



**Cyfoeth
Naturiol
Cymru**
**Natural
Resources
Wales**

Skomer Marine Conservation Zone Project Status Report 2014

K. Lock, M. Burton, P. Newman & J. Jones 2015
NRW Evidence Report No. 66



Synopsis

The 14th project status report produced by the Skomer Marine Conservation Zone summarises the progress and status of monitoring projects in the Skomer MCZ in 2014. A summary of all established projects in the MCZ is provided in a table format. For each project that was worked on in the 2014 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: K. Lock, M. Burton, P. Newman & J. Jones. (2015). Skomer Marine Conservation Zone Project Status Report 2014. NRW Evidence Report No. 66.

Crynodeb

Mae'r pedwerydd 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 2014. 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 2014 ceir adroddiad manwl, gan gynnwys hanes a chrynodeb o'r canlyniadau hyd yn hyn. Mae'r adroddiad hwn hefyd yn cynnwys crynodebau o brosiectau gwylidwriaeth eigionegol a meteorolegol.

Teitl: K. Lock, M. Burton, P. Newman & J. Jones. (2015). Adroddiad ar Statws Prosiectau Parth Cadwraeth Morol Sgomer 2014. Adroddiad Tystiolaeth CNC Rhif 66.

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1 Introduction

This is the fourteenth 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 2014. 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 summary of the results to date. Section 4 provides a summary of the oceanographic and meteorological surveillance projects.

Notable events in the 2014 field season:

- The *Zostera marina* bed at North Haven was successfully surveyed by volunteer divers. The NRW fisheries assessment team trialled 'Biosonics split beam sonar' equipment to map the *Z. marina* bed.
- The Grey seal pupping survey was completed at both island and mainland sites from August to December. 324 pups were born, the highest number ever for the MCZ, most notable was the increasing numbers of pups born at mainland sites over the past 9 years. Adult seal identification photos from 2007 to 2014 were entered into the NRW Wales seal database.
- Nudibranch species survey was completed at 13 sites representing a range of habitats resulting in a total of 49 species. Nudibranch species recorded include several classed as nationally scarce or with limited national distribution in the British Isles.
- Several diseased *Cliona celata* were found at Bull Hole & West Hook. Necrotic tissue was collected for analysis by Portsmouth University.
- A thick layer of silt covered the seabed and resulted in poor visibility throughout the whole year.

Sponge, *Cliona celata*, covered in a thick layer of silt.



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 to 1998 2002 to 2014	Every 14 days (April-Oct)	Jones 1998	Yes-SMCZ office
Suspended sediments	Idronaut Turbidity logger	2001 – failed 06	Continuous	No	No - raw only
	Secchi disc	1992 - onwards	Weekly (seasonal)	No	Yes – SMCZ office
	YSI 6600 multi parameter sonde – now stopped	2007 - 2013	Hourly	No	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.	1992 – 2002	Annual	Adams 1979/ Bunker 1983/ Crump 1993/96 Hudson 1995.	Yes-SMCZ office
	9 sites established in 2003 including 3 Marclim sites. Site marking completed in 2004.	2003 - ongoing	Annual	Burton & Crump 2004	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	Bullimore 1986 & 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 2006 – ongoing	Annual Every 4 years Next survey planned 2015 4 times / year	Bunker & Jones 2008 & 2012 Bell <i>et al</i> 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:					
<i>Zostera marina</i>	Extent of NHV bed & density distribution. Biosonics Acoustic sonar survey	1997/2002/2006, 2010 & 2014 (Boundary maps for 2000, 2002 & 2004) 2013 & 2014	Every 4years Next survey planned 2018 Annual	Jones & Hodgson 1980 & 1981, Jones <i>et al</i> 1983, Lock <i>et al</i> 1998, 2003 & 2006 Burton <i>et al</i> 2010	Yes-SMCZ office
Fauna:					
<i>Eunicella verrucosa</i>	101 colonies, time series mono-photo/digitised. 4 colonies stereo-photo.	1993- ongoing 1982- ongoing	Annual	Bunker <i>et al</i> 1985, Bullimore 1986 & 1987 Gilbert 1998	Yes-SMCZ office
<i>Alcyonium glomeratum</i>	Time series stereo-photo/digitised. North wall 5 transects (% frequency) North wall East, Thorn rock & Rye rocks.	1984- ongoing 2002 new transects	Annual	Bullimore 1986 & 1987	Yes-SMCZ office
<i>Parazoanthus axinellae</i>	6 sites, time series mono-photo/digitised.	2001- ongoing	Annual	Burton <i>et al</i> 2002	Yes-SMCZ office
<i>Pentapora foliacea</i>	3 sites, time series mono-photo/digitised. New sites established 2002 & 2003.	1994- ongoing	Annual	Bullimore 1986 & 1987 Bunker/ Mercer 1988 Gilbert 1998, Gibbs 2006	Yes-SMCZ office
<i>Balanophyllia regia</i>	Time series @ thorn rock stereo-photo/digitised The Wick. 3 transects	1984 – 2002 - ongoing 2002 - ongoing	Annual	Bullimore 1986 & 1987	Yes-SMCZ office
<i>Caryophyllia smithii</i> .	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 1992-2014, Skomer MCZ annual reports 1992-2014	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 <i>et al</i> 1993, Luddington 2002 Lock <i>et al</i> 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 <i>et al</i> 2006 Tompsett 2006 Sweet 2009 Bullimore, R 2010	Yes-SMCZ office
King scallop <i>Pecten maximus</i>	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 <i>et al</i> 2004 Lock <i>et al</i> 2009 & 2013	Yes-SMCZ office
Echinoderm Survey	Abundance of <i>Echinus esculentus</i> in Skomer MCZ using volunteer survey methods. Data for <i>Marthasterias</i> <i>glacialis</i> , <i>Crossaster papposus</i> & <i>Luidia ciliata</i>	2003,2007 & 2011	Every 4 years Next survey planned 2015	Luddington <i>et al</i> 2004 Lock <i>et al</i> 2008 & 2011	Yes-SMCZ office
Commercial Crustaceans	Parlour pot and diving study (Plymouth student project) Parlour pot study – MCZ Shell disease survey	2003 2011 2011	Aug / Sep 2003 Jul – Oct 2011 Sep – Oct 2011	Fothergill 2004 No 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
- South Haven
- South Stream
- The Lantern
- The Wick
- Double Cliff
- 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 1m² 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 Martin's 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 MCZ as a baseline littoral survey.

1992: Six permanent transects were established in the MCZ 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

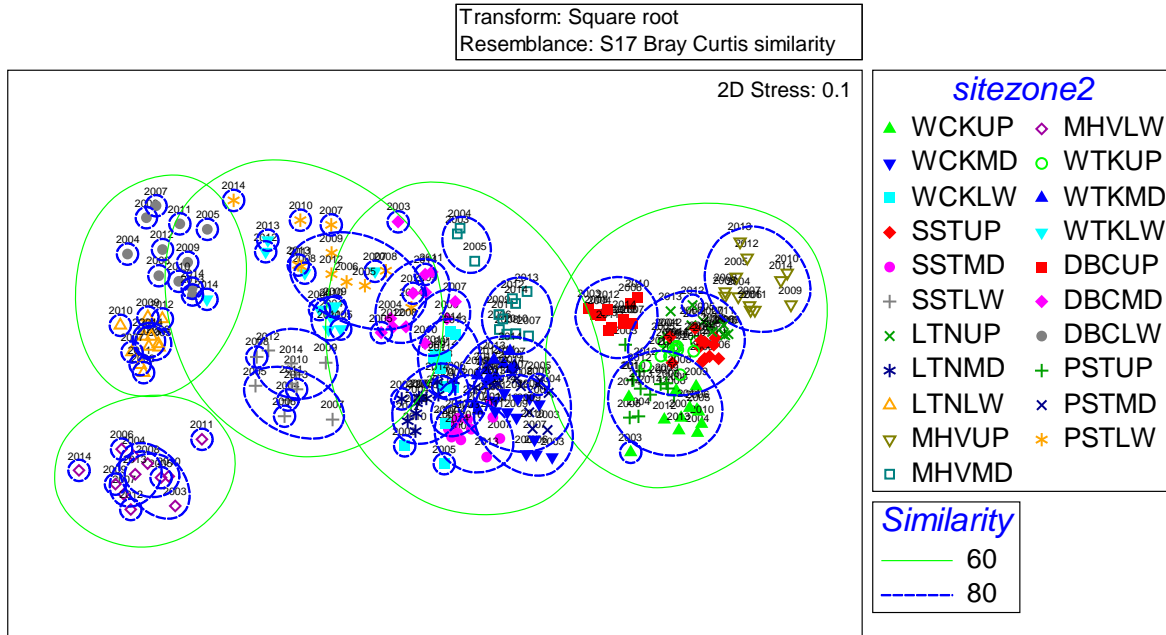
2014: All sites completed



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 2002 – 2014



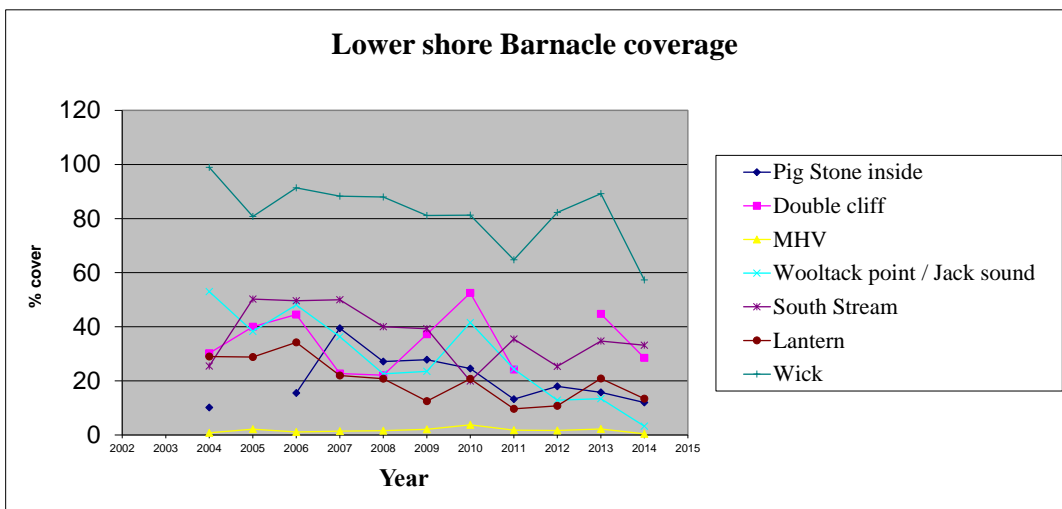
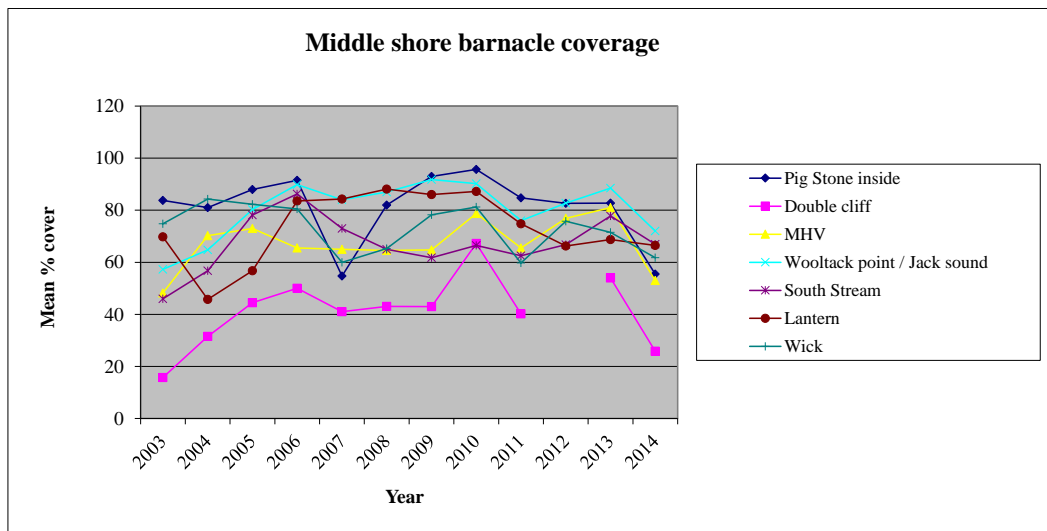
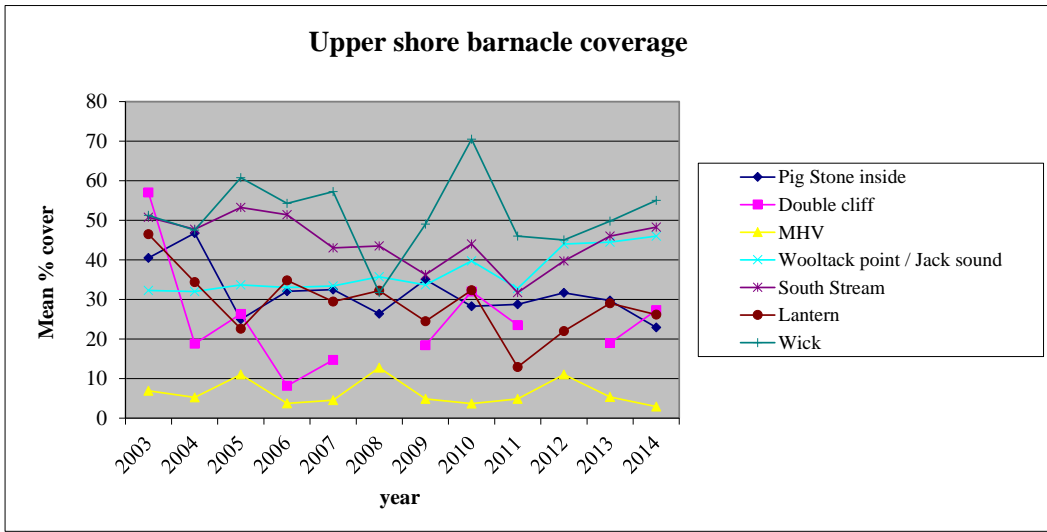
General summary:

- 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

2014 did not show any major variations from the overall trends seen since 2003.

Mean % Cover Barnacles

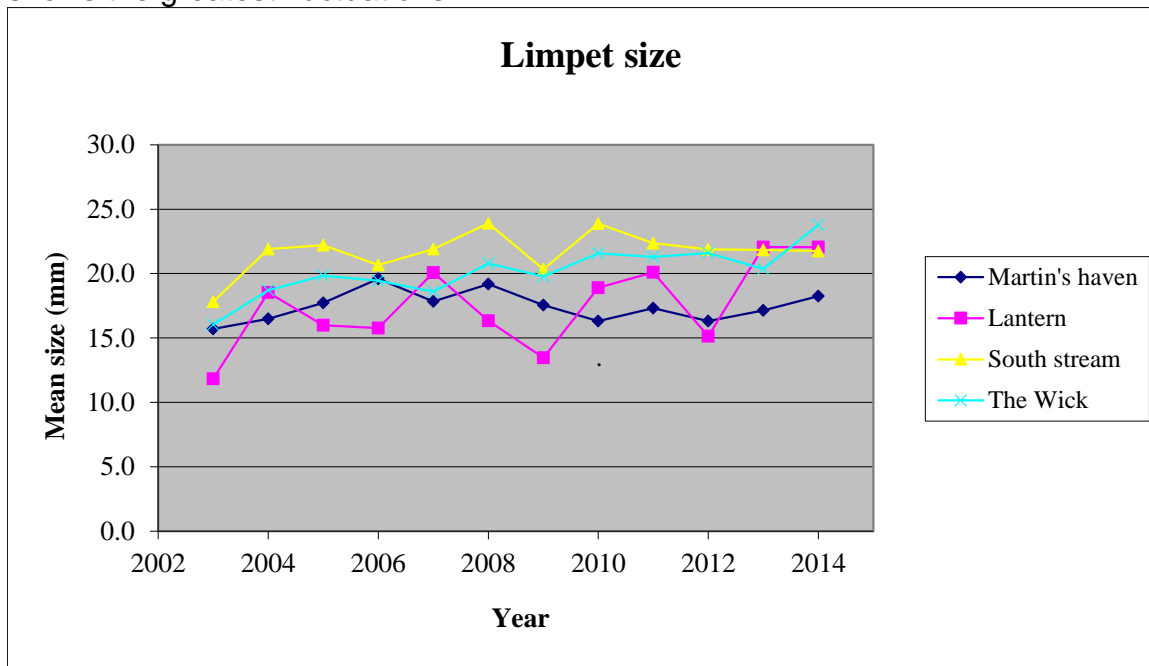
Barnacle coverage has been variable between sites over the last 8 years. In 2014 all sites saw a decrease in barnacle cover in the middle & lower shores, perhaps due to the extreme weather of the winter of 2013-14.



Limpet Size and Counts

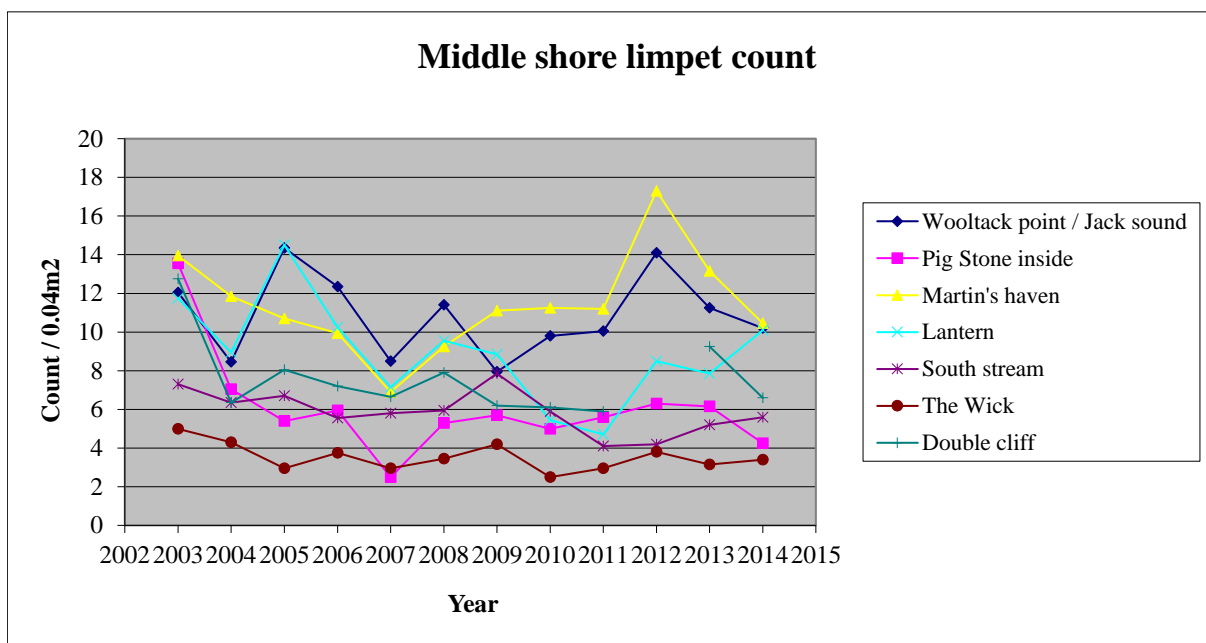
Size of limpets on the middle shore (mm)

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

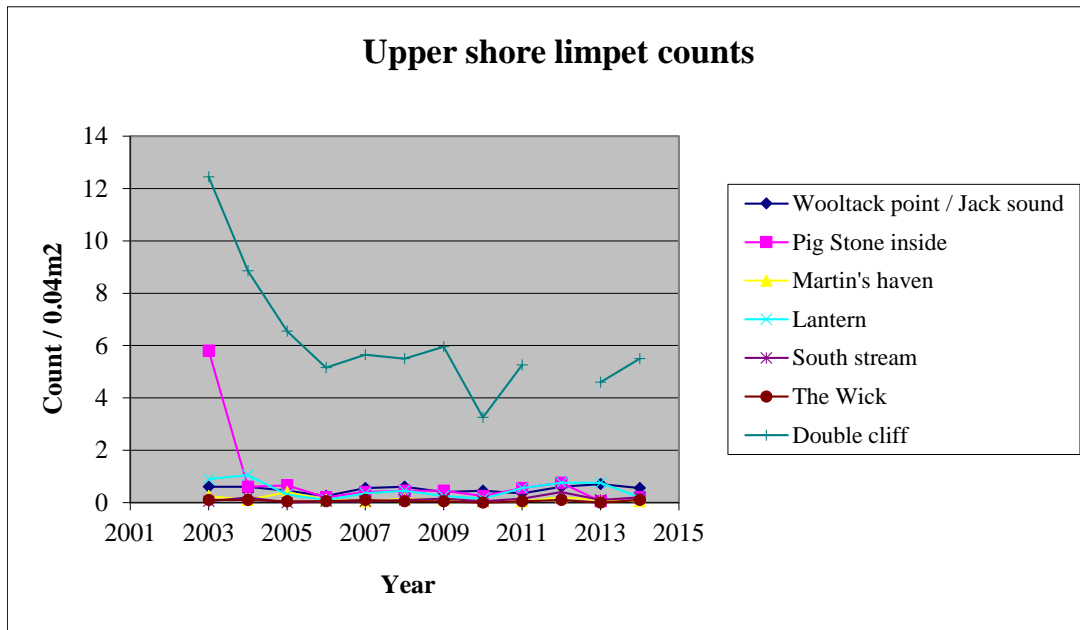


Counts of Limpets from 5 (20 X 20cm) Quadrats

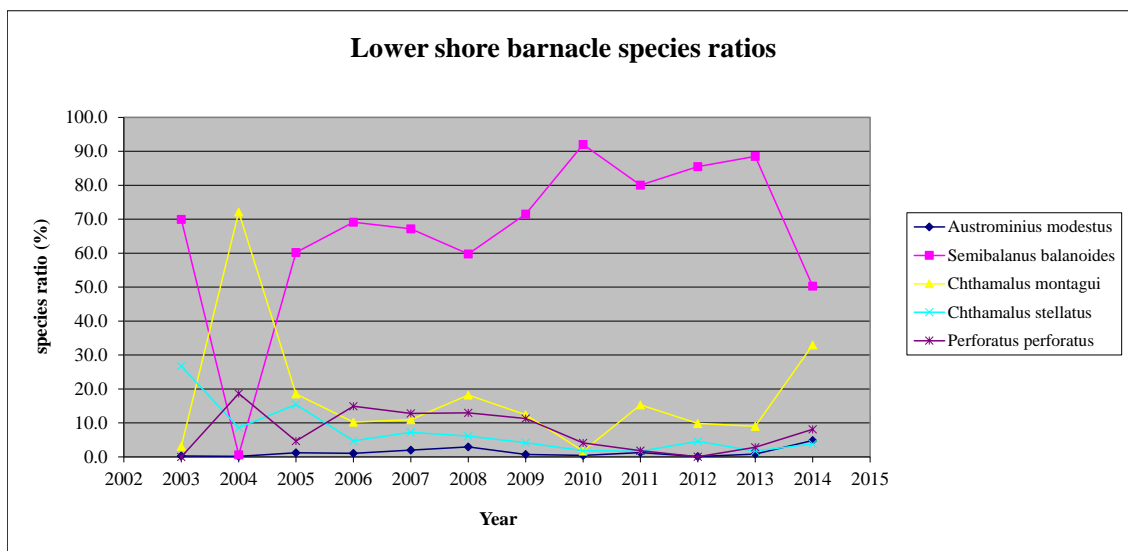
In the middle shore highest numbers of limpets are found on the north facing shores, but these figures tend to be the most erratic. 2007 appears to have had a dip in numbers on 6 of the sites, which all showed an increase the following year. On the middle shore the numbers have been stable from 2009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

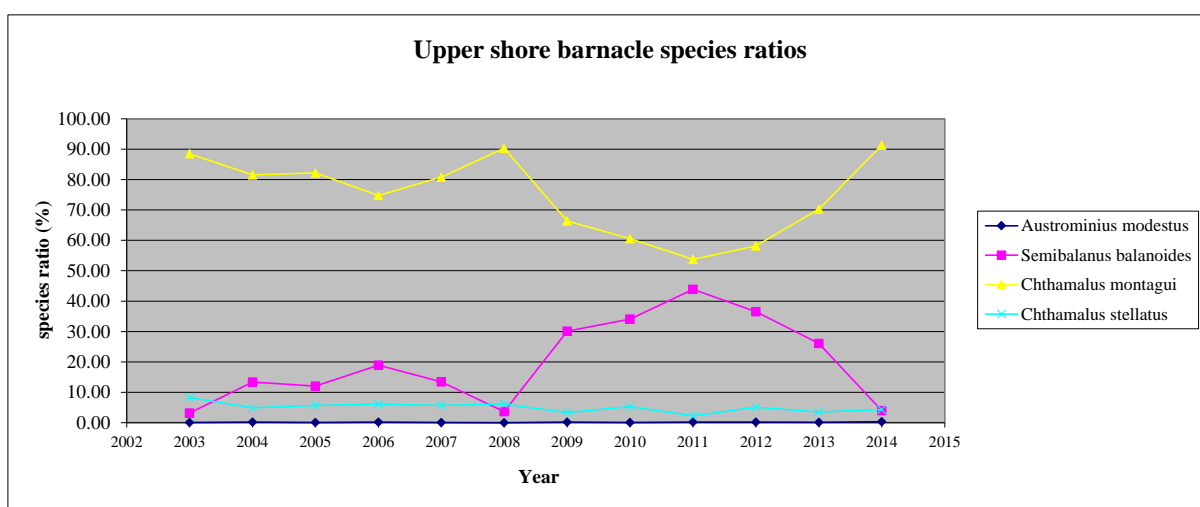
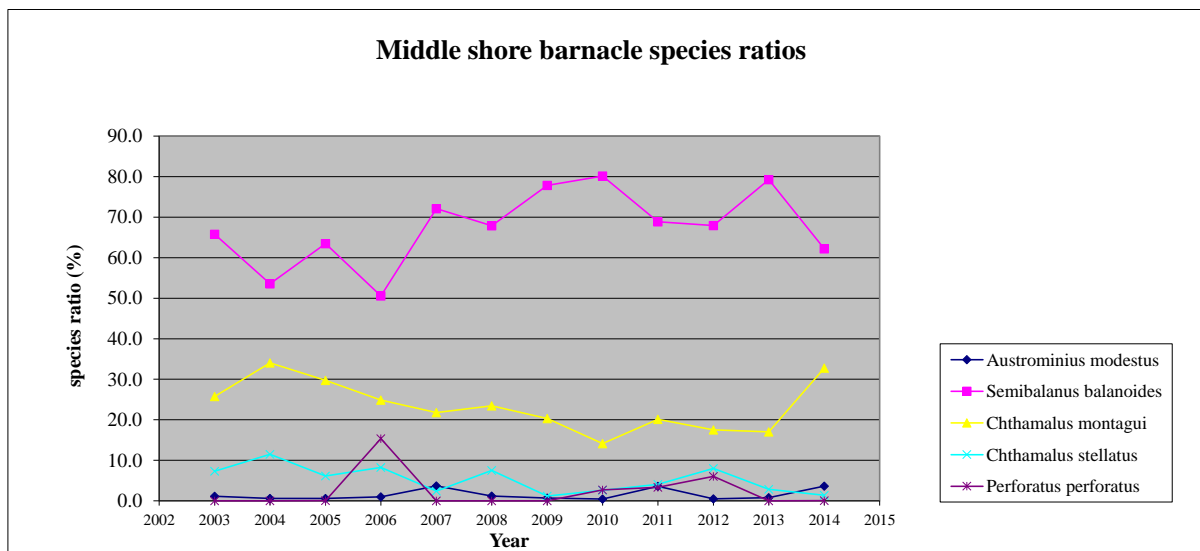


In the upper shore most sites have a low abundance of limpets. Double cliff has significantly more limpets than any other site (north facing shaded cliff) and an interesting declining trend from 2003 – 2006.



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 *Semibalanus* at all shore zones with an increase in *C. montagui*.





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 MCZ.

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 are included as a key habitat for conservation in the UK Biodiversity Action Plan 1994.



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 are included as a key habitat for conservation in the UK Biodiversity Action Plan 1994.

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 m² 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 *Zostera* shoot counts are taken in 6 25 x 25 cm² 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.

2014 Density Results

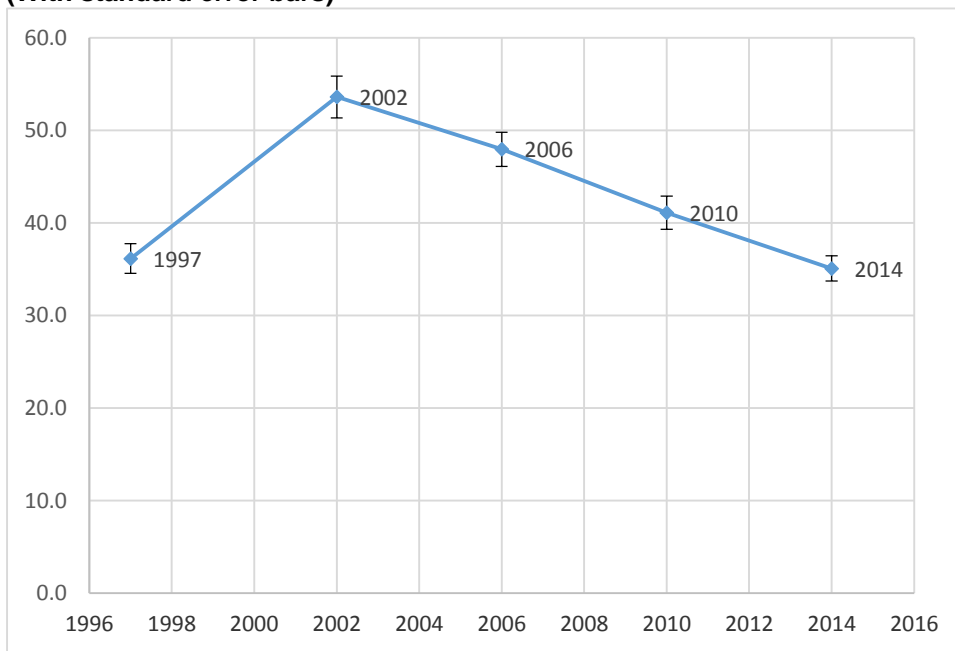
The central bed has been surveyed consistently from 1997 to 2014 but the outer transects (north, south, east and west) were only partly done in 1997 and 2002. To account for this only transect stations which were completed on all of the surveys have been included in the density calculations.

Comparison of Overall Shoot Density (per m²) for All Years 1997 - 2014

(Only using data from sample stations with replicates in every sampling year)

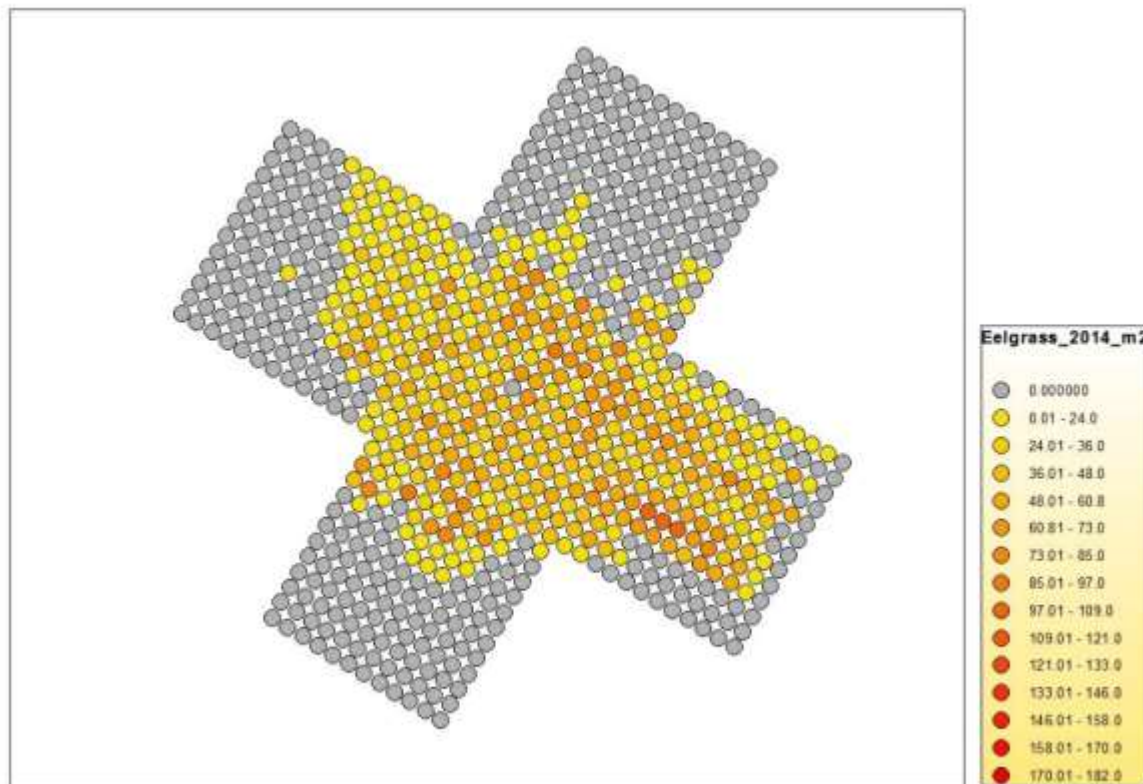
	1997	2002	2006	2010	2014
Mean	36.2	53.6	48.0	41.1	35.1
Std Dev	27.3	38.5	31.4	30.6	23.3
Variance	746.0	1478.4	987.8	933.6	544.4
Std error	1.6	2.3	1.8	1.8	1.4
n	289	288	289	289	289
min	0	0	0	0	0
max	104	156	128.7	182.7	104.7

**Density results from all comparable stations 1997 – 2014
(With standard error bars)**

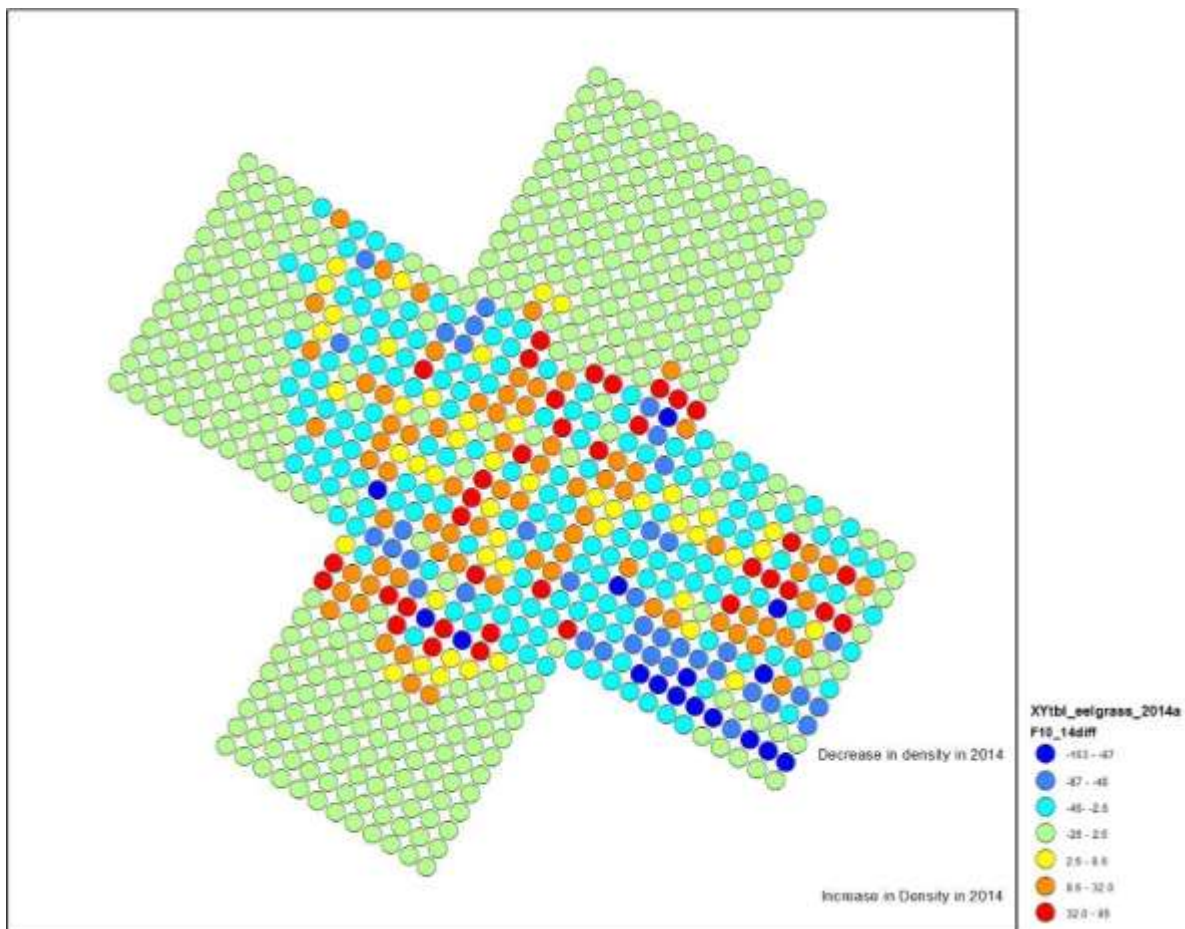


2014 Overall shoot density results are not significantly different to 2010 & 1997. It would appear that the *Z. marina* bed in North Haven had an increase in shoot density in 2002 & 2006 but since then the shoot density has decreased back to similar levels seen in 1997.

Density map of 2014 survey



Changes in density between 2010 and 2014

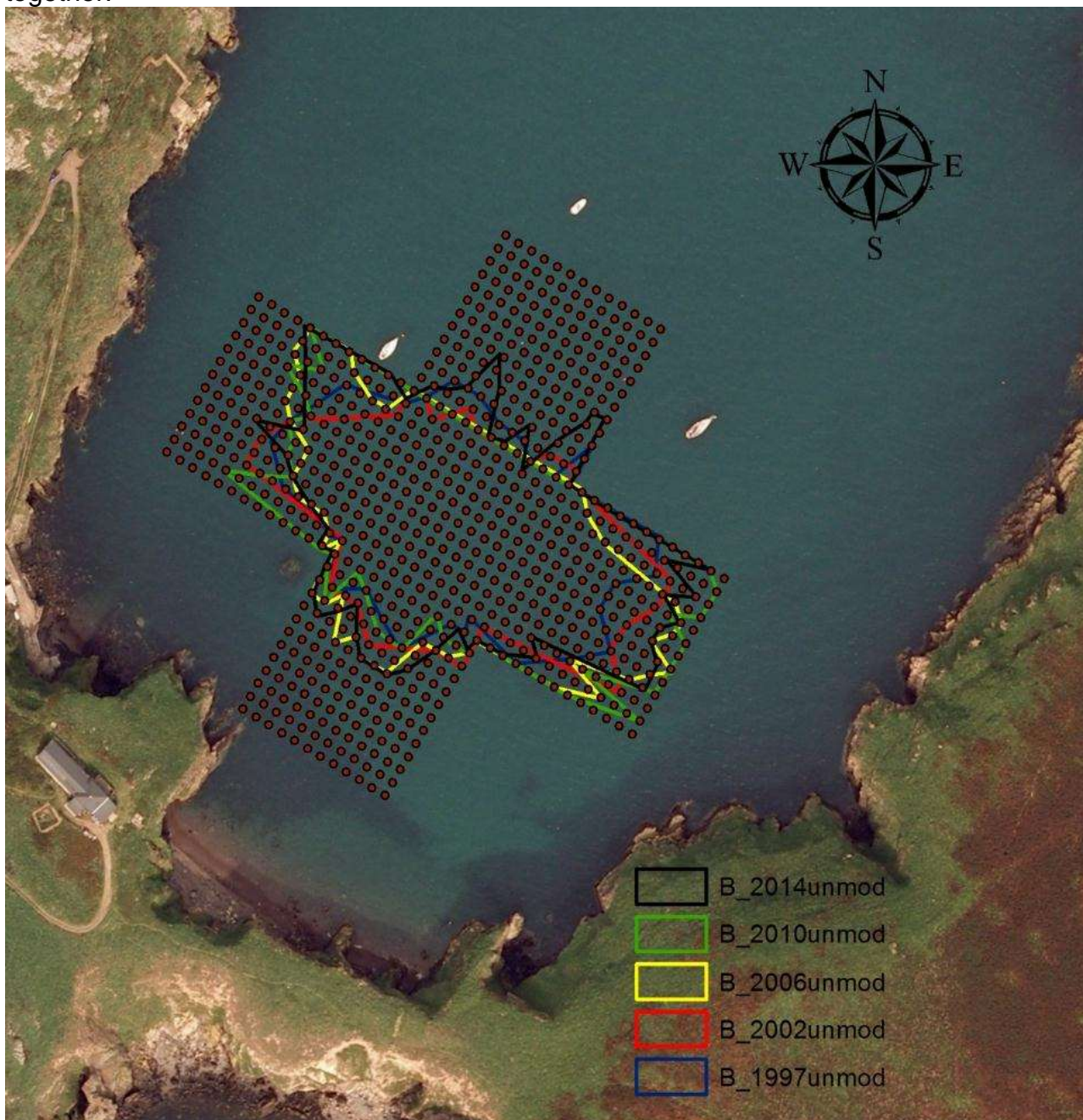


Blue areas show a decrease in density in 2014, compared with 2010. Red areas show an increase in density in 2014 & green highlights areas of little or no change.

Shows a mixed picture of losses and gains compared to 2010. Obvious loss of in the southeast corner.

Area of extent results

Seagrass bed extent polygons from the density survey records 1982 – 2014 shown all together.

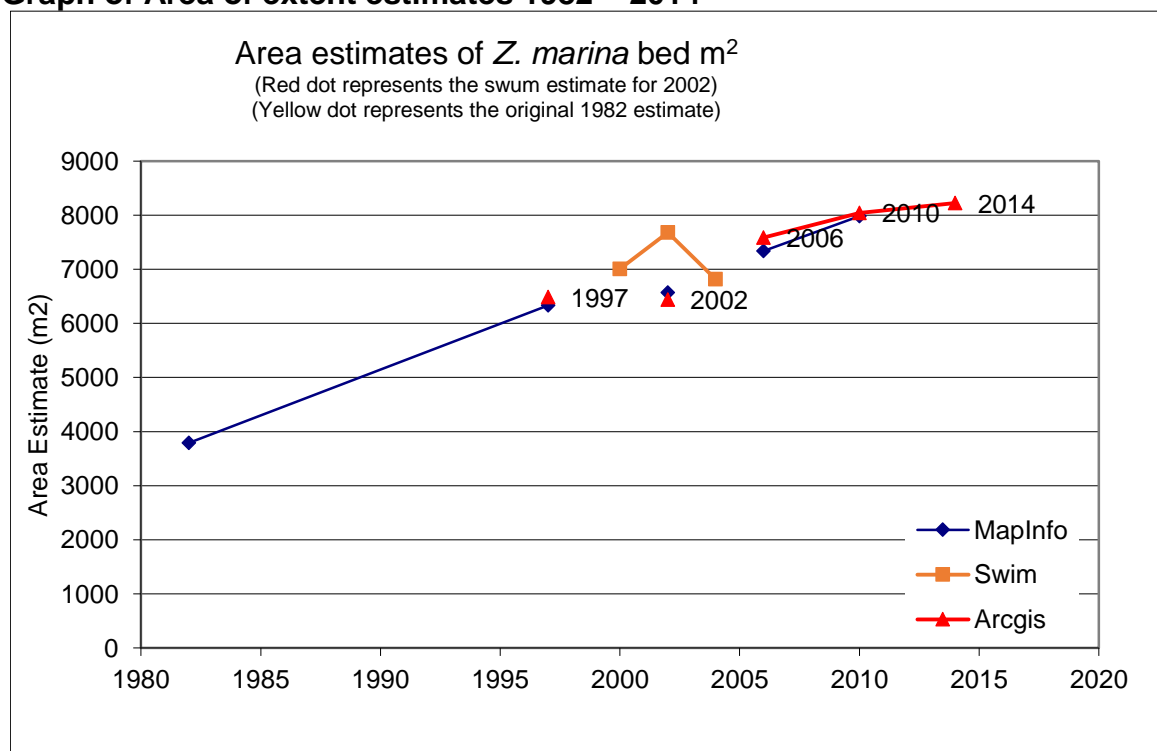


Up until 2010 the eastern boundary has increased year on year but in 2014 there is a slight contraction. The northern boundary has increased in 2014.

Area of extent estimates 1982 – 2014

Year	Area Estimate m ² (from survey grid) MapInfo	Area Estimate m ² (from survey grid) ArcGIS	Area Estimate m ² (from swim)
1982	3788		
1997	6333.4	6484.2	
2000	No survey		7007.8
2002	6569.5	6439.6	7683.20
2004	No survey		6817.5
2006	7336.6	7587.2	
2010	7980.6	8044.0	
2014		8224.6	

Graph of Area of extent estimates 1982 – 2014



The 2 different GIS methods (MapInfo & ArcMap) using 2 different projections (WGS 84 & British National Grid) give similar results.
 The area of extent appears to be increasing.

Acoustic Survey Results - 2013 & 2014

In 2013 and 2014 the *Z. marina* in North Haven was surveyed by the NRW Fisheries Assessment Team using a Biosonics DT-X split beam echo sounder, with a 7° circular 200 khz transducer, from the vessel “Skalmey”. The transducer was mounted vertically from 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.

Estimated Area of extent from Acoustic survey data 2013 & 2014

% Area Inhabited Contour	2013 Area Estimate (m ²)	2014 Area Estimate (m ²)
90	6140.2	6282.1
80	7126.0	7329.4
70	7742.1	8041.8
60	8290.1	8621.1

Different cut off (contour) values can be used to set the edge of *Z. marina* bed – the 60% contour appears to match up best with the in-situ diver data estimate (8224.6m²)

Comparison of Acoustic and In-situ Diver Survey Data 2014.



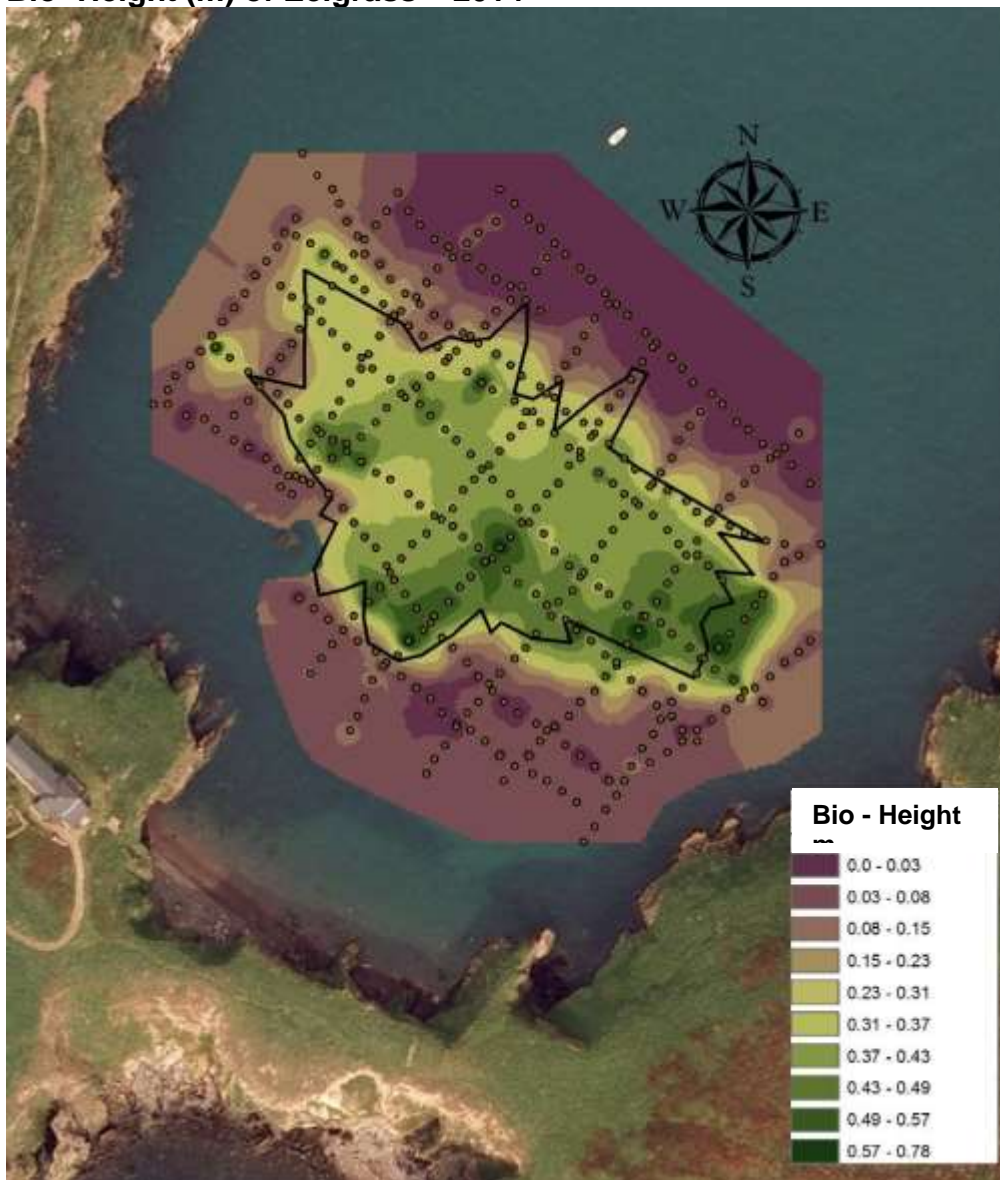
2014 Boundary Polygon (black) overlaid onto the 60% %AI contour boundary from the 2014 Acoustic survey.

The 2 areas match up very well. The acoustic survey will only ever be as good as the amount of data points used in the interpolation but the general shape is a good fit to the in-situ diver survey. The extended area out to the east, shown in the acoustic survey will need confirming as the diver survey suggested that this area was kelp with no eelgrass present.

Stand Height of Eelgrass 2014

The Sonar 5 Pro software also allows the user to estimate “bio-height” from the acoustic data. This measures the height of the eelgrass’s acoustic signal above the seabed which provides an estimate of stand height of the eelgrass fronds.

Bio- Height (m) of Eelgrass – 2014



Estimated height of eelgrass above seabed (see legend) shown with the acoustic sampling points used to create the interpolation (brown dots) and the 2014 eelgrass boundary from the in-situ diver survey (black outline).

Targets

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

- The 2014 Area estimate of 8224.6m² is well above the Lower Specified limit of 5500 m²
- The 2014 Shoot Density is 35.1 shoots/ m² This is lower than the Lower Specified limit of 36.0 (+/- 3.14 95% confidence interval) but does not differ significantly to it.

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, next survey due 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 (transects & species survey)
- 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 identified in 16, 50 x 70cm quadrats. In 2007 and 2011 no quadrats were used, survey completed in the general vicinity of the 4 transects with all species being identified if possible. Species photographs were taken in the field and samples taken, where necessary, for spicule preparations.

Seasonal survey from fixed quadrats: In 2005 15 1m² quadrats were marked out at 3 sites. 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:

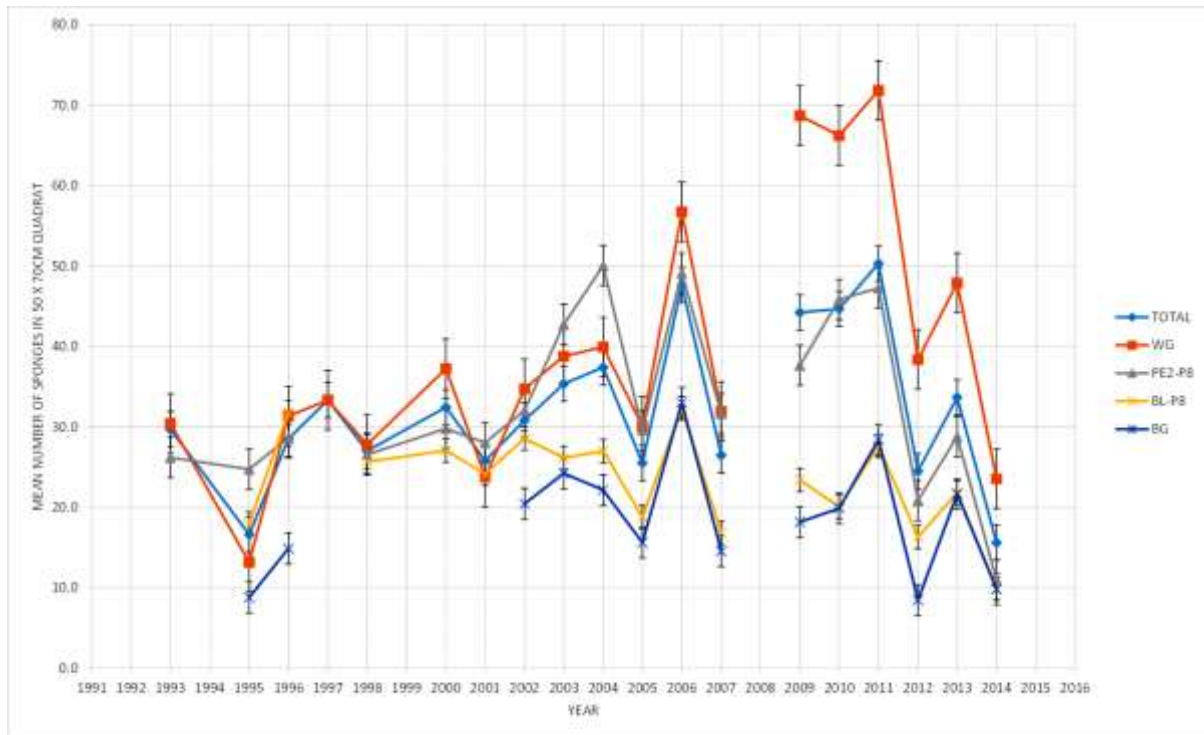
Data gathered from Thorn Rock sponge transects 1993 to 2013:
(Windy Gully =WG, Spongy Hillocks =SH, Broad Gully =BG, Dogleg = DL)

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

Sponge Morphology Analysis

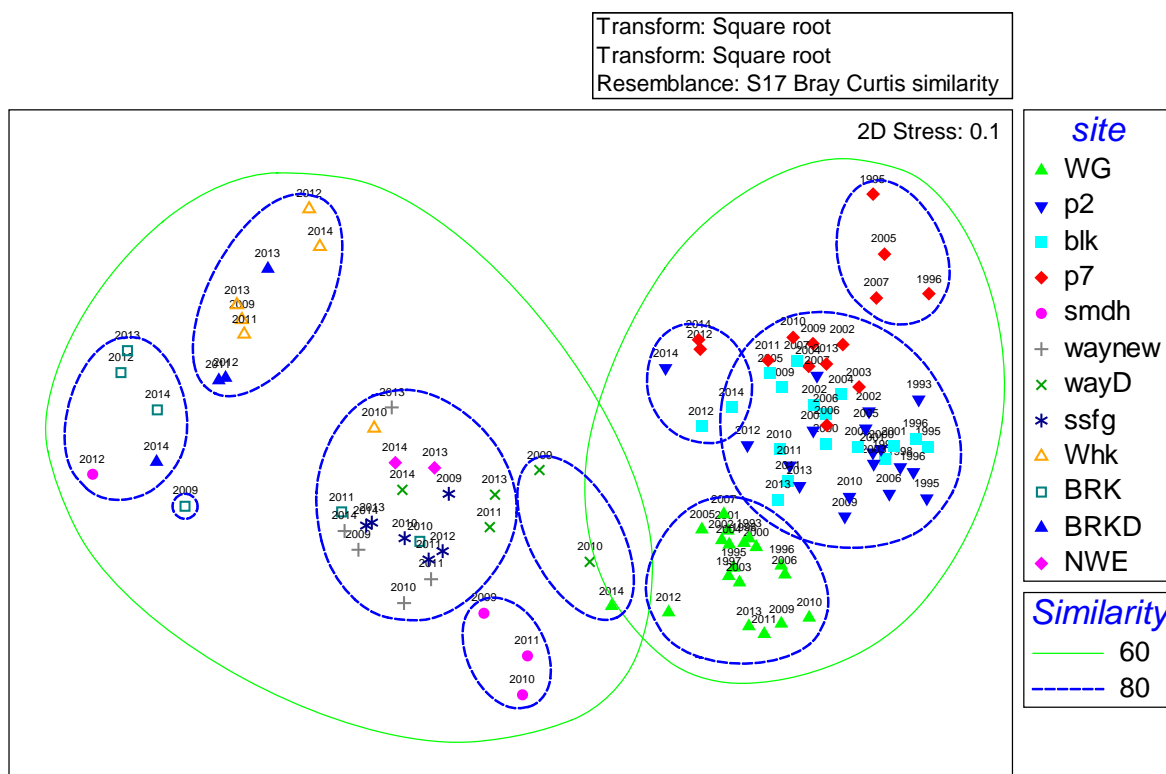
A simple way of assessing sponge assemblages is to classify them into morphology types (see Bell 2001). This method has been used for all the quadrats taken at Thorn Rock and for a series of sites around the MCZ where comparable quadrat photos are taken. The data can then be graphed or analysed using the Primer multivariate analysis software to compare similarity between sites.

Mean number of sponges counted in each quadrat at 4 sites –Thorn Rock 1993-2014



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 seen across all of the transects. In 2013 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 – 2014



The plot shows that the Thorn Rock sites all group together on the right hand side of the plot (similarity 60%) with Windy Gully (WG) forming a distinct cluster at the bottom (similarity 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 mainly of 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.

Diseased Cliona celata

Early in the 2014 diving season a large number of diseased *Cliona celata* sponges were noted with black necrotic tissue across all or the majority of the sponge tissue. See picture.



Most of the black sponges were seen at Bull Hole (West side of Skomer Island) but a small number were also found at West Hook Point (North Marloes Peninsula) and some heavily fouled sponges were seen at Tusker rock (Jack Sound).

Dr J Preston (Portsmouth University) organised the collection of tissue samples for analysis of the microbial content to see if a pathogen could be identified. These are currently being analysed.

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 MCZ;
- Continue sponge species recording every 4 years, next survey due 2015.

***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

1997 S. Burton (nee Gilbert) developed methods to study the fan area and branch length assessment to assess growth rate. This was completed for all fan images for 1994-1997 data using MapInfo software, (Gilbert 1998).

1998-2000 data was analysed using the methods developed in 1997.

2001 a re-evaluation of methods used for growth assessment was completed and the 1997 method was discontinued due to many inaccuracies found using the methods due mainly to inconsistencies in the images of individual fans matching between year sets.

2001 a method to assess fan condition was developed. This was completed for all photo images in the dataset.

2002 field records of fan condition were commenced to support the assessment completed using the photo images.

2002 small clippings were taken from some MCZ fans for a CCW Species Challenge funded project into the reproductive biology of sea fans. Reef Research undertook the study based sea fan colonies in Devon and at Skomer MCZ. The MCZ clippings showed what was thought to be eggs and sperm, although at lower levels than the Devon population. Time of spawning in Devon is thought to be during late August.

2007 small clippings were taken from 30 MCZ fans to support research at the University of Plymouth and the Marine Biological Association. The research aims to look at the connectivity between populations of pink sea fans using internal transcriber sequences.

2008 a digital SLR camera providing high quality images, thereby allowing improved photo analysis, replaced the film camera previously used.

2009 further small clipping were taken from MCZ fans to support the DNA connectivity research started at Plymouth University and continued at Exeter University. The results showed that the Skomer seafans 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.

2009 A digital camera set up for close up photography was used along with a graduated ruler for size reference was used to photograph the small fans

2010, 2011, 2012 and 2013 all sites visited and photographed.

2014 all sites except South Middleholm were visited and photographed.

In 2014 the overall drop of natural fans recorded is due to South Middleholm not being surveyed. There was one confirmed loss of a natural fan, SSFG 23, last seen in 2011, however SSFG 22 was re-found amongst the seaweed, this had not previously been seen since 2008. NWA 13 was not found for the first time, its status will be confirmed in 2015.

A new sea fan was added to the Rye Rocks site survey. RRK 25, found 3-4m below the mast.

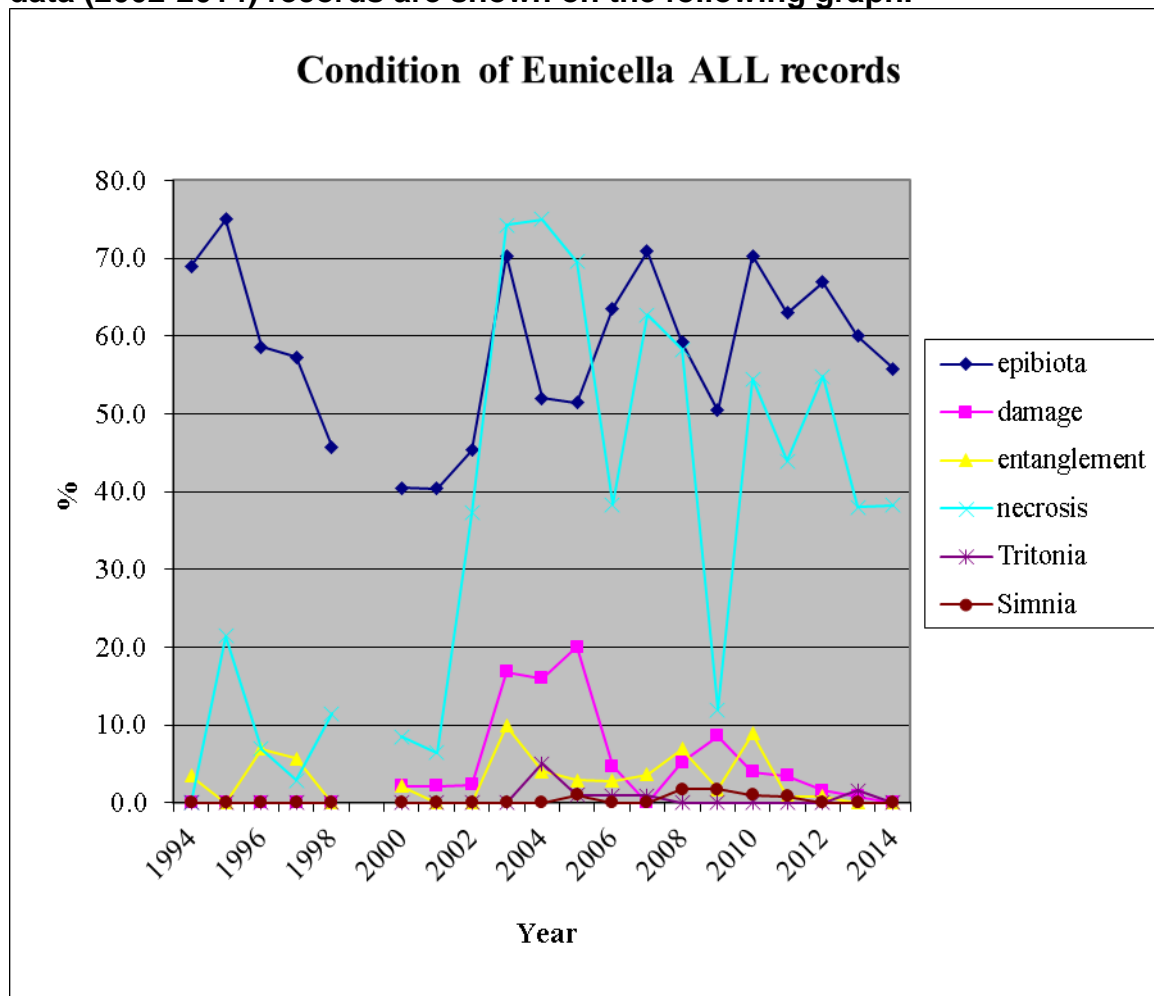
The cluster of 5 baby fans at Bull Hole are all present but very little growth has been observed since 2006 when they were first found. No direct anthropogenic damage (entanglement with pot ropes, removal from substrate with evidence of human activity nearby) to fans was recorded in 2014.



Survey results 1994 -2014:

year	Sites surveyed	Total fans recorded	Total natural fans	Total attached fans	New recruits (babies)	Natural fan Losses (confirmed)	Attached fan losses	Missing (to be confirmed)
1994	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
totals					10	11	3	

Condition of sea fans in the Skomer MCZ from photo images (1994- 2014) and field data (2002-2014) records are shown on the following graph.



Recording of necrosis from the photo images was inconsistent between years 1994 - 2001 due to variable image quality, recording necrosis in the field since 2002 has helped provide improve records. From 2008 onwards the images taken with an SLR digital camera provided excellent quality images and allowed improved recording of necrosis from the photos. 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 has fluctuated between 38% and 55% for the last 5 years, in 2014 it was 38.5%. The average level of necrosis since 2002 (13 years) is 50.5%.

An annual average of 60% of sea fans have been recorded with attached or entangled epibiota for the last 13 years of surveys. In 2014 this was on 56% of the sea fans. The epibiota include tangled and attached dog fish eggs, drift algae, bryozoans and hydroids. On occasion bryozoan sea fingers, *Alcyonidium diaphanum* and deadman’s fingers, *Alcyonium digitatum* have been recorded growing on a sea fan. Entanglement with epibiota and in particular dog fish eggs if extensive and persistent can cause some damage to the sea fan tissues.

No *Tritonia nilsodhneri* or *Simnia patula* were recorded in 2014.

Current Status

- Numbers: There have been 13 confirmed sea fans lost from the monitoring sites between 1994 and 2014 and there is 1 further possible loss in 2014. There are no new recruits (baby fans) found in 2014.
- Condition: Necrosis occurrence was found in 38.5% of the sea fans, this is below the average of 50.5% recorded for the last 13 years. Epibiota was recorded on 56% of the sea fans; this is below the average of 60% recorded for the last 13 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)

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 proforma.

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

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.

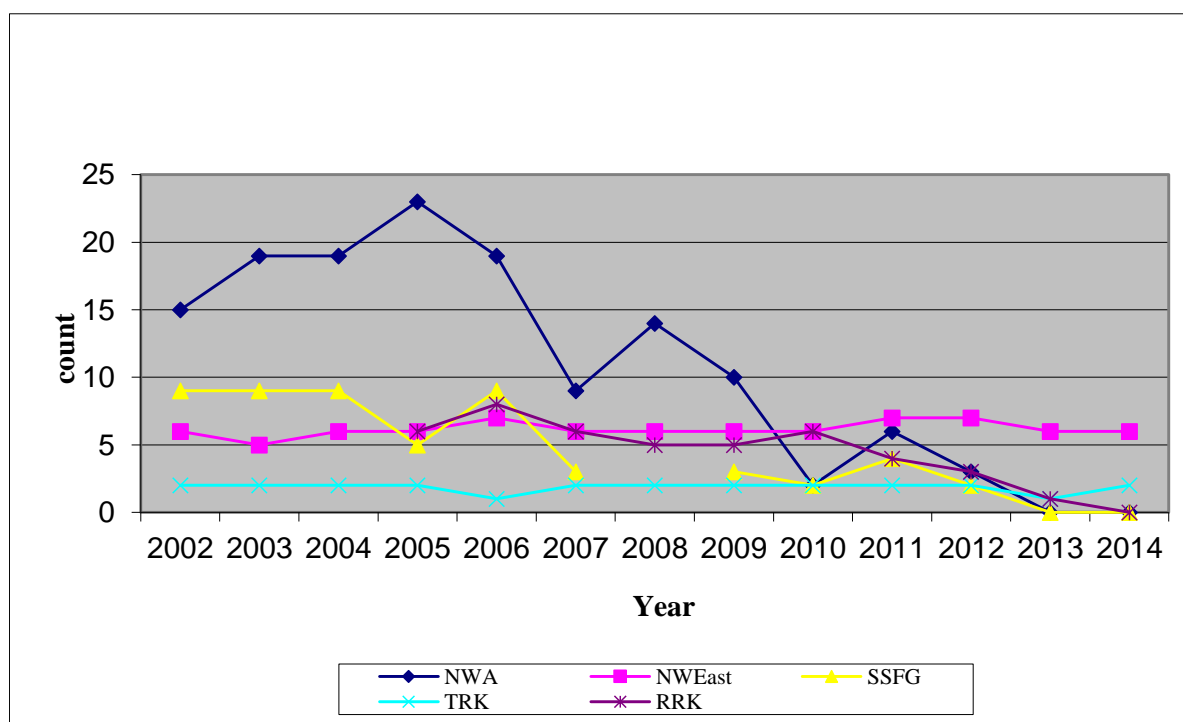
Results

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

Number of quadrats with *A. glomeratum* present.

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

Graph of the number of quadrats with *A. glomeratum* present 2002-2014

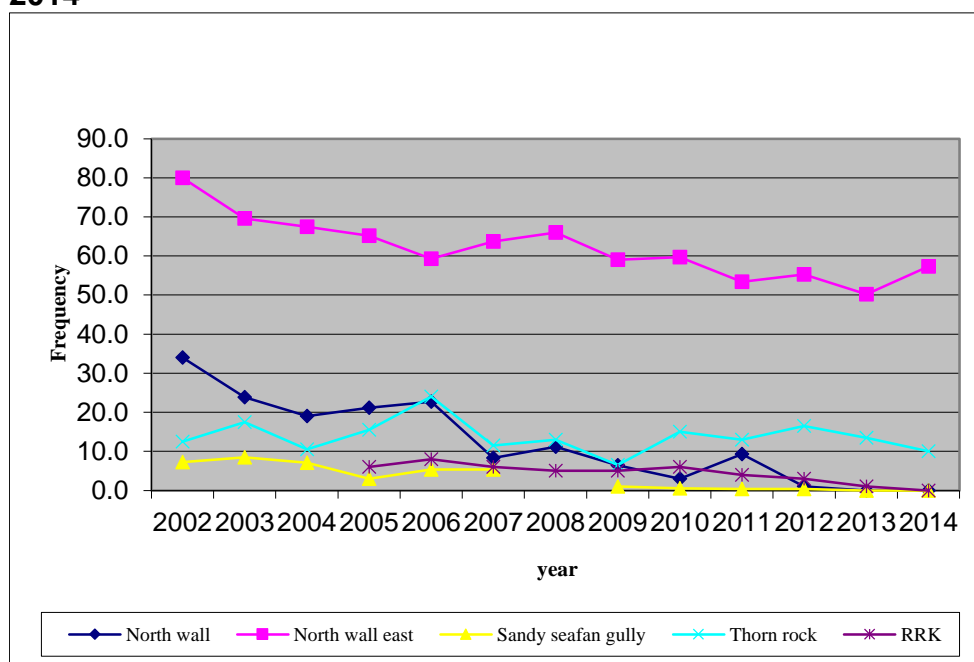


All sites except *NWA East* show a decreasing trend in the coverage of *A. glomeratum* colonies. In 2013 & 2014 *NWA* & *SSFG* had no visible colonies of *A. glomeratum*.

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

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

Graph of the mean frequency of *A. glomeratum* from within the quadrats 2002 to 2014



The frequency of *A. glomeratum* colonies declined at all sites except North Wall east in 2014 and no colonies at all were seen at North wall & Sandy seafan gully.

Current Status

- The distribution of *A. glomeratum* at the monitoring sites is declining. Only North Wall East has any sizable colonies of *A. glomeratum*. North wall & Sandy seafan gully now have no visible colonies.
- A search for other colonies of *A. glomeratum* is needed 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
- 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

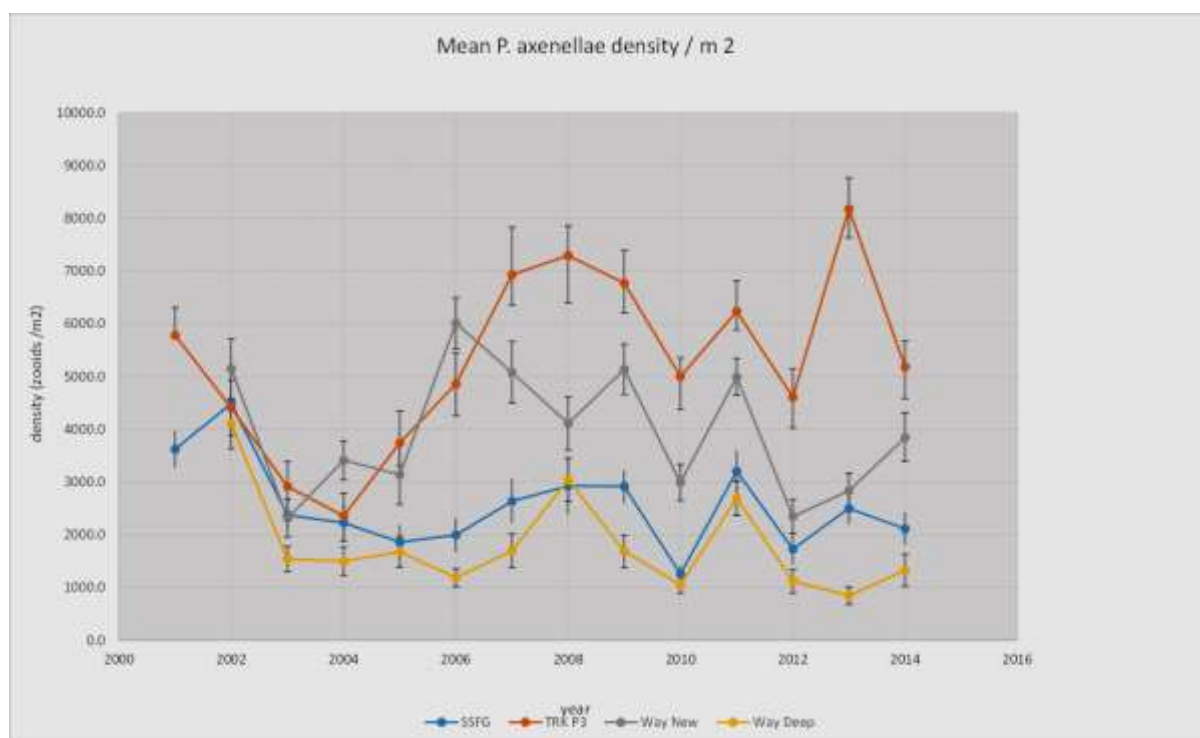


Results

2014 fieldwork completed:

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

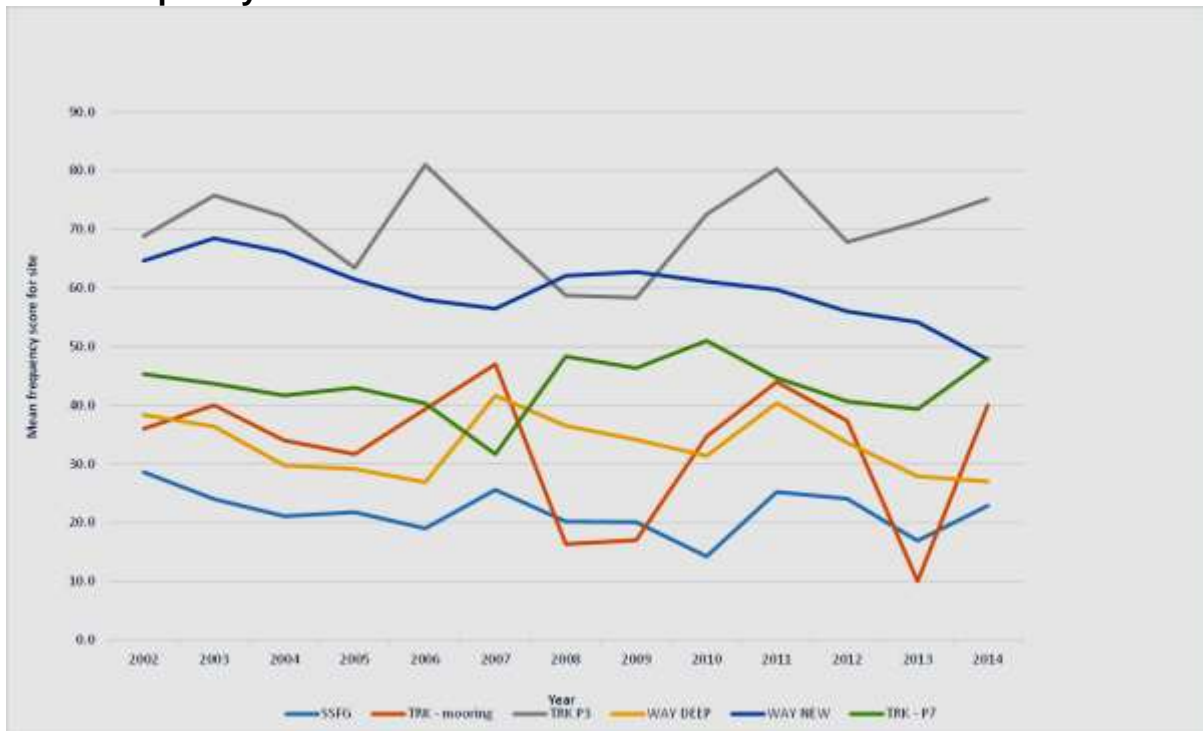
Density of polyp (numbers of polyps /m²) 2001 – 2014



Thorn Rock P3 has returned to similar values seen in 2010 & 2012.

The Way Bench sites have seen a slight increase while Sandy Sea-Fan Gully (SSFG) has declined very slightly.

Mean Frequency of *Parazoanthus* 2002 – 2014



A drop in area occurred at all sites in 2012 which continued in 2013 but in 2014 the TRK sites and SSFG saw an increase in coverage. The two Waybench sites continued to decrease and are now at the lowest levels recorded since 2002.

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. In 2013 two transects with 16 quadrats (50 x 40cm) were established to expand the survey area.
- *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:

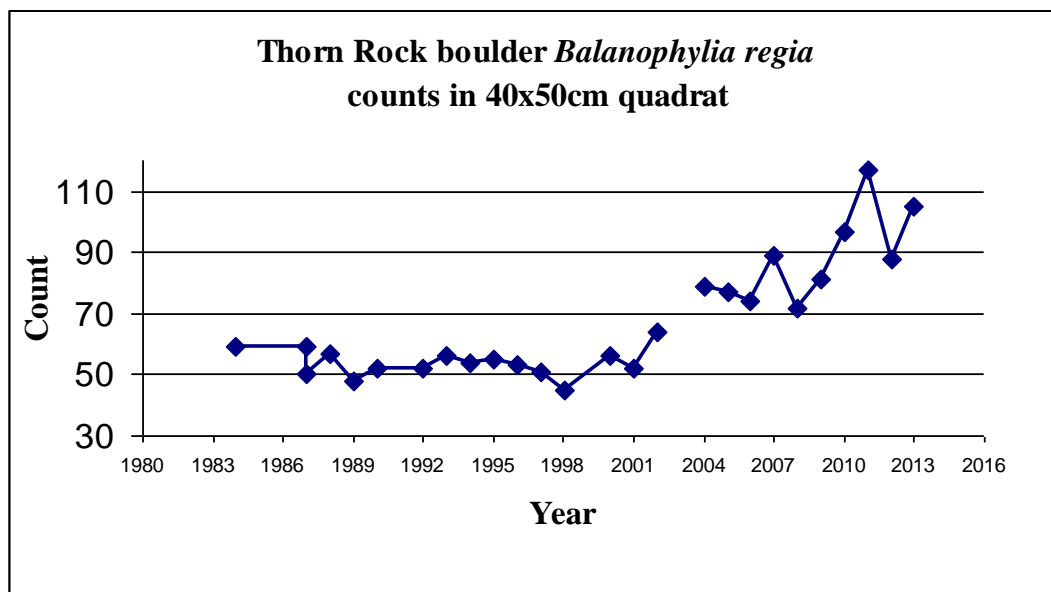
Approximately 70 quadrats have been analysed on an annual basis since 1993 from photographs taken for the sponge community project at Thorn Rock. Photographs are taken using a 50 x 70cm framer and counts are carried out using GIS techniques.

Results

Balanophyllia regia:

At Thorn Rock individuals have been traced for 20 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.

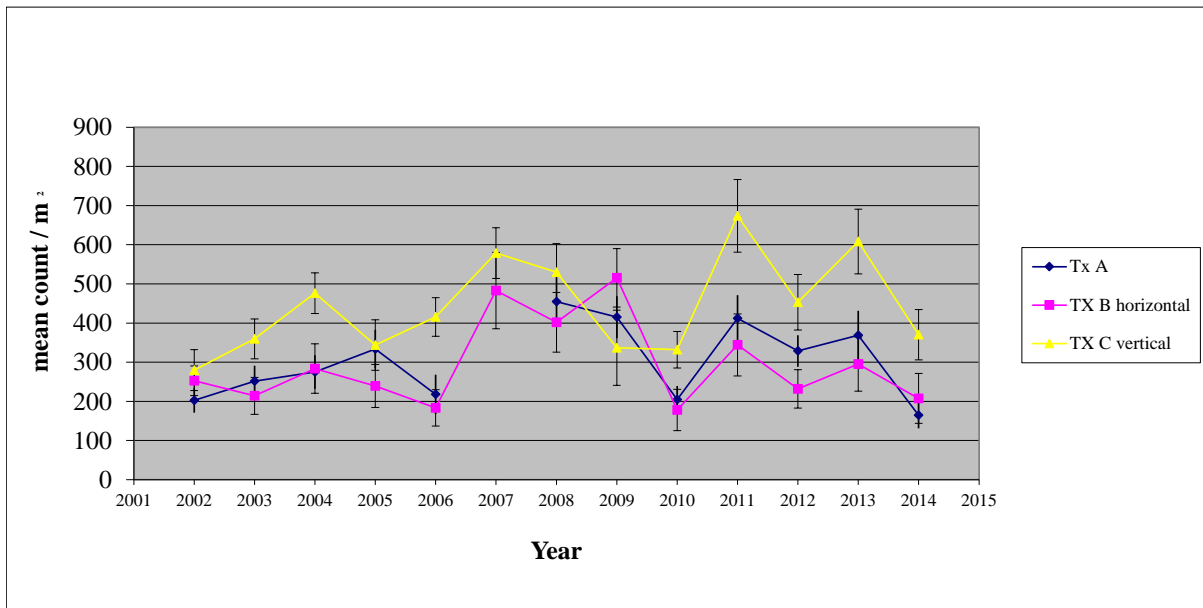


At the Wick all data has been adjusted to 1m² to enable the data from the 50 x 40 cm and the 50 x 70cm framer to be comparable.

Abundance of *Balanophyllia regia* in The Wick (adjusted to 1m²).

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	253	214	284	239	183	483	402
	S.E.	38	47	63	55	46	98	76
WCK C	Mean	280	360	476	344	416	579	530
	S.E.	52	51	52	65	49	65	73
Site	Year	2008	2009	2010	2011	2012	2013	2014
WCK A	Mean	455	415	205	412	329	369	165
	S.E.	62	53	35	59	40	62	34
WCK B	Mean	402	516	178	344	232	295	208
	S.E.	76	75	53	79	49	69	64
WCK C	Mean	530	337	332	674	453	608	370
	S.E.	73	96	46	93	71	83	64

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



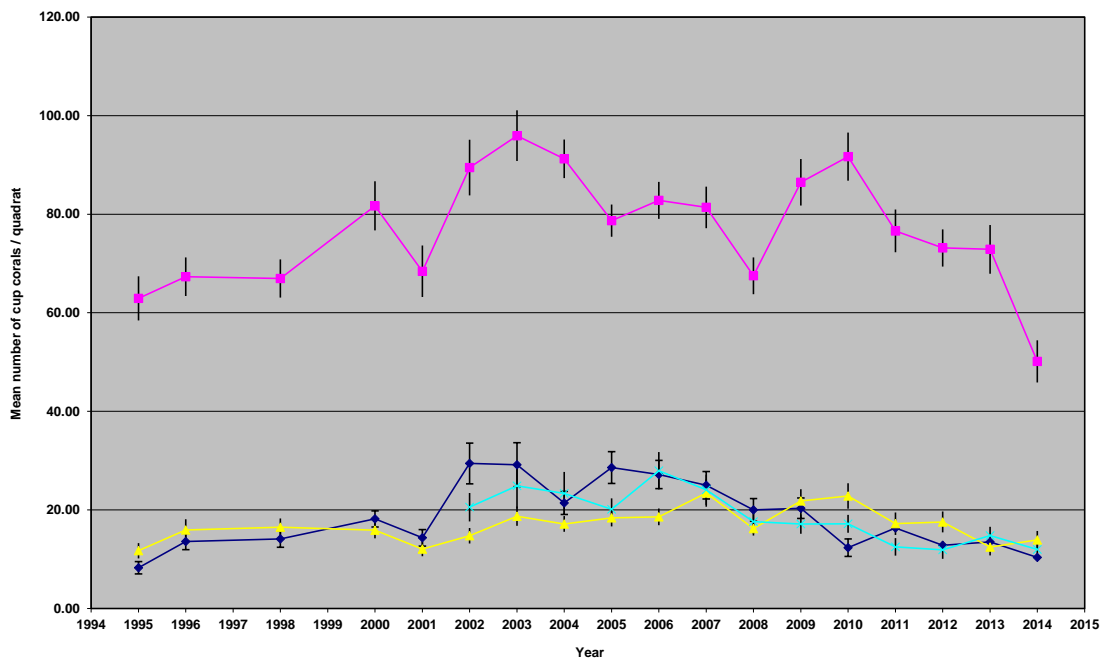
The average number/m² of *B. regia* has fluctuated at transects A, B and C. The variability is caused by dense covering of silt across the site hiding individuals and occasional very poor photographic conditions.

Caryophyllia smithii

At 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 Cup Corals per Quadrat at Thorn Rock 1996 - 2014



Current Status

Variability in numbers is partly due to varying levels of surface sediment. The populations appear stable although there is no firm evidence of recruitment. The photograph quality was very poor in 2014 resulting in all sites showing a drop in numbers.

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)

Method

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

Results

Pentapora foliacea photo dataset:

Year	North Wall	Waybench	Bernies Deep	Bernies Shallow	North Neck	South Middleholm	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	yes

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 (cm²) however this is only an approximate measure of colony size.

2005 Analysis methods were reviewed. The growth of *P. foliacea* colonies varies dramatically; one colony showed an increase in base area of over 800cm² 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. In 2005 base area measurements were not completed due to inaccuracies in the method.

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. With the historical dataset the precision of data was insufficient for the quantitative method. However a method of useful qualitative interpretation of the data by the creation of time-lapse films (at a rate of 25 days per second) in both monoscopic-colour and dichromatic-stereo was demonstrated. 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 – 2010 In 2007 the morphological classification method was applied to the current and historical photo dataset, this was continued in 2008 and 2009. In 2010 the method was reviewed due to inconsistencies between individuals completing the analysis and revised guidelines were produced. The revised guidelines were applied to the 2010 dataset and reapplied to the full historical dataset.

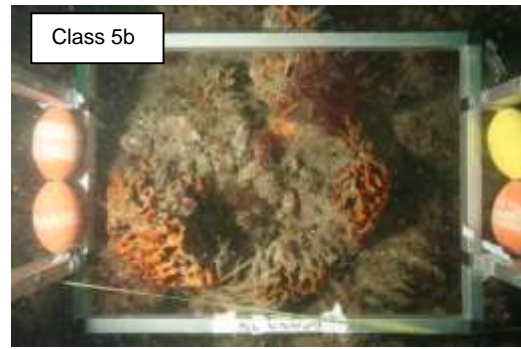
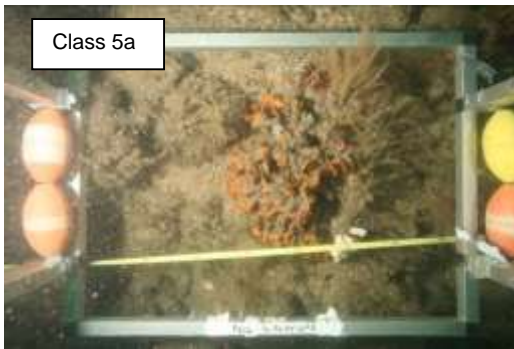
2011 and 2014 the revised 2010 morphological classification method (Burton, Lock and Newman 2011) was applied.

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.

Morphological classification

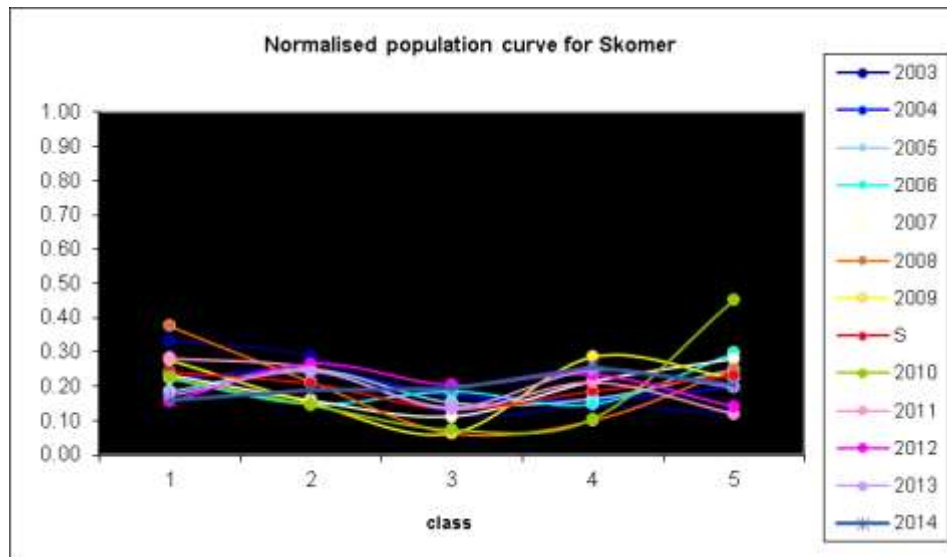
Class 1 (single flakes) to class 4 (20cm diameter) relate to size development, class 5 is not size based but relates to the levels of natural degradation. Class 5a is when more than 50% of the colony is covered in epiphytes and 5b when more than 25% of the colony has broken down. Class 5 can occur at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



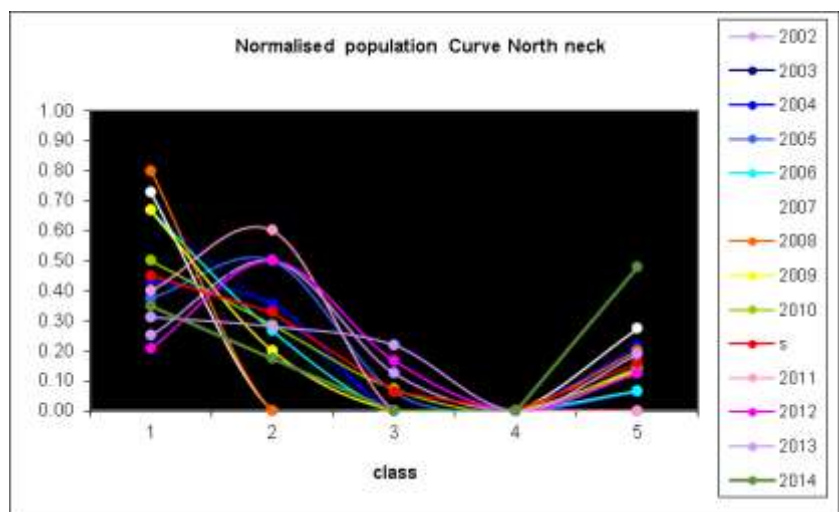


The following graph for all Skomer sites shows a general pattern of the classes with some fluctuations between year sets.

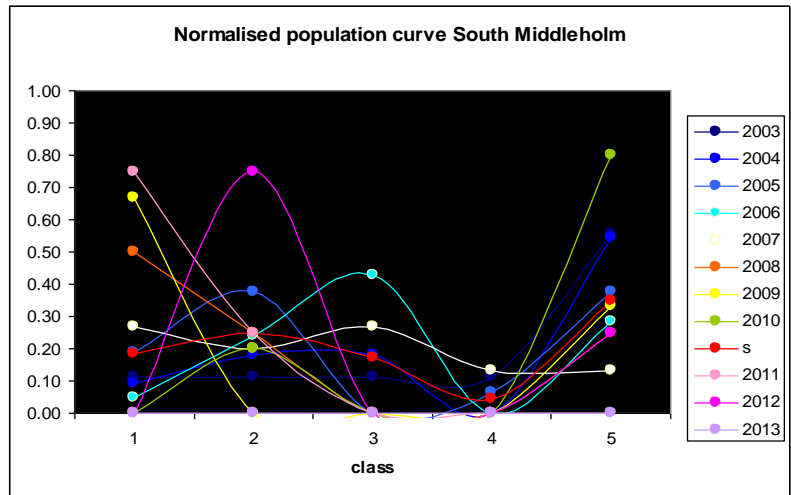
Class 2, 3 and 4 individuals can all progress directly into a class 5 stage if there is more than 50% cover in epiphytes or if there is more than 25% natural degradation, this is demonstrated by the high numbers of class 5 recorded at all sites. The population pattern varies between sites as colony development is affected by both substrate and environmental conditions at sites. The following graphs show the population patterns found at each site.



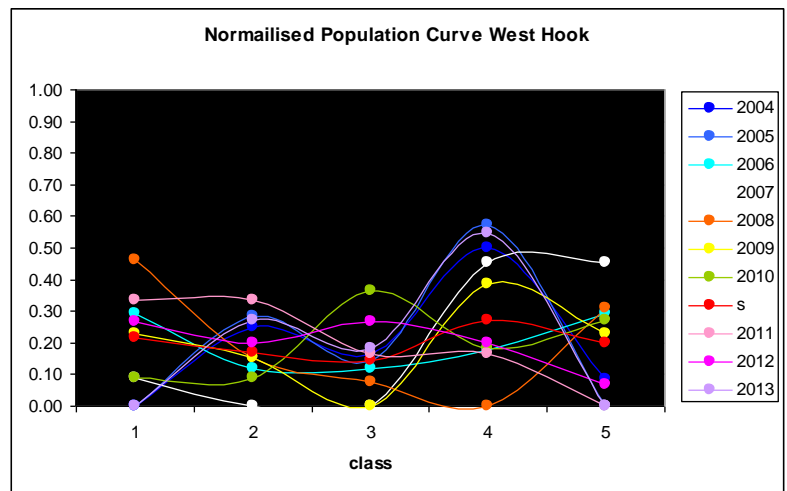
At North Neck class 1 and 2 individuals are the most abundant as at this site the colonies are growing on ground ropes not on bedrock or boulders so the colonies are restricted in their size. Some individuals grow to class 3 but there are no class 4 individuals.



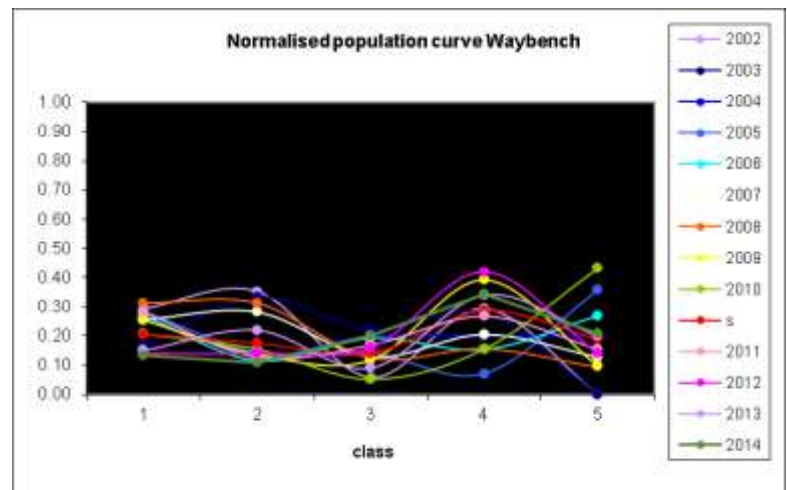
South Middleholm is a small bedrock site, class 1, 2 and 3 individuals are the most common, with very few developing into class 4 colonies, instead developing directly to class 5. This site is located on the south side of the island and subjected to the prevailing SW swell. No colonies were found in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



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



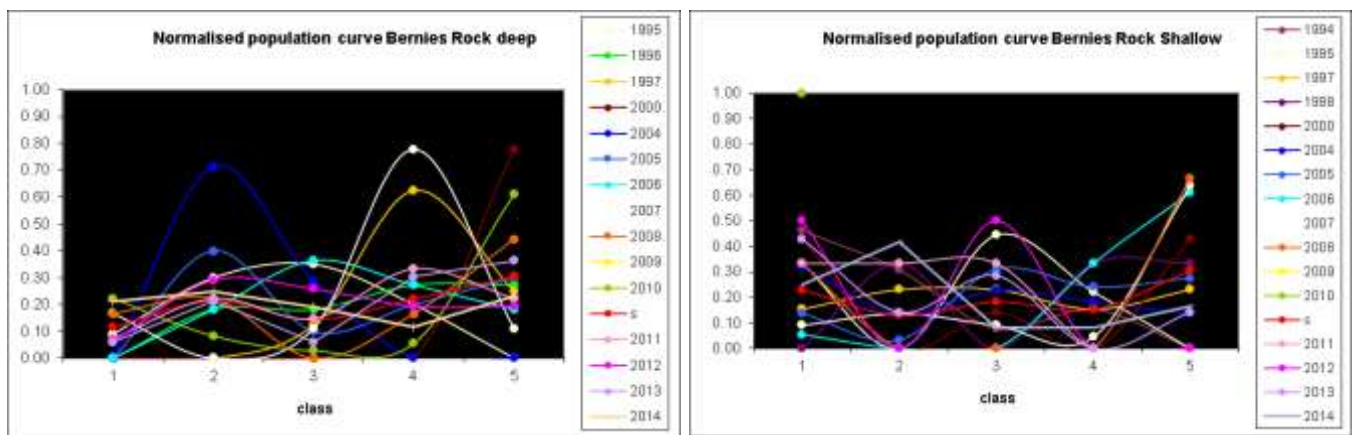
Waybench is a bedrock site with some boulders, located on the north side of the island. Large numbers of colonies are found at this site. A strong pattern between years is observed with a relatively even spread of class 1-4 individuals present. The pattern shows that many colonies reach class 4 before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

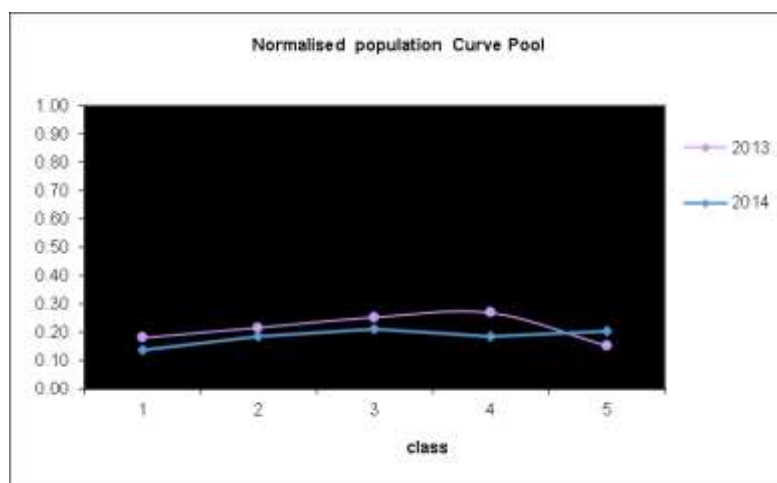
At the deep site between 1997 and 2003 no new colonies were recorded (the class 1a and 1b recorded in 2000 are likely fragments left from an old colony) and no colonies were recorded in 2002 or 2003. New colonies then developed in 2004 and a population at the deep site has continued.

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 2013 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*.

Nudibranch Species Diversity

(CMS code: RM54/01)

Status Ongoing. Nudibranch species survey every 4 years (next survey 2018).

Project Rationale

Nudibranchs are predators on a wide range of species. Most are seasonal and reliant on their prey for food, shelter and a place to lay their eggs. Being near the top of the food chain they can act as an indicator of the health of the communities they rely on. The Skomer MCZ nudibranch population have been identified as being rich and diverse including nationally rare and scarce species (Bunker, Picton & Morrow 1993).



Objectives

- To produce a species list for Skomer MCZ on a 4 yearly basis.
- To record a species check list annually.

Sites

All of the Skomer MCZ

Methods

Surveys are done in early summer. Sites from around the whole MCZ are chosen to provide a range of habitat types. The sub-littoral habitat found at each site is described briefly and associated nudibranch species recorded as a list for each site. In addition, an overall list of species is compiled for the Skomer MCZ and species recorded photographically.

Results

In 1972 and 1973 the first nudibranch sublittoral survey at 12 sites between Skomer and the mouth of Milford Haven was completed. 20-30 minute searches for nudibranchs along arbitrary transects of the seabed, species were counted and samples collected for identification in a laboratory. 35 nudibranch species were recorded at 6 sites located within the Skomer MCZ, (Hunnam & Brown 1975).

Between 1975 and 1991 62 species of nudibranchs were recorded during a total of 99 dives at 44 sites carried out at Skomer sites (Bunker, Picton & Morrow, 1993).

2002 the Skomer MNR team completed 20 dives at 16 sites representing a range of habitats were surveyed for nudibranch species resulting in a total of 32 species. A check list of 16 species was selected for annual monitoring with a target of observing 80% of these species annually, and it was recommended that a full species survey was carried out every 4 years. (Luddington 2002).

Checklist species:

<i>Acanthodoris pilosa</i>	<i>Facelina auriculata</i>
<i>Doris pseudoargus</i>	<i>Flabellina pedata</i>
<i>Crimora papillata</i>	<i>Janolus cristatus</i>
<i>Diaphorodoris luteocincta</i>	<i>Limacia clavigera</i>
<i>Doto fragilis</i>	<i>Polycera faeroensis</i>
<i>Doto pinnatifida</i>	<i>Polycera quadrilineata</i>
<i>Eubbranchus farrani</i>	<i>Tritonia lineata</i>
<i>Facelina annulicornis</i>	<i>Tritonia nilsodhneri</i>

2003 and 2004 all 16 species from the checklist were recorded. A notable record was *Tritonia nilsodhneri* on the pink seafan, *Eunicella verrucosa* at 2 sites. *T. nilsodhneri* is a nationally scarce species (Moore 2002).



Tritonia nilsodhneri

2006 surveys were completed at 13 sites representing a range of habitats for nudibranch species. 35 species were recorded during 21 dives. Notable records were *Doris sticta* a nationally scarce species (Moore, 2002) and three species not previously recorded in the historical data set, *Cadlina laevis*, *Doto eireana* and *Onchidoris pusilla* (Burton *et al* 2007).

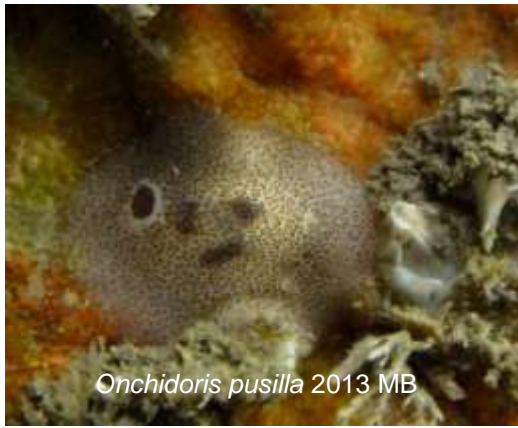


Trapania tartanella DK 2009

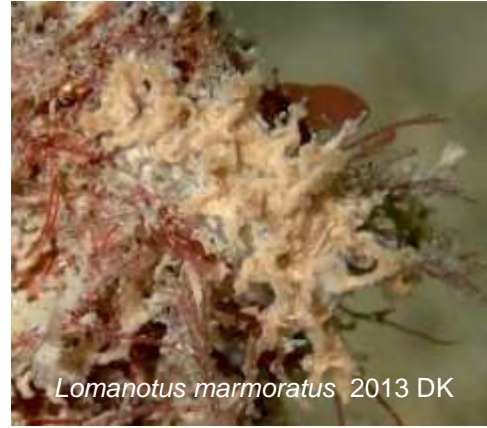
2007 14 of the 16 species from the check list were recorded and in 2009 15 of the 16 species. Notable records in 2009 were *Trapania tartanella*, a new record for both Skomer and Wales, *Doto hystrix* and *Cuthona caerulea* which had not been not found on either the 2002 or 2006 surveys. These were recorded and photographed at Rye Rocks by diving volunteers Sarah Bowen and David Kipling (Lock *et al* 2011).

2010 A nudibranch species identification course was provided by specialist Bernard Picton. 14 sites were surveyed resulting in a total of 55 species of nudibranchs. The number of species were significantly higher than the 2002 or 2006 surveys, this may have been due to improved identification skills and also to extra efforts made to target a wider range of habitats including mixed sediment sites. Two species not previously recorded in the Skomer MCZ were *Eubbranchus vittatus* and *Trapania pallida*.

2013 15 of the 16 species from the check list were recorded, including *Tritonia nilsodhneri* on pink sea fan, *E. verrucosa* at Rye Rocks. *Onchidoris pusilla* was recorded at the Mewstone and *Okenia elegans* at the Pool and Thorn Rock. A Notable record was *Lomanotus marmoratus* at High Point by David Kipling which had not been recorded in the MCZ since 1991.



Onchidoris pusilla 2013 MB



Lomanotus marmoratus 2013 DK

2014 survey was completed at 13 survey sites and 49 nudibranch species were recorded. 3 species had not been recorded since 1992 these were *Cuthona concinna*, *Eubranchus doriae* and *Doto floridicola*. *Doto floridicola* had previously been recorded as *Doto sp 'A'* in 1990 (Bunker *et al*, 1993), its identification was confirmed in 2002 (Picton *pers. comm.*).

A review was completed of all records for surveys between 1972 and 2014 including sediment infauna surveys. A total of 76 nudibranch species have been recorded in the Skomer MCZ. This represents 70% of UK species in an area of 13.2 square kilometres. 63 species have been found on those surveys carried out between 2002 and 2014, of which 5 species were unrecorded in the MCZ before 2002. Nudibranch species recorded include several classed as nationally scarce or with limited national distribution in the British Isles, see Lock *et al*, 2014 for full report.

Targets

- Observe 80% of the 16 check list species annually.
- To complete a species list for the MCZ every 4 years.

Current status

49 nudibranch species were recorded on dives during 2014. The number of species recorded were lower than in 2010 (55 species) however effort was lower in 2014 with a total of 19 dives completed compared to 14 sites surveyed and 27 dives completed in 2010 (Lock *et al*, 2011).

There was a general perception within the dive team that nudibranch species in general were not abundant and much lower than 2010 survey which was a particularly healthy year. In 2014 most of the survey sites were covered in a thick layer of silt, deposited following the violent storms of winter 2013/14. This silt buried many of the sessile filter feeding animals: hydroids, bryozoans, sponges and ascidians which are food sources for the different nudibranch species.

Recommendations

- Complete the annual check list;
- Photograph and collect any unusual species for identification;
- MCZ staff to complete nudibranch identification training;
- Complete a nudibranch species survey in the Skomer MCZ every 4 years.

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

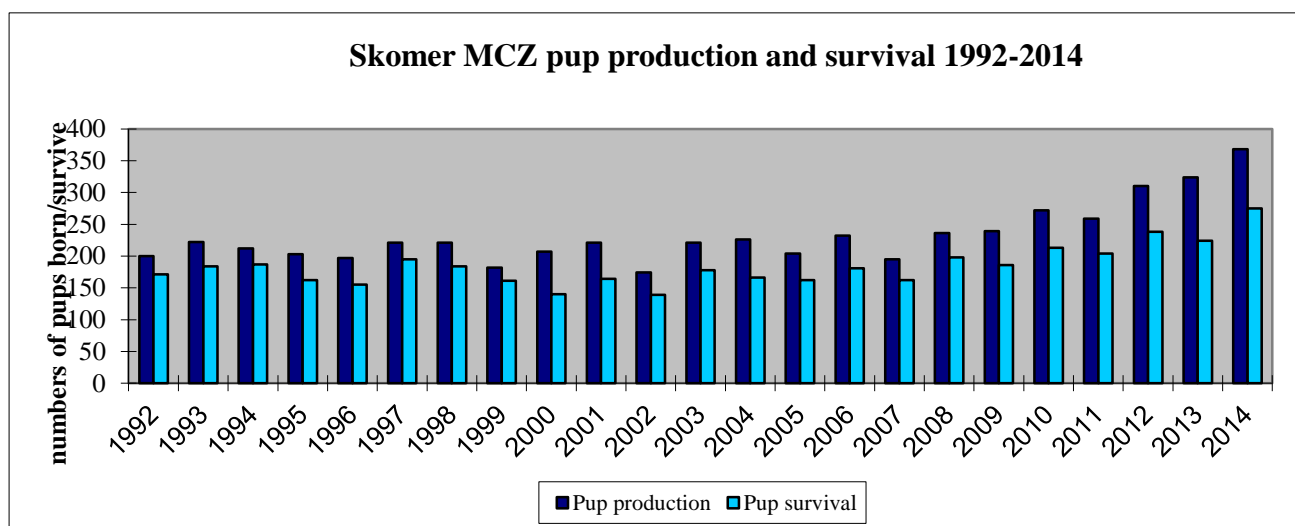
All pupping beaches and caves in the MCZ.

Methods

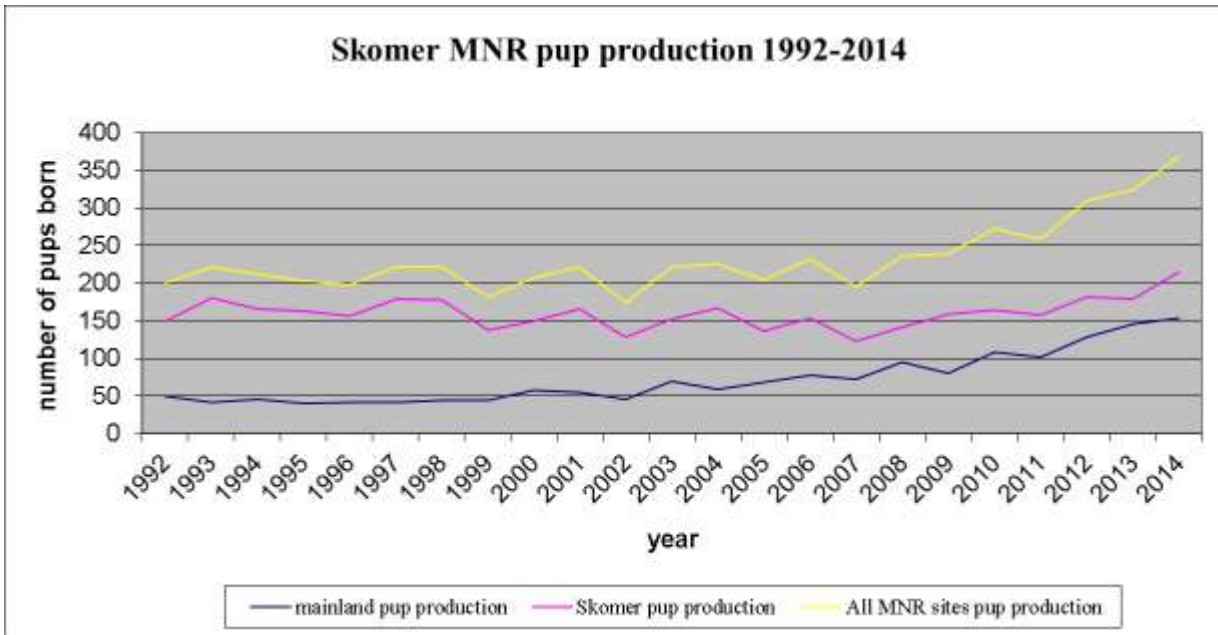
The pups are recorded from birth through to their first moult using the “Smith 5-fold classification system” (Poole 1996). Reason for death is recorded if possible. Additional behavioural observations are recorded for the Island seals (Full method described in ‘Grey Seal Monitoring Handbook’ Poole 1996).

Results

Regular recording began on Skomer Island in 1974 and surveys have been completed annually since 1983. From 1992 onwards a standard protocol has been adopted to record the pupping success on both the island and the mainland each year. A full survey report is produced for the seal survey at the Skomer Island sites.

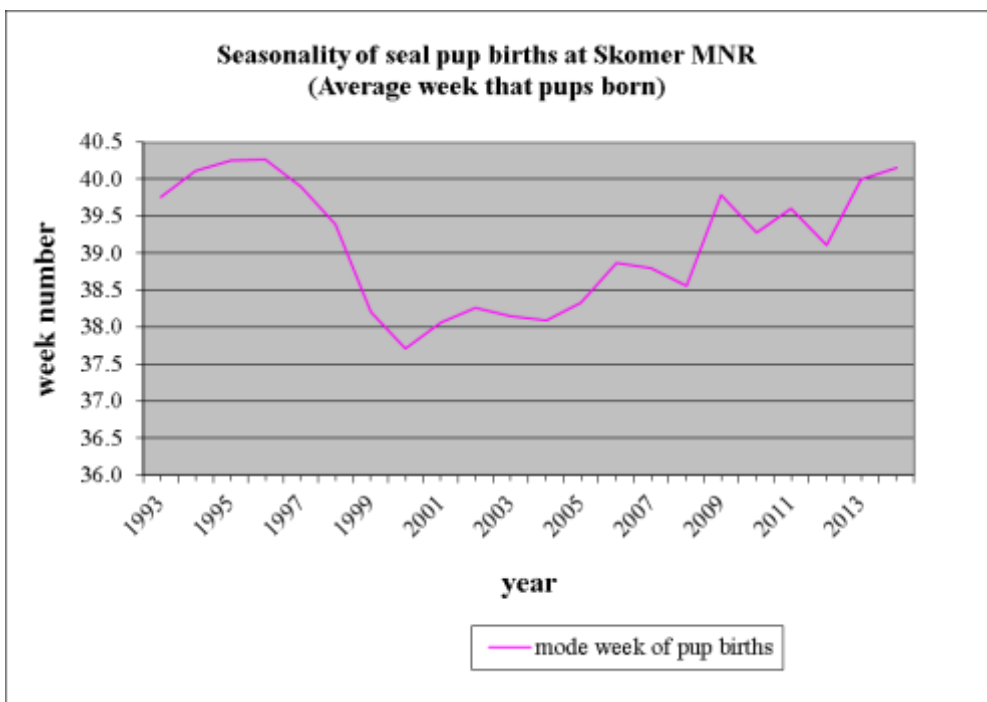


In 2014 215 pups were born at island sites and 153 pups at mainland sites giving a total 368 pups born in the MCZ with a recorded combined survival of 75% through to moult. Pup production was above the annual target (190 births) and survival was above the annual target (70%) set for the MCZ.



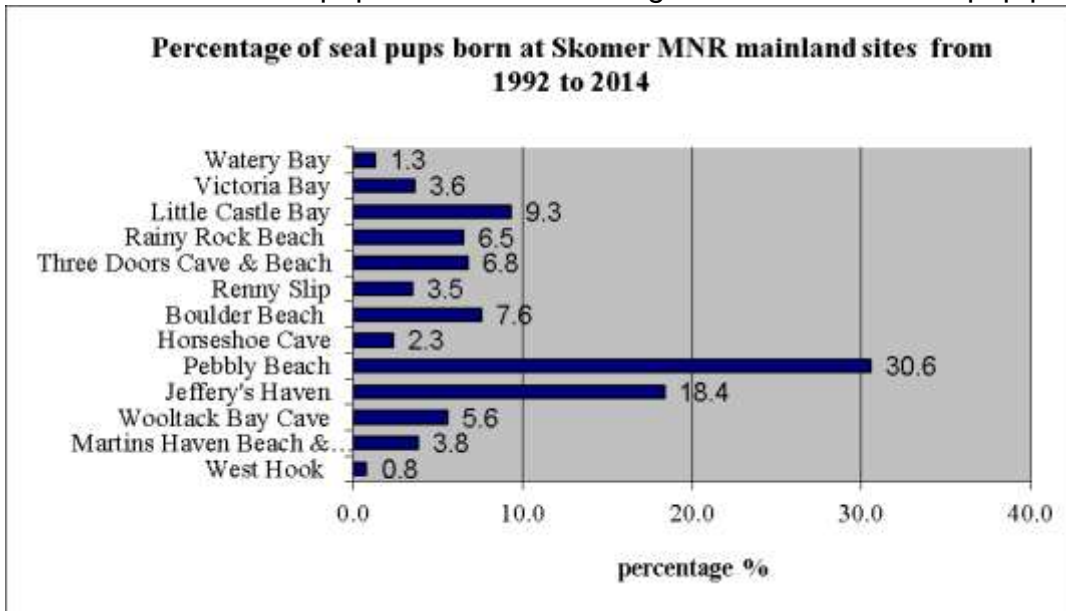
Pup production in the Skomer MCZ for the past 3 years has shown the highest totals ever recorded: 2012 (310 pups), 2013 (324 pups) and 2014 (368 pups). The pup production at the island sites shows the expected natural fluctuations and from 1992 to 2013 has remained fairly consistent with an average of 157 pups, production in 2014 shows a slight increase in numbers. The mainland sites show larger increases in pup production and these have contributed to the overall increase in numbers for the whole MCZ. Between 1992 and 2002 an average of 50 pups was born at the mainland sites, in contrast the average between 2003 and 2014 is 96 pups.

In 2014 pup production was 9% in August, 34% in September, 52% in October and 9% 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 2014 Skomer seal census details the production for the island sites, see Buche and Stubbings 2014.

The following graph shows the percentage of pups born at the mainland sites from 1992 to 2014. 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 - 2013 At Skomer sites photography was extended to include pupping cows to help increase knowledge of site fidelity, longevity and pupping frequency (Boyle 2009). 431 different cows are known to have pupped in the 6 years from 2008 to 2013. In 2012, 59 cows were photographed on both sides, 36% of which are known to have pupped on the island before.

In 2013 14 bulls were identified of which five have been recorded on Skomer before and nine were new to Skomer. Dave Boyle observed a bull hauled out in April 2013 which had a flipper tag. It was born in 2001 in Colwyn Bay, North Wales and was rehabilitated at the Welsh Mountain Zoo in 2012.

In 2011 - 2013 the work also expanded to some cows and bulls from mainland sites.

2010 - 2014 Collaboration work with Sue Sayer, Cornwall Seal Group, who has maintained extensive catalogues of seals photographed in Cornwall since 2000. In February 2013 Sue Sayer produced a report 'Skomer Seal Photo Identification Project Report 2007 – 2012' in which 36 seals had been matched between Cornwall/Devon sites and Skomer sites. Most of the seals matched were only seen at the West Cornwall haul out and Skomer, but eleven seals were seen at multiple additional sites (Sayer 2013). 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 2014 there have been 43 matches of seals identified between Cornwall and Skomer MCZ (Sayer *pers. comm.*). There were 3 further matches of Skomer seals with animals at Ramsey Island.

2014 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 has allowed all existing Pembrokeshire photos (2007 to 2014) to be entered, this is in addition to the North Wales seal ID datasets.

Tagged seals

Two seals were traced due to flipper tags. On 09/11/14 an immature seal was hauled out on Mathew's Wick which was identified as Bianca who was rescued by the Cornish Seal Sanctuary from Porthgwarra on 09/02/14 and released on 23/05/14 in Gunwalloe.

Also in 2014, a seal, which was hauled out on Skomer with a red tag with the number 117 on 04/11/13, was identified as Tina from the Cornish Seal Sanctuary. She was released at Gwithain on 06/05/13. (Buche B & Stubbs E, 2015)



Pollution

Monofilament line and netting continue to be the main obvious pollution affecting seals. In 2014 32 cows, 12 bulls, 1 immature and 2 weaners were photographed around the island showing obvious signs of being entangled in nets at some time in their lives, most commonly a deep scar around their necks, often with netting still embedded. The problem with netting entanglement is a growing concern especially with the high numbers recorded.

Targets

- Number of pups born annually should be greater than 190 (170 in any 4 year period, provided numbers recover to over 190 in the following year)
- Percentage survival of pups greater than 70% (67% in any 4 year period, provided survival recovers to over 72% in the following year).

Current Status

- 2014 pup numbers reached 368, 136 pups higher than the average for the last 23 years. Pup survival was 75%, 4% below the average. The majority of deaths were caused by abandonment or separation and by periods of harsh weather.
- In 2014 pup production was 9% in August, 34% in September, 52% in October and 9% in November, and modal week of production was week 40 (1-7th October)
- All Skomer and Marloes Peninsula seal photos between 2007 and 2014 have been entered into the NRW Welsh Seal database.

Recommendations

- To continue annual survey following the 'Grey Seal Monitoring Handbook' Poole 1996, 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 developments for a Wales photo identification 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.

Species Recording

(CMS code: RB06/01)

Status

Ongoing, annual recording.

Project Rationale

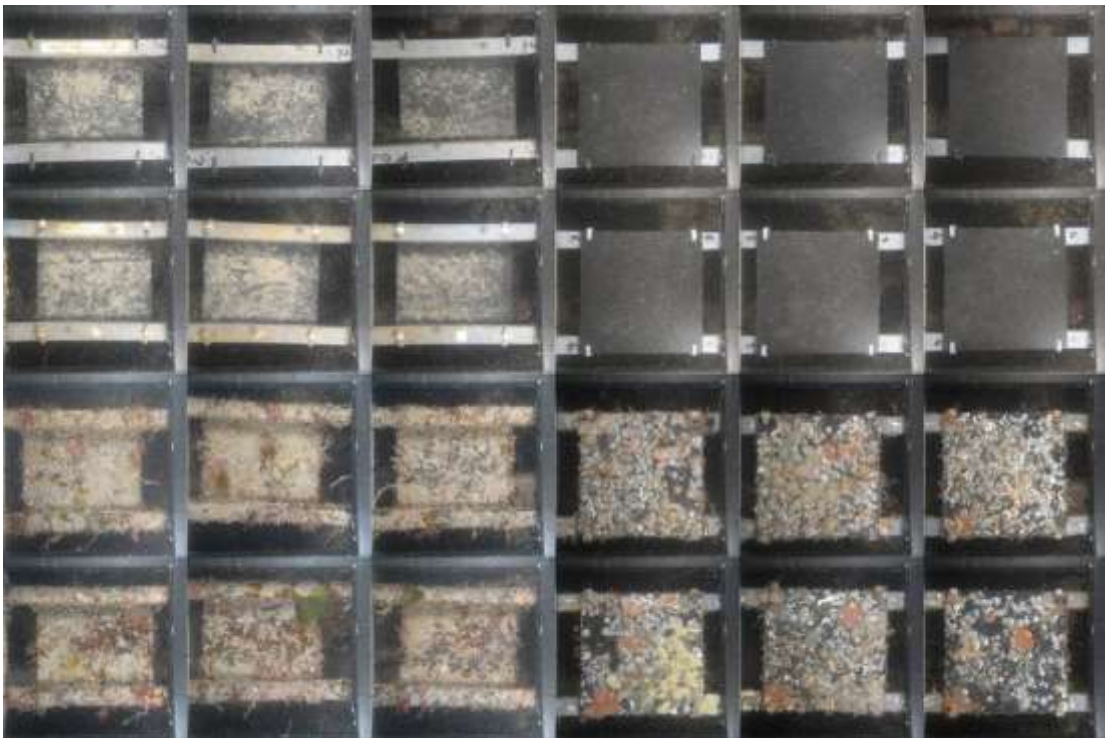
There are many species in the Marine Conservation Zone that do not have a dedicated monitoring project. It is important that species lists are maintained, particularly for phyla that are under-recorded. Records of unusual, rare, scarce or vagrant species are also maintained.

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. The project continued throughout the 2010 to 2013 seasons. This project is already established at sites in Spitzbergen, Baltic and Mediterranean.



Example of monthly sequence photos of settlement plates:



Analysis commenced by Marta Ronowicz of the monthly panels photographed and exchanged between June 2009 and Sept 2011. A total of 55 encrusting macrobenthic taxa belonging to 8 Phyla have been found. Bryozoans were the most abundant group followed by bivalves, polychaetes, hydrozoan, sponges and cirripeds. 8 bryozoan taxons dominated in terms of population abundance and were most frequently $F > 20\%$ settling on the panels. These represented 63% of the total abundance.

Site, position on panels, depth and year were significant variables influencing both the number of taxa and abundance of recruits. Higher number of taxa were found on the underside of the panels, the highest monthly mean number of taxa was found at the 12m depth. Mean assemblage abundance and species number were significantly higher at Bernie's Rock. A significant difference has been shown between 2010 and 2011 with the highest species richness and abundance in 2011. There were clear differences of particular fauna groups in each month. Large month to month fluctuations was noted in species richness. These results were published in the Journal of the Marine Biological Association of the UK by M. Ronowicz *et al* 2014.

Crawfish

Crawfish *Palinurus elephas* became a national Biodiversity Action Plan species in 2008. From 2009 to 2014 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.



Mollusc species records

In June 2014 volunteer diver Jon Chamberlain took a scooped gravel sample which he bagged, whilst diving at Martins Haven (west). The sample was sent to Simon Taylor at the Conchological Society for sorting and species identification. Both live and shell only species were identified and the abundance (based on ACFOR scale) was recorded. These records have been added to the ConchSoc dataset and the National Biological Network (NBN). The results are shown in the following table.

Mollusc species, Martins Haven West, June 2014

Species	shell/live	abundance	Species	shell/live	abundance
<i>Emarginula fissura</i>	S	O	<i>Hinia incassata</i>	S	F
<i>Diodora graeca</i>	S	O	<i>Mangelia coarctata</i>	S	O
<i>Tectura virginea</i>	S	O	<i>Raphitoma linearis</i>	S	O
<i>Patella vulgata</i>	S	O	<i>Raphitoma purpureus</i>	S	O
<i>Helcion pellucidum</i>	S	O	<i>Odostomia unidentata</i>	S	O
<i>Jujubinus montagui</i>	S	R	<i>Brachystomia eulimoides</i>	S	R
<i>Gibbula tumida</i>	L	F	<i>Chrysallida decussatus</i>	L	O
<i>Gibbula cineraria</i>	S	O	<i>Partulida spiralis</i>	S	O
<i>Gibbula umbilicalis</i>	S	F	<i>Turbonilla lactea</i>	S	O
<i>Calliostoma zizyphinum</i>	S	O	<i>Philine punctata</i>	S	O
<i>Dikoleps nitens</i>	S	O	<i>Retusa truncatula</i>	S	F
<i>Skenea serpuloides</i>	L	O	<i>Nucula nucleus</i>	L	F
<i>Tricolia pullus</i>	S	C	<i>Striarca lactea</i>	S	R
<i>Bittium reticulatum</i>	S	O	<i>Mytilus edulis</i>	S	O
<i>Turritella communis</i>	S	O	<i>Modiolula phaseolina</i>	S	R
<i>Lacuna pallidula</i>	S	O	<i>Mimachlamys distorta</i>	S	R
<i>Lacuna parva</i>	S	O	<i>Mimachlamys varia</i>	S	O
<i>Lacuna vincta</i>	S	O	<i>Aequipecten opercularis</i>	S	O
<i>Skeneopsis planorbis</i>	S	O	<i>Palliolium tigerinum</i>	S	R
<i>Rissoa interrupta</i>	L	F	<i>Lucinoma borealis</i>	S	O
<i>Rissoa parva</i>	S	C	<i>Lasaea adansonii</i>	S	F
<i>Alvania punctura</i>	S	F	<i>Mysella bidentata</i>	S	O
<i>Alvania semistriata</i>	S	F	<i>Parvicardium ovale</i>	L	O
<i>Manzonina crassa</i>	S	F	<i>Parvicardium scabrum</i>	S	O
<i>Obtusella alderi</i>	L	O	<i>Abra nitida</i>	L	O
<i>Onoba aculeus</i>	S	O	<i>Clausinella fasciata</i>	L	R
<i>Onoba semicostata</i>	S	C	<i>Timoclea ovata</i>	L	O
<i>Pusillina inconspicua</i>	S	F	<i>Tapes rhomboides</i>	S	R
<i>Caecum glabrum</i>	L	O	<i>Dosinia exoleta</i>	S	O
<i>Tornus subcarinatus</i>	S	O	<i>Sphenia binghami</i>	L	O
<i>Calyptrea chinensis</i>	S	R	<i>Corbula gibba</i>	S	R
<i>Trivia arctica</i>	S	O	<i>Hiatella arctica</i>	S	F
<i>Lamellaria perspicua</i>	S	R	<i>Alvania cancellata</i>	S	O
<i>Polinices polianus</i>	S	R	<i>Chrysallida interstincta</i>	S	O
<i>Cerithiopsis tubercularis</i>	S	O	<i>Crenella prideauxi</i>	S	R
<i>Marshallora adversa</i>	S	O	<i>Gari costulata</i>	L	R
<i>Epitonium clathratulum</i>	S	R	<i>Irus irus</i>	S	R
<i>Melanella alba</i>	S	O	<i>Menestho divisa</i>	S	O
<i>Ocenebra erinacea</i>	S	F	<i>Modiolarca subpicta</i>	S	O
<i>Hinia reticulatus</i>	S	R	<i>Otina ovata</i>	S	R
			<i>Pododesmus striatus</i>	S	O
			<i>Turbonilla jeffreysi</i>	S	R

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 GSM 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.

2012 - Weather station serviced by Cambell 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, when a new anemometer was installed. Most instruments serviced by Campbell Scientific in March 2015.

Results

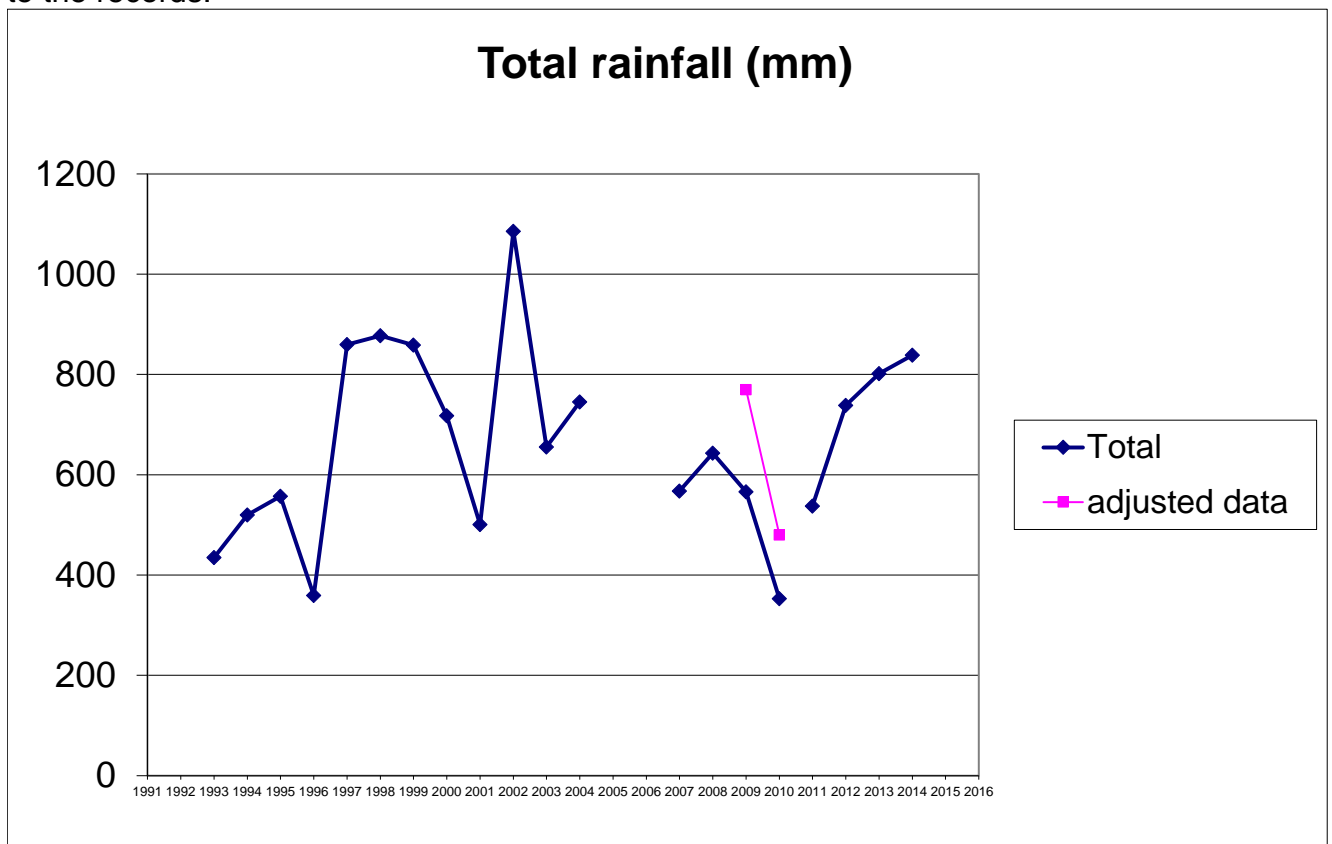
A continuous data set has been maintained since May 1993. However there are some gaps due to equipment failure, these are: March 1994, January 1998 and from November 2005 to April 2006.

The Fairmount weather station was already aging before it was replaced and the solarimeter, net radiometer and rain gauge readings were all unreliable during 2005.

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.

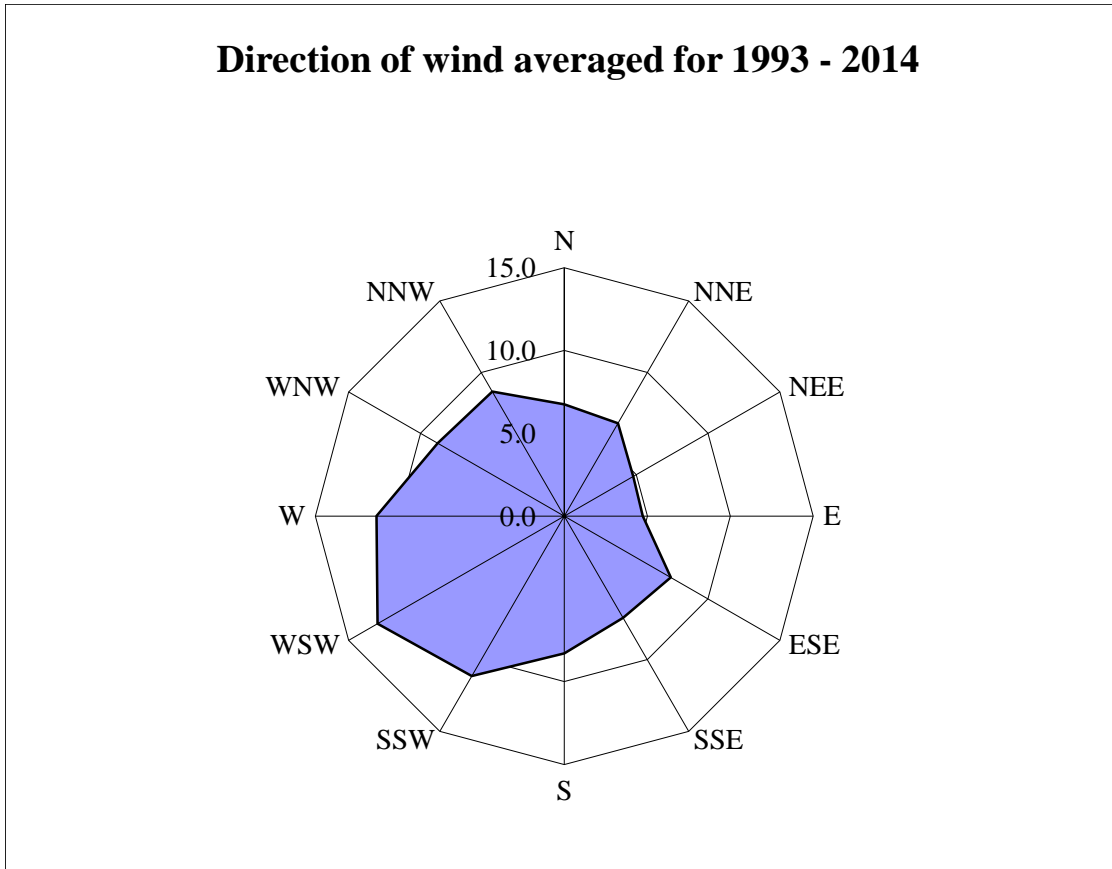


There was some extreme weather in February 2014 with 100mph winds recorded on the 12th Feb 2014. The rain gauge recorded 199mm of rain for that day. – It is most likely that this was a false reading. The winds will have vibrated the rain gauge causing it to “tip” when there was no water in the bucket.

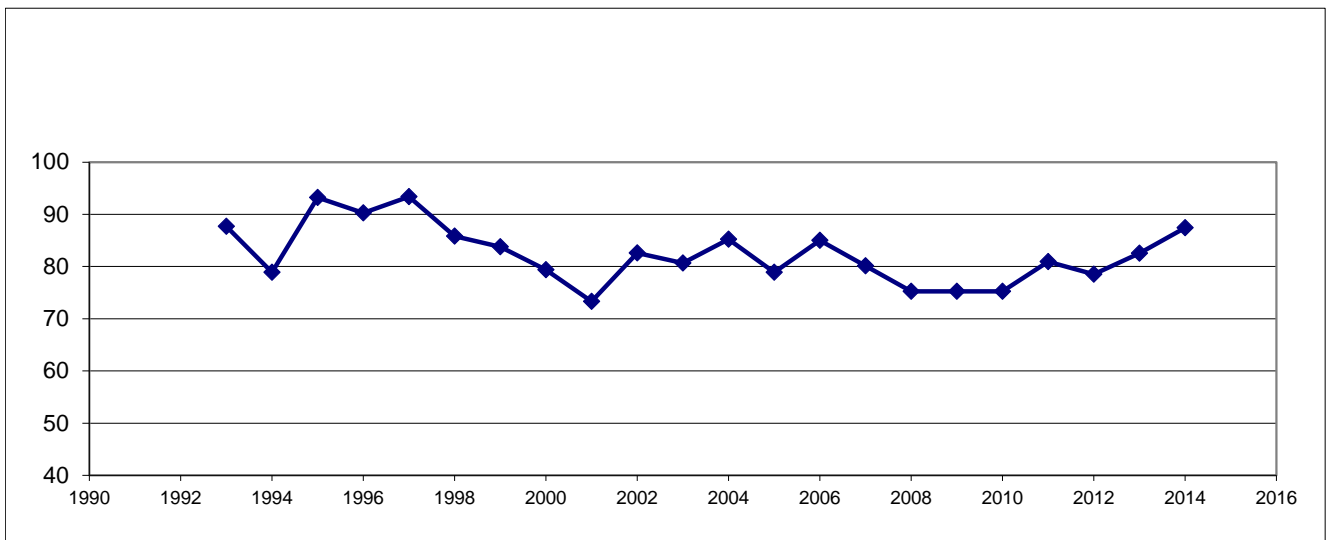
This day’s results have been removed from the data.

Wind speed and direction

Radar plot of frequency of wind direction. – Prevailing winds come from the WSW.
Maximum recorded 3 second gust

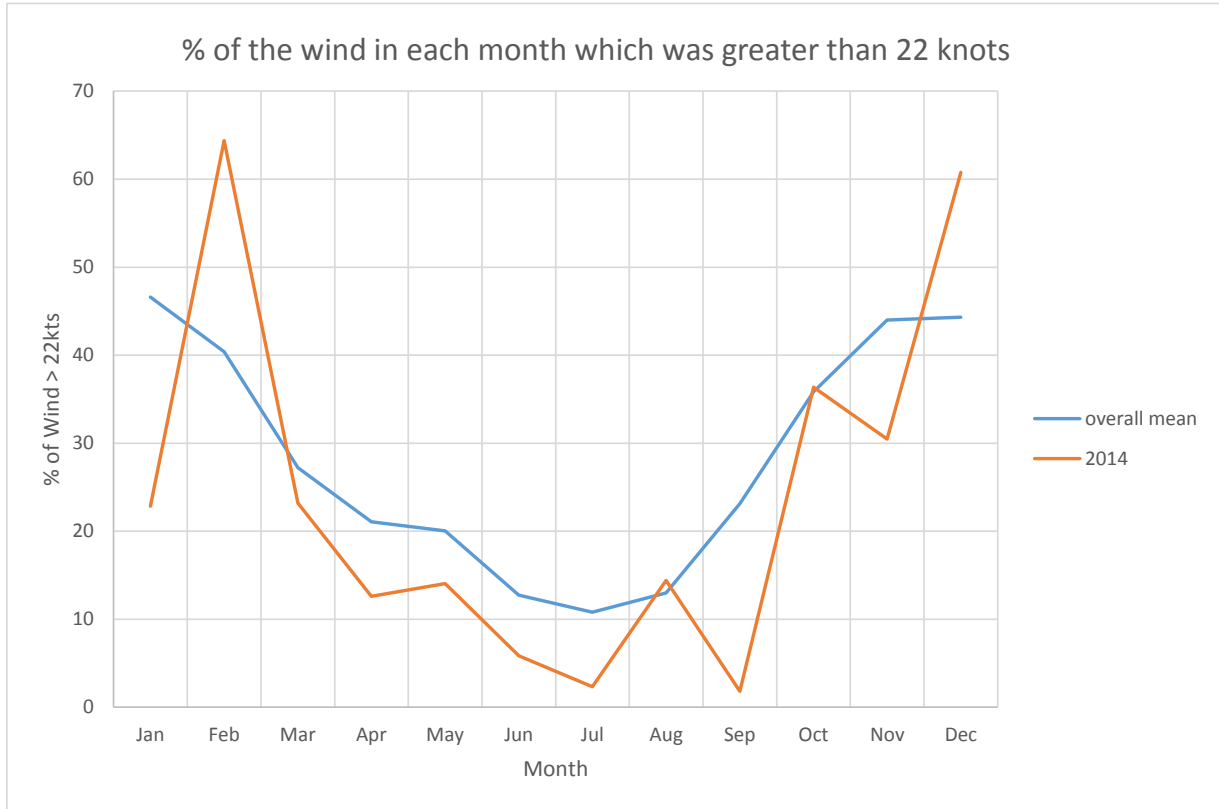


Maximum Wind Strength (Knots) 1993 - 2014

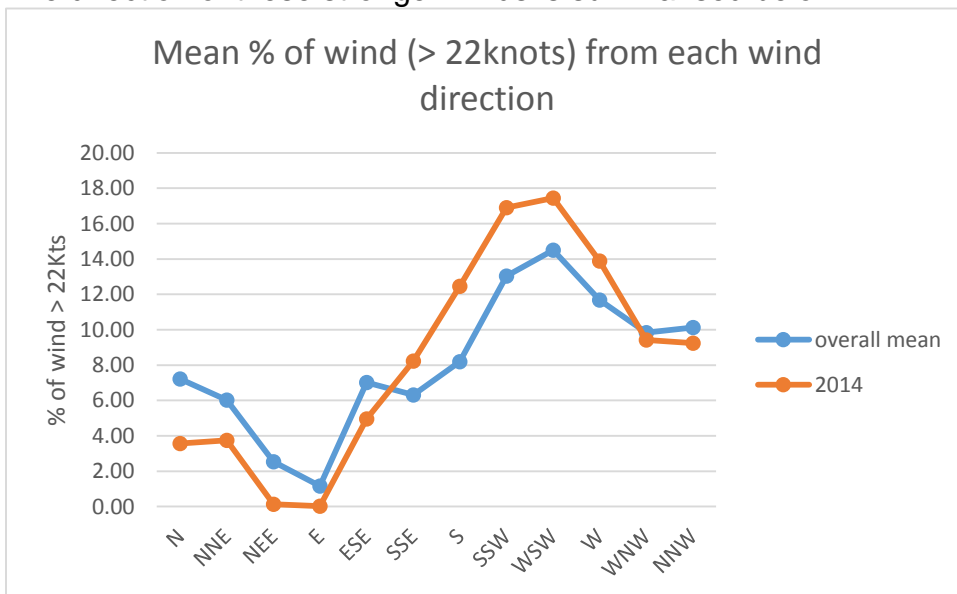


The maximum gust recorded for 2008, 2009 & 2010 was exactly the same (75.28 knots). It is possible the bearings were faulty. The bearings were replaced in 2011 and higher gusts are now being recorded. 2014 saw a maximum gust of 87.4 knots.

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 – 2013. It shows how windy February was in 2014 and how calm September was.

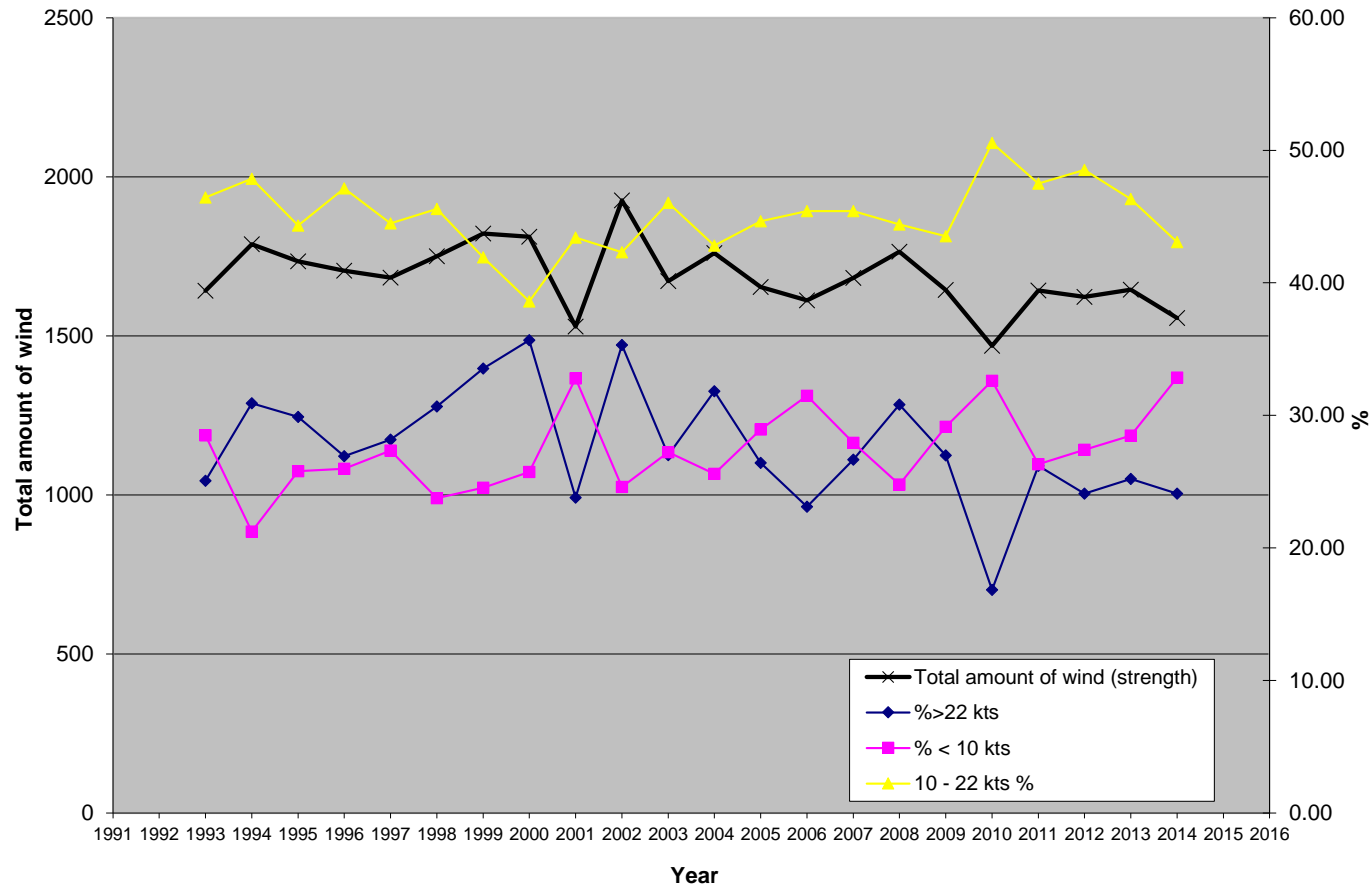


The winter months tend to have the high % of strong winds (Dec 1999 – 85% > 22Kts) but it is very variable from year to year. The direction of these stronger winds is summarised below.



2014 has a very similar distribution of winds compared to the overall mean for 1993-2013. Most of the stronger winds come from the SW, WSW & W but the NW & N can carry a high % of the strong winds in some years. The East tends to have the lowest % of strong winds.

Annual wind statistics 1993 - 2014



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 between 10 – 22 Kts is then shown as a percentage.

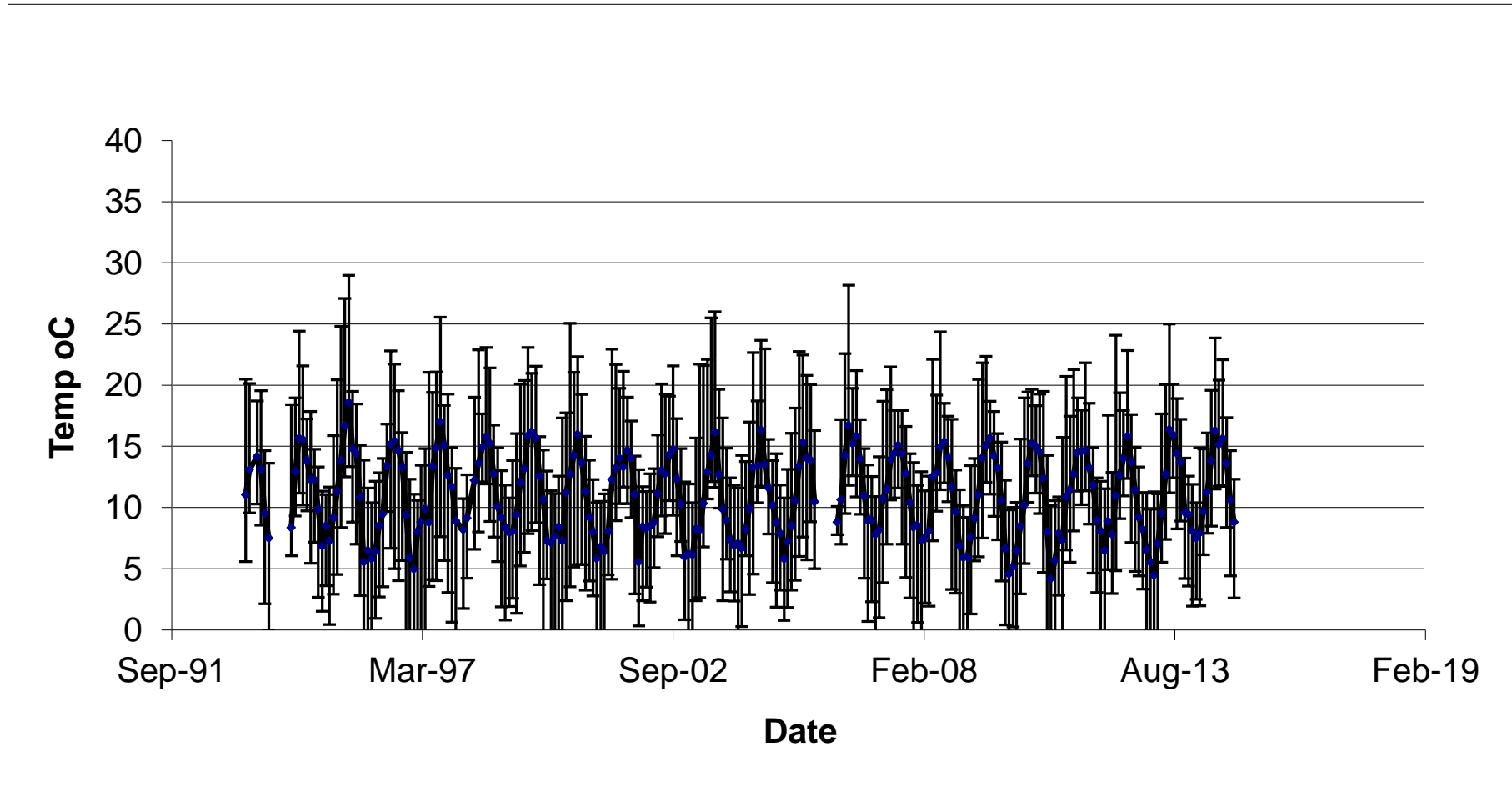
2002 was the windiest year with 35% of all the wind greater than 22Kts.

2010 was the calmest year with only 17% of the wind stronger than 22Kts and 33% of the wind less than 10Kts

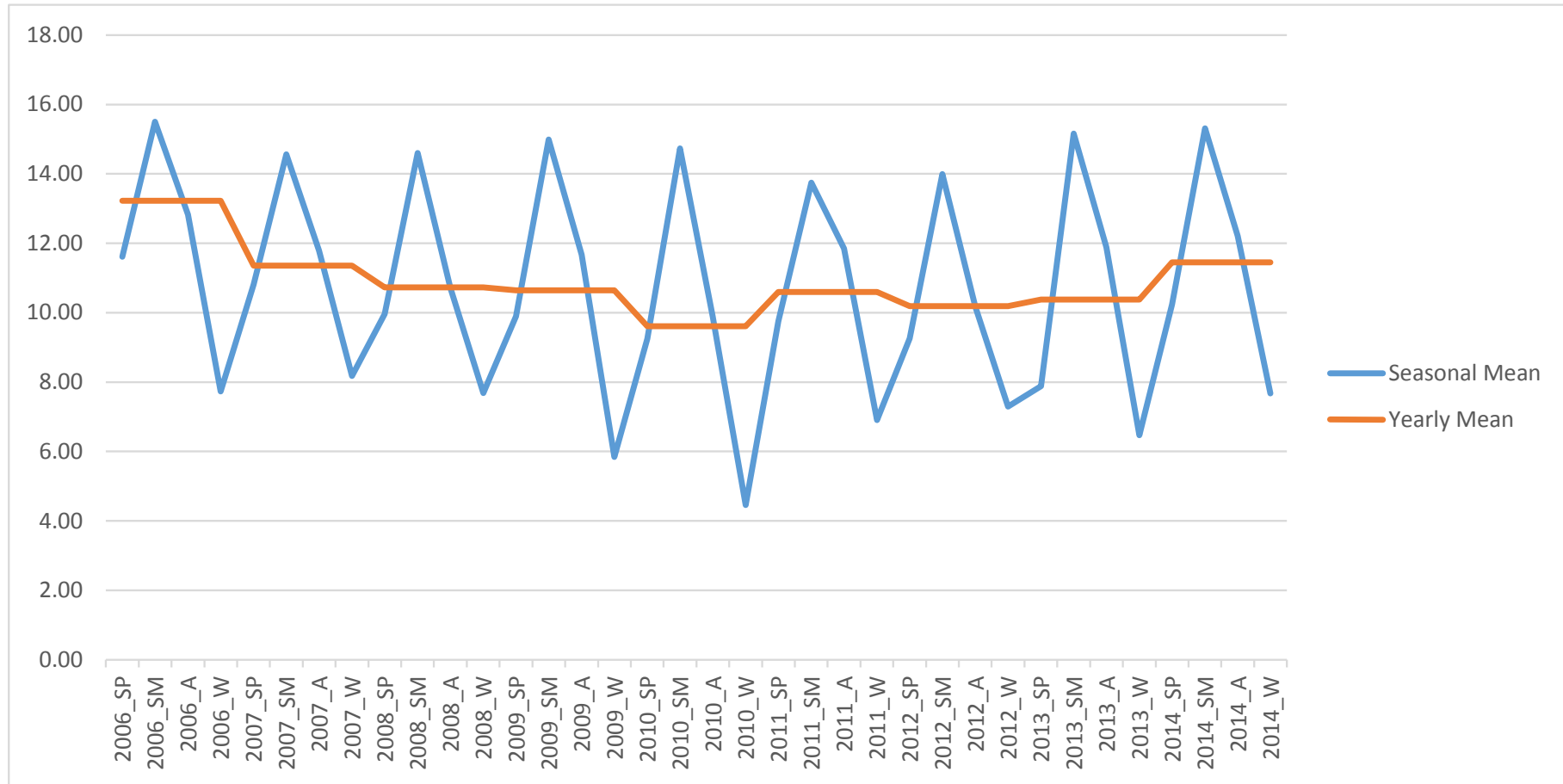
2014 annual meteorological summary

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AIR TEMP	MEAN	8.1	7.5	7.9	9.7	11.3	13.9	16.3	15.2	15.7	13.6	10.7	8.8
T107_1 0c	MAX	11.9	10.4	14.9	14.8	16.1	19.6	23.9	20.4	22.1	17.4	14.7	12.3
	MIN	1.9	2.5	2.0	6.1	7.9	8.5	11.5	11.7	11.8	8.4	4.4	2.6
BAROMETRIC PRESS	MEAN	990.5	986.1	1007.7	1006.7	1007.7	1012.2	1009.4	1004.4	1013.0	1003.0	996.8	1012.6
	MAX	1015.0	1007.0	1027.0	1022.0	1030.0	1023.0	1018.0	1017.0	1021.0	1023.0	1020.0	1036.0
	MIN	0.0	955.0	969.0	985.0	991.0	998.0	992.0	985.0	1001.0	979.0	977.0	0.0
RELATIVE HUMIDITY	MEAN	79.8	78.8	82.5	83.5	85.6	82.7	83.3	77.7	79.4	80.7	78.4	76.8
	MAX	97.0	97.6	97.9	97.7	97.9	97.9	97.5	97.0	97.4	98.9	96.3	100.0
	MIN	0.0	50.0	0.0	43.7	61.1	51.6	42.9	54.8	48.3	44.4	54.9	-10.8
RAINFALL	TOTAL(mm)	134.0	293.3	39.3	27.4	31.3	21.1	5.8	84.3	4.5	76.2	81.4	39.7
SUNSHINE	MEAN(kw/m2)	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.2	0.2	0.1	0.0	0.0
	sunshine hours	71.0	141.0	232.0	290.0	349.0	373.0	372.0	335.0	322.0	182.0	111.0	76.0
	Sunshine hrs (10min)	68.3	134.2	227.3	289.3	347.0	377.8	370.7	329.7	278.0	176.3	102.3	73.0
NET RADIATION	MEAN	-16.4	4.9	29.9	68.3	97.2	128.1	115.2	90.2	44.0	16.2	-9.1	-16.5
MAX GUST	M/sec	37.5	45.0	27.1	27.1	31.3	22.1	20.8	25.0	19.2	35.4	31.3	37.1
	direction	273.1	231.5	227.8	147.8	245.7	121.2	149.0	278.3	308.3	301.5	181.1	269.4
	Knots	72.8	87.4	52.6	52.6	60.7	42.9	40.5	48.6	37.2	68.8	60.7	72.0
	MPH	83.9	100.7	60.6	60.6	69.9	49.4	46.6	55.9	42.9	79.2	69.9	82.9
Notes													
anometer connection was lost between 02 Jan - 13th jan - No wind data for this period - and we did have some very strong winds													
New anometer and connection fitted 14 Jan 2014 - MB & PN													
weather station serviced 10th Dec 2014 3 hours data lost													

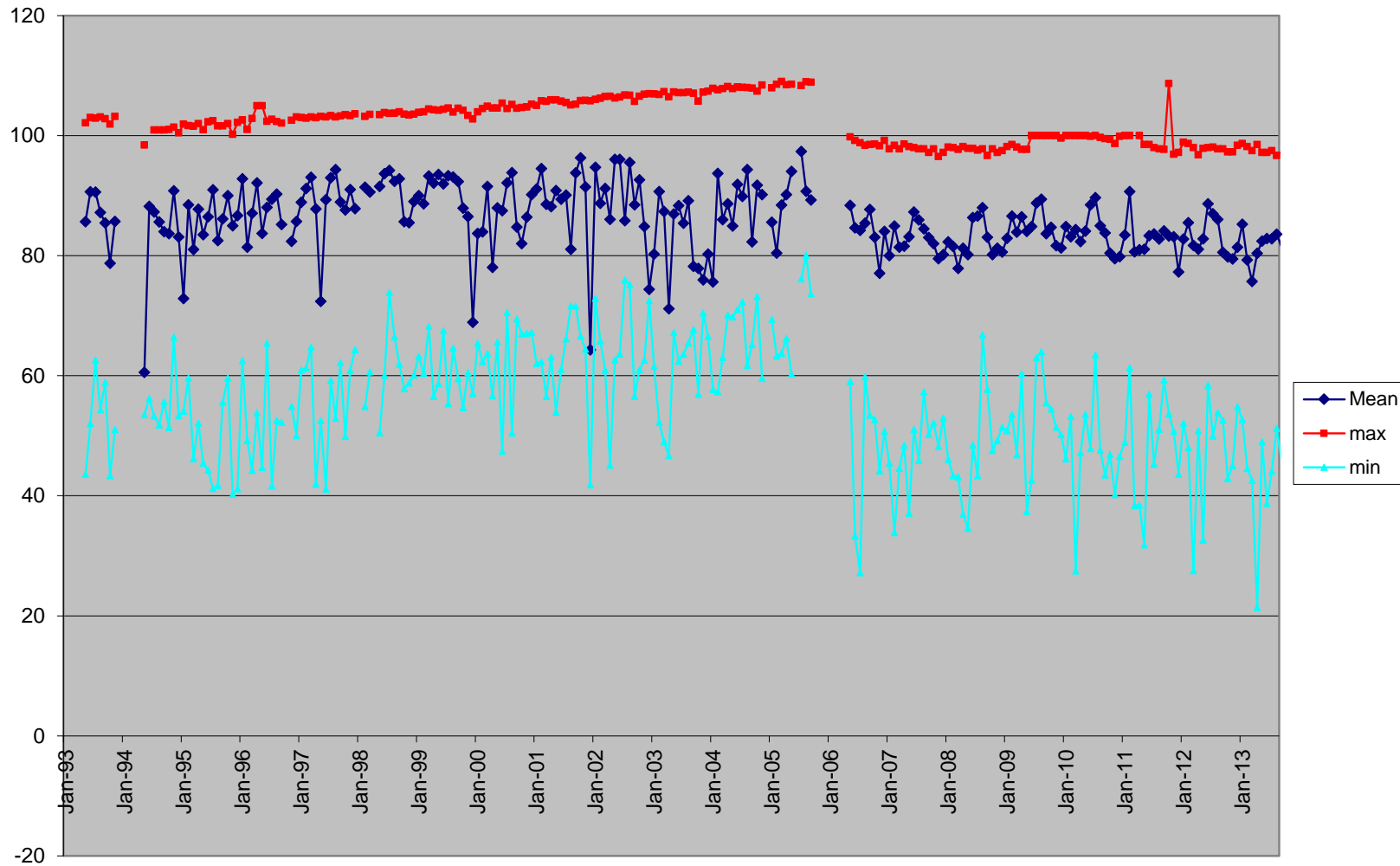
Monthly average air temperatures – Wooltack point 1993 – 2014 with Monthly Min / Max error bars



Annual & Seasonal Mean Air Temperatures (°C) 1996 - Onwards

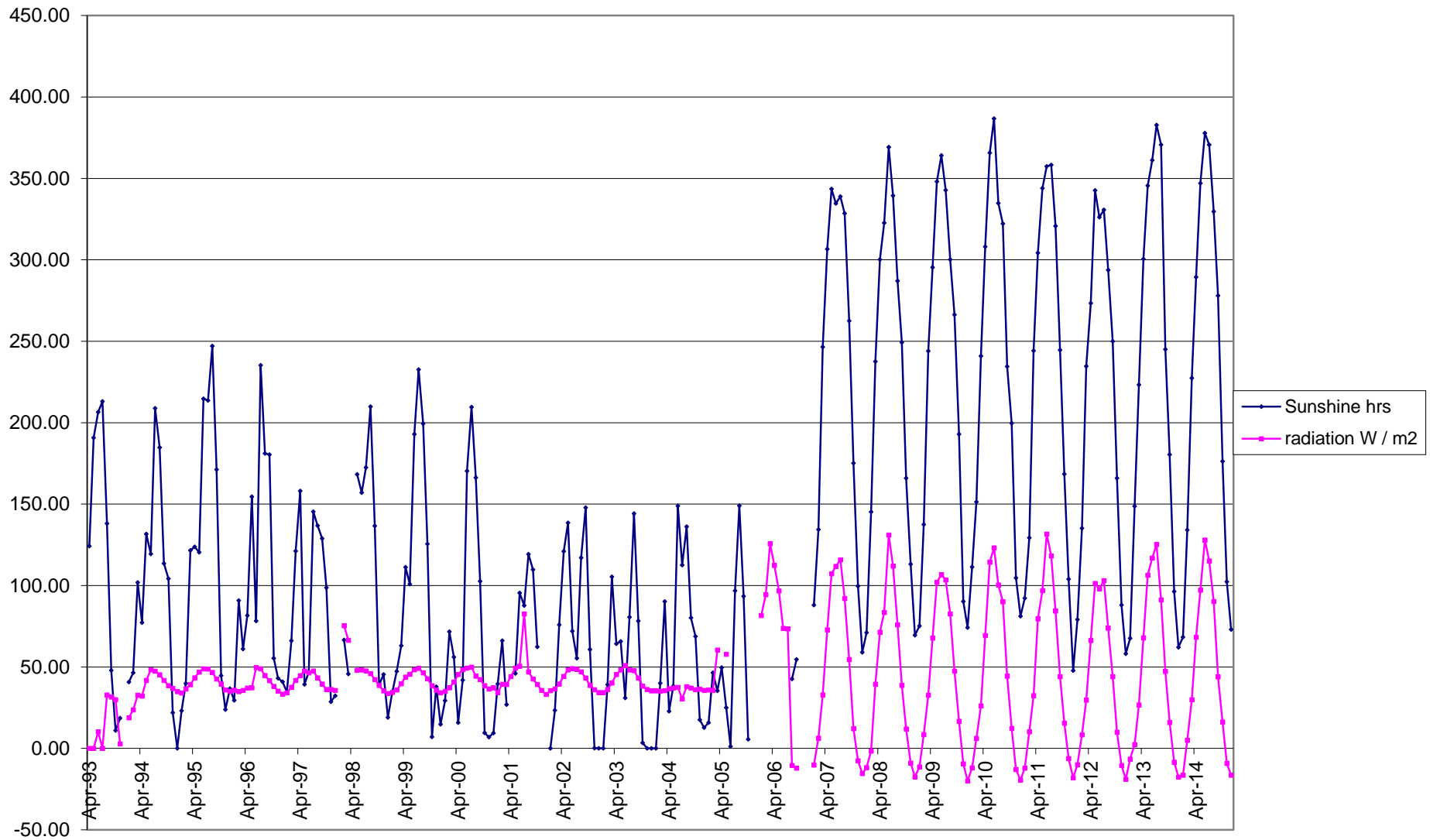


Relative Humidity 1993 - 2014



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 operation 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 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		
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):

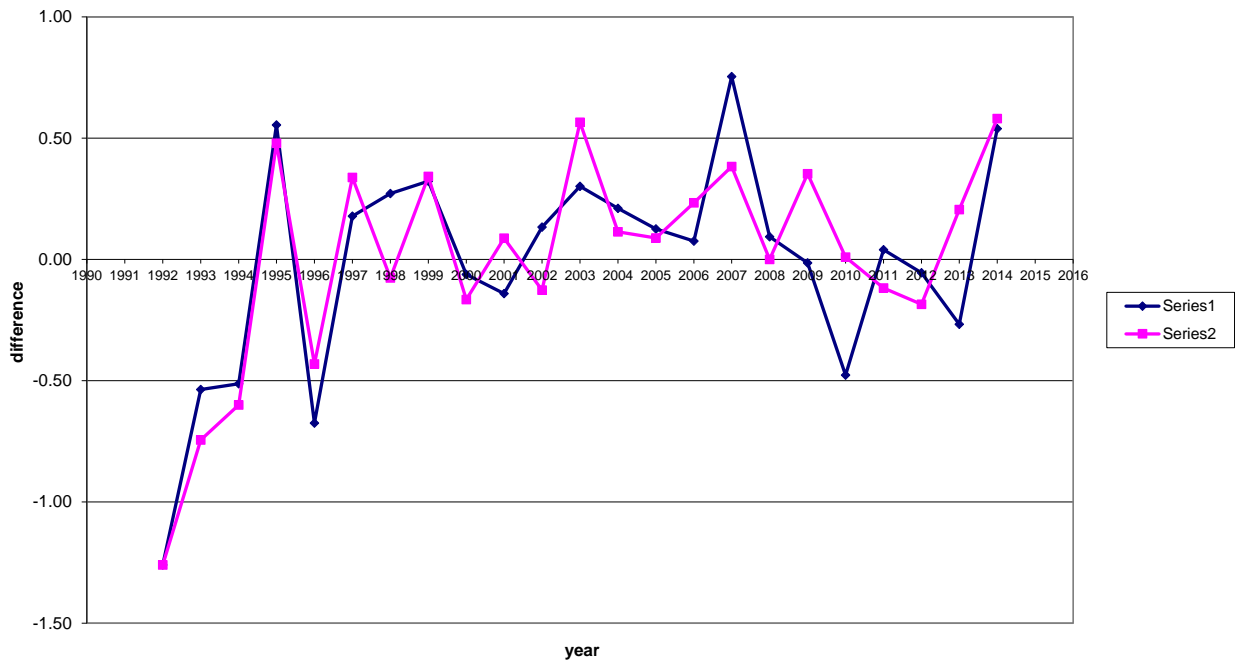
Temperature °C	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Minimum	8.4	7.27	8.7	7.6	7.7	7.36	7.5	8.8	8.4	7	6.9
Maximum	16.27	16.3	15.6	17.1	16.76	16.4	16.3	16.3	16.3	16.8	16.8
Year	2011	2012	2013	2014							
Minimum	7.6	8.0	6.98	8.14							
Maximum	15.9	16.6	16.82	16.72							

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 very cold April – May with sea temperatures remaining -1°C below average.

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.

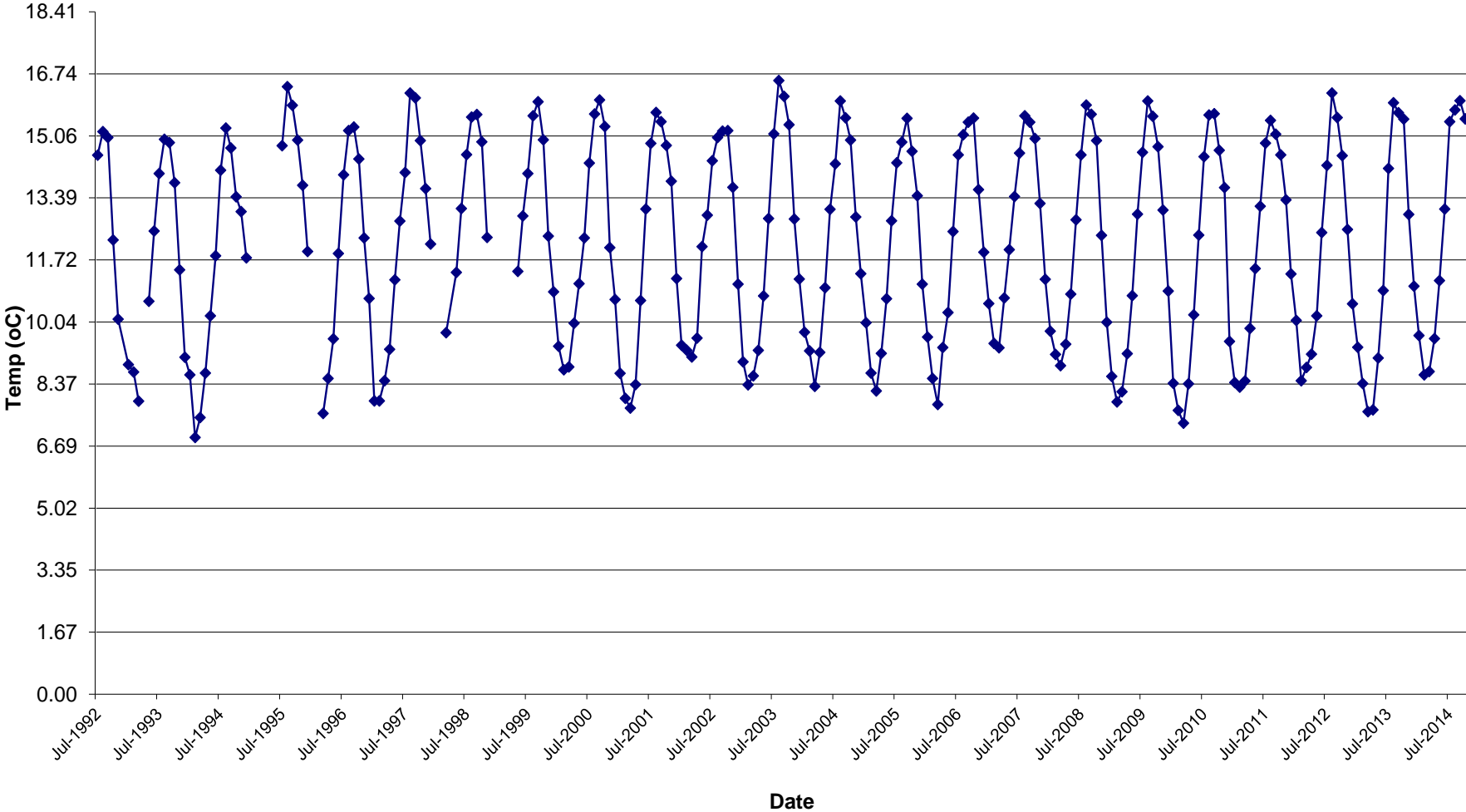
Two averages from this data were then used to express how cold / warm each year was. The blue line in the graph below averages all months in a year while the pink line just averages the months July – November (these months were chosen because all of the years have a full set of data for those months).

Average difference between the specific monthly mean temperature and the grand monthly mean (1992-2014)

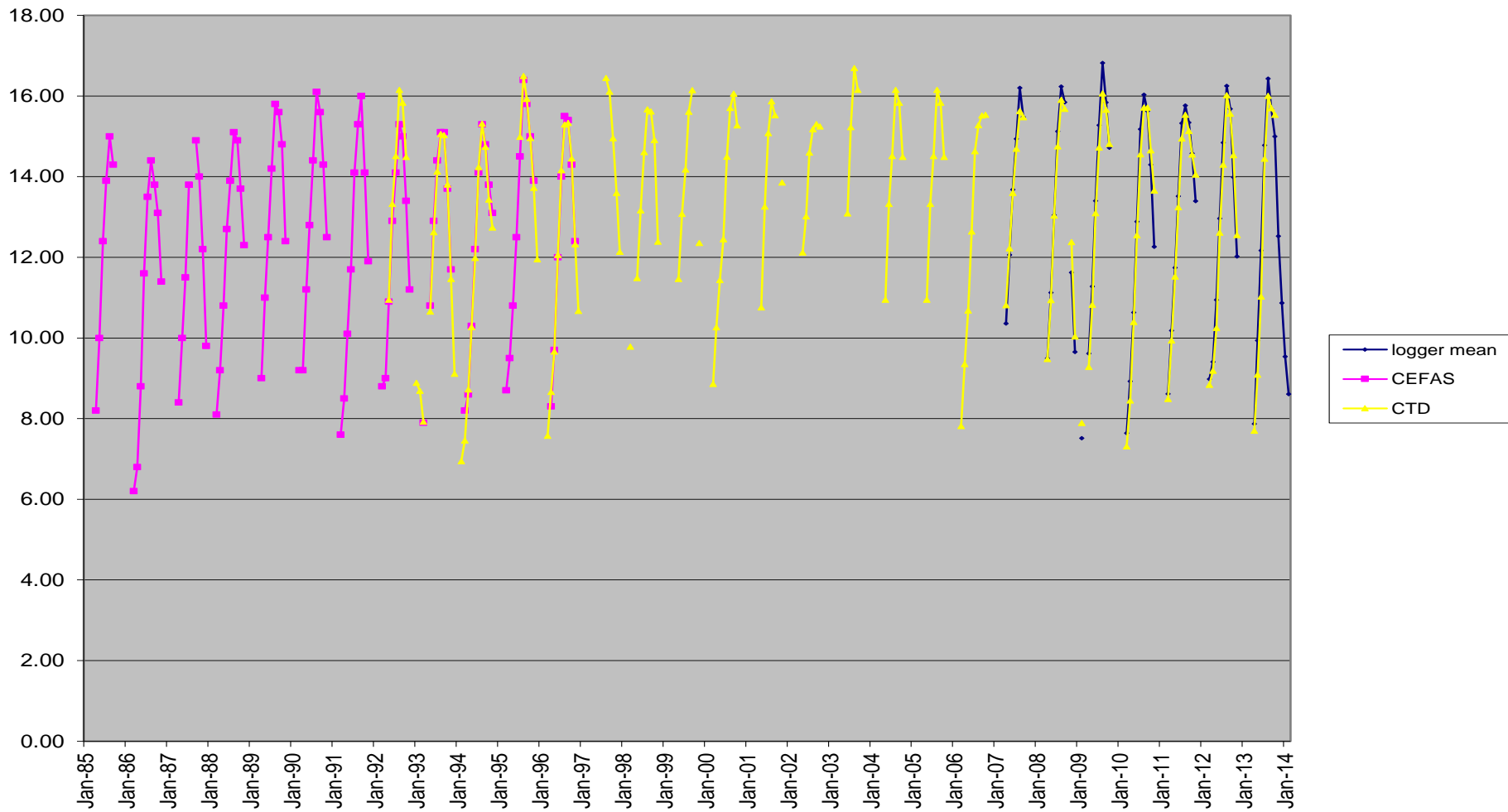


The cold winters of 2009 & 2010 have caused the trend to decline in sharp contrast to the very mild winter of 2008. The summer months are not so different – there has been a run of cool summers since 2004. 2014 showed a warm year.

Summary of the seabed temperature °C (data from Vemco minilog at 19m BCD)



Summary of Sea Surface Temperatures – Monthly Means 1985 - 2014



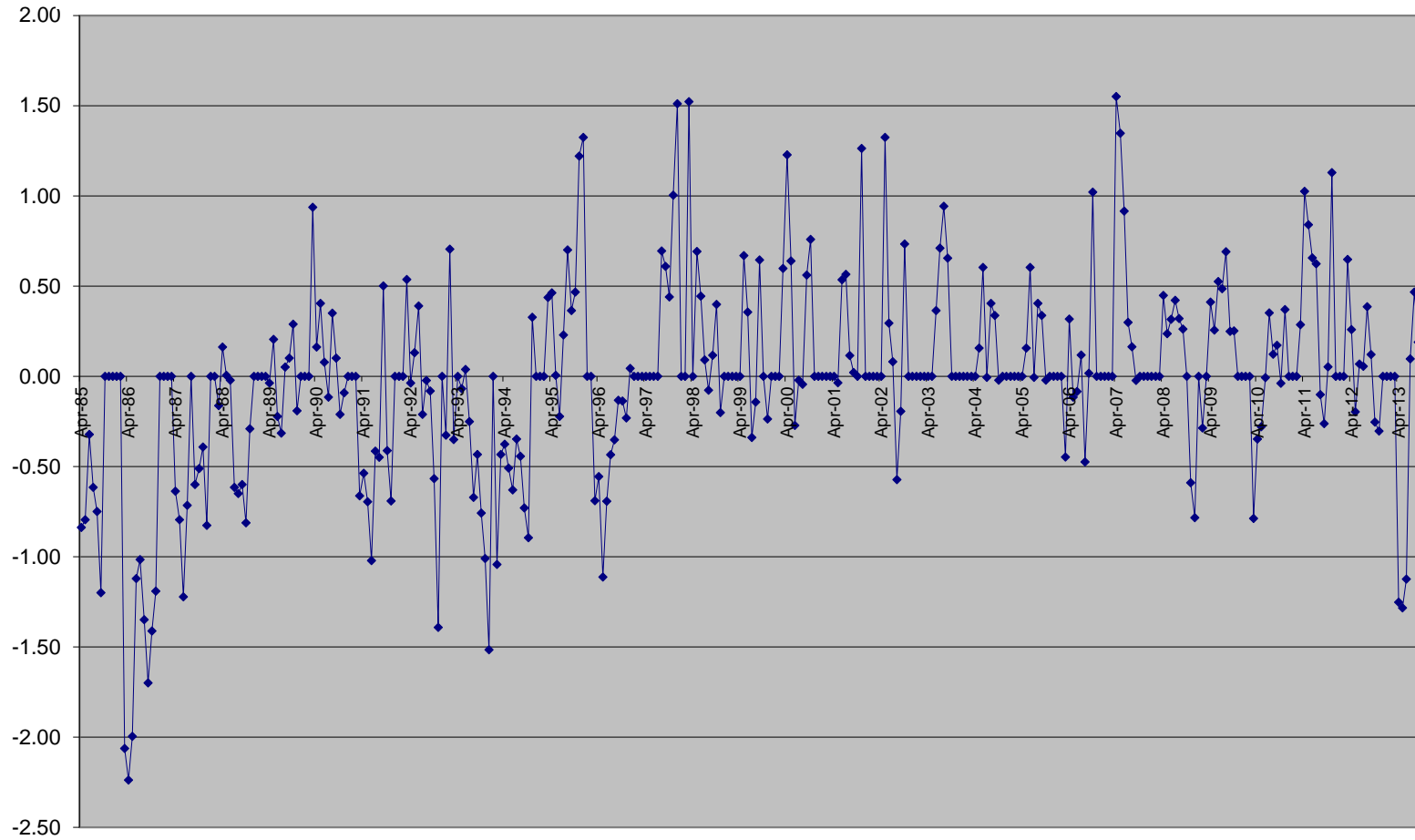
CEFAS Data - Taken from North Haven Skomer at high tide by a hand thermometer. Only available when the Skomer Warden was on site.

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 – 2014)



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.

Shore monitoring sites

10 Onset Hobo temperature / light loggers have been placed on 2 shores around the MCZ 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. An example of temperature data from the middle shore, Martins Haven is shown on the graph (next page).

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.

Results

Turbidity - Secchi disc

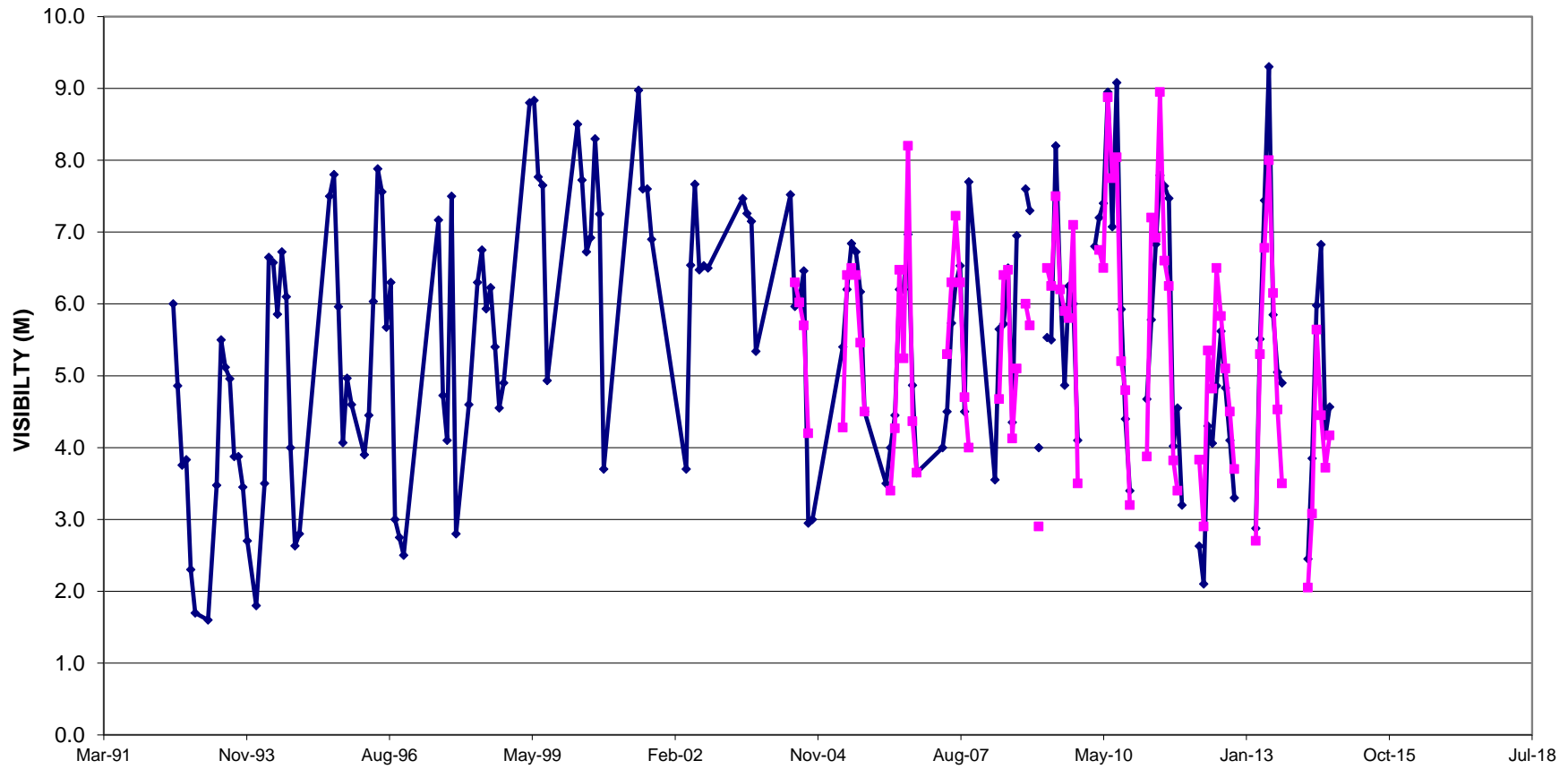
Measurements have been taken reasonably consistently for the months of May through to October since 1992. The results are summarised in the table:

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							
Yearly Mean	4.24	5.99	4.74							
Number of samples	41	34	26							
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			
Yearly Mean	5.5	6.15	6.74	6.17	5.17	5.37	3.99			
Number of samples	20	23	27	36	41	30	25			

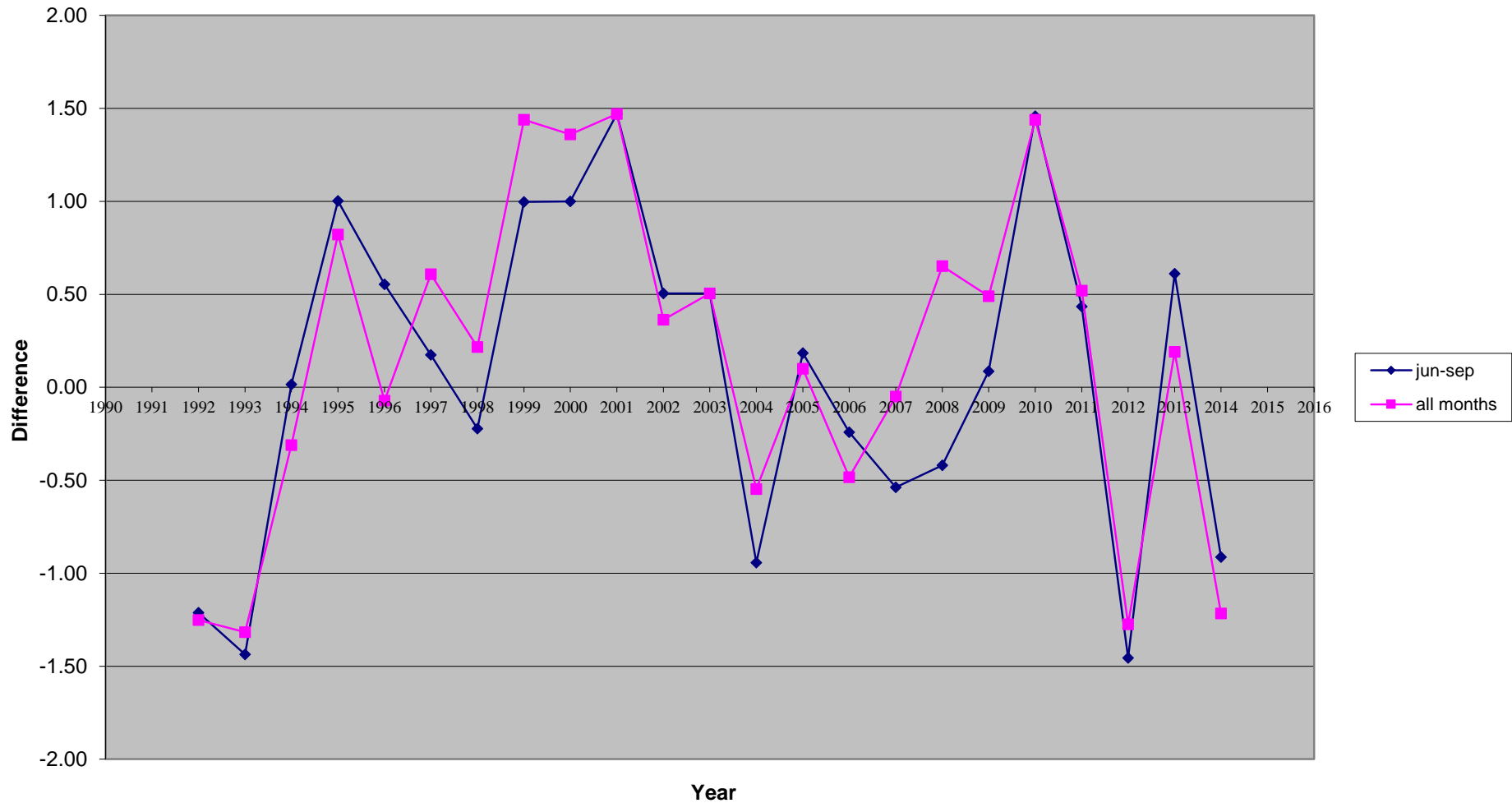
The mean monthly secchi disc readings for OMS and Thorn Rock are shown in the graph. This is followed by a table showing the monthly mean summary at the OMS from 1992 to 2010. Plotting the mean difference between the monthly average and the overall average highlights any significant fluctuations.

Mean Monthly Secchi disc Readings



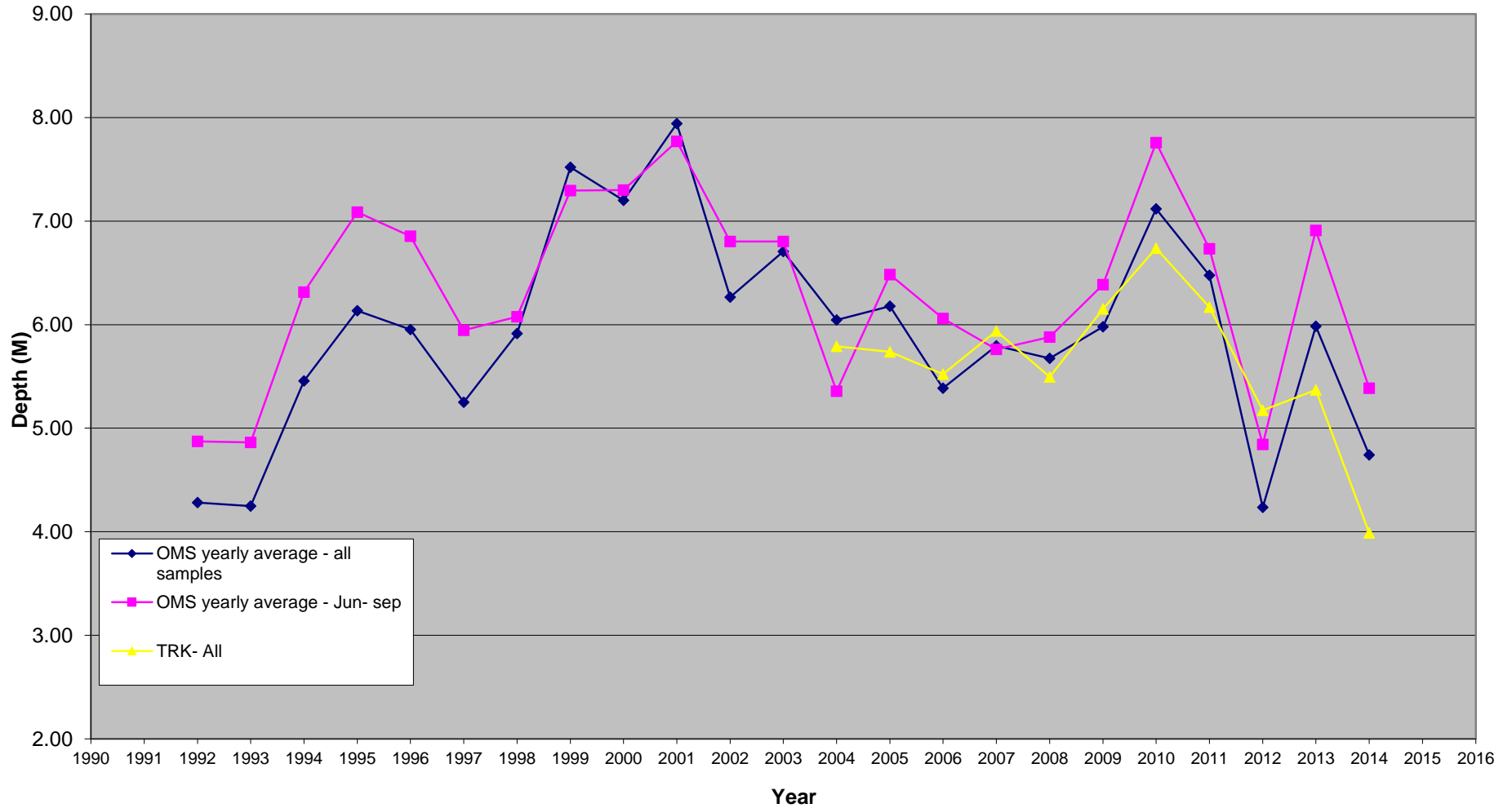
OMS = Blue line, TRK = Pink line

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.

Skomer MNR secchi disc readings



The Secchi disc readings for Thorn Rock are the worst in the MCZ records. There were very high levels of silt deposited on the South side of the MCZ during the winter storms, it is thought that this silt was continually being re-suspended into the water column throughout the year.

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 2013 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	May - Sep	OMS & TRK	Samples in storage

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°C not 450 °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 (Sb) 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 PSA has also changed.

2014 samples are waiting to be 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 – 2013 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 disc readings as often as possible to produce a long-term dataset.
- Continue with the sediment traps.

5 References

Adams, E. J. (1979) A littoral survey of the flora and fauna of the North and South Havens, Skomer Island. Undergraduate dissertation, Swansea

Ayling, A. L. (1983). Growth and regeneration rates in thinly encrusting Demospongiae from temperate waters. Biological Bulletin 165: 343-352.

Baines, M. E. (1992) The West Wales grey seal census. Interim report on the 1991 survey. Dyfed Wildlife Trust.

Baines, M. E. (1993) The West Wales grey seal census. Interim report on the 1992 season. Dyfed Wildlife Trust.

Baines, M. E., Earl, S.J. & Strong, P.G. (1994) The West Wales grey seal census. Interim report on the 1993 season. Dyfed Wildlife Trust.

Baines, M.E., Earl S.J., Pierpoint, C.J.L & Poole, J. (1995) The West Wales grey seal census. CCW Contract Science Report no. 131.

Barfield, P. (CORDAH) (1998) Skomer MCZ: A repeat survey of the sublittoral macrobenthos. CCW 009/1998

Barfield, P. Sea Nature studies (2004) Skomer MNR: A repeat survey of the sublittoral macrobenthos 2003. CCW West Area Report 28

Barfield, P. Sea Nature studies (2008) Skomer MNR: A repeat survey of the sublittoral macrobenthos 2007. CCW Regional report CCW/WW/08/

Barfield, P. (EMU) (2010) Skomer MNR: A repeat survey of the sublittoral macrobenthos 2009. A Report for CCW.

Bell, J.J & Barnes, D.K.A., (2001) Sponge morphological diversity: a qualitative predictor of species diversity? *Aquatic Conserv: Mar. Freshw. Ecosyst.* 11: 109-121 (2001).

Bell J.J & Barnes D.K.A. (2002) Modelling sponge species diversity using a morphological predictor: a tropical test of a temperate model. *J.Nat. Conserv.* 10: 41-50 (2002).

Bell J.J, Burton M., Bullimore B., Newman P. & Lock K. (2006) Morphological monitoring of sub-tidal sponge assemblages. *Marine Ecological Progress Series.* Vol 311: 79 – 91

Berman J, Burton M, Gibbs R, Lock K, Newman P, Jones J and Bell J. (2013) Testing the suitability of a morphological monitoring approach for identifying Temporal variability in a temperate sponge assemblage. *Journal of Nature Conservation.* Vol 21, 2013 No.3.

Bettridge, M. (2003) Visitor disturbance on the Atlantic Grey Seal *Halichorus grypus* during the pupping season, Pebbly beach, Skomer Marine Nature Reserve. HND 2nd year project, Pembrokeshire College.

- Bishop, G.M. (1982) A survey of the edible sea urchin *Echinus esculentus* in the Skomer Marine Nature Reserve. Underwater Conservation Society. 10pp.
- Boyle, D.P. (2001) Grey seal breeding census: Skomer Island 2001. CCW Report no. 507.
- Boyle, D.P. (2009) Grey seal breeding census: Skomer Island 2008. CCW Regional Report CCW/WW/09/1.
- Boyle, D.P. (2010) Grey Seal Breeding Census: Skomer Island, 2010. Wildlife Trust of South and West Wales CCW Regional Report CCW/WW/10/07
- Boyle, D.P. (2011) Grey Seal Breeding Census: Skomer Island, 2011. Wildlife Trust of South and West Wales CCW Regional Report CCW/WW/11/01
- Boyle, D.P. (2012) Grey Seal Breeding Census: Skomer Island, 2012. Wildlife Trust of South and West Wales CCW Regional Report CCW/WW/13/01
- Brodie, J. & Watson, D. (1999) Skomer MNR community and species monitoring: algal communities. Advice on conservation objectives. CCW report no. 334
- Brodie, J & Bunker, F. (2000) Skomer MNR community and species monitoring: algal communities. CCW report 387
- Brown, A. (2001) Habitat Monitoring for Conservation Management and Reporting. 3: Technical Guide. Life – Nature project No LIFE95 NAT/UK/000821.
- Buche, B & Stubbings E. (2013) Grey Seal Breeding Census: Skomer Island, 2013. Wildlife Trust of South and West Wales.
- Buche, B & Stubbings E. (2014) Grey Seal Breeding Census: Skomer Island, 2014. Wildlife Trust of South and West Wales. NRW Evidence Report No.65.
- Bullimore, B. (1983) Skomer marine MNR subtidal monitoring project, 1982-83.
- Bullimore, B. (1983, 1986) Photographic monitoring of subtidal epibenthic communities on Skomer Marine MNR, 1984-85. SMRSMP Report No 5
- Bullimore, B. (1983, 1986, 1987) Photographic monitoring of subtidal epibenthic communities on Skomer Marine MNR, 1986. SMRSMP Report No 6
- Bullimore, B. (1985) Diving survey of scallop stocks around SW Wales.
- Bullimore, R & Foggo, A. 2010. Assessing the effects of recreational fishing upon fish assemblages in a temperate Marine Nature Reserve with remote underwater video. Marine Biology and Ecology Research Centre, University of Plymouth.
- Bunker, F. et al. (1982) Skomer MNR littoral survey 1982 Vol 1 /2 FSC report FSC/(ofc) /3/83
- Bunker, F.StP.D., Iball, K. & Crump, R. (1983) Skomer marine MNR, littoral survey, July to September 1982.

Bunker, F.StP.D. (1983) Studies on the macrofauna and sediments of a bed of *Zostera marina* (L) in North Haven, Skomer.

Bunker, F. & Hiscock, S. (1987) Sublittoral habitats, communities and species around Skomer Marine MNR- a review. FSC/(OFC)/1/87

Bunker, F. & Hiscock, S. (1984) Surveys of sublittoral habitats and communities around Skomer Marine MNR, 1983.FSC/(OFC)/1/84

Bunker, F.StP.D. & Hiscock, S. (1985) Surveys of sublittoral habitats & communities around Skomer Marine MNR in 1984. FSC / (OFC)/ 2/85

Bunker, F.StP.D. (1986) A survey of the broad sea fan *Eunicella verrucosa* around Skomer Island Marine MNR in 1985 FSC report No FSC/(ofc)/ 1/86

Bunker, F. and Mercer, T. (1988) A survey of the ross coral *Pentapora foliacea* around Skomer Marine MNR in 1986 (together with data concerning previously unsurveyed or poorly documented areas).FSC report fsc/(ofc)/1/88.

Bunker, F., Picton, B. & Morrow, C. (1992) New information on species and habitats in SMNR and other sites off the Pembrokeshire coast.

Bunker, F & Jones J. (2008) Sponge monitoring Studies at Thorn Rock, Skomer Marine Nature Reserve in autumn 2007. CCW regional report CCW/WW/08/7

Burton, M. (2002) Summary of commercial potting activities in the Skomer MNR 1989 - 2002. CCW West Area Report No 19

Burton, M., Lock, K. & Newman, P.(2002) Skomer Marine Nature Reserve Monitoring Method Development. Yellow Trumpet Anemone *Parazoanthus axinellae*. CCW West Area Report 14.

Burton, M., Lock, K. Luddington L & Newman, P. (2004) Skomer Marine Nature Reserve Project Status Report 2003/4. CCW West Area Report 29.

Burton, M., Lock, K. Luddington L & Newman, P. (2005) Skomer Marine Nature Reserve Project Status Report 2004/5. CCW Regional Report CCW/WW/04/5

Burton, M., Lock, K. Gibbs, R & Newman, P. (2007) Skomer Marine Nature Reserve Project Status Report 2006/07. CCW Regional Report CCW/WW/08/3.

Burton, M., Lock, K. & Newman, P (2010). Skomer Marine Nature Reserve. Distribution and Abundance of *Zostera marina* in North Haven 2010. CCW Regional Report CCW/WW/10/10

Burton, M., Lock, K. Gibbs, R & Newman, P. (2011) Skomer Marine Nature Reserve Project Status Report. CCW Regional Report CCW/WW/10/8.

Burton, M., Lock, K. Jones, J & Newman, P. (2014) Skomer Marine Nature Reserve Project Status Report 2013/14. Natural Resources Wales report.

- Burton, M., Clabburn, P., Griffiths, J., Lock, K., Newman P. (2015). Skomer Marine Conservation Zone. Distribution & Abundance of *Zostera marina* in North Haven 2014. NRW Evidence Report No.69.
- Clarke, K.R. & Warwick, R.M. (2001) Changes in marine communities: and approach to statistical analysis and interpretation, 2nd Edition. PRIMER-E: Plymouth.
- Crump, R. (1993) Skomer Marine Nature Reserve littoral monitoring project (permanent quadrats) CCW report FC 73 01 27
- Crump, R. (1996) Skomer Marine Nature Reserve littoral monitoring project (permanent quadrats) Post Sea Empress oil spill. FC 73-02-48F
- Crump, R.G. & Burton, M (2004) Skomer MNR littoral monitoring: development of methods. CCW West Area Report 27.
- Duffield, S. E. (2003) Grey seal breeding census: Skomer Island 2002. Wildlife trust of South and West Wales CCW report no 555
- Earl, R.C. (1979) A survey of the edible urchin, *Echinus esculentus* in the Skomer Marine MNR. 9 pp.
- Edwards, E. Bunker, F. Maggs, C.A. & Johnson, M.P. (2003) Biodiversity within eelgrass (*Zostera marina*) beds on the Welsh coast: analysis of epiflora and recommendations for conservation.
- Field, R. (2000) Grey seal breeding census: Skomer Island 1999. Wildlife Trust West Wales, CCW report no. 388.
- Fothergill, B (2004) A comparison of the effectiveness of two surveying techniques for obtaining population information of economically important crustaceans within the Skomer Marine Nature Reserve. Undergraduate project. Institute of Marine Studies, University of Plymouth.
- Furby, G.L. (2003) *Eunicella verrucosa*: A study of biology, conservation and growth rates. Under graduate project, University of Cardiff. No 000521837.
- Gibbs, R (2007) Summary of work on *Pentapora foliacea* at Skomer Marine Nature Reserve Autumn 2006. CCW Regional Report CCW/WW/07/1.
- Gilbert, S. (1998) Skomer MNR monitoring field data analysis. summary report. Sea Empress contract FC 73-02-84
- Garrabou J. (1999) Life history traits of *Alcyonium acule* and *Parazoanthus axinellae*, with emphasis on growth. Marine Ecological Progress Series, vol 178. pp 193-204.
- Hiscock, K. (1980) SWBSS field survey of sublittoral habitats and species in West Pembrokeshire (Grassholm, Skomer and Marloes Peninsula), 1977-79.
- Hiscock, K. (1983) Sublittoral surveys in the region of the Skomer Marine Nature Reserve, 1982. FSC/(OPRU)/5/83

Hiscock, K. (1990) Marine Nature Conservation Review: Methods. Nature Conservancy Council, CSD Report No. 1072. Marine Nature Conservation Review Occasional Report MNCR/OR/05. Peterborough: Nature Conservancy Council.

Hiscock, K. (1998) Biological monitoring of marine S.A.C.'s: a review of methods for detecting change. JNCC Report No 284 Procedural guideline 6-2.

Hiscock, S. (1983) Skomer Marine MNR Seaweed Survey 1982 FSC report fsc/(ofc)/2/83

Hiscock, S. (1986) Skomer Marine MNR Subtidal Monitoring Project: Algal results August 1984 to February 1986. Smrsmp report No4

Hudson, K. (1996) Changes in rocky shore communities on Skomer Island between 1992 and 1995.

Hughes R.N. Cancino J.N. (1985). An ecological overview of cloning in metazoa. In Jackson JBC, Buss LW, Cook RE (eds) Population biology and evolution of colonial organisms. Yale University Press, New Haven 9 153-186.

Hunnam, P., J.(1976) Description of the sublittoral habitats and associated biota within the Skomer MNR.

Isojunno, S (2008). Temporal habitat use of the harbour porpoise around Skomer and Skokholm islands. CCW Species challenge project report.

Jackson J.B.C. (1977) Competition on marine hard substrata; adaptive significance of solitary and colonial strategies. Am. Nat. vol 3, pp 743 – 767.

Jones, H. (1990) Survey of scallops of the Skomer MNR. University of Manchester, Underwater Conservation Society.

Jones, B., Jones, J. & Bunker, F. (1983) Monitoring the distribution and abundance of *Zostera marina* in North Haven Skomer. Skomer MNR report vol 3 FSC report No FC73-01-168

Jones, J., Bunker, F., Newman, P., Burton, M. & Lock, K. (2012). Sponge diversity of Skomer Marine Nature Reserve. CCW Regional Report CCW/WW/12/3

Lindenbaum, C., Sanderson, W.G., Holt, R.H.F., Kay, L., McMath, A.J. & Rostron, D.M. (2002) An assessment of appropriate methods for monitoring a population of colonial anemone at Bardsey island (Ynys Enlli), Wales, UK. CCW Marine Monitoring Report No: 2, 31pp.

Lock, K. (1998) Development of method to assess nearshore territorial fish populations. A Skomer Marine Nature Reserve Report, CCW science report 276.

Lock, K. (1998) Distribution and abundance of *Zostera marina* in North Haven Skomer 1997. CCW science report no.277.

Lock, K. & Newman, P. (2001) Skomer MNR Scallop *Pecten maximus* survey 2000. CCW West Area Report No 16.

Lock, K. (2003) Distribution and abundance of *Zostera marina* in North Haven Skomer 2002. CCW West Area Report No. 22.

Lock, K, Burton, M & Newman, P. (2003) Skomer Marine Nature Reserve Project Status Report 2002/3. CCW West Area Report 24.

Lock, K. (2004) Skomer Marine Nature Reserve Seal Disturbance Study 2002 & 2003. CCW Regional Report CCW/WW/04/6.

Lock, K, Burton M, Newman P & Luddington, L (2006) Skomer Marine Nature Reserve Territorial Fish Population Study. CCW Regional Report CCW/WW/05/8

Lock, K, Burton, M, Luddington, L & Newman, P. (2006) Skomer Marine Nature Reserve Project Status Report 2005/06. CCW Regional Report CCW/WW/05/9.

Lock, K, Burton M, Gibbs R & Newman P (2007) Distribution and abundance of *Zostera marina* in North Haven, Skomer 2006. CCW Regional Report CCW/WW/08/2.

Lock, K, Gibbs, R, Burton, M & Newman, P (2008). Skomer Marine Nature Reserve Distribution & abundance of *Echinus esculentus* and selected starfish species. CCW Regional Report CCW/WW/08/2.

Lock, K, Gibbs R, Burton M & Newman P (2009). Skomer Marine Nature Reserve Scallop, *Pecten maximus* survey 2008. CCW Regional Report CCW/WW/09/4.

Lock, K, Burton, M, Gibbs, R & Newman, P. (2009) Skomer Marine Nature Reserve Project Status Report 2008/09. CCW Regional Report CCW/WW/09/2.

Lock, K, Newman P, Burton M (2010). Skomer Marine Nature Reserve Nudibranch Diversity Survey 2010. CCW Regional Report. CCW/WW/10/11

Lock, K, Burton, M, Newman, P & Jones, J (2012). Skomer Marine Nature Reserve Distribution & abundance of *Echinus esculentus* and selected starfish species 2011. CCW Regional Report CCW/WW/11/04

Lock, K, Burton M, Newman P & Jones, J (2013). Skomer Marine Nature Reserve Scallop. *Pecten maximus* survey 2012. CCW Regional Report CCW/WW/13/2.

Lock, K, Burton, M, Newman, P & Jones, J. (2013) Skomer Marine Nature Reserve Project Status Report 2012/13. CCW Regional Report CCW/WW/13/3

Lock, K, Newman P, Burton M & Jones, J (2015). Skomer Marine Conservation Zone Nudibranch Diversity Survey 2014. NRW Evidence Report No.67.

Longdin & Browning Ltd (2002) Habitat and feature distribution in Pembrokeshire marine SAC: Acoustic habitat survey. CCW science report 514

Luddington, L. (2002) Skomer MNR Nudibranch diversity survey, CCW West Area Report No 18

Luddington, L. Lock, K, Newman P. & Burton, M. (2004) Skomer Marine Nature Reserve Distribution & abundance of *Echinus esculentus* and selected starfish species. CCW West Area Report No. 45.

Luddington, L. Newman, P. Lock, K & Burton, M. (2004) Skomer MNR *Pecten maximus*, King scallop survey 2004. CCW Regional Report CCW/WW/04/2

Luddington, L. & Bunker, F. (in prep) Algal monitoring in Skomer MNR and other sites around Wales 2005.

Manuel R.L. (1988) British Anthozoa. The Linnean Society. ISBN 90 04085963, 241pp.

Matthews, J. H. (2004) Grey seal breeding census: Skomer Island 2003. Wildlife trust of South and West Wales CCW report no 621.

Matthews, J. H. (2005) Grey seal breeding census: Skomer Island 2004. Wildlife trust of South and West Wales CCW report no CCW/WW/04/7

Matthews, J. H. (2006) Grey seal breeding census: Skomer Island 2005. Wildlife trust of South and West Wales CCW report no CCW/WW/05/7

Matthews, J. H. & Boyle, D. (2008) Grey seal breeding census: Skomer Island 2007. Wildlife trust of South and West Wales CCW report no CCW/WW/08/1

McEvoy, A. Burton, M. Somerfield, P & Atkinson, A. (2013) Cost-effective method for establishing an ecological baseline of the zooplankton at Skomer Marine Nature Reserve. Plymouth Marine Laboratory Scientific Poster.

Mieszkowska, N. Kendal, M., R. Leaper, A. Southward, S. Hawkins & M. Burrows (2002) MARCLIM monitoring network: provisional sampling strategy and standard operating procedure.

Moore, J. (2001) Monitoring baseline for sediment surface and burrowing macro and mega fauna in Skomer Marine Nature Reserve. A report to the Countryside Council for Wales from Coastal Assessment, Liaison and Monitoring, Coshaston, Pembrokeshire. 39pp

Moore, J. (2005) Repeat monitoring for sediment surface and burrowing macro and mega fauna in Skomer Marine Nature Reserve. A report to the Countryside Council for Wales from Coastal Assessment, Liaison and Monitoring, Coshaston, Pembrokeshire. 46pp

MNCR (unpublished) (1994) MNCR sublittoral survey of South Pembrokeshire, Dyfed, 1994.

Munro, L. & Munro, C. (2003a) Reef Research. Determining the reproductive cycle of *Eunicella verrucosa*. Interim report March 2003. RR Report 3/2003 ETR 07

Munro, L. & Munro, C. (2003b) Reef Research. Determining the reproductive cycle of *Eunicella verrucosa*. Interim report Nov 2003. RR Report 10 Nov 2003

Munro, L. & Munro, C. (2004) Reef Research. Genetic variation in populations of *Eunicella verrucosa*. Interim report Jan 2004. RR Report ETR 11 Jan 2004.

Newman, P. & Lock, K. (2000) Skomer Marine Nature Reserve Management Plan. Working document. Countryside Council for Wales.

Newman, P. (1992) Skomer MNR Seal breeding on the Marloes Peninsula, Sept – Dec1991

Orsman, C. (1990) Grey seal breeding success- Skomer Island 1989. Dyfed Wildlife Trust.

Orsman, C. (1991) Grey seal breeding success- Skomer Island 1990. Dyfed Wildlife Trust.

Pegg, L. (2004) Human disturbance on Atlantic Grey Seal (*Halichoerus grypus*) during the pupping season at Jeffery's Haven, Skomer Marine Nature Reserve, Pembrokeshire. HND project report.

Picton, B.E. & Goodwin, C.E. (2007). Sponge biodiversity of Rathlin Island, northern Ireland. Journal of the Marine Biological Association of the UK 87 (6): 1441-1458

Pilsworth, M. (2001) Grey seal breeding census: Skomer Island 2000. CCW report no. 445.

Poole, J. (1992) Grey Seal breeding census, Skomer Island 1991. Dyfed Wildlife Trust.

Poole, J. (1993) Grey Seal breeding census, Skomer Island 1992. Dyfed Wildlife Trust.

Poole, J. (1994) Grey Seal breeding census, Skomer Island 1993. Dyfed Wildlife Trust.

Poole, J. (1995) Grey Seal breeding census, Skomer Island 1994. Dyfed Wildlife Trust.

Poole, J. (1996) Grey seal breeding census: Skomer Island 1995. CCW report.

Poole, J. (1997) Grey seal breeding census: Skomer Island 1996. CCW report no 191.

Poole, J. (1998) Grey seal breeding census: Skomer Island 1997. CCW report no 252.

Poole, J. (1999) Grey seal breeding census: Skomer Island 1998. CCW report no 316.

Ronowicz, M., Kuklinski, P., Lock, K., Newman, P., Burton, M. & Jones, J. (2014) Temporal and spatial variability of zoobenthos recruitment in a north-east Atlantic marine reserve. Journal of the Marine Biological Association of the United Kingdom, page 1 of 10, 2014 doi:10.1017/S0025315414000733

Rosta da Costa Oliver, T & Mc Math, M (2012) Grey seal (*Halichoerus grypus*) movement and site use connectivity with in the Irish sea: Implications of Management. Poster.

Rostron, D.M. (1983) Systematic descriptive surveys of animal species and habitats at two sites around Skomer Island.

Rostron, D.M. (1988) Skomer Marine MNR subtidal monitoring project: animal communities on stones March 1987 to January 1988

Rostron, D.M. (1994) The sediment infauna of the Skomer Marine Nature Reserve. CCW report 55

Rostron, D.M. (1996) Sediment interface studies in the Skomer Marine Nature Reserve. CCW 133. FC 73-01-109

Rostron, D.M. (1997) Sea Empress Subtidal Impact Assessment: Skomer Marine Nature Reserve Sediment Infauna.

Sayer, S (2013) Skomer – Cornwall seal photo identification project 2007 – 2012. Cornwall Seal Group.

Scott, S. (1994) Skomer MNR: recommendations for monitoring of algal populations. CCW report 63

Sharp J.H, Winson M.K, Wade S, Newman P, Bullimore B, Lock K, Burton M, Gibbs,R & Porter J.S. (2008). Differential microbial fouling on the marine bryozoan *Pentapora fascialis*. Journal of Marine Biological Association of the United Kingdom, 2008, 88(4), 705-710.

P.J. Somerfield , M. Burton , W.G. Sanderson (2014) Analyses of sublittoral macrobenthic community change in a marine nature reserve using similarity profiles (SIMPROF). Journal of Marine Environmental Research(2014) 1e8.

Trigg, J. (1998) Temporal changes in distribution and abundance of *Zostera marina* and possible effects on benthic community structure. Undergraduate thesis.

Woods, C. (2003) Pink sea fan survey 2001/2. A report for the Marine Conservation Society.

Woods, C. (2008) Seasearch pink sea fan surveys 2004/6. A report for the Marine Conservation Society.

