Cyfoeth Naturiol Cymru
Natural Resources Wales

Pen Llŷn a'r Sarnau SAC intertidal reef monitoring, Porth Oer 2012 – 2022

Report No: 786

Author Name: D Paul Brazier

Author Affiliation: Natural Resources Wales

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Mae'r Gyfarwyddeb Cynefinoedd yn sefydlu y dylai'r gwaith o reoli Ardaloedd Cadwraeth Arbennig (ACAau) anelu at gyflawni statws cadwraeth ffafriol cynefinoedd a rhywogaethau (nodweddion) a restrir yn ei Atodiad I ac Atodiad II. Mae Rheoliad 9a o'r Rheoliadau Cynefinoedd (hen Erthygl 17 o'r Gyfarwyddeb Adar a Chynefinoedd) yn ei gwneud yn ofynnol i adrodd ar statws cadwraeth y cynefinoedd a'r rhywogaethau hynny bob 6 blynedd. Yn achos ACAau yng Nghymru, Cyfoeth Naturiol Cymru (CNC) sy'n gyfrifol am y gwaith adrodd hwnnw. Er mwyn gwneud hyn, mae CNC wedi datblygu rhaglenni monitro cyflwr nodweddion, sy'n cynnwys nodweddion rhynglanwol ACAau morol.

Aquatic Survey & Monitoring Ltd. Mae ASML wedi cael eu contractio gan CCGC ac yn ddiweddarach CNC i barhau i ddatblygu'r gwaith o reoli'r rhaglen monitro rhynglanwol ar gyfer pob ACA morol ar gyfer y cyfnod 2007 i 2023, gan weithio fel tîm gyda staff CCGC/CNC.

Mae'r adroddiad presennol yn ymdrin â gwaith monitro hirdymor riff y craigwely ym Mhorth Oer, a gychwynnwyd yn 2012 ac sy'n defnyddio'r un fethodoleg â safleoedd eraill yn Aberdaugleddau, Nolton Haven a Thrwyn Monkstone ger Dinbych-y-pysgod.

Mae safle monitro parhaol wedi'i sefydlu ar lan Porth Oer ac ymwelwyd ag ef ar lanw isel a chafodd 12 cwadrat parhaol eu hadleoli, a thynnwyd ffotograffau ohonynt a'u harolygu bob blwyddyn. Cofnodir rhywogaethau fel cyfrif amlder mewn 25 cell o gwadratau 1 m^2, gyda mesuriadau ychwanegol sef gorchudd gwyrain mewn canrannau, niferoedd brennig a phroffil maint brennig.

Cwblhawyd dadansoddiad o'r data gan ddefnyddio Primer Plymouth Routines a swyddogaethau ystadegau sylfaenol Excel. Nid yw'r dadansoddiadau'n dangos unrhyw dueddiadau penodol yn y data dros amser, ac nid oes tystiolaeth bod effeithiau mawr ar y gymuned rhywogaethau sy'n nodweddu'r riff ym Mhorth Oer.

Executive summary

The Habitats Directive establishes that the management of Special Areas of Conservation (SACs) should aim to achieve favourable conservation status of habitat and species (features) listed within its Annex I and Annex II. Regulation 9a of the Habitats Regulations (formerly Article 17 of the Birds and Habitats Directive) requires reporting of the conservation status of those habitats and species every 6 years. For SACs in Wales, Natural Resources Wales (NRW) is responsible for that reporting. To do this NRW has developed programmes of feature condition monitoring, which include intertidal features of marine SACs.

Aquatic Survey & Monitoring Ltd. (ASML) have been contracted by CCW and later NRW to continue development and management of the intertidal monitoring programme for each marine SAC for the period 2007 to 2023, working as a team with CCW/NRW staff.

The present report deals with long term monitoring of the bedrock reef at Porth Oer, which was initiated in 2012 and uses the same methodology as other sites in Milford Haven, Nolton Haven and Monkstone Point near Tenby.

A permanent monitoring site is established at Porth Oer shore and was visited at low tide and 12 permanent quadrats were relocated, photographed and surveyed each year. Species are recorded as a frequency count in 25 cells of 1 m^2 quadrats, with additional measurements of barnacle % cover, limpet numbers and limpet size profile.

Analysis of the data was completed using Primer Plymouth Routines and Excel basic statistics functions. Analyses show no particular trends in the data over time, and there is no evidence that there are major impacts on the Reef feature species community at Porth Oer.

Introduction

The Habitats Directive establishes that the management of Special Areas of Conservation (SACs) should aim to achieve favourable conservation status of habitat and species (features) listed within its Annex I and Annex II. Regulation 9a of the Habitats Regulations (formerly Article 17 of the Birds and Habitats Directive) requires reporting of the conservation status of those habitats and species every 6 years. For SACs in Wales, Natural Resources Wales (NRW) is responsible for that reporting. To do this NRW has developed programmes of feature condition monitoring, which include intertidal features of marine SACs. Aquatic Survey & Monitoring Ltd. (ASML) have been contracted by NRW to develop and manage the monitoring programme for these intertidal features for the period 2006 to 2023; working as a team with NRW staff.

Conservation objectives for each feature are given in the Regulation 37 advice for the Pen Llŷn a'r Sarnau SAC (NRW 2018).

NRW developed an initial programme of intertidal monitoring work across Wales during 2004 and 2005. These surveys were managed and implemented for CCW by the Institute of Estuarine and Coastal Studies (IECS, University of Hull). These projects focused on a wide range of sensitive habitats such as Zostera, muddy gravels, caves, rockpools, algal dominated rocky shores, Sabellaria reefs, under-boulder habitats and various rare habitats and species.

Aquatic Survey & Monitoring Ltd. (ASML) have been contracted by CCW and later NRW to continue development and management of the intertidal monitoring programme for each marine SAC for the period 2007 to 2023, working as a team with CCW/NRW staff. This report continues on from previous, annual monitoring reports Mercer (2010a, 2010b; 2011, 2013; 2016a; 2016b; 2022).

Pen Llŷn a'r Sarnau SAC

Pen Llŷn a'r Sarnau SAC contains nine Annex 1 habitats. Annex I habitats that are a primary reason for selection of this site:

- Sandbanks which are slightly covered by sea water all the time
- Coastal lagoons
- Large shallow inlets and bays
- Reefs
- Estuaries

Annex I habitats present as a qualifying feature, but not a primary reason for selection of this site:

- Mudflats and sandflats not covered by seawater at low tide
- Salicornia and other annuals colonising mud and sand
- Atlantic salt meadows (Glauco-Puccinellietalia maritimae)
- Submerged or partially submerged sea caves

Of these, Estuaries and their constituent Mudflats and sandflats and Reefs, Large shallow inlets and bays with intertidal *Zostera* beds, populations of the shingle-dwelling amphipod *Pectenogammarus*, piddocks in clay and lower shore boulder communities and Reefs, particularly biogenic reefs of *Sabellaria alveolata* are the main habitats of interest within the intertidal areas of the SAC. Conservation Objectives for features of the SAC are given in the Regulation 37 advice for Pen Llŷn a'r Sarnau SAC (NRW 2018).

Phase 1 surveys of intertidal habitats in the SAC were carried out between 1999 and 2003 (Brazier *et al*. 2007), providing detailed mapping of the intertidal biotopes with some information on characterising species. Previous data exists on the intertidal habitats and communities present at many sites in the SAC, particularly the Mawddach Estuary where monitoring trials as part of the LIFE programme were carried out in 1999 and 2000 (Mercer 1999; Sanderson et al. 2001).

Surveys of intertidal habitats in the SAC in 1996 and 2003 (Brazier *et al*. 2007) provided detailed maps of the intertidal biotopes with some information on the characterising species. Intertidal reefs in Pen Llŷn a'r Sarnau SAC include areas of bedrock and boulder/ cobble habitats and many areas are characterised by biogenic reef formed by the honeycomb reef worm Sabellaria alveolata. The present report deals with long term monitoring of the bedrock reef at Porth Oer, which was initiated in 2012 and uses the same methodology as other sites in Milford Haven, Nolton Haven and Monkstone Point near Tenby.

Figure 1. Map showing location of Porth Oer in the Pen Llŷn a'r Sarnau SAC.

Method

During each fieldwork week the Porth Oer shore was visited at spring low tide and the 12 permanent quadrats were relocated, photographed and surveyed. Each quadrat's locating screws were found using the 'relocation photographs'. See Mercer (2013) for relocation details. The quadrats were originally sited in homogeneous areas of inclined rock, avoiding rockpools and large fissures where possible. The data were recorded on a form modified from Hull et al.(2008). This form is presented in Appendix 2, whilst the full quadrat results are available from NRW, or through the Marine Recorder Online Reporting tool.

Permanent Quadrat Recording (cell counts)

Within each 1 m^2 quadrat, presence/absence data were recorded for all conspicuous species using a 25 cell grid (i.e. 20 cm x 20 cm strung cells within the quadrat). This gave a frequency score of between 0 and 25 for each species. Organisms were identified to species level where possible with specimens, collected from outside the quadrat, being returned to the laboratory for verification where necessary. Species within the following taxa were aggregated for cell counts: barnacles, limpets, flat periwinkles, rough periwinkles, amphipods, *Verrucaria* spp (except *Verrucaria mucosa* type). Only algae whose stipes were within the quadrat were counted. This requires algae growing outside the quadrat to be separated to facilitate an accurate measure of abundance. Epiphytes on macroalgae were recorded from the cell in which the macroalga was attached. Care was taken to minimize disturbance of mobile invertebrates when macroalgae species were moved.

Limpet Counts

Limpet abundance (all species aggregated) was recorded from 5 random 20 cm x 20 cm cells within each quadrat. This allowed the estimation of mean limpet abundance for all three zones at the Porth Oer survey location on an annual basis.

Limpet Size Monitoring

Up to 150 limpets (minimum 100) were systematically selected within the mid-shore zone adjacent to the quadrats. All limpets encountered by the surveyor were measured to ensure an unbiased, representative population sample was collected. The longest basal shell length was measured in millimetres using Vernier callipers. Once measured, each limpet was marked with chalk to prevent duplication. These data have been used to construct annual limpet population profiles for the site.

Barnacle Abundance

Percentage cover of barnacles (all species aggregated) was recorded from 5 random 20 cm x 20 cm cells within each quadrat to allow the estimation of the annual mean Cirripedia abundance for all three zones at the Porth Oer survey site.

Photography

Photographs were taken on a variety of cameras throughout the surveys All the .jpg photograph files were renamed according to the following convention:

Date (*year month day*) space, *Photographers Initials* (up to 5 letters) space, *Site/Station* space, a *unique photograph number* that relates back to field notes, *any other useful info*.

e.g. 20180811 TSM Llandanwg 0013.JPG

The photographs are catalogued in the relevant spreadsheet data files. The photograph catalogues are included as Microsoft Excel files held by NRW.

Data collation, analysis and mapping

All data were entered into Microsoft Excel spreadsheet files during the course of the survey, usually by the individual surveyors who had collected it. Species names are according to WORMS, except for the lichens which are according to Dobson and Dalby (1997). The data were then validated by carrying out a series of independent checks to ensure that all the data were entered correctly and in the appropriate formats with no transcription errors. All recorded species and habitat data have been entered into Marine Recorder.

Results

Permanent Quadrat Recording

The upper shore is characterised by black lichen *Verrucaria* spp covered, steep and vertical bedrock with sparse barnacles *Chthamalus montagui* and channel wrack *Pelvetia canaliculata*. Rough winkles *Littorina saxatilis* and the sea slater *Ligia oceanica* are also present in high numbers.

Each of the mid shore quadrats are very similar, virtually flat and dominated by barnacles, *C montagui*, and *Semibalanus balanoides*, with fewer *Chthamalus stellatus*, limpets *Patella vulgata* and small littorinids in the crevices. The black lichens *Verrucaria* spp are found in most quadrats, and small patches of red algae such as crusts, pincer weed *Ceramium shuttleworthianum* and coral weeds *Corallina* sp are also present.

The low shore quadrats are on steep bedrock and are fairly similar across them. They have moderate amounts of barnacles *S. balanoides* and fewer *Chthamalus* spp, with common limpets *P. vulgata*. The amounts of red and brown algae are much higher on the lower shore, typically associated with crevices and small pools on the steep bedrock surface. The red algae coral weed *Corallina caespitosa*, false Irish moss *Mastocarpus stellatus*, pink coralline crust Corallinaceae, *C. shuttleworthianum*, thong weed *Himanthalia elongata*, sea spaghetti *Nemalion elminthoides* and pepper dulse *Osmundea pinnatifida* are commonplace across all quadrats.

See Appendix 1 for contextual images of each zone on the shore.

The data from the 12 permanent quadrats, for the 10 years were collated for analysis in Primer. Appropriate data manipulation prior to analysis included:

- Rationalising species names to account for taxonomic changes over time,
- Aggregating species, where recording was at differing levels of taxonomy across the years, e.g. combine all records of:
    - *Patella*

- *Verrucaria*
- *Corallina*
- *Anurida / Lipura*
- Barnacles – quantitative values as an aggregate Cirripedia, single presence for each of the barnacle species.

- Remove some species that are inconsistently recorded:
  - *Littorina obtusata/fabalis* with exception abundance just in 2013, when the weather was exceptionally wet.
- Transformation of data was unnecessary, because the range of values is constrained to between 0 and 25 (cell counts).

Cluster analysis identifies 3 major divisions – according to shore height (Figure 2). Plotting the similarity of species data averaged to each shore height per year on an nMDS shows a clear separation by shore height, but strong similarity between years (Figure 3). Average number of species per year are plotted in Figure 4. The average abundance (represented as No of cells per quadrat) at each shore height and year is plotted in Figure 5. The Shannon Diversity Index for each shore height each year is plotted in Figure 6.

On the upper shore, there are some weak trends in population changes:

- Barnacle (all aggregated) populations have gradually increased since 2012,
- *Collemopsidium* (Pyrenocollema), a lichen that lives in barnacle tests and limpet shells, and *Catenella caespitosa* have a weak trend of decline since 2012.

Figure 2. Cluster analysis plot of averaged shore height and year from Porth Oer.

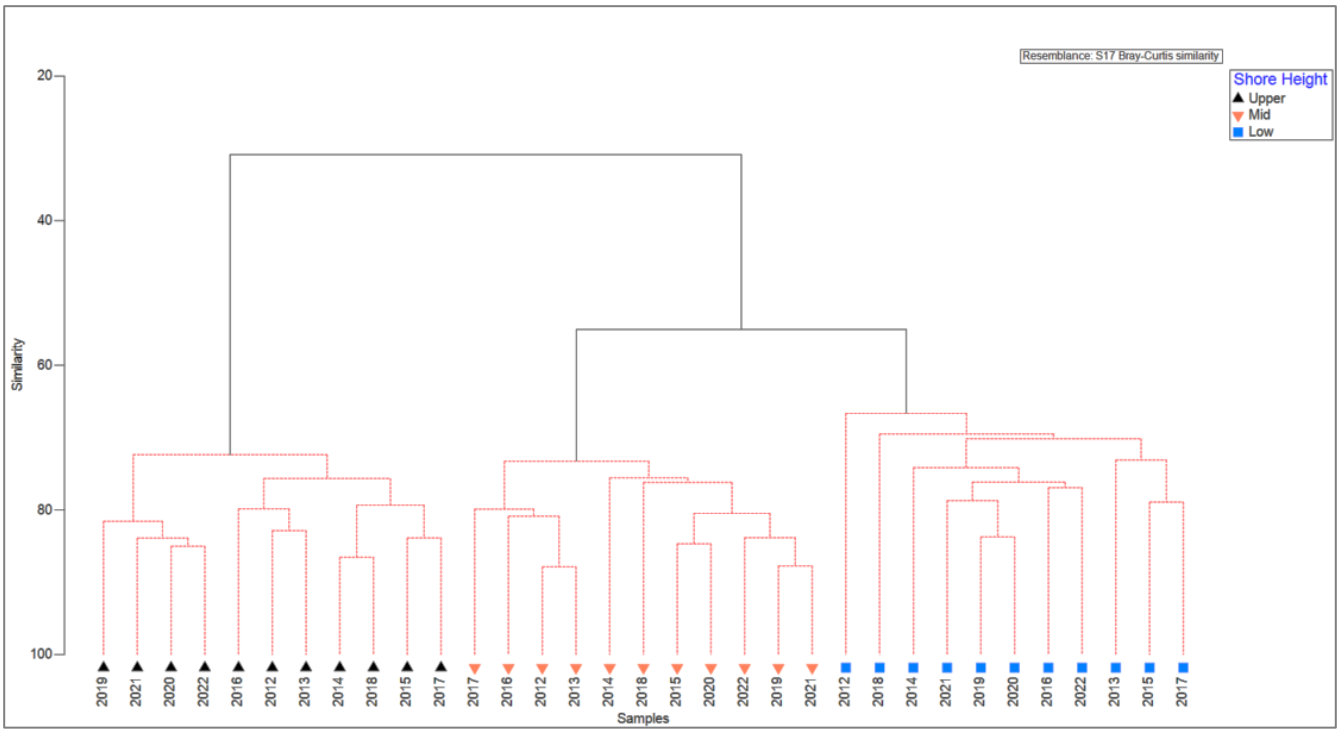


Figure 3. nMDS plot of averaged shore height and year data from Porth Oer

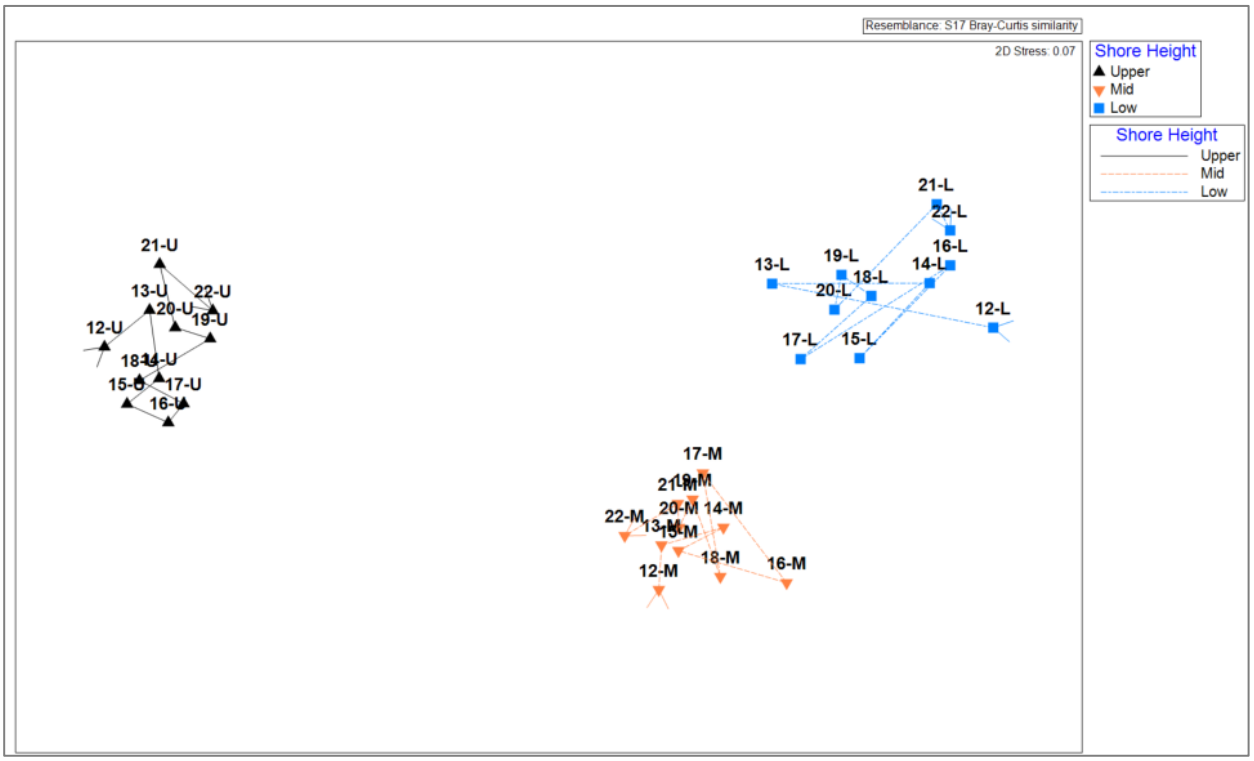


Figure 4. Average number of species per quadrat per shore height each year at Porth Oer.

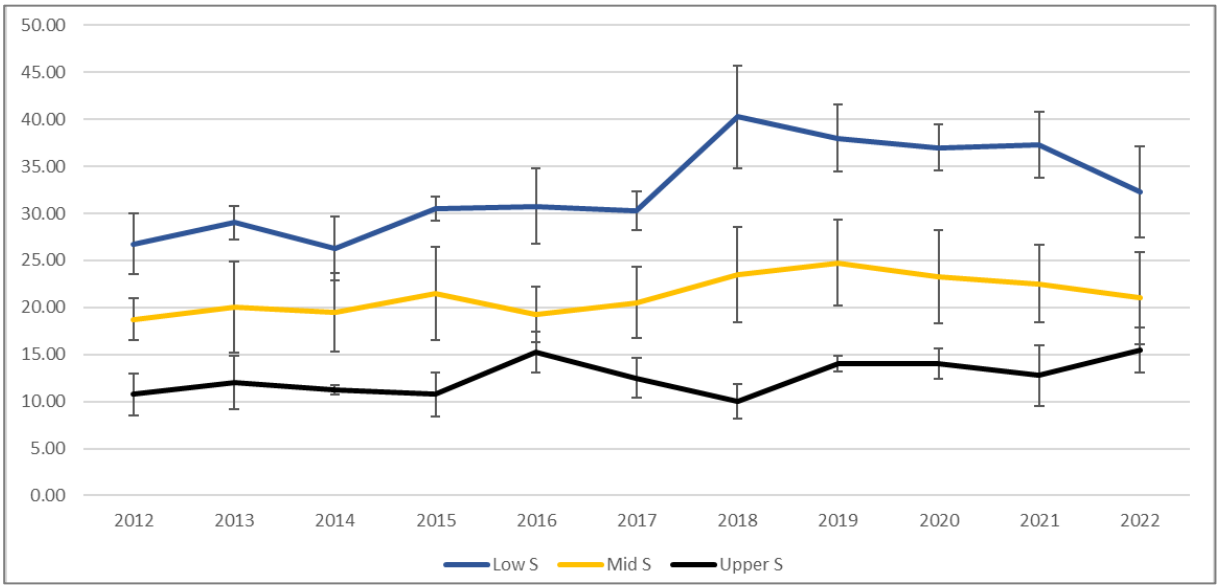


Figure 5. Total species abundance - the total number of cell records per shore height for each year at Porth Oer.

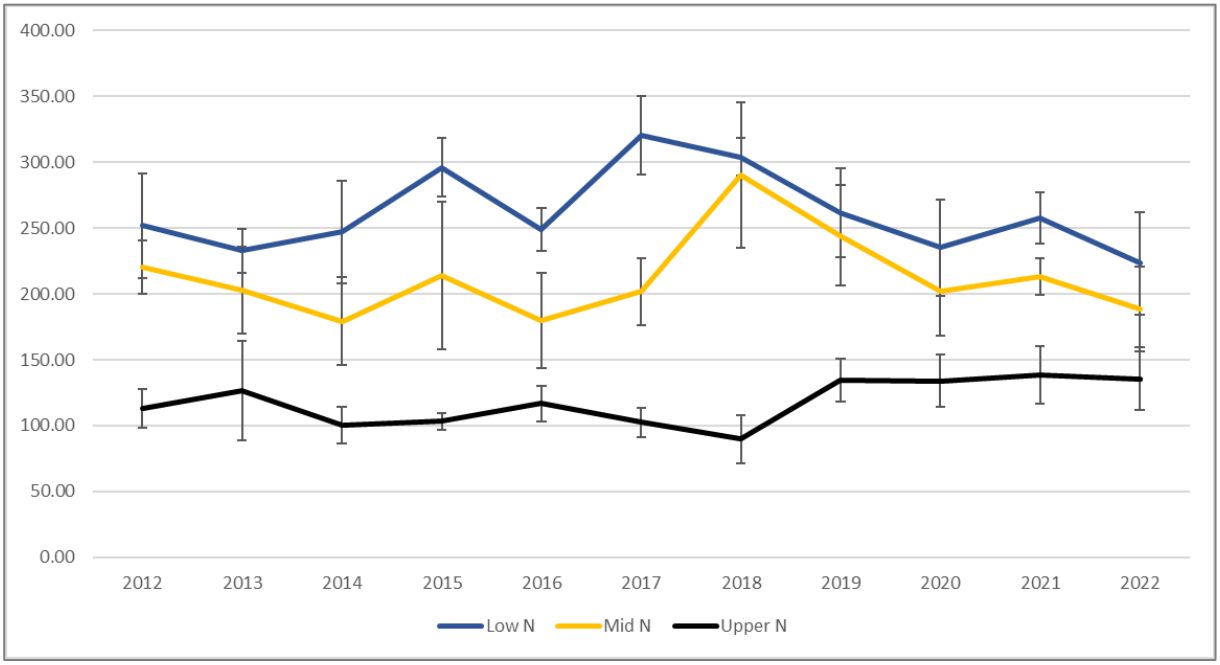
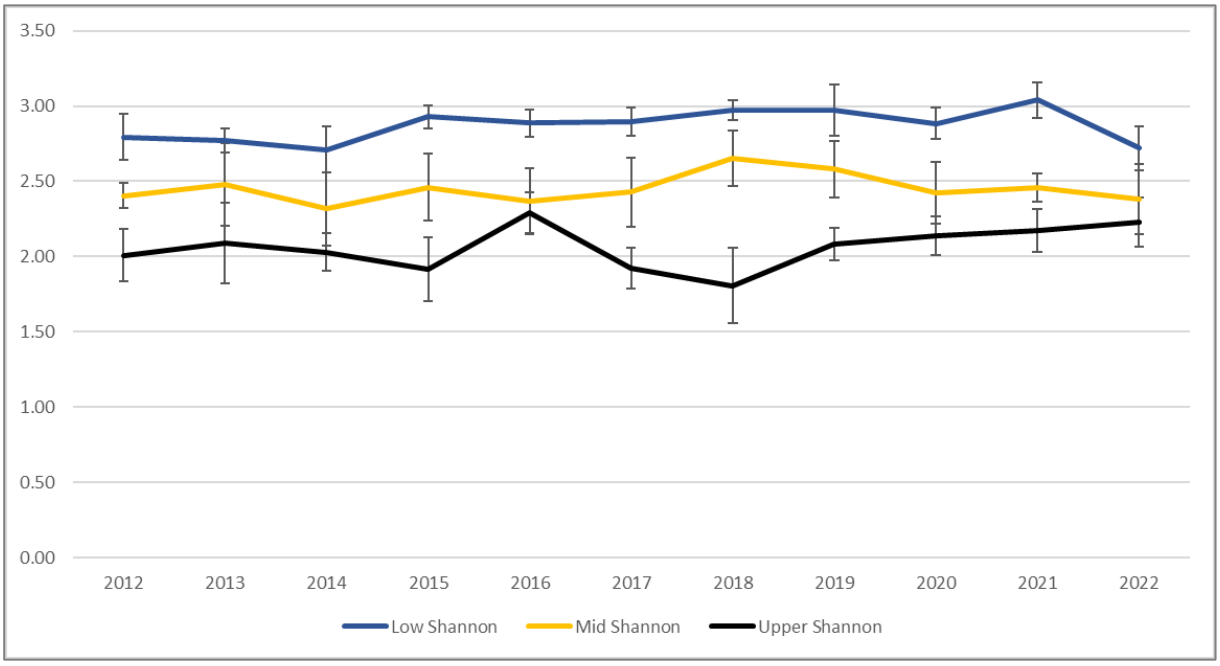


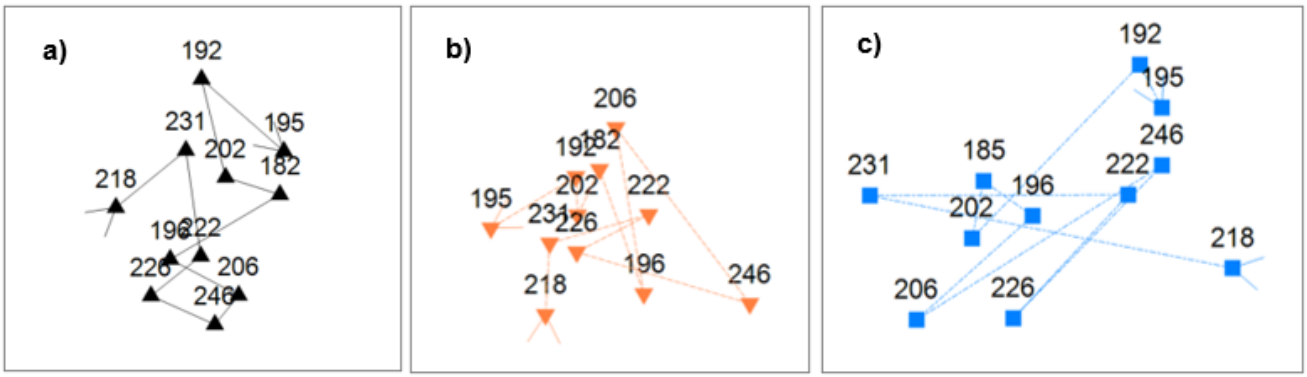
Figure 6. Shannon diversity index per shore height each year at Porth Oer.



Assessment of the effect of survey timing in the year

The survey period is kept as constant as possible. They range from 1st July (2019) to 2nd September (2016), due to logistical constraints. Does the time of survey during the summer months influence the overall community structure? In Figure 7, the labelling of each year as the respective Julian day on which survey was carried out shows that there is no particular pattern associated with the date on which surveys were carried out.

Figure 7. Cluster diagrams showing similarity between each year, labelled and trajectory overlain according to the Julian day for the upper, b) mid and c) lower shores.

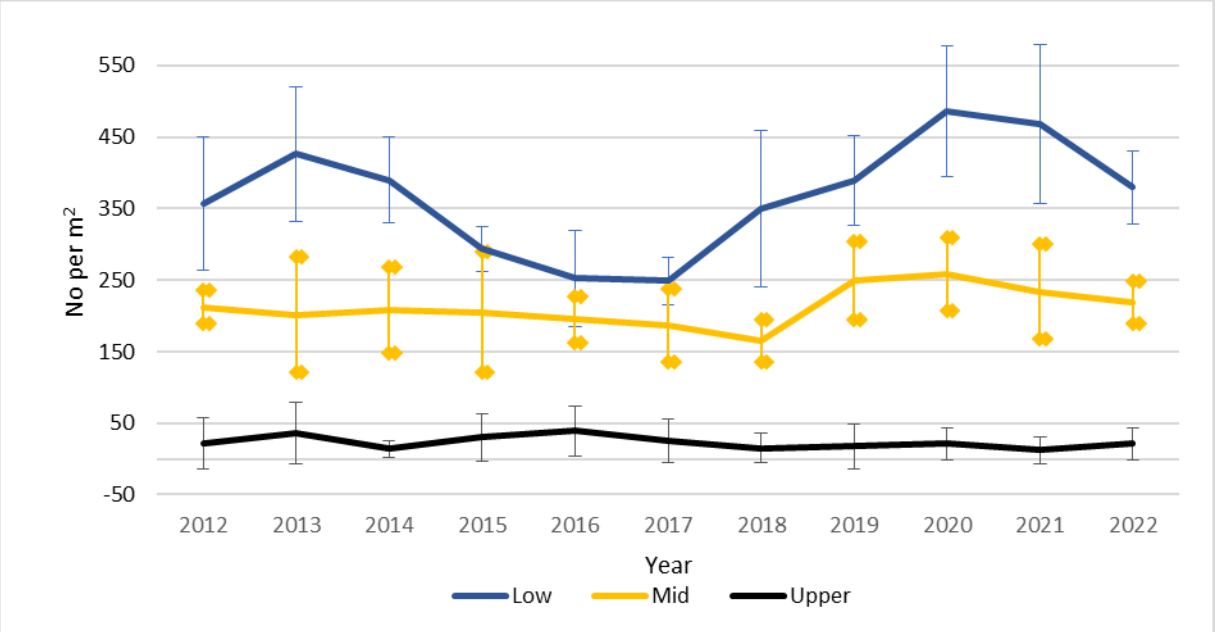


Limpet Counts

For each quadrat, 5 random cells are chosen and the number of limpets counted. The average per shore height are presented as number of limpets (*Patella vulgata*) per m^2. The mainly even bedrock on which the quadrats sit is primarily suitable habitat for *Patella vulgata*, whilst there may be the very occasional *Patella ulyssiponensis* present. The likely gradual increase of *Patella depressa*, with climate warming on this shore would necessitate the differentiation of each species, to be able to report the species separately in the future.

Limpet numbers decline between 2013 and 2017, but increase in numbers from 2018 to 2020, before a slight subsequent decrease. The period of increase matches the reduction in average limpet shell length from 2017 onwards, suggesting improved recruitment during this period, or a one off successful recruitment year?

Figure 8. Number of *Patella vulgata* per m^2 at each shore height for each year at Porth Oer.



Limpet Size Monitoring

Table 1. Mena length of limpets *Patella vulgata*, as a percentage, for each year

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
No of limpets measured	126	120	105	120	130	120	108	104	105	170	114
Mean length	16.53	20.59	20.85	19.70	21.13	24.19	19.95	19.49	15.97	15.82	18.78

See Appendix 3 for the full limpet shell length class frequency data.

A gradual decline in the number of larger individuals was observed, from 2013 to 2016 and also fewer new recruits (smallest length class) are present across the same time period. 2019 saw a substantial increase in the number of small individuals (<8 mm) which was reflected in the subsequent years as 8-16 mm class and 12-20 mm class individuals in 2020 and 2021 respectively.

Figure 9. Mean length of limpets *Patella vulgata* on the midshore at Porth Oer.

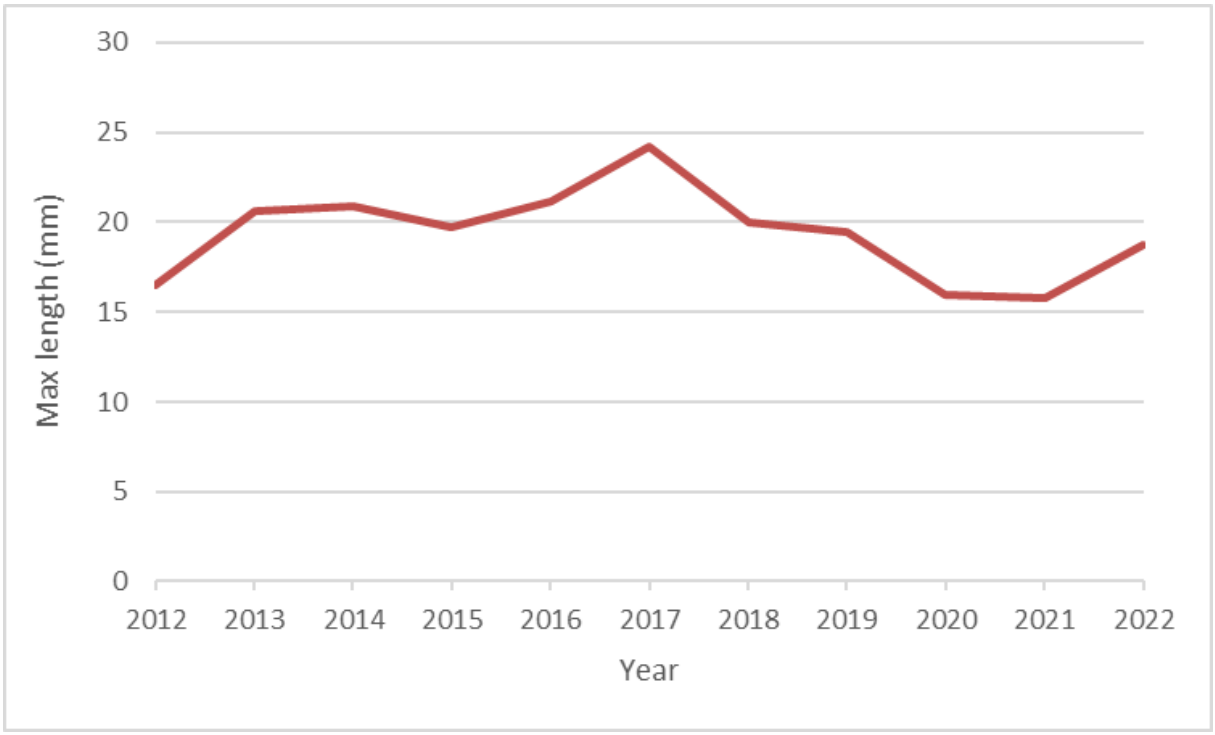
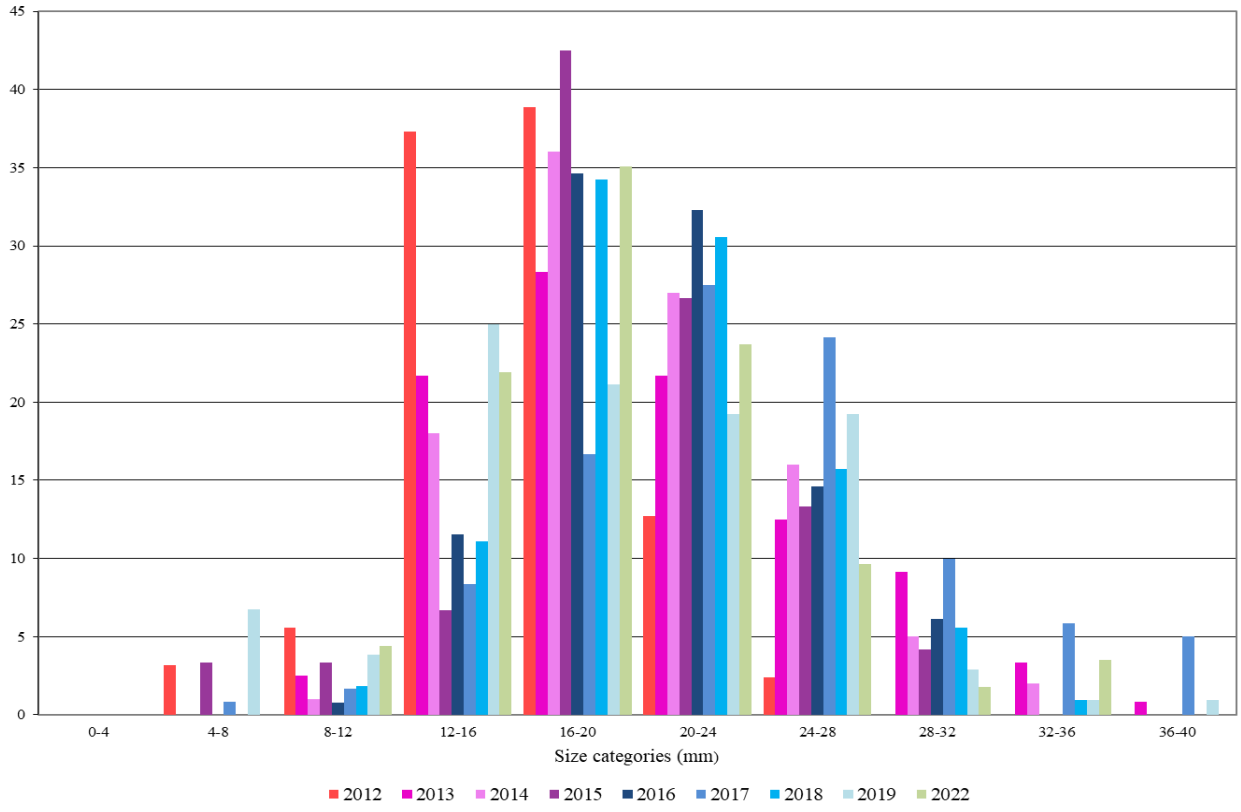
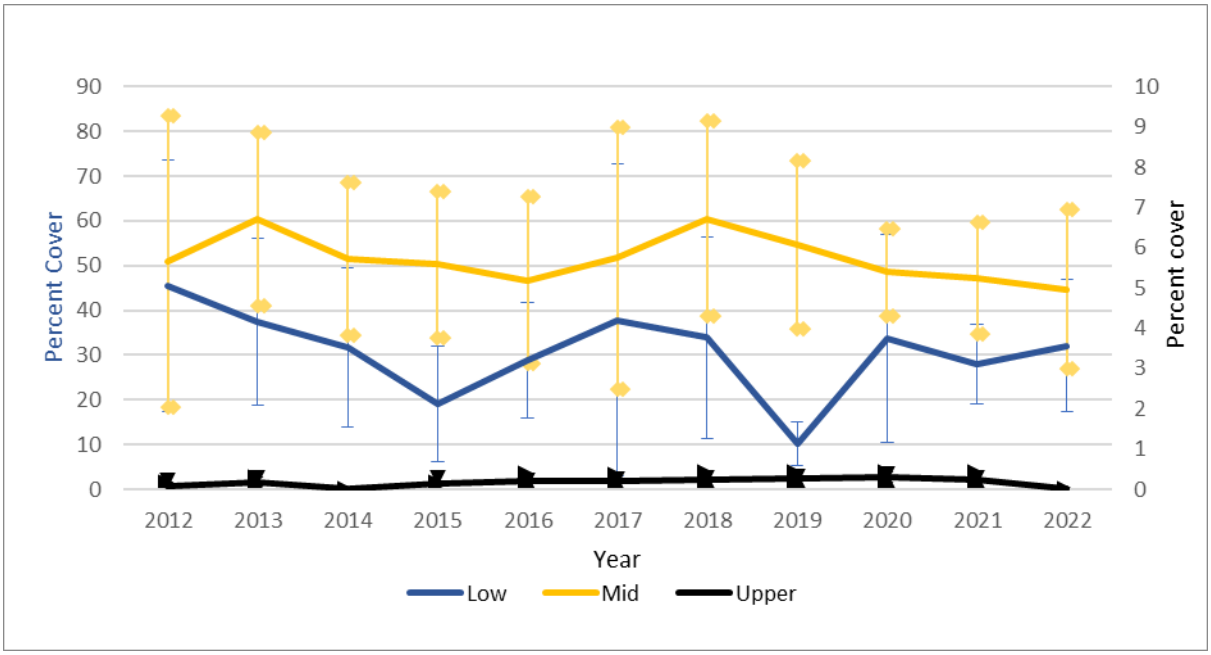


Figure 10. Graph of the frequency (% of population recorded) of different size classes of limpets *Patella vulgata* on the midshore at Porth Oer.



Barnacle Abundance

Figure 11. Percent cover of barnacles (Cirripedia Agg) at each shore height each year at Porth Oer. N.B. Upper shore values are on the right hand, secondary Y axis.



For each quadrat, 5 random cells are chosen and the percent cover of all barnacles is estimated. This figure will include all of the species that are present on the shore, *Semibalanus balanoides*, *Austrominius modestus*, *Chthamalus montagui and Chthamalus stellatus*. The density in the upper shore is very sparse, not exceeding 1% cover. The apparent gradual increase in frequency count in quadrats (detected from Primer analysis) is not reflected in the % cover values, this is likely because a change may not be observed until a threshold of density is reached across the whole quadrat.

Upper shore barnacle numbers remain very low, mostly at or below 0.5% cover. Low shore cover is dominated by red and brown algae, hence the barnacle populations are less than in the midshore. There is an apparent decline in barnacle cover from 45.5% in 2012 to 32% in 2022, but within-year variability reduces the significance of this trend. Midshore barnacle cover varies considerably within each quadrat, for example, in 2019, values between 25% to 90% were recorded (quadrat means 33% to 78%).

Conclusions

The biological communities are typical of wave exposed shores in north Wales. The biotopes, based on the JNCC Marine Habitat Classification (JNCC 2022) are:

Upper shore = LR.FLR.Lic.Ver.B
Mid shore = LR.HLR.MusB.Sem.Sem
Low shore = LR.HLR.FR.Coff.Coff

The continued presence of Nemalion elminthoides is notable on the low shore. He occasional observation of the southern limpet *Patella depressa* reflects range extension by this limpet in recent years (Mieszkowska & Sugden 2023; Burrows et al. 2020).

Species richness and abundance fluctuates little from year to year.

Permanent Quadrat Recording

The Primer analysis clearly differentiates the differences between the shore zones, but there are no significant differences between years at any of the shore heights, using species community similarity as a measure.

An assessment of the likely effect of changing dates has been made, and there is no clear correlation of species community change with Julian date.

Limpet Monitoring

The limpet population remains at a constant, with some years showing more new recruits, which can be seen growing up in following years. For example, the 2012 and 2019 cohorts can be seen moving up the size classes in subsequent years. The greatest mean length was in 2017, perhaps reflecting less recruitment in the previous few years, or conditions caused loss of smaller individuals.

The higher number of larger limpets and coincident lower number of limpets in 2016 and 2017 is ecologically meaningful. If there is reduced recruitment around these years, then the average size would increase, whilst number of individuals will be declining. In 2020 and 2021, the average size dropped, coincident with higher numbers per m^2.

Barnacle Abundance

There is considerable variability in values between quadrats in each year (Figure 11), resulting in none of the differences between years being statistically significant. The high field variability may be dealt with in the future through increasing the sampling (counts) of barnacles for each quadrat?

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Appendices

Appendix 1 Porth Oer Relocation form

Site: Porth Oer

Grid Coords: 216361 329852

Access:
Park at the top of the hill in the National Trust car park (pay or display NT membership card). Walk, via the road, to the beach, turn left across the top of the sandy beach and follow the low path around the headland for 150m. Drop off the path to clamber over the rocks to the site

Quadrat Relocation:

Upper shore quadrats (216360, 329855): the quadrats are close to the departure from the path (25 m) on rugged ridges of bedrock with sparse *Pelvetia*. The top 2 quadrats face north-west and the next 2 face north east on a vertical wall.

Beware in-coming tide here, on the flood

Mid shore quadrats (216315, 329866): The mid and low shore quadrats are 450 m north west of the upper shore station, across a low area of shore Quadrats are on a fairly flat area of bedrock with barnacles, crossed with small crevices and in the vicinity of a 2 metre long rockpool

Low shore quadrats (216326, 329876): the quadrats face to the east, 2 are almost vertical, in a gully and the 2nd 2 are within 10 m on 30° sloping bedrock with *Himanthalia*.

Quadrat Relocation:

Upper shore quadrats (216360, 329855): the quadrats are close to the departure from the path (25 m) on rugged ridges of bedrock with sparse *Pelvetia*. The top 2 quadrats face north-west and the next 2 face north east on a vertical wall.

Beware in-coming tide here, on the flood

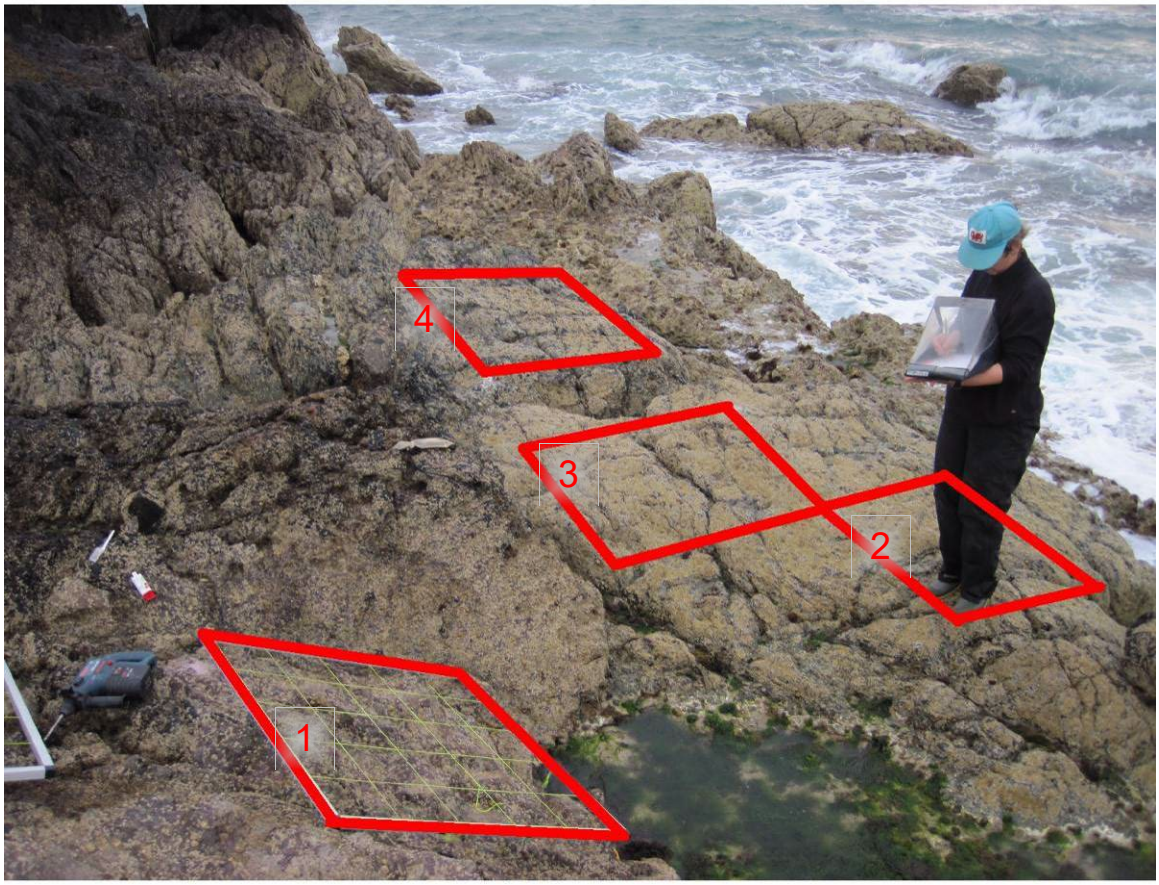
Mid shore quadrats (216315, 329866): The mid and low shore quadrats are 450 m north west of the upper shore station, across a low area of shore Quadrats are on a fairly flat area of bedrock with barnacles, crossed with small crevices and in the vicinity of a 2 metre long rockpool

Low shore quadrats (216326, 329876): the quadrats face to the east, 2 are almost vertical, in a gully and the 2nd 2 are within 10 m on 30° sloping bedrock with *Himanthalia*.

Site overview

Upper shore quadrats

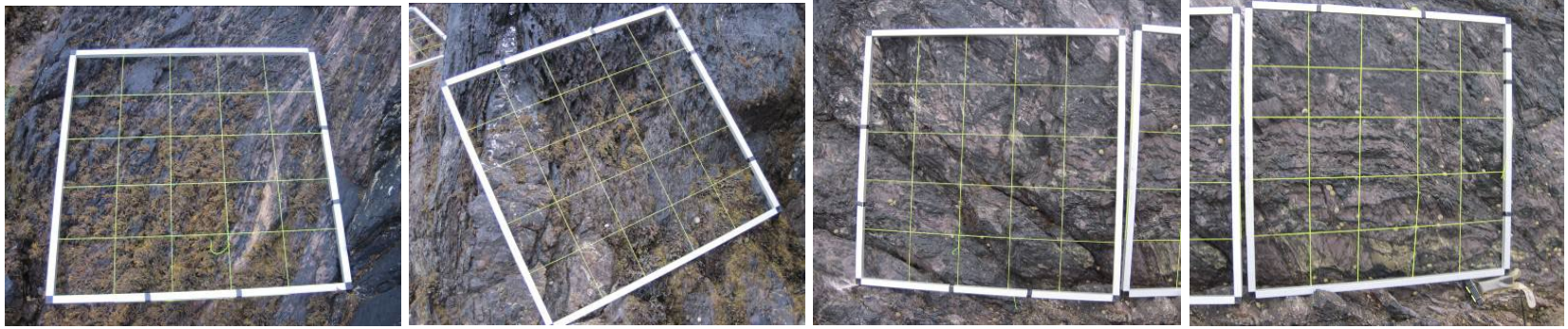
Mid shore quadrats



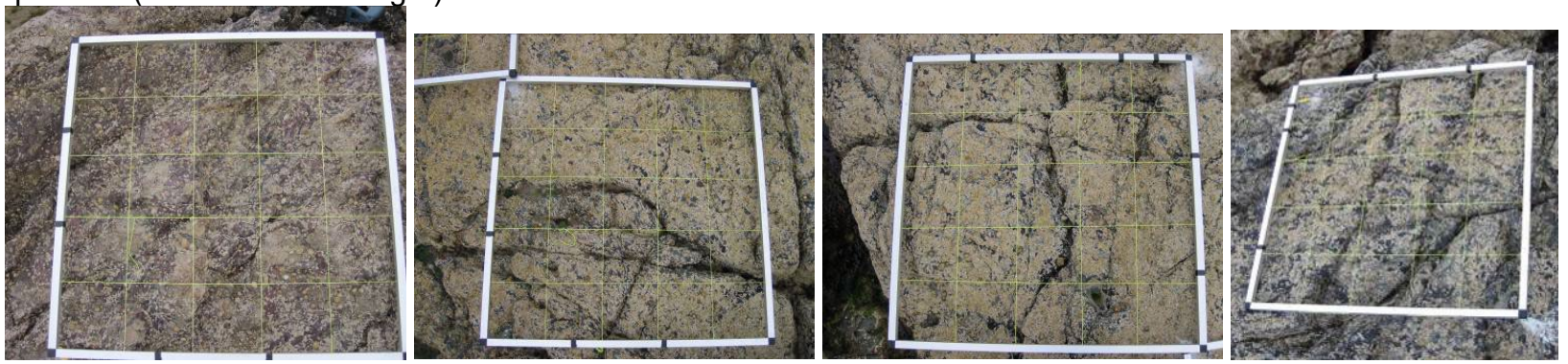
Low shore quadrats


Midshore
4
3
2
1

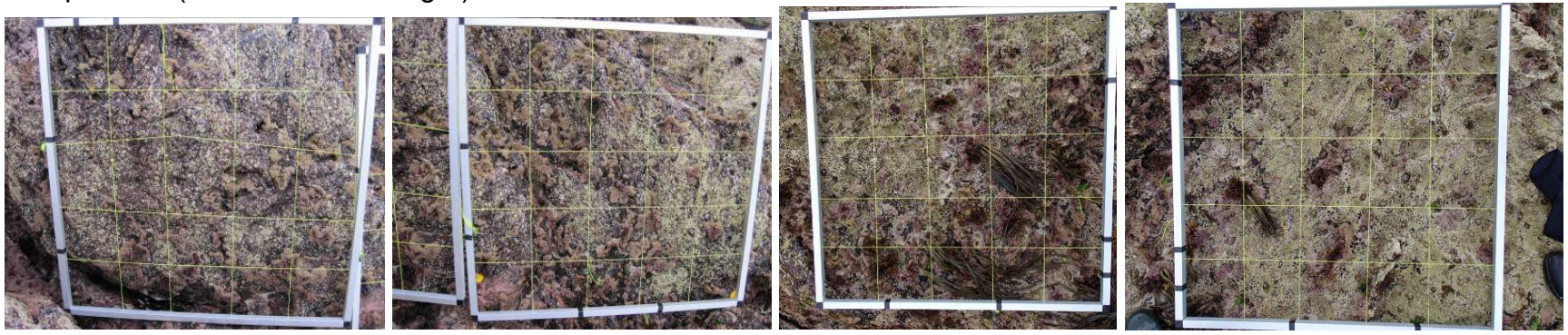
Upper shore quadrats (1 – 4 from left to right)



Mid shore quadrats (1 – 4 from left to right)



Low shore quadrats (1 – 4 from left to right)



Appendix 2 Bedrock quadrat recording form (example)

PLAS 2019 SAC: Rockyshore quadrats - Porth Oer: Surveyors:…… Date:……

Time at start:…… ….Conditions: …… /8 Camera: …… .....Stn. No: US / MS

Porth Oer – Frequency counts

	Upper shore fauna				Mid shore fauna			
Quadrat No.	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Photo no.								
Himeniacidon perlevis								
Actinia equina								
Prostigmata (mites)								
Lipura maritima								
Ligia oceanica								
Cirripedia								
Chthamalus montagui								
Chthamalus stellatus								
Semibalanus balanoides								
Melarhaphe neritoides								
Small gastropods in crevices								
Littorina saxatilis								
Patella spp								
Mytilus edulis								
Nucella lapillus								
Upper shore flora					**Mid shore flora**			
Caloplaca marina								
Verrucaria black								
Verrucaria green								
Pyrenocollema (lichen)								
RHODOPHYCOTA (filamentous)								
RHODOPHYCOTA (crustose)								
Aglaothamnion hookeri								
Corallinaceae								
Corallina officinalis								
Catenella caespitosa								
Ceramium sp.								
Ceramium shuttleworthianum								
Lomentaria articulata								
Mastocarpus stellatus								
Osmundea hybrida								
Osmundea pinnatifida								
Porphyra sp								
Rhodochorton purpureum								
Pelvetia canaliculata								
Ralfsia verrucosa								
Fucus spiralis								
Ectocarpaceae								
Ulva sp. (flat)								
Ulva intestinalis								
Chaetomorpha ligustica								
Cladophora sp.								
Cladophora albida								

PLAS 2019 SAC: Rockyshore quadrats - Porth Oer: Surveyors:.....Date:.....

Time at start:..... Conditions:.....Camera: ..... Stn. No: Lower shore

Porth Oer – Frequency counts

Lower shore fauna					Additional lower shore fauna				
Quadrat No.	**1**	**2**	**3**	**4**	**Taxa**	**1**	**2**	**3**	**4**
Hymeniacidon perleve									
Halichondria panicea									
Actinia equina									
Cirripedia									
Chthamalus montagui									
Chthamalus stellatus									
Austrominius modestus									
Semibalanus balanoides									
Melarhaphe neritoides									
Littorina saxatilus									
Patella spp									
Small gastropods in crevices									
Mytilus edulis									
Spirobranchus sp.									
Nemertean worm									
Lipura maritima									
Prostigmata (mites)									
Lowershore flora					**Additional lower shore flora**				
Taxa	**1**	**2**	**3**	**4**	**Taxa**	**1**	**2**	**3**	**4**
Verrucaria black					Aglaothamnion gallicum				
Verrucaria green					Ceramium gaditanum				
Pyrenocollema (barnacle lichen)					Corallina caespitosa				
Himanthalia elongata					Eliosanda elongata				
Ralfsia verrucosa					Laminaria sporelings				
Leathesia difformis					Petrospongium berkeleyi				
RHODOPHYCOTA (filamentous)					Porphyra umbilicalis				
RHODOPHYCOTA (Crusts)					Palmaria palmata				
Corallinaceae					Plumaria elegans				
Corallina sp					Scytosiphon				
Mastocarpus stellatus					Spongonema tormentosa				
Plocamium maggsiae									
Osmundea pinnatifida									
Lomentaria articulata									
Nemalion helminthoides									
Aglaothamnion hookeri									
Membranoptera alata									
Polysiphonia atlantica									
Polysiphonia broadiae									
Polysiphonia fibrata									
Polysiphonia harveyi									
Boergeseniella thuyoides									
Ceramium sp.									
Ceramium shuttleworthianum									
Ceramium virgatum									
Callithamnion granulatum									
Chaetomorpha ligustica									
Cladophora sp.									
Cladophora albida									
Ulva sp. (flat)									
Ulva (tubular)									

PLAS 2019 SAC: Rockyshore quadrats - Porth Oer: Surveyors:..... Date:.....

Time at start:..... ....Conditions: ..... /8 Camera: ....Stn. No: US / MS

	Upper shore				Mid shore			
Additional species	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**

This next table is only required if this team measures the middleshore limpets! Please measure all accessable limpets, do not be sizest!! Use chalk to mark the measured individuals.

Limpet monitoring (Middleshore zone 100+) maximum length measurements (mm)												

Barnacle species abundance photos - 5cm x 5cm quadrats (minimum of 5 to be taken in the zone - tick the box when complete)	**Upper shore** ☐ No. =				**Middle shore** ☐ No. =			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Barnacle abundance (5no. 20x20 cells - percentage for all spp.)								
Random no.s 2, 9, 13, 21, 23								
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Limpet abundance (All Zones – 5no. 20x20 cell counts)								
Random no.s 4, 6, 13, 15, 20								

Please photograph data sheet when complete in the field?

Appendix 3 Limpet size data

Table 2. Summary of proportion of each size class of *Patella vulgata* each year.

Size Class	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Number of *Patella* measured	126	120	105	120	130	120	108	104	105	170	114
0-4 mm	0	0	0	0	0	0	0	0	0	0	0
4-8 mm	3.17	0	0	3.33	0	0.83	0	6.73	1.90	0.59	0
8-12 mm	5.56	2.50	0.95	3.33	0.77	1.67	1.85	3.85	20	15.29	4.39
12-16 mm	37.30	21.67	17.14	6.67	11.54	8.33	11.11	25.00	31.43	32.94	21.93
16-20 mm	38.89	28.33	34.29	42.50	34.62	16.67	34.26	21.15	23.81	30.59	35.09
20-24 mm	12.70	21.67	25.71	26.67	32.31	27.50	30.56	19.23	10.48	14.71	23.68
24-28 mm	2.38	12.50	15.24	13.33	14.62	24.17	15.74	19.23	3.81	4.71	9.65
28-32 mm	0	9.17	4.76	4.17	6.15	10	5.56	2.88	4.76	1.18	1.75
32-36 mm	0	3.33	1.90	0	0	5.83	0.93	0.96	3.81	0	3.51
36-40 mm	0	0.83	0	0	0	5.00	0	0.96	0	0	0
40-44 mm	0	0	0	0	0	0	0	0	0	0	0
>44 mm	0	0	0	0	0	0	0	0	0	0	0
Mean	16.53	20.59	20.85	19.70	21.13	24.19	19.95	19.49	15.97	15.82	18.78

Appendix 4 Data Archive Appendix

Data outputs associated with this project are archived in on cloud based Document Management System and server–based storage at Natural Resources Wales.

The data archive contains:

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

[B] A set of excel spreadsheets for limpet, barnacle and full quadrat species data.

[C] A full set of images produced in jpg format.

Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue (English Version) or Catalog Llyfrgell (Welsh Version) by searching 'Dataset Titles'. The metadata is held here - Across-Wales intertidal SAC monitoring, Pen Llŷn ar Sarnau SAC 2015 - 2019

Further copies of this report are available from library@cyfoethnaturiolcymru.gov.uk