

Poole Bay/Harbour marine habitat surveys: Post Channel deepening EIA studies 2006

Progress report to Poole Harbour Commissioners

February 2007

Dr Ken Collins

School of Ocean and Earth Science, University of Southampton

National Oceanography Centre, Southampton

Southampton SO14 3ZH

Tel/fax : 023 8059 6010 email kjc@noc.soton.ac.uk



Summary

This study includes the key areas for biological monitoring detailed in Section 5 of the Poole Harbour Approach Channel Deepening EIA: Proposed Monitoring Programme Haskoning UK Ltd., Ref :9P07171/N/MAS/Exet, 5.3.05.

The post-dredging studies undertaken in Poole Bay and Poole Harbour in 2006 are described and comparison made with previous, pre-dredging data:

- Sedimentation rate studies, Poole Bay
- Seagrass, *Zostera marina*, Studland Bay and Poole Harbour
- Maerl, *Phymatolithon calcareum* density off Ballard Down
- Biogenic worm reefs (*Sabellaria spinulosa*) off Swanage
- Reef species
- Algal densities on Poole Bay patch reefs
- Pin seafan *Eunicella verrucosa*

In all cases, except the maerl, no significant changes post dredging and spoil deposition were detected. The maerl density remained stable from 2000 to 2003 with a significant decline observed in the 2006 core area survey data. Since this decline happened between 2003 and 2006 it cannot be directly attributed to the Channel deepening activities. Further studies are planned to determine if the observed decline is wider spread, beyond the core area. Novel maerl sectioning techniques akin to tree-ring methods will be used determine if and when there has been a check in growth in recent years. The sedimentation studies will continue through to May 2007

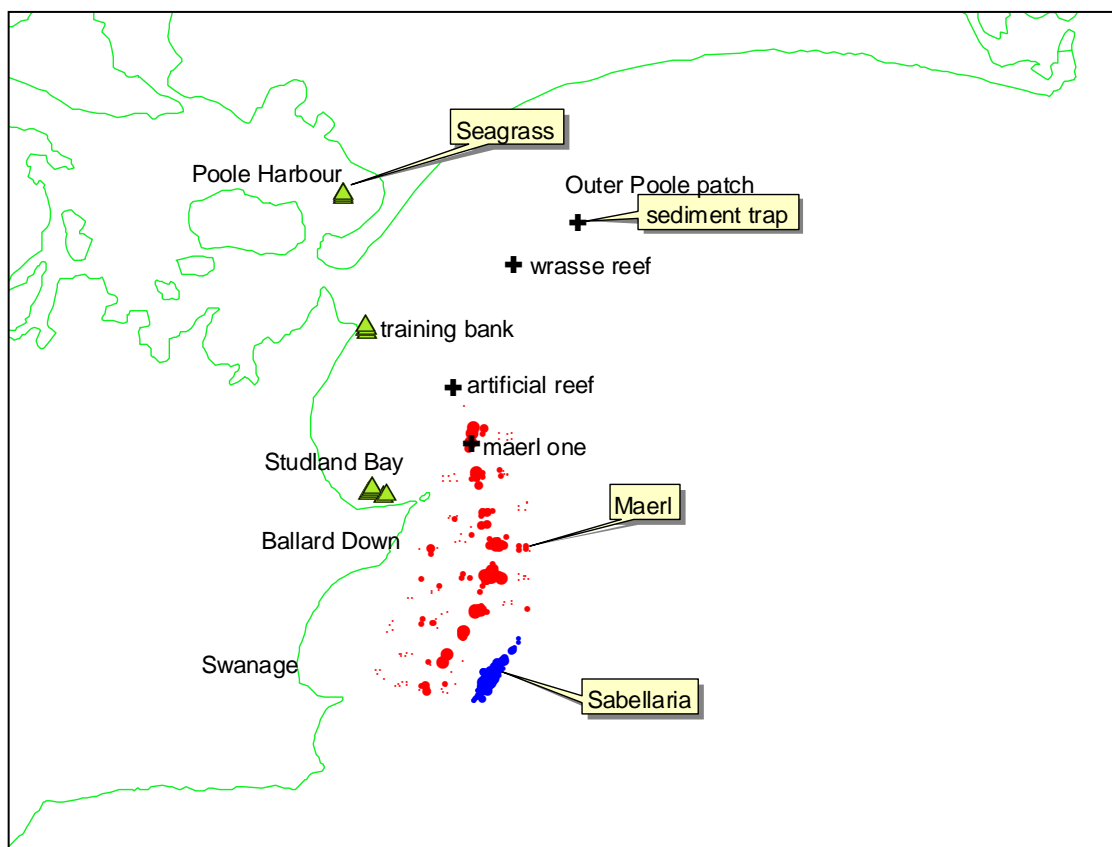


Fig.1 Main study sites described in this report.

1. Introduction

This study addresses the key areas for biological monitoring detailed in Section 5 of the Poole Harbour Approach Channel Deepening EIA: Proposed Monitoring Programme Haskoning UK Ltd., Ref :9P07171/N/MAS/Exet, 5.3.05.

The author has undertaken numerous studies in Poole Bay over the past 2 decades (see Bibliography). In 2005, to supplement this data, a number of pre-dredging studies (Collins, 2005) were undertaken to provide a baseline for comparison post-dredging:

- Seagrass (*Zostera marina*), Studland Bay and Poole Harbour
- Biogenic worm reefs (*Sabellaria spinulosa*) off Swanage
- Algal densities on Poole Bay patch reefs
- Sedimentation rate studies – Poole Bay

This report describes the post-dredging studies undertaken in Poole Bay and Poole Harbour in 2006:

- Sedimentation rate studies – Poole Bay
- Seagrass (*Zostera marina*), Studland Bay and Poole Harbour
- Maerl (*Phymatolithon calcareum*)
- Biogenic worm reefs (*Sabellaria spinulosa*) off Swanage
- Reef species
- Algal densities on Poole Bay patch reefs
- Pin seafan *Eunicella verrucosa*

Each section describes the data collected and makes comparison with previous data.

2.1. Sedimentation studies

To determine background rates of sedimentation in the Bay pre-, during and post-dredging, 2 sediment traps were deployed at each of 4 seabed sites in Poole Bay (Fig. 1). The deployments represent a gradient from the area of heaviest predicted sedimentation (Outer Poole Patch), through Wrasse Reef, the artificial reef and to Maerl One a site within the northern part of the maerl bed (see pre-dredging report 2005). The traps were replaced by divers at intervals, largely dictated by prevailing weather conditions. Initial results were reported as total dry weight collected. However following winter storms 2005/6 the traps were also contained shells and stones re-suspended from the seabed during the height of wave action. Since the object of the study was to determine if there was a significant increase in the silt fraction settling during the dredging and disposal periods, the samples were sieved and only the silt fraction (<63 μ) reported below. Appendix 1 shows all the sediment trap results with both the total dry weight and fraction <63 μ .

Poole Bay sedimentation <63 μ

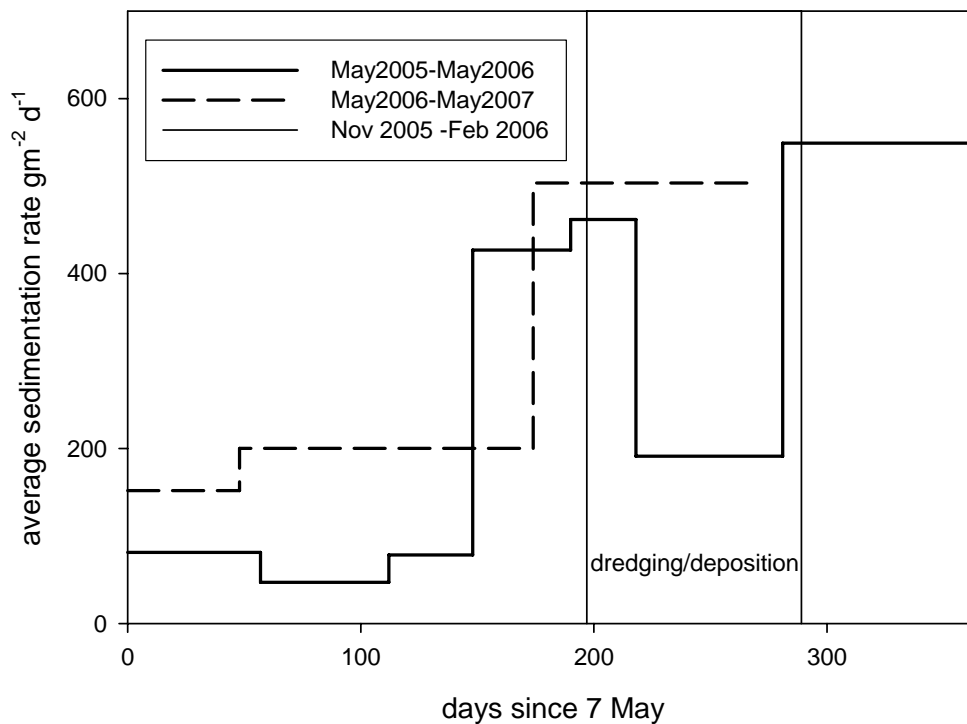


Fig.2. Average sedimentation rates (fraction <63 μ) derived from 4 sites in Poole Bay, May 2005- Jan 2007. The vertical lines indicate the start and finish of Channel dredging and spoil disposal operations.

The results above do not suggest that the dredging and deposition directly increased sedimentation rates within Poole Bay. HR Wallingford modeling of disposal site sediment plume behaviour suggested that there would be temporary silt deposition within the Bay during neap tides and re-suspension during spring tides. Our diving team observed considerable build-up of fresh sediment at sites within the Bay which persisted into summer 2006. Some of the increased sedimentation observed post Feb 2006 may reflect the re-mobilisation of these deposits over a longer than predicted time scale. A further complicating factor over winter 2006/7 is the beach recharge to the east of Bournemouth which certainly could have contributed to the elevated levels observed at this time.

Eoin Mac Craith (2006) worked under the author's supervision during summer 2006 for his MSc dissertation. This gives an excellent background to sediment impact studies and provides more extensive study of the sedimentation using Coulter laser particle size analysis. Examples are shown below in Fig.3. There was no distinctive signature from the dredged material which could distinguish it from background sedimentation.

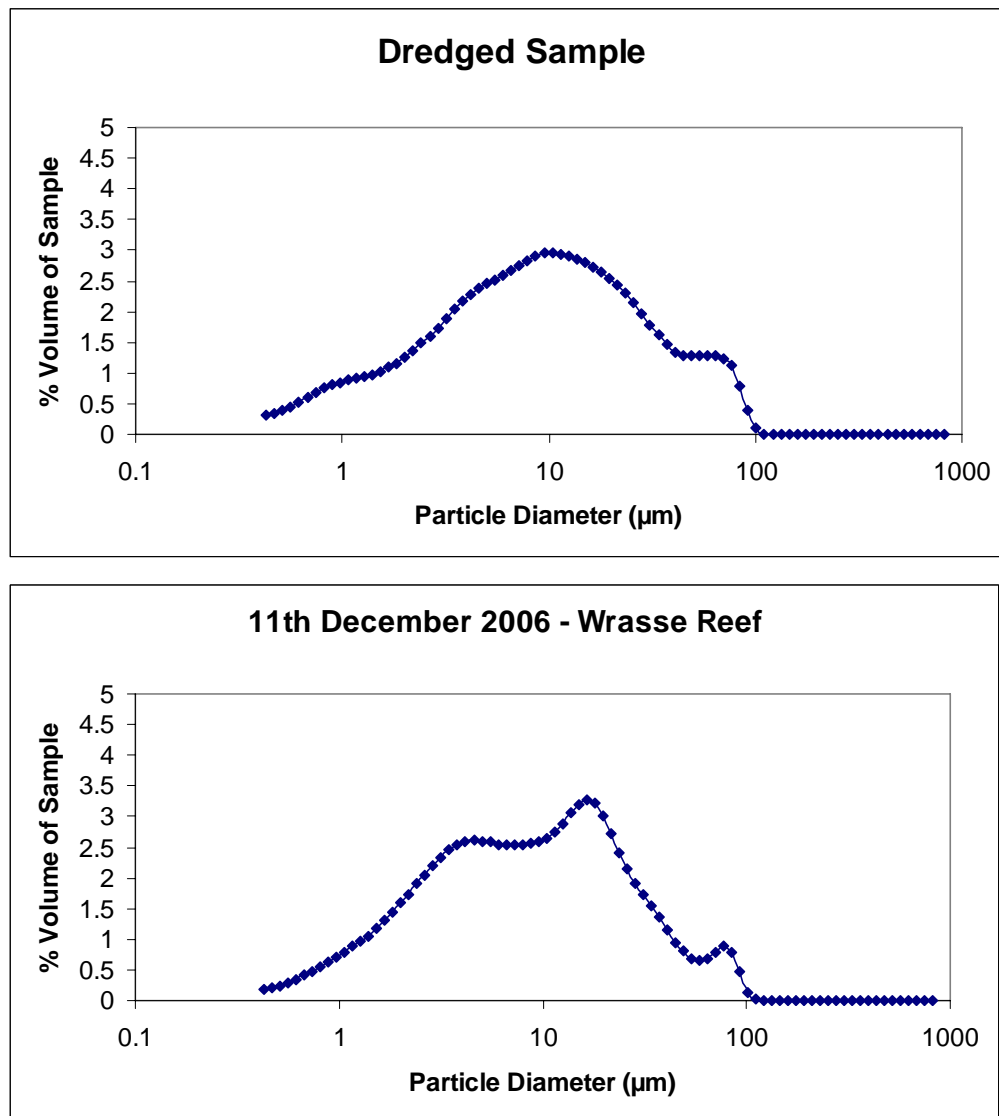


Fig.3. Results of the Coulter laser particle sizer analysis of the sediment trap material, a sample of Poole Harbour dredged material (above) , and a sample from the sediment trap deployed at Wrasse Reef, Nov-Dec 2005 (below).

2.2. Seagrass, Studland Bay and Poole Harbour

Detailed quantitative studies of the seagrass were undertaken by divers in Studland Bay, adjacent to the Poole Harbour entrance Training Bank and at one bed within the Harbour (Fig.1). At each study site a pair of divers each measured the shoot density within a 30x30cm quadrat and measured the maximum blade length within that quadrat. Using a tape measure (and noting the direction of travel) these measurements were repeated at 5 m intervals over a 30m distance yielding 14 measurements at each site. At each of the three locations 5/6 replicate sites were surveyed. These surveys were undertaken pre-dredging in July 2005 and exactly repeated post-dredging in July 2006. Full data is given in Appendix 2.

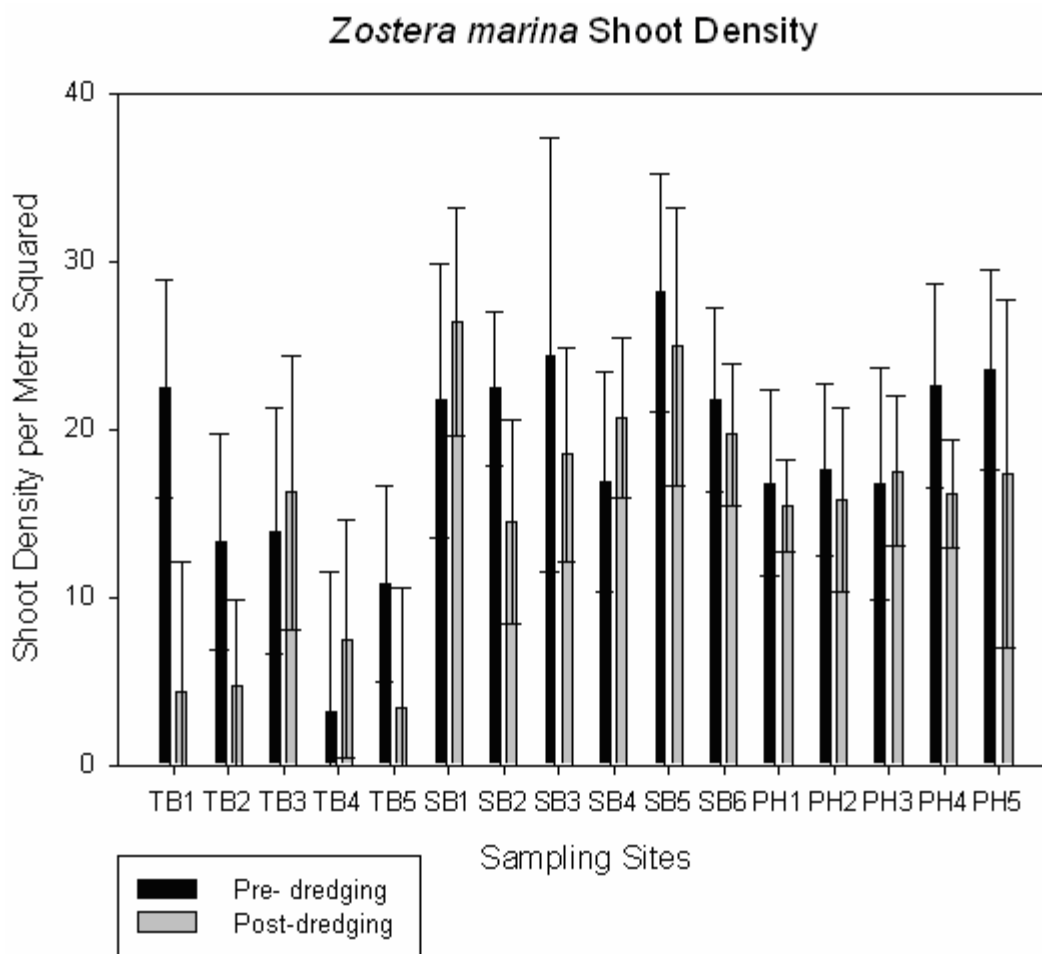


Fig.4. Average seagrass shoot densities (± 1 standard deviation) from before and after dredging (2005 and 2006, respectively). Site notation: TB=Training Bank, SB=Studland Bay and PH=Poole Harbour.

Mac Craith (2006) provides more extensive analyses of these seagrass studies (2006 data is given in Appendix 2). No significant change in shoot density or shoot length was found at the any of the 3 study locations.

2.3. Maerl density

The maerl (*Phymatolithon calcareum*) bed off Ballard Down was systematically surveyed 2000-3 by divers with 0.5m² quadrats collecting all the live (pink) maerl. There is a core area (Fig.5) of greatest density corresponding to the tidal jet stream around the headland (determined by ADCP studies). This core area was sampled in 2000, 2001 and 2003 the latter deliberately re-sampling sites from the previous 2 years to prove the validity of the survey technique. Preliminary studies described by Mac Craith (2006) showed a decline in 2006 samples. Further samples were taken deliberately targeting previous sites to address the possibility of effects due to spatial variation. (see Table 1, Fig.6 and Appendix 3).

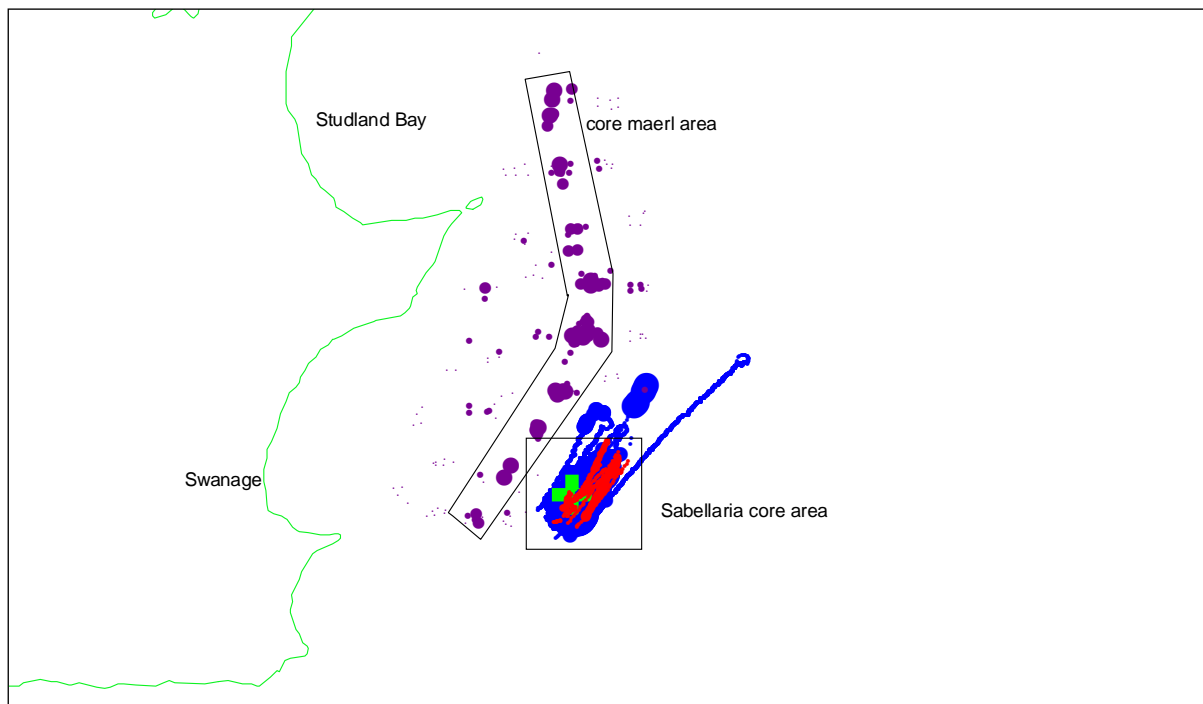


Fig.5. Extent of the core maerl and Sabellaria reef area. Density is proportional to the dot size (purple-maerl, blue&red-Sabellaria)

Table 1. Maerl density (gDW/0.5m²) statistics

year	samples	average	median	minimum	maximum
2000	54	32.4	26.8	1.0	82.2
2001	28	38.2	39.7	5.0	65.1
2003	32	35.4	31.8	9.2	76.8
2006	53	21.6	19.7	0.3	47.4

Table 2. Pairwise Multiple Comparison Procedures (Dunn's Method) :

Comparison	Diff of Ranks	Q	P<0.05
M2001 vs M2006	49.073	4.344	Yes
M2001 vs M2000	21.501	1.909	No
M2001 vs M2003	8.808	0.704	Do Not Test
M2003 vs M2006	40.265	3.720	Yes
M2003 vs M2000	12.693	1.177	Do Not Test
M2000 vs M2006	27.571	2.949	Yes

Kruskal-Wallis One Way Analysis of Variance on Ranks shows that the differences in the median values among the treatment groups (years) are greater than would be expected by chance; there is a statistically significant difference ($P = <0.001$). To isolate the year or years that differ from the others a multiple comparison procedure was used (Table 2).

From this it is evident that the 2006 data is statistically significantly less (95% confidence level) than 2000, 2001, 2003, whilst there is no evidence that the latter are significantly different from each other. Of all the habitats studied the maerl is acknowledged to be the most sensitive to increased sediment loads. Further studies are recommended to determine if this decline is detected in the peripheral regions and if the decline is permanent or will show signs of recovery.

Poole Bay maerl density 2000-6

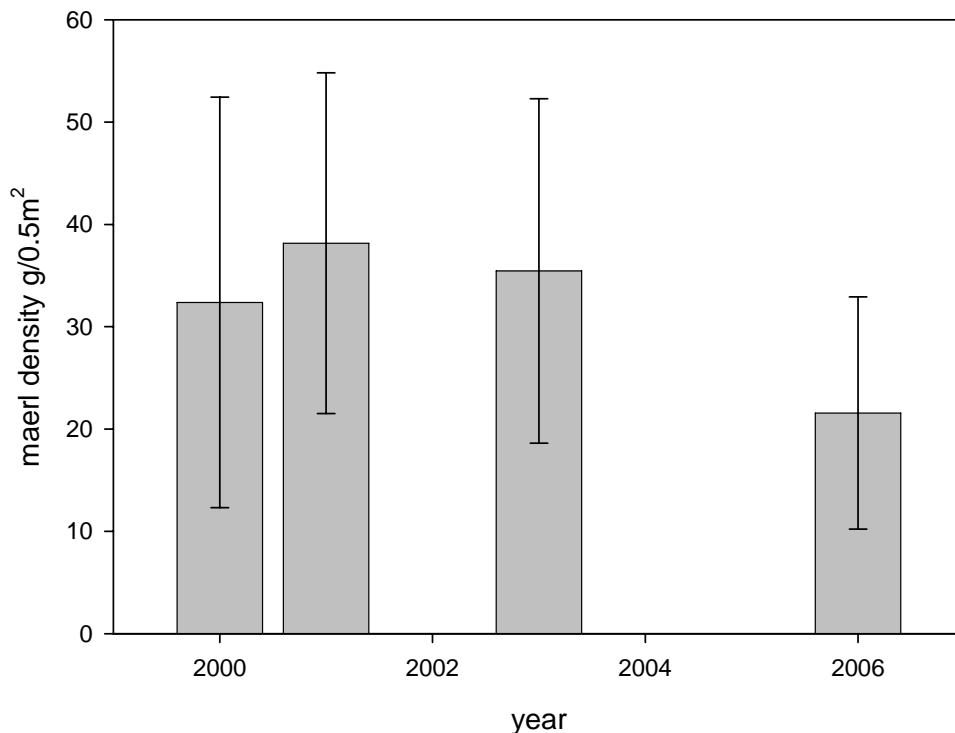


Fig.6. Maerl density measurements, average and standard deviation, of the core maerl bed off Ballard Down, determined in 2000-6.

A novel environmental monitoring technique will be explored in collaboration with the distinguished algologist, Prof. Christine Maggs, Queens University Belfast. Studies by Buchan (2005) showed that the Poole Bay maerl rhodoliths contains both annual growth rings and monthly sub-rings representing growth during the summer. These were detected by electron microscope examination of sections. Prof. Maggs' team has been using micro CT scanning of whole specimens. This technique will enable us to determine if there has been a check in growth prior to or coincident with the Channel deepening.

2.4. *Sabellaria spinulosa* reefs

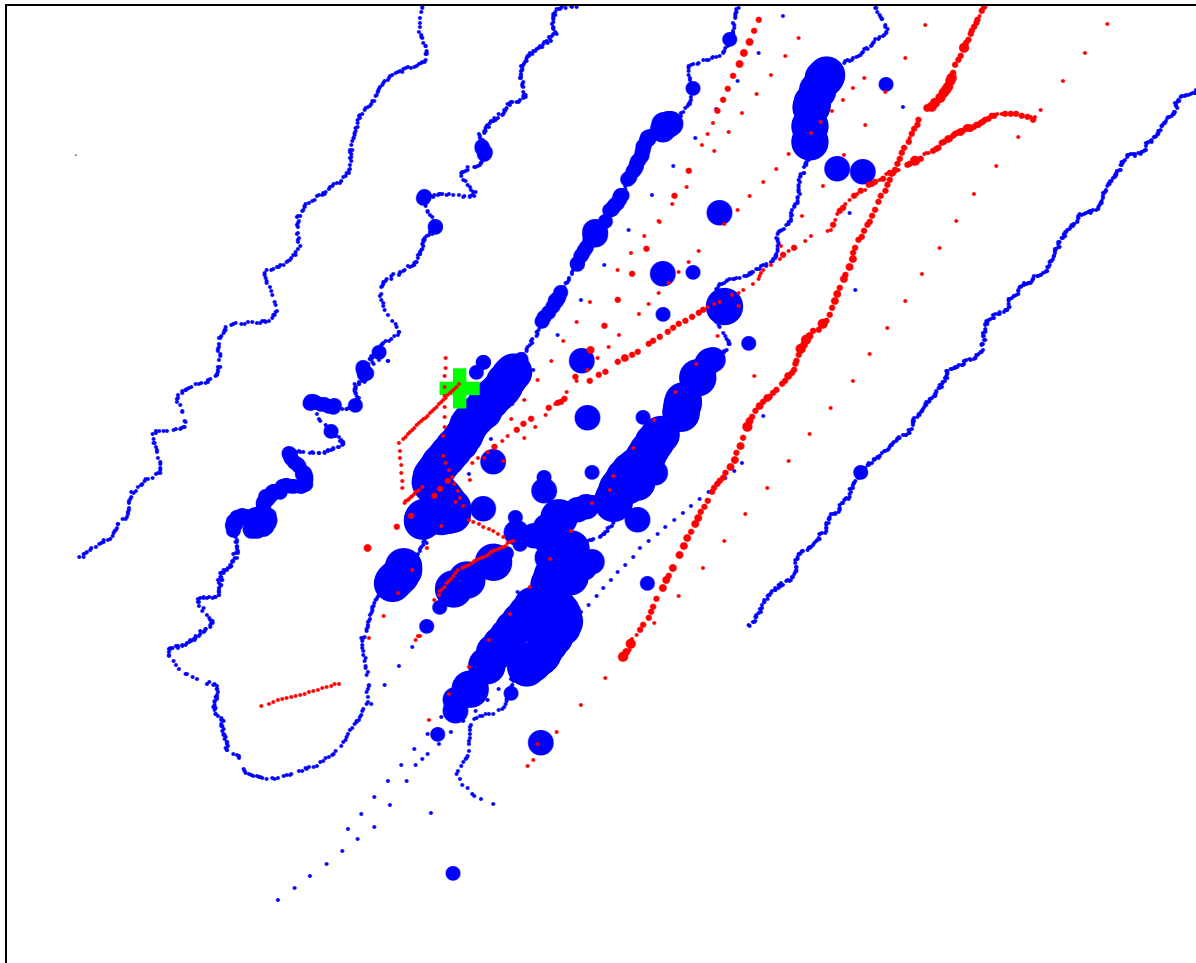


Fig.6. Core Sabellaria reef area off Swanage (see Fig.1) approximately 1 km², showing results of surveys 2002-4 (blue dots) and 2005-6 (red dots). Dot size is proportional to density with the smallest dot size representing absence of Sabellaria reefs. The green cross marks the location the sediment depth monitoring site.

The extent and density of the *Sabellaria spinulosa* reefs off Swanage have been monitored by towed seabed video sledge and drift diving since 2002. In 2004 some indication of damage by trawling or dredging was first noticed within the core area shown in Fig.6 above. It was considered essential to carry out a thorough survey in 2005 prior to the Poole Harbour dredging and spoil disposal. It was very evident that no extensive areas of undisturbed reef remained in the core area. Typically the reefs existed (prior to 2004) as irregular mounds 2-10m across and 0.5 high. Surveys in 2005 and 2006 showed that these had almost universally been levelled with only a thin band of damaged tubes around their perimeter. Small clumps still remained in the lee of isolated rocks and reefs, plus a patch of small reef clumps to the north of the area enclosed by Fig.6. Further analysis of this density data is planned.

No detrimental effects attributable to the spoil disposal were noted. The sediment depth monitoring site (a series of metal poles in the seabed) showed no new accumulation of sediment post disposal (Fig.7).

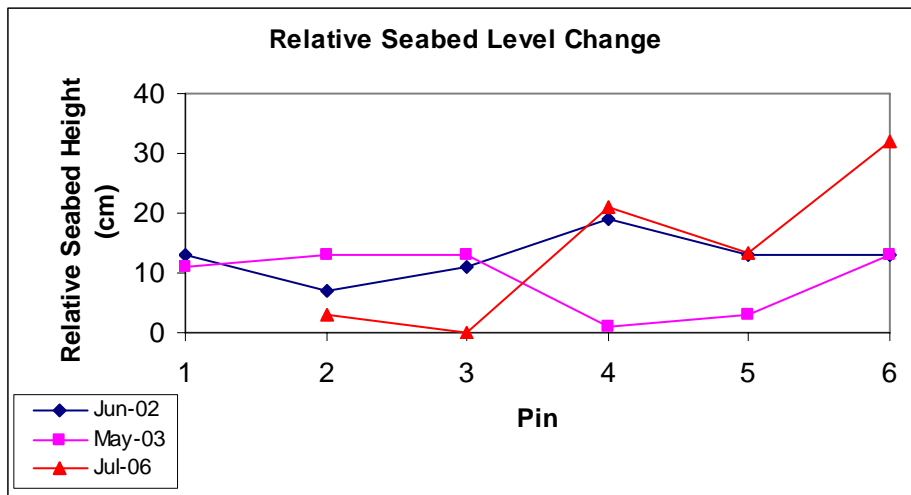


Fig.7. Relative seabed level within the *Sabellaria* reef area (Fig.-1) at 6 pins placed 3m apart in June 2002, subsequently monitored in May 2003 July 2006. Pin 1 had fallen over prior to the 2006 survey. A value of 0cm to the longest pin length in the dataset (the 3rd pin in July 2006), and plotting other measurements relative to that.

2.5. Reef Biota

Mallinson *et al.* (1999) documented the colonisation of the Poole Bay artificial reef since its deployment in 1989 alongside the biota of natural patch reefs in Poole Bay. This provides a baseline for comparison of species occurrence post-dredging. One of the potential impacts of increased sedimentation in Poole Bay could be increased silt thickness on reef surfaces which in turn may adversely affect sessile fauna and flora growth. A study of 71 such species found that they were still present on the Poole Bay artificial reef and natural reefs post-dredging. (Table 3 below) indicating no detectable impact.

Table 3. Species of sessile fauna and flora present before and after dredging.

Taxon	Species	common names
PORIFERA	<i>Dysidea fragilis</i>	
	<i>Esperiopsis fucorum</i>	shredded carrot sponge
	<i>Hemimycale columella</i>	
	<i>Hymeniacion perleve</i>	
	<i>Leucosolenia complicata</i>	
	<i>Oscarella lobularis</i>	
CNIDARIA	<i>Suberites carnosus</i>	
	<i>Aglaophenia parvula</i>	
	<i>Halecium halecinum</i>	
	<i>Hydrallmania falcata</i>	
	<i>Laomedea flexuosa</i>	
	<i>Nemertesia antennina</i>	antenna hydroid
	<i>Plumularia setacea</i>	
	<i>Sertularia argentea</i>	
ANNELIDA	<i>Tubularia larynx</i>	
	<i>Bispira volutacornis</i>	twin spiral worm
CRUSTACEA	<i>Pomatoceros triqueter</i>	keel worm
	<i>Acasta spongites</i>	barnacle
	<i>Balanus crenatus</i>	barnacle
	<i>Cancer pagurus</i>	edible crab
	<i>Carcinus maenas</i>	green shore crab
	<i>Galathea squamifera</i>	squat lobster
	<i>Galathea strigosa</i>	squat lobster
	<i>Homarus gammarus</i>	European lobster
	<i>Maja squinado</i>	spiny spider crab
	<i>Necora puber</i>	velvet swimming crab
	<i>Pagurus bernhardus</i>	hermit crab
	<i>Pagurus cuanensis</i>	hermit crab
MOLLUSCA	<i>Palaemon serratus</i>	prawn
	<i>Flabellina pedata</i>	
	<i>Calliostoma zizyphinum</i>	painted topshell
	<i>Crepidula fornicata</i>	slipper limpet
	<i>Gibbula cineraria</i>	grey topshell
	<i>Ocenebra erinacea</i>	tingle
BRYOZOA	<i>Ostrea edulis</i>	European oyster
	<i>Sepia officinalis</i>	cuttlefish
	<i>Bicellariella ciliata</i>	
	<i>Bugula flabellata</i>	
	<i>Bugula plumosa</i>	
	<i>Chartella papyracea</i>	
	<i>Flustra foliacea</i>	hornwrack

Table 3.cont. Species of sessile fauna and flora present before and after dredging.

Taxon	Species	common names
BRYOZOA	<i>Pentapora foliacea</i>	Ross 'coral'
	<i>Vesicularia spinosa</i>	
	<i>Disporella hispida</i>	
	<i>Electra pilosa</i>	
	<i>Parasmittina trispinosa</i>	
TUNICATA	<i>Aplidium punctum</i>	
	<i>Ascidia mentula</i>	
	<i>Clavelina lepadiformis</i>	Light bulb sea squirt
	<i>Polycarpa sp.</i>	
	<i>Styela clava</i>	
	<i>Diplosoma listerianum</i>	
ALGAE	<i>Bryopsis plumosa</i>	
green	<i>Cladophora sp.</i>	
brown	<i>Undaria pinnatifida</i>	
red	<i>Calliblepharis ciliata</i>	
	<i>Delesseria sanguinea</i>	sea beech
	<i>Gracilaria bursa-pastoris</i>	
	<i>Griffithsia corallinoides</i>	
	<i>Heterosiphonia plumosa</i>	
	<i>Hypoglossum hypoglossoides</i>	
	<i>Lithothamnion type crust</i>	coraline crust
	<i>Phyllophora crispa</i>	
	<i>Phyllophora pseudoceranooides</i>	
	<i>Plocamium cartilagineum</i>	
	<i>Rhodymenia holmesii</i>	
	<i>Spyridia filamentosa</i>	

2.6. Reef Algae

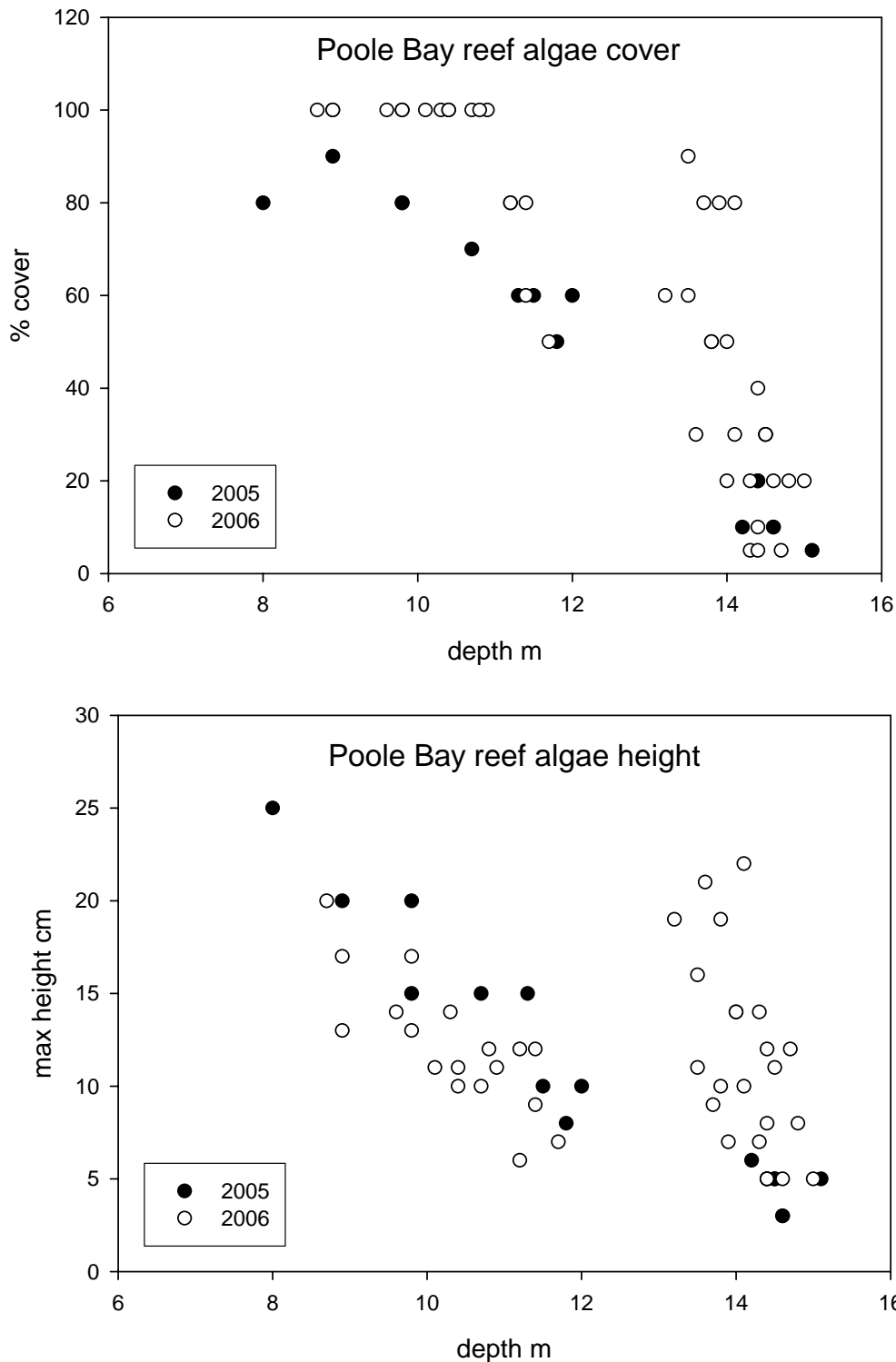


Fig.8. Poole Bay patch reef algae cover and maximum length on horizontal surfaces determined in summer 2005 and 2006.

The small patch reefs within the Bay support typically a mixture of brown (*Dictyota dichotoma*) and red algae (*Calliblepharis ciliata*) species shallower than 10mCD and purely red algae below this depth. One of the potential impacts of increased sedimentation in Poole Bay could be increased silt thickness on horizontal reef surfaces which may adversely affect algal growth. To check this algal

coverage and maximum height were measured at a range of depths (8-15m) on several patch reefs in summer 2005 and again in summer 2006, post dredging.

There is no evidence for any adverse impact post-dredging.

2.7. Pink sea fans, *Eunicella verrucosa*

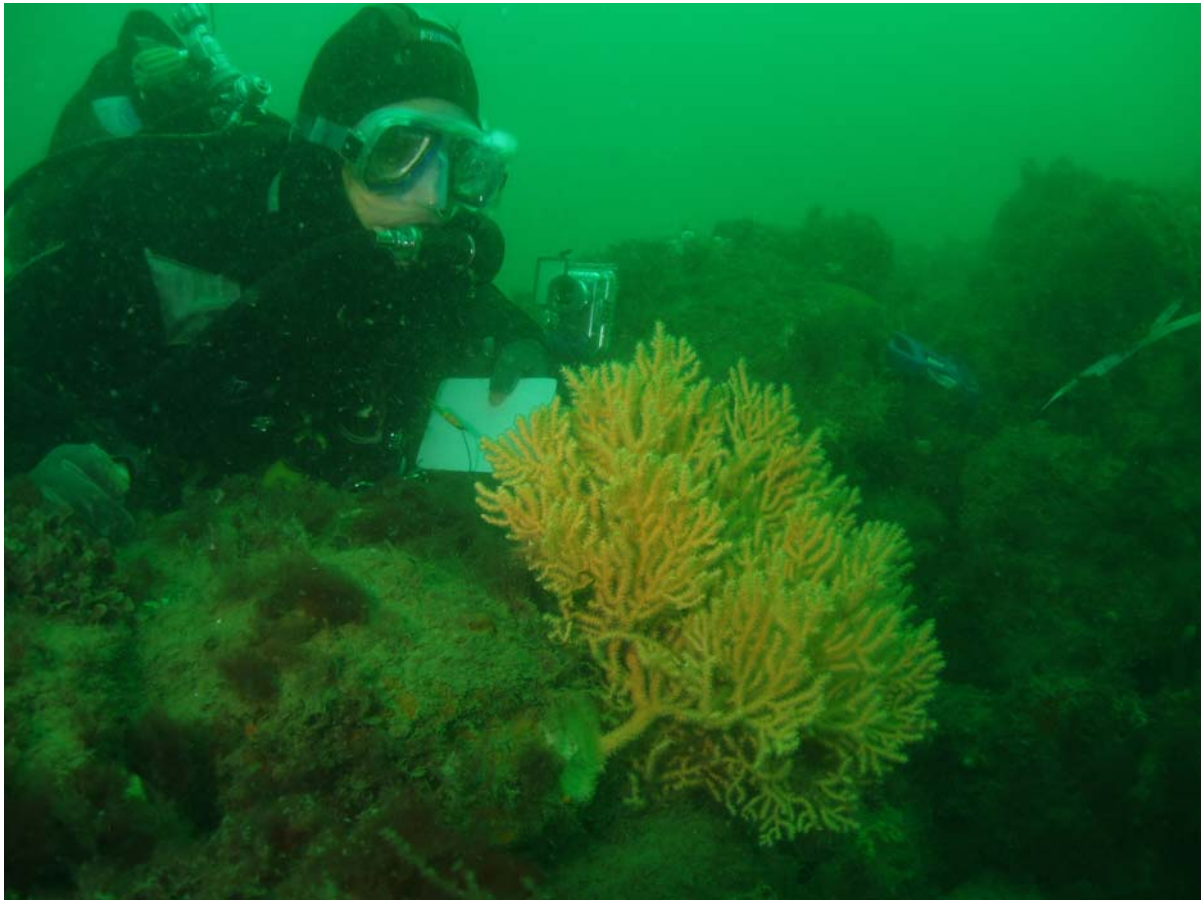


Fig.9. Healthy pink sea fan growing on a Poole Bay patch reef, photographed August 2006, post dredging/disposal

Poole Bay represents the eastern-most extent of the pink sea fan, *Eunicella verrucosa*, along the English Channel. To date four specimens have been found on isolated patch reefs within Poole Bay. Of these, two were relocated in summer 2006. Fig.9.shows one which has clearly has not suffered from raised suspended matter levels during the previous winter . The second specimen was located attached beneath an overturned rock slab, presumably moved by recent hauling of pot lines. The rock was returned to its original position and the sea fan found to be remarkably unaffected by this event or the dredging/disposal.

3. Bibliography

- Adey, W.H. and McKibben, D.L. (1970) Studies on the maerl species *Phymatolithon calcareum* (Pallas) nov. comb. and *Lithothamnion coralloides* Crouan in the Ria di Vigo. *Botanica Marina*, **13**: 100-106.
- Anderson, K. (2002) An investigation into the distribution of the Sabellarian reefs off Swanage, Dorset, UK. MSc dissertation, School of Ocean and Earth Science, University of Southampton, 63pp.
- Barker, K. (2001) Maerl incubation studies. BSc dissertation, School of Ocean and Earth Science, University of Southampton
- Birkett, D.A., Maggs, C. and Dring, M.J. 1998. Maerl (Volume V). An overview of dynamics and sensitivity characteristics for conservation management of marine SACs. Scottish Association for Marine Science. (UK Marine SACs Project). 116 pp.
- Brachi, R.A., Collins, K.J. and Roberts, C.D. (1978). A winter survey of a semi-exposed rocky coastline; survey strategy and field techniques. *Progress in Underwater Science*, **4**(NS): 37-47.
- Buchan, S. (2005) Swanage maerl MSc dissertation, School of Ocean and Earth Science, University of Southampton, 63pp.
- Collins, K.J., Jensen, A.C. and Mallinson, J.J. 1990. Poole Bay artificial island footprint and pipeline route survey. Report to BP Exploration, Wytch Farm. SUDO/TEC/90/8C.
- Collins, K.J. (1995) Seagrass (*Zostera marina*) survey off Ringstead, Dorset. Report to West Dorset District Council, March 1995, 7pp.
- Collins, K.J. (2002) Dorset Maerl and Seagrass: 2001 survey results. Report to Dorset Wildlife Trust and English Nature. January 2002, 21pp.
- Collins, K.J. (2003) Dorset marine habitat surveys: maerl, worm reefs, seagrass and brittlestars, 2002 survey results. Report to Dorset Wildlife Trust and English Nature January 2003, 18pp.
- Collins, K.J. (2004) Dorset marine habitat surveys: maerl, worm reefs, bream nests, sea fans and brittlestars, 2003 survey results. Report to Dorset Wildlife Trust and English Nature January 2003, 15pp.
- Collins, K.J. (2005) Poole Bay/Harbour marine habitat surveys: pre-channel deepening EIA studies, 2005 field report. Progress report to Poole Harbour Commissioners, September 2005, 18pp.
- Collins, K.J. (2005) Dorset marine habitat surveys: maerl, worm reefs, brittlestars, sea fans and seagrass, 2005 field report, Progress report to English Nature and Poole Harbour Commissioners, September 2005, 19pp.
- Collins, K.J., Johnson, M., Mallinson, J.J. and Markey, M. (2000) Seagrass (*Zostera marina*) and Sea Pen (*Virgularia mirabilis*) surveys, Portland Harbour to Ringstead, Dorset. Report to Dorset Wildlife Trust and English Nature, June 2000, 6pp.
- Collins, K.J. and Mallinson, J.M. Maerl survey, Poole Bay 2000 (2000). Report to Dorset Wildlife Trust, December 2000, 12pp.
- Collins, K.J. and Mallinson, J.J. (2001) Dorset maerl. Paper presented to: The scientific basis for conservation management of maerl grounds workshop, 23-27 February 2001, UMBS Millport, Scotland, submitted to: Aquatic Conservation: Marine and Freshwater Ecosystems.
- Collins, K.J. and Mallinson, J.J. (2004) Dorset maerl. *Journal of the Porcupine Marine Natural History Society*. 16: xx-xx.
- Council Directive 92/43/EEC (1992) Conservation of natural habitats and of wild flora and fauna. *International Journal of the European Communities*, L206, 7-49.
- Davidson, D.M. and Hughes, D.J. ((1998) Natura 2000. Volume I: *Zostera* biotopes. Scottish Association for Marine Science, Oban/English Nature. 95pp.
- DCC (2000) Dorset, a photographic atlas. CD-ROM. Dorset County Council.
- Haskoning UK Ltd. (2005) Poole Harbour Approach Channel Deepening EIA: Proposed Monitoring Programme. Haskoning UK Ltd., Ref :9P07171/N/MAS/Exet, 5.3.05.
- Irvine, L.M. and Chamberlain, Y.M. 1994. Seaweeds of the British Isles, Volume 1 Rhodophyta, Part 2B Corallinales, Hildenbrandiales. HMSO, London. 276 pp.

- Jensen, A.C., Collins, K.J. and Mallinson, J.J. (1990) Studland Bay baseline survey. Report to BP Exploration by Department of Oceanography, University of Southampton, Dec.1990, SUDO/TEC/90/19C, 13pp +appendices.
- Jones, R. (2002) Weymouth Bay seagrass survey. BSc dissertation, School of Ocean and Earth Science, University of Southampton
- Mac Craith, E. (2006) Poole Bay Dredging Environmental Impact Assessment. MSc dissertation, School of Ocean and Earth Science, University of Southampton. 45pp.
- Mallinson, J.J., Collins, K.J. and Jensen, A.C. (1999) Species recorded on artificial and natural reefs, Poole Bay, 1989-1996. Dorset Proceedings, **121**: 113-122.
- Mitchell, A. Dorset maerl. (2001) MSc dissertation, School of Ocean and Earth Science, University of Southampton, 62pp.
- Mitchell, A. and Collins, K.J. (2003) Understanding the distribution of maerl, a calcareous seaweed, off Dorset, UK. Proceedings of the Second International Symposium on GIS/Spatial Analyses in Fishery and Aquatic Sciences 3-6 Sept 2002, University of Sussex, Brighton, UK (in press)
- Rowe, G.A., Shearer, M. and Jensen, A.C. 1990. The infauna of the Handfast Point maerl bed. Report to the Nature Conservancy Council by the University of Southampton Department of Oceanography. Southampton University Report No. SUDO/TEC/90/16C.
- Southern, B. (2005) Swanage Sabellaria. BSc dissertation, Environmental Sciences, University of Southampton, 45pp.
- Stinchcombe (2003) Dorset maerl calcification studies. MSc dissertation, School of Ocean and Earth Science, University of Southampton, 50pp.
- Thompson, M. (2003) Maerl masses comparison. Nuffield Science Bursary project report, 9pp.
- Todd, D. (2003) A study into the density, distribution and size class structure of a Dorset Sabellaria spinulosa reef in association with sand waves. MSc dissertation, School of Ocean and Earth Science, University of Southampton, 50pp.
- UK Biodiversity Group 1999. Tranche 2 Action Plans Vol.V - maritime species and habitats. English Nature, Peterborough, 244pp.
- Vagianou, F. (2002) Seabed habitat surveys - maerl MSc dissertation, School of Ocean and Earth Science, University of Southampton, 62pp.

Appendix 1. Sediment trap results

site	deployed	recovered	days	dry wt. total	dry wt. <63u	<63u g/m2/day
Maerl One	7/5/05	2/7/05	56	34.8	18.5	99.4
Maerl One	7/5/05	2/7/05	56	27.5	14.6	78.4
Maerl One	7/5/05	2/7/05	56	27.1	14.4	77.3
Wrasse Reef	7/5/05	2/7/05	56	25.3	13.4	72.1
Wrasse Reef	7/5/05	2/7/05	56	25.9	13.7	74.0
Artificial Reef	7/5/05	3/7/05	57	27.8	14.7	77.9
Artificial Reef	7/5/05	3/7/05	57	27.8	14.7	78.0
Outer Poole Patch	7/5/05	3/7/05	57	30.7	16.3	86.2
Outer Poole Patch	7/5/05	3/7/05	57	31.7	16.8	88.7
Artificial Reef	3/7/05	18/7/05	15	3.1	1.6	32.6
Artificial Reef	3/7/05	18/7/05	15	3.0	1.6	31.6
Artificial Reef	18/7/05	18/8/05	31	7.2	3.8	37.0
Artificial Reef	18/7/05	18/8/05	31	6.6	3.5	33.9
Wrasse Reef	2/7/05	18/8/05	47	10.4	5.5	35.4
Maerl One	2/7/05	25/8/05	54	22.8	12.1	67.6
Maerl One	2/7/05	25/8/05	54	9.9	5.3	29.3
Outer Poole Patch	3/7/05	25/8/05	53	22.5	11.9	67.8
Outer Poole Patch	3/7/05	25/8/05	53	27.1	14.4	81.7
Wrasse Reef	2/7/05	27/8/05	56	19.2	10.2	54.9
Artificial Reef	18/8/05	2/10/05	45	15.2	8.0	53.8
Artificial Reef	18/8/05	2/10/05	45	15.5	8.2	55.1
Maerl One	25/8/05	2/10/05	38	18.6	9.8	78.1
Maerl One	25/8/05	2/10/05	38	31.9	16.9	134.0
Outer Poole Patch	25/8/05	2/10/05	38	17.7	9.4	74.6
Outer Poole Patch	25/8/05	2/10/05	38	23.8	12.6	100.1
Wrasse Reef	27/8/05	2/10/05	36	12.4	6.6	54.9
Wrasse Reef	18/8/05	2/10/05	45	21.6	11.4	76.6
Maerl One	2/10/05	13/11/05	42	287.1	89.4	642.2
Maerl One	2/10/05	13/11/05	42	408.2	49.3	354.0
Artificial Reef	2/10/05	13/11/05	42	300.2	33.5	240.6
Artificial Reef	2/10/05	13/11/05	42	296.5	103.6	744.0
Wrasse Reef	2/10/05	13/11/05	42	231.9	57.6	413.4
Wrasse Reef	2/10/05	13/11/05	42	246.9	34.2	245.6
Outer Poole Patch	2/10/05	13/11/05	42	282.5	42.8	307.5
Outer Poole Patch	2/10/05	13/11/05	42	252.9	65.2	468.0
Outer Poole Patch	13/11/05	11/12/05	28	322.6	30.4	327.6
Outer Poole Patch	13/11/05	11/12/05	28	293.4	49.2	530.4
Wrasse Reef	13/11/05	11/12/05	28	385.6	43.8	472.1
Wrasse Reef	13/11/05	11/12/05	28	356.8	58.7	632.5
Artificial Reef	13/11/05	11/12/05	28	789.0	42.3	456.0
Artificial Reef	13/11/05	11/12/05	28	803.7	62.2	669.7
Maerl One	13/11/05	11/12/05	28	757.6	33.3	358.4
Maerl One	13/11/05	11/12/05	28	645.4	22.9	247.1
Maerl One	11/12/05	12/2/06	63	343.4	20.6	98.4
Maerl One	11/12/05	12/2/06	63	295.6	11.3	54.0
Artificial Reef	11/12/05	12/2/06	63	235.6	20.0	95.9
Artificial Reef	11/12/05	12/2/06	63	297.0	69.0	330.2
Wrasse Reef	11/12/05	12/2/06	63	163.2	22.8	109.4
Wrasse Reef	11/12/05	12/2/06	63	223.2	162.0	775.5
Outer Poole Patch	11/12/05	12/2/06	63	266.9	41.2	197.1

site	deployed	recovered	days	dry wt. total	dry wt. <63u	<63u g/m2/day
Outer Poole Patch	11/12/05	12/2/06	63	253.8	40.0	191.5
Artificial Reef 1m	11/12/05	12/2/06	63	54.0	8.0	38.2
Artificial Reef 1m	11/12/05	12/2/06	63	34.5	4.5	21.6
Outer Poole Patch	12/2/06	7/5/06	84	342.0	216.1	775.7
Outer Poole Patch	12/2/06	7/5/06	84	356.1	223.8	803.4
Wrasse Reef	12/2/06	7/5/06	84	277.5	177.1	635.7
Wrasse Reef	12/2/06	7/5/06	84	335.2	252.9	907.9
Maerl One	12/2/06	7/5/06	84	370.8	117.4	421.5
Maerl One	12/2/06	7/5/06	84	272.1	67.1	240.9
Artificial Reef	12/2/06	7/5/06	84	166.8	80.2	287.9
Artificial Reef	12/2/06	7/5/06	84	184.0	88.8	318.9
Outer Poole Patch	7/5/06	24/6/06	48	54.3	12.6	78.8
Outer Poole Patch	7/5/06	24/6/06	48	52.9	21.7	136.5
Wrasse Reef	7/5/06	24/6/06	48	35.4	16.5	103.9
Wrasse Reef	7/5/06	24/6/06	48	36.1	17.9	112.2
Maerl One	7/5/06	24/6/06	48	53.2	35.8	224.9
Artificial Reef	7/5/06	24/6/06	48	62.5	40.6	255.1
Outer Poole Patch	24/6/06	28/10/06	126	182.3	90.8	217.2
Outer Poole Patch	24/6/06	28/10/06	126	169.3	97.4	233.2
Wrasse Reef	24/6/06	28/10/06	126	132.0	89.6	214.5
Wrasse Reef	24/6/06	28/10/06	126	128.5	81.9	196.1
Artificial Reef	24/6/06	28/10/06	126	127.2	79.6	190.4
Artificial Reef	24/6/06	28/10/06	126	122.9	62.8	150.3
Artificial Reef	28/10/06	28/1/07	92	324.7	153.5	503.3
Artificial Reef	28/10/06	28/1/07	92	326.0	221.0	724.5
Maerl One	28/10/06	28/1/07	92	710.3	101.0	331.1
Outer Poole Patch	28/10/06	28/1/07	92	465.6	138.4	453.6
Outer Poole Patch	28/10/06	28/1/07	92	486.6	183.5	601.6
Wrasse Reef	28/10/06	28/1/07	92	396.1	172.0	563.8
Wrasse Reef	28/10/06	28/1/07	92	413.8	158.6	519.7

Appendix 2a. Seagrass survey results 2006 – shoot density per 30cm square quadrat.

Date	Lat	Lon	direction	shoots	0m	5m	10m	15m	20m	25m	30m	Average
25/07/2006	50.643350	-1.933733	S	shoots	21	20	19	16	22	27	28	22
25/07/2006	50.643350	-1.933733	S	shoots	26	29	37	32	23	39	31	31
25/07/2006	50.643670	-1.932933	S	shoots	12	14	3	23	16	17	16	14
25/07/2006	50.643670	-1.932933	S	shoots	9	17	16	25	16	29	21	19
25/07/2006	50.643683	-1.937883	S	shoots	28	22	13	7	17	25	11	18
25/07/2006	50.643683	-1.937883	S	shoots	26	18	20	10	22	23	17	19
26/07/2006	50.644150	-1.937700	N	shoots	20	19	14	22	18	26	23	20
26/07/2006	50.644150	-1.937700	N	shoots	31	17	18	18	27	21	15	21
26/07/2006	50.644600	-1.937283	S	shoots	32	39	18	18	22	27	31	27
26/07/2006	50.644600	-1.937283	S	shoots	13	21	31	13	19	35	30	23
26/07/2006	50.644750	-1.936783	S	shoots	21	15	16	21	13	14	22	17
26/07/2006	50.644750	-1.936783	S	shoots	22	20	17	26	24	19	26	22
25/07/2006	50.672067	-1.938283	W	shoots	0	0	0	0	0	10	21	4
25/07/2006	50.672067	-1.938283	W	shoots	0	0	0	0	0	10	20	4
25/07/2006	50.672217	-1.938467	W	shoots	0	5	3	10	0	11	0	4
25/07/2006	50.672217	-1.938467	W	shoots	0	4	14	10	0	9	0	5
25/07/2006	50.672483	-1.938583	W	shoots	14	11	20	2	27	26	20	17
25/07/2006	50.672483	-1.938583	W	shoots	17	9	19	0	22	19	21	15
25/07/2006	50.672833	-1.938550	W	shoots	0	0	0	10	15	8	18	7
25/07/2006	50.672833	-1.938550	W	shoots	0	1	0	13	17	9	14	8
25/07/2006	50.673233	-1.938867	W	shoots	0	1	0	0	1	0	13	2
25/07/2006	50.673233	-1.938867	W	shoots	0	0	1	1	1	5	25	5
26/07/2006	50.695617	-1.944983	E	shoots	16	16	12	14	15	17	22	16
26/07/2006	50.695617	-1.944983	E	shoots	14	19	12	13	17	14	15	15
26/07/2006	50.695817	-1.944983	E	shoots	14	12	6	12	25	16	23	15
26/07/2006	50.695817	-1.944983	E	shoots	11	11	15	19	16	17	24	16
26/07/2006	50.696133	-1.945117	E	shoots	19	17	18	20	27	22	19	20
26/07/2006	50.696133	-1.945117	E	shoots	21	16	10	17	15	11	13	15
26/07/2006	50.696367	-1.945083	E	shoots	15	13	16	21	20	18	20	18
26/07/2006	50.696367	-1.945083	E	shoots	14	12	16	12	19	12	18	15
26/07/2006	50.696500	-1.945117	E	shoots	0	14	31	36	20	29	16	21
26/07/2006	50.696500	-1.945117	E	shoots	0	10	13	21	14	19	20	14

Appendix 2b. Seagrass survey results 2006 – maximum blade length per 30cm square quadrat

Date	Lat	Lon	direction	cm	0m	5m	10m	15m	20m	25m	30m	Average
25/07/2006	50.643350	-1.933733	S	cm	49	92	100	92	70	90	94	84
25/07/2006	50.643350	-1.933733	S	cm	66	83	82	76	55	79	89	76
25/07/2006	50.643670	-1.932933	S	cm	50	60	60	70	75	65	65	64
25/07/2006	50.643670	-1.932933	S	cm	62	70	70	60	63	70	74	67
25/07/2006	50.643683	-1.937883	S	cm	90	88	85	50	85	75	65	77
25/07/2006	50.643683	-1.937883	S	cm	82	84	65	60	92	75	76	76
26/07/2006	50.644150	-1.937700	N	cm	80	80	95	80	80	70	75	80
26/07/2006	50.644150	-1.937700	N	cm	90	110	115	85	95	70	80	92
26/07/2006	50.644600	-1.937283	S	cm	32	65	60	76	59	70	72	62
26/07/2006	50.644600	-1.937283	S	cm	39	59	72	78	66	105	94	73
26/07/2006	50.644750	-1.936783	S	cm	65	60	70	80	60	80	70	69
26/07/2006	50.644750	-1.936783	S	cm	37	46	69	76	72	71	59	61
25/07/2006	50.672067	-1.938283	W	cm	0	0	0	0	0	90	90	26
25/07/2006	50.672067	-1.938283	W	cm	0	0	0	0	0	75	100	25
25/07/2006	50.672217	-1.938467	W	cm	0	40	40	55	0	85	0	31
25/07/2006	50.672217	-1.938467	W	cm	0	37	47	56	0	83	0	32
25/07/2006	50.672483	-1.938583	W	cm	70	85	70	35	60	70	100	70
25/07/2006	50.672483	-1.938583	W	cm	70	60	62	0	60	80	84	59
25/07/2006	50.672833	-1.938550	W	cm	0	0	0	60	70	50	70	36
25/07/2006	50.672833	-1.938550	W	cm	0	10	0	50	65	40	75	34
25/07/2006	50.673233	-1.938867	W	cm	0	25	0	0	15	0	80	17
25/07/2006	50.673233	-1.938867	W	cm	0	0	10	5	15	35	55	17
26/07/2006	50.695617	-1.944983	E	cm	75	65	80	70	70	75	55	70
26/07/2006	50.695617	-1.944983	E	cm	90	73	80	85	65	75	60	75
26/07/2006	50.695817	-1.944983	E	cm	67	89	79	51	56	42	70	65
26/07/2006	50.695817	-1.944983	E	cm	88	85	92	73	58	59	88	78
26/07/2006	50.696133	-1.945117	E	cm	90	70	95	87	50	55	60	72
26/07/2006	50.696133	-1.945117	E	cm	65	84	75	54	50	56	61	64
26/07/2006	50.696367	-1.945083	E	cm	70	75	75	85	90	75	70	77
26/07/2006	50.696367	-1.945083	E	cm	56	63	57	66	84	77	57	66
26/07/2006	50.696500	-1.945117	E	cm	0	57	67	64	53	65	90	57
26/07/2006	50.696500	-1.945117	E	cm	0	50	60	60	51	50	78	50

Appendix 3. Maerl densities (0.5m² quadrat) observed within the core area shown in Fig.5 1999-2006

YEAR	LAT	LONG	mass g/m2	Quadrat 1	Quadrat 2
1999	50.652167	-1.909667	140.00	70.00	
2000	50.629200	-1.903467	121.30	53.60	67.70
2000	50.628500	-1.904133	127.20	63.80	63.40
2000	50.629150	-1.905183	74.90	39.10	35.80
2000	50.627983	-1.905717	94.40	49.70	44.70
2000	50.628900	-1.901817	55.40	32.40	23.00
2000	50.628217	-1.901267	102.90	48.20	54.70
2000	50.634217	-1.902933	49.70	21.90	27.80
2000	50.635033	-1.902133	38.40	18.50	19.90
2000	50.634133	-1.904567	55.40	27.40	28.00
2000	50.635333	-1.904300	43.40	20.60	22.80
2000	50.634167	-1.901333	66.80	33.40	
2000	50.646800	-1.909467	3.00	2.00	1.00
2000	50.646050	-1.909367	35.70	19.80	15.90
2000	50.646950	-1.908050	141.30	76.40	64.90
2000	50.646233	-1.908167	66.10	31.40	34.70
2000	50.646983	-1.906250	21.70	10.00	11.70
2000	50.646133	-1.906367	37.50	18.50	19.00
2000	50.653750	-1.906167	44.70	26.20	18.50
2000	50.654967	-1.906033	91.50	52.00	39.50
2000	50.653833	-1.909367	99.40	38.50	60.90
2000	50.654750	-1.909083	134.20	52.00	82.20
2000	50.640250	-1.906333	29.00	9.00	20.00
2000	50.639433	-1.906567	24.60	13.50	11.10
2000	50.640233	-1.904733	28.80	11.60	17.20
2000	50.640250	-1.903667	36.70	23.40	13.30
2000	50.623600	-1.906850	39.70	21.30	18.40
2000	50.622617	-1.907400	48.10	29.20	18.90
2001	50.619200	-1.912033	80.20	36.09	44.11
2001	50.618567	-1.912283	92.70	41.72	50.99
2001	50.618167	-1.911900	58.90	26.51	32.40
2001	50.617817	-1.911650	46.00	20.70	25.30
2001	50.618833	-1.911733	113.20	50.94	62.26
2001	50.618433	-1.912117	74.60	33.57	41.03
2001	50.652367	-1.909550	48.80	21.96	26.84
2001	50.651083	-1.910167	95.40	42.93	52.47
2001	50.622683	-1.907283	115.90	52.16	63.75
2001	50.623033	-1.907617	69.70	31.37	38.34
2001	50.622600	-1.905183	37.40	16.83	20.57
2001	50.622867	-1.905767	11.20	5.04	6.16
2001	50.622400	-1.908550	106.10	47.75	58.36
2001	50.622717	-1.908800	118.40	53.28	65.12
2003	50.628500	-1.904150	58.20	35.81	22.39
2003	50.629067	-1.904067	73.61	37.98	35.63
2003	50.628517	-1.905000	67.36	37.75	29.61
2003	50.628733	-1.906117	99.22	51.05	48.17
2003	50.628633	-1.903200	54.41	28.36	26.05
2003	50.630067	-1.903967	26.18	16.95	9.23
2003	50.640067	-1.905033	70.12	31.93	38.19
2003	50.637800	-1.905183	63.31	37.51	25.80
2003	50.640050	-1.906167	57.34	25.69	31.66

YEAR	LAT	LONG	mass g/m2	Quadrat 1	Quadrat 2
2003	50.637667	-1.906550	54.35	23.39	30.96
2003	50.633983	-1.901600	78.87	29.48	49.39
2003	50.634583	-1.900933	34.41	16.31	18.11
2003	50.634117	-1.900533	84.39	51.74	32.65
2003	50.635617	-1.899567	35.23	17.83	17.40
2003	50.634067	-1.902950	135.92	75.33	60.60
2003	50.634450	-1.902817	141.62	76.80	64.82
2006	50.652217	-1.909283	80.27	32.92	47.35
2006	50.652217	-1.909283	80.49	45.98	34.51
2006	50.630283	-1.903717	59.62	28.27	31.35
2006	50.630867	-1.903533	41.17	13.97	27.20
2006	50.629983	-1.904783	26.69	12.30	14.39
2006	50.630267	-1.904267	29.77	15.66	14.11
2006	50.630150	-1.903333	65.96	33.95	32.01
2006	50.630300	-1.903067	21.39	11.94	9.45
2006	50.628067	-1.904633	37.90	24.33	13.57
2006	50.629200	-1.904400	24.31	10.00	14.31
2006	50.627833	-1.905200	40.81	21.49	19.32
2006	50.628917	-1.905383	28.71	11.01	17.70
2006	50.628850	-1.902767	46.75	26.51	20.24
2006	50.628067	-1.904183	30.04	14.01	16.03
2006	50.628850	-1.904317	25.69	11.55	14.14
2006	50.627892	-1.905258	36.60	22.18	14.42
2006	50.626933	-1.906200	24.86	14.13	10.73
2006	50.625975	-1.907142	21.85	3.07	18.78
2006	50.652583	-1.909233	3.65	3.32	0.33
2006	50.652583	-1.909233	26.06	13.16	12.90
2006	50.654733	-1.909100	67.28	46.85	20.43
2006	50.654733	-1.909100	42.37	21.19	
2006	50.653817	-1.909383	77.81	38.10	39.71
2006	50.653817	-1.909383	70.51	35.26	
2006	50.646900	-1.908000	65.49	22.48	43.01
2006	50.646000	-1.907750	51.81	28.66	23.15
2006	50.644767	-1.907617	41.89	19.72	22.17
2006	50.644767	-1.907617	59.10	29.55	