

Scottish Natural Heritage

Commissioned Report 352

Preliminary assessment of the conservation importance of benthic species and habitats off the west coast of Orkney and in the Pentland Firth in relation to the development of renewable energy schemes.



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COMMISSIONED REPORT

Summary

Preliminary assessment of the conservation importance of benthic species and habitats off the west coast of Orkney and in the Pentland Firth in relation to the development of renewable energy schemes.

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Background

The seabed habitats, species assemblages and biotopes at 22 sites off the west coast of Orkney and in the Pentland Firth were described from video footage collected in 2009 by Marine Scotland (Science), Aberdeen. The aim was to aid Scottish Natural Heritage (SNH) in providing a preliminary assessment of the conservation importance of benthic species and habitats in relation to the development of renewable energy schemes in the area.

Main findings

- Seven circalittoral biotopes were recorded at the 19 sites off the west coast comprising either fairly low diversity faunal crust communities on rock (supplemented in places with dense brittlestars) or clean sands and gravels, with scattered stones supporting a low diversity epifauna off Hoy. Two circalittoral biotopes were recorded at three tideswept sites in the Pentland Firth. To the west of Stroma the seabed has formed into waves of shelly sand with little evidence of biota. To the east of Stroma and to the south of South Ronaldsay scoured rock supports a low diversity community, dominated by *Urticina felina* and patches of erect bryozoans and hydroids.
- Two species of recognised conservation importance were recorded but it is considered that conservation of these species is unlikely to be adversely impacted by renewable energy developments in the surveyed area. The sandeel, *Ammodytes marinus*, also appears to be present and so the implications of energy schemes for this species will need to be considered. Assessment of the conservation importance of the infaunal community of the sedimentary habitats must await the results of infaunal sampling.
- Four of the biotopes recorded during the survey have been recognised as being of conservation importance. Three of these biotopes may be of local significance in terms of their possible role as sandeel habitats. The fourth biotope, tideswept reef, supports a low diversity community in the Pentland

Firth as a result of high current speeds combined with high scour. As a poor example of its type, it is considered to be locally of low conservation importance and probably of relatively low sensitivity to physical changes resulting from the establishment of renewable energy schemes.

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1. Introduction

In order to assess the likely environmental impact of the development of renewable energy schemes around the Orkney Islands, the Scottish Government commissioned Marine Scotland (Science), Aberdeen (MSS) to map relevant areas of the seabed. MSS subsequently requested Scottish Natural Heritage to provide commentary on the conservation status of species and habitats in the area. This report provides a description of the habitats observed by video during a survey carried out by MSS in 2009. It builds on similar work in the area carried out during 2008 (Moore, 2008). It aims to inform SNH on the habitats and species of the area, with a view to assessing their conservation importance.

2. Methods

Observation of the seabed was carried out at 24 sites off the west coast of Orkney and in the Pentland Firth during cruise 1009S by the *RV Scotia* from 23rd July to 2nd August 2009. Site positions are shown in Figures 1 and 2 and further site details listed in Table A1. At each site a dropdown video system was deployed just above the seabed along runs of approximately 20 minutes. The camera frame also carried a laser scaling system and a digital stills camera, which took vertically-orientated photographs of the seabed at intervals. The images were used to describe the nature of the seabed, in terms of the physical structure and the species assemblages. Species present were, as far as possible, identified and quantified using the semi-quantitative MNCR SACFOR scale (Hiscock, 1996). Based on the physical and biological attributes, biotopes were allocated (Connor *et al.*, 2004). At the time of writing, video footage from two sites (EOS/22, WMO/20) was unavailable.

Positional and depth data were acquired at intervals of approximately 6 seconds. In order to characterise the depths during the video runs, depth data were filtered to exclude deployment and retrieval data and spurious records, such as double sonar returns. This was achieved by determination of the first and third quartiles, which provide an indication of range. These figures were then converted to depth below chart datum, employing TotalTide software (Admiralty, Taunton) to determine tidal rise at the nearest secondary port.

Figure 1 Video sites in the northern part of the surveyed area

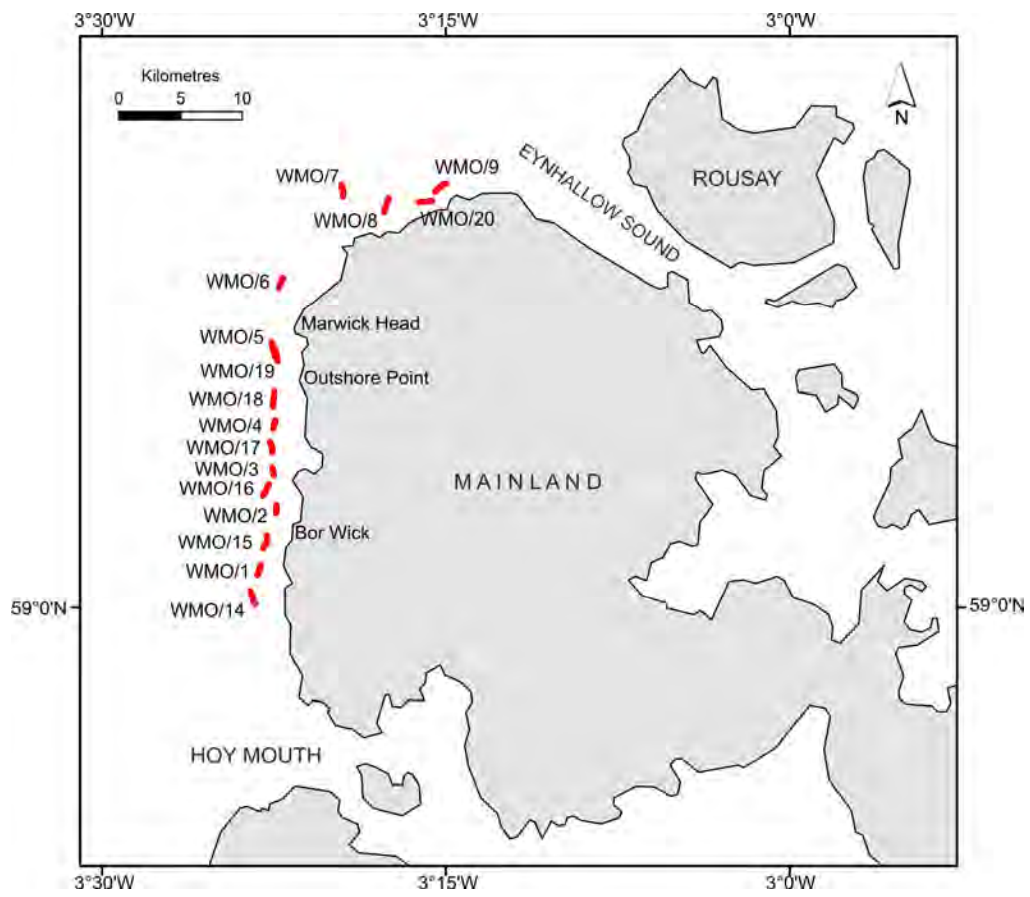
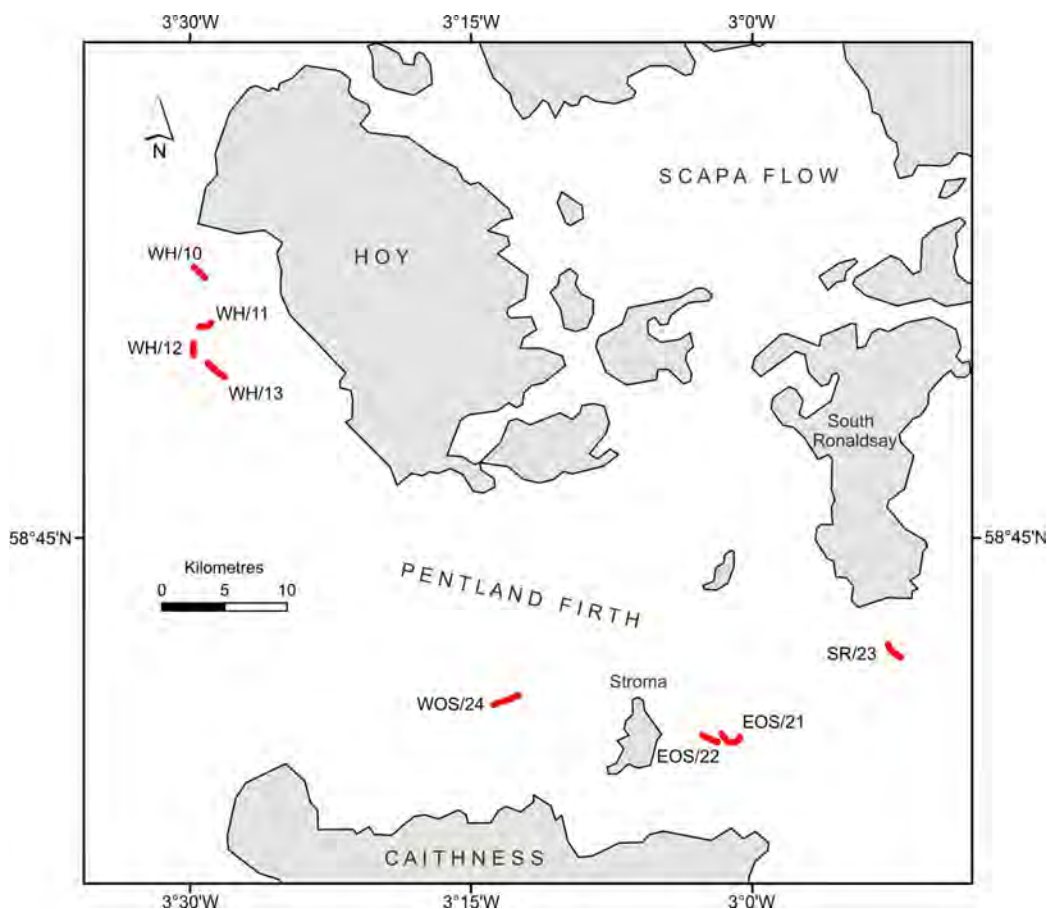


Figure 2 Video sites in the southern part of the surveyed area



3. Description of habitats

Habitat descriptions and biotopes are summarised in this section but presented in detail for each site in Table A2. Table A3 provides an inventory of the biotopes recorded, together with illustrative photographs and lists of their occurrence.

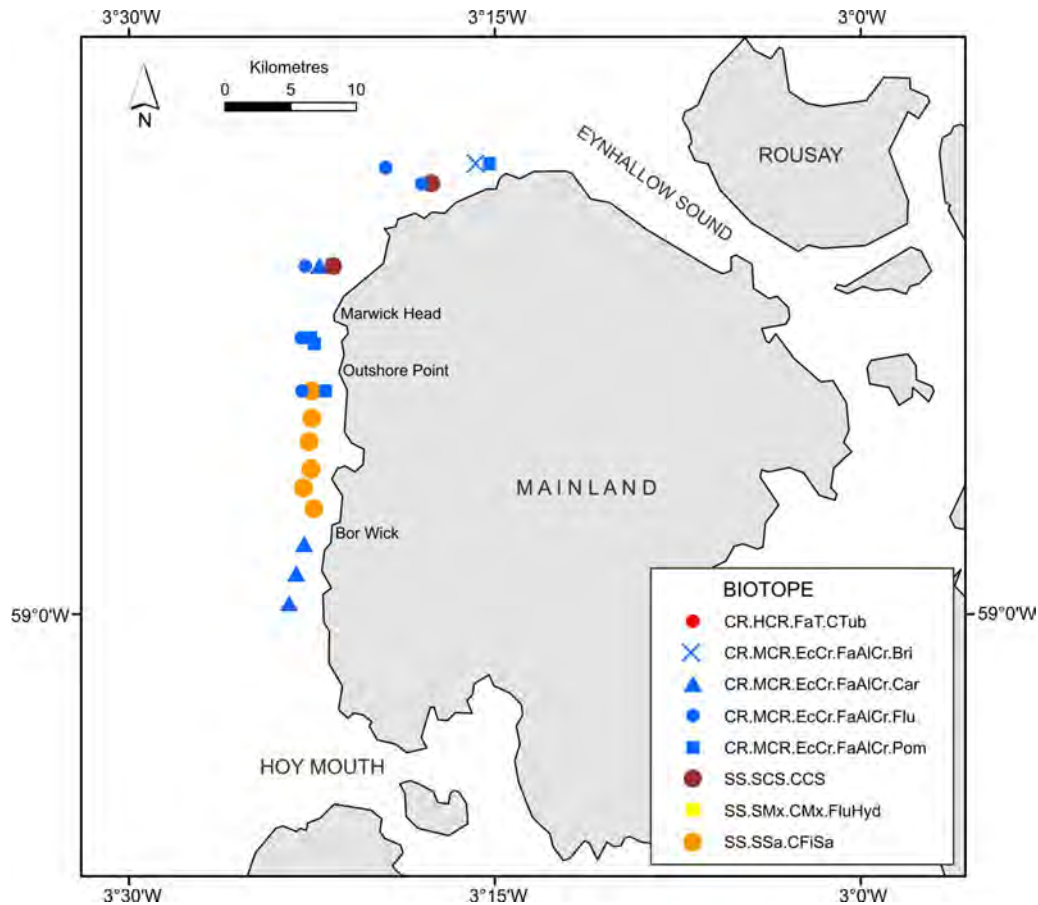
3.1 West of Mainland Orkney (Figure 3)

This area was the most intensively surveyed, with 16 runs located between Eynhallow Sound and Hoy Mouth at depths of 28 - 62 m. The habitats present are either fairly low diversity faunal crust communities on rock or clean sands and gravels. The distribution of biotopes (Figure 3) appears to be influenced predominantly by depth, current speed and sand scour.

At the three southernmost sites south of Bor Wick the substrate is a mix of boulders, cobbles and pebbles with a gravelly sand infill. The rock surface is mostly bare-looking with the sessile community dominated by crustose or low-profile calcareous forms such as *Pomatoceros* spp., orange bryozoans and sparse pink coralline algae. These sites are amongst the deepest reef communities observed along this coast (40 - 53 m), and probably for this reason also support numerous *Caryophyllia smithii*

(**CR.MCR.EcCr.FaAlCr.Car**). The motile fauna is dominated by echinoderms, particularly *Echinus esculentus*, whose grazing will contribute to the bare appearance of the rock.

Figure 3 Distribution of biotopes in northern part of surveyed area



From Bor Wick northwards to Outshore Point a string of six sites at depths of around 30 - 40 m display sediments of medium-fine sand. The habitat appears wave-disturbed, generally being slightly rippled, or at one site, formed into waves. The epibiota is extremely sparse and the only evidence of infaunal life is the numerous pairs of bivalve siphons around 1 mm in diameter, possibly *Timoclea ovata*. The habitat has been ascribed to **SS.SSa.CFiSa** on the basis of depth and sediment type, although confirmation would require evidence from infaunal and particle size analyses.

From southwest of Outshore Point to Marwick Head three sites display a seabed substrate of stepped bedrock platforms. The horizontal faces are mostly of bare appearance apart from encrustations of *Pomatoceros* spp., orange bryozoans and pink coralline algae (**CR.MCR.EcCr.FaAICr.Pom**). Some dense stands of *Flustra foliacea* occur on sediment-influenced rock (**CR.MCR.EcCr.FaAICr.Flu**). Scattered *Alcyonium digitatum* occurs on upward-facing rock surfaces but becomes much richer on the vertical faces of the steps and in the more uneven rocky areas, where it could be interpreted as representing localised patches of the biotope, **CR.MCR.EcCr.FaAICr.Alc**.

From Marwick Head to Eynhallow Sound the four sites examined display a mix of sediment and reef habitats. The shallowest site (30 - 32 m) close to the mouth of Eynhallow Sound possibly experiences elevated currents. The substrate of stepped bedrock supports a community similar to that of the stepped bedrock south of Marwick Point, except that much of it is covered by dense *Ophiocomina nigra* (**CR.MCR.EcCr.FaAICr.Bri**). At the other sites the rock is mostly broken into boulders, sometimes with cobbles and pebbles, on a bed of coarse sand or gravel, with some extensive areas of coarse sand. The rock supports faunal crusts of *Pomatoceros* spp. and bryozoans, with dense *Caryophyllia smithii* (**CR.MCR.EcCr.FaAICr.Car**) or *Flustra foliacea* (**CR.MCR.EcCr.FaAICr.Flu**) depending upon the degree of sediment influence. The coarse sediment, formed into 1 m long waves at one site, exhibits an impoverished epibiota and little evidence of infauna apart from the presence of bivalve siphons similar to those described above (**SS.SCS.CCS**).

3.2 West Hoy (Figure 4)

Four sites were located south of Rora Head off the west coast of Hoy in deep water (50 - 80 m). The site closest to Rora Head is probably tideswept. The mixed substrate of pebbles, cobbles and boulders with gravelly sand supports a crust fauna of *Pomatoceros* spp. and orange bryozoans supplemented by indicators of strong currents including patches of *Tubularia indivisa*, frequent *Alcyonium digitatum* and abundant brittlestars, both *Ophiocomina nigra* and *Ophiothrix fragilis* (**CR.MCR.EcCr.FaAICr.Bri**). Some areas, however, appear devoid of brittlestars (**CR.MCR.EcCr.FaAICr.Pom**).

The seabed at the other sites appears to be of medium sand, rippled at one site, gravelly at the other sites, with little evidence of an infaunal component (**SS.SSa.CFiSa**), although small numbers of possibly *Ammodytes* sp. were observed just above the sediment surface. Where the surface is scattered with pebbles, cobbles and boulders, the stones provide anchorage for patches of *Flustra foliacea* and hydroids (**SS.SMx.CMx.FluHyd**).

3.3 South of South Ronaldsay (Figure 4)

A single site was located at 41 - 56 m in the tidal race off the southern tip of South Ronaldsay, where currents reach 8 knots. The seabed here is mostly low relief bedrock and boulders, scoured by coarse sediment and cobbles, with the sediment collecting in pockets and dusting some rock surfaces. The biota varies according to localised differences in current strength and scour but is characterised by profuse numbers of *Urticina felina*. Elevated upward facing rock is very species-poor with a barnacle crust, scattered *U. felina* and bryozoan, and hydroid clumps, including

Tubularia indivisa, whereas in pockets of reduced current strength and areas of enhanced scour, the abundance of erect bryozoans and hydroids increases to form localised turfs. Occasional *Nucella lapillus* were observed, presumably feeding on the barnacles. The area could be considered to comprise a mosaic of biotopes but the most practical interpretation is to regard the variations as falling within the range of **CR.HCR.FaT.CTub**.

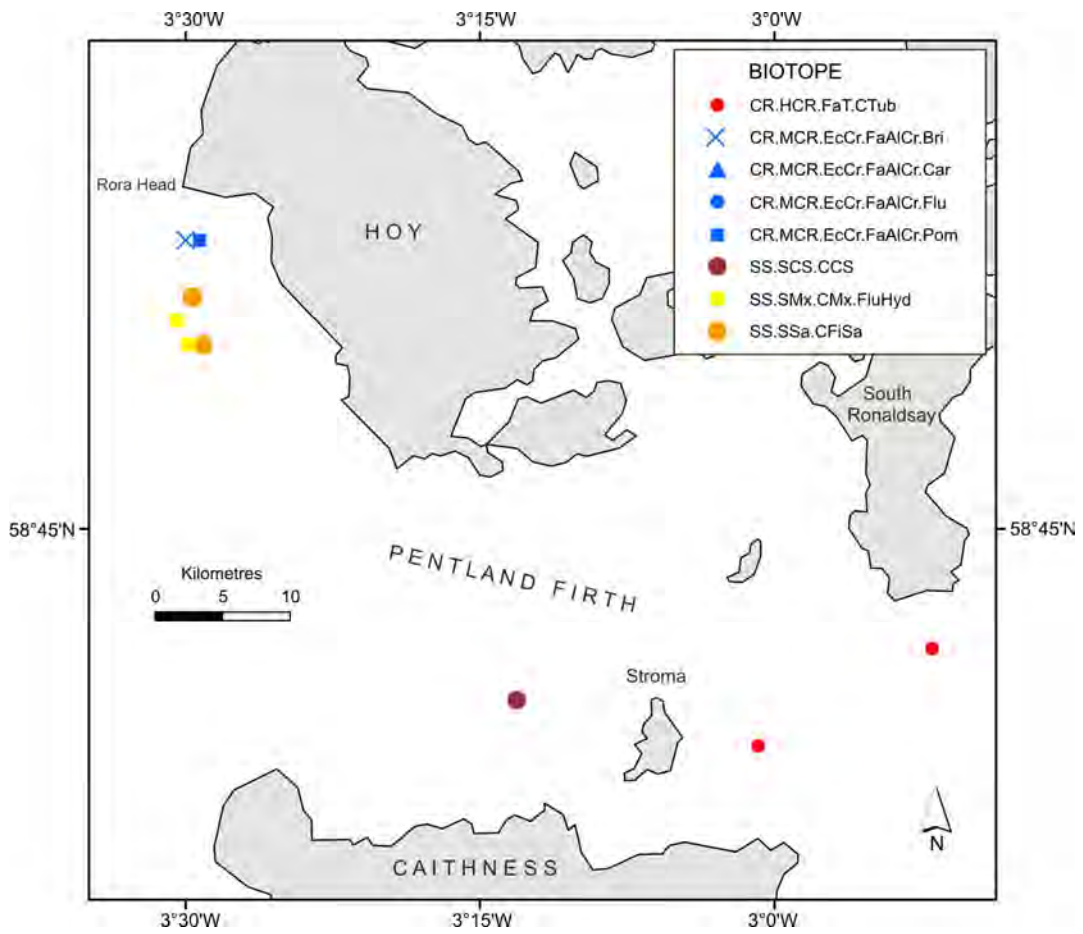
3.4 East of Stroma (Figure 4)

Two video runs were located in the Pentland Firth around 2.5 km to the east of Stroma in depths of 48 - 70 m. Video footage is currently only available from one of these sites (EOS/21). The seabed here consists of sand-scoured bedrock outcrops and boulders on shell gravel. The community is very similar to that at site SR/23 off the south of Ronaldsay, with the addition of sparse *Pachymatisma johnstonia* (**CR.HCR.FaT.CTub**).

3.5 West of Stroma (Figure 4)

One video run passed through the tidal race crossing the Pentland Firth south of Hoy, where spring currents are around 6 knots. At depths of 33 - 48 m the substrate of shelly medium sand is formed into waves with no evidence of infauna (**SS.SCS.CCS**).

Figure 4 Distribution of biotopes in southern part of surveyed area



4. Discussion

Three species recorded as present, or possibly present, during the survey have been formally identified as being of conservation importance (Table 1). *Nucella lapillus* was recorded off the southern tip of South Ronaldsay (SR/23), having been previously tentatively found at three other tide-swept sites in the Pentland Firth in 2008 (Moore, 2008). This species is principally found on rocky shores and is common around most of the United Kingdom.

Table 1 Species recorded during the survey of recognised conservation importance. SoCC = Species of Conservation Concern (UK Biodiversity Steering Group, 1995), IUCN = IUCN Red List of Threatened Species (lower risk category) (IUCN, 2009), OSPAR = OSPAR List of Threatened and/or Declining Species and Habitats (OSPAR, 2008), UK = UK Biodiversity Action Plan Priority Species (UKBAP, 2007), Scottish = Scottish Biodiversity List Species (BiodiversityScotland, 2005)

	SoCC	IUCN	OSPAR	UK	Scottish
<i>Nucella lapillus</i>	•		•		
<i>Echinus esculentus</i>	•	•			
<i>Ammodytes marinus</i>				•	•

Echinus esculentus is also common around most of the UK, including Scotland. It was present at all rock sites off the west coast of Mainland Orkney and Hoy, generally in high numbers, and is known to be also widely distributed in the Pentland Firth (Moore, 2008). This species is tolerant of a wide range of physical conditions and is considered to display low sensitivity to modification of such physical factors as current speed and sediment suspension (Tyler-Walter, 2008). Renewable energy schemes in the area are unlikely to adversely impact the conservation of either *E. esculentus* or *Nucella lapillus*.

Small numbers of what appeared to be sandeels were observed above the seabed of medium sand off the west coast of Hoy (WH/13). A large proportion of the fish stocking the Shetland sandeel fishery are *Ammodytes marinus* spawned off the west coast of Orkney (Goodlad and Napier, 1997). Sandeel nursery grounds are also known to occur in the Pentland Firth (Shields *et al.*, 2009). According to Wright *et al.* (2000), off Shetland *A. marinus* has a preference for medium to very coarse sands and an optimal depth range of 30 - 70 m. Most of the sedimentary sites surveyed off the western coast of Orkney and west of Stroma fall within this preference range and so renewable energy schemes may need to take account of the potential for adversely impacting sandeel habitat.

Whilst it is believed that the composition of the rock communities can be adequately characterised through the use of dropdown video, this does not extend to the sedimentary habitats encountered during the current survey, where the community was almost exclusively infaunal. Consequently, infaunal sampling will be needed to assess the conservation importance of the component species.

Table 2 lists the eight biotopes recorded during the survey and shows measures of their perceived conservation importance. No habitats are on the OSPAR List of Threatened and/or Declining Species and Habitats. Three fall within UK BAP Priority Habitats, though only as representatives from within the broadly defined priority

habitats of "tidal rapids" and "subtidal sands and gravels". In the Scottish Biodiversity List the same three habitats appear, but in addition **SS.SMx.CMx.FluHyd** is specifically listed.

Sublittoral medium and coarse sands are of widespread occurrence around Scotland and the UK but generally require infaunal data for detailed biotope recognition, when not distinguishable by the epibiotic community. Consequently such habitats have only been identified to biotope complex level (**SS.SCS.CCS**, **SS.SSa.CFiSa**). Consideration of their conservation importance should include the extent to which they support species of conservation importance, including sandeels, as discussed above. Such data appears to be currently lacking. **SS.SMx.CMx.FluHyd** was recorded at two sites to the west of Hoy. It is a scour-resistant, low diversity community widely recorded around the UK. With decreasing scatter of surface stones, this biotope merges into **SS.SSa.CFiSa** off the west coast of Hoy and so it may be of some local importance in supporting sandeel populations.

Table 2 Biotopes recorded during the survey, with measures of recognised conservation importance. UK = UK Biodiversity Action Plan Priority Habitat (UKBAP, 2007); Scottish = Scottish Biodiversity List Habitat (BiodiversityScotland, 2005)

Biotope	UK	Scottish
CR.HCR.FaT.CTub	•	•
CR.MCR.EcCrFaAlCr.Flu		
CR.MCR.EcCrFaAlCr.Bri		
CR.MCR.EcCr.FaAlCr.Pom		
CR.MCR.EcCr.FaAlCr.Car		
SS.SCS.CCS	•	•
SS.SSa.CFiSa	•	•
SS.SMX.CMx.FluHyd		•

Although tidal rapids are generally associated with abundant and diverse communities, including the support of uncommon species, extremely high current speeds can lead to low diversity assemblages (Hiscock, 1985). At the two sites in the Pentland Firth where **CR.HCR.FaT.CTub** was recorded, high tidal velocities combine with high levels of sand scour to produce low diversity assemblages. This is the case over a large area of the Pentland Firth (Moore, 2008). Off South Ronaldsay at depths of over 40 m these demanding conditions for benthic life were exacerbated by scour from cobbles and pebbles. The species recorded at these sites are of widespread occurrence and very common locally and nationally. Although this strongly tideswept biotope is uncommon nationally, in view of its poorly developed community in the Pentland Firth, it is suggested that the local manifestations of the biotope are of low conservation importance. In any event, such a scour-tolerant community is likely to have a low level of sensitivity to several of the engineering activities associated with the commissioning and decommissioning of tidal energy schemes. Community change could be invoked by any resultant decrease in current speed, although this could serve to enhance diversity and biomass.

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Appendices

Table A1 Details of video sequences recorded during the survey. Where there is more than one entry for a site, this reflects splitting of the video run amongst different habitat types. Depths were recorded approximately every 6 seconds; Q1 and Q3 represent the first and third quartiles of these data.

Site	Code	Time start (h:m:s)	Time finish (h:m:s)	Duration (h:m:s)	Date	Disk	Q1 (m)	Q3 (m)
West of Mainland Orkney	WMO/1	09:58:02	10:18:32	0:20:30	23/07/09	1	44	49
West of Mainland Orkney	WMO/2	11:16:31	11:36:40	0:20:09	23/07/09	1	36	37
West of Mainland Orkney	WMO/3	12:05:26	12:24:51	0:19:25	23/07/09	1	36	37
West of Mainland Orkney	WMO/4	12:55:06	13:15:07	0:20:01	23/07/09	2	30	32
West of Mainland Orkney	WMO/5	13:52:25	14:27:39	0:16:49*	23/07/09	2	28	31
West of Mainland Orkney	WMO/6	15:17:01	15:34:00	0:16:59	23/07/09	3	44	47
West of Mainland Orkney	WMO/6	15:34:00	15:37:10	0:03:10	23/07/09	3	44	47
West of Mainland Orkney	WMO/7	16:40:29	17:00:39	0:20:10	23/07/09	3	59	62
West of Mainland Orkney	WMO/8	17:40:44	17:54:08	0:13:24	23/07/09	3	48	57
West of Mainland Orkney	WMO/8	17:54:08	18:00:23	0:06:15	23/07/09	3	48	57
West of Mainland Orkney	WMO/9	18:32:41	18:52:48	0:20:07	23/07/09	4	30	32
West Hoy	WH/10	11:26:42	11:41:49	0:15:07	24/07/09	5	50	58
West Hoy	WH/11	12:48:45	13:03:44	0:14:59	24/07/09	5	59	75
West Hoy	WH/12	13:36:27	13:51:35	0:15:08	24/07/09	5	74	83
West Hoy	WH/13	14:41:41	14:56:36	0:14:55	24/07/09	5	74	80
West Hoy	WH/13	14:58:03	15:03:46	0:05:43	24/07/09	6	74	80
West of Mainland Orkney	WMO/14	16:47:24	17:07:27	0:20:03	24/07/09	6	47	53
West of Mainland Orkney	WMO/15	17:37:27	17:57:26	0:19:59	24/07/09	6	40	44
West of Mainland Orkney	WMO/16	18:29:34	18:44:41	0:15:07	24/07/09	7	38	43
West of Mainland Orkney	WMO/17	19:10:12	19:25:14	0:15:02	24/07/09	7	34	37
West of Mainland Orkney	WMO/18	19:52:09	20:00:13	0:08:04	24/07/09	7	31	37
West of Mainland Orkney	WMO/18	20:00:13	20:01:47	0:01:34	24/07/09	7	31	37
West of Mainland Orkney	WMO/18	20:01:47	20:04:29	0:02:42	24/07/09	7	31	37
West of Mainland Orkney	WMO/18	20:04:29	20:05:41	0:01:12	24/07/09	7	31	37
West of Mainland Orkney	WMO/18	20:05:41	20:12:20	0:06:39	24/07/09	7	31	37
West of Mainland Orkney	WMO/19	20:42:36	21:02:31	0:19:55	24/07/09	8	29	34
West of Mainland Orkney	WMO/20	†	†	†	25/07/09		30	33
East of Stroma	EOS/21	19:17:52	19:37:57	0:20:05	31/07/09	9	67 [‡]	70 [‡]
East of Stroma	EOS/22	†	†	†	02/08/09		48	53
South of Ronaldsay	SR/23	15:35:44	16:05:48	0:30:04	02/08/09	10	41	56
West of Stroma	WOS/24	21:35:51	22:01:14	0:25:23	02/08/09	10	33	48

* break in video footage of 00:18:25

‡ depths corrected for extensive delay in depth stabilisation

† video currently unavailable

Table A2 Physical and biological descriptions of the survey sites

Code	Substrate	Biota	Biotope	Comment
WMO/1	Mix of small boulders, cobbles and pebbles, with occasional large boulders, with gravelly sand infill.	Bare-looking rock with crusts of <i>Pomatoceros</i> (A) and other serpulid worms (P), orange bryozoans (O) and pink coralline algae (R); frequent <i>Caryophyllia smithii</i> and small specimens of <i>Porella compressa</i> (R). <i>Echinus esculentus</i> (C). Other taxa include small brown sponges (P), <i>Nemertesia antennina</i> (R), <i>Gibbula tumida?</i> (F), <i>Calliostoma zizyphinum</i> (P), <i>Luidia ciliaris</i> (O), <i>Crossaster papposus</i> (O), <i>Porania pulvillus</i> (R), <i>Asterias rubens</i> (F), <i>Stichastrella rosea</i> (P), <i>Asteroidea</i> sp. (R), <i>Ciona intestinalis?</i> (R), <i>Ascidia virginea</i> (R), <i>Clavelina lepadiformis</i> (O), Teleostei indet. (O), Teleostei sp. juv. (P) and <i>Labrus bimaculatus</i> (P).	CR.MCR.EcCr.FaAICr. Car	
WMO/2	Very slightly rippled plain of medium-fine sand.	Only surface fauna observed was 1 small <i>Asterias rubens</i> (R) and 1 <i>Pleuronectes platessa</i> (P). Only infaunal features observed were pairs of small (c.1 mm diameter) bivalve siphons (C).	SS.SSa.CFiSa	Absence of infaunal data makes biotope identification uncertain.
WMO/3	Plain of medium-fine sand.	Only surface fauna observed was 1 fish and 1 small <i>Asterias rubens</i> (R). Only infaunal features observed were pairs of small (c.1 mm diameter) bivalve siphons (C).	SS.SSa.CFiSa	Absence of infaunal data makes biotope identification uncertain.
WMO/4	Plain of very slightly rippled medium-fine sand.	No surface fauna observed. Only infaunal features observed were pairs of small (c.1 mm diameter) bivalve siphons (F).	SS.SSa.CFiSa	Absence of infaunal data makes biotope identification uncertain.
WMO/5	Mostly stepped rock platforms; horizontal surfaces with dusting of sand.	Upward facing flat areas with little life, which is largely concentrated on vertical and steep faces and in areas of higher rugosity, although where the sediment blanket is deeper there is a profuse sward of <i>Flustra foliacea</i> (locally S). Rock encrusted with <i>Pomatoceros</i> (C), orange bryozoans (O) and pink coralline algae (R), with an erect fauna dominated by <i>Alcyonium digitatum</i> (O, but C on steep and uneven faces) and <i>Echinus</i> (C). Other taxa include <i>Myxilla incrustans</i> (R), <i>Haliclona viscosa?</i> (P), <i>Munida rugosa</i> (P), <i>Calliostoma zizyphinum</i> (P), <i>Securiflustra securifrons</i> (R), <i>Alcyonidium diaphanum</i> (P), <i>Luidia ciliaris</i> (P), <i>Henricia sanguinolenta</i> (R), <i>Crossaster papposus</i> (O), <i>Asterias rubens</i> (R), <i>Porania pulvillus?</i> (R), <i>Botryllus schlosseri</i> (R), <i>Clavelina lepadiformis</i> (R), Teleostei sp. (P), Teleostei sp. juv. (P).	CR.MCR.EcCr.FaAICr. Pom CR.MCR.EcCr.FaAICr. Flu	Some areas of dense <i>Alcyonium</i> are possibly sufficiently extensive to recognize, in addition, the presence of the separate biotope CR.MCR.EcCr.FaAICr. Adig

Table A2 continued

Code	Substrate	Biota	Biotope	Comment
WMO/6	Uneven bedrock and boulders with patches of gravel/coarse sand and areas of boulders with gravel infill.	Rock encrusted with <i>Pomatoceros</i> (C, locally A), orange bryozoans (O, locally F) and <i>Caryophyllia smithii</i> (C), with occasional <i>Alcyonium digitatum</i> , although denser on steep faces (C); <i>Echinus esculentus</i> (C). Scattered patches of <i>Flustra foliacea</i> (R) and <i>Securiflustra securifrons</i> (R). Other taxa present include <i>Myxilla incrustans</i> (R), <i>Hymedesmia paupertas?</i> (R), <i>Urticina felina</i> (R), Serpulidae indet. (P), <i>Lanice conchilega</i> (R), <i>Cancer pagurus</i> (R), <i>Calliostoma zizyphinum</i> (O), red encrusting bryozoans (R), Bugulidae sp.? (R), <i>Alcyonidium diaphanum</i> (R), <i>Luidia ciliaris</i> (O), <i>Crossaster papposus</i> (O), <i>Porania pulvillus</i> (R), <i>Asterias rubens</i> (O), Asteroidea sp. (R), <i>Botryllus schlosseri</i> (R), <i>Clavelina lepadiformis</i> (R), Teleostei sp. (P) and pink coralline algal crusts (R).	CR.MCR.EcCr.FaAlCr. Car	
WMO/6	Coarse sand and gravel, with scattered boulders and probably sediment-covered bedrock at end of run.	Sediment with sparse epibiota of <i>Luidia ciliaris</i> and fish. Boulders dominated by <i>Flustra foliacea</i> (S); also <i>Pomatoceros</i> (C), <i>Alcyonium digitatum</i> (O), <i>Caryophyllia smithii</i> (P), <i>Securiflustra securifrons</i> (P), orange encrusting bryozoans (O) and <i>Echinus esculentus</i> (P).	SS.SCS.CCS CR.MCR.EcCr.FaAlCr. Flu	
WMO/7	Mixed substrate of dense pebbles and cobbles with boulders on sandy gravel. Boulder density varies greatly throughout run, initially dominating, then declining to occasional, then dominating, then declining once again towards end of run.	Pebbles and cobbles bare-looking apart from encrustations of serpulid worms (C), orange bryozoans (R) and occasional small <i>Alcyonium digitatum</i> and <i>Flustra foliacea</i> . Boulders similarly encrusted, though with richer erect fauna, especially of bryozoans, including <i>F. foliacea</i> (F), <i>Securiflustra securifrons</i> (O) and indeterminate species (R). Other species present include <i>Caryophyllia smithii</i> (R, locally C), <i>Kirchenpaueria pinnata?</i> (R), red encrusting bryozoans (R), <i>Alcyonidium diaphanum</i> (R), <i>Luidia ciliaris</i> (O), <i>Asterias rubens</i> (O), <i>Echinus esculentus</i> (F), <i>Ascidia mentula</i> (R) and fish (<i>Labrus bimaculatus</i> and indeterminate species).	CR.MCR.EcCr.FaAlCr. Flu	Areas with low boulder abundance are a poor fit to the biotope.

Table A2 continued

Code	Substrate	Biota	Biotope	Comment
WMO/8	Mostly boulders and cobbles on coarse sand.	Much of rock surface bare apart from crusts of orange (F) and red (R) bryozoans and <i>Pomatoceros</i> (C) and patches of dense <i>Flustra foliacea</i> (C). Other taxa present include <i>Echinus esculentus</i> (C), <i>Caryophyllia smithii</i> (locally C), <i>Homarus gammarus</i> ? (P), <i>Securiflustra securifrons</i> (R), <i>Porella compressa</i> (R), <i>Marthasterias glacialis</i> (P), <i>Luidia cilairis</i> (P), <i>Crossaster papposus</i> (P), <i>Porania pulvillus</i> (O), <i>Asterias rubens</i> (O), <i>Ascidia mentula</i> (R), <i>Clavelina lepadiformis</i> (R), Teleostei sp. (P), <i>Pholis gunellus</i> (P), <i>Labrus bimaculatus</i> (P) and filamentous red algae (R). Notable absence of <i>Alcyonium digitatum</i> .	CR.MCR.EcCr.FaAlCr. Flu	
WMO/8	Long (c.1 m) waves of coarse sand, with pebbles and cobbles in troughs towards end of run.	No surface life visible apart from single <i>Echinus esculentus</i> and <i>Securiflustra securifrons</i> ? on two small boulders. Bivalve siphons (C).	SS.SCS.CCS	Absence of infaunal data makes biotope identification uncertain.
WMO/9	Stepped bedrock platforms (often extensive) with sand dusting in places.	Extensive areas of flat bedrock apparently with <i>Pomatoceros</i> (C) and sparse crusts of orange bryozoans (R) and pink coralline algae (R), although the latter extensively covers some sand-dusted areas (S). <i>Alcyonium digitatum</i> is occasional on upward facing rock but becomes locally profuse on steep faces and in the more rugose areas (A). There are sparse patches of <i>Flustra foliacea</i> (R), <i>Securiflustra securifrons</i> (R) and <i>Nemertesia antennina</i> (R). Other species include <i>Marthasterias glacialis</i> (P), <i>Luidia ciliaris</i> (P), <i>Crossaster papposus</i> (O), <i>Porania pulvillus</i> (P), <i>Asterias rubens</i> (O), <i>Echinus esculentus</i> (F) and unidentified fish. Abundant <i>Ophiocomina nigra</i> can be seen coating the rock in some places.	CR.MCR.EcCr.FaAlCr. Pom CR.MCR.EcCr.FaAlCr. Bri	No photos available and video footage too rapid for certain identification of CR.MCR.EcCr.FaAlCr. Pom.

Table A2 continued

Code	Substrate	Biota	Biotope	Comment
WH/10	Mixed substrate of dense pebbles, cobbles and boulders with gravelly sand.	Rock surfaces encrusted with <i>Pomatoceros</i> (A) and orange bryozoans (R) and supporting frequent <i>Alcyonium digitatum</i> , <i>Urticina felina</i> (C) and scattered patches of <i>Flustra foliacea</i> (O) and <i>Tubularia indivisa</i> (O). The motile fauna is dominated by superabundant <i>Ophiocomina nigra</i> , with <i>Ophiothrix fragilis</i> locally abundant. Other species include <i>Munida rugosa</i> (C), <i>Cancer pagurus</i> (O), <i>Echinus esculentus</i> (F), <i>Luidia ciliaris</i> (O), <i>Marthasterias glacialis</i> (O), <i>Porania pulvillus</i> (O), <i>Crossaster papossus</i> (O), <i>Asteria rubens</i> (O) and <i>Botryllus schlosseri</i> ? (R). Some small areas appear devoid of brittlestars.	CR.MCR.EcCr.FaAlCr. Bri CR.MCR.EcCr.FaAlCr. Pom	
WH/11	Rippled medium-fine sand.	No evidence of surface biota or infaunal features observed.	SS.SSa.CFiSa	Absence of infaunal data makes biotope identification uncertain.
WH/12	Gravelly medium? sand with surface scatter of pebbles, cobbles and boulders.	Stones encrusted with <i>Pomatoceros</i> (A) and orange bryozoans (R) and support patches of the erect bryozoans, <i>Flustra foliacea</i> (F) and <i>Securiflustra securifrons</i> (R) and the hydroids, <i>Nemertesia ramosa</i> (F), <i>Sertularia cupressina</i> ? (F) and <i>Halecium halecinum</i> (P), together with <i>Urticina felina</i> (O) and sparse <i>Alcyonium digitatum</i> (R) and <i>Halichondria panicea</i> ? (R). Amongst the motile forms are frequent <i>Echinus esculentus</i> , <i>Munida rugosa</i> (O) and portunid crabs (R).	SS.SMx.CMx.FluHyd	
WH/13	Gravelly medium? sand with surface scatter of pebbles, cobbles and boulders.	Larger stones support patches of erect bryozoans, including <i>Flustra foliacea</i> (F), <i>Securiflustra securifrons</i> (P) and smaller forms (P), whilst pebbles and cobbles host scattered tufts of hydroids, including <i>Nemertesia ramosa</i> (F) and Hydroida indet. (P). Other species present include <i>Alcyonium digitatum</i> (R), <i>Urticina felina</i> (F), <i>Caryophyllia smithii</i> (P), <i>Pomatoceros</i> (locally A), <i>Munida rugosa</i> (O), portunid crabs (R), orange encrusting bryozoans (R), <i>Asterias rubens</i> (O), <i>Echinus esculentus</i> (F), <i>Callionymus</i> sp. (P) and juvenile fish (P).	SS.SMx.CMx.FluHyd	

Table A2 continued

Code	Substrate	Biota	Biotope	Comment
WH/13	Gravelly medium? sand with very sparse surface scatter of gravel, pebbles and cobbles and the occasional small boulder. Sand formed into short waves in places with gravel, pebbles and occasional cobbles in troughs.	No evidence of infaunal community. Surface with occasional <i>Asterias rubens</i> and <i>Liocarcinus</i> sp. (R), with stones supporting very sparse fauna of serpulids (P), hydroid? tufts (R) and <i>Urticina felina</i> (R). <i>Ammodytes</i> sp. possibly present.	SS.SSa.CFiSa	Absence of infaunal data makes biotope identification uncertain.
WMO/14	Mostly small boulders with cobbles and pebbles, with a gravelly sand infill.	Bare-looking rock with crusts of <i>Pomatoceros</i> (A), orange bryozoans (O) and pink coralline algae (R) and numerous <i>Caryophyllia smithii</i> (C) and <i>Echinus esculentus</i> (C). Other taxa include Hydroida indet. (R), <i>Munida rugosa</i> (P), <i>Luidia ciliaris</i> (O), <i>Porania pulvillus</i> (O), <i>Asterias rubens</i> (F), <i>Ascidia mentula</i> (P), Teleostei indet. (O), Labridae sp. (P) and pink coralline algal crusts (R).	CR.MCR.EcCr.FaAlCr. Car	
WMO/15	Mostly small boulders with cobbles and pebbles, with a gravelly sand infill.	Bare-looking rock with crusts of <i>Pomatoceros</i> (C), orange bryozoans (O) and pink coralline algae (O). Erect calcareous forms include <i>Caryophyllia smithii</i> (F) and small specimens of <i>Porella compressa</i> ? (R). <i>Echinus esculentus</i> (C). Other taxa include <i>Urticina felina</i> (P), <i>Munida rugosa</i> (F), <i>Cancer pagurus</i> (O), <i>Gibbula cineraria</i> ? (F), <i>Bivalvia</i> sp. (P), <i>Porania pulvillus</i> (O), <i>Asterias rubens</i> (F), <i>Stichastrella rosea</i> (P), <i>Ascidia mentula</i> (P), Teleostei indet. (O) and pink coralline algal crusts (O).	CR.MCR.EcCr.FaAlCr. Car	

Table A2 continued

Code	Substrate	Biota	Biotope	Comment
WMO/16	Initially low waves of medium sand with pebbles in troughs, gradually becoming medium sand plain.	No evidence of surface biota apart from a single <i>Luidia ciliaris</i> .	SS.SSa.CFiSa	Absence of infaunal data makes biotope identification uncertain.
WMO/17	Plain of medium-fine sand.	Only surface fauna observed was 1 small <i>Asterias rubens</i> (R). Only infaunal features observed were pairs of small (c.1 mm diameter) bivalve siphons (F).	SS.SSa.CFiSa	Absence of infaunal data makes biotope identification uncertain.
WMO/18	Very slightly rippled plain of medium-fine sand.	No surface fauna observed. Only infaunal features observed were pairs of small (c.1 mm diameter) bivalve siphons (C).	SS.SSa.CFiSa	Absence of infaunal data makes biotope identification uncertain.
WMO/18	Stepped bedrock platforms.	Upward surfaces with dense patches of <i>Flustra foliacea</i> (C, locally A), whilst steep faces support <i>Alcyonium digitatum</i> (F, locally A). Otherwise rock fairly bare, apart from encrustations of <i>Pomatoceros</i> (C) and sparse orange bryozoans (R) and pink coralline algae (R). <i>Caryophyllia smithii</i> (F), <i>Asterias rubens</i> (P), <i>Clavelina lepadiformis</i> (R), Teleostei indet. (P).	CR.MCR.EcCr.FaAlCr. Flu	Could also be interpreted as a mosaic of CR.MCR.EcCr.FaAlCr. Flu and CR.MCR.EcCr.FaAlCr. Adig
WMO/18	Stepped bedrock platforms, rock ridges and areas of small boulders.	Flatter areas of upward facing rock of bare appearance, apart from scattered <i>Alcyonium digitatum</i> , some <i>Caryophyllia smithii</i> and <i>Pomatoceros</i> , and sparse <i>Flustra foliacea</i> (R) in vicinity of sediment. Boulders and steeper faces richer, with crusts of orange bryozoans (F), pink coralline algae (P) and <i>Pomatoceros</i> (P) and an erect fauna of <i>A. digitatum</i> (F, locally C) and <i>Echinus esculentus</i> (C). Also present <i>Crossaster papposus</i> (R) and Teleostei indet. (P).	CR.MCR.EcCr.FaAlCr. Pom	Could also be interpreted as a mosaic of CR.MCR.EcCr.FaAlCr. Pom and CR.MCR.EcCr.FaAlCr. Adig
WMO/18	Very slightly rippled medium-fine sand.	One <i>Luidia ciliaris</i> observed.	SS.SSa.CFiSa	Absence of infaunal data makes biotope identification uncertain.

Table A2 continued

Code	Substrate	Biota	Biotope	Comment
WMO/18	Initially outcropping bedrock and boulders on sand, then mostly inclined rocky ridges.	Rock encrusted with <i>Pomatoceros</i> (A), orange bryozoans (O) and pink coralline algae (O). <i>Alcyonium digitatum</i> overall F, but C on steeper slopes. <i>Echinus esculentus</i> (C), <i>Crossaster papposus</i> (P), <i>Myxilla incrustans</i> (R), <i>Caryophyllia smithii</i> (P), <i>Calliostoma zizyphinum</i> (P), Teleostei indet. (P).	CR.MCR.EcCr.FaAlCr. Pom	Could also be interpreted as a mosaic of CR.MCR.EcCr.FaAlCr. Pom and CR.MCR.EcCr.FaAlCr. Adig
WMO/19	Mostly stepped bedrock platforms with areas of boulders and sand patches.	Upward facing flat areas with little life, which is largely concentrated on vertical and steep faces. Rock encrusted with <i>Pomatoceros</i> (C), orange bryozoans (O) and pink coralline algae (O), with an erect fauna dominated by <i>Alcyonium digitatum</i> (O, but C on steep faces) and <i>Echinus</i> (C). Other taxa include <i>Myxilla incrustans</i> (R), a yellow cushion sponge (R), <i>Urticina felina</i> (R), <i>Caryophyllia smithii</i> (O), <i>Cancer pagurus</i> (R), <i>Calliostoma zizyphinum</i> , <i>Alcyonidium diaphanum</i> (R), <i>Luidia ciliaris</i> (O), <i>Crossaster papposus</i> (O), <i>Porania pulvillus</i> (R), <i>Ophiothrix fragilis</i> (R), <i>Botryllus schlosseri</i> (R), <i>Scyliorhinus</i> sp. (P), Teleostei sp. (P), red encrusting algae (R), foliose red algae and patches of <i>Flustra foliacea</i> (R) and <i>Securiflustra foliacea</i> (R).	CR.MCR.EcCr.FaAlCr. Pom	Could also be interpreted as a mosaic of CR.MCR.EcCr.FaAlCr. Pom and CR.MCR.EcCr.FaAlCr. Adig
EOS/21	Bedrock outcrops, with small, large and very large boulders on shell gravel.	Abundance estimates are overall figures for the site. Most current-exposed upper faces of boulders with dense barnacle crust (although no live barnacles observed) and scattered <i>Urticina felina</i> , orange encrusting bryozoans (R) and <i>Pachymatisma johnstonia</i> (R). Boulder sides and low-lying rock with richer life dominated by <i>U. felina</i> (A) and patchy bryozoan turf (F) including <i>Flustra foliacea</i> (O), <i>Securiflustra securifrons</i> (P) and Bryozoa erect indet. (F). Hydroid patches (O), include <i>Tubularia indivisa</i> (P). Other taxa present include <i>Alcyonium digitatum</i> (R), <i>Necora puber</i> (P), <i>Calliostoma zizyphinum</i> (P), <i>Henricia sanguinolenta</i> (P), <i>Asterias rubens</i> (C), <i>Echinus esculentus</i> (F), <i>Botryllus schlosseri</i> (R) and Teleostei sp. (P).	CR.HCR.FaT.CTub	The site could be interpreted as a patchwork of biotopes. See comments for site SR/23

Table A2 continued

Code	Substrate	Biota	Biotope	Comment
SR/23	Mostly sediment and cobble-scoured low relief bedrock and boulders with coarse sand/gravel pockets and extensive sediment dusting of rock.	A patchwork of species assemblages dependent upon the degree of current strength and sediment scour. Elevated upper rock faces with relatively lower scour and higher current speed are species-poor with encrustations of barnacles (<i>Balanus crenatus</i> , P), mostly empty shells, and scattered <i>Urticina felina</i> and clumps of hydroids and erect bryozoans. In pockets of localised reduced current strength and in areas of enhanced scour there are profuse swards of <i>U. felina</i> , the abundance of bryozoans and hydroids increases to the extent of forming localised turfs and the community becomes more species rich. Overall estimates of abundance are as follows. <i>Urticina felina</i> (A), erect bryozoans (F) (including <i>Flustra foliacea</i> (O), <i>Securiflustra securifrons</i> (P), Bryozoa erect indet. (F)), hydroids (F) (including <i>Tubularia indivisa</i> (R) and <i>Halecium halecinum</i> (P)). <i>Alcyonium digitatum</i> is generally sparse (R) but becomes common on some steep faces. Other species present include <i>Esperiopsis fucorum?</i> (R), dwarf <i>Metridium senile?</i> (O), <i>Pomatoceros</i> spp. (P), <i>Homarus gammarus</i> (P), <i>Cancer pagurus</i> (P), <i>Necora puber</i> (O), <i>Nucella lapillus</i> (O), orange encrusting bryozoans (R), <i>Henricia sanguinolenta</i> (O), <i>Asterias rubens</i> (F), <i>Botryllus schlosseri</i> , <i>Teleostei</i> sp. (P) and <i>Pholis gunellus</i> (P).	CR.HCR.FaT.CTub	An extremely tideswept site (8 knots according to the Admiralty chart). Although this site has been regarded as supporting the biotope CR.HCR.FaT.CTub, it could also be interpreted as a mosaic of biotopes. Some patches are close to CR.MCR.EcCr.UrtScr and CR.HCR.XFa.
WOS/24	Waves of medium sand with shell, rippled in places, with accumulations of pebbles and cobbles in lows at end of run.	No evidence of biota on sand surface apart from Asteroidea sp. (R). <i>Teleostei</i> sp. (P).	SS.SCS.CCS	Not a good biotope fit. Sediment appears to be finer than is the norm for the nominated biotope.

Table A3. *Biotope inventory. Biotopes recorded during the survey, together with all site records and illustrative photograph (italicised site code indicates provenance).*

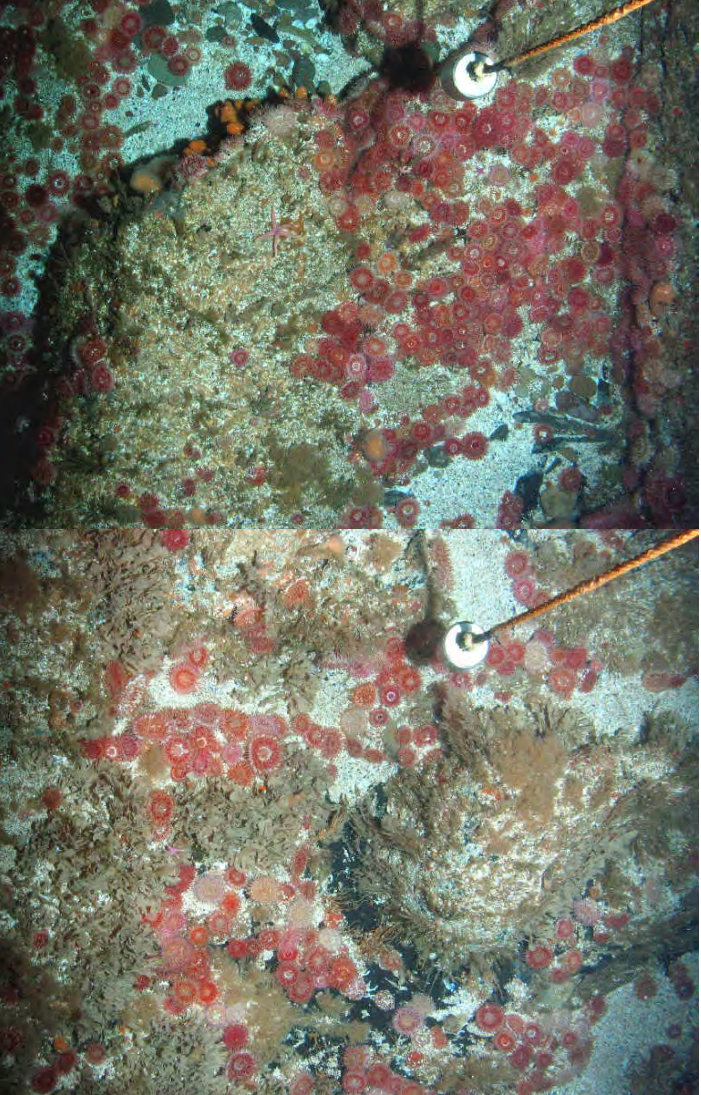

Biotope	Sites	Photograph
<p>CR.HCR.FaT. CTub</p> <p><i>Tubularia indivisa</i> on tide-swept circalittoral rock</p>	<p>EOS/21, SR/23</p>	
<p>CR.MCR.EcCr. FaAlCr.Flu</p> <p><i>Flustra foliacea</i> on slightly scoured silty circalittoral rock</p>	<p>WMO/5, WMO/6, WMO/7, WMO/8, WMO/18</p>	

Table A3 continued.


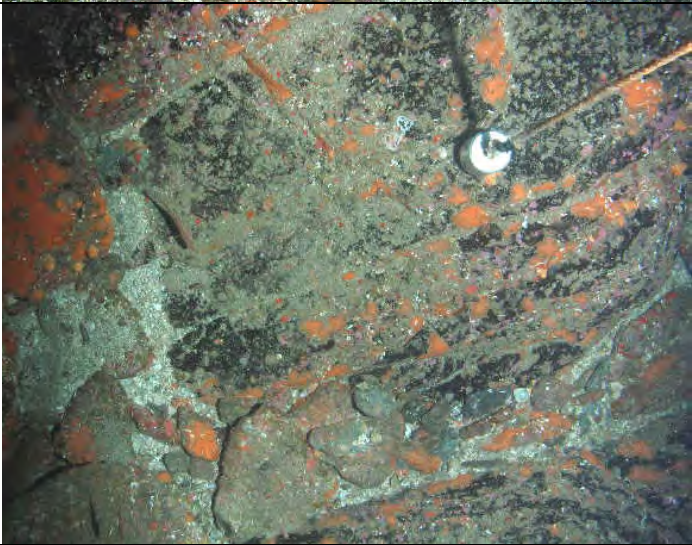


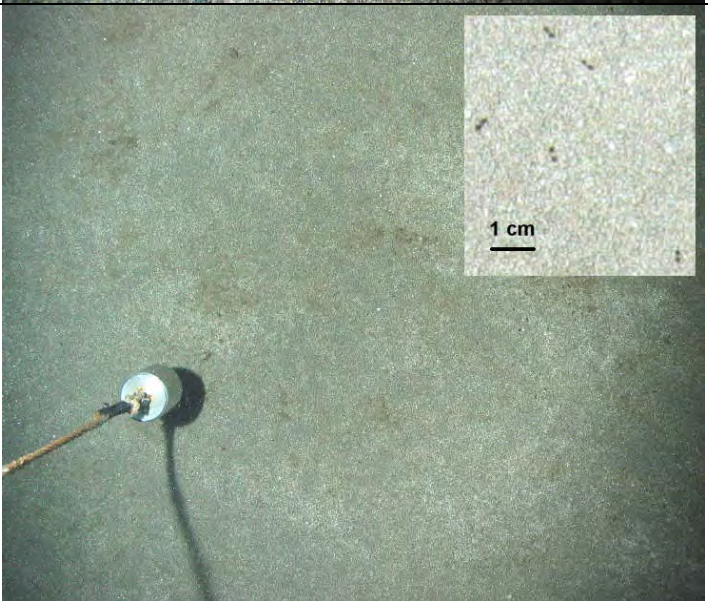


Biotope	Sites	Photograph
<p>CR.MCR.EcCr. FaAlCr.Bri</p> <p>Brittlestar bed on faunal and algal encrusted, exposed to moderately wave-exposed circalittoral rock</p>	<p>WMO/9, WH/10</p>	
<p>CR.MCR.EcCr. FaAlCr.Pom</p> <p>Faunal and algal crusts with <i>Pomatoceros triqueter</i> and sparse <i>Alcyonium digitatum</i> on exposed to moderately wave-exposed circalittoral rock</p>	<p>WMO/5, WMO/9, WMO/18, WMO/19, WH10</p>	
<p>CR.MCR.EcCr. FaAlCr.Car</p> <p><i>Caryophyllia smithii</i> with faunal and algal crusts on moderately wave-exposed circalittoral rock</p>	<p>WMO/1, WMO/6, WMO/14, WMO/15</p>	

Table A3 continued.

Biotope	Sites	Photograph
<p>SS.SCS.CCS</p> <p>Circalittoral coarse sediment</p>	<p>WMO/6, WMO/8, WOS/24</p>	
<p>SS.SSa.CFiSa</p> <p>Circalittoral fine sand</p> <p>Inset shows enlarged image of the numerous bivalve siphons typical of this habitat. Scale approximate.</p>	<p>WMO/2, WMO/3, WMO/4, WMO/16, WMO/17, WMO/18, WH/11, WH/13</p>	
<p>SS.SMx.CMx. FluHyd</p> <p><i>Flustra foliacea</i> and <i>Hydrallmania falcata</i> on tide-swept circalittoral mixed sediment</p>	<p>WH/12, WH/13</p>	



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