thanks Mark Tasker (JNCC) for commenting on drafts.

5.7.6 Further sources of information

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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, Aberdeen, tel: 01224 876544
UKDMAP software with maps showing distributions of selected sea fish species and spawning areas	*Project Manager, British Oceanographic Data Centre, Merseyside, tel: 0151 653 8633
Marine conservation issues	*Maritime Unit, Advisory Services, SNH, Edinburgh, tel: 0131 554 9797
Marine conservation issues	*Fisheries Officer, JNCC, Peterborough, tel: 01733 62626
Marine conservation issues	*Conservation Officer, RSPB, Sandy, tel: 01767 680551
Marine conservation issues	*Conservation Officer, WWF Scotland, Aberfeldy, 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.

5.8 Fish: salmon, sea trout and eels

C.F. Robson

5.8.1 Introduction

Diadromous fish spend part of their lives in fresh water and part at sea. The three exploited diadromous fish species covered in this section - the Atlantic salmon *Salmo salar*, sea trout *Salmo trutta* and eel *Anguilla anguilla* - are widespread in British waters and have been recorded in this region. (Twaite shad *Alosa fallax* and allis shad *Alosa alosa* are also diadromous but are discussed in section 5.9, as they are not routinely exploited.) The salmonids (salmon and sea trout) spawn in fresh water and then migrate out to sea to mature, while the eel matures in fresh water and reproduces at sea. Sea trout and brown trout are the same species, but the latter is a freshwater form and is therefore not covered in this section. Information on the life-cycles of these fish can be found in Jones (1959), Mills (1971, 1989), Moriarty (1978), Shearer (1992), Sinha & Jones (1975) and Tesch (1977).

5.8.2 Important locations

Salmon, sea trout and eels have a widespread distribution in rivers and the coastal seas of British waters. There are no main, large rivers in Orkney where salmon can spawn and they are thus not abundant. However, the many sea lochs, such as Loch of Stenness, and burns (streams) and the surrounding coastal seas are known to contain populations of sea trout. Eels can be found in waters throughout Orkney, as elsewhere in Britain.

5.8.3 Human activities

In this region there are no recorded landings of salmon (including grilse) or sea trout (Scottish Office 1996). Specific concern relating to the state of wild salmonid stocks has focused on a wide range of potential anthropogenic and natural impacts, such as the effects of oil-related activity in Orkney and predation by aquatic mammals and birds. Fish farms located on burns used by sea trout may need to incorporate ladders to allow wild fish to reach spawning grounds. Maitland & Campbell (1992) describe the possible effects of various other issues of relevance to freshwater fish.

5.8.4 Information sources used

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

5.8.5 Acknowledgements

The author thanks David Dunkley (SOAEFD) and Mark Tasker (JNCC) for commenting on drafts.

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 District Salmon Fishery Boards	*SOAEFD Division K2, Pentland House, Edinburgh, tel: 0131 556 8400
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.* Marine and estuarine fisheries research.	*SOAEFD Fisheries Research Services, Aberdeen, tel: 01224 876544
Conservation of wild salmon; salmonid research	Director, The Atlantic Salmon Trust, Moulin, Pitlochry PH16 5JQ, tel: 01796 473439
Conservation issues	*Aquatic Environments Branch, SNH, Edinburgh, tel: 0131 554 9797
Inter-government convention regulating salmon fishing on the high seas	Secretary, North Atlantic Salmon Conservation Organisation, 11 Rutland Square, Edinburgh EH1 2AS, tel: 0131 228 2551

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

5.9 Fish: other species

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

5.9.1 Introduction

Although the fish fauna of Orkney is not well documented, there have been 108 fishes recorded (out of a national total of 336), including one jawless fish (agnatha) - the sea lamprey, nineteen sharks and rays (elasmobranchs) and 88 bony fishes (teleosts). The species regional total is not definitive: some groups, such as skates and rays (Rajidae) and dragonets (Callionymidae), have not been identified to species level and the list must be considered incomplete.

This region has published records of three British marine and estuarine species protected under national, European and international legislation (Table 5.9.1). These have been individual records of sea lamprey *Petromyzon marinus,* sturgeon *Acipenser sturio* and sand goby *Pomatoschistus minutus.* The common goby *P. microps,* allis and twaite shads *Alosa alosa* and *A. fallax* and lampern *Lampetra fluviatilis* have not been recorded.

5.9.2 Important locations and species

There are only two records of sea lamprey and three of sturgeon for Orkney; clearly, these fish are rare. Day (British Fishes Volume XI) quoted in Buckley & Harvie-Brown (1891) describes the two sea lamprey records for Orkney. He states "one occurred several years ago off Stromness, and one had since been taken by Dr Duguid". Two sturgeon records, one at Melsetter from 1828 and another in 1867, were first published in Buckley & Harvie-Brown (1891). A more recent record of sturgeon (1956) was from the Pentland Skerries area (Rae & Wilson 1958).

Buckley & Harvie-Brown (1891) also contains records of unusual or rare species, including the smelt *Osmerus eperlanus,* recorded from Watersound, the gilthead *Sparus aurata,* which was first recorded in 1844, and the swordfish *Xiphias gladius,* seen off Westray in 1861 and 1865/6 and another in the Pentland Skerries. Basking sharks *Cetorhinus maximus* were also recorded, being described as "an extremely common species, and quite harmless, sometimes exceeding 27 feet in length". There have been strandings of basking sharks around Orkney, with records from 1808 on Stronsay and 1941 at Scapa Flow. This last was detailed in Bland & Swinney (1978), who clarified that the carcasses were basking sharks and not 'sea snakes' as suggested in historical publications.

The major marine habitat types and the species of fish associated with them have been categorised in a series of ecotypes, including estuarine, littoral, sublittoral, offshore habitats and specialist habitats (symbiotic and other relationships). These are further divided by substrate types: mud, sand, gravel and particulate substrate, bedrock or boulders (reef), and water column. Many fish species show complex life-styles and habitat requirements, and many occupy several different habitats during the various phases of their life-cycles (Potts & Swaby 1993b).

5.9.3 Human activities

Human activities affecting estuaries and adjacent coasts on Orkney are listed in Buck (1993). Activities that may affect fish in the region are sewage disposal and general marine pollution (Davies 1985). Fish are sensitive to poor water quality, particularly low dissolved oxygen levels, and are known to leave areas that are unsuitable (Potts & Swaby 1993b). The possible effects of fisheries on fish species are discussed in Rae (1971), Davies (1981) and Mason *et al.* (1985) and in sections 5.7 and 9.1. Sea angling occurs in many places throughout the region (Orton 1996) (see also section 9.1). Other activities such as oil exploration and seismic surveying activity can have an adverse impact on fish (Turnpenny & Nedwell 1994).

5.9.4 Information sources used

The most comprehensive fish list for Orkney is that of Buckley & Harvie-Brown (1891), information from which has been supplemented by records from the *Atlas of the North Sea fishes* (Knijn *et al.* 1993), which gives details of the distribution of fish on the east coasts of this region, and by commercial catch data between 1985 and 1987, in which coastal and inshore fish are under-represented.

The British Marine Fishes Database contains data on the marine and estuarine fishes of Scotland. The data include published literature, unpublished reports and personal communications from fish biologists, covering aspects of fish biology and ecology, conservation status and fish records. The Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD) holds information on marine and estuarine fish.

Table 5.9.1 Scheduled species recorded in the region and protected status

Species	*Wildlife & Countryside Act (Schedule)*	*EC Habitats & Species Directive (Annex)*	*Bern Convention (Appendix)*	*CITES (Appendix)*
Sea lamprey *Petromyzon marinus*		IIa	III	
Sturgeon *Acipenser sturio*	5	IIa, Va	III	I
Sand goby *Pomatoschistus minutus**			III	

Source: after Potts & Swaby (1993a). Key: *the sand goby is abundant in the UK.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
British Marine Fishes Database	Dr G.W. Potts/S.E. Swaby, Marine Biological Association UK, Citadel Hill, Plymouth PL1 2PB, tel: 01752 633100
Fisheries - Scotland	*SOAEFD Fisheries Research Services, Marine Laboratory, Aberdeen, tel: 01224 876544
Fish conservation - UK	*Fisheries Officer, JNCC Peterborough, tel: 01733 62626
Fish conservation - Scotland`	*Maritime Unit, SNH HQ, Edinburgh, tel: 0131 554 9797

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

The multi-layered cliffs that fringe the western shores of the Orkney Islands are especially important for nesting seabirds. Twenty-three colonies hold numbers at or above 1% of the species' total European Union populations; several colonies qualify as Special Protection Areas for birds. The colony here on Hoy holds populations of four species at levels of international importance – fulmar *Fulmarus glacialis,* arctic skua *Stercorarius parasiticus,* great skua *Catharacta skua* and great black-backed gull *Larus marinus.* Photo: Coastwatch, JNCC.

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 and seaduck: in other words, those species reliant for an important part of their life on the marine environment. Section 5.12 includes information on these waterfowl species, where they occur close inshore, especially within estuarine environments. Scientific names of seabird species are given in Table 5.10.1.

Most breeding seabirds require habitat that is free from predatory mammals, and so in the UK in general nearly all colonies are on offshore islands, cliffs or remote areas of moorland (although the large gulls and skuas appear to be able to tolerate more disturbance by mammals than the smaller seabird species). The region is especially important for cliff- and island-nesting seabirds. Numbers of at least twelve seabird species breeding in the region (fulmar, gannet, shag, arctic skua, great skua, common and great black-backed gull, kittiwake, arctic tern, guillemot, razorbill and black guillemot) exceed 1% of their European (as opposed to European Union) populations; numbers of a further seven species exceed nationally important (1% GB total population) levels (Table 5.10.1). Of special mention is the great skua population, whose numbers exceed 15% of the European population. Arctic skua, great black-backed gull and arctic tern are also present in numbers exceeding 5% of this level. In addition, more than 120 pairs of red-throated divers *Gavia stellata* nest in Orkney, representing around 10% of the Great Britain population (there is at present no estimate for the European population). Orkney supports considerable numbers of eiders *Somateria molissima*, but no assessment has been made of their total population.

Feeding areas associated with seabird colonies are equally important: this region is amongst the most important sea areas for offshore seabirds in Europe. The greatest concentrations of birds at sea in this region are near the colonies during the breeding season. When feeding conditions are favourable, most feeding occurs comparatively close inshore. Scapa Flow and the Sounds north of Mainland are important during winter, especially for great northern diver *Gavia immer*, eider, long-tailed duck *Clangula hyemalis* and black guillemot (Map 5.10.1).

Table 5.10.1 Overall importance of seabirds breeding in Orkney

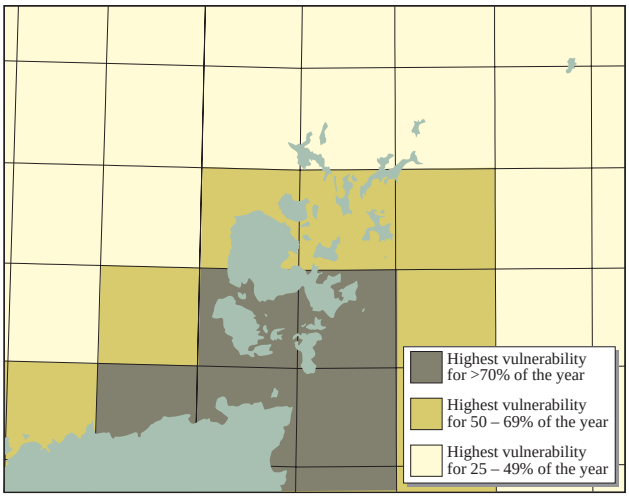
Species	*Total*	*% GB*	*% Europe*
Fulmar *Fulmarus glacialis*	84,450	15.7	1.4
Manx shearwater *Puffinus puffinus*	*c.* 50	n/a	n/a
Storm petrel *Hydrobates pelagicus*	*c.*10,000	n/a	n/a
Leach's petrel *Oceanodroma leucorhora*	>5	n/a	n/a
Gannet *Morus bassanus*	4,890	2.5	1.9
Cormorant *Phalacrocorax carbo*	*c.* 500	7.3	0.5
Shag *Phalacrocorax aristotelis*	2,610	7.1	2.1
Arctic skua *Stercorarius parasiticus*	1,060	33.1	6.0
Great skua *Catharacta skua*	*c.* 2,250	26.5	16.5
Black-headed gull *Larus ridibundus*	2,700	1.6	0.2
Common gull *Larus canus*	7,870	11.6	1.6
Lesser black-backed gull *Larus fuscus*	1,650	2.0	0.9
Herring gull *Larus argentatus*	2,800	1.9	0.2
Great black-backed gull *Larus marinus*	5,780	31.4	6.9
Kittiwake *Rissa tridactyla*	64,050	13.0	3.7
Sandwich tern *Sterna sandvicensis*	290	2.1	0.5
Common tern *Sterna hirundo*	200	1.6	0.2
Arctic tern *Sterna paradisaea*	21,160	49.0	7.6
Guillemot *Uria aalge*	182,600	17.4	4.1
Razorbill *Alca torda*	9,900	6.7	1.1
Black guillemot *Cepphus grylle*	6,940	18.5	3.5
Puffin *Fratercula arctica*	*c.* 51,000	11.4	0.7

Sources: regional totals compiled from the most recent available good quality counts up to 1995. Many of these counts derive from 1985-86 and monitoring indicates that there have been some changes since then. Figures for Great Britain from Thompson *et al.* (1996); those for Europe from Lloyd *et al.* (1991). Key: n/a = not available. Note: counts are of pairs, except for guillemots, black guillemots and razorbills , which are counted individually.

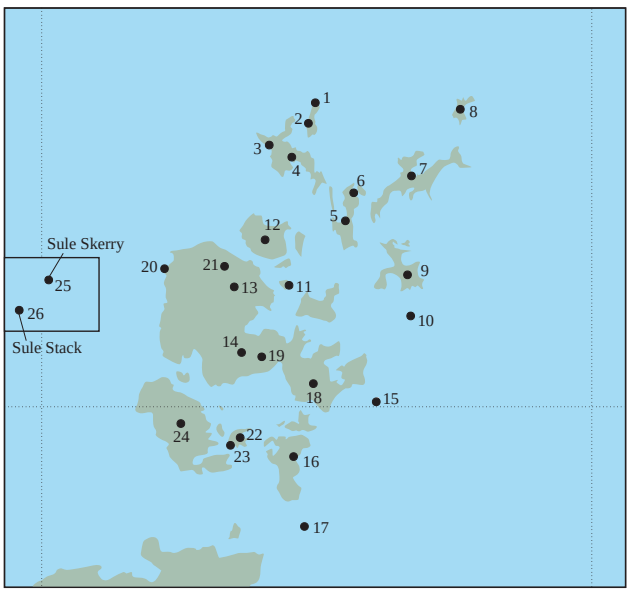
5.10.2 Important locations and species

Much of the coastline of this region is colonised by seabirds, and some sections of coastline have several contiguous colonies. Boundaries between 'colonies' in such areas are imprecise, making evaluation difficult. Colonies may not correspond to any statutory site. Of Orkney's colonies, 23 hold numbers of seabirds at or above 1% of the total population of the European total for that species; several colonies qualify as Special Protection Areas under the European Birds Directive (Table 5.10.2; Map 5.10.2). A further three colonies are important at the Great Britain level. Colonies on the islands of Papa Westray, Westray, Calf of Eday, Stronsay, Rousay, Mainland (Marwick Head), Hoy/South Walls and Sule Skerry hold more than one population of international importance.

Offshore, seabirds require food; natural foods range from zooplankton to small fish and waste from fishing fleets. Habitats that concentrate any of these foods are preferred. Zooplankton can be concentrated in zones where



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 (Table 5.10.2). Some colonies are in the centre of islands. Source: JNCC Seabird Colony Register.

water masses meet, or where tides converge around islands or over some sea-bed features. Many of the species for which the region is important feed on sandeels and other small fish in the summer. Sandeels require well-oxygenated sandy sediment to live in; such conditions occur in several areas in the region. Little research has been carried out around Orkney on precise seabird feeding ranges, although work is under way to determine the feeding range of black guillemots off Papa Westray. The nearshore waters of Orkney hold vulnerable concentrations of birds throughout the year (Stone *et al*. 1995; Carter *et al*. 1993). In July and August, large concentrations of the two larger auks (guillemots and razorbills) and kittiwakes occur to the south-east of the islands. In winter the main species present in nearshore waters are seaduck (eiders and long-tailed duck), black guillemots and divers, which feed on a variety of sea-bed organisms, including fish, shellfish and invertebrates, in waters <20 m deep. Species that feed further offshore, such as kittiwake, guillemot and razorbill, are present in lower numbers in winter and early spring. This is probably due to the relative lack of food in Orkney waters in winter, compared with areas south and eastwards in the North Sea.

The waterfowl using sites in the region during winter are also of considerable importance. There is no regular survey of the whole region, but counts have been carried out on several occasions in Scapa Flow and the Sounds to the north of Mainland (Benn 1986; Christer 1989; Ribbands 1990). Christer (1989) found approximately 5,000 seaduck in Scapa Flow in the 1988/89 winter. The most abundant species was long-tailed duck (*c*. 1,000), with about 900 eider. Both of these figures were smaller than numbers previously recorded (Benn 1986). A peak of 172 great northern divers were found in November 1988, representing more than 10% of the total off Great Britain. Large concentrations of shag occurred in the two entrances to the Flow. A peak of 4,800 seaduck occurred in the Eynhallow/Rousay/Gairsay Sound area in winter 1989/90 (Ribbands 1990). More than 2,500 of these were eider, with over 2,100 long-tailed duck. These Sounds also held large numbers of shag in December 1989.

There are, at present, no protected sites at sea in the region, and no sea areas off Orkney are included in any candidate Special Areas of Conservation put forward under the EC Habitats & Species Directive .

5.10.3 Human activities

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)).

Seabirds can be particularly affected by marine oil pollution, and spills near the main colonies during the breeding season could be catastrophic. Inevitably there were concerns that offshore oil exploration near the region would add to the risk of oil spills, but so far there have been no major incidents. Scapa Flow supports a large oil transhipment terminal, but there has not, as yet, been a major incident in the Sound, although operational spills continue to kill birds (Meek 1985). The wreck of HMS *Royal Oak,* lying in the north-east of the Flow, has been a persistent source of oil pollution since it was sunk during World War II. There are proposals to remove the remainder of the oil from the wreck. Further offshore, enhanced anti-pollution surveillance and tanker-handling procedures have meant that there has been a reduction in numbers of dead, oiled birds being washed up on beaches since the terminal was opened (Richardson *et al*. 1982). However, tankers on passage past Orkney still pose a threat to seabirds in the area, as was illustrated by the wreck of the oil tanker *Braer* in south Shetland in January 1993 (e.g. Heubeck *et al*. 1993). Spills can also occur from non-tanker shipping movements (there is a major shipping lane through the Pentland Firth), and the majority of oil collected from Orkney beaches appears to come from wastes from the bilges or fuel tanks of ships.

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

No. on Map 5.10.2	*Colony*	*Grid ref.*	*Species*	*Count date*	*Count*	*>1% EU/GB population*	*Conservation status*
1	North Hill, Papa Westray	HY499550	Fulmar	1986	15,810	EU	SPA, SSSI, RSPB
			Arctic skua	1994	149	EU	
2	Papa Westray	HY490520	Arctic tern	1989	4,120	EU	SPA, SSSI
			Black guillemot	1983	667	EU	
3	West Westray Cliffs	HY415470	Kittiwake	1988	23,896	EU	SPA, SSSI
			Guillemot	1988	42,146	EU	
			Razorbill	1988	1,946	EU	
			Black guillemot	1984	518	EU	
4	Westray	HY460460	Arctic skua	1993	100	EU	
			Arctic tern	1989	2,965	EU	
5	Eday	HY560340	Arctic skua	1992	120	EU	
			Arctic tern	1989	465	GB	
6	Calf of Eday	HY580390	Cormorant	1995	223	EU	SSSI
			Guillemot	1986	12,645	EU	
7	Sanday	HY680410	Arctic tern	1989	1,085	EU	
8	North Ronaldsay	HY760540	Arctic tern	1989	1,210	EU	
9	Stronsay	HY660250	Arctic skua	1992	40	EU	SSSI
			Arctic tern	1989	1,075	EU	
			Black guillemot	1983	456	EU	
10	Auskerry	HY675164	Storm petrel	1995	3,600	EU	
11	Holm of Boray	HY452206	Cormorant	1995	153	EU	
12	Rousay	HY410305	Arctic skua	1992	137	EU	
			Common gull	1986	685	GB	
			Arctic tern	1989	1,255	EU	
13	North-east Mainland	HY350210	Common gull	1986	755	GB	
14	Southern Mainland	HY500050	Common gull	1986	1,023	GB	
			Black guillemot	1984	553	EU	
15	Copinsay	HY610015	Guillemot	1994	20,440	EU	SSSI, RSPB
16	South Ronaldsay (including Swona)	ND450890	Fulmar	1986	5,654	GB	
			Arctic tern	1989	4,975	EU	
17	Pentland Skerries	ND465783	Arctic tern	1989	1,350	EU	SSSI
18	South-east Mainland	HY360100	Common gull	1986	1,023	GB	
19	Mainland	HY400100	Arctic tern	1989	780	GB	
20	Marwick Head	HY224250	Kittiwake	1994	6,830	EU	SSSI, RSPB
			Guillemot	1991	36,404	EU	
21	Birsay Moors	HY340240	Arctic skua	1991	50	EU	RSPB
22	Flotta	ND360940	Arctic skua	1992	80	EU	
23	Walls and Flotta	ND340920	Arctic tern	1989	1,780	EU	
24	Hoy and South Walls	ND260960	Fulmar	1986	37026	EU	SSSI, RSPB
			Arctic skua	1996	100	EU	
			Great skua	1996	>2,119	EU	
			Great black -backed gull	1986	1,780	EU	
			Guillemot	1986	20,819	EU	
25	Sule Skerry	HX623242	Storm petrel	1986	1,000	EU	SSSI
			Shag	1993	701	EU	
			Guillemot	1993	14,357	EU	
			Puffin	1993	43,384	EU	
26	Sule Stack	HX565177	Gannet	1994	4,888	EU	SSSI

Source: JNCC/Seabird Group Seabird Colony Register. Key to conservation status: SPA = Special Protection Area; SSSI = Site of Special Scientific Interest; RSPB = Royal Society for the Protection of Birds reserve. Key to importance: GB = nationally important; EU = internationally important. Notes: counts are of pairs, except for guillemots, black guillemots and razorbills, which are counted individually.

Seabird breeding numbers are likely to be affected by changes in fish stocks and fisheries activities. Some fish stocks have declined greatly as a result of man's fishing activities. It is possible, although not demonstrated, that direct fisheries on small fish consumed by seabirds, such as sandeels, might lead to decreases in seabird populations. Conversely, populations of scavenging seabirds may increase if amounts of waste discarded increase and, by extension, decrease should fisheries produce less waste. However, if other suitable foods are available, they might switch over to them.

5.10.4 Information sources used

All seabird colonies in the region were counted between 1984 and 1987; many areas have been re-counted since. In Table 5.10.2, colonies are those defined by the counters who contributed to the JNCC/Seabird Group Seabird Colony Register, or that have been used subsequently in analysis (Lloyd *et al*. 1991; Avery *et al*. 1993). 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 at several colonies

(including Marwick Head, Mull Head (a smaller, discrete colony on Mainland), Papa Westray and Hoy) are evaluated annually by the Joint Nature Conservation Committee and the Royal Society for the Protection of Birds. The Royal Society for the Protection of Birds co-ordinates annual monitoring of tern colonies.

Surveys of birds at sea off the region have been carried out by JNCC's Seabirds at Sea Team (SAST) since 1979. Survey effort from ships has been relatively even off the region, and 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.

5.10.5 Acknowledgements

Kate Thompson abstracted the Seabird Colony records and summarised the information presented here. Eric Meek organised most of the recent counts on which the Seabird Colony Register is based and made useful comments on drafts of this chapter. Many others carried out the counting.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Seabird colonies	*Co-ordinator, Seabird Colony Register, JNCC, Aberdeen, tel: 01224 655703
Seabirds at sea	*Seabirds at Sea Team, JNCC, Aberdeen, tel: 01224 655702
Seabirds in the region	*Regional Officer, RSPB, Smyrnil, Stenness, Stromness, Orkney KW16 3JX, tel: 01856 850176
Birds database	*Species Data Custodian, JNCC, Peterborough, tel: 01733 62626
Information on seabirds in Scotland	*SNH, Maritime Unit, Advisory Services, Edinburgh, tel: 0131 554 9797
Information on seabirds in Orkney area	*Conservation Officer, SNH, Kirkwall, tel: 01856 875302
Nearshore wildfowl	*Wildfowl and Wetlands Trust, Slimbridge, tel: 01453 890333

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

5.11 Other breeding birds

E.R. Meek

5.11.1 Introduction

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

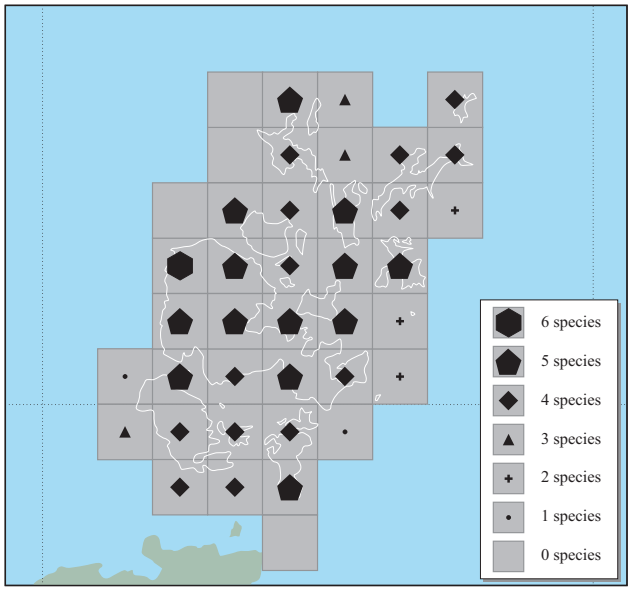
Apart from its seabirds, Orkney's ornithological richness lies in the diversity and abundance of breeding waterfowl, waders, owls and other raptors, all of which are present in high densities. Habitats present in the region that are of importance to breeding birds include moorland, lowland wet grasslands, machair and the numerous lochs on the islands. It is the diversity of habitats within a short distance of the sea that helps to make Orkney such an important locality for breeding birds. In addition, modern agriculture in Orkney has not, until very recently, had such a great effect on the environment as elsewhere and has allowed a mosaic of habitats to survive within the wider countryside.

The breeding waterfowl assemblages of this region are very diverse, and there are very high densities of breeding birds, particularly waders. Map 5.11.1 shows the incidence of confirmed breeding in coastal 10 km squares of selected species characteristic of wet grassland (teal *Anas crecca*, lapwing *Vanellus vanellus*, redshank *Tringa totanus*, mallard *Anas platyrhynchos*, snipe *Gallinago gallinago*, pintail *Anas acuta*), and Map 5.11.2 show the incidence of confirmed breeding in coastal 10 km squares of selected waterfowl species characteristic of shingle, sand dunes and other dry grassland (ringed plover *Charadrius hiaticula*, oystercatcher *Haemotopus ostralegus*, shelduck *Tadorna tadorna*). Curlew *Numenius arquata* populations in Orkney are considered to be amongst the most dense in Europe. Table 5.11.1 shows the densities of the breeding populations of five wader species in comparison with populations in other areas.

Overall numbers of several breeding wader species in Orkney are at levels of international importance: curlew numbers represent 4% of the north-west and central European breeding population, oystercatcher 5% and ringed plovers 4% (7% of the British population) (Table 5.11.2). In addition, more than 1% of the British breeding populations of several other wader species occur in Orkney, including whimbrel *Numenius phaeopus* (4%), lapwing, redshank, dunlin *Calidris alpina* and snipe, and the region is thus of national importance for these species.

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

Several of the duck species that breed in Orkney are present in nationally important numbers, including most notably pintail (57% of the British breeding population) (Meek 1993b), followed by wigeon *Anas penelope* (18%), red-breasted merganser *Mergus serrator* (7%), shoveler *Anas clypeata* (6%), eider *Somateria mollissima* (3%), teal (3%), mallard (>1%), tufted duck *Aythya fuligula* (1%) and shelduck (>1%).



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

Map 5.11.2 Number of confirmed breeding species characteristic of shingle, sand dunes and other dry coastal grassland (ringed plover, oystercatcher and shelduck) in coastal 10 km squares. Source: Gibbons *et al.* (1993).

Inland, this region is a major stronghold of the red-throated diver *Gavia stellata* (see also section 5.10), supporting over 11% of the British breeding population, and nationally important numbers of breeding short-eared owl *Asio flammeus* (2-7%), hen harrier *Circus cyaneus* (8%), peregrine falcon *Falco columbarius* (1%), rock pipit *Anthus petrosus* (2%) and raven *Corvus corax* (>1%) also occur.

A number of the sites in Orkney that support breeding

Table 5.11.1 Breeding wader densities (pairs/sq. km) in Orkney compared with recent UK surveys elsewhere

Site	*Lapwing*	*Snipe*	*Curlew*	*Redshank*	*Oystercatcher*	*Source*
Orkney	8.7	5.0	6.6	2.8	15.8	Whyte *et al.* (1995)
Shetland	4.9	6.7	3.6	2.7	8.3	Gill *et al.* (1994)
Outer Hebrides	22.5	13.4	0.0	11.9	11.4	Dodds *et al.* (1995)
Scottish farmland	2.3	0.7	1.0	0.1	1.2	O'Brien (1994)
Lowland wet grassland (England and Wales)	1.7	1.0	0.2	1.2	0.3	O'Brien & Smith (1992)

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

Area	*No. of pairs*	*% GB total counted in survey*
Orkney	552	7.7
Scotland	5,002	69.4
GB total	***7,207***	

Source: Prater (1989). Note: survey coverage varied between counties.

birds have one or more conservation designations (see Chapter 7), a reflection of the wealth of Orkney's habitats and its ornithological importance.

5.11.2 Important locations and species

Wading birds are one of the most conspicuous features of the Orkney scene during the summer months. Census work during 1993-94 has revealed some outstanding populations of the five commonest species (lapwing, curlew, redshank, oystercatcher and snipe) (Table 5.11.3).

A further six wader species nest in Orkney. The most significant of these is the ringed plover; Prater (1989), in a 1984 survey, found that 86% of the pairs were nesting in coastal habitats (sand, shingle, machair or adjacent farmland, emphasising the importance of these habitats for the species; the remaining 14% were inland, either on loch shores or disturbed ground. Golden plovers *Pluvialis apricaria* are also present, numbering 100-150 pairs, with the majority on Hoy, while similar numbers of dunlin occur, again chiefly on Hoy. Some 20 pairs of whimbrel nest in the region, on moors on the island of Eday and a discrete area of west Mainland. Common sandpipers *Actitis hypoleucos* are scarce, with only around fifteen pairs breeding on loch shores, chiefly in West Mainland. The rarest of the breeding waders is the Icelandic race of black-tailed godwit *Limosa limosa*; only one or two pairs attempt to nest each year.

The pintail is Orkney's most important breeding duck. A 1991 survey (Meek 1993b) revealed 22-26 pairs, mainly on lochs on West Mainland, Shapinsay and Stronsay. One of Scotland's main concentrations of shelduck - 100-150 pairs - is found in Orkney (Gibbons *et al*. 1993), where they nest in holes such as rabbit burrows in coastal and estuarine areas. Sheltered bays and estuarine-type habitats, such as at Widewall Bay on South Ronaldsay, Cumminess (Stenness, Mainland) and Otters Wick on Sanday, are important gathering grounds for shelduck (Eggeling 1987). Eiders are one of the commonest ducks and may number as many as 1,000 pairs, although, as in Shetland, there appears to have been some decline in recent years. Six species of 'dabbling' ducks nest in the islands, with eutrophic wetlands on the low ground being the most important habitats, although some species, especially mallard and wigeon, may nest on open moorland. The mallard is by far the commonest, with an estimated 1,000 pairs, and there are roughly 100 pairs of teal; shoveler and wigeon both number some 70 pairs. Gadwall *Anas strepera* are confined to North Ronaldsay, with a very small population of 6-8 pairs. Two other species of duck are regular breeders: the breeding population of the tufted duck is estimated at 100 pairs, which is slightly outnumbered by the red-breasted merganser *Mergus serrator* at *c*. 150 pairs.

Red-throated divers are characteristic birds of hill-top lochans, although small numbers breed on lower, more eutrophic waters; in either case, red-throated divers normally feed in coastal waters near to their breeding areas (Gibbons *et al*. 1993). A 1994 survey revealed 135 nesting attempts in Orkney, almost half of the pairs being on the island of Hoy. Mute swans *Cygnus olor* are also present in the region and number some 350, although the usual nesting population is 60-70 pairs. The Stenness and Harray Lochs used to hold half of this population but an invasion of the alien Canadian pondweed *Elodea canadensis* resulted in an abundance of food, allowing the numbers of mute swans on the two lochs to increase to 115 pairs in 1990. A sharp decline followed as the pondweed went through its normal cycle (Meek 1993a).

A number of raptors also breed in the region. Short-eared owls are a common sight in the islands, as many as 70 pairs nesting on the moors, being dependent to a very large extent on the Orkney vole *Microtus arvalis orcadensis* for food. Orkney is famous for its polygynous hen harrier population (Picozzi 1984). Concentrated on the west Mainland moors, there are currently fewer than 50 females and only half of these attempt to breed. Around 20 pairs of merlin *Falco columbarius* currently nest in Orkney, mostly on the moors of Hoy and the west Mainland (Meek 1988), and

Table 5.11.3 Estimated populations and breeding densities of waders on lowland sites in Orkney

Species	*Estimated total no. of pairs*	*Average breeding density (pairs/ sq. km)*	*Total nos. of upland* and lowland breeding waders in Orkney: % of British populations*
Lapwing	5,375	8.66	3
Curlew	4,100	6.63	14
Redshank	1,725	2.78	5
Oystercatcher	9,850	15.76	26
Snipe	3,125	5.01	6

Source: Whyte *et al*. (1995). Key: *curlew and snipe have considerable populations on higher ground; their total Orkney populations are estimated at 5,000 and 3,400 pairs respectively.

the number of peregrine falcons in the region is stable at about fifteen pairs. The great majority of peregrines are sea-cliff nesters, dependent to a large extent on seabirds as prey. Around fifteen pairs of kestrel *Falco tinnunculus* nested in the region in recent years and a proportion of them have the habit, unique in Britain, of being ground-nesters in moorland situations. Very small numbers of two other raptors breed in the region, namely buzzards *Buteo buteo* (two pairs) and sparrowhawks *Accipiter nisus* (six pairs).

Three other species reach significant population levels in Orkney: the corncrake *Crex crex,* the twite *Carduelis flavirostris* and the rock pipit, which has an estimated 700 pairs in the region. The shoreline of the islands, especially that of the smaller uninhabited islands, is ideal habitat for rock pipits. Some 90 pairs of ravens *Corvus corax* are distributed around the sea-cliffs of the region; only a small number are found inland.

5.11.3 Human activities

Perhaps the greatest threat to breeding birds in Orkney is the intensification of agriculture. Although the large-scale 'improvement' of moorlands and drainage of wetlands supported by Goverment grant aid has now slowed down considerably, some incremental loss of such natural and semi-natural habitats still occurs. The designation of sites as SSSIs or RSPB reserves can limit such activity, but in areas of the 'wider countryside' minor losses are continuing.

Changes in farming practices can have a marked effect on bird populations. The conversion of areas of rough grazing by improvement or for use for sheep grazing can cause declines in prey species such as the Orkney vole and passerine birds (e.g. songbirds). Oat stacks in farmyards were once a major source of small mammals but are now a rare sight in the islands. Such habitat losses may have contributed to the decline in the populations of species such as the kestrel and hen harrier, whose breeding numbers declined from over 100 females in the late 1970s to around 50; numbers of males are also reduced, with perhaps as few as fifteen present in the islands.

The lack of weed seeds in grain crops may be the cause of serious declines in twite and reed bunting *Emberiza schoeniclus*. It has also been suggested that the failure of the Orkney population of peregrines to rise in line with that of the rest of the UK in the post-organochlorine pesticide era is the result of low breeding success caused by contaminants such as PCBs in the marine food chain. Conversely, agricultural run-off in the form of silage or slurry effluent can cause the eutrophication of water bodies, which is thought to have resulted in the invasion of Harray Loch by Canadian pondweed; the subsequent abundance of food allowed the population of mute swans on Stenness and Harray Lochs to increase to artificially high levels in 1990 (Meek 1993a).

The corncrake population has undergone a major decline as a result of, amongst other factors, the change from hay-making to silage, and by 1993 this species, once common in the region, had been reduced to only six calling birds. However, by 1996 the Corncrake Initiative by RSPB and Scottish Natural Heritage, supported by the Scottish Crofters' Union, helped raise numbers to 43.

The use of areas of low-lying wetland (often considered to be 'waste' land) as land-fill sites can cause the loss of habitats used by breeding birds. Tourism results in some 120,000 visitors arriving in the islands each year, but pressure on wildlife sites has not yet become a problem.

5.11.4 Information sources used

A comprehensive overview of the status of breeding birds in Scotland is given in Thom (1986) and for Britain and Ireland in Gibbons *et al.* (1993). The latter summarises the results of a national breeding bird census undertaken between 1988 and 1991 and compares distributions at the 10 x 10 km square level with those recorded in the first breeding bird atlas of 1968-1972 (Sharrock 1976). Whilst these data are one of the best sources for comparisons at county, regional or national scales, care should be taken with their use to assess individual sites or 10 km squares. This is because the tetrad coverage of each 10 km square was not always the same, and since the atlas survey period (1988-1991) distributions of some breeding species may have changed. Between- and within-region comparisons of precise distributions and densities based on coastal 10 km squares should be undertaken with caution, as there may be greatly varying amounts of land within each square.

The standard work on Orkney ornithology is Booth *et al.* (1984), supplemented each year by the *Orkney Bird Report* (Booth *et al.* 1981 *et seq.*); these reports not only contain systematic information on all the species recorded each year but include papers on various species. *Scottish Birds* and other journals have published several papers on aspects of Orkney ornithology, while various unpublished internal reports, especially by the RSPB and Scottish Natural Heritage, contain a wealth of information.

Whyte *et al.* (1995) surveyed waders in Orkney during 1993-94. Census work was carried out on a sample of 67 one km squares in lowland areas of land class 5.3 or better (MLURI LCA Classification); upland areas (land classes 6.2, 6.3 and 7) were not covered.

5.11.5 Acknowledgements

Thanks are due to D.A. Stroud (JNCC) for comments on the text.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Breeding atlas data and breeding wader data	*Development Unit, The British Trust for Ornithology, Thetford, tel: 01842 750050
Coastal breeding wildfowl data	*Wildfowl & Wetlands Trust, Slimbridge, tel: 01453 890333
Site designations and breeding bird information	*SNH, Maritime Unit, Advisory Services, Edinburgh, tel: 0131 554 9797
Site designations and breeding bird information in the Orkney area	*SNH Orkney Office, Kirkwall, tel: 01856 875302
Breeding bird surveys; coastal habitat management	*RSPB HQ, Sandy, tel: 01767 680551
Breeding birds, coastal habitat management , RSPB reserves	*Regional Officer, RSPB East Scotland Office, Aberdeen, tel: 01224 624824

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

5.12 Migrant and wintering waterfowl

E.R. Meek

5.12.1 Introduction

This section describes the importance of the region for waterfowl, defined as waders and wildfowl (divers, grebes, ducks, geese and swans together with coot *Fulica atra*), during their non-breeding period. This section also notes the occurrence of wintering marine waterfowl and cormorant where they occur close inshore, especially within estuaries. The importance of offshore areas for wintering divers, grebes, seaducks and cormorant *Phalacrocorax carbo* is outlined in section 5.10. Scientific names of key species are given in the tables.

Twelve species of waterfowl reach levels of international significance in Orkney (great northern diver, Slavonian grebe, whooper swan, greylag goose, barnacle goose, wigeon, pochard, ringed plover, purple sandpiper, curlew, redshank and turnstone). The 5,700 purple sandpipers found in the islands represent 27% of the British population, making Orkney by far the most important wintering locality for this species in Britain. An additional fourteen species (mute swan, Greenland white-fronted goose, teal, mallard, tufted duck, scaup, eider, long-tailed duck, velvet scoter, goldeneye, red-breasted merganser, golden plover, sanderling and bar-tailed godwit) reach nationally important levels. Owing to a lack of comprehensive survey data, the precise proportions of waterfowl wintering in the region compared with the rest of Great Britain are uncertain. However, surveys of the Orkney shoreline in 1982/83 and 1983/84 (Tay and Orkney Ringing Groups 1984) found that some 51,000 waders alone were wintering on Orkney's coast. Although poorly monitored, the non-estuarine shoreline of the region has, in general, a relatively high density of waders in relation to the UK and the rest of Scotland, particularly in the north of the region (Moser & Summers 1987; Table 5.12.1). The densities of waders on sandy beaches and rocky shores in the region are higher than the average for British estuaries (Summers *et al.* 1991).

The coastline is also of importance for migrant waterfowl in spring and autumn. The region lies close to the principal migratory flyway of the east Atlantic, and some birds moving to and from wintering areas on the African, Mediterranean and south-west European coasts to northern and arctic breeding grounds pass through and stage here. The region is of significance in autumn migration periods for barnacle goose and whooper swan (Owen *et al.* 1986).

5.12.2 Important locations and species

Few sites in Orkney have been designated in recognition of their importance for wintering birds. However, the Lochs of Harray and Stenness are a Site of Special Scientific Interest (SSSI - see section 7.3.1) on the basis of their wintering wildfowl, and East Sanday is designated as a SSSI for its wintering and passage waders. Although the Loch of Isbister and The Loons SSSI/RSPB reserve holds substantial wildfowl numbers in winter, it is recognised chiefly for its breeding birds.

The key species wintering in Orkney, their populations and their national and international significance are detailed in Table 5.12.2.

The distribution of wintering waterfowl species is determined by habitat characteristics (Moser & Summers 1987). The key habitats for wintering waterfowl in Orkney are the lochs and the rocky and sandy shoreline. However, birds demonstrate complex patterns of interchange between sites during the course of a winter, and the importance of individual sites cannot be considered in isolation (Davidson *et al*. 1991).

The low, rocky shores and sandy beaches are of particular importance for wintering birds, although the number of species on the shore varies with the weather conditions, as waterfowl are more numerous on shores when cold weather results in fewer grassland invertebrates being available inland (Summers *et al.* 1991). Ringed plover, oystercatcher *Haematopus ostralegus*, dunlin *Calidris alpina*, knot *Calidris canutus* and bar-tailed godwit are associated with sandy coastlines, and rocky shores in the region support turnstone, purple sandpiper, oystercatcher, redshank and snipe *Gallinago gallinago*. The curlew is the most conspicuous wader in the islands during winter, the largest concentrations being on Mainland, South Ronaldsay and Shapinsay. Associated almost entirely with seaweed-covered rocky shores, the major concentrations of purple sandpipers are in the Northern Isles and Deerness (east Mainland). Turnstones are often found in close association with purple sandpipers but they are much more widely spread throughout the islands than the latter species. The major concentrations are in Orkney's northern isles, with Sanday predominant. Ringed plovers are scattered widely around the coast but are particularly associated with sandy beaches, the largest numbers being on Mainland and Sanday. Sanderling winter only in the northern isles, with Sanday being the most important locality. A large proportion of Sanday birds, however, appear to roost on North Ronaldsay, perhaps because the latter is rat-free. Bar-tailed godwits are an estuarine species with substantial flocks occurring in the Deer Sound/Scapa Bay area of east Mainland but more especially on Sanday, where the intertidal areas of Otters Wick and Cata Sand are

Table 5.12.1 Overall densities of wintering waders on non-estuarine coasts

	No. of wader species recorded	*Total no. non-estuarine waders*	*Extent of non-cliff, non-estuarine coast in county (km)*	*Extent of coast surveyed (km)*	*Overall wader density (birds/km coast)*
Orkney	14	51,484	734.2	671.1	76.7

Source: Moser & Summers (1987).

Table 5.12.2 Wintering waterfowl species in Orkney reaching levels of national and international importance

Species	*Orkney population*	*% British population*	*% international population*
Great northern diver *Gavia immer*	400	13.0	8.0
Slavonian grebe *Podiceps auritus*	80	20.0	1.6
Mute swan *Cygnus olor*	450	1.7	<1.0
Whooper swan *Cygnus cygnus*	300	5.5	2.6
Greenland white-fronted goose *Anser albifrons flavirostris*	220	1.6	<1.0
Greylag goose *Anser anser*	5,000	5.0	5.0
Barnacle goose (Greenland population) *Branta leucopsis*	1,100	4.1	3.4
Wigeon *Anas penelope*	20,000	7.1	2.7
Teal *Anas crecca*	3,500	2.5	<1.0
Mallard *Anas platyrhynchos*	5,000	1.0	<1.0
Pochard *Aythya ferina*	4,000	9.1	1.1
Tufted duck *Aythya fuligula*	2,750	4.6	<1.0
Scaup *Aythya marila*	370	3.4	<1.0
Eider *Somateria molissima*	5,000	6.7	<1.0
Long-tailed duck *Clangula hyemalis*	3,500	15.2	<1.0
Velvet scoter *Melanitta fusca*	150	5.0	<1.0
Goldeneye *Bucephala clangula*	850	5.0	<1.0
Red-breasted merganser *Mergus serrator*	650	6.5	<1.0
Ringed plover *Charadrius hiaticula*	1,600	5.5	3.2
Golden plover *Pluvialis apricaria*	(3,000)	1.2	<1.0
Sanderling *Calidris alba*	850	3.7	<1.0
Purple sandpiper *Calidris maritima*	5,700	27.1	11.0
Snipe *Gallinago gallinago*	(>2,000)	n/k	n/k
Bar-tailed godwit *Limosa lapponica*	770	1.5	<1.0
Curlew *Numenius arquata*	>20,000	16.7	5.7
Redshank *Tringa totanus*	7,000	6.4	4.7
Turnstone *Arenaria interpres*	6,000	9.4	8.6

Source: 1% levels for internationally/nationally important populations are based on Waters *et al.* (1996). Key: n/k = not known. Notes: populations given in brackets are best estimates.

particularly attractive to these birds. Other wader species wintering on the Orkney shore include oystercatcher and dunlin. Grey plover *Pluvialis squatarola* and knot are found in the region only in very small numbers. Snipe are extremely difficult to census and the figure quoted in Table 5.12.2 is considered to be an underestimate.

Farmland, too, helps to support the large winter numbers of waterfowl; whooper swans, geese and wigeon graze the grass fields in winter and substantial proportions of the wintering populations of waders use these areas. Redshanks are widely distributed throughout Orkney in winter; like curlews, they utilise grass fields, especially those immediately inland, as well as the shore. Wet grassland on Orkney provide roosting and feeding areas mainly for lapwing *Vanellus vanellus* and golden plover, as well as curlew, purple sandpiper and turnstone. Golden plovers winter mainly on grassland and only partly on the shore, and no full survey of this species' numbers has been carried out. Large numbers occur in the early part of the winter but the birds are driven out of the islands if hard frosts occur.

Most of the freshwater lochs are rich in nutrients and provide ideal feeding areas, especially for ducks. The Loch of Harray is of international importance for its waterfowl populations (Cranswick *et al.* 1995). It is the largest loch in Orkney and, together with the Loch of Stenness, the most important area for wildfowl (Owen *et al*. 1986). Wigeon are the commonest wintering duck in Orkney; they like to graze on short grass swards close to loch margins. Populations of this species have fluctuated in the 1980s/1990s, owing to the invasion and subsequent decline of Canadian pondweed *Elodea canadensis* in Loch of Harray, where wigeon numbers peaked at over 9,000 in 1990/91, falling to 2,700 by 1992/93. Amongst the diving ducks in the region, the pochard is the most numerous, although numbers are declining. In the early 1980s the Loch of Harray supported around 4,000, but numbers had declined by 1993 to 321, again owing to the pondweed cycle. A 1995 count revealed that numbers were increasing. Loch of Boardhouse is now often the more important site for pochard, with a peak there of 2,090 in 1993. Tufted ducks are found in small numbers on most lochs, but the largest concentration by far is on the Lochs of Harray and Stenness. An increasingly important flock of scaup is found on Loch of Stenness, where numbers in 1996/97 represented 3% of the British wintering population. Goldeneye are found scattered in small numbers on many lochs but over half the estimated Orkney population of 850 (5% British population) is found on Harray and Stenness. Red-breasted mergansers winter mainly at sea but the Stenness and Tankerness Lochs often hold significant numbers. The region also holds, in a GB context, significant numbers of red-throated diver *Gavia stellata*, with 20 birds wintering on the islands.

The normal winter population of mute swans in Orkney is around 450; however, the availability of Canadian pondweed on the Loch of Harray allowed some 800-1,000 whooper swans to winter on the Lochs of Harray and Stenness alone from 1988-1991. In 1990/91 there was a population of over 1,200 mute swans on the Harray/Stenness loch system (Meek 1993). A marked decline in the pondweed thereafter caused numbers to crash so that by 1992/93 only some 240 were present on the same

lochs. Whooper swans followed more or less the same pattern. Reynolds (1982) put the mean mid-November Orkney population at around 500. Later in the winter numbers fall dramatically as birds move further south in search of food. As with the mute swan numbers have since crashed and a January 1995 census, for example, found only 284 birds in the whole of Orkney; Shapinsay and Deerness/Toab (East Mainland) held the largest concentrations.

Of the geese, Greenland white-fronted geese are found in three discrete localities. The largest group of up to 150 winters in the northern part of west Mainland (The Loons - Durkadale - Loch of Swannay), a group of around 50 is found on Stronsay and a third, very elusive, group utilises the Holm/Tankerness area of east Mainland but rarely numbers more than 25. Greylag geese have been increasing in numbers in recent years and over 5,000 now winter in Orkney, the chief areas being west Mainland, east Mainland (especially in the areas of St Ola and Tankerness) and Shapinsay. A significant flock of 1,100 barnacle geese *Branta leucopsis* from the Greenland population winters in the southern part of Scapa Flow, roosting on the uninhabited island of Switha.

Orkney is also of note for several species of birds on autumn and spring passage. In autumn, it supports notable numbers of barnacle goose and whooper swan (Owen *et al*. 1986). Large numbers of snipe occur on passage, especially in autumn, with October being the main month. Ringed plover are also found in Orkney on autumn passage (Corse 1992), as well as whimbrel *Numenius phaeopus*, redshank, ruff *Philomachus pugnax*, wigeon, gadwall *Anas strepera* and teal (Booth *et al.* 1984, 1995, 1996). Purple sandpiper, turnstone, sanderling, knot and oystercatcher use Sanday in particular as a migration staging place in the spring (Corse 1992). Flocks of the northern race of golden plovers *P. a. albifrons* are frequently seen on spring passage in April, and a marked spring passage of turnstones, possibly of Greenland birds, through both Sanday and North Ronaldsay occurs in late April/early May (Prys-Jones *et al*. 1992).

5.12.3 Human activities

Whilst there is a tradition of Orcadians shooting wildfowl, especially geese, 'for the pot', there is little organised wildfowling except on Shapinsay. Here, a local farmer has developed his farm as a shoot and caters for visiting parties; habitat creation has been undertaken utilising the Scottish Office 'Habitats Scheme'. A west Mainland hotel began to bring parties of shooters from overseas to Orkney, which resulted in a storm of protest in the media and police investigations in autumn 1996. At its current level, wildfowling in the region does not pose any obvious threat to Orkney's important wintering bird populations, although the small breeding population of pintail *Anas acuta* may be at some risk in the early autumn before they leave the islands. There is no local branch of the British Association for Shooting and Conservation (the BASC).

Oil pollution, whilst being more of a threat to species wintering at sea (see section 5.10), could pose potential problems for wintering or passage birds. A spill in Scapa Flow could enter the Loch of Stenness via the Brig o'Waithe and affect species such as scaup and goldeneye. Oil coming ashore on low-lying sandy or rocky coastlines could contaminate feeding areas for waders and the birds themselves. However, 20 years of Beached Bird Surveys in the islands (Meek 1982-1997) indicate that this has not, to date, been a serious problem.

Land-claim for building or industrial purposes has not occurred on a large scale in Orkney, although there have been minor losses as a result of indiscriminate dumping. Bait digging is very localised, and whilst there are local traditions of collecting shellfish, especially razor shells ('spoots'), for personal consumption, this is infrequent enough to cause little disturbance. Some commercial collection of littoral shellfish does occur but on a very local scale and at a very low level. A recent application to carry out mechanised harvesting of cockles in Otters Wick, Sanday, was rejected.

Greylag geese have been increasing in numbers in recent years to the extent that the farming community is becoming worried about the damage apparently being caused to grass fields. Barnacle geese spend most of their time feeding on South Walls, where the pressure on grazing fields has necessitated the establishment of a refuge and scaring scheme by Scottish Natural Heritage; currently this is working well.

5.12.4 Information sources used

The chief sources of information on wildfowl are the Wetland Bird Surveys (WeBS - organised by the British Trust for Ornithology, the Wildfowl & Wetlands Trust, the Royal Society for the Protection of Birds and the JNCC). These have been supplemented by data from the censuses of greylag geese (Mitchell 1997) and Greenland white-fronted geese (Fox *et al.* 1994). The surveys of shorebirds in 1982/83 and 1983/84 by the Tay and Orkney Ringing Groups (Tay and Orkney Ringing Groups 1984) established Orkney as a major site for certain wader species; the data from these surveys and the subsequent repeat counts carried out on the five lengths of shore identified by the original survey as being the best areas (Anderson 1993; Gray & Bainbridge 1994) have been extensively used.

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

There have been a number of more detailed studies of the wintering waterfowl of this region, including *The birds of Orkney* (Booth *et al*. 1984) and a shorebird survey on the Orkney coastline in the winters of 1982-83 and 1983-84 (Summers *et al.* 1991). The *Orkney bird report*, produced every year, provides a systematic list of bird species on Orkney (e.g. Booth *et al.* 1995), while Thom (1986) provides a general source on birds of Scotland.

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

5.12.5 Acknowledgements

The author thanks D.A. Stroud (JNCC) for comments on the text.

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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)	*WeBS National Organiser (Wildfowl), The Wildfowl & Wetlands Trust, Slimbridge, tel: 01453 890333
High tide counts of wintering and migrant waders (WeBS)	*WeBS National Organiser (Waders), The British Trust for Ornithology, Thetford, tel: 01842 750050
Low tide counts of wintering and migrant waders (WeBS)	*WeBS National Organiser (Low Tide Counts), The British Trust for Ornithology, Thetford, tel: 01842 750050
Site designations and wildfowl information	*SNH, Aquatic Environments Branch, Advisory Services, Edinburgh, tel: 0131 554 9797
Site designations and waterfowl information in the Orkney islands	*SNH Orkney Office, Kirkwall, tel: 01856 875302

*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 the pipistrelle bat *Pipistrellus pipistrellus*. Other mammals - common and widespread throughout Britain, feral or recently introduced - have not been considered.

The region supports few nationally important species and many of those are only individual animals; this is typical of an island fauna. The otter is the only mammal that is found commonly on both the coastal and inland waters of many of the islands. The otter is classed as endangered and is absent from many areas of England (Morris 1993). Other species recorded from this region include noctule *Nyctalus noctula*, pipistrelle, black rat *Rattus rattus* and Orkney vole *Microtus arvalis orcadensis*. Table 5.13.1 summarises the recorded distribution of these mammal species in the region.

All British bats and the otter are listed on Schedule 5 of the Wildlife & Countryside Act 1981, Annex II of the Bern Convention and Annex IV of the EC Habitats & Species Directive. The black rat, classified as endangered and one of Britain's rarest mammals (Morris 1993), is now extinct in Orkney. It is listed on Schedule 9 of the Wildlife & Countryside Act 1981 to prevent its release in the wild.

Table 5.13.1 Recorded distribution of protected species

Protected species	*Estimate of importance in Region 2*
Noctule bat	Rare
Pipistrelle bat	Rare
Otter	Common
Orkney vole	Common
Black rat	Extinct

Source: Arnold (1993).

5.13.2 Important locations and species

Arnold (1993) recorded otters from 23 of the islands in Orkney where there is fresh running water, absence of human disturbance and often the presence of heathland behind the coastal sites (Ross 1991). Arnold (1993) records the pipistrelle bat from Mainland, and a pipistrelle colony of around fifteen individuals has recently been recorded from Hoy and may hold breeding animals (A. Dorrin pers. comm.). The noctule bat is a migratory species (Stebbings & Griffith 1986) and there are records of noctules from North and South Ronaldsay and Sanday (Arnold 1993). However, there are no records of noctule from mainland Scotland (Arnold 1993). As there are no records of noctules breeding, they are therefore probably incidental migrants. Noctules do, however, forage along the coastline.

The Orkney vole is the only vole recorded from the Orkney islands (Arnold 1993). Arnold (1993) shows records from twelve islands, although Corbett & Harris (1991) found them on only six islands. These are Mainland, Westray, Sanday, Stronsay, South Ronaldsay and Rousay. The distribution is the result of introductions. The Orkney vole is found in most habitat types, including marsh, heather moorland, hay meadows and ditches.

5.13.3 Human activities

Agricultural intensification, drainage and land improvement reduce the area of natural vegetation cover that otters need for shelter and are a threat to the otter population (Green & Green 1980). Any significant increase in human activities on the shoreline could disturb otters and reduce their breeding success. Although eel fishing is unregulated, most fykes are fitted with otter guards to prevent otter deaths (Jeffries *et al.* 1984). However, the use of creels can cause otter mortalities. Oil spills can cause high otter mortalities.

5.13.4 Information sources used

There have been no specifically coastal mammal surveys in Britain, although population estimates for British mammals exist (Harris *et al.* 1995). The otter survey covering the five main Orkney islands (Ross 1991) recorded 38-60% positive records from coastal and inland sites. Other than for otters (Green & Green 1997; Ross 1991), there are no survey data for mammals in the region that could be used to quantify the resource. There have been no comprehensive surveys for any bat species, and there are currently insufficient data to confirm the species present and whether any are breeding. An estimate has been made of the occurrence of other species in the region using data from Arnold (1993), although these data are incidental rather than comprehensive. As a general observation (Morris 1993), mammals are not recorded with the same intensity as botanical species, and the occurrence of mammals within 10 km squares is not enough to establish the status of the species.

5.13.5 Acknowledgements

The author thanks everyone who has contributed information and time to this work.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
General mammal information, Biological Records Centre	*Institute of Terrestrial Ecology, Monks Wood, Huntingdon, tel: 01487 773381
Species information; Bat Sites Register	*SNH, Advisory Services, Edinburgh, tel: 0131 554 9797
Local site and species information - Orkney	*SNH Orkney Office, Kirkwall, tel: 01856 875302
Otters	The Vincent Wildlife Trust, Otter Rehabilitation Centre, Barjarg, Barr Hill, Girvan, Ayrshire KA26 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

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

5.14 Seals

C.D. Duck

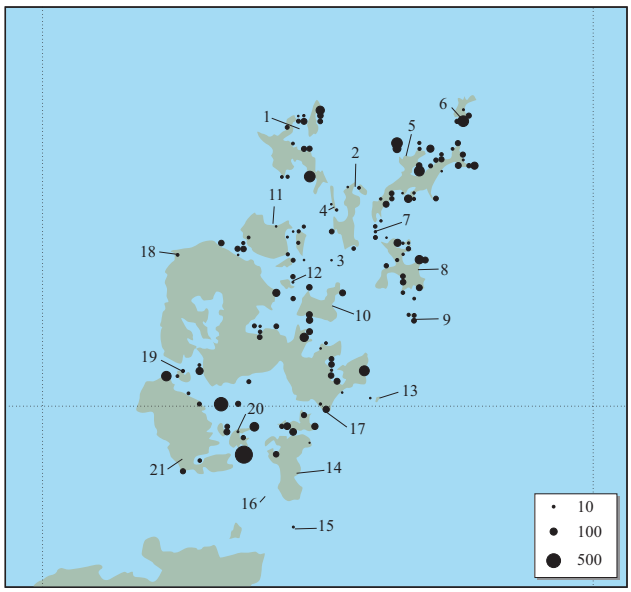
5.14.1 Introduction

Common (or harbour) seals *Phoca vitulina* are abundant in Orkney, the region holding over 27% of the GB counted population (Table 5.14.1). They can be seen at all times of the year and are distributed throughout the island group with the exception of exposed, steep, west-facing shores. Grey seals *Halichoerus grypus* may also be seen regularly anywhere in the region. There are a number of colonies, some large, together producing over 32% of the grey seal pups born in Great Britian (Table 5.14.1), a proportion second only to that for the Western Isles (Region 15).

5.14.2 Important locations

The sheltered waters and relatively undisturbed coast of Orkney, particularly around Scapa Flow, north-east and north-west Mainland, Stronsay, Sanday, Westray and North Ronaldsay, provide ideal haul-out sites for common seals (Map 5.14.1). During a survey in August 1993, the main concentrations were on islands in Scapa Flow (Switha, Cava, Flotta and the north tip of Hoy); the coast of Stronsay, Sanday, Westray and part of North Ronaldsay; and the east side of Mainland. The numbers of seals at sites in the region in August are given in Table 5.14.2. Numbers at specific sites vary considerably over time: between 1985 and 1989, common seals were abundant at sites south and east of Rousay, particularly around Eynhallow, Egilsay and the Holm of Scockness. In a survey carried out in August 1989 (Thompson & Harwood 1990), 15.4% of common seals counted in Orkney were in that area, while in 1993 the proportion was only 2.4%. The reasons for this difference, whether the result of some short-term local disturbance or of longer-term changes either in local abundance or distribution, are unknown.

Grey seals are scattered throughout the islands during the summer, with the main concentrations on the northern isles and on islands in the Pentland Firth (Map 5.14.2). In addition, Sule Skerry, to the west of Orkney, is an important non-breeding haul-out site lying outside the summer survey range. Individual grey seals, tracked by satellite, have been observed to move between the Moray Firth, the Farne Islands (McConnell *et al.*, 1994; Thompson *et al.* 1996), the Monach Isles (SMRU unpublished data) and various sites in Orkney. Grey seal breeding sites are concentrated in the



Map 5.14.1 Distribution of common seals in Orkney in August 1993. Size of circles is proportional to the number of seals within the 1 km square. Numbered sites are listed in Table 5.14.2. Source: SMRU.

north of the region, on islands off north Eday and north-west Stronsay. Other important sites are scattered throughout the archipelago, with a small group, including sites on South Ronaldsay, at the mouth of Scapa Flow (Map 5.14.3). In the northern group, Faray, Faraholm, Holm of Huip and Lingaholm each produce over 1,000 pups annually. Pup production for the main sites during the 1993 breeding season is given in Table 5.14.3. Production at two of the most recently colonised sites, Calf of Eday and Copinsay, has increased rapidly since 1992. Small numbers of pups are also born at the Point of Spurness on Sanday, on north-west Stronsay and along the south-west coast of Hoy.

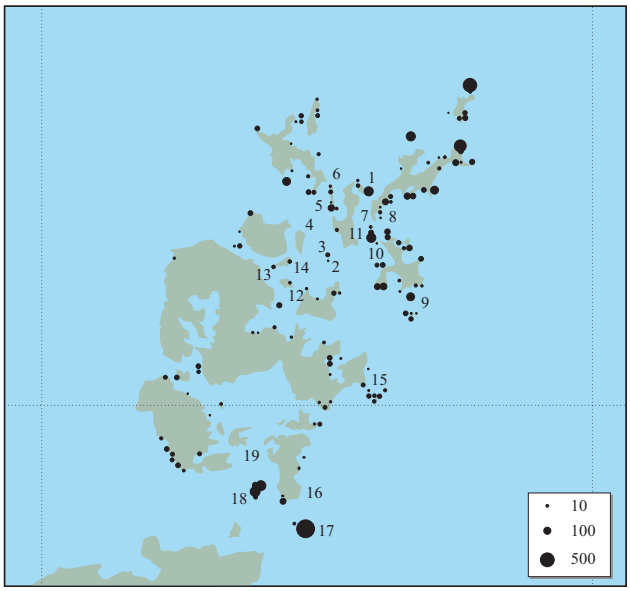
5.14.3 Human activities

Disturbance by humans is minimal: there is only one regular seal-watching tour operator, although local boats may be chartered for visiting colonies. Orkney Island Wildlife visit grey seal breeding sites on Muckle and Little Greenholm

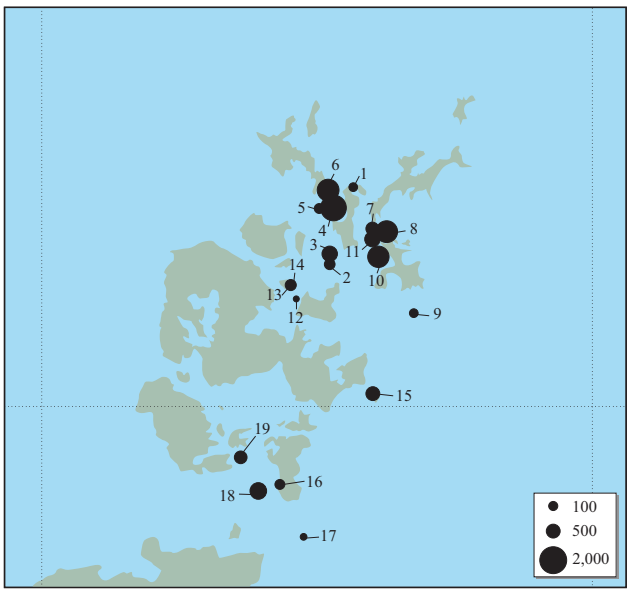
Table 5.14.1 Numbers of common and grey seals in the region in relation to the rest of GB

	Common seals		*Grey seals*		
Location	*No. of seals (to nearest 50)*	*% of GB total*	*Pup production (to nearest 50)*	*% of GB total*	*Associated population 1 yr old*
Orkney	***7,750***	***27.3***	***10,650***	***32.2***	***37,000***
Scotland	26,400	93.1	31,000	91.6	105,300
GB total	28,350	100	33,850	100	115,000

Source: SMRU data.



Map 5.14.2 Distribution of grey seals in Orkney in August 1993. Size of circles is proportional to the number of seals within the 1 km square. Numbered (breeding) sites are listed in Table 5.14.3. Sources: SMRU, E. Brown, SNH.



Map 5.14.3 Grey seal pup production, 1993 breeding season. Size of circle is proportional to the number of pups born at the breeding site (Table 5.14.3). Source: SMRU.

during the autumn and local common and grey seal haul-out sites during the summer.

There is a substantial crude oil reception terminal on Flotta in Scapa Flow and although there have been no significant spillages in this area to date, there are important haul-out and breeding sites of both species of seal in the vicinity that would be vulnerable to oil spillage, either from the terminal or from oil tankers navigating in Scapa Flow. New, offshore sites to the north-west of the region are currently being developed for hydrocarbon extraction. The long-term effects of these developments and the associated seismic activity on seals in the region are at present unknown.

The region supports an important inshore fishery, particularly for decapod crustaceans. Following numerous reports of lobster creels and crab pots being destroyed and/or the bait removed by seals, an investigation into the susceptibility of creels to predation by seals was instigated (Crossley 1994). There are a number of salmon farms in the region. Improvements in cage design, underwater sonic scaring devices and a general increase in the level of human

Table 5.14.2 Numbers of common seals counted in the region in August 1993

Site no. on Map 5.14.1	*Area surveyed*	*Grid ref.*	*No. of seals*	*% of region total*
1	Westray & Papa Westray	HY440460, HY490520	776	10.0
2	Eday & Calf of Eday	HY550320, HY580390	55	0.7
3	Muckle & Little Greenholm	HY526273, HY526262	1	<0.1
4	Faray, Faraholm & Ruskholm	HY530370, HY527390, HY513360	6	0.1
5	Sanday	HY680410	1,661	21.4
6	North Ronaldsay	HY760540	417	5.4
7	Holm of Huip, Little Linga, Lingaholm, Holms of Spurness	HY628311, HY607303, HY615274, HY605321	47	0.6
8	Stronsay	HY660250	659	8.5
9	Auskerry	HY673163	75	1.0
10	Shapinsay	HY500180	287	3.7
11	Rousay, Egilsay, Wyre & Eynhallow	HY400310, HY470300, HY440260, HY360290	185	2.4
12	Sweynholm & Gairsay	HY455228, HY440223	180	2.3
13	Copinsay	HY610015	1	<0.1
14	Burray & South Ronaldsay	ND480970, ND450860	377	4.3
15	Pentland Skerries	ND465784	1	<0.1
16	Swona & Switha	ND390845, ND362907	793	10.2
17	South & west Mainland	HY484012-HY233286	131	1.7
18	North & east Mainland	HY233286-HY484012	950	12.3
19	Graemsay	HY255055	8	0.1
20	Flotta, Fara, Rysa & Cava	ND350940, ND327958, ND310976, ND326995	801	10.3
21	Hoy and South Walls	ND250970, ND320900	341	4.4

Source: SMRU data (1993).

Table 5.14.3 Grey seal pup production in Orkney during the 1993 breeding season

Site no. on Map 5.14.3	*Location*	*Grid ref.*	*No. of pups*	*% of region total*
1	Calf of Eday	HY580390	268	2.4
2	Little Greenholm	HY526262	250	2.3
3	Muckle Greenholm	HY526273	665	6.1
4	Ruskholm	HY513360	224	2.0
5	Faray	HY530370	1,857	17.0
6	Faraholm	HY527390	1,397	12.8
7	Holms of Spurness	HY605321	402	3.7
8	Holm of Huip	HY628311	1,310	12.0
9	Auskerry	HY673163	169	1.5
10	Lingaholm	HY615274	1,285	11.7
11	Little Linga	HY607303	920	8.4
12	Grassholm	HY460197	86	0.8
13 & 14	Gairsay & Sweynholm	HY455228, HY455215	297	2.7
15	Copinsay	HY610015	498	4.6
16	South Ronaldsay	ND468897-ND429863	244	2.2
17	Pentland Little Skerry	ND472766	86	0.8
18	Swona	ND390845	644	5.9
19	Switha	ND362907	337	3.1

Source: SMRU data.

activity at fish farms has led to a reduction in damage caused by seals. However, seals persistently visiting farms are liable to be shot.

5.14.4 Information sources used

Common seals were surveyed by The Sea Mammal Research Unit (SMRU) during early August 1993 using a helicopter equipped with a thermal imaging camera, as part of a survey of common seals in Scotland. Common seals moult during August and the largest and most consistent numbers of seals are thought to haul-out at this time. To maximise the number of seals counted, surveys were restricted to early August and to within two hours of low tides occurring in the early afternoon. Given that an unknown proportion of seals would be at sea when each survey is being carried out, counts represent the minimum number of seals within the area surveyed.

SMRU records grey seal distribution during August but their numbers at haul-out sites outside the breeding season are unpredictable and can vary widely from day to day. Grey seal population figures presented here refer to the numbers of animals associated with pup production during the 1993 breeding season. Surveys of grey seal breeding colonies in the region are conducted annually using conventional aerial photography. Pups are counted from photographs and pup production derived from a series of counts obtained at regular intervals through the breeding season (Ward *et al.* 1987; Hiby *et al.* 1988). Both these surveys form part of the Natural Environment Research Council's statutory obligation under the Conservation of Seals Act, 1970, to provide the Scottish Office and Home Office with information and advice on the size and status of seal populations in the UK (Hiby *et al*. 1996).

Scientific studies of seals in the region include a three year investigation of the seasonal variation in haul-out behaviour of common seals around Eynhallow, Egilsay and the Holm of Scockness, carried out during the 1980s (Thompson 1989; Thompson *et al*. 1989; Thompson & Harwood 1990). The diving and foraging behaviour of seals in the same area has also been studied (Fedak *et al.* 1988), with, more recently, their responses to seismic air-gun array detonations (D. Thompson, SMRU unpublished data).

5.14.5 Acknowledgements

Thanks go to Alison Skene, John Baxter (Scottish Natural Heritage), Ross Flett, Maureen Bain (Orkney Seal Rescue), Eric Meek (Royal Society for the Protection of Birds), Paul and Louise Hollinrake (Orkney Island Wildlife) and Paul Thompson (University of Aberdeen) for providing information and for commenting on the manuscript. Thanks are also due to Dave Clem and PLM Helicopters for their help and enthusiasm during the helicopter surveys.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Numbers and distribution of seals around GB	Sea Mammal Research Unit, Gatty Marine Laboratory, St. Andrews University, St. Andrews, Fife KY16 8LB, tel: 01334 476161
Seals in Scotland	*SNH, Maritime Unit Advisory Services, Edinburgh, tel: 0131 554 9797
Seals in Orkney	*SNH, Orkney Office, Kirkwall, tel: 01856 875302
Seal rescue and rehabilitation	Orkney Seal Rescue Centre, Dyke End, South Ronaldsay, Orkney KW17 2TJ, tel: 01856 831463
General information on the environment and industry in the region	*International Centre for Island Technology, Stromness, tel: 01856 850605
Seals and fisheries	*SOAEFD Marine Laboratory, Aberdeen, tel: 01224 876544
Seals in Scotland	*Scottish Wildlife Trust, Edinburgh, tel: 0131 312 7765
Information on Copinsay	*RSPB, Scottish HQ, Edinburgh, tel: 0131 557 3136

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

5.15 Whales, dolphins and porpoises

Dr P.G.H. Evans

5.15.1 Introduction

The cetacean fauna (whales, dolphins and porpoises) of Orkney is one of the richest in Britain. Seventeen species of cetaceans have been recorded since 1980 along the coasts or in nearshore waters (within 60 km of the coast) of the region. Of these, seven species (26% of the 27 UK species) are either present throughout the year or are recorded annually as seasonal visitors to the region: minke whale *Balaenoptera acutorostrata*, harbour porpoise *Phocoena phocoena*, white-beaked dolphin *Lagenorhynchus albirostris*, white-sided dolphin *Lagenorhynchus acutus*, Risso's dolphin *Grampus griseus*, long-finned pilot whale *Globicephala melas* and killer whale *Orcinus orca*. As elsewhere in northern and western Britain, headlands and the sounds between islands are the most favoured localities for sighting cetaceans, along with offshore fishing banks.

The harbour porpoise is listed in Annex II of the EC Habitats & Species Directive as species whose conservation requires the designation of Special Areas of Conservation.

5.15.2 Important locations and species

Table 5.15.1 lists the species regularly occurring in Region 2 and notes their distribution. Maps 5.15.1 - 5.15.4 show the recorded distribution in the region of the four commonest species (minke whale, harbour porpoise, white-beaked dolphin, Risso's dolphin) respectively. Other cetacean species recently recorded in the region include fin whale *Balaenoptera physalus*, sei whale *Balaenoptera borealis*, sperm whale *Physeter macrocephalus*, Sowerby's beaked whale *Mesoplodon bidens*, Cuvier's beaked whale *Ziphius cavirostris*, northern bottlenose whale *Hyperoodon ampullatus*, common dolphin *Delphinus delphis*, bottlenose dolphin *Tursiops truncatus*, false killer *Pseudorca crassidens* and beluga *Delphinapterus leucas*. Sperm whales, although not annual, have been recorded several times in Orkney waters, mainly during the winter months. Six sperm whales remained in Scapa Flow between 22 February and 25 March 1993, and eleven sperm whales stranded and died at Backaskaill Bay, Sanday, in December 1994.

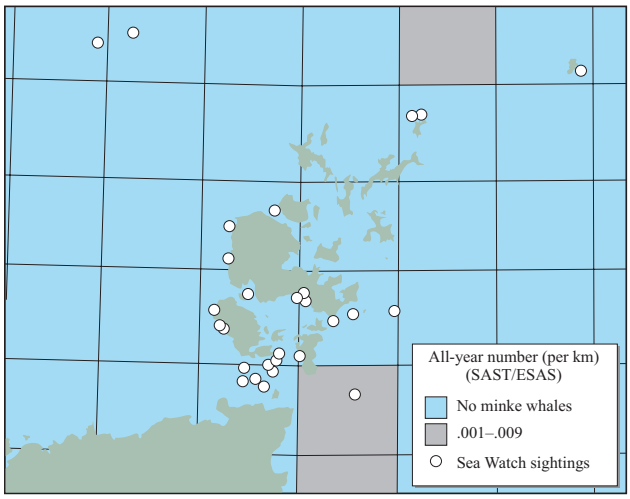
5.15.3 Human activities

For centuries, a drive fishery for long-finned pilot whales persisted, similar to those that once took place in neighbouring Shetland and continue in the Faroe Islands. The largest catch recorded was of 450 animals killed at Westray over several days in autumn 1843 (report from Orkney Herald, 21 April 1886). The last organised drive took place in July 1891, when 114 pilot whales were killed in Inganess Bay and Wideford Sands (Ritchie 1927). Similarly, a drive fishery formerly existed for white-sided dolphins, with entire schools being driven ashore, as occurred for example in August 1858, when about 20 individuals were captured in Scapa Bay.

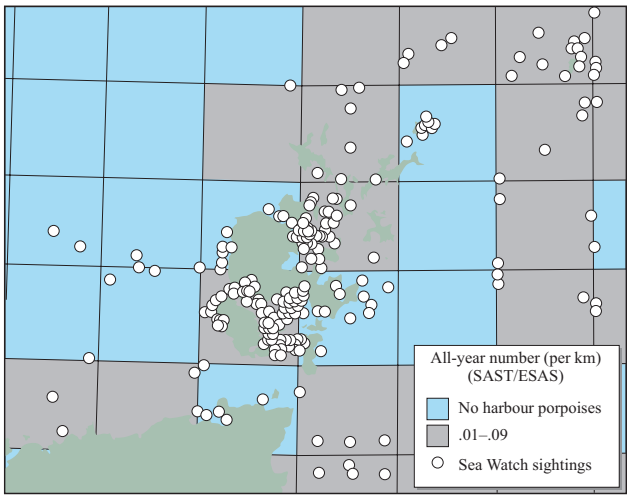
ASCOBANS (Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas) is an international agreement between countries bordering the North and Baltic Seas, with the aim of promoting the conservation of small cetaceans. It was ratified by the UK in 1993. Participating states agree to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

Table 5.15.1 Cetacean species commonly recorded in the region

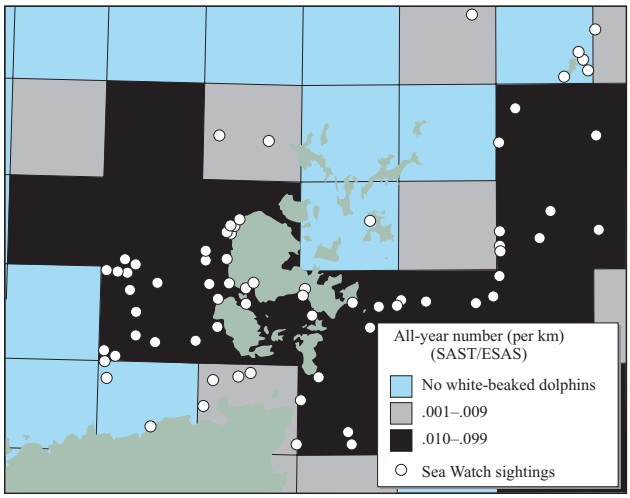
Species	*Status, distribution and seasonal occurrence*
Minke whale *Balaenoptera acutorostrata*	The most frequently observed baleen whale species in the region. Widely distributed in small numbers, particularly in the Pentland Firth and on the west coast, with most sightings occurring between July and October.
Harbour porpoise *Phocoena phocoena*	Widely distributed and common throughout Orkney, the only species regularly present in Scapa Flow and Gairsay Sound. Although present throughout the year, peak numbers and frequency of sightings occur between June and October when singles or family groups of 2-3 may form aggregations of up to 100 individuals.
White-beaked dolphin *Lagenorhynchus albirostris*	Widely distributed and fairly common, in groups usually numbering 5-20 individuals. Most sightings occur offshore east and south of Orkney, at either end of the Pentland Firth, and west towards Sule Skerry. Recorded in most months of the year, but with most sightings between June and October.
White-sided dolphin *Lagenorhynchus acutus*	Infrequent visitor to nearshore waters, being a deep-water species, generally travelling in large groups. Some nearshore movements have led to mass strandings. Most coastal sightings occur between May and October.
Risso's dolphin *Grampus griseus*	Widely distributed in groups of 5-20, usually nearshore, with most sightings along the west coasts of Orkney, particularly west of the island of Hoy but also off North Ronaldsay and in the Pentland Firth. Mainly seen between May and October, particularly August.
Long-finned pilot whale *Globicephala melas*	Infrequent visitor to nearshore waters, either singly or in groups numbering up to 20 individuals (occasionally up to 200 individuals), with no indication that any particular area is favoured. Recorded in most months of the year; nearshore sightings peak May - August, although largest numbers are recorded between November and March, when some mass strandings have also occurred.
Killer whale *Orcinus orca*	Regular though uncommon species (generally seen singly or in groups of 2-10); widely distributed throughout Orkney waters, occurring in all months of the year but with peak frequency of nearshore sightings between June and October.



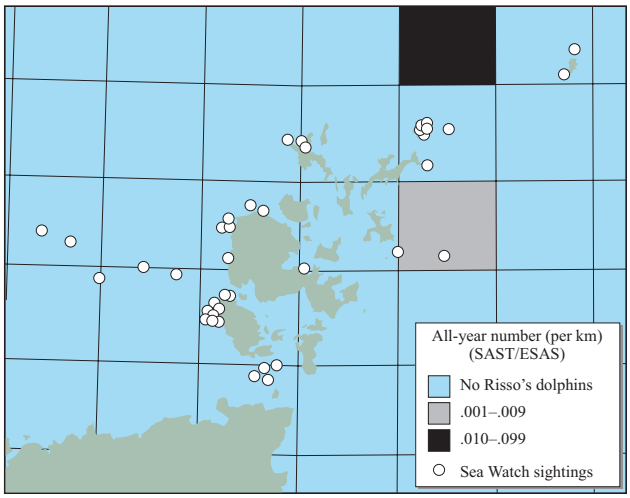
Map 5.15.1 Minke whale: all-year number sighted per km of Seabirds at Sea survey (source: JNCC: SAST/ESAS); and sightings reported to the Sea Watch sighting system (source: Evans (1992)).



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



Map 5.15.4 Risso's dolphin: all-year number sighted per km of Seabirds at Sea survey (source: JNCC: SAST/ESAS); and sightings reported to the Sea Watch sighting system (source: Evans (1992)).

Cetaceans in the region now face three potential pressures from human activities: conflicts with fisheries (either by competition for a common food resource, or accidental capture in fishing gear), habitat degradation (mainly by pollution) and disturbance (from underwater sounds). There have been a few reports of cetaceans in the region being killed accidentally in fishing gear, but no quantitative estimates of catch sizes (Northridge 1988; Evans 1993). A long-finned pilot whale became entangled and drowned in a creel line in 1984, and in a separate incident in the same year a minke whale became entangled but escaped (Northridge 1988). A minke whale that was entangled in rope and netting was washed ashore in December 1990 and another stranded dead with rope marks around the tail. A harbour porpoise drowned in a net set across a bay for sea trout. A juvenile male white-sided dolphin was found stranded on Sanday in October 1994 with fishing net around its tail and some lumps of metal entangled in the net (C. Booth pers. comm.).

Contaminant levels in cetaceans from the Northern Isles are amongst the lowest in the UK. Although none were analysed from Orkney, 22 harbour porpoises from Shetland were examined for total PCB (25 congeners) and were found to contain mean levels of 5.48 ppm, ranging from 0.12 to 15.05 ppm (Kuiken *et al*. 1994). The presence of fish farms could increase the risk of pollution, especially in and around Scapa Flow.

The use of ultrasonic seal screamers at fish farms may cause disturbance to cetaceans, as could seismic exploration west of Orkney. Underwater sounds from seismic activities involve low frequencies (20-500 Hz) and are therefore most likely to affect baleen whales. Nevertheless, recent studies indicate that other cetaceans may also be disturbed by seismic surveying, as they are sighted less frequently, either acoustically or visually, during seismic surveys (Goold 1996). It is possible that porpoises are affected (Baines 1993), perhaps indirectly by changing the distribution of their fish prey (Evans & Borges 1995).

Some speedboats operate out of Kirkwall and Stromness and in Scapa Flow, where diving activities have increased in

recent years. Such vessels pose threats of direct physical damage from collisions as well as disturbance from the high frequency noise they generate (Evans *et al.* 1992). Heavy shipping may also disturb cetaceans, but most of the sound produced by vessels with large engines is at frequencies below 1 kHz, thus overlapping more with baleen whales than with dolphins and porpoises (Evans 1987). However, vessels can also generate high-frequency (>1 kHz) sound overlapping the frequencies used by small cetaceans, and vessel avoidance and increased dive times by bottlenose dolphins and harbour porpoises have been reported by Evans *et al.* (1992, 1994).

There are no major holiday resorts in the region. Codes of conduct for boat users have been produced (Sea Watch Foundation & UK Mammal Society 1992) and Scottish Natural Heritage has a dolphin awareness scheme for Scotland, although this currently concentrates upon the Moray Firth.

5.15.4 Information sources used

Information on cetacean status and distribution comes primarily from the national sightings database (1973-present) maintained by the Sea Watch Foundation (Evans 1990, 1992), with records supplied by a network of local observers co-ordinated by C. Booth, and from the strandings scheme organised by the Natural History Museum in London (1913-present) (Sheldrick *et al.* 1994). Offshore effort-related data have been collected 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). Other dedicated offshore surveys in the region were conducted in August 1980 (Evans 1981) and more extensively in July 1994 (Hammond *et al.* 1995).

A major international collaborative programme, the Small Cetacean Abundance in the North Sea (SCANS) project, has aimed to provide a baseline assessment of abundance from intensive survey work in July 1994 (Hammond *et al.* 1995). Otherwise, systematic land-based watches have taken place at North Ronaldsay Bird Observatory. Most effort is concentrated in the months of April-October when sea conditions are also usually best. For geographical comparisons of sightings rates for various cetacean species in UK waters, see Evans (1990, 1992) and Northridge *et al.* (1995).

5.15.5 Acknowledgements

Thanks are due to I. Grant and J. Heimlich-Boran for help in the preparation of the maps, and to all those persons who have contributed valuable sightings data, particularly R.G. Adam, A. Alsop, M. Bain, C.J. and P.N. Booth, J. Crossley, M. Flaws, M. Gray, J.F. Holloway, R. Inkster, D. Kent, D. Lea, M. Lynch, D. McLean, E.R. Meek, S. Mowatt, D. Omand, K. Pirie, T. Prescott, P. Reynolds, J.B. Ribbands, A. Skene, M. Strudwick, M.L. Tasker, R. Thorne and A. Webb, and the wardens and staff of North Ronaldsay Bird Observatory. Thanks also go to John Baxter (SNH) for his comments on the draft version.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Cetacean sightings and surveys	*Seabirds & Cetaceans Team, JNCC, Aberdeen, tel: 01224 655702
Cetacean sightings and strandings - Orkney	C.J. Booth, 34 High Street, Kirkwall, Orkney KW15 1AZ, tel: 01856 872883
General information on cetaceans in Scotland	*SNH, Maritime Unit, Advisory Services, Edinburgh, tel: 0131 554 9797
General information on cetaceans in Orkney	*SNH, Kirkwall, tel: 01856 875302
Cetacean sightings, surveys and photo-ID	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 strandings (Scotland) and pathology	R.J. Reid & T. Patterson, SAC Veterinary Services, Drummondhill, Stratherrick Road, Inverness IV2 4JZ, tel: 01463 243030
Cetacean organochlorine and heavy metal levels	Dr R.J. Law, Centre for Environment, Fisheries & Aquaculture Sciences, Remembrance Avenue, Burnham-on-Crouch, Essex CM0 8HA, tel: 01621 787200

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

Security was an issue for the Iron Age inhabitants of the islands. Brochs, the most visible of 1st millenium monuments on Orkney, are round, dry-stone towers, with staircases and galleries within the walls, sometimes with extensive outbuildings. The best preserved group of brochs on Orkney overlook Eynhallow Sound, as if guarding the waterway; they include the Broch of Gurness, on Mainland (pictured). Photo: David Stroud, JNCC.

Chapter 6 History and archaeology

A.B. Gale & V.H. Fenwick

6.1 Introduction

Archaeological evidence - the physical remains of the human past preserved in landscapes and discrete sites - is an integral and irreplaceable part of the coastal resource. Archaeological sites 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.

The prehistoric monuments of Orkney constitute a complex unsurpassed elsewhere in Britain. A large number of Orcadian sites have been discovered as a result of coastal erosion, and others may lie in the intertidal or subtidal zones. Map 6.1.1 shows archaeological locations mentioned in the text.

The greater part of the Orcadian past, even down to the Viking Age, is largely undocumented. Its story must be drawn from information recovered by archaeological investigation of the many sites that survive on the islands. The information comes from diverse archaeological material: stray finds, scatters of artefacts such as pottery and flint tools, middens, monuments such as standing stones or burial chambers, buried structures, and environmental deposits such as peat. Organic remains, such as worked timber, preserved in waterlogged conditions, provide the best possible environmental data from which to reconstruct the landscape and its use by humans.

Shipwrecks are a more commonly recognised type of sea-bed site. Written accounts tell of many ship losses in the hostile waters of the Pentland Firth and on the Orkney coast and show the potential for wreck sites to be found. The records are comprehensive for the 19th century, relatively complete for the 18th, and patchy for the 14th to 17th centuries. For earlier periods it is necessary to examine documentary evidence for sea-borne trade and extrapolate the extent of ship losses by considering hazards to navigation. This process has then to be extended into the prehistoric period by looking at archaeological evidence for trade and seafaring.

In this century Orkney has played a central role in the defence and economy of Britain, being an essential fleet base in two world wars and a landing point for North Sea oil. However, the degree of cultural and political closeness between the islands and the mainland has changed through time. For some early periods of prehistory the monuments and artefacts, pottery and tools have clear affinities with those seen in Scotland and even southern Britain. At other times they become more distinctive. Orkney was untouched by the Roman military occupation and the Saxon migrations and felt only the long-term effects of the Norman invasion. The islands were, however, raided and settled by Vikings from Scandinavia. They remained under the rule of Norway until 1468, and were in a sphere of maritime cultural contact stretching from Ireland and Iceland to Scandinavia.

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 (Mesolithic, Neolithic)

Neolithic farmers were the first known human occupants of Orkney. Flint scatters are the only trace of earlier use by hunter-gatherers of the Mesolithic tradition, making seasonal use of the islands' resources. However, after the Neolithic clearance of woodland there was a rise in sea level, which is likely to have inundated some Neolithic and earlier sites and caused others to be engulfed by sand dune formation (Ritchie & Ritchie 1985). Consequently further evidence (as yet undiscovered) may lie offshore. Those structures that do survive on land are unrivalled in Britain.

Coast erosion has revealed a number of Neolithic settlements that were originally further from the sea. Their exceptional preservation arises from their being constructed in stone, partly set within consolidated midden material, and buried by sand dunes. The earliest is Knap of Howar, Papa Westray; later villages have been found at Rinyoon (Rousay) and Links of Noltland (Westray), and the best preserved is at Skara Brae on Mainland. The stone-furnished village houses are those of self-contained family units. The communal passages and drainage systems show them living as part of closely-knit communities, while the similarity between villages suggests interaction between communities (Clark & Sharples 1985). Excavation has produced an array of locally produced artefacts, including pottery and tools of stone and bone. Axes were produced from Orcadian stone but the factory sites have yet to be discovered.

The most common Neolithic structures are burial monuments: chambered cairns containing the remains of many dead. Five main groups of burial monument have been identified in Scotland, with the largest concentrations on Orkney and Shetland. The existence of two types on Orkney has been cited as evidence of two cultural groups occupying the islands in the 4th-3rd millenium BC (Henshall 1985). The most numerous type, of which at least 60 are known, is the Orkney-Cromarty passage grave. This type of grave is almost the only kind of chambered cairn found north of a line from Inverness to Ullapool. The exceptions are the cairns of the Clyde and Western Isles and the ten Maes Howe-type tombs on Orkney. Maes Howe itself is the finest example of Neolithic building in Britain, demonstrating precision engineering in stone; its construction is estimated to have required 100,000 man hours.

Even more demanding of labour, and therefore of social organisation, are the two great henges, the Ring of Brodgar and the Stones of Stenness. Henges are a British phenomenon, prevalent in Wessex and also found throughout eastern Scotland. They comprise large ditch and bank enclosures with causeway entrances. They often have internal circles, known from the post holes for timbers, or, as in the Orkney examples, the remaining standing stones. Their function is unknown, though ritual is the favoured explanation.

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

The most common known site types of the Bronze Age are burial mounds; some settings of standing stones may also belong to this period. Although metal-working technology was present in Scotland before 2000 BC, few early Bronze Age metal artefacts have been found in Orkney. In addition to burial sites, there are hundreds of burnt mounds, some with associated stone troughs, which are interpreted as the remains of cooking facilities. Stone ard (plough) shares have been found with burnt mounds at Liddel (South Ronaldsay) and Beaquoy (Mainland). Bronze Age society is seen as more isolated, receiving fewer imports from mainland Scotland, and more fragmented, perhaps because the deteriorating climate adversely affected resources (Ovrevik 1985).

Orkney has more metal finds from the later Bronze Age. By this date Shetland (Region 1) was also manufacturing metalwork. A wooden sword (900-700 BC) preserved in peat at Deerness, which replicates a type known as Ewart-Park, might have been a 'former' for casting in bronze, or simply a cheap copy of a desirable import from the bronze smiths of southern Scotland. Security is an issue raised by the most visible of 1st millenium monuments on Orkney, the brochs. These are round, dry-stone towers, with staircases and galleries within the walls. Brochs also occur in the Western Isles and adjoining mainland (Regions 15 and 16). Those of Caithness and Orkney, plus a few in Shetland, have extensive outbuildings, whereas those in the west often occur in isolation. The best preserved group on Orkney overlook Eynhallow Sound, as if guarding the waterway. The Broch of Burgar, Evie, contained the earliest direct evidence of boats in the islands: an antler chafing piece, which would slot over the gunwale to take the wear of fishing lines (Allen 1995b). Small quantities of glass and pottery from other brochs suggest that maritime links may have existed with the Roman zone on mainland Britain.

6.2.3 The Picts

The Roman period is not distinguished on Orkney by any political, cultural or technological change in the domestic dwellings, fortifications or native artefacts. Cultural material that pre-dates theViking period is known as Pictish. The Picts were war-like people identified by Roman historians as occupying the regions north of the frontier. The most diagnostic Pictish material is their symbol stones, the earliest dated to the 7th century AD, and these are concentrated on the Scottish east coast. The location of Pictish centres in coastal areas such as the Moray Firth (Region 3) leads some scholars to suggest that their power lay in naval expertise. Pictish symbol stones and ogham (letter) inscriptions have been found in Orkney. The Picts of Orkney, like their ancestors, would have been skilled boatmen, and a carving on a stone from Burness on Firth has been interpreted as a rare illustration of a Pictish boat (Ritchie 1993).

"As in most periods of prehistory in Scotland, more evidence of pre-Norse domestic settlement has been discovered in Orkney than elsewhere" (Ritchie 1993). Evidence has come from key excavations, particularly around Birsay Bay and from Deerness. These show domestic buildings of round, cellular or figure-of-eight plan, built of dry-stone with complex hearth structures. Faunal remains suggest a pastoral economy, although grains of wheat also indicate cultivation. Craftsmen provided local pottery and metalworking skills. 'Papa' place-names show the presence of Christian priests or missionaries at the time of the Norse settlement.

6.2.4 The Viking Age

Aspects of Orcadian history are narrated in a variety of chronicles, such as the Orkneyinga Saga. From these, key dates and events have been deduced. Viking raiders and settlers came to Orkney in the late 8th century. Political control was settled on the Earls of Orkney, who were Scandinavians until 1241. Archaeological investigations provide information with which to flesh out the picture of the period and to adjust the chronology.

Excavations at Buckquoy identified a Viking-age farmstead of the 9th century, overlying the Pictish settlement that had been abandoned some 50 years earlier. Elsewhere, distinctive rectangular Viking-age buildings also occupy Pictish sites, and in the early levels of Norse occupation Pictish artefacts predominate. The use of native goods suggests that the Norse settlement of Orkney was relatively peaceable. This blending of traditions may also be seen in the boats used in burials. Four excavations showed boats which, though constructionally similar to examples found in Scandinavia, had distinctive fastenings suggestive of a local boatbuilding tradition.

Excavation of Viking-age farmsteads shows a rural economy based on animal husbandry and cultivation, and an early horizontal watermill has been found at Earl's Bu, Orphir (Batey 1993). Extensive middens, such as that at Tuquoy (75 m long), provide opportunities for further environmental analysis.

Major hoards of precious metals have been found on Orkney at Skaill, Burray and Caldale. Whether accumulated by exchange or raiding, and whether hidden in peace or war, their richness indicates a considerable degree of wealth within the islands. Orkney was on maritime trade routes stretching as far as the Mediterranean. Excavation in Kirkwall has revealed part of the Viking trade centre and jetties used to import stone for the construction of St Magnus' Cathedral. This cathedral, together with the church at Birsay (which may have been Thorfinn's Minster) and the Round Church at Orphir, show the wealth of the Orkney Earls.

6.2.5 Late Norse to modern times

From the early 13th century Scottish influence over the islands increased, and in 1468 Orkney was formally passed to Scotland. The surviving 16th-17th century fortified dwellings of Noltland Castle, Earl Robert's Palace, Birsay, and Earl Patrick's Palace, Kirkwall, are reminders of the wealth and power of the families that controlled Orkney. Few physical remains tell of the rural lifestyle of these centuries. This is possibly the result of the continued occupation of successful farmsteads.

In 1486 Kirkwall was made a royal burgh, which sealed its importance as the islands' economic centre. During the next two centuries grain was sent from Kirkwall to Shetland and Norway, and timber and even boats were imported from the latter. The wharves once lay to the west of Broad Street and Victoria Street on a tidal inlet called the Peerie Sea. The 16th and 17th houses within the historic centre of the town belong to this era of prosperity. Two forts to guard the anchorage, constructed by Cromwellian troops in 1650, have not survived. After economic stagnation in the 18th century, new piers, begun in 1809, recreated the harbour. These remain, though the eastern one has been successively altered. Only small areas of the early waterfronts, which lie beneath Victorian landfill, have been revealed by excavation.

Throughout the war years of the 18th and early 19th centuries Orkney provided a haven and convoy assembly point on the north-about route, which avoided the privateers and enemy warships of the English Channel. This brought prosperity to its ports. Stromness, on the natural harbour of Hamnavoe, was also used by whaling ships from Hull and Aberdeen, especially those of the Hudson Bay Company. The town was a key recruiting station for crews. However, it was only the new burgh status of Barony (1817) that enabled it to rival Kirkwall's domination of trade. The individual quays and properties of the old waterfront contrast with the modern piers provided for the major ferry service and the modern fishing fleet.

It has been suggested, from the increased quantities of excavated fish remains, that commercial fishing first developed during the Viking period, perhaps prompted by Christian meatless days. Distinctive Orkney boatbuilding traditions may be traceable to this period (Allen 1995b). In the 16th century it was Dutch fleets which, paying for the right, harvested the local cod fisheries. Herring fishing brought a new boom in the 19th century. Curing stations were established at Stronsay, South Ronaldsay and Stromness and the islands were host to hundreds of vessels. In addition to the shore facilities required by packers and curers, steam drifters necessitated the siting of hulks at Stronsay for coal storage.

The rural economy was farming based, but in the 18th century, and again the 19th, the production of kelp by burning seaweed was a major, if short-lived, source of profit (Thompson 1983). This industry was demanding of labour but not capital, with most kelp burnt in simple beach kilns that were little more than pits lined with stones.

During the Napoleonic Wars two martello towers and a battery were built to defend Longhope Bay on Scapa Flow, an assembly point for convoys. These structures served during the American War and were re-used in the 1914-1918 War. The use of Scapa Flow as a fleet base bestowed strategic importance on Orkney, and 20th century military remains are a feature of the island. Among the most remarkable are the four Churchill Barriers, which seal the eastern entrance to the anchorage. The remains of earlier blockships are visible at low tide. These and the remaining ships of the German Navy, which were scuttled inside Scapa Flow, are a few of the many shipwrecks that form part of the sea-bed archaeological resource.

6.3 Human activities

6.3.1 Integrated management

Historic Scotland has identified the importance of integrating care of the archaeological resource within initiatives for coastal zone management (CZM). To that end it has established links with Scottish Natural Heritage and comparable national bodies, and liaises with CZM bodies as they are formed. In addition, it is working with the Royal Commission on the Ancient & Historical Monuments of Scotland (RCAHMS) to develop the archaeological database for the coastal zone, initially by rapid survey.

6.3.2 Activities and processes affecting the archaeological resource

The archaeological resource does not consist entirely of discrete sites and it is not constrained by environmental zones. Extensive palaeoenvironmental deposits, for example, can extend from dry land across the intertidal area and on to the sea bed. The need to consider the archaeological resource during the planning stage of land developments is recognised (see section 6.3.5). Developments such as sea defences, coast protection works, sewage outfalls and pipe and cable-laying can affect archaeology in the intertidal and subtidal zone.

Erosion, resulting from ongoing post-glacial sea-level rise, has been identified by Historic Scotland as a long-term serious threat to Scottish archaeological sites. By 1988, more than 100 diverse sites on Orkney had been classed as eroding (Ashmore 1994). The need to record such sites, by survey and excavation, ahead of destruction has necessarily focused the allocation of funds and research activity on the coastal erosion zone, thus potentially biasing analysis of settlement pattern (Morris 1985).

In addition to tidal, wave and storm attack, sites are threatened by blow-outs where dunes form the entombing and preserving environment. Human or animal activity can accelerate such soil erosion by denuding sites of vegetation. Visitor access is a management issue for popular sites such as Skara Brae, Ring of Brodgar and Maes Howe. Control of farm animals is also important, especially for smaller barrows and cairns. Ploughing and peat extraction have cut into archaeological sites, causing damage but also yielding discoveries. Drainage can lead to dessication of buried waterlogged deposits.

Orkney has an underwater heritage that attracts visitors from around the world. At present, the scuttled German vessels in Scapa Flow have no statutory protection but access is informally regulated through the Stromness Harbour Authority, which issues permits to divers. Most visitors use the services of local boatmen, whose interests are represented through the Orkney Dive Boat Operator's Association. Historic Scotland, in cooperation with local bodies, have identified as a priority the designation of the remaining three capital and three minor ships as Scheduled Ancient Monuments (see section 6.3.3), which would provide statutory protection while still permitting visitor access.

6.3.3 Protection of sites, monuments and wrecks

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

Four statutory designations can be applied specifically to protect *in situ* remains of archaeological or historic importance. The Ancient Monuments & Archaeological Areas Act 1979 (AMAA) provides for Scheduled Ancient Monuments (SAMs), and the Town & Country Planning (Listed Buildings and Conservation Areas) Act 1990 provides for Listed Buildings and Conservation Areas. The Protection of Wrecks Act 1973 and the Protection of Military Remains Act 1986 can be used to protect shipwreck sites.

The legislative arrangements, controls on works and criminal offences related to SAMs and the criteria for determining the national importance of sites are described in Planning Advice Note 42 (Scottish Office 1994b). The AMAA definition of monument includes sites both on land and in UK territorial waters, including remains of vehicles, vessels and aircraft. Prior consent is necessary from Historic Scotland for any works that will destroy, damage, repair or remove such a monument. The number of SAMs in Scotland is increasing at the rate of 300 a year, each being assessed against the published list of criteria for determining national importance. There are over 335 SAMs in Orkney (Historic Scotland 1995), ranging from Neolithic structures to 20th century military installations. The Orkney Sites and Monuments Records (SMR) - an archaeological database maintained at a regional level - is a key source of information on sites of local and regional significance. SAMs represent only a small number of the total known archaeological sites.

Buildings considered of special architectural or historic importance may be designated as Listed Buildings. There is now a presumption against the destruction of Listed Buildings, and consent from the Secretary of State for Scotland is required prior to any demolition, alteration or extension. Historic environments, particularly in urban settings, can be preserved as Conservation Areas. Many groups of buildings within the island's two principal towns are Listed and the historic importance of the centre of Kirkwall and the waterfront area of Stromness is emphasised by their designation as Conservation Areas. Of particular interest are the two Conservation Areas that are entirely rural, the Brodgar/Stenness Area and the Island of Eynhallow.

Shipwrecks of archaeological or historical importance can be designated under the Protection of Wrecks Act 1973, to ensure that the wreck is dived on and investigated only under licence and to prohibit any invasive activity within the designated area. There are no standard criteria for

designation, but Historic Scotland receives guidance from the Advisory Committee on Historic Wreck. Except under licence from Historic Scotland it is illegal to tamper with or remove material, to use diving or salvage equipment, or to deposit anything that may damage or obliterate the wreck (Archaeological Diving Unit 1994). Sites may be visited on behalf of Historic Scotland by the Archaeological Diving Unit, which is contracted by the Department of National Heritage to provide field inspection throughout the UK. However, no wrecks have been designated in this region (Archaeological Diving Unit 1994). Fewer than 45 wrecks have been designated in the whole of Britain and their distribution can not be regarded as indicative of the total sea bed resource. Information on wreck sites in the region is contained in the Orkney Sites and Monuments Record and the National Maritime Record for Scotland.

Ships such as HMS *Royal Oak* and HMS *Vanguard* in Scapa Flow and HMS *Hampshire* are protected not by a heritage protection measure but by designation under the Protection of Military Remains Act 1986. The Ministry of Defence regulates diving on such war graves.

6.3.4 Key organisations and their responsibilities

Historic Scotland 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). Historic Scotland compiles and amends the Schedule of Ancient Monuments and the statutory lists of buildings of special architectural or historic interest. Historic Scotland also has responsibility for wreck sites designated under the Protection of Wrecks Act 1973.

The Royal Commission on the Ancient & Historical Monuments of Scotland (RCAHMS) has responsibility for survey and inventory of archaeological sites. It maintains a database of terrestrial archaeological sites known as the National Monuments Record Scotland (NMRS). In 1992 a new Royal Warrant extended its remit to the territorial seas. The Commission has begun to compile a maritime section of the NMRS. 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 Orkney Heritage Society is an independent body which manages the Orkney Archaeologist post and maintains the Sites and Monuments Record for the island. The Local Authority contributes to staffing costs for this work.

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

6.3.5 Development control

To landward of low water mark the "development planning system provides the policy framework for meeting the needs of development along with the need for preserving archaeological resources, and for minimising the potential conflict between these two objectives" (Scottish Office 1994a). This framework is largely provided by Structure and Local Plans, which should carry general policies for the protection of archaeological sites.

"The preservation of ancient monuments and their settings is a material consideration in determining planning applications and appeals, whether a monument is scheduled or not" (Scottish Office 1994a). Government guidance (Scottish Office 1994a, b; Historic Scotland 1996) places emphasis on early consultation between developers and the planning authority and on the importance of drawing on the information and expertise available from the SMR: the preservation *in situ* of important archaeological remains is always to be preferred" (Scottish Office 1994a), but stress is placed on recognising that the value of the archaeological resource is much wider than the small proportion of sites that have so far received designation as Scheduled Ancient Monuments. Account must be taken of sites with regional or local significance and of other sites and finds recorded in the SMR. Specific guidance is also available on the treatment of SAMs within the planning system (Scottish Office 1994b).

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. Sea bed 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 & Historical Monuments of Scotland (RCAHMS) and Site Monument 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 Buldings should be directed to the Building Control Department of the local authority.

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

can be done *via* the Treasure Trove Advisory Panel Secretariat (at the National Museums of Scotland) or the local museum, local authority archaeologist, the police or the Procurator Fiscal. Finds from excavations funded by Historic Scotland, made casually on monuments in care, or from excavation undertaken with Scheduled Monument Consent, if not claimed under Treasure Trove by the Crown, go before the Finds Disposal Panel, which determines to which museum they should go (Historic Scotland 1994).

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

The seas around Orkney's Northern Isles are notoriously dangerous to shipping. Indeed, in the fifteen years between 1773 and 1788 sixteen ships were lost off Dennis Head, North Ronaldsay, alone, prompting the construction in 1789 of the Old Beacon, a former lighthouse now supplanted by the automatic light at Start Point. Photo: Coastwatch, JNCC.

6.4 Information sources

6.4.1 Information gathering and collation

The initial compilation of the National Monuments Record Scotland - Maritime Section (NMRS-MS) by the Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS) has drawn on entries within the Wreck Index of the Hydrographic Department, which is maintained as an aid to publishing Admiralty Charts for navigation. This index contains mainly metal wrecks that stand proud of the sea bed and which have been identified by remote sensing, as well as last reported positions of 20th century shipping casualties. The data supplied for the initial NMRS-MS contained 262 entries around Orkney. RCAHMS will develop their record using documentary accounts of ship losses and reports from field observations.

Highland Regional Council undertook a coastal recording project for which the Pentland Firth was a test recording area. This work identified private researchers with indices of wreck information (Groom 1994).

Historic Scotland's examination of archaeology in the coastal erosion zone (Ashmore 1994) states that, prior to 1993, there had been no surveys targeted to the coast of Orkney. Historic Scotland had funded excavation in advance of erosion, between 1977 and 1992, at Birsay Bay, Brough of Birsay, Hurnips Point, Links of Noltland, Point of Cott, Pool, Scar, St Boniface, Skara Brae, Tresness, Tuquoy and Warebeth. The content of the SMR has been updated following general reconnaissance of many stretches of coast undertaken by the archaeologist from the Orkney Heritage Society and staff of Historic Scotland. In 1995 more detailed work was funded by Historic Scotland. Portions of the coast have also been examined by an archaeologically dedicated survey, which identified areas of accretion and erosion. Information on archaeological sites was recorded on standard forms, which were passed to the SMR (Allen 1995a).

A survey of 1914-18 and 1939-45 defensive sites has been undertaken and the results, listing known sites, have been deposited with the NMRS (Guy 1994). The wrecks in Scapa Flow have been evaluated in (1990) by the Institute of Offshore Engineering on behalf of the Orkney Islands Council as a recreation and leisure resource.

6.4.2 Acknowledgments

Thanks are due to P. Ashmore and N. Fojut (Historic Scotland) and staff from all the organisations mentioned in the text who provided information and advice.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Scheduled Ancient Monuments; Listed Buildings; designated wreck sites; rescue archaeology; management of monuments in care	Principal Inspector of Monuments, Historic Scotland, Longmore House, Salisbury Place, Edinburgh EH9 1SH, tel: 0131 668 8650
Reporting of recovered wrecks in Britain	Receiver of Wreck, Coastguard Agency, Spring Place, 105 Commercial Road, Southampton SO15 1EG, tel: 01703 329474
Research and education	The Secretary, Scottish Institute for Maritime Studies, University of St Andrews, St Andrews, Fife KY16 9AL, tel: 01334 462916
Research and education	The Scottish Trust for Underwater Archaeology, Department of Archaeology, 16-20 George Square, University of Edinburgh EH8 9JZ, tel: 0131 650 1000
Code of practice for seabed developers	Joint Nautical Archaeology Policy Committee, Head of Recording (Maritime), National Monuments Record, Royal Commission on the Historical Monuments of England, National Monuments Record Centre, Kemble Drive, Swindon SN2 2GZ, tel: 01793 414600
National monuments - information and location of sites	Royal Commission on the Ancient and Historical Monuments of Scotland, National Monuments Record of Scotland, John Sinclair House, 16 Bernard Terrace, Edinburgh EH8 9NX, tel: 0131 662 1456
Regional Sites and Monuments Record	Orkney Archaeologist, The Janitor's House, Old Academy Buildings, Stromness KW16 3AW, tel: 01856 850285
Information on, and reporting of, Treasure Trove	Archaeology Department, National Museums of Scotland, Chambers Street, Edinburgh EH2 1JF tel: 0131 225 7534

Chapter 7 Coastal protected sites

J. Plaza & R. Keddie

7.1 Introduction

7.1.1 Chapter structure

This chapter incorporates statutory and non-statutory site protection mechanisms operating at international, national and local level, including those administered by voluntary bodies and other organisations who own land. It covers only the various types of site protection mechanisms currently found within this region, giving a brief explanation for each category. For the purposes of this chapter, any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as 'coastal'. Data included in this section are correct as at February 1997, unless otherwise stated.

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

Further explanation of the various site protection mechanisms can be found in Davidson *et al.* (1991). Planning Policy Guidance Note (PPG) 9 - Nature Conservation (DoE 1994), although dealing specifically with planning policy in England, gives useful summaries of some of the existing site protection mechanisms also found in Scotland. It sets out the Government's objectives for nature conservation and provides a framework for safeguarding the natural heritage under domestic/international law, emphasises the importance of both designated sites and undesignated areas for nature conservation, advises that potential Special Protection areas (SPAs) and candidate Special Areas of Conservation (SACs) should be treated similarly to classified SPAs and designated SACs, and deals with the treatment of nature conservation issues in development plans. It also includes copies of the Ramsar Convention, the EC Birds Directive and the EC Habitats & Species Directive (including lists of important species and habitat types). The statutory framework for site protection in Scotland is set out in Scottish Office Circular 6/90/95 (Scottish Office 1995). The Scottish Office is currently (September 1997) working on two National Planning Policy Guidance (NPPG) notes: one on natural heritage, and one on coastal matters.

Archaeological designations, protected sites (covered in Chapter 6) and sites designated for fisheries purposes, e.g. areas covered by Several Orders and Regulating Orders (discussed in sections 5.7, 9.1 and 9.2), are omitted from this chapter. 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.

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

Orkney is small, encompassing only 0.6% of the area of Great Britain but approximately 4.7% of the length of its coastline. Consequently, in absolute terms, only a small proportion by area of the Great Britain totals of many British coastal protected site categories are found here. Many types of protected site present in other regions of Great Britain do not occur in Orkney. Orkney is one of the few regions in Britain without National Nature Reserves, Ramsar sites or National Trust/National Trust for Scotland sites. However, Orkney is notable in that it contains 20% by area of Great Britain's RSPB reserves. Other site designations that are well represented in Orkney are Sites of Special Scientific Interest (2.3% by area of the national total), National Scenic Areas (2% of Great Britain's total) and Local Nature Reserves (LNRs) (1.8% of the total LNR area in Great Britain). 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 Orkney

	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*
Special Protection Areas	5	61.5	8.1	100	5.0	806	199,736	0.4	363,112	0.2
Possible Special Areas of Conservation	3	49	6.1	112	2.7	n/av	n/av	n/av	n/av	n/av
Sites of Special Scientific Interest	26	561	4.8	1,212	2.2	16,743	336,345	5.0	717,286	2.3
Local Nature Reserves	1	73	1.4	98	1.0	244	10,710	2.3	15,279	1.6
National Scenic Areas	1	4	25.0	27	3.7	14,800	52,400	28.2	745,800	2.0
Geological Conservation Review sites	14	551	2.5	1,096	1.3	n/ap	n/ap	n/ap	n/ap	n/ap
Regional Landscape Designations	3	39	7.7	63	4.8	n/av	n/av	n/av	n/av	n/av
Preferred Conservation Zones	1	17	5.9	22	3.7	n/av	n/av	n/av	n/av	n/av
Royal Society for the Protection of Birds reserves	11	56	19.6	87	12.6	8,132	24,836	32.7	39,888	20.4
The Wildlife Trusts reserves	2	145	1.4	241	0.8	83	11,574	0.7	25,884	0.3
Ministry of Defence sites	1	64	1.6	109	0.9	4	34,496	<0.1	53,456	<0.1

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

7.1.3 Further sources of information

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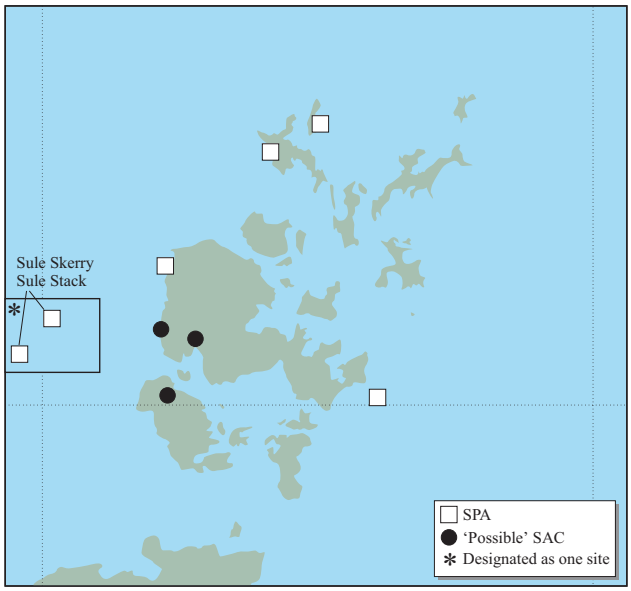
7.2 Sites designated under international conventions and directives

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 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 & Countryside Act 1981; all SPAs have first to be notified as Sites of Special Scientific Interest. There are five coastal SPAs (806 ha) in Orkney (Table 7.2.1; Map 7.2.1). Table 7.2.1 summarises the interest of these sites and sections 5.10, 5.11 and 5.12 describe the importance of these sites for the region's birds. Designation of SPAs is an ongoing process and further sites may be announced in the future.



Map 7.2.1 Special Protection Areas (SPAs) and possible Special Areas of Conservation (SACs). Sources: JNCC, SNH.

Table 7.2.1 Special Protection Areas (SPAs)

Site name	*No. of sites*	*Grid ref.*	*Area (ha*)*	*Date designated*	*Selection criteria used*
Papa Westray		HY500550; HY508520	254	1996	Internationally important numbers of breeding arctic skua *Stercorarius parasiticus*, arctic tern *Sterna paradisaea* and black guillemot *Cepphus grylle*
West Westray		HY425464	372	1996	Regularly supports internationally important breeding populations of arctic terns (Annex 1 sp.), kittiwake *Larus tridactyla* and guillemot *Uria aalge*
Copinsay		HY605015	152	1994	Internationally important numbers of breeding great black-backed gulls *Larus marinus*, guillemots and kittiwakes; breeding seabirds
Marwick Head		HY226257	9	1994	Nationally important numbers of breeding kittiwakes and guillemots; breeding seabirds
Sule Skerry & Sule Stack		HX623241; HX565177	19	1994	Internationally important numbers of breeding gannets *Sula bassana*, shags *Phalacrocorax aristotelis*, puffins *Fratercula arctica*, storm petrel *Hydrobates pelagicus* and Leach's petrel *Oceanodroma leucorhoa*; breeding seabirds.
Orkney	***5***		***806***		
North Sea Coast	61.5		199,736		
GB coast	100		363,112		
GB whole country	136		495,843		

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

7.2.2 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 (DoE 1994; Scottish Office 1995). A list of possible SACs was announced by the Government on 31 March 1995. There are three possible SACs within Orkney (Table 7.2.2; Map 7.2.1) out of a total of 112 coastal possible SACs in Great Britain (JNCC 1995).

7.2.3 Acknowledgements

Thanks are due to John Gibson and other staff of the JNCC, SOAEFD and the Ministry of Agriculture Fisheries and Food (MAFF).

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Scottish Natural Heritage. 1995. *Natura 2000: a guide to the 1992 EC Habitats Directive in Scotland's marine environment*. Perth, Scottish Natural Heritage.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
SPAs, Special Areas of Conservation	*Area Officer, SNH, Orkney, Kirkwall, tel: 01856 875302
Special Areas of Conservation	*Department of the Environment (DoE), European Wildlife Division, Bristol, tel: 0117 987 8000
SPAs	*Regional Officer, RSPB, Aberdeen, tel: 01224 624824

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

Table 7.2.2 Possible Special Areas of Conservation (SACs)

Site name	*No. of sites*	*Qualifying interest*
Loch of Stenness		Lagoons.
Stromness Heaths and Coast		Dry heaths (all subtypes). Vegetated sea cliffs of the Atlantic and Baltic coasts.
Hoy		Alpine and subalpine heaths, Northern Atlantic wet heaths with cross-leaved heath *Erica tetralix*; petrifying springs with tufa formations (Cratoneurion).
Orkney	***3***	
North Sea Coast	49	
GB	112	

Sources: JNCC, SNH (1995). 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.

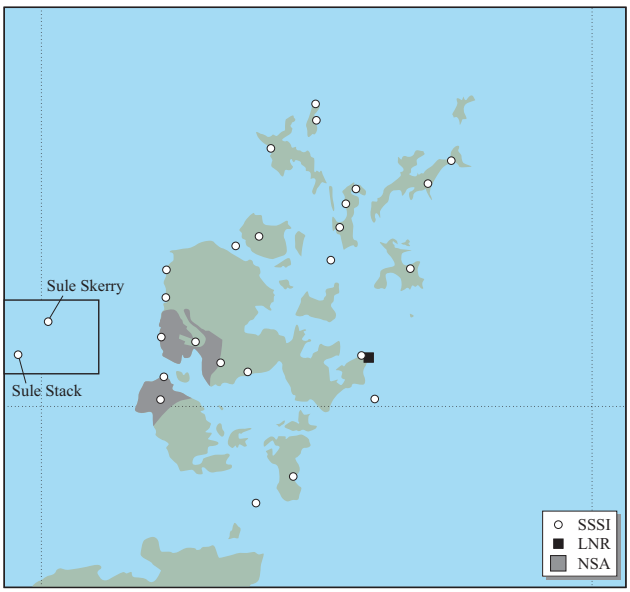
7.3 Sites established under national statute

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

7.3.1 Sites of Special Scientific Interest

Sites of Special Scientific Interest (SSSIs) are notified under the Wildlife & Countryside Act 1981. They are intended to form a national network of areas, representing in total the parts of Britain in which the natural features, especially those of greatest value to wildlife and earth science conservation, are most highly concentrated or of highest quality. Each SSSI represents a significant fragment of the much-depleted resource of wild nature remaining in Britain. Within the area of an SSSI the provisions of the Wildlife & Countryside Act 1981 and its 1985 amendments aim to limit or prevent operations that are potentially damaging to the wildlife interest of the area. There are 26 coastal SSSIs (16,644 ha) in Orkney (Table 7.3.1; Map 7.3.1). Around 8% of the total land mass of Britain is SSSI.

Approximately three-quarters of the SSSIs in the region (72%) have some intertidal land, while only 28% are purely terrestrial. The majority of the SSSIs (84%) were selected at least partly for their biological interest whilst a quarter (28%) were selected at least partly for their earth science (geological or geomorphological) interest. Of the total, 12% have both biological and earth science interest. Breeding seabirds occur in 56% of the sites, while 20% of sites contain lower plant interest. The most frequently occurring habitats within SSSIs in this region are sea cliffs and maritime heath. Each of these occurs in 20% of sites. Further details of SSSIs may be found in the *Coastal and marine UKDMAP datasets* module disseminated by JNCC (BODC 1992; Barne *et al.* 1994).



Map 7.3.1 Coastal Sites of Special Scientific Interest (SSSIs), Local Nature Reserve (LNR) and National Scenic Areas (NSAs). Sources: SNH, JNCC.

Table 7.3.1 SSSIs in Region 2

Site name	*No. of sites*	*Grid ref.*	*Area (ha*)*	*Date last notified*
Westray/Papa Westray	**3**			
North Hill		HY500550	206	1984
Holm of Papa Westray		HY508520	48	1988
West Westray		HY425464	372	1985
Eday	**4**			
Calf of Eday		HY581391	242	1983
Muckle & Little Greenholm		HY527272	53	1988
Doomy & Whitemaw Hill		HY547322	249	1983
Mill Loch		HY565368	24	1983
Sanday	**2**			
Northwall		HY740445	251	1983
Central Sanday		HY700403	655	1987
Stronsay	**1**			
Mill Bay		HY665254	2	1991
Rousay	**2**			
Rousay		HY400310	2,313	1989
Eynhallow		HY360293	103	1983
Mainland	**9**			
Denwick		HY576088	<1	1991
Copinsay		HY605015	152	1983
Ward Hill Cliffs		ND466885	36	1986
Waulkmill		HY377065	71	1986
Orphir & Stenness Hills		HY330080	890	1987
Lochs of Harray & Stenness		HY295160; HY283130	1,930	1985
Stromness Heath & Coast		HY226135	755	1991
Bay of Skaill		HY233197	8	1991
Marwick Head		HY226257	9	1986
Hoy	**5**			
Muckle Head & Selwick		HY213053; HY225055	2	1991
Hoy		HY225010	8,186	1986
Sule Stack		HX565177	3	1987
Sule Skerry		HX623241	16	1987
Pentland Firth Islands		ND388844; ND465783	168	1996
Orkney	***26***		***16,743***	
North Sea Coast	561		336,345	
GB coast	1,212		717,286	
GB whole country	6,150		2,069,628	

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

7.3.2 Local Nature Reserves

Local Nature Reserves (LNRs) are designated by local authorities under section 21 of the National Parks & Access to the Countryside Act 1949, for the same purposes as National Nature Reserves (to conserve their habitats, providing special opportunities for scientific study of the habitats, communities and species represented within them) 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 their LNRs. There is one LNR (244 ha) in Orkney (Table 7.3.2; Map 7.3.1).

Table 7.3.2 Local Nature Reserves+

Site name	*No. of sites*	*Grid ref.*	*Area (ha*)*	*Date last notified*
Mull Head		HY593097	244	1992
Orkney	***1***		***244***	
North Sea Coast	73		10,710	
GB coast	98		15,279	
GB whole country	396		21,513	

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

7.3.3 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. They are designated under section 262c of the Town & Country Planning Act (Scotland) 1972. 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 is one NSA (14,800 ha) within Orkney (Table 7.3.3; Map 7.3.1).

Table 7.3.3 National Scenic Areas

Site name	*No. of sites*	*Area (ha*)*	*Date designated*
Hoy & West Mainland		14,800	1980
Orkney	***1***	***14,800***	
North Sea Coast	4	52,400	
GB coast	27	745,800	

Sources: Countryside Commission for Scotland (1978), SNH. Key: *to the nearest whole hectare. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

7.3.4 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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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
SSSIs, NSAs	*Area Officer, SNH, Northern Isles Area, Kirkwall Office, tel: 01856 875302
Local Nature Reserves, NSAs	*Orkney Islands Council, Kirkwall, tel: 01856 873535
Coastal and marine UKDMAP datasets	*Coastal and Marine Data Custodian, 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.

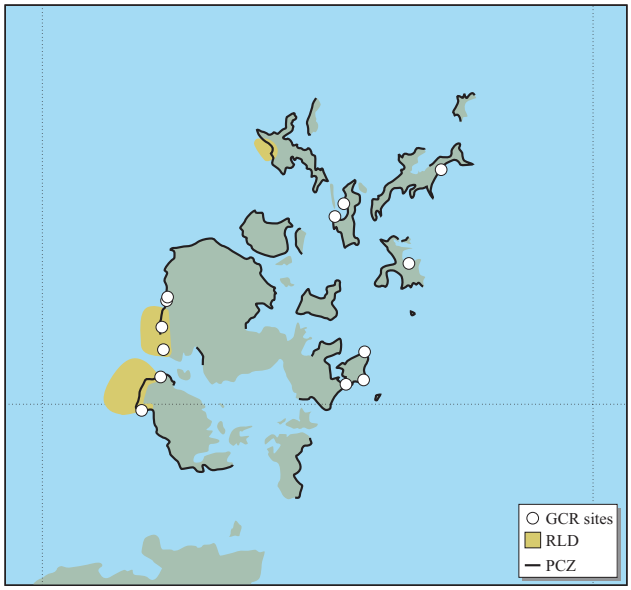
7.4.2 Geological Conservation Review sites

Geological Conservation Review (GCR) sites are non-statutory sites identified as having national or international importance for earth science. As such, it is intended that all GCR sites will eventually be notified as SSSIs. The GCR selection process describes and assesses key sites in the context of their geology, palaeontology, mineralogy or geomorphology; GCR sites are the earth science equivalent of NCRs. There are fourteen coastal GCR sites in Orkney (Table 7.4.1; Map 7.4.1). Detailed scientific accounts of coastal and inland GCR sites are contained in volumes of a planned 42-volume *Geological Conservation Review* series (see e.g. Ellis *et al.* 1996). Twelve of these volumes have been published to date.

7.4.3 Regional Landscape Designations

Regional Landscape Designations (RLDs) provide a mechanism whereby Scottish planning authorities can identify sites where there should be a strong presumption against development (Cobham Resource Consultants 1988). The designation recognises that these scenic areas have considerable unexploited potential for tourism and therefore for benefiting local economies. Local circumstances and the absence of central guidance since 1962 means that regional landscape designations vary in title, scale and objectives from one planning authority to another (Cobham Resource Consultants 1988), such that there are at least five types of RLD. The area of many of these sites is not available and there has been no monitoring or further comprehensive study of the number of RLDs since the study by Cobham Resource Consultants (1988).

There are three areas covered by RLDs that fall within the coastal zone in Orkney, where they are known as Areas of Scenic Value (ASV) (Table 7.4.2; Map 7.4.1).



Map 7.4.1 Coastal Geological Conservation Review (GCR) sites, Regional Landscape Designations (RLDs) and Preferred Conservation Zones (PCZs). Note: a single symbol may represent more than one site in close proximity. Sources: JNCC, SNH, NCC (1990).

Table 7.4.1 GCR sites

Site name	*No. of sites*
South Fersness Bay	
Greenan Nev Coast	
Central Sanday	
Mill Bay	
Denwick	
Point of Ayre	
Tarracliff Bay to Newark Bay	
South Stromness Coast Section	
Yesnaby & Gaulton Coast Section	
West Coast of Orkney	
Bay of Skaill	
Too of the Head	
Old Man of Hoy Coast	
North Hoy	
Orkney	***14***
North Sea Coast	551
GB coast	1,096
GB whole country	3,023

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

7.4.4 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 7.4.2 Regional Landscape Designations (RLDs)

Site name	*No. of sites*	*Area (ha*)*
Sea cliffs at Westray		338
Sea cliffs at Yesnaby		605
Sea cliffs at Hoy		672
Orkney	***3***	***1,615***
North Sea Coast	39	n/a
Scotland coast	63	n/a
Scotland whole country	178	n/a

Sources: Cobham Resource Consultants (1988), SNH. Key: *to the nearest whole hectare; n/a = not available. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.

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 Orkney there is one PCZ divided into several parts (Map 7.4.1). This compares with 22 PCZs in Scotland and numerous potential PCZs on the islands around Scotland (only the larger islands have defined Preferred Conservation Zones).

7.4.5 Acknowledgements

Thanks are due to Roger Bolt (JNCC), Marcus Polley (English Nature) and Donald Balsillie, Kathy Duncan, Natasha O'Connel and Stuart Gardner (Scottish Natural Heritage).

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Scottish Development Department. 1981. *National planning guidelines - priorities for development planning.* Edinburgh, Scottish Development Department.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
NCR sites, GCR sites	*Area Officer, SNH, Orkney, Kirkwall, tel: 01856 875302
PCZs, RLDs	*Orkney Islands Council, Kirkwall, tel: 01856 873535

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

7.5 Other types of protected site

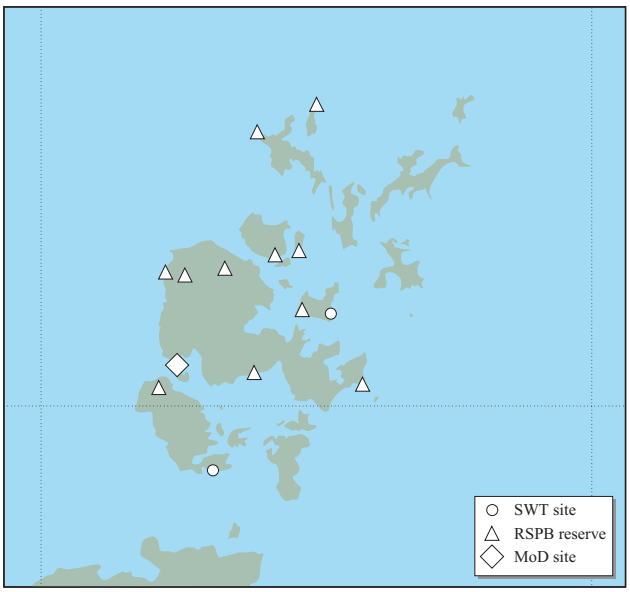
7.5.1 The Royal Society for the Protection of Birds

The Royal Society for the Protection of Birds (RSPB) currently manages over 140 reserves (97,100 ha) in Britain (Steve Gilbert pers. comm.). Wherever possible, reserves are purchased, so that the level of safeguard for the wildlife and their habitats is high. Where reserves are leased, the RSPB aims to acquire long leases (longer than 21 years) with appropriate management rights. There are eleven coastal RSPB reserves (8,132 ha) in Orkney (Table 7.5.1; Map 7.5.1).

Table 7.5.1 Royal Society for the Protection of Birds reserves

Site name	*No. of sites*	*Grid ref.*	*Area (ha*)*	*Date acquired*	*Interest*
Westray/Papa Westray	**2**				
Noup Cliffs, Westray		HY392500	14	1975	High sandstone cliffs; very large breeding seabird colony, breeding ravens *Corvus corax*, grey seals *Halichoerus grypus* offshore
North Hill, Papa Westray		HY500547	206	1987	Maritime heath, rocky coastline and sandstone cliffs; colony of arctic terns *Sterna paradisaea*, seabirds, wildfowl, waders, passerines, passing migrants
Shapinsay					
Mill Dam		HY485170	16	1993	Swamp fen with open water; breeding and wintering wildfowl, breeding waders, breeding gulls, otters *Lutra lutra*
Rousay					
The Loons		HY250240	81	1980-1984	Breeding waders and wildfowl including pintail *Anas acuta* and arctic terns
Trumland		HY427276	433	1985	Heather moorland with crags, small valleys; breeding colony of seabirds, breeding raptors, Orkney vole *Microtus arvalis orcadensis*
Egilsay		HY475300	145	1986	Farmland managed for corncrakes *Crex crex*; breeding waders especially redshank *Tringa totanus*
Mainland					
Birsay Moors & Cottascarth, Mainland		HY368187; HY346247	2,360	1971	Heather moorland, blanket bog and marsh; large numbers of nesting raptors, small colonies of seabirds, breeding waders and passerines
Copinsay		HY610010	153	1972	Island of old red sandstone, sheer cliffs, rocky shores, islets; large cliff-nesting colonies of seabirds, breeding terns, passing migrants
Hobbister		HY390067	759	1972	Heather moorland, bogs, fen, low sea cliff, saltmarsh; breeding raptors, breeding waders, breeding seabirds and breeding wildfowl
Marwick Head		HY225246	19	1979	Sheer red sandstone cliffs, rocky shore and wet meadowland; large breeding seabird colony
Hoy					
North Hoy		HY223034	3,946	1983	Moorland, glacial valleys, cliffs and heath; breeding seabirds, breeding gannets *Sula bassana*, breeding waders, breeding raptors, mountain hares *Lepus timidus*
Orkney	***11***		***8,132***		
North Sea Coast	56		24,836		
GB coast	87		39,888		

Sources: RSPB (1994; *in litt*.). Key: *to the nearest whole hectare. Note: in this table any site that is wholly or partly intertidal, and any terrestrial site at least partly within 1 km of the Mean High Water Mark, or any tidal channel as depicted on 1:50,000 Ordnance Survey maps, is included as coastal.



Map 7.5.1 Other types of coastal protected site. Sources: Scottish Wildlife Trust (SWT), Royal Society for the Protection of Birds (RSPB) and Ministry of Defence (MoD).

7.5.2 The Wildlife Trusts

The Wildlife Trusts were established to promote non-statutory nature conservation at a local level. They own/lease and manage (by agreement with owners) over 1,800 nature reserves (more than 52,000 ha). In England and Wales there is usually one Trust covering a whole county or group of counties, but both Scotland and the Isle of Man each have a single Trust. The Scottish Wildlife Trust owns/leases and manages (by agreement with owners) over 80 nature reserves (more than 15,000 ha). There are two coastal Wildlife Trust sites (83 ha) in Orkney (Table 7.5.2; Map 7.5.1).

Table 7.5.2 Wildlife Trust sites

Site name	*No. of sites*	*Grid ref.*	*Area (ha*)*	*Date acquired*
Shapinsay	**1**			
Holm of Burghlee		HY537162	11	1994
Hoy	**1**			
Hill of White Hamars		ND313885	72	1988
Orkney	***2***		***83***	
Scotland Coast	28		5,561	
North Sea Coast**	145		11,574	
GB coast**	241		25,884	

Source: Scottish Wildlife Trust (1996). Key: *to the nearest whole hectare; **includes Wildlife Trust sites in England (and Wales). 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.

7.5.3 The Ministry of Defence

As at August 1994, the Ministry of Defence (MoD) owned, leased or used under licence landholdings covering some 320 km of coastline around the UK, not all of it significant for its nature conservation value. The MoD gives high priority to nature conservation on the Defence Estate, subject to the overriding importance of military training. The restrictions to public access on some sites mean that they can be amongst the most undisturbed areas of wildlife habitat in the region. There is one coastal MoD site (4 ha) in Orkney (Table 7.5.3; Map 7.5.1).

Table 7.5.3 MoD sites

Site name	*No. of sites*	*Area (ha*)*	*Habitats*	*Protected status*
Stromness		4	Rock	None
Orkney	***1***	***4***		
North Sea Coast	64	34,496		
GB coast	109	53,456		

Source: Ministry of Defence. Key: *approximate areas, including land leased or used under licence. 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 Acknowledgements

The author wishes to thank Bob Scott, Steve Gilbert and Eric Meek (RSPB), Dr A. Somerville (Scottish Wildlife Trust) and Andrea Firth (MoD) for providing information.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
MoD sites	Conservation Officer, MoD Conservation Office, DEO, Blandford House, Farnborough Road, Aldershot, Hants. GU11 2HA, tel: 01252 348989
RSPB sites	*Regional Officer, RSPB East Scotland Office, Aberdeen, tel: 01224 624824
SWT sites	*Scottish Wildlife Trust, Edinburgh, tel: 0131 312 7765

*Starred contact addresses are given in full in Appendix.

Orkney, in common with other island communities, encounters problems disposing of some types of waste. Scrap metal such as old cars has to be compacted and shipped to the Scottish mainland for recycling. Sometimes, as here on Westray, fate lends a hand in disposing of wrecked cars in a less environmentally friendly way. Photo: Coastwatch, JNCC.

Chapter 8 Land use, infrastructure and coastal defence

S.J. Everett

8.1 Introduction

This chapter is divided into three sections: rural land use, covering agriculture (especially as it affects important coastal wildlife habitats) and woodland; infrastructure, covering population distribution, industry, ports, harbours, ferries and power generation; and coastal defence, including sea defence and coast protection.

Over half the population of Orkney lives on Mainland, primarily around Kirkwall and Stromness, with the remainder widely distributed over the other islands. The very indented nature of the coastline and small size of the islands means that none of the 20,000 population lives far from the coast. The predominant land use on Orkney is agriculture, with oil-related activity, fisheries and fish farming also important.

Orkney forms part of the Highlands and Islands Enterprise area, which is an Objective 1 (least favoured) region designated by the European Union (Objective 1 areas aim to promote the development and structural adjustment of regions whose development is lagging behind in relation to 'average' economic performance indicators within the EU). This provides for financial support under the EU's Structural Fund and Regional Aid programmes. Funds are available for economic development, tourism, improvement of the physical and social environment, investment in the development of people, transport, energy, development of agriculture and the rural economy, fisheries and protection of the natural and built environment. A series of proposed programmes were produced for the Objective 1 area (which also includes Shetland (Region 1), the Western Isles (Region 15) and most of north and west Scotland (Regions 14 and 16)) in 1993 (Highland Regional Council 1993 - see section 8.2.4A). The programmes cover agricultural consolidation, fisheries development, tourism investment and enterprise growth.

Sheep on North Ronaldsay have to be a hardy lot. The islanders, intent on protecting their precious crops, have ringed the island in stone walls, obliging the sheep to roam the rocky shores, where they survive on a diet of seaweed. Photo: Coastwatch, JNCC.

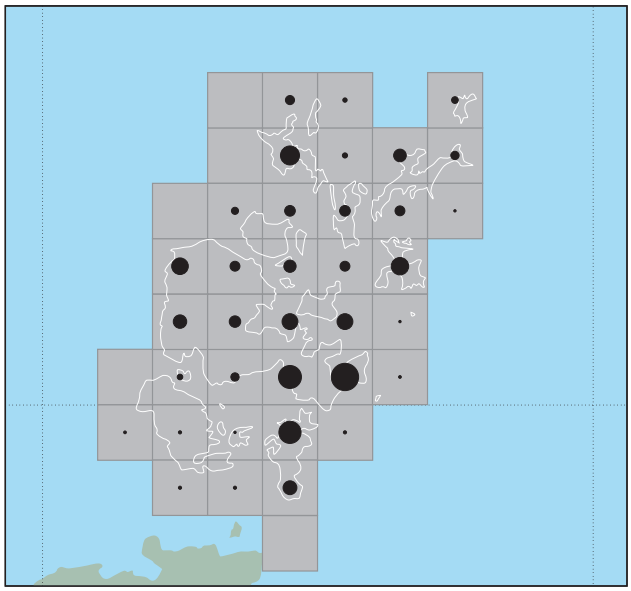
8.2 Land use

S.L. Fowler, S.J. Everett & Scott Wilson Resource Consultants

8.2.1 Agriculture

The areas of mown/grazed turf, meadow/semi-natural grassland and heath/bog/moor are shown on Maps 8.2.1, 8.2.2 and 8.2.3 respectively. Most of the coastal land in Orkney is low-lying and relatively fertile (Grade 4, with smaller areas of Grade 5). The exceptions are the islands of Hoy and Rousay, some of the hills and the west coast of Westray, which are mainly Grade 6 and suitable for use only as rough grazing. Sheep on North Ronaldsay are confined to the coastal fringe, including the beach, where they feed on the seaweed. A 'sea wall', which completely surrounds the island, prevents them from eating the grass inland. The islands are, for the most part, quite intensively farmed, with livestock being very important (the breeding herd comprises about 30,000 beef cows, 3,500 dairy cows and 55,000 ewes). In 1992 there were 1,310 holdings of an average size of 60.9 ha (nearly 80,000 ha in all, excluding common grazing). Overall, agricultural land use in the islands includes roughly 30,000 ha of rough grazings, 45,000 ha under grass and 4,000 ha under crops (barley being particularly important). Almost all the grain is grown for livestock feed.

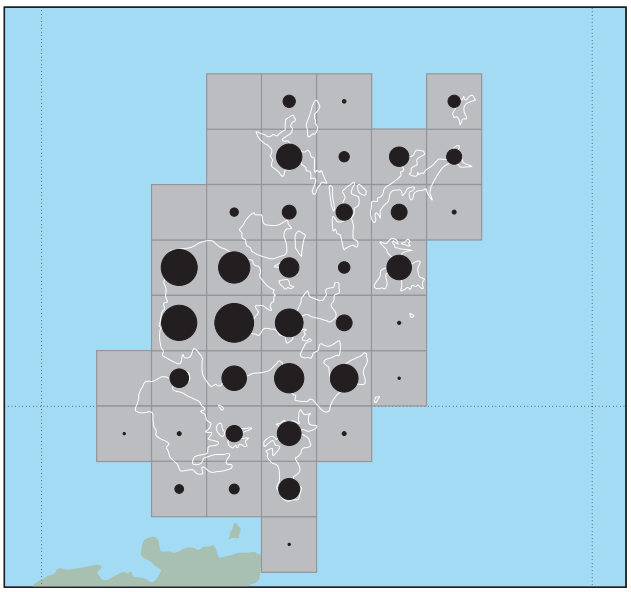
The five-year Agricultural Development Programme came to an end in early 1993, with almost £13 million having been invested in various projects, mostly in Farm Development Schemes (£9,424,000 in 581 projects) and 535 Livestock Improvement Schemes (£2,697,000). Employment in agriculture continues to decline but there has been increasing activity in fish farming (see section 9.2).



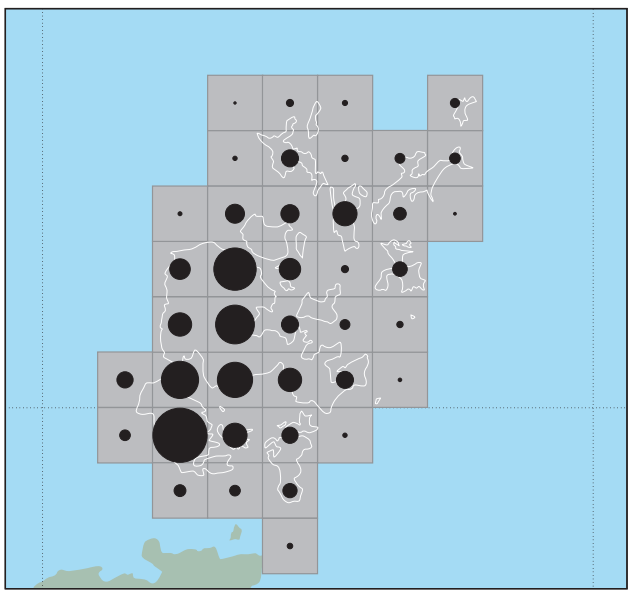
Map 8.2.1 Area of mown or grazed turf in coastal 10 km grid squares. Note: area of circle indicates the area of this land cover type in the 10 km square. Source: Countryside Survey (1990); ITE Monks Wood.

8.2.2 Woodland and forestry

There is little woodland on Orkney and no commercial forestry, although trees are increasingly being planted in shelter belts and for amenity use. Berriedale on Hoy hosts Britain's most northerly remnant of native woodland, and there are numerous coppices (mostly non-native species) in sheltered locations throughout the islands.



Map 8.2.2 Area of meadow or semi-natural grassland in coastal 10 km grid squares. Note: area of circle indicates the area of this land cover type in the 10 km square. Source: Countryside Survey (1990); ITE Monks Wood.



Map 8.2.3 Area of heath, bog and moor in coastal 10 km grid squares. Note: area of circle indicates the combined area of these land cover types in the 10 km square. Source: Countryside Survey (1990); ITE Monks Wood.

8.2.3 Information sources used

The main sources of information for this section were the Countryside Survey 1990 (ITE 1993), Macaulay Land Use Research Institute (1988) and Orkney Islands Council (1993). The Countryside Survey 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 these data, which are held in the Department of the Environment, Transport and the Regions (DETR, formerly DoE) Countryside Information System. The main limitations of these data are derived from errors in classifying areas covered by a mixture of land types. The Countryside Information System can provide data on a 1 km square framework, but this level of detail was not considered appropriate here.

8.2.4 Further sources of information

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Macaulay Land Use Research Institute. 1988. *Land cover of Scotland. Digital dataset (LCS 88).* Aberdeen, Macaulay Institute for Soil Research.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Agricultural policy in Scotland	*The Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD), Edinburgh, tel: 0131 556 8400
Land use (agricultural and forestry land capability information) in Scotland	Macaulay Land Use Research Institute, Craigiebuckler, Aberdeen AB15 8QH, tel: 01224 318611
ITE Countryside Survey 1990	*Department of Rural Affairs, DETR, Bristol, tel: 0117 987 8000
Crofting	Crofters Commission, 4/6 Castle Wynd, Inverness IV2 3EQ, tel: 01463 663 450
Crown agricultural and forestry estates	The Crown Estate, 10 Charlotte Square, Edinburgh EH2 4DR, tel: 0131 226 7241

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

8.3 Infrastructure

S.L. Fowler & S.J. Everett

8.3.1 Introduction

This section summarises the infrastructure of the region, including population distribution, industry (including oil refining), ports, harbours, ferries and power generation, and land claim for these developments. Power-producing plants are included as coastal if they are less than 2 km inland. Oil and gas exploration and development are covered in section 9.5. Fisheries and mariculture are covered in sections 9.1 and 9.2 respectively.

Orkney's location and geography are significant barriers to economic development, but the oil industry, mariculture and related service industries have enabled economic growth in recent years. The economic development of Orkney is fostered through annually reviewed Economic Development Programmes. These are funded from external sources, including the European Union Structural and Regional Development Funds (see section 8.1), Highlands and Islands Enterprise and Orkney Enterprise. In 1991 it was estimated that Orkney's Gross Domestic Product was almost £52,000 per worker, the second highest Scottish district figure after Shetland.

Map 8.3.1 Urban, suburban and rural development. Note: area of circle is proportional to the combined area of these land cover types in the 10 km square. Source: Countryside Survey (1990); ITE Monks Wood.

8.3.2 Important locations

Residential development

Orkney has only a few towns, villages and small hamlets, with scattered areas of low-density housing. In 1991 there were 7,695 households and around 700 second or holiday homes and unoccupied dwellings. Map 8.3.1 shows the proportion of urban, suburban and rural development in the 10 km squares (all of them coastal) of the region. More than half the population of Orkney is on Mainland, particularly concentrated around Kirkwall and Stromness (Table 8.3.1). The 1991 population of Orkney represented a slight increase since the 1981 census; during this period the population of Mainland (particularly Kirkwall) had increased, while the population of some outer islands had reduced. Orkney Islands Council (1993) has stated that depopulation of some of the outer islands is a cause for concern.

Table 8.3.1 Centres of population in Orkney

Location	*Population*
Kirkwall	~7,000
Stromness	~2,000
Orkney	***19,328***

Source: 1991 population census data.

Industrial developments

Services (transport, distribution and catering) currently provide the greatest source of employment, with primary industries such as agriculture and fisheries (particularly fish farming) also being important. The industrial service sector includes oil-related activities such as offshore supply and marine engineering services. Serviced sites on industrial estates have been provided in Kirkwall, Stromness and at St Margaret's Hope. The oil terminal at Flotta is an important component of the North Sea oil industry (see also section 9.5): oil-related employment there in 1993 was around 400. The terminal provides rent, rates and disturbance payments to Orkney Islands Council and so has benefited the island's economy and infrastructure. Ten oil fields are connected to Flotta and the supply of oil to the terminal is expected to continue well into the 21st century. Spin-off industries have developed as a result of the terminal. These include the Water Test Centre and the Centre for Island Technologies operated by Heriot-Watt University. Major areas of industrial infrastructure in Orkney are listed in Table 8.3.2

Fisheries (including for shellfish) and the development of fish hatcheries are of great importance in Orkney (see sections 9.1 and 9.2). The council provides incentives for onshore developments such as ice plants, improvements to piers and associated engineering works at local harbours, with the aim of enhancing the local fleet and the local fish catch. There are processing facilities in Stromness, Kirkwall, Westray and Rousay. Scallop-dredgers and divers supply small factories.

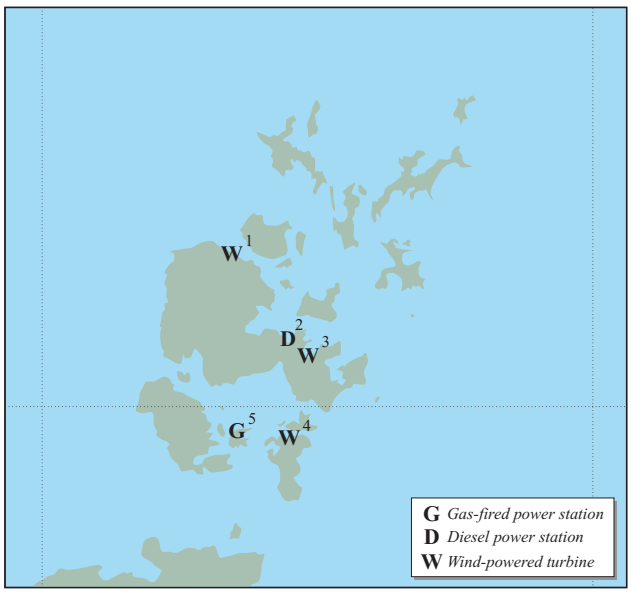
Power generation

One quarter of all Europe's harnessable wind has been identified in Scotland. Islands exposed to prevailing westerly winds are particularly attractive for harnessing wind power, since the winds are favourable. In Orkney, in

Table 8.3.2 Major areas of coastal industrial development

Site no. on Map 8.3.2	*Location*	*Grid ref.*	*Details*
1	Burgar Hill	HY3426	Wind farm: 3.55 MW (1 x 3 MW + 1 x 250 kW + 1 x 300 kW)
2	Kirkwall	HY4510	Small industrial estate; distillery and other development related to the main urban centre for Orkney. Diesel power station: 30 MW
3	Inganess Bay	HY4609	Wind turbine, output 75 kW
4	Berriedale	ND4593	Wind turbine, output 50 kW
5	Flotta	ND3595	Oil terminal, *c.* 100 ha oil storage tanks and associated buildings; 9 large oil storage tanks plus other smaller tanks. Gas turbine power station: 21 MW.

Source: Orkney Islands Council and Ordnance Survey 1:50,000 Landranger maps. Note: there are also numerous small industrial sites located around the islands; mariculture sites are considered in section 9.2.



Map 8.3.2 Industrial sites and coastal power stations in the region (Table 8.3.2). Source: Ordnance Survey Landranger maps. © Crown copyright.

addition, domestic heating is desirable for most of the year, oil and coal supplies from the mainland are increasingly expensive and population density is low. Consequently there are significant renewable energy developments in the region in the form of wind-powered turbines. The capacity of Orkney's wind farms (including those under construction) represents 2.2% of the UK total wind capacity of 160.5 MW (British Wind Energy Association pers. comm.).

Coastal power installations in Orkney are listed in Table 8.3.2. Until 1983 all power generation was by the diesel fired power station at Kirkwall (now owned by Scottish Hydro-Electric). Since 1983 the islands have been connected to the mainland grid via a cable across the Pentland Firth; the maximum capacity of the cable is 20 MW (Scottish Hydro-Electric pers. comm.). As the region has an annual power demand of approximately 29 MW, power requirements in excess of this have to be met by facilities on the island.

The operational diesel fired station at Kirkwall, which has a maximum output of 30 MW, produces <0.1% of the UK's conventionally-produced power (Scottish Hydro-Electric pers. comm.). The six gas turbine generators on Flotta were built by Scottish Hydro-Electric but have been bought by the oil terminal operators. Three of the generators supply the network, whilst power from the remaining three supply the oil terminal on Flotta.

Wind turbines were constructed at Burgar Hill, West Orkney, in 1981 by North of Scotland Hydro-Electric Board (NSHEB). The installation consists of three turbines: a 250 kW Wind Energy Group (WEG) machine, a Howden 300 kW turbine and a larger 3 MW machine, which is leased by Orkney Sustainable Energy Ltd. Scottish Hydro-Electric hold the lease for the two smaller wind turbines, which are not currently operational; a proposal to upgrade them is under consideration (Orkney Sustainable Energy Ltd. pers. comm.). There are further privately-operated individual turbines at Inganess Bay on Mainland and at Berridale on South Ronaldsay.

Competition in the electricity generating industry has been intense since privatisation in 1990. This has stimulated some diversification, which has been further encouraged by guidelines such as the Scottish Renewable Order (SRO), introduced by the Secretary of State for Scotland under the 1989 Electricity Act, and the EC's 1988 Directive on Large Combustion Plant. Bids for further renewable energy installations under SRO round 2 are currently under consideration and the final list will be published in 1997 (OFFER pers. comm. 1996).

Ports and harbours

The main port developments on Orkney are Stromness and Kirkwall on Mainland, the third largest being the 19th century fishing station of St Margaret's Hope, South Ronaldsay. Stromness has fish landing and roll-on roll-off facilities, and Kirkwall handles shipments of livestock, grain and fertiliser and provides handling and tanker discharge facilities. The Royal Naval base at Lyness, Hoy, closed in 1957. There are many smaller harbours or jetties on the other islands that are primarily used as fishing harbours, with larger sites also used for importing and exporting goods and for inter-island ferry traffic (Table 8.3.3). The huge natural harbour of Scapa Flow has long been an important sheltered anchorage, able to accommodate very large vessels, and now has its own port facilities as a result of the oil terminal development on Flotta. In 1994 the port ranked as the ninth most important in the UK in terms of the volume of oil-related traffic. The current level of port activity will be increased in the forseeable future as the terminal will take oil from the Foinaven field 130 miles north-west of Orkney (Robertson 1996). Under a five-year contract, shuttle tankers will deliver 85,000 barrels per day of production to Flotta for storage. The contract is expected to increase the throughtput at Flotta by at least 25% and

Table 8.3.3 Ports, harbours and other facilities

No. on Map 8.3.3	*Location*	*Grid ref.*	*Details*
	Northern Islands		
1	Papa Westray east	HY4952	Pier/public slipway
2	Moclett, Papa Westray	HY4849	Landing pier (inter-island ferry); public slipway
3	Gill Pier and Pierowall, Westray	HY4448	Landing pier (inter-island ferry) and pier at Pierowall
4	Faray	HY5335	Jetty
5	Backaland, Eday	HY5730	Landing pier (inter-island ferry); public slipway
6	Howmae Brae, North Ronaldsay	HY7552	Landing pier (inter-island ferry); public slipway
7	North of Overbister, Sanday	HY6942	Jetty
8	Kettletoft, Sanday	HY6638	Landing pier (inter-island ferry); public slipway
9	Whitehall, Stronsay	HY6528	Landing pier (inter-island ferry); public slipway
10	Auskerry	HY6716	Small harbour with pier on west side of island
11	Balfour, Shapinsay	HY4716	Landing pier (inter-island ferry); public slipway
12	Skaill, Egilsay	HY4630	Landing pier (inter-island ferry); public slipway
13	Trumland, Rousay	HY4327	Landing pier (inter-island ferry); public slipway
14	Russ Ness, Wyre	HY4426	Landing pier (inter-island ferry)
	Mainland/South Ronaldsay		
15	Tingwall	HY4022	Landing pier (inter-island ferry)
16	Finstown	HY3613	Pier
17	Kirkwall	HY4411	Landing piers and harbour; six berths, total length 780 m; lo-lo (crane load on and off), ro-ro (roll on, roll off), car and passenger ferry, dry bulks, grain/feedstuffs, oil/petroleum, livestock
18	St Mary's	HY4700	Pier; public slipway
19	Bur Wick, South Ronaldsay	ND4483	Landing pier (summer ferry from John O'Groats)
20	St Margaret's Hope, South Ronaldsay	ND4494	Landing pier (inter-island ferry)
21	Burray Village, Burray	ND4795	Pier; public slipway
22	The Baits	HY4408	Pier
23	Toy Ness	HY3504	Pier
24	Houton	HY3103	Landing pier (inter-island ferry); anchorage in Houton Bay
25	Stromness: Hamnavoe	HY2509	Piers and harbour; terminal for passenger/vehicle ferries to Aberdeen, Lerwick and Hoy; ro-ro, dry bulks; two berths, 388 m total length.
26	Graemsay	HY2705	Landing pier (inter-island ferry)
	Hoy/Flotta		
27	Moaness, Hoy	HY2403	Landing pier (inter-island ferry)
28	Lyness/Ore Bay, Hoy	ND3194	Two piers, and quay for inter-island ferry
29	Flotta	ND3495	Piers and jetty for oil terminal, and pier at Calf Sound; crude oil and associated liquid gases (LPG and ethane)
30	South Ness, South Walls	ND9091	Landing pier (inter-island ferry)

Sources: Walker (1996), Ordnance Survey 1:50,000 Landranger 3 maps. Note: for information on recreational harbours and associated facilities see section 9.7.

result in extra cash flowing into Orkney's oil revenue fund (standing at £100 million in 1995). The ports at Stromness, Kirkwall and Flotta are owned and operated by Orkney Islands Council.

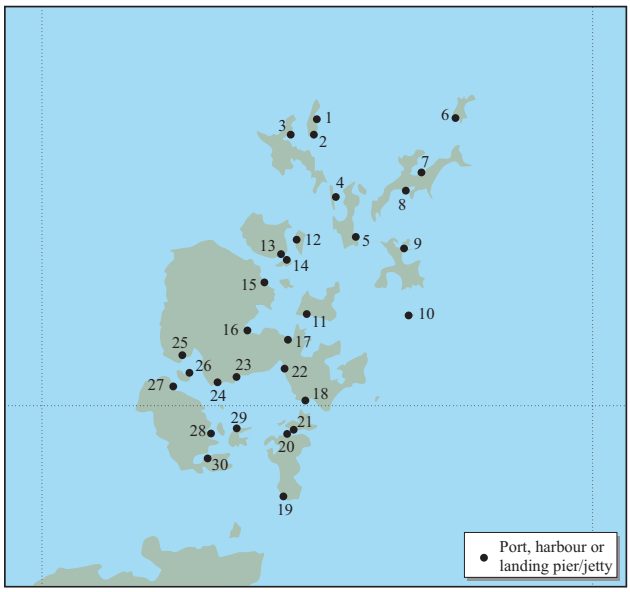
Lord Donaldson (1994) records that there is virtually no clear information available on where ships go within UK waters. The Department of Transport, UK Offshore Operators Association and the Health and Safety Executive have addressed this issue by jointly funding a project to produce a ship traffic database (COAST), which provides details of 3,500 shipping routes across the UK continental shelf, giving the number of vessels and their distribution by ship type, age and flag. An extract from this database is shown on Map 8.3.4, with an indication of Areas To Be Avoided (ATBA) by shipping.

Cables and pipelines

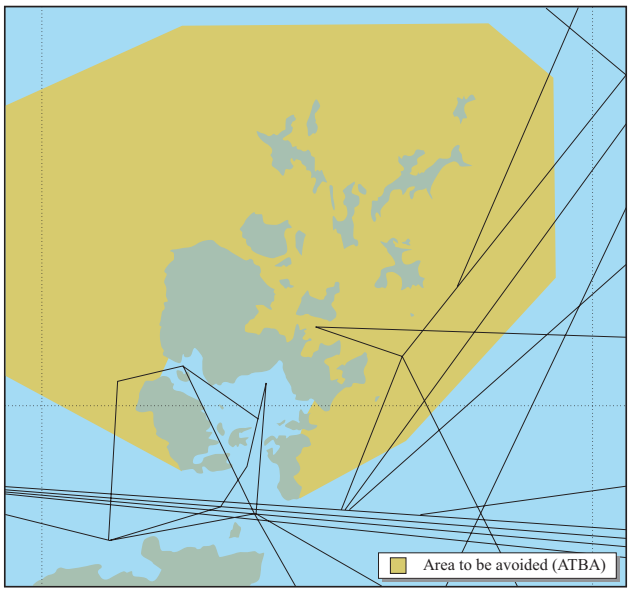
There are numerous cables and pipelines between the Orkney Islands, carrying services such as telephone lines and electricity, and a submarine telephone cable runs from Orkney to Shetland. A major oil pipeline comes into the Flotta Terminal from North Sea fields to the east of the islands, entering Scapa Flow through Holm Sound between Burray and Mainland.

8.3.3 Information sources used

The main sources of information for this section were Orkney Islands Council (1993), Walker (1996) and Ordnance Survey Landranger 1:50,000 maps. A limited amount of information on the Orkney ports has been published in the Compass UK Ports Directory (Walker 1996). 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'. Data regarding output capacity of power stations in the region were obtained from the Scottish Hydro-Electric District Office in Kirkwall.



Map 8.3.3 Ports, harbours and piers/jetties (Table 8.3.3). Sources: Walker (1996) and others.



Map 8.3.4 Shipping routes and Areas To Be Avoided (ATBA). Sources: shipping routes reproduced from the COAST database, held by Dovre Safetec Ltd; other information from the Marine Safety Agency.

8.3.4 Acknowledgements

Thanks are due to Dovre Safetec Ltd. for providing information from the COAST Database. Thanks also go to John Orr, Orkney Islands Council, for his useful comments on the draft text.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Planning developments	*Orkney Islands Council, Development Department, Kirkwall, tel: 01856 873535
European Social Fund and Regional Aid programmes - Highlands and Islands	Programme Director, Highlands & Islands Partnership Programme, Bridge House, 20 Bridge Street, Inverness IV1 1QY, tel: 01463 244292
Industrial and economic development	Highlands and Islands Enterprise, Bridge House, 20 Bridge Street, Inverness IV1 1QY, tel: 01463 234171
Economic and urban development policy including European Funds (Scotland)	*SOAEFD, Development Department, Edinburgh, tel: 0131 556 8400
Economic development: Orkney	Orkney Enterprise, 14 Queen Street, Kirkwall, Orkney KW15 1JE, tel: 01856 874638
Energy production	
Energy production general	Department of Trade and Industry, 1 Victoria Street, London SW1H 0ET, tel: 0171 215 5000
Energy production general	Secretary, Institute of Energy, 18 Devonshire Street, London W1N 2AU, tel: 0171 580 7124
Conventional power production, power stations	District Power Systems, Scottish Hydro-electric, Kirkwall, Orkney, Great Western Road, Kirkwall KW15 1HP, tel: 01856 870377
Renewable energy general	*SOAEFD, Development Department, Energy Efficiency Office, Edinburgh, tel: 0131 556 8400

Type of information	*Contact address and telephone no.*
Energy production (continued)	
Renewable energy (SRO - 2 list)	Office for Electricity Regulation, Regent Court, 70 West Regent Street, Glasgow G2 2QZ, tel: 0141 331 2678
Wind energy	Orkney Sustainable Energy Ltd., The Old Academy, Stromness, Orkney KW16 3AW, tel: 01856 850054
Ports and shipping	
British Ports Association	217 Africa House, 64-78 Kingsway, London WC2B 6AH, tel: 0171 242 1200
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
Flotta Harbour development	*Orkney Islands Council, Kirkwall, tel: 01856 873535
Flotta Harbour Operator	Elf Exploration UK plc, Flotta Terminal, Flotta, Orkney KW16 3NP, tel: 01856 884000
Stromness	Orkney Islands Council, Dept of Harbours, Harbour Authority Building, Scapa, Orkney KW15 1SD, tel: 01856 873636
Kirkwall	*Orkney Islands Council, Kirkwall, tel: 01856 873535

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

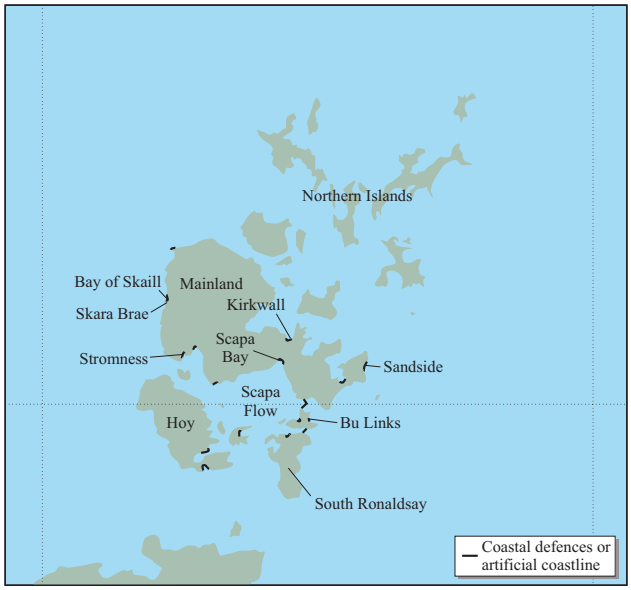
8.4 Coastal defence

S.L. Fowler & S.J. Everett

8.4.1 Introduction

Coastal defence covers two types of works: coast protection and sea (or flood) defence. Coast protection works prevent or slow the erosion of land and encroachment by the sea. Sea defences protect low-lying land from flooding, especially to protect human life and property in coastal settlements and industrial areas; some were also built in the past to protect agricultural land and to allow agricultural improvement and drainage. Some forms of coastal defence may protect against both erosion and flooding. It is sometimes difficult to differentiate between the two different forms of coastal works, particularly where they are owned and maintained privately or by bodies (such as MoD) not usually responsible for coastal defences.

Overall, land in the south of England is sinking relative to sea level, while it is rising in the north of Britain (see section 2.5). Recent sea-level change trends suggest a net fall in sea level around the coast of the region, so the risk of coastal erosion or flooding in Orkney is only very localised. In future, rising sea levels and increasing frequency of storm conditions in the Atlantic and North Sea resulting from climate change are likely to increase the potential for erosion and flooding on the north coast of Scotland and decrease 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 threats to low-lying coastal areas in Orkney.



Map 8.4.1 Principal locations of coastal defence works (Table 8.4.1). Sources: HR Wallingford (1995) and Ordnance Survey 1:50,000 Landranger maps.

8.4.2 Important locations

There are very few areas of coastal defence or artificial shoreline in Orkney, other than where land has been claimed for ports or industrial or urban purposes, notably in Kirkwall and Stromness and on the island of Flotta. There are also artificial causeways constructed between Mainland and the islands of Burray and South Ronaldsay via Lamb Holm and Glimps Holm. Principal locations of coastal defence works are listed in Table 8.4.1 (Map 8.4.1).

Coastal erosion is thought to be threatening more than 100 ancient archaeological sites, including Skara Brae, which was once separated from the sea by a lagoon and a barrier of sand dunes. The site was exposed by coastal erosion one winter, when these processes are most active.

8.4.3 Management

Orkney Islands Council has powers as the coast protection authority in Orkney to protect land from erosion and encroachment. Legislation relating to the carrying out of flood or sea defence works is included in the Water

Table 8.4.1 Coastal erosion and main locations of coastal works

Location	*Details*
Northern Islands (Westray, Eday, Sanday, Stronsay, Shapinsay, Rousay)	No significant long-term erosion by the sea but wind and sheep grazing have a major influence on a number of sand dune and machair areas. A number of small localised coastal defence schemes exist, typically to protect roads, cemeteries and individual properties.
Kirkwall	Sea walls and rock revetments either side of Kirkwall Harbour.
Scapa Flow	There is little erosion in this area. A sea wall protects the B9053 road in the centre part of Scapa Bay and at Stromness. Other small sea walls have been built to protect the fishing villages along the coast.
Outer shores of Mainland, South Ronaldsay and Hoy	Long-term coastal retreat is occurring on most of the beach areas, most notably at the Bay of Skaill, where a vertical sea wall fronts part of Skara Brae. There is also cliff erosion, which is more noticeable along the till cliffs. The sandstone cliffs are being eroded by both wave and wind action. Extraction of beach material has had a detrimental effect on a number of beach areas, in particular at Bay of Skaill, Sandside and Bu Links on Burray. There are small localised works protecting individual properties, cemeteries and roads.

Source: HR Wallingford (1995).

Resources Act (1991) and the Land Drainage Act (1991). In this region, departmental responsibility for flood defence and coast protection lies with the Scottish Office Agriculture, Environment and Fisheries Department under the Flood Prevention (Scotland) Act 1961 and the Land Drainage (Scotland) Act 1959.

8.4.4 Information sources used

The principal source of information was HR Wallingford (1995), a study on coastal cells in Scotland to identify areas of sediment accretion and erosion, co-sponsored by Scottish Natural Heritage, the Scottish Office and Historic Scotland. Information on coast protection works and sea defences in Orkney is limited and it is often not possible to tell from Ordnance Survey maps which areas of coastline are artificial, so the information marked on Map 8.4.1 may be incomplete.

8.4.5 Acknowledgements

Thanks are due to the Planning Department of Orkney Islands Council for additional information and to George Lees of Scottish Natural Heritage for his comments on the draft.

8.4.6 Further sources of information

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Scottish Office Environment Department. 1995. *National Planning Policy Guideline. Planning and flooding*. Edinburgh, Scottish Office Environment Department.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Flood defence and coast protection policy, grants towards capital expenditure	*The Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD), Edinburgh, tel: 0131 556 8400
Coast protection and flood defence	*Orkney Islands Council, Department of Technical Services, Kirkwall, tel: 01856 873535
Storm Tide Warning Service	Meteorological Office, Johnstone House, London Road, Bracknell, Berkshire RG12 2SZ, tel: 01344 420242
National Landslide Databank	Rendel Geotechnics, Norfolk House, Smallbrook Queensway, Birmingham B5 4LJ, tel: 0121 627 1777
Coastal Engineering Advisory Panel	Secretary, Institute of Civil Engineers, 1 Great George Street, London SW1P 3AA, tel: 0171 222 7722

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

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 of Orkney. There are fisheries for pelagic and demersal fish (demersal fish live on or near the sea bed; pelagic fish do not), several marine shellfish species 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 and islands in Orkney where landings are recorded by SOAEFD and the boundaries between the Orkney, Shetland and Wick Sea Fisheries Districts are shown on Map 9.1.1. Mainland supports two principal fishing ports, Kirkwall and Stromness. Other islands supporting commercial fishing boats are Sanday, Westray, Stronsay, Rousay, South Ronaldsay and Hoy. The Orkney Islands support a modern offshore trawling fleet, the majority of the boats being based on Westray. They target demersal fish species and work the creel fishery, mainly targeting lobsters and crabs but also velvet crab, shore crab and whelks. Other shellfish species such as *Nephrops*, scallops and queen scallops are also fished. Some boats may switch to the creel fishery during the warmer months. There are no fish markets in Orkney and fish and shellfish are landed directly to the processors, some of which are situated at Scottish mainland ports.

In 1992, 0.4% of all recorded landings of fish and shellfish species in Britain and the Isle of Man were made in Orkney, which is below the average of all regions of 5.9%, with no recorded landings of pelagic or diadromous species. However these low figures could, in part, be attributed to the amount of fish that is landed directly to processors on mainland Scotland (Coull & Sheves 1979). The total tonnage of demersal species landed in the region represents 0.6% of the British and Isle of Man totals. Total landings of shellfish species in the region in 1992, at 1,262 tonnes, account for 1.2% of the British and Isle of Man and 2.7% of the Scottish totals. The 797 tonnes of crabs landed in Orkney represents 4.7% of the British and Isle of Man total and there are also significant landings of lobsters (11.9%) and whelks (8.2%). A summary of the totals for pelagic, demersal and shellfish species is given in Table 9.1.1.

Map 9.1.1 Fishing ports, areas and islands in the Orkney Sea Fisheries District.

Approximately 65% of all fish registered as landed in the region in 1992 was landed to Kirkwall. Table 9.1.2 summarises landings to Kirkwall in the four years from 1991 to 1994, showing trends in landings in relation to 1992, the

Table 9.1.1 Species group landings in 1992 (tonnes)

Species group	*Region 2*	*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	0	184,309	227,669	252,335	0	0
Demersal	1,506	228,056	193,914	275,460	0.7	0.6
Shellfish	1,262	61,933	46,112	104,917	2.0	1.2
All species	***2,777***	***474,298***	***467,695***	***632,712***	***0.6***	***0.4***

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.). Key: *of Britain (see section 9.1.4). Notes: amounts landed are rounded up to the next whole tonne. Figures are given in 'nominal live weight' i.e. weight of the whole fish. Calculating the figures in this table was a complex process: refer to section 9.1.4.

year on which the more detailed landings data analysis in Table 9.1.1 was based.

In the Orkney Salmon Fishery Statistical District, no salmon or sea trout catches were recorded between 1989 and 1993 (Scottish Office Department of Agriculture and Fisheries 1990; Scottish Office 1991, 1992, 1993, 1994).

Table 9.1.2 Landings* of all fish species to Kirkwall 1991 - 1994 (thousands of tonnes)

	1991	*1992*	*1993*	*1994*
Kirkwall	0.5	1.8	1.9	1.3
Scotland	458.4	467.7	491.8	487.8
% of Scottish total landed in Kirkwall	0.1	0.4	0.4	0.3

Sources: Ministry of Agriculture, Fisheries and Food (1995b). Key: *landings totals relate to 'nominal live weight', i.e. weight of the whole fish.

9.1.2 The fisheries

Demersal species

Table 9.1.3 gives the quantities of various demersal species landed in 1992 in the region, compared with landings nationally. Inshore trawlers target demersal fish species, which are also landed as a by-catch in the *Nephrops* fishery. Most of the trawling fleet fishes offshore for demersal species, although a number of local trawlers remain inshore. The use of mobile fishing gear is restricted in the west of the Orkney Islands, so fixed gear such as nets and lines are used. These catch species such as cod, pollack, plaice and dogfish.

Shellfish species

Table 9.1.4 gives the quantities of various shellfish species

Table 9.1.3 Demersal species landings in 1992 (tonnes)

Species	*Region 2*	*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	309	7,449	9,657	13,348	4.1	2.3
Skates and rays	73	3,816	3,670	7,827	1.9	0.9
Gadoids						
Cod	236	53,440	35,898	59,524	0.4	0.4
Haddock	218	49,221	49,867	53,586	0.4	0.4
Hake	6	589	1,993	3,620	1.0	0.3
Ling	146	4,594	4,318	6,027	3.2	2.4
Pollack (lythe)	16	1,921	1,285	3,023	0.8	0.5
Saithe	66	11,032	10,310	12,602	0.6	0.5
Whiting	139	36,733	35,923	41,055	0.4	0.3
Whiting, blue	0	6,531	6,531	6,531	0	0
Flatfish						
Brill	0	317	50	443	0	0
Dab	9	1,017	759	1,215	0.9	0.7
Dover sole	0	2,021	57	2,876	0	0
Flounders	0	167	4	273	0	0
Halibut	P	166	114	194	-	-
Halibut, Greenland	0	119	20	137	0	0
Lemon sole	25	5,004	2,566	5,573	0.5	0.4
Megrim	30	1,379	2,566	4,037	2.2	0.7
Plaice	72	20,749	7,902	23,887	0.3	0.3
Turbot	1	561	196	742	0.2	0.1
Other species						
Catfish	12	1,896	1,378	1,935	0.6	0.6
Conger eel	1	99	107	510	1.0	0.2
Gurnard	7	368	32	627	1.9	1.1
Monkfish/angler	94	9,813	11,557	14,678	1.0	0.6
Redfish	11	718	193	774	1.5	1.4
Sand eel	0	4,152	4,152	4,152	0	0
Torsk (tusk)	18	165	194	207	10.9	8.7
Witch	12	1,405	1,789	1,981	0.9	0.6
Others	5	2,419	682	3,833	0.2	0.1
Fish roes	0	195	144	243	0	0
Total	***1,506***	***228,056***	***193,914***	***275,460***	***0.7***	***0.6***

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: *of Britain (see section 9.1.4); P = species landed in the region in small quantities (here <0.5 tonnes). Notes: amounts landed are rounded up to the next whole tonne. Calculating the figures in this table was a complex process: refer to section 9.1.4.

Table 9.1.4 Shellfish landings* in 1992 (tonnes)

Species	*Region 2*	*North Sea coast***	*Scotland*	*Britain and Isle of Man*	*% of North Sea coast** total landed in region*	*% of combined British and Isle of Man total landed in region*
Cockles	0	26,199	2,546	32,047	0	0
Crabs	797	9,117	7,501	16,970	8.7	4.7
Lobsters	127	622	564	1,069	20.4	11.9
Mussels	0	4,865	3,067	6,555	0	0
Nephrops	1	8,368	17,707	19,639	<0.1	<0.1
Periwinkles	14	315	1,837	1,907	4.4	0.7
Queen scallops	1	2,207	5,518	11,273	<0.1	<0.1
Scallops	113	4,519	5,068	8,290	2.5	1.4
Shrimps	0	615	180	743	0	0
Squids	12	1,382	1,071	2,005	0.9	0.6
Whelks	197	1,905	858	2,393	10.3	8.2
Others	0	1,819	195	2,026	0	0
Total*	***1,262***	***61,933***	***46,112***	***104,917***	***2.0***	***1.2***

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; **of Britain (see section 9.1.4). Notes: amounts landed are rounded up to the next whole tonne. Figures are given in 'nominal live weight' i.e. weight of the whole fish. Calculating the figures in this table was a complex process: refer to section 9.1.4.

landed in 1992 in the region, compared with landings nationally.

There are many part-time fishermen operating beach boats around the islands, many of them crofters. The majority of the local fleet depends on the creel fishery, mainly targeting lobsters and crabs but also velvet crab, shore crab and whelks. Lobsters are the most important resource in terms of revenue, being exploited nearly all year. Larger inshore creel boats use over 1,000 creels. During the peak lobster season from August and through the autumn, creels are also set outside Orkney, for example in the Pentland Firth. The main creeling season for edible crab is from March through to the start of the peak lobster season in August. During the winter the majority of fishing effort takes place within Scapa Flow, as this area is relatively sheltered. Creels are also set to the west of Orkney for edible crab when the weather is calmer. *Nephrops* are occasionally targeted by the inshore trawling fleet, although most effort towards this fishery comes from the larger trawlers fishing 50-65 km offshore.

Both scallops and queen scallops are dredged in coastal waters, around the islands and further offshore. Visiting scallop dredging boats, some from as far away as the Isle of Man and Wales, also work local beds. Scallops and queen scallops are also harvested by SCUBA divers, especially between the islands within sheltered areas inaccessible to dredgers. Razor shells are traditionally taken by hand on a small scale around Orkney.

Diadromous species

The distribution of diadromous fish species in sea lochs and coastal sea of the region is discussed in section 5.8. In this region there are no recorded landings of salmon (including grilse) or sea trout (Scottish Office Department of Agriculture and Fisheries 1990; Scottish Office 1991, 1992, 1993, 1994).

Sea angling

Sea angling is distinguished from two other types of sport fishing: game fishing for salmon, sea trout, brown and rainbow trout (the first two are covered here) and coarse fishing, which is for freshwater fish species and so is not covered here. Sea angling has three main forms: angling from the shore, inshore fishing within about 5 km of the shore and deep sea fishing. Sea angling is a popular sport practised by over two million people in Great Britain (Fowler 1992). The governing body in Scotland is the Scottish Federation of Sea Anglers, which has approximately 64 affiliated clubs and approximately 200 additional personal members, who are not always members of affiliated clubs. Kirkwall and the sheltered waters of Scapa Flow are reknowned for sea angling, with many species such as skate, halibut, ling, plaice, pollack, mackerel and haddock caught (Orton 1996). Other locations such as the Loch of Stenness are also important for sea trout. Charter boats can be hired from many of the harbours and piers around the Orkney Islands.

Bait collection

Fowler (1992) identified that at the time of the bait collection survey (1985) the exploitation of bait species was very localised in the Orkney Islands. Anglers collect their own bait, including species such as 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.

9.1.3 Management and issues

Responsibility for the management of fisheries in coastal waters rests with the Commission for the European Union (EU), who delegate it to member states under the Common Fisheries Policy (CFP). European Council regulations are implemented through UK law, usually by means of statutory instruments, which define limits and restrictions and set down powers of enforcement and penalties.

All national regulation measures, including local sea fisheries bylaws, must conform with the requirements of the CFP.

The CFP seeks to manage stocks of fish in EU waters on a biological basis, principally by implementing catch quota management measures, by setting agreed annual Total Allowable Catches (TACs) for particular stocks. The policy came into effect in 1983 and was subject to a mid-term review in 1993, with a full review planned for 2002. The CFP is described in Coffey (1995), which sets out the basic elements of the policy and contributes to the debate on fisheries and the environment. A central principle of the policy is the rule of 'equal access' - that all member states of the EU have equal access to all community waters and all fishing resources. However, this rule is subject to the principle of 'relative stability', which takes account of established practice, and consequently a number of exceptions have been adopted, based on various precedents and historic fishing patterns. Between 6 and 12 nautical miles from baseline (low water mark) other member states with historic rights also have access, and beyond 12 nautical miles (the limit of British Territorial Seas) access by vessels from the other member states is limited based on historic fishing rights and by vessels from non-member countries by reciprocal agreements with 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 Division IVa (Northern North Sea). ICES provides scientific advice on the management of all the important commercial species of fin fish and some shellfish stocks in all areas of the north-east Atlantic. This work is summarised in the annual report of the Advisory Committee for Fisheries Management, which is responsible for providing scientific advice on TACs and other conservation measures to the international fisheries commissions, including the EU. The TAC is a fishery management tool which may, amongst other management needs, take account of the maximum level of exploitation that a given stock can sustain. Precautionary TACs are applied to important stocks where there are not enough scientific data to make an analytical assessment. Once the TACs are set for each stock they are divided between member states in the form of catch quotas. European Council Regulation No. 3074/95 (European Council 1995) fixed, for 1996, details of the catch quotas for fish and shellfish species for all European countries and certain conditions under which the species could be fished. The TACs, UK quotas and 'uptake' for 1995 for each species in the ICES statistical division in the region are given in SOAEFD (1996a), which is published annually. European Council Regulation No. 3760/92 (European Council 1992) summarises the CFP, including the proportions by which TACs are allocated as national quotas. Information on minimum landing sizes and whether an annual quota applies in the region for the important pelagic and demersal species is given in Table 5.7.1.

The economy of Orkney is underpinned by the fishing industry and the region has important spawning areas for many species (section 5.7.2). Thus fishing effort is restricted by the European Council in an area known as the 'Shetland Box', which includes Orkney. The number of visiting boats allowed to fish within this area is limited through the 'Shetland Box licensing scheme', which limits the activity of vessels >26 m long fishing for demersal species. It is designed to help Shetland and Orkney as fisheries-dependent areas by restricting access by non-UK vessels to a greater degree than elsewhere in UK waters. 128 licences are allocated - 62 to UK, 52 to France, twleve to Germany and two to Belgium. The western boundary of the 'Norway pout box' dissects Orkney, thus covering the waters extending to the north-east, east and south-east of Orkney. In the Norway pout box the use of small mesh net (16 mm minimum) for Norway pout is prohibited, thus also protecting juvenile stock of other demersal species.

Map 9.1.2 Seasonal closures on the use of mobile fishing gear and general prohibition of fishing for crustacea. 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.

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 Orkney Sea Fisheries District Office collects data on landings from the Orkney Islands. Administration and enforcement of sea fisheries legislation within the Orkney Sea Fisheries District is the responsibility of the Sea Fisheries Inspectorate branch of the Scottish Fisheries Protection Agency, which operates the Fisheries Protection Fleet and aircraft. In Scottish inshore waters (to 6 nautical 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. Map 9.1.2 and Table 9.1.5 show the seasonal fishing closures in two 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 and further reviewed in 1996.

The Sea Fisheries (Wildlife Conservation) Act 1992 gives SOAEFD limited scope to have due regard for wider environmental interests when managing fisheries. There are

Table 9.1.5 Seasonal fishing closures in the region

Sea area within which prohibition applies	*Full year closure or seasonal closure*	*Type of prohibition, and the period of prohibition (all dates are inclusive)*
The Berry to Costa Head	Seasonal	Ban on use of mobile gear from May to September
Scapa Flow	Seasonal	Ban on fishing for all crustacea from 1 June to 15 September

Source: Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 1989. Note: 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.

a total of nine Regulating Orders in Britain, covering approximately 215,889 ha (as at July 1995) (MAFF 1995a). While Regulating Orders do not apply in Scotland at present, the Scottish Office issued a consultation paper in December 1994 reviewing its policy on Several and Regulating Orders. Regulating Orders can be granted under the Sea Fisheries (Shellfish) Act 1967 by SOAEFD to a responsible body to enable it to regulate the natural fishery via regulations and restrictions and to levy tolls or royalties. Several Orders are discussed in more detail in section 9.2.3. Fisheries managers have been given environmental responsibilities under the Environment Act 1995 and the Conservation (Natural Habitats etc.) Regulations 1994.

Fishermen's Organisations, such as the national Scottish Fishermen's Federation and, in the region, the Orkney Fishermen's Association, represent fishermen's and boat owners' interests in the fishing industry and are consulted on fisheries management issues and other fisheries-related issues. The Orkney Islands Council has a role in providing infrastructure and support to the fishing industry, by means of which the traditional trawling fleet has developed into an offshore fleet.

The Orkney Salmon Fishery Statistical District covers the whole region. In Scotland there is no public right to fish for salmon, and exclusive rights for each stretch of river are privately owned. Coastal and estuarine fisheries are similarly governed by heritable titles. Within District Salmon Fishery Board areas there may be associations of those concerned with a fishery, such as the proprietors, tenants, gillies and anglers.

Issues relating to the fisheries for pelagic, demersal, diadromous 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, 5.7 and 5.8.

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 - 9.1.4 come from various sources: MAFF, SOAEFD and Isle of Man Department of Agriculture, Fisheries and Forestry (IoM DAFF); their interpretation is described below.

Information on the number and size of fishing vessels based in the region may be obtained from the *The Scottish fishing fleet at December 1995* (SOAEFD 1996b). Numbers of full-time and part-time fishermen resident in the Orkney Sea Fisheries District are also given in this annual publication. Trends in fish landings (tonnage and value) at Scottish ports are decribed in detail in MacKay & Adam (1995).

Pelagic, demersal and shellfish species

Statistics given in this section are for landings recorded in the region, as distinct from fish catches taken. Choice of landing port reflects a combination of operational factors such as market prices, distance from the fishing grounds and the location of fishermen's weekend bases. Consequently, locally based vessels may land at ports in other regions. Some fish caught may have been discarded before the catch is landed. 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 for the Orkney Sea Fisheries District in the *Scottish sea fisheries statistical tables* and for 1992, 1993 and 1994 are available in SOAFD (1993, 1994, 1995) and for 1995 in SOAEFD (1996a).

The landings for the Sea Fisheries Districts have been combined to give the figures in the 'Region 2' column for Tables 9.1.1 and 9.1.3 - 9.1.4. 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, as defined in section 1.1. The figures in the 'Scotland' column of these tables were calculated by adding together all 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 Orkney Salmon Fishery Statistical District is 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. The figures presented are the reported catch and no allowance is made for inaccuracies, non-returns or gaps in the roll of proprietors and occupiers. In order to protect commercial confidentiality, the reported catches for each district are published without an indication of catch method. A *Statistical Bulletin* of Scottish salmon and sea trout lists catch returns for each individual Salmon Fishery Statistical District and is published annually (SODAF 1990; SO 1991-1996).

Sea angling

In the 85th edition of *Where to fish*, Orton (1996) lists much useful information relating to sea angling.

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

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Scientific aspects of managing important fish and shellfish stocks	General Secretary, International Council for the Exploration of the Sea, Palaegade 2 -4, DK-1261 Copenhagen K, Denmark, tel: 00 45 331 57092
Inter-government convention regulating salmon fishing on the high seas	Secretary, North Atlantic Salmon Conservation Organisation, 11 Rutland Square, Edinburgh EH1 2AS, tel: 0131 228 2551
Statistics on sea fish landings in Scotland. Analysis and dissemination of data and statistics on vessels in the Scottish fishing fleet.	*SOAEFD Division J4, Pentland House, Edinburgh, tel: 0131 244 6230
International fisheries policy for Scotland. Fisheries conservation including quota policy	*SOAEFD Division J1, Pentland House, Edinburgh, tel: 0131 244 6230
Domestic fisheries policy for Scotland. Inshore and shellfisheries management - including Regulating Orders, enforcement and environmental aspects	*SOAEFD Division J2, Pentland House, Edinburgh, tel: 0131 244 6230
Marine and estuarine fisheries research in Scottish waters; interaction between fisheries and non-fisheries conservation issues in Scotland; seals and fisheries	*SOAEFD Fisheries Research Services, Marine Laboratory, Aberdeen, tel: 01224 876544
Diadromous fish and fisheries information	SOAEFD Freshwater Fisheries Laboratory, Montrose Field Station, 16 River Street, Montrose, Angus DD10 8DL, tel: 01674 677070
Wild salmon and freshwater fisheries policy; contact details of the Clerks of the District Salmon Fishery Boards	*SOAEFD Division K2, Pentland House, Edinburgh, tel: 0131 556 8400 or 0131 244 6231
Scottish Office publications sales	HMSO, 71-73 Lothian Road, Edinburgh EH3 9AZ, tel: 0131 479 3141
Research and development, marketing and training for the fishing industry	Sea Fish Industry Authority, 18 Logie Mill, Logie Green Road, Edinburgh EH7 4HG, tel: 0131 558 3331
Representation of fishermen's and boat owners' interests in the Scottish fishing industry	Scottish Fishermen's Federation, 14 Regent Quay, Aberdeen AB11 5AE tel: 01224 582583
Representation of fishermen's and boat owners' interests in Orkney	Orkney Fishermen's Society Ltd., Garson Industrial Estate, Stromness, Orkney KW16 3BL, tel: 01856 850375

Type of information	*Contact address and telephone no.*
UKDMAP software; mapped fishing areas of selected species, ICES Statistical Division boundaries etc.	*Project Manager, BODC, Birkenhead, tel: 0151 653 8633
Shellfish production (commercial)	Director, Shellfish Association of the UK, Clerk, Fishmongers Hall, London Bridge, London EC4R 9EL, tel: 0171 626 3531
Affiliated sea angling clubs	Secretary, Scottish Federation of Sea Anglers, Administrator, Caledonia House, South Gyle, Edinburgh EH12 9DQ, tel: 0131 317 7192
Game fishing	Director, Salmon and Trout Association (Scottish Branch), Administrator, 10 Great Stuart Street, Edinburgh EH3 7TN, tel: 0131 225 2417
Interaction between fisheries and non-fisheries conservation issues	*Fisheries Officer, JNCC, Peterborough, tel: 01733 62626
Interaction between fisheries and non-fisheries conservation issues	*Aquatic Environments Branch, RASD, SNH, Edinburgh, tel: 0131 554 9797
Interaction between fisheries and non-fisheries conservation issues	*Marine Policy Officer, RSPB HQ, Sandy, tel: 01767 680551, and RSPB Orkney Office, Smyril, Stenness, Stromness, Orkney KW16 3JX, tel: 01856 850176
Interaction between fisheries and non-fisheries conservation issues	*Conservation Officer, WWF Scotland, Aberfeldy, 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, 105 Halsford, Park Road, East Grinstead, West Sussex RH19 1DPR, tel: 01342 315440
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*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 the coastline provides good shelter and adequate water exchange for mariculture, mainly for salmon farms, which have become an important feature of the local economy. Mussels, Pacific oyster, native oyster, scallop and queen scallop are the shellfish species cultivated around the Orkney coast.

9.2.2 Locations and species

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.

Salmonids and non-salmonids

Salmon are cultivated in many of the sheltered voes, sounds and firths in Orkney, and there are halibut hatcheries at Brinian, Skaill and Flotta. There is also one land-based salmon farm that uses sea water that is pumped ashore and two salmon hatchery/smolt units, at Lyness on Hoy and on Rousay. There may be additional sites that are leased for fish farming but not currently used for cultivation. Region 2 - and Scotland as a whole - has shown large increases in production since 1992. Salmon farming is significant to the economy of Orkney and, as Table 9.2.2 shows, in 1995 Orkney supplied about 2.7% of the farmed salmon produced in Scotland. Rainbow trout *Onchorynchus mykiss* and sea trout may sometimes be cultivated in sea cages alongside salmon. Halibut are cultivated in a number of sheltered bays and voes scattered around the islands.

Shellfish

Shellfish farming in Scotland has developed significantly in the last ten years but the number of active shellfish companies has decreased slightly since its peak in 1990. Sites in production are widely distributed, mainly around western Mainland and the southern islands. There may also be other sites that are leased for shellfish farming but not currently used for cultivation. Mussels are mainly grown using pastorally cultivated wild beds. Scallops and queen scallops are grown on the lower shore from natural spat suspended either in net bags or individually from holes drilled in the shells. Hatchery-reared 'spat' of Pacific and native oysters are grown to market size in net bags located on trestles on the lower shore. Table 9.2.3 shows the production levels of shellfish companies in Orkney in the 1995 SOAEFD survey compared with those for the whole of Scotland.

9.2.3 Management and issues

The Food Safety (Live Bivalve Molluscs) Regulations (which implement European Council Directives) require that all waters from which bivalve molluscs are taken for human consumption are classified by the Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD) following sampling carried out by the Port Health Authority or Local Authority. Samples of live shellfish are submitted to SOAEFD Marine Laboratory for bacteriological examination and, depending on the resulting category (A - D), restrictions and further treatment may apply before human consumption is permitted. Samples are taken regularly and the classification can change. Shellfish

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 Estate & Scottish Office Agriculture, Environment and Fisheries Department (pers. comms.), La Tene Maps (1995a, b). Note: for the JNCC's Marine Nature Conservation Review (MNCR), non-native species are those introduced species that are established in the wild; other introduced species are described as un-established introductions.

Table 9.2.2 Employees and annual production (tonnes) in 1995 of salmon at sea sites

	*No. of staff**	*Annual production*
Region 2	69	1,903
Scotland	1,355	70,060

Source: Scottish Office Agriculture, Environment and Fisheries Department (1996a). Key: *full and part time.

must also meet the 'End Product Standard', with which all live bivalves intended for immediate human consumption must comply.

The consent of the owners or managers of the sea bed is required and a lease may be needed, applications for which must go through an extensive consultation process, before structures for mariculture can be erected on the sea bed. In many areas a lease must be sought from the Crown Estate, since it owns or manages 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. If the intended structures are potentially hazardous to navigation the Department of the Environment, Transport and the Regions (DETR) must also issue a consent. In Orkney all maritime structures within Harbour Board Areas are controlled by a system of works licences. Thus in Orkney a Crown Estate lease is issued for mariculture purposes following the grant of a works licence (if appropriate) by the Orkney Islands Council. Scapa Flow is a Harbour Board Area. If structures 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 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 named molluscan shellfish species. Although in this region a number of applications for Several Orders have been received by the Scottish Office, none has been granted. There are 22 Several Orders in Britain, covering a total of approximately 3,299 ha (as at July 1995) (MAFF 1995). There are consultations proceeding to extend the Act to cover crustaceans as well as molluscs.

The Scottish Salmon Growers Association and the Association of Scottish Shellfish Growers are trade associations, acting as information sources for the mariculture industry in Scotland, encouraging research and acting 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 under the Registration of Fish Farming and Shellfish Farming Businesses Order 1985, to prevent the spread of disease. Diagnosis, collation of information and research on fish- and shellfish-related diseases in Scotland are carried out by SOAEFD Marine Laboratory.

Issues relating to the cultivation of marine species are closely linked to marine nature conservation interests, particularly the possible effects on species and habitats of nature conservation interest. For instance, the intensification of mussel farming has enhanced the potential for eider ducks, which feed on mussels, increasingly to predate the farmed shellfish, causing a conflict between interests in the area. Advice on precautions against eider duck predation of mussel farms is outlined in Galbraith (1992). Bird-scaring devices and human presence on the farms may also be effective deterrents.

As in agriculture, efficient mariculture operations depend on intensive production methods (i.e. at greater than natural population densities), requiring high water quality. The maintenance of the coastal marine environment in an uncontaminated and fully functional state is recognised as an important objective shared by mariculturists and other users of the coastal zone. The presence of fish farming operations in the sea may lead to

Table 9.2.3 Scottish shellfish companies 1995 production* (tonnes)

	No. of companies	*No. of staff*	*Pacific oysters*	*Native oysters*	*Mussels*	*Queen scallops*	*Scallops*
Region 2	14	22	3.5	<1	12	<1	2.4
Scotland	190	327	273	15	882	46	36

Source: Scottish Office Agriculture, Environment and Fisheries Department (1996b). Key: * 'production' is that for sale for the table only. Note: production is recorded in numbers of individuals, 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. Numbers of staff include full-time, part-time and casual staff.

some interactions between husbandry procedures and the environment. This subject is an active research and monitoring area in Scotland and other northern European countries where salmon farming has developed as the primary type 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, such as cormorants and seals), opportunities for exchange of pathogens and parasites between wild and farmed fish, the use of veterinary medicines to treat sea lice, the use of antibiotics and their persistence in sediments and the potential for genetic interactions between wild fish and escaped farmed fish. Since January 1997 all treatments used in fish farms must be licensed veterinary medicines. All shellfish species cultivated in Scotland depend on natural food supplies and receive no therapeutic (chemical) treatments for disease or parasites.

9.2.4 Acknowledgements

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B. Further reading

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Wildlife & Countryside Link Seals Group. 1995. *Seals and fisheries: the facts.* East Grinstead, Wildlife & Countryside Link Seals Group.

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, Pentland House, Edinburgh, tel: 0131 556 8400
Research into fish and shellfish cultivation in Scotland, interaction between mariculture activities and marine nature conservation issues	*SOAEFD Fisheries Research Services, Marine Laboratory, Aberdeen, tel: 01224 876544
Leases	The Crown Estate, 10 Charlotte Square, Edinburgh EH2 4DR, tel: 0131 226 7241
Discharge consents and water quality	*SEPA, Northern Region HQ, Dingwall, tel: 01349 862021
Market research and technical advice on shellfish purification	Sea Fish Industry Authority, 18 Logie Mill, Logie Green Road, Edinburgh EH7 4HG, tel: 0131 558 3331
Salmon farming	Director, Scottish Salmon Growers Association, Drummond House, Scott Street, Perth PH1 5EJ, tel: 01738 635420
Shellfish farming	Association of Scottish Shellfish Growers, Overton, 2a Manse Road, Roslin, Midlothian EH25 9LF, tel: 0131 440 2116
Commercial advice on shellfish	Director, Shellfish Association of the UK, Fishmongers Hall, London Bridge, London EC4R 9EL, tel: 0171 626 3531

Type of information	*Contact address and telephone no.*
Representation of fishermen's and boat owners' interests in Orkney	Orkney Fishermen's Society Ltd., Garson Industrial Estate, Stromness, Orkney KW16 3BL, tel: 01856 850375
Interaction between mariculture activities and marine nature conservation issues	*Aquatic Environments Branch, RASD, SNH, Edinburgh, tel: 0131 554 9797
Interaction between mariculture activities and marine nature conservation issues	*Fisheries Officer, JNCC, Peterborough, tel: 01733 62626
Mariculture and marine nature conservation issues	*Marine Policy Officer, RSPB HQ, Sandy, tel: 01767 680551, and RSPB Orkney Office, Smyril, Stenness, Stromness, Orkney KW16 3JX, tel: 01856 850176
Mariculture and marine nature conservation issues	*Conservation Officer, WWF Scotland, Aberfeldy, 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, 105 Halsford Park Road, East Grinstead, West Sussex RH19 1PR, tel: 01342 315440
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*Starred contact addresses are given in full in the Appendix.

9.3 Quarrying and landfilling

Scott Wilson Resource Consultants

9.3.1 Introduction

In this section, quarries are included as coastal if they are less than 2 km inland; all landfill sites are included as the whole of the region is in coastal 10 km squares. The minerals quarried in Orkney on a commercial basis are sandstone and gravel. Table 9.3.1 presents production levels for Scotland compared with British levels, for the main minerals quarried in the region. Because of the small number of operators in Orkney, regional production figures for these minerals are not available as their publication could compromise the commercial confidentiality of the operations.

Table 9.3.1 Minerals production: thousands of tonnes

	Sand & gravel		*Sandstone*	
	Tonnes	*% of GB total*	*Tonnes*	*% of GB total*
Scotland	11,359	12.7	1,716	14.2
Great Britain	89,470		12,100	

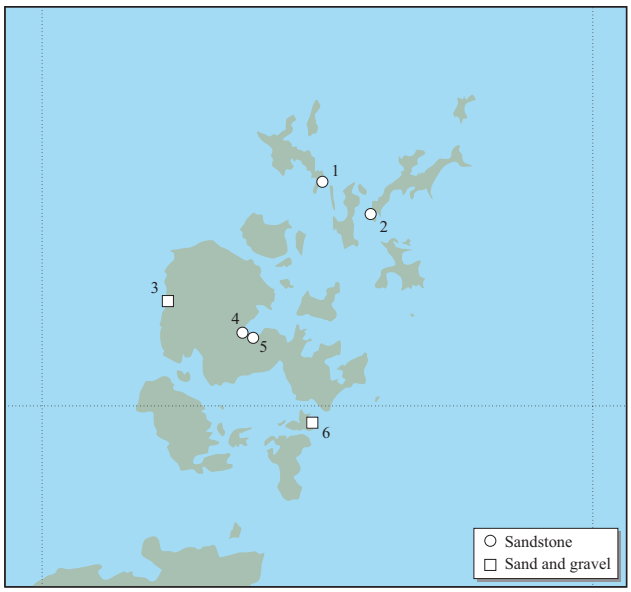
Source: Central Statistical Office (1994). Note: amounts rounded up to the next whole thousand.

9.3.2 Important locations

In this region there are six coastal quarries extracting one or more minerals (Table 9.3.2; Map 9.3.1). Of these quarries, two extract sand and gravel (beach sand), and the remaining four extract Devonian sandstone, one also extracting hard mud.

Table 9.3.3 details the location of the region's currently used coastal landfill sites and the type of waste, according to the Scottish Environment Protection Agency (SEPA pers. comm.) (Map 9.3.2).

Orkney and other UK island communities use different categories to describe waste in waste management licences from those used elsewhere in the UK, because of the difficulties of disposal. Inert wastes comprise uncontaminated excavated natural earth materials, and uncontaminated brick rubble and concrete with similar properties to natural earth materials. Household and putrescible wastes include the typical contents of a household dustbin and similar wastes of industrial origin, e.g. food processing wastes. Scrap metal is described as a non-hazardous waste, as are other mainly uncontaminated and industrial wastes such as packaging materials, wood and plastic. Some of these wastes are biodegradable, but not rapidly so. Difficult wastes include any wastes that require particular handling techniques at the disposal site, e.g. vehicle tyres, dry feathers, animal carcasses. In Orkney the two latter categories are disposed of through suitably equipped waste transfer sites. Toxic ('special') wastes require pre-notification of disposal to the Scottish Environment Protection Agency (SEPA).



Map 9.3.1 Coastal quarries (Table 9.3.2). Source: British Geological Survey (1994).

Table 9.3.2 Coastal quarries in the region

Site no. on Map 9.3.1	*Location*	*Operator*	*Mineral*
	Westray		
1	Rapness	Orkney Island Council	Sandstone
	Sanday		
2	Loth	Orkney Island Council	Sandstone
	Mainland		
3	Skaill Beach, Sandwick	Isbister Brothers	Sand and gravel (beach sand)
4	Heddle Hill, Finstown	Orkney Builders Ltd.	Sandstone, hard mud
5	Cursiter, Finstown	Orkney Island Council	Sandstone
	Burray		
6	Bu Links	J.R. Dass	Sand and gravel (beach sand)

Source: British Geological Survey (1994).

Table 9.3.3 Status of the region's waste disposal sites

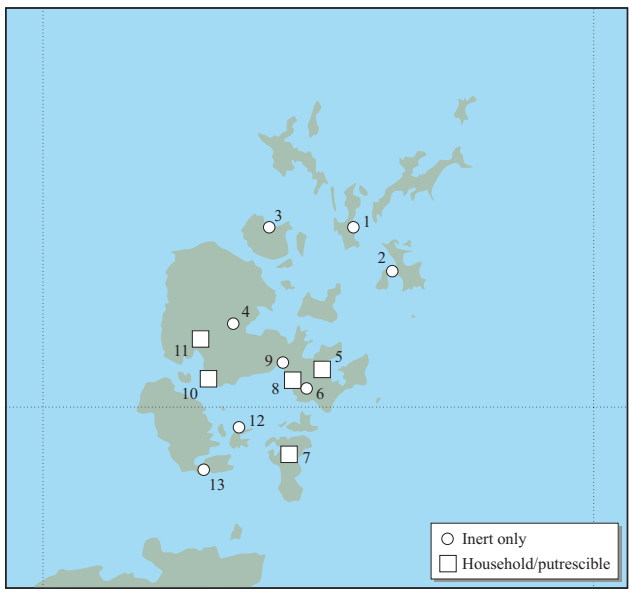
Site no. on Map 9.3.2	*Location*	*Grid ref.*	*Type of waste disposal facility*	*Type of waste handled*
	Eday			
1	Westside Road Landfill	HY562334	Landfill and waste transfer site	Landfill for inert waste, transfer site for scrap metal
	Stronsay			
2	Mitchell's Quarry	HY657028	Landfill and waste transfer site	Landfill for inert waste, transfer site for scrap metal
	Rousay			
3	Blossom Quarry	HY424324	Landfill and waste transfer site	Landfill for inert waste, transfer site for scrap metal
	Mainland			
4	Kingsdale Landfill	HY370116	Landfill (private)	Inert only
5	Bossack Quarry	HY504084	Landfill and waste transfer site	Landfill for inert waste, transfer site for scrap metal
6	South House Landfill	HY498073	Landfill (private)	Inert only
7	St Margarets Hope Civic Amenity Site	ND449929	Civic Amenity Site*	Various
8	Moss Quarry	HY473037	Treatment site	Shredding of garden wastes
9	Chinglebraes Quarry	HY427096	Landfill	Inert only
10	Workwell Quarry	HY307054	Treatment site	Shredding of garden wastes
11	Stromness Civic Amenity Site	HY266096	Civic Amenity Site*	Various
	Flotta			
12	Peat Road Landfill	ND347926	Landfill	Inert and scrap metal
	Hoy			
13	Gallow Tuag Quarry	ND304896	Landfill	Inert and scrap metal

Source: SEPA (pers. comm.) Key: *civic amenity sites receive a varity of wastes from the public, including garden refuse, builders rubble, paper and glass; some wastes are recycled, others are landfilled.

9.3.3 Management and issues

In April 1996 the Scottish Environment Protection Agency (SEPA) came into force, under the terms of the 1995 Environment Act. The region falls entirely within SEPA North Region. The new agency integrates the functions of several former authorities: Her Majesty's Industrial Pollution Inspectorate (HMIPI), the local Waste Regulation Authorities (WRAs) and the River Purification Boards. Landfill site licensing is now the responsibility of SEPA, which is required to maintain public registers of waste management licences and resolutions. Waste management licences were introduced by the Environmental Protection Act 1990 to replace the disposal site licences previously required by the 1974 Control of Pollution Act. Also within the Environment Act 1995 is the requirement for mine operators to give SEPA at least six months' notice of their intention to abandon a mine, in order that steps can be taken to avoid pollution from minewater. Also relevant to quarrying and landfilling are the provisions relating to producer responsibility for waste. These will provide a mechanism to ensure that business initiatives on re-using, recovering and recycling waste are not undermined by those seeking to avoid their obligations.

Planning for mineral extraction in Scotland is guided by *Land for mineral working* (National Planning Policy Guideline (NPPG) 4) (Scottish Office 1994). This notes that aggregates in Scotland are supplied mainly from land-based sources. Planning authorities are requested to maintain a minimum of a ten-year 'landbank' for minerals, i.e. a stock of planning permissions for the winning and working of minerals.



Map 9.3.2 Coastal waste disposal sites (Table 9.3.3). Source: SEPA (pers. comm.).

Demand for aggregates in the UK is anticipated to rise to around 370-440 million tonnes in twenty years' time (Scottish Office 1996). The potential role of coastal superquarries (producing in excess of 5 million tonnes per year) in meeting this demand has been identified. In a 1992 report (Whitbread & Marsay 1992) the Department of the Environment speculated that there may be scope for five superquarries in Scotland, with the greatest potential being

found on the north and west coasts. Regions considered suitable for the development of superquarries are listed in Scottish Office (1994). However, Scottish Office (1994) notes that no more than four sites should be identified by 2009. The main environmental objection to development is likely to be the potential release of contaminated ballast water from transport ships, as has been the case with the proposed superquarry on the Isle of Harris (Region 15). It is thought that this could result in damage to the aquatic environment, including impacts on local fish farms. Landscape issues are also potentially important. A number of criteria have been devised to guide the selection of sites for superquarry development; these include minimising impacts to local interest and the natural heritage and assessing the potential benefits to the community (Scottish Office 1994).

9.3.4 Information sources used

Data on quarrying were obtained from the *Directory of mines and quarries* (British Geological Survey 1994) and from *Business monitor (minerals)* (Central Statistical Office 1994), which are the most up to date and comprehensive information sources available. Additional information can also be gained from *NPPG4 Land for mineral working* (Scottish Office 1994). Data for quarrying in BGS (1994) may predate that publication date by up to three years and may therefore include information on some operations that have now ceased. Additional information is also available in NPPG4 *Land for mineral working*.

Aspinwall & Co.'s *Sitefile Digest* on waste treatment and disposal (Aspinwall & Co. 1994) contains regularly updated information from the 152 former Waste Regulation Authorities (WRAs) (now SEPA) and represents the most up-to-date collection of public information on British waste management available at the time of writing. The Hazardous Waste Inspectorate produced summary statistics of waste disposal in Scotland between 1991-92.

9.3.5 Acknowledgements

Thanks go to Dr R. Moore and S. Morley (Aspinwall & Co.) for providing information on the *Sitefile Digest*. Thanks are also due to D. Sinclair (SEPA) for information on waste disposal sites in Orkney.

9.3.6 Further sources of information

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Scottish Office. 1996. *Scotlands coasts. A discussion paper*. Edinburgh, Scottish Office Agriculture, Environment and Fisheries Department.

C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Waste disposal licences	*SEPA, Northern Region, Dingwall, tel: 01349 862021
Local Plans and Minerals Policies	*Orkney Islands Council, Kirkwall, tel: 01856 873535
Landfill database and Sitefile Digest	Senior Consultants, Aspinwall & Co., Walford Manor, Baschurch, Shrewsbury SY4 2HH, tel: 01939 262200
Mines and quarries (British Directory of Mines and Quarries)	*Director, British Geological Survey, Nottingham, tel: 0115 936 3393

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

9.4 Marine aggregate extraction, dredging and solid waste disposal at sea

Scott Wilson Resource Consultants

9.4.1 Introduction

Sand and gravel on the sea bed are important sources of industrial aggregate for concrete production, road construction, building and, increasingly, beach replenishment and soft coastal defences. The national demand for aggregate from all sources increased steadily during the 1980s, and marine aggregates satisfy an increasing proportion of the British requirement - 8.2% in 1992 (British Marine Aggregate Producers Association pers. comm.). Marine sand and gravel, of which 26.1 million tonnes were dredged in 1995 (Crown Estate 1996), are extracted by commercial mineral companies under licence from the Crown Estate.

There is currently no commercial extraction of aggregate in this region and no aggregate was extracted under licence from the Crown Estate in Scottish waters or landed in Scottish ports in 1993 (Crown Estate 1995). Generally, prospecting for sand and gravel deposits in Scotland's waters has been unpromising, with only limited exploitable 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 (see also section 9.3). British Geological Survey sea-bed sediment sheets give an overview of potential resources (see also section 2.2), but in the absence of detailed company prospecting, these have not been verified.

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.

Between 1988 and 1993, there was a downward trend in the wet tonnage of dredged material deposited in the seas around the UK, from 44,305,995 tonnes in 1989 to 29,866,256 tonnes in 1993. However, this trend was reversed in 1994, when 35,962,835 tonnes were deposited around the UK (Table 9.4.1). The amount of dredged material deposited in the region in 1994 (32,800 tonnes) constituted approximately 0.1% of the total dredged material deposited around the UK as a whole. In 1994 there were two licensed disposal sites near Orkney, one to the west of Hoy Sound (Stromness A) and the other in the southern approaches to Scapa Flow.

Other solid materials deposited at sea under licence from MAFF include sewage sludge and solid industrial waste. Some sewage sludges are principally of domestic origin and contain low levels of metals and other persistent components. Others include industrial inputs, resulting in higher concentrations of contaminants. In terms of sewage disposal, the UK produces some 1.1 million tonnes of dry solids (tds) annually and disposes of approximately 300,000 tds (equivalent to about 11,000,000 wet tonnes) to the sea. No sewage sludge is deposited within the region. 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. UK sewage sludge production is set to increase dramatically over the next decade, to a predicted 3.3 million tds by 2006.

Solid industrial waste is waste rock from mining operations and disposal at sea occurs chiefly in north-east England. There are no licensed disposal sites in this region.

Table 9.4.1 Dredged material licensed and disposed of at sea in 1994

	Licences issued	*Sites under licence*	*Sites used*	*Wet tonnage deposited*
Region 2	3	2	2	32,800
Scotland	23	28	22	1,822,053
UK	***134***	***120***	***98***	***35,962,835***

Source: MAFF (pers. comm.). Note: licences may commence at any time and generally last for one year.

9.4.2 Important locations

Marine aggregates dredging

No aggregate was extracted from waters around Orkney or landed in Orkney ports in 1995 (Crown Estate pers. comm.).

Navigational dredging

Navigational dredging to maintain shipping channels is undertaken infrequently in the region. Capital dredging is limited and no maintenance dredging is practised.

Dredged material disposal at sea

Table 9.4.2 lists the sites used recently for the disposal of dredged material in Region 2 (Map 9.4.1) and the quantities of material disposed of.

9.4.3 Management and issues

Marine aggregates dredging

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

Map 9.4.1 Licensed sites for the disposal of dredged material used in the period 1990-1994. Source: SOAEFD (pers. comm).

extraction. So government policy for the provision of aggregates, formulated in 1982 and 1989, has encouraged marine extraction of sand and gravel. The government promotes environmentally sustainable coastal defences, and, as a result, the use of sand and gravel for beach recharge is predicted to grow substantially (NERC undated). The Scottish Office is currently considering changing the system whereby approval is given for the issuing of licences for aggregate extraction. The current system involves obtaining a favourable 'Government View', through a non-statutory analysis and consultation process co-ordinated by the Scottish Office (Crown Estate 1994). As part of this process SOAEFD undertakes a comprehensive assessment of the potential effect of the new aggregate extraction areas on the marine environment, on commercial fisheries and fisheries operations. The government intends that, in future, applications for marine aggregate extraction licences should be subject to the same type of process as terrestrial planning applications under the Town and Country Planning Acts, regardless of the ownership of the sea bed. A consultation exercise outlining options for a new system in Scotland was undertaken by the Scottish Office. No statement of intent has yet been issued.

Aggregate extraction from the sea bed commonly involves using suction pipes or bucket dredgers. Short- or long-term changes in sediment deposition can result, as well as inevitable changes in the topography of the bed. The biological implications of extraction depend upon the characteristics of the individual area concerned. In general, the principal biological impact of marine aggregate extraction is the disturbance and removal of benthic infauna and epifauna and alteration of the substrate upon which colonisation depends. Disturbance of muddy material in order to access underlying aggregate can destroy feeding grounds for flatfish through the displacement of muddy sand fauna. If an area is used by fish for spawning, for which a stable bed is required, egg laying can be disrupted. Where the remnant substrate is identical to the superficial sediments, disturbance is unlikely to be permanent and the extraction area will be recolonised. Aggregate extraction licences are generally only granted where these conditions are fulfilled (Campbell 1993).

Navigational dredging

Navigational dredging is the responsibility of individual harbour authorities and is carried out as required.

Dredged material disposal at sea

The primary legislation in force to control the disposal of dredged material at sea in the UK is the Food and Environmental Protection Act (1985), part of which deals with deposit 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 the disposal of sewage sludge and dredged material at sea. In this region the disposal of sewage sludge and dredged material is licensed by SOAEFD under the Food and Environmental Protection Act 1985. Illegal dumping of material occurs from time to time.

The main effect of the disposal of dredged material is blanketing of the sea bed, so that benthic flora and fauna are buried and prevented from respiring and feeding. Other impacts may include the elevation of metal concentrations originating from the deposited sediment. Localised increases in the turbidity of the water column may temporarily interfere with fish migration. Changes in sediment particle size can result in changes in benthic flora and fauna which, whilst not damaging *per se*, may affect the distribution of higher animals by altering the food chain.

Table 9.4.2 Amounts of dredged material disposed of at each licensed site in the region 1990 - 1994

Location	*MAFF code (see Map 9.4.1)*	*Wet tonnages disposed of in:*					*Water depth*	*Distance from coast*
		1990	*1991*	*1992*	*1993*	*1994*	*(m)*	*(km)*
Kirkwall	FI015	-	99,359	-	-	-	20-25	0.5
Stromness A	FI040	-	-	-	-	22,067	75	4
Stromness B	FI050	5,454	-	-	-	-	55	1.4
Scapa	FI055	-	-	133,900	-	12,349	62	1.85

Source: SOAEFD (pers. comm.)

9.4.4 Information sources used

The statistics on marine aggregate extraction were obtained from the Crown Estate (as owners of the sea bed). The information on disposal of dredged material is derived from licences granted by SOAEFD.

9.4.5 Acknowledgements

Thanks go to Dr C. Vivian (Centre for Environment, Fisheries & Aquaculture Sciences, Burnham-on-Crouch Laboratory) for information on solid waste disposal and navigational dredging.

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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.*
Marine sand and gravel extraction in the UK	British Marine Aggregate Producers Association/British Aggregate Construction Materials Industries, 156 Buckingham Palace Road, London SW1W 9TR, tel: 0171 730 8194
Marine aggregate extraction licensing	The Crown Estate, 10 Charlotte Square, Edinburgh EH2 4DR, tel: 0131 226 7241
Offshore geoscience data including 1:250,000 maps of geology of coastline	*Director, British Geological Survey, Keyworth, tel: 01602 363100
Waste regulation	*SEPA, Northern Region HQ, Dingwall, tel: 01349 862021
Disposal of dredge spoil at sea - International	The Oslo and Paris Commissions, New Court, 48 Carey Street, London WC2A 2JQ tel: 0171 242 9927
Database of licensed disposal operations at sea	Dr C. Vivian, Marine Environmental Protection Division, Ministry of Agriculture, Fisheries and Food, Fisheries Laboratory, Rememberance Avenue, Burnham-on-Crouch, Essex CM0 8HA, tel: 01621 787200
Disposal of dredged material at sea - international	London Convention Secretariat, International Maritime Organisation (IMO), 4 Albert Embankment, London SE1 7SR, tel: 0171 735 7611
Dredging operations in Region 2	*Harbour Engineer, Orkney Island Council, Kirkwall, tel: 01856 873535
Disposal of pulverised fuel ash as artificial reefs	Oceanography Dept. Oceanography Centre, University of Southampton, Empress Dock, European Way, Southampton SO14 3ZH; tel: 01703 595000

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

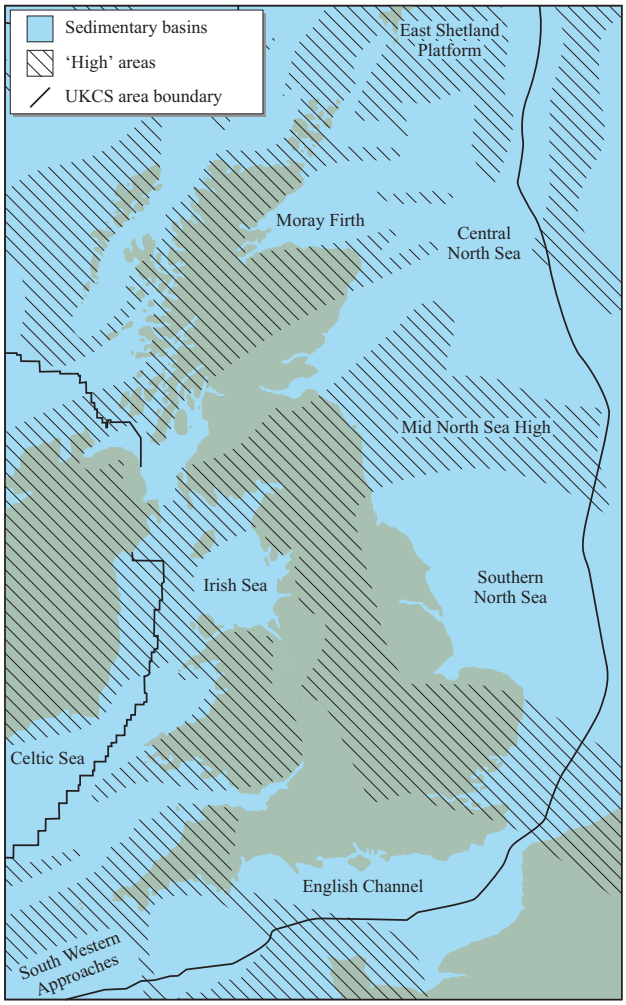
9.5 Oil and gas developments

Scott Wilson Resource Consultants

9.5.1 Introduction

This section describes oil and gas exploration and related development in the region; oil and gas infrastructure is described in section 8.3. Map 9.5.1 shows sedimentary basins and structural 'highs', which determine the distribution of oil and gas deposits. The geology which underlies the Orkney Islands and the coastal waters that surround them has been found to contain no hydrocarbon deposits (DTI pers. comm.). As a result there have been no applications for licences in the sea areas adjacent to Orkney in the Landward Rounds for oil and gas exploration, and none are likely in forthcoming rounds.

Total UK Continental Shelf (UKCS) oil and gas production in 1995 was a record of some 220 million tonnes of oil equivalent, which accounted for some 2% of Gross Domestic Product (DTI 1996). A total of 98 exploration and appraisal wells were drilled in 1995, and seven 'significant discoveries' were announced (significant discoveries refers to wells where test flow rates are in excess of 1,000 barrels of oil per day). Of these, four significant discoveries were identified in the Northern North Sea (including the East Shetland Platform), and a further fourteen exploration wells and nine appraisal wells were drilled in the West of Shetland area (DTI 1996).

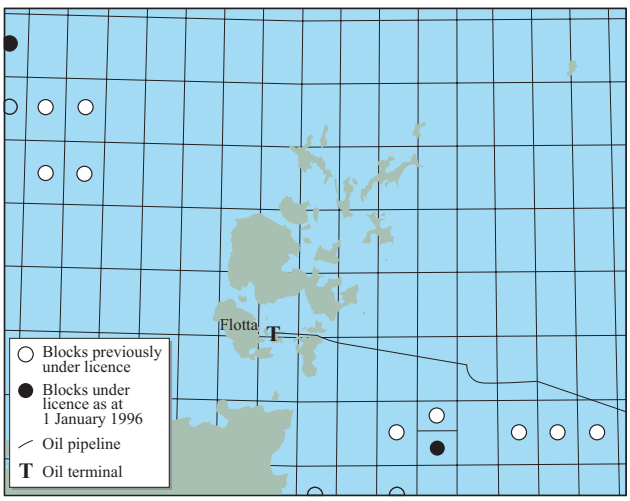


Map 9.5.1 UK Continental Shelf (UKCS) sedimentary basins and structural 'highs'. Source: DTI (1994). © Crown copyright.

9.5.2 Important locations

Map 9.5.2 shows the locations of offshore oil and gas activity in the sea areas in the vicinity of Orkney. A block licensed to Fina is located approximately 30 km south-east of South Ronaldsay. No blocks under licence near the region are currently operational.

Of great economic importance in the region is the oil handling terminal on the island of Flotta in Scapa Flow. In 1995, forecasts for 1996 predicted a throughput of approximately 82 million barrels of crude oil (10.93 million tonnes), 2.3 million barrels (306,666 tonnes) of propane and 1.1 million barrels (146,666 tonnes) of ethane (Elf Exploration UK plc pers. comm.). Throughput at Flotta is expected to increase by at least 25% when the Foinaven field in the Atlantic comes into production.



Map 9.5.2 Oil and gas licensing, fields and infrastructure. Large areas (not shown) further west of Orkney are licensed. Source: DTI (1994). © Crown copyright.

9.5.3 Management and issues

The 16th Offshore Oil and Gas Licensing Round was completed in 1995 and a total of 79 blocks were awarded around the UK. Awards for the 26 blocks applied for in the West of Shetland area were made on 18 May 1995. The awards for the remaining areas were made on 4 July 1995, including twelve blocks in the Northern North Sea area. In the 17th Offshore Oil and Gas Licensing Round a total of 275 blocks were offered for licence, including 35 blocks in the Northern North Sea area; none was awarded in the sea areas adjacent to Orkney. Licences 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 (Davies & Wilson 1995).

The potential for oil spills to harm birds and marine and coastal wildlife is well known, especially in sheltered embayments and estuaries. Orkney Island Council and Elf Exploration UK plc, the operators of Flotta Oil Terminal, have a co-ordinated oil spill response plan for Scapa Flow. In addition, Elf Exploration UK plc have a general oil spill response plan.

There is a small risk of injury to marine mammals 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 (Evans *et al*. 1993). Nevertheless recent studies indicate that cetaceans may be disturbed by seismic surveying, as they are sighted less frequently, either acoustically or visually, during seismic surveys (Goold 1996). The UK Offshore Operators Association (UKOOA 1995) has published guidelines on the best current practice in environmental management for operators in near-shore areas, without compromising safety or operational viability. Licensees and their contractors are required by the DTI to conduct seismic exploration in accordance with Department of the Environment's *Guidelines for the minimisation of acoustic disturbance to small cetaceans* (DoE undated).

9.5.4 Information sources used

Many of the data used here come from the annually updated *'Brown Book'* (DTI 1996), which should be referred to for further explanation.

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C. Contact names and addresses

Type of information	*Contact address and telephone no.*
Oil and gas developments in the UK	Public Relations Officer, Department of Trade and Industry, 1 Palace Street, London SW1E 5HE, tel: 0171 215 5000
Oil and gas developments in the UK - licensing	Oil and Gas Division - Exploration and Licensing Branch, Department of Trade and Industry, 1 Victoria Street, London SW1H 0ET, tel: 0171 215 5000
Oil and gas industry issues	Public Relations Officer, UK Offshore Operators Association, 3 Hans Crescent, London SW1X 0LN, tel: 0171 589 5255
Oil transportation and terminals	Technical Adviser, Oil Companies International Marine Forum (OCIMF), 15th Floor, 96 Victoria Street, London SW1E 5JW, tel: 0171 828 7696
General information on the oil industry	Librarian, Institute of Petroleum Library and Information Service, 61 New Cavendish Street, London W1M 8AR, tel: 0171 467 7100
Scapa Flow oil spill contingency plan	Elf Exploration UK plc, Flotta Terminal, Flotta, Orkney KW16 3NP, tel: 01856 884000
Oil spillages in the UK	Executive Secretary, British Oil Spill Control Association (BOSCA), 4th Floor, 30 Great Guildford Street, London SE1 0HS, tel: 0171 928 9199
Oil spillages: government body carrying out pollution control at sea	Marine Pollution Control Unit, Spring Place, 105 Commercial Road, Southampton SO15 1EG, tel: 01703 329484
Research into oil pollution	Oil Pollution Research Unit, 3 Dolphin Drive, Brunel Quay, Neyland, Pembroke SA73 1PY, tel: 01646 691000
Research into oil pollution	Orkney Marine Biology Unit, Department of Harbours, Harbour Authority Buildings, Scapa, Orkney KW15 1SD, tel: 01856 876070
Licensing the use of dispersants for oil spill - Scotland	*Marine Environment and Wildlife Branch, SOAEFD, tel: 0131 244 6232
Guidelines on the environmental protection of offshore waters	*SOAEFD, Marine Laboratory, Aberdeen, tel: 01224 876544
Scientific assessment of oil dispersants and effects of gas and oil exploitation on the marine environment	Head of Laboratory, MAFF CEFAS, Rememberance Road, Burnham-on-Crouch, Essex CM0 8HA, tel: 01621 787200
Information regarding oil pollution incidents	*Scottish Natural Heritage, Aberdeen, tel: 01224 642863
Gas industry in Britain	Director and Secretary, Society of British Gas Industries, 36 Holly Walk, Leamington Spa, Warwickshire CV32 4LY, tel: 01926 334357
Information on the environmental effects of exploration and production	*Marine Conservation Officer, WWF - UK, Godalming, tel: 01483 426444

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

9.6 Water quality and effluent discharges

Scott Wilson Resource Consultants

9.6.1 Introduction

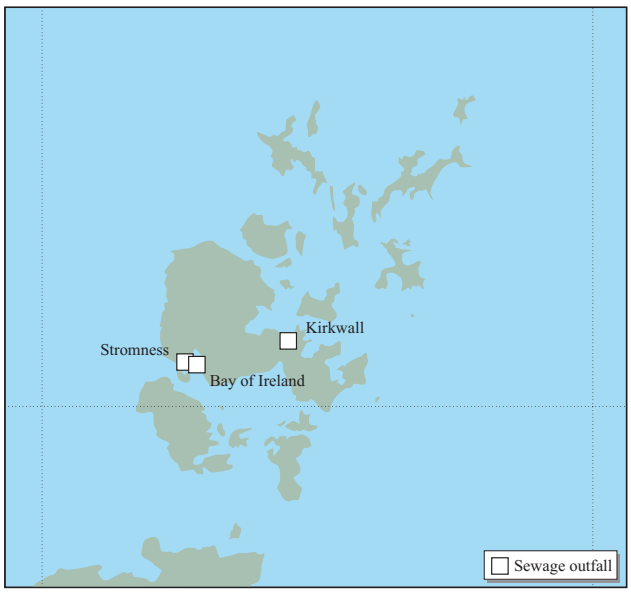
This section summarises information about water quality and effluent discharge from a number of sources. Sewage sludge disposal is covered in section 9.4. Full interpretation of the information base on pollutants and water quality is complex and beyond the scope of this book.

Waste products and effluents containing contaminants reach the marine environment in this region in a number of ways: sewage, agricultural run-off and trade effluents are discharged from outfalls into rivers or directly into the sea, and contaminants can reach the sea by airborne means, for example aerosols and rain. Industrial pollutants can enter the marine environment under licensed discharge or by accidental release. Discharges occurring outside the region may also have a detrimental effect on coastal water quality.

In Orkney there are only two operational sewage outfalls and one planned, non-operational outfall with maximum consented flows in excess of 900 m^3/day, and no trade outfalls of that size (SEPA pers. comm.). There are no bathing waters in this region identified under the EC Bathing Water Directive (76/160/EEC). EC bathing waters are identified on the basis of the numbers of people using a beach in a day, and because of Orkney's small population and latitude, the numbers of bathers do not reach the minimum level for assessment. Similarly, because too few water quality samples are tested during the season, no beaches in the region qualify for consideration as Blue Flag beaches or for Seaside Awards issued by the Tidy Britain Group (Tidy Britain Group pers.comm.). The Marine Conservation Society reports many of the beaches of Orkney to be pristine, although it has no systematic data (Marine Conservation Society 1994).

9.6.2 Important locations

There are approximately 98 sewage outfalls discharging to coastal waters in the region, some of which also contain trade effluent, by far the majority being very small. The two with consented daily flows greater than 900 m^3 are listed in Table 9.6.1 (Map 9.6.1). Also listed is the proposed outfall to the String at Kirkwall, which will require at least primary treatment; under the EC Urban Waste Water Treatment Directive the actual level of treatment will be determined in the light of the estimated population equivalent served by the outfall (see section 9.6.3).



Map 9.6.1 Sewage outfalls with consented flows >900 m^3/day. Source: SEPA (pers. comm.).

9.6.3 Management and issues

Responsibility for water quality in the region lies with the Scottish Environment Protection Agency (SEPA), which became operational in April 1996. The activities of SEPA are grouped under two broad headings: pollution prevention and control, and water management. There is a strong link between pollution 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 as amended by the Water Act 1990. Trade effluent involving 'scheduled' (hazardous) substances must be authorised by SEPA under the Environmental Protection Act 1990. Environmental Quality Standards (EQSs) for many of the substances are specified in the Environmental Protection (Prescribed Processes etc.) Regulation 1991. The EQSs may be set by the EC (under the Dangerous Substances Directive 76/464/EEC and Framework Directive 86/280/EEC) or nationally (DoE Circular 7/89, March 1989).

Discharges from nuclear installations are licensed under the Radioactive Substances Act 1993 by SEPA. Their effect

Table 9.6.1 Sewage outfalls (operational and proposed) to tidal waters in the region with consented daily flows >900 m^3 per day

Location	*Discharges to*	*Grid ref.*	*Max. dry weather flow (m^3/day)*	*Level of treatment*
Kirkwall	The String	HY479144	34,500	*
Bay of Ireland	Scapa Flow	HY275092	950	None
Stromness	Hamnavoe Bay	HY253086	1,279	None

Sources: SEPA (pers. comm.). Key: *to be determined prior to operation.

on the aquatic environment is monitored by SOAEFD. Small amounts of radioactivity are discharged from Dounreay (Region 3). Radioactive discharges from Sellafield (Region 13) are traceable as Caesium-137 for many years and over long distances. This radionuclide is carried northwards around the region's southern shores to the North Sea, arriving at the Norwegian coast about five years after discharge.

Under the Urban Waste Water Treatment Directive (91/271/EEC) 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. The majority of outfalls in this region are extremely small scale, being septic tank outputs from domestic premises.

Monitoring of water quality in the region is carried out by SEPA and SOAEFD, with SEPA concerned mainly with point sources of contamination from outfalls in the nearshore environment. The interests of SOAEFD lie with the disposal of sewage sludge and dredge spoil further offshore and their possible effects on fisheries, and they carry out a wide range of sampling work associated with this. SEPA and SOAEFD contribute to the National Marine Monitoring Plan, which monitors a wide range of listed chemicals in water, biota and sediments, at a range of frequencies which decreases from the estuarine to the offshore environment.

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). Secondly, there is the European Blue Flag Award Scheme for beaches that meet the EC guideline standards. Thirdly, there is the Tidy Britain Group Seaside Award Scheme, designed to complement the Blue Flag scheme. There are also litter surveys by 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. There are no Coastwatch UK or Beachwatch reports specific to Orkney.

9.6.4 Information sources used

The Department of the Environment, Transport and the Regions (DETR) Environmental Protection Statistics Division publishes an annual *Digest of environmental statistics* (e.g. DoE 1996), which provides detailed national statistics on aspects of environmental protection, including coastal and marine waters, radioactivity, waste and recycling, and wildlife. 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. Other information sources available include the RPB's (now SEPA's) Annual Reports, and the Scottish Office Water Quality Series reports (e.g. Scottish Office 1992). Further information on discharges can be obtained from the local offices of SEPA, who issue discharge consents and authorisations. MAFF (Centre for Environment, Fisheries and Aquaculture Sciences, 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).

9.6.5 Acknowledgements

Thanks are due to Tracy Grove and Chris Matthews (SEPA, Orkney Area Office) for providing information on trade and sewage effluent outfalls in the region.

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Schultz-Bull, D.E., Petrick, G., & Duinker, J.C. 1991. Polychlorinated biphenyls in North Sea water. *Marine Chemistry, 36:* 365-384.

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, Northern Region HQ, Dingwall, tel: 01349 862021
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
Information on water quality in Scotland	*SNH, Aquatic Environments Branch, Advisory Services, Edinburgh, tel: 0131 554 9797
Beachwatch	*Marine Conservation Society, Ross-on-Wye, tel: 01989 566017
Coastwatch UK	Project Officer, Coastwatch UK, Farnborough College of Technology, Boundary Road, Farnborough, Hampshire GU14 6SB, tel: 01252 377503
Tidy Britain Group Seaside Award and European Blue Flag beaches	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.J. Everett

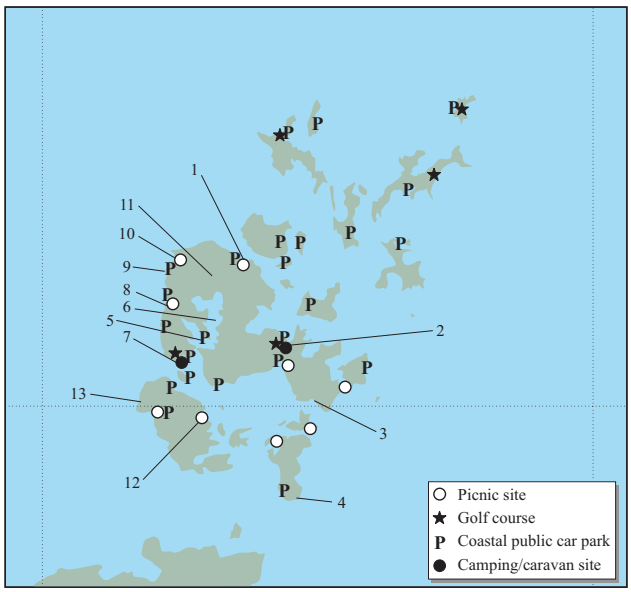
9.7.1 Introduction

A wide range of land-based leisure activities take place along the coast, including walking, camping, golf, beach recreation, bird watching, wildfowling, horse riding, angling. The most important examples of land-based leisure infrastructure on the coast of Orkney are golf courses, caravan parks, campsites and rural car parks (which provide the access points necessary for most land and water-based leisure activities). However, much of this type of infrastructure and activity is small in scale, because Orkney's relatively remote location makes visiting comparatively difficult and expensive. However, most of the islands are well served by ferries and air services and there is a network of roads on most of the islands.

Tourism is a major industry for Orkney, with visitor spending in 1991 estimated at £24 million (Orkney Islands Council 1993) and visitor numbers reaching 120,000. The tourist resources of the islands are the scenery, archaeology and wildlife and maritime and wartime history. There are over 350 scheduled ancient monuments and over 30 of these are open to the public, including Skara Brae prehistoric village, which is located to the north of Stromness. The majority of tourists come from within the UK, and about a third from Europe and the rest of the world (RSPB pers. comm.).

9.7.2 Important locations

In May 1996 the Scottish Sports Council database had 108 records of leisure and sporting activities for Orkney, of which the most numerous were for angling (27 records), sailing (15), boardsailing (13), canoeing (12) and riding/pony-trecking (11). The greatest concentration of tourist-related infrastructure and the greatest intensity of tourist- and leisure-related activity is on Mainland, Burray and the north-west coast of South Ronaldsay. Important historical and ancient monuments such as Skara Brae are amongst Orkney's most visited sites. There are visitor centres located at Scapa Flow (wartime and naval history) and on Rousay. The only two camping/caravan sites, located near Kirkwall and Stromness, are small. There are golf courses on North Ronaldsay, Sanday and Westray and near Stromness and Kirkwall on Mainland. Map 9.7.1 shows the locations of coastal public car parks, picnic sites, golf courses and camping/caravan sites, as well as Orkney's most visited buildings and monuments (Table 9.7.1). The Old Man of Hoy is a popular site for rock climbing. The wildife of Orkney is a major tourist attraction but there is little supporting infrastructure, with most visits being informal. However, there are viewing hides sited on some of the RSPB reserves (e.g. Birsay Moors and The Loons), and there is also a bird observatory on North Ronaldsay with hostel-type accommodation for visiting birdwatchers. Wildfowling takes place on the Orkney estuaries of Cata Sand, Otters Wick, Kettletoft Bay and Deer Sound & Peter's Pool (Buck 1993), generally as an informal, localised activity, occurring on a relatively infrequent basis.



Map 9.7.1 Land-based leisure infrastructure (Table 9.7.1). Sources: Orkney Islands Council (1993), OS Landranger maps.

Table 9.7.1 Orkney's most visited buildings/monuments

No on Map 9.7.1	*Site*	*No. of visitors per year*
1	Broch of Gurness	5,000-25,000
2	Kirkwall:	
	St Magnus Cathedral	25,000-50,000
	Tankerness Museum	5,000-25,000
	Earls'/Bishops' Palaces	5,000-25,000
3	Italian Chapel	25,000-50,000
4	Tomb of the Eagles	5,000-25,000
5	Maes Howe	25,000-50,000
6	Corrigall Museum	5,000-25,000
7	Stromness Museum	5,000-25,000
8	Skara Brae	>50,000
9	Marwick Head	5,000-25,000
10	Brough of Birsay	5,000-25,000
11	Kirbister Museum	5,000-25,000
12	Scapa Flow Visitor Centre	5,000-25,000
13	Old Man of Hoy	n/a

Source: Orkney Islands Council (1993). Key: n/a = not available.

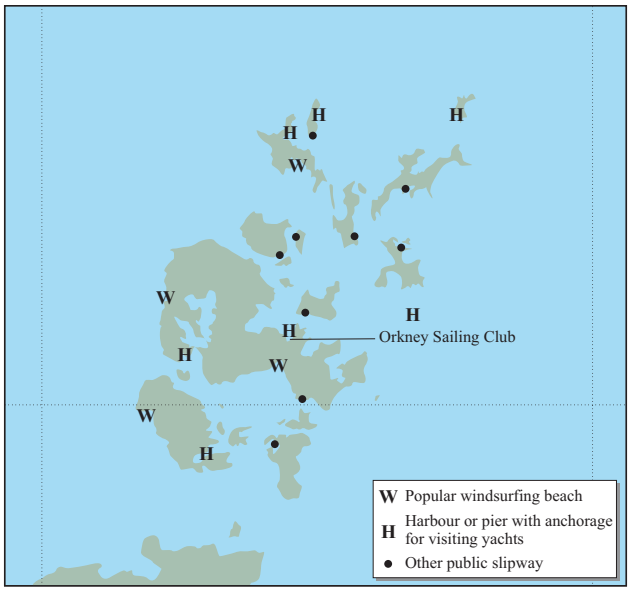
Sailing is a major recreational activity in Orkney. Facilities for the relatively small number of visiting yachts are provided in the main harbours of Stromness and Kirkwall. Public slipways and landing jetties are present on most of the islands and visiting yachts can safely anchor in many of the sheltered sounds and bays. Regattas are held at Westray, Kirkwall, Stromness and Holm. Waterskiing takes place in Scapa Flow, off Kirkwall and elsewhere, and windsurfing and motorised watersports are practised off the coastline along the north and east sides of Scapa Flow. The most popular windsurfing beach is Scapa Beach, but the Bay of Skaill, Rackwick Bay (Hoy) and some bays around

Westray are also popular. Subaqua is popular for viewing both marine wildlife and the many shipwrecks that are present around the coast. Scapa Flow has become a major attraction for wreck divers as it has the largest number of sunken battleships (the remains of the German fleet, scuttled in 1919) within a single area in Britian. Map 9.7.2 shows locations important for water-based leisure activities.

9.7.3 Management and issues

Although national planning guidance on sport and recreation has been drafted (Scottish Office 1995), it will not apply to the many forms of recreation that lie outwith the planning system. Furthermore, planning law specifically excludes areas below low water mark. Locally, tourism planning and policy is overseen by Orkney Islands Council and Orkney Tourist Board, which markets the region as a tourist destination and produces a general tourist brochure with information on facilities, transportation and accommodation. The work of the local authority and the Tourist Board is supported by national agencies and other specific-purpose bodies, including the Scottish Sports Council, which is the national body responsible for the promotion of sport and physical recreation in Scotland, and Scottish Natural Heritage, which has a statutory duty to facilitate the enjoyment of the countryside and to promote recreation while having regard for the conservation of Scotland's natural heritage.

The provision of recreational facilities is mainly the responsibility of the local authority. Orkney Islands Council provided significant investment between 1989-1992 for development of the tourist industry via a Tourist Development Programme and continues to develop initiatives to enhance the industry. Initiatives include the establishment of countryside visitor sites and walks with on-site interpretation throughout the islands, with the aim of encouraging visits to a wider range of localities and to deflect intense visitor pressure from some of the more popular sites, such as Skara Brae, which has in excess of 50,000 visitors a year. In its Structure Plan the Council draws attention to the fact that some of the most visited monuments are in danger of erosion due to excess visitor pressure. Visitor pressure on wildlife sites has been insignificant so far. To enhance the protection of Orkney's natural and built heritage, and as a means of developing a sustainable tourist industry, the Orkney Islands Council has also established an Environmental Heritage Trust. This comprises representatives from local authorities, government nature conservation agencies and other local organisations. The Trust aims to facilitate access to ancient monuments, encourage new low-key visitor developments and environmental schemes, and promote other projects that will provide some economic return to local people. It also acquires areas of conservation value and enters into management agreements with landowners. Through its planning policies, the council is also mindful of the importance of the islands' natural and archaeological heritage to the tourist industry. An archaeological trust was estabilised in December 1996, comprising representatives from the local authority, tourist board, heritage society, University of Highlands and Islands, National Farmers Union and Historic Scotland.



Map 9.7.2 Water-based leisure. Sources: Orkney Tourist Board (1996), D'Oliveira & Featherstone (1993).

9.7.4 Information sources used

The use of the coast of Scotland for leisure and sport has been the subject of a project undertaken by the Scottish Sports Council, which maintains a GIS database of leisure and sporting activity around the Scottish coast. Most of the above information on the location of infrastructure is derived from Ordnance Survey 1:50,000 Landranger maps, Ordnance Survey & Hamlyn (1995), Pemberton (1994) and a leisure map of the islands (Estate Publications undated). It has not always been possible to gauge the scale of some facilities from the information that was available for this review. The maps and tables are therefore only indicative of the distribution of leisure and tourism in the region.

9.7.5 Acknowledgements

Thanks are due to Vicki Eachus, Planning Data Management Service, University of Edinburgh, for supplying information from the Scottish Sports Council database. Thanks also go to Eric Meek (RSPB), John Orr (Orkney Islands Council) and Mark Tasker (JNCC) for their comments on the draft text.

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C. Contact names and addresses

Type of information	Contact address and telephone no.
Tourist information, policy, development and planning in Scotland; support for Area Tourist Boards (ATBs)	Scottish Tourist Board, 23 Ravelston Terrace, Edinburgh EH4 3EU, tel: 0131 332 2433
Local tourism development, planning and promotion	Orkney Tourist Board, 6 Broad Street, Kirkwall K15 1NX, tel: 01856 872856
Local tourism development, planning and promotion	*Orkney Islands Council, Development and Planning Department, tel: 01856 873535
North Ronaldsay Bird Observatory	Twingness, North Ronaldsay, Orkney KW17 2BE
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
Marine leisure industries	British Marine Industries Federation, Meadlake Place, Thorpe Lea Road, Egham, Surrey TW20 8HE, tel: 01784 473377
Water quality of bathing beaches - UK	*Marine Conservation Society, Ross-on-Wye, tel: 01989 566017
Information on environmental effects of leisure activities	*SNH, Advisory Services, Edinburgh, tel: 0131 447 4784
Leisure activities	
Angling	Scottish Anglers National Association, Caledonia House, South Gyle, Edinburgh EH12 9DQ, tel. 0131 339 8808
Board sailing	UK Board Sailing Association, PO Box 28, Fareham, Hants PO14 3XD, tel: 01329 664779
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: 01602 821100
Canoeing - Scotland	Administrator, Scottish Canoe Association, Caledonia House, South Gyle, Edinburgh EH12 9DQ, tel: 0131 317 7314
Field Sports	Secretary, British Field Sports Society (Scottish Branch), Green Burns, Coupar, Angus PH13 9HA, tel: 01828 27015
Golf	Secretary, Scottish Golf Union, The Cottage, 181a Whitehouse Road, Edinburgh EH4 6BY, tel: 0131 339 7546
Horse riding	Secretary, The Trecking and Riding Society of Scotland, Boreland Riding Centre, Fearnan, Aberfeldy PH15 2PG, tel: 01887 830274
Jet skiing	UK Jet Ski Association, Goodwood Road, Boyatt Road Industrial Estate, Eastleigh, Hants. SO5 4NT, tel: 01703 601684
Sailing, yachting and windsurfing	Royal Yachting Association, Scottish Region, Caledonia House, South Gyle, Edinburgh EH12 9DQ, tel: 0131 317 7388
Sub Aqua - Britain	British Sub Aqua Club, Telfords Quay, Elesmere Port, South Wirral, Cheshire L65 4FY, tel: 0151 357 1951
Sub Aqua - Scotland	Scottish Sub Aqua Club, Cockburn Centre, 40 Bogmoor Place, Glasgow G51 4TQ, tel: 0141 425 1021
Sub Aqua - Orkney	Karl Cooper, Orkney Sub-Aqua Club, 59 Albert Street, Kirkwall, Orkney KW15 1HQ
Surfing	Secretary, Scottish Surfing Federation, c/o Royal Yachting Association, Scottish Region, Caledonia House, South Gyle, Edinburgh EH12 9DQ, tel: 0131 317 7388
Water skiing	Scottish Water Ski Association, Development Officer, Scottish Water Ski Centre, Town Loch, Town Hill, Dunfermline KY12 0HT, tel: 01383 620123
Wildfowling (general information on wildfowl, habitats and conservation)	*Enquiry Officer, RSPB HQ, Sandy, tel: 01767 680551
Wildfowling (the sport)	Press and Information Officer, British Field Sports Society, 59 Kennington Road, London SE1 7PZ, tel: 0171 928 4742
Wildfowling bans in severe weather	*Licensing Officer, SNH, Advisory Services, Edinburgh, tel: 0131 554 9797
Windsurfing - Britain	British Windsurfing Association, 86, Sinah Lane, Hayling Island, Hants. PO11 9JX, tel: 01705 468182
Windsurfing - Scotland	Secretary, Scottish Windsurfing Association, c/o Royal Yachting Association, Scotland, Caledonia House, South Gyle, Edinburgh EH12 9DQ, tel: 0131 317 7388
Yachting	Honorary Secretary, Royal Yachting Association, Scotland, Caledonia House, South Gyle, Edinburgh EH12 9DQ, tel: 0131 317 7388
Yacht harbours	The Yacht Harbour Association, Evegate Park Barn, Smeth, Ashford, Kent TN25 6SX, tel: 01303 814434

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

Orkney's terrestrial coastal zone is known only patchily in terms of its environmental and historical heritage resource. However, much knowledge has recently been acquired about its seas and shores with the completion of the JNCC's Marine Nature Conservation Review surveys of the islands. These have confirmed Orkney's outstanding importance for marine conservation, a significant factor in planning decisions relating to use of both land and sea. Photo: Bill Sanderson, Countryside Council for Wales.

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 Orkney. 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 10.3.5C), contact points for some of these organisations are included there.

10.1.1 Coastal zone management in the UK

This section outlines the direction of UK policy-making, within which many of the regional initiatives operate. Many, frequently competing, issues and activities affect the coastal environment and inshore waters, making the task of coastal zone planning and management a very complex one, particularly as numerous different authorities are responsible for particular statutory duties. Coastal zone management promotes an inter-disciplinary approach to multiple use and conflict resolution between interest groups, "to ensure the long-term future of the resources of the coastal zone through environmentally sensitive programmes, based on the principle of balanced, sustainable use" (Gubbay 1990). Integrated coastal zone management aims to ensure that all land and sea use issues are co-ordinated, including development, conservation, waste disposal, fisheries, transport, coastal protection and flood defence. The advantages of this have been recognised by coastal planners in many areas, and several local authorities and other bodies now promote coastal zone management. However, approaches differ from area to area, 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 zone management planning;
- the integration of responsibility for coast protection and sea defence under one body;
- better statutory protection for sites of nature conservation importance;
- better provisions for control of marine pollution;
- the need for fisheries activities to take account of marine conservation issues.

Strategic planning guidelines for the Scottish coast were first set out in Scottish Development Department (1974), based on a series of maps published in Skinner (1974). These guidelines were updated by Scottish Development Department (1981) to cover most of the major developments for port, industrial and power generation purposes. More recently, the Scottish Office has commissioned a review of Scottish coastal issues (Burbridge & Burbridge 1994). This review urges the development of new coastal planning policies and guidelines to deal with the integration of coastal resource-based activities at the local and regional level. The report suggests that these should support planning authorities in dealing with planning applications and advise on the production of local and regional coastal management plans and strategies. It also suggests the promotion of a national strategy for the sustainable development and management of coastal land and water resources.

The Burbridge report of 1994 has since been followed up with the publication of a discussion paper (Scottish Office Agriculture, Environment and Fisheries Department 1996). This provides a summary of Scottish coastal issues and identifies a range of actions that should be taken or investigated for the purposes of achieving sustainable management of the coast and its resources. The government proposed the establishment of a Scottish Coastal Forum, similar to those that have already been established in England and Wales (Scottish Office Agriculture, Environment and Fisheries Department 1996). The Scottish Coastal Forum was announced in November 1996 and comprises representative bodies with a major interest or responsibility in coastal zone issues; it will provide a national context for coastal zone management planning.

In 1994, the UK Government published its Regulations to implement the EC Habitats Directive (Department of the Environment/Welsh Office 1994). In Scotland, the EC Habitats Directive is implemented in accordance with

Scottish Office Environment Division Circular 6/90/95 (Scottish Office 1995). As they relate to the coast, these regulations provide for single management groups to be set up for whole sites, making the production of unified management plans a practical proposition. Where these sites are of European importance for their nature conservation interest, the conservation of that interest must be the primary consideration of the management plan. For this, the regulations require all relevant authorities to exercise a general duty of care for their long-term conservation. At the time of writing, discussions are continuing on how these requirements will work in practice (see also section 10.2.6).

In 1995 the European Commission adopted the *Communication on integrated management of coastal zones* (COM/511/95), which sets out proposals for EU funding for demonstration programmes of coastal zone management (European Commission 1995). The strategy is to be based on the principles of sustainability and sound ecological and environmental practice, but will have no legal standing. In February 1996 the European Commission published a *Demonstration programme on integrated management of coastal zones* (European Commission Services 1996), intended as a spur to urgent co-operative action for Europe's coast.

In 1995 the Local Government Management Board (LGMB) issued 'Roundtable Guidance' on the implementation of Local Agenda 21 on the coast (LGMB 1995).

10.2 National coastal initiatives with regional elements

10.2.1 Introduction

Partly as a result of developments at UK and international level, many national bodies, including several with no direct management role through a statutory remit or ownership of coastal land, are now becoming involved in the promotion of coastal management initiatives. These include non-governmental organisations with a particular interest in the conservation of the coastal zone, such as CoastNET (the Coastal Heritage Network), the Marine Conservation Society, World Wide Fund for Nature (UK) and the Royal Society for the Protection of Birds (see section 10.2.5). The National Trust for Scotland has recently been carrying out a complete review of its Coastal Strategy Plans and has an ongoing review of coastal site management plans. Only national initiatives that have distinct local elements in the region are described here. Many other diverse interest groups and organisations now have national policies with regard to coastal management and estuaries management, for example the British Association for Shooting and Conservation and the Royal Yachting Association. Regionally-led coastal management initiatives are dealt with in section 10.3.

10.2.2 Scottish Coastal Forum

The Scottish Coastal Forum, which was put forward in the discussion paper *Scotland's coasts* (Scottish Office Agriculture, Environment and Fisheries Department 1996), was announced in November 1996. A wide range of organisations with an interest in coastal matters will be invited to participate in the Scottish Coastal Forum, including representatives from the Association of Shellfish Growers, Confederation of British Industry Scotland, CoastNET, Convention of Scottish Local Authorities, Crown Estate, Highlands and Islands Enterprise, Scottish Enterprise, Scottish Environment Protection Agency, Scottish Fishermen's Federation, Scottish Natural Heritage, Scottish Salmon Growers' Association, Scottish Sports Council, Scottish Tourist Board, Scottish Wildlife and Countryside Link and the Scottish Office. The Forum will provide a focus for coastal issues as well as a national context for the work of local coastal forums.

10.2.3 CoastNET: the Coastal Heritage Network

CoastNET was established in 1995 to link individuals and organisations working for the sustainable management of the coastal and marine environment, building on the achievements of its predecessor, the Heritage Coast Forum. CoastNET aims to provide a network for coastal managers and field staff on the UK coast, to improve the ways in which the coastal heritage of the UK is managed, and to ensure that the practical experience of coastal managers and field staff contributes to the formulation of policy for the coastal zone. CoastNET is a membership body open to all those with an interest in the practical management of the UK coastline. In November 1996 it held a national workshop for coastal managers in Scotland (CoastNET 1997).

10.2.4 Scottish Environment Protection Agency (SEPA)

The Scottish Environment Protection Agency 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 in England and Wales, there is currently no system of Integrated Catchment Management planning (see Macaulay Land Use Research Institute 1995) in Scotland, although there is widespread support that this approach should be pursued.

10.2.5 Royal Society for the Protection of Birds

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* (Royal Society for the Protection of Birds 1995). The Royal Society for the Protection of Birds (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, some 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 areas managed by Scottish Natural Heritage for nature conservation objectives and nature reserves managed by the Scottish Wildlife Trust, local authorities, the RSPB and other bodies, and National Scenic Areas (see section 7.3.3) managed for a broader range of conservation and recreational objectives. The Natural Heritage (Scotland) Act 1991 makes provision for the designation of Natural Heritage Areas (NHAs), which will cover extensive areas of land within which nature conservation, landscapes and cultural interests will be managed under a single integrated management plan to be approved by the Secretary of State. No NHAs have been designated yet. Of particular interest because of their specific requirement for wide consultation are Special Areas of Conservation (SACs), to be designated under the EC Habitats & Species Directive (see also section 7.2.2).

Special Areas of Conservation (SACs)

Under the EC Habitats & Species Directive 1992, a list of Special Areas of Conservation (SACs) to be designated in the UK must be agreed by the UK Government and the European Commission by 1998 (see section 7.2.2). Three candidate sites in Orkney have been put forward for consideration by the European Commission. Marine SACs may include intertidal areas and/or subtidal areas; terrestrial SACs may include important coastal maritime habitats such as lagoons, saltmarshes and sand dunes. Under Scottish Office Environment Division Circular 6/90/95 (Scottish Office 1995), marine and terrestrial SACs will have to be managed in a way that secures their 'favourable conservation status'. A range of bodies and individuals will be involved, including all 'relevant and competent authorities', e.g. local authorities, the Scottish Environment Protection Agency (SEPA), port and harbour authorities, Scottish Natural Heritage, Scottish Office Agriculture Environment and Fisheries Department, as well as owners and occupiers of foreshore land and representatives of those who rely on marine areas for their livelihood or for recreation. Management will be coordinated through an agreed management scheme, backed by existing statutory measures. The Department of the Environment has drafted guidance (DoE/WO 1996) on the preparation and application of management schemes for SACs and the Scottish Office will be producing similar guidance in due course. A European marine sites handbook is being prepared by the UK nature conservation agencies (Laffoley in prep.) to provide guidance on all aspects of developing management schemes within marine SACs.

10.3 Regional coastal management groups and initiatives

10.3.1 Introduction

The Government has stated its support for the encouragement of more local coastal fora along the lines of Scottish Natural Heritage's Focus of Firths initiative (Scottish Office 1996), although no such fora currently exist or are planned for Orkney. However, Orkney Islands Council, through its structure planning policies (see section 10.3.2), has a strategy for protecting the coastal environment of Orkney through development control and has undertaken other initiatives that aim to protect important aspects of Orkney's coastal heritage.

10.3.2 Local planning authorities and port/harbour authorities

Orkney Islands Council has far-reaching powers over development in both land and sea areas, under the Orkney Islands Council Act 1974. Orkney Islands Council also acts as the Harbour Authority. As a result Orkney Islands Council is already able to undertake integrated coastal zone management on a statutory basis, rather than simply in voluntary co-operation with other statutory organisations. The Council has published a structure plan, which provides the statutory planning framework for development control purposes.

10.3.3 Coastal engineering groups

At present there are no formal coastal (engineering) groups and no shoreline management plans in Orkney. Hydraulics Research have carried out a study on coastal process cells in Scotland (HR Wallingford 1995), co-sponsored by Scottish Natural Heritage, the Scottish Office Environment Department and Historic Scotland. This study aims to set out for the first time a framework for management of coastal areas in Scotland and could be used to set up new coastal management initiatives, similar to the coastal (engineering) groups established in England and Wales. HR Wallingford are also producing a series of eleven regional reports, summarising coastal processes for each of the coastal cells in Scotland (HR Wallingford 1996).

10.3.4 Other local initiatives

Public and political concern at chronic oil pollution around Shetland and Orkney, following the opening of the Sullom Voe and Flotta oil terminals, stimulated the introduction of a number of non-statutory measures designed to eliminate or reduce chronic pollution off-shore. One of the main concerns was the illegal discharge of ballast water or tank slops from tankers trading to Sullom Voe, which resulted in large numbers of oiled seabirds being found in the waters around the northern isles of Scotland in 1979. As a result, the local authority and oil industry introduced a system of tanker routeing, Areas To Be Avoided, unscheduled aerial surveillance of all tankers, rigorous inspection of ballast quality and quantity, and the introduction through chartering contracts of the requirement for vessels to carry at least 35% ballast on arrival at the port (so providing a strong disincentive to deballast at sea). An advisory scheme is operated via port and shipping organisations and the Marine Safety Agency (Table 10.3.1). All the coastal waters around Orkney, with the exception of the Pentland Firth, have been notified as Areas To Be Avoided (Marine Safety Agency undated) (see Map 8.3.4).

10.3.5 Further sources of information

A. References cited

Burbridge, P., & Burbridge, V. 1994. *Review of Scottish coastal issues.* Edinburgh, Scottish Office. (Consultants report to the Central Research Unit.)

CoastNET. 1997. *CoastNET: a new deal for the Scottish coast.* Manchester, CoastNET. (Report of a national workshop for coastal managers in Scotland, 14 November 1996, University of Edinburgh.)

Department of the Environment/Welsh Office. 1994. *The Conservation (Natural Habitats &c.) Regulations.* London, HMSO (SI 2716).

Department of the Environment/Welsh Office. 1996. *A guide to the Conservation of Natural Habitats &c Regulations 1994 and to the preparation and application of management schemes.* London, HMSO.

Earll, R.C., *ed.* 1994. *Statutory and non-statutory plans in the estuarine and coastal environment. Overlapping plans - is this an issue?* Kempley, Gloucestershire, Marine Environmental Management and Training. (Unpublished report of a meeting held in July 1994.)

European Commission. 1995. *Communication from the Commission to the Council and European Parliament on the integrated management of coastal zones.* Brussels. (COM(95)511 final.)

European Commission Services. 1996. *Demonstration programme on integrated management of coastal zones*. Brussels.

Gubbay, S. 1990. *A future for the coast? Proposals for a UK coastal zone management plan*. Ross-on Wye, a report to the World Wide Fund For Nature from the Marine Conservation Society (unpublished).

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

HR Wallingford. 1995. *Coastal cells in Scotland*. Wallingford, HR Wallingford. (Report to Scottish Natural Heritage, the Scottish Office and Historic Scotland. EX/3176.)

HR Wallingford. 1996. *Regional cells analysis*. (Report to Scottish Natural Heritage, Scottish Office and Historic Scotland.) Wallingford, HR Wallingford.

Laffoley, D.d'A., *ed.* In prep. *A generic management model for marine SACs.* Peterborough, English Nature.

Local Government Management Board. 1995. *Local Agenda 21: roundtable guidance. Action on the coast*. Luton, Local Government Management Board.

Macaulay Land Use Research Institute. 1995. Integrated catchment management. *In: The Macaulay Land Use Research Institute Annual Report 1994.* Craigiebuckler, Aberdeen, MLURI.

Table 10.3.1 Marine oil pollution avoidance advisory scheme

Initiative	*Scope / aims*	*Organisations involved*	*Contact details*
Advisory routes for shipping around Orkney and Shetland	To minimise the risk of a shipping accident and consequent coastal and marine pollution. Areas To Be Avoided and Precautionary Areas: vessels of 5,000 GRT or more carrying oil or other hazardous cargoes are advised to avoid ATBAs. Precautionary Areas are ones in which there may be large, deep-draught vessels with limited manoeuvrability. Shipping is advised to observe recommended directions of traffic flow through the Fair Isle Channel. Laden vessels using the Fair Isle Channel are requested to make position reports to Shetland Coastguard.	Port and shipping organisations and the Marine Safety Agency.	*Orkney Islands Council, Kirkwall, tel: 01856 873535

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

Royal Society for the Protection of Birds. 1993. *Making the coast count: strategic planning and management on the north-west coast.* Sandy, RSPB.
Royal Society for the Protection of Birds. 1995. *Review of coastal zone management powers.* Sandy, RSPB.
Scottish Office. 1995. *Nature conservation: implementation in Scotland of the EC Directives on the conservation of natural habitats and of wild flora and fauna, and the conservation of wild birds: the conservation (natural habitats, etc.) regulations 1994.* Edinburgh, Scottish Office Environment Division, Rural Affairs Department. (Circular 6/90/95.)
Scottish Office Agriculture, Environment and Fisheries Department. 1996. *Scotland's coast: a discussion paper.* Edinburgh, HMSO.
Skinner, D. 1974. *The coast of Scotland: some recently collected survey material prepared for the Scottish Development Department.* Edinburgh, Scottish Development Department.

B. Further reading

Included in the following list of references are items relating to England and Wales that may be of interest to individuals and organisations involved in coastal management in Scotland.

Bown, D. 1988. *Coastal development: a planner's view.* Paper presented to the Council for the Protection of Rural Wales (CPRW) Annual Study Conference (unpublished).
Coastal Heritage Forum. 1995. *Heritage Coasts: a guide for councillors and officers.* Manchester, Coastal Heritage Forum.
Department of the Environment/Welsh Office. 1992. *Planning policy guidance - coastal planning*. PPG 20. London, HMSO.
Department of the Environment/Welsh Office. 1993. *Development below low water mark: a review of regulation in England and Wales.* London, HMSO.
Department of the Environment/Welsh Office. 1993. *Managing the coast: a review of coastal management plans in England and Wales and the powers supporting them.* London, HMSO.
Department of the Environment. 1995. *Policy guidelines for the coast.* London, HMSO.
Ecological Steering Group on the oil spill in Shetland. 1994. *The environmental impact of the wreck of the Braer.* Edinburgh, The Scottish Office.
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.)
Royal Society for the Protection of Birds. 1992. *A shore future. RSPB vision for the coast*. Sandy, Royal Society for the Protection of Birds.
Scottish Development Department. 1974. *Coastal planning guidelines and land-use summary sheet*. Edinburgh, Scottish Development Department.
Scottish Development Department. 1981. *National planning guidelines.* Edinburgh, Scottish Development Department.
Scottish Natural Heritage. 1995. *Natura 2000: a guide to the 1992 EC Habitats directive in Scotland's marine environment*. Edinburgh, SNH.
Scottish Natural Heritage. 1995. *Natura 2000: a guide to the 1992 EC Habitats directive in Scotland's terrestrial environment*. Edinburgh, SNH.
Scottish Natural Heritage. 1996. *Natura 2000: Special Protection Areas.* Edinburgh, SNH.
Scottish Natural Heritage. 1997. *Natura 2000: managing European marine sites - an introduction.* Edinburgh, Scottish Natural Heritage.
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.)
World Wide Fund For Nature. 1995. *Integrated coastal zone management UK and European initiatives.* Godalming, World Wide Fund For Nature UK. (Marine Update, No. 19.)

Newsletters

Many national statutory, non-governmental and scientific bodies are now producing publications or newsletters on the subject of coastal management. These provide either information on particular local or national initiatives (such as the statutory or non-governmental organisations' estuaries and firths initiatives) or general information on a range of coastal news (for example the newsletters of Eurocoast UK and the European Union for Coastal Conservation). Some of these publications are listed below. Addresses of those publishing the newsletters are given in section 10.3.5C.

Coastline 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 Update. A briefing to highlight World Wide Fund For Nature's work in marine conservation. Published by WWF.
Wavelength. The (English) Coastal Forum newsletter. Reports the work of the Forum to a wider audience. Published by the Department of the Environment.

National planning/management publications

House of Commons Environment Committee. 1992. *Second report - coastal zone protection and planning*. London, HMSO. (Recommended that coastal zone management be adopted as the framework for all coastal zone planning and management practice in the United Kingdom. Called for a national coastal strategy, a review of the many organisations responsible for the coast, the extension of planning controls offshore, and the establishment of a Coastal Zone Unit in Department of the Environment.)

Scottish Office. 1995. *Nature conservation: implementation in Scotland of the EC Directives on the conservation of natural habitats and of wild flora and fauna, and the conservation of wild birds: the conservation (natural habitats, etc.) regulations 1994.* Edinburgh, Scottish Office Environment Division, Rural Affairs Department. (Circular 6/90/95.)

Scottish Office. 1995. *Planning and flooding.* Edinburgh, Scottish Office. (National Planning Policy Guidelines (NPPG) 7.)

C. Contact names and addresses

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 Technical Officers Group	The coastal group of the statutory conservation agencies (English Nature, Scottish Natural Heritage, Countryside Council for Wales, Department of the Environment for Northern Ireland, Joint Nature Conservation Committee and the Countryside Commission)	Coastal Technical Officers Group, Maritime Team, English Nature, Northminster House, Peterborough PE1 1UA, tel: 01733 455000 (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, Department of Maritime Studies, Univerity of Wales Cardiff, PO Box 907, CF1 3YP, tel: 01222 874271
European Union for Coastal Conservation (EUCC)	International grouping of organisations and individuals with an interest in coastal nature conservation matters, including coastal management.	European Union for Coastal Conservation (EUCC) Secretariat, PO Box 11232, NL-2301 EB Leiden, tel: +31 71 122900/123952
European Union for Coastal Conservation – United Kingdom (EUCC-UK)	UK membership network affiliated to EUCC, providing focus for information exchange about European-level coastal conservation issues	EUCC, c/o 5 Green Lane, Brampton, Huntingdon, Cambridgeshire PE18 8RE, tel: 01480 457624
Joint Nature Conservation Committee	Information and advice on coastal management	*Earth Science/Coastal Advisor, JNCC, Peterborough, tel: 01733 62626
JNCC Marine Nature Conservation Review	Project to extend knowledge of benthic marine habitats, communities and species in Great Britain and identify sites and species of nature conservation importance; producing a series of 15 reports *(Coasts and seas of the United Kingdom. MNCR series)* on a coastal sector basis, as well as more detailed area summaries.	*JNCC, Peterborough, tel: 01733 62626
Les Esturiales Environmental Study Group	International programme for co-operation, the exchange of experience on estuarine management and personal contacts between local authority practitioners in Europe.	Esturiales Environmental Study Group, Professor Graham King, Swansea Institute of Higher Education, Faculty of Leisure and Tourism, Mount Pleasant Campus, Swansea SA1 6ED, tel: 01792 456326
Marine Conservation Society	Provides advice and supports local coastal management initiatives: runs grant-aided coastal management workshops and courses for coastal managers; promotes the establishment of voluntary coastal groups.	*Marine Conservation Society, Ross-on-Wye, tel: 01989 566017
Marine Forum	National network; provides forum for discussion of marine issues relating to the seas around UK. Members include governmental and non-governmental organisations and individuals. Occasional seminars are held, covering a range of topics including coastal management.	*Honorary Secretary, The Marine Forum for Environmental Issues, University College Scarborough, Scarborough, tel: 01723 362392

C. Contact names and addresses (continued)

Organisation/group	*Activities*	*Contact address and telephone no.*
National Coasts and Estuaries Advisory Group (NCEAG)	Provides advice to local authorities on sustainable management of coastal and estuarine environments; published guide to good practice (NCEAG 1993)	Alan Inder, Secretary, National Coasts and Estuaries Advisory Group (NCEAG), Hampshire County Council, The Castle, Winchester SO23 8UJ, tel: 01962 846749
National Trust for Scotland	Has extensive coastal land holdings in Scotland and plans to extend its Enterprise Neptune project to Scotland (purchase and management of coastal land for nature conservation, landscape and public enjoyment)	*National Trust for Scotland, Edinburgh, tel: 0131 226 5922
Royal Society for the Protection of Birds	National and local campaigns for the protection of coastal wildlife. Landowner and manager of nature reserves.	*Coastal Policy Officer, RSPB HQ, Sandy, tel: 01767 680551
Scottish Environment Protection Agency (SEPA)	Water resources planning, pollution control and enforcement, flood warning, waste regulation and disposal, regulation of land drainage to controlled waters.	*SEPA Head Office, Stirling, tel: 01786 457700, and *SEPA Northern Region Head Office, Dingwall, tel: 01349 862021
Scottish Natural Heritage	Coastal cells in Scotland	*Focus on Firths Project Manager, Scottish Natural Heritage, 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.	*A.S. Burdekin, SOAEFD European Environment and Engineering Unit, Victoria Quay, Edinburgh, tel: 0131 556 8400
Scottish Office Development Department	Coastal policy and planning. Preparation of Rural White Paper.	Environment Department, Room 6/61, Scottish Office Development Department, New St. Andrew's House, Edinburgh EH1 3TG, tel: 0131 244 4807
World Wide Fund for Nature - UK	Provides funding for research, local voluntary policy development and local initiatives, publications on integrated coastal management.	*World Wide Fund for Nature - UK, Godalming, tel: 01483 426444, and *WWF Scotland, Aberfeldy, tel: 01887 820449

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

Probably the most important higher plant species on the Orkney islands is the Scottish primrose *Primula scotica* (pictured). It is endemic (confined) to Scotland, where it grows only in Orkney, Sutherland and Caithness. Other Scottish endemic species present in the region are the eyebrights *Euphrasia heslop-harrisonii* and *E. marshallii;* eyebrights are notoriously difficult to identify to species level. Photo: Pat Doody, English Nature.

Appendix

A.1 Frequently cited contact names and addresses

Name	*Contact address and telephone no.*
Statutory bodies	
British Oceanographic Data Centre (BODC)	Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, tel: 0151 653 8633
Department of the Environment (DoE), European Wildlife Division/ Dept. of Rural Affairs	DoE, Room 9/03B, Tollgate House, Houlton Street, Bristol BS2 9DJ, tel: 0117 987 8000
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
Joint Nature Conservation Committee (JNCC), Headquarters	Monkstone House, City Road, Peterborough, Cambs. PE1 1JY, tel: 01733 62626
JNCC, Seabirds and Cetacean Team	Seabirds and Cetaceans Team, Joint Nature Conservation Committee, 11 Dunnet House, 7 Thistle Place, Aberdeen AB10 1UZ, tel: 01224 655702
Scottish Environment Protection Agency (SEPA), Head Office	Erskine Court, The Castle Business Park, Stirling FK9 4TR, tel: 01786 457700
SEPA North Region HQ	Graesser House, Fodderty Way, Dingwall IV14 9XB, tel: 01349 862021
Scottish Natural Heritage (SNH) HQ	12 Hope Terrace, Edinburgh EH9 2AS, tel: 0131 447 4784
SNH Advisory Services	Bonnington Bond, 2 Anderson Place, Edinburgh EH6 5NP, tel: 0131 554 9797
SNH North-east Region Head Office	Wynne-Edwards House, 17 Rubislaw Terrace, Aberdeen AB10 1XE, tel: 01224 642863
SNH Orkney Office	54-65 Junction Road, Kirkwall, Orkney KW15 1AW, tel: 01856 875302
Scottish Office Development Department	Victoria Quay, Edinburgh EH6 6QQ, tel: 0131 556 8400
Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD)	Pentland House, 47 Robb's Loan, Edinburgh EH14 11Y, tel: 0131 556 8400 and Victoria Quay, Edinburgh EH6 6QQ, tel: 0131 244 0213

Name	*Contact address and telephone no.*
Statutory bodies (continued)	
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 AB11 9DB, tel: 01224 876544
Wildlife Trusts	
Scottish Wildlife Trust (SWT) HQ	Cramond House, Kirk Cramond, Cramond Glebe Road, Edinburgh EH4 6NS, tel: 0131 312 7765
National voluntary bodies	
The British Trust for Ornithology	The Nunnery, Thetford, Norfolk IP24 2PU, tel: 01842 750050
Marine Conservation Society	9 Gloucester Road, Ross-on-Wye, Herefordshire HR9 5BU, tel: 01989 566017
The National Trust for Scotland	5 Charlotte Square, Edinburgh EH2 4DU, tel: 0131 226 5922
Royal Society for the Protection of Birds (RSPB) HQ	The Lodge, Sandy, Bedfordshire SG19 2DL, tel: 01767 680551
RSPB Scottish HQ	17 Regent Terrace, Edinburgh EH7 5BN, tel: 0131 557 3136
RSPB East Scotland Office	10 Albyn Terrace, Aberdeen, AB10 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
WWF Scotland	1 Crieff Road, Aberfeldy, Perthshire PH15 2BJ, tel: 01887 820449
Others	
British Geological Survey	Keyworth, Nottingham NG12 5GG, tel: 0115 936 3100
Marine Forum for Environmental Issues	c/o University College of Scarborough, Filey Road, Scarborough, Yorkshire YO11 3AZ, tel: 01723 362392
International Centre for Island Technology, Institute for Offshore Engineering	Old Academy, Back Road, Stromness, Orkney KW16 3AW, tel: 01856 850605

A.2 Local planning authorities; port and harbour authorities

Name	*Address and telephone no.*
Orkney Islands Council	Council Offices, Kirkwall KW15 1NY, tel: 01856 873535
Ports and harbours	
Flotta	Flotta Oil Terminal, Flotta, Stromness, Orkney KW16 3NP, tel: 01856 884000
Kirkwall	Orkney Islands Council, Department of Harbours, Harbour Authority Building, Scapa, Orkney KW15 1SD, tel: 01856 873636

A.3 Core reading list

There are a number of publications that either provide information on a variety of topics covered in these regional reports (and so are frequently referred to) or give a good overview of regional and national information on coasts and seas. They are listed below.

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

British Oceanographic Data Centre. 1992. UKDMAP *(United Kingdom digital marine atlas).* Birkenhead, BODC. (Computer software.)

Brown, A. 1992. *The UK environment.* London, HMSO.

Buck, A.L. 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.

Lee, A.J., & Ramster, J.W. 1981. *Atlas of the seas around the British Isles.* Lowestoft, MAFF.

Local Government Management Board. 1995. *Local Agenda 21: roundtable guidance. Action on the coast.*

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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