Cyfoeth Naturiol Cymru
Natural Resources Wales

# Skomer Marine Conservation Zone Project Status Report 2016

K. Lock, M. Burton, P. Newman, J. Jones

NRW Evidence Report No. 197

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

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# Contents

# 1. Crynodeb Gweithredol

Dyma'r unfed adroddiad ar bymtheg ar statws y prosiect a luniwyd gan Barth Cadwraeth Morol Sgomer. Mae'n crynhoi cynnydd a statws presennol prosiectau monitro ym Mharth Cadwraeth Morol Sgomer yn ystod 2016. Mae'r prosiectau hyn nid yn unig yn darparu'r dystiolaeth sydd ei hangen i adrodd ar gyflwr y Parth Cadwraeth Morol ei hun, ond maent hefyd yn gwneud cyfraniad pwysig at y dystiolaeth a ddefnyddir i asesu cyflwr a statws cadwraethol Ardal Cadwraeth Arbennig Sir Benfro Forol, y lleolir y Parth Cadwraeth Morol oddi mewn iddi. Ymhellach, mae data hirdymor Parth Cadwraeth Morol Sgomer, biolegol yn ogystal â defnydd pobl, wedi cael ei ddefnyddio i sefydlu ac adrodd ar ddangosyddion biolegol ar gyfer gofynion y DU dan Gyfarwyddeb Fframwaith y Strategaeth Forol. Nodir yr achosion penodol hynny lle y cafodd data Parth Cadwraeth Morol Sgomer ei ddefnyddio i ategu mentrau eraill ac eithrio'r rheini sy'n uniongyrchol gysylltiedig â'r Parth Cadwraeth Morol yng nghrynodebau'r prosiectau unigol.

Mae'r tablau statws yn Adran 3 yn crynhoi'r holl brosiectau monitro sefydledig yn y Parth Cadwraeth Morol. Mae Adran 5 yn nodi prosiectau biolegol y gweithiwyd arnynt yn ystod 2016 a cheir crynodeb o'r canlyniadau hyd yn hyn. Yn Adran 6 ceir crynodeb o'r prosiectau gwyliadwriaeth eigionegol a meteorolegol.

Digwyddiadau nodedig yn nhymor maes 2016:

- Cwblhawyd arolwg o gymuned isfilod y gwaddodion ar gyfer y Parth Cadwraeth Morol gan ychwanegu at y gyfres amser a gychwynnwyd yn 1993. Dengys y canlyniadau gynnydd yn amrywiaeth y rhywogaethau, gyda 142 o rywogaethau newydd wedi'u cofnodi. Cyfanswm y nifer o rywogaethau a gofnodwyd yng ngwaddodion y Parth Cadwraeth Morol er 1993, felly, yw 1123.

Cwblhawyd arolwg o'r gragen fylchog *Pecten maximus* dros ddau benwythnos gyda thîm o ddeifars gwirfoddol. Cwblhawyd 60 o drawsluniau. Arolygwyd cyfanswm o 8620 $m^2$ a chafodd 2534 o'r cregyn bylchog hyn eu cyfrif a'u mesur. Amcangyfrifwyd bod dwysedd cyfartalog y cregyn bylchog oddi mewn i'r Parth Cadwraeth Morol yn 35 o gregyn bylchog / 100$m^2$, sef cynnydd ers yr arolwg diwethaf a gynhaliwyd yn 2012.

- Darganfu'r arolwg blynyddol o fôr-wyntyll *Eunicella verrucosa* bod nifer o fôr-wyntyllau wedi cael eu colli. Cadarnhawyd bod tair o fôr-wyntyllau naturiol a dwy o fôr-wyntyllau a oedd wedi'u hailosod yn artiffisial wedi cael eu colli yn 2015 a bod 10 o fôr-wyntyllau eraill ar goll yn 2016 (5 o golledion pendant a 5 i'w cadarnhau yn arolwg 2017). Gwelwyd yr holl golledion pendant ar safle Bull Hole.

Rhwng Awst a Rhagfyr cwblhawyd arolwg o forloi llwyd bach a anwyd ar yr ynysoedd a'r tir mawr. Yn 2016, ganwyd 202 o forloi bach ar yr ynysoedd a 143 ar y tir mawr. Felly, ganwyd cyfanswm o 345 o forloi bach yn y Parth Cadwraeth Morol a goroesodd 73.3% o'r rhain drwy'r cyfnod bwrw blew. Mae nifer y morloi bach a anwyd ym Mharth Cadwraeth Morol Sgomer yn ystod y 5 mlynedd diwethaf wedi dangos y cyfansymiau uchaf a gofnodwyd ar gyfer yr ardal, gyda 345 o forloi bach wedi'u geni ar gyfartaledd ar gyfer 2012-16.

## 2. Executive Summary

This is the sixteenth project status report produced by the Skomer Marine Conservation Zone. It summarises the progress and current status of monitoring projects in the Skomer MCZ during 2016. 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 Are of Conservation, within which the MCZ is situated. Skomer MCZ long-term data, biological as well as human use, has also been used in establishing and reporting on biological indicators for UK requirements under the Marine Strategy Framework Directive (MSFD). Specific cases where Skomer MCZ data has 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 3 provide a summary of all established monitoring projects in the MCZ. Section 5 details biological projects that were worked on during 2016 and a summary of the results to date. Section 6 provides a summary of the oceanographic and meteorological surveillance projects.

Notable events in the 2016 field season:

- Sediment infauna community survey was completed for the MCZ adding to the time series started in 1993. The results show an increase in species diversity with 142 new species recorded. This takes the total number of species recorded within the MCZ sediments since 1993 to 1123.

- The king scallop (*Pecten maximus*) survey was completed over two weekends with a team of volunteer divers. 60 transects were completed, surveying a total of 8620 $m^2$ and 2534 king scallops counted and measured. Average density of scallops within the MCZ was estimated to be 35 scallops / 100$m^2$, which is an increase from the last survey in 2012.

- The annual sea fan (*Eunicella verrucosa*) survey found a worrying number of lost sea fans. Three natural sea fans and two attached seafans were confirmed as lost from 2015 and an additional 10 natural sea fans have been found to be missing in 2016 (5 definite losses and 5 to be confirmed in the 2017 survey). The definite losses all occurred at the Bull Hole site.

- The Grey seal pupping survey was completed at both island and mainland sites from August to December. In 2016 202 pups were born at island sites and 143 pups at mainland sites giving a total 345 pups born in the MCZ with a recorded combined survival of 73.3% through to moult. Pup production in the Skomer MCZ for the past 5 years has shown the highest totals recorded for the area with average production for 2012-16 at 345 pups.

## 3. Project Status Tables

| | Brief description | Year sets | Sampling frequency | Report | Data summary |
|---|---|---|---|---|---|
| **PHYSICAL** | | | | | |
| Meteorological data | Wind, rain, sunshine, temperature, humidity, net radiation. Automatic station logging 10 minute means. New met station (2006) is compatible with the ECN and logs files daily, hourly and (since Oct 06) every ten minutes. | 1993 – ongoing (Old station removed Oct 05) New Met station installed 25 /04 2006 - ongoing | Continuous | No | Yes-SMCZ office |
| Wave data | Height, period, etc. Automatic station logging every 10mins. | 1993-1998 Discontinued | Continuous | No | No - raw only |
| Seawater data | Temperature, salinity, conductivity, suspended sediment. | 1992 – ongoing | Weekly (May - Sept) | No | Yes-SMCZ office |
| | YSI 6600 multi parameter sonde Temperature, salinity, dissolved $O_2$, Chlorophyll, turbidity & depth | 2007 – 2013 | Temp (since 99) Hourly | | |
| | OSIL buoy automatically transmitting data from YSI 6600 sonde. | | | No | Yes-SMCZ office |
| | Buoy redeployed 2010 | | Hourly samples | | |
| | Buoy lost Nov 2013- Onset logger re-deployed Apr 2014 (no telemetry) | 2014 - ongoing | Hourly samples | | |

| | Brief description | Year sets | Sampling frequency | Report | Data summary |
|---|---|---|---|---|---|
| Seabed sedimentation | Auto sampler | 1994-1998 Discontinued | Continuous | No | Yes-SMCZ office |
| | Sediment trap | 1994 – ongoing<br>1995 to1998<br>2002 to 2016 | Every 14 days (April-Oct) | Jones 1998 | Yes-SMCZ office |
| Suspended sediments | Idronaut Turbidity logger<br><br>Secchi disc<br><br>YSI 6600 multi parameter sonde – now stopped | 2001 – failed 06<br><br>1992 - onwards<br><br>2007 - 2013 | Continuous<br><br>Weekly (seasonal)<br><br>Hourly | No<br><br>No<br><br>No | No - raw only<br><br>Yes – SMCZ office<br>Yes-SMCZ office |
| **ACTIVITY** | | | | | |
| Recreation activities | Boats, divers, anglers recorded in the MCZ | 1987 - ongoing | Weekly (May - Sept) | Skomer MCZ annual reports | Skomer MCZ annual reports |
| Commercial fishing activities | Pot buoys and fishing net positions | 1989 - ongoing | Weekly (May - Sept) | Burton 2002<br>SMCZ annual reports | Yes-SMCZ office |
| Tankers in St Brides bay | Number and names of tankers and movements. Now using AIS system | 1994 - ongoing | Daily<br>24/7 electronic AIS | No | Yes-SMCZ office<br>Yes-SMCZ office |
| **BIOLOGICAL** | | | | | |
| **Littoral communities:** | | | | | |
| Macro scale (view point photographs) | Time series photos/digitised. | 1992 - ongoing | Annual | Internal report – Daguet 2000 and Gibbs 2007 | Yes-SMCZ office |
| **Sub littoral communities:** | | | | | |
| Rocky reef communities | Time series stereo photos. | 1982 - ongoing | Annual | Bullimore1986 & 1987 | Yes-SMCZ office |

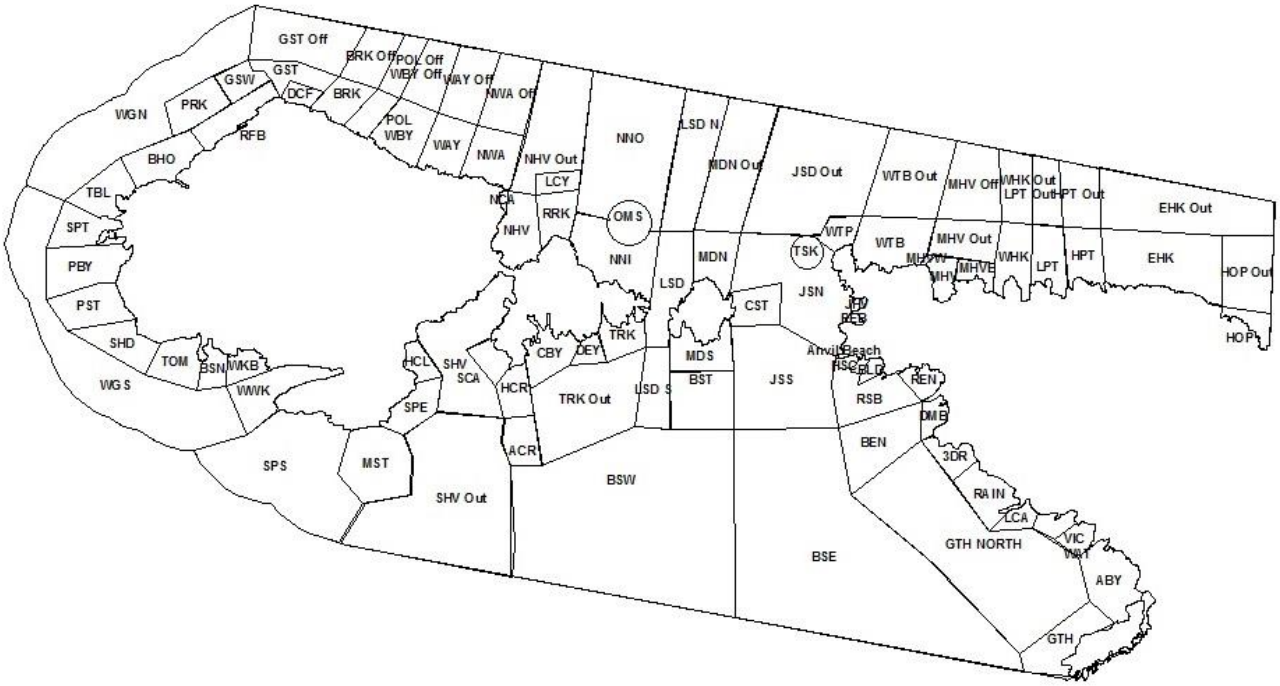
| | Brief description | Year sets | Sampling frequency | Report | Data summary |
|---|---|---|---|---|---|
| Algal communities | Survey and report completed<br>Survey completed report in preparation<br>Full survey and method development | 1999<br>2005<br>2007 | | Hiscock, S 1983 & 1986 Scott 1994<br>Brodie & Bunker 1999/2000<br>Maggs & Bunker 2007 | Yes-SMCZ office |
| Sponge assemblages | Time series mono-photo/digitised.<br><br>Species recording at TRK<br><br>Seasonal monitoring from 15 fixed quadrats – Dr J Bell | 1994 - ongoing<br><br>2002/3, 2007/8 2011, 2015<br><br>2006 – ongoing | Annual<br><br>Every 4 years Next survey planned 2019 | Bunker & Jones 2008 & 2012<br>Bell *et al* 2012<br>Jones *et al* 2012<br>Jones et al 2015<br>Berman *et al* 2013 | Yes-SMCZ office |
| Infaunal sediment | Surveys and reports completed | 1993/1996/ 1998/ 2003 2007/ 2009 / 2013 & 2016 | Every 4 years Next survey planned 2020 | Rostron 1994 & 1996<br>Barfield 1998 & 2003<br>Barfield 2007 & 2010 | Yes-SMCZ office |
| Epifaunal sediment | Survey and report completed | 1995/ 2001 & 2004<br>Video 2009 | Project now combined with Infauna | Rostron 1996<br>Moore 2002<br>Moore 2005 | Yes-SMCZ office |
| Plankton communities | Zooplankton samples taken with a 200um net. Vertical haul using methods that are comparable to others used in UK. | 2009 ongoing | Weekly samples taken during the field season. | Unpublished report with method recommendations and links to data spreadsheets – Plymouth Marine Laboratories 2015. | Yes-SMCZ office |

| | Brief description | Year sets | Sampling frequency | Report | Data summary |
|---|---|---|---|---|---|
| **Flora:** | | | | | |
| *Zostera marina* | Extent of NHV bed & density distribution.<br><br>Biosonics Acoustic sonar survey | 1997/2002/2006, 2010 & 2014 (Boundary maps for 2000, 2002 & 2004)<br>2013, 2014 & 2015 | Every 4years Next survey planned 2018<br><br>Annual | Jones & Hodgson 1980 &1981, Jones *et al* 1983, Lock *et al* 1998, 2003 & 2006 Burton *et al* 2010 Lock *et al* 2015 | Yes-SMCZ office |
| **Fauna:** | | | | | |
| *Eunicella verrucosa* | 101 colonies, time series mono-photo/digitised.<br>4 colonies stereo-photo. | 1993- ongoing<br><br>1982- ongoing | Annual | Bunker *et al* 1985, Bullimore1986 & 1987 Gilbert 1998 | Yes-SMCZ office |
| *Alcyonium glomeratum* | Time series stereo-photo/digitised. North wall 5 transects (% frequency) North wall East, Thorn rock &Rye rocks. | 1984- ongoing 2002 new transects | Annual | Bullimore1986 & 1987 | Yes-SMCZ office |
| *Parazoanthus axinellae* | 6 sites, time series mono-photo/digitised. | 2001- ongoing | Annual | Burton *et al* 2002 | Yes-SMCZ office |
| *Pentapora foliacea* | 3 sites, time series mono-photo/digitised.<br>New sites established 2002 & 2003. | 1994- ongoing | Annual | Bullimore1986 & 1987 Bunker/ Mercer 1988 Gilbert 1998, Gibbs 2006 | Yes-SMCZ office |
| *Balanophyllia regia* | Time series at Thorn Rock stereo-photo/digitised<br>The Wick. 3 transects | 1984 – 2002 - ongoing<br>2002 - ongoing | Annual | Bullimore 1986 & 1987 | Yes-SMCZ office |
| *Caryophyllia smithii.* | Counted from sponge project quadrats (stereo-photo/digitised) | 1993 - ongoing | Annual | No | Yes-SMCZ office |
| | | | | | |

| | Brief description | Year sets | Sampling frequency | Report | Data summary |
|---|---|---|---|---|---|
| Atlantic Grey Seal | Annual pup production and survival records at Skomer Island and mainland MCZ sites.<br>Site fidelity and other behavioural records for Skomer Island sites. | 1976- ongoing | Annual | Grey Seal breeding census, Skomer Island 1992-2016, Skomer MCZ annual reports 1992-2016 | Yes-SMCZ office |
| Nudibranch species | Various surveys<br>MCZ survey completed. | 1975-1991<br>2002, 2006, 2010 & 2014 | Every 4 years<br>Next survey planned 2018 | Hunnam & Brown 1975,<br>Bunker *et al* 1993,<br>Luddington 2002<br>Lock*et al* 2010& 2014 | Yes-SMCZ office |
| Territorial fish | Survey methods developed.<br>Survey completed.<br><br>N. Sweet drop down video survey<br>R. Bullimore video survey | 1997,2001/2002<br>2005, 2009, 2013,2007<br>2009, 2013 | Every 4 years<br>Next survey planned 2017 | Lock 1998<br>Lock *et al* 2006<br>Tompsett 2006<br>Sweet 2009<br>Bullimore, R 2010 | Yes-SMCZ office |
| King scallop<br>*Pecten maximus*<br>(including *Crepidula fornicata*, *Aequipecten opercularis* and *Arctica islandica* from 2008) | UCS survey,<br><br>Survey completed, 3 sites- 2000<br>Survey completed, 7 sites 2004, 2008, 2012& 2016 | 1979/80, 1979-82<br>2000, 2004, 2008, 2012, 2016 | Every 4 years<br>Next survey planned 2020 | Bullimore 1985<br>Jones 1979 & 1980<br>Lock 2002<br>Luddington *et al* 2004<br>Lock *et al* 2009 & 2013 | Yes-SMCZ office |
| Echinoderm Survey | Abundance of *Echinus esculentus* in Skomer MCZ using volunteer survey methods. Data for *Marthasterias glacialis*, *Crossaster papposus* & *Luidia ciliata* | 2003,2007 & 2011, 2015 | Every 4 years<br>Next survey planned 2019 | Luddington *et al* 2004<br><br>Lock *et al* 2008, 2011 & 2016 | Yes-SMCZ office |

| | Brief description | Year sets | Sampling frequency | Report | Data summary |
|---|---|---|---|---|---|
| Commercial Crustaceans | Parlour pot and diving study (Plymouth student project)<br>Parlour pot study – MCZ<br>Shell disease survey<br>Crawfish recording | 2003<br><br>2011<br>2011<br>2011 onwards | Aug / Sep 2003<br><br>Jul – Oct 2011<br>Sep – Oct 2011<br>SMCZ team | Fothergill 2004<br><br>No<br>No | Yes-SMCZ office |
| Cetaceans | Observations of all Cetacean species. | 2001 onwards | Records from Skomer Island, Dale princess and SMCZ team | No | Yes-SMCZ office |

# 4. Skomer MCZ Sites and codes




| Site code | Site Name | Site Code | Site Name | Site Code | Site Name |
|---|---|---|---|---|---|
| ACR | Anchor Reef | JNK | Junko's Reef | SCA | South Castle |
| ABY | Albion Beach | JHV | Jeffrey's Haven | SHD | Skomer Head |
| BEN | The Bench | JSD Out/JSN/JSS | Jack Sound /North /South | SHV/SHV Out | South Haven /Outer |
| BHO | Bull Hole | LCA | Little Castle beach | SPE | South Plateau East |
| BLD | Boulder Beach | LCY | Lucy wreck | SPS | South Plateau South |
| BRK/BRK Off | Bernie's Rocks/ Offshore | LPT/LPT Out | Low point/Outer | SPT | The Spit |
| BSE | Broad Sound East | LSD/LSDN/LSDS | Little Sound /North/South | TBL | The Table |
| BSN | The Basin | MDN/MDS/MDN Out | Middleholm North/South/ North Outer | TOM | Tom's House |
| BST | Black Stones | MHV/MHVE/ MHVW/MHV Out/MHV Off | Martins Haven/East /West /Outer /Offshore | TRK/Out | Thorn Rock /Outer |
| BSW | Broad Sound West | MST | Mew Stone | TSK | Tusker Rock |
| CBY | Castle Bay | NCA | North Castle | VIC | Victoria Bay |
| CST | Crab Stones | NHV/Out | North Haven/Outer | WAT | Watery Bay |
| DCF | Double Cliff | NNI/NNO | North Neck Inner/Outer | WAY/Off | Waybench /Offshore |
| DEY | Dead Eye wreck | NWA/NWA Off | North Wall /Offshore | WBY/Off | Waterfall Bay /Offshore |
| DMB | Dead Man's Bay | OMS | Oceanographic Monitoring Site | WGN | |

| | | | | | |
|---|---|---|---|---|---|
| EHK/EHK Out | East Hook/Outer | PBY | Pig Stone Bay | WGS | |
| GST/GST Off | Garland Stone/Offshore | PEB | Pebbly beach | WHK/Out | West Hook /Outer |
| GSW | Garland Stone West | POL/POL Off | The Pool /Offshore | WKB | Wick Basin |
| GTH/GTH North | Gateholm/North | PST | Pig Stone | WTB/Out | Wooltack Bay /Outer |
| HCL | High Cliff | RAIN | Rainy Rock | WTP | Wooltack Point |
| HCR | High Court Reef | REN | Renney slip | WWK | The Wick |
| HOP/HOP Out | Hopgang/Outer | RFB | Rockfall Bench | 3DR | Three Doors |
| HPT/HPT Out | High Point/Outer | RRK | Rye Rocks | | |
| HSC | Horseshoe Cave | RSB | Renney Slip Bay | | |

# 5. Skomer MCZ Biological Project Summaries

## 5.1. Littoral Communities

*CMS code: RB03/01*

### 5.1.1. Project Status

Ongoing.
Annual photographic sampling.
Annual quantitative survey.

### 5.1.2. Project Rationale

Littoral communities are one of the management features of the Skomer MCZ and are a habitat of principal importance under Section 7 of the Environment (Wales) Act 2016. This project also encompasses intertidal boulder communities, which are a priority habitat under the same Act. They are susceptible to impacts from the water and the air. They 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 to provide guidance and support information for littoral monitoring projects.

### 5.1.3. Objectives

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

### 5.1.4. Sites

| | Started: | |
|---|---|---|
| North Haven | 1992 | |
| South Haven | 1992 | |
| South Stream | 1992 | |
| The Lantern | 1992 | |
| The Wick | 1992 | |
| Double Cliff | 1992 | |
| Pig Stone | 2003 | |
| Wooltack | 2003 | |
| Martins Haven | 2003 | |
| Hopgang | 1996 | Lichen station only |

### 5.1.5. Methods

*Permanent Quadrats*(1992 – Ongoing)
Transects with permanent, fixed position quadrats (50 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 as follows:
Sites were divided into 4 zones based on heights on the shore 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$^2$ quadrats 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:

- 1m$^2$ quadrat divided into a 25 cell grid is used to record presence/absence for all species. Some species are aggregated for recording as follows: Rough winkle species, barnacle species, limpets recorded as *Patella spp*. Encrusting red algae.
- Four digital photographs are taken using a 50 x50 cm quadrat within each 1m$^2$ 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 and barnacles are photographed within the same 5 grid cells using a 5 x 5cm quadrat. The photographs provide 20 samples from each shore height, these are stored for barnacles species counts for all individuals > 2mm (currently the photos are stored and counts will be completed when time allows).

*At Middle Shore Zones*: Over 100 limpets (*Patella spp*) are measured to the nearest mm using callipers from within the quadrats. In areas of low density at least 100 limpets were measured.

*At Splash Zones:* % cover of all lichen species are recorded in 50 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. Martin's Haven, North Haven and South Haven were selected as suitable sites for the project (see Mieszkowska *et al.* 2002):
The MarClim method:

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

*Shore Clingfish (Lepadogaster lepadogaster)* (2004 - Ongoing)
Timed counts of clingfish are carried out at Martins Haven and North Haven together with records of egg masses. Counts started in 2011 at South Haven.

| Site | Permanent Quadrats | Shore zone quadrats, Limpets, Barnacles | Lichen quadrats | MarClim | Shore clingfish |
|---|---|---|---|---|---|
| **North Haven** | | | | Yes | Yes |
| **South Haven** | Yes | | | Yes | Yes |
| **South Stream** | Yes | Yes | Yes | | |
| **The Lantern** | Yes | Yes | Yes | | |
| **The Wick** | Yes | Yes | Yes | | |
| **Double Cliff** | Yes | Yes | | | |
| **Pig Stone** | | Yes | Yes | | |
| **Wooltack** | | Yes | Yes | | |
| **Martins Haven** | | Yes | Yes | Yes | Yes |
| **Hopgang** | | | Yes | | |

Table 5.1.1Summary of methods completed at each littoral site.

### 5.1.6. Project history

1982: Bunker *et al.* surveyed twenty two sites in the MNR as a baseline littoral survey.

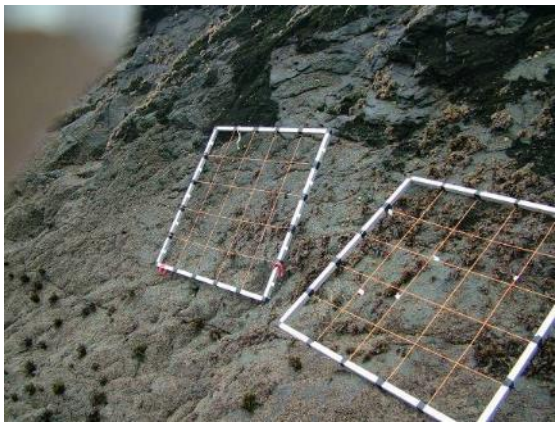
1992: Six permanent transects were established in the MNR and surveyed/ photographed (Crump, 1993).
1992 – 2002: Photographs of the six permanent transects were taken and stored.

1996: Following the Sea Empress oil spill (February 1996) the six transects were resurveyed 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 lichens 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 1992 & 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 at the six original sites and four additional sites were established, (Burton & Crump 2003).

2004: Methods established in 2003 were continued. All site marking was completed and all results collected. Marclim surveys were started at 3 sites: Martins Haven, South Haven and North Haven.



2005: All the sites established in 2003 were resurveyed except for the lower shore at Pig Stone.
2006: All sites were completed.

2007: All sites were completed and temperature loggers were placed at the Martins Haven and South Haven sites.
2008: All sites resurveyed except for Double cliff, upper shore.
2009 - 2011: All sites completed.
2012 All sites complete except Double cliff (no data for any shore height)
2013 - 2015: All sites completed
2016: All sites completed except for Pig Stone – no landing was possible (no data).

### 5.1.7. Results

*Whole Community Analysis*

All shore zone quadrat data is entered into PRIMER statistics software for community analysis. The results can be visualised as MDS plots.

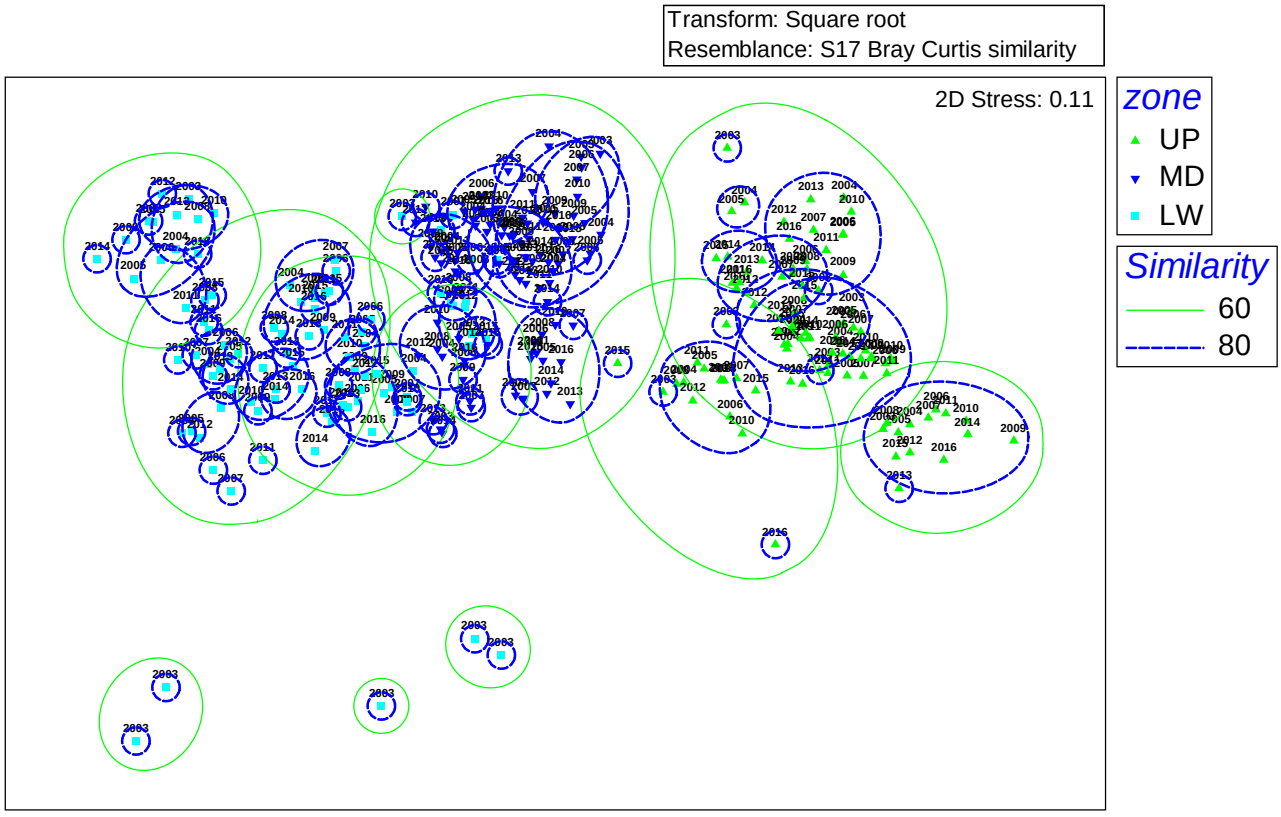



Fig. 5.1.1 PRIMER Multi-dimensional scaling (MDS) plot of all littoral community data 2003 – 2016

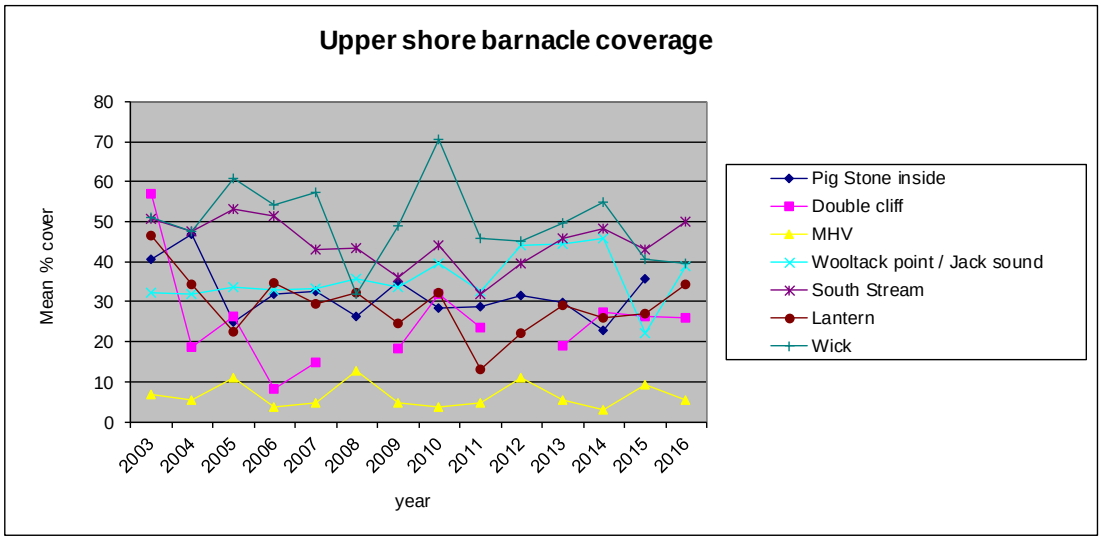
General summary:

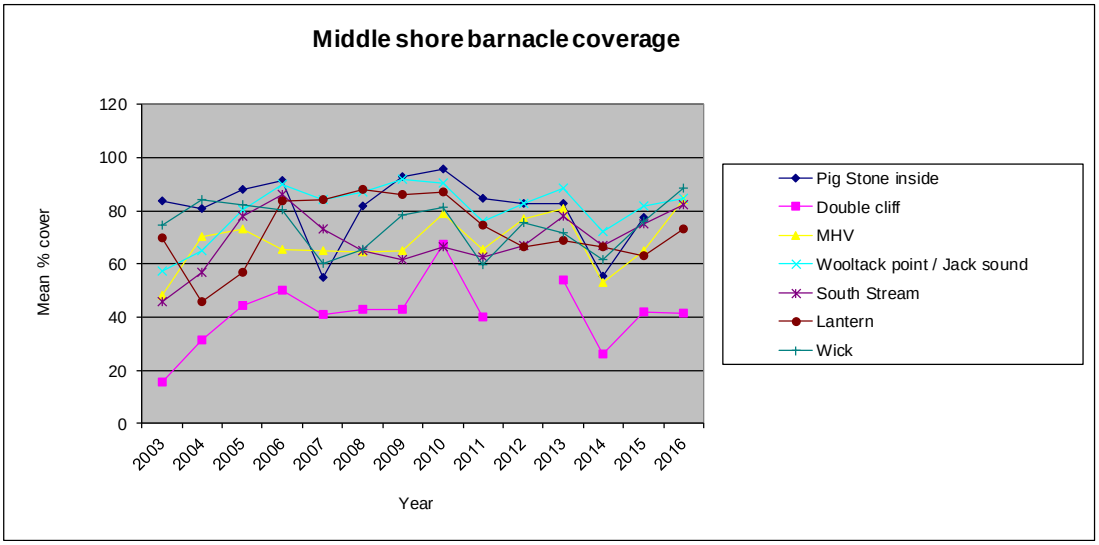
- Upper shores group neatly on the right.
- Lower shore sites are much more disparate and grouped on the left.
- Middle shore sites sit in between with some overlap (60%) with the lower shores.
- Some sites form distinct clusters e.g. MHV Upper, MHV Lower.
- Some sites are very variable from year to year e.g. PST Lower & WTK Lower

2016 did not show any major variations from the overall trends seen since 2004.

*Mean Percentage Cover Barnacles*

Barnacle coverage has been variable between sites over the last 8 years. In 2014 all sites saw a decrease in barnacle cover in the middle and lower shores. This was perhaps due to the extreme weather of the winter of 2013-14. In 2016 barnacle coverage increased in the middle shore while remaining stable in the lower and upper shores.



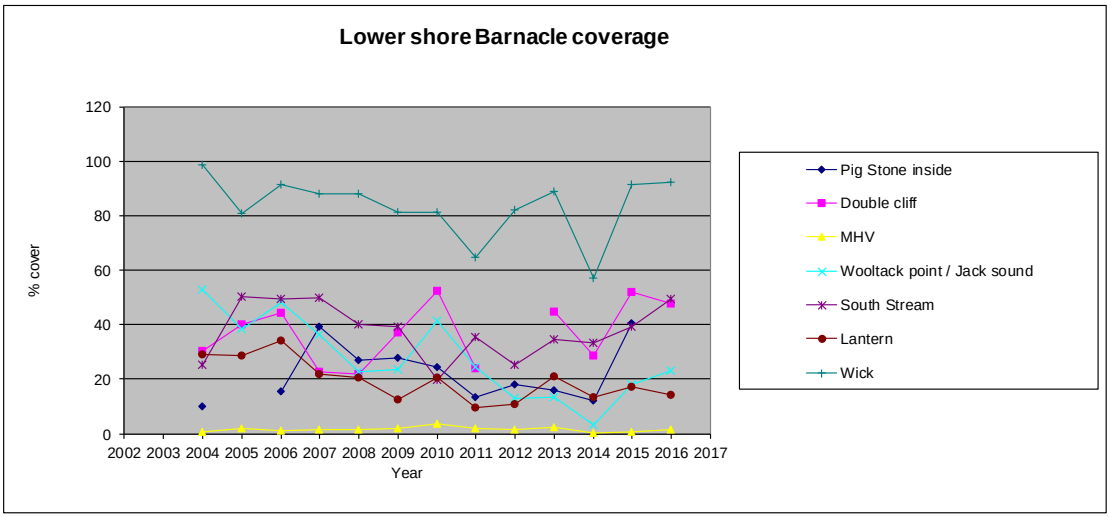




Fig. 5.1.2 Changes in upper, middle and lower shore barnacle coverage 2003 - 2016

*Limpet Size and Counts*

The mean limpet size recorded at sites shows a stable trend at most sites, the Lantern shows the greatest fluctuations.

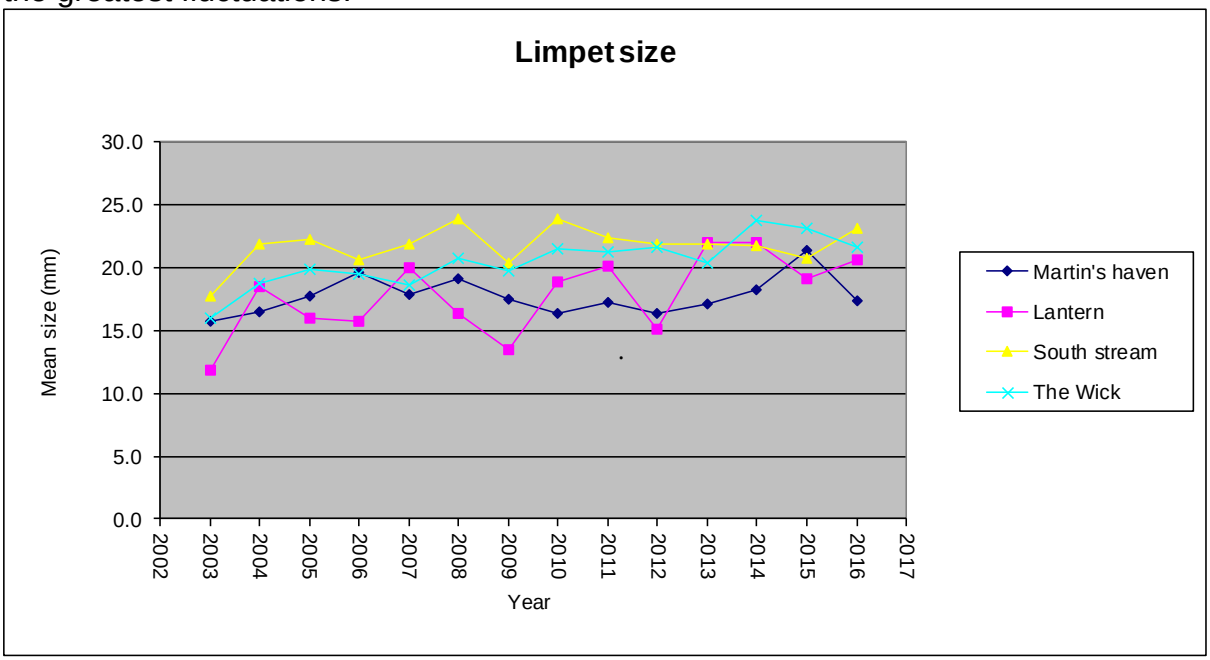



Fig. 5.1.3 Changes in mean limpet size 2003 - 2016

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. 2007 appears to have had a dip in numbers at six of the sites, which all showed an increase the following year. On the middle shore the numbers have been stable from 2009 onwards with an increase in numbers at all sites in 2012 followed by a slight decrease in 2013 & 2014.

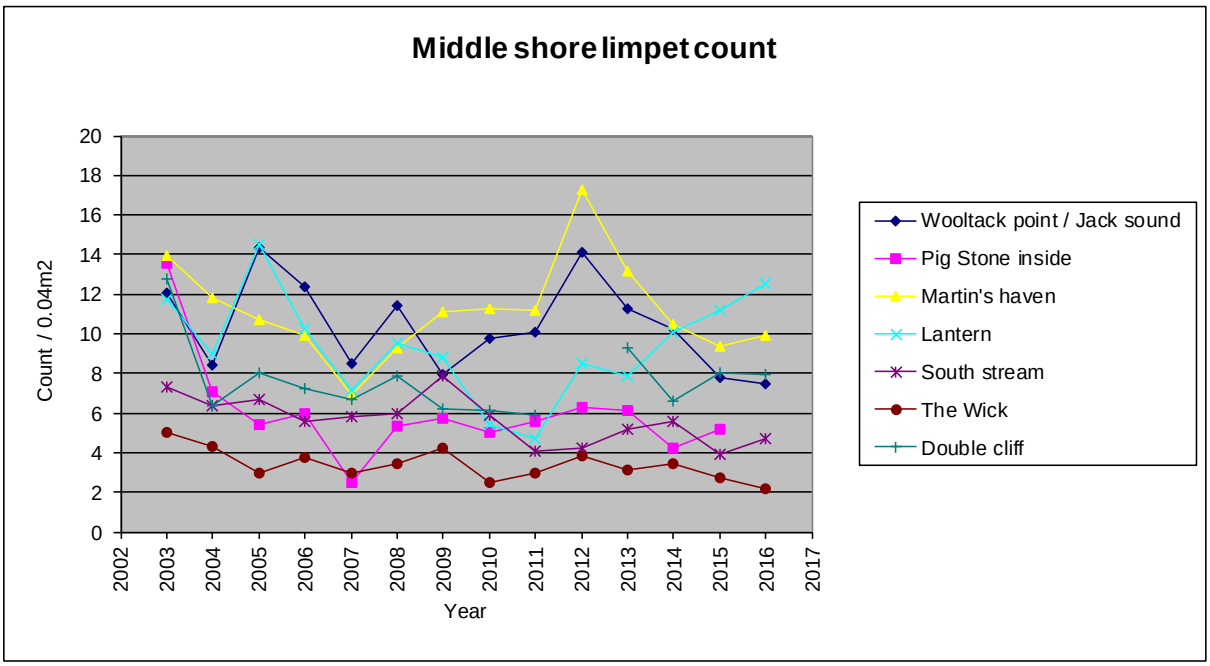



Fig. 5.1.4 Changes in middle shore limpet counts 2003 - 2016

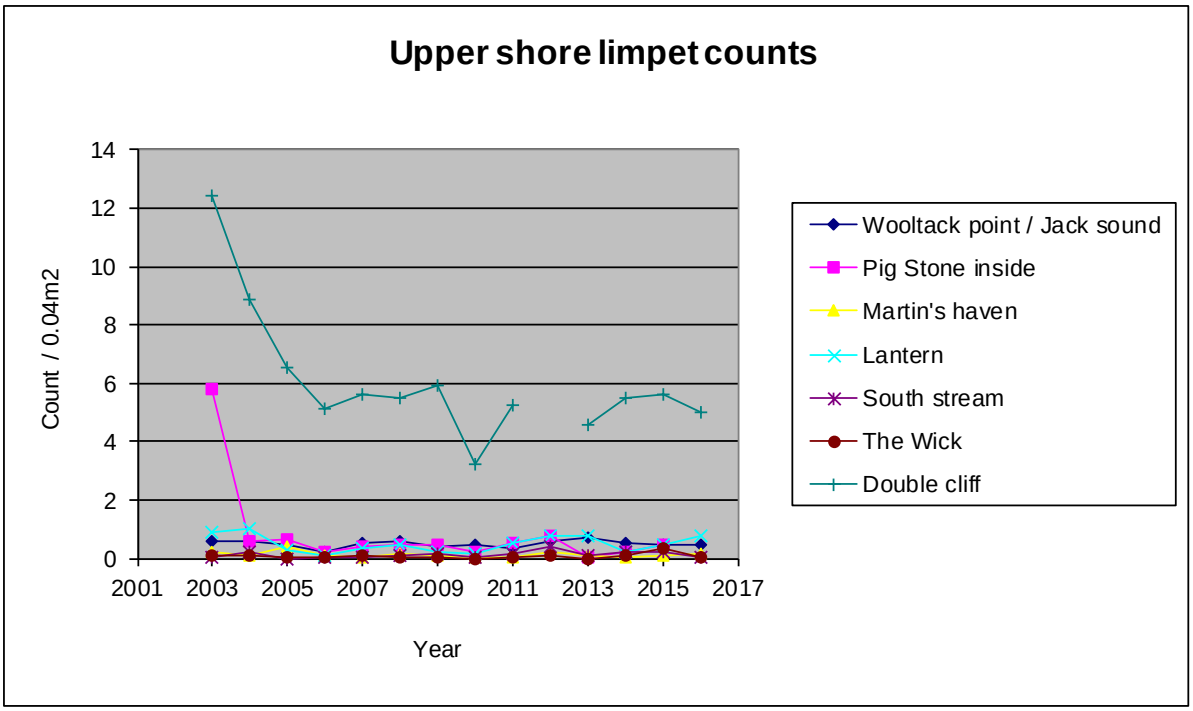


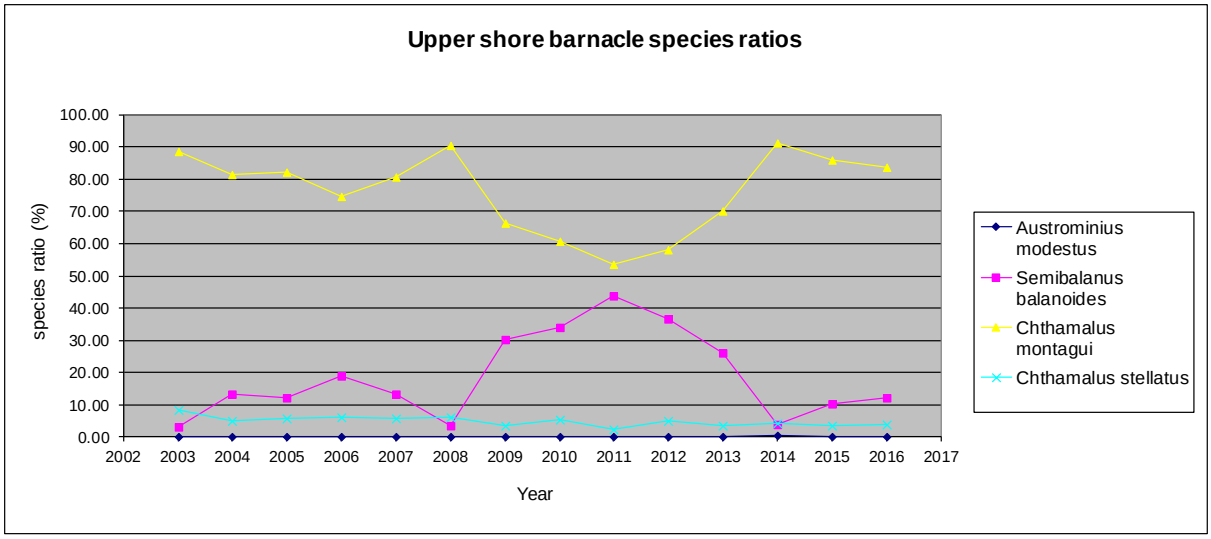

Fig. 5.1.5 Changes in upper shore limpet counts 2003 - 2016

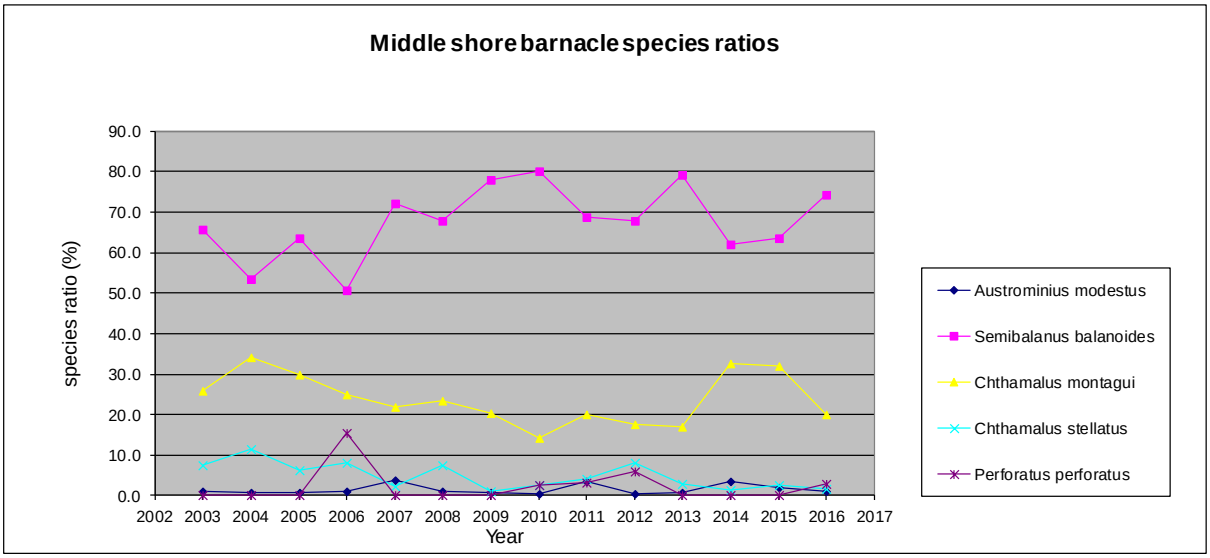
In the upper shore most sites have a low abundance of limpets. Double cliff has significantly more limpets than any other site (north facing shaded cliff) and an interesting declining trend from 2003 – 2006.

*Barnacle Species Ratios*

The barnacles species counts have been completed from the photographs of the 5cm X 5cm quadrats at the 3 MarClim Sites, (photographs taken at the other sites are stored for analysis when time allows).

The lower shore underwent some dramatic changes in 2004 with *Semibalanus balanoides* declining and being immediately replaced by *Chthamalus montagui*. This may be due to a poor settlement of *S. balanoides* spat in the winter of 2002/3 (possibly linked to mild sea temperatures), *C. montagui* individuals would then benefit from a lack of competition. In 2014 there was a significant drop in *S. balanoides* at all shore zones with an increase in *C. montagui*. In 2016 *S. balanoides* numbers continued to increase.



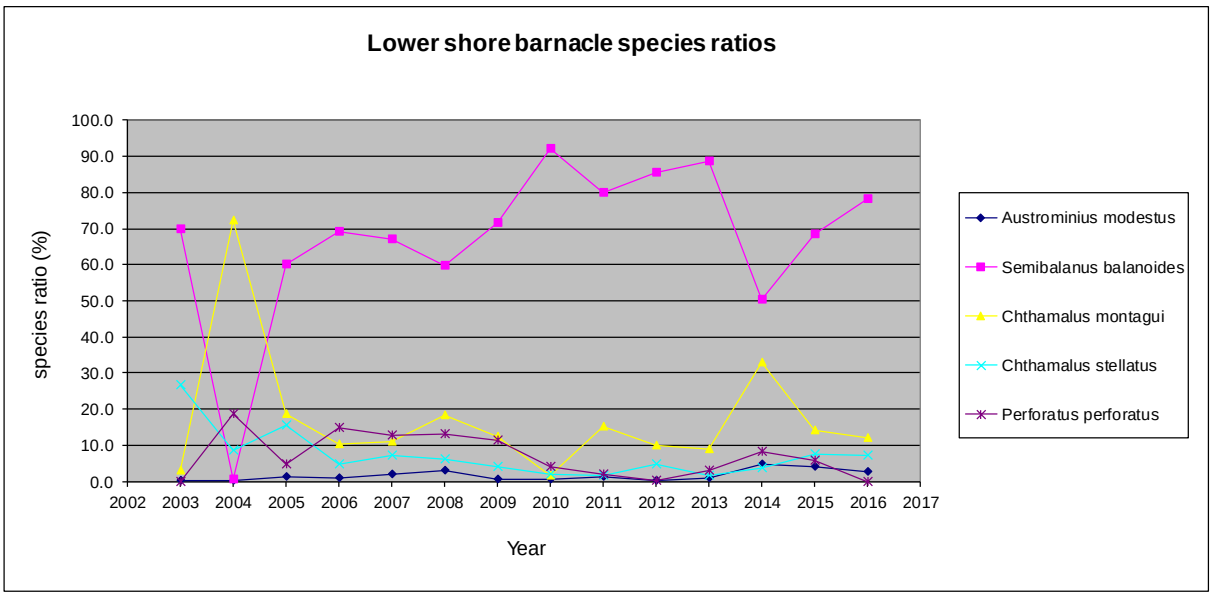




Fig. 5.1.6 Changes in upper, middle and lower shore barnacle species ratios 2003 - 2016

*Lichen quadrats*
Lichen data has been entered into spreadsheets, and the photographs stored ready for further analysis.

*MarClim survey*
MarClim data has been entered into spreadsheets and supplied to the MarClim team.

*Clingfish records*
Timed searches have been completed at North Haven and Martins Haven since 2003. In 2010 a single clingfish was also found at South Haven beach and in 2015 & 2016 they were found in greater numbers so this has been added as a monitoring site.

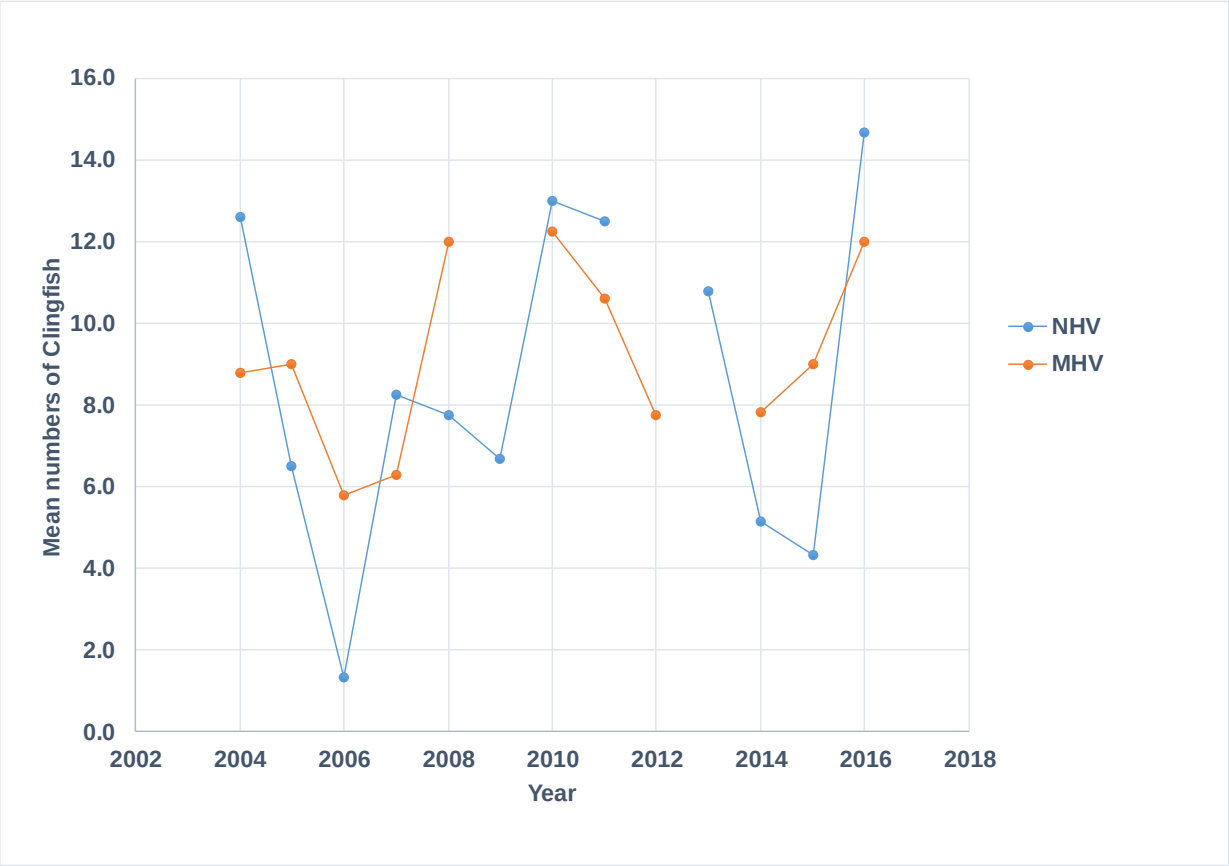



Figure 5.1.7 Average numbers of clingfish 2003 – 2016 at North Haven and Martins Haven

Numbers are very variable but there are always clingfish present and eggs are always seen in various stages of development.

### 5.1.8. Current Status
The shores appear to be in a condition typical of the area without any unfavourable changes to the shore communities.

## 5.2. Sponge Assemblages

*(CMS code: RM13/01)*

### 5.2.1. Project Status

Annual sampling of photographs along fixed transects (1993-ongoing);
Species surveyed every 4 years (2003, 2007, 2011 and 2015);
Seasonal sampling of fixed quadrats photographs (2005 – ongoing).

### 5.2.2. 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 known to be undescribed. Six species are nationally scarce and eight species are near the limit of their distribution. Sponges are filter feeders and therefore reliant on water quality which makes them susceptible to changes in sediment deposition. They are therefore useful biotic indicators of changes in suspended sediment and surface sedimentation rates, the cause of which might include dredge spoil dumping.

### 5.2.3. Objectives

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

### 5.2.4. Sites

- Thorn Rock (annual transects, fixed quadrat and species survey)
- Wick and High Court Reef (species survey 2011, 2015)
- MCZ sites, other digital images taken for other projects are used to assess the sponge assemblages around the MCZ. (2009 – ongoing)

### 5.2.5. Methods

*Transects:* Four fixed transects are located at Thorn Rock. Until 2008 photographs were taken from fixed positions along the transect using paired cameras set up on a 50 x 70cm frame. The resulting images were analysed using a stereo viewer to count the abundance of sponge species and morphology types. Classifying sponge assemblages into morphology types (Bell 2001) 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. In 2009 a digital SLR taking high resolution images was substituted for the stereo cameras.

*Species survey:* In 2003 all sponge species were identified in sixteen 50 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 species being identified if possible. In 2011 and 2015 the survey was additionally completed at the Wick and High Court Reef sites. Species photographs were taken in the field and samples taken, where necessary, for spicule preparations.

*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 (20 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. This is completed in May and October and if time allows in July. The digital photographs are then merged together to form a mosaic of the full 1m$^2$ quadrats. This data is stored and supplied to Dr. James Bell, Wellington University, New Zealand for ongoing research and analysis.

### 5.2.6. Project history

| Year | No of samples | Transects |
|---|---|---|
| 1993 | 24 | WG |
| 1995 | 77 | WG, SH, BG, DL |
| 1996 | 72 | WG, SH, BG, DL |
| 1997 | 20 | WG |
| 1998 | 60 | WG, SH, DL |
| 2000 | 63 | WG, SH, DL |
| 2001 | 62 | WG, SH, DL |
| 2002 | 81 | WG, SH, BG, DL |
| 2003 | 79 | WG, SH, BG, DL |
| 2004 | 80 | WG, SH, BG, DL |
| 2005 | 80 | WG, SH, BG, DL |
| 2006 | 79 | WG, SH, BG, DL |
| 2007 | 81 | WG, SH, BG, DL |
| 2008 | 0 | Transects were completed but the image quality was very poor and **no** analysis was possible |
| 2009 | 81 | Digital SLR used – not stereo 35mm Results very good – better resolution than the 35mm system |
| 2010 | 81 | Digital SLR used |
| 2011 | 81 | Digital SLR used |
| 2012 | 81 | Digital SLR used – lots of sediment on the surfaces |
| 2013 | 81 | Digital SLR – good conditions |
| 2014 | 81 | Digital – Poor visibility |
| 2015 | 81 | Digital SLR – good conditions |
| 2016 | 81 | Digital SLR – good conditions |

Table 5.2.1 Data gathered from Thorn Rock sponge transects 1993 to 2016: (Windy Gully =WG, Spongy Hillocks =SH, Broad Gully =BG, Dogleg = DL)

### 5.2.7. Results

*Transects:*

*Sponge Morphology Analysis*

This method has been used for all the quadrats taken at Thorn Rock and for a series of sites around the MCZ where comparable quadrat photos are taken. The data can then be graphed or analysed using the Primer multivariate analysis software to compare similarity between sites.

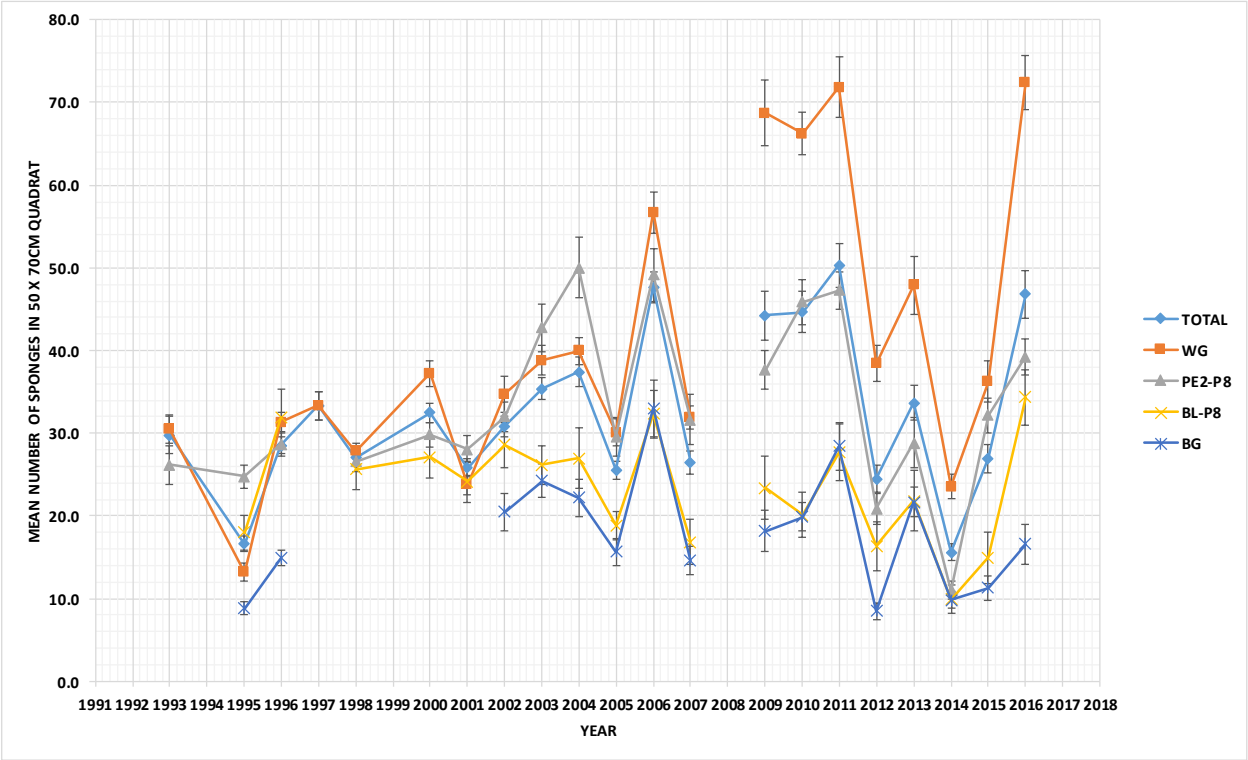



Figure 5.2.1 Mean number of sponges counted in each quadrat at 4 sites –Thorn Rock 1993-2016

Improvement in image quality and resolution has meant that more sponge entities have been recorded from 2009 onwards than in previous years. However in 2012 and 2014 there was a noticeable drop in the numbers of sponges across all transects. In 2013 and 2015 all transects showed an increase in abundance of visible sponges and this increase continued in 2016. This variability will in part be due to the image quality. “Wafting” the surface sediment away would improve consistency but does compromise the comparability of the whole time series.

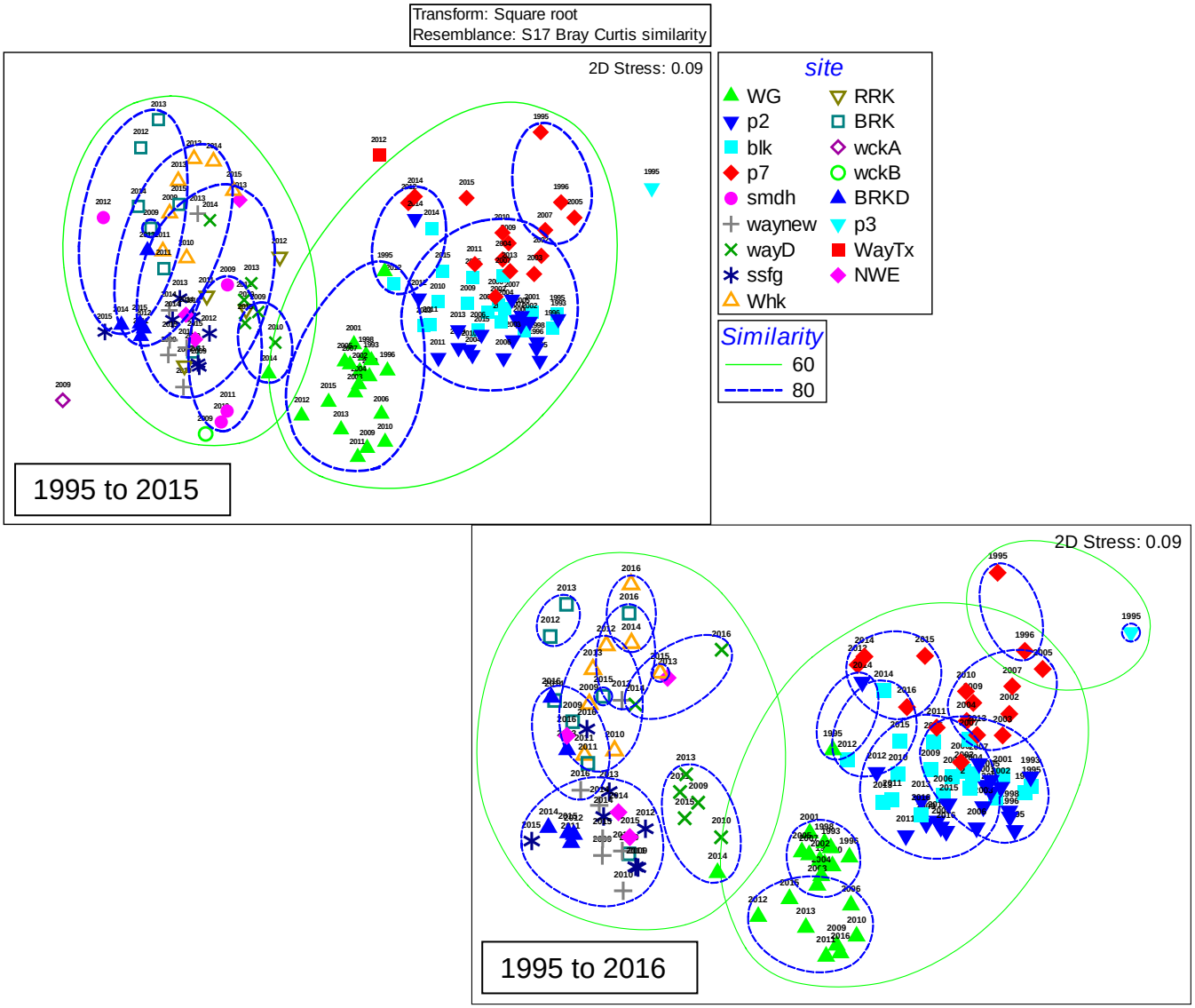



Figure 5.2.2 PRIMER Multi-dimensional scaling (MDS) plot of sponge morphology data averaged to site and year 1995 – 2015

Both plots show very similar patterns. The Thorn Rock sites all group together on the right hand side of the plot (similarity 60%) with Windy Gully (WG) forming a distinct cluster at the bottom (80% similarity). Spongy Hillocks (Blk), DogLeg (P2) Broad Gully (P7) generally clustering together but with a few years throwing out some outlying clusters.
Windy Gully is a vertical rock face, the other sites are all horizontal.

In 2016 there seems to be more differentiation at the 80% similarity level but the broad pattern is very similar to 2015. So even with an increase in the number of sponges seen the assemblage appears to be stable. The 2016 samples are not outliers.

The years 2012 and 2014 are often responsible for the small outlying groups, these years had poor quality photos and sponge numbers were down.

The large cluster on the left (similarity 60%) comprises the other sites around Skomer. These form several distinct clusters at 80% similarity. There are far fewer sponges found at these sites and it is likely that the prevailing conditions at Thorn Rock are more suitable for sponges than elsewhere in the MCZ.

*Species Survey 2015 - update*

In 2015 six sites were surveyed on the south side of Skomer Island as part of the continuing full species monitoring programme. A total of 67 species/entities were recorded in situ or from samples taken for microscopic identification of spicules. Of these, 11 are undescribed or need to be fully researched. A report has now been published (Jones et al 2015):

The 2015 species survey brings the total number of sponge species recorded in the MCZ to 129 (31 of these have yet to be described or identified to species level).

*Supported Research – update*

Boring sponge (*Cliona celata*) samples were collected in 2015 and sent to Dr Joanne Preston, University of Portsmouth. Samples were taken of healthy, fouled and diseased (so-called "Black Death") sponges for microbial community profiling. The research results are being presented at the World Sponge Conference 2017.

Sponge samples taken during the 2015 species survey were also supplied to Dr Preston for DNA research. This is ongoing work and the results will contribute towards the National Gen-bank. Samples have also been supplied to the Natural History Museum, London, to be stored as part of the national sponge collection.

### 5.2.8. Recommendations

- Continue application of morphology method for analysis of photos.
- Expand transect photo-monitoring programme to other sites in the MCZ with good diversity of sponge species.
- 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 is 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 2019.
- Continue support of sponge research carried out by academic bodies.

## 5.3. Sediment Infauna Communities

*(CMS code: RM03/04)*

### 5.3.1. Project Status

Ongoing
Survey every 4-5 years (next survey 2020).

### 5.3.2. Project Rationale

Sediment infauna and epifaunal communities are recognized as management features of the Skomer MCZ. The sediments studied at Skomer also include a number 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 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.

### 5.3.3. Objectives

To assess species richness and diversity and to sample for inorganic pollutants.

### 5.3.4. Sites

Nineteen sites in Skomer MCZ were sampled in the first survey in 1993. This was reduced to ten sites in subsequent surveys (eight on the north side of Skomer and the Marloes peninsula and two in South Haven). In 2009 two extra sites were added to include stations from the epifauna study project.

### 5.3.5. Methods

- Two replicate samples are taken at each site 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.
- A third grab sample is taken at each site and two sub samples are taken and stored. These are sent to specialist laboratories for sediment grain size analysis and hydrocarbon content analysis.

### 5.3.6. Project history

Surveys were completed in 1993, 1996, 1998, 2003, 2007, 2009, 2013 and 2016 .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 a storm a month previous to sampling.

### 5.3.7. Results

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| | S<br>Species richness | N<br>abundance | D<br>Margalef richness | J'<br>Eveness | H'(loge)<br>Shannon | 1-Lambda'<br>Simpson | Delta+<br>TD |
|---|---|---|---|---|---|---|---|
| **1993** | 313 | 583.18 | 48.99 | 0.73 | 4.19 | 0.96 | 71.80 |
| **1996** | 246 | 173.97 | 47.49 | 0.81 | 4.45 | 0.98 | 71.16 |
| **1998** | 359 | 684.90 | 54.83 | 0.76 | 4.50 | 0.98 | 74.16 |
| **2003** | 417 | 773.50 | 62.55 | 0.73 | 4.40 | 0.97 | 69.08 |
| **2007** | 502 | 1290.90 | 69.94 | 0.77 | 4.81 | 0.99 | 74.17 |
| **2009** | 507 | 867.92 | 74.78 | 0.77 | 4.78 | 0.98 | 73.54 |
| **2013** | 380 | 698.58 | 57.87 | 0.77 | 4.60 | 0.98 | 75.08 |
| **2016** | 463 | 679.44 | 70.85 | 0.74 | 4.53 | 0.98 | 74.68 |

Table 5.3.1 Average species richness (S), average number of individuals (N) and average taxonomic diversity (Delta+) at Skomer MCZ.

2007 & 2009 surveys had the highest number of species (S) and individuals (N). 2016 saw an increase in species richness.

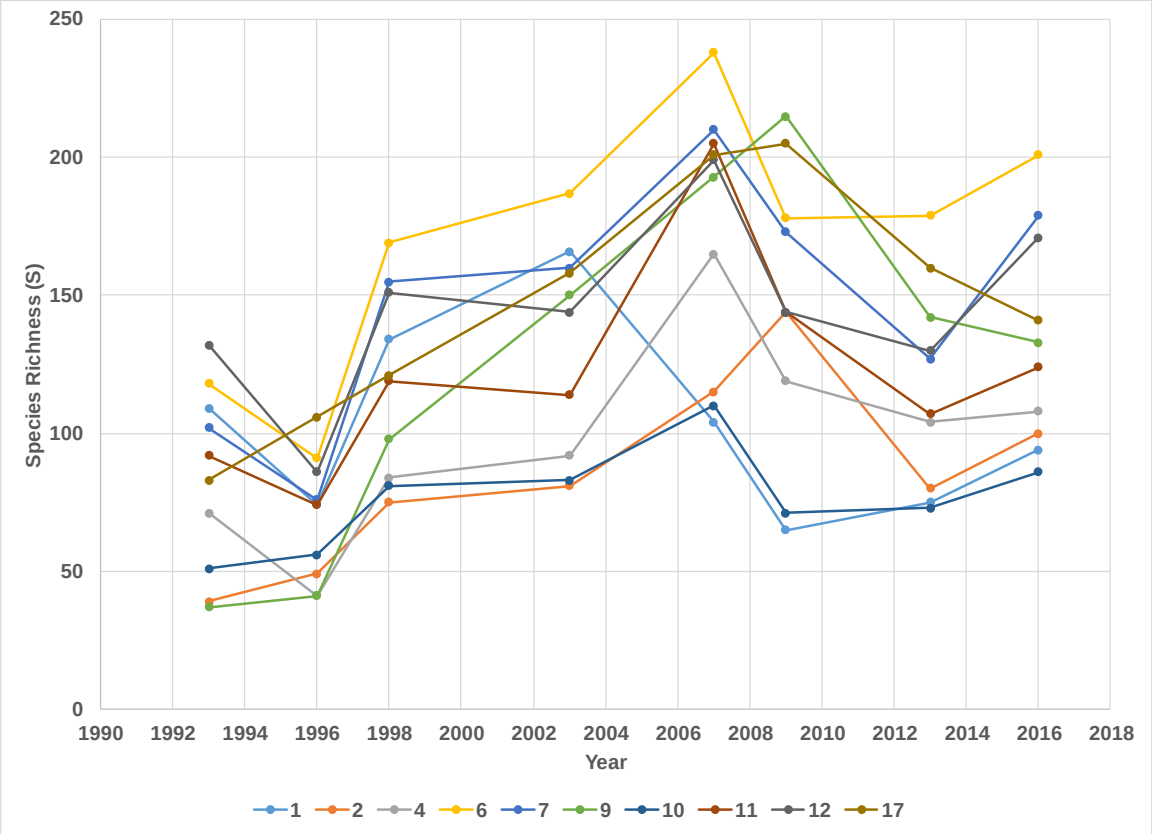


Figure 5.3.1 Species richness 1993 – 2016 for each sampling station.

The 10 sites generally follow the same pattern over the years with the exception of site 1. In 2007 the position of site 1 had to be moved due to a change in the local sediment dynamics (the site was now rock!) this may be responsible for site 1 deviating from the general pattern of change.
The 2016 results show a general increase in species compared to the previous survey.

Species have been very variable over the survey period with over 100 new species recorded in every new survey. In 2016 142 new species were recorded which have not been identified in any of the previous surveys. This suggests that the infauna community in the sediment around Skomer are both diverse and dynamic.

| | 1993 | 1996 | 1998 | 2003 | 2007 | 2009 | 2013 | 2016 |
|---|---|---|---|---|---|---|---|---|
| **Species Richness** | 313 | 246 | 360 | 418 | 505 | 555 | 380 | 483 |
| **New Species (not recorded befor** | 0 | 86 | 132 | 142 | 150 | 119 | 39 | 142 |
| **Cumulative total** | 313 | 399 | 531 | 673 | 823 | 942 | 981 | 1123 |

Table 5.3.1 Average species richness (S), compared to cumulative total and new species observed in each survey.

It may also suggest that the sampling effort of 24 grabs / year is not sufficient to capture the full diversity within the site.

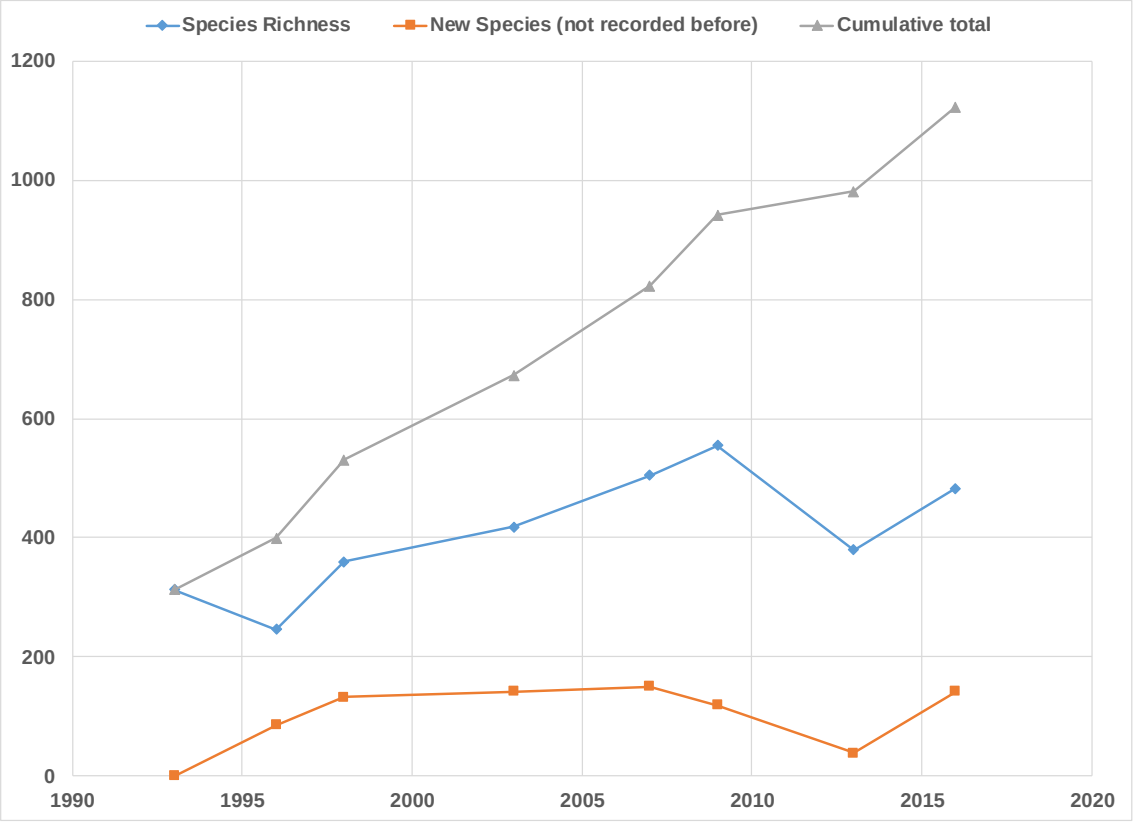


Figure 5.3.2 Species Richness, Cumulative species total & New species 1993-2016

Another way of looking at diversity is to use the taxonomic diversity measures available in the statistical package Primer. This uses an underlying taxonomic tree to assess how closely related the species are to each other as well as how many different species there are.

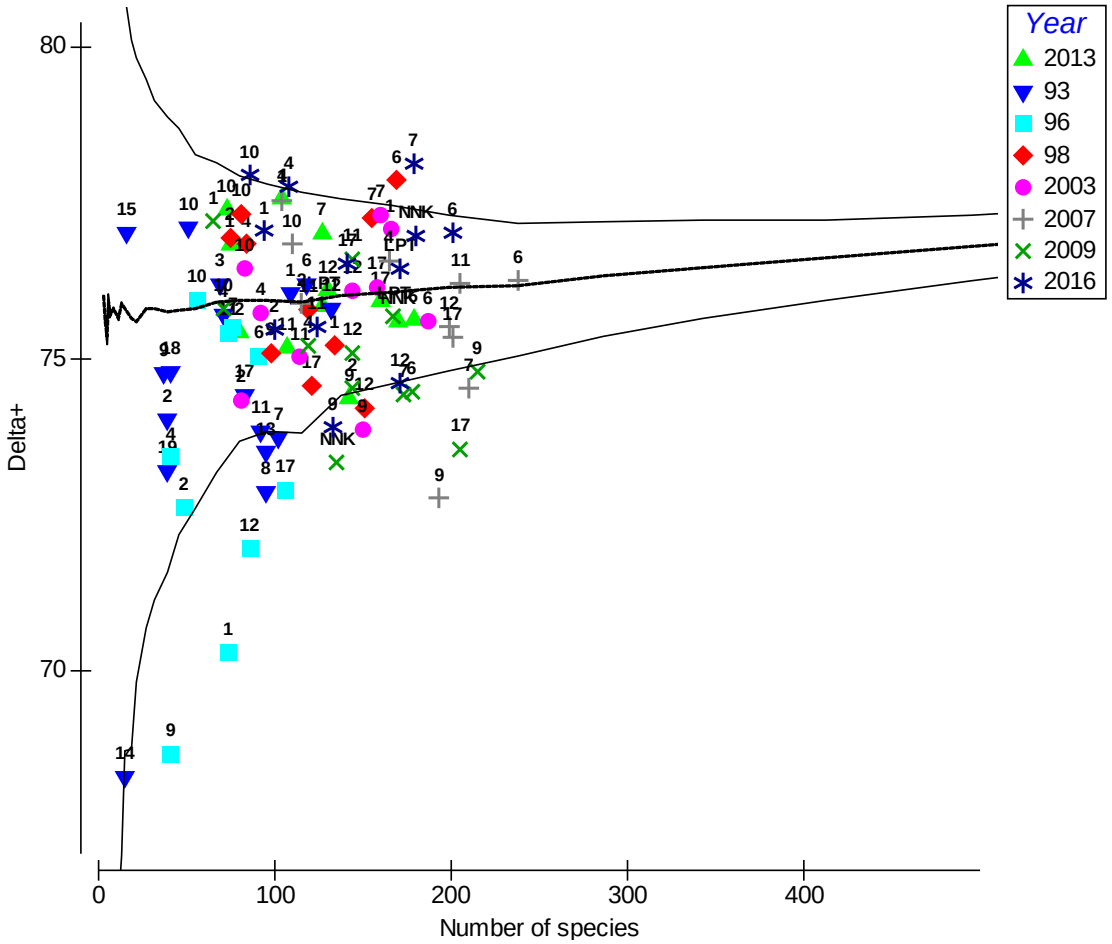


Figure 5.3.3 Funnel plot of taxonomic distinctness tests 1993 – 2016 ( Delta+ from Primer)

The samples from 1993 & 1996 drop below the expected values. All of 2016 samples (except NNK) are within the 95% boundary of the expected levels.

A simple way of looking at this very diverse set of species is to look at the representation of the major phyla (top level of the taxonomic tree). The graph below plots the number of species in each phylum from the different years.

| | 1993 | 1996 | 1998 | 2003 | 2007 | 2009 | 2013 | 2016 |
|---|---|---|---|---|---|---|---|---|
| ***Cnidaria*** | 3 | 2 | 0 | 9 | 1 | 0 | 1 | 12 |
| ***Platyhelminthes*** | 1 | 1 | 1 | 2 | 3 | 2 | 1 | 1 |
| ***Nemertea*** | 1 | 1 | 4 | 5 | 1 | 4 | 4 | 1 |
| ***Nematoda*** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ***Sipuncula*** | 4 | 5 | 3 | 6 | 5 | 6 | 4 | 6 |
| ***Annelida*** | 139 | 120 | 150 | 175 | 222 | 244 | 165 | 191 |
| ***Arthropoda*** | 82 | 57 | 110 | 112 | 142 | 140 | 102 | 126 |
| ***Mollusca*** | 62 | 40 | 76 | 65 | 107 | 123 | 84 | 66 |
| ***Phoronida*** | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| ***Echinodermata*** | 12 | 9 | 11 | 10 | 19 | 16 | 13 | 22 |
| ***Hemichordata*** | 1 | 0 | 1 | 1 | 2 | 2 | 1 | 1 |
| ***Chordata*** | 4 | 7 | 0 | 9 | 0 | 5 | 3 | 8 |
| ***Bryozoa*** | 1 | 0 | 2 | 20 | 1 | 11 | 0 | 38 |
| ***Porifera*** | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 3 |
| ***Ciliophora*** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| ***Entoprocta*** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| ***Animalia*** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

Table 5.3.2 Number of species found from each phylum 1993 – 2016.

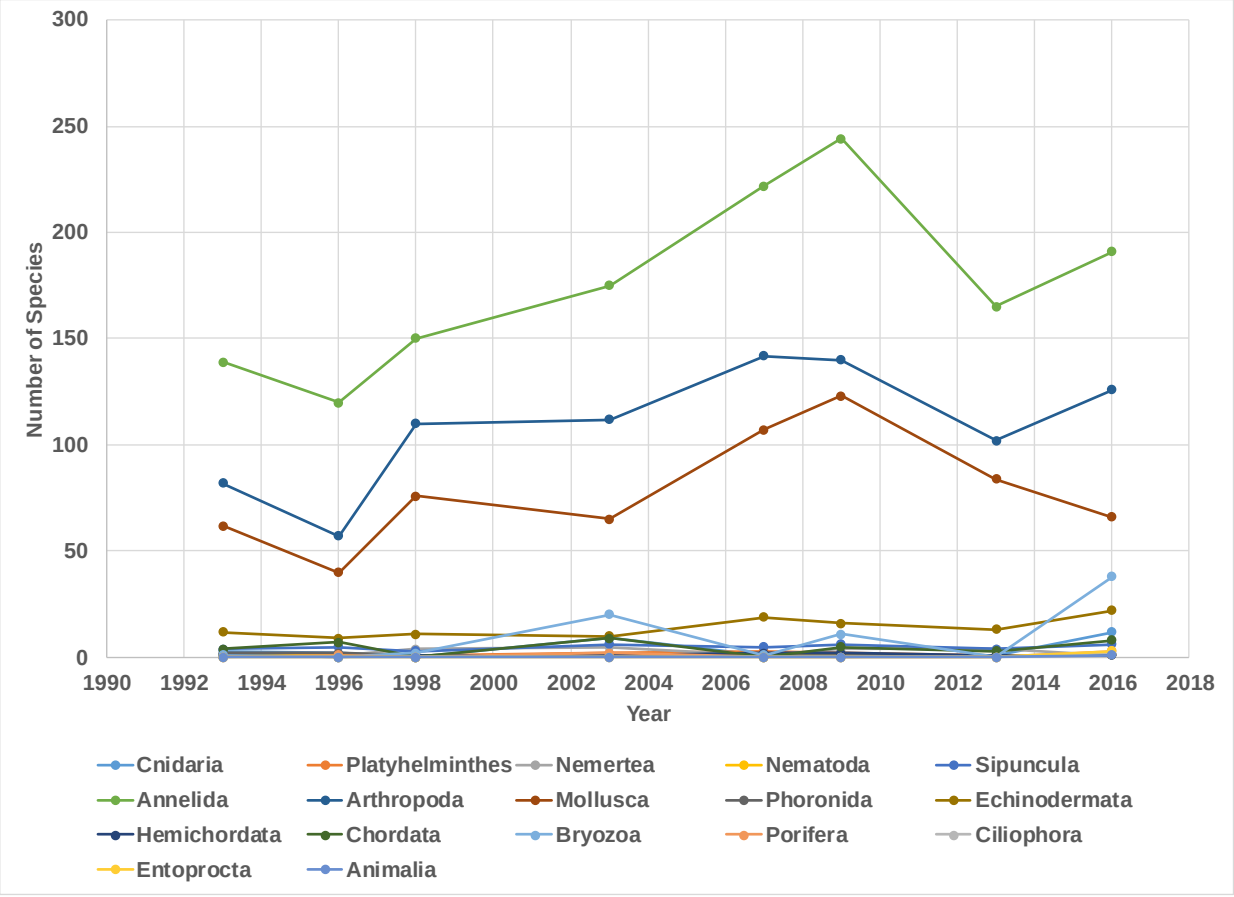


Figure 5.3.4 Number of species in each phylum 1993 – 2016.

Annelida (worms), Arthropoda (crabs, gammarids etc.) and Mollusca are always the 3 major phyla represented in the species lists. It is species from these phyla that drive the changes in diversity. Bryozoans have increased in 2016.

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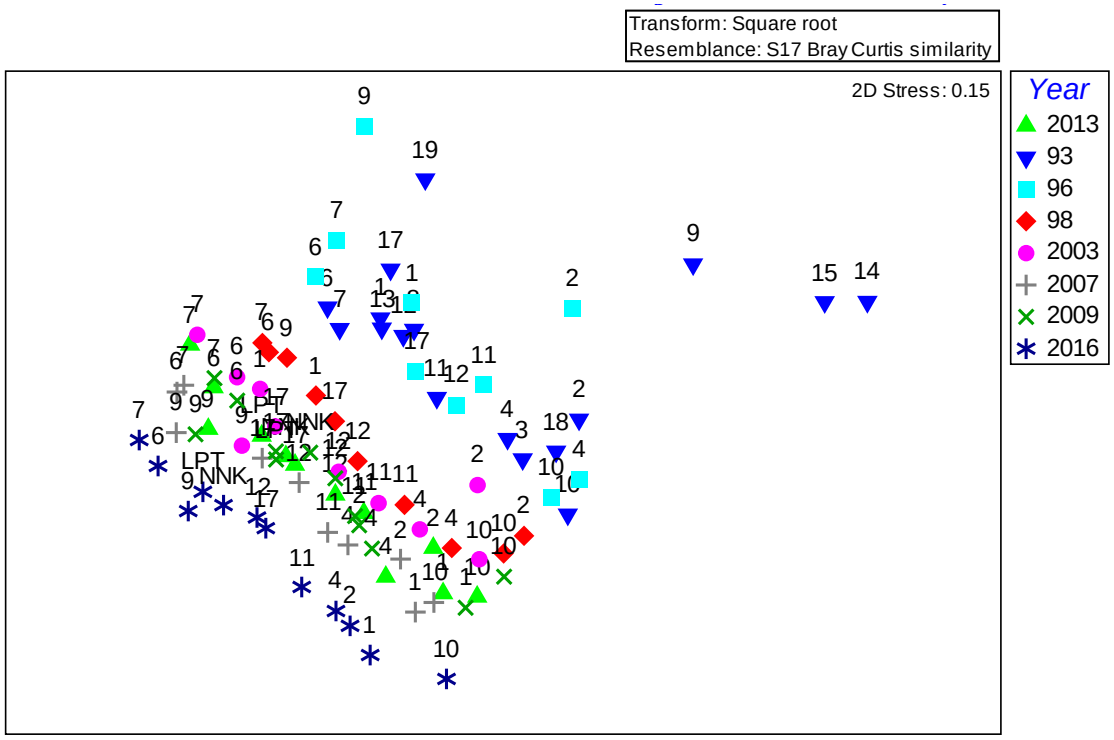



Figure 5.3.5 PRIMER Multi-dimensional scaling (MDS) plot showing the separation of samples from 1993 – 2016 Skomer MCZ infauna data

The MDS Primer plot shows that both 1993 and 1996 differ from all other year sets. The community as a whole 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. This contrasts with the diversity results but it suggests that the common species which define the different sediment communities remain stable but there are a lot of rarer species which contribute to the very high diversity within the MCZ.

### 5.3.8. 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 has increased again in 2016 and compared to other areas of the UK the sediment communities around Skomer MCZ are very diverse.

### 5.3.9. Recommendations

- Re-survey in 2020.
- Publish results and put the results into context with similar surveys from the surrounding area.

## 5.4. Scallop (*Pecten maximus*) population
(*CMS code: RM53/01*)

### 5.4.1. Project Status
Ongoing.
Volunteer survey every 4 years (next survey 2020).

### 5.4.2. Project Rationale
Scallop populations are a management feature of the Skomer MCZ as well as being a component of the sediment faunal community feature. The decision to select scallops as a management feature in its own right stems largely from the history of the area: Scallops were collected commercially and recreationally in the area of the MCZ until 1990. In 1990 the South Wales Sea Fisheries Committee (SWSFC) introduced a byelaw prohibiting scallop collecting by any means. Monitoring of the scallop population not only provides valuable evidence on the recovery from exploitation of an important component of the sediment community, but also to assess the effectiveness of the fishery byelaw. Long-term population data for an unexploited commercial species is also valuable for fishery managers.

### 5.4.3. Objectives
- To estimate the density of scallops within suitable habitats in the Skomer MCZ.
- To assess the age structure in the scallop population.

### 5.4.4. Sites
The 2000 survey established three sites, a further four sites were added in 2004. The seven sites were resurveyed in 2008, 2012 & 2016. Because scallop data are deemed to be of a sensitive nature, site locations are kept anonymous for reporting purposes.

### 5.4.5. Methods
In 2000 a method was developed suitable for volunteer diving teams at fixed sites which could be repeated in subsequent surveys. Full methods are detailed in Lock & Newman 2002.
- Sites are marked using GPS positions with temporary sinkers, buoyed to the surface;
- The sinkers are used by divers as the start point to lay transect tapes 30m or 50m in length in different directions;
- Scallops are collected by divers from a four-metre band, two metres either side of the transect tapes;
- The scallops are brought to the surface, their growth rings measured, shells marked with notches for identification and then returned to the site.

This is repeated for several transects over suitable habitat at each site.

All scallop shells are also checked for the presence of the invasive non-native slipper limpet, *Crepidula fornicata*. These are counted, removed from the scallop shell and destroyed. (Results are detailed in Section 4.12).

### 5.4.6. Project History

1979 / 80 (Jones & Hodgson) a small survey was completed. No density estimates. Age class data suggest strong recruitment in 1973-75 and then a decline for 1976-1980.

Bullimore (1985a) summarised the available data for 1979 – 1982. Scallop survey was completed at North Marloes Peninsula sites and North of the Neck, densities of 0.01$m^{-2}$ ($1/100\ m^{-2}$) were estimated for all sites.

2000 survey was completed using a small team of 8 volunteer divers and 3 fixed sites were established. The results suggest an increase in density to 0.05 $m^{-2}$ ($5/100\ m^{-2}$) compared to 1985 with a maximum site density of 0.01$m^{-2}$ ($1/100\ m^{-2}$). The age class data suggested strong recruitment in 1992 – 94, 2 years after the SWSFC byelaw was introduced and the first full year of staff presence at Skomer MNR.

2002 - A collaborative SWSFC/ Skomer MCZ scallop poster, explaining the byelaw, was produced in 2002. This was distributed to local dive clubs and dive shops and has been posted at local slipways.

2004 survey was completed with a large team of 50 volunteer divers. Sites established in 2000 were re-surveyed and a further 4 sites established. The total area surveyed was 11,120$m^2$ and 1293 individuals were measured.

2008 survey repeated the 7 sites previously established with a team of 40 volunteer divers. The total area surveyed was 9780$m^2$ and 1661 scallops were measured.

2012 survey again repeated at the established 7 sites with a team of 32 volunteer divers. Visibility was poor during the survey, therefore it was decided to reduce the search area to a 1m band either side of 30m length transects at most sites. The total area surveyed was 3240$m^2$ and 913 scallops were measured. A new control site was also set up in 2012 just outside of the Skomer MCZ northern boundary in St Brides Bay.

2016 the 7 established sites were re-surveyed along with the St Brides Bay site outside the MCZ boundary. Visibility was good and the volunteer team completed 60 transects covering 8620 $m^2$ and collecting 2534 scallops.

| | **Scallop *P.maximus*** | **Survey Area** | **MCZ Transects** | |
|---|---|---|---|---|
| Year | **Total** | **$M^2$** | **completed** | **Notes** |
| 1984 | 36 | N/A - Timed searches | 10 | Not a comparable method. Density estimate of 0.01 Scallops / $m^2$ |
| 2000 | 155 | 3400 | 17 | Only 3 sites surveyed |
| 2004 | 1292 | 11120 | 63 | 7 sites surveyed including 3 from 2000 |
| 2008 | 1661 | 9780 | 61 | As 2004 |
| 2012 | 913 | 3480 | 49 | As 2008 but with poor visibility so transect area was reduced. St Brides survey site added |
| 2016 | 2534 | 8620 | 60 | As previous surveys. Good visibility. St Brides survey repeated |

Table 5.4.1 Summary of survey results for the whole MCZ 1984 – 2016

### 5.4.7. Results

*Average density of scallops in Skomer MCZ*
The average density of scallops in the Skomer MCZ as a whole can be calculated in different ways:

*Simple mean*: Total number of scallops / total area surveyed.

*Simple site density mean:* total number of scallops at each site / total area surveyed at each site. Then average these to get an annual average.

*Site transect density mean*: calculate a density for each transect at each site then average these densities. Then average the 7 site densities to get an annual average

*Transect average*: calculate densities for all of the transects completed that year and then average these.

These have been calculated and results shown in the following table and graph.

| | | Simple | Tx | All |
|---|---|---|---|---|
| Year | Simple | site average | site Tx average | Tx average |
| 1984 | 0.01 | | | |
| 2000 | 0.05 | 0.06 | 0.06 | 0.05 |
| 2004 | 0.12 | 0.13 | 0.13 | 0.13 |
| 2008 | 0.17 | 0.22 | 0.22 | 0.20 |
| 2012 | 0.26 | 0.31 | 0.32 | 0.28 |
| 2016 | 0.29 | 0.35 | 0.35 | 0.33 |

Table 5.4.2 Average density of scallops within Skomer MCZ 2000 - 2016

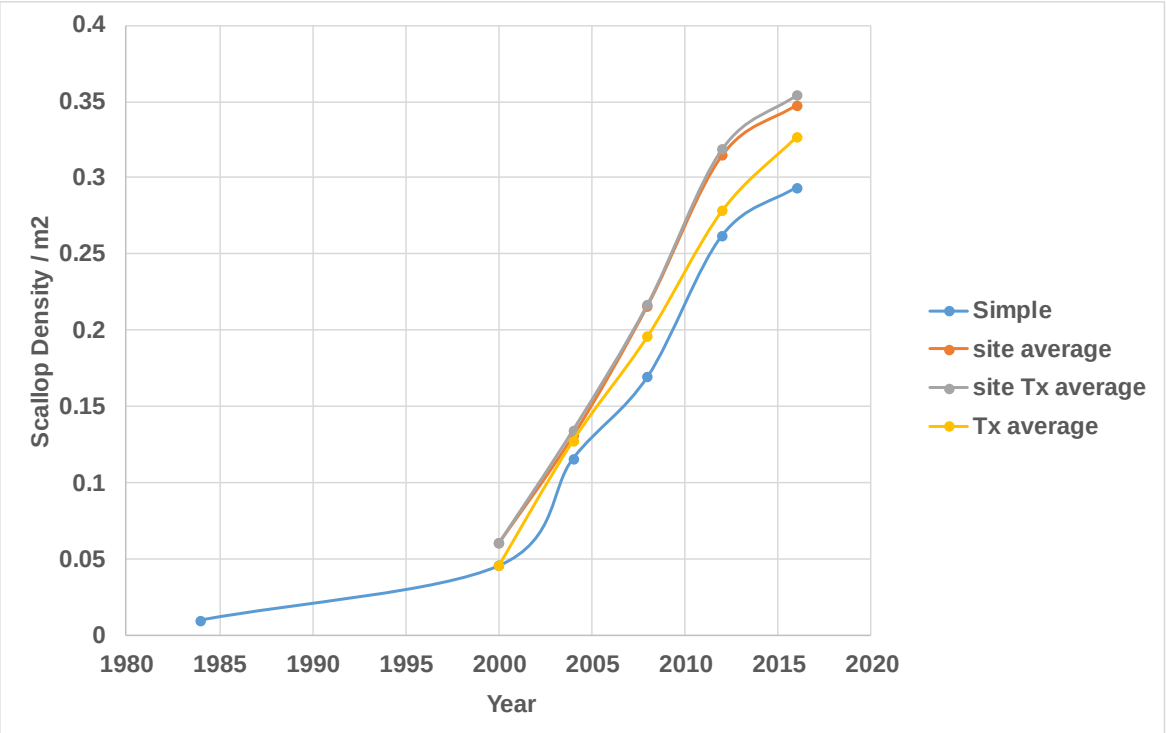



Figure 5.4.1 Scallop density ($m^2$) averaged for the whole Skomer MCZ 1985 - 2016

Regardless of calculation method used in each the graph shows a steep increase in density since 2000 with the indication of a plateau in 2016. The simple mean is always the lowest estimate of density and suggests very similar densities between 2012 and 2016.

*Statistical testing on annual density.*
The clumped nature of the density results makes parametric statistical methods unsuitable, even on transformed data.

A Kruskal-Wallace test on scallop density vs year (2004 – 2016) for individual transect data gave a significant difference between the medians (KW chi$^2$= 28.8, df3, P=2.45e- 10).

Mann-Whitney U tests between the years show that 2016 is significantly different ($p<0.05$) to 2004 and 2008 but not to 2012

Density results are very variable between sites and years, suggesting a highly clumped dispersion of scallops across the MCZ. Density does not change uniformly across all of the sites surveyed in the MCZ. This suggests that certain sites have a habitat more suited to the settlement and growth of *P. maximus* than others. Skomer scallop sites have a range of sediment profiles as well as varying degrees of exposure to wave action and tidal currents.

*Summary of P. maximus densities at each site 2000 – 2016*

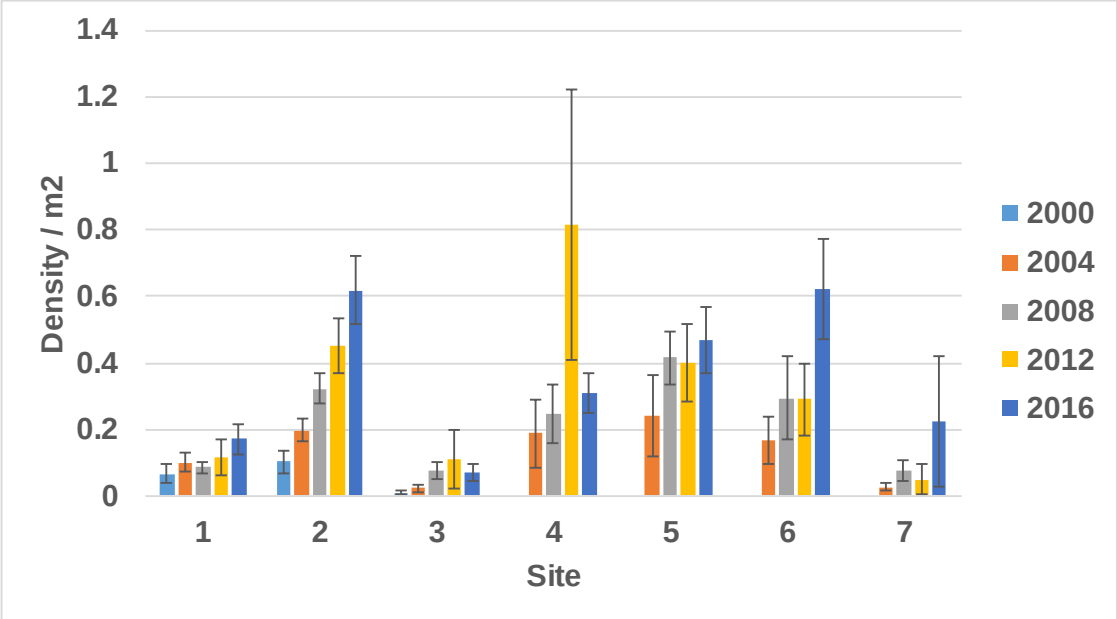



Figure 5.4.2 Individual Skomer MCZ site density changes (scallops / m$^2$) 2000 – 2016 with 95% confidence intervals.

The annual density results show an increasing trend in scallop density, however this trend is not uniform across all the sites. There is a lot of variability in how each site responds over time.

| Site | Trends observed |
|---|---|
| 1 | Very little change since 2004. Density in 2016 was 150% higher than in 2000 (60% higher than 2004). |
| 2 | Steady year on year increase. Densities in 2016 are now 500% higher than those in 2000. |
| 3 | Little change since 2008 but 2016 is now 600% higher than in 2000 |
| 4 | 2012 stands out as a very dense year. 2016 is 60% denser than 2004 |
| 5 | Large increase between 2004 & 2008 which stabilised, in 2016 density was 90% higher than in 2004. |
| 6 | Large increase in 2016 with density now 270% higher than in 2004 |
| 7 | A very large increase found in 2016 – but this must be treated with caution as it was attributable to 1 single transect result. |

Table 5.4.1 Trends in scallop populations at individual sites within Skomer MCZ 2000 - 2016

*Growth rate and age structure.*

All scallops were measured and age estimates made from annual growth rings.

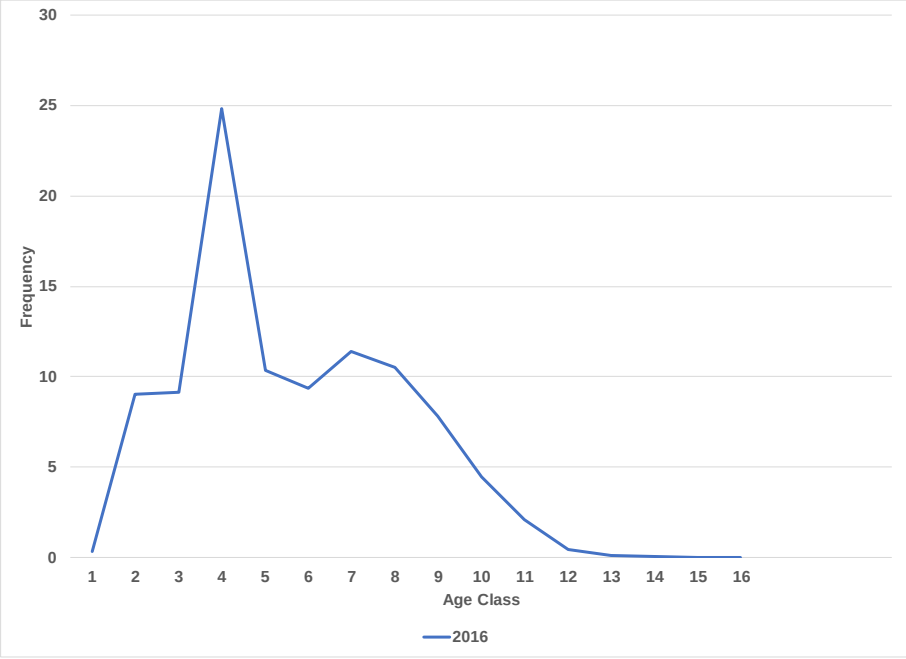



Figure 5.4.3 Age structure of *P. maximus* sampled at Skomer MCZ in 2016– aged using ring count.

The four-year age class is very well represented, suggesting good recruitment in 2012.

Estimating the age of older scallops from the growth rings can be problematic as beyond the 8th annual ring they are very close together and difficult to differentiate.

A more reliable, alternative method to estimating the age class is to use the overall length of the scallop, which allows for a better estimate of maximum age. This method is derived from the large body of growth ring data for the whole survey.

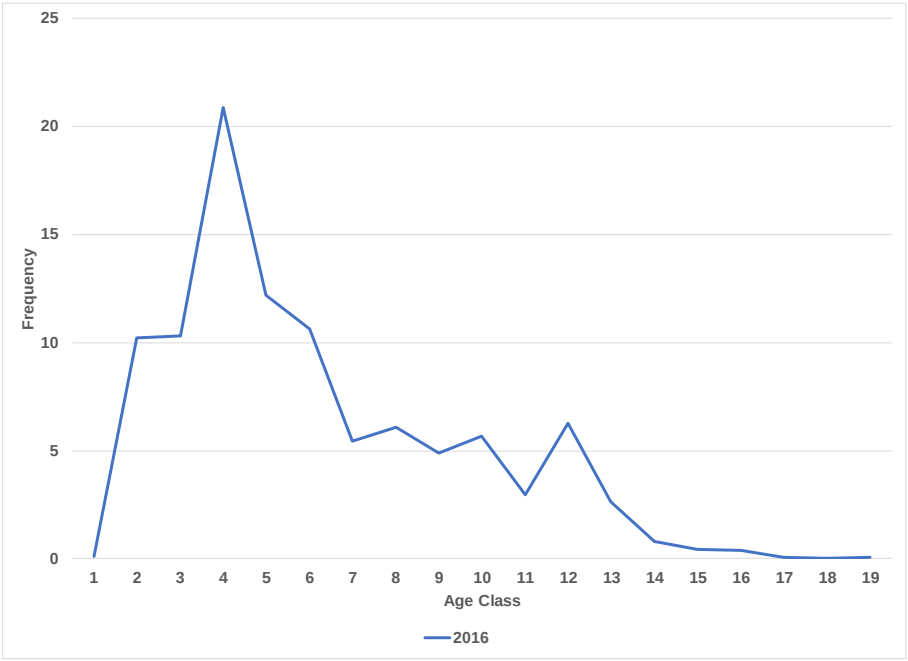
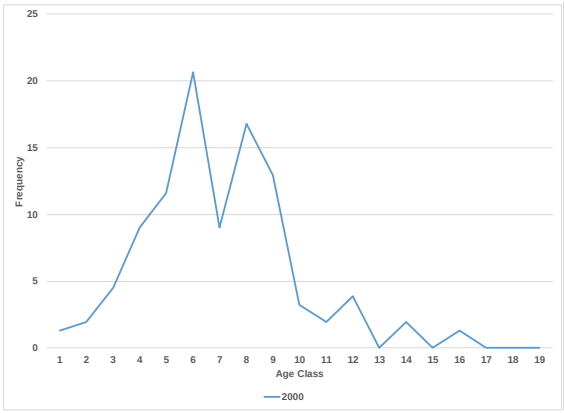


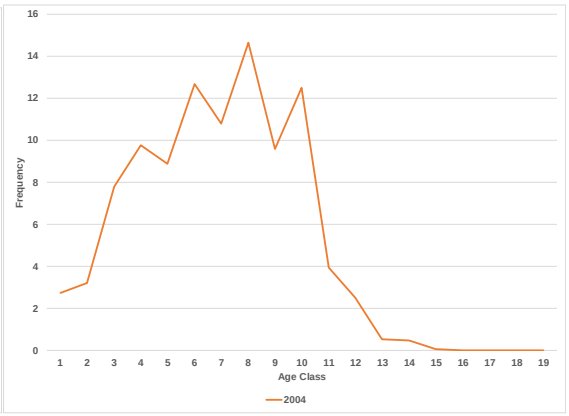

Figure 5.4.4 Age structure of 2016 *P. maximus* at Skomer MCZ – aged using estimated age from overall length.

Using overall length shows that the four-year age class is still very dominant, but now indicates that the population includes scallops older than 16 years.

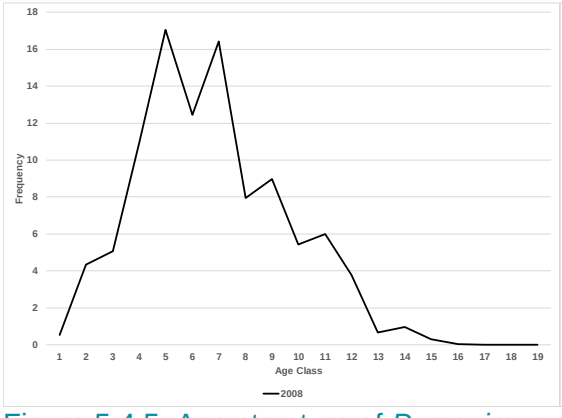
Year 2000




Year 2004




Year 2008




Year 2012

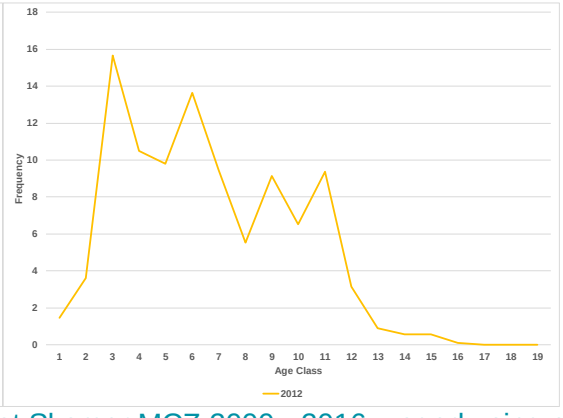



Figure 5.4.5 Age structure of *P. maximus* at Skomer MCZ 2000 - 2016 – aged using estimated age from overall length.

In 2000 there were only150 scallops to measure so that year's results may not be comparable to estimates from the following years. Since 2004 there seems to be a shift of the modal size class towards younger scallops.

Without supporting information about recruitment and survival rates it is difficult to interpret these results but it would be useful to compare these results to other populations around the UK.

Analysis of the age structure data within each site and between years did not show any strong trends. Age structure is very variable between sites and sites are not consistent between years. It does suggest that the proportion of scallops under 4 years old is increasing over time.

The density ($m^{-2}$) of scallops of four or less years old can be calculated. This shows a clearer picture of increasing trend since 2008 at all sites except site 4. This will be linked in part to the overall increase in density of all scallops but it is also down to an increase in the proportion of scallops of four or less years of age in the whole population.

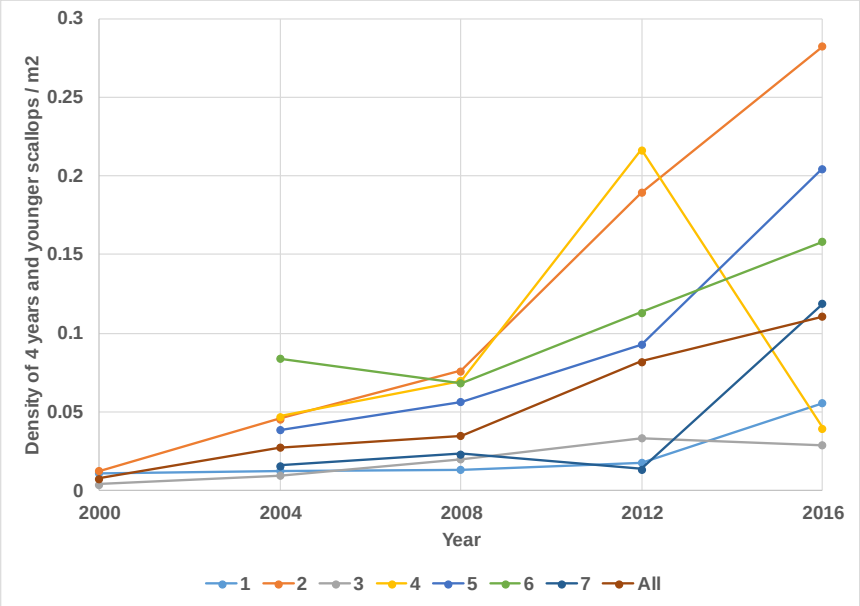



Figure 5.4.6 Density (scallops / m2) of aged 4 and younger scallops at Skomer MCZ 2000-2016

Site 4 had a dramatic rise in density of scallops of four or less years old in 2012 followed by a drop in density in 2016. It would appear that there has been very little recruitment at site 4 in the last 4 years.

The average change in overall density (all scallop ages) between 2012 & 2016 was more than 66%.
The average percentage change in density of scallops of four or less years of age was more than 150%.
These young scallops have increased at over twice the rate of the older scallops which is what would be expected in a growing population with healthy recruitment. The relatively long period that the larvae spend in the water column (20 – 40 days, Salomonsen *et al.* 2015) makes it difficult to ascertain the origin of the spat that are contributing to this high level of recruitment.

*Growth rates*

The rate of change in size can be calculated between each age class to show how growth varies as the scallop ages. These can be compared between years.

*Size at t/size at t+1 = proportional change in size*

Growth rates between age classes (2000 – 2016) with associated 95% confidence limits

| Year | 1 - 2 | 2 - 3 | 3 - 4 | 4 - 5 | 5 - 6 | 6 - 7 | 7 - 8 | 8 - 9 | 9 - 10 | 10 - 11 | 11 - 12 | 12 - 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2000** | 2.3199 | 1.5808 | 1.2505 | 1.1077 | 1.0659 | 1.0425 | 1.0403 | 1.037 | 1.029 | 1.0233 | 1.0132 | 1.0143 |
| **2004** | 2.53 | 1.5699 | 1.2171 | 1.1119 | 1.059 | 1.044 | 1.0349 | 1.0319 | 1.0317 | 1.0337 | 1.0255 | 1.038 |
| **2008** | 2.3396 | 1.5146 | 1.2121 | 1.1056 | 1.0623 | 1.042 | 1.0327 | 1.027 | 1.0233 | 1.0225 | 1.0174 | 1.0314 |
| **2012** | 2.3276 | 1.4945 | 1.2031 | 1.1141 | 1.0559 | 1.0404 | 1.0311 | 1.0274 | 1.0258 | 1.0218 | 1.0194 | 1.0184 |
| **2016** | 2.6265 | 1.5157 | 1.1955 | 1.0934 | 1.0517 | 1.0343 | 1.0254 | 1.02 | 1.0164 | 1.0157 | 1.0205 | 1.0154 |
| | **95% CI** | | | | | | | | | | | |
| **2000** | 0.1155 | 0.0449 | 0.0245 | 0.0107 | 0.0092 | 0.006 | 0.0066 | 0.0071 | 0.0062 | 0.0118 | 0.0059 | 0 |
| **2004** | 0.0894 | 0.0316 | 0.0102 | 0.0143 | 0.0027 | 0.0023 | 0.0018 | 0.002 | 0.0029 | 0.0084 | 0.0043 | 0.0168 |
| **2008** | 0.0324 | 0.0117 | 0.0071 | 0.0038 | 0.0031 | 0.0027 | 0.0021 | 0.0023 | 0.0037 | 0.0034 | 0.0034 | 0.0177 |
| **2012** | 0.0455 | 0.0149 | 0.0099 | 0.0278 | 0.0031 | 0.003 | 0.0025 | 0.0046 | 0.0047 | 0.0098 | 0.0076 | 0.0128 |
| **2016** | 0.0309 | 0.0091 | 0.0043 | 0.0029 | 0.0017 | 0.0012 | 0.001 | 0.0009 | 0.0008 | 0.0017 | 0.0086 | 0.0045 |

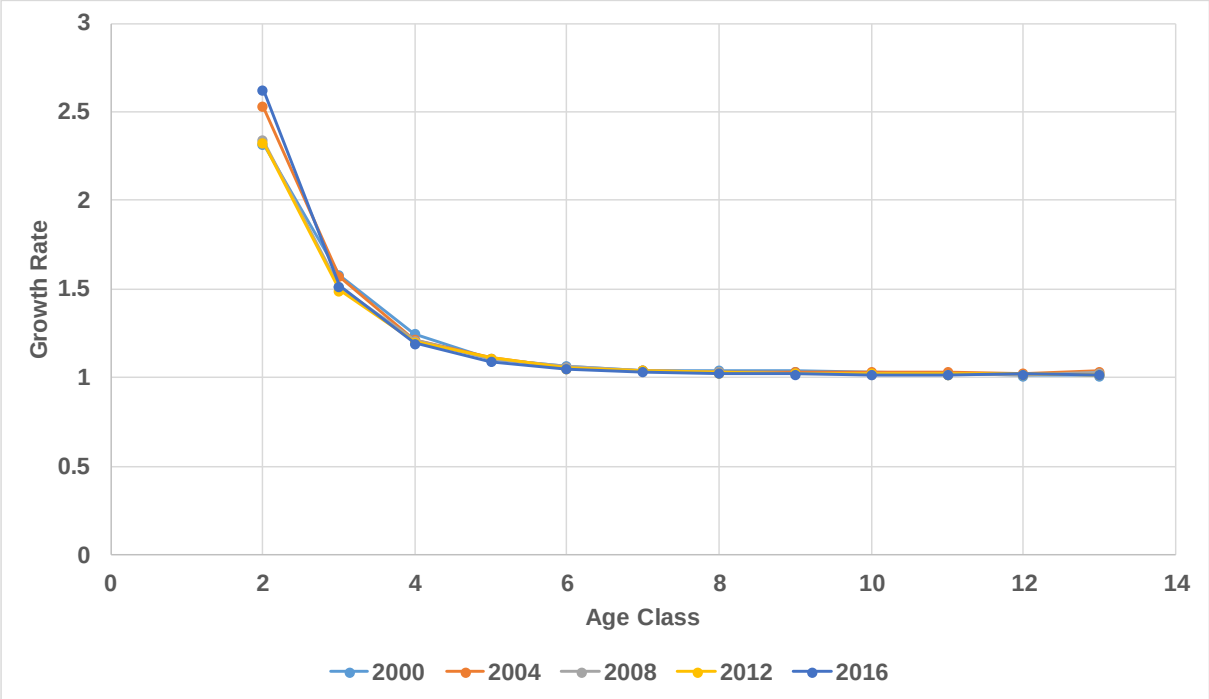



Figure 5.4.7 Changes in at Skomer MCZ scallop growth rates with age (2000 – 2016)

All years show a very similar pattern of growth rate, with rapid growth in age classes 2 and 3, slowing down in 4 and 5 and almost stopping by age 6.

The 1st - 2nd growth ring shows the only possible significant difference but this could be compounded by a double spawning event resulting in very variable 1st growth ring measurement.

The double spawning event may not be as pronounced some years (due to environmental factors) therefore the growth rate between age classes 1 - 2 will depend upon how much growing time the young scallop has in its 1st year – Spring-spawned scallops will have more time to grow than scallops spawned in the late summer. The most recent study into spawning

times for *P. Maximus* in Wales (Salomonsen *et al.* 2015) suggests a double spawning event ; one in spring and a second in late summer with continuous, low level of spawning in between. Times of spawning are very variable between geographical areas and are affected by genetics and the environment (Salomonsen *et al.* 2015), and are therefore subject to change.

### 5.4.8. Current Status

- The 2016 results have shown another increase in density of scallops across the whole MCZ with a suggestion that the rate of increase may be slowing down.
- There is strong evidence of healthy recruitment in the last 4 years (especially in 2012) and these young recruits appear to be driving the increase in scallop numbers at most sites.
- Growth rates are very similar across the years.

### 5.4.9. Recommendations

- Compare these results with other protected and fished areas in the UK.
- Offer the dataset to a university to produce a peer reviewed paper.
- Increase sampling effort outside the MCZ in St Brides Bay to allow comparison with the MCZ results.

## 5.5. Plankton Recording
*(CMS Code RB04/01)*

### 5.5.1. Project Status
Ongoing, annual survey

### 5.5.2. Project Rationale
Whereas 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 feature species have planktonic larval stages. The abundance and composition are influenced by available nutrients, water movement, temperature and light.

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

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

### 5.5.5. Method
*Zooplankton:*
2008 &2009: A plankton sample was collected once a week using a 63um 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.

PML method adopted: A 200um mesh net is pulled on a vertical haul from 35- 40m depth at 0.2m / second. The sample is collected in the 'cod-end' bottle and this is preserved in 4% formalin. Two samples are taken at each sampling event.

*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 can be used to identify species responsible for "blooms". A second water sample was also taken at 1m below the surface. This was then used to filter three 250ml samples over a 0.2um filter to estimate chlorophyll content. The chlorophyll samples are analysed by PML. The phytoplankton samples in Lugol's solution are stored as a record of any plankton bloom.
2013 onwards – discontinued due to lack of analysis.

### 5.5.6. Project History

- 2008 - samples were used for an undergraduate project at Aberystwyth University. A report was produced which detailed the species found. The student was not an expert in plankton identification so it cannot be considered a comprehensive list.
- 
- 2009 - 12 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 10th May 2009 to the 9th Nov 2009. All zooplankton individuals were identified to species if possible and counted. Phytoplankton individuals were identified to species level but their abundance was recorded semi quantitatively.
- 
- 2010, 2011 & 2012 - samples were collected from March to November, these have been analysed by the Plymouth Marine Laboratory.
- 
- 2013 –onwards - Samples were sent to Dr D. Conway of SAHFOS (Plymouth Marine Biological Association) for identification and enumeration.
- 
- 2014 - Plymouth Marine Laboratory reviewed the current data set, standardised the species list and made recommendations on how the data set should continue (McEvoy, 2015).

### 5.5.7. Results

*Zooplankton:*

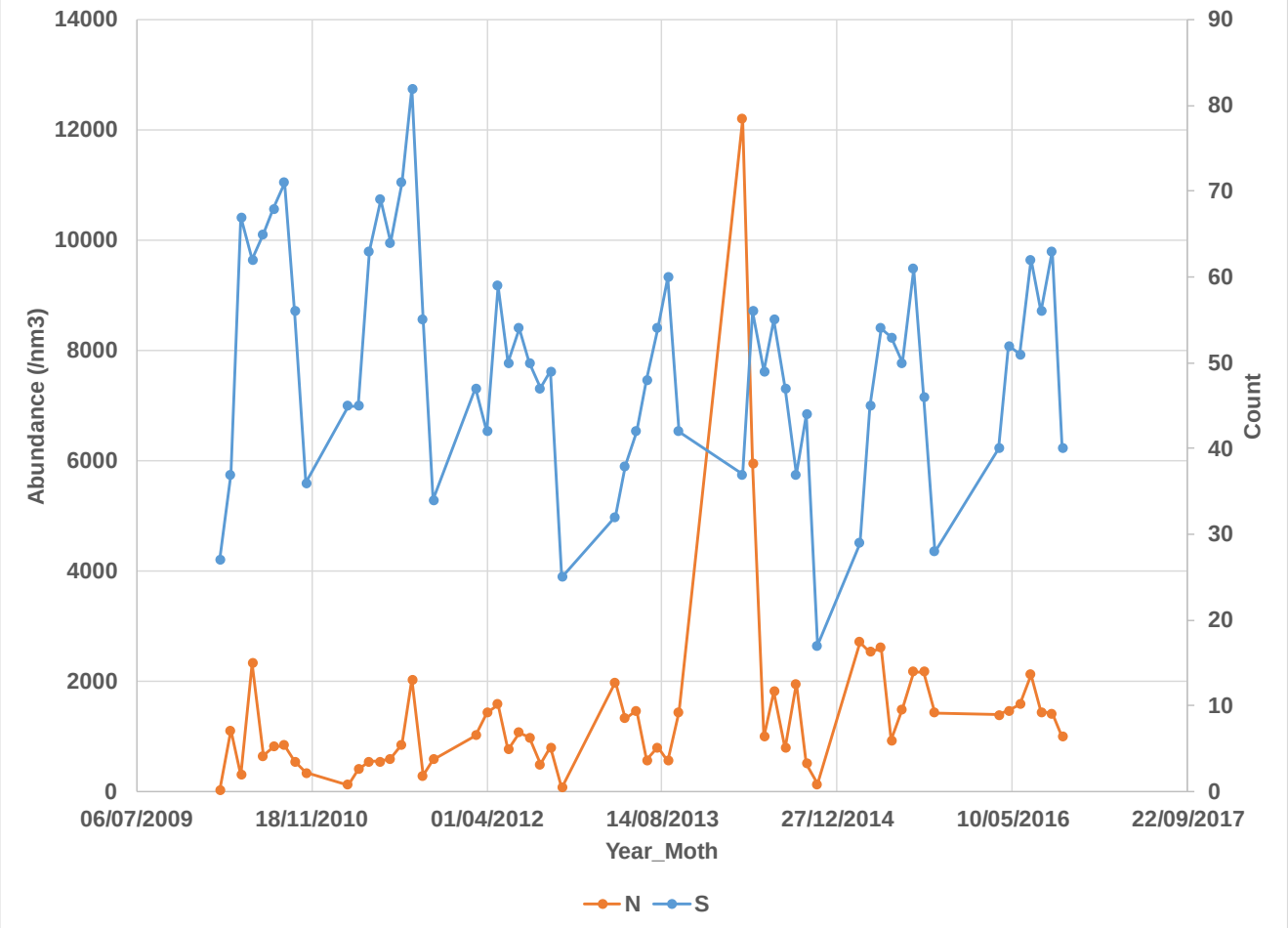



Figure 5.5.1 Average plankton species richness (S) and total number of individuals (N) 2009- 2016

All zooplankton data is held on file at the Skomer MCZ office in a spreadsheet format and as Primer files. This allows for a wide range of data analysis: Individual species can be selected, differences between years can be analyses or the whole data set can be combined to look for seasonal trends.

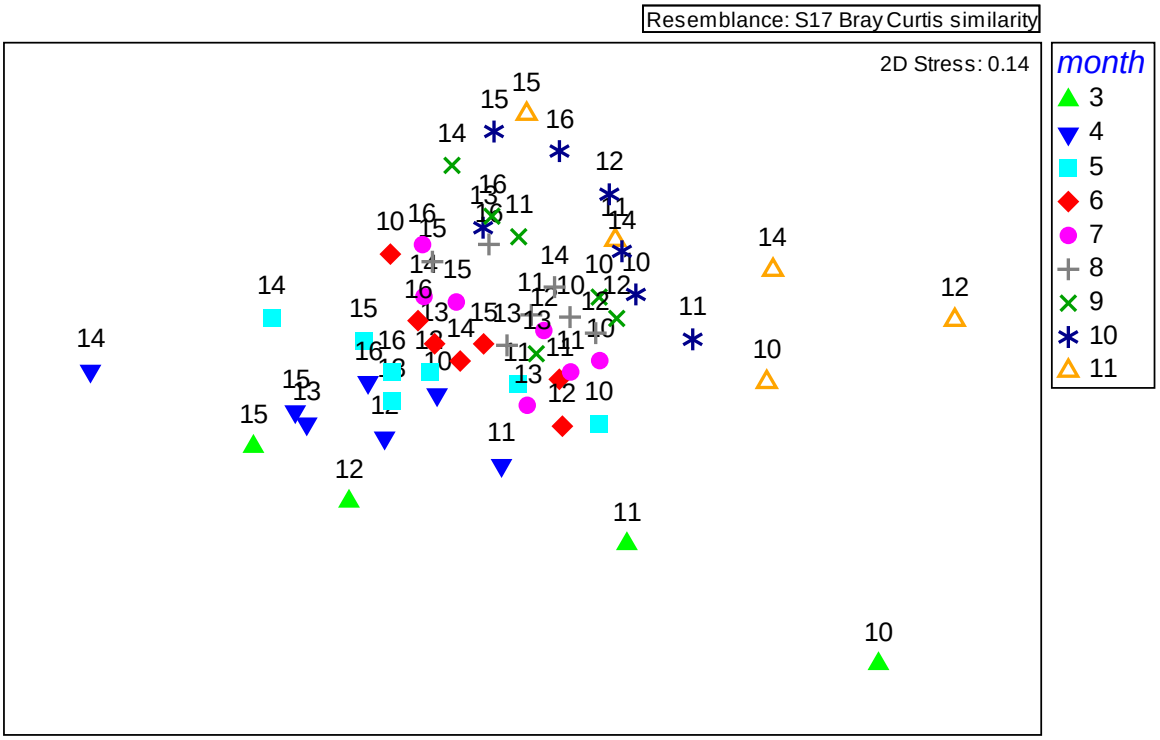



Table 5.5.1 PRIMER MDS Plot of the whole Skomer MCZ zooplankton data set – symbols denote month, figures denote year.

Statistical analysis of the differences between datasets shows a strong seasonal pattern with months grouping together, however these groups are in lines which does suggest inter-annual variability. 2016 points appear very close to 2015.

### 5.5.8. Current Status

The status of the plankton at Skomer MCZ is unknown. Further data is required to estimate natural variability.

### 5.5.9. Recommendations

- Continue to collect seasonal data for zooplankton.
- Restart the water sampling for chlorophyll not only to help monitor primary productivity in the plankton, but also to enable turbidity due to phytoplankton to be factored into the interpretation of overall seawater turbidity data (see Section 6.3).
- Compare data sets to Plymouth Marine Laboratory L4 site to help ascertain natural variability and give geographic context.
- Publish a descriptive paper with Plymouth Marine Laboratory.

## 5.6. *Eunicella Verrucosa*: Population and Growth Rate
*(CMS Code: RM23/01)*

### 5.6.1. Project Status
Ongoing, annual survey.

### 5.6.2. Project Rationale
The pink sea fan *Eunicella verrucosa* (Pallas) is a component of the Lusitanian anthozoan management feature of the Skomer MCZ. It is a UK Biodiversity Action Plan Species, is on 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. Sea fans are a slow growing, erect species susceptible to permanent damage. Recovery and reproduction rates are thought to be very slow.

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

| 5.6.4. Sites | Date started |
|---|---|
| North Wall stereo | (1987) |
| Bernie's Rocks (East and West) | (1994) |
| Bull Hole | (2002) |
| The Pool | (1997) |
| North Wall East | (2000) |
| Sandy Sea Fan Gully | (1994) |
| Thorn Rock | (2002) |
| Way Bench | (1994) |
| Rye Rocks | (2002) |
| South Middleholm | (2002) |
| West Hook | (2005) |

### 5.6.5. Methods
- Individual pink 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 newly established ("baby") fans which are counted as 'new recruits'.

- Photographs are taken using a single camera mounted on a 50 x 70 cm 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 nudibranch *Tritonia nilsodhneri* and mollusc *Simnia patula.*

- Where practicable detached sea fans that are found in the Skomer MCZ are re-attached artificially to the rock substrate at one of the monitoring sites if enough polyps remain alive on the colony for it to recover. These fans are then added to the monitoring programme.

- The photographs are analysed using image analysis techniques.

### 5.6.6. Project history

*Image analysis*

- 1997 - methods were developed using MapInfo software to study the fan area and branch length to assess growth (Gilbert 1998). This was completed for all fan images taken from1994 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 fans matching between year sets. A method to assess fan condition was developed, this was completed for all photo images in the dataset since 1994.

- 2002 to date - fan condition assessment has been completed each year using both photo images and supportive field records. In 2008 a new digital SLR camera providing high quality images helped to improve photo analysis.

### 5.6.7. Results

| year | Sites surveyed | Total fans recorded | Total natural fans | Total attached fans | New recruits (babies) | Natural fan Losses (confirmed) | Attached fan losses | Missing (to be confirmed) |
|---|---|---|---|---|---|---|---|---|
| 1994 | 4 | 34 | 34 | | | | | |
| 1995 | 4 | 33 | 33 | | | 1 | | |
| 1996 | 4 | 33 | 33 | | | | | |
| 1997 | 5 | 39 | 39 | | | | | |
| 1998 | 5 | 39 | 39 | | | | | |
| 1999 | 0 | | | | | | | |
| 2000 | 5 | 54 | 54 | | | | | |
| 2001 | 5 | 55 | 55 | | | 1 | | |
| 2002 | 9 | 86 | 86 | | | 1 | | |
| 2003 | 9 | 99 | 99 | | 1 | | | |
| 2004 | 9 | 101 | 100 | | | | | |
| 2005 | 10 | 114 | 111 | 3 | 1 | 1 | | |
| 2006 | 10 | 119 | 116 | 3 | 7 | | | |
| 2007 | 10 | 121 | 118 | 3 | 1 | 2 | | |
| 2008 | 10 | 126 | 122 | 4 | | 1 | | |
| 2009 | 10 | 128 | 121 | 7 | | | | |
| 2010 | 10 | 126 | 120 | 6 | | 3 | 1 | |
| 2011 | 10 | 126 | 122 | 4 | | | 2 | |
| 2012 | 10 | 126 | 121 | 5 | | 1 | | |
| 2013 | 10 | 127 | 122 | 5 | | | | |
| 2014 | 9 | 123 | 119 | 4 | | | | |
| 2015 | 10 | 123 | 121 | 2 | | 3 | 2 | |
| 2016 | 10 | 116 | 113 | 3 | 1 | 5 | | 5 |
| totals | | | | | 11 | 19 | 5 | 5 |

Table 5.6.1 Skomer MCZ sea fan survey results 1994 -2016

*Losses*

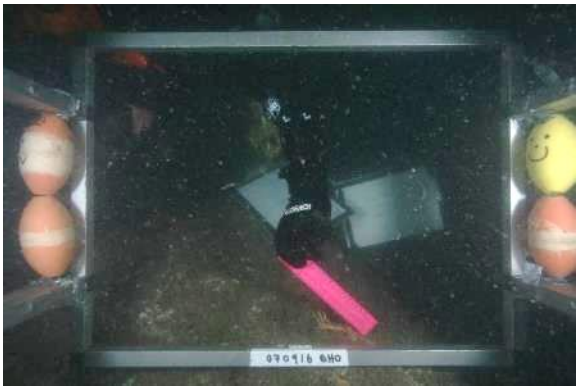
A total of 19 losses of natural sea fans and 5 of artificially attached fans have been recorded. There are currently a further 5 missing fans whose status needs to be confirmed in 2017.

In 2016 an unusually high number of losses were recorded. Three fans recorded as missing in 2015 were confirmed as losses, these were BHO6, SSFG22 and NWA1. Two artificially attached fans were also confirmed as losses.

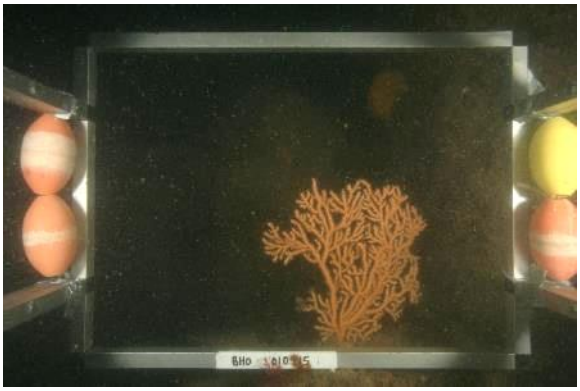
The NWA1 was a significant loss as this was one of the fans from the North Wall stereo monitoring programme started in 1987 and had been photographed annually for 28 years.

Some fans can become very encrusted and hidden in seaweed making it difficult to find so care is taken each year to check, this year Way16 was re-found after being missing in 2015.

Five additional confirmed losses were recorded in 2016. These were all from the Bull Hole site. The base of both BH14 and BH29 were the only remains found in May and when the site was revisited in September both BH19 and BH21 had also been reduced to their bases although they had been photographed as healthy fans in May.

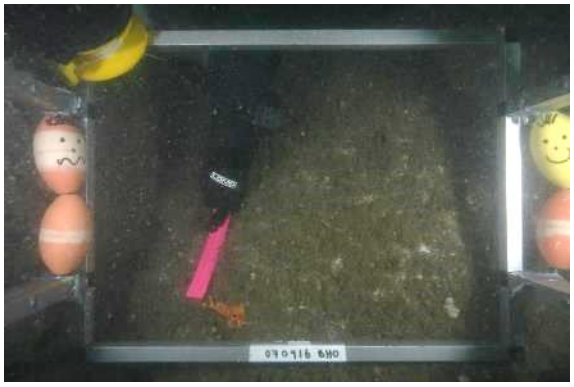


BHO14 in 2015, reduced to a small stump in May 2016.



BH29 in 2015, reduced to a base only in May 2016

.

BH19 in May 2016, reduced to a base only in September 2016


BH21 in May 2016, reduced to stump in September 2016


BHO2 photographed together with BHO1 in 2015 and only BHO1 left in May 2016

BHO2 was also missing, this fan was positioned very close to another fan (BHO1) which was still present.

Five additional fans were absent in 2016, BH16, BRK8, TRK1, TRK4 and NWAe11, these will be checked again and their status confirmed in 2017.

*Recruitment*

Recruitment has been very low with a total of only 11 “baby” sea fan colonies being recorded at the monitoring sites since 2000. Condition and growth in the recruits has been variable. BHO23 was a confirmed loss in 2010 and the cluster of 5 babies at BHO have shown no growth in 11 years.

| 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 2016. |
| 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 2016. |
| NWAe15 | 2005 | Found below NWAe13. 3 branches in 2005 grown to 6 branches in 2016. |
| BHO 5babies | 2006 | A cluster of 5 baby fans on a single boulder, all single or double branched stalks. **No growth** recorded from 2006 to 2016. |
| RRK24 | 2006 | Found next to RRK7. 5 branches in 2006 grown to 16 branches in 2016. |
| RRK26 | 2016 | Found in gully close to RRK12. |

Table 5.6.2 Skomer MCZ sea fan recruitment

*Sea fan condition*

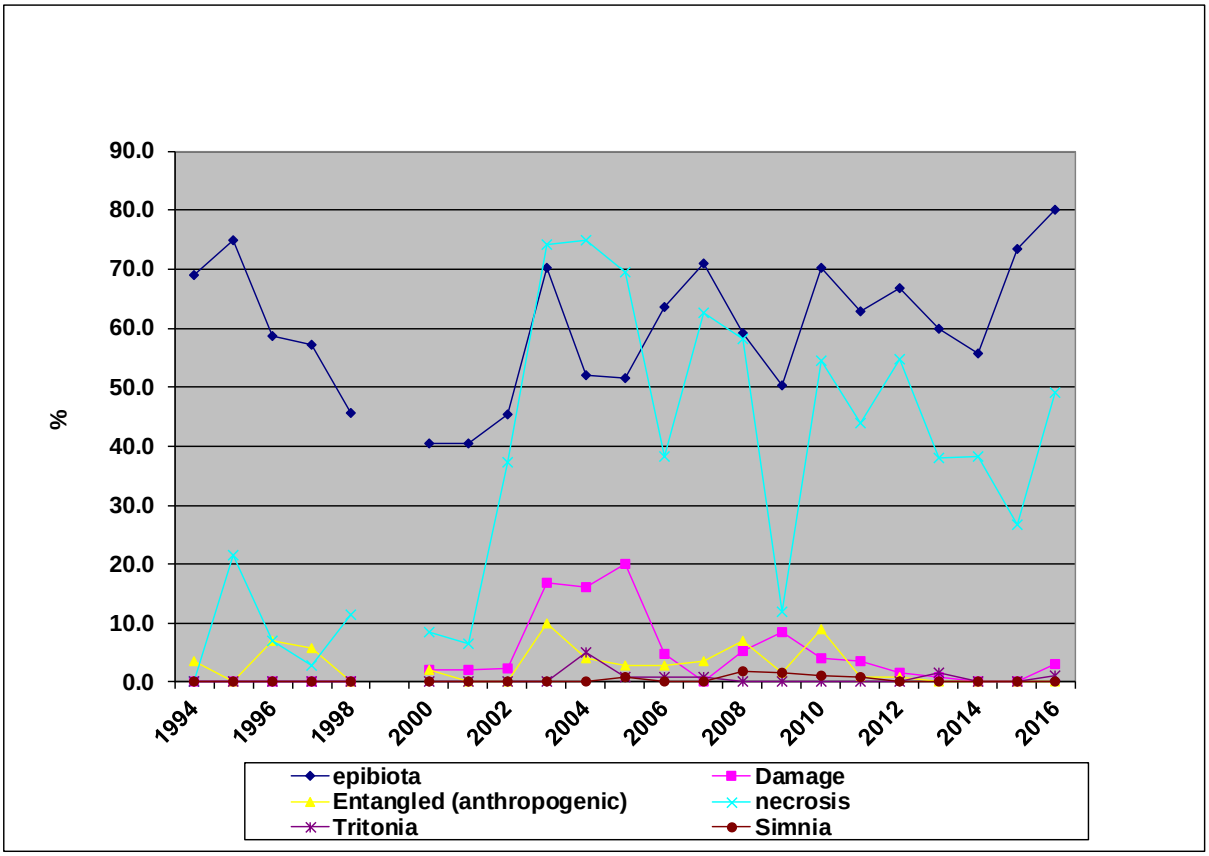



Figure 5.6.1 Condition of sea fans in the Skomer MCZ from photographic images (1994-2016) and field data (2002-2015).

*Necrosis:*
Necrosis is recorded when sea fan soft tissue has died back to leave just the black skeleton showing.
In most cases just tiny tips of necrosis are recorded but in some cases larger sections on a fan are seen (this is then also recorded as damage). Dead tips will often fall off but it is possible for healthy neighbouring tissue to grow over the exposed skeleton, thus a fan may have no necrosis recorded in the following year.
Necrosis recording from photos from 1994 to 2001 was inconsistent due to variable image quality, therefore field recording of necrosis and the other condition parameters started in 2002 to support condition assessment. Since 2008 image quality has significantly improved with the use of a digital SLR camera allowing more accurate assessment of necrosis.
In 2009 a large drop in necrosis was observed with records of its presence in only 12% of the surveyed sea fans. However, the occurrence of necrosis increased in 2010 and then fluctuated between 26% and 55% for the following 6 years - in 2016 necrosis was 49%, equal to the average level of necrosis since 2002 (15 years).

*Epibiota*
Epibiota includes tangled and attached dog fish eggs, drift algae, bryozoans and hydroids. On occasion bryozoan sea fingers, *Alcyonidium diaphanum*, deadman's fingers, *Alcyonium digitatum* and ross coral *Pentapora foliacea* have been recorded growing on a fan. Entanglement with epibiota and in particular dog fish eggs if extensive and persistent can cause damage to the sea fan tissues. An annual average of 62% of sea fans have been recorded with attached or entangled epibiota for the last 15 years of surveys. In 2016 this was on 80% of the fans.

*Entanglement (anthropogenic)*
Fans have been found with fishing line entanglement, which, if extensive and persistent, can cause some damage to the sea fan tissues. Whenever possible the line is cleaned off the fan to allow recovery. No entanglements were recorded in 2016.

*Damage*
Damage is recorded when entanglement in fishing line or natural epibiota results in large areas of necrosis. In addition fans are recorded as damaged when dislodged from the rock, in some cases they are found nearby and an attempt is made to re-attach using pitons. In 2016 a record number of sea fans were lost. Of particular concern are the five losses at Bull Hole: No specific cause is evident for the disappearances, but what remains of the sea fans show signs of the colony having been knocked or broken off.

*Tritonia nilsodhneri* or *Simnia patula*
Very low numbers of these species have been recorded over the years. In 2016 one sea fan sea slug, *Tritonia nilsodhneri* , with its eggs was recorded at North Wall east.

### 5.6.8. Supported research

2002 Reef Research - Sea fan reproductive biology. Small clippings were taken from some fans 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 2004).

- 2007 to 2013 Exeter University: Connectivity between populations of pink sea fans using internal transcriber sequences: Small clippings were taken from some Skomer fans in both 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 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 *Scyliorhinus stellaris* eggs. Fouling was found to have a significant negative association with growth with a decline of 0.2% over a 20 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).

### 5.6.9. Current Status

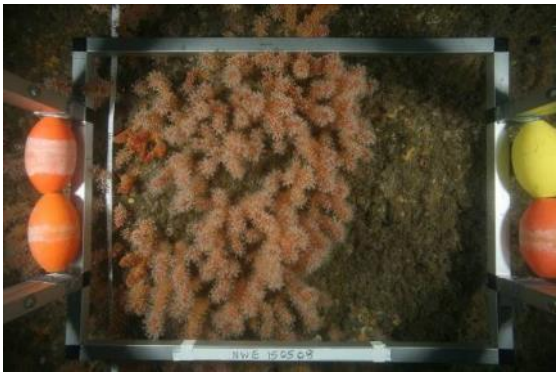
- Numbers: There have been 24 confirmed sea fans lost from the monitoring sites between 1994 and 2016 and there are 5 further possible losses in 2016.
- There was 1 new recruit (“baby” fan) found in 2016.
- Condition: Necrosis occurrence was found in 49% of the sea fans, which is the average recorded for the last 15 years. Epibiota was recorded on 80% of the sea fans; this is above the average of 64% recorded for the last 15 years.
- As an attribute of the Lusitanian anthozoan assemblages feature for Skomer MCZ, the condition of the sea fan population means the feature is in Unfavourable conservation status.
- The timing and the mechanical nature of the damage evident from the remains of sea fans indicates that anchoring or lobster pot fishing is responsible for the loss of at least some sea fans rather than storm damage or other natural event. Only lobster pot fishing has been recorded in the vicinity of sea fan sites over the period of study - adherence to the no-anchoring voluntary code of conduct remains very high.

### 5.6.10. Recommendations

- Observe persistence of biotic fouling/entanglement e.g. dogfish eggs;
- Take close-up photos of all baby/small sea fans found;
- Monitor sea temperature and suspended turbidity levels to provide background data for the biological monitoring;
- Continue to record fishing and anchoring activity in Skomer MCZ;
- Work with fisheries legislators to better protect sea fans from mechanical damage;
- Support research work on the biology of sea fans.

## 5.7. *Alcyonium glomeratum* Population

*(CMS Code: RM23/03)*



### 5.7.1. Project Status

Ongoing, annual sampling.

### 5.7.2. Project Rationale

*Alcyonium glomeratum* (red sea fingers) is a Lusitanian species near to its northern limit of distribution and is a component of the Lusitanian anthozoan management feature of the Skomer MCZ. Colonies are long-lived and possible indicators of climate change.

### 5.7.3. Objectives

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

### 5.7.4. Sites

| | Date started: |
|---|---|
| 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) |

### 5.7.5. Methods

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

| | **Sequence** |
|---|---|
| North Walll Stereo bar | 3 quadrats |
| North Wall (main) | five vertical transects |
| Thorn Rock mooring | two fixed position quadrats |
| Sandy Sea Fan Gully | two vertical transects |
| North Wall East | two vertical transects |
| Rye Rocks | one transect |
| Junko's Reef | one vertical transect |

- North Wall Stereo: three quadrats (50 x 40cm) are photographed using stereo or high definition digital SLR photography.
- All other sites: photographs (mono) are taken using a 50 x 70cm framer.

The colonies are "wafted" before photographing to make them retract in an attempt to control the variability in colony size. The images are analysed by overlaying a 5 x 5cm grid and recording presence/absence of *A. glomeratum* within the grid squares (see Burton, Lock & Newman 2002 for full details).

### 5.7.6. Results

Quadrat results for the following sites are shown in the table and graph: North Wall main, North Wall east, Sandy Sea fan gully, Thorn rock, Rye Rocks and Junko's reef.

| | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **NWA** | 15 | 19 | 19 | 23 | 19 | 9 | 14 | 10 | 2 | 6 | 3 | 0 | 0 | 0 | 0 |
| **NWEast** | 6 | 5 | 6 | 6 | 7 | 6 | 6 | 6 | 6 | 7 | 7 | 6 | 6 | 6 | 6 |
| **SSFG** | 9 | 9 | 9 | 5 | 9 | 3 | | 3 | 2 | 4 | 2 | 0 | 0 | 1 | 0 |
| **TRK** | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 |
| **RRK** | | | | 6 | 8 | 6 | 5 | 5 | 6 | 4 | 3 | 1 | 0 | 1 | 0 |
| **JUNKO** | | | | | | | | | | | | | | 4 | 4 |

Table 5.7.1 Number of quadrats with *A. glomeratum* present.

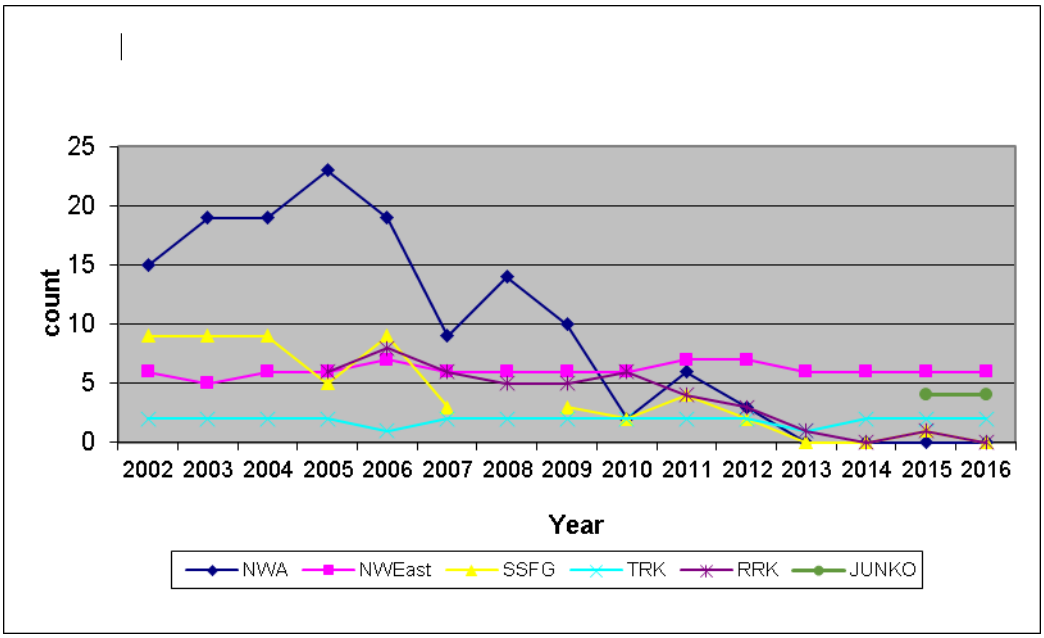



Figure 5.7.1 Number of quadrats with *A. glomeratum* present at Skomer MCZ sites 2002 - 2016.

All sites except *NWA East* show a decreasing trend in the coverage of *A. glomeratum* colonies. From 2013 onwards *NWA & SSFG* have had no visible colonies of *A. glomeratum*.

| | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **NWA** | 34.0 | 23.8 | 19.0 | 21.2 | 22.7 | 8.3 | 11.1 | 6.4 | 3.0 | 9.3 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **NWEast** | 80.0 | 69.6 | 67.5 | 65.2 | 59.3 | 63.7 | 66.0 | 59 | 59.7 | 53.4 | 55.3 | 50.2 | 57.3 | 53.5 | 47.5 |
| **SSFG** | 7.2 | 8.4 | 7.1 | 3.0 | 5.3 | 5.3 | | 1.0 | 0.5 | 0.4 | 0.4 | 0.0 | 0.0 | 0.2 | 0.0 |
| **TRK** | 12.5 | 17.5 | 10.5 | 15.5 | 24 | 11.5 | 13 | 6.5 | 15.0 | 13.0 | 16.5 | 13.5 | 10.0 | 8.5 | 14.5 |
| **RRK** | | | | 5.3 | 10.3 | 8.0 | 9.8 | 10.0 | 7.2 | 4.8 | 3.3 | 14.0 | 0.0 | 0.1 | 0.0 |
| **JUNKO** | | | | | | | | | | | | | | 75.3 | 77.5 |

Table 5.7.2 Mean Frequency count from Skomer MCZ quadrats with *A. glomeratum* occurring

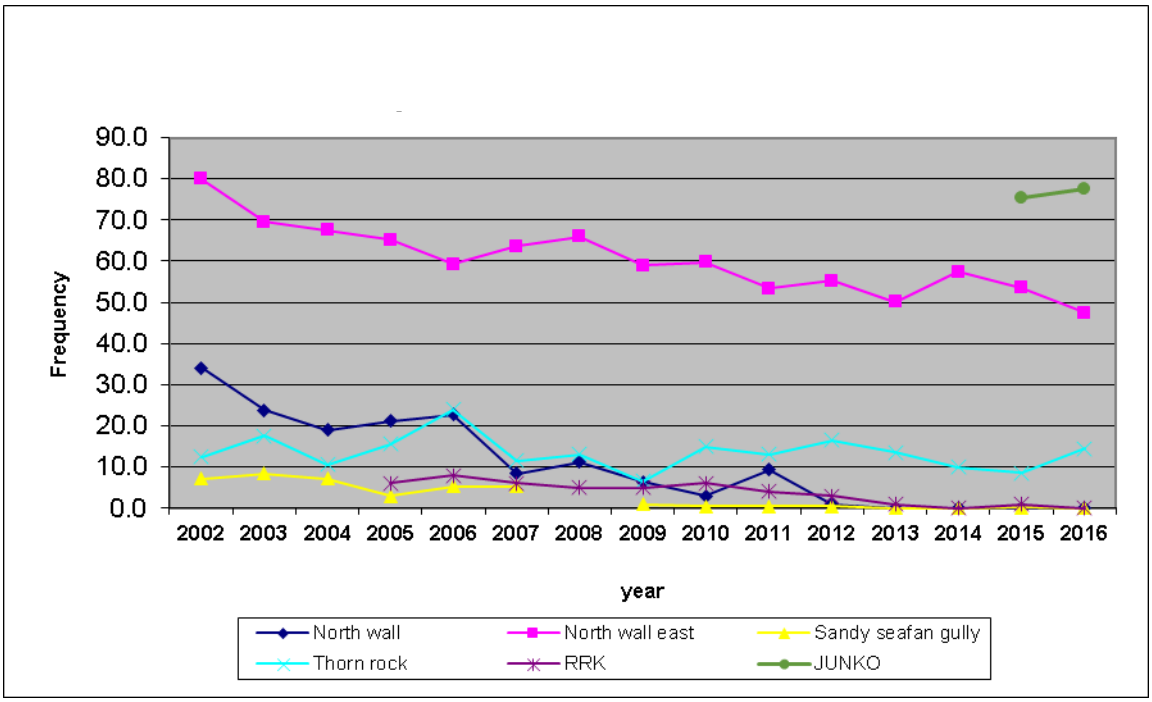



Figure 5.7.2 Mean frequency of *A. glomeratum* within quadrats Skomer MCZ 2002 - 2016.

The declining trend or disappearance of *A. glomeratum* has continued at all sites except for Thorn Rock & Junko's reef.

*North Wall Stereo colony*

The time series for these 3 quadrats on the north side of Skomer runs back to the 1980's. The quadrats have been photographed annually for most years since 1988.

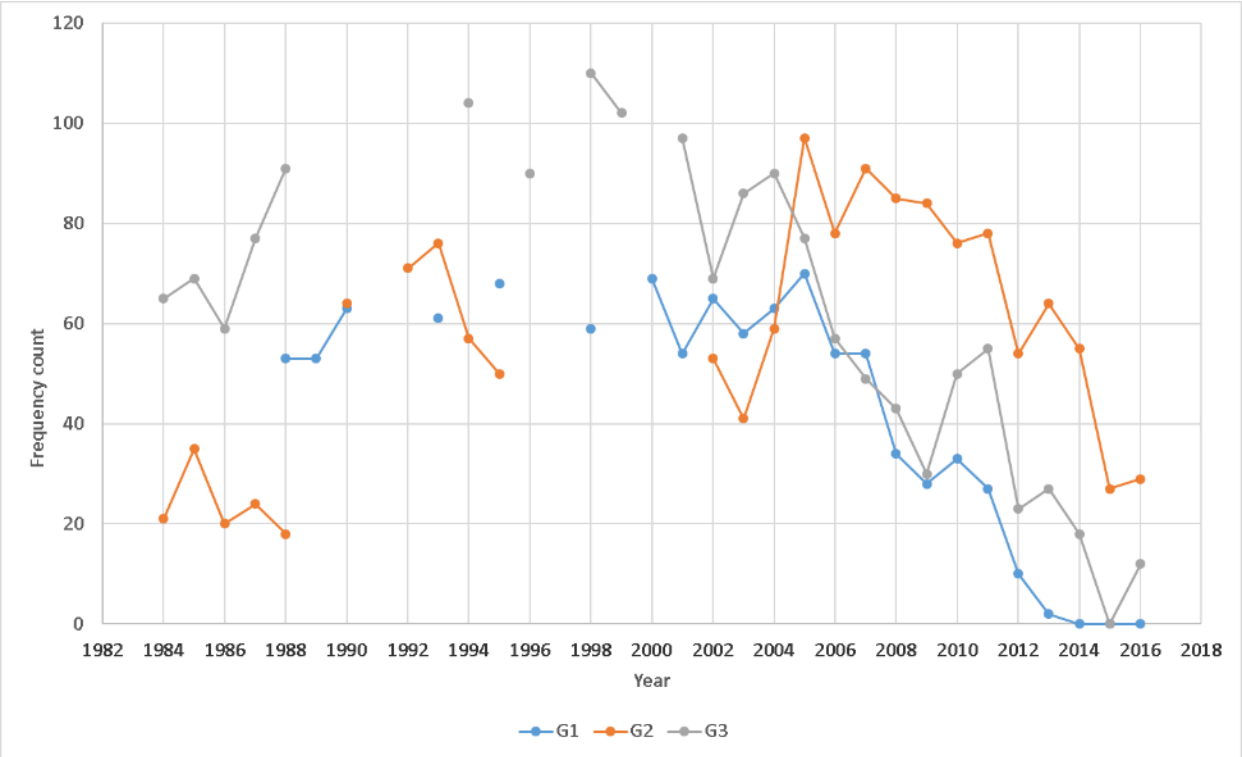



Figure 5.7.3 Frequency count (120 squares) of presence of *A. glomeratum* in 3 quadrats at the North wall – Skomer MCZ

All 3 quadrats show a similar trend of increasing cover peaking in the late 90's- early 2000's and then declining from 2006 onwards. G2 now has a similar coverage of *A. glomeratum* to what was found in 1984. The other quadrats have considerably less.

Example photographs of "then & now"

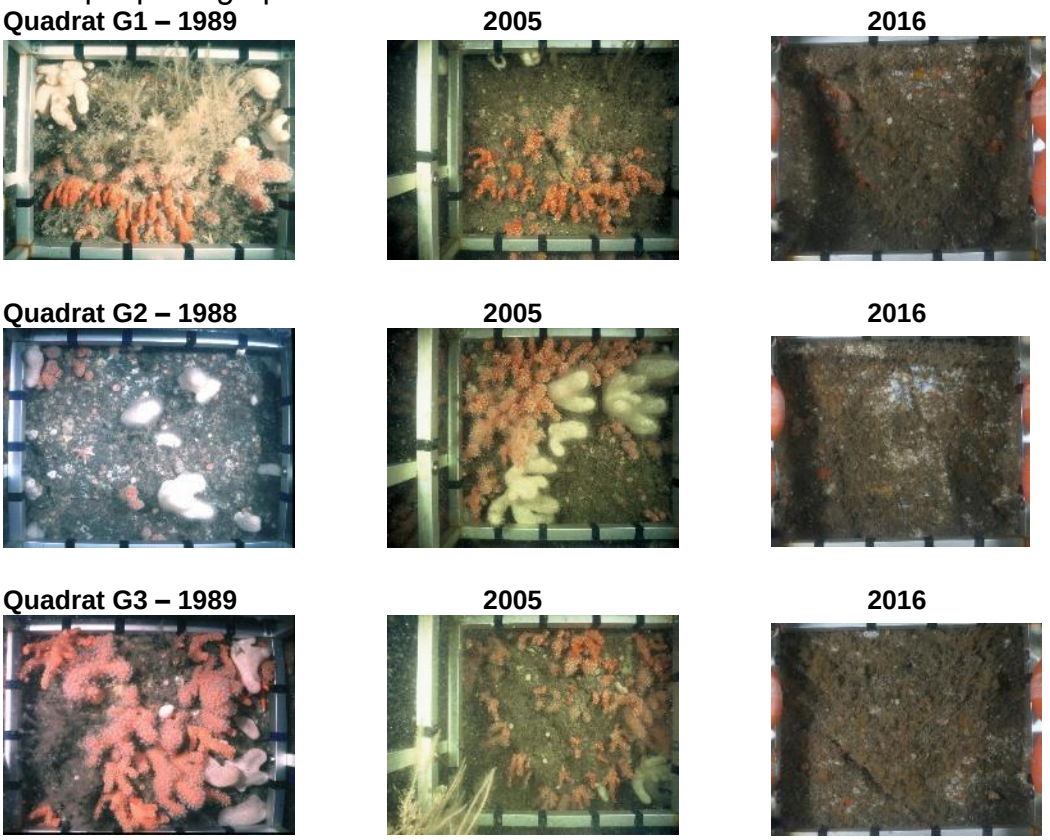



Figure 5.7.4 Photographic examples of declining populations of A. glomeratum at Skomer MCZ between 1989 and 2016.

### 5.7.7. Current Status

The abundance of *A. glomeratum* at the monitoring sites is declining: North Wall East and Junko's reef have sizable colonies of *A. glomeratum*. North Wall main, Rye Rocks and Sandy sea fan gully now have no visible colonies.

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 significant enough to cause colony loss.

### 5.7.8. Recommendations

- Search for further colonies in the MCZ and establish new monitoring sites.
- Improve site marking to allow accurate relocation of quadrats.
- 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.

## 5.8. *Parazoanthus axinellae* Population
*(CMS code: RM23/05)*

### 5.8.1. Project Status
Ongoing, annual sampling.

### 5.8.2. Project Rationale
The population of *Parazoanthus axinellae* (yellow cluster anemone) is a component of the Lusitanian anthozoan management feature of the Skomer MCZ.
*P. axinellae* is a Lusitanian species near to the edge of its range and may act as an indicator of climatic change.

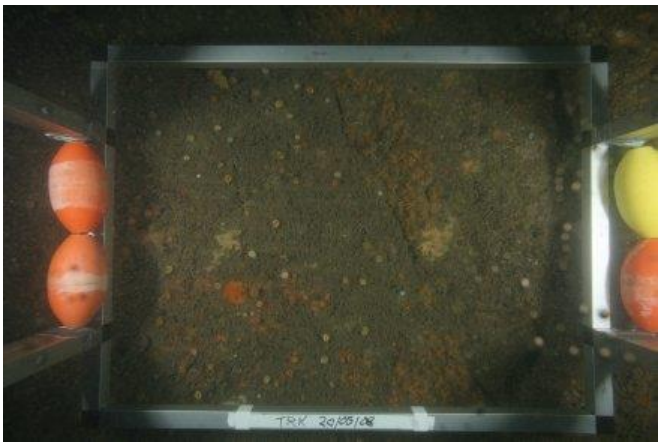
### *5.8.3.* Objectives
Monitor *P. axinellae* colonies for changes in polyp density and colony area.

### 5.8.4. Sites
- Sandy Sea Fan Gully (2002)
- Sandy Sea Fan Gully Buttress (2015)
- Thorn Rock (3 colonies) (2002)
- Way Bench (2 colonies) (2002)

### 5.8.5. Methods
*Density Estimates:*
Close-up photographs are taken using a digital camera. The digital camera is mounted on a 20 x 20cm framer. *P. axinellae* polyps are counted in each 20 x 20 cm quadrat.

*Area of the Colony:*
A series of transects are placed through the colonies. Photographs are taken using a 50 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 5 x 5cm grid and recording presence/absence of *P. axinellae* within the grid squares. See Burton, Lock & Newman 2002 for details.

Figure 5.8.1 Density: 20 x 20cm framer



Colony area: 50 x 70cm framer

## 5.8.6. Results

| **Colony area** | | **Density** |
|---|---|---|
| **Site** | **Index of Area** | **Close up photographs** |
| Sandy sea fan gully | 5 transects (20 samples) | Yes |
| Sandy sea fan gully Buttress | 2 permanent transects set up 13 quadrats | Yes |
| Waybench – *New Wall* | 9 re-locatable samples | Yes |
| Waybench – *Deep Wall* | 2 transects (8 samples) | Yes |
| Waybench – *Deep Wall* | New lower transect established – 6 quadrats | No |
| Thorn Rock – *Piton 7* | 3 re-locatable samples | No |
| Thorn Rock - *Mooring* | 3 re-locatable samples<br>4 new quadrats west of mooring | No |
| Thorn Rock – *Piton 3* | 3 transects (11 samples) | Yes |

Table 5.8.1 Fieldwork completed at Skomer MCZ in 2016

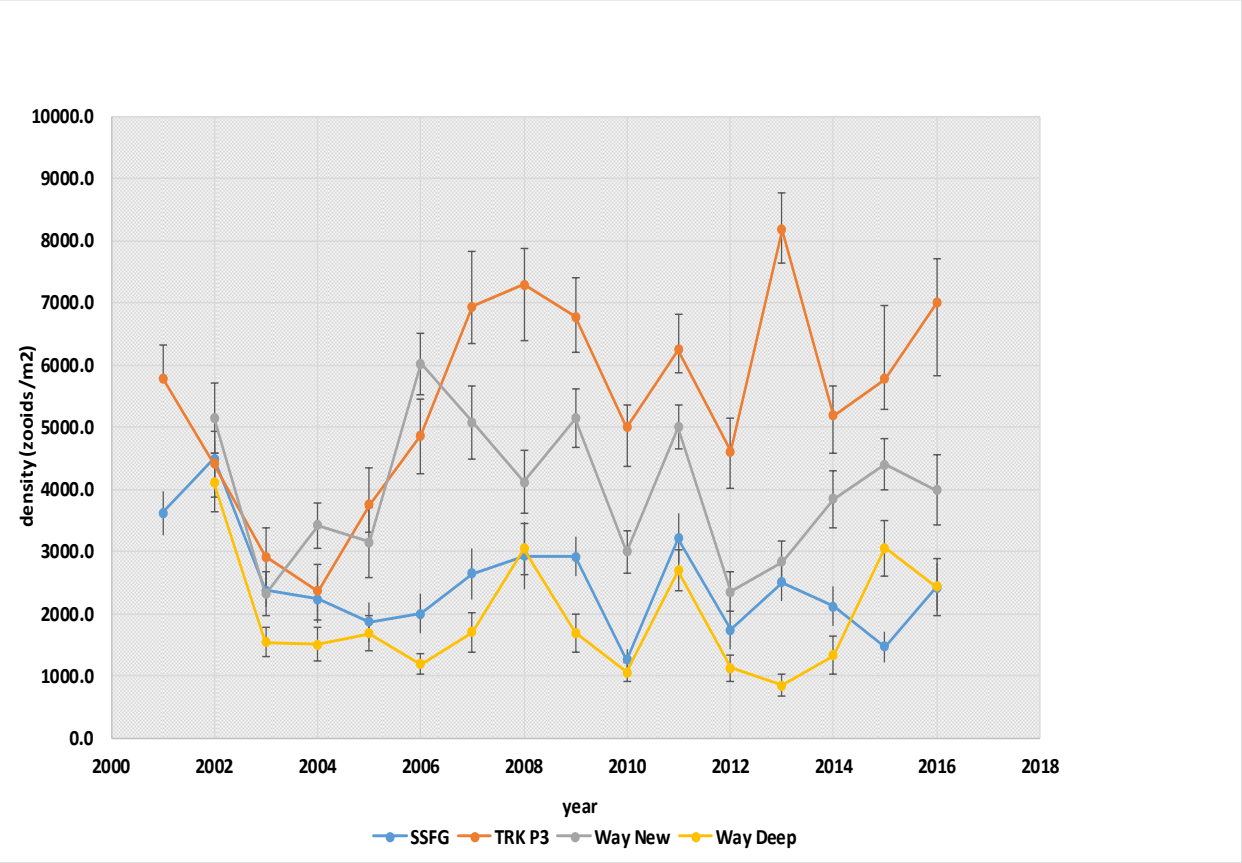



Figure 5.8.1 Density of polyp (numbers of polyps /m$^2$) at Skomer MCZ sites 2001 – 2016

No significant changes in density were seen in 2016.


Figure 5.8.2 Mean frequency of *Parazoanthus axinellae* 2002 – 2016. Thorn Rock (TRK) transects.

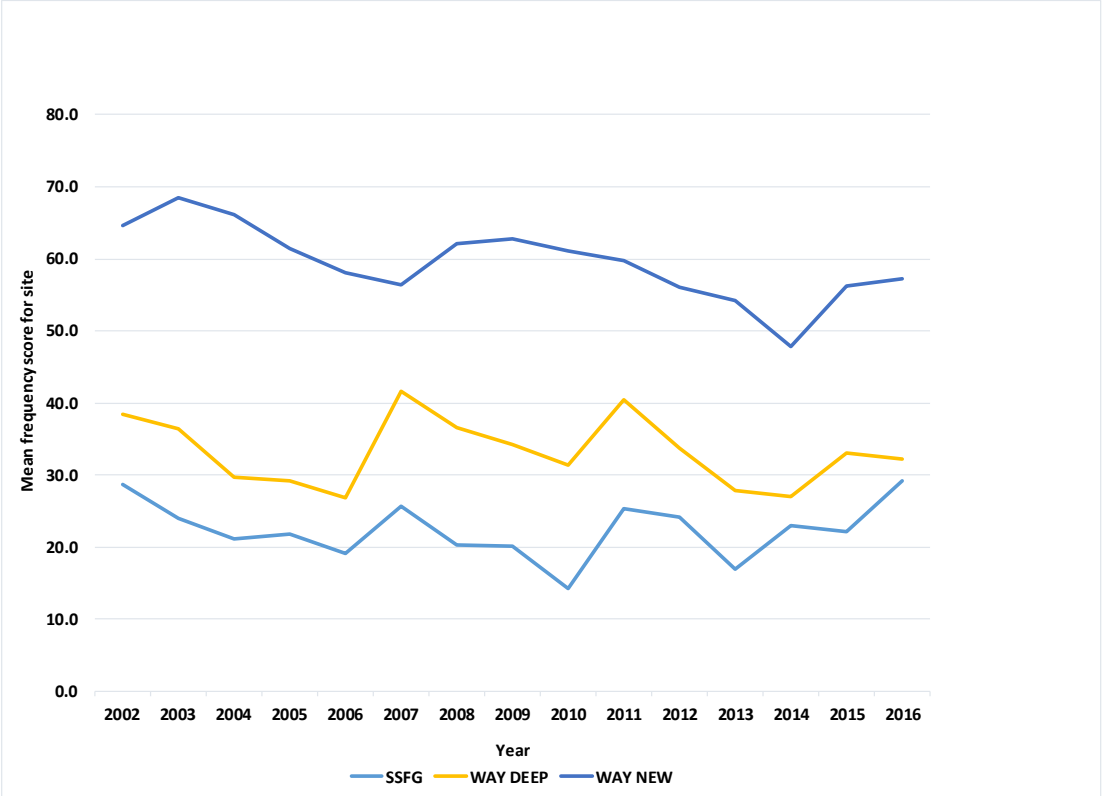



Figure 5.8.3 Mean frequency of *Parazoanthus axinellae* 2002 – 2016. Other Skomer MCZ sites

The Thorn rock sites all decreased compared to 2014. The other sites show a slight increase.

### 5.8.7. Current Status

- All the colonies are still present and populations appear to be stable.

### 5.8.8. Recommendation

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

## 5.9. *Pentapora foliacea* (ross coral) Population

*CMS code: RM63/01*


### 5.9.1. Status

Ongoing. Annual survey.

### 5.9.2. Project Rationale

Colonies of the bryozoan *Pentapora foliacea* are fragile structures thought to be moderately slow growing and long lived. They are important microhabitats for mobile species and are regarded as useful indicators of anthropogenic activity such as mobile fishing gear, potting and anchoring. As such they were selected as a management feature of the Skomer MCZ. They are also a component of the of the fragile sponge and anthozoan community habitat of priority importance under Section 7 of the Environment Act (Wales) 2016.

### 5.9.3. Objectives

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

### 5.9.4. Sites

| **Site** | **substrate** | **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 |

Table 5.9.1 *Pentapora foliacea* monitoring sites at Skomer MCZ in 2016

### 5.9.5. Methods

Photographs are taken using a digital camera set up on a 50 x 70 cm frame. Photographs are taken along marked transects at each site following detailed site proforma.

### 5.9.6. Project History

*Growth and community structure*

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.

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 $800cm^2$ 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.

2006 Gibbs developed an empirical calibration method by which a three-dimensional reconstruction of a *P. foliacea* colony may be created from stereo-photographs. This method allows the quantification of the growth of the *P. foliacea* colony over time. A useful qualitative interpretation of some colonies by the creation of time-lapse films (at a rate of 25 days per second) in both monoscopic-colour and dichromatic-stereo was demonstrated. Sadly it was found that most of the photo images had insufficient precision of data to apply the method. However conclusions drawn from study of the films 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.

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 2012). The revised guidelines were reapplied to the full historical dataset and continued each year.

2013 a new site was established at the Pool on the north side of Skomer using a 'pendulum transect' method which proved effective at covering a large search area. The site is a boulder slope and very rich in *P. foliacea* with 250 colonies found.

| Year | North Wall | Wayben ch | Bernies Deep | Bernies Shallow | North Neck | South Middlehom | West Hook | Pool |
|---|---|---|---|---|---|---|---|---|
| **1993** | yes | yes | | | | | | |
| **1994** | yes | | | yes | | | | |
| **1995** | yes | | yes | yes | | | | |
| **1996** | yes | | | | | | | |
| **1997** | yes | | yes | yes | | | | |
| **1998** | yes | | yes | yes | | | | |
| **1999** | yes | | | | | | | |
| **2000** | yes | | yes | yes | | | | |
| **2001** | yes | | | | | | | |
| **2002** | yes | yes | yes | yes | yes | yes | | |
| **2003** | | yes | yes | yes | yes | yes | | |
| **2004** | | yes | yes | yes | yes | yes | yes | |
| **2005** | | yes | yes | yes | yes | yes | yes | |
| **2006** | | yes | yes | yes | yes | yes | yes | |
| **2007** | | yes | yes | yes | yes | yes | yes | |
| **2008** | | yes | yes | yes | yes | yes | yes | |
| **2009** | | yes | yes | yes | yes | yes | yes | |
| **2010** | | yes | yes | yes | yes | yes | yes | |
| **2011** | | yes | yes | yes | yes | yes | yes | |
| **2012** | | yes | yes | yes | yes | yes | yes | |
| **2013** | | yes | yes | yes | yes | yes | yes | yes |
| **2014** | | yes | yes | yes | yes | | yes | yes |
| **2015** | | yes | yes | yes | yes | yes | yes | yes |
| **2016** | | yes | yes | yes | yes | yes | yes | yes |

Table 5.9.2 *Pentapora foliacea* photo dataset for Skomer MCZ

*Morphological classification:*
Class 1 (single flakes) to class 4 (20cm 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 – 4.

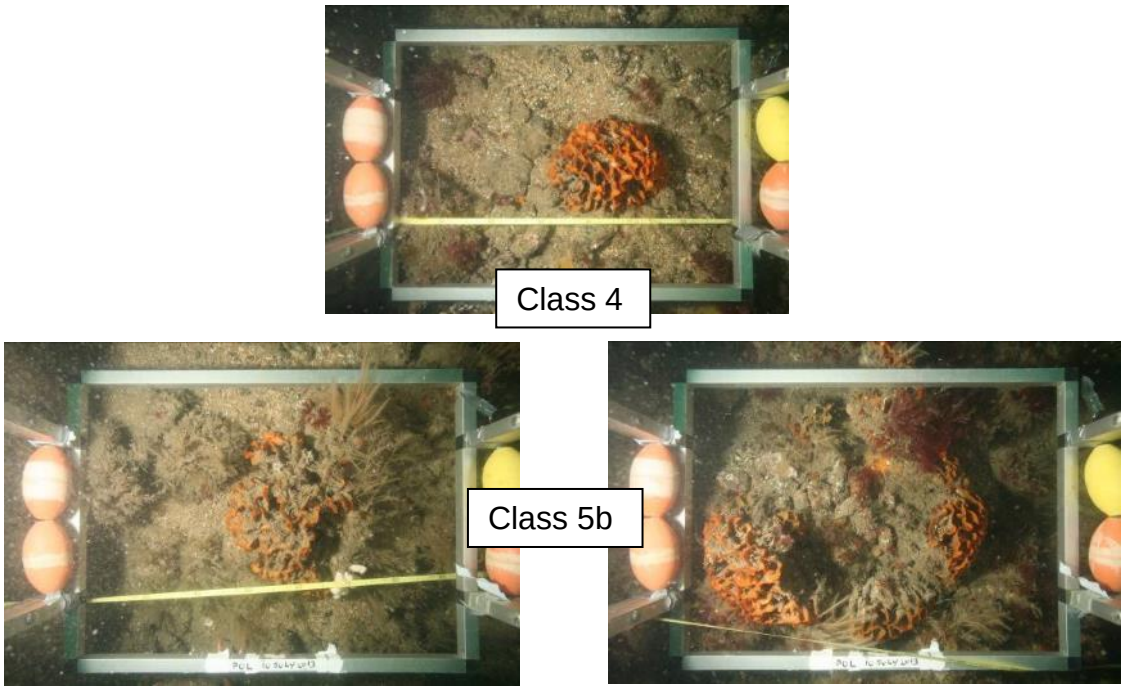



Figure 5.9.1 *Pentapora foliacea* - examples of Class 4 and Class 5b colonies.

## 5.9.7. Results

The following graph for all Skomer sites shows a general pattern of the classes. The population pattern varies between sites as colony development is affected by both substrate and environmental conditions at sites.

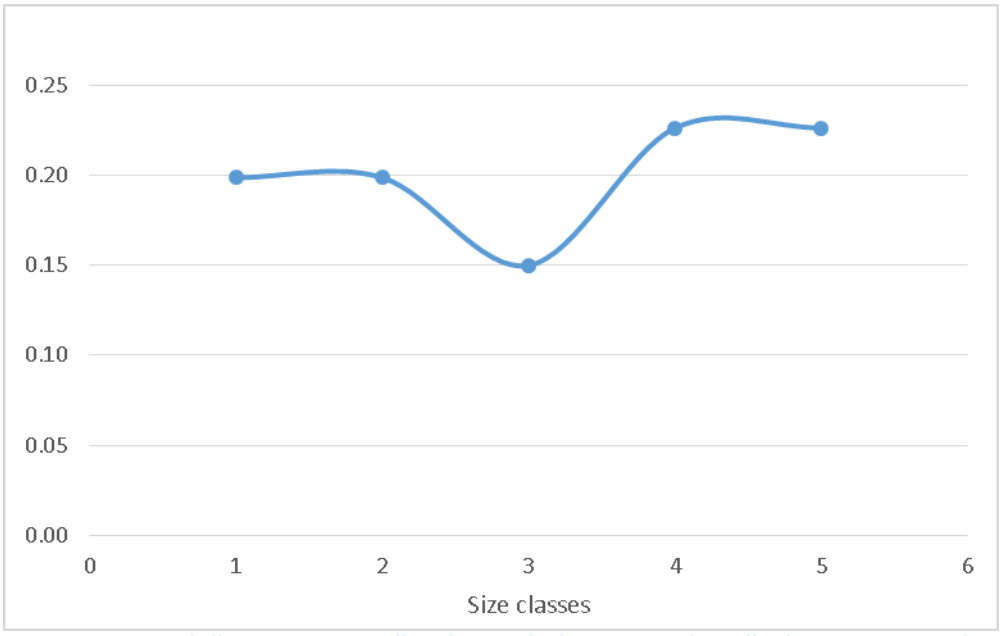



Figure 5.9.2 *Pentapora foliacea* - normalised population curve for all Skomer MCZ sites

*Waybench* is a large bedrock site, on the north side of the island, and divided into two sections: an exposed rock ridge and a neighbouring boulder area. On the ridge colonies tend to be class 1-3 and rarely reach a class 4, whilst in the more sheltered boulder area high

numbers of colonies are found and many of them reach large class 4 before developing into a class 5.

*Bernies Rock* is located on the north side of the island. There is a shallow site and a deep site, both consisting of boulder substrate. The numbers of colonies has varied at both sites year by year, with some years no colonies being found. All classes of colonies are found with many developing into a class 4 before progressing to a class 5.

*The Pool* is a new site 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 survey area is covered and large numbers of colonies are found (up to 250 individuals) with an even spread of classes present. It will be interesting to monitor the population pattern for this site with the high numbers of colonies present.

*North Neck* is unusual as it monitors colonies 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.

*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.

*West Hook* is a small bedrock site located on the North Marloes Peninsula, most colonies reach class 4 before developing into class 5.

The ratio between class 2-4: class 5 for colonies at all sites between 2002 to 2016 is shown in the graph below. Class 2-4 colonies represent healthy growing colonies whilst class 5 represent those with deterioration from either natural or anthropogenic factors. The results show that each year the ratio is less than 1, therefore there are more class 5 colonies than class 2-4.

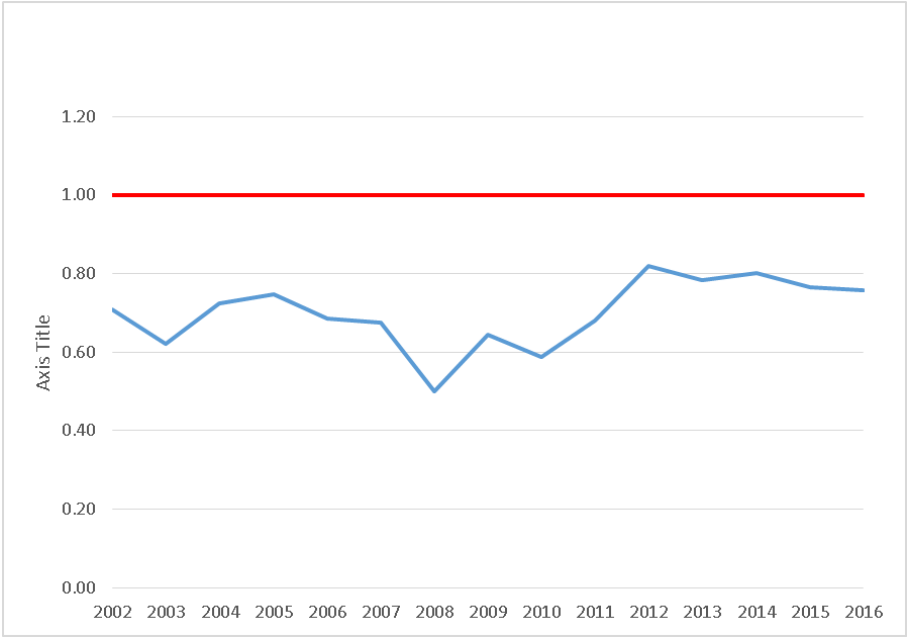



Figure 5.9.3 *Pentapora foliacea* - ratio of class2-4 colonies to class 5 colonies - all Skomer sites

The current dataset is forming an important baseline for Skomer sites, however it needs to be remembered that all sites are currently subjected to pot fishing. Ropes linking the fishing pots lay across the seabed and observations show that these, as well as the pots themselves, can damage *P. foliacea* colonies, especially when fished on steeply-inclined saebeds.

Figure 5.9.4 Pentapora foliacea – interaction with fishing gear

Other anthropogenic activities in the area include recreational diving and boat angling. A non- impacted study area is needed to provide an understanding of normal functioning ecosystem.

### 5.9.8. Current Status

There has always been a higher number of "degraded" (Class 5) *P. foliacea* colonies compared with intact and growing colonies (Classes 2-4) over the period of monitoring. This ratio has changed slightly to a population with a slightly lower proportion of "degraded" colonies since 2012, since when the ratio has changed very little despite the inclusion of a much larger number of colonies from the Pool site since 2013. The question remains as to whether this ratio is a "healthy" one, or whether a non-impacted population would demonstrate the same characteristics. Given that lobster pot fishing effort continues to be unrestricted in the MCZ and that observations show that interactions of this type of gear can damage *P. foliacea*, this feature is judged to be unfavourable.

### 5.9.9. 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 totally non-impacted study area. Until all destructive 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*.

## *5.10.* Cup Coral Populations; *Balanophyllia regia* and *Caryophyllia smithii*
(CMS code: RM23/04)

### 5.10.1. Project Status
Ongoing. Annual sampling.

### 5.10.2. 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.

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

### 5.10.4. Sites
- Thorn Rock *B. regia* 1985 to current and *C. smithii* 1993 to current
- The Wick *B. regia* 2002 to current

### 5.10.5. Methods
*Balanophyllia regia*
- *Thorn Rock:* A fixed position quadrat using a 50 x 40 cm framer at Thorn Rock has been photographed since 1985.
- *The Wick:* Three transects with 51 quadrats were established at the Wick in 2002. A 50 x 40 cm framer was used up until 2008 when it was replaced with a larger 50 x 70cm framer using a digital SLR camera. This provides high quality images allowing improved photo analysis.
- Counts are carried out using GIS techniques (see Burton, Lock & Newman 2002).

*Caryophyllia smithii:*
Approximately 70 quadrats have been analysed on an annual basis since 1993 from photographs taken for the sponge community project at Thorn Rock. Photographs are taken using a 50 x 70cm framer and counts are carried out using GIS techniques.

### 5.10.6. Results
*Balanophyllia regia:*
At the Wick all data has been adjusted to $1m^2$ to enable the data from the 50 x 40 cm and the 50 x 70 cm framer to be comparable.

| Site | Year | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|
| **WCK A** | Mean | 203 | 252 | 275 | 334 | 218 | | 455 | 415 |
| | S.E. | 32 | 39 | 43 | 49 | 50 | | 62 | 53 |
| **WCK C** | Mean | 323 | 360 | 476 | 397 | 445 | 579 | 530 | 516 |
| | S.E. | 50 | 51 | 52 | 62 | 42 | 65 | 73 | 75 |
| **WCK B** | Mean | 253 | 214 | 284 | 239 | 183 | 483 | 402 | 337 |
| | S.E. | 38 | 47 | 63 | 55 | 46 | 98 | 76 | 96 |
| **Site** | **Year** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | |
| **WCK A** | Mean | 205 | 412 | 329 | 435 | 236 | 455 | 409 | |
| | S.E. | 35 | 59 | 40 | 66 | 39 | 55 | 51 | |
| **WCK C** | Mean | 178 | 674 | 453 | 608 | 399 | 541 | 702 | |
| | S.E. | 53 | 93 | 71 | 83 | 62 | 85 | 97 | |
| **WCK B** | Mean | 332 | 344 | 232 | 295 | 291 | 356 | 386 | |
| | S.E. | 46 | 79 | 49 | 69 | 80 | 96 | 92 | |

Table 5.10.1 Abundance of *Balanophyllia regia* in The Wick (adjusted to 1m$^2$).

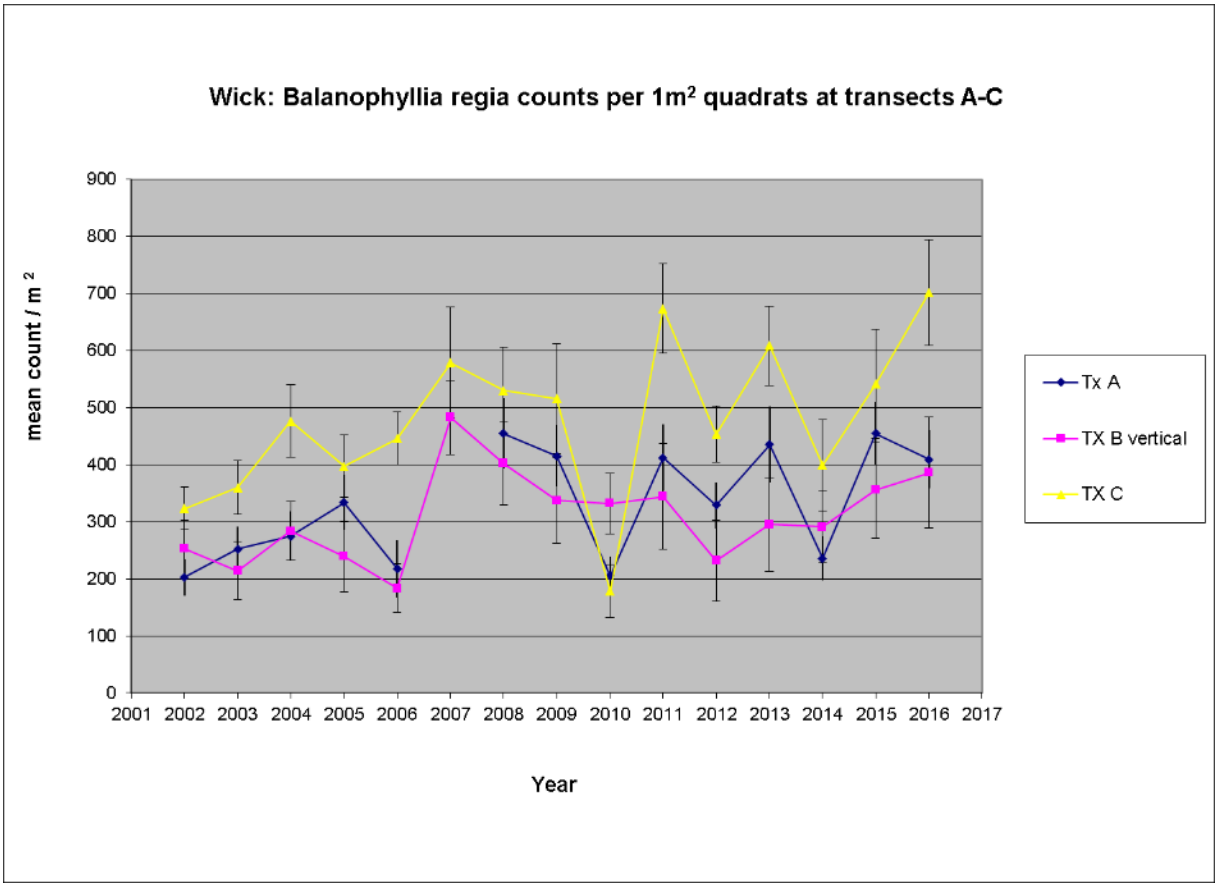



Figure 5.10.1 *Balanophyllia regia* abundance at Transects A, B and C at the Wick

The average number/m$^2$ of *B. regia* has fluctuated at transects A, B and C. The variability is caused by dense covering of silt across the site hiding individuals and occasional very poor photographic conditions (e.g. 2010).

At Thorn Rock individuals have been traced for 30 years in a single 40 x 50cm quadrat. Some evidence of recruitment has been observed, numbers have shown a general increase between 1998 and 2013. Variability will occur due to changes in surface sediment which

obscures small individuals. Due to very poor photographic conditions no counts were possible in 2014 & 2016.

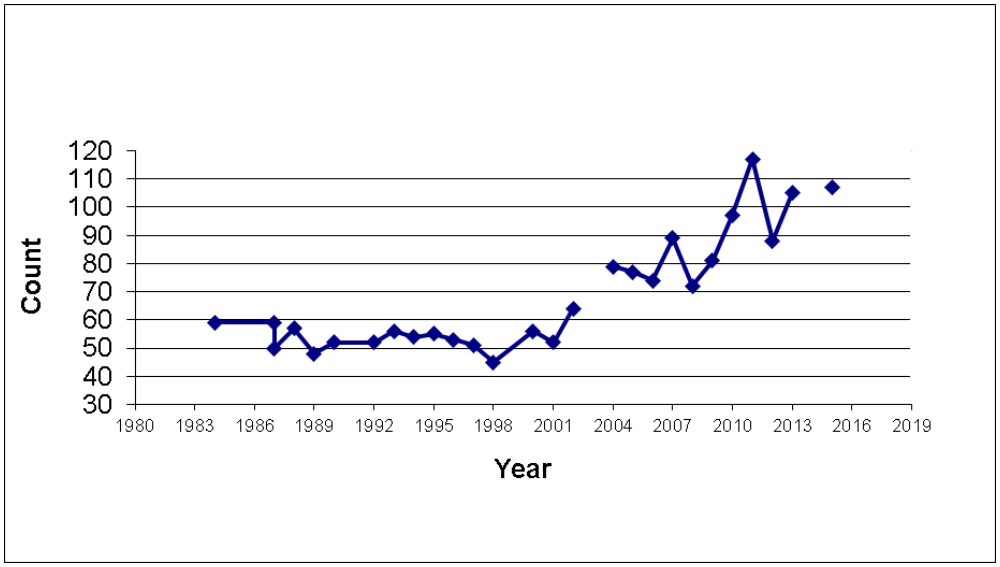



Figure 5.10.2 Thorn Rock boulder *Balanophyllia* regia counts (per 40 x 50cm quadrat)

*Caryophyllia smithii*

Thorn Rock shows changes in mean abundance, this 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 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.

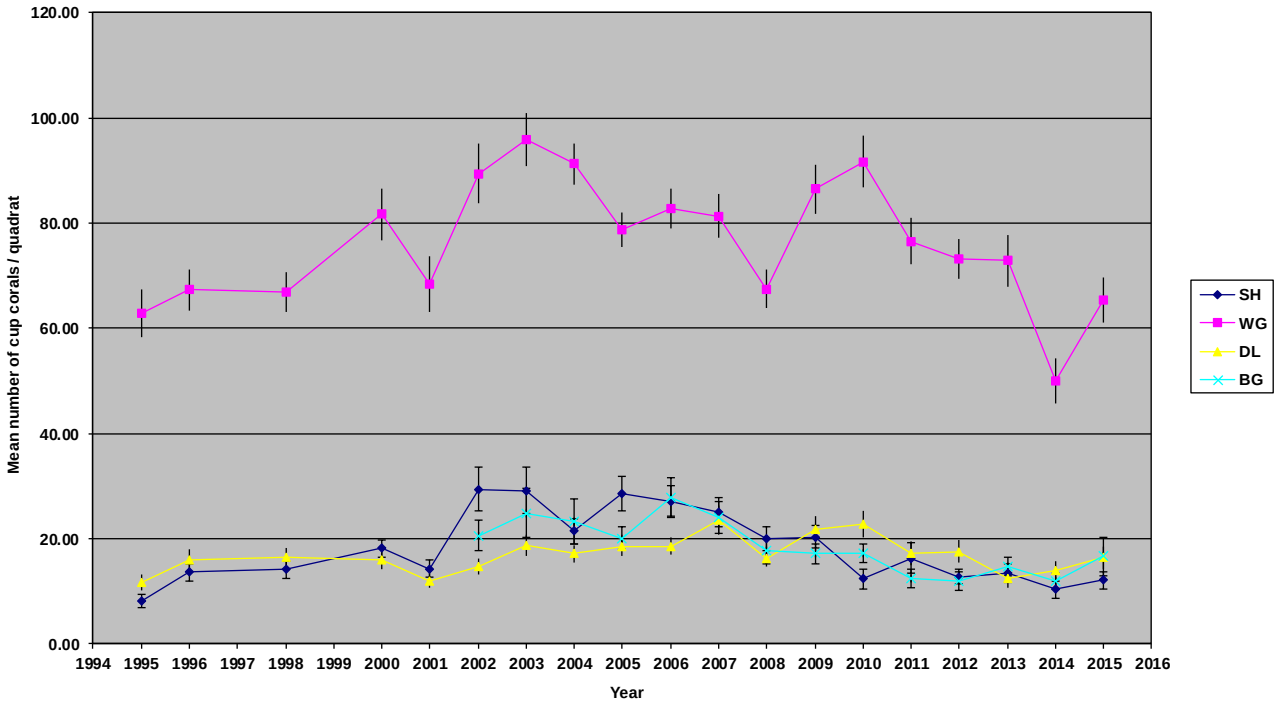



Figure 5.10.3 Mean Number of *Caryphyllia smithii* per 50 x 70 cm quadrat at Thorn Rock (4 transects) 1996 - 2016

### 5.10.7. Current Status

Variability in numbers of both *B. regia* and *C. smithii* is partly due to varying levels of surface sediment. The populations appear stable although there is no firm evidence of recruitment.

### 5.10.8. Recommendations

- Records of surface sediment levels may help determine whether reduced abundance of cup corals is significant or due to recording inconsistencies.
- Review photographs to test the possibility of tracing individuals from year to year.

## 5.11. Grey Seal (*Halichoerus grypus*) Population

*(CMS code: RA03/01)*

### 5.11.1. Project Status

Ongoing. Annual survey.

### 5.11.2. 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. Seals are listed under Annex II of the EU Habitats Directive of the European Union and 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).

### 5.11.3. 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.

### 5.11.4. Sites

All pupping beaches and caves in the MCZ.

### 5.11.5. Methods

The pups are recorded from birth through to their first moult using the “Smith 5-fold classification system” (Poole 1996). Reason for death is recorded if possible. Additional behavioural observations are recorded for the Island seals (full method described in ‘Grey Seal Monitoring Handbook’ Poole 1996 and Skomer MCZ and Skomer Island seal management plan Alexander 2015).

The Skomer sites are completed through a contract and a full survey report is produced, the mainland sites are completed by MCZ staff. The results are combined to provide the full Skomer MCZ results.

### 5.11.6. Project History

Regular recording began at Skomer MCZ in 1974. From 1992 onwards a standard protocol has been adopted to record the pupping success on both the island and the mainland each year.

*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 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 methods set out in the 'Grey Seal Monitoring Handbook' (Poole, 1996) 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 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 - 2015 - At Skomer sites photography included pupping cows to help increase knowledge of site fidelity, longevity and pupping frequency. In 2011 - 2015 the work also expanded to some cows and bulls from mainland sites.

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 have 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 are extracted from photographs and entered into the database, and "matching" is 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 and 2016 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 have also used statistical models to look at the long-term data sets (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 started by mapping the historical Pembrokeshire seal ringing/tagging data collected between the 1950s and the 1970s, including many seal pups from Skomer.

2016 - student Callan Lofthouse began research on seal diets and started analysis on seal scat samples collected at Skomer sites.

## 5.11.7. Results

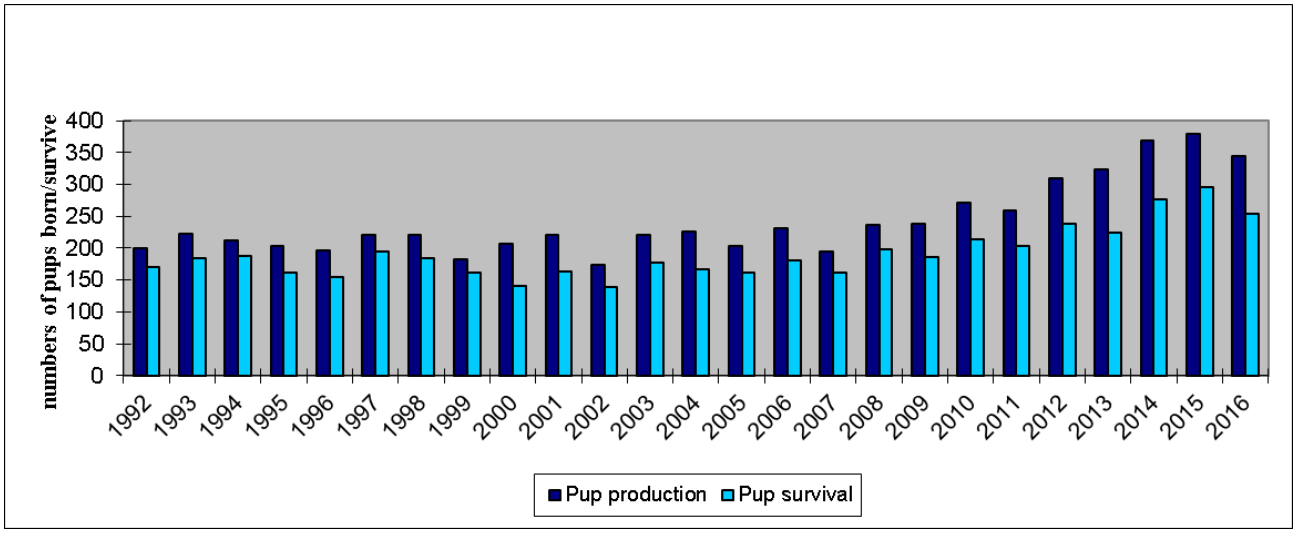



Figure 5.11.1 Skomer MCZ pup production and survival 1992 - 2016

In 2016 202 pups were born at Skomer Island sites and 143 pups at mainland sites giving a total of 345 pups born in the MCZ with a recorded combined survival of 73.3% through to moult.

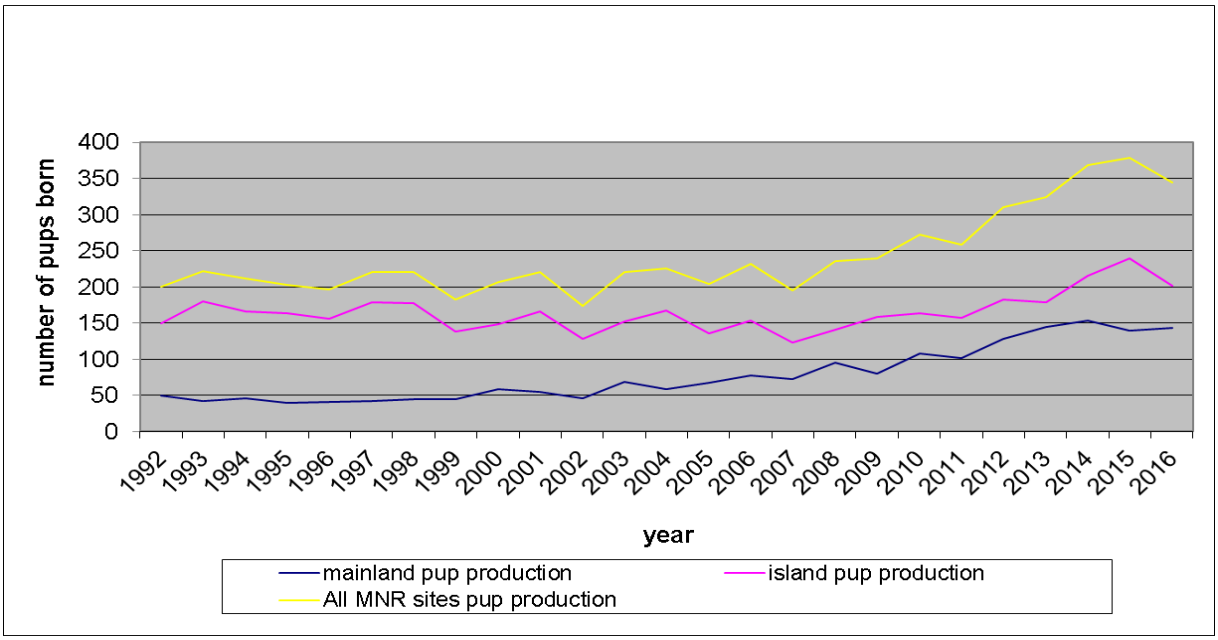



Figure 5.11.2 Skomer MCZ pup production 1992 - 2016

Pup production in the Skomer MCZ for the past 5 years has shown the highest totals recorded for the area with average production for 2012-16 at 345 pups. The pup production from 1992 to 2008 remained fairly consistent, within expected natural fluctuations, and with an average of 208 pups. Since 2009 there has been a steady increase in pup production: The greatest increase has been seen at the mainland sites, but there have also been increases at the island sites from 2012, except for a slight dip in production observed in 2016.

Pup production at the Marloes peninsula sites versus the Skomer island sites expressed as a percentage of the total pup production for the Skomer MCZ is shown in Figure 5.11.3. From 1992 to 2002 Marloes peninsula contributed an average of 22% of total production. This has then gradually increased to a peak of 45% in 2013 and the average over the last five years is 41% of total production.

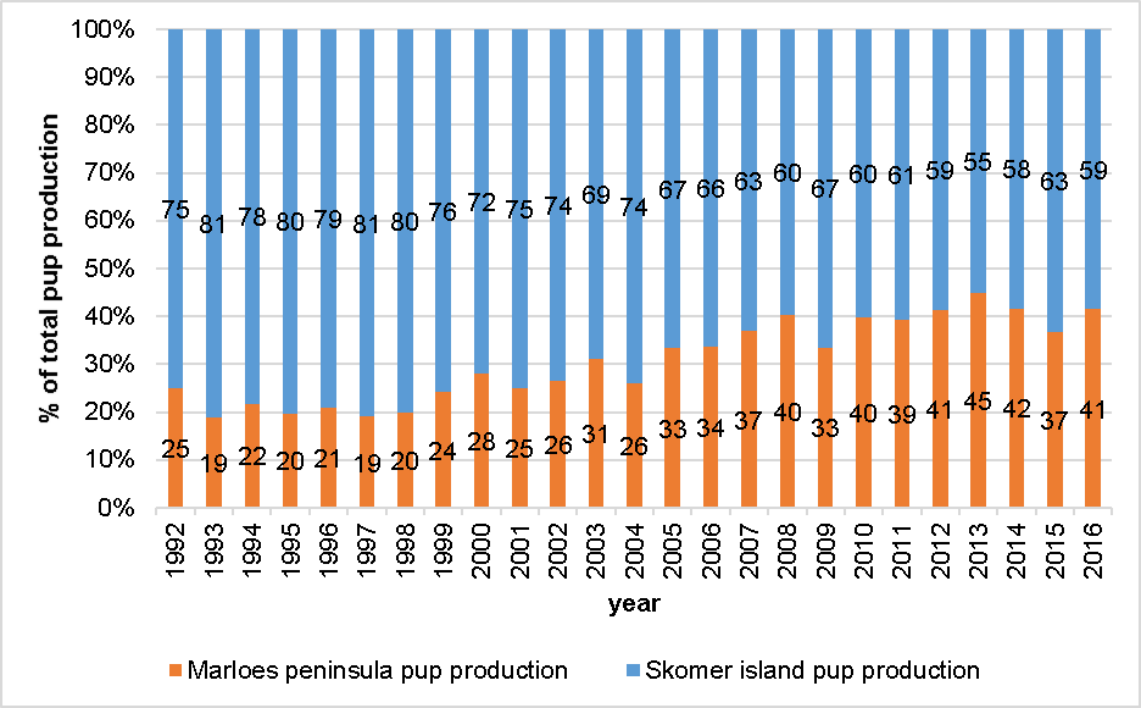



Figure 5.11.3 Skomer MCZ pup production – proportion born on Island vs. mainland sites

In 2016 4% of pup production occurred in August, 52% in September, 40% in October and 4% in November, and the peak week of production was week 39 (24-30th September). The trend over the last 23 years shows that the peak week of production has fluctuated between weeks 38 to 40 (17th September to 7th October).

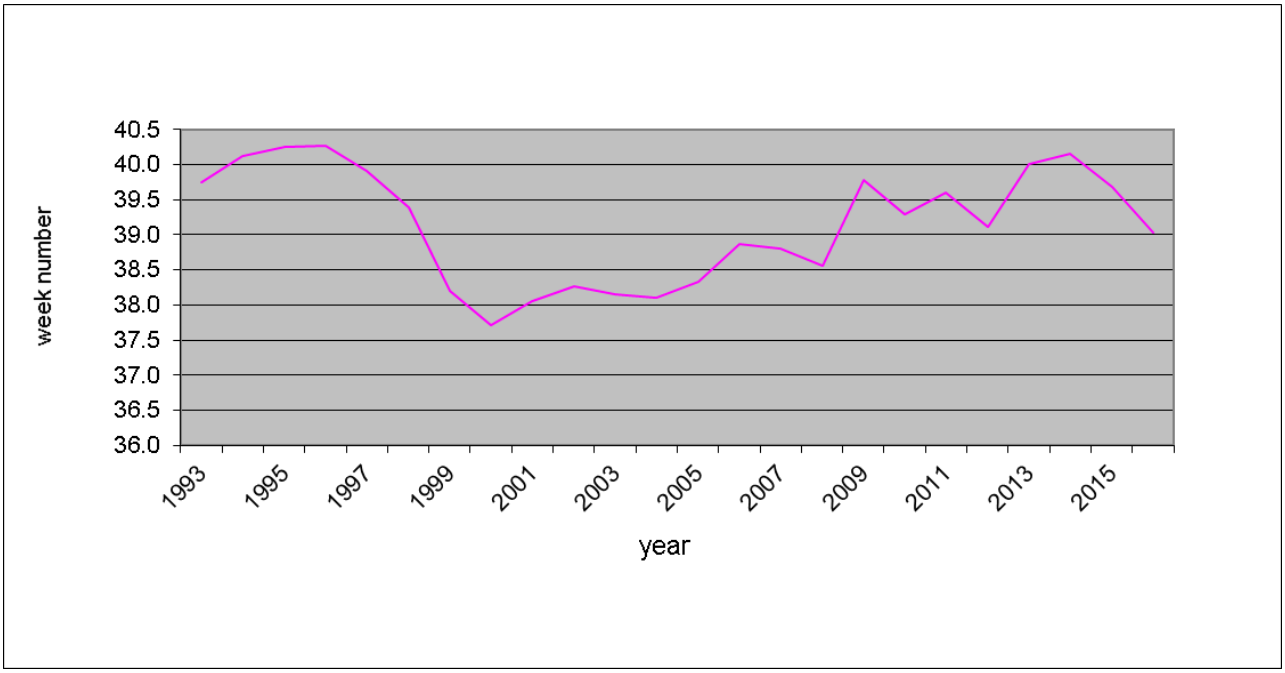



Figure 5.11.4 Skomer MCZ pup production – peak seal birth number seasonality

A full report for the 2016 Skomer seal census details the production for the island sites (Buche & Stubbings, 2017). A Marloes peninsula seal survey report 1992 to 2016 has been completed summarising the pup production and survival at the mainland sites (Lock *et al.,* 2017).

*Pollution*

Monofilament line and netting were the most obvious pollutants affecting seals. In 2016 26 animals (22 females, three males, one immature) 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.

The problem with netting entanglement is a growing concern especially with the high numbers recorded.

### 5.11.8. Current Status

Grey seals at Skomer MCZ are considered to be in favourable condition:

- In 2016 pup numbers reached 345, 5 pups higher than the management plan target pup production lower limit of 340 pups.
- Pup survival was 73%, 2% below the target percentage survival lower limit of 75% (however this is offset by 2014 and 2015 survival rates equal or higher than the target). In 2016 the majority of deaths were caused by abandonment or separation and by periods of harsh weather.
- All Skomer and Marloes Peninsula adult seal photos are stored ready for entry into the NRW Wales Seal ID database.

### 5.11.9. Recommendations

- To continue annual survey following the 'Grey Seal Monitoring Handbook' Poole 1996 and the 'Skomer MCZ and Skomer Island Seal Management Plan' Alexander 2015, at both island and mainland sites;
- 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;
- Develop a photo database for Pembrokeshire and neighbouring areas. To continue the adult seal identification project and contribute to the development of the Wales Seal ID database. To continue collaboration with the Cornwall Seal Group;
- Provide visitors with information about Atlantic grey seals both in the visitor centre and through the distribution of the 'seal watching' leaflet developed in 2002 in order to minimise disturbance to breeding seals.

## 5.12. Cetacean Species Recording
*(CMS Code RA01/ 01)*

### 5.12.1. Project Status
Ongoing. Annual recording.

### 5.12.2. Project Rational
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 unidentifiable it is not possible to establish whether the MCZ waters are used regularly by a large number of peripatetic animals or whether a smaller group remains in the immediate area. *P. phocoena* are an internationally protected species listed on: CITES, the Berne Convention, the EC Habitats Directive 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 candidate SAC following submission to the European Commission in January 2017.
Bottlenose dolphin (*Tursiops truncatus*), Common dolphin (*Delphinus delphis*) 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.

### 5.12.3. Objectives
To record numbers of individual cetaceans and the locations used by them in the Skomer MCZ.

### 5.12.4. Method
Recording effort varies annually but includes:
- Skomer Island NNR staff and volunteers using binoculars and telescopes from cliff locations around the island.
- Dale Princess crew maintaining records in a diary 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.

Species, numbers, sites, date and time are recorded for each sighting.

### 5.12.5. Results
All sightings of cetaceans have been collated for the period between 2001 and 2016. There are no records in years 2003, 2007, 2010 & 2011. The effort is variable not just between years but also during the season which makes the data difficult to effort correct.

In 2016 a standard set of site names and recording system was applied to all data collected by Skomer MCZ and Skomer NNR staff.


Figure 5.12.1 Harbour porpoise sightings within Skomer MCZ 2001 - 2016

This data is not effort corrected and there was a more concerted effort to collate all the records in a consistent way in 2016

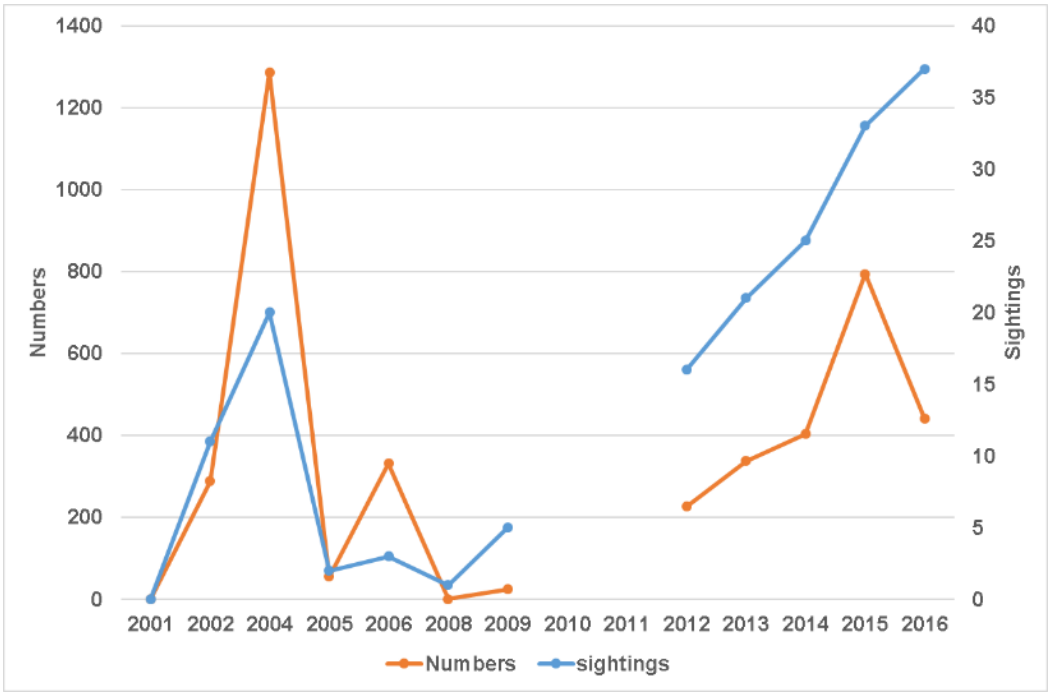



Figure 5.12.2 Common dolphin sightings within Skomer MCZ 2001 - 2016

Common dolphins use the area infrequently but they can appear in large numbers. There were no observations in 2010 & 2011 but since then they seem to be increasing. This data is not effort corrected but common dolphin sightings are much more unusual and tend to get recorded. There were more sightings in 2016 but no big pods were seen.

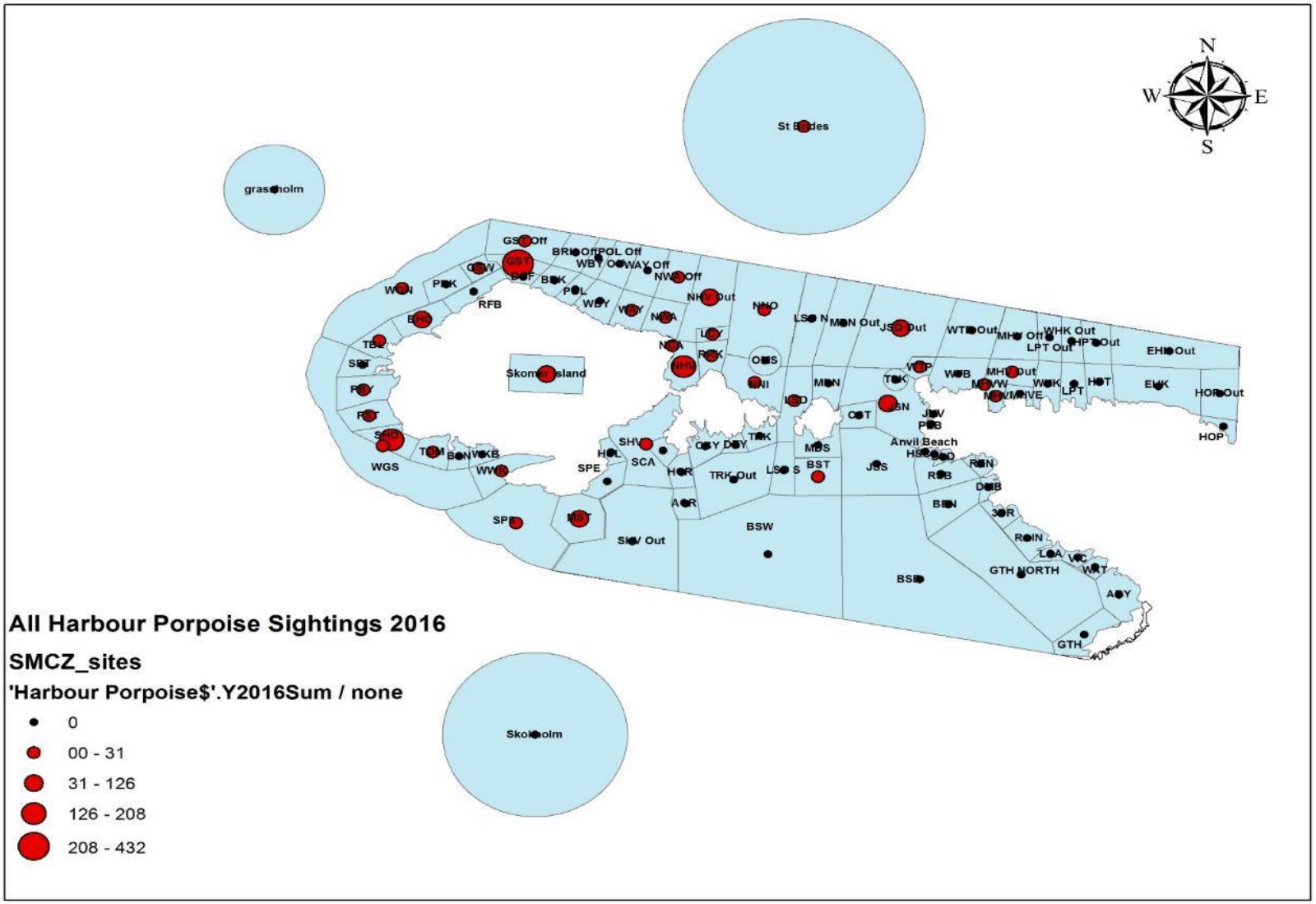



Figure 5.12.3 Harbour porpoise sightings Skomer MCZ 2016.

This data is not effort-corrected but is useful in showing areas that harbour porpoise frequent. All vagrant and mobile species records are now recorded using this site code format.

### 5.12.6. Current status

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

### 5.12.7. Recommendations

- Standardised method of recording needs to be developed and used by all recorders.

- Standard method needs to include an estimate of days / time spent recording as well as the sightings data.

- Re-establish the sightings records from the island ferry (Dale Princess).

## 5.13. General Species Recording
*(CMS code: RB06/01)*

This section also includes: “vagrant and alien species recording” (CMS code: RB01/01) and “record commercial crustacean populations” (CMS code: RM44/01) projects.

### 5.13.1. Project Status
Ongoing, annual recording.

### 5.13.2. 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 and non-native species (INNS) are just two examples.
General recording of unusual, rare, scarce or vagrant species are also maintained.
Records are entered into the JNCC-administered Marine Recorder database for access via the National Biodiversity Network on-line gateway.

### 5.13.3. Settlement Plates


In 2009 the Skomer MCZ became host to the ‘Cryptic fauna colonisation and succession project’ led by Professor Piotr Kukliński from Warsaw Oceanographic Institute and the Natural History Museum, London. Prof. Kukliński set up settlement plates at two depth locations (6m and 12m) at Bernie’s Rocks on the north side of the island and at Thorn Rock on the south side. A programme of sequence photography and panel exchanges is followed on a monthly basis at each site. This project is already established at sites in Spitzbergen, Baltic and Mediterranean. The project at Skomer continued throughout the 2010 to 2015 seasons and ended in 2016 once the year’s sequence had been completed and all panels removed (Ronowicz et al. 2014)

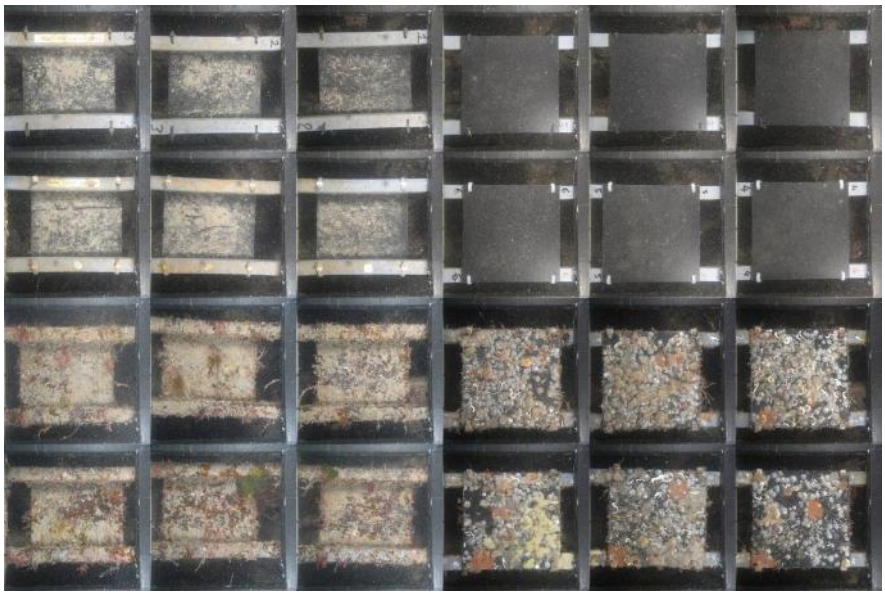


Figure 5.13.1 Example of monthly sequence photos of settlement plates:

### 5.13.4. Crawfish

Crawfish *Palinurus elephas* became a national Biodiversity Action Plan species in 2008, and is now an Environment Act (Wales) 2016, Section7 species of principal importance. From 2009 to 2016 it was recorded in low numbers in Skomer MCZ by staff and volunteers. These records have been submitted to the online recording scheme set up by the Seasearch organisation (www.seasearch.org.uk) in an effort to gain better knowledge of the historical and current status of this species in the UK.

### 5.13.5. Sunfish

Sunfish *Mola mola* is the largest bony fish in the world; 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'C or warmer. Sunfish records are from both MCZ staff and from Dale Princess crew. Although they can grow up to 1000kg, those recorded are usually relatively small individuals. Some years several individuals have been spotted whilst in other years there have been no records.

### 5.13.6. *Arctica islandica*, Icelandic cyprine or Ocean quahog


*Arctica islandica* is a heavy, thick, rounded shell up to 13cm. It has a thick glossy periostracum that becomes greenish- brown to black in large shells. *Arctica islandica* is exceptionally long lived. Growth is relatively fast during the juvenile stage and then slows down. Counts of internal growth lines by Bangor and Iowa State Universitiy researchers suggested ages of around 500 years old, making it the longest-lived non-colonial animal so far reported (Butler *et al* 2013). Recruitment rate is very low, therefore any populations that are removed may take a considerable time to recolonise a habitat by larval recruitment. *Arctica islandica* is a species of principal importance as defined under Section 7 of the Environment Act (Wales) 2016.

*Arctica islandica* is found in sediment habitats of the Skomer MCZ. Records of sightings were made during the 2016 scallop survey.

### 5.13.7. *Crepidula fornicata*, American slipper limpet

*Crepidula fornicata* is an INNS species and was first recorded from Welsh coastal waters in 1952 when single individuals were found in the low intertidal in the Milford Haven Waterway. Since then it has rapidly established itself and spread throughout much of Milford Haven. However, there was no indication of a northwards range extension until 2008 when two individuals were found in the Skomer MCZ during the scallop survey. In the 2012 survey a total of ten *C. fornicata* were found, all attached to *P. maximus* or *Aequipecten opercularis*. Individuals were solitary or occurred in stacks of two, and at least three of the bottom-most individuals were carrying eggs, i.e. had reached sexual maturity and reproduced successfully. The sampling effort involved in the 2012 survey is considered high with 1074 *P. maximus* inspected and densities of *C. fornicata* were very low.

In 2016 the scallop survey was repeated and a total of 68 *C. fornicata* were found attached to *P. maximus* shells either as individuals or in stacks. Once again the sampling effort involved in the survey is high with 2534 *P. maximus* inspected and the density of *C. fornicata* low. However the numbers have increased from previous records and it is notable that they were found over a wider range of locations along the north Marloes peninsula and also from a site on the north side of Skomer Island.

| | **Scallops with *C.fornicata*** | | | |
|---|---|---|---|---|
| **Site** | **2012** | **%** | **2016** | **%** |
| 1 | 0 | 0 | 13 | 2.73 |
| 2 | 2 | 0.9 | 19 | 3.20 |
| 3 | 0 | 0.0 | 5 | 6.49 |
| 4 | 0 | 0.0 | 0 | 0.00 |
| 5 | 1 | 0.6 | 5 | 1.27 |
| 6 | 2 | 1.2 | 10 | 2.07 |
| 7 | 0 | 0.0 | 6 | 2.60 |
| St Brides | 1 | 0.6 | 1 | 1.16 |
| Total | **6** | | **59** | |
| MCZ average % | | **0.4** | | **2.6** |

Table 5.13.1 Numbers and percentage of scallops found with *Crepidula fornicata* 2012 & 2016

The records have been entered into the I-record database for access via the National Biodiversity Network on-line gateway.

# 6. Skomer MCZ Meteorological and Oceanographic Project Summaries

## 6.1. Meteorological Data

*CMS Code: RP 04/01*

### 6.1.1. Project Status

Ongoing, continuous.

### 6.1.2. Project Rationale

The weather is an important factor that directly affects species / communities on the shore and in the sub-littoral. 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 is used to improve the interpretation of biological changes seen in monitoring projects by putting them into a climatic context. This application of Skomer MCZ data can also be made for Skomer Island NNR and Pembrokeshire Marine monitoring data.

### 6.1.3. Objectives

To provide continuous meteorological data for the Skomer MCZ.

### 6.1.4. Sites

Coastguard lookout station, Wooltack Point, Martins Haven.
Grid Ref: SM 7588 0922 (LL 51.44.78N 005.14.78W)

### 6.1.5. 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 was automatically downloaded to a computer in the Skomer MCZ office where it was stored. An uninterruptible power supply was used, but there were occasional problems with data dropout.

April 2006 – current. A Campbell Scientific Environmental Change Network (ECN) compatible weather station with a CR1000 measurement and control system was installed. 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 is automatically downloaded to a computer in the Skomer MCZ office using “Loggernet” software. The data is 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 enabled the data to be automatically updated into an external website.

### 6.1.6. Project history relevant to data

A continuous data set 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 it could be viewed and downloaded.
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 was 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. In 2015 and 2016 there were no issues with the weather station, but there is currently no service contract in place.

### 6.1.7. Results

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

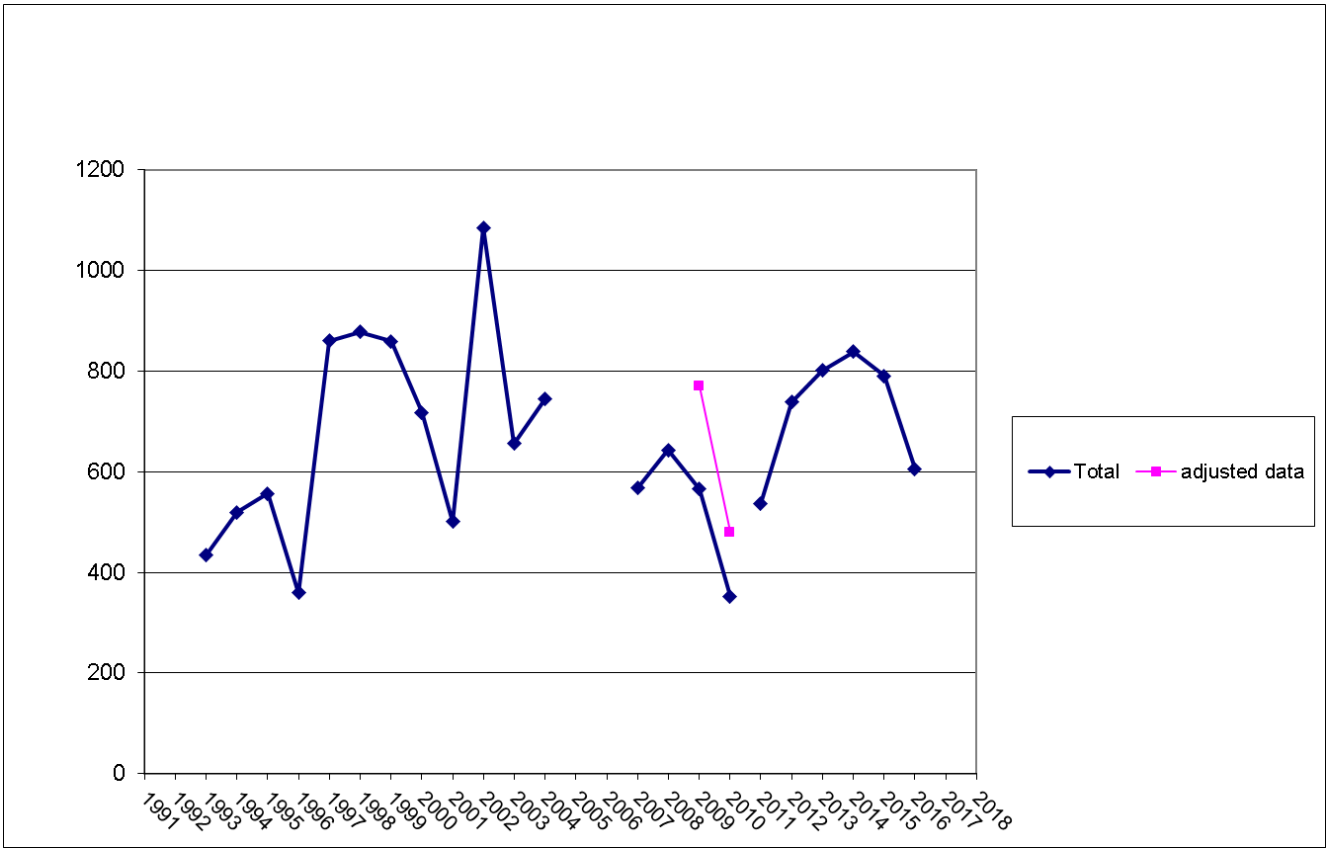


Figure 6.1.1 Skomer MCZ automatic weather station total rainfall (mm) data

There was some extreme weather in February 2014 with 100mph winds recorded on the 12th Feb 2014. The rain gauge recorded 199mm of rain for that day, but it is likely that this was a false reading and this has been removed from the data. The winds will have vibrated the rain gauge causing it to “tip” when there was no water in the bucket.

*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

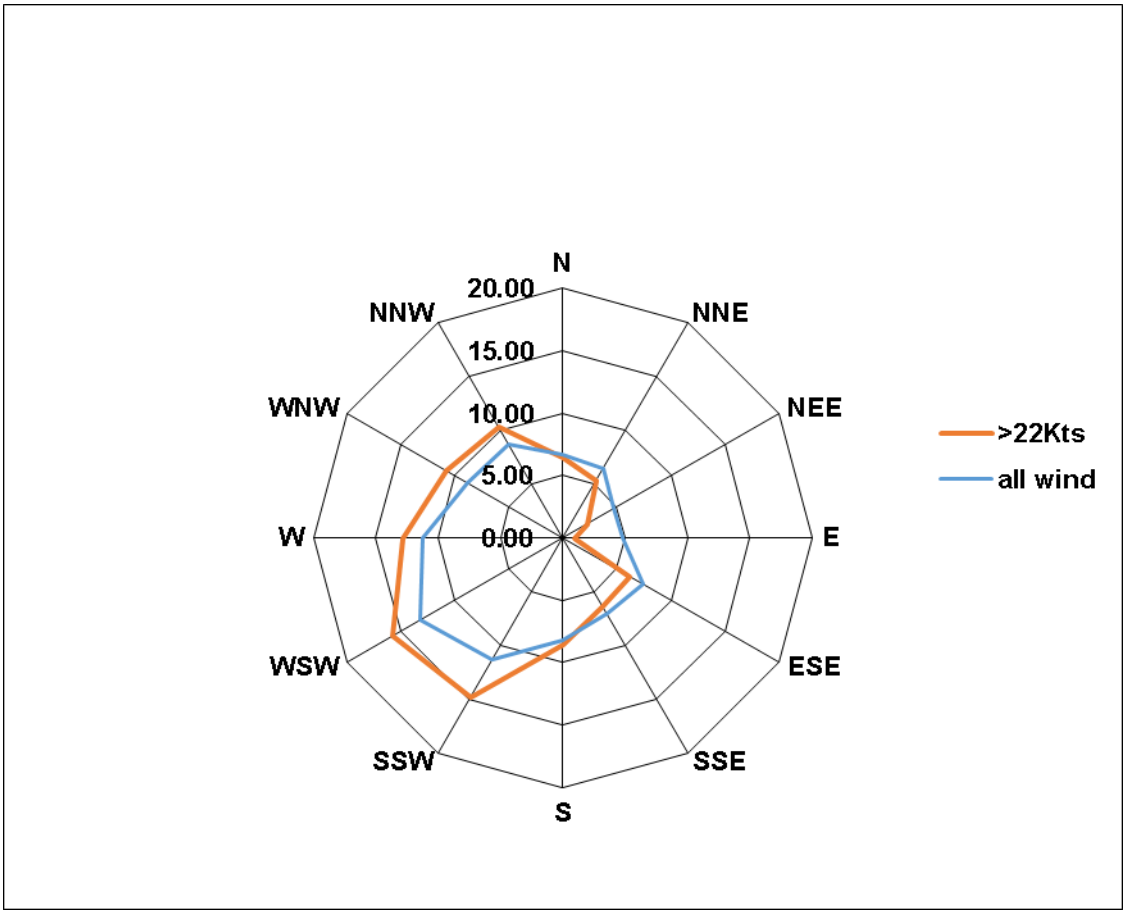



Figure 6.1.2 Skomer MCZ automatic weather station – average wind direction 1993 - 2016

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 has been gathered.

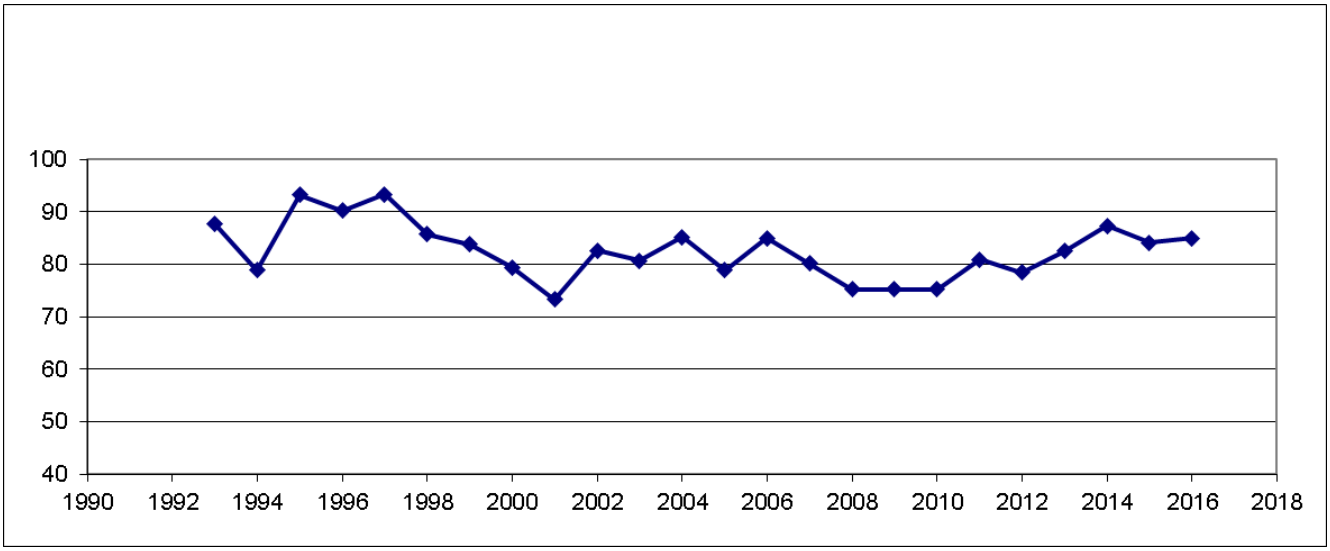



Figure 6.1.3 Skomer MCZ automatic weather station – maximum wind strength (knots) 1993 - 2016

The maximum gust recorded for 2008, 2009 & 2010 was exactly the same (75.28 knots). This led to the suspicion that the anemometer bearings were faulty. After the bearings were replaced in 2011 higher gusts were recorded; 2016 saw a maximum gust of 84.99 knots.

Analysis of wind data from each year that was greater than 22 knots compared to the overall average for 1993 to 2016 shows that 2016 was not particularly windy in October, November or December when compared to other years.

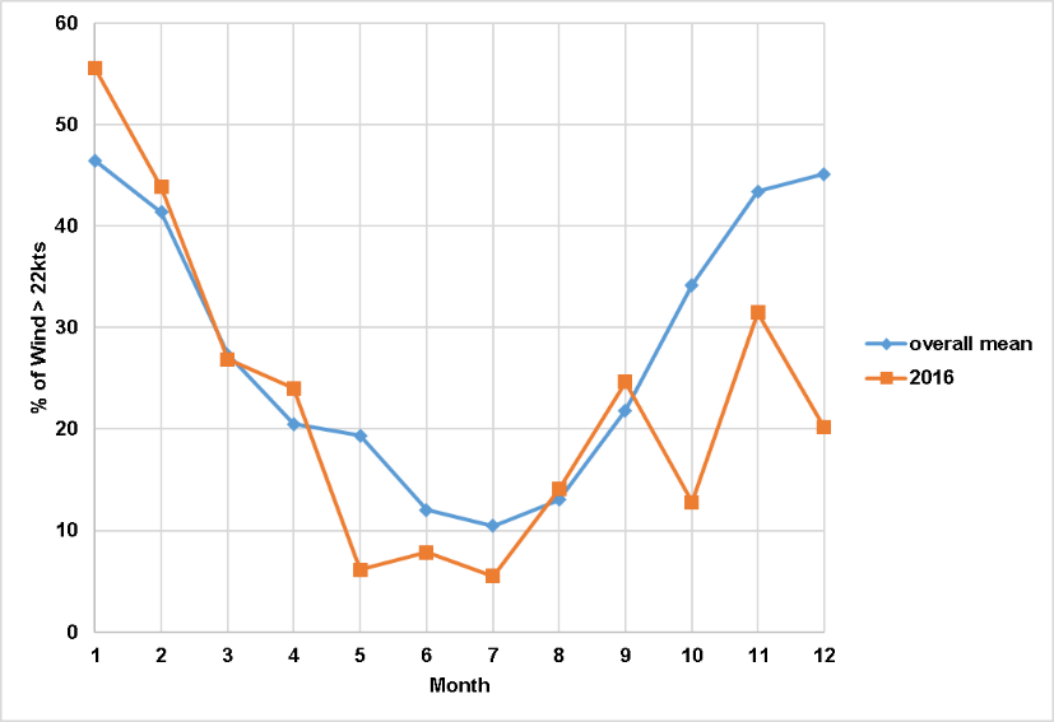



Figure 6.1.4 Skomer MCZ automatic weather station – percentage of wind greater than 22 kts

The winter months tend to have the highest percentage of strong winds (Dec 1999: 85% > 22Kts) but it is very variable from year to year.

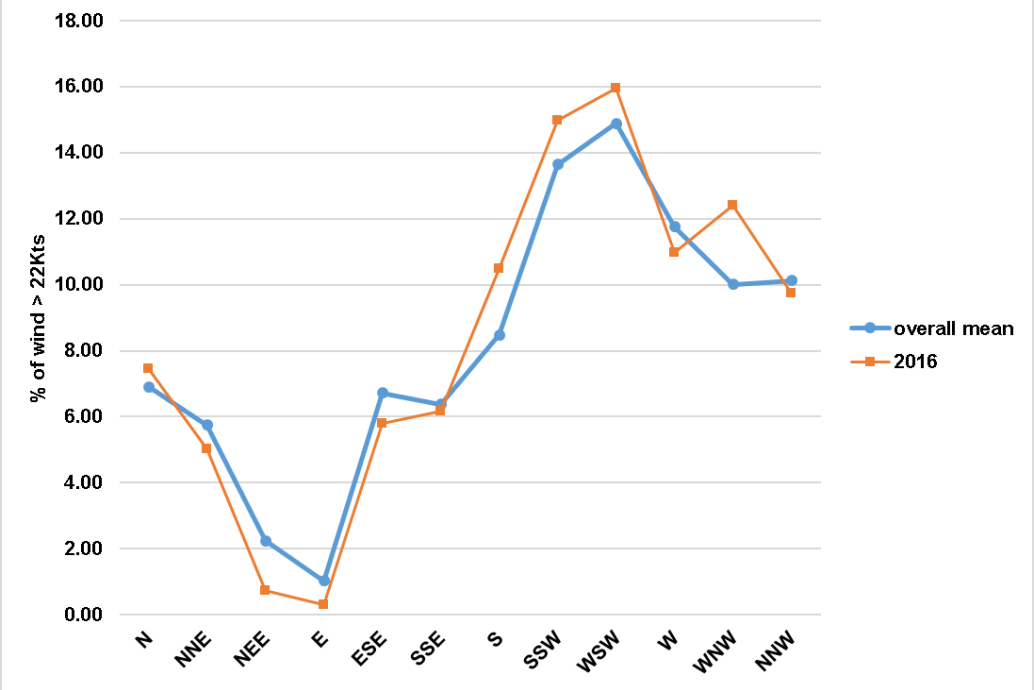



Figure 6.1.5 Skomer MCZ automatic weather station – percentage of wind over 22kts from each wind direction

2016 has a similar distribution of winds compared to the overall mean for 1993 to 2016. Most of the stronger winds come from the SW, WSW & W. The east tends to have the lowest percentage of strong winds.

Another ecologically important measure of exposure is total annual wind, which is a measure of the energy that littoral and sublittoral habitats are subject to. The total amount of wind is calculated from the percentage of wind recorded in each year at each Beaufort force multiplied by the mid wind strength (knots) for that wind force. The windier the year the higher the "Total amount of wind".
The amount of wind recorded over 22 knots, less than 10 knots and in between 10 to 22 knots is then shown as a percentage.
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.

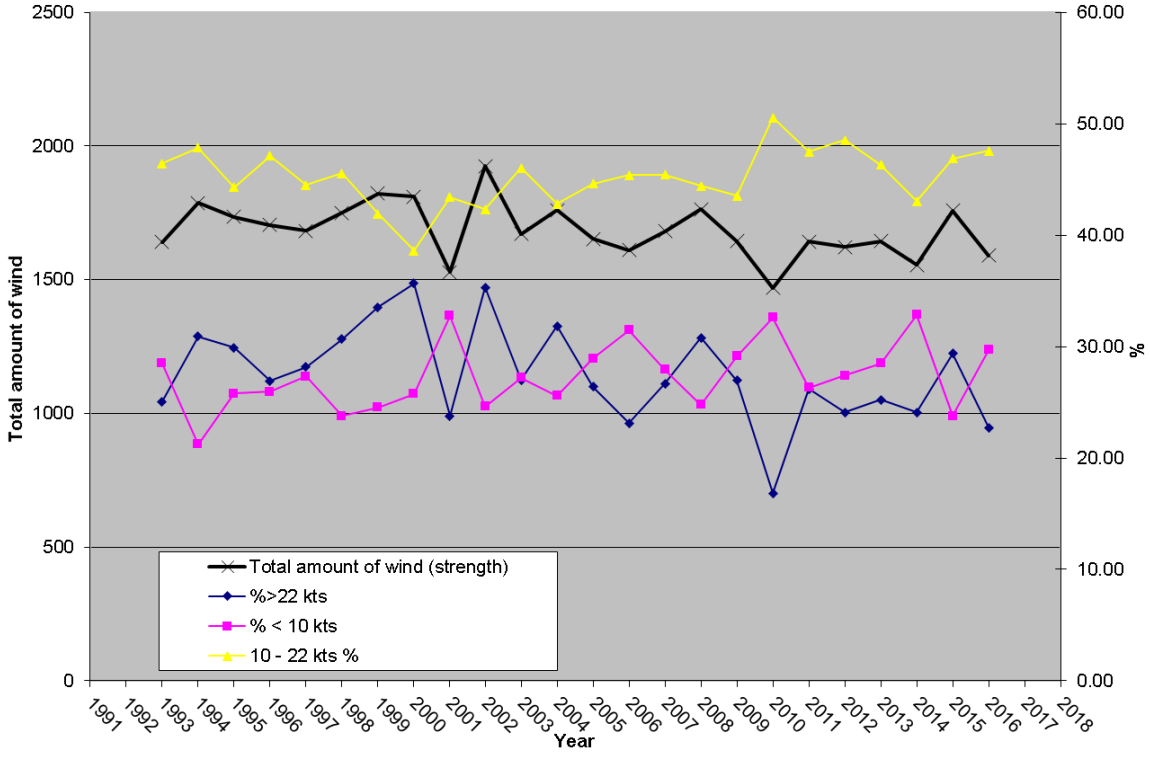



Figure 6.1.6 Skomer MCZ automatic weather station – "total wind" 1993 to 2016

| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AIR TEMP | MEAN | 8.3 | 7.1 | 7.2 | 8.3 | 11.7 | 13.7 | 14.9 | 15.7 | 15.4 | 12.1 | 8.7 | 9.4 |
| T107_1 0c | MAX | 12.1 | 11.7 | 11.1 | 14.8 | 21.7 | 19.7 | 26.3 | 21.9 | 22.0 | 16.7 | 13.0 | 12.9 |
| | MIN | 0.4 | 2.2 | 2.5 | 2.9 | 8.1 | 9.6 | 11.7 | 11.7 | 10.7 | 6.1 | 1.2 | 2.5 |
| BAROMETRIC PRESSURE | MEAN | 998.2 | 1002.2 | 1007.7 | 1005.7 | 1007.6 | 1007.7 | 1010.3 | 1011.2 | 1008.7 | 1013.8 | 1008.1 | 1018.0 |
| | MAX | 1024.0 | 1028.0 | 1028.0 | 1022.0 | 1021.0 | 1019.0 | 1021.0 | 1023.0 | 1018.0 | 1029.0 | 1029.0 | 1036.0 |
| | MIN | 968.0 | 969.0 | 971.0 | 991.0 | 995.0 | 988.0 | 995.0 | 989.0 | 998.0 | 992.0 | 976.0 | 1004.0 |
| RELATIVE HUMIDITY | MEAN | 84.7 | 79.2 | 81.4 | 79.2 | 88.3 | 92.8 | 92.6 | 90.9 | 88.5 | 82.6 | 79.8 | 88.3 |
| | MAX | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| | MIN | 48.1 | 46.1 | 43.5 | 26.4 | 45.6 | 55.2 | 58.8 | 53.9 | 54.8 | 54.4 | 25.8 | 48.5 |
| RAINFALL | TOTAL(mm) | 100.5 | 135.0 | 81.1 | 13.7 | 40.6 | 39.4 | 11.7 | 47.6 | 36.3 | 25.3 | 55.7 | 19.2 |
| SUNSHINE | MEAN(kw/m2) | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.0 | 0.0 |
| | sunshine hours | 77.0 | 146.0 | 252.0 | 305.0 | 354.0 | 339.0 | 350.0 | 314.0 | 242.0 | 210.0 | 110.0 | 60.0 |
| | Sunshine hrs (10min) | 75.3 | 140.3 | 248.8 | 302.7 | 347.3 | 340.8 | 342.5 | 307.2 | 236.3 | 205.2 | 113.7 | 59.3 |
| NET RADIATION | MEAN | -9.8 | 3.0 | 33.8 | 74.5 | 98.0 | 113.1 | 112.7 | 79.3 | 43.6 | 7.7 | -12.4 | -11.6 |
| MAX GUST | M/s | 35.0 | 43.8 | 40.8 | 28.3 | 20.8 | 29.6 | 22.9 | 28.3 | 23.8 | 27.1 | 37.9 | 29.6 |
| | direction | 213.0 | 261.3 | 299.3 | 111.7 | 249.6 | 219.3 | 258.1 | 247.2 | 218.3 | 198.4 | 263.1 | 235.5 |
| | Knots | 68.0 | 85.0 | 79.3 | 55.0 | 40.5 | 57.5 | 44.5 | 55.0 | 46.1 | 52.6 | 73.7 | 57.5 |
| | | | | | | | | | | | | | |
| **Notes** | | | | | | | | | | | | | |
| No service in 2016 | | | | | | | | | | | | | |

Table 6.1.1 Skomer MCZ automatic weather station – 2016 annual meteorological summary

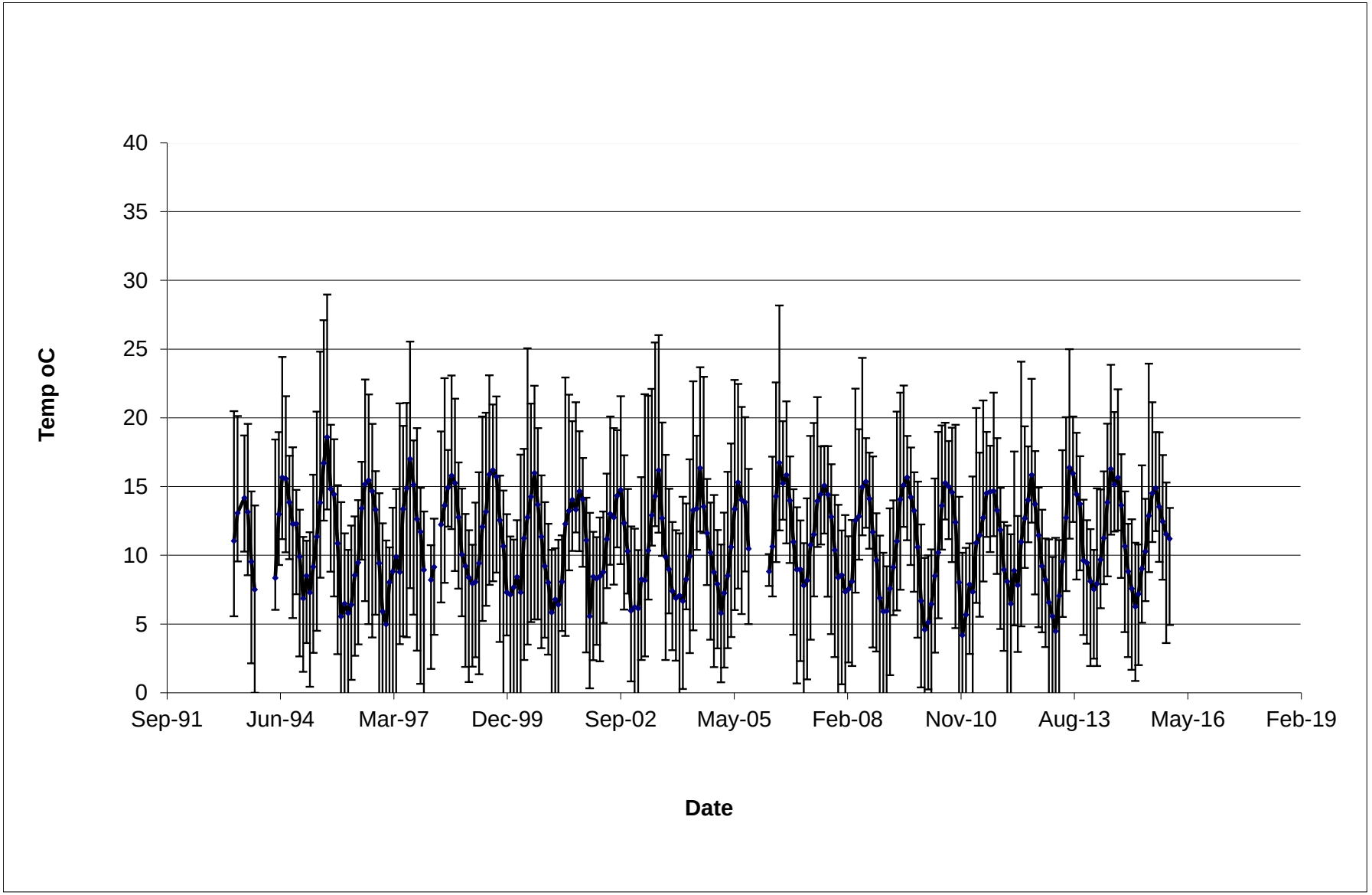



Figure 6.1.7 Skomer MCZ automatic weather station – monthly average air temperatures 1993 - 2016 with monthly min / max error bars:

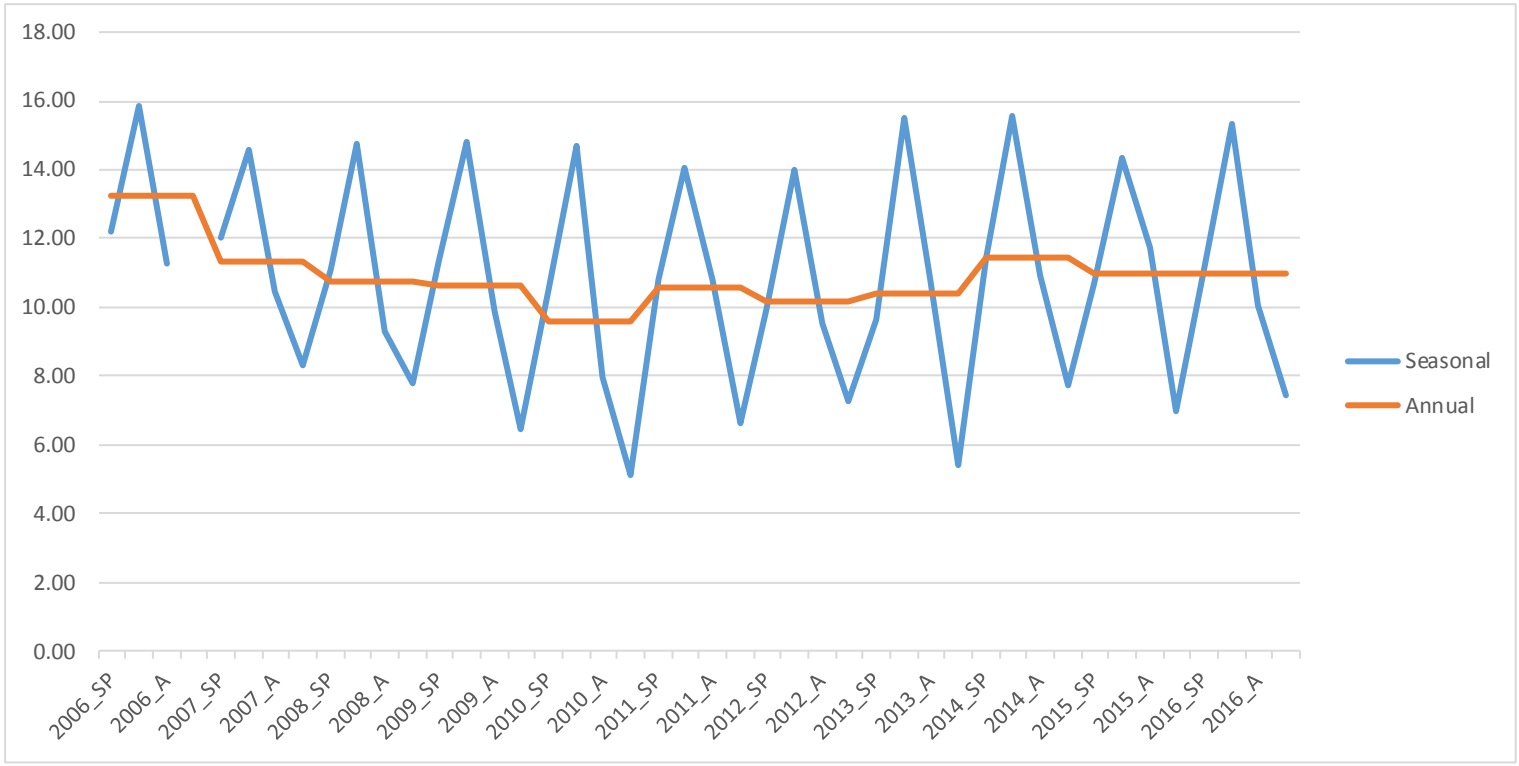



Figure 6.1.8 Skomer MCZ automatic weather station – annual and seasonal mean air temperatures (°C) 2006 – onwards:

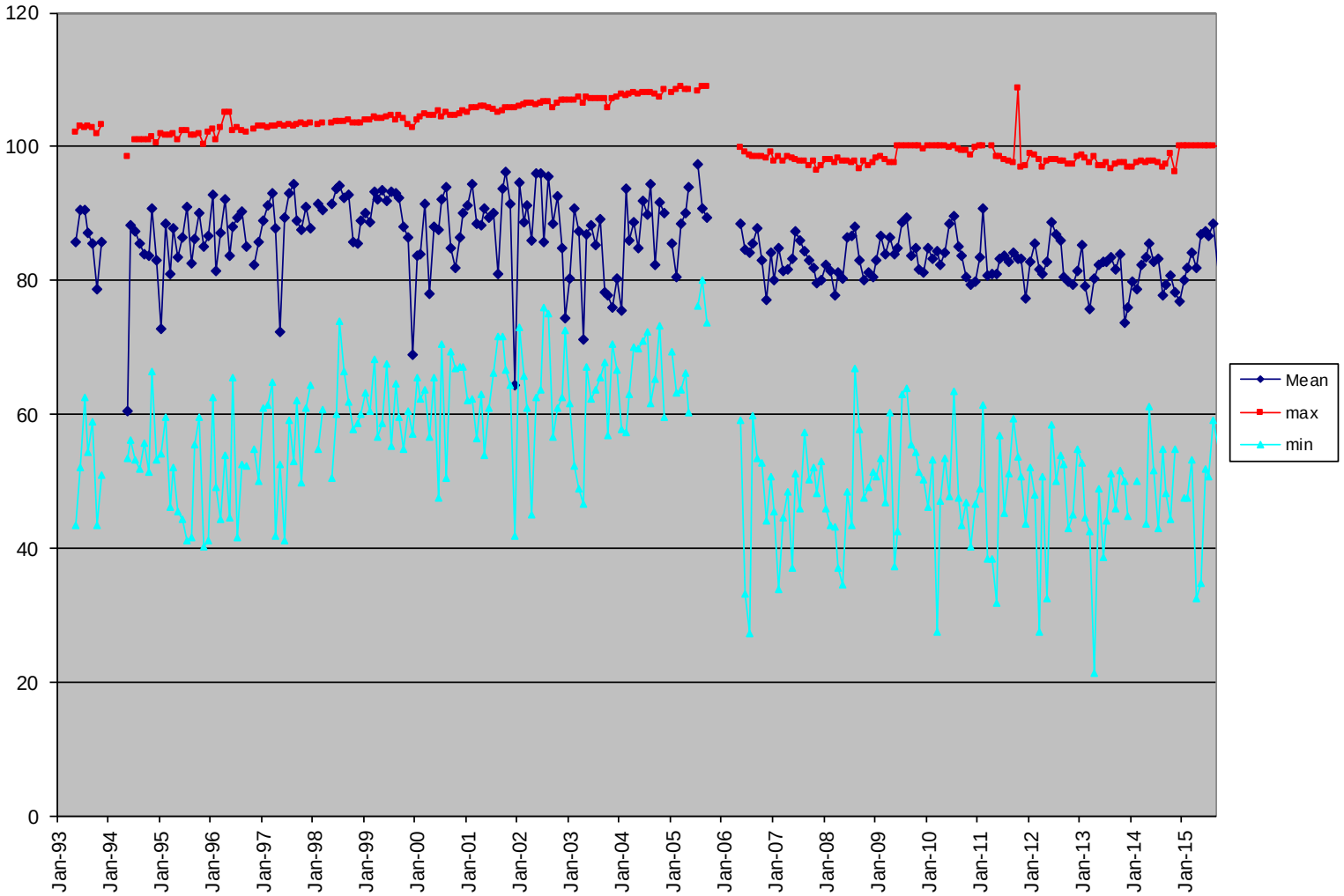



Figure 6.1.9 Skomer MCZ automatic weather station – relative humidity 1993 - 2016:

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

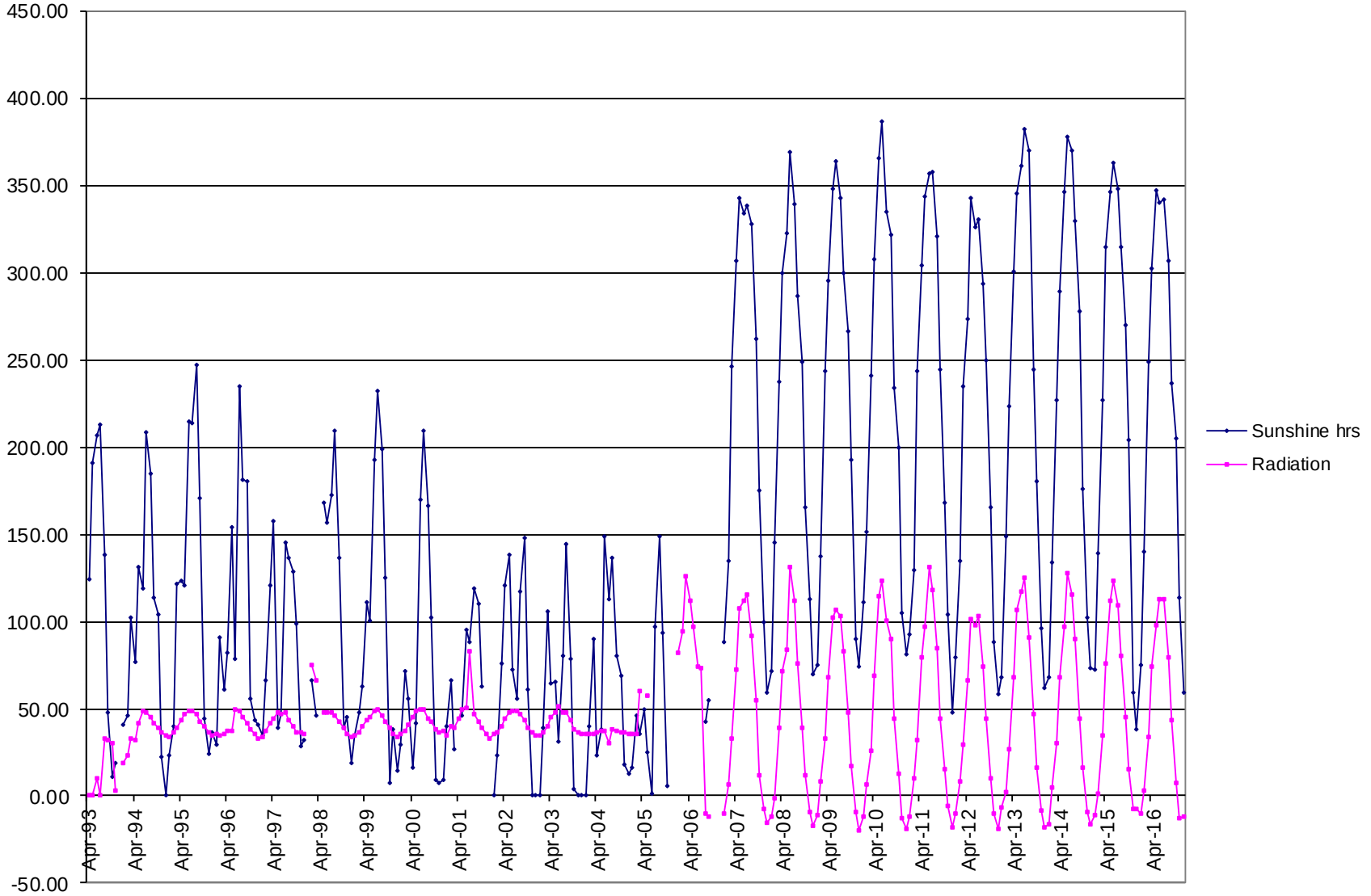



Figure 6.1.10 Skomer MCZ automatic weather station – solar radiation and sunshine hours 1993 - 2016

There was an obvious change in the data when the weather station equipment was changed in 2006.

### 6.1.8. Current Status

Skomer MCZ weather data demonstrates no significant anomalies other than those attributable to equipment changes or failures.  Therefore the features of the MCZ are not being subject to climatic exposure at different levels or in patterns different to those over the previous 23 of recording.

### 6.1.9. Recommendations

- Keep meteorological equipment maintained and calibrated.
- Change the bearings in the anemometer every 2 years.
- Continue contributing to the Environmental Change Network (ECN).
- Make Skomer MCZ data available via the internet.

## 6.2. Seawater Temperature Recording

*(CMS Code: RP64 / 01)*

### 6.2.1. Project Status

Ongoing, continuous

### 6.2.2. 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 is relevant to the Pembrokeshire Marine SAC and potentially to the West Wales Marine cSAC for harbour porpoise.

### 6.2.3. 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 data set for the site.

### 6.2.4. 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 & Pembroke Power station Outfall

### 6.2.5. Methods

*Ocean monitoring site*

- Oceanographic Monitoring site: from 1992 onwards a Valeport series 600 MKII CTD probe. A drop down CTD probe 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).

- Vemco minilog is attached to a fixed steel frame on the seabed at 19m below chart datum (BCD). The logger maintains a 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). In 2008 the sonde was linked up to a telemetry buoy to provide live 10 minute readings. The data was sent via VHF to the coastguard look out hut and then onto the Skomer MCZ office via a fibre- optic link. 2010 the YSI sonde was repositioned onto the buoy. It recorded from 06.m below the water surface. The telemetry system was changed to a GSM system to allow remote updates to the ECN website. In 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 the OMS site was re-established with a marker buoy and a logger attached at 1m below sea level.

*Shore Sites*

- 2007, Onset "Hobo" pendant loggers have been deployed at: Martins Haven and South Haven shores (lower, middle and upper shore).
- 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 pools. Pembroke Power station Outfall upper and middle shore.

### 6.2.6. Project history

Seabed temperature is not commonly measured in UK waters, sea surface temperatures being the most common records. Since July 1999 only 1 month of data is 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. 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.

Valeport series 600 MKII CTD probe water profile records:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1992 | Jul – Nov | 1999 | May – Nov | 2006 | Mar – Oct | 2013 | Apr - Oct |
| 1993 | Jan – Dec | 2000 | Mar- Oct | 2007 | Apr – Oct | 2014 | Apr - Nov |
| 1994 | Feb – Dec | 2001 | May – Nov | 2008 | Apr – Dec | 2015 | Mar - Oct |
| 1995 | Jul – Dec | 2002 | May – Oct | 2009 | Feb – Oct | 2016 | Apr - Oct |
| 1996 | Mar – Dec | 2003 | Jun – Sept | 2010 | Mar - Nov | | |
| 1997 | Aug – Dec | 2004 | May – Oct | 2011 | Mar - Nov | | |
| 1998 | Mar – Nov | 2005 | May – Oct | 2012 | Mar – 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

### 6.2.7. Results

*Oceanographic monitoring site:*

| Temperature °C | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum | 8.4 | 7.27 | 8.7 | 7.6 | 7.7 | 7.36 | 7.5 | 8.8 | 8.4 | 7 | 6.9 |
| Maximum | 16.27 | 16.3 | 15.6 | 17.1 | 16.76 | 16.4 | 16.3 | 16.3 | 16.3 | 16.8 | 16.8 |
| Year | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | | | | | |
| Minimum | 7.6 | 8.0 | 6.98 | 8.14 | 7.8 | 8.5 | | | | | |
| Maximum | 15.9 | 16.6 | 16.82 | 16.72 | 15.98 | 16.8 | | | | | |

Table 6.2.1 Skomer MCZ maximum and minimum annual seabed temperatures 2000 – 2016 (19m BCD)

2009 and 2010 both had very cold air temperatures in the winter and the seawater temperature also dropped to 7 °C, the coldest recorded this decade. Seabed temperatures in 2012 were mild in the winter and average in the summer. 2013 had a

cold April/ May with sea temperatures remaining -1$^{o}$C below average. 2015's seawater temperatures were mild both in the winter and the summer. The winter of 2016 was very mild (the mildest December in our records).

A summary of the seabed temperature (data from Vemco minilog at 19m BCD) is shown in Figure 6.2.1. Monthly means have been calculated from seabed temperature but substituted with the CTD probe seabed temperature data where logger data was absent.

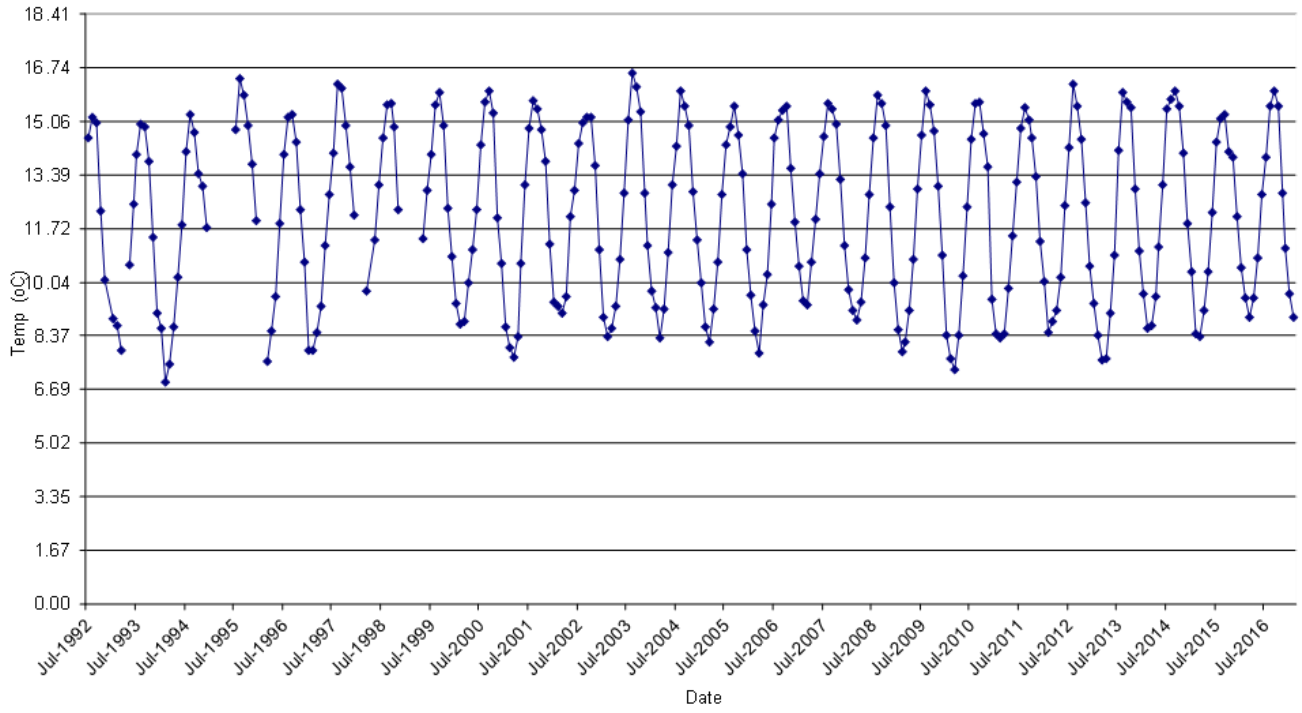



Figure 6.2.1 Skomer MCZ summary of monthly mean seabed temperature (19m BCD) 1992 - 2016

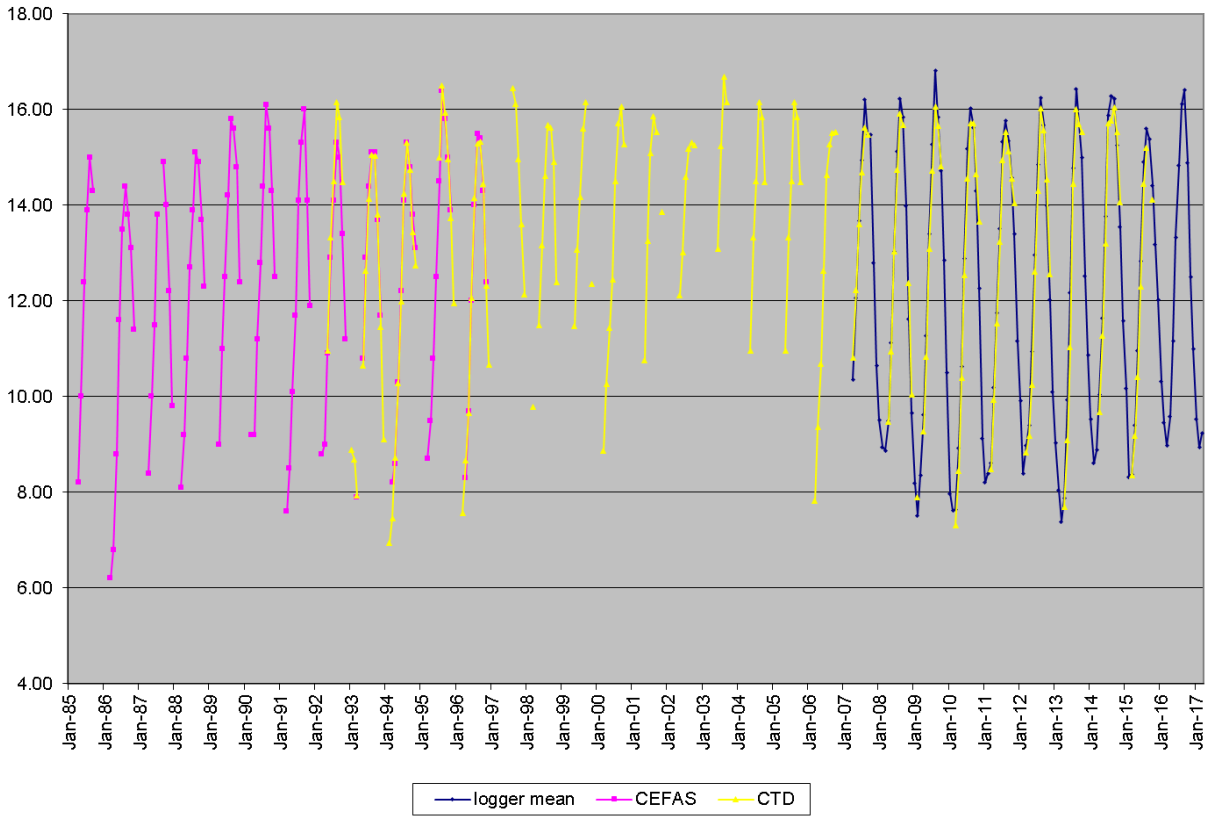



Figure 6.2.2 Skomer MCZ summary of monthly mean sea surface temperature1985 – 2016

A summary of the sea surface temperature is shown in Figure 6.2.2. 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 data set (Figure 6.2.3).

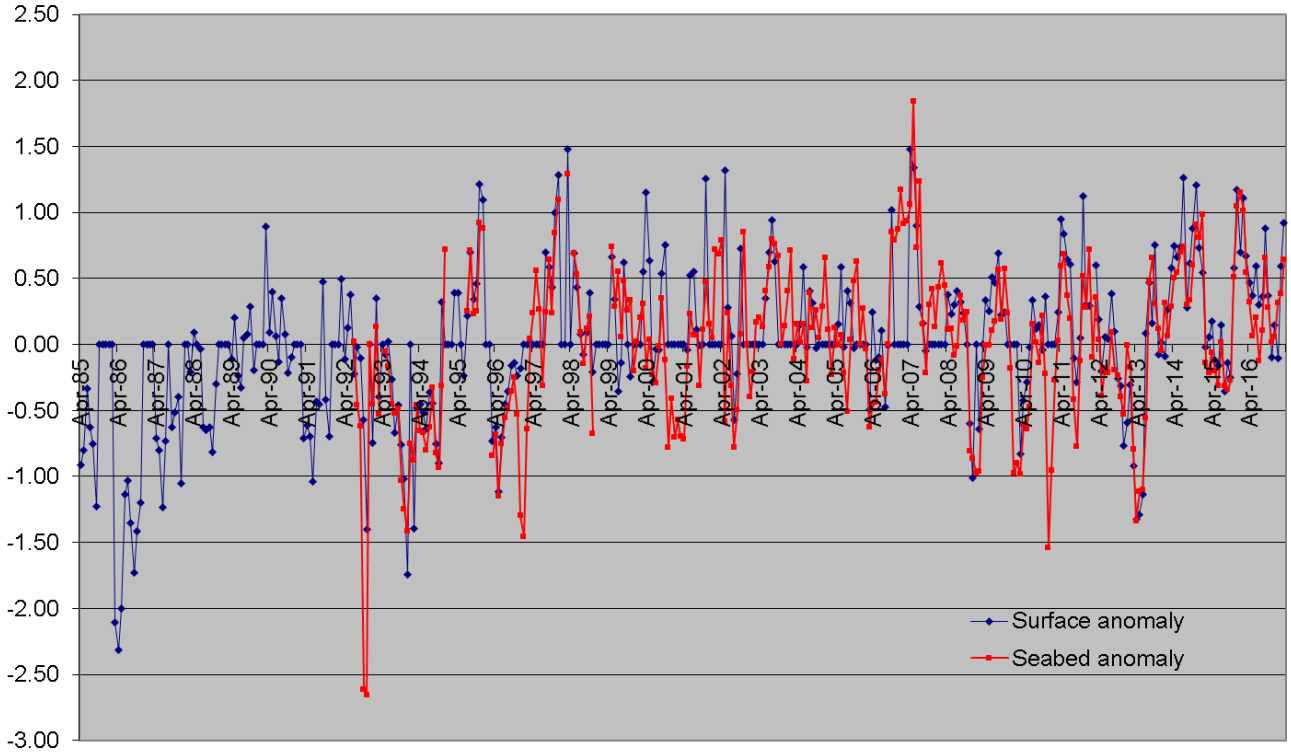



Figure 6.2.3 Skomer MCZ sea temperatures – monthly anomaly between the specific monthly mean and the grand monthly mean, surface and seabed temperatures (1985 to 2016)

Sea temperatures prior to 1995 were generally cold. From 1995 to 2006 there was a warmer period, but from 2006 onwards the data has been very erratic with some very cold winter temperatures but some warm summer temperatures. 2016 had a very warm period from December to September.

*Shore monitoring sites*

The loggers provide a record of the temperature regime experienced by sessile organisms in the inter-tidal 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.

### 6.2.8. Current Status

There does not appear to be any long-term trend in sea water temperatures, which if anything appear to be becoming more erratic. The increase of more extreme weather events may put the marine communities under additional pressure through increases in exposure to wind and wave energy and increases in suspended sediment load.

### 6.2.9. Recommendations

- Continue data set to form a long-term record of variation in seabed temperature at Skomer MCZ.
- Keep the data set as complete as possible. An additional logger running at the same time would add redundancy into the methods should the equipment fail (so far when equipment has failed the data has fortunately been retrievable).

## 6.3. Seawater Turbidity / Suspended Particulates and Seabed Sedimentation

*(CMS CODE RP63/01)/(CMS CODE RP63/04)*

### 6.3.1. Project Status

Ongoing

### 6.3.2. 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 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.

### 6.3.3. 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.

### 6.3.4. Sites

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

### 6.3.5. Methods and Project History

- Secchi disk measurements: the depth to which a white 30cm "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. 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 0.6m below the surface. This was discontinued in 2013.

| Year | Months with samples | Sites | Notes |
|---|---|---|---|
| 1994 | Jul – Dec | OMS & TRK | |
| 1995 | Jan – Dec | OMS & TRK | |
| 1996 | Feb – Dec | OMS & TRK | |
| 1997 | Mar – Dec | OMS & TRK | |
| 1998 | Mar – Sep | OMS & TRK | |
| 1999- 2001 | No samples | | Re-established 02 Nov 2001 |
| 2002 | Mar – Nov | OMS & TRK | TRK site damaged |
| 2003 | May – Sep | OMS only | |
| 2004 | May – Sep | OMS only | |
| 2005 | Jun- Oct | OMS only | Collector damaged |
| 2006 | Jun - Oct | OMS & TRK | Repaired and TRK re-established |
| 2007 | May - Sep | OMS & TRK | |
| 2008 | May - Sep | OMS & TRK | |
| 2009 | Apr - Sep | OMS & TRK | Shell fragments in samples. |
| 2010 | Apr - Sep | OMS & TRK | |
| 2011 | Apr - Nov | OMS & TRK | |
| 2012 | Apr - Sep | OMS & TRK | |
| 2013 | Apr - Oct | OMS & TRK | New Lab used |
| 2014 | Apr - Oct | OMS & TRK | |
| 2015 | Apr - Oct | OMS & TRK | |
| 2016 | Apr - Oct | OMS & TRK | Awaiting results |

Table 6.3.1 Skomer MCZ sediment trap sampling effort from 1994 to 2016 at OMS and Thorn rock (TRK).

### 6.3.6. Results

*Turbidity*

*Secchi disc*: Measurements have been taken with reasonable consistently for the months of May to October since 1992. The mean monthly Secchi disc readings for

OMS and Thorn Rock (TRK) are shown in figure 6.3.1.

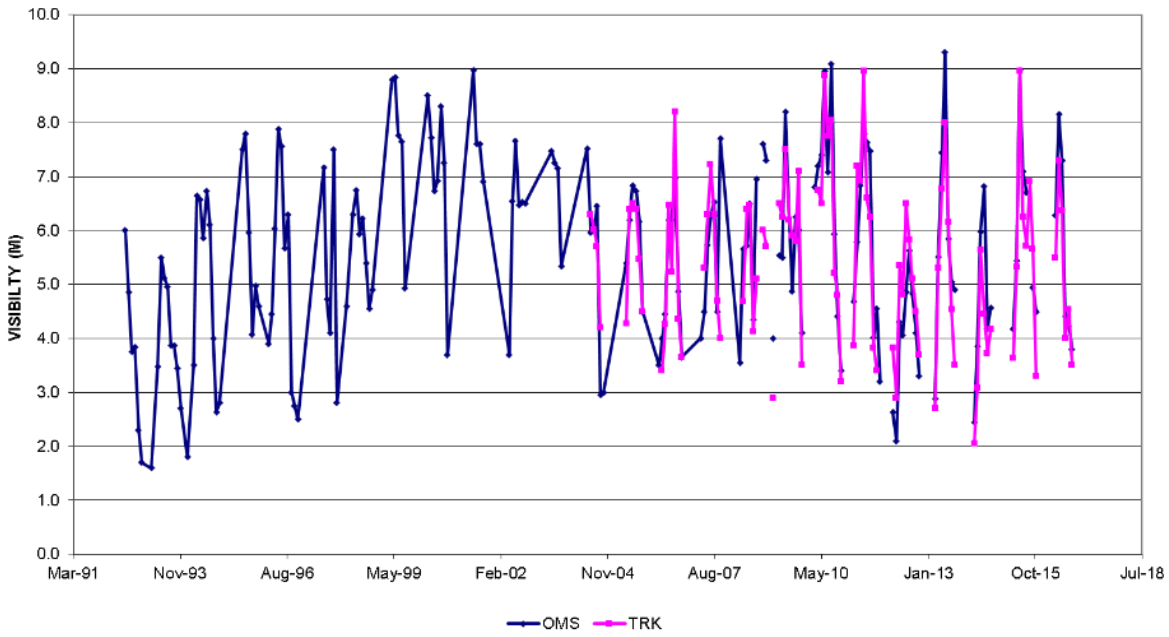



Figure 6.3.1 Skomer MCZ summary of monthly mean Secchi disc data (m) 1992 – 2016

This rather dynamic picture can be simplified by calculating the mean Secchi disk value for each year as shown in Figure 6.3.2.

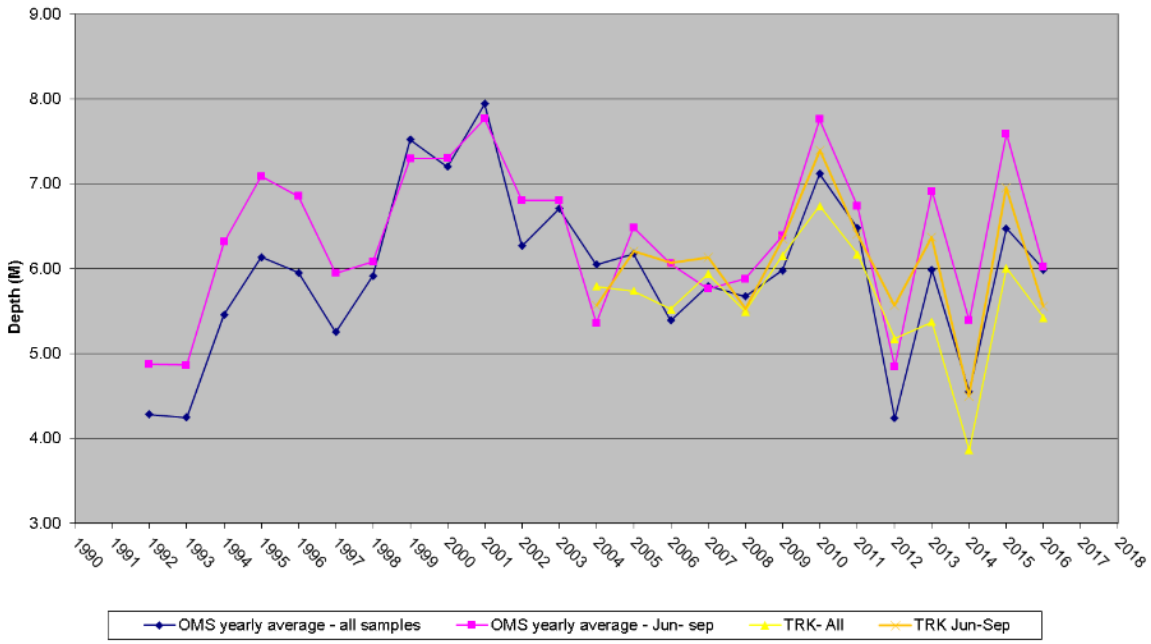



Figure 6.3.2 Skomer MCZ summary of annual mean Secchi disc data (m)

The Secchi disc readings for Thorn Rock in 2014 are 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 have returned towards average levels.

*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.

| 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 |

Table 6.3.2 Skomer MCZ sediment trap sample analysis - OMS site (awaiting 2016 results)

| TRK | g/day trk | % 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 | | | |
| 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 | 3.04 | 11.18 | 2.23 | 51.32 | 46.47 |

Table 6.3.3 Skomer MCZ sediment trap sample analysis - TRK site (awaiting 2016 results)

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.

Another change in 2013 was that the organic content analysis included heating the sample to 550$^{o}$C rather than 450$^{o}$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$^{o}$C.

The NRW laboratories carry out a slightly different suit 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.

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.

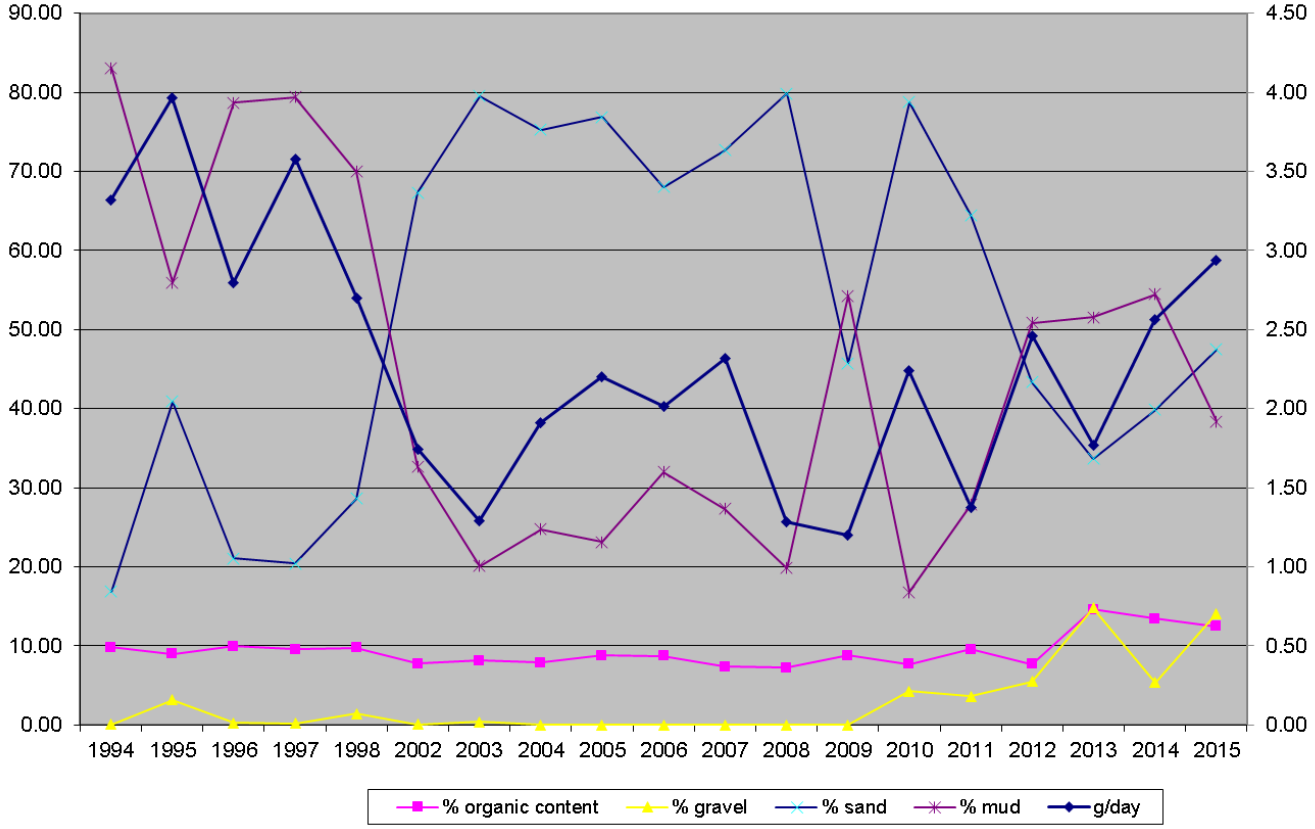



Figure 6.3.2 Skomer MCZ sediment trap sample total sediment, PSA and organic content analysis – both sites combined (awaiting 2016 results)

Final laboratory analysis results for 2016 have not been received at time of writing.

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.

### 6.3.7. Current Status

- Secchi disc method works well and has provided the most reliable and meaningful estimate of turbidity. The data set will become more useful the longer data is accumulated.

- The passive sediment traps work well and provide a sample that can be analysed in the future (this may be useful in the event of an unforeseen pollution incident).

- The optical turbidity probe has proved unreliable and difficult to interpret. It is not sensitive enough.

- 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 a beneficial effect until recent years. Dredge spoil disposal techniques and locations have not changed again, but sediment deposition and turbidity have reverted to levels not seen since the early 1990s. From satellite imagery and from reports of various rivers trusts it would appear that much of the sediment load is from high levels of terrestrial “run-off” emptying into the Bristol Channel and transported towards Skomer by the prevailing tidal currents. This increase in soil erosion is linked by some to poor agricultural practices and to changes in rainfall patterns, whereby intense downpours flush sediment into water courses and out into the sea before it has a chance to settle back out.

### 6.3.8. Recommendations

- Continue the Secchi disk readings as often as possible to produce a long-term data set.
- Restart the water samples for chlorophyll not only to help monitor primary productivity in the plankton (see Section 5.5), but also to enable turbidity due to phytoplankton to be factored into the interpretation of overall turbidity data.

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