

Liverpool Bay and the Solway Firth

Area summaries

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1998

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Coasts and seas of the United Kingdom

Marine Nature Conservation Review series

Area summaries

Preface

The *Marine Nature Conservation Review* (MNCR) was initiated by the Nature Conservancy Council in 1987 as the third major resource survey, following the *Nature Conservation Review* and the *Geological Conservation Review*. Since April 1991, the MNCR has been undertaken within the Support Unit of the Joint Nature Conservation Committee. The JNCC is a forum through which the three country agencies, the Countryside Council for Wales, English Nature and Scottish Natural Heritage, deliver their special statutory responsibilities for Great Britain as a whole and internationally. These special responsibilities, known as special functions, contribute to sustaining and enriching biological diversity, enhancing geological features and sustaining natural systems.

The MNCR is drawing together information on marine ecosystems around Great Britain with the objectives of:

- extending our knowledge of benthic marine habitats, communities and species in Great Britain, particularly through description of their characteristics, distribution and extent; and
- identifying sites of nature conservation importance.

The data collected also provide information to support more general measures to minimise adverse effects of development and pollution, particularly on sites and species of nature conservation importance.

The area included in the MNCR is the coastline of England, Scotland and Wales (excluding the Isle of Man and the Channel Isles), extending on the shore from the lower limit of terrestrial flowering plants and within marine inlets from the limit of marine influence out to the limit of British territorial seas. Saline lagoons are also included. The MNCR included a major field survey programme of the shores and near-shore subtidal zone, undertaken to standard methodology.

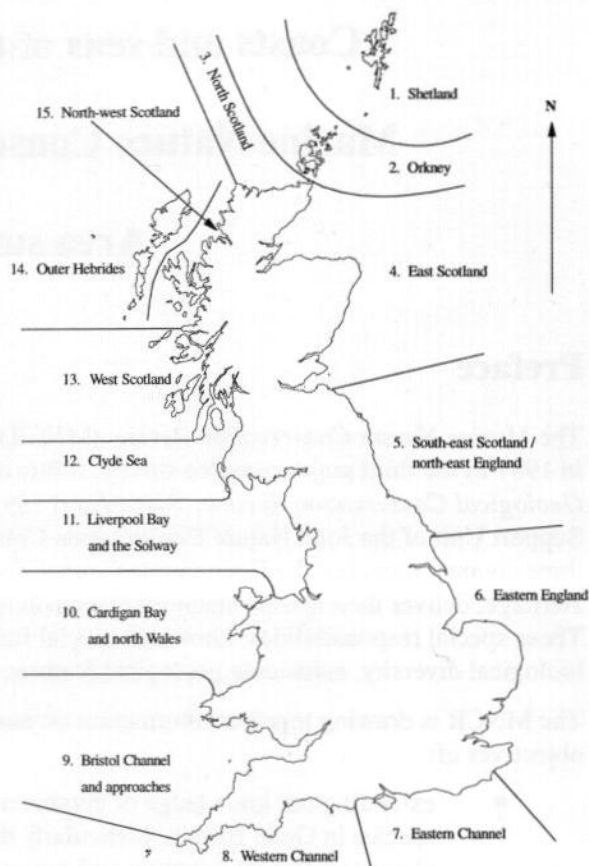
MNCR studies have been undertaken within particular coastal sectors around Britain (see map overleaf) or of major physiographic types, such as lagoons and sealochs. These studies are being presented, in the *Coasts and Seas of the United Kingdom - MNCR series*, as *area summaries*, each of which provides an account of a discrete stretch of open coast, a marine inlet or a lagoon within the area of study. A list of *area summary* volumes and other major publications from the MNCR is given overleaf.

A full list of MNCR and other JNCC marine reports is available from the Marine Information Officer, JNCC. JNCC publications can be purchased from NHBS Ltd, 2-3 Wills Road, Totnes, Devon, TQ9 5XN (tel. 01803 865913; fax. 01803 865280; e-mail nhbs@nhbs.co.uk).

Dr Keith Hiscock
Joint Nature Conservation Committee

Publications in the MNCR series

MNCR coastal sectors, as used in the *Coasts and seas of the United Kingdom. MNCR series.*



Volumes published or near publication:

Sector	Title	Authors	Date
Foundation volumes			
1-15	Rationale and methods	Hiscock, <i>ed.</i>	1996
1-15	Benthic marine ecosystems of Great Britain and the north-east Atlantic	Hiscock, <i>ed.</i>	1998
Biotope classification			
1-15	Marine biotope classification for Britain and Ireland. Volume 1. Littoral biotopes (<i>JNCC Report, No. 229</i>)	Connor, Brazier, Hill & Northen	1997
1-15	Marine biotope classification for Britain and Ireland. Volume 2. Sublittoral biotopes (<i>JNCC Report, No. 230</i>)	Connor, Dalkin, Hill, Holt & Sanderson	1997
Area summaries			
1	Shetland	Howson	Due 1998
2	Orkney	Murray, Dalkin, Fortune & Begg	Due 1998
5	South-east Scotland and north-east England	Brazier, Davies, Holt & Murray	1998
6	Inlets in eastern England	Hill, Emblow & Northen	1996
8	Inlets in the western English Channel	Smith, Moore & Northen	Due 1998
9	Inlets in the Bristol Channel and approaches	Smith, Moore, Northen & Little	Due 1998
10	Cardigan Bay and north-west Wales	Brazier, Holt, Murray & Nichols	Due 1998
11	Liverpool Bay and the Solway Firth	Covey	1998
1-2	Lagoons in Shetland and Orkney	Thorpe	1998
3, 4, 12, 13, 15	Lagoons in mainland Scotland and the Inner Hebrides	Covey, Fortune, Nichols & Thorpe	1998
14	Lagoons in the Outer Hebrides	Thorpe, Dalkin, Fortune & Nichols	1998

Other volumes in the series are also in preparation.

Marine Nature Conservation Review

Sector 11: Liverpool Bay and the Solway Firth

Area summaries

Synopsis

The coast from Colwyn Bay in north Wales to the Mull of Galloway in south-west Scotland (MNCR Sector 11: Liverpool Bay and the Solway Firth) has been studied as part of the Marine Nature Conservation Review programme. The studies included field surveys of the shores and the subtidal zone to describe the habitats and communities (together referred to as biotopes) present and to assess their natural heritage importance. Comparable data from other organisations or previous studies have been added to provide information on over 320 sites within the region and the data analysed to classify the biotopes present. Information on the designated conservation sites and main human influences in the areas has also been compiled.

The information is presented here as 12 *area summaries*:

1. Colwyn Bay
2. River Dee
3. River Mersey
4. River Ribble
5. Fylde coast
6. Morecambe Bay
7. Duddon Sands
8. West Cumbria
9. Southern Solway Firth
10. Inner Solway Firth
11. Wigtown and Kirkcudbright Bays
12. Luce Bay

Each area is described in a standard format, giving details of its physical and biological character, the biotopes present and their distribution, current nature conservation designations, the main human influences and relevant literature. The areas surveyed and the marine biotope information are also presented in a series of maps. These *area summaries* are supported by a summary of the biotopes defined for the region (from Connor *et al.* 1997a, b) and by a list of species recorded from the surveys.

References

- Connor, D.W., Brazier, D.P., Hill, T.O., & Northen, K.O. 1997a. Marine Nature Conservation Review: marine biotope classification for Britain and Ireland. Volume 1. Littoral biotopes. Version 97.06. *JNCC Report*, No. 229.
- Connor, D.W., Dalkin, M.J., Hill, T.O., Holt, R.H.F., & Sanderson, W.G. 1997b. Marine Nature Conservation Review: marine biotope classification for Britain and Ireland. Volume 2. Sublittoral biotopes. Version 97.06. *JNCC Report*, No. 230.

Introduction

Background

MNCR Sector 11 extends from Colwyn Bay, north Wales, northwards to the Mull of Galloway in south-west Scotland (Figure 1). This coastline forms the eastern basin of the Irish Sea and is interrupted by a series of major estuaries, including the Dee, Mersey, Ribble and Solway, and the large embayment of Morecambe Bay. The coastline is relatively complex when compared with the North Sea coast of England, in having a range of wave exposures, salinities and tidal stream strengths. However, the coastline lacks the diversity of rocky habitats found on the adjacent shores of Wales and southern Scotland. In Sector 11 the coastline is heavily developed in the south, including the sprawling conurbations of the Wirral, but becomes rural in the north along the Cumbrian and Solway coasts.

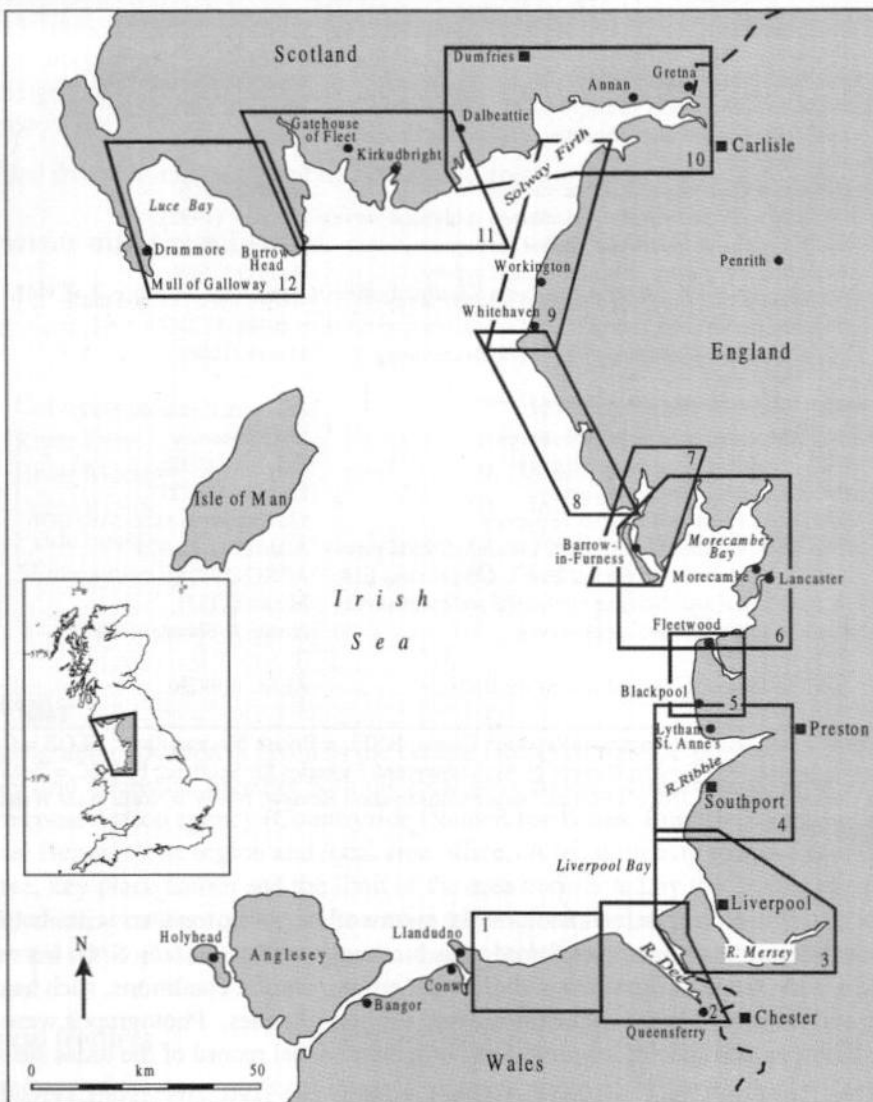


Figure 1 Location of the 12 reporting areas (area summaries) in MNCr Sector 11.
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Data collection and the classification of biotopes

Field surveys in the region were undertaken between 1989 and 1991 as part of the Marine Nature Conservation Review programme, to describe the marine biology of the shores and nearshore subtidal zone and to assess their natural heritage importance. These surveys complemented other studies carried out previously or by other organisations, including the Applied Environmental Research Centre, British Nuclear Fuels Ltd, the Central Electricity Generating Board, the Field Studies Council Research Centre, North West Water and the Solway River Purification Board, all of whom made data available to the MNCR. A summary of these surveys is given in Table 1. Further references to other studies are given in the individual *area summary* accounts.

Table 1 Sources of field survey information.

MNCR database survey no.	Survey	Source	No. of sites	No. of habitats surveyed
16	1989 MNCR outer Solway Firth littoral survey	Covey (1990)	18	73
20	1989 MNCR Cumbria littoral survey	Covey & Davies (1989)	28	87
36	1991 MNCR Dumfries and Galloway coast littoral survey	Covey & Emblow (1992)	18	83
38	1991 MNCR Ravenglass area, Duddon & Ribble estuaries littoral survey	Davies (1992)	25	76
41	1990 MNCR outer Solway sublittoral survey	Covey (1992)	26	37
61	1990 MNCR Morecambe Bay to Whitehaven sublittoral survey	Emblow (1992)	1	2
62	1990 MNCR Crosby to Fleetwood littoral survey	Davies (1991)	15	51
193	1987 CEGB Mersey estuary littoral sediment survey	Bamber (1988)	34	34
240	1990 MNCR Rhos Point to New Brighton littoral survey	Garwood & Foster-Smith (1991)	16	57
275	1989 FSCRC Blackshaw Bank hydraulic cockle-dredging survey	Moore (1990)	6	27
286	1991 MNCR inner Solway littoral survey	Covey & Emblow (1992)	28	91
287	1991 MNCR Morecambe Bay littoral survey	MNCR survey	17	70
288	1991 MNCR Lune Deep sublittoral survey	Emblow (1992)	9	11
289	1991 MNCR Cumbria sublittoral survey	Emblow (1992)	7	14
326	1965-1970 DAFS Scottish sandy shore survey	Eleftheriou & McIntyre (1976)	1	15
365	1991 NWW St Bees Head to Maryport, Cumbria littoral survey	Allen <i>et al.</i> (1992)	20	160
441	1992 AERC inner Solway survey for BNFL Chapelcross EIA	AERC (1992a)	27	27
476	1993 FSCRC Fylde Coast Scheme sublittoral sediment survey	Moore (1993)	1	15
478	1986 Sellafield sublittoral sediment survey	Jensen & Sheader (1986)	12	12
479	1992 SRPB inner Solway sublittoral sediment survey	Rendall & Bell (1993)	5	5
480	1992 AERC Sellafield sublittoral survey for BNFL	AERC (1992b)	15	15
Total			329	962

Abbreviations: AERC = Applied Environmental Research Centre; BNFL = British Nuclear Fuels; CEGB = Central Electricity Generating Board; DAFS = Department of Agriculture and Fisheries for Scotland; FSCRC = Field Studies Council Research Centre; MNCR = JNCC's Marine Nature Conservation Review; NWW = North West Water; SRPB = Solway River Purification Board.

During the MNCR field surveys information on the nature of each site, together with its habitats and their associated communities (together referred to as biotopes) were collected. Sites were selected in order to sample a wide range of substrata and different environmental conditions, such as differing wave exposure and salinity regimes in the littoral and sublittoral zones. Photographs were taken of the sites, and their biotopes and species, to provide a permanent visual record of the areas surveyed.

The sites were surveyed following standard MNCR recording and infaunal sampling techniques (Connor & Hiscock 1996). The location and physiographic characteristics of each site were recorded on a standard MNCR Site form. The physical details of each habitat and the species present were recorded on standard MNCR Habitat forms (Littoral or Sublittoral as appropriate). The conspicuous species were recorded using the MNCR semi-quantitative abundance scales. Species which could not be identified *in situ* were collected for later identification in the laboratory.

Core samples of intertidal sediment habitats were taken for infaunal species identification and granulometric analysis. Four 0.01 m² core samples were taken for infaunal analysis. These were combined and sieved over a 0.5 mm mesh sieve. Material retained on the sieve was preserved in seawater-formalin for subsequent identification and enumeration of the species present. A separate sediment sample was taken for particle size analysis. In the subtidal most samples were derived from external sources which used Day or Van Veen grabs.

Once fully processed the data were entered into the MNCR database to facilitate subsequent analysis and reporting. Data from other organisations, when collected with compatible techniques, were added to increase the volume of information available and its geographical coverage.

The species data from the surveys were analysed, in conjunction with their associated habitat data, to identify which biotopes, as defined in the MNCR national biotope classification (Connor *et al.* 1997a, b), were present in the dataset. Multivariate analytical techniques, including TWINSPAN and DECORANA, were employed to facilitate the identification of distinct assemblages of species within the dataset, using the procedures given in Mills (1994). Data from 329 sites (962 different habitat records) from MNCR Sector 11 were used in the analyses, resulting in the identification of 105 biotopes or sub-biotopes from the national classification (Appendix A). Full descriptions of each biotope and the general approach to biotope classification are given in Connor *et al.* (1997a, b). Appendix B shows the distribution of biotopes in each area.

Species recorded from the surveys listed in Table 1 are given in Appendix C.

Area summaries and their format

The coast of MNCR Sector 11 has been divided into 12 discrete areas (see Figure 1) and each has been described in the standard MNCR *area summary* format. The 12 areas described are:

- | | |
|------------------|------------------------------------|
| 1. Colwyn Bay | 7. Duddon Sands |
| 2. River Dee | 8. West Cumbria |
| 3. River Mersey | 9. Southern Solway Firth |
| 4. River Ribble | 10. Inner Solway Firth |
| 5. Fylde coast | 11. Wigtown and Kirkcudbright Bays |
| 6. Morecambe Bay | 12. Luce Bay |

Each *area summary* contains the following sections:

Location

The geographic location is given as the central latitude/longitude position and Ordnance Survey grid reference, together with the local government administrative area and the relevant nature conservation agency (Countryside Council for Wales, English Nature or Scottish Natural Heritage), its region and local area office. A location map shows the main features of the area, key place names and the limit of the area considered by the *area summary*. The sites surveyed are shown according to four main types of survey: recording on littoral (▲) or sublittoral (●) rock/hard substrata and sampling in littoral (Δ) or sublittoral (○) sediment habitats.

Physical features

A summary of the main physical features includes: the type of physiographic feature as defined in Connor & Hiscock (1996) or, for estuary types, in Davidson *et al.* (1991); the length of coastline and bathymetry summarised from Admiralty charts; the areas and lengths of inlets, taken from Buck (1993), the length being from the mouth of the inlet to the limit of tidal influence; wave exposure and tidal stream ranges taken from field observations, as defined in Connor & Hiscock (1996); tidal range figures are for maximum spring tidal range, quoted for the nearest secondary port, and taken from Buck (1993); and the salinity range is estimated at

the time of survey or given in available literature; categories are as in Connor & Hiscock (1996). All heights and depths given are corrected to chart datum.

Introduction

The overall physical characteristics of the area and any significant human influences and activities are described. Water quality information is from Buck (1993).

Marine biological surveys

Marine biological surveys of the shores and sublittoral zone which have been used in compiling the *area summary* are listed to include the survey type (littoral/sublittoral), survey method, date of survey and reference source. The distribution of survey sites is shown on the location map.

Marine biology

The biological nature of the area is described with reference to the biotopes present and their distribution within each area, based on the findings of the MNCR surveys and other studies. The heights and depths noted in the text are corrected to chart datum. The biotope codes given in parentheses are from the MNCR national classification, as listed in Appendix A, and a summary of the biotopes present within each area is presented in Appendix B. Species nomenclature follows Howson & Picton (1997); that for lichens follows Purvis *et al.* (1992) and that for higher plants follows Stace (1991).

A map illustrates the distribution of the main biotopes within the area; some mapped areas represent more than one biotope. **NOTE:** this map gives an indication of the *likely* distribution and extent of biotopes, based on the data available, including sketch maps of biotope distribution made at the time of survey, cited literature and information on Admiralty charts. In some areas data are sparse and additional data or more comprehensive survey would enable more accurate maps to be drawn.

Nature conservation

A summary of statutory and non-statutory wildlife and landscape conservation designations for the marine and adjacent coastal parts of the area is given; Barne *et al.* (1996) provide further information on each designation.

Key to site designations:

AONB	Area of Outstanding Natural Beauty
ESA	Environmentally Sensitive Area
HC	Heritage Coast
LNR	Local Nature Reserve
MoD	Ministry of Defence
NNR	National Nature Reserve
NP	National Park
NSA	National Scenic Area
NT	National Trust
NTS	National Trust for Scotland
Ramsar	Ramsar site
RSPB	Royal Society for the Protection of Birds reserve
cSAC	candidate Special Area of Conservation
SMA	Sensitive Marine Area
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
SWT	Scottish Wildlife Trust
WT	County Wildlife Trust

Human influences

This section describes the main uses and activities of the area, including urbanisation, industrial or commercial activities that have (or potentially have) an impact on the area. These can include sewage discharges, industrial effluent, development, dredging, spoil dumping, commercial fishing, recreation and shipping.

References and further reading

This lists cited references and other relevant literature.

Sites surveyed

This lists the sites surveyed within the area from the surveys shown in Table 1, with additional information on the location of each site, the date of survey and an inventory of the biotopes present at the time of survey.

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1

Colwyn Bay

Location

<i>Position (centre)</i>	SH 940 800	53°19'N 3°35'W
<i>County/district</i>	Aberconwy and Colwyn Denbighshire	Colwyn Rhuddlan
<i>Conservation agency/area</i>	Countryside Council for Wales	North East

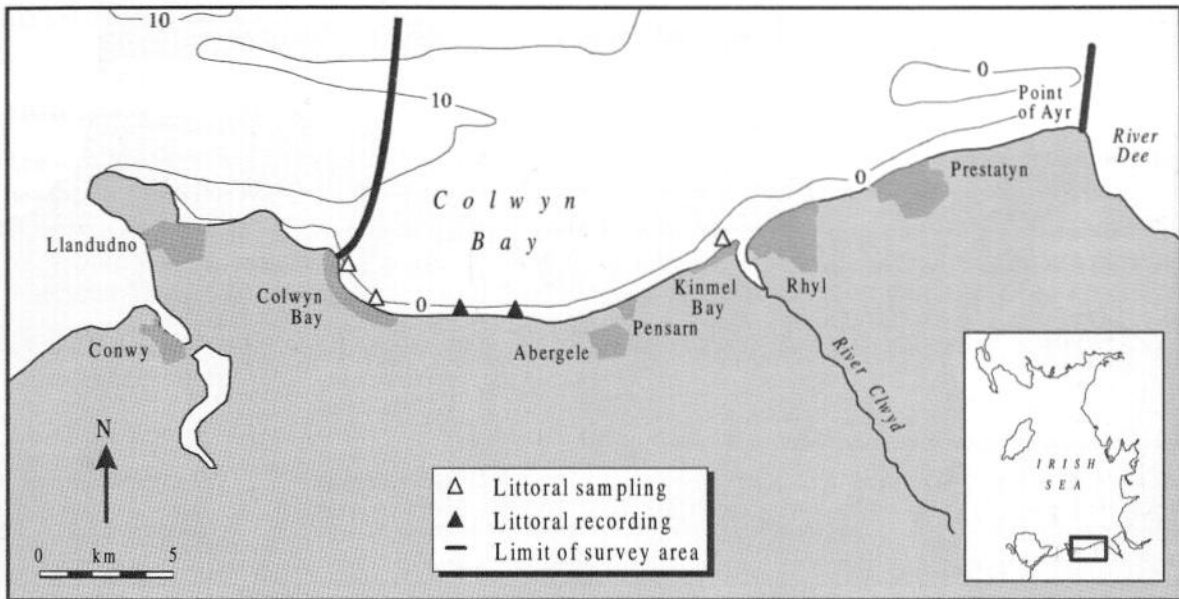


Figure 1.1 Location of area showing sites surveyed and main bathymetric features.

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Marine biological surveys

	<i>Survey method</i>	<i>Date of survey</i>	<i>Source</i>
<i>Littoral</i>	Recording and sampling	May 1990	Garwood & Foster-Smith (1991)

Introduction

Colwyn Bay is a long embayment on the north coast of Wales between the mouth of the River Dee and Ormes Head. The broad sweep of the coastline is largely uninterrupted except for the inlet of the River Clwyd at Rhyl. The shores consist of sandy beaches, with occasional areas of boulders and mixed hard ground. Much of the backing hinterland is developed, with popular seaside resorts at Colwyn Bay, Rhyl and Prestatyn. Consequently the upper shore is modified in many places by coastal defences, with groynes on some shores to inhibit sediment transport. Towards the eastern limit of the area more natural coastal habitats occur, with sand dunes at Point of Ayr adjacent to the mouth of the River Dee.

The predominantly sandy shores give way to shallow sublittoral plains of sandy sediment. Submerged fossil forests are present at Pensarn and Rhyl.

Physical features

<i>Physiographic type</i>	Open linear coast
<i>Length of coast</i>	42 km
<i>Bathymetry</i>	Less than 10 m; maximum depth of 10 m up to 3 km offshore
<i>Wave exposure range</i>	Moderately exposed
<i>Tidal stream range</i>	Weak
<i>Tidal range</i>	6.7 m
<i>Salinity range</i>	Fully marine

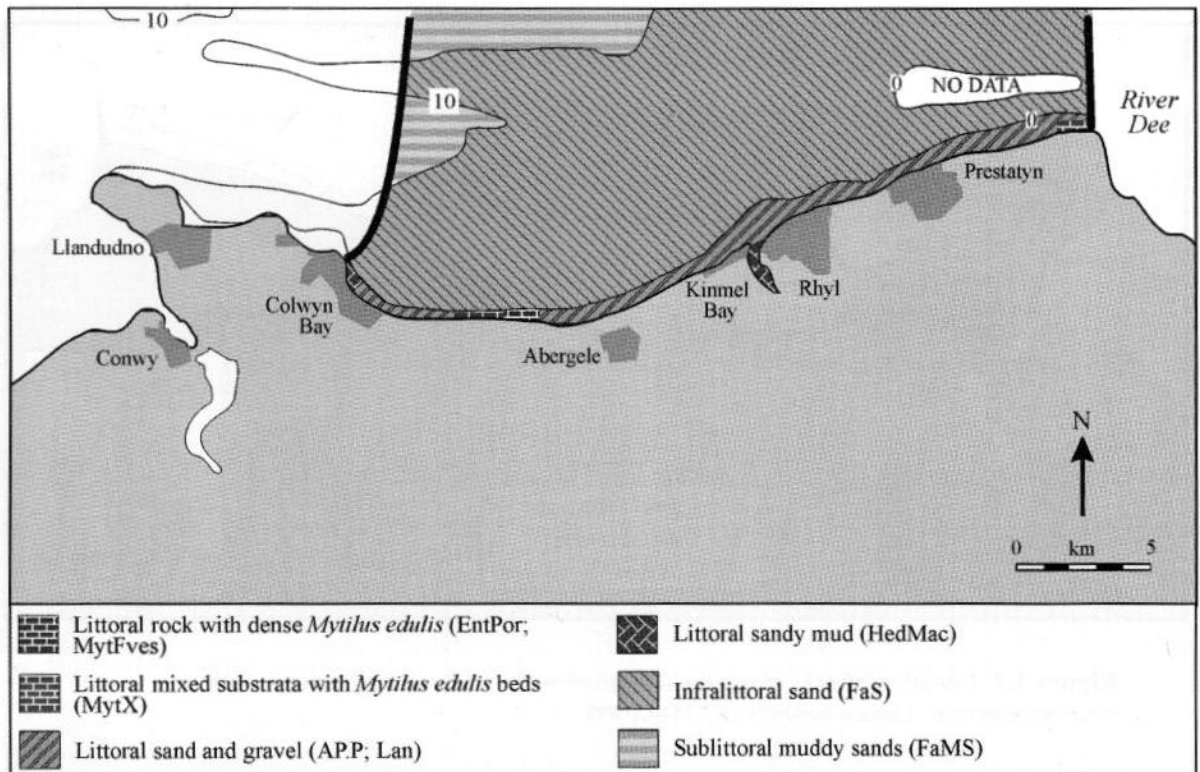
Marine biology

Figure 1.2 Indicative distribution of the main biotopes in the area (based on data from survey sites shown in Figure 1.1, additional field observations and cited literature).

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Marine habitats throughout the area are rather uniform, with predominantly sandy beaches interrupted only occasionally by small areas of boulders. These boulders are extensively scoured by the surrounding sediments and typically support sparse communities of barnacles in the most scoured areas (BPat). Communities of the mussel *Mytilus edulis* and green alga *Enteromorpha* sp. occur where there is increased stability such as rock outcrops or shelter from scouring (MytFves; EntPor; MytX); these communities have a limited distribution around Abergele. Elsewhere the sandy beaches of the area consist of mobile, fine sands with sparse communities of amphipods and polychaetes in the most exposed areas (AP.P). In sediment adjacent to the boulder areas there are dense populations of the sand mason worm *Lanice conchilega* (Lan). Within the small estuary of the River Clwyd at Rhyl, muddy sand with ragworm *Hediste diversicolor* and the Baltic tellin *Macoma balthica* is likely to be present (HedMac). A small area of muddy sand with the peppery furrow shell *Scrobicularia plana* (HedScr) is present in the west of Colwyn Bay, and has also been recorded from the River Clwyd (Parsons & Pugh-Thomas 1979).

Offshore communities are likely to be dominated by mobile, shallow sand with a sparse epifauna in the inshore areas (FaS), grading to sediments with richer communities of amphipods, polychaetes and bivalves further offshore (FaMS) (Mackie 1990).

Nature conservation

Conservation sites			
Site name	Designation	Centre grid ref.	Main features
Llandulas Beach	SSSI	SH 932 782	Flora
Gronant Dunes and Talacre Warren	SSSI	SJ 100 847	Flora, invertebrates, ornithology
Point of Ayr	RSPB	SJ 113 833	Ornithology

Human influences

The coastline is extensively developed with seaside resorts at Colwyn Bay, Rhyl and Prestatyn and the beaches are popular during the summer months for recreation and water sports. There has been extensive modification of the upper shore by coastal protection, with groynes on the beaches to inhibit long-shore drift of sediment. Offshore oil and gas exploration occurs and there are plans for a pipeline from offshore gas fields to come ashore at Point of Ayr.

The area is not known to be heavily fished, although some amateur bait collection may take place. A small harbour at Rhyl supports some inshore fishing.

References and further reading

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Sites surveyed

Survey 240: 1990 MNCR Rhos Point to New Brighton littoral survey (Garwood & Foster-Smith 1991).

Littoral sites					
<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude/longitude</i>	<i>Biotopes present</i>
240	1	Rhos-on-Sea, Clwyd.	SH 844 806	53°18.5'N 03°44.1'W	AP.P; Lan; HedMac
240	2	Min-y-don Park, Clwyd.	SH 871 788	53°17.6'N 03°41.6'W	AP.P; Lan
240	3	Penmaenrhos Point, Clwyd.	SH 882 788	53°17.6'N 03°40.6'W	BPat; EntPor; MytFves; Lan
240	4	Llandulas Point, Clwyd.	SH 913 787	53°17.6'N 03°37.8'W	BPat; MytX; Lan
240	5	Foryd, Clwyd.	SH 992 812	53°19.0'N 03°30.8'W	AP.P; Lan

Compiled by: Roger Covey

Location

<i>Position (centre)</i>	SJ 260 740	53°20'N 03°15'W
<i>County/district</i>	Flintshire Cheshire Merseyside	Alyn, Deeside & Delyn Neston, Chester Wirral, Ellesmere Port
<i>Conservation agency/area</i>	Countryside Council for Wales English Nature	North East North West

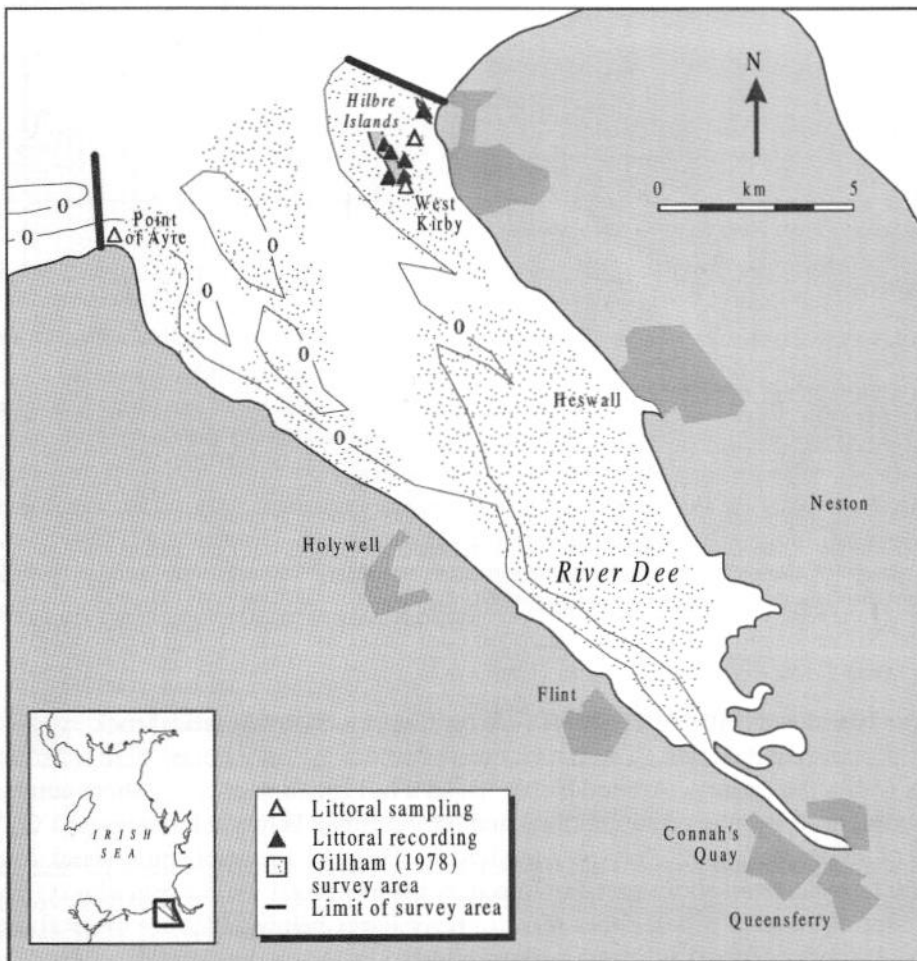


Figure 2.1 Location of area showing sites surveyed and main bathymetric features (position of chart datum bathymetry liable to change significantly).

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Marine biological surveys

	<i>Survey method</i>	<i>Date of survey</i>	<i>Source</i>
<i>Littoral</i>	Recording and sampling	May 1990	Garwood & Foster-Smith (1991)
	Recording, core sampling (346 sites indicated by shaded area on figure 2.1 and used in preparation of figure 2.2)	1971-76	Gillham (1978)

Introduction

The River Dee lies between the Wirral peninsula and the north Wales coast and straddles the border between England and Wales. Much of the estuary has been modified by man's activities, with extensive land claim in the upper reaches where the main channel has been artificially constrained in a canal from Flint to Chester. Much of the intertidal area of the Dee consists of sediment flats, with extensive areas of saltmarsh, particularly at the head of the estuary. The coastline and saltmarsh have changed considerably in their extent over the last two centuries (Countryside Council for Wales 1993).

Physical features

<i>Physiographic type</i>	Coastal plain estuary
<i>Length of coast</i>	100 km
<i>Area of inlet</i>	12,900 ha
<i>Length of inlet</i>	36.8 km
<i>Bathymetry</i>	Predominantly intertidal
<i>Wave exposure range</i>	Moderate to very sheltered
<i>Tidal stream range</i>	Not known
<i>Tidal range</i>	7.6 m
<i>Salinity range</i>	Full to low

Marine biology

Much of the Dee estuary is characterised by extensive intertidal flats of muddy fine sand with a ragworm *Hediste diversicolor* and Baltic tellin *Macoma balthica* community (HedMac.Pyg) and isolated areas of ragworm *H. diversicolor* and peppery furrow shell *Scrobicularia plana* (HedScr). The *Hediste/Macoma* biotope extends over much of the inner section of the estuary, south-east of a line from Holywell to Heswall, and is present over the upper shore to the mouth of the estuary. The lower shore sediment flats of the outer section of the estuary are also characterised by fine muddy sand, but with a community of polychaetes and the cockle *Cerastoderma edule* (PCer; MacAre). Around the mouth of the estuary, where wave action is greatest, the sediment is clean mobile sand, characterised by a sparse community of amphipods and polychaetes (AP.P). Sediment adjacent to the rocky reefs of Hilbre Island is subject to enhanced tidal water movement, and here communities of sand mason worm *Lanice conchilega* occur (Lan).

Around Hilbre Island and Little Hilbre, west of West Kirby, a reef of intertidal rock extends for about 3 km in a north-westerly direction. These rocky reefs harbour the only littoral hard substratum communities within the estuary. Around Hilbre Island a full zonation of rocky shore communities is present, including well-developed supralittoral and littoral fringe lichen communities (YG; Ver.Ver), a narrow band of channelled wrack *Pelvetia canaliculata* (Pel) and a zone of spiral wrack *Fucus spiralis* (Fspi). Below these is a mid-shore area dominated by bladder wrack *Fucus vesiculosus* (Fves) and a lower shore zone of serrated wrack *Fucus serratus* (Fser.Fser), below which are lower shore sediment communities. Patches of mixed substrata are consolidated by the mussel *Mytilus edulis* (MytX).

Some areas of fucoid-dominated communities also occur, associated with sea walls and on waste tips on the Welsh shoreline.

Away from the mouth of the estuary the shallow infralittoral consists of mobile sand, described as the "shallow *Venus* community" by Mackie (1990). This community is characterised by the bivalves *Fabulina fabula* and *Spisula elliptica* and by the polychaetes *Magelona mirabilis* and *Nephtys cirrosa* (FaS).

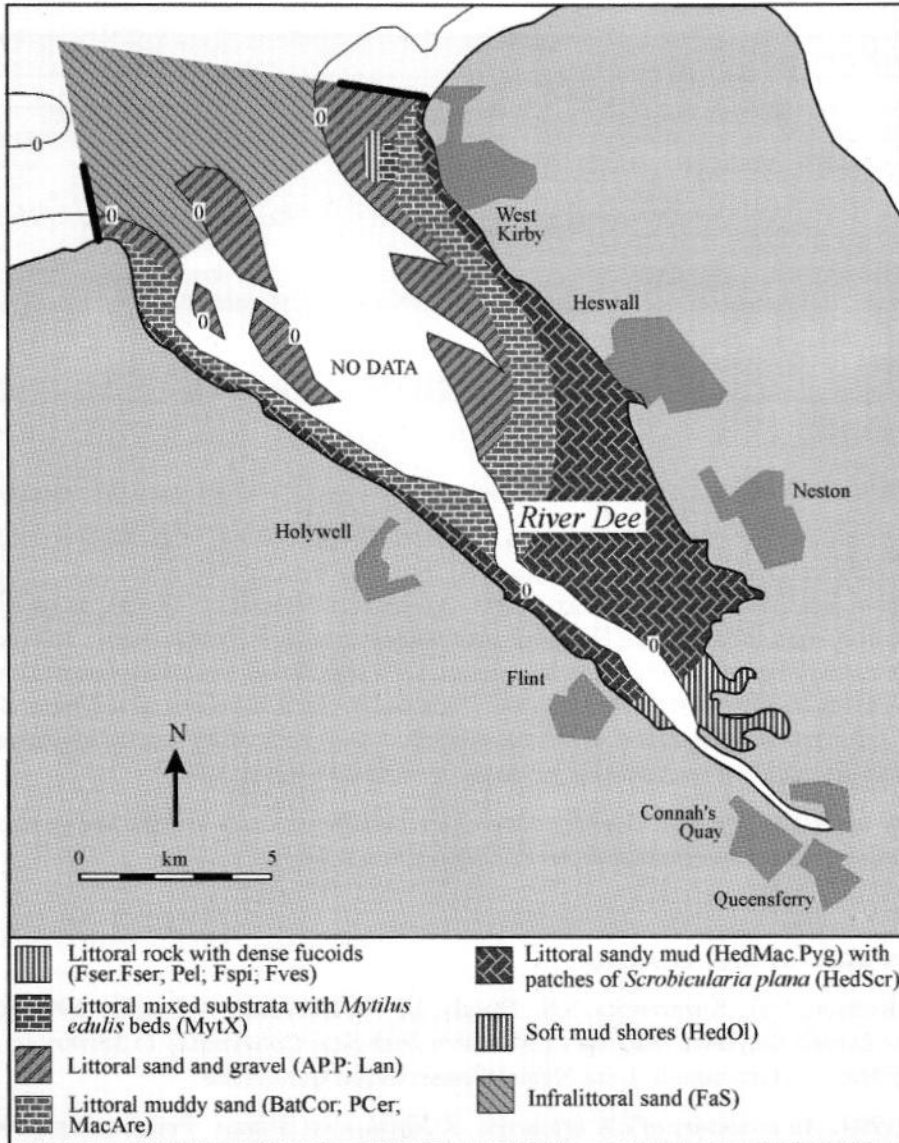


Figure 2.2 Indicative distribution of the main biotopes in the area (based on data from the survey sites shown in Figure 2.1, additional field observations and cited literature).
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Nature conservation

Conservation sites			
Site name	Designation	Centre grid ref.	Main features
Dee Estuary	Ramsar, SPA, SSSI	SJ 220 800	Ornithology, coastal habitats, seals
Dee Cliffs	SSSI	SJ 238 832	Coastal habitats and flora
Red Rocks	SSSI, WT	SJ 207 878	Coastal habitats and flora, ornithology, amphibians
Hilbre Island	LNR	SJ 190 875	Flora, ornithology, geology
Dee Estuary and North Wirral Coast	SMA	SJ 123 853 - SJ 313 942	Marine biology, ornithology
Point of Ayr	RSPB	SJ 113 833	Ornithology
Gayton Sands	RSPB	SJ 274 789	Ornithology

Human influences

Much of the coastline surrounding the estuary is extensively developed, with urban development on the northern shores and industry on the southern shores. The industry has undergone significant change in recent years, from heavy industries and textiles to more modern industries such as gas-fired power generation, light industry and chemical manufacturing plants. Additionally, much of the upper section of the estuary has been subject to land claim, with significant loss of marine communities and significant changes to other parts of the estuary. This has resulted in enhanced sediment deposition encouraging saltmarsh development on the intertidal flats and, with water quality improvements, species such as the cockle *Cerastoderma edule* are now more widespread.

Some parts of the River Dee are fished for cockles *Cerastoderma edule* and the brown shrimp *Crangon crangon*. Little other commercial fishing activity occurs.

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Sites surveyed

Survey 240: 1990 MNCR Rhos Point to New Brighton littoral survey (Garwood & Foster-Smith 1991).

Littoral sites					
<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude/longitude</i>	<i>Biotopes present</i>
240	6	Point of Ayr, Clwyd.	SJ 122 854	53°21.4'N 03°19.1'W	AP.P; Lan; MacAre
240	7	Little Eye, Wirral.	SJ 199 867	53°22.2'N 03°12.2'W	AP.P; MacAre; PCer
240	8	SE Little Hilbre, Wirral.	SJ 192 872	53°22.5'N 03°12.8'W	MytX; HedScr
240	9	SW Little Hilbre, Wirral.	SJ 186 873	53°22.5'N 03°13.4'W	YG; Ver.Ver; FvesB; Ent; Pel; Fves; SR; AP.P
240	10	Shell Bay, Hilbre, Wirral.	SJ 184 883	53°23.1'N 03°13.6'W	Ver.Ver; BPat; Fser.Fser; MF; Fspi; Fves; Rkp
240	11	Calabar reef, Hilbre, Wirral.	SJ 184 884	53°23.1'N 03°13.6'W	BPat; BPat.Sem; Ent; SByAs; Lan
240	12	E side of Hilbre Island, Wirral.	SJ 185 883	53°23.1'N 03°13.5'W	Fser.Fser; Fspi; Fves
240	13	Hilbre - Red Rocks, Wirral.	SJ 195 885	53°23.2'N 03°12.6'W	Lan; HedMac.Pyg
240	14	Red Rocks, Wirral.	SJ 202 887	53°23.3'N 03°12.0'W	BPat.Lic; Ent; EntPor

Compiled by: Roger Covey

3

River Mersey

Location

<i>Position (centre)</i>	SH 940 800	53°19'N 3°35'W
<i>County/district</i>	Cheshire	Ellesmere Port & Neston, Vale Royal, Halton, Warrington
	Merseyside	Wirral, Liverpool, Sefton
<i>Conservation agency/area</i>	English Nature	North West

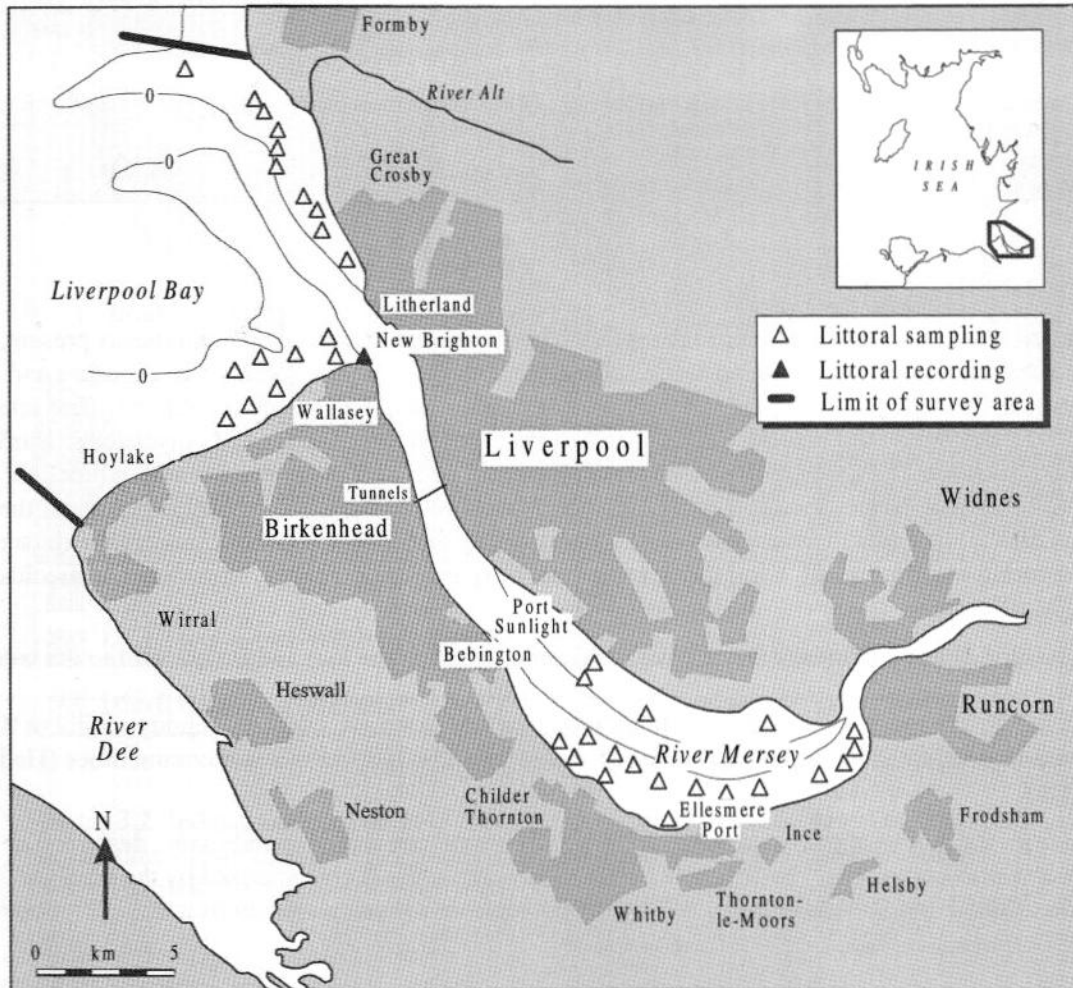


Figure 3.1 Location of area showing sites surveyed and main bathymetric features.

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Marine biological surveys

	<i>Survey method</i>	<i>Date of survey</i>	<i>Source</i>
<i>Littoral</i>	Core sampling	March 1987	Bamber (1988)
	Recording, core sampling	May 1990	Garwood & Foster-Smith (1991)
	Core sampling	September 1990	Davies (1991)

Introduction

The Mersey is an estuary that has been modified considerably by man's activities. The estuary is restrained within concrete banks for part of its length and is enclosed on both sides by industrial and urban development and there are numerous discharges of sewage and industrial waste into the estuary. There are few natural transitional coastal habitats present within the estuary but there are sand dunes along the open coast to the north of the estuary mouth.

Physical features

<i>Physiographic type</i>	Coastal plain estuary
<i>Length of coast</i>	103 km
<i>Area of inlet</i>	9,000 ha
<i>Length of inlet</i>	55 km
<i>Bathymetry</i>	Less than 10 m maximum depth
<i>Wave exposure range</i>	Moderately exposed to very sheltered
<i>Tidal stream range</i>	Moderately strong in main channel
<i>Tidal range</i>	8.9 m
<i>Salinity range</i>	Variable to low

Marine biology

Due to the extensive modification of the estuary a limited range of marine communities is present, with the greatest variety on the extensive sandy shores at the estuary mouth. Here, wave exposure and strong tidal streams have led to the development of mobile banks of intertidal sediment. The upper shores of these areas are characterised by populations of mobile amphipods and polychaetes (BarSh; AP; AP.P; AP.Pon). These grade into bivalve-dominated mid- and lower shore communities (MacAre), with some areas with locally accelerated tidal streams having dense aggregations of the sand mason worm *Lanice conchilega* (Lan). Along the tip of the Wirral peninsula limited exposures of rocky ground are present, allowing the development of sparse upper shore communities of fucoids (Fspi; MytFves).

In its lower reaches the estuary lies between Liverpool docks in the east and Birkenhead to the west. Here the narrow intertidal zone consists of vertical artificial embankments, with little exposed sediment. Upstream of Liverpool the estuary broadens and extensive intertidal muddy sediment flats are present, dominated by ragworm *Hediste diversicolor* and oligochaete worm communities (HedOl; HedMac).

Away from the mouth of the estuary the shallow infralittoral consists of mobile sand, described as the "shallow *Venus* community" by Mackie (1990). The community is characterised by the bivalves *Fabulina fabula* and *Spisula elliptica* and by the polychaetes *Magelona mirabilis* and *Nephtys cirrosa* (FaS).

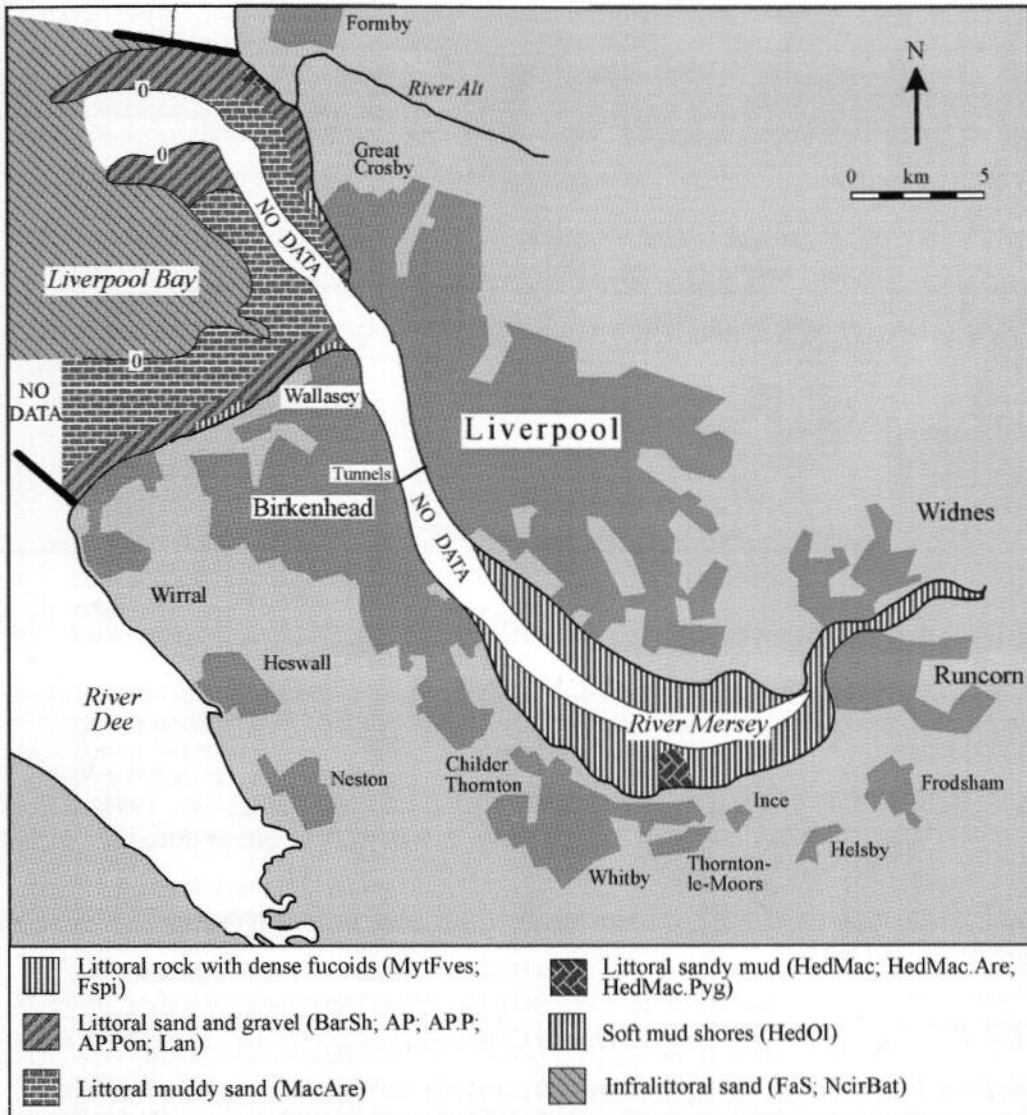


Figure 3.2 Indicative distribution of the main biotopes in the area (based on data from survey sites shown in Figure 3.1, additional field observations and cited literature).

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Human influences

The whole estuary is extensively developed and modified by man's activities. Away from the open mouth of the estuary no natural transitional habitats are present, having been replaced by urban development with coastal protection. Large amounts of effluent are discharged to the estuary which has contributed to poor water quality, although upgrading of treatment systems is resulting in improvements in water quality.

Proposals have been made to construct a barrage across the Mersey to generate tidal power. This has stimulated a large volume of research in the area to assess possible environmental impacts. However, the scheme looks unlikely to go forward in the foreseeable future.

Estuarine habitats are significantly affected by dredging of the channel.

The area is not commercially fished. However, large amounts of angling bait are collected from the open sediment flats at the mouth of the estuary by both amateur and professional diggers.

Nature conservation

Conservation sites			
Site name	Designation	Centre grid ref.	Main features
Alt Estuary	Ramsar, SPA, SSSI	SD 280 040	Coastal habitats and flora, ornithology
Ribble and Alt	Ramsar, SPA, SSSI	SD 375 240 & SD 285 030	Coastal habitats and flora, ornithology
Mersey Estuary	Ramsar, SPA, SSSI	SJ 440 800	Ornithology, coastal habitats and flora
Altcar Sand Dunes and Foreshore	SSSI	SD 285 030	Coastal habitats and flora, invertebrates, ornithology, amphibians and reptiles
North Wirral Foreshore	SSSI	SJ 250 920	Ornithology, coastal habitats
Dee Estuary & North Wirral Coast	SMA	SJ 123 853- SJ 313 942	Marine biology, ornithology
Raven Meols Hills	LNR	SD 275 055	Flora
Seaforth Dock	WT	SD 315 970	Ornithology
Altcar	MoD	SD 280 050	Coastal habitats

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Sites surveyed

- Survey 62: 1990 MNCR Crosby to Fleetwood littoral survey (Davies 1991).
- Survey 193: 1987 CEGB Mersey estuary littoral sediment survey (Bamber 1988).
- Survey 240: 1990 MNCR Rhos Point to New Brighton littoral survey (Garwood & Foster-Smith 1991).

Littoral sites

<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude/longitude</i>	<i>Biotores present</i>
62	13	N of Taylor Bank, Merseyside Coast.	SD 260 060	53°32.7'N 03°07.0'W	Lan
62	14	Taylor Bank, Mersey Estuary.	SD 265 045	53°31.9'N 03°06.5'W	AP.P; Lan; HedMac.Are
62	15	Blundellsands Shore, Crosby, Mersey estuary.	SD 294 003	53°29.6'N 03°03.8'W	MytFves; BarSh; AP.P
193	1	S of Garston Rocks, inner Mersey estuary.	SJ 397 823	53°20.0'N 02°54.3'W	HedOl
193	2	SW of Garston Rocks, inner Mersey estuary.	SJ 391 821	53°19.9'N 02°54.8'W	HedOl
193	3	SE Eastham Dock, inner Mersey estuary.	SJ 375 805	53°19.0'N 02°56.3'W	HedOl
193	4	Between Mount Manisty and Eastham, inner Mersey estuary.	SJ 381 800	53°18.7'N 02°55.7'W	HedOl
193	5	Between Mount Manisty and Eastham offshore, inner Mersey estuary.	SJ 382 801	53°18.8'N 02°55.6'W	HedOl
193	6	Mount Manisty inshore, inner Mersey estuary.	SJ 395 791	53°18.3'N 02°54.4'W	HedOl
193	7	Mount Manisty offshore, inner Mersey estuary.	SJ 399 795	53°18.5'N 02°54.1'W	HedOl
193	8	Stanlow Banks west, inner Mersey estuary.	SJ 403 799	53°18.7'N 02°53.7'W	HedOl
193	9	Eastham Sands, inner Mersey estuary.	SJ 415 804	53°19.0'N 02°52.6'W	HedOl
193	10	Dungeon Banks, inner Mersey estuary.	SJ 458 810	53°19.3'N 02°48.8'W	HedOl
193	11	Weaver Sluices north, inner Mersey estuary.	SJ 493 805	53°19.1'N 02°45.6'W	HedOl
193	12	Weaver Sluices, inner Mersey estuary.	SJ 492 800	53°18.8'N 02°45.7'W	HedOl
193	13	Weaver Sluices, south, inner Mersey estuary.	SJ 498 798	53°18.7'N 02°45.2'W	HedOl
193	13	Weaver Sluices, south, inner Mersey estuary.	SJ 498 798	53°18.7'N 02°45.2'W	HedOl
193	14	N Score Bank, inner Mersey estuary.	SJ 479 798	53°18.7'N 02°46.9'W	HedOl
193	15	W Score Bank, inner Mersey estuary.	SJ 465 796	53°18.6'N 02°48.1'W	HedOl
193	16	E Ince Bank, inner Mersey estuary.	SJ 453 793	53°18.4'N 02°49.2'W	HedOl
193	17	Ince Bank, inner Mersey estuary.	SJ 445 795	53°18.5'N 02°49.9'W	HedOl
193	18	Stanlow Banks, inner Mersey estuary.	SJ 428 784	53°17.9'N 02°51.5'W	HedMac.Pyg
193	19	N Stanlow Banks, inner Mersey estuary.	SJ 423 790	53°18.2'N 02°51.9'W	HedMac.Pyg
193	20	SE of Spencer's Spit, outer Mersey estuary.	SJ 246 923	53°25.3'N 03°08.0'W	AP.P
193	21	N of Lingham Farm, outer Mersey estuary.	SJ 252 923	53°25.3'N 03°07.5'W	AP.P
193	22	Between North Bank and Spencer's Spit, outer Mersey estuary.	SJ 257 933	53°25.8'N 03°07.1'W	AP.P
193	23	SE of North Bank, outer Mersey estuary.	SJ 260 940	53°26.2'N 03°06.8'W	AP.P
193	24	North Bank, outer Mersey estuary.	SJ 261 941	53°26.2'N 03°06.7'W	AP.P
193	25	NW of Wallasey coastguard look-out, outer Mersey estuary.	SJ 278 939	53°26.2'N 03°05.2'W	AP.P
193	26	S of Brazil Bank, outer Mersey estuary.	SJ 293 943	53°26.4'N 03°03.8'W	AP.P
193	27	Brazil Bank, outer Mersey estuary.	SJ 293 948	53°26.7'N 03°03.8'W	AP.P
193	28	Crosby lower shore 1, outer Mersey estuary.	SJ 301 985	53°28.7'N 03°03.2'W	AP
193	29	Crosby lower shore 2, outer Mersey estuary.	SJ 301 985	53°28.7'N 03°03.2'W	NcirBat
193	30	Brighton le Sands lower shore, outer Mersey estuary.	SJ 297 990	53°28.9'N 03°03.5'W	AP
193	31	Blundellsands lower shore 1, outer Mersey estuary.	SJ 292 996	53°29.2'N 03°04.0'W	AP
193	32	River Alt lower shore 1, outer Mersey estuary.	SD 287 004	53°29.7'N 03°04.4'W	AP.Pon
193	33	River Alt lower shore 2, outer Mersey estuary.	SD 286 009	53°29.9'N 03°04.5'W	AP.P
193	34	Blundellsands upper shore, outer Mersey estuary.	SD 287 009	53°29.9'N 03°04.5'W	AP

Littoral sites - continued

<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude/longitude</i>	<i>Biotores present</i>
240	15	Leasowe Hospital, Wirral.	SJ 260 920	53°25.1'N 03°06.8'W	MytFves; Fspi; AP; Lan; HedMac
240	16	Perch Rocks, Wirral.	SJ 310 945	53°26.5'N 03°02.3'W	BPat; Ent; MF; MytFves; AP.P

Compiled by: Roger Covey

4

River Ribble

Location

<i>Position (centre)</i>	SD 330 250	53°43'N 3°01'W
<i>Country/district</i>	Merseyside Lancashire	Sefton Fylde, Preston, South Ribble & West Lancashire
<i>Conservation agency/area</i>	English Nature	North West

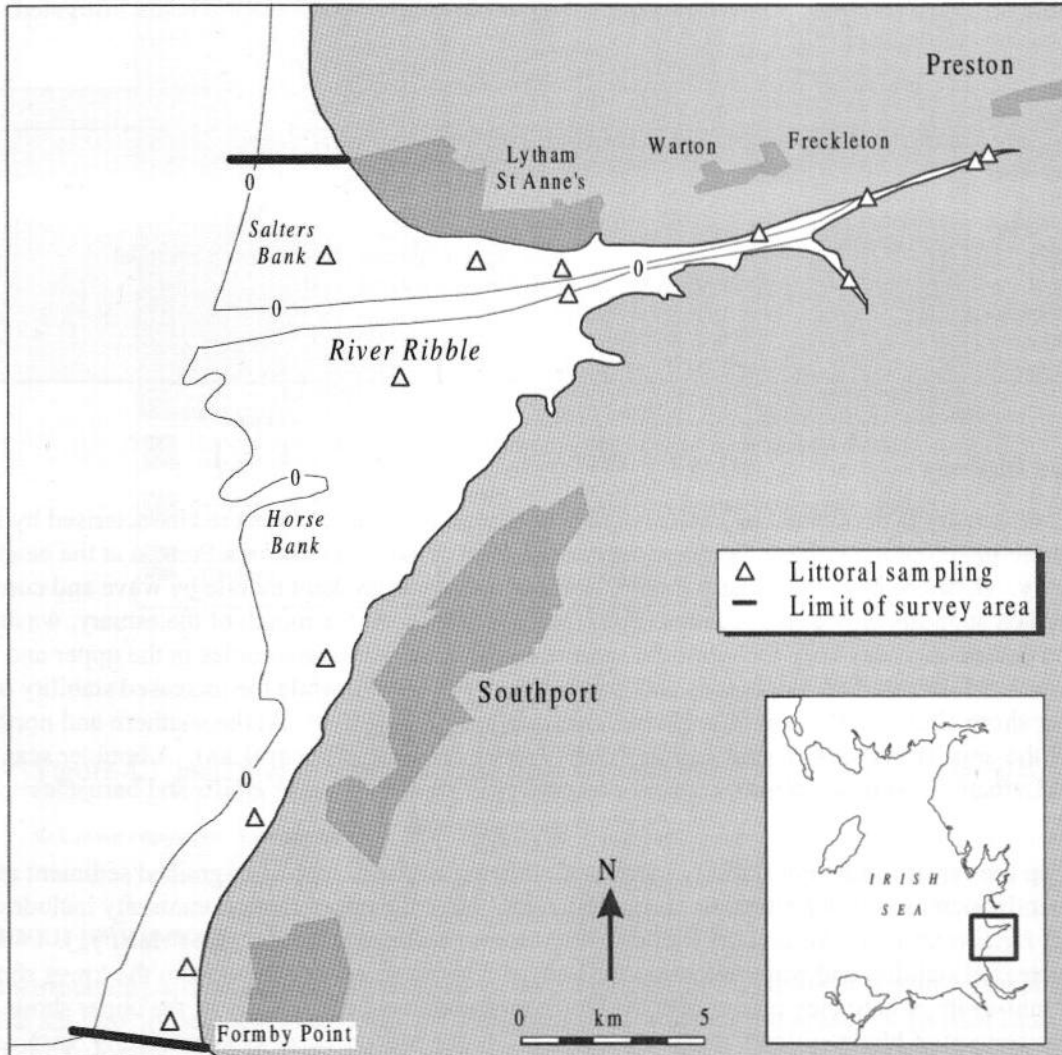


Figure 4.1 Location of area showing sites surveyed and main bathymetric features.

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Marine biological surveys

	<i>Survey method</i>	<i>Date of survey</i>	<i>Source</i>
<i>Littoral</i>	Core sampling	September 1990	Davies (1991)
	Core sampling	July 1991	Davies (1992)

Introduction

The Ribble is a long, narrow estuary with extensive fringing saltmarsh and intertidal sediment flats, particularly along the southern shore. At its mouth the estuary widens to become a broad bay, enclosed by Salter's Bank in the north and Formby Point to the south, where it is adjacent to the outer Mersey estuary.

Much of the immediate surrounding land is farmed, with major urban centres at Preston at the head of the estuary, Lytham St Anne's at the mouth of the estuary on the north shore and Southport and Formby on the southern shore. The estuary has poor water quality in its upper sections, where sewage discharges from Preston. There are also discharges to the open coast around Lytham St Anne's, Southport and Formby, but as these are areas of high water exchange the discharges have a less noticeable effect. Improvements to discharges involving secondary treatment are being instigated.

Physical features

<i>Physiographic type</i>	Coastal plain estuary
<i>Length of coast</i>	107.5 km
<i>Area of inlet</i>	12,000 ha
<i>Length of inlet</i>	28.4 km
<i>Bathymetry</i>	Less than 10 m maximum depth in channel. Predominantly intertidal
<i>Wave exposure range</i>	Moderately exposed to extremely sheltered
<i>Tidal stream range</i>	Moderately strong in channel
<i>Tidal range</i>	7.9 m
<i>Salinity range</i>	Variable to low

Marine biology

The Ribble estuary is dominated by extensive intertidal sediment flats. These are characterised by fine sands at the mouth of the estuary, grading to a narrow zone of soft mud towards Preston at the head of the estuary. Offshore from the estuary mouth, shallow sediments are kept mobile by wave and current action which supports only a sparse fauna (FaS) (Mackie 1990). At the mouth of the estuary, wave exposure and strong tides keep the intertidal sediment mobile so that communities in the upper and mid-shore are dominated by amphipods and polychaetes (AP; AP.P), while the increased stability of the lower shore allows settlement of cockles *Cerastoderma edule* (PCer). At the southern and northern limits of the area dense beds of sand mason worms *Lanice conchilega* occur (Lan). A boulder scar south of Lytham St Anne's supports a mixed community of mussels *Mytilus edulis* and barnacles (MytX).

Further up the estuary sediment stability increases, allowing deposition of finer-grained sediment and consequently increased water retention during low tides. Here the upper shore community includes the ragworm *Hediste diversicolor* and the Baltic tellin *Macoma balthica* (HedMac; HedMac.Pyg). Owing to the increased stability and water retention the beds of cockles *C. edule* extend from the lower shore into the mid-shore, where they merge with the Baltic tellin *Macoma* community of the upper shore. This arrangement of biotopes continues to the point where the estuary narrows significantly, between Lytham and Warton, where *Hediste/Macoma* communities extend over the whole intertidal zone. In the inner sections of the estuary, where salinity is consistently lower, these communities are replaced by a community of ragworms *Hediste diversicolor* and oligochaete worms (HedOl).

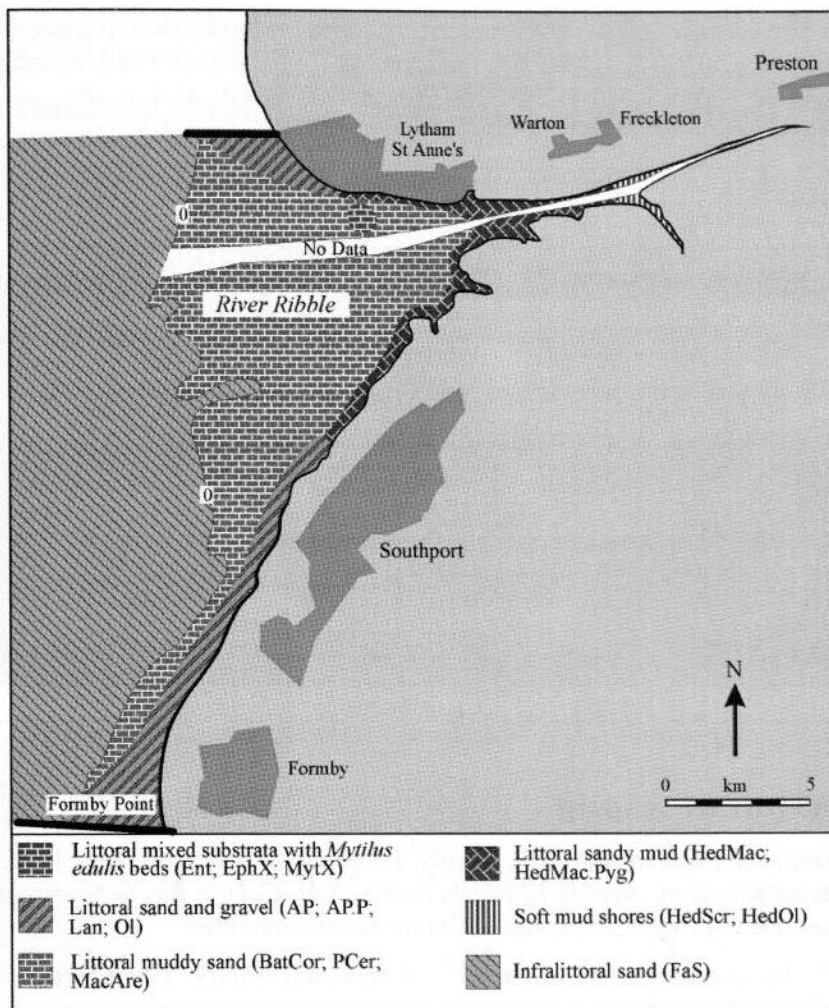


Figure 4.2 Indicative distribution of the main biotopes in the area (based on data from survey sites shown in Figure 4.1, additional field observations and cited literature).

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Human influences

The surrounding area is extensively developed, with a number of major towns nearby. The only towns which are directly adjacent to the coast are Preston, which straddles the estuary at its tidal limit, and Lytham St Anne's, Formby and Southport at the open mouth of the estuary. Effluent discharges from Preston are responsible for a reduction in water quality in the upper reaches but improvements in effluent discharges are underway. The coastal towns also discharge sewage to the sea, but due to high water exchange their effect is more limited. Sediment extraction takes place on both Salter's Bank, off St Anne's, and at Horse Bank, off Southport. The Salter's Bank site is licensed for extraction of 150,000 m³ of sand per annum. Concern has been expressed about the possible effects on beach sedimentation and structure.

Dredging of the main estuary channel to Preston ceased in the early 1980s and since then the sandbanks and channels have reverted to a more natural structure.

The littoral zone of the estuary supports commercial fisheries for brown shrimp *Crangon crangon* and cockles *Cerastoderma edule*. The brown shrimp fishery is carried out with varying intensity from hand-push nets to tractor-towed nets with facilities for processing the catch on-site.

Nature conservation

Conservation sites			
Site name	Designation	Centre grid ref.	Main features
Ribble and Alt	Ramsar, SPA, SSSI	SD 375 240 & SD 285 030	Ornithology
Ribble Estuary	SPA, NNR, SSSI	SD 375 240	Ornithology, coastal habitats
Formby Sands & Foreshore	SSSI, part NT	SD 285 030	Coastal habitats and flora, invertebrates, ornithology, amphibians and reptiles
Ainsdale Sand Dunes	NNR, SSSI	SD 288 105	Coastal habitats and flora, invertebrates, ornithology, amphibians and reptiles
Sefton Coast	pSAC	SD 288 106	Dune vegetation
Southport Sand Dunes and Foreshore	SSSI	SD 305 150	Coastal habitats and flora, invertebrates, ornithology, amphibians and reptiles
Lytham St Anne's Dunes	SSSI, LNR, WT	SD 310 305	Coastal habitats and flora, invertebrates
Ainsdale and Birkdale Sand Hills	LNR	SD 305 135	Coastal habitats and flora, invertebrates, amphibians and reptiles
Marshside	RSPB	SD 352 204	Ornithology

References and further reading

- Barne, J.H., Robson, C.F., Kaznowska, S.S., Doody, J.P., & Davidson, N.C., eds. 1996. *Coasts and seas of the United Kingdom. Region 13 Northern Irish Sea: Colwyn Bay to Stranraer, including the Isle of Man*. Peterborough, Joint Nature Conservation Committee.
- Buck, A.L. 1993. *An inventory of UK estuaries. 3. North-west Britain*. Peterborough, Joint Nature Conservation Committee.
- Davies, J. 1992. Littoral survey of the Ribble, Duddon and Ravenglass estuary systems, east basin of the Irish Sea. *JNCC Report*, No. 37. (Marine Nature Conservation Review Report, No. MNCR/SR/21.)
- Davies, L.M. 1991. Littoral survey of the coast from Crosby to Fleetwood. *Nature Conservancy Council, CSD Report*, No. 1,217. (Marine Nature Conservation Review Report, No. MNCR/SR/17.)
- Mackie, A.S.Y. 1990. Offshore benthic communities of the Irish Sea. In: *The Irish Sea: an environmental review. Part 1: nature conservation*, ed. by Irish Sea Study Group, 169-218. Liverpool, Liverpool University Press for Irish Sea Study Group.
- Taylor, P.M., & Parker, J.G., eds. 1993. *The coast of north Wales and north west England: an environmental appraisal*. London, Hamilton Oil Company.

Sites surveyed

- Survey 38: 1991 MNCR Ravenglass area, Duddon & Ribble estuaries littoral survey (Davies 1992).
 Survey 62: 1990 MNCR Crosby to Fleetwood littoral survey (Davies 1991).

Littoral sites					
<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude/longitude</i>	<i>Biotores present</i>
38	1	SE Lifeboat station, Lytham St Anne's, Ribble estuary.	SD 370 265	53°43.8'N 02°57.3'W	EphX; BatCor; MacAre; HedMac
38	2	E Bank Sands, Ribble estuary.	SD 370 260	53°43.5'N 02°57.3'W	MytX; NVC SM8; HedMac.Pyg; HedScr
38	3	W Naze Mount, Ribble estuary.	SD 425 272	53°44.2'N 02°52.3'W	Ent; HedMac.Pyg; HedOl
38	4	Longton Marsh, Ribble estuary.	SD 453 253	53°43.2'N 02°49.7'W	EphX; HedOl
38	5	Clifton Marsh sewage works, Ribble estuary.	SD 455 278	53°44.6'N 02°49.5'W	EphX; HedOl
38	6	N Marsh Farm, Ribble estuary.	SD 496 289	53°45.2'N 02°45.8'W	Ent; Ol
38	7	W Preston Docks, Ribble estuary.	SD 498 291	53°45.3'N 02°45.6'W	HedOl
38	8	Preston Bridge, Ribble estuary.	SD 527 288	53°45.1'N 02°43.0'W	Ol
62	6	Salter's Bank, Lancashire Coast.	SD 310 268	53°43.9'N 03°02.7'W	MytX; MacAre; PCer
62	7	S of Lytham St Anne's, Ribble Estuary.	SD 350 266	53°43.8'N 02°59.1'W	MytX; AP; HedMac.Pyg; HedScr
62	8	Ribble Estuary.	SD 325 245	53°42.7'N 03°01.3'W	MacAre; PCer
62	9	Birkdale Sands/Angry Brow, Merseyside Coast.	SD 309 171	53°38.7'N 03°02.7'W	AP.P; Lan; BatCor
62	10	Ainsdale Sands, Merseyside Coast.	SD 292 133	53°36.6'N 03°04.2'W	AP.P; Lan
62	11	Mad Wharf, Formby, Merseyside Coast.	SD 269 085	53°34.0'N 03°06.2'W	AP.P; Lan
62	12	Formby Point, Merseyside Coast.	SD 261 069	53°33.1'N 03°06.9'W	Lan

Compiled by: Roger Covey

Location

<i>Position (centre)</i>	SH 940 800	53°19'N 3°35'W
<i>County/district</i>	Lancashire	Fylde, Wyre & Blackpool
<i>Conservation agency/area</i>	English Nature	North West

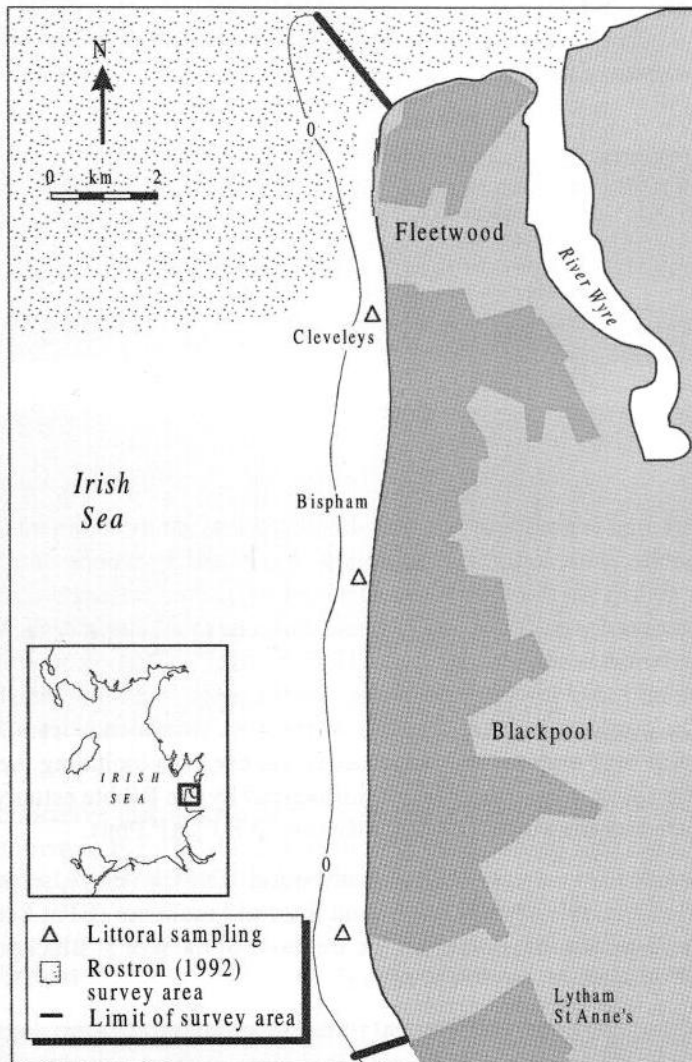


Figure 5.1 Location of area showing sites surveyed (shaded area indicates extent of sites given in Rostron 1992) and main bathymetric features.

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Marine biological surveys

	<i>Survey method</i>	<i>Date of survey</i>	<i>Source</i>
<i>Littoral</i>	Core sampling	September 1990	Davies (1991)
<i>Sublittoral</i>	Day grab sampling (extent of sampling area shown in figure 5.1)	August 1988	Rostron (1992)

Introduction

The coastline of this area is extensively modified by human activities, and it is the most extensively built-up area of open coast shoreline in MNCR Sector 11. In the north the shore is backed by Fleetwood which merges southwards into Cleveleys, then Blackpool, and Lytham St Anne's in the south. All of these conurbations have a direct effect on the marine environment. Fleetwood is a major fishing port of the area, while Blackpool, Cleveleys and Lytham St Anne's are popular seaside resorts with large numbers of people using the beaches in the summer months.

The coastline is protected by sea defences throughout most of the area, the exception being to the south of Lytham St Anne's where sand dunes form a more natural transition. Elsewhere the upper shore sediments are directly adjacent to concrete promenades which encourage increased sediment movement due to reflected wave action.

Physical features

<i>Physiographic type</i>	Open linear coast
<i>Length of coast</i>	20 km
<i>Bathymetry</i>	10 m maximum depth within 3 km offshore
<i>Wave exposure range</i>	Moderately exposed
<i>Tidal stream range</i>	Weak
<i>Tidal range</i>	8 m
<i>Salinity range</i>	Fully saline

Marine biology

The intertidal zone of this area is composed predominantly of fine sandy sediments. Owing to wave action these are often mobile, with communities in them dominated by mobile amphipods and polychaetes. The upper shores are the most wave-exposed, due to the reflected wave energy from sea defences. Here the sediments are colonised by a sparse community of amphipods, with the only characteristic polychaete being *Scolelepis squamata* (BarSh; AP.P). This community changes with increased stability on the mid- and lower shores to one with a range of amphipods, bivalves and polychaetes. Towards the northern limit of the area, where there is influence from Morecambe Bay, the lower shore community is of amphipods, polychaetes and bivalves including the rayed trough shell *Maetra stultorum*. To the south, where the shore is influenced by the Ribble estuary, the lower shore is a sediment flat dominated by lugworm *Arenicola marina* (AP.P; AP.Pon).

Hard substratum communities have a very limited distribution. Off Cleveleys, scoured boulders, with a sparse fauna of barnacles, mussels *Mytilus edulis* and littorinid molluscs (BPat.Sem; BLit), are found. The only other hard substratum communities are those of the pier at Blackpool, which is dominated by growths of mussels *M. edulis* (MytFves).

Data from Rostron (1992) suggest that offshore the sublittoral communities are dominated by sediment, with mobile sand with a sparse infauna in the shallow inshore zone, grading to sand with a richer infaunal community of amphipods, polychaetes and bivalves in water deeper than 5 m (NcirBat; FaS). Around the south-western edges of the Lune Deep, at the mouth of Morecambe Bay, depth (around 10 m) and shelter from wave action are great enough to allow the development of a rich sediment community dominated by burrowing anthozoans and polychaetes (AfilEcor).

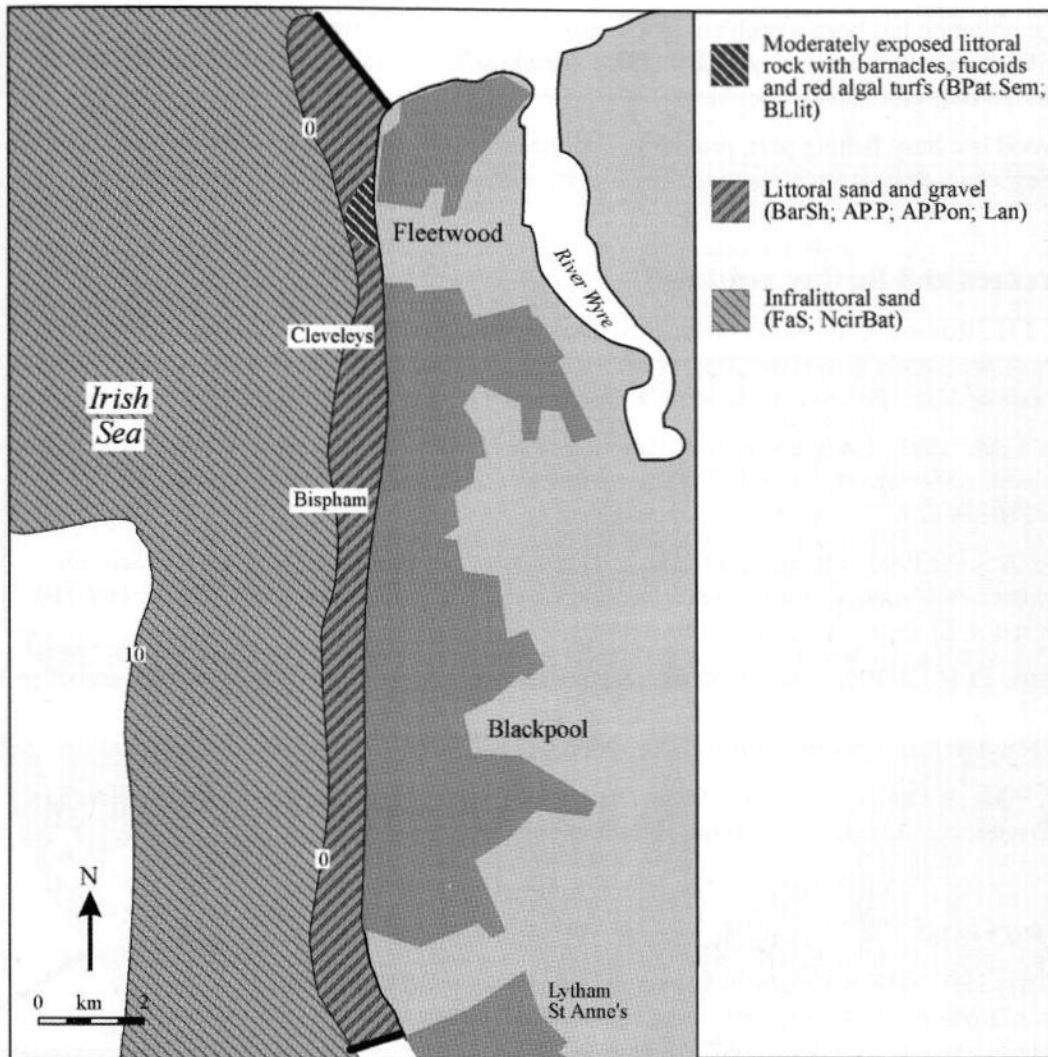


Figure 5.2 Indicative distribution of the main biotopes in the area (based on data from survey sites shown in Figure 5.1, additional field observations and cited literature).

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Nature conservation

Conservation sites

Site name	Designation	Centre grid ref.	Main features
Lytham St Anne's Dunes	SSSI, LNR, WT	SD 310 305	Coastal habitats and flora, invertebrates

Human influences

The coastline is extensively developed with major conurbations backing the shore from Fleetwood in the north to Lytham St Anne's in the south. Associated with this development are extensive coastal defences in the form of promenades, modifying the upper shore communities. Because of the number of holiday visitors to the area, the shores are extensively used for beach recreation, although water sports such as sailing are limited in extent. Sport angling occurs from the beaches but is unlikely to have a major impact on fish stocks.

Sewage pollution has been a problem in the past, with extensive sewage debris littering the shore. However, the development of new sewage treatment facilities and a long sea outfall in the north of the area should help alleviate this problem.

Fleetwood is a busy fishing port, providing facilities for a large fleet that operates throughout the Irish Sea. Few of these boats operate in the shallow inshore waters around the Fylde coast.

References and further reading

- Barne, J.H., Robson, C.F., Kaznowska, S.S., Doody, J.P., & Davidson, N.C., eds. 1996. *Coasts and seas of the United Kingdom. Region 13 Northern Irish Sea: Colwyn Bay to Stranraer, including the Isle of Man*. Peterborough, Joint Nature Conservation Committee.
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- Rostron, D.R. 1992. Sublittoral benthic sediment communities of Morecambe Bay. (Contractor: SubSea Survey, Pembroke.) *JNCC Report*, No. 47. (Marine Nature Conservation Review Report, No. MNCR/SR/22.)
- Taylor, P.M., & Parker, J.G., eds. 1993. *The coast of north Wales and north west England: an environmental appraisal*. London, Hamilton Oil Company.

Sites surveyed

Survey 62: 1990 MNCR Crosby to Fleetwood littoral survey (Davies 1991).
Data from Rostron (1992) were also used to compile the summary.

Littoral sites					
Survey	Site	Place	Grid reference	Latitude/longitude	Biotopes present
62	3	Cleveleys shore, Lancashire Coast.	SD 310 434	53°52.9'N 03°02.9'W	BLit; BPat.Sem; BarSh; AP.P
62	4	Blackpool North Pier, Lancashire Coast.	SD 301 367	53°49.3'N 03°03.7'W	MytFves; AP.P; AP.Pon
62	5	Crusader Bank, St Annes, Lancashire Coast.	SD 302 316	53°46.5'N 03°03.5'W	AP.P; Lan

Compiled by: Roger Covey

6

Morecambe Bay

Location

<i>Position (centre)</i>	SD 350 690	54°06'N 03°W
<i>County/district</i>	Lancashire Cumbria	Lancaster & Wyre Barrow in Furness, South Lakeland
<i>Conservation agency/area</i>	English Nature	North West, Cumbria

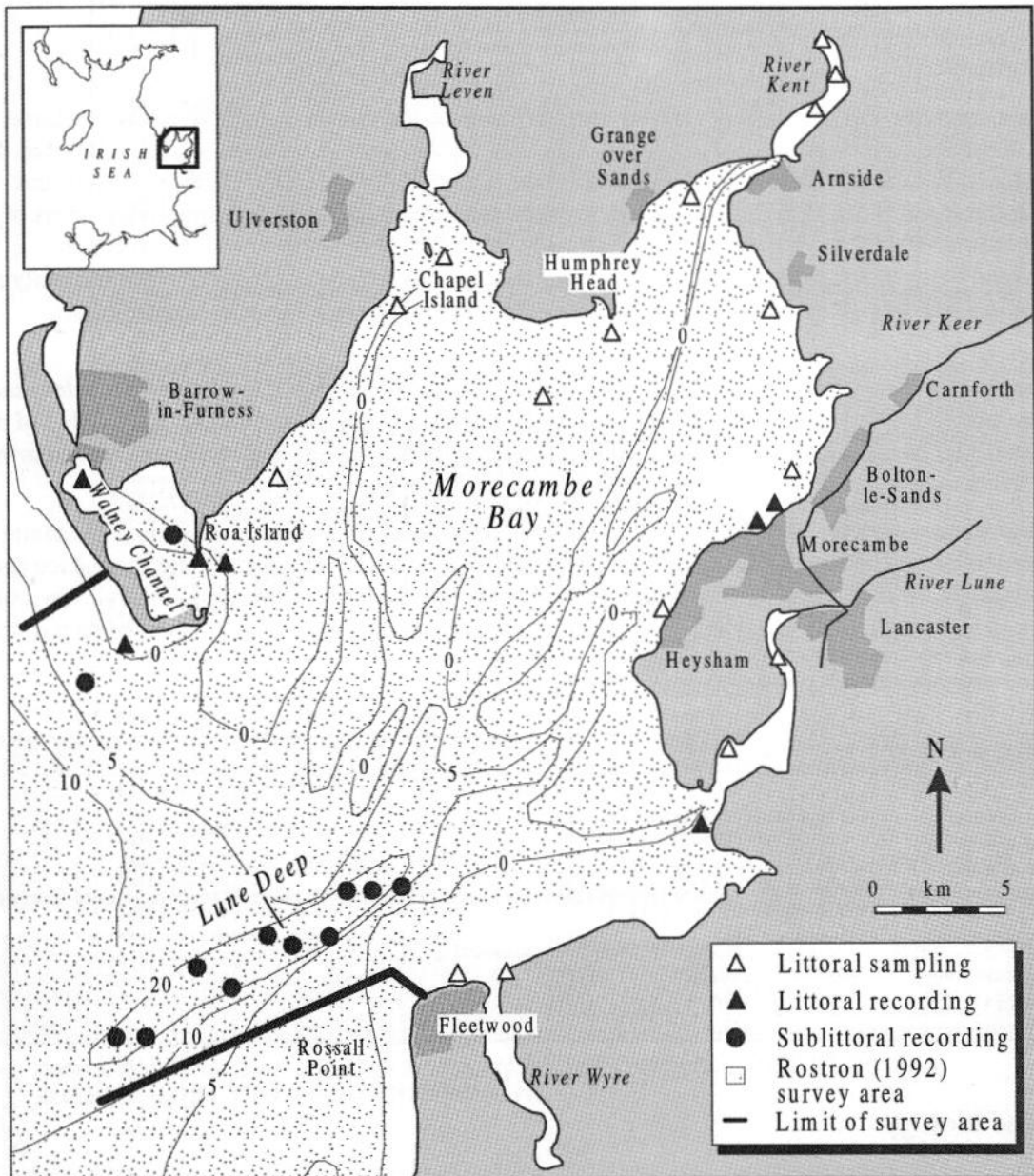


Figure 6.1 Location of area showing sites surveyed and main bathymetric features (position of chart datum bathymetry liable to change significantly).

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Marine biological surveys			
	Survey method	Date of survey	Source
<i>Littoral</i>	Recording and core sampling	September 1991	MNCR survey 287
	Recording and core sampling	September 1990	Davies (1991)
	Recording and core sampling	April 1989	Covey & Davies (1989)
<i>Sublittoral</i>	Dredge sampling	August 1990	Emblow (1992)
	Recording	June 1991	Emblow (1992)
	Recording	August 1991	Emblow (1992)
	Recording	September 1993	Moore (1993)
	Day grab sampling	August 1988	Rostron (1992)

Introduction

This area includes the large embayment of Morecambe Bay, the estuaries of the rivers Wyre, Lune, Keer, Kent and Leven and also the southern section of the Walney Channel. Morecambe Bay has the largest area of intertidal flats in the United Kingdom at over 34,000 ha (Buck 1993). Much of the surrounding land is low-lying, with adjacent habitats being saltmarsh or grazing marshes. Areas of major coastal development are limited to Barrow-in-Furness to the north and Morecambe and Fleetwood in the south, whilst much of the land is predominantly rural in character. Water quality is generally good, though the Wyre estuary has a major input from sewage and chemical works.

Morecambe Bay is the focus for fisheries of brown shrimp *Crangon crangon*, edible cockle *Cerastoderma edule* and the mussel *Mytilus edulis*. The area is also important for salmon *Salmo salar* and sea trout *Salmo trutta* which are found in virtually all the rivers draining into the bay. Also of note are records of rare fish species, the lampern *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus*, from rivers in the area (Potts & Swaby 1993).

At the entrance to Morecambe Bay is a deep channel known as the Lune Deep. This glacial feature is believed to be the result of scouring by water draining underneath an ice sheet during the last ice age. In contrast to the surrounding plains of sediment, the sides of the Lune Deep slope steeply from around 10 m to a maximum depth of 80 m in places and consist of boulders and cobble. In the bottom of the channel, boulders give way to tide-swept fine sediment.

Physical features	
<i>Physiographic type</i>	Embayment fed by estuaries
<i>Length of coast</i>	256.1 km
<i>Area of inlet</i>	44,872 ha
<i>Length of inlet</i>	40.3 km
<i>Bathymetry</i>	Maximum depth 80 m (in Lune Deep) but predominantly intertidal east of Fleetwood to Roa Island
<i>Wave exposure range</i>	Exposed to extremely sheltered
<i>Tidal stream range</i>	Moderate to negligible
<i>Tidal range</i>	8.4 m
<i>Salinity range</i>	Full to low

Marine biology

Much of the intertidal extent of the Morecambe Bay area consists of sediments, grading from mobile sand in the mouth of the bay, through muddy fine sand in the inner reaches to muds at the head of some of the estuaries.

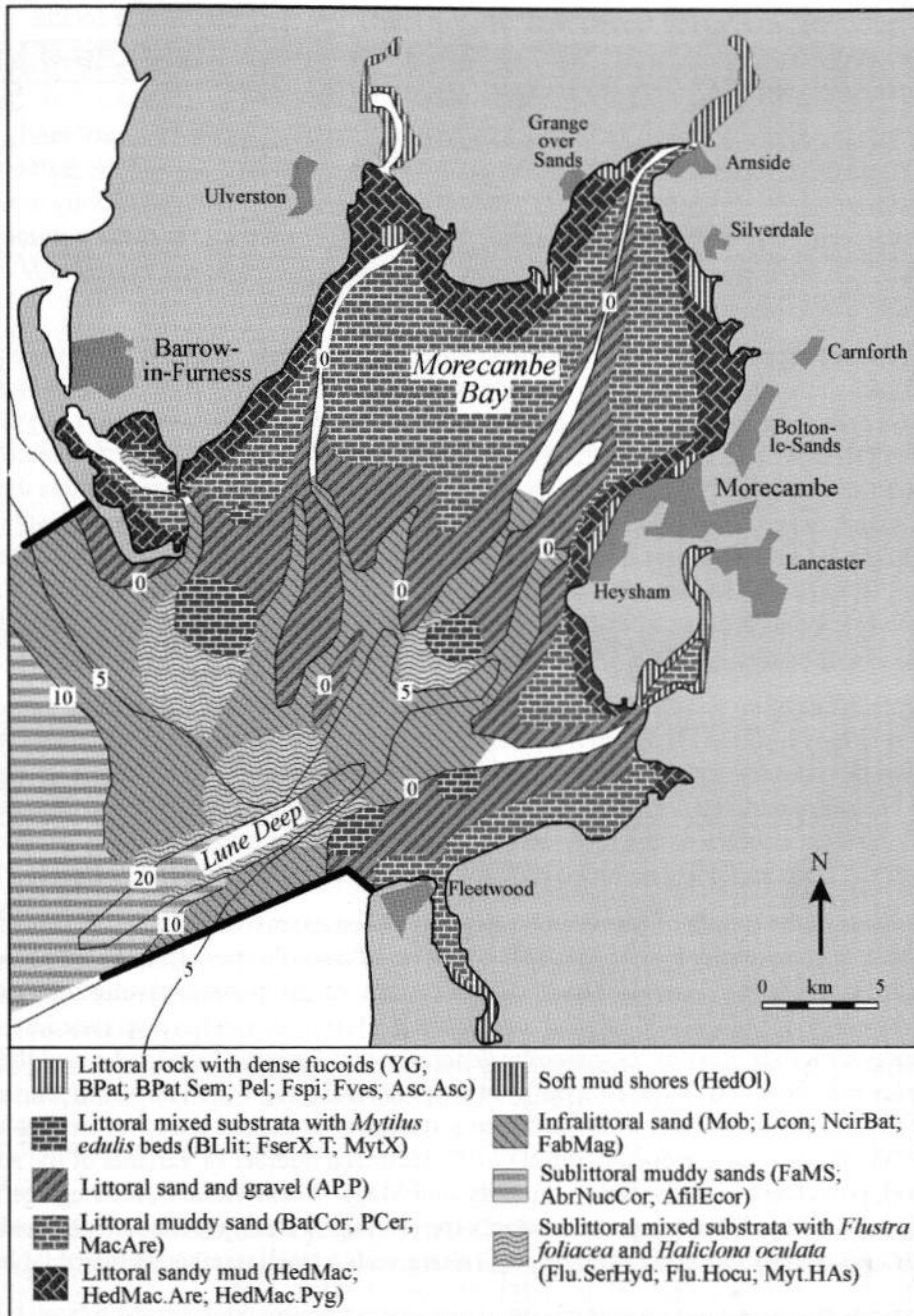


Figure 6.2 Indicative distribution of the main biotopes in the area (based on data from survey sites shown in Figure 6.1, additional field observations and cited literature).

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Wave exposed medium-grained sand on the upper shore of the open coast is extensively duned and rippled. Here there is a sparse community of amphipods and the isopod *Eurydice pulchra* (AEur). In areas where there is a slight increase in the sediment stability and water retention, this allows settlement of the more robust polychaete *Scolecopsis squamata* in addition to the range of amphipods present in the wave exposed locations. With further decreases in wave exposure a wider range of polychaetes are present, amongst which are significant densities of the lugworm *Arenicola marina* (A.P.P; MacAre).

More stable sediments are colonised by bivalve molluscs such as banded wedge shell *Donax vittatus*, thin tellin *Angulus tenuis* or rayed trough shell *Mactra stultorum*. Polychaete and cockle *Cerastoderma edule*-dominated sands (PCer) cover much of the central intertidal area of Morecambe Bay and support an extensive fishery for cockles.

In the lower reaches of the estuaries and along the shores of the bay, reduced salinity sandy mud occurs with communities characterised by the ragworm *Hediste diversicolor* and the Baltic tellin *Macoma balthica* (HedMac; HedMac.Are; HedMac.Pyg). In muddier, reduced salinity areas these grade into a ragworm *H. diversicolor* and peppery furrow shell *Scrobicularia plana* community (HedScr) or, within the estuaries with lower salinity, these are replaced by the ragworm *H. diversicolor* and mud shrimp *Corophium volutator* (HedOl).

Exposures of littoral rock in Morecambe Bay are extremely limited in extent, with only isolated areas of upper and mid-shore rock present in the inner part of the bay at Chapel Island and Humphrey Head, and at Heysham. In these areas supralittoral or splash zone bedrock has communities of yellow and grey lichens (YG), ending at the littoral fringe with sparse channelled wrack *Pelvetia canaliculata* (Pel). Below this is a band of sparse spiral wrack *Fucus spiralis* (Fspi). Lower than this the community present depends upon local conditions. Where the rock is wave exposed or subject to some scour, algae are limited in extent and the rock is dominated by barnacles and the limpet *Patella vulgata* (BPat; BPat.Sem). Reduced wave exposure or scour allow the growth of bladder wrack *Fucus vesiculosus* (Fves), while in areas of extreme shelter the rock is clothed in a dense growth of the knotted wrack *Ascophyllum nodosum* (Asc.Asc).

Mixed substrata occur more widely than bedrock, with numerous glacial boulder scars exposed in the intertidal zone. Many of these mixed areas have a substantial mid-shore growth of mussel *Mytilus edulis* beds (MytX) which are commercially harvested. In these areas the upper shore is sparsely colonised by barnacles and littorinids (BLlit). In the southern section of the Walney Channel, around Roa Island, tide-swept cobbles on the lower shore are colonised by a rich community of sponges and ascidians (FserX.T), a community recorded only infrequently elsewhere in MNCR Sector 11.

Subtidal sediments in the mouth of Morecambe Bay have been extensively studied (Rostron 1992). Much of the area is comparatively uniform, with variation in communities occurring in response to depth and sediment mobility. Wave action in shallow water (<5 m), particularly during winter storms, prevents the development of a stable infaunal community. Here, fine sand is dominated by epifauna such as the crabs *Carcinus maenas*, *Liocarcinus depurator* and *Pagurus bernhardus* and the common starfish *Asterias rubens* (Lcon; Mob; NcirBat). In some areas the lugworm *Arenicola marina* is able to settle. In the outer parts of the bay, where sediments at a depth of greater than 5 m are stable but which can be moved by tidal currents, Rostron (1992) records a number of variants of the sublittoral sand amphipod, polychaete and bivalve community (FabMag). These variants, although broadly similar, are dominated by different species, notably the amphipod *Bathyporeia pelagica* and the polychaetes *Magelona mirabilis* and *Nephtys* spp., along with a small number of intertidal bivalves such as cockles *Cerastoderma edule*, Baltic tellin *Macoma balthica* and banded wedge shell *Donax vittatus*. Deeper sediments are largely stable and support a rich community dominated by brittlestars (AfilEcor; AbrNucCor).

Sublittoral bedrock is present south-east of Walney Island. Here shallow water and strong tidal currents scour the rock with adjacent sediment, leading to a community predominantly of barnacles *Balanus crenatus* (Flu.Hocu) with few other species present.

Sublittoral mixed substrata of cobbles, pebbles and sediment are most common in the Lune Deep, although some areas are also present in the southern section of Walney Channel. Typically, in both cases, the habitat consists of heavily silted boulders, cobbles and pebbles with a dense growth of hydroids (particularly seaboard *Nemertesia antennina*), bryozoans such as the hornwrack *Flustra foliacea* and the erect sponge *Haliclona oculata* (Flu.Hocu; Flu.SerHyd). This community extends from shallow areas about 5 m in depth to around 35 m depth on the sides of the Lune Deep channel.

Nature conservation

Conservation sites			
Site name	Designation	Centre grid ref.	Main features
Burrows Marsh	SSSI, WT	SD 353 446	Coastal habitats
Barnaby Sands Marsh	SSSI, WT	SD 350 461	Coastal habitats
Lune Estuary	SSSI	SD 395 550	Marine and coastal habitats, ornithology
Jack Scout	SSSI, NT	SD 459 737	Coastal habitats, flora
Morecambe Bay	Ramsar, SPA, cSAC, SSSI, part RSPB	SD 360 700	Marine and coastal habitats; ornithology
Far Arnside	SSSI	SD 451 761	Cliff habitat and flora
Arnside Knott	SSSI	SD 447 771	Flora
Humphrey Head	SSSI, WT	SD 392 739	Geology, flora
Skelwith Hill	SSSI	SD 331 810	Geology
Roudsea Woods and Mosses	NNR, SSSI	SD 335 822	Coastal habitats, woodland, flora, invertebrates
Sea Wood	SSSI	SD 335 823	Coastal woodland
South Walney and Piel Channel Flats	SSSI	SD 220 650	Ornithology, marine and coastal habitats and flora
Morecambe Bay & Lune Deep	SMA	SD 186 739- SD 335 485	Marine biology, ornithology
Arnside and Silverdale	AONB	SD 460 770	Landscape
Lake District	ESA, NP	NY 030 300	Landscape
Plumpton Marsh	NT	SD 324 804	Saltmarsh
Grubbins Wood	WT	SD 447 780	Woodland, flora
Beach Wood	WT	SD 453 787	Flora
Foulney Island	WT	SD 245 640	Flora, geology
South Walney Island	WT	SD 215 620	Ornithology, geology

Human influences

Much of the land surrounding Morecambe Bay is rural, with large coastal developments limited to Barrow-in-Furness in the north and Morecambe, Heysham and Fleetwood in the south. There are large docks at Barrow, and the southern section of the Walney Channel has recently been extensively dredged to improve access for shipping. The coastal development at Morecambe is predominantly associated with tourism, with the foreshore extensively used for recreation.

At Heysham the large nuclear power station's coolant water/discharge gives rise to localised heating of the seawater.

The sewage outfalls of Morecambe and Heysham are being re-diverted to a new sea outfall off Middleton, which is expected to result in improvements in water quality and dispersion.

The intertidal area of Morecambe Bay is extensively fished commercially for brown shrimps *Crangon crangon*, cockles *Cerastoderma edule* and mussels *Mytilus edulis*.

References and further reading

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Sites surveyed

- Survey 20: 1989 MNCR Cumbria littoral survey (Covey & Davies 1989).
- Survey 61: 1990 MNCR Morecambe Bay to Whitehaven sublittoral survey (Emblow 1992).
- Survey 62: 1990 MNCR Crosby to Fleetwood littoral survey (Davies 1991).
- Survey 287: 1991 MNCR Morecambe Bay littoral survey.
- Survey 288: 1991 MNCR Lune Deep sublittoral survey (Emblow 1992).
- Survey 289: 1991 MNCR Cumbria sublittoral survey (Emblow 1992).
- Survey 476: 1993 FSCRC Fylde Coast Scheme sublittoral sediment survey (Moore 1993).
- Additional data from Rostron (1992) (not shown below) were also used in preparing this area summary.

Littoral sites					
Survey	Site	Place	Grid reference	Latitude/longitude	Biotores present
20	1	Foulney Island.	SD 245 635	54°03.7'N 03°09.2'W	MytX
20	2	Roa Island.	SD 232 648	54°04.3'N 03°10.4'W	FserX.T; MytX; HedMac
20	3	SW tip of Walney Island.	SD 210 615	54°02.5'N 03°12.3'W	AP.P
20	4	S of bridge, Walney Channel.	SD 188 682	54°06.1'N 03°14.5'W	BLlit; HedMac; HedMac.Are
62	1	North Wharf, Fleetwood, Morecambe Bay.	SD 321 497	53°56.3'N 03°02.0'W	BPat.Sem; BLlit; MytX; AP.P; HedMac

Littoral sites - continued

<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude/longitude</i>	<i>Biotopes present</i>
62	2	Rossall Point, Lancashire Coast.	SD 310 480	53°55.4'N 03°03.0'W	MytX; AP.P
287	1	Newbiggin Scar, Morecambe Bay.	SD 272 693	54°06.8'N 03°06.8'W	BLlit; PCer
287	2	Wadhead Scar, Morecambe Bay.	SD 309 744	54°09.6'N 03°03.5'W	MytPid; BLlit; MacAre
287	3	Chapel Island, Morecambe Bay.	SD 322 757	54°10.3'N 03°02.3'W	YG; BPat.Sem; Pel; Fves; BLlit; G; HedMac.Pyg
287	4	Cartmel Wharf, Morecambe Bay.	SD 360 680	54°06.2'N 02°58.7'W	AP.P; BatCor; PCer; MacAre
287	5	Humphrey Head, Morecambe Bay.	SD 398 728	54°08.8'N 02°55.3'W	YG; Pel; Fspi; BatCor; MacAre; HedMac.Are; HedMac.Pyg
287	6	Holme Island, Kent Estuary.	SD 421 780	54°11.6'N 02°53.2'W	YG; EntPor; Pel; BatCor; PCer; HedMac.Pyg
287	7	E of High Foulshaw, Kent Estuary.	SD 472 833	54°14.5'N 02°48.6'W	BatCor
287	8	SW of Moss Side Farm, Kent Estuary.	SD 481 823	54°14.0'N 02°47.7'W	BatCor
287	9	Milnethorpe Sands, Kent Estuary.	SD 473 806	54°13.0'N 02°48.5'W	BatCor
287	10	Warton Sands, Morecambe Bay.	SD 443 727	54°08.8'N 02°51.1'W	BPat; BatCor; MacAre; HedMac.Are
287	11	Priest Skear, Morecambe Bay.	SD 466 684	54°06.5'N 02°49.0'W	BLlit; BatCor; PCer; MacAre; HedMac
287	12	Morecambe breakwater, Morecambe Bay.	SD 439 649	54°04.6'N 02°51.4'W	BPat; Ent; MytFR; Fspi; MytX
287	13	Morecambe boating lake, Morecambe Bay.	SD 431 645	54°04.3'N 02°52.1'W	Fspi
287	14	St Patrick's Chapel, Heysham, Morecambe Bay.	SD 408 618	54°02.9'N 02°54.2'W	Pel; Fspi; Asc.Asc; AP.P; HedMac
287	15	Plover Scar, Lune Estuary.	SD 424 542	53°58.8'N 02°52.7'W	Ent; BLlit; Fves; FcerX; MytX; LMS
287	16	N of Sunderland, Lune Estuary.	SD 431 565	54°00.0'N 02°52.0'W	FvesX; BatCor; MacAre; HedOl
287	17	S of Oxcliffe Hill, Lune Estuary.	SD 448 615	54°02.7'N 02°50.5'W	BLlit; BatCor; HedOl

Sublittoral sites

<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude/longitude</i>	<i>Biotopes present</i>
61	8	NW of Lightning Knoll, Cumbria coast.	SD 190 585	54°00.9'N 03°14.1'W	Flu.SerHyd; FaMS
288	9	Lune Deep Buoy.	SD 224 488	53°55.7'N 03°10.9'W	Flu.Hocu; CMU
288	10	Shell Wharf, Lune Deep.	SD 246 481	53°55.4'N 03°08.8'W	Flu.Hocu
288	11	N of North West Boulders, Lune Deep.	SD 264 490	53°55.9'N 03°07.2'W	Flu.Hocu
288	12	SW of Fisher Bank Patches, Lune Deep.	SD 265 510	53°57.0'N 03°07.1'W	CMX
288	13	NE of North West Boulders, Lune Deep.	SD 271 494	53°56.1'N 03°06.5'W	Flu.Hocu
288	14	Mid-way between North West Boulders and King Scar, Lune Deep.	SD 278 498	53°56.3'N 03°05.9'W	Flu.Hocu
288	15	Danger Patch, Lune Deep.	SD 280 520	53°57.5'N 03°05.8'W	Flu.Hocu
288	16	S of Danger Patch Buoy, Lune Deep.	SD 282 515	53°57.3'N 03°05.6'W	CMS
288	17	King Scar Buoy, Lune Deep.	SD 296 505	53°56.7'N 03°04.3'W	MarMu
289	7	Head Scar, Walney Channel, Cumbria.	SD 224 653	54°04.6'N 03°11.1'W	Flu.Hocu
476	1	Rossall Point to Lune Deep, Fylde Coast.	SD 266 491	53°56.0'N 03°07.0'W	AP.P; Lcon; Flu.SerHyd; MytHAS

Compiled by: Roger Covey

Duddon Sands

Location

<i>Position (centre)</i>	SD 190 770	54°11'N 3°15'W
<i>County/district</i>	Cumbria	Barrow-in-Furness, Copeland, South Lakeland & Lake District Special Planning Board
<i>Conservation agency/area</i>	English Nature	Cumbria

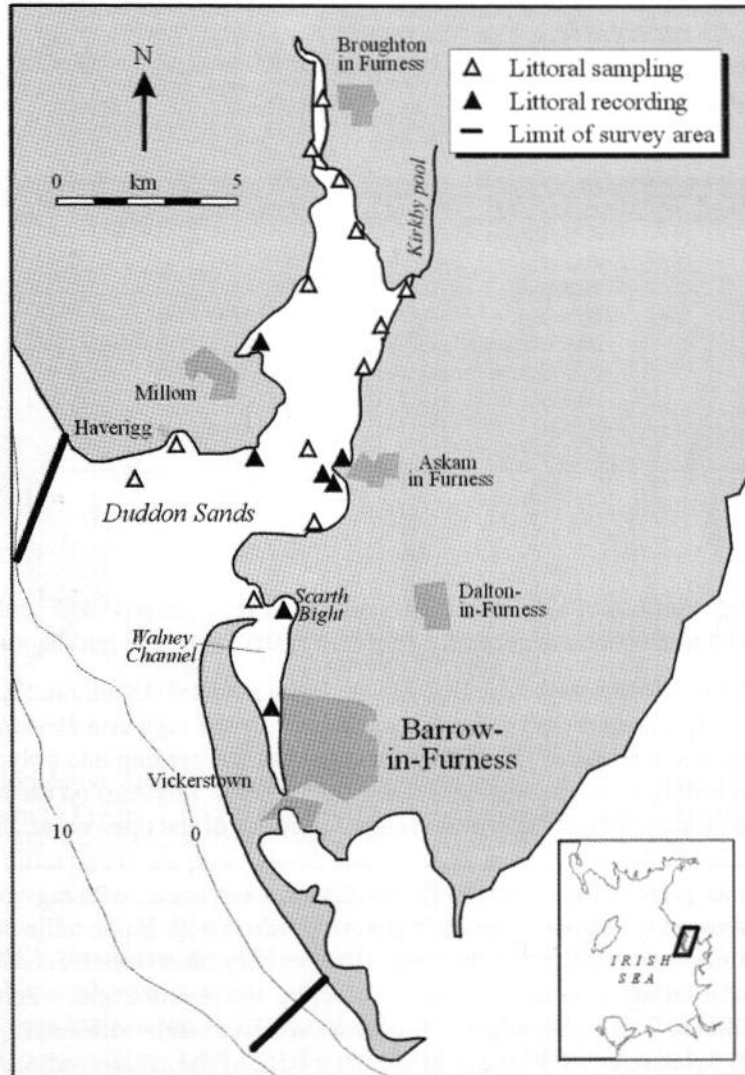


Figure 7.1 Location of area showing sites surveyed and main bathymetric features.
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Marine biological surveys

	<i>Survey method</i>	<i>Date of survey</i>	<i>Source</i>
<i>Littoral</i>	Recording, core sampling	April 1989	Covey & Davies (1989)
	Core sampling	July 1991	Davies (1992)

Introduction

The Duddon is a small, sandy estuary on the west coast of Cumbria. Much of the estuary consists of intertidal sandflats, with only narrow channels of water remaining at low tide. The area is bounded by predominantly natural habitats such as expanses of saltmarsh or sand dunes, and areas of rural land such as salted grazing. The immediate surroundings of the estuary are low-lying, with the land rising steeply within around 5 km of the shore to the Lakeland fells.

There are a number of small towns and villages close to the shores, including Millom to the north-west, Broughton in Furness at the head of the estuary, and Askam in Furness to the east. The major town of Barrow-in-Furness lies on the southern edge of the area, having an effect on the environment of the northern section of the Walney Channel, but little impact on the Duddon estuary itself.

Freshwater input to the estuary is from two main rivers, the Duddon and the smaller river of Kirkby Pool. As seawater penetrates far into the estuary on each tide, salinity is reduced only in the uppermost parts of the estuary.

Physical features

<i>Physiographic type</i>	Coastal plain estuary
<i>Length of coast</i>	65.5 km
<i>Area of inlet</i>	6,092 ha
<i>Length of inlet</i>	22.6 km
<i>Bathymetry</i>	Predominantly intertidal
<i>Wave exposure range</i>	Moderately exposed to extremely sheltered
<i>Tidal stream range</i>	Moderately strong to very weak
<i>Tidal range</i>	8.1 m
<i>Salinity range</i>	Full to low

Marine biology

Most of Duddon Sands consists of extensive intertidal flats of fine-grained sand, with only limited exposures of hard substrata which are generally confined to the upper and mid-shore.

By far the most widespread biotopes of the Duddon are those associated with muddy fine sands. Typically the communities present vary from that dominated by the ragworm *Hediste diversicolor* and the mud shrimp *Corophium volutator* (HedOl) on the upper shore, grading into polychaetes with the Baltic tellin *Macoma balthica* and the lugworm *Arenicola marina* (MacAre) on the lower shore. However, in the mid-estuary, where the salinity is similar to that of the open coast, the upper shore is characterised by a community of ragworm *Hediste diversicolor* with the Baltic tellin *Macoma balthica* (HedMac). In the inner parts of the estuary both communities can occur, with ragworm *Hediste* and mud shrimp *Corophium* on the upper shore and ragworm *Hediste* with Baltic tellin *Macoma* on the lower shore adjacent to the river drainage channels. The peppery furrow shell *Scrobicularia plana* (HedScr) is only present at two sites in the estuary, Haverigg and Scarth Bight, where there is extremely localised shelter from wave action. Wave exposed fine sands with amphipods and the polychaete *Scolecopsis squamata* (AP.P) occur at the outer edge of the estuary, adjacent to the main river channel, where wave exposure and tidal flow keep the sediments mobile.

The most extensive area of hard substrata occurs at Askam Pier. This was created during the last century by the dumping of molten slag from local steel furnaces to create a solid breakwater about 0.5 km long with a surface similar to fissured rock. The zonation present is similar to that of estuarine rocky shores, with a narrow band of channelled wrack *Pelvetia canaliculata* (Pel) and occasional spiral wrack *Fucus spiralis*. The base of the pier has a band of bladder wrack *Fucus vesiculosus* (FvesB; MytFves) beyond which are extensive sandflats. Elsewhere in the estuary, mixed sediments harbour some species more typical of rocky shores. This is particularly the case in the northern section of the Walney Channel, where mixed cobbles and pebbles are colonised by serrated wrack *Fucus serratus* with the red alga *Chondrus crispus* (FserX), while other areas are colonised by dense beds of mussels

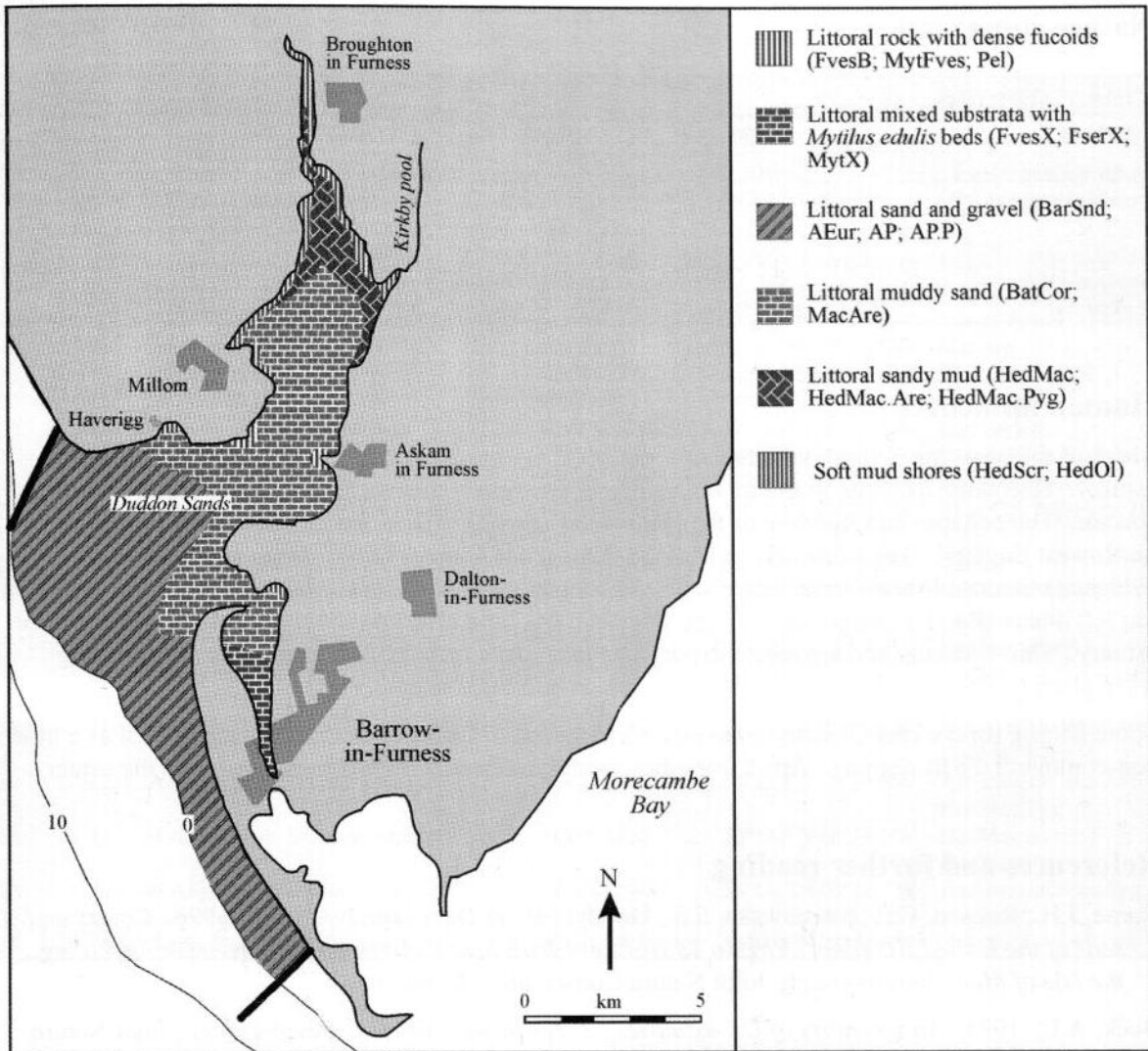


Figure 7.2 Indicative distribution of the main biotopes in the area (based on data from the sites shown in Figure 7.1, additional field observations and cited literature).
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Mytilus edulis (MytX). In other parts of the estuary, such as in Scarth Bight or towards the head of the estuary, mixed pebbles and cobbles are characterised by a low number of species which are tolerant of reduced salinity. These include the barnacles *Semibalanus balanoides* and *Elminius modestus*, and the edible periwinkle *Littorina littorea* (BLit). Where salinity is particularly low the green alga *Enteromorpha* sp. is also present (Ent).

Nature conservation

Conservation sites			
Site name	Designation	Centre grid ref.	Main features
North Walney Island	NNR, WT	SD 177 724	Coastal and marine habitats
Duddon Estuary	SSSI	SD 190 775	Ornithology, coastal and marine habitats, geology
Lake District	ESA, NP	NY 030 300	Landscape
Sandscale Haws	NT	SD 185 755	Coastal habitats
Hodbarrow	RSPB	SD 174 791	Ornithology, coastal habitats

Human influences

Much of the coastline is rural, with the adjacent small towns and villages having little impact on the estuary. Haematite iron ore occurs on both sides of the estuary and was mined at Hodbarrow and near Askam. The collapse and flooding of the Hodbarrow site has created the largest coastal lagoon in north-west England. The ironworks at Millom, Askam and Barrow have now gone, but much evidence remains of their former large scale. The dumping of blast furnace slag on the shore at Askam has left a hard pier, but the presence of the slag heap has little effect on the surrounding habitats of the estuary. Ship-breaking and aggregate export now take place from Millom pier. Some turf-cutting takes place on the saltmarsh and grazing marshes around the estuary.

Some fishing for cockles *Cerastoderma edule* and mussels *Mytilus edulis* takes place as well as a little non-commercial bait-digging. Apart from these activities there is little fishery impact on the estuary.

References and further reading

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- Taylor, P.M., & Parker, J.G., eds. 1993. *The coast of north Wales and north west England: an environmental appraisal*. London, Hamilton Oil Company.

Sites surveyed

Survey 20: 1989 MNCR Cumbria littoral survey (Covey & Davies 1989).

Survey 38: 1991 MNCR Ravenglass area, Duddon & Ribble estuaries littoral survey (Davies 1992).

Littoral sites					
<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude/longitude</i>	<i>Biotopes present</i>
20	5	S of Walney Meetings.	SD 185 705	54°07.4'N 03°14.8'W	FvesX; FserX; MytX
20	6	Scarth Bight.	SD 189 737	54°09.1'N 03°14.5'W	BLlit; AP; HedScr
20	7	S side, Askam Pier.	SD 204 775	54°11.2'N 03°13.2'W	FvesB; MytFves; Pel
20	8	W end of Askam Pier.	SD 203 776	54°11.2'N 03°13.2'W	Ver.B; BPat.Cat; Rho
20	9	Off Askam Pier.	SD 200 778	54°11.3'N 03°13.5'W	MacAre
20	10	N side of Askam Pier.	SD 204 776	54°11.2'N 03°13.2'W	BPat.Cat; FvesX
20	11	Carl Cross.	SD 215 814	54°13.3'N 03°12.2'W	AP.P; HedOl
20	12	Sandside, Kirkby-in-Furness.	SD 226 826	54°13.9'N 03°11.2'W	Ent; HedOl
20	13	W of Foxfield.	SD 204 853	54°15.4'N 03°13.3'W	Ent; BatCor; HedMac
20	14	E of Salthouse, Millom.	SD 186 808	54°12.9'N 03°14.9'W	MacAre; HedOl
20	15	Hodbarrow Point, Duddon Estuary.	SD 184 775	54°11.1'N 03°15.0'W	BPat.Cht; MytFves; H; AP.P
20	16	Bullstone Bed.	SD 152 778	54°11.3'N 03°17.9'W	BarSnd
38	9	SE Haverigg, Duddon estuary.	SD 165 784	54°11.6'N 03°16.8'W	Pel; BLlit; AEur; HedMac.Are; HedMac.Mare; HedScr
38	10	Lowsey Point, Duddon estuary.	SD 185 739	54°09.2'N 03°14.8'W	BLlit; AP.P; MacAre
38	11	NW Roanhead Farm, Duddon estuary.	SD 199 760	54°10.4'N 03°13.6'W	MacAre; HedMac.Are; HedMac.Mare
38	12	Dunnerholme, Duddon estuary.	SD 210 800	54°12.5'N 03°12.6'W	AP; BatCor; MacAre; HedMac.Pyg
38	13	Millom Marsh, Duddon estuary.	SD 195 825	54°13.9'N 03°14.1'W	HedMac.Are; HedMac.Pyg
38	14	W Angerton, Duddon estuary.	SD 210 840	54°14.7'N 03°12.7'W	BatCor; HedMac.Pyg
38	15	Lady Hall, Duddon estuary.	SD 199 859	54°15.7'N 03°13.7'W	MacAre
38	16	Greey Gate, Duddon estuary.	SD 213 867	54°16.1'N 03°12.5'W	HedOl

8

West Cumbria

Location

<i>Position (centre)</i>	SD 050 940	54°20'N 3°28'W
<i>County/district</i>	Cumbria	Copeland, Allerdale & Lake District Special Planning Board
<i>Conservation agency/area</i>	English Nature	Cumbria

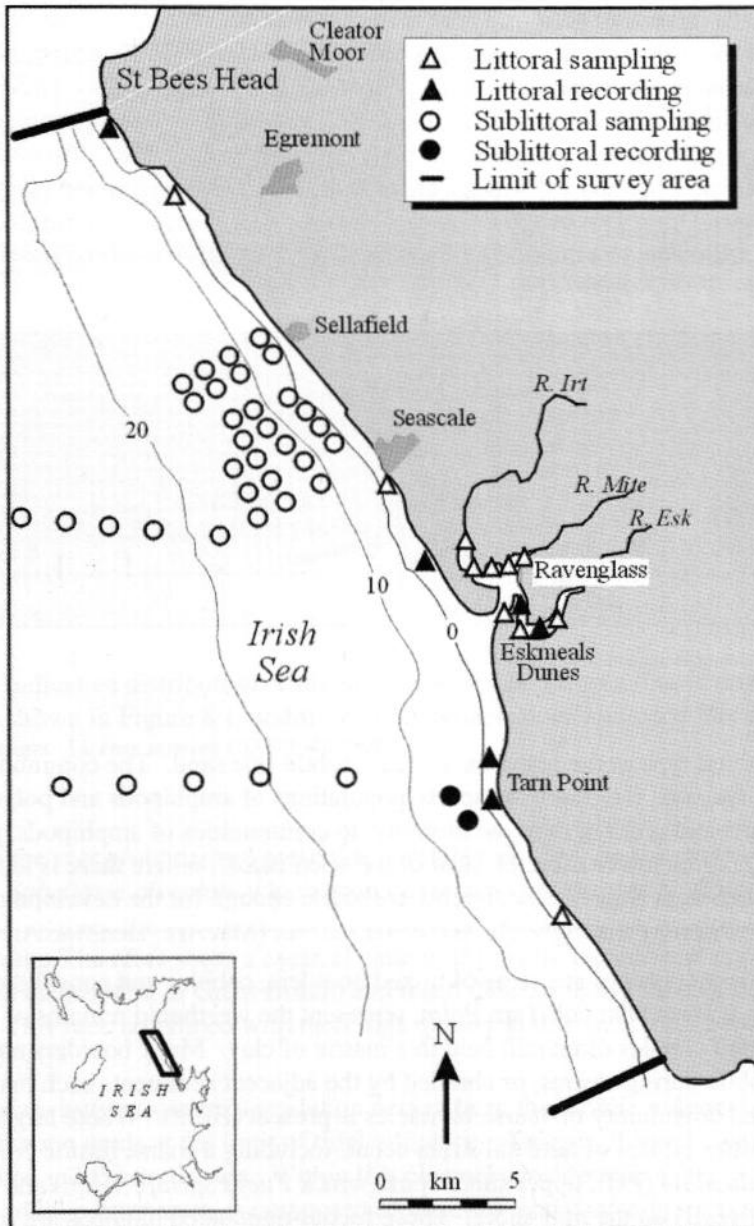


Figure 8.1 Location of area showing sites surveyed and main bathymetric features.

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Marine biological surveys			
	Survey method	Date of survey	Source
<i>Littoral</i>	Recording, core sampling	April 1989	Covey & Davies (1989)
	Recording, core sampling	July 1991	Davies (1992)
	Recording	July 1991	Allen <i>et al.</i> (1992)
<i>Sublittoral</i>	Day grab sampling	1986	Jensen & Sheader (1986)
	Recording	August 1991	Emblow (1992)
	Day grab sampling	April 1992	AERC (1992)

Introduction

The Cumbrian coast is an area of predominantly natural coastline, backed by low-lying agricultural land and the fells of the western Lake District. The coastline consists of long stretches of sandy beach, with areas of boulder shore composed of glacial boulder clay, known as scars. These scar grounds are the only appreciable areas of hard substrata in the area. The coastline is uninterrupted apart from the Ravenglass estuary system, which is situated towards the middle of the area. This inlet is a joint estuary of the rivers Esk, Mite and Irt, which converge at Ravenglass to join the open coast through a single channel between Drigg Dunes and Eskmeals Dunes. Within these estuaries, communities grade from mobile sandy sediments to estuarine muds, with some areas of tide-swept gravels.

Physical features

<i>Physiographic type</i>	Open coast with bar-built estuary
<i>Length of coast</i>	65 km
<i>Area of inlet</i>	456 ha
<i>Length of inlet</i>	11.4 km
<i>Bathymetry</i>	10 m depth contour within 1-3 km offshore
<i>Wave exposure range</i>	Moderately exposed to extremely sheltered
<i>Tidal stream range</i>	Moderate to negligible
<i>Tidal range</i>	7.7 m
<i>Salinity range</i>	Full to low

Marine biology

The predominant habitat type in the intertidal zone is mobile fine sand. The communities present vary according to wave exposure, ranging from sparse populations of amphipods and polychaetes (AEur) in upper shore sediments and areas of extreme mobility, to communities of amphipods, polychaetes and bivalves (AP; AP.P) on the lower shore of most of the open coast. Where there is localised shelter from wave action, such as at Seascale, sediments are stable enough for the development of communities characterised by the lugworm *Arenicola marina* (MacAre; HedMac.Are).

Interrupting the sediment beaches are areas of mixed boulders, cobbles and consolidated gravels. These areas, such as at Barn Scar and Tarn Point, represent the weathered remains of glacial boulder clay, with boulders and cobbles often still held in a matrix of clay. Many boulders around the edges of scar grounds are mobile during storms, or abraded by the adjacent sediments such that an impoverished scoured community of sparse barnacles is present (BLit). Where large, stable boulders are present communities typical of hard substrata occur, including a sparse littoral fringe of channelled wrack *Pelvetia canaliculata* (Pel), upper shore spiral wrack *Fucus spiralis* (Fspi) and bladder wrack *Fucus vesiculosus* (FvesB) on the mid-shore. These fucoid-dominated biotopes are frequently less species-rich than their counterparts on bedrock, although in some places the lower eulittoral zone has rich communities of sponges, ascidians and red algae.

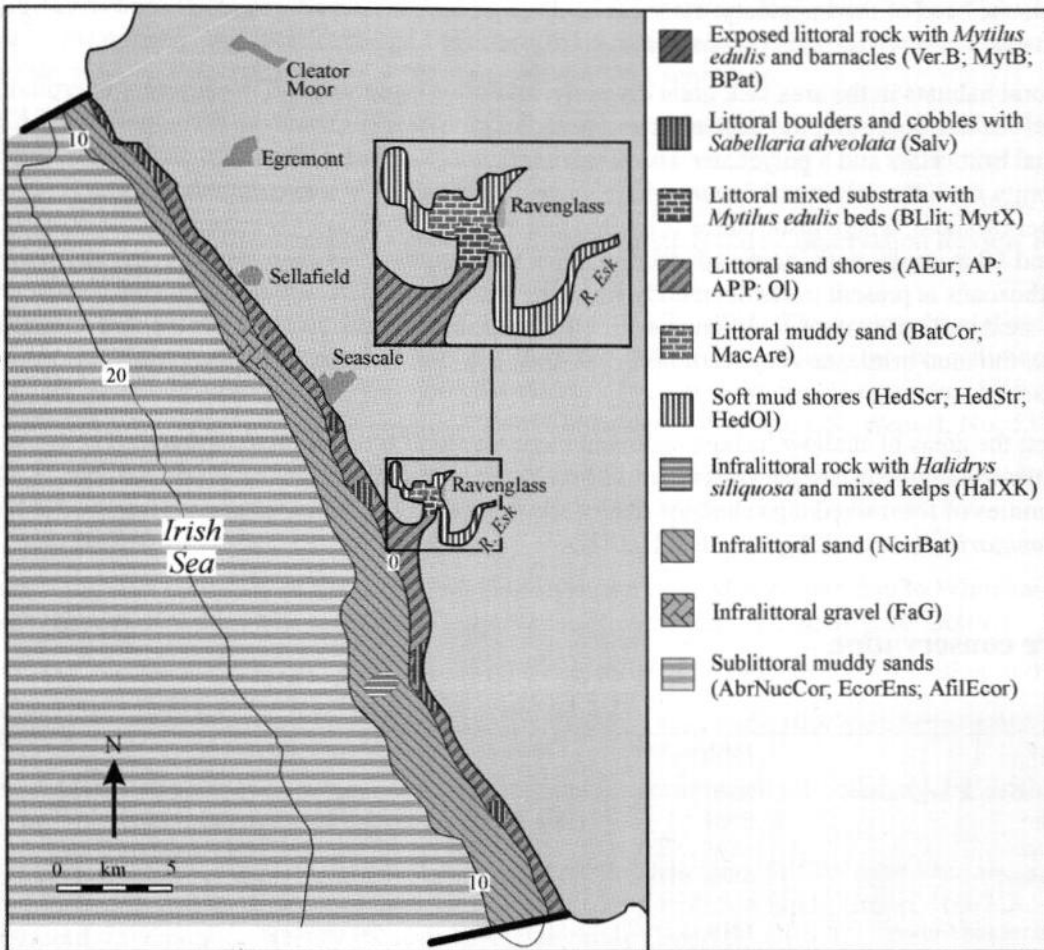


Figure 8.2 Indicative distribution of the main biotopes in the area (based on data from survey sites shown in Figure 8.1, additional field observations and cited literature).
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Of significance on the scar grounds, and present at a number of sites, are the extensive reefs of the honeycomb worm *Sabellaria alveolata* which grows over and consolidates boulders and large cobbles (Salv). These reefs increase the habitat diversity of the scar grounds by increasing the range of microhabitats present. The reefs show a cyclical pattern of growth, erosion and regrowth. *Sabellaria* reefs have a limited distribution in Great Britain and reach their northerly limit of distribution around the Solway Firth. This fact, combined with their high quality in this area, makes these reefs of particular interest.

Within the Ravenglass estuary system a gradation occurs from the mobile sediments of the open coast to the enclosed estuarine muds at the limit of tidal influence. A single channel connects the confluence of the rivers Irt, Mite and Esk to the sea. Within this channel considerable water movement mobilises all fine sediments and the substratum is composed of medium- and coarse-grained sands with a sparse infauna of amphipods and polychaetes (Ol). Shingle on the south-eastern shore of the channel is stabilised by mussels *Mytilus edulis* (MytX), a biotope which extends along the south-eastern shore of the channel to cover a large area of the lower Esk estuary around Ravenglass. The middle and upper sections of the Esk consist of fine, sandy mud with communities of the ragworm *Hediste diversicolor* (HedMac.Pyg; HedOl). These communities also characterise much of the Mite and Irt estuaries.

Towards the head of the Irt estuary, close to the limits of tidal influence, an area of mud with oligochaete worms (HedOl) is present, adjacent to a narrow band of saltmarsh vegetation.

Sublittoral habitats in the area lack great diversity, and often closely match the adjacent intertidal zone. Much of the nearshore sublittoral zone is composed of mobile fine sands with a community of epifaunal brittlestars and a polychaete and bivalve infauna (NcirBat). There is a gradation in this community from the sublittoral fringe, where wave disturbance is at a maximum and biota is reduced, to deeper offshore, where disturbance is limited and a richer community is present. Further offshore, at around 10 m depth, with increased stability a rich community of amphipods, polychaetes, bivalves and anthozoans is present in stable, muddy fine sand (EcorEns). Circalittoral sediments consist of muddy sand and sandy mud communities with infauna including the bivalves *Abra nitida* and *Nucula nitidosa*, the mud brittlestar *Amphiura filiformis* and deep-burrowing crustaceans (AbrNucCor; AfilEcor).

Amongst the areas of shallow inshore sediment there are small areas of mixed ground. These patches of boulders and cobbles are the subtidal extension of the intertidal boulder scars and harbour communities of foliose red algae and the dahlia anemone *Urticina felina*, extending from lower shore kelp *Laminaria digitata* (Ldig.Ldig.Bo; HalXK).

Nature conservation

Conservation sites			
Site name	Designation	Centre grid ref.	Main features
Shaw Meadow & Sea Pasture	SSSI	SD 122 812	Flora
Annaside	SSSI	SD 083 874	Coastal habitats, amphibians
Drigg Coast	cSAC, SSSI	SD 070 955	Marine and coastal habitats, flora
St Bees Head	SSSI, RSPB, HC	NX 945 133	Geology, coastal habitats, ornithology, landscape
Drigg Dunes and Gullery	LNR	SD 070 960	Ornithology
Cumbria Coast	SMA	NX 966 176 - SD 109 830	Marine biology
Lake District	ESA, NP	NY 030 300	Landscape
Eskmeals	MoD	SD 085 915	Coastal habitats, ornithology
Eskmeals Dunes	WT	SD 087 944	Coastal habitats

Human influences

This section of coastline is largely undeveloped and unspoilt, with the only major town being Seascale. The Cumbria coastal railway runs just behind the shore for much of its length. There is the major development of Sellafield nuclear power station and reprocessing plant which discharges into the sea, and the Drigg low level nuclear waste repository. Elsewhere the coast is low-lying and backed by agricultural land and the lower Lakeland fells. There is a Ministry Of Defence range at Eskmeals.

The area is little used for commercial fishing, although small amounts of sport fishing occur from the beaches.

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Sites surveyed

- Survey 20: 1989 MNCR Cumbria littoral survey (Covey & Davies 1989).
- Survey 38: 1991 MNCR Ravenglass area, Duddon & Ribble estuaries littoral survey (Davies 1992).
- Survey 365: 1991 NWW St Bees Head to Maryport, Cumbria littoral survey (Allen *et al.* 1992).
- Survey 289: 1991 MNCR Cumbria sublittoral survey (Emblow 1992).
- Survey 478: 1986 Sellafield sublittoral sediment survey (Jensen & Shearer 1986).
- Survey 480: 1992 AERC Sellafield sublittoral survey for BNFL (AERC 1992).
- Information from Hughes and Atkinson (1997) (not shown below) was also used to compile this summary.

Littoral sites					
Survey	Site	Place	Grid reference	Latitude/longitude	Biotopes present
20	17	Gutterby Spa.	SD 095 845	54°14.8'N 03°23.3'W	Salv; BLlit; MytX; Cor; SR; AP; Ldig.Ldig.Bo
20	18	Selker coastguard lookout.	SD 075 887	54°17.1'N 03°25.2'W	Salv; SwSed; MytX; EcorEns
20	19	River Esk, S Ravenglass.	SD 087 955	54°20.8'N 03°24.2'W	EphX; MytX; AEur
20	20	W of Ravenglass.	SD 078 966	54°21.3'N 03°25.1'W	HedMac.Are; HedOl

Littoral sites - continued

<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude/longitude</i>	<i>Biotores present</i>
20	21	Barn Scar.	SD 045 983	54°22.2'N 03°28.2'W	BLlit; Rkp; Ldig.Ldig; Ldig.Ldig.Bo
20	22	Seascale (Whitriggs Scar).	NY 035 007	54°23.5'N 03°29.1'W	Salv; AP.P
20	24	S St Bees Bay.	NX 967 107	54°28.8'N 03°35.6'W	EntPor; MytFves; BLlit; FcerX; AP.P
38	17	Tarn Bay, Ravenglass.	SD 075 901	54°17.8'N 03°25.2'W	Salv; EcorEns
38	18	Eskmeals Range, Ravenglass.	SD 078 950	54°20.5'N 03°25.1'W	Fspi; BLlit; AP.P
38	19	Newbiggin Viaduct, Ravenglass.	SD 087 946	54°20.3'N 03°24.2'W	Ent; Asc.VS; EphX; Ol; BatCor; HedOl
38	20	NW Newbiggin, Ravenglass.	SD 082 945	54°20.2'N 03°24.7'W	BatCor; MacAre; HedStr
38	21	Hall Waberthwaite, Ravenglass.	SD 099 952	54°20.6'N 03°23.1'W	EphX; NVC SM8; HedMac.Are; HedScr; HedStr
38	22	W Saltcoats, Ravenglass.	SD 068 968	54°21.4'N 03°26.0'W	BLlit; HedMac.Pyg; HedOl
38	23	NW Hall Carleton, Ravenglass.	SD 064 983	54°22.2'N 03°26.4'W	EphX; HedOl
38	24	Railway bridge, Ravenglass.	SD 084 967	54°21.4'N 03°24.5'W	Pel; Fspi; Asc.VS; AscX; FcerX; MacAre
38	25	Lower Mite estuary, Ravenglass.	SD 086 972	54°21.7'N 03°24.4'W	HedMac.Are; HedMac.Pyg; Mu; HedOl
365	20	St Bees Head, Fleswick, Parton Bay.	NX 944 133	54°30.2'N 03°37.8'W	Ver.B; MytB; BPat; FvesB; Fspi; H; Ldig.Ldig

Sublittoral sites

<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude/longitude</i>	<i>Biotores present</i>
289	5	N side of Selker Rocks, Cumbria.	SD 061 892	54°17.4'N 03°26.5'W	HalXX
289	6	S side of Selker Rocks, Cumbria.	SD 062 890	54°17.3'N 03°26.4'W	HalXX
478	1	Sellafield SA1.	SC 980 970	54°21.4'N 03°34.1'W	AfilEcor
478	2	Sellafield SA2.	SC 920 980	54°21.9'N 03°39.7'W	AfilEcor
478	3	Sellafield SA3.	SC 900 980	54°21.9'N 03°41.5'W	AfilEcor
478	4	Sellafield SA4.	SC 880 990	54°22.4'N 03°43.4'W	AfilEcor
478	5	Sellafield SA5.	SC 820 990	54°22.3'N 03°49.0'W	AfilEcor
478	6	Sellafield SA6.	NX 780 000	54°22.8'N 03°52.7'W	AfilEcor
478	7	Sellafield SA7.	NX 730 010	54°23.3'N 03°57.3'W	AfilEcor
478	8	Sellafield SB5.	SD 010 890	54°17.2'N 03°31.2'W	AfilEcor
478	9	Sellafield SB4.	SC 950 890	54°17.1'N 03°36.7'W	AfilEcor
478	10	Sellafield SB3.	SC 900 880	54°16.5'N 03°41.3'W	AfilEcor
478	11	Sellafield SB2.	SC 850 870	54°15.9'N 03°45.9'W	AfilEcor
478	12	Sellafield SB1.	SC 790 860	54°15.3'N 03°51.4'W	AfilEcor
480	1	Inshore, River Calder, Sellafield.	NY 019 025	54°24.5'N 03°30.6'W	NcirBat
480	2	Inshore, Sellafield Station.	NY 019 029	54°24.7'N 03°30.6'W	NcirBat
480	3	Inshore, High Sellafield.	NY 007 037	54°25.1'N 03°31.8'W	NcirBat
480	4	NW of Starling Castle, Sellafield.	NY 001 045	54°25.6'N 03°32.4'W	FaG
480	5	Inshore off Braystones, Sellafield.	NX 995 055	54°26.1'N 03°32.9'W	FaG
480	6	1 mile offshore from River Calder, Sellafield.	NY 010 015	54°24.0'N 03°31.4'W	AfilEcor
480	7	1 mile offshore, Sellafield Station.	NY 004 023	54°24.4'N 03°32.0'W	FaG
480	8	1 mile offshore, High Sellafield.	NX 998 032	54°24.9'N 03°32.6'W	FaG
480	9	1 mile offshore, Starling Castle, Sellafield.	NX 989 041	54°25.3'N 03°33.4'W	AfilEcor
480	10	1 mile offshore, Braystones, Sellafield.	NX 986 048	54°25.7'N 03°33.7'W	AbrNucCor
480	11	2 miles offshore, River Calder, Sellafield.	NX 999 008	54°23.5'N 03°32.4'W	AfilEcor

Sublittoral sites - continued

<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude / longitude</i>	<i>Biotopes present</i>
480	12	End of BNFL outfall pipe, Sellafield.	NX 996 019	54°24.1'N 03°32.8'W	AfilEcor
480	13	2 miles offshore, High Sellafield.	NX 989 027	54°24.6'N 03°33.4'W	AfilEcor
480	14	2 miles offshore, Starling Castle, Sellafield.	NX 984 035	54°25.0'N 03°33.8'W	AfilEcor
480	15	2 miles offshore, Braystones, Sellafield.	NX 978 043	54°25.4'N 03°34.4'W	AfilEcor

Compiled by: Roger Covey

Southern Solway Firth

Location

<i>Position (centre)</i>	NY 020 390	54°44'N 3°31'W
<i>County/district</i>	Cumbria	Allerdale & Copeland
<i>Conservation agency/area</i>	English Nature	Cumbria

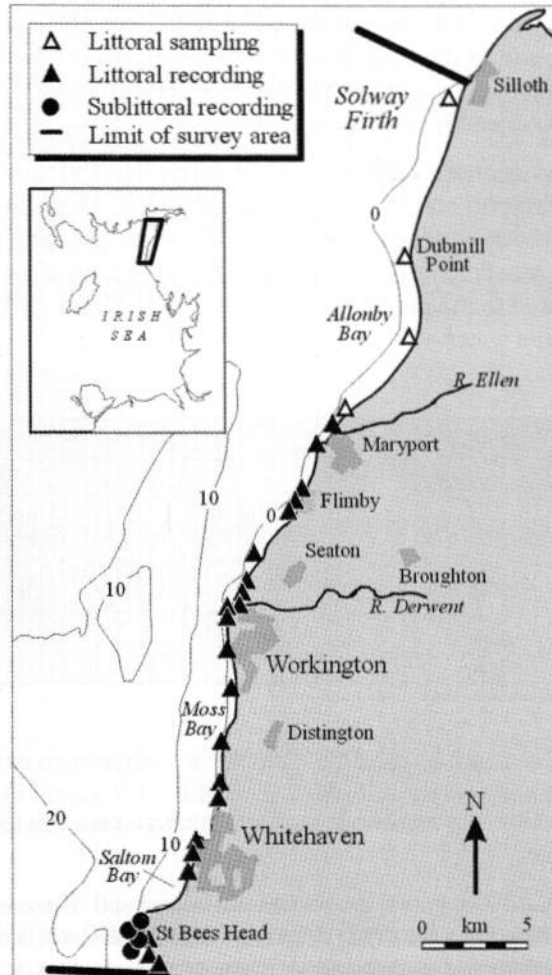


Figure 9.1 Location of area showing sites surveyed and main bathymetric features.

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Marine biological surveys

	<i>Survey method</i>	<i>Date of survey</i>	<i>Source</i>
<i>Littoral</i>	Recording	April 1989	Covey & Davies (1989)
	Recording	May 1991	Allen <i>et al.</i> (1992)
	Recording, core sampling	August 1991	Covey & Emblow (1992)
	Habitat mapping	Sept.-Oct. 1994	Cutts & Hemingway (1996)
<i>Sublittoral</i>	Recording	August 1991	Emblow (1992)
	Habitat mapping	Sept.-Oct. 1994	Cutts & Hemingway (1996)

Introduction

The southern coast of the Solway Firth is an area of contrasts. To the north, the coastline is low-lying and rural, with little development or human impact. To the south the coastline has been extensively modified by a long history of iron and steel making, with blast furnace waste dumped on the shores, abrading the natural littoral communities and artificially raising the level of the beach and creating artificial rocky shores. Perkins (1973) reported that, in many places, the majority of the littoral zone was composed of waste material derived from ironworks and collieries. However, since the decline of iron, steel and coal industries in the area, much of the loose material has been washed away and redistributed by wave action, leaving only the larger pebble and cobble-sized debris in place. Recent surveys (Allen *et al.* 1992) suggest a gradual return to communities typical of mixed rock and boulder shores. At the southern extreme of the area are the cliffs of St Bees Head, the only extensive area of bedrock cliff in the eastern basin of the Irish Sea south of the Solway. The St Bees Head area is unspoilt with natural rocky shore communities extending to the sublittoral fringe, backed by high cliffs that support important seabird breeding colonies.

The coastline is uninterrupted, with the exception of the minor inlets of the rivers Ellen and Derwent which flow into the sea at Maryport and Workington respectively. These two inlets have been extensively modified for use as major ports. In the nineteenth century Maryport and Workington were more important for shipping movements than Liverpool, but both have since declined in use. The coastline is moderately exposed to the prevailing westerly winds, although it receives some shelter by virtue of the shallowness of the water offshore.

Physical features

<i>Physiographic type</i>	Open linear coast
<i>Length of coast</i>	48 km
<i>Bathymetry</i>	Less than 10 m maximum depth within 3 km offshore, except around St Bees Head, where 20 m depth occurs within 3 km
<i>Wave exposure range</i>	Moderately exposed
<i>Tidal stream range</i>	Moderately strong around the north, weak along much of the coast
<i>Tidal range</i>	8 m
<i>Salinity range</i>	Full

Marine biology

The intertidal zone of this section of coastline is uniform in character over long distances, and can be divided into three main regions.

In the north, between Silloth and Maryport, the shores are composed of areas of cobble scars and localised beds of the mussel *Mytilus edulis* (MytX). Between these scars, and lower on the shore, mobile fine sands support a sparse community of amphipods and polychaetes, with bivalves in some places (AP.P; AP.Pon). Of note amongst these shores is Dubmill Scar, where boulders on the lower shore have a rich community of the honeycomb worm *Sabellaria alveolata* with sponges (particularly the breadcrumb sponge *Halichondria panicea*), ascidians and anemones (Salv).

Between Maryport and Whitehaven the shore is predominantly rocky, with areas of bound shingle, boulders or mobile blast-furnace waste. The shores are rugged, with the typical zonation of fucoid shore communities interrupted by ridges or gullies. Communities present include spiral wrack *Fucus spiralis* (Fspi), particularly on the upper shore, bladder wrack *Fucus vesiculosus* (Fves) and, less commonly, serrated wrack *Fucus serratus* (Fser.Fser) in zones down the shore. Mid- and lower shores often support dense *Mytilus edulis* (MytFves; MytFR) with barnacle communities (BPat.Sem) present on some shores. In places, where mobile mixed substrata are adjacent to bedrock, scoured communities occur characterised by mussels and sparse algae (MytX).

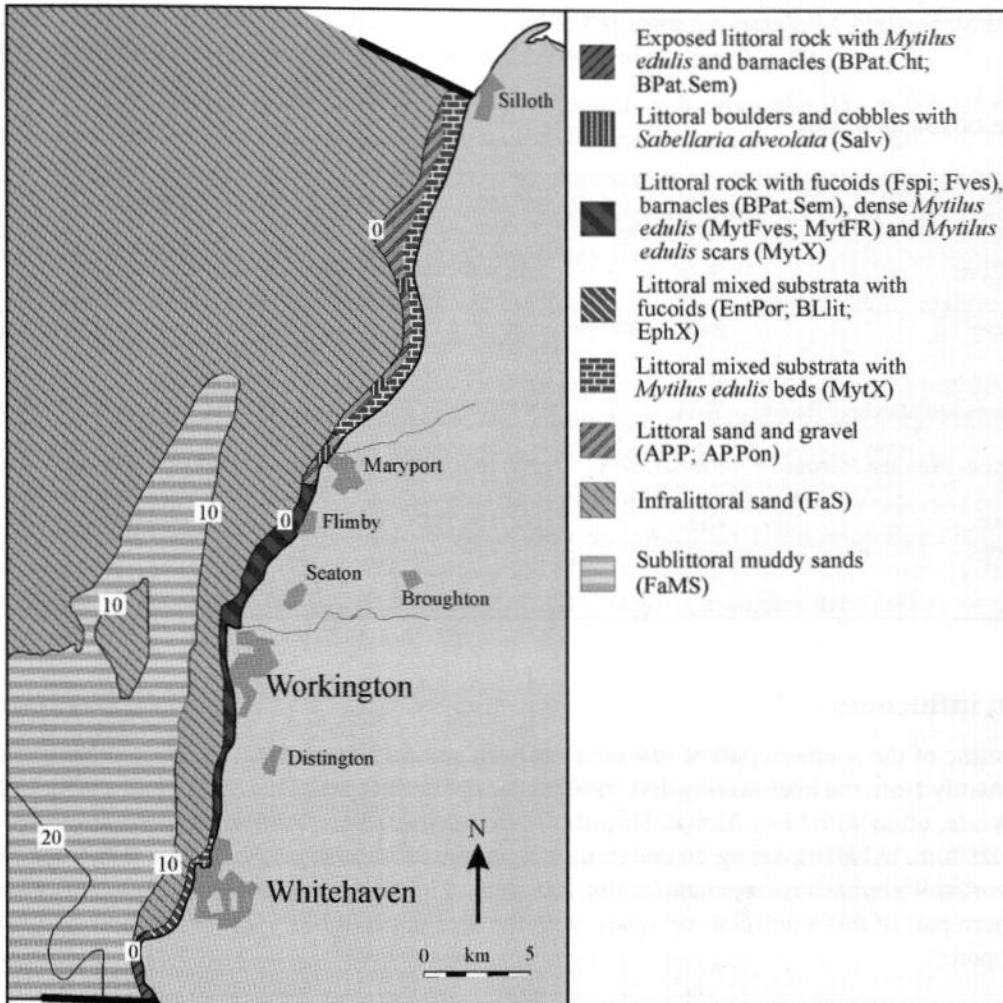


Figure 9.2 Indicative distribution of the main biotopes in the area (based on data from survey sites shown in Figure 9.1, additional field observations and cited literature).
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South of Whitehaven, in Saltom Bay, the shore is extensively scoured and supports only impoverished communities (EntPor; BLlit; EphX). Rocky shore communities here are improving following the cessation of blast-furnace slag dumping. The character of the shores changes abruptly at St Bees Head, where a wave-cut rock platform supports a range of rocky shore communities. At the top of the shore, where it abuts the high cliffs, an extensive lichen zone occurs with a range of yellow and grey lichens (YG) as well as the black lichen *Verrucaria maura* (Ver.Ver). Below this, the shores are flat expanses of rock covered by barnacles and limpets (BPat.Cht; BPat.Sem), with occasional areas of spiral wrack *Fucus spiralis* (Fspi) or bladder wrack *Fucus vesiculosus* (FvesB). The lower shore is steep, with a turf of serrated wrack *Fucus serratus* and red algae such as *Corallina officinalis*, *Palmaria palmata* and coralline crusts (Fser.R). At the extreme lower shore this grades into a narrow band of the kelp *Laminaria digitata* (Ldig.Ldig). Some small pools are lined with the honeycomb worm *Sabellaria alveolata*.

The subtidal zone of this area is less well studied, but available data suggest that the shallow inshore zone is composed of mobile fine sands with sparse infauna and epifauna (FaS) grading, with increasing depth, to a more stable sediment characterised by brittlestars and a richer infauna of polychaetes and bivalves (FaMS). Close inshore around St Bees Head the spectacular cliffs and rocky

shore end abruptly in the shallow sublittoral zone with an area of sand-scoured bedrock sparsely colonised by barnacles *Balanus crenatus* (CC.Mob).

Nature conservation

Conservation sites			
Site name	Designation	Centre grid ref.	Main features
Cumbria Coast	SMA	NX 966 176- SD 109 830	Marine biology
St Bees Head	SSSI, RSPB, HC	NX 945 133	Geology, coastal habitats, ornithology, landscape
Maryport Harbour	SSSI	NY 029 636	Flora, invertebrates
Silloth Dunes and Mawbray Banks	SSSI	NY 105 525	Coastal habitats and flora, amphibians and reptiles
Upper Solway Flats and Marshes	Ramsar, SPA, SSSI	NY 160 610	Coastal and marine habitats and flora, ornithology, amphibians, geology
Solway Firth	cSAC	NX 818 532	Coastal and marine habitats
Solway Coast	AONB	NY 170 560	Landscape
Solway	SMA	NX 899 552- NY 076 458	Marine biology

Human influences

The coastline of the southern part of this area has been extensively modified by past industrial activity, predominantly from the coal-mining and steel production industries. These have left a legacy of coastal waste, often with blast-furnace slag dumped on the shores, solidifying to produce an artificial hard substratum. Also impacting on the area are a number of discharges, including that from Albright and Wilson at Whitehaven who manufacture detergent. Housing and coastal development is limited to the southern part of this south Solway coast, with the area north of Maryport being more natural and undeveloped.

Fishing occurs, mostly for demersal species. Some locally-based boats from Maryport, Workington and Whitehaven Harbours are involved, but fishing is mostly carried out by boats based outside the area. There is also some sport angling from the beaches and collection of shellfish.

References and further reading

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Sites surveyed

- Survey 20: 1989 MNCR Cumbria littoral survey (Covey & Davies 1989).
- Survey 286: 1991 MNCR inner Solway littoral survey (Covey & Emblow 1992).
- Survey 289: 1991 MNCR Cumbria sublittoral survey (Emblow 1992).
- Survey 365: 1991 NWW St. Bees Head to Maryport, Cumbria littoral survey (Allen *et al.* 1992).
- Information from Cutts & Hemingway (1996) (not shown below) was used in the compilation of this summary.

Littoral sites					
Survey	Site	Place	Grid reference	Latitude/longitude	Biotopes present
20	25	SE South Head.	NX 953 117	54°29.3'N 03°36.9'W	YG; Ver.Ver; BPat.Cht; BPat.Sem; Ent; MytFves; Fspi; Ldig.Ldig.Bo
20	26	S Fleswick Bay.	NX 948 125	54°29.8'N 03°37.4'W	YG; Ver.Por; Ver.Ver; BPat.Sem; Salv; Fspi; FK; Ldig.Ldig.Bo
20	27	St Bees Head.	NX 943 134	54°30.2'N 03°37.9'W	BPat.Sem; EntPor; MytFves; Cor; FK; Ldig.Ldig.Bo
286	1	NW of Brown Rigg, Inner Solway.	NY 053 395	54°44.4'N 03°28.2'W	Salv; MytX; AP.P
286	2	Allonby Scar, Inner Solway.	NY 075 430	54°46.4'N 03°26.2'W	BLlit; EphX; MytX; AP.P; AP.Pon
286	3	Dubmill Scar, Inner Solway.	NY 073 450	54°47.4'N 03°26.5'W	Salv; MytX; AP.Pon
286	4	Silloth Lighthouse, Lees Scar, Inner Solway.	NY 095 529	54°51.7'N 03°24.6'W	MytX; AP.P; MacAre; HedMac.Are
365	1	North Maryport, Parton Bay.	NY 037 374	54°43.3'N 03°29.7'W	Fser.Fser; XR; Ent; EntPor; EphX; Salv; Fspi; Fves
365	2	Maryport South, Parton Bay.	NY 037 360	54°42.5'N 03°29.6'W	EntPor; Salv; EphX
365	3	N Flimby, Parton Bay.	NY 023 346	54°41.8'N 03°30.9'W	BPat.Sem; EntPor; Fspi; Fves; BLlit; EphX

Littoral sites - continued

<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude/longitude</i>	<i>Biotopes present</i>
365	4	Flimby central, Parton Bay.	NY 020 339	54°41.4'N 03°31.2'W	MytFves; MytFR; Ent; Fspi; MytX
365	5	S Flimby, Parton Bay.	NY 016 333	54°41.1'N 03°31.5'W	Fser.Fser; XR; EntPor; Ent; Fspi; BLLit
365	6	Lowca Lane, Parton Bay.	NY 001 317	54°40.2'N 03°32.9'W	FvesB; MytFR; Fspi; Fves; BLLit
365	7	South Siddick Point, Parton Bay.	NX 994 308	54°39.7'N 03°33.5'W	BPat.Sem; FvesB; Ent; Salv; Fspi
365	8	N of North Side, Parton Bay.	NX 993 305	54°39.5'N 03°33.6'W	Fser.Fser; Pel; Fspi; Fves
365	9	Workington North Side, Parton Bay.	NX 990 299	54°39.2'N 03°33.9'W	BPat; Ent; Asc.Asc; BLLit; MytX
365	10	John Pier, Derwent estuary, Parton Bay.	NX 988 293	54°38.9'N 03°34.1'W	Ent; Fspi; Fves; Asc.VS
365	11	German Arch, Parton Bay.	NX 985 284	54°38.4'N 03°34.3'W	FvesB; MytFR; Ent; Fspi; MytFves; Fves; MytX
365	12	Shore Road, Salterbeck, Parton Bay.	NX 987 264	54°37.3'N 03°34.1'W	YG; BPat.Sem; Ent; MytFves; BLLit
365	13	Harrington, Parton Bay.	NX 986 251	54°36.6'N 03°34.2'W	Fser.R; Rho; Fspi; EphX
365	14	Cunning Point, Parton Bay.	NX 978 228	54°35.3'N 03°34.9'W	Ent; MytFves; MytFR; Fves; Asc.Asc; MytX; Ldig.Ldig
365	15	Parton, Parton Bay.	NX 978 212	54°34.5'N 03°34.8'W	Fspi; BLLit; EphX; MytX
365	16	Tanyard Rocks, Parton Bay.	NX 977 204	54°34.1'N 03°34.9'W	BPat.Sem; Fspi; MytX
365	17	Tom Hurd Rocks, Parton Bay.	NX 966 181	54°32.8'N 03°35.9'W	BPat.Sem; XR; EntPor; Ent; BLLit
365	18	West Strand, Parton Bay.	NX 965 179	54°32.7'N 03°36.0'W	BPat; EntPor; Ent; Rho; EphX
365	19	Old Kells, South Saltom Bay, Parton Bay.	NX 963 172	54°32.3'N 03°36.1'W	BPat.Sem; XR; Eph; Ent

Sublittoral sites

<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude/longitude</i>	<i>Biotopes present</i>
289	1	N of St Bees Head, Cumbria.	NX 937 145	54°30.8'N 03°38.5'W	Ldig.Ldig.Bo; FaS
289	2	N side of Fleswick Bay, Cumbria.	NX 942 143	54°30.7'N 03°38.0'W	FoR; Lhyp.Ft; FaS
289	3	S Head of St Bees, Cumbria.	NX 951 120	54°29.5'N 03°37.1'W	CC.Mob; FaS
289	4	S side of South Head of St Bees, Cumbria.	NX 955 116	54°29.3'N 03°36.8'W	FoR; Ldig.Ldig.Bo; FaMS

Compiled by: Roger Covey

Inner Solway Firth

Location

<i>Position (centre)</i>	NY 105 605	54°50'N 03°23'W
<i>County or administrative area/district</i>	Cumbria Dumfries and Galloway	Allerdale, Carlisle
<i>Conservation agency/area</i>	English Nature Scottish Natural Heritage	Cumbria Dumfries and Galloway

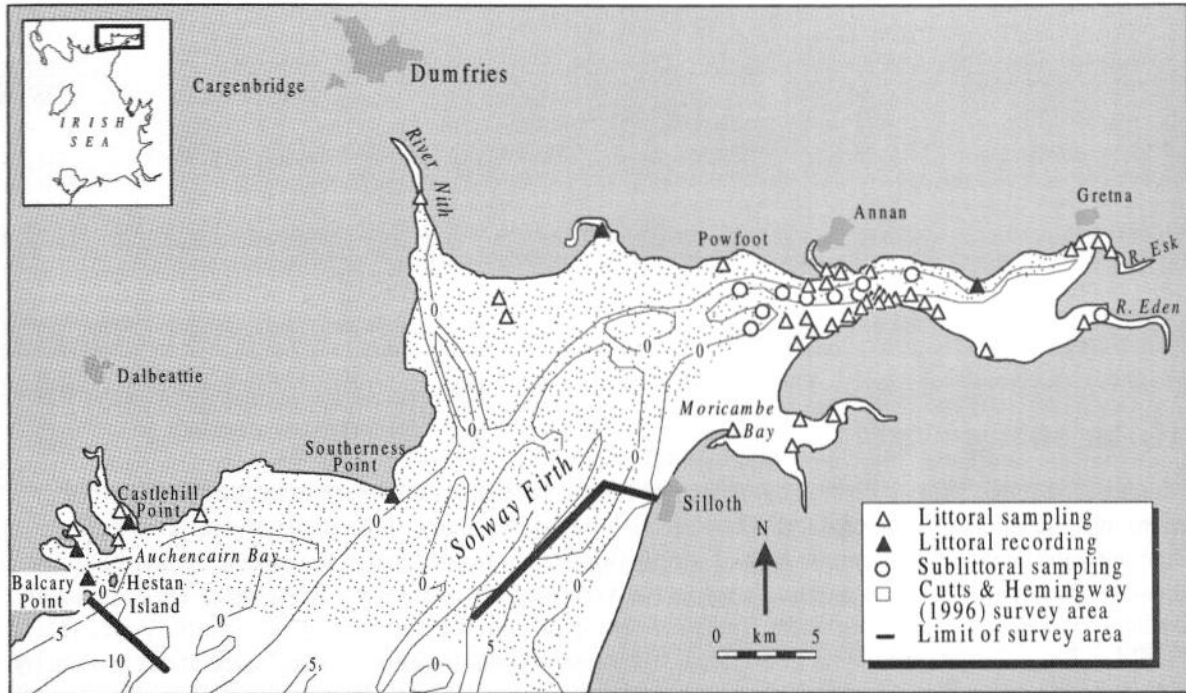


Figure 10.1 Location of area showing sites surveyed and main bathymetric features (position of chart datum bathymetry liable to change significantly).

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Marine biological surveys

	<i>Survey method</i>	<i>Date of survey</i>	<i>Source</i>
<i>Littoral</i>	Recording, core sampling	May 1992	AERC (1992)
	Recording, core sampling	August 1989	Moore (1990)
	Recording, core sampling, granulometry	August 1991	Covey & Emblow (1992)
	Habitat mapping	Sept.-Nov. 1994	Cutts & Hemingway (1996)
<i>Sublittoral</i>	Van Veen grab, granulometry	June 1992	Rendall & Bell (1993)
	Day grab	May 1992	AERC (1992)
	Habitat mapping	Sept.-Oct. 1994	Cutts & Hemingway (1996)

Introduction

The Solway Firth is a large complex estuary, considered to be one of the least developed large estuaries in Europe. The inner Firth is an area of constantly shifting sandbanks, between areas of saltmarsh (known locally as merse). Hard substratum is limited in extent, with only small exposures in the upper and mid-shore zones. Much of the surrounding land is sparsely populated, with major towns at Dumfries at the head of the Nith estuary, Gretna and Annan on the northern shores of the Solway, and Carlisle at the head of the Eden estuary, beyond the limit of tidal influence.

The intertidal flats of the Solway form one of the largest continuous intertidal areas in Britain. Because of the extensive areas of sediment shore, with their rich invertebrate populations, the area is of high ornithological importance, which is recognised by a number of national and international designations.

Physical features

<i>Physiographic type</i>	Complex estuary and embayments
<i>Length of coast</i>	200 km
<i>Area of inlet</i>	42,056 ha
<i>Length of inlet</i>	46.3 km
<i>Bathymetry</i>	<20 m depth within Solway Firth; much of Firth is intertidal
<i>Wave exposure range</i>	Moderately exposed to extremely sheltered
<i>Tidal stream range</i>	Strong in main channel
<i>Tidal range</i>	8.4 m
<i>Salinity range</i>	Full to low

Marine biology

Much of the inner Solway Firth is composed of littoral sediment flats, often extending for 2 km or more into the middle of the estuary. They are also present in many of the embayments such as Auchencairn Bay and Moricambe Bay. Littoral sediment communities in the area are predominantly those of sheltered fine sands and muds subject to variable or low salinity. These areas are dominated by large populations of the ragworm *Hediste diversicolor* and the bivalve *Macoma balthica* (HedMac; HedMac.Are). In the outer parts of the area, fine sands in variable salinity conditions are colonised by a community of cockles *Cerastoderma edule* and polychaetes (PCer). This grades with reducing salinity into a community of polychaetes and the Baltic tellin *Macoma balthica* (MacAre), many transitional examples having populations of both cockles *C. edule* and tellins *M. balthica*, with more mobile sands characterised by sparse infauna (AP; AEur). Some sites have no bivalves due to the reduced salinity conditions, but are dominated by a community of the ragworm *Hediste diversicolor* and the mud shrimp *Corophium volutator* (HedOl) with only a limited range of other polychaetes. In the inner sections of the estuaries, where muddier sediment occurs, small areas of ragworm *H. diversicolor* and the peppery furrow shell *Scrobicularia plana* are present (HedScr). The distribution of the *Hediste/Scrobicularia* biotope appears to be limited by the distribution of muddy sediments rather than salinity alone.

Littoral hard substrata communities are restricted to the rock headlands of Southernness Point, the scar grounds around the upper shore in the inner Firth, and on the whole shore in the south of the area around Lees Scar, Silloth. Bedrock sites generally have a supralittoral or splash zone of yellow and grey lichens (YG), below which is a zone of the channelled wrack *Pelvetia canaliculata* (Pel). This generally grades into a zone of spiral wrack *Fucus spiralis* (Fspi) below which is either a band of bladder wrack *Fucus vesiculosus* (Fves) or knotted wrack *Ascophyllum nodosum* (Asc.Asc), depending on the wave exposure prevalent at the site. Rocky shores usually end at this level, with lower shore habitats being of sediment.

Stable scar grounds mostly have communities similar to those of rocky shores. The scar grounds generally lack the littoral fringe and supralittoral communities of bedrock, but are characterised by

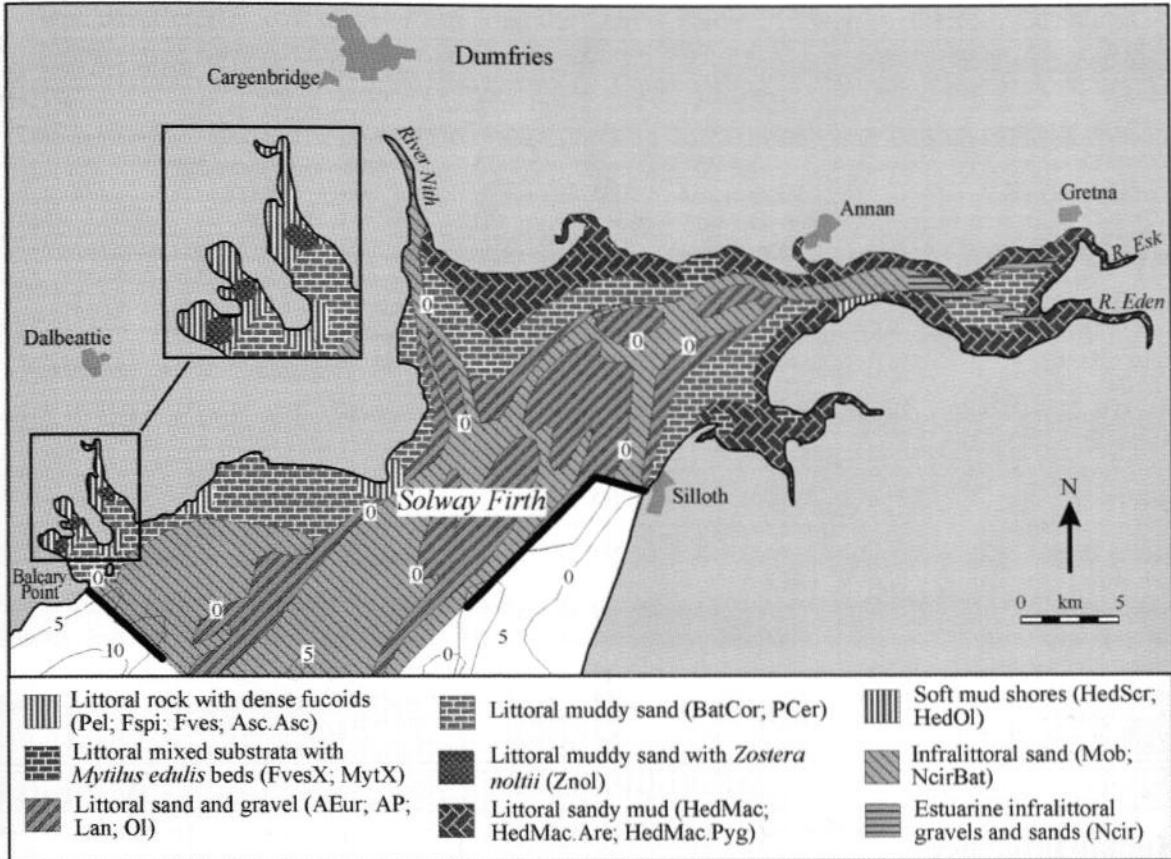


Figure 10.2 Indicative distribution of the main biotopes in the area (based on data from survey sites shown in Figure 10.1, additional field observations and Cutts & Hemingway 1996).

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Fucus spiralis (Fspi) and *Fucus vesiculosus* (FvesX) in the mid shore. Many sites additionally have mussel *Mytilus edulis* beds (MytX).

The sublittoral environment of the Solway is dominated by sediments, with only a limited variety of biotopes present. Over much of the inner Firth the sediment is dominated by a sparse community of mobile opportunistic species such as the amphipods *Bathyporeia pelagica*, *Bathyporeia pilosa* and *Haustorius arenarius*, with some sites also having the Baltic tellin *Macoma balthica* and the polychaetes *Eteone longa* and *Pygospio elegans* (MobRS; Ncir). These communities are likely to extend over the whole subtidal area of the inner Firth where tide-swept mobile sediments are present. Shallow sands in the outer parts of the Firth support a sparse epifauna (Mob; NcirBat), while deeper sediments have a more stable community of brittlestars (AfilEcor).

Nature conservation

Conservation sites			
Site name	Designation	Centre grid ref.	Main features
Silloth Dunes & Mawbray Banks	SSSI	NY 105 525	Coastal habitats and flora, amphibians and reptiles
Rockcliffe Marshes	Ramsar, SPA, WT, NY part NTS	320 640	Ornithology
Upper Solway Flats & Marshes	Ramsar, SPA, SSSI, part NT	NY 160 610	Coastal and marine habitats and flora, ornithology, amphibians, geology
Caerlaverock	Biosphere reserve, NNR, WWT	NY 005 603	Coastal and marine habitats, ornithology, amphibians
Solway Firth	cSAC	NX 818 532	Coastal and marine habitats
Royal Ordnance, Powfoot	SSSI	NY 165 657	Botany
Port O'Warren	SSSI	NX 876 534	Ornithology, flora
Auchencairn & Orchardton Bays	SSSI	NX 809 517, NX 818 532	Coastal habitats and flora, ornithology
Solway	SMA	NX 899 552- NY 076 458	Marine biological
Solway Coast	AONB	NY 170 560	Landscape
Stewartry	ESA	NX 650 700	Landscape
Nith Estuary	NSA	NY 030 630	Scenery
East Stewartry Coast	NSA	NX 870 528	Scenery
Drummains Reedbed	WT	NX 984 610	Ornithology
Southwick Coast	WT	NX 910 558	Ornithology
Campfield Marsh	RSPB	NY 195 616	Ornithology, coastal habitats
Mershead Farm	RSPB	NX 925 560	Ornithology, coastal habitats

Human influences

Much of the area is undeveloped and predominantly rural. The northern shores are more developed than the southern bank, with the towns of Dumfries, Gtretna and Annan all in close proximity to the firth or its feeder estuaries. On the southern shores there are no major conurbations, with the exception of Carlisle at the head of the firth.

Tourism and recreational activities are based around Powfoot, Southernness, Sandyhills and Rough Firth.

Little fishing activity takes place in the area, due to the predominantly shallow water and the extent of intertidal ground. However, these attributes encourage the harvesting of cockles *Cerastoderma edule*, often by suction dredger on the intertidal sediment flats, with cockle stocks reported to be severely depleted in the mid-1990s. The subtidal channels are fished for shrimp *Crangon crangon* and flatfish. Wildfowling occurs over 90% of the saltmarshes.

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Sites surveyed

- Survey 275: 1989 FSCRC Blackshaw Bank hydraulic cockle dredging survey (Moore 1990).
 Survey 286: 1991 MNCR inner Solway littoral survey (Covey & Emblow 1992).
 Survey 441: 1992 AERC inner Solway survey for BNFL Chapelcross EIA (AERC 1992).
 Survey 479: 1992 SRPB inner Solway sublittoral sediment survey (Rendall & Bell 1993).
 Information from Cutts & Hemingway (1996) (not shown below) was also used to compile this summary.

Littoral sites					
Survey	Site	Place	Grid reference	Latitude/longitude	Biotopes present
275	D1	Dredge site 1, Blackshaw Bank.	NY 030 620	54°56.5'N 03°30.8'W	PCer; BatCor; HedMac.Are; HedMac.Pyg
286	5	Grune Point, Inner Solway.	NY 145 568	54°53.9'N 03°20.0'W	MytX; MacAre; HedMac; HedMac.Are; HedOI
286	6	NE of Border, Inner Solway.	NY 179 555	54°53.2'N 03°16.8'W	MacAre; HedMac.Pyg
286	7	W of Anthorn, Inner Solway.	NY 186 572	54°54.1'N 03°16.1'W	BatCor; HedMac.Pyg
286	8	Longdyke Scar, Inner Solway.	NY 179 577	54°54.4'N 03°16.8'W	BLlit; MytX; HedMac.Are
286	9	Cardurnock Flats, Inner Solway.	NY 170 615	54°56.4'N 03°17.7'W	BatCor; MacAre; HedMac
286	10	Herdhill Scar, Inner Solway.	NY 213 628	54°57.2'N 03°13.7'W	Ent; Fspi; Fves; Asc.Asc; FvesX; AP; HedOI
286	11	Port Carlisle, Inner Solway.	NY 244 620	54°56.8'N 03°10.8'W	MacAre; HedMac.Mare
286	12	Drumburgh, Inner Solway.	NY 268 603	54°55.9'N 03°08.5'W	AP
286	13	NW of Rockcliffe Marsh, Inner Solway.	NY 316 655	54°58.7'N 03°04.1'W	BatCor; HedMac.Pyg
286	14	Redkirk Point, Inner Solway.	NY 302 651	54°58.5'N 03°05.4'W	Ent; HedMac; HedMac.Pyg
286	15	Torduff Point, Inner Solway.	NY 265 637	54°57.7'N 03°08.8'W	Fspi
286	16	Powfoot Scar, Inner Solway.	NY 145 651	54°58.3'N 03°20.1'W	Fspi; BLlit; EphX; MytX; HedMac; HedMac.Mare
286	17	Stanhope, Inner Solway.	NY 084 673	54°59.5'N 03°25.9'W	Ent; HedOI
286	18	Blackshaw Bank, Inner Solway.	NY 022 637	54°57.4'N 03°31.6'W	BatCor; PCer; HedMac.Pyg
286	19	Glencaple, Inner Solway.	NX 994 685	55°00.0'N 03°34.3'W	EphX; HedMac.Pyg
286	20	Southernness Point, Inner Solway.	NX 977 543	54°52.3'N 03°35.6'W	YG; BPat; MytFves; Pel; Fspi; Asc.Asc; BLlit; Lan

Littoral sites - continued					
<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude/longitude</i>	<i>Biotores present</i>
286	21	Port O' Warren, Inner Solway.	NX 879 534	54°51.7'N 03°44.8'W	YG; BPat.Cat; BPat.Sem; Pel; Fspi; Fves; Asc.Asc; G; SR; MacAre.Mare
286	22	Port Donnel Beach, Inner Solway.	NX 845 538	54°51.9'N 03°47.9'W	YG; Ver.Ver; Pel; Fspi; Asc.VS
286	23	Rough Island Causeway and Flats, Inner Solway.	NX 844 535	54°51.7'N 03°48.0'W	BLlit; MacAre; ZnoI
286	24	White Horse Bay, Inner Solway.	NX 839 525	54°51.2'N 03°48.5'W	YG; Pel; Fspi; Asc.Asc; MytX; G; Ol; HedScr
286	25	SW of Orchardton Bay, Inner Solway.	NX 820 523	54°51.0'N 03°50.2'W	MacAre; ZnoI; HedScr
286	26	Torr Point, Inner Solway.	NX 823 517	54°50.7'N 03°49.9'W	YG; Ver.Ver; MytB; PelB; G
286	27	W side of Auchencairn Bay, Inner Solway.	NX 814 507	54°50.2'N 03°50.8'W	ZnoI; HedScr
441	2	Chapelcross site 2, Zone 1.	NY 194 643	54°58.0'N 03°15.4'W	HedMac.Pyg
441	6	Chapelcross site 7, Zone 1.	NY 199 641	54°57.9'N 03°15.0'W	Mob
441	8	Chapelcross site 9, Zone 1.	NY 220 639	54°57.8'N 03°13.0'W	NcirBat
441	9	Chapelcross site 10, Zone 1.	NY 170 629	54°57.2'N 03°17.7'W	AEur
441	10	Chapelcross site 11, Zone 1.	NY 180 629	54°57.2'N 03°16.8'W	NcirBat
441	13	Chapelcross site 14, Zone 1.	NY 208 629	54°57.3'N 03°14.2'W	HedMac.Pyg
441	14	Chapelcross site 15, Zone 1.	NY 212 630	54°57.3'N 03°13.8'W	AP
441	16	Chapelcross site 17, Zone 1.	NY 180 619	54°56.7'N 03°16.8'W	NcirBat
441	17	Chapelcross site 18, Zone 1.	NY 190 623	54°56.9'N 03°15.8'W	PCer
441	18	Chapelcross site 19, Zone 1.	NY 201 624	54°57.0'N 03°14.8'W	PCer
441	19	Chapelcross site 20, Zone 1.	NY 169 610	54°56.2'N 03°17.7'W	PCer
441	20	Chapelcross site 53, Zone 1.	NY 175 645	54°58.0'N 03°17.3'W	HedMac.Are
441	21	Chapelcross site 54, Zone 1.	NY 190 641	54°57.8'N 03°15.9'W	HedMac.Pyg
441	22	Chapelcross site 55, Zone 1.	NY 195 645	54°58.1'N 03°15.4'W	HedMac.Mare
441	23	Chapelcross site 56, Zone 1.	NY 210 648	54°58.2'N 03°14.0'W	HedMac.Pyg
441	24	Chapelcross site 57, Zone 1.	NY 235 650	54°58.4'N 03°11.7'W	HedMac.Mare
441	25	Chapelcross site 62, Zone 1.	NY 228 630	54°57.3'N 03°12.3'W	BatCor
441	26	Chapelcross site 63, Zone 1.	NY 211 629	54°57.2'N 03°13.9'W	HedMac.Pyg
441	27	Chapelcross site 64, Zone 1.	NY 195 619	54°56.7'N 03°15.4'W	HedMac

Sublittoral sites					
<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude/longitude</i>	<i>Biotores present</i>
479	1	Esk 1, Inner Solway Firth.	NY 305 654	54°58.6'N 03°05.1'W	MobRS
479	2	Esk 2, Inner Solway Firth.	NY 328 655	54°58.7'N 03°03.0'W	MobRS
479	3	Eden 1, Inner Solway Firth.	NY 318 615	54°56.6'N 03°03.8'W	MobRS
479	4	Eden 2, Inner Solway Firth.	NY 330 619	54°56.8'N 03°02.7'W	Ncir
479	5	Deep Channel 7, Inner Solway Firth.	NY 215 633	54°57.4'N 03°13.5'W	NcirBat
441	1	Chapelcross site 1, Zone 1.	NY 164 657	54°58.7'N 03°18.3'W	NcirBat
441	3	Chapelcross site 3, Zone 1.	NY 221 647	54°58.2'N 03°12.9'W	NcirBat
441	4	Chapelcross site 4, Zone 1.	NY 170 639	54°57.8'N 03°17.7'W	NcirBat
441	5	Chapelcross site 5, Zone 1.	NY 180 639	54°57.8'N 03°16.8'W	NcirBat
441	7	Chapelcross site 8, Zone 1.	NY 206 640	54°57.8'N 03°14.4'W	NcirBat
441	11	Chapelcross site 12, Zone 1.	NY 188 635	54°57.5'N 03°16.0'W	NcirBat
441	12	Chapelcross site 13, Zone 1.	NY 200 629	54°57.3'N 03°14.9'W	Mob
441	15	Chapelcross site 16, Zone 1.	NY 170 619	54°56.7'N 03°17.7'W	NcirBat

Compiled by: Roger Covey

Wigtown and Kirkcudbright Bays

Location

<i>Position (centre)</i>	NX 650 430	54°40'N 04°5'W
<i>Administrative area</i>	Dumfries and Galloway	
<i>Conservation agency/area</i>	Scottish Natural Heritage	Dumfries and Galloway

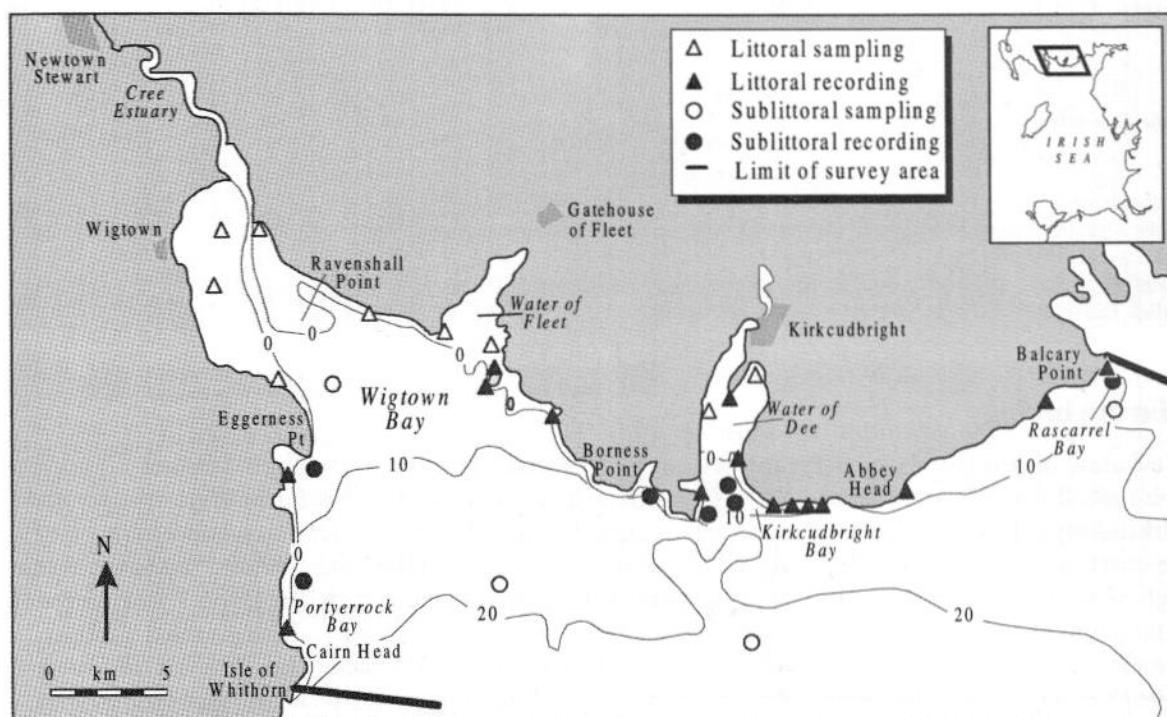


Figure 11.1 Location of area showing sites surveyed and main bathymetric features.

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Marine biological surveys

	<i>Survey method</i>	<i>Date of survey</i>	<i>Source</i>
<i>Littoral</i>	Recording, core sampling	September 1989	Covey (1990)
	Recording, core sampling	June 1991	Covey & Emblow (1992)
	Recording, core sampling	August 1991	Covey & Emblow (1992)
<i>Sublittoral</i>	Recording and anchor dredging	July 1990	Covey (1992)

Introduction

This area includes the coastline between the Isle of Whithorn in the west and Balcarry Point in the east, and encompasses the substantial embayment of Wigtown Bay with the Cree estuary and the smaller Water of Dee and Water of Fleet estuaries. Much of the surrounding land is agricultural, with towns at Newton Stewart at the head of Wigtown Bay and Kirkcudbright on the Dee. The coastline is generally low-lying, with roads in close proximity to the shore.

Much of the extensive intertidal area consists of sediment flats, particularly of muddy fine sand within the estuaries, while around the open coast the intertidal zone is narrow and composed of bedrock and boulders. Subtidally, sediments predominate, apart from a narrow strip of rock in the sublittoral fringe and shallow infralittoral adjacent to rocky intertidal sites. This ends abruptly, often at about 4 m depth, and leads to an extensive plain of sediment, generally muddy, fine sand in the estuaries or fine sands on the open coast.

Physical features	
<i>Physiographic type</i>	Embayments with estuaries; open coast
<i>Length of coast</i>	110 km
<i>Area of inlet</i>	Dee estuary 1,144 ha Water of Fleet 790 ha Cree estuary 4,727 ha
<i>Length of inlet</i>	Dee estuary 11.7 km Water of Fleet 7.2 km Cree estuary 23.2 km
<i>Bathymetry</i>	Less than 20 m within 3 km offshore
<i>Wave exposure range</i>	Moderately exposed to extremely sheltered
<i>Tidal stream range</i>	Moderate to negligible
<i>Tidal range</i>	6.7 m
<i>Salinity range</i>	Full to low

Marine biology

Most areas of bedrock shore in the area are on the open coast east of Kirkcudbright between Gypsy Point and Balcarry Point or around the entrance to inlets such as the Water of Fleet, Wigtown Bay and Kirkcudbright Bay. The geology of the area is such that vertical beds of rock run parallel to much of the coast, so that rocky shores are rugged, with numerous ridges, gullies and crevices. This results in a high number of intertidal biotopes being present. Rocky shores on the open coast have a wide range of communities in conditions of moderate wave exposure and near full salinity. In these areas a full zonation pattern is present, with a yellow and grey lichen zone (YG), black lichen *Verrucaria maura* zone (Ver.Ver), channelled wrack *Pelvetia canaliculata* zone (Pel), spiral wrack *Fucus spiralis* zone (Fspi), bladder wrack *Fucus vesiculosus* zone (Fves) and serrated wrack *Fucus serratus* zone (Fser.Fser), ending in the sublittoral fringe with forests of kelp *Laminaria digitata* (Ldig.Ldig). The richness of these shores is increased by the varied geology, with some sites having vertically bedded layers giving shores numerous vertical faces and horizontal ledges, and small rockpools dominated by coralline algae. Other areas have rock layers which are perpendicular to the shore, leading to numerous gullies and fissures, though still with the biotopes outlined above.

Isolated areas of mixed ground are present in some parts of the inlets, extending over the upper and mid-shore. These areas are predominantly a feature of the south-eastern shores of Wigtown Bay and Kirkcudbright Bay. Here a sparse community of mussels *Mytilus edulis*, barnacles, the periwinkles *Littorina saxatilis* and *Littorina littorea* and the green alga *Enteromorpha* sp. is present (MytX). Small areas of boulder shore occur on the open coast, where they are mobile during winter storms, resulting in a scoured community of sparse barnacles (FvesB; BLit). On the open coast, at Abbey Burn Foot east of Kirkcudbright, localised areas of shelter from wave action coincide with the presence of mixed substrata on the lower shore and support an extremely rich community of sponges, hydroids and ascidians.

The dominant littoral marine habitat within the area is sediment, with extensive intertidal mud and sandflats in the inlets where rocky substrata are limited to the upper shore. Within the inlets the littoral fringe is an extensive area of saltmarsh, backed by low-lying grazing land. Below the saltmarsh are extensive intertidal flats of muddy, often soft, fine sand. These sediment flats are dominated by communities of the lugworm *Arenicola marina* and the Baltic tellin *Macoma balthica* and polychaetes (MacAre) in the middle sections of the estuaries. In the inner sections, where soft mud occurs, a

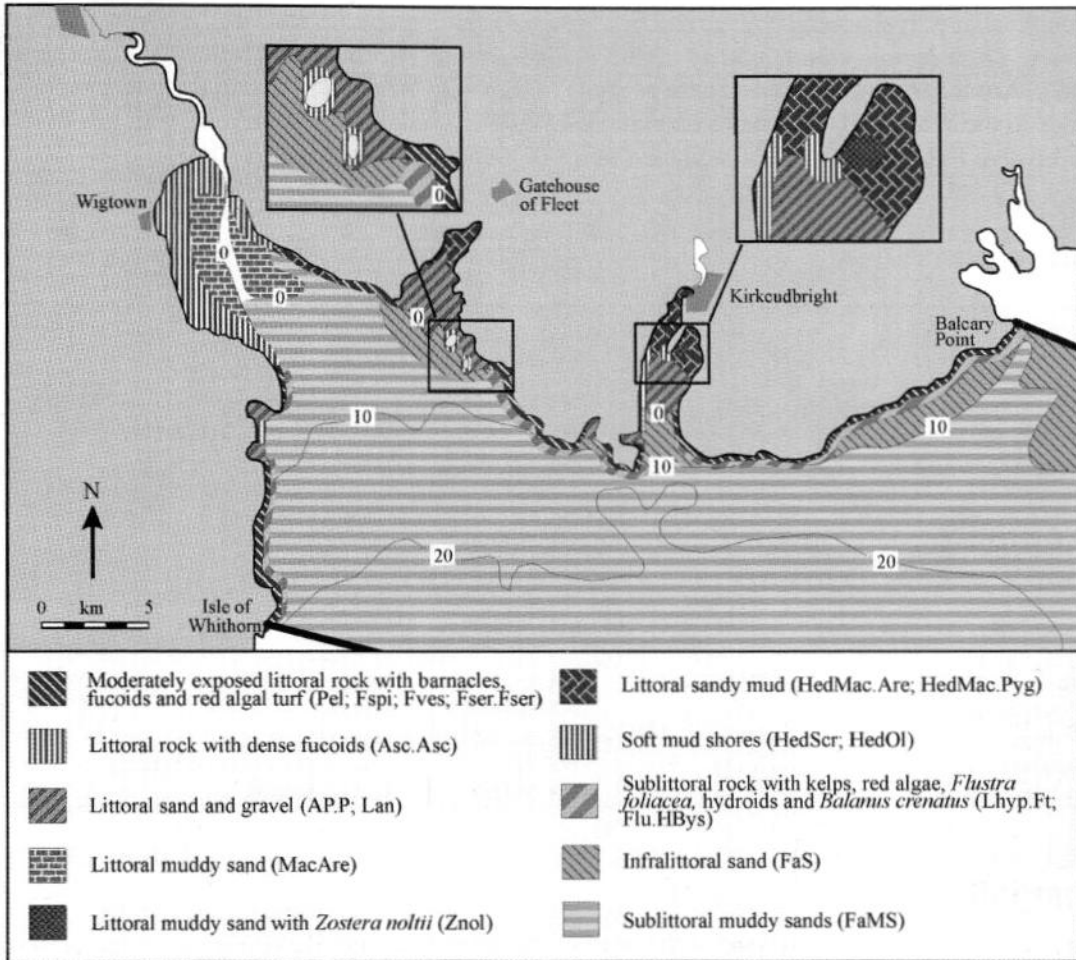


Figure 11.2 Indicative distribution of the main biotopes in the area (based on data from the sites shown in Figure 11.1, additional field observations and cited literature).
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community of ragworm *Hediste diversicolor* and peppery furrow shell *Scrobicularia plana* is present (HedScr, HedOl). Beds of seagrass *Zostera* sp. occur in Manxman's Lake, Water of Dee (Znol).

Bedrock around the shores does not extend far into the sublittoral zone, with the rock/sediment interface occurring at a maximum depth of 4 m. The sublittoral communities are frequently impoverished due to silt deposition and water turbidity, being richest where there is most water movement, such as at the mouth of the Water of Dee. Here stable boulders and outcrops of bedrock are colonised by the kelps *Laminaria hyperborea* and *Laminaria saccharina* and the bootlace weed *Chorda filum* with a dense understorey of red algae such as *Delesseria sanguinea*, *Membranoptera alata* and *Plocamium cartilagineum* (Lhyp.Ft; LsacChoR). On the open coast sublittoral rocky communities are frequently heavily silted, with low species richness. In shallow water, down to about 3 m depth, rock surfaces are colonised by a mixture of erect bryozoans and hydroids, including *Flustra foliacea*, *Alcyonidium diaphanum* and *Nemertesia* spp., and by a sparse growth of red algae such as *Delesseria sanguinea*, *Griffithsia flosculosa* and *Membranoptera alata* (AlcByH; Flu.HBys; FoR). These algae are not present below 3 m due to reduced light intensity but the rock supports a similar range of animal species to the community in shallower water.

Much of the sublittoral area is characterised by muddy sands. These sediments have rich infaunal communities of polychaetes, bivalves and brittlestars, including species such as the bivalve *Abra alba*, tubeworm *Lagis koreni*, common heart urchin *Echinocardium cordatum* and brittlestar *Ophiura albida* (FaMS). Around the wave exposed base of some of the rocky headlands, and in the tide-swept entrance to the Water of Dee, a more impoverished mobile sand biotope is present, with low numbers of the bivalve *Fabulina fabula* and a limited range of mobile epifaunal species (FaS).

Nature conservation

Conservation sites			
Site name	Designation	Centre grid ref.	Main features
Abbey Burn Foot to Balcary Point	SSSI	NX 790 469	Coastal habitats and flora, ornithology
Torrs to Mason's Walk	SSSI	NX 710 437	Geology, coastal habitats and flora
Shoulder O'Craig	SSSI	NX 663 491	Geology
Borgue Coast	SSSI	NX 610 457	Geology, coastal habitats, ornithology
Ravenshall Wood	SSSI	NX 510 531	Coastal woodland, invertebrates
Lower River Cree	SSSI	NX 413 649, NX 448 619	Fish
Cree Estuary	SSSI	NX 465 545	Coastal habitats, fish, ornithology
Cruggleton Bay	SSSI	NX 477 448, NX 479 448	Geology
Stewartry	ESA	NX 650 700	Landscape
East Stewartry Coast	NSA	NX 870 528	Scenery
Fleet Valley	NSA	NX 565 520	Scenery
Kirkcudbright	MoD	NX 705 455	Coastal and terrestrial habitats
Murray Isles	NTS	NX 562 501	Coastal habitats

Human influences

The main towns are Newton Stewart at the head of the River Cree and Kirkcudbright at the head of the Dee. Owing to sewage input and discharges from small factories in these towns there is some deterioration of water quality.

There is a small harbour at Kirkcudbright which provides yacht moorings and facilities for fishing boats and scallop dredgers. Most fishing in the immediate area is potting for lobsters *Homarus gammarus* and crabs *Cancer pagurus*, with scallop dredgers working well offshore in the Irish Sea. Oil exploration has been licensed in blocks to the south of this area.

References and further reading

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Sites surveyed

Survey 16: 1989 MNCR outer Solway Firth littoral survey (Covey 1990).

Survey 36: 1991 MNCR Dumfries and Galloway coast littoral survey (Covey & Emblow 1992).

Survey 41: 1990 MNCR outer Solway sublittoral survey (Covey 1992).

Survey 286: 1991 MNCR inner Solway littoral survey (Covey & Emblow 1992).

Littoral sites					
<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude/longitude</i>	<i>Biotopes present</i>
16	9	Portyerrock, Isle of Whithorn, N Solway.	NX 479 391	54°43.4'N 04°21.7'W	BPat.Cht; Fser.R; PelB; FK; Ldig.Ldig; Lhyp.Ft
16	10	Garlieston, N Solway.	NX 485 459	54°47.1'N 04°21.3'W	Fser.Fser.Bo; Pel; Fspi; Asc.Asc; AP.P; HedMac.Are; Ldig.Ldig.Bo
16	11	Crook of Baldoon, N Solway.	NX 459 533	54°51.0'N 04°24.0'W	MacAre; HedScr
16	12	Ardwall Sound, N Solway.	NX 575 497	54°49.3'N 04°13.0'W	Lan
16	13	S Ardwall Island, N Solway.	NX 573 492	54°49.0'N 04°13.2'W	YG; Ver.Ver; FvesB; Fser.Fser; Pel; Fspi; Asc.Asc; Ldig.Ldig
16	14	NW of Meggerland Point, Kirkcudbright Bay, N Solway.	NX 595 477	54°48.2'N 04°11.1'W	PelB; FvesB; Fser.R; Salv; FK; Ldig.Ldig
16	15	Meikle Ross, Kirkcudbright Bay, N Solway.	NX 656 435	54°46.1'N 04°05.3'W	YG; Ver.Ver; FvesB; Fser.Fser.Bo; Pel; AP.P; Ldig.Ldig.Bo
16	16	N Torrs Point, Kirkcudbright Bay, N Solway.	NX 673 453	54°47.0'N 04°03.8'W	YG; Ver.Ver; BPat.Sem; PelB; Fser.R; G; Cor
16	17	Abbey Burn Foot, Dundrennan, N Solway.	NX 743 445	54°46.7'N 03°57.2'W	BPat.Cht; Fser.Fser.Bo; Pel; Ldig.Ldig.Bo
16	18	Rascarrel Bay, Auchencairn, N Solway.	NX 803 480	54°48.7'N 03°51.7'W	BPat.Cht; Fser.Fser; MytFves; MytFR; Pel
36	5	Innerwell Fisheries, Wigtown Bay, Dumfries and Galloway.	NX 479 494	54°48.9'N 04°22.0'W	Ent; Pel; AscX; HedMac.Pyg
36	6	Wigtown Sands, Wigtown Bay, Dumfries and Galloway.	NX 468 560	54°52.5'N 04°23.2'W	Asc.VS; MacAre; HedScr; HedOI
36	7	Creetown Quay, Wigtown Bay, Dumfries and Galloway.	NX 473 563	54°52.6'N 04°22.8'W	Pel; Fspi; Asc.Asc; MytX; HedMac.Pyg
36	8	Ravenshall Point, Wigtown Bay, Dumfries and Galloway.	NX 524 523	54°50.6'N 04°17.9'W	YG; Ver.B; MytB; BPat.Cht; BPat.Sem; Lan
36	9	Mossyard Bay, Dumfries and Galloway.	NX 555 516	54°50.2'N 04°15.0'W	MytFves; Asc.VS; Rkp; Lan; HedScr
36	10	Murray's Isle to Craigmole Point, Dumfries and Galloway.	NX 568 510	54°49.9'N 04°13.7'W	YG; Ver.Ver; MytB; Pel; Fves; Asc.Asc; Cor; Lan
36	11	Brighthouse Bay, Dumfries and Galloway.	NX 633 453	54°47.0'N 04°07.5'W	YG; PelB; BPat.Sem; Fser.Fser.Bo; AP.P; Cor; Ldig.Ldig.Bo
36	12	Devil's Thrashing Floor/Milton Sands, Dumfries and Galloway.	NX 665 475	54°48.2'N 04°04.6'W	YG; Ver.Ver; Pel; Asc.Asc; Fves; H; MacAre

Littoral sites - continued

<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude/longitude</i>	<i>Biotopes present</i>
36	13	Tip of St Mary's Isle, Dumfries and Galloway.	NX 668 480	54°48.5'N 04°04.3'W	MytFves; Pel; Fspi; Asc.Asc; SwSed
36	14	Manxman's Lake, Kirkcudbright Bay, Dumfries and Galloway.	NX 680 490	54°49.1'N 04°03.2'W	Znol; HedScr
36	15	Gipsy Point, Dumfries and Galloway.	NX 684 436	54°46.1'N 04°02.7'W	YG; Ver.Ver; MytB; BPat.Cht; BPat.Sem; Ala.Ldig
36	16	Middle of Howell Bay, Dumfries and Galloway.	NX 695 437	54°46.2'N 04°01.7'W	YG; Ver.B; BPat.Sem; Fser.R; BLlit; FK; Ldig.Ldig
36	17	E of Howell Bay, Dumfries and Galloway.	NX 699 437	54°46.2'N 04°01.3'W	YG; Ver.B; BPat.Sem; Fser.R
36	18	Mullock Bay, Dumfries and Galloway.	NX 709 436	54°46.2'N 04°00.4'W	Ver.B; BPat.Cht; FvesB; Fser.R; Fspi; Cor; Ala.Ldig
286	28	Balcary Point, Inner Solway.	NX 829 493	54°49.4'N 03°49.3'W	YG; BPat.Sem; MytFves; MytFR; Pel; Cor

Sublittoral sites

<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude/longitude</i>	<i>Biotopes present</i>
41	16	Wreck of the "Jasper", North Solway.	NX 486 406	54°44.2'N 04°21.1'W	MarMu; Flu.HByS
41	17	Eggerness Point, North Solway.	NX 498 461	54°47.2'N 04°20.1'W	FaG; Flu.HByS
41	18	Wigtown Flats, North Solway.	NX 505 490	54°48.8'N 04°19.5'W	IMU
41	19	Wigtown Bay, North Solway.	NX 567 411	54°44.7'N 04°13.5'W	not recorded
41	20	Dunrod Point, North Solway.	NX 626 442	54°46.4'N 04°08.1'W	FaG; Flu.HByS; FoR
41	21	Meikle Sound, North Solway.	NX 657 436	54°46.1'N 04°05.2'W	Flu.HByS; LsacChoR
41	22	Offshore from Kirkcudbright Bay, North Solway.	NX 666 377	54°43.0'N 04°04.1'W	not recorded
41	23	Offshore from Balcary Point, North Solway.	NX 836 471	54°48.3'N 03°48.6'W	not recorded
41	24	Airds Point, North Solway.	NX 826 484	54°49.0'N 03°49.5'W	Flu.HByS; Lhyp.Ft; AlcByH
41	25	W of Gipsy Point, North Solway.	NX 678 440	54°46.4'N 04°03.3'W	Flu.HByS
41	26	SW of Torrs Point, North Solway.	NX 665 447	54°46.8'N 04°04.4'W	FaMS

Compiled by: Roger Covey

Location

<i>Position (centre)</i>	NX 240 400	54°45'N 4°45'W
<i>Administrative area</i>	Dumfries and Galloway	
<i>Conservation agency/area</i>	Scottish Natural Heritage	Dumfries and Galloway

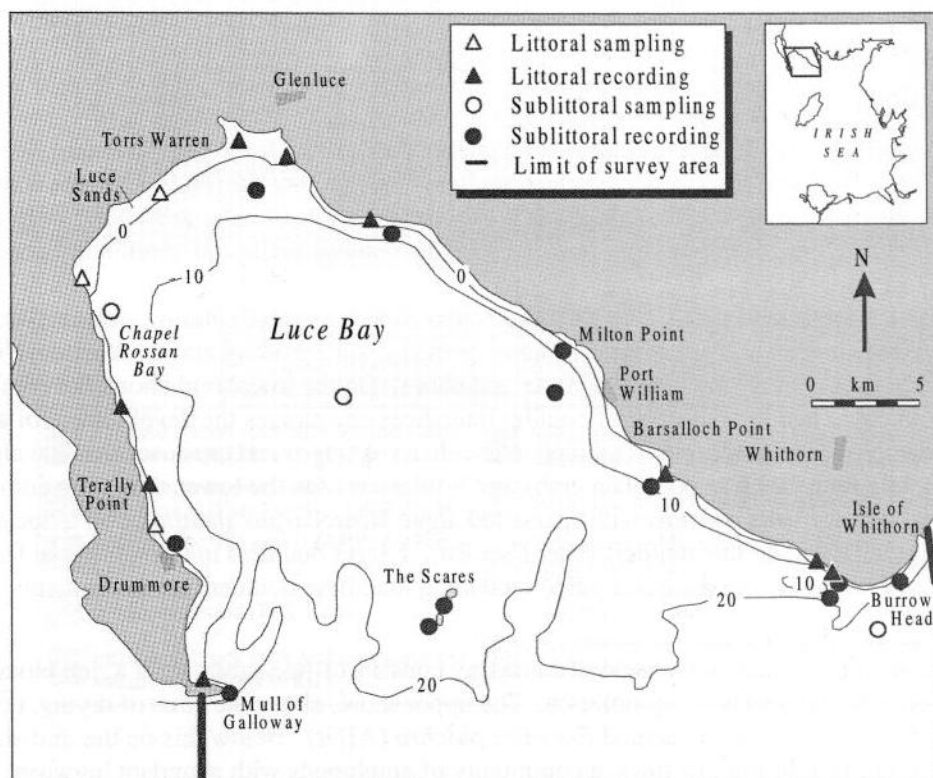


Figure 12.1 Location of area showing sites surveyed and main bathymetric features.

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Marine biological surveys

	<i>Survey method</i>	<i>Date of survey</i>	<i>Source</i>
<i>Littoral</i>	Recording and core sampling	September 1989	Covey (1990)
	Recording and core sampling	June 1991	Covey & Emblow (1992)
	Core sampling	June 1968	Eleftheriou & McIntyre (1976)
<i>Sublittoral</i>	Recording and anchor dredging	July 1990	Covey (1992)

Introduction

Luce Bay is encompassed by the tide-swept headlands of the Mull of Galloway and Burrow Head, and includes the offshore rocks known as the Scares which lie at the mouth of the Bay. Except for the cliffs of the headlands, much of the coast is low-lying, with an extensive intertidal area often composed of boulders. Much of the head of Luce Bay is characterised by sandy sediments, backed by sand dunes and scrub, while the headlands are composed of steep rock.

The area is predominantly rural, with scattered small villages around the edges of the Bay.

Physical features	
<i>Physiographic type</i>	Embayment
<i>Length of coast</i>	80 km
<i>Bathymetry</i>	20 m depth within about 1 km at the headlands; less than 20 m depth throughout the rest of the embayment
<i>Wave exposure range</i>	Moderately exposed to sheltered
<i>Tidal stream range</i>	Moderately strong at the headlands, weak elsewhere
<i>Tidal range</i>	5.3 m
<i>Salinity range</i>	Fully saline

Marine biology

Most of the intertidal area of the bay comprises small boulders, often resting on sediment, though frequently with spaces beneath and between the boulders which allow rich under-boulder communities to develop on the lower shores. These boulders are relatively stable, with in most cases only the smaller boulders moving around during winter storms. Here the supralittoral community consists of sparse yellow and grey lichens (YG) on the largest boulders, with no biota present on smaller, more mobile boulders, cobbles and pebbles. Below the lichen zone are sparse clumps of channelled wrack *Pelvetia canaliculata* (Pel) and spiral wrack *Fucus spiralis* (Fspi), grading into more extensive areas of bladder wrack *Fucus vesiculosus* (FvesX) in the mid-shore. On the lower mid-shore, the combination of dense fucoid cover and the presence of boulder interstices encourages the development of a rich biota. Here damp under-boulder surfaces support ascidians, sponges and crustose coralline algae, along with mobile fauna such as porcelain crabs and brittlestars. On the lower shore, the dominant alga is serrated wrack *Fucus serratus* with sparse red algae *Mastocarpus stellatus*, still associated with a rich fauna amongst and on the boulders (Fser.Fser.Bo). Larger boulders in the sublittoral fringe have sparse kelp *Laminaria digitata* (Ldig.Ldig.Bo) indicating that these boulders are infrequently moved by wave action.

The extensive sediment beach at the head of Luce Bay consists of fine sands, with a rich biota of crustaceans, polychaetes and bivalve molluscs. The upper shore, above the zone of drying, contains a sparse biota of amphipods and the isopod *Eurydice pulchra* (AEur). Below this on the mid-shore, where water is retained during low tides, a community of amphipods with abundant lugworm *Arenicola marina* is present, grading on the lower shore into a rich community of amphipods, polychaetes and bivalves (AP.Pon). The richest areas of the bay are where public access is controlled by Ministry of Defence military training activity. Bait-digging is minimal in this area, although it occurs on other sediment shores in Luce Bay.

Wave exposed rocky shores occur around the headlands of the Mull of Galloway and Burrow Head, with extensive lichen zones and a barnacle/*Patella*-dominated intertidal zone (Ver.Ver; PelB; BPat.Sem; Fser.R).

Subtidally much of the bay consists of sandflats, with a fringe of shallow sublittoral mixed boulders and sediment around the eastern and western sides of the bay. These mixed boulders and sediment harbour a shallow-water community of sparse kelp *Laminaria hyperborea* and sea oak *Halidrys siliquosa*, red algae and the dahlia anemone *Urticina felina*, typical of sand-influenced hard substrata (HalXK). This biotope extends into deeper water near the mouth of the bay where suitable rocky substrata are present. Around the fringes of the rocks, mobile sediment is present with extremely sparse biota due to the constant mobility. The fauna associated with this sediment consists of epifauna such as crabs and prawns, and juvenile lugworms *Arenicola marina* which settle during the comparative stability of the summer months (FaS; Lcon). Much of the central part of Luce Bay consists of deeper sediments which are not as mobile as the fringing sand. Within these sediments is a rich community of polychaetes, bivalves and brittlestars, particularly *Ophiura* spp. (EcorEns;

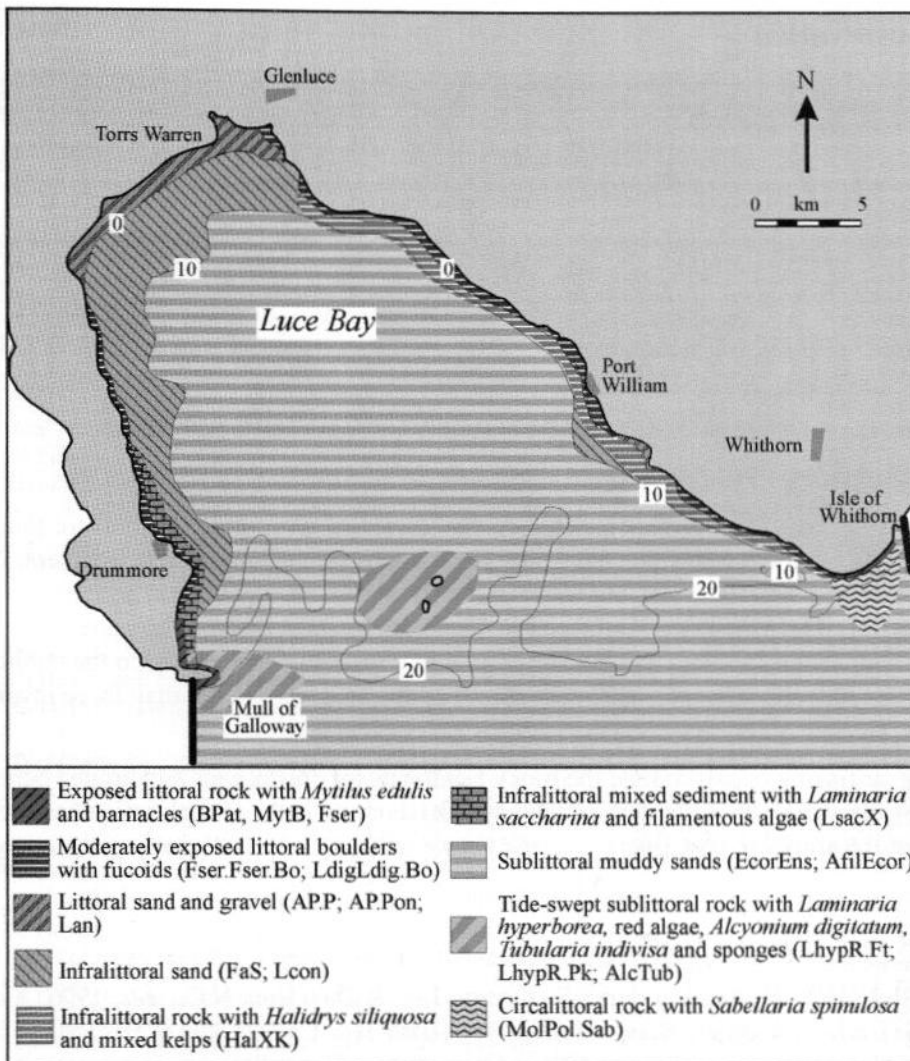


Figure 12.2 Indicative distribution of the main biotopes in the area (based on data from the sites shown in Figure 12.1, additional field observations and cited literature).

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AfilEcor). Also present at two sites is the holothurian *Labidoplax digitata*, a species not recorded during other surveys of MNCR Sector 11. Tide-swept rocky reefs are present around the Mull of Galloway and the Scares, with kelp *Laminaria hyperborea* (LhypR.Ft; LhypR.Pk) in the shallow sublittoral, grading into sponge and hydroid-dominated circalittoral bedrock (AlcTub) below about 10 m. These communities are very rich and are not recorded elsewhere in MNCR Sector 11. In the east of the area, off Burrow Head, a rich sublittoral community on tide-swept boulders is present, with reefs of the polychaete *Sabellaria spinulosa* and a very rich associated biota of hydroids, bryozoans and ascidians (MolPol.Sab). This community also is not recorded from any other site in MNCR Sector 11, and is of particular note for its very high species richness for this biotope.

Nature conservation

Conservation sites			
Site name	Designation	Centre grid ref.	Main features
Isle of Whithorn Bay	SSSI	NX 476 363	Geology
West Burrow Head	SSSI	NX 452 341	Geology
Back Bay to Carghidown	SSSI	NX 400 367	Geology, botanical, coastal habitats and flora, ornithology
Torrs Warren - Luce Sands	cSAC, SSSI	NX 140 545	Dune habitats
Scare Rocks	SSSI, RSPB	NX 258 333	Ornithology
Mull of Galloway	SSSI, RSPB	NX 115 315	Ornithology, coastal habitats and flora
West Freugh	MoD	NX 135 545	Dune habitats

Human influences

Only limited coastal development occurs close to the foreshore, with some facilities for tourists. These include camp and caravan sites which have only limited effect on the marine environment. Some sewage is discharged directly to sea, but water exchange within the bay is good and there is no noticeable impact. The Ministry of Defence run a gunnery range at the head of Luce Bay. This has little negative impact on the biota, but has the benefit of creating an area closed to the public and therefore suffers little disturbance. Sediment shores in this area were richer than those in areas open to the public.

Some static gear fishing occurs around the rocky headlands for crustaceans and limited benthic trawling takes place over the sediments of the bay. Offshore oil and gas exploration has been licensed to the south of the area.

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Sites surveyed

Survey 16: 1989 MNCR outer Solway Firth littoral survey (Covey 1990).

Survey 36: 1991 MNCR Dumfries and Galloway coast littoral survey (Covey & Emblow 1992).

Survey 41: 1990 MNCR outer Solway sublittoral survey (Covey 1992).

Survey 326: 1965-70 DAFS Scottish sandy shore survey (Eleftheriou & McIntyre 1976).

Littoral sites					
<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude/longitude</i>	<i>Biotopes present</i>
16	1	East Tarbet, Mull of Galloway, N Solway.	NX 146 309	54°38.3'N 04°52.3'W	Ver.Ver; FvesB; Fser.Fser.Bo; Pel; Fspi; Cor; Ldig.Ldig.Bo
16	2	E of Garrochtrie, Mull of Galloway, N Solway.	NX 131 388	54°42.5'N 04°54.0'W	Fser.Fser.Bo; AscX; AP.P
16	3	Terally Point, N Solway.	NX 127 405	54°43.4'N 04°54.5'W	FvesB; BLlit; AP.P
16	4	Logan Mills, N Solway.	NX 119 436	54°45.1'N 04°55.3'W	BPat.Sem; Fser.Fser.Bo; Pel; Asc.Asc; AP.P; Ldig.Ldig; Lhyp.Ft
16	5	Sandhead, Rhinns of Galloway, N Solway.	NX 101 495	54°48.2'N 04°57.3'W	Fser.Pid; FvesX; FserX; AP.P; Lan
16	6	St Helena golf links, N Solway.	NX 178 557	54°51.7'N 04°50.3'W	Pel; FvesX; AP.P
16	7	Cock Inn caravan site, N Solway.	NX 238 514	54°49.5'N 04°44.5'W	Fser.Fser.Bo; Pel; Fspi; FvesB; G
16	8	Port Castle Bay, Isle of Whithorn, N Solway.	NX 425 357	54°41.4'N 04°26.6'W	BPat.Sem; Fser.Fser.Bo; BLlit; Ldig.Ldig.Bo
36	1	Luce Sands (centre), Luce Bay, Dumfries and Galloway.	NX 127 526	54°49.9'N 04°54.9'W	AP.P; EcorEns
36	2	Crow's Nest, Luce Bay, Dumfries and Galloway.	NX 203 533	54°50.5'N 04°47.9'W	Salv; Fspi; Asc.Asc; MytX; Pel; AP.Pon
36	3	Point of Lagg, Luce Bay, Dumfries and Galloway.	NX 362 395	54°43.4'N 04°32.6'W	BPat.Sem; Fser.Fser.Bo; Pel; FK; Ala.Ldig
36	4	SE of Port Castle Bay, Dumfries and Galloway.	NX 428 356	54°41.4'N 04°26.3'W	YG; BPat.Sem; PelB; Fser.R; FK
326	21	Sandhead, Luce Bay.	NX 108 508	54°48.9'N 04°56.7'W	AP.P; AP.Pon; PCer

Sublittoral sites					
<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude/longitude</i>	<i>Biotopes present</i>
41	1	Offshore Burrow Head, North Solway.	NX 457 317	54°39.4'N 04°23.5'W	CMX
41	2	Burrow Head, North Solway.	NX 461 338	54°40.5'N 04°23.1'W	MolPol.Sab
41	3	Off Point of Lagg, North Solway.	NX 360 390	54°43.1'N 04°32.7'W	HalXX
41	4	SW of Port William, North Solway.	NX 316 410	54°44.1'N 04°36.9'W	Lcon
41	5	Between Milton Point and Port William, North Solway.	NX 327 450	54°46.3'N 04°36.0'W	HalXX; EcorEns
41	6	Big Scare, North Solway.	NX 256 332	54°39.8'N 04°42.1'W	LhypR.Ft; LhypR.Pk
41	7	Garheugh Port, North Solway.	NX 254 507	54°49.2'N 04°43.0'W	HalXX; AfilEcor
41	8	SW of Mull of Sinniness, Luce Bay, North Solway.	NX 182 508	54°49.1'N 04°49.7'W	AfilEcor
41	9	Off Sandhead Bay, Luce Bay, North Solway.	NX 124 473	54°47.1'N 04°55.0'W	AfilEcor
41	10	E of Balgown Point, Luce Bay, North Solway.	NX 214 436	54°45.3'N 04°46.5'W	AfilEcor
41	11	S of Little Scares, Luce Bay, North Solway.	NX 265 344	54°40.5'N 04°41.4'W	AlcTub
41	12	Drummore Bay, North Solway.	NX 134 378	54°42.0'N 04°53.7'W	LsacX

Sublittoral sites - continued

<i>Survey</i>	<i>Site</i>	<i>Place</i>	<i>Grid reference</i>	<i>Latitude/longitude</i>	<i>Biotopes present</i>
41	13	Mull of Galloway, North Solway.	NX 161 307	54°38.2'N 04°50.9'W	FoR; AlcTub
41	14	W of Burrow Head, North Solway.	NX 427 344	54°40.8'N 04°26.4'W	FaS
41	15	NW of Burrow Head, North Solway.	NX 429 347	54°41.0'N 04°26.1'W	MolPol.Sab

Compiled by: Roger Covey

Appendix A

Biotopes classification

A hierarchical classification of the biotopes present in MNCR Sector 11 (Liverpool Bay and the Solway Firth) (using the data listed in Table 1), shown together with their higher types, is given below. The biotopes listed are derived from the MNCR national biotope classification (Connor *et al.* 1997a, b).

Higher code	Biotope code	Biotope
LR		LITTORAL ROCK (and other hard substrata)
LR.L		Lichens or algal crusts
LR.L	YG	Yellow and grey lichens on supralittoral rock
LR.L	Ver	<i>Verrucaria maura</i> on littoral fringe rock
LR.L	Ver.Por	<i>Verrucaria maura</i> and <i>Porphyra umbilicalis</i> on very exposed littoral fringe rock
LR.L	Ver.B	<i>Verrucaria maura</i> and sparse barnacles on exposed littoral fringe rock
LR.L	Ver.Ver	<i>Verrucaria maura</i> on moderately exposed to very sheltered upper littoral fringe rock
ELR		Exposed littoral rock (mussel/barnacle shores)
ELR.MB		<i>Mytilus</i> (mussels) and barnacles
ELR.MB	MytB	<i>Mytilus edulis</i> and barnacles on very exposed eulittoral rock
ELR.MB	BPat	Barnacles and <i>Patella</i> spp. on exposed or moderately exposed, or vertical sheltered, eulittoral rock
ELR.MB	BPat.Cht	<i>Chthamalus</i> spp. on exposed upper eulittoral rock
ELR.MB	BPat.Lic	Barnacles and <i>Lichina pygmaea</i> on steep exposed upper eulittoral rock
ELR.MB	BPat.Cat	<i>Catenella caespitosa</i> on overhanging, or shaded vertical, upper eulittoral rock
ELR.MB	BPat.Sem	<i>Semibalanus balanoides</i> on exposed or moderately exposed, or vertical sheltered, eulittoral rock
MLR		Moderately exposed littoral rock (barnacle/furoid shores)
MLR.BF		Barnacles and furoids (moderately exposed shores)
MLR.BF	PelB	<i>Pelvetia canaliculata</i> and barnacles on moderately exposed littoral fringe rock
MLR.BF	FvesB	<i>Fucus vesiculosus</i> and barnacle mosaics on moderately exposed mid eulittoral rock
MLR.BF	Fser	<i>Fucus serratus</i> on moderately exposed lower eulittoral rock
MLR.BF	Fser.R	<i>Fucus serratus</i> and red seaweeds on moderately exposed lower eulittoral rock

Higher code	Biotope code	Biotope
MLR.BF	Fser.Fser	Dense <i>Fucus serratus</i> on moderately exposed to very sheltered lower eulittoral rock
MLR.BF	Fser.Fser.Bo	<i>Fucus serratus</i> and under-boulder fauna on lower eulittoral boulders
MLR.BF	Fser.Pid	<i>Fucus serratus</i> and piddocks on lower eulittoral soft rock
MLR.R		Red seaweeds (moderately exposed shores)
MLR.R	XR	Mixed red seaweeds on moderately exposed lower eulittoral rock
MLR.Eph		Ephemeral green or red seaweeds (freshwater or sand-influenced)
MLR.Eph	Ent	<i>Enteromorpha</i> spp. on freshwater-influenced or unstable upper eulittoral rock
MLR.Eph	EntPor	<i>Porphyra purpurea</i> or <i>Enteromorpha</i> spp. on sand-scoured mid or lower eulittoral rock
MLR.Eph	Rho	<i>Rhodothamniella floridula</i> on sand-scoured lower eulittoral rock
MLR.MF		Mytilus (mussels) and furoids (moderately exposed shores)
MLR.MF	MytFves	<i>Mytilus edulis</i> and <i>Fucus vesiculosus</i> on moderately exposed mid eulittoral rock
MLR.MF	MytFR	<i>Mytilus edulis</i> , <i>Fucus serratus</i> and red seaweeds on moderately exposed lower eulittoral rock
MLR.MF	MytPid	<i>Mytilus edulis</i> and piddocks on eulittoral firm clay
MLR.Sab		Littoral Sabellaria (honeycomb worm) reefs
MLR.Sab	Salv	<i>Sabellaria alveolata</i> reefs on sand-abraded eulittoral rock
SLR		Sheltered littoral rock (furoid shores)
SLR.F		Dense furoids (stable rock)
SLR.F	Pel	<i>Pelvetia canaliculata</i> on sheltered littoral fringe rock
SLR.F	Fspi	<i>Fucus spiralis</i> on moderately exposed to very sheltered upper eulittoral rock
SLR.F	Fves	<i>Fucus vesiculosus</i> on sheltered mid eulittoral rock
SLR.F	Asc	<i>Ascophyllum nodosum</i> on very sheltered mid eulittoral rock
SLR.F	Asc.Asc	<i>Ascophyllum nodosum</i> on full salinity mid eulittoral rock
SLR.F	Asc.VS	<i>Ascophyllum nodosum</i> and <i>Fucus vesiculosus</i> on variable salinity mid eulittoral rock
SLR.FX		Furoids, barnacles or ephemeral seaweeds (mixed substrata)
SLR.FX	BLlit	Barnacles and <i>Littorina littorea</i> on unstable eulittoral mixed substrata
SLR.FX	FvesX	<i>Fucus vesiculosus</i> on mid eulittoral mixed substrata

<i>Higher code</i>	<i>Biotope code</i>	<i>Biotope</i>
SLR.FX	AscX	<i>Ascophyllum nodosum</i> on mid eulittoral mixed substrata
SLR.FX	FserX	<i>Fucus serratus</i> on lower eulittoral mixed substrata
SLR.FX	FserX.T	<i>Fucus serratus</i> with sponges, ascidians and red seaweeds on tide-swept lower eulittoral mixed substrata
SLR.FX	EphX	Ephemeral green and red seaweeds on variable salinity or disturbed eulittoral mixed substrata
SLR.FX	FcerX	<i>Fucus ceranoides</i> on reduced salinity eulittoral mixed substrata
SLR.MX		<i>Mytilus</i> (mussel) beds (mixed substrata)
SLR.MX	MytX	<i>Mytilus edulis</i> beds on eulittoral mixed substrata
Littoral rock (other)		
LR.Rkp		Rockpools
LR.Rkp	G	Green seaweeds (<i>Enteromorpha</i> spp. and <i>Cladophora</i> spp.) in upper shore rockpools
LR.Rkp	Cor	<i>Corallina officinalis</i> and coralline crusts in shallow eulittoral rockpools
LR.Rkp	FK	Fucoids and kelps in deep eulittoral rockpools
LR.Rkp	SwSed	Seaweeds in sediment (sand or gravel)-floored eulittoral rockpools
LR.Rkp	H	Hydroids, ephemeral seaweeds and <i>Littorina littorea</i> in shallow eulittoral mixed substrata pools
LR.Ov		Overhangs and caves
LR.Ov	SR	Sponges and shade-tolerant red seaweeds on overhanging lower eulittoral bedrock
LR.Ov	SByAs	Sponges, bryozoans and ascidians on deeply overhanging lower shore bedrock
LS		LITTORAL SEDIMENTS
LGS		Littoral gravels and sands
LGS.Sh		Shingle (pebble) and gravel shores
LGS.Sh	BarSh	Barren shingle or gravel shores
LGS.S		Sand shores
LGS.S	BarSnd	Barren coarse sand shores
LGS.S	AEur	Burrowing amphipods and <i>Eurydice pulchra</i> in well-drained clean sand shores

Higher code	Biotope code	Biotope
LGS.S	AP	Burrowing amphipods and polychaetes in clean sand shores
LGS.S	AP.P	Burrowing amphipods and polychaetes (often with <i>Arenicola marina</i>) in clean sand shores
LGS.S	AP.Pon	Burrowing amphipods <i>Pontocrates</i> spp. and <i>Bathyporeia</i> spp. in lower shore clean sand
LGS.S	Lan	Dense <i>Lanice conchilega</i> in tide-swept lower shore sand
LGS.Est		Estuarine coarse sediment shores
LGS.Est	Ol	Oligochaetes in reduced or low salinity gravel or coarse sand shores
LMS		Littoral muddy sands
LMS.MS		Muddy sand shores
LMS.MS	BatCor	<i>Bathyporeia</i> spp. and <i>Corophium</i> spp. in upper shore slightly muddy fine sands
LMS.MS	PCer	Polychaetes and <i>Cerastoderma edule</i> in fine sand and muddy sand shores
LMS.MS	MacAre	<i>Macoma balthica</i> and <i>Arenicola marina</i> in muddy sand shores
LMS.MS	MacAre.Mare	<i>Arenicola marina</i> , <i>Macoma balthica</i> and <i>Mya arenaria</i> in muddy sand shores
LMS.Zos		Littoral <i>Zostera</i> (seagrass) beds
LMS.Zos	Znol	<i>Zostera noltii</i> beds in upper to mid shore muddy sand
LMU		Littoral muds
LMU.Sm		Saltmarsh
LMU.Sm	NVC SM8	<i>Salicornia</i> spp.
LMU.SMu		Sandy mud shores
LMU.SMu	HedMac	<i>Hediste diversicolor</i> and <i>Macoma balthica</i> in sandy mud shores
LMU.SMu	HedMac.Are	<i>Hediste diversicolor</i> , <i>Macoma balthica</i> and <i>Arenicola marina</i> in muddy sand or sandy mud shores
LMU.SMu	HedMac.Pyg	<i>Hediste diversicolor</i> , <i>Macoma balthica</i> and <i>Pygospio elegans</i> in sandy mud shores
LMU.SMu	HedMac.Mare	<i>Hediste diversicolor</i> , <i>Macoma balthica</i> and <i>Mya arenaria</i> in sandy mud shores
LMU.Mu		Soft mud shores
LMU.Mu	HedScr	<i>Hediste diversicolor</i> and <i>Scrobicularia plana</i> in reduced salinity mud shores
LMU.Mu	HedStr	<i>Hediste diversicolor</i> and <i>Streblospio shrubsolii</i> in sandy mud or soft mud shores
LMU.Mu	HedOl	<i>Hediste diversicolor</i> and oligochaetes in low salinity mud shores

Higher code	Biotope code	Biotope
IR		INFRA-LITTORAL ROCK (and other hard substrata)
EIR		Exposed infralittoral rock
EIR.KFaR		Kelp with cushion fauna, foliose red seaweeds or coralline crusts (exposed rock)
EIR.KFaR	Ala	<i>Alaria esculenta</i> on sublittoral fringe bedrock
EIR.KFaR	Ala.Ldig	<i>Alaria esculenta</i> and <i>Laminaria digitata</i> on exposed sublittoral fringe bedrock
EIR.KFaR	LhypR	<i>Laminaria hyperborea</i> with dense foliose red seaweeds on exposed infralittoral rock
EIR.KFaR	LhypR.Ft	<i>Laminaria hyperborea</i> forest with dense foliose red seaweeds on exposed upper infralittoral rock
EIR.KFaR	LhypR.Pk	<i>Laminaria hyperborea</i> park with dense foliose red seaweeds on exposed lower infralittoral rock
EIR.KFaR	FoR	Foliose red seaweeds on exposed or moderately exposed lower infralittoral rock
EIR.SG		Robust faunal cushions and crusts (surge gullies & caves)
EIR.SG	CC	<i>Balanus crenatus</i> and/or <i>Pomatoceros triqueter</i> with spirorbid worms and coralline crusts on severely scoured infralittoral rock
EIR.SG	CC.Mob	Coralline crusts and crustaceans on mobile boulders or cobbles in surge gullies
MIR		Moderately exposed infralittoral rock
MIR.KR		Kelp with red seaweeds (moderately exposed rock)
MIR.KR	Ldig	<i>Laminaria digitata</i> on moderately exposed or tide-swept sublittoral fringe rock
MIR.KR	Ldig.Ldig	<i>Laminaria digitata</i> on moderately exposed sublittoral fringe rock
MIR.KR	Ldig.Ldig.Bo	<i>Laminaria digitata</i> and under-boulder fauna on sublittoral fringe boulders
MIR.KR	Lhyp	<i>Laminaria hyperborea</i> and foliose red seaweeds on moderately exposed infralittoral rock
MIR.KR	Lhyp.Ft	<i>Laminaria hyperborea</i> forest and foliose red seaweeds on moderately exposed upper infralittoral rock
MIR.SedK		Sand or gravel-affected or disturbed kelp and seaweed communities
MIR.SedK	LsacChoR	<i>Laminaria saccharina</i> , <i>Chorda filum</i> and dense red seaweeds on shallow unstable infralittoral boulders and cobbles
MIR.SedK	HalXK	<i>Halidrys siliquosa</i> and mixed kelps on tide-swept infralittoral rock with coarse sediment

Higher code	Biotope code	Biotope
Infralittoral rock (other)		
IR.FaSwV		Fauna and seaweeds (shallow vertical rock)
IR.FaSwV	AlcByH	<i>Alcyonium digitatum</i> and a bryozoan, hydroid and ascidian turf on moderately exposed vertical infralittoral rock
CR		CIRCALITTORAL ROCK (and other hard substrata)
ECR		Exposed circalittoral rock
ECR.Alc		<i>Alcyonium</i>-dominated communities (tide-swept/vertical)
ECR.Alc	AlcTub	<i>Alcyonium digitatum</i> with dense <i>Tubularia indivisa</i> and anemones on strongly tide-swept circalittoral rock
MCR.ByH		Bryozoan/hydroid turfs (sand-influenced)
MCR.ByH	Flu	<i>Flustra foliacea</i> and other hydroid/bryozoan turf species on slightly scoured circalittoral rock or mixed substrata
MCR.ByH	Flu.HByS	<i>Flustra foliacea</i> with hydroids, bryozoans and sponges on slightly tide-swept circalittoral mixed substrata
MCR.ByH	Flu.SerHyd	<i>Sertularia argentea</i> , <i>S. cupressina</i> and <i>Hydrallmania falcata</i> on tide-swept circalittoral cobbles and pebbles
MCR.ByH	Flu.Hocu	<i>Haliclona oculata</i> and <i>Flustra foliacea</i> with a rich faunal turf on tide-swept sheltered circalittoral boulders or cobbles
MCR.M		Mussel beds (open coast circalittoral rock/mixed substrata)
MCR.M	MytHAs	<i>Mytilus edulis</i> beds with hydroids and ascidians on tide-swept moderately exposed circalittoral rock
MCR.As		Ascidian communities (silt-influenced)
MCR.As	MolPol	<i>Molgula manhattensis</i> and <i>Polycarpa</i> spp. with erect sponges on tide-swept moderately exposed circalittoral rock
MCR.As	MolPol.Sab	Dense ascidians, bryozoans and hydroids on a crust of <i>Sabellaria spinulosa</i> on tide-swept circalittoral rock
SS		SUBLITTORAL SEDIMENTS
IGS		Infralittoral gravels and sands
IGS.FaG		Shallow gravel faunal communities
IGS.FaS		Shallow sand faunal communities
IGS.FaS	Mob	Sparse fauna in marine infralittoral mobile clean sand
IGS.FaS	NcirBat	<i>Nephtys cirrosa</i> and <i>Bathyporeia</i> spp. in infralittoral sand
IGS.FaS	Lcon	Dense <i>Lanice conchilega</i> and other polychaetes in tide-swept infralittoral sand

Higher code	Biotope code	Biotope
IGS.EstGS		Estuarine sublittoral gravels and sands
IGS.EstGS	MobRS	Sparse fauna in reduced salinity infralittoral mobile sand
IGS.EstGS	Ncir	<i>Nephtys cirrosa</i> and fluctuating salinity-tolerant fauna in reduced salinity infralittoral mobile sand
IMS		Infralittoral muddy sands
IMS.FaMS		Shallow muddy sand faunal communities
IMS.FaMS	EcorEns	<i>Echinocardium cordatum</i> and <i>Ensis</i> sp. in lower shore or shallow sublittoral muddy fine sand
CMS		Circalittoral muddy sands
CMS	AbrNucCor	<i>Abra alba</i> , <i>Nucula nitida</i> and <i>Corbula gibba</i> in circalittoral muddy sand or slightly mixed sediment
IMU		Infralittoral muds
IMU.MarMu		Shallow marine mud communities
CMU		Circalittoral muds
IMX		Infralittoral mixed sediments
IMX.KSw		<i>Laminaria saccharina</i> (sugar kelp) and filamentous seaweeds (mixed sediment)
IMX.KSw	LsacX	<i>Laminaria saccharina</i> , <i>Chorda filum</i> and filamentous red seaweeds on sheltered infralittoral sediment
CMX		Circalittoral mixed sediments

References

- Connor, D.W., Brazier, D.P., Hill, T.O., & Northen, K.O. 1997a. Marine Nature Conservation Review: marine biotope classification for Britain and Ireland. Volume 1. Littoral biotopes. Version 97.06. *JNCC Report*, No. 229.
- Connor, D.W., Dalkin, M.J., Hill, T.O., Holt, R.H.F., & Sanderson, W.G. 1997b. Marine Nature Conservation Review: marine biotope classification for Britain and Ireland. Volume 2. Sublittoral biotopes. Version 97.06. *JNCC Report*, No. 230.

Appendix B

Biotores present in each area

The biotores recorded in each area, using the data listed in Table 1, are summarised below; other biotores noted in the text but not shown here come from additional published sources listed in the individual area summaries. Biotope codes are given according to MNCR classification version 97.06 (Connor *et al.* 1997a, b).

Numbers refer to the area summaries as follows:

- | | |
|------------------|------------------------------------|
| 1. Colwyn Bay | 7. Duddon Sands |
| 2. River Dee | 8. West Cumbria |
| 3. River Mersey | 9. Southern Solway Firth |
| 4. River Ribble | 10. Inner Solway Firth |
| 5. Fylde coast | 11. Wigtown and Kirkcudbright Bays |
| 6. Morecambe Bay | 12. Luce Bay |

	Area	1	2	3	4	5	6	7	8	9	10	11	12
<i>Littoral rock</i>													
YG			•				•			•	•	•	•
Ver.Por										•			
Ver.B								•	•			•	
Ver.Ver			•								•	•	•
MytB									•		•	•	
BPat		•	•	•			•		•	•	•		
BPat.Cht								•		•		•	
BPat.Lic			•										
BPat.Cat								•			•	•	
BPat.Sem			•			•	•			•	•	•	•
PeIB											•	•	•
FvesB			•					•	•	•		•	•
Fser.R										•		•	•
Fser.Fser			•							•		•	
Fser.Fser.Bo												•	•
Fser.Pid													•
XR										•			
Eph										•			
Ent			•	•	•		•	•	•	•	•	•	
EntPor		•	•				•		•	•			
Rho								•		•			
MF			•	•									
MytFves		•		•		•		•	•	•	•	•	
MytFR							•			•		•	
MytPid							•						
Salv									•	•		•	•
Pel			•				•	•	•	•	•	•	•
Fspi			•	•			•		•	•	•	•	•
Fves			•				•		•	•	•	•	
Asc.Asc							•			•	•	•	•
Asc.VS									•	•	•	•	
BLlit						•	•	•	•	•	•	•	•
FvesX							•	•			•		•
AscX									•			•	•
FserX								•					•

	Area	1	2	3	4	5	6	7	8	9	10	11	12
FserX.T							•						
EphX					•				•	•	•		
FcerX							•		•				
MytX		•	•		•		•	•	•	•	•	•	•
Rkp			•						•			•	
G							•				•	•	•
Cor									•	•		•	•
FK										•		•	•
SwSed									•			•	
H								•	•			•	
SR			•						•		•		
SByAs			•										
<i>Littoral sediment</i>													
BarSh				•		•							
BarSnd								•					
AEur								•	•		•		
AP				•	•			•	•		•		
AP.P		•	•	•	•	•	•	•	•	•		•	•
AP.Pon				•		•				•			•
Lan		•	•	•	•	•					•	•	•
OI					•				•		•		
LMS							•						
BatCor					•		•	•	•		•		
PCer			•		•		•				•		•
MacAre			•	•	•		•	•	•	•	•	•	
MacAre.Mare											•		
Znol											•	•	
NVC SM8					•				•				
HedMac		•		•	•		•	•			•		
HedMac.Are				•			•	•	•	•	•	•	
HedMac.Pyg			•	•	•		•	•	•		•	•	
HedMac.Mare								•			•		
Mu									•				
HedScr			•		•			•	•		•	•	
HedStr									•				
HedOI				•	•		•	•	•		•	•	
<i>Sublittoral rock</i>													
Ala.Ldig												•	•
LhypR.Ft													•
LhypR.Pk													•
FoR										•		•	•
CC.Mob										•			
Ldig.Ldig									•	•		•	•
Ldig.Ldig.Bo									•	•		•	•
Lhyp.Ft										•		•	•
LsacChoR												•	
HalXK									•				•
AlcByH												•	
AlcTub													•
Flu.HByS												•	
Flu.SerHyd							•						
Flu.Hocu							•						
MytHAs							•						
MolPol.Sab													•

	Area	1	2	3	4	5	6	7	8	9	10	11	12
<i>Sublittoral sediment</i>													
FaG									•			•	
FaS										•			•
Mob											•		
NcirBat				•					•		•		
Lcon							•						•
MobRS											•		
Ncir											•		
FaMS							•			•		•	
EcorEns									•				•
SpSpi													
CMS							•						
AbrNucCor									•				
AfilEcor									•				•
IMU												•	
MarMu							•					•	
CMU							•						
LsacX													•
CMX							•						•

References

- Connor, D.W., Brazier, D.P., Hill, T.O., & Northen, K.O. 1997a. Marine Nature Conservation Review: marine biotope classification for Britain and Ireland. Volume 1. Littoral biotopes. Version 97.06. *JNCC Report*, No. 229.
- Connor, D.W., Dalkin, M.J., Hill, T.O., Holt, R.H.F., & Sanderson, W.G. 1997b. Marine Nature Conservation Review: marine biotope classification for Britain and Ireland. Volume 2. Sublittoral biotopes. Version 97.06. *JNCC Report*, No. 230.

Appendix C

Species recorded

All taxa recorded during the surveys given in Table 1 are listed below; records of species noted in the text but not shown here come from additional published sources noted in the individual area summaries. Species nomenclature follows Howson & Picton (1997); that for higher plants follows Stace (1991) and that for lichens follows Purvis *et al.* (1992).

Numbers refer to the *area summaries* as follows:

- | | |
|------------------|------------------------------------|
| 1. Colwyn Bay | 7. Duddon Sands |
| 2. River Dee | 8. West Cumbria |
| 3. River Mersey | 9. Southern Solway Firth |
| 4. River Ribble | 10. Inner Solway Firth |
| 5. Fylde coast | 11. Wigtown and Kirkcudbright Bays |
| 6. Morecambe Bay | 12. Luce Bay |

PORIFERA

Porifera indet.	6	<i>Sarsia eximia</i>	12
<i>Clathrina coriacea</i>	11	<i>Eudendrium</i> spp.	12
<i>Leucosolenia botryoides</i>	6, 8, 11, 12	<i>Eudendrium ramosum</i>	6
<i>Leucosolenia complicata</i>	6	<i>Garveia nutans</i>	6, 12
<i>Scypha ciliata</i>	6, 8, 9, 11, 12	<i>Hydractinia echinata</i>	6, 9, 11, 12
<i>Leuconia nivea</i>	12	<i>Calycella syringa</i>	6, 8, 9
<i>Grantia compressa</i>	9, 11, 12	<i>Grammaria abietina</i>	11
<i>Oscarella lobularis</i>	12	<i>Halecium</i> spp.	6
<i>Pachymatisma johnstonia</i>	12	<i>Halecium beanii</i>	6, 11
<i>Tethya aurantium</i>	12	<i>Halecium halecinum</i>	6, 8, 11
<i>Suberites carnosus</i>	9, 11, 12	<i>Halecium lankesteri</i>	6
<i>Suberites domuncula</i>	6, 12	<i>Halecium muricatum</i>	6
<i>Polymastia boletiformis</i>	12	<i>Halecium plumosum</i>	11
<i>Polymastia mamillaris</i>	12	<i>Hydranthea margarica</i>	6
<i>Cliona celata</i>	6, 11, 12	<i>Aglaophenia pluma</i>	8, 12
<i>Axinella infundibuliformis</i>	12	<i>Halopteris catharina</i>	9, 11
<i>Stelligera rigida</i>	11, 12	<i>Kirchenpaueria pinnata</i>	6, 8, 9, 11, 12
<i>Raspailia</i> spp.	12	<i>Kirchenpaueria similis</i>	11
<i>Raspailia ramosa</i>	12	<i>Nemertesia antennina</i>	6, 8, 11, 12
<i>Halichondria bowerbanki</i>	6, 12	<i>Nemertesia ramosa</i>	6, 11, 12
<i>Halichondria panicea</i>	2, 6, 8, 9, 11, 12	<i>Plumularia setacea</i>	6, 8, 9, 12
<i>Hymeniacionidon perleve</i>	6, 8, 9, 11, 12	<i>Abietinaria</i> spp.	6
<i>Mycale</i> spp.	6, 11	<i>Abietinaria abietina</i>	6, 10, 11, 12
<i>Esperiopsis fucorum</i>	6, 8, 11, 12	<i>Diphasia rosacea</i>	6, 12
<i>Myxilla incrustans</i>	6, 8, 12	<i>Dynamena pumila</i>	8, 9, 10, 11, 12
<i>Hemimycale columella</i>	12	<i>Hydrallmania falcata</i>	6, 8, 9, 11, 12
<i>Ophlitaspongia seriata</i>	9	<i>Sertularella gayi</i>	6, 12
<i>Haliclona</i> spp.	12	<i>Sertularella polyzonias</i>	11
<i>Haliclona oculata</i>	6, 9, 11, 12	<i>Sertularella rugosa</i>	6
<i>Haliclona simulans</i>	12	<i>Sertularia argentea</i>	6, 8, 9, 11, 12
<i>Haliclona urceolus</i>	12	<i>Sertularia cupressina</i>	6, 8, 11
<i>Dysidea fragilis</i>	6, 11, 12	Campanulariidae indet.	8
<i>Aplysilla</i> spp.	12	<i>Clytia hemisphaerica</i>	6, 9, 11
<i>Aplysilla sulfurea</i>	12	<i>Laomedea</i> spp.	3
<i>Halisarca dujardini</i>	6, 9, 11, 12	<i>Laomedea flexuosa</i>	1, 2, 3, 6, 7, 8
Porifera indet. (crusts)	6, 8, 9, 11, 12	<i>Obelia</i> spp.	6, 10, 11
CNIDARIA		<i>Obelia bidentata</i>	10
<i>Aurelia aurita</i>	12	<i>Obelia dichotoma</i>	6, 12
Hydrozoa indet.	8, 9, 10, 11	<i>Obelia geniculata</i>	6, 8, 9, 10, 11, 12
<i>Tubularia indivisa</i>	6, 9, 11, 12	<i>Obelia longissima</i>	4, 5, 6, 9, 11
<i>Tubularia larynx</i>	6, 9, 11, 12	<i>Obelia plicata</i>	11
<i>Coryne</i> spp.	6, 12	<i>Rhizocaulus verticillatus</i>	6, 11
<i>Sarsia</i> spp.	6, 8	Anthozoa indet.	8
		<i>Alcyonium digitatum</i>	6, 8, 9, 11, 12
		<i>Virgularia mirabilis</i>	8

<i>Cerianthus lloydii</i>	6, 8, 11, 12	<i>Eteone</i> spp.	3, 10
<i>Epizoanthus couchii</i>	12	<i>Eteone longa</i>	2, 3, 4, 5, 6, 7, 8, 9, 10, 11
Actinaria indet.	4	<i>Mysta picta</i>	2
<i>Actinia equina</i>	1, 2, 3, 6, 7, 8, 9, 10, 11, 12	<i>Anaitides groenlandica</i>	3, 8
<i>Actinia fragacea</i>	11, 12	<i>Anaitides maculata</i>	7
<i>Actinia prasina</i>	8, 9	<i>Anaitides mucosa</i>	1, 2, 3, 4, 8, 10
<i>Anemonia viridis</i>	12	<i>Anaitides rosea</i>	1, 8
<i>Urticina felina</i>	6, 8, 9, 11, 12	<i>Eulalia viridis</i>	8, 9, 11, 12
<i>Urticina eques</i>	11	<i>Eumida sanguinea</i>	1, 2, 3, 4
<i>Metridium senile</i>	1, 2, 3, 5, 6, 8, 9, 10, 11, 12	<i>Phyllodoce</i> spp.	1, 8
<i>Sagartia elegans</i>	6, 8, 9, 11, 12	<i>Glycera</i> spp.	4, 7
<i>Sagartia troglodytes</i>	1, 2, 3, 5, 6, 9, 11	<i>Glycera alba</i>	8
<i>Cereus pedunculatus</i>	2, 6, 10, 11	<i>Glycera rouxi</i>	8
<i>Actinothoe sphyrodeta</i>	11, 12	<i>Glycera tridactyla</i>	4, 5, 6, 8, 11
<i>Sagartiogeton</i> spp.	6, 11	<i>Glycinde nordmanni</i>	8
<i>Sagartiogeton laceratus</i>	6	<i>Goniada maculata</i>	8
<i>Sagartiogeton undatus</i>	6, 11, 12	<i>Sphaerodorum gracilis</i>	8
<i>Peachia cylindrica</i>	12	Hesionidae indet.	8
<i>Edwardsiella carnea</i>	12	<i>Ophiodromus flexuosus</i>	6, 8
<i>Caryophyllia smithii</i>	12	<i>Microphthalmus aberrans</i>	1, 2
PLATYHELMINTHES		<i>Microphthalmus listensis</i>	1
Platyhelminthes indet.	1	<i>Microphthalmus similis</i>	1
<i>Planaria</i> spp.	8	Syllidae indet.	8
NEMERTEA		<i>Syllis</i> spp.	6
Nemertea indet.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12	<i>Eusyllis blomstrandii</i>	8
Cephalothricidae indet.	11	<i>Exogone hebes</i>	8
<i>Tubulanus</i> spp.	12	<i>Autolytus langerhansi</i>	6
<i>Tubulanus annulatus</i>	8	Nereididae indet.	2, 9, 10
<i>Tubulanus polymorphus</i>	3, 4, 5, 11	<i>Hediste diversicolor</i>	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12
<i>Tubulanus superbus</i>	6	<i>Neanthes virens</i>	7
<i>Cerebratulus</i> spp.	3, 4, 10	<i>Nereis</i> spp.	7, 8, 9
<i>Lineus longissimus</i>	6, 8, 9, 11, 12	<i>Nereis longissima</i>	2, 8
<i>Emplectonema</i> spp.	2	<i>Nereis pelagica</i>	11
NEMATODA		<i>Nephtys</i> spp.	3, 4, 6, 8, 9, 10, 11, 12
Nematoda indet.	6, 9, 10	<i>Nephtys caeca</i>	4, 9
SIPUNCULA		<i>Nephtys cirrosa</i>	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12
<i>Golfingia margaritacea</i>	8	<i>Nephtys hombergii</i>	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
<i>Golfingia procera</i>	8	<i>Nephtys hombergii</i> var. <i>kersivalensis</i>	3, 4
ECHIURA		<i>Nephtys incisa</i>	8
<i>Amalosoma eddystonense</i>	8	<i>Nephtys longosetosa</i>	2, 5, 9
<i>Maxmuelleria lankesteri</i>	8	<i>Lumbrineris fragilis</i>	8
POLYCHAETA		<i>Lumbrineris gracilis</i>	6, 7, 8
Polychaeta indet.	6, 7, 8, 9, 11, 12	<i>Lumbrineris hibernica</i>	8
Polynoidae indet.	8	<i>Arabella iricolor</i>	8
<i>Gattyana cirrosa</i>	2, 8, 11	<i>Orbinia</i> spp.	11
<i>Harmothoe</i> spp.	1, 3, 6, 8, 9, 11, 12	<i>Orbinia sertulata</i>	8
<i>Harmothoe antilopes</i>	11	<i>Scoloplos armiger</i>	2, 6, 7, 8, 9, 10, 11, 12
<i>Harmothoe imbricata</i>	9, 11	<i>Aricidea minuta</i>	1, 8, 11
<i>Harmothoe ljunghmani</i>	12	<i>Levinsenia gracilis</i>	8, 9
<i>Harmothoe lunulata</i>	2, 3, 4, 5, 8	<i>Paradoneis lyra</i>	8
<i>Harmothoe marphysae</i>	9	<i>Paraonis fulgens</i>	1, 10
<i>Lepidonotus squamatus</i>	6, 8	<i>Poecilochaetus serpens</i>	8
<i>Pholoe</i> spp.	8	Spionidae indet.	1, 3, 8, 9
<i>Pholoe inornata</i>	2, 3, 7, 8	<i>Malacoceros fuliginosus</i>	2
<i>Sigalion mathildae</i>	3, 4, 9, 11, 12	<i>Malacoceros tetracerus</i>	9
<i>Sthenelais boa</i>	2	<i>Minuspio cirrifera</i>	8
<i>Sthenelais limicola</i>	8	<i>Polydora</i> spp.	1, 7, 8, 10, 11
Phyllodoceidae indet.	9	<i>Polydora ciliata</i>	3
		<i>Polydora ligni</i>	4, 10
		<i>Prionospio malmgreni</i>	8
		<i>Prionospio fallax</i>	8
		<i>Prionospio multibranchiata</i>	8

<i>Pseudopolydora pulchra</i>	8	<i>Eupolymnia nebulosa</i>	10, 12
<i>Pygospio elegans</i>	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12	<i>Lanice conchilega</i>	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
<i>Scolelepis</i> spp.	9	<i>Polycirrus</i> spp.	8
<i>Scolelepis mesnili</i>	6	Sabellidae indet.	5, 8, 12
<i>Scolelepis squamata</i>	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12	<i>Branchiomma bombyx</i>	6
<i>Scolelepis tridentata</i>	8	<i>Manayunkia aestuarina</i>	3, 4, 7, 8, 10, 11
<i>Spio</i> spp.	2, 8	<i>Myxicola infundibulum</i>	12
<i>Spio decorata</i>	12	<i>Pseudopotamilla reniformis</i>	6
<i>Spio filicornis</i>	6, 10	<i>Sabella pavonina</i>	6, 8, 12
<i>Spio martinensis</i>	1, 2, 3, 4, 8, 10, 11, 12	<i>Pomatoceros</i> spp.	7, 8, 9, 11, 12
<i>Spiophanes bombyx</i>	1, 2, 3, 4, 5, 6, 8, 10, 11, 12	<i>Pomatoceros lamarcki</i>	6, 9, 11, 12
<i>Spiophanes kroeyeri</i>	8	<i>Pomatoceros triqueter</i>	6, 8, 9, 11, 12
<i>Magelona</i> spp.	12	Spirorbidae indet.	11, 12
<i>Magelona alleni</i>	8	<i>Spirorbis</i> spp.	11, 12
<i>Magelona filiformis</i>	4, 7, 8, 10, 11	<i>Spirorbis corallinae</i>	12
<i>Magelona minuta</i>	1, 2, 8	<i>Spirorbis spirorbis</i>	12
<i>Magelona mirabilis</i>	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12	Oligochaeta indet.	4, 7, 8, 10, 11
<i>Chaetopterus variopedatus</i>	8, 12	<i>Clitellio arenarius</i>	2
<i>Caulleriella zetlandica</i>	2	<i>Tubifex costatus</i>	3, 4, 8, 10, 11
<i>Chaetozone setosa</i>	8	<i>Tubificoides</i> spp.	6
<i>Cirratulus</i> spp.	12	<i>Tubificoides benedii</i>	1, 2, 3, 4, 6, 7, 8, 9, 10, 11
<i>Cirratulus cirratus</i>	10	<i>Tubificoides pseudogaster</i>	2, 4, 7, 8, 11
<i>Cirriformia tentaculata</i>	8	<i>Monopylephorus rubroniveus</i>	10
<i>Tharyx</i> spp.	8	Enchytraeidae indet.	4, 7, 8, 10, 11
<i>Tharyx marioni</i>	1, 6, 8, 11	<i>Lumbricillus</i> spp.	3
<i>Tharyx vivipara</i>	1	PYCNOGONIDA	
<i>Psammodrilus balanoglossoides</i>	1, 2	Pycnogonida indet.	11, 12
<i>Diplocirrus glaucus</i>	8	<i>Nymphon brevirostre</i>	6
<i>Flabelligera affinis</i>	11	<i>Nymphon hirtum</i>	6
<i>Capitella</i> spp.	9, 10	<i>Achelia laevis</i>	6
<i>Capitella capitata</i>	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12	<i>Endeis</i> spp.	6, 8, 9
<i>Heteromastus filiformis</i>	8, 11	<i>Phoxichilidium femoratum</i>	6
<i>Mediomastus fragilis</i>	2, 7, 8	Pycnogonidae indet.	6, 8
<i>Notomastus latericeus</i>	8	<i>Pycnogonum littorale</i>	6
<i>Arenicola</i> spp.	6	Halacaridae indet.	6, 7, 8, 10
<i>Arenicola marina</i>	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	CRUSTACEA	
Maldanidae indet.	8, 10	Cirrapedia indet.	1, 4, 10, 11, 12
<i>Euclymene</i> spp.	8	<i>Verruca stroemia</i>	9, 11, 12
<i>Praxillella affinis</i>	8	<i>Chthamalus montagui</i>	7, 8, 9, 10, 11, 12
<i>Ophelia borealis</i>	2, 3	<i>Chthamalus stellatus</i>	9, 11, 12
<i>Ophelia limacina</i>	3	<i>Semibalanus balanoides</i>	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
<i>Ophelina acuminata</i>	8	<i>Balanus balanus</i>	8, 9, 11, 12
<i>Scalibregma inflatum</i>	8	<i>Balanus crenatus</i>	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
<i>Protodrilus</i> spp.	1	<i>Balanus improvisus</i>	4, 6
<i>Myriochele oculata</i>	8	<i>Elminius modestus</i>	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12
<i>Owenia fusiformis</i>	1, 2, 3, 4, 5, 8, 10, 11	Copepoda indet.	6
<i>Amphictene auricoma</i>	8	Mysidae indet.	6, 8, 10, 11, 12
<i>Lagis koreni</i>	3, 4, 8, 11	<i>Leptomysis gracilis</i>	11
<i>Pectinaria</i> spp.	8	<i>Neomysis integer</i>	7, 10
<i>Sabellaria</i> spp.	6	<i>Schistomysis kervillei</i>	10
<i>Sabellaria alveolata</i>	8, 9, 10, 11, 12	Amphipoda indet.	6, 7, 8, 9, 10, 11, 12
<i>Sabellaria spinulosa</i>	8, 11, 12	Gammaridea indet.	6, 9
Ampharetidae indet.	8	<i>Calliopius laeviusculus</i>	9
<i>Melinna cristata</i>	8	<i>Pericolodes longimanus</i>	8
<i>Melinna palmata</i>	8	<i>Pontocrates altamarinus</i>	1, 3, 4, 5,
<i>Ampharete</i> spp.	8, 10	<i>Pontocrates arenarius</i>	6, 8, 9, 12
<i>Ampharete grubei</i>	9	<i>Hyalé nilssoni</i>	9
<i>Ampharete lindstroemi</i>	8	<i>Orchestia gammarellus</i>	12
<i>Terebellides stroemi</i>	8	<i>Orchestia mediterranea</i>	10
<i>Trichobranchus glacialis</i>	8	<i>Talorchestia</i> spp.	9
Terebellidae indet.	6, 8, 11, 12		

<i>Urothoe elegans</i>	7	<i>Pandalus montagui</i>	6, 8, 9, 11, 12
<i>Harpinia antennaria</i>	8	<i>Crangon</i> spp.	9
<i>Harpinia pectinata</i>	8	<i>Crangon allmanni</i>	8, 10
<i>Orchomene nana</i>	8	<i>Crangon crangon</i>	3, 4, 6, 7, 8, 9, 10, 11, 12,
<i>Atylus swammerdami</i>	1, 3, 4, 9		12,
<i>Tritaeta gibbosa</i>	8	<i>Pontophilus trispinosus</i>	8
<i>Ampelisca brevicornis</i>	8	<i>Homarus gammarus</i>	6, 11, 12
<i>Ampelisca diadema</i>	8	<i>Jaxea nocturna</i>	8
<i>Ampelisca spinipes</i>	8	<i>Callianassa subterranea</i>	8
<i>Ampelisca tenuicornis</i>	8	<i>Upogebia</i> spp.	8
<i>Bathyporeia</i> spp.	6, 9, 10	<i>Anapagurus hyndmanni</i>	6, 12
<i>Bathyporeia elegans</i>	4, 6, 8, 9	<i>Pagurus</i> spp.	6
<i>Bathyporeia guilliamsoniana</i>	8	<i>Pagurus bernhardus</i>	4, 6, 8, 9, 10, 11, 12
<i>Bathyporeia pelagica</i>	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	<i>Pagurus cuanensis</i>	12
		<i>Pagurus prideaux</i>	8, 9
<i>Bathyporeia pilosa</i>	3, 4, 6, 7, 8, 10	<i>Pagurus pubescens</i>	12
<i>Bathyporeia sarsi</i>	7, 8, 9, 10, 12	<i>Galathea intermedia</i>	12
<i>Haustorius arenarius</i>	1, 3, 4, 5, 7, 8, 9, 10	<i>Galathea squamifera</i>	12
Gammaridae indet.	4, 6, 7, 8, 9, 10, 11, 12	<i>Pisidia longicornis</i>	1, 2, 6, 8, 9, 11, 12
<i>Echinogammarus marinus</i>	9	<i>Porcellana platycheles</i>	1, 6, 8, 11, 12
<i>Echinogammarus obtusatus</i>	8, 9	<i>Brachyura</i> indet.	8
<i>Gammarus locusta</i>	9	<i>Hyas araneus</i>	6, 8, 9
<i>Gammarus salinus</i>	9	<i>Hyas coarctatus</i>	6, 12
<i>Gammarus zaddachi</i>	7, 10, 11	<i>Inachus</i> spp.	6, 11
<i>Cheirocratus</i> spp.	8	<i>Inachus dorsettensis</i>	6, 8
<i>Melita</i> spp.	8	<i>Inachus phalangium</i>	12
<i>Melita palmata</i>	9	<i>Macropodia rostrata</i>	12, 6, 8, 9, 12
<i>Photis pollex</i>	8	<i>Corystes cassivelaunus</i>	8, 11, 12
<i>Erichthonius punctatus</i>	8	<i>Atelecyclus rotundatus</i>	12
<i>Jassa</i> spp.	6	<i>Cancer pagurus</i>	6, 8, 9, 11, 12
<i>Jassa falcata</i>	8	<i>Liocarcinus</i> spp.	11
<i>Jassa marmorata</i>	8	<i>Liocarcinus depurator</i>	1, 4, 6, 9, 11, 12,
<i>Parajassa pelagica</i>	11	<i>Liocarcinus holsatus</i>	6, 9
<i>Aora gracilis</i>	6	<i>Liocarcinus puber</i>	1, 6, 8, 9, 11, 12
<i>Lembos longipes</i>	8	<i>Liocarcinus pusillus</i>	12
<i>Corophium</i> spp.	5, 6, 7, 8, 9, 10, 11	<i>Carcinus maenas</i>	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
<i>Corophium arenarium</i>	4, 7, 8, 10		
<i>Corophium volutator</i>	1, 2, 3, 4, 6, 7, 8, 9, 10, 11	<i>Pilumnus hirtellus</i>	6, 12
		<i>Pinnotheres pisum</i>	4, 11
<i>Dyopedos porrectus</i>	6, 11, 12		
Caprellidae indet.	6, 8, 9, 11, 12	INSECTA	
<i>Pariambus typicus</i>	2	Insecta indet.	7, 8, 12
Isopoda indet.	4, 6, 8, 9, 12	Chironomida indet.	10
<i>Cyathura carinata</i>	6	<i>Collembola</i> spp.	4, 7, 8
<i>Eurydice pulchra</i>	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12	<i>Petrobius maritimus</i>	7
		<i>Bembidian laterale</i>	8
<i>Sphaeroma hookeri</i>	7	<i>Anurida maritima</i>	2, 6, 7, 8, 9, 10, 11, 12
<i>Sphaeroma monodi</i>	9		
<i>Sphaeroma rugicauda</i>	6, 7	MOLLUSCA	
<i>Jaera albifrons</i>	9	Mollusca indet.	10
<i>Idotea</i> spp.	8, 9, 11	Polyplacophora indet.	6, 7, 8, 9, 12
<i>Idotea granulosa</i>	8, 9	<i>Lepidochitona cinereus</i>	1, 6, 7, 8, 9, 12
<i>Idotea pelagica</i>	10, 11	<i>Tonicella</i> spp.	11
<i>Ligia oceanica</i>	8, 9, 11	<i>Tonicella rubra</i>	11
<i>Leptognathia</i> spp.	8	<i>Acanthochitona crinitus</i>	11
<i>Cumopsis goodsiri</i>	11, 12	Gastropoda indet.	4, 12
<i>Bodotria pulchella</i>	9	<i>Tectura testudinalis</i>	8, 9, 11, 12
<i>Bodotria scorpioides</i>	1, 8	<i>Tectura virginea</i>	8, 9, 12
<i>Eudorella truncatula</i>	8	<i>Patella</i> spp.	11
<i>Pseudocuma longicornis</i>	8, 11, 12	<i>Patella ulyssiponensis</i>	11, 12
<i>Diastylis bradyi</i>	1, 8	<i>Patella vulgata</i>	1, 6, 7, 8, 9, 10, 11, 12
<i>Diastylis rathkei typica</i>	8	<i>Helcion pellucidum</i>	9, 11, 12
Decapoda indet.	5, 6, 12	<i>Margarites undulata</i>	12
Caridea indet.	6, 10, 11	<i>Monodonta lineata</i>	11
<i>Palaemon elegans</i>	9, 11, 12	<i>Gibbula tumida</i>	12
<i>Pandalina brevirostris</i>	8	<i>Gibbula cineraria</i>	6, 8, 9, 11, 12
<i>Pandalus</i> spp.	6	<i>Gibbula umbilicalis</i>	8, 11, 12

<i>Calliostoma zizyphinum</i>	6, 8, 12	<i>Nucula nitidosa</i>	8
<i>Lacuna</i> spp.	8	Mytilidae indet.	8, 9, 10
<i>Lacuna pallidula</i>	11, 12	<i>Mytilus edulis</i>	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
<i>Lacuna vincta</i>	11	<i>Musculus</i> spp.	8
<i>Littorina littorea</i>	2, 3, 6, 7, 8, 9, 10, 11, 12	<i>Modiolarca tumida</i>	11, 12
<i>Littorina neritoides</i>	10	<i>Modiolus</i> spp.	7
<i>Littorina mariaae</i>	7, 8, 10, 11, 12	<i>Ostrea edulis</i>	6
<i>Littorina obtusata</i>	7, 8, 11, 12	<i>Chlamys distorta</i>	12
<i>Littorina neglecta</i>	7, 9, 11	<i>Chlamys varia</i>	11, 12
<i>Littorina saxatilis</i>	1, 2, 5, 6, 7, 8, 9, 10, 11, 12	<i>Aequipecten opercularis</i>	11, 12
<i>Littorina obtusata/mariaae</i>	9	<i>Anomia ephippium</i>	11
<i>Hydrobia</i> spp.	10	<i>Pododesmus patelliformis</i>	6, 11, 12
<i>Hydrobia ulvae</i>	1, 2, 4, 6, 7, 8, 9, 10, 11	<i>Thyasira flexuosa</i>	8
<i>Onoba</i> spp.	8	<i>Mysella bidentata</i>	2, 3, 4, 7, 8, 10
<i>Skeneopsis planorbis</i>	11	<i>Tellinmya ferruginosa</i>	3
<i>Turritella communis</i>	12	<i>Cerastoderma edule</i>	2, 3, 4, 6, 7, 8, 9, 10, 11, 12
<i>Aporrhais pespelecani</i>	12	<i>Mactra stultorum</i>	3, 4, 5, 8
<i>Trivia arctica</i>	12	<i>Spisula elliptica</i>	4, 8
<i>Trivia monacha</i>	12	<i>Spisula subtruncata</i>	4
<i>Lunatia</i> spp.	12	<i>Ensis</i> spp.	11, 12
<i>Polinices poliana</i>	8	<i>Ensis arcuatus</i>	12
<i>Nucella lapillus</i>	1, 6, 7, 8, 9, 10, 11, 12	<i>Ensis ensis</i>	8
<i>Ocenebra erinacea</i>	12	<i>Ensis siliqua</i>	12
<i>Buccinum undatum</i>	6, 8, 9, 11, 12	Tellinacea indet.	10
<i>Neptunea antiqua</i>	12	<i>Angulus tenuis</i>	2, 3, 6, 8, 9, 11, 12
<i>Colus gracilis</i>	12	<i>Fabulina fabula</i>	3, 4, 8, 9, 11, 12
<i>Hinia incrassata</i>	11, 12	<i>Macoma balthica</i>	1, 2, 3, 4, 6, 7, 8, 9, 10, 11
<i>Hinia reticulata</i>	11, 12	<i>Donax vittatus</i>	3, 4, 12
<i>Acteon tornatilis</i>	3, 4	<i>Scrobicularia plana</i>	1, 2, 3, 4, 6, 7, 8, 10, 11
<i>Cylichna cylindracea</i>	8	<i>Abra alba</i>	1, 2, 3, 7, 8
<i>Philine aperta</i>	8, 11, 12	<i>Abra nitida</i>	4, 8, 11
<i>Retusa obtusa</i>	8	<i>Pharus legumen</i>	3
<i>Pleurobranchus membranaceus</i>	12	<i>Arctica islandica</i>	12
<i>Tritonia hombergii</i>	6	<i>Venerupis</i> spp.	1
<i>Tritonia lineata</i>	6	<i>Chamelea gallina</i>	12
<i>Tritonia plebeia</i>	6	<i>Clausinella fasciata</i>	8
<i>Dendronotus frondosus</i>	11, 12	Myacea indet.	10
<i>Doto</i> spp.	6, 9, 11	<i>Mya truncata</i>	12
<i>Doto coronata</i>	6	<i>Mya arenaria</i>	2, 6, 7, 8, 10
<i>Doto maculata</i>	11	<i>Corbula gibba</i>	8
<i>Doto pinnatifida</i>	11	<i>Hiatella arctica</i>	11, 12
<i>Goniodoris nodosa</i>	6, 11, 12	<i>Barnea candida</i>	12
<i>Ancula gibbosa</i>	6	<i>Eledone cirrhosa</i>	6
<i>Acanthodoris pilosa</i>	6	BRYOZOA	
<i>Adalaria proxima</i>	11	Bryozoa indet.	6, 8, 10, 11, 12
<i>Onchidoris bilamellata</i>	8, 9, 12	Crisiidae indet.	6, 11, 12
<i>Onchidoris muricata</i>	9, 11, 12	<i>Crisidia cornuta</i>	12
<i>Limacia clavigera</i>	12	<i>Crisia denticulata</i>	6, 12
<i>Polycera quadrilineata</i>	8, 12	<i>Crisia eburnea</i>	6, 8, 11, 12
<i>Archidoris pseudoargus</i>	6, 8, 9, 11, 12	<i>Alcyonidium diaphanum</i>	6, 8, 9, 11, 12
<i>Jorunna tomentosa</i>	6	<i>Alcyonidium gelatinosum</i>	6, 7, 9, 11
<i>Janolus cristatus</i>	6, 12	<i>Alcyonidium hirsutum</i>	6, 9, 11, 12
<i>Coryphella browni</i>	6	<i>Alcyonidium mytili</i>	11, 12
<i>Coryphella lineata</i>	6	<i>Alcyonidium parasiticum</i>	6
<i>Flabellina pedata</i>	6, 8	<i>Flustrellidra hispida</i>	10, 11
<i>Cuthona amoena</i>	6	<i>Anguinella palmata</i>	6
<i>Catriona gymnota</i>	11	<i>Vesicularia spinosa</i>	6, 11, 12
<i>Eubbranchus</i> spp.	12	<i>Amathia lendigera</i>	8, 12
<i>Eubbranchus tricolor</i>	6	<i>Bowerbankia imbricata</i>	8, 11
<i>Facelina bostoniensis</i>	6, 12	<i>Bowerbankia pustulosa</i>	6, 11
<i>Facelina coronata</i>	6	<i>Umbonula littoralis</i>	11
<i>Aeolidia papillosa</i>	6	<i>Cryptosula pallasiana</i>	1
<i>Aeolidiella glauca</i>	6		
<i>Pelecypoda</i> indet.	11		

<i>Pentapora foliacea</i>	12	<i>Aplidium</i> spp.	11, 12
<i>Parasmittina trispinosa</i>	11	<i>Aplidium glabrum</i>	12
<i>Schizomavella</i> spp.	11	<i>Aplidium nordmanni</i>	12
<i>Schizomavella linearis</i>	11	<i>Aplidium punctum</i>	12
<i>Eucratea loricata</i>	6, 11, 12	Didemnidae indet.	8, 11, 12
<i>Membranipora membranacea</i>	8, 11, 12	<i>Didemnum maculosum</i>	12
<i>Conopeum reticulum</i>	1, 2	<i>Diplosoma</i> spp.	12
<i>Electra pilosa</i>	6, 8, 9, 11, 12	<i>Diplosoma listerianum</i>	6, 8
<i>Flustra foliacea</i>	6, 8, 9, 11, 12	<i>Ciona intestinalis</i>	9, 11, 12
<i>Chartella papyracea</i>	9	<i>Perophora listeri</i>	6, 8, 11, 12
<i>Securiflustra securifrons</i>	8	<i>Corella parallelogramma</i>	12
<i>Cellaria</i> spp.	12	<i>Asciella</i> spp.	8
<i>Cellaria fistulosa</i>	11	<i>Asciella aspersa</i>	8, 11, 12
<i>Cellaria sinuosa</i>	12	<i>Asciella scabra</i>	6, 8, 9, 11, 12
<i>Scrupocellaria</i>	6, 8, 11, 12	<i>Ascidia conchilega</i>	11, 12
<i>Scrupocellaria reptans</i>	11	<i>Ascidia mentula</i>	11, 12
<i>Scrupocellaria scruposa</i>	11, 12	<i>Polycarpa</i> spp.	12
<i>Bicelliaria ciliata</i>	6, 8, 11, 12	<i>Polycarpa pomaria</i>	12
<i>Bugula</i> spp.	6	<i>Polycarpa rustica</i>	11, 12
<i>Bugula avicularia</i>	8, 11	<i>Dendrodoa grossularia</i>	6, 8, 11, 12
<i>Bugula flabellata</i>	8, 11, 12	<i>Botryllus schlosseri</i>	6, 8, 10, 11, 12
<i>Bugula plumosa</i>	6, 11, 12	<i>Botrylloides leachi</i>	6, 8, 11, 12
<i>Bugula turbinata</i>	6	<i>Molgula</i> spp.	8
Bryozoa indet. (crusts)	6, 8, 11	<i>Molgula manhattensis</i>	11, 12
		<i>Molgula occulta</i>	12
PHORONIDA		PISCES	
<i>Phoronis muelleri</i>	8	Pisces indet.	10
ECHINODERMATA		<i>Scyliorhinus canicula</i>	6, 11, 12
<i>Antedon bifida</i>	11, 12	<i>Raja clavata</i>	6
<i>Astropecten irregularis</i>	12	Osteichthyes indet.	7
<i>Asterina gibbosa</i>	12	<i>Anguilla anguilla</i>	6
<i>Crossaster papposus</i>	8, 11, 12	<i>Conger conger</i>	6, 11
<i>Henricia</i> spp.	11, 12	<i>Lepadogaster lepadogaster</i>	11
<i>Henricia oculata</i>	6, 8, 11, 12	Gadidae indet.	11, 12
<i>Asterias rubens</i>	1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12	<i>Molva molva</i>	6
<i>Leptasterias muelleri</i>	6, 11, 12	<i>Pollachius pollachius</i>	8, 11, 12
Ophiuroidea indet.	8	<i>Pollachius virens</i>	9
<i>Ophiothrix fragilis</i>	2, 6, 8, 11, 12	<i>Trisopterus</i> spp.	6
<i>Ophiopholis aculeata</i>	6, 11, 12	<i>Trisopterus luscus</i>	6, 11
<i>Amphiura</i> spp.	12	<i>Syngnathus acus</i>	6, 8, 11, 12
<i>Amphiura brachiata</i>	8, 12	<i>Myoxocephalus scorpius</i>	6, 11
<i>Amphiura filiformis</i>	8	<i>Taurulus bubalis</i>	11, 12
<i>Amphipholis squamata</i>	8	<i>Agonus cataphractus</i>	6, 9, 12
<i>Ophiura</i> spp.	6	<i>Crenilabrus melops</i>	6
<i>Ophiura albida</i>	8, 11, 12	<i>Ctenolabrus rupestris</i>	6, 11, 12
<i>Ophiura ophiura</i>	8, 11, 12	<i>Labrus bergylta</i>	9, 12
<i>Psammechinus miliaris</i>	9, 11, 12	<i>Trachinus draco</i>	9
<i>Echinus esculentus</i>	8, 11, 12	<i>Lipophrys pholis</i>	12
<i>Echinocardium cordatum</i>	3, 8, 11, 12	<i>Pholis gunnellus</i>	6, 8, 11, 12
<i>Echinocardium flavescens</i>	3	<i>Ammodytes</i> spp.	3, 4, 8, 12
<i>Aslia lefevrei</i>	11	<i>Callionymus</i> spp.	9
<i>Leptosynapta bergensis</i>	8	<i>Callionymus lyra</i>	6, 12
<i>Labidoplax digitata</i>	12	<i>Callionymus reticulatus</i>	8
TUNICATA		<i>Gobius</i> spp.	6, 10, 11
Clavelinidae indet. ('pinhead')	11, 12	<i>Gobius niger</i>	6
<i>Clavelina lepadiformis</i>	11, 12	<i>Gobius paganellus</i>	8
<i>Distaplia rosea</i>	6, 11, 12	<i>Gobiusculus flavescens</i>	12
<i>Archidistoma aggregatum</i>	11	<i>Pomatoschistus</i> spp.	6, 7, 12
Polyclinidae indet.	8, 12	<i>Pomatoschistus minutus</i>	6, 12
<i>Polyclinum aurantium</i>	12	<i>Pomatoschistus pictus</i>	6, 8, 12
<i>Synoicum pulmonaria</i>	12	Pleuronectidae indet.	6, 7, 9, 11, 12
<i>Morchellium argus</i>	11, 12	<i>Limanda limanda</i>	6
<i>Sidnyum elegans</i>	12	<i>Pleuronectes platessa</i>	6, 9, 11, 12
<i>Sidnyum turbinatum</i>	8, 12	<i>Solea solea</i>	12

RHODOPHYCOTA

<i>Porphyridium purpureum</i>	8
<i>Porphyra</i> spp.	2, 3, 5, 6, 7, 8, 9, 10, 11, 12
<i>Porphyra linearis</i>	9, 12
<i>Porphyra purpurea</i>	8, 9
<i>Porphyra umbilicalis</i>	7, 8, 9, 11, 12
<i>Audouinella</i> spp.	6, 7, 8, 9, 10, 11, 12
<i>Audouinella sanctae-mariae</i>	12
<i>Bonnemaisonia asparagoides</i>	12
<i>Bonnemaisonia hamifera</i>	12
<i>Gelidium</i> spp.	8
<i>Gelidium latifolium</i>	12
<i>Gelidium pusillum</i>	8, 9, 12
<i>Palmaria palmata</i>	8, 9, 10, 11, 12
<i>Dilsea carnosa</i>	8, 9, 11, 12
<i>Dunontia contorta</i>	1, 6, 7, 8, 9, 11, 12
<i>Grateloupia filicina</i>	12
<i>Callophyllis laciniata</i>	12
<i>Hildenbrandia</i> spp.	6, 7, 8, 9, 10, 11, 12
Corallinaceae indet. (crusts)	6, 7, 8, 9, 10, 11, 12
<i>Corallina officinalis</i>	6, 7, 8, 9, 11, 12
<i>Lithothamnion</i> spp.	9
<i>Lithothamnion glaciale</i>	11
<i>Gracilaria verrucosa</i>	8
<i>Ahnfeltia plicata</i>	8, 9, 11, 12
<i>Gymnogongrus griffithsiae</i>	9
<i>Phyllophora</i> spp.	9
<i>Phyllophora crispa</i>	9, 11, 12
<i>Phyllophora pseudoceranoidea</i>	6, 9, 11, 12
<i>Phyllophora traillii</i>	11, 12
<i>Schottera nicaeensis</i>	9
<i>Mastocarpus stellatus</i>	6, 8, 9, 10, 11, 12
<i>Chondrus crispus</i>	1, 2, 6, 7, 8, 9, 10, 11, 12
<i>Polyides rotundus</i>	6, 8, 9, 11, 12
<i>Plocamium cartilagineum</i>	8, 9, 11, 12
<i>Furcellaria lumbricalis</i>	8, 9, 11
<i>Halarachnion ligulatum</i>	12
<i>Catenella caespitosa</i>	2, 6, 7, 9, 10, 11, 12
<i>Calliblepharis jubata</i>	12
<i>Cystoclonium purpureum</i>	8, 9, 11, 12
<i>Rhodophyllis divaricata</i>	12
<i>Petrocelis</i> spp.	9
<i>Cordylecladia erecta</i>	11, 12
<i>Rhodymenia</i> spp.	11
<i>Rhodymenia delicatula</i>	12
<i>Rhodymenia pseudopalmata</i>	12
<i>Chylocladia verticillata</i>	12
<i>Lomentaria</i> spp.	12
<i>Lomentaria articulata</i>	11, 12
<i>Lomentaria clavellosa</i>	6, 11, 12
<i>Lomentaria orcadensis</i>	12
<i>Antiithamnion</i> spp.	9
<i>Callithamnion</i> spp.	9, 11
<i>Callithamnion roseum</i>	8
<i>Callithamnion sepositum</i>	11
<i>Ceramium</i> spp.	1, 6, 7, 8, 9, 10, 11, 12
<i>Ceramium nodulosum</i>	2, 8, 9, 11, 12
<i>Ceramium shuttleworthianum</i>	9, 11
<i>Ceramium strictum</i>	8, 9
<i>Griffithsia flosculosa</i>	8, 11, 12
<i>Plumaria elegans</i>	10, 11, 12
<i>Pterothamnion plumula</i>	11
<i>Ptilota plumosa</i>	12
<i>Acrosorium reptans</i>	12
<i>Cryptopleura ramosa</i>	12

<i>Delesseria sanguinea</i>	8, 9, 11, 12
<i>Hypoglossum hypoglossoides</i>	8, 9, 11, 12
<i>Membranoptera alata</i>	11, 12
<i>Myriogramme bonnemaisonii</i>	12
<i>Myriogramme heterocarpum</i>	12
<i>Nitophyllum punctatum</i>	12
<i>Phycodrys rubens</i>	8, 9, 11, 12
<i>Polyneura laciniata</i>	12
<i>Heterosiphonia plumosa</i>	12
<i>Bostrychia scorpioides</i>	9
<i>Brongniartella byssoides</i>	11, 12
<i>Laurencia hybrida</i>	9, 11, 12
<i>Laurencia obtusa</i>	11
<i>Laurencia pinnatifida</i>	8, 9, 11, 12
<i>Odonthalia dentata</i>	11, 12
<i>Polysiphonia</i> spp.	6, 7, 8, 9, 10, 11, 12
<i>Polysiphonia atlantica</i>	9
<i>Polysiphonia lanosa</i>	10, 11, 12
<i>Polysiphonia fucoides</i>	6, 7, 8, 9, 11, 12
<i>Polysiphonia spiralis</i>	8
<i>Polysiphonia urceolata</i>	11
<i>Rhodomela confervoides</i>	6, 11, 12
Filamentous red algae	6, 11
Foliose red algae	11
Rhodophycota indet. (non-calc. crusts)	6, 7, 8, 9, 10, 11, 12

CHRYSOPHYCOTA

Chrysophycota indet.	6
Diatoms - colonial	8, 9, 12
Diatoms - film	4, 6, 10, 12

CHROMOPHYCOTA

Ectocarpaceae indet.	4, 6, 7, 8, 9, 10, 11, 12
<i>Ectocarpus siliculosus</i>	8, 9
<i>Giffordia granulosa</i>	8, 9
<i>Pilayella littoralis</i>	9
<i>Ralfsia</i> spp.	7, 11
<i>Elachista</i> spp.	10, 11, 12
<i>Elachista fucicola</i>	8, 10
<i>Leathesia difformis</i>	12
<i>Cutleria multifida</i> (Aglaozonia)	8, 12
<i>Sphacelaria</i> spp.	12
<i>Halopteris filicina</i>	8, 11, 12
<i>Cladostephus spongiosus</i>	8, 9, 11, 12
<i>Dictyota dichotoma</i>	6, 8, 11, 12
<i>Desmarestia aculeata</i>	11, 12
<i>Desmarestia viridis</i>	11
<i>Asperococcus fistulosus</i>	12
<i>Punctaria latifolia</i>	9
<i>Petalonia fascia</i>	11
<i>Scytosiphon lomentaria</i>	11, 12
<i>Chorda filum</i>	6, 11, 12
<i>Laminaria</i> spp.	9, 11, 12
<i>Laminaria digitata</i>	6, 8, 9, 11, 12
<i>Laminaria hyperborea</i>	8, 9, 11, 12
<i>Laminaria saccharina</i>	8, 9, 11, 12
<i>Alaria esculenta</i>	11, 12
<i>Ascophyllum nodosum</i>	2, 6, 7, 8, 9, 10, 11, 12
<i>Fucus</i> spp.	6, 7, 8, 11, 12
<i>Fucus ceranoides</i>	8, 9, 11
<i>Fucus serratus</i>	2, 6, 7, 8, 9, 10, 11, 12
<i>Fucus spiralis</i>	2, 3, 6, 7, 8, 9, 10, 11, 12
<i>Fucus vesiculosus</i>	2, 3, 4, 6, 7, 8, 9, 10, 11, 12
<i>Pelvetia canaliculata</i>	2, 6, 7, 8, 9, 10, 11, 12

<i>Halidrys siliquosa</i>	8, 11, 12	<i>Bryopsis hypnoides</i>	9
Chromophycota indet. (crusts)	7, 12	<i>Bryopsis plumosa</i>	6, 8, 9, 11
CHLOROPHYCOTA			
Chlorophycota indet.	2, 4, 8, 9, 10, 12,	<i>Codium</i> spp.	12
<i>Ulothrix</i> spp.	9	Encrusting green algae	6
<i>Ulothrix speciosa</i>	9	Filamentous green algae	6, 8, 11
<i>Enteromorpha</i> spp.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	ANGIOSPERMAE	
<i>Enteromorpha compressa</i>	8, 9	Angiospermae indet.	7, 8
<i>Enteromorpha intestinalis</i>	8, 9	<i>Zostera angustifolia</i>	10, 11
<i>Enteromorpha linza</i>	8, 9, 11	<i>Zostera noltii</i>	10, 11
<i>Enteromorpha prolifera</i>	9	<i>Salicornia</i> spp.	4, 6, 7, 8
<i>Ulva</i> spp.	1, 2, 5, 6, 7, 8, 9, 10, 11, 12	<i>Armeria maritima</i>	10
<i>Ulva lactuca</i>	8, 9	LICHENS	
<i>Blidingia</i> spp.	6	Lichens indet.	10
<i>Prasiola stipitata</i>	6, 9, 12	<i>Anaptychia fusca</i>	10
<i>Urospora penicilliformis</i>	9	<i>Caloplaca</i> spp.	11
<i>Spongomorpha aeruginosa</i>	8, 9	<i>Caloplaca marina</i>	2, 9, 10, 11, 12
<i>Spongomorpha arcta</i>	2, 8, 11, 12	<i>Caloplaca thallicola</i>	6, 10
<i>Chaetomorpha</i> spp.	6, 9, 10, 11	<i>Lecanora atra</i>	9, 10, 11, 12
<i>Chaetomorpha linum</i>	6	<i>Lichina pygmaea</i>	2, 7, 10, 11, 12
<i>Chaetomorpha melagonium</i>	6, 9, 10, 12	<i>Ochrolechia parella</i>	11
<i>Cladophora</i> spp.	2, 4, 6, 7, 8, 9, 10, 11, 12	<i>Ramalina</i> spp.	10, 11, 12
<i>Cladophora pellucida</i>	12	<i>Verrucaria</i> spp.	8, 9
<i>Cladophora rupestris</i>	2, 6, 7, 8, 9, 10, 11, 12	<i>Verrucaria maura</i>	2, 6, 7, 9, 10, 11, 12
<i>Cladophora sericea</i>	8, 9	<i>Verrucaria mucosa</i>	2, 7, 8, 9, 10, 11, 12
<i>Rhizoclonium</i> spp.	10, 11	<i>Xanthoria parietina</i>	6, 9, 10, 11, 12
		Grey lichens	6, 9, 10, 11, 12

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