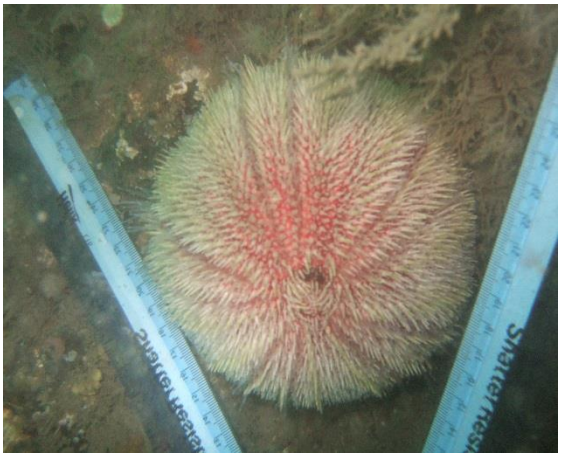
Cyfoeth Naturiol Cymru
Natural Resources Wales

Skomer Marine Conservation Zone Project Status Report 2015

M. Burton, K. Lock, P. Newman & J. Jones 2016

NRW Evidence Report No. 148



Synopsis

The fifteenthproject status report produced by the Skomer Marine Conservation Zone summarises the progress and status of monitoring projects in the Skomer MCZ in 2015. A summary of all established projects in the MCZ is provided in a table format. For each project that was worked on in the 2015 field season a detailed account is given including a history and summary of the results so far. This report also includes summaries of the oceanographic and meteorological surveillance projects.

Title: M. Burton, K. Lock, P. Newman & J. Jones. (2016). Skomer Marine Conservation Zone Project Status Report 2015. NRW Evidence Report No. 148.

Crynodeb

Mae'r pymthegfed adroddiad ar ddeg ar statws prosiectau a gynhyrchwyd gan Barth Cadwraeth Morol Sgomer yn crynhoi cynnydd a statws prosiectau monitro ym Mharth Cadwraeth Morol Sgomer yn 2015. Mae crynodeb o'r holl brosiectau sefydledig yn y Parth Cadwraeth Morol ar gael ar ffurf tabl. Ar gyfer pob prosiect y gweithiwyd arno yn nhymor maes 2015 ceir adroddiad manwl, gan gynnwys hanes a chrynodeb o'r canlyniadau hyd yn hyn. Mae'r adroddiad hwn hefyd yn cynnwys crynodebau o brosiectau gwyliadwriaeth eigionegol a meteorolegol.

Teitl: M. Burton, K. Lock, P. Newman & J. Jones. (2016). Adroddiad ar Statws Prosiectau Parth Cadwraeth Morol Sgomer 2015. Adroddiad Tystiolaeth CNC Rhif 148.

Contents

1 Introduction

This is the fifteenth project status report produced by the Skomer Marine Conservation Zone. It summarises the progress and current status of monitoring projects in the Skomer MCZ in 2015. The project status tables in section 2 provide a summary of all established projects in the MCZ. Section 3 details biological projects that were worked on this year and a summary of the results to date. Section 4 provides a summary of the oceanographic and meteorological surveillance projects.

Notable events in the 2015 field season:

- The common urchin and selected starfish species survey was carried out by a volunteer diving team of 29 divers over two weekends. A total of 151 transects were completed covering an area of 9060 m^2 and a total of 879 urchins were recorded and measured.

- The sponge species survey recorded 67 species. The Wick proved to be the richest site in terms of number of species found and the Thorn Rock location (4 sites) the most diverse. Two species, *Prosuberites longispinus* and *Spongosorites calcicola*, have not been recorded in previous surveys while nine are undescribed/new to science. Species samples were taken and provided to Portsmouth University for DNA analysis. A total of 128 sponge species (31 of these still to be described to species level) have now been recorded in the Skomer MCZ.

- The Grey seal pupping survey was completed at both island and mainland sites from August to December and 379 pups were recorded. Pup production in the Skomer MCZ for the past 3 years has shown the highest totals ever recorded with average production for 2013-15 at 357 pups. Since 2009 there has been a steady increase in pup production with the greatest increase seen at the mainland sites. However, in 2014 and 2015 increases at the island sites were also recorded.

2 Skomer MCZ Project Summary Tables

	Brief description	Year sets	Sampling frequency	Report	Data summary
PHYSICAL					
Meteorological data	Wind, rain, sunshine, temp, 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. YSI 6600 multi parameter sonde Temp, salinity, dissolved O_2, Chlorophyll, turbidity & depth OSIL buoy automatically transmitting data from YSI 6600 sonde. Buoy redeployed 2010 Buoy lost Nov 2013- Onset logger re-deployed Apr 2014 (no telemetry)	1992 – ongoing 2007 – ongoing	Weekly (May - Sept) Temp (since 99) Hourly Hourly samples Hourly samples	No No	Yes-SMCZ office Yes-SMCZ office

	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 1995 to1998 2002 to 2015	Every 14 days (April-Oct)	Jones 1998	Yes-SMCZ office
Suspended sediments	Idronaut Turbidity logger Secchi disc YSI 6600 multi parameter sonde – now stopped	2001 – failed 06 1992 - onwards 2007 - 2013	Continuous Weekly (seasonal) Hourly	No No No	No - raw only Yes – SMCZ office 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 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 24/7 electronic AIS	No	Yes-SMCZ office 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
Meso scale (transects)	6 Transects. Time series photos/digitised. 9 sites established in 2003 including 3 Marclim sites. Site marking completed in 2004.	1992 – 2002 2003 - ongoing	Annual Annual	Adams 1979/ Bunker 1983/ Crump 1993/96 Hudson 1995. Burton & Crump 2004	Yes-SMCZ office Yes-SMCZ office

	Brief description	Year sets	Sampling frequency	Report	Data summary
Sub littoral communities:					
Rocky reef communities	Time series stereo photos.	1982 - ongoing	Annual	Bullimore1986 & 1987	Yes-SMCZ office
Algal communities	Survey and report completed Survey completed report in preparation Full survey and method development	1999 2005 2007		Hiscock, S 1983 & 1986 Scott 1994 Brodie & Bunker 1999/2000 Maggs & Bunker 2007	Yes-SMCZ office
Sponge assemblages	Time series mono-photo/digitised. Species recording at TRK Seasonal monitoring from 15 fixed quadrats – Dr J Bell	1994 - ongoing 2002/3, 2007/8 2011, 2015 2006 – ongoing	Annual Every 4 years Next survey planned 2019 4 times / year	Bunker & Jones 2008 & 2012 Bell *et al* 2012 Jones *et al* 2012	Yes-SMCZ office
Infaunal sediment	Surveys and reports completed	1993/1996/ 1998/ 2003 2007/ 2009 & 2013	Every 4 years Next survey planned 2017	Rostron 1994 & 1996 Barfield 1998 & 2003 Barfield 2007 & 2010	Yes-SMCZ office
Epifaunal sediment	Survey and report completed	1995/ 2001 & 2004 Video 2009	Project now combined with Infauna	Rostron 1996 Moore 2002 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.	Report in prep 2015	Yes-SMCZ office

	Brief description	Year sets	Sampling frequency	Report	Data summary
Flora:					
Zostera marina	Extent of NHV bed & density distribution. Biosonics Acoustic sonar survey	1997/2002/2006, 2010 & 2014 (Boundary maps for 2000, 2002 & 2004) 2013, 2014 & 2015	Every 4years Next survey planned 2018 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. 4 colonies stereo-photo.	1993- ongoing 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. New sites established 2002 & 2003.	1994- ongoing	Annual	Bullimore1986 & 1987 Bunker/ Mercer 1988 Gilbert 1998, Gibbs 2006	Yes-SMCZ office
Balanophyllia regia	Time series @ thorn rock stereo-photo/digitised The Wick. 3 transects	1984 – 2002 - ongoing 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
Atlantic Grey Seal	Surveys and reports.	1976- ongoing	Annual	Grey Seal breeding census, Skomer Island 1992-2015, Skomer MCZ annual reports 1992-2015	Yes-SMCZ office

	Brief description	Year sets	Sampling frequency	Report	Data summary
Nudibranch species	Various surveys MCZ survey completed.	1975-1991 2002, 2006, 2010 & 2014	Every 4 years Next survey planned 2018	Hunnam & Brown 1975, Bunker *et al* 1993, Luddington 2002 Lock *et al* 2010 & 2014	Yes-SMCZ office
Territorial fish	Survey methods developed. Survey completed. N. Sweet drop down video survey R. Bullimore video survey	1997,2001/2002 2005, 2009 & 2013 2007 2009	Every 4 years Survey to be reviewed	Lock 1998 Lock *et al* 2006 Tompsett 2006 Sweet 2009 Bullimore, R 2010	Yes-SMCZ office
King scallop *Pecten maximus*	UCS survey, Survey completed, 3 sites- 2000 Survey completed, 7 sites 2004, 2008 & 2012	1979/80, 1979-82 2000, 2004, 2008, 2012	Every 4 years Next survey planned 2016	Bullimore 1985 Jones 1979 & 1980 Lock 2002 Luddington *et al* 2004 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 Next survey planned 2019	Luddington *et al* 2004 Lock *et al* 2008, 2011 & 2016	Yes-SMCZ office
Commercial Crustaceans	Parlour pot and diving study (Plymouth student project) Parlour pot study – MCZ Shell disease survey Crawfish recording	2003 2011 2011 2011 onwards	Aug / Sep 2003 Jul – Oct 2011 Sep – Oct 2011 SMCZ team	Fothergill 2004 No 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

3 Skomer MCZ Biological Project Summaries

Littoral Communities
CMS code: RB03/01

Status Ongoing. Annual photographic sampling. Annual quantitative survey.

Project Rationale
Littoral communities 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.

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

Sites
- North Haven (1992)
- South Haven (1992)
- South Stream (1992)
- The Lantern (1992)
- The Wick (1992)
- Double Cliff (1992)
- Inside of Pig Stone (started 2003)
- Jack Sound / Wooltack (started 2003)
- Martins Haven (started 2003)
- Hopgang (North Marloes Peninsula) Lichen station only (started 1996).

Methods
Permanent Quadrats 1992 - Ongoing
Transects with permanent, fixed position quadrats were established in 1992. The quadrats extend from spring low water into the splash zone at regular height intervals.
Species abundance was recorded using the semi-quantitative SACFOR abundance scale (Hiscock 1990) and photographs taken of each 50 x 50cm quadrat. In addition a selection of close-up photographs of 10 x10cm quadrats were taken within the main quadrat.

Littoral Community Monitoring 2003 - Ongoing
(See Crump & Burton 2004 for full details)
At each site samples were taken from 4 heights on the shore:
Lower shore – 1.8m Above Chart Datum (ACD)
Middle shore – 4.2m ACD
Upper shore – 6.0m ACD
Splash zone ~ 9.0m ACD (selected sites only. To include Hopgang)

At Each Shore Zone:

- Four 1m^2 quadrats were placed in relatively homogenous areas of inclined rock (avoiding rock pools and large fissures)
- Presence / absence recorded for all species using a 25 cell grid.
- Digital photographs were taken of the whole quadrat
- Limpets were counted in 5 randomly selected cells
- Photographs of barnacles from 5 randomly selected cells using a 5 x 5cm quadrat
- % cover of barnacle species estimated in 5 random 20 x 20cm cells
- % cover of lichen species recorded in 50 x 50cm quadrats at selected sites

Counting Protocols:

- Aggregate rough winkle species
- Aggregate *Verrucaria spp* other than *V. mucosa*
- Only counted limpets > 10mm and aggregate to *Patella spp* (species are separated in the MarClim methodology)
- Aggregate barnacle species for cell frequency counts
- Presence/absence of barnacle *spp* in 1m quadrat; barnacles were identified to species level from close up photographs

Barnacle Monitoring 2003 - Ongoing

From each quadrat in the lower, middle and upper shore 5 photographs were taken using a 5 x 5cm quadrat from random locations within the quadrat on flat areas of bedrock. This provided a total of 20 samples from each shore zone. Species counts were carried out for all individuals > 2mm. All photographs were taken at all sites to obtain a complete record for future use, however the number of sites analysed depended on the time involved in analysing the photographs. So far only the Marclim sites have been analysed.

Limpet Monitoring 2003 - Ongoing

At all shore levels counts of limpet species were made from 5 random cells (20 x 20cm) from within each quadrat giving a total of 20 cell counts. In the middle shore only, the first 200 limpets were measured to the nearest mm. In areas of low density at least 100 limpets were measured.

MarClim Methodology 2003 - Ongoing

The MarClim project (Plymouth Marine Laboratory) offers an opportunity to compare the Skomer shores to the rest of the UK and contribute to the assessment of the effects of global warming.

The MarClim methodology was used at Martins Haven, North Haven and South Haven (see Mieszkowska *et al.* 2002). This involved recording abundances for a selected list of edge of range species, counting barnacles in 5 x 5cm quadrats and limpets in 50 x 50cm quadrats. Timed searches were conducted for *Osilinius 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.

Results

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

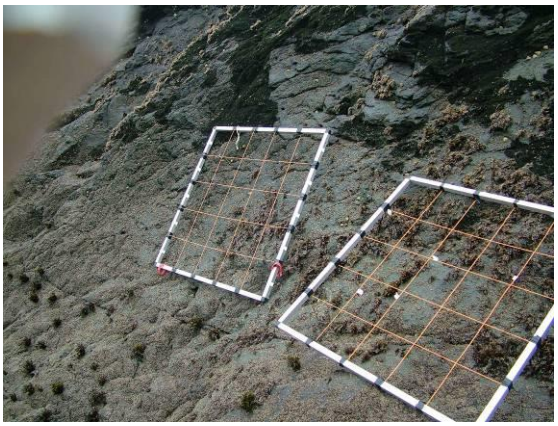
1992: Six permanent transects were established in the MNR and surveyed/ photographed (Crump, 1993).
1992 – 2002: Photographs of the six permanent transects were taken and stored.

1996: Following the Sea Empress oil spill (Feb 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.

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.

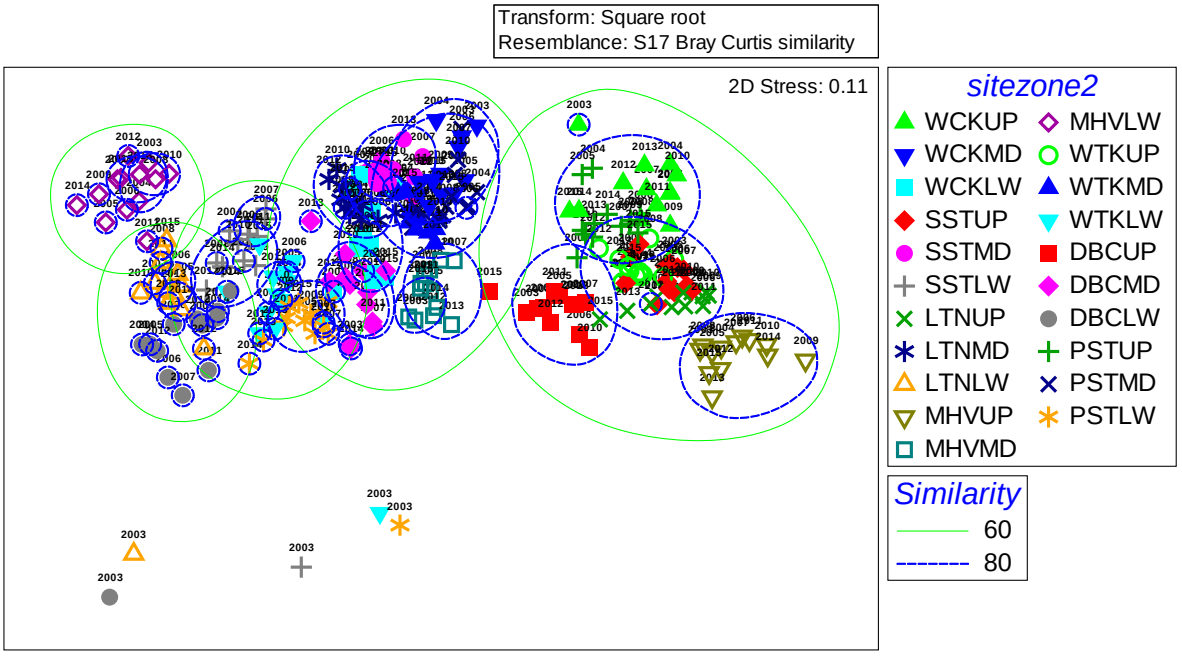


2005: All the sites established in 2003 were resurveyed except for the lower shore at Pig Stone.
2006: All sites were completed.
2007: All sites were completed and temperature loggers were placed at the Martins Haven and South Haven sites.
2008: All sites resurveyed except for Double cliff, upper shore.
2009: All sites completed.
2010: All sites completed
2011: All sites completed
2012 All sites complete except Double cliff (no data for any shore height)
2013: All sites completed
2014: All sites completed
2015: All sites completed

Whole Community Analysis

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

MDS Plot of All Littoral Community Data 2003 – 2015



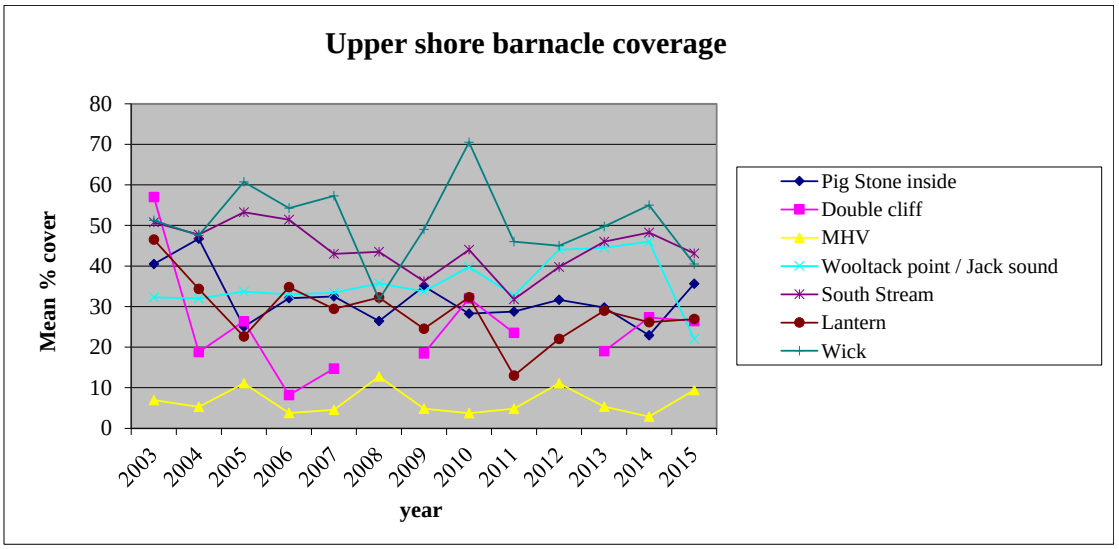
General summary:

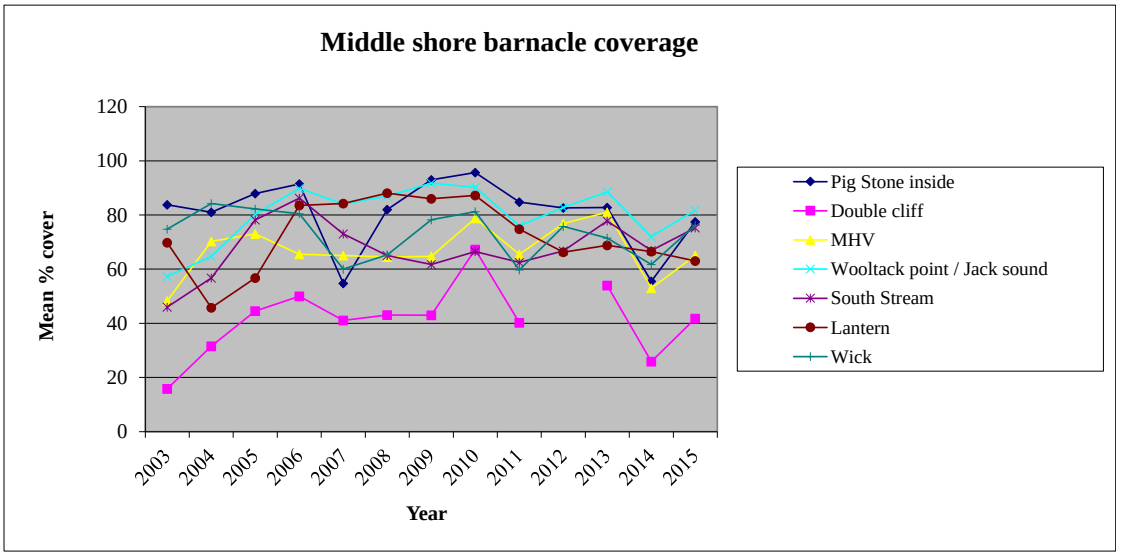
- Upper shores group neatly on the right.
- Lower shore sites are much more disparate and grouped on the left.
- Middle shore sites sit in between with some overlap (60%) with the lower shores.
- Some sites form distinct clusters e.g. MHV Upper, MHV Lower.
- Some sites are very variable from year to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

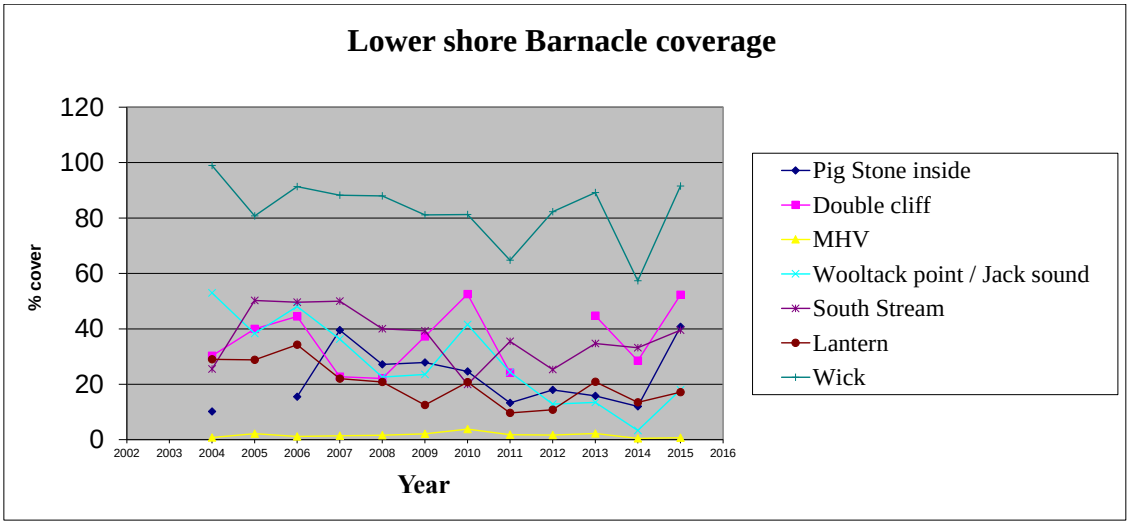
2015 did not show any major variations from the overall trends seen since 2004.

Mean % 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 & lower shores - perhaps due to the extreme weather of the winter of 2013-14. In 2015 barnacle coverage increased in the middle & lower shores.



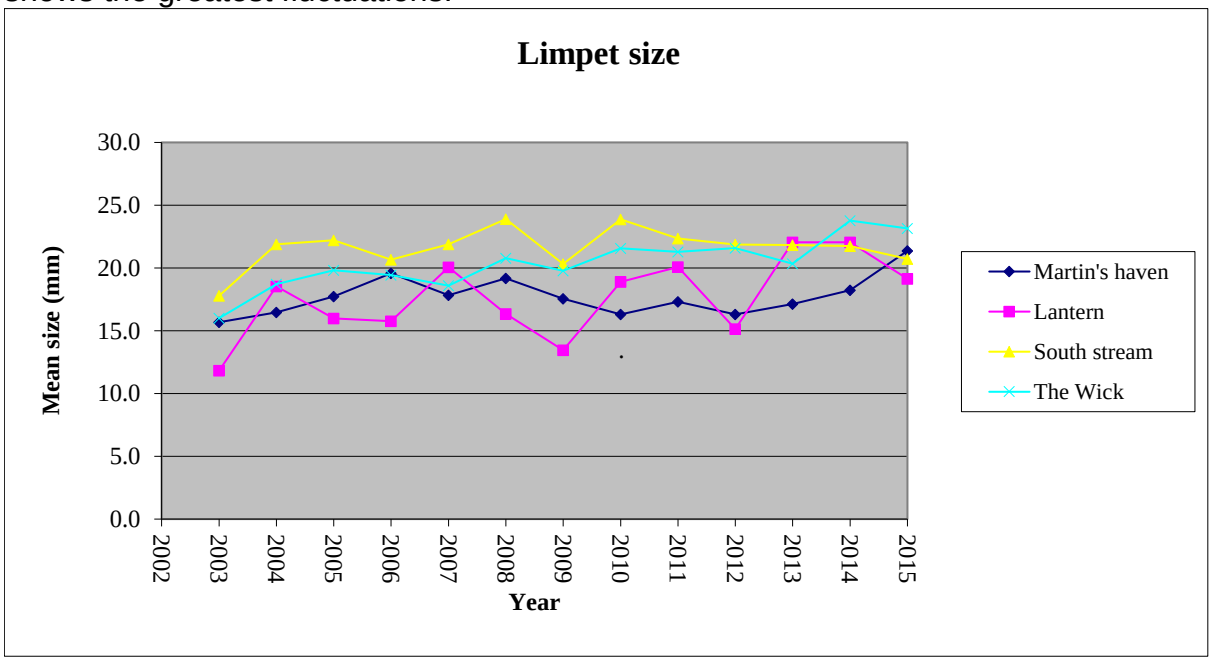




Limpet Size and Counts

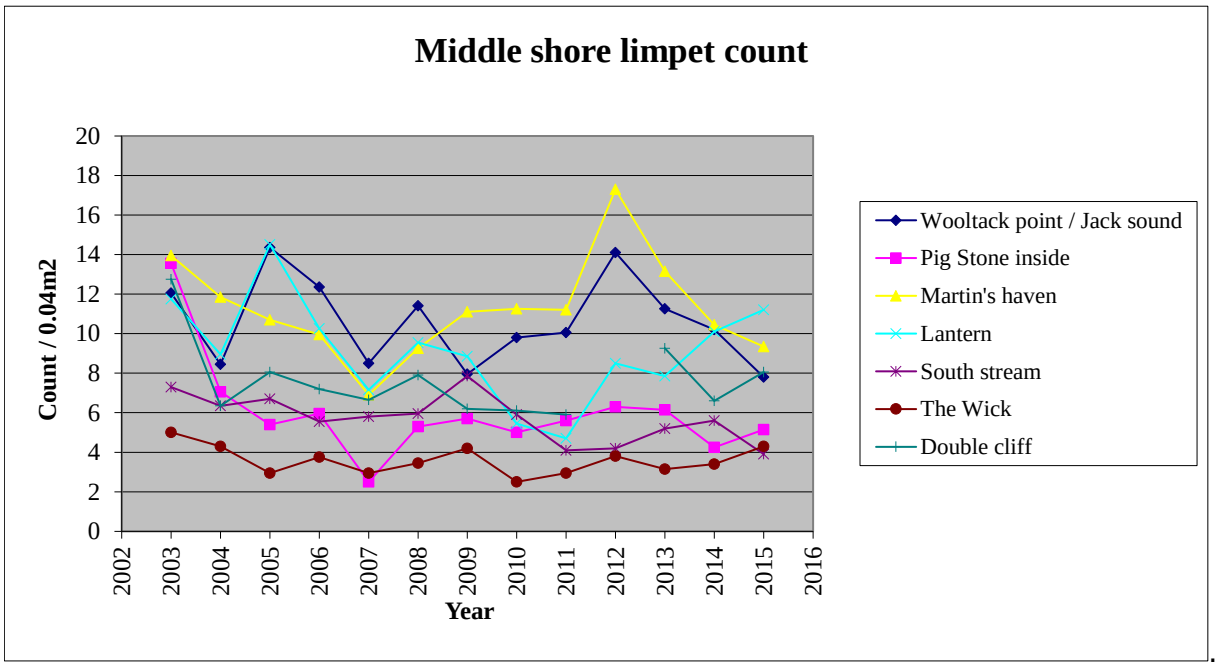
Size of limpets on the middle shore (mm)

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

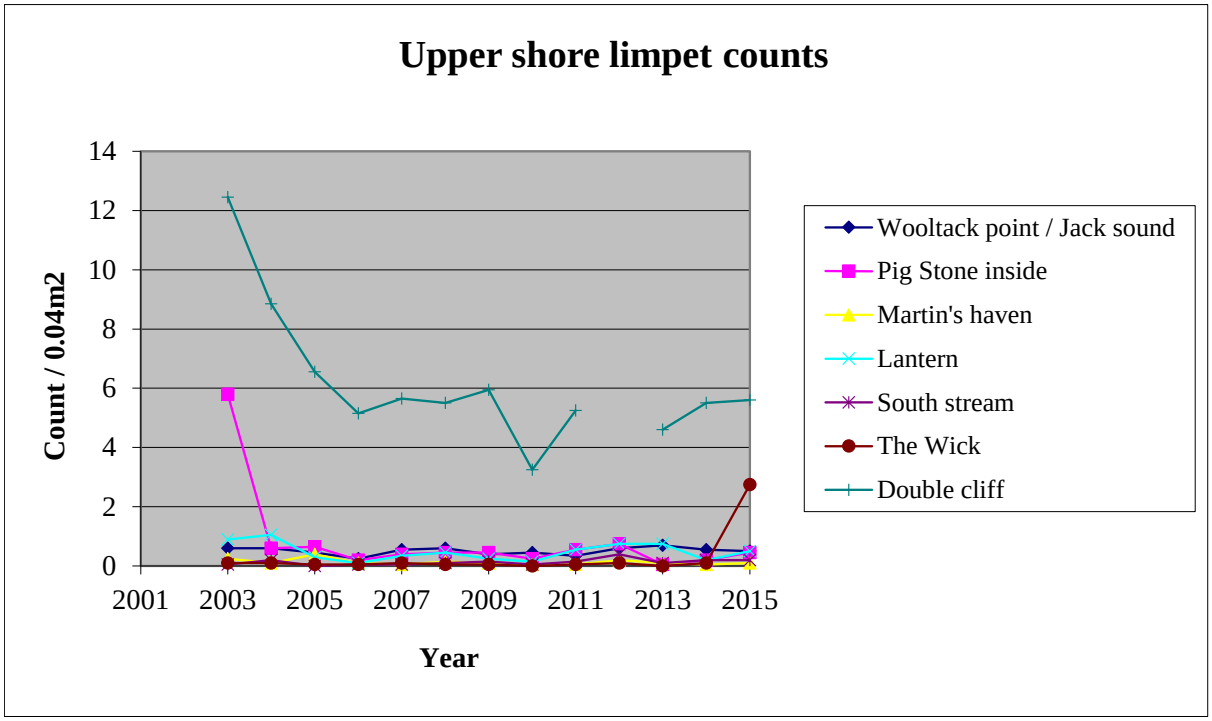


Counts of Limpets from 5 (20 X 20cm) Quadrats

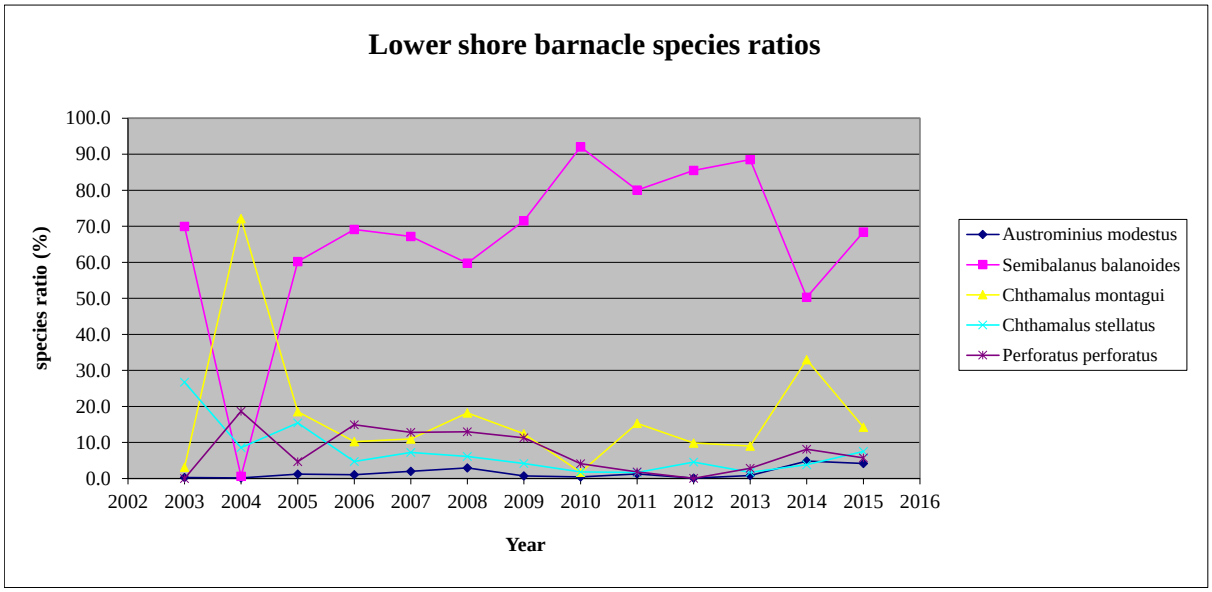
In the middle shore highest numbers of limpets are found on the north facing shores, but these figures tend to be the most erratic. 2007 appears to have had a dip in numbers on 6 of the sites, which all showed an increase the following year. On the middle shore the numbers have been stable from 2009 onwards with an increase in numbers at all sites in 2012 followed by a slight decrease in 2013 & 2014.

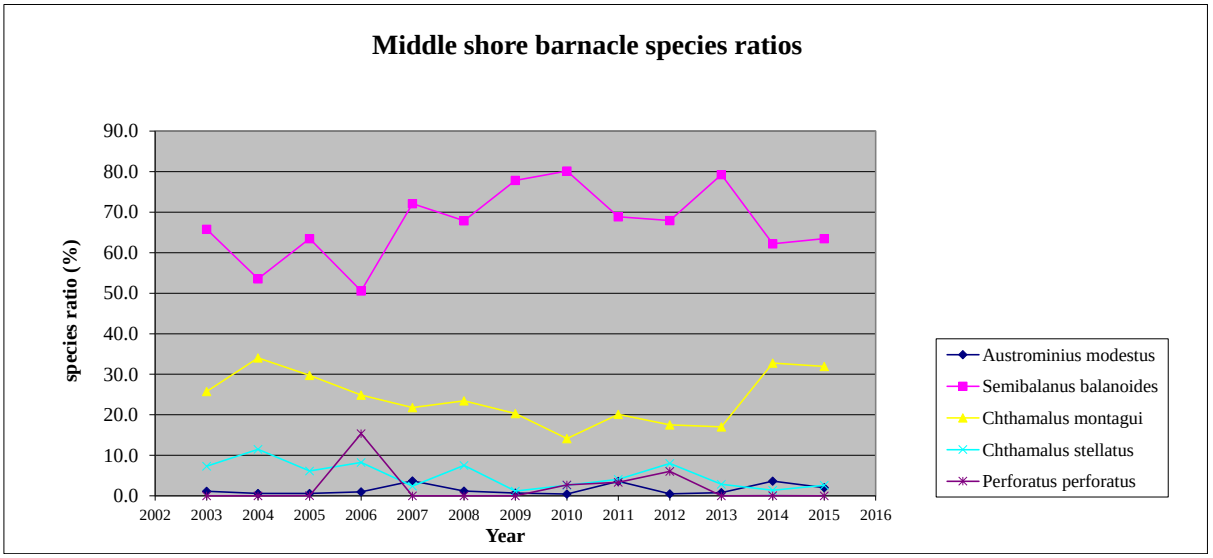


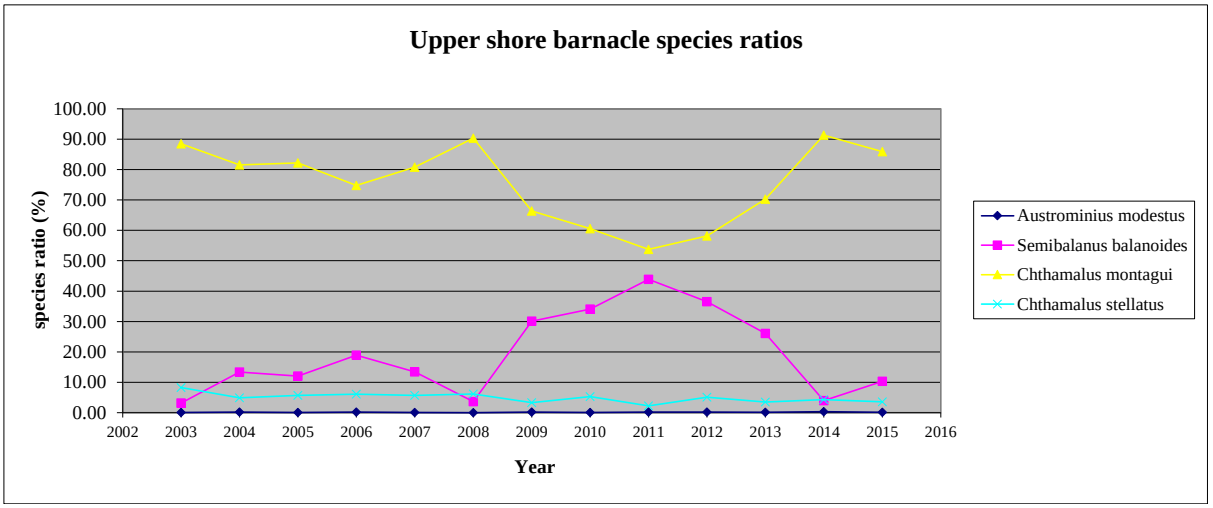
In the upper shore most sites have a low abundance of limpets. Double cliff has significantly more limpets than any other site (north facing shaded cliff) and an interesting declining trend from 2003 – 2006.



Barnacle Species Ratios at the 3 Marclim Sites from Photographs of 5cm X 5cm Quadrats
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 2015 *S. balanoides* numbers increased slightly.







Current Status

The shores appear to be typical of the area.

Recommendations

- Continue full survey annually including MarClim methods at South Haven, Martins Haven and North Haven
- Contract in field support on an annual basis.
- Encourage and support littoral research in the Reserve.

Zostera marina Population
(CMS code: RF23/01)

Status Ongoing. Surveyed every 4 years, (next survey 2018).

Project Rationale
Zostera marina is the only flowering plant within the British Isles that grows and produces seed entirely submerged by seawater. *Z. marina* populations are highly productive habitats and they provide an important stabilising function for the mobile marine sediments. The maintenance of *Z. marina* populations directly influences the associated algal & invertebrate communities that it supports**,** which are an important source of food for birds. *Z. marina* is one of two seagrass species which are listed as nationally scarce and it is on the Section **42** list of habitats of principal importance in Wales as a key requirement of the NERC Biodiversity Duty in the UK.

Objectives
1. To map the boundaries of the *Z. marina* bed.
2. To determine and identify changes in its distribution and abundance.
3. Record conspicuous organisms associated with the *Z. marina* population.

Site
North Haven

Methods
Permanent markers define the corners of a survey plot of 60 x 65 m^2 in North Haven and lead lines marked every 5m are laid for the survey duration. Within the plot area transects are completed every 5m. Every 5 metres along each transects *Z. marina* shoot counts are taken in 6 25 x 25 cm^2 quadrats. The transect lines are continued outside the survey plot where *Z. marina* is present. Quadrat counts are completed along these transects at 5 metres out to 60m.
A boat based GPS unit was used to electronically record the boundary of the *Z. marina* bed as divers with a surface marker buoy (SMB) swam the edge of the *Z. marina* bed.
For detailed methodology see Lock *et al* 2006.

Results
The first mapping studies were completed in 1979, 1980 and 1981 by divers swimming on compass bearings and taking abundance readings at 20m intervals. The results were sparse and patchy and comparison between years was difficult.

1982 A detailed method was devised based on a fixed grid area and used a defined abundance scale this method formed the basis of the survey completed in 1997.

1997 Permanent plot markers established and methods developed for *Z. marina* shoot density and boundary maps (Lock 1998)

1997 Student project was completed by Joanne Trigg: Temporal changes in distribution and abundance of *Z. marina* and possible effects on benthic community structure.

2000 *Z. marina* bed boundary map was completed using GPS.

2002 *Z. marina* shoot density and boundary map was completed following the method established in 2002 and compared maps with those from 1997 (Lock 1003).

2003 A study on the epiflora in *Zostera* beds in Wales, including North Haven was completed (Edwards et al 2003).

2004 A *Z. marina* bed boundary map was completed using GPS.

2006 A *Z. marina* shoot density and boundary map was completed following the method established in 2002 with additional transects every 5m out to the east and west.

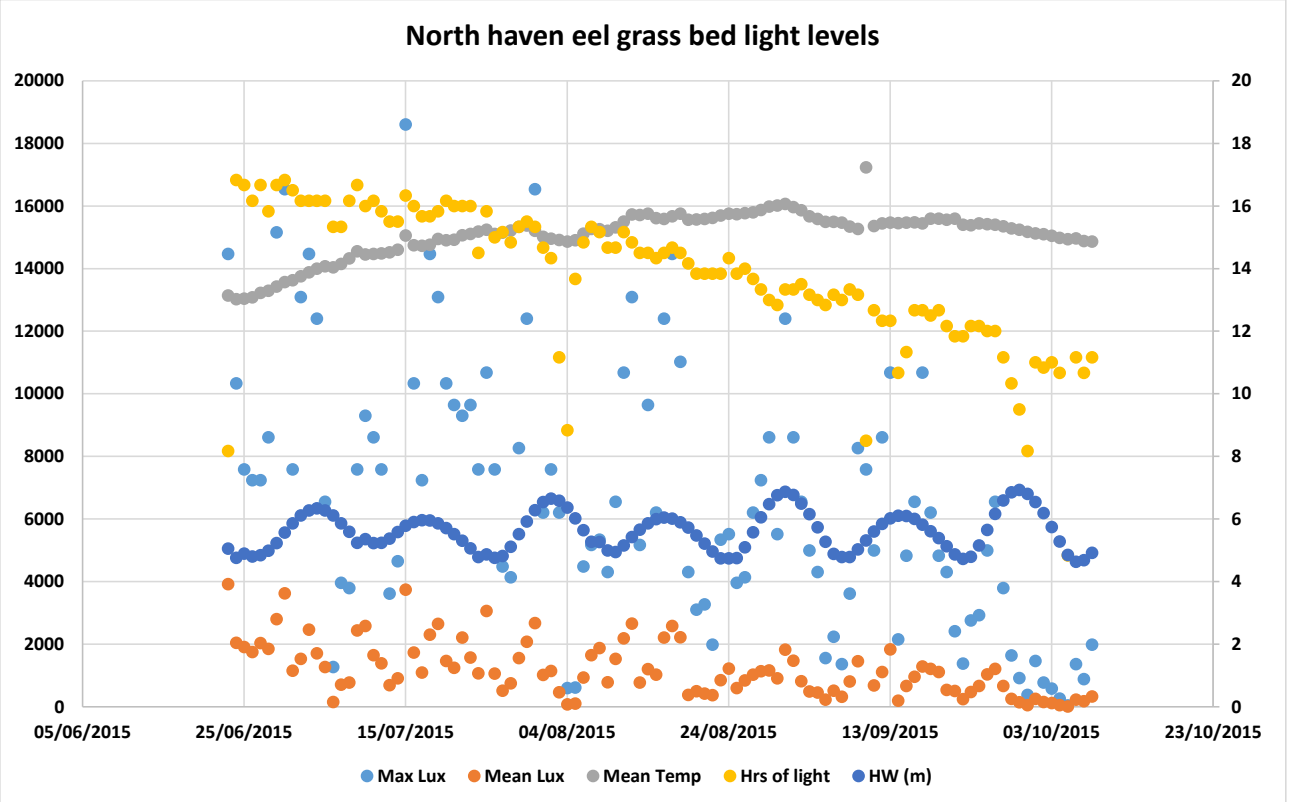
2010 A repeat survey of *Z. marina* shoot density and boundary using the 2006 methodology.

2013 An acoustic survey of the extent of the eel grass bed using a Biosonics DT-X split beam echo sounder.

2014 A repeat survey of *Z. marina* shoot density and boundary using the 2006 methodology and an acoustic survey of extent. See Burton *et al* 2014 for full report.

2015 An acoustic survey of the extent of the eel grass bed using a Biosonics DT-X split beam echo sounder. A trial of the ARIS acoustic system to see if it could detect eelgrass stands. Regular light readings were taken over the eelgrass bed using a Licor PAR sensor. A light logger was also deployed in the centre of the eelgrass bed taking incident light readings (Lux) every 10 minutes.

2015 Light levels & temperature at the North Haven eel grass bed



Acoustic Survey Results

In2015 (10 Sep 2015) a full acoustic survey of *Z. marina* was conducted in North Haven by the NRW Fisheries Assessment Team. They used a Biosonics DT-X split beam echo sounder, with a 7^{O} circular 200 khz transducer, from the vessel "Skalmey". The transducer was mounted vertically on the port side of the vessel and suspended 50cm below the water surface. The DT-X's transmit power was set to -221.0dB, pulse width 0.1ms, ping rate 10ings per second and raw data was collected at -130dB.
GPS data were logged using a Garmin 72 GPS, which was linked to the Biosonics system, and the boat speed for the survey was approximately $10kmh^{-1}$.

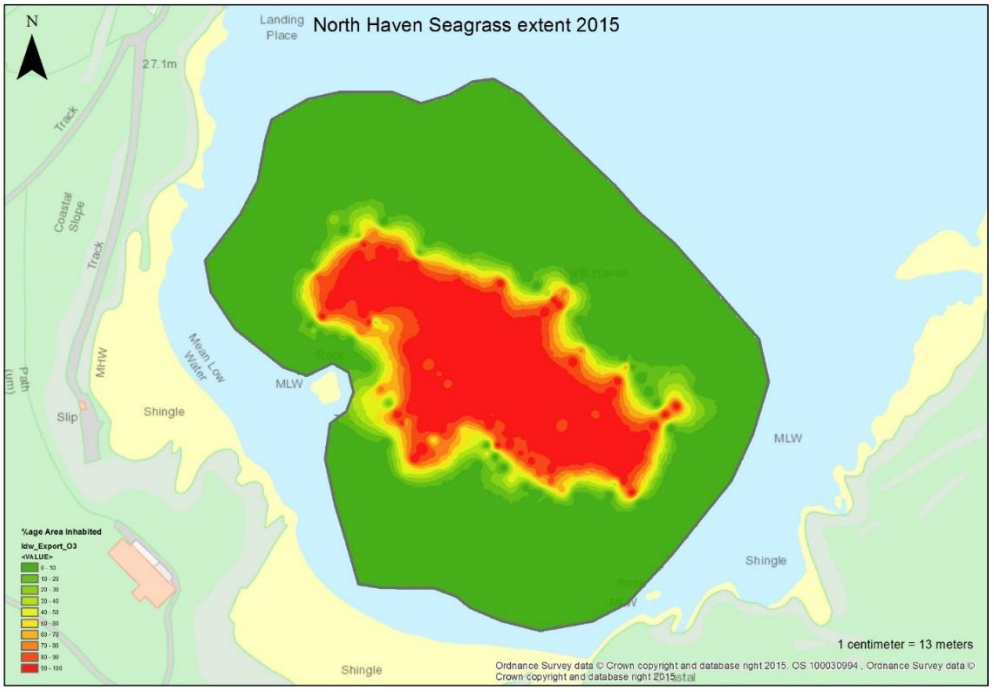
The results suggest the area of the *Z. marina* bed has reduced by approximately 40% compared to the 2014 survey.

Area estimates from diver survey and Biosonic acoustic surveys 1997 – 2015.

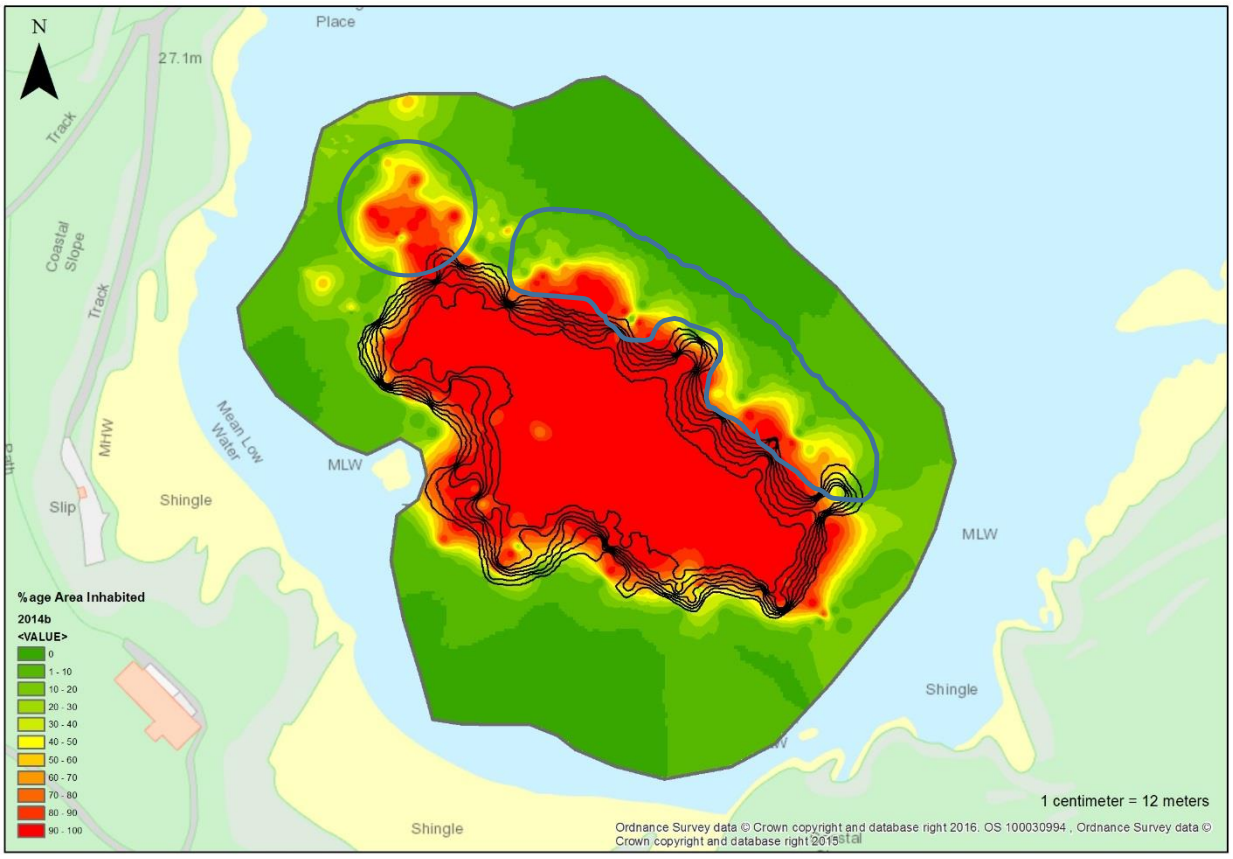
Year	Diver survey - Area m^2	Acoustic survey - 60% PAI (m^2)
1997	6484	
2002	6440	
2006	7587	
2010	8044	
2013		8290
2014	8225	8621
2015		6133

The area of estimate of 6133 m^2 is the lowest in the 18 years of survey.

Results of Biosonic split beam acoustic survey 2015



Comparison of the 2015 boundary overlaid onto the 2014 thematic map.
(Red areas are where eel grass was present in 2014, the black lines are the boundary contours for the 2015 acoustic survey)



Areas outlined in blue are where the most obvious loss of eel grass can be identified. These are at the northern limit of the bed.

It is not clear why the bed is so much smaller in 2015 compared to 2014. The 2014 acoustic map and diver survey match up very well so we can have some faith in the acoustic method. There are many possibilities which need further investigation;

- Data processing error – Fisheries Assessment Team have re-run the analysis and found no obvious errors.
- Eel grass was missed by the 2015 acoustic survey – MCZ team to ground truth the northern boundary in 2016 to see if eel grass is present early in the season. Early surveys with a drop down video camera suggest eelgrass is present in the “missing areas” but very sparse – perhaps too sparse to be detected by the acoustic system.
- Seasonal change – 2015 survey was done in September instead of August (2014) the diver survey is usually done in July– it is possible that the eel grass shoots die off late in the season.
- Light levels restricted growth - 2015 was a poor summer for weather but underwater visibility was good. There are light readings for 2015 taken directly above the eel grass bed but there is no other data set to compare to.

Trial of ARIS acoustic equipment

A brief trial was completed using ARIS sonar imaging equipment. This method produces an image of the sea bed rather than a series of echo returns. These images may be very useful in discriminating eel grass in areas of mixed sea bed. It may also allow for an estimate of density or patchiness. It is a method that is still in development. The data was sent to Girona University who produced a mosaic image from the raw data.

Example of a mosaic image from the 2015 ARIS survey.

It will be possible to geo-register these images (i.e. map them) which would mean the image could be overlaid onto the Biosonics acoustic data which would help ground truth the data.

Targets

The population of *Z. marina* in North Haven is to maintain favourable conservation status where:

- The 2014 Area estimate of 8224.6m^2 is well above the Lower Specified limit of 5500 m^2
- The 2014 Shoot Density is 35.1 shoots/ m^2 This is lower than the Lower Specified limit of 36.0 (+/- 3.14 95% confidence interval) but does not differ significantly to it.
- 2015 Acoustic survey estimated the area of Eel grass to be 6133m^2 which is above the Lower limit but still a 40% reduction needs investigating.

Recommendations

- Continue the 4 yearly in-situ diver survey and maintain the continuity of data.
- Continue with an annual acoustic survey of the eelgrass bed for area of extent.
- Check the boundary areas of the bed with a drop down video to confirm acoustic results.
- Ground-truth the bio height results from the acoustic survey with in-situ records.
- Develop an annual project to monitor shoot density, plant health and surveillance of environmental factors to allow some conclusions to be drawn about changes in shoot density.
- Link in with other research and monitoring projects for eelgrass around Wales and the UK (see Unsworth 2014).
- Start monitoring C:N & C:P ratios along with measurements of leaf area.

Sponge Assemblages
(CMS code: RM13/01)

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

Project Rationale
The sponge communities at Skomer MCZ have been identified as rich and diverse with around 120 species, some of which are known to be undescribed. Six are nationally scarce species and eight 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.

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

Sites
- Thorn Rock (annual transects , fixed quadrats and species survey)
- Wick and High Court Reef (species survey 2011, 2015)
- 2009 onwards – other digital images were used to assess the sponge assemblages around the MCZ.

Methods
Transects: Four fixed transects are located at Thorn Rock. Photographs are taken from fixed positions along the transect using a stereo camera set up on a 50 x 70cm frame. The slides are analysed using a stereo viewer to count the abundance of sponge species and morphology types.

Species survey: In 2003 all sponge species were identified in 16, 50 x 70cm quadrats positioned close to the four fixed transects at Thorn Rock. In 2007 survey onwards no quadrats were used, survey 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 15 1m^2 quadrats were marked out at three of the four fixed transects at Thorn Rock. The quadrats each consist of 25 cells (20 X 20cm), which are photographed using a digital camera three times between March and October.

Results

Transects:

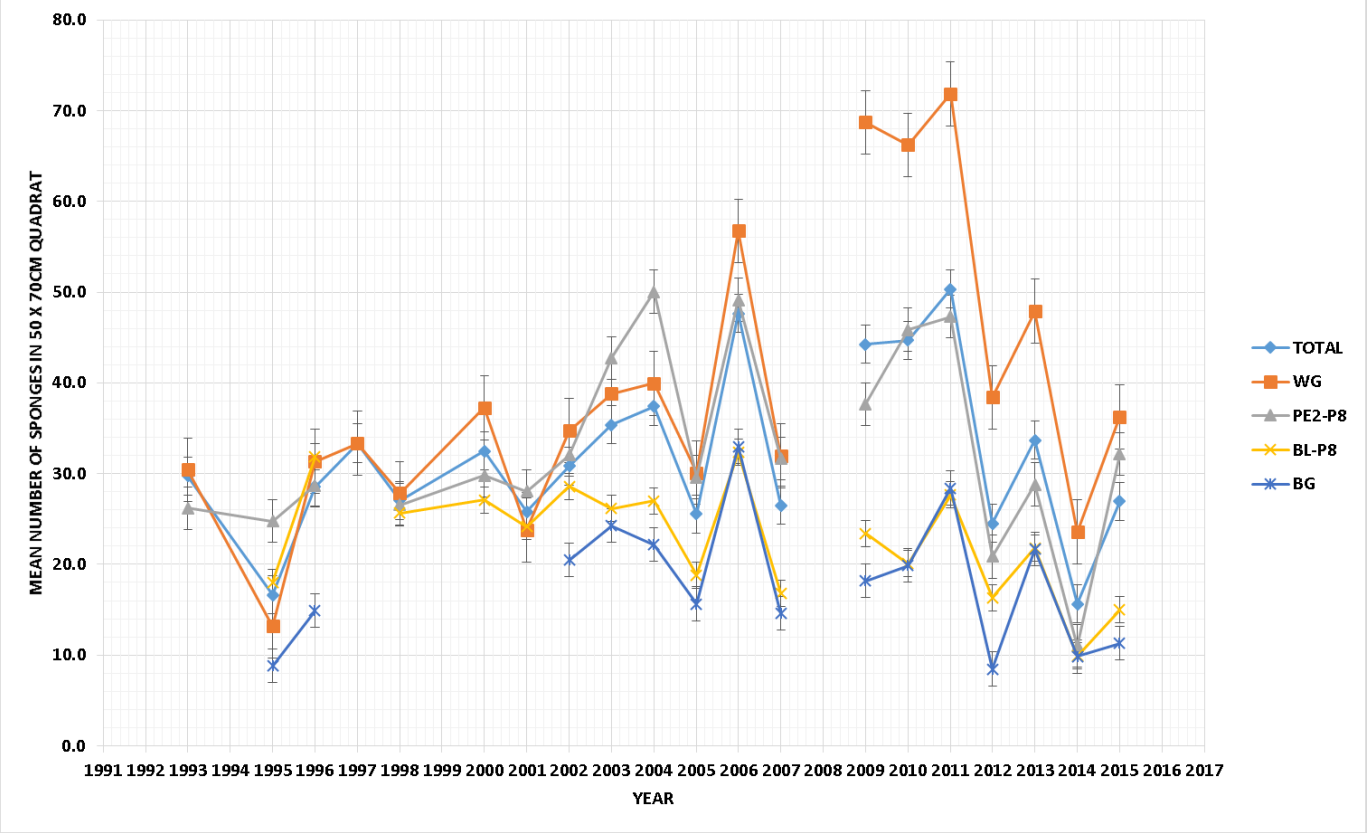
Data gathered from Thorn Rock sponge transects 1993 to 2015:
(Windy Gully =WG, Spongy Hillocks =SH, Broad Gully =BG, Dogleg = DL)

Year	No of samples	Transects
1993	24	WG
1995	77	WG, WG, BG, DL
1996	72	WG, WG, BG, DL
1997	20	WG
1998	60	WG, SH, DL
2000	63	WG, SH, DL
2001	62	WG, SH, DL
2002	81	WG, WG, BG, DL
2003	79	WG, WG, BG, DL (Species survey for WG & SH)
2004	80	WG, WG, BG, DL
2005	80	WG, WG, BG, DL
2006	79	WG, WG, BG, DL (Seasonal quadrats photographed in Oct at BG, SH, DL)
2007	81	WG, WG, BG, DL Seasonal quadrats photographed in May and Sep at BG, SH, DL. Species survey conducted throughout the year at WG, SH, 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 Species survey for WG, SH ,DL & BG Surveys were also completed at: The Wick & High Court Reef
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

Sponge Morphology Analysis

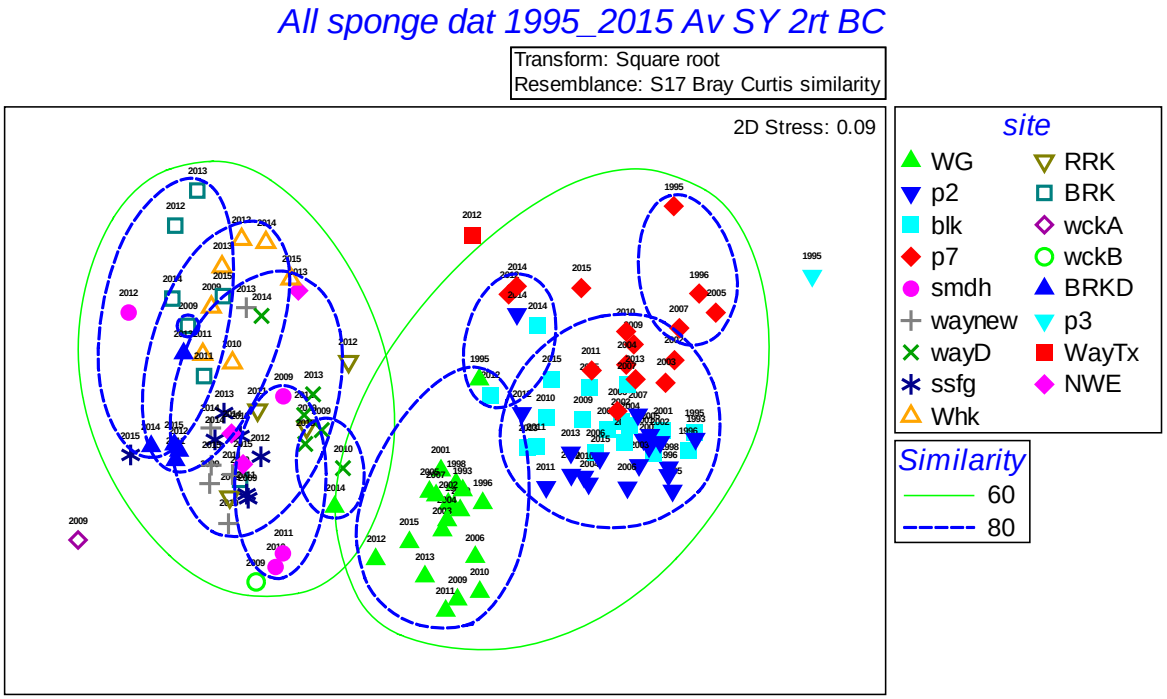
A simple way of assessing sponge assemblages is to classify them into morphology types (see Bell 19**). This method has been used for all the quadrats taken at Thorn Rock and for a series of sites around the MCZ where comparable quadrat photos are taken. The data can then be graphed or analysed using the Primer multivariate analysis software to compare similarity between sites.

Mean number of sponges counted in each quadrat at 4 sites –Thorn Rock 1993-2015



The improvement in the image quality & resolution has meant that more sponge entities have been recorded from 2009 onwards than in previous years. However in 2012 & 2014 there is a noticeable drop in the numbers of sponges that can be seen across all of the transects. In 2013 & 2015 all transects showed an increase in abundance of visible sponges. This will be due to the variation in image quality – wafting the surface sediment away would improve consistency but does compromise the comparability of the whole data set.

MDS Plot of Sponge Morphology Data Averaged to Site & Year 1993 – 2015



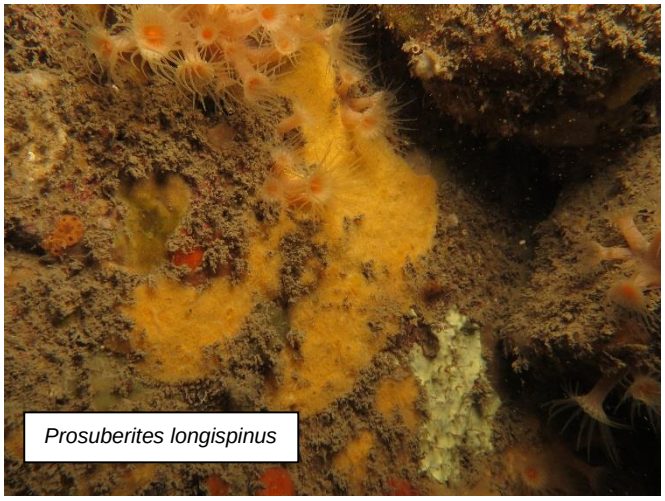
The plot shows that the Thorn Rock sites all group together on the right hand side of the plot (sim 60%) with Windy Gully (WG) forming a distinct cluster at the bottom (80%). Spongy Hillocks (Blk), DogLeg (P2) Broad Gully (P7) generally clustering together but with a few years throwing out some outlying clusters.
Windy Gully is a vertical rock face, the other sites are all horizontal.
The years 2012 & 2014 are often responsible for the small outlying groups – these years had poor quality photos and sponge numbers were down.

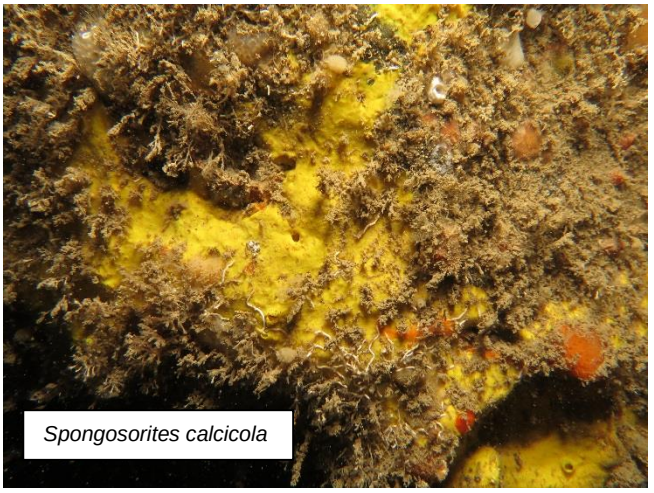
The large cluster on the left (60%) comprises the other sites around Skomer. These form 5 distinct clusters at 80%. The 2 in the top left corner are from *Pentapora* quadrats taken on horizontal substrates. The others are mainly from quadrats taken on vertical rock faces.

Species Survey 2015
In 2015 six sites were surveyed on the south side of Skomer as part of the continuing full species monitoring programme, completed every 4 years.

This survey resulted in a total of 67 species/entities being recorded from 125 samples over 15 dives. Of these, two species, *Prosuberites longispinus* and *Spongosorites calcicola*, have not been recorded in previous surveys while nine are undescribed/new to science.

Two species notable by their absence were *Paratimea constellata* and *Hymeraphia stellifera*. These have consistently been found in previous surveys, however both are very small thin crusts and can be easily overlooked so it is likely they are still present.





The most frequently recorded species were *Cliona celata, Dysidea fragilis, Hemimycale columella, Pachymatisma johnstonia*, and *Stelligera stuposa*.

The Wick proved to be the richest individual site in terms of number of species found and the Thorn Rock location (4 sites) had the greatest overall diversity.

A total of 128 sponge species (31 of these still to be described to species level) have now been recorded in the Skomer MCZ.

Supported Research

Microbial community profiling of healthy, fouled and black sponges (*Cliona sp*.) from Skomer MCZ, Wales. Dr Joanne Preston, University of Portsmouth.

In 2012 necrotic (black) individuals of *Cliona celata* were seen at Bull Hole. Since then this diseased form of *Cliona* and fouled *C. celata* have been seen at various sites around the Reserve. Samples of healthy, fouled & diseased *C. celata* have been sent to Portsmouth University for microbial analysis.

A report summarising the results so far can be found in Appendix 1.

Recommendations

- Continue transect photo-monitoring programme at Thorn Rock and continue application of morphology method for analysis of photos.
- Thorn Rock has the greatest diversity of sponge types found within the MCZ. Other useful sites to collect morphology data from would be areas on the West side of the island. Expand method to sites outside of the MCZ. This will provide improved 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 Reserve;
- Continue sponge species recording every 4 years, next survey due 2019.

Eunicella Verrucosa: Population and Growth Rate

(CMS Code: RM23/01)

Project Rationale

The pink sea fan *Eunicella verrucosa* (Pallas) is a Lusitanian anthozoan soft coral nearing the northern limit of its distribution in North Pembrokeshire. It is a UK Biodiversity Action Plan Species on Schedule 5 of the Wildlife and Countryside Act 1981. Sea fans are a slow growing, erect species susceptible to permanent damage. Recovery and reproduction rates are thought to be very slow.

Objectives

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

SITES	Date started
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)

Methods

Photographic monitoring using a single camera on a 50 x 70 cm frame. Both sides of the sea fan are photographed and each fan is visually inspected for damage, fouling by epibiota, entanglement with man-made materials, necrosis (loss of living tissue) and the nudibranch *Tritonia nilsodhneri* Marcus, 1983 and *Simnia patula* (Pennant, 1777).

Results

Image analysis

- 1997 methods were developed using MapInfo software.to study the fan area and branch length to assess growth (S. Burton (nee Gilbert). 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 2015 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 improve photo analysis

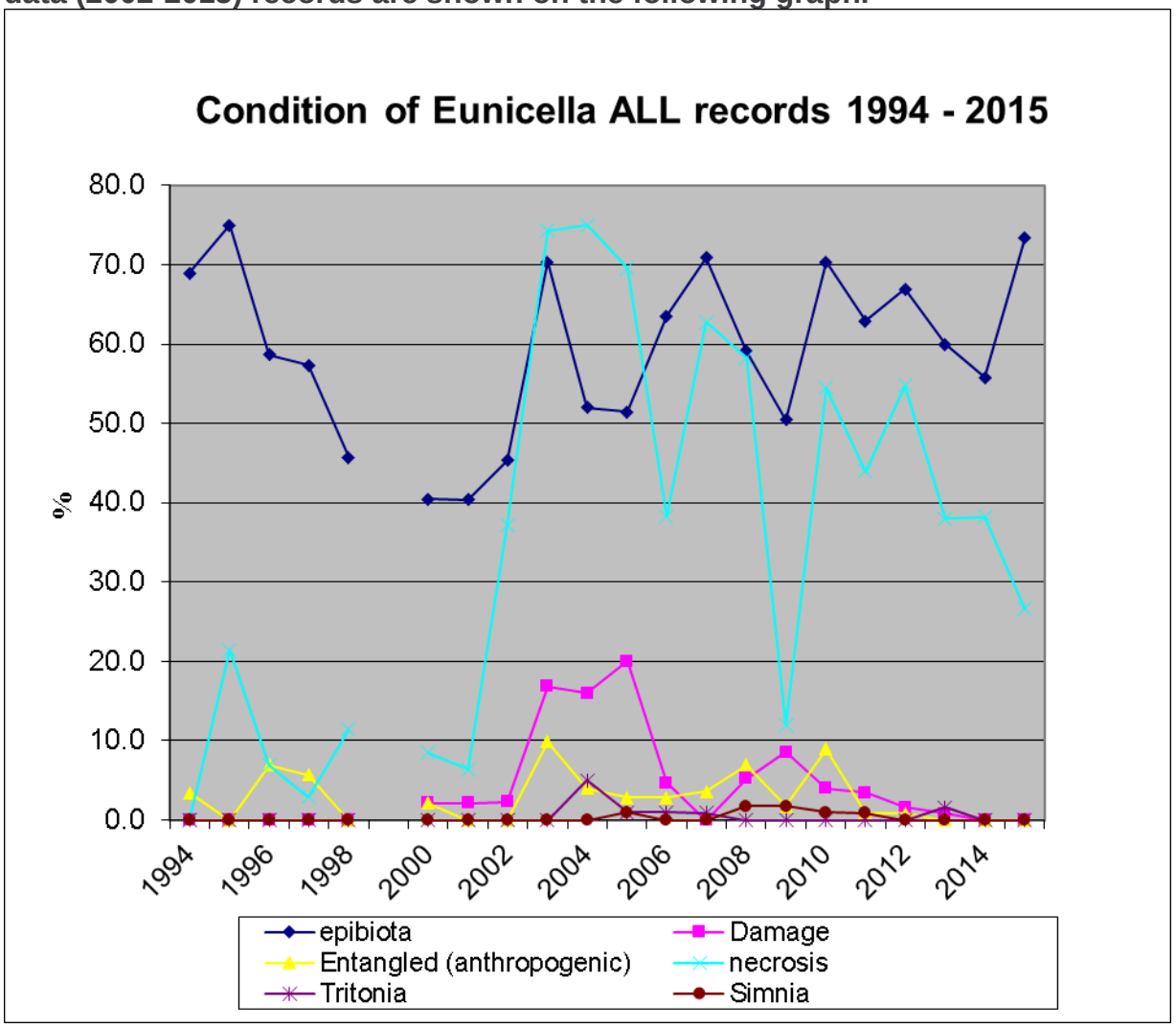
Survey results 1994 -2015:

year	Sites surveyed	Total fans recorded	Total natural fans	Total attached	New recruits (babies)	Natural fan Losses (confirmed)	Attached fan losses	Missing (to be
1994	3	30	30					
1995	3	29	29			1		
1996	3	29	29					
1997	4	35	35					
1998	4	35	35					
1999	0							
2000	5	50	50					
2001	5	52	52			1		
2002	9	81	80			1		
2003	9	95	94		1			
2004	9	97	96					
2005	10	110	107	3	1	1		
2006	10	115	112	3	7			
2007	10	117	114	4	1	2		
2008	10	122	118	4		1		
2009	10	124	117	7				
2010	10	122	116	6		3	1	
2011	10	121	117	4			2	
2012	10	121	116	5		1		
2013	10	121	116	5				
2014	9	118	114	4			1	
2015	10	121	119	2		1	2	3
totals					10	12	6	3

In 2015 there was one confirmed loss of a natural (i.e. not artificially reattached) fan, NWA13, last seen in 2013. Three other fans were absent, BHO6, SSF22 and WAY16. Their status will be checked again in 2016 and any losses confirmed. Some fans can become very encrusted and hidden in seaweed making it difficult to find so no loss is confirmed until it can be checked the following year; for example this year SSF23 was found again after 3 years of not being recorded.

The cluster of 5 baby fans at Bull Hole are all present but very little growth has been observed since 2006 when they were first found. No anthropogenic damage to fans was recorded in 2015.

Condition of sea fans in the Skomer MCZ from photo images (1994- 2015) and field data (2002-2015) records are shown on the following graph.



Necrosis:
Necrosis is where dead tissue leaves just the black fan 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 to support assessment field recording of necrosis and the other condition parameters started in 2002. Since 2008 image quality has significantly improved with the use of an SLR digital 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 38% and 55% for the following 5 years, in 2015 necrosis reduced again to 26%. The average level of necrosis since 2002 (14 years) is 48%.

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 some damage to the sea fan tissues. An annual average of 60% of sea fans have been recorded with attached or entangled epibiota for the last 14 years of surveys. In 2015 this was on 73% of the fans.


Rob Spray

Entanglement (anthropogenic)
Fans have been found with fishing line entanglement and 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 2015.

Damage
Damage can be caused by entanglement of fishing line or epibiota resulting in large areas of necrosis. In addition fans have been damaged when dislodged off the rock, in some cases they are found nearby and an attempt is made to re-attach artificially. In 2015 no damaged fans were recorded although 3 fans could not be found and may have been knocked off the rocks, these will be confirmed in 2016.

Tritonia nilsodhneri or *Simnia patula*
Very low numbers of these species have been recorded over the years and in 2015 none were found.

Supported research

- 2002 Reef Research: Seafan 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.

- 2007 Plymouth and Exeter Universities : 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 results showed that the Skomer fans are not genetically distinct but they form part of a general southwest Britain regional group. 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.

Current Status

- Numbers: There have been 14 confirmed sea fans lost from the monitoring sites between 1994 and 2015 and there are 3 further possible losses in 2015.
  There were no new recruits (baby fans) found in 2015.

- Condition: Necrosis occurrence was found in 26% of the sea fans, this is below the average of 48% recorded for the last 14 years.
  Epibiota was recorded on 73% of the sea fans; this is above the average of 60% recorded for the last 14 years.

Recommendations

- Continue annual photographic monitoring programme;
- Complete field records for each colony, recording damage, man-made entanglement, necrosis, levels of epibionts and numbers of *Tritonia nilsodhneri and Simnia patula;*
- Observe persistence of biotic fouling/entanglement e.g. dogfish eggs;
- Search for new recruitments at established sites;
- 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;
- Support research work on the biology of sea fans

Alcyonium glomeratum Population
(CMS Code: RM23/03)

Status
Ongoing Annual sampling.

Project Rationale
Alcyonium glomeratum (red sea fingers) is a Lusitanian species near to its northern limit of distribution. Colonies are long-lived and possible indicators of climate change.

Objectives
To monitor colony area and to look for damage and disease.

Sites	Established
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)

Methods
North Wall Stereo: three quadrats (50 x 40cm) are photographed using stereo photography. At all other sites photographs (mono) are taken using a 50 x 70cm framer. Each site follows either a sequence of photos or transects that are prescribed in site relocation pro-forma.

Site	Sequence
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

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 details.

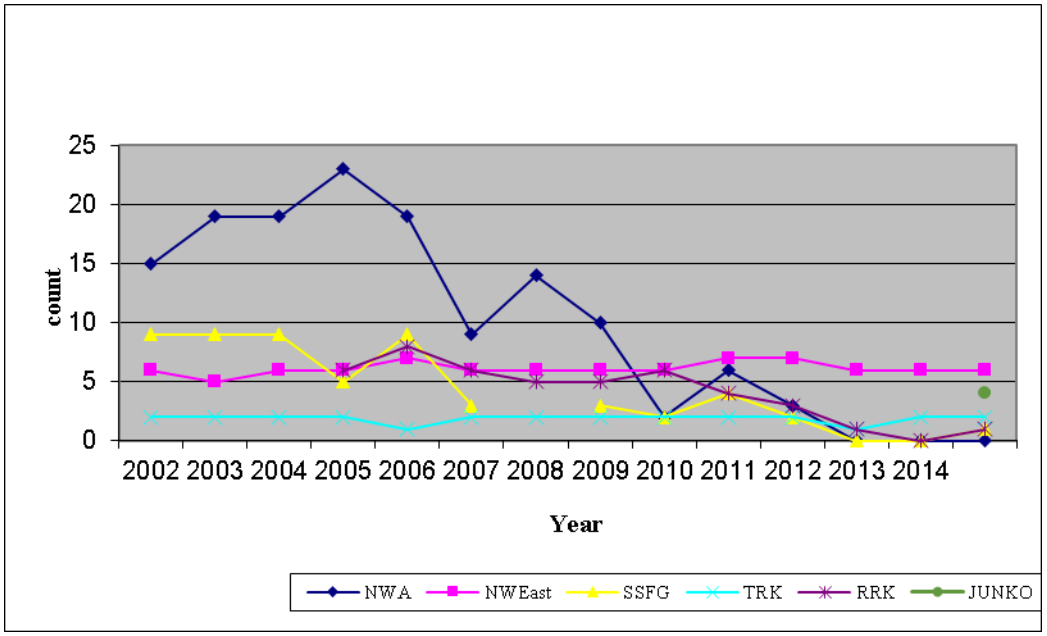
Results

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

Number of quadrats with *A. glomeratum* present.

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

Graph of the number of quadrats with *A. glomeratum* present 2002-2015

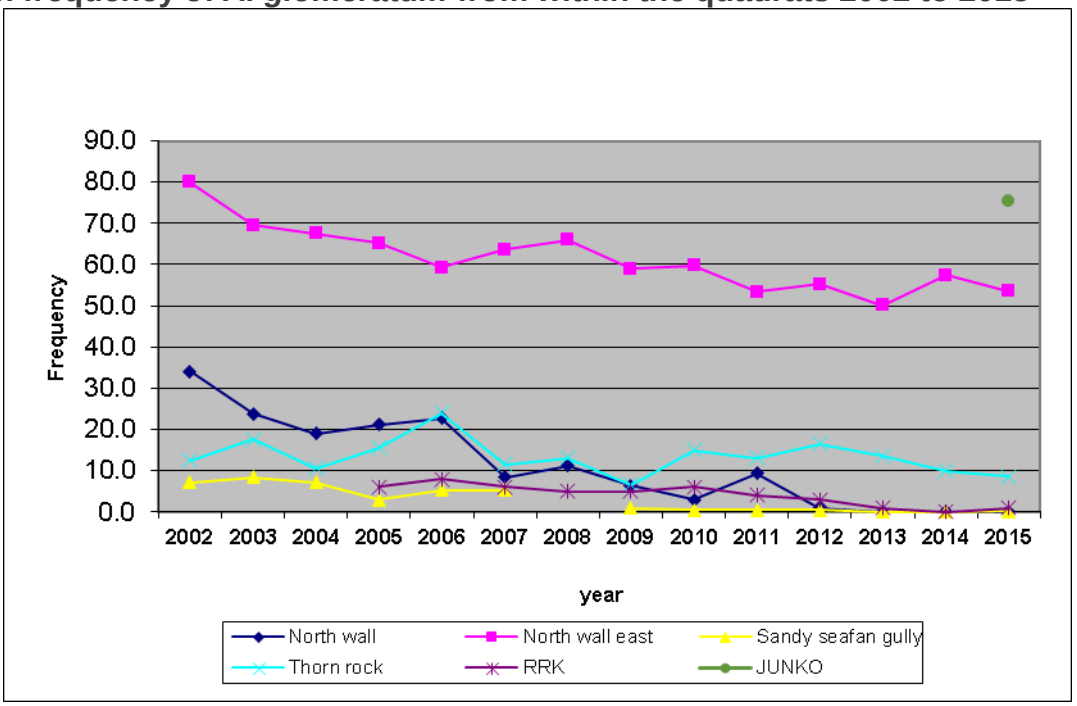


All sites except *NWA East* show a decreasing trend in the coverage of *A. glomeratum* colonies. In 2013 & 2014 *NWA & SSFG* had no visible colonies of *A. glomeratum*. RRK & SSFG had 1 visible colony in 2015.

Mean Frequency count from quadrats with *A. glomeratum* occurring

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
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
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
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
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
RRK				5.3	10.3	8.0	9.8	10.0	7.2	4.8	3.3	14.0	0.0	0.1
JUNKO														75.3

Mean frequency of *A. glomeratum* from within the quadrats 2002 to 2015



The frequency of *A. glomeratum* colonies decline at all sites.
In 2015 no colonies at all were seen at North wall while Sandy seafan gully and Rye Rocks had just a single colony each. Junko's reef was photographed for the first time, an average of 75 colonies were found in the 4 quadrats surveyed.

Current Status

The distribution of *A. glomeratum* at the monitoring sites is declining. North Wall East and Junko's reef have sizable colonies of *A. glomeratum*. North wall & Sandy seafan gully now have no visible colonies.
Junko's reef site was established in 2015, searches for further colonies of *A. glomeratum* are required to expand the monitoring within the MCZ.

Recommendations

- Continue with monitoring at all established sites and establish new sites.
- Improve site marking to allow accurate relocation of quadrats.
- Analyse photographs to assess what species have replaced the lost colonies of *A. glomeratum.*

Parazoanthus axinellae Population

(CMS code: RM23/05)

Status

Ongoing, annual sampling.

Project Rationale

The population of *Parazoanthus axinellae* (yellow trumpet anemone) is an important feature of Skomer MCZ. *P. axinellae* is a Lusitanian (south-western) species near to the edge of its range and may act as an indicator of climatic change.

Objectives

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

Sites

- Sandy Sea Fan Gully
- Sandy Sea Fan Gully Buttress (2015)
- Thorn Rock (3 colonies)
- Way Bench (2 colonies)

Methods

Density Estimates:

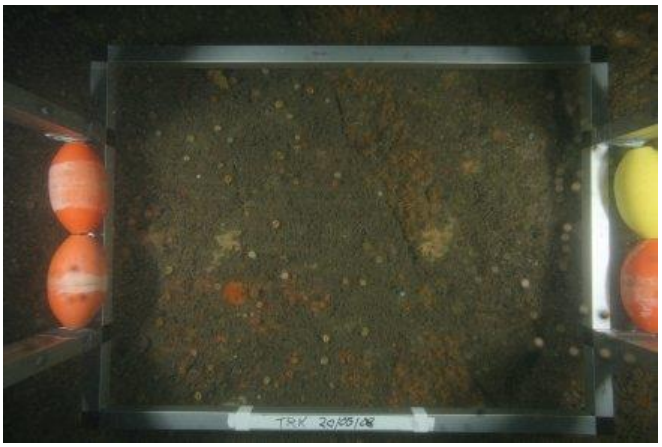
Close-up photographs are taken using a digital camera. The digital camera is mounted on a 20 x 20cm framer. *P. axinellae* polyps are counted in each quadrat.

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.

Density: 20 x 20cm framer

Colony area: 50 x 70cm framer

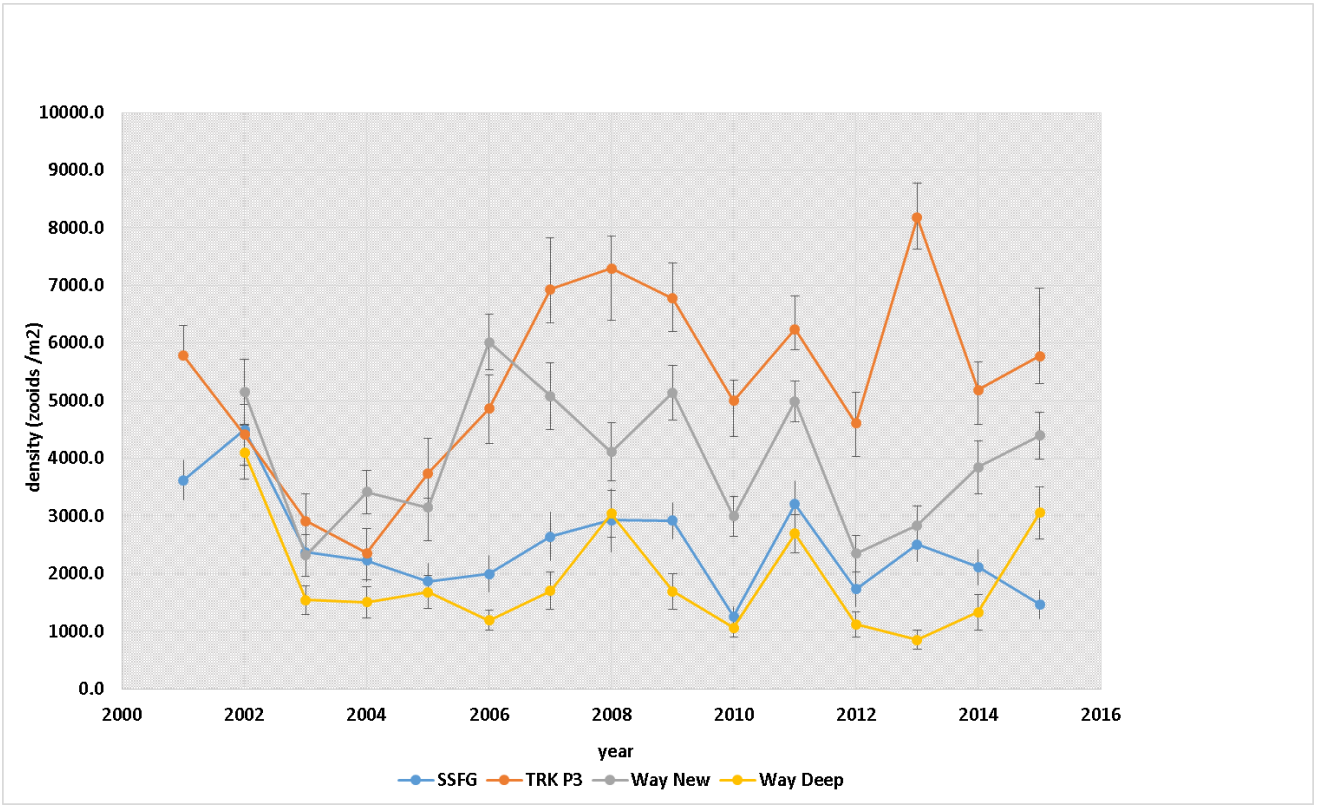


Results

2015 fieldwork completed:

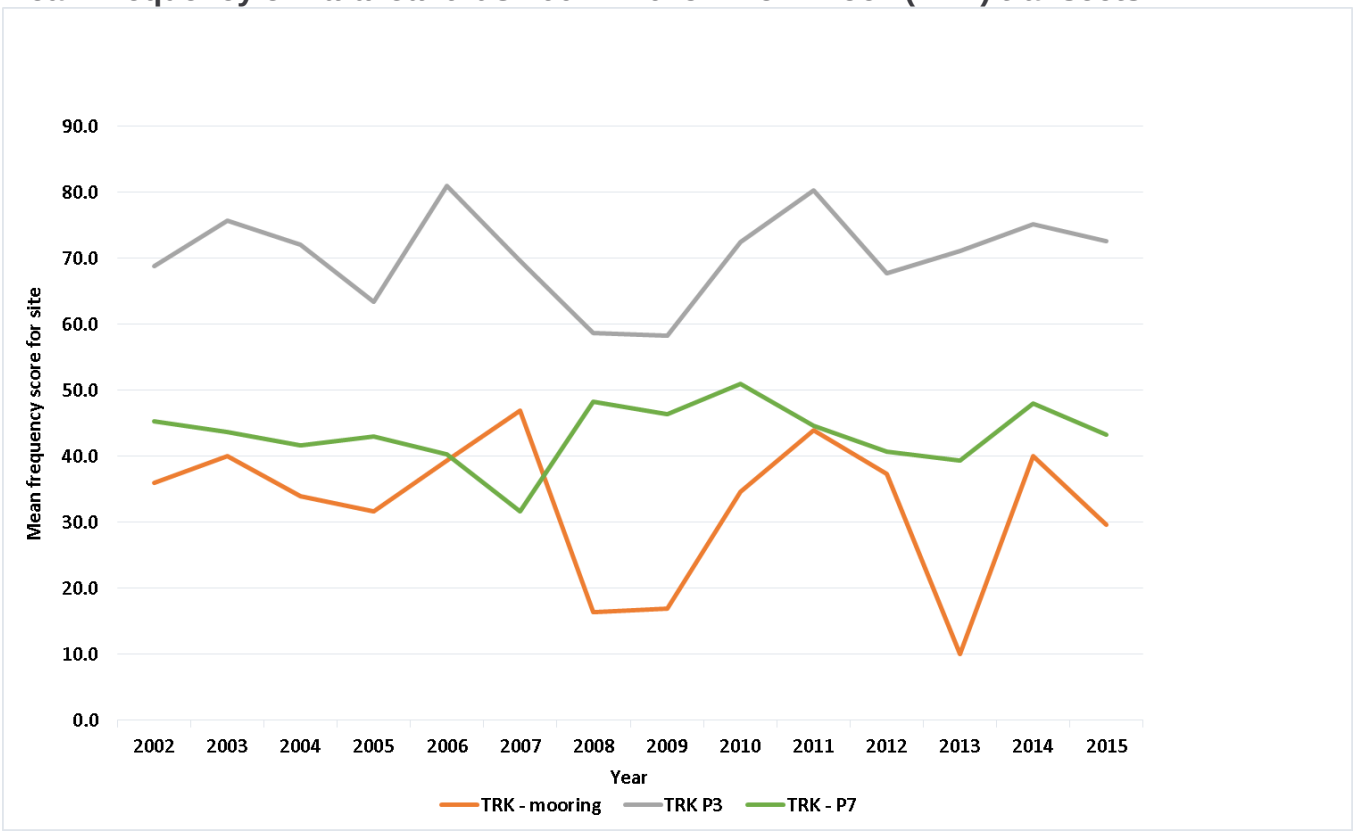
Colony area		Density
Site	**Index of Area**	**Close up photographs**
Sandy sea fan gully	5 transects (20 samples)	Yes
Sandy sea fan gully Buttress	11 re-locatable samples	Yes
Waybench – *New Wall*	9 re-locatable samples	Yes
Waybench – *Deep Wall*	2 transects (8 samples)	Yes
Thorn Rock – *Piton 7*	3 re-locatable samples	Yes
Thorn Rock - *Mooring*	3 re-locatable samples	Yes
Thorn Rock – *Piton 3*	3 transects (11 samples)	Yes

Density of polyp (numbers of polyps /m²) 2001 – 2015

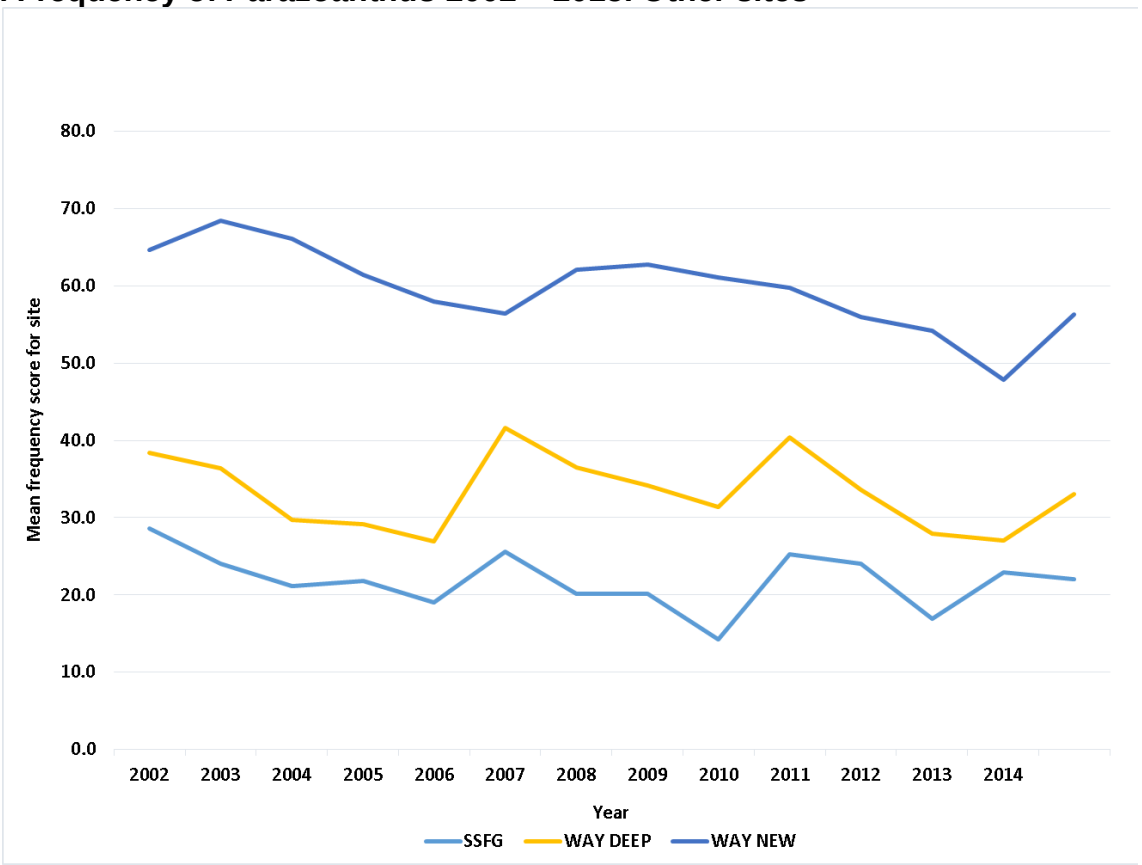


Thorn Rock P3 has returned to similar values seen in 2010 & 2012.
The Way Bench sites have seen a continued increase while Sandy Sea-Fan Gully (SSFG) has continued to decline.

Mean Frequency of *Parazoanthus* 2002 – 2015. Thorn Rock (TRK) transects



Mean Frequency of *Parazoanthus* 2002 – 2015. Other sites



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

Current Status
- All the colonies are still present.

Recommendation
- Continue current monitoring.
- Continued research is needed on the biology of *Parazoanthus axinellae.*

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

Status
Ongoing. Annual sampling.

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; Skomer MCZ is close to the northern edge of its range in the UK.
Caryophyllia smithii is a common feature of the sub-littoral benthic community of south-western Britain.

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

Sites
- Thorn Rock
- The Wick

Methods
Balanophyllia regia
- *Thorn Rock:* A fixed position quadrat using a 50 x 40 cm framer at Thorn Rock has been photographed since 1985.
- *Wick:* In 2002 three transects with 51 quadrats were established at the Wick using a 50 x 40 cm framer and in 2008 the framer size was increased to 50 x 70cm using a digital SLR camera, providing 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.

Results

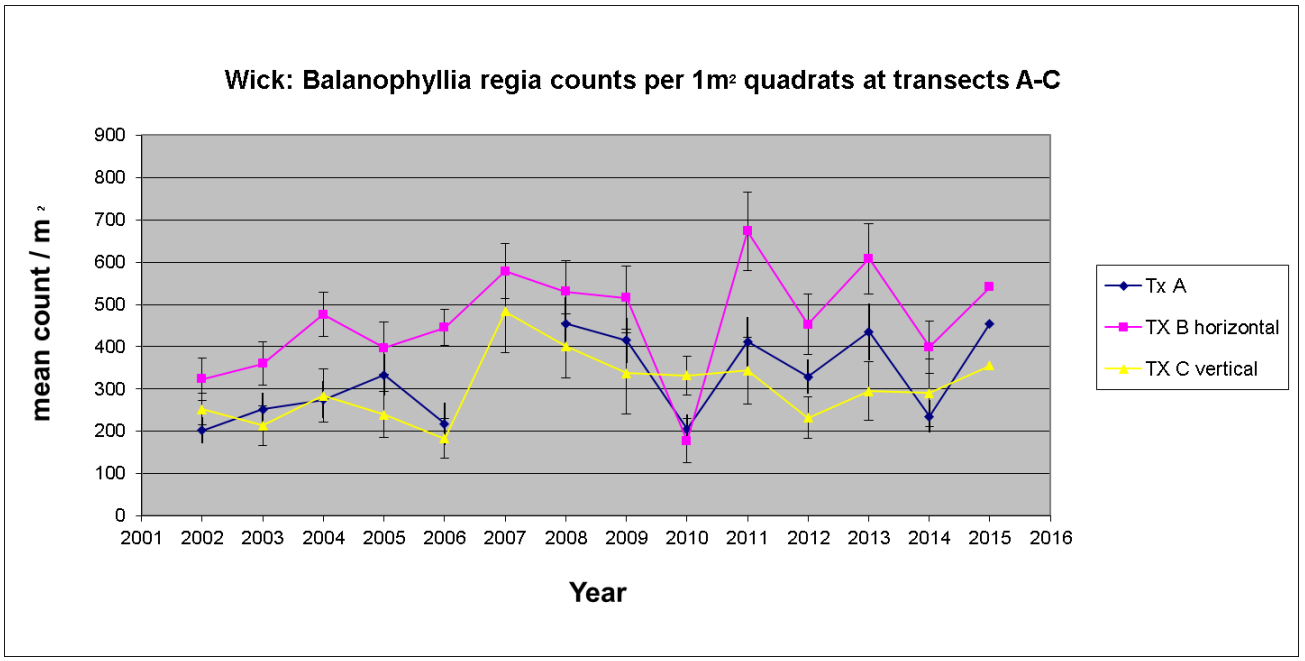
Balanophyllia regia:

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 70cm framer to be comparable.

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

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

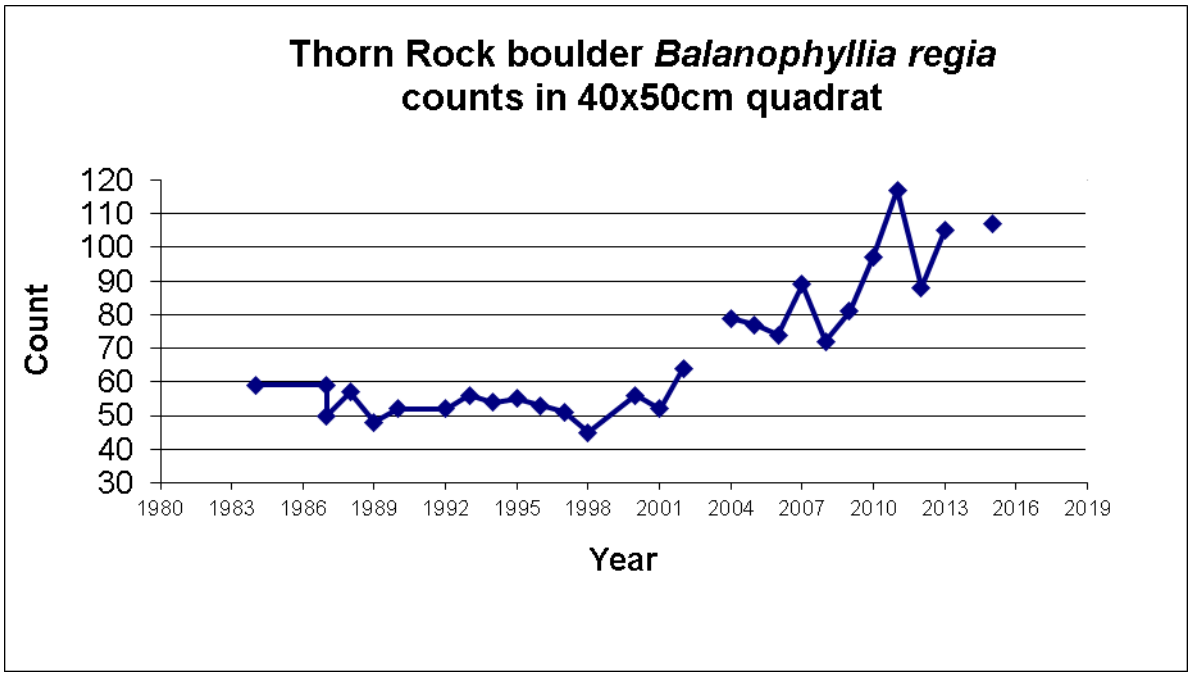
Balanophyllia regia abundance at Transects A, B and C at the Wick



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.

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.

In 2014 the visibility was so poor no photographs were taken, in 2015 better conditions allowed the dataset to be continued.

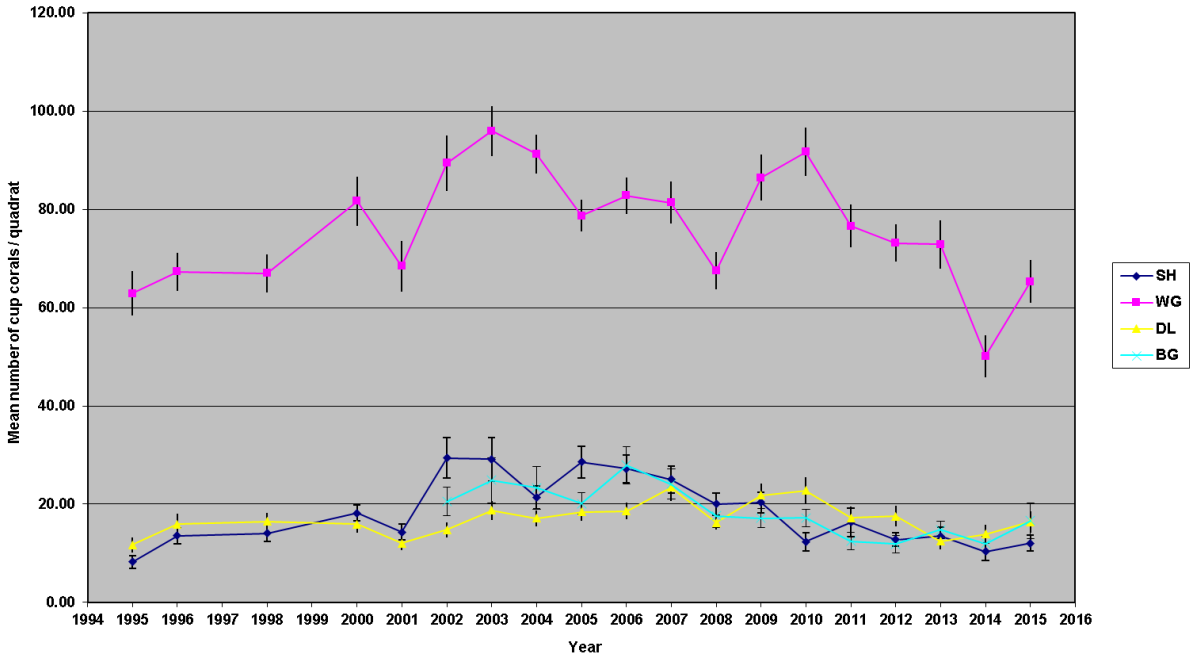


Caryophyllia smithii

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.

Mean Number of *Caryophyllia smithii* per Quadrat at Thorn Rock 1996 - 2015



Current Status

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

Recommendations

- Continue monitoring
- 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.

Pentapora foliacea (Ross coral) population

CMS code: RM63/01

STATUS Ongoing. Annual survey.

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 and anchoring.

OBJECTIVES

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

SITES

• 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	(2 sites 1995 onwards)
• South Middleholm	rock	(2003- onwards)
• West Hook	rock	(2004- onwards)
• Pool	rock and boulders	(2013 - onwards)

METHODS

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

RESULTS

***Pentapora foliacea* - Growth and community structure**

1998 - Gilbert tested various image analysis methods for assessing growth rate, but concluded that a 3D method would be most suitable. Colonies can be put into size classes using base area (cm^2) however this is only an approximate measure of colony size. In 2005 - Analysis methods were reviewed. The growth of *P. foliacea* colonies varies dramatically; one colony showed an increase in base area of over $800cm^2$ in one year, whilst other large colonies have 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 colonies are being physically destroyed or rapidly disintegrate 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 scheme is designed to provide a quick and simple classification of colonies seen during a survey, the distribution of classes within the surveyed population can elucidate the state of the population.

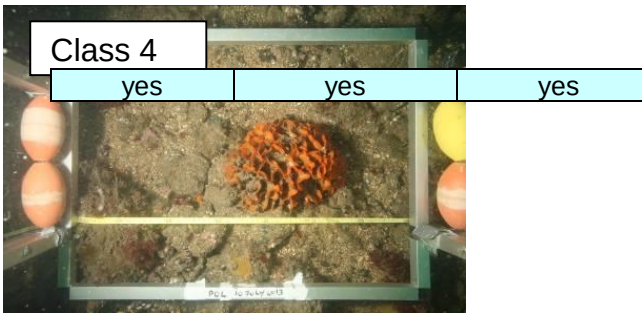
2007 to 2015 the morphological classification method was applied to historical photo dataset and continued each year. In 2010 the method was reviewed due to inconsistencies between individuals completing the analysis and revised guidelines were produced (Lock 2012). The revised guidelines were reapplied to full historical dataset and continued each year.

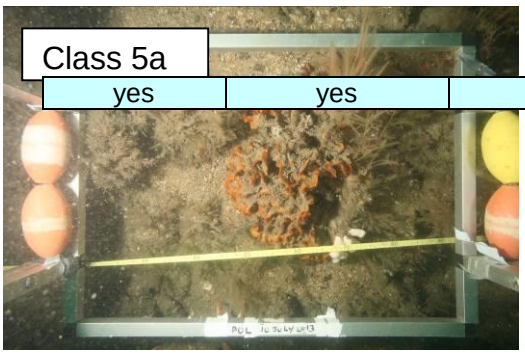
2013 a new site was established at the Pool on the north side of Skomer using a 'pendulum transect' method which proved effective at covering a large search area. The site is a boulder slope and very rich in *P. foliacea* with 250 colonies found.

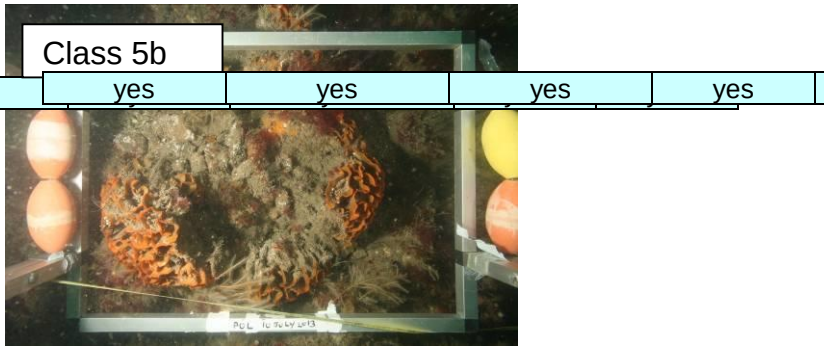
***Pentapora foliacea* photo dataset:**

Year	North Wall	Waybench	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

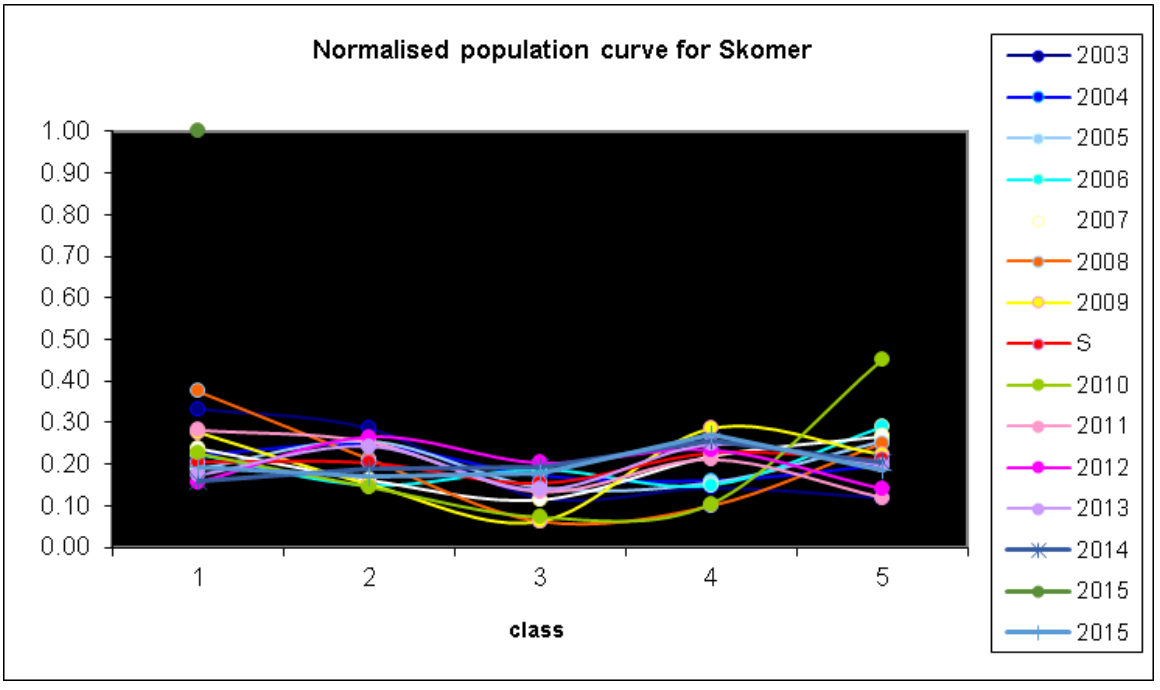
Morphological classification:
Class 1 (single flakes) to class 4 (20cm diameter) relate to size development, class 5 is not size based but relates to the levels of natural degradation.
Class 5a is when more than 50% of the colony is covered in epiphytes and 5b when more than 25% of the colony has broken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





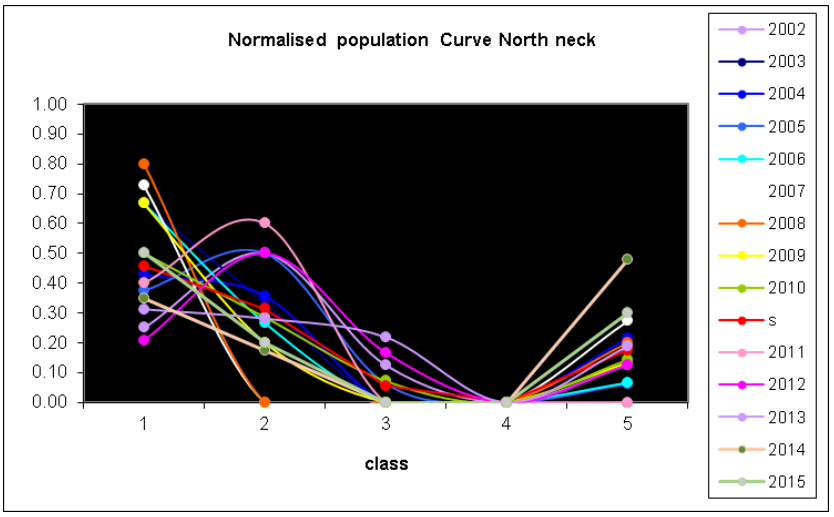


The following graph for all Skomer sites shows a general pattern of the classes with some fluctuations between year sets.
Class 2, 3 and 4 individuals can all progress directly into a class 5 stage if there is more than 50% cover in epiphytes or if there is more than 25% natural degradation, this is demonstrated by the high numbers of class 5 recorded at all sites. The population pattern varies between sites as colony development is affected by both substrate and environmental conditions at sites.

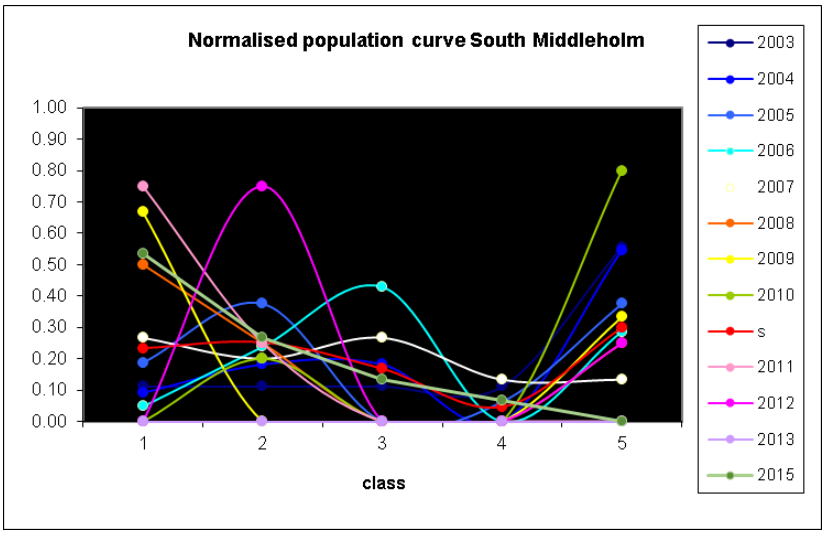


The following graphs show the population patterns found at each site.

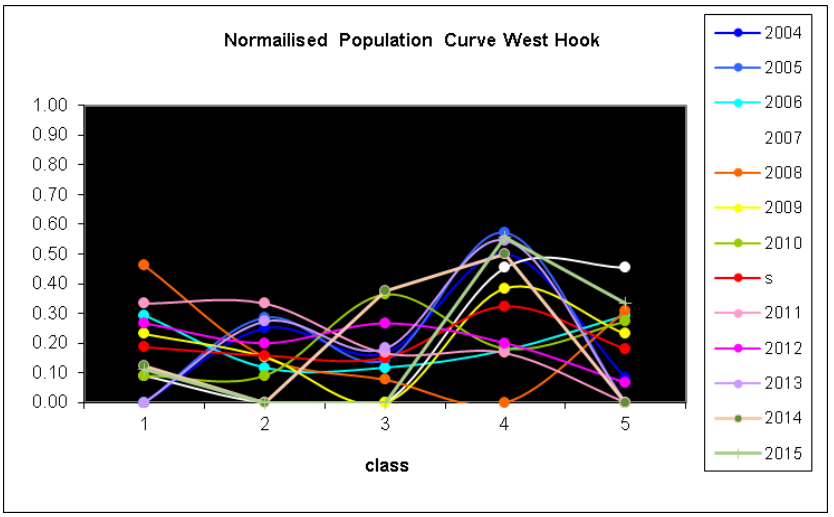
At North Neck class 1 and 2 individuals are the most abundant, at this site the colonies are growing on ground ropes not on bedrock or boulders so the colonies are restricted in their size. Some individuals grow to class 3 but there are no class 4 individuals.



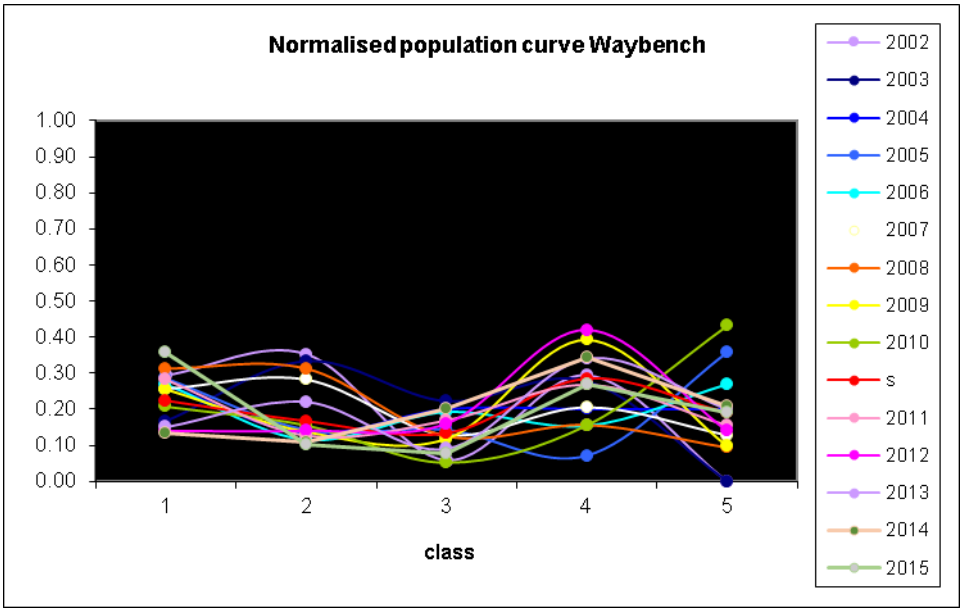
South Middleholm is a small bedrock site, class 1, 2 and 3 individuals are the most common, with very few developing into class 4, instead developing directly to class 5. This site is located on the south side of the island and subjected to the prevailing SW swell.
No colonies were found in 2013 and in 2014 the site was not surveyed, however new colonies were recorded in 2015.



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



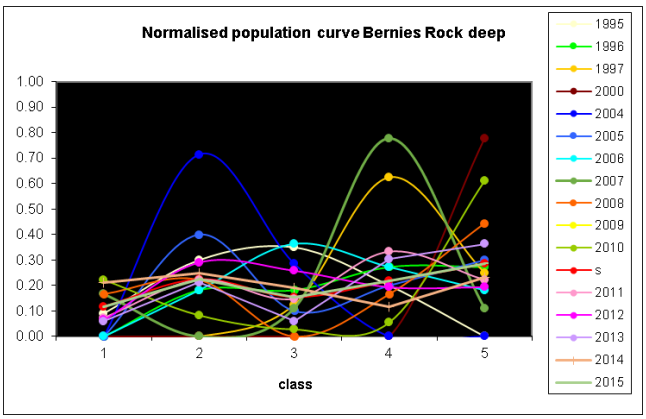
Waybench is a bedrock site with some boulders, located on the north side of the island. Large numbers of colonies are found at this site. A strong pattern between years is observed with a relatively even spread of class 1-4 individuals present. The pattern shows that many colonies reach class 4 before developing into class 5.

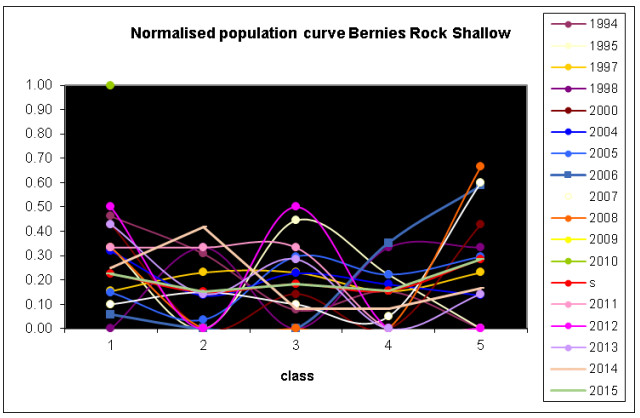


Bernies Rock is located on the north side of the island. The shallow and deep sites both consist of boulder substrate, the pattern of the population curve varies between years and no strong patterns are apparent.

At the deep site between 1997 and 2003 no new colonies were recorded (the class 1a and 1b recorded in 2000 are likely fragments left from an old colony) and no colonies were recorded in 2002 or 2003. New colonies then developed in 2004 and a population at the deep site has continued.

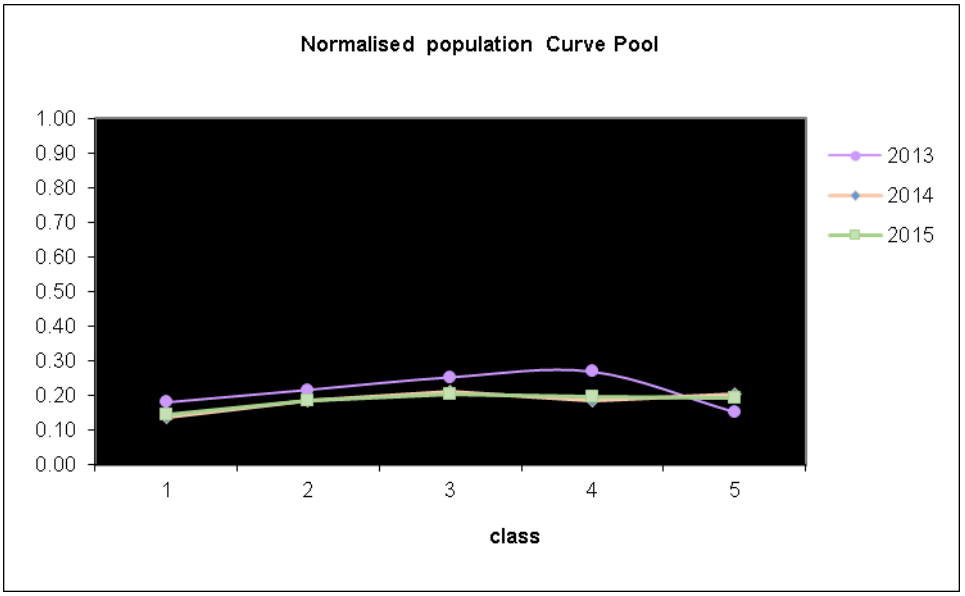
At the shallow site the population pattern is varied between years and new colonies are not observed every year. In 2006, 2008 and 2009 a population dominated with class 4 and 5 colonies were recorded and in 2010 no colonies were found. In 2011 to 2015 new colonies were found but in low numbers.





The boulder substrate at Bernies rock possibly supports less stable populations than found at the bedrock sites.

The Pool is a new site started in 2013 located on the north side of Skomer east of Bernies Rock. The site is primarily a boulder slope from 10m down to 22m bcd. A large survey area was covered and large numbers of *P. foliacea* colonies were found (250 individuals) with an even spread of classes present. It will be interesting to monitor the population pattern for this site as it has similar substrate to Bernies Rock.



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 *Pentapora foliacea*.

Atlantic Grey Seal (*Halichoerus grypus*) Population

(CMS code: RA03/01)

Status

Ongoing. Annual survey.

Project Rationale

Grey seals are a protected species of conservation importance, which live and breed in the Skomer MCZ. The west Wales population is the largest in south west Britain and is a feature of the Pembrokeshire Marine SAC.

Objectives

To monitor the number and survival rate of seal pups born in the MCZ.

Sites

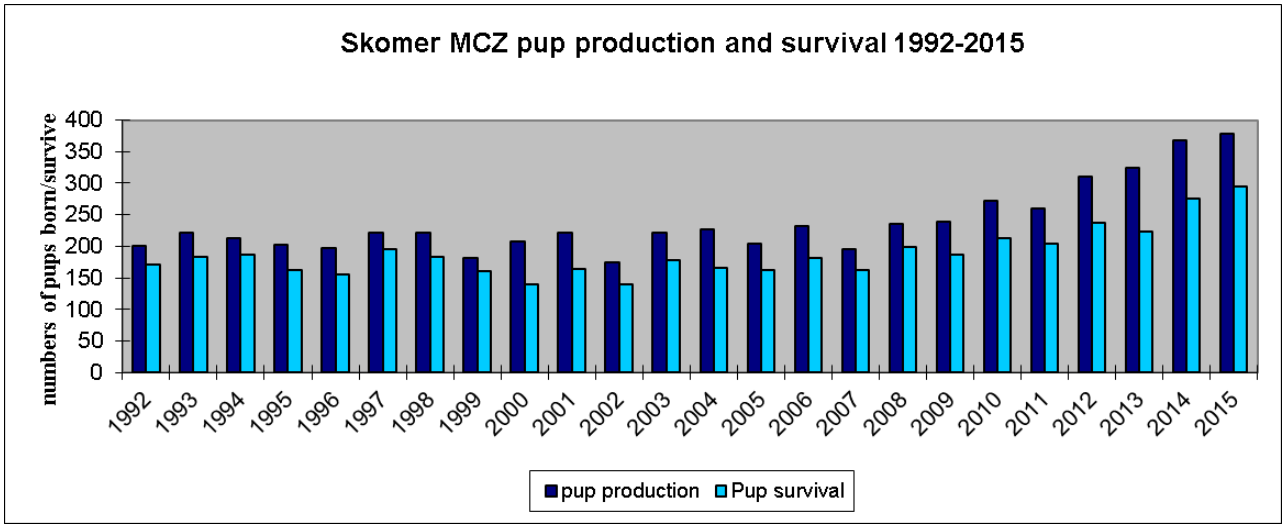
All pupping beaches and caves in the MCZ.

Methods

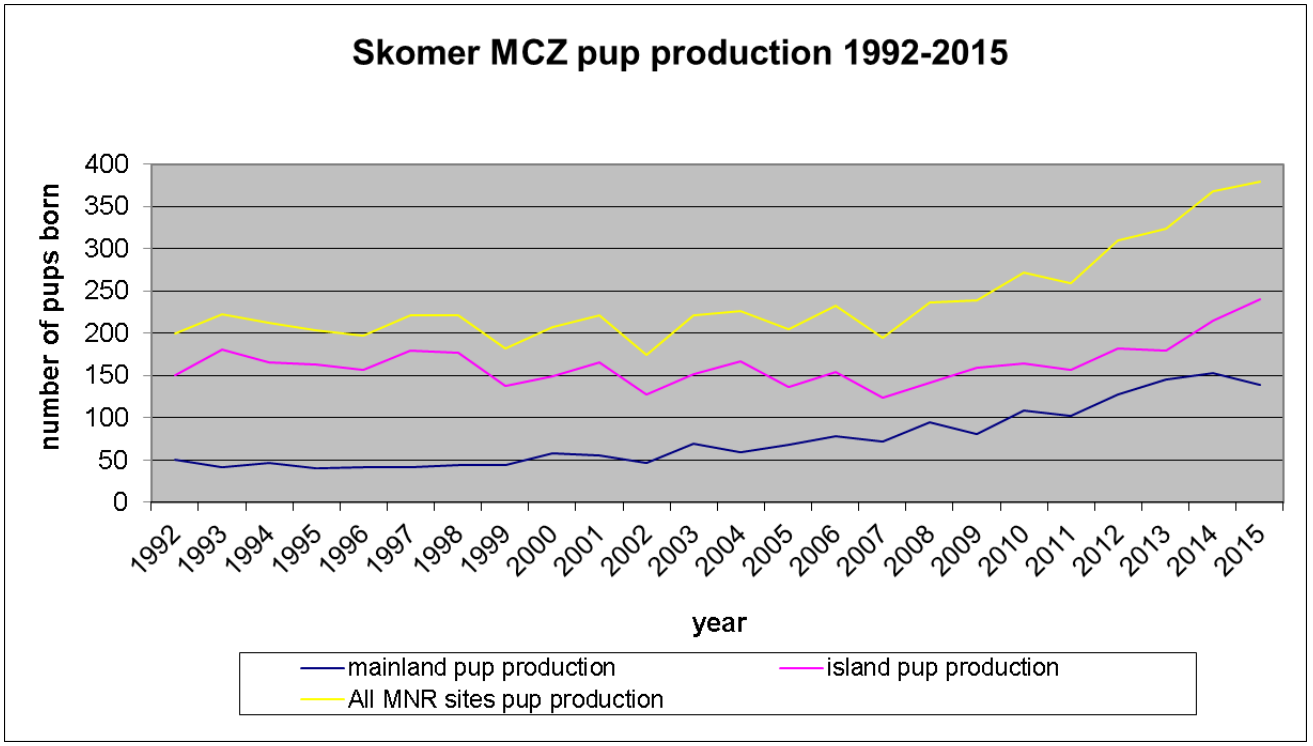
The pups are recorded from birth through to their first moult using the “Smith 5-fold classification system” (Poole 1996). Reason for death is recorded if possible. Additional behavioural observations are recorded for the Island seals (Full method described in ‘Grey Seal Monitoring Handbook’ Poole 1996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

Results

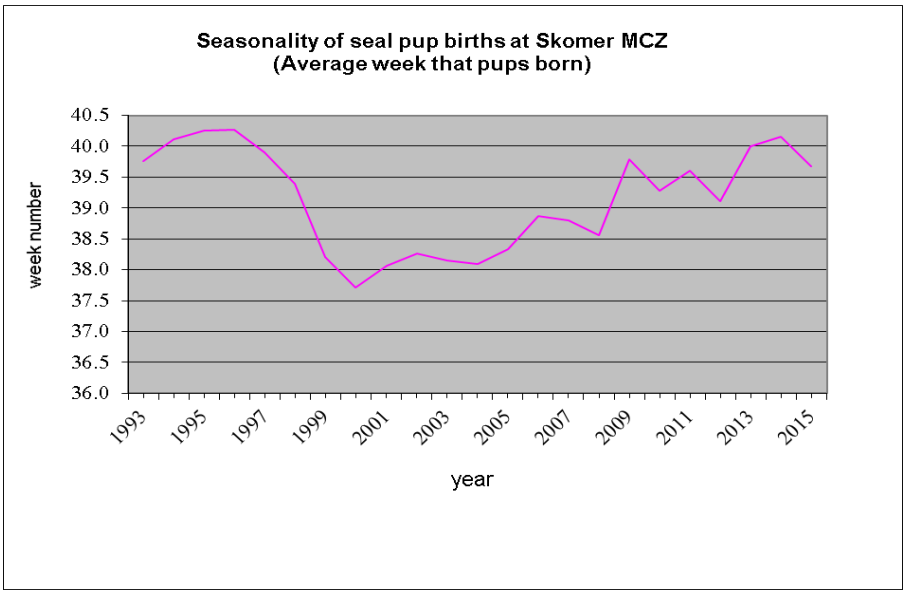
Regular recording began at Skomer MCZ in 1974. From 1992 onwards a standard protocol has been adopted to record the pupping success on both the island and the mainland each year. The Skomer sites are completed through a contract and a full survey produced, the mainland sites are completed by MCZ staff. The results are combined to provide the full Skomer MCZ results.



In 2015 240 pups were born at island sites and 139 pups at mainland sites giving a total 379 pups born in the MCZ with a recorded combined survival of 77.8% through to moult.



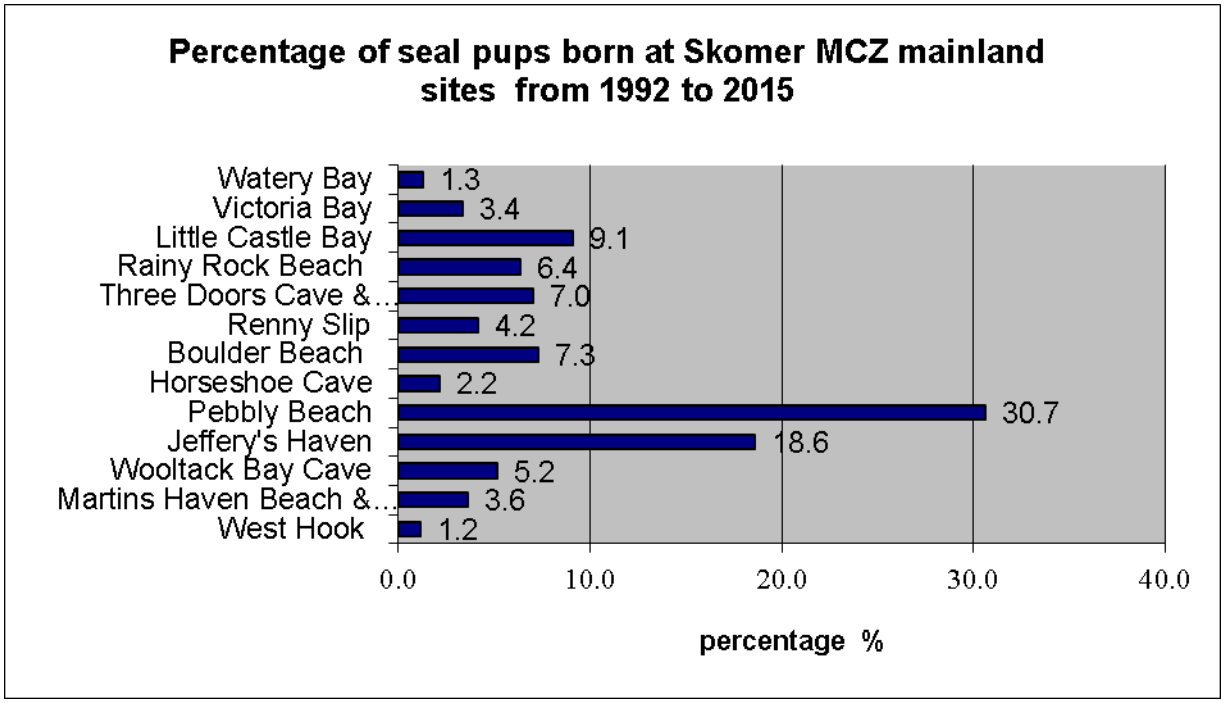
Pup production in the Skomer MCZ for the past 3 years has shown the highest totals ever recorded with average production for 2013-15 at 357 pups. The pup production from 1992 to 2008 remained fairly consistent with the expected natural fluctuations with an average of 208 pups. From 2009 to 2015 there has been a steady increase in pup production with the greatest increase seen at the mainland sites. However in 2014 and 2015 increases at the island sites were also recorded.



In 2015 pup production was 5.8% in August, 43.7% in September, 43.7% in October and 7.4% in November, and modal week of production was week 40 (1-7th October). The trend over the last 23 years shows that from 1993 to 1998 the modal week of production was week 40 and then it shifted to an earlier modal production of week 38 (17-23rd Sept) from 1999 to 2008. Since 2009 the pattern has shown that modal production has moved back to week 40.

A full report for the 2015 Skomer seal census details the production for the island sites, see Buche & Stubbings 2016.

The following graph shows the percentage of pups born at each of the mainland sites from 1992 to 2015. Pebbly beach and Jeffery's Haven, both small bays located on the southern side of the Deer Park are the most popular sites accounting for 49% of mainland pup production.



Additional Seal Studies

1998 Provision of information about seal watching and current pup numbers at sites around the Marloes Peninsula was commenced at the MCZ Visitor Centre.

2002 Methods to study seal disturbance at mainland sites were tested and a further survey 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 completed a questionnaire on the usefulness of the leaflet. The leaflet was a success and 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 was started for mainland sites by a placement student from Pembrokeshire College; this followed methods in the 'Grey Seal Monitoring Handbook' Poole 1996 and tested photo and video methods.

2005 Photo methods were also 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' 36 seals had been matched between Cornwall/Devon sites and Skomer sites. Most of these seals seem to be spending the breeding season on Skomer, returning to Cornwall for the winter and spring, but disappearing during the summer, presumably going off somewhere else to feed up before the next breeding season (Boyle 2011). Between 2007 and 2013 there have been 43 matches of seals identified between Cornwall and Skomer MCZ (Sayer *pers. comm*.).

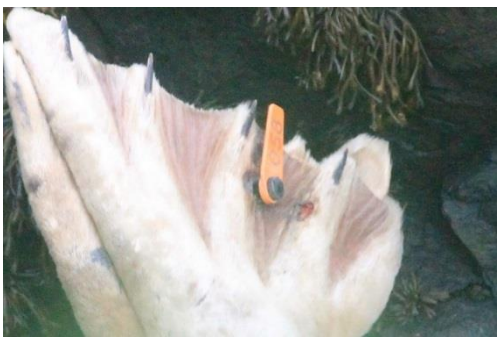
NRW have developed in collaboration with SMRU an EIRPHOT database called the Wales Seal ID database. Photos are entered using extracts of head and neck profiles of individual seals and photo matching is then completed between images. In 2014 an NRW contract allowed all 2007 to 2014 Pembrokeshire photos to be entered, this is in addition to the North Wales seal ID datasets. 2015 photos are stored ready for entry.

2014- 2015 Collaboration work with Swansea University researchers Dr Jim Bull and Dr Luca Borger. They have been working on the long- term pupping data from the Marloes Peninsula (1992-2014) to look at temporal trends and phenology in grey seal pups and a NRW report is being produced. The team are now using statistical models to look at the long term data sets (1985-2015) for the Skomer sites. In January 2016 a new PhD student, William Kay, co-supervised between Swansea University and NRW began research on seal movements in the Irish sea and marine renewables. The research has begun by mapping the historical Pembrokeshire seal ringing/tagging data collected during the 1950's to 1970's including many seal pups from Skomer.

Tagged seals

In 2015 three tagged seals were recorded, one was an immature which had been tagged by Oceanopolis in Brest, France. The other tagged seals were a breeding female and an immature. More information is awaiting these tagged seals, Buche & Stubbings 2016.

Tagged immature from France hauled-out in North Haven



Buche & Stubbings 2016.

Pollution

Monofilament line and netting continue to be the most obvious pollutants affecting seals. In 2015 27 different cows and three bulls 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. 9 of these animals were re-identified from previous years. The problem with netting entanglement is a growing concern especially with the high numbers recorded.

Targets

- Pup production lower limit: number based on average for last 3 years.
  Pup production for 3 consecutive years with an average not less than 357 pups each year within the MCZ.

- Pup survival to moult lower limit: Percentage based on average for last 10 years.
  Percentage survival of pups for 3 consecutive years no less than 75%.

Current Status

- 2015 pup numbers reached 379, 157 pups higher than the average for the last 24 years. Pup survival was 76%, 3% below the average. The majority of deaths were caused by abandonment or separation and by periods of harsh weather.

- In 2015 pup production was 5.8% in August, 43.7% in September, 43.7% in October and 7.4% in November, and modal week of production was week 40 (1-7th October).

- All Skomer and Marloes Peninsula adult seal photos are stored ready for entry into the NRW Wales Seal ID database.

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 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.

Echinoderm populations*: Echinus esculentus, Marthasterias glacialis, Crossaster papposus and Luidia ciliaris*

(CMS CODE: RM73/01)

Status
Ongoing, survey every 4 years (next survey 2019).

Project Rationale
Echinus esculentus Linnaeus (1758) is an omnivorous grazer and a key biological structuring factor in sub-tidal communities. The grazing clears space making it available for colonisation by other species. In low numbers this grazing effect is beneficial; in high numbers it can be highly destructive even destroying whole kelp forests (Hagan, 1983). During the 1970s divers targeted the Skomer MCZ population for the curio trade and large numbers were removed. Bishop (1982) reported that mean densities of *E. esculentus* in Skomer MCZ were not significantly different from densities in a commercially exploited population.

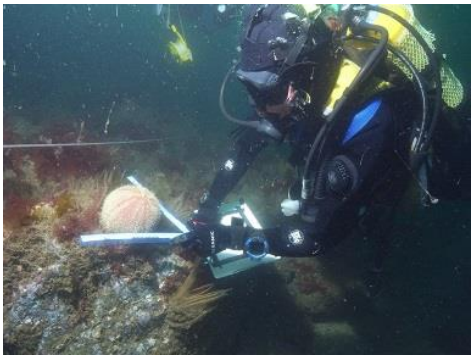
The starfish, *Marthasterias glacialis*, *Crossaster papposus* and *Luidia ciliaris* are easily identifiable and information on their distribution and abundance would be of interest.

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

Sites
- North Wall
- Rye Rocks
- Thorn Rock
- Castle Bay/ High Court Reef
- High Low point
- Martins Haven point/Junkos Reef

Method
The methods involve recording sightings of the target species along a 30m transect (from within a 2m wide strip). In addition, the widest diameter of each urchin was measured using callipers and the distance on the tape measure recorded. The method was designed for use with volunteer divers and is described in Luddington & Lock (2004).

In 2007 methods were modified to allow improved statistical analysis and comparison between surveys. The study sites were marked and GPS positions taken, allowing for relocation of sites in future surveys. Four depth zones were surveyed at 20m, 15m, 10m and 5m below chart datum. *E. esculentus* were measured using a fixed 60 degree divider (the *Gibbs urchin divider*), as this was easier to use and has less error than the sliding callipers.



'Bald' *E. esculentus*, *M. glacialis, C. papposus* and *L. ciliaris* were counted along each completed transect. Seasearch methods were used for recording seabed substrate and habitats present at each site. The revised methods are fully described in Lock *et al.* (2008).

In 2011 one site at Castle Bay was relocated to a new position with more suitable habitat for *E. esculentus.*

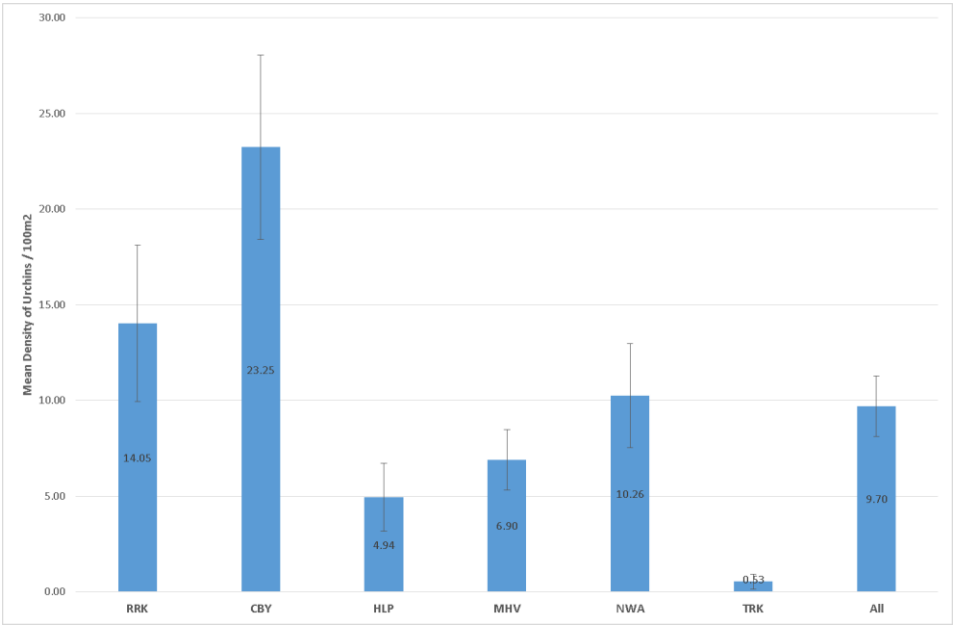
A plankton trawl was completed weekly from Easter to end of October on the north side of Skomer. The plankton samples were analysed by Plymouth Marine Laboratory.

Results

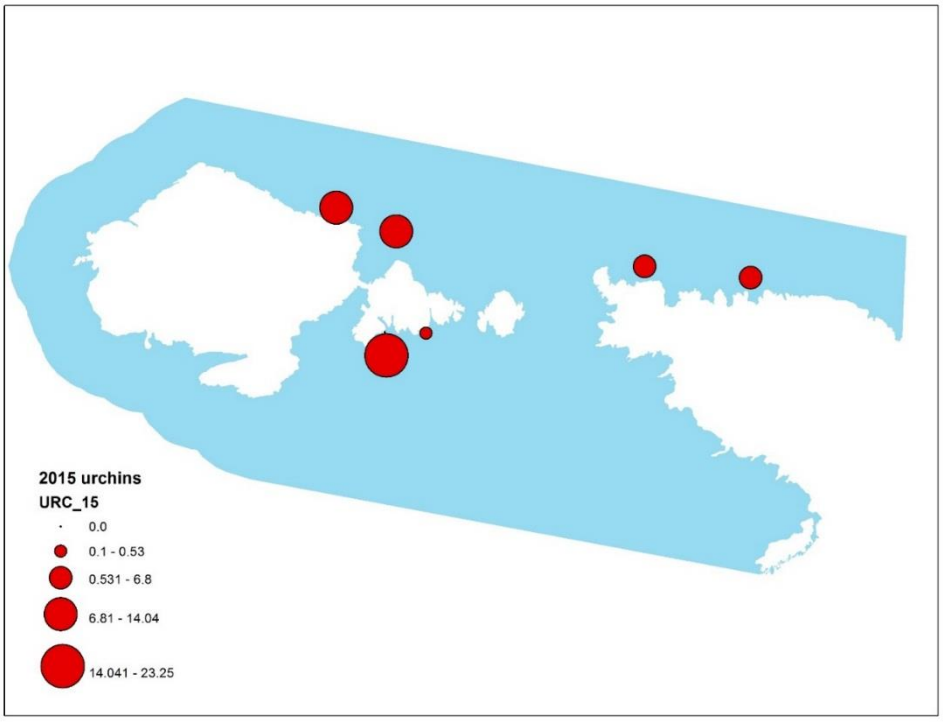
Echinus esculentus

In 2015 the mean density of *E. esculentus* for all sites surveyed was 9.7 per 100m^2 Density of *E. esculentus* at different sites in 2015 with error bars (95% CI) is shown in the graph. A wide range of mean densities were found at the different sites. The highest mean density of 23.25 per 100m^2 was recorded at Castle Bay and the lowest was 0.53 per 100m^2 at Thorn Rock.

Density of *E. esculentus* per 100 m^2. at survey sites in the Skomer MCZ.

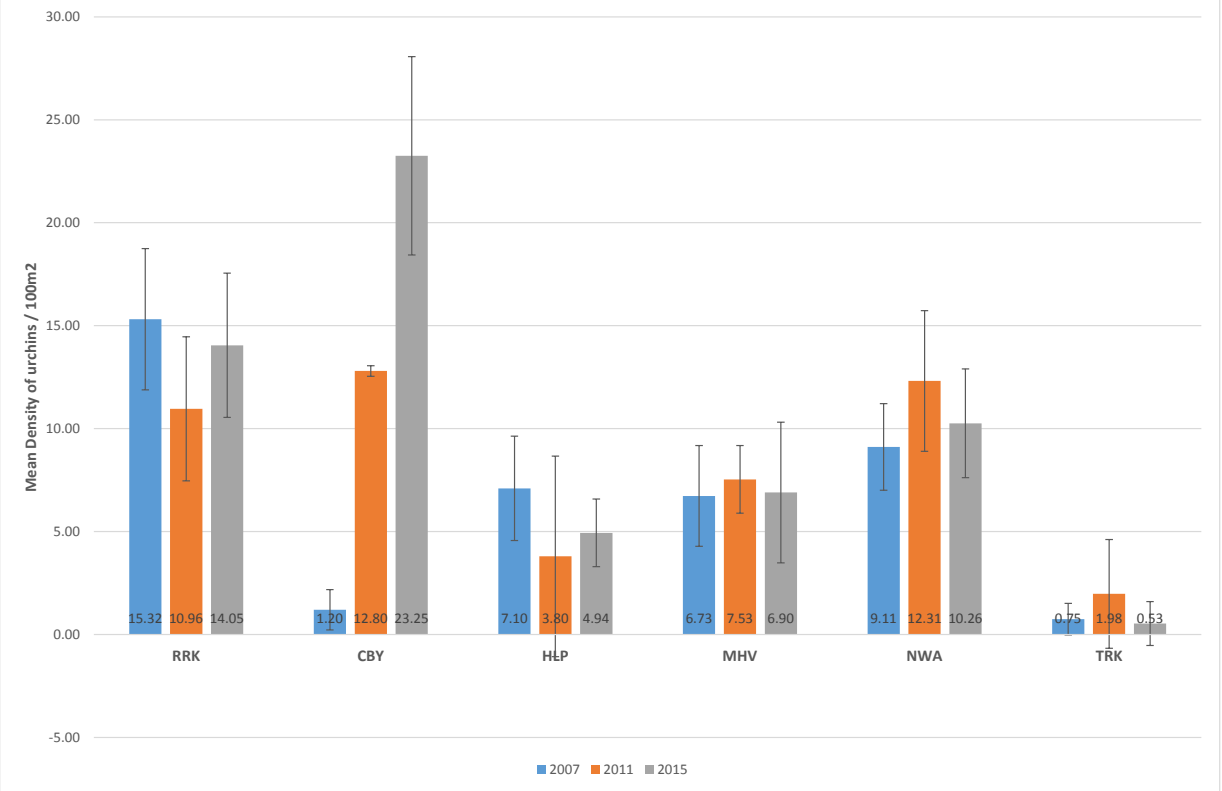


Graduated bubble map of *E. esculentus* density with Skomer MCZ 2015.



These results can be compared to the 2007 & 2011 surveys

Mean *E. esculentus* density (per 100m2) at each site for 2007, 2011 & 2015.



The pattern of variation in density between the sites has not varied much between the years. It is only the Castle Bay site which has shown any significant change (**p<0.1%).** In 2007 an unsuitable location was used in Castle Bay before relocating it in 2011, this

accounts for the comparatively low density recorded in 2007. The 2015 Castle Bay records have shown a significant increase in density (p<0.1%) compared to 2011. All the other sites show no significant change in density between the years.

Transects were completed at the 20m, 15m, 10m and 5m below chart datum depth contours at each site.

One way ANOVA test showed that there was **no** significant difference between the densities of *E. esculentus* found at each depth zone (F = 1.15 f critc 2.67 not sig @ p 5%). This is consistent with results from 2007 & 2011.

Summary table of *E. esculentus* density with depth.

	Transects	Area	Total	Mean density	95%CI	Mean Density	95%CI
Depths	completed	covered	No of urchins	per Transect	(mean / Tx)	Per 100m2	Mean/ 100m2
5 M bcd	11	660	73	6.64	2.85	11.06	4.75
10 M bcd	62	3720	413	6.66	1.62	11.10	2.70
15 M bcd	67	4020	331	4.87	2.00	8.11	2.15
20 M bcd	10	600	62	6.20	2.35	10.33	3.92

The 'Gibbs urchin divider' data was converted to *E. esculentus* diameter. The population of *E. esculentus* shows a normal size frequency distribution. The mean, maximum and minimum diameters were 13.34 cm, 20 cm and 4 cm respectively.

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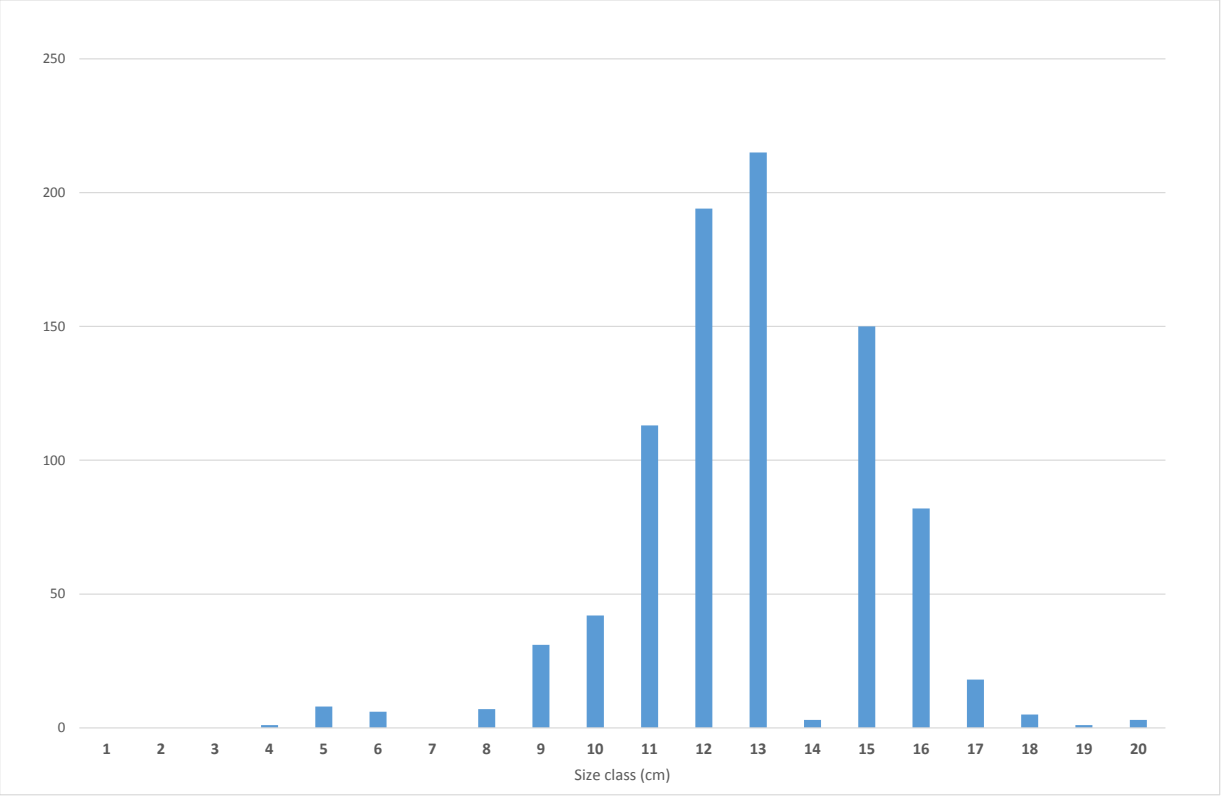
Size frequency distribution of *E. esculentus* in Skomer MCZ 2015



2015 has seen the highest occurrence of 'bald' *E. esculentus* since 2003. All records come from the Castle Bay site from transects at 10m and 15m depths. The numbers found are still very low accounting for only 1.15% of the total.

Numbers of "bald" *Echinus esculentus* 2003 - 2015

	2003	2007	2011	2015
Total *E. esculentus*	505	609	755	869
Total "bald" *E. esculentus*	0	2	1	10

Starfish species

In 2015 a density of 2.17 per 100m^2 *Marthasterias glacialis* was recorded, 2 individual *Luidia ciliaris.* There were no records of *Crossaster papposus* in 2015 and there have been none recorded since 2003.

Starfish records for Skomer MCZ 2003 – 2015

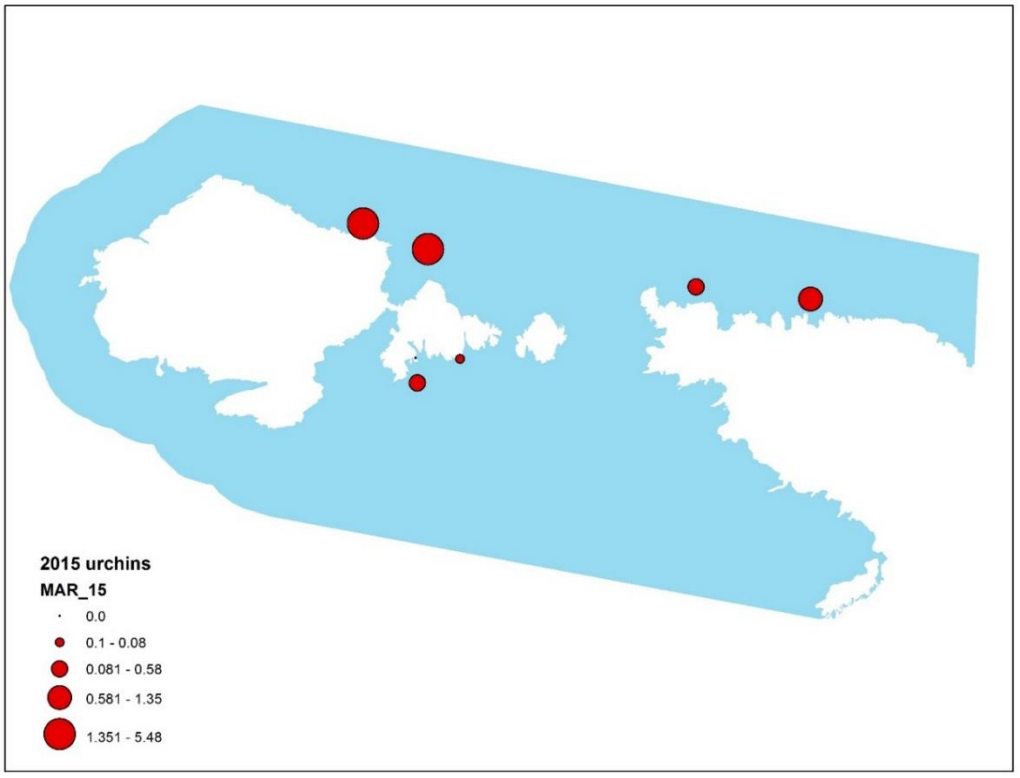
Year	2003	2007	2011	2015
C. papposus - counts	21	0	0	0
M. glacialis – density / 100m^2	4.98	3.47	4.0	2.17
L.ciliaris - counts	0	2	10	2

Marthasterias glacialis was the most abundant starfish recorded in 2015, although less were seen in 2015 compared to previous years across all sites.

Density of *M. glacialis* / 100m^2 2003 - 2015

Site	2003	2007	2011	2015
Whole MCZ	4.98	3.47	4	2.17
HLP		2.9	2.1	1.35
MHV		2.37	6	0.57
TRK		1.4	0.6	0.08
RRK		6.3	6.8	5.48
NWA		5.3	7.25	4.23
CBY 2007		1.1		
CBY 2011			1.7	0.58

Graduated bubble map of *M. glacialis* density / 100m^2 Skomer MCZ 2015



Only two *Luidia ciliaris* were recorded seen in 2015, both at the North Wall site.

Current status

Surveys completed in 2003, 2007, 2011 and 2015

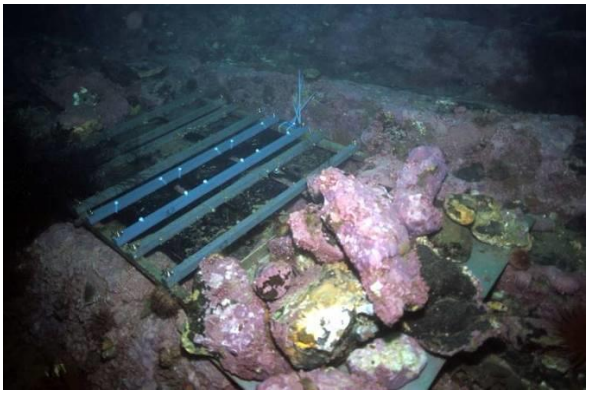
Recommendations

- Continue with volunteer survey methodology to produce a time series of comparable data.
- Surveys to be repeated every 4 years; next survey 2019.

General Species Recording
(CMS code: RB06/01)
Vagrant and Alien species Recording
(CMS code: RB01/01)
Record Commercial crustacean populations
(CMS code: RM44/01)

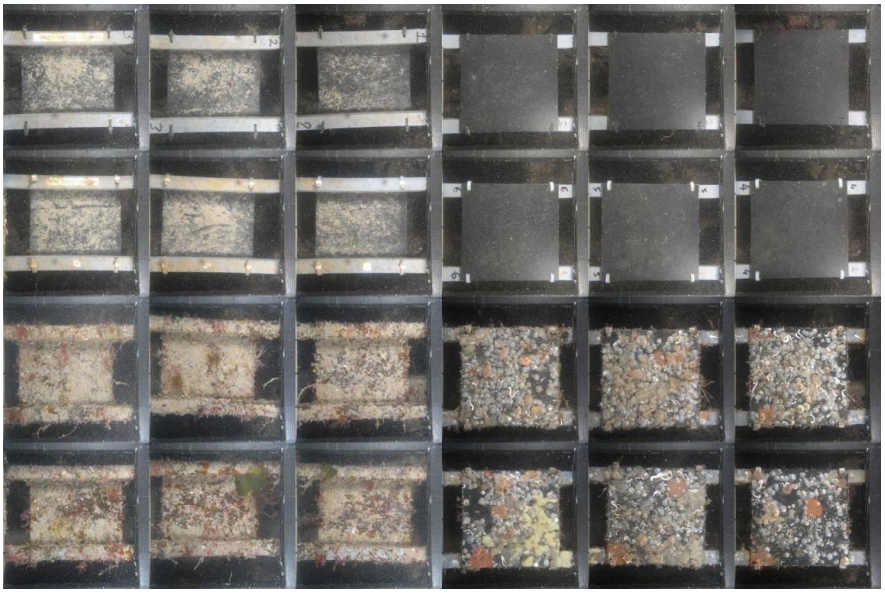
Status
Ongoing, annual recording.

Project Rationale
There are many species in the Marine Conservation Zone that do not have a dedicated monitoring project. It is important that species lists are maintained, particularly for phyla that are under-recorded. Records of species of important conservation concern in Wales (NERC section 42 species) and 'Alien' Invasive and Non-Native species (INNS) is important. General recording of unusual, rare, scarce or vagrant species are also maintained. These records are entered into the JNCC administered Marine Recorder for access onto the National Biodiversity Network.



Settlement Plates
In 2009 the Skomer MCZ became host to a project 'Cryptic fauna colonisation and succession project' lead by Piotr Kuklinski from Warsaw Oceanographic Institute and the Natural History Museum London. Piotr set up settlement plates at two depth locations (6m and 12m) at Bernie's Rocks on the north side of the island and 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. The project will end in 2016 once the sequence of panels has been completed.

Example of monthly sequence photos of settlement plates:



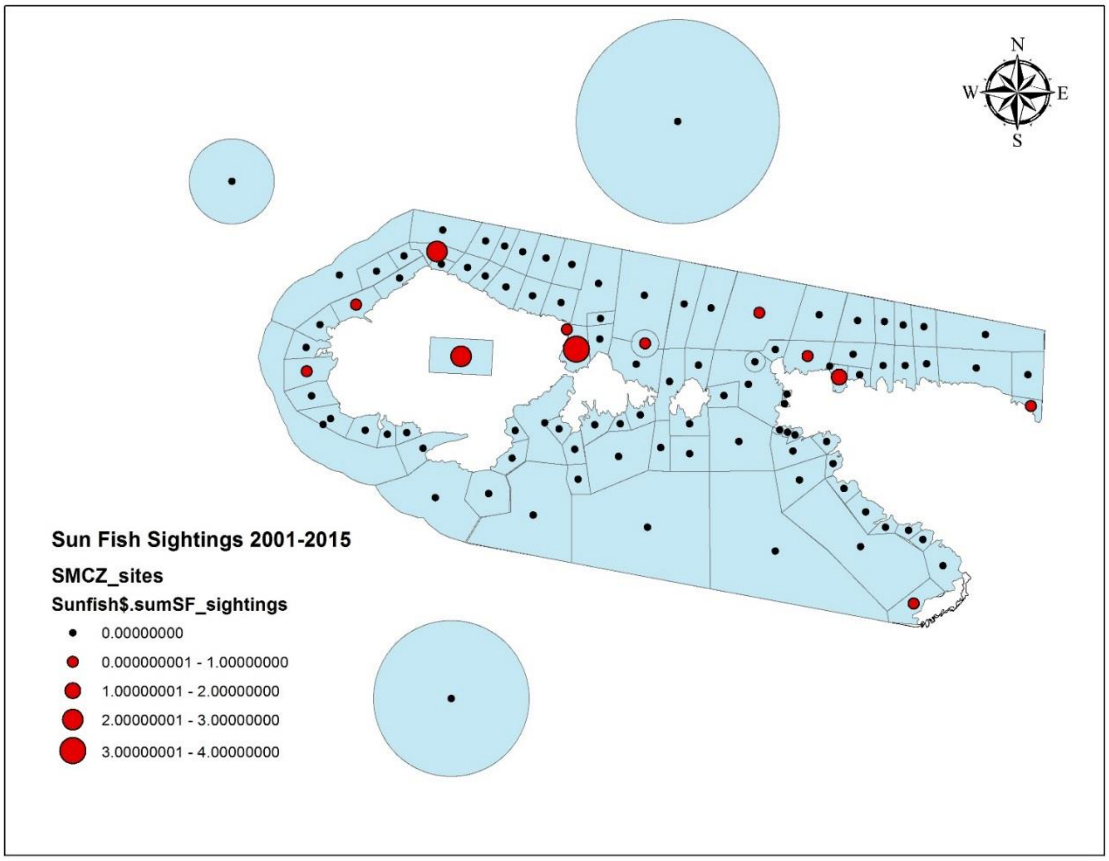
Crawfish

Crawfish *Palinurus elephas* became a national Biodiversity Action Plan species in 2008, now Section42 species. From 2009 to 2015 it was recorded in low numbers in the MCZ by MCZ staff and volunteers. These records have been entered into the online recording scheme that has been set up on the Seasearch website **www.seasearch.org.uk** with the aim being to gain better knowledge of the historical and current status of this species in the UK.

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 will be 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.

The data from 2001 to 2015 has been plotted to show the location of sightings.



Cetacean Species Recording
(CMS Code RA01/ 01)

Status
Ongoing. Annual recording.

Project Rational
Cetaceans are regularly recorded in and adjacent to the MCZ.
Harbour porpoise (*Phocoena phocoena*) are the 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 Bern Convention, the EC Habitats Directive and under the Agreement of Small Cetaceans of the Baltic and North Seas (ASCOBANS). In British waters they are legally protected under the Wildlife and Countryside Act 1981 and are a species for conservation in the UK Biodiversity Action Plan 1994. There are currently plans to establish harbour porpoise SACs which would include the waters in the MCZ.
Bottlenose dolphin (*Tursiops truncatus*), Common dolphin (*Delphinus delphis*) and Rissos dolphin (*Grampus griseus*) are occasional visitors to the MCZ.

Objectives
To record numbers of individuals and the locations used by cetaceans in the MCZ.

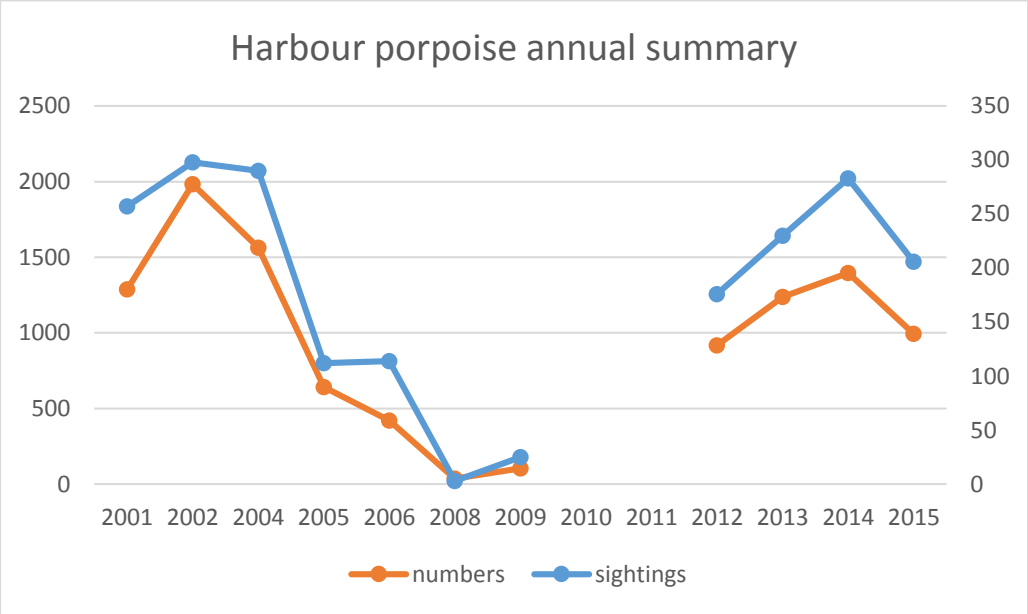
Method
Recording effort varies annually but is completed by:

- Island NNR staff and volunteers, binoculars and telescopes are used from cliff locations around the island.
- Dale Princess crew maintain records in a diary of sightings during the ferry run between Martins Haven and North Haven and on the round island trips.
- MCZ staff record all sightings whilst at sea.

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

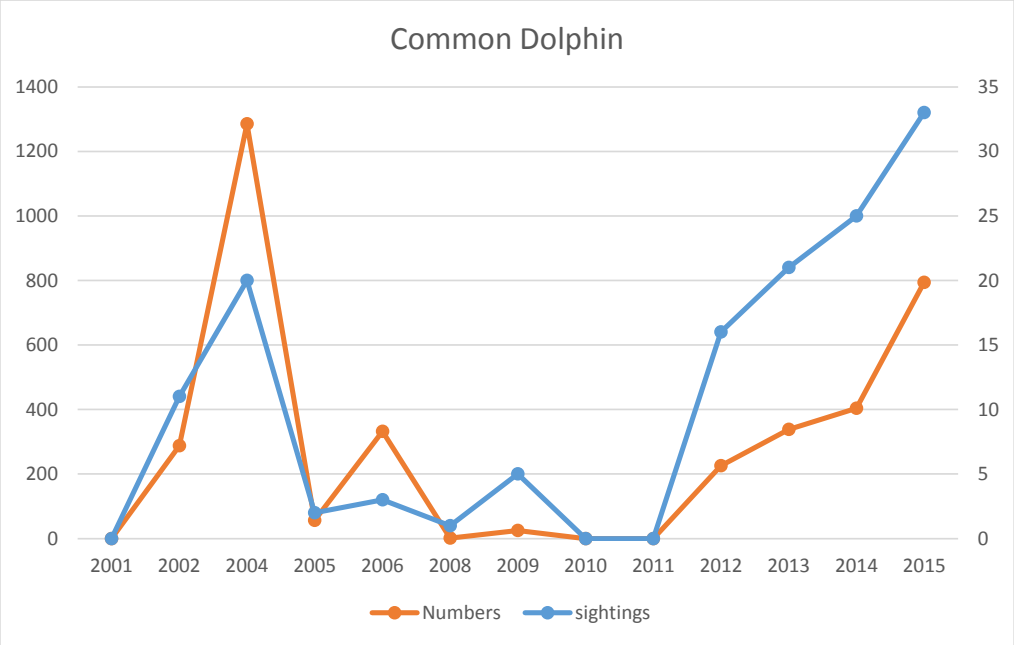
Results
All the sightings of cetaceans have been collated for the period between 2001 to2015. There are no records in years 2003, 2007, 2010 & 2011. The effort is variable not just between years but also during the season which makes the data difficult to effort correct.

Harbour Porpoise



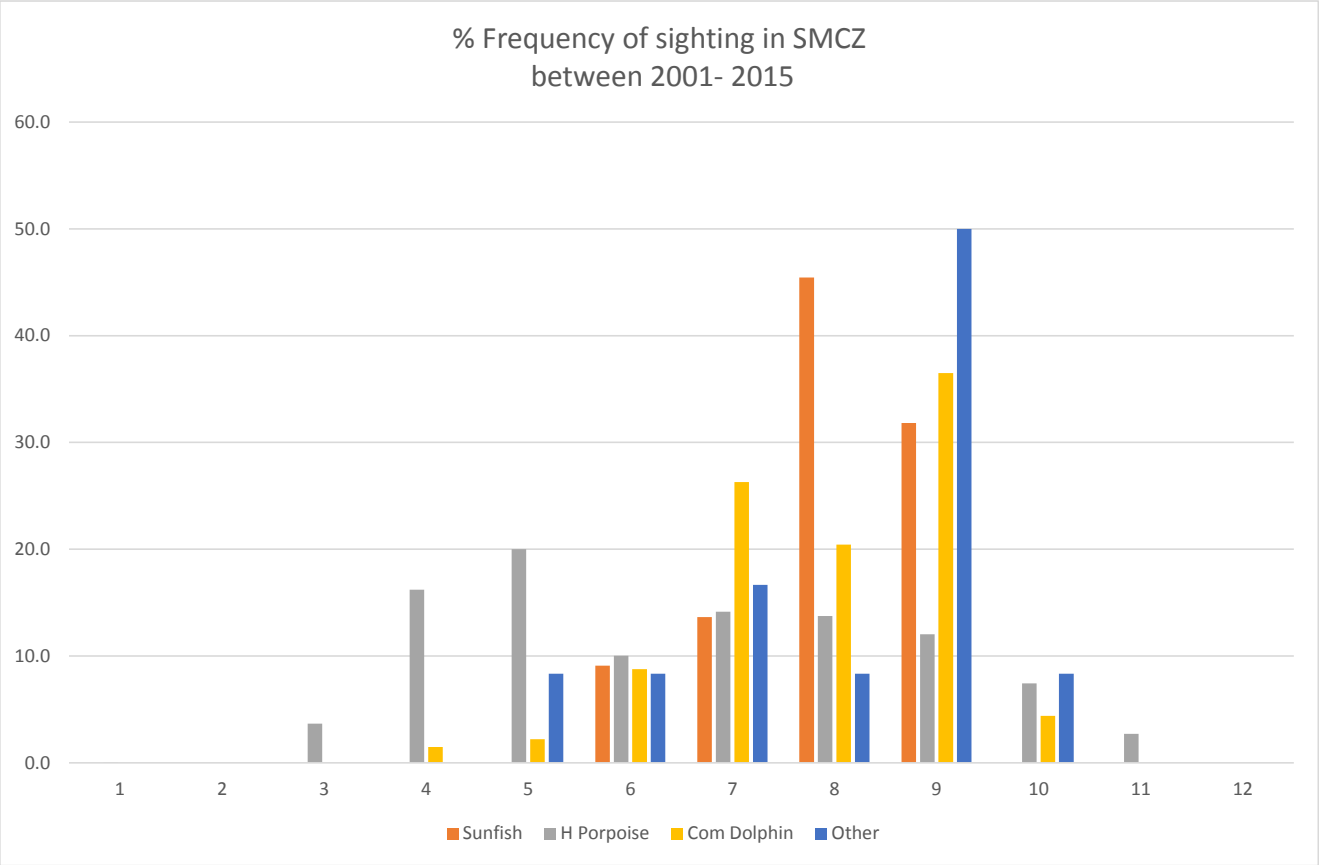
The very low numbers in 2008 & 2009 are probably due to a low effort in recording. Harbour Porpoise are considered resident to the area around Skomer MCZ. Without some form of effort correction it is not possible to draw conclusions from this data.

Common Dolphin



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 isn't effort corrected but Common Dolphin sightings are much more unusual and tend to get recorded.

% Frequency of monthly sightings for all species (for the period 2001 - 2015).



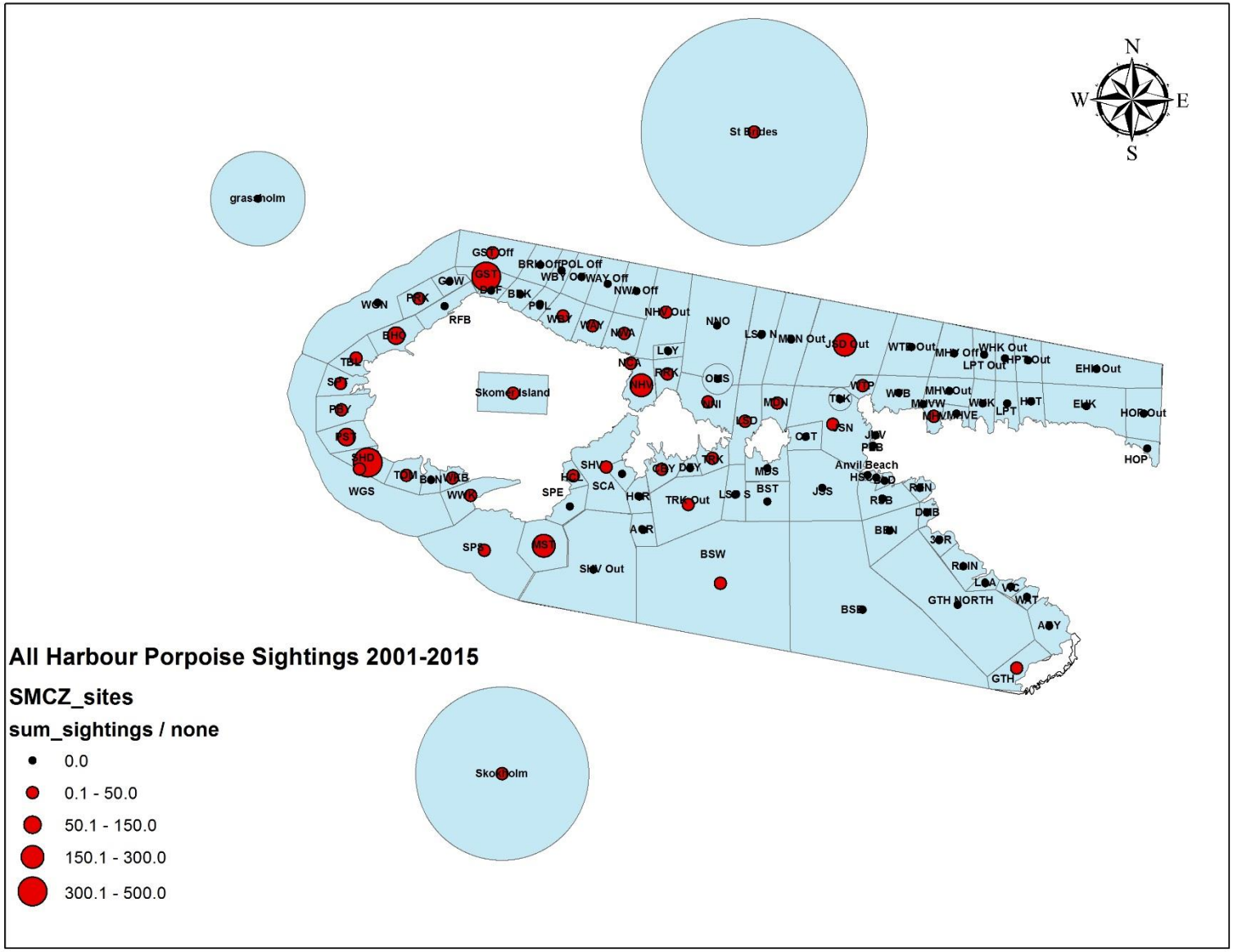
(Note: Other species include; Rissos dolphin, Minke whale and Bottlenose dolphin)

Harbour porpoise are seen all year round (there will be little or no records for Dec – Feb as there are no observers out on the water or on the island). July – Aug are the peak months for seeing other cetacean species and Sunfish.

To make this data suitable for analysis it needs to be effort corrected. Times when cetaceans are not sighted need to be included (or made deducible) as well as sightings records.

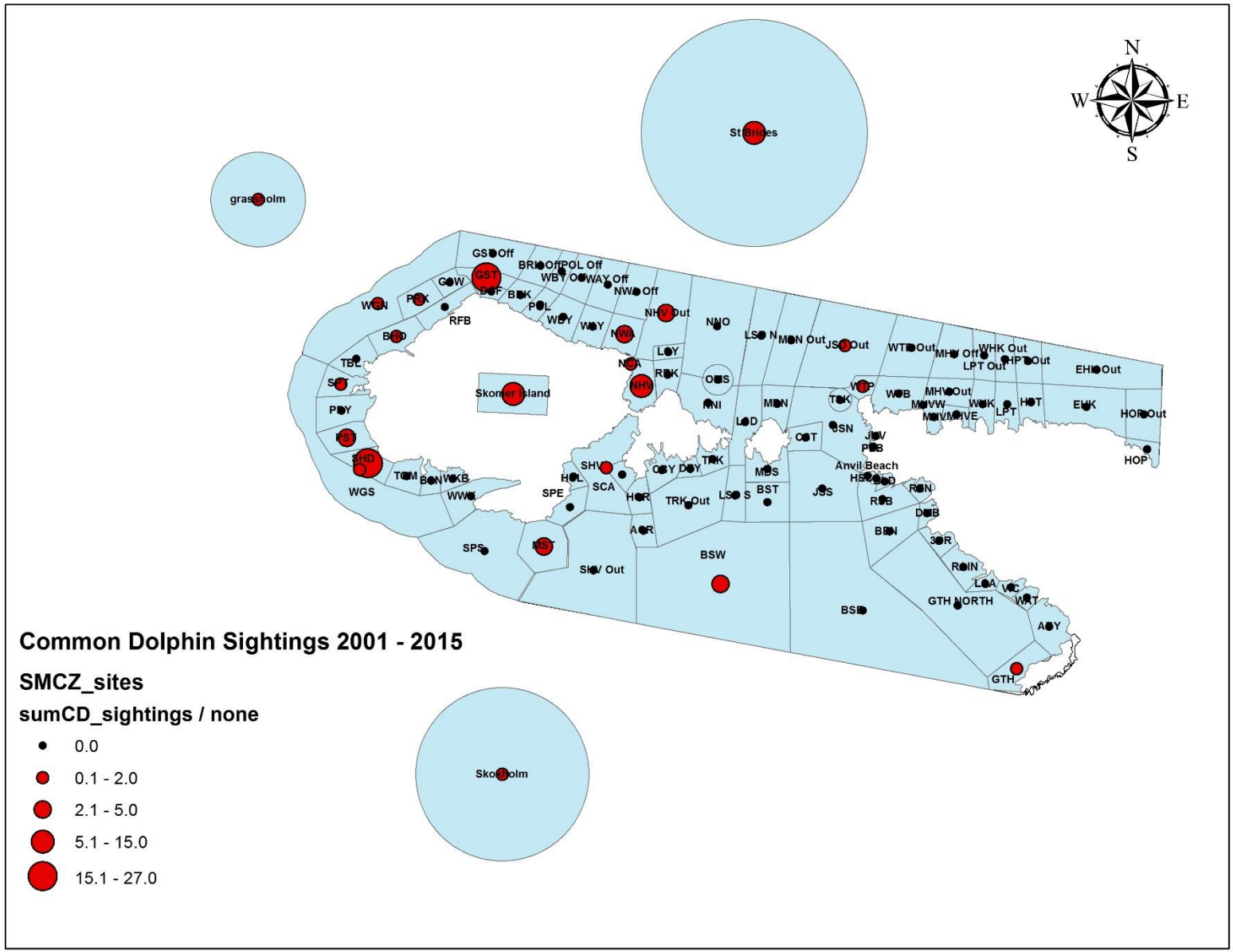
All the data since 2001 has been transcribed from the paper records and added to a data base. This has allowed the records to be mapped using GIS

Total number of Habour Porpoise sightings 2001 - 2015 (example of GIS data output).



This data is not effort corrected but is useful in showing areas that harbour porpoise frequent. The large number of sightings in North Haven bay are an artefact of how the position was recorded, in reality these sightings will be from outside of the bay. A standard recording method for site names will be adopted in 2016. The square in the middle of the island is used for non-specific location sightings of “Skomer Island”.

Total number of sightings of Common Dolphin 2001 – 2015.

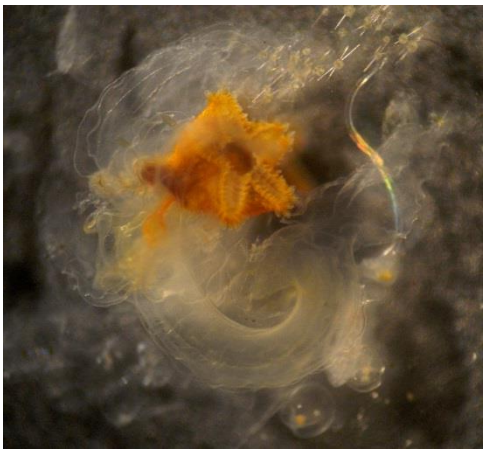


Other Cetacean studies:
In 2007 Saana Isojunno completed a study looking at the temporal habitat use of the Harbour porpoise around Skomer and Skokholm Islands.
The aim of the study was to identify any significant patterns in harbour porpoise occurrence and behaviour in relation to tidal phase, strength and direction alongside other temporal (time of the day, sea surface temperature) and spatial environmental factors in the study area.
Results reported in: S. Isojunno, J. Matthiopoulos, P. G. H. Evans.2012 Harbour porpoise habitat preferences: robust spatio-temporal inferences from opportunistic data. Mar Ecol Prog Ser, Vol. 448: 155–170.

Current status
All the data has been collated from all the sources available.

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).

Plankton Recording
(CMS Code RB04/01)



Status
Ongoing, annual survey

Project Rationale
Plankton is a vital ecological component of the marine ecosystem providing primary production and many species have planktonic larval stages. The abundance and composition are influenced by available nutrients, water movement, temperature and light.

Objectives
To collect a time series of seasonal data for zooplankton and phytoplankton

Sites
- North coast Skomer between OMS site buoy and the Lucy buoy 2008 & 2009
- North of the Lucy buoy 2010 onwards

Method
Zooplankton:
2008 &2009: A plankton sample is collected once a week using a 63um mesh plankton net trawled at less than two knots between the OMS and Lucy site markers. Samples are 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 matches 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 will be replicated at Skomer and analysis completed by PML.
A 200um mesh net is pulled on a vertical haul from 35- 40m depth at 0.2m / sec (3.5 minute haul). 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 Lugols 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 3 times 250ml samples over a 0.2um filter to estimate chlorophyll content. The chlorophyll samples are analysed by PML. The phytoplankton samples in Lugols solution are stored as a record of any plankton bloom.

2013 onwards – discontinued due to lack of analysis.

Results

The 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 planktonic identification so it cannot be considered a comprehensive list.

In 2009 12 samples were sent to 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.

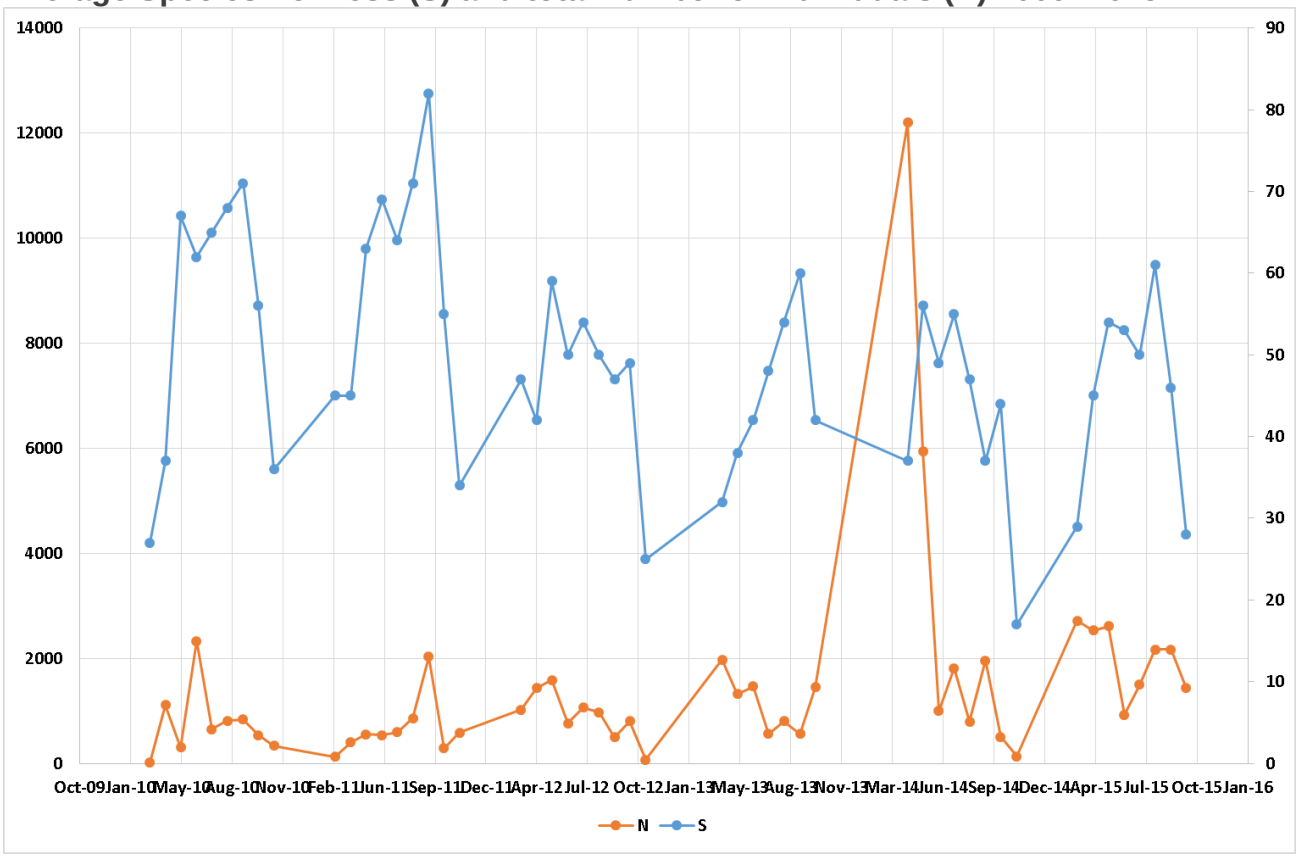
2010, 2011 & 2012 samples were collected from March to November, these have been analysed by the Plymouth Marine Laboratory.

2013 to 2015. Samples were sent to Dr D. Conway of SAHFOS (Plymouth Marine Biological Association) for ID and enumeration.

2015 Plymouth Marine Laboratory reviewed the Skomer data set from 2010 to 2014, standardised the species list and made recommendations on how the data set should continue.

Zooplankton:

Average Species richness (S) and total number of individuals (N) 2009- 2015

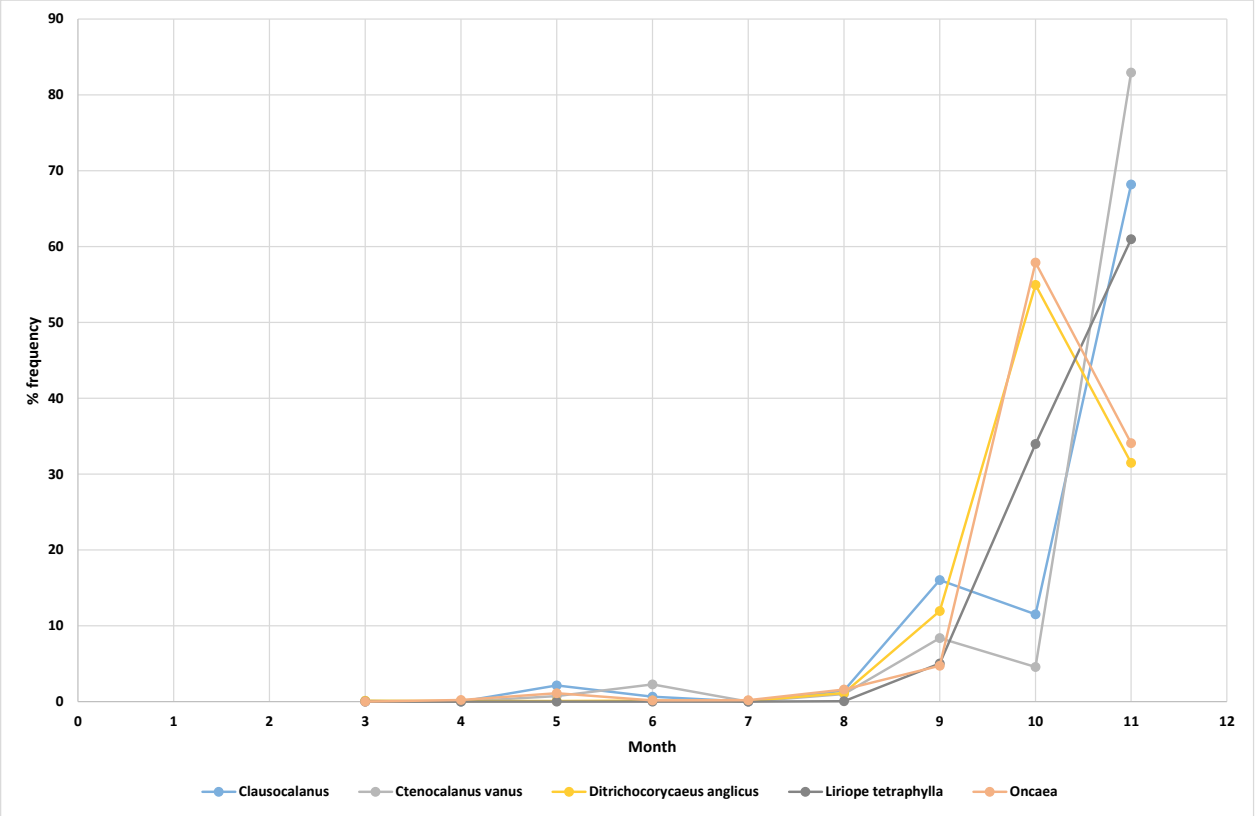


(S = number of species, N = numbers of individuals)

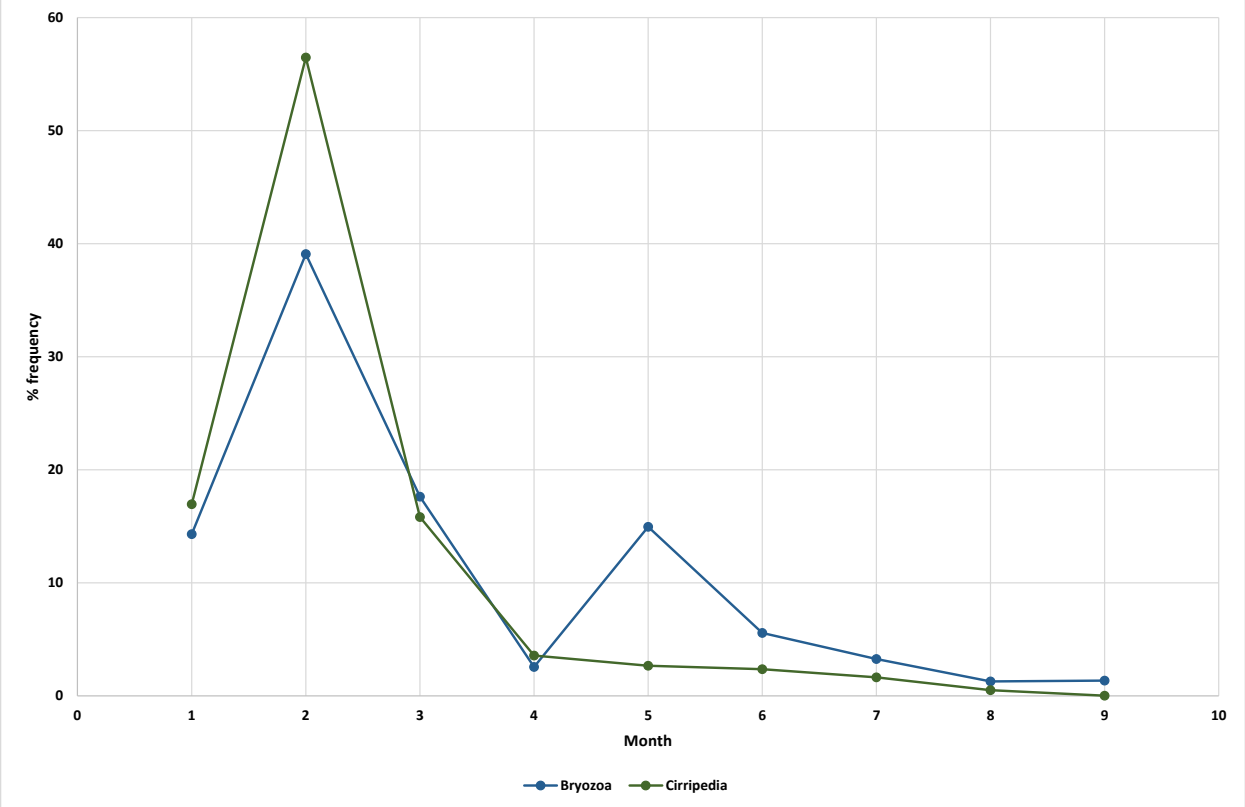
All the Zooplankton data is held on file at the Skomer MCZ office in a spreadsheet format and as Primer files. This allows for a wide range of data analysis. Individual species can be selected, differences between years can be analysed or the whole data set can be combined to look for seasonal trends.

2010 – 2015 Seasonal trends

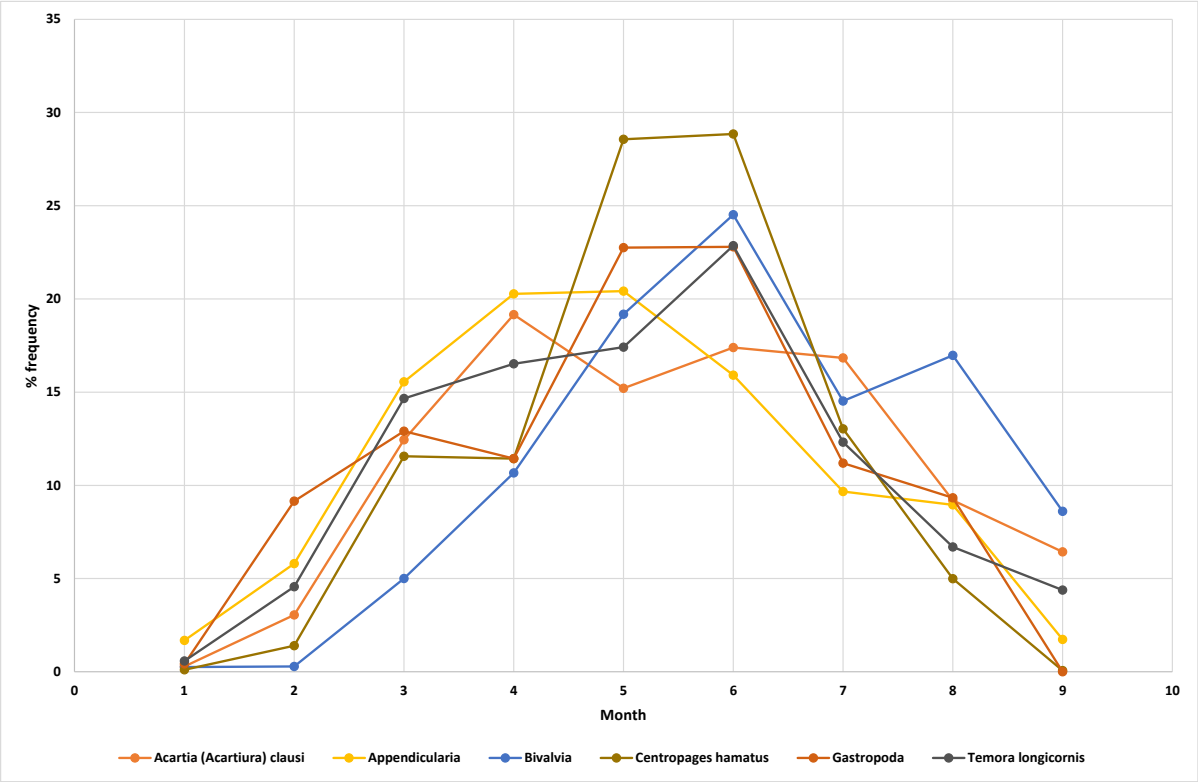
- Species which peak in the autumn.



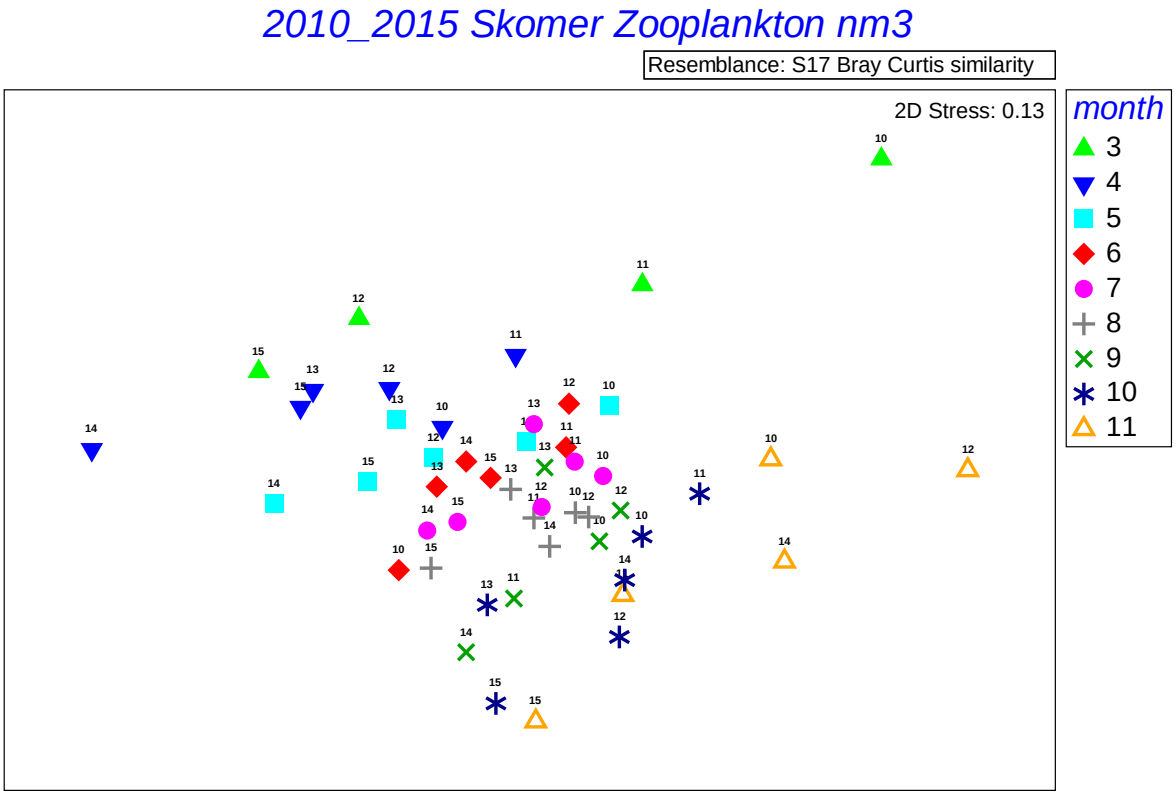
- Species which peak in the spring



- Species with a general summer distribution



Primer MDS Plot of the whole data set - labelled by month



Plankton data shows a strong seasonal pattern with months grouping together. However, these groups are in lines which does suggest inter annual variability as well.

Current Status

- Basic data collected in 2009, new methods commenced in 2010 and these have continued to 2015.
- 2015 review by Plymouth Marine Laboratory has produced for the Skomer MCZ:
  A standardised species list for 2010-2014 data.
  A method to record and archive all data.
  A method for storing the samples.

Recommendations

- Establish a time series of seasonal data for phytoplankton and zooplankton.
- Compare data sets to Plymouth Marine Laboratory L4 site.
- Publish a descriptive paper with Plymouth Marine Laboratory.
- Adopt the standardised methods produced by the 2015 review.

4 Skomer MCZ Meteorological and Oceanographic Project Summaries

Meteorological Data

CMS Code: RP 04/01

Status Ongoing, continuous.

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 the long-term weather patterns so it is essential to have meteorological data for the site.

Objectives

To provide continuous meteorological data for the Skomer MCZ area.

Sites

Coastguard lookout station, Wooltack point, Martins Haven.
Grid Ref: SM 7588 0922 (LL 51.44.78N 005. 14.78W)

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 temp, humidity, shaded and un-shaded solarimeter, net radiometer, barometric pressure 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.

January 2009. A rain collector and ammonia detector were added to the equipment suite. Monthly collections will be made for precipitation chemistry and ammonia concentration in the air records. A GMS communicator has been added to the CR1000 allowing phone access to the data. This will enable the data to be automatically updated into an external website.

January 2010. The ammonia tubes were not continued in 2010 due to a lack of funding. The weather station and oceanographic buoy have been put onto a website where the data can be viewed and downloaded.

2011. Same methods as 2010. In Jan 2012 the rain water chemistry sample was reduced to a 250ml sub-sample. Now discontinued

2012 - Weather station serviced by Campbell scientific Sep 2012.

2013 – All methods the same as 2012. Weather station equipment was not serviced.

2014 – The anemometer failed in early January and no wind data was recorded between 2nd -13th Jan 2014. A new anemometer was installed on the 13th. Weather station serviced by Campbell scientific Dec 2014. It was too windy to service the anemometer.

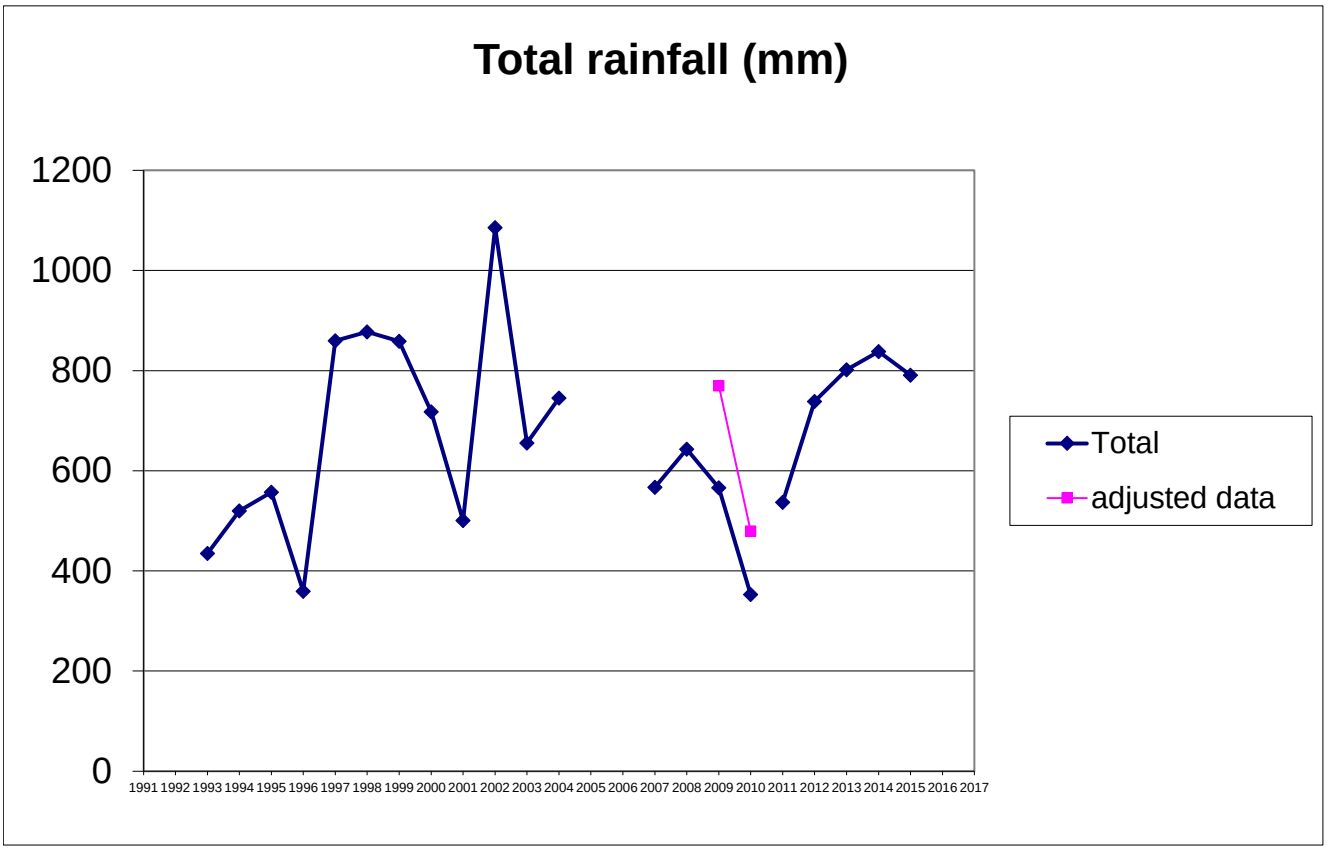
2015 – Campbell Scientific serviced the anemometer. No issues with the weather station.

Results

A continuous data set has been maintained since May 1993. However there are some gaps due to equipment failure, these are: March1994, 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.
Examples of the data are shown in the following tables / graphs.

Rainfall

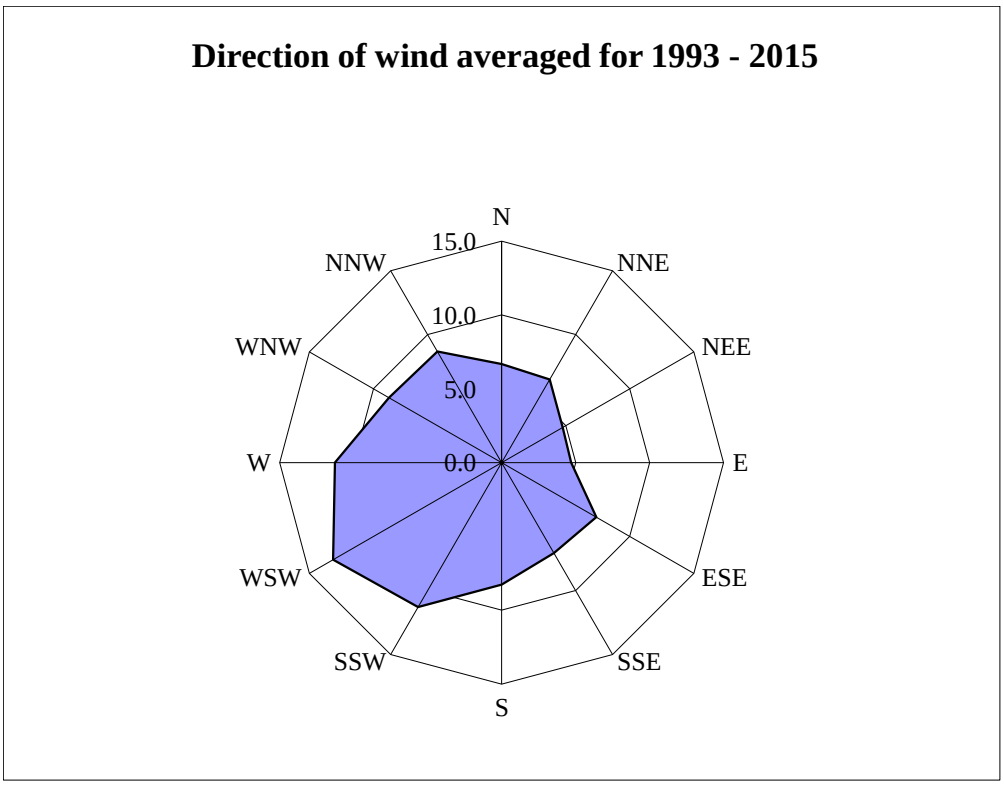
The rain gauge was not calibrated properly in 2009 & 2010 so a correction has been added to the records.



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. – It is most likely that this was a false reading. The winds will have vibrated the rain gauge causing it to "tip" when there was no water in the bucket.
This day's results have been removed from the data.

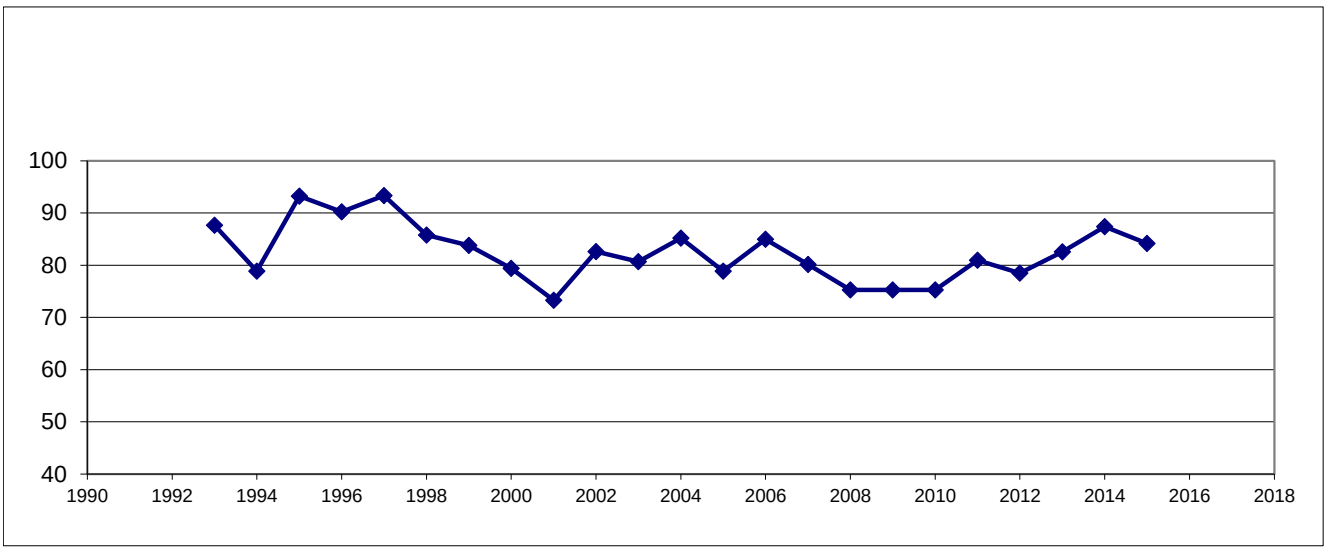
Wind speed and direction

Radar plot of frequency of wind direction. – Prevailing winds come from the WSW



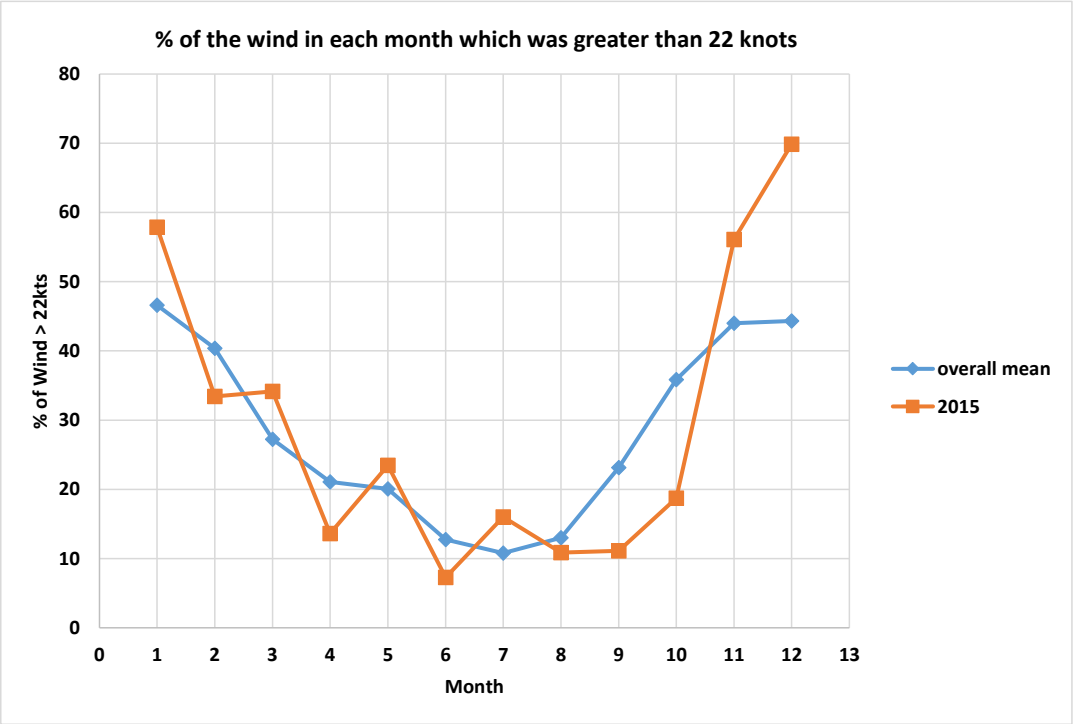
Maximum recorded 3 second gust

Maximum Wind Strength (Knots) 1993 - 2015

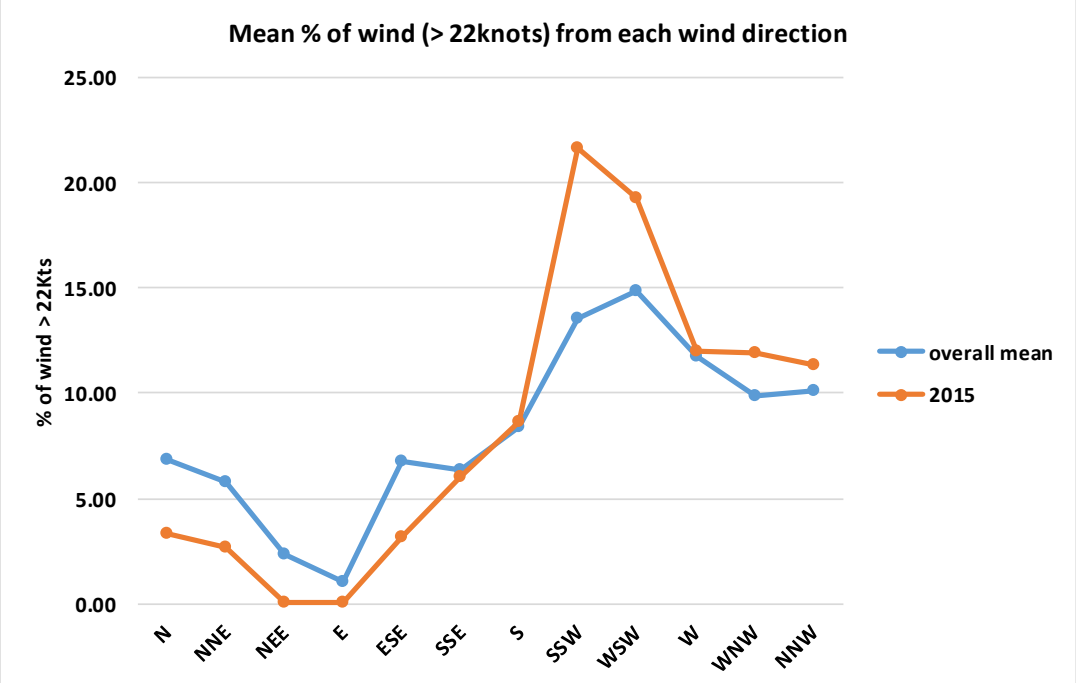


The maximum gust recorded for 2008, 2009 & 2010 was exactly the same (75.28 knots). It is possible the bearings were faulty. The bearings were replaced in 2011 and higher gusts are now being recorded. 2015 saw a maximum gust of 84.17 knots.

The strength of the wind can be summarised in a lot of different ways. The data is very complex and can be analysed in a lot of detail if needed.
Below is a graph of the % of wind recorded each year that was greater than 22 knots compared to the overall average for 1993 – 2015. Shows how windy it was in November & December of 2015.

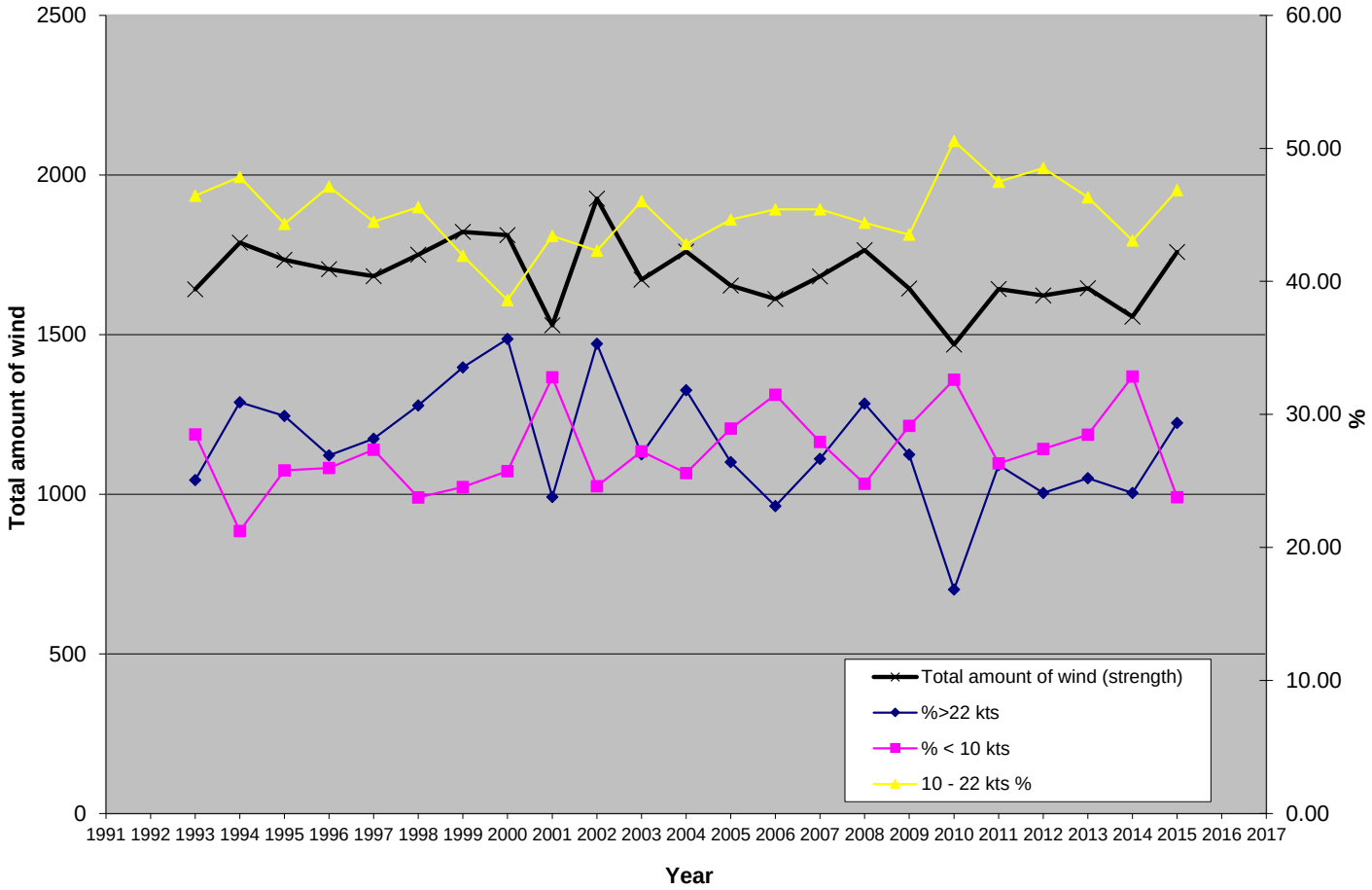


The winter months tend to have the high % of strong winds (Dec 1999 – 85% > 22Kts) but it is very variable from year to year.
The direction of these stronger winds is summarised below.



2015 has a very similar distribution of winds compared to the overall mean for 1993-2015. Most of the stronger winds come from the SW, WSW & W. The East tends to have the lowest % of strong winds.

Annual wind statistics 1993 - 2015

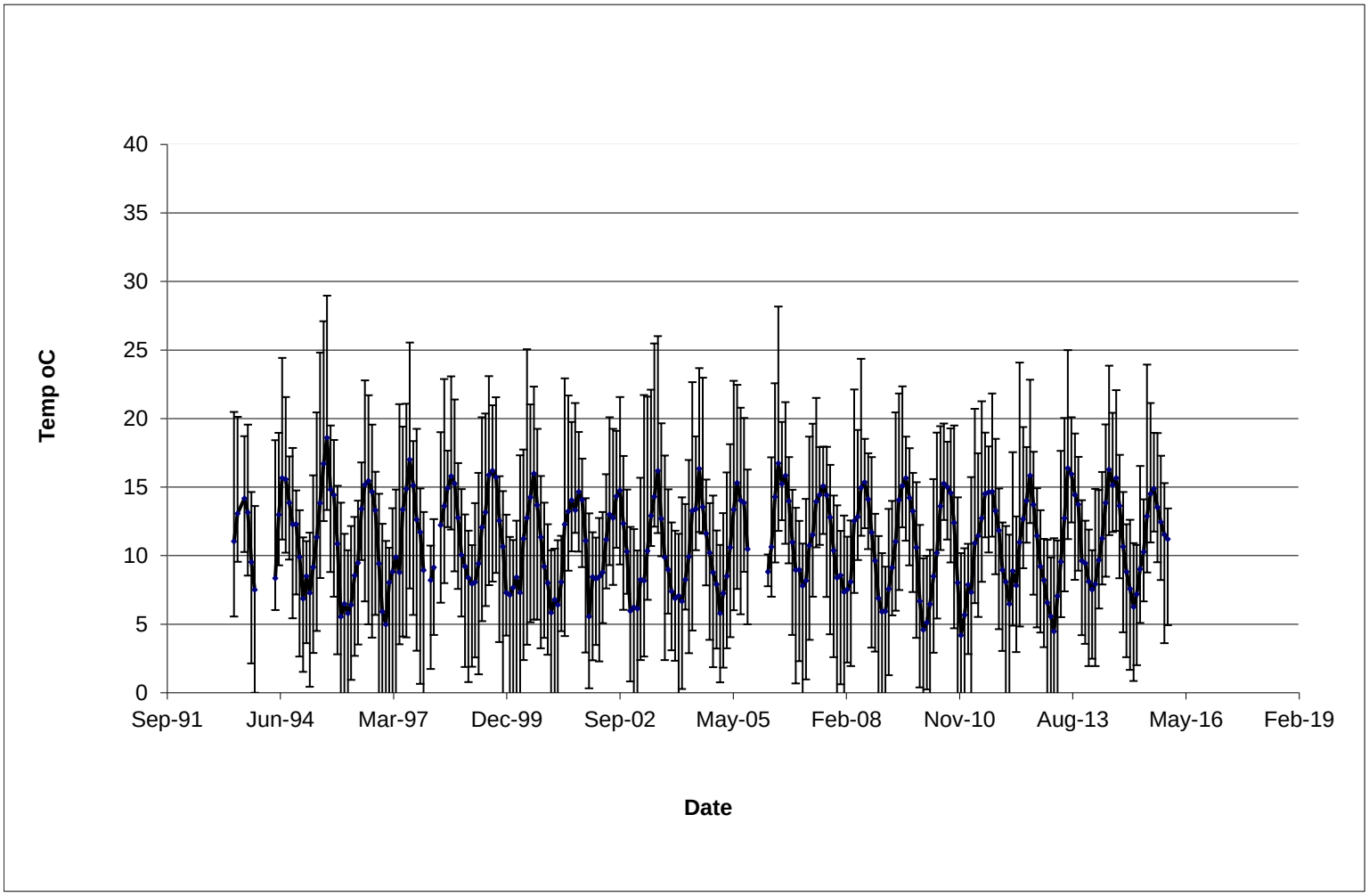


Total amount of wind is calculated from the % of wind recorded in each Beaufort force multiplied by the mid wind strength (knots) for that wind force. The windier the year the higher the “Total amount of wind”.
The amount of wind recorded over 22Kts, less than 10Kts and in-between 10 – 22 Kts is then shown as a percentage.
2002 was the windiest year with 35% of all the wind greater than 22Kts.
2010 was the calmest year with only 17% of the wind stronger than 22Kts and 33% of the wind less than 10Kts

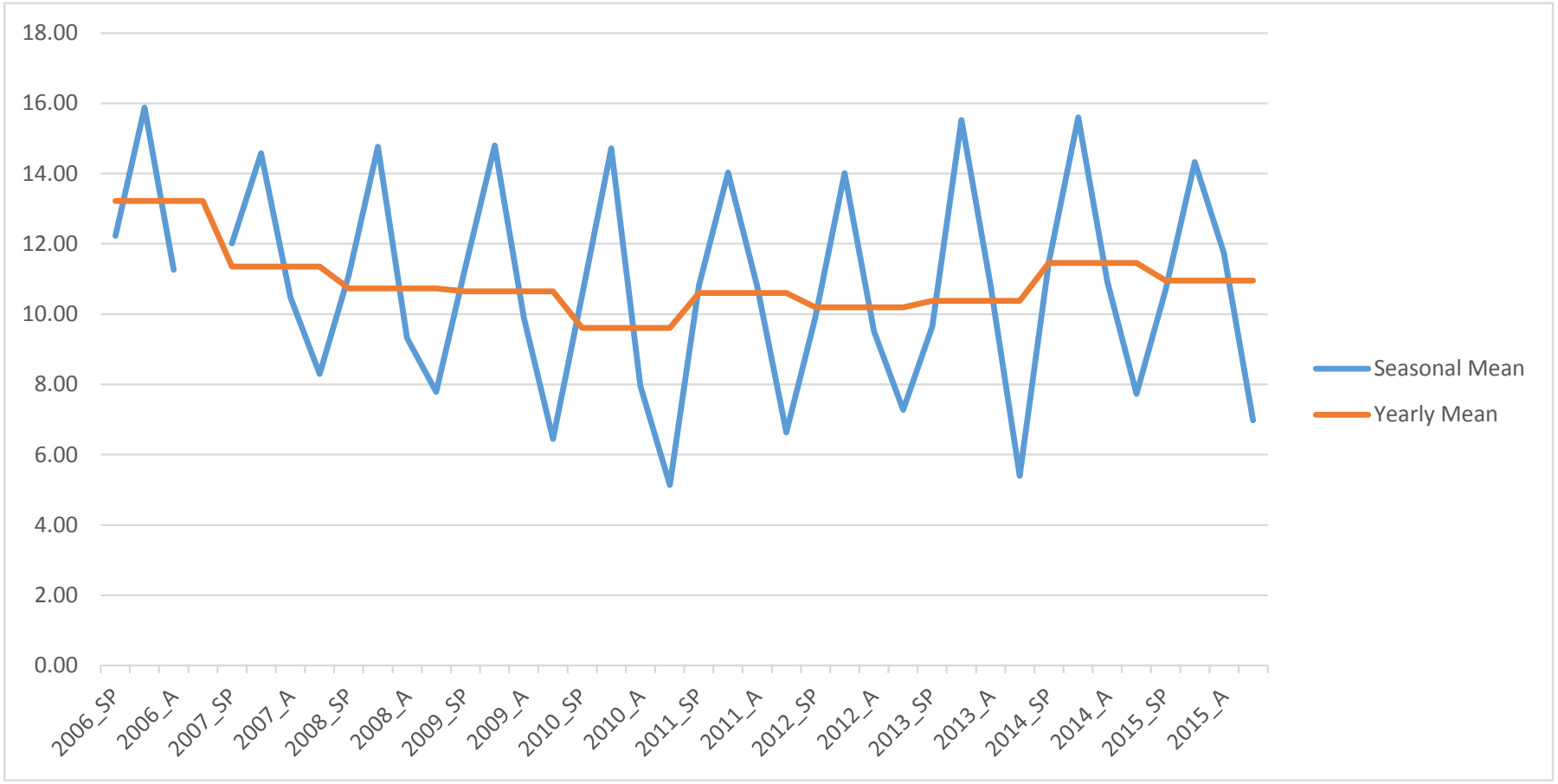
2015 Annual meteorological summary

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AIR TEMP	MEAN	7.6	6.3	7.2	9.0	10.3	12.9	14.5	14.9	13.5	12.5	11.5	11.2
T107_1 0c	MAX	12.6	10.9	10.8	16.5	14.1	23.9	21.1	19.0	18.9	17.3	15.3	13.4
	MIN	1.7	0.9	2.0	5.1	6.7	8.8	11.0	11.8	9.5	8.2	3.6	4.9
BAROMETRIC PRESS	MEAN	1006.1	1009.6	1013.8	1014.4	1007.3	1013.1	1007.0	1006.5	1010.3	1010.2	1007.2	1005.5
	MAX	1027.0	1035.0	1033.0	1031.0	1022.0	1030.0	1018.0	1018.0	1028.0	1026.0	1021.0	1022.0
	MIN	971.0	980.0	988.0	997.0	978.0	990.0	988.0	989.0	982.0	985.0	988.0	988.0
RELATIVE HUMIDITY	MEAN	80.2	81.9	84.2	81.9	86.9	87.3	86.6	88.6	82.2	84.0	87.3	88.2
	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	47.5	47.5	53.1	32.5	34.8	52.0	50.8	59.1	55.5	51.7	49.1	47.4
RAINFALL	TOTAL(mm)	191.0	22.2	33.3	11.4	58.3	35.0	38.9	49.2	84.5	33.4	142.8	90.7
SUNSHINE	MEAN(kw/m2)	0.0	0.1	0.1	0.2	0.2	0.3	0.2	0.2	0.2	0.1	0.0	0.0
	sunshine hours	75.0	143.0	231.0	317.0	354.0	366.0	352.0	325.0	276.0	205.0	60.0	43.0
	Sunshine hrs (10min	72.3	139.0	226.8	314.7	346.3	363.3	348.5	315.3	270.2	203.8	59.2	37.8
NET RADIATION	MEAN	-11.3	1.3	34.3	76.2	111.8	123.2	109.7	80.4	44.8	15.5	-7.1	-7.9
MAX GUST	M/sec	42.5	34.2	34.6	25.0	30.0	32.1	28.8	23.8	29.2	23.8	43.3	36.3
	direction	320.8	265.6	292.5	274.1	284.1	225.5	267.0	198.5	37.8	166.0	240.8	198.4
	Knots	82.6	66.4	67.2	48.6	58.3	62.3	55.8	46.1	56.7	46.1	84.2	70.4
Notes													
Anemomter serviced (Cambell Scientific) 02 March 2015													

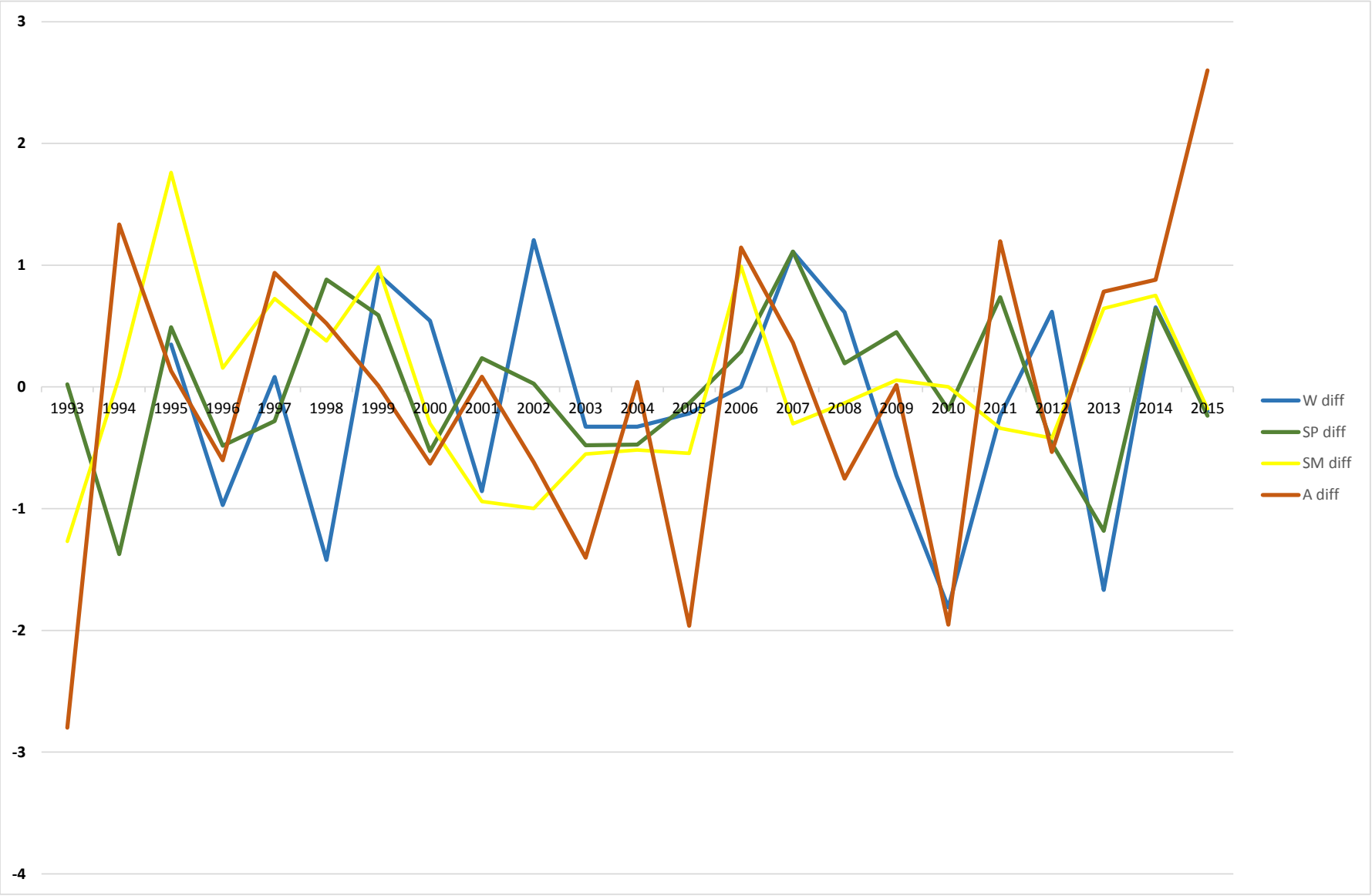
Monthly average air temperatures – Wooltack point 1993 – 2015 with Monthly Min / Max error bars



Annual & Seasonal Mean Air Temperatures (ºC) 1996 - Onwards

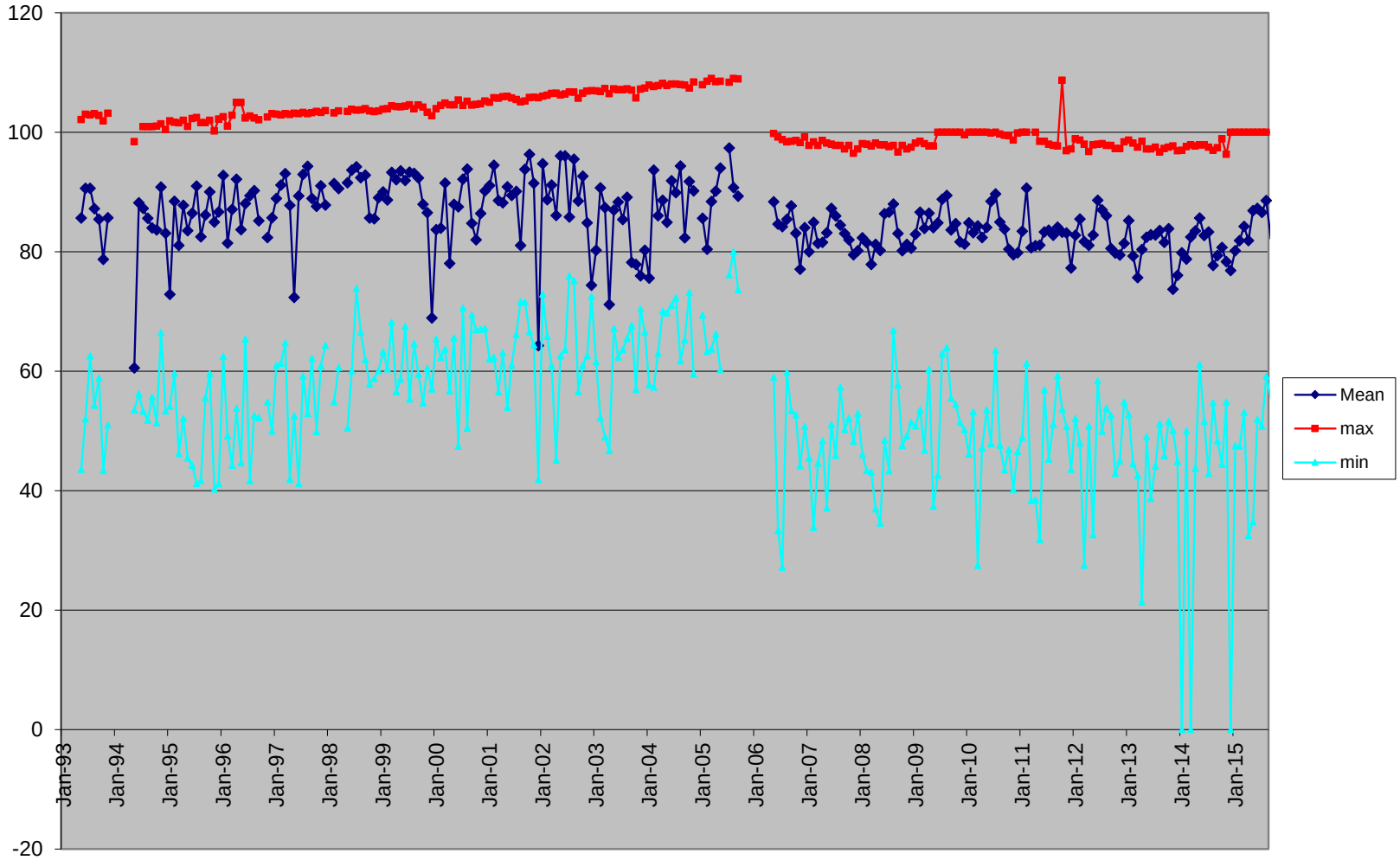


Seasonal (winter, spring, summer & autumn) Differences to Grand Seasonal Mean



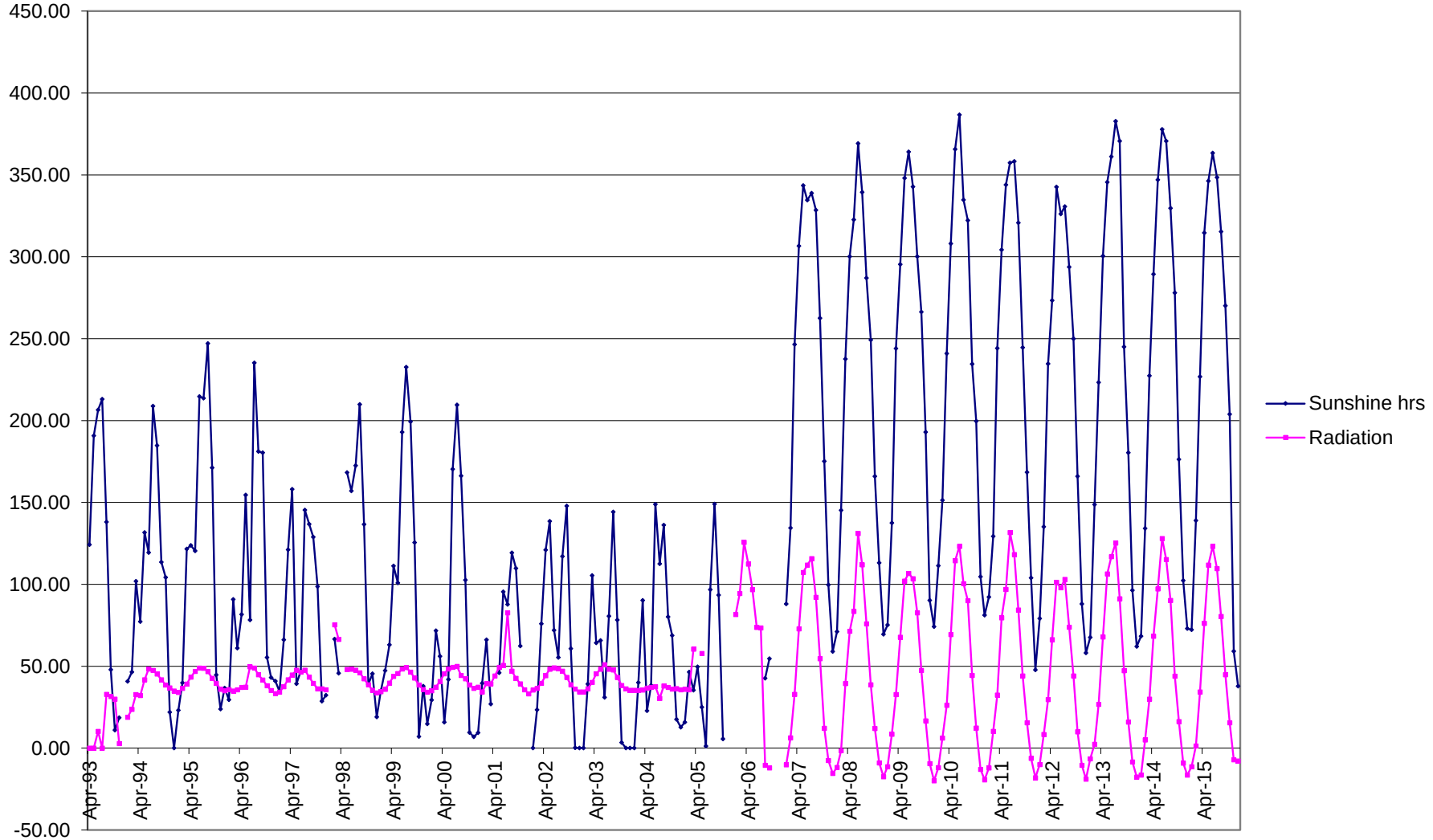
The autumn period (Oct – Dec) was very warm (2.6^{o}C higher than the average autumn air temperature), December 2015 was 4.5^{o}C warmer than normal.

Relative Humidity 1993 – 2015



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

Solar Radiation & Sunshine Hours



Note the obvious change in the data when the weather station equipment was changed in 2006

Current Status

New weather station is now fully operational with no data loss since its instalment in 2006.
The ECN website which did allow direct access to the weather data is currently disabled.

Recommendations

- Keep meteorological equipment maintained and calibrated.
- Change the bearings in the anemometer every 2 years.
- Continue contributing to the Environmental Change Network (ECN).
- Re-establish the data links to the ECN website.

Seawater Temperature Recording

(CMS Code: RP64 / 01)

Status: Ongoing, continuous

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.

Objectives

To provide accurate seawater temperature records for near seabed and in the water column. To record temperature as continuously as possible to produce an ongoing long-term data set for the site.

Sites

- Oceanographic Monitoring Site (LL 51.73913 -5.26976 W).
- Shore sites: Martins Haven, South Haven;
- Non MCZ shore sites: West Angle, Jetty beach, Castle beach & Pembroke Power station Outfall

Methods

The current equipment and methods used to record temperature is as follows:
Oceanographic Monitoring site:

- 1992 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 (19m below chart datum). The logger maintains a record every hour and is retrieved every six months to download the data. Two loggers are used; these are left out alternately at the site to allow uninterrupted data.
- 2007, YSI 6600 multi parameter sonde is attached to a fixed steel frame on the seabed (19m below chart datum). It records temperature along with: salinity, turbidity, dissolved oxygen, chlorophyll and pressure (=depth). In 2008 the YSI 6600 was linked up to a telemetry buoy to provide live 10 minute readings. The data is sent via VHF to the coastguard lookout hut and then onto the Skomer MCZ office via a fibre-optic link.
- 2010 the YSI sonde was repositioned onto the buoy. It records 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 put out in Martin's haven for the 2013 / 14 winter period.
- 2014 the OMS site was re-established with a marker buoy and a logger attached at 1m BSL.

Shore Sites:

- 2007, Onset "Hobo" pendant loggers have been deployed at Martins Haven shore (lower, middle and upper shore). South Haven shore (lower, middle and upper shore). 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 & middle shore.

Results

Oceanographic monitoring site:

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		
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

A summary of the seabed temperature (data from Vemco minilog at 19m BCD) is shown in the graph on page 64. Monthly means have been calculated from seabed temperature but substituted with the CTD probe data (seabed temp) where logger data was absent.

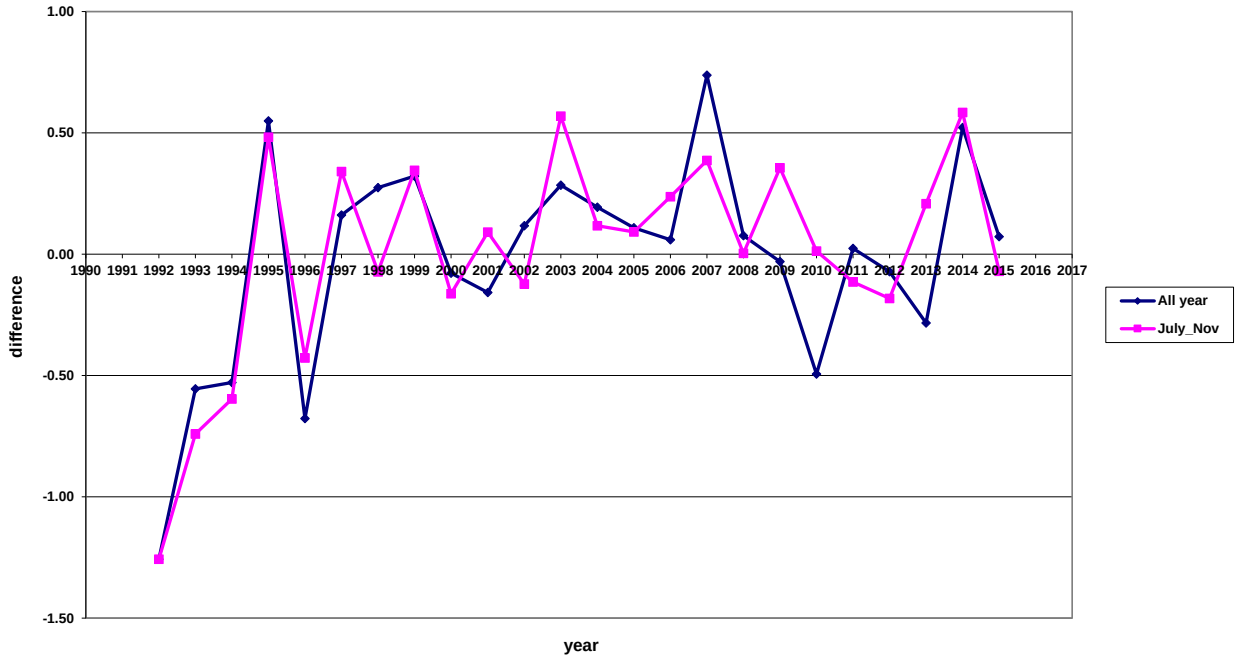
Annual maximum and minimum seabed temperature records from 2000 to 2011 are as follows (data from Vemco minilog at 19m BCD):

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**						
Minimum	7.6	8.0	6.98	8.14	7.8						
Maximum	15.9	16.6	16.82	16.72	15.98						

2009 & 2010 both had very cold air temperatures in the winter and the seawater temperature also dropped to 7 °C, the coldest recorded this decade. 2012 had a mild winter and the summer was average. 2013 had a cold April – May with sea temperatures remaining -1°C below average. 2015 was mild both in the winter and the summer.

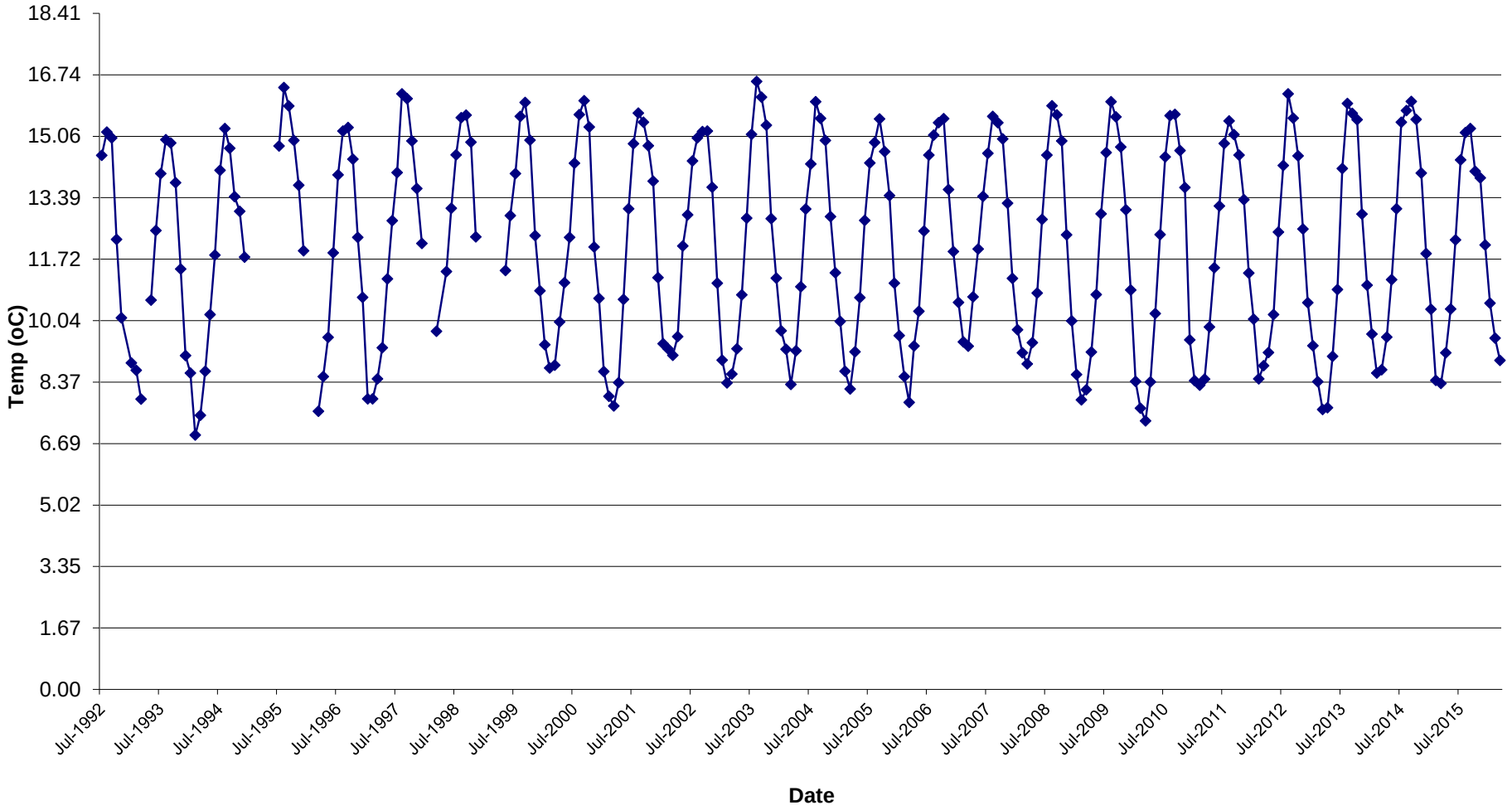
Comparing the overall monthly mean with the monthly mean for each year gives an indication of how cold / warm that particular month was compared to the whole data set. Two averages from this data were then used to express how cold / warm each year was. The blue line in the graph below averages all months in a year while the pink line just averages the months July – November (these months were chosen because all of the years have a full set of data for those months).

Average difference between the specific monthly mean temperature and the grand monthly mean (1992-2015)

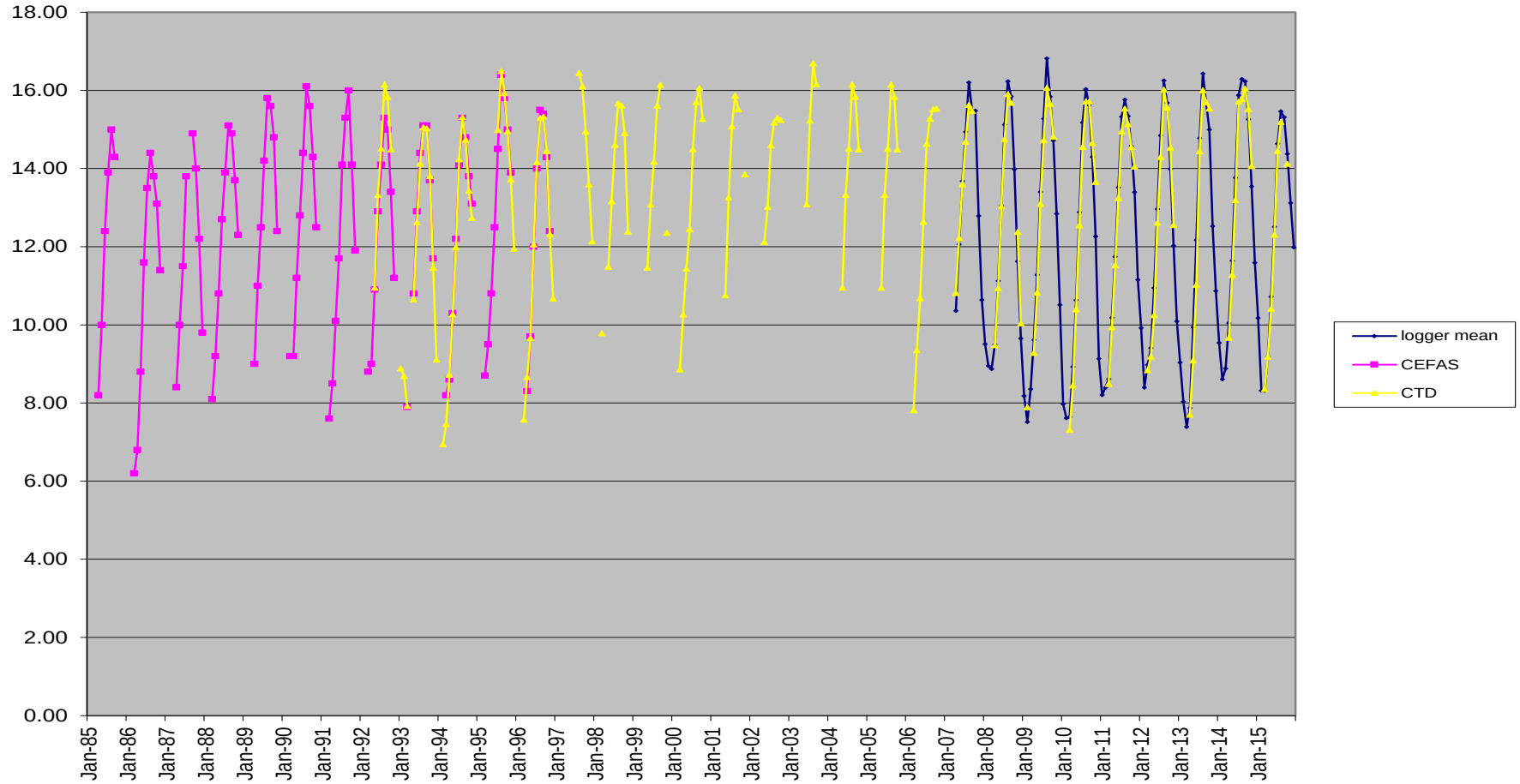


The cold winters of 2009 & 2010 have caused the trend to decline in sharp contrast to the very mild winter of 2008.

Summary of the seabed temperature ^{0}C (data from Vemco minilog at 19m BCD)



Summary of Sea Surface Temperatures – Monthly Means 1985 - 2015

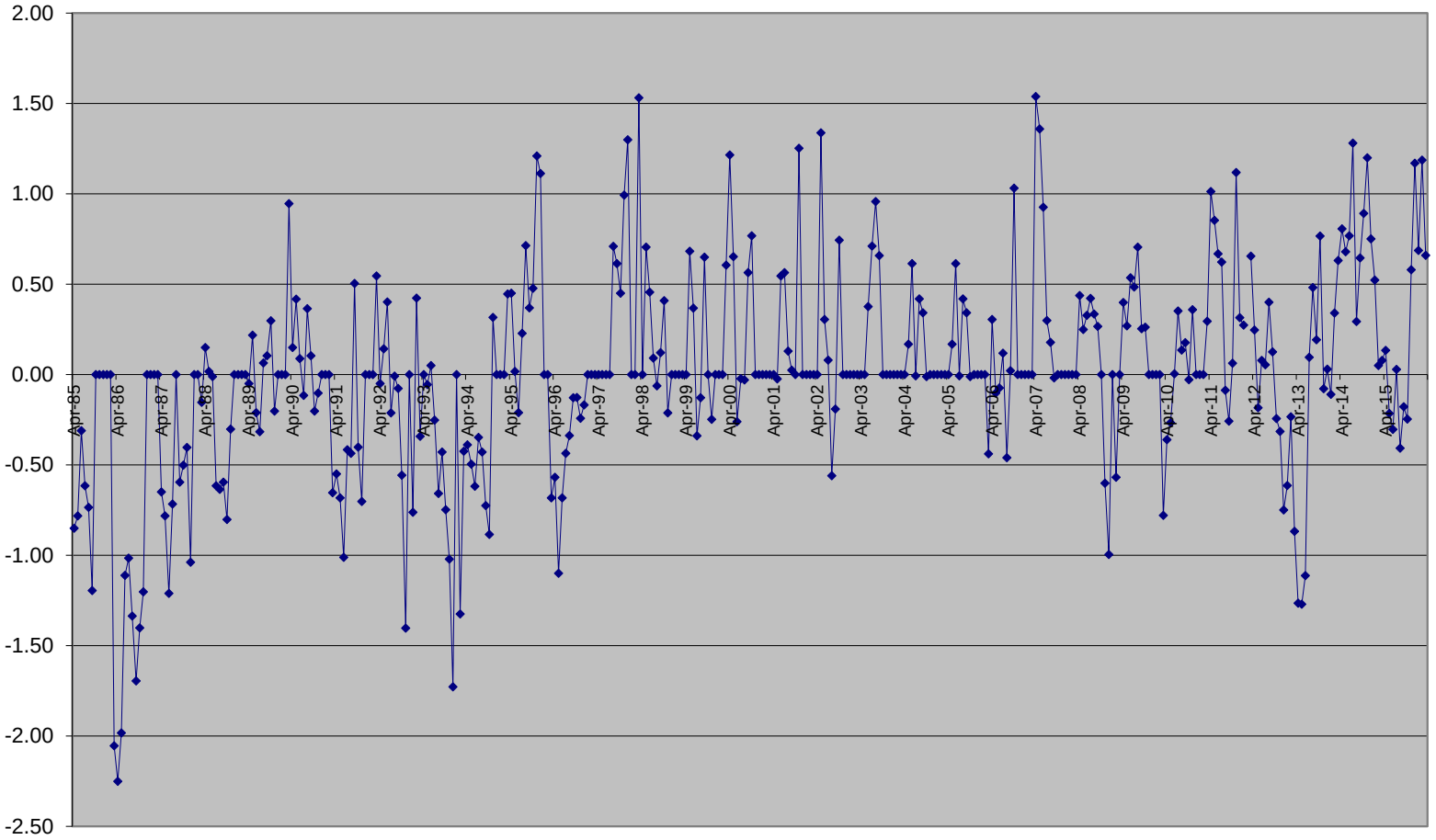


CEFAS Data - Taken from North Haven Skomer at high tide by a hand thermometer. Only available when the Skomer Warden was on site.

CTD – MCZ data taken using 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. Only 1m & 5m are used as Sea Surface Temperature records.

Logger mean – Mixture of shore loggers (when covered by the tide) and YSI 6600 sonde at OMS site.

Sea Surface Temperatures – Monthly Anomaly between the specific monthly mean and the grand Monthly Mean - (1985 – 2015)



Pre 1995 was generally cold. 1995 – 2006 was a warmer period. 2006 onwards has been very erratic with some very cold winter temperatures but some warm summer temperatures. 2015 had a very warm period from Oct - Dec.

Shore monitoring sites

10 Onset Hobo temperature / light loggers have been placed on 2 shores around the Reserve and 4 other shore locations in Pembrokeshire. These loggers will 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.

Current Status

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.

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).

Seawater Turbidity / Suspended Particulates and Seabed Sedimentation

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

Status: Ongoing

Project Rationale

Coastal waters are naturally turbid but this turbidity can change due to anthropogenic activities such as dredge spoil dumping or land management. Filter feeders will be adversely affected by large increases in turbidity.

Objectives

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

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

Methods

Secchi disk measurements - the depth to which a white “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 - 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 and heavy metal content.

Optical turbidity probe - A Seapoint OEM turbidity probe connected to an Idronaut data logger has been fixed to the frame on the seabed at the OMS site since 2002. Length of time deployed varied and there were varied levels of success. This was replaced by a 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 oceanographic buoy. Same geographical position but readings are taken from 0.6m below the surface. This was discontinued in 2013.

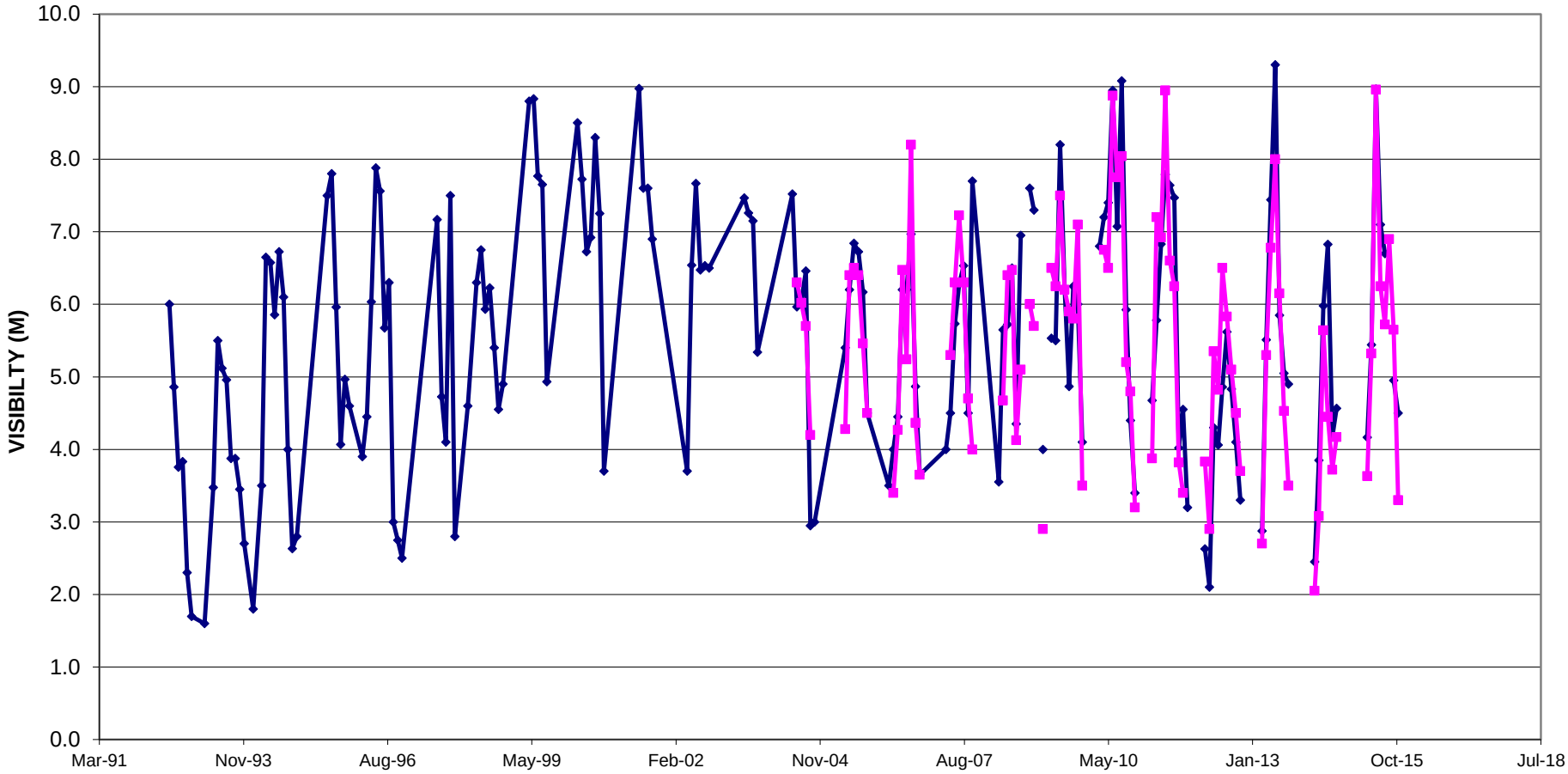
Results - Turbidity

Secchi disc: Measurements have been taken reasonably consistently for the months of May through to October since 1992. The results are summarised in the table:

Summary of Secchi disc data (m) Annual mean:

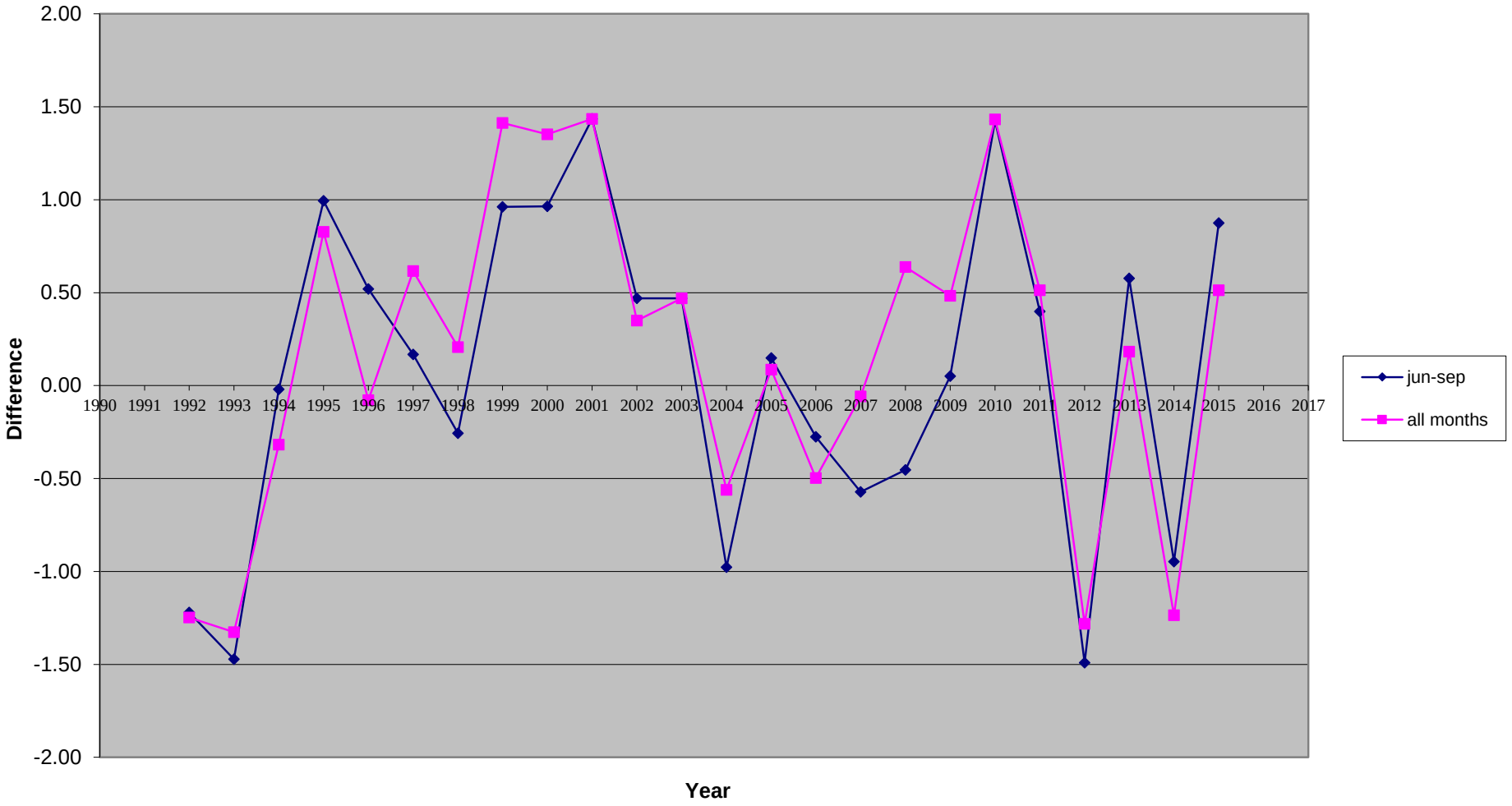
OMS (North of Skomer island)										
Year	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Yearly Mean	4.3	4.2	5.5	6.15	6.0	5.3	5.933	7.53	7.2	7.93
Number of samples	29	36	35	20	27	12	23	15	20	12
Year	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Yearly Mean	6.23	6.73	6.0	6.2	5.4	5.8	5.7	5.98	7.12	6.48
Number of samples	20	17	20	22	23	19	23	26	27	60
Year	**2012**	**2013**	**2014**	**2015**						
Yearly Mean	4.24	5.99	4.74	6.47						
Number of samples	41	34	34	23						
Thorn Rock (South of Skomer island)										
Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**		
Yearly Mean	no data	no data	no data	no data	5.8	5.7	5.5	5.9		
Number of samples	no data	no data	no data	no data	12	22	22	18		
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**		
Yearly Mean	5.5	6.15	6.74	6.17	5.17	5.37	3.86	6.01		
Number of samples	20	23	27	36	41	30	28	25		

The mean monthly Secchi disc readings for OMS and Thorn Rock are shown in the graph. This is followed by a table showing the monthly mean summary at the OMS from 1992 to 2010. Plotting the mean difference between the monthly average and the overall average highlights any significant fluctuations.

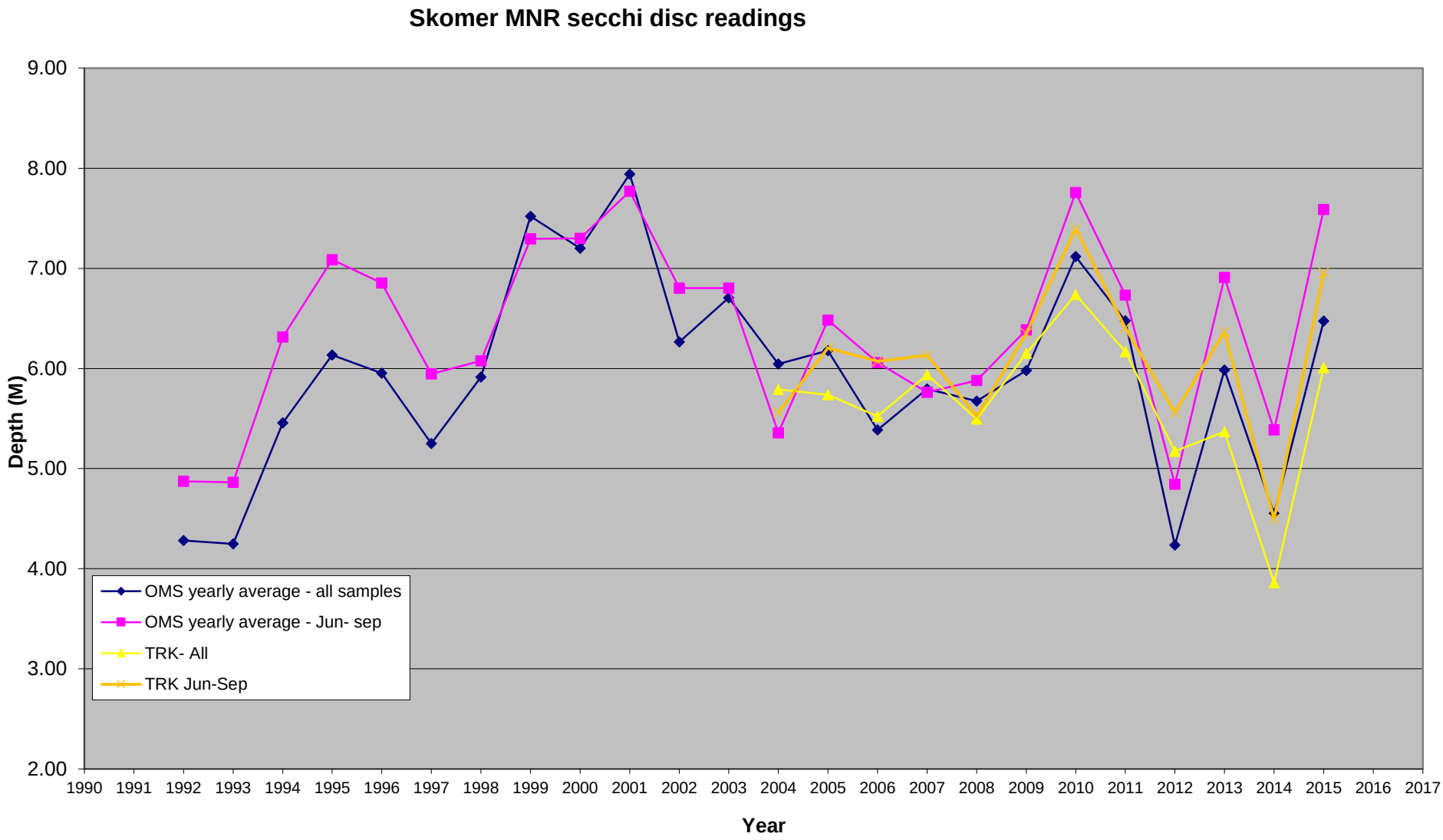


OMS = Blue line, TRK = Pink line

Plot of the mean differences between the monthly average Secchi reading and the overall average at the OMS site.
(All months = pink, June – Sep = blue line)



2012 appears to have been more turbid than the previous 18 years. 2014 was another poor year for visibility but in 2015 the water was a lot clearer.



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 Reserve during the winter storms, it is thought that this silt was continually being re-suspended into the water column throughout the year. In 2015 although the weather was unsettled the visibility was better than 2014.

Seabed sedimentation - passive sediment traps

The samples from the sediment traps have been analysed for; dry weight, organic content, grain size analysis and metal content.

Passive sediment trap results

The table shows the sampling effort from 1994 to 2015 at OMS and Thorn rock (TRK).

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	

In 2013 the sediment samples were sent to the NRW Llanelli Labs for analysis. They have a different set of analysis tools / machines to the BGS.
The organic content was done at 550^{o}C not 450 ^{o}C therefore more carbonates will be included in the %organic carbon – this will explain the sudden leap in the 2013 values.

The NRW labs do a slightly different suit of metals analysis but it is more comprehensive;
Cobalt (Co) & antimony (Se) are not done but manganese, mercury, lithium, aluminium, barium, tin and iron are all now added to the metal analysis.

The method for the coarse (gravel) particle size analysis (PSA) has also changed.

Yearly results from the OMS site

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

Sand % for 1995 – 1998 are estimated. The 2009 results have been adjusted to remove the effect of shell fragments in the samples (see note below).

Yearly results from the TRK site

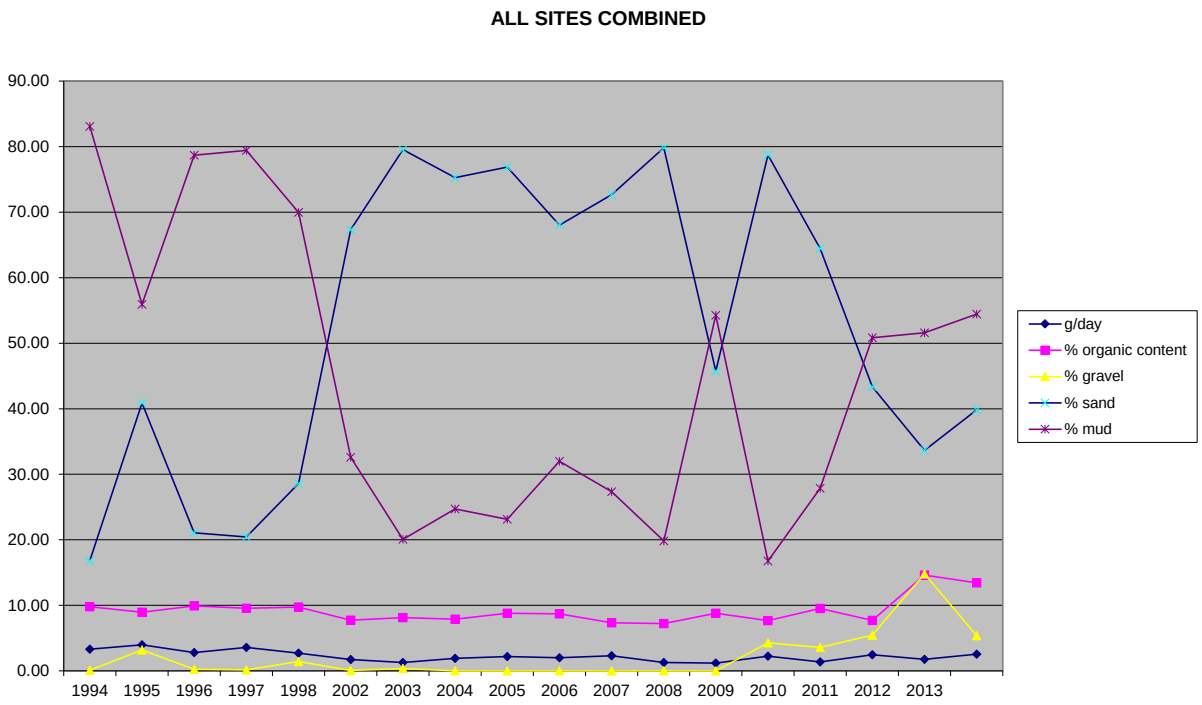
TRK	g/day trk	% organic content	% gravel	% sand	% mud
1994	3.32	9.80	0.10	16.83	83.07
1995	5.76	8.59	0.41	55.76	43.83
1996	3.53	9.90	0.21	22.56	77.23
1997	5.81	9.43			
1998	4.15	10.25	0.23	23.89	75.89
2002	2.44	7.61	0.00	61.63	38.36
2006	1.74	8.65	0.00	60.35	39.65
2007	1.54	7.73	0.00	69.81	30.19
2008	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

Note: 2009 values have been adjusted.
2009 samples were contaminated by large amounts of small shell fragments

General trends:
1994 – 1998 samples were characterised by higher mud content to sand content.
2002 – 2008 samples had higher sand content to mud content.
2009 the trend has swapped back to higher mud content
2010- 2012 have a higher sand content and gravel is getting more prevalent.

2013 – Gravel content increases again as does the mud content. The %organic carbon doubles but this is probably due to a change in methodology – see below

Combined Results for Passive Sediment Traps 1994 - 2014

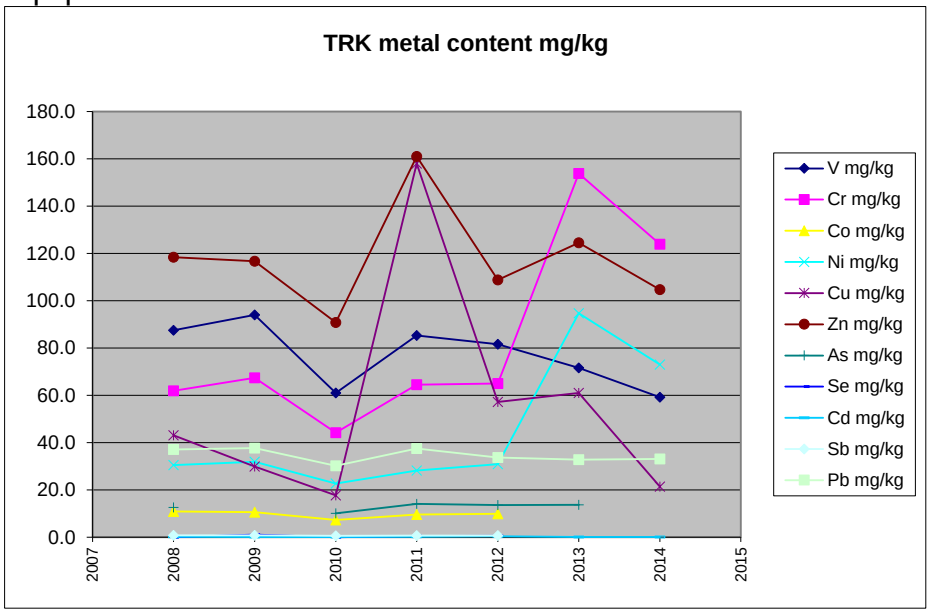


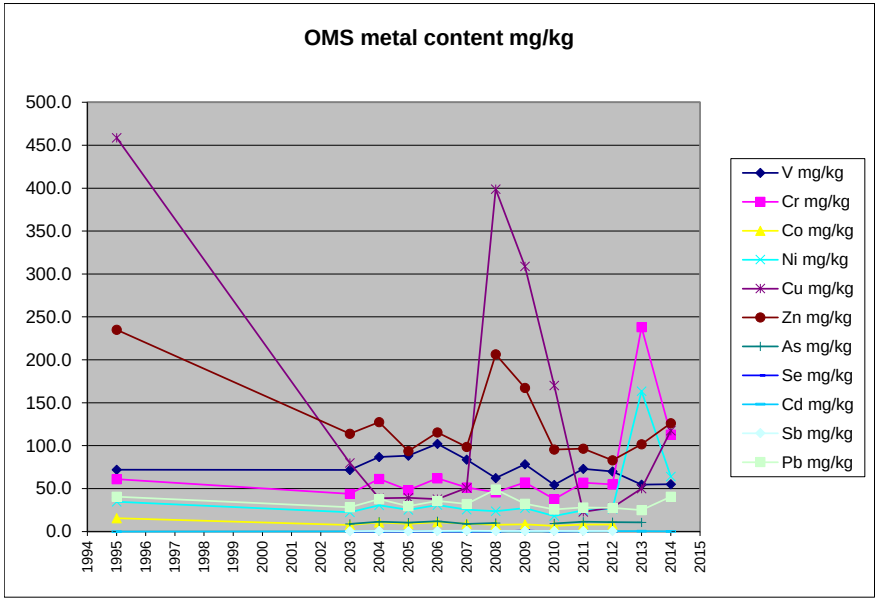
Gravel content increased in 2013 – mainly at the OMS site.
2012 saw mud become more prevalent than sand and this continued into 2013 & 14.

1994 – 1998 mud content was very high; in 1998 the dredge spoil dumping site for Milford Haven was moved 20 miles off shore. When records began again in 2002 the mud content was much lower.

Metal Analysis Results

The metal analysis has been done at the OMS site since 1995. From 2008 onwards TRK samples were also analysed.
Most of the values are very consistent except copper (Cu). The 1995 -8 average and the 2008 values for OMS are a factor of 10 higher than the rest. The most likely reason for this is the use of copper based anti-fouling paint in the collector and on nearby oceanographic equipment.





2013 was analysed by a different Lab – chromium (Cr) and nickel (Ni) both show elevated levels compared to previous years – so far no methodological reason can be found for this discrepancy. These new levels take Cr & Ni over the PEL levels for these metal. The 2015 samples are currently with the lab but have not been analysed.

Current Status

- Secchi disc method works well and has provided the most reliable / meaningful estimate of turbidity. The data set is still young but could form a very useful long-term data set if continued regularly.
- 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 incident). The samples from 1995- 98 & 2002 – 2015 were sent away and analysed for; dry weight, organic content, grain size analysis and metal content.
- The optical turbidity probe has proved unreliable and difficult to interpret. It is not sensitive enough.

Recommendations

- Continue the Secchi disk readings as often as possible to produce a long-term data set.
- Continue with the sediment traps.
- Restart the water samples for chlorophyll.

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Appendix 1 Microbial community profiling of healthy, fouled and black sponges (Cliona sp.) from Skomer MCZ, Wales.

Microbial community profiling of healthy, fouled and black sponges (*Cliona sp*.) from Skomer MCZ, Wales.

Joanne Preston, University of Portsmouth.

Background

Marine sponges are the oceans natural filters and play an essential role in maintaining water quality in coastal and deep seas. They are key players in the marine carbon and silicon cycles, providing a link between the water column and seabed. The biodiversity and biomass contribution of sponges to temperate ecosystems alone is vast, and they provide habitat heterogeneity and refugia for many other organisms in a similar way to corals in coral reefs. Disease in both tropical corals and sponges has been increasing over the last few decades, and has led to catastrophic population crashes in the Mediterranean and Caribbean, with deleterious impacts for the water quality and fisheries (Cebrian et al., 2011).

In 2012 Mark Burton and Jennifer Jones observed sponge disease in the boring sponge *Cliona celata* in Skomer Marine Conservation Zone (SMCZ), Wales, and it has reoccurred and spread each summer since. The sponges either recovered, or died exposing bare rock. By 2015 black individuals were observed in all sites monitored by the conservation team at SMCZ (Burton, pers comms). This is the first recorded incident of sponge disease in temperate waters, but whether the cause is pathological or a breakdown in sponge function due to incremental or major environmental stressors, is currently unknown. However, there is a clear seasonality to this phenomenon, which could be indicative of a climatic trigger.

Sponges produce antifouling and antibacterial compounds to deter organisms from settling on their surface but when affected by this pathogen/stressor, sponges are visibly unable to prevent fouling on their surface and become smothered with growth, leading to death. Mass global sponge mortality would have fundamental and deleterious impacts on marine ecosystems in ways we are just beginning to understand. This research will provide a greater understanding of the microbial mechanisms of sponge disease in temperate marine systems and more broadly the role of marine microbes driving biogeochemical cycles in coastal ecosystems.

Sponges host a diverse, and often specialist, symbiotic microbial community, providing an unrivalled model of marine symbioses. The bacterial biomass of sponges can account for 35% of total biomass (Maldonado *et al.* 2012) and exceed that of ambient seawater by several orders of magnitude (Gili *et al.* 1998). An astonishing fact, given the high density of microorganisms in seawater, particularly coastal areas. Importantly, many sponge functions are dependent on their microbial symbionts (Wilkinson, 1978), including the production of chemical defence molecules (Richardson *et al.* 2004), and secondary metabolites (Webster & Blackall, 2009). Given the complexity and specificity of sponge-microbe associations, shifts in microbe associations due to environmental stressors (including climatic change) will likely affect sponge resilience to predatory and pathogenic attack, sponge health and function, and consequently ecosystem services to the marine environment, a hypothesis this preliminary data analysis supports.

In this study we used a metagenomic approach. Metagenomics enables the analysis of DNA from microbial communities in environmental samples, and removes the need for culturing. This allows us to create a community biodiversity profile and relate this to metadata (environmental data) derived from the sampling site, or compare different samples. The approach used here is marker gene amplification metagenomics using PCR amplification and sequencing of the 16S ribosomal RNA gene. The 16S rRNA gene reflects eubacterial evolution, and is widely used for taxonomic identification in microbial ecology.

Methods

Black, fouled and healthy *Cliona celata* sponge tissue, collected from 4 locations around Skomer in June 2013 and September 2014, were immediately preserved in RNAlater™. From each site, 250mL of seawater was filtered to sample the microbial community of the ambient seawater. Filters were frozen at -20°C. All samples were sent to the University of Portsmouth for molecular analysis. DNA was extracted from the sponge samples using a CTAB extraction method (Simister et al, 2011). A total of 12 samples were analysed: 3 replicate samples of healthy, fouled and black sponges from Bull Hole site, 1 healthy sponge sample from Thorn Rock, and healthy, fouled and diseased/black sponge form West Hook. The diseased/black sponges were collected from Bull Hole during summer 2015, the diseased sample from West Hook in 2013 and the remaining samples collected in 2014 (Table 1). An approximately 300 base pair fragment from the V3 region of the 16S ribosomal RNA gene was amplified by PCR using the universal primer set 515F – 806F (Ref) and next generation sequencing was performed on the Illumina MiSeq system by LGC Genomics, Germany. Sequencing was funded by Natural Resource Wales.

Bull Hole	Thorn Rock	West Hook
3 x Healthy sponges (2014) BHO-C1a, C2a, C3a	1x Healthy sponge (2014) TRK-C1a	1x Healthy sponge (2014) WHK-C1a
3x Fouled sponges (2014) BHO-F1a, F2a, F4a		1x Fouled sponge (2014) WHK-CF3a
3x Diseased sponges (2015) BHO-E6, E18, E20		1x Diseased sponge (2013) WHK-Black

Table 1: Cliona celata samples analysed by 16S rRNA gene tagged parallel sequencing on the Illumina MiSeq Platform (LGC Genomics, Germany).

Results

The number of sequence reads for each sample is given in Table 2. The black *C. celata* sample from West Hook yielded a lower number of sequences than expected, but the remaining samples provide a robust data set of the microbial community profile in all 3 states of healthy, fouled and black.

Sample name	Raw total reads	Combined reads	Uncombinable read pairs
515F-806R	3,950,908	0	0
515F-806R-Sk-BHO-C1a	170,944	84,426	692
515F-806R-Sk-BHO-C2a	107,886	52,723	439
515F-806R-Sk-BHO-C3a	195,626	95,383	684
515F-806R-Sk-BHO-E6	342,686	169,678	1,008
515F-806R-Sk-BHO-E18	266,334	127,835	699
515F-806R-Sk-BHO-E20	301,902	143,638	576
515F-806R-Sk-BHO-F1a	290,644	139,467	930
515F-806R-Sk-BHO-F2a	67,266	33,049	290
515F-806R-Sk-BHO-F4a	535,636	262,351	2,268
515F-806R-Sk-TRK-C1a	136,772	67,585	431
515F-806R-Sk-WHK-Black	1,082	442	3
515F-806R-Sk-WHK-C2a	52,196	25,500	182
515F-806R-Sk-WHK-CF3a	194,360	95,564	619

Table 2: Number of individual sequence reads, and combined fragment reads.

In environmental microbiology, species distinction is determined by sequences of 97% or greater similarity and referred to as operational taxonomic units. If the sequence matches that of a described bacteria you can infer the taxonomic classification to species level. In some cases the sequence similarity only allows classification to higher groupings such as genus, family or class etc.
Preliminary analysis was performed on a subset of the metagenomic database, including the samples highlighted in Table 2. The processing power required for analysis of such a large dataset requires is substantial and often requires remote or cloud based servers. Bioinformatic analysis of the metagenomic subset was performed using the remote Silvangs pipeline (Quast et al 2013), which has a maximum limit per run, which equated to sequences from 3 samples from this study. Further, comprehensive analysis using the complete data set is currently ongoing by J Preston using the UoP supercomputer SCIAMA and software QIIME.
A total of 501,372 combined 16S rRNA gene sequences were retrieved with only 0.03% rejected based on quality, indicating high quality sequence data. Sequences had an average length of 251bp. A total of 10,039 OTUs, or species, of bacteria and archaea were identified across the 3 samples of Healthy, fouled and diseased sponges. The diversity, reflected in the number of OTUs, varied greatly across the sponge states (Table 3).

Cliona celata sample	Tissue state	No. OTUs (species designations)
BHO-C3a	Healthy yellow sponge	816
BHO-F4a	Fouled yellow sponge	5652
BHO-E20	Black/necrotic	3571
	Total	10,039

Table 3: Number of Operational Taxonomic Units (sequences with > 97% similarity) in sponge samples from Bull Hole, Skomer MCZ.

There are striking differences in microbial community between the healthy, fouled and black sponges (Figures 1 & 2). In the healthy *Cliona celata* sponge, Betaproteobacteria (68%) and Gammaproteobacteria (28%) were the most abundant classes. In the fouled sponge, a large increase in Betaproteobacteria (92%), decrease in Gammaproteobactera (3%) and 10 fold decrease in Archaea was

observed. A significant increase in bacteria of no known relative (6%) in the fouled sponge accompanied a large increase in the number of OTUs (5,654) from rare but diverse sequences. The healthy sponge exhibited the lowest microbial diversity (816 OTUs), with a microbial community defined by the dominance of a single species *Candidatus Branchiomonas* (59%); recently identified as a novel Betaproteobacterial agent of gill epitheliocystis in sea-farmed Atlantic Salmon (Toenshoff *et al* 2012). The dominance of *Candidatus Branchiomonas* increased to 85% in the fouled sponge, but was only present at 3% in the necrotic/black sponge. In the black sponge Alphaproteobacteria (42%) and Gammaproteopacteria (28%) were the most abundant classes. Deltaproteobacteria (20%) increased and a much larger representation from the phyla Bacteroides (27%) and Firmicutes (9%) shifted the microbial community in the black sponge dramatically.

A large percentage of healthy microbial population were assigned to the phototrophic purple sulphur bacteria family Ectothiorhodospiraceae (19%) and the sulphur oxidising Thioalkalispira (8%). Cyanobacteria, namely *Syneococcus* sp. were also present at an abundance of 1%. Most of these groups were reduced to < 1% in the microbial community of the fouled and black sponges. Pseudovibrio sp (23%) were most abundant in the diseased sponge, but absent in the healthy or at very low abundance (0.005%) in the fouled state sponge.

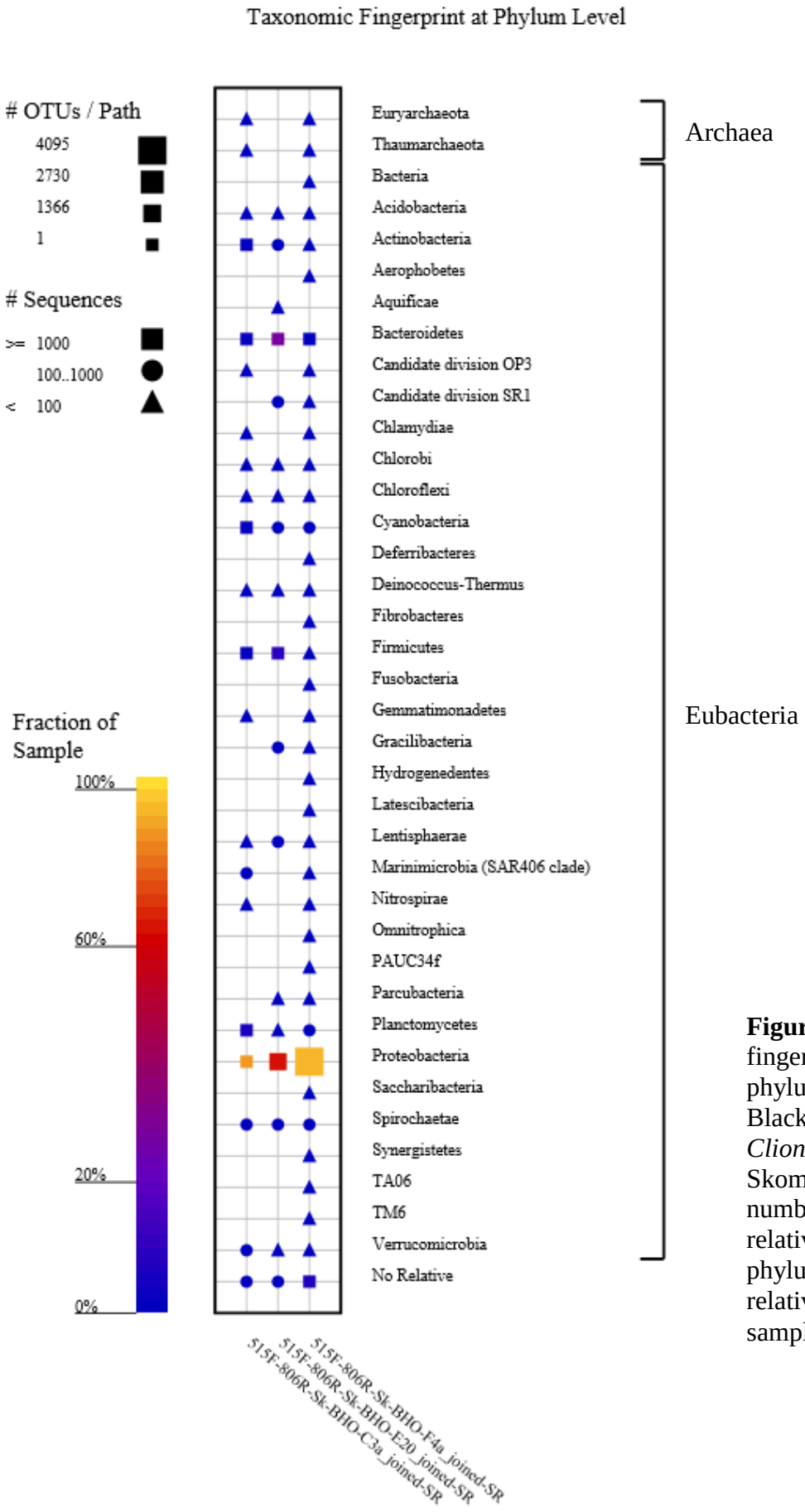
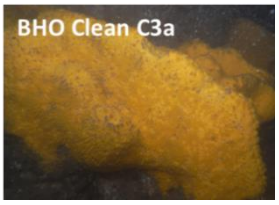
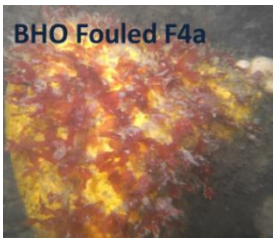


Figure 1. Taxonomic fingerprint of 16S sequences at phylum level for Healthy (C3a), Black (E20) and Fouled (F4a) *Cliona celata* from Bull Hole, Skomer. Shape indicates the number of sequences, size is relative to number of OTUs per phylum and colour indicates relative abundance (fraction of sample).



Bacteria – 99%
88% Proteobacteria
- 68% Beta
- 28% Gamma
- 3% Alpha
- 1% Delta

5% Plantomycetes
2% Bacteroidetes
2% Firmicutes
1% Actinobacteria
1% Cyanobacteria



Bacteria – 94%
99% Proteobacteria
- 92% Beta
- 3% Gamma
- 2% Alpha
- 2% Delta

< 1% rare sequences

Bacteria – 100%
63% Proteobacteria
- 4% Beta
- 28% Gamma
- 42% Alpha
- 20% Delta

27% Bacteroidetes
9% Firmicutes

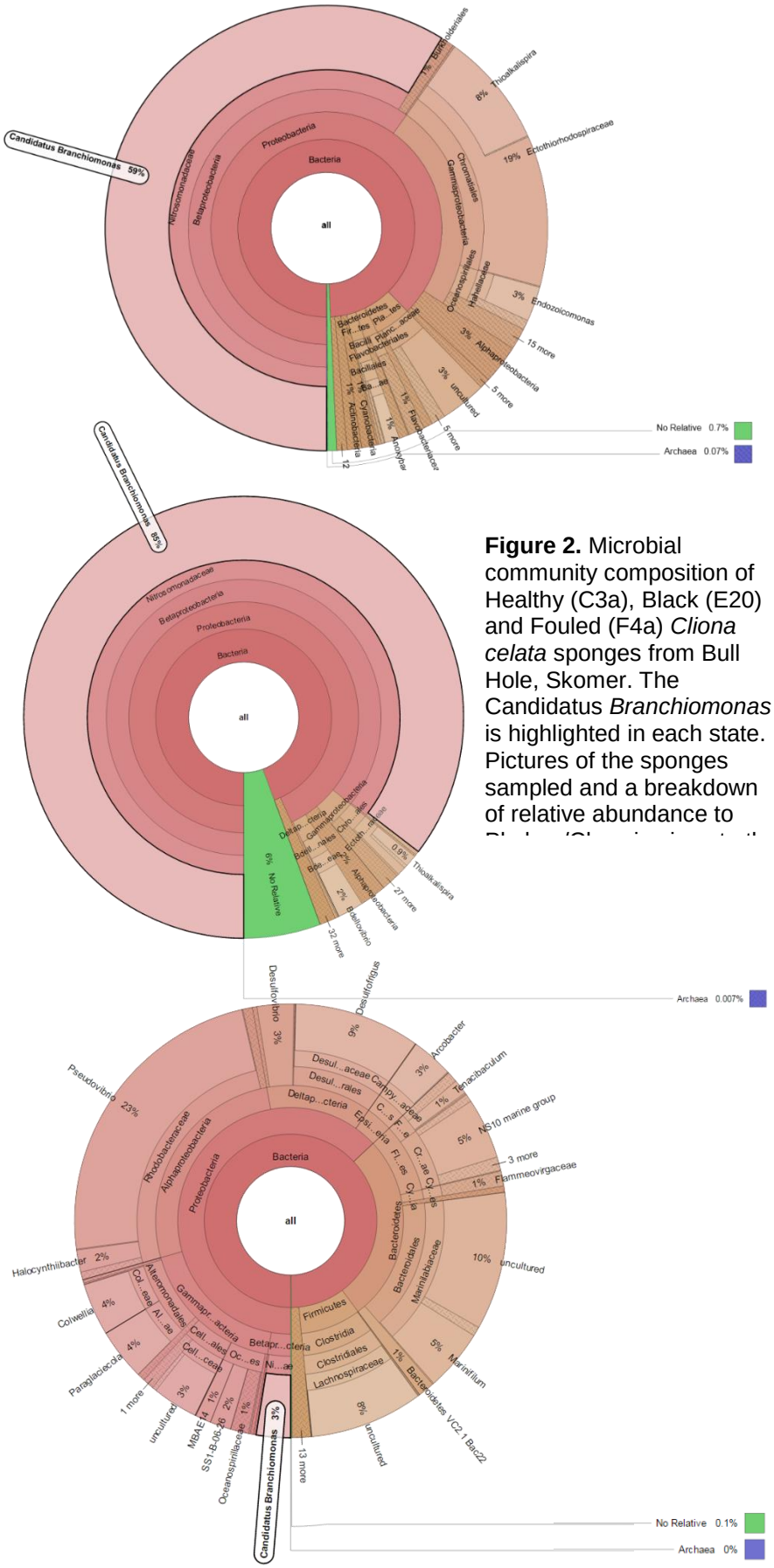


Figure 2. Microbial community composition of Healthy (C3a), Black (E20) and Fouled (F4a) *Cliona celata* sponges from Bull Hole, Skomer. The Candidatus *Branchiomonas* is highlighted in each state. Pictures of the sponges sampled and a breakdown of relative abundance to

Discussion

The filtering behaviour of sponges exposes them to more foreign organisms, including pathogens and viruses, than most marine organisms. Sponges possess a relatively complex immune system and produce low molecular weight non-proteinaceous secondary metabolites. These provide a first class and potent chemical defence system that has been honed during their 800 mya existence as sessile organisms. Therefore, the inability to deter fouling or degradative agents, as observed in *C. celata* from Skomer MCZ, indicates a serious deterioration of the host's robust innate immunity and anti-fouling capacity.

Any stressor that compromises physiological fitness of marine invertebrates and/or their symbionts and provides conditions conducive to pathogenic microbes will increase the prevalence of disease in marine systems. Under stressful conditions several processes may start to breakdown; sponge pathogens may switch on virulence mechanisms, sponges are unable to control the proliferation of bacteria, and degeneration of sponge tissue subsequently occurs when exogenous bacteria replace the associated symbiotic population of healthy sponge tissue.

This pathway is indicated by the microbial community profiles of the healthy, fouled and black *Cliona celata* samples from Skomer MCZ. The increased diversity observed in the fouled sponge demonstrates a lack of immunological resistance, and colonisation by a wide range of exogenous microbes. However, simultaneously, the associated microbial community observed in the healthy sponge has been shifted out of balance with a very high abundance of *Candidatus Branchiomonas* observed in the fouled sponge. Of significance is the loss of Gammaproteobacterial diversity and the associated sulphur cycling pathways in the fouled sponge community compared to that of the healthy sponge. Concurrently there is a loss of archaea in the fouled sponge, often associated with nitrogen cycling in sponge-microbe symbioses. The microbial community present in the black sponge is typical of marine sediment, indicating almost complete replacement of the symbiotic community (and its associated functions) by exogenous bacteria from the surrounding water and sediment.

The dominance of Candidatus *Branchiomonas* in the healthy and fouled sponges is of much interest because this betaproteobacteria is an agent of gill disease in seawater farmed Altantic Salmon (Toenshoff *et al.* 2012), and poses the question - is this a benign associated community with a functional role in the sponge symbiosis, or the onset of disease that leads to reduced immunological resilience, black tissue and cell death. Further analysis will determine if similarly high abundance is observed in the other healthy or fouled sponge samples.

In conclusion, the fouled state observed in sponges as a precursor to the black tissue and death in *C. celata*, is associated with a significant shift in microbial community, compared with the microbial population of the healthy sponge. This is defined by a startling increase in dominance by *Candidatus Branchiomonas*, and an increased colonisation by rare sequences, suggesting that the microbial population is no longer being tightly controlled by the sponge host. Once all the samples have been analysed, if this pattern is repeated across the healthy and fouled sponges, we may propose *Candidatus Branchiomonas* as an agent of disease in marine sponges. Further analysis to prove this as a causative agent would be required according to Koch's postulate. The microbal community of the black sponge is appears to reflect that of marine sediment, however further comparisons are yet to be made. Environmental stressors are not excluded as a potential drivers of this phenomenon. If the microbial community across all samples proves to be inconsistent with a pathogenic causative agent, then increased attention to water quality and extreme events is essential. Continued monitoring of the spread of diseased sponges across Skomer MCZ is highly recommended as the contribution of sponges to marine ecosystem health cannot be underestimated.

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