Distribution and abundance of *Palinurus elephas* in North Pembrokeshire

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for the Marine Conservation Society (Seasearch)

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Summary

Crynodeb

Yn 2011 cafwyd cyllid gan Gronfa Grant Bioamrywiaeth Amgylchedd Cymru i chwilio am, a chofnodi, *Palinurus elephas* (cimwch yr afon) ar riffiau creigiog islanwnol yng ngogledd Sir Benfro er mwyn penderfynu ar eu dosbarthiad a'u nifer.

Aeth deifwyr *Seasearch* ati i arolygu saith o safleoedd i gyd dros gyfnod o chwe diwrnod. Daethpwyd o hyd i gyfanswm o 44 cimwch yr afon, gyda 23 ohonynt yn rhai ifanc. Y safleoedd gyda'r dwysedd uchaf o'r rhywogaeth oedd riffiau garw gydag agennau a waliau rhigol fertigol.

English

Funding was obtained in 2011 from Environment Wales Biodiversity Grant Fund to look for and record *Palinurus elephas* (crawfish) on subtidal rocky reefs in north Pembrokeshire to determine their current distribution and abundance.

Seven sites were surveyed in total over six days by Seasearch divers and a total of forty four crawfish were found, twenty three of which were juveniles. The sites with the highest density of the species were rugged reefs with vertical gulley walls and crevices.

1 Introduction

Palinurus elephas (crawfish, crayfish, spiny lobster) are large marine crustaceans similar in size to *Homarus gammarus* (European lobster). They are found in the sub-tidal on rugged rocky reefs throughout Europe, and in Britain and Ireland they occur along western coasts from Shetland southwards towards the Isles of Scilly. In Wales they are found mainly off the west and north west Pembrokeshire coast in the south, and around the Lleyn Peninsula in the north.

There has been a dramatic decline in the number of crawfish seen by divers since the late 1970's due to extensive commercial fishing by potting, scuba diving and later tangle netting, particularly around Wales (Lock 2011) and it has now been identified as a species that needs protection and is on the UK Biodiversity Action Plan species list.

Funding was obtained in 2011 from Environment Wales Biodiversity Grant Fund to survey reefs in north Pembrokeshire and record the number of crawfish seen with the help of 'Seasearch' volunteer divers. Seasearch is a national volunteer diving project run by the Marine Conservation Society. It trains recreational divers to undertake habitat and species surveys and organises diving surveys all around the coastline of the British Isles. Seasearch data are entered into the national database Marine Recorder and summary reports are produced each year. In Wales Seasearch surveys have been completed around the coast targeting popular diving areas as well as sites that are relatively unknown. The surveys also collect data on both Biodiversity Action Plan marine habitats and species.

2 Aims

The Biodiversity grant fund was awarded to achieve the following aims:

- To establish baseline monitoring of crawfish in north Pembrokeshire, and collect data to help determine their current distribution and population.

- To determine a suitable method for searching for and recording crawfish that can be adopted for any future monitoring programme.

- To determine which sites would be most suitable for a possible re-population programme in the future.

3 Methods

3.1 Search methods

One aim of the survey was to establish a suitable systematic search and record method which could be adopted for future monitoring. Environmental factors that had to be taken into consideration were (a) nature of the habitat to be surveyed and (b) tidal current. It was also important to ensure that on each visit to a site a different area was surveyed, and if more than one pair of divers were in close proximity in the water at the same time they did not cover the same ground.

The preferred habitat for crawfish is rugged rocky reef, often with vertical walls, with many crevices. Therefore a method had to be devised that did not involve ropes and lines that could get easily snagged, but would still ensure systematic and thorough searches. Crawfish often inhabit rocky reefs subject to tidal movement, so a search method had to be used that did not involve the necessity of returning to a start point if any current was present. An information pack published by the Countryside Council for Wales was used as an aid to determine what methods would or would not work (Morris *et al* 2010).

Two methods were eventually employed, depending on the orientation of the reef.

Vertical or sloping substrate
A weight attached to a buoyed line to the surface (shot line) was placed on the reef for reference and the position recorded using GPS. Divers descended down the line in pairs, swam to pre-determined depths at 5 metre depth intervals , and moved along the rock face keeping to their appropriate depth contour. At the end of the dive, before commencing their ascent, divers deployed a delayed surface marker buoy (SMB) to enable the support boat crew to record their end of search position. Assuming a reasonably constant direction of swim, accurate start and finish positions allowed an estimate of the area surveyed, and the delayed SMB position provided a start position for the next search of the site if the reef had not been fully surveyed.

Horizontal substrate
Shot lines were placed on the seabed and their positions recorded on a GPS. Divers descended in pairs and swam on pre-determined compass bearings. At the end of the dive, before commencing their ascent, the same routine was adopted as described above. If a

current was present, diver pairs were dropped in a few metres apart across the current, and all pairs went with the direction of the flow deploying an SMB if they deemed necessary, and deploying a second at the end of their dive to pinpoint their finish position. Diving did not take place if the current was considered too strong for thorough surveying.

3.2 Recording

Each time a crawfish was seen the diver made a note of the depth, the time elapsed on the dive, and the size of the animal in order to determine whether they were adult or juvenile. Crawfish are measured along the carapace from behind the eye socket to the beginning of the first segment, which can prove difficult if they are occupying a crevice. In this instance surveyors estimated whether the carapace was more or less than 100 mm. Research in a marine reserve in the Mediterranean found that crawfish were sexually mature when the carapace length reached 76 mm in females and 82mm in males (Goni *et al* 2003). In the British Isles, size at maturity is generally larger, the smallest berried female found in Wales being 121 mm, while in Cornwall the smallest berried female measured 90mm (Hunter 1999). For the purpose of this survey individuals smaller than 100 mm were classed as juvenile, but the sex was not noted.

The number of European lobsters (*Homarus gammarus)*, edible or brown crabs (*Cancer pagurus)* and spiny spider crabs (*Maja squinado)* encountered on each dive were also recorded in order to make a comparison between the numbers of other commercially fished crustacea with the number of crawfish. Velvet swimming crabs (*Necora puber*) are not currently fished commercially around north Pembrokeshire but were also recorded to ascertain the population of an unfished species to provide a further comparison.

4. Sites

North Pembrokeshire is known to be one of the few remaining areas in Wales where crawfish are still present in any number, and they have been recorded by Seasearch divers during previous organised survey events on rocky reefs at certain locations (Jones 2005, Lock 2009). These sites were targeted for surveying together with two additional sites with slightly different habitats for comparison. Crawfish are named on the CCW species sensitive data list, therefore access to data is restricted and exact positions for the sites cannot be given in this report. Seven sites were surveyed in total.

Site A An uneven, gently sloping rocky reef with occasional vertical gullies with many crevices in the walls, leading to boulders and sediment at the base. The top of the reef is dominated by kelp and red seaweeds, with the sloping and deeper sections covered with diverse faunal turf, dominated by sponges, hydroids and bryozoans. The depth ranges from 9 to 17 metres.

Site B A rocky reef covering a large area, with a series of steep sided rock pinnacles rising up from the seabed at 20 metres to 15 metres below the surface surrounded by undulating bedrock with gullies and crevices. All covered with abundant faunal turf, dominated by sponges, hydroids and bryozoans.

Site C Mainly horizontal, rugged, uneven bedrock with areas of large boulders and sediment, ranging from 19 to 22 metres depth. Branching sponges are the dominant cover on the rock surfaces, with brittle stars abundant on some sediment patches.

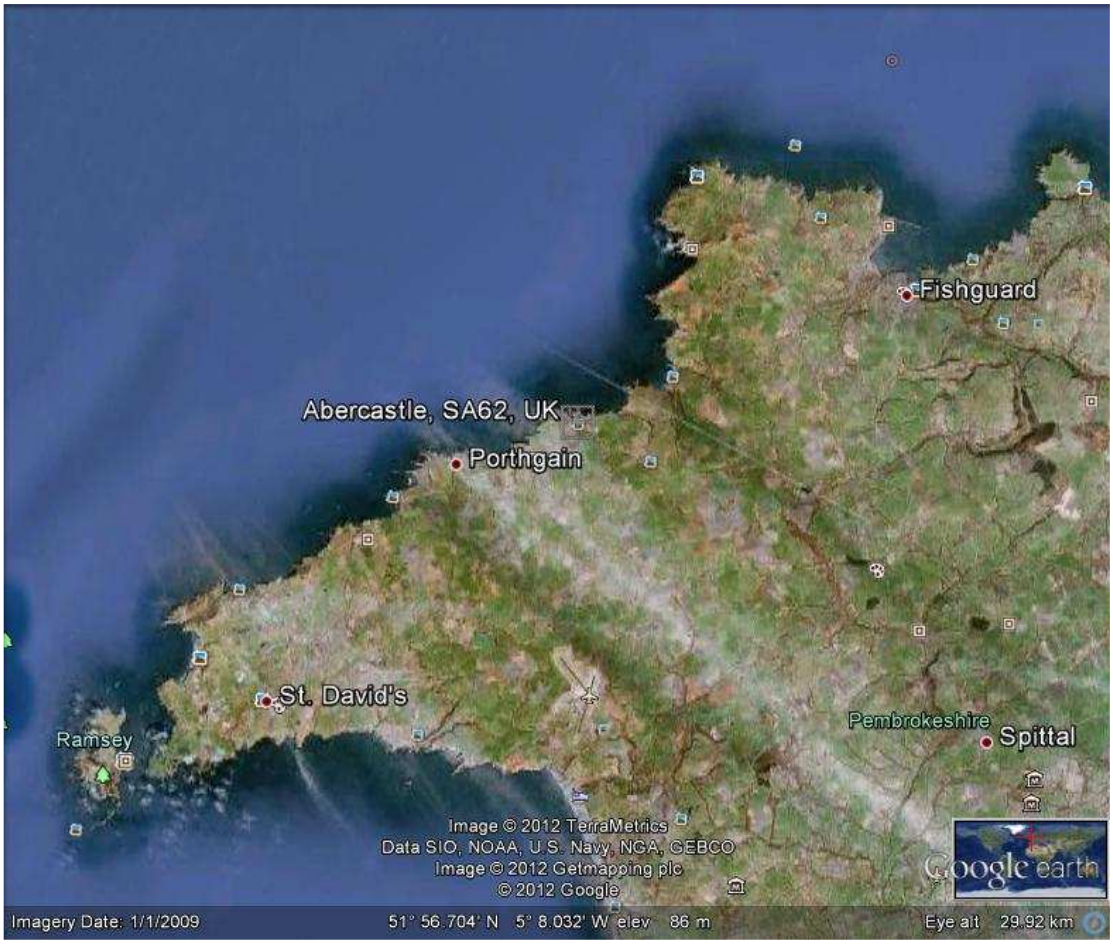

Figure 1. Map showing North Pembrokeshire coastline

Site D A rugged rocky reef with three pinnacles rising to the surface from 35 metres, creating vertical and steeply sloping walls with many crevices and fissures, dominated by diverse faunal turf including sponges and hydroids with extensive patches of yellow cluster anemones (*Parazoanthus axinellae*).

Site E A rock headland that slopes steeply down to 20 metres to a sediment seabed with frequent large boulders at the base of the slope. Bedrock and boulders all covered with diverse faunal turf including sponges, hydroids and bryozoans.

Site F Occasional silt-covered rock outcrops in between areas of cobbles and pebbles at a depth of 20 metres. Brittle star beds were present on the sediment, and a carpet mussel bed (*Musculus discors*) on rock was present in one area with common starfish (*Asterias rubens)* feeding. Carpet mussel beds are a Welsh BAP habitat.

Site G Generally flat seabed dominated by rounded medium sized boulders with occasional low rocky outcrops in a 15-18 metres depth range, mostly covered with red algal turf and sparse sponge/bryozoan turf.

5. Results

	No. Dives	Adult Crawfish	Juvenile crawfish	Lobsters	Edible crabs	Spider crabs	Velvet crabs
Site A	7	2	5	6	20	48	30
Site B	10	13	12	19	52	75	178
Site C	7	4	4	13	11	18	72
Site D	7	1	1	26	24	17	70
Site E	4	1	1	8	6	9	138
Site F	4	0	0	8	22	33	125
Site G	4	0	0	11	21	8	80
Total		21	23	91	154	208	693

Table 1. Total number of crustaceans recorded at each site

More crawfish were recorded from Site B than any other site (Table 1). However, Site B was also the largest expanse of reef, therefore an estimate of the total area surveyed at each site was needed in order to draw a more meaningful comparison. By measuring the distance between the start and end GPS positions of each dive, and assuming each diver surveyed a band width of 2 metres, an approximate size of area covered could be estimated for each site. A further calculation was made to find the approximate number of crawfish and other crustacea per 100 m² (Table 2).

Site A was found to have the largest density of crawfish followed by Site B, correlating with their preferred habitat being rugged rocky reef with many crevices. However, Site D had a very low density and only two crawfish were recorded here, which was surprising given that the site is a typically suitable habitat for them and they had been seen there frequently in the past. No crawfish were seen at Sites F or G, which was as expected as they were the less rocky sites chosen for survey.

	Crawfish per 100 m²	Lobsters per 100 m²	Edible crabs per 100 m²	Spider crabs per 100 m²	Velvet crabs per 100 m²
Site A	.54	.46	1.54	3.7	2.3
Site B	.42	.32	.88	1.3	3
Site C	.13	.22	.19	.3	1.22
Site D	.1	1.3	1.2	.85	3.5
Site E	.13	.52	.39	.59	8.9
Site F	0	.3	.81	1.22	4.6
Site G	0	.37	.7	.27	2.7

Table 2. Density of crustaceans at each site

Surveyors were asked to note the dive time elapsed each time they recorded a crawfish. The results show that in the majority of cases a number of crawfish were usually found close together. The greatest number recorded on a single dive was eight at Site B, all juveniles, and five of these were found in one gulley in crevices in the vertical rock face.

The depth at which a crawfish was seen was recorded each time and corrected to chart datum. The shallowest depth at which one was found was 11.8 metres below chart datum, while the deepest was 22.8 metres. Thirty four out of the forty four recorded (77%) were found in the 14-18 metre depth range.

Crawfish have a growth rate of 12mm per year (Mercer 1973), and over half of the juveniles seen had a carapace length of 60-70 mm, making them an estimated 5-6 years old.

Figure 2. Juvenile crawfish next to A5 slate
Photo: Andrew Everett

The largest adult recorded had a carapace length of 150mm (12 years old), with the majority measuring 100-120mm (8-10 years old).

Of the other commercially fished species recorded, fewer lobsters were recorded overall than edible and spider crabs, but all species were found in greater numbers than crawfish. Only 7 out of the 91 lobsters recorded were classed as juveniles (carapace size less than 100mm) compared to 23 out of 44 crawfish. Velvet swimming crabs were by far the most frequently recorded crustacean.

Figure 3. Adult crawfish in crevice
Photo: Chris Wood

Figure 4. *Necora puber* (Velvet swimming crabs).
Photo: Chris Wood

6. Conclusions

North Pembrokeshire is known to be one of the few areas remaining in Wales where crawfish are regularly seen by divers, but the numbers recorded during this survey were still critically low and in sharp contrast to the high numbers that were recorded by divers during the 1970's and into the 1980's (Lock 2011). It is encouraging that juveniles were present as a high proportion of animals encountered, but there is an urgent need for the species to be protected to enable them to reach maturity and be able to reproduce.

Crawfish have been recorded from sites A and B on previous occasions by Seasearch divers (Jones 2005, Lock 2009), and this survey has shown that these reefs are still inhabited by the species and would appear to be nursery grounds for juveniles. If a re-population programme was undertaken in the future these sites could be possible suitable locations for it to take place.

The survey has established satisfactory methods of searching for and recording crawfish that can be easily adopted for any future monitoring surveys. A higher degree of accuracy of distance covered could be obtained if divers were able to use a measuring tape to reel out from a shot line, however this would not be feasible if a current was present.

The high number of velvet crabs seen compared to the number of commercially fished crustaceans possibly highlights the effect that an intense fishing effort has on the population of a species. If in the future the fishing industry should begin to target these, this report could provide a useful baseline for future monitoring even though it was not part of the aim of this survey.

7. Recommendations

During the 5th quinquennial review of the Wildlife & Countryside Act crawfish were proposed by the Countryside Council for Wales as a candidate species for inclusion on Schedule 5 of the Wildlife & Countryside Act, to provide it with full protection. The proposal was rejected as there was doubt as to the current stocks of the species in Welsh water. This survey contributes to the evidence that the population is significantly smaller than historically, and it is strongly recommended that the species is put forward for inclusion on Schedule 5 of the Wildlife & Countryside Act once more when the next review takes place.

Repeat monitoring surveys should be undertaken at these sites adopting the methods used during this survey to observe any change in population, age and distribution. Surveys could also take place in other areas to gain further knowledge about the current population and distribution of crawfish throughout Wales.

A restoration programme should be considered at the sites that appear to be the most suitable and where the highest numbers/density of crawfish was recorded.

8. Acknowledgments

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Appendix 1. Numbers and size of *Palinurus elephas* (Crawfish) recorded at each site

Date	Site	Recorders	Depth metres (bcd)	Adult Crawfish	Juv Crawfish	Size (cms)
18/06/11	Site 'A'	Sarah Bowen/David Kipling		0	0	
18/06/11	Site 'A'	Edward Male/Carolyn Waddell		0	0	
18/06/11	Site 'A'	Emily Williams/Joanne Thomson	12,12,12,12	0	4	7, 7, 7, 7
18/06/11	Site 'A'	Jon Moore/Blaise Bullimore	15.2	0	1	4
18/06/11	Site 'A'	Emily Williams/Carolyn Waddell	15.2,15.8	2	0	10,12
18/06/11	Site 'A'	Sarah Bowen/David Kipling		0	0	
18/06/11	Site 'A'	Jon Moore/Blaise Bullimore		0	0	
09/07/11	Site 'B'	Andrew Everett/Vicki Howe	16.3,16.3,15.8,17.3	2	2	6, ?, ?, ?
09/07/11	Site 'B'	Edward Male/Carolyn Waddell	11.8,13.3	2	0	?, ?
09/07/11	Site 'B'	Jim Bull/Emma Kenyon	15.1,15.1,15.1	3	0	12, 12, 10
10/07/11	Site 'B'	Andrew Everett/Vicki Howe	14.6,14.6,14.3,14.6	4	0	11, ?, ?, ?
10/07/11	Site 'B'	Jim Bull/Emma Kenyon		0	0	
10/07/11	Site 'B'	Edward Male/Carolyn Waddell		0	0	
07/08/11	Site 'B'	Sarah Bowen/David Kipling		0	0	
07/08/11	Site 'B'	Richard West/Erin Smyth	14.3	0	1	7
07/08/11	Site 'B'	Steve Bound/Robert Beresford	16.8,16.8,16.8	2	1	8, 8, 4
07/08/11	Site 'B'	Scott Tompsett/Chris Wood	14.4,14.1,16.7,16.2,16,15.8,16.5,16.4	0	8	5, 6, 6, 6, 7, 4, 7, 6
09/07/11	Site 'C'	Edward Male/Carolyn Waddell	17.3,17	2	0	Small adults
09/07/11	Site 'C'	Andrew Everett/Vicki Howe		0	0	
09/07/11	Site 'C'	Jim Bull/Emma Kenyon	20	1	0	10
06/08/11	Site 'C'	Sarah Bowen/David Kipling		0	0	
06/08/11	Site 'C'	Scott Tompsett/Chris Wood	18.8,18.8,18.3	0	3	7, 7, 7,
06/08/11	Site 'C'	Steve Bound/Robert Beresford	19.8	1	0	8
06/08/11	Site 'C'	Richard West/Erin Smyth	20.6	0	1	?
10/07/11	Site 'D'	Jim Bull/Emma Kenyon	22.8	1	0	15
10/07/11	Site 'D'	Edward Male/Carolyn Waddell		0	0	
10/07/11	Site 'D'	Andrew Everett/Vicki Howe		0	0	
06/08/11	Site 'D'	Steve Bound/Robert Beresford		0	0	
06/08/11	Site 'D'	Scott Tompsett/Chris Wood		0	0	
06/08/11	Site 'D'	Sarah Bowen/David Kipling		0	0	

06/08/11	Site 'D'	Richard West/Erin Smyth	15.5	0	1	8
25/09/11	Site 'E'	Sarah Bowen/David Kipling		0	0	
25/09/11	Site 'E'	Neil Davies/Steffan Richards		0	0	
25/09/11	Site 'E'	Blaise Bullimore/Carolyn Waddell	16.7,18.1	1	1	14, 7
25/09/11	Site 'E'	Robert Beresford/Andrew Everett		0	0	
07/08/11	Site 'F'	Richard West/Erin Smyth		0	0	
07/08/11	Site 'F'	Scott Tompsett/Chris Wood		0	0	
07/08/11	Site 'F'	Steve Bound/Robert Beresford		0	0	
07/08/11	Site 'F'	Sarah Bowen/David Kipling		0	0	
25/09/11	Site 'G'	Sarah Bowen/David Kipling		0	0	
25/09/11	Site 'G'	Neil Davies/Steffan Richards		0	0	
25/09/11	Site 'G'	Robert Beresford/Andrew Everett		0	0	
25/09/11	Site 'G'	Blaise Bullimore/Carolyn Waddell		0	0	

Appendix 2. Habitats recorded on each dive

Date	Site	Recorders	Habitat Description
18/06/11	Site 'A'	Sarah Bowen/David Kipling	Mixed ground - ridges, gullies and outcrops of bedrock with areas of sediment/pebbles in between. Small overhangs and ledges with edible crabs and velvets. Turf of mainly red weeks (*Delessaria/Heterosiphonia* dominant) and hydroids. Large number of nudibranchs and spawn.
18/06/11	Site 'A'	Edward Male/Carolyn Waddell	Rocky reef beneath kelp park, mainly small gullies with occasional larger gullies and swim throughs.
18/06/11	Site 'A'	Emily Williams/Joanne Thomson	Gently sloping rocky reef with areas of sediment between, going to boulders at approx 17.5 metres. Abundant crevices and gullies, one gully 2 mts wide with soft sandy bottom and vertical walls, all Crawfish found in this gully in crevices in walls
18/06/11	Site 'A'	Jon Moore/Blaise Bullimore	Uneven bedrock outcrops and ridges, some small verticals and gulleys where one crawfish found but overall not good Crawfish habitat
18/06/11	Site 'A'	Emily Williams/Carolyn Waddell	Sandy bottom with gravel and cobbles, with brittlestar bed. Travelled west onto broken rocky reef dominated by red algae and *Nemertesia* hydroids. Two crawfish in vertical gully at approx 16 metres.
18/06/11	Site 'A'	Sarah Bowen/David Kipling	Low lying rocky reef interspersed with areas of sediment and sand. No crawfish, but other crustaceans present. Sponges, red algae and *Nemertesia* hydroids dominated.
18/06/11	Site 'A'	Jon Moore/Blaise Bullimore	Low lying, mostly broken reef interspersed with gravel/sand patches. Reef with occasional taller outcrops, gullies and boulders. Very extensive areas of very dense *Musculus discors*. Sponge/hydroids/bryozoan dominated.
09/07/11	Site 'B'	Andrew Everett/Vicki Howe	Deep rock gullies with cobbles and sand at base. Short animal turf, many sponges. Frequent leopard spotted gobies. Crawfish found in crevices in gullies
09/07/11	Site 'B'	Edward Male/Carolyn Waddell	Reef covered with sponges and short animal turf. Bedrock with vertical fissures and crevices. Abundant red seaweeds covering top of reef.
09/07/11	Site 'B'	Jim Bull/Emma Kenyon	1-2 metre deep gullies with fissures and crevices. First crawfish on top of large boulder, others 1 metre apart in crevice at bottom of gulley. Animal turf dominated by hydroids and sponges
10/07/11	Site 'B'	Andrew Everett/Vicki Howe	Boulders and undulating bedrock at start of dive with some gravel. Crawfish found as habitat changed to bedrock with gullies and sand patches. One large *Eunicella* (pink sea fan). Numerous sponges and abundant short animal turf.
10/07/11	Site 'B'	Jim Bull/Emma Kenyon	Mostly flat bedrock with shallow gullies, well covered in short animal turf and red algae. Occasional shingle patches and large boulders 1-3 metres high
10/07/11	Site 'B'	Edward Male/Carolyn Waddell	Flat rock broken by few small gullies. Covered in short animal turf and abundant red seaweeds. Occasional kelp. At edge of reef gravel and sand bed. Depth mostly 13-15 metres.
07/08/11	Site 'B'	Sarah Bowen/David Kipling	Jagged rocky reef deeply intersected with gullies and swim throughs. Extremely silty, ledges of sponges and cup corals. Several extensive patches *of Parazoanthus axinellae* and big areas of *Thymosia guernei.*
07/08/11	Site 'B'	Richard West/Erin Smyth	Rocky reef 15-20 metres covered in sponges, hydroids and bryozoans. Short faunal turf with

			some red seaweeds. Sand gravel areas between bedrock
07/08/11	Site 'B'	Steve Bound/Robert Beresford	Rocky reef 18-22 metres, with gullies. Very silty, sponges dominant
07/08/11	Site 'B'	Scott Tompsett/Chris Wood	Rocky reef 15-20 metres. Very rugged with gullies, vertical faces and boulders in base of gullies. Animal turf including sponges. Crawfish all in fissures, holes in vertical rock
09/07/11	Site 'C'	Edward Male/Carolyn Waddell	Bedrock, broken reef with short animal turf and gullies. Brittle stars later in dive. Crawfish in bedrock crevices facing current
09/07/11	Site 'C'	Andrew Everett/Vicki Howe	Large boulders approx. 1 metre high and cobbles. Outcrops of bedrock towards end of dive with narrow deep vertical fissures. Outcrops small, 1-2 metres high. Short animal turf and *Pentapora foliacea* (potato crisp bryozoan) . Frequent *Crossaster* (sunstar).
09/07/11	Site 'C'	Jim Bull/Emma Kenyon	Flat bedrock before finding Crawfish. Large boulders with fissures and crevices on latter part of dive. Crawfish found in small crevice on top edge of boulder.
06/08/11	Site 'C'	Sarah Bowen/David Kipling	Low lying reef, cobbles and pebbles 22-23 metres depth. Branching sponges, very silty, hydroids. Large angler fish.
06/08/11	Site 'C'	Scott Tompsett/Chris Wood	Reef and boulders 22-24 metres, with many branching sponges
06/08/11	Site 'C'	Steve Bound/Robert Beresford	Mixed ground with rocky reef and boulders. Brittle star and feather star beds. Sponge and hydroid fauna. 20-24 metres depth
06/08/11	Site 'C'	Richard West/Erin Smyth	Pebbly/gravel areas interspersed with rocky ridges and boulders
10/07/11	Site 'D'	Jim Bull/Emma Kenyon	Followed 25 metre depth contour along pinnacle. Vertical rock face with animal turf leading to broken rock and boulders. Crawfish seen under boulder.
10/07/11	Site 'D'	Edward Male/Carolyn Waddell	Followed 15 metre depth contour. Vertical rock walls with occasional crevices. Boulders on some horizontal ledges
10/07/11	Site 'D'	Andrew Everett/Vicki Howe	Followed 20 metre depth contour. Vertical rock covered in hydroids and small animal turf. At 20 metres gullies narrow with dead mussel shell and numerous common starfish. Numerous dog fish, 1 *Eunicella*. Near end of dive abundant *Antedon bifida*. Two *Dromia* (sponge crab), patches of *Parazoanthu*s common.
06/08/11	Site 'D'	Steve Bound/Robert Beresford	16-19 metres depth range. Rock walls with gullies, some boulders. Sponge and hydroid turf with algal turf at shallower depth
06/08/11	Site 'D'	Scott Tompsett/Chris Wood	Open bedrock 18-20 metres leading to large flat boulders at 21-22 metres. Silty surfaces with sponges and cup corals
06/08/11	Site 'D'	Sarah Bowen/David Kipling	Walls, gullies and large boulders in 14m approx.. with one pinnacle to 8 metres. Stepped areas, silty ledges with sponges and cup corals. Verticals with dense bryozoan turf. Several areas of *Parazoanthus axinellae*.
06/08/11	Site 'D'	Richard West/Erin Smyth	Boulders and walls with sponges, hydroids and bryozoans and red seaweeds. Many *Tritonia lineata* and *Limacia clavigera* (sea slugs).
25/09/11	Site 'E'	Sarah Bowen/David Kipling	Boulders and cobbles with occasional patches of sand. Continuing east, a vertical undercut wall with ledges, nooks and crannies. Enormous *Cliona* (boring sponge) patches plus black tar sponges. Many common prawns and leopard spotted gobies..
25/09/11	Site 'E'	Neil Davies/Steffan Richards	Gullies with small and large boulders leading to bedrock. Lots of nooks and crannies

25/09/11	Site 'E'	Blaise Bullimore/Carolyn Waddell	Boulders and cobbles and occasional bedrock outcrops 14-17m for 25 mins leading to steep broken reef at 16-19m. Reef with many deep crevices and frequent deep gullies. Ridges perpendicular to adjacent islet. Animal turf, *Eunicella* and *Parazoanthus* patch. 1 *Dromia personata.*
25/09/11	Site 'E'	Robert Beresford/Andrew Everett	Large boulders with crevices under, leading to bedrock
07/08/11	Site 'F'	Richard West/Erin Smyth	Pebbly area with brittlestar bed, interspersed with rocky reef red and brown seaweeds, hydroids and bryozoans with starfish and crabs
07/08/11	Site 'F'	Scott Tompsett/Chris Wood	Bedrock reef with gullies interspersed with gravel beds. 20m - areas of open gravel with smaller boulders. 15m - rock gullies with kelp on top. *Asterias* on *Musculus discors* bed
07/08/11	Site 'F'	Steve Bound/Robert Beresford	Reef with cobbles and pebbles surrounding. Sponges, brittle stars and feather stars on the pebbles, quite silty
07/08/11	Site 'F'	Sarah Bowen/David Kipling	Initially cobbles and pebbles with abundant *Ophiura albida*, swam east to rocky reef 20-15 metres with gullies, boulders interspersed with sandy patches. Four *Crossaster* seen, Octopus, *Adamsia* (cloak anemone) on crab. Many sponges, very silty.
25/09/11	Site 'G'	Sarah Bowen/David Kipling	Mixed ground of upstanding bedrock, sloping bedrock with crevices and overhangs. Abundant red and brown weeds with understorey of bryozoans and *Caryophyllia* (cup corals).
25/09/11	Site 'G'	Neil Davies/Steffan Richards	Bedrock with large boulders. Deep crevices. Further north flattened out to a flat slate like scree with occasional medium sized boulders
25/09/11	Site 'G'	Robert Beresford/Andrew Everett	Bedrock and a few large boulders
25/09/11	Site 'G'	Blaise Bullimore/Carolyn Waddell	One scallop seen. Generally flat seabed dominated by medium boulders - almost slate like but rounded, occasional low rocky outcrops. Red algal turf and sparse sponge/bryozoan turf. Evidence of scour and sediment on rock

Appendix 3. Numbers of all crustaceans recorded on each dive

Date	Site	Adult Crawfish	Juv Crawfish	Adult lobster	Juv lobster	Edible crab	Spider crab	Velvet crab
18/06/11	Site 'A'			1		4	8	7
18/06/11	Site 'A'							
18/06/11	Site 'A'		4			2	7	
18/06/11	Site 'A'		1	3		5	15	10+
18/06/11	Site 'A'	2		1		5	3	
18/06/11	Site 'A'					1	5	
18/06/11	Site 'A'			1		3	10	12
09/07/11	Site 'B'	2	2			4	3	10
09/07/11	Site 'B'	2		2		12	4	12
09/07/11	Site 'B'	3		1		7	5	21
10/07/11	Site 'B'	4		4		13	25	25
10/07/11	Site 'B'			3			8	11
10/07/11	Site 'B'			2		3	3	18
07/08/11	Site 'B'			2		9	3	22
07/08/11	Site 'B'		1	3		5	8	33
07/08/11	Site 'B'	2	1	2		5	12	11
07/08/11	Site 'B'		8			4	4	15
09/07/11	Site 'C'	2		3		5	3	11
09/07/11	Site 'C'			4			1	19
09/07/11	Site 'C'	1		4		2	5	15
06/08/11	Site 'C'							2
06/08/11	Site 'C'		3	1			1	10
06/08/11	Site 'C'	1				2	3	3
06/08/11	Site 'C'		1	1		2	5	12
10/07/11	Site 'D'	1		1		8	1	1
10/07/11	Site 'D'			3		5	5	12
10/07/11	Site 'D'			7		4	7	16
06/08/11	Site 'D'			3	4	1	1	8
06/08/11	Site 'D'			5		3		14
06/08/11	Site 'D'			3		2	1	9
06/08/11	Site 'D'		1			1	2	10
25/09/11	Site 'E'			2	2	2	1	35

Date	Site	Adult Crawfish	Juv Crawfish	Adult lobster	Juv lobster	Edible crab	Spider crab	Velvet crab
25/09/11	Site 'E'					1	2	37
25/09/11	Site 'E'	1	1	3		2		38
25/09/11	Site 'E'			1		1	6	28
07/08/11	Site 'F'			3		4	28	58
07/08/11	Site 'F'					4	5	30
07/08/11	Site 'F'			2		6		23
07/08/11	Site 'F'			3		8		14
25/09/11	Site 'G'			4		4	1	28
25/09/11	Site 'G'			6		16	1	28
25/09/11	Site 'G'				1		6	18
25/09/11	Site 'G'					1		6