Cyfoeth Naturiol Cymru
Natural Resources Wales

Skomer Marine Nature Reserve Project Status Report 2013

M. Burton, K. Lock, P. Newman & J. Jones 2014

Synopsis

The 13th project status report produced by the Skomer Marine Nature Reserve summarises the progress and status of monitoring projects in the Skomer MNR in 2013. A summary of all established projects in the MNR is provided in a table format. For each project that was worked on in the 2013 field season a detailed account is given including a history and summary of the results so far. This report also includes summaries of the oceanographic and meteorological surveillance projects.

Title: M. Burton, K. Lock, P. Newman & J. Jones. (2014). Skomer Marine Nature Reserve Project Status Report 2013

Crynodeb

Mae'r 13ed adroddiad statws prosiect a gynhyrchwyd gan Warchodfa Natur Forol Sgomer yn crynhoi datblygiad a statws prosiectau monitro yn y Warchodfa yn 2013. Mae crynodeb o'r holl brosiectau sefydledig yng Ngwarchodfa Natur Forol Sgomer ar gael ar ffurf tabl. Ar gyfer pob prosiect y gweithiwyd arno yn nhymor maes 2013, fe geir adroddiad manwl, gan gynnwys hanes a chrynodeb o'r canlyniadau hyd yn hyn. Mae'r adroddiad hwn hefyd yn cynnwys crynodeb o'r prosiectau gwyliadwriaeth eigionegol a meteorolegol.

Teitl: K. Lock, M. Burton, P. Newman & J. Jones. (2014). Adroddiad statws prosiect Gwarchodfa Natur Forol Sgomer 2013/14

Contents

1 Introduction

This is the thirteenth project status report produced by the Skomer Marine Nature Reserve. It summarises the progress and current status of monitoring projects in the Skomer MNR in 2013. The project status tables in section 2 provide a summary of all established projects in the MNR. 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 2013 field season:

- The Territorial fish population survey was completed by teams of volunteer divers over two weekends. The survey data was compared to previous survey results.

- 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 Reserve, most notable was the increasing numbers of pups born at mainland sites over the past 9 years.

- A team from NRW trialled 'Biosonics split beam sonar' equipment to map the *Zostera marina* bed at North Haven. The results were very promising and it has been proposed that they will return in 2014 to assist with the scheduled full *Z.marina* mapping survey.

- The in-fauna grab sampling fieldwork was completed at the MNR sites. The analysis of the sediments was completed at the NRW Llanelli laboratory and the biological analysis was done by Hebog Environmental.

Bull seal at Martins Haven

2 Skomer MNR 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-SMNR 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	1992 – ongoing 2007 – ongoing	Weekly (May - Sept) Temp (since 99) Hourly 10 Min sampling Hourly samples	No No	Yes-SMNR office Yes-SMNR office
Seabed sedimentation	Auto sampler	1994-1998 Discontinued	Continuous	No	Yes-SMNR office
	Sediment trap	1994 – ongoing 1995 to1998 2002 to 2013	Every 14 days (April-Oct)	Jones 1998	Yes-SMNR office
Suspended sediments	Idronaut Turbidity logger Secchi disc YSI 6600 multi parameter sonde	2001 – failed 2006 1992 - onwards 2007 - ongoing	Continuous Weekly (seasonal) Hourly	No No No	No - raw only Yes – SMNR office Yes-SMNR office

	Brief description	Year sets	Sampling frequency	Report	Data summary
ACTIVITY					
Recreation activities	Boats, divers, anglers recorded in the Reserve	1987 - ongoing	Weekly (May - Sept)	Skomer MNR annual reports	Skomer MNR annual reports
Commercial fishing activities	Pot buoys and fishing net positions	1989 - ongoing	Weekly (May - Sept)	Burton 2002 SMNR annual reports	Yes-SMNR 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-SMNR office
BIOLOGICAL					
Littoral communities:					
Macro scale (view point photographs)	Time series photos/digitised.	1992 - ongoing	Annual	Internal report – Daguet 2000 and Gibbs 2007	Yes-SMNR office
Meso scale (transects)	6 Transects. Time series photos/digitised. 9 sites established in 2003 including 3 Marclim sites. Site marking completed in 2004.	1992 – 2002 2003 - ongoing	Annual Annual	Adams 1979/ Bunker 1983/ Crump 1993/96 Hudson 1995. Burton & Crump 2004	Yes-SMNR office Yes-SMNR office
Sub littoral communities:					
Rocky reef communities	Time series stereo photos.	1982 - ongoing	Annual	Bullimore1986 & 1987	Yes-SMNR 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-SMNR 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 *et al* 2012	Yes-SMNR office

	Brief description	Year sets	Sampling frequency	Report	Data summary
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-SMNR office
Epifaunal sediment	Survey and report completed	1995/ 2001 & 2004 Video 2009	Every 4 years	Rostron 1996 Moore 2002 Moore 2005	Yes-SMNR office
Flora:					
Zostera marina	Extent of NHV bed & density distribution.	1997/2002/2006 & 2010 (Boundary maps for 2000, 2002 & 2004)	Every 4years Next survey planned 2014	Jones & Hodgson 1980 &1981, Jones *et al* 1983, Lock *et al* 1998, 2003 & 2006 Burton *et al* 2010	Yes-SMNR office
Fauna:					
Eunicella verrucosa	101 colonies, time series mono-photo/digitised. 4 colonies stereo-photo.	1993- ongoing 1982- ongoing	Annual	Bunker *et al* 1985, Bullimore1986 & 1987 Gilbert 1998	Yes-SMNR office
Alcyonium glomeratum	Time series stereo-photo/digitised. North wall 5 transects (% frequency) North wall East, Thorn rock & Rye rocks.	1984- ongoing 2002 new transects	Annual	Bullimore1986 & 1987	Yes-SMNR office
Parazoanthus axinellae	6 sites, time series mono-photo/digitised.	2001- ongoing	Annual	Burton *et al* 2002	Yes-SMNR office
Pentapora foliacea	3 sites, time series mono-photo/digitised. New sites established 2002 & 2003.	1994- ongoing	Annual	Bullimore1986 & 1987 Bunker/ Mercer 1988 Gilbert 1998, Gibbs 2006	Yes-SMNR office
Balanopyllia regia	Time series @ thorn rock stereo-photo/digitised	1984 – 2002 - ongoing	Annual	Bullimore 1986 & 1987	Yes-SMNR office

	Brief description	Year sets	Sampling frequency	Report	Data summary
	The Wick. 3 transects	2002 - ongoing			
Cayophyllia smithii.	Counted from sponge project quadrats (stereo-photo/digitised)	1993 - ongoing	Annual	No	Yes-SMNR office
Atlantic Grey Seal	Surveys and reports.	1976- ongoing	Annual	Grey Seal breeding census, Skomer Island 1992-2013, Skomer MNR annual reports.	Yes-SMNR office
King scallop Pecten maximus	UCS survey, Survey completed, 3 sites- 2000 Survey completed, 7 sites 2004, 2008 & 2012	1979/80, 1979-82 2000 2004 2008 2012	Every 4 years Next survey planned 2016	Bullimore 1985 Jones 1979 & 1980 Lock 2002 Luddington *et al* 2004 Lock *et al* 2009 & 2013	Yes-SMNR office
Nudibranch species	Various surveys MNR survey completed.	1975-1991 2002, 2006 & 2010	Every 4 years Next survey planned 2014	Bunker *et al* 1993, Luddington 2002 Lock 2010	Yes-SMNR office
Territorial fish	Survey methods developed. Survey completed. N. Sweet drop down video survey R. Bullimore video survey	1997,2001/2002 2005, 2009 & 2013 2007 2009	Every 4 years Survey to be reviewed	Lock 1998 Lock *et al* 2006 Tompsett 2006 Sweet 2009 Bullimore, R 2010	Yes-SMNR office
Echinoderm Survey	Abundance of *Echinus esculentus* in Skomer MNR using volunteer survey methods. Data for *Marthasterias glacialis*, *Crossaster papposus* & *Luidia ciliata*	2003,2007 & 2011	Every 4 years Next survey planned 2015	Luddington *et al* 2004 Lock *et al* 2008 & 2011	Yes-SMNR office
Commercial Crustaceans	Parlour pot and diving study (Plymouth student project) Parlour pot study – MNR Shell disease survey	2003 2011 2011	Aug / Sep 2003 Jul – Oct 2011 Sep – Oct 2011	Fothergill 2004 No No	Yes-SMNR office

3 Skomer MNR Biological Project Summaries

Zostera Marina Population
(CMS code: RF23/01)

Status
Ongoing. Surveyed every 4 years, (next survey 2014).

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.

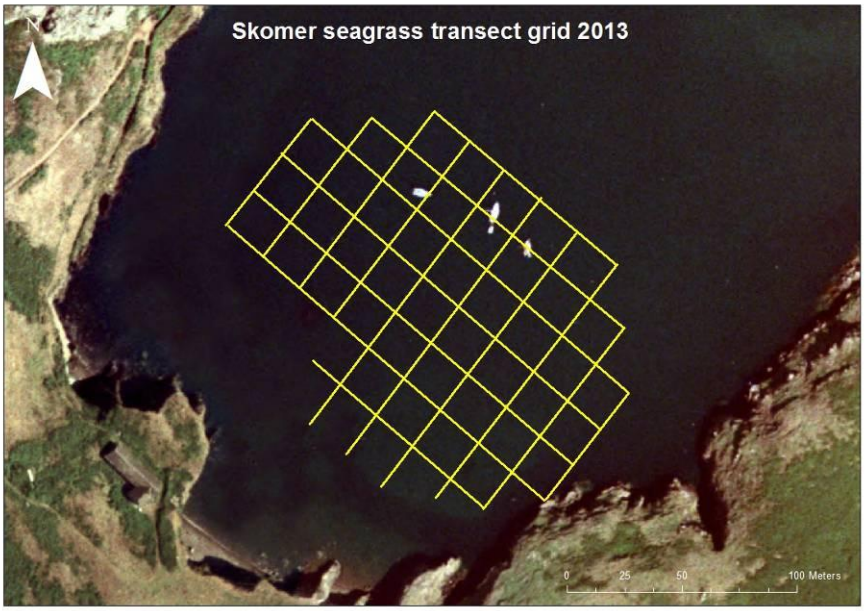
Objectives
- To map the boundaries of the *Zostera marina* bed.
- To determine and identify changes in its distribution and abundance.
- Record conspicuous organisms associated with the *Zostera* population.

Sites
North Haven, Skomer Island

Methods
In 2013 the NRW Fisheries Assessment Team brought their Biosonics DT-X echo-sounder to acoustically survey the seagrass bed in North Haven.
See preliminary report below.

- The eelgrass in North Haven, Skomer was surveyed using a Biosonics DT-X echo-sounder on 13/08/2013

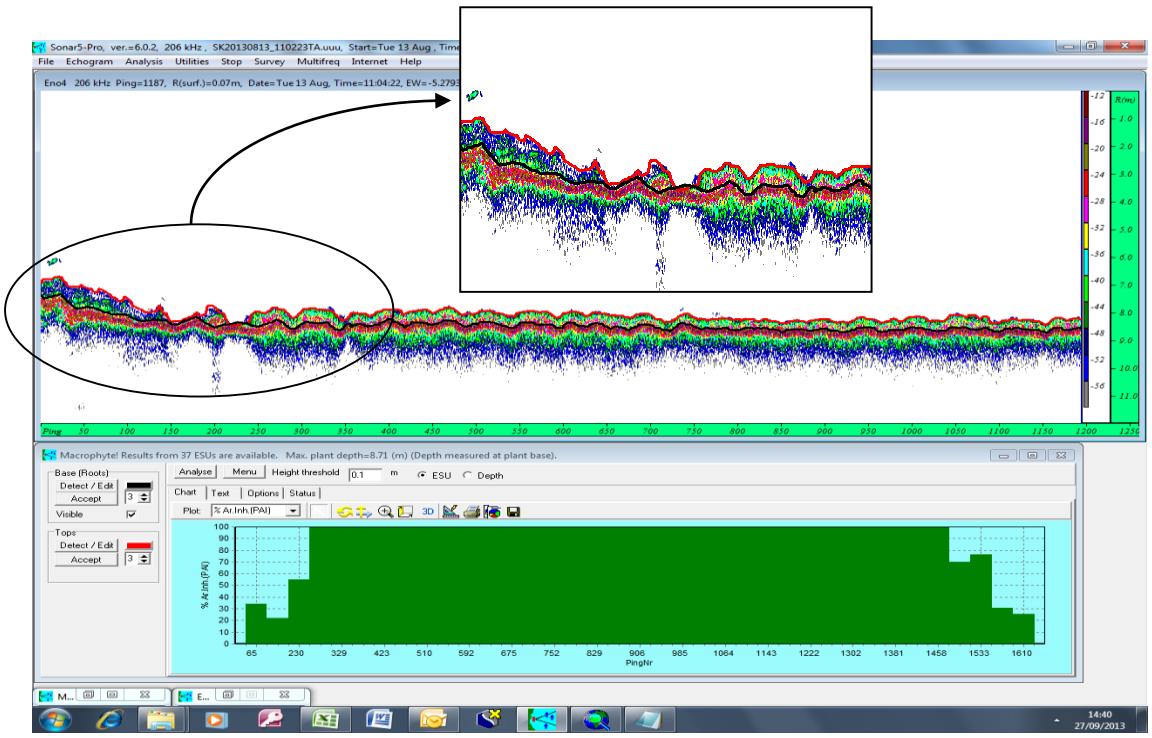
- The survey grid comprised 18 transects spaced at 20 metre intervals.



North Haven survey grid

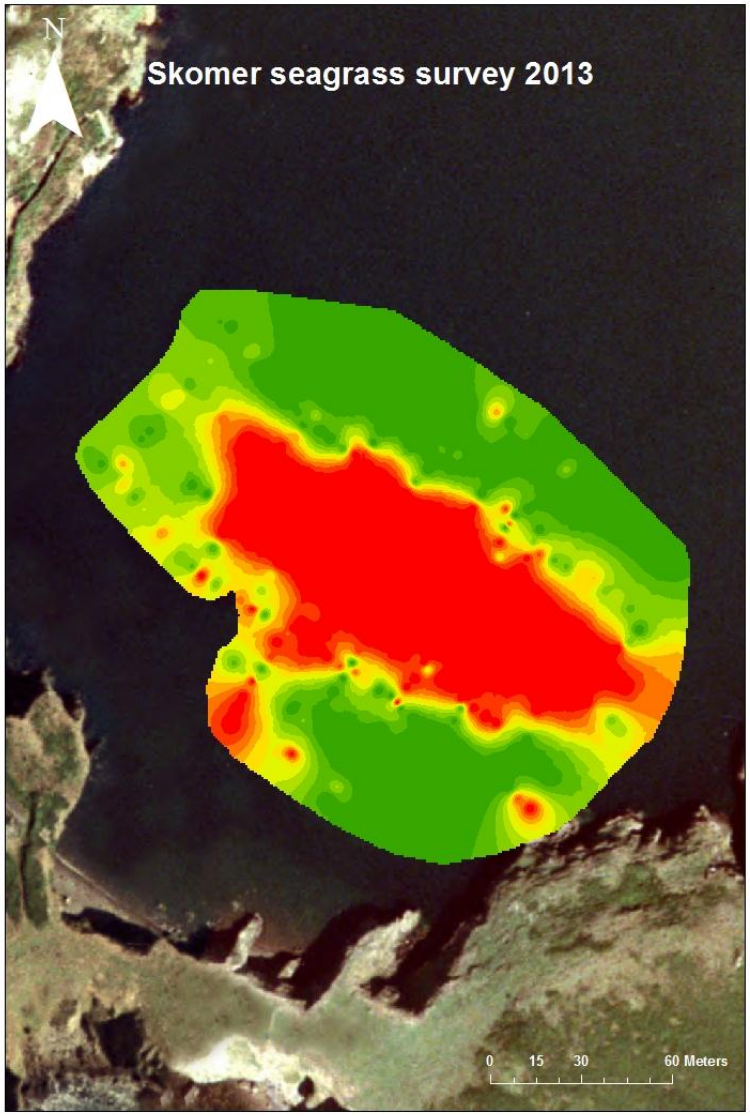
- The hydroacoustic data was analysed in Sonar 5 Pro. Analysis of macrophyte data involves defining the extent of the macrophyte roots (the sea bed) and the extent of the macrophyte tips. Algorithms in Sonar 5 pro then produce macrophyte metrics within these bounds for user defined Ecological Sample Units along the transects.

- Analysis of the echograms, in Sonar 5 Pro, indicate that macrophyte echo returns from some ends of the transects appear different to those in the middle, forming a much less uniform sward with smaller echo returns. Typically the change appeared before or after a break in the main, uniform stand. It is assumed that these areas are not eelgrass.

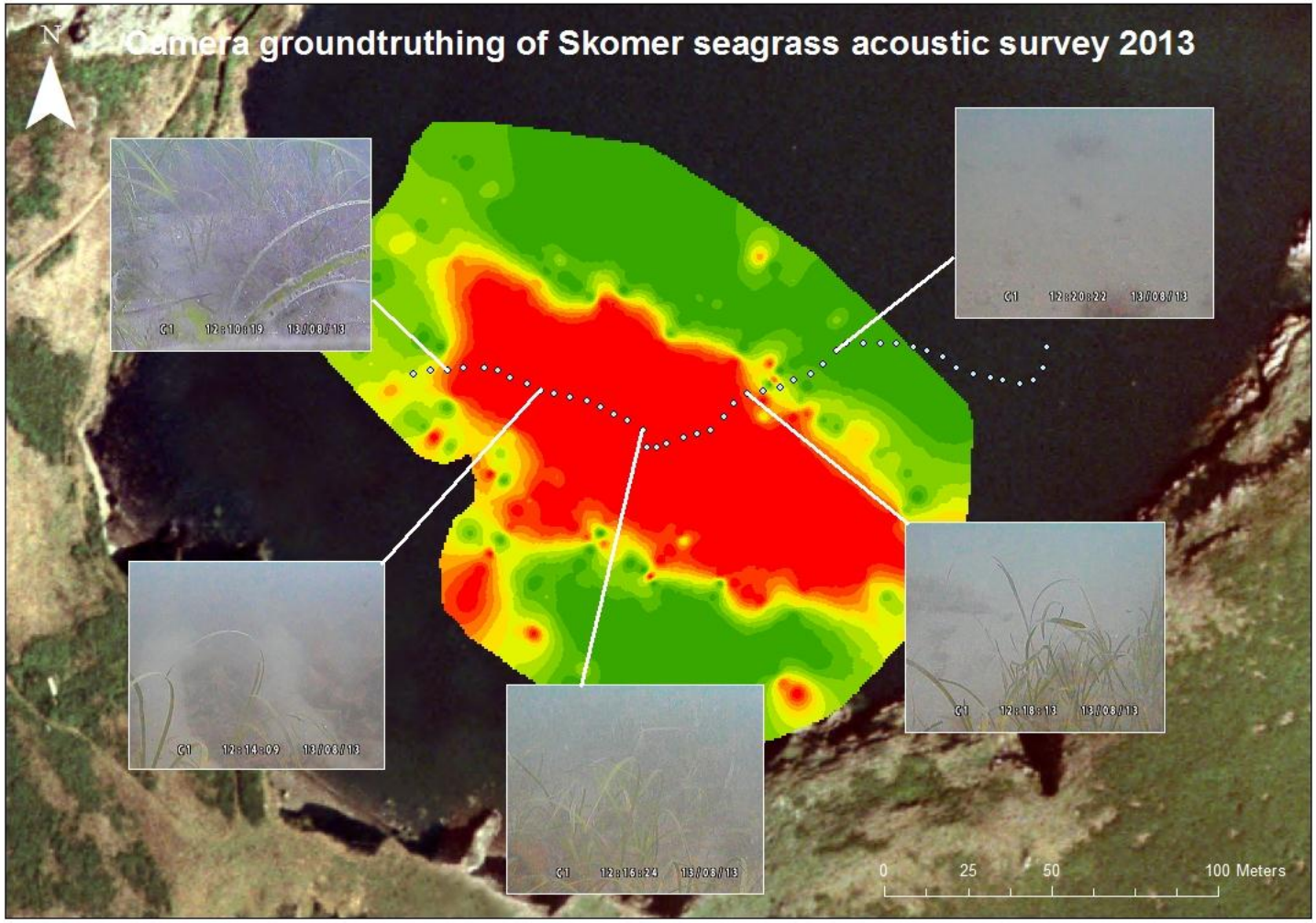


Sonar-5 analysis screen of Skomer eelgrass transect. Inset shows sea grass returns (right side) and non sea grass returns (left side). Macrophyte bases are defined by the black line and tips by the red line.

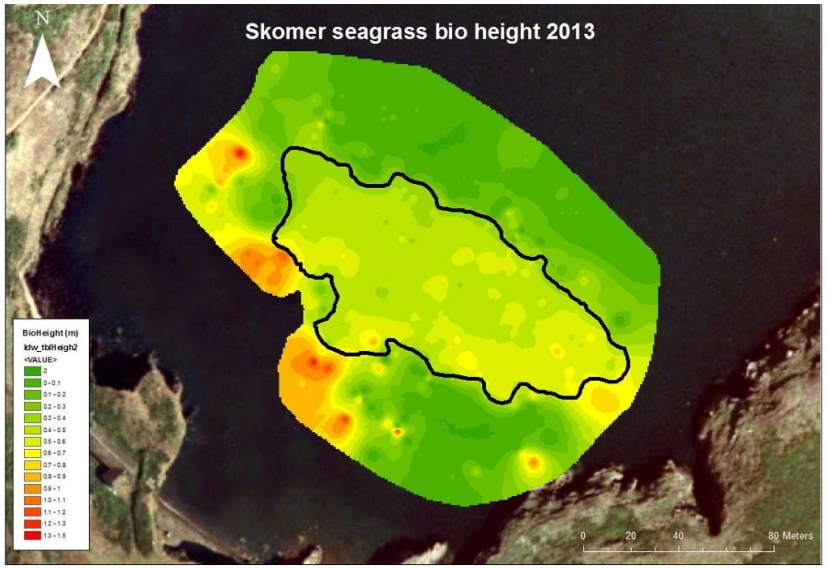
- Preliminary IDW plots of percentage area inhabited (PAI) are shown below.
- A drift over the survey area, using an underwater camera alongside the hydroacoustics indicate that the uniform areas were primarily eelgrass . Video data suggests that the less uniform areas were comprised primarily of fucoids and laminaria.



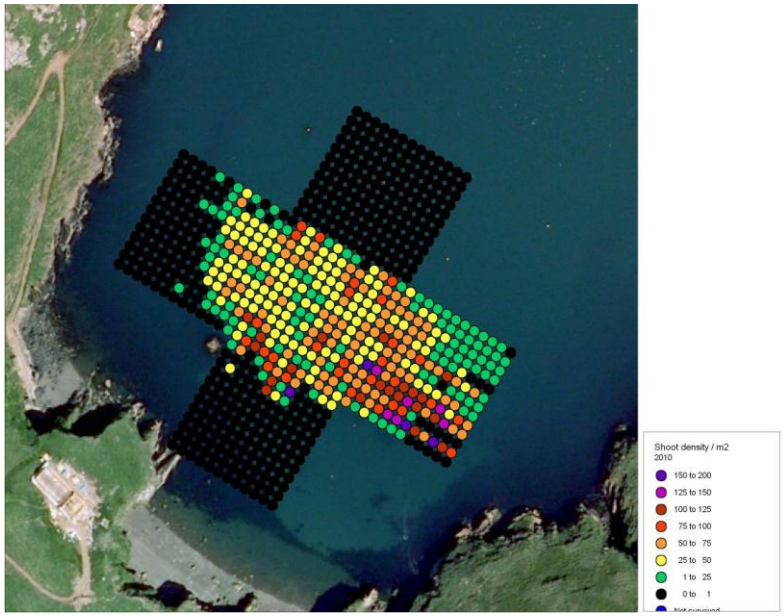
Percentage area inhabited (PAI), with preliminary differentiation based on the appearance of the echo returns.



Images obtained during camera drift (dotted line) over eelgrass bed – the acoustic signal for seagrass was verrified by the images from a towed camera.



North Haven macrophyte bioheight (cm) 70% PAI



2010 Diver survey density map

The 2010 density map shows a bed of very similar size and shape to the acoustic defined by 70% PAI contour

Over lay of the 50% PAI contour line with the 2010 diver survey density map – The 50% PAI is not as good a match as the 70% PAI

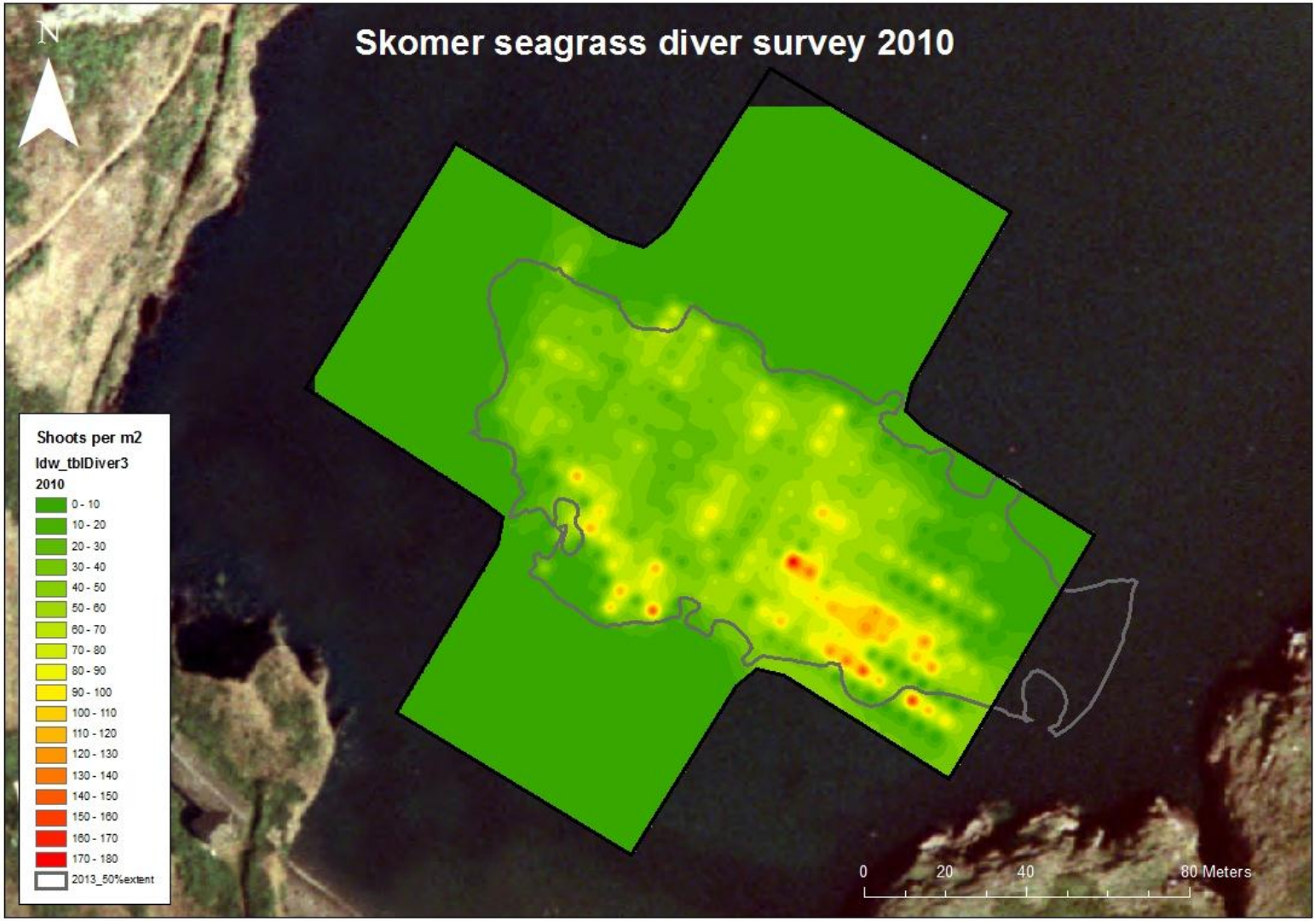


Table below shows the total area covered within increasing PAI contour lines. Further camera work and/or diver surveys will be required to ground truth the most appropriate PAI contour at which to assess the area of the eelgrass bed in North Haven.

Estimated area of North Haven eelgrass bed at increasing PAI contours.

PAI Contour	Area (m^2)
50-60	9575
60-70	8650
70-80	7918
80-90	7130
90-100	6102

Area of extent estimates of eel grass bed N Haven 1982 – 2010 from diver surveys

Year	m^2
1982 original estimate (not GIS)	5500.0
1982 (GIS)	3788.0
1997	6333.5
2000 swim	7007.8
2002	6569.5
2002 swim	7683.2
2004 swim	6817.5
2006	7336.6
2010	7980.6

The 70-80% PAI contour area estimate closely matches the 2010 diver survey estimate.

Recommendations

- Re-run the acoustic survey in 2014 alongside the planned volunteer diver survey to ground truth the compatibility of the 2 methods.

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

Counting Protocols:

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

Barnacle Monitoring 2003 - Ongoing

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

Limpet Monitoring 2003 - Ongoing

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

Marclim Methodology 2003 - Ongoing

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

The MarClim methodology was used at 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 MNR as a baseline littoral survey.

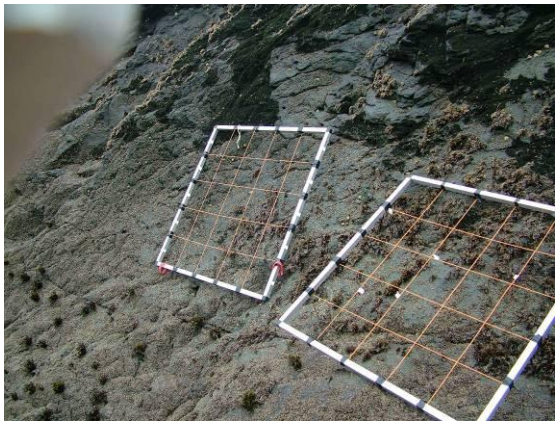
1992: Six permanent transects were established in the MNR and surveyed/ photographed (Crump, 1993).
1992 – 2002: Photographs of the six permanent transects were taken and stored.

1996: Following the Sea Empress oil spill (Feb 1996) the six transects were resurveyed and a lichen monitoring site was set up at Hopgang (Crump, 1996). The littoral shores around Skomer showed no significant changes after the Sea Empress oil spill, with the exception of lichens at Hopgang, which showed signs of necrosis.

2001: Slide photographs from 1992 – 2000 were reviewed and abundance estimates from the photographs compared with abundance records from Crump 1992 & 1996 field data. Photograph quality was insufficient to allow accurate abundance estimates.
2001/02: Digital imaging was tested to obtain pictures of permanent quadrats. Image quality was improved; however estimates of species abundance were still inaccurate due to difficulties with identification of species and individuals from the images. This method cannot replace collection of data in the field for quantitative assessment.

2003: New quantitative methods were tested at the six original sites and four additional sites were established.

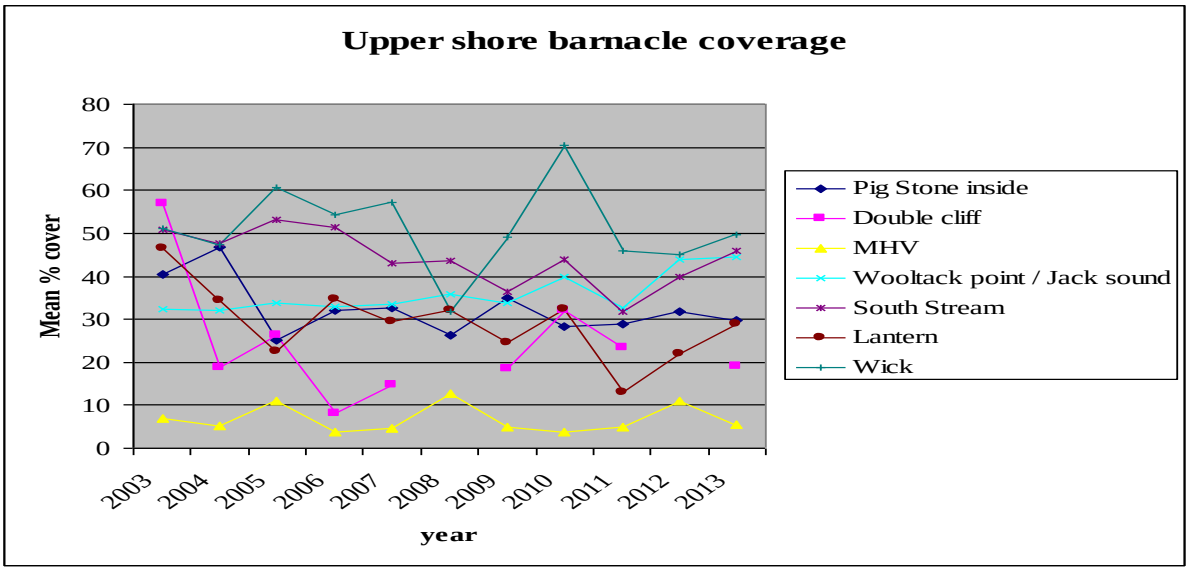
2004: Methods established in 2003 were continued. All site marking was completed and all results collected. Marclim surveys were started at 3 sites: Martins Haven, South Haven and North Haven.

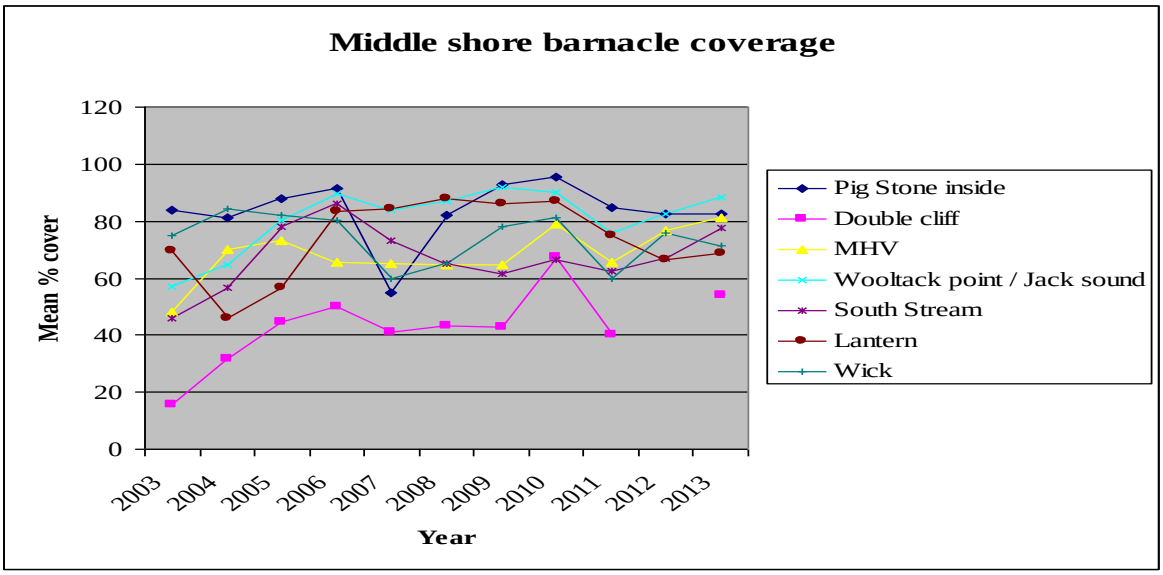


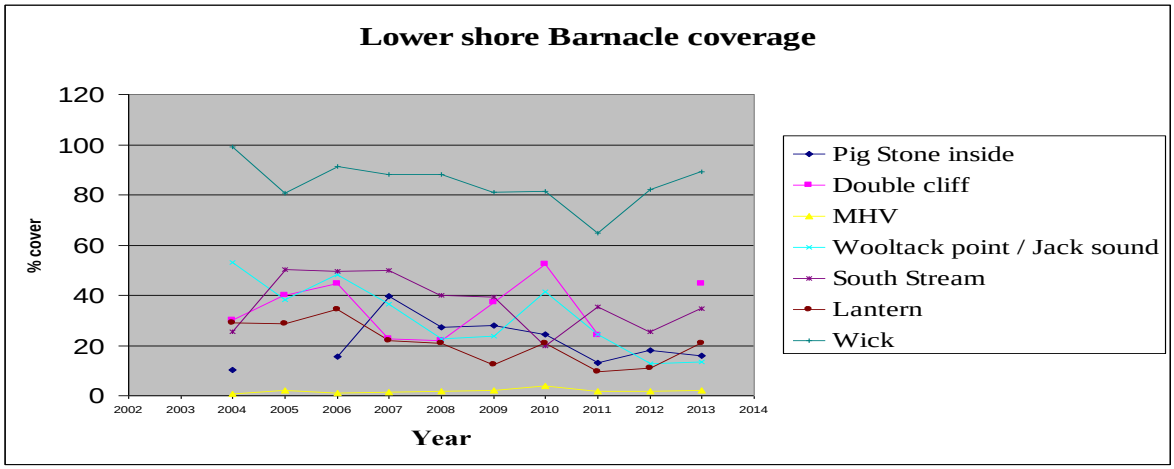
2005: All the sites established in 2003 were resurveyed except for the lower shore at Pig Stone.
2006: All sites were completed.
2007: All sites were completed and temperature loggers were placed at the Martins Haven and South Haven sites.
2008: All sites resurveyed except for Double cliff, upper shore.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

Mean % Cover Barnacles

Barnacle coverage has been variable between sites over the last 8 years. In 2011 a decrease of barnacle coverage in the upper shore was found across most sites which has stabilised in 2012 with most sites showing an increase in 2013. The decrease at all sites in the middle shore and a drop at all sites except South Stream in the lower shore stabilised in 2012 and 2013 saw a general increase.

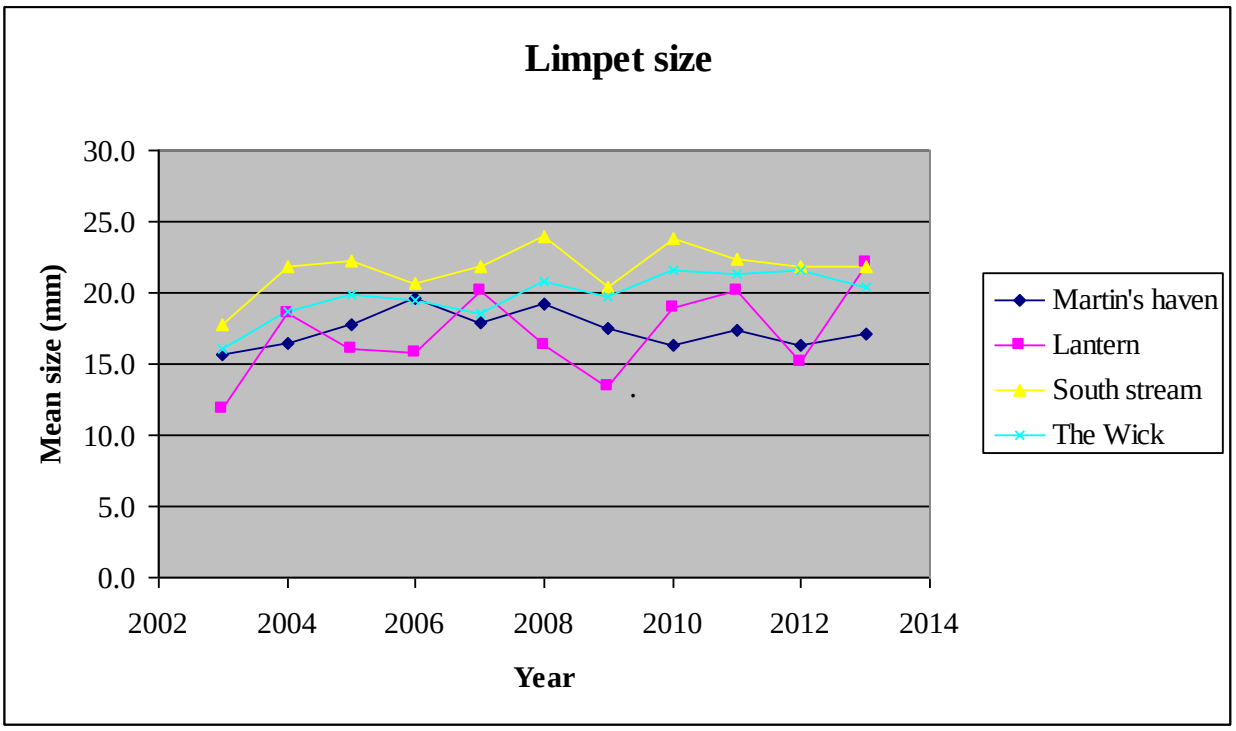





Lower shore Barnacle coverage
120
100
80
60
40
20
0
% cover
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Year
Pig Stone inside
Double cliff
MHV
Wooltack point / Jack sound
South Stream
Lantern
Wick

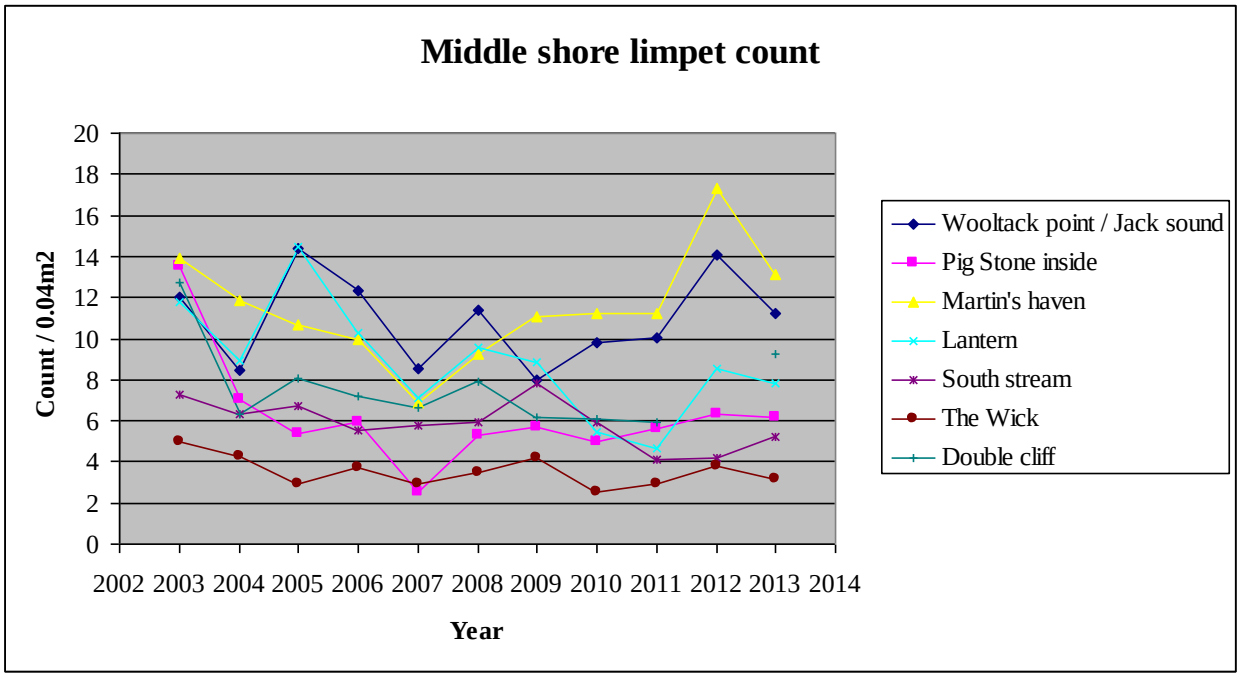
Size of limpets on the middle shore (mm)

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

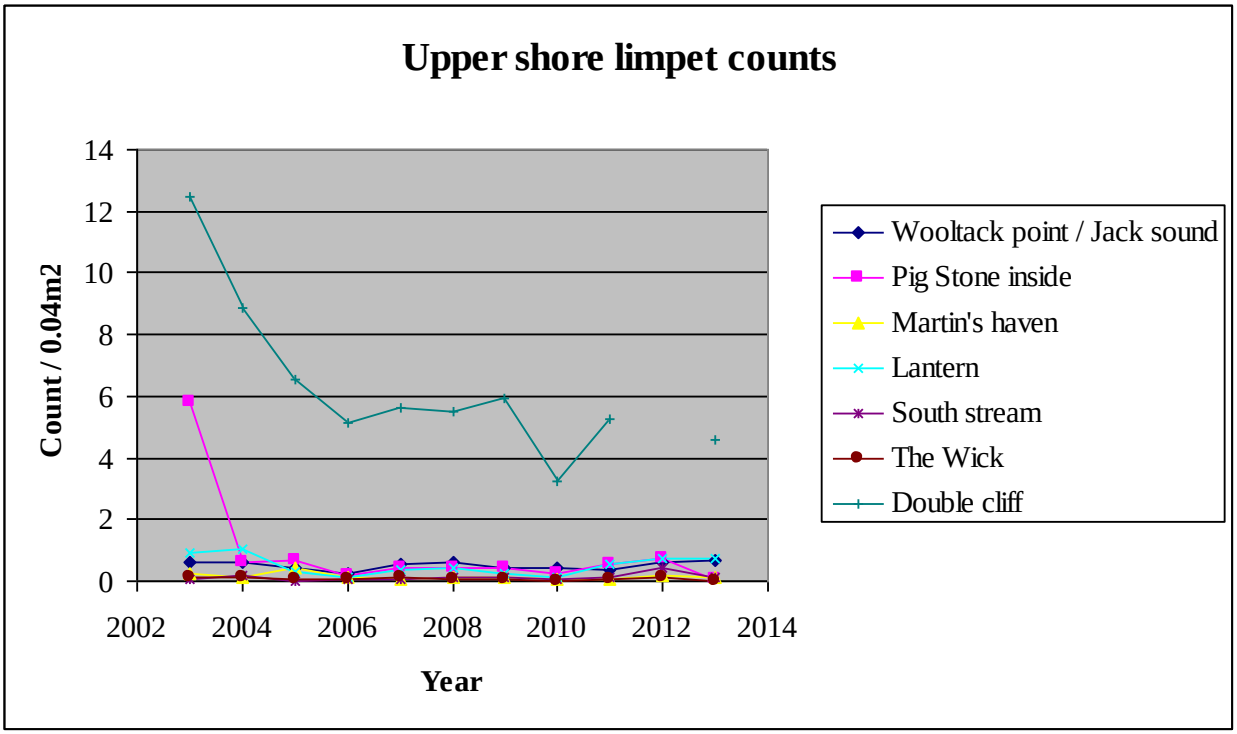


Counts of Limpets from 5 (20 X 20cm) Quadrats

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.

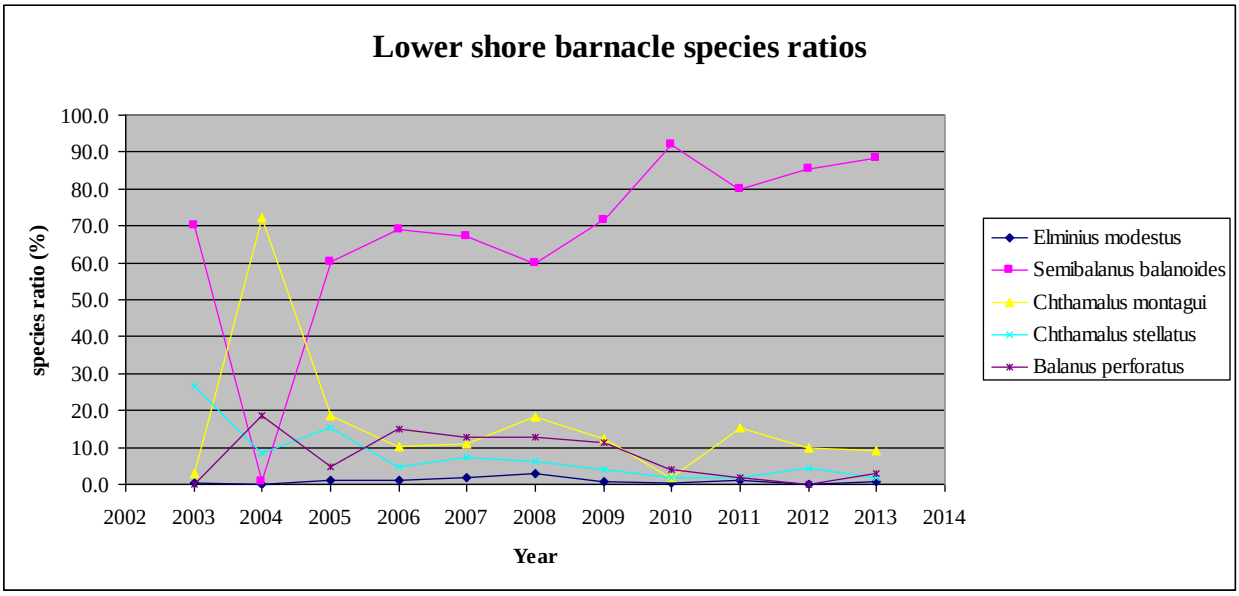


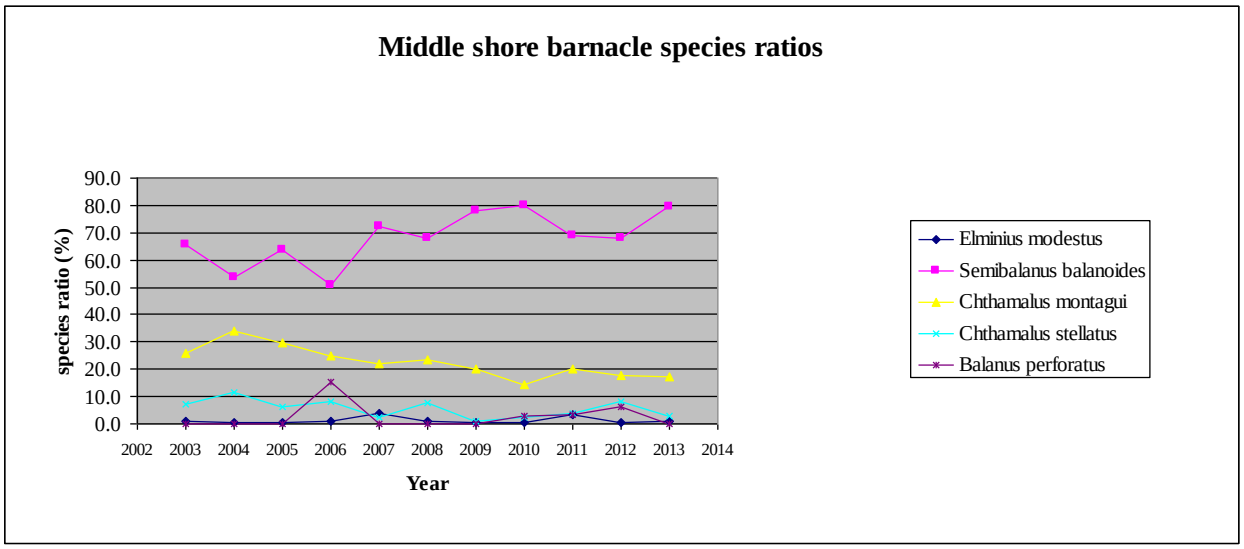
In the upper shore most sites have a low abundance of limpets. Double cliff has significantly more limpets than any other site (north facing shaded cliff) and an interesting declining trend from 2003 – 2006.

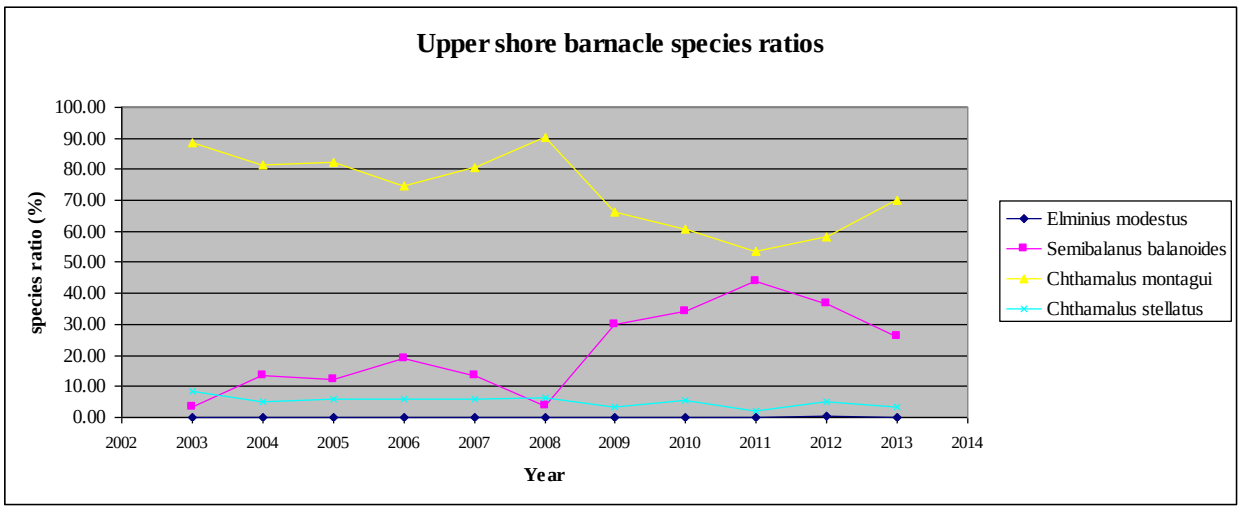


Barnacle Species Ratios at the 3 Marclim Sites from Photographs of 5cm X 5cm Quadrats

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. The middle & upper shore were show a trend of an increasing presence of *S. balanoides* with a corresponding decreasing in *Chthamalus spp* but in the last 3 years that trend has reversed.







Current Status

The shores appear to be typical of the area.

Recommendations

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

References

Adams 1979, Bunker *et al* 1983, Hiscock, K 1990, Crump 1993, Crump 1996, Hudson 1995. Burton, Daguet, Lock & Newman 2001. Skomer Littoral Monitoring Manual.
Crump R.G. & Burton. M 2004, Skomer Marine Nature Reserve Littoral monitoring: Development of methods. CCW West Area Report 27.
N. Mieszkowska, M., R. Leaper, A. Southward, S. Hawkins & M. Burrows. 2002. MARCLIM monitoring network: provisional sampling strategy and standard operating procedure.

Sediment Infauna Communities

(CMS code: RM03/04)

Status Ongoing. Survey every 4- 5 years (next survey 2017).

Project Rationale

Despite the relatively high number of surveys carried out in Skomer MNR much remains unknown about the sediment communities. Sediments accumulate pollutants and toxins and sediment communities have been shown to respond to these pollutants.

Objectives

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

Sites

Nineteen sites in Skomer MNR were sampled in the first survey in 1993. This was reduced to 10 sites in subsequent surveys i.e. 8 on the north side of Skomer and 2 in South Haven.

Methods

Two replicate samples were taken at each site using a 0.1m_2 day grab, and processed and preserved on site. The retained samples were then identified and enumerated by a specialist contractor. A third sample was analyzed for sediment grain size and hydrocarbon content.

Results

Surveys were completed in 1993, 1996, 1998, 2003, 2007, 2009 and 2013 .The aim of the survey in 1996 was to assess the effect of the Sea Empress oil spill. The average number of individuals, species richness and taxonomic diversity was significantly lower in 1996 than all other years

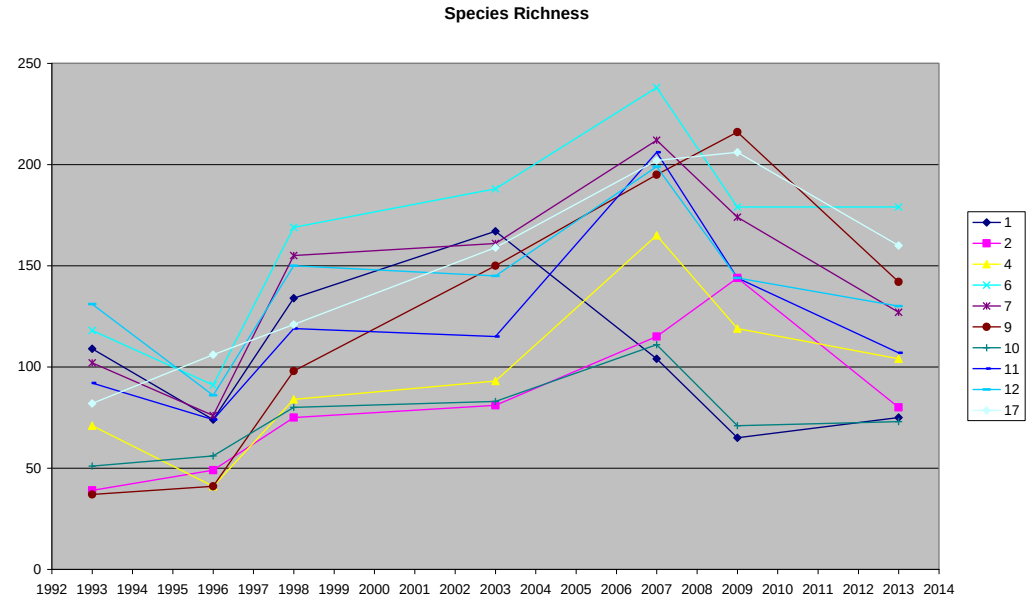
.

Table showing average species richness (S), average number of individuals (N) and average taxonomic diversity (Delta+).

Year	S Species richness	N abundance	D Margalef richness	J' Evenness	H'(loge) Shannon	1-Lambda' Simpson	Delta+ Taxonomic distinctness
1993	312	582.88	48.84	0.73	4.19	0.96	88.88
1996	246	173.97	47.49	0.81	4.45	0.98	88.46
1998	359	684.70	54.83	0.77	4.50	0.98	88.71
2003	418	773.50	62.70	0.73	4.41	0.97	90.17
2007	505	1290.90	70.36	0.77	4.81	0.99	88.69
2009	509	867.92	75.08	0.77	4.78	0.98	88.87
2013	380	698.58	57.87	0.77	4.60	0.98	89.11

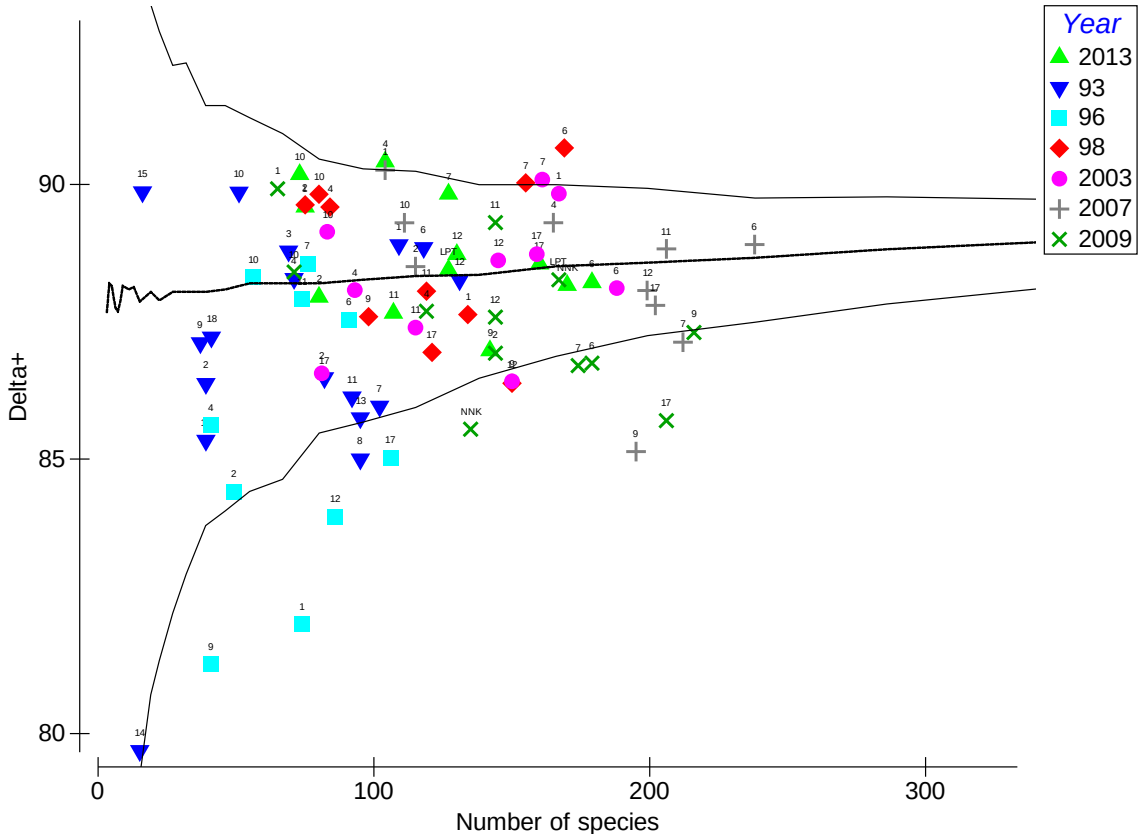
2007 & 2009 survey had the highest number of species (S) and individuals (N)

Graph of Species richness 1993 - 2013



The 2013 results are very similar to the previous survey.

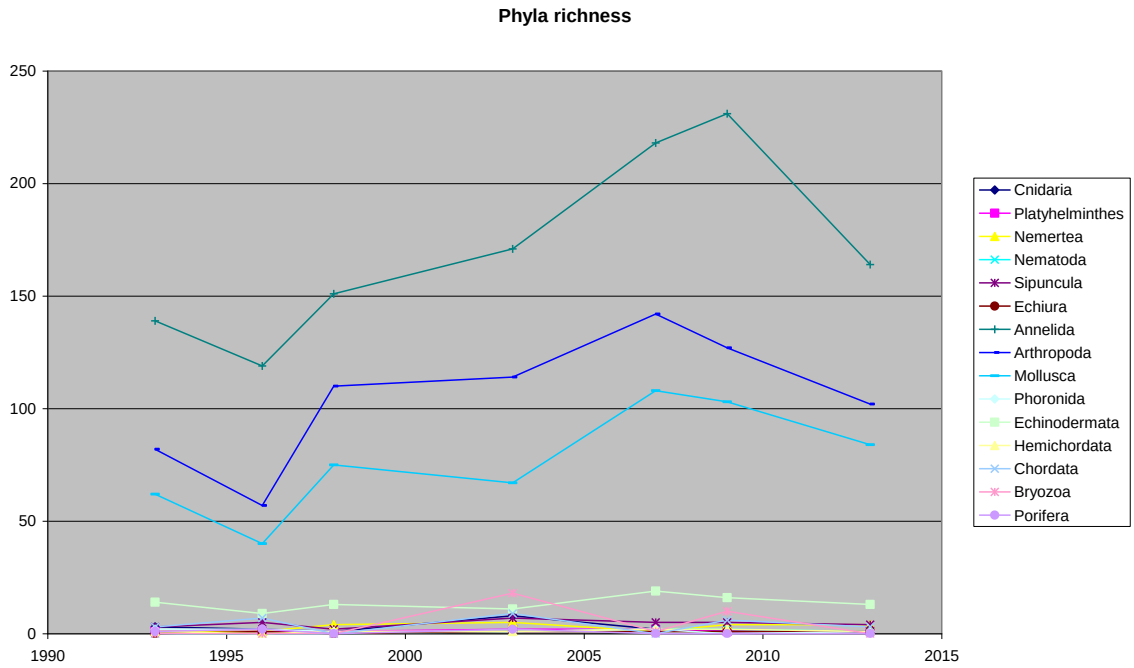
Funnel plot of Taxonomic distinctness tests 1993 – 2013 (Delta+ from Primer)



All the 2013 samples are within the 95% confidence limits – and although the number of species have declined compared to 2007 the taxonomic variability has remained. I.e. there is still a wide spread of species for all groups and taxa.

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

Number of species found from each Phyla 1993 - 2013



Annelida (worms), Arthropoda (crabs, gammarids and other crustaceans) and Mollusca are always the 3 major phyla represented in the species lists.
In 2003 there was a notable increase in bryozoans; this may be due to those species being recorded quantitatively that year whilst in other years they have just been recorded qualitatively.

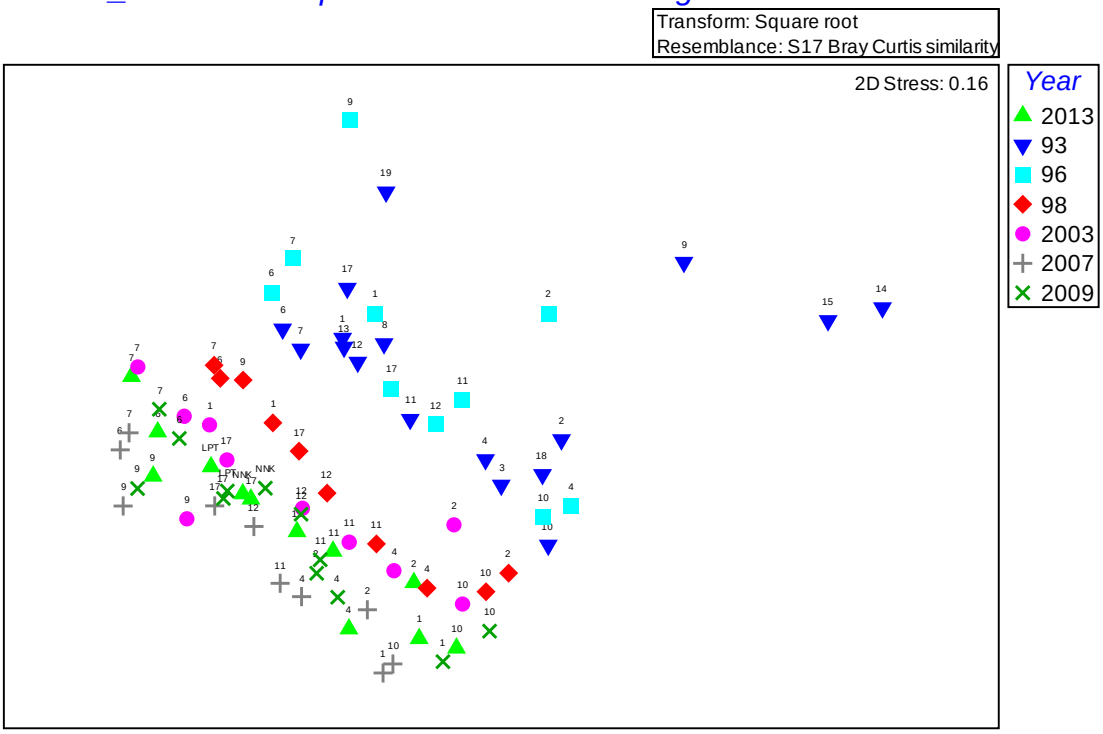
Qualitative Summary of the fauna found in the 2013 survey by L. Hewitt (infaunal taxonomist) at HEBOG Environmental;

"There aren't any protected or especially rare species but things worth mentioning:

- Species diversity is exceptionally high. Even with similar mixed sediments samples we rarely record such diversity throughout all major phyla/groups
- *Amphipod*a diversity- approximately 60 different species found. To put this in some sort of context, looking at sites with a similar sediment type, for example a lot of the MCZ work we have done recently for the EA and NRW, we generally record 20-30 species of amphipod. Both *Iphimedi*a species that were recorded I can't recall seeing before and are very specific to the west coast, in the original paper describing them (1987) they were only from the west coasts of Scotland and Ireland.
- Diversity of encrusting species. Again high, including sponges, hydroids, soft corals, zoanthid anemones, *Sabellaria, Pomatocerous* (now *Spirobranchus*), entoprocts, bryozoans, tunicates. All species that increase species/habitat diversity.
- Presence of species only found on the west coast or rarely recorded elsewhere in the British Isles *including Epizoanthus, Isozoanthus, Iphimedia* (as mentioned above), *Parametopa, Pyura microcosmus* (south west), *Hippoporina* (south west), *Thalassema thalassemum, Mangelia coarctata, Ophiactis balli, Moerella donancina, Pandora pinn*a to name a few."

Multi-dimensional scaling (MDS) plot using PRIMER showing the separation of samples from 1993 - 2013 .

1993_2013 SMNR quantitative Infauna Data good ID No Juvs Av SY 2rt



The MDS Primer plot shows that both 1993 and 1996 differ from 1998, 03, 07, 09 & 2013. The community as a whole appears to have been very stable for the last 10 to15 years.

Physical Sediment Data

Hydrocarbon content:

Hydrocarbon content was analysed at the NRW Llanelli Labs (results in table below). So many different techniques have been used over the years it is difficult to compare the hydrocarbon content across the time series.

Summary of 2013 hydrocarbon results – Skomer MNR

Site	2013	2013	2013
	Ekofisc mg/kg	Total PAH ug/kg	HC by UVF mg/kg
1	0.29	300.1	0.29
2	0.72	402.2	0.72
4	6.47	943.3	6.47
6	0.05	668.6	0.05
7	11.9	646.6	11.9
9	3.16	291.6	3.16
10	0.27	436.3	0.27
11	0.76	1007	0.76
12	14	688.8	14
17	2.27	543.6	2.27
LPT	8.49	2518	8.49
NNK	5.67	849.7	5.67

Particle size analysis.

The initial results from the Llanelli labs showed a surprising drop in the amounts of fines (<63um). This has been queried as the biological results would not suggest a complete lack of fines. The samples will need to be reanalysed before they can be relied upon.

Current Status:

The last four surveys have shown the infaunal community to be healthy and species rich. The similarity between the surveys from 1998 to 2013 is encouraging as is the increase in richness and abundance in 2007. There is a suggestion of a decline in species richness in 2009 & 2013 but compared to other areas of the UK the sediment communities around Skomer MNR are very diverse.

Recommendations

- Next survey due 2017.
- Publish results and put the results into context with similar surveys from the surrounding area.

References

Rostron 1994, Rostron 1996, Barfield 1999, Barfield 2004 & Barfield 2008.

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 Smoker MNR 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

In 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 MNR 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 MNR. The MNR 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 MNR 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 MNR 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.

Survey results 1994 -2013:

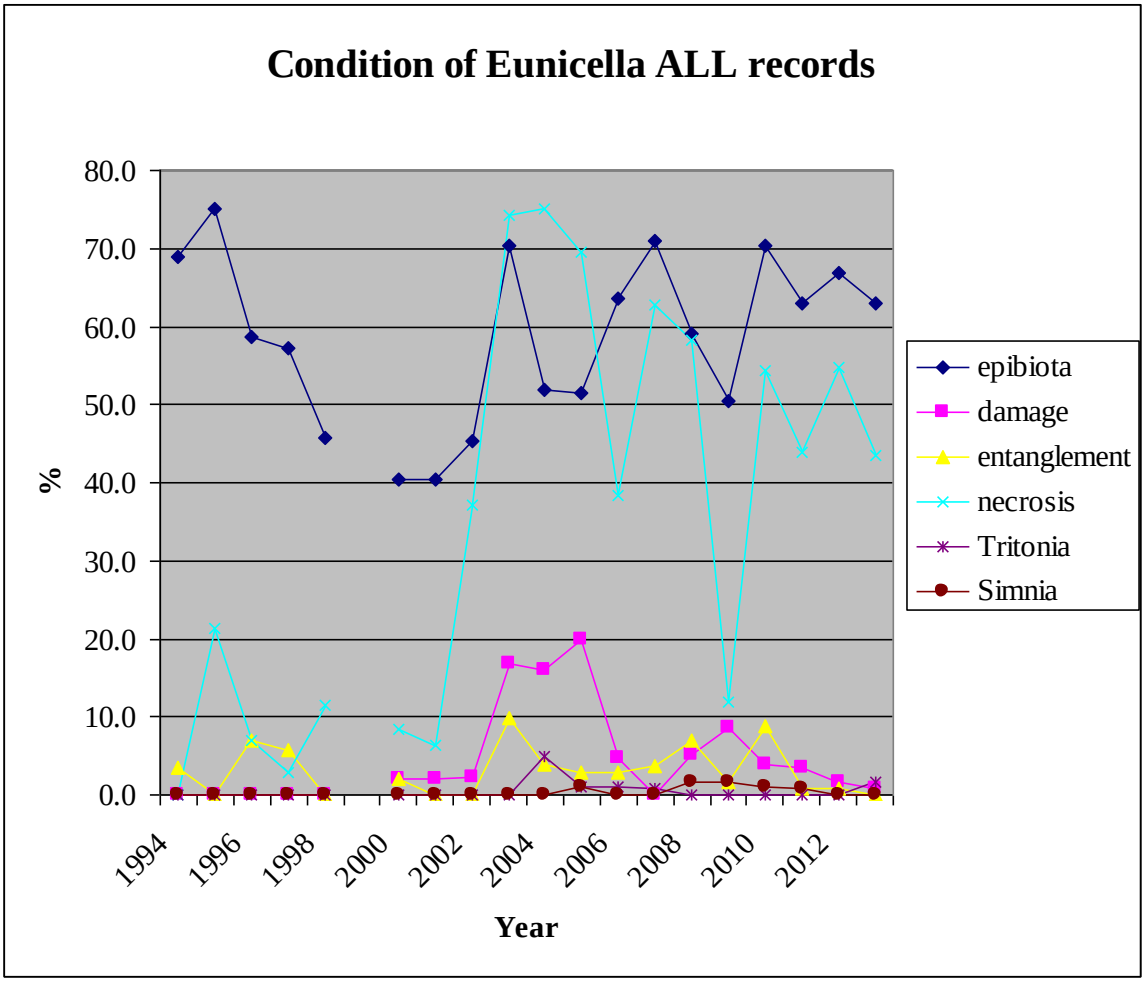
year	Sites surveyed	Total fans recorded	Total natural fans	Total attached fans	New recruits (babies)	Losses (confirmed)	Missing (to be confirmed)
1994	3	30	30				
1995	3	29	29			1	
1996	3	29	29				
1997	4	35	35				
1998	4	35	35				
1999	0						
2000	5	50	50				
2001	5	52	52			1	
2002	9	81	80	1		1	
2003	9	95	94	1	1		
2004	9	97	96	1			
2005	10	110	107	3	1	1	
2006	10	115	112	3	7		
2007	10	117	114	3	1	2	
2008	10	122	118	4		1	
2009	10	124	117	7			
2010	10	122	116	6		3	
2011	10	121	117	4		3	2
2012	10	121	116	5		1	1
2013	10	121	116	5			2
totals					10	13	

In 2013 there was no confirmed loss of any naturally-attached fans from the 2012 season. WAY15, missing in both 2011 and 2012, was re-found in 2013. SSFG 23, missing in 2012, was not found so its status as a loss will be established in 2014. SMD 6 was not found in 2013 for the first time.

A new sea fan was added to the Pool site survey, this a double sea fan found whilst setting up a new *Pentapora foliacea* survey site at the Pool.

The cluster of 5 baby fans at Bull Hole are all present but very little growth has been observed since 2006 when they were first found. No anthropogenic damage to fans was recorded in 2013.

Condition of sea fans in the Skomer MNR from photo images (1994- 2013) and field data (2002-2013) 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 44% and 55% for the last 4 years, in 2013 it was 43%. The average level of necrosis since 2002 (12 years) is 52%.

An annual average of 60% of sea fans have been recorded with attached or entangled epibiota for the last 12 years of surveys. In 2013 this was on 63% 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.

Two Pink sea fan slugs *Tritonia nilsodhneri* were recorded in 2013, found on two different sea fans at Rye Rocks.

Photo by John Archer Thomson

Genetic Analysis of Octocorals from Skomer Marine Reserve
Lyndsey P. Holland and Jamie R. Stevens Biosciences, University of Exeter

Samples collected in 2009 have now been analysed:
Allelic richness values for the Skomer *Eunicella* population are not markedly different from other proximal British or Irish populations, indicating that these populations are not genetically isolated and suggesting on going gene flow with nearby populations.
The Skomer population of *Eunicella verrucosa* forms part of a continuum of genetically similar populations from southwest Britain, all of which are markedly different from those collected from Donegal (NW Ireland).

At the same time as the *Eunicella* samples were collected samples of *Alcyonium digitatum* were also collected.
The Skomer samples of *A digitatum* form part of a continuum of genetically similar populations of *A. digitatum* from western Britain & Ireland. This group shows genetic differentiation from *A digitatum* samples from the North sea.

Current Status

- Numbers: There have been 13 confirmed sea fans lost from the monitoring sites between 1994 and 2013 and there is 1 further possible loss in 2013.
- There are no new recruits found in 2013.
- Condition: Necrosis occurrence was found in 43% of the sea fans, this is below the average of 52% recorded for the last 12 years.
- Epibiota was recorded on 65% of the sea fans; this is above the average of 60% recorded for the last 12 years.
- Two *Tritonia nilsodhneri* were recorded in 2013.

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

References

Bunker 1985**,** Gilbert 1998**,** Wood 2003**,** Munro 2004**,** Wood 2008.

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 MNR 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 MNR.
- To identify natural and anthropogenic fluctuations.
- To identify the presence of rare, scarce and edge of range species in the MNR.

Sites

- Thorn Rock (transects & species survey)
- 2009 onwards – other digital images were used to assess the sponge assemblages around the Reserve

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 1m^2 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.

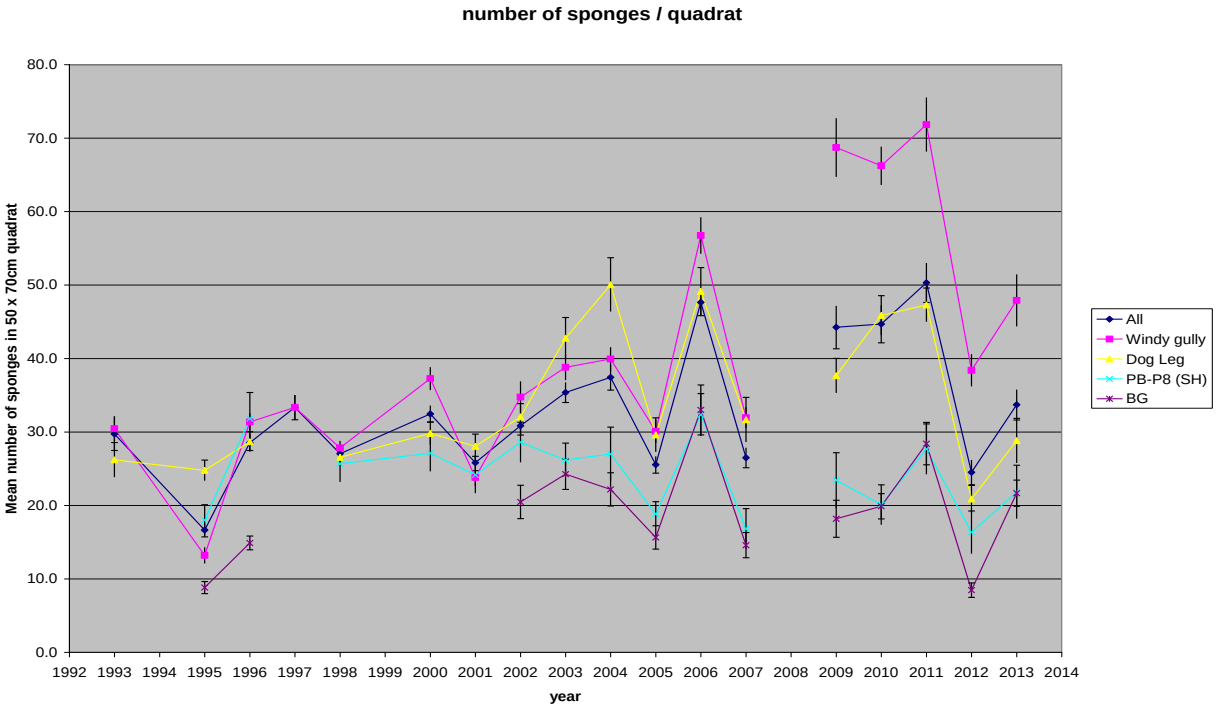
Results

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

Mean number of sponges counted at 4 sites 1992 - 2013



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 there was a 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 may be partly due to poor visibility conditions in 2012.

Seasonal variation in sponge assemblages

A study of the seasonal variation of sponges at Thorn rock has been running since 2006 as a PhD project by Jade Berman at Wellington University New Zealand. The PhD was completed in 2012 and a scientific paper was published in 2013 in the Journal for Nature Conservation.

Testing the suitability of a morphological monitoring approach for identifying temporal variability in a temperate sponge assemblage

Jade Berman, Mark Burton, Robert Gibbs, Kate Lock Philip Newman, Jen Jones, James Bell

Abstract:

Sponges are a dominant component of benthic assemblages in hard substratum environments across the world, but despite the importance of sponges, they are generally poorly represented in most marine monitoring programmes. There is considerable need to develop effective monitoring tools to monitor changes in sponge assemblages. Morphological monitoring has been proposed as a suitable method to monitor sponges and while morphological monitoring has already taken place at Skomer Marine Reserve (MNR), Wales, here we investigate whether species level and morphological level data sets are correlated with respect to temporal variation. Furthermore, we examine the environmental factors that correlate with the patterns of temporal variability. Both species and morphological data sets revealed significant seasonal changes and spatial variation in sponge assemblages; these

data sets were highly correlated and explained by a number of environmental factors. We conclude that morphological monitoring of sponge assemblages may represents a cost-effective method for assessing temporal and spatial variation in sponges, where full species level monitoring is not possible, as patterns identified from morphological data were a suitable surrogate of species-level data.

The seasonal photo data set will continue to be collected as part of the Reserve's sponge monitoring programme to see if there are any larger-scale patterns that operate on a longer timescale then has currently been recorded. In 2013 samples were taken in May, July & October. A new digital set was used in July & October which will help improve image quality.

Microbial content of Sponges

In a joint project with Wellington University and Marine Sciences Institute (ICM-CSIC Spain) sponges were collected at Thorn Rock to investigate the different microbial content of different species in different geographical areas.
Samples were collected from Lat/Lon (deg.decimal degrees) N51.73276 W05.274
On 14th & 15th Oct 2013. Water samples collected on 15th Oct 2013 - 3 X 1ltr samples filtered on 0.2um filter papers.
Species collected:
Axinella damicornis, Axinella dissimillis, Aximella infundibuliformis, Cliona celata, Dysidea fragilis, Haliclona viscosa, Hemmimycale columella, Homaxinella subdola, Pachymatisma johnstonia, Polymastia boletiformis, Raspailia hispida, Raspalia ramosa, Stelligera stuposa, Suberites carnosa, Tethya citrina, Thymosia guernei

3 small pieces of tissue from 3 separate individuals of each species were collected and stored in RNA Later to preserve the microbial DNA / RNA.

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 MNR. 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 MNR. This will provide improved knowledge of the diversity of sponge assemblages.
- Seasonality patterns need further investigation as seasonal changes in the sponge assemblages have been found. Winter data is needed as samples have only been collected from April to October. Encourage continued research on sponge seasonality in the Reserve;
- Continue sponge species recording every 4 years, next survey due 2015.

References

Picton, B.E. & Goodwin, C.E. (2007).
Picton & Morrow 1993, Bell & Barnes 2001, Clarke & Warwick 2001, Bunker & Jones 2008, Jones & Bunker, 2012.
Ayling, A. L. (1983).
Bell J, Burton M, Bullimore B, Newman P, Lock K (2006)
Bullimore B (1986)
Jones J, Bunker F, Newman P, Burton M, Lock K (2012)
Berman J, Burton M, Gibbs R, Lock K, Newman P, Jones J and Bell J. (2013)

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.

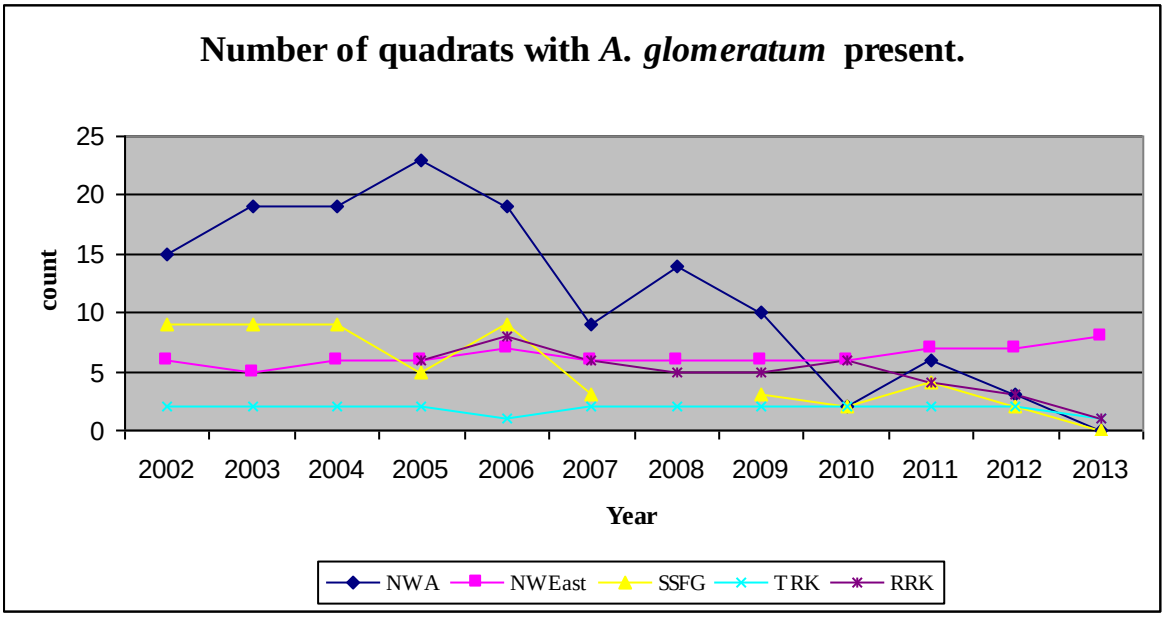
Results

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
NWA	15	19	19	23	19	9	14	10	2	6	3	0
NWEast	6	5	6	6	7	6	6	6	6	7	7	8
SSFG	9	9	9	5	9	3		3	2	4	2	0
TRK	2	2	2	2	1	2	2	2	2	2	2	1
RRK				6	8	6	5	5	6	4	3	1

Graph of the number of quadrats with *A. glomeratum* present 2002-2013

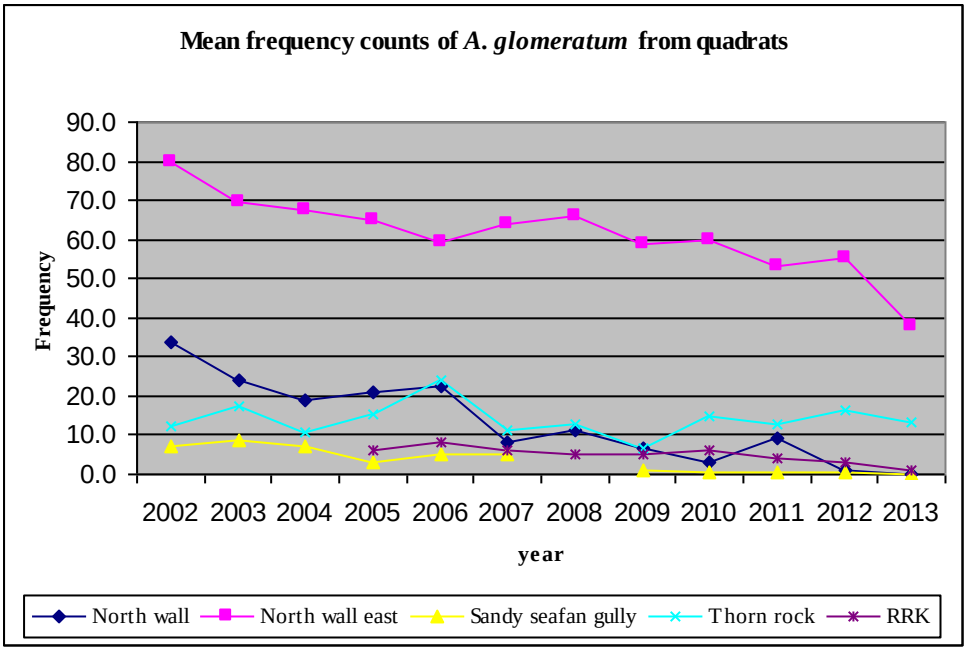


All sites except *NWA East* show a decreasing trend in the coverage of *A. glomeratum* colonies. In 2013 *NWA & SSFG* had no visible colonies of *A. glomeratum*.

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

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
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
NWEast	80.0	69.6	67.5	65.2	59.3	63.7	66.0	59	59.7	53.4	55.3	37.6
SSFG	7.2	8.4	7.1	3.0	5.3	5.3		1.0	0.5	0.4	0.4	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
RRK				5.3	10.3	8.0	9.8	10.0	7.2	4.8	3.3	14.0

Graph of the mean frequency of *A. glomeratum* from within the quadrats 2002 to 2012



The frequency of *A. glomeratum* colonies declined at all sites in 2013 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 Reserve.

Recommendations

- Continue with monitoring at all established sites and establish new sites.
- Improve site marking to allow accurate relocation of quadrats.
- Analyses 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 MNR. *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:

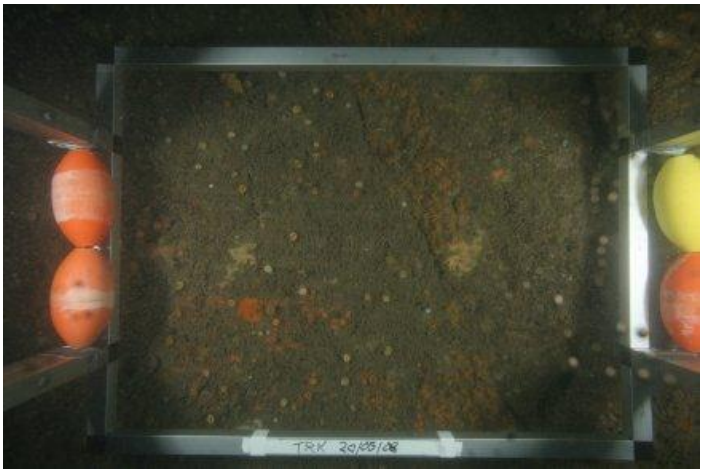
Close-up photographs are taken using a digital camera. The digital camera is mounted on a 20 x 20cm framer. *P. axinellae* polyps are counted in each quadrat.

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

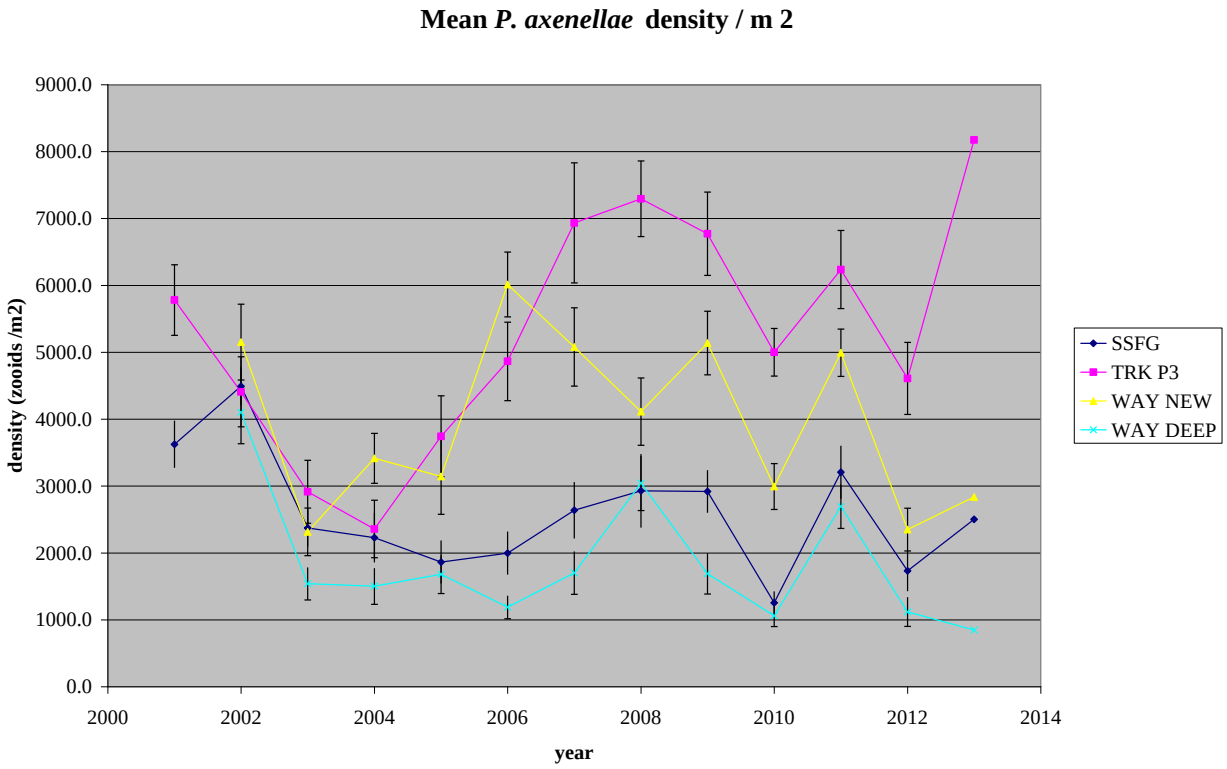


Results

2013 fieldwork completed:

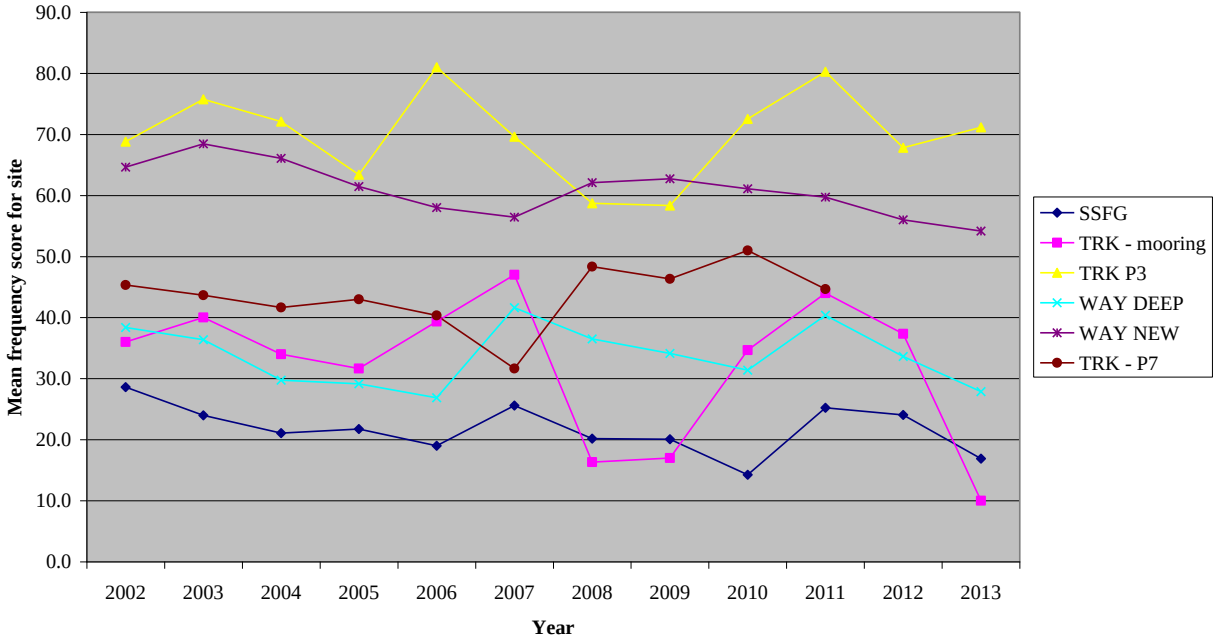
Colony area		Density
Site	**Index of Area**	**Close up photographs**
Sandy sea fan gully	5 transects (20 samples)	Yes
Waybench – *New Wall*	9 re-locatable samples	Yes
Waybench – *Deep Wall*	2 transects (8 samples)	Yes
Thorn Rock – *Piton 7*	3 re-locatable samples	Yes
Thorn Rock - *Mooring*	3 re-locatable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

Density of polyp (numbers of polyps /m^2) 2001 – 2013



The density of polyps seems very erratic at all sites. A drop in density was observed at all sites in 2012 followed by a rise in 2013 in all but *Way Deep*. The reason for these fluctuations is unknown.

Parazoanthus Transect Results 2002 - 2013



A drop in area occurred at all sites in 2012 which continued in 2013. TRK mooring, SSFG, Way New & Way Deep are at, or close to, their lowest recorded levels.

Current Status

- All the colonies are still present.
- The transect frequency counts show a general decrease in frequency in 2013.
- Polyp density has increased at most sites in 2013.

Recommendation

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

References

Bullimore B. (1986). Burton, M. Lock, K & Newman, P (2002). Brown, A. (2001). Garrabou J. (1999). Gilbert S.E. (1998). Hiscock, K. (1998). Holt R. H. F. (1998) Hughes R.N. Cancino J.N. (1985). Jackson J.B.C. (1977).Lindenbaum, C. *et al.* (2002). Manuel R.L. (1988). Newman P. & Lock K. (2000).

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 MNR 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).

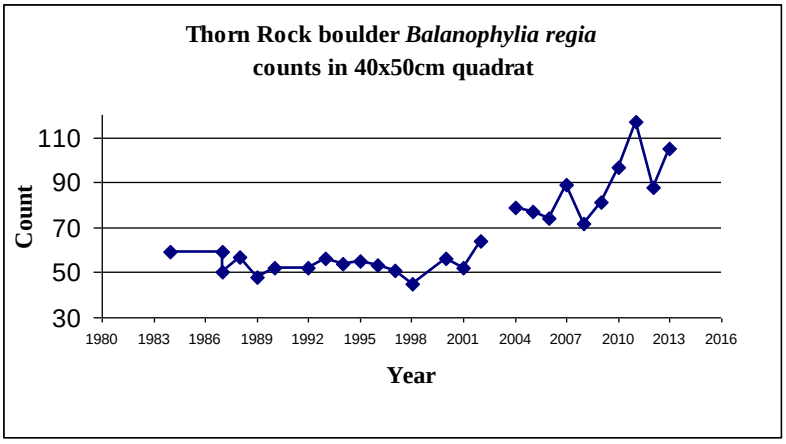
Caryophyllia smithii:

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. Variablity will occur due to changes in surface sediment which obscures small individuals.

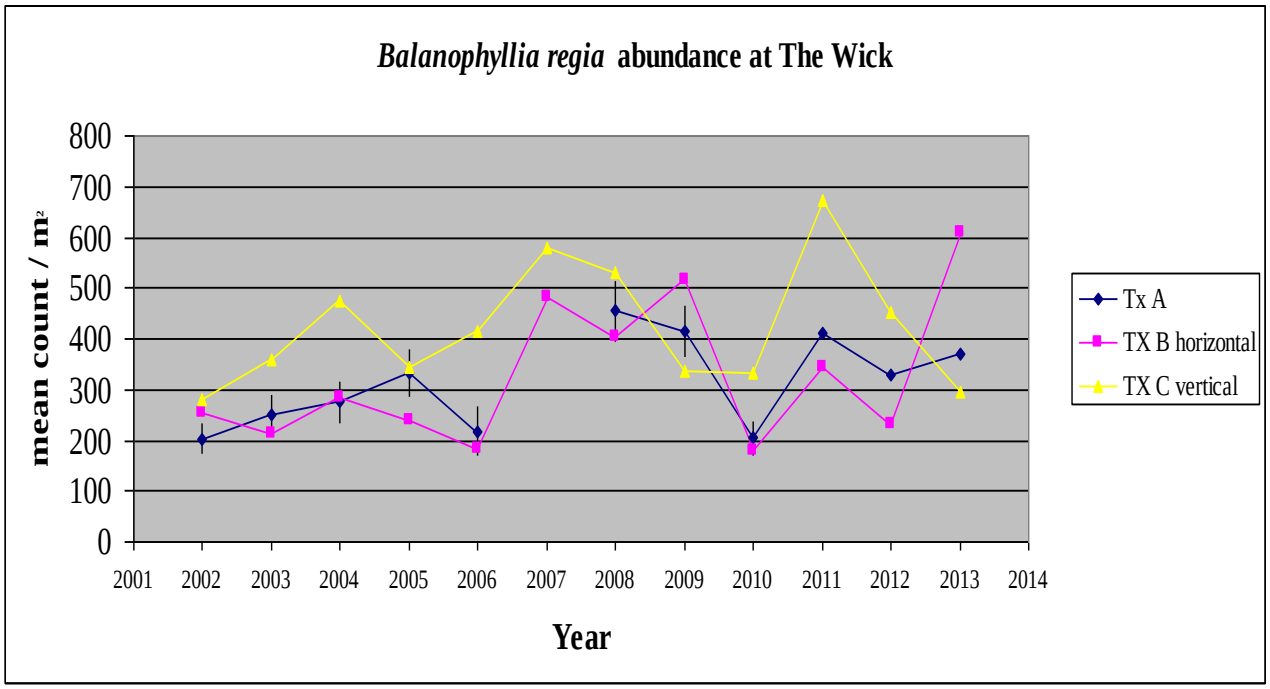


At the Wick all data has been adjusted to $1m^2$ to enable the data from the 50 x 40 cm and the 50 x 70cm framer to be comparable.

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

Site	Year	2002	2003	2004	2005	2006	2007
WCK A	Mean	203	252	275	334	218	
	S.E.	32	39	43	49	50	
WCK B	Mean	253	214	284	239	183	483
	S.E.	38	47	63	55	46	98
WCK C	Mean	280	360	476	344	416	579
	S.E.	52	51	52	65	49	65
Site	**Year**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
WCK A	Mean	455	415	205	412	329	369
	S.E.	62	53	35	59	40	62
WCK B	Mean	402	516	178	344	232	608
	S.E.	76	75	53	79	49	83
WCK C	Mean	530	337	332	674	453	295
	S.E.	73	96	46	93	71	69

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

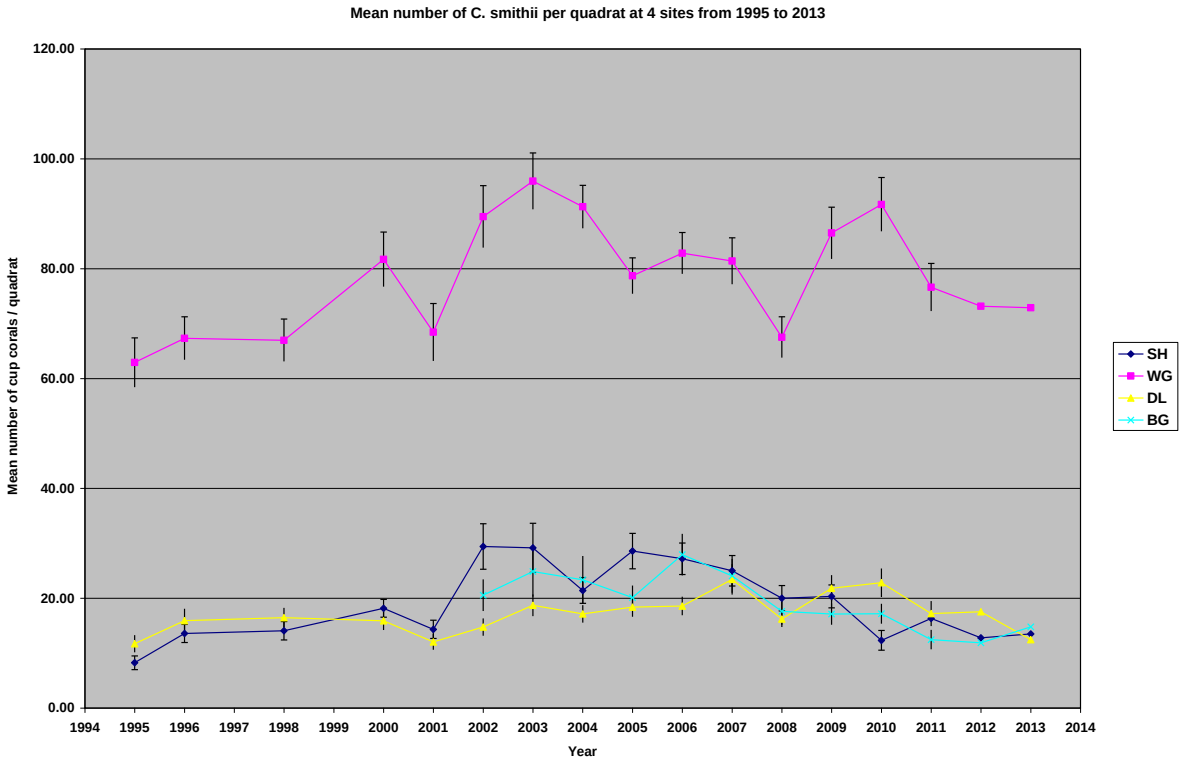


The average number/m^2 of *B. regia* has fluctuated at transects A, B and C. The Variability is caused by dense covering of silt across the site hiding individuals and occasional very poor photographic conditions.

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 area all on horizontal rock.



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.

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

- To monitor the numbers and growth rate of colonies.
- 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)

Methods

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 Middlehom	West Hook	Pool
1993	yes	yes						
1994	yes			yes				
1995	yes		yes	yes				
1996	yes							
1997	yes		yes	yes				
1998	yes		yes	yes				
1999	yes							
2000	yes		yes	yes				
2001	yes							
2002	yes	yes	yes	yes	yes	yes		
2003		yes	yes	yes	yes	yes		
2004		yes	yes	yes	yes	yes	yes	
2005		yes	yes	yes	yes	yes	yes	
2006		yes	yes	yes	yes	yes	yes	
2007		yes	yes	yes	yes	yes	yes	
2008		yes	yes	yes	yes	yes	yes	
2009		yes	yes	yes	yes	yes	yes	
2010		yes	yes	yes	yes	yes	yes	
2011		yes	yes	yes	yes	yes	yes	
2012		yes	yes	yes	yes	yes	yes	
2013		yes	yes	yes	yes	yes	yes	yes

Pentapora foliacea - Growth and community structure
1998 - Gilbert tested various image analysis methods for assessing growth rate, but concluded that a 3D method would be most suitable. Colonies can be put into size classes using base area (cm^2) however this is only an approximate measure of colony size.

2005 - Analysis methods were reviewed. The growth of *P. foliacea* colonies varies dramatically; one colony showed an increase in base area of over $800cm^2$ in one year, whilst other large colonies have all but disappeared. In general colonies that survive tend to grow whilst other colonies of all sizes can just disappear in the space of a year. This suggests that colonies are being physically destroyed or rapidly disintegrate rather than just decrease in size by slow wastage. 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 2012 the revised 2010 morphological classification method (Burton, Lock and Newman 2011) was applied.

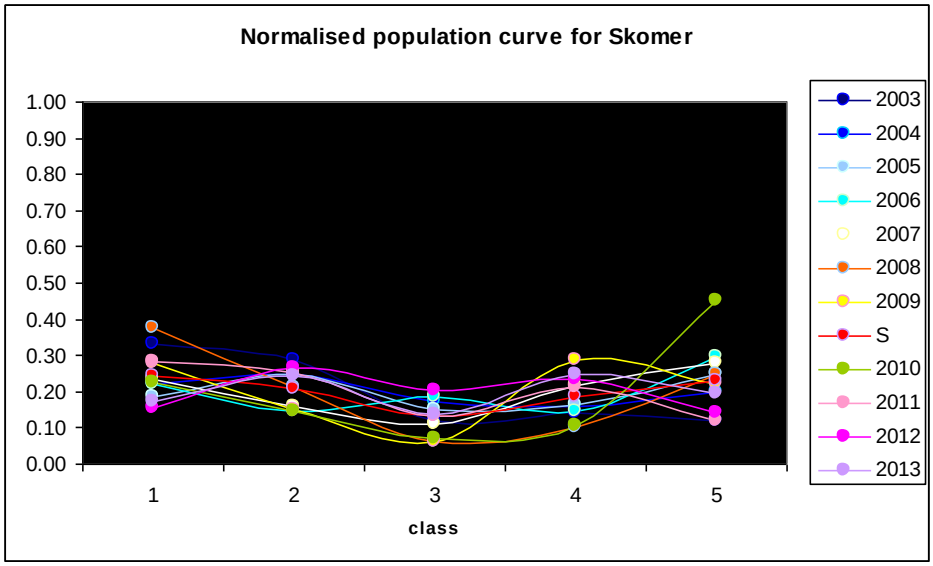
2013 a new site was established at the Pool on the north side of Skomer using a 'pendulum transect' method which proved effective at covering a large search area. The site is a boulder slope and very rich in *P. foliacea* with 250 colonies found.

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.

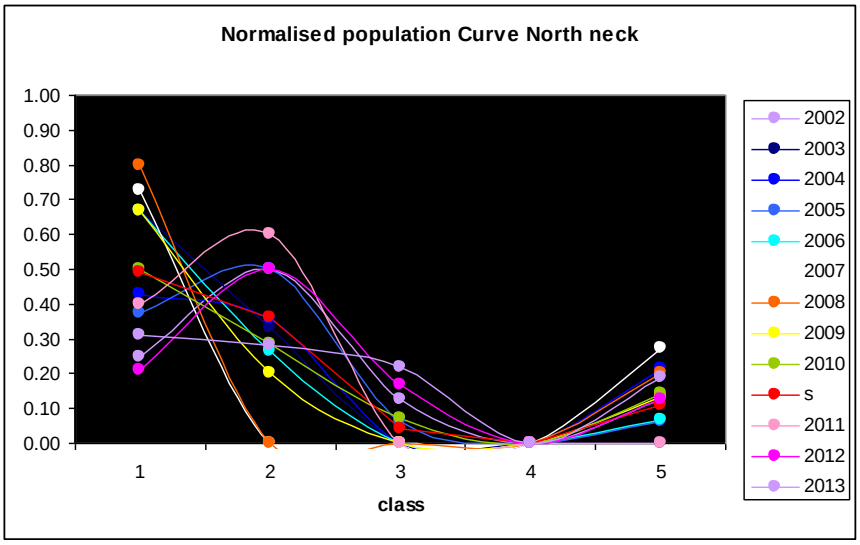

Class 4

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.

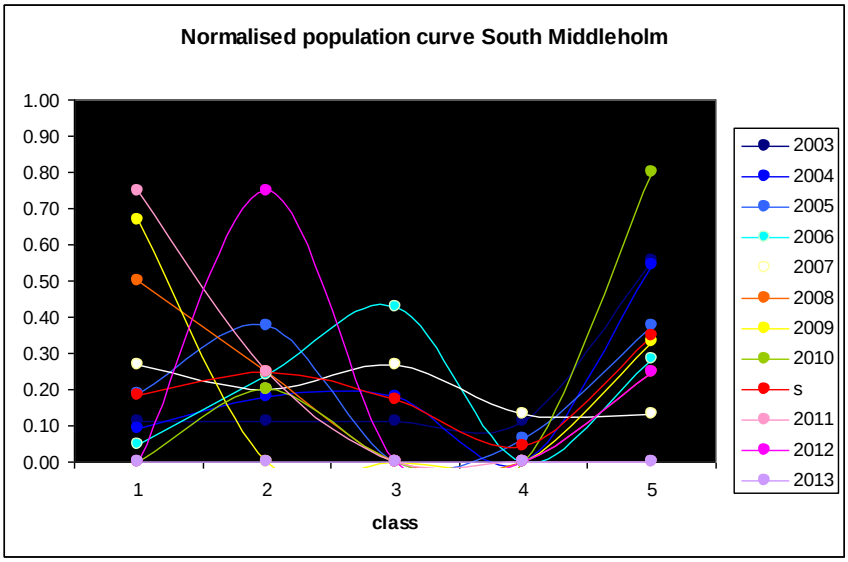
The following graph for all Skomer sites shows a general pattern with some fluctuations between year sets.

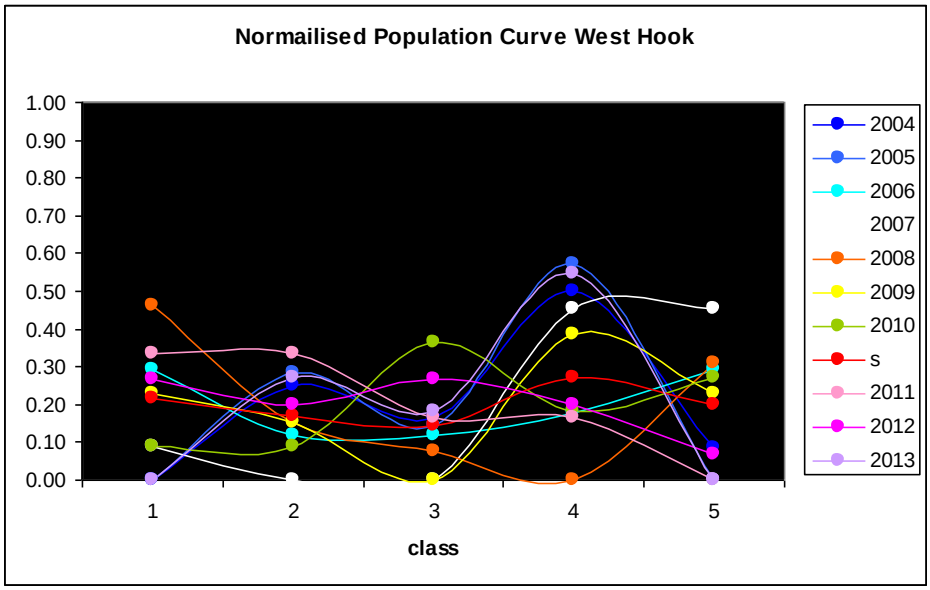


At North Neck class 1 and 2 individuals are the most abundant as at this site the colonies are growing on ground ropes not on bedrock or boulders so the colonies are restricted in their size. Some individuals grow to class 3 but there are no class 4 individuals.

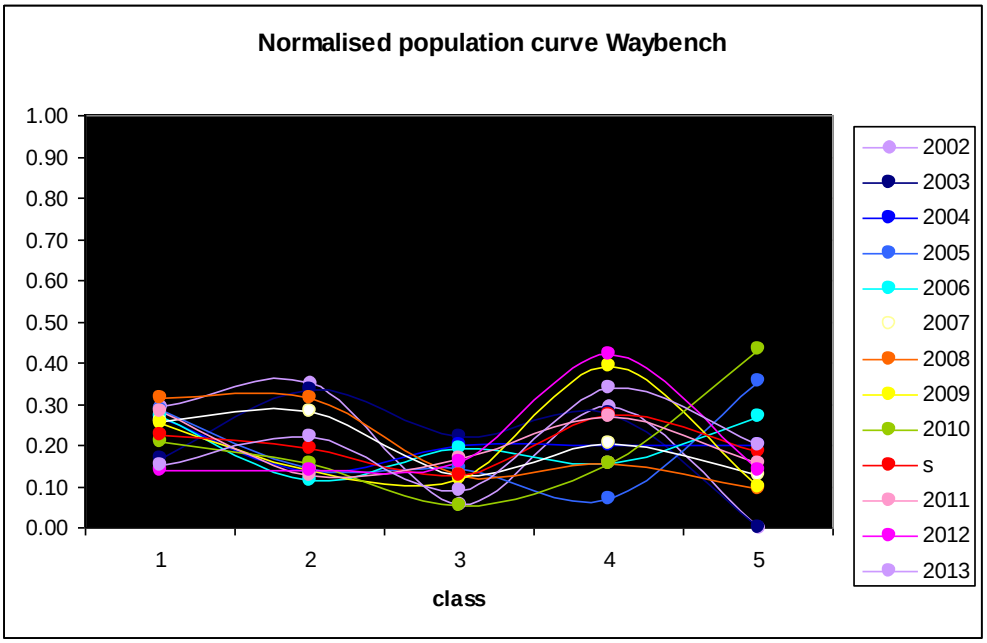


South Middleholm is a bedrock site, class 1, 2 and 3 individuals are the most common, with very few developing into class 4 colonies, instead developing directly to class 5. This site is located on the south side of the island and subjected to the prevailing SW swell.
No colonies were found in 2013 however the survey area at this site is small.
West Hook is a bedrock site located on the North Marloes peninsula, many colonies reach class 4 before developing into class 5.



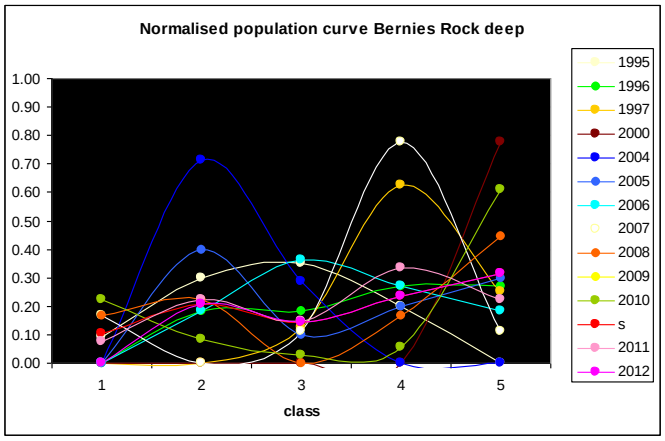


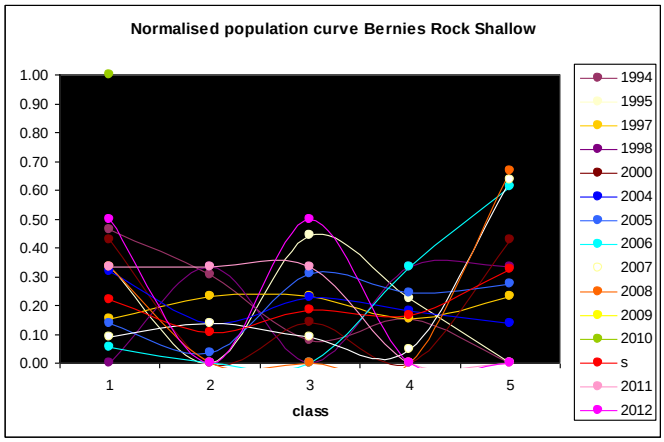
Waybench is a bedrock site with some boulders, located on the north side of the island. A strong pattern between years is observed with a relatively even spread of class 1-4 individuals present. The pattern shows that many colonies reach class 4 before developing into class 5.



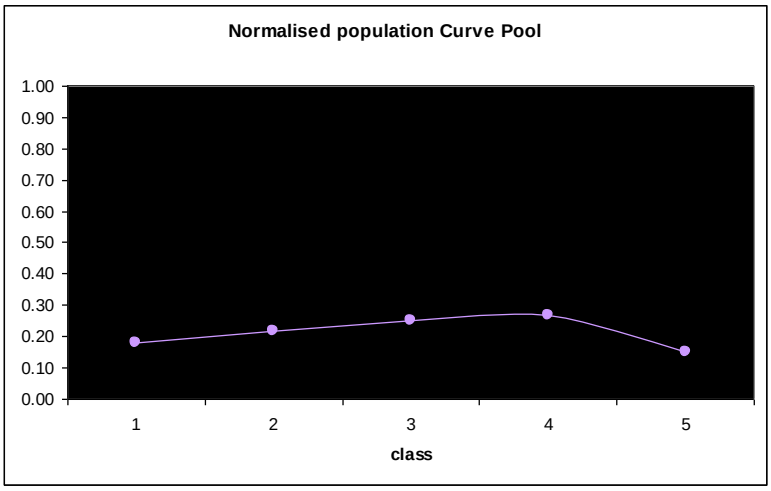
Bernies Rock is located on the north side of the island. The shallow and deep sites both consist of boulder substrate, the pattern of the population curve varies between years and no strong patterns are apparent. Graphs have been produced for each year set to show clearly the patterns present between years at Bernie's rocks shallow and deep sites (Lock *et a*l 2012).

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 although new colonies are not observed every year.
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*.

References

Gilbert 98, Gibbs 2006, Lock et al 2012.

Territorial Fish Populations

(CMS code: RA33/01)

Status Ongoing, sampling every 5 years.

Project Rationale

Fish have received little attention and are poorly described in the survey literature. There is a need to improve knowledge of the diversity and distribution of territorial fish species.

Objectives

To assess the distribution and abundance of territorial fish species and to describe their key habitats;

Nine territorial fish species were selected based on common occurrence in the MNR.

Wrasse species:	Ballan wrasse	*Labrus bergylta*
	Cuckoo wrasse	*Labrus mixtus*
	Goldsinny	*Ctenolabrus rupestris*
	Corkwing wrasse	*Ctenolabrus melops*
	Rock cook	*Centrolabrus exoletus*
Benthic species:	Butterfish	*Pholis gunnellus*
	Tompot blenny	*Parablennius gattorugine*
	Sea Scorpion (short spine and long spine)	*Myoxocephalus scorpius/ Taurulus bubalis*
	Leopard spotted goby	Thorogobius *ephippiatus*

Sites

Sites are selected from a range of locations around the North Marloes peninsula (NMPE) and from around the North side of Skomer Island.

Methods

The methods have been designed for use with volunteer divers and are fully described in Lock 1998.

In 2005 methods were modified to allow improved statistical analysis. The changes allowed some comparison with the 2001 and 2002 surveys. The study sites were marked and GPS positions taken, allowing for replicate transects to be completed and relocation of sites for future surveys. Two depth zones were surveyed 15m and 10m below chart datum. The transect length was increased to 45m (50m tapes used but the first 5m not surveyed to allow for diver disturbance at the start of survey)

A speed of 3m/min was maintained to allow consistency of recording and thorough recording of all fish species. Seasearch methods were used for recording seabed substrate and habitats at all transect locations. The revised methods are fully described in Lock *et al.* 2006, and were followed in 2009 & 2013

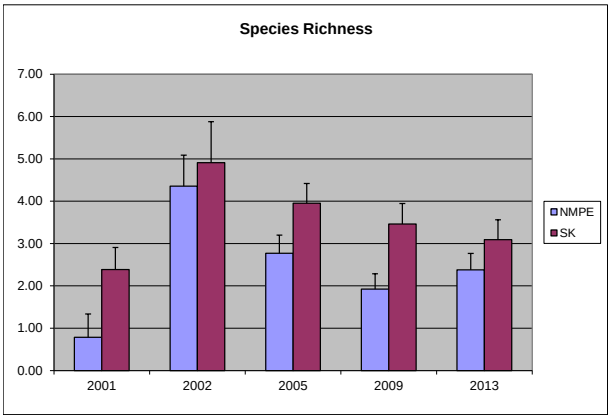
Results

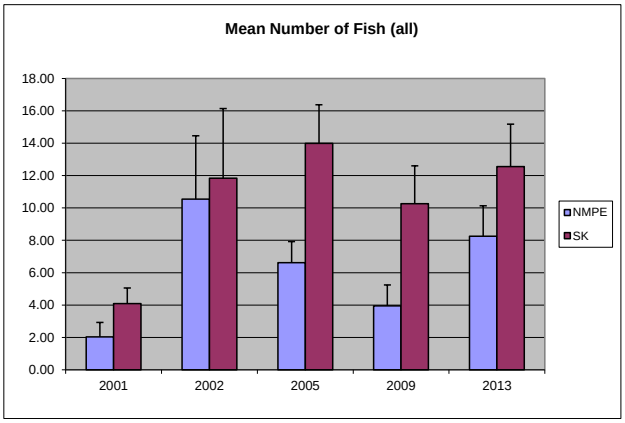
Summary of average fish abundance / 90m^2 from the 4 surveys (2001 – 2013) separated into 2 areas:

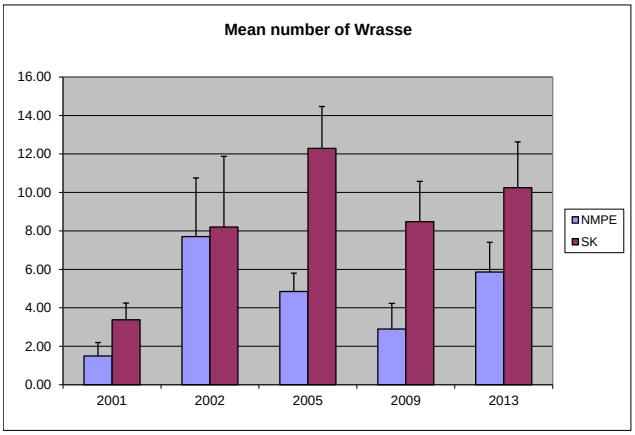
North side of Skomer Island (SK) & North Marloes Peninsula (NMPE)

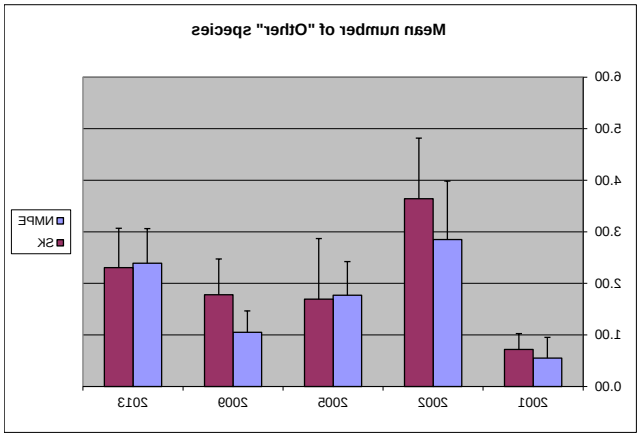
			# species	Wrasse	Other
Year	Area	Mean N	Mean	Mean	Mean
2001	NMPE	2.04	0.79	1.49	0.55
2001	SK	4.09	2.38	3.37	0.72
2002	NMPE	10.55	4.36	7.70	2.85
2002	SK	11.84	4.91	8.20	3.64
2005	NMPE	6.62	2.77	4.85	1.77
2005	SK	13.98	3.95	12.29	1.69
2009	NMPE	3.95	1.92	2.90	1.05
2009	SK	10.26	3.46	8.48	1.78
2013	NMPE	8.25	2.38	5.86	2.39
2013	SK	12.56	3.09	10.25	2.31

The 2001 numbers are very low. This was due to poor visibility during the survey.
The results show a clear trend of less fish (wrasse and other species) found at north Marloes peninsula sites compared with a great number recorded at the north Skomer sites. The numbers of wrasse show a greater difference in abundance between the two areas especially from 2005 onwards. But it should be noted that the variances attributed to these figures are high (see S.E 95% bars on the graphs). The difficulty in any direct method of counting fish is the high variability in the counts.





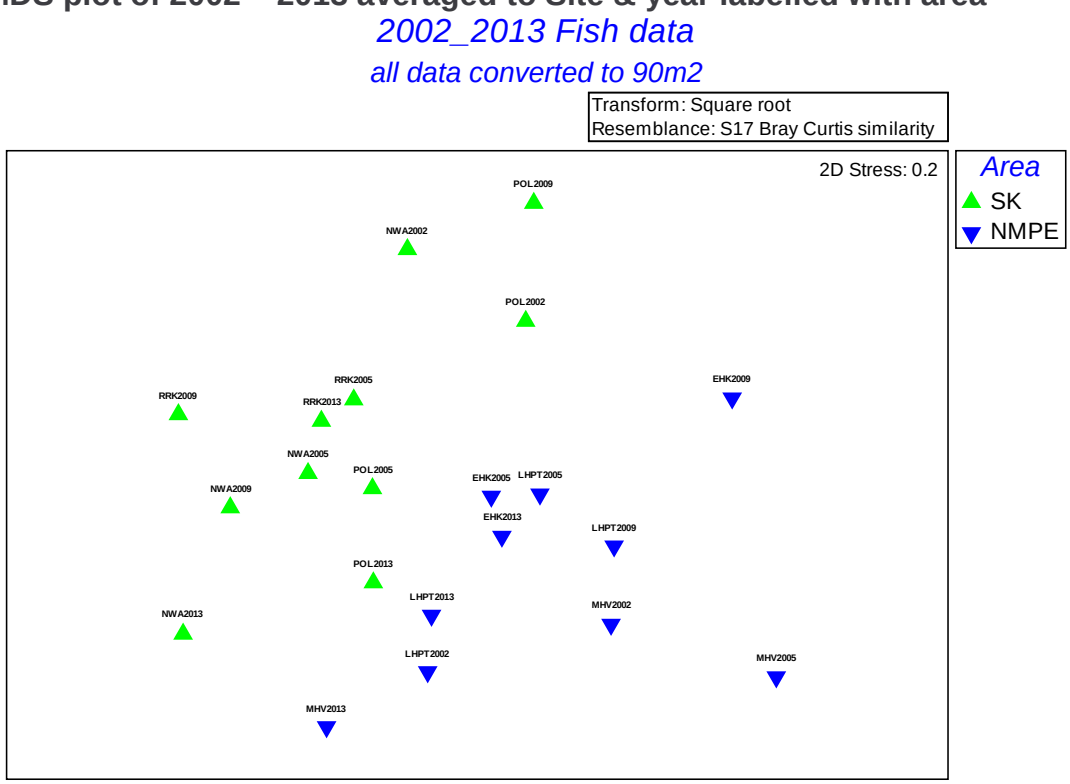




Multivariate statistical analysis

Another way of analysing the data is to look at the whole community structure of the fish assemblage using multivariate techniques. The data was analysed using the PRIMER statistical software to test for differences between the fish communities found at the 2 different areas.

MDS plot of 2002 – 2013 averaged to Site & year labelled with area



A 1-way "ANOSIM" test for area showed a significant difference between the 2 areas**:**
Global Test
Sample statistic (Global R): **0.347**, Significance level of sample statistic: **0.01%**

This shows that the community assemblage of territorial fish is significantly different in the 2 areas.

A "SIMPER" Test then highlights what these differences are:

Groups SK & NMPE
Average dissimilarity **= 25.48**

Species	Group SK Av.Abund	Group NMPE Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cuckoo Wrasse	1.39	0.53	5.00	2.05	19.62	19.62
Goldsinny	1.76	1.26	3.64	1.46	14.30	33.92
Rock Cook	1.01	0.55	3.23	1.18	12.68	46.60
Ballan Wrasse	1.73	1.37	3.22	1.34	12.64	59.24
Corkwing Wrass	0.77	0.63	2.66	1.35	10.45	69.70
Leopard Sp. Goby	1.32	1.15	2.14	1.25	8.38	78.08
Scorpion fish	0.28	0.43	2.01	1.30	7.87	85.95
Tompot Blenny	0.38	0.38	1.81	1.31	7.10	93.05

These results back up the simple analysis of the mean numbers; they show that in all species other than scorpion fish the abundance is higher in the Skomer Area.

The Wrasse species (cuckoo, ballan, rock cook, goldsinny & corkwing) account for 70% of the difference found between the 2 areas.

It is clear that more fish are visible off the Skomer Island coast compared with the mainland coast of the Marloes peninsula. Four separate diver surveys have shown the same pattern of abundance and 2 video surveys (described below) have also come to the same conclusion. Differences between the two areas have been compared:

- Habitat: rocky cliffs and boulder slopes in both areas;
- Depth: the surveys were mainly conducted at 10m & 15m BCD, however the Skomer sites do continue deeper down to 40m whereas the north Marloes sites flattens out to a sediment seabed at 18-20m BCD;
- Current: the current regime is not the same although both areas do get regular current flow across them;
- Diver visits: both areas regularly visited from May to September;
- Commercial fishing: fishing effort in both areas is comparable in effort and gear type (potting).
- Angling: the obvious difference between the two areas is the amount of recreational angling (see table below). The north Marloes coastline is a very popular area for line fishing from the shore and from boats with 89% of observed angling occurring in this area. The main target species is mackerel (*Scomber scombrus*) but it also popular for Spurdog (*Squalus acanthias*). Wrasse species are not specifically targeted except in species competitions, but can be caught as non-target “bye-catch”.
- Recreational angling on the Skomer coast is very rare (1.4% from MNR recreational user records) and it can only be reached by boat.

Summary of observations of recreational anglers (shore and boat) from the Skomer MNR activity records 2001 – 2013 (NMPE & North Skomer are relevant to this study)

YEAR	NMPE	JKS	S Skomer	Nskomer	W skomer	Total
2001	98.7	0.9	0.4	0.0	0.0	453
2002	94.9	3.6	1.5	0.0	0.0	528
2003	89.0	7.8	2.2	0.9	0.0	757
2004	94.8	4.9	0.0	0.0	0.3	755
2005	92.3	4.4	1.3	1.5	0.5	779
2006	90.7	5.9	2.5	0.9	0.0	529
2007	84.5	4.7	6.1	2.2	2.5	554
2008	74.6	10.2	9.4	1.5	4.2	615
2009	88.7	3.2	5.6	0.3	2.2	719
2010	81.6	5.5	12.5	0.5	0.0	786
2011	73.2	0.5	25.0	0.5	0.9	440
2012	86.5	3.6	4.6	3.2	2.1	475
2013	61.5	12.0	17.1	7.5	1.9	416

2013 has seen the lowest levels of total angling in the Reserve. However since 2010 there has been a general increase in angling at sites around Skomer Island.

Other Studies:
Natalie Sweet, in 2007 and Ross Bullimore, in 2010, completed fish drop-down video surveys as undergraduate projects (Plymouth University). Both projects proved the use of drop down video as a surveying method in assessing fish populations.

Current Status
Baseline survey completed in 2001/2002 and survey repeated in 2005, 2009 & 2013.
2 Video surveys completed 2007 & 2010
All of the diver surveys and video surveys have highlighted the same results, more fish are visible around Skomer Island compared to North Marloes Peninsula. Wrasse species account for most of the increased number of visible fish around Skomer.

Recommendations
- Continue with the volunteer survey methodology as established in 1997 with modifications made in 2005 to produce a time series of comparable data;
- Surveys to be repeated every four years, next survey 2017;
- Support research projects studying fish populations in the Reserve;
- Continue recording recreational angler numbers and angling locations in the Reserve.

References
Lock 1998. Lock *et al.* 2006. Sweet 2008, Bullimore, R. 2010.

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 MNR. 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 MNR.

Sites

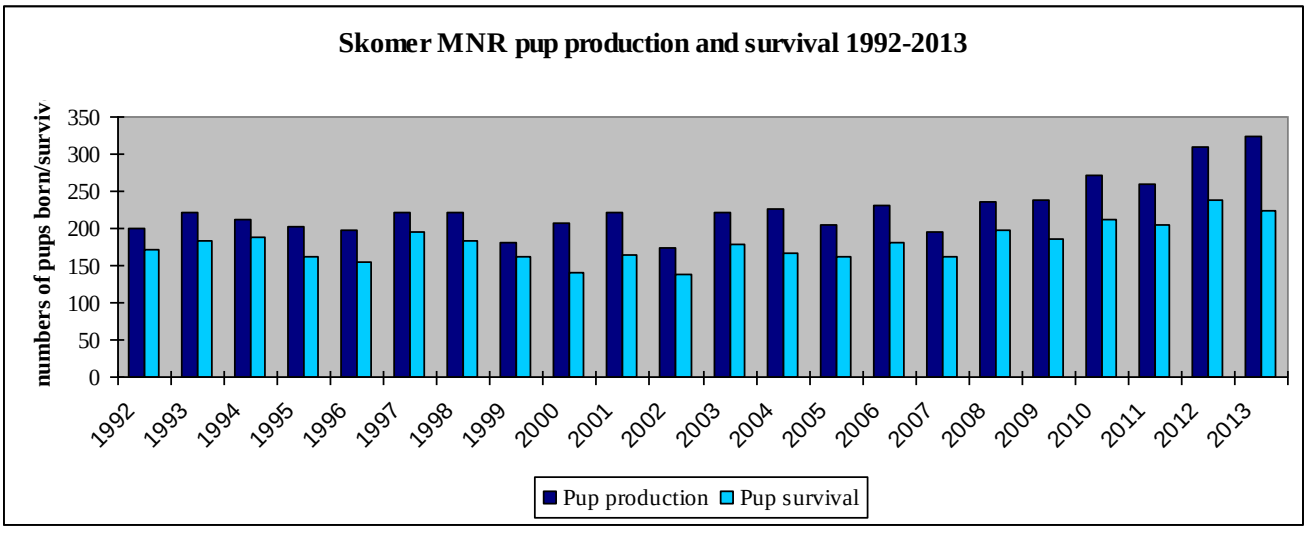
All pupping beaches and caves in the MNR.

Methods

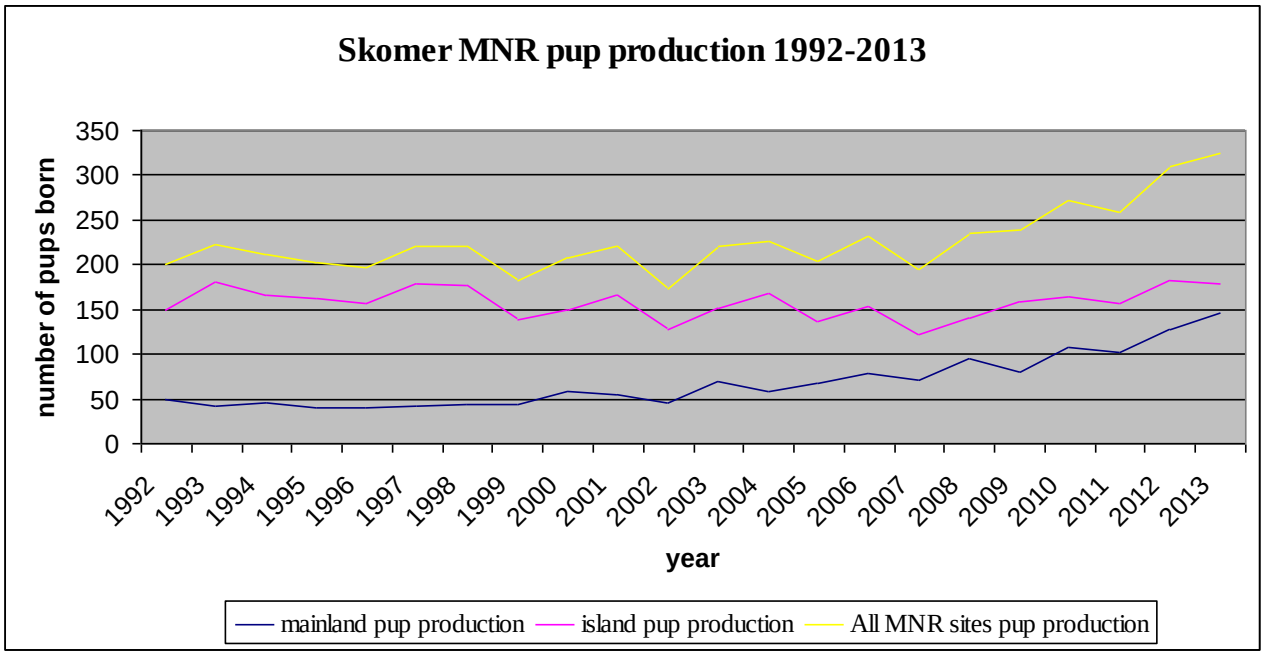
The pups are recorded from birth through to their first moult using the "Smith 5-fold classification system" (Poole 1996). Reason for death is recorded if possible. Additional behavioural observations are recorded for the Island seals (Full method described in 'Grey Seal Monitoring Handbook' Poole 1996).

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.

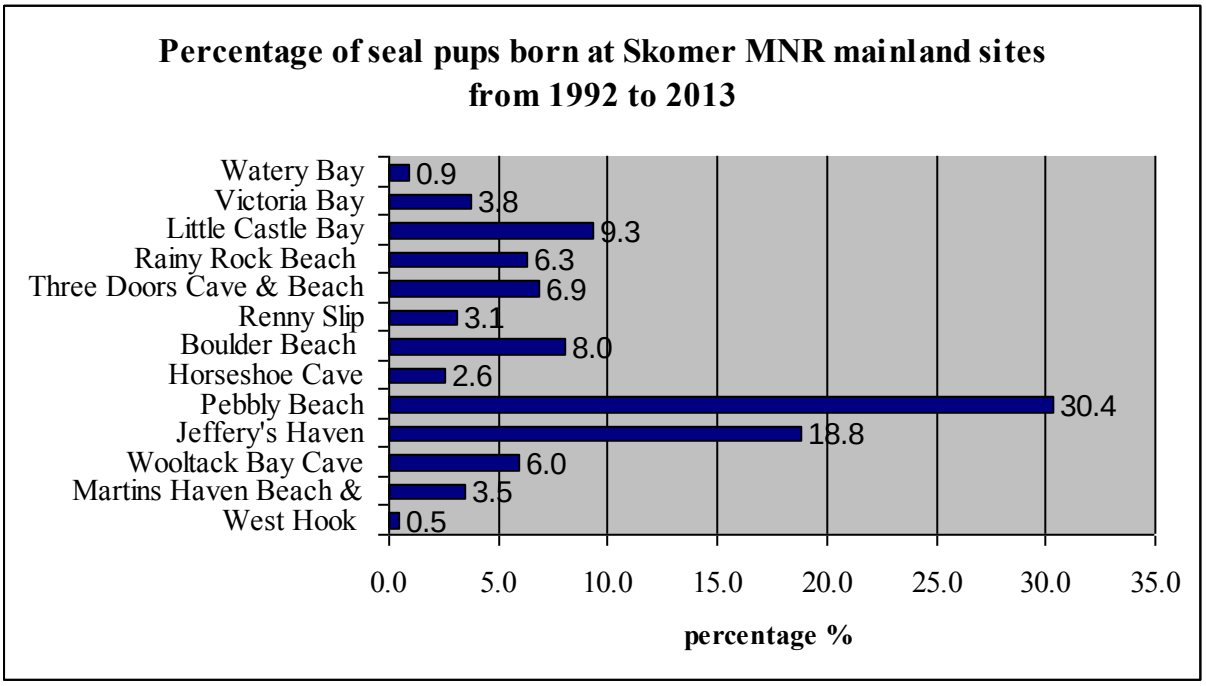


In 2013 179 pups were born at island sites and 145 pups at mainland sites giving a total 324 pups born in the MNR with a recorded combined survival of 69% through to moult. Pup production was above the annual target (190 births) however survival was just below the annual target (70%) set for the MNR. Survival for mainland sites was recorded as 76% however for island sites it was lower at only 64%.



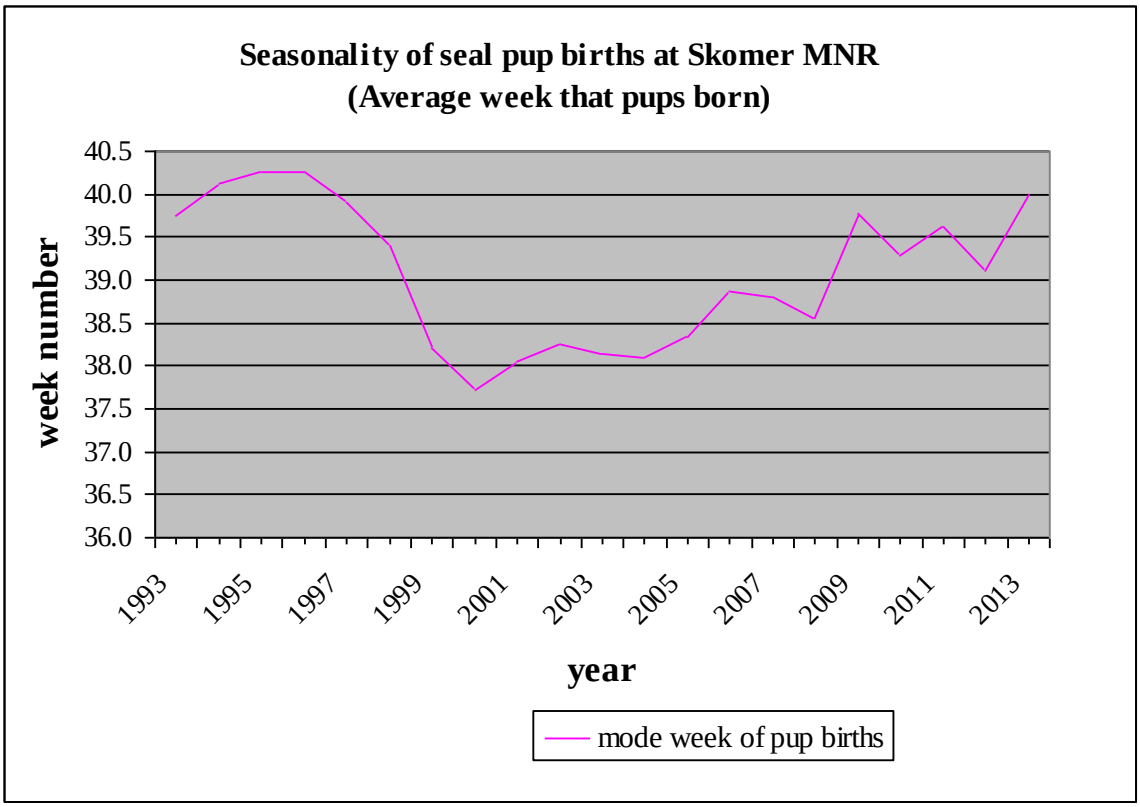
Production in 2012 (310 pups) and 2013 (324 pups) are the highest totals ever recorded. The number of seal pups born each year fluctuates but looking at the trend lines the number of pups born at island sites has remained fairly consistent for the last 22 years with an average of 157 pups. However significant increases in pup production at mainland sites have contributed to the overall increase in numbers for the whole MNR. Between 1992 and 2002 an average of 50 pups was born at the mainland sites, in contrast the average between 2003 and 2013 is 91 pups.

The following graph shows the percentage of pups born at the mainland sites from 1992 to 2013. 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 49.2% of mainland pup production.



In 2013 pup production was 41% in September, 43% in October, 11% in November, 5% in August and modal week of production was week 40 (1-7th October). The trend over the last

22 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 2009. Since 2010 the pattern has shown that modal production has moved back to week 40.



Additional Seal Studies

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

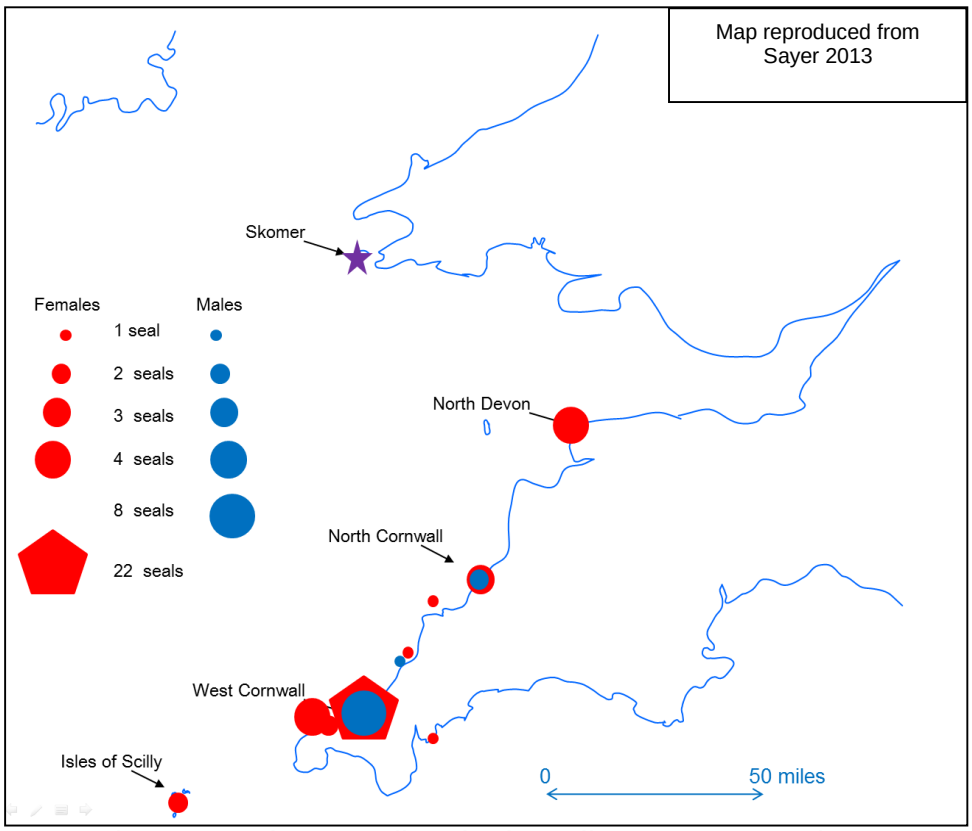
2005 Photo methods were also introduced to the adult seal identification project on Skomer (Matthews 2006). A Pembrokeshire college student, Liz Coutts, completed a study on the behaviour of bull seals at two island sites (Coutts 2006).

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 - 2013 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 and to clarify this, a map was generated to show all the site links these seals have created to Skomer (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 43 matches of seals have been identified for Cornwall and Skomer MNR (Sayer pers. comm.). There were 3 further matches of Skomer seals with animals at Ramsey Island.

Pollution

Monofilament line and netting continue to be the main obvious pollution affecting seals. In 2013 12 seals were seen 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 12 seals were previously unknown from the photo catalogues. The problem with netting entanglement is a growing concern especially as these are all new cases in addition to the 25 entangled seals identified in 2012 (of which 16 were returning individuals).

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

2013 pup numbers reached 324, 98 pups higher than the average for the last 22 years. Pup survival was 69%, 10% below the average. The majority of deaths were caused by abandonment or separation and by periods of harsh weather. There were no signs of disease. Pup production was 41% in September and 43% in October, 11% in November and 5% in August. The modal week of production was week 40 (1-7th October).

2013 is the sixth year an attempt has been made to photograph all the pupping cows on Skomer and the results are showing that does not have an isolated seal population. 2012 only 69 of the identified 147 cows (47%) (Boyle 2012) and in 2013 with less cows successfully photographed only 21 of the identified 59 cows (36%) are known to have pupped on the island in previous years (Buche 2013).

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.

References

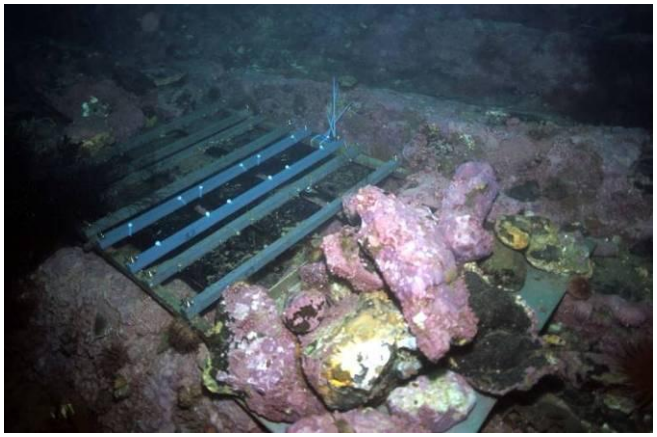
Skomer Seal Census Reports: Davis & Davis 1976; Alexander & Alexander 1985; Hellawell, 1987, 1988; Sutcliffe, 1989; Orsman 1990, 1991; Poole, 1992 - 1999; Field 2000; Pillsworth 2001, Boyle 2002, Duffield 2003, Matthews 2004 –2007, Matthews & Boyle 2008, Boyle 2009 – 2012. Buche & Stubbings 2013.
Grey Seal Monitoring Handbook, Poole 1996.
Bull Seal studies on Skomer: Coutts 2006 and Matthews & Boyle 2008.
Marloes Peninsula pup production data: Anderson 1977; Cullen 1978; MNR records 1992-2013. Marloes Peninsula seal pup production summary 1992-2013, Lock 2014.
Seal disturbance studies, Lock 2004.
Skomer/Corwall seal photo identification project report 2007 – 2013, Sayer 2013.

Species Recording
(CMS code: RB06/01)

Status
Ongoing, annual recording.

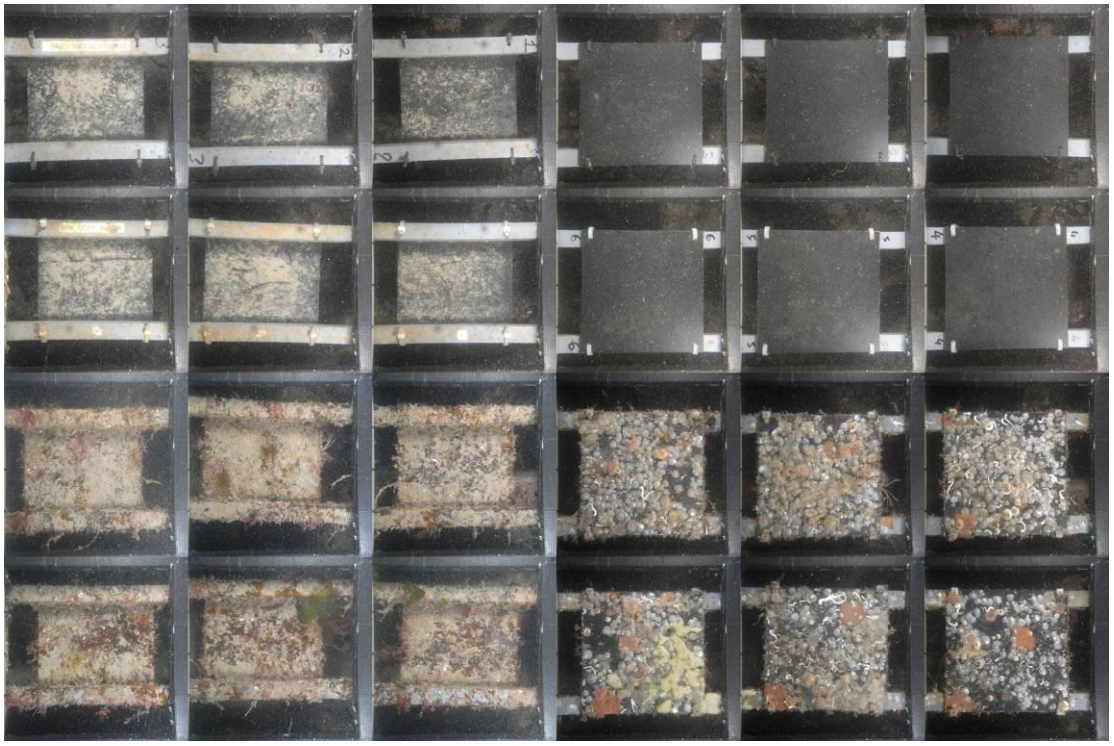
Project Rationale
There are many species in the Marine Nature Reserve that do not have a dedicated monitoring project. It is important that species lists are maintained, particularly for phyla that are under-recorded. Records of unusual, rare, scarce or vagrant species are also maintained.

Settlement Plates



In 2009 the Skomer MNR 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 has 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 planels. 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 fuana groups in each month. Large month to month fluctations was noted in species richness. Marta Ronowicz is currently preparing a scientific paper on this work

Crawfish

Crawfish *Palinurus elephas* became a national Biodiversity Action Plan species in 2008. From 2009 to 2013 it was recorded in low numbers in the Reserve by MNR 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.

Plankton Recording
(CMS Code RB04/01)

Status
Ongoing, annual survey

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

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

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

Method
Zooplankton:
2008 &2009: A plankton sample is collected once a week using a 63um mesh plankton net trawled at less than 2 knots between the OMS and Lucy site markers. Samples are preserved in 2% formalin and seawater.

2010 onwards: A review of the results and objectives called for a change in methods. It was proposed that the sampling from Skomer matches that from other plankton time series projects to make the results comparable. The Plymouth Marine Laboratory (PML) has a plankton sample time series (L4), which would act as a good comparison site. The methods used at L4 will be replicated at Skomer and analysis completed by PML.
A 200um mesh net is pulled on a vertical haul from 35- 40m depth at 0.2m / sec (3.5 minute haul). The sample is collected in the 'cod-end' bottle and this is preserved in 4% formalin. Two samples are taken at each sampling event.

Phytoplankton and chlorophyll:
2011- 2012: A water sample was taken and preserved in Lugols solution to provide a record of the phytoplankton species present. This can be used to identify species responsible for "blooms". A second water sample was also taken at 1m below the surface. This was then used to filter 3 times 250ml samples over a 0.2um filter to estimate chlorophyll content. The chlorophyll samples are analysed by PML. The Phytoplankton samples in Lugols solution are stored as a record of any plankton bloom.

Results

The 2008 samples were used for an undergraduate project at Aberystwyth University. A report was produced which detailed the species found. The student was not an expert in planktonic identification so it cannot be considered a comprehensive list.

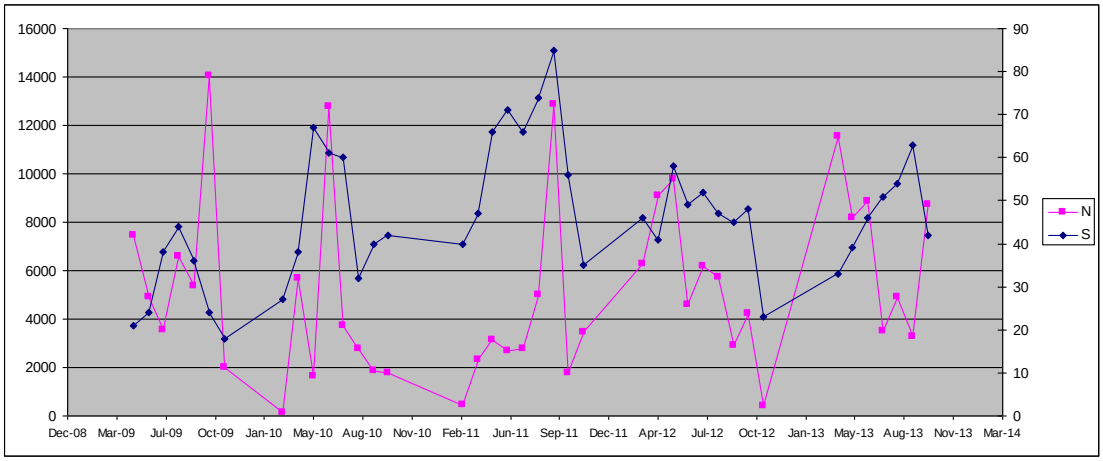
In 2009 12 samples were sent to SAHFOS for identification and enumeration by Dr D. Conway. The sample dates were from the 10th May 2009 to the 9th Nov 2009. All zooplankton individuals were identified to species if possible and counted. Phytoplankton individuals were identified to species level but their abundance was recorded semi quantitatively.

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

2013 samples were sent to Dr D. Conway of SAHFOS (Plymouth Marine Biological Association).

Zooplankton:

Average Species richness (S) and total number of individuals (N) 2009- 2013



Year	S	N
2009	53	6274.071
2010	90	3804.541
2011	112	3827.228
2012	93	5459.052
2013	95	6998.129

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

2011 has the highest number of recorded species but one of the lowest abundances.
The higher number of individuals in 2009 and 2013 will be due to different nets being used; in 2009 a 63um mesh was used & in 2013 the mesh on the collecting bottle was changed from 400um to 200um.

A poster was published by Plymouth Marine Laboratory looking at the methods and results from 2010 and 2011. Cost-effective method for establishing an ecological baseline of the zooplankton at Skomer Marine Nature Reserve by Andrea McEvoy, Mark Burton, Paul Somerfield and Angus Atkinson.

PML | Plymouth Marine Laboratory

Listen to the ocean

Cost-effective method for establishing an ecological baseline of the zooplankton at Skomer Marine Nature Reserve

Andrea McEvoy, Mark Burton, Paul Somerfield and Angus Atkinson

Eunicella verrucosa – pink sea fan. Nationally rare and delicate species monitored at Skomer

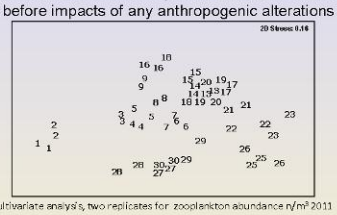
Skomer is a small island located approximately one mile off the south west of Pembrokeshire in Wales. The area was designated a Marine Nature Reserve (MNR) in 1990 and is managed by Natural Resources Wales.

The reserve is nationally important due to its rich marine life and diversity of habitats. Many species are at the edge of their geographical range with an overlap between warmer southern waters and the cooler nutrient rich waters of the northern Irish Sea.

Necora puber – velvet swimming crab. *Coynactis viridis* – jewel anemone. High diversity exists in close proximity

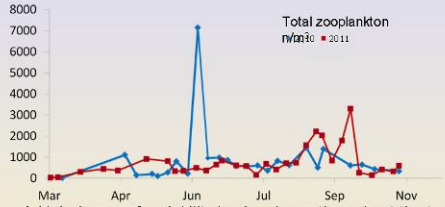
Plankton samples have been collected at Skomer since 2010

The Marine Strategy Framework Directive (MSFD) requires EU member states to assess their coastal waters and achieve "Good Environmental Status" (GES) by 2020. A cost effective monitoring programme needs to be established in order to fulfil this criteria. Plankton forms the basis of marine food webs so is an essential component within the marine ecosystem. Therefore a baseline must be determined in order to quantify the natural variability before impacts of any anthropogenic alterations can be considered.

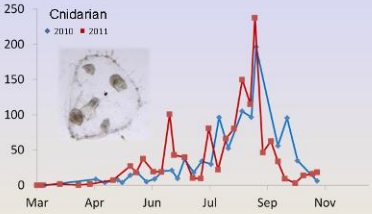


Multivariate analysis, two replicates for zooplankton abundance n/m³ 2011

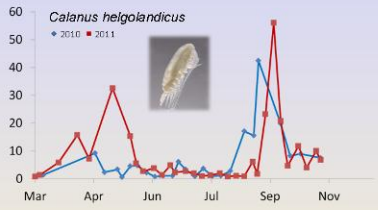
Multivariate analysis reveals that replicate net hauls were consistently similar. The analysis of one haul per time point would improve the cost effectiveness of monitoring this MNR.



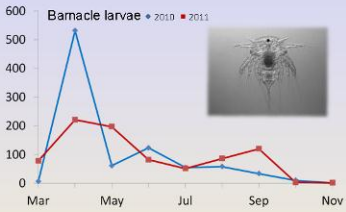
A high degree of variability in abundance throughout the two years means that long-term monitoring is necessary to gain a better understanding of natural and seasonal variability.



Cnidarians are gelatinous planktonic consumers of other zooplankton and can have a negative impact on fish recruitment through competition and predation. In high numbers they make bathing waters unusable so may have profound ecological and socio-economic consequences.

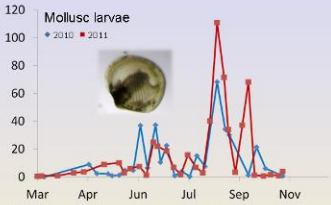


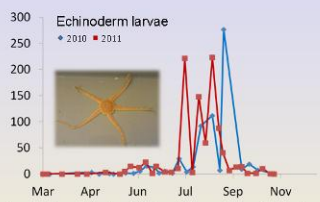
This energy-rich copepod is an important link between primary production and higher trophic levels. It is a major food source for commercially important fish. The distribution range and abundance of *C. helgolandicus* have increased as surface sea temperature has warmed making it a useful indicator of climate change.



There was a notable spike in barnacle larvae in April 2010 which coincided with a large spatfall of *Semibalanus balanoides* on the shore. This species tends to be intolerant of warmer conditions. A temperature above 10°C can lead to reproductive failure.

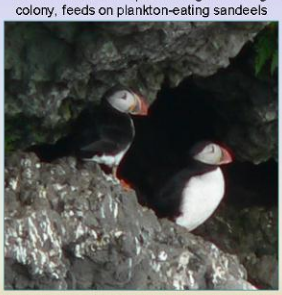
Zostera marina – eelgrass. Provides a highly productive habitat, particularly for sandeels





Some species reach peak abundances for relatively short periods of time demonstrating strong seasonal signals. In order to resolve this variability weekly sampling is preferable to monthly.

Fratercula arctica - puffin. Large breeding colony, feeds on plankton-eating sandeels



Skomer Marine Reserve offers a high diversity of marine habitats which support nationally rare and endangered species. Plankton provides a key role in this oceanic food web. Cost-effective monitoring of the plankton at Skomer will broaden knowledge and lead to a better understanding of the impacts of human activity.

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Cyfoeth Naturiol Cymru Natural Resources Wales Mark.Burton@cyfoethnaturiolcymru.gov.uk

Current Status
Basic data collected in 2009, new methods commenced in 2010 and continued. In 2011 Chlorophyll samples commenced.

Recommendations
- Establish a time series of seasonal data for phytoplankton and zooplankton.
- Compare data sets to Plymouth Marine Laboratory L4 site.
- Publish a descriptive paper with Plymouth Marine Laboratory.

References
Andrea McEvoy, Mark Burton, Paul Somerfield and Angus Atkinson (2013).

4 Skomer MNR 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 MNR 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 MNR 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 MNR office using “Loggernet” software. The data is saved in three files: daily, hourly and 10 minute intervals.

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

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

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

2012 - Weather station serviced by Cambell scientific Sep 2012

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

Results

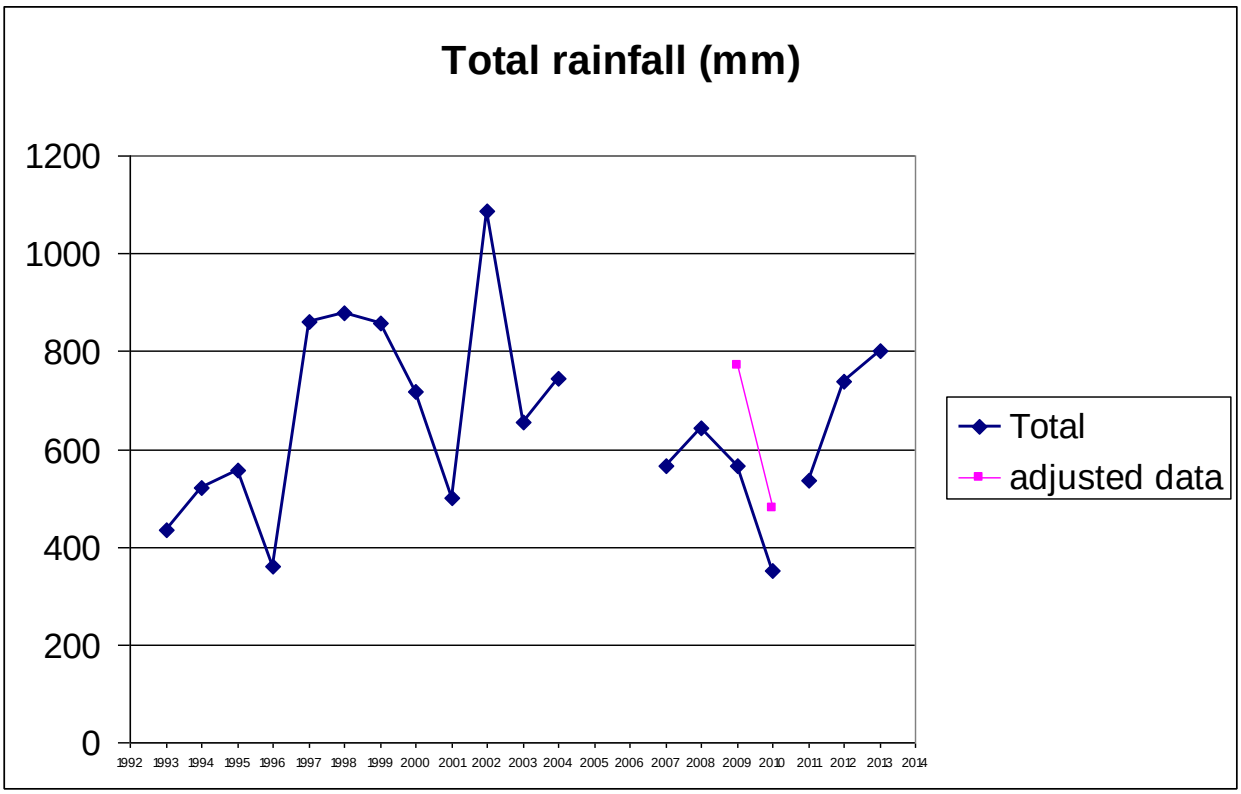
A continuous data set has been maintained since May 1993. However there are some gaps due to equipment failure, these are: March 1994, January 1998 and from November 2005 to April 2006.

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.

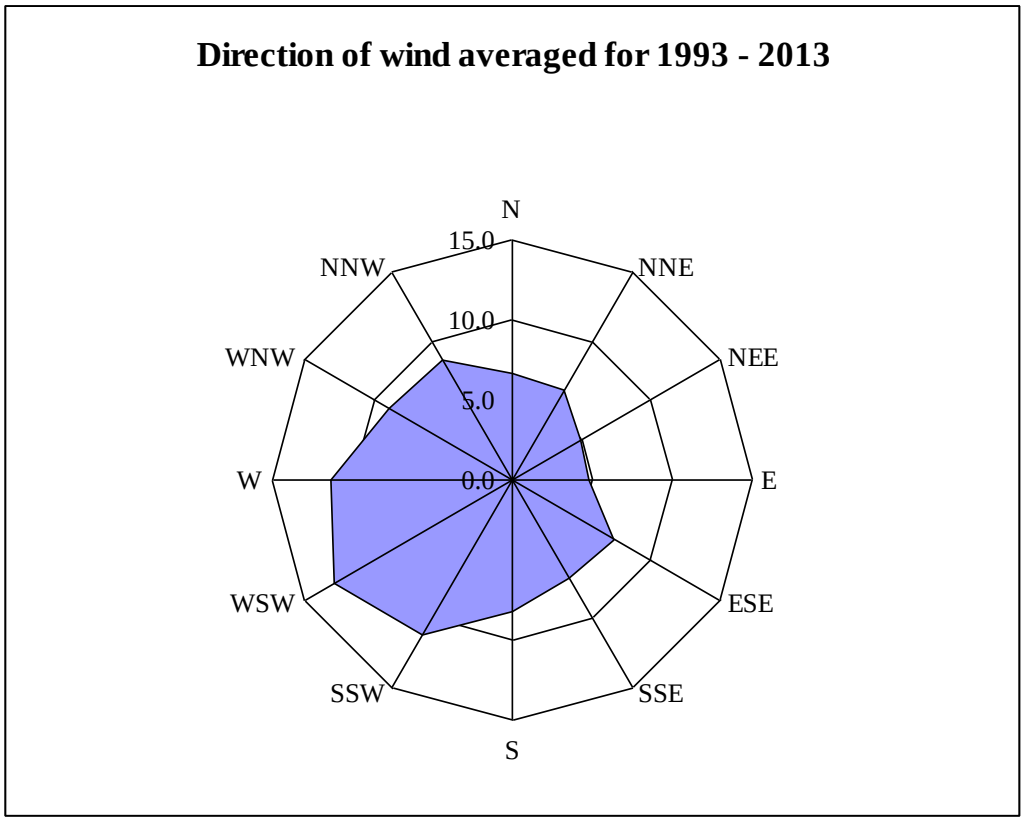
Rainfall

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

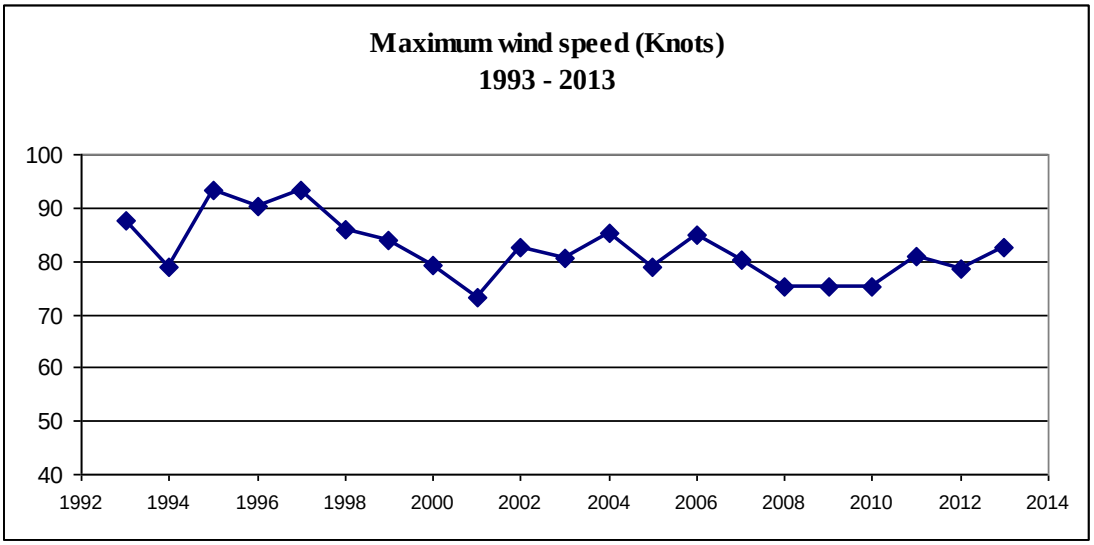


Wind speed and direction

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

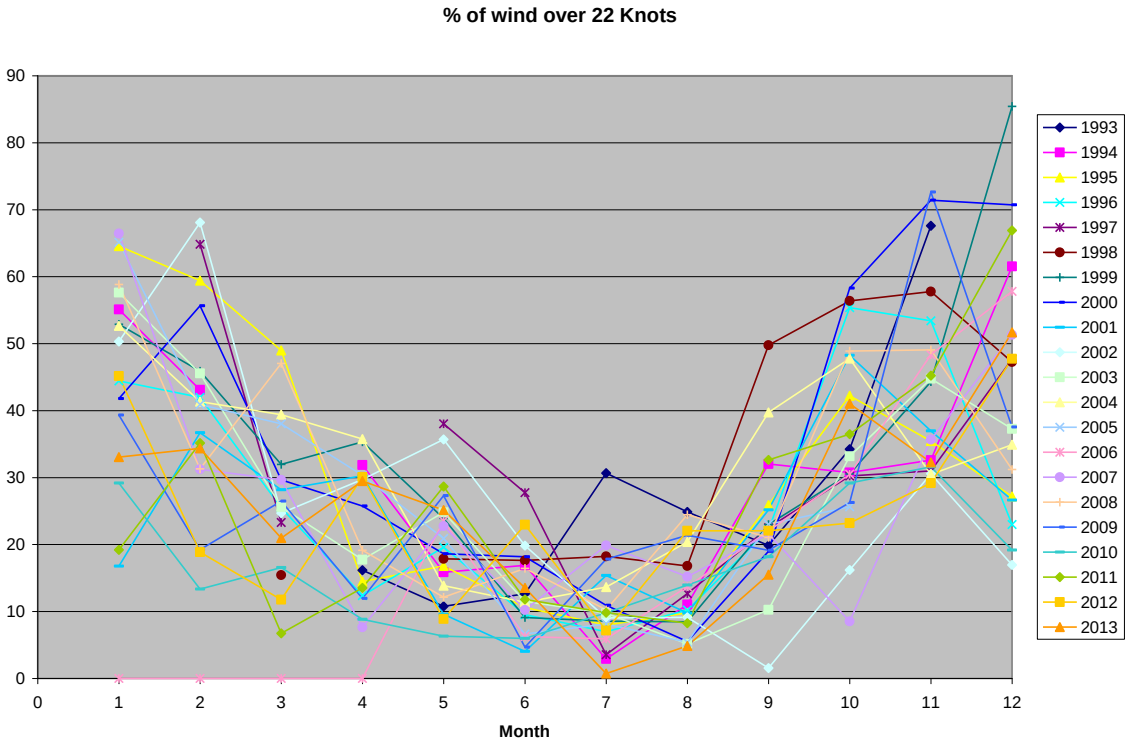


Maximum recorded 3 second gust

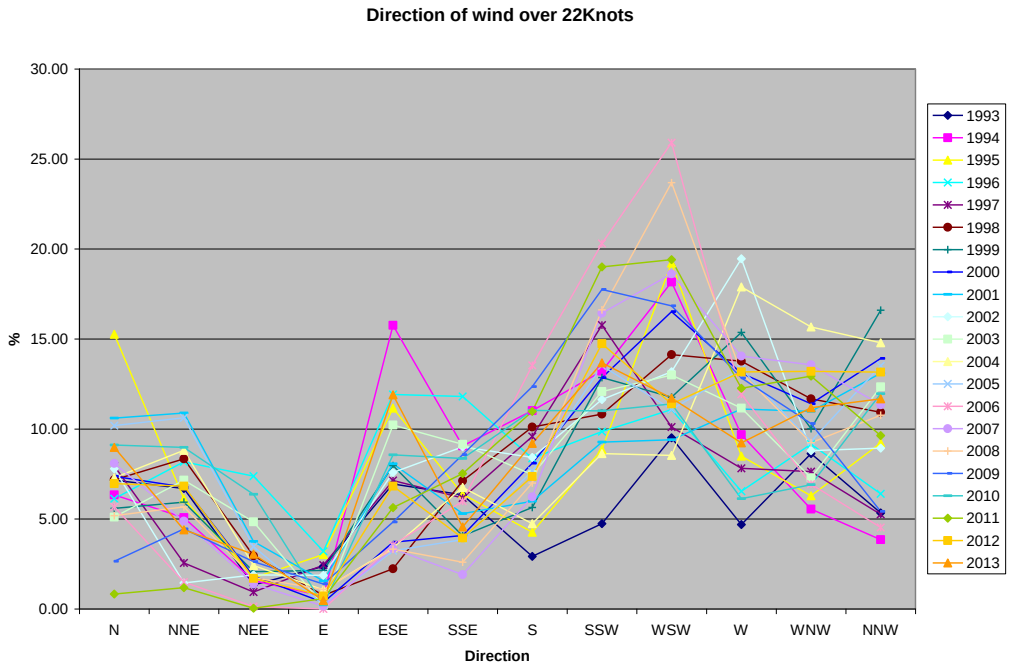


The maximum gust recorded for 2008, 2009 & 2010 was exactly the same (75.28 knots). It is possible the bearings were faulty. The bearings were replaced in 2011 and higher gusts are now being recorded.

The strength of the wind can be summarised in a lot of different ways. The data is very complex and can de 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.

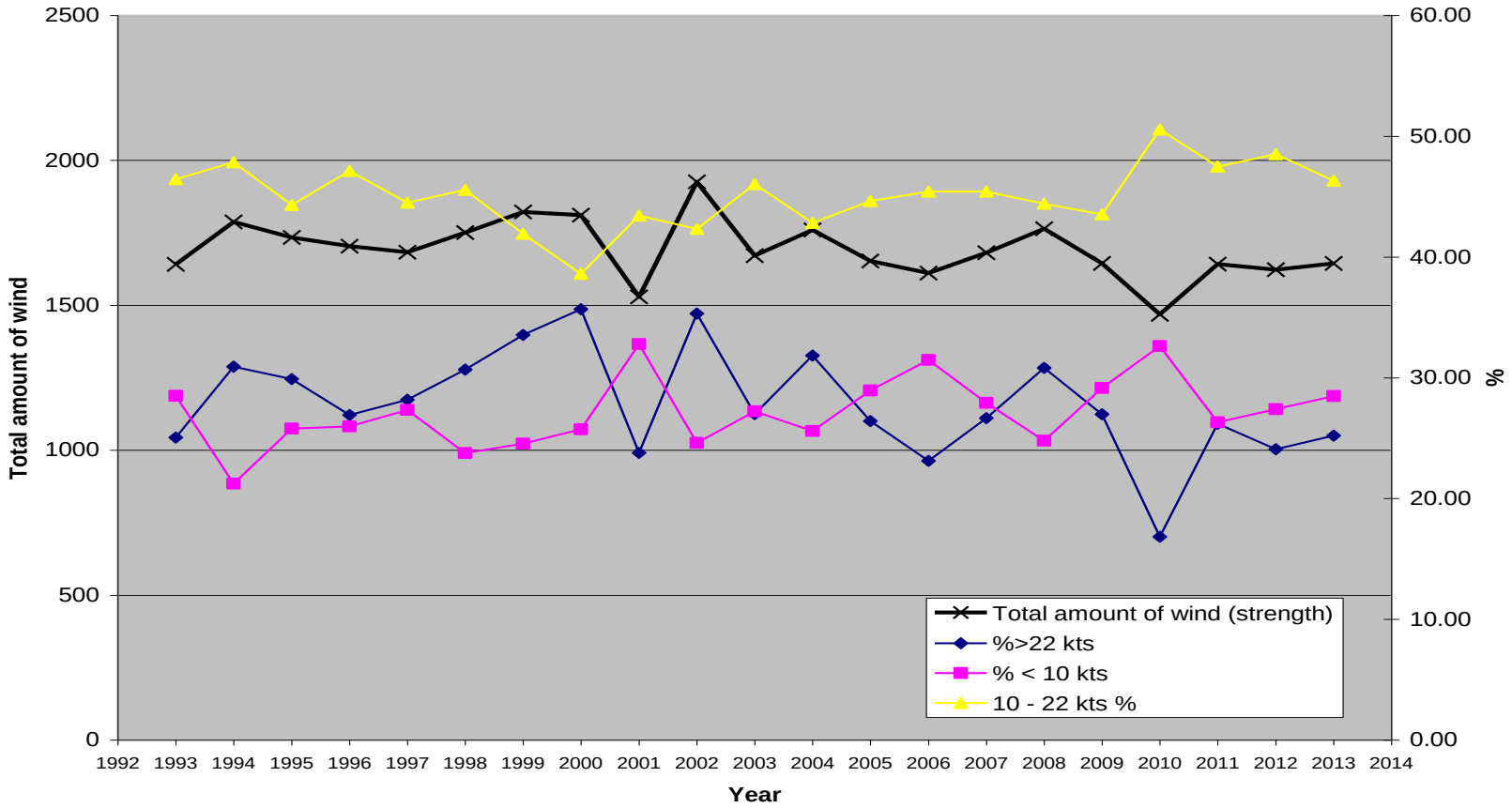


The winter months tend to have the high % of strong winds (Dec 1999 – 85% > 22Kts) but it is very variable from year to year. The direction of these stronger winds is summarised below.



A lot 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 - 2013

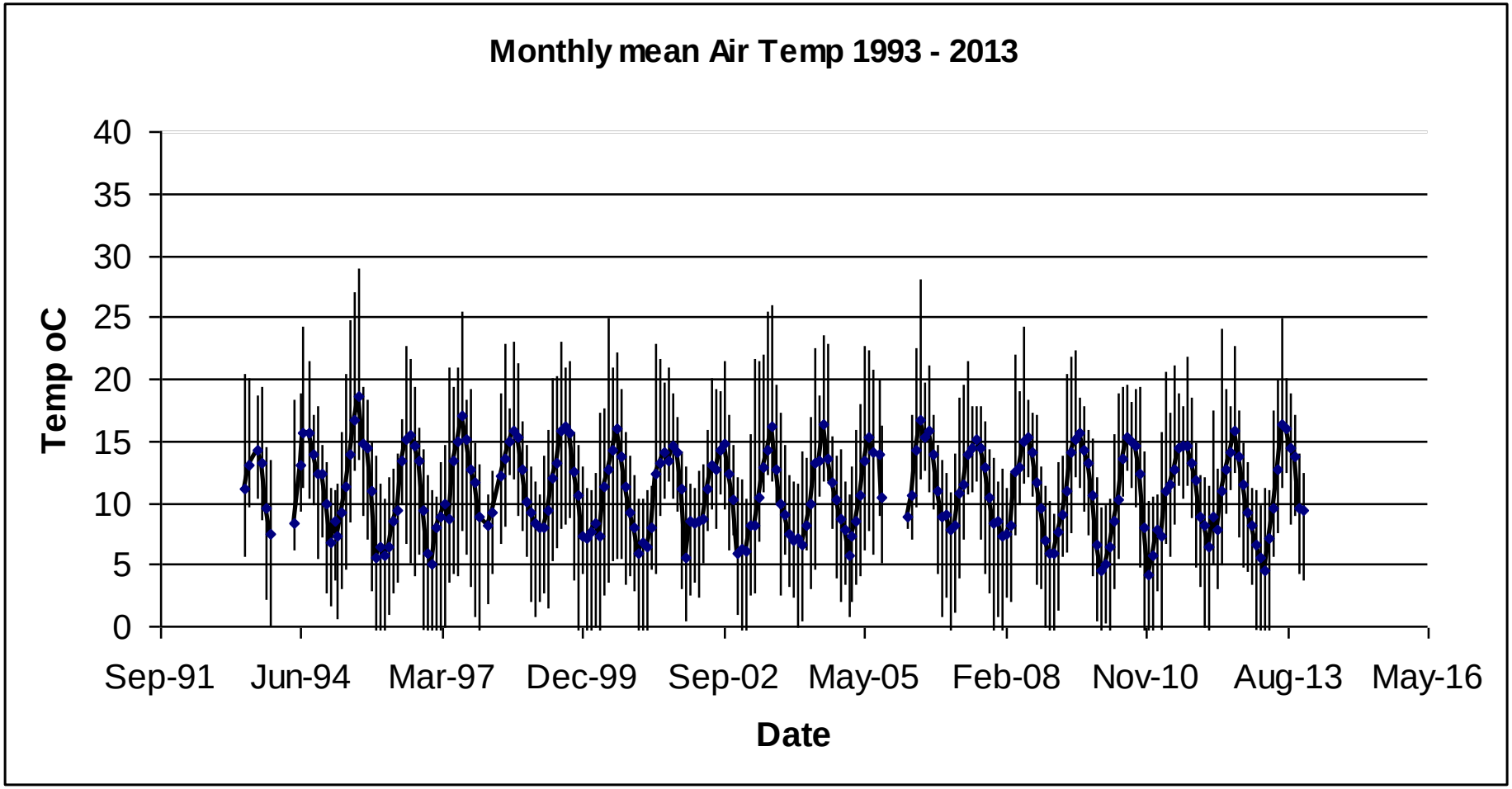


Total amount of wind is calculated from the % of wind recorded in each Beaufort force multiplied by the mid wind strength (knots) for that wind force. The windier the year the higher the “Total amount of wind”.
The amount of wind recorded over 22Kts, less than 10Kts and between 10 – 22 Kts is then shown 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

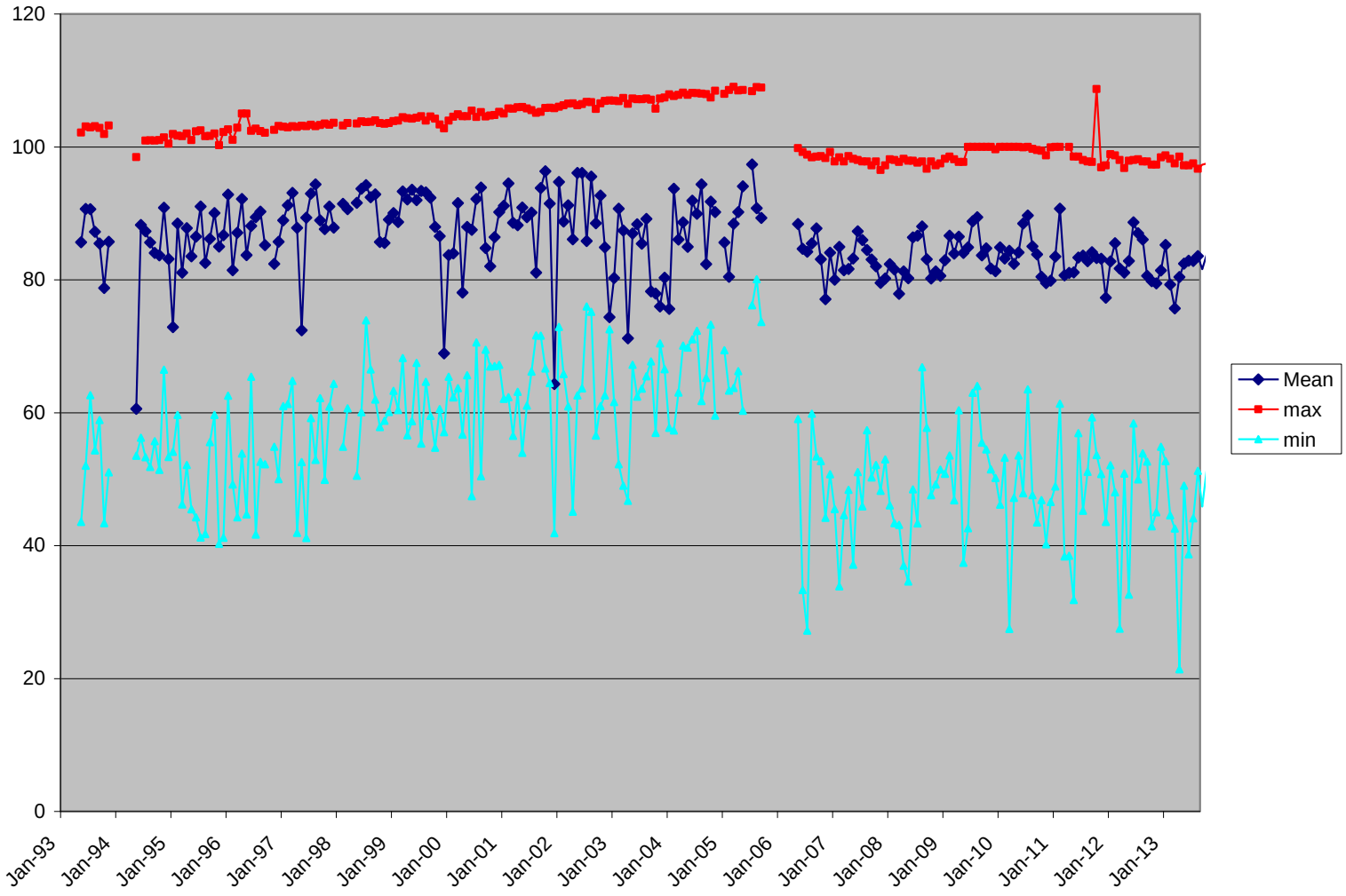
2013 annual meteorological summary

Countryside Council for Wales Skomer Marine Nature Reserve					YEAR	SUMMARY		2013					
Weather station - Coatguard lookout hut, Wooltack point													
Grid ref: SM75880922													
Geographical position: 51.44.78N 005.14.78W													
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AIR TEMP	MEAN	6.6	5.6	4.5	7.1	9.5	12.7	16.4	16.0	14.4	13.7	9.6	9.4
T107_1 0c	MAX	11.2	9.9	11.3	11.1	17.7	20.1	25.0	20.1	18.9	17.2	14.1	12.6
	MIN	-0.4	-0.5	-1.6	-0.8	5.5	7.4	11.2	12.4	8.2	8.9	4.2	3.6
BAROMETRIC PRESSURE	MEAN	1004.6	1011.0	1000.2	1007.2	1006.2	1011.6	1012.7	1011.2	1008.9	1002.2	1012.2	1004.0
	MAX	1031.0	1029.0	1024.0	1026.0	1020.0	1026.0	1027.0	1025.0	1026.0	1020.0	1035.0	1028.0
	MIN	980.0	983.0	980.0	984.0	985.0	995.0	994.0	996.0	989.0	976.0	978.0	961.0
RELATIVE HUMIDITY	MEAN	85.2	79.3	75.7	80.4	82.4	82.9	82.8	83.6	81.6	83.9	73.7	76.1
	MAX	98.7	98.2	97.5	98.5	97.2	97.2	97.5	96.7	97.3	97.5	97.7	96.9
	MIN	52.7	44.6	42.6	21.4	49.0	38.7	44.1	51.2	45.9	51.6	50.1	44.9
RAINFALL	TOTAL(mm)	79.2	65.4	35.3	22.5	26.3	9.3	16.5	37.6	28.8	108.0	179.7	192.9
SUNSHINE	MEAN(kw/m2)	0.0	0.1	0.1	0.2	0.3	0.3	0.3	0.2	0.1	0.1	0.0	0.0
	sunshine hours	70.0	146.0	227.0	312.0	351.0	363.0	381.0	370.0	246.0	189.0	100.0	68.0
	Sunshine hrs (10min)	67.7	148.7	223.3	300.5	345.5	361.2	382.8	370.7	245.0	180.3	96.3	62.0
NET RADIATION	MEAN	-6.5	2.3	26.8	67.9	106.5	116.9	125.3	91.3	47.4	16.0	-8.5	-17.7
MAX GUST	M/sec	33.8	42.5	29.2	29.2	30.8	26.3	19.6	22.9	27.9	29.2	41.7	39.2
	direction	255.1	280.9	117.5	191.3	232.2	202.6	194.5	230.3	263.4	214.6	234.6	247.9
	Knots	65.6	82.6	56.7	56.7	59.9	51.0	38.0	44.5	54.2	56.7	80.9	76.1
Notes	No problems in 2013												

Monthly average air temperatures – Wooltack point 1993 – 2013

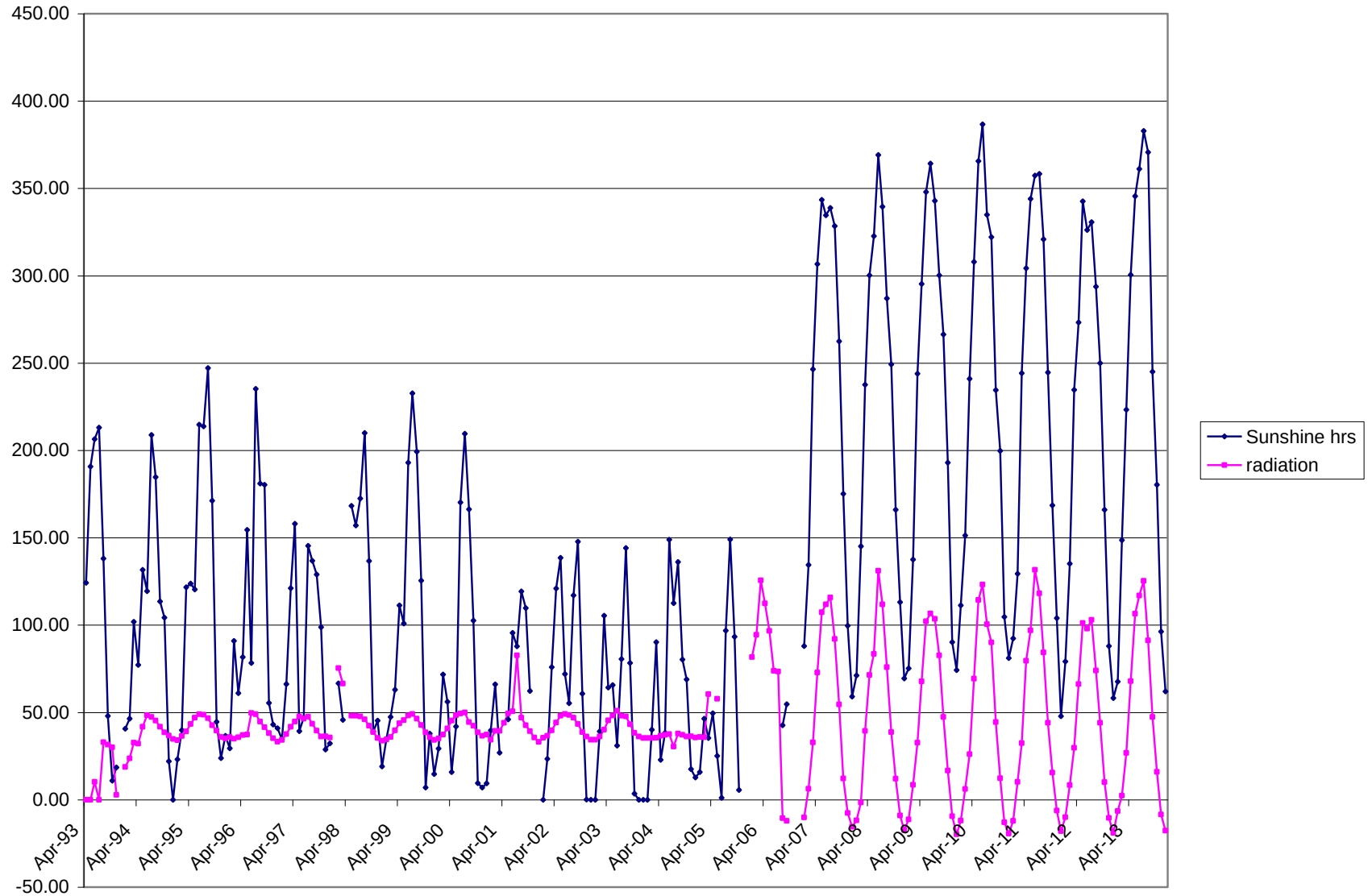


Relative Humidity 1993 - 2013



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 weather data can now be viewed on the internet with hourly updates on the ECN website.

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

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 MNR shore sites: West Angle, Jetty beach, Castle beach, ferry Inn 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 MNR 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 was put out in Martin's haven for the 2013 / 14 winter period.

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. In 2013 a logger was sited at Ferry Inn Beach in the upper reaches of Milford Haven.

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		
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.

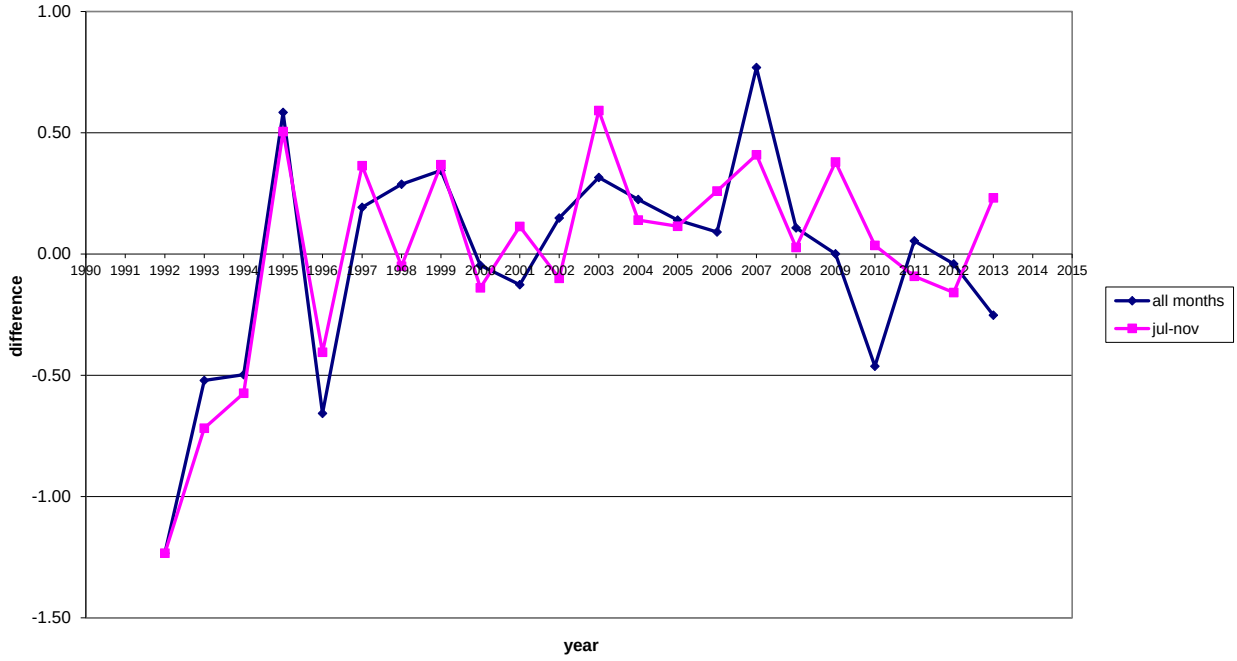
Annual maximum and minimum seabed temperature records from 2000 to 2011 are as follows (data from Vemco minilog at 19m BCD):

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**								
Minimum	7.6	8.0	6.98								
Maximum	15.9	16.6	16.82								

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.

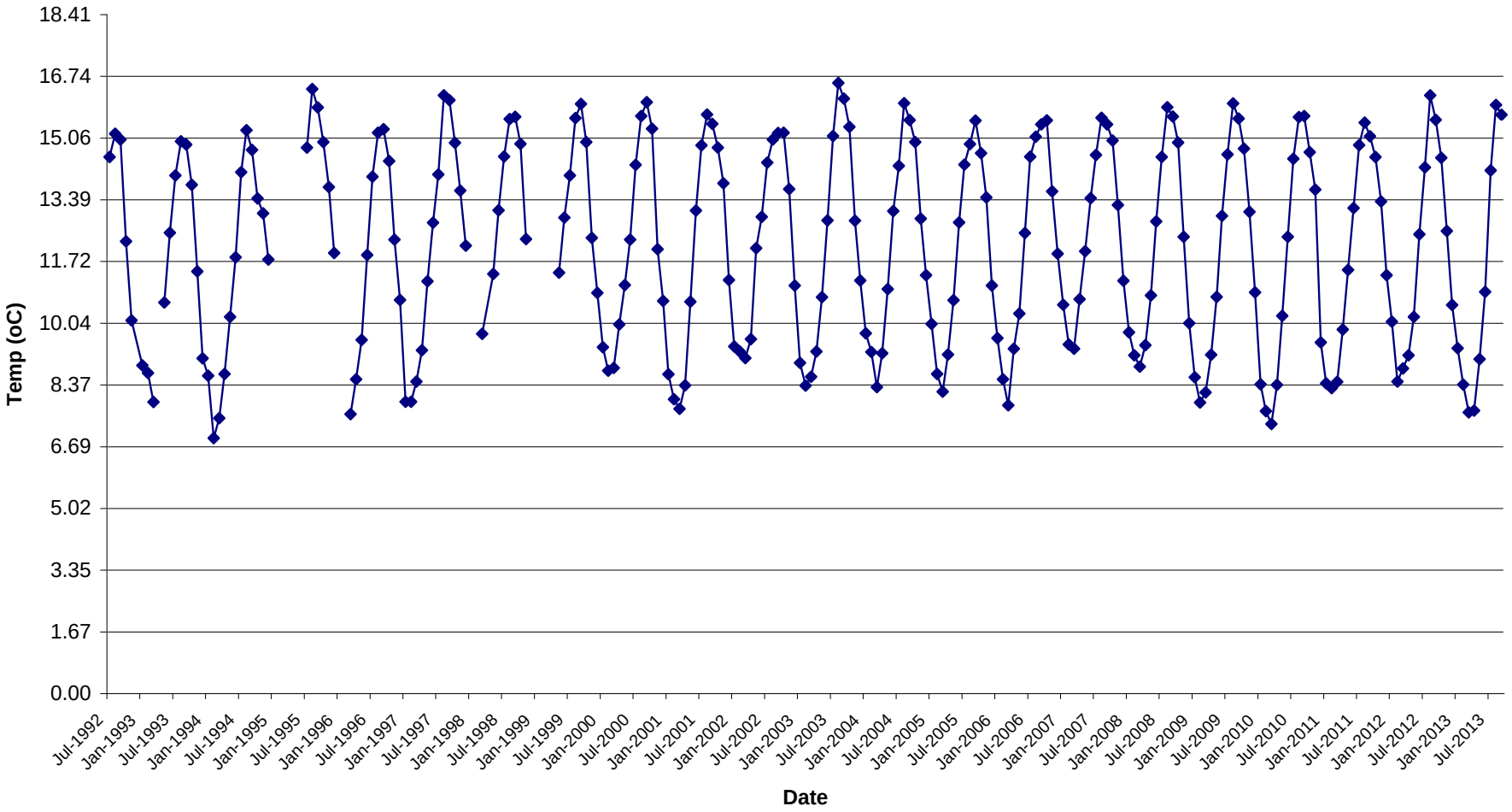
Comparing the overall monthly mean with the monthly mean for each year gives an indication of how cold / warm that particular month was compared to the whole data set. Two averages from this data were then used to express how cold / warm each year was. The blue line in the graph below averages all months 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 (1992-2012)

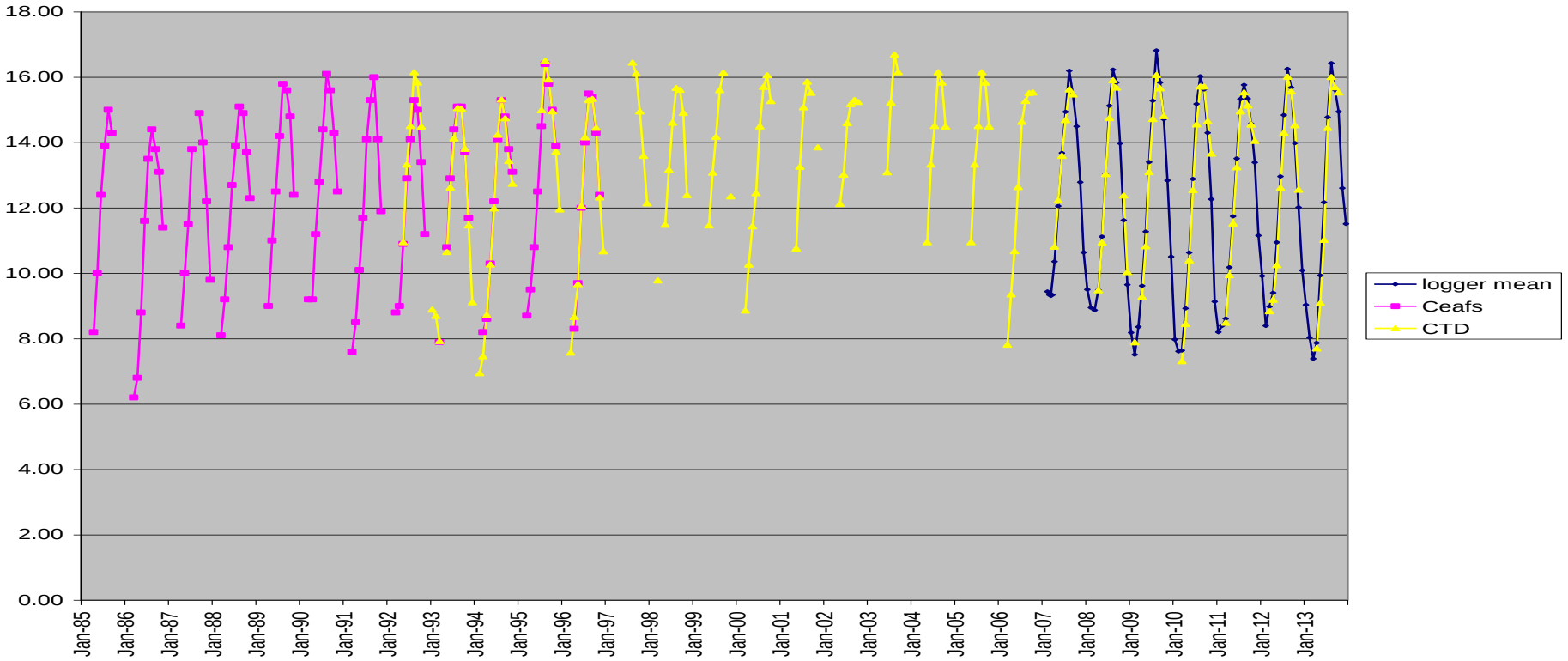


The cold winters of 2009 & 2010 have caused the trend to decline in sharp contrast to the very mild winter of 2008. The summer months are not so different – there has been a run of cool summers since 2004.

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



Summary of Sea Surface Temperatures – Monthly Means 1985 - 2013



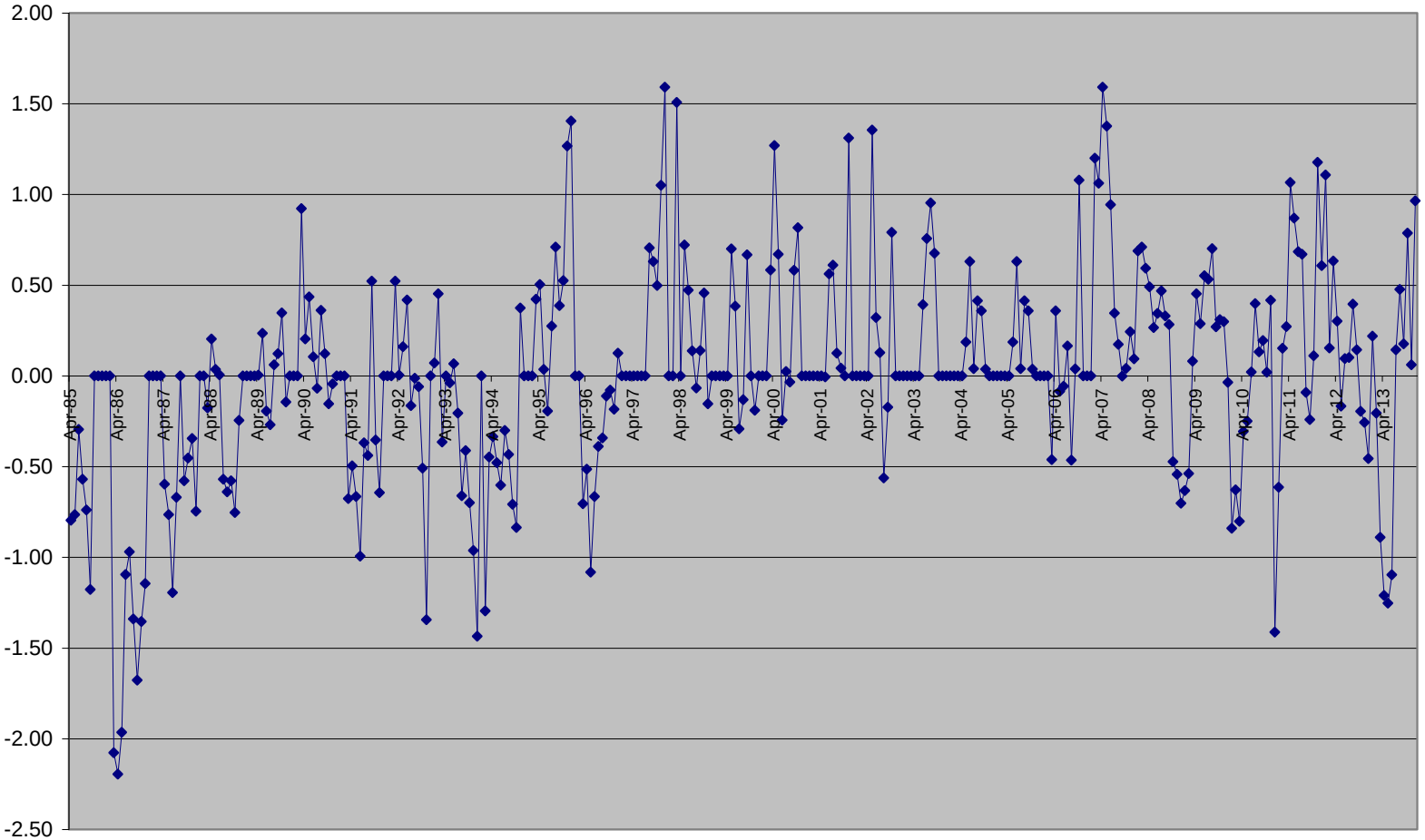
CEFAS Data - Taken from North Haven Skomer at high tide by a hand thermometer. Only available when the Skomer Warden was on site.

CTD – MNR 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 rand Monthly Mean - (1985 – 2013)



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 Reserve and 4 other shore locations in Pembrokeshire. These loggers will provide a record of the temperature regime experienced by sessile organisms in the inter-tidal zone. The data can be split into periods of immersion under water and exposure in the air. The immersed period can be used as a record of Sea Surface temperature.

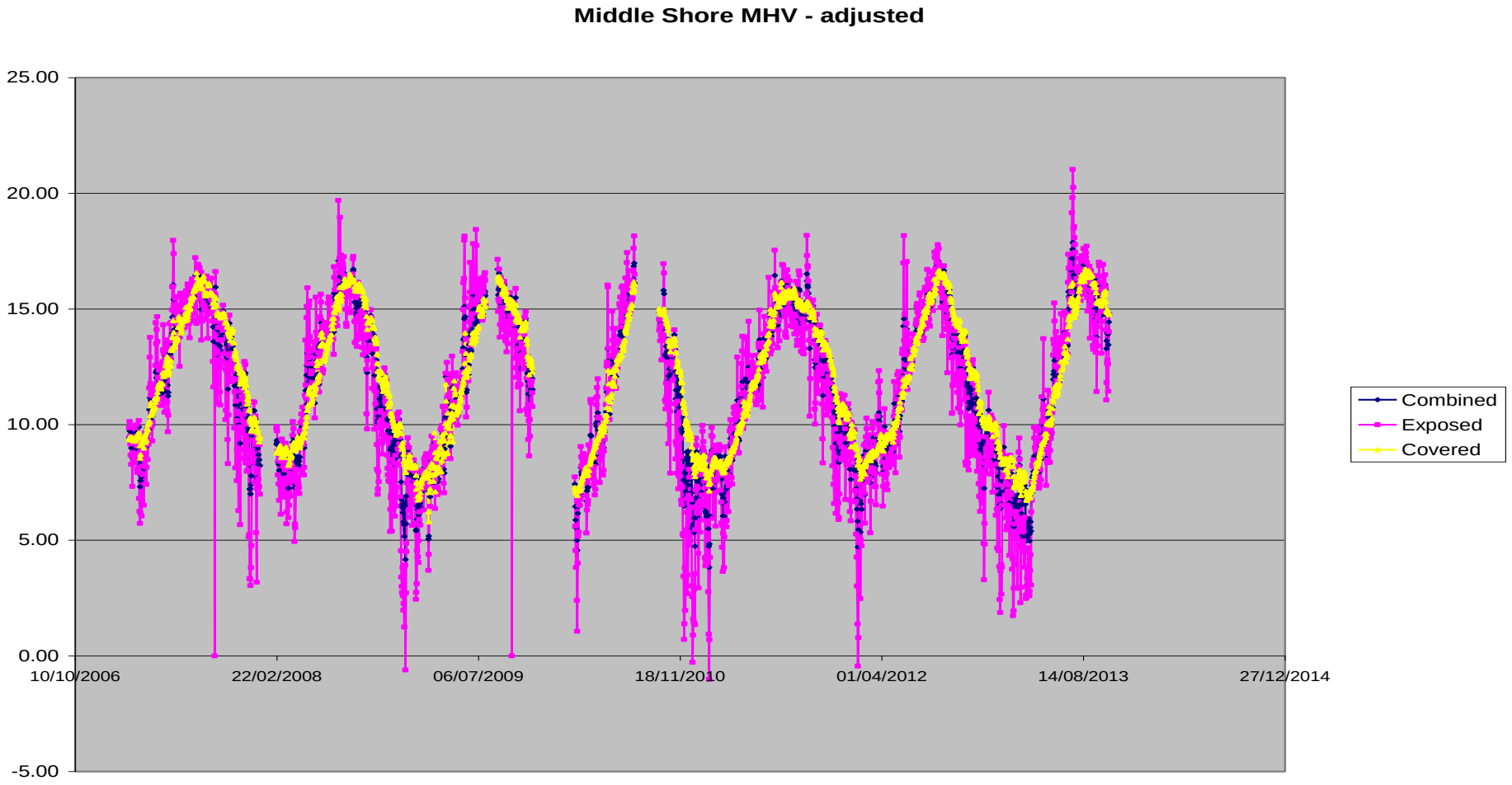
An example of temperature data from the middle shore, Martins Haven is shown on the graph (next page).

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 MNR/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 MNR.
- 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).



The pink data represents the air temperature (logger out of the water). The yellow data is sea temperature (logger covered by the tide.

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 MNR.

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

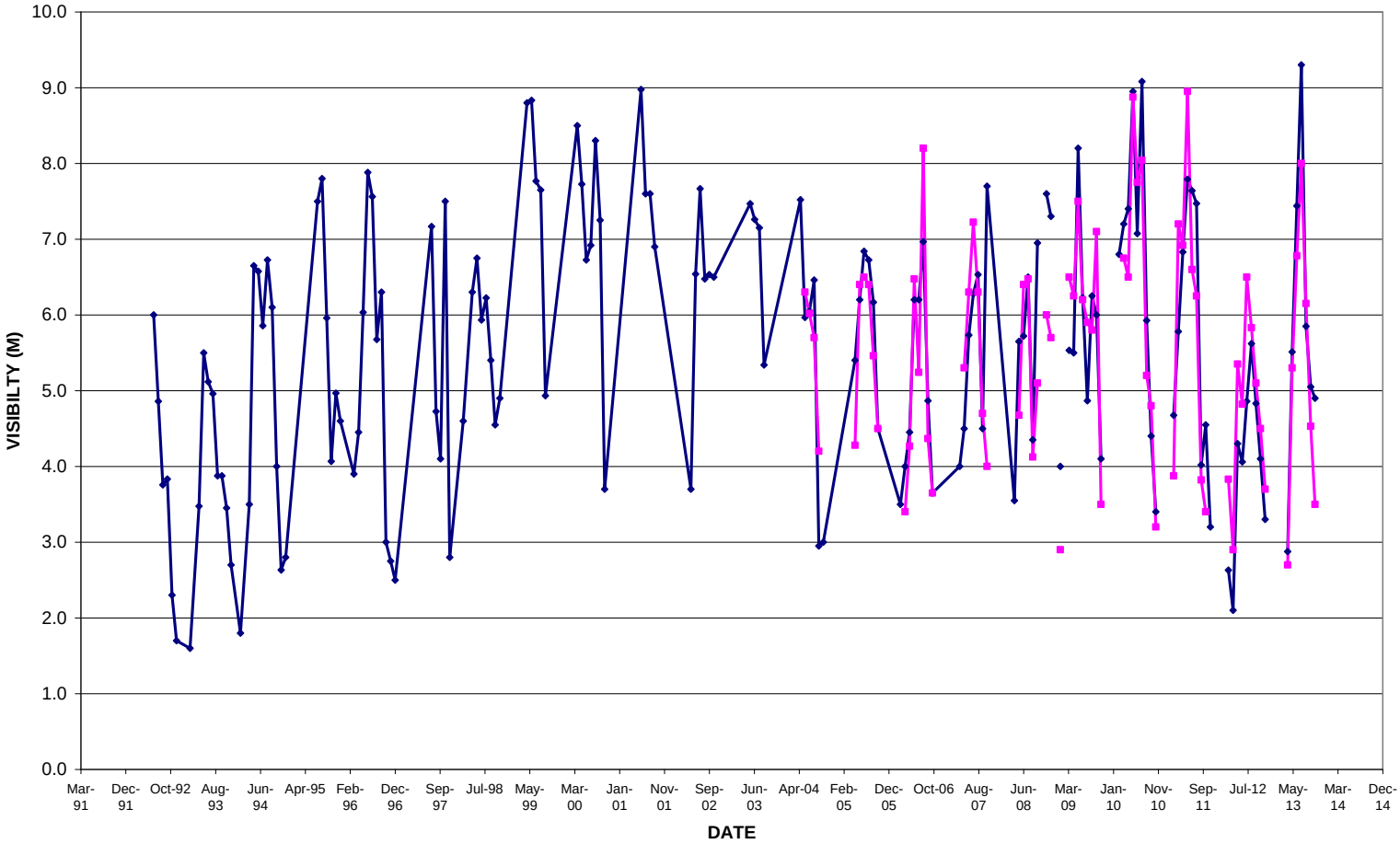
Secchi disc: Measurements have been taken reasonably consistently for the months of May through to October since 1992. The results are summarised in the table:

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

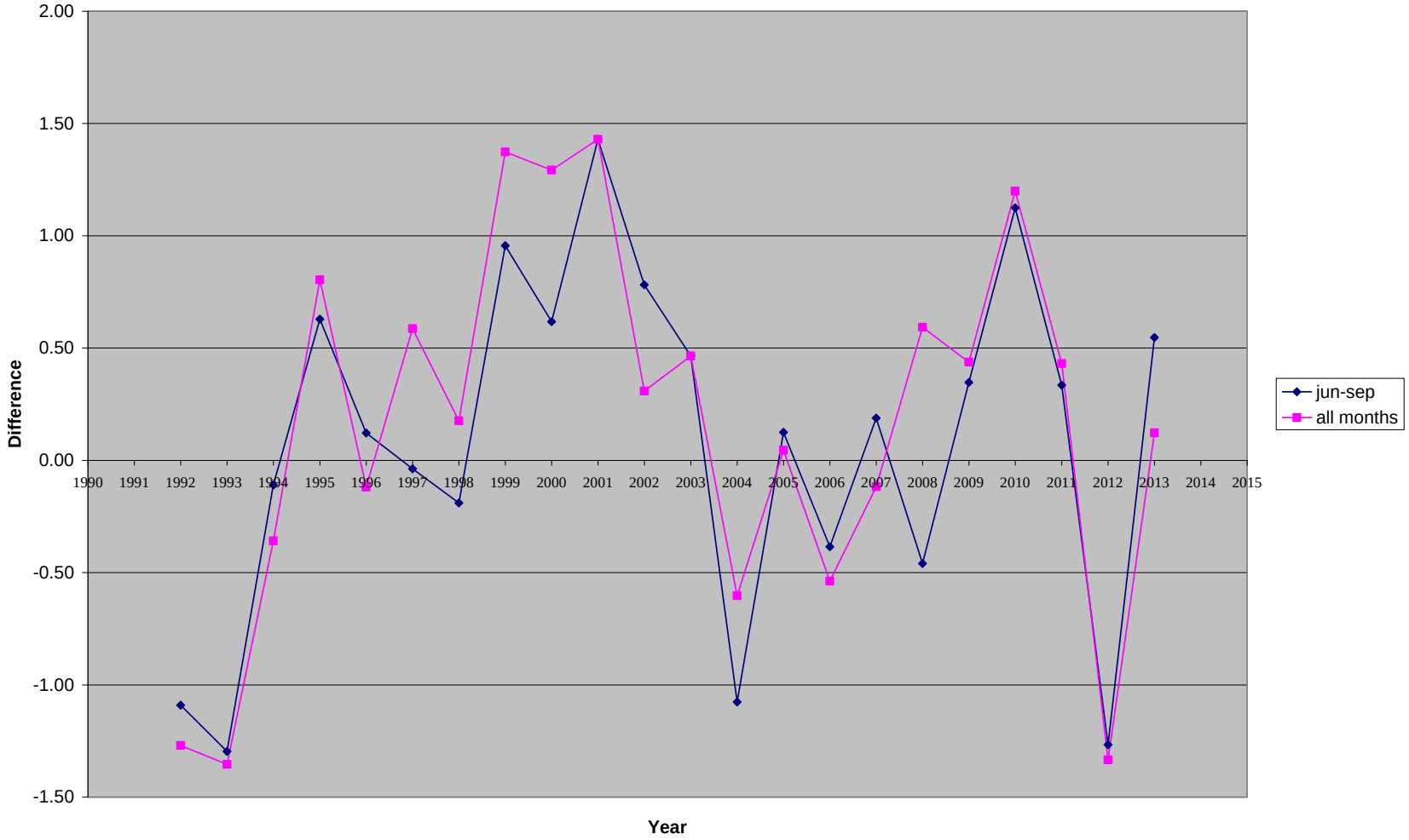
The mean monthly secchi disc readings for OMS and Thorn Rock are shown in the graph. This is followed by a table showing the monthly mean summary at the OMS from 1992 to 2010. Plotting the mean difference between the monthly average and the overall average highlights any significant fluctuations.

Mean Monthly Secchi disc Readings

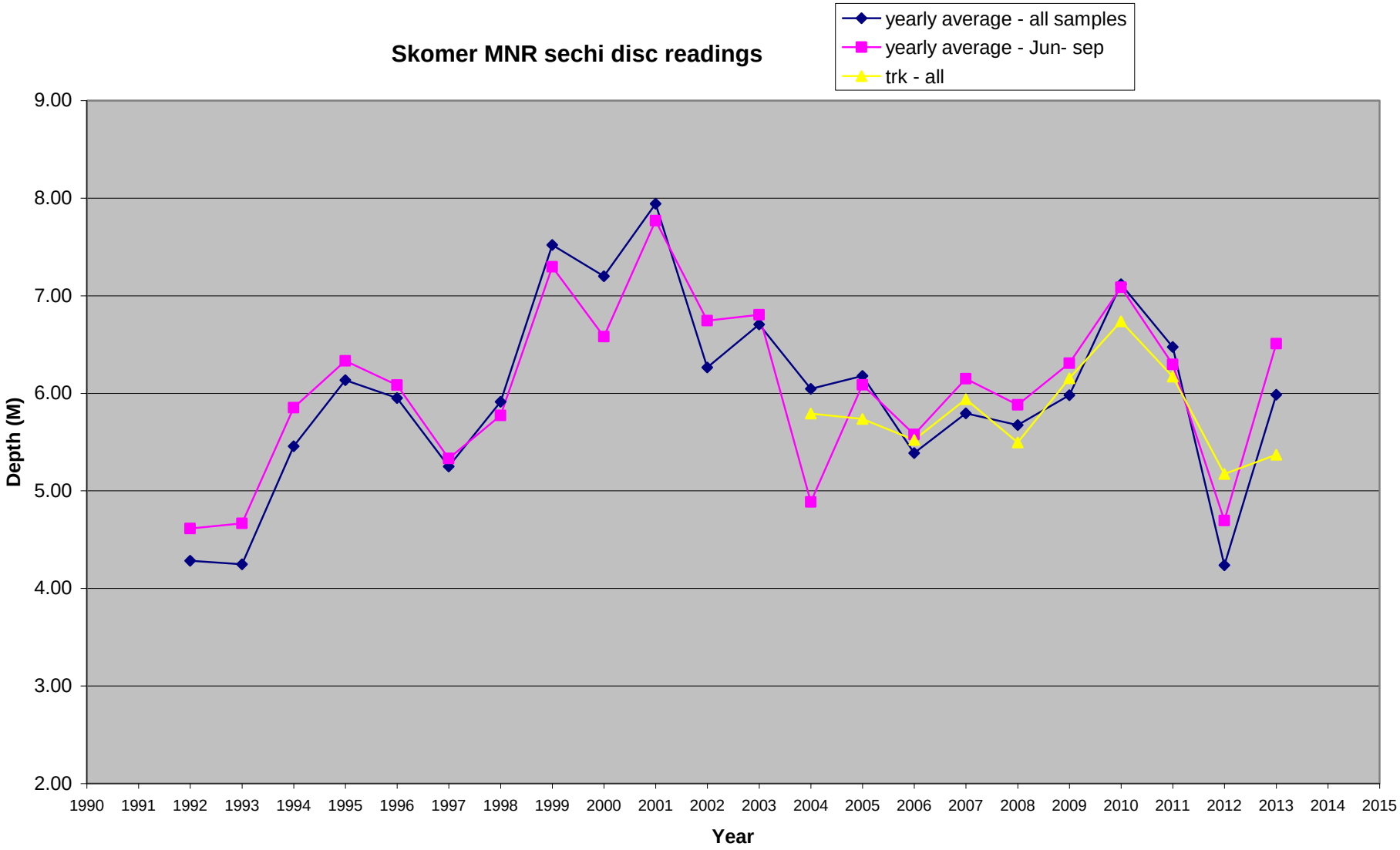


OMS = Blue line, TRK = Pink line

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. This would tally with the diver observations of very poor visibility in the 2012 field season. In 2013 the diving visibility was a lot better and the secchi readings are much higher.


Skomer MNR sechi disc readings
yearly average - all samples
yearly average - Jun- sep
trk - all
Depth (M)
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
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

In 2013 the sediment samples were sent to the NRW Llanelli Labs for analysis. They have a different set of analysis tools / machines to the BGS.
The Organic content was done at 550^{o}C not 450 ^{o}C therefore more carbonates will be included in the %Organic Carbon – this will explain the sudden leap in the 20133 values.

The NRW labs do a slightly different suit of metals analysis but it is more comprehensive;
Cobalt (C0) & antimony (Se) are not done but manganese, mercury, lithium, aluminium, barium, tin and iron are all now added to the metal analysis.

The method for the coarse PSA has also changed.

Yearly results from the OMS site

OMS	g/day oms	% organic content	% gravel	% sand	% mud
1995	2.17	9.33	7.37	18.56	74.07
1996	2.16	9.95	0.40	17.08	82.52
1997	1.69	9.64	0.18	20.43	79.40
1998	1.25	9.24	5.08	42.73	52.19
2002	1.05	7.91	0.17	73.51	26.32
2003	1.29	8.14	0.37	79.54	20.09
2004	1.91	7.90	0.00	75.27	24.72
2005	2.20	8.80	0.00	76.86	23.14
2006	2.33	8.79	0.00	76.80	23.21
2007	2.94	7.05	0.00	74.93	25.07
2008	0.56	7.34	0.00	81.48	18.23
2009	0.68	8.90	0.00	47.27	52.73
2010	1.75	7.66	4.93	77.99	16.88
2011	1.26	9.73	4.36	60.54	30.81
2012	2.00	7.87	9.12	45.39	45.14
2013	1.01	13.79	26.48	32.25	41.30

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

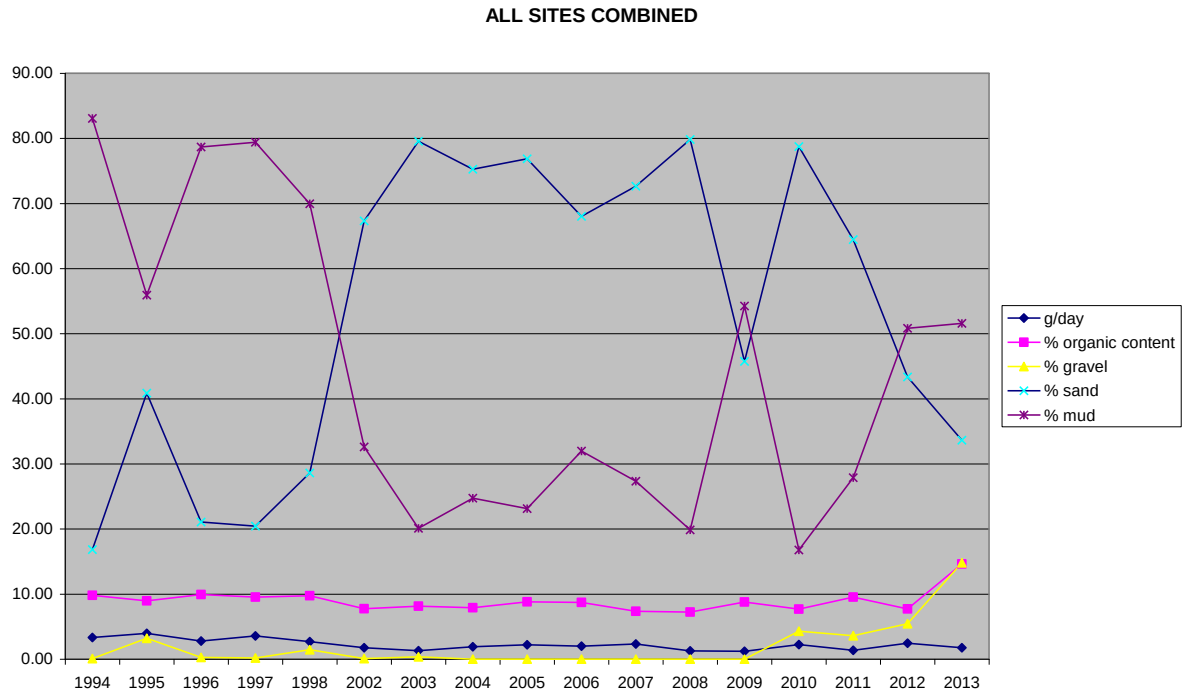
Yearly results from the TRK site

TRK	g/day trk	% organic content	% gravel	% sand	% mud
1994	3.32	9.80	0.10	16.83	83.07
1995	5.76	8.59	0.41	55.76	43.83
1996	3.53	9.90	0.21	22.56	77.23
1997	5.81	9.43			
1998	4.15	10.25	0.23	23.89	75.89
2002	2.44	7.61	0.00	61.63	38.36
2006	1.74	8.65	0.00	60.35	39.65
2007	1.54	7.73	0.00	69.81	30.19
2008	1.91	7.13	0.00	78.39	21.23
2009	1.78	8.66	0.00	44.06	55.94
2010	2.73	7.70	3.66	79.47	16.67
2011	1.51	9.31	2.73	68.80	24.61
2012	2.96	7.55	1.43	41.12	57.08
2013	2.53	15.34	3.14	35.04	61.86

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

General trends:
1994 – 1998 samples were characterised by higher mud content to sand content.
2002 – 2008 samples had higher sand content to mud content.
2009 the trend has swapped back to higher mud content
2010- 2012 have a higher sand content and gravel is getting more prevalent.
2013 – Gravel content increases again as does the mud content. The %organic carbon doubles but this is probably due to a change in methodology – see below

Combined Results for Passive Sediment Traps 1994 - 2013

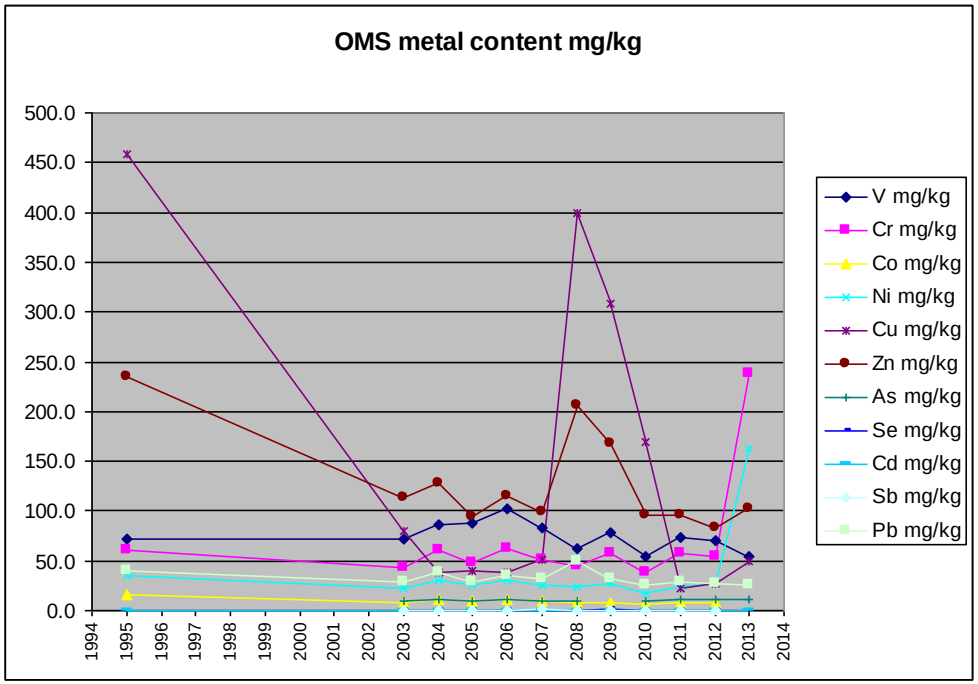


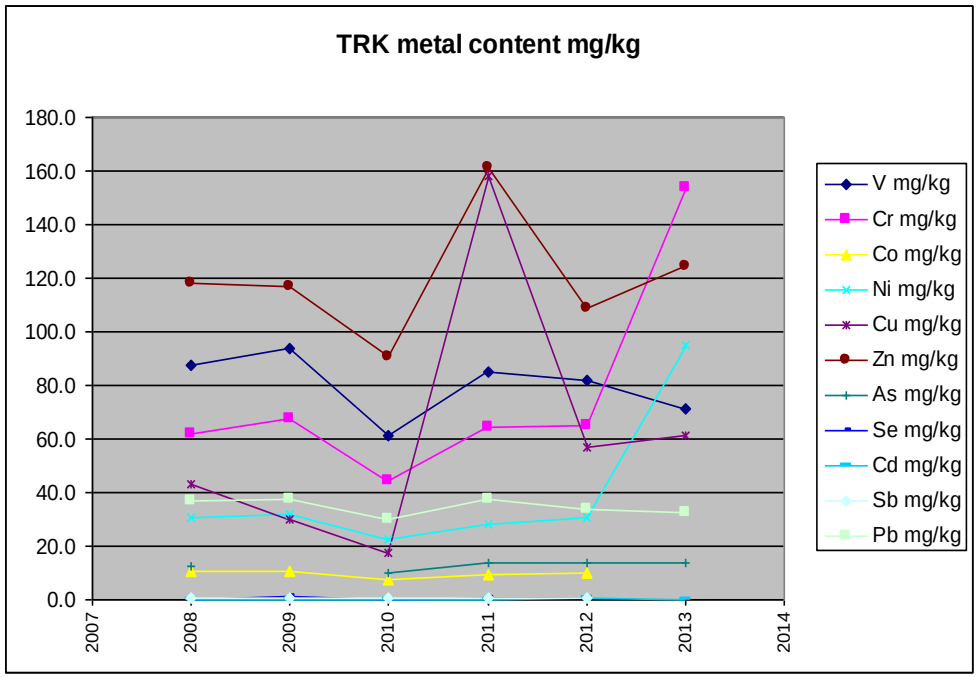
Gravel content increased in 2013 – mainly at the OMS site.
2012 saw mud become more prevalent than sand and this continued into 2013.

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

Metal Analysis Results

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





2013 was analysed by a different Lab – chromium (Cr) and nickel (Ni) both show elevated levels compared to previous years – so far no methodological reason can be found for this discrepancy. These new levels take Cr & Ni over the PEL levels for these metal.

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

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 MNR: 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.

Bullimore, B. (1983) Skomer marine reserve subtidal monitoring project, 1982-83.

Bullimore, B. (1983, 1986) Photographic monitoring of subtidal epibenthic communities on Skomer Marine Reserve, 1984-85. SMRSMP Report No 5

Bullimore, B. (1983, 1986, 1987) Photographic monitoring of subtidal epibenthic communities on Skomer Marine Reserve, 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 videoMarine 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 reserve, 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 Reserve- a review. FSC/(OFC)/1/87

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

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

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

Bunker, F. and Mercer, T. (1988) A survey of the ross coral *Pentapora folicaea* around Skomer Marine Reserve 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.

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 Reserve. 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. Insitute 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 Reserve Seaweed Survey 1982 FSC report fsc/(ofc)/2/83

Hiscock, S. (1986) Skomer Marine Reserve 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 colonal 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 stratergies. 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 (2012) Sponge monitoring studies in the Skomer Marine nature Reserve in autumn 2011. A report to CCW by Marine Seen. CCW/WW/12/03

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) Disribution 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

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 frpm Coastal Assessment, Liaison and Monitoring, Cosheston, 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 frpm Coastal Assessment, Liaison and Monitoring, Cosheston, 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.

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 Reserve 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.

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.

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