Cyfoeth Naturiol Cymru
Natural Resources Wales

NRW Rhiannon *Modiolus* survey 2015: video and still image analysis

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About Natural Resources Wales

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We work for the communities of Wales to protect people and their homes as much as possible from environmental incidents like flooding and pollution. We provide opportunities for people to learn, use and benefit from Wales' natural resources.

We work to support Wales' economy by enabling the sustainable use of natural resources to support jobs and enterprise. We help businesses and developers to understand and consider environmental limits when they make important decisions.

We work to maintain and improve the quality of the environment for everyone and we work towards making the environment and our natural resources more resilient to climate change and other pressures.

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- Maintaining and developing the technical specialist skills of our staff;
- Securing our data and information;
- Having a well resourced proactive programme of evidence work;
- Continuing to review and add to our evidence to ensure it is fit for the challenges facing us; and
- Communicating our evidence in an open and transparent way.

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- Yn 2008 cynhaliwyd arolwg gan Brosiect Rhyng-gysylltydd Dwyrain-Gorllewin EIR Grid tua 10nm i'r Gogledd o Ynys Môn a chlustnodwyd ardal o wely'r môr â llofnod acwstig oedd yn arwydd o rîff *Modiolus modiolus* biogenig. Yn ddiweddarach cadarnhawyd presenoldeb y rîff gan arolwg fideo tanddwr. Yn 2012 clustnododd arolygon ar gyfer fferm wynt alltraeth arfaethedig Rhiannon yn yr un safle hefyd nifer o safleoedd â signal acwstig oedd yn arwydd o rîff *Modiolus*.
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- Cafodd 5074 o ddelweddau llonydd a gwerth 7.5 awr o fideo eu casglu i gyd ar ôl 32 sesiwn o lusgo a gollwng camerâu tanddwr, o fewn ardal sy'n mesur tua 10 km wrth 5km. Cafodd y delweddau llonydd a'r fideo eu dadansoddi er mwyn canfod ffawna, amcangyfrif digonedd a disgrifio'r cynefin. Yna cafodd y data ei fwydo i gronfa ddata'r Cofnodydd Morol. Cynhaliwyd gweithdrefnau gwirio a dilysu i sicrhau ansawdd y data. Cofnodwyd 136 tacson i gyd mewn 39 o ardaloedd a archwiliwyd drwy lusgo camerâu; cafodd chwe biotop eu neilltuo i'r ardaloedd a archwiliwyd fel hyn.
- Roedd y rhan fwyaf o'r ardal gwely'r môr a gafodd ei arolygu yn cynnwys gwaddod cymysg a ysgubwyd gan y llanw a / neu waddod bras gyda cherrig mân, graean, cregyn deuglawr cyfan neu rai wedi torri, tywod bras a cherrig crynion, gyda chlogfeini bychain yn achlysurol. Roedd yr epiffawna oedd yn bresennol yn y cynefinoedd hyn yn nodweddiadol o waddodion bras a ysgubwyd gan y llanw.
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2. Executive Summary

- *Modiolus modiolus* (Horse Mussel) reef is an OSPAR threatened and declining habitat and a component of Annex I Reef. In Wales two *Modiolus* reefs have been well described to date off the North Lleyn Peninsula.
- In 2008 the EIR Grid East West Interconnector Project conducted a survey approximately 10nm North of Anglesey and identified an area of seabed with an acoustic signature indicative of biogenic *Modiolus modiolus* reef. The presence of reef was later confirmed by drop down video survey. In 2012 surveys for the proposed Rhiannon Offshore Windfarm in the same location also identified several areas with an acoustic signal indicative of *Modiolus* reef.
- NRW undertook some survey work in October 2015 to collect video and still images from areas identified as potential *Modiolus* reef by the two previous commercial projects in welsh waters. This report provides a detailed description of the method, a summary of the results, and some initial conclusions from the study.
- A total of 5074 still images and 7.5 hours of video were collected from 32 drop-camera tows, within an area measuring approximately 10 km by 5km. The stills and video were analysed to identify fauna, estimate abundances and characterise the habitat. The data were then entered into the Marine Recorder database. Verification and validation procedures were undertaken to ensure the quality of the data. A total of 136 taxa were recorded from 39 tow sections; six biotopes were assigned to the tow sections.
- The majority of the surveyed seabed was composed of tide-swept mixed and / or coarse sediment with pebbles, gravel, whole and broken bivalve shells, coarse sand and cobbles, with occasional small boulders. The epifauna present on those habitats were typical of tide-swept coarse sediments.
- Live *Modiolus modiolus* were observed in some tows and in five tows they were in sufficient abundance to be characterised as *Modiolus* reef. Some areas of *Sabellaria* reef and bedrock reef were also described.
- The areas of live *Modiolus* reef correlated well in terms of their location with live reef areas identified during the 2008 EIR Grid Cable Corridor Survey. Other biotopes identified during the study were typical of those previously recorded off the coast of Anglesey in similar circalittoral, tideswept environments.

3. Introduction

Our knowledge of the distribution and extent of seabed habitats in Welsh waters is extremely patchy and in some areas we have very little knowledge of which habitats may be present. In order to increase our knowledge and improve our evidence base NRW's marine evidence staff have been using collaborative opportunities where possible to collect survey data in areas where we believe habitats or species of conservation importance may be present. This current piece of work was undertaken in collaboration with the Environment Agency as part of a Service Level Agreement with Natural Resources Wales.

Modiolus modiolus (Horse Mussel) reef is an OSPAR threatened and declining habitat and a component of Annex I Reef; in addition, it is a Section 42 (Natural Environment and Rural Communities Act 2006) habitat of principal importance. *Modiolus* beds appear to be extremely sensitive to physical disturbance and are thought to have declined in extent and quality. In Wales we have good knowledge of two *Modiolus* reefs off the North Lleyn Peninsula within the Pen Llŷn a'r Sarnau Special Area of Conservation (Lindenbaum et al., 2008). *Modiolus modiolus* beds are also thought to occur on the seabed off the North and West coasts of the Isle of Anglesey. In the past, several surveys have recorded aggregations of *Modiolus* in these areas but in general the density and extent of any beds has not been accurately mapped. A survey conducted by the Countryside Council for Wales (CCW), in conjunction with the Joint Nature Conservation Committee (JNCC) also recorded aggregations of *Modiolus* to the North West of Anglesey (Ramsay *et al.*, in prep).

In 2008, the EIR Grid East West Cable Interconnector Project undertook an acoustic survey of the proposed cable corridor which ran to the North of Anglesey. The data collected from this survey identified an area with an acoustic signature indicative of biogenic *Modiolus modiolus* reef. Further investigations using drop-down video confirmed the presence of live *Modiolus* reef along with extensive areas of dead shell (Fugro, 2009). In 2012 multibeam and sidescan sonar surveys were undertaken as part of a characterisation survey for the proposed Rhiannon Offshore Windfarm approximately 10nm North of Anglesey. These again identified several areas with an acoustic signal indicative of *Modiolus* reef. Unfortunately, the windfarm proposal was terminated before ground-truthing surveys could be carried out. NRW therefore undertook some survey work in October 2015 to collect video and still images from the areas identified as potential *Modiolus* reef (shown in Figure 1) to assess the presence and likely extent of the reef in a number of locations, and to identify other seabed habitats that are also present in the area.

The aims of the study were to i) verify the presence of *Modiolus modiolus* reef in the areas identified as possible reef from commercial sidescan sonar data; ii) define the quality and extent of any *Modiolus* reef present and iii) collect data on other seabed habitats in the area to improve our benthic knowledge for this location.

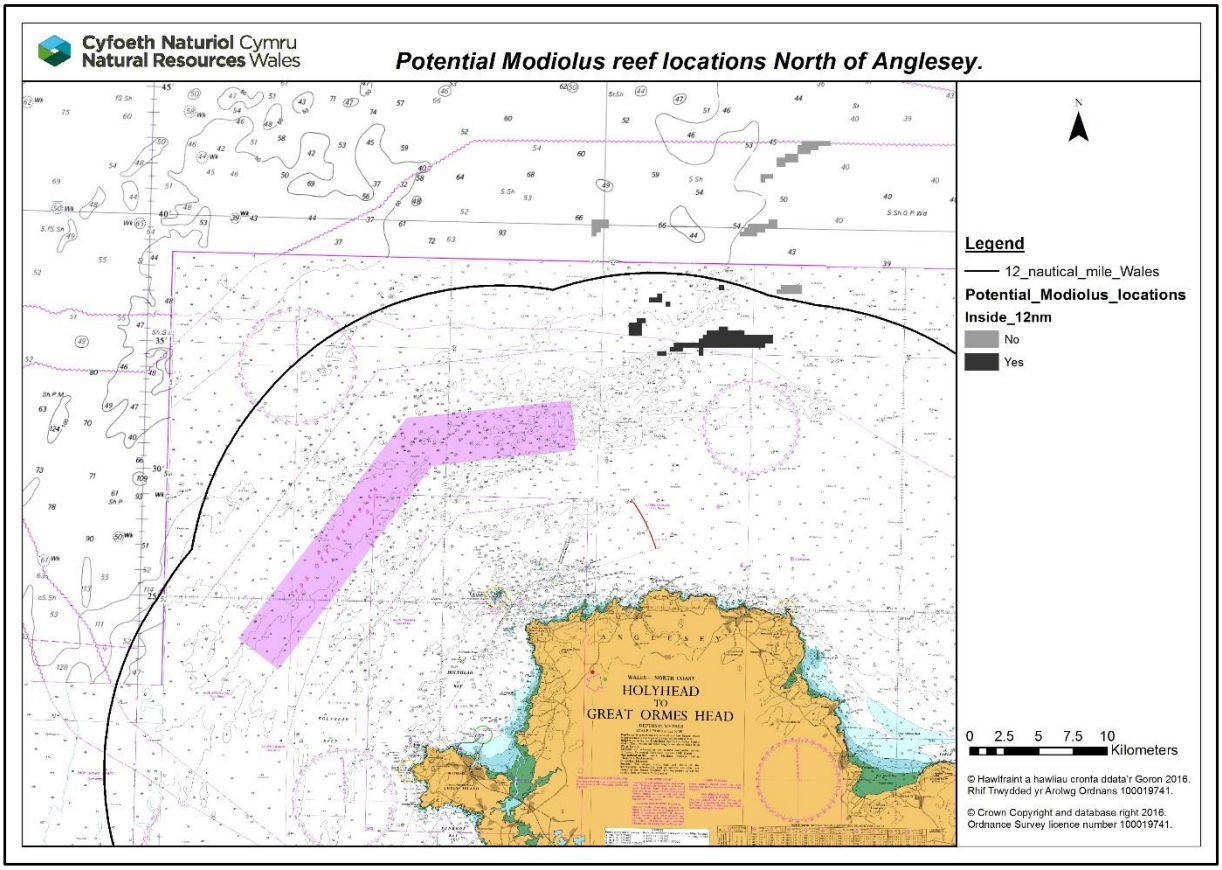


Figure 1 Potential *Modiolus* reef locations identified from commercial surveys North of Anglesey. © British Crown and OceanWise Ltd, 2016. All rights reserved. License No. EK001-20120402.

4. Methods

4.1. Survey sites and drop-down image collection

Natural Resources Wales worked in collaboration with the Environment Agency under the organisation's joint Service Level Agreement to undertake a 3-day survey on board the RV Mersey Guardian from 14th to 16th October 2015. The survey locations were chosen based on evidence of the presence of the horse mussel *Modiolus modiolus* from previous sidescan sonar data that had been collected during benthic characterisation work for both the EIR Grid Interconnector project and the proposed Rhiannon windfarm. The full extent of the area of interest was approximately 10 km in an east west direction by 5 km north south. Sample stations were allocated on a grid basis throughout the potential reef areas and split into high and low priority sites to achieve highest level of coverage in the boat time available (Figure 2).

The camera equipment used for the survey was a sledge mounted a C-Tecnics High definition CT3009 camera providing full 1080i HD recording (1920 x 1080). This was obliquely mounted on a sledge accompanied by two x C-Tecnics CT4004 LED Lamps each of approximately 1100 Lumens, accompanied by two C-Tecnics Laser lights (CT4005 – subsea Laser Modules) and two lasers set at a width of 10cm apart to

provide a visual scale on the resulting video footage. The video unit had its own integrated depth sensor. The video feed was relayed to the surface unit via a 200m umbilical where real-time GPS positional and other information were over-laid on the video footage and recorded on the surface units' computer hard drive.

The drop down sledge was also equipped with a RovTech Seacam 18megapixel auto stills camera with an 18 mm lens, twin strobes and battery pack. This was a self-contained system that was set to take pictures at predefined intervals (for this study the stills camera interval varied from 6 to 10 seconds). The camera was set to start recording before the sledge was placed in the water and continued to take images at the predefined interval until it was brought back on board. Images were then downloaded between each camera tow and saved to a computer hard drive.

The drop down video survey method followed the MESH (Mapping European Seabed Habitats) standard protocols (Coggan *et al.*, 2007) as closely as possible. Drops were carried out during a neap tide and where possible during the period either side of slack water. Even on a neap tide, given the depth of some of the survey locations and the fast running currents in the area, it was difficult to position the video tow so that it passed exactly through the survey location, although every effort was made to get as close as possible.

During the survey, the vessels' position was logged every five seconds and plotted onto a trackline in the Manifold GIS (Geographical Information System) software package. After the survey, the points relating to each individual video tow line were extracted from this position log using the recorded times and locations for the start of line and end of line.

For each survey station visited, a hand-written station log was completed to record essential information relating to the location, video quality, water depth, locations of the start and end of line and also any notes taken by the surveyor watching the video on the vessel. This was used to help inform post-survey data analyses and data entry.

Unfortunately, a software error on 14th October (day 1) meant that no video footage was collected on that day; only still images were collected from the 10 sites visited that day. Because of this, we decided to standardise our approach to data analysis by focussing on the still images from all survey sites as the primary source of information for species identification, enumeration and biotope classification. Where video footage was available this was used to aid species identification, enumeration and biotope analysis, as well as providing supplementary information such as records of additional large species not seen in the still images, position (Lat / Long coordinates) of features, water depth etc.

A total of 5074 still images were collected from 32 camera tows on 14th, 15th and 16th October. The video dataset comprised 24 tows of approximately 100m length each (Fig 2) (total video footage of approximately 7.5 hours; longest single tow was 32 minutes) collected on 15th and 16th October. In some cases, drop down camera sites

were combined in to a single long tow (e.g. at sites 6, 7 and 8) to reduce time wasted on deploying and retrieving the sledge in deeper water.

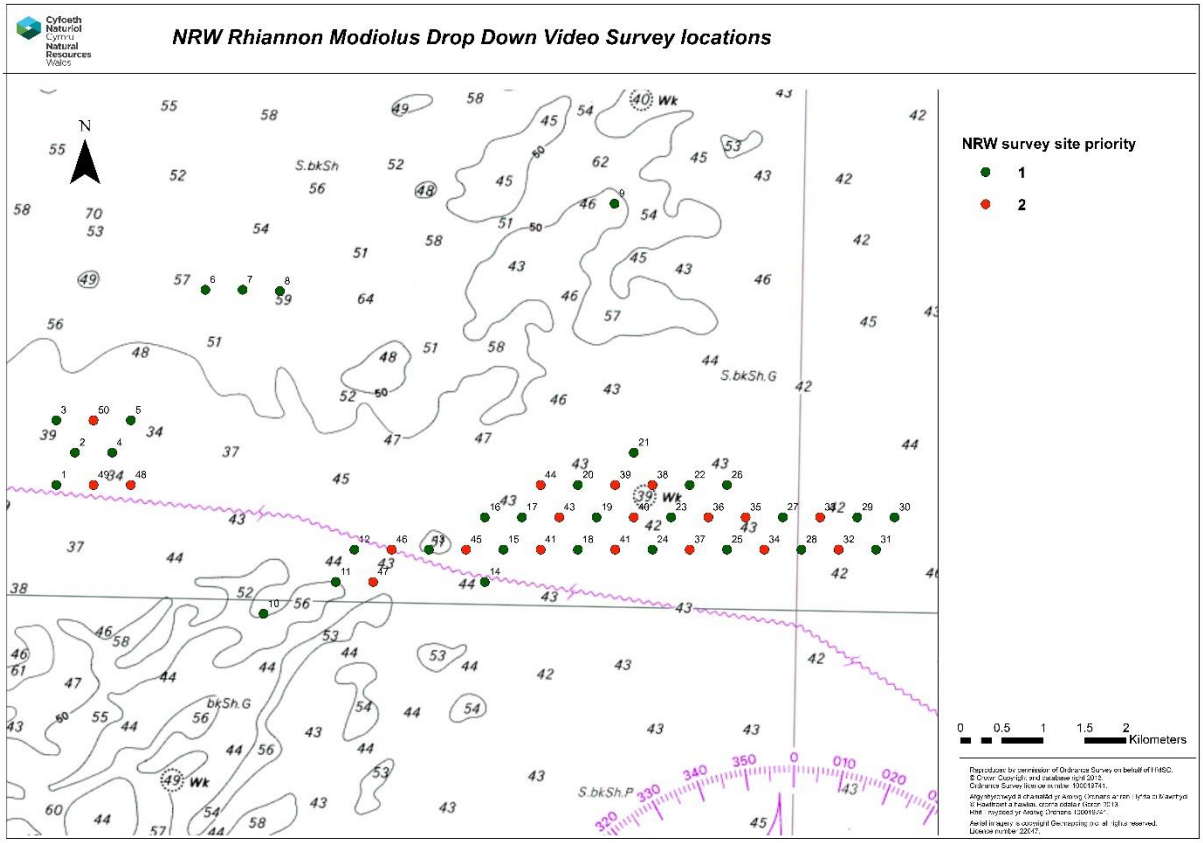


Figure 2 *Modiolus modiolus* sample stations split in to priority 1 and 2 locations (not all stations were surveyed).

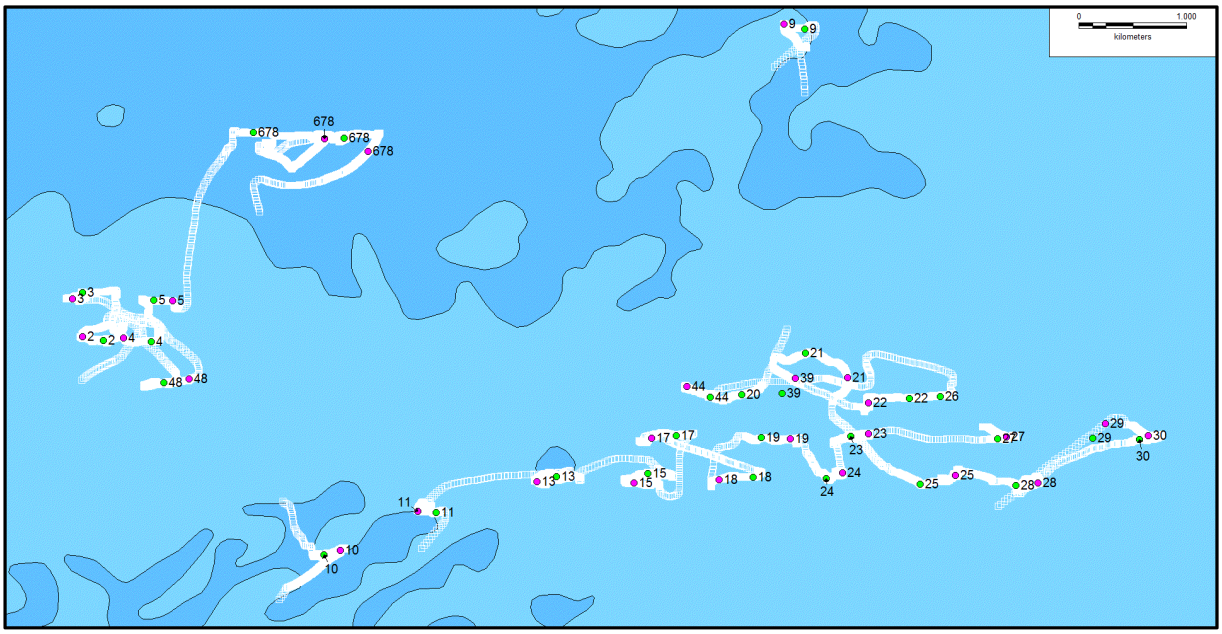


Figure 3 Start (green) and end (red) locations of each survey tow, with vessel track (white) and depth contours (dark blue deeper than 50m, light blue shallower than 50m).

4.2. Data collation and preparation for analysis

All relevant data from the metadata, field logs (site numbers, positions, dates and times, survey staff, equipment details, vessel details, etc.) and image files (Exif data) was collated. These data were then sense-checked (coordinates for tows and stills in expected locations, correct dates and times, etc.) and formats were standardised as appropriate for further analysis. Cross-reference was made to metadata standards to check that all necessary data was present. A data entry spreadsheet for video and stills analysis was prepared.

4.3. Video and stills analysis, including verification

The procedures used for analysing the video are described below:

The videos were played through VLC media player software on a computer with a high definition LCD monitor. The software allowed considerable control over the playback, including variable speed advance and reverse, freeze frame and view frame-by-frame, so that the analyst could study the substrata and fauna and record appropriate information to support the more detailed information available from the stills. The stills were viewed in a standard Windows photo viewer.

Analysis began with a rapid overview of the full collection of videos and stills to identify any problems with viewing the files, checking image quality, becoming familiar with the range of biotopes, and splitting the tows into sections. Where biotope boundaries were identified, the tow was divided into two or more separate sections, and the coordinates for start and end positions taken from the positions of the video. Where video was unavailable (and therefore also the overlaid positional information) the start and end positions of mid-tow sections was calculated from the number of stills in each section and the proportional difference between the Lat Long positions from the start and end of the whole tow. A column in the data entry spreadsheet (= 1 sample) was made for each section and a one sentence description written for each.

The sections were then analysed one at a time. The stills associated with a section were analysed first, using the zoom and pan functions where necessary, to identify fauna, estimate abundances and characterise the habitat (substratum types etc.). The video was then analysed to provide any additional or complimentary details on habitat or species that were not picked up in the stills analysis.

A single sample comprised the data derived from a single section of video and the group of stills taken along that section. Sample data included start and end coordinates and times, image file information, substratum characteristics, water depth, names and estimated abundances (SACFOR scale) of taxa, other details listed in the contract specification and any other relevant metadata. Biotope codes were assigned for each sample and then reviewed on completion of all the image analysis.

Verification

10% of the video tows (4 tows, 8 tow sections) were randomly selected by another analyst for verification (complete re-analysis, without reference to the original

analysis). The verification data and original data were pasted into a single spreadsheet and directly compared. Inevitably there were some differences, particularly in recorded abundances and a few differences in identification (usually due to one analyst assigning a higher or lower taxon than the other). Most of the differences were small (one abundance category different, higher or lower with no bias), but for certain species one analyst had recorded higher abundances (one or two abundance categories, usually higher) than the other. This difference was discussed and found to be a difference in the application of the abundance scales (one analyst using the % cover scales and the other using the density scales, for certain species). The appropriate scales for each species were discussed and agreed and some changes were made to the final data.

4.4. Marine Recorder data, including validation

Data were entered into the Marine Recorder database (http://jncc.defra.gov.uk/page-1599), using the standard guidance and protocols provided by NRW. Data were then exported from Marine Recorder using the Snapshot Tool and the following data validation procedures were carried out on the Snapshot file. Any errors were fixed in the Marine Recorder database.

In Access Snapshot

- Export Survey, Location, SurveyEvent, PhysicalData, Sample and SampleBiotope tables to Excel.
- Check in Sample table that all UserSampleRefs are unique
- Create matrix of species v UserSampleRef from SampleSpecies data (Access Crosstab Query) and export to Excel.

In Excel

Species matrix

- Check through list of species, using knowledge of species, to see if any do not seem right for locality (i.e. geographic range and habitat). Carry out search in WoRMS and Google for any unknown taxa, to check that names are valid and that they seem right for locality.
- Species abundances - compare with original data. Start by calculating and comparing total count of records for each species in original data and in MR extract.

Survey data and Location data

- Browse through to check entries are suitable and consistent
- Positions - Import into GIS and plot Lat/LongWGS84 positions - place on appropriate map or chart backdrop to check that positions look right. Import Lat/LongWGS84 positions from original data spreadsheet and compare with positions from the Snapshot. Check that all positions match-up.

SurveyEvent data

- Positions - do same as for Survey data. Plot start and end positions from drop down video tows as well as the centre positions. Check that none are outside the survey box defined by the SW and NE positions in the Survey data.
- Other data - browse through to check entries are suitable and consistent, compare with original data (at least 5%, more if errors are found) - particularly depths and dates.

Sample data

- Positions - do same as for SurveyEvent.
- Habitat descriptions – check against original data, check spelling and check that species mentioned in the description are also recorded in the Species data.
- Other data - browse through to check entries are suitable and consistent, compare with original data (at least 5%, more if errors are found)

Biotope data

- Other data - browse through to check entries are suitable and consistent, compare with original data (at least 5%, more if errors are found)

Physical data

- Check that data has been entered for all samples
- Calculate sum of substrata % for each sample to check that they add up to 100%
- Check that biological zones are suitable and consistent
- Compare depths with original data (at least 5%, more if errors are found)

5. Results

The total of 39 sections were described from the 32 tows (8 tows were split into 2 or 3 sections). Six biotopes were assigned, either partially or wholly, to the tow sections.

5.1. Summary characteristics of the seabed habitats and communities

Figure 4 shows the distribution of the seabed biotopes that are described in the following text. Tables 1 to 3 summarise the habitat characteristics and taxa present in each biotope.

The surveyed seabed lies in water depths of approximately 40m to 70m, which therefore has insufficient light penetration for algal populations (i.e. characterised as circalittoral). The majority of the surveyed seabed was tide-swept mixed or coarse sediment of pebbles, gravel, whole and broken bivalve shells, coarse sand and cobbles, with occasional small boulders. The epifauna present on those habitats were typical of tide-swept coarse sediments, including a variety of scour resistant hydroids,

bryozoa, ascidians, the soft coral *Alcyonium digitatum* and the serpulid worm *Spirobranchus*. The majority of those tow sections were assigned to the level 3 biotope complex SS.SMx.CMx, but two tow sections were wholly or partly characterised by faunal communities that could be assigned to higher level biotopes (SS.SMx.CMx.FluHyd and SS.SMx.CMx.OphMx).

A large proportion of the dead bivalve shells observed on the tow images were *Modiolus modiolus* (horse mussel), typically forming an unconsolidated layer of mobile shells on the surface of the sediment. Live *M. modiolus* were observed in some tows and in five tows they were in sufficient abundance to be characterised as *Modiolus* reef (SS.SBR.SMus.ModMx). Live *Sabellaria spinulosa* (ross worm) was present in many tows and in one tow section it was sufficiently abundant and elevated enough to be characterised as *Sabellaria* reef (SS.SBR.PoR.SspiMx). Areas of low lying bedrock were present in some tows and in six tow sections it was of sufficient cover to be characterised as a rocky reef biotope (CR.HCR.XFa). The bedrock and *Modiolus* reef habitats were characterised by a greater variety and abundance of fauna.

A total of 136 taxa were recorded from the still images and video. 1394 individual species abundances were recorded. The maximum number of taxa recorded from a tow section was 58, the minimum was 5. The total and average number of taxa for each biotope are given at the end of Table 3.

Figure 4 Distribution of biotopes along video track.

Table 1 Frequency of biotopes assigned to video tow sections

BiotopeCode	Biotope description	Sections
CR.HCR.XFa	Mixed faunal turf communities	6
SS.SBR.PoR.SspiMx	*Sabellaria spinulosa* on stable circalittoral mixed sediment	1
SS.SBR.SMus.ModMx	*Modiolus modiolus* beds on open coast circalittoral mixed sediment	5
SS.SMx.CMx	Circalittoral mixed sediment	30
SS.SMx.CMx.FluHyd	*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment	1
SS.SMx.CMx.OphMx	*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment	1

Table 2 Average substrata (% cover) recorded in tow sections for each biotope. (Only includes data for biotopes that were wholly assigned to a tow section (i.e. not SS.SMx.CMx.OphMx)).

Biotope	Bedrock	Small boulders	Cobbles	Pebbles	Dead shells	Modiolus	Gravel	Sand	Mud
XFa	27.5	5	12.8	16.8	14.2	0	13.8	10	0
SspiMx	0	0	65	10	10	0	10	5	0
ModMx	0	0.2	3.6	16	24.8	38	12	3	2.4
CMx	0.1	0.3	7	19.6	38.4	0.1	18.6	15	0.8
FluHyd	0	0	1	20	35	0	25	19	0

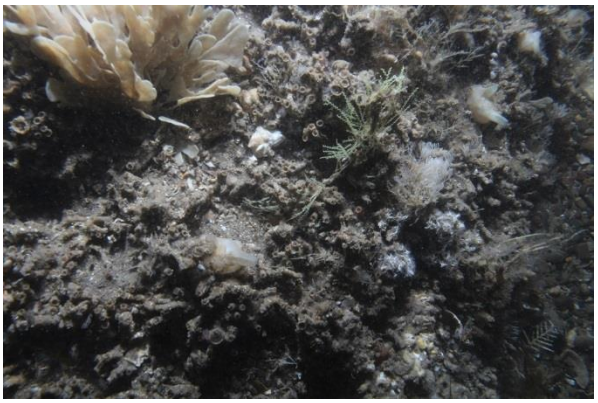
Table 3 Maximum abundance (SACFOR scale) and number of records (tow sections) of the most frequently occurring taxa (all tows) for each biotope (number of brackets denotes the total number of tow sections where the biotope was recorded). Only includes data for biotopes that were wholly assigned to a tow section (i.e. not SS.SMx.CMx.OphMx).

Taxa	Maximum abundance	XFa (6)	SspiMx (1)	ModMx (5)	CMx (30)	FluHyd (1)
Porifera (enc)	F	4	1	4	17	
Porifera	O	2		5	10	
Hymedesmia paupertas	R	2	1	5	5	
Dysidea fragilis	F	2	1	5	3	
Hydrozoa	C	3	1	2	12	
Nemertesia antennina	F	4	1	4	11	
Abietinaria abietina	C	4	1	3	19	1
Hydrallmania falcata	C	3	1	5	23	1
Sertularella gayi	C	4	1	1	16	
Sertularia argentea	C	1	1	5	18	1
Alcyonium digitatum	A	3	1	5	15	1
Actiniaria	F	2		3	10	
Urticina felina	F	2	1	5	18	1
Capnea sanguinea	O	1	1	4	16	1
Sagartia elegans	O	2	1	3	9	
Hormathia coronata	F	4	1	5	9	

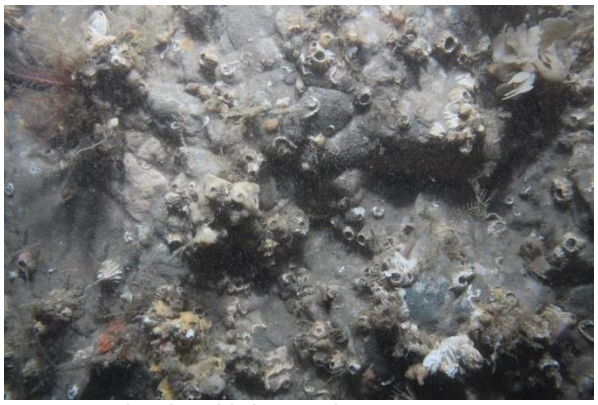
Taxa	Maximum abundance	XFa (6)	SspiMx (1)	ModMx (5)	CMx (30)	FluHyd (1)
Sabellaria spinulosa	A	3	1		15	1
Sabella pavonina	C	3	1	2	8	1
Serpulidae	F	3		3	12	1
Spirobranchus	C	4	1	5	24	1
Balanus balanus	F	4	1	5	20	1
Balanus crenatus	O	4	1	2	14	
Pandalus	F	4	1	5	18	1
Paguridae	F	2	1	1	15	1
Ebalia	F	3		4	12	
Inachus	C	3	1	5	8	
Polyplacophora	O	1	1	1	9	
Gibbula magus (/tumida)	O	2			9	
Gibbula cineraria	O	1			10	1
Calliostoma zizyphinum	F	4	1	5	16	1
Buccinum undatum	F	2		4	13	1
Modiolus modiolus	A			5	5	
Chlamys	O	3	1		9	
Aequipecten opercularis	O			1	6	1
Anomiidae	R			1	9	
Bryozoa (enc)	C	4	1	4	23	
Crisia	C	4	1		9	
Pentapora foliacea	R		1		1	
Eucratea loricata	F	3	1	1	12	1
Electra pilosa	F	3	1	1	24	1
Flustra foliacea	C	4	1	4	18	1
Cellaria	C	4	1		5	
Crossaster papposus	C	1		2	9	1
Henricia	F	3		5	7	
Asterias rubens	C	2	1	5	12	
Psammechinus miliaris	C	2		5	9	
Echinus esculentus	C	3		1	5	
Ascidiacea	C	3	1	5	15	1
Ascidia conchilega	C	2		5	8	
Polycarpa pomaria	C	4	1	5	16	1
Dendrodoa grossularia	F	2	1	2	16	1
Total number of taxa recorded		**55**	**52**	**82**	**108**	**27**
Average number of taxa per section		**37**	**52**	**48**	**31**	**27**

5.2. Representative images of the habitats and characterising species

Tow 19 *Modiolus* reef, with *Alcyonium*, sponges, ascidians, hydroids and snails



Tow 4 *Sabellaria* reef, with *Flustra, Sertularella gayi* and *Polycarpa pomaria*



Tow 5 Bedrock, with barnacles, sponges, hydroids and bryozoa

Tow 26 Mixed sediment with *Spirobranchus*, encrusting bryozoa and hydroids

Tow 8 Mixed sediment with sparse hydroids

Tow 13 Mixed sediment with *Capnea sanguinea*

Tow 10 Mixed sediment with hydroid and bryozoan turf

Tow 17 Mixed sediment with *Flustra* and *Hydrallmania*

Tow 17 Mixed sediment with *Urticina*, *Eucratea* and barnacles

Tow 3 Mixed sediment with *Ophiothrix fragilis*

6. Conclusions

The habitats recorded during this survey were broadly similar to those recorded in other surveys nearby, notably the Countryside Council for Wales / JNCC survey carried out to the North West of Anglesey in 2009 (Ramsay et al., in prep.), the JNCC 2008 North Anglesey survey (Blyth-Skyrme et al. 2008), the 2008 EIR Grid Cable Corridor Survey (Fugro, 2009) and the 2004 SEA6 survey (Rees 2005). All of these studies recorded seabed habitats that were often a mixture of coarse sediments, gravel, pebbles, cobbles and boulders with both live and empty *Modiolus* shell aggregations. Areas of *Sabellaria spinulosa* crusts and / or reef were also recorded in this and other surveys off the coast of Anglesey, with more extensive areas of reef being recorded more recently in Church Bay to the north of Holyhead by NRW in 2016 (Gouge et al in prep).

Records of *Modiolus modiolus* in this particular location were first noted during a survey conducted by the EIR Grid East West Interconnector Project in 2008, when a number of video transects were conducted following multibeam and sidescan sonar survey that had originally identified an area of potential biogenic reef extending to approximately 185,006 m^2. The EIR Grid surveys identified large areas of dead shell, with smaller extents of live mussel bed (approximately 15% of the area surveyed contained live mussel reef) in the same or similar locations to those identified during the current NRW survey. The large areas of shell around smaller patches of live *Modiolus* suggest that this bed was once extensive and healthy, though

the absence of previous data from this area makes it difficult to determine when and why the area of live mussels declined.

In terms of biotopes identified in the present study, the *Modiolus* reef was assessed as SS.SBR.SMus.ModMx (*Modiolus modiolus* beds on open coast circalittoral mixed sediment), compared with SS.SBR.SMus.ModCvar (*Modiolus modiolus* beds with *Chlamys varia*, sponges, hydroids and bryozoans on slightly tide-swept circalittoral mixed substrata) during the EIR Grid survey. The differences in assigned biotopes were due to differences in epifauna associated with the areas of live *Modiolus* reef; *Chlamys varia* was found to be present amongst live *Modiolus* during the EIR Grid surveys, but this species was not recorded on any areas of live mussel bed in the NRW survey (though was recorded as occasionally present at other mixed sediment sites). The 'ModMx' biotope is usually associated with open coast mussel beds, occurring in environments with greater wave exposure or higher tidal velocities than other *Modiolus* biotopes. 'ModCvar' is often associated with more sheltered environments found in e.g. sea lochs or embayments, though has also previously been assigned to some areas of the *Modiolus* bed off the Lleyn peninsula in Wales. Given the high tidal flows experienced in the survey area off North Anglesey, and the fauna observed during the NRW survey, the 'ModMx' classification was deemed the most appropriate designation for this site. 'ModMx' was also recorded in similar conditions during the 2009 CCW / JNCC survey off North West Anglesey. Other biotopes identified during the survey fitted well with those found elsewhere off the coast of Anglesey, and are typical of the high tidal flows, water depths and sediment types found in the area.

7. References

Blyth-Skyrme, V., Lindenbaum, C., Verling, E., Van Landeghem, K., Robinson, K., Mackie, A., Darbyshire, T. 2008. Broad-scale biotope mapping of potential reefs in the Irish Sea (north-west of Anglesey). JNCC Report No 423

Coggan, R., Mitchell, A., White, J., Golding, N. 2007. Recommended operating guidelines (ROG) for underwater video and photographic imaging techniques. MESH Recommended operating Guidelines. http://www.searchmesh.net/PDF/GMHM3_Video_ROG.pdf

Fugro Ltd. (2009). EIR Grid East West Interconnector project: Habitat Investigation Results. Volume 1 of 5. Report Number: 9617V1.1

Lindenbaum C., Bennell J.D., Rees E.I.S., McClean D., Cook W., Wheeler A.J. and Sanderson W.G. (2008) Small-scale variation within a *Modiolus modiolus* (Mollusca: Bivalvia) reef in the Irish Sea. I. Seabed mapping and reef morphology. Journal of the Marine Biological Association of the United Kingdom 88, 133–141.

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8. Appendix 1

8.1. Video and still analysis summary Table.

The following table contains a summary of the video and still image data collected during each video tow section.

Sample Reference	**V.RM_3-S1**	**V.RM_3-S2**	**V.RM_2_S1**	**V.RM_4_S1**
Tow Number (Field log)	3	3	2	4
Tow segment No.	3.1	3.2	2.1	4.1
Habitat name	Mixed sediment with dense empty Modiolus shell and sparse fauna	Cobbles and occasional boulders with abundant faunal turf	Mixed sediment with small areas of very low lying bedrock with diverse faunal turf	Mixed sediment with hydroids and bryozoans
Depth (m)	47 - 47.6	47 - 47.6	42.8 - 45.8	43.7 - 45.9
Habitat description	Mixed sediment with dense empty Modiolus shell, small numbers of Ophiothrix fragilis. Occasional cobbles.	Cobbles with occasional boulders and bedrock with abundant faunal turf dominated by hydroids and Alcyonium digitatum. Areas of mixed sediment between.	Mixed sediment with small areas of very low lying bedrock, some scoured, but mostly with diverse faunal turf dominated by hydroids. Sediment comprising pebbles, gravel, sand and empty Modiolus shell.	Level seabed of tideswept gravel, pebbles and empty shells (particularly Modiolus), with sparse fauna
Lat_start (Field log)	53.6028	53.6025	53.5989	53.5989
Long_start (Field log)	-4.4669	-4.4677	-4.4637	-4.4570
Lat_end (Field log)	53.6025	53.6023	53.5991	53.5991
Long_end (Field log)	-4.4677	-4.4683	-4.4667	-4.4595
Biotope 1	SS.SMx.CMx	CR.HCR.XFa	SS.SMx.CMx	SS.SMx.CMx
Certain / Uncertain 1:	Certain	Certain	Certain	Certain
Applicable to Part / Whole of habitat 1:	Whole	Part	Part	Whole
Biotope 2		SS.SMx.CMx	CR.HCR.XFa	
Certain / Uncertain 2:		Certain	Uncertain	
Applicable to Part / Whole of habitat 2:		Part	Part	
Annex 1 reef present? (Y/N/uncertain)	No	Yes	Uncertain	No

Sample Reference	V.RM_4_S2	V.RM_48_S1	V.RM_5_S1	V.RM_6&7_S1
Tow Number (Field log)	4	48	5	678
Tow segment No.	4.2	48.1	5.1	6&7.1
Habitat name	Sabellaria spinulosa reef on mixed sediment	Mixed sediment with areas of dense empty Modiolus shell	Very low lying bedrock with diverse faunal turf	Mixed sediment with patches of dense empty Modiolus shell
Depth (m)	43.7 - 45.9	43.6 - 46.1	44.1 - 46	68.2 - 70.6
Habitat description	Sabellaria spinulosa reef on mixed sediment (underlying subtrata not visible) with diverse fauna dominated by hydroids and bryozoans.	Mixed sediment with areas of dense empty Modiolus shell. Larger cobbles with hydroid and bryozoan turf and other fauna.	Very low lying bedrock with diverse faunal turf with patches of mixed sediment between.	Mixed sediment with patches of dense empty Modiolus shell. Occasional cobbles with diverse faunal turf dominated by hydroids and ascidians. Very silty in places, making analysis difficult.
Lat_start (Field log)	53.5991	53.5955	53.6024	53.6167
Long_start (Field log)	-4.4595	-4.4551	-4.4569	-4.4437
Lat_end (Field log)	53.5992	53.5959	53.6024	53.6164
Long_end (Field log)	-4.4609	-4.4515	-4.4542	-4.4337
Biotope 1	SS.SBR.PoR.SspiMx	SS.SMx.CMx	CR.HCR.XFa	SS.SMx.CMx
Certain / Uncertain 1:	Certain	Certain	Certain	Certain
Applicable to Part / Whole of habitat 1:	Whole	Whole	Whole	Whole
Biotope 2				
Certain / Uncertain 2:				
Applicable to Part / Whole of habitat 2:				
Annex 1 reef present? (Y/N/uncertain)	Yes	No	Yes	No

Sample Reference	V.RM_8_S1	V.RM_10_S1	V.RM_11_S1	V.RM_13_S1
Tow Number (Field log)	678	10	11	13
Tow segment No.	8.1	10.1	11.1	13.1
Habitat name	Mixed sediment with hydroids and other faunal turf	Mixed sediment with hydroids and mixed faunal turf	Mixed sediment seabed with boulders and cobbles with diverse faunal turf	Mixed sediment with empty Modiolus shell
Depth (m)	63.1 - 66.3	54.1 - 57.2	52.5 - 55.1	55 - 55.3
Habitat description	Mixed sediment with occasional very low lying bedrock and cobbles. Faunal turf dominated by hydroids.	Mixed sediment with hydroids and mixed faunal turf on larger cobbles. Empty Modiolus shell throughout, with some dense patches. Small numbers of Sabellaria spinulosa present in one area.	Mixed sediment seabed with boulders and cobbles. Abundant faunal turf dominated by hydroid/bryozoan turf and sponges.	Tideswept level seabed of sandy pebbles, gravel and whole shells, with sparse fauna of hydroids and erect and encrusting bryozoa. More cobbles near end of tow, and small patches of Sabellaria reef.
Lat_start (Field log)	53.6165	53.5816	53.5855	53.5888
Long_start (Field log)	-4.4309	-4.4317	-4.4162	-4.3994
Lat_end (Field log)	53.6154	53.5820	53.5855	53.5883
Long_end (Field log)	-4.4275	-4.4294	-4.4187	-4.4021
Biotope 1	SS.SMx.CMx	SS.SMx.CMx	SS.SMx.CMx	SS.SMx.CMx
Certain / Uncertain 1:	Certain	Certain	Certain	Certain
Applicable to Part / Whole of habitat 1:	Part	Whole	Part	Whole
Biotope 2	CR.HCR.XFa		CR.HCR.XFa	
Certain / Uncertain 2:	Uncertain		Certain	
Applicable to Part / Whole of habitat 2:	Part		Part	
Annex 1 reef present? (Y/N/uncertain)	Uncertain	No	Yes	No

Sample Reference	V.RM_13_S2	V.RM_15_S1	V.RM_17_S1	V.RM_18_S1
Tow Number (Field log)	13	15	17	18
Tow segment No.	13b	15.1	17.1	18.1
Habitat name	Mixed sediment with empty Modiolus shell	Mixed sediment with empty bivalve shell with sparse fauna	Mixed sediment with Hydrallmania falcata and Flustra foliacea	Mixed sediment with Alcyonium digitatum
Depth (m)	55.2-55.9	50 - 51.7	52 - 53	50.9 - 51.6
Habitat description	Tideswept level seabed of sandy pebbles, gravel and whole empty shells, including Modiolus, with sparse fauna.	Mixed sediment with empty bivalve shell with hydroids. Larger cobbles and isolated small boulders covered with Alcyonium digitatum.	Mixed sediment with Hydrallmania falcata and Flustra foliacea, and frequent Alcyonium digitatum. Empty Modiolus shell dense in patches.	Mixed sediment with Alcyonium digitatum and hydroids on larger cobbles and isolated boulders. Small patches of bare rock showing in places.
Lat_start (Field log)		53.5893	53.5925	53.5893
Long_start (Field log)		-4.3866	-4.3828	-4.3718
Lat_end (Field log)		53.5885	53.5923	53.5890
Long_end (Field log)		-4.3885	-4.3863	-4.3765
Biotope 1	SS.SMx.CMx	SS.SMx.CMx	SS.SMx.CMx.FluHyd	SS.SMx.CMx
Certain / Uncertain 1:	Certain	Certain	Uncertain	Certain
Applicable to Part / Whole of habitat 1:	Whole	Whole	Whole	Whole
Biotope 2				
Certain / Uncertain 2:				
Applicable to Part / Whole of habitat 2:				
Annex 1 reef present? (Y/N/uncertain)	No	No	No	No

Sample Reference	V.RM_19_S1	V.RM_24_S1	V.RM_23_S1	V.RM_27_S1
Tow Number (Field log)	19	24	23	27
Tow segment No.	19.1	24.1	23.1	27.1
Habitat name	Modiolus modiolus on mixed sediment with Chalmys varia, Alcyonium digitatum and sponges	Mixed sediment with empty Modiolus shell	Modiolus modiolus on mixed sediment	Modiolus modiolus and empty shell on mixed sediment with Alcyonium digitatum, Chlamys varia and sponges
Depth (m)	51.6 - 52.7	50.3 - 50.7	50 - 50.6	48.5 - 49.1
Habitat description	Modiolus modiolus on mixed sediment with Chalmys varia, Alcyonium digitatum and sponges being the dominant faunal turf. Psammechinus miliaris frequent.	Mixed sediment with empty Modiolus shell, and very rare single live Modiolus. Isolated large cobbles and small boulders with faunal turf.	Modiolus modiolus on mixed sediment with Alcyonium digitatum and sponges.	Modiolus modiolus and empty shell on mixed sediment with Alcyonium digitatum, Chlamys varia and sponges.
Lat_start (Field log)	53.5926	53.5894	53.5930	53.5932
Long_start (Field log)	-4.3709	-4.3615	-4.3583	-4.3376
Lat_end (Field log)	53.5926	53.5899	53.5933	53.5934
Long_end (Field log)	-4.3667	-4.3593	-4.3558	-4.3364
Biotope 1	SS.SBR.SMus.ModMx	SS.SMx.CMx	SS.SBR.SMus.ModMx	SS.SBR.SMus.ModMx
Certain / Uncertain 1:	Certain	Certain	Certain	Uncertain
Applicable to Part / Whole of habitat 1:	Whole	Whole	Whole	Whole
Biotope 2				
Certain / Uncertain 2:				
Applicable to Part / Whole of habitat 2:				
Annex 1 reef present? (Y/N/uncertain)	Yes	No	Yes	Uncertain

Sample Reference	V.RM_27_S2	V.RM_29_S1	V.RM_39_S1	V.RM_9_S1
Tow Number (Field log)	27	29	39	9
Tow segment No.	27.2	29.1	39.1	9.1
Habitat name	Mixed sediment with little fauna	Mixed sediment with areas of dense empty Modiolus modiolus shell	Mixed sediment with scattered Ophiothrix fragilis and faunal turf	Mixed sediment with very rare small patches of Sabellaria spinulosa
Depth (m)	49.30-49.89	47.8 - 48.6	49.2 - 49.3	52.7 - 52.9
Habitat description	Tideswept mixed sediment with little fauna. Many empty Modiolus modiolus shell.	Tideswept and fairly mobile mixed sediment with areas of dense empty Modiolus modiolus shell. Occasional large cobbles and small boulders with Alcyonium digitatum and other faunal turf.	Mixed sediment with scattered Ophiothrix fragilis in the first half of the tow. Alcyonium digitatum, hydroids and sponges the dominant fauna on the pebbles and cobbles. Live Modiolus at the very end of the tow signifying the possible start of a bed.	Mixed sediment with very rare small patches of Sabellaria spinulosa and occasional empty Modiolus shell.
Lat_start (Field log)		53.5935	53.5964	53.6269
Long_start (Field log)		-4.3242	-4.3681	-4.3666
Lat_end (Field log)		53.5948	53.5977	53.6272
Long_end (Field log)		-4.3226	-4.3663	-4.3696
Biotope 1	SS.SMx.CMx	SS.SMx.CMx	SS.SMx.CMx	SS.SMx.CMx
Certain / Uncertain 1:	Certain	Certain	Certain	Certain
Applicable to Part / Whole of habitat 1:	Whole	Whole	Whole	Whole
Biotope 2				
Certain / Uncertain 2:				
Applicable to Part / Whole of habitat 2:				
Annex 1 reef present? (Y/N/uncertain)	No	No	No	No

Sample Reference	V.RM_9_S2	V.RM_9_S3	V.RM_20_S1	V.RM_44_S1
Tow Number (Field log)	9	9	20	44
Tow segment No.	9.2	9.3	20.1	44.1
Habitat name	Large cobbles and small boulders with hydroid and bryozoan turf	Ophiothrix fragilis on mixed sediment	Patchy clumps of Modiolus modiolus on mixed sediment	Modiolus modiolus reef with Alcyonium digitatum and mixed faunal turf
Depth (m)	52.7 - 52.9	52.7 - 52.9	50.1 - 50.1	50.4 - 51.1
Habitat description	Large cobbles and small boulders with hydroid and bryozoan turf. Area not thought to be large enough to be labelled Annex 1 Reef.	Areas of dense Ophiothrix fragilis on mixed sediment.	Patchy clumps of Modiolus modiolus on mixed sediment with Alcyonium digitatum	Modiolus modiolus reef with Alcyonium digitatum and mixed faunal turf, mainly solitary ascidians and sponges.
Lat_start (Field log)			53.5961	53.5958
Long_start (Field log)			-4.3738	-4.3782
Lat_end (Field log)				53.5967
Long_end (Field log)				-4.3815
Biotope 1	CR.HCR.XFa	SS.SMx.CMx.OphMx	SS.SBR.SMus.ModMx	SS.SBR.SMus.ModMx
Certain / Uncertain 1:	Certain	Certain	Certain	Certain
Applicable to Part / Whole of habitat 1:	Whole	Part	Whole	Whole
Biotope 2		SS.SMx.CMx		
Certain / Uncertain 2:		Certain		
Applicable to Part / Whole of habitat 2:		Part		
Annex 1 reef present? (Y/N/uncertain)	No	No	Yes	Yes

Sample Reference	V.RM_44_S2	V.RM_26_S1	V.RM_22_S1	V.RM_22_S2
Tow Number (Field log)	44	26	22	22
Tow segment No.	44.2	26.1	22.1	22.2
Habitat name	Mixed sediment with some live Modiolus modiolus and areas of dense empty Modiolus shell	Circalittoral mixed sediment with Spirobranchus and encrusting bryozoa on larger pebbles and cobbles	Mixed sediment with dense empty Modiolus shell	Mixed sediment with dense empty Modiolus shell
Depth (m)	50.4 - 51.1	49.5 - 49.5	50.02	50.02-50.33
Habitat description	Mixed sediment with some live Modiolus modiolus and areas of dense empty Modiolus shell.	Tideswept and fairly mobile circalittoral mixed sediment with Spirobranchus and encrusting bryozoa on larger pebbles and cobbles.	Tideswept, unconsolidated (fairly mobile) whole dead shells (particularly Modiolus), pebbles and coarse sand, with sparse fauna of encrusting bryozoa (mostly dead), Spirobranchus (mostly dead), and occasional gastropods	Tideswept and unconsolidated (fairly mobile) whole dead shells (particularly Modiolus), pebbles and coarse sand, with sparse fauna.
Lat_start (Field log)		53.5966	53.5963	
Long_start (Field log)		-4.3459	-4.3502	
Lat_end (Field log)			53.5959	
Long_end (Field log)			-4.3559	
Biotope 1	SS.SMx.CMx	SS.SMx.CMx	SS.SMx.CMx	SS.SMx.CMx
Certain / Uncertain 1:	Certain	Certain	Certain	Certain
Applicable to Part / Whole of habitat 1:	Whole	Whole	Whole	Whole
Biotope 2				
Certain / Uncertain 2:				
Applicable to Part / Whole of habitat 2:				
Annex 1 reef present? (Y/N/uncertain)	No	No	No	No

Sample Reference	V.RM_22_S3	V.RM_21_S1	V.RM_25_S1	V.RM_25_S2
Tow Number (Field log)	22	21	25	25
Tow segment No.	22.3	21.1	25.1	25.2
Habitat name	Mixed sediment with empty Modiolus shell	Mixed sediment with dense empty Modiolus shell, hydroids and Flustra foliacea	Silty mixed sediment with dense empty Modiolus shell	Silty cobbles and pebbles with Alcyonium digitatum and hydroids
Depth (m)	49.92-50.94	52.1 - 54.7	51.1 - 51.7	51.1 - 51.7
Habitat description	Tideswept and fairly mobile mixed sediment with empty Modiolus shell with sparse fauna and very rare isolated live Modiolus	Mixed sediment with dense empty Modiolus shell, with fauna of hydroids and Flustra foliacea. Small cluster of larger cobbles with faunal turf. Video footage fast at times.	Silty mixed sediment with dense empty Modiolus shell	Silty cobbles and pebbles with Alcyonium digitatum and hydroids. Split from previous section due to different substrata, but still classed as a sediment habitat due to size not being enough for a reef. Empty Modiolus shell dominate end of tow.
Lat_start (Field log)		53.5998	53.5892	
Long_start (Field log)		-4.3650	-4.3483	
Lat_end (Field log)		53.5979	53.5900	
Long_end (Field log)		-4.3590	-4.3434	
Biotope 1	SS.SMx.CMx	SS.SMx.CMx	SS.SMx.CMx	SS.SMx.CMx
Certain / Uncertain 1:	Certain	Certain	Certain	Certain
Applicable to Part / Whole of habitat 1:	Whole	Whole	Whole	Whole
Biotope 2				
Certain / Uncertain 2:				
Applicable to Part / Whole of habitat 2:				
Annex 1 reef present? (Y/N/uncertain)	No	No	No	No

Sample Reference	V.RM_28_S1	V.RM_30_S1	V.RM_30_S2
Tow Number (Field log)	28	30	30
Tow segment No.	28.1	30.1	30.2
Habitat name	Mixed sediment with abundant empty Modiolus shell	Mixed sediment with little fauna	Mixed sediment with dense areas of empty Modiolus shell
Depth (m)	50.4 - 50.8	50.5 - 51.5	51.35-51.46
Habitat description	Tideswept and fairly mobile mixed sediment with abundant empty Modiolus shell on sand and gravel. Very little fauna.	Tideswept and fairly mobile mixed sediment with little fauna, abundant bivalve shell.	Tideswept and fairly mobile mixed sediment with dense areas of empty Modiolus shell. Occasional Hydrallmania falcata.
Lat_start (Field log)	53.5893	53.5935	
Long_start (Field log)	-4.3349	-4.3177	
Lat_end (Field log)	53.5896	53.5939	
Long_end (Field log)	-4.3317	-4.3165	
Biotope 1	SS.SMx.CMx	SS.SMx.CMx	SS.SMx.CMx
Certain / Uncertain 1:	Certain	Certain	Certain
Applicable to Part / Whole of habitat 1:	Whole	Whole	Whole
Biotope 2			
Certain / Uncertain 2:			
Applicable to Part / Whole of habitat 2:			
Annex 1 reef present? (Y/N/uncertain)	No	No	No

Data Archive Appendix

Data outputs associated with this project are archived in project 476, media 1553 (metadata number 118981) on server–based storage at Natural Resources Wales.

The data archive contains:

[A] The final report in Microsoft Word and Adobe PDF formats.

[B] Excel spreadsheets of data recorded during the analysis of the drop-down videos and stills, including verification data (repeated analysis of 10% of the tows) and metadata.

[C] A NBN data file containing the relevant survey details.

[D] A Marine Recorder snapshot of the survey for NRW validation purposes.

[E] An Excel spreadsheet containing the metadata for the survey and its products.

[F] A full set of images from the drop down camera, in jpg format.

[G] A full set of videos from the drop down video camera, in asf format.

Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue http://libcat.naturalresources.wales/webview/ (English Version) and http://libcat.naturalresources.wales/cnc/ (Welsh Version) by searching 'Dataset Titles'. The metadata is held as record no [NRW to insert this number]

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