Skomer Marine Conservation Zone Project Status Report 2025

NRW Evidence Report 957

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Mae'r tablau statws prosiect yn Adran 2 yn rhoi crynodeb o'r holl brosiectau monitro sydd wedi'u sefydlu yn y Parth Cadwraeth Morol. Mae Adran 4 yn manylu ar brosiectau biolegol y gweithiwyd arnynt yn ystod 2025 a chrynodeb o'r canlyniadau hyd yma. Mae Adran 5 yn rhoi crynodeb o'r prosiectau gwyliadwriaeth cefnforegol a meteorolegol.

Cofnodion nodedig yn 2025:

Cofnododd gwaith monitro'r fôr-wyntyll binc, *Eunicella verrucosa,* golledion pellach yn 2025. Mae'r ffaith ein bod yn parhau i golli môr-wyntyllau fel hyn, ynghyd â'r cyflwr gwael yr ydym yn ei arsylwi sy'n deillio o nifer fawr o wyau morgwn, necrosis (meinwe marw) a mathau eraill o wymon ac anifeiliaid sy'n glynu yn achosi pryder.

Cofnododd penwythnos arolwg plymio gwirfoddol boblogaethau pysgod tiriogaethol ac echinodermau fel arolwg cyfun. Mae'r data hwn wedi'i ychwanegu a'i gymharu ag arolygon blaenorol sy'n darparu dros 20 mlynedd o setiau data hirdymor.

Cofnodwyd tymereddau môr cynnes yn y gaeaf eto ym mis Mawrth 2025 gan barhau â'r duedd a gofnodwyd dros y 4 blynedd diwethaf. Cofnodwyd y tymereddau isaf yn y môr ym mis Mawrth ac yn 2022, i 2025 roeddent yr uchaf erioed ers 2007, gyda'r tymheredd uchaf erioed o 9.1 ˚C yn 2024. Mae cymarebau rhywogaethau cregyn llong ar y traethau canol ac isaf wedi dangos symudiad o'r rhywogaeth dŵr oer *Semibalanus balanoides* yn dominyddu i'r rhywogaeth dŵr cynnes *Cthalamus spp* a geir fel arfer ymhellach i'r De.

Executive summary

This is the twenty-third project status report produced by the Skomer Marine Conservation Zone (MCZ). It summarises the progress and current status of monitoring projects in the Skomer MCZ during 2025. These projects not only provide the evidence needed to report on the condition of the Skomer MCZ itself, but make an important contribution to the evidence used in assessing the condition and conservation status of the Pembrokeshire Marine Special Area of Conservation (PMSAC), within which the MCZ is situated. Skomer MCZ long-term data, both biological as well as human use, has also been used in establishing and reporting on biological indicators for UK requirements under the UK Marine Strategy (UKMS). Specific cases where Skomer MCZ data have been used to support initiatives other than those directly linked to the MCZ are detailed in individual project summaries.

The project status tables in Section 2 provide a summary of all established monitoring projects within the MCZ. Section 4 details biological projects that were worked on during 2025 and a summary of the results to date. Section 5 provides a summary of the oceanographic and meteorological surveillance projects.

Notable records in 2025:

Pink sea fan, *Eunicella verrucosa*, monitoring recorded possible further losses in 2025. The continued loss of sea fan, along with the poor condition we are observing due to large numbers of catshark eggs, necrosis (dead tissue) and other attached seaweeds and animals is a concern.

A volunteer dive survey weekend recorded territorial fish, echinoderm populations as a combined survey. This data has been added and compared to previous surveys providing over 20 years of long-term datasets.

Warm winter sea temperatures were recorded again in March 2025 continuing the trend recorded for the last 4 years. The minimum sea temperatures are recorded in March and in 2022, to 2025 were the highest on record since 2007, with a record high of 9.1^{o}C in 2024. Barnacles species ratios on middle and lower shores have shown a shift from the cold water *Semibalanus balanoides* dominating to the *Cthalamus spp* usually found further South.

1. Skomer MCZ and Sustainable Management of Natural Resources

The Environment (Wales) Act and the Wellbeing of Future Generations (Wales) Act provide the framework for NRW's work to pursue the sustainable management of natural resources as defined in the former, while maximising our contribution to the well-being goals set out in the latter.

Sustainable management of natural resources follows nine main principles, and the work of Skomer Marine Conservation Zone can be shown to apply (and to have been applying for many years) these principles:

Adaptive management – the management of Skomer MCZ is not fixed. Our monitoring programme provides the evidence we need to review our management actions and, where necessary, change them.

Scale – whereas the boundary of the site was established decades ago, our extensive knowledge of the MCZ allows us to apply aspects of our management to specific and appropriate areas. For instance, we are confident that the seabed in South Haven and parts of North Haven can tolerate current and historical levels of recreational anchoring, but the rest of the site cannot. This allows us to identify areas where recreational anchoring can take place rather than try to impose a blanket ban on anchoring. For the same reason it would be unreasonable to restrict public access to the whole coastline of Skomer when there are specific small areas that are more sensitive to disturbance at certain times of year. Hence our seasonal access restrictions are designed to protect birds and breeding seals at the most sensitive sites in the Spring and Autumn respectively.

Collaboration and engagement – this report demonstrates the importance we place upon liaison with academic institutions to increase our knowledge of the site by supporting research projects. The Skomer MCZ Annual Report further documents our connections with regulatory and recreational organisations to ensure legal and voluntary measures are effective in protecting the site. The Skomer MCZ Advisory Committee is pivotal in this respect.

Public participation – without public participation we would be unable to carry out as much monitoring work as we do. We are dependent on volunteers: from teams of volunteer divers carrying out intensive surveys of species and habitats like scallops and eelgrass, to individuals making up our own dive team to allow work to continue in the absence of staff. Our voluntary controls would be unworkable without public support and the local community provide valuable help in safeguarding the site through their vigilance.

Evidence – NRW is an evidence-based organisation, so evidence is needed to inform policy and underpin operations, whether we are collecting it ourselves or relying on our extensive collaborative network to provide it to us.

Multiple benefits – we are fully aware of the intrinsic value of a site, such as Skomer MCZ, where people can come to enjoy wildlife in as unspoilt a marine area as we are likely to have anywhere in Wales. This is all the more important in the context of the value of tourism and recreation to the Welsh economy is considered. We can only theorise on the level of benefits to the wider marine environment of larval export from seabed communities and species deriving a high level of protection as a result of the fishery byelaws we have.

Long term – at Skomer MCZ, we are in an almost unique position to be able to report on the long-term consequences of marine conservation management actions taken over three decades ago. This is because we have some of the longest-running time-series data from a marine protected site in the UK.

Preventative action – the site-based nature of the team at Skomer MCZ is a major contributory factor to the protection of the site. We are able to respond quickly to potentially damaging events and intervene. Sometimes this is by our mere presence acting as a deterrent, and sometimes by educating those who might cause harm unknowingly.

Building resilience – by applying nature conservation principles we can help to build diversity, populations, and connectivity; all of which contribute to the maritime ecosystem's resilience in the face of anthropogenic change.

2. Project Summary tables

2.1 Physical data projects

Dataset	Brief description	Year sets	Sampling frequency	Report	Data summary and availability
Meteorological data	Automatic station logging 10 mins mean for wind, rain, sunshine, temperature, humidity, net radiation New met station (2006) compatible with the Environmental Change Network (ECN) and logs files daily, hourly and every ten minutes.	1993 to ongoing (Old station removed October 2005 and new station installed April 2006)	Continuous	SMCZ Project status reports	Yes, Skomer MCZ office
Wave data	Height, period, etc. Automatic station logging every 10mins.	1993-1998 Discontinued	Continuous	No	No, raw data, paper format only
Seawater data	Temperature, salinity, conductivity	1992 to ongoing	Weekly (April to Oct)	SMCZ Project status reports	Yes, Skomer MCZ office
Seawater data	YSI 6600 multi parameter sonde: Temperature, salinity, dissolved O2, Chlorophyll, turbidity & depth. OSIL buoy automatically transmitting data from YSI 6600 sonde.	2007 to 2013 Discontinued	Hourly samples	SMCZ Project status reports	Yes, Skomer MCZ office
Seawater data	Temperature onset logger	2014 to ongoing	Hourly samples	SMCZ Project status reports	Yes, Skomer MCZ office
Seabed sedimentation	Auto sampler	1994 to1998 Discontinued	Continuous	No	Yes, Skomer MCZ office
Seabed sedimentation	Sediment trap	1994 – ongoing	Every 14 days (April to Oct)	SMCZ Project status reports	Yes, Skomer MCZ office
Suspended sediments	Idronaut turbidity logger	2001-2006 Discontinued	Continuous	No	No, raw data only
Suspended sediments	Secchi disc	1992 to ongoing	Weekly (April to Oct)	No	Yes, Skomer MCZ office
Suspended sediments	YSI 6600 multi parameter sonde	2007 to 2013 Discontinued	Hourly	No	Yes, Skomer MCZ office

2.2 Activity projects

Dataset	Brief description	Year sets	Sampling frequency	Report	Data summary and availability
Recreation activities	Numbers and locations of boats, divers, anglers	1987 to ongoing	Weekly (May -Sept)	Skomer MCZ annual reports	Yes, Skomer MCZ office
Commercial fishing activities	Date and location of fishing boats	1987 to ongoing	Weekly (May -Sept)	Skomer MCZ annual reports	Yes, Skomer MCZ office
Commercial fishing activities	Mapping of pot buoys and fishing net positions	1989 to ongoing	Weekly (May -Sept)	Burton 2002, Skomer MCZ annual reports	Yes, Skomer MCZ office
Tankers in St Brides bay	Number and names of tankers and movements.	1994 to ongoing	Daily	No	Yes, Skomer MCZ office
Tankers in St Brides bay	Automatic Identification System (AIS)	2013 to ongoing	Continuous	No	Yes, Skomer MCZ office

2.3 Biological projects

Dataset	Brief description	Year sets	Sampling frequency	Report	Data summary and availability
Littoral Community Macro scale	Viewpoint photos/digitised to form time-series dataset	1992 to ongoing	Annual	Internal reports: Daguet 2000, Gibbs 2007	Yes, Skomer MCZ office
Littoral Community Meso scale	6 Transects, photos/digitised to form time-series dataset	1992 to ongoing	Annual	Adams 1979, Bunker 1983, Crump 1993/96, Hudson 1995.	Yes, Skomer MCZ office
Littoral Community Meso scale	7 sites, quadrats at lower, middle, upper shores and lichen zone. Limpet and barnacle populations 3 sites MarClim methods	2003 to ongoing	Annual	Crump & Burton 2004, SMCZ Project status reports	Yes, Skomer MCZ office
Sub-Littoral Rocky reef communities	Stereo photos/digitised to form time-series dataset	1982 – ongoing	Annual	Bullimore 1986 & 1987	Yes, Skomer MCZ office

Dataset	Brief description	Year sets	Sampling frequency	Report	Data summary and availability
Sub-Littoral Algal communities	Algae species and community survey.	1983, 1986,1994, 1999, 2007	No current planned survey	Hiscock 1983 & 1986, Scott 1994, Brodie & Bunker 1999/2000, Maggs & Bunker 2007.	Yes, Skomer MCZ office. Algae herbarium stored at National Museum Wales.
Sub-Littoral Algal communities	Kelp forest and algae community survey	Method testing 2024	Every 4 years, next survey planned 2028	Lock *et al* 2025	Yes, Skomer MCZ office.
Sub-Littoral Sponge assemblages	4 transects, photos/digitised to form time-series dataset	1994 to ongoing	Annual	SMCZ Project status reports	Yes, Skomer MCZ office.
Sub-Littoral Sponge assemblages	Species recording	2002/3, 2007/8 2011, 2015, 2019, 2023	Every 4 years, next planned 2027	Bunker & Jones 2008 Jones *et al*. 2012, 2016, 2020, 2024.	Yes, Skomer MCZ office.
Sub-Littoral Sponge assemblages	15 fixed quadrats, photos/digitised to form time-series dataset	2006 to ongoing	Annual	Berman *et al*. 2013.	Yes, Skomer MCZ office.
Sub-Littoral Infauna sediment	12 sampling stations. Grab sampling: 5 biological replicas, 1 PSA and 1 metals sample.	1993,1996, 1998, 2003, 2007, 2009, 2013, 2016, 2020, 2024	Every 4 years, next survey planned 2028	Rostron 1994 & 1996, Barfield 1998 & 2003, 2007 & 2010. SMCZ Project status reports	Yes, Skomer MCZ office.
Sub-Littoral Epifaunal sediment	2 sampling stations. Diver species recording, suction sampling collection.	1995, 2001 & 2004, 2009 video only.	Project now combined with Infauna	Rostron 1996, Moore 2002 & 2005.	Yes, Skomer MCZ office.
Plankton communities	Zooplankton samples taken with a 200um net. Vertical haul methods comparable to others used in UK.	2009 ongoing	Weekly (April to Oct)	SMCZ Project status reports	Yes, Skomer MCZ office.
Plankton communities	Phytoplankton samples taken with 20um net. Vertical haul methods comparable to others used in UK.	2009 – 2012 Restarted 2019	Weekly (April to Oct)	SMCZ Project status reports	Yes, Skomer MCZ office.

Dataset	Brief description	Year sets	Sampling frequency	Report	Data summary and availability
Zostera marina	Extent of North Haven bed & density distribution	1997, 2002, 2006, 2010, 2014, 2018 2013, 2014, 2015, 2018, 2023	Every 4 years Next survey planned 2027	Jones & Hodgson 1980 &1981, Jones et al. 1983, Lock et al. 1998, 2003 & 2006, Burton et al. 2010, Lock et al. 2015. Burton et al 2019. Massey et al 2024	Yes, Skomer MCZ office
Zostera marina	Biosonics acoustic sonar survey	2018, 2019 & 2021, 2022	Annual if possible	Skomer MCZ annual reports	Yes, Skomer MCZ office
Eunicella verrucosa	10 sites. Colonies photographed to form time-series dataset	1993 to ongoing	Annual	Bunker *et al*. 1985, Bullimore1986 & 1987, Gilbert 1998, SMCZ Project status reports	Yes, Skomer MCZ office
Alcyonium glomeratum	4 sites. Colonies photographed to form time-series dataset	1984 to ongoing	Annual	Bullimore1986 & 1987. SMCZ Project status reports	Yes, Skomer MCZ office
Parazoanthus axinellae	6 sites. Colonies photographed to form time-series dataset	2001 to ongoing	Annual	Burton et al. 2002. SMCZ Project status reports	Yes, Skomer MCZ office
Pentapora foliacea	6 sites, Colonies photographed to form time-series dataset	1994- ongoing	Annual	Bullimore1986 & 1987, Bunker & Mercer 1988, Gilbert 1998, Gibbs 2006. SMCZ Project status reports	Yes, Skomer MCZ office

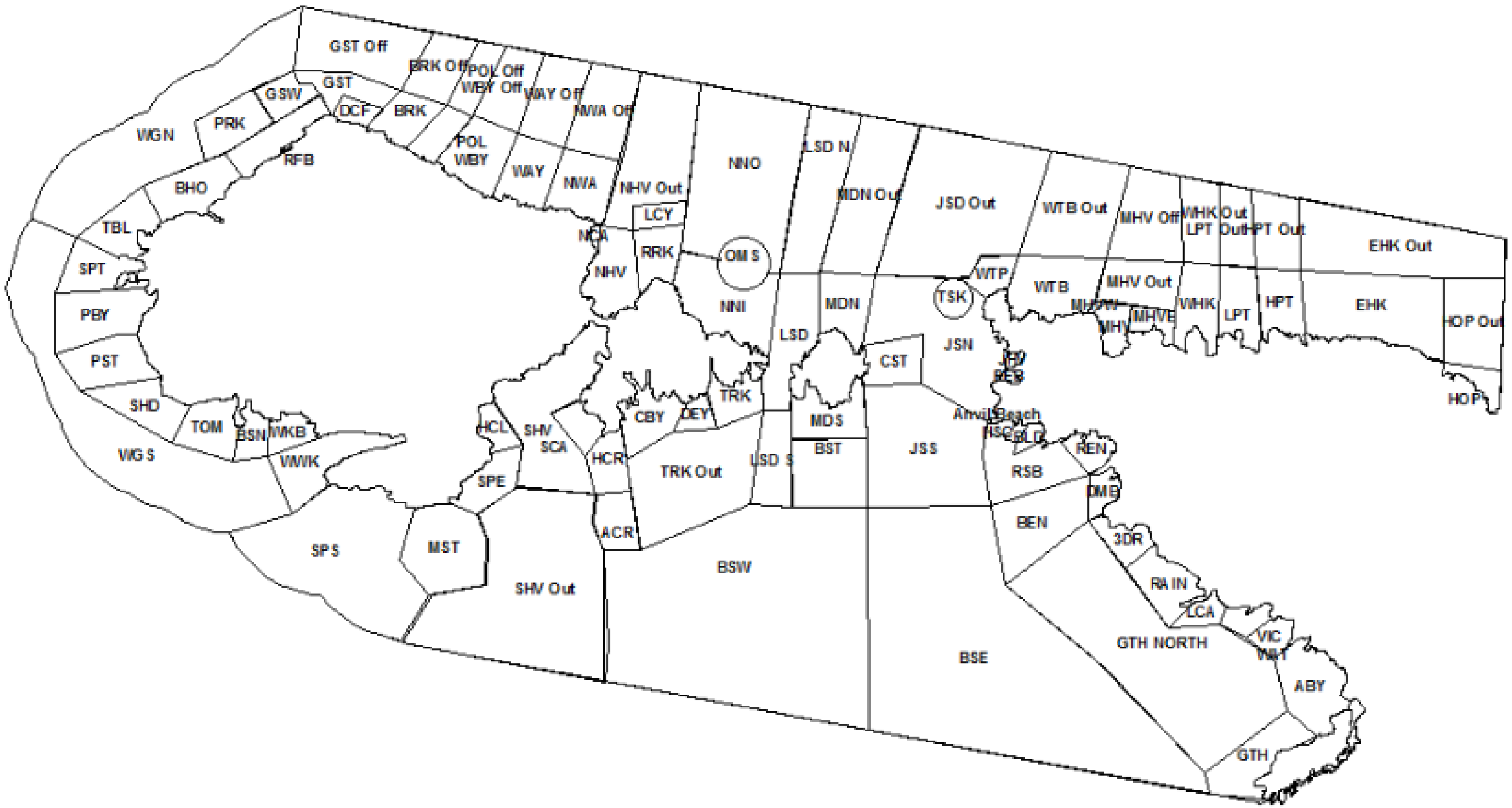
Dataset	Brief description	Year sets	Sampling frequency	Report	Data summary and availability
Balanophyllia regia	2 sites, Colonies photographed to form time-series dataset	TRK, 1984 to ongoing, WCK 2002 to ongoing	Annual	Bullimore 1986 & 1987. SMCZ Project status reports	Yes, Skomer MCZ office
Caryophyllia smithii	Counted from sponge project photo quadrats	1993 to ongoing	Annual	SMCZ Project status reports	Yes, Skomer MCZ office
Grey seal ***Halichoerus grypus***	Pup production and survival records at Skomer Island and mainland MCZ sites. Site fidelity and other behavioural records for Skomer Island sites.	1976- ongoing	Annual	Grey seal breeding census, Skomer Island 1992-2023, SMCZ Project status reports	Yes, Skomer MCZ office
Nudibranch species	Species recording.	1975, 1991 2002, 2006, 2010, 2014, 2018 & 2022	Every 4 years Next survey planned 2026	Hunnam & Brown 1975, Bunker *et al*. 1993, Luddington 2002, Lock *et al*. 2010, 2014 & 2019. Jones *et al* 2023.	Yes, Skomer MCZ office. NBN database

Dataset	Brief description	Year sets	Sampling frequency	Report	Data summary and availability
Territorial fish	Counts completed along transects at 15m, 10m & 5m depths at sites on the North sides Skomer and Marloes Peninsula.	1997, 2001/2002 2005, 2009, 2013, 2007, 2009, 2013 & 2017 2025	Every 4 years Next survey planned 2029	Lock 1998, Lock *et al*. 2006, Tompsett 2006 SMCZ Project status reports	Yes, Skomer MCZ office
Territorial fish	Drop-down video surveys	2009, 2010	Student projects	Sweet 2009, Bullimore 2010	Yes, Skomer MCZ office
King scallop ***Pecten maximus***	UCS survey in 1979 and 1980 Survey completed, 3 sites-2000 and 7 sites 2004, 2008, 2012, 2016, 2022	2000, 2004, 2008, 2012, 2016, 2022	Every 4 years. Next survey planned 2026	Bullimore 1985, Jones 1979 & 1980, Lock 2002, Luddington *et al*. 2004, Lock *et al*. 2009 & 2013, Burton *et al*. 2016. Massey *et al* 2022.	Yes, Skomer MCZ office
Echinoderm species	Abundance of *Echinus esculentus* in Skomer MCZ using volunteer survey methods. Data for *Marthasterias glacialis*, *Crossaster papposus* & *Luidia ciliata*.	2003,2007 & 2011, 2015, 2019, 2025	Every 4 years. Next survey planned 2029	Luddington *et al*. 2004, Lock *et al*. 2008, 2011, 2016 & 2019.	Yes, Skomer MCZ office

Dataset	Brief description	Year sets	Sampling frequency	Report	Data summary and availability
Commercial Crustacean	Parlour pot and diving study (Plymouth student project), parlour pot study and shell disease survey.	2003, 2011	Aug / Sep 2003, Jul – Oct 2011	Fothergill 2004, no	Yes-SMCZ office
Commercial Crustacean	Crawfish recording	2011 onwards	Annual	No	Yes-SMCZ office, NBN database.
Cetaceans	Observations of all Cetacean species.	2001 onwards	Records from Skomer Island, "Dale Sailing" , Coastwatch and SMCZ team	SMCZ Project status reports	Yes-SMCZ office
Invasive and non-native species	Recording of non-native species during littoral and sublittoral surveys	ongoing	Annual	SMCZ Project status reports	Yes, Skomer MCZ office, NBN database.

3. Skomer MCZ Sites and codes

3.1 Map of Skomer MCZ divided into site code areas (see the table in Section 3.2 for a list of site names)



3.2 Site codes with corresponding site names

Site code	Site name
ACR	Anchor Reef
ABY	Albion Beach
BEN	The Bench
BHO	Bull Hole
BLD	Boulder Beach
BRK / BRK Off	Bernie's Rocks / Offshore
BSE	Broad Sound East
BSN	The Basin
BST	Black Stones
BSW	Broad Sound West
CBY	Castle Bay
CST	Crab Stones
DCF	Double Cliff
DEY	"Dead Eye" wreck
DMB	Dead Man's Bay
EHK / EHK Out	East Hook / Outer
GST / GST Off	Garland Stone / Offshore
GSW	Garland Stone West
GTH / GTH North	Gateholm / North
HCL	High Cliff
HCR	High Court Reef
HOP / HOP Out	Hopgang / Outer
HPT / HPT Out	High Point / Outer
HSC	Horseshoe Cave
JNK	Junko's Reef
JHV	Jeffrey's Haven
JSD Out/ JSN / JSS	Jack Sound / North / South
LCA	Little Castle Beach
LCY	"Lucy" wreck
LPT / LPT Out	Low Point / Outer
LSD / LSDN / LSDS	Little Sound /North/South
MDN / MDS / MDN Out	Middleholm North / South / North Outer
MHV / MHVE / MHVW / MHV Out / MHV Off	Martins Haven / East / West / Outer / Offshore
Site code	Site Name
MST	Mew Stone
NCA	North Castle
NHV / Out	North Haven / Outer
NNI / NNO	North Neck Inner / Outer
NWA / NWA Off	North Wall / Offshore
OMS	Oceanographic Monitoring Site
PBY	Pig Stone Bay
PEB	Pebbly Beach
POL / POL Off	The Pool / Offshore
PST	Pig Stone
RAIN	Rainy Rock
REN	Renney Slip
RFB	Rockfall Bench
RRK	Rye Rocks
RSB	Renney Slip Bay

Site code	Site name
SCA	South Castle
SHD	Skomer Head
SHV / SHV Out	South Haven / Outer
SPE	South Plateau East
SPS	South Plateau South
SPT	The Spit
TBL	The Table
TOM	Tom's House
TRK / Out	Thorn Rock / Outer
TSK	Tusker Rock
VIC	Victoria Bay
WAT	Watery Bay
WAY / Off	Waybench / Offshore
WBY / Off	Waterfall Bay / Offshore
WGN	Wild goose north
WGS	Wild goose south
WHK / Out	West Hook / Outer
WKB	Wick Basin
WTB / Out	Wooltack Bay / Outer
WTP	Wooltack Point
WWK	The Wick
3DR	Three Doors

4. Biological Project summaries

4.1. Littoral communities

4.1.1. Project rationale

Littoral rock communities are a management feature of the Skomer MCZ. This management feature includes intertidal boulders and supralittoral lichens which are habitats of principal importance under Section 7 of the Environment (Wales) Act 2016. They are susceptible to impacts from the water and the air and occupy a harsh niche with an extreme range of environmental conditions. Salt tolerant terrestrial species exist within metres of truly marine species. These factors coupled with the relative ease of fieldwork compared to sub-littoral habitats make littoral communities useful for a wide range of environmental monitoring. There is a wealth of literature on the biology of rocky shores which provides guidance and supporting information for littoral monitoring projects.

4.1.2. Objectives

To monitor the littoral communities on bedrock and boulder shores over the continuum of exposure and aspect ranges.

4.1 3. Sites

Table 4.1.1 Survey site names, site code and start date.

Site Name	Site code	Start of survey
North Haven	NHV	1992
South Haven	SHV	1992
South Stream	SST	1992
The Lantern	LTN	1992
The Wick	WCK	1992
Double Cliff	DCF	1992
Pig Stone	PST	2003
Wooltack	WTK	2003
Martins Haven	MHV	2003
Hopgang	HOP	1996 Lichens only

4.1.4. Methods

Permanent Quadrats (1992 – Ongoing)

Transects with permanent, fixed position quadrats (50cm x 50cm) were established in 1992. The quadrats extend from spring low water into the splash zone at regular height intervals. Photographs are taken annually of each quadrat as permanent records.

In 1992 and 1996 a species abundance survey was completed using the semi-quantitative SACFOR abundance scale (Crump 1993 & 1996).

Littoral Community Monitoring (2003 – Ongoing)

In 2003, new methods were developed, these are detailed in Crump & Burton (2004) and summarised below. Sites were divided into 4 zones, based on shore height Above Chart Datum (ACD)

Lower shore – 1.8m ACD
Middle shore – 4.2m ACD
Upper shore – 6.0m ACD
Splash zone ~ 9.0m ACD (selected sites only)

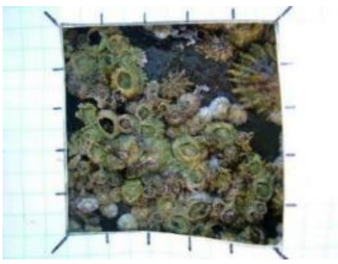
At Each Lower, Middle and Upper Shore Zones:

Four 1m^2 quadrat positions are permanently marked. The positions were selected to cover relatively homogenous areas of inclined rock (avoiding rock pools and large fissures). At each position:

- 1 m^2 quadrat divided into a 25-cell grid is used to record presence/absence of all conspicuous species. Some species are aggregated for recording as follows: Rough winkle species, barnacle species, limpets (recorded as *Patella* spp.) and encrusting red algae.
- Four digital photographs are taken of a 50cm x 50cm quadrat, placed within each 1 m^2 quadrat.
- Limpets are counted in 5 randomly selected grid cells, providing 20 samples at each shore height.
- % cover of barnacle species is estimated in 5 randomly selected grid cells.

  20 samples of barnacles are photographed using a 5 x 5cm quadrat within the area of the quadrats in each shore zone. Photos need to be taken on a shaded flat area with minimum 25% barnacle cover, avoiding rock pools or deep cracks and crevices (Figure 4.1.1). The photographs provide 20 samples from each shore height, these are stored for barnacle species counts of all individuals > 2mm (currently the photos are stored, and counts will be completed when time allows).

Figure 4.1.1 Barnacle 5cm x 5cm quadrat



At Middle Shore Zones:

The widest shell width of over 100 limpets (*Patella* spp.) from within the quadrats are measured to the nearest mm using callipers. In areas of low density at least 100 limpets are measured.

At Splash Zones:

% cover of all lichen species is recorded in 50cm x 50cm quadrats at selected sites and a quadrat photograph taken.

MarClim Methodology (2003 - Ongoing):

The MarClim project offers an opportunity to compare Skomer MCZ shores to the rest of the UK and contribute to the assessment of the effects of climate change. Martins Haven, North Haven, and South Haven are a mix of bedrock and boulders and selected as suitable sites for the project (see Mieszkowska *et al.* 2002). The MarClim methods:

- Abundance recording of a selected list of edge-of-range species.
- Photograph barnacles in 5cm x 5cm quadrats to complete barnacle species counts.
- Limpet species counts in 50cm x 50cm quadrats.
- Timed searches of *Phorcus lineatus* and *Steromphala umbilicalis* with individuals measured to the nearest mm.

Shore Clingfish (Lepadogaster lepadogaster) (2004 - Ongoing)

Timed counts of clingfish are carried out at Martins Haven, North Haven and South Haven together with records of egg masses. Counts started in 2004 at Martins Haven and North Haven and in 2011 at South Haven.

A different combination of survey methods is used as appropriate for each littoral site depending on the shore type (bedrock or boulders) along with aspect and exposure, these are summarised in Table 4.1.2.

Table 4.1.2 Summary of methods completed at each littoral site.

Site	Permanent quadrats pre 2003	Shore zone quadrats 2003 onwards	Lichen quadrats	MarClim	Shore Clingfish
North Haven	No	No	No	Yes	Yes
South Haven	Yes	No	No	Yes	Yes
South Stream	Yes	Yes	Yes	No	No
The Lantern	Yes	Yes	Yes	No	No
The Wick	Yes	Yes	Yes	No	No
Double Cliff	Yes	Yes	No	No	No
Pig Stone	No	Yes	Yes	No	No
Wooltack	No	Yes	Yes	No	No
Martins Haven	No	Yes	Yes	Yes	Yes
Hopgang	No	No	Yes	No	No

4.1.5. Project history

1982: Bunker *et al*. surveyed twenty-two sites on Skomer as a baseline littoral survey.

1992: Six permanent transects were established on Skomer and surveyed/ photographed (Crump 1993).

1992 – 2002: Photographs of the six permanent transects were taken and stored.

1996: Following the Sea Empress oil spill (February 1996) the six transects were re-surveyed and a lichen monitoring site was set up at Hopgang (Crump 1996). The littoral shores around

Skomer showed no significant changes after the Sea Empress oil spill, with the exception of the lichen community at Hopgang, which showed signs of necrosis.

2001: Slide photographs from 1992 – 2000 were reviewed and abundance estimates from the photographs compared with abundance records from Crump 1993 & 1996 field data. Photograph quality was insufficient to allow accurate abundance estimates.

2001/02: Digital imaging was tested to obtain pictures of permanent quadrats. Image quality was improved; however, estimates of species abundance were still inaccurate due to difficulties with identification of species and individuals from the images. This method cannot replace collection of data in the field for quantitative assessment.

2003: New quantitative methods were tested (Crump & Burton 2004). MarClim surveys were started at 3 sites: Martins Haven, South Haven and North Haven.

2007: Temperature loggers were placed at the Martins Haven and South Haven sites.

2024: All Marclim sites were completed but only 3 Skomer sites due to adverse weather conditions.

2025: All sites were completed except the Double cliff middle and upper shores. John Archer Thomson completed some initial analysis of the lichen data and a report has been completed (Archer-Thomson, 2025).

4.1.6. Results

The survey methods for each site completed in years 2003 to 2025 are shown in Table 4.1.3.

Table 4.1.3 Summary of survey sites completed 2003 – 2025. (Lower shore: LS, Middle shore: MS, Upper shore: US. Yes = all planned completed).

Site	**North Haven**	**South Haven**	**South Stream**	**The Lantern**	**The Wick**	**Double Cliff**	**Pig Stone**	**Wooltack**	**Martins Haven**	**Hopgang**
2003	MarClim	MarClim	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2004	MarClim	MarClim	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2005	MarClim	MarClim	Yes	Yes	Yes	Yes	No LS	Yes	Yes	Yes
2006	MarClim	MarClim	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2007	MarClim	MarClim	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2008	MarClim	MarClim	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2009	MarClim	MarClim	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Site	North Haven	South Haven	South Stream	The Lantern	The Wick	Double Cliff	Pig Stone	Wooltack	Martins Haven	Hopgang
2010	MarClim	MarClim	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2011	MarClim	MarClim	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2012	MarClim	MarClim	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2013	MarClim	MarClim	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2014	MarClim	MarClim	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2015	MarClim	MarClim	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2016	MarClim	MarClim	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
2017	MarClim	MarClim	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2018	MarClim	MarClim	Yes	Yes	Yes	LS only	Yes	Yes	Yes	Yes
2019	MarClim	MarClim	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2020	MarClim	MarClim	No	No	No	No	No	No	MarClim only	No
2021	MarClim	MarClim	No	No	No	No	No	No	MarClim only	No
2022	MarClim	MarClim	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2023	MarClim	MarClim	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2024	MarClim	MarClim	No	Yes	No	No	No	Yes	Yes	No
2025	MarClim	MarClim	Yes	Yes	Yes	LS only	Yes	Yes	Yes	Yes

Whole Community Analysis

All the shore zone, quadrat data are entered into the PRIMER statistics software for community analysis. The results can be visualised as multi-dimensional scaling (MDS) plots, see Figure 4.1.2.

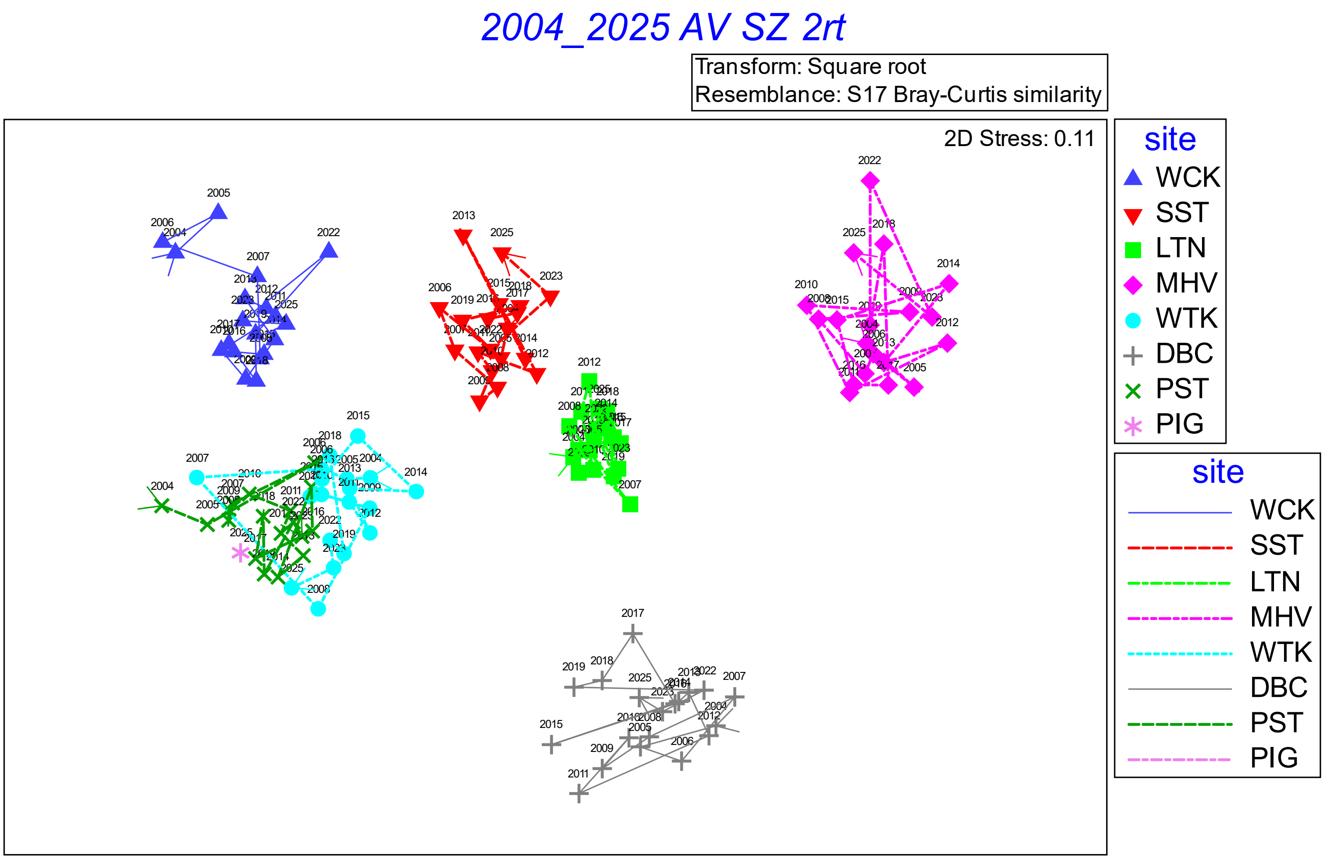
General summary:

- The sites neatly separate out and stay separate over the twenty-year period. This suggests community composition at each site is distinct from the other sites (except WTK and PST which have similar communities).
- Between years, there is not a lot of variation within each site. The communities are stable over time.
- No one year consistently sticks out as an outlier, again, suggesting the communities are stable over the time period.

An "ANOSIM" test for differences between years showed no significant difference between any of the years. Sample statistic (R): -0.071 Significance level of sample statistic: 100%. This confirms that there is no significant change in the intertidal communities over time.

The communities on the shores have not shown any major changes during the monitoring period 2003 to 2025. The shores were not surveyed in 2020, 2021 and 2024.

Figure 4.1.2 PRIMER Multi-dimensional scaling (MDS) plot of all littoral community data 2004 – 2025 (Averaged to site and year with a trajectory line with time).



Detailed analysis of some specific groups of species are given below.

Mean Percentage Cover of Barnacles

Barnacle coverage (all species aggregated) has been variable between sites over the last 16 years. In 2014, all sites saw a decrease in barnacle cover in the middle and lower shores. In 2023, the barnacle coverage showed little change (Figures 4.1.3 a-c). 2024 was only a partial survey and not all sites were completed. In 2025, the average barnacle cover was similar to previous years as shown in Figure 4.1.4 a-c.

Figure 4.1.3(a) Changes in upper shore barnacle coverage 2003 – 2025, with standard error bars.

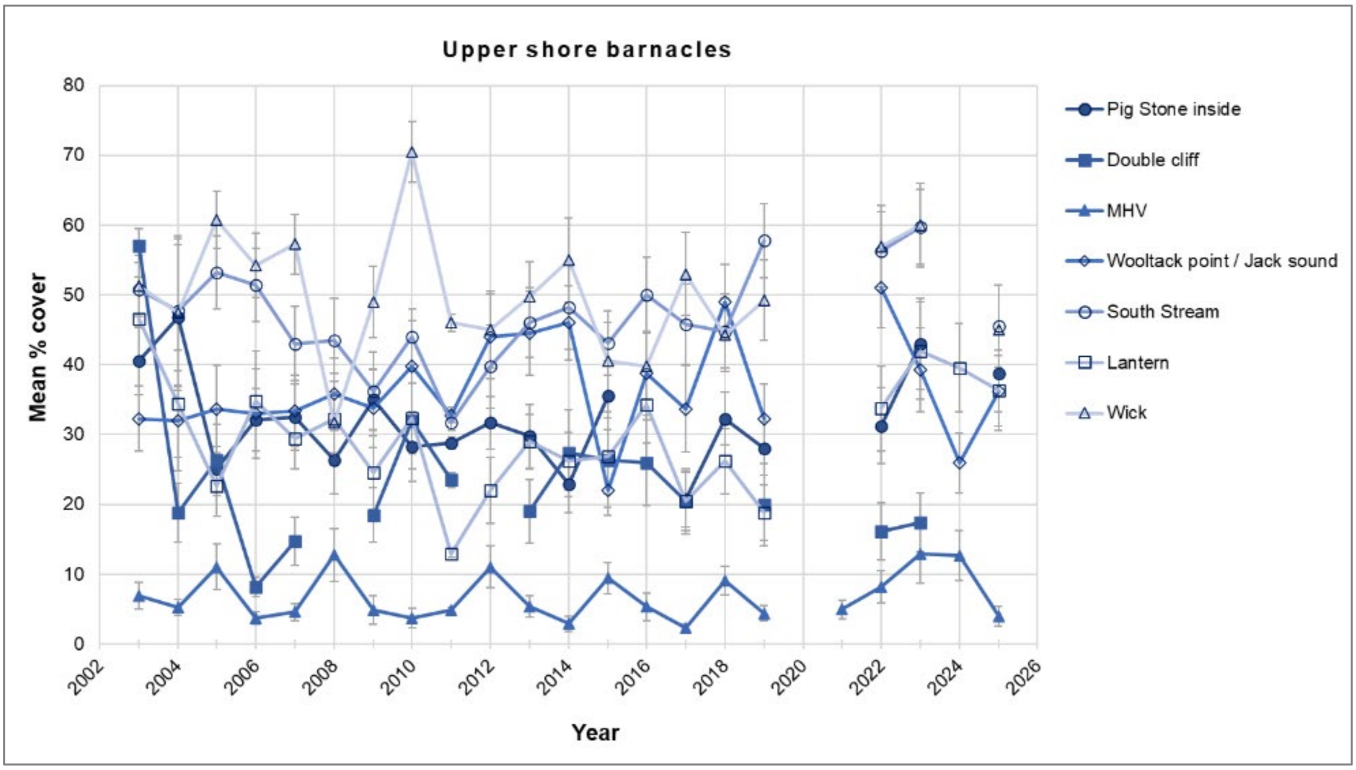


Figure 4.1.3(b) Changes in middle shore barnacle coverage 2003 – 2025, with standard error bars.

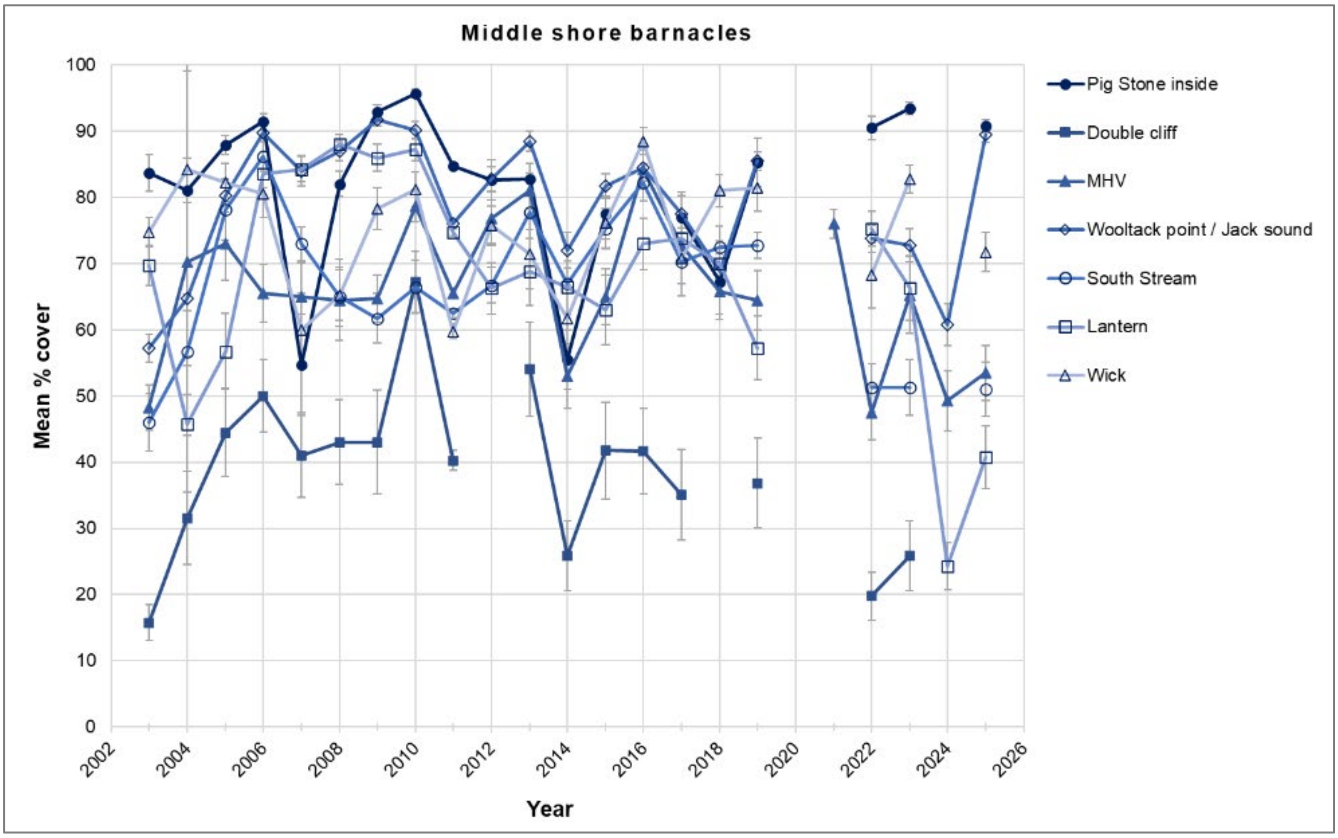


Figure 4.1.3 (c) Changes in lower shore barnacle coverage 2004 – 2025 (no lower shore data collected in 2003), with standard error bars.

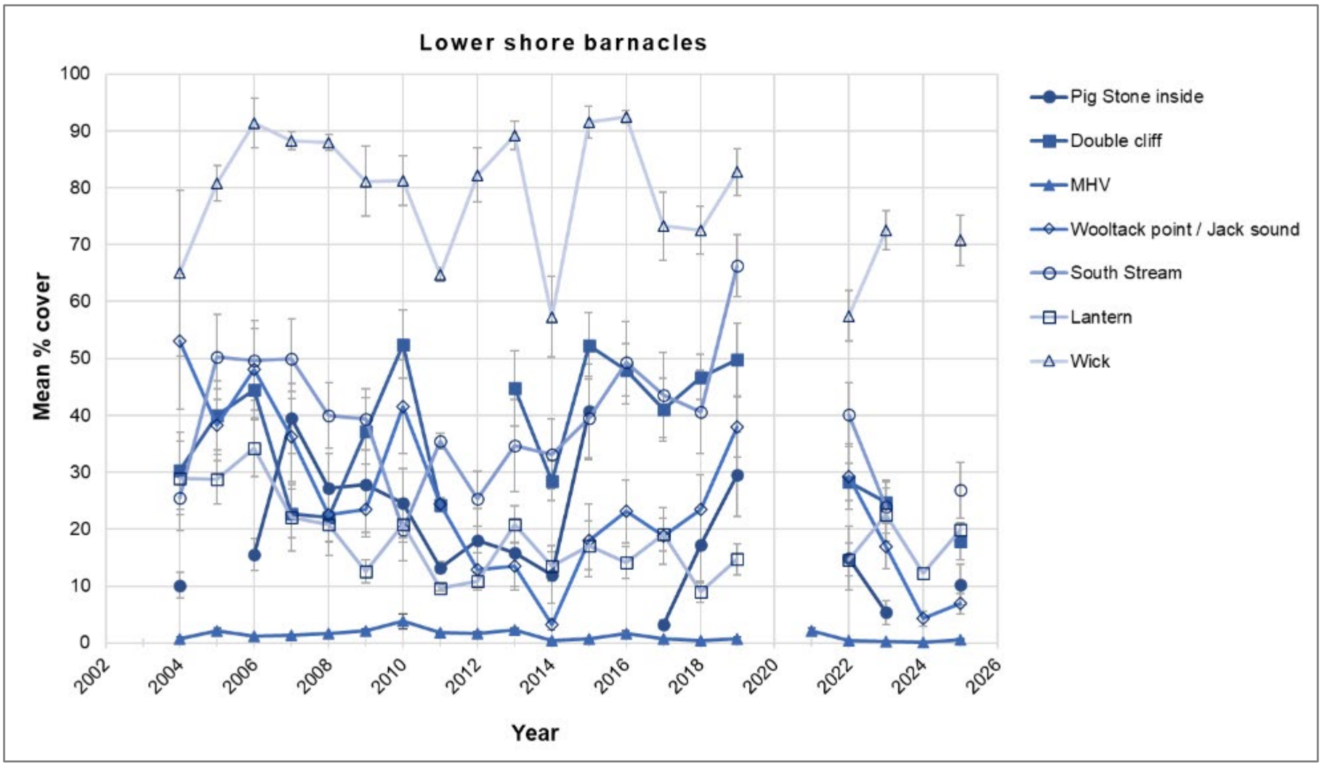
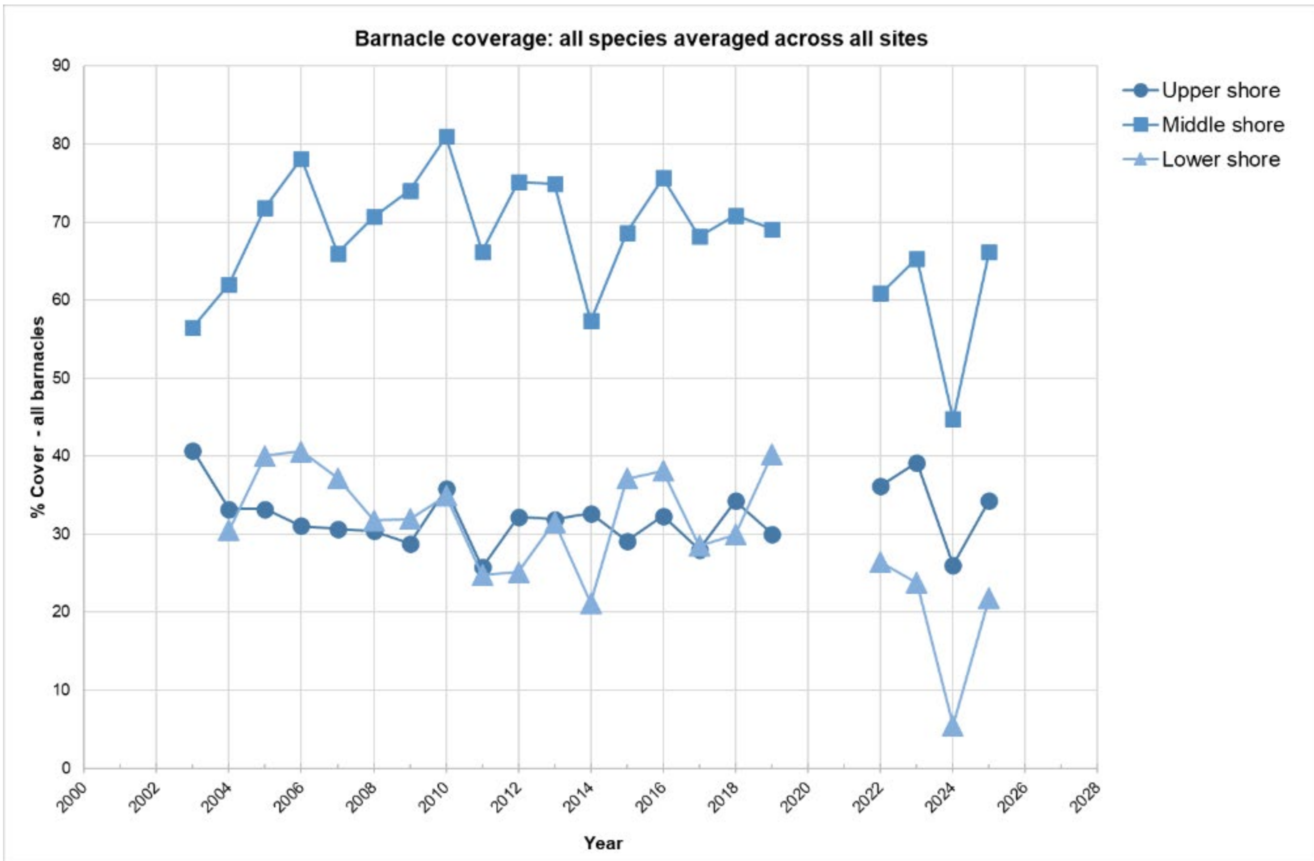


Figure 4.1.4 Changes in barnacle coverage – averaged across all sites for each shore zone.



Barnacle coverage (all species) has remained relatively stable with 60-80% coverage in the middle shore and 25-40% coverage in the upper and lower shores as shown in Figure 4.1.4. The dip in 2024 will be due to less survey data being collected.

Barnacle Species Ratios

The barnacle species counts have been completed from the photographs of the 5cm x 5cm quadrats at the 3 MarClim Sites: Martins Haven, North Haven and South Haven (photographs taken at the other sites are stored for analysis when time allows).

The 3 shore zones show how the different species tend to be dominant in different zones, with *Chthamalus spp* dominating the upper shore and *Semibalanus balanoides* being more abundant in the middle & lower shores (Figures 4.1.5 a-c). The *Chthamalus spp* have a preference for warmer waters with a more southerly distribution in the UK. *S. balanoides* has a more northerly distribution.

In 2022, *S. balanoides* abundance ratio declined by 60% in the middle shore and 80% in the lower shore and has continued to decline in 2023 and 2024 with a slight increase in 2025 but still well below what was seen pre- 2022. The overall coverage of barnacles has not changed with the space being claimed by *Chthamalus spp*. This may be due to spring sea temperatures affecting spat survival. The minimum sea temperatures are recorded in March and in 2022, 2023 and 2024 were the highest on record since 2007, with 8.2°C recorded in 2025 compared to an average of 7.9 °C for years 2000 to 2024. This may have affected the survival of the early settlement of *S. balanoides* spat. The summer maximum temperatures in 2022 and 2023 were some of the highest on record at 17.1ºC and 17.5ºC in 2024 and 2025 which may have improved the survival rate of *Chthamalus* spat.

The plankton data does not suggest a shift in the seasonal timing of barnacle larvae with the majority of planktonic larvae seen in March to May (see Figure 4.12.4 d).

Figure 4.1.5(a) Changes in upper shore barnacle species ratios 2003 – 2025.

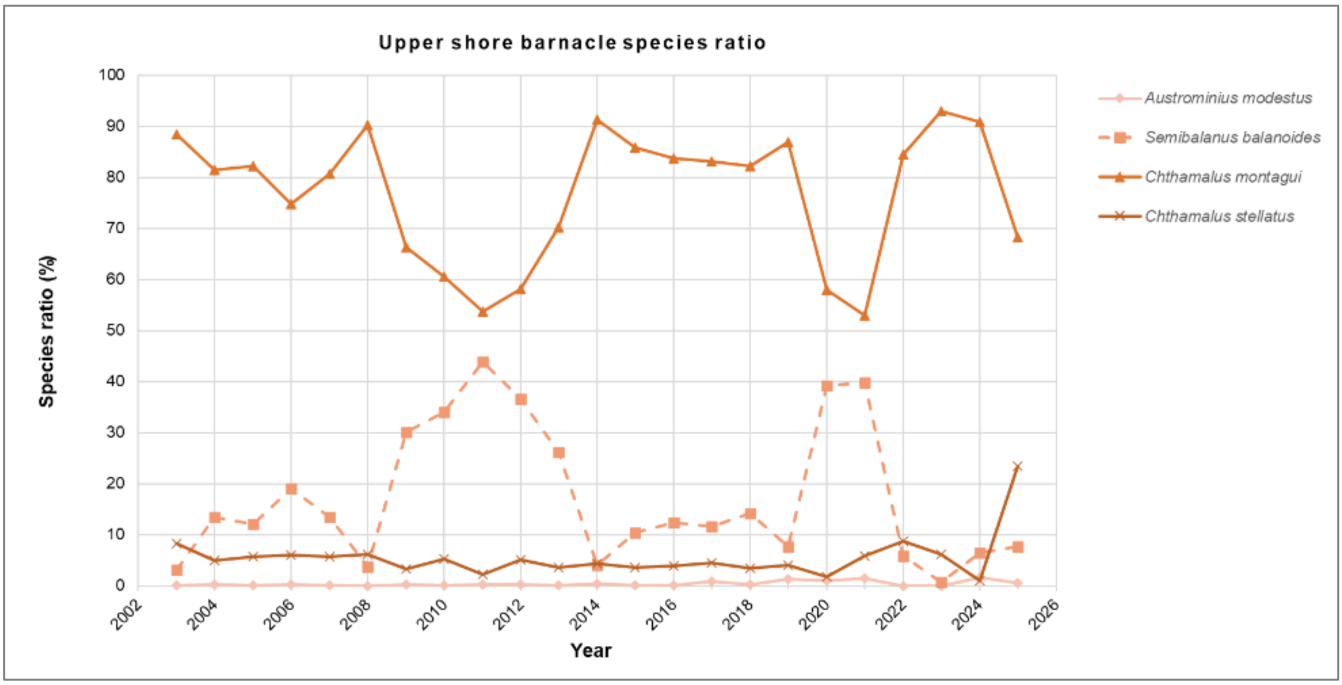


Figure 4.1.5(b) Changes in middle shore barnacle species ratios 2003 – 2025.

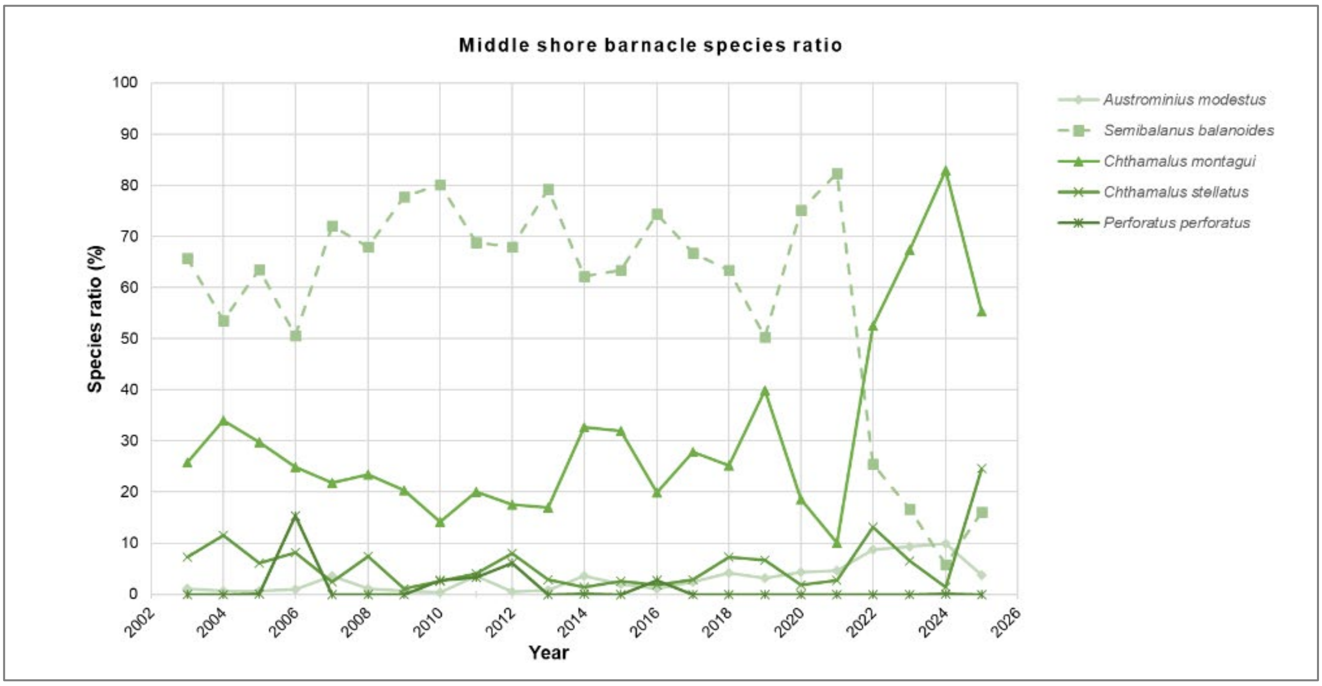
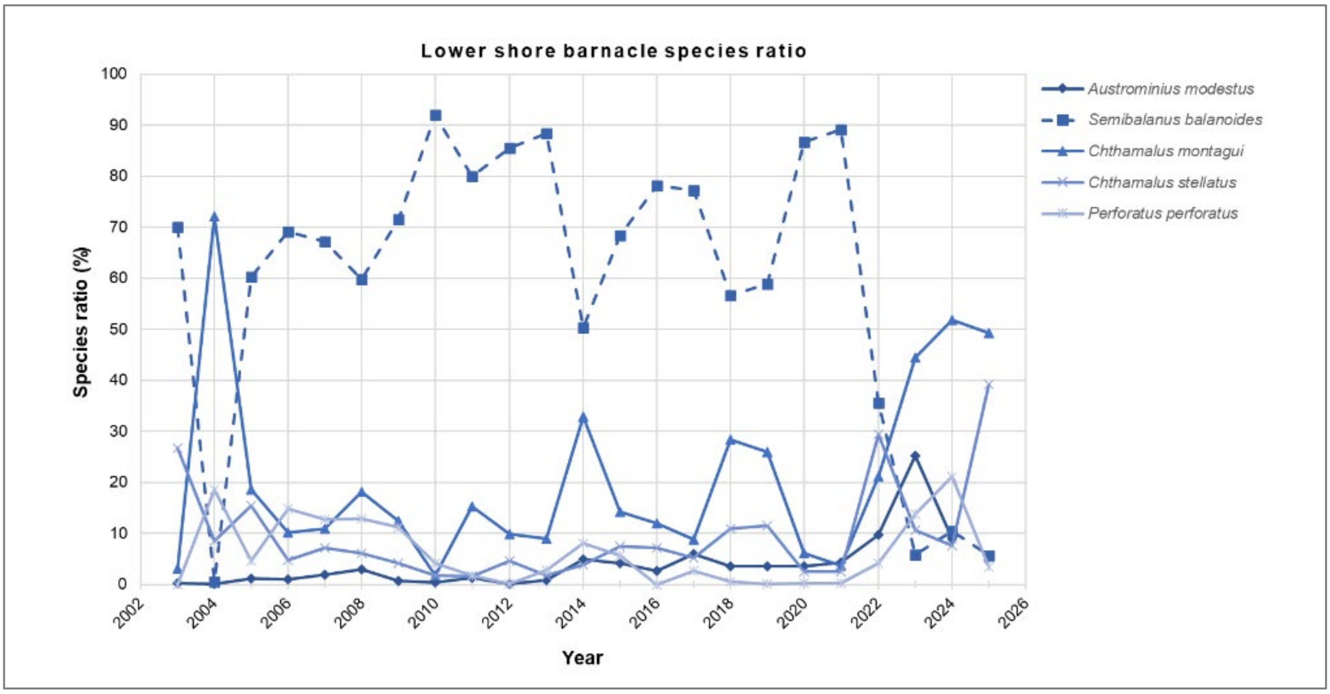


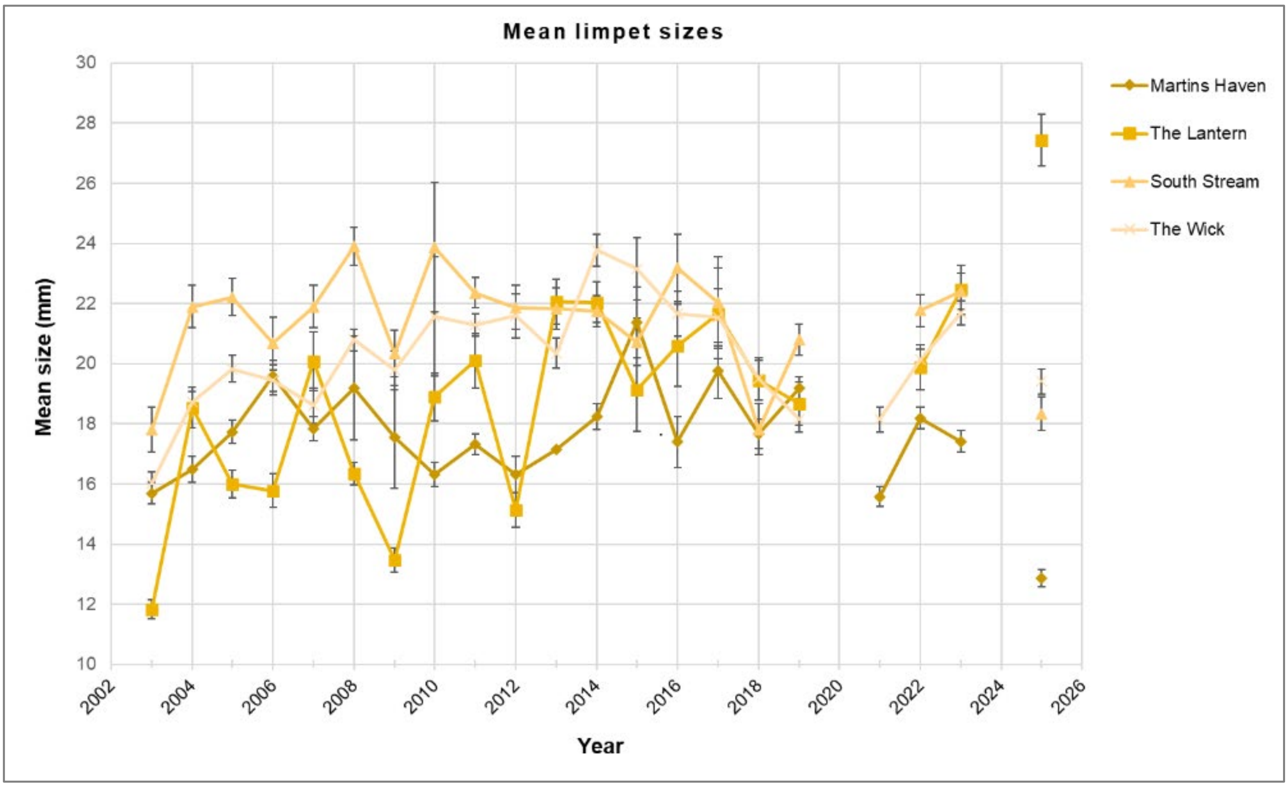
Figure 4.1.5(c) Changes in middle shore barnacle species ratios 2003 – 2025.



Limpet Size and Counts

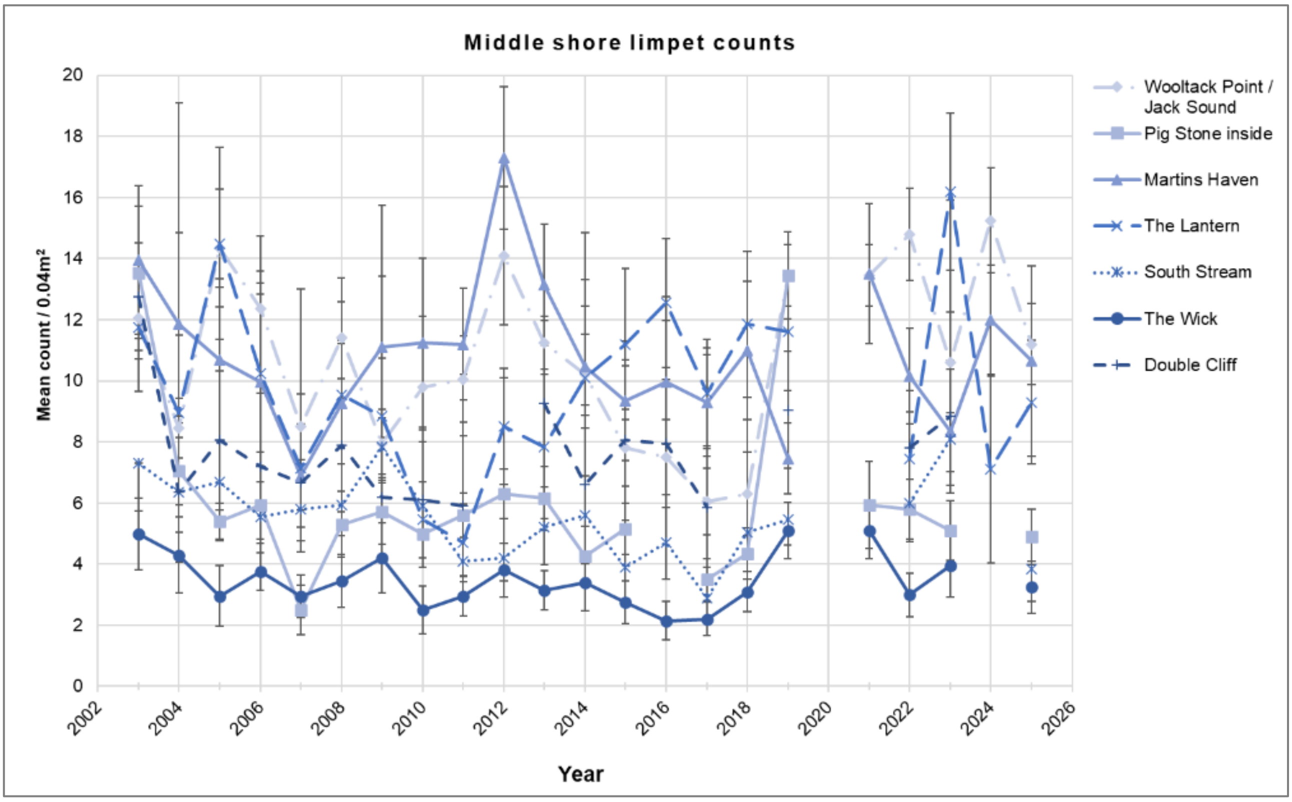
The mean limpet size (mm) recorded shows a stable trend at most sites, with The Lantern showing the greatest fluctuations (Figure 4.1.6). In 2025 the mean limpet size ranged between 12.9 mm to 27.4 mm across all four sites, a much greater range than seen before. No recording was completed in 2020 and 2021 and only partial recording in 2024.

Figure 4.1.6 Mean limpet size 2003 – 2025 mm with standard error bars.



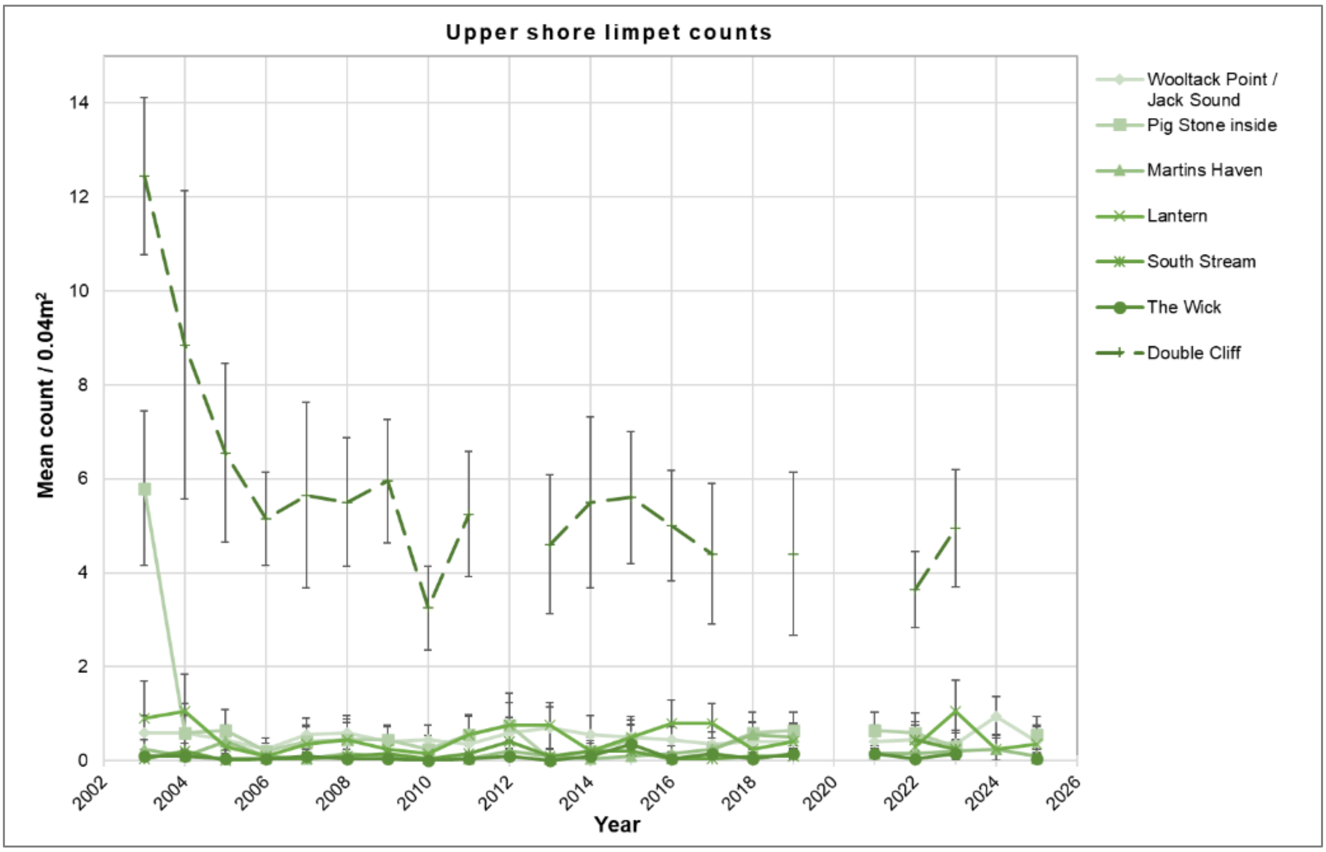
In the middle shore the highest numbers of limpets are found on the north facing shores, but these figures tend to be the most erratic (Figure 4.1.7).

Figure 4.1.7 Middle shore limpet counts 2003 – 2025 (per 0.04 m^2), with standard error bars.



Most upper shore sites have a low abundance of limpets. Double cliff has significantly more limpets than any other sites (north facing shaded cliff) which interestingly declined in numbers between 2003 – 2006 after which, numbers stabilised at around 4-6 per 0.04 m^2. Double cliff upper shore was not surveyed in 2012, 2018, 2020, 2021 2024 & 2025. All other sites have very similar limpet densities (Figure 4.1.8).

Figure 4.1.8 Upper shore limpet counts 2003 - 2025 (per 0.04 m^2), with standard error bars.



Lichen quadrats

Lichen data have been entered into spreadsheets, and the photographs stored. John Archer Thomson completed some initial analysis of the data from 2003 to 2025 and a report has been completed (Archer-Thomson, J.H.S. 2025. An initial report for NRW into the splash zone lichen communities of the Skomer Marine Conservation Zone).

Tables 4.1.4 and Figure 4.1.9 show an overview of the seven Skomer MCZ lichen sites. Over the survey period the three shores with the lowest number of species and similar Simpson's Diversity Index (SDI) values were the Wick the Pigstone and South Stream. These three sites are all island sites and the most exposed sites which receive a combination of high UV levels, wave action, salt spray and (probably) bird guano.

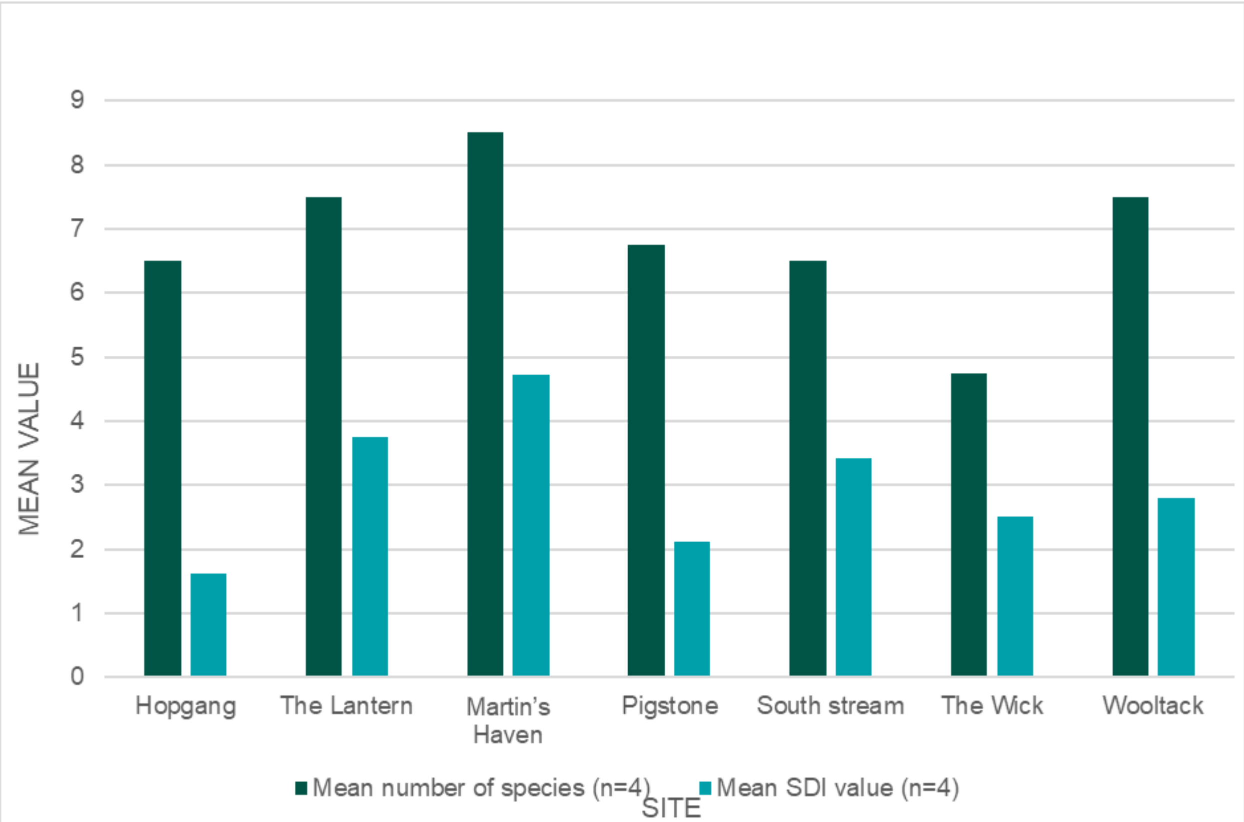
Wooltack is a bit of an intermediate. It is exposed to UV, wave action and salt spray but presumably there is less of an issue with bird guano.

The slightly more sheltered sites, the Lantern, and Martin's Haven, seem to be the richest in terms of their SDI scores and, except for Wooltack, their number of species.
Hopgang's low SDI score is due to the complete dominance of *Hydropunctaria (Verrucaria) maura.*

Table 4.1.4 Mean number of species and mean SDI value for the seven Skomer MCZ lichen sites.

Site	Number of years' worth of data	Mean number of species (n=4)	Mean SDI value (n=4)
Hopgang	17	6.5	1.61
The Lantern	20	7.5	3.75
Martin's Haven	20	8.5	4.73
Pigstone	18	6.75	2.11
South stream	19	6.5	3.41
The Wick	19	4.75	2.51
Wooltack	20	7.5	2.79

Figure 4.1.9 Mean number of species and mean SDI value for the seven Skomer MCZ lichen sites.



Marclim survey

MarClim data have been entered into spreadsheets and supplied to the MarClim team for reporting (Mieszkowska, N & Sugden, H, 2025). Marclim will publish a 2025 season report to NRW later in 2026.

4.1.7. Current Status

- The littoral rock and boulder community features for Skomer MCZ are in favourable conservation status. The shores appear to be stable, and in a condition that is typical of the area without any significant changes to the communities.
- So far there is no evidence of any prolonged shift in the community due to climate change. The barnacle species have shown a shift in species ratios over the last 3 years. *Semibalanus balanoides* has been replaced by *Cathamalus montagui* at all shore heights. This may be due to a series of very mild winters.
- Invasive species have been found but so far, none are present in large numbers.

4.1.8. Recommendations

- Continue with the littoral monitoring programme.
- Continue MarClim survey methodology.
- Report littoral communities feature as in favourable condition and stable.

4.2 Sponge Assemblages

4.2.1. Project Rationale

The sponge communities at Skomer MCZ have been identified as a management feature due to their rich and diverse nature. Sponges form part of the fragile sponge and anthozoan communities on subtidal rocky habitats, which are of priority importance under Section 7 of the Environment (Wales) Act 2016. Around 130 species have been recorded during this project, some of which are new to science and currently undescribed. Six species are nationally scarce, and eight species are near the limit of their distribution. Sponges are filter feeders, making them susceptible to changes in water quality and sediment deposition. They are therefore useful biotic indicators of changes in rates of suspended and deposited sediments (sedimentation). Dredge spoil dumping has previously been attributed to increases in sedimentation at Skomer MCZ. Other sources of sedimentation could include riverine inputs, increased storminess or towed fishing gear.

4.2.2. Objectives

- To monitor the sponge assemblages in the MCZ.
- To identify natural and anthropogenically caused fluctuations in the sponge assemblages.
- To identify the presence of rare, scarce and edge of range species in the MCZ.

4.2.3. Sites

- Thorn Rock (annual transects, fixed quadrat and species survey).
- Thorn Rock, Wick and High Court Reef (species survey).
- MCZ sites, digital images taken for other projects are used to assess the sponge assemblages around the MCZ (2009 – ongoing).

4.2.4. Methods

Transects: Annual photos are taken along four fixed transects at Thorn Rock. From 1994 to 2008, photographs were taken from fixed positions along the transect using paired cameras set up on a 50cm x 70cm frame, in 2009, the cameras were replaced with a digital SLR taking high resolution images.

Sponge assemblages are classified into morphology types (Bell & Barnes 2001). This has proved to be a quick and simple method to analyse annual photographic datasets, as long as the four-yearly species “inventory” (see below) is used to check that there has been no undetected “drift” in species composition of the assemblage.

Species survey: Every 4 years, species photographs are taken in the field and samples collected, where necessary, for spicule preparations and microscopic analysis to confirm identification.

In 2003, all sponge species were identified in sixteen 50cm x 70cm quadrats positioned close to the four fixed transects at Thorn Rock. From the 2007 survey onwards no quadrats were used, and surveys were completed in the general vicinity of the Thorn Rock transects, with all specimens identified to the highest possible taxonomic resolution. In 2011, the survey was extended to include The Wick, with High Court Reef being added in 2015.

Seasonal survey from fixed quadrats: In 2005, fifteen 1m^2 quadrats were marked out at three of the four fixed transects locations at Thorn Rock. The quadrats each consist of 25 cells (20cm x 20cm). The quadrats are positioned and then "wafted" to clear the surface silt, before being photographed with a digital camera fixed to a small camera framer.

4.2.5. Project history

Transects: 1993 to 2025 photo quadrats taken at Thorn Rock (Table 4.2.1).

Table 4.2.1 Data gathered from Thorn Rock sponge transects photo quadrats 1993 to 2025. Transects: Windy Gully =WG, Spongy Hillocks =SH, Broad Gully =BG, Dogleg = DL.

Year	Number of photo quadrats	Transects (WG,SH,BG,DL)
1993	24	WG Only
1995	77	All completed
1996	72	All completed
1997	20	WG Only
1998	60	WG, SH & DL
1999	0	No fieldwork
2000	63	WG, SH & DL
2001	62	WG, SH & DL
2002	81	All completed
2003	79	All completed
2004	80	All completed
2005	80	All completed
2006	79	All completed
2007	81	All completed
2008	0	All completed but image quality very poor - no analysis possible
2009	81	All completed. - Digital SLR replaced 35mm slide film
2010	81	All completed
2011	82	All completed
2012	81	All completed- lots of surface sediment
2013	82	All completed
2014	83	All completed - poor visibility
2015	81	All completed
2016	83	All completed
2017	81	All completed
2018	80	All completed
2019	75	All completed
2020	0	No fieldwork
2021	78	All completed
2022	80	All completed. - New Digital SLR Camera
2023	80	All completed – very low levels of surface sediment
2024	82	All completed
2025	82	All completed

Species surveys:

Table 4.2.2 presents the years sponge species surveys were completed at Thorn Rock, High Court Reef and Wick.

Table 4.2.2 Sponge species surveys summary.

Year	Thorn Rock	High Court Reef	Wick
2003	Yes	No	No
2007	Yes	No	No
2011	Yes	No	Yes
2015	Yes	Yes	Yes
2019	Yes	Yes	Yes
2023	Yes	Yes	Yes

Samples have been supplied to the Natural History Museum (London) and National Museum Wales, to be stored as part of the national sponge collection.

Seasonal survey from fixed quadrats:

The quadrat survey has been completed annually from 2006 to 2019, no photos were taken in 2020 but completed in 2021 and 2022. No photos were taken in 2023 but were taken in 2024 and 2025. The digital photographs are merged to form a mosaic of the full 1m^2 quadrats.

Survey frequency varied between 1-3 survey events in a year (from 2006 to 2016) depending on weather and resources to allow seasonal variability to be identified. Seasonal variability was successfully identified in the publication Berman et al. (2013), so it was decided in 2017 to reduce the survey to once annually in September to concentrate on annual variability and reduce the amount of fieldwork required.

New morphology classification method tested in 2023 & 2024.

An internationally recognised system for classifying sponges from different habitats around the world was produced in 2021. Designed specifically to be used on photographs (figure 4.2.1).

Schönberg C,H,L , 2021. Ecological Indicators vol 129. No taxonomy needed: Sponge functional morphologies inform about environmental conditions. Article 107806

This new system is based on the Bell & Barnes 2001 method but has been expanded. In 2023 the whole MCZ data set was analysed using the Schonberg (2021) method. In 2024 this method was used again and tested for consistency between different observers. The method does take longer but would potentially allow the MCZ data to be shared with other projects and compared to results from other MPAs around the world.

It is a straightforward process to back transform the results from the new method into the Bell & Barnes 2001 categories, so all analysis for 2023 and 2024 data has been done on back transformed results to align with the Bell & Barnes method.

The 2025 data has not yet been completed due to time constraints but it is planned to compete using the new method.

Figure 4.2.1 The tabulated structure and hierarchy of the classification system based on sponge functional morphologies. There are four basic forms: functioning as encrusting, massive, cup-like and erect (in frames). These are subdivided into some further morpho-functions for finer scoring as indicated by numbering.

1.-2. CRUST-LIKE in function CAAB 10 000901		
1. Encrusting *sensu lato* *CAAB 10 000922	1.1. True crusts, crusts *sensu stricto* CAAB 10 000902	1.1.1. Thin crusts *CAAB 10 000923 1.1.2. Thick crusts *CAAB 10 000924
	1.2. Endolithic-bioeroding CAAB 10 000921 (= "alpha" and "beta" bioeroders)	
2. Creeping, repent CAAB 10 000917		
3.-6. MASSIVE in function CAAB 10 000903		
3. Simple-massive CAAB 10 000904		
4. Globular-massive, balls CAAB 10 000905		
5. Composite-massive, meshes and dense clusters * CAAB 10 000925		
6. Fistular, cryptic-massive, endopsammic CAAB 10 000908 (incl. "delta" bioeroders)		
7.-9. CUP-LIKE in function CAAB 10 000909		
7. Cups CAAB 10 000910	7.1. Tabular "cups" CAAB 10 000920 7.2. Incomplete "cups", curled fans CAAB 10 000918 7.3. Complete, apically wide cups, vases CAAB 10 000919	
8. Tube-like forms, "narrow cups" *CAAB 10 000926	8.1. Chimneys, proper tubes CAAB 10 000911 8.2. Amphoras, sack-like sponges, bladders *CAAB 10 000927	
9. Barrels, "massive cups" CAAB 10 000907 (incl. some "gamma" bioeroders)		
10.-14. ERECT in function CAAB 10 000912		
10. One-dimensionally erect, simple erect CAAB 10 000916		
11. Two-dimensionally erect *CAAB 10 000928	11.1 Erect-laminar, flabellate CAAB 10 000913 11.2 Erect-palmate CAAB 10 000914 11.3 Erect-reticulate *CAAB 10 000929	
12. Three-dimensionally erect, branching CAAB 10 000915		
13. Stalked CAAB 10 000906		
14. Carnivorous *CAAB 10 000930		

Figure 4.2.2 Decision flow chart or layman key for scoring the 14 sponge functional morphologies that can be used as a proxy for environmental conditions. The scoring context needs to be strictly functional.

Is it a sponge?	Yes													
Where is it?	Flat on the ground			Still near to the ground, but with a body							Extending vertically			
What is the overall shape	Flat sheet or flat patches	Horizontal branches or loosely attached sheet, can have some vertical branches	Flat disc, only 1 attachment point	It is hollow, with a wide opening	It is hollow, with a narrow opening	It is (mostly) solid, but has a concave upper part or large upper hollow	It is solid and ball-shaped	It is solid and has a more or less uniform surface	It is made up of merged lumps, or is a tight, three-dimensional mesh	Its main body is usually hidden, only vertical, finger- or knuckle-like fistules are visible	Solid branch, in 1 dimension, without a body above; includes sponges encrusting 1D structures	Solid branches, in 2 dimensions, flat-erect, without long stalk	Solid branches, in 3 dimensions, buch or tree, without long, pronounced stalk	Erect with long, pronounced stalk; includes sponges that grow on erect non-sponge objects
Scored as:	Crust	Creeping	Tabular	Cup	Tubes, amphoras	Barrel	Ball	Simple-massive	Composite-massive	Fistular	Simple-erect	Fan, palmate or vertical mesh	Erect-branching in 3 dimensions	Stalked
Categories as listed in Tab. 1	1	2	7	7	8	9	4	3	5	6	10	11	12	13
Does it have "branchelets" along central axes/branches or around the top part, or does it have inflated bulbs?		Not 2, but carnivorous										Not 11, 12 or 13, but carnivorous		
		14										14		

4.2.6. Results

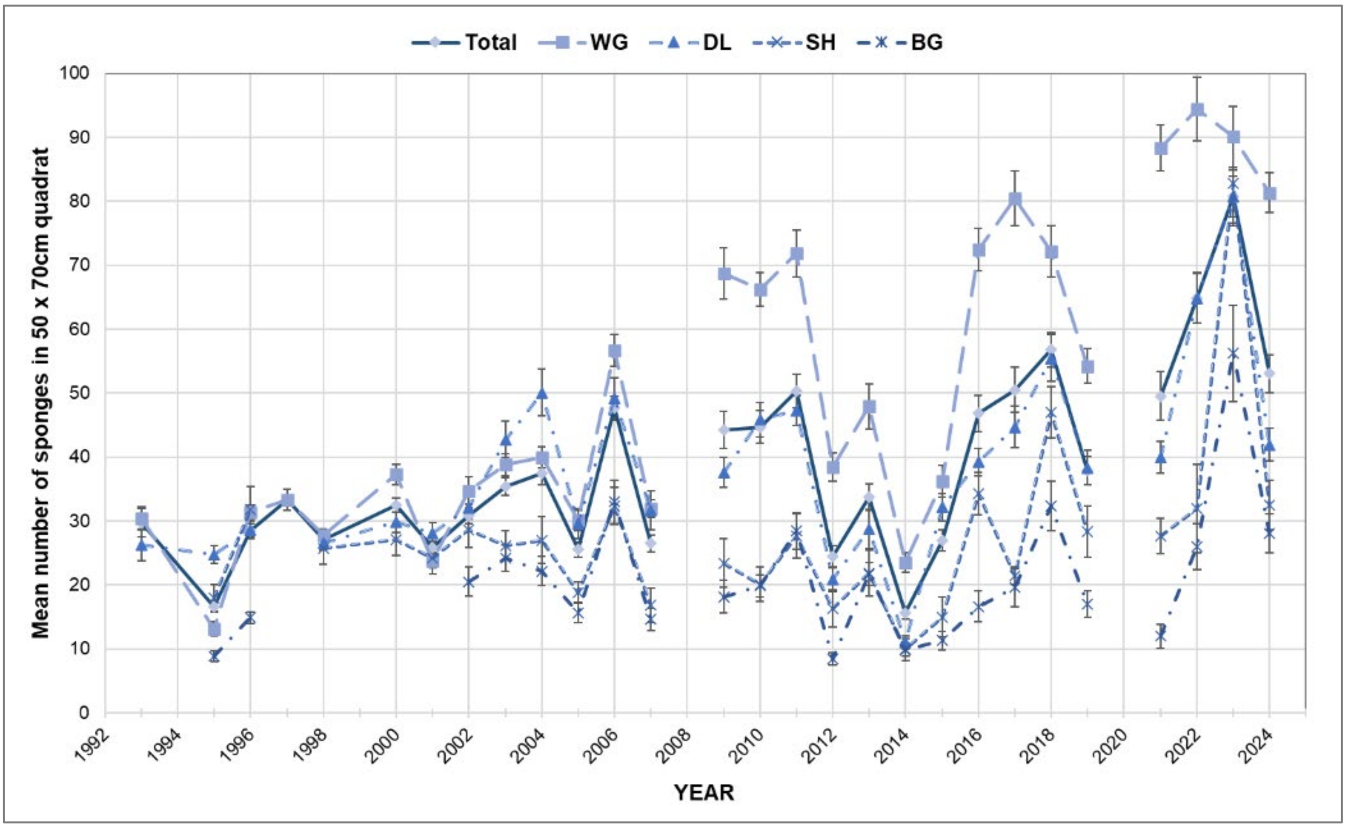
Transects:

The sponge morphology analysis method has been used for all the quadrats taken at Thorn Rock and additionally for a selection of comparable quadrat photos taken at other sites around the MCZ during other projects. The data is plotted or analysed using the PRIMER multivariate analysis software to compare similarity between sites and over time.

2025 photo analysis has not yet been completed. The results shown below are for data between 1995 and 2024.

Improvement in image quality and resolution has meant that more sponge entities have been recorded from 2009 onwards compared to previous years. However, in 2012 and 2014 there was a noticeable drop in the numbers of sponges across all transects. In 2019 all sites decreased in abundance, despite good image quality and this lower number was again recorded in 2021. In 2022 a new digital camera with increased pixel resolution was used (sensor size: 6720 X 4480 pixels =1.54 increase in resolution compared to previous camera) and the number of sponges seen increased in 2022. It was noted that small entities could be confidently identified in the new images. This may account for some of the increases seen in 2022. (Figure 4.2.3). In 2023 & 2024 the new digital camera was used again. The image quality was good, and it was noted that there was very little fine sediment on the rock on the day the photographs were taken

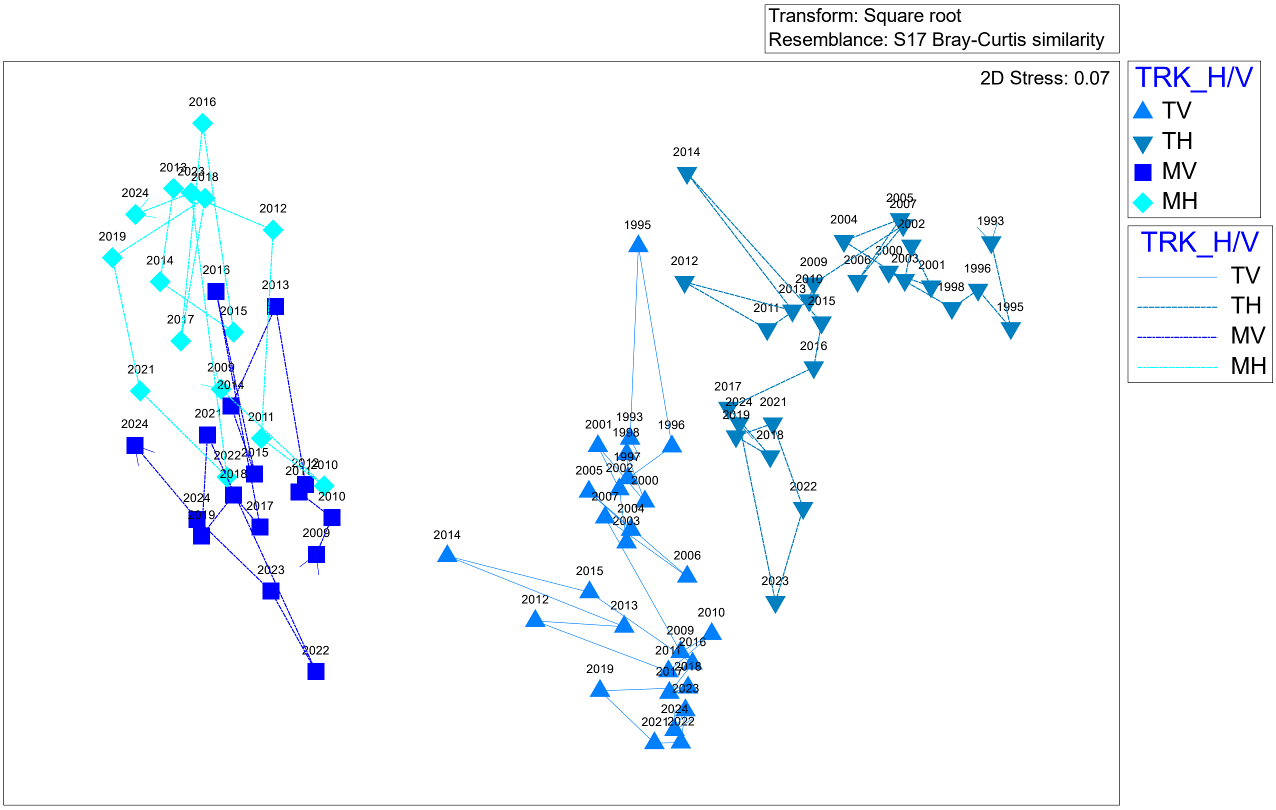
Figure 4.2.3 Mean number of sponges counted in each quadrat at 4 sites –Thorn Rock 1993-2024, with standard error bars. (Transects: Windy Gully =WG, Spongy Hillocks =SH, Broad Gully =BG, Dogleg = DL).



The morphology method for characterising sponge assemblages has also been applied to suitable monitoring photographs taken from a range of other sites around Skomer MCZ. This puts the Thorn Rock transects into context. The morphology data are entered into the PRIMER V7 statistics package, averaged to site and year, and a similarity matrix produced using the Bray-Curtis similarity coefficient on the square root transformed data (Figure 4.2.4).

The inclination of each site is noted (vertical rock face or flat-horizontal aspect). The inclination of the rock seems to make a big difference to the types of sponge morphologies recorded. The sites at Thorn Rock (TRK) are notably different to those elsewhere in the MCZ with much higher abundances of sponges from a wider range of morphologies.

Figure 4.2.4 PRIMER Multi-dimensional scaling (MDS) plot of sponge morphology data averaged by site and year 1995 – 2024 with the sites collated to those at Thorn Rock (T), those around the rest of the MCZ (M) and Vertical & Horizontal (V / H) inclinations. Trajectory overlain with year.

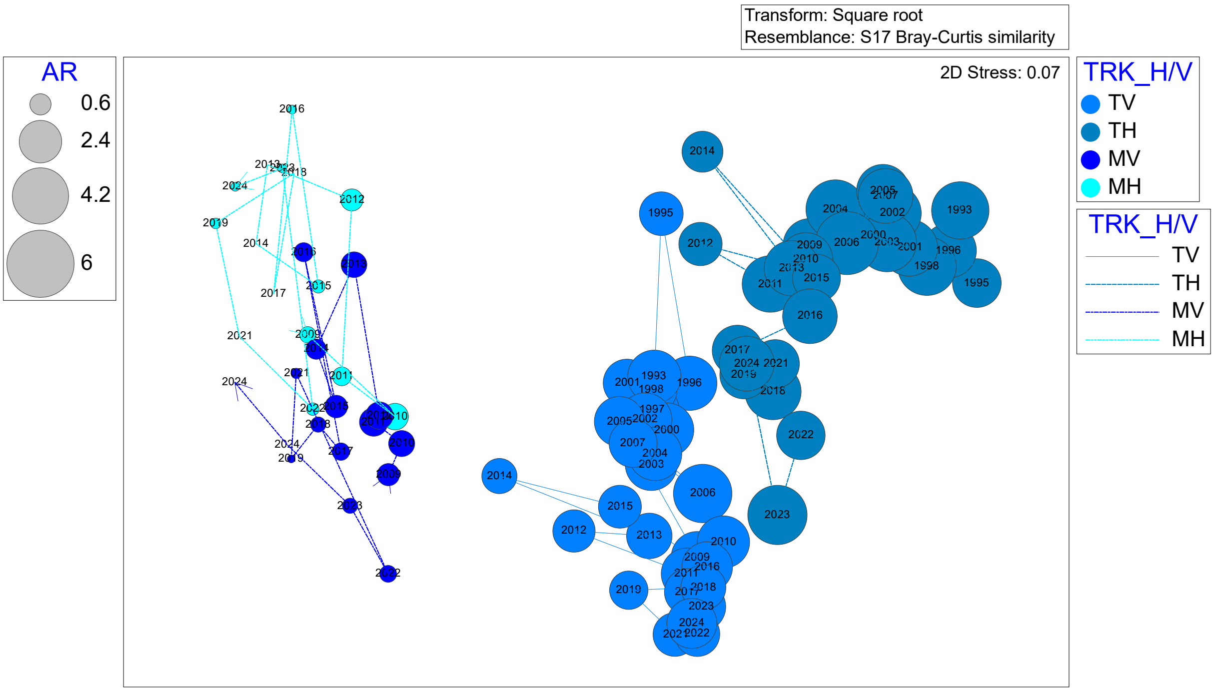


The data used in this plot has been averaged from 4 sites at Thorn Rock (3 -Horizontal, 1 Vertical) and 7-10 sites from elsewhere around the MCZ with a mixture of vertical and horizontal aspects.

The plot shows a clear separation between the Thorn Rock sites (T - Triangles) and the rest of the MCZ (M - squares). One of the main differences between the sponge communities at Thorn Rock and the rest of the MCZ is the abundance of erect sponge species (see Figure 4.2.5)

The sponge community at Thorn Rock has much higher numbers of Arborescent (AR erect) sponges. The diversity of sponge morphologies is also higher at Thorn Rock with globular, papillate and tubular sponge morphologies also being more abundant at Thorn Rock.

Figure 4.2.5 PRIMER MDS plot of sponge assemblages at Skomer MCZ 1995-2024. Plot overlaid with bubbles representing the relative abundance of arborescent (AR erect) sponges.



4.2.7. Current status

- The species surveys show that Skomer has a high biodiversity of sponge species. A total of 132 species/entities have been recorded at the MCZ of which 42 are undescribed and need further investigation. In 2023, 78 species/entities were recorded (Jones 2024).
- The sponge community feature for Skomer MCZ is stable and in favourable condition.

4.2.8. Recommendations

- Continue application of morphology method for analysis of photos and continue to test the Schönberg 2021 classification method.
- Expand transect photo-monitoring programme to sites outside the MCZ to provide contextual data for changes in populations seen at Skomer MCZ and thereby improve knowledge of the diversity of sponge assemblages.
- Seasonality patterns need further investigation as seasonal changes in the sponge assemblages have been found. Winter data are needed as samples have only been collected from April to October. Encourage continued research on sponge seasonality in the MCZ.
- Continue sponge species recording every 4 years, next survey due 2027.
- Support academic sponge research projects, in particular new species research and identification work on Skomer MCZ samples.
- Continue to provide preserved species samples to National Museum Wales for record verification and future research.
- Maintain Skomer MCZ sponge species records on Marine Recorder database and NBN Atlas.

4.3. *Eunicella Verrucosa* Population

4.3.1. Project Rationale

The pink sea fan *Eunicella verrucosa* (Pallas) is a component of the Lusitanian anthozoan management feature of the Skomer MCZ, it is chosen as it is near to the edge of its range and may act as an indicator of climatic change.

It is listed in Schedule 5 of the Wildlife and Countryside Act 1981 and is a species of principal importance under Section 7 of the Environment Act (Wales) 2016. It is also a component of the fragile sponge and anthozoan community habitat of priority importance under Section 7.

E. verrucosa is a soft coral nearing the northern limit of its distribution in north Pembrokeshire. They are slow growing, erect species and reproduction rates are also thought to be very slow. Lusitanian species have become important indicators of climate change in the UK. It is reasonable to assume that species that are near the limit of their distribution will exhibit greater sensitivity to changes in the physical environment.

Damage can be caused through changes in water temperature, poor water quality and possibly from extensive entanglement in biota or marine litter (e.g. fishing line). Pink sea fans have the potential to be damaged by anthropogenic activities with physical effects on the seabed.

4.3.2. Objectives

To monitor numbers and condition of pink sea fans recorded in the Skomer MCZ and to expand the monitored population.

4.3.3. Sites

Table 4.3.1 Pink sea fan sites names, codes and survey start date.

Site name	**Site code**	**Started survey**
North Wall stereo	NWA	1987
Bernie's Rocks (East and West)	BRK	1994
Bull Hole	BHO	2002
The Pool	POL	1997
North Wall East	NWAe	2000
Sandy Sea Fan Gully (Waybench west)	SSFG	1994
Thorn Rock	TRK	2002
Waybench	WAY	1994
Rye Rocks	RRK	2002
South Middleholm	SMD	2002
West Hook	WHK	2005

4.3.4. Methods

- Individual sea fan colonies are mapped out at each site. The maps are used to navigate to each fan and are expanded when additional mature fans are found in the area. Care is taken to search the area for small, newly established fans which are counted as ‘new recruits’.

- Photographs are taken using a single camera mounted on a 50cm x 70cm frame. Both sides of the sea fan are photographed.
- Each sea fan is visually inspected for damage, fouling by epibiota, entanglement with man-made materials, necrosis (loss of living tissue) and the presence of predatory molluscs *Candiella odhneri* and *Simnia patula.*
- Where practicable, and if enough polyps remain alive on the colony for it to recover, detached sea fans are re-attached artificially to the rock substrate at one of the monitoring sites. These fans are then added to the monitoring programme and called ‘attached fans’.
- The photographs are analysed for entanglement of small-spotted catshark *Scyliorhinus canicula* and bull huss *Scyliorhinus stellaris* eggs, entanglement of other biota, attached epibiota, necrosis, damage and presence of the nudibranch *Candiella odhneri* and mollusc *Simnia patula*.
- Missing sea fans are recorded, these are searched for the following year to confirm if they are losses.

Photo analysis allows detailed assessment of the current condition of the individual sea fans. Necrosis is recorded when sea fan soft tissue has died back to leave just the black skeleton showing. Necrosis is assessed on a level 1 to 4 rating (Table 4.3.2 and Figure 4.3.1).

Table 4.3.2 Sea fan condition necrosis levels 1 to 4.

Level of necrosis	Description
Level 1	Less than 5 tips
Level 2	Multiple tips, more than 5 tips
Level 3	Epiphytes growing from tips
Level 4	Full branches/extensive epiphytes

Figure 4.3.1 Sea fan necrosis levels 1 to 4.

4.3.5. Project history

1997: Methods were developed using MapInfo software to study the sea fan area and branch length to assess growth (Gilbert 1998). This was completed for all sea fan images taken from 1994 to 2000.

2001: A re-evaluation of methods used for growth assessment was completed and the 1997 method was discontinued due to many inaccuracies, mainly from inconsistencies in the images of individual sea fans matching between year sets. A method to assess sea fan condition was developed, this was completed for all photo images in the dataset since 1994.

2002 to 2025: Sea fan condition assessments were completed each year using both photo images and supportive field records. In 2008, a new digital SLR camera provided higher quality images, and this helped to improve photo analysis.

2018 to 2023: To help understand potential causes of sea fan losses at Skomer MCZ, human activity data have been analysed in more detail, concentrating on activities with the potential to make contact with the seabed or sea fans, and the sites where sea fans are monitored. These data are available in the Skomer MCZ Annual reports 2018 – 2023. Natural Resources Wales / Marine and coastal evidence reports.

2020: No field work was completed due to Covid restrictions.

2021: A re-evaluation of methods used to assess sea fan condition was completed. This aimed to provide a more detailed assessment of the condition of sea fans ranging in scale from the whole of Skomer MCZ, to site level, and even down to each individual sea fan. The new method (as described in Section 4.3.4 above) was applied to the full historical data set of sea fan photos and has been applied to all photos 2021 to 2025.

4.3.6. Results

The numbers of sites surveyed, total number of sea fans recorded, confirmed losses and missing sea fans to be confirmed are summarised for each survey year in Table 4.3.3. Between 1994 and 2005, areas with sea fan were explored and mapped to establishing monitoring sites, in 2005 there were 10 sites and 111 sea fans surveyed. In subsequent years, some sites were expanded through mapping and further sea fans have been added to the programme; with a peak of 124 natural fans monitored in 2014. In 2025, 9 of the 10 sites were surveyed as South Middleholm was not dived, and a total 84 natural fans and 3 attached fans monitored.

Table 4.3.3 Skomer MCZ sea fan survey results 1994 -2025.

Year	Sites surveyed	Total fans recorded	Total natural fans	Total attached fans	New recruits	Natural fan Losses confirmed	Attached fan losses	Missing to be confirmed
1994	4	34	34	0	0	0	0	0
1995	4	33	33	0	0	1	0	0
1996	4	33	33	0	0	0	0	0
1997	5	39	39	0	0	0	0	0
1998	5	39	39	0	0	0	0	0
1999	0	no data	no data	no data	no data	no data	no data	no data
2000	5	54	54	0	0	0	0	0
2001	5	55	55	0	0	1	0	0
2002	9	86	86	0	0	1	0	0
2003	9	99	99	0	1	0	0	0
2004	9	101	100	0	0	0	0	0
2005	10	114	111	3	1	1	0	0
2006	10	119	116	3	7	0	0	0
2007	10	121	118	3	1	2	0	0
2008	10	126	122	4	0	0	0	0
2009	10	128	121	7	0	1	0	0
2010	10	126	120	6	0	3	1	0
2011	10	126	122	4	0	0	2	0
2012	10	126	121	5	0	0	0	0
2013	10	129	124	5	0	0	0	0
2014	9	124	120	4	0	0	0	0
2015	10	125	123	2	0	3	2	0
2016	10	118	115	3	1	9	0	0
2017	10	114	112	2	0	3	1	0
2018	10	110	108	2	1	4	0	0
2019	10	107	105	2	0	5	0	0
2020	no data	no data	no data	no data	no data	no data	no data	no data
2021	10	93	91	2	0	0	0	0
2022	10	92	88	4	0	13	0	0
2023	10	92	87	5	0	3	0	0
2024	10	89	83	6	0	0	0	3
2025	9	84	79	3	0	3	1	8
Totals	**n/a**	**n/a**	**n/a**	**n/a**	**12**	**54**	**7**	**n/a**

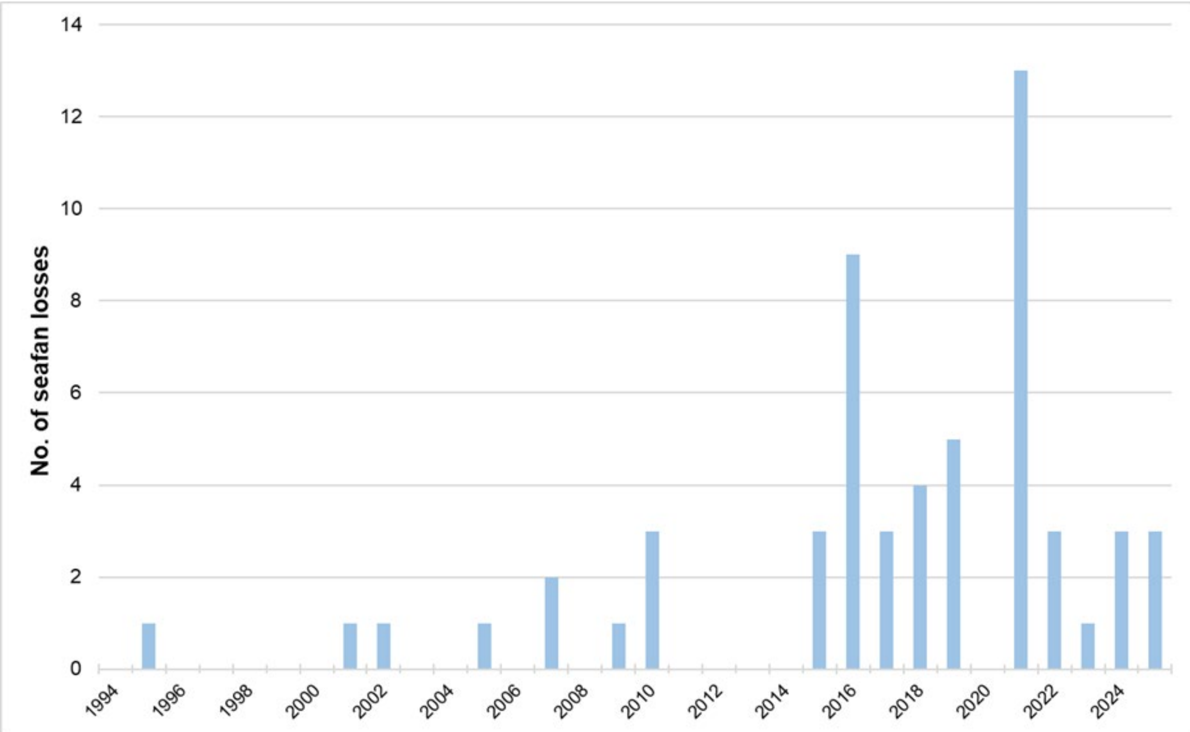
Losses

A total of 54 losses of natural sea fans and 7 losses of artificially attached sea fans has been recorded throughout the period of this project, as shown in Table 4.3.3 and Figure 4.3.2.

In 2025, there were 3 confirmed losses of natural fans at Rye Rocks RRK1, RRK15 and RRK25, and a confirmed loss of attached fan WHK2 at West Hook.

There were 4 further natural fans not found for the first time, these were RRK11, WAY8, WHK4 and TRK10, 1 attached fan was also missing WHK18, these will need to be re-checked in 2026. In 2024 the South Middleholm sea fan's MDS2, MDS4, MDS6, MDS7 were missing, but the site was not dived in 2025 so these fans will need to be re-checked in 2026.

Figure 4.3.2 Annual number of natural sea fan losses,1994 to 2025 (2020 omitted as survey not completed)

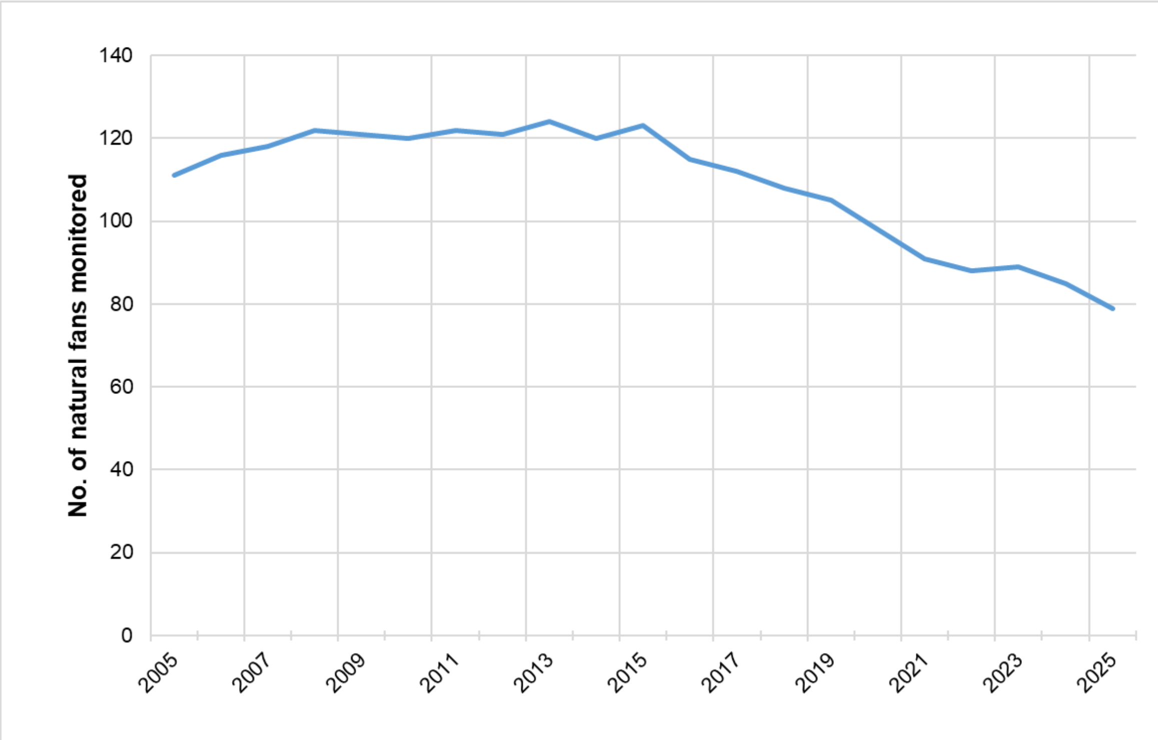


The rate of 'natural' sea fan losses increased from 2015. At the 10 sites in the ten-year period from 2005 to 2014, the total number of natural sea fans recorded was between 119-124 fans and during this period 7 losses were recorded. In the next ten-year period from 2015 to 2024 the losses have increased, there have been 47 natural fans confirmed as missing in this period.

Eight further 'natural fans' were absent in 2024 and 2025 that need to be confirmed in the 2026 field season.

The total number of natural sea fans recorded from the 10 sites from 2005 to 2023 is shown in Figure 4.3.3, (1994 to 2004 data not shown as during this period sites were being mapped and added to the programme). The increase in numbers between 2005 and 2014 is due to further expansion of the sites, a decreasing trend is shown since 2015 due to the large number of losses.

Figure 4.3.3 Total number of natural sea fans recorded from 10 sites 2005 to 2025 (2020 omitted as no survey completed)   Note: artificially attached sea fans not included in these data.



Recruitment

Recruitment has been low with a total of only 12 “new recruit” sea fan colonies being recorded at the monitoring sites since 2000. Condition and growth in the recruits are variable as described in Table 4.3.4. BHO23 was a confirmed loss in 2010, NWAe15 in 2021 and RRK26 in 2022. The cluster of 5 “new recruits” at BHO showed no growth in 12 years and in 2022 all were confirmed as losses (Table 4.3.4).

Table 4.3.4 Skomer MCZ sea fan recruitment

Sea fan site and number	Year first found	Description and growth
WAY14	2000	Found close to WAY2. 3 branches in 2000 grown to a small bushy fan in 2023.
BHO23	2003	No growth recorded from 2003 to 2008. Confirmed loss in 2010.
SSFG23	2005	Found next to SSFG17. 8 branches in 2008 grown to small bushy fan in 2023.
NWAe15	2005	Found below NWAe13. 3 branches in 2005 grown to 8 branches in 2018 and then reduced to 2 branches in 2019. Confirmed loss in 2021.
BHO 5 “new recruits”	2006	A cluster of 5 “new recruit” sea fans on a single boulder, all single or double branched stalks. **No growth** recorded between 2006 and 2019. All confirmed loss in 2022.
RRK24	2006	Found next to RRK7. 5 branches in 2006 grown to 18 branches in 2023.
RRK26	2016	Found in gully close to RRK12. 2 branches. Confirmed loss in 2022.
MDS7	2018	Found close to MDS 4 and 5. Only 3 branches in 2023.

Sea fan condition

All sea fan photos have been assessed for sea fan condition as follows:

1. Small-spotted catshark *S. canicula* and bull huss *S. stellaris* eggs, numbers of eggs and % entanglement of sea fan.

   S. canicula eggs were found on 25-35% of recorded sea fans between 1994 to 1997, since then it has fluctuated between 5 and 25% from all sites, in 2025 17% of fans were recorded with *S. canicula eggs* (Figure 4.3.4). *S. stellaris* eggs were first recorded on a sea fan in 2000 and up to 2010 was found on less than 12% of sea fans. In 2012, 25% of sea fans had *S. stellaris* eggs and this has steadily increased each year with 51% of sea fans recorded with these eggs in 2025 (Figure 4.3.5).

   Figure 4.3.4 Proportion of sea fans at Skomer MCZ entangled in *S. canicula* eggs.

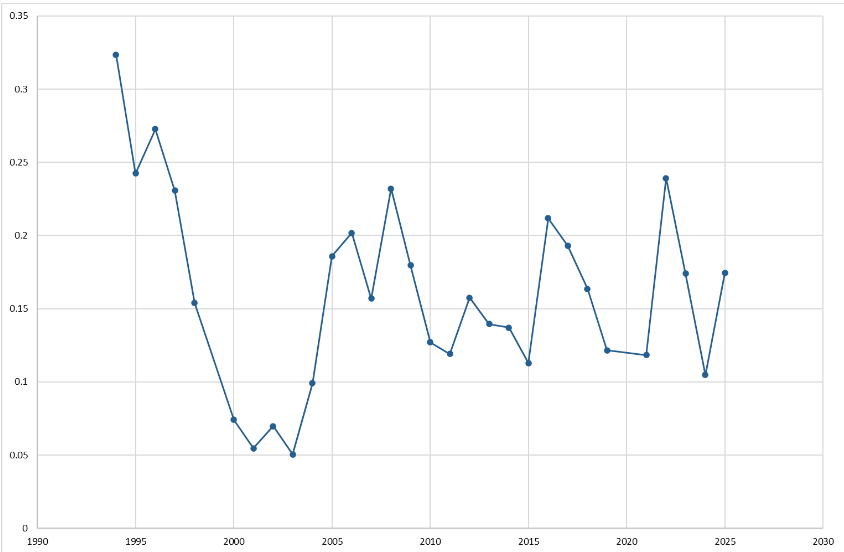
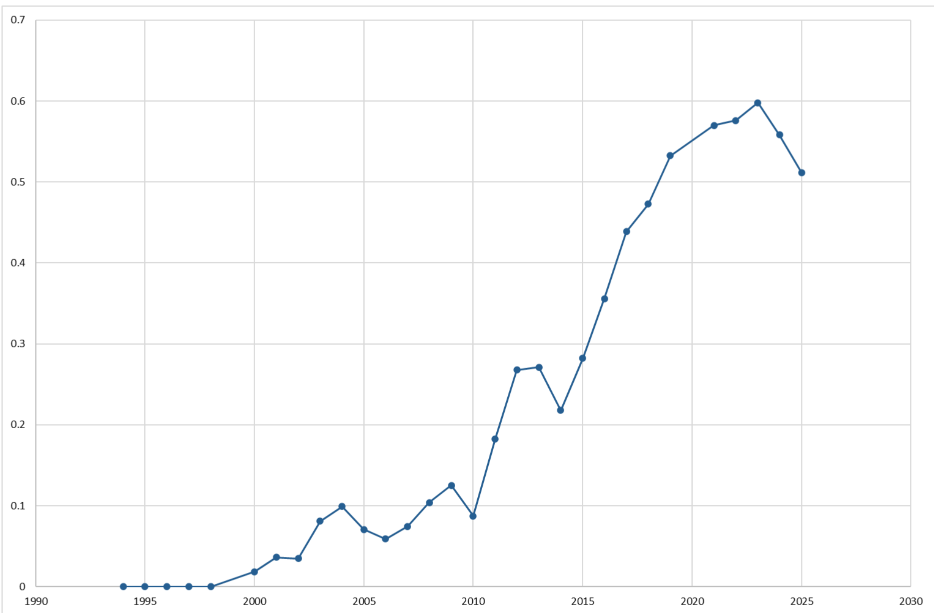
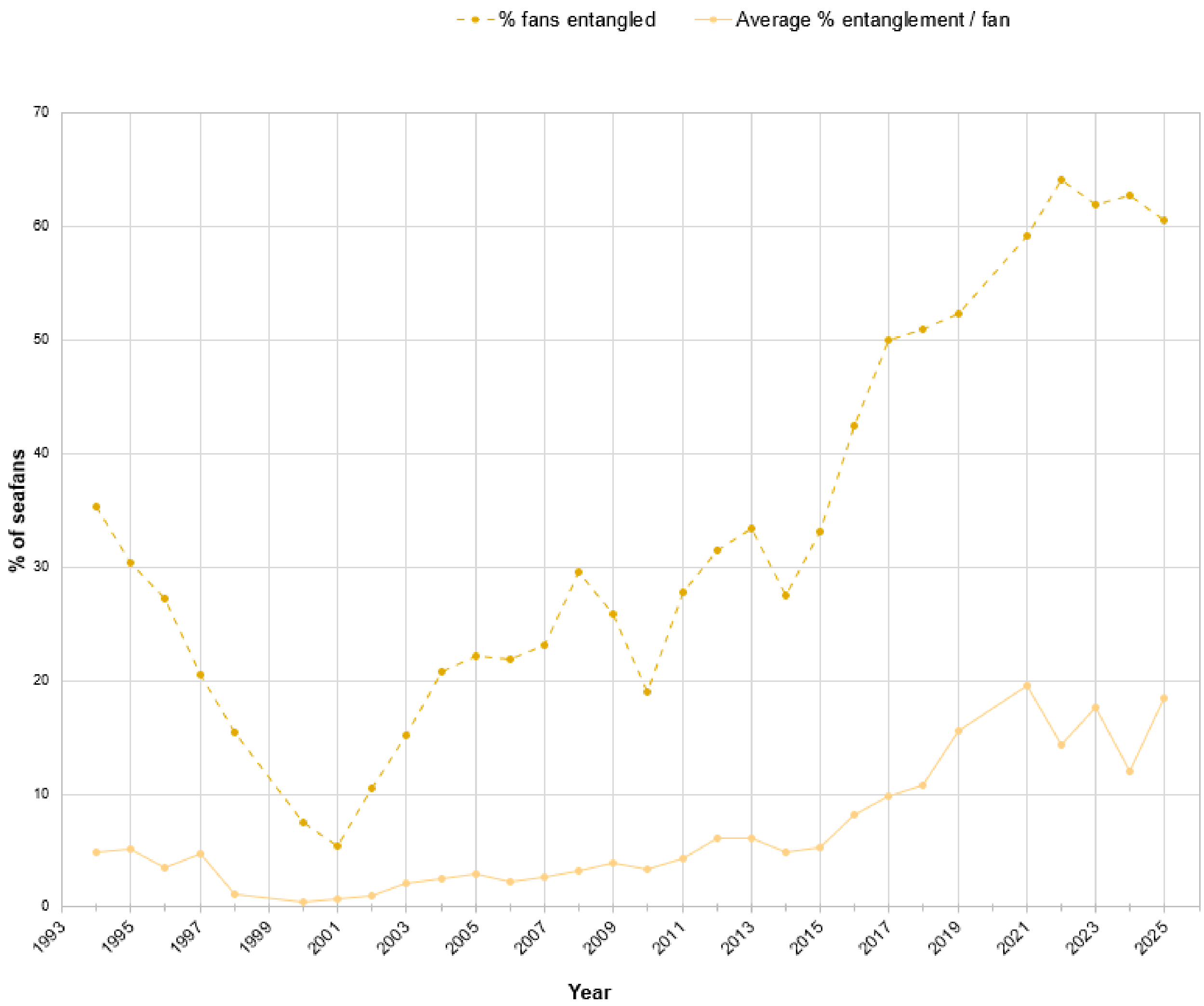


   Figure 4.3.5 Proportion of sea fans at Skomer MCZ entangled in *S. stellaris* eggs.



2. Biota entanglement including tangled *S. canicula* eggs and *S. stellaris* eggs, squid eggs, drift algae, bryozoans and hydroids. Entanglement with epibiota, and in particular eggs, if extensive and persistent, can cause damage to the sea fan tissues (Figure 4.3.6).

Figure 4.3.6 Percentage of sea fans at Skomer MCZ entangled in biota and the average percentage of entanglement per sea fan.



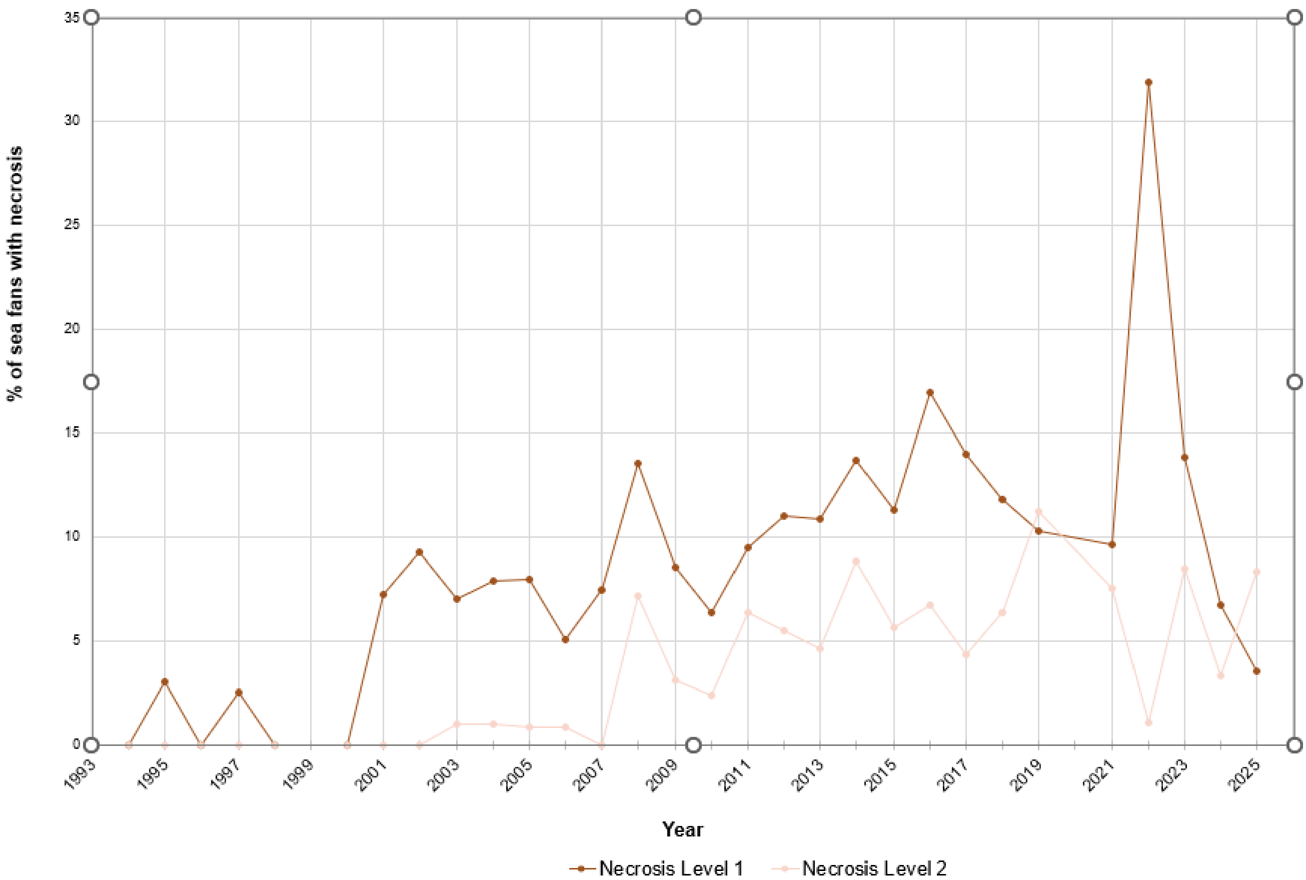
S. canicula eggs and *S. stellaris* eggs make up the bulk of the entangled biota and the pattern of entanglement reflects the proportion of sea fans entangled in eggs as shown in Figures 4.3.4 and 4.3.5. There has been an increase in entanglement since 2001 and in 2025 60% of sea fans were recorded with biota entanglement (Figure 4.3.6, top line). Opportunistic bryozoan and hydroid species are regularly found growing on the egg cases or on the curly tendrils tightly entangled around the sea fan branches (Figure 4.3.7).

Between 1994 to 2015, those sea fans with entanglement averaged between 0.5 to 6% cover and in 2016 this increased to 8%. Since 2016 this increased each year reaching 20% in 2021, in 2025 the entanglement averaged 19% cover (Figure 4.3.6, bottom line).

Figure 4.3.7 Sea fan with *S. stellaris* egg covered in bryozoan turf and *Pentapora foliacea*, an epiphytic species growing on the sea fan (necrosis level 4).

3. Necrosis is assessed for each sea fan and recorded on a scale from level 1 to 4 (Figure 4.3.1, Table 4.3.2). Necrosis was recorded on 49% of sea fans in 2025. Both levels 3 and 4 have opportunistic epiphytes growing on the sea fan, which can include bryozoan, hydroids and small red algae. On occasion, bryozoan sea fingers *Alcyonidium diaphanum*, deadman's fingers *Alcyonium digitatum* and ross coral *Pentapora foliacea* have been recorded growing on sea fans.

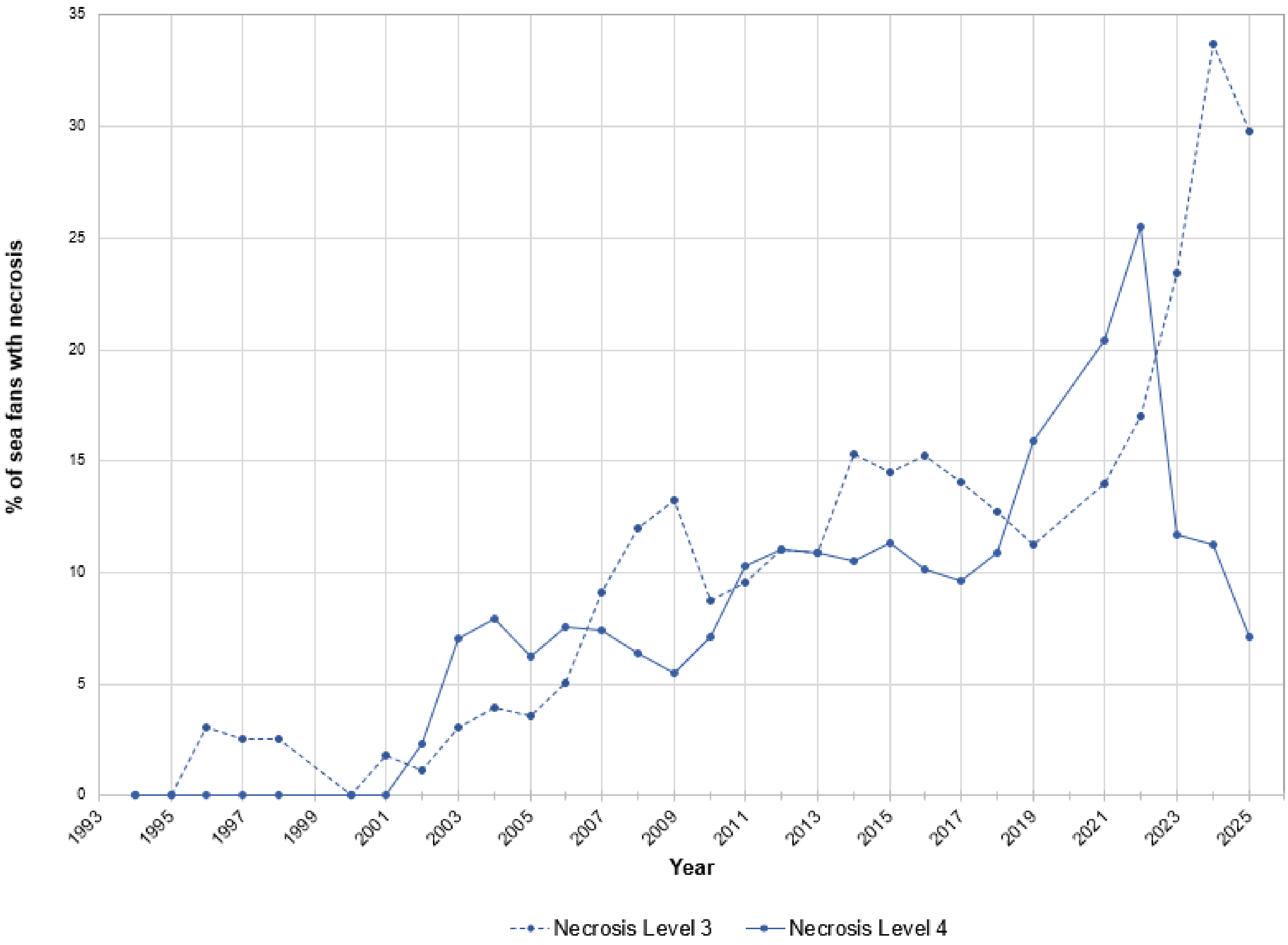
Figure 4.3.8 Percentage of sea fans at Skomer MCZ with necrosis level 1 and 2.



Necrosis level 1 (less than 5 tips necrosed) was recorded on 0 to 17.4% of sea fans since 1994, this increased to 31% of sea fans in 2022 then dropped down to 3.5% in 2025. Necrosis level 2 (more than 5 tips necrosed, but no epiphytes) was not recorded until 2002, after which it was found on 1% or less of sea fans until 2006. Since 2007 necrosis level 2 has increased, fluctuating between 2.5 and 11.7%, and in 2024 was recorded on 8.3% of sea fans (Figure 4.3.8).

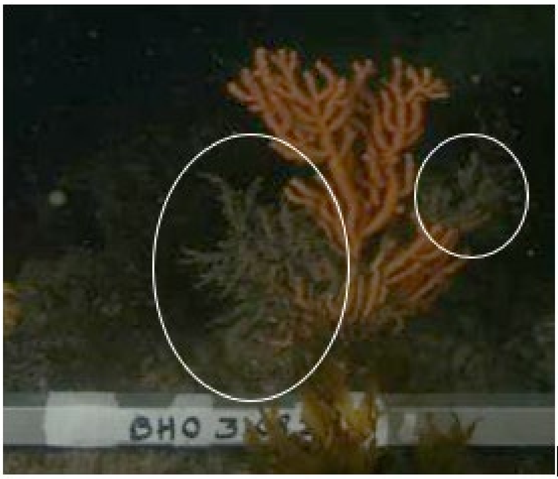
Necrosis level 3 (epiphytes growing on tips) was found on 0 to 5% of sea fans between 1994 and 2006 and since 2007 increased, varying between 7.3 and 17% of sea fans. 2024 saw the highest recorded percentage of level 3 necrosis at 34%, this dropped slightly to 29.7% in 2025. Necrosis level 4 (extensive areas of bare necrosis or epiphytes growing on sea fan) was not recorded on any sea fans until 2001, in 2002 it was 2.4% and by 2012 fluctuated around to 10%. During 2019, 2021 and 2022 increases were recorded with the highest record of 25.5% in 2022, this dropped back to 7.1% in 2025 (Figure 4.3.9).

Figure 4.3.9 Percentage of sea fans at Skomer MCZ with necrosis level 3 and 4.



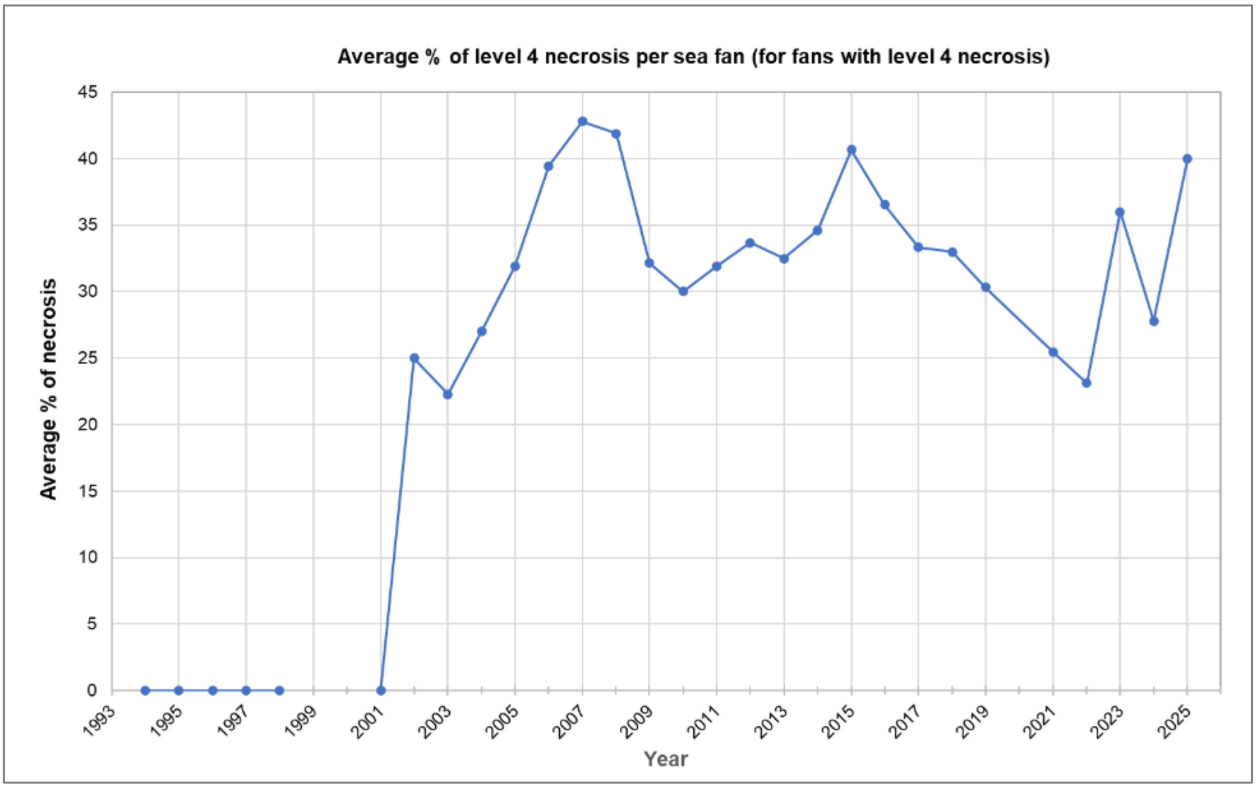
4. Damage is recorded as the percentage of level 4 necrosis on each sea fan. This can be caused from persistent biota entanglement or attached epibiota (Figure 4.3.10)

Figure 4.3.10 A sea fan with 30% level 4 necrosis damage as shown in circled areas.



The average percentage of level 4 necrosis damage per sea fan (for those with level 4 necrosis recorded), has fluctuated from 18% to 43% since it was first observed in 2002, and in 2025 was recorded as 40% damage per sea fan (Figure 4.3.11). Sea fans are also recorded as damaged when losses of branches are recorded or if the sea fan is dislodged from the rock, this is recorded in the individual data files for each sea fan.

Figure 4.3.11 The average percentage of level 4 necrosis per sea fan (for fans showing level 4 necrosis).

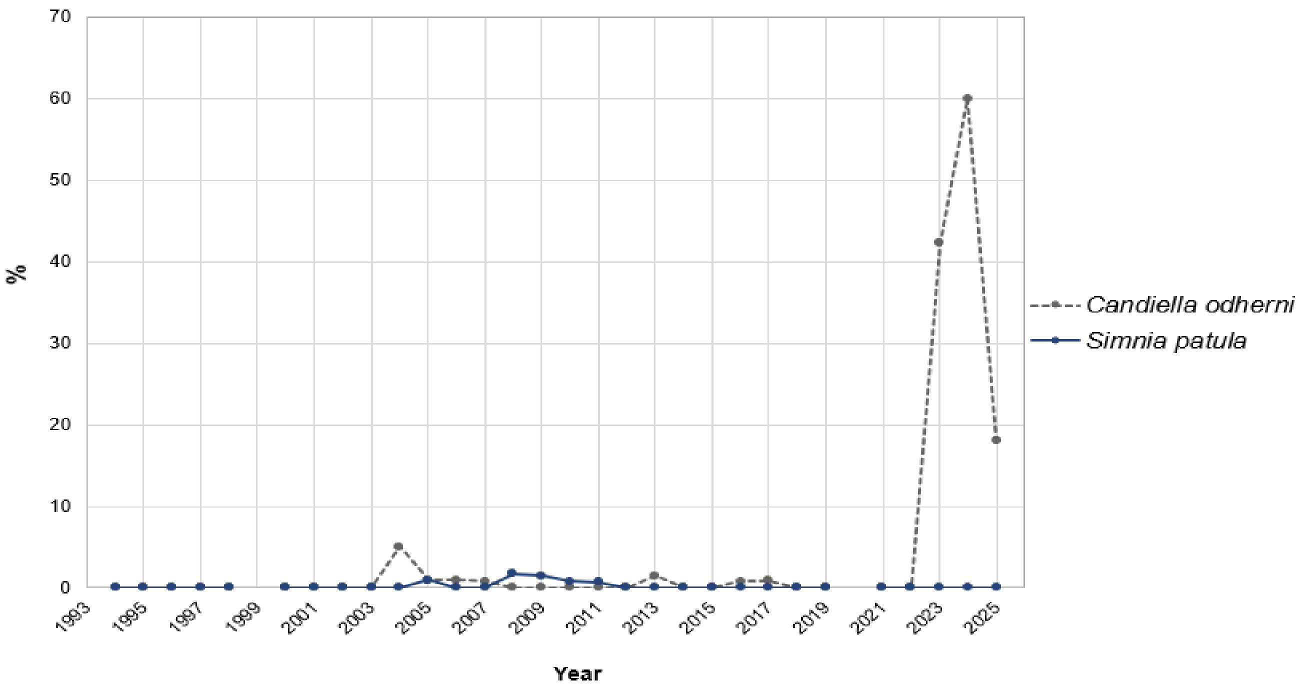


5. Presence of the nudibranch *Candiella odhneri* (Figure 4.3.12) and mollusc *Simnia patula* are recorded. *C. odhneri* was only recorded on 7 occasions between 2004 and 2022 with a maximum of 4 individuals on a single fan, whilst *S. patula* has only been found on 4 occasions.

   In 2023, unusually high numbers of *C. odhneri* were found, they were recorded on 42% sea fans with between 2-4 individuals found on each with egg masses. In 2024 *C. odhneri* continued to be found in high numbers and were recorded on 60% of sea fans, 2-4 individuals with egg masses were found on most but as high as 10 individuals were found on one sea fan. In 2025 a drop in numbers of *C. odhneri* were recorded being found on 16% of sea fans (Figure 4.3.12). No *S. patula* were recorded in 2025.

Figure 4.3.12 *Candiella odherni* and egg masses on sea fan.

Figure 4.3.13 Percentage of sea fan with *Candiella odherni* and *Simnia patula*.



6. Anthropogenic entanglement is recorded when sea fans have been found entangled with angling line, which, if extensive and persistent, has been observed to cause damage to the sea fan tissues. Whenever possible the line is cleaned off the fan to allow recovery. Angling line entanglement was not observed in 2025.

4.3.7. Supported research

- 2002 Reef Research: Sea fan reproductive biology. Small clippings were taken from some fan colonies in Devon and at Skomer. The Skomer clippings showed what was thought to be eggs and sperm, although at lower levels than the Devon population (Munro & Munro 2004).
- 2007 to 2013 Exeter University: Connectivity between populations of pink sea fans using internal transcriber sequences: Small clippings were taken from some Skomer sea fans in 2007 and 2009. The study has recognised genetic variation, with markers showing several distinct groupings across the range of the entire sample collection of Ireland, UK, France and Portugal. The results showed that the Skomer sea fans are not genetically distinct, but that they form part of a general southwest Britain regional group (Holland 2013).
- 2016 Cardiff University: Assessing the effects of fouling on the growth rate of pink sea fans in Skomer MCZ. The Skomer MCZ photographic dataset was provided for this study. The branches of 43 colonies (totalling 531 photographs) were counted and each colony was analysed for damage from natural fouling by epibiota and *S. stellaris* eggs. Fouling was found to have a significant negative association with growth with a decline of 0.2% over a twenty-year period. This may not seem extreme but the current state of the population along a health spectrum from pristine to system collapse is unknown (Whittey 2016).
- 2022, Kaila Wheatley Kornblum began a PhD entitled *"Factors limiting range-edge populations of the pink sea fan, Eunicella verrucosa"*, supervised by Professor Jamie Stevens at the University of Exeter. During 2023 and 2024, Kaila undertook fieldwork at Skomer MCZ, diving with the team to collect samples for genomic analyses. Results from the first subset of samples have already revealed higher-resolution connectivity between populations than previously available. Analysis of the second submission is currently underway and will address more detailed questions relating to population connectivity and health. In parallel, Kaila has been developing ocean physical models to simulate larval dispersal within ocean currents, providing insights into present-day connectivity patterns and how these may change under future climate scenarios.

  Kaila has also been assessing the connectivity and ecological coherence of the Marine Protected Area (MPA) network in the UK and adjacent regions using the pink sea fan (*Eunicella verrucosa*) as a model species. This work combines validated ocean circulation and particle-tracking models to simulate larval dispersal, identify key sites that maintain connectivity across the network, and highlight potential gaps in protection, with Skomer identified as one of the crucial sites.

  Kaila collaborated with the aquarist team at the Horniman Museum and Gardens in South London, where pink sea fans collected off the coast of Devon were photographed spawning for the first time in a UK institution. The larvae successfully settled and are now developing into juvenile sea fans, with growth and survival being closely monitored (Figure 4.3.14). Experimental work has provided critical information for conservation, including settlement timing, the effects of elevated water temperatures on settlement success and duration, and feeding trials.

In 2025, a subset of juveniles was transferred onto small tiles in preparation for reintroduction to the natural environment. In late July, juveniles, along with small clippings from adult colonies, were transplanted into a selected experimental area at the Sandy Sea Fan Gully site. Colonies were secured to the rock using epoxy putty (Figure 4.3.15). Follow-up dives were carried out in early October to re-photograph the transplants, with further monitoring planned for spring 2026 to assess overwinter survival. This represents the first out-planting trial of pink sea fans in the UK and northern Europe and provides valuable insights into the species' restoration potential.

Figure 4.3.14 Pink sea fan juveniles (photo credit: Horniman Museum and Gardens)

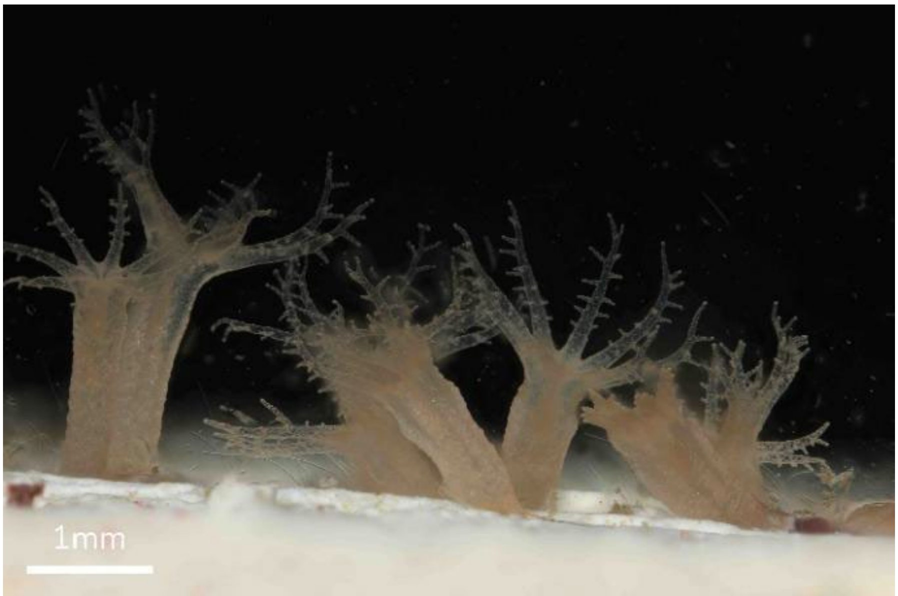


Figure 4.3.15 Pink sea fan juveniles out-planting trial (photo credit: Blaise Bullimore)

4.3.8. Current status

- The Lusitanian anthozoan assemblages feature for Skomer MCZ is in unfavourable conservation status due to a negative trend in sea fan population resulting from further increases in recorded losses compared to recruitment.
- 54 natural sea fans and 7 artificially attached sea fans were confirmed as lost from the monitoring sites between 1994 and 2024. A further 8 possible losses are to be confirmed in 2026. No new recruits were recorded in 2025.
- Biota entanglement has increased on sea fans from 27% in 2011 to 60% in 2025. *S. canicula* eggs were found on 17% of sea fans and *S. stellaris* eggs were recorded on 51% of sea fans. Opportunistic species grow on the egg cases and on the tendrils, tightly entangled in the sea fan branches. For sea fans recorded with entanglement, the average sea fan area covered was 19% in 2025.
- Necrosis was recorded on 49% of sea fans in 2025, of this 29.7% was at level 3 (epiphytes growing on tips) and 7.1% at level 4 (extensive areas of bare necrosis or epiphytes growing on sea fan). Level 4 necrosis was not recorded on any sea fans from 1994 to 2001, since 2002 it has steadily increased with a peak of 25% of fans showing some level 4 necrosis in 2022.
- The average percentage of level 4 necrosis damage per sea fan (for those with it recorded) has fluctuated since it was first observed in 2002, from 18% to 43% and in 2025 was recorded as 40%.

4.3.9. Recommendations

- Report pink sea fan status as declining and in unfavourable condition.
- Take close-up photos of all "new recruits" /small sea fans found.
- Observe persistence of biotic fouling/entanglement e.g. catshark eggs.
- Continue to record fishing, diving, angling and anchoring activity in Skomer MCZ.
- Explore the opportunities to set up an "exclusion zone" where potentially damaging activities are excluded.
- Support research work on the biology of sea fans and publish results in scientific literature.

4.4. *Alcyonium glomeratum* Population

4.4.1. Project Rationale

Alcyonium glomeratum (red sea fingers) is a Lusitanian species, common in the Mediterranean (Garrabou 1999), reaching its northern limit on the west coast of the UK near southern Scotland. Lusitanian species have become important indicators of climate change in the UK. It is reasonable to assume that species that are near the limit of their distribution will exhibit greater sensitivity to changes in the physical environment.

The population of *A. glomeratum* is a component of the Lusitanian anthozoan management feature of the Skomer MCZ, it is chosen as it may act as an indicator of climatic change. *A. glomeratum* is a component of the fragile sponge and anthozoan community habitat of priority importance under Section 7 of the Environment Act (Wales) 2016.

4.4.2. Objectives

To monitor colony populations and to look for damage and disease.

4.4.3. Sites

Table 1 *A. glomeratum* site names and survey start date.

Site	Survey Start Year
North Wall Stereo	1982
North Wall (main)	2002
Thorn Rock	2002
Sandy Sea Fan Gully	2002
North Wall East	2002
Rye Rocks	2003
Junko's Reef	2015

4.4.4. Methods

Each site follows either a sequence of photo-quadrats or transects that are described in site relocation pro-formas.

North Wall Stereo bar	3 quadrats
North Wall (main)	5 vertical transects
Thorn Rock mooring	2 fixed position quadrats
Sandy Sea Fan Gully	2 vertical transects
North Wall East	2 vertical transects
Rye Rocks	1 transect
Junko's Reef	1 vertical transect

North Wall Stereo: three quadrats (50cm x 40cm) are photographed using stereo or high definition digital SLR photography.

All other sites: photographs (mono) are taken using a 50cm x 70cm framer using high definition digital SLR photography.

The colonies are gently “wafted” before photographing to make them retract in an attempt to control the variability in colony size. The images are analysed by overlaying a 5cm x 5cm grid and recording presence/absence of *A. glomeratum* within each grid square.

Photographs are analysed for presence of *A. glomeratum* and a frequency count is completed for each quadrat using a 5cm x 5cm grid (140 squares) for the 50cm x 70cm frame.

4.4.5. Results

There has been a declining trend and disappearance or near disappearance of colonies from 5 sites. Currently only colonies at North Wall East and Junko’s reef remain healthy.

North Wall Stereo: A healthy colony area had been recorded since 1982 within 3 quadrats, since 2006 the size of the colonies slowly reduced until finally no colonies were found from 2019.

North wall (main): A large number of colonies were recorded spread across a steep vertical wall since 2002, the peak quadrat count of 23 was in 2005, the numbers of colonies reduced over the next 5 years to only 2 quadrats and no colonies have been found since 2013.

Rye Rocks: A small area with colonies that were first recorded in 2005, these have not been found since 2015 (not included in graph as low numbers).

Thorn Rock: A small area with colonies was recorded from 2002 to 2019 within 2 quadrats and none since then. A very small colony was found in 2025.

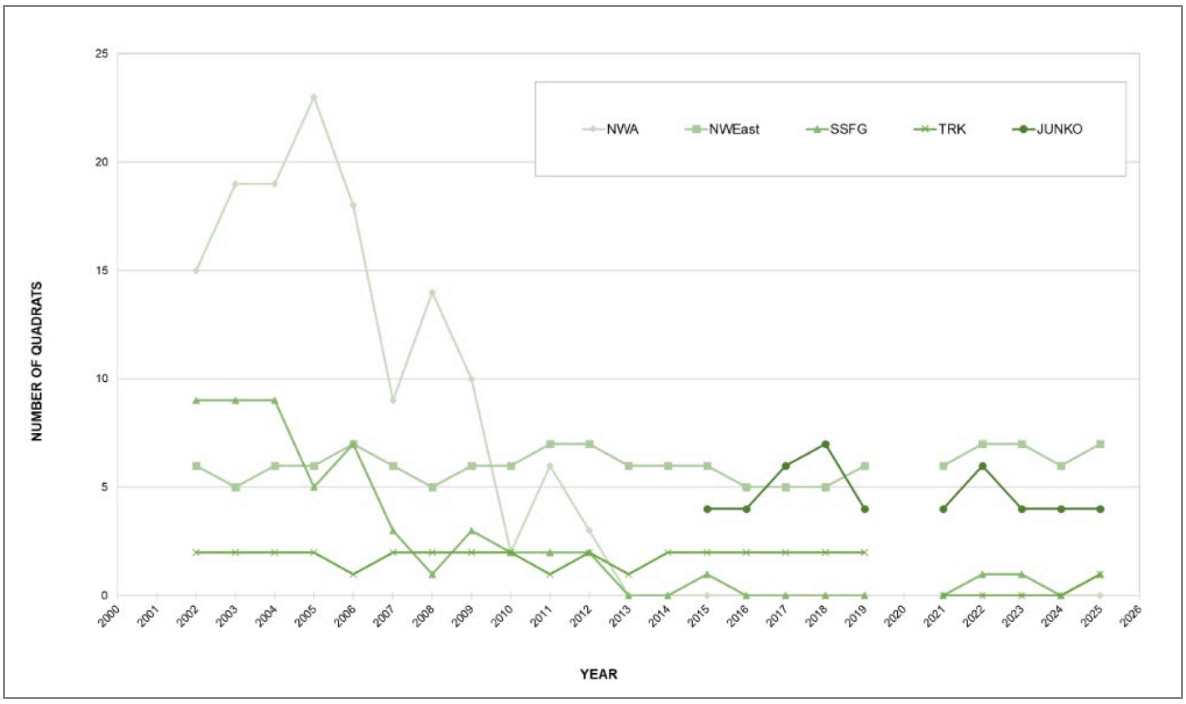
Sandy Sea Fan Gully: A small area of colonies that were first recorded in 2002 on a vertical wall alongside *Parazoanthus axinellae*. It was recorded in 7 quadrats but slowly reduced in area to only 2 quadrats from 2008 and none since 2013, a very small colony has been found a few times since then including in 2025.

North Wall East: A healthy colony area has been recorded since 2002 with 7 quadrats. This has stayed healthy with 6 quadrats recorded in 2025.

Junko’s Reef: A healthy colony area has been recorded since 2015 with 4 quadrats, this has stayed healthy with 4 quadrats recorded in 2025.

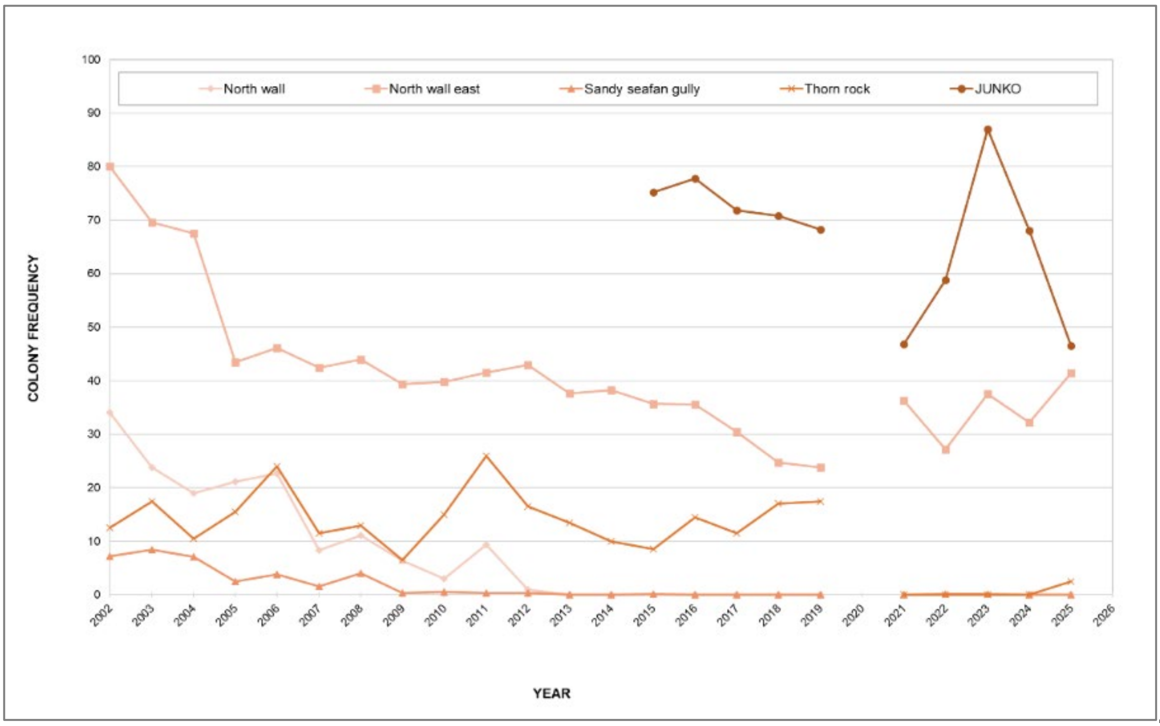
The number of quadrats with *A. glomeratum* recorded at North Wall (main), North Wall East, Sandy Sea Fan Gully, Thorn Rock and Junko’s Reef sites from 2002 to 2025 is shown in Figure 4.4.1.

Figure 1.4.1 Number of quadrats with *A. glomeratum* present at Skomer MCZ sites 2002 – 2025: NWA = North Wall main, NWEast = North Wall east, SSFG = Sandy Sea fan gully, TRK = Thorn rock and JUNKO = Junko's reef.



The mean frequency counts of *A. glomeratum* colonies at North Wall (main), North Wall East, Sandy Sea Fan Gully, Thorn Rock and Junko's Reef sites from 2002 to 2025 are shown in Figure 4.4.2. A declining trend of colony frequency is recorded at all sites except for Junko's Reef.

Figure 4.4.2 Mean frequency of *A. glomeratum* colonies per quadrat Skomer MCZ 2002 – 2025



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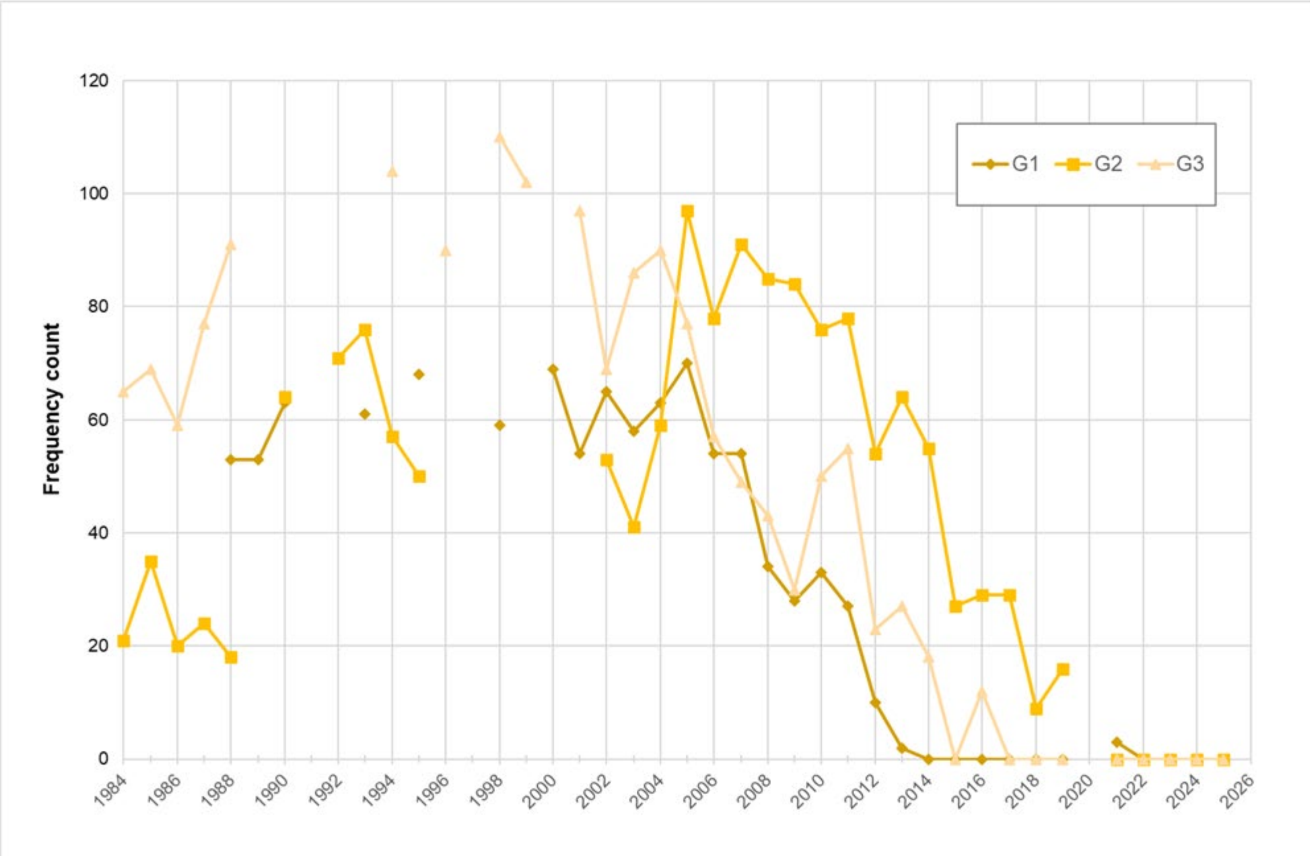
North Wall Stereo colony

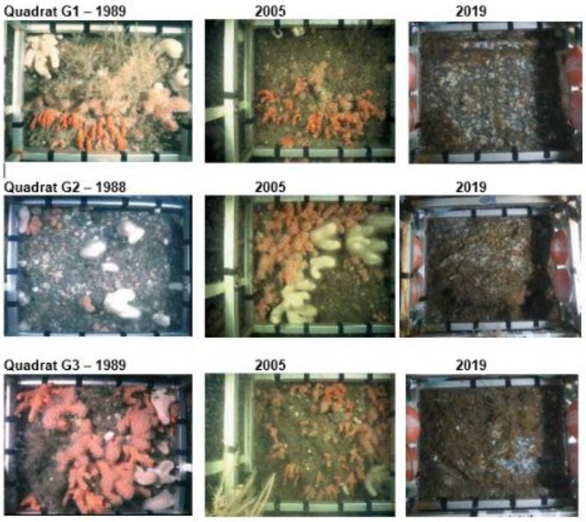
The time series for these 3 photo quadrats on the north side of Skomer goes back to 1982. The quadrats have been photographed at least once a year for most years since 1988. A frequency count of *A. glomeratum* for each quadrat is completed using a 120 square grid (4 x 4cm squares) then presence counted for each square (Figure 4.4.3).

Figure 4.4.3 Frequency count (120 squares) of presence of *A. glomeratum* in 3 quadrats at the North Wall 1984 to 2025. (G1 – Quadrat 1, G2 – Quadrat 2, G3 – Quadrat 3).



All three quadrats show a similar trend of increasing cover peaking in the late 1990’s to early 2000’s and then declining from 2006 onwards. *A. glomeratum* has now disappeared at this site. Looking at the 1989, 2005 and 2019 photographs shown in Figure 4.4.4, it is interesting to note that *Alcyonium digitatum* (white deadman’s fingers) has also reduced significantly in the three quadrats.

Figure 4.4.4 Photographic examples of declining populations of *A. glomeratum* at Skomer MCZ between 1989 and 2019.



4.4.6. Current Status

- The Lusitanian anthozoan assemblages feature for Skomer MCZ is in unfavourable conservation status due to a negative trend in *A. glomeratum* population.
- The colonies have disappeared from 5 sites. North Wall East and Junko's reef are the only sites left with healthy colonies but frequency of *A. glomeratum* is showing a decline at North Wall East.
- The reason for this decline is unknown. There is no evidence of disease or mechanical damage at the monitoring sites and changes in environmental conditions are not thought to be large enough to cause colony loss.

  Despite the habitats being suitable for *A.glomeratum* no new colonies have been found during monitoring dives at these sites.

4.4.7. Recommendations

- Report *A. glomeratum* feature as declining and in unfavourable condition.
- Search for further colonies in the MCZ and establish new monitoring sites.
- Analyse photographs to assess what species have replaced the lost colonies of *A. glomeratum* and establish whether other species (e.g. *Alcyonium digitatum*) have also declined.
- Encourage research to investigate potential reasons for population decline and to look at the wider picture across Pembrokeshire Marine SAC.

4.5. *Parazoanthus axinellae* Population

4.5.1. Project Rationale

The yellow cluster anemone, *Parazoanthus axinellae* (O. Schmidt 1862) is a colonial anthozoan found on inclined rocky substrata from depths of 5m to 50m.

P. axinellae forms dense aggregations of polyps that have an important role in the benthic community. Like many colonial organisms *P. axinellae* grows by repeated replication of structural units conferring the ability to asexually reproduce (fragmentation and fission) and inferring a high regenerative capability (Jackson 1977; Hughes & Cancino 1985). *P. axinellae* is thought to be able to reproduce sexually as well as asexually (Manuel 1988) but sexual reproduction is difficult to observe and identify in the field (Garrabou 1999).

P. axinellae is a Lusitanian species, common in the Mediterranean, reaching its northern limit on the west coast of the UK near southern Scotland (Garrabou 1999). Lusitanian species have become important indicators of climate change in the UK. It is reasonable to assume that species that are near the limit of their distribution will exhibit greater sensitivity to changes in the physical environment.

The population of *P. axinellae* is a component of the Lusitanian anthozoan management feature of the Skomer MCZ, it is chosen as it is near to the edge of its range and may act as an indicator of climatic change. *P. axinellae* is a component of the fragile sponge and anthozoan community habitat of priority importance under Section 7 of the Environment (Wales) Act 2016.

4.5.2. Objectives

Monitor *P. axinellae* colonies for changes in polyp density and colony area.

4.5.3. Sites

Table 4.5.1 Yellow trumpet anemone sites names and survey start date.

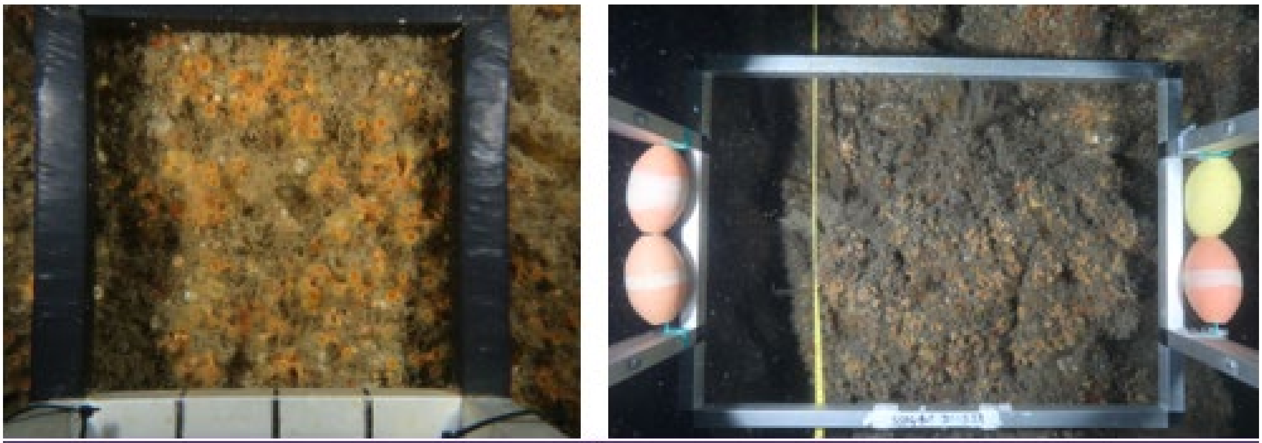
Site	Survey Start Year
Sandy Sea Fan Gully	2002
Sandy Sea Fan Gully Buttress	2015
Thorn Rock (3 colonies)	2002
Way Bench (2 colonies)	2002

4.5.4. Methods

Density Estimates: Close-up photographs are taken using a digital camera. The digital camera is mounted on a 20 x 20 cm framer. *P. axinellae* polyps are counted in each 20 x 20 cm quadrat (Figure 4.5.1, left).

Coverage of the Colony: A series of transects are placed through the colonies. Photographs are taken using a 50cm x 70cm framer. In 2008 a digital SLR camera replaced the film camera providing high quality images allowing improved photo analysis. The images are analysed by overlaying a 5cm x 5cm grid and recording presence/absence of *P. axinellae* within the grid squares to provide frequency counts (Figure 4.5.1, right). See Burton, Lock & Newman (2002) for details. In 2022 a new digital camera was used for the transect pictures which has an increased pixel resolution.

Figure 4.5.1 Left: density method using a 20 cm x 20 cm framer; and right: colony coverage method using a 50 cm x 70 cm framer.



4.5.5. Results

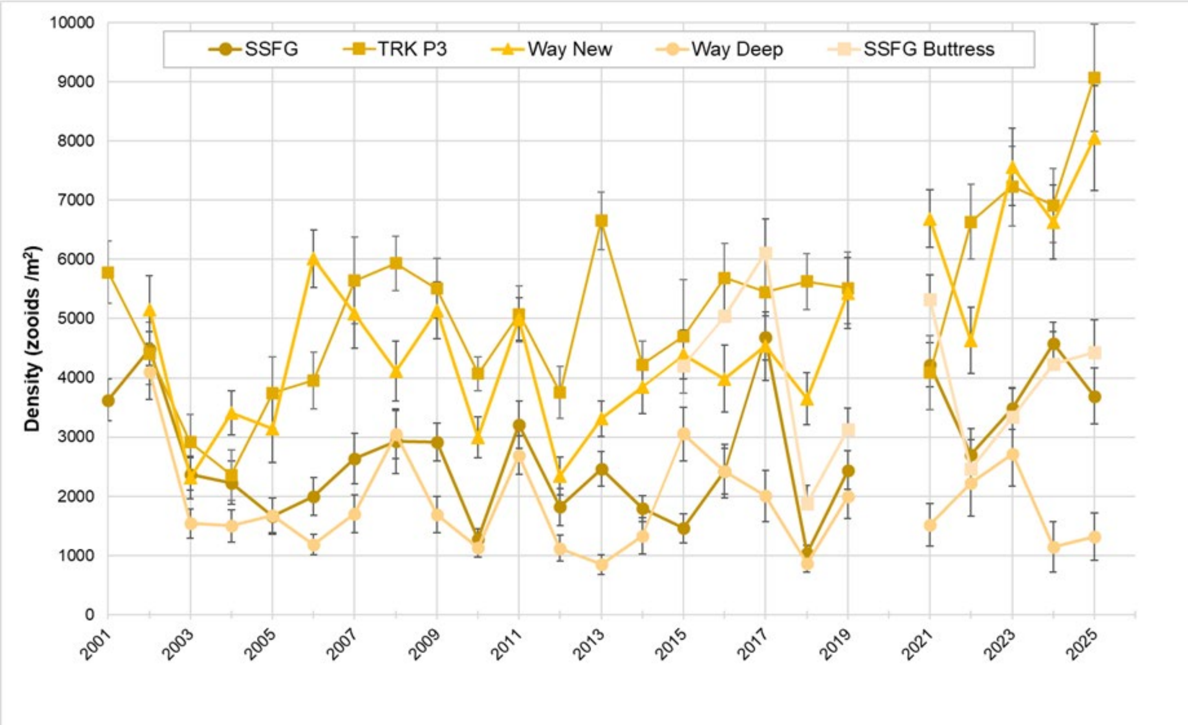
The fieldwork completed in 2024 is shown in Table 4.5.2.

Table 4.5.2 *Parazoanthus axinellae* fieldwork completed at Skomer MCZ in 2023.

Site	Site Code	Colony coverage	Density data
Sandy sea fan gully (SSFG)	SSFG	5 transects (20 quadrats)	Yes
Sandy sea fan gully Buttress (SSFG Buttress)	SSFG Buttress	2 permanent transects set up 13 quadrats	Yes
Waybench – New Wall	Way New	9 re-locatable quadrats	Yes
Waybench – Deep Wall	Way Deep	2 transects (8 quadrats)	Yes
Waybench – Deep Wall	Way Deep	New lower transect resurveyed– 6 quadrats	No
Thorn Rock – Piton 7	TRK P7	3 re-locatable quadrats	No
Thorn Rock – Mooring	TRK Mooring	3 re-locatable quadrats 4 new quadrats west of mooring	No
Thorn Rock – Piton 3 (TRK P3)	TRK P3	3 transects (11 quadrats)	Yes

The mean density of *P. axinellae* (number of polyps /m^2) at all sites has shown fluctuations from year to year, but overall there is no obvious trend (Figure 4.5.2).

Figure 4.5.2 Mean density of *P. axinellae* (number of polyps /m^2) at five Skomer MCZ sites 2001 – 2025 with standard error bars.



The frequency of *P. axinellae* at all sites has shown fluctuations year to year, but overall show a stable population. The mean frequency of *P.axinellae* at Thorn rock and Sandy seafan gully sites showed an increase from 2024 to 2025 (Figures 4.5.3 and 4.5.4).

Figure 4.5.3 Mean frequency of *Parazoanthus axinellae* 2002 – 2025. Thorn Rock (TRK) transects.

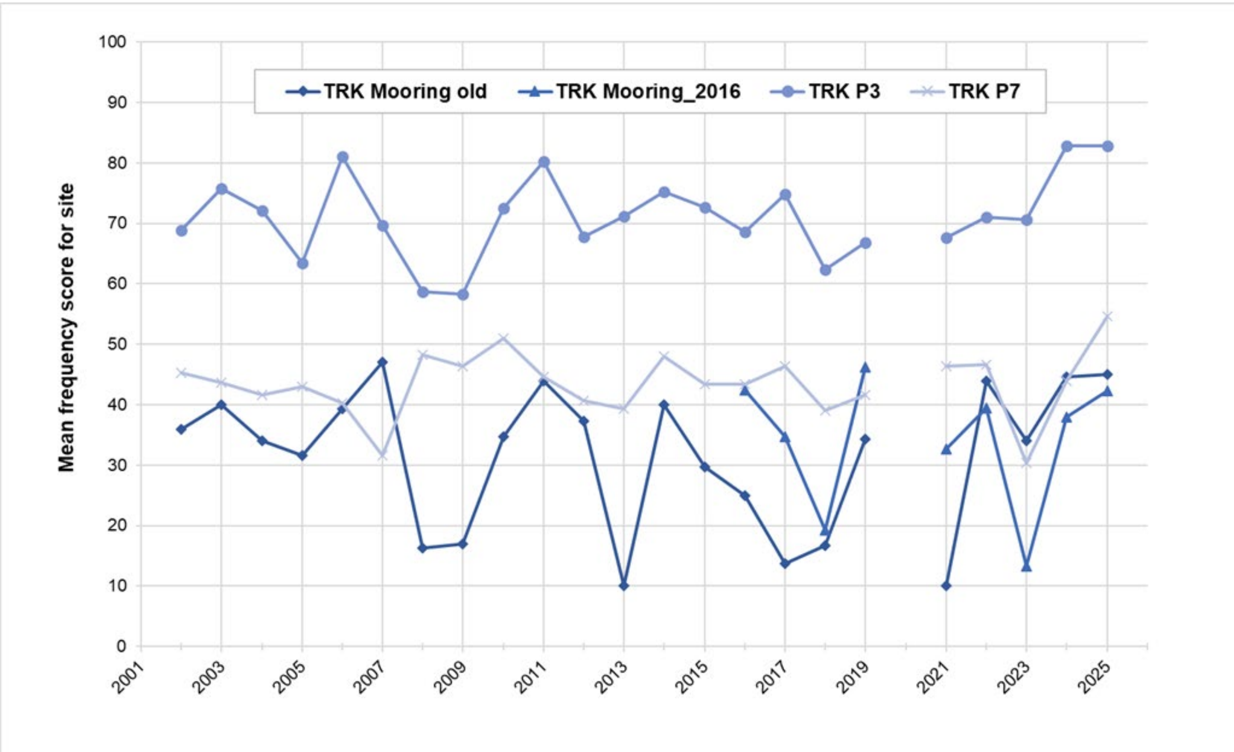
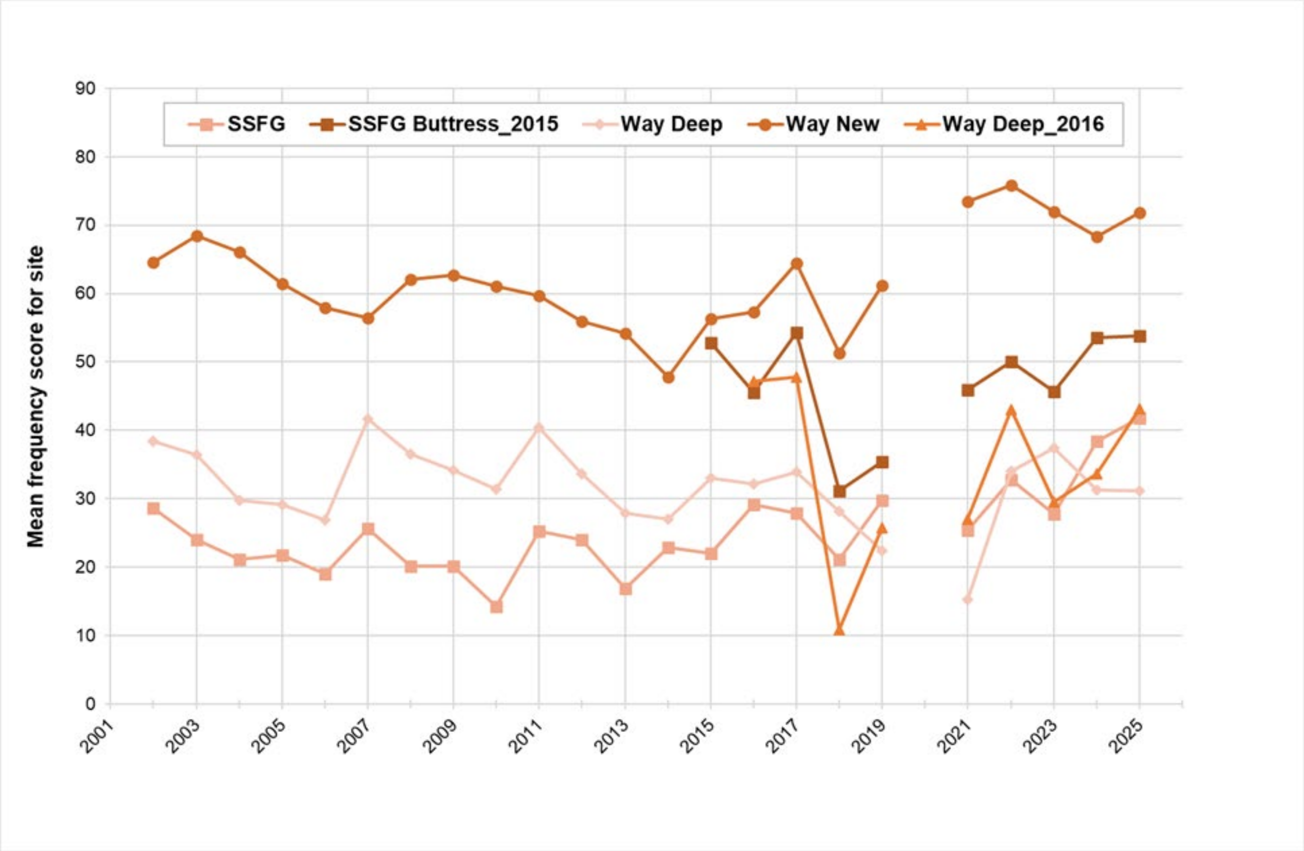


Figure 4.5.4 Mean frequency of *Parazoanthus axinellae* 2002 – 2025. Waybench and Sandy Sea Fan Gully transects.



4.5.6. Current Status

All previously recorded colonies are still present and population trends appear stable.

4.5.7. Recommendation

- Search for further colonies in the MCZ and establish new sites.
- Continued research is needed on the biology of *Parazoanthus axinellae*.
- Report *P. axinellae* feature as stable.

4.6. *Pentapora foliacea* Population

4.6.1. Project Rationale

Pentapora foliacea forms fragile (brittle) colonies ranging in size from single 'flakes' to those over 1 metre wide and is considered regionally important at Skomer MCZ. Large colonies are ecologically important, acting as micro-habitats, and colonies are known to harbour a large number of species including juvenile forms of commercially important species.

Colonies are vulnerable if subjected to changes in environmental conditions, elevated levels of chemical pollutants, suspended sediments and seabed sedimentation, and physical damage by natural events and/or anthropogenic activities. As such, they are regarded as useful indicators of physical disturbance. The level of potential damage and recovery is dependent on the health, growth, recruitment and robustness of the current population. They were selected as a management feature of the Skomer MCZ and are a component of the fragile sponge and anthozoan community habitat of priority importance under Section 7 of the Environment (Wales) Act 2016.

4.6.2. Objectives

- To monitor the numbers and growth rate of colonies.
- To monitor the amount of damage occurring to the colonies.

4.6.3. Sites

Table 4.6.1 *Pentapora foliacea* monitoring sites at Skomer MCZ in 2024.

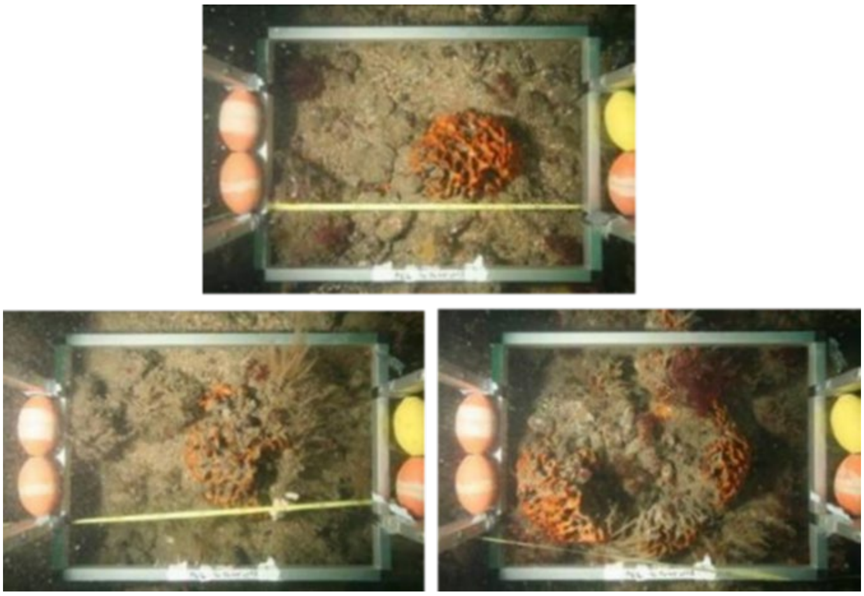
Site	Substrata	dataset
North of the Neck	ground ropes	2002 - onwards
North wall	rock and boulders	1984 – 2002
Way bench	rock and boulders	1993/4 restarted 2002 -onwards
Bernie's Rocks	boulders	1995 onwards
South Middleholm	rock	2003 - onwards
West Hook	rock	2004 - onwards
Pool	boulders	2013 - onwards
Martins Haven East	rock and boulders	2021

4.6.4. Methods

Photographs are taken along marked transects at each site following detailed site proforma. Photographs are taken using a 50cm x 70cm framer. In 2008 a digital SLR camera replaced the film camera providing high quality images allowing improved photo analysis.

Photo analysis is completed using morphological classification. Class 1 (single flakes) to class 4 (20 cm diameter) relate to size development. Class 5 is not size based but relates to the levels of degradation. Class 5a is when more than 50% of the colony is covered in epiphytes and class 5b when more than 25% of the colony has broken down. Class 5 can occur at any stage from class 2 to 4 (Figure 4.6.1).

Figure 4.6.1 *Pentapora foliacea* - examples of Class 4 (top) and Class 5a and 5b (bottom) colonies.



4.6.5. Project History

1998: Gilbert tested various image analysis methods for assessing growth rate but concluded that a three-dimensional method would be most suitable. Colonies were put into size classes using base area (cm^2) however this only provided an approximate measure of colony size (Gilbert 1998).

2005: the analysis methods were reviewed. The growth of *P. foliacea* colonies were found to vary dramatically; one colony showed an increase in base area of over 80 cm^2 in one year, whilst other large colonies had all but disappeared. In general, colonies that survive tend to grow whilst other colonies of all sizes can just disappear in the space of a year. This suggests that some colonies are being physically destroyed or rapidly disintegrate naturally rather than just decrease in size by slow wastage (Burton *et al.* 2005).

2008: Gibbs developed an empirical calibration method by which a three-dimensional reconstruction of a *P. foliacea* colony may be created from stereophotographs. This method allows the quantification of the growth of the *P. foliacea* colony over time. Sadly, it was found that most of the photo images had insufficient precision of data to apply the method. However, conclusions drawn from the study led to the creation of a 5-stage morphological classification system for *P. foliacea*. The system is designed to provide a quick and simple classification of colonies seen during a survey, to give an idea of the state of the population from the distribution of classes within the surveyed population (Gibbs 2007).

2010: The morphological classification method was applied to the historical photo dataset and continued each year. In 2010 the method was reviewed due to inconsistencies between individuals completing the analysis and revised guidelines were produced (Lock 2013b). The revised guidelines were re-applied to the full historical dataset and continued each year.

2013: A new site was established at the Pool on the north side of Skomer. The site is a boulder slope and very rich in *P. foliacea* with high numbers of colonies found.

2021: A new site was established at Martins Haven east rocky reef on the north side of the Marloes Peninsula.

4.6.6. Results

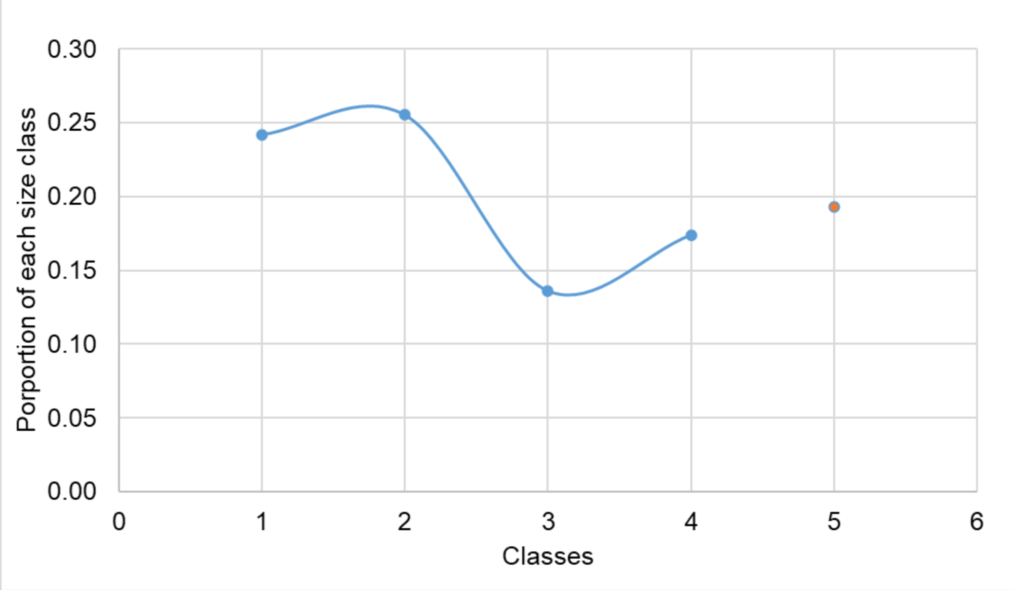
Photo datasets collected each year for each survey sites are shown in Table 4.6.2.

Table 4.6.2 *Pentapora foliacea* photo dataset for Skomer MCZ.

Year	North Wall	Waybench	Bernies Deep	Bernies Shallow	North Neck	South Middleholm	West Hook	Pool	Martins Haven E
1993	yes	yes	no	no	no	no	no	no	no
1994	yes	no	no	yes	no	no	no	no	no
1995	yes	no	yes	yes	no	no	no	no	no
1996	yes	no	no	no	no	no	no	no	no
1997	yes	no	yes	yes	no	no	no	no	no
1998	yes	no	yes	yes	no	no	no	no	no
1999	yes	no	no	no	no	no	no	no	no
2000	yes	no	yes	yes	no	no	no	no	no
2001	yes	no	no	no	no	no	no	no	no
2002	yes	yes	no	no	yes	yes	no	no	no
2003	no	yes	yes	yes	yes	yes	no	no	no
2004	no	yes	yes	yes	yes	yes	yes	no	no
2005	no	yes	yes	yes	yes	yes	yes	no	no
2006	no	yes	yes	yes	yes	yes	yes	no	no
2007	no	yes	yes	yes	yes	yes	yes	no	no
2008	no	yes	yes	yes	yes	yes	yes	no	no
2009	no	yes	yes	yes	yes	yes	yes	no	no
2010	no	yes	yes	yes	yes	yes	yes	no	no
2011	no	yes	yes	yes	yes	yes	yes	no	no
2012	no	yes	yes	yes	yes	yes	yes	no	no
2013	no	yes	yes	yes	yes	yes	yes	yes	no
2014	no	yes	yes	yes	yes	no	yes	yes	no
2015	no	yes	yes	yes	yes	yes	yes	yes	no
2016	no	yes	yes	yes	yes	yes	yes	yes	no
2017	no	yes	yes	yes	yes	yes	yes	yes	no
2018	no	yes	yes	yes	yes	yes	yes	yes	no
2019	no	yes	yes	yes	yes	yes	yes	yes	no
2020	no	no	no	no	no	no	no	no	no
2021	no	yes	yes	yes	yes	no	yes	yes	yes
2022	no	yes	yes	yes	yes	yes	yes	yes	yes
2023	no	yes	yes	yes	yes	yes	yes	no	yes
2024	no	yes	yes	yes	no	yes	yes	yes	yes
2025	no	yes	yes	yes	yes	no	yes	yes	yes

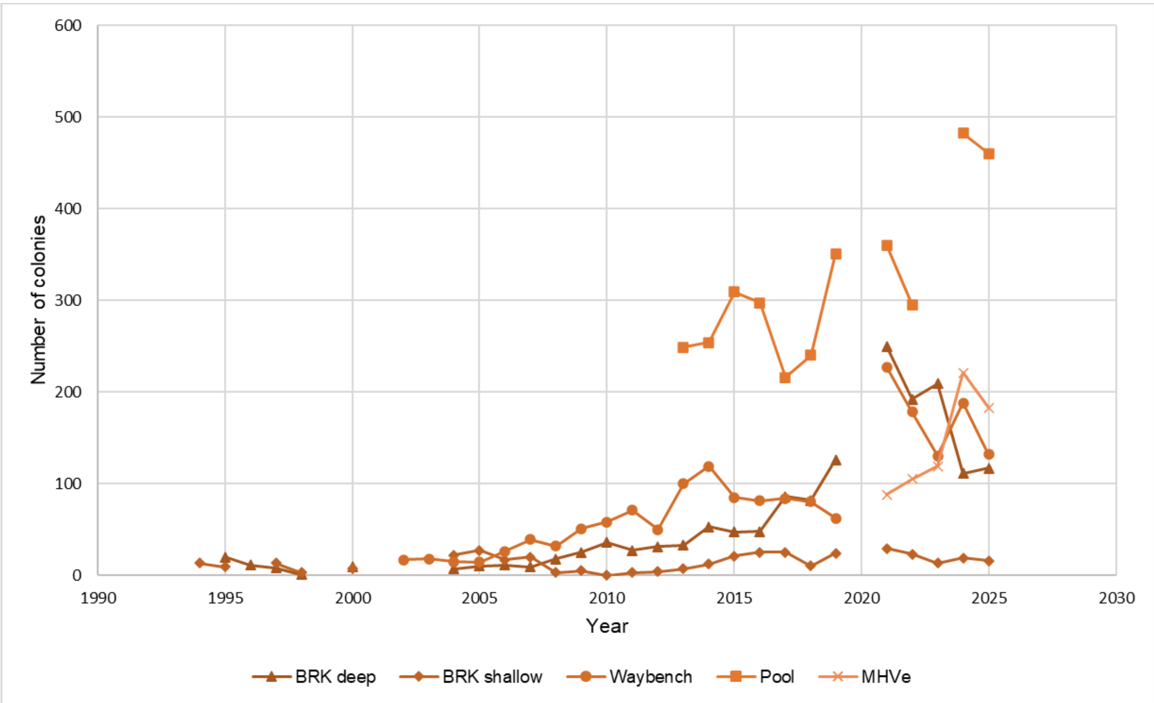
The normalised population curve in Figure 4.6.2 shows the proportions of each size class (1-4) across all Skomer sites and gives an overall pattern of size-class distribution. Class 5 is not connected via the curve as it is not a continuum from class 4 but is related to degradation which can develop directly from class 2, 3 or 4. The population pattern varies between sites as colony development is affected by both substrate, environmental conditions, disease and recruitment at sites.

Figure 4.6.2 *Pentapora foliacea* - normalised population curve for all Skomer MCZ sites.



Waybench, Pool, Bernies Rock and Martins Haven east are the largest sites surveyed, the total number of colonies (all classes) recorded in each survey year is shown in Figure 4.6.3.

Figure 4.6.3 Total number of *Pentapora foliacea* colonies (all classes) recorded each year surveyed at Waybench, Pool, Bernies Rock shallow and deep sites, Martins Haven east.



Waybench is a large bedrock site, on the north side of the island, and is divided into two areas: an exposed rocky ridge and a neighbouring boulder area. Ridge colonies tend to be recorded as class 1-3 and occasionally reach class 4, whilst in the more sheltered boulder area higher numbers of colonies are found and many of them reach the larger class 4, before developing into a class 5. Between 2002 and 2014 a steady increase in colony numbers was recorded from 17 to 119, numbers then dropped over the following years to 62 in 2019, however, in 2021 a significant increase was recorded with 227 colonies with all classes represented. Numbers dropped in 2022 to 178 and to 130 colonies in 2023 but increased up to 188 in 2024 of which 40% were class 5. In 2025 the numbers of colonies dropped to 132 (Figure 4.6.3) of which 71% were small class 1 and 2, and 23% class 3 and 4 colonies, It will be interesting to see if these small colonies grow to larger sizes.

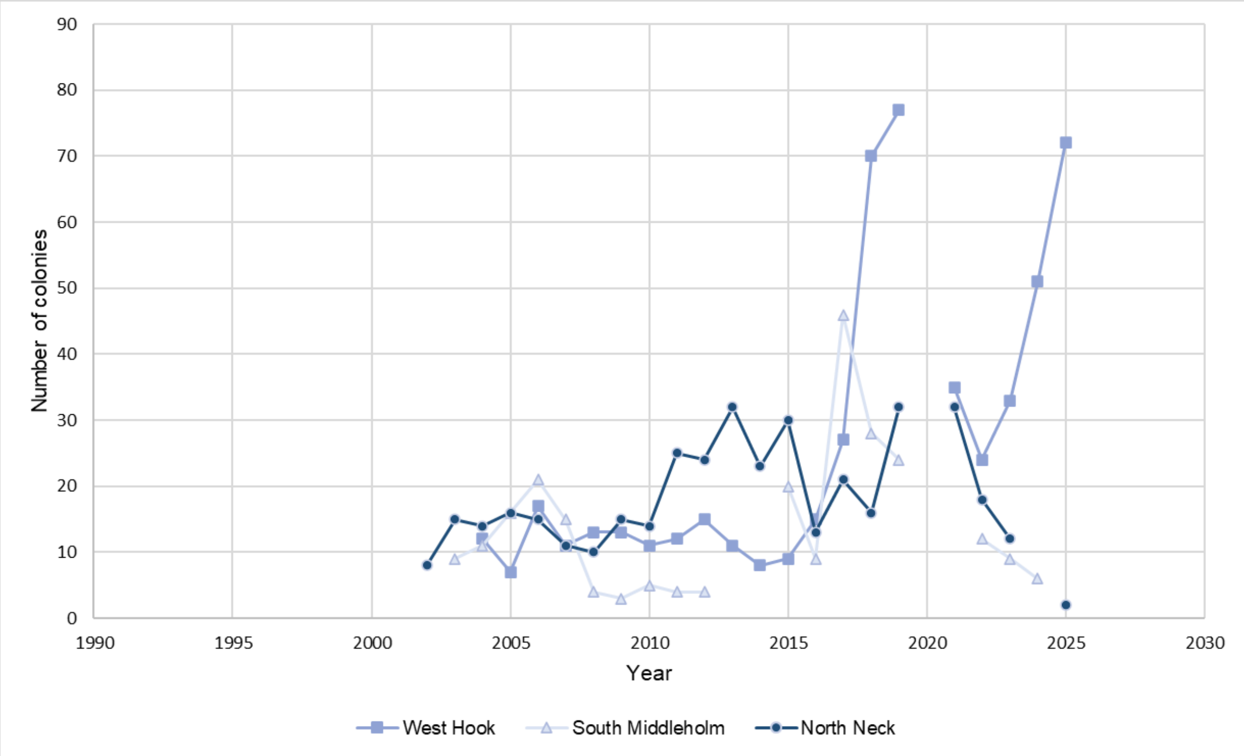
Bernie's Rock is located on the north side of the island. There is a shallow site (12-14m depth) and a deep site (26-28m depth), both consisting of boulder substrate. The number of colonies has varied at both sites year by year, with some years having no colonies present. All classes of colonies are found with many developing into a class 4, before progressing to a class 5. In 2025, 16 colonies were recorded at the shallow site, similar to previous years (Figure 4.6.3). At the deep site, colony numbers had fluctuated between 0 to 50 colonies between 1994 and 2016, however, over the next 3 years this increased to 126 colonies in 2019, and a further increase to 250 colonies were found in 2021 with all classes represented. In 2023 numbers of colonies remained high with 209 recorded but this dropped to 111 colonies in 2024 (Figure 4.6.3). In 2025 117 colonies were recorded of which 53% were class 1 and 2, 31% class 3 and 4, and 20% class 5.

The Pool monitoring was started in 2013, located on the north side of Skomer. The site is a boulder slope from 10m down to 22m below chart datum. A large area is surveyed, and large numbers of colonies are found with an even spread of classes present. Between 2013 and 2018, total numbers fluctuated between 216 and 309 colonies, in 2019 this increased to 351 colonies and in 2021 to 360 colonies, with all classes represented. In 2022 the numbers of colonies remained healthy with 295 recorded, (Figure 4.6.3), there was no survey in 2023 but it was completed in 2024 with a record high of 482 colonies recorded of these 56% were the small 1 and 2 size classes showing good recruitment. In 2025 460 colonies were recorded of which 61% were class 1 and 2, and 28% class 3 and 4.

Martins Haven East is a small bedrock site located on the North Marloes Peninsula established as a survey site in 2021. Many of the colonies seem to grow flat across the rocks rather than in a dome, therefore there are high numbers of 1 and 2 size classes as only a few form the larger 3 and 4 size classes Angling line is regularly found wrapped around several colonies, a consequence of being located below a popular angling shore site. In 2021 88 colonies were recorded this increased to 105 in 2022, 119 in 2023 and 221 in 2024. In 2025 there were 183 colonies recorded (Figure 4.6.3).

North Neck, South Middleholm, West Hook represent sites with small survey sites and the total number of colonies (all classes) recorded in each survey year is shown in Figure 4.6.4.

Figure 4.6.4 Total number of *Pentapora foliacea* colonies (all classes) recorded each year surveyed at South Middleholm, West Hook and North Neck sites.



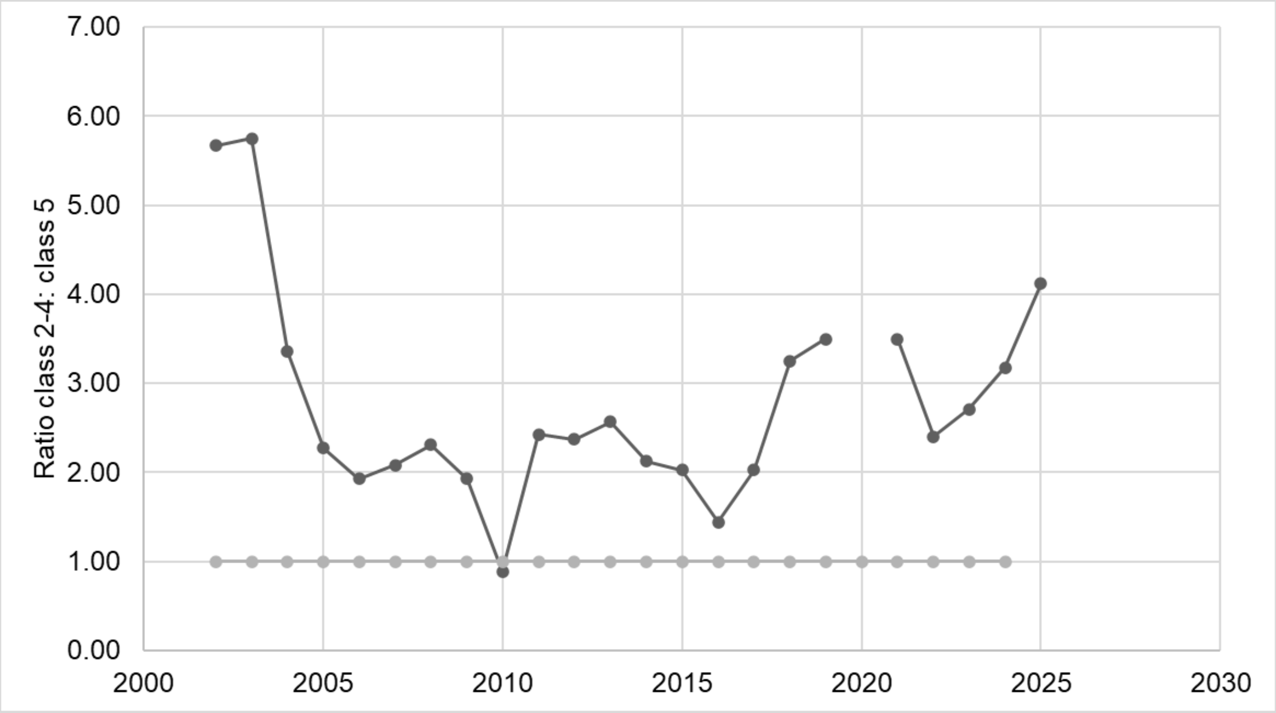
North Neck is unusual as colonies are growing on ground ropes laid upon a mixed sediment seabed. Movement of the ropes due to wave and current action restricts growth of most of the colonies to class 1 and 2. Some individuals grow to class 3 but there are no class 4 individuals. Generally low numbers are recorded (Figure 4.6.4). Only 1 small colony was recorded in 2025.

South Middleholm is a small bedrock site on the south side of the island and subjected to the prevailing south-westerly swell. Class 1 to 3 individuals are the most common, with very few developing into class 4, instead developing directly to class 5. The numbers have ranged between 3 to 46 colonies, only 6 colonies were recorded in 2024 (Figure 4.6.4) all were size classes 1 and 2. The site was not dived in 2025.

West Hook is a small bedrock site located on the North Marloes Peninsula, most colonies reach class 4 before developing into class 5. It was first established and surveyed in 2004. In 2025 72 colonies were recorded (Figure 4.6.4), of which 83% were the very small class 1 and 2 sizes..

The ratio between class 2-4 and class 5 colonies at all sites between 2002 and 2025 is shown in Figure 4.6.5. Class 2-4 colonies represent healthy growing colonies whilst class 5 represents those with natural or anthropogenic damage and deterioration. The results show that for most years the ratio is greater than 1 (shown as straight line in Figure 4.6.5), therefore there are more healthy growing colonies than degraded colonies.

Figure 4.6.5 *Pentapora foliacea* - ratio of class 2-4 colonies to class 5 colonies, all Skomer sites.



The current dataset forms an important baseline for Skomer sites. However, it needs to be remembered that all sites are currently subject to anthropogenic activities including pot fishing, angling and recreational diving, which all have the potential to harm *P. foliacea* colonies.

Field and photographic observations provide evidence that ropes linking fishing pots lay across the seabed and these, as well as the pots themselves, can damage *P. foliacea* colonies, especially when fished on steeply-inclined seabeds (Figure 4.6.6).

Figure 4.6.6 *Pentapora foliacea* – interaction with fishing gear.

Evidence of damage from angling line has also been observed. Line has been found tangled in *P. foliacea* at the new Martins Haven east survey site in each year it has been surveyed (2021-2025) as shown in Figure 4.6.7. This location is popular for shore angling.

Figure 4.6.7 *Pentapora foliacea* – interaction with angling line.

Human activities, where contact with the seabed may occur, such as pot fishing, angling, diving and anchoring, are recorded at Skomer MCZ. These data have been analysed in more detail for monitoring sites and are available in the Skomer MCZ Annual reports 2018 – 2025. [Natural Resources Wales / Marine and coastal evidence reports]

A study area that excludes all potentially impacting anthropogenic activities is needed to provide an understanding of a normal functioning ecosystem.

4.6.7. Current Status

- At the largest survey sites: Waybench, Pool and Bernies Rock, an increase in total numbers of colonies (all classes) were recorded in 2021. In 2025, numbers of colonies at Waybench and Bernies Rock still remain high when compared to previous years. Martins Haven east site first surveyed in 2021 has seen an increase in numbers of colonies each year to 2024 with a slight drop in 2025.
- In most years of recording there has been a higher number of intact and growing colonies (Classes 2-4) compared to “degraded” (Class 5) colonies.
- The question still remains as to whether this ratio is a “healthy” one, or whether a population not subjected to any anthropogenic activities would demonstrate different characteristics. Given that some potentially damaging anthropogenic activities are unrestricted and occur in the MCZ, we are unable to judge whether the population exhibits a “healthy” ratio of degraded to intact colonies, so the condition of this feature is judged to be “unknown”.

4.6.8. Recommendations

- Maintain long-term photographic datasets of individual colonies at a number of different sites to establish the longevity of the colonies and their response to damage.
- Apply the morphological classification system to identify community structure at a number of different sites.
- Establish a completely unimpacted study area. Until all potentially damaging anthropogenic impacts can be removed from the ecosystem, understanding of its normal functioning cannot begin.
- Continued research is needed on the biology of *P. foliacea*.
- Report the conservation status of *P. foliacea* feature as unknown.

4.7. Cup Coral Populations; *Balanophyllia regia* and *Caryophyllia smithii*

4.7.1. Project Rationale

Cup corals are slow growing filter feeders, which are susceptible to changes in water quality and planktonic food supply.

Balanophyllia regia is a Lusitanian species and Skomer MCZ is close to the northern edge of its range in the UK. It is only found at limited locations within the MCZ.

Caryophyllia smithii is a common species of the sub-littoral benthic community of south-western Britain and is found across the whole MCZ on hard substrates.

Both species are components of the Lusitanian anthozoan management feature of the Skomer MCZ.

4.7.2. Objectives

Monitor the population for changes in densities and to look for evidence of recruitment.

4.7.3. Sites

- *B. regia* 1984 to current: Thorn Rock and Wick
- *C. smithii* 1993 to current: Thorn Rock, Sandy sea fan gully, Waybench, West Hook, North Wall, Bernies Rock

4.7.4. Methods

Balanophyllia regia

1. Thorn Rock: The 'Rock Mill' with 5 quadrats and a single boulder quadrat was established in 1984 and since 2004 has been photographed with the digital SLR fixed to a 50cm x 40cm framer. In 2013, 2 new transects were set up with a combined 16 quadrats.
2. The Wick: Three transects with 51 quadrats were established at the Wick in 2002. A 50cm x 40cm framer was used up until 2008 when it was replaced with a larger 50cm x 70cm framer using a digital SLR camera.
3. Counts are carried out using image analysis techniques described in Burton *et al.* (2002).

Caryophyllia smithii

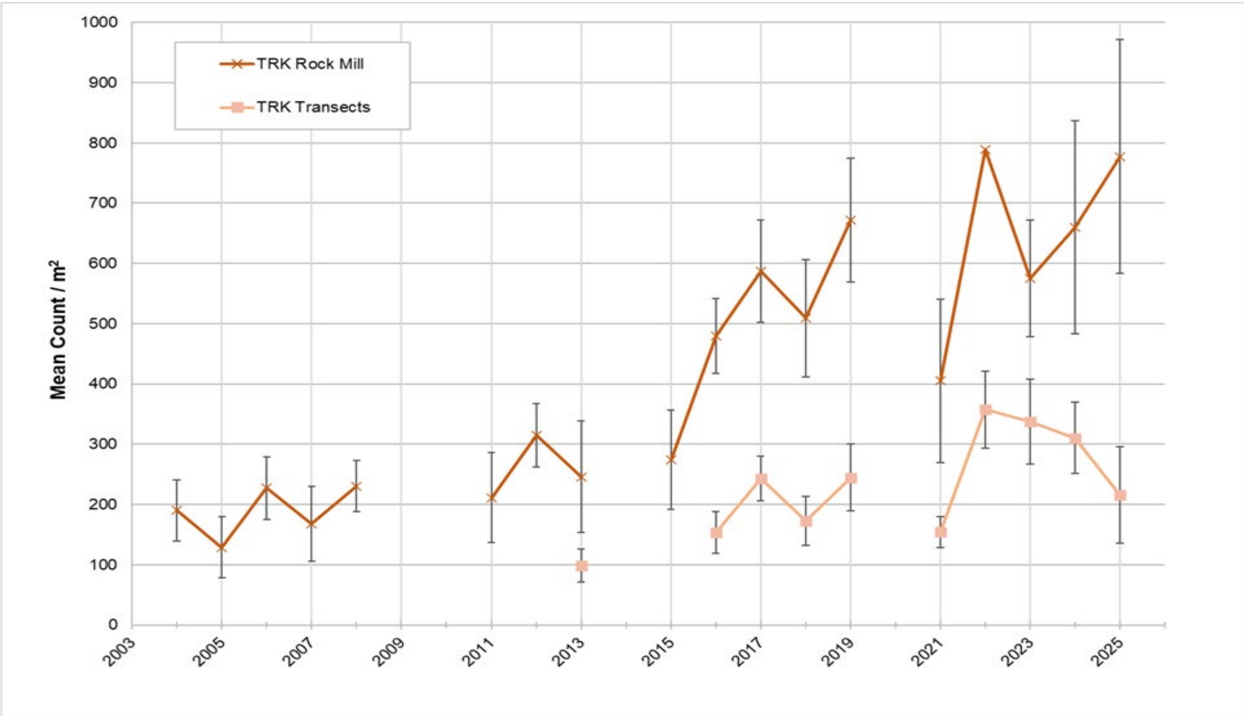
Approximately 70 quadrats have been analysed on an annual basis since 1993 from photographs taken for other projects. Photographs are taken using a 50cm x 70cm framer using a digital SLR camera and counts are carried out using image analysis techniques described in Burton *et al.* (2002).

4.7.5. Results

Balanophyllia regia

Thorn Rock Transects and Rock Mill quadrat data have been standardised to abundance per 1m^2 to enable comparison between the 50cm x 40cm and the 50cm x 70cm framers (Figure 4.7.1).

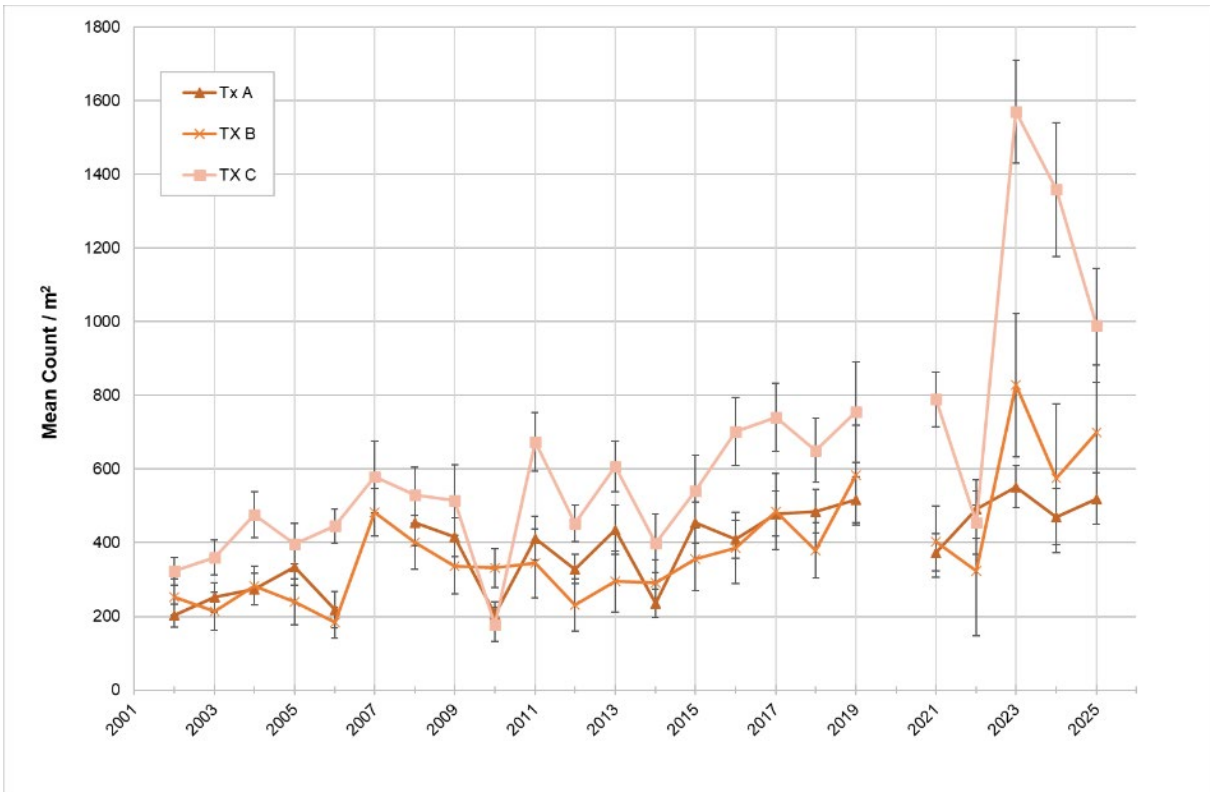
Figure 4.7.1 Mean abundance per m^2 (and standard error) of *Balanophyllia* regia at Rock Mill and Thorn Rock Transects (counted within 50cm x 40cm framers).



The average count/m^2 of *B. regia* has fluctuated at the Rock Mill, variability is most likely due to a combination of dense covering of algae obscuring the corals and thick coverings of silt at the site from time to time. Years with data missing are due to poor photographic conditions. An increase in numbers has been recorded over the last ten years with highest counts to date in 2022 when high photo quality was obtained with clear images of the corals, this dropped slightly in 2023 but increased again in 2025. The average count/m^2 of *B. regia* at the transects is lower than that at Rock Mill. Further data are needed to monitor trends.

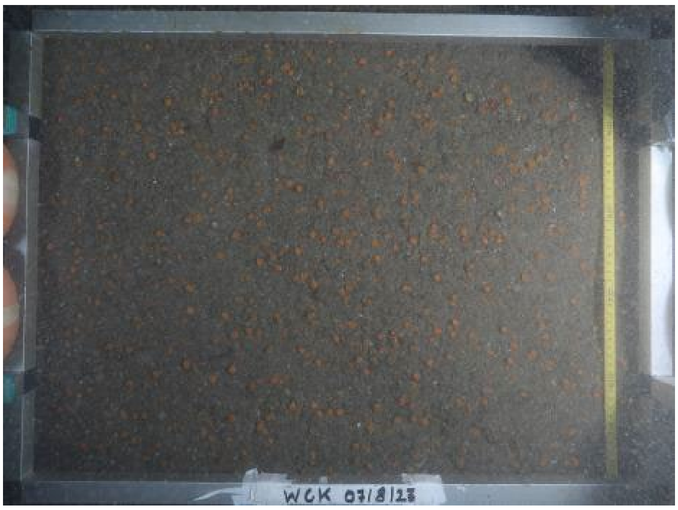
At the Wick, all data have been standardised to abundance per 1m^2 to enable comparison between the 50cm x 40cm and the 50cm x 70cm framers (Figure 4.7.2).

Figure 4.7.2 Mean abundance per m^2 (and standard error) of *Balanophyllia regia* at Transects A, B and C at The Wick, counted within 50cm x 40cm framers (pre-2008) and 50cm x 70cm framers (since 2008).



The average count/m^2 of *B. regia* has fluctuated at transects A, B and C at the Wick. The variability is most likely to be caused by the dense covering of silt that occurs across the site from time to time and occasional very poor photographic conditions (e.g. 2010). In 2023 there was very little silt and the cup corals were visible, even very tiny ones could be seen, which could explain why counts were their highest for each of the transects (Figure 4.7.2). In 2023 a record number of 921 individuals were counted in one 50cm x 70cm framer (2631/m^2) (Figure 4.7.3). Transect C continued to have high density counts in 2024 and 2025.

Figure 4.7.3 *Balanophyllia regia* (individuals 921) in a 50cm x 70cm framer at the Wick, representing a density of 2631/m^2.



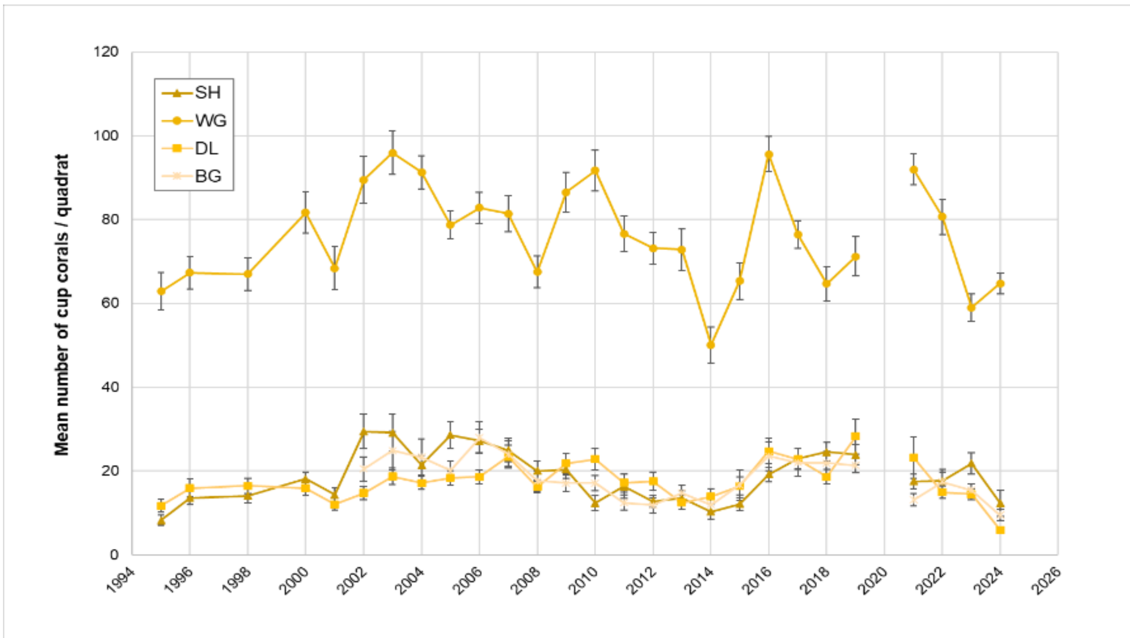
Caryophyllia smithii

The average density of *C. smithii* has fluctuated at each of the Thorn Rock sites as shown in Figure 4.7.4. for 1995 to 2024 data. Photos were taken in 2025 but analysis is still to be completed.

The average density fluctuations recorded between years may be due to variable levels of surface sediment affecting the actual numbers visible during recording. The Windy gully (WG) quadrats show significantly higher counts when compared to the other sites. This is most likely due to it being the only vertical wall site where less surface sediment accumulates. The other three sites are all on horizontal rock.

The abundance has fluctuated at Windy Gully (WG) but has been reasonably stable at the other three sites. It is not known how long these cup corals live (Biotic Database suggests a life span of 11-20 years [BIOTIC (marlin.ac.uk)](marlin.ac.uk)) nor what variability in their numbers would be natural.

Figure 4.7.4 Mean Number of *Caryophyllia smithii* /m^2 quadrat at Thorn Rock (4 transects) 1995 – 2024.



4.7.6. Current Status

- Variability in observed numbers of both *B. regia* and *C. smithii* is partly due to varying levels of surface sediment.
- The populations appear stable and in favourable condition.

4.7.7. Recommendations

- Records of surface sediment levels may help determine whether reduced abundance of cup corals is significant or due to recording inconsistencies.
- Support research work.
- Report the conservation status of *B. regia* and *C. smithii* feature as stable and in favourable condition.

4.8. Grey Seal (*Halichoerus grypus*) Population

4.8.1. Project Rationale

Grey seals are a protected species under the Conservation of Seals Act 1970. They live and breed in the Skomer MCZ as part of the west Wales population, which is the largest in South West Britain. Grey seals are listed under Annex II of the Habitats Regulations (2017) and are one of the features of the Pembrokeshire Marine SAC. Seals are also a management feature of the Skomer MCZ. This project supplies data for reporting on SAC, MCZ and Site of Special Scientific Interest feature condition (Dale and South Marloes coast SSSI, and Skomer Island and Middleholm SSSI).

4.8.2. Objectives

To monitor the number and survival rate of seal pups born in the MCZ as an indication of the state of the general seal population.

4.8.3. Sites

All pupping beaches and caves in the MCZ (Site descriptions in Skomer MCZ and Skomer Island seal management plan (Alexander 2015)).

4.8.4. Methods

The pups are recorded from birth through to their first moult using the “Smith 5-fold classification system” (Poole 1996b).

Reason for death is recorded where possible. Mortality will occur for different reasons including still-birth, abandonment, starvation, disease, insufficient growth, injury and severe weather. It is not always possible to know the reason for death so for analysis purposes it has been simplified into three groups:

Stillborn. These include both stillborn and those that died immediately after birth and were not seen alive.

Died. Pups seen alive but subsequently recorded dead.

Assumed mortality. These include pups assessed not to have survived following the survival assessment in Table 4.8.1.

Table 4.8.1 Seal pup survival assessment method

Class	Condition score	Size	Assessment	Pup survival outcome
I	1	Very small	Success not likely	assume not survived
II	2	Small but healthy	In good condition, reasonable chance of success	Subjective assume not survived or survived depending on circumstance.
III/IV/V	3	Good size	Most should be successful	Assumed or known to survive
III/IV/V	4	Very good size	All should be successful	known to survive
III/IV/V	5	Super moulter	All should be successful	known to survive

Additional behavioural observations are recorded for the Island seals (full method described in Skomer MCZ and Skomer Island seal management plan version 5 (Alexander 2015)).

Surveys of the Skomer Island sites are completed by Wildlife Trust South and West Wales Island staff and a full survey report is produced, whilst the mainland Marloes Peninsula sites are surveyed by MCZ staff. When possible results are combined to provide the full Skomer MCZ results.

4.8.5. Project History

Regular recording began at Skomer MCZ in 1974 at both mainland and island sites, but effort and methods varied. From 1992 onwards a standard protocol has been adopted to record the pupping success on both the island and the mainland each year, and the methods were documented in the Grey Seal Monitoring Handbook (Poole 1996b). In 2015 this was revised and updated (Alexander 2015).

2024 the Skomer Island seal survey work was not contracted due to cuts in NRW funding. Skomer Island staff reviewed the survey methods to test a scaled down methodology using cliff top views only (beach and cave access stopped). The survey was completed at the Marloes Peninsula sites as detailed in Alexander 2015 by MCZ staff.

2025 Alexander 2015 was reviewed and changes to survey methods at Skomer Island sites were agreed based on the 2024 trial and insurance restrictions stopping beach and cave access The methods were adapted to mirror the methods used on the mainland pupping beaches for pup production and pup survival and a subset of survey sites (11 of the original 16 sites) were identified to test using cliff top viewing recording only. Attendance at haul outs was monitored similarly to previous years. The survey work on the island was led by South and West Wales Wildlife Trust funded by Nature Networks.

Additional Seal Studies carried out at Skomer MCZ

2002 - Methods to study seal disturbance at mainland sites were tested and a further survey done in 2003 by placement students from Pembrokeshire College. A trial MCZ ‘seal watching’ leaflet was produced and distributed at the National Trust car park at Martins Haven. The leaflet included information on how to behave whilst watching seals. The 2003 survey included a questionnaire on the usefulness of the leaflet, which indicated that the leaflet was successful. A professionally produced version was published ready for the 2004 season and a full report on the seal disturbance study was completed (Lock 2004).

2004 - A project to identify individual seals at mainland sites was started by a placement student from Pembrokeshire College. This followed the methods set out in the ‘Grey Seal Monitoring Handbook’ (Poole 1996b.) and tested photographic and video methods.

2005 - Photographic methods were introduced to the adult seal identification project on Skomer (Matthews 2006). A Pembrokeshire college student, Liz Coutts, completed a study on the behaviour of bull seals at two island sites (Coutts 2006).

2007 - A project was completed by Dave Boyle studying the bull seals at all Skomer sites during September and October through funding secured by the Wildlife Trust of South and West Wales. The bulls were individually identified by their scars and markings. All bulls were sketched and photographed along with dates, location and dominance being recorded (Matthews & Boyle 2008).

2008 - 2019 - At Skomer island, sites photography included pupping cows, to help increase knowledge of site fidelity, longevity and pupping frequency. In 2011 - 2017 the work also expanded to some cows and bulls from mainland sites. (Matthews & Boyle 2008; Boyle 2009 – 2012; Buche & Stubbings 2013 - 2019).

2010 - 2015 - Collaboration work with Sue Sayer, Cornwall Seal Group, who has maintained extensive catalogues of seals photographed in Cornwall since 2000. In the ‘Skomer Seal Photo Identification Project Report 2007 – 2012’ photographs taken at Cornwall/Devon and at Skomer sites were compared and 36 seals were identified as having been at both areas. Most of these seals seemed to be spending the breeding season on Skomer, returning to Cornwall for the winter and spring, but disappearing during the summer, presumably going somewhere else to feed up before the next breeding season (Boyle 2011). Between 2007 and 2013 there were a total of 43 “matches” of individual seals in the Cornwall and Skomer MCZ datasets (Sayer *pers. comm*.).

NRW developed an EIRPHOT database called the Wales Seal ID database in collaboration with the Sea Mammal Research Unit. Head and neck profiles of individual seals were extracted from photographs and entered into the database, and “matching” was then carried out on these extracted images. In 2014, a NRW contract allowed all 2007 to 2014 Pembrokeshire photos to be entered, in addition to the North Wales seal ID datasets. 2015 to 2018 photos are stored ready for entry.

2014 - 2016 Collaboration work with Swansea University researchers Dr James Bull and Dr Luca Borger. Long-term Skomer MCZ pup production data from the Marloes Peninsula (1992-2014) has been used to look at temporal trends and phenology in grey seal pups (Bull *et al*. 2017a). The same team has also used statistical models to look at the long-term datasets (1985-2015) for the Skomer Island sites (Bull *et al*. 2017b).

2016 PhD student William Kay, co-supervised between Swansea University and NRW, began research on seal movements in the Irish Sea in relation to potential marine renewable energy projects. The research mapped the historical Pembrokeshire seal ringing/tagging data collected between the 1950s and the 1970s, including many seal pups from Skomer.

2016- 2017 Callan Lofthouse, a student at Swansea University, completed analyses on seal scat samples collected from Skomer sites in the 2015 and 2016 seasons (Lofthouse 2017).

2024 Elin Down, a student at Swansea University completed analysis on seal pup survival assessments for Marloes Peninsula data (Down – in preparation).

4.8.6. Results

Skomer Island

Skomer Island staff completed the survey at Skomer island sites using the modified methods in Alexander 2015 (version 5). An interim report has been produced and a final report planned.

In 2025 129 new born pups were recorded from the 11 selected sites monitored between 31/7/25 and 15/11/25. This number must be treated with caution as cannot be compared to Skomer island data prior to 2024 due to the change in survey method, and it cannot be combined with the mainland results to provide a total for the Skomer MCZ. Once the final report is available a review will be completed to finalize the options for future seal monitoring work on Skomer.

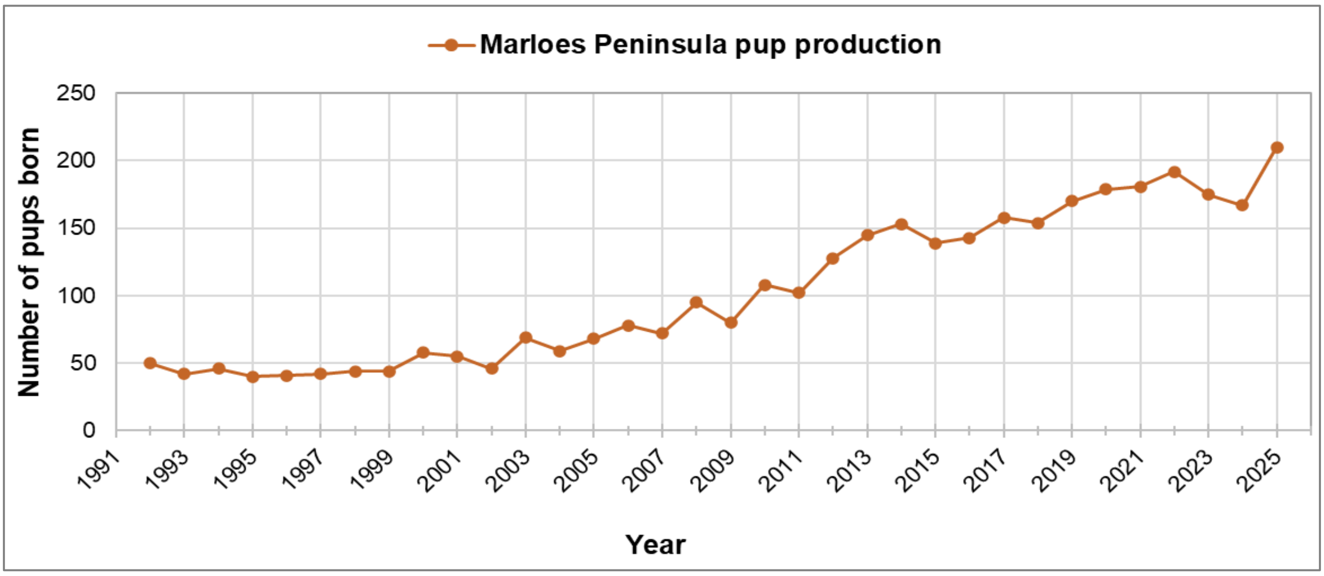
A total of 52 visits were made in 2025 to count seal haul outs within two hours either side of low water across 14 sites. The peak counts across all sites were 327 cows, 24 bulls and 39 immatures.

Marloes Peninsula

The Marloes Peninsula survey was completed at all sites by Skomer MCZ staff.

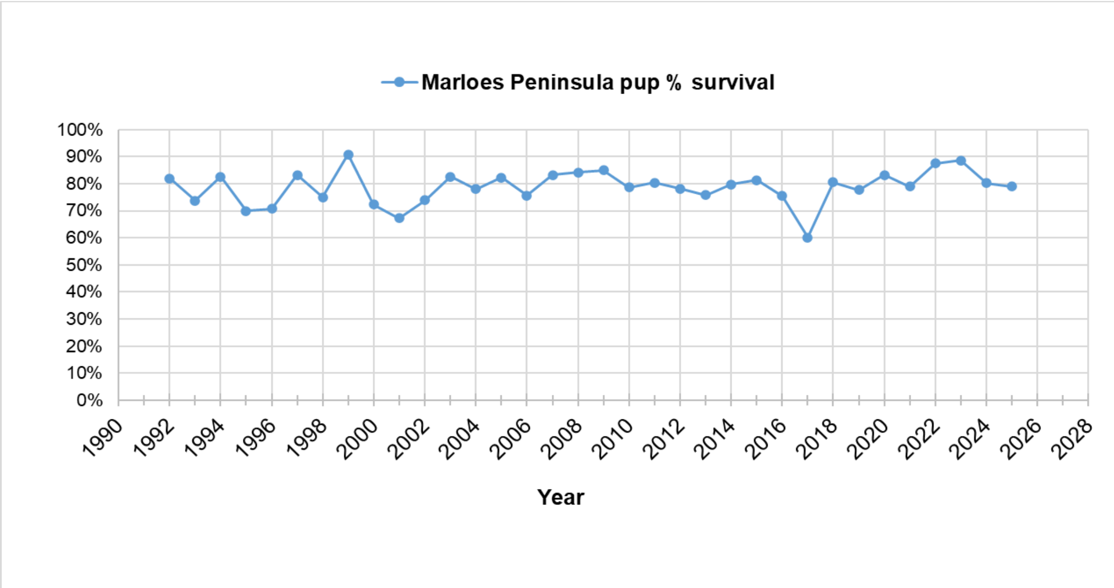
In 2025 210 pups were recorded at Marloes Peninsula sites, this is an increase from that recorded in the last 5 years. Since 2009 there has been a steady increase in pup production at Marloes Peninsula sites as shown in Figure 4.8.1.

Figure 4.8.1 Seal pup production Marloes Peninsula 1992 to 2025



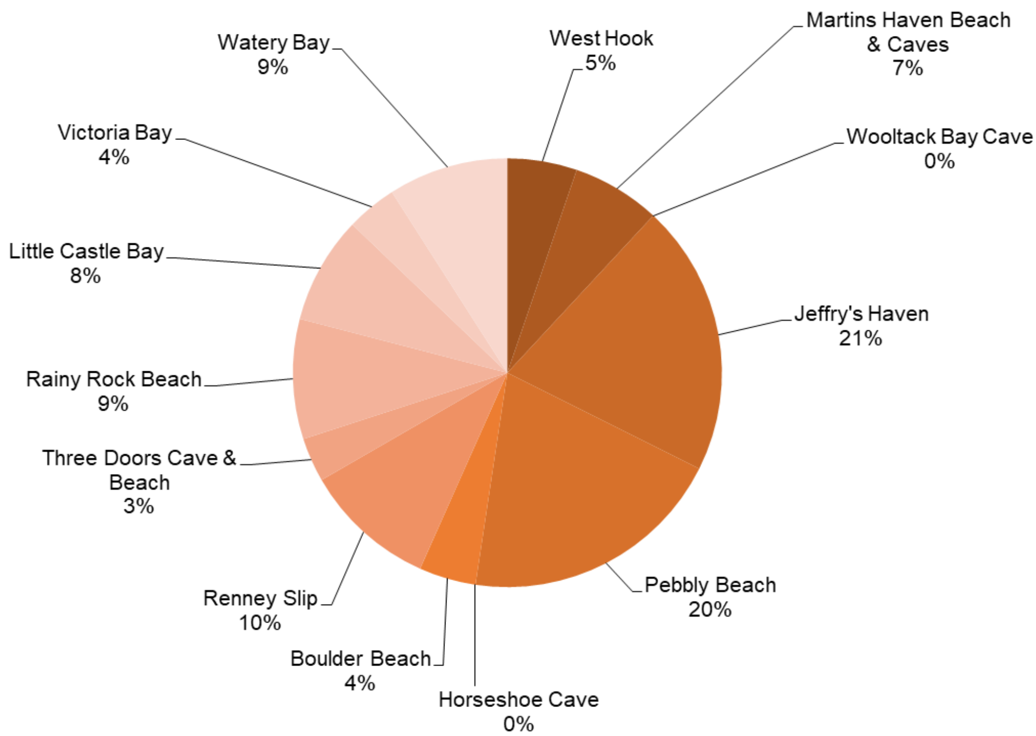
197 pups could be tracked from birth of these 79% were recorded to become a healthy class 3 pup or began moult so assume survived. The pup survival for Marloes Peninsula from 1992 to 2025 is shown in Figure 4.8.2.

Figure 4.8.2 Seal pup survival Marloes Peninsula 1992 to 2025.



The most productive sites were Pebbly beach (20%) and Jeffery's Haven (21%) as shown in Figure 4.8.3.

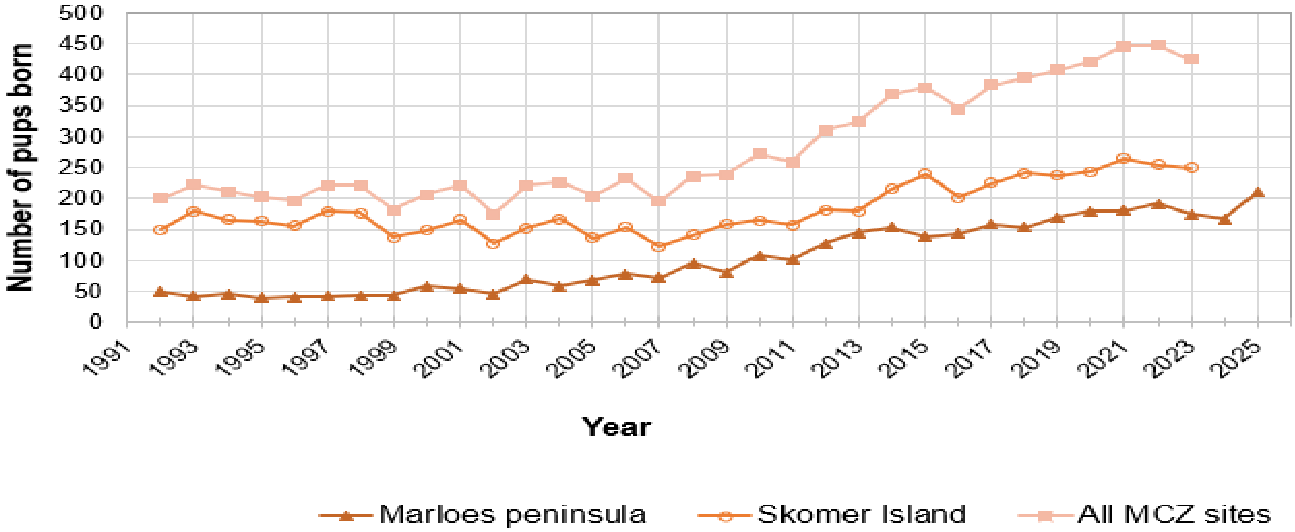
Figure 4.8.3 Seal pup production at Marloes Peninsula sites 2025.



Skomer MCZ whole site

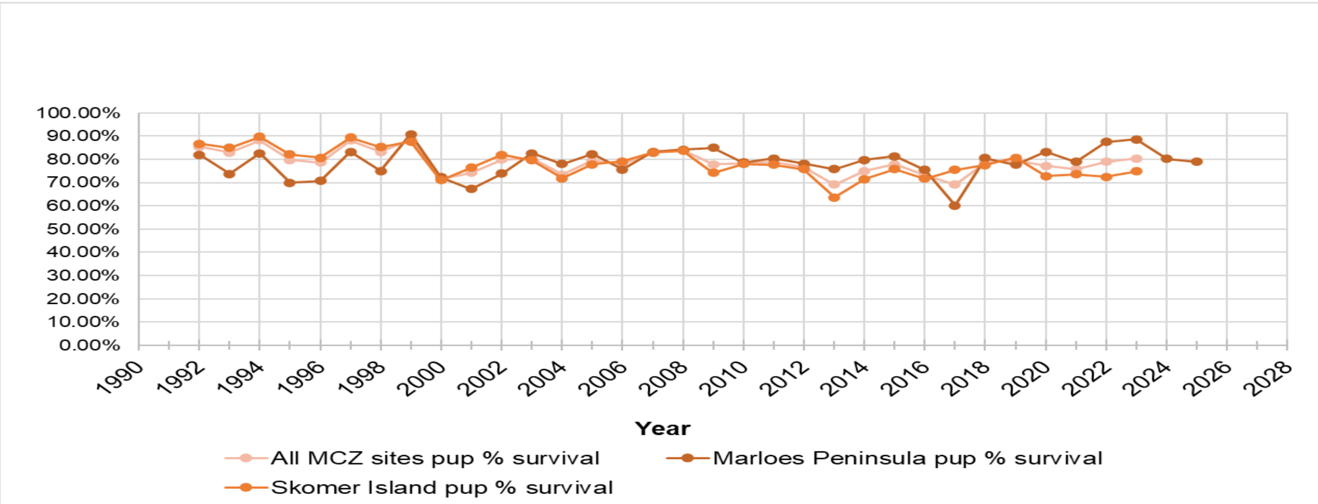
Marloes Peninsula and Skomer Island data were combined to provide whole Skomer MCZ data for the period 1992 to 2023 as consistent survey methods and effort where used. In 2024 and 2025 the same methods continued for the Marloes Peninsula so this data can be included in the graphs, but with changes in Skomer Island methods this data is omitted. This has produced a valuable long term data set on production and survival as shown in Figure 4.8.4 and 4.8.5. Only Marloes Peninsula data is included for 2024 and 2025. Since 2009 there has been a steady increase in pup production at Skomer MCZ

Figure 4.8.4 Skomer MCZ pup production 1992 – 2023 (Marloes Peninsula data included in 2024 & 2025)



In the Skomer MCZ, pup survival from 1992 to 2023 fluctuated between 69% and 88%, with an average of 79%, this is consistent with 79% recorded for Marloes Peninsula in 2025.

Figure 4.8.2 Skomer MCZ pup survival 1992 – 2023 (Marloes Peninsula data included in 2024 & 2025)



Pollution and Litter

Monofilament line and netting were the most visible pollutants affecting seals. Figures are not available for 2024 and 2025 but in 2023, 29 individual seals on Skomer were photographed with obvious signs of being entangled in nets at some time in their lives, most commonly a deep scar around their necks, often with netting still embedded.

No pollution by oil or tar was observed in 2025, however large quantities of beach rubbish including fishing ropes, netting, and bag loads of plastic debris are collected and cleared when possible from seal pupping beaches Skomer Island Wardens, the Skomer MCZ team and volunteers.

Seal disturbance

In 2025, two incidents were recorded of seals being flushed off Rye Rocks by boats coming too close.

4.8.7. Current Status

- In 2025 an assessment of the current status on pup production and survival for the whole Skomer MCZ is not possible. Changes in methods for Skomer sites means the numbers cannot be compared directly with data prior to 2024. Methods for whole site assessment are being reviewed.
- 210 pups were recorded at Marloes Peninsula sites, this is an increase from that recorded in the last 5 years. Pup survival was 79%.
- Grey seals at Skomer MCZ are considered to be in favourable condition based on survey results over the last 10 years.

4.8.8. Recommendations

- To use the combined Marloes peninsula and Skomer island seal survey results to report on the status of seals in the Skomer MCZ using criteria set out in the Skomer MCZ and Skomer Island NNR Seal Management Plan.
- To use the Skomer MCZ seal survey results to report on the status of seals in the Pembrokeshire Marine SAC.
- To continue recording seal disturbance at mainland and island sites.
- To continue to contribute seal ID photos to collaborative projects in South West Britain.
- Provide visitors with information about grey seals both in the visitor centre and through the distribution of the ‘seal watching’ leaflet to minimise disturbance to breeding seals.
- Report the conservation status of the grey seal species feature as stable and in favourable condition.

4.9. Cetacean Species Recording

4.9.1. Project Rationale

Cetaceans are regularly recorded in and adjacent to the MCZ.

Harbour porpoise *Phocoena phocoena* are most frequently recorded around the island from spring to autumn. However, as individual animals are currently unidentifiable, it is not possible to establish whether the MCZ waters are regularly used by a large number of peripatetic animals, or whether a smaller group remains in the immediate area and are seen more frequently. *P. phocoena* is an internationally protected species listed on: the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Berne Convention, the Habitats Regulations (2017) and under the Agreement on the Conservation of Small Cetaceans in the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS). In British waters they are legally protected under the Wildlife and Countryside Act 1981 and species of principal importance in Wales (Environment Act (Wales) 2016, Section 7). The proposed West Wales Marine SAC for harbour porpoise, which includes the waters of the MCZ, became a designated SAC in 2019.

Bottlenose dolphin *Tursiops truncatus*, Common dolphin *Delphinus delphis* (pictured above) and Risso's dolphin *Grampus griseus* are occasional visitors to the Skomer MCZ.

This project could potentially provide data for reporting on SAC as well as MCZ feature condition.

4.9.2. Objectives

To record numbers of cetaceans and their distribution within the Skomer MCZ.

4.9.3. Method

Recording effort varies annually but includes:

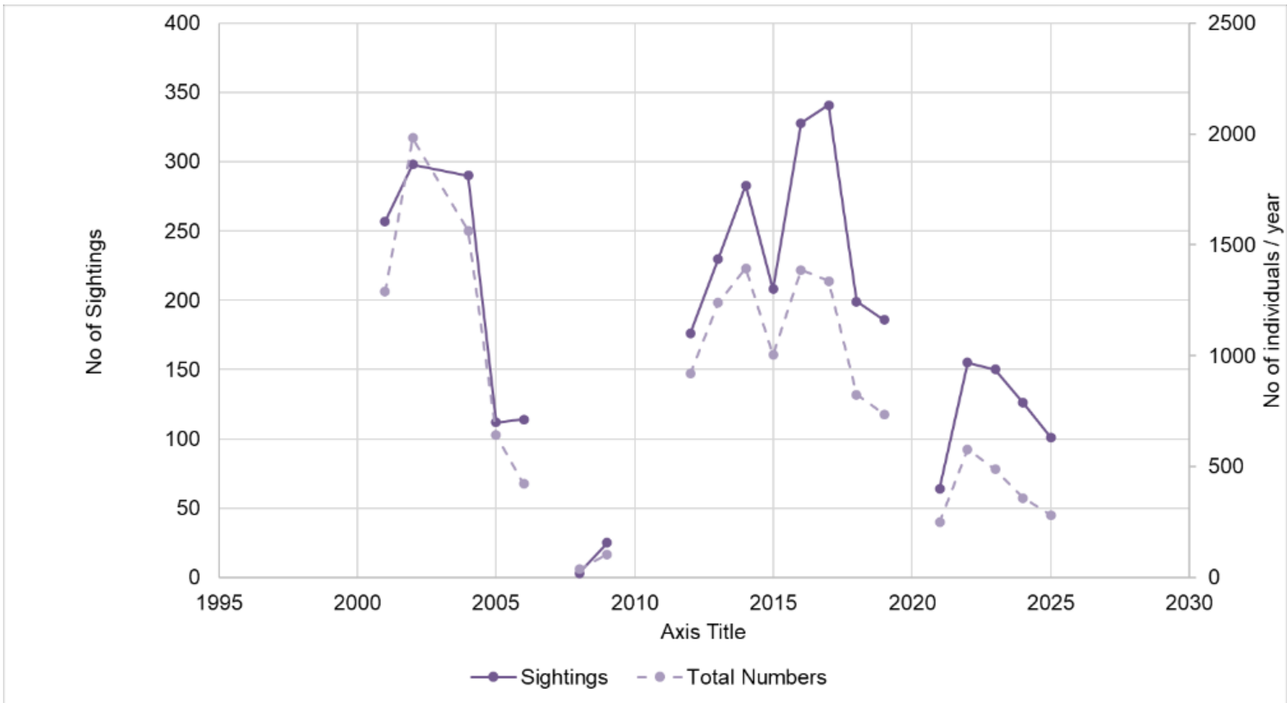
- Species, numbers of individuals, sites, date and time are recorded for each sighting.
- Skomer Island NNR staff and volunteers using binoculars and telescopes from cliff locations around the island.
- Dale Sailing crews maintaining records of sightings during the ferry run between Martins Haven and North Haven and on the round island trips.
- MCZ staff recording all sightings whilst at sea.

4.9.4. Results

All sightings of cetaceans have been collated for the period between 2001 and 2025. There are no records in years 2003, 2007, 2010, 2011 and in 2020 (Figure 4.9.1). The effort is variable not just between years but also during the season which makes the data difficult to effort correct. Very few records were received from the Dale Sailing crew in 2017 or 2018, records were received in 2019 but none for 2020 - 2022. Records have been received for 2024. As several cetaceans are frequently seen together during the same sighting, total numbers of cetaceans reported are higher than total sightings reported.

In 2016, a standard set of site names and recording system was applied to all data collected by Skomer MCZ and Skomer NNR staff and volunteers (Wildlife Trust of South & West Wales).

Figure 4.9.1 Harbour porpoise sightings Skomer MCZ 2001 – 2025. No recording occurred in 2010, 2011 and 2020.

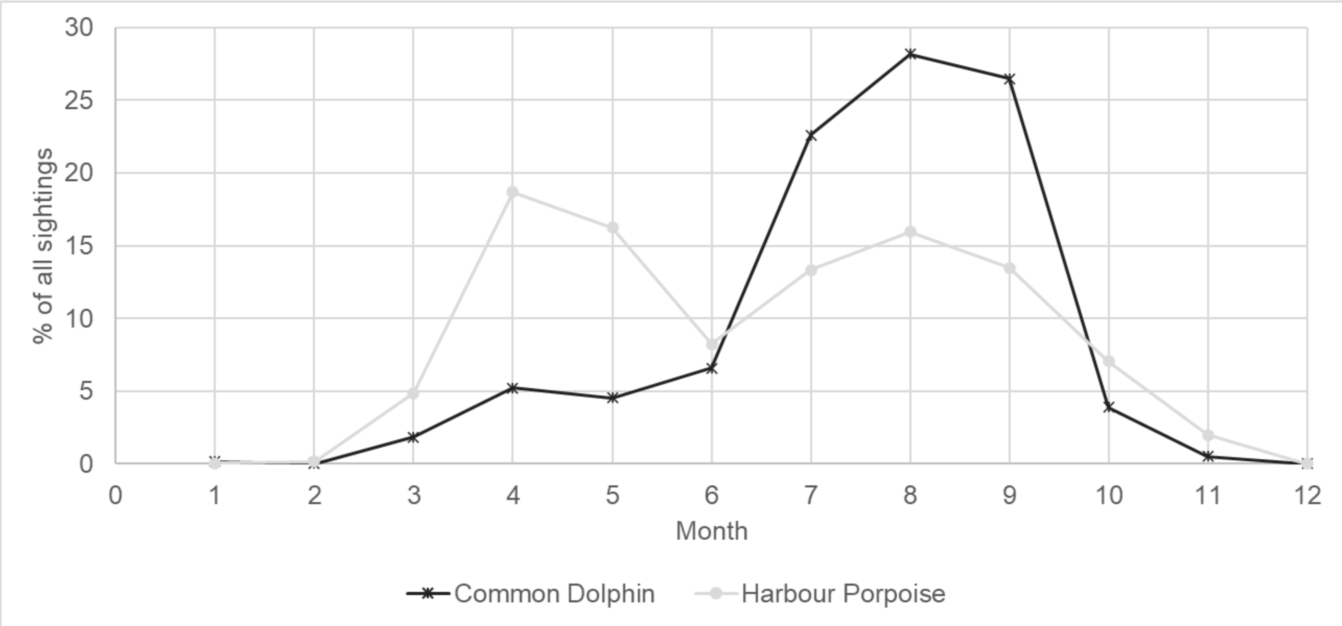


A “sighting” refers to a single event when one or more cetacean is recorded from a specific location. “Total numbers” is the sum of all the counts of a specific cetacean species for the whole year.

These data are not effort corrected and there was a more concerted effort to collate all the records in a consistent way from 2016 onwards. In 2020 there were no records collected and in 2021 the amount of recording effort was reduced especially from Skomer NNR due to lower numbers of researchers and volunteers.

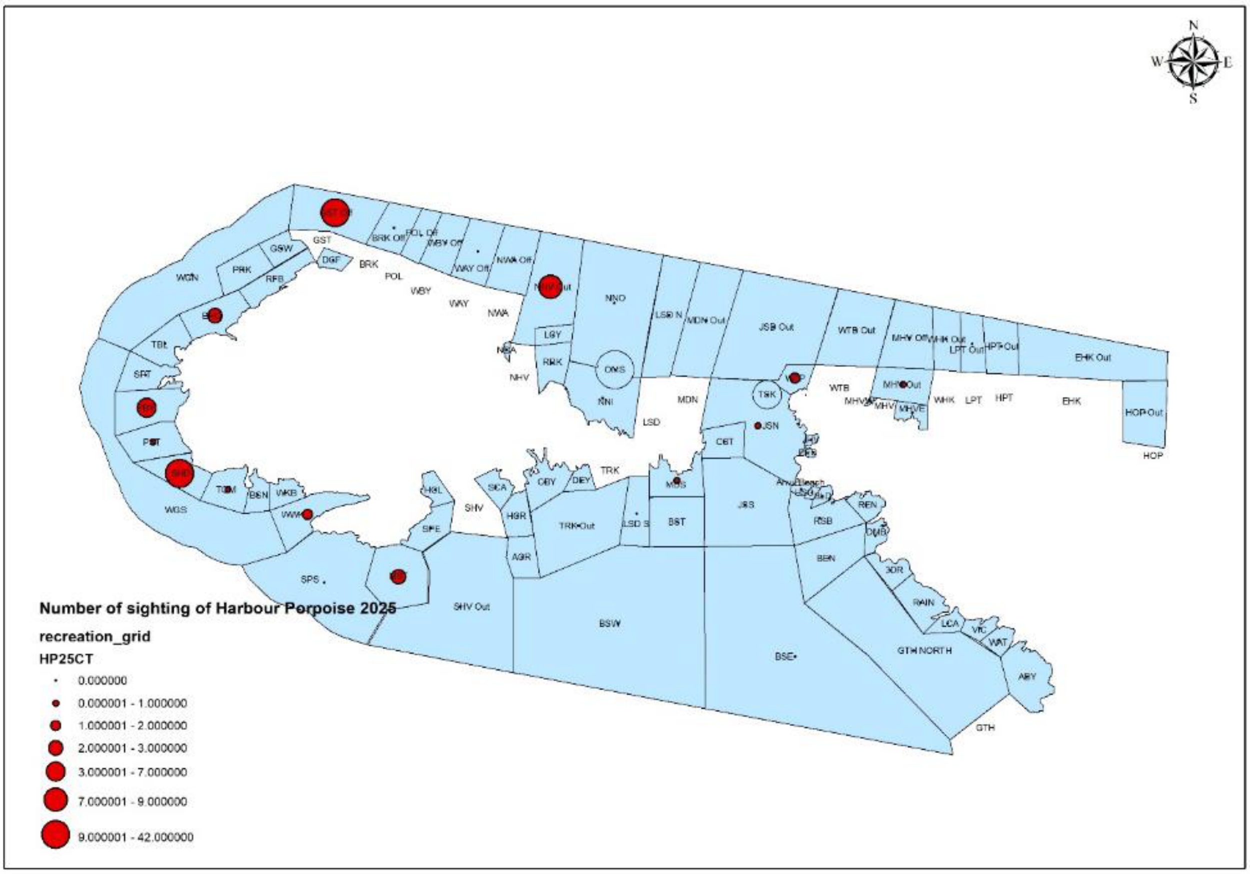
Harbour porpoise are sighted throughout the whole year and are assumed to be resident or regular users within the MCZ. Common Dolphins are predominantly seen from July to September as shown in Figure 4.9.2.

Figure 2.2 Percentage of sightings per month 2001 to 2025 Harbour porpoise and Common dolphin.



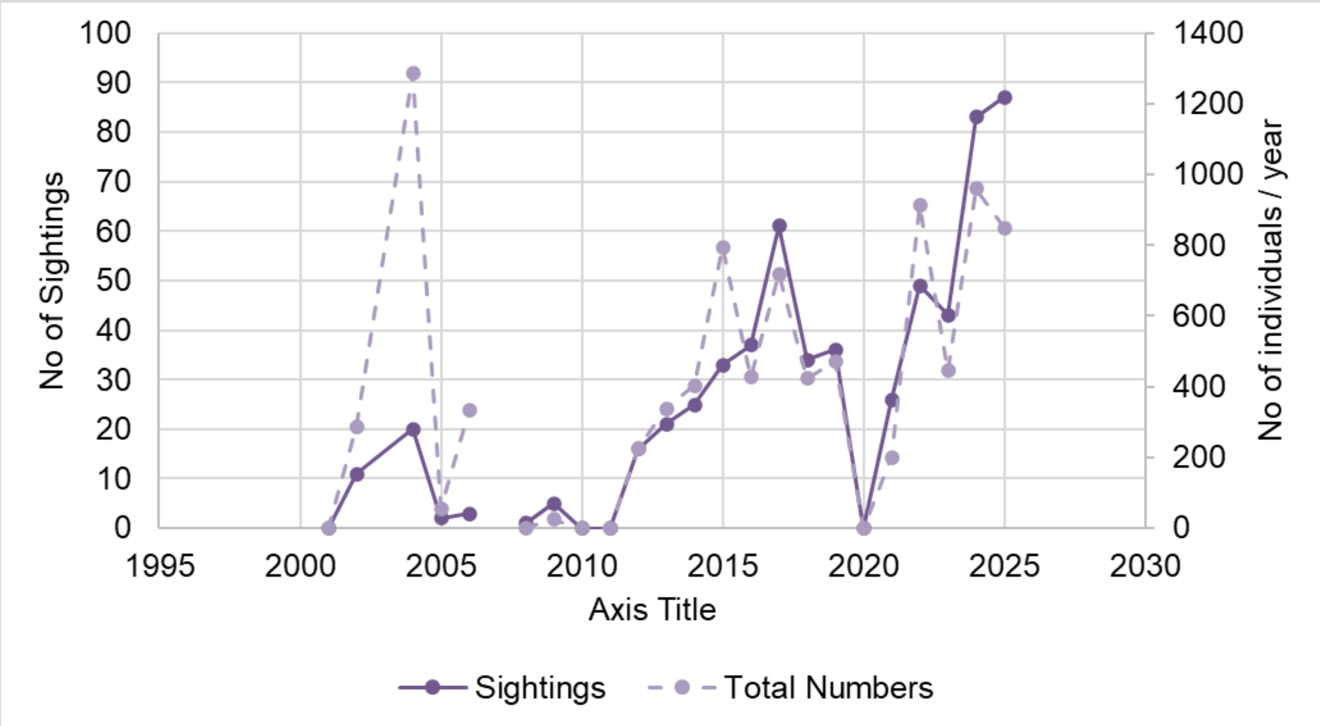
There are hot spots of sightings around the MCZ. The tidal races off the Garland Stone and Skomer Head are popular spots to see Harbour Porpoise (see Figure 4.9.3).

Figure 4.9.3 Harbour porpoise sightings and distribution Skomer MCZ 2025.



These data are not effort-corrected but are useful in showing areas that harbour porpoise frequent. All vagrant and mobile species records are now recorded using this site code format. Common dolphin use the area infrequently but can appear in large numbers. There were no observations in 2010 and 2011 but since then their numbers seem to be increasing (Figure 4.9.4). These data are not effort corrected but as Common dolphin sightings are more unusual, they tend to get recorded when observed. There were more sightings in 2016 but no big pods were seen. In 2019, there was a similar number of sightings compared with 2018. 2021 had very few sightings but from 2022 onwards the number of sightings and total numbers seen have increased.

Figure 4.9.4 Common dolphin sightings within Skomer MCZ 2001 to 2025.



Bottlenose dolphins *Tursiops truncatus* are not often seen within the MCZ, in 2019 there were 2 sightings of individuals off the Garland stone and 5 individuals were seen in 2022, 2 individuals were sighted off the Garland Stone in 2024. There were no sightings in 2025.

Risso's dolphin *Grampus griseus* are regularly seen around Ramsey Island, 8 miles to the north but there are only infrequent sightings within the MCZ. They are rarely seen off Skomer but in 2025 there were 8 sightings and 28 individuals recorded. The first group was on the 11th July, a group of 6 including 3 calves outside of South Haven, an additional 3 groups of 4 individuals were spotted in July and a group of 3 off the Wick in August. The last sighting was a group of 3 off the Garland Stone on the 5th September.

A single sighting of a Minke Whale was recorded off Skomer Head in 2024 but there were no further records in 2025.

4.9.5. Current status

Cetaceans continue to be recorded in apparently increasing numbers within Skomer MCZ, although it is unclear whether the increase is an artefact of the lack of consistency of recording in previous years.

Insufficient data are available to report on the cetacean feature in the Skomer MCZ so its status is judged to be 'unknown'.

4.9.6. Recommendations

- A standardised method of recording needs to be developed and used by all recorders. This standard method needs to include an estimate of days / time spent recording as well as the sightings data.
- Encourage and support Skomer Island NNR staff and Dale Sailing crews to record sightings.
- Encourage and support volunteers based at the Deer Park coastguard hut to start record sightings.
- Support cetacean research, for example deploy acoustic loggers.
- Report the conservation status of the cetacean feature as unknown.

4.10. Algal Communities

4.10.1. Project Rationale

The Skomer MCZ has a wide range of habitats, including excellent examples of algal communities on bedrock, boulders and cobbles. Skomer MCZ's algal communities have been identified as being rich and diverse with 241 species of red, green and brown algae recorded. This represents 34% of the British marine flora and 21% of North Atlantic marine flora including: two nationally scarce species; five near their limit of distribution; four species with specialised habitat preferences and five deep water algal species. Rare or threatened species include: *Atractophora hypnoides, Sphacelaria mirabilis, Hydrolithon cruciatum* and *Hinksia ovata* (Burton *et al* 2008). Skomer MCZ has been identified as a Criteria B European IPA (important plant area) for marine algae.

Kelp habitats dominate the infralittoral zone on bedrock and boulder reefs found along most of the Skomer MCZ coast. Kelp species recorded in Skomer MCZ include oar weed *Laminaria digitata*, forest kelp *Laminaria hyperborea*, dabberlocks *Alaria esculenta*, furbelows *Saccorhiza polyschides* and sugar kelp *Saccharina latissima*. The relative abundance of kelp species is influenced by a range of abiotic (eg. temperature, latitude, wave exposure, light levels, disturbance) and biotic (eg. competition, grazing) factors.

Kelp habitats are important for other species, kelp alter light, nutrients, sediments, physical scour and water flow conditions for proximal organisms while providing structural habitat for a wide range of flora and fauna. Species richness on sublittoral rocky reefs around the UK generally increases with increasing relative abundances of all the major canopy forming kelp species (Burrows et al, 2014).

4.10.2. Objectives

- To monitor kelp species density and associated algae species at sites representing a range of wave and tidal current exposures.
- To monitor kelp habitat associated fish, echinoderm and crustacean communities.
- To collect visual records of kelp habitat condition.
- To collect algae species records from a range of sites within the Skomer MCZ.

4.10.3. Sites

- Skomer Head
- Mewstone
- North Wall
- Wick
- Martins Haven west
- High Point

- Junko’s Rock

(Pre-2007 pebble sites: Martins Haven, Wick Basin, Garland Stone)

4.10.4. Project history

In 1983, detailed surveys of macro-algal populations at a number of sites were conducted (Hiscock, S 1983). In 1984, monitoring of sub-littoral seaweeds at two sites on the north coast of Skomer was established for a 2-year project (Hiscock, S 1986).

In 1998, Brodie and Watson were contracted to provide advice on the development of conservation objectives for algal species and community monitoring. In 1999, a survey was carried out at seven sites based on their recommendations and a Skomer MCZ algae herbarium was produced (Brodie & Bunker 2000).

In 2006, Bunker & Luddington completed a review of algal monitoring methods used at Welsh sites including Skomer MCZ. The study investigated whether species lists derived from previous studies can show change and are suitable for monitoring purposes. Presence/absence data for algal species at Skomer and other Welsh sites showed variation with depth zone, season and sampling method.

In 2007, Maggs, Johnson and Bunker were contracted to develop methods of quantitative algae species monitoring building on the previous studies and recommendations. A survey was completed where species lists were derived from timed searches at selected depths and kelp density counts were completed at selected sites.

In 2024, proposed dive survey methods in Burrows et al 2014 were reviewed and methods were developed for testing by both the Skomer MCZ dive team and volunteer dive teams.
The use of Remote Underwater Video System (RUVS) was also explored to capture visual records of algae community condition. Francis Bunker provided lists of algae species from a range of sites.

4.10.5. Methods

In 2024 a kelp habitat survey method was developed. The survey is completed in two zones, the kelp forest zone and kelp park zone and are defined by the density cover of kelp plants. In the Skomer MCZ the kelp park is found deeper than the kelp forest, the depths of these zones vary at each site.

- Kelp park zone, lower infralittoral, kelp plants < 5 % cover
- Kelp forest zone, upper infralittoral, kelp plants > 20% cover

Kelp Habitat density and algae species recording

At each site the maximum depth at which kelp is found is recorded along with the kelp species present. The survey is completed in the kelp park first followed by in the kelp forest zone.

A 10m weighted rope marked every metre with fluorescent cable ties is laid along a depth contour. Recording is completed in 1m^2 ‘quadrats’ using a 1m pole positioned with its centre perpendicular to the rope and moved between the rope markers. Record:

1. Number of adult kelp plants (=/> 50cm height), total for each species.
2. Number of juvenile kelp plants (< 50cm height), total for each species.
3. Numbers of crustacean, echinoderm and fish, total for each species.
4. Percentage cover of foliose algae and encrusting algae.
5. List of dominant red and brown algae species.

Fish, echinoderms and crustaceans in kelp habitats

The method has been designed for use with volunteer divers and follows the methods used for territorial fish population survey (Lock 2006) and for the echinoderm populations survey (Lock 2007). It is completed in the 2 depth zones as for the kelp habitat.

At each site, the maximum depth kelp is found and the kelp species present are recorded. The transects are then completed as follows:

1. Dive pair secure weight attached to a 30m tape and start laying the tape on depth contour. The first 5m are used to obtain control in orientation and buoyancy, fish counts start from the 5m mark onwards in a 2m corridor, 1m either side of the tape. Within the 2m corridor record the number of each fish species. Diver pair maintain a swimming speed of 3m per minute.

2. On completion rewind the tape slowly and record numbers of each crustacean and echinoderm species found.

Algae communities condition – visual records

A Remote Underwater Video System (RUVS) is used to record the condition of the kelp and algae habitat and the presence of mobile species and to obtain a visual condition assessment of the algae community at a selection of sites. The RUVS system comprises a GoPro11 in an underwater housing mounted in a modified lobster pot frame; a length of rope and a marker buoy (Figure 4.10.1).

Figure 4.10.1. Skomer MCZ's Remote Underwater Video System (RUVS).

4.10.6. Results

The diving survey was completed at 4 sites: North Wall, Junko's reef, Martins Haven West and High Point. The sites were limited to the shelter of the north coasts of Marloes Peninsula and Skomer island as the sea conditions were too challenging on the more exposed South and West coasts during the survey period. The results are provided for each site. In addition to recording conspicuous algae species as part of the kelp density transects the survey also benefited from general algae species recording by algae identification specialist Francis Bunker. The full results are available in Lock, K, Burton M, Massey, A & Jones, J. (2026) Skomer Marine Conservation Zone, Kelp Habitat Survey 2024. NRW Evidence Report 955.

Junko's reef, Wooltack Bay. A rocky reef semi-exposed to wave action from the north and moderate tidal currents. The reef juts out from the coast within Wooltack bay, the top of the reef is a flat plateau around 30m across at 5-6m below chart datum (bcd). Steep vertical faces are found on the north-west, north and north-east sides down to 20m bcd, and shallower boulder slopes on the south-west, south and south-east sides of the reef. The deepest kelp plant was recorded at 10.5m bcd. *Saccorhiza polyschides* was the dominant kelp species along with small patches of *Laminaria hyperborea* and healthy numbers of juvenile kelp plants*. Saccharina latissimia* was occasionally recorded.

Martins Haven West. A bedrock reef interspersed with boulders located due west of Martins Haven bay, semi-exposed to wave action from the north and moderate tidal currents. The deepest kelp plant was recorded at 14.8m bcd. *L. hyperborea* was the main kelp species with occasional *S. polyschides* and high number of juvenile kelp plants.

High Point. A bedrock reef sloping around 45 degrees leading down to extensive gentle sloped boulder area. The site is semi-exposed to wave action from the North and moderate tidal currents. The deepest kelp plant was recorded at 13.1m bcd. The kelp was a mix of both *L. hyperborea* and *S. polycshides* along with juvenile kelp plants*. Saccharina latissimia* was occasionally recorded.

North Wall A bedrock reef and boulders semi-exposed to wave action from the north and moderate tidal currents. There are steep vertical faces broken up by rock ridges, ledges and boulder slopes. The deepest kelp plant was recorded at 9.5m bcd. The kelp was composed of both *S. polyschides* and *L. hyperborea* along with high numbers of juvenile kelp plants.

The density counts of kelp plants and percentage cover of foliose red and brown algae for each site in the kelp forest are shown in Table 4.10.1 and for the kelp park in Table 4.10.2.

Table 4.10.1 Density of adult and juvenile kelp plants and percentage cover of foliose in kelp forest zone at each site.

Kelp Forest	***Saccorhiza polyschides*** **Number/m^2**	***Laminaria hyperborea*** **Number/m^2**	**Juvenile kelp(<50cm length) Number/m^2**	**Foliose red and brown algae % cover/m^2**
Junkos reef	4.6.	0.8	3.4	23.5
Martins Haven	0.3	4.6	6.3	61.5
High point	2.6	3.8	3.7	67.5
North wall	3.4	2.6	9.4	54.5

Table 4.10.2 Density of adult and juvenile kelp plants and percentage cover of foliose algae per 1m^2 in kelp park zone at each site.

Kelp Park	***Saccorhiza polyschides*** **Number/m^2**	***Laminaria hyperborea*** **Number/m^2**	**Juvenile kelp(<50cm length) Number/m^2**	**Foliose red and brown algae % cover/m^2**
Junkos reef	1.1	0.8	1.7	48
Martins Haven	1.0	2.6	2.0	77.5
High point	0.3	1.2	2.1	77.5
North wall	1.9	0.5	1.7	62.5

Animal counts per 100m^2 for each site in the kelp forest is shown in Table 4.10.3 and for the kelp park in Table 4.10.4.

Table 4.10.3 Animal counts per 100m^2 for each site in the kelp forest.

Kelp forest	**Junko's Reef** **Number/**100**m^2**	**Martins Haven west** **Number/**100**m^2**	**High Point** **Number/**100**m^2**	**North Wall** **Number/**100**m^2**
Labrus bergylta	2.6	4	6	6
Crenilabrus melops	0.6	1	2	0
Ctenolabrus exoletus	0.6	1	5	0
Labrus mixtus	1.5	0	0	0
Parablennius gattorugine	0	0	1	0
Necora puber	0	4	1	3
Maja squimado	4	2	3	8
Echinus esculentus	9.3	5	8	0

Table 4.10.4 Animal counts per 100m^2 for each site in the kelp park

Kelp Park	**Junko's Reef** **Number/100m^2**	**Martins Haven west** **Number/100m^2**	**High Point** **Number/100m^2**	**North Wall** **Number/100m^2**
Labrus bergylta	3	3	8	2
Crenilabrus melops	1	1	0	0
Ctenolabrus rupestris	*2.5*	0	*2.5*	0
Ctenolabrus exoletus	0.6	1	4	2
Thorogobius ephippiatus	0	1	1	0
Taurulus bubalis	0	1	1	0
Parablennius gattorugine	0	0	1	0
Necora puber	0	0	4	0
Maja squimado	1	1	8	8
Echinus esculentus	4.5	3	3	3
Marthasterias glacialis	12	0	0	2

Visual records using RUVS were completed at 3 sites. The RUVS was a good method in gaining a visual condition of the algae communities at a selection of sites that can be stored as a permanent record. A benefit of the method is that deployments can be combined with routine monitoring activities thus requiring minimal additional time and effort.

The method however has limitations. It only provides a visual record at the location that it lands on the seabed, and it is not possible to target the kelp forest and kelp zones. It was also not effective in recording presence of mobile animal species.

These limitations could be overcome if in addition video records can be done by divers completing a 30m 'swim through' the kelp park and kelp forest zones at each site with a video camera. This would however require an additional dive at each site.

4.10.7. Current status

Healthy kelp habitats are present at the survey sites supporting algae and animal communities. Further surveys are needed to allow a status assessment to be completed.

4.10.8. Recommendations

- To continue recording algae species
- To continue recording kelp densities and algae species in kelp habitats at selected sites and repeat every 4 years.
- To use volunteer dive teams to record densities of fish, echinoderm and crustacean communities in kelp habitats.
- To use RUVS and diver video swim throughs to provide visual records of kelp habitat.
- To expand the 2024 survey to further sites with a range of wave and current exposures, including sites located on the south and west sides of Skomer Island.

4.11 General Species Recording

This section also includes: "vagrant and alien species recording" and "record commercial crustacean populations" projects.

4.11.1. Project Rationale

There are many species in the Skomer MCZ that do not have a dedicated monitoring project. However, it is important that species lists are maintained, particularly for phyla that are under-recorded or of particular conservation importance. Recording of species of principal importance as defined under Section 7 of the Environment Act (Wales) 2016 and 'Alien' invasive (INNS) and non-native species (NNS) are just two examples.

General recording of unusual, rare, scarce or vagrant species is also maintained.

Records are entered into the JNCC-administered Marine Recorder database for access via the National Biodiversity Network on-line gateway NBN Atlas - UK's largest collection of biodiversity information.

4.11.2. Crawfish

Crawfish *Palinurus elephas* (Figure 4.11.1) is an Environment (Wales) Act 2016, Section 7 species of principal importance. From 2009 to 2024 it was recorded in low numbers in Skomer MCZ by staff and volunteers. These records have been submitted to the i-Record online recording scheme Crawfish survey | iRecord in an effort to gain better knowledge of the current status of this species in the UK.

Figure 4.11.1 Crawfish, *Palinurus elephas*.

4.12.3. Sunfish

Sunfish (*Mola mola*) are the largest bony fish in the world (Figure 4.11.2); they are an ocean vagrant that can be found in both tropical and temperate waters. They feed mainly on jellyfish so are found often when there are jellyfish blooms around the coast. Sunfish are often recorded in the Skomer MCZ in low numbers from July to September when seawater temperatures are around 15^{o}C or warmer. Sunfish records are from both MCZ staff and from the crew of the Dale

Princess and Dale Queen. Although they can grow up to 1000kg, those recorded are usually relatively small individuals. In some years several individuals have been spotted whilst in other years there have been no records. In 2025 there were 3 records in August.

Figure 4.11.2 Sunfish, *Mola mola.*

4.11.4. Non-native species

In 2025, searches for non-native species were completed at each of the shores during the MarClim surveys:

Wakame *Undaria pinnatifida*, was found attached to boulders for the first time on Skomer and Skokholm shores during the 2018 MarClim surveys. This is a non-native kelp species from Japan and China, but in recent years it has spread around the world via mariculture and shipping vectors. It first arrived in the UK in England in 1994, in the Solent and has since spread around the UK. It has not been recorded in the Skomer MCZ since 2018.

Wire weed *Sargassum muticum* (Figure 4.11.3) was first found at Martins Haven attached to a cobble in 2008 and it has been recorded again on 7 annual surveys over the last 14 years including in 2025. On each occasion it has just been a small number of individuals.   In 2024 it was also found during the volunteer diving kelp communities survey on the east side of South Haven in 2.2m depth below chart datum. In 2025 the South Haven site was dived to assess the extent of the *S. muticum*, an extensive area was found in the shallow areas with plants up to 2m length.

Figure 4.11.3 Wire weed *Sargassum muticum* in South Haven

4.11.5 Unusual records

Slipper lobster *Scyllarus arctus*, are found throughout the Mediterranean Sea, and in eastern parts of the Atlantic Ocean, it is rare to find it north of the Bay of Biscay but there have been a small number of records from Cornwall and the Isles of Scilly.

On 19th May 2025 Neptune's Army of Rubbish Collectors (NARC) found one attached to a lost pot that they had removed from the seabed off Martins Haven. This is the fourth known record of this species in Wales, the 3 previous records were from a fisherman in 2019, one off Skomer Island and two at Hand Marks in St Brides Bay.

This record is also notable as the slipper lobster found was carrying eggs.

Figure 4.11.4 Slipper lobster *Scyllarus arctus, Martins Haven (*photo credit Lloyd Rees-Jones)

4.11.5. Recommendations

- Continue recording phyla that are under-recorded in particular species of principal importance as defined under Section 7 of the Environment (Wales) Act 2016 and 'Alien' invasive (INNS) and non-native species (NNS).
- Continue recording of unusual, rare, scarce or vagrant species.
- Records are entered Marine Recorder Online database.

4.12. Plankton Recording

4.12.1 Project Rationale

Whilst plankton is not identified as a management feature for Skomer MCZ, its importance as a vital ecological component of the marine ecosystem makes it a major factor influencing all other MCZ features. Plankton provides primary production to drive the whole system and many species have planktonic larval stages. The abundance and species composition of plankton is influenced by available nutrients, water movement, temperature and light.

4.12.2. Objectives

To collect seasonal abundance and species diversity data for zooplankton and phytoplankton.

4.12.3. Sites

- North coast Skomer between OMS site buoy and the Lucy buoy (2008 & 2009).
- Northwest of North Haven (2010- ongoing).

4.12.4. Method and Project History

Zooplankton

2008 and 2009: A plankton sample was collected once a week using a 63 micron mesh plankton net, trawled at less than 2 knots between the OMS and Lucy site markers. Samples were preserved in 2% formalin and seawater.

2010 onwards: A review of the results and objectives called for a change in methods. It was proposed that the sampling from Skomer matched that from other plankton time series projects to make the results comparable. The Plymouth Marine Laboratory (PML) has a plankton sample time series (L4), which would act as a good comparison site. The methods used at L4 are replicated at Skomer and analysis completed by PML. This uses a 200µm mesh net hauled vertically from 40m.

PML method adopted: A 200 micron mesh net is hauled vertically from 35 – 40m depth at approximately 0.2 mper second from a set sampling location. The sample is collected in the ‘cod-end’ bottle and this is preserved in 4% formalin. This process is repeated to give two samples per sampling event. Samples are collected on a weekly basis between May to September and then on a monthly basis for other months.

Phytoplankton and chlorophyll

2011- 2012: A water sample was taken and preserved in Lugol’s solution to provide a record of the phytoplankton species present. This was used to identify species responsible for “blooms”. A second water sample was also taken at 1 m below the surface. This was then used to filter three 250 ml samples over a 0.2 micron filter to estimate chlorophyll content. The chlorophyll samples were analysed by PML. The phytoplankton samples in Lugol’s solution were stored as a record of any plankton bloom.

2013 onwards – discontinued due to lack of funding for analysis.

2019 - Phytoplankton sampling was restarted in June. A 20 micron mesh net with a 30cm diameter opening was used. The samples were collected by a vertical haul from 20m with the net attached to a CTD probe (conductivity, temperature and salinity). Samples were then stored in 2% formalin.

For the zooplankton ID and enumeration, the procedure was as follows: Formaldehyde was rinsed from the sample using a 20 micron filter and the sample transferred to tap water. The sample was then divided into eighths with a Folsom splitter. One of the eighths was then made up to 100ml to dilute it further, agitated vigorously and then a 0.5ml subsample was taken with a graduated pipette to get a 1600^{th} subsample. This was then put on a Sedgewick Rafter graduated slide and the cells counted in a series of traverses under the high power of a compound microscope with a mechanical stage.

No samples were taken in 2020.

In 2021, standard L4 method was used to collect zooplankton samples (200µm net, vertical haul from 40 m). The phytoplankton method was changed to match the Water Environment Regulations 2017 (WFD) phytoplankton method. This also included collecting water samples for turbidity, salinity, dissolve inorganic nutrients, chlorophyll (1l filtered), temperature and dissolved oxygen. The phytoplankton sample is a 125 ml surface water sample preserved in Lugol’s solution.

An increased effort was made to collect at least 1 zooplankton and phytoplankton samples every month with higher sampling rates (2+) for the months of April – September.

2022, 2023 and 2024– continuation of the 2021 methodology.

2025 the same methods were used, but following the loss of the net in September a new plankton net was bought to the same specifications but has a smaller neck opening of 40cm diameter (area $0.126m^2$).

Analysis History

2009: 12 plankton samples were sent to the Sir Alister Hardy Foundation for Ocean Science (SAHFOS) for identification and enumeration by Dr D. Conway. The sample dates were from the 10^{th} May 2009 to the 9^{th} Nov 2009. All zooplankton individuals were identified to species level where possible and counted. Phytoplankton individuals were identified to species level, but their abundance was recorded semi quantitatively, (no report: raw data provided).

- 2010, 2011 & 2012 - Samples were collected from March to November, these were analysed by the Plymouth Marine Laboratory, (no report: raw data provided).
- 2013 onwards – Zooplankton samples were sent to Dr D. Conway (Plymouth Marine Biological Association) for identification and enumeration, (no report; raw data provided).
- 2014 - Plymouth Marine Laboratory reviewed the current dataset, standardised the species list and made recommendations on how the dataset should continue (McEvoy *et al.* 2013).
- In 2019 - Phytoplankton sampling was restarted. Zooplankton and phytoplankton samples sent to Dr D. Conway (Plymouth Marine Biological Association) for identification

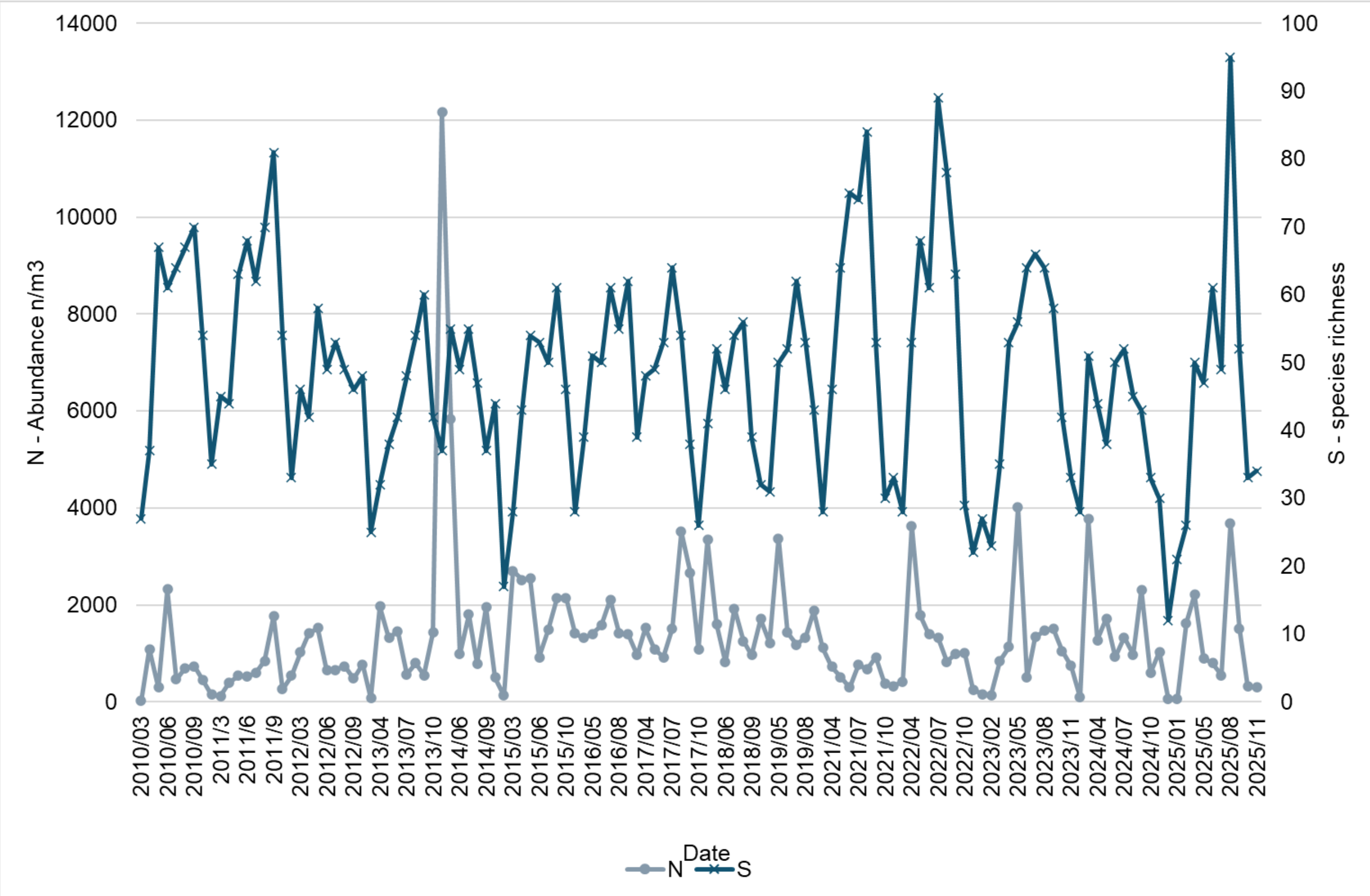
and enumeration, (no report; raw data provided). This is the last year Dr Conway analysed plankton samples due to retirement.

- In 2020 No field work was completed.
- From 2021 onwards, zooplankton sampling was completed alongside the collection of phytoplankton samples collected using the WFD methodology. This also included the collection of nutrient and chlorophyll samples. Zooplankton Identification conducted by Marine Biological association. Phytoplankton identification conducted by CEFAS. Zooplankton data was entered into DASHH Pelagic Lifeforms Tool.

4.12.5. Results

Zooplankton

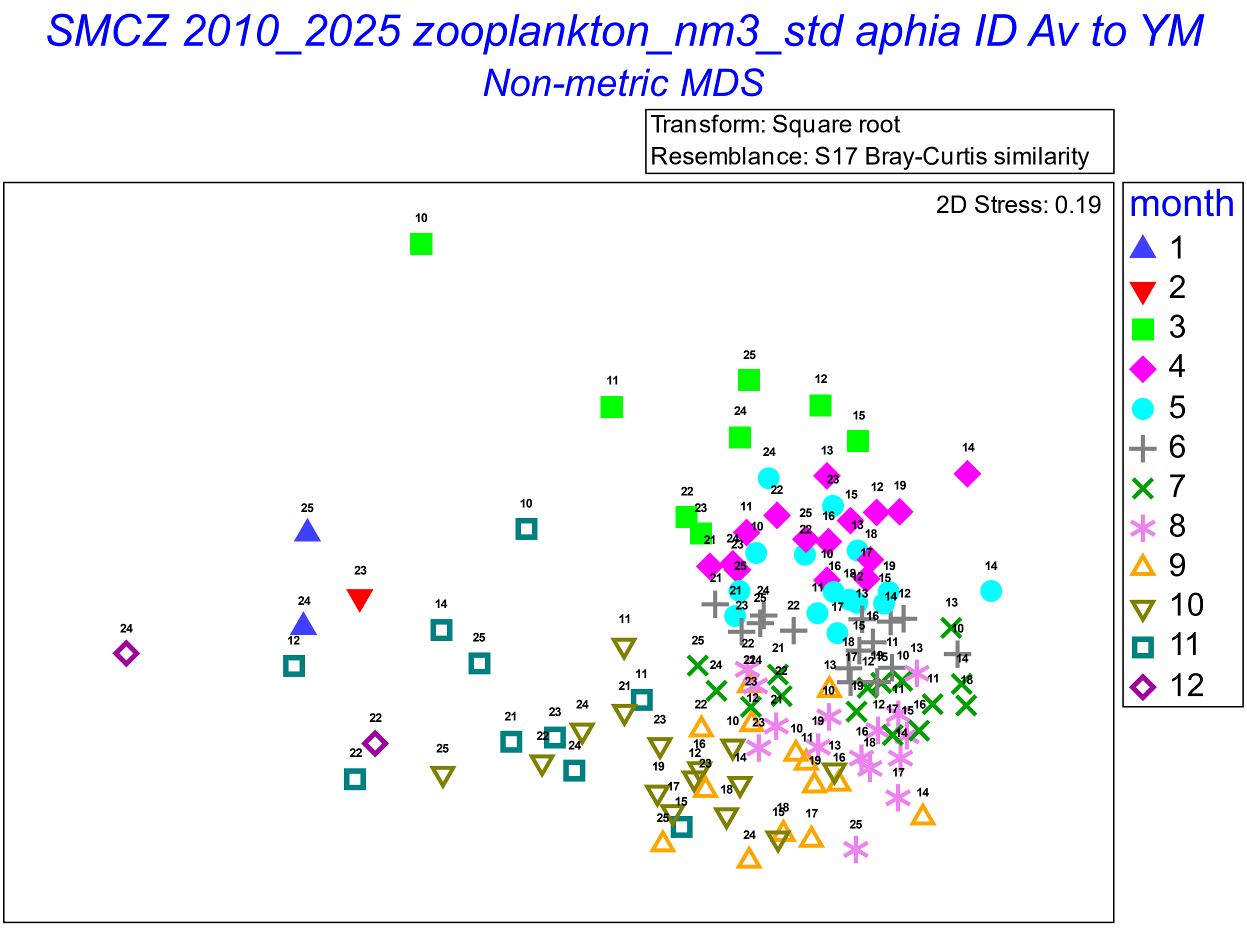
Figure 4.12.1 Average plankton species richness (S) and total number of individuals / abundance (N) 2010- 2025.



The peak in abundance in April 2014 was due to huge numbers of barnacle larvae in the plankton (Figure 4.12.1). The seasonal peaks in species richness are obvious on the graph.

All zooplankton data are held on file at the Skomer MCZ office in spreadsheet format and as Primer files. This allows for a wide range of data analyses; Individual species can be selected, differences between years can be analysed or the whole dataset can be combined to look for seasonal trends (Figure 4.12.2).

Figure 4.12.2 MDS plot of zooplankton community showing seasonal changes (symbols representing months and labelled with year).



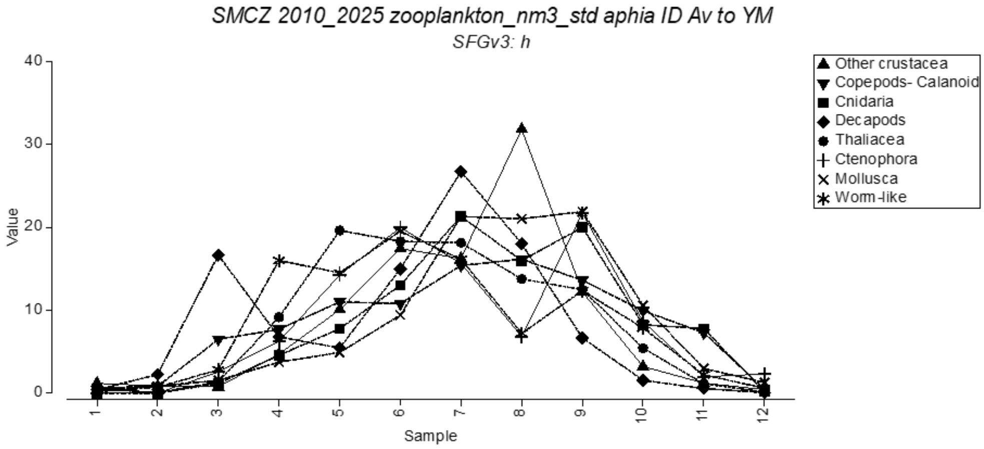
Statistical analysis of the dataset shows a strong seasonal pattern with months grouping together. However, these groups are in lines, which does suggest inter-annual variability. This seasonal pattern is driven by different groups of taxa appearing in the plankton at different times. Figure 4.12.3 a-c shows how selected groups have different seasonal patterns.

Cirripedia (barnacle larvae) & fish larvae are most abundant early in the year. while echinoderm larvae are abundant later in the year.

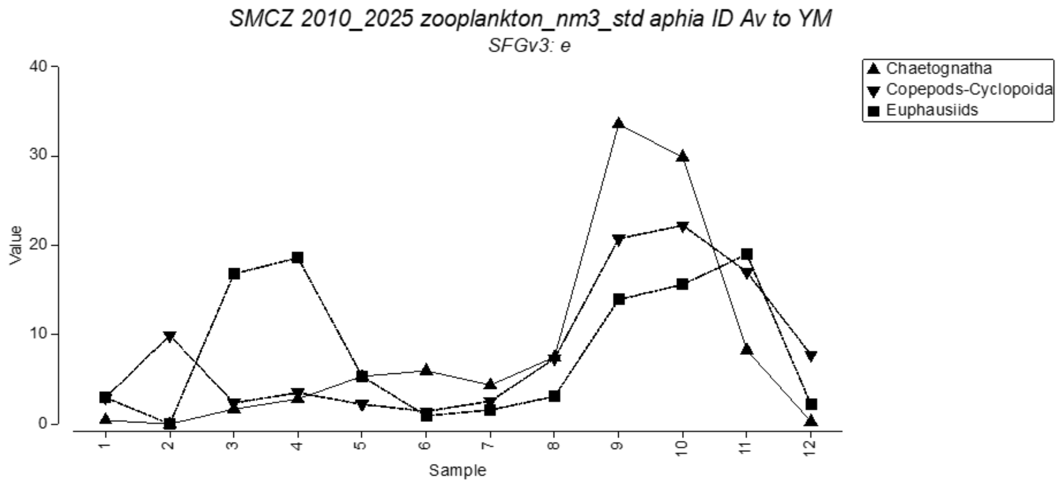
Cheatognathia, Cyclopodia copedpods and Euphausiids show a spring and autumn peak. Most other groups have a summer peak abundance.

Figure 4.12.3 Seasonal abundance patterns for the major groups of zooplankton taxa averaged from data collected between 2010 - 2025 with 4 obvious patterns; a)– Taxa with a broad seasonal distribution with peak abundance in Jul-Aug, b)- taxa with an Autumn peak, c)- taxa with a spring peak.

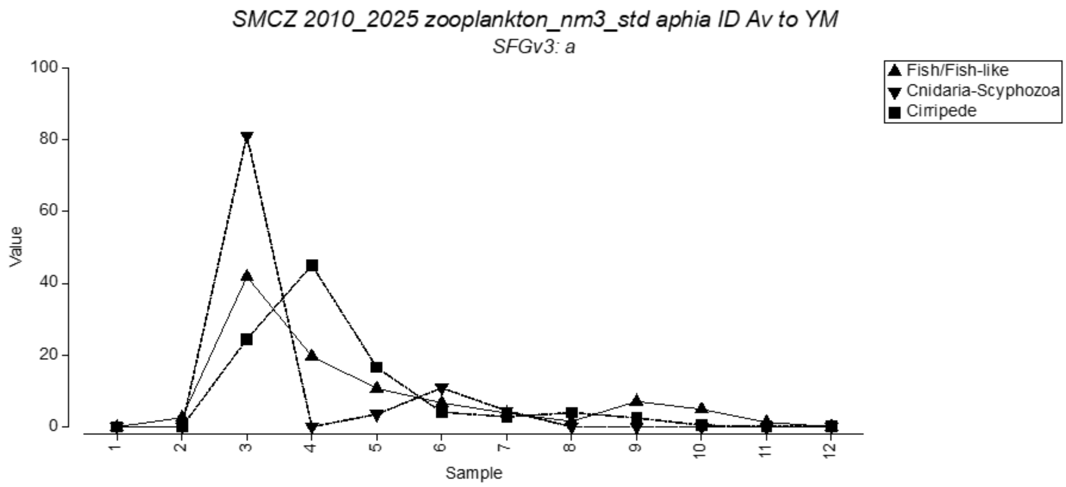
a)



b)



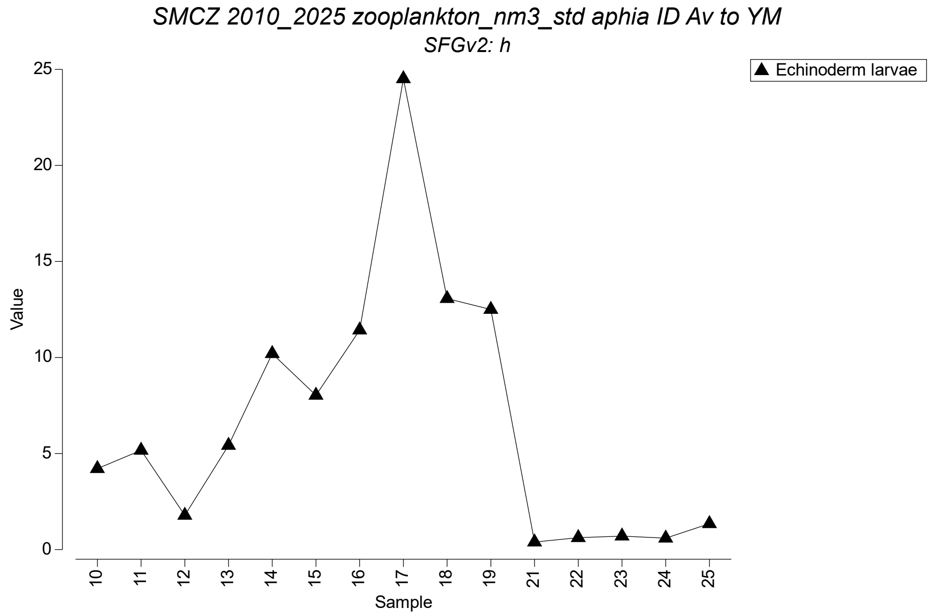
c)



Annual variation in abundances of major groups are plotted in Figure 4.12.4 a-e. The plots do highlight how variable the species abundances are between years and between species.

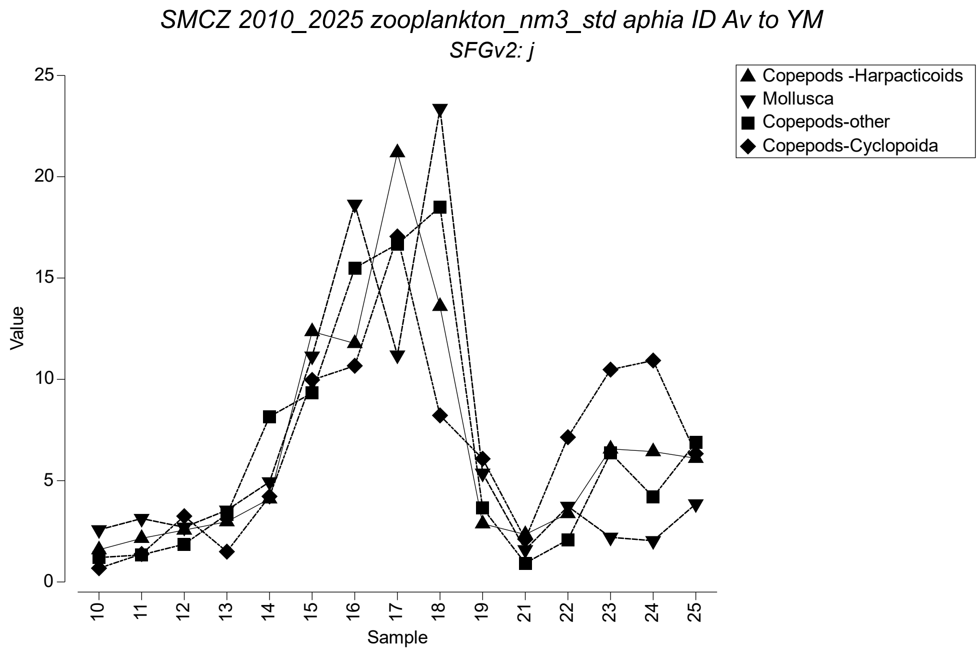
Figure 4.12.4 Coherence plots for the major taxonomic groups making up the zooplankton community at Skomer MCZ 2010 – 2025; a & b- taxa with a notably drop in abundance in 2021, c & d - taxa with consistent abundance over time & e – Ciripedia.

a)

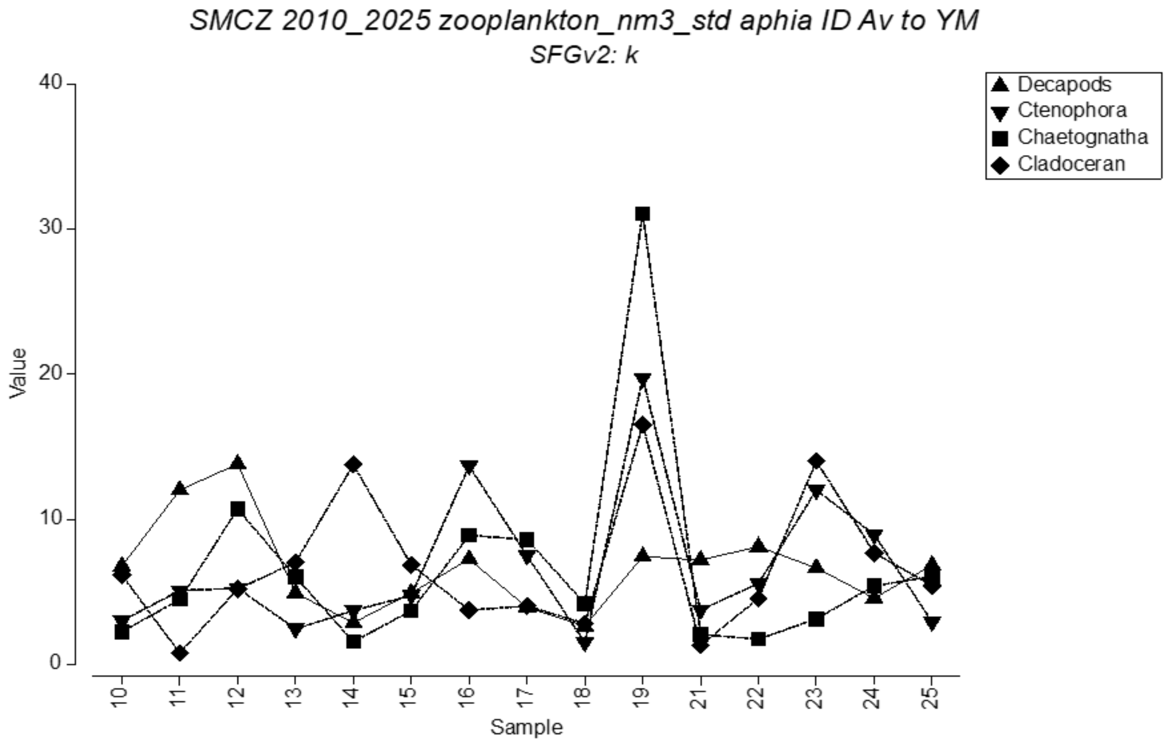


Echinoderm larvae have been almost absent from the samples since 2021.

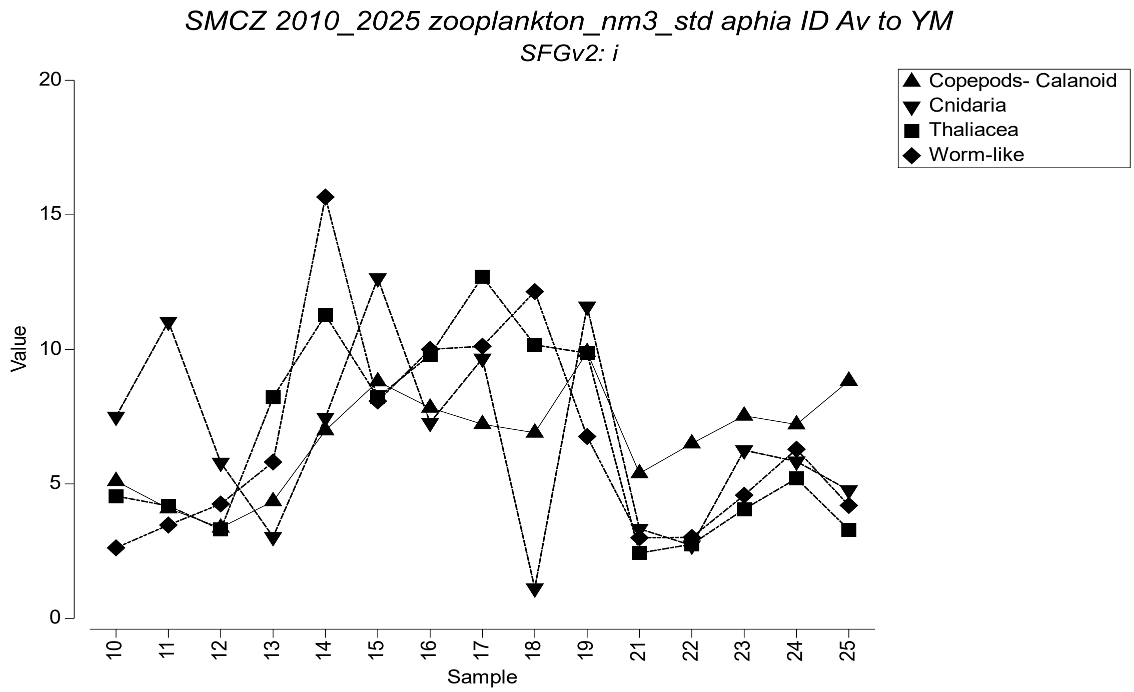
b)



These groups declined in 2019 – 2021 and then have shown some increase in abundance in the following years c)

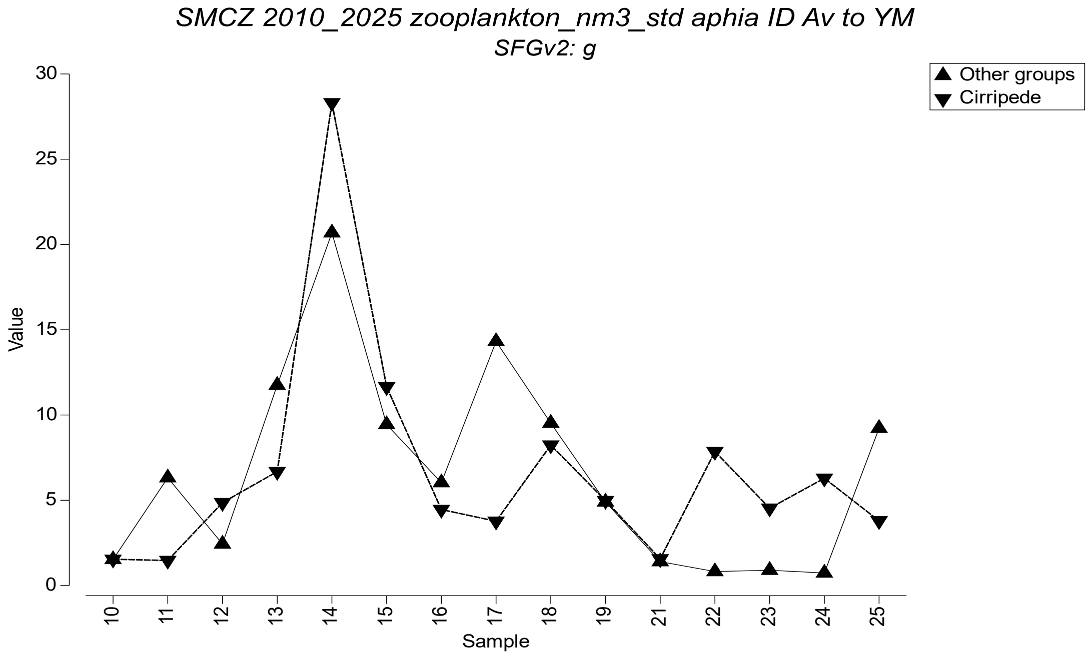


d)



These groups are erratic but always present in the plankton.

e)



The Cirripede (Barnacle larvae) had a notable peak in 2014.

Phytoplankton

There has not been a consistent approach to collecting phytoplankton samples at Skomer MCZ. In 2021 the WFD methodologies were adopted as these will provide comparable results to samples taken across the UK.

4.12.7 Current status

- A 10+ year timeseries of zooplankton has been collected. These data are comparable with other sites in the UK (e.g. Plymouth L4).
- Skomer MCZ zooplankton data have now been archived with DASHH (marine species and habitats data archive) and submitted to the Pelagic Lifeforms Tool dataset.
- Phytoplankton data are now being collected in such a way that samples from Skomer MCZ can be compared with other WFD sampling stations across the UK. The data will also be compatible with the Pelagic Lifeforms tool in the future.
- With the current data available it is not possible to report on the zooplankton and phytoplankton status in Skomer MCZ, so the condition of this feature is judged to be "unknown".

4.12.8. Recommendations

- Continue to collect zooplankton & phytoplankton samples on at least a monthly basis with as much coverage across the whole year as possible.
- Report zooplankton and phytoplankton feature as unknown.

4.13. Echinoderm populations

4.13.1 Project Rationale

The common urchin *Echinus esculentus* Linnaeus (1758) is an omnivorous grazer and a key biological structuring factor in sub-tidal communities. The grazing clears space making it available for colonisation by other species. In low numbers this grazing effect is beneficial; in high numbers it can be highly destructive even destroying whole kelp forests (Hagan, 1983).

During the 1970s divers targeted the Skomer population for the curio trade and large numbers were removed.

The starfish species: spiny starfish *Marthasterias glacialis*, seven-armed starfish *Luidia ciliaris* and common sunstar *Crossaster papposus* are easily identifiable and information on their distribution and abundance would be of interest. *M. glacialis* is regularly found in the Skomer MCZ, however *L. ciliaris* and *C. papposus* are less frequently found despite both having a wide distribution around the UK.

4.13.2 Objectives

- To determine the distribution and abundance of *E. esculentus* and describe their key habitats;
- To determine the size frequency distribution of *E. esculentus*;
- To allow a time series of comparable data to develop with surveys completed every 4 years.
- To investigate the presence of Echinoderm larvae in plankton samples.
- To record sunstar, *C. papposus*, spiny starfish *M. glacialis* and seven-armed starfish *L. ciliaris*;

4.13.3 Sites

- North Wall (NWA)
- Rye Rocks (RRK)
- Thorn Rock (TRK)
- Castle Bay (CBY)
- High/Low point (HLPT)
- Martins Haven west (MHV)

4.13.4 Project history

The Underwater Conservation Programme carried out the first survey of the *E. esculentus* population in Skomer waters in 1978 (Nichols, 1979). The results of the 1978 survey prompted a similar survey in 1981 by the Underwater Conservation Society (Bishop, 1982). Bishop (1982) reported mean densities of *E. esculentus* of 5.5 individuals per 100m^2 for Skomer in 1981 were not significantly different from densities in a commercially exploited population in Lamorna Cove, Devon. Densities were also significantly lower than those of other non-exploited localities around the UK.

In 2003, the first *E. esculentus* survey since the designation in 1990 of the Skomer Marine Nature Reserve (now Skomer MCZ) was completed with the help of volunteer diving teams. In 2007 methods were modified to allow improved statistical analysis and comparison between surveys (Lock *et* al 2008). Surveys were repeated in 2011, 2015 and 2019.

In 2024 the method was modified to combine with recording territorial fish and crustacean populations as part of the kelp habitat survey (see Section 4.10). In 2024 this combined method was completed in two zones: the kelp forest zone and kelp park zone (defined by the density cover of kelp plants) and in 2025 at 10m and 15m depth zones.

4.13.5 Methods

Site markers (weights with buoy line to surface) are set using GPS positions for each site at a depth 15m below chart datum.

The method was designed for use with volunteer divers and is described in Lock *et al* 2007. The survey is completed along 30m and can be completed at depths of 20m, 15m, 10m and 5m bcd for each marked site. The site sinker positioned at 15m bcd is used as a reference for completing the transects at the different depths.

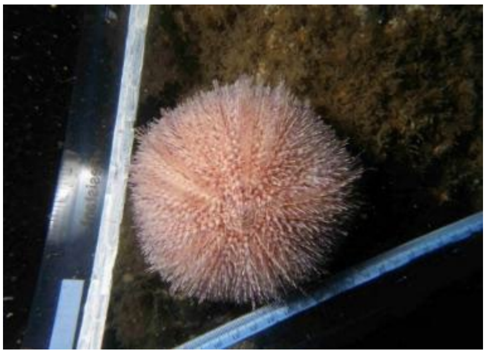
Each dive pair is allocated transects (depth and direction) to complete before the dive with the aim to complete 2 transects per dive. The divers completed the method as follows:

1. Dive pair secure weight at the allocated transect depth and swim together on a depth contour laying out the 30m tape as shown in Figure 4.13.1.

Figure 4.13.1 Divers swimming along transect

2. Dive pair swim back along the tape counting and measuring *E. esculentus* and counting starfish in a 2m corridor, 1m either side of the tape.
3. Within the 2m corridor record the distance each urchin is found along the tape and measure each *E. esculentus* using a fixed 60 degree divider (the Gibbs urchin divider) where the ruler touches the urchin as shown in Figure 4.13.2.

Figure 4.13.2. Measuring Echinus esculentus with Gibbs urchin divider



4. Record any 'bald' *E. esculentus*
5. Within the 2m corridor, record the total number of each selected starfish species
6. On completion of the 30m transect rewind the tape.
7. Repeat the survey at shallower depth.
8. On return to the boat the data is transferred from slates to prepared recording sheets.

4.13.5 Results

In 2025 the survey was completed at the 10m and 15m depth zones at 8 sites of which 6 sites were repeats from previous surveys (RRK, NWA, TRK, MHV, CBY and LHPT). Two additional sites were completed The Pool (POL) on the north side of Skomer island and East Hook (EHK) on the north Marloes peninsula.

***Echinus esculentus* density**

The mean density for the Skomer MCZ for each survey year is shown in Table 4.13.1.

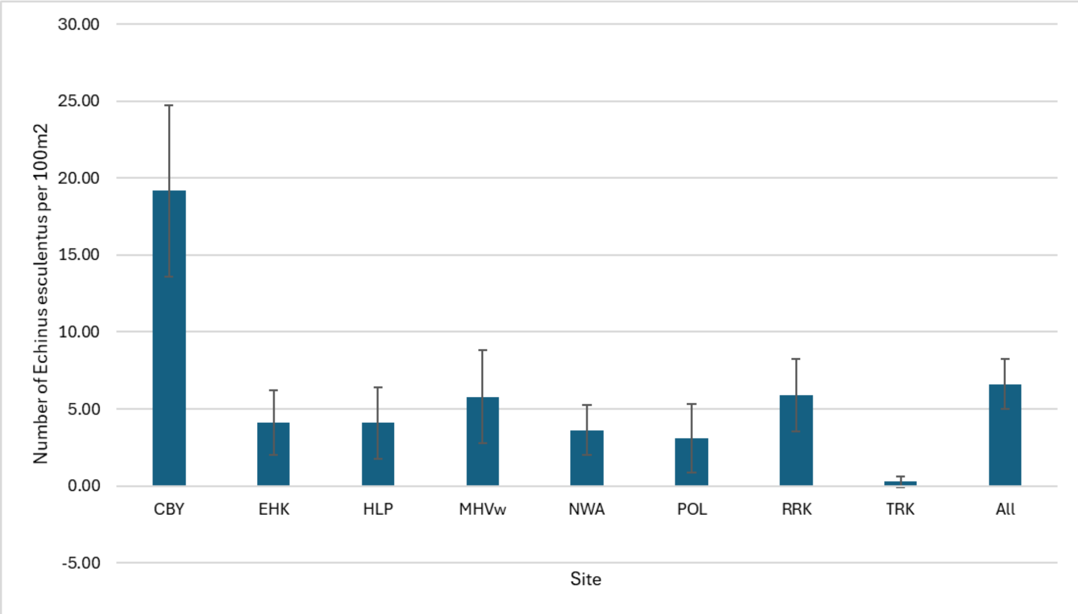
Table 4.13.1. Summary of density results for *Echinus esculentus* in each survey year

Year	2007	2011	2015	2019	2025
Transects completed	140	139	151	144	105
Area covered (m^2)	8400	8340	9060	8640	6290
Total number of Urchins	602	755	879	953	414
Mean density / 100 m^2	6.87	9.05	9.70	11.11	6.62

In 2025 the mean density of *E. esculentus* for all sites surveyed was 6.62/100m^2, similar to that recorded in 2007 and much lower than recorded on the last survey in 2019.

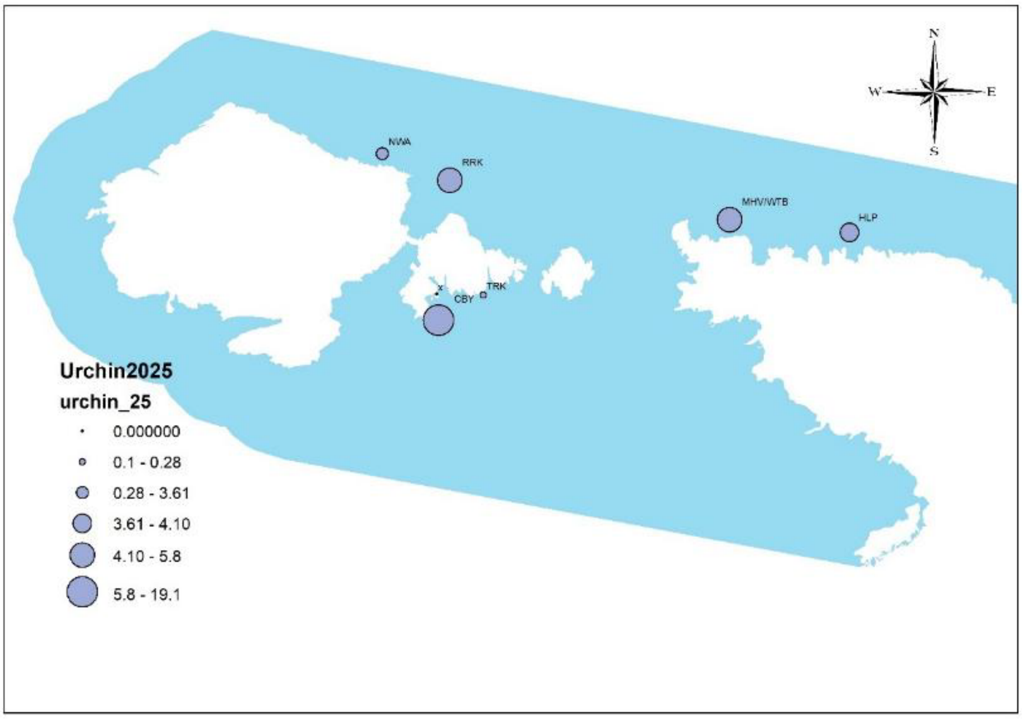
The mean density of *E. esculentus* at each site in 2025 with error bars (95% CI) is shown Figure 4.13.3. The highest mean density of 19.7 per 100m² was recorded at Castle Bay and the lowest was 0.28 per 100m² at Thorn Rock. Other sites ranged between 3.1 to 5.89 per 100m².

Figure 4.13.3. Mean density of *E. esculentus* at each site in 2025 with error bars (95% CI) Thorn Rock (TRK), North Wall (NWA), Rye Rocks (RRK), Martins Haven westt (MHVw), High/Low Point (HLP) and Castle Bay area (CBY).



The distribution of *E. esculentus* density at sites in the Skomer MCZ 2025 is shown in Figure 4.13.4.

Figure 4.13.4. Graduated bubble map of *E. esculentus* density in Skomer MCZ 2025.



The 2025 results can be compared to the 2007, 2011, 2015 and 2025 surveys for the comparable sites, shown in Figure 4.13.5. The density at all sites is lower in 2025, but overall, the pattern of variation in density between the sites has not varied much between the years. It is only the Castle Bay site which has shown any significant change (**$p<0.1\%$).** In 2007 an unsuitable location was used in Castle Bay before relocating it in 2011, this accounts for the comparatively low density recorded in 2007.

The highest *E. esculentus* density was recorded at Castle Bay in all surveys. This site is a rocky reef area made up of steep rock pinnacles and wide gullies; a habitat that is suitable for *E. esculentus* with lots of areas to shelter from wave action, as shown in Figure 4.13.6.

Figure 4.13.5 Mean *E. esculentus* density (per 100m^2) at each site for 2007, 2011, 2015, 2019 & 2025 with error bars (95% CI). Thorn Rock (TRK), North Wall (NWA), Rye Rocks (RRK), Martins Haven Point (MHV), High/Low Point (HLP) and Castle Bay area (CBY).

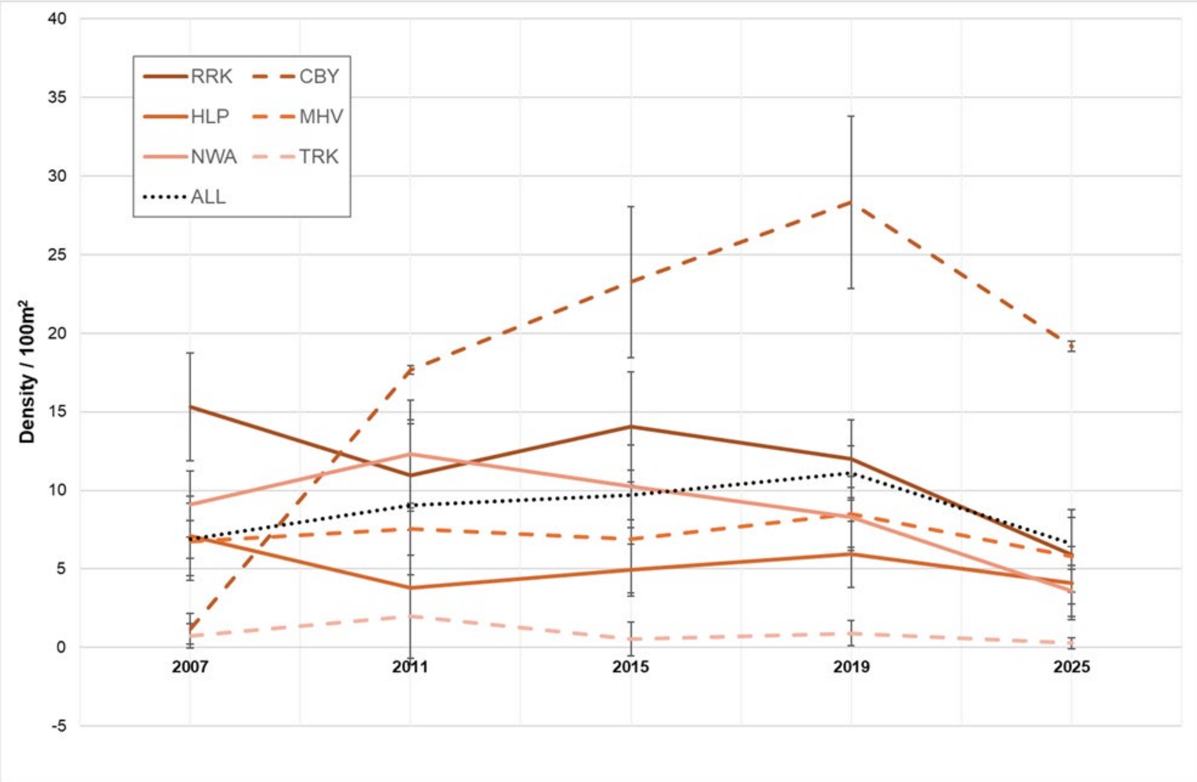


Figure 4.13.6. *Echinus esculentus* habitat at Castle Bay (photo credit Blaise Bullimore)

Echinus esculentus size

The urchins were measured using the 'Gibbs urchin divider' and the data converted to *E. esculentus* diameter (Lock *et a*l 2020) where divider reading *d is used to* calculate the urchin diameter *D* with the formula:

$$D = \frac{2}{\sqrt{3}} \times (d - 4)$$

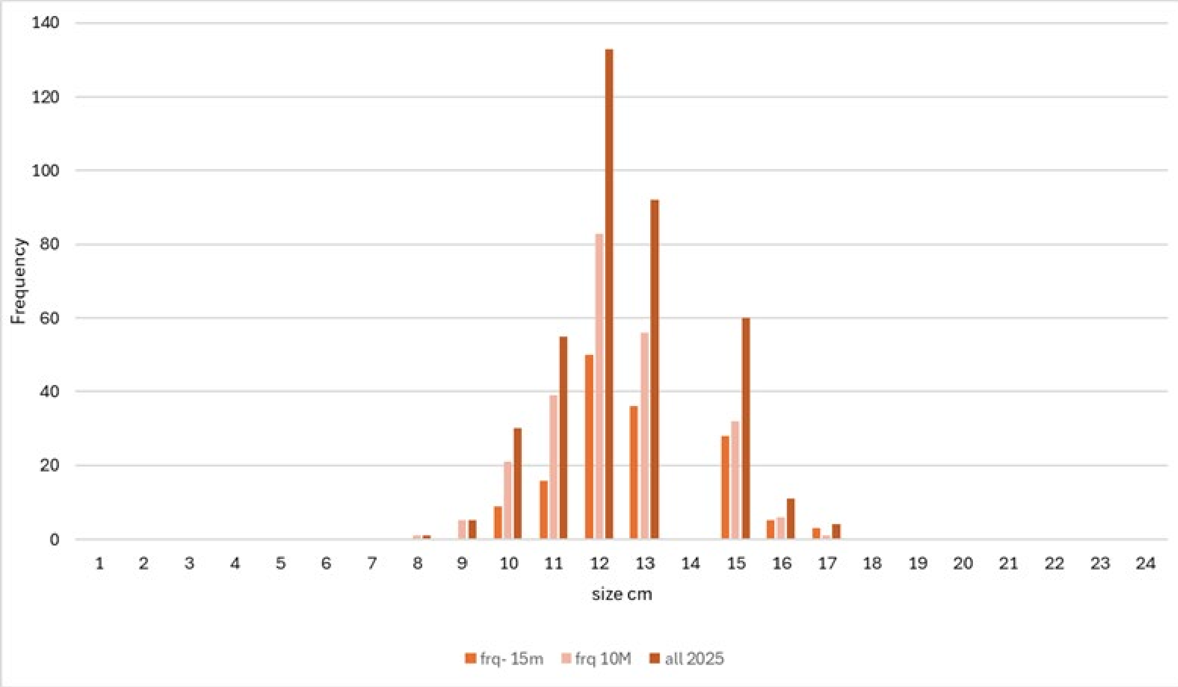
The *E. esculentus* size distribution is shown in Figure 4.13.7. The population of *E. esculentus* shows a normal size frequency distribution. Mean, maximum and minimum diameters were 13.1 cm, 24.3 cm and 8.1 cm respectively.

The mean diameter of *E. esculentus* measured in 2007, 2011, 2015 and 2025 surveys is compared in Table 4.13.2.

Table 4.13.2. Mean diameter of *Echinus esculentus* measured in each survey.

Year	**2007**	**2011**	**2015**	**2019**	**2025**
Mean diameter (cm)	11.65	13.24	13.34	13.40	13.08
95% CL	0.10	0.15	0.14	0.16	0.15

Figure 4.13.7 Size frequency distribution for whole MCZ population 2025.



The 2025 survey completed transects at 10m and 15m depth zones and a normal size distribution was found at both. *E. esculentus* was found to have a larger mean diameter at the 15m zone,13.4 cm, compared to 12.9cm at the 10m zone.

"Bald" Echinus esculentus

Bald urchin disease is a bacterial disease known to affect several species of sea urchin. Only 1 bald *E. esculentus* was found in 2025. The occurrence of 'bald' *E. esculentus* in surveys from 2003 to 2025 are shown in Table 4.13.3. The highest numbers were recorded in 2019, this only represented 2/2% of the total animals recorded.

Table 4.13.3. Numbers of "bald" *Echinus esculentus* 2003 – 2019

Year	**2003**	**2007**	**2011**	**2015**	**2019**	**2025**
Total *E. esculentus*	505	609	755	869	953	414
Total "bald" *E. esculentus*	0	2	1	10	21	1

Starfish species

The numbers of starfish records for starfish surveys recorded on surveys from 2003 to 2025 is shown in Table 4.13.4.

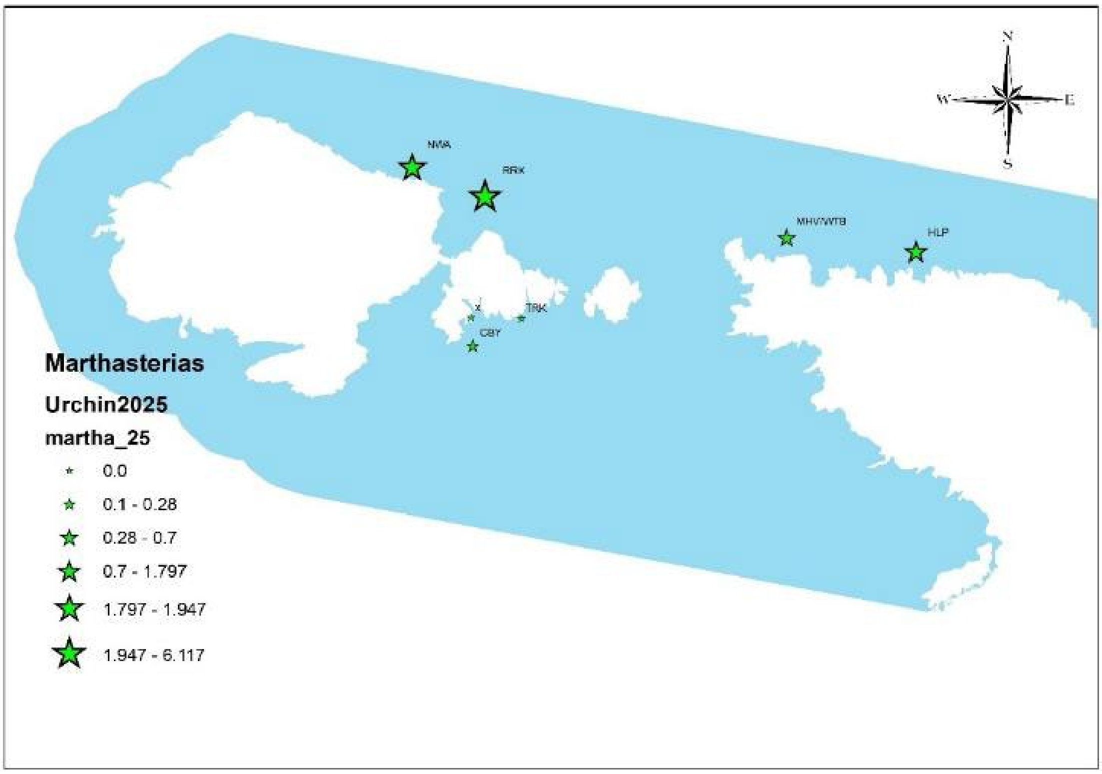
Figure 4.13.4 Starfish records from surveys 2003 to 2025 at Skomer MCZ.

Year	2003	2007	2011	2015	2019	2025
C. papposus - counts	21	0	0	0	0	0
M. glacialis – density / 100m^2	4.98	3.47	4.0	2.17	2.79	1.74
L. ciliaris - counts	0	2	10	2	0	0

In 2025, *Marthasterias glacialis* was the only starfish from the targeted list to be recorded, a total of 115 were recorded from all sites with a mean density of 1.74/100m^2. There were no records of either *Luidia ciliaris* or *Crossaster papposus. Crossaster papposus* has not been recorded on a survey since 2003*. Luidia ciliaris* was recorded in 2007, 2011 and 2015 but in very low numbers and mainly as juveniles.

A graduated bubble map of M.glacialis density is shown in Figure 4.13.8. The highest numbers were recorded from Rye Rocks and North Wall.

Figure 4.13.8. Graduated bubble map of *M. glacialis* density / 100m^2 Skomer MCZ 2025



4.13.5 Current Status

Surveys completed in 2003, 2007, 2011, 2015, 2019 and 2025

4.13.6 Recommendations

- Repeat *E. esculentus* and starfish populations survey every four years, with territorial fish and crustacean populations in 10m and 15m depth zones, next survey 2029.

- Complete *E. esculentus* and starfish populations survey with territorial fish and crustacean populations as part of the kelp habitat survey in kelp park and kelp forest zones, next survey due 2028.

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- Survey methods should follow those developed in the 2007 survey and used in subsequent surveys to allow comparisons between surveys.

- *C. papposus* and *L. ciliaris* should be recorded during routine dives.

- Plankton studies should be continued to investigate the presence of echinoderm larvae in the Skomer MCZ.

- ‘Bald’ *E. esculentus* recording should be continued.

4.14.Territorial Fish

4.14.1 Project Rationale

Territorial fish have received little attention and are poorly described in the survey literature. There is a need to improve knowledge of the diversity and distribution of territorial fish species. They have the potential to be affected by recreational angling, by-catch in commercial potting and as a targeted species collected for the use as cleaner fish in aquaculture, (Bullimore *et al* 1999, Tallaksen *et el* 2017).

4.14.2 Objective

1. To assess the distribution and abundance of nine territorial fish species.
2. Record and describe their key habitats.

The fish species were selected based on common occurrence at Skomer MCZ.

Wrasse species:

- Ballan wrasse*, Labrus bergylta*
- Cuckoo wrasse*, Labrus mixtus*
- Goldsinny, *Ctenolabrus rupestris*
- Corkwing wrasse, *Ctenolabrus melops*
- Rock cook, *Centrolabrus exoletus*

Benthic species:

- Butterfish, *Pholis gunnellus*
- Tompot blenny, *Parablennius gattorugine*
- Sea Scorpion, *Taurulus bubalis*
- Leopard spotted goby, *Thorogobius ephippiatus*

4.14.3 Sites

The survey sites include Skomer sites (SK) Rye rocks, North Wall, Pool and North Marloes Peninsula sites (NMPE) Wooltack Bay, Martins Haven, High/Low Point, and East Hook.

For each site GPS positions are used to allow for replicate transects to be completed and relocation of sites for future surveys. At each site there are 2 or 3 replicate stations within 200m of the survey sites to allow divers to complete the transects at the same time without overlapping or interfering with each other.

4.14.4 Project History

In 1997 diver survey methods were tested and in 2001 the first territorial fish survey was completed in the Skomer MCZ with the help of volunteer dive teams. The survey was completed at 10m and 15m depth zones.

In 2001 very poor visibility resulted in very few fish being recorded so the survey was repeated in 2002 with better visibility. In 2005 the number of sites was increased to 8 sites and methods were modified to allow improved statistical analysis (Lock *et al* 2006b). The survey was repeated at the 8 sites in 2009, 2013 and 2017.

Drop down video surveys were completed as Plymouth University student projects in 2007 and 2009 (Sweet 2007 and Bullimore 2009).

In 2024 the diver survey method was modified to combine with recording echinoderm and crustacean populations as part of the kelp habitat survey (see Section 4.10). In 2024 this combined method was completed in two zones: the kelp forest zone and kelp park zone (defined by the density cover of kelp plants) and in 2025 at 10m and 15m depth zones.

4.14.5 Method

Site markers (weights with buoy line to surface) are set using GPS positions for each site at a depth 15m below chart datum.

The diving survey is completed along transects, either 50m or 30m) transect tapes can be used as follows:

1. Dive pair secure a weight to the base of the site marker and swim together on a depth contour of 15m (+/-2m) laying out the tape. The first 5m are used to obtain control in orientation and buoyancy. Fish counts are completed in a 2m corridor, 1m either side of the tape. Diver pair maintain a swimming speed of 3m min^{-1}. Use fish identification sheets to assist species identification.

3. On completion rewind the tape slowly and record the transect depth, direction (e.g. east of west transect) and a description of the seabed substrate and habitat.

4. From the site marker ascend upslope 5m, secure the weight (in a crevice or around a boulder) and repeat the method for a second transect.

The methods are fully described in Lock *et al.* 2006 a. In the 2002 to 2017 surveys a 50m transect tape was used, but in 2024 and 2025 a 30m transect tape was used to allow time for the additional recording of echinoderm and crustacean populations to be recorded as described in Section 4.10.

4.14.6 Results

In 2025, the survey was completed at the 10m and 15m depth zones at eight sites. Six of the sites were repeated from previous fish surveys: Rye rocks, North Wall, Martins Haven, East Hook, Low/high point, and Pool. Two additional sites were completed on the south side of Skomer island: Thorn Rock and Castle Bay

Distribution of territorial fish species

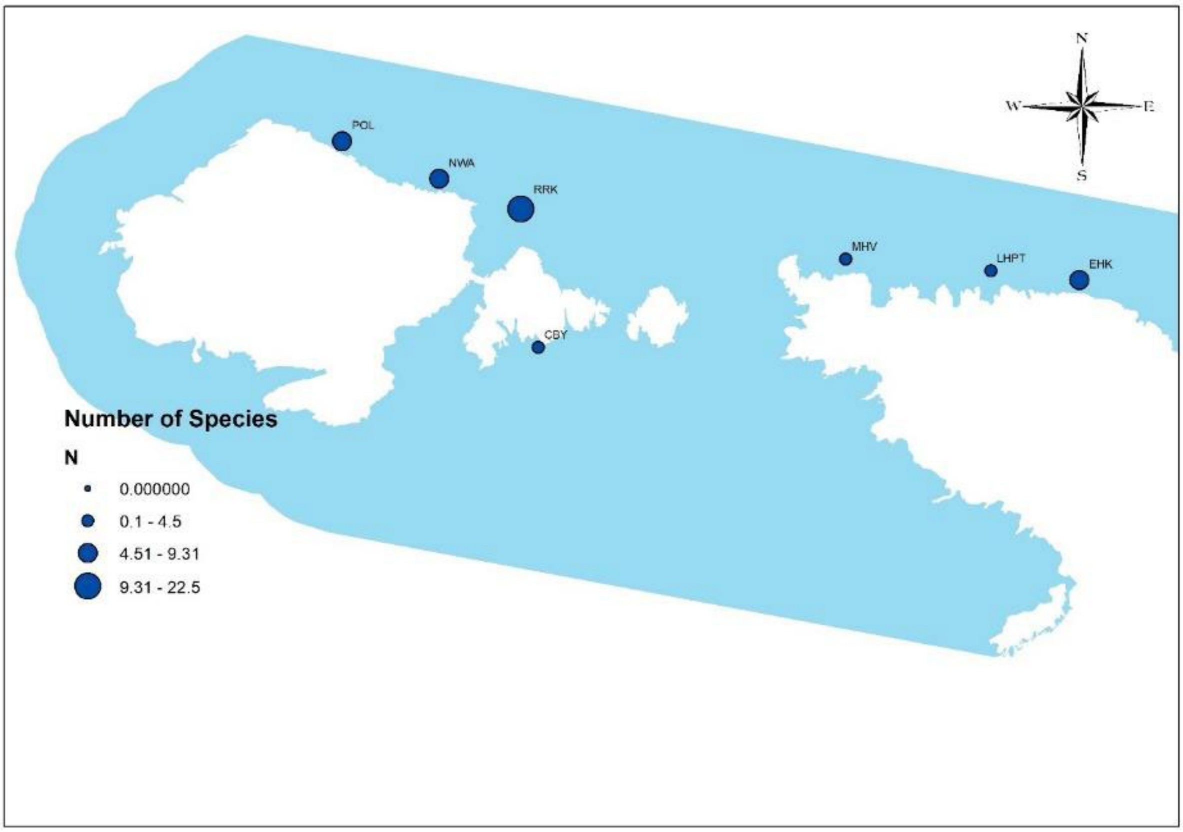
The average number of fish species per 50m^2 recorded at each site is shown in table 4.14.1. The highest numbers of fish were recorded at Rye Rocks where particularly high numbers of wrasse species were found, rock cook averaged 10.9/50m^2 and ballan wrasse averaged 4.8/50m^2. Numbers of tompot blenny and scorpion fish was low and no butterfish were recorded. The numbers of wrasse species varied between sites, the most frequently recorded were ballan wrasse, goldsinny and rock cook. One notable record from the 2025 survey was a grey triggerfish *Balistes capriscus* at the Low/High Point survey site. This has not been included in the statistical analysis. Triggerfish are an annual visitor to Pembrokeshire but not often recorded at Skomer.

Table 4.14.1 Mean number of each fish species per 2025. (Sites: Rye Rocks (RRK) North Wall (NWA), Pool (POL), Martins Haven (MHV), Low and High Point (LHPT), East Hook (EHK), Thorn Rock (TRK) Castle Bay (CBY).

Site	**Ballan wrasse**	**Cuckoo wrasse**	**Goldsinny wrasse**	**Corkwing wrasse**	**Rock Cook**	**Leopard spotted goby**	**Tompot blenny**	**Scorpion fish**	**Total all sites**
CBY	1.1	1.3	1.0	0	0.9	0.3	0	0	4.5
EHK	2.7	0.5	4.2	1.2	0.4	0.1	0.1	0.1	9.3
LHPT	1.8	0.3	0.3	0.2	1.1	0.5	0.1	0	4.3
MHV	1.3	0	0.9	0.1	0.1	0	0	0	2.4
NWA	2.9	2.1	1.9	0.1	0	0.1	0.3	0.1	8.5
POL	1.4	2.4	1.8	1.5	0.4	1.3	0.1	0.1	8.9
RRK	4.8	1.6	2.3	2.6	10.9	0.4	0.1	0	22.6
TRK	0.9	0.1	0.1	0	0.3	0.4	0.1	0	1.9
Total all fish	2.3	0.9	1.7	0.8	2.3	0.4	0.1	0	8.6

A graduated bubble plot to show distribution of numbers of fish species recorded at sites is shown in Figure 4.14.1. The highest numbers were found at Rye Rocks followed by East Hook, Pool and North Wall.

4.14.1. Figure 4.14.1 Graduated bubble plot to show distribution of territorial fish (all species) in Skomer MCZ. (Sites: Rye Rocks (RRK) North Wall (NWA), Pool (POL), Martins Haven (MHV), Low and High Point (LHPT), East Hook (EHK), Thorn Rock (TRK) Castle Bay (CBY).



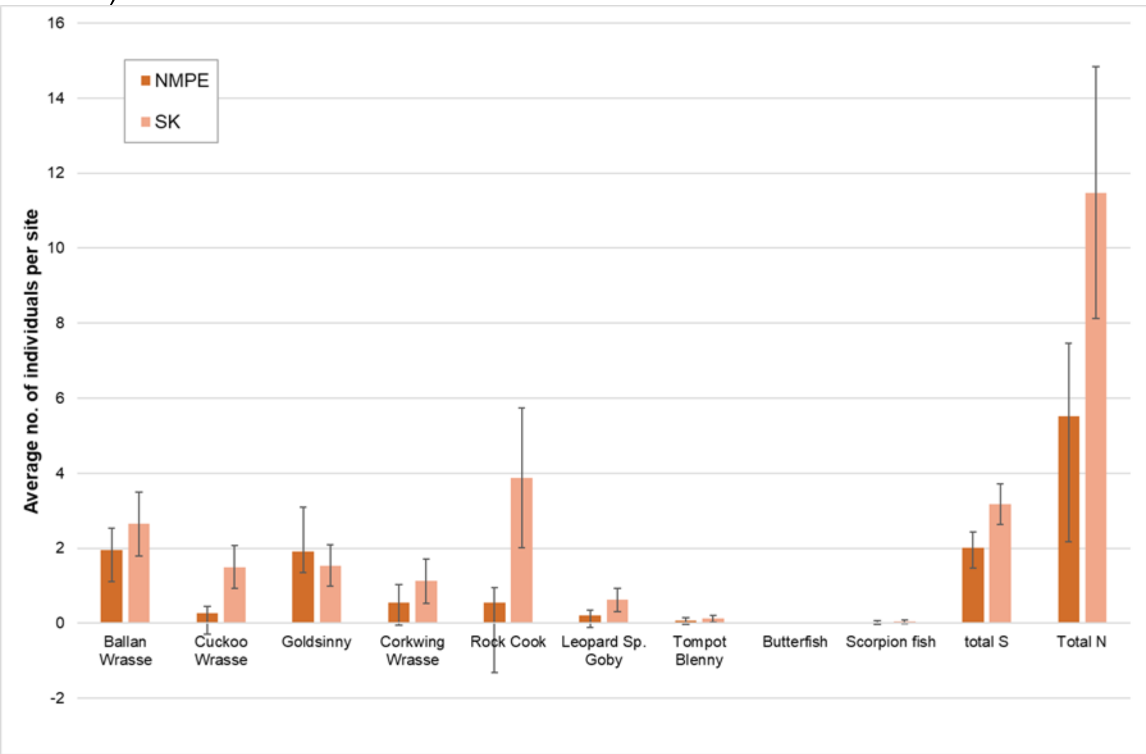
Differences between areas (Skomer & North Marloes Peninsula).

Skomer sites and all North Marloes Peninsula sites have been grouped to compare the two areas. Transects were averaged to area and the abundances of each species, the species richness (S) and the overall abundance of all fish (N) are compared as shown in Table 4.14.2 and Figure 4.14.2.

Table 4.14.2 Average number of each fish species per 50m^2 at North Marloes Peninsula NMPE and Skomer SK sites 2025 (Species richness S, total number of fish N)

Area	**Ballan wrasse**	**Cuckoo wrasse**	**Goldsinny wrasse**	**Corkwing wrasse**	**Rock Cook**	**Leopard spotted goby**	**Tompot blenny**	**Scorpion fish**	**Total S**	**Total N**
NMPE	1.95	0.27	0.90	0.54	0.54	0.20	0.06	0.02	2.02	5.52
SK	2.6	1.5	1.54	1.13	3.87	0.62	0.12	0.04	3.16	11.48

Figure 4.14.2 Average number of fish with 95% error bars for each species average at North Marloes Peninsula NMPE and Skomer SK sites 2025 (Species richness S, total abundance of fish N)

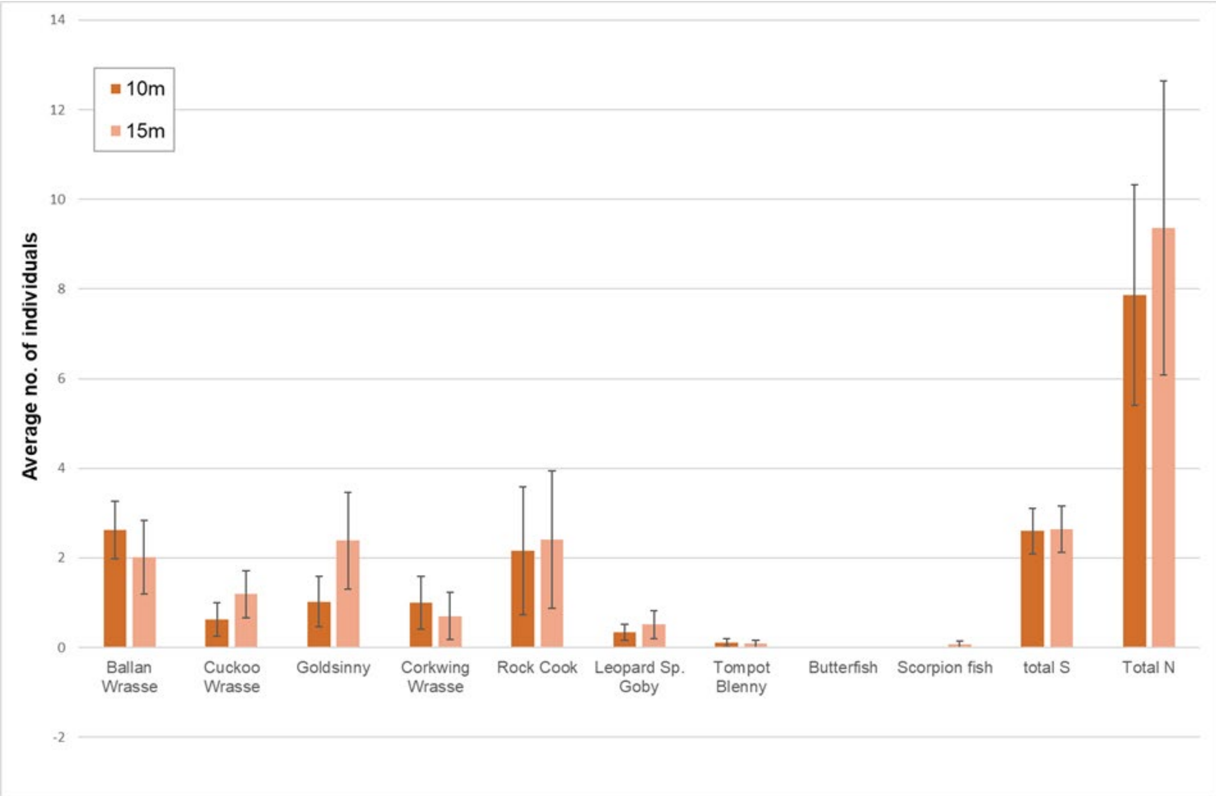


Cuckoo wrasse and rock cook wrasse had significantly higher abundances in the Skomer area. There were also significant differences in Species Richness (S) <1% and overall abundance (N) <1%. Both are higher in the Skomer area.

Difference between depth zones

The average number of each fish species has been grouped for the 10m and 15m depth zones as shown in Figure 4.14.3. Most species closely matched in abundance at the two depth zones, ballan wrasse were slightly higher in the 10m zone whilst cuckoo wrasse and goldsinny wrasse higher in the 15m zone.

Figure 4.14.3 Average number of fish with 95% error bars for each species average to depth zone 10m and 15m, 2025. (Species richness S, total abundance of fish N)



Comparison between years 2005 to 2025

To enable comparison across years all data has been converted to numbers/90m2 and only comparable sites have been included.

1. Species richness (S) 2005 to 2025

As only certain species are recorded in the survey there is an artificial limit to species richness. Species richness can be compared between areas and depth zones. Raw transect data was used to calculate species richness and then values averaged to area and depth zone.

Species richness averaged to area 2005 to 2025 is shown in Figure 4.14.4 and averaged to depth zone and area in Figure 4.14.5. Species richness is higher in the Skomer area by year.

Figure 4.14.4 Species richness (S) averaged to area (North Marloes Peninsula NMPE and Skomer SK) 2005 – 2025 with 95% error bars.

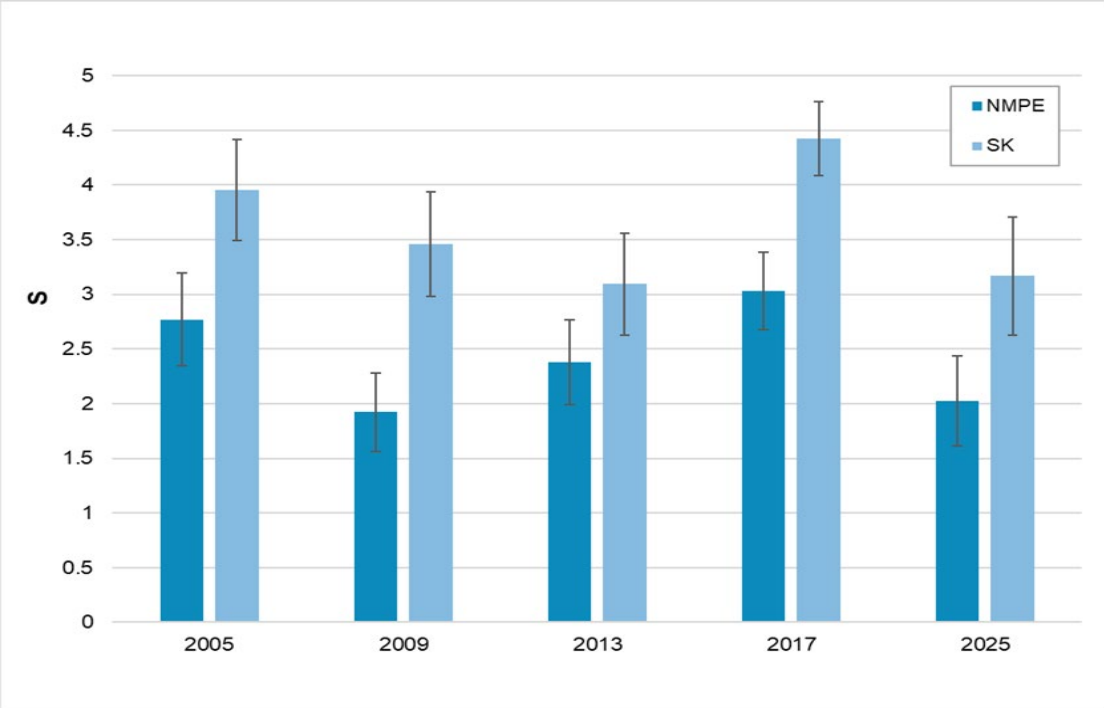
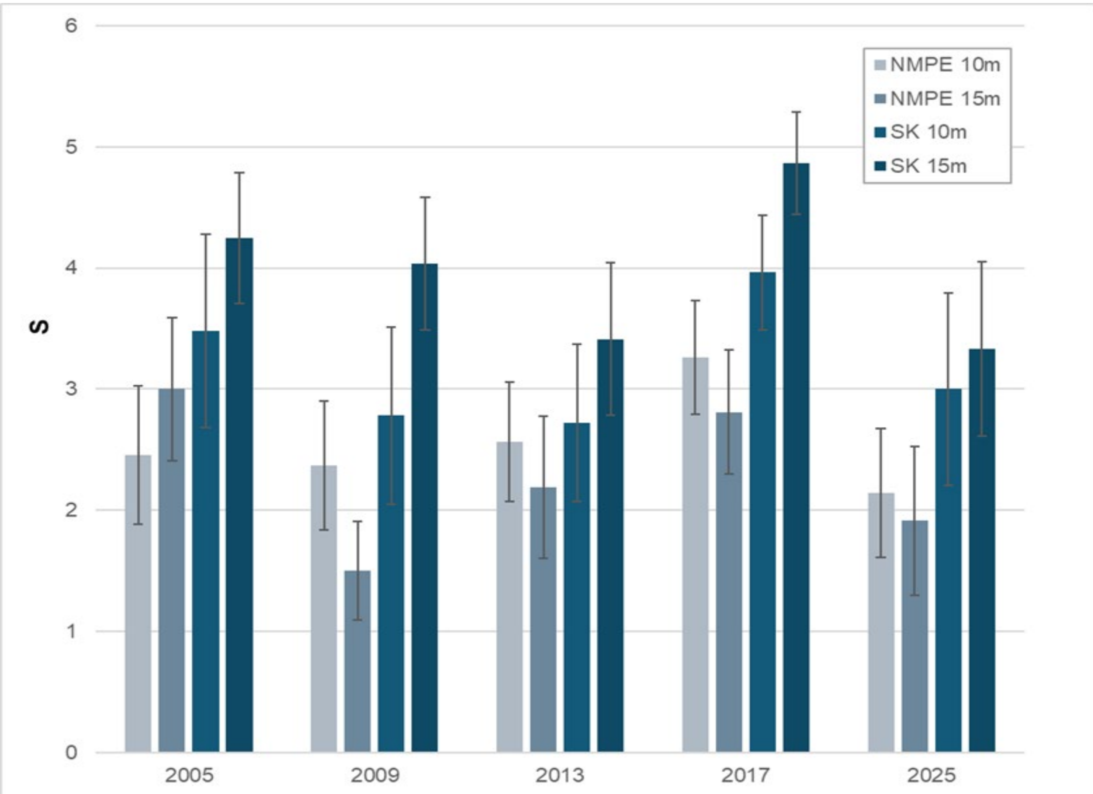


Figure 4.14.5 Species richness (S) averaged to depth zones 10m & 15m and to area (North Marloes Peninsula NMPE and Skomer SK) 2005 – 2025 with 95% error bars.



2. Overall abundance of fish (N) 2005 to 2025

Overall abundance of individuals (N) was calculated by summing the counts of all fish species. These were averaged to area by year as shown in Figure 4.14.6 and averaged to area and depth zone by year as shown in Figure 4.14.7.

Figure 4.14.6 Overall abundance (N) averaged to area (North Marloes Peninsula NMPE and Skomer SK) 2005 – 2025 with 95% error bars.

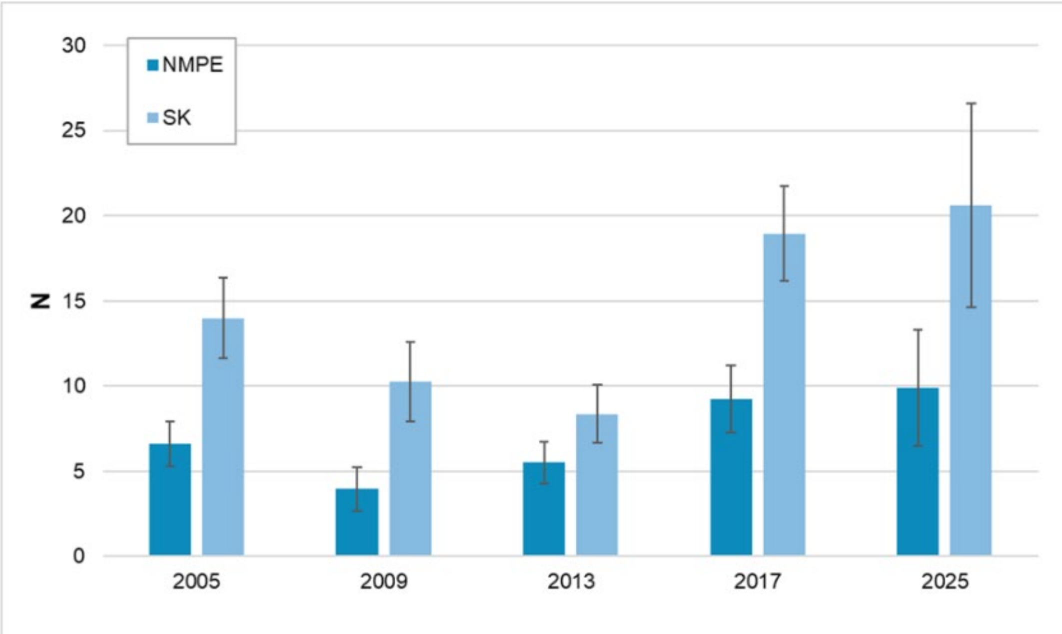
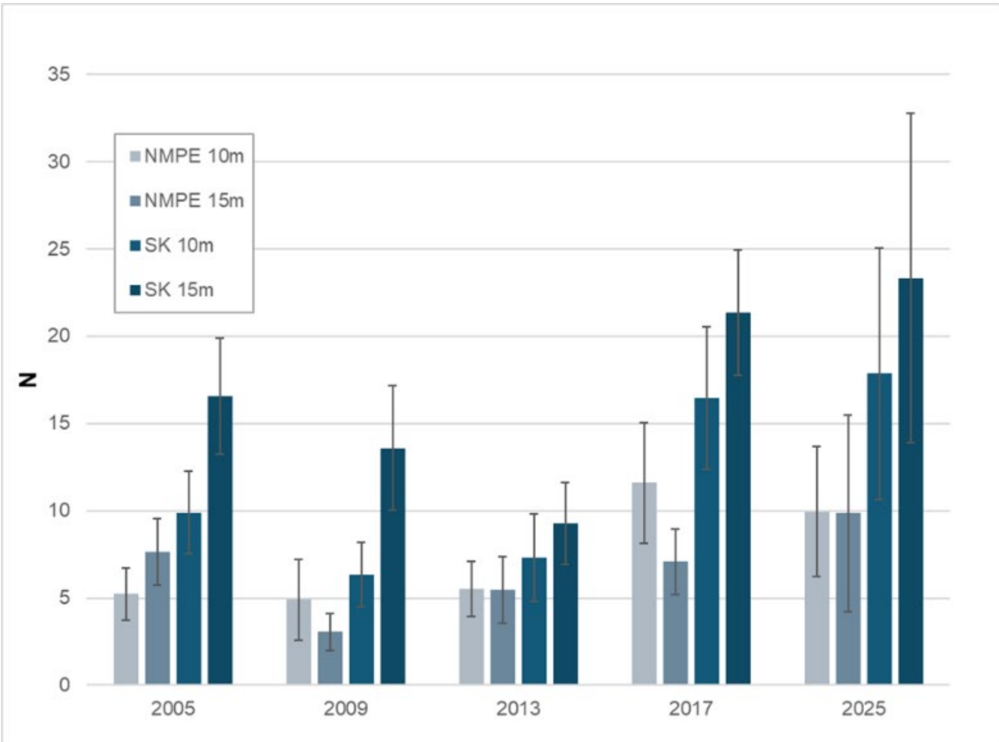


Figure 4.14.7 Overall abundance (N) averaged to depth zones 10m & 15m and to area (North Marloes Peninsula NMPE and Skomer SK) 2005 – 2025 with 95% error bars.



The Skomer area has significantly higher numbers of fish compared to NMPE for all years.

Skomer 15m depth zone always has the highest numbers of fish, with significantly more fish than NMPE 10m and NMPE 15m in all years except 2013.

4.15.7 Current Status

The 2 areas (Skomer and North Marloes Peninsula) do have different communities of territorial fish. The differences between the two areas are mainly down to the abundance of wrasse species, especially in the 15m depth zone at Skomer. Here the surveys have consistently found the higher numbers of fish compared to the North Marloes Peninsula.

The numbers of fish recorded during the diving surveys are too variable to draw conclusions on any trends in the abundance of territorial fish over the years.

4.15.8 Recommendations

- Repeat territorial fish survey every 4 years as combined survey with echinoderms and crustacean populations in 10m and 15m depth zones, next survey due 2029.
- Complete territorial fish survey with echinoderms and crustacean populations as part of the kelp habitat survey in kelp park and kelp forest zones, next survey due 2028.
- Encourage student projects in the use of video cameras to study fish communities in different habitats around the Skomer MCZ.
- Encourage further research on the impacts of recreational angling, wrasse by-catch in lobster pots and 'ghost pots'

4.16. Sediment Infauna

4.16.1 Project Rationale

Sediment infauna and epifaunal communities are recognised as management features of the Skomer MCZ. The sediments studied at Skomer also include several of the priority sediment habitats identified in Section 7 of the Environment (Wales) Act 2016.

Despite the relatively high number of surveys carried out in Skomer MCZ much remains unknown about the sediment communities. Sediments can accumulate pollutants and toxins and the faunal communities living within them have been shown to respond to these pollutants. The seabed within the MCZ has a byelaw preventing the use of all dredges and trawls, which makes it one of the most protected areas in the UK. The sediment communities within the MCZ can be thought of as recovering to a natural state and this makes them a useful control area. This aspect of Skomer MCZ sediment communities has been used by NRW in its investigation into the effects of commercial ship anchoring in St Brides Bay and in academic studies comparing “fished” and “unfished” seabed biota.

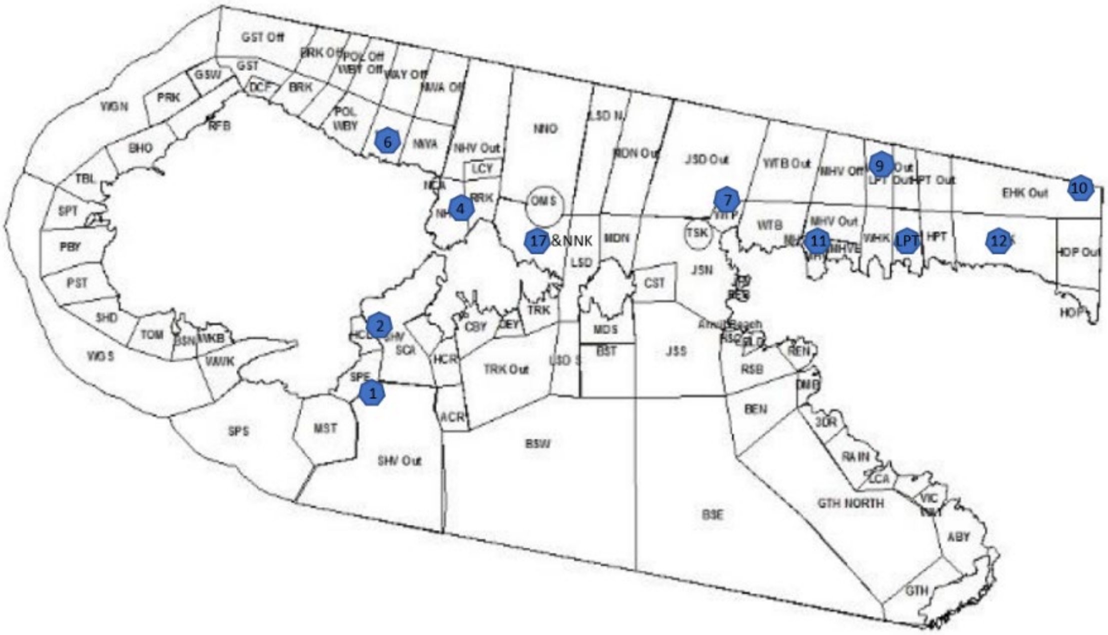
4.16.2 Objectives

To assess species richness and diversity and to measure inorganic pollutant concentrations.

4.16.3 Sites

Nineteen sample stations in Skomer MCZ were sampled in the first survey in 1993. This was reduced to ten stations in subsequent surveys (eight on the north side of Skomer and the Marloes peninsula and two in South Haven). In 2009 the two stations from the epifauna study project were added to the survey, these were at Low Point and North Neck (same location as station 17). The survey station locations are shown in Figure 4.16.1.

Figure 4.16.1 Map of the sample stations.



4.16.4 Methods

1. Two replicate samples are taken at each station using a 0.1m[2] day grab, sieved with a 0.5mm sieve and preserved on site for biological analysis. The faunal content of these samples is then identified and enumerated by a specialist contractor.

2. A third grab sample is taken at each site and three sub samples are taken and stored. These are sent to specialist laboratories for sediment grain size analysis, hydrocarbon content analysis and metals content analysis.

4.16.5 Project history

Surveys were completed in 1993, 1996, 1998, 2003, 2007, 2009, 2013, 2016, 2020 and 2024.

The aim of the survey in 1996 was to assess the effect of the Sea Empress oil spill. The average number of individuals, species richness and taxonomic diversity was significantly lower in 1996 than all other years, but it was not clear if that was a direct effect of the oil spill or a combined effect of the oil spill and an exceptional storm (16m wave height) a month before sampling.

4.16.6 Results

This time series has shown a very dynamic range in type and number of species recorded each year and it is very hard to analyse the data using univariate methods. The data set spans 30 years, infaunal taxonomy has changed a lot in that time which makes it difficult to compare species lists from 1993 to those from 2024, especially when different taxonomists have been used over the time series. These changes in identification of species are likely to confuse the results when assessing temporal variation. When all data from 1993 to 2024 are combined there are 2590 different taxa records, many of which would be duplicates due to changes in how species have been recorded over time.

To mitigate issues described above, a data truncation has been undertaken. The objective of the truncation was to maintain the most precise quantification and highest taxonomic resolution possible, with the greatest degree of consistency between data sets. This was conducted by infauna taxonomic experts from APEM environmental consultancy in accordance with the NMBAQC scheme.

Two truncations were completed; the full truncation for the purpose of analysing the community over the whole time series resulted in a list of 809 taxa which can be confidently attributed to distinct entities over the whole time series. Many of these taxa are higher than species or genus level but this higher order truncation was necessary to overcome changes in identification techniques over the 30 years.

A second truncation was made for biodiversity assessments rather than temporal analysis. This was not as strict in the full truncation method and resulted in a list of 1189 taxa which gives a better indication of the diversity of species recorded each year. This biodiversity truncation is not as reliable when looking at temporal changes.

Species Richness -Using the biodiversity truncation.

Table 2 Average species richness, average abundance or number of individuals and average species diversity indices at Skomer MCZ.

Index name	Richness (S)	Abundance (N)	Margalef Richness (d)	Eveness (J)	Shannon (H(loge)	Simpson(1-Lambda)
1993	308	580.1	48.6	0.73	4.20	0.96
1996	245	175.7	47.4	0.81	4.44	0.98
1998	367	704.6	56.0	0.77	4.54	0.98
2003	382	773.4	57.3	0.74	4.39	0.97
2007	505	1304.2	70.4	0.77	4.79	0.99
2009	514	915.6	75.7	0.78	4.85	0.99
2013	491	784.4	73.5	0.77	4.79	0.99
2016	427	708.0	64.9	0.76	4.58	0.98
2020	531	1046.5	76.4	0.78	4.88	0.99
2024	510	967	85.1	0.73	4.63	0.98

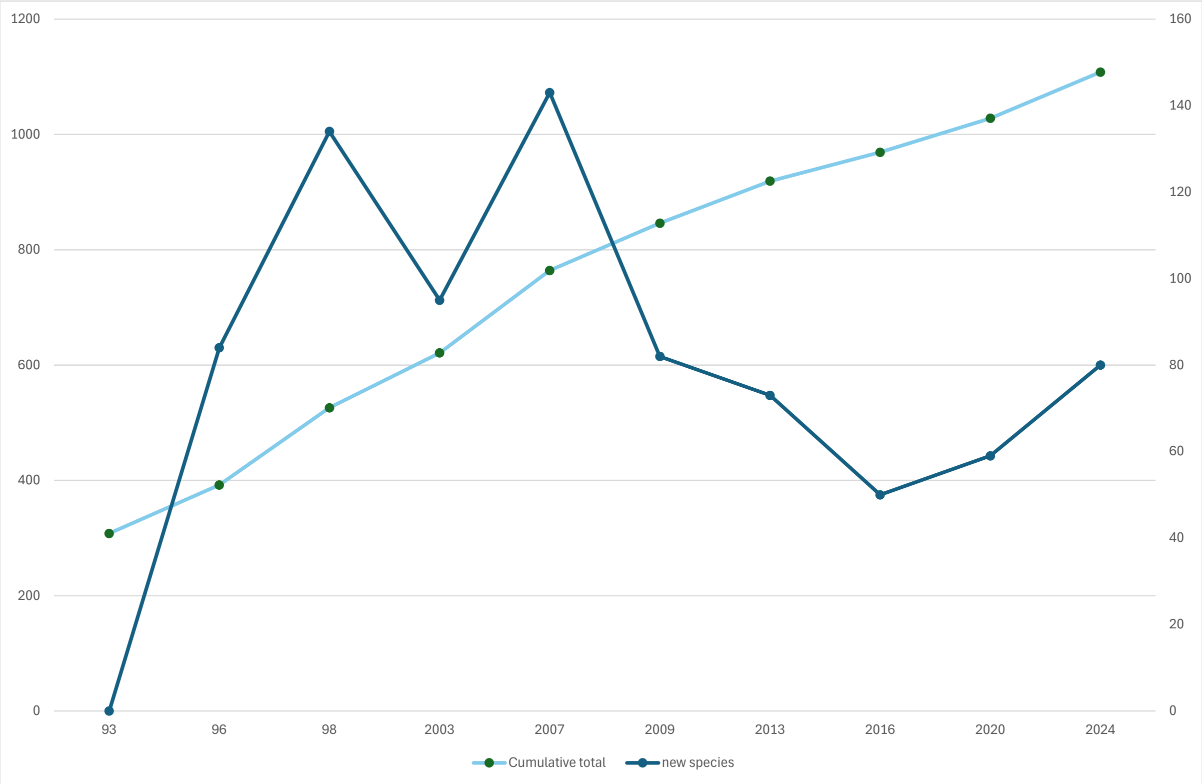
The 2020 survey had the highest number of species (S) and a high abundance of individuals (N). Since 2007, there have consistently been 420+ species recorded in each survey shown in Table 4.16.1.

Species have been very variable over the survey period with 100+ new species recorded in some new surveys (Table 4.16.2). In 2024, 80 new species were recorded which have not been identified in any of the previous surveys. The cumulative count of species is still increasing (Figure 4.16.1) which suggests that the infauna community in the sediment around Skomer are both diverse and dynamic. It also suggests that the sampling effort of 24 grabs / year is not sufficient to capture the full diversity within the site.

Table 3.16.2 Average species richness (S), compared to cumulative total and new species observed in each survey.

Year	1993	1996	1998	2003	2007	2009	2013	2016	2020	2024
Species richness (S)	308	245	367	382	505	514	491	427	531	510
New species	0	84	134	95	143	82	73	50	59	80
Cumulative species count	308	308	392	526	621	764	846	919	969	1028

Figure 4.16.1 Species richness (S), cumulative species count & new species observed 1993-2024.



The species discovery curve is still increasing linearly which suggests there has not been enough sampling completed to fully describe the biodiversity of the sediments.

Temporal changes analysis (using PRIMER v7)

The data was truncated for analysis, juveniles and none epifauna species were removed resulting in a matrix of 728 taxa from 210 grab samples (1993-2024). This data was averaged to site and year, square root transformed to reduce the effect of very abundant species and then analysed with a Bray Curtis similarity index. A Bray Curtis similarity coefficient was used to construct resemblance matrices for the multivariate analysis.

To reduce the size of the taxa list down to a manageable number for species plots and cluster dendrograms the BEST routine was used to select a subset of species which would match (RELATE) to the overall full species list matrix at 0.95 correlation.

The routine was repeated with each set of taxa being removed from the overall set until the BEST routine failed to reach a Spearman’s rank correlation of 0.95 match. This process resulted in a final analysis list of 90 taxa from the square root transformed data. A multi-dimensional scaling plot (MDS) is a visual way to look at how similar sites are in terms of species composition (Figure 4.16.2).

The MDS Primer plot (Figure 4.16.2) shows that both 1993 and 1996 differ from all other year sets. The community appears to have been very stable for the last ten to fifteen years. The different sites form very similar patterns year on year, suggesting that the communities are stable.

Station 1 was moved in 2007 due to a change in seabed type from sediment to hard ground.

In 2024 two sites show a big shift from the pattern of the last 15 years; Site 1 shifts again and site 4 (circled on Figure 4.16.2).

Site 1 (in South Haven) shows a drop in species richness compared to other years and a shift in species composition. A few species have disappeared in 2024 and *Aricidea (Aricidea) minuta, Armandia polyophthalma, Streptosyllis websteri* have been seen for the first time. The position of the grab sample was only 50m from the target position. An analysis of the sediment particle size data does show a shift in sediment composition with a shift to larger sand particles rather than fine sand and silt as shown in Figure 4.16.3..

Figure 4.16.2 PRIMER Multi-dimensional scaling (MDS) plot showing the grouping of samples from 1993 – 2024 Skomer MCZ infauna data.

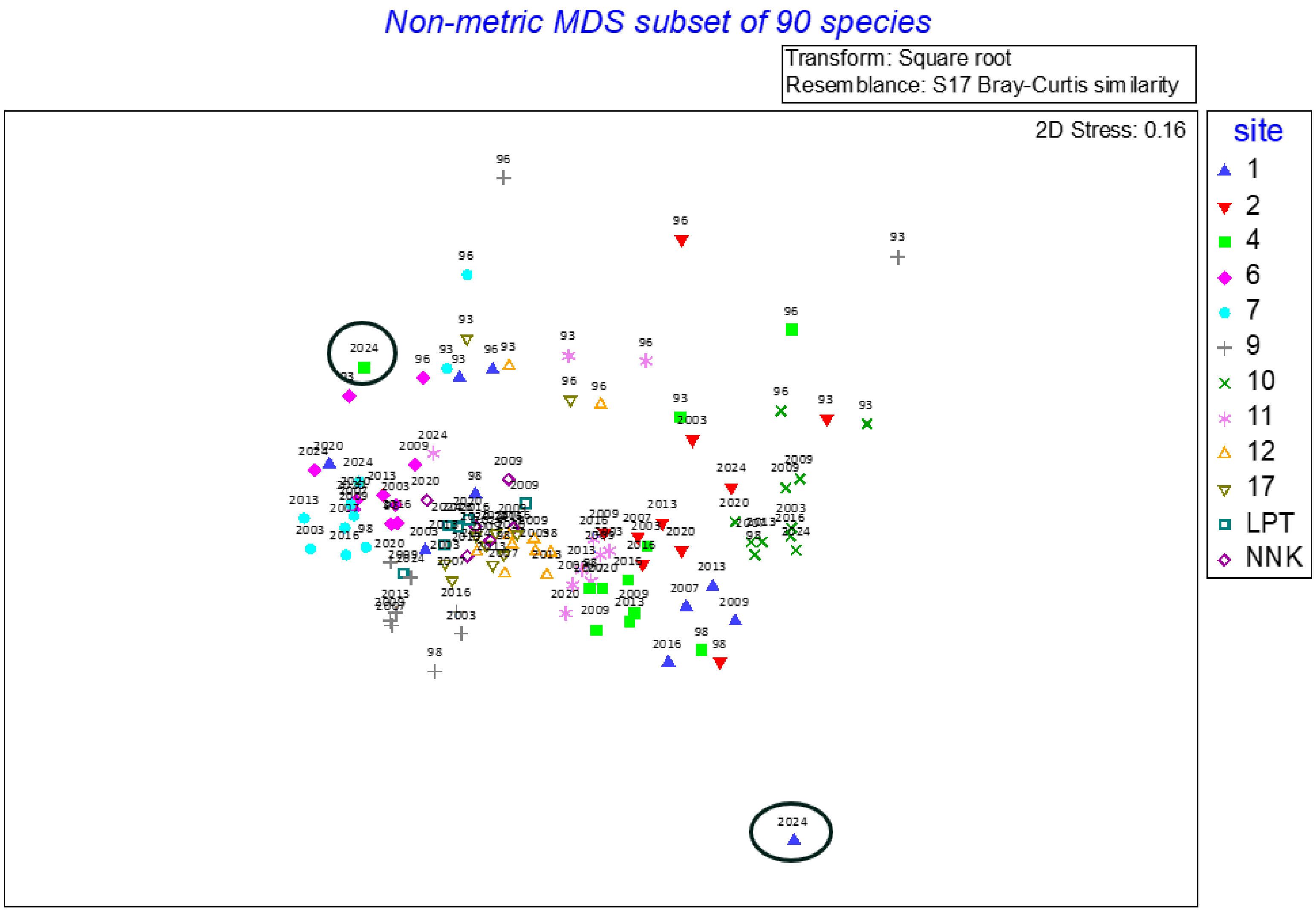
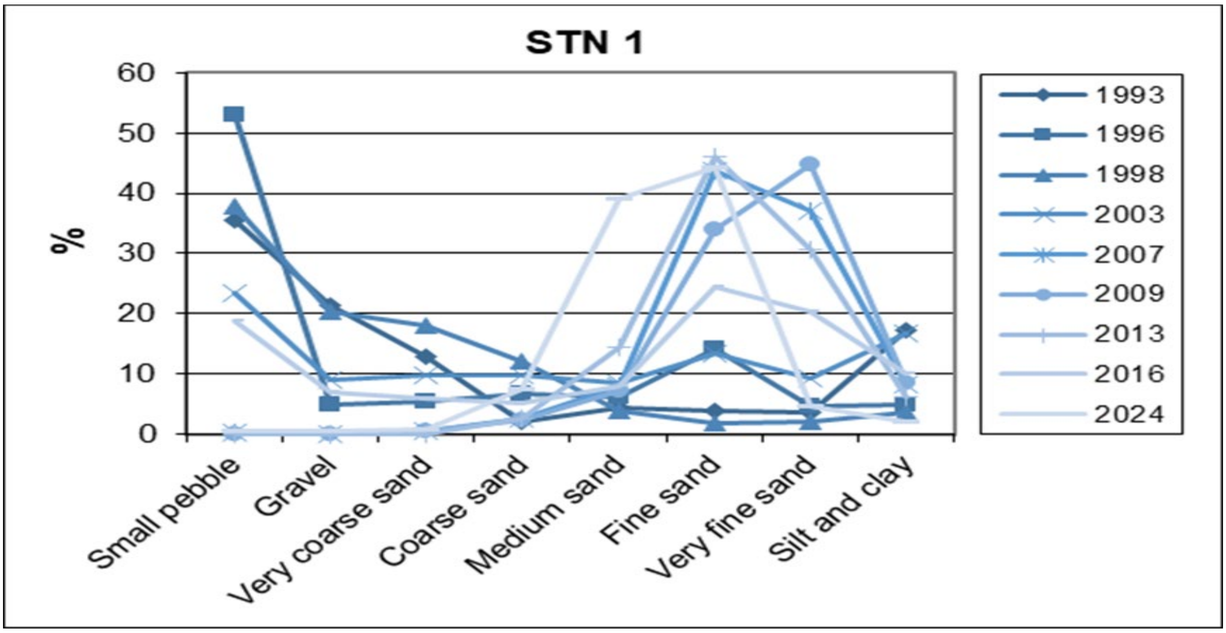


Figure 4.16.3. Site 1. Sediment particle size data, 1993 to 2024.



Site 4 (in North Haven) has a consistent species richness and abundance compared to other years but there have been notable increases in certain species e.g. *Oligochaeta, Mediomastus fragilis, Cirriformia & Aphelochaeta marioni.* The sediment analysis shows a big shift in the sediment composition of 2024 compared to other years; with a shift to much larger grain sizes rather than the fine sands and silt as shown in Figure 4.16.4.

A PCA plot of all the sediment data is shown in Figure 4.16.5 circled are the 2024 stations for sites 1 & 4 to show the shift from the normal pattern.

Figure 4.16.4. Site 4. Sediment particle size data, 1993 to 2024.

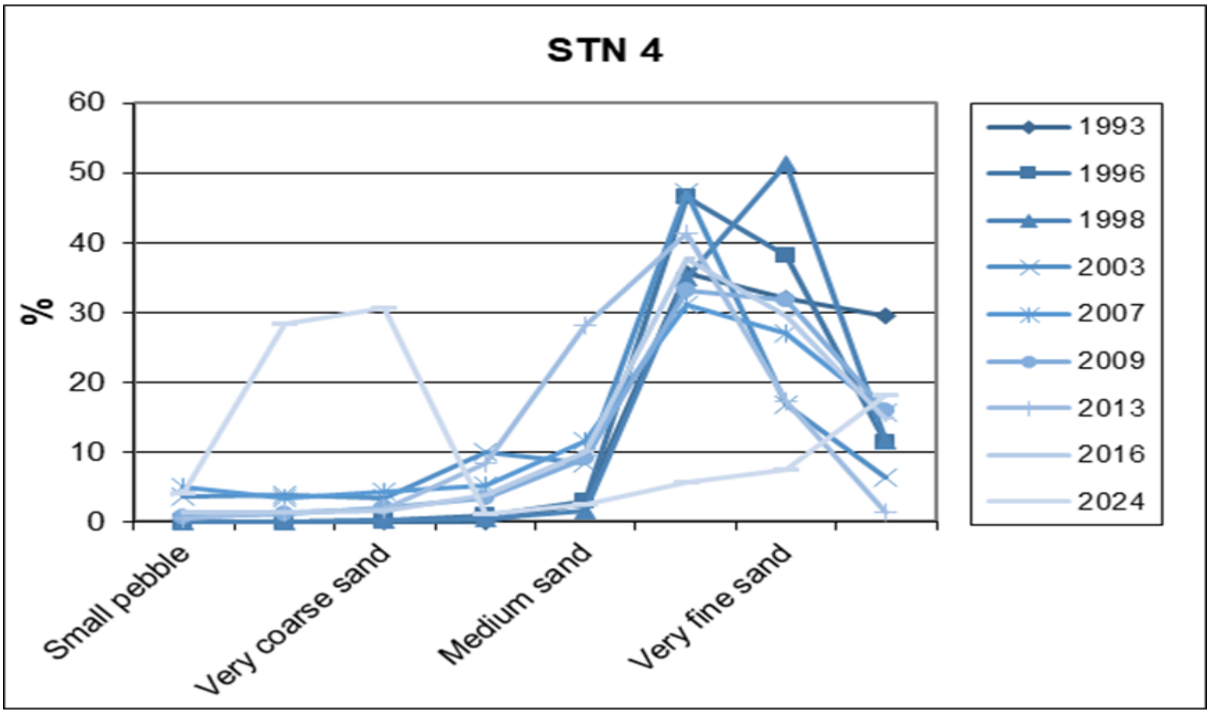
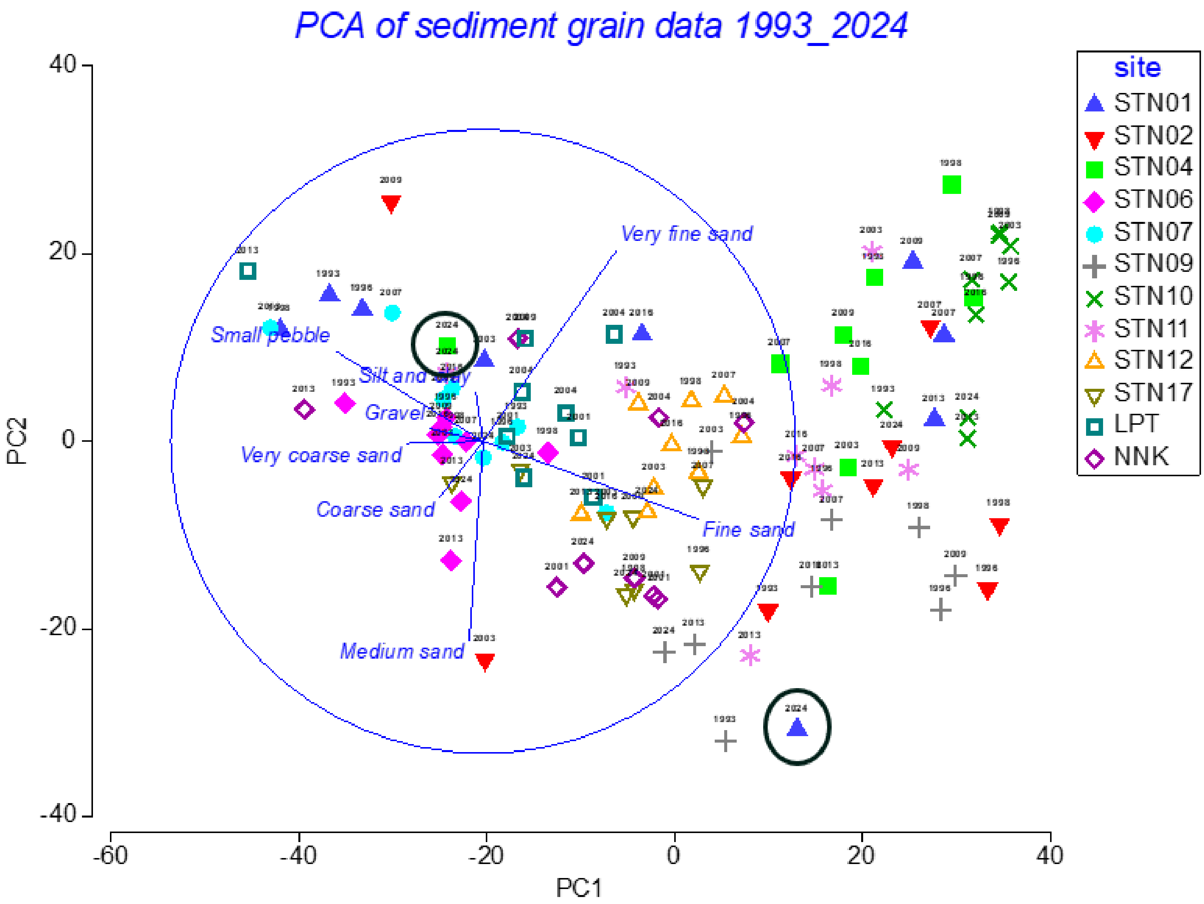


Figure 4.16.5 PCA plot of all the sediment data 2024 stations for sites 1 & 4 circled)



4.16.7 Current Status

- The last five surveys have shown the infauna community to be healthy and species rich.
- There was a suggestion of a decline in species richness in 2009 & 2013, but this increased again in 2024 and compared to other areas of the UK the sediment communities around Skomer MCZ are very diverse.

4.16.8 Recommendations

- Re-survey in 2028.
- Publish results and put the results into context with similar surveys from the surrounding area.

5. Meteorological and Oceanographic Project Summaries

5.1. Meteorological Data

5.1.2. Project Rationale

The weather is an important factor that directly affects species and communities on the shore and in the sub-littoral zone. Climate change is by definition a change in long-term weather patterns, so it is essential to have meteorological data for the site. Meteorological data are used to improve the interpretation of biological changes seen in monitoring projects by putting them into a climatic context. This application of Skomer MCZ meteorological data can also be made for Skomer Island NNR and Pembrokeshire Marine SAC monitoring data.

5.1.3. Objectives

To provide continuous meteorological data for the Skomer MCZ.

5.1.4. Sites

- Old Coastguard station, Wooltack Point, Martins Haven.

  Grid Ref: SM 7588 0922 (51° 44’ 78” N; 005° 14’ 78” W).

5.1.5. Methods

May 1993 to October 2005. A Fairmount EMS1200 weather station was mounted on the coastguard hut. The station included an anemometer, wind vane, air temperature and humidity sensors, shaded and un-shaded solarimeter, net radiometer, barometric pressure sensor and a tipping bucket rain gauge. The data were automatically downloaded to and stored on a computer in the Skomer MCZ office. An uninterruptible power supply was used, but there were occasional problems with data dropout.

April 2006 – current. Installation of a Campbell Scientific Environmental Change Network (ECN) compatible weather station with a CR1000 measurement and control system. Hardware consists of: switching anemometer, potentiometer wind vane, temperature and relative humidity probe, 3 temperature probes (air, ground and below ground), tipping bucket rain gauge, pyranometer, net radiometer, water content reflectometers and barometric pressure sensor.

The CR1000 is capable of storing the data internally, but as with the Fairmount weather station the data are automatically downloaded to a computer in the Skomer MCZ office using “Loggernet” software. The data are saved in three files: daily, hourly and 10 minute intervals.

In January 2009 a rain collector and ammonia detector were added to the equipment suite. Monthly collections were made for precipitation chemistry and atmospheric ammonia concentration records. A GMS communicator has been added to the CR1000 allowing mobile telephone access to the data. This enables the data to be automatically updated into an external website.

5.1.6. Project history relevant to data

A continuous dataset has been maintained since May 1993. However, there are some gaps due to equipment failure. These are: March 1994, January 1998 and from November 2005 to April 2006. The Fairmount weather station was already aging before it was replaced and the solarimeter, net radiometer and rain gauge readings were all unreliable during 2005.

In 2010 the weather station and oceanographic buoy data were put onto a website where they could be viewed and downloaded. This was discontinued when Countryside Council for Wales became part of NRW in 2013. The ammonia tubes were discontinued in 2010 due to a lack of funding.

In January 2012, the rain water chemistry sample was reduced to a 250ml sub-sample.

In January 2014, the anemometer failed and there were no data from 2nd -13th Jan 2014. A new anemometer was installed on the 13th January 2014.

The weather station was serviced by Campbell Scientific in 2012 and 2014. Between 2015 and 2017 there was no service contract in place but there were no problems with the station. In 2018 the weather station was serviced. The rain gauge had failed and the Pyranometer sensor was reading outside the required tolerance.

In 2019 the weather station was dismantled between 18th April to May 25th as the Coastguard hut was being renovated. The rain gauge has continued to give unreliable readings in high winds and 2019 rainfall data have been discarded.

In 2020 the relative humidity probe was unreliable but it was not possible to service the station and therefore the data have not been used. The temperature data collected by the same probe were also discarded.

In 2021 the weather station was serviced (3rd March 2021) and the relative humidity probe was changed. Humidity data were unreliable in January & February. The new relative humidity probe failed again in Oct 2021 and was replaced with a new probe in Nov 2021.

In 2022 the only malfunction on the weather station was seized bearings on the anemometer in February, about 4 days of wind strength records were lost before the bearings were replaced.

In 2023 (6th Apr 2023) a new wind recording system was installed which use sound (Wind Sonic) to measure wind and removes the need for bearings. Both systems are currently running alongside each other so we can compare the readings.

In 2024 WiFi transmitter domes were installed close to the existing anemometer and wind vane making wind data from the old wind system unreliable from 4th Oct 2024 onwards. The wind sonic sensor was moved onto a 3m pole well above the transmitters on 20th Nov 2024. 7th Dec 2024 saw 100mph gusts which damaged the cover of the Air temp & RH sensor. The cover was replaced – no damage or loss of data from the sensors. On 7th December high winds damaged the solar shade on the air temperature probe.

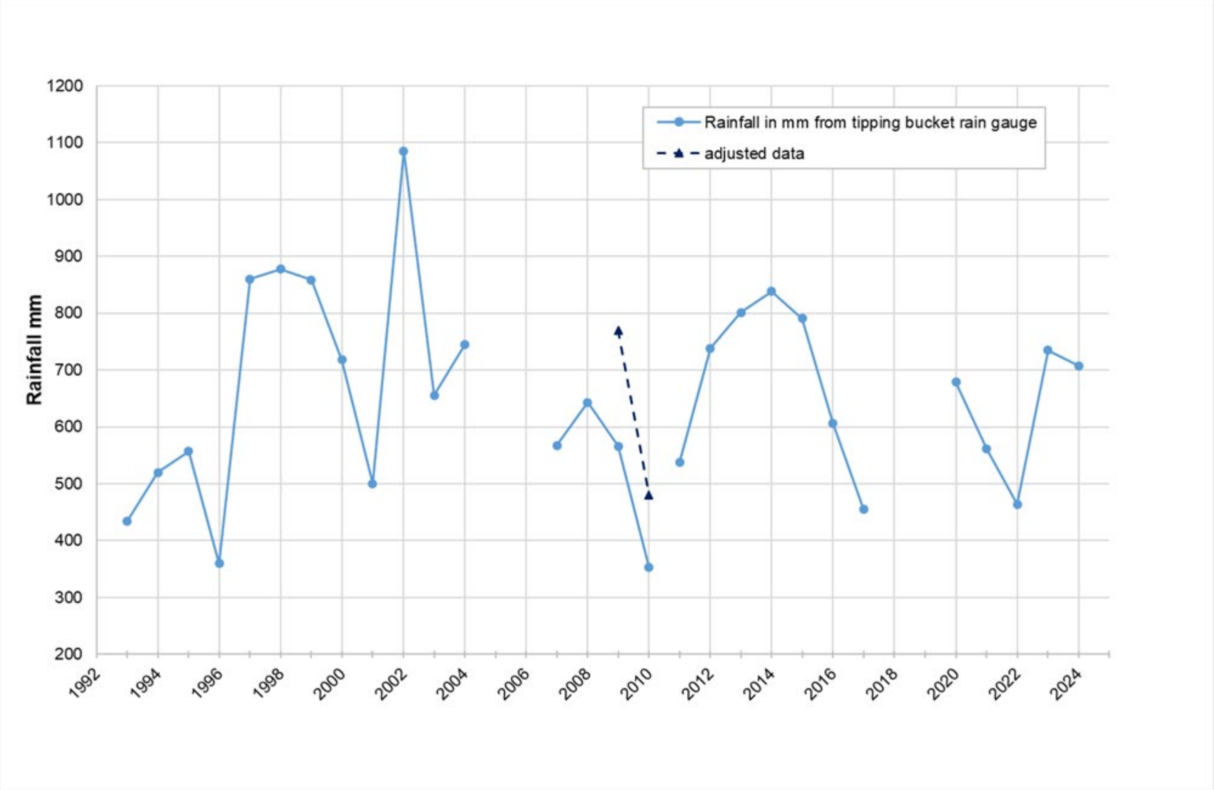
2025 – Weather station was serviced by Campbell Scientific (05/02/2025). In Oct 2025 the rain gauge stopped recording.

5.1.7. Results

Rainfall

The rain gauge was not calibrated properly in 2009 and 2010 so a correction has been added to the records.

Figure 5.1.1 Skomer MCZ automatic weather station total rainfall (mm) data (incomplete data for 2018 & 2019).



The rain gauge was faulty in 2025 and stopped recording in October, therefore

no annual data has been plotted for 2025.

Wind speed and direction

Extreme wind speeds can affect littoral and sublittoral habitats and communities by subjecting them to damaging levels of exposure. Changes in wind direction can also affect normally sheltered habitats.

A radar plot of frequency of wind direction shows that the prevailing winds come from the WSW and this has not changed over the period data have been gathered. The stronger winds (>34 knots) are more bimodal in distribution with peaks from the SSW and the WNW (Figure 5.1.2).

Figure 5.1.2 Skomer MCZ automatic weather station, radar plot average wind direction and strength 1993 – 2025

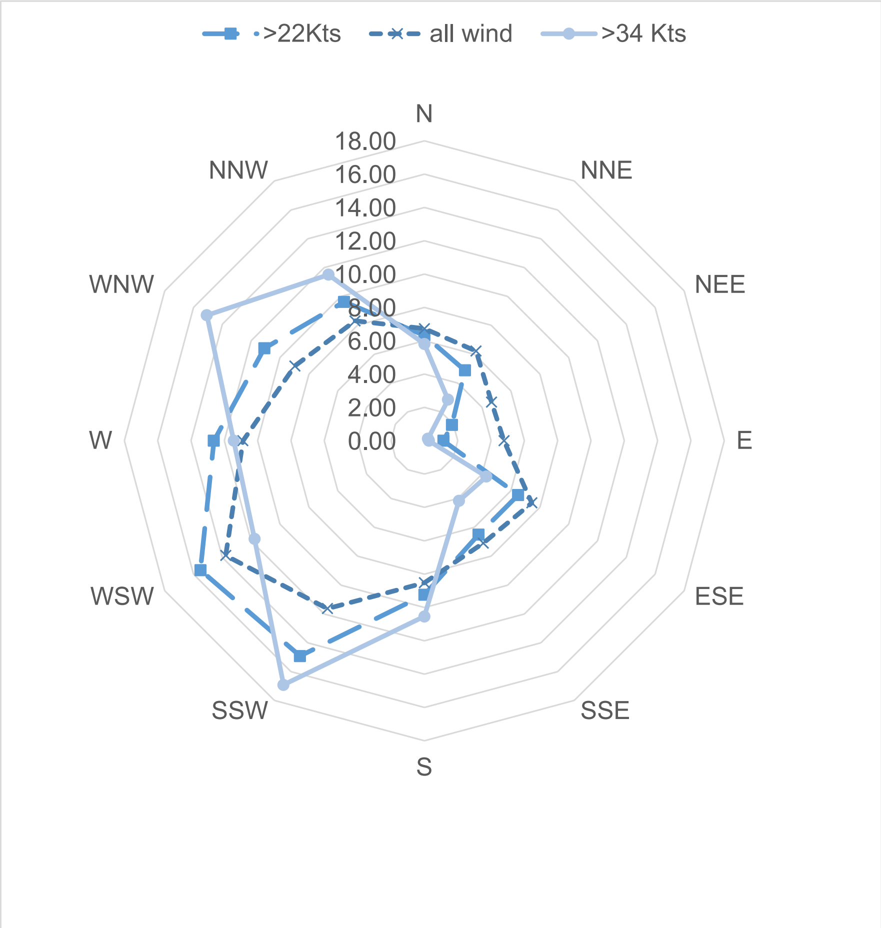
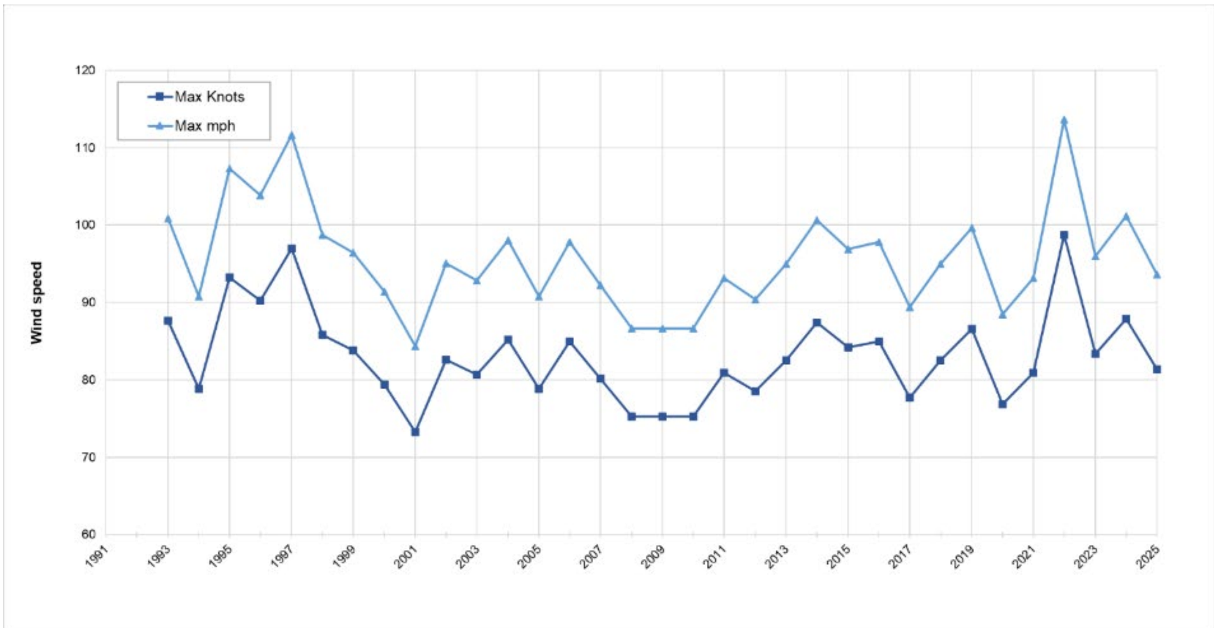


Figure 5.1.3 Skomer MCZ automatic weather station data, maximum wind strength (knots) 1993 – 2025.

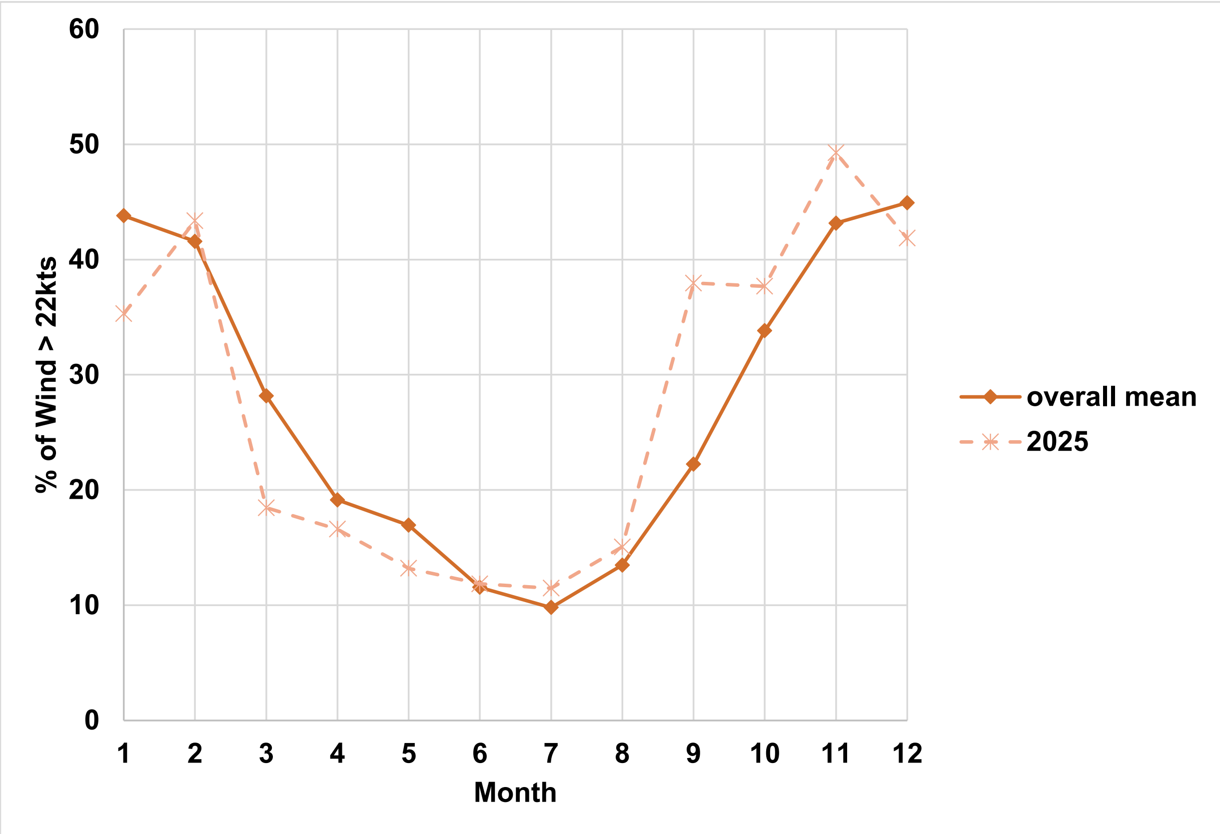


The maximum gust recorded for 2008, 2009 and 2010 was exactly the same (86.6 mph) (Figure 5.1.3). This led to the suspicion that the anemometer bearings were faulty. After the bearings were replaced in 2011 higher gusts were recorded. 2025 saw a maximum gust of 81 mph in January.

In 2022 (18th Feb 2022) Storm Eunice brought some very windy weather and a record reading of 113 mph was recording at 11:00am (Figure 5.1.3). The bearings in the anemometer then seized so no more readings were taken during the storm. Previous to this the highest recorded gust at Wooltack Point was 111 mph on 5th Jan 1997.

The winter months tend to have the highest percentage of strong winds but it is very variable from year to year. Fig 5.1.4 compares 2025 with the overall average wind >22knots for each month of the year (1992-2025). In 2025 wind >22knots was below the overall average for the first half of the year and then slightly above average from June onwards.

Figure 5.1.4 Skomer MCZ automatic weather station data – percentage of wind greater than 22 knots for each month. All years averaged and 2025 data.



2025 follows a similar pattern of wind distribution to the overall mean (1991-2025). Most of the stronger winds come from the SSW, WSW & W (Figure 5.1.5). The east tends to have the lowest percentage of strong winds.

Figure 5.1.5 Skomer MCZ automatic weather station data – percentage of wind over 22 knots from each wind direction.

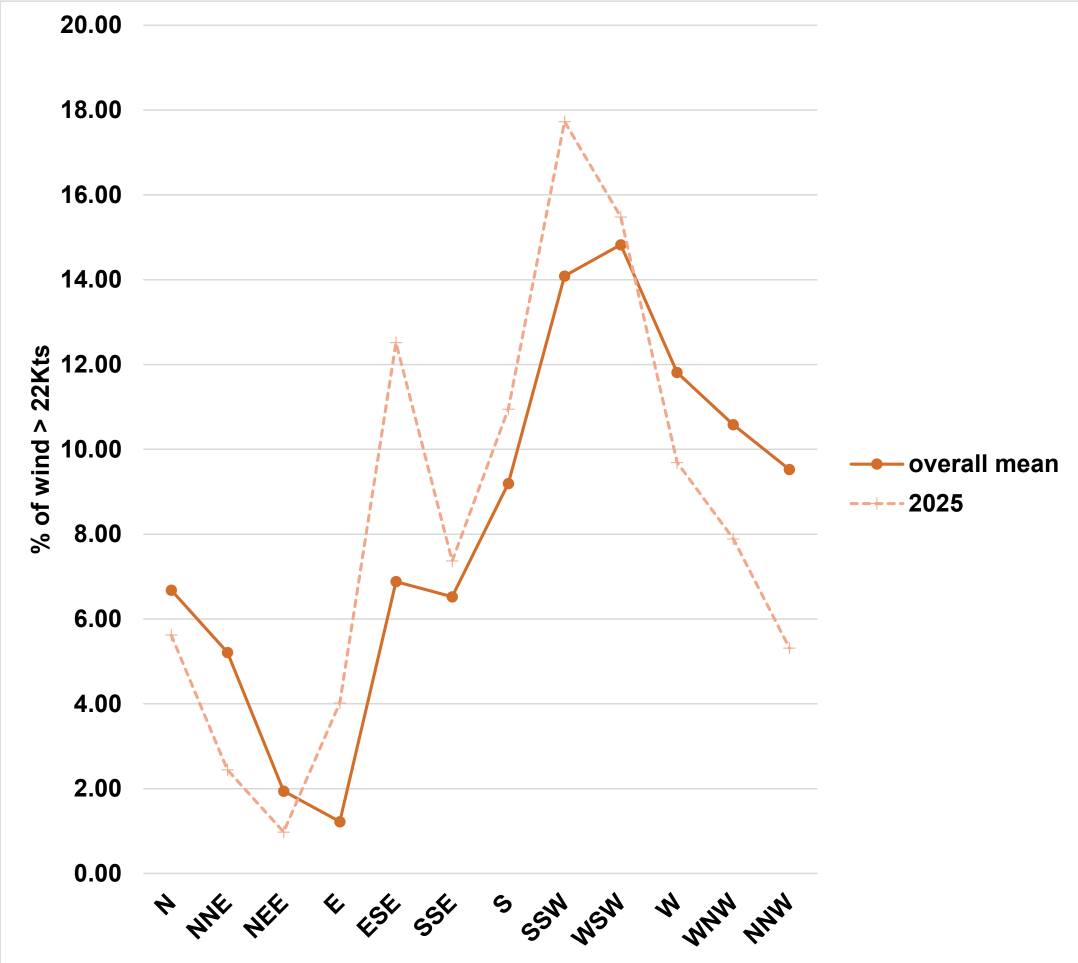
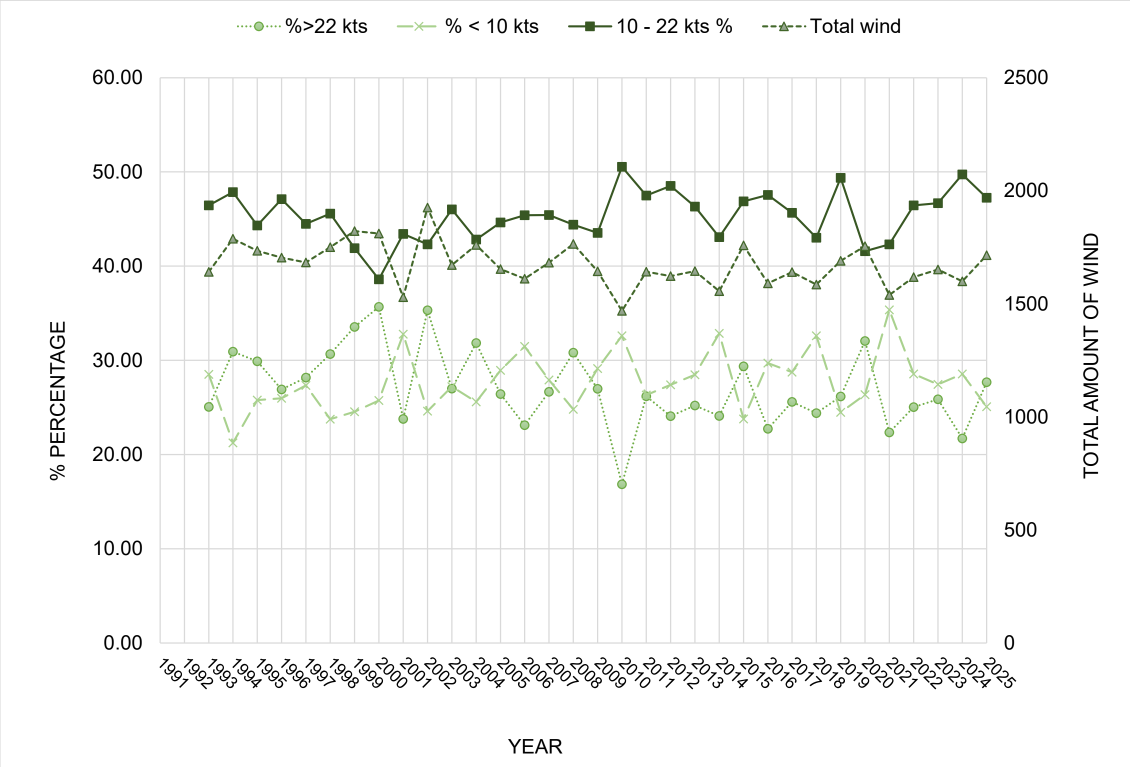


Figure 5.1.6 Skomer MCZ automatic weather station data – “total annual wind” 1993 to 2025.



2002 was the windiest year, with 35% of all the wind greater than 22 knots. 2010 was the calmest year with only 17% of the wind stronger than 22 knots and 33% of the wind less than 10 knots (Figure 5.1.6).

The 2025 annual meteorological summary from the Skomer MCZ automatic weather station is shown in Table More detailed data is available.

Monthly average air temperature, relative humidity and solar radiation results are summarised in 5.1.7 to Figure 5.1.10.

Table 5.1.1 Skomer MCZ automatic weather station – 2025 annual meteorological summary.

Measurement	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean air temp (°C)	7.0	6.9	8.5	10.8	12.6	14.9	16.5	17.1	14.6	12.8	10.9	9.1
Max. air temp (°C)	12.1	11.5	16.2	21.8	20.3	25.5	26.9	25.5	19.9	17.0	15.6	14.1
Min. air temp (°C)	0.5	1.9	3.8	5.1	5.7	10.0	13.0	13.3	9.0	8.9	1.5	2.5
Mean barometric pressure (mb)	999.	1007.8	1005.1	1004.6	1008.0	1004.9	1005.7	1004.9	1001.8	1002.1	996.7	999.6
Max. barometric pressure (mb)	103	1037.0	1029.0	1023.0	1022.0	1022.0	1024.0	1021.0	1024.0	1029.0	1021.0	1029.0
Min. barometric pressure (mb)	954.	983.0	982.0	981.0	989.0	984.0	981.0	982.0	980.0	968.0	976.0	968.0
Mean relative humidity (%)	83.6	85.1	81.1	79.0	82.5	89.1	87.4	82.8	83.1	84.2	86.6	84.5
Max. relative humidity (%)	98.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Min. relative humidity (%)	49.4	57.6	47.1	34.5	48.9	55.1	34.4	42.0	49.8	55.7	56.7	60.4
Total rainfall (mm)	69.2	23.2	15.0	58.0	10.3	40.8	15.6	16.1	11.6	0.0	0.0	0.0
Mean sunshine (kw / m^2)	0.0	0.1	0.1	0.2	0.3	0.2	0.3	0.2	0.1	0.1	0.0	0.0
Sunshine hours	76.0	144.0	252.0	303.0	377.0	353.0	367.0	333.0	251.0	172.0	82.0	71.0
Sunshine hours (10min)	75.0	139.8	249.7	304.3	374.3	351.2	363.5	324.2	241.2	166.7	81.2	68.5
Mean net radiation ($Wm^{-2)}$	-	3.9	23.0	52.7	106.0	109.4	110.5	76.0	39.7	11.3	-9.5	-19.3
Max. wind gust (m/s)	41.8	30.1	22.9	29.3	22.9	24.7	29.5	24.85	35.73	34.9	30.8	33.7
Max wind gust (Knots)	81.4	58.4	44.5	56.9	44.5	47.9	57.2	48.3	69.4	67.8	59.8	65.4
Direction of max wind gusts	252.	165.3	3.1	300.8	223.6	200.0	244.6	218.7	246.1	197.2	254.3	200.6
Days > Force 7 Mean	3	1	0	0	0	0	0	0	1	2	3	3
Days > Force 7 Gust	17	17	11	10	7	12	8	9	19	17	26	20
Days max hr av>Force 7	11	8	1	2	0	2	2	2	5	11	14	12

Figure 5.1.7 Skomer MCZ automatic weather station – monthly average air temperatures 1993 - 2025 with monthly min / max error bars.

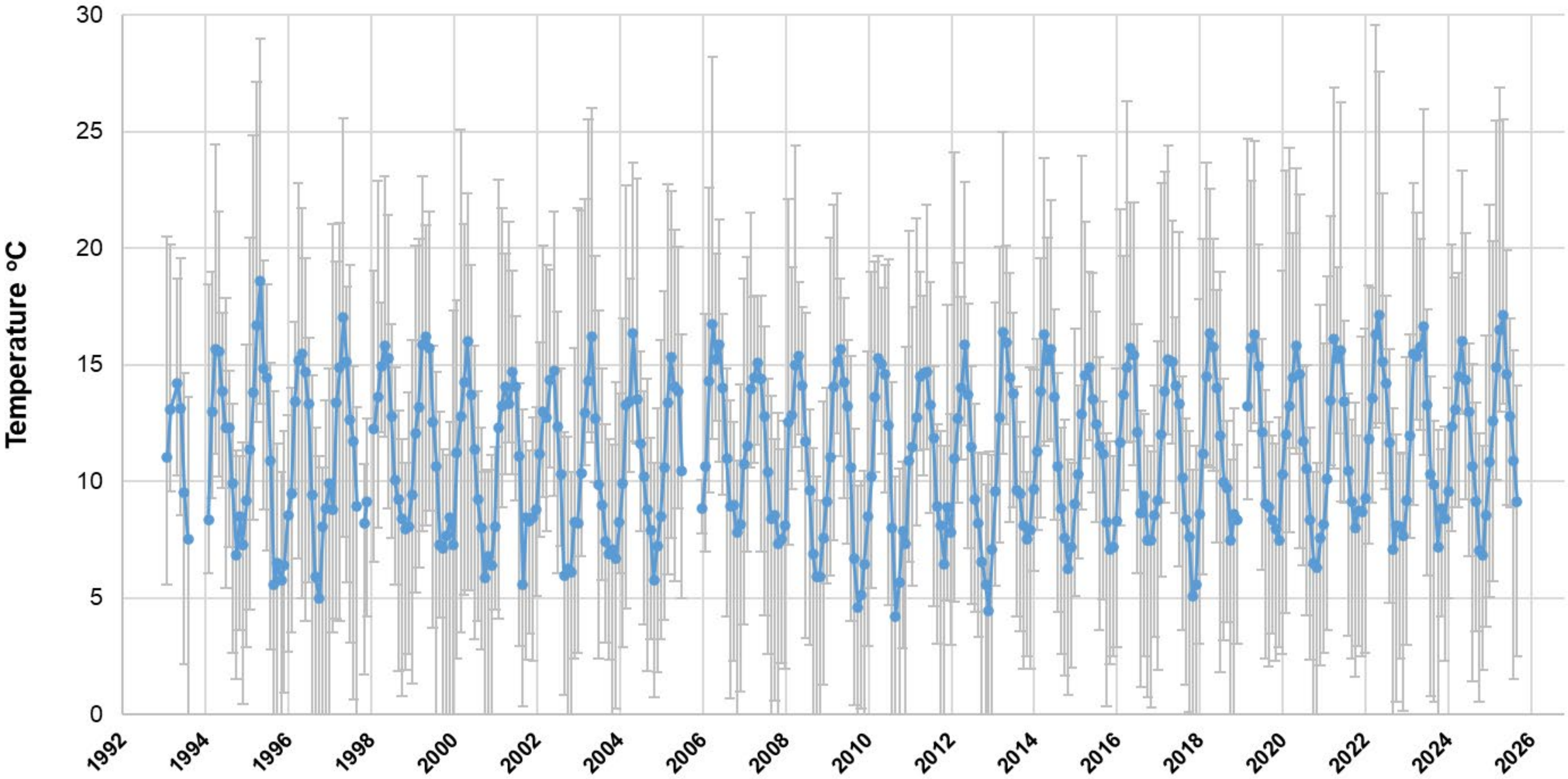


Figure 5.1.8 Skomer MCZ automatic weather station – annual and seasonal mean air temperatures (°C) 2006 – 2025.

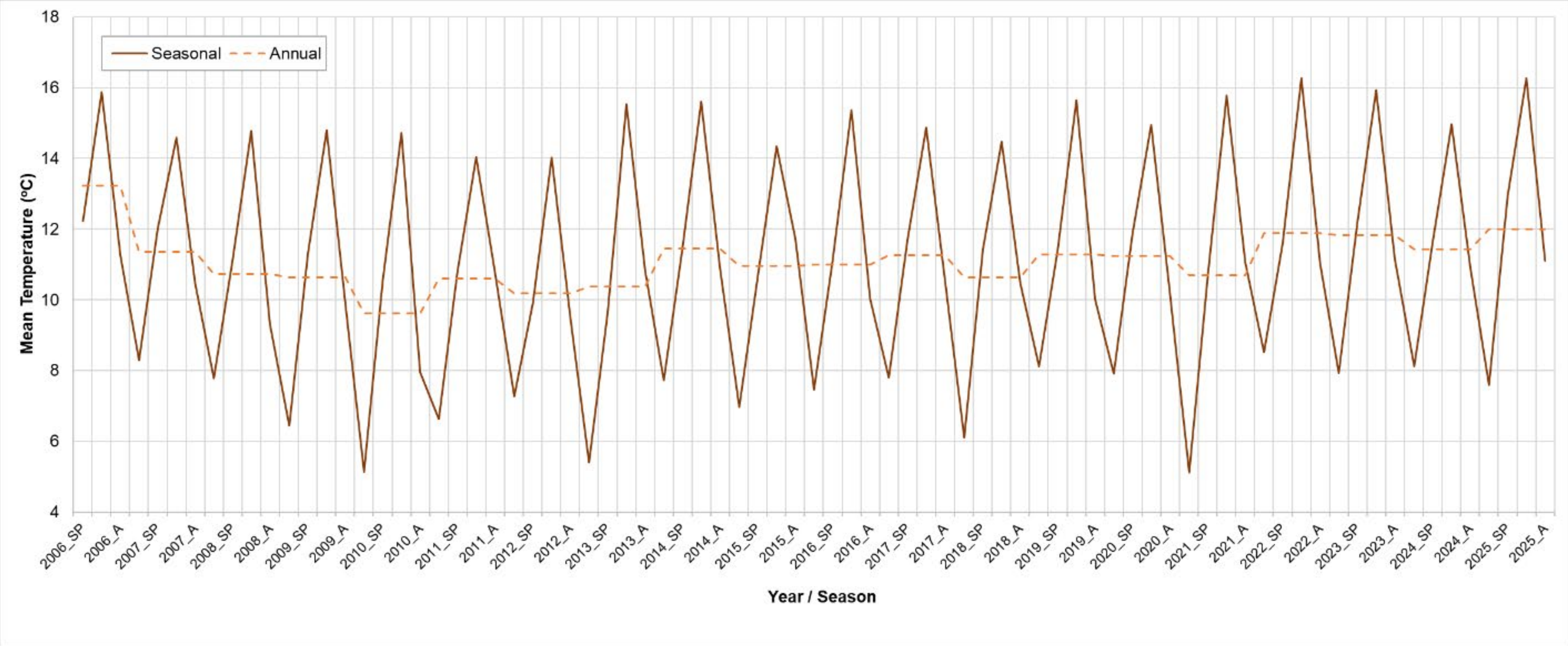
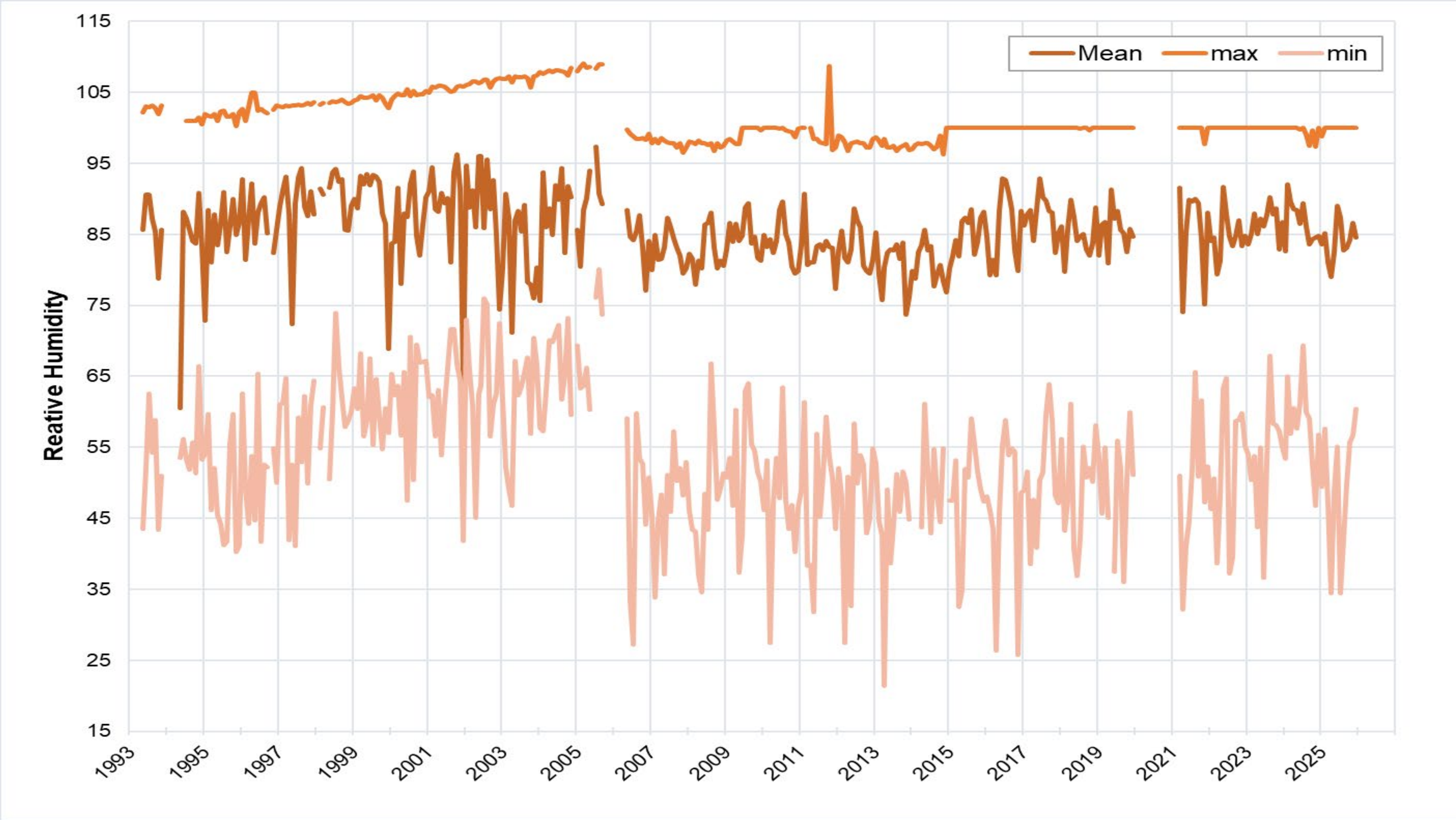
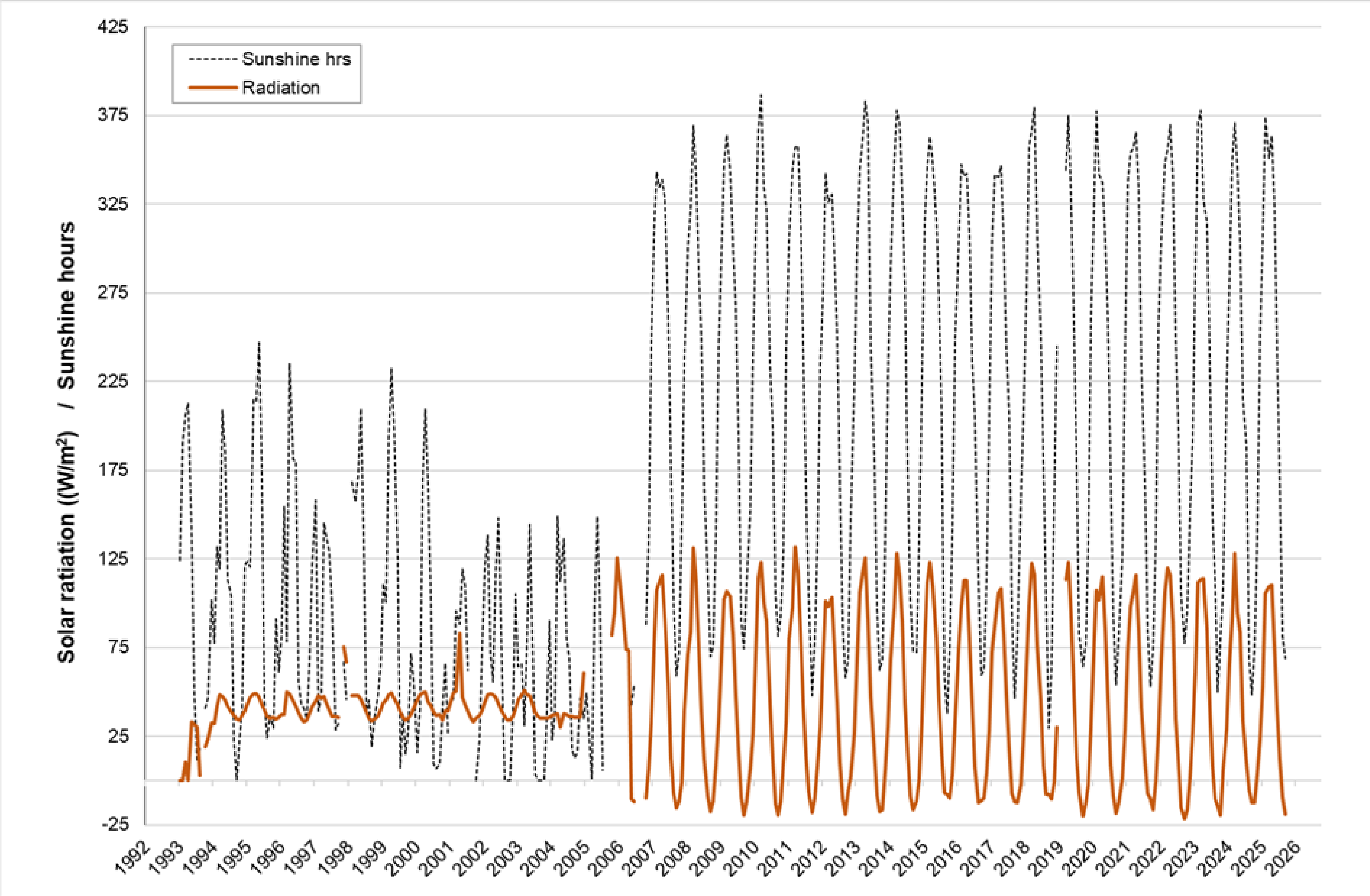


Figure 5.1.9 Skomer MCZ automatic weather station – relative humidity 1993 – 2025.



The increasing trend in relative humidity from 1997 to 2005 could be due to equipment error. From 2006 onwards there is no obvious trend.

Figure 5.1.10 Skomer MCZ automatic weather station – solar radiation (W/m^2) and sunshine hours 1993 – 2025.



There was an obvious change in the data when the weather station equipment was changed in 2006. This is due to a change in the equipment type used.

5.1.8. Current Status

Skomer MCZ weather data demonstrate no significant anomalies other than those attributable to equipment changes or failures.

5.1.9. Recommendations

- Keep meteorological equipment maintained and calibrated.
- Change the bearings in the anemometer every 2 years.
- Make Skomer MCZ meteorological data available via the internet.

5.2. Seawater Temperature Recording

5.2.1. Project Rationale

Temperature is one of the most important physical factors controlling the distribution of living creatures. Climate change has been highlighted as a potential threat to all ecosystems. Data collected at Skomer MCZ are relevant to the Pembrokeshire Marine SAC and potentially to the West Wales Marine SAC for harbour porpoise.

5.2.2. Objectives

- To provide accurate seawater temperature records for near seabed, water column and shore sites.
- To record temperature as continuously as possible to produce an ongoing long-term dataset for the site.

5.2.3. Sites

- Oceanographic Monitoring Site (LL 51.73913 N 5.26976 W).
- Shore sites: Martins Haven, South Haven.
- Non MCZ shore sites: West Angle, Jetty Beach, Castle Beach and Pembroke Power Station outfall.

7.2.4. Methods

Ocean monitoring site (OMS)

- 1992 onwards: a Valeport series 600 MKII CTD probe has been deployed. A drop down CTD probe is used to take a depth profile of temperature at intervals: 1m, 5m, 10m, 15m below sea level and 2m above seabed. This is completed weekly during the field season (March to October).

- 1993 onwards: a Vemco minilog has been attached to a fixed steel frame on the seabed at 19m below chart datum (BCD). The logger maintains a temperature record every hour and is retrieved every six months to download the data. Two loggers are used alternately at the site to allow uninterrupted data.
- 2007: YSI 6600 multi parameter sonde was attached to a fixed steel frame on the seabed (19m below chart datum). It recorded temperature along with salinity, turbidity, dissolved oxygen, chlorophyll and pressure (=depth).
- 2008: the sonde was linked up to a telemetry buoy to provide live 10 minute readings. The data were sent via VHF to the coastguard look-out hut and then onto the Skomer MCZ office via a fibre- optic link.
- 2010: due to ongoing malfunctions in the readings and high levels of maintenance, the YSI sonde was repositioned onto the telemetry buoy. It recorded from 0.6m below the water surface. The telemetry system was changed to a GSM system to allow remote updates to the ECN website.
- Nov 2013: the data buoy was lost in a storm. A replacement logger (Onset watertemp pro v2) was deployed in Martins Haven for the 2013/14 winter period.
- 2014: a new marker buoy for the OMS site was established and a logger attached at 1m below the sea surface.

Shore Sites

- 2007, Onset “Hobo” pendant temperature loggers have been deployed at: Martins Haven and South Haven shores (lower, middle and upper shore).
- Temperature loggers have been deployed at sites outside of the Skomer MCZ as follows:
    - Dale Fort Field Centre: Jetty beach (mid shore) and Castle beach (mid shore).
    - West Angle Bay: upper shore rock pool.
    - Pembroke Power Station outfall: middle shore.

5.2.5. Project history

Seabed temperature is not commonly measured in UK waters, with sea surface temperatures being the most common records. Since July 1999 only 1 month of data are missing from the temperature logger record and since June 2001 there have been continuous hourly records for seabed temperature. By adding in the water profile records there is a fairly complete sea temperature record going back to 1992 (Table 5.1.1). This makes this dataset not only unusual, but highly important not only for putting MCZ/SAC monitoring into context, but also for other applications, including academic and fisheries research.

Table 5.2.1 Valeport series 600 MKII CTD probe water profile records.

Year	Months samples taken
1993	Jan – Dec
1994	Feb – Dec
1995	Jul – Dec
1996	Mar – Dec
1997	Aug – Dec
1998	Mar – Nov
1999	May – Nov

Year	Months samples taken
2000	Mar- Oct
2001	May – Nov
2002	May – Oct
2003	Jun – Sept
2004	May – Oct
2005	May – Oct
2006	Mar – Oct
2007	Apr – Oct
2008	Apr – Dec
2009	Feb – Oct
2010	Mar – Nov
2011	Mar – Nov
2012	Mar – Nov
2013	Apr – Oct
2014	Apr – Nov
2015	Mar – Oct
2016	Apr – Oct
2017	Apr – Oct
2018	Apr – Oct
2019	Apr – Oct
2020	No records
2021	May – Oct
2022	Mar – Dec
2023	Feb – Nov
2024	Jan – Dec
2025	Apr- Nov

Vemco minilog seabed temperature logger deployment:

- Aug 1993 – Nov 1994
- Dec 1996 – Sept 1997
- Jul 1999 – Apr 2001
- Jun 2001 – 8th May 2002
- 30th May 2002 – ongoing (now using Onset Temp Pro V2 logger)

5.2.6. Results

Oceanographic monitoring site

Minimum seawater temperatures are recorded in March, the minimum average for 2000 to 2025 is 7.9 °C, ranging from the lowest of 6.6°C in 2016 to the highest of 9.1°C in March 2024 (1.2°C above the average).

The maximum average seawater temperature for 2000 to 2025 is 16 °C, ranging from the lowest 15.6 °C in 2002 and the highest of 17.5 °C in 2023 and 2025. 2025 records are showing above average minimum and maximum seawater temperatures as shown in Table 5.2.2.

Table 5.2.2 Skomer MCZ maximum and minimum annual seabed temperatures 2000 to 2025 at 19 m below chart datum.

Year	Minimum temperature ºC	Maximum temperature ºC
2000	8.4	16.27
2001	7.27	16.3
2002	8.7	15.6
2003	7.6	17.1
2004	7.7	16. 7
2005	7.36	16.4
2006	7.5	16.3
2007	8.8	16.3
2008	8.4	16.3
2009	7	16.8
2010	6.9	16.8
2011	7.6	15.9
2012	8.0	16.6
2013	6.98	16.8
2014	8.14	16.7
2015	7.8	15.98
2016	8.5	16.8
2017	8.3	16.4
2018	6.6	16.6
2019	8.7	17.2
2020	8.4	16.3
2021	7.3	16.4
2022	8.8	17.1
2023	8.7	17.5
2024	9.1	16.8
2025	8.2	17.5

A summary of the seabed temperature (data from Vemco minilog at 19 m BCD) is shown in Figure 5.2.1. Monthly means have been calculated from seabed temperature but substituted with the CTD probe seabed temperature data where logger data were absent.

Figure 5.2.1. Skomer MCZ summary of monthly mean seabed temperature 1992 – 2025.

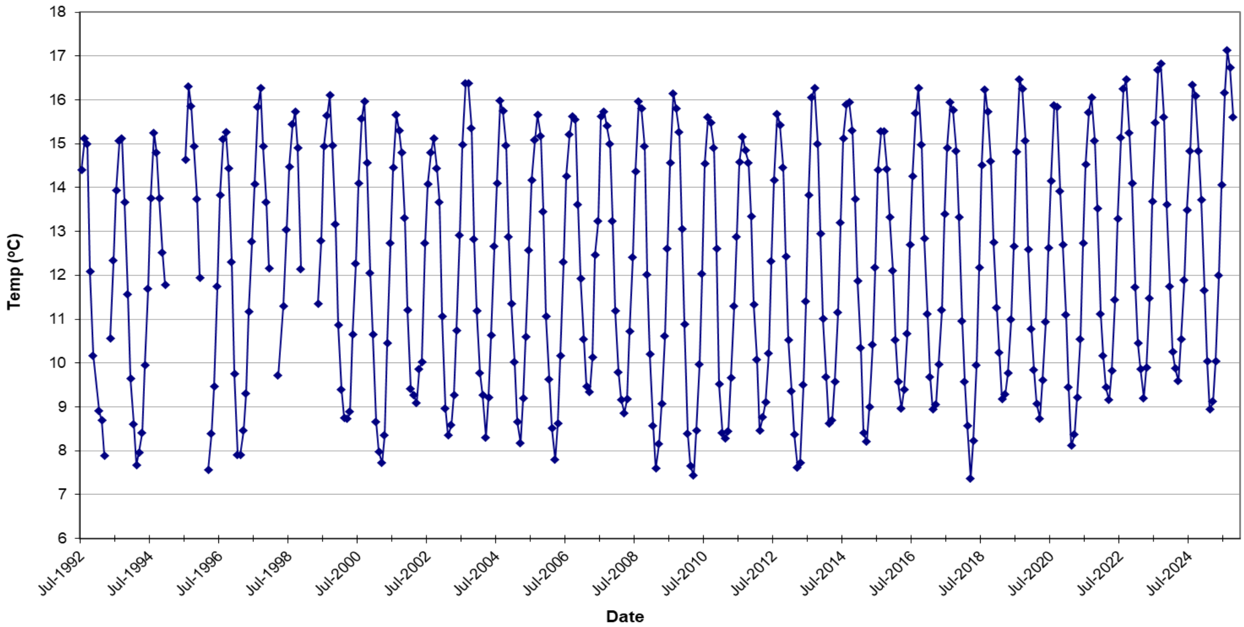
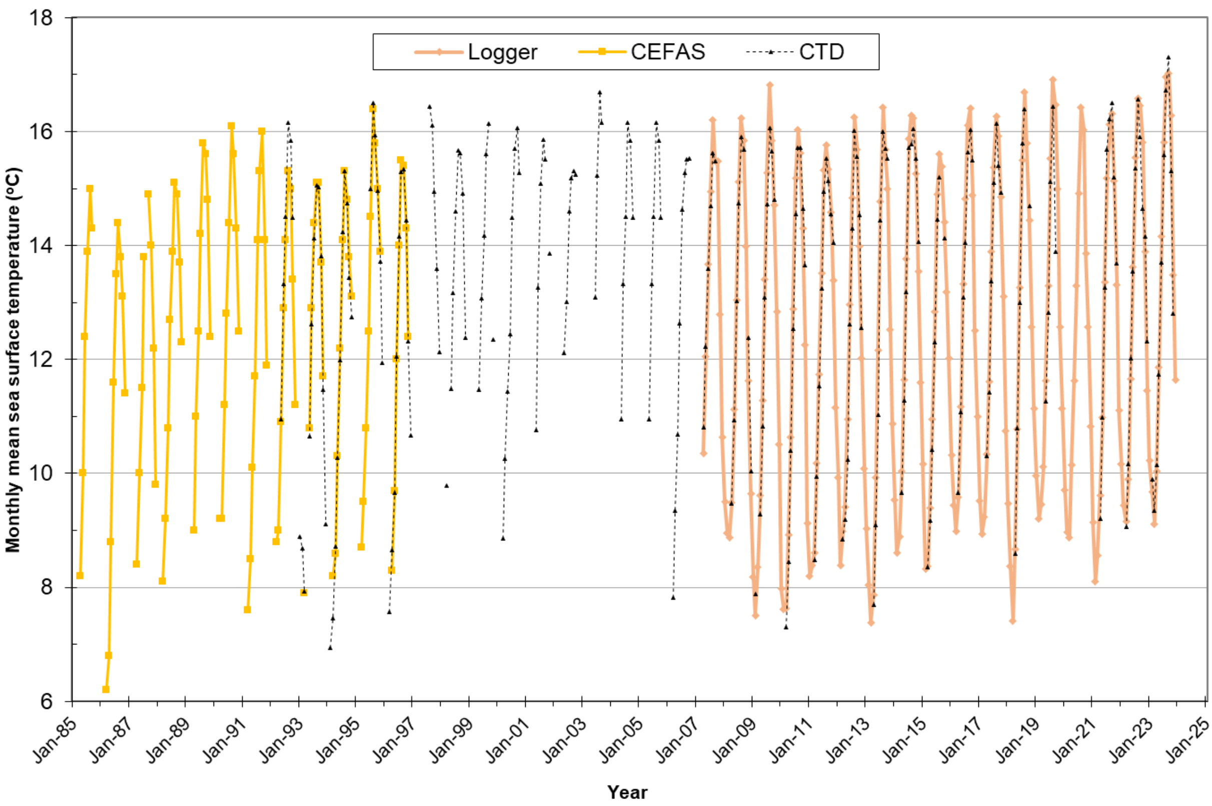


Figure 5.2.2 Skomer MCZ summary of monthly mean sea surface temperature (°C) 1985 – 2025.



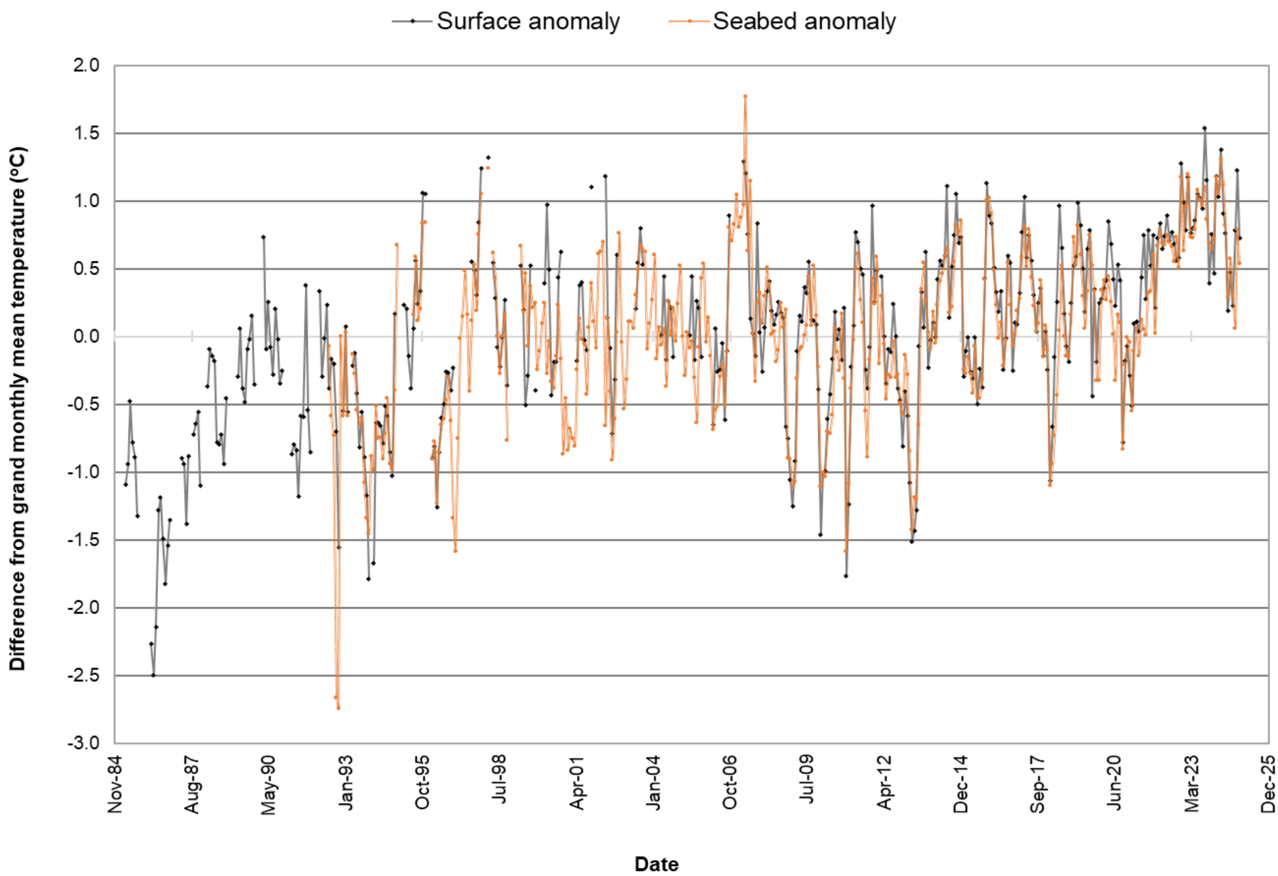
A summary of the sea surface temperature is shown in Figure 5.2.2. This is made up of:

- CEFAS data taken from North Haven, Skomer at high tide and only recorded when the Skomer warden was on site.
- Skomer MCZ drop down CTD probe data from a depth profile at intervals: 1m, 5m, 10m, 15m below sea level and 2m above seabed. Only 1m and 5m are used as sea surface temperature records.
- Mixture of data from shore loggers (when covered by the tide) and YSI 6600 sonde at the OMS site (**logger mean**).

Comparing the overall monthly mean with the monthly mean for each year.

By taking the mean for a specific month across the whole dataset (grand monthly mean) and comparing this with the same month's mean for a specific year (specific monthly mean) the "monthly anomaly" can be calculated. Repeating this calculation for each month of each year in the dataset gives an indication of how cold or warm that particular month was compared to the whole dataset (Figure 5.2.3).

Figure 3 Skomer MCZ sea temperatures – monthly anomaly between the specific monthly mean and the grand monthly mean, surface and seabed anomalies (April 1985 – Dec 2024).

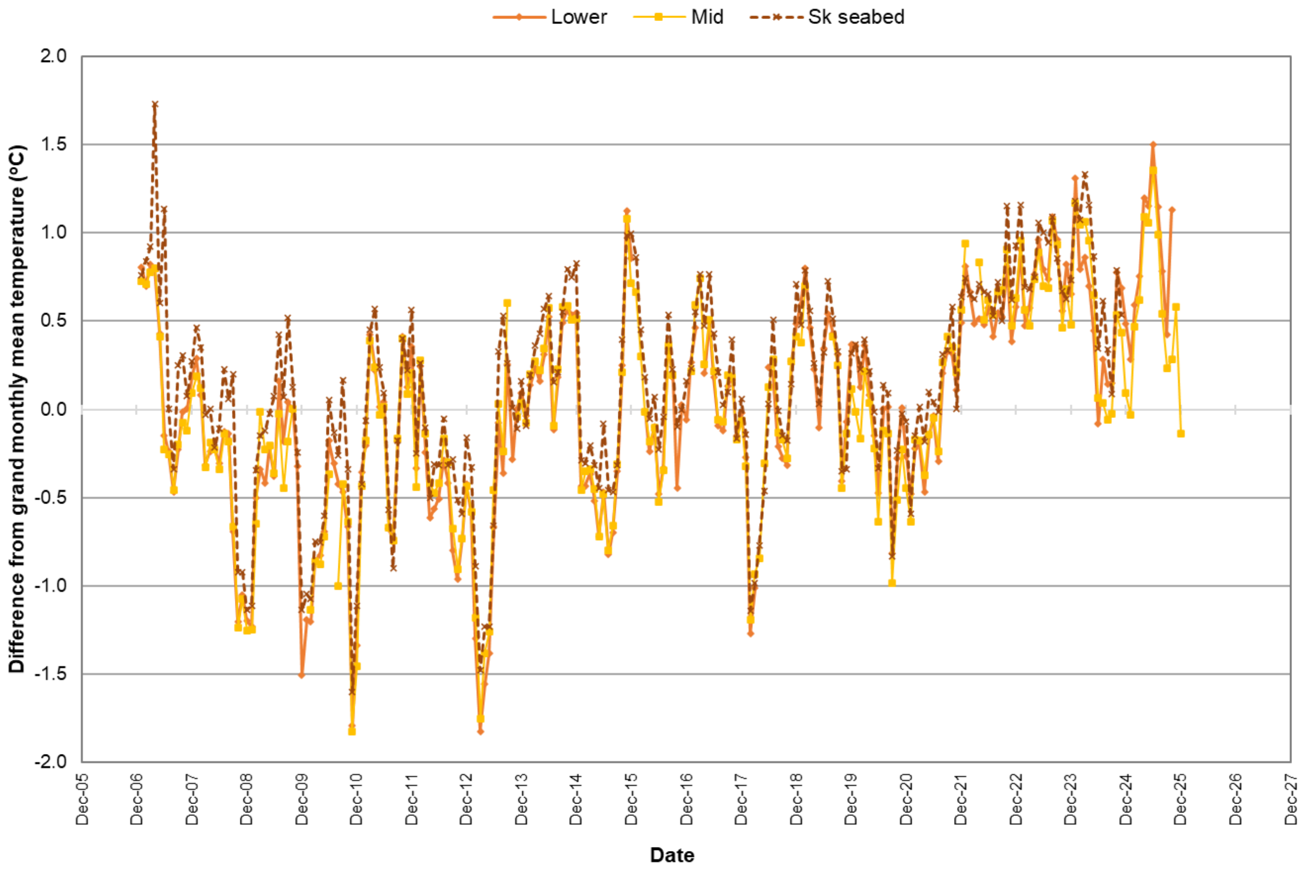


Sea temperatures prior to 1995 were generally colder than average. From 1995 to 2006 there was a warmer period, but from 2006 onwards the data have been very erratic with some very cold winter temperatures but some warm summer temperatures. 2022 to 2025 recorded above average sea temperatures.

Shore monitoring sites

The loggers provide a record of the temperature regime experienced by sessile organisms in the intertidal zone. The data can be split into periods of immersion under water and exposure in the air. The immersed period can be used as a record of sea surface temperature. The data from the intertidal loggers follow a very similar trend to the logger recording on the seabed at Skomer.

Figure 5.2.4 Martins Haven intertidal temperature loggers - monthly anomaly between the specific monthly mean and the grand monthly mean, Lower shore, middle shore and seabed anomalies (2006 – 2025).



This data is a subset of the temperature logger data taken when the logger is immersed in water. 2022 to 2025 temperatures have been consistently higher than average.

5.2.7. Current Status

There does not appear to be any long-term trend in sea water temperatures, but the last 4 years (2022 to August 2025) have been consistently warmer than average (see figs 5.2.3 & 5.2.4.). The highest ever Skomer sea bed temperature was recorded at 17.5 °C in both 2023 and 2025 and the highest annual minimum temperature of 9.1°C was recorded in March 2024 (1.2°C above the average).

5.2.8. Recommendations

- Continue dataset to form a long-term record of variation in seabed temperature at Skomer MCZ.
- Keep the dataset as complete as possible. An additional logger running at the same time would add redundancy into the methods should the equipment fail or get lost.

5.3. Seawater Turbidity / Suspended Particulates and Seabed Sedimentation

5.3.1. Project Rationale

Coastal waters are naturally turbid but this turbidity can change due to anthropogenic activities such as dredge spoil dumping or freshwater run-off from poor land management. Turbidity can also increase due to high phytoplankton levels. Increases in turbidity have the potential to adversely affect many of the species of the Skomer MCZ which depend upon filter feeding strategies that can become "clogged" with metabolically useless material or others that depend on photosynthesis and are affected by lack of light penetration through seawater.

Historically, at Skomer, high deposition levels of fine sediments have been observed to partially or completely bury certain sessile life forms, preventing them from feeding and, in the longer term, killing them.

5.3.2. Objectives

The project aims to provide a long-term record of sediment load in the water column in the Skomer MCZ and levels of deposition of sediment on the seabed.

5.3.3. Sites

- Oceanographic Monitoring Site (OMS): (51.73913 -5.26976) north side of Skomer (1992)
- Thorn Rock (TRK): (51.73329 -5.27369) south side of Skomer (2004)

5.3.4. Methods and Project History

- Secchi disk measurements: the depth to which a white 30cm diameter Secchi disc can be seen through the water column has been recorded during the field season since 1992 at OMS and, since 2004, at Thorn Rock.
- Suspended sediment sampler (pump driven): fixed to the frame on the seabed at OMS site between 1994 and 1997, but with limited success.
- Passive sediment traps: these have been deployed at each site since 1994 (Table 5.3.1). Sediment dropping out of the water column is collected into a pot. The sample pots are changed every 2 weeks during the field season, and the sediment samples are frozen. These are then analysed for dry weight, organic content, particle size analysis (PSA) and heavy metal content.
- Optical turbidity probe: A Seapoint OEM turbidity probe connected to an Idronaut data logger was fixed to the frame on the seabed at the OMS site from 2002 to 2007. The length of time deployed varied and there were varied levels of success. This was replaced by YSI 6600 multi-parameter sonde in 2007.
- YSI 6600 multi-parameter sonde was fixed to the frame on the seabed at the OMS site in 2007. The sonde includes an optical turbidity probe. This has been deployed several times to date and again, with varying levels of success. From 2010 onwards

the YSI sonde was repositioned to a surface mounting on the OMS buoy taking readings 0.6 m below the surface. This was discontinued in 2013.

Table 5.3.1 Skomer MCZ sediment trap sampling effort from 1994 to 2025 at OMS and Thorn Rock (TRK).

Year	Months with samples	Sites	Notes
1994	Jul – Dec	OMS & TRK	None
1995	Jan – Dec	OMS & TRK	None
1996	Feb – Dec	OMS & TRK	None
1997	Mar – Dec	OMS & TRK	None
1998	Mar – Sep	OMS & TRK	None
1999- 2001	No samples	None	Re-established 02 Nov 2001
2002	Mar – Nov	OMS & TRK	TRK site damaged
2003	May – Sep	OMS only	None
2004	May – Sep	OMS only	None
2005	Jun- Oct	OMS only	Collector damaged
2006	Jun - Oct	OMS & TRK	Repaired and TRK re-established
2007	May - Sep	OMS & TRK	None
2008	May - Sep	OMS & TRK	None
2009	Apr - Sep	OMS & TRK	Shell fragments in samples.
2010	Apr - Sep	OMS & TRK	None
2011	Apr - Nov	OMS & TRK	None
2012	Apr - Sep	OMS & TRK	None
2013	Apr - Oct	OMS & TRK	New Lab used
2014	Apr - Oct	OMS & TRK	None
2015	Apr - Oct	OMS & TRK	None
2016	Apr - Oct	OMS & TRK	None
2017	Apr - Oct	OMS & TRK	None
2018	Apr - Oct	OMS & TRK	None
2019	Apr - Oct	OMS & TRK	None
2020	No Samples	None	None
2021	May - Oct	OMS & TRK	None
2022	Apr - Sep	OMS & TRK	Collectors still on seabed
2023	Apr - Oct	OMS & TRK	None
2024	Jan - Aug	OMS & TRK	None
2025	May - Sep	OMS & TRK	None

5.3.5. Results

Turbidity

Secchi disc: Measurements have been taken with reasonable consistency for the months of May to October since 1992.

TRK and OMS follow a very similar trend over time suggesting that the waters on the north and south side of the island are well mixed. This rather dynamic picture can be simplified by calculating the mean Secchi disk value for each year as shown in Figure 5.3.3 a & b.

The Secchi disc readings for Thorn Rock in 2014 were the lowest in the MCZ records. There were very high levels of silt deposited on the south side of the MCZ during the winter storms and it is thought that this silt was continually being re-suspended into the water column throughout the year. In 2015 and 2016 the readings had returned towards average levels but in 2017 there was a drop in water clarity at both OMS and TRK. Water clarity then improved in 2018 since then there has been a drop in water clarity at both sites continuing in 2023. 2024 saw an improvement in water clarity but a slight drop was again recorded in 2025 as shown in Figure 5.3.2(a) for the OMS site and Figure 5.3.2(b) for the TRK site.

Figure 5.3.2 (a) Skomer MCZ summary of annual mean Secchi disc data (m) for OMS site with standard error bars 1992 – 2025

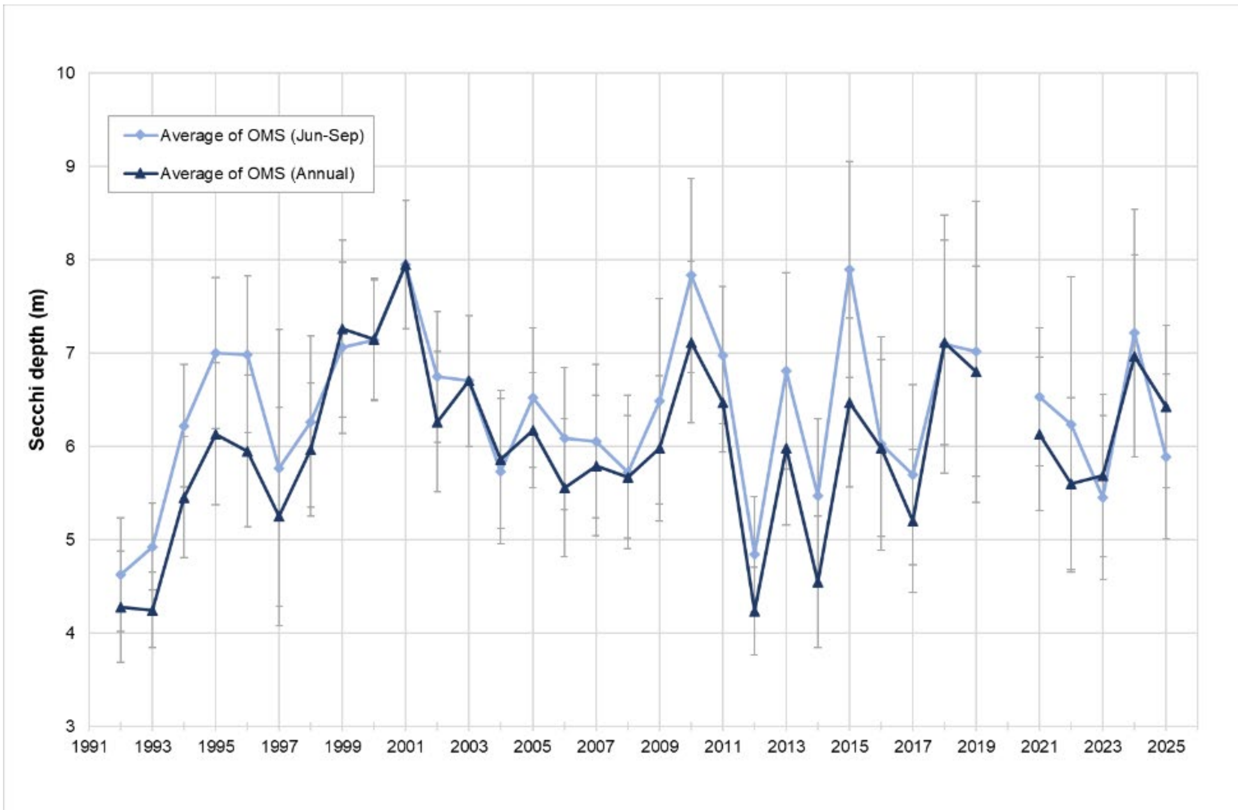
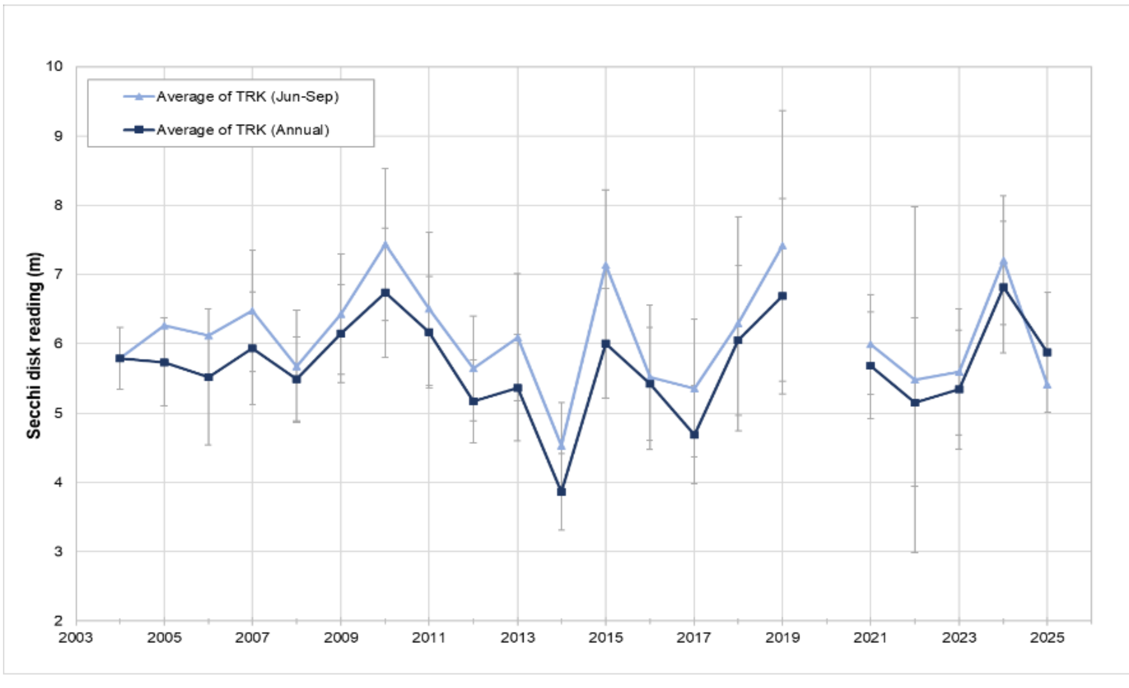


Figure 5.3.2 (b) Skomer MCZ summary of annual mean Secchi disc data (m) for TRK site with standard error bars 2004 – 2025.



Seabed sedimentation

Passive sediment traps: The samples from the sediment traps were analysed for: dry weight, organic content, particle size analysis (PSA) and metal content. Results for 1994 to 2022 from Thorn Rock are shown in Table 5.3.2 and for OMS in Table 5.3.3. The combined results for the two sites are shown in Figure 5.3.1. The 2025 samples are currently being analysed and this data will be available in 2026.

Table 5.3.2 Skomer MCZ sediment trap sample analysis from Thorn Rock (TRK) site (1994 to 1998 % sand data estimated).

TRK	g/day	% organic content	% gravel	% sand	% mud
1994	3.32	9.80	0.10	16.83	83.07
1995	5.76	8.59	0.41	55.76	43.83
1996	3.53	9.90	0.21	22.56	77.23
1997	5.81	9.43	No Data	No Data	No Data
1998	4.15	10.25	0.23	23.89	75.89
2002	2.44	7.61	0.00	61.63	38.36
2006	1.74	8.65	0.00	60.35	39.65
2007	1.54	7.73	0.00	69.81	30.19
2008	1.91	7.13	0.00	78.39	21.23
2009	1.78	8.66	0.00	44.06	55.94
2010	2.73	7.70	3.66	79.47	16.67
2011	1.51	9.31	2.73	68.80	24.61
2012	2.96	7.55	1.43	41.12	57.08
2013	2.53	15.34	3.14	35.04	61.86
2014	2.67	13.33	0.18	31.04	68.77
2015	3.26	11.18	2.23	51.32	46.47
2016	2.01	10.85	1.07	51.33	45.21
2017	2.48	11.12	0.47	39.20	56.07
2018	1.92	10.80	0.93	33.25	62.67
2019	2.71	9.14	1.66	32.06	52.99
2020	No Data	No Data	No Data	No Data	No Data
2021	1.14	9.15	0.86	31.47	65.43
2022	1.87	10.10	0.08	29.61	68.16
2023	3.58	11.5	6.50	40.38	51.59
2024	1.49	11.98	0.98	20.60	77.58

Table 5.3.3 Skomer MCZ sediment trap sample analysis from OMS site (1994 to 1998 % sand data estimated).

OMS	g/day oms	% organic content	% gravel	% sand	% mud
1995	2.17	9.33	7.37	18.56	74.07
1996	2.16	9.95	0.40	17.08	82.52
1997	1.69	9.64	0.18	20.43	79.40
1998	1.25	9.24	5.08	42.73	52.19
2002	1.05	7.91	0.17	73.51	26.32
2003	1.29	8.14	0.37	79.54	20.09
2004	1.91	7.90	0.00	75.27	24.72
2005	2.20	8.80	0.00	76.86	23.14
2006	2.33	8.79	0.00	76.80	23.21
2007	2.94	7.05	0.00	74.93	25.07
2008	0.56	7.34	0.00	81.48	18.23
2009	0.68	8.90	0.00	47.27	52.73
2010	1.75	7.66	4.93	77.99	16.88
2011	1.26	9.73	4.36	60.54	30.81
2012	2.00	7.87	9.12	45.39	45.14
2013	1.01	13.79	26.48	32.25	41.30
2014	2.46	13.57	10.55	48.65	40.11
2015	2.61	13.80	25.94	43.63	30.34
2016	0.79	12.38	5.54	53.42	29.51
2017	1.36	11.72	2.99	47.80	40.50
2018	1.31	13.30	5.00	36.77	35.55
2019	1.39	8.48	6.16	20.70	40.79
2020	No Data	No Data	No Data	No Data	No Data
2021	0.91	9.84	2.38	32.31	57.40
2022	1.05	10.40	1.67	25.19	54.76
2023	1.25	14.73	26.43	40.42	32.57
2024	1.47	14.03	15.12	20.45	62.00

The samples from 2002 to 2012 were analysed by British Geological Society (BGS). In 2013 the sediment samples were sent to the NRW Llanelli laboratories for analysis, using a different set of analysis tools / machines to BGS (no data recorded for sand in 1995 – 1998).

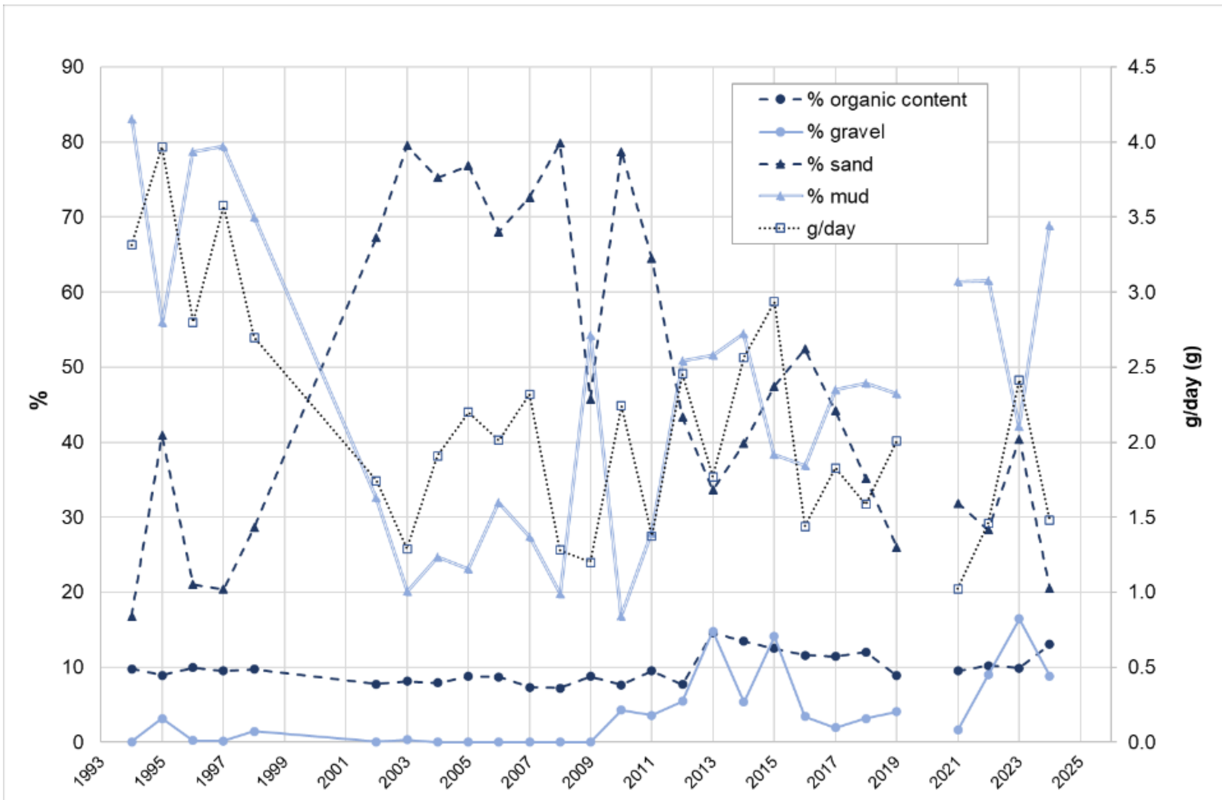
Another change in 2013 was that the organic content analysis included heating the sample to 550°C rather than 450°C resulting in more carbonates being included in the % organic content. This explains the sudden rise in the 2013 values. The ignition temperature used from 2014 onwards at the NRW laboratories is 480°C.

The NRW laboratories carry out a slightly different suite of metals analysis, but it is more comprehensive: cobalt and antimony are not done but manganese, mercury, lithium, aluminium, barium, tin and iron are all now added to the metal analysis. This data is available on request.

The methodology for quantifying the coarse (gravel) element of the PSA has also changed.

PSA for the sand fraction for 1995 to 1998 is estimated and the 2009 PSA results have been adjusted to remove the effect of large amounts shell fragments contaminating the samples.

Figure 5.3.5 Skomer MCZ sediment trap total sediment sampled, PSA and organic content analysis – OMS and Thorn Rock sites combined 1994-2024.



General trends: 1994 to1998 samples were characterised by higher mud content to sand content. 2002 to 2008 samples had higher sand content to mud content and a reduced overall sedimentation rate overall, whereas from 2009 the trend has reverted to higher mud content and higher levels of gravel (Figure). The settlement rate of sediment was higher in the 1990's (3-4g/day) this dropped in the 2000's to fluctuate between 1.2 – 3g/day. 2021 saw the lowest settlement rate (1 g/day).

5.3.6. Current Status

- The Secchi disc method works well and has provided the most reliable and meaningful estimate of turbidity. The dataset will become more useful the longer the time series of data runs for.
- The passive sediment traps work well and provides a sample that can be analysed in the future (this may be useful in the event of a pollution incident).
- The optical turbidity probe has proved unreliable and difficult to interpret. It also lacks the sensitivity needed for the type of sediment load encountered at Skomer.
- Results from the particle size analysis of sediment trap samples reflect the turbidity data from the Secchi disk in that high levels of water turbidity occur in years when finer sediments are being deposited in the sediment traps (and therefore on the seabed).
- In the early 1990s, high sediment deposition and turbidity were of sufficient concern to prompt the re-evaluation of dredge spoil disposal management from Milford Haven and this appeared to have had a beneficial effect. Dredge spoil disposal techniques and locations have not changed again, but sediment deposition and turbidity have occasionally reverted to levels not seen since the early 1990s.

5.3.7. Recommendations

- Continue the Secchi disk readings as often as possible to continue the long-term dataset.
- Continue passive sediment trap collection for particle size analysis and metals analysis.
- Access the WFD chlorophyl data for Skomer water samples to help monitor primary productivity in the plankton (see Section 4.13), but also to enable turbidity due to phytoplankton to be factored into the interpretation of overall turbidity data.

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