

**Skomer Marine Nature Reserve
Project Status Report 2008/09
CCW Regional Report
CCW/WW/09/2**

**K. Lock, M. Burton, R. Gibbs
& P. Newman February 2009**



Installing new oceanographic telemetry data buoy, 2008

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SYNOPSIS

The 8th project status report produced by the Skomer Marine Nature Reserve summarises the progress and status of monitoring projects in the Skomer MNR in 2008. A summary of all established projects in the MNR is provided in a table format. For each project that was worked on in the 2008 field season a detailed account is given including a history and summary of the results so far. This report also includes summaries of the oceanographic and meteorological surveillance projects.

Title: K. Lock, M. Burton, R. Gibbs & P. Newman. (2009). Skomer Marine Nature Reserve project status report 2008/09. CCW Regional Report CCW/WW/09/2.

CRYNODEB

Mae'r 8^{ed} adroddiad statws prosiect a gynhyrchwyd gan Warchodfa Natur Forol Sgomer yn crynhoi datblygiad a statws prosiectau monitro yn y Warchodfa yn 2008. 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 2008, 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.

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CONTENTS

SYNOPSIS	III
CRYNODEB.....	III
CONTENTS.....	IV
1 INTRODUCTION.....	1
2 SKOMER MNR PROJECT SUMMARY TABLES.....	2
3 SKOMER MNR BIOLOGICAL PROJECT SUMMARIES.....	7
LITTORAL COMMUNITIES: MESO-SCALE.....	8
SPONGE ASSEMBLAGES	15
<i>EUNICELLA VERRUCOSA</i> : POPULATION AND GROWTH RATE	20
ALCYONIUM GLOMERATUM POPULATION	25
PARAZOANTHUS AXINELLAE POPULATION.....	29
CUP CORAL POPULATIONS; <i>BALANOPHYLLIA REGIA</i> AND <i>CARYOPHYLLIA SMITHII</i>	33
<i>PENTAPORA FOLIACEA</i> (ROSS CORAL) POPULATION.....	36
<i>PECTEN MAXIMUS</i> (SCALLOP) POPULATION.....	42
ATLANTIC GREY SEAL (<i>HALICHOERUS GRYPUS</i>) POPULATION.....	48
4 SKOMER MNR METEOROLOGICAL AND OCEANOGRAPHICAL PROJECT SUMMARIES	52
METEOROLOGICAL DATA.....	53
SEAWATER TEMPERATURE RECORDING.....	56
SEAWATER TURBIDITY / SUSPENDED PARTICULATES	63
5 REFERENCES.....	73

1 INTRODUCTION

This is the eighth project status report produced by the Skomer Marine Nature Reserve. It summarises the progress and status of monitoring projects in the Skomer MNR in 2008. The project status table in section 2 provides a summary of all established projects in the MNR. Section 3 details biological projects that were worked on this year and a summary of the results to date. Section 4 provides a summary of the oceanographic & meteorological surveillance projects.

Notable events in the 2008 field season:

- King scallop, *Pecten maximus* survey. A team of 40 volunteer divers completed transects surveying a total of 9780m² of seabed within which a total of 1653 *P. maximus* were measured.
- A new digital camera and underwater housing for photo monitoring provided high quality images allowing improved photo analysis
- An OSIL telemetry buoy was deployed at the Oceanographic monitoring site (purchased under the Welsh Marine Environmental Change Network). The buoy was linked to the YSI 6600 sonde (a logger fitted with an array of probes) fixed to the seabed, 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.
- Skomer MNR data is being used to prepare a scientific paper comparing seabed with sea surface temperatures from satellite data. MNR staff also contributed to a paper on microbial fouling on Ross coral, *Pentapora foliacea* published in the Journal of the Marine Biological Society.
- A record year for seal pups born on the mainland part of the MNR. The previous record was 78, but this year 95 pups were recorded.

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. Data collected by a range of methods. YSI 6600 multi parameter sonde Temp, salinity, dissolved O ₂ , Chlorophyll, turbidity & depth OSIL buoy automatically transmitting data from YSI 6600 sonde	1992 – ongoing 2007 – ongoing 2008 - ongoing	Weekly (May -Sept) Temp continuous all year round (since 99) Hourly 10 Min sampling	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 – 98 samples 2002 –08 samples analysed	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) Continuous	No No No	No - raw only Yes – SMNR office Yes-SMNR office
Bathymetry	Sidescan & Multi-beam (SAC) Cardiff university trials of “swath” Multi-beam equipment	2001 2006		Longdin & Browning 2002	No Raw data at 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	1994 - ongoing	Daily	No	Yes-SMNR office
BIOLOGICAL					
Littoral communities:					
Macro scale (view point photographs)	Time series photos/digitised.	1992 - ongoing	Annual	Internal report – Daguett 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	Bullimore 1986 & 1987	Yes-SMNR office
Algal communities	Survey and report completed Survey completed report in preparation Full survey and method development	1999 2005 2007	Every 4 years	Hiscock, S 1983 & 1986 Scott 1994 Brodie & Bunker 1999/2000 Maggs & Bunker 2007 in prep	Yes-SMNR office
Sponge assemblages	Time series mono-photo/digitised. Species recording at TRK Seasonal monitoring from 15 fixed quadrats – Dr J Bell Species recording at TRK	1994 - ongoing 2002/3 2006 – ongoing 2007 2008	Annual Every 4 years 4 times / year	Bunker <i>et al</i> 1992 Bunker & Jones 2007	Yes-SMNR office

	Brief description	Year sets	Sampling frequency	Report	Data summary
Infaunal sediment	Surveys and reports completed	1993/1996/ 1998/ 2003 & 2007	Every 4 years Next survey planned 2011	Rostron 1994 & 1996 Barfield 1998 & 2003 Barfield 2007	Yes-SMNR office
Epifaunal sediment	Survey and report completed	1995/ 2001 & 2004	Every 4 years Next survey planned 2008	Rostron 1996 Moore 2002 Moore 2005	Yes-SMNR office
Flora:					
<i>Zostera marina</i>	Extent of NHV bed & density distribution.	1997/2002/2006 (Boundary maps for 2000, 2002 & 2004)	Every 4years Next survey planned 2010	Jones & Hodgson 1980 & 1981, Jones <i>et al</i> 1983, Lock <i>et al</i> 1998, 2003 & 2006	Yes-SMNR office
Fauna:					
<i>Eunicella verrucosa</i>	101 colonies, time series mono- photo/digitised. 4 colonies stereo-photo.	1993- ongoing 1982- ongoing	Annual	Bunker <i>et al</i> 1985, Bullimore 1986 & 1987 Gilbert 1998	Yes-SMNR office
<i>Alcyonium glomeratum</i>	Time series stereo-photo/digitised. North wall 5 transects (% frequency) North wall East, Thorn rock & Rye rocks.	1984- ongoing 2002 new transects	Annual	Bullimore 1986 & 1987	Yes-SMNR office
<i>Parazoanthus axinellae</i>	6 sites, time series mono- photo/digitised.	2001- ongoing	Annual	Burton <i>et al</i> 2002	Yes-SMNR office
<i>Pentapora foliacea</i>	3 sites, time series mono- photo/digitised. New sites established 2002 & 2003.	1994- ongoing	Annual	Bullimore 1986 & 1987 Bunker/ Mercer 1988 Gilbert 1998, Gibbs 2006	Yes-SMNR office
<i>Balanopyllia regia</i>	Time series @ thorn rock stereo- photo/digitised The Wick. 3 transects	1984 – 2002 - ongoing 2002 - ongoing	Annual	Bullimore 1986 & 1987	Yes-SMNR office
<i>Cayophyllia smithii</i>	Counted from sponge project quadrats (stereo-photo/digitised)	1993 - ongoing	Annual	No	Yes-SMNR office

	Brief description	Year sets	Sampling frequency	Report	Data summary
Atlantic Grey Seal	Surveys and reports.	1976- ongoing	Annual	Grey Seal breeding census, Skomer Island 1992-2008, Skomer MNR annual reports.	Yes-SMNR office
King scallop Pecten maximus	UCS survey, Survey completed, 3 sites- 2000 Survey completed, 7 sites 2004 & 2008	1979/80, 1979-82 2000 2004 2008	Every 4 years Next survey planned 2012	Bullimore 1985 Jones 1979 & 1980 Lock 2002 Luddington <i>et al</i> 2004	Yes-SMNR office
Nudibranch species	Various surveys MNR survey completed.	1975-1991 2002 & 2006	Every 4 years Next survey planned 2010	Bunker <i>et al</i> 1993, Luddington 2002	Yes-SMNR office
Territorial fish	Survey methods developed. Survey completed. N. Sweet drop down video survey	1997 2001/2002 2005 2007	Every 4years Next survey planned 2009	Lock 1998 Lock <i>et al</i> 2006 Tompsett 2006 Sweet 2007	Yes-SMNR office
Echinoderm Survey	Abundance of <i>Echinus esculentus</i> in Skomer MNR using volunteer survey methods. Data for <i>Marthasterias glacialis</i> , <i>Crossaster papposus</i> & <i>Luidia ciliata</i>	2003 & 2007	Every 4 years Next survey planned 2011	Luddington <i>et al</i> 2004 Lock 2007	Yes-SMNR office

3 SKOMER MNR BIOLOGICAL PROJECT SUMMARIES

LITTORAL COMMUNITIES

CMS code: RB03/01

STATUS Ongoing. Annual photographic sampling. Annual quantitative survey.

PROJECT RATIONALE

Littoral communities are susceptible to impacts from the water and the air. They occupy a harsh niche with an extreme range of environmental conditions. Salt tolerant terrestrial species exist within metres of truly marine species. These factors coupled with the relative ease of fieldwork compared to sub-littoral habitats make littoral communities useful for a wide range of environmental monitoring. There is a wealth of literature on the biology of rocky shores to provide guidance and support information for littoral monitoring projects.

OBJECTIVES

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

SITES

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

METHODS

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.

RESULTS

1982 – Bunker *et al.* surveyed 22 sites in the MNR as a baseline littoral survey.

1992 – 6 permanent transects were established in the MNR and surveyed/ photographed (Crump, 1993).

1992 – 2002 Photographs of the 6 permanent transects were taken and stored.

1996 – Following the Sea Empress oil spill (Feb 1996) the 6 transects were resurveyed and a lichen monitoring site was set up at Hoptang (Crump, 1996). The littoral shores around Skomer showed no significant changes after the Sea Empress oil spill, with the exception of lichens at Hoptang, 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 6 original sites and 4 additional sites were established.

2004 – Methods established in 2003 were continued. All site marking was completed and all results collected.

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.

Littoral community monitoring methods 2004

(see Crump & Burton 2004 for full details)

At each site samples were taken from 4 heights on the shore:

Lower shore – 1.8m Above Chart Datum (ACD)

Middle shore – 4.2m ACD

Upper shore – 6.0m ACD

Splash zone ~ 9.0m ACD (selected sites only. To include Hopgang)

At each shore zone:

- Four 1m² quadrats were placed in relatively homogenous areas of inclined rock (avoiding rock pools and large fissures)
- Presence / absence recorded for all species using a 25 cell grid.
- Digital photographs were taken of the whole quadrat
- Limpets were counted in 5 randomly selected cells
- Photographs of barnacles from 5 randomly selected cells using a 5 x 5cm quadrat
- % cover of barnacle species estimated in 5 random 20 x 20cm cells
- % cover of lichen species recorded in 50 x 50cm quadrats at selected sites

Counting protocols:

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

Barnacle monitoring

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

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

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.

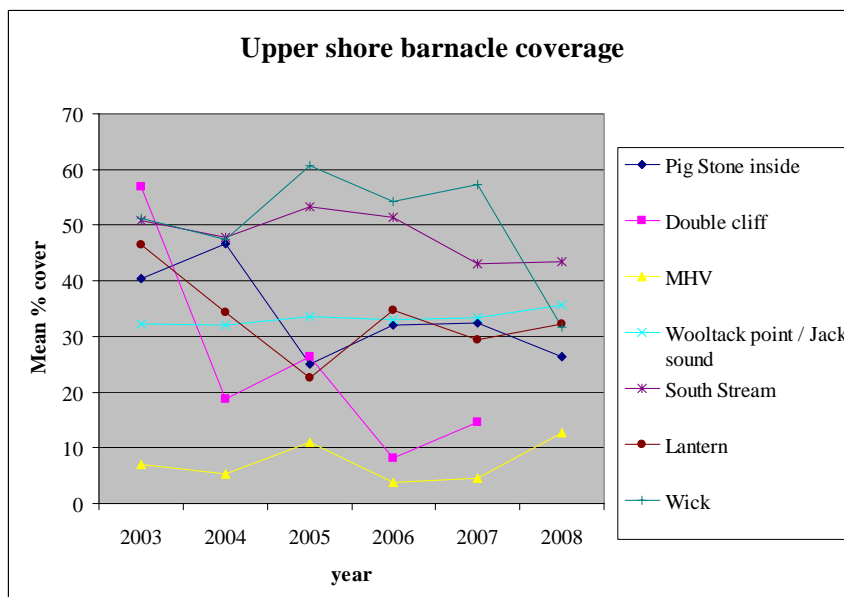
The MarClim methodology was used at Martin's Haven, North Haven and South Haven (see Mieszkowska *et al.* 2002). This involved recording abundances for a selected list of edge of range species, counting barnacles in 5 x 5cm quadrats and limpets in 50 x 50cm quadrats. Timed searches were conducted for *Osilinius lineatus* and *Gibbula umbilicalis* and individuals measured to the nearest mm.

Shore clingfish (*Lepadogaster lepadogaster*)

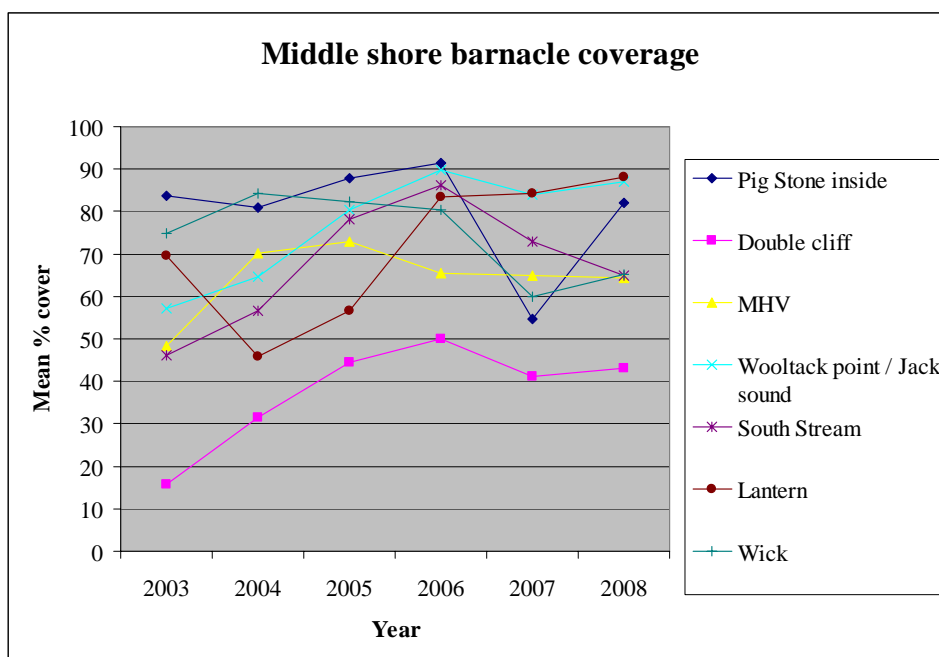
Timed counts of clingfish are carried out at Martins Haven and North Haven together with records of egg masses.

RESULTS

Mean % cover barnacles



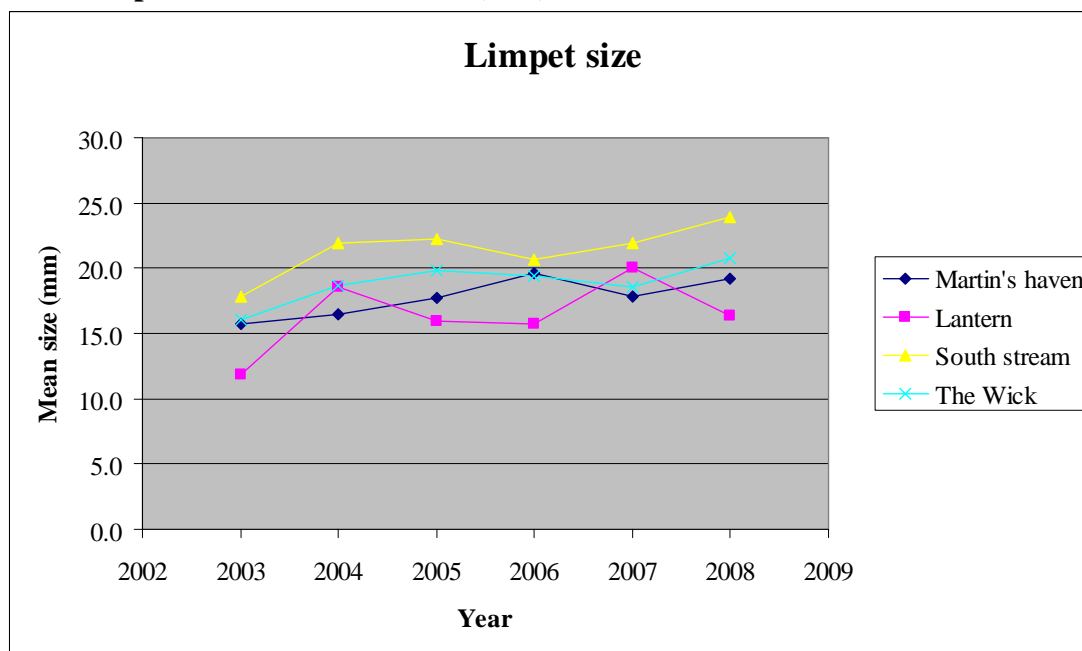
Barnacle coverage in the upper shore appears stable over the 4 years but variable between sites.



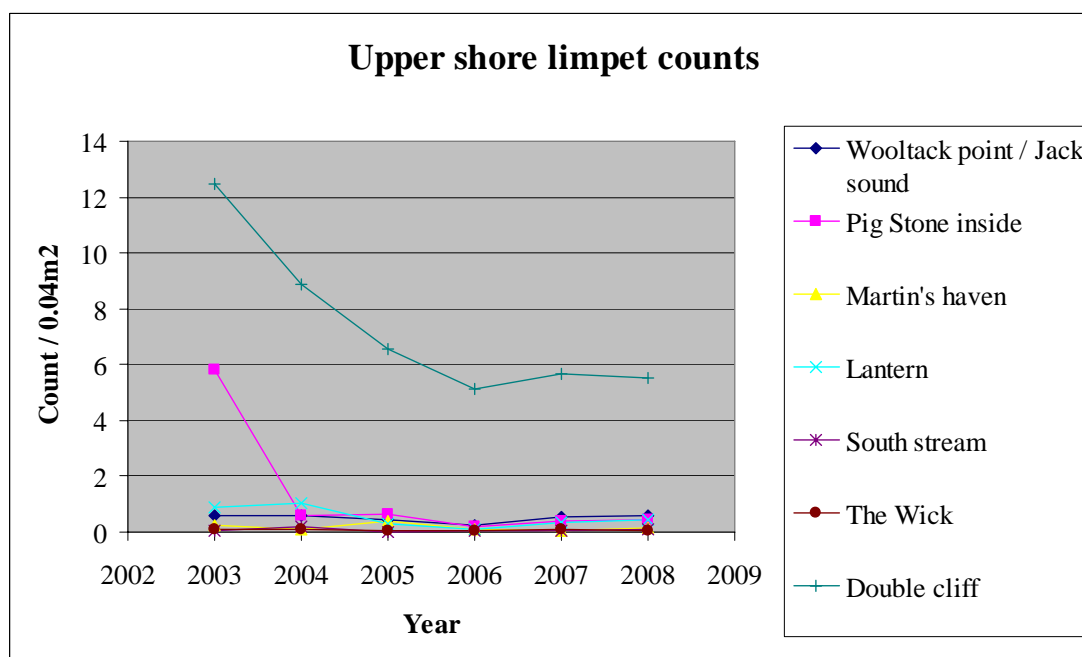
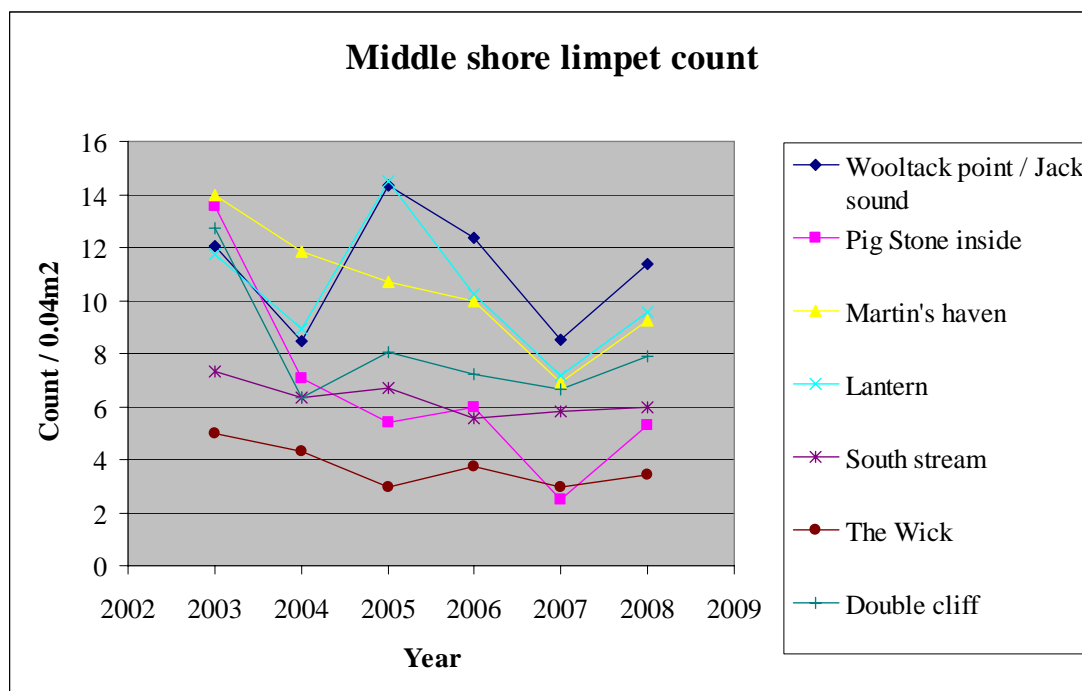
There appears to be an increasing trend in barnacle coverage on the middle shore which has now stabilised. Barnacle and furoid coverage is known to fluctuate.

Limpets

Size of limpets on the middle shore (mm)

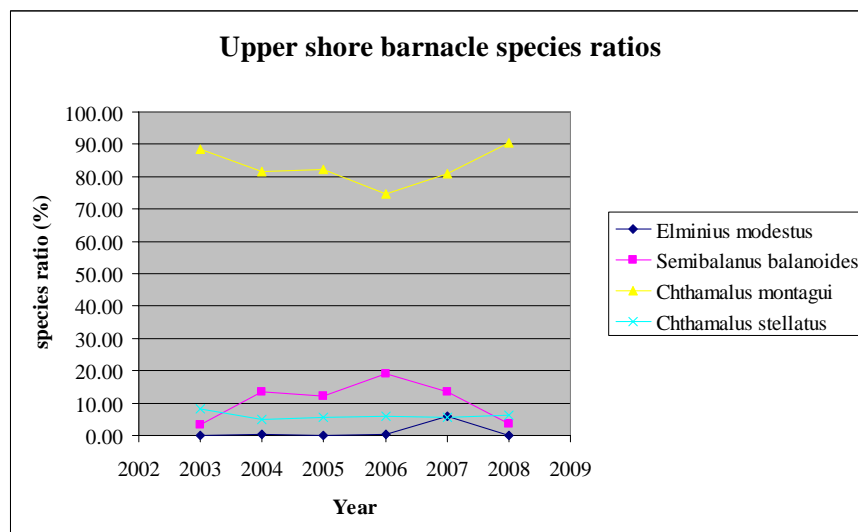
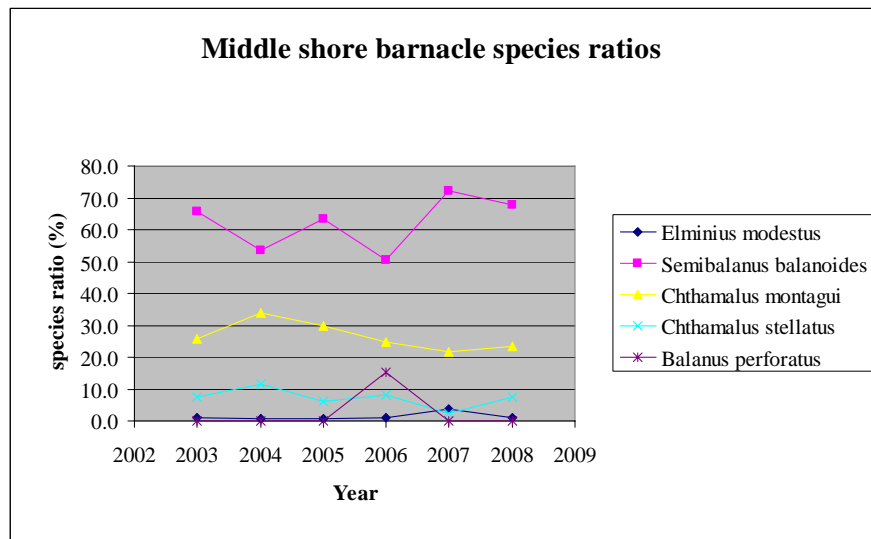
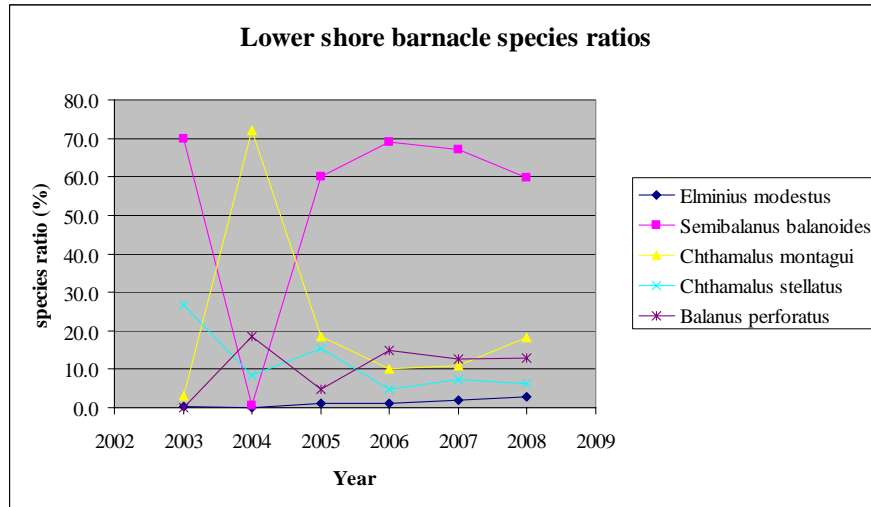


Counts of limpets from 5 (20 x 20cm) quadrats



Barnacle species ratios

Results from the 3 Marclim sites. Derived from photographs of 5cm X 5cm quadrats.



Upper and middle shore ratios show small changes in relative abundance. The lower shore has undergone some dramatic changes over the 4 years 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). *Chthamalus montagui* individuals would then benefit from a lack of competition. The upper shore barnacles are showing a stable trend.

CURRENT STATUS

The shores appear to be typical of the area.

RECOMMENDATIONS

- Continue the MarClim methods.
- Contract in field support on an annual basis.

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.

SPONGE ASSEMBLAGES

(CMS code: RM13/01)

STATUS Ongoing. Annual sampling of stereo photograph quadrats (1993-ongoing). Species surveyed every 4 years last survey 2007.

PROJECT RATIONALE

The sponge communities at Skomer MNR have been identified as rich and diverse with over 80 species. 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 and sediment load in the water column. 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)

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 no quadrats were used, survey completed in the general vicinity of the 4 transects with all species being identified if possible. Species photographs were taken in the field and samples taken, where necessary, for spicule preparations.

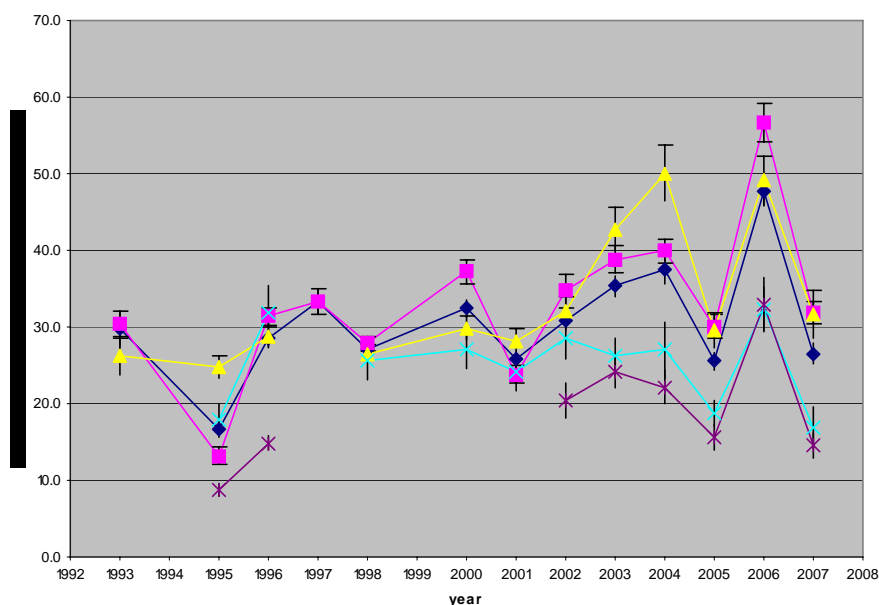
Seasonal survey from fixed quadrats: In 2005 15 1m² quadrats were marked out at 3 sites. The quadrats each consist of 25 cells (20 X 20cm), which are photographed using a digital camera.

RESULTS**Transects**

Data gathered from Thorn Rock sponge transects 1993 to 2006:

(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
1999	0	No fieldwork due to lack of staff
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

Mean number of sponges counted at 4 sites 1992 - 2007

Sponge Research by Dr James Bell and Jade Berman, Wellington University New Zealand

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 project is nearing completion and a summary of the results follows:

Table 1: Permanent quadrat surveys carried out at Thorn Rock since July 2006.

The first two letters in the key represent the Site (SH: Spongy Hillocks, BG: Broad Gully and DL: Dog leg).

Sites surveyed	Year	Month
SH	2006	July (7)
SH, BG, DL	2006	October (10)
SH, BG, DL	2007	May (5)
SH, BG, DL	2007	July (7)
SH, BG, DL	2008	May (5)
SH, BG, DL	2008	July (7)
SH, BG, DL	2008	September (9)

At each site there are five permanently marked positions for 1m² quadrats. The quadrats each consist of 25 cells (20 x 20cm), which are photographed using a digital camera. The photographs of all of the cells within each quadrat were analysed for the number of sponges present in each cell and identified to species wherever possible. The species identifications have been ground-truthed by taking small samples from sponges within the quadrat for spicule analysis during the sponge surveys of 2007 (Burton et al. 2008). Where it was difficult to distinguish species visually from a photograph the data collected was aggregated together to reduce variability due to photographic quality.

Across the three sites 47 different sponge species and 14 entities (species which could not be described from the literature) were recorded.

Across all sites and time periods the species richness (mean number of species m⁻²) was 22 (21.6 +/-0.75 S.E) as shown in figure 1. The mean abundance of sponges found per m² is shown in figure 2.

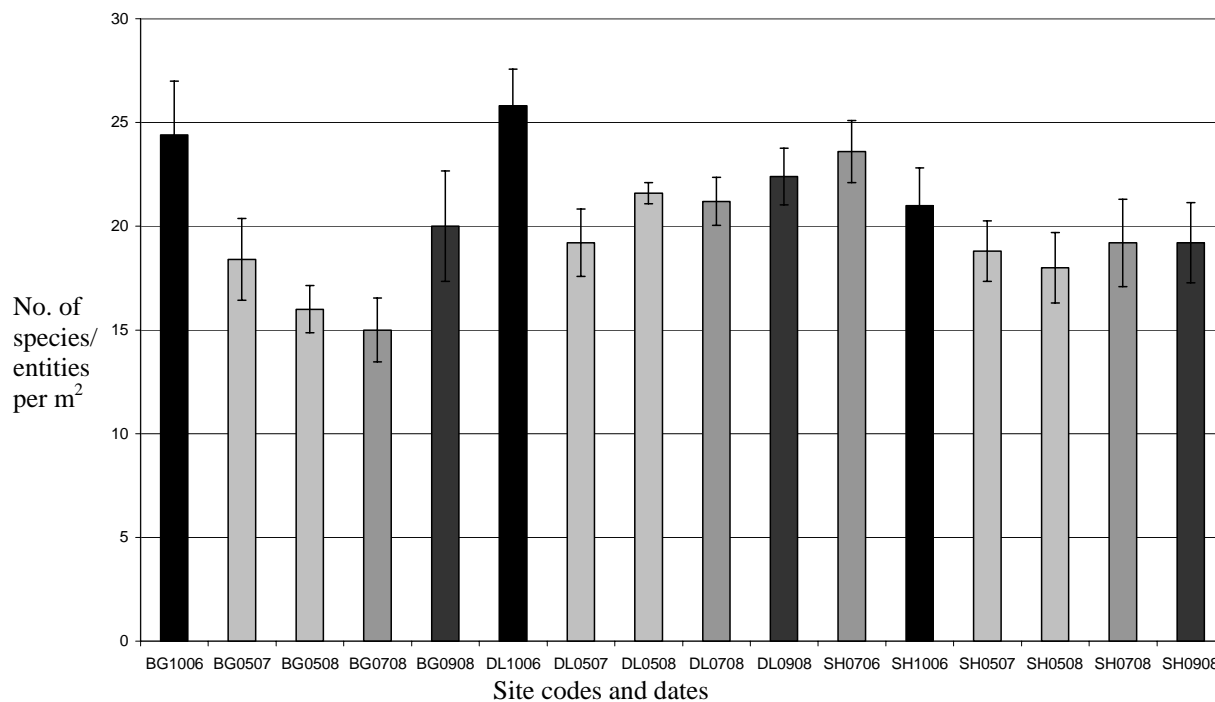


Figure 1. Mean sponge species per metre squared at the three sites (SH, BG, and DL) at seasonally from 2006-2008. For details of site codes see Table 1. The shading of the columns indicates which month the data was collected. The darkest column is October and the lightest column is May with July and September in-between.

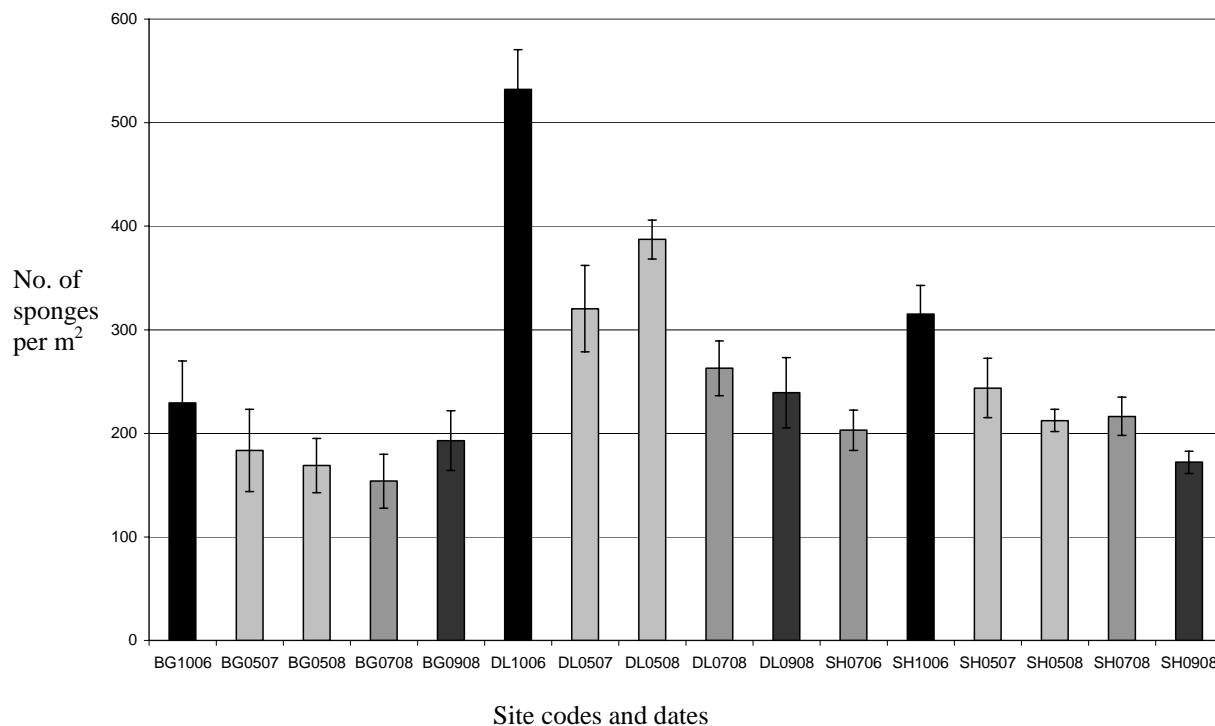


Figure 2. Mean number of sponges recorded per metre squared at the three sites (SH, BG and DL) seasonally from 2006-2008. For Site Codes see Table 1 and shading of columns is the same as Figure 1.

PRIMER (ver. 6) was used to carry out Ordination by non-metric Multi-Dimensional Scaling on a dissimilarity matrix created from a Bray-Curtis similarity analysis to compare species assemblages between all three sites, between years and also seasonal changes by month the data were collected.

Using ANOSIM "Site" was found to be a significant factor ($R= 0.309$, $P= <0.01$, 999 permutations) effecting species diversity and abundance (Figure 4). This shows the high variability in sponge diversity even though the sites are only a couple of hundred metres apart. The data was also related to the month it was collected and although the data is sparse and not collected for every month the data were grouped by season and this was significant ($R= 0.314$, $P = <0.01$ 999 permutations) (Figure 4.). However, there was no significant difference between the years the data were collected ($R=0.119$, $P = 69.6\%$) (Figure 5). This would suggest that there are seasonal patterns however the annual cycle of sponges is harder to predict. This may relate to the paucity of data for 2006 and 2007 as more data were collected for 2008. This analysis will be repeated to see if there are further annual patterns once data is collected in 2009.

Research recommendations:

- Seasonality patterns need further investigation as we have certainly found seasonal changes in the sponge assemblages, therefore it is important to try and collect some winter data as currently all data collected are during May-October.
- The last set of data to be collected for analysing as part of Jade Berman's PhD should be collected in July 2009 for elucidating any significant annual patterns. This is so the data can all be processed and compared with the data of other sponge assemblages in Indonesia and New Zealand by the end of her PhD in July 2010. However, it would be useful to continue collecting the data annually as part of the monitoring scheme to see if there are any larger-scale patterns that operate on a longer timescale than has currently been recorded.

RECOMMENDATIONS

- Continue transect photo-monitoring programme at Thorn Rock and continue application of morphology method for analysis of photos.
- Expand the photo monitoring/morphology method to further sites within the Skomer MNR and to sites outside of the MNR. This will provide improved knowledge of the diversity of sponge assemblages.
- Seasonality of sponge assemblages needs further investigation. Continue supporting research work by Dr James Bell and Jade Berman.
- Continue sponge species recording every 4 years, next survey due 2011.

REFERENCES

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***EUNICELLA VERRUCOSA*: POPULATION AND GROWTH RATE**

(CMS Code: RM23/01)

STATUS Ongoing. Annual sampling.

PROJECT RATIONALE

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

OBJECTIVES

To monitor numbers and condition of the recorded sea fans in Skomer 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 estimating the connectivity between population of pink sea fans using internal transcriber sequences. The work is currently being undertaken by Gemma Veneruso based at the University of Plymouth and the Marine Biological Association.
- 2008 a digital SLR camera providing high quality images, thereby allowing improved photo analysis, replaced the film camera previously used.

2003-2008 condition assessment of fans have been completed using both field and photo images.

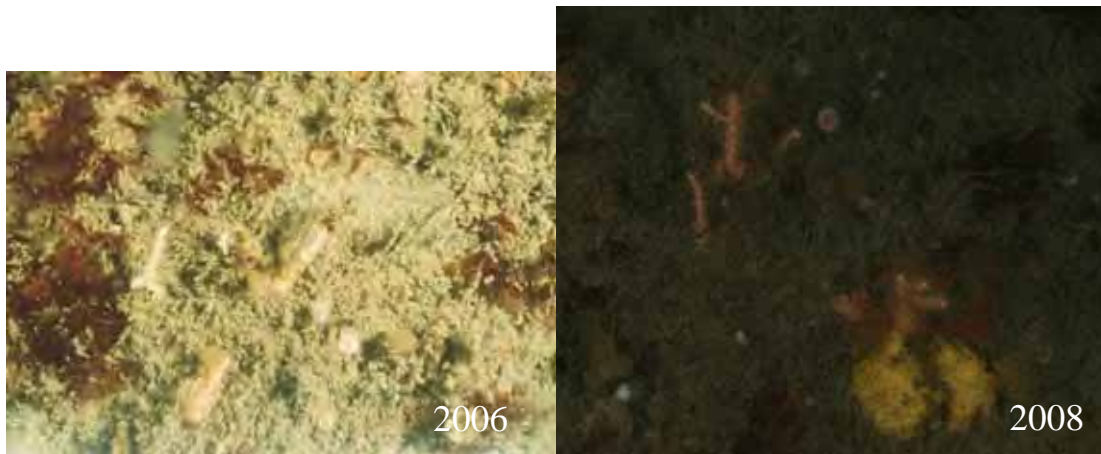
Sampling effort 1994 -2008:

Year	Number recorded	No. of fans analysed	New recruits (babies)	Not found in current year	Confirmed loss	Condition assessment	
						Photo	Field
1994	33	29				Yes	No
1995	32	28		Way 9		Yes	No
1996	33	29			Way 9	Yes	No
1997	37	28				Yes	No
1998	37	28				Yes	No
1999	4	0				Yes	No
2000	55	26	Way 14			Yes	No
2001	54	35		Way 12		Yes	No
2002	74	64		Trk 1	Way 12	Yes	Yes
2003	102	94	Bho 23		Trk 1	Yes	Yes
2004	105	101				Yes	Yes
2005	107	105	Nwa 15	Nwa 7		Yes	Yes
2006	112	106	Bho 32-36, Ssg 23, Rrk 7b	Way 15, Pool 7	Nwa 7	Yes	Yes
2007	116	110	Bho 23 returned or new?	Ssfg 22, Trk 3, Bho 9, Rrk 7b	Bho 9, Trk 3	Yes	Yes
2008	118	112		Ssfg 23, Pool 8		Yes	Yes

One additional sea fan was found in 2008, this was a well established colony that had not been seen before at Thorn Rock on the reef above the P3 *Parazoanthus axinellae* patch.

There are no confirmed losses in 2008, Sandy seafan gully 22 and Rye Rocks 7b that were not seen in 2007 were found again in 2008 and Waybench 15 that had not been seen in 2006 or 2007 was re-found tangled up in seaweed. Two sea fans were not found for the first time 2008, these are Sandy seafan gully 23 and Pool 8, and their status will be confirmed in 2009.

There were no new recruits in 2008. New recruits found in the past 4 years have shown very little growth since first found. In 2006 5 baby fans were first found clustered together at Bullhole. Photo comparison between 2006 and 2008 is difficult due to image quality. The 2008 photo is taken using a digital camera and shows a much clearer image, two of the fans showing clear branching.

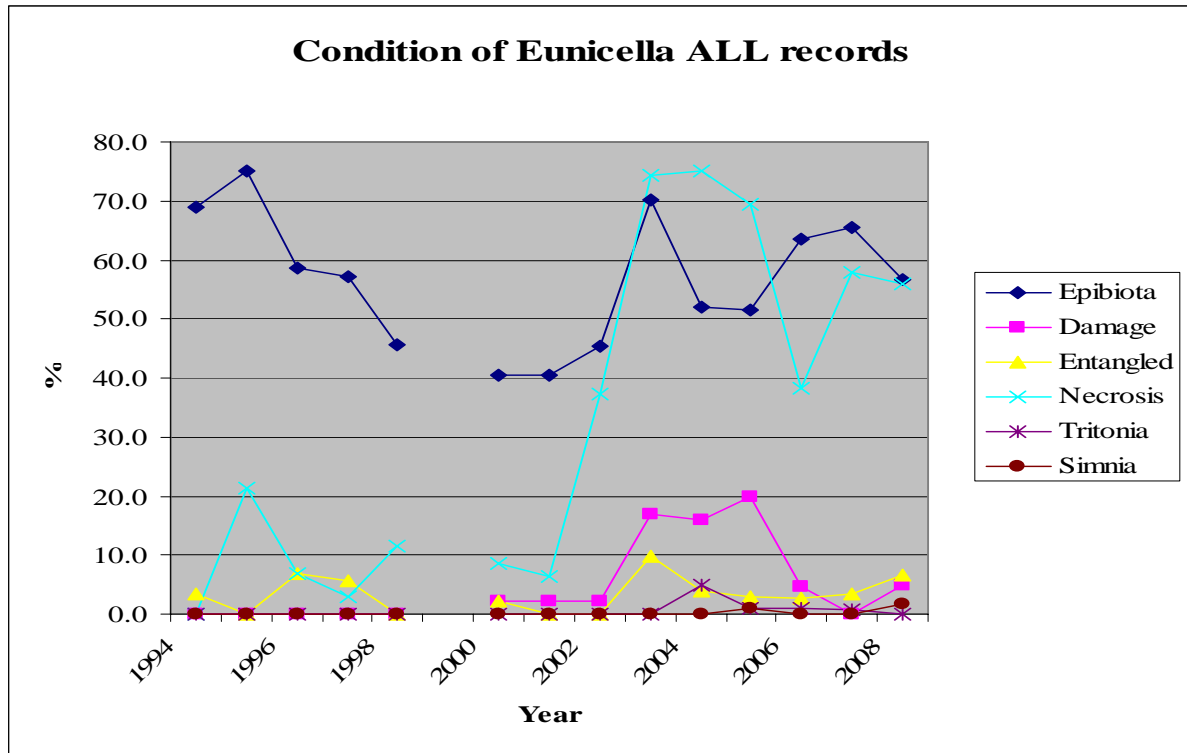


Currently photos of the small sea fans are taken using the same camera set up as the larger fans. A digital camera set up for close up photography should be used to target the small fans along with a graduated ruler for size reference. This will allow growth of the small fans to be assessed.

In 2008 one sea fan at Thorn Rock was found damaged, totally flattened and with several branches broken off.



Condition of sea fans in the Skomer MNR from photo images (1994- 2008) and field data (2002-2008) records are shown on the following graph.



Recording of necrosis from the photo images was inconsistent between years due to variable image quality, recording necrosis in the field since 2002 has helped provide improved records. In 2008 the images taken with an SLR digital camera provided excellent quality images and allowed improved recording of necrosis from the photos. In 2007 an increase in necrosis was observed, this has dropped slightly in 2008. No sightings of *Tritonia nilsodhneri* or *Simnia patula* were recorded in 2008.

CURRENT STATUS

- Numbers: There have been 6 confirmed sea fans lost from the monitoring sites between 1994 and 2008, and there are 2 further possible losses in 2008.
- One sea fan at Thorn Rock was found flattened with several branches broken off.
- There are no new recruits found in 2008.
- Condition: The amount of necrosis increased in 2007, this was only slightly lower in 2008.
- There were no records of *Tritonia nilsodhneri* or *Simnia patula* in 2008.

RECOMMENDATIONS

- Continue annual photographic monitoring programme;
- Complete field records for each colony, recording damage, entanglement, necrosis, levels of epibionts and numbers of *Tritonia nilsodhneri*;
- Observe persistence of biotic fouling/entanglement e.g. Greater spotted dogfish eggs;
- Differentiate between drift algae and epibionts in field records;
- 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, Munroe 2004, Wood 2008.

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 big wall (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.



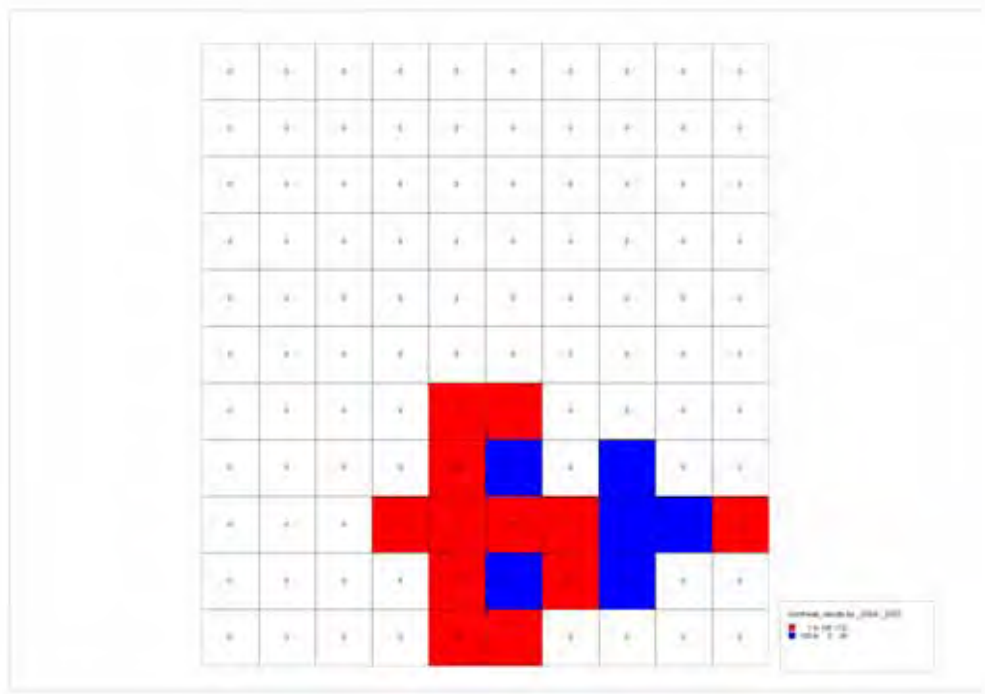
Site	Sequence
North Wall big wall	five vertical transects
Thorn Rock mooring	two fixed position quadrats
Sandy Sea Fan Gully	two vertical transects
North Wall East	two vertical transects
Rye Rocks	one transect

The colonies are “wafted” before photographing to make them retract in order to 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.

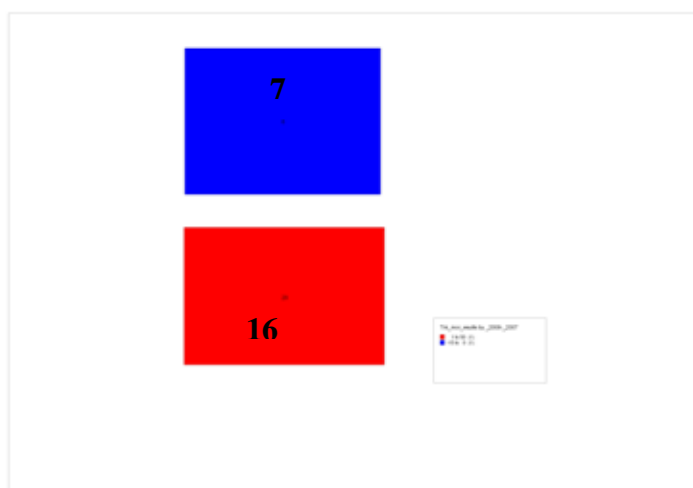
RESULTS

North Wall Stereo: The three quadrats have a steady abundance of *A. glomeratum* of approximately 50% since 1984.

North Wall big wall: Difference in frequency of *A. glomeratum* between 2007 & 2008. Red boxes indicate an increase in abundance in 2008; blue boxes indicate a decrease in abundance.

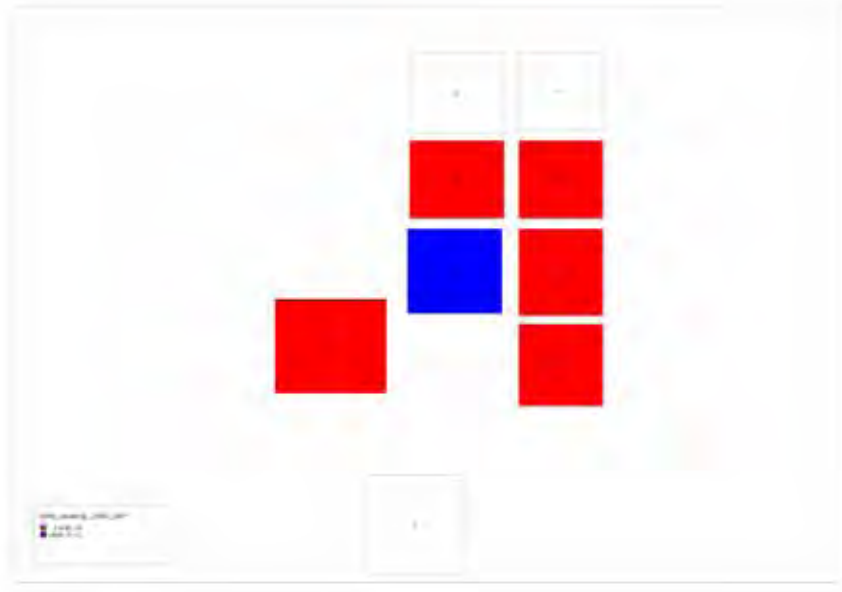


Thorn rock mooring: Difference in frequency of *A. glomeratum* between 2007 & 2008.

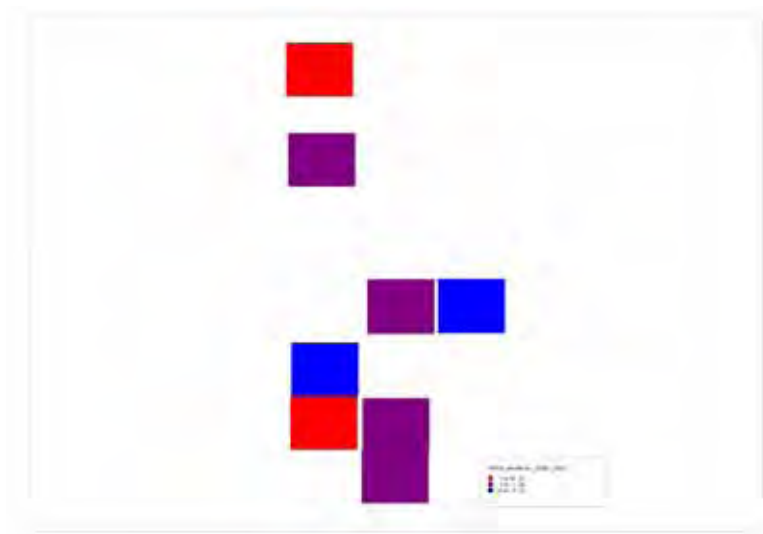


Sandy Seafan gully: Photos taken in incorrect positions, no analysis.

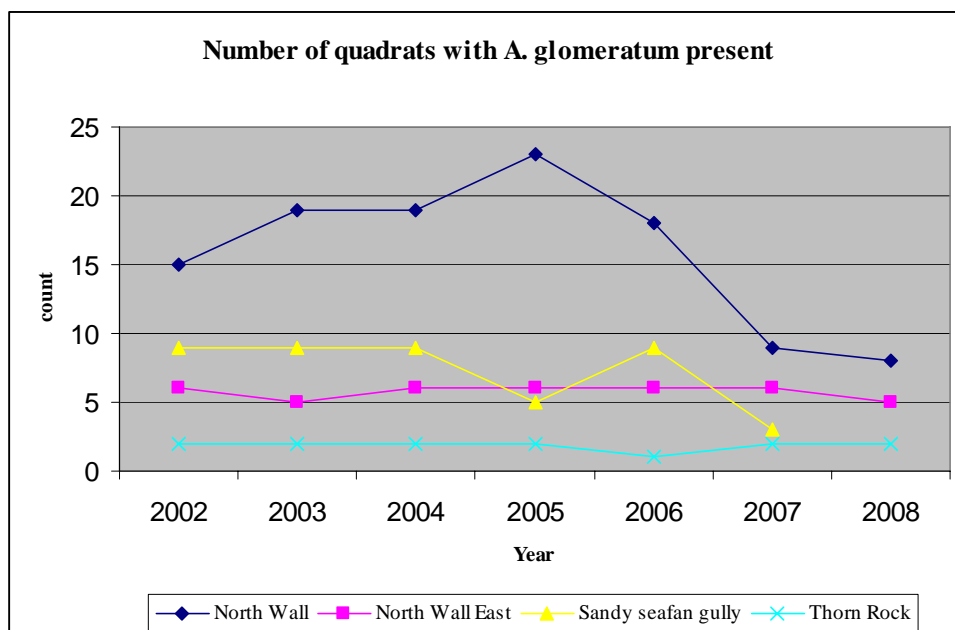
North Wall East: Difference in frequency of *A. glomeratum* between 2007 & 2008



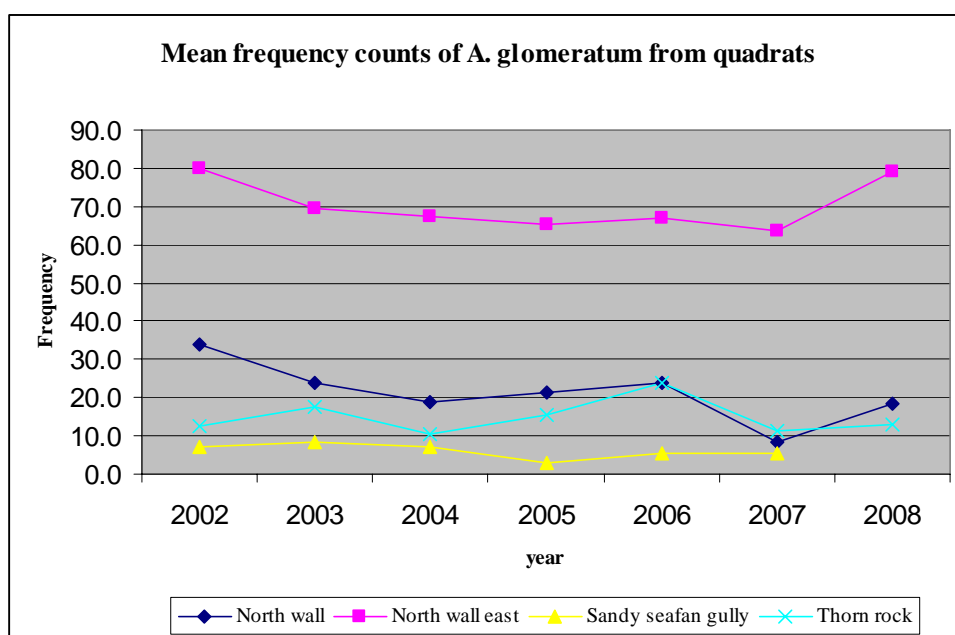
Rye Rocks: Difference in frequency of *A. glomeratum* between 2007 & 2008



Graph of the number of quadrats with *A. glomeratum* present:



Graph of the mean frequency of *A. glomeratum* from within the quadrats:



CURRENT STATUS

The colony on the North Wall stereo site (which is made up of large individuals) has remained stable over the last 10 years. The populations of *A. glomeratum* at the new transect sites is variable. North wall east and Thorn rock show stable colonies, whilst North wall main wall shows a dramatic decrease in the number of quadrats with *A. glomeratum* present and there has been a decrease in quadrats at Sandy sea fan gully. Continued monitoring is needed to follow these trends in the long term.

RECOMMENDATIONS

- Continue with monitoring.
- Improve site marking to allow accurate relocation of quadrats.

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

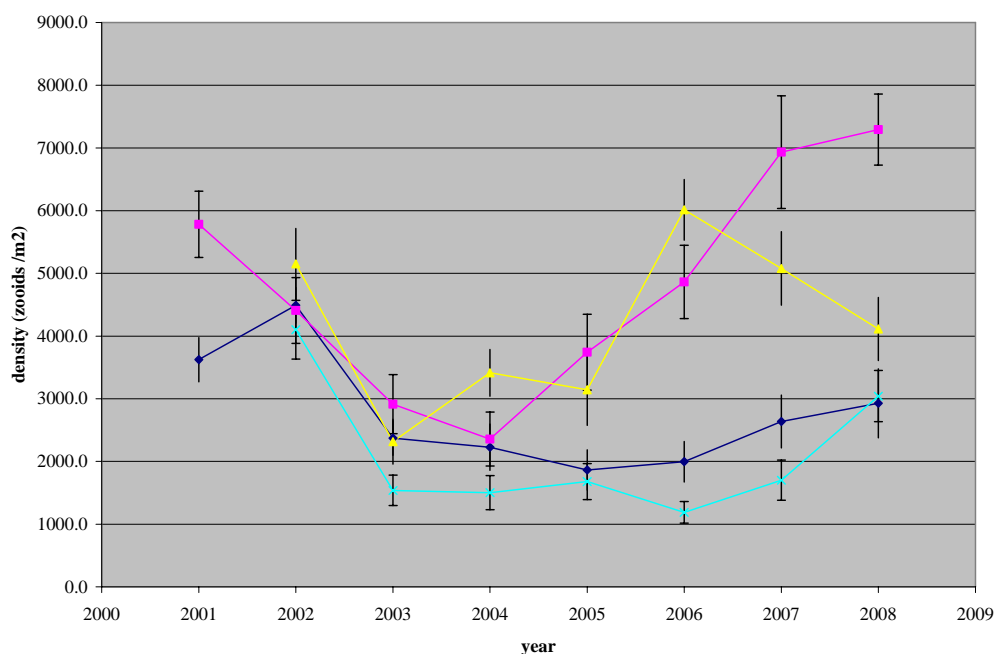
RESULTS

2008 fieldwork completed:

COLONY AREA		DENSITY
SITE	INDEX OF AREA	CLOSE UP PHOTOGRAPHS
<i>Sandy Sea Fan Gully</i>	5 transects (20 samples)	Yes
Waybench – <i>New Wall</i>	9 re-locatable samples	Yes
Waybench – <i>Deep Wall</i>	2 transects (8 samples)	Yes
Thorn Rock – <i>Piton 7</i>	3 re-locatable samples	No
Thorn Rock – <i>Mooring</i>	3 re-locatable samples	No
Thorn Rock – <i>Piton 3</i>	3 transects (11 samples)	Yes

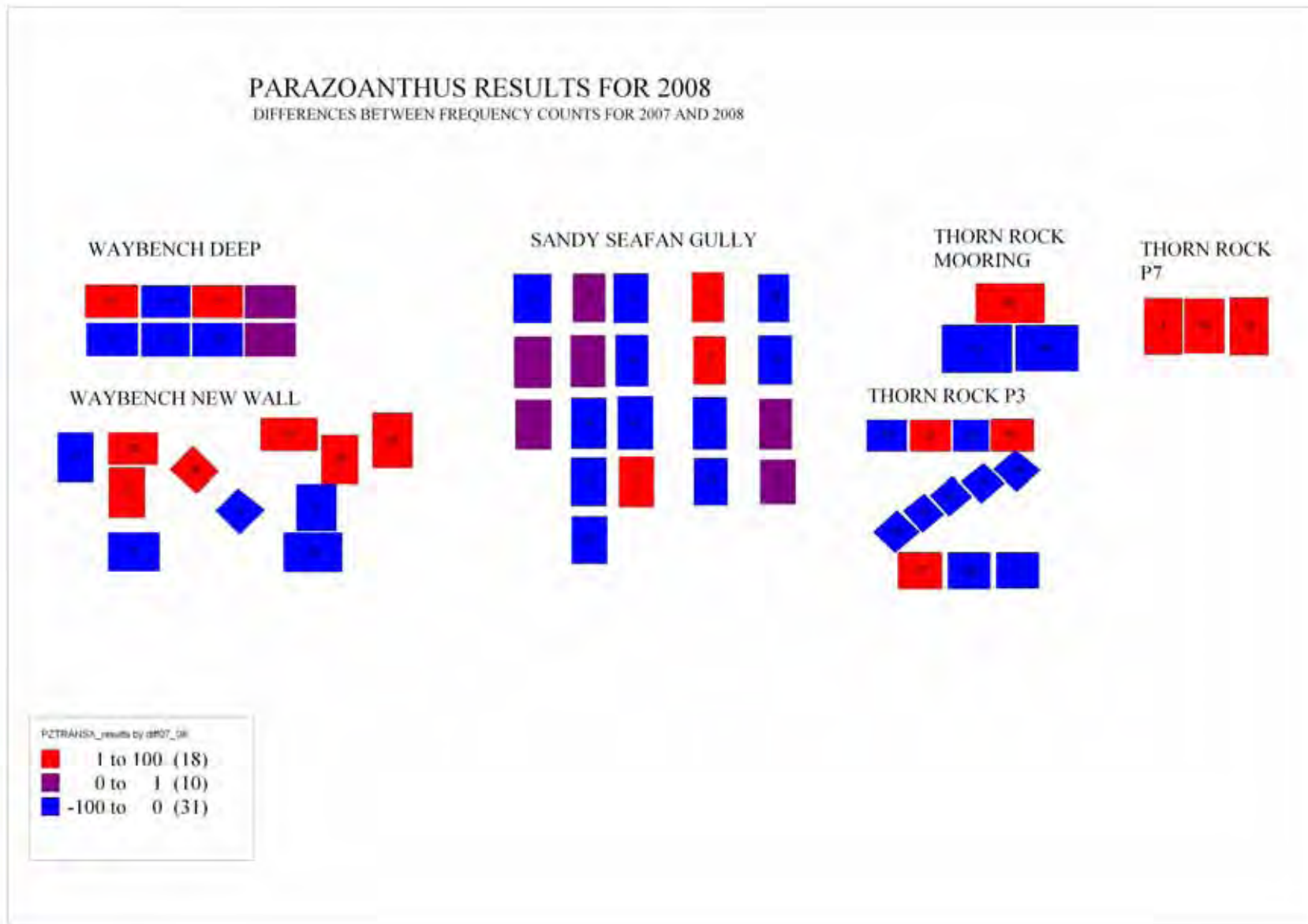
Density estimate results (number of polyps / m²)

Site		2001	2002	2003	2004	2005	2006	2007	2008
SSFG	Mean	3624.0	4491.2	2373.3	2227.3	1864.2	1996.9	2638.3	2928.1
	STDEV	1762.4	1132.8	1554.7	2085.9	1607.0	1820.4	2385.6	3106.6
	n	25	16	32	32	25	32	32	32
	std error	352.485	283.19	274.8341	368.744	321.407	321.797	421.713	549.182
TRK P3	Mean	5781.2	4408.6	2914.7	2357.9	3743.4	4863.9	6933.9	7294.5
	STDEV	2176.6	2223.4	2307.8	2432.1	3083.9	3102.8	4016.7	2711.9
	n	17	18	24	32	26	28	20	23
	std error	527.905	524.067	471.0725	429.942	604.799	586.368	898.165	565.466
Way New	Mean		5151.69	2315.9	3414.1	3143.4	6013.33	5078.68	4112.5
	STDEV		2,264.6	2,075.0	2,078.4	2,658.9	1872.3	3,410.9	2,463.7
	n		16	34	31	22	15	34	24
	std error		566.157	355.8524	373.294	566.872	483.427	584.965	502.908
Way Deep	Mean		4101.4	1539.5	1502.6	1679.5	1188.7	1701.6	3042.6
	STDEV		1871.5	1264.6	1553.8	1,494.3	958.228	1808.31	2121.11
	n		16	27	33	27	31	32	27
	std error		467.884	243.3808	270.476	287.572	172.103	319.668	408.209

Density of polyps 2001 - 2008**Mean *P. axenellae* density / m²**

RESULTS OF COLONY AREA TRANSECTS FOR 2008

Changes in frequency between 2007 and 2008 (blue shows a loss in frequency red shows an increase)

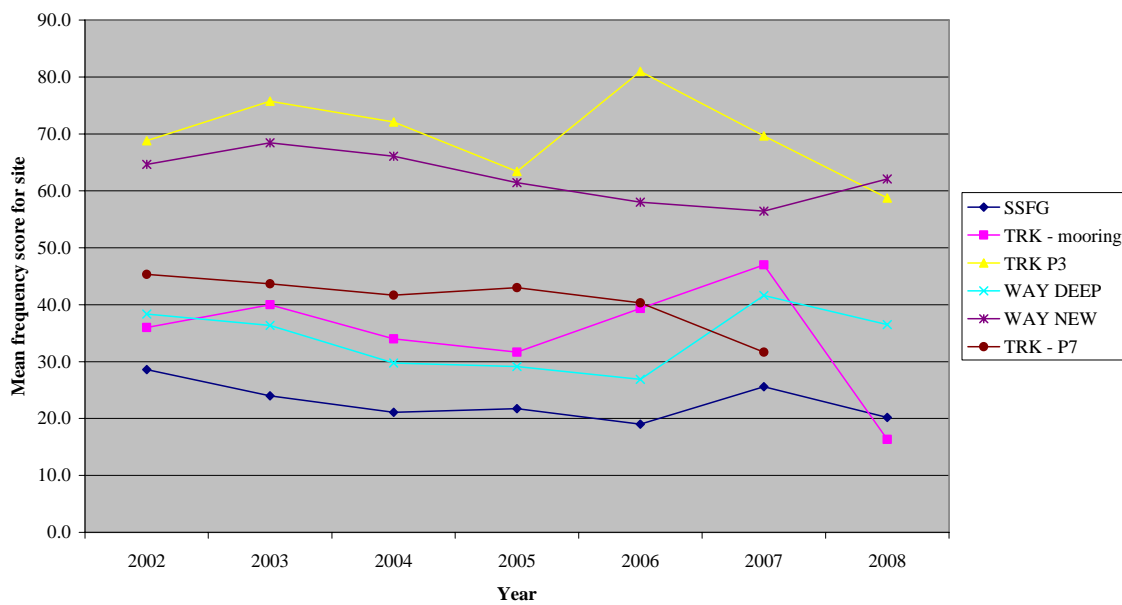


Transect results 2002 - 2008

Mean frequency score from a 120 square grid.

Site / Year	2002	2003	2004	2005	2006	2007	2008
SSFG	28.6	24	21.1	21.8	19	25.6	20.2
TRK P3	68.8	75.8	72.1	63.4	81	69.6	16.3
TRK P7	45.3	43.7	41.7	43	40.3	31.7	58.7
TRK Mooring	36	40	34	31.7	39.3	47	48.7
Way Deep	38.4	36.4	29.8	29.1	26.9	41.6	36.5
Way New	64.6	68.5	66.1	61.4	58	56.5	62.1

Parazoanthus transect results 2002 - 2008



CURRENT STATUS

All the colonies are still present. The frequency counts suggest a mixture of gains and losses in area covered between 2007 and 2008 but overall the trend is stable. The density counts have a stable or increasing trend.

RECOMMENDATION

- Continue 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

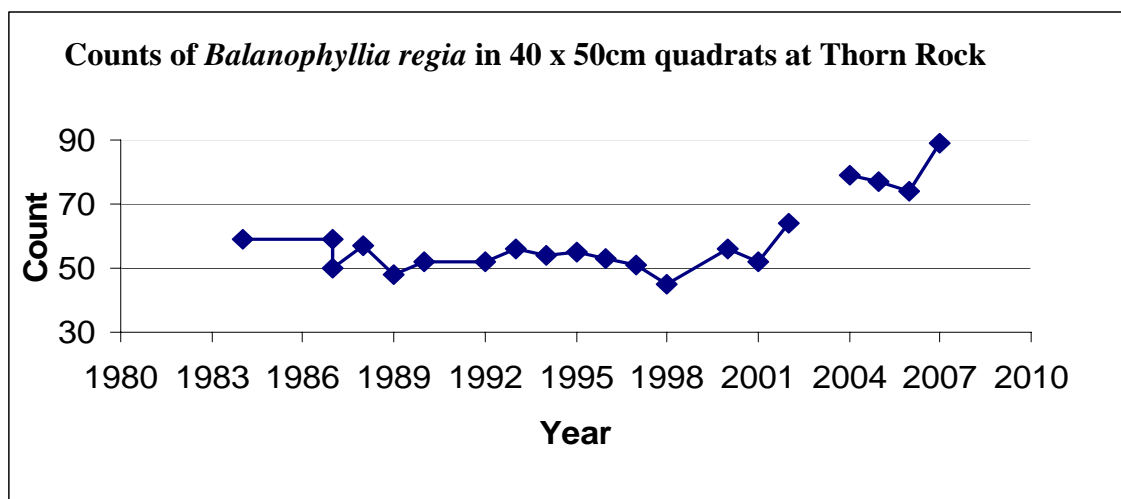
Balanophyllia regia: A fixed position quadrat using a 50 x 40 cm framer at Thorn Rock has been photographed since 1985. In 2002 three transects with 51 quadrats were established at the Wick. Photographs are taken and counts are carried out using GIS techniques (see Burton, Lock & Newman 2002). In 2008 the framer size at the Wick was increased to 50 x 70cm using a digital SLR camera, providing high quality images allowing improved photo analysis.

Caryophyllia smithii: approximately 70 quadrats have been analysed on a yearly 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, however surface sediments obscure small individuals.

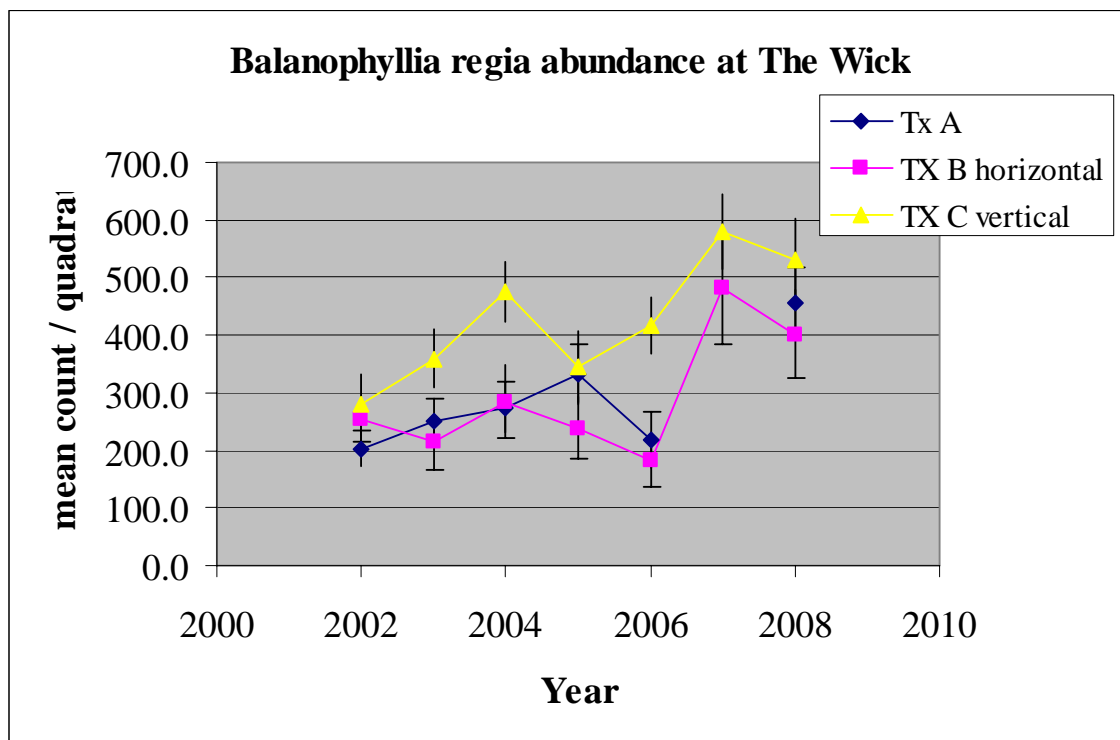


At the Wick all data has been adjusted to 1m² to enable the data from the 50 x 40 cm and the 50 x 70cm framer to be comparable. The average number of *B. regia* has fluctuated but there are no significant differences in densities observed between the 6 years for transects A, B or C. 2007 and 2008 data shows a general increase in abundances for each transect, continued data is needed to monitor this trend.

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

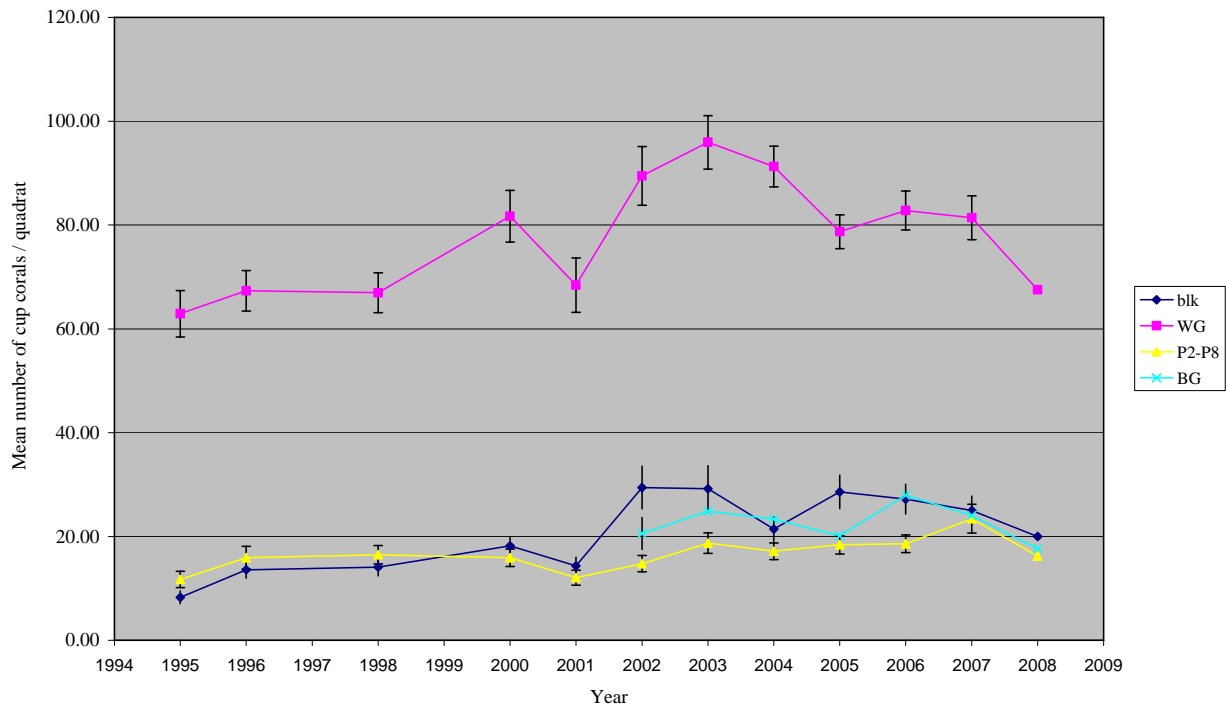
Site	Year	2002	2003	2004	2005	2006	2007	2008
WCK A	Mean	202.5	251.8	274.8	333.6	217.8		454.7
	S.E.	31.6	39.3	43.1	49.0	50.0		62.3
WCK B	Mean	252.6	214.0	283.8	239.3	183.3	483.1	401.9
	S.E.	37.7	47.0	63.0	54.7	46.4	97.6	76.4
WCK C	Mean	280.0	359.7	476.3	344.0	415.7	578.7	529.9
	S.E.	52.4	50.8	51.8	64.5	49.4	64.9	73.0

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



Caryophyllia smithii shows changes in mean abundance, this maybe due to variable levels of surface sediment affecting the actual numbers visible during recording.

Mean number of *C. smithii* per quadrat at 4 sites from 1995 to 2008



CURRENT STATUS

Ongoing. 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

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

SITES

- North of the Neck (2002- onwards)
- North wall (1984 – 2002)
- Way bench (1993/4 restarted 2002- onwards)
- Bernie's Rocks (2 sites 1995 onwards)
- South of Middleholm (2003- onwards)

METHODS

Photographs are taken using a single or stereo camera set up on a frame 50 x 70 cm. Photographs of *P. foliacea* are taken along marked transects at each site.

RESULTS

***Pentapora foliacea* photo dataset:**

Site	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Waybench	yes	no	no	no	no	no	no	no	no	yes	yes	yes	yes	yes	yes	yes
Bernie's Rks Deep			yes	no	yes	yes	no	yes	no	yes	yes	yes	yes	yes	yes	yes
Bernie's Rks Shal		yes	yes	no	yes	yes	no	yes	no	yes	yes	yes	yes	yes	yes	yes
North of Neck										yes	yes	yes	yes	yes	yes	yes
South Middleholm										yes	yes	yes	yes	yes	yes	yes
Northwall (1984-	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes						
West Hook												yes	yes	yes	yes	yes

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

1998 - Gilbert tested various image analysis methods for assessing growth rate, but concluded that a 3D method would be most suitable. Colonies can be put into size classes using base area (cm²) however this is only an approximate measure of colony size.

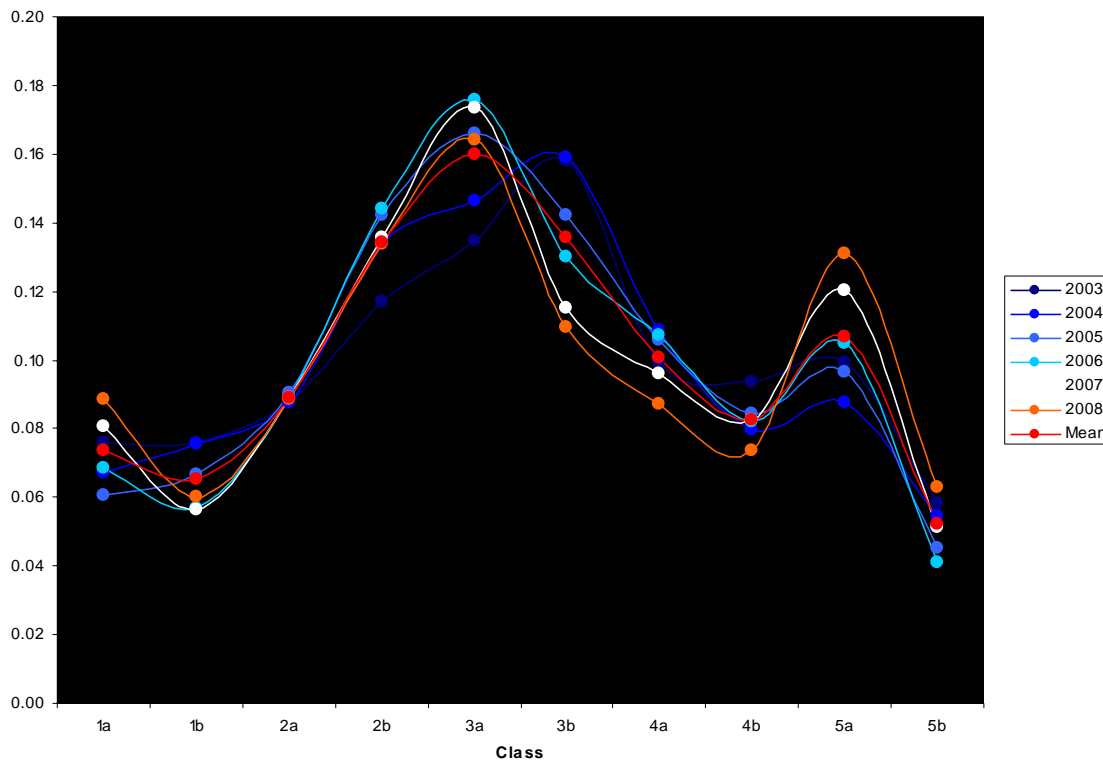
2005 - Analysis methods were reviewed. The growth of *Pentapora* colonies varies dramatically; one colony showed an increase in base area of over 800cm² in one year, whilst other large colonies have

all but disappeared. In general colonies that survive tend to grow whilst other colonies of all sizes can just disappear in the space of a year. This suggests that colonies are being physically destroyed or rapidly disintegrate rather than just decrease in size by slow wastage. In 2005 base area measurements were not completed due to inaccuracies in the method.

2006 - Gibbs developed an empirical calibration method by which a three-dimensional reconstruction of a *Pentapora* colony may be created from stereo-photographs. This method allows the quantification of the growth of the *Pentapora* 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 - The morphological classification method was applied to the current and historical photo dataset, this was continued in 2008. The following graph shows a general pattern with some fluctuations between year sets. Class 3 stage individuals are the most abundant in the population, these can then either progress into a class 4 and then to a class 5 stage (degradation) or move directly from a class 3 to a class 5 stage missing the class 4 stage out. This is demonstrated by the higher numbers of class 5 individuals compared to class 4.

Skomer Cumulative Sigma Curve



It is recommended that the method is field tested during in-situ surveys at a selection of sites. Study sites need to include those 'non-impacted' by morphological activities to allow an understanding of normal community functioning of *P. foliacea*. Currently there are none in the Skomer MNR.

Pentapora foliacea* Biological Research by Dr Jo Porter.*Genetics**

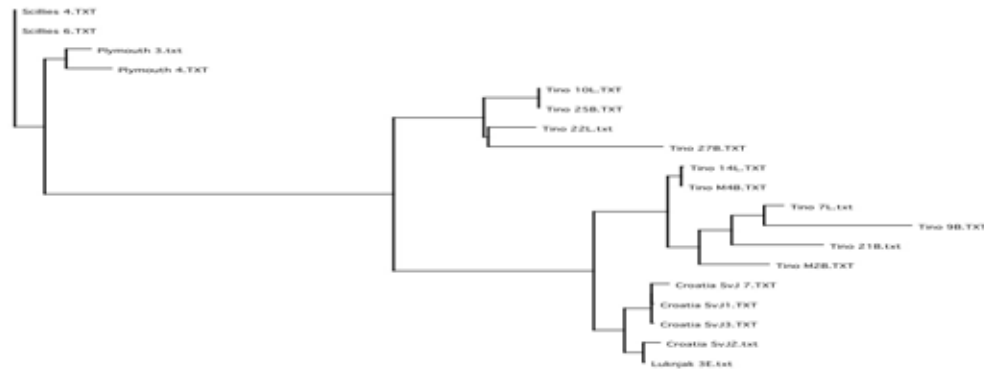
During April 2008, Chiara Lombardi visited the lab of Dr Jo Porter at Aberystwyth University. Prior to this visit Dr Jo Porter and Mr Scott Tompsett (PhD student, Aberystwyth University) joined Dr Maja Novosel and Dr Piotr Kuklinski, in Croatia to collect further samples of *Pentapora* from the Adriatic Sea.

The samples previously collected at the MNR had been used in technique development, but due to problems with getting enough clean DNA these samples had to be discarded from the analysis. With recently collected material, it has been found that by dissecting out the lophophores at the growing edge, a reasonable amount of pure tissue may be obtained for DNA extraction. The table below illustrates samples that have been collected and used in the analysis so far and the success of DNA/sequencing.

Location	Colony form	DNA extracted	DNA sequence obtained
Gateholm	Laminar	Y	X
Watwick Point	Laminar	Y	X
Plymouth	Laminar	Y	Y
Tino Island, Italy	Dichotomous and Laminar	Y	Y
Sveti Juraj, Croatia	Dichotomous	Y	Y
Lucnjak Island, Croatia	Dichotomous	Y	Y
Sark	Laminar	Y	Y
Marseilles	Dichotomous	Y	X
Isle of Wight	Laminar	Y	X
Scillies	Laminar	Y	Y

Three gene regions have been targeted so far, COI (mitochondrial DNA), Elongation factor 1 alpha (nuclear DNA) and 28s r RNA (nuclear DNA). The data so far show that there is variability between locations in the COI gene, and also with the EF1 alpha gene. 28s analysis has been focussed on the Mediterranean samples, and there is little variability between them, we are waiting for further sequence results for the UK material in order to complete the analysis for this gene region.

A preliminary phylogenetic analysis has been conducted on the COI sequence data. See the diagram below. This analysis indicates that there is some differentiation occurring between the UK and the Mediterranean samples.



Some bootstrapping analysis to provide confidence limits for the branches has revealed that there is good support for this tree topology.

The next stage in the analysis would be to try to obtain some samples from the Atlantic coast of France and Spain, some samples from around Gibraltar and some samples around the Mediterranean coast of Spain. It would also be interesting to include some samples from around the Isle of Man and the west coast of Scotland if they could be obtained. By analysing these further samples it would be possible to fill in gaps of the known geographic distribution of *Pentapora*. As it stands at the moment, it seems that there is significant separation genetically between the UK laminar morphology and the Mediterranean dichotomous branching/laminar morphologies, suggesting that they might be considered as separate allopatric species. Further analysis involving haplotype mapping (ongoing) and mismatch analysis should reveal information regarding the extent of gene flow between locations and whether the population sizes have undergone demographic change (i.e. expansion/contraction) in the recent past. These further analyses should help to provide support or not for the hypothesis that there are two separate species.

The technique for the DNA sequencing is now much improved following several rounds of development and as new samples arrive it should be straightforward to screen them within a period of 2 weeks. When this further data is collected a manuscript for publication will be prepared.

Morphology

Chiara Lombardi has completed a full morphological analysis of all the specimens using Scanning Electron Microscopy and this information is currently being written up into a paper for publication. The analysis shows very little difference in the morphology of the zooids of *Pentapora* between UK and Mediterranean populations.

Bacterial analysis

From the work of Jasmine Sharp (PhD student, Aberystwyth University), a paper was published in 2008 regarding the extent of biofouling on the surfaces of zooids of *Pentapora* collected at Skomer MNR. Crude assays of the tissue of *Pentapora* have been used in anti-microbial tests, and results have shown that there is some anti-microbial activity against specific reporter strains of bacteria. More work

needs to be conducted to repeat these results and Jasmine has now completed the PhD and taken a position at Bangor University. A second PhD student Heather Moore has taken up the mantle and when she is trained up, it is hoped to continue with this area of study.

***Pentapora foliacea* Biological Research by Tanya Knowles.**

In 2007 and 2008 Tanya Knowles a PhD student based at the Natural History Museum, London requested samples of *P. foliacea* to support her research. Tanya is investigating palaeoclimate using two different techniques:

1. Variation of zooid size within a colony. Intra-colonial zooid size relies on bryozoans following the inverse size-temperature rule i.e. smaller zooids in warmer temperatures, larger zooids in colder temperatures. This is seen as an empirical relationship between the amount of variation seen and the annual temperature range experienced. This is being done on fossil bryozoans, including fossil *Pentapora*, so having some data where the technique can be tested using recent *Pentapora* really supports the use of the technique.

The tests showed that the zooid size variation technique gives good estimates of seasonal temperature variation. Specimens collected from Skomer were used, the annual temperature range estimates varied between 6.3 to 7.5°C closely matching the actual temperature range that varies between 6.6 and 8.3°C.

2. Isotopic signature of the carbonate skeleton. It is believed that bryozoans deposit their skeletons in isotopic equilibrium with seawater and they grow over a period of time. Therefore, it should be possible to analyse the stable oxygen isotopes in the carbonate and use these to provide information about the seawater temperature when the carbonate was deposited. The *Pentapora* samples from Skomer are ideal as they come from a place where the temperature has been recorded at a depth where the bryozoans lived (not just sea surface).

The tests have shown some seasonal inferences but the isotope signal doesn't seem to be reflecting the coldest temperatures that the datalogger at 18m recorded. This could be for a number of reasons: *Pentapora* is bimineralic and is made up of calcite and aragonite, the latter being added to the skeleton gradually, thickening up the skeleton over time. If this thickening happens over time, and when conditions are warmer, then the sample analysed for isotope ratios will have a mixture of carbonates, the original calcite skeleton and the aragonite added later, suggesting a warmer temperature.

It is possible that when a zooid is bulk analysed, the temperature suggested by the isotopes is higher than it may really have been. This is one sensible explanation. However, this was tested analysing the calcite walls of the skeleton only, before any aragonite was added. This produced the same sort of results too and this can not be explained.

It is proposed that further tests are carried out to thin section some *Pentapora* pieces and see if the zooid walls look as though they are formed of many layers which are likely to be added to over time.

It should be stressed that MNR staff collect suitably fresh pieces of *Pentapora foliacea* that are already broken rather than from intact colonies, wherever possible.

RECOMMENDATIONS

1. Maintain long-term photographic datasets of individual colonies at a number of different sites.
2. Complete in-situ recording of colonies using the morphological classification system identify community structure at a number of different sites.
3. 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.
4. Continue surveillance to establish the longevity of the colonies and their response to damage.
5. Continued research is needed on the biology of *Pentapora foliacea*.

REFERENCES

Bunker & Mercer 1988, Bullimore B. 1987, Gilbert S. 1998, Gibbs R. 2007.
Pope A. 2006, Cocito S.*et al* 1998, Sharp J et al 2008, Porter J. 2009. per
comms, Knowles T 2009. per comms.

***PECTEN MAXIMUS* (SCALLOP) POPULATION**

(CMS code: RM53/01)

STATUS Ongoing. Volunteer survey every 4 years (next survey 2012).

PROJECT RATIONALE

The scallop population in the northeast of the Reserve is of conservation value because of its small size and its remoteness from any substantial population. Scallops were collected commercially and recreationally in the area of the Reserve until 1990. In 1990 the South Wales Sea Fisheries Committee (SWSFC) introduced a byelaw prohibiting scallop collecting by any means. The population of scallops needs to be monitored in order to assess the effectiveness of this byelaw.

OBJECTIVES

To estimate the density of scallops within suitable habitats in the Reserve and to assess the age structure in the population.

SITES

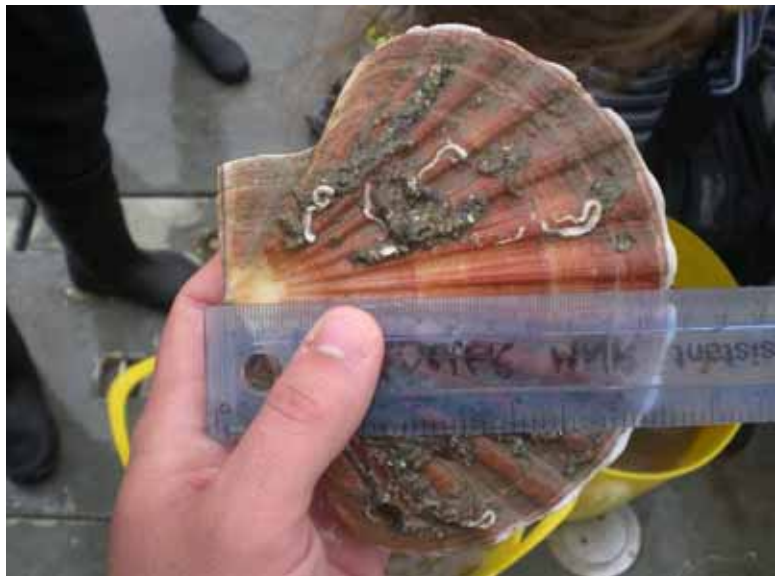
2000 survey established 3 sites, a further 4 sites were added in 2004 giving a total of 7 survey sites. The 7 sites were surveyed in 2008.

METHODS

The 1979-82 and 1985 surveys used slightly different methods. In 2000 a standard method was developed suitable for volunteer diving teams and which could be repeated in subsequent surveys.

Scallops are collected by divers from a two metre band, one metre either side of 50m transects (100m²). The scallops are brought to the surface, their growth rings measured, shells marked with notches for identification and then returned to the site.

This is repeated for several transects over several sites of suitable habitat. Full methods detailed in Lock & Newman 2002.



RESULTS

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

Bullimore **1985a** summarises the available data for 1979 – 1982. Scallop survey was completed at North Marloes Peninsula sites and North of the Neck, densities of 0.01m⁻² (1/100 m⁻²) were estimated for all sites.

2000 survey was completed using a small team of 8 volunteer divers and 3 fixed sites were established. The results suggest an increase in density to 0.04 m^{-2} ($4/100 \text{ m}^{-2}$) compared to 1985 with a maximum site density of 0.10 m^{-2} ($10/100 \text{ m}^{-2}$). The age class data suggested strong recruitment in 1992 – 94, 2 years after the SWSFC byelaw was introduced.

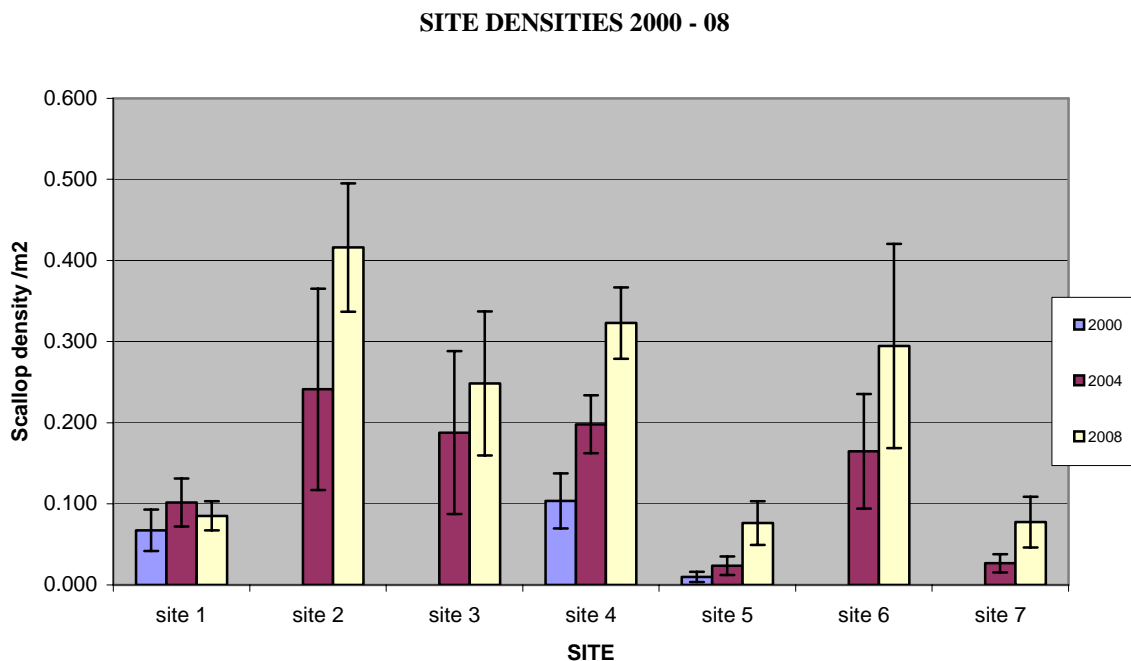
2002 A joint collaborative SWSFC/ MNR scallop poster, explaining the byelaw, was produced in 2002. This was distributed to local dive clubs and dive shops and has been posted at local slipways.

2004 survey was completed with a large team of 50 volunteer divers. Sites established in 2000 were resurveyed and a further 4 sites established. The total area surveyed was $10,632 \text{ m}^2$ and 1312 individuals were measured. Mean density for the whole MNR in 2004 was 0.12 m^{-2} , showing a 3-fold increase since 2000 (0.04 m^{-2}).

2008 survey repeated the 7 sites previously established with a team of 40 volunteer divers. The total area surveyed was 9780 m^2 and 1653 scallops were measured. The mean density for the whole MNR in 2008 was 0.169 m^{-2} higher than the overall density recorded in 2004.



The graph below shows the differences in scallop densities at each site over the eight years. The error bars are the 1.96 standard error bars, representing the 95% confidence interval.



It is clear that the site 4 and 7 have seen significant increase in scallop density, with 3 fold increase over the 8 years. Site 2 has a significant increase at 90% but not 95% confidence limits. Site 6 has not shown significant increase, but the data has very broad error bars for this site, indicating difficulties with the sampling.

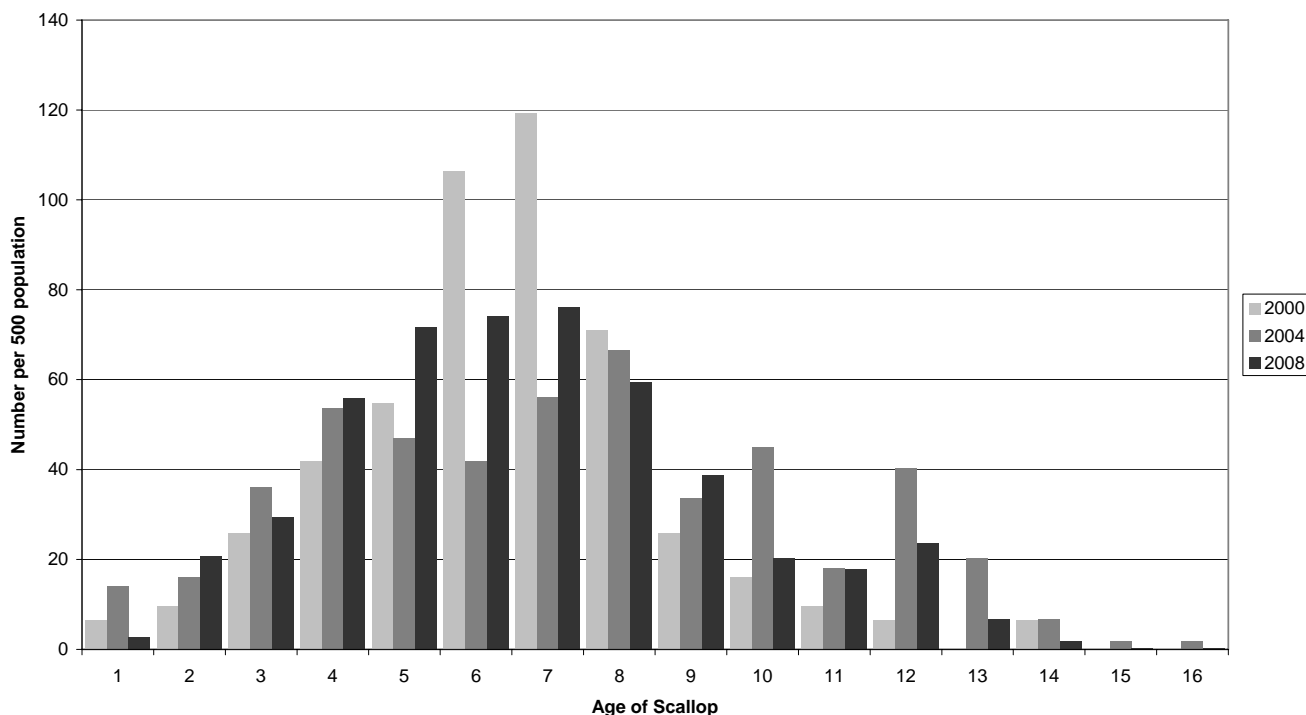
There is a clear separation of sites within the Skomer Marine Nature Reserve into those for which the density of scallops has increased some 3-fold over the last 8 years (sites 7, 5, 4 and Site 2 (90%)) and those for which there has been no significant change in scallop density (sites 6, 1 and 3).

Scallop Age classes

Scallop age is determined by counting the number of growth rings present, one growth ring representing one year of growth. Growth rings up to the age of 7 are distinguished with reasonable confidence, but growth rings 8 and above are more difficult as growth slows down and the distance between rings is very small. Therefore for ages of 8 years or above the mean growth rate of an annual increase of 1.033 times the previous year has been used to extrapolate scallop sizes.

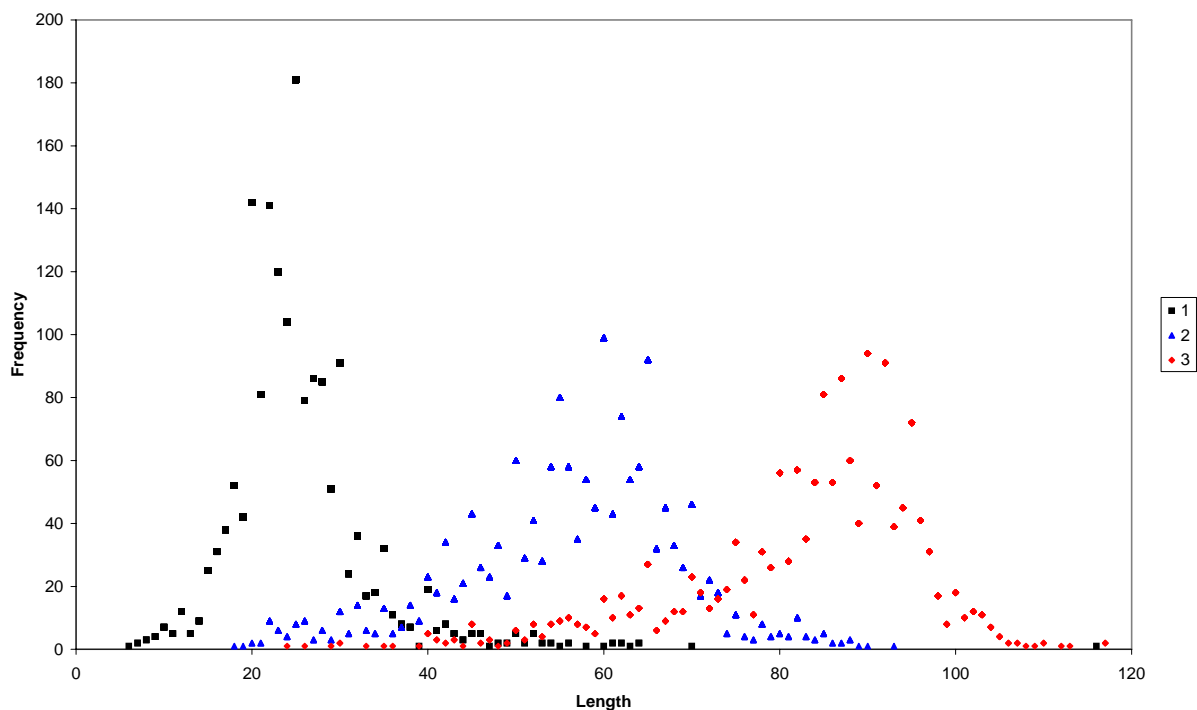
The following graph shows the ages for all sites in 2000, 2004 and 2008, each show a normal distribution.

Scallop Ages (per 500 population) in Skomer MNR



Scallop growth

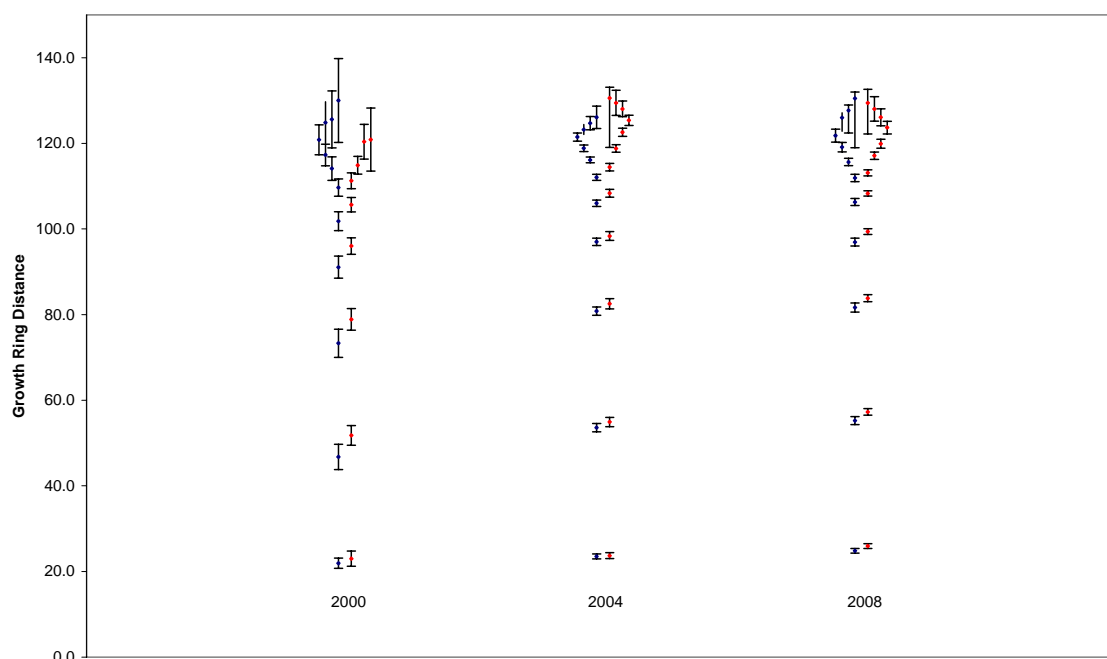
Scallop growth is determined by measuring the length distance of each growth ring. Growth rings on some scallops were difficult to identify but with the numbers of scallops measured it is possible to smooth out this difficulty. The 2008 length frequency graph shows the first three growth rings of the scallops measured.



The graph shows that the position of each growth ring is fairly normally distributed about a common mean and this pattern was also seen for the 2000 and 2004 data.

The 1985 study suggested that there is a biannual nature to the recruitment of scallops, with two distinct spawning times during one year. No obvious bimodal pattern was present in the 2000, 2004 or 2008 data, with all growth rings indicating only a single mid point with varying degrees of spread. It is possible that the bimodal effect is so slight it is not detectable within the level of noise (spread of curve) of these data, if it does exist.

The scallop growth was investigated between those sites that had shown an increase in density (sites C) and for sites where there had been no significant change (sites NC). The mean length distance for each growth ring, along with the 95% confidence standard error bars have been calculated and are presented on the following graph:



On the X axis the plot is separated between 2000, 2004 and 2008. For each of these years the data is then further separated into the data for the sites C (red) and NC (blue). The length of each growth ring is plotted on the Y axis with the 95% SE bars, progressively from the 1st year to the 12th year. From the 7th year onwards the data point are stepped out simply for clarity in distinguishing the error bars.

The graph shows that the length of the growth rings from Sites C is greater than those from sites NC. This shows that where a site is suitably favourable for population increase, it is similarly favourable for growth of individual scallops. A scallop of a given age will be larger at a site where population density is increasing than where population density is constant, and a scallop of given age in 2008 will be larger than a scallop of that same age in 2004 and again in 2000.

TARGETS

To maintain or increase the scallop population density.

CURRENT STATUS

- Seven sites were surveyed in 2008 and data compared to 2004 and 2000 surveys. An increase in density has been seen at 4 sites and no significant change in density at 3 sites.
- Age distribution shows a normal distribution curve in 2008, as was shown in 2000 and 2004.
- Growth is greater from those sites that have shown an increase in population density.
- Where a site is suitably favourable for population increase, it is similarly favourable for growth of individual scallops.

RECOMMENDATIONS

- Continue surveys every 4 years (next survey 2012);
- Future surveys follow the methods established in 2000, and repeat sites established in 2000 and 2004;
- Continue use of volunteer divers to allow sufficient data and sites to be completed;
- Support research work on the biology of *Pecten maximus*;
- Monitor sea temperature and suspended turbidity levels to provide background data for the biological monitoring.

REFERENCES Jones & Hodgson 1979 & 1980, Bullimore 1985a, Lock & Newman 2002. Luddington, Lock, Newman & Burton 2004.

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 SW 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.

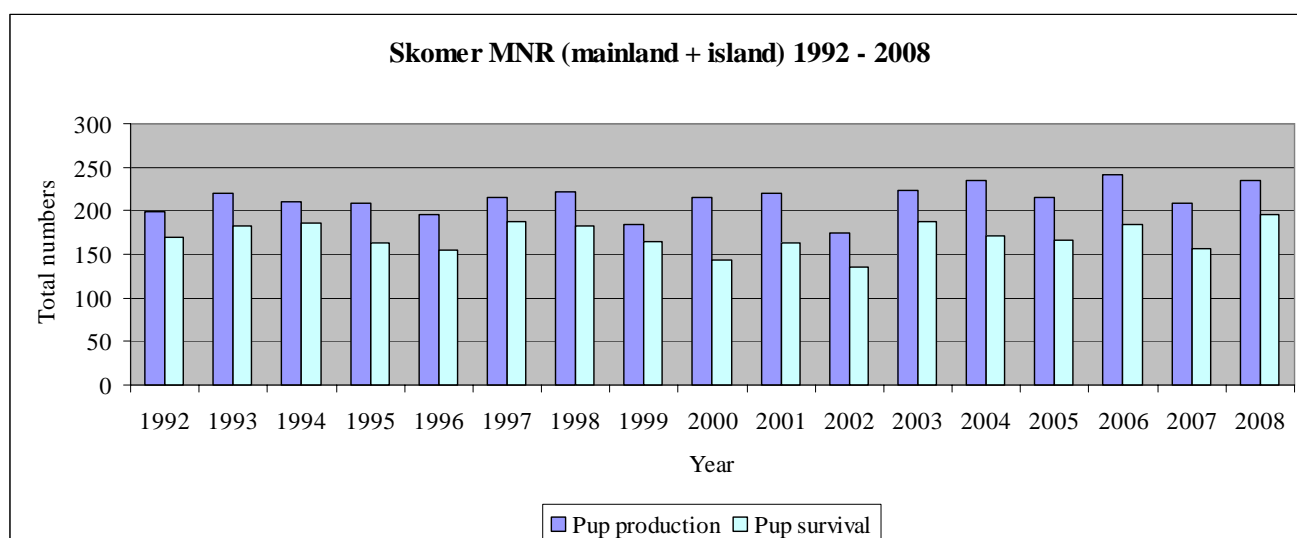
METHODS

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).

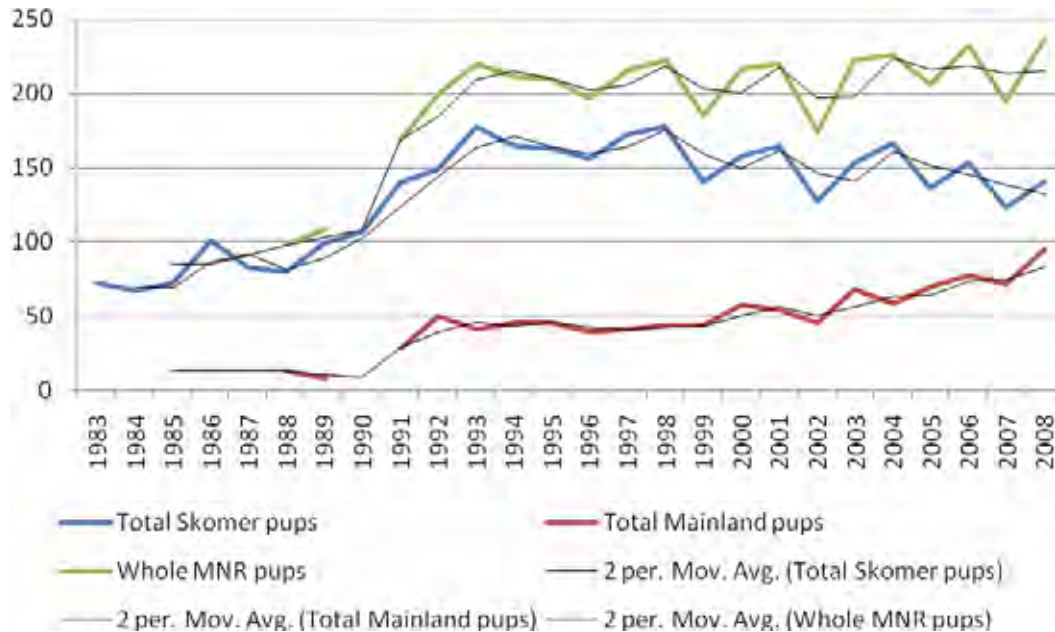


RESULTS

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.



Number of Seal Pups born in Skomer Marine Nature Reserve 1983-2008



236 pups were born in the MNR in 2008, 141 on Skomer and 95 on the mainland, the highest year ever for the mainland. The number of seal pups born each year fluctuates but looking at the trend lines the number of pups born in the MNR as a whole has remained fairly consistent for the last 17 years. The number of pups born on Skomer, however, appears to show a slow decline since the late nineties, almost exactly mirroring a gradual increase on the mainland. As far as seals are concerned Skomer and the adjacent mainland are a single site and it is only with long term monitoring of both areas that the true picture becomes clear. Monitoring just Skomer would suggest the population is in slow decline, monitoring just the mainland would suggest the seal population is increasing (Boyle 2009).

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).

Seals with distinct scar marks are sketched, photographed and allocated a code name, for example BK154-2006 (BK=back)



2005 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 At Skomer sites photography was extended to include indistinct pupping cows help increase knowledge of site fidelity, Longevity and pupping frequency (Boyle 2009).

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

2008 pup numbers reached 236, 21 pups higher than the average for the last 17 years. Pup survival was 83%, 3% higher than the average. There were relatively few periods of harsh weather until late November and little sign of disease; the majority of deaths were caused by abandonment or separation. 60% of births occurred in September. The most prolific period was week 38 (17th – 23rd September) when 46 pups were born.

In 2008 monofilament line and netting were recorded entangled on adult seals. Most of these were old cases, with 10-15 individual seals around the island showing signs of having been caught in nets at some time in their lives. Four seals were seen this year showing more obvious signs of having been caught in nets, two were returning individuals. Photo records are being maintained.



NK100 is a young cow with green monofilament netting around her neck seen for the first time in 2008. She was present throughout the season, usually hauled out in North Haven.

RECOMMENDATIONS

1. To continue annual survey following the 'Grey Seal Monitoring Handbook' Poole 1996.
2. To continue recording seal disturbance at mainland and island sites.
3. To continue the adult seal identification project following methods developed in 2004 (mainland) and 2005 (island).
4. 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.

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 1992-2007.

Seal disturbance studies: Lock 2004.

4 SKOMER MNR METEOROLOGICAL AND OCEANOGRAPHICAL 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 – current. 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 receiver 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. The website is still under development and the Skomer data is not available yet.

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.

The 2008 data is shown in the following table; no problems were incurred during the year. The graph shows the mean air temperature from 1993 to 2008.

In March 2009 the Skomer MNR data was linked to the Environmental Change biodiversity Network project (ECBN), which links into a UK wide co-ordinated project.

Countryside Council for Wales Skomer Marine Nature Reserve

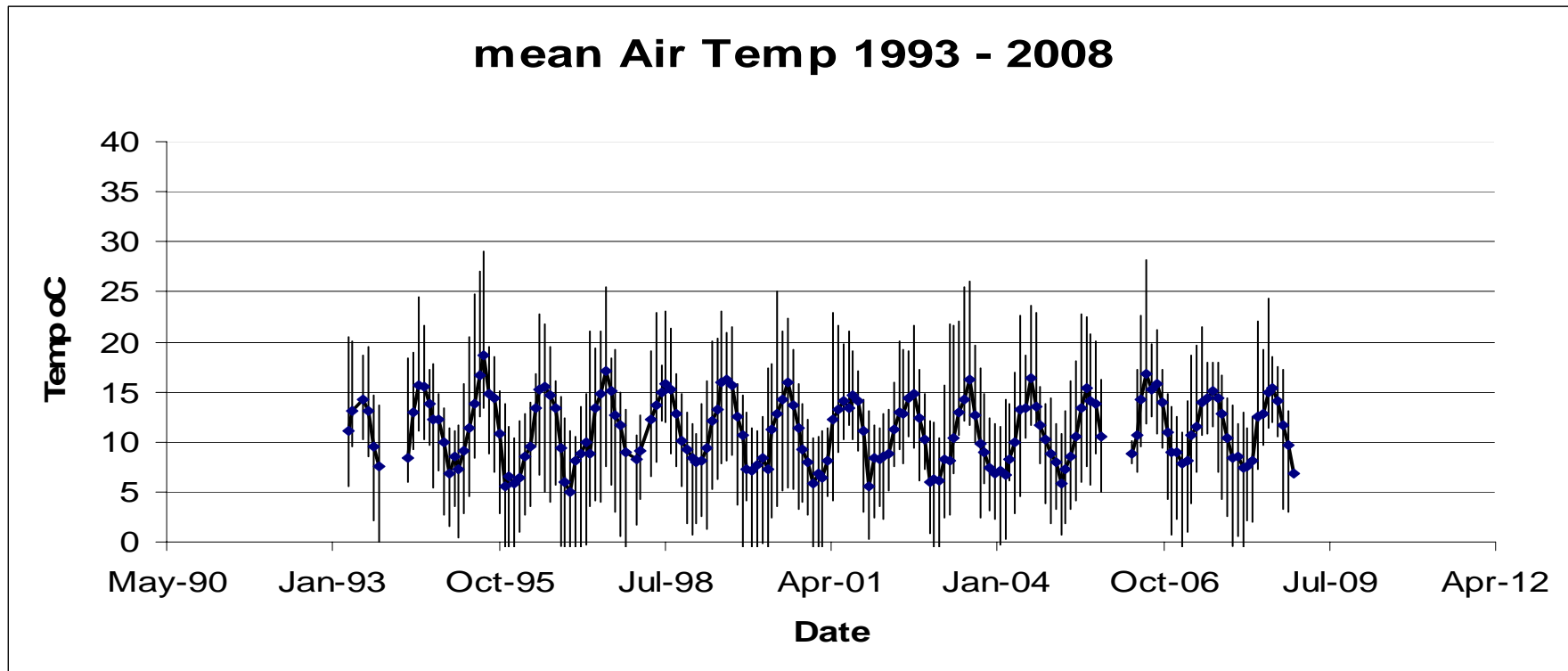
Weather station - Coastguard lookout hut, Wooltack point

Grid ref: SM75880922

Geographical position: 51.44.78N 005.14.78W

YEAR SUMMARY 2008

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AIR TEMP	MEAN	8.6	7.3	7.5	8.1	12.5	12.8	15.0	15.4	14.1	11.7	9.6	6.9
	T107_1 0c												
	MAX	11.8	12.9	11.4	12.6	22.1	19.2	24.4	18.5	17.5	17.2	13.1	11.4
	MIN	0.6	-1.0	2.2	1.9	7.3	9.7	11.5	12.0	10.5	3.3	3.0	-0.2
BAROMETRIC PRESSURE	MEAN	1002.7	1013.6	1000.3	1003.2	1007.2	1009.8	1005.6	1002.1	1009.2	1006.7	1007.4	1011.0
	MAX	1029.0	1034.0	1029.0	1026.0	1019.0	1021.0	1021.0	1016.0	1028.0	1022.0	1028.0	1030.0
	MIN	970.0	976.0	946.0	980.0	991.0	991.0	989.0	978.0	977.0	982.0	984.0	969.0
RELATIVE HUMIDITY	MEAN	82.3	81.5	77.9	81.2	80.2	86.4	86.6	88.0	83.1	80.2	81.3	80.6
	MAX	98.1	98.0	97.7	98.2	97.9	97.9	97.6	97.8	96.7	97.8	97.2	97.5
	MIN	46.1	43.4	43.1	37.0	34.6	48.4	43.3	66.8	57.7	47.6	49.2	51.4
RAINFALL	TOTAL(mm)	80.1	39.7	61.7	41.3	35.0	27.5	58.3	44.9	37.8	131.2	54.1	31.6
SUNSHINE	MEAN(kw/m2)	0.0	0.1	0.1	0.2	0.2	0.3	0.2	0.2	0.1	0.1	0.0	0.0
	sunshine hours	73.0	147.0	243.0	306.0	328.0	375.0	341.0	295.0	250.0	173.0	116.0	71.0
	Sunshine hrs (10min)	71.2	145.2	237.7	300.2	322.7	369.2	339.5	287.0	249.3	166.0	113.2	69.5
NET RADIATION	MEAN	-11.8	-1.5	39.4	71.4	83.5	131.0	111.9	75.9	38.8	12.0	-9.0	-17.4
MAX GUST	M/sec	36.3	30.0	38.3	25.4	27.9	27.1	23.3	26.3	28.8	37.5	35.8	38.8
	direction	240.0	237.2	262.5	352.2	49.9	218.3	175.3	267.6	253.3	290.7	246.3	264.9
	Knots	70.4	58.3	74.5	49.4	54.2	52.6	45.3	51.0	55.8	72.8	69.6	75.3



CURRENT STATUS

New weather station is now fully operation with no data loss since its instalment in 2006.

RECOMMENDATIONS

- Data to be made available via Internet site to allow for greater public access.

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.

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.

Shore sites:

- 2007, Onset “Hobo” pendant loggers have been deployed at: Martins Haven shore (lower, middle and upper shore) and 1m below surface on the “Morlo” mooring. 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.

RESULTS**Oceanographic monitoring site:**

Valeport series 600 MKII CTD probe water profile records:

1992	Jul – Nov	1999	May – Nov	2006	Mar – 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		
1996	Mar – Dec	2003	Jun – Sept		
1997	Aug – Dec	2004	May – Oct		
1998	Mar – Nov	2005	May – Oct		

Vemco minilog seabed temperature logger deployment:

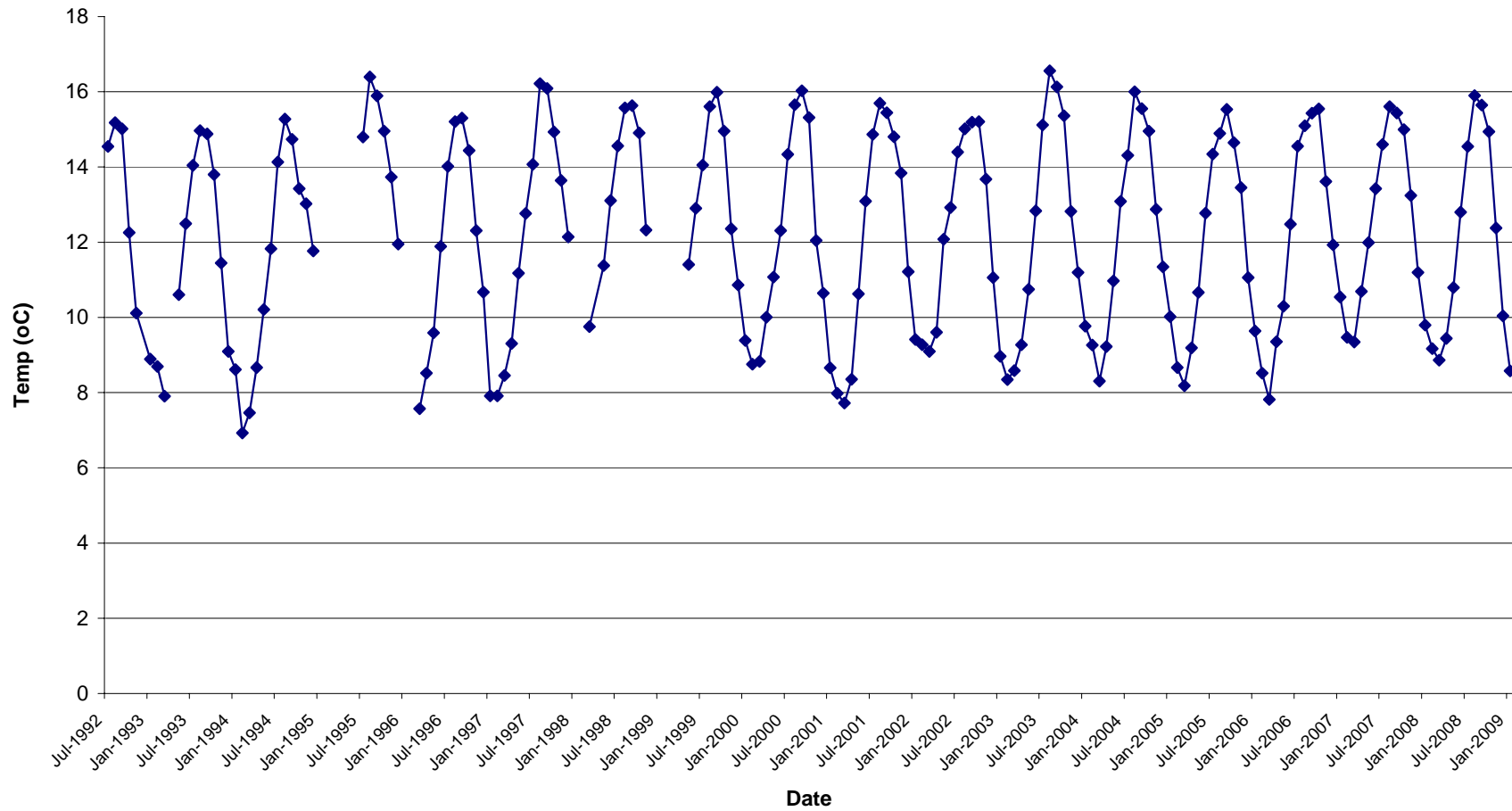
- Aug 1993 – Nov 1994
- Dec 1996 – Sept 1997
- Jul 1999 – Apr 2001
- Jun 2001 – 8th May 2002
- 30th May 2002 – ongoing

A summary of the seabed temperature (data from Vemco minilog at 19m BCD) is shown in the graph. 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 2008 are as follows (data from Vemco minilog at 19m BCD):

Temp °C	2000	2001	2002	2003	2004	2005	2006	2007	2008
Minimum	8.4	7.27	8.7	7.6	7.7	7.36	7.5	8.8	8.4
Maximum	16.27	16.3	15.6	17.1	16.76	16.4	16.3	16.3	16.3

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



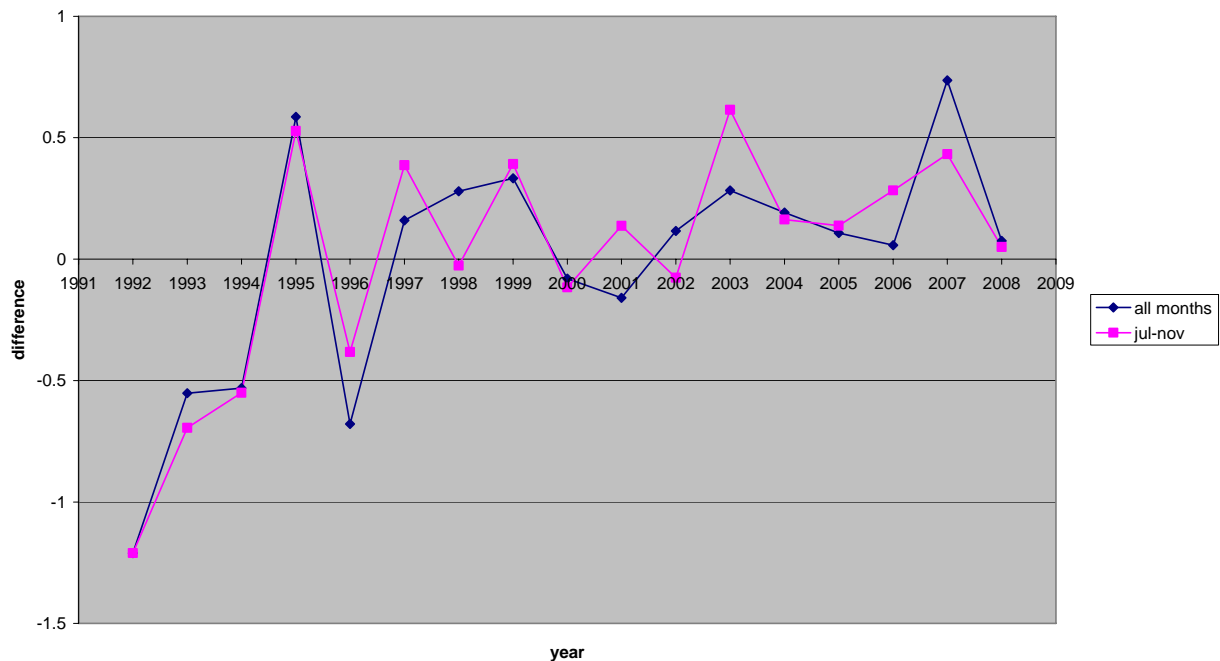
Comparing the overall monthly mean with the monthly mean for each year gives an indication of how cold / warm that particular month was compared to the whole data set. The results show that 2007 data, January- July were comparatively warm.

Difference between overall mean and monthly mean for that year

	Jan	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1992							0.04	-0.41	-0.60	-2.53	-2.56	
1993	-0.34	0.05	-0.55		-0.12	-0.21	-0.43	-0.48	-0.47	-0.95	-1.15	-1.42
1994	-0.63	-0.97	-0.48	-0.66	-0.74	-0.85	-0.60	-0.28	-0.80	-0.85	-0.21	0.71
1995							0.27	0.76	0.25	0.33	1.02	0.87
1996			-0.87	-0.68	-1.22	-0.80	-0.54	-0.43	-0.33	-0.17	-0.43	-1.30
1997	-1.34	-0.73	0.02	0.24	0.49	0.22	-0.29	0.30	0.67	0.32	0.94	1.09
1998			1.27		0.62	0.49	0.11	-0.10	0.14	0.29	-0.58	
1999					0.67	0.24	0.57	0.10	0.51	0.34	0.43	-0.21
2000	0.14	0.11	0.28	-0.18	-0.03	-0.27	-0.27	0.04	0.37	-0.04	-0.68	-0.42
2001	-0.59	-0.66	-0.72	-0.72	-0.24	0.19	0.09	0.12	-0.29	0.19	0.58	0.15
2002	0.17	0.63	0.65	0.79	-0.66	0.19	-0.29	-0.73	-0.47	0.16	0.95	0.00
2003	-0.28	-0.29	0.14	0.21	0.06	0.36	0.61	0.84	0.78	0.75	0.10	0.13
2004	0.52	0.62	-0.14	0.16	-0.06	0.11	-0.26	0.44	0.15	0.34	0.15	0.28
2005	0.77	0.02	-0.26	0.12	-0.08	0.02	-0.19	-0.46	0.06	0.56	0.72	0.00
2006	0.39	-0.12	-0.65	-0.45	-0.51	-0.24	-0.10	-0.33	0.02	0.93	0.89	0.86
2007	1.29	0.82	0.91	1.06	1.77	0.68	1.26	0.20	-0.19	0.38	0.52	0.13
2008	0.55	0.53	0.42	0.11	0.05	-0.13	0.01	0.42	0.20	0.32	-0.71	-0.87

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 monthly mean and the overall monthly mean (1992-2007)



Mean differences between the average month's temperature and the overall monthly average.

	1992	1993	1994	1995	1996	1997	1998	1999	2000
Mean yearly difference	-1.21	-0.55	-0.53	0.59	-0.68	0.16	0.28	0.33	-0.08
Mean difference for July-Nov	-1.21	-0.69	-0.55	0.53	-0.38	0.39	-0.03	0.39	-0.12
	2001	2002	2003	2004	2005	2006	2007	2008	2009
Mean yearly difference	-0.16	0.12	0.28	0.19	0.11	0.06	0.74	0.08	To be collected
Mean difference for July-Nov	0.14	-0.08	0.61	0.16	0.14	0.28	0.43	0.05	To be collected

Shore monitoring sites

10 Onset Hobo temperature / light loggers have been placed at 2 shore sites around the Reserve and 3 other shore locations in Pembrokeshire. These loggers will provide a record of the temperature regime experienced by sessile organisms in the inter-tidal zone.

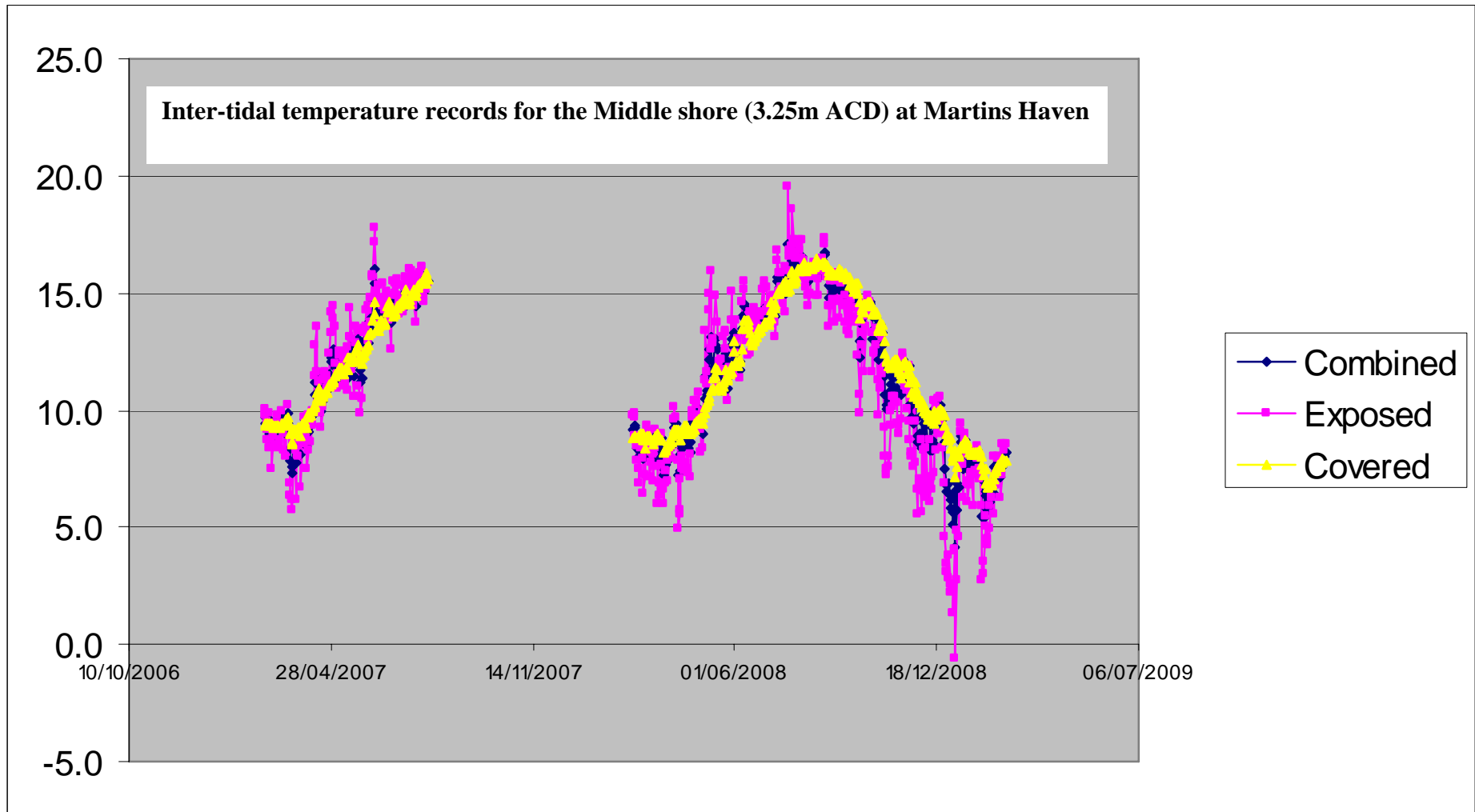
An example of temperature data from the middle shore, Martins Haven is shown on the graph (next page).

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).



Pink line = logger exposed to the air. Yellow line = logger covered by tide. Blue line = average of all readings

SEAWATER TURBIDITY / SUSPENDED PARTICULATES (CMS CODE RP63/01) AND SEABED SEDIMENTATION (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:

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 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.

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 3 times to date and again, with varying levels of success.

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 side Skomer island)

Year	1992	1993	1994	1995	1996	1997	1998	1999	
Yearly Mean	4.3	4.2	5.5	6.15	6.0	5.3	5.933	7.53	
Number of samples	29	36	35	20	27	12	23	15	
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008
Yearly Mean	7.2	7.93	6.23	6.73	6.0	6.2	5.4	5.8	5.7
Number of samples	20	12	20	17	20	22	23	19	23

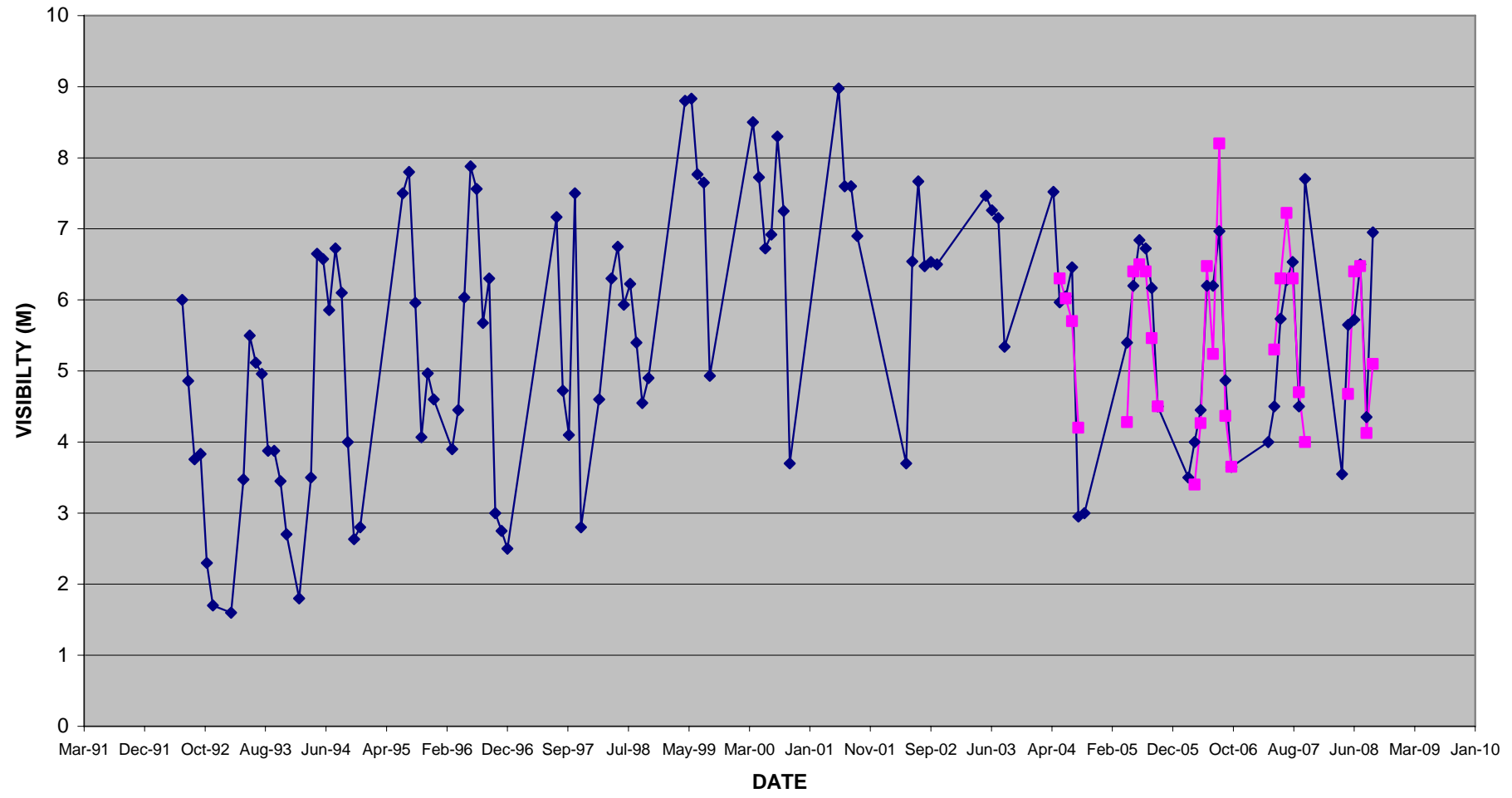
Thorn Rock

(south side of Skomer island)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008
Yearly Mean	no data	no data	no data	no data	5.8	5.7	5.5	5.9	5.5
Number of samples	no data	no data	no data	no data	12	22	22	18	20

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 2008. Plotting the mean difference between the monthly average and the overall average highlights any significant fluctuations.

MEAN MONTHLY SECCHI READINGS



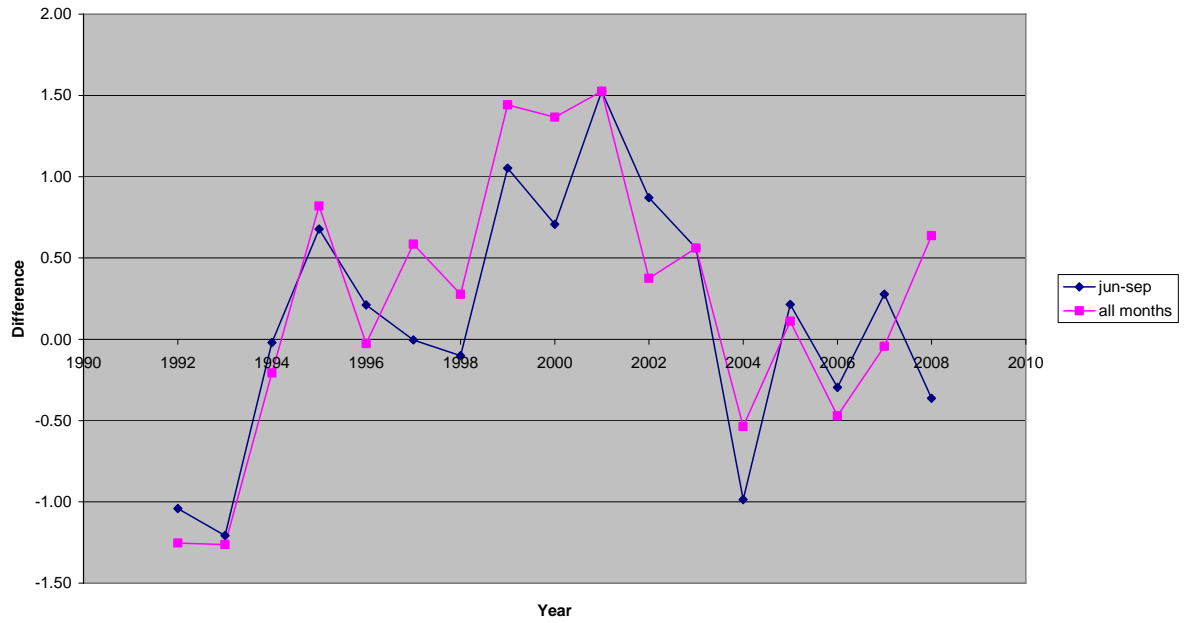
OMS = Blue line, TRK = Pink line

OMS monthly means summary – Secchi disc depth (m)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Jan																	
Feb			0														
Mar		-1.8			0.5		1.2										
Apr			-0.89		0.06				4.11							-0.39	-0.84
May		-2.33	0.85		0.23		0.50	3.00	1.92		-2.10		1.72	-0.40	-1.35	-1.30	-0.15
Jun		-1.25	-0.17		1.13		0.00	2.09	-0.02	2.23	-0.21	0.72	-0.78	-0.55	-0.55	-1.01	-1.03
Jul	-0.61	-1.49	-0.75	0.89	0.95		-0.67	1.16	0.31	0.99	1.06	0.65	-0.56	0.23	-0.41	-0.33	-0.11
Aug	-1.47	-1.37	0.40	1.47	-0.65	0.84	-0.10	1.32	1.97	1.27	0.15	0.82	0.13	0.40	0.64	0.21	-1.98
Sep	-1.53	-1.41	0.81	0.67	1.01	-0.56	0.11	-0.36	1.96	1.61	1.24	0.05	-2.34	0.88	-0.42	-0.79	1.66
Oct	-0.56	-0.51	-0.39	-0.32	-1.39	-0.29	0.16		-0.69		2.11		-1.39	0.11	-0.74	3.31	
Nov	-1.57	-0.42	-1.24	1.09	-1.12	3.63	1.03										3.73
Dec	-1.79	-0.79	-0.69	1.11	-0.99	-0.69											3.81
yearly mean difference	-1.25	-1.26	-0.21	0.82	-0.03	0.59	0.28	1.44	1.37	1.53	0.38	0.56	-0.54	0.11	-0.47	-0.04	0.64
Mean diff jun-oct	-1.04	-1.21	-0.02	0.68	0.21	0.00	-0.10	1.05	0.71	1.53	0.87	0.56	-0.99	0.21	-0.30	0.28	-0.36

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)



Optical turbidity probe:

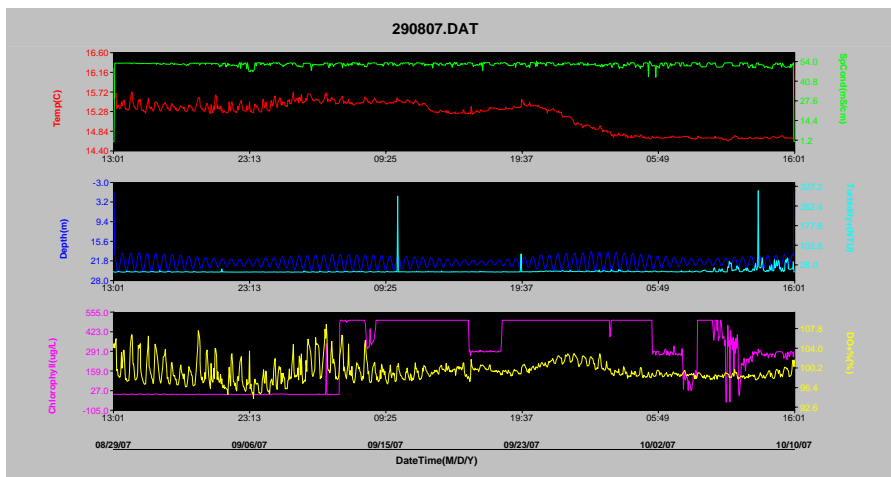
Seapoint OEM turbidity probe (2002) -results have been very variable with problems due to data corruption in the logger and fouling of the optical probe. It was vital that the optical sensor is cleaned every 2 weeks (a diver can clean it underwater).

In February 2003 the probe was calibrated in the lab with local seawater / sediment. This calibration suggested that the most sensitive setting (gain 4: 0 – 25 FTU) be used. To correlate the probe readings to actual sediment content, water samples were taken from around the probe (at 19m bcd whilst the probe was deployed). These samples were then filtered and dried to give an actual value of sediment load to compare with the probe readings from the same time.

It is currently very difficult to interpret the results and separate out real changes in turbidity from errors and noise. The probe has shown it can pick up variations with tidal cycle and storm events if it is clean and running properly.

In the winter of 2006/07 the probe suffered some major damage and was not operational during 2007. An YSI 6600 multi-parameter probe has been used in its place. This has an optical turbidity probe with a self-cleaning function. The probe was deployed twice in the 2007 season but on the second deployment the turbidity probe flooded. This had been replaced and the sonde was deployed over the full winter.

Example of data output from YSI 6600 – Aug 2007



In 2008 an OSIL telemetry buoy was deployed at OMS. The buoy was purchased with the intention being to have a suite of buoys deployed at sites around the coast of Wales as part of a Wales Marine Environmental Change Network. However the project has so far failed to attract further funding and so the Skomer remains the only site. The buoy was linked to the YSI 6600 sonde 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. The system functioned for a while but currently telemetry is switched off and the YSI 6600 sonde is recording hourly samples on its internal memory.

RESULTS - 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 2008 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	

Yearly results from the OMS site

	grams/day	% organic			
OMS	OMS	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

Yearly results from the TRK site

	grams/day	% organic			
TRK	TRK	content	% gravel	% sand	% mud
1994	3.32	9.80	0.10	16.83	83.07
1995	5.76	8.59	0.41	55.76	43.83
1996	3.53	9.90	0.21	22.56	77.23
1997	5.81	9.43	No data	No data	No data
1998	4.15	10.25	0.23	23.89	75.89
2002	2.44	7.61	0.00	61.63	38.36
2006	1.74	8.65	0.00	60.35	39.65
2007	1.54	7.73	0.00	69.81	30.19
2008	1.91	7.13	0.00	78.39	21.23

The most notable feature is the very low amount of sediment caught at OMS in 2008 (0.56 g/day) compared with the other years. The sand fraction is higher in 2008 at OMS and TRK.

Metal analysis results

	V	Cr	Co	Ni	Cu	Zn	As	Se	Cd	Sb	Pb
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
OMS 1995-98											
Average	71.89	60.98	15.50	34.71	458.75	235.07	Not done	Not done	<1	Not done	40.59
OMS 2003	71.72	43.81	7.49	22.35	79.75	113.96	8.9	<5	0.13	0.44	28.23
OMS 2004	86.68	61.12	10.72	30.52	38.74	127.29	11.5	<5	0.13	0.63	37.61
OMS 2005	69.79	48.23	8.87	25.06	39.19	93.55	10.3	<5	0.10	0.49	29.46
OMS 2006	102.21	62.10	10.97	30.68	37.64	115.43	11.8	<5	0.11	0.63	35.63
OMS 2007	83.77	51.26	9.20	25.44	50.62	98.58	8.84	<5	0.10	0.80	32.05
OMS 2008	62.15	45.53	7.83	23.58	398.75	206.43	9.85	<2	0.18	0.56	48.83
TRK 2008	87.48	61.91	10.91	30.48	43.06	118.41	12.56	<2	0.13	0.75	37.07

All the metal analysis has been done at the OMS site except for 2008 when 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 near by oceanographic equipment.

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 – 2008 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.

RECOMMENDATIONS

- Continue the Secchi disk readings as often as possible to produce a long-term data set.
- Continue with the sediment traps. Keep the samples for use in future analysis.

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