

Marine Nature Conservation Review

Benthic marine ecosystems of Great Britain and the north-east Atlantic

edited by

Keith Hiscock

*Joint Nature Conservation Committee
Monkstone House, City Road
Peterborough PE1 1JY
UK*

Part 2

Shetland (MNCR Sector 1)

Reviews within MNCR Coastal Sectors

Coastline of Great Britain and the north-west Atlantic, ed. by A. Hirstick, 77–106. Penwith Books, Joint Nature Conservation Committee. (Coasts and seas of the United Kingdom, MNCR series)

Synopsis

The Shetland Isles are the most northerly part of Britain and have a coastline of about 1450 km in length. The inshore marine habitats present are predominantly rocky and range from those exposed to severe wave action to extremely sheltered situations within the main fjords, coes and spuds. Subtidal regions include both rocky and sedimentary habitats with the variety of sediment types particularly notable. Although surface salinity in exposed areas might be significantly reduced by rainfall, there are no estuarine habitats present. However, brackish conditions exist in houses and yachts within or at the heads of coes. Rocky shore communities are very varied because of the differences in wave exposure and include some especially well-developed examples of exposed coast communities. In the subtidal, rock surfaces have extensive kelp forests but grazing reduces the diversity and abundance of many species. However, grazing by sea urchins in shallow depths is reduced by wave action on exposed coasts while urchins are uncommon in extreme shelter so that richer communities may exist in these situations. The wide range of conditions of tidal current strength are

important after wave action in determining the types of communities present in the subtidal zone. The former habitats are generally restricted to a few pocket localities. In the inshore and the subtidal zone are not extensively developed. Invertebrates sandy beaches occur at wave exposed locations in the south of Shetland and hold low-diversity communities typical of disturbed sediments. Many of the subtidal sediment communities are very rich, but small and generally small beds of pebbles. Corals occur in shallow depths in some coes and the bryozoan water-wearer *Scrupa* spp. in isolated waters. Bedrock communities occur extensively in tide-swept areas. Molluscs predominantly *Phoron* spp., *Chama* spp. and *Hydrobia ulvae* occur in some of the coasts. Bivalve coes in some locations, especially Papa Westray and Fair Isle, have characteristic communities. Abundant species which are rarely or not found elsewhere in Britain occur in Shetland. These include the sea urchin *Paracentrotus lividus* and the sea cucumber *Cucumera japonica*. The coastal zone around Shetland supports large populations of common and grey seals and of otters.

1.1 Introduction and historical perspective

The Shetland Islands (Figure 1.1) are the most northerly part of the British Isles, lying at the northern extremity of the North Sea on a similar latitude to northern Norway. Fair Isle is some 40 km south-west of Summerson, the most southerly point of mainland Shetland, and is separated from Orkney by a deep 100 m channel, the Fair Isle Channel. The island of Lewis lies approximately 20 km to the west of Shetland while to the south, the Hebride Channel, which is over 1000 m deep, separates the Shetland archipelago from the rest of Britain.

Shetland consists of numerous large and small islands with a highly indented coastline of approximately 1400 km in length and no part of the archipelago is more than 2 km from the coast (Plan 1976). The coastline, which is predominantly rocky, has some of the most spectacular wave-exposed coastal scenery in the British Isles, with high cliffs, caves and long, steep-walled narrow inlets called 'goes'. Deep water areas of up to 100 m depth occur in some of the goes, which are in depth contrast with the coastline at a

An initial review was undertaken in 1976 by the Joint Nature Conservation Committee (JNCC) as part of a wider study of the Shetland Islands. This report has been substantially revised by the present author in 1994 and is based on a major field visit to the islands in 1993. The text and other illustrations have been updated to the end of 1994 by the editor. The chapters do not include further references to the literature, but are published in the *Journal of Marine Biological Association of the United Kingdom*, which is World Wide Web (http://www.jmab.org.uk) and is available to subscribers. The journal is published by the British Ecological Society, which is also available to subscribers.

Chapter 14: Outer Hebrides (MNCR Sector 14)*

David W. Connor and Mike Little

Citation: Connor, D.W., & Little, M. 1998. Outer Hebrides (MNCR Sector 14). In: *Marine Nature Conservation Review. Benthic marine ecosystems of Great Britain and the north-east Atlantic*, ed. by K. Hiscock, 371–383. Peterborough, Joint Nature Conservation Committee. (Coasts and seas of the United Kingdom. MNCR series.)

Synopsis

The Outer Hebrides including the offshore rocks of the St Kilda archipelago, Sula Skeir, North Rona and, far to the west, the isolated outcrop of Rockall include locations ranging from exceptionally exposed to exceptionally sheltered to wave action. Although there are no marine research stations in the area, the special features of the islands have attracted significant research studies. The islands of North and South Uist are especially characterised by extensive shallow marine and brackish-water fjordic sealochs and obs connected to each other and to the sea by rapids. These lagoonal features include highly specialised communities. On

Lewis and Harris, fjordic sealochs are present and hold communities similar to those on mainland Scotland. The open coast of the islands includes rocky areas and some extensive sediment beaches. The offshore rocks are extremely exposed. St Kilda has communities and species characteristic of these exposed conditions and extensive cave, arch and tunnel habitats mainly colonised by encrusting animals. Rockall is remarkable for the extent of the *Alaria esculenta* forest and for the absence of intertidal species with a pelagic larva but has a rich fauna on underwater rock.

14.1 Introduction

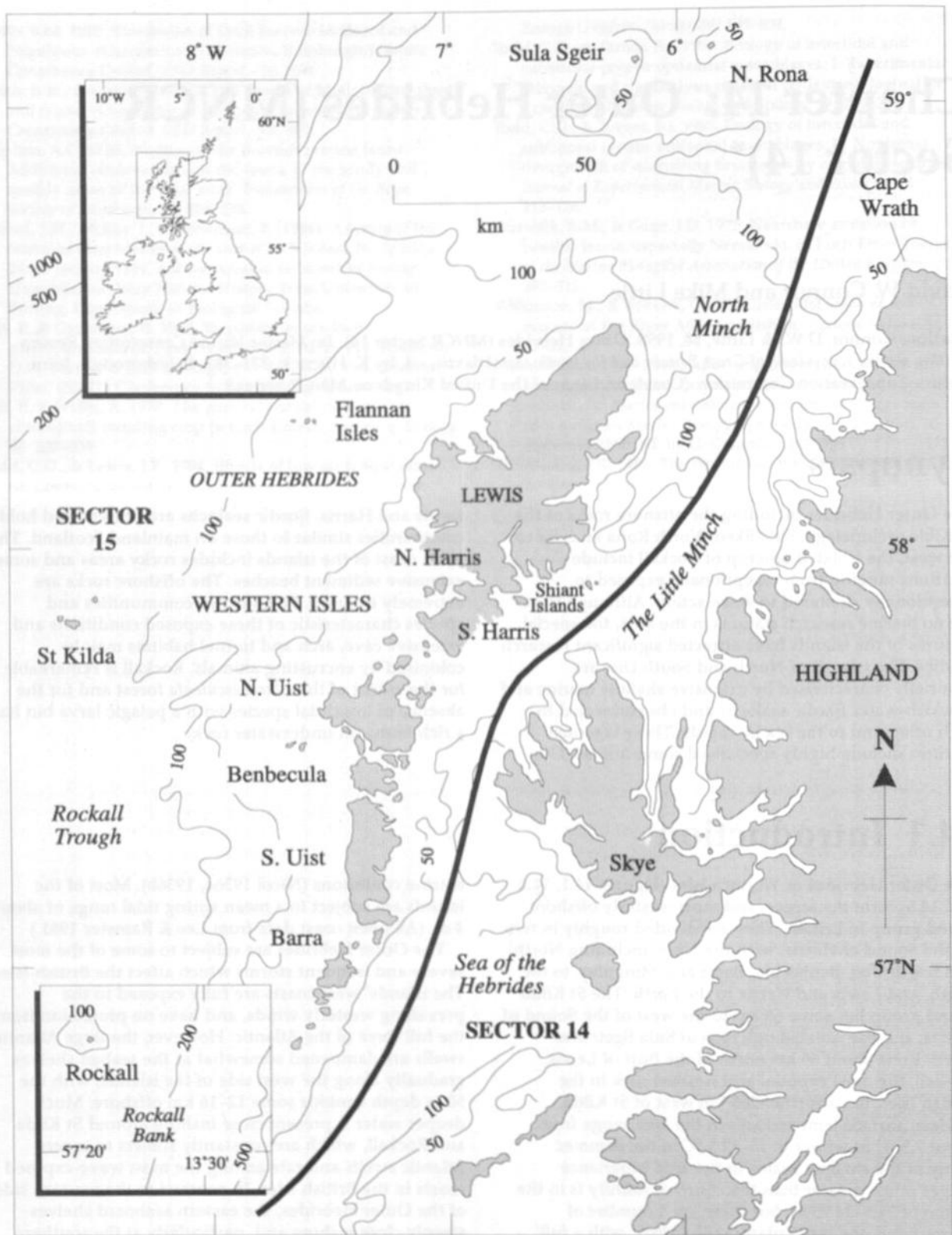
The Outer Hebrides or Western Isles (Figures 14.1, 14.2 and 14.5) form the largest and most westerly offshore island group in Britain. They are divided roughly in two by the Sound of Harris, with the Uists, including North and South Uist, Benbecula, Barra and Mingulay, to the south, and Lewis and Harris to the north. The St Kilda island group lies some 65 km to the west of the Sound of Harris, and the isolated outcrops of Sula Sgeir and North Rona about 65 km north of the Butt of Lewis. Rockall, the most exposed and isolated rock in the British Isles, lies a further 265 km west of St Kilda.

Mean surface temperatures in the area range from about 7.5 °C in winter to 13–13.5 °C in the summer. Many of the shallow basins in the area experience ranges much greater than this. Surface salinity is in the region of 34.5–34.75‰, but there are a number of lagoons and obs, particularly in the Uists, with a full range of salinities from fresh to brackish and fully

marine conditions (Nicol 1936a, 1936b). Most of the islands are subject to a mean spring tidal range of about 4 m. (All open coast data from Lee & Ramster 1981.)

The Outer Hebrides are subject to some of the most severe and frequent storms which affect the British Isles. The islands' west coasts are fully exposed to the prevailing westerly winds, and have no protection from the full force of the Atlantic. However, the large Atlantic swells are dampened somewhat as the seabed shelves gradually along the west side of the islands, with the 50 m depth contour some 12–16 km offshore. Much deeper water is present close inshore around St Kilda and Rockall, which are constantly subject to severe Atlantic swells and rate among the most wave-exposed coasts in the British Isles. In contrast to the western side of the Outer Hebrides, the eastern seaboard shelves steeply close inshore and, particularly at the southern and northern approaches to the Minch, is also affected

* This review was completed from published and, where available, unpublished sources of information on benthic habitats and communities including the results of interviews with relevant workers undertaken up to 1991. That work was published in Connor (1991a). The review has been revised to take account of major additional studies up to the end of 1994 by the second author and up to the end of 1996 by the series editor. It does not include benthic survey information summarised for or published in the MNCR *Regional Reports* series or work now being undertaken to describe and map biotopes in candidate Special Areas of Conservation. For information on conservation status and an analysis of rare and scarce seabed species, the reader is referred to the *Coastal Directories* series.



Based on Admiralty Chart 2635 with the permission of the Controller of Her Majesty's Stationery Office. © Crown copyright.

Figure 14.1 The Outer Hebrides (MNC Sector 14).

by the Atlantic swell. As with much of the rest of Scotland's west coast, the islands are highly indented by a series of sealochs which provide areas of extreme shelter from wave action, and a wide range of tidal stream strengths through the many narrow channels and rapids.

The Western Isles, particularly the Uists, have a very varied topography giving rise to a complex of land, water, islands and rocks. The highly indented coastline is formed into a series of sealochs many of which are further divided. These lochs range from fully marine to brackish and freshwater. Earll & Pagett (1984), in a catalogue of the sealochs, classified the lochs on the basis of salinity, with a secondary division based on water chemistry for freshwater and brackish lochs and on physiographic features for marine lochs. Marine lochs were distinguished from open bays by the presence of a sill, and divided into ob-like, fjordic, fjordic with fjordic features and truly fjordic sealochs. Earll & Pagett (1984) noted that obs, fjards and fjards with fjordic features are well represented in the Western Isles, but that fjordic sealochs are not as common as on the mainland. Loch Bee was considered to be the only machair-type brackish loch and Loch Obisary was rated as an outstanding brackish loch. Much of the recent information for sealochs in Sector 14 is based on surveys undertaken for the MNCR by the University Marine Biological Station, Millport, the results of which were described in Howson, Connor & Holt (1994) and in a series of separate survey reports cited below.

Connor (1991b) compared Scottish sealochs with Norwegian fjords and concluded that some of the extensive shallow systems in the Western Isles were of particularly high conservation interest. Connor (1994) considered the sublittoral zone of Loch Maddy to be one of the richest and most interesting in the British Isles. Buck (1993) included nine Outer Hebridean sites in her inventory of UK estuaries. Some of the obs of the Hebrides and north-west Scotland were surveyed by Smith (1987), and more recently by the MNCR. Harvey *et al.* (1980) regarded a number of rocky shores in the Western Isles as being of national importance while Bishop & Holme (1980) provided an assessment of the conservation value of sediment shores. A compilation of studies relating to the environment of the Outer Hebrides, including a number covering marine aspects, was brought together by Boyd (1979).

The Western Isles lie in the path of the Gulf Stream, which helps maintain winter sea temperatures above those on the mainland, and encourages the growth of warm-water species at a higher latitude than farther east on the Scottish mainland. Species such as the algae *Carpomitra costata*, *Meredithia microphylla* and *Rhodomenia ardissoni* have their most northerly known locations in the Western Isles or St Kilda (Maggs 1986). Maggs suggested that these species may also be restricted to these offshore islands because they require offshore water quality and hence cannot survive in the coastal and less saline inshore waters of mainland Scotland. The inshore water from the Clyde is known to mix with Atlantic water on the shelf west of Islay, and from there diverges to flow north through the Little Minch or around Barra Head and along the west coast of the

Outer Hebrides (Ellett 1979). St Kilda however receives unmixed Atlantic water direct from the Rockall Channel. The influence of the North Atlantic Drift appears to be stronger on the Outer Hebrides, with southern species, such as the anemone *Bunodactis verrucosa*, the brown alga *Cystoseira tamariscifolia* (Harvey *et al.* 1980), and the red alga *Meredithia microphylla* (Maggs 1986) extending farther north than they do on the Scottish mainland. The northern brown alga *Fucus distichus edentatus* has its southern limit on North Rona and another subspecies *anceps* is found on the extremely exposed shores at the north end of Lewis, North Rona, Sula Sgeir, the Flannan Isles and St Kilda (Powell 1957, 1958). Powell *et al.* (1979) considered the islands, because of their offshore location, to have a slightly reduced littoral fauna and flora compared with mainland Scotland. The outlying islands of the Shiant Islands, Monach Islands, Flannan Islands, North Rona, Sula Sgeir, St Kilda and Rockall have a further reduced complement of shore species as a result of greater isolation and more severe exposure to wave action (Dipper & Mitchell 1980).

Stornoway is the principal fishing port for the Western Isles with the area being an important fishing ground for sprat *Sprattus sprattus*, Norway pout *Trisopterus esmarkii*, blue whiting *Micromesistius poutassou*, mackerel *Scomber scombrus*, Norway lobster *Nephrops norvegicus* and shrimps. There are also major spawning grounds for haddock *Melanogrammus aeglefinus*, whiting *Merlangius merlangus* and cod *Gadus morhua* in the area, which provide the principal demersal fisheries for the Sea of the Hebrides (Bailey, Hislop & Mason 1979). Dogfish and sand-eels (Ammodytidae) are caught seasonally. Recently, oil exploration companies have investigated the Hebridean Sea as a possible source of oil, with promising finds off Barra.

The sheltered shores of the east coast lochs have been extensively used for the commercial harvesting of the knotted wrack *Ascophyllum nodosum*. Walker (1947) estimated that 70% of Scotland's *Ascophyllum* and fucoid biomass occurred in the Outer Hebrides, with the bulk of this being in the Uists and Benbecula. Its harvesting in the Outer Hebrides since the Second World War has yielded the largest production of alginates in the world (Norton & Powell 1979). Norton & Powell (1979) also discussed the use of kelp *Laminaria* spp. as fertiliser and as a source of soda, potash and iodine.

There are no marine biological research stations in the Western Isles, but the area has attracted much attention because of its relative remoteness, its natural beauty and its wide variety of marine habitats. Consequently, the marine communities have been reasonably well studied, and the islands are perhaps better known than the less remote coast of north-west Scotland. Many surveys were initiated by the Nature Conservancy Council, including shore surveys by the Intertidal Survey Unit (SMBA/MBA) (Powell *et al.* 1979) and Smith (1978, 1982), surveys on the impact of fish-farms (Earll & Pagett 1984) and more recently MNCR surveys of sealochs (Holt 1991; Howson 1989, 1991) and subsequent MNCR surveys of isolated saline waters.

Powell *et al.* (1979) gave a description of the main shore communities in the Western Isles from the wide-ranging survey of rocky and sedimentary shores

undertaken by the NCC-commissioned Intertidal Survey Unit. Powell *et al.* (1979) selected 17 areas as of biological interest, including Loch Roag, which they considered to be of outstanding quality for its variety and richness. Six other areas (north-west Lewis, Griminish Point on North Uist, Rubha Ardvule on South Uist, Eoligarry off Barra, Bagh nam Faileann off South Uist, and Loch Maddy on North Uist) were highly rated and are discussed below under the relevant sections. Angus (1979) described 20 sediment beaches around the island group, splitting the faunas into similar categories to those of Powell *et al.* (1979), from the exposed crustacean-dominated sands to the finer sediments with bivalves and lugworm *Arenicola marina* in sheltered conditions. He concluded that the abundance and composition of the fauna was principally determined by variation in wave exposure and found

there to be a well developed zonation on most beaches. Norton & Powell (1979) gave a checklist of marine algae for the islands. Waterston *et al.* (1979) provided a useful summary of the biology of brackish lochs, which they considered together with freshwater systems on the islands. They noted that 25‰ appeared to be a critical salinity for marine species and 5‰ for freshwater species. Campbell & Williamson (1979) reviewed the fish populations of these brackish and freshwater systems. Rostron (1984) gave brief descriptions of sites surveyed by the Nature Conservancy Council from many of the fully saline sealochs in connection with pollution monitoring near salmonid fish-farms. Bryan (1994) provided a summary of current knowledge of the marine and coastal environment of Sector 14, and human influences affecting it.

14.2 The Uists

14.2.1 Introduction

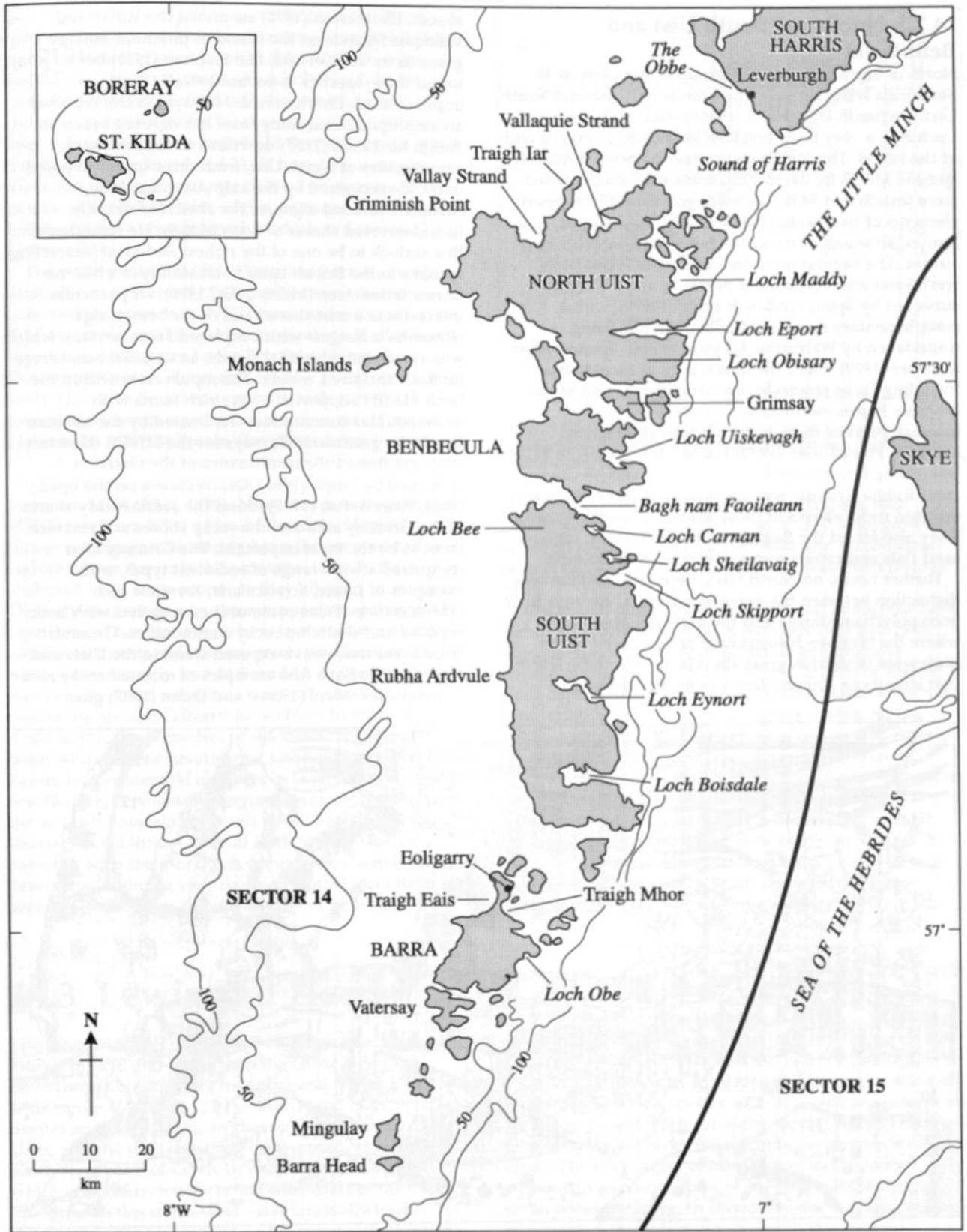
Interest in the marine biology of the Uists and Barra (Figure 14.2) dates back to the last century when M'Intosh (1866) noted the littoral fauna of North Uist to be particularly rich and varied. The islands since then have attracted much attention with a number of studies in the 1930s, particularly on the extensive brackish-water systems of the island group, and more recently with surveys for NCC (e.g. Dipper & Mitchell 1980). General accounts of the molluscan fauna of the Uists were given by Angus (1977) and Smith (1978) who included species lists from a wide range of sites.

14.2.2 Barra

Sandy shores on Vatersay, at the southern end of the island group, and on neighbouring Barra, were first described by Stephen (1930). The Vatersay shores were rather barren, but a 5 km stretch of coast on Barra at Traigh Mhor, known as 'cockle shore', had a rich and very extensive bed of commercially fished *Cerastoderma edule*. Here Stephen (1930) was surprised not to find the tellin *Macoma balthica*, a common associate of *Cerastoderma edule*. Further attention to this shore and the formation of shell-banks from dead cockle shells was given by Farrow (1974). Indeed, the importance of the cockle shore at Traigh Mhor is recorded in the old writings of Dean Munro quoted (but without a date) in Gosse (1865): "This ile is full of grate cokills, and aledgit be the auncient coutremen that the same cokills comes down out of the foresaid hill throw the said strype in the first smalle forme that wee have spokyn of, and aftir theyr comyng down to the sandes growis gate cockills allways. Ther is no fayer and more profytable sandes for cokills in all the worlde". The Traigh Mhor shore was classed as 'sheltered' by Eleftheriou & McIntyre (1976) in their appraisal of Scotland's sandy beaches. Traigh Eais, on the west side of Barra fell into their 'exposed' category, and from there to Traigh Mhor was one of the most highly-rated sites described in Powell *et al.* (1979).

Forrest, Waterston & Watson (1936) gave an account of Barra's flora and fauna, including species lists for most marine groups, and Sinclair (1938) described the marine algae of the island. Both authors give records for Loch Obe on the east side of the island. Gunning, Pate & Crosset (1966) gave a description of the algal zonation along the long narrow gorge-like entrance channel to this small sealoch. This steep-sided entrance, with a rich fauna and flora (Powell *et al.* 1979), is a unique feature in the Outer Hebrides. Consequently, Loch Obe was promoted as an MCA (Nature Conservancy Council 1990).

Littoral and sublittoral sites on Barra and surrounding islands were surveyed by the MNCR in 1996. The southernmost islands of Berneray and Mingulay have deep water close inshore and so wave action from Atlantic swell and during strong onshore winds is severe. Very steep bedrock shores are characterised by very wide bands of lichens above typical wave-exposed communities of mussels and barnacles and red algae. In the sublittoral, the kelp *Alaria esculenta* dominates the sublittoral fringe. Below this lies a very rich forest and park of *Laminaria hyperborea* with dense red algae, sponges and a turf of bryozoans. The west-facing coast farther north, around Barra and Vatersay, is also characterised by steep barnacle-dominated rocky shores with kelp forests in the sublittoral zone. The kelp forest and park in this area extend several kilometres offshore on the flat bedrock plain that characterises this area. Surge gullies, caves and arches occur in several places around the islands especially on the west coast. Although varying with local conditions, the walls of these gullies and tunnels was characterised by a robust fauna of sponge crusts, anemones and colonial ascidians. Between the islands, there are shallow sounds where tidal streams are strong and the kelp plants are colonised by dense growths of sponges, colonial ascidians, anemones and brittlestars. Wherever sheltered conditions occur, shores were dominated by fucoïd algae.



Based on Admiralty Chart 2635 with the permission of the Controller of Her Majesty's Stationery Office. © Crown copyright.

Figure 14.2. The Uists, Barra and St Kilda, showing places mentioned in the text.

14.2.3 North and South Uist and Benbecula

North of Barra lies the main group of the Uists, with Benbecula lying between the islands of North and South Uist. On South Uist, Nicol (1936b) studied the fauna of Loch Bee, a very large brackish loch at the northern end of the island. The loch is connected to both the Atlantic and the Minch by narrow channels with sluices which were installed in 1836. Loch Bee was found to support elements of freshwater, brackish and fully marine faunas, although much of the fauna was brackish in nature. The vegetation of this and other lochs, both freshwater and brackish, of northern South Uist was surveyed by Spence, Allen & Fraser (1979), with a complementary survey of the macrofauna being undertaken by Waterston & Lyster (1979). Spence, Allen & Fraser (1979) noted the dominance of furoid algae, including *Fucus ceranoides*, on rocky shores and of the seagrass *Ruppia maritima* in silty areas within the brackish parts of these lochs. Of the fully marine sealochs, Powell *et al.* (1979) found Loch Eynort to have interesting littoral rapids communities, and on the west coast Rubha Ardvule was considered to have the richest exposed rocky shores of those examined on the island. They also found the Bagh nam Faileann area, with its sand flats and rapids communities, to be of interest.

Farther north, on North Uist, Stephen (1935) found a distinction between the exposed sandy shores with their poor polychaete fauna and the more sheltered sites where the bivalves *Macoma balthica* and *Cerastoderma edule* were present in great abundance. On these North Uist strands an *Angulus tenuis* zone was apparently

absent. Eleftheriou (1970) examined the Vally and Vallaquie Strands on the island as potential nursery grounds for flatfish and, like Stephen (1935) before him, found these beaches to be faunistically quite impoverished. Eleftheriou & McIntyre (1976) reported an amphipod community from the exposed beach at Traigh Iar. Lewis (1957) described the rocky shore communities of North Uist, from those on the exposed coast, characterised by the kelp *Alaria esculenta*, barnacles and red algae, to the sheltered densely furoid-covered shores of Loch Maddy. He considered this sealoch to be one of the richest and most interesting systems in the British Isles; Loch Maddy is a Marine Consultation Area (MCA) (NCC 1990). Of particular interest was a mid-shore band of the brown alga *Himanthalia elongata* which replaced *Fucus serratus*, which was associated with tidal rapids, an unusual occurrence for such sheltered waters. The rapids areas within the Loch Maddy supported a very rich fauna with underboulder communities dominated by the ascidian *Dendrodoa grossularia*. Surveys for the MNCR (Howson 1991) confirmed the continuance of the situation described by Lewis (1957). Of the shores on the open coast, Powell *et al.* (1979) found the sedimentary shores of the Grimsay area and the rocky shores at Griminish Point to be the most important. The Grimsay area comprised a wide range of sediment types, with examples of *Lanice*, *Scrobicularia*, *Arenicola* and *Echinocardium-siliqua* communities, together with both exposed and sheltered rocky communities. Griminish Point is the most wave-exposed shore in the Uists and was found to have fine examples of exposed rocky shore communities. Nicol (1936a) and Dunn (1937) gave

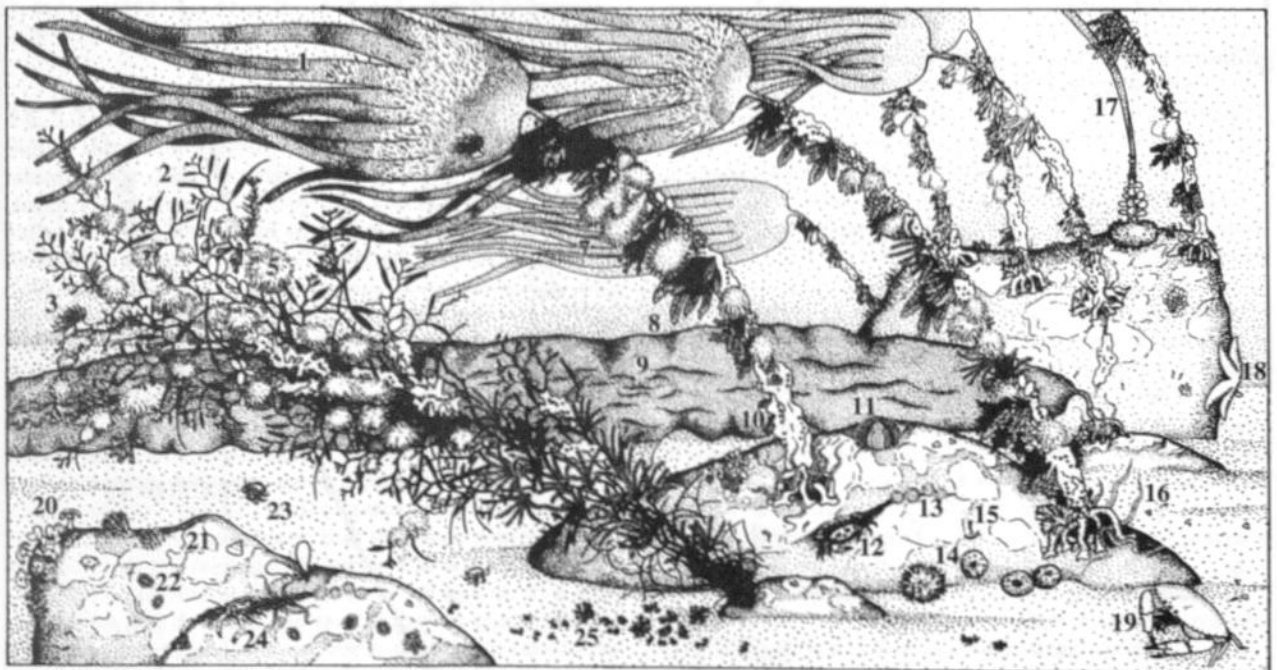


Figure 14.3. A tidal rapids community. Species illustrated include: 1. *Laminaria hyperborea*, 2. *Halidrys siliquosa*, 3. *Anemonia viridis*, 4. *Scypha ciliata*, 5. *Leucosolenia botryoides*, 6. *Antedon bifida*, 7. *Alcyonium digitatum*, 8. *Delesseria sanguinea*, 9. *Laminaria saccharina*, 10. *Halichondria panicea*, 11. *Echinus esculentus*, 12. *Necora puber*, 13. *Sagartia elegans*, 14. *Urticina felina*, 15. *Pomatoceros triqueter*, 16. *Ophiothrix fragilis*, 17. *Saccorhiza polyschides*, 18. *Asterias rubens*, 19. *Cancer pagurus*, 20. *Metridium senile*, 21. Encrusting Corallinacea, 22. *Lepidochitona cinerea/Tonicella rubra*, 23. *Pagurus bemhardus*, 24. *Galathea* sp., 25. *Phymatolithon calcareum*. From Howson, Connor & Holt (1994). (Drawing by Sue Scott.)

descriptions of the brackish-water lochs of the North Uist, and these were given further attention by Mitchell *et al.* (1980) and Dipper, Lumb & Palmer (1987) who highlighted the importance of Loch Obisary (Figure 14.4). Edwards (1989) discussed the physical and chemical nature of Loch Obisary, suggesting that there is deep saline water at the bottom of the north basin which is only slowly replaced and likely to produce anoxic sediments. The hydrography of the loch appears to be unique in the British Isles, with a permanent halocline giving a vertical separation of brackish and marine communities.

The sublittoral zone of the Uists has been less well studied than the shores, and much of the existing information comes from NCC-sponsored surveys. Rostron (1984) provided brief descriptions of sites from surveys undertaken in Lochs Boisdale, Skipport, Sheilavaig, Carnan, Eport and Maddy. Loch Eynort, in South Uist, was found to support a wide variety of communities for its small size, including maerl beds, gravel beds with the brown alga *Asperococcus turneri*, rich circalittoral rock communities with the sea fan *Swiftia pallida* and a rich rapids area (Dipper 1985). The loch is an MCA (NCC 1990). More recent surveys for the MNCR (Howson 1991) of Lochs Boisdale, Skipport, Uiskevagh, Eport and Maddy have shown most of the sealochs, even towards their mouths, to be fairly sheltered from wave action, as they all open to the east. The very sheltered rocky areas supported a forest of the cape form of *Laminaria hyperborea* to the seaward side of areas with forests of *Laminaria saccharina*. Sediments were predominantly fine and muddy. At the mouths of the sealochs these sediments were colonised by the burrowing shrimp *Calocaris macandreae*. In much softer muds in the upper reaches of the sealochs the very rarely encountered holothurian *Labidoplax media* was found, in considerable numbers in Loch Maddy. Another holothurian, *Leptosynapta bergensis*, was common at one site in Loch Boisdale. As Lewis (1957) found with the shores, the sublittoral zone of Loch Maddy was very complex, with the inner loch comprising a series of basins that drain via very narrow channels and form several waterfalls on the ebb and flood tides. Maerl beds

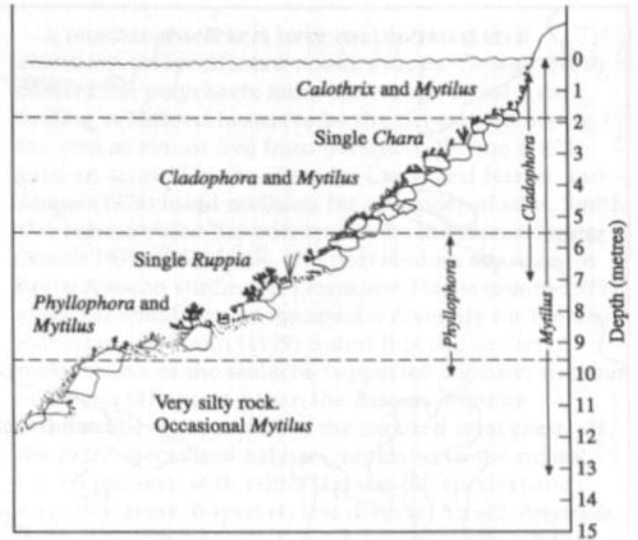


Figure 14.4. Vertical distribution of the main zones and communities in the south basin of Loch Obisary. (From Dipper, Lumb & Palmer 1987.)

were present in the numerous tidal channels, and exceptionally long kelp plants, with very large growths of the sponges *Leucosolenia botryoides* and *Halichondria panicea* on their stipes, grew near the waterfalls (Figure 14.3).

The obs on North and South Uist and Benbecula have been surveyed by the MNCR between 1993 and 1995. They included a variety of substrata and biotopes depending especially on salinity, the degree of shelter, their depth and type of lagoon. Shallow areas were often dominated by macrophytes (seagrass *Zostera marina*, dwarf seagrass *Zostera noltii*, beaked tasselweed *Ruppia maritima* and spiral tasselweed *Ruppia spiralis* (now *Ruppia cirrhosa*), and the lagoon species foxtail stonewort *Lamprothamnium papulosum*. Filamentous green algae often dominated the surface of rocks and sediments. Sediments were especially colonised by the worms *Arenicola marina* and *Hediste diversicolor*. The tide-swept rapids included coralline crusts and often rich communities of sponges and ascidians.

14.3 Lewis and Harris

Lewis and Harris (Figure 14.5), although much less a mosaic of land and water than the Uists, are nevertheless quite highly indented and have a very wide range of habitats. The sealochs tend to be much deeper and more fjordic in character than those in the Uists, and the west coast is more exposed, as the north-west coast of Lewis lacks the wide shallow shelf which is so characteristic of the west coast of the Uists. The cliffs on this north-west coast unusually have saltmarsh at the top, indicating the frequency of marine influence up to 50 m above sea level.

Powell *et al.* (1979) provided an overall appraisal of the shores, choosing seven areas to give a representative selection of habitats for the islands. Of these, Loch Roag

was considered to be of outstanding importance because of its wide range of communities. In the loch there were a number of rapids which supported large quantities of suspension-feeding species such as ascidians, and some shores had species typical of the sublittoral, such as the alga *Nitophyllum punctatum* and the featherstar *Antedon bifida*. The north-west coast of Lewis was predominantly rocky with good examples of very exposed shores and small pocket beaches. In Broad Bay the sandstone shores represented the only rocky shores in the area not composed of gneiss. The Bay had rock and sediment habitats in both exposed and sheltered conditions. The shores at the entrance to Loch Erisort were representative of the east coast of Lewis and Harris, and



Based on Admiralty Chart 2635 with the permission of the Controller of Her Majesty's Stationery Office. © Crown copyright.

Figure 14.5. Lewis and Harris, showing places mentioned in the text.

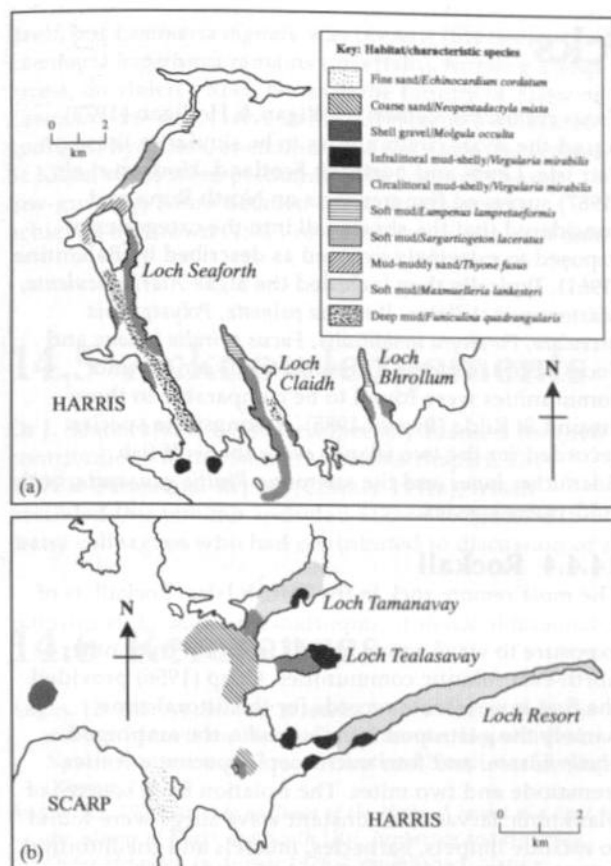


Figure 14.6. Distribution of sediment communities in (a) Lochs Seaforth, Claidh and Bhrollum (east Lewis) and (b) Lochs Tamanavay, Tealasavay and Resort (west Lewis) (re-drawn from Howson 1989).

notable for the presence of the non-native barnacle *Elminius modestus*. For sheltered habitats, and shores subject to brackish conditions, the small tidal inlet of the Obbe at Leverburgh was found to have moderately rich fauna and a variety of communities. The Luskentyre area of Harris supported the richest and most varied sediment shores in the area. The offshore island group of the Shiantas was found to have rich cave habitats and an exceptionally well developed lichen *Xanthoria parietina* zone. Loch Roag and the Obbe have been promoted as MCAs (NCC 1990).

In an overview of Britain's coastal lagoons, Barnes (1988) considered Scotland to have only two proper lagoons, both of which are situated in Lewis, at Loch Ordais and Loch Arnol on the north-west coast. This rarity of true saline lagoons (as opposed to lagoonal definitions of other workers) places considerable importance on these sites. Both sites fall into the category of 'streams dammed by sand and/or shingle bars', and Loch Arnol is only temporarily a brackish lagoon, being for the most time freshwater, whilst Loch Ordais is permanently brackish, supporting the seagrass *Ruppia* spp. (MNCR, unpublished data).

A number of workers have concentrated their attentions on specific taxonomic groups. George (1979) studied the polychaete fauna at a range of habitats, finding sublittoral faunas to be the richest and noting the area as almost free from pollution. Norton (1972) gave an account of the algae for Lewis and Harris, and Angus (1976) listed molluscs for a number of sites. Smith also concentrated her surveys on the molluscan fauna (Smith 1979, 1982, 1983). She provided an overview of her molluscan studies on Lewis and Harris (Smith 1979), giving an indication of the species diversity for the main habitat types. Smith (1979) found that the sheltered rocky shores of the sealochs supported a greater number of species (47 species) than the *Balanus-Mytilus* communities (15 species) of the exposed west coast. Of the more specialised habitats, rapids were the richest (50–65 species), with saline lagoons (26 species) and estuarine areas (6 species) less diverse. Ansell, Angus & Robb (1985) and Ansell, Robb & Powell (1988) studied populations of the bivalve *Donax vittatus*, including work on their mass mortality following dislodgement from the sediment because of excessive algal growth on the shells.

As with other parts of the Outer Hebrides, the sublittoral zone of Lewis and Harris is not well studied. Rostron (1984) provided a brief description of sites in the Obbe and in Lochs Roag and Mharabhig. Dipper (1983) described in more detail the communities of Loch Roag, which included the seagrass *Zostera marina* and horse mussel *Modiolus modiolus* beds. The area was noted for its range of sediment types and for the variety of communities in the many rapids of the sealoch complex. Lochs Seaforth, Claidh and Bhrollum on the east of Lewis and Harris and Lochs Tamanavay, Tealasavay and Resort on the west coast were surveyed by Howson (1989) as part of NCC's sealoch survey. Loch Seaforth, the only large fjordic sealoch in the Western Isles, was found to contain typical fjordic communities such as the *Neocrania anomala/Protanthea simplex* association of sheltered bedrock (Figure 14.6a), and has been given MCA status (NCC 1990). The deep muds of Loch Seaforth and Loch Claidh had populations of the tall sea pen *Funiculina quadrangularis*, as do many of the mainland fjordic lochs. In contrast, the soft muds of Lochs Resort and Tamanavay supported large numbers of the echinuran *Maxmuelleria lankesteri*, a species found in only a few other sealochs. At the exposed mouths to the west coast sealochs, shell-gravel was colonised by the large and uncommon ascidian *Molgula occulta* (Figure 14.6b). The NCC's sealoch survey was continued by Holt (1991) who carried out mainly sublittoral surveys of Lochs Stockinish, East and West Tarbert, Erisort, Leurbost and Grimshader. The infralittoral bedrock communities ranged from *Laminaria hyperborea* in wave- and tide-exposed areas to dense *Laminaria saccharina* in the most sheltered areas. *Leptometra celtica*, *Swiftia pallida* and *Diazona violacea* were typically found at the entrances to the east coast sealochs. Loch Erisort held a particularly wide range of sediment communities including undisturbed sediment with the sea pen *Virgularia mirabilis* and the opisthobranch *Philine aperta*.

14.4 Outlying islands and rocks

14.4.1 Introduction

The offshore islands and rocks of St Kilda, Sula Sgeir, North Rona and Rockall have attracted much attention because of their isolation and remoteness. Such areas often offer extremes of wave exposure which are of interest to ecological studies and provide ground for the discovery of new records of species. Their remoteness is also useful in the study of speciation and biogeographic trends.

14.4.2 St Kilda

The St Kilda group has predominantly very exposed rocky shores, many of which are vertical and broken by sea-caves. Hiscock (1992) considered these cave systems to be special features of the Scottish marine environment. Gauld, Bagenal & Connell (1953) found the shores to be remarkably uniform, with three distinct zones: a supralittoral fringe of bare rock with limpets *Patella vulgata* and the red alga *Porphyra umbilicalis*; a midlittoral zone dominated by barnacles, and a sublittoral fringe with the kelp *Alaria esculenta* and calcareous algae. The single sediment beach of the islands, in Village Bay, is a sandy beach which is completely washed away in winter, leaving a storm beach of boulders. This shore, also described by Scott (1960), supported a sparse fauna of amphipods, the worm *Nephtys cirrosa* and the isopod *Eurydice pulchra*. The extreme exposure to wave action has brought about records of marine species at very high altitudes. Bagenal (1957) noted *Littorina saxatilis* and *Enteromorpha* sp. at 95 feet (29 m) above sea level and the amphipod *Orchestia gammarellus* at 350 feet (107 m). Watling, Irvine & Norton (1970) gave an account of the marine algae of the St Kilda group.

The sublittoral zone of St Kilda is renowned for its clear oceanic waters, extensive vertical rock faces and complex system of caves and tunnels. The combination of high wave exposure and constant surge produces a rich marine life which comprises mainly encrusting or low-growing species, such as sponges, polyclinal ascidians and anemones (Howson & Picton 1985). The caves and tunnels, which are probably the best-developed in Britain, and the extensive wave-exposed communities, resulted in MCA status for the island group (NCC 1990). St Kilda is owned by the National Trust for Scotland and is recognised as a site of international importance, being designated a World Heritage Site, a Biosphere Reserve, a National Nature Reserve and a National Scenic Area.

14.4.3 North Rona and Sula Sgeir

The islands to the north of the Butt of Lewis are isolated and have required dedicated expeditions to reach their shores. Powell (1958) visited the islands in the 1950s as part of his work on furoid algae, in this case the two subspecies of *Fucus distichus* which occur on the islands. Rice & Chapman (1985) also used samples of furoids from the region in a taxonomic study of *Fucus distichus* subspecies. On the basis of morphology they determined that there were actually two species; *Fucus distichus* and

Fucus evanescens. Gilbert, Holligan & Holligan (1973) found the shore communities to be similar to those on Fair Isle, Lewis and northern Scotland. Hodson *et al.* (1987) surveyed five transects on North Rona and considered that the shores fell into the categories of exposed to extremely exposed as described by Ballantine (1961). Typically they included the algae *Alaria esculenta*, *Mastocarpus stellatus*, *Palmaria palmata*, *Polysiphonia urceolata*, *Porphyra umbilicalis*, *Fucus spiralis* f. *nana* and *Fucus distichus anceps*. The sublittoral scenery and communities were found to be comparable to those around St Kilda (Brown 1985). Amongst the species recorded for the two islands were the wolf fish *Anarhichas lupus* and the anemone *Phellia gausapata*, both cold-water species.

14.4.4 Rockall

The most remote rock in the British Isles, Rockall, is of considerable scientific importance because of its extreme exposure to wave action and its isolation from other north-east Atlantic communities. Crisp (1956) provided the first invertebrate records for the littoral zone, namely the gastropod *Littorina rudis*, the amphipod *Hyale nilssoni* and four microscopic species; a rotifer, trematode and two mites. The isolation from sources of planktonic larvae and constant wave surge were found to exclude limpets, barnacles, mussels and the littorinid *Littorina neritoides*, all species that are typically present on other very exposed shores. Moore (1977) listed a further 11 microscopic littoral species, and confirmed Crisp's (1956) view that none of the littoral fauna has a pelagic dispersal phase. This has prompted the idea that the rock is too remote and too small to receive recruitment of larvae from larger land masses. Powell & Chamberlain (1956) gave an account of the plant life on the rock, describing an *Alaria esculenta* zone in the sublittoral fringe, a narrow band of red algae, and then wide bands of black and green algae/lichens above in the splash zones. This zonation was considered to be similar to other very exposed coasts, although species diversity was perhaps lower and the vertical extent of the zones was extended considerably due to wave action.

Brown (1987) provided the first description of sublittoral communities around Rockall from an amateur expedition. He reported a total lack of kelp *Laminaria* spp., with the sublittoral fringe species *Alaria esculenta* extending down to 35 m, considerably deeper than at any other very exposed location in the British Isles. Rock surfaces were covered by species typical of wave surge conditions, and the expedition failed to find any soft coral *Alcyonium digitatum*, ascidians or fish. An MNCR team added considerably to these findings in 1988 (Laffoley & Hiscock 1988) in the first scientific expedition to survey both the littoral and sublittoral communities and to include the adjacent reefs of Hasselwood Rock and Helen's Reef. The survey yielded the first records of a barnacle (*Verruca stroemia*) and a limpet (*Tectura virginea*) from the littoral zone of Rockall. Again *Laminaria* was found to be absent from Rockall

itself, but *Laminaria digitata* was present (the presence of *Laminaria hyperborea* remains uncertain), forming a kelp forest, on Helen's Reef. Beneath the canopy of *Alaria* or *Laminaria* the rocks were richly covered by a mosaic of sponges, hydroids, anemones and red algae. As around St Kilda, these were predominantly encrusting and low-growing. More detailed surveying than was achieved by Brown (1987) revealed the presence of fish,

ascidians and *Alcyonium digitatum*, although the latter appeared to be confined to the deeper rock at about 45 m. Although the rocks were very richly colonised, species diversity was not particularly high, as might be expected in such an extreme environment and remote location. The oceanography, including biotic aspects, of the Rockall Trough and adjacent waters was discussed in a symposium volume (Mauchline 1986).

14.5 Acknowledgements

Dr J. Baxter and S. Scott are especially thanked for their contributions to or comments on this chapter. The MNCR Occasional Report (Connor 1991a), which preceded this volume, included acknowledgement to many colleagues who had contributed to discussion of a

review of MNCR sectors 12 to 15 including, for Sector 14, G. Brown, Nature Conservancy Council staff (especially the Regional and Headquarters staff) in Scotland and H. Powell.

14.6 References

- Angus, I.S. 1976. *A check list of species in the collection of marine molluscs of Lewis and Harris, Outer Hebrides*. Unpublished, Nature Conservancy Council (Scotland North-west Region). (Report, No. 22.)
- Angus, I.S. 1977. *Marine molluscs of the Uists. A report of a visit to the islands of North and South Uist, Benbecula and Berneray, Outer Hebrides, in August 1976*. Unpublished, Nature Conservancy Council (Scotland North-west Region). (Report, No. 20.)
- Angus, I.S. 1979. The macrofauna of intertidal sand in the Outer Hebrides. In: *The natural environment of the Outer Hebrides*, ed. by J.M. Boyd, *Proceedings of the Royal Society of Edinburgh. Series B: Biological Sciences*, 77: 155-171.
- Ansell, A.D., Angus, I.S., & Robb, L. 1985. *Variations in shell morphology and growth of the banded wedge shell Donax vittatus in populations in Lewis and Harris*. (Contractor: Scottish Marine Biological Association, Oban.) Unpublished report to Comhairle nan Eilean. (SMBA Internal Report, No. 131.)
- Ansell, A.D., Robb, L., & Powell, H.T. 1988. Algal-induced dislodgement as a cause of bivalve mortality on some Scottish beaches. *Journal of the Marine Biological Association of the United Kingdom*, 68: 219-234.
- Bagenal, T.B. 1957. The vertical range of some littoral animals on St Kilda. *Scottish Naturalist*, 69: 50-51.
- Bailey, R.S., Hislop, J.R.G., & Mason, J. 1979. The fish and shellfish resources in seas adjacent to the Outer Hebrides. In: *The natural environment of the Outer Hebrides*, ed. by J.M. Boyd, *Proceedings of the Royal Society of Edinburgh. Series B: Biological Sciences*, 77: 479-494.
- Ballantine, W.J. 1961. A biologically-defined exposure scale for the comparative description of rocky shores. *Field Studies*, 1: 1-19.
- Barnes, R.S.K. 1988. The coastal lagoons of Britain: an overview. (Contractor: University of Cambridge, Department of Zoology, Cambridge.) *Nature Conservancy Council, CSD Report*, No. 933.
- Bishop, G.M., & Holme, N.A. 1980. Survey of the littoral zone of the coast of Great Britain. Final report - part 1: The sediment shores - an assessment of their conservation value. (Contractor: Marine Biological Association/Scottish Marine Biological Association, Plymouth.) *Nature Conservancy Council, CSD Report*, No. 326.
- Boyd, J.M. 1979. *The natural environment of the Outer Hebrides. Proceedings of the Royal Society of Edinburgh. Series B: Biological Sciences*, 77.
- Brown, G. [1985]. *British Sub-Aqua Club expedition to Rona, Sula Sgeir and Stack Skerry*. Unpublished, British Sub-Aqua Club. (Expedition Scheme Report.)
- Brown, G. 1987. *Inverness Sub-Aqua Club expedition to Rockall*. Unpublished, Inverness Sub-Aqua Club.
- Bryan, A. 1994. *The Minch review*. Scottish Natural Heritage/Comhairle nan Eilean.
- Buck, A.L. 1993. *An inventory of UK estuaries. Volume 3. North-west Britain*. Peterborough, Joint Nature Conservation Committee.
- Campbell, R.N., & Williamson, R.B. 1979. The fishes of the inland waters of the Outer Hebrides. In: *The natural environment of the Outer Hebrides*, ed. by J.M. Boyd, *Proceedings of the Royal Society of Edinburgh. Series B: Biological Sciences*, 77: 377-393.
- Connor, D.W. 1991a. Benthic marine ecosystems in Great Britain: a review of current knowledge. Clyde Sea, west Scotland, Outer Hebrides and north-west Scotland (MNCR Coastal sectors 12 to 15). *Nature Conservancy Council, CSD Report*, No. 1175. (Marine Nature Conservation Review Report, No. MNCR/OR/11.)
- Connor, D.W. 1991b. Norwegian fjords and Scottish sealochs: a comparative study. *Joint Nature Conservation Committee Report*, No. 12. (Marine Nature Conservation Review Report, No. MNCR/SR/18.)
- Connor, D.W. 1994. The sublittoral ecology of Scotland's islands. In: *The islands of Scotland. A living marine heritage*, ed. by J.M. Baxter & M.B. Usher, 144-159. HMSO for Scottish Natural Heritage.
- Crisp, D.J. 1956. Appendix C: The intertidal zoology of Rockall. In: *Rockall*, ed. by J. Fisher, 177-179. London, Geoffrey Bles.
- Dipper, F. 1983. Sublittoral survey of habitats and species in and around Loch Roag, Lewis, Outer Hebrides. (Contractor: Underwater Conservation Society, Ross-on-Wye.) *Nature Conservancy Council, CSD Report*, No. 505.
- Dipper, F. 1985. Sublittoral survey of Loch Eynort, South Uist, Outer Hebrides, July 14th to July 28th 1984. (Contractor: Marine Conservation Society, Ross-on-Wye.) *Nature Conservancy Council, CSD Report*, No. 611.

- Dipper, F., & Mitchell, R. 1980. Sublittoral survey of selected marine and brackish water ecosystems of the Uists, Outer Hebrides. *Nature Conservancy Council, CSD Report, No. 275.*
- Dipper, F.A., Lumb, C.M., & Palmer, M.A. 1987. A littoral, sublittoral and limnological survey of Loch Obisary, North Uist 21 to 29 June 1985. (Contractor: F.A. Dipper, Huntingdon.) *Nature Conservancy Council, CSD Report, No. 807.*
- Dunn, M.D. 1937. Notes on the flora of Loch Harray and Loch Stenness and a comparison with the brackish-water lochs of North Uist. *Transactions and Proceedings of the Botanical Society of Edinburgh, 32: 368-372.*
- Earl, R.C., & Pagett, R.M. 1984. A classification and catalogue of the sea lochs of the Western Isles. (Contractor: Marine Biological Consultants Ltd, Kempsey, Gloucestershire.) *Nature Conservancy Council, CSD Report, No. 525.*
- Edwards, A. 1989. The Loch Obisary surveys 1986/7. (Contractor: Scottish Marine Biological Association, Oban.) *Nature Conservancy Council, CSD Report, No. 952.*
- Eleftheriou, A. 1970. *Report on the general biological survey at North Uist.* Unpublished, Department of Agriculture and Fisheries for Scotland.
- Eleftheriou, A., & McIntyre, A.D. 1976. *The intertidal fauna of sandy beaches - a survey of the Scottish coast Aberdeen,* Department of Agriculture and Fisheries for Scotland. (Scottish Fisheries Research Report, No. 6.)
- Ellett, D.J. 1979. Some oceanographic features of Hebridean waters. In: *The natural environment of the Outer Hebrides*, ed. by J.M. Boyd, *Proceedings of the Royal Society of Edinburgh. Series B: Biological Sciences, 77: 61-74.*
- Farrow, G.E. 1974. On the ecology and sedimentation of the *Cardium* shell sands and transgressive shellbanks of Traigh Mhor, Island of Barra, Outer Hebrides. *Transactions of the Royal Society of Edinburgh, 69: 203-230.*
- Forrest, J.E., Waterston, A.R., & Watson, E.V. 1936. The natural history of Barra, Outer Hebrides. The results of a scientific expedition organised by the Biological Society of the University of Edinburgh, 1st to 14th July 1935. *Proceedings of the Royal Physical Society of Edinburgh, 22: 244-296.*
- Gauld, D.T., Bagenal, T.B., & Connell, J.H. 1953. The marine fauna and flora of St Kilda. *Scottish Naturalist, 65: 29-49.*
- George, J.D. 1979. The polychaetes of Lewis and Harris with notes on other marine invertebrates. In: *The natural environment of the Outer Hebrides*, ed. by J.M. Boyd, *Proceedings of the Royal Society of Edinburgh. Series B: Biological Sciences, 77: 189-216.*
- Gilbert, O.L., Holligan, P.M., & Holligan, M.S. 1973. The flora of North Rona, 1972. *Transactions and Proceedings of the Botanical Society of Edinburgh, 42: 43-68.*
- Gosse, P.H. 1865. *A year at the shore.* London, Alexander Strahan.
- Gunning, B.E.S., Pate, J.S., & Crossett, R.N. 1966. The distribution of intertidal algae in a Hebridean Loch. *Transactions and Proceedings of the Botanical Society of Edinburgh, 40: 185-194.*
- Harvey, R., Knight, S.J.T., Powell, H.T., & Bartrop, J. 1980. Survey of the littoral zone of the coast of Great Britain. Final report - part 2: The rocky shores - an assessment of their conservation value. (Contractor: Marine Biological Association/Scottish Marine Biological Association, Oban.) *Nature Conservancy Council, CSD Report, No. 326.*
- Hiscock, K. 1992. The ecology and conservation of sublittoral hard substratum ecosystems in Scotland. In: *Marine conservation in Scotland*, ed. by J.M. Baxter & A.D. McIntyre, *Proceedings of the Royal Society of Edinburgh. Series B: Biological Sciences, 100: 95-112.*
- Hodson, D.P., Millar, W., Pratley, J., Thomas, J., & Twemlow, M. 1987. Report on the littoral survey of North Rona, July 1987. In: *North Rona - an island survey.* Rutland Sixth Form College/Leicester Polytechnic, School of Life Sciences.
- Howson, C.M. 1989. Surveys of Scottish sealochs. Sealochs on the Isles of Harris and Lewis. (Contractor: University Marine Biological Station, Millport.) *Nature Conservancy Council, CSD Report, No. 982.*
- Howson, C.M. 1991. Surveys of Scottish sealochs. The sealochs of North and South Uist and Benbecula. (Contractor: University Marine Biological Station, Millport.) *Joint Nature Conservation Committee Report, No. 3.*
- Howson, C.M., Connor, D.W., & Holt, R.H.F. 1994. The Scottish sealochs. An account of surveys undertaken for the Marine Nature Conservation Review. (Contractor: University Marine Biological Station, Millport.) *Joint Nature Conservation Committee Report, No. 164.* (Marine Nature Conservation Review Report, No. MNCR/SR/27.)
- Howson, C.M., & Picton, B.E. 1985. A sublittoral survey of St Kilda. (Contractor: British Sub-Aqua Club/Marine Conservation Society.) *Nature Conservancy Council, CSD Report, No. 595.*
- Holt, R. 1991. Surveys of Scottish sealochs. Sealochs of the Islands of Harris and Lewis. Part II. (Contractor: University Marine Biological Station, Millport.) *Joint Nature Conservation Committee Report, No. 4.*
- Laffoley, D.d'A., & Hiscock, K. 1988. *Marine biological survey of Rockall, 28 and 29 June 1988. Field report.* Unpublished, Nature Conservancy Council, Peterborough.
- Lee, A.J., & Ramster, J.W. 1981. *Atlas of the seas around the British Isles.* 1st ed. Lowestoft, Ministry of Agriculture, Fisheries and Food, Directorate of Fisheries Research.
- Lewis, J.R. 1957. An introduction to the intertidal ecology of the rocky shores of a Hebridean island. *Oikos, 8: 130-160.*
- M'Intosh, W.C. 1866. Observations on the marine zoology of North Uist, Outer Hebrides (Coelenterata, Mollusca, Echinodermata, Gephyrea and Pisces). *Proceedings of the Royal Society of Edinburgh, 5: 600-614.*
- Maggs, C.A. 1986. Scottish marine macroalgae: a distributional checklist, biogeographical analysis and literature abstract. (Contractor: C.A. Maggs, Belfast.) *Nature Conservancy Council, CSD Report, No. 635.*
- Mauchline, J., ed. 1986. *The oceanography of the Rockall Channel. Proceedings of the Royal Society of Edinburgh. Series B: Biological Sciences, 88.*
- Mitchell, R., Dipper, F.A., Earl, R., & Rowe, S. 1980. A preliminary study of Loch Obisary: a brackish Hebridean loch. *Progress in Underwater Science, New series: 5: 99-118.*
- Moore, P.G. 1977. Additions to the littoral fauna of Rockall, with a description of *Araeolaimus penelope* sp. nov. (Nematoda: Axonolaimidae). *Journal of the Marine Biological Association of the United Kingdom, 57: 191-200.*
- Nature Conservancy Council. 1990. *Marine Consultation Areas: Scotland.* Unpublished, Nature Conservancy Council (Scotland), Edinburgh.
- Nicol, E.A.T. 1936a. The brackish-water lochs of North Uist. *Proceedings of the Royal Society of Edinburgh, 56: 169-195.*
- Nicol, E.A.T. 1936b. The fauna of Loch Bee. *Scottish Naturalist, 131-134.*
- Norton, T.A. 1972. The marine algae of Lewis and Harris in the Outer Hebrides. *British Phycological Journal, 7: 375-385.*
- Norton, T.A., & Powell, H.T. 1979. Seaweeds and rocky shores of the Outer Hebrides. In: *The natural environment of the Outer Hebrides*, ed. by J.M. Boyd, *Proceedings of the Royal Society of Edinburgh. Series B: Biological Sciences, 77: 141-153.*
- Powell, H.T. 1957. Studies in the genus *Fucus* L. II. Distribution and ecology of forms of *Fucus distichus* L. emend Powell in Britain and Ireland. *Journal of the Marine Biological Association of the United Kingdom, 36: 663-693.*
- Powell, H.T. 1958. Occurrence of forms of *Fucus distichus* L. emend. Powell on North Rona and Sula Sgeir. *Nature, 182: 1246.*

- Powell, H.T., & Chamberlain, Y.M. 1956. Appendix B: Plant life on Rockall. In: *Rockall*, ed. by J. Fisher, 1-6. London, Geoffrey Bles.
- Powell, H.T., Holme, N.A., Knight, S.J.T., Harvey, R., Bishop, G., & Bartrop, J. 1979. Survey of the littoral zone of the coast of Great Britain. 3. Shores of the Outer Hebrides. (Contractor: Scottish Marine Biological Association/Marine Biological Association Intertidal Survey Unit, Oban.) *Nature Conservancy Council, CSD Report*, No. 272.
- Rice, E.L., & Chapman, A.R.O. 1985. A numerical taxonomic study of *Fucus distichus* (Phaeophyta). *Journal of the Marine Biological Association of the United Kingdom*, 65: 433-459.
- Rostron, D. 1984. Western Isles sea loch survey, July 1984. (Contractor: Field Studies Council, Oil Pollution Research Unit, Pembroke.) *Nature Conservancy Council, CSD Report*, No. 594.
- Scott, A. 1960. The fauna of the sandy beach, Village Bay, St Kilda: a dynamical relationship. *Oikos*, 11: 153-160.
- Sinclair, J. 1938. The marine algae of Barra. *Transactions and Proceedings of the Botanical Society of Edinburgh*, 32: 432-437.
- Smith, S.M. 1978. Mollusca of rocky shores: North Uist, Benbecula and South Uist, Outer Hebrides. (Contractor: S.M. Smith, Edinburgh.) *Nature Conservancy Council, CSD Report*, No. 210.
- Smith, S.M. 1979. Mollusca of rocky shores: Lewis and Harris, Outer Hebrides. In: *The natural environment of the Outer Hebrides*, ed. by J.M. Boyd, *Proceedings of the Royal Society of Edinburgh. Series B: Biological Sciences*, 77: 173-187.
- Smith, S.M. 1982. The shores of the east coast of Lewis and Harris between Lochs and Leverburgh, with emphasis on the Mollusca. (Contractor: S.M. Smith, Edinburgh.) *Nature Conservancy Council, CSD Report*, No. 410.
- Smith, S.M. 1983. The shores of Lewis: Marine flora and fauna. (Contractor: S.M. Smith, Edinburgh.) *Nature Conservancy Council, CSD Report*, No. 470.
- Smith, S.M. 1987. Obs in northwest Scotland and the Hebrides. (Contractor: S.M. Smith, Carlisle.) *Nature Conservancy Council, CSD Report*, No. 801.
- Spence, D.H.N., Allen, E.D., & Fraser, J. 1979. Macrophytic vegetation of fresh and brackish waters in and near the Loch Druidibeg National Nature Reserve, South Uist. In: *The natural environment of the Outer Hebrides*, ed. by J.M. Boyd, *Proceedings of the Royal Society of Edinburgh. Series B: Biological Sciences*, 77: 307-328.
- Stephen, A.C. 1930. Studies on the Scottish marine fauna. Additional observations on the fauna of the sandy and muddy areas of the tidal zone. *Transactions of the Royal Society of Edinburgh*, 56: 521-535.
- Stephen, A.C. 1935. Notes on the intertidal fauna of North Uist. *Scottish Naturalist*, 1935: 137-142.
- Walker, F.T. 1947. A seaweed survey of Scotland: Fucaceae. *Proceedings of the Linnean Society of London*, 159: 90-99.
- Waterston, A.R., Holden, A.V., Campbell, R.N., & Maitland, P.S. 1979. The inland waters of the Outer Hebrides. In: *The natural environment of the Outer Hebrides*, ed. by J.M. Boyd, *Proceedings of the Royal Society of Edinburgh. Series B: Biological Sciences*, 77: 329-352.
- Waterston, A.R., & Lyster, I.H.J. 1979. The macrofauna of brackish and fresh waters of the Loch Druidibeg National Nature Reserve and its neighbourhood, South Uist. In: *The natural environment of the Outer Hebrides*, ed. by J.M. Boyd, *Proceedings of the Royal Society of Edinburgh. Series B: Biological Sciences*, 77: 353-376.
- Watling, R., Irvine, L.M., & Norton, T.A. 1970. The marine algae of St Kilda. *Transactions and Proceedings of the Botanical Society of Edinburgh*, 41: 31-42.

15.1 Introduction

The coast of north-west Scotland, from the Point of Ardnamurchan to Cape Wrath (figure 15.1), includes perhaps the least remote and rugged stretch of coast on mainland Britain. The Hebrides, dispersed along a narrow sea-loch, with the Outer Hebrides (Lewis and Harris, Raasay and the Small Isles (Canna, Eigg, Higg and Muck) lying offshore.

Sector 14 encompasses a narrow range of physical conditions to begeth the hebrides (Sector 14) and consequently includes a wide range of habitats. While much of the coast is rocky and exposed to wave action, it is sheltered from the full force of the Atlantic wind by the broad protection afforded by the Western Isles. Here too, the southern and typical deposits of the British are exposed and can be seen to considerable effect. At Harbair, extreme parts of the coastline are protected by a low of narrow and very shallow.

Here, the water is shallow and the wind is strong, and the sea is the source of much of the wind along the coast. The wind is strong and the sea is shallow and the water is shallow and the wind is strong.

The climate is temperate and the water is shallow and the wind is strong. The temperature is between 10°C and 15°C in the summer and 5°C and 10°C in the winter. The wind is strong and the sea is shallow and the water is shallow and the wind is strong.

The fauna of the north-west coast is very diverse and includes many species of plants and animals. The fauna is very diverse and includes many species of plants and animals. The fauna is very diverse and includes many species of plants and animals.

This report was compiled from a number of sources, including the work of the Marine Biological Association of the United Kingdom, the Scottish Naturalists' Club, and the Scottish Natural Heritage. The work was carried out in 1985. The report has been revised to take account of changes in the data since 1985. The report is published in the *Journal of the Marine Biological Association of the United Kingdom*, 65: 433-459. The report is published in the *Journal of the Marine Biological Association of the United Kingdom*, 65: 433-459. The report is published in the *Journal of the Marine Biological Association of the United Kingdom*, 65: 433-459.

Chapter 15: North-west Scotland (MNCR Sector 15)*

David W. Connor and Mike Little

Citation: Connor, D.W., & Little, M. 1998. North-west Scotland (MNCR Sector 15). In: *Marine Nature Conservation Review. Benthic marine ecosystems of Great Britain and the north-east Atlantic*, ed. by K. Hiscock, 385–397. Peterborough, Joint Nature Conservation Committee. (Coasts and seas of the United Kingdom. MNCR series.)

Synopsis

Descriptions of the marine biology of north-west Scotland including the northern isles of the Inner Hebrides are predominantly found in limited circulation publications commissioned by the nature conservation agencies. The coastline is greatly indented and predominantly rocky, although with some extensive sandy beaches in a few places. Rocky shore and sublittoral biotopes present range from those characteristic of very exposed coasts to those found only in extreme shelter. The sealochs, which are most intensively studied, hold some of the most extensive and richest examples of sealoch biotopes. The Loch Duich,

Alsh and Long complex holds deep mud and rock communities in extreme shelter from wave action and tidal streams but with narrows areas having typical tidal stream-swept communities. Loch Long is notable for the presence of extensive rocky areas in low salinity. On the open coast, the Summer Isles include a particularly wide range of biotopes with some rare or unusual species present. Of the localised areas of intertidal sediments the sands of Kenra Bay and Loch Moidart are noted as amongst the most extensive littoral estuarine sediments in western Scotland.

15.1 Introduction

The coast of north-west Scotland, from the Point of Ardnamurchan to Cape Wrath (Figure 15.1), includes perhaps the most remote and rugged stretch of coast on mainland Britain. It is highly dissected by a series of sealochs, with the Inner Hebridean islands of Skye, Raasay and the Small Isles (Canna, Rum, Eigg and Muck) lying offshore.

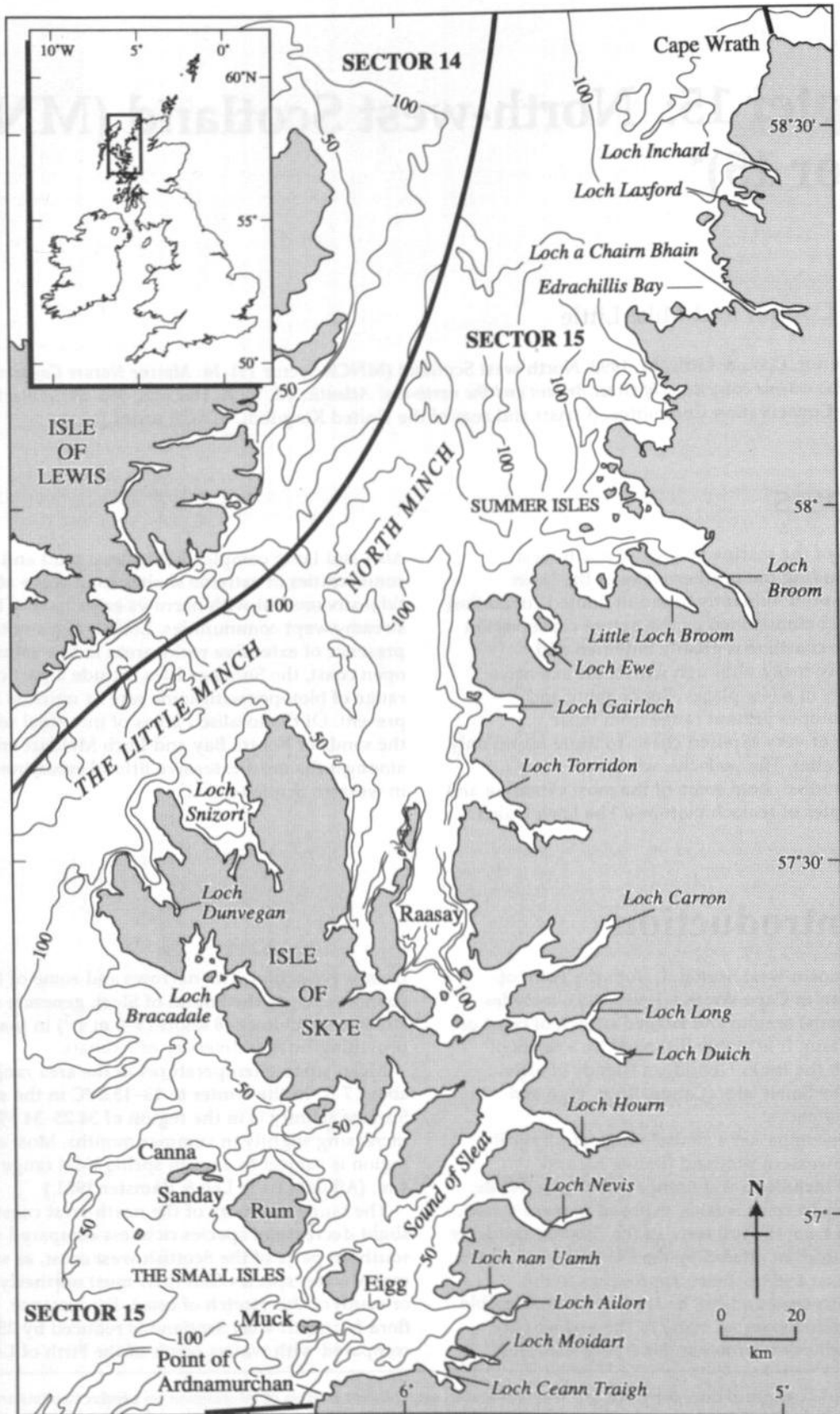
Sector 15 encompasses a similar range of physical conditions to western Scotland (Sector 13) and consequently includes a wide range of habitats. While much of the open coast is fairly exposed to wave action, it is sheltered from the full force of the Atlantic swells by the broad protection offered by the Western Isles. Even so, the southern and northern approaches to the Minches are exposed and can be subject to considerable swell. At the other extreme many of the sealochs are protected by sills or narrows and are very sheltered

from wave action. The narrows and some of the tidal sounds, such as the Sound of Sleat, generate strong tidal streams, reaching 6–8 knots ($3\text{--}4\text{ m s}^{-1}$) in places and providing further diversity of habitats.

Mean surface temperatures in the area range from about $7\text{ }^{\circ}\text{C}$ in the winter to $13\text{--}13.5\text{ }^{\circ}\text{C}$ in the summer. Surface salinity is in the region of $34.25\text{--}34.5\text{ }^{\text{‰}}$, increasing slightly in summer months. Most of the region is subject to a mean spring tidal range of about 4 m. (All data from Lee & Ramster 1981.)

The fauna and flora of the north-west coast show a slight decrease in species richness compared with more southern parts of the Scottish west coast, as some of the warm-water species find their most northerly limits on or south of this stretch of coast. For instance, the algal flora for north-west Scotland is reduced by 25 species compared with waters south of the Firth of Lorn (Maggs

* This review was completed from published and, where available, unpublished sources of information on benthic habitats and communities including the results of interviews with relevant workers undertaken up to 1991. That work was published in Connor (1991). The review has been revised to take account of major additional studies up to the end of 1994 by the second author and up to the end of 1996 by the series editor. It does not include benthic survey information summarised for or published in the MNCR *Regional Reports* series or work now being undertaken to describe and map biotopes in candidate Special Areas of Conservation. For information on conservation status and an analysis of rare and scarce seabed species, the reader is referred to the *Coastal Directories* series.



Based on Admiralty Chart 2635 with the permission of the Controller of Her Majesty's Stationery Office. © Crown copyright.

Figure 15.1. North-west Scotland (MNCR Sector 15).

1986). On the shores, the abundance of *Chthamalus* spp. is very much reduced as *Semibalanus balanoides* becomes the dominant barnacle, while northern algae such as *Odonthalia dentata* and *Ptilota plumosa* become more abundant in appropriate habitats compared with farther south (Harvey *et al.* 1980). In the sublittoral, the effect of urchin grazing is suggested as a major factor in reducing species richness in rocky areas (Dipper 1981a; Davies 1989).

The seabed of The Minch has been surveyed mainly as a part of fisheries investigations and a programme of studies using acoustic survey and ground-truthing by video and grab sampling was initiated by the SOAEFD Marine Laboratory in 1995. Surveys were carried out over an area extending throughout the Greater Minch, from off Kinlochbervie to east of Barra Head. The RoxAnn[®] acoustic seabed discrimination system was used to map the seabed sediments and the data collected were ground-truthed. Benthic samples, both epifaunal and infaunal, were collected from the sedimentary zones defined by the acoustic system using a combination of grabbing, closed-circuit television and still photography. Statistical analysis of these data revealed four broad groupings which could be related to the sediment types suggesting that these groups may represent differing biotopes. Community A was characterised by a gravel substratum and was dominated by the featherstar *Antedon bifida* while the soft mud substratum of Community B was dominated by burrowing decapods such as *Calocaris macandreae* and *Nephrops norvegicus*. Community C was characterised by mixed sediments with a variable fauna and, finally, Community D was represented by boulders and bedrock dominated by echinoderms.

15.2 Mainland coast

The mainland coast of north-west Scotland (Figures 15.2 and 15.3) was a major study area for Lewis's (1957) work on the ecology of rocky shores, from which he described general zonation patterns in relation to wave exposure and tidal movement (for instance, Figure 15.4). The well developed exposed coast communities characterised by mussels *Mytilus edulis* and red algae, so widespread on the Caithness coast (Lewis 1954), were not found to be so prevalent on the west coast. Nor did Lewis & Powell (1960) find the wide range of communities recorded in Loch Sween, Argyll, repeated in any of the lochs in north-west Scotland, although many included a proportion of Loch Sween's features together with characteristics of their own.

Further widespread surveys of shores on the north-west coast were undertaken by Eleftheriou & McIntyre (1976) and by Powell *et al.* (1980). The former, a survey of sandy beaches, concentrated on the moderately exposed and sheltered shores between Gruinard Bay and Gairloch. The moderately exposed shores were numerically dominated by crustaceans (mainly *Bathyporeia* spp. on the upper shore) and polychaetes, together with large numbers of the bivalve *Angulus tenuis* on the lower shore. The more sheltered

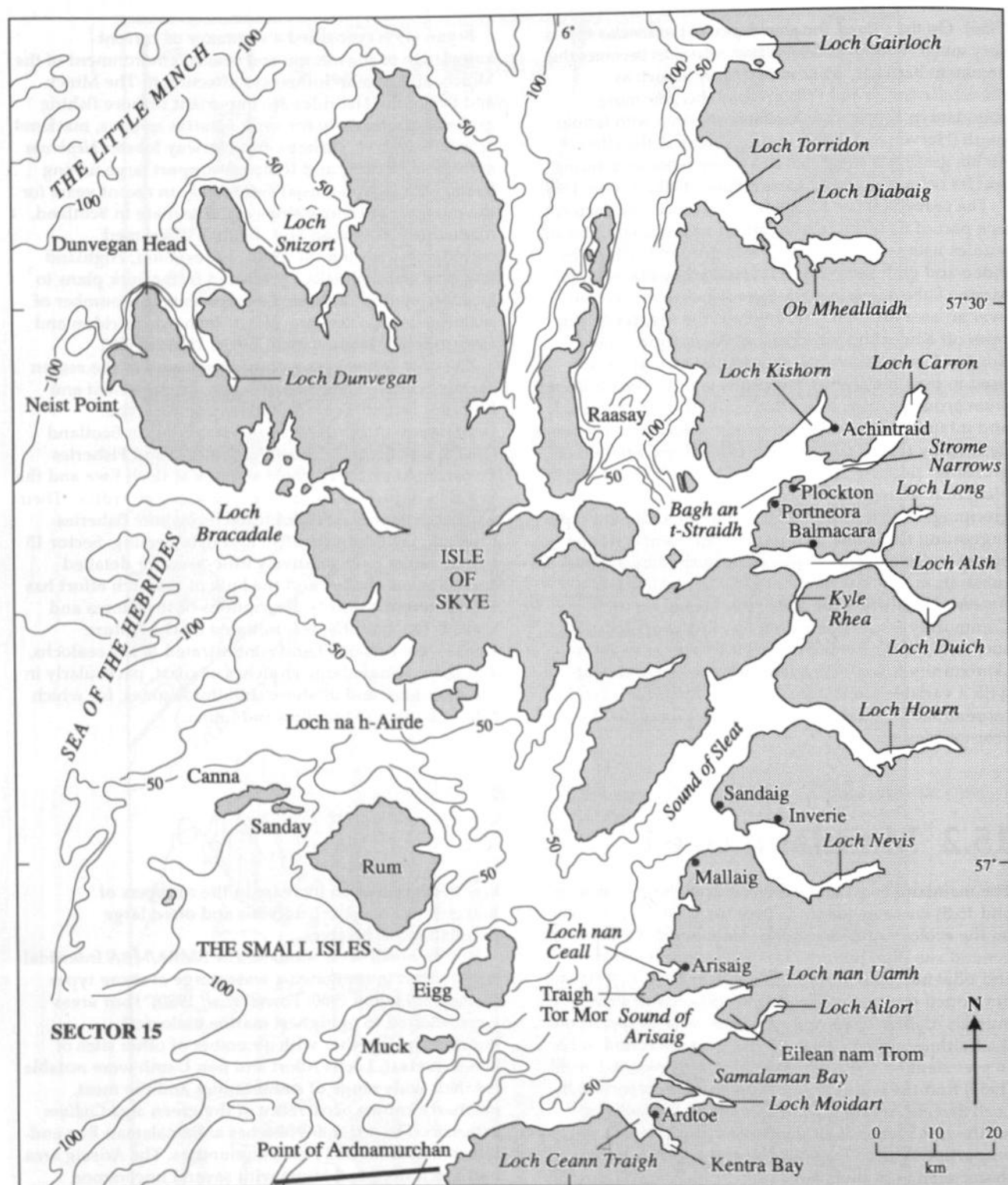
Bryan (1994) provided a summary of current knowledge of the marine and coastal environment of the Minch, and human influences affecting it. The Minch and Sea of the Hebrides are important inshore fishing grounds, particularly for sprat *Sprattus sprattus*, mackerel *Scomber scombrus*, shrimps and Norway lobster *Nephrops norvegicus*. Mallaig and Ullapool support large fishing fleets, with Ullapool used extensively in recent years for the mooring of factory ships. As elsewhere in Scotland, mariculture of salmon and shellfish developed considerably during the 1980s. In response, Highland Regional Council (HRC) produced framework plans to facilitate control of these developments in a number of sealochs (e.g. Lochs Ewe, Nevis, Inchard, Torridon and Hourn) (HRC 1988a; 1988b; 1988c; 1988d; 1989).

The only centres for biological research in the region are the Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD) (formerly the Department of Agriculture and Fisheries for Scotland (DAFS) and Scottish Office Agriculture and Fisheries Department (SOAFD)) field stations at Loch Ewe and the Sea Fish Industries Authority laboratory at Ardtoe. Their work is primarily oriented towards inshore fisheries research, including shellfish and fish-farming. Sector 15 has therefore been relatively little-used for detailed autecological studies and the bulk of research effort has been directed towards descriptions of the shores and seabed. Much of this was initiated by the Nature Conservancy Council and concentrated in the sealochs, and there remain large stretches of coast, particularly in the nearshore and offshore sublittoral zones, for which little is known of the flora and fauna.

beaches revealed an increase in the numbers of polychaetes, fewer crustaceans and often large populations of bivalves.

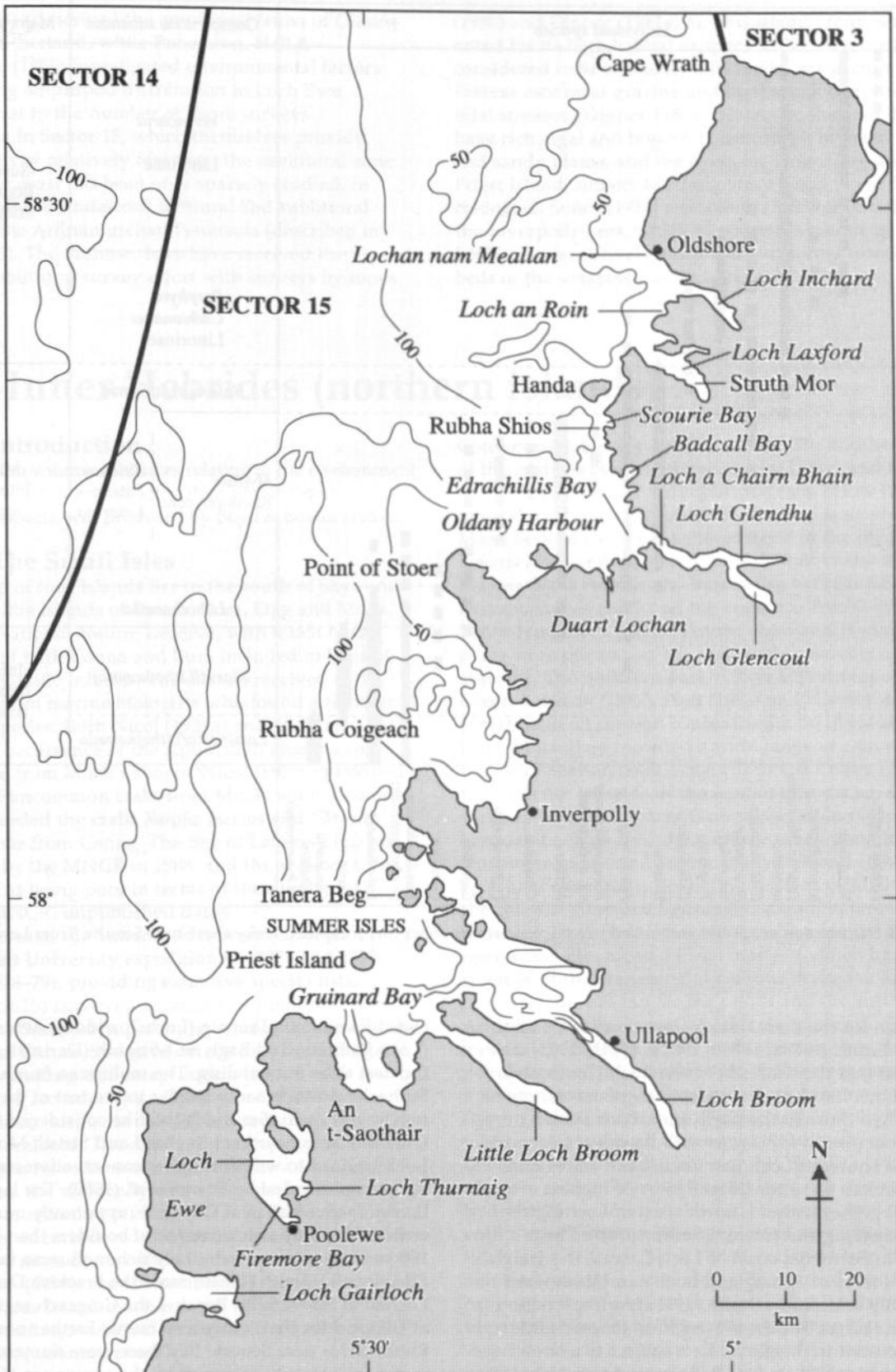
Within north-west Scotland the SMBA/MBA Intertidal Survey Unit investigated a wide range of shore types (Bishop & Holme 1980; Powell *et al.* 1980). Four areas were selected as of highest marine biological importance, together with a number of other sites of lesser interest. Lochs Ailort and nan Uamh were notable for their wide range of communities and the most northerly known occurrence of the green alga *Codium adhaerens*. The sediment beaches at Samalaman Bay and Eilean nan Trom had rich communities. The Arisaig area had a rich flora and fauna with several uncommon species and a seagrass *Zostera* bed, while the head of Loch Duich held a prime example of an *Ascophyllum nodosum* ecad *mackaii* bed. The Point of Stoer coast farther north, with its exposed boulder and bedrock shores and the more sheltered Oldany Island area included a wide variety of richly colonised habitats. The range of sediment shores in Loch Ewe and at Rubha Coigeach was also highly rated.

A series of further studies on the shores, with particular emphasis on the molluscan fauna, were



Based on Admiralty Charts 2528, 1795, 2208, 2207 with the permission of the Controller of Her Majesty's Stationery Office. © Crown copyright.

Figure 15.2. The coast of north-west Scotland (southern part), including Skye and the Small Isles, showing places mentioned in the text.



Based on Admiralty Chart 2635 with the permission of the Controller of Her Majesty's Stationery Office. © Crown copyright.

Figure 15.3. The coast of north-west Scotland (northern part), showing places mentioned in the text.

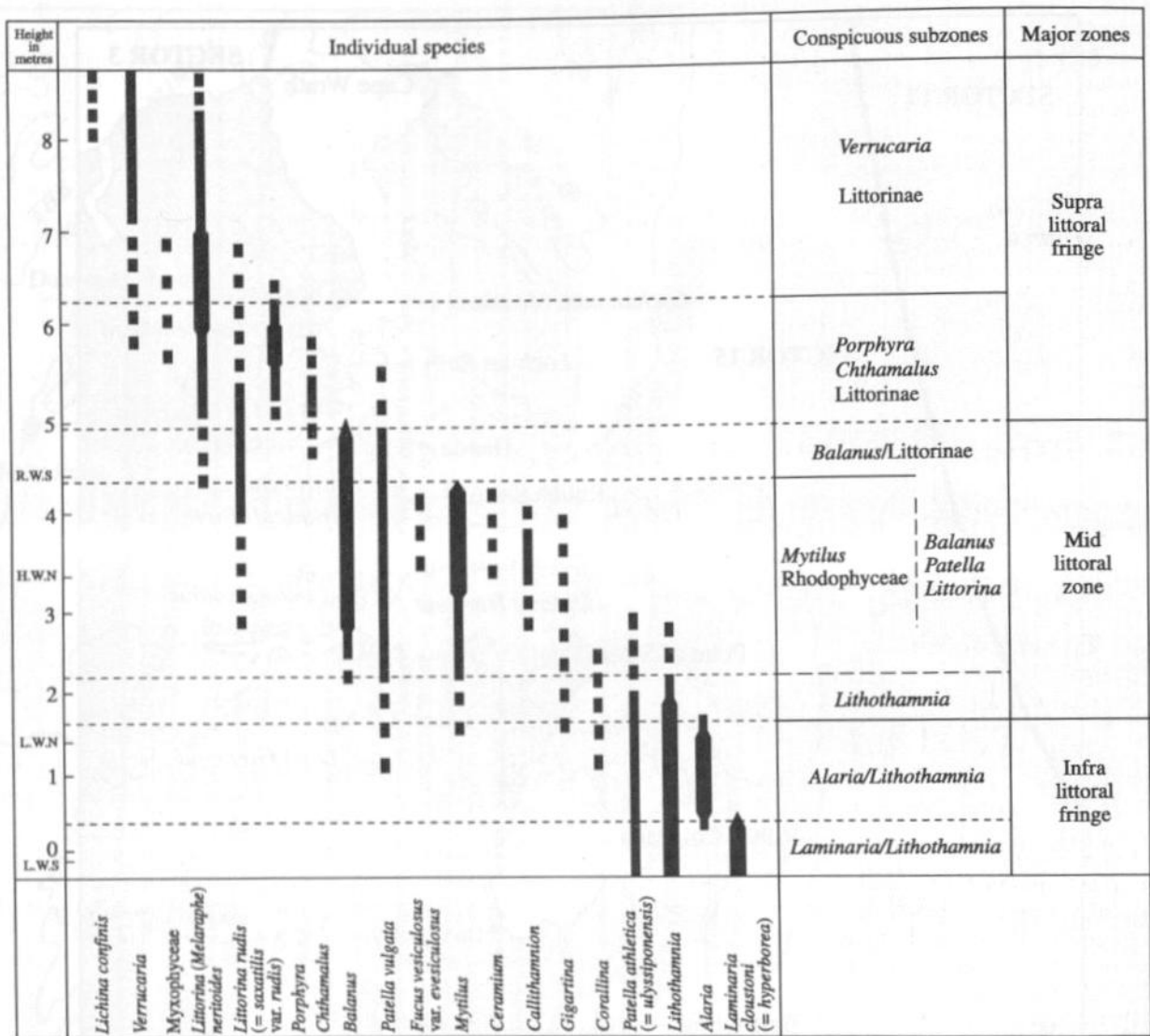


Figure 15.4. Distribution of species and extent of conspicuous sub-zones on an exposed rocky shore near Scourie (from Lewis 1957).

undertaken for the then Nature Conservancy Council (NCC) by Smith (1978a, 1978b, 1981a, 1981b, 1985). She considered that the shores between Loch Hourne and south to Loch Linnhe encompassed a greater variety of habitats than those to the north from Loch Hourne to Loch Broom (Smith 1978a). As with Powell *et al.*'s work (1980), the shores of Loch nan Ceall, Loch Ailort and Ardnamurchan were considered to be of highest interest, together with the north coast of Loch Nevis between Sandaig and Inverie (Smith 1978b). The Plockton to Portneora coast of Loch Carron, the Traigh Torr Mor shores of Arisaig and Loch nan Uamh were additionally selected by Smith (1981a) for their rich molluscan faunas. For the Wester Ross shores Smith (1978a) pointed to the gravel flats subject to a large freshwater input (such as at Balmacara, Loch Alsh) as a habitat common on the mainland but lacking from similar situations in the Western Isles. Of the Wester Ross shores Smith (1978a) found those at Ob Mheallaidh (Loch Torridon), An t-Saothair (Gruinard Bay), Loch Thurnaig

(Loch Ewe), Loch Diabaig (Loch Torridon), Achintraid (Loch Kishorn) and Bagh an t-Straidh (Darinish, Loch Carron) to be outstanding. The molluscan fauna of Sutherland was broadly similar to the rest of the north-west coast (Smith 1981b). She considered the Oldshore area near Loch Inchard and Struth Mor in Loch Laxford to warrant higher conservation status than that recommended by Powell *et al.* (1980). The lagoonal Lochan nam Meallan at Oldshore, apparently more enclosed now by a storm beach of boulders than it was 100 years ago, has an extremely rich molluscan fauna. Additionally, Smith (1981b) rated the brackish Duart Lochan in Eddrachillis Bay and the Coigeach region north of Ullapool for their molluscan fauna. Farther north at Rubha Shios near Scourie Bay there were numerous small rock pools densely colonised by the anemones *Metridium senile* and *Sagartia elegans*, and a thick growth of red algae, barnacles and mussels *Mytilus edulis* on open rock faces (Smith 1985).

Reid (1941) described the amphipod fauna of Oldany harbour, Sutherland, while Roberston, Hall & Eleftheriou (1989) investigated environmental factors determining amphipod distribution in Loch Ewe.

In contrast to the number of shore surveys undertaken in Sector 15, which themselves provide descriptions of relatively few sites, the sublittoral zone of the open coast has been only sparsely studied. In 1994, the MNCr undertook a littoral and sublittoral survey of the Ardnamurchan Peninsula (described in Chapter 13). The Summer Isles have received the greatest sublittoral survey effort with surveys by Jones

(1980) and Dipper (1981a, b). This island group was not noted for its high habitat or species diversity, the latter considered to be markedly affected by sea urchin *Echinus esculentus* grazing and by the lack of appreciable tidal streams. (Dipper 1981a). However, the area did have rich algal and bivalve communities in maerl beds and sandy plains, and the caves on Tanera Beg and Priest Island, subject to strong wave surge, were richly colonised. James [1978] and White (1988) gave details of the Inverpolly area, which supported a mosaic of habitats in a relatively small area, including extensive beds of the seagrass *Zostera marina*.

15.3 Inner Hebrides (northern islands)

15.3.1 Introduction

A symposium volume of studies relating to the environment of the Inner Hebrides, including their physical and biological aspects, was produced by Boyd & Bowes (1983).

15.3.2 The Small Isles

This group of four islands lies to the south of Skye and comprises the islands of Canna, Rum, Eigg and Muck. Rum is a National Nature Reserve, with much of the shoreline of both Canna and Rum included in Sites of Special Scientific Interest. The islands received early attention from marine biologists who found a number of unusual species. Both Nicol (1939a) and Stephen (1961) noted the occurrence of the sipunculan *Phascolosoma granulatum* from Muck's shores. Nicol (1939b) provided records of uncommon crabs from Muck, while Campbell (1948) recorded the crabs *Xantho incisus* and *Corystes cassivelaunus* from Canna. The Bay of Laig on Eigg was surveyed by the MNCr in 1988, and the sediment was described as being poor in terms of the number of species (MNCr, unpublished data).

The shores of the Summer Isles were surveyed by Heriot-Watt University expeditions in 1978 and 1979 (Anon. 1978-79), providing extensive species lists. Dipper (1981b) surveyed a number of sublittoral sites around the Small Isles, particularly around Rum and the east side of Canna. She gave details for a wide range of habitats including tide-swept rock, offshore reefs and gravels, and recorded the tall sea pen *Funiculina quadrangularis*, a species more characteristic of the sheltered sealochs. The nationally rare sea cucumber *Parastichopus tremulus* was present in the area (Dipper 1981b), and the nationally rare anemone *Actinauge richardi* was recorded off Eigg (MNCr, 1988 unpublished data). Dipper considered the Canna, Sanday and Muck areas to be more diverse than Rum. In a later survey by Mackinnon (1989), the spectacular south-eastern corner of Canna was found to have dense growths of dead-man's fingers *Alcyonium digitatum* on sublittoral buttresses of columnar basalt.

15.3.3 Island of Skye

Skye has remained remarkably little studied, not attracting surveys by NCC and by the Marine

Conservation Society until the 1980s. The southern half of the island was studied by Dipper (1981c) and Smith (1983). Dipper found the sublittoral rock below kelp forests to be intensely grazed by *Echinus esculentus*. Maerl beds in the area sheltered nests of the file shell *Limaria hians* and supported populations of the urchin *Psammechinus miliaris*, the burrowing sea cucumber *Neopentadactyla mixta* and the anemone *Peachia cylindrica*. Loose-lying beds of filamentous algae and *Phyllophora crispa* were present on the sheltered sediments of the sealochs. The northern part of Skye was surveyed by Green & Green (1987), Holt (1988) and Hiscock & Covey (1991), with all surveys concentrating on the sealochs, from which they recorded a wide range of communities typical of sheltered sealochs. Hiscock & Covey (1991) found dense growths of the seagrass *Ruppia* sp. and three-spined sticklebacks *Gasterosteus aculeatus* in the brackish Loch na h-Airde; a coarse sandy plain in Loch Dunvegan supported an unusually rich and stable epifaunal community, including solitary ascidians and the colonial anemone *Epizoanthus couchii* in large numbers. Hiscock & Covey (1991) also examined some open coast sites around Skye, many of which had large colonies of the branching calcareous bryozoan *Porella compressa*, the sea fan *Swiftia pallida* and the cup sponge *Axinella infundibuliformis*, species characteristic of moderately exposed coasts in this Sector. Very dense populations of the anemone *Hormathia coronata*, an uncommon species in Scotland, were present at Neist Point, while a wide range of algae and animals in the tide-swept gravels off Dunvegan Head justified the selection of this small area as an MCA (NCC 1990). The narrows at Kyle Rhea supported very rich growths of hydroids, anemones, barnacles, bryozoans and sponges, with a species composition typical of very strongly tide-swept bedrock. Scott (1991) surveyed five littoral and two sublittoral sites along the route of the then proposed Skye road bridge as part of an environmental impact assessment and described communities associated with a mixture of substrata including brittlestar, horse mussel (*Modiolus modiolus*) and maerl (*Lithothamnion corallioides*) beds and extensive areas of tide-swept algal communities.

15.4 Mainland sealochs

15.4.1 Introduction

Much of the recent information for sealochs in Sector 15 is based on surveys undertaken for the MNCR by the University Marine Biological Station, Millport, the results of which were described in Howson, Connor & Holt (1994) and in a series of separate survey reports cited below.

15.4.2 Sound of Arisaig sea lochs

Lochs Ceann Traigh (Kentra Bay), Moidart, Ailort, nan Uamh and nan Ceall were surveyed for the MNCR in 1989 (Howson 1990), following surveys of shores in the area by the SMBA/MBA Intertidal Survey Unit and Smith (see Section 15.2). The littoral sands of Kentra Bay and Loch Moidart are amongst the most extensive littoral estuarine sediments in western Scotland, with those in Kentra Bay considered to be particularly rich (Powell *et al.* 1980). The shores in Loch Moidart were also examined by Wilkinson & Scanlan (1987), who paid particular attention to the algae, and found the area to be unspoilt but less rich in species than open coast sites. The conservation status of Kentra Bay and Loch Moidart was summarised by Buck (1993). Howson's (1990) survey revealed rich littoral sediments in Loch Ailort, with populations of the sipunculan *Golfingia vulgaris*, and extensive furoid communities at the entrance to Loch nan Ceall on the complex of rocky outcrops. In the sublittoral, the area was most notable for its maerl beds which were widespread in the entrance channels to each of the sealochs, with particularly rich beds in Loch Ailort and Loch nan Ceall. The communities in the Sound of Arisaig were more typical of the open coast than sealochs because of the greater exposure to wave action, with the sea cucumber *Neopentadactyla mixta* common in coarse sediments in shallow water. In contrast, the shallow fine sediments of Loch nan Ceall had populations of the small holothurian *Labidoplax media*, a species previously known in the British Isles only from Loch Eynort in South Uist and one location in Ireland (Dipper 1985).

15.4.3 Sound of Sleat sealochs

Lochs Nevis and Hourn are amongst the most inaccessible of the mainland sealochs, with restricted road access along the loch sides. Loch Duich and Loch Long, both opening into Loch Alsh at the northern end of the Sound of Sleat, have easier access, and although each of these lochs had been little studied prior to 1989 they now have MCA status (NCC 1990). The deep mud faunas of Loch Nevis were compared with those of the Fladen grounds in the North Sea (McIntyre 1961), the former area having a foraminiferan-dominated community which typically included the brittlestar *Amphiura chiajei*. McIntyre (1961) found a greater biomass in the Loch Nevis benthos which he considered may be due to more stable sea temperatures and higher primary production than are present in the North Sea. The shallower parts of Loch Nevis and Loch Hourn were surveyed by Breen, Connor & MacKenzie (1986), with

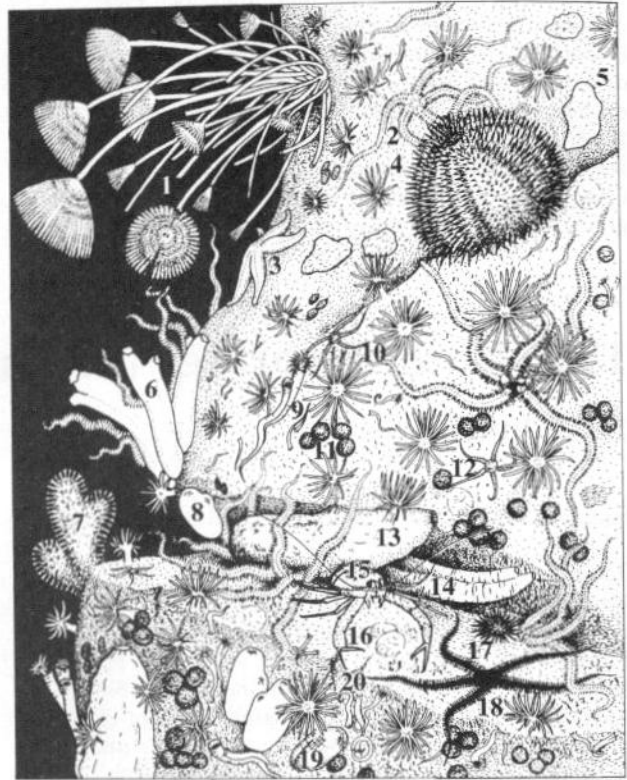


Figure 15.5. Rock wall circalittoral community typical of fjordic sea lochs. The illustration is based on locations in Loch Duich. Species illustrated include: 1. *Sabella pavonina*, 2. *Ophiothrix fragilis*, 3. *Asterias rubens*, 4. *Echinus esculentus*, 5. *Parasmittina trispinosa*, 6. *Ciona intestinalis*, 7. *Alcyonium digitatum*, 8. *Ascidia virginea*, 9. *Serpula vermicularis*, 10. *Protanthea simplex*, 11. *Neocrania anomala*, 12. *Ophiura albida*, 13. *Ascidia mentula*, 14. *Chaetopterus variopedatus*, 15. *Munida rugosa*, 16. *Terebratulina retusa*, 17. *Psammechinus miliaris*, 18. *Ophiocoma nigra*, 19. *Corella parallelograma*, 20. *Pomatoceros triquetrum*. From Howson, Connor & Holt (1994). (Drawing by Sue Scott.)

Loch Nevis receiving more detailed attention in 1988 and 1990 (MNCR, unpublished). The brackish upper reaches of the sealochs supported dense populations of the urchin *Psammechinus miliaris*, with the anemone *Protanthea simplex* and the brachiopod *Neocrania anomala* typically present on sheltered bedrock. Forests of the sea pen *Funiculina quadrangularis* lined the lochs in sediments below about 25 m, as they do in Loch Duich (Connor 1989). Although Connor's (1989) survey revealed broadly similar communities in Lochs Duich, Long and Alsh to those in Nevis and Hourn, the Duich system also held more unusual communities. Most important of these were the brackish communities in Loch Long, dense populations of the fireworks anemone *Pachycerianthus multiplicatus* and rich sublittoral cliff communities (Figure 15.5, 15.6). On the shore, the head of Loch Duich supported perhaps the most extensive bed of the brown alga *Ascophyllum nodosum* ecad *mackaii* known in Scotland. These features of Lochs Duich and Long were important in the MCA designations for the

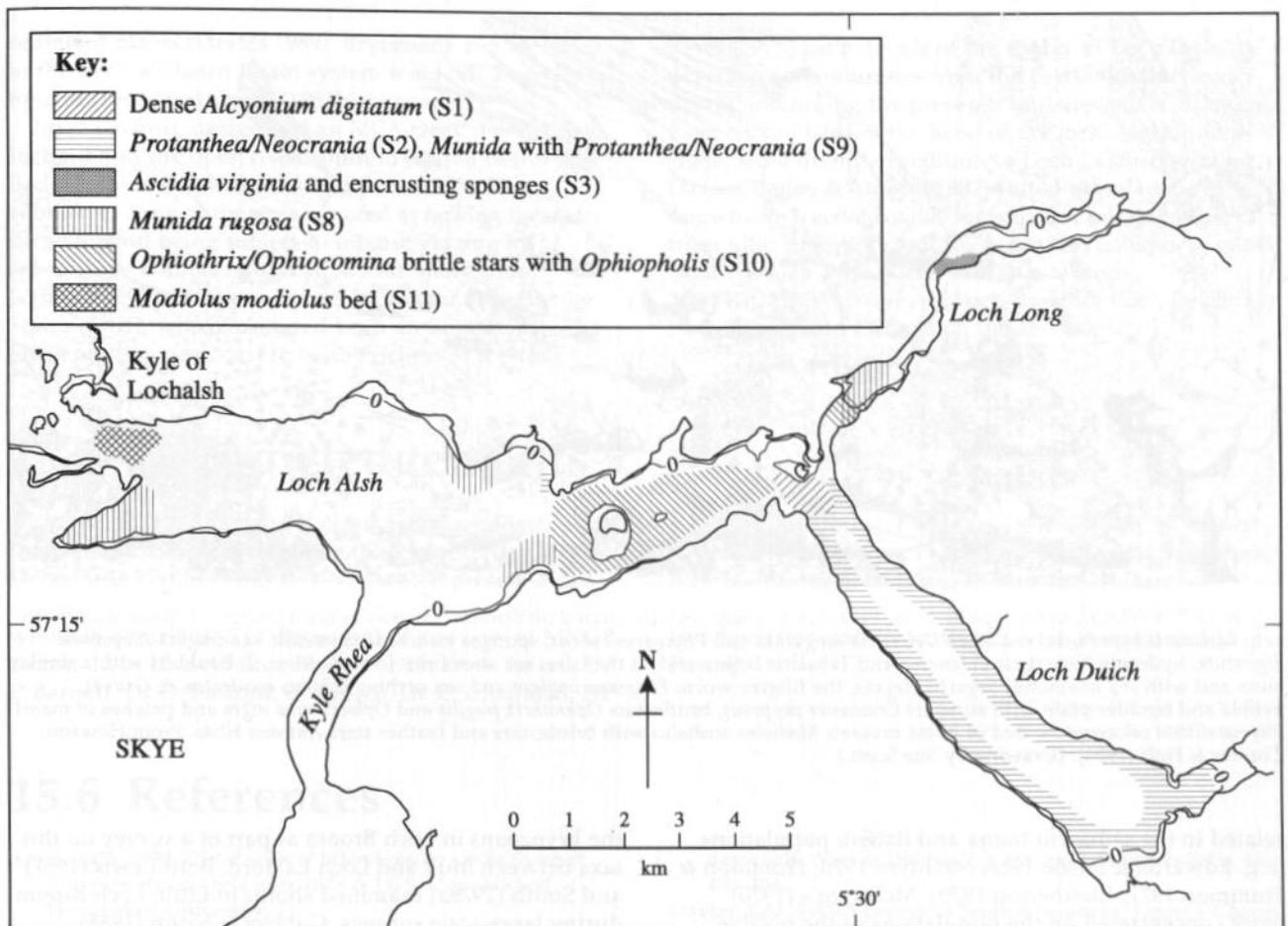


Figure 15.6. Predicted distribution of circalittoral rocky communities in Lochs Duich, Long and Alsh (re-drawn from Connor 1989).

two lochs (NCC 1990). Intertidal surveys of Loch Long and Loch Duich were carried out by the MNCr (Hiscock 1991).

15.4.4 Sealochs in Wester Ross and Cromarty

The Ross and Cromarty sealochs comprise Lochs Carron, Kishorn, Torridon, Gairloch, Ewe, Little Loch Broom and Broom. Of these, the first three have been most well surveyed, with Loch Torridon and Loch Carron achieving MCA status (NCC 1990). Loch Ewe has also received much attention from workers at the SOAFD research laboratory at Firemore Bay, Poolewe.

A number of shores in Lochs Carron, Kishorn and Torridon were examined by Smith (1978a) and Powell *et al.* (1980), as discussed above, before Smith & Hiscock (1985) made a more thorough investigation of the area, including the sublittoral zone. Loch Carron is notable for having a number of sublittoral communities which extend onto the shores, in particular beds of the horse mussel *Modiolus modiolus* and maerl *Lithothamnion corallioides*. Strome Narrows supports a 'nursery' of urchins *Echinus esculentus* and has rich and diverse bedrock communities, whilst in other tide-swept areas the encrusting alga *Aglaozonia* sp. binds pebbles on the seabed, unusual for this species. Figure 15.7 illustrates

some of these communities. Continuing studies of Strome Narrows (S. Scott pers. comm.) have revealed a particularly wide range of biotopes present in the area including seagrass *Zostera marina* beds, dense file shells *Limaria hians*, comparatively large numbers of the anemone *Aureliania heterocera*, and species-rich rock wall communities. In Loch Torridon the shallow lagoonal Ob Mheallaidh was considered to be exceptionally rich (Smith & Hiscock 1985), with abundant hydroids, bryozoans, molluscs, maerl and seagrass *Zostera* found in a complex array of communities. Together with the characteristic communities in Loch Torridon of sea pens, brittlestars and burrowing megafauna, the Torridon narrows has dense stands of hydroids, and the rare northern starfish *Hippasteria phrygiana* has been recorded within the loch (Smith & Hiscock 1985). Loch Carron has been used for environmental assessment studies around fish farms (Gowen *et al.* 1988), and Miller, Rice & Johnstone (1973) noted a population of leopard-spotted gobies *Thorogobius ephippiatus* in upper Loch Torridon; a very northern record for this cryptic species.

Sandy beaches in both Gairloch and Loch Ewe were surveyed by Eleftheriou & McIntyre (1976) as part of the large-scale survey in western Scotland described in Section 15.2. Firemore Bay in Loch Ewe was the focus of a number of other studies by SOAFD workers, mainly



Figure 15.7. A tidal narrow typical of the entrance to some sealochs (based on Strome Narrows in Loch Carron). 1. Rock walls with kelp *Laminaria hyperborea*, red algae *Delesseria sanguinea* and *Phycodrys rubens*, sponges *Halichondria panicea*, sea fingers *Alcyonium digitatum*, hydroids *Nemertesia antennina* and *Tubularia larynx* and, at the base, sea anemones *Urticina felina*. 2. Boulders with a similar biota and with sea anemones *Sagartia elegans*, the filigrine worm *Filograna implexa* and sea urchins *Echinus esculentus*. 3. Gravel, pebble and boulder plain with sunstars *Crossaster papposus*, brittlestars *Ophiothrix fragilis* and *Ophiocomina nigra* and patches of maerl *Phymatolithon calcareum*. 4. Bed of horse mussels *Modiolus modiolus* with brittlestars and feather stars *Antedon bifida*. From Howson, Connor & Holt (1994). (Drawing by Sue Scott.)

related to the sediment fauna and flatfish populations (e.g. Edwards & Steele 1968; McIntyre 1970; Hummon & Hummon 1977; Eleftheriou 1979). McIntyre's (1970) work concentrated on the populations of the bivalve *Tellina* (now *Angulus*) *tenuis* which were found to be affected by predation, plankton dispersal and wave exposure during larval settlement. The laboratory facility at Firemore Bay has also attracted external workers to the area for a variety of studies, e.g. kelp ecology (Kain 1962), mysid breeding cycles (Mauchline 1967) and nematode taxonomy (Warwick & Platt 1973).

In 1989 a Marine Conservation Society (MCS) *Seasearch* team surveyed the habitats in Gairloch, Loch Ewe and Gruinard Bay (Gubbay 1990) with more detailed community studies being undertaken in the two sealochs for the MNCR in 1990 (Howson 1991). The broad and open aspect of the two sealochs reduces the amount of shelter from wave action within the lochs compared with many other mainland sealochs. Consequently, communities in sands and gravels were found well into each of the lochs, with only limited areas of finer sediments. In early June, dense stands of foliose algae flourished in some rocky sublittoral areas despite very high densities of urchins *Echinus esculentus* (Howson 1991). However, by late summer the urchins appeared to have a marked effect on communities with many rock surfaces very well grazed (Gubbay 1990).

Little Loch Broom and Loch Broom remained poorly studied until an MCS *Seasearch* expedition in 1988 (Gubbay & Nunn 1988). Prior to this, Thomas (1950) recorded Fries's goby *Gobius* (now *Lesueurigobius*) *friesii* from Little Loch Broom. Walker (1955) undertook a survey of the kelps in this loch, and Ryland (1963) listed

the bryozoans in Loch Broom as part of a survey on this taxa between Mull and Loch Laxford. Both Lewis (1957) and Smith (1978a) examined shores in Little Loch Broom during large-scale surveys. Gubbay & Nunn (1988) described sublittoral habitats in the area on intensely grazed bedrock and boulders, maerl, horse mussel *Modiolus modiolus* and file shell *Limaria hians* beds and a variety of sandy and muddy plains; they depicted the predicted distribution of each habitat within the lochs.

15.4.5 Sealochs in west Sutherland

Lochs a'Chairn Bhain, Laxford and Inchard, because of their remoteness in the extreme north-west of Scotland, have attracted the attention of a number of 'amateur' expeditions as well as NCC-sponsored surveys. The Loch a'Chairn Bhain complex, including Lochs Glencoul and Glendhu, was found to have communities reflecting a variety of exposures to both wave-action and tidal streams (Davies 1989). In the outer part of the loch complex, coarse sediment had populations of the heart urchin *Spatangus purpureus* and the brittlestar *Amphiura securigera*, while increasing shelter within the lochs produced finer sediments supporting populations of the echiuran worm *Amalosoma eddystonense* and the large bivalve *Arctica islandica*, together with more typical and widespread sheltered loch species. *Amalosoma eddystonense* has recently been recorded from a number of sealochs (Connor 1990) in north-west Scotland though it was previously recorded only from Plymouth and Galway Bay, Ireland. Accelerated tidal movement through the narrows at Kylestrome and Glencoul produced dense stands of *Alcyonium digitatum* and hydroids on rocky substrata, and beds of brittlestars, *Modiolus modiolus* and *Limaria hians* on the coarse

sediment plains (Davies 1989). Bryozoans and molluscs in the Loch a'Chairn Bhain system were discussed by Ryland (1963) and Smith (1981b) respectively.

Loch Laxford, designated an MCA (NCC 1990), Loch Inchard and the open coast south to Handa Island and Badcall Bay were described by Smith (1985). The sublittoral zone of the area is noted as lacking habitat diversity and being subject to intense grazing by sea-urchins *Echinus esculentus*. Of the shores, four lagoonal enclosures were given particular attention by Smith (1985), who considered Loch an Roin and Rudha Shios on the open coast to be the richest of the four.

15.5 Acknowledgements

Dr J. Baxter, D. Moore and S. Scott are especially thanked for their comments on this chapter. The MNCR Occasional Report (Connor 1991), which preceded this volume, included acknowledgement to many colleagues who had contributed to discussion of a review of MNCR sectors 12 to 15 including, for Sector 15: Dr A. Ansell, Dr P. Barnett, Dr D. Basford, G. Brown, Dr C. Chapman, Dr

Jones [1975] gave details of the shores in Loch Inchard, describing communities from the predominantly rocky shores and noting the presence of *Ascophyllum nodosum* ead *mackaii* beds at the head of the loch. Mackinnon (1986) led a diving expedition to Loch Laxford, while Davies, Bailey & Moore (1987) tested populations of dogwhelks *Nucella lapillus* for imposex in relation to tributyltin pollution, and Ryland (1963) listed bryozoans from the loch. Holt (1991) and a team from MNCR/UMBSM surveyed Loch Laxford, Loch Inchard, Loch Broom and Little Loch Broom.

15.6 References

- Anon. 1978–1979. *Distribution of littoral species on the Summer Isles from student field work 1978 & 1979*. Unpublished, Heriot-Watt University.
- Bishop, G.M., & Holme, N.A. 1980. Survey of the littoral zone of the coast of Great Britain. Final report – part 1: The sediment shores – an assessment of their conservation value. (Contractor: Marine Biological Association/Scottish Marine Biological Association, Plymouth.) *Nature Conservancy Council, CSD Report*, No. 326.
- Boyd, J.M., & Bowes, D.R., eds. 1983. *The natural environment of the Inner Hebrides. Proceedings of the Royal Society of Edinburgh. Series B: Biological Sciences*, 83.
- Breen, J.P., Connor, D.W., & McKenzie, J.D. 1986. A marine survey of Loch Nevis and Loch Hourn, western Scotland. *Glasgow Naturalist*, 21: 153–172.
- Bryan, A. 1994. *The Minch review*. Scottish Natural Heritage/Comhairle nan Eilean.
- Buck, A.L. 1993. *An inventory of UK estuaries. Volume 3. North-west Britain*. Peterborough, Joint Nature Conservation Committee.
- Campbell, J.L. 1948. Rare crabs at Canna, Inner Hebrides. *Scottish Naturalist*, 1948: 47.
- Connor, D.W. 1989. Survey of Loch Duich, Loch Long and Loch Alsh. *Nature Conservancy Council, CSD Report*, No. 977. (Marine Nature Conservation Review Report, No. MNCR/SR/10.)
- Connor, D.W. 1990. *Amalosomea eddystonense* Stephen, 1956, an echiuran new to Scotland with notes on its proboscis and habitat. *Porcupine Newsletter*, 4: 226–228.
- Connor, D.W. 1991. Benthic marine ecosystems in Great Britain: a review of current knowledge. Clyde Sea, west Scotland, Outer Hebrides and north-west Scotland (MNCR Coastal sectors 12 to 15). *Nature Conservancy Council, CSD Report*, No. 1175. (Marine Nature Conservation Review Report, No. MNCR/OR/11.)
- Davies, I.M., Bailey, S.K., & Moore, D.C. 1987. Tributyltin in Scottish sea lochs, as indicated by degree of imposex in the dogwhelk, *Nucella lapillus* (L.). *Marine Pollution Bulletin*, 18: 400–404.
- Davies, L.M. 1989. Surveys of Scottish sealochs: Lochs a'Chairn Bhain, Glendhu and Glencoul. (Contractor: University Marine Biological Station, Millport.) *Nature Conservancy Council, CSD Report*, No. 983.
- Dipper, F. 1981a. Sublittoral survey of the Summer Isles, Ross and Cromarty. (Contractor: Underwater Conservation Society.) *Nature Conservancy Council, CSD Report*, No. 365.
- Dipper, F. 1981b. Sublittoral survey in the Small Isles, Inner Hebrides: Rhum, Canna, Eigg and Muck. *Nature Conservancy Council, CSD Report*, No. 314.
- Dipper, F. 1981c. Report of a sublittoral survey of south Skye, Inner Hebrides. (Contractor: Underwater Conservation Society, Ross-on-Wye.) *Nature Conservancy Council, CSD Report*, No. 342.
- Dipper, F. 1985. Sublittoral survey of Loch Eynort, South Uist, Outer Hebrides, July 14th to July 28th 1984. (Contractor: Marine Conservation Society, Ross-on-Wye.) *Nature Conservancy Council, CSD Report*, No. 611.
- Edwards, R.R.C., & Steele, J.H. 1968. The ecology of O group plaice and common dab in Loch Ewe. 1. Population and food. *Journal of Experimental Marine Biology and Ecology*, 2: 215–238.
- Eleftheriou, A. 1979. *The ecology and biology of the shallow-water hyperbenthos in a sandy bay*. PhD thesis, University of Aberdeen.
- Eleftheriou, A., & McIntyre, A.D. 1976. *The intertidal fauna of sandy beaches – a survey of the Scottish coast*. Aberdeen, Department of Agriculture and Fisheries for Scotland. (Scottish Fisheries Research Report, No. 6.)
- Gowen, R., Brown, J., Bradbury, N., & McLusky, D.S. 1988. *Investigations into benthic enrichment, hypernutrification and eutrophication associated with mariculture in Scottish coastal waters (1984–1988)*. (Contractor: University of Stirling, Department of Biological Science, Stirling.) Unpublished report to Highlands and Islands Development

- Board/Crown Estate Commissioners/Nature Conservancy Council/Countryside Commission for Scotland/Scottish Salmon Growers' Association.
- Green, E., & Green, G. 1987. *Sublittoral observations from four dive sites in north Skye 5/10/87 to 7/10/87*. Unpublished, E. & G. Green.
- Gubbay, S. 1990. Seasearch survey of Gruinard Bay, Loch Ewe and Loch Gairloch. (Contractor: Marine Biological Consultants Ltd, Ross-on-Wye.) *Nature Conservancy Council, CSD Report*, No. 1082. (MBC report, No. 89/SS/4.)
- Gubbay, S., & Nunn, J. 1988. Seasearch survey of Loch Broom and Little Loch Broom. (Contractor: Marine Biological Consultants Ltd, Ross-on-Wye.) *Nature Conservancy Council, CSD Report*, No. 898. (MBC Report, No. SS/3/88.)
- Harvey, R., Knight, S.J.T., Powell, H.T., & Bartrop, J. 1980. Survey of the littoral zone of the coast of Great Britain. Final report - part 2: The rocky shores - an assessment of their conservation value. (Contractor: Marine Biological Association/Scottish Marine Biological Association, Oban.) *Nature Conservancy Council, CSD Report*, No. 326.
- Highland Regional Council. 1988a. *Loch Ewe framework plan*. Unpublished, Highland Regional Council, Planning Department. (Marine Fish Farming Policy Paper, No. 3.)
- Highland Regional Council. 1988b. *Loch Incharad framework plan*. Unpublished, Highland Regional Council, Planning Department. (Marine Fish Farming Policy Paper, No. 5.)
- Highland Regional Council. 1988c. *Loch Nevis framework plan*. Unpublished, Highland Regional Council, Planning Department. (Marine Fish Farming Policy Paper, No. 4.)
- Highland Regional Council. 1988d. *Loch Torridon framework plan*. Unpublished, Highland Regional Council, Planning Department. (Marine Fish Farming Policy Paper, No. 7.)
- Highland Regional Council. 1989. *Loch Hourn framework plan*. Unpublished, Highland Regional Council, Planning Department. (Marine Fish Farming Policy Paper, No. 9.)
- Hiscock, K. 1991. *Intertidal surveys in Loch Long, Loch Duich (unpublished note)*. Unpublished, Joint Nature Conservation Committee.
- Hiscock, S., & Covey, R. 1991. Marine biological surveys around Skye. *Nature Conservancy Council, CSD Report*, No. 1076. (Marine Nature Conservation Review Report, No. MNCR/SR/3.)
- Holt, R.H.F. 1988. Seasearch: Skye sealochs. (Contractor: Marine Biological Consultants Ltd, Ross-on-Wye.) *Nature Conservancy Council, CSD Report*, No. 897. (Seasearch report, No. SS/1/1988.)
- Holt, R.H.F. 1991. Surveys of Scottish sealochs. Lochs Laxford, Incharad, Broom and Little Loch Broom. (Contractor: University Marine Biological Station, Millport.) *Joint Nature Conservation Committee Report*, No. 16.
- Howson, C.M. 1990. Surveys of Scottish sealochs. Sealochs of Arisaig and Moidart. (Contractor: University Marine Biological Station, Millport.) *Nature Conservancy Council, CSD Report*, No. 1086.
- Howson, C.M. 1991. Surveys of Scottish sealochs. Loch Gairloch and Loch Ewe. (Contractor: University Marine Biological Station, Millport.) *Joint Nature Conservation Committee Report*, No. 15.
- Howson, C.M., Connor, D.W., & Holt, R.H.F. 1994. The Scottish sealochs. An account of surveys undertaken for the Marine Nature Conservation Review. (Contractor: University Marine Biological Station, Millport.) *Joint Nature Conservation Committee Report*, No. 164. (Marine Nature Conservation Review Report, No. MNCR/SR/27.)
- Hummon, W.D., & Hummon, M.R. 1977. Meiobenthic subcommunity structure: spatial vs. temporal variability. In: *Biology of benthic organisms. 11th European Symposium on Marine Ecology, Galway, 1976*, ed. by B.F. Keegan, P. Ó Céidigh & P. Boaden, 339-347. Oxford, Pergamon Press.
- James, G. [1978]. *Loch an Eisg-Bhrachaidh: a preliminary survey of a small sea loch by amateur SCUBA divers*. (Contractor: University of York, Department of Biology, York.) Unpublished report to Underwater Conservation Society.
- Jones, A.M. [1975]. *A littoral survey of Loch Incharad, Sutherland*. Unpublished, University of Dundee, Department of Biological Sciences. (Centre for Industrial Research and Consultancy Report.)
- Jones, D. 1980. *A marine survey of the Summer Isles*. Unpublished, Nature Conservancy Council.
- Kain, J.M. 1962. Aspects of the biology of *Laminaria hyperborea*. I. Vertical distribution. *Journal of the Marine Biological Association of the United Kingdom*, 42: 377-385.
- Lee, A.J., & Ramster, J.W. 1981. *Atlas of the seas around the British Isles*. 1st ed. Lowestoft, Ministry of Agriculture, Fisheries and Food, Directorate of Fisheries Research.
- Lewis, J.R. 1954. The ecology of exposed rocky shores of Caithness. *Transactions of the Royal Society of Edinburgh*, 62: 695-723.
- Lewis, J.R. 1957. Intertidal communities of the northern and western coasts of Scotland. *Transactions of the Royal Society of Edinburgh*, 63: 185-220.
- Lewis, J.R., & Powell, H.T. 1960. Aspects of the intertidal ecology of rocky shores in Argyll, Scotland. II. The distribution of *Chthamalus stellatus* and *Balanus balanoides* in Kintyre. *Transactions of the Royal Society of Edinburgh*, 64: 75-102.
- MacKinnon, M. 1986. *Loch Laxford expedition, August 1986*. Unpublished, Eastwood Sub-Aqua Club/Marine Conservation Society.
- MacKinnon, M.C. 1989. Seasearch: Canna expedition. (Contractor: Marine Biological Consultants Ltd, Ross-on-Wye.) *Nature Conservancy Council, CSD Report*, No. 899.
- Maggs, C.A. 1986. Scottish marine macroalgae: a distributional checklist, biogeographical analysis and literature abstract. (Contractor: C.A. Maggs, Belfast.) *Nature Conservancy Council, CSD Report*, No. 635.
- Mauchline, J. 1967. The biology of *Schistomysis spiritus* (Crustacea, Mysidaceae). *Journal of the Marine Biological Association of the United Kingdom*, 47: 383-396.
- McIntyre, A.D. 1961. Quantitative differences in the fauna of boreal mud associations. *Journal of the Marine Biological Association of the United Kingdom*, 41: 599-616.
- McIntyre, A.D. 1970. The range of biomass in intertidal sand, with special reference to the bivalve *Tellina tenuis*. *Journal of the Marine Biological Association of the United Kingdom*, 50: 561-575.
- Miller, P.J., Rice, A.L., & Johnstone, A.D.F. 1973. A western Scottish population of the leopard-spotted goby, *Thorogobius ephippiatus* (Lowe) (Teleostei: Gobiidae). *Journal of Fish Biology*, 5: 233-239.
- Nature Conservancy Council. 1990. *Marine Consultation Areas: Scotland*. Unpublished, Nature Conservancy Council (Scotland), Edinburgh.
- Nicol, E.A.T. 1939a. Note on the sipunculid *Physicocoma granulatum* Heuck. *Scottish Naturalist*, 1939: 30.
- Nicol, E.A.T. 1939b. Three rare crabs from the Inner Hebrides. *Scottish Naturalist*, 235: 1-4.
- Powell, H.T., Holme, N.A., Knight, S.J.T., Harvey, R., Bishop, G., & Bartrop, J. 1980. Survey of the littoral zone of the coast of Great Britain: 6. Report on the shores of north-west Scotland. (Contractor: Scottish Marine Biological Association/Marine Biological Association, Intertidal Survey Unit, Oban.) *Nature Conservancy Council, CSD Report*, No. 289.
- Reid, D.M. 1941. The amphipod fauna of Oldany Harbour, Sutherland. *Journal of Animal Ecology*, 10: 296-305.
- Robertson, M.R., Hall, S.J., & Eleftheriou, A. 1989.

Index of place names

- Abbotsbury 225
 Aber Mawr 289
 Aberavon 276
 Aberdeen 123, 131
 Aberdeen Beach 131
 Aberdour 142
 Abereiddy Quarry 285-6
 Aberlady Bay 137, 142-3
 Aberporth 299
 Abertay 134-5
 Abertay Sands 136
 Aberystwyth 301-2
 a'Chairn Bhain, Loch 394
 Achintraid 390
 Add, River 360
 Adur estuary 204
 Adur, River 202-3
 Afon Cefni estuary 305
 Afon Water 207
 Ailort, Loch 387, 390, 392
 Airds Point 334
 Aith Voe 91-2, 94
 Albufeira 57-8
 Aldeburgh 185
 Aline, Loch 357
 Alloa 139
 Almond estuary 140
 Almond, River 134
 Alnmouth 162-3
 Aln, River 162
 Alsh, Loch 385, 392
 Alturlie Deep 131
 Alturlie Point 127
 Alvor 57
 Amble 161, 163
 Amlwyth 306-7
 Amsterdam Point 239
 an Roin, Loch 395
 an t-Sailein, Loch 364
 An t-Saothair 390
 Angle Bay 282
 Angle Peninsula 282
 Angle Point 282
 Anglesey 15-16, 297, 304
 Annan 332
 Annat 363
 Annat Narrows 360, 363
 Arachon 14
 Arbroath 131, 133
 Arbroath Bay 131
 Ardersier 126, 130
 Ardjachie 128
 Ardmucknish Bay 359
 Ardnamurchan 359, 385, 390
 Ardnamurchan Peninsula 364
 Ardnoe Point 360
 Ardwall Sound 333
 Area Longa 57
 Arisaig 387, 390, 392
 Arnol, Loch 379
 Arran 339, 342-3
 Arun 202
 Arun, River 202
 Arva Skerry 102
 Auchencairn Bay 332-3
 Aveton Gifford 233
 Avon estuary 140, 233, 273
 Avon, River 267
 Axmouth 225, 229
 Ayre of Dury 86
 Ay Wick 83
 Azores 14
 Badcall Bay 395
 Baggy Point 265
 Bagh an t-Straidh 390
 Bagh nam Faoileann 374, 376
 Baglan 276
 Baie de Somme 52
 Baie de Veys 52
 Balcarray Point 331, 334
 Baligill Point 118
 Ballantrae 342
 Ballantrae Bank 342
 Ballast Pound 236
 Ballintore 127
 Ballochmartin Bay 342
 Balta Sound 83-4
 Balta Voe 84
 Baltic 39-40
 Bamburgh 161
 Bancos Arenosus 57
 Banff 123
 Bangor 309
 Bangor Flats 309
 Banna Minn 91
 Bantham 233
 Bantry Bay 48
 Barcaldine 361
 Bardsey 297, 302-3
 Bardsey Island 299
 Bardsey Sound 5, 302-3
 Barmouth 300
 Barnhill Bay 142
 Barns Ness 158
 Barnstaple 265
 Barnstaple Bay 265
 Barra 371, 373-5
 Barra Head 387
 Barrow Deep 189
 Barrow-in-Furness 327
 Barton Pool 182
 Basque 56
 Basque coast 14, 53
 Bass Rock 138, 144-5
 Basta Voe 83-4
 Biscay, Bay of 50
 Beachy Head 190, 202-3
 Beacon Point 164
 Beadnell 161-2
 Beatrice oilfield 128
 Beaulieu, River 207
 Beaulieu Firth 125, 131
 Bee, Loch 373, 376
 Beer 225, 229
 Beer Head 226
 Bees Head 331
 Belgium 44, 46, 51
 Belhaven Bay 142
 Bell Rock 133
 Bembridge 206, 208
 Bembridge Harbour 208
 Bembridge Ledges 208
 Bempton 168
 Benbecula 371, 376
 Bergen 36
 Berkley 273
 Berneray 374
 Berrow 267
 Berrow Flats 272
 Berry Head 230
 Berwick 15
 North 141-3, 145, 158
 Berwick-upon-Tweed 145, 158, 160-1
 Bhrollum, Loch 379
 Bideford 265
 Bideford Bay 15, 264
 Bigbury-on-Sea 233
 Bigga Ruins 98
 Bight of Haggrister 94
 Bigton Wick 91
 Birling Carrs 162
 Blackhall 167
 Black Middens 166
 Blackness 139
 Blackpool 322, 324
 Blackshaw Flats 310, 334
 Black Stone 232
 Blackstones Bank 359
 Blackwater estuary 181, 188
 Blackwater, River 187
 Bladnoch estuary 333
 Blakeney 184-5
 Blue Anchor 268
 Bluemull Sound 83-4
 Blyth 156, 165
 Blyth estuary 155, 186
 Boatsroom Voe 96
 Bognor 203
 Boisdale, Loch 377
 Bolt Head 233
 Bolt Tail 233
 Bonar Bridge 128
 Bonawe 361
 Bo'ness 138, 142
 Borgenfjorden 36
 Boston 183, 185
 Boston Haven 184
 Bothkennar 144
 Boulby 168
 Boulogne 51
 Bournemouth 209
 Bovisand 234
 Bradwell 188
 Braefoot 141
 Braefoot Bay 142
 Braich y Pwll 303
 Braunton Burrows 264-5
 Brean Down 267
 Brei Wick 86
 Bressay 75, 85-7
 Bressay Sound 87
 Brest 55
 Breydun Water 185
 Briaghann 357
 Bridge of Brodgar 114
 Bridge of Walls 88-9
 Bridgwater Bay 268, 272
 Bridlington 155-6, 166-8, 179, 181
 Brighton 202-3
 Brindister 76
 Brindister Voe 91-3
 Bring Deeps 114
 Bristol Channel 14-15, 21, 28
 Brittany 14, 50, 53-6
 Broad Bay 377, 379
 Broad Sound 288
 Broom, Loch 390, 393-4
 Brora, River 125
 Broughty Ferry 136
 Broughty Ferry Castle 134
 Brownsea Island 210
 Bryher 245
 Buddon Ness 134
 Bude 257
 Budle Bay 161-2
 Bull Hill Bank 229-30
 Bure, River 185
 Burghead 127
 Burniston Bay 168
 Burnmouth 159-60
 Burntisland 142-3
 Burra Firth 83-4
 Burra Ness 84
 Burra Voe 75, 95
 Burrow Head 334
 Burry Inlet 276-8
 Busta Voe 91-2
 Bute 339
 Kyles of 339, 342
 Butt of Lewis 371, 381
 Byfjorden 39
 Cadgwith 242
 Caernarfon Bay 299, 301, 304
 Caister 185
 Caithness 118
 Calback Ness 94, 96, 99
 Caldey Island 278
 Calgary Bay 366
 Calshot Beach 204
 Calstock Bend 236
 Camaschoirk 364
 Cambois Bay 165-6
 Cambuscurrie Bay 128
 Camel estuary 257-8, 260
 Canal de Mira 57
 Canna 385, 391
 Canty Bay 141
 Canvey Island 190
 Caolisport, Loch 360
 Cap d'Antifer 52
 Cape Clear Island 48
 Cape Cornwall 219, 242, 258-9
 Cape Wrath 118, 385
 Cap Gris-Nez 51
 Cardiff 15, 270, 272, 274
 Cardiff Bay 274
 Cardigan Bay 15, 28, 297, 299, 301
 Carew, River 280

- Carmarthen Bay 15, 278
 Carmel Head 15, 306
 Carnan, Loch 377
 Carricknath Point 239–40
 Carriden 139
 Carron estuary 140
 Carron, Loch 390, 393–4
 Carsaig Island 359
 Castlemartin Peninsula 279
 Cata Sand 111
 Cat Firth 85–7
 Cat Nab 169
 Catta Ness 86
 Cavendish Dock 327
 Cawsand Bay 234, 237
 Ceann Traigh, Loch 392
 Cefni estuary 308
 Celicar Rib 160
 Cellars Beach 233–4
 Celtic Deep 301
 Celtic Sea 33
 Cemlyn 306
 Channel Islands 13, 46, 32, 51
 Chanonry 131
 Chanonry Point 130
 Chapel Point 158
 Chapelcross 332
 Chesil Bank 224–5
 Chesil Beach 10, 224
 Chichester 199, 202, 204
 Chichester Harbour 202, 204, 207
 Chourdon Point 166
 Christchurch 209
 Christchurch Bay 209
 Christchurch Harbour 199, 210
 Christchurch Ledges 209
 Churchill Barriers 110
 Clachandu 357, 366
 Clachan Sound 357, 365
 Claidh, Loch 379
 Clare Island 16, 47
 Cleddau Bridge 280
 Cleethorpes 183
 Cleveleys 324
 Cliffe Marshes 190
 Cliff Quay 186, 236
 Clift Sound 88
 Clousta, Voe of 91
 Clwyd estuary 317
 Clyde estuary 345
 Clyde, Firth of 343
 Clyth Ness 128
 Coble House Point 137
 Cockenzie 138
 Cofflete Creek 233
 Coigeach 390
 Coldingham Bay 159
 Colgrave 83
 Colgrave Sound 84
 Coll 355, 366
 Colla Firth 94, 99
 Collieston 131
 Colne estuary 181
 Colne, River 188
 Colonsay 355, 359, 365
 Colwyn Bay 318
 Colywell Bay 165
 Combe Martin 265–6
 Concarneau 55
 Conwy 299
 Conwy Bay 310
 Conwy estuary 310
 Copinsay 113
 Copt Point 191
 Coquet estuary 155, 163
 Coquet Island 155, 158
 Coquet, River 155, 163
 Cornelian Bay 168
 Cornwall 20, 33
 Corran Narrows 360
 Corryvreckan, Gulf of 5, 355, 365
 Corunna 57
 Cotentin Peninsula 32
 Coulport 347
 Craigiellaw 142
 Craignish, Loch 360
 Cramond 141, 143
 Cramond Island 138, 143
 Craster 161
 Cree, River 332–3
 Creran, Loch 355, 357, 360
 Cresswell 164
 Cresswell, River 280
 Cresswell Skeres 163
 Crinan, Loch 360
 Cromarty Firth 123, 125–6, 128–9
 Cromer 185
 Crosby 320
 Crouch estuary 188
 Crouch, River 187–8
 Croyde 265
 Cuan Ferry 365
 Cuckmere, River 202
 Culbin 127
 Culbin Bars 126
 Cullen 126–7
 Cullercoats 20, 160, 165–6
 Cullingsburgh, Voe of 87
 Culross 139–40
 Culver Cliff 208–9
 Cumbrae 342
 Cumbria 15
 Cunning Point 331
 Cuthill Links 125
 Cwm yr Eglwys 274, 285
 Daddyhole 230
 Da Doon Banks 102
 Dale 284
 Dale Roads 281
 Dale Sands 284
 Dales Voe 76, 85, 94, 96, 99
 Dalgety Bay 142
 Dancing Ledge 209
 Da Ness 102–3
 Darinish 390
 Dart estuary 231
 Dartmouth 231
 Dart, River 231
 Dauceddau 280
 Dawlish 230
 Dawlish Warren 230
 Deben estuary 181
 Dee estuary 131, 315, 317–19, 322, 333
 Deepgrove Wyke 168
 Dee, River 131, 332–3
 Deerness 114
 Deer Sound 111, 113–14
 Degnish Point 360
 Delta Region 44
 Denmark 16, 40
 Denver Sluice 184
 Deveron, River 127
 Devil's Cauldron 279
 Devil's Frying Pan 242
 Devon
 North 264
 South 14, 19
 Diabaig, Loch 390
 Dingle Peninsula 48
 Dingwall Bay 130
 Dirleton 142
 Dodman Point 238
 Dogger Bank 10
 Dollard estuary 42
 Don estuary 131
 Don, River 131
 Donibristle Bay 142
 Donna Nook 183
 Doom Bar 260
 Dornoch 128
 Dornoch Firth 123, 125, 128
 Dorset 21, 33, 221
 Dounreay 118–19
 Dover 191
 Dowlands Cliff 229
 Drakes Island 234
 Dronachy Burn 142
 Druridge Bay 163
 Duart Lochan 390
 Dubmill Point 331
 Duckpool 260
 Duddon estuary 324, 328
 Duich, Loch 385, 387, 392
 Dulas Bay 297
 Dulcey Dock 168
 Dunbar 123, 137, 141–2, 145, 155, 158–60
 Dunbeath 127
 Duncansby Head 118, 123, 125, 127
 Dundee 134, 136
 Dunnet 119
 Dunraven Bay 276
 Dunstaffnage Bay 359
 Dunstaffnage Channel 361
 Dunstanburgh 162
 Dunvegan Head 391
 Dunvegan, Loch 391
 Durdle Door 221
 Durham 166
 Durlston Head 209, 221
 Durness, Kyle of 118–19
 Dury Voe 85, 87
 Dyfi estuary 297, 300
 Earn, River 135
 Easdale Quarry 285
 Easington 166
 East Anglia 25, 184
 Eastbourne 203
 East Burra Firth 92
 East Haven 133
 East Hoyle Bank 319
 East Loch Tarbert 348, 379
 East Lunna Voe 86
 East Runton 185
 East Tennants Reef 225
 East Voe of Scalloway 89
 Edderton Sands 128
 Eddrachillis Bay 390
 Eddystone, the 234
 Eden estuary 136, 332
 Edenside Flat 137
 Edinburgh 16, 141, 143
 Eggerness Point 333
 Egilsay 113
 Eigg 385, 391
 Eight Acre Pond 207
 Eil, Loch 39, 344, 357, 360
 Eilean Fraoch 365
 Eilean nan Trom 387
 Elbe estuary 42
 Elbe, River 42
 Elie 141
 Elliot Links 131
 Emblestone 162
 Emblestone Reef 162
 Ems estuary 42
 Ems, River 42
 English Grounds 272
 Eoligarry 374
 Eport, Loch 377
 Eriboll, Loch 117–18, 120
 Erisort, Loch 377, 379–80
 Erme estuary 233
 Esbjerg 40
 Esha Ness 91–2
 Esk estuary 140, 155, 328–9, 332
 Etive, Loch 355, 357, 360
 Ewe, Loch 387, 390–1, 393–4
 Exe estuary 16, 221, 226, 229
 Exe, River 229
 Exmoor National Park 265
 Exmouth 225, 228–9
 Eyemouth 158–9
 Eynhallow 114
 Eynort, Loch 376–7, 392
 Faeroe 74, 82
 Faeroe Islands 13–14, 22, 36, 78, 97
 Fair Isle 73, 82, 89, 91, 93, 100
 Fair Isle Channel 73
 Fal estuary 239, 283
 Falls of Lora 361
 Falmouth 239–40
 Fal, River 238–9
 Fal/Ruan estuary 221, 240
 Farne Islands 145, 155, 161–2
 Faslane 347
 Fast Castle 159
 Fawley 206–7
 Felixstowe 186
 Fenham Flats 161
 Fensford 39
 Feochan, Loch 360
 Fetlar 83
 Fife Ness 131, 137, 142
 Filey 167
 Filey Beach 168
 Filey Brigg 168
 Fills Reef 162
 Findhorn Bay 125–7
 Findhorn, River 127
 Firemore Bay 393
 Firth, The 88–9
 Firths Voe 99
 Fishguard 285
 Fitful Head 88
 Flamborough 14, 168
 Flamborough Head 155, 157–8, 168–9
 Flannan Isles 373
 Fleet, The 224–6
 Fleet Bay 333
 Fleet, Loch 125–6, 128
 Fleet, River 128
 Fleetwood 324–5
 Flemish Banks 46
 Flooded Field Pond 144
 Flotta 111, 113
 Fluke Hole 163
 Fogla Skerry 92
 Folkestone 190, 202
 Fora Ness, Houb at 96
 Foreland Point 266
 Formby 319–20, 324
 Formby Point 323
 Fort Charles 232
 Fort George 127, 130–1
 Fort William 360

- Forth and Clyde canal 16
 Forth Bridges 142
 Forth estuary 10, 138, 166
 Forth, Firth of 123, 131, 137, 141-2, 144
 Forvie, Sands of 133
 Foryd estuary 308
 Foula 73, 89, 91, 93, 102
 Fowey estuary 238
 France 50
 Mediterranean 58
 Fraserburgh 125, 127
 Freshwater Bay 209
 Fugla Ness 94, 96
 Furzey Island 210
 Fyde 322, 324
 Fyne, Loch 339, 342, 344, 347-8

 Gaa 134
 Gairloch 387, 393-4
 Gairloch, Loch 393
 Galloway peninsula 342
 Galtagarth, Ness of 94
 Galway Bay 47-9
 Gannel estuary 258
 Gannets Rock 264
 Gann Flats 284
 Gardenstown 126
 Gareloch 346
 Gareloch, Loch 342
 Garlieston Harbour 333
 Garnock estuary 342
 Garroch Head 343
 Garth's Ness 88-9
 Houb at 96
 Garths Voe 94, 96, 99-100
 Garvellachs 365
 Gascony 55
 Gulf of 14
 North 56
 German Bight 26, 42, 44
 Germany 42
 Gew 242
 Giant's Leg 87
 Gibraltar Point 183
 Gibraltar, Straits of 58
 Gigha 359
 Gillan Harbour 241
 Gilp, Loch 348
 Gin Head 142
 Gironde 13
 Gironde estuary 53
 Glaslyn/Dwyrhyd estuary 300
 Glénan archipelago 55
 Glencoul 394
 Gletness 86
 Gluss Isle 99
 Gluss Voe 76, 78, 94, 96, 99
 Godrevy Point 259
 Goil, Loch 346
 Goldcliffe 273
 Golspie 125, 128
 Gon Firth 94
 Gourcock 344
 Gower Peninsula 277
 Grangemouth 138, 140, 144
 Grange-over-Sands 325
 Granton 141-2, 144
 Granton Harbour 142
 Grassholm 287
 Gravesend 190
 Great Burbo Bank 319
 Great Castle Head 285
 Great Cumbrae 341-2
 Greater Liverpool Bay 322
 Greatham Creek 167

 Great Hangman 264
 Great Hogus 242
 Great Orme 297, 322
 Great Ormes Head 299, 310
 Great Ouse, River 184
 Great West Bay 226, 229-230
 Great Yarmouth 185
 Greenala Point 279
 Green Island 211
 Greenock 346
 Grimbury Pond 210
 Griminish Point 374, 376
 Grimsay 376
 Grimsby 179, 182
 Grimshader, Loch 380
 Gruinard Bay 387, 390, 394
 Gruinart, Loch 364
 Grunn Taing 77
 Gruting Voe 88-9
 Gruting, Wick of 83-4
 Grutness 85
 Guardbridge 137
 Guernsey 46
 Gulber Wick 87
 Gullane 142
 Gullane Point 143
 Gullmar Fjord 17, 39
 Gutcher 83-4
 Gutter, The 301
 Gwendraeth, River 278
 Gwent Levels 267

 Hadston Carrs 163
 Haggriester, Ness of 94
 Hamble estuary 206
 Ham Burn 102-3
 Hamford Water 181, 187
 Hamna Voe 94
 Hamaoze 234, 237
 Ham Voe 102-3
 Handa Island 395
 Handfast Point 212
 Hannafore Point 238
 Harbour Farm Lagoon 208
 Hardangerfjord 36, 38
 Harolds Wick 83-4
 Harray, Loch of 109-10, 114
 Harris 371, 377, 379
 Sound of 371
 Hartland Quay 264
 Hartlepool 167
 Harwich 186
 Haslar Lake 205
 Hasselwood Rock 381
 Hastings 202
 Havergate Island 189
 Hayle estuary 258-9
 Head Scar 327
 Hebrides 39
 Helen's Reef 381
 Helford 238
 Helford estuary 221
 Helford Passage 241
 Helford Point 241
 Helford River 239, 241
 Helmsdale, River 125
 Humber, River 179, 184
 Helgoland 44
 Hellister 88-9
 Helmsdale 126
 Hemmick Beach 238
 Hemsby 185
 Hengistbury Head 209-10
 High Cliff 260
 Hilbre Island 319-20
 Hillswick 75, 91
 Ness of 92

 Hilsford Point 327
 Hilsea Point 236
 Hinkley Point 273
 Hodbarrow Point 328
 Hoe, the 236
 Holborn Head 118
 Holes Bay 211
 Holkham Salts Hole 189
 Holme 185
 Holm Islands 267
 Holyhead 297, 299
 Holyhead Harbour 297, 306
 Holy Island 155, 161, 306
 Holy Loch 346
 Holywell 203
 Home Farm 144
 Hore Stone 238
 Horestone Point 208
 Hound Point 144
 Hourn, Loch 387, 390, 392
 Hoy 109, 112-14
 Hoylake 319
 Hubbet 113
 Humber estuary 10, 181
 Humberstone Fitties 183
 Hunstanton 179
 Hunterston 342
 Hurst Point 204, 209
 Hythe 207

 Iceland 13
 Ilfracombe 16, 265
 Inchard, Loch 387, 390, 394-5
 Inchcolm 138, 140
 Inchkeith 138
 Inchmickery 138, 143
 Indaal, Loch 364
 Inganess Bay 113
 Inland Sea 306
 Inner Hebrides 364, 391
 Inner West Voe 91
 Inver Bay 129
 Inverbervie 127
 Invergowrie 134, 136
 Invergowrie Bay 135-6
 Inverie 390
 Inverkeithing 142
 Inverkeithing Bay 142
 Inverness 123, 127
 Inverness/Beaully Firth 123, 128
 Inverness Firth 125, 127, 130
 Inverpollly 391
 Iona 359
 Sound of 359, 366
 Ipswich 186
 Ireland 47-8
 Irvine Bay 344
 Island Farm 144
 Island Farm Pond 144
 Islay 5, 355, 364
 Sound of 365
 Isle of Man 16-17, 20, 47-8
 Isle of May 138, 144-5
 Isle of Portland 221, 225
 Isle of Whithorn 334
 Isle of Wight 13, 204, 206-9
 Isles of Scilly 219, 243
 Itchen estuary 206

 Jack Sound 5
 Jade 43
 Jade Bay 42
 Jennycliff Bay 236
 Jersey Marine 276
 John O'Groats 118
 Joppa 141, 144

 Jura 355, 364
 Sound of 355, 359-60

 Kames Bay 342-3
 Kattegat 39-42
 Kellan Head 260
 Kenidjack Castle 259
 Kentra Bay 385, 392
 Kerrera 365-6
 Kessock 130-1
 Kettletoft Bay 111
 Keyhaven 207
 Kiel Bay 40
 Kilbrannan Sound 344
 Kilcreggan 344
 Kilkieran Bay 48-9
 Killary Fjord 48
 Killingholme Pools 182
 Kilmote 125
 Kilpate 282
 Kimmeridge 222
 Kincape Flat 136-7
 Kincardine 138, 142
 Kincardine Bridge 137, 139-40
 King Harry Ferry 239
 King Harry Passage 240
 Kingoodie 135
 Kingoodie Bay 136
 Kingsbridge 15
 Kingsbridge estuary 221, 232, 239
 King's Manor 208
 Kingsnorth power station 190
 King's Quay Sands 208
 Kingston 135
 Kinlochbervie 387
 Kinneil 138, 140
 Kinneil Bay 140
 Kintyre 359, 364
 Kirkcaldy 141-3
 Kirkudbright Bay 334
 Kirkwall Bay 113
 Kishorn, Loch 390, 393
 Knoll Pins 264
 Konigshafen 42-3
 Kristinebergs 39
 Kyle Rhea 391
 Kylestrome 394

 Ladram Bay 230
 Laig, Bay of 391
 Lamash 343
 Lancashire 8
 Landing Bay 263-4
 Land's End 243
 Langstone 199, 204
 Langstone Harbour 204-5
 La Palu 59
 Largo Bay 142-4
 Laugharne Burrows 278
 Lavan Sands 308-10, 334
 Lavernock Point 15, 272, 274, 276
 Lawrenny 283
 Lawrenny Ferry 283
 Lawyer's Farm Pool 184
 Lax Firth 85-7
 Laxford, Loch 390, 394-5
 Leith 142
 Leith Sands 142
 Lerwick 36, 75, 82, 85-6
 Leurboost, Loch 380
 Leven 141
 Leven, Loch 360
 Leverburgh 379
 Lewis 371, 373-4, 377, 379
 Limekilns 142

- Limfjord 40-1
 Lindaspollene 39
 Lindsfarne 155, 161
 Linga Sound 83, 85
 Lingness 86
 Linnhe, Loch 357, 360, 390
 Linnhe Mhuirich 359-60
 Lismore 360, 363
 Littlehampton 202
 Little Loch Broom 393-4
 Little Ormes Head 299, 310
 Liverpool 321
 Liverpool Bay 307, 317, 319, 321
 Lizard Peninsula 242
 Lizard Point 242
 Llandulas Point 318
 Llanelli 277
 Llanrhidian Sands 278
 Lleyn Peninsula 297, 299, 302-3
 Lligwy Bay 297
 Llwyngwrl 300
 Lobster Carr 162
 Lochan Havurn 120
 Lochan nam Meallan 390
 Lochranza 343
 Loe Pool 242
 Lofoten Islands 36
 London Bridge 230
 Longannet 138
 Long, Loch 346, 385, 392
 Longman Point 130
 Long Rock 190
 Long Scar 167
 Looe 33, 237
 Looe estuary 237-8
 Lorn, Firth of 355, 357, 359, 365, 385
 Lough Hyne 47, 49
 Lough Ine 47, 49
 Loughor 278
 Loughor, River 277
 Lowestoft 179
 Lowestoft Harbour 185
 Lübeck Bay 40
 Luce Bay 332, 334
 Luing 365
 Lulworth Banks 223
 Lulworth Cove 221
 Lumsdaine 159
 Lunan Bay 131
 Lundy 255, 260
 Lune Deep 325-6
 Lune, River 325
 Lunna Ness 85-6, 94, 96, 100
 Lunning 85
 Lunning Sound 87
 Lyme Bay 21, 224-6
 Lyme Regis 219, 225-6, 228
 Lymington 207, 209
 Lymington-Keyhaven 206
 Lynemouth 164-5
 Lynher estuary 236
 Lynher, River 234, 236
 Lynnmouth 264
 Lynn of Lorn 360
 Lynn of Morvern 360
 Lysekil 39
 Lytham 324
 Lytham St Annes 324-5
 Macduff Harbour 127
 Maddy, Loch 373-4, 376-7
 Maismore Weir 255
 Mallaig 387
 Manacles, The 242
 Manchester Ship Canal 322
 Maplin Sands 186
 Margam Sands 275
 Marine Hotel 232
 Marine Lake 320
 Marlee Loch 94
 Marloes Peninsula 284, 288
 Marloes Rocks 285
 Marloes Sands 285
 Marske-by-the-Sea 167
 Martin's Point 136
 Maryport 331
 Masti Geo 85
 Mavis Grind 77
 Mawddach estuary 300
 Maw Wyke Hole 168
 Medes Islands 59
 Medina estuary 206-7
 Mediterranean 58
 Medway 181
 Medway estuary 189
 Medway, River 190
 Melfort, Loch 360
 Melvich Bay 118
 Menai Bridge 20
 Menai Strait 5, 289, 297, 299, 304-5, 307
 Menaver Beach 241
 Mersey 320
 Mersey estuary 10, 315, 317, 320, 322, 324
 Methil 138
 Meuse, River 44
 Mevagissey Bay 238-9
 Mharabhig, Loch 379
 Middlesbrough 156
 Mid Yell Voe 83-4
 Milford Haven 271, 279-80
 Milford-on-Sea 209
 Mill Bay 232
 Millbay Docks 234
 Millport 16, 341
 Minch, The 28, 39, 364, 371, 387
 Mingulay 371, 374
 Minster 190
 Mio Ness 100
 Misery Point 233-4
 Mixon Hole 203
 Mochras 300
 Moidart, Loch 385, 392
 Monach Islands 373
 Mongstad 82
 Monifieth 136
 Montrose Basin 133
 Montrose Bay 131
 Mont-St-Michel 52
 Moray 123
 Moray Firth 10, 123, 125, 127-9, 131
 Morecambe Bay 10, 317, 325
 Morfa Dyffryn 297, 300
 Morfa Harlech 297
 Morlaix, Bay of 50, 53-4
 Morrich More 125
 Morte Point 264-5
 Mortimer's Deep 142
 Motray 137
 Mound Alderwoods National Nature Reserve 128
 Mountbatten Bay 236
 Mounts Bay 242
 Mousa 85-7
 Mousa Sound 83, 87
 Muck 385, 391
 Muckle Flugga 76, 89, 91, 93
 Muckle Holm 75, 95
 Muckle Roe 91
 Mugdrum Island 135
 Mull 355, 366
 Island of 357
 Sound of 355, 357, 360, 366
 Mull of Galloway 5, 332-4, 339, 357
 Mull of Kintyre 5, 339, 355
 Mull of Oa 365
 Mumbles 275
 Munloch Bay 126, 130
 Musselwick 285
 na Cille, Loch 359
 na h-Airde, Loch 391
 Nairn, River 127
 na Keal, Loch 366
 nan Ceall, Loch 390, 392
 nan Uamh, Loch 387, 390, 392
 Nare Head 238
 Nare Point 242
 Nash Point 274, 276
 Nash Sands 272
 Naze 187
 Neath estuary 276
 Nene, River 184
 Ness, River 131
 Netherlands, The 10, 44
 Nevis, Loch 387, 390, 392
 Newbiggin 158
 Newbiggin Point 164
 Newbiggin-by-the-Sea 164
 Newborough Warren 297
 New Brighton 320
 Newburgh 131, 135
 Newcastle-upon-Tyne 155-6
 New England Creek 189
 Newhaven 141
 Newport 274
 Newport Deep 272
 Newquay 257, 259, 299
 Newton Creek 233
 Newton Ferrers 233
 Newton Harbour 208
 Newton Haven 162
 Newtown Harbour 206, 208
 Newtrain Bay 259
 Nigg 129
 Nigg Bay 129-31
 Normandy 50
 Gulf of 52
 North Bank 319
 Northcoates lagoons 183
 Northern Ireland 47, 50
 North Esk, River 131
 North Gare Sands 167
 North Gavel 100-1
 North Haven 100-1
 North Morecambe Gas Field 327
 North Queensferry 142
 North Rona 371, 373, 381
 North Ronaldsay 112
 North Lynne, River 137
 North Uist 374-6
 Norway 13, 36
 Nor Wick 83-4
 Nose's Point 166
 Noss 85, 87
 Noss Sound 83, 87
 Oban 359
 Obe, Loch 374
 Obbe 379
 Obidos 57
 Obisary, Loch 39, 373, 377
 Ob Mheallaidh 390, 393
 Ogmore 276
 Oldany harbour 391
 Oldany Island 387
 Oldbury 273
 Old Grimsby 245
 Old Harry Rocks 209
 Old Shandwick 130
 Oldshore 390
 Ollaberry, Bay of 96
 Olna Firth 91, 93-4
 Oosterschelde 45
 Ordais, Loch 379
 Orford Ness 181
 Orka Voe 94, 99-100
 Orkney 13-14, 73-4, 82
 Oronsay 365
 Orwell estuary 181, 186-7
 Oslofjord 39
 Otters Wick 83
 Otterwick 111
 Ouse, River 202
 Outer Hebrides 39, 372
 Out Skerries 75-6, 85-7
 Oxwich 277
 Oxwich Bay 276-7
 Oyster Ground 45-6
 Padstow 260
 Pagham 203
 Pagham Harbour 204
 Pagham Lagoon 204
 Papa, Sound of 91, 93
 Papa Stour 73, 89, 91-3
 Parrett, River 267
 Passage Cove 242
 Pease Bay 158
 Pegwell Bay 190-1
 Pembrey Sands 276
 Pembroke River 280, 283
 Pembrokeshire 20
 North 285
 South 279
 Pembrokeshire islands 287
 Pendine 278
 Pendine Sands 278
 Penlee Point 236
 Penmaenrhos Point 318
 Pennan 126
 Pennar Gut 283
 Pennar Mouth 283
 Pennar Point 283
 Pennington 207
 Penrhyn Bay 310
 Pentland Firth 5, 109, 118
 Pen-y-Cil 303
 Penzance 243
 Percuil, River 240
 Perranporth 259
 Perth 135
 Peterhead 125, 131
 Peter's Pool 111
 Pettico Wick 159
 Pettico Wick Bay 160
 Peveril 209
 Piel Channel 327
 Pittenweem 141
 Place Cove 239
 Plockton 390
 Plumpudding Island Lagoon 190
 Plym estuary 236
 Plymouth 10, 16-17, 19-20, 241
 Plymouth Sound 10, 17, 221, 235-7
 Plym, River 234
 Point of Ardnamurchan 355,

- 357
 Point of Ayr 317, 323
 Point of Stoer 387
 Polperro 15
 Pontevedra 57
 Poole 199, 209
 Poole Bay 14, 209, 211–12
 Poole Harbour 199, 210, 212
 Pool of Virkie 85–6
 Porlock Bay 15, 267
 Port Appin 363
 Port-Cros 59
 Port Edgar 140
 Portelet Bay 46
 Portencross 342
 Port Erin 16, 20, 47
 Port Eynon 277
 Port Glasgow 346
 Porthcawl 276
 Porth China 305
 Porth Colman 303
 Porth Dinllaen 303
 Porth Offereiad 307
 Portholland 238
 Porthselaun 285
 Porth Trecastell 304
 Port Isaac 259
 Portishead 268
 Portland 5
 Portland Bill 5, 225
 Portland Harbour 223–4
 Port Logan 342
 Portneora 390
 Portobello 141
 Port Seton 142
 Portsmouth 199, 204
 Portsmouth Harbour 205
 Port Talbot 275
 Portugal 57–8
 Prawle Point 231
 Preston docks 325
 Priest Island 391
 Princess Pier 230
 Prisk Cove 242
 Puffin Island 16, 299, 307–8
 Purbeck 212, 222, 225
 Pwllcrochan 282
 Pwllleuog 285
 Pwllheli 302
 Pyewipe 183
 Pyewipe mudflats 182
- Queensferry 137
 Queen's Ground 234
 Quendale, Bay of 78, 88–9
 Quey Firth 94
 Quoys, Bay of, 112
- Raasay 385
 Rame Head 236–7
 Ramna Stacks 91, 94
 Ramsey 287
 Ramsey Sound 5, 289
 Ramsgate Harbour 191
 Rat Island 262
 Raunefjorden 36
 Ravenglass 328–9
 Ravenglass estuary 324
 Ravenscar 168
 Reculver 190
 Redcar 160, 167
 Red Head 131
 Redheugh Farm 159
 Red Wharf Bay 297, 307, 320
 Reighton 155
 Renny Rocks 236
 Resort, Loch 379
- Restronguet Creek 239
 Rhine, River 44
 Rhôs-on-Sea 309, 317
 Rhossili 276
 Rhossili Bay 277
 Rhumney Great Wharfe 274
 Ría de Arosa 57
 Ría de Aveiro 57
 Ría de El Barquero 57
 Ría Formosa 57
 Ribble estuary 315, 317, 322, 324–5
 Ribble, River 324
 Riddon, Loch 342, 347
 Rillage Point 266
 Ringkøbing Fjord 41
 Ringstead 222
 Ringstead Bay 223
 Ristie 103
 Riverside 136
 Roach, River 187
 Roag, Loch 377, 379
 Roa Island 327
 Roaringwater Bay 48
 Robin Hood's Bay 20, 157–8, 167–8
 Rock 260
 Rockall 371, 373, 381
 Rockall Bank 39
 Ronas Voe 91, 93–4
 Roosecote Sands 327
 Roscoff 50, 53, 55
 Roseland Peninsula 240
 Rosemarkie 125
 Rosemarkie lagoon 127
 Rosemullion Head 242
 Rother, River 202
 Rough Firth 332–3
 Rousay 114
 Rousay Sound 109, 111
 Ruan estuary 239
 Rubha Ardvule 374, 376
 Rubha Coigeach 387
 Rubh' Aird Luig 365
 Rubha Shios 390, 395
 Rum 385, 391
 Ryan, Loch 346
 Ryde 208
 Ryde Bay 206
 Ryde Pier 208
 Ryde Sands 208
- Saberstone 77
 St Abbs 158–60
 St Abb's Head 157, 159–60
 St Alban's Head 32
 St Andre 57
 St Andrews 123, 159
 St Andrews Bay 123, 134–6
 St Austell Bay 238
 St Bees Head 328
 St Brides Bay 284–5
 St Brides Haven 285
 St David's 285
 St David's Peninsula 285, 299
 St Govan's Chapel Cove 279
 St Helen's Ledges 208
 St Helen's Roads 209
 St Ives 258
 St Ives Island 259
 St John's Lake 237
 St Kilda 8, 371, 373, 375, 381
 St Magnus Bay 74–5, 91–2, 94
 St Malo 52
 St Martin's 245
 St Martin's Flats 245
 St Marys 247
- St Mary's Island 156, 158, 165
 St Mawes 239
 St Mawes Bank 240
 St Mawes Harbour 240
 St Michael's Mount 242
 St Ninian's 88
 St Ninian's Isle 89
 St Patrick's Causeway 300
 St Peter's Pool 113–14
 St Tudwal's Island 297, 303
 Salcombe estuary 16, 221
 Salcombe Harbour 232, 239, 241
 Saltburn 167
 Saltburn Scar 168
 Saltburn-by-the-Sea 167
 Saltfleetby 183
 Saltness 92
 Saltom Bay 329
 Salt Stone 232
 Saltwick Bay 168
 Samalaman Bay 387
 Sarns, The 300
 Samson 245
 Sandaig 390
 Sanday 111
 Sandbanks 209
 Sandness 91
 Sandon Dock 321–2
 Sand Point 272
 Sandsend 168
 Sandsfoot 224
 Sandside 119
 Sandsound Voe 88
 Sandvadden Loch 103
 Sand Voe 89
 Sandwick 84
 San Sebastian 53
 Santander 56
 Sarn Badrig 300–1
 Sarn Cynfelin 300
 Sarn-y-Bwch 300
 Saundersfoot 278
 Saunton 265
 Sawdern Point 282
 Scalby Mills 168
 Scalby Ness 168
 Scalloway 82, 88–9
 Scapa Flow 17, 109, 111–14
 Scarba 355, 365
 Scarborough 168
 Scarth Bight 329
 Scatness 88–9
 Scatsta 94
 Houb of 96
 Scatsta Voe 96
 Scheldt estuary 46
 Scheldt, River 44
 Scoble Point 232
 Scolt Head Island 184
 Scourie 390
 Scourie Bay 390
 Scousburgh, Bay of 88
 Scrape at Minsmere 189
 Scremerston 161
 Seacliff 142
 Seacombe 209
 Seafield 141–2, 144
 Seaford 203
 Seaford Head 203
 Seaforth, Loch 379
 Seaham 165–6
 Seaham Harbour 166
 Seahouses 162
 Seal Sands 167
 Seaside 135
 Seaton 229
- Seaton Channel 167
 Seaton Point 162
 Seaton Sluice 165
 Seil 365
 Seine Bay 52
 Sellafield 329
 Selsey Bill 199, 203–4, 207
 Sennen Cove 243
 Seton 142
 Seton Sands 141
 Seven Sisters 203
 Severn estuary 5, 10, 15, 257, 267
 Sewerby 168
 Shaalds Reef 102
 Shakespeare Cliff 191
 Sharpness 268
 Sheerness 190
 Sheilavaig, Loch 377
 Shell Bay 209
 Shell Island 301
 Shelly Point 137
 Sheringham 185
 Shetland 10, 13–14, 16, 20, 26, 36, 73
 Shiant Islands 373
 Shingle Street 189
 Shoeburyness 190
 Shoreham 203–4
 Shuna Island 363
 Siccar Point 160
 Sinclair's Bay 123, 125
 Sizewell 185–6
 Sizewell Power Station 185–6
 Skagerrak 39
 Skaldervik 42
 Skateraw 142
 Skelda Voe 89
 Skellister 86
 Skinflats 138–9, 144
 Skinningrove 168
 Skippers Island 187
 Skipport, Loch 377
 Skokholm 287
 Skomer 275, 285, 287
 Skye 385, 391
 Sleat, Sound of 392
 Slipper Mill Pond 204
 Slog Burn 102
 Small Isles 385, 391
 Smallmouth 224, 266
 Smallmouth Sands 224
 Smalls, The 288
 Smith Bank 125, 128
 Snab Sands 327
 Snapes Point 232
 Sognfjord 36, 59
 Solent 10, 199, 204, 206–7, 209
 Solway estuary 315, 332
 Solway Firth 5, 10, 310, 315, 317, 330
 Somme estuary 51
 Sörfjord 38
 Sound, Voe of 87
 Souter Point 158
 Southampton 206
 Southampton Water 199, 204, 206–7
 South Benfleet Creek 190
 Southbourne 209
 South Cliff 169
 South Docks 322
 Southernness Point 331–2
 South Esk, River 133
 South Gare Sands 167
 South Haven 100–1
 South Nesting 85–6

- South Nesting Bay 85-6
 South Queensferry 141-2
 South Ronaldsay 110-11
 South Spital Carrs 164
 South Sutor 129-30
 South Uist 371, 374-6, 392
 South Voe 89
 Southwold 179, 185
 Spain 14, 55, 58
 Speeton 168
 Spelve, Loch 366
 Spey, River 127
 Spiggie, Loch of 88
 Spurn Bight 182
 Spurn Head 181
 Stackpole Head 279
 Stackpole Quay 279
 Stack Rock 279, 283
 Staithes 168
 Stanlow Banks 321
 Stanshaw Lake 205
 Stanswood Bay 207
 Stanton Bank 359
 Starehole Bay 233
 Start Bay 10, 231
 Start Point 14, 32, 230-2
 Stenness, Loch of 109-10, 114
 Stiffkey 185
 Stirling 137, 140
 Stockinish, Loch 380
 Stoke Point 231
 Stone Band 187
 Stonehouse Pool 234
 Stornoway 373
 Stoupe Beck Sands 168
 Stour estuary 181, 186-7
 Strangford Lough 50
 Strangford Lough Narrows 289
 Stranraer 346
 Strathy 119
 String, The 114
 Striven, Loch 342, 347
 Strome Narrows 393-4
 Strom, Loch of 88-9
 Stromness Voe 88-9
 Stronsay 112
 Strumble Head 285
 Struth Mor 390
 Studland 209
 Studland Bay 209, 222
 Sudbrook 274
 Suffolk 179
 Sula Sgeir 373, 381
 Sula Skeir 371
 Sullom Voe 75-8, 81-2, 94-100
 Sumburgh 86, 91
 Sumburgh Head 73, 85, 88, 100
 Summer Isles 385, 391
 Sunart, Loch 364
 Sunderland 156
 Sutherland 118
 Kyle of 128
 Swale 181, 190
 Swale, River 190
 Swanage 202, 209
 Swanage Bay 212
 Swanpool 240
 Swansea Bay 15, 267, 271, 275-6
 Swarbacks Minn 81, 91, 94
 Sweden 39
 Sween, Loch 357, 359
 Swining Voe 94, 96, 99
 Swinister 96
 Swinister Voe 94
 Swinna Ness 83
 Switha 113
 Sylt 42-3
 Taff estuary 274
 Taff, River 267, 273
 Taf, River 278
 Tail of Uran 101
 Tain Sands 128
 Tamanavay, Loch 379
 Tamar 16, 237
 Tamar estuary 221, 236
 Tamar, River 10, 234
 Tanera Beg 391
 Tarbat Ness 126, 128
 Tarbert, Loch 364
 Tarff estuary 333
 Tavy, River 234
 Tawe estuary 274, 276-7
 Taw estuary 257
 Taw-Torridge estuary 264-5
 Tay, Firth of 123, 127, 134
 Taylor's Bank 319
 Tayport 135
 Tay, River 131
 Teacuis, Loch 364
 Tealasavay, Loch 379
 Teddington Weir 190
 Tees Bay 167
 Tees estuary 155, 166-7
 Tees Mouth 167
 Tees, River 167
 Teesside 156, 158
 Teign estuary 230
 Tenby 16, 275, 279
 Tentsmuir 134
 Tentsmuir Beach 135
 Texel 44
 Thames estuary 10, 179, 189
 Thanet 14, 191
 Theddlethorpe Dunes 183
 Thorntonloch 158
 Three Chimneys 285
 Three Rivers 278
 Thurlestone 233
 Thurnaig, Loch 390
 Thurso 118
 Tintagel Head 260
 Tipner Lakes 205
 Tiree 355, 359, 366
 Toberonochy 365
 Tofts Voe 99
 Tongue, Kyle of 118, 121
 Torbay 16, 229-30
 Torness 142, 158
 Torness Point 158
 Torpoint 236
 Torquay 230
 Torre Abbey Sands 230
 Torridge estuary 257
 Torridon, Loch 387, 390, 393
 Torrisdale Bay 118
 Torry Bay 138-40
 Torryburn 139
 Tosnos Point 232
 Tostre 277
 Traeth Lafan 308, 310
 Traeth Melynog 308-9
 Traigh Eais 374
 Traigh Iar 376
 Traigh Mhor 374
 Traigh Torr Mor 390
 Trebetherick 259
 Tremadoc Bay 305
 Tresco 245
 Tresta, Wick of 83-4
 Treveal Reefs 259
 Trevone 259
 Trevoise Head 259
 Trink, The 165
 Trolli Geo 102
 Tromsø 13, 36
 Trondheim 14, 36
 Trondheimfjord 36
 Truro 239
 Turnaware Point 240
 Tweed estuary 155
 Tweed, River 161
 Tyne 160
 Tyne estuary 155, 165-6
 North 142
 Tynemouth Long Sands 165
 Tyne, River 165
 Tynninghame 137, 142
 Tyn Llan pool 306
 Tywi, River 278
 Udale Bay 129-30
 Ugie estuary 131
 Uiskevagh, Loch 377
 Ullapool 387, 390
 Unst 75, 83-4, 91
 Ura Firth 93
 Urr Water 333
 Usk estuary 273-4
 Uskmouth 273
 Usk, River 267, 272-3
 Vadills, The 76, 86, 91-3
 Vila Sound 88-9
 Vallaquie Strand 376
 Vallay Strand 376
 Watersay 374
 Vementry 91
 Vidlin 85
 Vidlin Voe 85-7
 Vigo 57
 Vigo Bay 13
 Village Bay 381
 Voxter Ness 94-5, 99
 Voxter Voe 94, 99
 Wadbister Voe 85, 87
 Wadden Sea 40-2, 44
 Wales
 North 19-20
 South-west 274
 Walls 88-9, 91
 Walney Channel 327-9
 Walney Island 325-8
 Wansbeck, River 165
 Warkworth Harbour 163
 Wash, The 10, 179, 181, 183-4
 Watchet 15
 Water of Fleet 332-3
 Waveney, River 185
 Wear estuary 155, 166
 Weir Quay 236
 Weisdale Voe 88-9
 Welland, River 184
 Welsh Grounds 272
 Welton Waters Central Lagoon 182
 Wembury 19
 Wembury Bay 233-4
 Wentlooge 272
 Wentlooge Flats 274
 Weser estuary 42
 Weser, River 42
 West Angle 279
 West Angle Bay 279
 West Bay 226
 West Burra 88
 West Burra Firth 88
 Westdale Bay 285
 Western Isles 373
 West Ferry 345
 Westgate 190
 West Loch Tarbert 360
 West Lunna Voes 96
 West Rousay 113
 West Runton 185
 West Tarbert Loch 380
 West Thurrock power station 189
 West Tump 288
 West Voe 87-8
 Westward Ho 265
 Weybourne 185
 Weymouth Bay 221-5
 Whale Firth 91-3
 Whalsay 75, 86
 White Bay 343
 Whiteford Sands 277
 Whiteford Scar 278
 Whiteness Head 127
 Whiteness Voe 81, 88-91
 White River 238
 Whitesand Bay 243, 285
 Whitley Bay 165
 Whitsand Bay 237
 Whitstable 20, 190
 Wick 125
 Wick, River 125
 Widewater Lagoon 204
 Widewell Bay 111
 Wigtown Bay 317, 334
 Wild Pear Beach 266
 Wilhelmshaven 42-3
 Wirral 319-20
 Wisbech 184
 Witham, River 184
 Woolacombe 265
 Wootton Creek 208
 Wormit Bay 135
 Worms Head 276
 Worthing 202-3
 Wyberton Marsh pond 184
 Wye estuary 273-4
 Wye, River 267, 273
 Wylfa 306
 Wyre estuary 324
 Wyre, River 325
 Wyre Sound 109, 111, 114
 Yar 208
 Yare, River 185
 Yarm 167
 Yealm estuary 233
 Yealm Sand Bank 233
 Yell 83-4, 91-2, 94
 Yell Sound 75, 94-6, 98
 Ynys 300
 Ynys Llanddwyn 305
 Ythan estuary 123, 131, 133
 Zone Point 238