JOINT NATURE CONSERVATION COMMITTEE

Marine Nature Conservation Review

Sector 10

Cardigan Bay and north Wales

Area summaries

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Coasts and seas of the United Kingdom - MNCR series

16 Caernarfon Bay

Location		
Position (centre)	SH 41 50	53°01'N 4°22'W
County/district	Gwynedd; Ynys Môn (Anglesey)	Dwyfor; Arfon
Conservation agency/area	Countryside Council for Wales	North-west Area

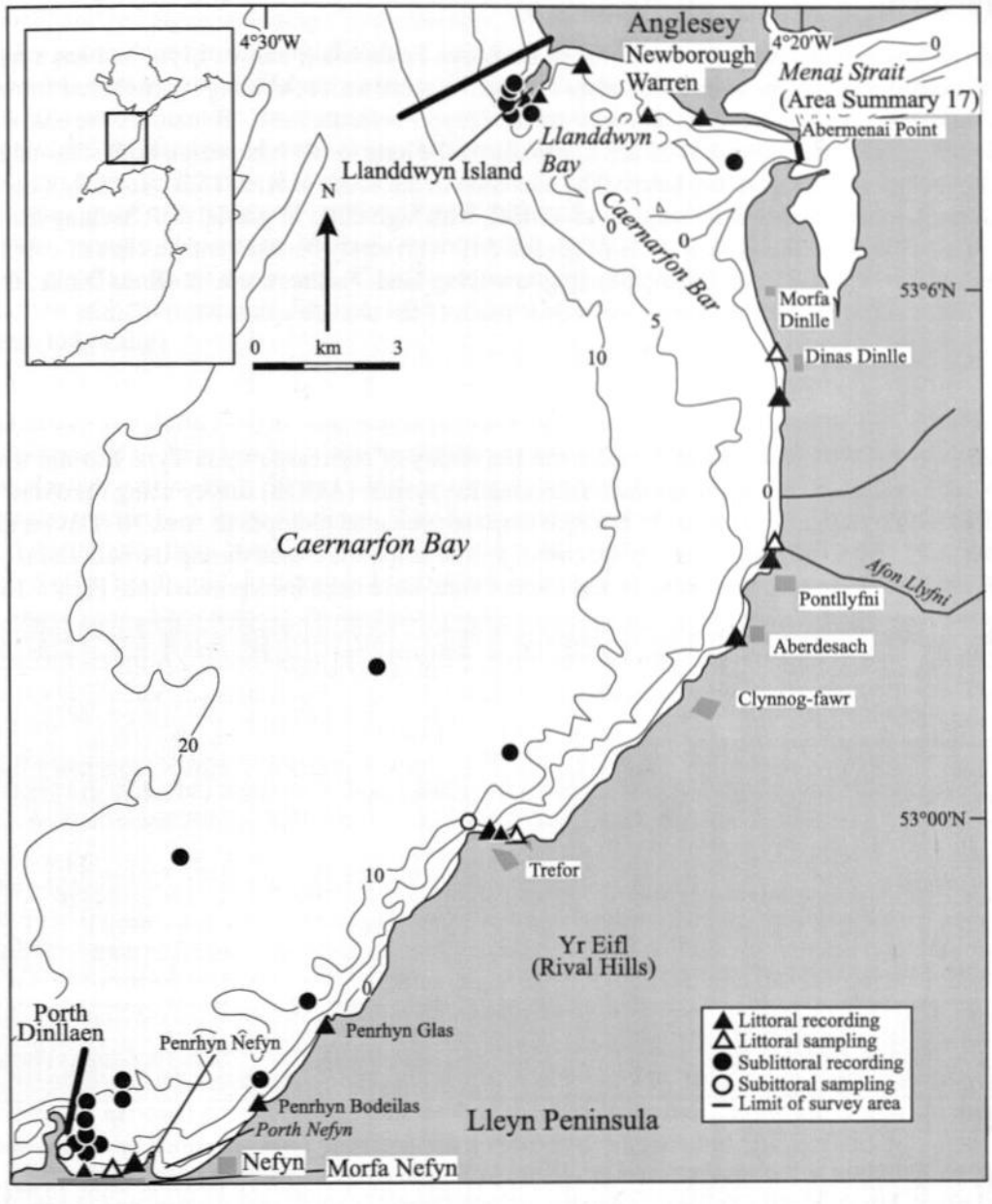

Figure 16.1 Main features of the area, showing sites surveyed.

Physical features	
Physiographic type	Open coast
Length of coast	36 km
Bathymetry	20 m isobath within 1.5 km offshore in south; 10 km offshore in north
Wave exposure	Exposed to sheltered
Tidal streams	Moderately strong to very weak
Tidal range	4.3 m springs; 1.8 m neaps (at Trefor)
Salinity	Fully marine

Introduction

Caernarfon Bay is situated on the north side of the Lleyn Peninsula (Penrhyn Llŷn) and has a mainly north-westerly aspect exposed or moderately exposed to wave action, although is sheltered from swell action coming from the south-west and west by the Lleyn Peninsula itself. It includes the east side of the tide-swept headland at Porth Dinllaen north-east to the long sandy beaches on both sides of the south-west entrance of the Menai Strait. The shoreline in the south of Area 16 is generally steep hard igneous rock, particularly around the foot of Yr Eifl, with high cliffs of glacial drift backing the embayments. North of Trefor, low cliffs of glacial drift with sandy beaches and patches of cobbles and boulders give way to a shingle ridge protecting low-lying land. Further north, at Dinas Dinlle, there is another short cliff of rapidly-eroding glacial drift south of the shingle spit at Morfa Dinlle.

Marine biology

In addition to the MNCR survey of Area 16, the University of Newcastle-upon-Tyne BioMar team carried out a broad-scale acoustic ground discrimination system (AGDS) survey using RoxAnn™ ground-truthed by drop-down video to produce maps of predicted biotopes in Area 16 (Davies & Sotheran 1995; W. Cook and I. Rees, pers. comm.). The maps were used during the sublittoral part of the survey as an aid to targeting habitats and biotopes and have been incorporated into Figure 16.2.

Marine biological surveys				
	Survey methods	***No. of sites***	***Date(s) of survey***	***Source***
Littoral	Recording (epibiota)	14	June – July 1995	MNCR survey 627
		1	1983	Rostron (1984)
		3	July – August 1996	MNCR survey 641
	Habitat (biotope) mapping		Aug 1997	CCW survey 10.47.1
	Infaunal sampling (8 x 10.3 cm diam. cores plus granulometry)	2	July – August 1996	MNCR survey 641
		3	June – July 1995	MNCR survey 627
Sublittoral	Recording (epibiota)	7	June – July 1995	MNCR survey 628
		5	1982	Lumb (1983)
		6	1983	Hiscock (1984)
		1	August 1997	MNCR survey 647
	Infaunal sampling (8 x 10.3 cm diam. cores plus granulometry)	2	June – July 1995	MNCR survey 628
	RoxAnn acoustic tracking ground-truthed by drop-down video	Whole area	June 1995	Davies & Sotheran (1995)

Littoral

The rugged shoreline at the southern end is subject to a wide range of wave exposure, from the exposed tip of Trwyn Porth-Dinllaen to locally sheltered areas in small rocky coves and sandy embayments such as Porth Dinllaen. North of Trefor the character of the coast changes to more continuous stretches of sand, shingle and gravel interspersed by patches of cobbles and boulders, before reaching the rocky outcrop of Llanddwyn Island.

Around Trwyn Porth-Dinllaen the craggy bedrock and boulder shores support a mixture of fucoid-dominated communities with small sheltered areas covered in *Ascophyllum nodosum* (Asc.Asc). There are also shores characteristic of more exposed conditions with almost complete covering of barnacles *Chthamalus montagui*, *Semibalanus balanoides*, limpets *Patella vulgata* and *Patella ulyssiponensis*

and small mussels *Mytilus edulis* (BPat.Sem). The supralittoral (splash zone) and littoral fringe (upper shore) bedrock is very heavily creviced and is covered by patches of yellow and grey lichens (YG), while lower on the shore there is a distinct band of black lichen *Verrucaria maura* (Ver.Ver). The crevices are crowded with large numbers of small gastropods *Littorina saxatilis* and, at the more exposed sites, *Melarhaphe neritoides*, sea slaters *Ligia oceanica* and bristletails *Petrobius maritima*. Rockpools are a prominent feature of the southern part of Area 16. Small pools and drainage channels are lined with pink encrusting coralline algae and *Corallina officinalis*, with the limpet *Tectura virginea* grazing on the surface of the crusts (Cor). The bigger pools, several metres in diameter and over 1 m deep, contain kelp *Laminaria digitata*, other brown algae (*Halidrys siliquosa* and *Dictyota dichotoma*) and red algae including *Ceramium* spp., *Mastocarpus stellatus*, *Gastroclonium ovatum*, *Phyllophora pseudoceranoides* and *Gelidium latifolium* (FK). These larger pools also contain sponges *Halichondria panicea* and *Haliclona viscosa*, anemones *Actinia equina* and *Anemonia viridis*, and hydroids *Dynamena pumila*; the animals are generally found on the vertical sides of the pools in the shade provided by the algae. Lower shore communities at the same sites are similar in species composition to the rockpools. A carpet of the fucoid *Fucus serratus* provides shade and humidity for an understorey turf of red algae (Fser.Fser; Fser.R), comprising mainly *M. stellatus* and *Laurencia pinnatifida*, sponges *H. panicea*, *Hymeniacidon perleve* and *Halisarca dujardini* and anemones *A. equina* and *Bunodactis verrucosa*. Coralline crusts and *L. digitata* characterise the sublittoral fringe, often with the anemones *Sagartia elegans* and *Urticina felina* wedged into small crevices under the algae (Ldig.Ldig).

Trwyn Porth-Dinllaen provides shelter from westerly winds and wave action for the sandy bays at Porth Dinllaen and Porth Nefyn. The sediment is fine and medium-grained sand which is rich in species compared to the more open coast sediment shores of the Lleyn, particularly amongst the eelgrass *Zostera marina* beds (Zmar) which occur at just above chart datum in the most sheltered area amongst the moorings in Porth Dinllaen. The *Zostera* beds appear to be rather patchy, probably due to physical disturbance from boating activities. Between the two sandy bays a small rocky headland, Penrhyn Nefyn, has fucoid-dominated communities, with a mixture of barnacles, *A. nodosum* and *Fucus vesiculosus* characterising the localised shelter.

The headlands Penrhyn Bodeilas and Penrhyn Glas, to the north-east of Nefyn, both have steep to vertical rocky shores characterised by mussel, barnacle and limpet-dominated communities with patchy turfs of red algae on the lower shore and in sediment-floored rockpools (SwSed). There are locally sheltered areas of bedrock and boulder on the north-facing sides of the headlands which have a partial covering of fucoid algae as well as ephemeral species, such as the green alga *Enteromorpha* sp., and filamentous red algae including cushions of sand-binding *Rhodothamniella* sp. *Rhodothamniella* sp. is tolerant of sand-scour and tends to be characteristic of turbid water conditions. Smoothly-rounded boulders cover the shores between these headlands and extend northwards towards Trefor. Few species other than ephemeral algae, shore crabs *Carcinus maenas*, gastropods such as *Littorina littorea* and *Gibbula umbilicalis* and barnacle spat live on and amongst the boulders (BLlit) which suggests that they are thrown around by winter storms which scours the plants and animals off the rock. Even in the relative shelter of Trefor harbour the boulders on the lower shore have only a partial covering of the fucoid *F. serratus* with some kelp *L. saccharina* between the boulders - again indicative of disturbed conditions. The area of sand beach just north of Trefor is also characteristic of the moderately exposed conditions; rippled sand on the mid-shore holds lugworm *Arenicola marina* casts and the lower shore has sand mason worm *Lanice conchilega* tubes (AP.P; Lan).

The 8 km of coast north of Trevor to Dinas Dinlle has very similar characteristics, comprising boulders and cobbles set in sandy sediment with small patches of sandy beach between them. The steep cobble bank running almost continuously along the top of the shore supports very few conspicuous species, other than small numbers of gammarid amphipods and small *C. maenas* (BarSh). The mid-shore is also rather species-poor, particularly where widely-spaced stones are set in mobile sand. However, where the stones form a more consolidated pavement, they support a variety of filamentous and foliose red algae amongst dense fucoids (FvesX). Below and amongst the *F. serratus* zone, where fine sand surrounds the stones, meadows of bootlace weed *Chorda filum* merge with *L. saccharina* into the sublittoral fringe (LsacChoR).

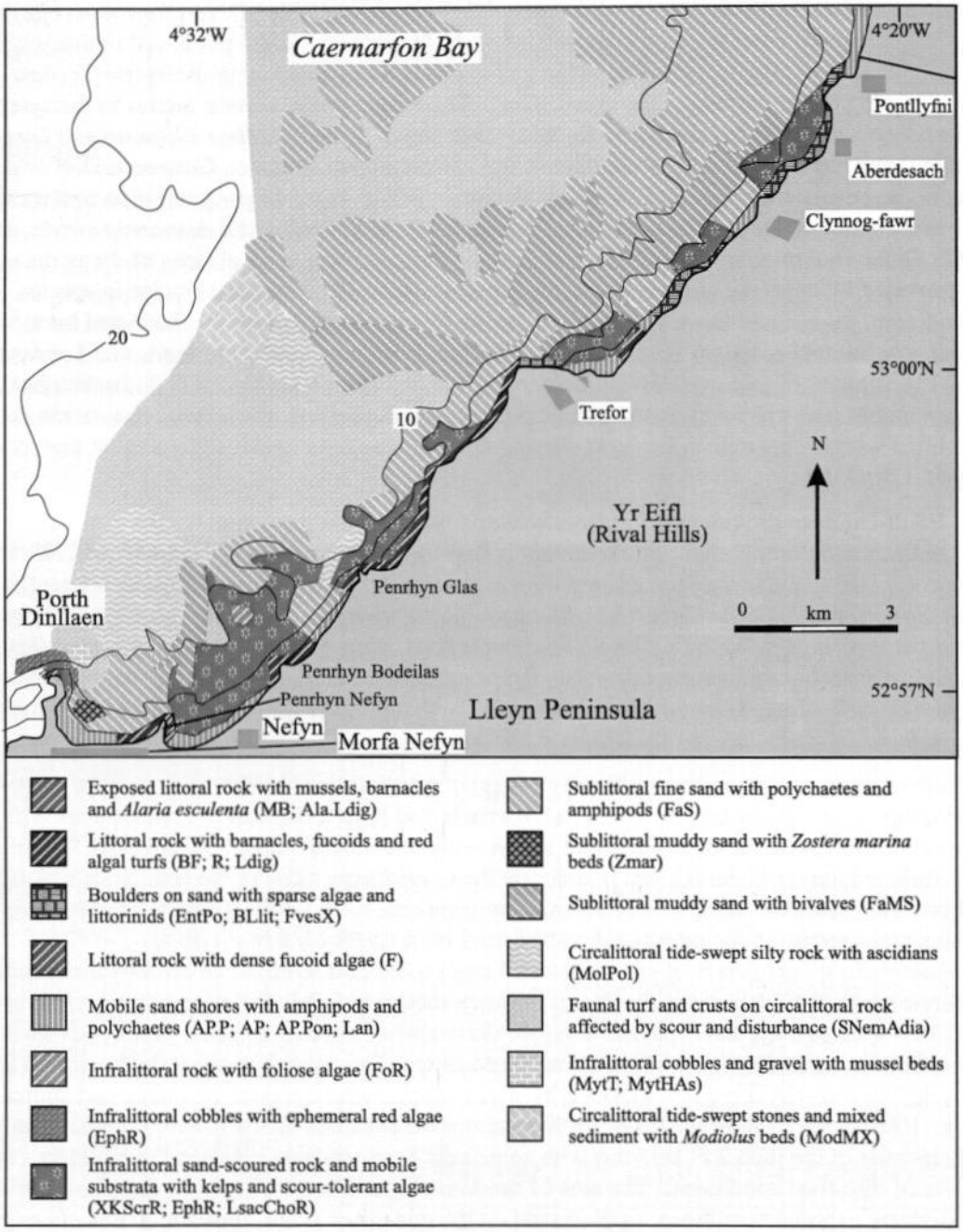

Figure 16.2 Indicative distribution of the main biotopes in the area (southern part) (based on data from survey sites shown in Figure 16.1, AGDS surveys, cited literature and additional field observations).

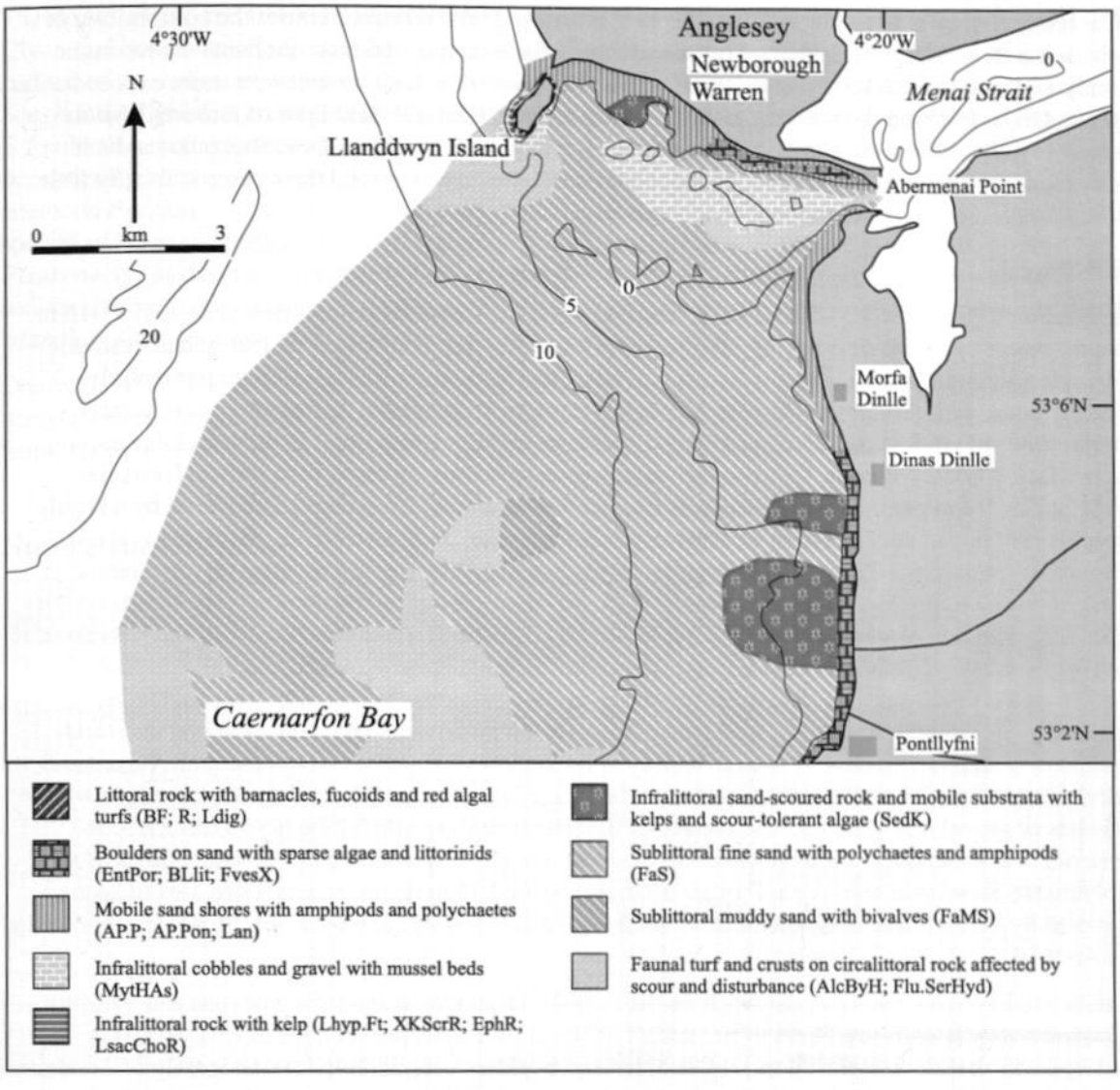

Figure 16.3 Indicative distribution of the main biotopes in the area (northern part) (based on data from survey sites shown in Figure 16.1, AGDS surveys, cited literature and additional field observations).

Several small rivers, for example Afon Llyfni at Pontllyfni, flow across the shore in this section of Area 16. Small flounder *Pleuronectes flesus* are seen in the rivers and green algal cover is particularly dense on stones near the river mouths', comprising a large proportion of *Enteromorpha* sp. with some *F. vesiculosus* (FvesX). However, species-richness is generally low.

A wide expanse of sandy beach backed by a steep slope of rounded cobbles and slates runs from Dinas Dinlle to the south-west entrance of the Menai Strait. It continues on the north side of the Strait towards Llanddwyn Island, although here the sandy shore is backed by sand dunes and conifer plantations. The sand is characterised by a sparse crustacean/polychaete infauna, with the burrowing heart urchin *Echinocardium cordatum* on the extreme lower shore (AP.P; AP.Pon), and areas of shingle with little or no obvious fauna (BarSh). Although Llanddwyn Bay was not surveyed, there are large areas of gravelly sediment bound together by mussels *Mytilus edulis* (MytX) which are themselves covered in a crust of barnacles.

The rocky shores of Llanddwyn Island support a variety of fucoid communities the composition of which are dictated by the degree of wave exposure. For example, the most sheltered shores in the sandy and rocky coves have dense patches of *A. nodosum* (Asc.Asc), whereas the more exposed areas of smooth bedrock on the west shore of the island support barnacles and lines of mussels *Mytilus edulis* (MytB). However, the overriding factor affecting the majority of these shores is sand and gravel-scour. Many of the hard rocky outcrops are scoured clean around their bases with very little other than a few barnacles and mussels in crevices.

Sublittoral

Several biotopes recorded in Area 14 extend into Area 16. Cobbles and boulders at around 13-15 m depth, swept by moderately strong tides, support a species-rich faunal turf. Crustose and cushion-forming sponges *Dysidea fragilis*, *Phorbas fictitius* and *Hemimycale columella* are particularly conspicuous, with dead man's fingers *Alcyonium digitatum*, anemones *Epizoanthus couchii* and *Actinothoe sphyrodeta* and a wide range of bryozoans including ross coral *Pentapora foliacea*, hornwrack *Flustra foliacea*, *Cellaria* spp. and *Bugula* spp. forming part of the turf (SNemAdia; ErSPbolSH; MolPol). A plain of boulders and cobbles at around 25 m depth, is covered by a highly species-rich turf of sponges such as *Polymastia boletiformis*, *Stelligera rigida*, *Raspailia hispida*, *Raspailia ramosa* and *Tethya aurantium*, hydroids, mainly *Nemertesia antennina*, *Hydrallmania falcata* and *Sertularia argentea*, bryozoans such as *F. foliacea* and *Alcyonidium diaphanum*, and ascidians *Molgula manhattensis* and *Polycarpa* spp. (ErSPbolSH, MolPol). Some of the faunal turfs overgrow crusts of *Sabellaria spinulosa* tubes (MolPol.Sab). These biotopes extend from south-west of Trwyn Porth-Dinllaen (Area 14) and continue north-eastwards up the coast towards Trefor, gradually becoming more patchy and sandy, and grading into extensive plains of gravel and sandy sediment in the inner parts of Caernarfon Bay and Llanddwyn Bay. Here only the more robust and sand-tolerant species are found on the hard substrata (Flu.SerHyd). Where the cobbles merge with patches of gravel, the stones on the surface of the gravel support tufts of the bryozoans *Eucratea loricata* and *Vesicularia spinosa* while larger stones are partially covered by the sandy tubes of the polychaete *Sabellaria spinulosa*. Further offshore, beyond 25 m depth, an extensive area of seabed covered by dense horse mussel *Modiolus modiolus* beds (ModMx) just overlaps the western boundary of Area 16.

Cobble and boulder reefs lie close inshore, just off the headlands at Penrhyn Bodeilas and Penrhyn Glas, and similar reefs are likely to be present off most of the steeper sections of rocky coast in Area 16. In shallow water (< 4 m) the cobbles and boulders support kelp forests, mainly of *Laminaria hyperborea* with a few *Laminaria saccharina* plants; in slightly deeper water a dense carpet of filamentous and foliose red algae covers the boulder tops amongst the kelp holdfasts (XKScrR; EphR). The algae include very dense *Plocamium cartilagineum*, with *Heterosiphonia plumosa*, *Brongniartella byssoides*, *Halurus equisetifolius*, *Delesseria sanguinea* and *Ceramium* spp. with *Palmaria palmata* growing in large bunches on the kelp stipes. In sandier areas with little wave action, for example south of Dinas Dinlle, the sublittoral fringe communities are characterised by dense stands of bootlace weed *Chorda filum* (LsacChoR). Foliose brown algae including *Dictyota dichotoma* and *Desmarestia ligulata* are also conspicuous on these boulder reefs.

Short vertical bedrock faces, overhangs and the undersides of loose boulders influenced by sand, for example around Trevor and off Llanddwyn Island, supported several species of sponge and ascidian. The sponges *Halichondria panicea*, *Dysidea fragilis* and *Esperiopsis fucorum* and ascidians *Clavelina lepadiformis*, *Botryllus schlosseri* and *Perophora listeri* were recorded frequently (AlcByH). In addition, a variety of encrusting bryozoans, saddle oysters *Pododesmus patelliformis*, keel worms *Pomatoceros triqueter* and fan worms *Bispira volutacornis* are found amongst the boulders and in boulder holes. At the rock-sand interface, just below some of the kelp forests, the communities are characterised by plants and animals tolerant of scour. Dense mussels *Mytilus edulis* interspersed with anemones *Urticina felina* cover the boulders and shallow bedrock, occasionally with sand-encrusted *Molgula* sp. (possibly *M. oculata*) between them. Red algae forms dense turfs including *Polysiphonia elongata* and the robust *Phyllophora* spp. The brown alga *Taonia atomaria*, known to have a generally southern and western distribution, is found in this habitat just offshore at Penrhyn Glas.

The mixed gravel and fine sand plains at the northern end of Area 16, for example off Trefor and Clynnog-fawr, contain large numbers of ascidians *Eugyra arenosa* and *M. oculata* buried in the surface of the sediment with only their siphons protruding. The opisthobranchs *Philine aperta* and *Scaphander lignarius* crawl just under the surface of the sand, where the necklace shell *Euspira catena* is found also, particularly around Llanddwyn Island (EcorEns). These predators were found occasionally holding on to their prey of razor shells *Ensis* spp. Less common was the burrowing anemone *Peachia cylindrica*, although it was found occasionally in fine sand off Trefor. A second species of burrowing sea anemone, *Cerianthus lloydii*, hermit crabs *Pagurus bernhardus*, plaice *Pleuronectes platessa* and dragonets *Callionymus lyra* are recorded regularly on most grades of sediment throughout Area 16. Infaunal core-samples of the sediments contained the bivalves *Arctica islandica*, *Gari fervensis* and *Chamelea gallina*, as well as a variety of polychaetes.

Dense *M. edulis*, themselves covered in barnacles *Semibalanus balanoides*, consolidate the sand and shingle which forms a bank just outside the Menai Strait at Caernarfon Bar. Seed mussels are taken from this area to grow on to marketable size on the Bangor mussel lays.

Nature conservation

Conservation sites

Site name	*Status*	*Location*	*Main features*
Pen Llŷn a'r Sarnau/Lleyn Peninsula and the Sarnau	cSAC	SH 50 30	Estuaries; Reefs.
Lleyn Peninsula	AONB	N/A	High scenic quality
Anglesey	AONB	N/A	High scenic quality.
Llyn Peninsula	ESA	N/A	Agri-environmental scheme
Ynys Mon	ESA	N/A	Agri-environmental scheme
Lleyn Peninsula	HC	SH 424 514 - SH 324 266	Coastal scenery
Newborough Warren - Ynys Llanddwyn	SSSI; NNR; GCR; cSAC	SH 410 630	Biological; geological.
Dinas Dinlle	SSSI; GCR	SH 437 562	Geological.
Gwydir Bay	SSSI; GCR	SH 391 481	Geological
Yr Eifl	SSSI	SH 365 447	Botanical; ornithological.
Carreg y Llam	SSSI	SH 334 437	Ornithological.
Porth Dinllaen	SSSI; GCR	SH 270 411 to SH 297 410	Biological, including intertidal habitats; geological.

Human influences

Coastal developments and uses

The coast is mostly backed by rural grazing land although the Newborough section in the north is backed by sand dunes and coniferous forest. There are a few small villages such as Trefor, which has a small pier once used by the nearby quarries, and Aberdesach and Pontllyfni are situated along the main A499 Caernarfon to Pwllheli road. Area 16 is sparsely populated, although some of the small towns and villages are popular with tourists during the summer and there are several camping and caravan sites. The main centres for tourism in Area 16 are at Nefyn, Morfa Nefyn and Porth Dinllaen which have long stretches of adjoining sandy beach. The latter also has moorings sheltered by the headland Trwyn Porth-Dinllaen. Dinas Dinlle also has a popular sandy beach, backed by a shingle storm beach, which is protected by boulder groynes perpendicular to the shore. Small stretches of the coast near Nefyn have sea walls. The sandy beaches at Newborough and the small coves around Llanddwyn Island are popular with day visitors. Penrhyn Glas has the remains of a disused quarry pier, jetty and associated buildings.

Marine developments and uses

There is a small busy harbour and moorings at Porth Dinllaen; here a separation scheme for water skiers and other water users is in force during the summer. Trefor has a small working harbour

sheltered by a wall and pier. The small coves around Llanddwyn Island are used as an anchorage by yacht owners. The buoyed channel in the approaches to the south-west end of the Menai Strait cuts through this Area and receives heavy usage by small boats during the summer months.

The rocky reefs throughout Area 16 are potted for lobsters *Homarus gammarus*, crabs *Cancer pagurus* and whelks *Buccinum undatum*. Small commercial fishing boats use Porth Dinllaen and Trefor harbours. Angling from the shore is popular throughout much of Area 16 and large numbers of anglers use the rocks around Llanddwyn Island, particularly for mackerel *Scomber scombrus* and bass *Dicentrarchus labrax* fishing.

There is a small fish farm at Pont Llyfni and seed mussels *Mytilus edulis* are gathered on the Caernarfon Bar for growing to a larger marketable size at Bangor.

The main sewage outfall at Nefyn is the largest in Area 16, and at the time of writing, was screened only. There were several smaller untreated outfalls including at Nefyn and Trefor.

References and further reading

Davies, J., & Sotheran, I. 1995. *Field report for the mapping of the sublittoral biotopes of the north-west Lleyn Peninsula.* Unpublished, University of Newcastle-upon-Tyne (BioMar report).

Duckworth, J., Holder, C., & Smart, S. 1995. Sand dune survey of Great Britain. Site report No 121. Morfa Dinlle, Arfon, Wales. 1991. *JNCC Report*, No. 87.

Hiscock, K. 1984. Sublittoral survey of Bardsey and the Lleyn Peninsula. August 13th to 27th, 1983. (Contractor: Field Studies Council, Oil Pollution Research Unit, Pembroke.) *Nature Conservancy Council, CSD Report*, No. 612.

Lumb, C.M. 1983. Menai Strait sublittoral survey. (Contractor: University College of North Wales, Marine Science Laboratories, Menai Bridge.) *Nature Conservancy Council, CSD Report*, No. 467.

Richards, A., Bunker, F. St.P., Foster-Smith, R. 1996. Handbook for marine intertidal Phase 1 and SSSI habitat mapping. *Countryside Council for Wales Natural Sciences Report*, No. 95/6/1.

Rostron, D. 1984. Littoral survey of Bardsey and the Lleyn peninsula. August 8th to 13th, 1983. (Contractor: Field Studies Council, Oil Pollution Research Unit, Pembroke.) *Nature Conservancy Council, CSD Report*, No. 540.

Sites surveyed

Survey 186. 1983 Bardsey and the Lleyn Peninsula, sublittoral survey (Hiscock 1984).
Survey 205. 1983 Bardsey and the Lleyn Peninsula littoral survey (Rostron 1984).
Survey 293. 1982 Menai Strait sublittoral survey (Lumb 1983).
Survey 627. 1995 MNCR North Lleyn Peninsula and Tremadog Bay, littoral survey (MNCR, unpublished data).
Survey 628. 1995 MNCR Lleyn Peninsula and Tremadog Bay, sublittoral survey (MNCR, unpublished data).
Survey 641. 1996 MNCR west Anglesey littoral survey (MNCR, unpublished data).
Survey 647. 1997 MNCR west Anglesey sublittoral survey (MNCR, unpublished data).

Littoral sites

Survey	Site	Place	Grid reference	Latitude/longitude	Biotopes present
205	19	Porth Dinllaen	SH 278 418	52°56.7'N 04°33.7'W	YG, Ver.Ver, Fspi, Asc.Asc, XKScrR, Cor, Fser.Fser.Bo, Pel
627	2	E of Porth Dinllaen, Morfa Nefyn.	SH 289 409	52°56.2'N 04°32.7'W	Tal, Lan, AP
627	3	Penrhyn Nefyn, Morfa Nefyn.	SH 294 412	52°56.4'N 04°32.3'W	BPat.Sem, YG, Ver.Ver, FvesB, Fspi, Fser.R, Fser.Fser, FK, Pel
627	4	Trefor Beach.	SH 376 475	52°59.9'N 04°25.2'W	AP.P, Lan
627	5	W of Trefor Pier.	SH 372 475	52°59.9'N 04°25.5'W	YG, Ver.Ver, BPat, FvesB, Fser.R, BLlit, FK, Pel
627	6	Bodfan - South west of Dinas Dinlle, Trefor.	SH 434 558	53°04.5'N 04°20.2'W	Fspi, Fser.Fser, BLlit, FvesX, SwSed
627	7	Dinas Dinlle, Trefor.	SH 432 575	53°05.4'N 04°20.5'W	AP.P
627	8	SW of Aberdesach, Trefor.	SH 418 509	53°01.9'N 04°21.5'W	BPat, Fser.Fser, BLlit, FvesX, SwSed, Ver.B
627	9	Trefor Pier.	SH 374 475	52°59.9'N 04°25.4'W	Fser.Fser, BLlit, FvesX, SwSed
627	18	Penrhyn Glas, Morfa Nefyn.	SH 338 438	52°57.9'N 04°28.5'W	BPat.Sem, YG, Ver.Ver, BPat, Fser.Fser, FvesX, Cor, IR, Pel
627	28	Pontlyfni Sand Beach, Trefor.	SH 431 528	53°02.9'N 04°20.4'W	AP.P, Lan
627	29	Pontlyfni, Trefor.	SH 431 528	53°02.9'N 04°20.4'W	Fser.Fser, FvesX
627	30	Penrhyn Bodeilas, Morfa Nefyn.	SH 318 423	52°57.0'N 04°30.2'W	BPat.Sem, YG, Ver.Ver, Fser.R, Ldig.Ldig, FK, SwSed
641	1	S of Newborough Warren.	SH 425 618	53°07.7'N 04°21.2'W	AP.Pon, BLlit, FvesX, AP.P
641	2	Llanddwyn Bay, Newborough.	SH 402 634	53°08.6'N 04°23.3'W	BarSh, AP.P
641	3	E side Llanddwyn Island, Newborough.	SH 387 626	53°08.1'N 04°24.6'W	YG, Ver.Ver, Asc.Asc, Fser.R, SwSed, PelB
641	4	S end of Llanddwyn Island, Newborough.	SH 385 624	53°08.0'N 04°24.8'W	YG, MytB, Fser.R, Ver.B
641	5	Below W. lighthouse, Llanddwyn Island, Newborough.	SH 384 625	53°08.0'N 04°24.9'W	BPat.Sem, G, YG, Ver.Ver, BPat, SByAs, Cor

Sublittoral sites

Survey	*Site*	*Place*	*Grid reference*	*Latitude/longitude*	*Biotopes present*
186	9	N Carreg-y-Chiswen	SH 281 424	52°57.0'N 04°33.5'W	Flu.SerHyd, MytHAs
186	10	S Carreg-yr-Afr	SH 280 422	52°56.9'N 04°33.6'W	XKScrR, EphR
186	11	Porth Dinllaen (Tow)	SH 282 419	52°56.8'N 04°33.4'W	LsacChoR
186	12	Porth Dinllaen 1	SH 279 414	52°56.5'N 04°33.6'W	Zmar
186	13	Porth Dinllaen 2	SH 282 412	52°56.4'N 04°33.4'W	LsacChoR
186	14	Porth Dinllaen 3	SH 283 417	52°56.6'N 04°33.3'W	XKScrR
293	W2	Ynys-yr-Adar, Llanddwyn Island	SH 382 625	53°08.0'N 04°25.1'W	XKScrR
293	W3	SW Buoy Rock, Llanddwyn Island	SH 385 621	53°07.8'N 04°24.8'W	Flu.Hocu, AlcC, MytHAs
293	W4	SW Island, Llanddwyn Island	SH 386 622	53°07.9'N 04°24.7'W	Flu.SerHyd, Urt.Urt, Lhyp.Ft, MytHAs, ErSPbolSH
293	W5	Llanddwyn Beacon	SH 387 624	53°08.0'N 04°24.6'W	AlcC, Bug
293	W6	Mussel Bank to Abermenai Point, Menai Straits.	SH 433 610	53°07.3'N 04°20.5'W	Flu.SerHyd
628	19	N of Penrhyn Nefyn, Morfa Nefyn.	SH 289 431	52°57.4'N 04°32.8'W	MolPol
628	20	Eilias Bank, Morfa Nefyn.	SH 312 427	52°57.2'N 04°30.7'W	FoR
628	21	Porth Dinllaen Harbour, Morfa Nefyn.	SH 277 415	52°56.5'N 04°33.8'W	Zmar
628	22	Offshore NW of Penrhyn Glas, Morfa Nefyn.	SH 301 480	53°00.1'N 04°31.8'W	ModT
628	23	W of Aberdesach, Trefor.	SH 355 512	53°01.9'N 04°27.2'W	SNemAdia
628	24	N of Trefor.	SH 376 492	53°00.9'N 04°25.2'W	EcorEns
628	25	NW Trefor.	SH 365 479	53°00.2'N 04°26.2'W	IMS
628	26	Inshore Penrhyn Glas, Morfa Nefyn.	SH 332 438	52°57.9'N 04°28.9'W	MolPol, XKScrR
628	27	Off Penrhyn Bodeilas, Morfa Nefyn.	SH 320 426	52°57.2'N 04°30.0'W	XKScrR
647	3	SW Llanddwyn Island, Newborough.	SH 382 625	53°08.1'N 04°25.1'W	AlcByH, MytT

Compiled by: Rohan H.F. Holt

17 Menai Strait (Afon Menai)

Location		
Position (centre)	SH 52 68	53°13'N 4°11'W
County/district	Gwynedd; Ynys Môn (Anglesey)	Arfon; Aberconwy
Conservation agency/area	Countryside Council for Wales	North-west Area

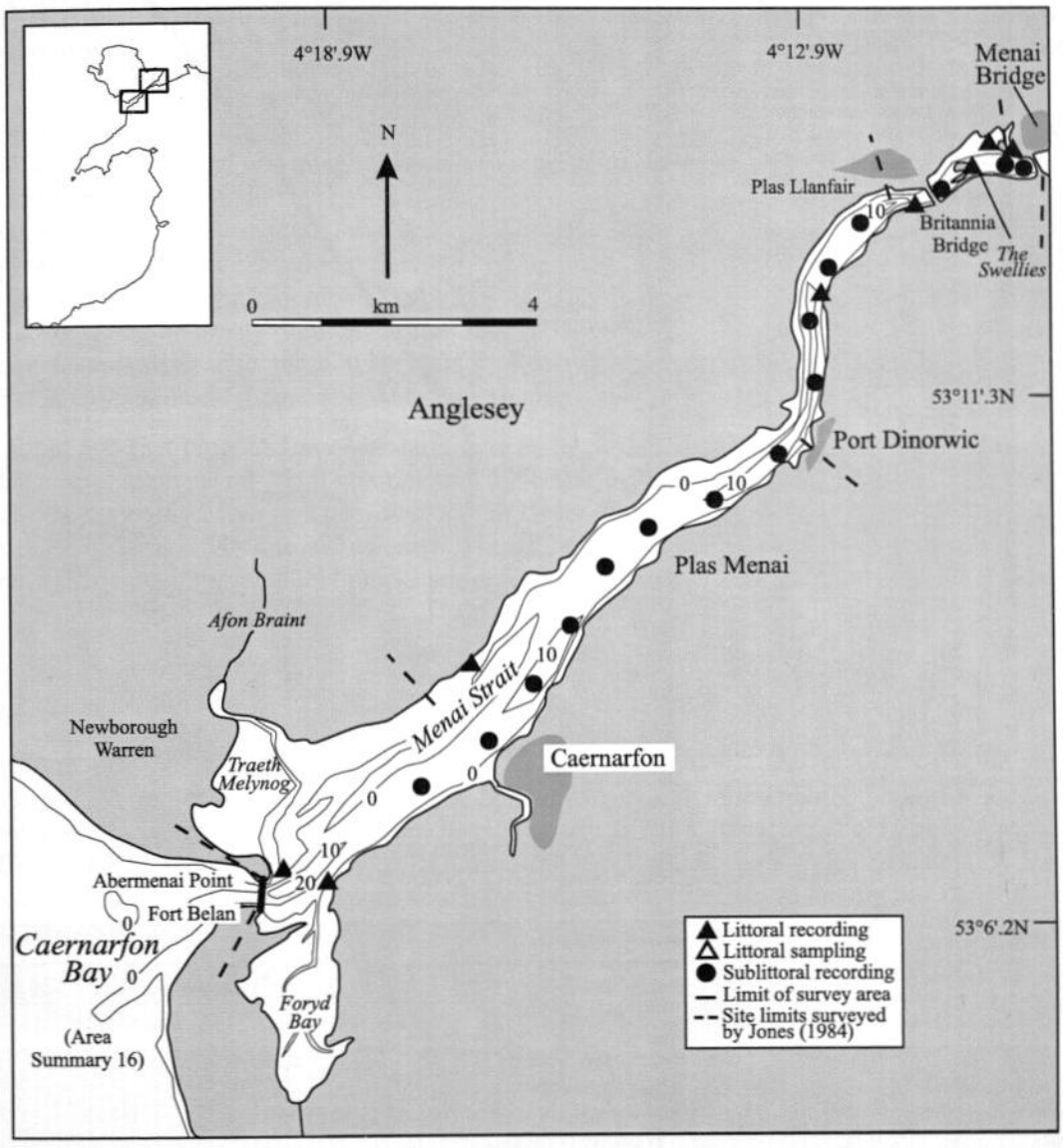

Figure 17.1 Main features of the area (south-western part), showing sites surveyed.

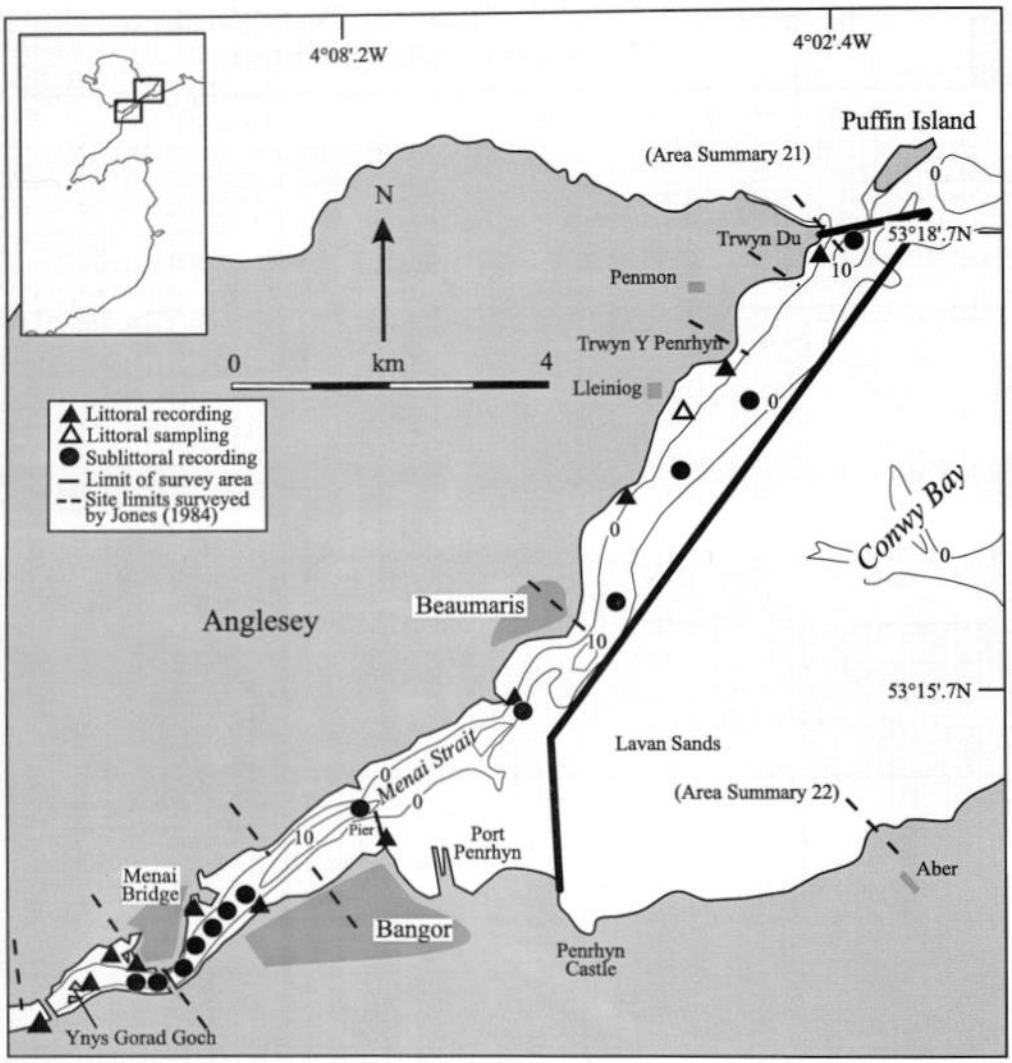

Figure 17.2 Main features of the area (north-eastern part), showing sites surveyed.

Physical features	
Physiographic type	Strait
Length of feature	20 km
Bathymetry	Central channel between 3 m and 25 m deep
Wave exposure	Sheltered to very sheltered
Tidal streams	Very strong to moderately strong
Tidal range	6.7 m springs; 3.6 m neaps (Menai Bridge)
Salinity	Fully marine but occasionally variable

Introduction

The Menai Strait (Afon Menai) separates the north Wales mainland from the Isle of Anglesey (Ynys Môn). The channel is narrow, in places only 250-500 m wide, approximately 20 km long, and runs south-west / north-east, connecting Caernarfon Bay with Conwy Bay. There are various hypotheses concerning the formation of the Strait. One maintains that the continuous channel was formed during the late Pleistocene as ice broke through a narrow section of raised ground which once separated two pre-existing river valleys running in almost opposite directions - hence the 'S' bend in the central Strait at the 'new' link between the two valleys.

Although sheltered from wave action, many areas within the Menai Strait experience very powerful tidal streams, reaching over 8 knots during spring tides. Extensive sand beaches and subtidal muddy sand plains are found at either end of the Strait; Foryd Bay (Y Foryd), the open stretch of sand at Newborough at the south-west end, and Lavan Sands (Traeth Lafan) at the north-east end (*area summary* 22). The mid-section is characterised by mixtures of boulder, cobble and gravel plains with rocky outcrops and reefs.

The environmental conditions of Menai Strait, particularly extremely strong tides, high turbidity and a high nutrient loading from land runoff and sewage effluent, combine to support a unique mixture of species. In particular, a very high biomass of communities dominated by filter-feeding animals has developed in shallow water, especially on the reefs in the middle section and at the north-east end of the Strait.

The reason for such high turbidity in Menai Strait has been debated over many years, although it seems likely that its cause is local and mainly natural (Thompson 1974; Buchan, Floodgate & Crisp 1967, 1972), rather than dredging in Liverpool Bay as has been suggested by other workers. Fine silt deposited on the relatively sheltered east coast of Anglesey (*area summary* 21) is readily re-suspended in rough weather and then carried into the Strait by the residual flow to the south-west (Harvey 1967, 1968). Blooms of the prymnesiomonad flagellate *Phaeocystis pouchetii* occur in the nutrient-rich water during spring and early summer, increasing turbidity still further. The flagellates also release acrylic acid, supporting an increase in bacterial growth as the colonies break down, leading to a depletion in oxygen levels (Spencer 1981).

Menai Strait was first proposed as a Marine Nature Reserve (MNR) in 1988 (CCW 1992). However, extended consultation meant that it was not until 1996 that the Secretary of State for Wales announced his intention to create a MNR and published a draft Order for its designation. Final confirmation of the Order designating a MNR is still awaited. The Strait includes six SSSI and the wreck of a sixteenth century slate vessel at Pwllfanogl which is protected under the Protection of Wrecks Act 1975.

Marine biology

Numerous marine biological studies have been undertaken in Menai Strait, many centred at the University of Wales School of Ocean Sciences, Menai Bridge. Organised marine biological studies by the Liverpool Marine Biological Committee began as early as 1887, based at the old semaphore station on Puffin Island, and more recent surveys of littoral and sublittoral habitats were carried out by Jones (1983) and Lumb (1983) respectively, on which the present area summary is largely based. The Church Island reefs are considered one of the major teaching areas for marine biology in the UK.

Marine biological surveys

	Survey methods	*No. of sites*	*Date(s) of survey*	*Source*
Littoral	Recording (epibiota)	12	1982	Jones (1983)
		1	1990	Porcupine & Conchological Society (1990)
		1	1994	MNCR survey 646
Sublittoral	Recording (epibiota)	29	1982	Lumb (1983)

Littoral

The shores around Puffin Island (Ynys Seiriol) and from Penmon to the Ormes are described in detail in *area summary* 23, but are also summarised here to demonstrate the transition from the moderately exposed limestone slab shores on Puffin Island to the very sheltered shores in the central section of the Strait.

The headlands at Trwyn Du and Puffin Island are composed of limestone strata sloping to the north-east and are part of the same mass that appears on Great Ormes Head. The splash zone on the headlands supports only a few species of lichen; mainly patches of the orange lichens *Xanthoria parietina* and *Caloplaca thallincola* (YG) with black streaks of *Verrucaria maura* below (Ver.Ver).

On the north-east and east side of the headland and around most of Puffin Island the bulk of the shore is fucoid-dominated with sequential bands of *Pelvetia canaliculata* (Pel), *Fucus spiralis* (Fspi), *Fucus vesiculosus* (Fves), small patches of *Ascophyllum nodosum* (Asc.Asc) and a broad band of *Fucus serratus* (Fser). The low abundance of *A. nodosum* reflects the moderate amount of wave exposure across Conwy Bay. Barnacles *Semibalanus balanoides* and limpets *Patella vulgata* live amongst the mid-shore fucoids, whilst red algae such as *Osmundea pinnatifida* and *Gelidium pusillum* and green algae *Cladophora rupestris* grow in the more shaded damp areas under the fucoid canopy and in crevices and shallow gullies.

Lower on the shore the limestone becomes more pitted with burrows of the rock-boring piddock *Hiatella arctica* and the polychaete *Polydora* sp. Filamentous red algae are common low on the shore and in some areas form dense turfs with *Polysiphonia fucoides*, *Ceramium nodulosum* and sand-binding *Rhodothamniella floridula*. Mussels *Mytilus edulis* are also common on the lower mid-shore often covered with dense green *Enteromorpha* spp. Deep grykes on the lower shore often contain accumulations of muddy sand. These grykes also contain large kelps *Laminaria saccharina* and *Laminaria digitata* (Lsac.Ldig) and animals more regularly encountered in the shallow sublittoral such as plumose anemones *Metridium senile* and dead man's fingers *Alcyonium digitatum*. The same species can also be found on the open rock surfaces in the sublittoral fringe.

Towards the north-east end of the main channel of Menai Strait, a complete cover of fucoids develops wherever there is sufficient hard substrata either in the form of bedrock outcrops or boulders and cobbles on the muddy mixed gravel and sand. Jones (1983) rated the area around Trwyn y Penrhyn (Black Rock) as the second most species-rich site in the Strait (after Church Island), with a wide variety of sponges, anemones and decapod crustaceans. Some of the larger limestone boulders on the lower shore, heavily pitted by the piddock *Hiatella arctica*, support the small anemone *Edwardsiella carnea* (SByAs). However, Jones (1983) noted that a considerable amount of bait-digging seemed to have degraded the area during the ten years prior to his study (it has continued since). This may account for the apparent loss of the acorn worm *Saccoglossus ruber* from the muddy gravel in this area.

Ascophyllum nodosum abundance increases in the more sheltered area around Trwyn y Penrhyn and is often mixed with *F. vesiculosus* and scattered *F. spiralis* with patches of barnacles *S. balanoides* and *Elminius modestus*. Sand-tolerant algae, particularly *Polyides rotundus*, *Gracilaria verrucosa*, *Halurus flosculosus* and *Cystoclonium purpureum* are also common, many attached to rocks in sand-floored rockpools (SwSed). Small streams running across the gravel shores, for example at Lleiniog, are marked by an increase in ephemeral green algae such as *Ulva lactuca* and *Enteromorpha* spp. and horned wrack *Fucus ceranoides* (FcerX) on the more stable patches of cobbles and boulders. Some of the lines of jumbled boulders on the shore are the remains of goradau (fish traps), once raised walls which have now collapsed (although those in the Swellies are in a better state of preservation). Other species found in abundance include winkles *Littorina littorea* and shore crabs *Carcinus maenas* although, in general, species richness on the gravel shores tends to be rather low.

The sandflats of Lavan Sands, at the north-east end of Menai Strait, are described in detail in *area summary* 22. They comprise a range of bivalve-dominated stable fine sand and muddy sand grading to mobile gravelly sandbanks adjacent to the faster-flowing main channel of the Strait.

At Bangor Pier the channel narrows and wave action is reduced. Filamentous algae such as *Bangia atropurpurea* and *Prasiola* sp. are found on silty rocks at the top of the beach; the only hard substrata on the lower shore is beds of mussels *Mytilus edulis* on muddy sand and gravel (MytX). Dogwhelks *Nucella lapillus*, sparse green filamentous algae and barnacles are found amongst the mussels. Low shale cliffs opposite the pier support silty fucoids in their typical zonation pattern with *A. nodosum* attached to larger stones and bedrock outcrops. At Gorad y Gyt (mainland side) the rock type changes from shale to carboniferous limestone and then to igneous rock where an intrusion runs down onto the shore. There is a reduction in the number of lichens on the limestone of the upper shore and the north side of the intrusion supports fucoids on the upper shore with a dense turf of the red alga *Catenella caespitosa* separated by thin crusts of *Hildenbrandia* sp.

The shores on the mainland to the east of the A4080 Menai Suspension Bridge are of muddy sand and coarse gravel with fucoids attached to scattered bedrock outcrops, boulders and cobbles (FX). Freshwater draining from the cliffs results in luxuriant growths of *Enteromorpha intestinalis* (Ent). *H. arctica* is present in the limestone on the lower shore and the softer underlying shales are bored by the larger piddock *Zirfaea crispata*. On the opposite side of the Strait, to the east of the School of Ocean Science's pier, there are a series of tidal mudflats sheltered by small islands. On the islands a complete rocky shore zonation occurs only on the shore facing the main channel. Boulders on the upper middle shore have dense *A. nodosum* and *F. vesiculosus* with dense growths of *Pilayella littoralis* attached to them. The infaunal communities of the sediment were not included in Jones' (1983) report.

Ynys y Moch, just below the northern tower of Menai Suspension Bridge, is strongly swept by tides running through the narrows. There are a series of species-rich rockpools to the west of the island which contain anemones such as *Sagartia elegans* and red algae (FK). Barnacles are highly abundant and are predated by large numbers of *N. lapillus*; the shells of which form a coarse gravel in the pools and the main channel.

Around the Swellies, the area between Menai Suspension Bridge and the A5 Britannia Bridge, there is a series of small rocky islands and a complex of small sediment-floored channels. Ynys Welltog and Church Island have steep shores with a complete fucoid zonation in which *A. nodosum* (Asc.VS - see also Asc.T) is particularly well-developed. Jones (1983) describes large plants estimated as being 12-14 years old here. Several small streams run across the short, fairly steep bedrock shores on the south side of the channel defined by localised patches of *Fucus ceranoides*. Lower shore boulder slopes allow water currents to percolate between the boulders (in contrast to boulders embedded in sediment) supporting a rich assemblage of filter feeding animals including sponges such as *Halichondria panicea* and *Dysidea fragilis*, hydroids such as *Tubularia indivisa* and *Tubularia larynx*, the colonial ascidian *Didemnum maculosum* and small crabs *Porcellana platycheles* and *Pisidia longicornis* (Ldig.Ldig.Bo; see also Fser.Fser.Bo). The sublittoral fringe *Laminaria digitata* kelp plants in this area exhibit growth forms not seen on the open coast. This results from a lack of wave action but increased tidal flow, allowing their blades to grow longer without splitting.

West of Britannia Bridge, dense fucoids continue to colonise outcrops of rock on the mixed substrata shores. The height of the hard substrata on the shore dictates which fucoids it supports, although the shore west of the small quay below the bridge comprises mainly stones on muddy gravel which provide less anchorage for large plants. Littorinid molluscs are common on both sides of the Strait, *Littorina obtusata* and *L. littorea* being found in large numbers. The shore at Port Dinorwic is composed mainly of slate fragments (the port was a major slate exporting centre in the past) which support little other than winkles, *S. balanoides* and clumps of *F. vesiculosus* on the mid-shore (FvesX). Jones (1983) noted appreciable numbers of *Balanus crenatus* on the mid- and lower shore here, higher up the shore than at other sites within the Strait. Stony and mixed sediment shores continue west of Port Dinorwic, on both sides of the Strait, although the shores broaden to around 200 m width and are colonised by dense *M. edulis* beds (MytX). Fucoid zonation is virtually complete on the stones and rocky outcrops the tops of which support the green alga *Prasiola stipitata*. Red algae are also abundant on the stones and mussel shells including *Mastocarpus stellatus*, *Polysiphonia fucoides*, *Dumontia contorta*, *Chondrus crispus*, *Osmundea pinnatifida*, *Osmundea hybrida* and the green alga *Cladophora rupestris*. *S. balanoides* and a few *Elminius modestus* are present here and the tubes and casts of the polychaetes *Lanice conchilega* and *Arenicola marina* can be found between the stones. Approaching Caernarfon, the shores steepen again and the mussel density thins out.

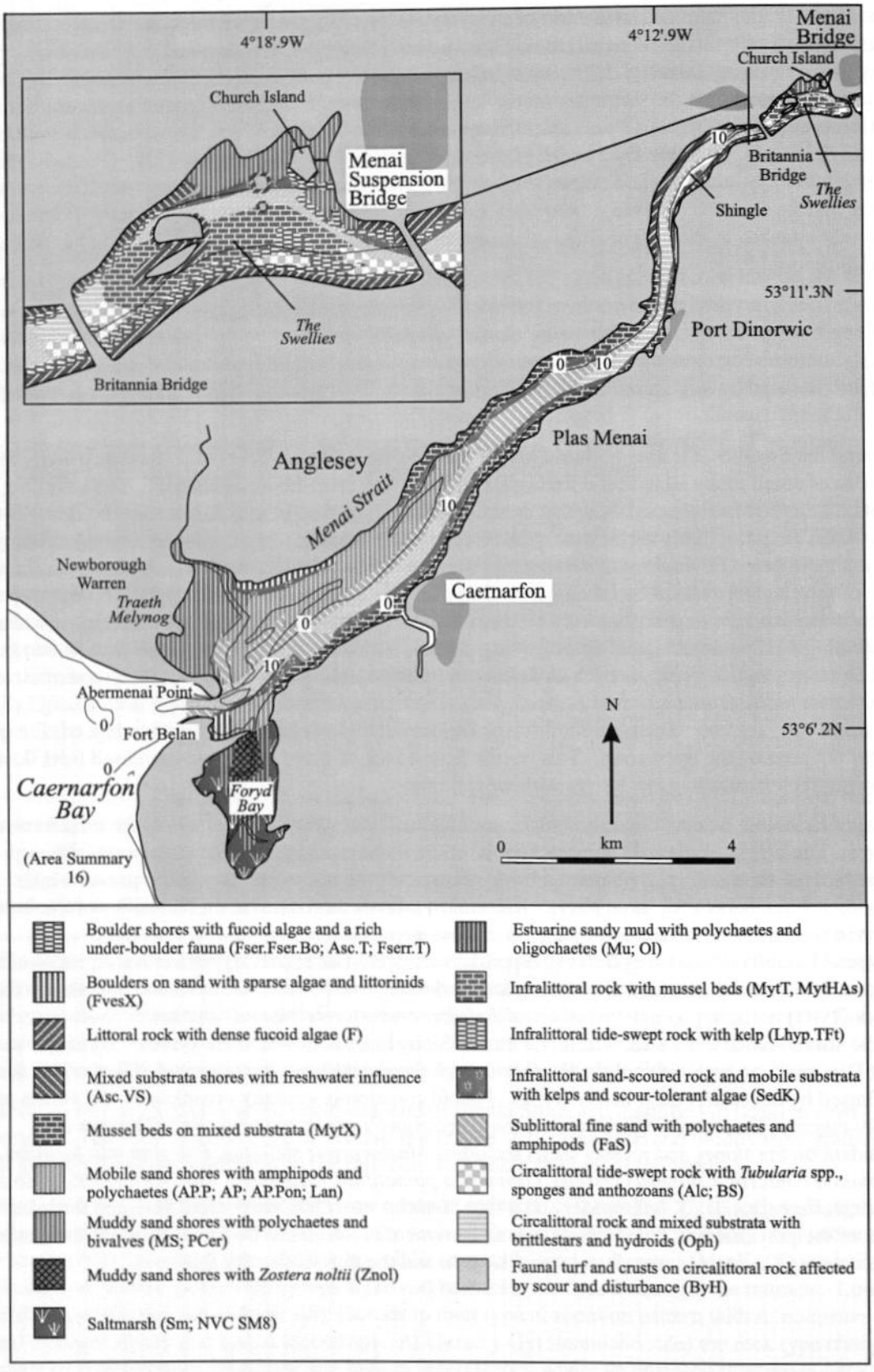

Figure 17.3 Indicative distribution of the main biotopes in the Strait (south-western part) (based on data from survey sites shown in Figure 17.1, cited literature and additional field observations).

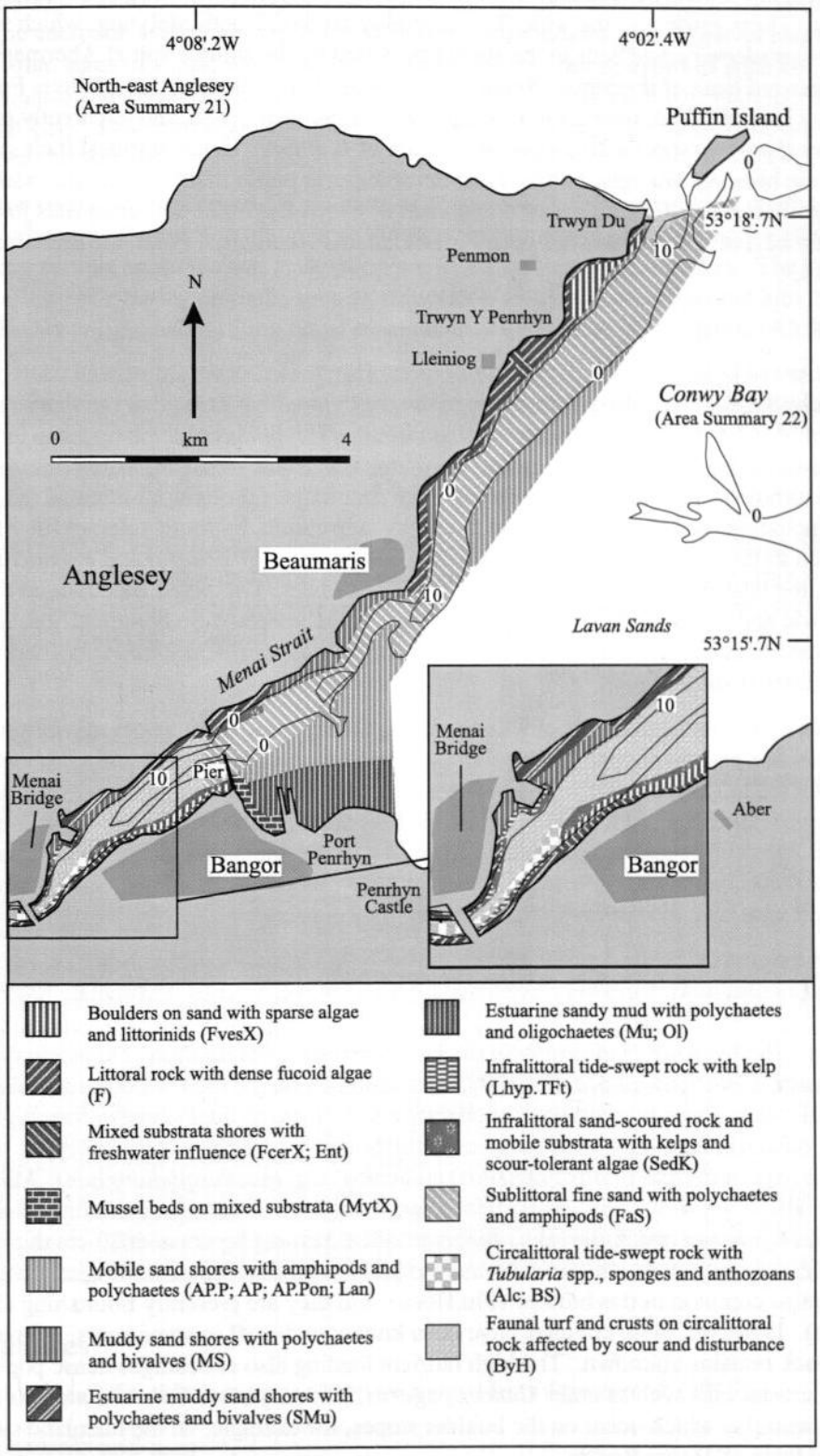

Figure 17.4 Indicative distribution of the main biotopes in the Strait (north-eastern part) (based on data from survey sites shown in Figure 17.2, cited literature and additional field observations).

Extensive, highly-mobile sandbanks have formed towards the northern half of the channel opposite Caernarfon. These grade into the wide flats of muddy sand of Traeth Melynog, which support dense cockles *Cerastoderma edule* beds in the shelter provided by the shingle spit at Abermenai, on the southern seaward limit of the Strait. Belan Point, opposite Abermenai Point, shelters Foryd Bay (Y Foryd), a large mudflat, over 2 km in length, which supports dense, and apparently expanding, beds of cordgrass (*Spartina* spp.) with a large population of *L. littorea* living amongst their stems (Jones 1983) and the bivalves *Macoma balthica* and *Scrobicularia plana* in the muddy fine sand (?HedScr). The eelgrass *Zostera noltii* (Znol) is also abundant in Foryd Bay. The sediment flats just outside the Strait, south-west of the narrows between Fort Belan and Abermenai Point, are included in *area summary* 16.

Sublittoral

A narrow zone of kelp *Laminaria hyperborea* forest (Lhyp.TFt) occurs at around chart datum on suitable rocky substrata all along Menai Strait; the depth to which kelp grows in the Strait is limited by the high turbidity levels, not usually greater than 0-2 m. The blades of the kelp grow larger and tend to be less torn and divided than kelp plants on the open coast as they are subject to lamina water flow rather than turbulent wave action. The strong tides encourage dense colonisation of the available substrata, including the kelp holdfasts and the rocky substratum, by scour-tolerant filter feeding animals such as the ascidians *Botryllus schlosseri*, *Dendrodoa grossularia* and *Pycnoclavella aurilucens*, the latter near its northern limit in the British Isles. On mixed substrata, as found around Port Dinorwic and south of the A5 Britannia Bridge, an ephemeral kelp community develops where the larger species cannot maintain hold on the substrata. *Laminaria saccharina* is characteristic of these conditions (Lsac.T)

In the Swellies, where the tides run at 8 knots during spring tides, a compact crust of barnacles *Balanus crenatus* and the sponge *Halichondria panicea* covered by a short turf of robust hydroids such as *Hydrallmania falcata* and encrusting bryozoans, attaches to rocks and dense beds of mussels *Mytilus edulis* (BalTub; CuSH; MytHAs). Brittlestars occasionally occur in dense aggregations amongst the mussels; one area in particular, under the north side of Britannia Bridge, was recently noted for its dense bed of *Ophiothrix fragilis* (Oph) (Seasearch information). Such aggregations can be ephemeral in nature and the brittlestars may move elsewhere .

Throughout the rest of Menai Strait, hydroid and bryozoan-dominated communities, representative of the tide-swept conditions, form very extensive turfs on the rocky reefs. Particulate food carried in suspension ensures that these faunal turfs grow more profusely in the Strait than elsewhere around the Welsh coast. The hydroids *Hydrallmania falcata*, *Abietinaria abietina* and *Tubularia indivisa* and the bryozoan sea mat *Flustra foliacea* (Flu.HByS) are common on the tops of boulders and rocky ridges. These are all robust scour-tolerant species characteristic of strong tidal streams, forming an important source of food and refuge for a wide range of nudibranchs (sea slugs) and other cryptic animals such as small fish (e.g. butterfish *Pholis gunnellus*) and crabs (e.g. *Inachus phalangium*). Most rocky surfaces are also covered with unusually dense, large cushions of sponges including, *Halichondria bowerbanki*, *H. panicea* and *Esperiopsis fucorum*, often forming layers over 20 cm thick, interspersed with thin encrusting sponges such as *Microciona* spp. Large colonies of the finger sponge *Haliclona oculata* are also common in this biotope (Flu.Hocu), and they are presently flourishing (Seasearch information). However, these colonies have been known to die off in some years, although the cause of the die-back remains unknown. The high nutrient loading also encourages dense populations of scavenging crustaceans such as crabs *Cancer pagurus*, *Necora puber*, *Carcinus maenas* and lobsters *Homarus gammarus* which occur on the boulder slopes, for example, on the mainland side of the Strait opposite the town of Menai Bridge.

At the north-east end of Menai Strait around Puffin Island, just outside the channel between Puffin Island and Penmon (*area summary* 23), the combination of moderate tides, moderate wave action and limestone substratum produces another set of species-rich reef communities, although different in species composition from the middle parts of the Strait. The broken limestone bedrock is rich in sponges including large *Suberites ficus*, *Dysidea fragilis* and sheets of *Hemimycale columella*. It also

supports the phoronid *Phoronis hippocrepia* and dense stands of dead man's fingers *Alcyonium digitatum* and the anemone *Metridium senile* (?SubSoAs). Consolidated muddy gravel and stones in this area show some signs of scour, while the larger stones are covered in hydroids such as *Hydrallmania falcata* and *Sertularia argentea* and large *Urticina felina* are found between the stones (Flu.SerHyd; Urt.Urt). There are also very dense patches of the anemone *Cerianthus lloydii* in the sediment between the pebbles.

In the more wave-sheltered and deeper (21 m) parts of Menai Strait, for example just south of the A5 Britannia Bridge towards Caernarfon, the rugged substratum supports a variety of active filter-feeding animals including various ascidians and *P. hippocrepia* living on limestone boulders. The limestone is soft enough to allow rock-boring animals, such as piddocks *Hiatella arctica*, to tunnel into the rock and produce a highly cryptic habitat for a range of small crustaceans and echinoderms (AlcByH.Hia).

The brachiopod *Gwynia capsula* was recently refound in Menai Strait following a gap of over 20 years since the previous record. It is small (< 1 mm), inconspicuous, and lives on the undersides of pebbles covered in empty calcareous worm tubes; these factors probably account for the scarcity of records from around Britain. Another species of small brachiopod rarely recorded in Britain, *Argyrotheca cistellula*, has also been found in the Strait.

Although not surveyed in detail, the sand habitats in shallow water at either end of Menai Strait are highly mobile and are shifted back and forth with each change of the tide to produce large waves in the sediment surface. Such mobile sediment supports a very sparse infauna; perhaps a few surface scavengers such as hermit crabs *Pagurus bernhardus* and starfish *Asterias rubens* (Mob).

Nature conservation

Conservation sites

Site name	*Status*	*Location*	*Main features*
Menai Strait	pMNR	SH 50 67	Marine habitats and species.
Anglesey	AONB	N/A	High scenic quality.
Ynys Môn	ESA	N/A	Agri-environmental scheme
Y Foryd (Foryd Bay)	SSSI; LNR	SH 450 600	Estuarine mudflat & saltmarsh
Traeth Lafan (Lavan Sands)	SPA; SSSI; LNR	SH 630 750	Intertidal sand and mudflats; ornithology
Coedydd Afon Menai	SSSI	SH 536 707 - SH 553 712, SH 562 717 - SH 582 731	Broadleaved woodland
Menai Strait Shore	SSSI	SH 538 737 - SH 580 730	Intertidal zone on both sides of Menai Strait
Puffin Island	SSSI	SH 650 820	Nesting seabirds
Newborough Warren to Ynys Llanddwyn	SSSI; GCR; NNR; cSAC	SH 410 630	Geomorphological; Dunes
Traeth Lavan	SPA	SH 630 750	Feeding waders.
'Slate wreck'	Historic wreck site	SH 534 707	Marine archaeology: seabed exclusion zone
Plas Newydd	NT	SH 521 696	Coastal estate and woodland

Human influences

Much of the information for this section has been abstracted from Barne *et al.* (1995).

Coastal developments and uses

Several small towns line the banks of the Menai Strait: Beaumaris, Menai Bridge, Port Dinorwic and Caernarfon and the city of Bangor. Sewage pollution was, until recently, a problem in the Strait. Water entering the north-east end of the Strait is estimated to take around three days to reach the south-west end and the consequent build-up of sewage contamination led to complaints of foul-smelling water and gastrointestinal infections, particularly amongst watersports enthusiasts. However, the sewage transfer system completed in 1997 should significantly reduce the amount of raw and partially

treated sewage entering the Strait by piping the bulk of the effluent from both sides of the channel to a central treatment plant.

There are few industrial developments in Area 17; there is a brick and plastics works near Caernarfon and a small freight port at Port Penrhyn in Bangor.

Tourism is a major contributor to the economy in Area 17, many visitors attracted to the castles at Beaumaris and Caernarfon. Water-based leisure activities such as sailing, water-skiing, jet-skiing and SCUBA-diving are particularly popular in the sheltered waters of the Strait. There are harbours and moorings at Caernarfon, Bangor, Beaumaris and Port Dinorwic and a sail training centre at Plas Menai. There are also a number of marina developments proposed at Fort Belan, Caernarfon, Menai Bridge and Bangor, although none of these have passed the planning stage.

Angling is popular throughout Menai Strait, both from the shore and from boats, around the Swellies and in Penmon Sound between Puffin Island and Anglesey. Sight-seeing boat trips run from Beaumaris to Puffin Island during the summer. The main attractions are the seal colony on the north-east tip of the island and the nesting seabirds.

Marine developments and uses

Ancient fish traps (goradau) are in evidence throughout Menai Strait, although in most cases there is little left of these apart from lines of fucoid-covered stones where the walls used to stand (Momber 1991). The best preserved examples are at Ynys Gorad Goch.

The native oyster *Ostrea edulis* used to be harvested and cultivated in the Menai Strait. Although the commercial fishery for this species has long finished there are now several other species of shellfish cultivated on a small scale in the Menai Strait. Pacific oyster *Crassostrea gigas*, hard-shell clam *Mercenaria mercenaria*, Manila clam *Tapes philippinarum* and palourde *Tapes decussatus* are cultivated at an experimental site by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS, Conwy) at the south-western end of Menai Strait opposite Caernarfon. New Zealand oysters *Tiostrea lutaria* and the American oyster *Crassostrea virginica* are also kept in the Strait as broodstock for experimental hatchery use. Mussels *Mytilus edulis* are also harvested here by CEFAS, where yield is enhanced by husbandry techniques. The commercial companies harvest mussels from the lays near Bangor Pier.

Small-scale bait-digging by anglers for lugworm *Arenicola marina* and king ragworm *Neanthes virens* occurs throughout Area 17 and concentrated commercial bait-digging has degraded the natural sediment habitats at several locations. The species-rich shores around Church Island attract university students in search of specimens. This has been thought to pose a real threat to the diversity of flora and fauna in the area.

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Sites surveyed

Survey 129: 1982 hard substrata of the Menai Strait, littoral survey (Jones 1983).
Survey 280: 1990 Porcupine/Conchological Society field meeting, Anglesey shores (unpublished data).
Survey 293. 1982 Menai Strait sublittoral survey (Lumb 1983).
Survey 468: Nov 1994 MNCR Menai Strait littoral survey (MNCR, unpublished data).
Survey 646. 1997 MNCR east Anglesey littoral survey (MNCR, unpublished data).

Littoral sites

Survey	*Site*	*Place*	*Grid reference*	*Latitude/longitude*	*Biotopes present*
129	2	Penmon, Menai Strait.	SH 639 808	53°18.3'N 04°02.5'W	LR
129	3	Aber to Gorad y Gyt, Menai Strait.	SH 584 732	53°14.2'N 04°07.3'W	LR, LGS
129	4	Penmon Priory to Black Rock, Menai Strait.	SH 628 796	53°17.7'N 04°03.5'W	F, LR
129	5	Lleiniog to Beaumaris, Menai Strait.	SH 616 778	53°16.7'N 04°04.5'W	FcerX, SLR
129	6	Gallows Point to Craig-y-Don, Menai Strait.	SH 599 751	53°15.2'N 04°06.0'W	F, PCer
129	7	Gorad-y-Gyt to Menai Suspension Bridge, Menai Strait.	SH 565 721	53°13.5'N 04°08.9'W	SLR
129	8	Craig y Don to Carreg yr Halen, Menai Strait.	SH 559 720	53°13.5'N 04°09.5'W	YG, BPat, Fcer, LR
129	9	Church Island to Pwll Fanogl, Menai Strait.	SH 551 717	53°13.3'N 04°10.2'W	Fcer, Asc.Asc
129	10	Ynys Gorad Goch, Menai Strait.	SH 545 713	53°13.1'N 04°10.7'W	LR
129	11	Menai Suspension Bridge to Port Dinorwic, Menai Strait.	SH 527 696	53°12.1'N 04°12.3'W	Fcer, Asc.VS, Fserr.VS, SLR, Fserr
129	12	Pwll Fanogl to Tal-y-Foel, Menai Strait.	SH 474 645	53°09.3'N 04°16.9'W	Fcer, MytX
129	13	Port Dinorwic to Dinas Dinlle, Menai Strait.	SH 454 612	53°07.5'N 04°18.6'W	FX, Fcer, MytX
129	14	Tal y Foel to Llanddwyn, Menai Strait.	SH 443 614	53°07.6'N 04°19.6'W	F, MytX, LR, LGS
280	1	Church Island, Anglesey.	SH 552 717	53°13.3'N 04°10.1'W	Fves, Asc.Asc, Fserr.T, Fserr
468	1	SW side of Britannia Bridge, Menai Strait.	SH 540 708	53°12.8'N 04°11.2'W	Ver.Ver, Fspi, Asc.T, Fserr.T, Ldig.Ldig.Bo
646	14	Lleiniog, N Menai Strait.	SH 622 789	53°17.3'N 04°04.0'W	FX, Lan, FvesX, Pel, FserX

Sublittoral sites

Survey	*Site*	*Place*	*Grid reference*	*Latitude/longitude*	*Biotopes present*
293	4	Caernarfon Swimming Baths, Menai Straits.	SH 469 626	53°08.2'N 04°17.3'W	Flu.SerHyd, Lsac.T, AlcByH.Hia
293	5	Caernarfon Dock, Menai Straits.	SH 476 633	53°08.6'N 04°16.7'W	Urt.Urt, Flu.SerHyd, CuSH, Lsac.T, Lcon
293	6	Waterloo Port, Menai Straits.	SH 485 643	53°09.2'N 04°15.9'W	Flu.HByS, Flu.SerHyd, CuSH
293	7	Landing Stage, Menai Straits.	SH 487 649	53°09.5'N 04°15.7'W	PomByC
293	8	Ferodo Works, Menai Straits.	SH 494 659	53°10.1'N 04°15.1'W	LsacX
293	9	Plas-y-Deri, Menai Straits.	SH 499 663	53°10.3'N 04°14.7'W	Flu.SerHyd
293	10	Plas Llanfair, Menai Straits.	SH 510 667	53°10.5'N 04°13.7'W	Urt.Urt, Oph
293	11	S of Port Dinorwic, Menai Straits.	SH 518 673	53°10.9'N 04°13.0'W	Urt.Urt, Flu.Hocu, Lsac.Ft, CuSH
293	12	Raybourne Marina, Menai Straits.	SH 522 682	53°11.4'N 04°12.7'W	Flu.HByS, Urt.Urt
293	13	S of Plas Newydd, Menai Straits.	SH 524 691	53°11.8'N 04°12.5'W	Urt.Urt, Flu.SerHyd, Flu.Hocu, Oph, Pol, Lhyp.TFt
293	14	Carreg Ginnog, Menai Straits.	SH 526 701	53°12.4'N 04°12.4'W	Ldig.T, AlcC, Lhyp.TFt
293	15	Pwllfanog, Menai Straits.	SH 535 706	53°12.7'N 04°11.6'W	Flu.Hocu, CuSH, BalTub
293	16	Britannia Bridge, Menai Straits.	SH 542 710	53°12.9'N 04°11.0'W	Urt.Urt, Flu.SerHyd, Flu.Hocu, CuSH, BalTub, Lhyp.TFt, Lsac.T
293	16A	Careg Halen to Platters Rocks, Menai Straits.	SH 555 714	53°13.1'N 04°09.8'W	Urt.Urt, Flu.SerHyd, CuSH
293	17	Ynys-y-Moch to Platters Rock, Menai Straits.	SH 555 714	53°13.1'N 04°09.8'W	Urt.Urt, Flu.HByS, Flu.Hocu, CuSH
293	17A	Menai Suspension Bridge, Menai Straits.	SH 557 713	53°13.1'N 04°09.6'W	Urt.Urt, CuSH, BalTub
293	17B	Perch Rock, Menai Straits.	SH 558 716	53°13.2'N 04°09.6'W	Flu.HByS, Flu.SerHyd, Ldig.T, CuSH
293	18	George Hostel to Menai Bridge Pier, Menai Straits.	SH 560 718	53°13.4'N 04°09.4'W	Urt.Urt, , Flu.SerHyd, Flu.Hocu, CuSH
293	18A	Ynys Faelog, Menai Straits.	SH 561 721	53°13.5'N 04°09.3'W	Urt.Urt, Flu.Hocu, CuSH, Lsac.T
293	19	Ynys Big, Menai Straits.	SH 568 726	53°13.8'N 04°08.7'W	Flu.SerHyd
293	21	Bangor Pier to Glyn Garth, Menai Straits.	SH 582 737	53°14.4'N 04°07.5'W	Flu.SerHyd, MytHAs
293	23	Gallows Point, Menai Straits.	SH 599 747	53°15.0'N 04°06.0'W	Flu.SerHyd
293	25	Beaumaris Swimming Pool, Menai Straits.	SH 612 762	53°15.8'N 04°04.8'W	Flu.SerHyd
293	27	Near Trecastell Point, Menai Straits.	SH 621 781	53°16.9'N 04°04.1'W	Oph, LsacChoR
293	28	Careg Duon, Menai Straits.	SH 629 787	53°17.2'N 04°03.4'W	Flu.SerHyd,
293	W7	SW of Abermenai Point, Menai Straits.	SH 441 613	53°07.5'N 04°19.8'W	Mob

Compiled by: Rohan H.F. Holt

18 West Anglesey (Ynys Môn)

Location		
Position (centre)	SH 25 79	53°17'N 4°37'W
County	Ynys Môn (Anglesey)	
Conservation agency/area	Countryside Council for Wales	North-west Area

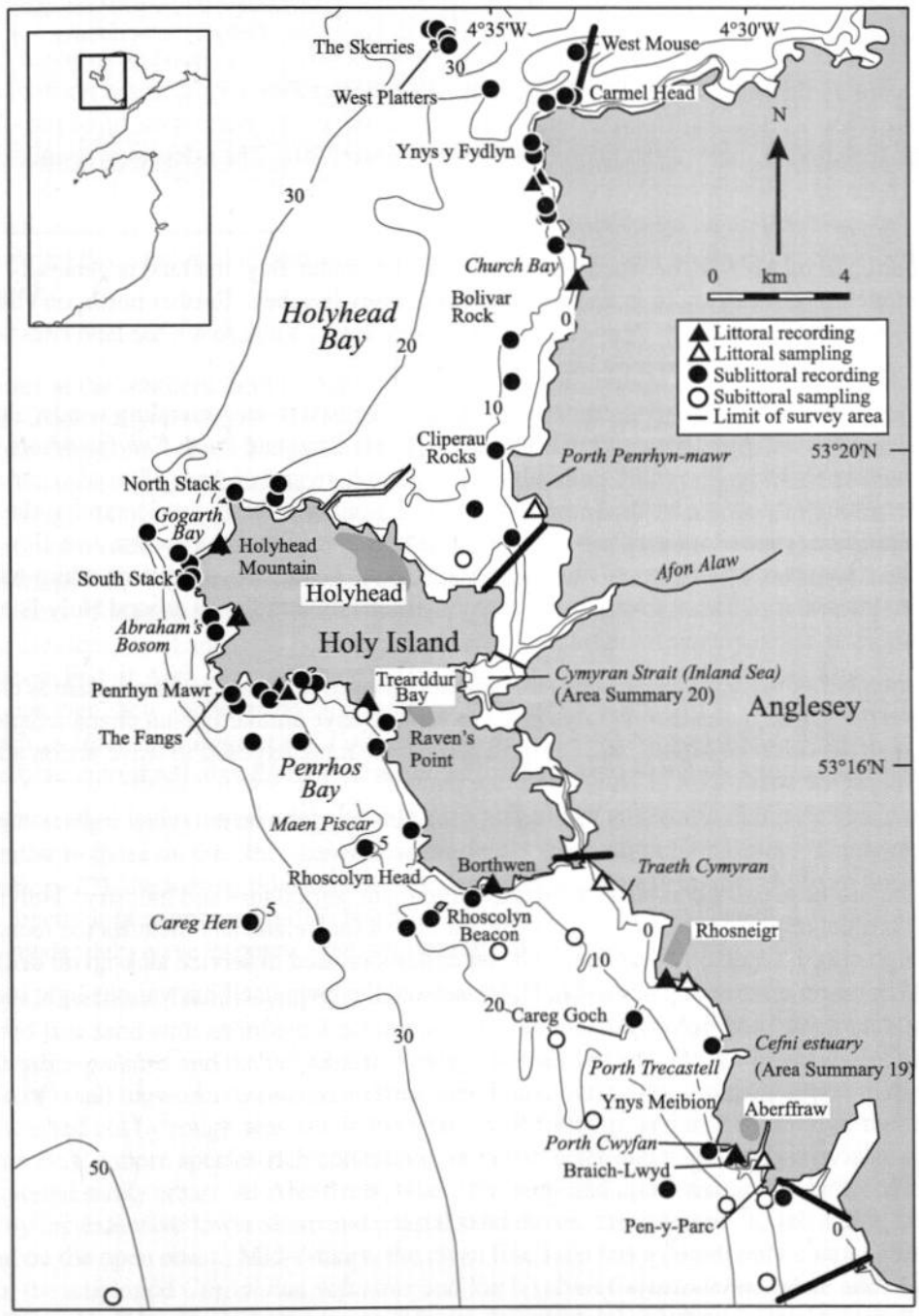

Figure 18.1 Main features of the area, showing sites surveyed.

Physical features	
Physiographic type	Open coast
Length of coast	52 km
Bathymetry	30 m depth contour within 0.5 km around Skerries and west coast of Holy Island. 10 m and 20 m isobaths within 5 km of the coast throughout the rest of the Area.
Wave exposure	Exposed to sheltered to wave action
Tidal streams	Strong to negligible
Tidal range	4.5 m springs; 2.1 m neaps (Trearddur Bay)
Salinity	Fully marine

Introduction

This *area summary* describes the west coast of Anglesey between Pen-y-Parc, to the north of the Cefni estuary (*area summary* 19), and Carmel Head (Trwyn y Gader) on the north-west tip of the island but excludes the sheltered channel of the Inland Sea (*area summary* 20). The tide-swept islands of the Skerries (Ynysoedd y Moelrhoniaid) and West Mouse (Maen y Bugael), off Carmel Head, are also included.

In the southern part of Area 18, between Pen-y-Parc and Trearddur Bay, the land is generally low-lying with stretches of rocky shore interspersed by open sandy beaches. Further north, on Holy Island (Ynys Gybi) between South Stack (Ynys Lawd) and North Stack (Ynys Arw), the land rises to form spectacular cliffs of highly-folded pre-Cambrian rock.

The coastline is generally west and south-west facing and exposed to the prevailing winds, although there are numerous small bays such as Porth Trecastell (Cable Bay) and Porth Cwyfan where the wave action is considerably less. The coast, particularly at the southern end of Area 18, is also partially protected from southerly swells by the Lleyn Peninsula. Strong tides have considerable influence on biotope composition; charted information includes large numbers of overfalls where fast-flowing water accelerates as it passes over submerged obstructions or around headlands, producing white-water conditions on the surface. These overfalls are situated just off the headlands around Holy Island and the Skerries.

There are a number of offshore islands and submerged pinnacles in Area 18. Those islands close to shore, such as the Rhoscolyn Beacon (Ynysoedd Gwylanod) have similar habitat characteristics to the headlands, whereas offshore islands, such as the Skerries, are more exposed to wave action and tides. The pinnacles off the south-west of Holy Island are particularly tide-swept, and the complex pattern of tides and eddy currents in Penrhos Bay means that each pinnacle here is individual in its composition of its biotopes.

The main land use in Area 18 comprises a mixture of tourism, agriculture and industry. Holyhead (Caer Gybi) is a major port for passengers and freight bound for Ireland and includes the recently-completed high-speed 'superferry' terminal. The outer harbour used to service jack-up oil drilling rigs. Anglesey Aluminium is situated just outside Holyhead and the town itself has various light industries, a marina and major road and rail links.

Marine biology

Marine biological surveys				
	Survey methods	*No. of sites*	*Date(s) of survey*	*Source*
Littoral	Recording (epibiota)	1	1990	Porcupine & Conchological Society (1990)
		13	July - August 1996	MNCR survey 641
	Habitat (biotope) mapping		Oct 1997	Richards *et al.* (in prep.)
	Infaunal sampling (Cores and granulometry samples)	5	July - August 1996	MNCR survey 641
Sublittoral	Recording (epibiota)	1	September 1982	Lumb (1983)
		38	July, 1996 & August 1996	MNCR survey 640
		22	August 1997	MNCR survey 647
	Infaunal sampling (Cores and granulometry samples)	7	July 1996 & August 1996	MNCR survey 640
		2	August 1997	MNCR survey 647

In the following two sections the coastline and its main characterising biotopes are described from south to north.

Littoral

Rocky shores at the southern limit of Area 18 support biotopes typical of moderately wave-exposed conditions. Zones of yellow, grey (YG) and black lichens (Ver.Ver) are found in the supralittoral and upper littoral fringe; *Pelvetia canaliculata* in the lower littoral fringe (Pel); scattered *Fucus spiralis* in the upper eulittoral (Fspi) and barnacle and limpet-dominated rock throughout much of the mid-eulittoral (BPat). However, patchy *Fucus vesiculosus* and barnacle (FvesB) mosaics occur on less exposed eulittoral rock. *Fucus serratus* (Fser.Fser) is often present on the lower shore grading into sublittoral fringe kelp forests of *Laminaria digitata* (Ldig.Ldig). In general, species richness reflects habitat richness - for example, the greatest number of species occur at locations with a full 'suite' of rockpools, crevices, overhangs and boulders, such as at Rhosneigr. However, some sites, particularly at the southern end of Area 18, are influenced by sand. The sand-scoured biotopes generally support fewer species than their counterparts on cleaner rocky shores and are characterised by scour-tolerant species such as *Halidrys siliquosa* and *Polyides rotundus* (in sand-floored pools - SwSed) or cushions of the fine filamentous red alga *Rhodothamniella* sp. binding sand to the rock surfaces (Rho).

North of Rhosneigr, Cymyran Bay is predominantly sandy with crustacean and polychaete biotopes (AP.P) similar to those on the other sandy beaches on the west coast of Anglesey. The Inland Sea (*area summary* 23), the narrow tidal stretch of water which separates Holy Island from the mainland of Anglesey, opens at the north end of this beach. The biotopes on the sand beach at Aberffraw are typical of moderately wave-exposed sites, supporting only a sparse infauna.

Sampling at Aberffraw, Traeth Cymyran and the southern end of the Inland Sea, revealed clean medium and fine sand with an infaunal community characterised by amphipods *Bathyporeia* spp., the isopod *Eurydice pulchra* and the polychaete *Nephtys cirrosa* (AP.P). On the lower shore, a sparse population of small lugworm *Arenicola marina* were found during the summer, although these are probably washed out by rough seas late in the year. At Rhosneigr, and at the mouth of the Inland Sea in Cymyran Bay, a more species-rich community of polychaetes and amphipods is evident on the more stable, sheltered sandy areas. At Aberffraw, where the mid- and upper estuary is sheltered from wave exposure by the extensive lower shore and coastal sand dunes, the sediment is well sorted and more stable than on the open coast. Mid-estuary, the clean fine sand has a community characterised by *A. marina*, the amphipod *Corophium volutator* and the bivalves *Cerastoderma edule* and *Macoma balthica* (PCer; HedMac.Pyg). In the upper estuary, the intertidal sediments contain a small fraction of mud, with a community tolerant of a variable salinity environment characterised by ragworm *Hediste diversicolor* and *C. volutator* (?HedOl). The upper reaches of this small estuary are muddier and support glasswort *Salicornia* spp., forming a 'pioneer' saltmarsh (Sm or NVC SM8) on the upper shore. Rocky outcrops in the middle of the sand beach are scoured virtually clean, although a few support a

covering of ephemeral green algae *Enteromorpha* sp. and sparse barnacles (Ent). The bedrock fringing the sand to the north of the beach supports a dense covering of large mussels *Mytilus edulis* (MytFR).

Porth Cwyfan, just north of the headland Braich-Lwyd, is a small naturally sheltered embayment with a small area of clean sand and a bedrock and boulder beach. This shelter allows for luxuriant growth of fucoid algae over the whole of the rocky shore with dense *P. canaliculata* overlying *Catenella caespitosa* (Pel) in the littoral fringe; dense *Ascophyllum nodosum* mixed with occasional *F. vesiculosus* (Asc.Asc) covering much of the mid-shore and dense *F. serratus* (Fser.Fser) on the lower shore. Green algae *Ulva* spp. and *Enteromorpha* spp. are found where trickles of freshwater cross the shore. Littorinids such as *Littorina saxatilis*, *Littorina littorea* and *Littorina obtusata/mariae* populate the dense weed in large numbers. Sublittoral fringe biotopes are characterised by a mixture of both *Laminaria digitata* and *Laminaria saccharina* (Lsac.Ldig) with underlying robust red algae *Furcellaria lumbricalis* and more ephemeral *Plocamium cartilagineum*, indicative of sand-scour and instability in the substratum. Some of these algae will be lost when winter storms mobilise the less-consolidated stones.

The long, low-profile rocky outcrops protecting the moorings at Rhosneigr break up wave action and are themselves characterised by a range of particularly species-rich algal dominated biotopes, in particular characterised by *A. nodosum* (Asc.Asc). However, a few of the communities are influenced by a degree of sand-scour and smothering. Long narrow pools (Cor; FK) have formed in the shallow depressions between a series of rocky ridges, creating permanently damp microhabitats for a wide range of species. For example, large numbers of the anemone *Aulactinia verrucosa* and decapods such as small *Cancer pagurus* thrive in the cracks and small pools under the *F. serratus* canopy. Kelp forests of *L. digitata* are particularly extensive on the long lower shore rocky platforms on the seaward side of these outcrops. Species-richness is particularly high amongst kelp-covered boulders where the undersides are rich in encrusting sponges such as *Leuconia nivea* and *Aplysilla sulfurea*, colonial ascidians such as *Morchellium argus* and *Botryllus schlosseri* and mobile crustaceans such as *Pisidia longicornis* and *Porcellana platycheles*.

The coastline along the south and west of Holy Island is slightly steeper and rockier than further south on the Anglesey coast and more open to swell action from the south and west. Wave- and tide-exposed rocky headlands at Rhoscolyn Head and Raven's Point, south of Trearddur Bay, are characterised by barnacle, limpet and mussel-dominated mid-shores (BPat) and lower eulittoral and sublittoral fringe zones by *Himanthalia elongata* (Him) with small amounts of *Alaria esculenta* amongst the dense forests of *L. digitata* (Ldig.Ldig). However, there are naturally sheltered bays, such as Borthwen and the many smaller bays around Trearddur Bay, where dense fucoids and the associated fauna and flora dominate shores of bedrock, boulders and cobbles. *L. saccharina*, *Furcellaria lumbricalis* and dense turfs of foliose red algae have colonised the stones in sand-floored rockpools (SwSed) and where patches of sand interface with hard substrata in the more sheltered areas.

The sandy shores directly opposite the entrance to Borthwen and at the head of Trearddur Bay are similar to those found on the open coast, although the more sheltered sand is densely colonised by *A. marina* to the sides of the bays. Eelgrass *Zostera marina* (Zmar) is reported from the shallow sublittoral sediment in Borthwen (SSSI citation). There are exposures of clay and peat on the shore in Trearddur Bay with sections of naturally preserved wood protruding from the sediment, which may be comparable to examples found elsewhere in north Wales which have been carbon dated to at least 7000 years before present. These outcrops are subject to considerable trampling during peak holiday times and sand smothering during the winter and have no species associated with them.

Rounding Penrhyn Mawr and heading northwards towards South Stack, the land rises dramatically below Holyhead Mountain. South of the main cliffs there is a small bedrock and boulder shore at Abraham's Bosom supporting fucoid biotopes typical of moderate wave exposure and sand-scour with *L. saccharina* and *L. digitata* (Ldig.Ldig) on the lower shore and *Sabellaria spinulosa* forming thin crusts of sandy tubes on the undersides of boulders.

The 100 m high cliffs around South Stack, Gogarth Bay and North Stack face mainly north-west and north. The majority of shores are inaccessible except by small boat or scrambling down very steep grassy slopes and so were surveyed at only a couple of sites. The zonation patterns on these exposed shores are similar to those on other exposed rocky shores in Area 18, with little more than continuous coverage of *Verrucaria maura*, barnacles *Chthamalus montagui* (Ver.Ver; Ver.B) and *Semibalanus balanoides* and limpets *Patella vulgata* and *Patella ulyssiponensis* (BPat.Sem). *P. ulyssiponensis* is characteristic of the exposed conditions and is more common lower down the shore. In the black lichen zone on the upper shore cracks and crevices support the gastropod *Melarhaphe neritoides*, a species also characteristic of wave-exposed conditions. The sublittoral fringe is characterised by a dense cover of *A. esculenta* mixed with *L. digitata* on coralline algae encrusted rock (Ala.Ldig). Patches of red algae *Osmundea pinnatifida* and short stumpy *Mastocarpus stellatus* are found at the foot of the cliffs, amongst very large rounded boulders in gullies where wave action is reduced.

Holy Island and the breakwater protect Holyhead harbour and its approaches from wave action. Stable silty mud and sandflats occur in the outer harbour at Porth Tywyn Mawr at the northern entrance to the Inland Sea. The mid- and upper shore community is characterised by *A. marina* (HedMac.Are), whilst the clean, medium and coarse tide-scoured sand on the lower shore is characterised by dense populations of the sand mason worm *Lanice conchilega* (Lan). There is also a sparse bed of eelgrass *Zostera noltii* (Znol) on the mid-shore where the sediment is less disturbed by tidal action.

The shores on the Anglesey mainland, from the east side of Holyhead outer harbour to Carmel Head, comprise a series of rocky headlands and small bays, such as Church Bay which has a sandy beach with similar biotopes to those found on the exposed sandy beaches to the south. The biotopes on the rocky shores are very similar to those found south of Holy Island and reflect the range of sheltered to exposed conditions. For example, on the sheltered south side of Ynys y Fydlyn there are dense fucoids such as *A. nodosum* (Asc.Asc) and *Catenella caespitosa* in the shaded gullies (BPat.Cat). However, *H. elongata* (Him), *A. esculenta* and *L. digitata* (Ala.Ldig) characterise the more exposed north side of the same island.

The shores around the Skerries appear similar to those around North and South Stacks on Holy Island, characterised by dense barnacles and limpets in the mid-eulittoral (Bpat) and by *A. esculenta* and *L. digitata* in the sublittoral fringe (Ala.Ldig).

Sublittoral

In the southern part of Area 18, between Pen-y-Parc and the south end of Cymyran Bay, the seabed comprises bedrock grading to boulders, cobbles and pebbles, eventually leading onto plains of sandy sediment offshore. These sediments comprise a mixture of sand with stable gravel, pebbles, cobbles and horse mussel *Modiolus modiolus* shells providing suitable habitats for amphipods, scale-worms, porcelain crabs *Pisidia longicornis* and *Porcellana platycheles* and other cryptic species. The infauna is characterised by species typical of gravel habitats such as the polychaetes *Mystides limbata*, *Protomystides bidentata*, *Eusyllis blomstrandi*, *Sphaerosyllis* spp., *Aonides paucibranchiata*, *Polydora* spp. and *Glycera lapidum* and the bivalves *Spisula elliptica* and *Timoclea ovata* (Sell).

Dense forests of kelp *L. hyperborea* (Lhyp.Ft) thrive down to 2-3 m depth at the south end of Area 18. Red algae such as *Plocamium cartilagineum*, *Delesseria sanguinea*, *Phycodrys rubens*, *Palmaria palmata* and *Cryptopleura ramosa* colonise the kelp stipes and seem largely unaffected by the few grazing urchins *Echinus esculentus* in the vicinity. Tough, scour-tolerant algae, including the red *Calliblepharis ciliata* and the brown *Taonia atomaria* (XKScrR), are common. For example, off Raven's Point further north on Holy Island, these algae grow in deeper water than the kelps, occasionally forming a dense carpet on the hard substrata except where limited by severe sand-scour. In these scoured situations, for example around Pen-y-Parc, Ynys Meibion and Mynydd Mawr, cobbles and pebbles in the lower infralittoral are colonised by the keel worm *Pomatoceros triqueter*, sparse bryozoan crusts, barnacles *Balanus crenatus*, occasional *Laminaria saccharina* plants, *Flustra foliacea* (Flu.HByS) and occasionally by large numbers of mussels *Mytilus edulis* (MytHAs) and *Urticina felina*. Where scour action is reduced, remote from the sand-rock interface, turfs of

bryozoans (particularly *Scrupocellaria* spp.), didemnid ascidians and dense *Metridium senile* and *Sagartia elegans* cover the short vertical faces.

In the deeper water (15 m depth) in the south of Area 18, scattered boulders on sediment support rather indistinct communities of anemones *M. senile*, ascidians *Molgula manhattensis* and various bryozoans (?Flu.HByS). Further north, however, many examples of distinct ascidian-dominated and bryozoan-dominated circalittoral communities are found on rocky habitats. Off Rhosneigr, bedrock ridges perpendicular to the shoreline continue out to sea for several kilometres, forming features such as Carreg Goch, where short vertical faces support dense erect bryozoans *Bugula turbinata*, *Bugula plumosa* and *Bugula flabellata*, the ascidians *Clavelina lepadiformis* and *Pycnoclavella aurilucens*, the sponges *Tethya aurantium* and *Hemimycale columella* and star anemones *Epizoanthus couchii* (Bug). Horizontal surfaces at the same sites tend to be covered in a thick layer of silt, under which the ascidians *Polycarpa pomaria*, *Polycarpa scuba*, (in MolPol.Sab) and *M. manhattensis* cover most of the rock surface (MolPol). Branching sponges *Axinella dissimilis*, *Raspailia* spp. and *Stelligera* spp., encrusting sponges *Hemimycale columella* and *Phorbas fictitius* and the cushion-forming sponge *Polymastia boletiformis* are regularly found on these ascidian beds.

Tide-swept reefs and pinnacles to the south and west of Rhoscolyn (Llanwenfaen) and Trearddur Bay are particularly interesting for their wide range of faunal-dominated communities and are subject to varying strengths of tide, scour and siltation. The outermost pinnacle surveyed, Careg Hen, supports robust faunal turfs typical of the strongly tide-swept situation. The shallower bedrock supports kelp forest (LhypR) with sheets of jewel anemones *Corynactis viridis* and massive sponges such as *Pachymatisma johnstonia* and *Cliona celata* (AlcMaS) below. The hydroid *T. indivisa* (TubS) is also abundant (although at the time of the survey their polyps had been eaten away by nudibranchs and other grazers). In deeper water the biotopes are characterised by species more tolerant of slight scour and siltation, large areas being covered in *F. foliacea*, dense *Polycarpa scuba*, *M. manhattensis* and the polychaete *Sabellaria spinulosa*, whose sand-built tubes cover much of the rock surfaces below 20 m (MolPol.Sab). Closer to shore at Maen Piscar and off the west end of Rhoscolyn Beacons, tide-scour has a more pronounced effect in shallower water producing *L. hyperborea* kelp forests with robust red algae (LhypR) and patchy *M. edulis* beds interspersed with areas of *M. senile*, *Actinothoe sphyrodeta* and *Alcyonium digitatum* (MytT).

A second pinnacle (known by local divers as 'Pinnacle C') 2 km east of Carreg Hen, is less tide-swept and therefore supports faunal turfs comprised of different species. Instead of dense ascidians the main cover species are short, fine hydroids including *Aglaophenia* spp. *Sertularella gayi* and an overall 'fuzz' of *Sertularella polyzonias* and *Diphasia rosacea*. *Bugula* spp. dominate vertical surfaces and small patches of *C. viridis* are also present. Cup sponges *Axinella infundibuliformis*, cushion sponge *P. boletiformis* and branching sponges, including *A. dissimilis* (ErSPbolSH) were recorded more frequently here than on the other pinnacles nearby.

Approaching the Fangs off Penrhyn Mawr and around North and South Stack, kelp forest with *L. hyperborea* (LhypR) occurs below a sublittoral fringe zone of *Alaria esculenta* and *L. digitata* (Ala.Ldig). The kelp forests thin out at about 2 m depth, while red algae continue down to 4-5 m. Ascidians are particularly abundant in this zone, growing amongst the kelp and in deeper water, *Dendrodoa grossularia* being the most abundant with the bryozoan *Alcyonidium diaphanum* living amongst them. *Bugula* spp. and patches of encrusting sponge on vertical rock faces are found at throughout this part of Area 18, and were particularly abundant during the 1996 survey. In deeper water sponge diversity increases to include many of the branching and cup sponges found on the pinnacles further south. The bryozoans *Bowerbankia citrina* and *Bowerbankia pustulosa*, found throughout Area 18 on circalittoral rock, are particularly common here.

On the eastern side of the entrance to Holyhead harbour wave exposure and tidal stream strengths are lower than elsewhere in Area 18. Water turbidity is evidently high since the kelp forests only extend as far as chart datum and red algae are found at a maximum of only 3-4 m. Most surfaces are covered in a thick layer of dark, fine silt, much of which is pseudo-faeces from mussels *Musculus discors* (Mus) which colonise most of the rock surfaces below the kelp at Cliperau Rocks and Bolivar Rock. At Bolivar Rock, lower circalittoral communities are well developed at around four to eight m and are

particularly species-rich with sponges such as *Axinella infundibuliformis*, *Axinella dissimilis*, *Polymastia boletiformis*, *Tethya aurantium* and *Stelligera stuposa*, dense ascidians (mainly *M. manhattensis*), and the holothurian *Pawsonia saxicola* (ErSPbolSH). Further north, in Church Bay, the sponge-rich boulder plains continue although sponge density increases as tidal stream strength increases towards Carmel Head. Further offshore, the seabed comprises consolidated pebbles and gravel with scattered boulders, all covered in thick layers of silt. Dense patches of brittlestars *Ophiothrix fragilis* (Oph) cover the seabed with scattered *U. felina*, *F. foliacea* and amphipod tubes found amongst them. The seabed in the outer part of Holyhead Harbour and into Holyhead Bay (Bae Caergybi) comprises muddy fine sand and gravel which supports stands of the slender seapen *Virgularia mirabilis* (I. Rees, pers. com.). Attempts to find the seapens during the MNCR surveys were unsuccessful.

The Skerries and Carmel Head have the most tide-swept and wave-exposed habitats in Area 18. Very strong tides (6.2 knots on spring floods - charted information) run through the sound between the Skerries and Carmel Head and are further accelerated as they hit underwater obstructions around the islands. At the most tide-swept sites, kelp forests, which reach a depth of three to four m, comprise mainly stout *L. hyperborea* with *A. esculenta* in shallower water, and dense *M. edulis* (MytT) encrusts the upward-facing rock surfaces to the exclusion of other plants and animals. Where mussels are absent, robust red algae such as *P. rubens*, *P. cartilagineum* and *C. ramosa* form dense turfs (FoR) on coralline alga-encrusted bedrock. Faunal dominated communities are found on the vertical faces below the kelp forests. The areas subject to strong tides and wave surge are densely covered in *D. grossularia* and the white sponge *Clathrina coriacea* (SCAs.DenCla) - a biotope highly characteristic of these conditions. In localised areas of shelter, *Bugula* spp. dominates the vertical rock faces.

In deeper water (> 17-20 m), virtually all the rocky surfaces on the tide-swept sites are covered in a uniformly dense faunal turf comprising abundant *T. indivisa*, *D. grossularia*, *Halichondria panicea*, patches of jassid amphipod tubes (*Jassa ?falcata*) and patches of other ascidians including *P. scuba*, *Polyclinum aurantium* and *Distomus variolosus* (TubS). The barnacles *Balanus balanus* (a few extremely large - maximum basal diameter of 5 cm) and *Balanus hameri* are found in these areas. Anemones *Sagartia elegans* var. *rosea* and small *Actinothoe sphyrodeta* are conspicuous on some surfaces not covered in dense sponge and large conger eels *Conger conger* are found in holes under boulders and amongst steel wreckage at West Platters.

There was a marked difference in the abundance of *B. turbinata* and *B. plumosa* growing on vertical rock faces in the lower infralittoral/upper circalittoral (Bug) between sites surveyed in 1996 and 1997. In 1996, virtually every vertical boulder or bedrock face in Area 18 supported dense turfs of both species, but in 1997 the same habitats only supported silty and rather ragged colonies. As both surveys were conducted at the same time of year, this observation suggests that *Bugula* spp. populations may vary considerably from year-to-year.

Hiscock (1976), Jones (1983) and Hughes & Moore (1985) suggested that a discontinuity of fauna occurs at Carmel Head, separating the rich communities on the west coast of Anglesey from comparatively species-poor communities on the north and east coasts. At present MNCR data are insufficient to confirm or refute this suggestion, although Seasearch (Phase 1) data from the north coast of Anglesey and MNCR data from further east (Area 22) show that there is a gradual change from the exposed and tide-swept west coasts to the more sheltered lower energy areas towards Liverpool Bay.

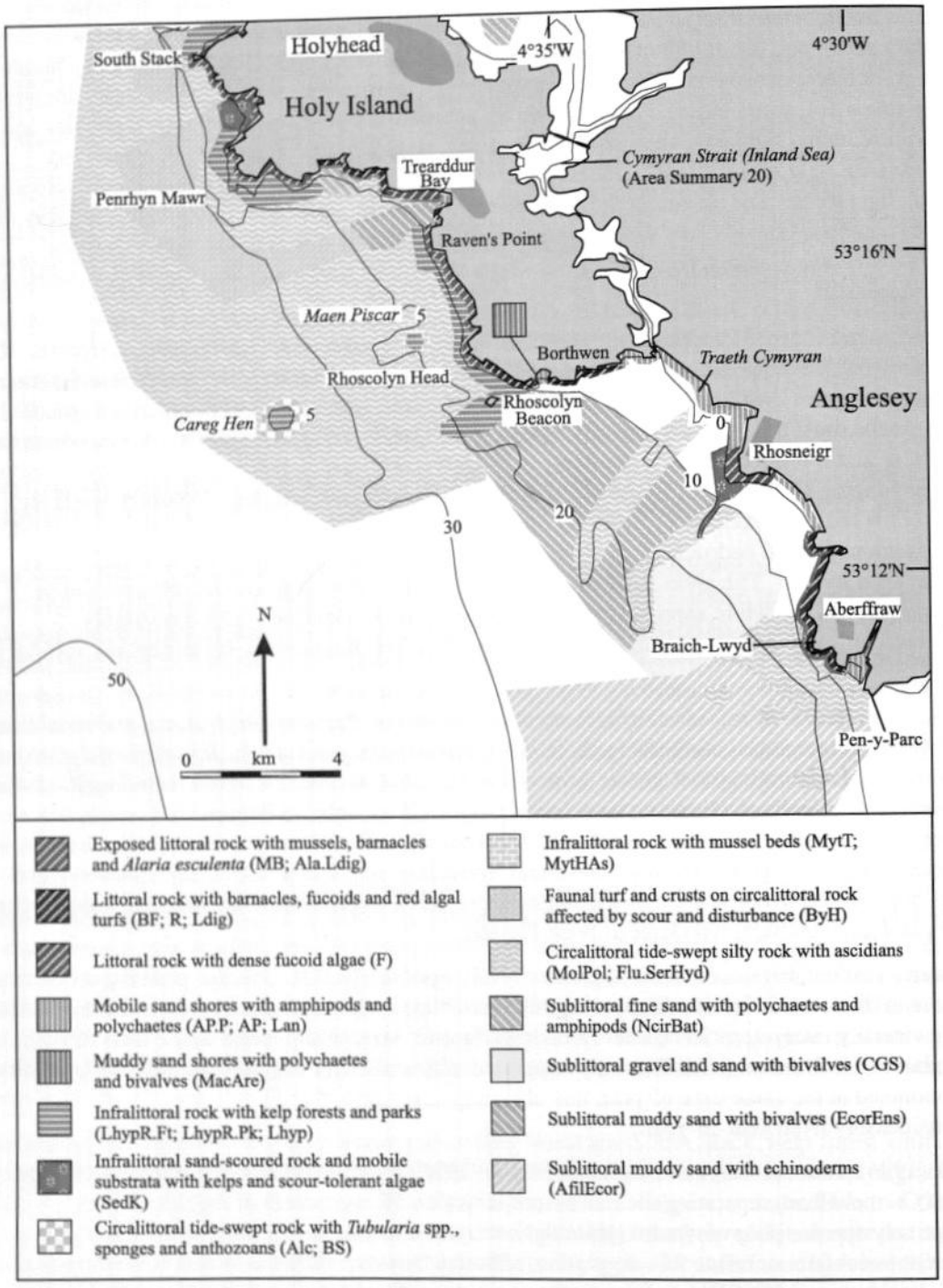

Figure 18.2 Indicative distribution of the main biotopes in west Anglesey (southern part) (based on data from survey sites shown in Figure 18.1, cited literature and additional field observations).

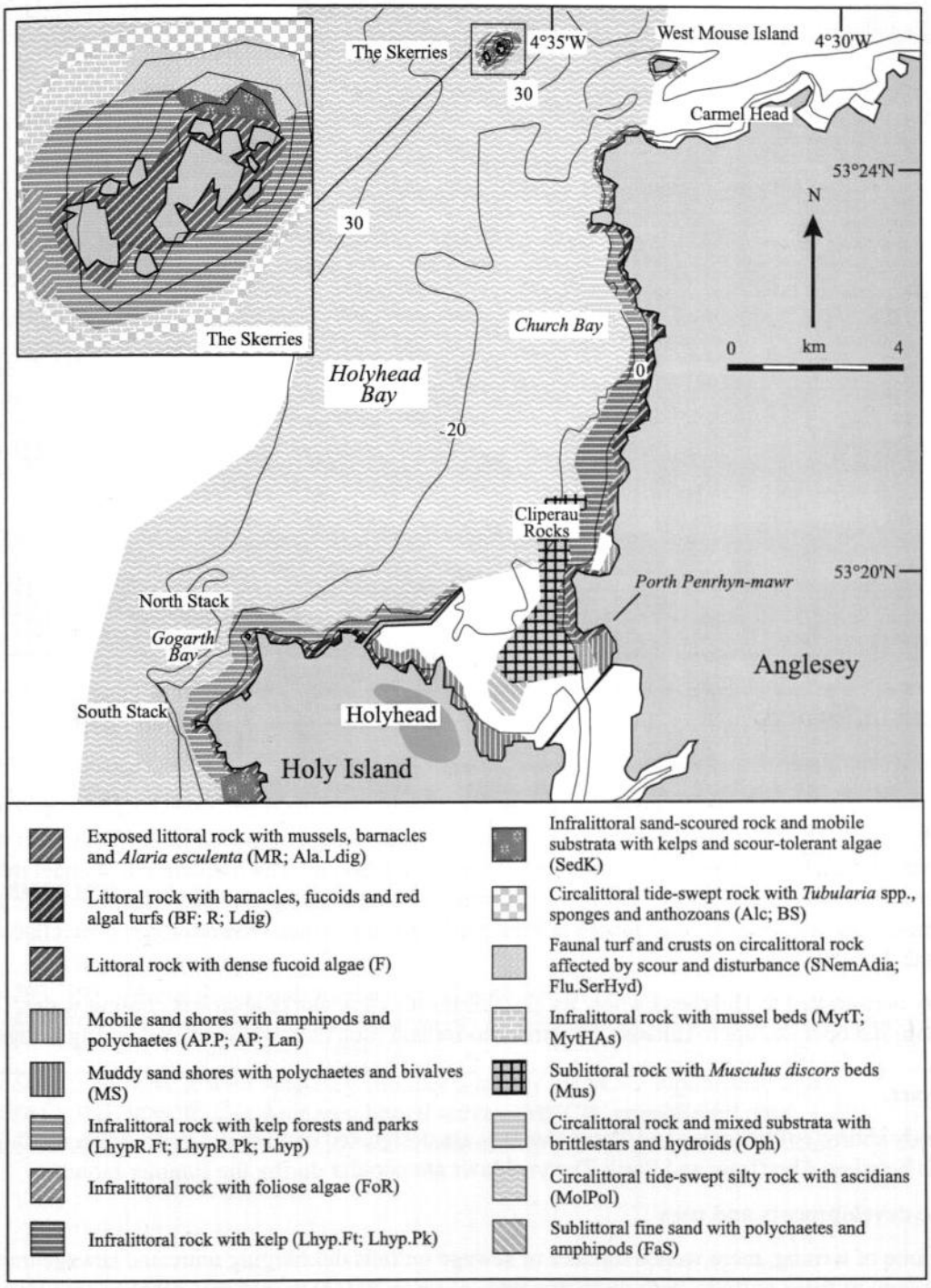

Figure 18.3 Indicative distribution of the main biotopes in west Anglesey (northern part) (based on data from survey sites shown in Figure 18.1, cited literature and additional field observations).

Nature conservation

Conservation sites

Site name	*Status*	*Location*	*Main features*
Anglesey	AONB	N/A	High scenic quality
Ynys Môn	ESA	N/A	Agri-environmental scheme
Glannau Ynys Gybi (Holy Island Coast)	SPA	SH 210 820	Ornithological
Ynys Feurig, Cemlyn Bay and the Skerries	SPA	SH 26 94	Ornithological
Penrhynoedd Llangadwaldr	SSSI	SH 365 655	Rocky coast, grassland, sand dunes and dune grassland
Tywyn Aberffraw	SSSI; GCR	SH 365 690	Dune system
Rhosneigr Reefs	SSSI; GCR	SH 313 727	Intertidal rocky and sandy habitats
Ynys Feurig	SSSI, RSPB	SH 305 737	Breeding seabirds
Rhoscolyn Coast	SSSI	SH 269 746	Marine algae on intertidal rocky habitats
Pant-yr-Hyman	SSSI	SH 262 764	Mainly terrestrial botanical
Porth Diana	SSSI	SH 254 781	Botanical
Glannau Ynys Gybi (Holy Island coast)	SSSI; GCR; cSAC	SH 237 796	Geological, ornithological and botanical
Beddmanarch – Cymyran (Inland Sea)	SSSI	SH 275 790	Ornithological; intertidal sediment flats
Clegir Mawr	SSSI	SH 299 900	Botanical.
Carmel Head	SSSI; GCR	SH 293 928	Geological.
The Skerries	SSSI; RSPB	SH 269 949	Seals and seabirds
South Stack Cliffs	RSPB	SH205823	Ornithological
The Skerries	Protected wreck site	SH 267 948	Marine archaeology
Breakwater Quarry	CP	SH 227 832	Disused quarry

Human influences

Coastal developments and uses

Sea defences are limited to the Holyhead harbour breakwater and the piers, ferry terminals and walls of the harbour. The main breakwater (approximately 2.4 km long, completed in 1873) shelters the inner harbour, including the marina, and most of the outer harbour. The harbour and channel into the harbour are dredged periodically. Dredge spoil from this area is dumped at sea. Minor sea defences in the form of low walls on the upper shore at Rhosneigr, Borthwen and Trearddur Bay protect housing and roads from storms.

Industry is restricted to Holyhead where an aluminium smelting works abstracts cooling water. The ferry terminal operates approximately ten ferries to Ireland each day, while other shipping brings in raw materials for the aluminium smelting works. Cruise liners occasionally berth at the aluminium works pier.

The sandy shores at Rhosneigr and Trearddur Bay are designated bathing beaches, although all of the beaches between Aberffraw and Porth Tywyn-Mawr are popular during the summer months.

Marine developments and uses

At the time of writing, there were a number of sewage outfalls discharging untreated sewage into the sea. Several of these outfalls, with discharge rates of up to 20,000 m^3 per day, emptied into Holyhead harbour. A similarly large single outfall discharged into Trearddur Bay to the south of Porth Diana. Smaller outfalls discharged into the sea to the west of Aberffraw and the aluminium works, to the east of Holyhead, has three outfalls at Penrhos.

Rhosneigr, Trearddur Bay and Holyhead are popular resorts with watersports facilities including swimming, dinghy sailing, wind-surfing, water-skiing and SCUBA-diving. Angling is very popular out of Trearddur Bay and Holyhead.

There is a small inshore fishing fleet at Holyhead harbour and potting for lobster *Homarus gammarus* and crab *Cancer pagurus* takes place around the reefs of Rhosneigr, Rhoscolyn, west of Trearddur Bay, west of Church Bay and around the Skerries.

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Survey 293. 1982 Menai Strait sublittoral survey (Lumb 1983).
Survey 634. 1989-91 BIOMÔR, benthic biodiversity of the southern Irish Sea, sublittoral survey (Mackie, Oliver & Rees 1995).
Survey 640. 1996 MNCR west Anglesey sublittoral survey (MNCR, unpublished data).
Survey 641. 1996 MNCR west Anglesey littoral survey (MNCR, unpublished data).
Survey 647. 1997 MNCR west Anglesey sublittoral survey (MNCR, unpublished data).

Littoral sites

Survey	*Site*	*Place*	*Grid reference*	*Latitude/longitude*	*Biotopes present*
280	2	Trearddur Bay, Anglesey.	SH 254 789	53°16.6'N 04°37.1'W	Fves, Fspi, Pel, Fserr
641	7	Aberffraw Sands, Rhosneigr.	SH 354 685	53°11.2'N 04°27.8'W	HedMac.Pyg, HedOl, AP.P, PCer, Ent, MytFR
641	8	Porth Cwyfan, Rhosneigr.	SH 336 681	53°11.0'N 04°29.4'W	YG, Asc.Asc, Fser.Fser, Ldig.Ldig, FK, Cor, Pel, XR
641	9	E of Braich Parlwr, Rhosneigr.	SH 319 725	53°13.3'N 04°31.0'W	AP.P
641	10	Braich yr Orsedd, Rhosneigr.	SH 317 724	53°13.3'N 04°31.2'W	YG, Fspi, Asc.Asc, SwSed, Fser.Fser.Bo, Pel, Ldig.Ldig.Bo
641	11	Traeth Cymyran, Rhosneigr.	SH 297 749	53°14.6'N 04°33.1'W	AP.P
641	14	Borthwen, Holy Island.	SH 272 749	53°14.5'N 04°35.3'W	MacAre, Ver.Ver, Fspi, Asc.Asc, AP, Pel, Fser,
641	15	W of Borthwen, Holy Island.	SH 272 746	53°14.4'N 04°35.3'W	YG, Ver.Ver, FvesB, Fspi, Fser.Fser, Ldig.Ldig, IR, PelB, XR
641	16	Porth-Yr-Afon, Holy Island.	SH 248 792	53°16.8'N 04°37.6'W	BPat.Sem, YG, Asc.Asc, BLlit, Cor, Fser.Fser.Bo, Pel, Ldig.Ldig.Bo,
641	17	Porth Ryffydd, Holy Island.	SH 218 798	53°17.0'N 04°40.4'W	BPat.Sem, YG, FvesB, Fspi, Fser.Fser.Bo, Ldig.Ldig.Bo, PelB
641	18	Abraham's Bosom Shore, Holy Island.	SH 215 814	53°17.9'N 04°40.7'W	BPat.Sem, YG, Ver.Ver, Fser.R, Ldig.Ldig, FK, Ldig.Ldig, Ver.B
641	19	Gogarth Bay, Holy Island.	SH 213 829	53°18.7'N 04°40.9'W	BPat.Sem, Ov, YG, Ver.Ver, Ala.Ldig, Cor, Pal
641	21	Porth Penrhyn Mawr, Holy Island.	SH 286 837	53°19.3'N 04°34.4'W	MacAre, Lan
641	22	Church Bay, Holy Island.	SH 299 892	53°22.3'N 04°33.4'W	BPat.Sem, Ver.Ver, Fser.Fser.Bo, Ldig.Ldig.Bo
641	23	S Ynys y Fydlyn, Holy Island.	SH 292 917	53°23.6'N 04°34.1'W	YG, Ver.Ver, Fspi, Asc.Asc, BPat.Cat, Fser.Fser.Bo, Pel
641	24	NW Ynys y Fydlyn, Holy Island.	SH 289 918	53°23.7'N 04°34.4'W	BPat.Sem, Him, Ala.Ldig, Ldig.T

Sublittoral sites

Survey	*Site*	*Place*	*Grid reference*	*Latitude/longitude*	*Biotopes present*
293	W1	Pen-y-Parc, Menai Straits.	SH 367 648	53°09.3'N 04°26.5'W	Urt.Urt, Flu.HByS, AlcC, MytHAs, MytT
634	1	NW of Anglesey, St. George's Channel.	SH 109 975	53°26.4'N 04°50.8'W	ModMx
634	2	W of Anglesey, St. George's Channel.	SH 006 914	53°22.9'N 04°59.8'W	ModMx
634	28	Aberffraw, Caernarfon Bay.	SH 334 647	53°09.2'N 04°29.5'W	AbrNucCor
634	29	Caernarfon Bay.	SH 173 616	53°07.2'N 04°43.8'W	ModMx
640	1	W of Braich Lwyd, Holy Island.	SH 314 675	53°10.6'N 04°31.3'W	MolPol.Sab, AfilEcor
640	2	SW of Ynys Meibion, Rhosneigr.	SH 303 686	53°11.2'N 04°32.3'W	IGS
640	3	N side Ynys Meibion, Rhosneigr.	SH 323 686	53°11.2'N 04°30.5'W	FoSwCC, Bug, LhypR.Ft, CC.Mob
640	4	Mynydd Mawr, Rhosneigr.	SH 327 708	53°12.4'N 04°30.3'W	LhypR.Ft, XKScrR
640	5	Offshore Carreg Goch, Rhosneigr.	SH 300 703	53°12.1'N 04°32.7'W	IGS
640	6	Careg Goch, Rhosneigr.	SH 308 714	53°12.7'N 04°31.9'W	MolPol
640	7	Centre of Cymyran Bay, Rhosneigr.	SH 296 731	53°13.6'N 04°33.1'W	MolPol, Ven.Neo

Sublittoral sites continued

Survey	*Site*	*Place*	*Grid reference*	*Latitude/longitude*	*Biotopes present*
640	8	S of Ynysoedd Gwylanod, Holy Island.	SH 277 731	53°13.6'N 04°34.8'W	Lcon
640	9	Porth y Cerwgl, Holy Island.	SH 269 746	53°14.4'N 04°35.5'W	LhypR.Ft, XKScrR
640	10	SW of Rhoscolyn Beacon, Holy Island.	SH 256 738	53°13.9'N 04°36.7'W	MolPol.Sab
640	11	Rhoscolyn Reef, Holy Island.	SH 262 742	53°14.1'N 04°36.2'W	MolPol.Sab
640	12	SW off Rhoscolyn Head (Pinnacle 'C'), Holy Island.	SH 229 735	53°13.7'N 04°39.2'W	ErSPbolSH
640	13	Careg Hen, Holy Island.	SH 208 741	53°14.0'N 04°41.0'W	MolPol.Sab, AlcMaS (?)
640	14	N Rhoscolyn Head, Holy Island.	SH 256 756	53°14.9'N 04°36.8'W	MolPol
640	15	Maen Piscar, Holy Island.	SH 243 762	53°15.2'N 04°38.0'W	MolPol
640	16	Ravens Point, Holy Island.	SH 250 781	53°16.2'N 04°37.4'W	EphR, Bug
640	17	Central Porth Diana Beach, Holy Island.	SH 253 782	53°16.3'N 04°37.2'W	XKScrR, Lhyp.Ft
640	18	Off Trearddur Bay, Holy Island.	SH 247 785	53°16.4'N 04°37.7'W	EcorEns
640	19	Shallow Porth Dafarch, Holy Island.	SH 230 794	53°16.9'N 04°39.2'W	XKScrR
640	20	Porth Dafarch, Holy Island.	SH 226 798	53°17.1'N 04°39.6'W	NcirBat
640	21	Off Porth Dafarch, Holy Island.	SH 230 794	53°16.9'N 04°39.2'W	IMS, MolPol.Sab
640	22	South of Porth Dafarch, Holy Island.	SH 227 788	53°16.5'N 04°39.5'W	MolPol.Sab, Flu.SerHyd
640	23	Shallow Clybyddiad, Holy Island.	SH 219 795	53°16.9'N 04°40.2'W	Bug, Ala.Myt, Lhyp.Ft, FoR
640	24	E of Porth Ryffydd, Holy Island.	SH 220 794	53°16.9'N 04°40.1'W	Bug, FoR
640	25	SW of Porth Dafarch, Holy Island.	SH 220 787	53°16.5'N 04°40.1'W	MolPol.Sab
640	26	Inshore N of South stack, Holy Island.	SH 202 824	53°18.4'N 04°41.9'W	MolPol
640	27	Inshore N of North Stack, Holy Island.	SH 216 842	53°19.4'N 04°40.6'W	MolPol.Sab
640	28	Shallow N Porth Namarch, Holy Island.	SH 223 838	53°19.2'N 04°40.0'W	LhypR.Ft, Ala.Ldig, EphR
640	29	Porth Namarch, Holy Island.	SH 224 838	53°19.3'N 04°40.0'W	MolPol
640	30	Cerrig y Gwyr, Holy Island.	SH 271 826	53°18.7'N 04°35.6'W	FabMag
640	31	Outer Holyhead Harbour, Holy Island.	SH 272 839	53°19.4'N 04°35.6'W	Mus
640	32	W Cliperau Rocks, Holy Island.	SH 274 853	53°20.1'N 04°35.5'W	Mus, Lhyp.Ft
640	33	Reef NW of Porth Trefadog, Holyhead Bay.	SH 282 867	53°20.9'N 04°34.8'W	Lhyp.Ft
640	34	N Bolivar Rock, Holyhead Bay.	SH 279 878	53°21.5'N 04°35.1'W	MolPol
640	35	W of Ynys Arw, The Skerries.	SH 263 947	53°25.2'N 04°36.8'W	TubS, LhypR.Ft, SCAs.DenCla, FoR
640	36	West Platters, The Skerries.	SH 267 944	53°25.1'N 04°36.4'W	TubS, MytHAs,
640	37	W Ynys Berchen, The Skerries.	SH 270 951	53°25.4'N 04°36.2'W	XKScrR
640	38	N of The Skerries.	SH 269 953	53°25.5'N 04°36.2'W	Urt.Urt, MytHAs, Flu.SerHyd, ErSPbolSH
647	4	Pen-y-Parc, Rhosneigr.	SH 366 647	53°09.2'N 04°26.5'W	SCAs.ByH, MytT
647	7	The Fangs, Holy Island.	SH 213 791	53°16.7'N 04°40.7'W	MolPol
647	8	Penrhyn Mawr, Holy Island.	SH 209 798	53°17.0'N 04°41.2'W	Flu.SerHyd, MolPol
647	9	Off Abraham's Bosom, Holy Island.	SH 209 810	53°17.7'N 04°41.2'W	Flu.HByS, IMS
647	10	N Abraham's Bosom, Holy Island.	SH 211 813	53°17.9'N 04°41.0'W	XKScrR
647	11	W of Goferydd viewpoint, Holy Island.	SH 205 819	53°18.2'N 04°41.6'W	ErSPbolSH
647	12	S South Stack, Holy Island.	SH 202 821	53°18.3'N 04°41.8'W	SNemAdia
647	13	W of South Stack, Holy Island.	SH 201 821	53°18.3'N 04°42.0'W	Flu.SerHyd
647	14	Off Clegir Point, Holyhead Bay.	SH 292 897	53°22.6'N 04°34.0'W	MolPol
647	15	NW of Clegir, Holyhead Bay.	SH 291 905	53°23.0'N 04°34.1'W	Oph
647	16	Porth y Bribys, Holyhead Bay.	SH 293 907	53°23.1'N 04°33.9'W	LhypR.Ft, LhypR.Pk
647	17	S of Trwyn y Crewyn, Holyhead Bay.	SH 293 910	53°23.2'N 04°34.0'W	ErSPbolSH
647	18	N of Ynys-y-Fydlyn, Holyhead Bay.	SH 290 920	53°23.8'N 04°34.2'W	MolPol, XKScrR
647	19	S of Trwyn Cerig-yr-eryr, Holyhead Bay.	SH 290 921	53°23.8'N 04°34.2'W	Lhyp.TFt, Lhyp.TPk
647	20	Off Trwyn Cerig-yr-eryr, Holyhead Bay.	SH 287 923	53°23.9'N 04°34.5'W	StoPaur, MytHAs
647	21	Porth-y-Dyfn, Holyhead Bay.	SH 292 929	53°24.3'N 04°34.1'W	LhypR.Ft, XKScrR
647	22	W Carmel Head, Holyhead Bay.	SH 296 931	53°24.4'N 04°33.7'W	LhypR.Ft, Ant
647	23	Middle rock, Holyhead Bay.	SH 282 935	53°24.6'N 04°35.0'W	MolPol.Sab
647	24	Carmel Head, Holyhead Bay.	SH 298 932	53°24.4'N 04°33.6'W	MolPol
647	25	E side of West Mouse, Holyhead Bay.	SH 304 943	53°25.1'N 04°33.1'W	MolPol.Sab, Mob

Compiled by: Rohan H.F. Holt

19 Cefni estuary (Malltraeth Sands)

Location		
Position (centre)	SH 400 670	
County	Ynys Môn (Anglesey)	
Conservation agency/area	Countryside Council for Wales	North-west Area

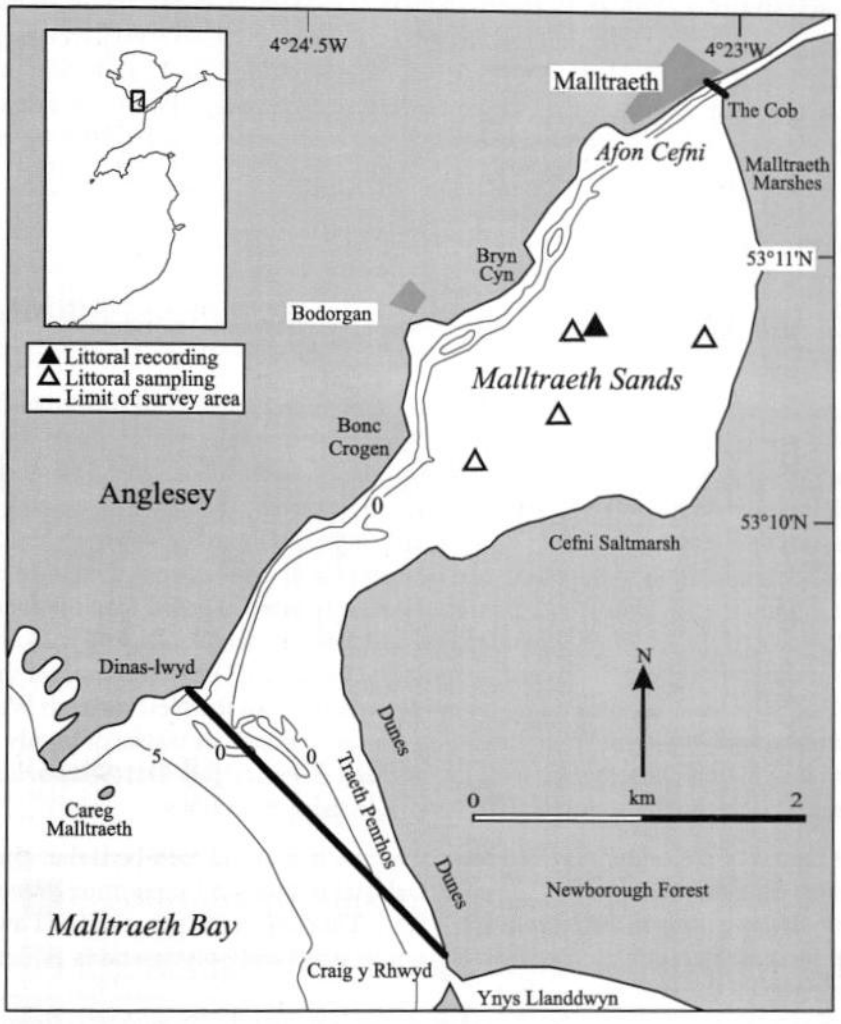

Figure 19.1 Main features of the area, showing sites surveyed.

Physical features	
Physiographic type	Bar-built estuary
Length of coast	11.7 km (Malltraeth Sands); 26.1 km (to NTL)
Channel length	5 km (Malltraeth Sands); 12.7 km (to NTL)
Area of inlet	744 ha
Bathymetry	Intertidal with a shallow river channel
Wave exposure	Moderately exposed to very sheltered
Tidal streams	Moderately strong to negligible
Tidal range	4.7 m springs; 1.9 m neaps (Llanddwyn Island)
Salinity	Full to variable

Introduction

The Cefni estuary in the south-west of Anglesey is a broad, shallow sandy estuary with a water channel approximately 30 m wide and 1 m deep (at low water) meandering along the north-west shore and a saltmarsh on the south-east shore. The estuary is approximately 1.5 km wide at high water and restricted to 0.8 km wide at the entrance. Large areas of the sandflats, known as Malltraeth Sands, are sufficiently flat to keep a sheen of water a few millimetres thick on the surface while the tide is out during spring tides. However, during neap tides, large areas of sand remain continually dry and, on hot days, can suffer wind erosion (Rees & Walker 1976). Malltraeth Sands have a high conservation value, being part of the Newborough Warren to Ynys Llanddwyn SSSI and National Nature Reserve. The Cob, which was built as a flood prevention embankment in 1819, now divides the estuary from the freshwater Malltraeth Marsh (Buck 1993). However, the Afon Cefni is subject to tidal influence for several kilometres further upstream along its canalised channel through the Marsh. Area 19 also includes Traeth Penrhos, a stretch of more wave-exposed beach to the south of the estuary mouth.

Marine biology

Marine biological surveys

	Survey methods	*No. of sites*	*Date(s) of survey*	*Source*
Littoral	Infaunal sampling (cores)	1	August 1996	MNCR survey 641
	Infaunal sampling (unspecified)	-	1975	Rees & Walker (1976)

The whole Cefni estuary and adjacent open coast shores are entirely composed of sediment. Traeth Penrhos, the broad sandy shore up to 500 m wide that lies between Llanddwyn Island and the entrance to the Cefni estuary, is relatively flat in the mid- and lower shore. The upper shore is dry and much steeper with no obvious infauna, formed into foredunes exposed to erosion by high seas. The whole beach is moderately exposed to wave action and hence made up of well-sorted, mobile clean sand. Although not sampled for infauna, Traeth Penrhos is slightly more exposed than the sand shore south-east of Llanddwyn Island, not having the protection of nearshore sandbanks, and is likely to have a community characterised by amphipods and sparse polychaetes (AP.P). The width of the estuary mouth is restricted by a sand-bar created by wind-blown sand from the Newborough Warren dune system. The rapid tidal and river flow at the estuary entrance produces waves of highly mobile, well-sorted, clean sand. Few species other than the crustaceans *Eurydice pulchra*, *Haustorius arenarius* and *Bathyporeia* spp. are sufficiently robust to survive in these conditions.

The south-east border of the estuary is lined with dense saltmarsh and reed-beds that grade through mature saltmarsh communities to very wave-sheltered, stable fine sand supporting pioneer saltmarsh community with dense glasswort *Salicornia* spp. (Sm). The *Salicornia* spp. thins out away from the shore where an increase in sediment disturbance from bivalves and polychaetes is evident from the siphons and burrows on the sediment surface. This estuary fringe of fine sand has dense populations of mud snails *Hydrobia* sp. on the surface, the burrowing amphipod *Corophium volutator* just below the surface and the large burrows and surface casts of the lugworm *Arenicola marina* (HedMac.Pyg).

The extensive central area of sandflats comprising very fine, well-sorted sand is broken-up by four slightly muddier areas, three of which are old river meanders that have since filled with sediment and one which lies adjacent to the saltmarsh at the top of the estuary. Large areas of uniform sandflat are characterised by the presence of polychaetes and cockles *Cerastoderma edule*, although the density of cockles varies throughout the sandflats (PCer).

Using aerial photographs and old maps, Rees & Walker (1976) found that the estuary contains three continually changing meanders at Bonc Crogen, Bryn Cyn and Malltraeth. In 1950, the Malltraeth meander was dredged out and the river channel has remained straight since. However, the excised meander remained as a muddy area which, in 1975, was found to contain a dense bed of peppery furrow shell *Scrobicularia plana* and ragworm *Hediste diversicolor*. The muddy area still remains, although the recent MNCR survey has not confirmed if the same infaunal community is still present.

The Bryn Cyn meander appears to be well established as a feature of the estuary. In 1960 and 1974, the Bonc Crogen meander was excised and formed a muddy area, partially isolated from the main flats by raised drying sands and colonised by dense *Corophium arenarium* and *A. marina* but no *C. edule*.

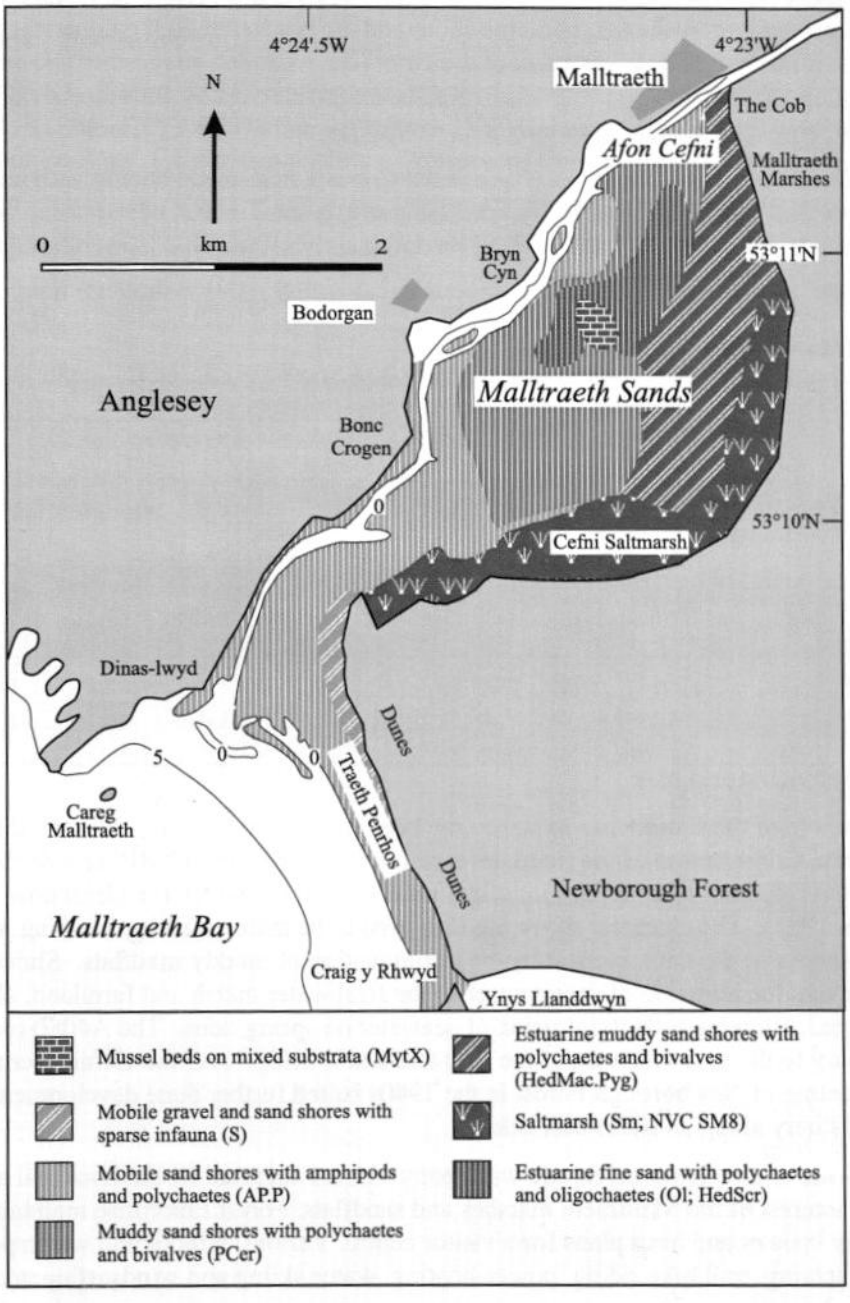

Figure 19.2 Indicative distribution of the main biotopes in the area (based on data from survey sites shown in Figure 19.1, cited literature and additional field observations).

In the middle of the sandflats, a slightly raised area inside an old meander is covered by a dense bed of mussels *Mytilus edulis* with spiral wrack *Fucus spiralis*, barnacles and littorinids (MytX). The substratum is made up largely of empty shells of *M. edulis*, *S. plana* and *C. edule*. Adjacent to the mussel bed is an area of fine sand with dense *S. plana* and *C. edule* (HedScr). Despite the sheltered

nature of the upper estuary, none of the sediments below the causeway and road are very muddy, although the sand is very fine throughout the estuary.

Seaward of the Bryn Cyn meander, adjacent to the main channel, few species are found except amphipods (mainly *Bathyporeia sarsi*) and sparse polychaetes (AP.P) (Rees & Walker 1976). *C. edule* and *A. marina* are limited by the height on the shore and are not found on the upper shore flats. *H. diversicolor* is rarely found downstream of the Bryn Cyn meander, suggesting a salinity or mud fraction limitation. The extensive areas of sandflats are characterised by the presence of *H. diversicolor*, *Pygospio elegans*, *A. marina*, *C. arenarium* and *C. edule* (?HedMac).

Inland of the Malltraeth Sands the 'lagoon' above the Cob is a man-made habitat with an area of approximately 6 ha. The lagoon is slightly brackish due to a small influx of sea water on high tides. The survey completed by Barnes (1987) found predominantly saltmarsh communities on soft silt.

Nature conservation

Conservation sites

Site name	*Status*	*Location*	*Main features*
Newborough Warren (Tywyn Niwbwrch) - Ynys Llanddwyn	SSSI; NNR; GCR; NCR	SH 410 630	Geological, geomorphological, botanical, invertebrate and ornithological interest.
Anglesey	AONB	N/A	High scenic quality.
Ynys Môn	ESA	N/A	Agri-environmental scheme
Menai Strait	pMNR	SH 52 68	Marine habitats & species.
Newborough Forest	FC	SH 400 650	Working forest with conservation areas.

Human influences

Coastal developments and uses

Virtually the whole of the estuary has in some way been influenced by man, although this is not always apparent. Construction of the flood defence known as the Cob in 1819 caused the accretion of sediment and development of extensive intertidal sandflats, across which the Cefni now meanders at low tide (Buck 1993). The channels above the Cob used to be maintained by dredging, although this no longer appears to be the case, evident by the accumulation of muddy sandflats. Sluice gates were installed to prevent the intrusion of saline water to the freshwater marsh and farmland, although they are now damaged, allowing a small intrusion of seawater on spring tides. The A4080 road crosses the top of the estuary to the landward side of the Cob and a new bridge over the Cefni river near Malltraeth. Planting of Newborough Forest in the 1940s halted further dune development and stabilised the estuary along its south-east side.

Most activities are of a recreational nature with many visitors attracted by the botanical and ornithological interest of the Malltraeth marshes and sandflats. Forest Enterprise maintain access to the beaches for day visitors and have plans for a visitor centre. Various outdoor and watersport activities such as land-yachting, trail bike riding, power-boating, water-skiing and windsurfing take place on the open coast beaches.

There are various schemes for species and habitat management, such as localised fox and rabbit control on adjacent land, *Spartina* control and pond and lake creation.

Marine uses

There are few commercial fishery interests, although cockles *Cerastoderma edule* and mussels *Mytilus edulis* are gathered in small quantities and there is limited bait-digging. Wildfowling occurs over the central section of the estuary.

At the time of writing, primary treated sewage (up to 5000 m^3 per day) entered the Cefni estuary immediately downstream of Malltraeth, and additional storm sewer facilities catered for the overflow of untreated sewage when the system is overloaded.

References and further reading

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Buck, A.L. 1993. *An inventory of UK estuaries. Volume 2. South-west Britain*. Peterborough, Joint Nature Conservation Committee.

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Rees, E.I.S., & Walker, A.J.M. 1976. Survey of macro-invertebrate populations in the Cefni estuary, Gwynedd. (Contractor: Marine Science Laboratories, University College of North Wales, Menai Bridge.) *Nature Conservancy Council, CSD Report*, No. 69.

Sites surveyed

Survey 641. 1996 MNCR west Anglesey littoral survey (MNCR, unpublished data).

Littoral sites

Survey	*Site*	*Place*	*Grid reference*	*Latitude/longitude*	*Biotopes present*
641	6	Malltraeth Sands, Newborough	SH 600 670	53°10.5'N 04°23.6'W	PCer, HedMac.Pyg, AP.P, HedScr, MytX

Compiled by: Paul Brazier

20 Inland Sea (Cymyran Strait)

Location		
Position (centre)	SH 280 780	53°16.5'N 04°34.5'W
County	Ynys Môn (Anglesey)	
Conservation agency/area	Countryside Council for Wales	North-west Area

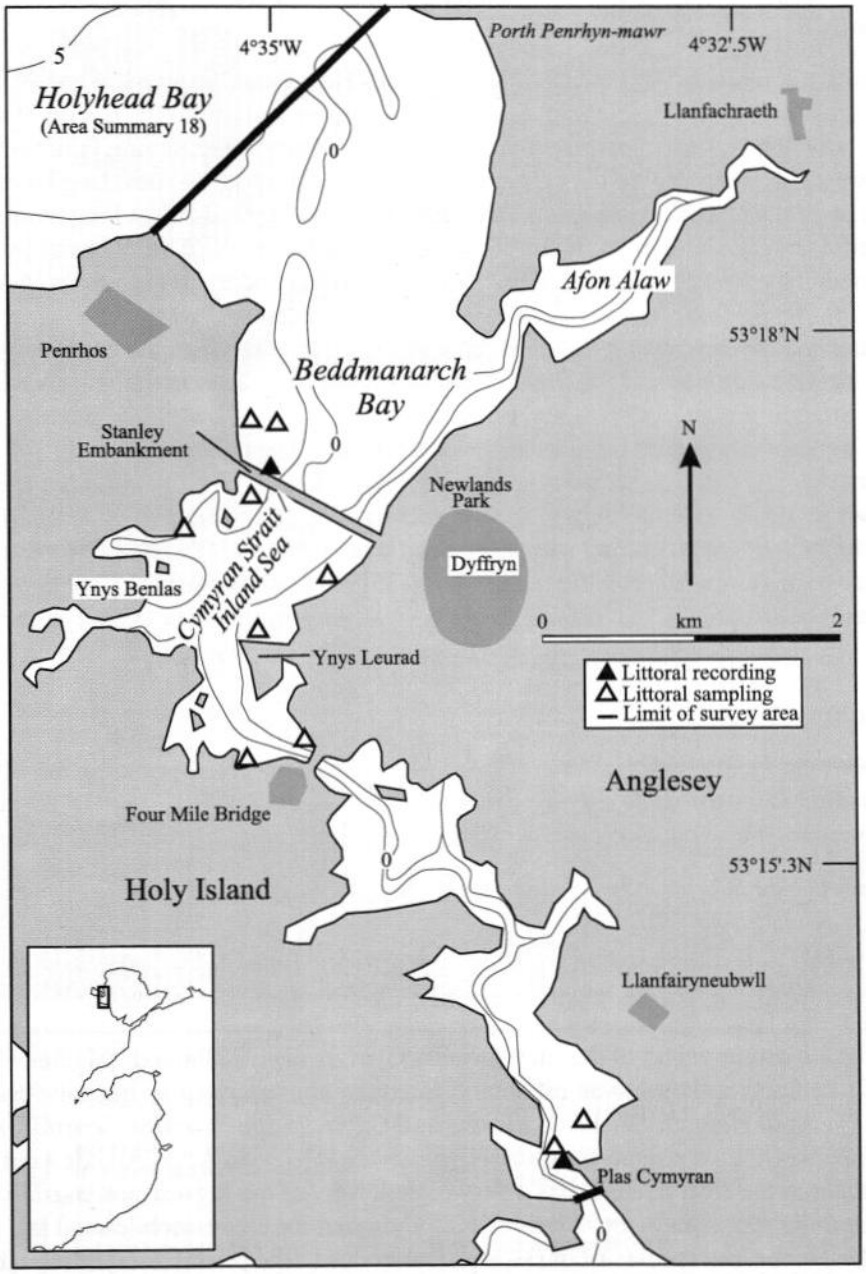

Figure 20.1 Main features of the area, showing sites surveyed.

Physical features	
Physiographic type	Enclosed coast
Length of coast	38.2 km
Area of inlet	1,085 ha
Bathymetry	Maximum depth of 9 m at the Stanley embankment culvert
Wave exposure	Sheltered to extremely sheltered
Tidal streams	Moderate to negligible
Tidal range	1.2 m in Inland Sea, 5 m seaward of the bridges on springs
Salinity	Fully marine to variable

Introduction

The Cymyran Strait is a narrow channel which separates Holy Island from mainland Anglesey. It is locally known as the Inland Sea and includes the Alaw estuary and the southern part of Holyhead Harbour. Its boundaries, for the purposes of this report, are from a line joining Penrhos with Porth Penrhyn Mawr at the north end, to the entrance into Cymyran Bay at the south end (*area summary* 18). It consists of two broad, shallow basins, Beddmanarch Bay and Inland Sea; a long, narrow, but complex intertidal basin south of the Inland Sea and the Alaw estuary. The deepest basin, the Inland Sea, is impounded by the A5 Stanley Embankment to the north and the B4545 Four Mile Bridge (Pont-rhydbont) to the south. Therefore there is a limited exchange of water with the open coast. The enclosed nature and the large extent of intertidal habitats means that, with the exception of the north-facing Beddmanarch Bay north of the Stanley Embankment, Area 20 is extremely sheltered from wave action. Tidal streams are generally negligible, except immediately adjacent to the culverts through which the rising and falling tides pass under the two bridges. The tidal range outside of the bridges is 5 m, but restricted flow through the culverts means that the daily tidal range does not exceed 0.6 m. The Inland Sea gradually fills during spring tides and empties during neap tides such that the lowest tides within the Inland Sea are during periods of neap tide (Jones 1978). The Inland Sea, as a result, has an tidal range of 1.2 m. The salinity ranges from 29.5 to 35.0 ‰ over the year, depending upon the rainfall, and temperatures can rise well above normal sea temperatures (> 19°C) during summer.

Marine biology

The only known marine biological surveys of Area 20 are by Jones (1978) and by the MNCR in 1996. No data are available for the Alaw estuary (Buck 1993).

Marine biological surveys				
	Survey methods	*No. of sites*	*Date(s) of survey*	*Source*
Littoral	Recording (epibiota)	3	August 1996	MNCR survey 641
	Infaunal sampling (cores)	3	August 1996	MNCR survey 641
	Infaunal sampling ($0.01m^2$ van Veen grab)	7	Pre-1978	Jones (1978)

Information for the southern end of the inlet towards Cymyran Bay is limited. Medium-fine sand south-west of Llanfairyneubwll has an infaunal community characterised by the polychaetes *Hediste diversicolor*, *Pygospio elegans*, *Arenicola marina* and *Capitella* spp., cockles *Cerastoderma edule* and very high numbers of the amphipod *Corophium arenarium* (HedMac.Are). Anoxic sand with buried leaf litter adjacent to the river channel has a very high density of the lugworm *A. marina* and the polychaete *Capitella* spp. (MacAre). North of Plas Cymyran the clean, mobile sand and gravel has sparse polychaetes; the low species-richness is probably due to the perturbation of the sediment by the tidal streams (?Ol). The channel narrows between two rocky outcrops at Cymyran. This shore has small patches of yellow and grey lichens (YG), and the fucoids *Pelvetia canaliculata* (Pel) with zones of *Fucus spiralis* (Fspi), *Ascophyllum nodosum* (Asc.VS) and *Fucus serratus* (Fserr). Steep vertical bedrock on this shore has dense barnacles *Semibalanus balanoides* and limpets *Patella vulgata* with large mussels *Mytilus edulis* in the crevices (BPat.Sem).

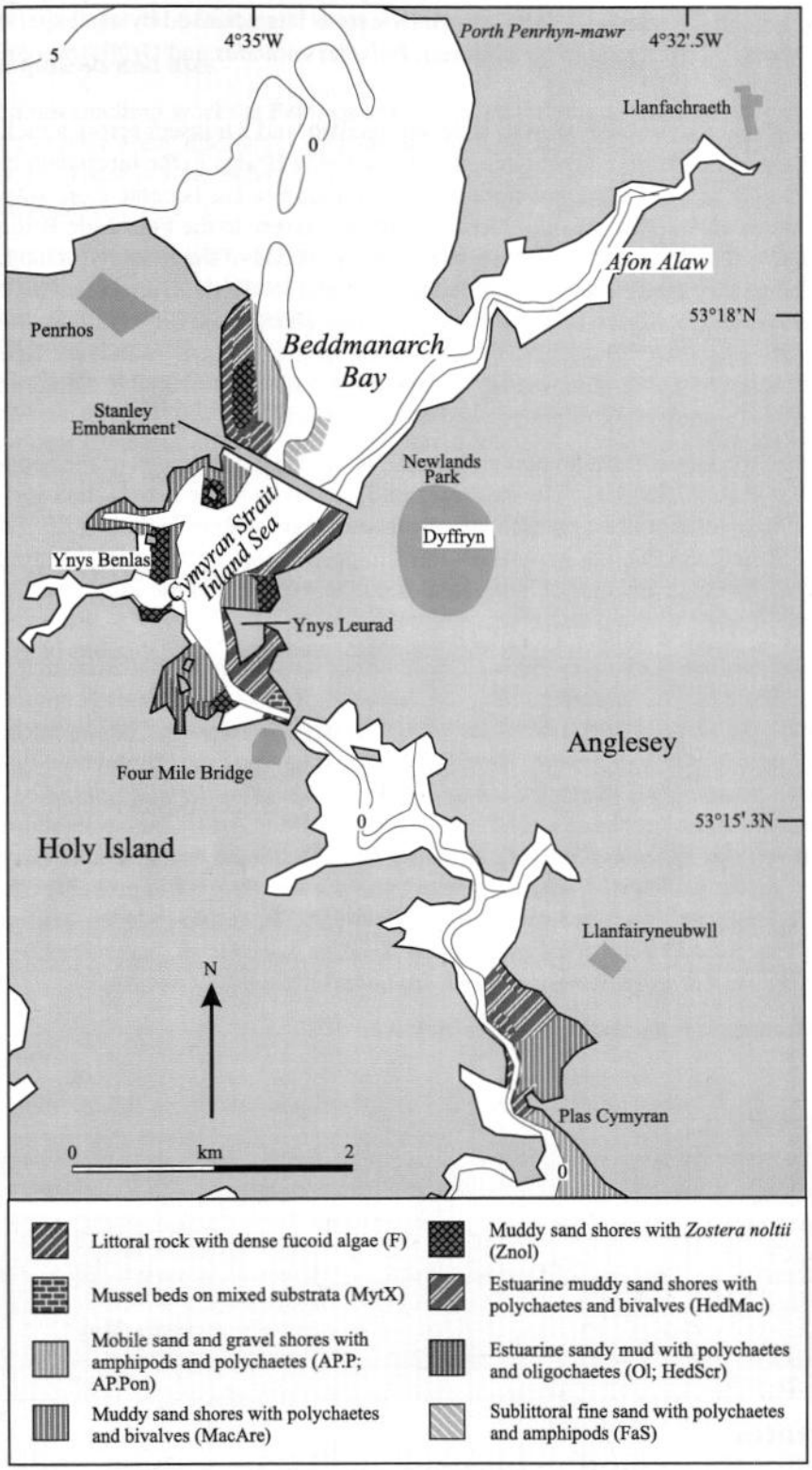

Figure 20.2 Indicative distribution of the main biotopes in the inlet (based on data from survey sites shown in Figure 20.1, cited literature and additional field observations).

The sublittoral fringe at Cymyran is largely smothered by sand and is influenced by strong tidal streams running through the narrows. The community here is characterised by algal species that are tolerant of sand-scour, including *Halidrys siliquosa*, *Polyides rotundus* and *Griffithsia corallinoides* (HalXK).

Jones (1978) completed five transects across sediment habitats and a transect across a rocky shore. Prior to the building of the Stanley Embankment and Four Mile Bridge in the nineteenth century, the sediments were largely of clean sand, but since then, the Inland Sea has become more silty and now contains muddy sands and muddy gravels. Gravel habitats adjacent to the Four Mile Bridge are covered by a dense bed of *M. edulis* (MytX); gravel at the west end of the Stanley Embankment was not surveyed. The muddy sands found throughout the mid-and lower shore are colonised by polychaetes *Hediste diversicolor* and *Pygospio elegans*, oligochaetes and the mud-burrowing amphipod *Corophium* sp. (?HedMac.Pyg). Pockets of sandy mud and mud within sheltered inlets in the Inland Sea were not sampled. Less-muddy sediment north of Ynys Leurad is colonised by the polychaetes *Scoloplos armiger* and *A. marina* and oligochaetes (?MacAre).

In the south-west of the Inland Sea, the upper shore sandy mud has dense beds of the peppery furrow shell *Scrobicularia plana* (?HedScr). The extensive mid-and lower shore here is sand and muddy sand, probably with an infauna characterised by polychaetes and bivalves including *Abra tenuis* (MacAre). In 1978, eelgrass *Zostera* sp. was recorded in patches in all of the most sheltered areas, but most extensively to the south and east of Ynys Benlas on the west side of the Inland Sea. The present-day status of these *Zostera* stands is unknown.

Immediately to the north of the Stanley Embankment, on the west shore of Beddmanarch Bay, the upper shore has a dense bed of *Zostera noltii* on muddy sand (Znol). The infaunal community is characterised by the presence of polychaetes including *Scoloplos armiger* and *Mediomastus fragilis* and oligochaetes, particularly *Tubificoides benedii*. A similar habitat exists throughout the mid-shore, where the infaunal community is characterised by *H. diversicolor*, *Caulleriella zetlandica*, *S. armiger*, *Aphelochaeta marioni* and oligochaetes *Tubificoides* spp. (HedMac.Are). The lower shore is swept by the strong tidal flow from the culvert and is a clean gravel and sand too coarse to core-sample. At the extreme lower shore, the well-sorted, tide-swept sand was not sampled, but is probably characterised by an infauna of robust amphipods and sparse polychaetes (?AP.Pon). A silt-laden, artificial bank of cobbles and boulders close to the embankment is colonised by *A. nodosum*, barnacles *Elminius modestus* and littorinids *Littorina littorea* and *Littorina obtusatalmariae* (Asc.Asc).

No sublittoral information is available for the Inland Sea.

Nature conservation

Conservation sites

Site name	*Status*	*Location*	*Main features*
Beddmanarch to Cymyran	SSSI	SH 275 790	Ornithological; botanical.
Beddmanarch Bay Nature Reserve	LNR	SH 275 805	Wildfowl and wader feeding grounds.
Ynys Môn	ESA	N/A	Agri-environmental scheme
Anglesey	AONB	N/A	High scenic quality.

Human influences

Coastal developments and uses

Prior to the construction of the Stanley embankment in 1822, and the earlier Four Mile Bridge, the Inland Sea was an open strait separating Holy Island from Anglesey. These causeways severely restrict the tidal flow into the Inland Sea which has resulted in a limited tidal range (1.2 m) and the originally sandy habitats have become progressively muddier. There is little coastal development other than the causeways. Consent has been granted for improvements to the A5 trunk road which

currently runs over the Stanley embankment. At Newlands Park, near Dyffryn, there has been a small amount of land-claim for car parking and there is a small boatyard.

Marine developments and uses

A large aluminium smelting works at Penrhos to the west of Beddmanarch Bay discharges effluent into the estuary. Other waste discharges include storm drains, sewage and rubbish from Dyffryn and from day visitors. There is a secondary treatment sewage works at Llanfachraeth which discharges into the Alaw estuary.

Water-based recreational activities such as windsurfing, canoeing and water-skiing take place throughout most of the Cymyran Strait and Alaw estuary although most are concentrated on the channel south of the Stanley embankment. The small harbour near Dyffryn has boat moorings and is a popular site from which to sail. The Coastguard uses the estuary for rescue exercises, particularly the headlands and islands around the estuary entrance. Angling is a popular sport in the area, with associated bait-collecting activities. Commercial oyster *Crassostrea gigas* farming started in the Inland Sea and near Cymyran in 1991. Control of the invasive cordgrass *Spartina* has been proposed to limit the loss of intertidal mudflats (Buck 1993).

References and further reading

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Jones, D.C. 1978. *The ecology of two coastal lagoons.* MSc thesis, University College of North Wales, School of Ocean Sciences, Menai Bridge.

Sites surveyed

Survey 641. 1996 MNCR west Anglesey littoral survey (MNCR, unpublished data).

Littoral sites

Survey	*Site*	*Place*	*Grid reference*	*Latitude/longitude*	*Biotopes present*
641	12	Plas Cymyran, Rhosneigr.	SH 296 755	53°14.9'N 04°33.2'W	BPat.Sem, YG, Fspi, Asc.VS, SByAs, Pel, HalXK, Fserr,
641	13	South end of inland sea, Rhosneigr.	SH 295 761	53°15.2'N 04°33.3'W	HedMac.Are, MacAre, Ol
641	20	Beddmanarch Bay, Holy Island.	SH 278 805	53°17.5'N 04°35.0'W	HedMac.Are, Znol, Asc.Asc

Compiled by: Paul Brazier

21 North-east Anglesey (Ynys Môn)

Location		
Position (centre)	SH 520 870	53°21'N 4°13'W
County	Anglesey (Ynys Môn)	
Conservation agency/area	Countryside Council for Wales	North-west Area

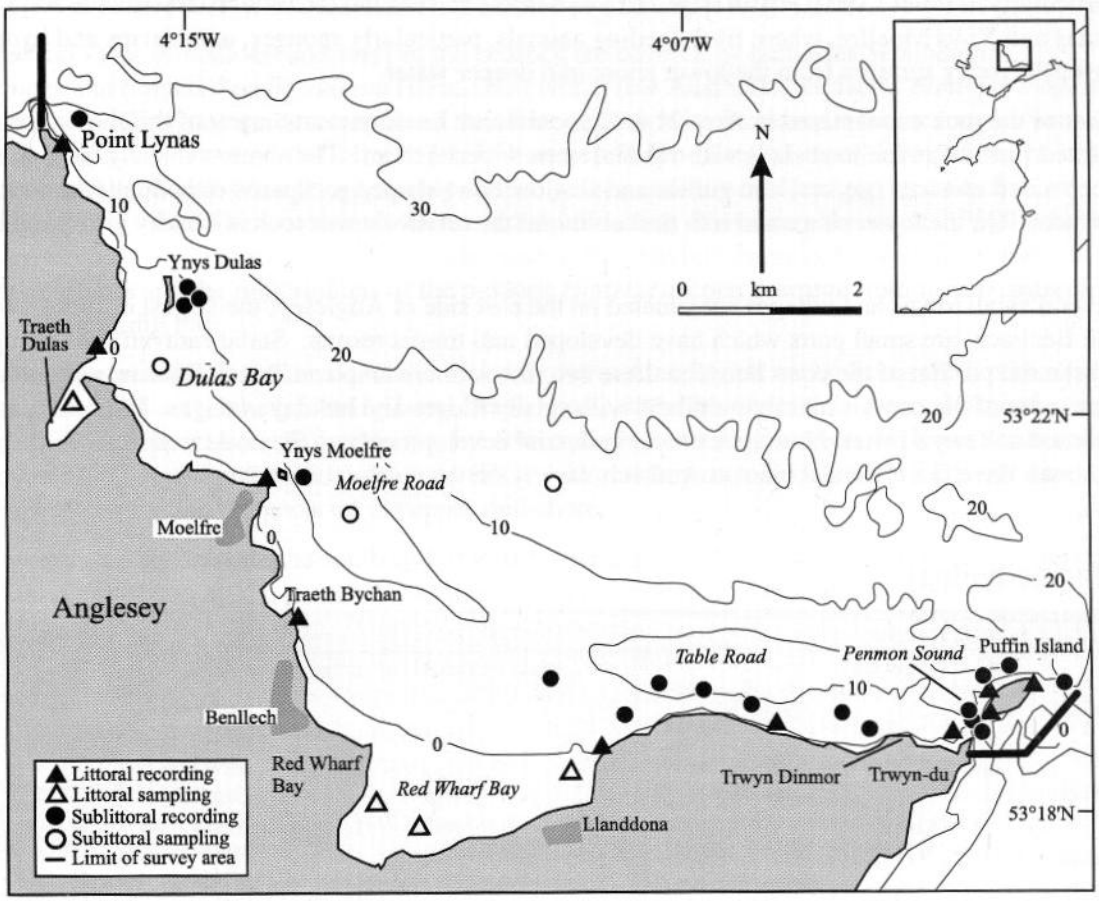

Figure 21.1 Main features of the area, showing sites surveyed.

Physical features	
Physiographic type	Open coast
Length of coast	Approx. 35 km
Bathymetry	10 m isobath from 50 m to 6 km offshore; 20 m isobath 500 m to 8 km offshore
Wave exposure	Moderately exposed to sheltered
Tidal streams	Moderately strong to negligible
Tidal range	6.7 m spring tides; 3.4 m neap tides
Salinity	Fully marine, although generally lower than west coast of Anglesey

Introduction

The north-east facing coast of Anglesey protects Conwy Bay and to some extent Liverpool Bay from the prevailing wind, allowing large ships awaiting berths in Liverpool to anchor in the shallow, relatively calm waters offshore. The sheltered nature of this stretch of coast is reflected in the plants

and animals which inhabit the shores and shallow sublittoral; there are several species present in large numbers which, on the more exposed coast further west in Sector 10, are found only sporadically. Extensive sediment and cobble plains are found throughout most of Area 21, particularly in Red Wharf Bay (Traeth-coch) and the small enclosed inlet of Traeth Dulas, although heavily silted and sand-scoured rocky shores and seabed are present on the steeper sections of the coast. Large amounts of silt in suspension and planktonic blooms keep turbidity high virtually all year round. Not only does this prevent the kelp forests from extending much below chart datum but it also appears to affect the zonation patterns of fucoid algae on the shore.

Moderately strong tidal streams influence the composition of the communities in parts of Area 21, particularly at Point Lynas, Puffin Island (Ynys Seiriol) and around the small rocky islands Ynys Dulas and Ynys Moelfre, where filter-feeding animals, particularly sponges, anthozoans and hydroids, cover the rocky surfaces from the lower shore into deeper water.

Most of the rock encountered in Area 21 is Carboniferous limestone, and many of the shores are formed from large inclined slabs with vertical steps between them. The shores typically have deep, steep-sided crevices (grykes) and gullies and shallow bowl-shaped rockpools etched into the rock surfaces. On the lower shore and into the sublittoral the relatively soft rock is heavily pitted and bored by a variety of invertebrates characteristic of this rock type.

Several small towns and villages are situated on the east side of Anglesey; the largest of these, Moelfre and Benllech, are small ports which have developed into tourist resorts. Static caravan sites occupy a substantial portion of the coast between these two towns, for example at Traeth Bychan, although the remainder of the coast is mainly rural land with small villages and holiday cottages. Limestone is quarried at Trwyn Dinmor but there are no industrial developments on the coast within Area 21, although there is a chemical plant at Amlwch, nearby on the north coast of Anglesey.

Marine biology

Marine biological surveys

	Survey methods		*No. of sites*	*Date(s) of survey*	*Source*
Littoral	Recording	(epibiota)	1	1982	Jones (1983)
			9	July 1997	MNCR survey 646
	Infaunal sampling	(cores)	4	July 1997	MNCR survey 646
Sublittoral	Recording	(epibiota)	7	1982	Lumb (1983)
			10	August 1997	MNCR survey 648
	Infaunal sampling	(Day grab)	1	1995	Mackie, Oliver & Rees (1995)
		(cores)	3	August 1997	MNCR survey 648

Littoral

Littoral rock

The shores on the east side of Anglesey support communities characteristic of the moderately wave-exposed to sheltered conditions both over a range of sediment grades and rocky substrata. On most of the rocky shores, lichens occur in the splash zone (YG) followed by fucoid alga-dominate zones with a gradation from channelled wrack *Pelvetia canaliculata* (Pel) at the top of the shore, then spiral wrack *Fucus spiralis* (Fspi), bladder wrack *Fucus vesiculosus* (Fves), knotted wrack *Ascophyllum nodosum* (Asc.Asc), serrated wrack *Fucus serratus* (Fser) to sparse kelp *Laminaria digitata* (Ldig.Ldig) in the sublittoral fringe. However, in north-east Anglesey, the abundance and vertical range of some of these species are atypical compared to other moderately exposed rocky shores in north Wales. The main difference is that the lower eulittoral zone, dominated by *F. serratus*, is wider, extending higher up these shores than in adjacent Areas. At the top of the shore the algae in the littoral fringe and mid- and upper eulittoral are in relatively narrow bands with *F. serratus* covering much of the remaining area. Although the reason for this elevation of the lower shore zones has not been investigated, it is likely that the consistently high water turbidity plays an important role in influencing growth of algae on the shore such that only those capable of growing under low light regimes do well from mid-shore

downwards. The high turbidity also prevents *L. hyperborea* from growing much below chart datum in the middle of Area 21 (see below); instead a mixture of silt-tolerant and opportunistic species are found (XKScrR).

At most of the sites surveyed there is a zone of mussels *Mytilus edulis* on the rock between the lower limit of *F. serratus* and the start of the kelp (MytFR). Few species are recorded amongst the mussels, although the green alga *Enteromorpha* sp. forms a blanketing layer attached to their shells. At some sites, for example on Puffin Island and west of Trwyn-du, *L. digitata* and *F. serratus* are sparse or absent on the lower shore and instead silty turfs of red algae such as *Ceramium* spp., *Polysiphonia* spp., *Rhodothamniella* sp. and *Palmaria palmata* and the brown alga *Desmarestia aculeata* cover the rock surfaces in the lower eulittoral and sublittoral fringe (Fser.R, ?Pal and XR) .

The vertical faces of boulders and steps in the bedrock are covered by barnacles *Semibalanus balanoides* and limpets *Patella vulgata* (BPat.Sem) with a few Australian barnacles *Elminius modestus* amongst them. This biotope covers more of the shore in areas with increased wave action, for example on Point Lynas and on the north-facing bedrock shores on Puffin Island. Lower down the shore, in the lower eulittoral and sublittoral fringe, deeply-shaded gullies and vertical faces are virtually free of algae apart from a few filamentous and foliose red algae such as *Plumaria plumosa* and *Phyllophora pseudoceranoides* (SR). Dense muddy mats formed by the tubes of the polychaete *Polydora* sp. cover the rock surfaces and the pink siphons of the piddock *Hiatella arctica* protrude from their burrows in the limestone (Ldig.Pid).

Rockpools are a common feature on all the rocky shores in Area 21. At several sites the limestone surfaces are pitted and etched, forming bowl-shaped pools with little more than green algae and copepods on the upper shore (G) and kelps and other species normally found on the lower shore and shallow subtidal on the mid- and lower shore (FK). Littorinids, particularly *Littorina littorea*, are particularly common in the pools on the upper mid-shore.

The lower shore boulders on the south end of Puffin Island and to the east of Llanddona are notable for their fauna. The latter site in particular has large amounts of dead man's fingers *Alcyonium digitatum,* sponges including *Suberites ficus*, *Halichondria panicea* and the branching sponge *Raspailia ramosa* as well as anemones *Urticina felina*, *Cereus pedunculatus*, *Metridium senile*, *Sagartia elegans* and *Sagartiogeton laceratus* living in the permanently damp spaces between the boulders. All these species are also found in higher abundance on sublittoral rock in Area 21 (a rich version of XKScrR?)

Littoral sediment

Dulas Bay is a sheltered estuarine sandflat situated downstream from a series of mines on Parys Mountain. Saltmarsh with glasswort *Salicornia* sp. and cordgrass *Spartina* sp. (Sm) fringes the upper shore and patches of boulders embedded in sand are found in the narrower part of the bay. Very few animals have been found in the sediment apart from sparse lugworm *Arenicola marina* and the amphipod *Corophium volutator* (AP.P). Species richness and abundance is fairly low although the cobbles and small boulders towards the entrance of the bay support clumps of fucoids (Asc.VS; FvesX), including *Fucus ceranoides* near the freshwater course (Fcer). This area is probably affected by high levels of heavy metals in the run-off from the disused mines.

The extensive (5 km-long) sediment flat in Red Wharf Bay grades from muddy sand in the most sheltered west; a variety of polychaetes are highly abundant in patches, but thin out as the mud fraction decreases towards the more mobile sediments in the middle of the bay, where large numbers of *Arenicola marina* are found (HedMac.Are). The most mobile and clean sand on the lower shore supports some *A. marina* with sand-eels *Ammodytes tobianus* and the large nemertean *Cerebratulus marginatus* (AP.P).

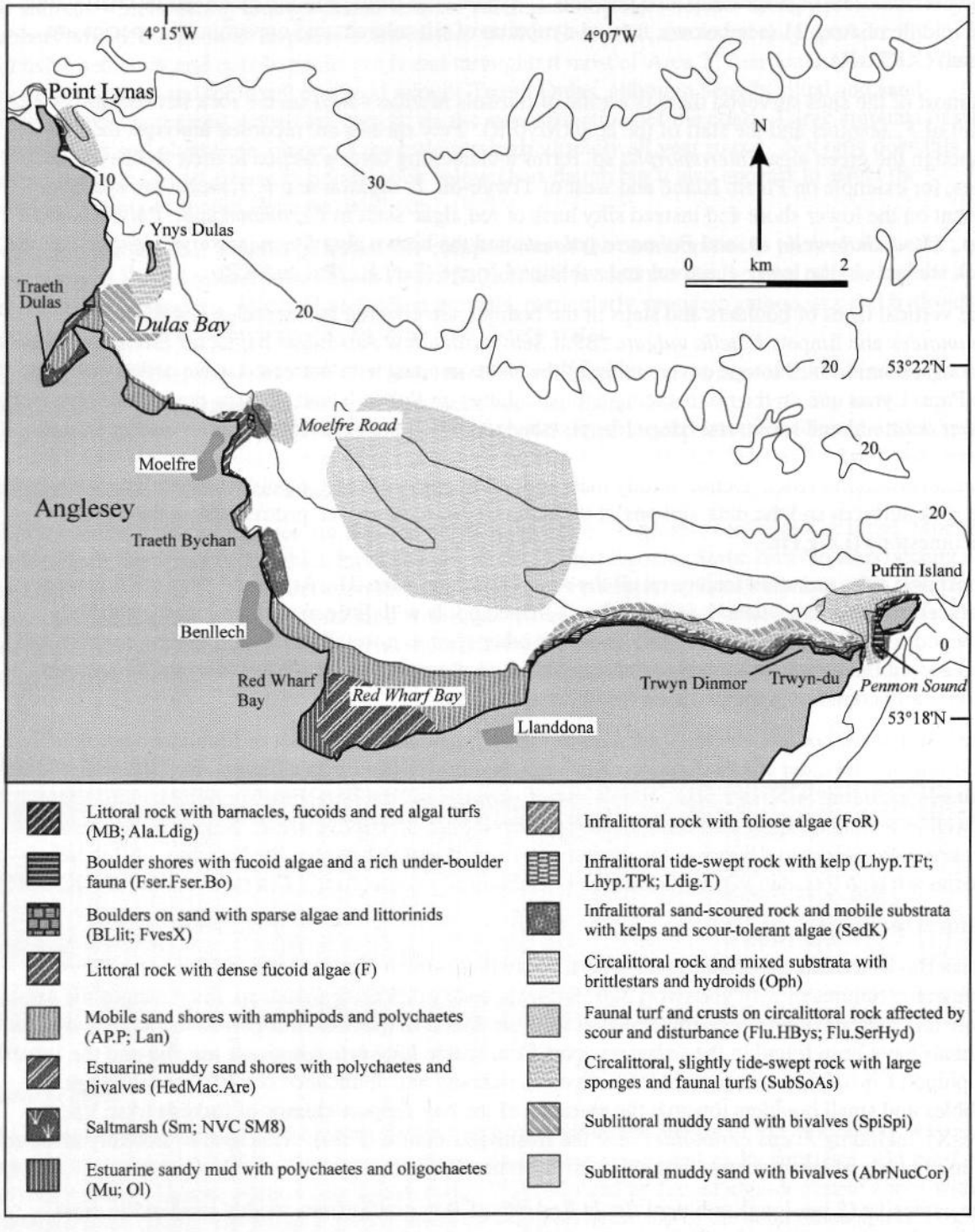

Figure 21.2 Indicative distribution of the main biotopes in the area (based on data from survey sites shown in Figure 21.1, cited literature and additional field observations).

Sublittoral

Sublittoral rock

Gradients of wave exposure, tidal stream strength and turbidity can be followed with respect to biotope composition from one end of Area 21 to the other. To the north, Point Lynas is moderately exposed to wave action and the water is relatively clear but with low overall species-richness. The kelp *Laminaria hyperborea* (Lhyp.Ft) grows to at least 3 m below chart datum. Although sparse, the kelp forests have a dense understorey turf of red algae with *Palmaria palmata* on the kelp stipes and *Delesseria sanguinea*, *Plocamium cartilagineum*, *Phycodrys rubens* and *Cryptopleura ramosa* on the underlying rock. Below the kelp the seabed slopes quickly into deeper water (> 25 m) where silt and scour-tolerant turfs of robust bryozoans (mainly *Crisia* spp. and *Alcyonidium diaphanum*), dead man's fingers *Alcyonium digitatum* and keel worms *Pomatoceros triqueter* cover the short vertical rock faces. On upward-facing surfaces with some sand, the anemone *Urticina felina*, which is known for its tolerance to sand-scour (Urt.Urt), is common and brittlestars *Ophiothrix fragilis* (Oph) are also abundant.

Further south, the tide sweeps steadily past the small island of Ynys Dulas although wave action is somewhat less than at Point Lynas. All rocky surfaces are coated in 2-3 cm of fine cohesive silt and *L. hyperborea* forest grows to only 2 m below chart datum. At the lower limit of the kelp and red algal turf and into deeper water, the bedrock is covered with large masses of several species of sponge in an unusual assemblage. The dominant species is *Suberites ficus*, which forms globular orange-brown masses occasionally over 20 cm across. Biotopes characterised by *S. ficus* (SubSoAs) have been found in other sheltered locations such as Loch Feochan on the west coast of Scotland and Milford Haven in south-west Wales (MNCR data), although in Anglesey the biotope also has characteristic species associated with moderate tidal streams (i.e. dense *Metridium senile* and *A. digitatum*). Other sponges present include *Polymastia mamillaris*, *Cliona celata, Esperiopsis fucorum*, *Dysidea fragilis* and branching sponges such as *Stelligera rigida* and *Raspailia ramosa*. *A. digitatum* and *M. senile* are particularly common along the tide-swept ridges, and a turf of the bryozoans *Electra pilosa* (erect form), *Flustra foliacea*, *Bugula* spp., *Cellaria* spp. and *Scrupocellaria* spp. and crusts of *Smittina landsborovii* cover vertical faces.

To the south of Ynys Dulas, the seabed comprises a consolidated bed of cobbles and small boulders with a matrix of gravelly sand. It would appear that this bed is rarely disturbed by wave action as most of the cobbles support an almost continuous 'reef' of calcareous keel worms *Pomatoceros lamarcki* growing perpendicularly to their surface (?Flu.SerHyd). The cobbles also support dense patches of *O. fragilis*, *A. digitatum* and a variety of nudibranchs including large *Tritonia hombergii* and *Eubranchus tricolor*, both found regularly throughout Area 21 (Oph).

Ynys Moelfre shares many habitat characteristics with Ynys Dulas, although it is more sheltered from wave action and the silt covering is thicker. The *L. hyperborea* forest has a similar understorey assemblage of red algae (Lhyp), but the kelp itself reaches a depth of just over 1 m. Below the kelp, a steep slope of limestone blocks and bedrock outcrops support a similar *Suberites*-dominated sponge community, with several other species of sponge equally as abundant. Large globular *Hymeniacidon perleve*, a very tasselled form of *E. fucorum* and massive growths of *Halichondria panicea* cover most surfaces except for the rock-sediment interface at around 8 m depth, where *U. felina* is common (SubSoAs).

Very sparse kelp grows at chart datum on the bedrock below the headlands to the east of Red Wharf Bay, for example at Carreg Onnan and further east at Trwyn-du. Instead there are dense turfs of *P. cartilagineum*, *P. rubens* and *C. ramosa* (FoR). Below this red turf, the massive-sponge community seen further north is present on slabs of limestone and the short inclined faces support *A. digitatum*. There are also large patches of rock covered in little other than the acorn worm (a phoronid) *Phoronis hippocrepia*; smaller populations of *P. hippocrepia* are often found on limestone elsewhere in Sector 10.

Puffin Island is more exposed to wave and tidal action than the sites closer to Red Wharf Bay, indicated by the greater variety of filter-feeding animals, other than sponges, found on the north-west

and east-facing sides of the island. *M. senile* and *A. digitatum* are the most abundant component of the fauna, although *H. perleve*, *C. celata* (both the rock-boring form and the massive form) and *E. fucorum* are found on the tops of the ruggedly sculptured limestone boulders at 3-10 m depth. Hydroids such as *Tubularia indivisa*, *Nemertesia antennina*, *Nemertesia ramosa*, *Abietinaria abietina* and *Hydrallmania falcata* are more common than further west, growing in tufts on upward-facing surfaces and often mixed amongst turfs of the bryozoans *F. foliacea* and *Chartella papyracea* (Flu.HByS). Fairly dense *L. hyperborea* grows at over 3 m depth, indicating that the water clarity is greater on Puffin Island than further west towards Red Wharf Bay. Large numbers of the daisy anemone *Cereus pedunculatus* are found on vertical surfaces amongst the kelp (Lhyp.TPk).

Sublittoral sediment

Relatively few sediment sites were sampled by the MNCR, although by Admiralty charts and work carried out by the Menai Bridge School of Ocean Science (I. Rees, pers. comm.), indicate that the predominant sediment type is fine sand, particularly around the sandbanks in the outer parts of Conwy Bay and Red Wharf Bay. The sandy seabed outside Dulas Bay is probably representative of shallow water sediments throughout much of Area 21. Razor shells *Ensis siliqua* and burrowing sea urchins *Echinocardium cordatum* are found in the sediment (EcorEns) and mobile scavenging species such as the swimming crab *Liocarcinus depurator*, shrimp *Crangon crangon* and the small crab *Thia scutellata* (nearing the northern limit of its known range), are present on or just below the surface. In the more sheltered parts to the west side of Red Wharf Bay, the sublittoral sediment has a higher mud fraction than the more exposed areas and supports large number of the brittlestars *Amphiura brachiata*, *Amphiura filiformis*, *E. cordatum* and the bivalve *Spisula subtruncata* (EcorEns) (I. Rees, pers. comm.).

Mixed sediment, containing fragments of shell and pebbles, often lies adjacent to the rocky habitats described above and supports large numbers of the burrowing anemone *Cerianthus lloydii*. Brittlestar beds of *Ophiothrix fragilis* (Oph) are found on similar sediments, for example on the north-west of Puffin Island. Further offshore, for example east of Moelfre and around 6 km off Red Wharf Bay, the extensive sand plains are rich in infauna and epifauna. On the surface of the sand, brittlestars *Ophiura ophiura* and *Ophiura albida* are common and small fragments of shell support small *A. digitatum* colonies, *U. felina* and the hydroid *Hydrallmania falcata*. Swimming crabs as well as hermit crabs *Pagurus bernhardus* are common and the long antennae of the sand crab *Corystes cassivelaunus* are seen protruding from the surface of the sand. *Cerianthus lloydii* and another burrowing anemone *Sagartiogeton undatus* are seen regularly and the polychaete *Lagis koreni* is particularly abundant. Numerous small depressions in the sediment surface mark the presence of *E. cordatum* and its larger relative *Spatangus purpurea*.

Nature conservation

Conservation sites

Site name	*Status*	*Location*	*Main features*
Menai Strait	pMNR	SH 5067	Marine habitats and species
Puffin Island	SSSI	SH 650 820	Botanical; ornithological; grey seals and rare spider
Fedw Fawr	SSSI	SH 606 819	Botanical; ornithological.
Tandinas Quarry	SSSI	SH 585 821	Geological.
Trwyn Dwlban	SSSI; GCR	SH 512 817	Geological.
Coed y Gell & Morfa Dulas	SSSI	SH 483 880	Coastal woodland, dune grassland and saltmarsh
Anglesey	AONB	N/A	High scenic quality
Ynys Môn	ESA	N/A	Agri-environmental scheme

Human influences

Coastal developments and uses

The main sources of income are from tourism and farming. There are several villages and small towns such as Moelfre, Benllech and Red Wharf Bay, as well as several static caravan sites which become busy during the summer. Small-scale sea defences are in place in these inhabited areas. Water sports including power-boating, jet-skiing and sailing are popular, particularly from the yacht club at Traeth Bychan. Angling is also popular, especially at Trwyn-du (Black Point) and from boats in Penmon Sound between Puffin Island and the Anglesey shore. Sightseeing boat trips around Puffin Island run from Beaumaris.

Marine developments and uses

At the time of writing, there were several sewage outfalls: at Benllech crude, secondary treated and screened sewage was discharged and at Moelfre there was a continuous flow of crude sewage. Mine waste, containing dissolved heavy metal compounds, flows from old mines in the low hills above Dulas Bay.

There are few large-scale commercial fishing operations although small-scale potting for crabs *Cancer pagurus*, lobsters *Homarus gammarus* and whelks *Buccinum undatum* and trawling for demersal species does occur.

Oil and gas are extracted from beneath the seabed offshore in Liverpool Bay to the north-east of Anglesey. Ships awaiting the Liverpool pilot or berths use the area to the east of Anglesey as an anchorage. Localised physical disturbance to the seabed will occur each time a ship anchors although the cumulative effects have not been investigated.

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Sites surveyed

Survey 129: 1982 hard substrata of the Menai Strait, littoral survey (Jones 1983).
Survey 293. 1982 Menai Strait sublittoral survey (Lumb 1983).
Survey 634. 1989-91 BIOMÔR, benthic biodiversity of the southern Irish Sea, sublittoral survey (Mackie, Oliver & Rees 1995).
Survey 646. 1997 MNCR east Anglesey littoral survey (MNCR, unpublished data).
Survey 648. 1997 MNCR east Anglesey sublittoral survey (MNCR, unpublished data).

Littoral sites

Survey	*Site*	*Place*	*Grid reference*	*Latitude/longitude*	*Biotopes present*
129	1	Puffin Island, Menai Strait.	SH 642 822	53°19.1'N 04°02.3'W	SLR
646	1	E Lynas Point, Dulas Bay.	SH 483 931	53°24.7'N 04°16.9'W	YG, BPat.Sem, MytFR, FvesB, Fspi, Asc.Asc, Ldig.Ldig, SR, Pel
646	2	Dulas Bay sands.	SH 484 886	53°22.3'N 04°16.7'W	Sm, AP.P
646	3	Dulas Bay rocky shore.	SH 485 891	53°22.6'N 04°16.6'W	Fspi, Asc.VS, FvesX
646	4	Y-Swnt, Moelfre, Red Wharf Bay.	SH 516 869	53°21.4'N 04°13.8'W	YG, Fspi, MytFR, Asc.Asc, Fser.R, Ldig.Pid, Pel
646	5	Penrhyn, near Traeth Bychan, Red Wharf Bay.	SH 520 847	53°20.2'N 04°13.3'W	YG, BPat.Sem, MytFR, Fspi, Asc.Asc, XKScrR, Pel, Fser
646	6	W Red Wharf Bay.	SH 534 810	53°18.3'N 04°12.0'W	Lan, PCer, AP.P
646	7	Mid-Red Wharf Bay.	SH 537 802	53°17.8'N 04°11.7'W	HedMac.Are
646	8	Llanddona, E Red Wharf Bay.	SH 572 812	53°18.4'N 04°08.6'W	AP.P
646	9	Llanddona Boulder shore, Red Wharf Bay.	SH 576 815	53°18.6'N 04°08.2'W	YG, BLlit, XKScrR, Fser.Fser.Bo, Pel
646	10	White Beach, Glyn-yr-Afon, Red Wharf Bay.	SH 606 820	53°18.9'N 04°05.5'W	YG, BPat.Sem, MytFR, Fspi, Asc.Asc, FK, XKScrR, Pel
646	11	W Penmon Point, N Menai Strait.	SH 638 814	53°18.7'N 04°02.6'W	YG, Ver.Ver, Pel, FvesB, Fspi, Fser.R, Ldig.Ldig, SwSed, Asc
646	12	N Puffin Island, N Menai Strait.	SH 655 825	53°19.3'N 04°01.1'W	G, Pra, MytFR, Fspi, SR, XKScrR, PelB
646	13	S Puffin Island, N Menai Strait.	SH 646 817	53°18.8'N 04°01.9'W	YG, Fspi, MytFR, Asc.Asc, Ldig.Pid, LsacChoR, Pel

Sublittoral sites

Survey	*Site*	*Place*	*Grid reference*	*Latitude/longitude*	*Biotopes present*
293	E1	Careg Onnen, Menai Straits.	SH 589 824	53°19.1'N 04°07.1'W	AlcC, FoR
293	E2	E of Careg Onnen, Menai Straits.	SH 596 823	53°19.1'N 04°06.4'W	Flu.Hocu, Flu.SerHyd, AlcC, Pol, AlcByH.Hia, Lhyp.TFt, Lcon
293	E3	Fedw Fawr, Menai Straits.	SH 605 820	53°18.9'N 04°05.6'W	Flu.Hocu, AlcC, Pol
293	E4	E of Fedw Fawr, Menai Straits.	SH 619 816	53°18.7'N 04°04.3'W	Flu.Hocu, AlcC, Pol, FoR
293	E6	Penmon Sound (1), Menai Straits.	SH 643 815	53°18.7'N 04°02.2'W	Flu.Hocu, Flu.SerHyd, AlcC, Pol
293	E7	Penmon Sound (2), Menai Straits.	SH 643 815	53°18.7'N 04°02.2'W	Urt.Urt, Flu.HByS, Flu.Hocu, AlcC, CuSH, Pol, Flu.SerHyd, Urt.Cio
293	E8	NW Puffin Island, Menai Straits.	SH 648 822	53°19.1'N 04°01.7'W	Flu.Hocu, AlcC
634	30	Red Wharf Bay, Anglesey.	SH 568 830	53°19.5'N 04°09.0'W	AbrNucCor,
648	1	E Point Lynas, Dulas Bay.	SH 483 932	53°24.8'N 04°16.9'W	Urt.Urt
648	2	E side of Ynys Dulas, Dulas Bay.	SH 505 902	53°23.2'N 04°14.8'W	SubSoAs
648	3	S of Ynys Dulas, Dulas Bay.	SH 502 898	53°23.0'N 04°15.1'W	XKScrR, Lhyp.Ft
648	4	Mid-Dulas Bay.	SH 497 889	53°22.8'N 04°15.4'W	SpiSpi
648	5	SE Ynys Dulas, Dulas Bay.	SH 508 903	53°23.3'N 04°14.6'W	Oph, Flu.SerHyd
648	6	Ynys Moelfre, Red Wharf Bay.	SH 520 867	53°21.4'N 04°13.4'W	SubSoAs, Flu.SerHyd, FoR
648	7	Moelfre Road, Red Wharf Bay.	SH 533 860	53°21.0'N 04°12.2'W	IMS
648	8	Off Red Wharf Bay.	SH 566 863	53°21.2'N 04°09.2'W	AfilEcor
648	9	Off Careg Onnen, Red Wharf Bay.	SH 590 824	53°19.1'N 04°07.0'W	SubSoAs, MytT, FoR
648	10	Trwyn Dinmor, Red Wharf Bay.	SH 627 818	53°18.9'N 04°03.6'W	SubSoAs, Lhyp.Pk, EcorEns
648	11	N end of Penmon Sound, N Menai Strait.	SH 643 817	53°18.9'N 04°02.2'W	Flu.HByS, Flu.SerHyd AbrNucCor
648	12	NW Puffin Island, N Menai Strait.	SH 652 824	53°19.3'N 04°01.4'W	Flu.HByS, Oph, Lhyp.TPk
648	13	N Puffin Island, N Menai Strait.	SH 656 825	53°19.3'N 04°01.0'W	Flu.HByS

Compiled by: Rohan H.F. Holt

22 Penmon Point to Great Ormes Head

Location		
Position (centre)	SH 69 80	53°16'.3N 4°02'.4W
County/district	Gwynedd	Arfon; Aberconwy
Conservation agency/area	Countryside Council for Wales	North Area

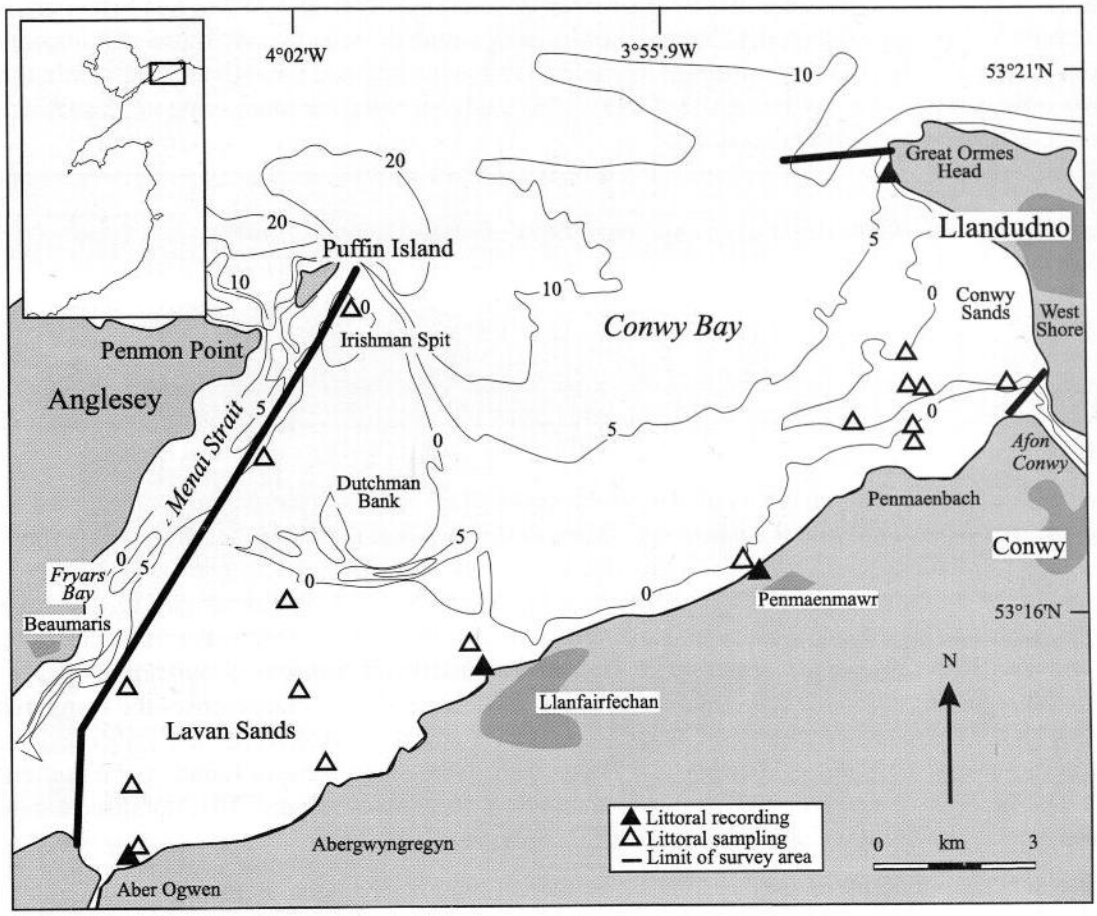

Figure 22.1 Main features of the area, showing sites surveyed.

Physical features	
Physiographic type	Embayment
Length of coast	36 km
Bathymetry	A shallow embayment to 20 m depth
Wave exposure	Moderately exposed to very sheltered
Tidal streams	Moderately strong to negligible
Tidal range	6.7 m springs; 3.8 m neaps (Conwy)
Salinity	Fully marine to variable salinity

Introduction

This report describes the large expanses of sediment at Lavan Sands (Traeth Lafan) and Conwy Sands, but due to the different nature of the sediments and rocky habitats west of the Menai Strait channel,

apart from the gap between Puffin Island and Great Ormes Head and, as a result, the sediment and rock habitats experience a variety of wave exposures. Strong tides flow over the lower shores of the sandflats and to the west of Great Ormes Head where the ebb tide is deflected by the headland. Freshwater outflow from the Conwy estuary influences the salinity, although it is unknown to what extent.

Marine biology

Several studies on dredging impact and monitoring of the cockle *Cerastoderma edule* stocks on Lavan Sands have been completed since 1974 (Allen 1995; Moore 1990; NW & N Wales Sea Fisheries Committee internal reports). A detailed monitoring programme to study the environmental impact of the construction of the A55 Conwy tunnel started in 1982 and continued through to 1992 within the Conwy estuary and in Conwy Bay (Allen 1993). This study included the monitoring of 33 subtidal sites in Conwy Bay (raw data unavailable).

Marine biological surveys

	Survey methods	*No. of sites*	*Date(s) of survey*	*Source*
Littoral	Recording (epibiota)	3	July 1997	MNCR survey 646
	Infaunal sampling (cores)	9	July 1997	MNCR survey 646
	(cores)	6	June 1989	Moore (1990)
	(cores)	40	August 1990	Moore (1990)
	(cores)	4	December 1993	Allen (1995)
Sublittoral	Infaunal sampling (Day grab)	33	1990	Allen (1993)

Littoral

A narrow band of smooth, rounded cobbles on the upper shore makes up the majority of the hard substrata from Aber Ogwen to Penmaenbach. Most of this material is washed out of the low-lying alluvial soils, but does not become dissipated due to the shelter from wave action afforded by the extensive mud and sandflats. At other sites such as Llanfairfechan and Penmaenmawr, further cobbles have been added to the upper shore as sea defences. At Aber Ogwen, the freshwater influence of the river encourages the growth of horned wrack *Fucus ceranoides* with barnacles *Semibalanus balanoides* and *Elminius modestus* (FcerX). Spiral wrack *Fucus spiralis* characterises the community at the top of the shore at Penmaenmawr, whilst the cobbles around Llanfairfechan are embedded in a dense bed of mussels *Mytilus edulis* (MytX). Dense beds of *M. edulis* are also found on the sheltered (south-east-facing) sides of the sand banks at the mouth of the Conwy estuary. This stabilised habitat also has dense populations of sand mason worms *Lanice conchilega*.

The littoral sediment plains of Conwy Sands give way to steep rocky outcrops around Great Ormes Head (*area summary* 23), with a substratum of mixed cobbles and boulders on the west side of the headland. Large friable boulders at the top of the shore are sparsely colonised by yellow and grey lichens (YG), black lichens *Verrucaria maura* (Ver.Ver), channelled wrack *Pelvetia canaliculata* (Pel) and *F. spiralis* (Fspi). Partly-mobile cobbles and boulders covered with *S. balanoides* comprise most of the mid-shore (BLlit and BPat.Sem), with more consolidated, larger boulders on the lower shore supporting dense beds of *M. edulis* (MytX). The soft limestone mid- and lower shore boulders are pitted by the piddock *Hiatella arctica*. Dense kelp *Laminaria digitata* colonises the tops of boulders in the sublittoral fringe where dense sponges *Halichondria panicea* and *Esperiopsis fucorum*, keel worms *Pomatoceros triqueter* and ascidians *Botryllus schlosseri* are found on their steep and overhanging sides (Ldig.Ldig.Bo and SByAs).

A band of firm muddy sand (>10% mud) fringes the upper shore at Lavan Sands. This sediment is more stable than the remainder of the sandflat and supports dense populations of ragworm *Hediste diversicolor*, oligochaetes *Heterochaeta costata* and *Tubificoides* spp. and the peppery furrow shell *Scrobicularia plana* (HedScr). Between Aber Ogwen and Llanfairfechan, cordgrass *Spartina* sp.-dominated saltmarsh encroaches onto the upper shore, forming a transition zone of firm mud (Sm).

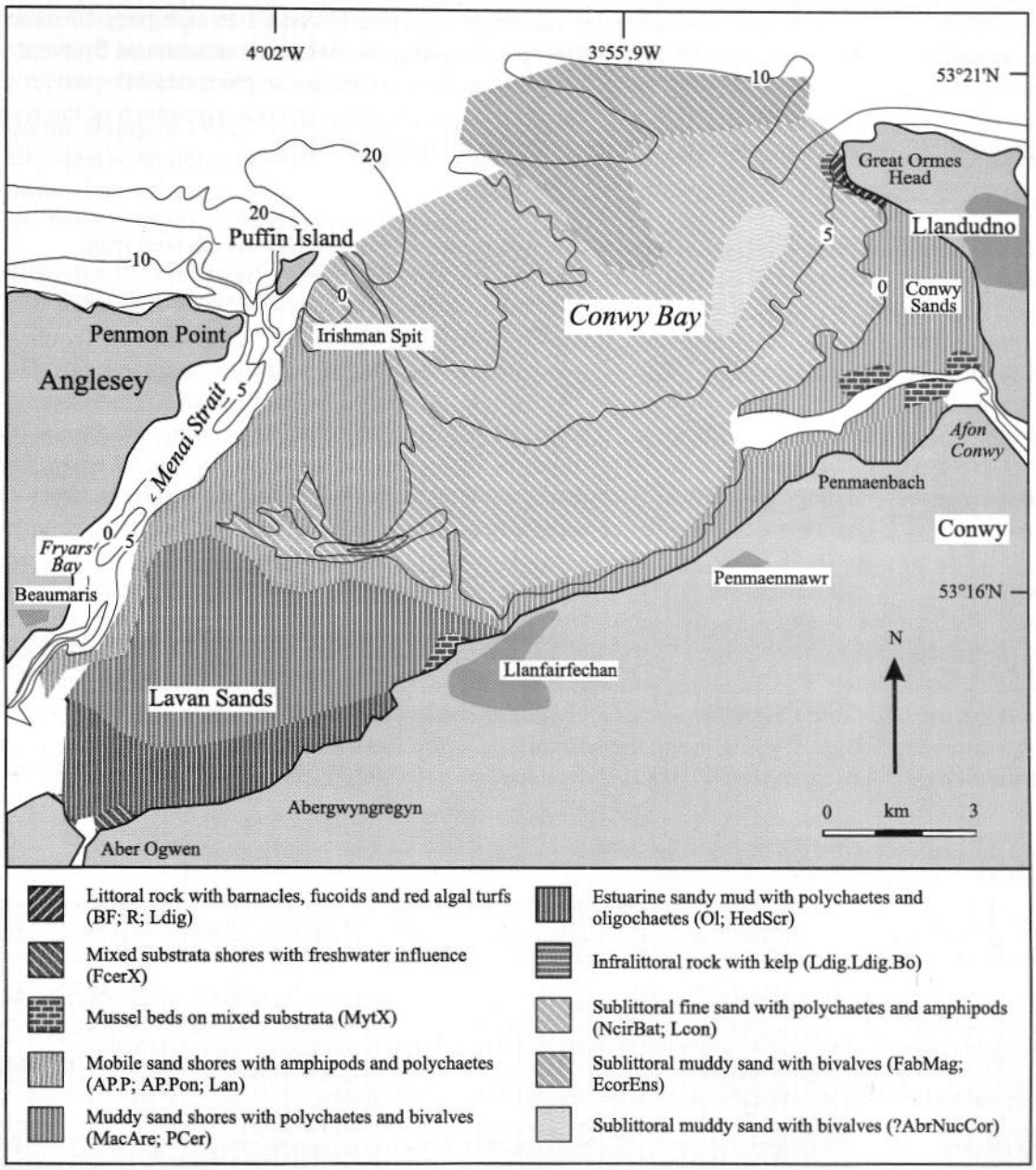

Figure 22.2 Indicative distribution of the main biotopes in the area (based on data from survey sites shown in Figure 22.1, cited literature and additional field observations).

The large, level, central area of Lavan Sands has patchy and variable proportions of silt, producing an ever-changing mosaic of communities. The muddiest habitat is characterised by the polychaetes *H. diversicolor* and *Pygospio elegans* and the tellin *Macoma balthica* (HedMac). Where the mud fraction is less (approximately < 5%), the polychaetes *Arenicola marina* and *Scoloplos armiger* (MacAre) and/or the cockle *Cerastoderma edule* (PCer) may also characterise the community. The tidal streams are accelerated along the seaward edge of the sandflats and through lower shore drainage channels where there is increased density of *L. conchilega* (Lan). A bed of *Zostera marina* was described from Lavan Sands (SSSI citation), but it is unclear whether this still exists. On the banks of the Menai Strait's low water channel, on Dutchman Bank and between Llanfairfechan and the west

shore of Great Ormes Head, the sand has little or no silt present and the community is characterised by polychaetes *Nephtys cirrosa*, *Aricidea minuta* and *Magelona mirabilis* and the amphipods *Urothoe brevicornis* and *Bathyporeia* spp. (AP.P). At more wave-exposed sites, such as Irishman Spit and adjacent to the Afon Conwy channel, the community is characterised by amphipods *Bathyporeia pelagica* and *Bathyporeia sarsi* (AP.Pon). This community probably extends over much of the wave exposed, north-facing, sandy habitats of Conwy Bay and Dutchman Bank.

Sublittoral

All information for the sublittoral habitats and communities of Conwy Bay are derived from descriptions and maps in Allen (1995), who repeated the survey of Conwy Bay over six consecutive years. The seabed of Conwy Bay consists entirely of well-sorted sand with varying degrees of mud. The west-flowing tidal streams that are deflected and accelerated across the north of Great Ormes Head maintain a strip of relatively clean well-sorted sand. In 1990, the infaunal community of this clean sand was characterised by polychaetes *Nephtys cirrosa* and *Scolelepis bonnieri*, amphipods *Bathyporeia guilliamsoniana* and robust bivalves *Dosinia lupinus*, *Chamelea gallina* and *Donax vittatus* (NcirBat). In previous years, the polychaetes *Scoloplos armiger* and *Chaetozone setosa* were dominant in these habitats, possibly as a result of a small amount of silting of the sediment. In contrast, the sediment on the south side of Great Ormes Head appears to be an area of deposition and is consistently muddier (> 10% silt) than the rest of Conwy Bay (Allen 1995). Over the five years of study, the species that have dominated the infauna in different years include the polychaetes *Lagis koreni* and *Nephtys hombergii* and bivalves *Abra alba* and *Spisula subtruncata* (?AbrNucCor). The central and western parts of Conwy Bay comprise muddy sand with between approximately 1% and 3% mud composition. The infaunal community here is dominated by the polychaetes *S. armiger*, *Magelona mirabilis* and *Chaetozone setosa*, bivalves *Fabulina fabula* and *Ensis* sp. and brittlestars *Ophiura* sp. (FabMag). Close inshore, the sand mason worm *Lanice conchilega* forms dense carpets of tubes where tidal streams are accelerated over shallow sand-bars (Lcon).

Nature conservation

Conservation sites

Site name	*Status*	*Location*	*Main features*
Traeth Lafan (Lavan Sands), Conway Bay	SPA; SSSI; LNR	SH 630 750	Varied intertidal habitats, invertebrate infauna and ornithology.
Great Ormes Head	pSAC; SSSI; GCR; LNR	SH 767 833	Geological; botanical; entomological; ornithological
Conwy Nature Reserve	RSPB	SH 799 771	Ornithological
Great Orme	CP	SH 767 834	Informal recreation
Great Orme	HC	SH 768 823 - SH 783832	Coastal scenery
Snowdonia	NP	N/A	(Part of coast at Penmaenbach)

Human influences

Coastal and marine developments and uses

Area 22 is used for recreational purposes such as sailing, water-skiing, walking, bird watching and wildfowling. Lavan Sands has two nature reserves with bird hides overlooking the saltmarsh and mudflats; an area is used for wildfowling.

Shellfish collecting is an important activity. The mussel *Mytilus edulis* banks at the entrance to the Conwy estuary are maintained and harvested commercially, being seeded regularly with spat. Lavan Sands is a designated shellfish water for the collection of cockles *Cerastoderma edule*. Harvesting is controlled by the North Wales and North Western Sea Fisheries Committee. Hand-collecting normally yields about 50-100 tonnes per year (J. Andrews, pers. comm.). However, suction dredging at high tide took place in four years between 1989 and 1996, resulting in cockle landings as high as 1038 t in 1993.

In 1996 Lavan Sands were experimentally zoned into hand-collecting only areas and an area where hydraulic dredging was permitted. The latter method leaves swathes of disturbed sediment, and environmental impact assessments were undertaken by Moore (1990) and Allen (1995). Suction-dredging has not been permitted in any year since 1996.

Prior to the laying of a crude oil pipeline across Lavan Sands from Abergwyngregyn to Fryars Bay, near Beaumaris, an impact assessment study was completed by Eagle *et al.* (1974). Uneven erosion of the surrounding sediment in the vicinity of the pipeline has made it necessary to lay netting over the pipeline to encourage the deposition of sediments.

Sea defence walls protect the A55 expressway and the coastal towns of Llandudno (west shore), Penmaenmawr and Llanfairfechan from erosion. Sea defences consist mainly of mounds of rough boulders strategically positioned to deflect wave action, or to reinforce existing concrete walls.

Allen (1993) studied the impact on the habitats and communities of Conwy Bay of the construction of the A55 expressway tunnel under the Conwy estuary. The main issue in Conwy Bay was the introduction of large amounts of silt from work in the estuary and dumping of spoil material north of Puffin Island and north of Anglesey. During dredging between 1985 and 1991, there were noticeably higher levels of silt adjacent to the estuary mouth on the lower shores. The loss of mussel *M. edulis* condition during this period was thought to be associated with the increased silt levels, but correlation with changes in infaunal communities was not possible.

At the time of writing, there were numerous small raw sewage outfalls into the Conwy estuary and along the north-facing coast of Conwy Bay. Larger outfalls at Llandudno (west shore) and Llanfairfechan discharge treated sewage.

References and further reading

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Eagle, R.A., Hartley, J.P., Rees, E.I.S., Rees, L.J., & Walker, A.J.M. 1974. *Ecological survey of the Lavan Sands: invertebrate macrofauna.* (Contractor: University College of North Wales, Marine Science Laboratories, Menai Bridge.). Unpublished report to Nature Conservancy Council. (Benthos research report, No. 74-3.)

Moore, J. 1990. Experimental studies of the impact of hydraulic cockle dredging on intertidal sediment flat communities. (Contractor: Field Studies Council Research Centre, Pembroke.) *Nature Conservancy Council, CSD Report,* No. 1121. (FSC Report, No. FSC/RC/2/90.)

Sites surveyed

Survey 291. 1989 hydraulic cockle dredging experiments on intertidal sediment flat communities. Lavan Sands study. (Moore 1990).

Survey 292. 1990 hydraulic cockle dredging experiments on intertidal sediment flat communities. Lavan Sands study. (Moore 1990).

Survey 646. 1997 MNCR east Anglesey littoral survey (MNCR, unpublished data).

Survey 693. 1993/4 assessment of the impact of hydraulic cockle dredging on the macroinvertebrate faunas of Traeth Lafan. (Allen 1995).

Littoral sites

Survey	*Site*	*Place*	*Grid reference*	*Latitude/longitude*	*Biotopes present*
291	C1	Control site 1, Lavan Sands.	SH 620 740	53°14.6'N 04°04.1'W	MacAre, PCer
291	D1	Dredge site 1, Lavan Sands.	SH 620 740	53°14.6'N 04°04.1'W	MacAre, PCer
292	1	Control area, stations 1-12, Lavan Sands.	SH 620 740	53°14.6'N 04°04.1'W	AP.P, MacAre, PCer, HedMac
292	67	Control area, stations 67-70, 74-77, Lavan Sands.	SH 620 740	53°14.6'N 04°04.1'W	AP.P, MacAre, PCer, HedMac, BatCor
646	15	Irishman Spit, N Menai Strait.	SH 652 816	53°18.8'N 04°01.4'W	AP.Pon
646	16	W Dutchman Bank, N Menai Strait.	SH 632 803	53°18.1'N 04°03.1'W	AP.P
646	17	Aber Ogwen, N Menai Strait.	SH 614 740	53°14.6'N 04°04.6'W	HedScr, FcerX, AP.P
646	18	S Lavan Sands, N Menai Strait.	SH 642 742	53°14.8'N 04°02.1'W	PCer, HedScr
646	19	NW of Llanfairfechan, N Menai Strait.	SH 674 757	53°15.6'N 03°59.2'W	MacAre, MytX, AP.P
646	20	Penmaenmawr, Conwy Bay.	SH 717 767	53°16.2'N 03°55.4'W	Lan, Fspi, AP.P
646	21	Penmaenbach, Conwy Bay.	SH 753 792	53°17.6'N 03°52.2'W	AP.P, AP.Pon
646	22	W Conwy Sands, Conwy Bay.	SH 745 793	53°17.7'N 03°52.9'W	AP.P
646	23	Conwy Sands, Conwy Bay.	SH 762 803	53°18.2'N 03°51.4'W	MytX, AP.P
646	24	W Great Ormes Head, Llandudno.	SH 750 835	53°20.0'N 03°52.6'W	BPat.Sem, YG, BLlit, Ver.Ver, Fspi, MytX, SByAs, EntPor, Pel, Ldig.Ldig.Bo
693	1	1 Lavan Sands.	SH 623 740	53°14.7'N 04°03.8'W	MacAre
693	2	2 Lavan Sands.	SH 633 743	53°14.9'N 04°02.8'W	PCer, Lan
693	3	3 Lavan Sands.	SH 643 749	53°15.2'N 04°02.0'W	Lan
693	4	4 Lavan Sands.	SH 651 753	53°15.4'N 04°01.2'W	Lan

Compiled by: Paul Brazier

23 Great Ormes Head to Rhôs Point

Location		
Position (centre)	SH 810 824	53°19'.7N 4°47'.3W
County/district	Gwynedd	Aberconwy
Conservation agency/area	Countryside Council for Wales	North-east Area

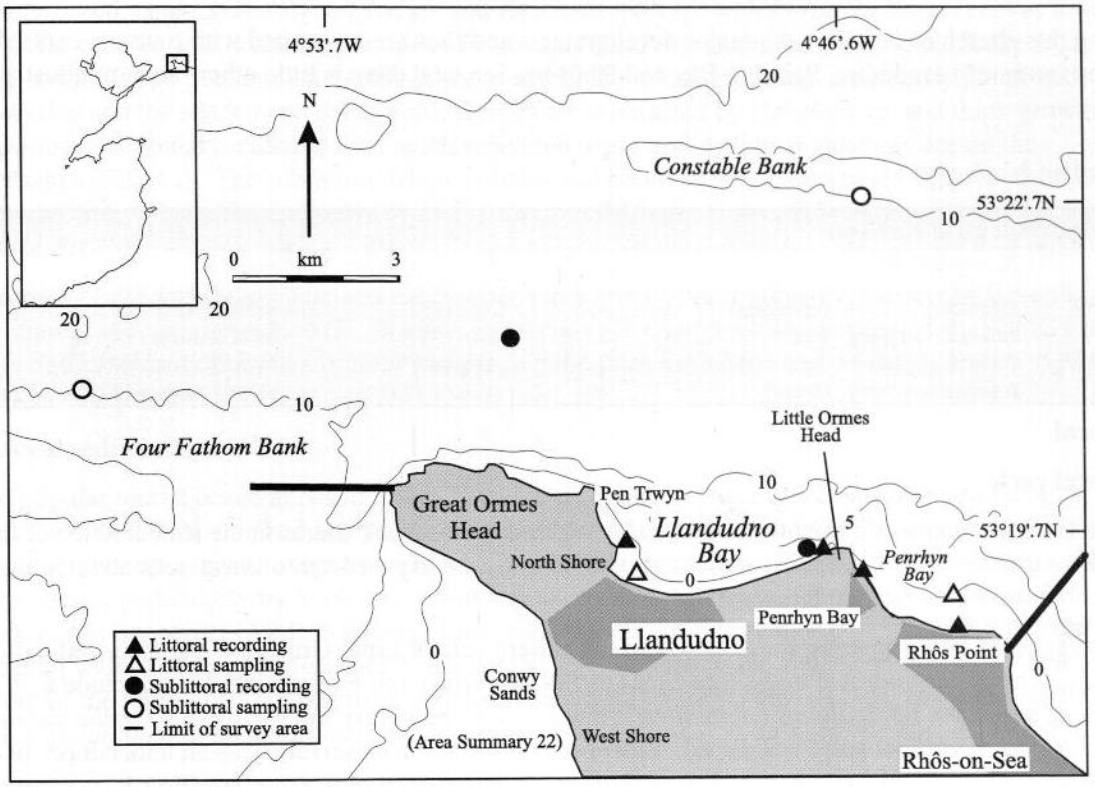

Figure 23.1 Main features of the area, showing sites surveyed.

Physical features	
Physiographic type	Linear open coast
Length of coast	12 km
Bathymetry	20 m isobath within 9 km
Wave exposure	Moderately exposed (sheltered cave)
Tidal streams	Moderately strong to negligible
Tidal range	5.2 m spring tides; 3.5 m neap tides
Salinity	Fully marine

Introduction

The coastline between Great Ormes Head and Rhôs Point, at the north-eastern limit of MNCR Sector 10, includes the sandy bays of Llandudno and Penrhyn and the two Carboniferous limestone headlands of Great Orme and Little Orme (collectively known as the Ormes). Great Ormes Head is connected to the coast by a low-lying isthmus forming the peninsula which divides Conwy Bay to the west (*area summary* 22) from Llandudno Bay, Little Orme and Penrhyn Bay to the east. The main part

of the headland has a mainly northerly aspect and is moderately exposed to wave action, whereas the embayments on the east of the isthmus are more sheltered. Moderately strong tidal streams are experienced inshore, particularly around the headlands. The seabed is predominantly shallow throughout Area 23, rarely reaching more than 15 m depth and rising to 7 m on Four Fathom Bank to the west and 5 m on Constable Bank to the north-east.

The majority of the coastline is soft limestone which is prone to erosion by a combination of wave action which sculpture the rock into gullies and sea caves, and rock-boring animals. The Ormes have very narrow steep bedrock and boulder shores below the cliffs but the intertidal zone is far broader on the isthmus (between 200 and 300 m wide) and comprises boulders, cobbles and sand. Much of the coastline adjacent to towns has sea walls, groynes and onshore coastal defences.

Along this stretch of coastline the major developments and uses are associated with tourism, centred on the towns of Llandudno, Penrhyn Bay and Rhôs-on-Sea, and there is little other modern industry.

Marine biology

Marine biological surveys

	Survey methods		*No. of sites*	*Date(s) of survey*	*Source*
Littoral	Recording	(epibiota)	4	July 1997	MNCR survey 646
	Infaunal sampling	(cores)	2	July 1997	MNCR survey 646
Sublittoral	Recording	(epibiota)	2	August 1997	MNCR survey 648
	Infaunal sampling	(cores)	2	August 1997	MNCR survey 648

Littoral

Littoral rock

The coastline comprises a mixture of dense algal-dominated bedrock shores in the sheltered lee of the Ormes, barnacle-dominated steep bedrock shores on the more exposed tips of headlands and boulder and cobble shores at Llandudno and Penrhyn Bay.

Steep sheltered bedrock areas, for example on the eastern side of Little Orme, are characterised by fucoids. The upper-mid- and mid-shore zones of *Fucus spiralis* and *Fucus vesiculosus* include a matrix of barnacles *Semibalanus balanoides*, a few *Elminius modestus* and gastropods *Patella vulgata* and *Littorina saxatilis* (Fspi; Fves; BPat). Lower on the shore *Fucus serratus* has an understorey of red algae, such as *Chondrus crispus*, *Palmaria palmata* and *Membranoptera alata* (Fser.R). Narrow damp ledges which hold small rockpools support patches of green algae *Enteromorpha* sp. and pink coralline algae including *Corallina officinalis* (Cor). The sublittoral fringe consists of a narrow zone of kelp *Laminaria digitata* and a variety of sponges such as *Grantia compressa* and *Halichondria panicea* and red algae including *C. crispus*, *M. alata* and *Polysiphonia* spp. The bedrock is heavily pitted by the piddocks *Hiatella arctica* and rock-boring sponge *Cliona celata* and supports dense mats formed by the short muddy tubes of the polychaete *Polydora* sp. (Ldig.Pid).

On the moderately wave-exposed tips of the headlands near-vertical bedrock shores are dominated by barnacles and limpets *Patella* spp., characteristic of this wave exposure. Dense patches of mussels *Mytilus edulis* have also been found in this area (Taylor & Parker 1993).

The coastline around the Ormes is indented with small caves, some extending deep into the rock. One cave was surveyed on the west of Little Ormes Head; it is likely that others in this area have similar characteristics. The cave is approximately 30 m long with a narrow entrance and a much hollowed out central section. At the back of the cave scour action, from the well-rounded boulders on the cave floor, keep the lower part of the cave walls free of encrusting species although higher up and across the ceiling the rock surface is encrusted by dense *S. balanoides*, scattered crustose and non-crustose bryozoans such as *Alcyonidium diaphanum*, spirorbid worms and patches of *M. edulis* (Ov).

The species characterising the mid-shore boulders and cobbles at Penrhyn Bay and at either end of the sand beach in Llandudno Bay are typical of moderately exposed to sheltered boulder shores influenced by sand. On the upper shore *F. spiralis* and *Enteromorpha* sp. support winkles *Littorina* spp. (Fspi),

interspersed with a dense *M. edulis* bed, the shells of the mussels being covered in *S. balanoides* (MytX). Large numbers of *Littorina littorea* and dogwhelk *Nucella lapillus* are present amongst the mussels. Below this, on the lower shore at Penrhyn Bay, is a 50 m stretch of thixotropic rippled, fine sand dominated by polychaetes including lugworm *Arenicola marina*, *Nephtys* spp., *Spio martinensis* and *Magelona mirabilis* and amphipods such as *Bathyporeia guilliamsoniana* (AP.P). The sublittoral fringe community on small boulders is characterised by abundant kelp *Laminaria saccharina* covered with sea mat *Electra pilosa* and with an understorey of red algae such as *Ceramium* sp. and *Cystoclonium purpureum* (XKScrR). Underboulder habitats are covered with sponge *H. panicea* and bryozoan crusts. Patches of sand from the mid-eulittoral to the sublittoral fringe are characterised by the sand mason worm *Lanice conchilega*. At the north-east end of Llandudno Bay, below the *M. edulis* bed, dense green algae *Ulva* sp. and *Enteromorpha* sp. with *Porphyra linearis* cover lower eulittoral cobbles with scattered clumps of *F. serratus* (EntPor), characteristic of disturbance from sand-scour. Large boulders on the lower shore and in the sublittoral fringe are heavily pitted with *H. arctica* and the shaded and damp vertical faces are dominated by *Polydora* sp. and thick growths of *H. perleve*. Colonial ascidians, such as *Morchellium argus* and *Aplidium punctum*, are on the overhangs (SByAs). The sublittoral fringe cobbles and boulders are characterised by *L. digitata* with an understorey of silted red algae such as *C. crispus* and *Mastocarpus stellatus* covered in *E. pilosa* (Ldig.Ldig.Bo).

Outcrops of piddock-bored peat and ancient tree roots low on the shore in the vicinity of East Shore, Llandudno have been reported (K. Hiscock, pers. com.; N. Campbell Bannerman, pers. com.). These were not re-located during the present surveys, but the trees have been carbon-dated to at least 7000 years before present.

Littoral sediment

The popular tourist beach at North Shore, Llandudno, is the only extensive sand shore in Area 23. The beach is 100-300 m wide and approximately 3 km long with groynes most of the way along it. The beach is moderately wave exposed and comprises rippled fine sand. The mid-shore is dominated by polychaetes, particularly by *Scolelepis squamata* and amphipods such as *Bathyporeia* spp. and *Pontocrates arenarius* (AP.P; AP.Pon). Lower shore medium-fine sand is covered with a layer of standing water and has a sub-surface black anoxic layer indicating the water-retaining and stable nature of the sediment. The sediment contains polychaetes *Nephtys cirrosa*, *Magelona mirabilis*, *Spio* spp. and *Spiophanes bombyx* with amphipods *Pontocrates* spp. and *Bathyporeia elegans* (AP.P).

Sublittoral

Sublittoral rock

Bedrock outcrops on the seabed are confined to the areas adjacent to the rocky shores below the cliffs. Only very sparse kelp *Laminaria hyperborea* grows in the narrow infralittoral zone, reaching no more than 1-2 m depth because of the consistently high turbidity.

The northern point of Great Ormes Head was not surveyed, but is swept by moderately strong tides which probably encourages a variety of filter-feeding animals such as those found around Puffin Island, north-east Anglesey (*area summary* 21) (?Flu.HByS).

As previously described, there are sea caves in the steep cliffs of the Ormes. The sublittoral section of the sea cave surveyed on Little Ormes Head comprises vertical limestone walls to 3 m depth, densely covered with the rock-boring polychaete *Polydora* sp. and the piddock *Hiatella arctica*. Amongst these rock-boring animals are abundant anemones *Sagartia elegans*, dense patches of *Mytilus edulis* and the ascidian *Polycarpa scuba*. A variety of sponges are also attached to the walls such as *Halichondria panicea*, *Dysidea fragilis* and *Hymeniacidon perleve* (Pol and ?AlcByH.Hia).

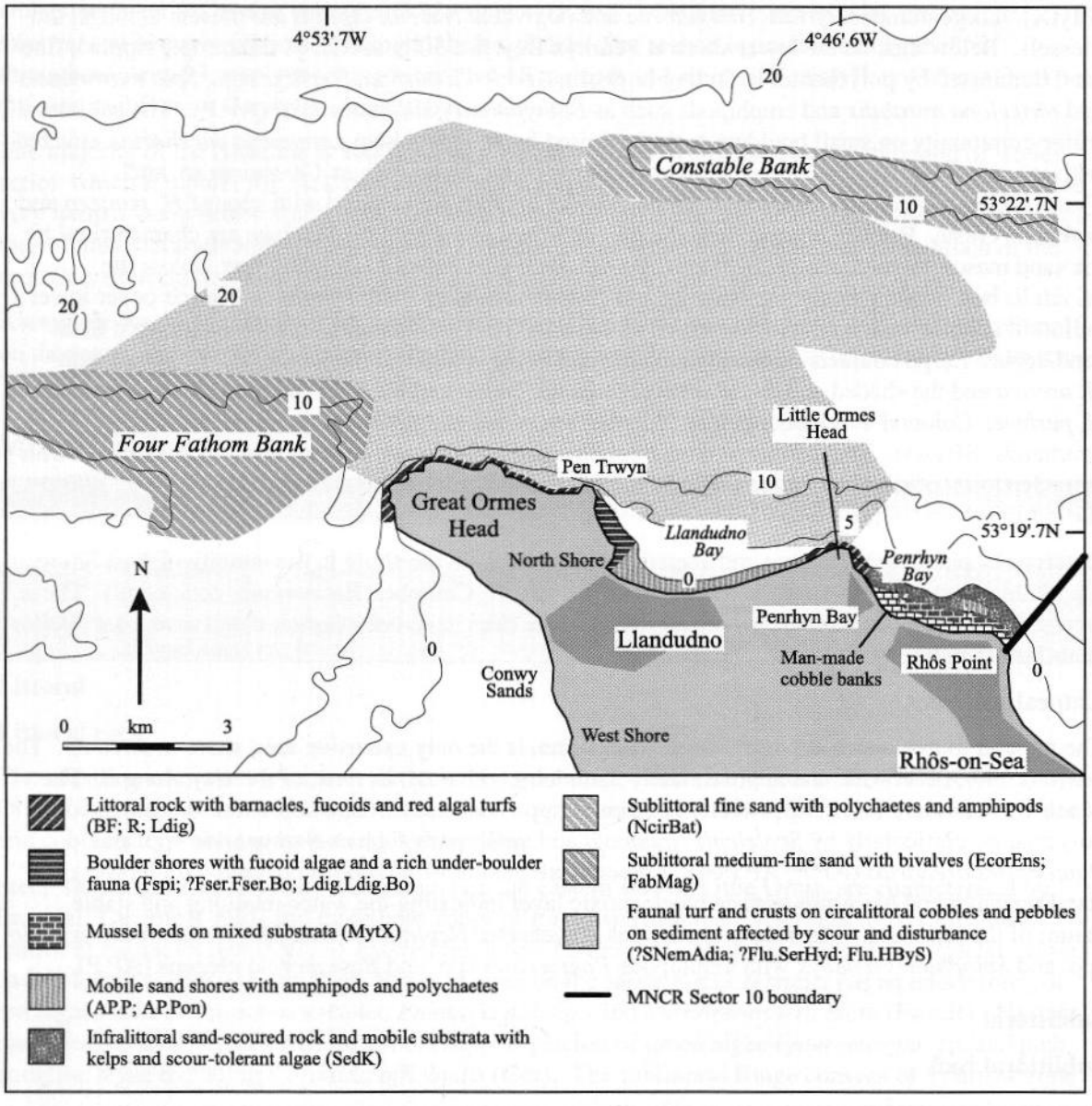

Figure 23.2 Indicative distribution of the main biotopes in the area (based on data from survey sites shown in Figure 23.1, cited literature and additional field observations).

Amongst the offshore sediment plains are areas of sand, shingle and cobbles. One such area lies 3 km north-east of Great Ormes Head at 12 m depth, where the seabed consists of a level plain of consolidated cobbles, pebbles and muddy sand. The rocks are dominated by dead man's fingers *Alcyonium digitatum* and hydroids such as *Abietinaria abietina*, *Nemertesia antennina* and *Hydrallmania falcata*. Urchins *Psammechinus miliaris* are hidden in rock crevices (Flu.HByS). The muddy sand is dominated by the anemone *Cerianthus lloydii* and polychaetes *Chaetopterus variopedatus* and *Lanice conchilega*.

Sublittoral sediment

According to Admiralty charts, offshore to the edge of the survey area (6 km north and 5 km west of Great Ormes Head), the seabed consists mainly of sediment with patches of sandy gravel and cobbles.

Offshore sediment comprises mobile sand from 15 m depth, rising up to 7 m and 5 m on Four Fathom Bank and Constable Bank respectively. Four Fathom Bank, 2 km north-west of Great Ormes Head, comprises rippled medium fine sand with epifauna such as juvenile flatfish and starfish *Asterias rubens*. The infaunal species are dominated by the polychaete *Nephtys cirrosa*, razor shell *Ensis siliquosa* and sea potato *Echinocardium cordatum* (EcorEns). Four Fathom Bank is subject to occasional disturbance during winter storms which influences the communities and causes them to fluctuate from year to year (Allen 1990). Constable Bank, 6 km north of Little Ormes Head, consists of fine mobile sand characterised by *Nephtys cirrosa*, mysids *Gastrosaccus sanctus* and amphipods *Bathyporeia* spp. *L. conchilega* tubes are also present (NcirBat).

Nature conservation

Conservation sites

Site name	*Status*	*Location*	*Main features*
Great Ormes Head	pSAC; SSSI; GCR; LNR	SH 767 833	Geological; botanical; entomological; ornithological
Great Orme	CP	SH 767 834	Informal recreation
Great Orme	HC	SH 768 823 - SH 783832	Coastal scenery
Little Ormes Head	SSSI, GCR	SH 814 826	Botanical; ornithological
Gogarth, Great Orme	CWT	SH 760 832	Botanical; entomological
Rhiwledyn, Little Orme	CWT	SH 813 821	Botanical; ornithological; entomological

Human influences

Coastal and marine developments and uses

This stretch of coastline is backed both by grazing land, which is mostly on the Ormes, and the towns of Llandudno, Penrhyn Bay and Rhôs-on-Sea. These towns have a combined population of approximately 11,100 (1991 census) and, with their adjoining sandy beaches, have been established as seaside holiday resorts since the Victorian era. There is a slipway in Llandudno and at Colwyn Bay Sailing Club, and mooring facilities and a slipway at Rhôs-on-Sea. Rhôs-on-Sea is also a base for local charter boats and commercial fishing boats. Water sports such as sailing, water-skiing, jet-skiing, SCUBA-diving, bathing and sea angling are very popular, particularly around the slipways at Llandudno and Rhôs-on-Sea. Walking and birdwatching are popular on the Ormes.

Both Llandudno beach and the stretch of beach north of Rhôs Point to east of Colwyn Bay are identified by the DoE/Welsh Office as falling within the terms of the EC Bathing Waters Directive (76/160/EEC). However bathing waters failed to comply with the Directive in some recent years due to an increase in residential development in the area and inadequate sewage facilities. In 1993 Llandudno North Shore passed but Llandudno West Shore and Colwyn Bay both failed the EC Directive's standards.

Large stretches of the upper shore have been reinforced with boulders and concrete sea-walls. Groynes have been built at Llandudno and onshore coastal defences constructed at Penrhyn Bay.

On Great Orme, mining of metals including copper, lead and iron was an important industry in the past, with evidence of copper mining since pre-Roman times. There were formerly a few small limestone quarries operating on Great Orme and one on Little Orme but they are now disused. Two limestone quarries still operate to the east near Colwyn Bay in MNCR Sector 11.

References and further reading

Allen, P.L. 1990. *A55 north Wales Conwy tunnel scheme biological monitoring study, Annual report 1990.* (Contractor: University of Wales, School of Ocean Sciences, Menai Bridge.). Unpublished report to Welsh Office, Water and Environment Protection Division.

National Rivers Authority, Welsh Region, 1995. *Clwyd Catchment Management Plan Consultation, May 1997*

Taylor, P.M., & Elliott, R., *eds*. 1993. *The coast of north Wales & north-west England - an environmental appraisal*. Aberdeen, Hamilton Oil Company Ltd.

Sites surveyed

Survey 646. 1997 MNCR east Anglesey littoral survey (MNCR, unpublished data).
Survey 648. 1997 MNCR east Anglesey sublittoral survey (MNCR, unpublished data).

Littoral sites

Survey	*Site*	*Place*	*Grid reference*	*Latitude/longitude*	*Biotopes present*
646	25	N Llandudno Pier	SH 783 831	53°19.8'N 03°49.6'W	Fspi, MytX, EntPor Ldig.Ldig.Bo, SByAs
646	26	W Llandudno Bay	SH 783 825	53°19.5'N 03°49.6'W	AP.P, AP.Pon
646	27	E Little Orme, Llandudno	SH 819 825	53°19.5'N 03°46.4'W	BPat, Fspi, Cor, Ldig.Pid, Fser.R
646	28	Rhôs Point, Llandudno	SH 838 815	53°19.0'N 03°44.6'W	XKScrR, Fspi, AP.P, MytX
646	29	W Little Orme, Llandudno	SH 816 827	53°19.7'N 03°46.6'W	CC.BalPom, Cv

Sublittoral sites

Survey	*Site*	*Place*	*Grid reference*	*Latitude/longitude*	*Biotopes present*
648	14	Four Fathom Bank, Conwy Bay	SH 700 852	53°20.8'N 03°57.1'W	EcorEns
648	15	SW of Constable Bank, Llandudno	SH 767 868	53°21.8'N 03°51.1'W	Flu.HByS
648	16	Constable Bank, Llandudno	SH 818 883	53°22.7'N 03°46.6'W	NcirBat
648	17	W Little Orme, Llandudno	SH 816 827	53°19.7'N 03°46.6'W	Pol, AlcByH.Hia

Compiled by: Dora Nichols

Appendix A Biotopes classification

A hierarchical classification of the biotopes present in Sector 10 (using the data listed in Table 1), shown together with their higher types, is given below. The biotopes listed are derived from the MNCR national biotope classification (Connor *et al.* 1997a, b).

Higher code	*Biotope code*	*Biotope*
LR		**LITTORAL ROCK (and other hard substrata)**
LR.L		**Lichens or algal crusts**
LR.L	YG	Yellow and grey lichens on supralittoral rock
LR.L	Pra	*Prasiola stipitata* on nitrate-enriched supralittoral or littoral fringe rock
LR.L	Ver	*Verrucaria maura* on littoral fringe rock
LR.L	Ver.Por	*Verrucaria maura* and *Porphyra umbilicalis* on very exposed littoral fringe rock
LR.L	Ver.B	*Verrucaria maura* and sparse barnacles on exposed littoral fringe rock
LR.L	Ver.Ver	*Verrucaria maura* on moderately exposed to very sheltered upper littoral fringe rock
LR.L	Bli	*Blidingia* spp. on vertical littoral fringe soft rock
ELR		**Exposed littoral rock (mussel/barnacle shores)**
ELR.MB		***Mytilus* (mussels) and barnacles**
ELR.MB	MytB	*Mytilus edulis* and barnacles on very exposed eulittoral rock
ELR.MB	BPat	Barnacles and *Patella* spp. on exposed or moderately exposed, or vertical sheltered, eulittoral rock
ELR.MB	BPat.Cht	*Chthamalus* spp. on exposed upper eulittoral rock
ELR.MB	BPat.Cat	*Catenella caespitosa* on overhanging, or shaded vertical, upper eulittoral rock
ELR.MB	BPat.FvesI	Barnacles, *Patella* spp. and *Fucus vesiculosus* f. *linearis* on exposed eulittoral rock
ELR.MB	BPat.Sem	*Semibalanus balanoides* on exposed or moderately exposed, or vertical sheltered, eulittoral rock
ELR.FR		**Robust fucoids or red seaweeds**
ELR.FR	Coff	*Corallina officinalis* on very exposed lower eulittoral rock
ELR.FR	Him	*Himanthalia elongata* and red seaweeds on exposed lower eulittoral rock
MLR		**Moderately exposed littoral rock (barnacle/fucoid shores)**
MLR.BF		**Barnacles and fucoids (moderately exposed shores)**

Higher code	*Biotope code*	*Biotope*
MLR.BF	PelB	*Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock
MLR.BF	FvesB	*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid-eulittoral rock
MLR.BF	Fser	*Fucus serratus* on moderately exposed lower eulittoral rock
MLR.BF	Fser.R	*Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock
MLR.BF	Fser.Fser	Dense *Fucus serratus* on moderately exposed to very sheltered lower eulittoral rock
MLR.BF	Fser.Fser.Bo	*Fucus serratus* and under-boulder fauna on lower eulittoral boulders
MLR.R		**Red seaweeds (moderately exposed shores)**
MLR.R	XR	Mixed red seaweeds on moderately exposed lower eulittoral rock
MLR.R	Pal	*Palmaria palmata* on very to moderately exposed lower eulittoral rock
MLR.R	Mas	*Mastocarpus stellatus* and *Chondrus crispus* on very to moderately exposed lower eulittoral rock
MLR.R	Osm	*Osmundea* (*Laurencia*) *pinnatifida* and *Gelidium pusillum* on moderately exposed mid-eulittoral rock
MLR.R	RPid	*Ceramium* sp. and piddocks on eulittoral fossilised peat
MLR.Eph		**Ephemeral green or red seaweeds (freshwater or sand-influenced)**
MLR.Eph	Ent	*Enteromorpha* spp. on freshwater-influenced or unstable upper eulittoral rock
MLR.Eph	EntPor	*Porphyra purpurea* or *Enteromorpha* spp. on sand-scoured mid-or lower eulittoral rock
MLR.Eph	Rho	*Rhodothamniella floridula* on sand-scoured lower eulittoral rock
MLR.MF		***Mytilus*** **(mussels) and fucoids (moderately exposed shores)**
MLR.MF	MytFves	*Mytilus edulis* and *Fucus vesiculosus* on moderately exposed mid-eulittoral rock
MLR.MF	MytFR	*Mytilus edulis*, *Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock
MLR.Sab		**Littoral *Sabellaria* (honeycomb worm) reefs**
MLR.Sab	Salv	*Sabellaria alveolata* reefs on sand-abraded eulittoral rock
SLR		**Sheltered littoral rock (fucoid shores)**
SLR.F		**Dense fucoids (stable rock)**
SLR.F	Pel	*Pelvetia canaliculata* on sheltered littoral fringe rock

Higher code	*Biotope code*	*Biotope*
SLR.F	Fspi	*Fucus spiralis* on moderately exposed to very sheltered upper eulittoral rock
SLR.F	Fves	*Fucus vesiculosus* on sheltered mid-eulittoral rock
SLR.F	Asc	*Ascophyllum nodosum* on very sheltered mid-eulittoral rock
SLR.F	Asc.Asc	*Ascophyllum nodosum* on full salinity mid-eulittoral rock
SLR.F	Asc.T	*Ascophyllum nodosum*, sponges and ascidians on tide-swept mid-eulittoral rock
SLR.F	Asc.VS	*Ascophyllum nodosum* and *Fucus vesiculosus* on variable salinity mid-eulittoral rock
SLR.F	Fserr	*Fucus serratus* on sheltered lower eulittoral rock
SLR.F	Fserr.T	*Fucus serratus*, sponges and ascidians on tide-swept lower eulittoral rock
SLR.F	Fserr.VS	*Fucus serratus* and large *Mytilus edulis* on variable salinity lower eulittoral rock
SLR.F	Fcer	*Fucus ceranoides* on reduced salinity eulittoral rock
SLR.FX		**Fucoids, barnacles or ephemeral seaweeds (mixed substrata)**
SLR.FX	BLlit	Barnacles and *Littorina littorea* on unstable eulittoral mixed substrata
SLR.FX	FvesX	*Fucus vesiculosus* on mid-eulittoral mixed substrata
SLR.FX	FserX	*Fucus serratus* on lower eulittoral mixed substrata
SLR.FX	FcerX	*Fucus ceranoides* on reduced salinity eulittoral mixed substrata
SLR.MX		***Mytilus* (mussel) beds (mixed substrata)**
SLR.MX	MytX	*Mytilus edulis* beds on eulittoral mixed substrata
		Littoral rock (other)
LR.Rkp		**Rockpools**
LR.Rkp	G	Green seaweeds (*Enteromorpha* spp. and *Cladophora* spp.) in upper shore rockpools
LR.Rkp	Cor	*Corallina officinalis* and coralline crusts in shallow eulittoral rockpools
LR.Rkp	Cor.Bif	*Bifurcaria bifurcata* in shallow eulittoral rockpools
LR.Rkp	FK	Fucoids and kelps in deep eulittoral rockpools
LR.Rkp	SwSed	Seaweeds in sediment (sand or gravel)-floored eulittoral rockpools
Ov		**Overhangs and caves**
LR.Ov	SR	Sponges and shade-tolerant red seaweeds on overhanging lower eulittoral bedrock
LR.Ov	SByAs	Sponges, bryozoans and ascidians on deeply overhanging lower shore bedrock

Higher code	*Biotope code*	*Biotope*
LS		**LITTORAL SEDIMENTS**
LGS		**Littoral gravels and sands**
LGS.Sh		**Shingle (pebble) and gravel shores**
LGS.Sh	BarSh	Barren shingle or gravel shores
LGS.Sh	Pec	*Pectenogammarus planicrurus* in mid-shore well-sorted gravel or coarse sand
LGS.S		**Sand shores**
LGS.S	Tal	Talitrid amphipods in decomposing seaweed on the strand-line
LGS.S	BarSnd	Barren coarse sand shores
LGS.S	AEur	Burrowing amphipods and *Eurydice pulchra* in well-drained clean sand shores
LGS.S	AP	Burrowing amphipods and polychaetes in clean sand shores
LGS.S	AP.P	Burrowing amphipods and polychaetes (often with *Arenicola marina*) in clean sand shores
LGS.S	AP.Pon	Burrowing amphipods *Pontocrates* spp. and *Bathyporeia* spp. in lower shore clean sand
LGS.S	Lan	Dense *Lanice conchilega* in tide-swept lower shore sand
LGS.Est		**Estuarine coarse sediment shores**
LGS.Est	Ol	Oligochaetes in reduced or low salinity gravel or coarse sand shores
LMS		**Littoral muddy sands**
LMS.MS		**Muddy sand shores**
LMS.MS	BatCor	*Bathyporeia* spp. and *Corophium* spp. in upper shore slightly muddy fine sands
LMS.MS	PCer	Polychaetes and *Cerastoderma edule* in fine sand and muddy sand shores
LMS.MS	MacAre	*Macoma balthica* and *Arenicola marina* in muddy sand shores
LMS.MS	MacAre.Mare	*Arenicola marina*, *Macoma balthica* and *Mya arenaria* in muddy sand shores
LMS.Zos		**Littoral *Zostera* (seagrass) beds**
LMS.Zos	Znol	*Zostera noltii* beds in upper to mid-shore muddy sand
LMU		**Littoral muds**
LMU.Sm		**Saltmarsh**
LMU.Sm		**Saltmarsh (pioneer)**
LMU.Sm	NVC SM8	*Salicornia* spp.

Higher code	*Biotope code*	*Biotope*
LMU.SMu		**Sandy mud shores**
LMU.SMu	HedMac	*Hediste diversicolor* and *Macoma balthica* in sandy mud shores
LMU.SMu	HedMac.Are	*Hediste diversicolor*, *Macoma balthica* and *Arenicola marina* in muddy sand or sandy mud shores
LMU.SMu	HedMac.Pyg	*Hediste diversicolor*, *Macoma balthica* and *Pygospio elegans* in sandy mud shores
LMU.SMu	HedMac.Mare	*Hediste diversicolor*, *Macoma balthica* and *Mya arenaria* in sandy mud shores
LMU.Mu		**Soft mud shores**
LMU.Mu	HedScr	*Hediste diversicolor* and *Scrobicularia plana* in reduced salinity mud shores
LMU.Mu	HedStr	*Hediste diversicolor* and *Streblospio shrubsolii* in sandy mud or soft mud shores
LMU.Mu	HedOl	*Hediste diversicolor* and oligochaetes in low salinity mud shores
IR		**INFRALITTORAL ROCK (and other hard substrata)**
EIR		**Exposed infralittoral rock**
EIR.KFaR		**Kelp with cushion fauna, foliose red seaweeds or coralline crusts (exposed rock)**
EIR.KFaR	Ala	*Alaria esculenta* on sublittoral fringe bedrock
EIR.KFaR	Ala.Myt	*Alaria esculenta*, *Mytilus edulis* and coralline crusts on very exposed sublittoral fringe bedrock
EIR.KFaR	Ala.Ldig	*Alaria esculenta* and *Laminaria digitata* on exposed sublittoral fringe bedrock
EIR.KFaR	LhypR	*Laminaria hyperborea* with dense foliose red seaweeds on exposed infralittoral rock
EIR.KFaR	LhypR.Ft	*Laminaria hyperborea* forest with dense foliose red seaweeds on exposed upper infralittoral rock
EIR.KFaR	LhypR.Pk	*Laminaria hyperborea* park with dense foliose red seaweeds on exposed lower infralittoral rock
EIR.KFaR	FoR	Foliose red seaweeds on exposed or moderately exposed lower infralittoral rock
EIR.KFaR	FoR.Dic	Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock
EIR.SG		**Robust faunal cushions and crusts (surge gullies & caves)**
EIR.SG	FoSwCC	Foliose seaweeds and coralline crusts in surge gully entrances
EIR.SG	SCAn	Sponge crusts and anemones on wave-surged vertical infralittoral rock
EIR.SG	SCAn.Tub	Sponge crusts, anemones and *Tubularia indivisa* in shallow infralittoral surge gullies

Higher code	*Biotope code*	*Biotope*
EIR.SG	SCAs	Sponge crusts and colonial ascidians on wave-surged vertical infralittoral rock
EIR.SG	SCAs.DenCla	*Dendrodoa grossularia* and *Clathrina coriacea* on wave-surged vertical infralittoral rock
EIR.SG	SCAs.ByH	Sponge crusts, colonial (polyclinid) ascidians and a bryozoan/hydroid turf on wave-surged vertical or overhanging infralittoral rock
EIR.SG	CC	*Balanus crenatus* and/or *Pomatoceros triqueter* with spirorbid worms and coralline crusts on severely scoured infralittoral rock
EIR.SG	CC.BalPom	*Balanus crenatus* and/or *Pomatoceros triqueter* with spirorbid worms and coralline crusts on severely scoured vertical infralittoral rock
EIR.SG	CC.Mob	Coralline crusts and crustaceans on mobile boulders or cobbles in surge gullies
MIR		**Moderately exposed infralittoral rock**
MIR.KR		**Kelp with red seaweeds (moderately exposed rock)**
MIR.KR	Ldig	*Laminaria digitata* on moderately exposed or tide-swept sublittoral fringe rock
MIR.KR	Ldig.Ldig	*Laminaria digitata* on moderately exposed sublittoral fringe rock
MIR.KR	Ldig.Ldig.Bo	*Laminaria digitata* and under-boulder fauna on sublittoral fringe boulders
MIR.KR	Ldig.T	*Laminaria digitata*, ascidians and bryozoans on tide-swept sublittoral fringe rock
MIR.KR	Ldig.Pid	*Laminaria digitata* and piddocks on sublittoral fringe soft rock
MIR.KR	Lhyp	*Laminaria hyperborea* and foliose red seaweeds on moderately exposed infralittoral rock
MIR.KR	Lhyp.Ft	*Laminaria hyperborea* forest and foliose red seaweeds on moderately exposed upper infralittoral rock
MIR.KR	Lhyp.Pk	*Laminaria hyperborea* park and foliose red seaweeds on moderately exposed lower infralittoral rock
MIR.KR	Lhyp.TFt	*Laminaria hyperborea* forest, foliose red seaweeds and a diverse fauna on tide-swept upper infralittoral rock
MIR.KR	Lhyp.TPk	*Laminaria hyperborea* park with hydroids, bryozoans and sponges on tide-swept lower infralittoral rock
MIR.SedK		**Sand or gravel-affected or disturbed kelp and seaweed communities**
MIR.SedK	LsacChoR	*Laminaria saccharina*, *Chorda filum* and dense red seaweeds on shallow unstable infralittoral boulders and cobbles
MIR.SedK	XKScrR	Mixed kelps with scour-tolerant and opportunistic foliose red seaweeds on scoured or sand-covered infralittoral rock
MIR.SedK	EphR	Ephemeral red seaweeds and kelps on tide-swept mobile infralittoral cobbles
MIR.SedK	HalXK	*Halidrys siliquosa* and mixed kelps on tide-swept infralittoral rock with coarse sediment
MIR.SedK	PolAhn	*Polyides rotundus*, *Ahnfeltia plicata* and *Chondrus crispus* on sand-covered infralittoral rock

Higher code	*Biotope code*	*Biotope*
SIR		**Sheltered infralittoral rock**
SIR.K		**Silted kelp (stable rock)**
SIR.K	Lsac	*Laminaria saccharina* on very sheltered infralittoral rock
SIR.K	Lsac.Ft	*Laminaria saccharina* forest on very sheltered upper infralittoral rock
SIR.K	Lsac.T	*Laminaria saccharina*, foliose red seaweeds, sponges & ascidians on tide-swept infralittoral rock
SIR.EstFa		**Estuarine faunal communities (shallow rock/mixed substrata)**
SIR.EstFa	MytT	*Mytilus edulis* beds on reduced salinity tide-swept infralittoral rock
		Infralittoral rock (other)
IR.FaSwV		**Fauna and seaweeds (shallow vertical rock)**
IR.FaSwV	AlcByH	*Alcyonium digitatum* and a bryozoan, hydroid and ascidian turf on moderately exposed vertical infralittoral rock
IR.FaSwV	AlcByH.Hia	*Hiatella arctica*, bryozoans and ascidians on vertical infralittoral soft rock
CR		**CIRCALITTORAL ROCK (and other hard substrata)**
ECR		**Exposed circalittoral rock**
ECR.EFa		**Faunal crusts or short turfs (wave-exposed rock)**
ECR.EFa	CorCri	*Corynactis viridis* and a crisiid/*Bugula*/*Cellaria* turf on steep or vertical exposed circalittoral rock
ECR.EFa	PomByC	*Pomatoceros triqueter*, *Balanus crenatus* and bryozoan crusts on mobile circalittoral cobbles and pebbles
ECR.Alc		***Alcyonium*-dominated communities (tide-swept/vertical)**
ECR.Alc	AlcTub	*Alcyonium digitatum* with dense *Tubularia indivisa* and anemones on strongly tide-swept circalittoral rock
ECR.Alc	AlcMaS	*Alcyonium digitatum* with massive sponges (*Cliona celata* and *Pachymatisma johnstonia*) and *Nemertesia antennina* on moderately tide-swept exposed circalittoral rock
ECR.Alc	AlcC	*Alcyonium digitatum*, *Pomatoceros triqueter*, algal and bryozoan crusts on vertical exposed circalittoral rock
ECR.BS		**Barnacle, cushion sponge and *Tubularia* communities (very tide-swept/wave-sheltered)**

Higher code	*Biotope code*	*Biotope*
ECR.BS	BalTub	*Balanus crenatus* and *Tubularia indivisa* on extremely tide-swept circalittoral rock
ECR.BS	TubS	*Tubularia indivisa*, sponges and other hydroids on tide-swept circalittoral bedrock
ECR.BS	CuSH	Cushion sponges, hydroids and ascidians on very tide-swept sheltered circalittoral rock
MCR		**Moderately exposed circalittoral rock**
MCR.XFa		**Mixed faunal turfs (moderately exposed rock)**
MCR.XFa	ErSEun	Erect sponges, *Eunicella verrucosa* and *Pentapora foliacea* on slightly tide-swept moderately exposed circalittoral rock
MCR.XFa	ErSPbolSH	Cushion sponges (*Polymastia boletiformis*, *Tethya*), stalked sponges, *Nemertesia* spp. and *Pentapora foliacea* on moderately exposed circalittoral rock
MCR.ByH		**Bryozoan/hydroid turfs (sand-influenced)**
MCR.ByH	SNemAdia	Sparse sponges, *Nemertesia* spp., *Alcyonidium diaphanum* and *Bowerbankia* spp. on circalittoral mixed substrata
MCR.ByH	Flu	*Flustra foliacea* and other hydroid/bryozoan turf species on slightly scoured circalittoral rock or mixed substrata
MCR.ByH	Flu.HByS	*Flustra foliacea* with hydroids, bryozoans and sponges on slightly tide-swept circalittoral mixed substrata
MCR.ByH	Flu.SerHyd	*Sertularia argentea*, *S. cupressina* and *Hydrallmania falcata* on tide-swept circalittoral cobbles and pebbles
MCR.ByH	Flu.Hocu	*Haliclona oculata* and *Flustra foliacea* with a rich faunal turf on tide-swept sheltered circalittoral boulders or cobbles
MCR.ByH	Urt	*Urticina felina* on sand-affected circalittoral rock
MCR.ByH	Urt.Urt	*Urticina felina* on sand-scoured circalittoral rock
MCR.ByH	Urt.Cio	*Urticina felina* and *Ciocalypta penicillus* on sand-covered circalittoral rock
MCR.M		**Mussel beds (open coast circalittoral rock/mixed substrata)**
MCR.M	MytHAs	*Mytilus edulis* beds with hydroids and ascidians on tide-swept moderately exposed circalittoral rock
MCR.M	Mus	*Musculus discors* beds on moderately exposed circalittoral rock
MCR.M	ModT	*Modiolus modiolus* beds with hydroids and red seaweeds on tide-swept circalittoral mixed substrata
MCR.Bri		**Brittlestar beds**
MCR.Bri	Oph	*Ophiothrix fragilis* and/or *Ophiocomina nigra* beds on slightly tide-swept circalittoral rock or mixed substrata
MCR.As		**Ascidian communities (silt-influenced)**

Higher code	*Biotope code*	*Biotope*
MCR.As	StoPaur	*Stolonica socialis* and/or *Polyclinum aurantium* with *Flustra foliacea* on slightly sand-scoured tide-swept moderately exposed circalittoral rock
MCR.As	MolPol	*Molgula manhattensis* and *Polycarpa* spp. with erect sponges on tide-swept moderately exposed circalittoral rock
MCR.As	MolPol.Sab	Dense ascidians, bryozoans and hydroids on a crust of *Sabellaria spinulosa* on tide-swept circalittoral rock
MCR.SfR		**Soft rock communities**
MCR.SfR	Pol	*Polydora* sp. tubes on upward-facing circalittoral soft rock
SCR		**Sheltered circalittoral rock**
SCR.BrAs		**Brachiopod and solitary ascidian communities (sheltered rock)**
SCR.BrAs	SubSoAs	*Suberites* spp. and other sponges with solitary ascidians on very sheltered circalittoral rock
		Circalittoral rock (other)
CR.FaV		**Faunal turfs (deep vertical rock)**
CR.FaV	Bug	*Bugula* spp. and other bryozoans on vertical moderately exposed circalittoral rock
CR.Cv		**Caves and overhangs (deep)**
CR.Cv	SCup	Sponges, cup corals and *Parerythropodium coralloides* on shaded or overhanging circalittoral rock
SS		**SUBLITTORAL SEDIMENTS**
IGS		**Infralittoral gravels and sands**
IGS.Mrl		**Maerl beds (open coast/clean sediments)**
IGS.Mrl	Phy	*Phymatolithon calcareum* maerl beds in infralittoral clean gravel or coarse sand
IGS.Mrl	Phy.R	*Phymatolithon calcareum* maerl beds with red seaweeds in shallow infralittoral clean gravel or coarse sand
IGS.FaG		**Shallow gravel faunal communities**
IGS.FaG	Sell	*Spisula elliptica* and venerid bivalves in infralittoral clean sand or shell gravel
IGS.FaS		**Shallow sand faunal communities**
IGS.FaS	Mob	Sparse fauna in marine infralittoral mobile clean sand
IGS.FaS	NcirBat	*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand

Higher code	*Biotope code*	*Biotope*
IGS.FaS	Lcon	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand
IGS.FaS	FabMag	*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves in infralittoral compacted fine sand
CGS		**Circalittoral gravels and sands**
CGS	Ven	Venerid bivalves in circalittoral coarse sand or gravel
CGS	Ven.Neo	*Neopentadactyla mixta* and venerid bivalves in circalittoral shell gravel or coarse sand
IMS		**Infralittoral muddy sands**
IMS.Sgr		**Seagrass beds (sublittoral/lower shore)**
IMS.Sgr	Zmar	*Zostera marina/angustifolia* beds in lower shore or infralittoral clean or muddy sand
IMS.FaMS		**Shallow muddy sand faunal communities**
IMS.FaMS	EcorEns	*Echinocardium cordatum* and *Ensis* sp. in lower shore or shallow sublittoral muddy fine sand
IMS.FaMS	SpiSpi	*Spio filicornis* and *Spiophanes bombyx* infralittoral clean or muddy sand
CMS		**Circalittoral muddy sands**
CMS	AbrNucCor	*Abra alba*, *Nucula nitida* and *Corbula gibba* in circalittoral muddy sand or slightly mixed sediment
CMS	AfilEcor	*Amphiura filiformis* and *Echinocardium cordatum* in circalittoral clean or slightly muddy sand
IMX		**Infralittoral mixed sediments**
CMX		**Circalittoral mixed sediments**
CMX	ModMx	*Modiolus modiolus* beds on circalittoral mixed sediment

References

Connor, D.W., Brazier, D.P., Hill, T.O., & Northen, K.O. 1997a. Marine Nature Conservation Review: marine biotope classification for Britain and Ireland. Volume 1. Littoral biotopes. Version 97.06. *JNCC Report*, No. 229.

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

Appendix B Biotopes recorded in each area

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

Numbers refer to the *area summaries* as follows:

1 Cwm-yr-Eglwys to New Quay (Ceinewydd)
2 Nyfer estuary (Newport Bay)
3 Teifi estuary
4 New Quay (Ceinewydd) to Clarach Bay
5 Aeron estuary (Aberaeron)
6 Rheidol and Ystwyth estuaries (Aberystwyth)
7 Clarach Bay to Mochras Point (Sarnau)
8 Dovey estuary (Afon Dyfi)
9 Dysynni estuary (Broad Water)
10 Mawddach estuary (Aber Mawddach)
11 Mochras Lagoon (Artro estuary)
12 Traeth Bach (Glaslyn and Dwyryd estuaries)
13 Tremadog Bay
14 South-west Lleyn Peninsula (Penrhyn Llŷn)
15 Bardsey Island (Ynys Enlli)
16 Caernarfon Bay
17 Menai Strait (Afon Menai)
18 West Anglesey (Ynys Môn)
19 Cefni estuary (Malltraeth Sands)
20 Inland Sea (Cymyran Strait)
21 North-east Anglesey (Ynys Môn)
22 Penmon Point to Great Ormes Head
23 Great Ormes Head to Rhôs Point

	Open coast areas												*Estuarine areas*									
Area	***1***	***4***	***7***	***13***	***14***	***15***	***16***	***17***	***18***	***21***	***22***	***23***	***2***	***3***	***5***	***6***	***8***	***9***	***10***	***11***	***12***	***19***	***20***
Littoral rock																							
LR								•															
YG	•	•		•	•	•	•	•	•	•	•			•		•	•		•		•		•
Pra	•									•													
Ver	•	•											•										
Ver.Por	•	•	•		•	•																	
Ver.B	•			•	•	•	•		•														
Ver.Ver	•	•		•	•	•	•	•	•	•	•			•			•		•		•		
Bli						•																	
MytB	•			•	•		•																
BPat		•	•	•	•	•	•	•															
BPat.Cht	•	•		•	•	•																	
BPat.Cat					•				•														
BPat.Fvesl	•				•	•																	
BPat.Sem	•	•	•	•	•	•	•		•	•	•	•		•									•
Coff	•	•			•	•																	
Him					•	•			•														
PelB	•			•	•	•	•		•	•													
FvesB	•	•			•	•	•		•	•													
Fser				•	•	•			•	•													
Fser.R	•	•	•		•	•	•		•	•		•											
Fser.Fser	•		•		•	•	•		•				•										
Fser.Fser.Bo		•	•	•	•		•		•	•													
XR					•	•			•														
Pal									•														
Mas	•				•																		
Osm				•																			

Area	1	4	7	13	14	15	16	17	18	21	22	23	2	3	5	6	8	9	10	11	12	19	20
RPid			•																				
Ent	•		•											•									
EntPor	•	•	•		•						•	•											
Rho			•			•																	
MytFves			•																				
MytFR	•		•							•													
Salv	•	•	•	•																			
SLR								•		•													
F	•							•					•										
Pel	•	•	•	•	•	•	•	•	•	•	•		•	•			•		•		•		•
Fspi	•	•	•	•	•	•	•	•	•	•	•	•	•	•			•		•		•		•
Fves		•	•	•	•			•	•				•	•					•		•		
Asc.Asc			•	•	•	•	•	•	•	•			•										•
Asc.T								•															
Asc.VS								•		•				•			•		•		•		•
Fserr				•		•		•	•														•
Fserr.T								•															
Fserr.VS								•															
Fcer								•					•	•	•	•			•		•		
FX								•															
BLlit		•	•		•		•		•	•									•				
FvesX		•	•	•	•		•	•		•				•			•						
FserX								•															
FcerX				•				•			•						•						
MytX		•	•					•			•	•	•			•			•			•	
G	•			•	•		•			•			•										
Cor	•	•	•	•	•	•	•		•			•	•										
Cor.Bif						•																	
FK	•	•	•	•	•	•	•		•	•													
SwSed		•	•		•	•	•		•	•													
Ov	•											•											
SR	•	•		•	•		•		•	•													
SByAs	•			•	•		•				•	•											•
Littoral sediment																							
LGS				•				•															
BarSh		•	•	•																			
Pec		•																					
Tal	•		•	•	•		•										•		•				
BarSnd			•	•																			
AEur	•		•	•	•		•						•	•			•		•		•		
AP				•			•		•								•				•		
AP.P	•	•	•	•	•		•		•	•	•	•	•	•			•		•	•	•	•	
AP.Pon				•	•		•				•	•					•		•		•		
Lan							•	•	•	•	•								•				
Ol														•		•	•		•	•	•		•
LMS											•												
BatCor											•		•	•							•		
PCer								•			•						•		•		•	•	
MacAre									•		•								•				•

Area	1	4	7	13	14	15	16	17	18	21	22	23	2	3	5	6	8	9	10	11	12	19	20
MacAre.Mare				•																			
Znol																							•
NVC SM										•									•	•	•		
HedMac											•										•		
HedMac.Are										•							•						•
HedMac.Pyg									•									•	•		•	•	
HedMac.Mare																	•						
HedScr										•	•		•	•			•	•	•	•	•	•	
HedStr										•				•	•			•					
HedOl				•									•	•		•	•	•	•		•		
Sublittoral rock																							
Ala	•		•			•																	
Ala.Myt					•	•			•														
Ala.Ldig	•				•	•			•														
LhypR.Ft					•	•			•														
LhypR.Pk					•	•			•														
FoR			•		•	•			•	•													
FoR.Dic					•	•	•																
FoSwCC					•																		
SCAn					•	•																	
SCAn.Tub						•																	
SCAs					•																		
SCAs.DenCla					•				•														
SCAs.ByH	•				•		•		•														
CC.BalPom					•																		
CC.Mob									•														
Ldig.Ldig	•	•	•		•	•	•		•	•													
Ldig.Ldig.Bo	•							•	•		•	•											
Ldig.T								•	•														
Ldig.Pid										•		•											
Lhyp.Ft				•	•	•	•		•	•													
Lhyp.Pk					•	•				•													
Lhyp.TFt					•	•		•	•	•													
Lhyp.TPk					•	•			•	•													
LsacChoR			•			•	•	•		•													
XKScrR	•	•	•	•	•	•	•	•	•	•		•											
EphR			•	•	•	•	•		•														
HalXK		•	•	•		•																	•
PolAhn	•	•	•		•																		
Lsac.Ft								•															
Lsac.T								•															
MytT							•		•	•													
AlcByH.Hia										•													
CorCri						•																	
PomByC	•		•		•	•		•															
AlcTub	•					•																	
AlcMaS					•	•			•														
AlcC							•	•	•	•													
BalTub					•	•		•															

Area	1	4	7	13	14	15	16	17	18	21	22	23	2	3	5	6	8	9	10	11	12	19	20
TubS					•	•			•														
CuSH						•		•		•													
MCR	•	•																					
ErSEun						•																	
ErSPbolSH					•	•	•		•														
SNemAdia	•	•	•	•	•	•	•		•			•											
Flu.HByS	•	•	•		•	•		•	•	•													
Flu.SerHyd	•	•	•		•	•	•	•	•	•													
Flu.Hocu							•	•		•													
Urt.Urt	•		•		•	•	•	•	•	•													
Urt.Cio					•					•													
MytHAs					•		•	•	•														
Mus					•				•														
ModT							•																
Oph	•				•			•	•	•													
StoPaur			•			•			•														
MolPol	•				•	•	•		•														
MolPol.Sab	•	•							•														
Pol								•		•		•											
SubSoAs										•													
Bug					•	•	•		•														
Sublittoral sediment																							
SCup					•	•																	
IGS	•		•		•				•														
Phy.R					•																		
Sell			•				•																
Mob	•		•			•		•	•														
NcirBat	•	•	•	•					•			•											
Lcon			•	•			•	•	•	•													
FabMag	•	•	•	•					•														
Ven.Neo	•		•	•		•			•														
IMS	•	•	•		•		•		•	•													
Zmar							•																
EcorEns			•				•		•	•		•											
SpiSpi	•	•	•				•		•	•													
AbrNucCor	•		•	•		•			•	•													
AfilEcor	•	•	•	•					•	•													
IMX	•																						
CMX	•																						
ModMx	•					•			•														

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

Appendix C Species recorded

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

Numbers refer to the *area summaries* as follows:

1 Cwm-yr-Eglwys to New Quay (Ceinewydd)
2 Nyfer estuary (Newport Bay)
3 Teifi estuary
4 New Quay (Ceinewydd) to Clarach Bay
5 Aeron estuary (Aberaeron)
6 Rheidol and Ystwyth estuaries (Aberystwyth)
7 Clarach Bay to Mochras Point (Sarnau)
8 Dovey estuary (Afon Dyfi)
9 Dysynni estuary (Broad Water)
10 Mawddach estuary (Aber Mawddach)
11 Mochras Lagoon (Artro estuary)
12 Traeth Bach (Glaslyn and Dwyryd estuaries)
13 Tremadog Bay
14 South-west Lleyn Peninsula (Penrhyn Llŷn)
15 Bardsey Island (Ynys Enlli)
16 Caernarfon Bay
17 Menai Strait (Afon Menai)
18 West Anglesey (Ynys Môn)
19 Cefni estuary (Malltraeth Sands)
20 Inland Sea (Cymyran Strait)
21 North-east Anglesey (Ynys Môn)
22 Penmon Point to Great Ormes Head
23 Great Ormes Head to Rhôs Point

Protozoa

Haliphysema tumanowiczi 1, 14, 18

Porifera

Clathrina coriacea 1, 7, 13, 14, 15, 16, 17, 18, 21
Clathrina lacunosa 1, 13, 17, 18
Leucosolenia sp. 1, 7, 15, 17
Leucosolenia botryoides 1, 7, 13, 14, 15, 16, 17, 18
Leucosolenia complicata 1, 7, 13, 14, 15, 16, 17, 18, 21
Scypha sp. 15
Scypha ciliata 1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Scypha coronata 14, 15, 17
Scypha fistulosa 15
Leuconia sp. 7, 14
Leuconia caminus 14
Leuconia johnstoni 16, 18
Leuconia nivea 13, 14, 15, 16, 17, 18, 21
Grantia compressa 1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Ute ensata 17
Oscarella lobularis 15, 17, 18
Dercitus bucklandi 1, 14, 15, 18, 21
Stelletta grubii 14, 15, 18
Stryphnus ponderosus 14, 18, 21
Pachymatisma johnstonia 1, 14, 15, 17, 18, 21
Thymosia guernei 14, 15
Tethya aurantium 1, 4, 7, 14, 15, 18, 21, 23
Suberites carnosus 1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Suberites ficus 7, 14, 16, 17, 18, 21, 23
Laxosuberites sp. 17
Pseudosuberites sulphureus 14, 16, 18
Terpios fugax 4, 18
Polymastia agglutinans 14, 17
Polymastia boletiformis 7, 14, 15, 16, 17, 18, 21
Polymastia mamillaris 1, 7, 14, 15, 16, 17, 18, 21
Cliona celata 1, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Axinella damicornis 15
Axinella infundibuliformis 14, 15, 18
Axinella dissimilis 14, 15, 18
Phakellia vermiculata 7
Stelligera rigida 1, 4, 7, 14, 15, 16, 18, 21
Stelligera stuposa 1, 4, 7, 14, 15, 16, 17, 18
Raspailia hispida 1, 4, 7, 13, 14, 15, 16, 18
Raspailia ramosa 1, 4, 7, 14, 15, 16, 18, 21
Tethyspira spinosa 14, 15, 17, 18, 21
Eurypon lacazei 1
Halichondria bowerbanki 7, 15, 17, 18, 21
Halichondria panicea 1, 4, 7, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23
Halichondria topsenti 17
Ciocalypta penicillus 7, 14, 15, 18, 21, 23
Hymeniacidon perleve 1, 4, 7, 13, 14, 15, 16, 17, 18, 20, 21, 23
Hymeniacidon sanguinea 1
Rhaphidostyla sp. 14
Mycale sp. 1, 7, 14, 15, 16, 18
Mycale macilenta 16, 17
Mycale rotalis 7
Asbestopluma pennatula 7
Biemna variantia 1, 17
Esperiopsis fucorum 1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22

Myxilla sp.	14, 15, 17, 18, 21
Myxilla incrustans	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Myxilla rosacea	7, 14, 17, 18
Iophonopsis nigricans	4
Hymedesmia sp.	15, 18
Hymedesmia brondstedi	17, 18
Hymedesmia pansa	17
Hymedesmia paupertas	7, 14, 15, 18
Phorbas fictitius	7, 13, 14, 15, 16, 18
Stylostichon plumosum	7, 14, 15, 18
Hemimycale columella	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Ophlitaspongia seriata	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22
Microciona sp.	1, 4, 7, 14, 15, 17, 18, 21
Microciona armata	17
Microciona atrasanguinea	17, 21
Microciona laevis	17
Antho involvens	14
Plocamilla coriacea	17
Haliclona sp.	1, 7, 14, 15, 17
Haliclona cinerea	15, 17, 18
Haliclona fistulosa	7, 13, 14, 18, 21
Haliclona indistincta	17
Haliclona oculata	1, 4, 7, 14, 15, 16, 17, 18, 21, 23
Haliclona rosea	14, 15
Haliclona simulans	1, 7, 4, 13, 14, 15, 18
Haliclona urceolus	4, 14, 18
Haliclona viscosa	1, 4, 14, 16, 18
Acervochalina limbata	17
Dysidea fragilis	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Aplysilla rosea	4, 14, 17, 18, 20
Aplysilla sulfurea	7, 14, 15, 16, 17, 18
Halisarca dujardini	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Halisarca metschnikovi	17
Porifera indet. (crusts)	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23

Cnidaria

Haliclystus auricula	15, 18
Chrysaora hysoscella	17
Cyanea capillata	17
Aurelia aurita (scyphistomae)	7, 17
Rhizostoma octopus	17
Corymorpha nutans	1, 14, 15, 16, 23
Ectopleura dumortieri	7
Tubularia indivisa	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Tubularia larynx	14, 15, 17, 18
Coryne sp.	14, 18
Coryne muscoides	15, 16, 18
Coryne pusilla	15, 17
Sarsia sp.	14
Sarsia eximia	17
Eudendrium sp.	7, 14, 17
Eudendrium capillare	17
Eudendrium rameum	17
Eudendrium ramosum	17
Bimeria vestita	17
Bougainvillia sp.	7, 18
Bougainvillia ramosa	17, 21
Garveia nutans	14, 15, 17, 18, 21
Hydractinia echinata	7, 13, 16, 17, 18
Clava multicornis	1, 15, 17, 20
Laodicea undulata	17
Calycella syringa	17, 18, 23
Lovenella sp.	15
Aequorea vitrina	17
Opercularella lacerata	17
Phialella quadrata	17
Filellum serpens	14, 15, 17, 21
Lafoea dumosa	7, 14, 15, 18, 21
Halecium sp.	1, 7, 14, 15, 16, 17, 18
Halecium beanii	7, 14, 15, 16, 17, 21
Halecium halecinum	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Halecium muricatum	7, 14, 15, 16
Halecium tenellum	21
Hydranthea margarica	21
Aglaophenia sp.	1, 7, 14, 15, 16, 18
Aglaophenia acacia	15
Aglaophenia pluma	1, 4, 7, 13, 14, 15, 16, 17, 18, 20, 21
Aglaophenia tubiformis	18
Aglaophenia tubulifera	7, 14, 15, 16, 17, 18, 21
Gymnangium montagui	14, 15, 18
Antennella secundaria	7, 14, 15, 18
Halopteris catharina	1, 7, 14, 15, 17, 18, 21
Kirchenpaueria sp.	18
Kirchenpaueria pinnata	1, 7, 14, 15, 16, 17, 18, 21
Kirchenpaueria similis	1
Nemertesia antennina	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Nemertesia ramosa	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Plumularia setacea	1, 7, 14, 15, 16, 17, 18, 21
Polyplumaria flabellata	7
Polyplumaria frutescens	7
Abietinaria abietina	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Abietinaria filicula	7, 14, 17, 21
Amphisbetia operculata	7, 14, 15, 17, 21
Diphasia sp.	1, 4, 14, 15, 17, 21
Diphasia attenuata	1, 14, 21
Diphasia pinaster	1, 14, 15
Diphasia rosacea	1, 7, 14, 15, 17, 18, 21
Dynamena pumila	2, 1, 4, 7, 8, 10, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23
Hydrallmania falcata	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Thuiaria articulata	17
Sertularella sp.	14
Sertularella gaudichaudi	18
Sertularella gayi	1, 7, 13, 14, 15, 16, 18
Sertularella polyzonias	1, 13, 14, 15, 16, 18, 21
Sertularella rugosa	17, 21
Sertularia argentea	1, 4, 7, 13, 14, 15, 16, 17, 18, 21

Sertularia cupressina	13, 14, 15, 16, 17, 18, 21, 23
Tridentata distans	7, 14
Tamarisca tamarisca	21
Campanularia hincksii	17
Campanularia volubilis	17
Clytia hemisphaerica	14, 17
Gonothyraea loveni	17
Hartlaubella gelatinosa	17
Laomedea sp.	21
Laomedea angulata	17
Laomedea flexuosa	14, 15, 17
Laomedea neglecta	17
Obelia sp.	1, 7, 14, 15, 16, 17, 18, 21
Obelia dichotoma	4, 7, 14, 15, 17, 18
Obelia geniculata	1, 7, 14, 15, 16, 17, 18, 21
Obelia longissima	7, 14, 16, 17, 18, 21
Obelia plicata	17
Rhizocaulus verticillatus	7, 13, 16, 17, 18, 21
Eutima gracilis	17
Physalia physalis	17
Muggiaea atlantica	17
Gossea corynetes	17
Sarcodictyon roseum	14, 15, 16, 17, 21
Alcyonium digitatum	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Alcyonium glomeratum	15
Cerianthus lloydii	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Epizoanthus couchii	4, 7, 13, 14, 15, 18
Parazoanthus axinellae	15
Isozoanthus sulcatus	1, 7, 13, 14, 15, 18
Actinia equina	2, 1, 4, 7, 10, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23
Actinia fragacea	16, 21
Anemonia viridis	1, 4, 7, 13, 14, 15, 16, 17, 18
Urticina felina	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Urticina eques	1, 14
Aulactinia verrucosa	14, 15, 17, 18
Aureliania heterocera	14, 18
Diadumene cincta	4, 14, 15
Metridium senile	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Sagartia elegans	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Sagartia troglodytes	7, 14, 15, 16, 17, 18, 21
Cereus pedunculatus	1, 13, 14, 15, 16, 17, 18, 21
Actinothoe sphyrodeta	14, 15, 16, 17, 18, 21
Sagartiogeton laceratus	7, 17, 21
Sagartiogeton undatus	1, 7, 13, 14, 16, 17, 18, 21, 23
Adamsia carciniopados	14, 15, 17, 18, 21
Mesacmaea mitchellii	14
Peachia cylindrica	14, 15, 16, 17
Halcampa chrysanthellum	7, 17
Edwardsiidae indet.	1, 4, 7, 13, 18, 21
Edwardsiella carnea	17
Edwardsia sp.	17
Edwardsia claparedii	1, 13
Corynactis viridis	14, 15, 18
Caryophyllia smithii	1, 14, 15, 18
Caryophyllia inornata	14, 15

Ctenophora

Pleurobrachia pileus	17
Bolinopsis infundibulum	17
Beroe cucumis	17

Platyhelminthes

Procerodes littoralis	17
Polycelis nigra	16, 18
Leptoplana tremellaris	17
Prostheceraeus vittatus	1, 4, 7, 13, 14, 15, 16, 17, 18
Cycloporus papillosus	17
Oligocladus sanguinolentus	17
Stylostomum ellipse	17

Nemertea

Nemertea indet.	2, 1, 3, 4, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23
Cephalothrix rufifrons	17
Tubulanus annulatus	7, 13, 14, 17, 18, 21
Tubulanus linearis	17
Cerebratulus sp.	7, 18
Cerebratulus fuscus	7, 17, 21
Cerebratulus marginatus	7, 17
Lineus sp.	13, 16, 17, 18
Lineus bilineatus	17
Lineus longissimus	1, 4, 7, 15, 17, 18, 21
Lineus ruber	17
Valencinia longirostris	17
Amphiporus hastatus	17
Amphiporus lactifloreus	17
Nipponnemertes pulcher	17
Emplectonema gracile	17
Emplectonema neesii	17
Oerstedia dorsalis	17
Tetrastemma candidum	17
Tetrastemma cephalophorum	17
Tetrastemma vermiculus	17
Malacobdella grossa	17

Nematoda

Nematoda indet.	2, 1, 3, 4, 7, 9, 11, 13, 15, 16, 17, 18, 19, 20, 21, 22

Priapulida

Priapulus caudatus	17

Entoprocta

Loxosomella obesa	17
Barentsia gracilis	21
Pedicellina cernua	17

Sipuncula

Sipunculidae indet.	7
Golfingia sp.	1, 4, 7, 15
Golfingia elongata	7, 13, 17, 18
Golfingia vulgaris vulgaris	1, 15, 16, 17

Nephasoma minutum	13, 15, 17
Thysanocardia procera	1, 4, 7, 13
Phascolion strombus strombus	1, 4, 7, 13, 15, 18

Echiura

Thalassema sp.	14
Thalassema thalassemum	17
Amalosoma eddystonense	1, 7

Annelida

Polychaeta indet.	1, 3, 4, 5, 7, 9, 10, 12, 13, 14, 15, 16, 18, 19, 21, 22, 23
Pisione remota	1, 4, 7, 13, 15, 16, 17, 18
Aphrodita aculeata	1, 13, 15, 16, 17, 18, 21
Polynoidae indet.	4, 14, 16, 17, 18, 22
Acholoe squamosa	7
Adyte pellucida	18, 21
Alentia gelatinosa	4, 17, 18, 21
Gattyana cirrosa	1, 4, 7, 18, 21
Harmothoe sp.	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Harmothoe extenuata	15, 17, 21
Harmothoe imbricata	17
Harmothoe impar	1, 7, 13, 16, 18, 21
Harmothoe ljungmani	1, 15
Harmothoe maxillospinosa	17
Harmothoe mcintoshi	15
Harmothoe andreapolis	4, 7, 13, 18, 21
Harmothoe castanea	17
Harmothoe glabra	1, 7, 17, 21
Harmothoe lunulata	1, 7, 13, 16, 18, 21, 22, 23
Harmothoe marphysae	17
Lepidonotus clava	17
Lepidonotus squamatus	1, 4, 17, 18
Pholoe sp.	1, 7, 13, 15, 18, 21
Pholoe inornata	1, 4, 6, 7, 13, 16, 17, 18, 21, 22
Pholoe synophthalmica	7, 11, 13, 16, 18, 21
Sigalion mathildae	1, 4, 7, 13, 16, 17, 18, 21, 22
Sthenelais sp.	1, 13
Sthenelais boa	1, 17, 21
Sthenelais limicola	1, 4, 7, 15, 18, 21
Sthenelais zetlandica	1, 18
Eteone flava	7, 17, 18, 21
Eteone longa	1, 4, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23
Hesionura elongata	1, 4, 7, 13, 15, 16, 21
Hypereteone foliosa	17
Mysta picta	1, 17
Mystides borealis	15
Pseudomystides limbata	1, 7, 13, 15, 16, 18
Protomystides bidentata	1, 15, 18
Anaitides groenlandica	1, 15, 18, 21, 22, 23
Anaitides lineata	4, 17, 18
Anaitides longipes	16
Anaitides maculata	1, 13, 17
Anaitides mucosa	7, 10, 13, 16, 18, 20, 21, 22, 23
Anaitides rosea	4, 7, 13, 18, 21, 23
Eulalia sp.	1, 7, 13, 16, 18
Eulalia bilineata	1
Eulalia tripunctata	1
Eulalia viridis	1, 4, 7, 9, 13, 16, 17, 18, 23
Eulalia ornata	1
Eumida sp.	1
Eumida bahusiensis	1, 4, 7, 13, 15, 16, 17, 18, 21
Eumida sanguinea	1, 7, 15, 18, 18, 22
Eumida ockelmanni	1, 4, 7
Nereiphylla lutea	1, 4, 7, 13, 15, 18, 21
Notophyllum foliosum	18
Paranaitis kosteriensis	1, 7, 18
Phyllodoce sp.	1, 15, 18
Phyllodoce lamelligera	18
Phyllodoce laminosa	7, 18, 21
Phyllodoce macropapillosa	4
Pirakia punctifera	18
Tomopteris helgolandica	18
Glycera sp.	17
Glycera alba	1, 4, 7, 13, 15
Glycera gigantea	15, 17
Glycera lapidum	1, 7, 13, 15, 16, 17, 18, 21
Glycera oxycephala	1, 4, 7, 13, 15, 16, 18, 21
Glycera tridactyla	1, 4, 7, 11, 13, 16, 17, 18, 21, 22, 23
Glycinde nordmanni	1, 13, 15, 18
Goniada maculata	4, 7, 13, 18
Goniadella sp.	7, 13, 16
Goniadella gracilis	1, 15,17, 18
Ephesiella abyssorum	15
Sphaerodoropsis sp.	7
Sphaerodorum gracilis	1, 15, 18, 21
Gyptis sp.	1, 7, 13
Podarkeopsis capensis	1, 4, 7, 21, 22
Gyptis rosea	7
Hesiospina similis	18
Kefersteinia cirrata	1, 7, 13, 15, 16, 17, 18, 21
Ophiodromus flexuosus	4, 13
Podarke pallida	1, 7, 13, 15, 16, 18
Syllidia armata	7, 13, 18
Microphthalmus sp.	3, 7, 11, 16, 17, 18, 21, 22
Microphthalmus sczelkowii	22
Syllidae indet.	1, 18
Eurysyllis tuberculata	15, 18
Ehlersia cornuta	1, 18
Syllis sp.	1, 7, 15, 18
Trypanosyllis sp.	1, 15, 18
Typosyllis armillaris	1, 21
Typosyllis hyalina	1, 7
Typosyllis prolifera	15, 17
Eusyllis blomstrandi	1, 13, 15, 17, 18
Eusyllis lamelligera	18
Odontosyllis ctenostoma	17
Odontosyllis fulgurans	1, 15
Odontosyllis gibba	17
Opisthodonta pterochaeta	15

Streptosyllis bidentata	1, 4, 7, 15, 18
Streptosyllis websteri	7, 13, 16, 22
Syllides sp.	1, 4, 7, 15, 17, 18
Syllides benedicti	7, 13
Brania sp.	1, 18
Brania limbata	17
Exogone sp.	22
Exogone furcifera	15, 18
Exogone hebes	1, 4, 7, 13, 15, 16, 18, 20, 21
Exogone naidina	1, 4, 7, 13, 15, 16, 17, 18, 21
Exogone verugera	7, 15, 18
Sphaerosyllis sp.	1, 4, 7, 13, 15, 16, 18
Sphaerosyllis bulbosa	1, 13, 15, 16, 18
Sphaerosyllis hystrix	1, 7, 15, 17
Sphaerosyllis pirifera	17
Sphaerosyllis tetralix	1, 7, 13, 15, 18
Autolytinae indet.	1, 18
Autolytus sp.	1, 7, 13, 15, 17, 18
Autolytus alexandri	1, 15, 18
Autolytus aurantiacus	17
Autolytus inermis	18
Autolytus longeferiens	10, 21
Autolytus prolifera	17
Myrianida pinnigera	17
Proceraea sp.	13, 18
Proceraea picta	17
Nereididae indet.	8, 10, 11, 12
Hediste diversicolor	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22
Neanthes fucata	17
Neanthes virens	17
Nereis sp.	1, 4, 5, 7, 14, 21
Nereis elitoralis	1, 4, 15, 18
Nereis longissima	1, 4, 7, 13, 16, 17, 18, 21
Nereis pelagica	14, 15, 17, 18, 21
Nereis zonata	1, 7, 13, 17, 18
Perinereis cultrifera	15, 17
Platynereis coccinea	15
Platynereis dumerilii	4, 17, 21
Websterinereis glauca	17
Nephtyidae indet.	10
Aglaophamus rubella	1, 4, 15, 18
Nephtys sp.	1, 3, 4, 7, 8, 10, 11, 13, 16, 17, 18, 21, 22, 23
Nephtys caeca	7, 8, 17, 18
Nephtys cirrosa	2, 1, 3, 4, 7, 8, 10, 11, 12, 13, 14, 16, 17, 21, 22, 23
Nephtys hombergii	1, 4, 7, 8, 10, 11, 13, 16, 17, 18, 19, 20, 21, 22, 23
Nephtys kersivalensis	1, 4, 7, 13, 16, 18, 19, 20, 21
Nephtys incisa	1, 4, 7, 13
Nephtys longosetosa	17, 22
Paramphinome jeffreysii	22
Euphrosine foliosa	13, 15
Nothria britannica	1, 7, 17
Lysidice ninetta	1, 17
Marphysa bellii	1, 4, 15, 18
Marphysa sanguinea	17
Nematonereis unicornis	1, 7, 16, 18
Lumbrineris sp.	1, 4, 13
Lumbrineris agastos	1, 4, 15, 18
Lumbrineris gracilis	1, 4, 7, 13, 15, 16, 18, 21
Lumbrineris magnidentata	1, 15
Lumbrineris scopa	1, 4
Lumbrineris tetraura	1, 17
Arabella iricolor	17
Notocirrus scoticus	1
Dorvillea sp.	17
Ophryotrocha sp.	13, 17
Ophryotrocha puerilis siberti	17
Ougia subaequalis	7, 13
Parougia sp.	7, 15, 18
Parougia caeca	7
Parougia eliasoni	4, 13
Protodorvillea kefersteini	1, 7, 15, 16, 18, 21
Schistomeringos sp.	1, 13, 21
Schistomeringos neglecta	1, 7, 13, 16
Schistomeringos rudolphi	15
Orbinia latreillii	13, 17
Orbinia sertulata	1, 4, 7, 15, 18
Orbinia armandi	4, 15
Scoloplos armiger	1, 4, 7, 8, 10, 11, 13, 16, 17, 18, 19, 20, 21, 22, 23
Paraonidae indet.	7
Aricidea sp.	18
Aricidea minuta	4, 7, 13, 17, 18, 21, 22
Aricidea catherinae	1, 4, 7, 13, 15, 18
Aricidea cerrutii	1, 13, 15, 18
Cirrophorus branchiatus	18
Levinsenia gracilis	7, 13, 21, 22
Paradoneis sp.	1, 15, 18
Paradoneis lyra	1, 4, 7, 13, 15, 18, 21
Paraonis fulgens	2, 3, 4, 7, 8, 16, 18, 22
Questidae indet.	4, 7, 15
Apistobranchus sp.	18
Poecilochaetus serpens	1, 4, 7, 13, 16, 17, 18, 21, 22
Spionidae indet.	1, 4, 7, 13, 18
Aonides oxycephala	1
Aonides paucibranchiata	1, 4, 7, 13, 15, 16, 17, 18, 21
Laonice sp.	16
Laonice bahusiensis	1, 7, 15, 18
Malacoceros fuliginosus	2, 1, 3, 15, 16, 17, 18
Malacoceros tetracerus	7, 12, 13, 14, 16, 17
Malacoceros vulgaris	17
Minuspio cf. *multibranchiata*	13
Polydora sp.	1, 4, 13, 14, 16, 17, 18, 20, 21, 22, 23
Polydora caeca	1, 15, 17, 18
Polydora caulleryi	1, 7, 15, 18, 21
Polydora ciliata	8, 13, 15, 17
Polydora flava	4, 13, 15, 18
Polydora hoplura	17
Polydora quadrilobata	22

Prionospio sp.	1
Prionospio steenstrupi	4, 7, 12
Prionospio ehlersi	1, 4, 7, 13, 16, 18, 21
Prionospio caspersi	13
Pseudopolydora antennata	1
Pseudopolydora pulchra	1, 7, 13, 15, 16, 18, 21
Pygospio elegans	2, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22
Scolelepis sp.	1, 7, 13, 14, 16
Scolelepis foliosa	1, 17
Scolelepis mesnili	4, 7, 14
Scolelepis squamata	2, 1, 3, 4, 7, 8, 10, 12, 13, 14, 16, 18, 19, 21, 22, 23
Scolelepis cantabra	7
Scolelepis (*Parascolelepis* sp.)	1, 4, 18
Spio sp.	1, 4, 7, 13, 15, 18, 21
Spio armata	2, 1, 4, 15, 16, 18, 21, 23
Spio decorata	7, 13, 16, 18, 21, 23
Spio filicornis	7, 13, 16, 17, 18, 22
Spio martinensis	2, 3, 4, 7, 8, 10, 13, 16, 18, 21, 22, 23
Spiophanes bombyx	2, 1, 4, 7, 11, 13, 15, 16, 17, 18, 21, 22, 23
Spiophanes kroyeri	1, 4, 7, 15, 18
Streblospio shrubsolii	2, 1, 3, 5, 8, 9, 11, 17
Magelona sp.	4, 7, 13, 18
Magelona alleni	1, 4, 7, 13, 16, 18
Magelona filiformis	1, 3, 4, 7, 13, 16, 18, 21, 22
Magelona minuta	1, 4, 7, 13, 18
Magelona mirabilis	1, 7, 13, 16, 17, 18, 21, 22, 23
Magelona wilsoni	18
Chaetopterus sp.	4
Chaetopterus variopedatus	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Phyllochaetopterus socialis	18
Cirratulidae indet.	1, 7, 13, 15, 16, 18
Caulleriella sp.	22
Caulleriella alata	1, 7, 13, 15, 16, 18, 21
Caulleriella bioculata	4
Caulleriella caputesocis	17
Tharyx killariensis	1, 4, 7, 13, 15, 18, 21
Caulleriella zetlandica	1, 7, 15, 16, 18, 20
Chaetozone sp.	1, 4, 7, 13, 18, 21
Chaetozone setosa	1, 7, 13, 16, 17, 18, 21, 22
Cirratulus sp.	13, 14
Cirratulus cirratus	15, 17, 21
Cirriformia tentaculata	15, 16, 17, 21, 22
Dodecaceria concharum	17
Tharyx sp.	1, 13, 16, 22, 23
Aphelochaeta marioni	1, 4, 17, 20
Ctenodrilus sp.	17
Psammodrilus balanoglossoides	4, 7, 21, 22
Cossura sp.	1
Diplocirrus glaucus	1, 4, 7, 13
Flabelligera affinis	17, 21
Pherusa plumosa	17, 21
Macrochaeta caroli	18
Macrochaeta clavicornis	1, 15, 18
Capitellidae indet.	8, 15
Capitella sp.	2, 1, 3, 4, 6, 7, 9, 11, 13, 14, 16, 18, 19, 20, 21, 22, 23
Capitella capitata	1, 4, 7, 8, 10, 12, 13, 15, 21, 22
Capitomastus minimus	17
Heteromastus filiformis	8, 11, 13
Mediomastus fragilis	2, 1, 4, 7, 13, 15, 16, 17, 18, 20, 21, 22
Notomastus sp.	1, 4, 7, 13, 15, 16, 18, 21, 22
Notomastus latericeus	1, 17, 18, 20, 22
Arenicola sp.	13, 14, 16, 21, 22, 23
Arenicola marina	2, 3, 4, 5, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23
Arenicolides ecaudata	15
Maldanidae indet.	4, 18
Praxillura longissima	7, 13, 18
Maldane sarsi	1, 13
Clymenura sp.	1, 7, 13, 18
Clymenura johnstoni	1, 15, 18
Euclymene sp.	18
Euclymene oerstedii	1, 7, 13, 16, 18
Praxillella affinis	1, 15, 18
Proclymene muelleri	17
Micromaldane ornithochaeta	15
Nicomache personata	17
Petaloproctus terricola	15
Ophelia bicornis	7, 17, 19
Ophelia borealis	1, 4, 7, 13, 17, 18, 21
Ophelia celtica	1, 18
Ophelia limacina	1, 17
Travisia forbesii	4, 7, 13, 21, 22
Armandia polyophthalma	1
Ophelina acuminata	1, 4, 7, 15, 17, 21
Asclerocheilus	1, 18
Scalibregma sp.	13
Scalibregma inflatum	1, 4, 7, 11, 13, 15, 18, 21
Nerilla antennata	17
Dinophilus gyrociliatus	17
Dinophilus taeniatus	17
Trilobodrilus heideri	17
Polygordius sp.	1, 4, 7, 13, 15, 16
Protodrilus sp.	4, 13, 15, 18
Protodrilus flavocapitatus	17
Protodriloides symbioticus	17
Saccocirrus sp.	13
Saccocirrus papillocercus	4
Oweniidae indet.	1, 4, 7, 13, 18
Myriochele heeri	13
Galathowenia oculata	1, 18, 20
Owenia fusiformis	1, 4, 7, 13, 15, 16, 17, 18, 21, 22, 23
Amphictene auricoma	1, 4, 7, 13, 18
Lagis koreni	1, 4, 7, 13, 15, 16, 17, 18, 21, 22

Sabellaria alveolata	1, 4, 7, 13, 16, 17, 18, 21, 22, 23
Sabellaria spinulosa	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Melinna elisabethae	1, 18
Melinna palmata	1, 4, 7, 11, 13, 18, 20
Ampharetinae indet.	1
Ampharete sp.	1, 4, 7, 13, 15, 18, 21
Ampharete baltica	18, 20
Ampharete grubei	17
Ampharete lindstroemi	1, 4, 7, 13, 16, 18, 21
Sabellides sp.	18
Sabellides octocirrata	1, 15, 18
Terebellides stroemi	1, 4, 7, 15, 18
Trichobranchus glacialis	15, 18
Terebellidae indet.	1, 4, 7, 13, 14, 16, 17, 18, 21, 22, 23
Amphitrite edwardsi	13, 17
Amphitritides gracilis	1
Axionice maculata	18, 21
Eupolymnia nebulosa	7, 13, 17
Eupolymnia nesidensis	18
Lanice conchilega	2, 1, 3, 4, 7, 10, 13, 14, 15, 16, 17, 18, 21, 22, 23
Loimia medusa	17
Neoamphitrite affinis	7, 13
Neoamphitrite figulus	17, 21
Nicolea venustula	13, 18
Nicolea zostericola	17, 18
Phisidia aurea	1, 15, 18
Pista cristata	1, 4, 7, 15, 16, 18
Amaeana trilobata	1, 7, 15, 16, 18
Lysilla sp.	1, 15, 18
Polycirrus sp.	1, 4, 7, 13, 15, 16, 18, 21
Polycirrus aurantiacus	17
Polycirrus denticulatus	17
Polycirrus haematodes	17
Polycirrus medusa	1
Polycirrus norvegicus	1
Parathelepus collaris	18
Thelepus cincinnatus	18, 21
Thelepus setosus	17, 18
Sabellidae indet.	1, 7, 14, 15, 16, 18, 21, 23
Bispira volutacornis	14, 15, 16, 18
Branchiomma bombyx	7, 14, 15, 16, 17, 21
Chone sp.	1, 4, 13, 15, 18
Chone duneri	1, 7
Chone filicaudata	1, 15, 18
Demonax cambrensis	1
Demonax torulis	7
Fabricia sabella	17, 20
Jasmineira caudata	18
Jasmineira elegans	1, 15, 17, 18
Manayunkia sp.	17
Manayunkia aestuarina	2, 3, 4, 9, 11, 21, 22
Megalomma vesiculosum	7
Myxicola sp.	15
Myxicola infundibulum	14, 15
Potamilla torelli	17
Pseudopotamilla reniformis	1, 14, 15, 18
Sabella sp.	7, 16, 18, 23
Sabella pavonina	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Serpulidae indet.	7, 13, 14, 15, 18, 21, 23
Hydroides sp.	1, 4, 14, 22
Hydroides norvegica	1, 14, 15, 17, 18, 21
Pomatoceros sp.	17, 21
Pomatoceros lamarcki	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Pomatoceros triqueter	2, 1, 4, 7, 10, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23
Serpula vermicularis	1, 7, 17, 18
Filograna implexa	4, 7, 14, 15, 16, 17, 18
Protula tubularia	7, 13, 15, 18
Salmacina dysteri	14, 17
Spirorbidae indet.	1, 4, 13, 14, 15, 16, 17, 18, 20
Circeis spirillum	17, 18
Janua pagenstecheri	1, 14, 15, 17, 18
Spirorbis sp.	1, 14, 15, 16
Spirorbis corallinae	1, 14, 15, 16, 18, 21
Spirorbis cuneatus	18
Spirorbis inornatus	15
Spirorbis rupestris	1, 15
Spirorbis spirorbis	1, 4, 14, 15, 16
Spirorbis tridentatus	1, 4, 7, 14, 15, 17, 18
Myzostomum cirriferum	17
Oligochaeta indet.	8, 12, 22
Paranais litoralis	2, 3, 9, 17
Nais elinguis	17
Tubificidae indet.	1, 7, 8, 10, 12, 15, 16, 18, 21
Clitellio arenarius	15, 17
Heterochaeta costata	2, 3, 4, 8, 10, 11, 12, 13, 15, 17, 18, 20, 21, 22
Heterochaeta tubifex	17
Tubificoides amplivasatus	1, 4, 7, 13, 15, 21
Tubificoides benedii	3, 6, 8, 10, 11, 13, 14, 16, 17, 18, 19, 20, 21, 22
Tubificoides pseudogaster	3, 6, 9, 10, 11, 18, 20, 21, 22
Enchytraeidae indet.	2, 1, 3, 4, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 18, 19, 20, 21, 23
Enchytraeus albidus	17
Fridericia sp.	17
Grania sp.	1, 4, 7, 15, 18
Lumbricillus lineatus	17
Lumbricillus pagenstecheri	17
Lumbricillus reynoldsoni	17
Lumbricillus scoticus	17
Lumbricillus semifuscus	17
Lumbricillus tuba	17

Chelicerata

Pycnogonida indet.	14, 15, 21, 23
Nymphon sp.	14
Nymphon brevirostre	17, 18
Nymphon gracile	15, 17
Achelia echinata	1, 4, 7, 17, 18, 22
Achelia hispida	1

Achelia longipes	13, 17
Endeis spinosa	17, 18
Callipallene brevirostris	1, 7, 18
Anoplodactylus petiolatus	1, 7, 13, 15, 18
Anoplodactylus pygmaeus	4
Phoxichilidium femoratum	17
Pycnogonum littorale	14, 15, 17, 21
Halacaridae indet.	2, 1, 4, 8, 10, 12, 13, 14, 16, 18, 21
Halacarus actenos	18

Crustacea

Evadne nordmanni	17
Podon intermedius	17
Podon leuckarti	17
Cirripedia indet.	1, 14, 16, 17, 18
Verruca stroemia	1, 4, 7, 13, 14, 15, 16, 17, 18
Chthamalus montagui	1, 4, 7, 12, 13, 14, 15, 16, 17, 18, 22
Chthamalus stellatus	1, 4, 14, 15, 16, 17, 21
Semibalanus balanoides	2, 1, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23
Balanus balanus	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Balanus crenatus	2, 1, 4, 7, 13, 14, 15, 16, 17, 18, 20, 21, 23
Balanus improvisus	17
Elminius modestus	4, 6, 7, 8, 10, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23
Trypetesa lampas	17, 21
Drepanorchis neglecta	17
Sacculina carcini	17, 21
Sacculina inflata	17
Peltogaster paguri	17
Peltogastrella sulcata	21
Copepoda indet.	1, 4, 13, 16, 18, 21
Acartia clausii	17
Acartia discaudata	17
Centropages hamatus	17
Temora longicornis	17
Pseudocalanus elongatus	17
Calanus finmarchicus	17
Harpacticoida indet.	13
Longipedia coronata	17
Longipedia minor	17
Longipedia scotti	17
Bradya typica	17
Ectinosoma melaniceps	17
Halectinosoma curticorne	17
Halectinosoma neglectum	17
Halectinosoma propinquum	17
Euterpina acutifrons	17
Harpacticus flexus	17
Harpacticus gracilis	17
Tigriopus brevicornis	1, 17, 21
Tigriopus fulvus	1, 17
Zaus spinatus	17
Tisbe ensifer	17
Tisbe furcata	17
Alteutha sp.	7
Alteutha depressa	17
Tegastes nanus	17
Itunella muelleri	17
Cletodes limicola	17
Heterolaophonte littoralis	17
Laophonte cornuta	17
Laophonte elongata	17
Dactylopusia neglecta	17
Dactylopusia tisboides	17
Dactylopusia vulgaris	17
Microthalestris littoralis	17
Parathalestris harpacticoides	17
Phyllothalestris mysis	17
Thalestris longimana	17
Thalestris rufoviolascens	17
Cyclopoida indet.	7
Enterocola sp.	17
Cyclopina sp.	21
Pachypygus gibber	17
Notodelphys allmani	17
Oithona nana	17
Acanthochondria limandae	21
Lichomolgus agilis	17
Lichomolgus forficula	21
Macrochiron fucicolum	21
Sabelliphilus elongatus	17, 21
Acontiophorus armatus	21
Artotrogus orbicularis	21
Caligus sp.	17
Congericola pallidus	17
Lernaeocera branchialis	17
Clavella sp.	17
Semicytherura nigrescens	17
Mysidae indet.	2, 1, 8, 13, 16, 18, 21, 22
Gastrosaccus lobatus	7
Gastrosaccus sanctus	23
Gastrosaccus spinifer	7
Leptomysis gracilis	13
Hemimysis lamornae	17
Neomysis integer	3, 8, 10, 12, 22
Praunus flexuosus	17
Praunus neglectus	17
Schistomysis kervillei	7
Schistomysis parkeri	2
Heteromysis formosa	17
Amphipoda indet.	2, 1, 3, 4, 5, 6, 7, 8, 10, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23
Gammaridae indet.	1, 3
Apherusa jurinei	14, 15
Calliopius laeviusculus	16
Gammarellus sp.	14
Gammarellus homari	17
Monoculodes carinatus	1, 13
Perioculodes longimanus	1, 4, 7, 13, 18, 21, 23
Pontocrates altamarinus	7, 13, 16, 18, 21, 22, 23
Pontocrates arenarius	2, 1, 3, 4, 7, 11, 13, 14, 16, 21, 22, 23
Synchelidium maculatum	1, 4, 7, 13, 18, 21
Westwoodilla caecula	18

Parapleustes assimilis	18
Parapleustes bicuspis	18
Stenopleustes nodifera	18
Amphilochus manudens	18
Amphilochus neapolitanus	1, 7, 13, 15, 16, 18
Leucothoe incisa	4, 7, 13, 16, 18, 22
Leucothoe lilljeborgi	4, 7, 18, 20
Colomastix pusilla	14
Cressa dubia	18
Metopa sp.	18
Metopa pusilla	18
Stenothoe sp.	14
Stenothoe marina	1, 4, 7, 15, 18, 21
Stenothoe monoculoides	15, 23
Hyale sp.	14, 15
Hyale prevostii	14, 15, 16, 17
Hyale perieri	17
Hyale stebbingi	15
Orchestia sp.	17
Orchestia gammarellus	15, 17
Talitrus saltator	7, 8, 13, 14, 17
Talorchestia deshayesii	13, 14, 15, 17
Urothoe brevicornis	3, 7, 16, 20, 21, 22
Urothoe elegans	1, 13, 15, 18
Urothoe marina	1, 13
Urothoe pulchella	3
Harpinia antennaria	1, 13, 21
Harpinia crenulata	1, 4
Harpinia pectinata	1, 7, 13, 18, 21
Parametaphoxus fultoni	7, 15
Lysianassidae indet.	4, 7
Acidostoma sp.	7, 14, 15
Acidostoma nodiferum	15
Hippomedon denticulatus	7, 18
Lepidepecreum longicorne	21
Nannonyx spinimanus	22
Orchomene nanus	7, 18, 21
Socarnes erythrophthalmus	7, 14
Tryphosella sarsi	17
Argissa hamatipes	1, 4, 7, 15, 18, 21, 23
Iphimedia obesa	17
Liljeborgia sp.	18
Liljeborgia kinahani	15
Atylus falcatus	7
Atylus guttatus	4, 14, 16
Atylus swammerdamei	4, 7, 13, 15, 16, 18, 21, 23
Atylus vedlomensis	1, 7, 13, 16, 18
Dexamine spinosa	14, 17
Dexamine thea	16
Guernea coalita	1, 7, 13, 15, 16, 18
Tritaeta gibbosa	14
Ampelisca sp.	1, 13
Ampelisca brevicornis	4, 7, 13, 16, 18, 21
Ampelisca spinipes	1, 7, 15, 18, 21
Ampelisca tenuicornis	1, 4, 7, 13, 15, 18, 21
Ampelisca typica	1, 15, 16, 18, 21
Bathyporeia sp.	3, 4, 7, 8, 10, 16, 17, 18
Bathyporeia elegans	3, 4, 7, 8, 13, 16, 21, 22, 23
Bathyporeia guilliamsoniana	1, 7, 13, 16, 18, 21, 22, 23
Bathyporeia nana	1, 7, 13, 18
Bathyporeia pelagica	2, 1, 3, 4, 7, 8, 10, 11, 12, 13, 14, 16, 18, 21, 22, 23
Bathyporeia pilosa	2, 1, 3, 8, 10, 12, 13, 16, 18, 19, 20
Bathyporeia sarsi	7, 13, 16, 18, 19, 21, 22, 23
Bathyporeia tenuipes	7, 18, 23
Haustorius arenarius	2, 3, 7, 8, 10, 12, 13, 14, 15, 16, 18, 19, 22, 23
Gammaridae indet.	1, 8, 10, 12, 13, 14, 15, 16, 18, 21, 22, 23
Echinogammarus marinus	15, 17
Echinogammarus stoerensis	17
Gammarus sp.	16, 17, 18, 21, 23
Gammarus chevreuxi	18
Gammarus duebeni	17
Gammarus locusta	14, 15, 16
Gammarus zaddachi	3
Pectenogammarus planicrurus	4, 7, 11, 13
Megaluropus agilis	1, 4, 7, 18, 21, 23
Melitidae indet.	1, 16, 18
Abludomelita obtusata	1, 7, 13, 15
Cheirocratus sp.	1, 4, 18
Cheirocratus assimilis	18
Cheirocratus sundevallii	4, 7
Maera othonis	1, 18
Maerella tenuimana	1, 15, 18
Melita sp.	15
Ampithoe rubricata	14, 15
Ampithoe gammaroides	15
Gammaropsis sp.	16
Gammaropsis maculata	4, 18
Gammaropsis nitida	18
Gammaropsis palmata	18
Gammaropsis cornuta	1, 7, 13, 15, 16, 18
Microprotopus maculatus	1, 4, 7, 13, 16, 17, 18, 21, 23
Photis longicaudata	1, 7, 15, 17, 21
Photis pollex	13
Ischyroceridae indet.	7
Ericthonius punctatus	7, 16
Ischyrocerus anguipes	18
Jassa sp.	1, 4, 13, 14, 15, 17, 18
Jassa falcata	4, 14, 15, 17, 18, 21
Microjassa cumbrensis	7, 13, 16, 18
Parajassa pelagica	17
Aoridae indet.	1, 4, 7, 13, 15
Aora sp.	14
Aora gracilis	7, 13, 16, 17, 18, 21
Leptocheirus hirsutimanus	13, 16, 18
Leptocheirus pectinatus	1, 7, 13, 18
Leptocheirus pilosus	17
Chelura terebrans	17
Corophium sp.	2, 3, 8, 9, 10, 16, 18, 19, 21, 22
Corophium arenarium	10, 12, 18, 19, 20, 21, 22
Corophium bonnellii	14, 17
Corophium crassicorne	13, 16, 18, 23

Corophium volutator	2, 1, 3, 4, 6, 8, 9, 10, 12, 13, 16, 18, 20, 21, 22
Siphonoecetes kroyeranus	4, 7, 13, 16, 18
Siphonoecetes striatus	13
Unciola planipes	15
Dyopedos sp.	1
Dyopedos monacanthus	18
Dyopedos porrectus	1, 4, 14, 15, 18
Podocerus variegatus	1
Caprellidae indet.	1, 8, 14, 16, 17, 18, 21
Caprella acanthifera	14
Caprella fretensis	17
Caprella linearis	7, 13, 14, 15, 17, 18
Caprella tuberculata	14
Pariambus typicus	1, 4, 7, 13, 15, 16, 18, 21, 23
Phtisica marina	1, 7, 13, 15, 16, 21
Pseudoprotella phasma	17
Hyperia galba	17
Isopoda indet.	10, 13, 14, 16, 18, 21
Gnathiidae indet.	11
Gnathia sp.	1, 7, 15, 16, 18
Gnathia maxillaris	15, 17
Gnathia oxyuraea	1, 7, 13, 16
Paragnathia formica	11
Anthura gracilis	1
Cyathura carinata	8, 9, 10, 11, 12, 17, 22
Limnoria lignorum	17
Conilera cylindracea	1
Eurydice sp.	8, 10, 16
Eurydice pulchra	2, 1, 3, 4, 7, 8, 10, 11, 12, 13, 14, 15, 16, 19, 21, 22, 23
Eurydice spinigera	2
Dynamene bidentata	14, 15, 17
Sphaeroma sp.	18
Sphaeroma monodi	7, 13
Sphaeroma rugicauda	1, 7, 8, 14, 15, 18, 21, 22
Sphaeroma serratum	17
Jaera albifrons	7, 15, 17
Jaera nordmanni	17
Janira maculosa	14, 17, 18
Janiropsis breviremis	14, 15
Munna sp.	13, 18
Munna minuta	17
Paramunna bilobata	15
Pleurogonidae indet.	14
Pleurogonium rubicundum	7
Desmosoma sp.	1, 15
Idotea sp.	1, 3, 7, 13, 14, 18, 21
Idotea baltica	4, 15, 16, 17
Idotea chelipes	4, 9, 13, 17
Idotea granulosa	1, 7, 13, 14, 15, 16, 17, 18, 21
Idotea linearis	7, 13, 16, 17
Idotea neglecta	15, 17
Idotea pelagica	17
Astacilla longicornis	1
Hemioniscus balani	17
Athelges paguri	17
Hemiarthrus abdominalis	17
Pleurocrypta galatheae	17
Pinnotherion vermiforme	21
Ligia oceanica	1, 8, 10, 12, 13, 14, 15, 16, 17, 18, 21, 22
Trichoniscus pusillus	18
Armadillidium album	1
Armadillidium vulgare	17
Tanais dulongii	15
Leptognathia gracilis	4, 7
Tanaopsis graciloides	1, 4, 7, 13, 16, 18, 21
Tanaissus lilljeborgi	13, 16
Apseudes talpa	15
Cumopsis goodsiri	2, 3, 13, 14, 16, 21, 22, 23
Bodotria sp.	7, 15
Bodotria pulchella	1, 4, 7, 13, 18
Bodotria scorpioides	1, 4, 7, 16, 17, 18, 21
Iphinoe sp.	18
Iphinoe trispinosa	4, 7, 13, 17, 18, 21, 23
Eudorella truncatula	1, 4, 7, 13, 15, 21
Eudorellopsis deformis	4, 7
Cumella pygmaea	15, 18
Pseudocuma longicornis	1, 4, 7, 13, 15, 17, 18, 21, 22, 23
Pseudocuma similis	1, 4, 7, 21, 23
Diastylis sp.	1, 4, 7, 13, 15, 23
Diastylis bradyi	7, 13, 16, 17, 18, 21, 23
Diastylis laevis	4, 7, 13, 15, 16, 18, 21
Diastylis rathkei typica	17
Diastylis rugosa	4, 7, 13, 18, 21, 23
Pasiphaea sivado	17
Leander tenuicornis	15
Palaemon sp.	14, 15, 21
Palaemon adspersus	15
Palaemon elegans	13, 14, 16, 17
Palaemon longirostris	14
Palaemon serratus	2, 1, 4, 7, 14, 15, 16, 17, 18, 21
Athanus nitescens	15, 17
Caridion steveni	17
Eualus pusiolus	17, 18
Hippolyte varians	7, 17
Thoralus cranchii	17
Processa sp.	4
Processa canaliculata	17
Processa edulis crassipes	4, 7, 13
Processa nouveli holthuisi	7, 13
Pandalina brevirostris	17
Pandalus sp.	7
Pandalus montagui	7, 13, 14, 17
Crangonidae indet.	16, 17
Crangon allmanni	15
Crangon crangon	4, 7, 8, 10, 12, 13, 15, 16, 17, 18, 20, 21, 22, 23
Pontophilus sp.	18
Philoceras fasciatus	17
Philoceras trispinosus	7, 16
Homarus gammarus	1, 7, 14, 15, 16, 17, 18, 21
Jaxea nocturna	17
Callianassa subterranea	1, 4, 17

Upogebia deltaura	1, 4, 7, 14, 16, 17, 18, 21, 23
Palinurus elephas	15, 17
Diogenes pugilator pugilator	7, 17
Paguridae indet.	1, 7, 13, 14, 15, 18
Anapagurus chiroacanthus	1, 4, 18
Anapagurus hyndmanni	1, 7, 13, 14, 15, 16, 17, 18, 21
Pagurus sp.	7, 14, 15, 16, 17, 18, 21
Pagurus bernhardus	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Pagurus cuanensis	1, 7, 13, 14, 16, 17, 18
Pagurus prideaux	14, 15, 17, 18
Galathea sp.	1, 7, 13, 14, 16, 18
Galathea intermedia	7, 14, 15, 16, 17, 18, 21
Galathea nexa	14, 18
Galathea squamifera	7, 14, 15, 16, 17, 18
Galathea strigosa	4, 7, 14, 15, 17, 18
Munida rugosa	14
Pisidia longicornis	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Porcellana platycheles	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Dromia personata	15
Ebalia sp.	7, 18
Ebalia tuberosa	14, 17, 18, 21
Ebalia tumefacta	1, 14, 16, 17
Maja squinado	1, 7, 14, 15, 16, 18
Hyas sp.	1, 7, 18
Hyas araneus	7, 13, 14, 16, 17, 18, 21
Hyas coarctatus	7, 14, 16, 17, 18, 21
Inachus sp.	1, 7, 14, 15, 16, 17, 21
Inachus dorsettensis	7, 13, 14, 16, 17, 18, 21
Inachus phalangium	1, 7, 13, 14, 16, 17, 18, 21
Macropodia sp.	7, 14, 15, 21
Macropodia rostrata	1, 4, 7, 13, 14, 16, 17, 18, 21, 23
Macropodia tenuirostris	7, 13
Eurynome sp.	7
Eurynome aspera	1, 7, 14, 16, 17, 21
Eurynome spinosa	7, 14
Pisa armata	7
Corystes cassivelaunus	1, 7, 13, 16, 17, 18, 21, 23
Atelecyclus rotundatus	18
Thia scutellata	7, 21
Cancer pagurus	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Liocarcinus sp.	1, 7, 14, 15, 16, 18, 21
Liocarcinus arcuatus	17
Liocarcinus corrugatus	14, 15
Liocarcinus depurator	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Liocarcinus holsatus	17, 21
Liocarcinus marmoreus	14
Necora puber	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Liocarcinus pusillus	7, 18
Carcinus maenas	2, 1, 3, 4, 5, 6, 7, 8, 10, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23
Portumnus latipes	7, 17
Goneplax rhomboides	1, 4
Monodaeus couchi	17
Pilumnus hirtellus	1, 4, 7, 13, 14, 15, 16, 17, 18
Xantho sp.	1, 14
Xantho incisus	7, 14, 18
Xantho pilipes	7, 15
Pinnotheres pisum	7, 13, 17

Insecta

Insecta indet.	9, 10, 11, 12, 20, 23
Chironomida indet.	2, 1, 3, 4, 8, 10, 11, 21, 22
Collembola indet.	2, 3, 10, 21
Petrobius maritimus	1, 10, 12, 13, 14, 16, 17, 18, 20, 21
Diptera larva	2, 3, 8, 9, 10, 12, 19, 21
Anurida maritima	2, 1, 4, 8, 10, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23
Coleoptera indet.	2, 3, 8, 9, 12, 21

Mollusca

Nematomenia banyulensis	18
Rhopalomenia aglaopheniae	17
Polyplacophora indet.	2, 14, 18, 22
Leptochiton asellus	1, 4, 7, 13, 15, 16, 17, 18, 23
Lepidochitona cinerea	4, 7, 10, 13, 14, 15, 16, 17, 18, 21
Tonicella marmorea	4, 13
Tonicella rubra	13, 18
Callochiton septemvalvis	17
Acanthochitona crinita	4, 14, 15, 17
Emarginula fissura	7, 16, 17, 18
Diodora graeca	14, 17, 18
Tectura testudinalis	18
Tectura virginea	4, 7, 14, 15, 17, 18
Patella depressa	1, 4, 14, 15, 17, 18
Patella ulyssiponensis	1, 4, 7, 13, 14, 15, 16, 17, 18
Patella vulgata	2, 1, 3, 4, 5, 7, 8, 9, 10, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23
Helcion pellucidum	1, 4, 7, 13, 14, 15, 16, 17, 18
Osilinus lineatus	4, 7, 13, 14, 17
Gibbula magus	13, 14
Gibbula tumida	1, 4, 7, 14, 16, 17, 18
Gibbula cineraria	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Gibbula umbilicalis	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Calliostoma zizyphinum	1, 4, 7, 13, 14, 15, 16, 17, 18, 23
Calliostoma granulatum	14
Dikoleps pusilla	15, 18
Skenea ossiansarsi	15, 18
Tricolia pullus	1, 4, 14, 15, 18, 21
Lacuna sp.	14, 16
Lacuna pallidula	18
Lacuna parva	14, 15, 16, 17, 18
Lacuna crassior	17

Lacuna vincta	7, 13, 14, 15, 16, 17, 18
Littorina littorea	2, 1, 3, 4, 5, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23
Melarhaphe neritoides	1, 4, 7, 10, 13, 14, 15, 17, 18, 21, 22, 23
Littorina mariae	8, 10, 13, 14, 15, 16
Littorina obtusata	2, 1, 8, 10, 12, 13, 14, 15, 16, 17, 18
Littorina neglecta	1, 7, 14, 15, 16, 21
Littorina nigrolineata	14, 15, 17, 18
Littorina saxatilis	2, 1, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23
Littorina obtusata mariae	2, 1, 3, 4, 7, 10, 12, 13, 16, 17, 18, 20, 21, 22, 23
Hydrobia ulvae	3, 22
Ventrosia ventrosa	2, 3, 4, 8, 9, 10, 11, 12, 19, 20, 21, 22
Rissoidae indet.	7, 13, 14, 16, 18
Rissoa interrupta	7, 17, 18
Rissoa parva	7, 14, 15, 16, 17, 18, 21
Pusillina inconspicua	4, 7, 13
Alvania semistriata	17, 21
Onoba aculeus	17
Obtusella intersecta	4, 15, 18
Hyala vitrea	1, 4, 17, 21
Ceratia proxima	4
Skeneopsis planorbis	15
Omalogyra atomus	21
Rissoella diaphana	1
Eatonina fulgida	18
Caecum glabrum	1, 7, 13, 15, 16, 17
Caecum trachea	1
Turritella communis	1, 4, 7, 13, 17
Bittium reticulatum	14
Cerithiopsis barleii	7
Chrysallida indistincta	4
Ondina divisa	13
Odostomia sp.	17
Odostomia turrita	6
Brachystomia sp.	13
Brachystomia eulimoides	1, 4
Brachystomia scalaris	7, 17
Epitonium clathrus	7, 17
Eulima bilineata	18
Aporrhais pespelecani	7, 15, 16, 17, 18
Trivia sp.	7, 14, 17, 18, 21
Trivia arctica	1, 4, 7, 13, 14, 15, 16, 17, 18
Trivia monacha	1, 4, 7, 13, 14, 15, 17, 18
Lamellaria	7
Lamellaria latens	13, 17
Lamellaria perspicua	16, 17, 18
Velutina velutina	17
Polinices sp.	16
Euspira catena	7, 16
Polinices pulchellus	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Trophon muricatus	18
Trophon truncatus	18
Nucella lapillus	1, 4, 7, 10, 13, 14, 15, 16, 17, 18, 21, 22, 23
Ocenebra erinacea	1, 13, 14, 15, 16, 17, 18
Buccinum undatum	4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Neptunea antiqua	18
Colus gracilis	7, 14, 17, 18
Hinia sp.	14
Hinia incrassata	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Hinia pygmaea	13
Hinia reticulata	1, 7, 13, 14, 15, 16, 17, 18
Haedropleura septangularis	7
Mangelia attenuata	7
Mangelia brachystoma	7
Oenopota rufa	17
Opisthobranchia indet.	1, 21
Acteon tornatilis	4, 7, 13
Scaphander lignarius	16, 17, 18
Cylichna cylindracea	1, 4, 7, 13, 17, 18
Philine sp.	7, 16, 18
Philine aperta	1, 4, 7, 13, 14, 16, 18
Philine punctata	21
Philine quadrata	16, 17
Diaphana minuta	1, 4, 7, 13, 15, 17, 18
Retusa obtusa	13, 16, 21, 22
Retusa truncatula	4, 7
Retusa umbilicata	13
Runcina coronata	14, 15
Elysia viridis	14, 15, 16
Hermaea bifida	17, 18
Limapontia capitata	17
Limapontia depressa	11
Limapontia senestra	17
Aplysia punctata	7, 14, 15, 16, 17, 18
Pleurobranchus membranaceus	17
Berthella plumula	15, 17, 18
Tritonia hombergii	14, 16, 17, 18, 21
Tritonia lineata	13, 14, 15, 17, 18, 21
Tritonia plebeia	16, 17
Dendronotus frondosus	14, 17, 18
Doto sp.	1, 4, 13, 14
Doto coronata	15, 16, 17, 18
Doto dunnei	1, 18
Doto fragilis	14, 15, 16
Doto pinnatifida	1, 7, 15, 16, 17, 18
Goniodoris castanea	17
Goniodoris nodosa	13, 14, 15, 16, 17, 18
Ancula gibbosa	17
Acanthodoris pilosa	1, 14, 15, 17, 18, 21
Adalaria proxima	17, 21
Onchidoris sp.	7, 14
Onchidoris bilamellata	1, 7, 14, 17, 18, 21, 22, 23
Onchidoris muricata	14, 17, 18
Onchidoris pusilla	17
Crimora papillata	14
Aegires punctilucens	17
Limacia clavigera	1, 7, 14, 15, 16, 17

Polycera faeroensis	14, 15
Polycera quadrilineata	1, 4, 7, 14, 15, 16, 17, 18
Palio dubia	17
Thecacera pennigera	1, 7, 14, 16
Cadlina laevis	1, 4, 15, 17, 18
Rostanga rubra	7, 17
Archidoris pseudoargus	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Geitodoris planata	17
Jorunna tomentosa	1, 14, 16, 17, 18
Janolus cristatus	4, 7, 14, 15, 16, 18, 21, 23
Janolus hyalinus	17
Hero formosa	17
Coryphella sp.	14, 17, 21
Coryphella browni	16
Coryphella gracilis	17, 18, 21
Coryphella lineata	1, 7, 14, 17, 18
Coryphella verrucosa	17
Flabellina pedata	1, 7, 13, 14, 15, 16, 17, 18, 21
Flabellina pellucida	17
Cuthona sp.	18
Cuthona caerulea	7, 17, 21
Cuthona concinna	17
Cuthona nana	17, 21
Cuthona rubescens	1
Cuthona viridis	21
Catriona gymnota	1, 17
Tergipes tergipes	17
Fiona pinnata	17
Embletonia pulchra	7, 13, 16, 17
Eubranchus exiguus	14, 17
Eubranchus farrani	16, 17
Eubranchus pallidus	17
Eubranchus tricolor	7, 14, 15, 16, 17, 18, 21
Facelina sp.	14, 17, 18
Facelina annulicornis	17
Facelina bostoniensis	1, 14, 17, 18, 21
Facelina auriculata	14, 18
Facelina auriculata	1, 14
Favorinus branchialis	17
Aeolidia papillosa	14, 17, 18
Aeolidiella sp.	14
Aeolidiella glauca	17
Auriculinella bidentata	11
Antalis entalis	17
Nucula sp.	16, 18
Nucula hanleyi	1, 15
Nucula nitidosa	1, 4, 7, 13, 14, 15, 17, 18, 21
Nucula nucleus	1, 7, 13, 15, 16, 18
Nuculoma tenuis	1, 15
Nuculana sp.	4, 18
Mytilus edulis	2, 1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23
Musculus sp.	7, 14
Musculus costulatus	15, 17
Musculus discors	14, 15, 17, 18
Modiolarca tumida	1, 7, 13, 14, 15, 17, 18
Modiolus sp.	7, 16
Modiolus adriaticus	15, 17
Modiolus barbatus	17
Modiolus modiolus	1, 4, 14, 15, 16, 18
Modiolula phaseolina	15, 21
Glycymeris glycymeris	15, 18
Ostrea edulis	1, 17
Pectinidae indet.	18
Chlamys sp.	14
Chlamys distorta	7, 14, 15, 17, 18
Chlamys varia	1, 4, 7, 13, 14, 15, 17, 18
Aequipecten opercularis	13, 14, 15, 17, 18, 21
Pecten maximus	14, 18
Anomiidae indet.	1, 7, 14, 15, 18
Anomia ephippium	1, 4, 7, 13, 14, 16, 17, 18
Pododesmus patelliformis	1, 4, 7, 13, 14, 15, 16, 17, 18, 20, 21, 23
Heteranomia squamula	17, 18
Lucinoma borealis	18
Thyasira flexuosa	1, 4, 7, 13, 17, 21
Lasaea adansoni	7, 15, 17
Semierycina nitida	1, 4, 7, 15
Kellia suborbicularis	1
Montacuta substriata	17
Devonia perrieri	4, 7
Mysella bidentata	1, 4, 7, 11, 13, 15, 16, 17, 18, 21, 22
Tellimya ferruginosa	4, 7, 13, 15, 17, 18, 21, 22
Lepton squamosum	4, 7
Astarte sulcata	1, 14, 15, 18
Goodallia triangularis	1, 4, 7, 15, 18
Acanthocardia echinata	1, 4, 7, 13, 15, 18
Parvicardium minimum	17
Parvicardium ovale	1, 7
Parvicardium scabrum	1
Laevicardium crassum	17, 21
Cerastoderma sp.	13
Cerastoderma edule	3, 8, 10, 11, 12, 17, 18, 19, 20, 21, 22
Cerastoderma glaucum	8, 10
Mactra sp.	7
Mactra stultorum	4, 7, 17, 22, 23
Spisula elliptica	1, 4, 7, 15, 16, 17, 18, 21
Spisula solida	7, 17, 21
Spisula subtruncata	17, 21, 22
Lutraria sp.	13
Lutraria lutraria	1, 4, 7, 15
Solen marginatus	7
Ensis sp.	7, 13, 14, 16, 18, 21, 22, 23
Ensis arcuatus	4, 7, 17, 18
Ensis ensis	1, 4, 7, 13, 16, 17
Ensis siliqua	7, 13, 16, 17, 21
Phaxas pellucidus	1, 4, 7, 13, 15, 16, 17, 18, 21
Tellinidae indet.	8, 10
Angulus tenuis	7, 8, 10, 11, 12, 13, 17, 18, 21, 22
Arcopagia crassa	1, 7, 15, 17

Fabulina fabula	1, 4, 7, 13, 16, 17, 18, 21, 22, 23
Moerella donacina	15, 17, 21
Moerella pygmaea	1, 4, 7, 15
Macoma balthica	2, 3, 8, 10, 11, 12, 13, 17, 18, 20, 21, 22
Donax variegatus	7
Donax vittatus	7, 13, 21, 22, 23
Gari fervensis	7, 16, 17, 21
Gari tellinella	17
Gari depressa	17
Scrobiculariidae indet.	9
Scrobicularia plana	2, 3, 8, 9, 10, 11, 12, 17, 19, 21, 22
Abra sp.	18
Abra alba	1, 4, 6, 7, 8, 10, 13, 14, 15, 16, 17, 18, 21, 22
Abra nitida	1, 4, 7, 13, 18
Abra prismatica	4, 7
Solecurtus scopula	4
Pharus legumen	7, 21
Arctica islandica	1, 4, 7, 13, 15, 16, 18
Veneridae indet.	1
Venus verrucosa	14, 17
Circomphalus casina	4, 14, 15, 18
Dosinia sp.	7, 13, 16
Dosinia lupinus	1, 4, 7, 13, 16, 21
Dosinia exoleta	1, 4, 7, 15, 17, 18, 21
Tapes decussatus	13, 17
Tapes aureus	13
Tapes rhomboides	1, 17
Venerupis senegalensis	7, 13, 17, 18, 22
Chamelea gallina	1, 4, 7, 13, 16, 17, 21
Clausinella fasciata	1, 7, 14, 17, 21
Timoclea ovata	1, 7, 15, 17, 18
Petricola pholadiformis	17
Mysia undata	4, 13
Turtonia minuta	18
Mya truncata	1, 7, 13, 15, 16, 17, 18, 21
Mya arenaria	7, 8, 9, 11, 13, 17
Sphenia binghami	7, 21
Corbula gibba	1, 4, 7, 13, 15
Hiatella arctica	7, 14, 15, 16, 17, 18, 21, 22, 23
Saxicavella jeffreysi	13
Barnea candida	17
Barnea parva	17
Zirfaea crispata	17
Martesia striata	17
Psiloteredo megotara	17
Lyonsia norwegica	1, 18
Thracia sp.	21, 22
Thracia phaseolina	1, 4, 7, 13, 15, 17
Thracia pubescens	17
Thracia villosiuscula	1, 4, 7, 13, 17, 18, 21
Thracia distorta	17
Cochlodesma praetenue	4, 7, 13, 17
Sepiola atlantica	17, 23
Alloteuthis subulata	17
Todarodes sagittatus	17
Octopus vulgaris	14
Eledone cirrhosa	14, 15, 17

Brachiopoda

Gwynia capsula	17
Argyrotheca cistellula	17

Bryozoa

Bryozoa indet.	1, 14, 16
Cyclostomatida indet.	7, 15, 16
Crisiidae indet.	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Crisidia cornuta	7, 14, 15, 17, 18, 21, 23
Crisia sp.	7, 9, 18
Crisia aculeata	7
Crisia denticulata	1, 4, 7, 14, 15, 17, 18
Crisia eburnea	1, 7, 13, 14, 15, 17, 18, 21
Stomatoporina incurvata	17
Tubulipora flabellaris	17
Plagioecia patina	14, 17, 18
Lichenopora sp.	14
Disporella hispida	1, 14, 17
Alcyonidium sp.	14, 15, 16
Alcyonidium diaphanum	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Alcyonidium gelatinosum	2, 3, 4, 7, 13, 14, 15, 16, 17, 18, 20, 21
Alcyonidium hirsutum	4, 7, 15, 16, 17, 18, 21, 23
Alcyonidium mytili	7, 16
Alcyonidium parasiticum	1, 7, 17, 18, 21
Flustrellidra hispida	1, 4, 7, 8, 10, 12, 13, 14, 15, 16, 17, 18, 21, 23
Nolella dilatata	13
Walkeria uva	15, 17
Vesicularia spinosa	1, 7, 14, 15, 16, 18, 21, 23
Amathia lendigera	7, 11, 16, 17, 23
Bowerbankia sp.	7, 14, 15, 16, 18, 23
Bowerbankia citrina	7, 14, 15, 18
Bowerbankia imbricata	14, 15, 17, 20
Bowerbankia pustulosa	7, 15, 16, 18
Umbonula littoralis	1, 7, 13, 14, 15, 16, 17, 18
Escharoides coccinea	7, 14, 15, 16, 17
Cryptosula pallasiana	17, 23
Pentapora foliacea	1, 14, 15, 18
Smittina landsborovii	14, 21
Smittoidea reticulata	15
Parasmittina trispinosa	1, 7, 14, 18
Escharella sp.	15
Escharella immersa	1, 14
Escharella variolosa	1, 7, 14, 15
Schizoporella unicornis	14, 15, 17, 18
Schizomavella sp.	14
Schizomavella auriculata	1, 14, 15
Schizomavella linearis	7, 14, 15, 21
Microporella ciliata	15
Fenestrulina malusii	14
Chorizopora brongniartii	15
Celleporella hyalina	14, 15, 17
Rhynchozoon bispinosum	15

Cellepora pumicosa	1, 4, 7, 14, 15, 16, 17, 18, 21
Celleporina hassallii	14, 15, 17, 18
Omalosecosa ramulosa	14, 15, 18
Buskea dichotoma	15
Aetea anguina	11, 14
Scruparia sp.	18
Scruparia chelata-	14, 15
Eucratea loricata	14, 15, 16, 18, 21
Membranipora membranacea	1, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Conopeum reticulum	7, 14, 15, 16, 17
Electra pilosa	1, 3, 4, 5, 7, 9, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23
Flustra foliacea	1, 4, 7, 9, 13, 14, 15, 16, 17, 18, 21, 23
Chartella papyracea	14, 15, 17, 18, 21
Securiflustra securifrons	1, 7, 18
Hincksina flustroides	15
Callopora sp.	15
Amphiblestrum auritum	1
Cellaria sp.	1, 14, 15, 18
Cellaria fistulosa	1, 4, 14, 15, 16, 18, 21
Cellaria salicornioides	21
Cellaria sinuosa	1, 14, 15, 18, 21
Scrupocellaria sp.	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Scrupocellaria reptans	1, 7, 14, 15, 17, 18, 20
Scrupocellaria scrupea	14, 15, 18
Scrupocellaria scruposa	1, 7, 14, 15, 16, 17, 18, 21
Tricellaria ternata	14
Bicellariella ciliata	1, 4, 7, 14, 15, 17, 18, 21, 23
Bugula sp.	7, 16, 17, 18, 21
Bugula avicularia	17
Bugula flabellata	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Bugula fulva	18
Bugula plumosa	1, 7, 13, 14, 15, 16, 17, 18, 21
Bugula turbinata	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Bryozoa indet. (crusts)	1, 4, 7, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23

Phoronida

Phoronis sp.	1, 4, 7, 13, 15, 16, 18, 21, 23
Phoronis hippocrepia	17, 18, 21
Phoronis muelleri	17, 18, 21
Phoronis ovalis	15, 18
Phoronis pallida	4, 7, 18

Echinodermata

Antedon bifida	1, 4, 7, 14, 15, 16, 17, 18, 21
Astropecten irregularis	1, 7, 13, 14, 17, 21, 23
Luidia ciliaris	15
Asterina gibbosa	4, 14, 15, 18, 20
Asterina phylactica	14, 15, 18
Anseropoda placenta	14
Crossaster papposus	1, 7, 14, 15, 16, 17, 18, 21
Henricia sp.	1, 7, 13, 14, 15, 16, 17, 18, 21
Henricia oculata	1, 4, 7, 13, 14, 15, 16, 17, 18
Henricia sanguinolenta	7, 14, 15, 16, 17
Stichastrella rosea	17
Asterias rubens	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Leptasterias muelleri	16, 18, 21
Marthasterias glacialis	13, 14, 15, 16
Ophiuroidea indet.	1, 4, 7, 13, 15, 16, 18, 21
Ophiothrix fragilis	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Ophiocomina nigra	1, 4, 14, 16, 18, 21
Ophiactis balli	7
Ophiopholis aculeata	1, 13, 14, 18
Amphiuridae indet.	16, 18, 21, 23
Amphiura brachiata	4, 7, 13, 16, 17, 18, 21, 22
Amphiura chiajei	1, 4, 18
Amphiura filiformis	1, 4, 7, 13, 16, 18, 21
Amphiura chiajei/filiformis	7, 13, 18, 21
Amphipholis squamata	1, 4, 7, 14, 15, 17, 18, 21, 22
Ophiura sp.	1, 7, 13, 15, 17, 18, 21, 22
Ophiura affinis	1, 4, 15
Ophiura albida	1, 13, 15, 16, 17, 18, 21
Ophiura ophiura	1, 7, 13, 14, 15, 16, 17, 18, 21
Psammechinus miliaris	1, 4, 7, 13, 14, 16, 17, 18, 21, 22, 23
Echinus esculentus	14, 15, 17, 18, 23
Echinocyamus pusillus	17
Spatangidae indet.	21, 22
Spatangus purpureus	17, 21
Echinocardium sp.	21, 23
Echinocardium cordatum	4, 7, 13, 16, 17, 18, 21, 22, 23
Holothurioidea indet.	1, 4, 15
Holothuria forskali	18
Cucumariidae indet.	1, 7, 14, 15
Leptopentacta elongata	4
Paracucumaria hyndmani	7, 17, 18
Pawsonia saxicola	1, 4, 7, 13, 14, 17, 18
Aslia lefevrei	1, 14, 15, 18
Ocnus lacteus	18
Ocnus planci	13
Thyone fusus	1, 7, 16, 17, 18, 21
Thyone roscovita	7, 16
Neopentadactyla mixta	7, 14, 15, 16, 18, 21
Synaptidae indet.	1, 4, 15
Leptosynapta sp.	7, 18
Leptosynapta inhaerens	1, 4, 7, 13, 17, 18
Leptosynapta minuta	7, 17
Labidoplax sp.	7
Labidoplax digitata	1, 4, 7, 13

Hemichordata

Enteropneusta indet.	1, 15
Protoglossus koehleri	17

Saccoglossus ruber	17

Tunicata

Clavelina lepadiformis	1, 4, 7, 13, 14, 15, 16, 17, 18, 20, 21, 23
Clavelina sp. (pin-head)	14, 15, 16, 17, 18
Pycnoclavella aurilucens	7, 14, 15, 18
Distaplia rosea	1, 4, 7, 13, 14, 15, 16, 18, 21
Archidistoma aggregatum	14, 15, 18
Polyclinidae indet.	4, 7, 14, 15, 16, 17, 18, 21
Polyclinum aurantium	1, 4, 7, 13, 14, 15, 17, 18, 23
Synoicum incrustatum	7
Synoicum pulmonaria	17
Morchellium argus	1, 7, 13, 14, 15, 16, 17, 18, 20, 21, 23
Sidnyum sp.	1, 7, 14, 18
Sidnyum elegans	15, 17, 18
Sidnyum turbinatum	1, 7, 14, 15, 16, 17, 18, 20, 21, 23
Sidnyum sp. (strawberry)	14, 15, 17, 21
Aplidium sp.	7, 14, 15, 18
Aplidium glabrum	18
Aplidium nordmanni	7, 14, 15, 16, 17, 18, 21
Aplidium proliferum	7, 14, 17
Aplidium punctum	1, 7, 13, 14, 15, 16, 17, 18, 20, 21, 23
Didemnidae indet.	1, 4, 7, 14, 15, 16, 17, 18, 21
Trididemnum cereum	14, 17
Didemnum sp.	7
Didemnum gelatinosum	7, 17
Didemnum maculosum	7, 13, 14, 15, 16, 17, 18, 20, 21
Polysyncraton lacazei	14
Diplosoma listerianum	1, 7, 14, 15, 16, 17, 18, 21
Diplosoma spongiforme	7, 14, 15, 18, 21
Lissoclinum perforatum	1, 7, 14, 15, 18, 21
Ciona intestinalis	1, 7, 14, 15, 16, 17, 18, 21
Perophora listeri	1, 4, 7, 13, 14, 16, 17, 18, 23
Corella parallelogramma	1, 7, 14, 15, 18
Ascidiella sp.	1, 7, 14, 15, 16
Ascidiella aspersa	1, 7, 13, 14, 17, 18, 21
Ascidiella scabra	1, 7, 13, 14, 15, 16, 17, 18, 21
Ascidia sp.	14, 15
Ascidia conchilega	7, 13, 14, 15, 17, 18
Ascidia mentula	1, 4, 7, 13, 14, 15, 16, 17, 18
Ascidia virginea	4, 14, 15, 16
Phallusia mammillata	15
Styela clava	13
Styela partita	16
Polycarpa sp.	1, 13, 14, 15, 18
Polycarpa fibrosa	1, 7, 13, 15
Polycarpa pomaria	1, 7, 14, 15, 17, 18, 21
Polycarpa scuba	1, 13, 14, 15, 16, 18, 21, 23
Polycarpa violacea	17
Dendrodoa grossularia	1, 4, 7, 13, 14, 15, 16, 17, 18, 20, 21
Distomus variolosus	14, 15, 16, 18
Stolonica socialis	14, 15, 18
Botryllus schlosseri	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Botrylloides leachi	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Pyura sp.	18
Pyura squamulosa	13
Pyura tessellata	14, 15
Pyura microcosmus	13
Molgula sp.	1, 7, 14, 16, 18
Molgula citrina	17
Molgula complanata	17, 18
Molgula manhattensis	1, 4, 13, 14, 15, 16, 18
Molgula occulta	7, 14, 15, 16, 18
Molgula oculata	16, 18
Eugyra arenosa	1, 4, 7, 15, 16, 18

Cephalochordata

Branchiostoma lanceolatum	1, 22

Pisces

Lampetra fluviatilis	17
Lamna nasus	17
Cetorhinus maximus	17
Alopias vulpinus	17
Scyliorhinus canicula	7, 13, 14, 15, 16, 17, 18
Scyliorhinus stellaris	7, 14
Galeorhinus galeus	17
Mustelus mustelus	15, 17
Squalus acanthias	21
Squatina squatina	17
Torpedo nobiliana	17
Raja batis	16
Raja clavata	7, 18
Raja montagui	17
Raja radiata	17
Raja undulata	17
Dasyatis pastinaca	17
Anguilla anguilla	2, 4, 17
Conger conger	14, 15, 16, 17, 18, 21
Alosa fallax	17
Clupea harengus	17, 21
Sardina pilchardus	17
Sprattus sprattus	17
Engraulis encrasicolus	17
Salmo salar	17
Diplecogaster bimaculata	17
Lepadogaster sp.	14
Lepadogaster lepadogaster	15
Lophius piscatorius	14, 16, 17, 18
Gadidae indet. (Juveniles)	7, 13, 18
Ciliata mustela	4, 17, 18
Gadus morhua	1, 7, 15
Gaidropsarus mediterraneus	17
Merlangius merlangus	7, 17
Molva molva	7, 18
Pollachius sp.	14, 16, 18
Pollachius pollachius	7, 14, 15, 17, 18
Pollachius virens	1, 13, 14, 16, 18
Raniceps raninus	17
Trisopterus luscus	7, 14, 17, 18, 21

Trisopterus minutus	7, 14, 16, 18, 21
Belone belone	17
Atherina presbyter	17
Gasterosteus aculeatus	7
Spinachia spinachia	15, 17
Entelurus aequoreus	7, 14, 17, 23
Nerophis lumbriciformis	15, 17, 18
Syngnathus acus	1, 4, 7, 13, 14, 16, 17, 18
Syngnathus rostellatus	7, 16, 17
Scorpaena sp.	7
Scorpaena scrofa	7
Aspitrigla cuculus	13, 14
Eutrigla gurnardus	7, 13, 18
Myxocephalus scorpius	1, 7, 13, 14, 17, 18, 21
Taurulus bubalis	1, 7, 13, 14, 15, 16, 17, 18, 21, 23
Agonus cataphractus	1, 7, 13, 14, 17
Cyclopterus lumpus	17
Liparis liparis	17
Liparis montagui	17
Dicentrarchus labrax	13, 14, 17, 18
Brama brama	17
Pagellus sp.	17
Spondyliosoma cantharus	17
Centrolabrus exoletus	7, 14, 15, 16, 17, 18
Crenilabrus melops	7, 13, 14, 15, 17, 18
Ctenolabrus rupestris	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Labrus bergylta	1, 7, 13, 14, 15, 16, 18, 21
Labrus mixtus	4, 14, 15, 16, 17, 18
Echiichthys vipera	21
Blenniidae indet.	7, 14, 16
Lipophrys pholis	1, 4, 7, 10, 13, 14, 15, 16, 18, 21, 23
Parablennius gattorugine	1, 7, 13, 14, 15, 16, 17, 18
Anarhichas lupus	17
Chirolophis ascanii	14
Pholis gunnellus	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Ammodytes sp.	7, 14, 18
Ammodytes tobianus	7, 8, 10, 13, 14, 15, 16, 17, 18, 21
Hyperoplus lanceolatus	15, 17
Callionymus sp.	14, 15, 16, 17
Callionymus lyra	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Callionymus reticulatus	18
Gobiidae indet.	16, 17, 18, 21
Gobius sp.	2, 14, 15
Gobius niger	7, 13, 14, 18
Gobius paganellus	4, 7, 17
Gobiusculus flavescens	7, 14, 15, 16, 17, 18
Pomatoschistus sp.	1, 7, 13, 14, 18, 21, 23
Pomatoschistus minutus	7, 13, 14, 15, 16, 17, 18, 21, 22
Pomatoschistus pictus	7, 14, 16, 17, 18
Thorogobius ephippiatus	7, 14, 15, 18, 21
Phrynorhombus norvegicus	13, 18
Psetta maxima	14, 17
Scophthalmus rhombus	15
Zeugopterus punctatus	1, 14, 15, 18
Pleuronectidae indet. (juveniles)	1, 7, 14, 17, 18, 21, 23
Pleuronectes platessa	1, 7, 13, 14, 15, 16, 18, 21, 23
Buglossidium luteum	7
Solea solea	1, 7, 13, 14

Cyanophycota

Cyanophycota indet.	14, 15, 16, 18
Oscillatoria rosea	14

Rhodophycota

Porphyropsis sp.	14, 15
Porphyropsis coccinea	14, 15
Bangia atropurpurea	15, 17
Porphyra sp.	2, 1, 3, 4, 7, 14, 15, 16, 17, 18, 21, 23
Porphyra leucosticta	14, 15
Porphyra linearis	4, 7, 16, 23
Porphyra purpurea	3, 4, 7, 13, 14, 16, 17, 21, 22
Porphyra umbilicalis	1, 3, 4, 7, 14, 15, 16, 17, 18, 21, 22, 23
Audouinella sp.	2, 1, 3, 4, 7, 8, 10, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23
Rhodothamniella floridula	2, 1, 15, 16, 17, 21
Audouinella membranacea	14, 15
Audouinella purpurea	15, 17, 21
Audouinella virgatula	15
Schmitziella endophloea	14
Helminthocladia calvadosii	7, 13, 14
Helminthora divaricata	7
Nemalion helminthoides	13, 14, 15
Scinaia sp.	13, 14
Scinaia furcellata	7, 13, 14, 18
Scinaia trigona	7, 14, 15
Atractophora hypnoides	7, 15
Naccaria wiggii	7, 14, 15, 18
Asparagopsis armata	14
Bonnemaisonia sp.	13, 15
Bonnemaisonia asparagoides	1, 7, 13, 14, 15, 16, 18
Bonnemaisonia hamifera	14, 16, 18
Trailliella intricata	1, 7, 13, 14, 15, 16
Gelidium sp.	14, 15, 16
Gelidium latifolium	4, 13, 14, 15, 16, 18, 21, 23
Gelidium pusillum	1, 4, 10, 12, 13, 14, 15, 16, 17, 18, 21, 22, 23
Pterocladia capillacea	4, 14, 15
Palmaria palmata	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Dilsea carnosa	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Dudresnaya verticillata	14, 16, 18
Dumontia contorta	2, 1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Harveyella mirabilis	17
Holmsella pachyderma	17
Dermocorynus montagnei	14
Grateloupia filicina	7, 14
Callophyllis laciniata	14, 15, 16, 18
Kallymenia reniformis	14, 15, 18

Meredithia microphylla	7, 13, 14, 15, 16, 18
Gloiosiphonia capillaris	7, 14, 16
Peyssonnelia sp.	7, 18
Peyssonnelia dubyi	14, 16
Hildenbrandia sp.	2, 1, 10, 12, 14, 15, 16
Hildenbrandia rubra	2, 1, 3, 4, 6, 7, 8, 10, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23
Corallinaceae indet. (crusts)	2, 1, 4, 7, 10, 13, 14, 15, 16, 17, 18, 21, 22, 23
Corallina officinalis	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Hydrolithon sp.	15
Jania rubens	4, 7, 17
Lithophyllum sp.	15
Lithophyllum incrustans	1, 15
Lithothamnion sp.	14
Lithothamnion corallioides	18
Lithothamnion glaciale	1, 17
Mesophyllum lichenoides	15, 18
Phymatolithon calcareum	14, 18
Phymatolithon lenormandii	1, 15
Titanoderma pustulatum	15
Titanoderma litorale	13, 14
Gracilaria gracilis	4, 7, 13, 14, 15, 16, 17, 18, 21
Schmitzia sp.	14, 15
Schmitzia hiscockiana	14, 15, 18
Schmitzia neapolitana	7, 14, 15, 18
Ahnfeltia plicata	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Gymnogongrus crenulatus	7, 14, 21
Phyllophora sp.	14, 15, 17, 18, 21
Phyllophora crispa	1, 4, 7, 13, 14, 15, 16, 18, 21
Phyllophora pseudoceranoides	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Erythrodermis traillii	4, 7, 14, 15, 16, 18
Coccotylus truncata	7, 14, 17
Schottera nicaeensis	1, 7, 13, 14, 15, 16, 18, 21
Stenogramme interrupta	1
Mastocarpus stellatus	2, 1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Mastocarpus stellatus (*Petrocelis*)	15
Chondrus crispus	2, 1, 3, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Chondracanthus acicularis	18
Polyides rotundus	1, 4, 7, 13, 14, 15, 16, 17, 18, 20, 21
Plocamium cartilagineum	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Sphaerococcus coronopifolius	7, 14, 15
Sphaerococcus coronopifolius (*Haematocelis*)	15
Furcellaria lumbricalis	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Halarachnion ligulatum	7, 13, 14, 15, 16, 18
Catenella caespitosa	2, 1, 4, 7, 8, 10, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22
Calliblepharis ciliata	1, 7, 13, 14, 15, 16, 17, 18, 21
Calliblepharis jubata	7, 16, 18
Cystoclonium purpureum	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Rhodophyllis divaricata	7, 13, 14, 15, 18
Cruoria sp.	16
Cruoria pellita	7, 14, 15, 18
Cruoria cruoriaeformis	14
Haemescharia hennedyi	2, 14, 15, 16, 18
Cordylecladia erecta	1, 7, 14, 16, 17
Rhodymenia sp.	1, 14, 15
Rhodymenia delicatula	7, 14, 15, 16, 21
Rhodymenia holmesii	1, 7, 14, 15, 16, 18, 23
Rhodymenia pseudopalmata	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Rhodymenia ardissonei	7, 16, 18
Chylocladia verticillata	7, 14, 17, 21
Gastroclonium ovatum	1, 14, 15, 16, 17, 18
Gastroclonium reflexum	13, 14
Lomentaria sp.	7, 14
Lomentaria articulata	1, 4, 13, 14, 15, 16, 17, 18, 21, 22, 23
Lomentaria clavellosa	1, 7, 14, 15, 16, 17, 18
Lomentaria orcadensis	7, 14, 15, 16, 17, 18
Antithamnion sp.	7, 13, 16
Antithamnion cruciatum	7, 14
Antithamnionella spirographidis	14, 18
Callithamnion sp.	7, 13, 14, 15, 16, 18
Aglaothamnion byssoides	7, 14, 15, 16
Callithamnion granulatum	1, 15
Aglaothamnion hookeri	14, 15
Aglaothamnion roseum	17
Aglaothamnion sepositum	14, 15
Callithamnion tetragonum	1, 14, 15, 18
Callithamnion tetricum	15
Callithamnion sp. (spongy)	1, 16
Ceramium sp.	2, 1, 4, 7, 10, 13, 14, 15, 16, 17, 18, 21, 22, 23
Ceramium pallidum	1, 13, 14, 16, 18, 22
Ceramium ciliatum	14, 15, 18
Ceramium deslongchampii	14, 18
Ceramium diaphanum	7, 14, 16, 17, 18, 23
Ceramium echionotum	1, 4, 16, 18
Ceramium cimbricum	7, 14, 16
Ceramium gaditanum	1, 14, 15, 21
Ceramium flaccidum	14
Ceramium nodulosum	1, 4, 7, 10, 13, 14, 15, 16, 17, 18, 21
Ceramium shuttleworthianum	1, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Ceramium secundatum	7
Ceramium strictum	7, 14, 15
Ceramium botryocarpum	4, 8, 14, 16
Compsothamnion	14, 15
Compsothamnion thuyoides	13, 14, 18
Compsothamnion gracillimum	7
Crouania attenuata	7

Griffithsia corallinoides	7, 13, 14, 15, 17, 20, 21
Halurus flosculosus	7, 14, 15, 16, 17, 18, 21, 23
Halurus equisetifolius	1, 7, 13, 14, 15, 16, 18
Anotrichium barbatum	13
Monosporus pedicellatus	7, 17
Pleonosporium caribbaeum	14
Plumaria plumosa	1, 14, 15, 16, 17, 18, 21
Pterothamnion plumula	7, 13, 14, 15, 16, 17, 18, 21
Pterothamnion crispum	7, 14
Pterothamnion plumula	7, 14
Ptilota gunneri	14, 16, 17, 18
Ptilothamnion pluma	13
Seirospora seirosperma	14
Spermothamnion sp.	7
Spermothamnion repens	7, 14, 17
Spermothamnion strictum	18
Sphondylothamnion multifidum	7, 13, 14, 15, 16
Spyridia filamentosa	7, 13, 17
Acrosorium sp.	7, 18
Acrosorium reptans	14, 15, 16, 18
Acrosorium venulosum	7, 13, 14, 15, 16, 18
Apoglossum ruscifolium	1, 7, 13, 14, 15, 16, 18, 21
Cryptopleura ramosa	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Delesseria sanguinea	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Drachiella sp.	16, 18
Drachiella spectabilis	14, 15
Drachiella heterocarpa	1, 4, 7, 14, 15
Hypoglossum hypoglossoides	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Membranoptera alata	1, 4, 7, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23
Haraldiophyllum bonnemaisonii	1, 7, 14, 15, 16, 18
Nitophyllum punctatum	1, 7, 14, 18
Phycodrys rubens	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Erythroglossum laciniatum	1, 7, 14, 15, 16, 17, 18, 21
Radicilingua thysanorhizans	7, 14, 15, 16
Dasya sp.	15
Dasya hutchinsiae	14, 15
Dasya ocellata	17
Heterosiphonia plumosa	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Bostrychia scorpioides	17
Brongniartella byssoides	1, 7, 13, 14, 15, 16, 17, 18, 21
Chondria dasyphylla	1, 7, 13, 14, 15, 16
Chondria tenuissima	17
Osmundea sp.	4, 18
Osmundea hybrida	1, 4, 7, 13, 14, 15, 17, 21, 22
Osmundea pinnatifida	1, 4, 13, 14, 15, 16, 17, 18, 21, 23
Odonthalia dentata	18
Polysiphonia sp.	1, 4, 7, 8, 13, 14, 15, 16, 17, 18, 21, 22, 23
Polysiphonia atlantica	14
Polysiphonia brodiei	1, 13, 15, 18
Polysiphonia devoniensis	7
Polysiphonia elongata	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Polysiphonia elongella	7
Polysiphonia fibrata	7
Polysiphonia fibrillosa	16
Polysiphonia sanguinea	13
Polysiphonia lanosa	2, 7, 8, 10, 12, 13, 14, 15, 16, 17, 18, 20, 21
Polysiphonia harveyi	7
Polysiphonia nigra	1, 7, 14, 15, 17, 18, 21
Polysiphonia fucoides	1, 4, 7, 8, 10, 13, 14, 16, 17, 18, 21, 22, 23
Polysiphonia spiralis	1, 15, 18
Polysiphonia stricta	1, 7, 13, 14, 15, 16, 17, 18
Polysiphonia violacea	14
Pterosiphonia sp.	10, 15
Pterosiphonia parasitica	14, 15, 16, 18
Boergeseniella thuyoides	17
Rhodomela sp.	18
Rhodomela confervoides	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 23
Rhodomela lycopodioides	16, 18
Filamentous red algae	7, 13, 14
Rhodophycota indet. (non-calcareous crusts)	1, 7, 13, 14, 15, 16, 18, 21

Chrysophycota

Diatoms - colonial	1, 7, 13, 15, 18, 21
Diatoms - film	4, 7, 13, 14, 16, 18, 20, 21

Chromophycota

Ectocarpaceae indet.	2, 4, 7, 8, 10, 12, 13, 14, 15, 16, 18, 20, 21
Ectocarpus fasciculatus	15, 17
Ectocarpus siliculosus	7, 15, 17
Hincksia sp.	16, 18
Hincksia granulosa	17
Hincksia hincksiae	15, 17
Pilayella littoralis	1, 7, 15, 17
Spongonema tomentosum	1, 7, 10, 14, 15, 16, 17, 18, 21
Pseudolithoderma sp.	7, 14, 15, 16
Ralfsia verrucosa	7, 14, 15, 20
Chilionema reptans	21
Myrionema sp.	17
Myrionema strangulans	17
Elachista sp.	1, 3, 4, 10, 13, 14, 16, 17, 21
Elachista fucicola	2, 1, 14, 15, 16
Elachista scutulata	15
Leathesia difformis	1, 4, 13, 14, 15, 16, 17, 18, 21
Stilophora tenella	7
Chordaria flagelliformis	7, 17
Eudesme virescens	4, 7, 15, 17
Sauvageaugloia sp.	7

Sauvageaugloia griffithsiana	17
Cutleria sp.	1, 4, 7, 23
Cutleria multifida	7, 14, 15
Aglaozonia (asexual *Cutleria*)	7, 13, 14, 15, 18
Tilopteris mertensii	7
Sphacelaria sp.	7, 14, 16, 18, 21, 23
Sphacelaria cirrosa	7, 15, 16, 17
Sphacelaria plumigera	17
Sphacelaria plumosa	7, 17
Sphacelaria plumula	14
Sphacelaria radicans	14, 17, 21
Sphacelaria rigidula	7
Halopteris filicina	7, 14, 15, 16, 17, 18
Stypocaulon scoparia	7, 15, 17
Cladostephus spongiosus	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Dictyopteris membranacea	1, 7, 14, 15, 16, 18
Dictyota dichotoma	1, 4, 7, 13, 14, 15, 16, 17, 18, 21
Taonia atomaria	1, 7, 14, 15, 16, 18
Sporochnus pedunculatus	7, 14, 15, 16, 17
Desmarestia aculeata	7, 13, 14, 15, 16, 17, 18, 21
Desmarestia ligulata	7, 14, 15, 16, 17, 18
Desmarestia viridis	1, 7, 13, 14, 15, 16, 18
Arthrocladia villosa	7, 14, 15, 16, 17
Isthmoplea sphaerophora	17
Stictyosiphon tortilis	17
Giraudia sphacelarioides	7
Asperococcus sp.	7, 16, 18
Asperococcus compressus	7, 16
Asperococcus fistulosus	7, 13, 14, 15, 16, 17, 18
Punctaria sp.	7
Punctaria latifolia	7
Dictyosiphon sp.	7, 13, 14, 16
Dictyosiphon foeniculaceus	17
Colpomenia sp.	18
Colpomenia peregrina	15
Petalonia sp.	14, 15, 17
Petalonia fascia	1, 7, 14, 16
Petalonia filiformis	7
Scytosiphon lomentaria	1, 7, 13, 14, 15, 16, 17, 18
Chorda filum	7, 13, 14, 15, 16, 17, 18, 20, 21
Laminaria sp. (sporelings)	1, 4, 7, 14, 15, 16, 18, 21, 23
Laminaria digitata	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Laminaria hyperborea	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22
Laminaria saccharina	1, 4, 7, 13, 14, 15, 16, 17, 18, 21, 22, 23
Saccorhiza polyschides	4, 14, 15, 16, 18
Alaria esculenta	1, 7, 14, 15, 16, 17, 18
Ascophyllum nodosum	2, 3, 7, 8, 10, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22
Fucus sp. (sporelings)	1, 4, 7, 10, 13, 14, 15, 17, 21
Fucus ceranoides	2, 3, 5, 6, 8, 10, 12, 13, 17, 21, 22
Fucus serratus	2, 1, 4, 7, 10, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23
Fucus spiralis	2, 1, 3, 4, 7, 8, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23
Fucus vesiculosus	2, 1, 3, 4, 7, 8, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22
Pelvetia canaliculata	2, 1, 3, 4, 7, 8, 10, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22
Himanthalia elongata	14, 15, 18
Bifurcaria bifurcata	14, 15, 16, 21
Cystoseira nodicaulis	1, 13
Halidrys siliquosa	1, 4, 7, 13, 14, 15, 16, 17, 18, 20, 21
Filamentous brown algae	1, 14, 15, 16, 17
Chromophycota indet. (crusts)	1, 7, 14, 15

Chlorophycota

Ulothrix flacca	15
Entocladia flustrae	17
Enteromorpha sp.	2, 1, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23
Enteromorpha clathrata	17
Enteromorpha compressa	15, 17
Enteromorpha intestinalis	1, 3, 5, 7, 14, 15, 16, 17
Enteromorpha linza	14, 15, 17
Enteromorpha prolifera	17
Enteromorpha ramulosa	17
Ulva sp.	2, 1, 3, 4, 7, 8, 10, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23
Ulva lactuca	1, 15, 17, 21
Blidingia minima	1, 4, 15, 17
Prasiola stipitata	1, 4, 14, 15, 17, 21
Spongomorpha	7
Spongomorpha arcta	2, 1, 14, 15
Spongomorpha centralis	15
Chaetomorpha sp.	1, 14, 15, 16, 17, 18, 21
Chaetomorpha aerea	17
Chaetomorpha capillaris	15
Chaetomorpha linum	1, 14, 16, 17, 18
Chaetomorpha melagonium	1, 4, 14, 15, 16, 17, 18, 21, 22
Cladophora sp.	2, 1, 3, 4, 7, 10, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23
Cladophora hutchinsiae	15
Cladophora laetevirens	17
Cladophora pellucida	14, 15, 17, 21
Cladophora pygmaea	14
Cladophora rupestris	2, 1, 3, 4, 7, 12, 14, 15, 16, 17, 18, 21, 22, 23
Cladophora sericea	2, 4, 14, 15, 17, 18, 21
Rhizoclonium tortuosum	17
Bryopsis hypnoides	17, 18, 21
Bryopsis plumosa	1, 7, 13, 14, 15, 16, 17, 18, 21, 23

Derbesia marina	14, 15, 17
Codium sp.	14, 16
Codium fragile subsp. *tomentosoides*	13
Codium tomentosum	15, 21
Encrusting green algae indet.	1, 18
Filamentous green algae indet.	1, 7, 17

Angiospermae

Zostera marina	14, 16
Zostera noltii	20
Salicornia sp.	8, 10, 11, 19, 21
Armeria maritima	2, 8

Lichens

Anaptychia fusca	1, 8, 10, 12, 13, 16, 17, 18, 20
Arthropyrenia halodytes	1, 4, 7, 13, 16, 17, 20, 21, 22, 23
Caloplaca sp.	2, 8, 13, 14, 15, 16
Caloplaca marina	1, 4, 8, 10, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22
Caloplaca thallincola	1, 8, 10, 12, 14, 15, 17, 18, 20, 21, 22
Lecanora sp.	10, 17, 18, 22
Lecanora atra	1, 4, 6, 8, 10, 12, 13, 14, 16, 17, 18, 20, 21
Lecanora rupicola	12, 13, 17, 20
Lichina confinis	1, 8, 10, 13, 14, 15, 16, 17, 18, 21
Lichina pygmaea	1, 3, 4, 7, 10, 12, 13, 14, 15, 16, 17, 18, 21
Ochrolechia parella	1, 8, 10, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22
Ramalina sp.	1, 3, 8, 10, 12, 13, 14, 15, 16, 18, 20, 21
Ramalina siliquosa	14, 17, 18
Rhizocarpon sp.	10, 12
Verrucaria maura	2, 1, 3, 4, 6, 7, 8, 10, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22
Verrucaria microspora	17
Verrucaria mucosa	1, 3, 4, 7, 8, 9, 13, 14, 15, 16, 17, 18, 21, 23
Verrucaria striatula	17
Xanthoria parietina	1, 3, 6, 8, 10, 12, 13, 14, 15, 16, 17, 18, 20, 21
Grey lichens indet.	1, 3, 4, 6, 8, 12, 13, 14, 16, 18, 20, 21, 22

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