A report to the
Nature Conservancy Council

from the
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LITTORAL AND SUBLITTORAL MONITORING

IN THE ISLES OF SCILLY

SEPTEMBER 22ND TO 29TH, 1984

edited by
Keith Hiscock

January 1985

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SYNOPSIS

The Isles of Scilly are one of seven locations identified in Great Britain as proposed statutory marine nature reserves. In order to provide information to assist in management of these areas, monitoring programmes are being developed which are aimed at detecting change in populations and communities of high nature conservation importance. In the Isles of Scilly, the specific objectives were to 'establish a monitoring programme to investigate changes in species and communities of high nature conservation interest. This will include studies on Zostera beds present on the sand flats between the latger islands'. In addition, two sites were established for monitoring littoral underboulder communities and some further surveys of sublittoral sites were carried out.This report describes part of the work undertaken in the Isles of Scilly. Studies of the sea urchin Echinus esculentus and an aerial photographic survey will be described elsewhere.

Two adjacent sites at one location north of Gap Point on the east side of St Mary's were selected for photographic monitoring of Mediterranean-Atlantic species of high scientific interest. They were marked with pitons and a reference line was tied betwen the pitons. Both distance and close-up photographs were taken along the line. The photography worked well in providing record photographs and can be repeated in future years.

The extensive beds of Zostera marina present in the Isles of Scilly are of considerable conservation importance. The work described here was undertaken in beds at English Island and Old Grimsby Harbour and was aimed at measuring the density of plants and length of leaves, recording the species associated with the Zostera and comparing the two sites. The English Island site was found to be much richer in the variety and abundance of associated species than the Old Grimsby Harbour site although the plants there were more dense.

Underboulder communities at several locations in the Isles of Scilly are considered to be especially rich examples of this type of habitat. Two sites were selected for study and monitoring: at English Island Point and on the east side of Samson. Here, boulders selected for study were lifted, the undersides photographed using a picture area of 0.033 m^2, and the species present were noted. The location of the boulders was recorded on polaroid photographs.

Dives were undertaken at four additional locations to provide further data and photographs for the description of habitats and communities in the Isles of Scilly. Records were made from Peninnis Head, Giant's Castle and Deep Point (St Mary's) and from north of St Agnes.

A summary of the main recommendations made were:

Photographic monitoring

- Re-photograph the site established in 1984 at about the same time of year in 1985 and make a detailed comparison.

Zostera bed

- Resurvey the English Island and Old Grimsby Harbour sites including descriptive and quantitative work at about the same time of year for the next two years to assess the stability of the different community types.

- Undertake vertical aerial photography employing a specialist company to provide large format colour transparency photographs to a set scale for mapping.

Underboulder communities

- Re-survey and photograph the same boulders at about the same time of year in 1985 and make a detailed comparison.

Concern was also expressed that sea-borne dumping at Gap Point had occured very near to some of the richest populations of sponges in the Isles of Scilly and that protection was appropriate.

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1. GENERAL INTRODUCTION

Seven sites have been identified in Great Britain as proposed statutory marine nature reserves. They are Bardsey Island and the adjacent Lleyn Peninsula, Loch Sween, Lundy, the Menai Strait, the Isles of Scilly, Skomer and St. Abbs. In order to provide information to assist in the management of these areas, monitoring programmes are being developed aimed at detecting change in communities and populations of high nature conservation importance.

This report describes the work undertaken in the Isles of Scilly to establish monitoring sites on rock surfaces on the east side of St. Mary's and in the Zostera marina beds on the southeast side of St. Martins and to establish sites for monitoring underboulder communities at St. Martin's and Samson. The work undertaken on sublittoral rock surfaces on the east side of St. Mary's includes photography of Mediterranean-Atlantic species present at monitoring sites at Lundy and Skomer and gives a geographical spread to the work. Other work carried out in the same week and the following week and reported separately included aerial photography of the islands and surveys of populations of the sea urchin Echinus esculentus.

The specific objectives given in the contract were to 'establish a monitoring programme to investigate changes in species and communities of high nature conservation interest. This will include studies on Mediterranean-Atlantic species found around the island and on Zostera beds present on the sand flats between the larger islands'. In addition, two sites were established for monitoring littoral underboulder communities and some further surveys of sublittoral sites was undertaken to expand data and photographic material available for the 1983 survey (Hiscock, 1984a).

The different activities undertaken each day are noted in the record of daily activities (Appendix 1). The location of sites mentioned in the text is shown in Fig.1.

Photographs taken have been filed and their index numbers are given in the text. Two sets of photographs were produced: a complete set of original slides and a duplicate set of key slides excluding unsuccessful or inferior quality series at the same site. Both sets are held by NCC. Much of the work was written-up on the Isles of Scilly by the field team and edited for this report by K. Hiscock.

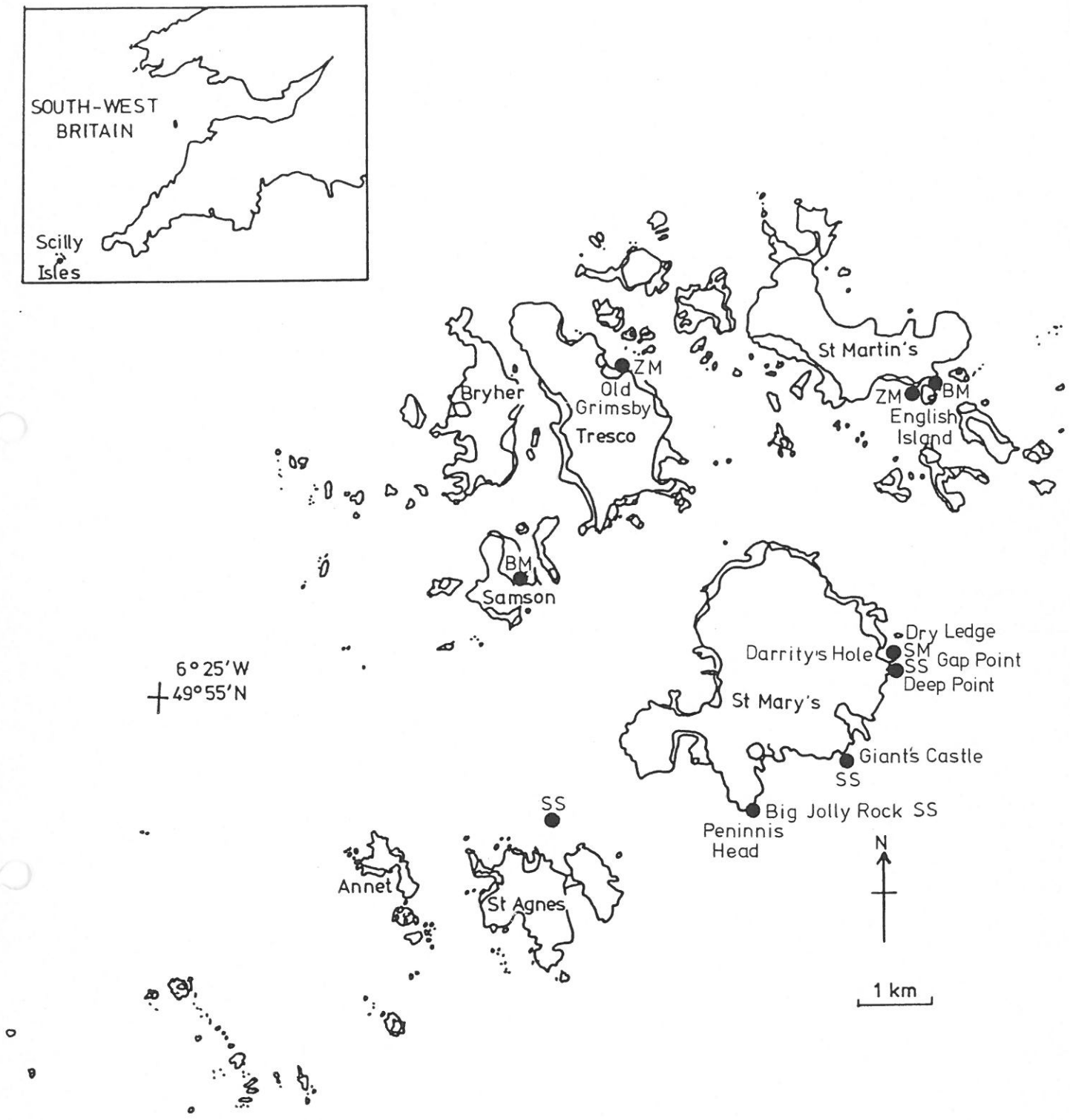


Fig.1. Location of sites. SM = Sublittoral Monitoring; ZM = Zostera Monitoring; BM = Boulder Monitoring; SS = Sublittoral Survey.

2. PHOTOGRAPHIC MONITORING AT GAP POINT

2.1. Introduction

The bay north of Gap Point and east of Darrity's Hole on the east side of St. Mary's was identified during the 1983 survey (Hiscock, 1984a) as including species of high nature conservation interest. These included the sponges ?Pytheus rosea, Homaxinella subdola and Axinella polypoides, the corals Leptopsammia pruvoti and Balanophyllia regia and the zoanthid anemone Parazoanthus axinellae. Most of these species were present on broken rock surfaces to the north of the mud plain between Gap Point and Dry Ledge at a depth of about 22 m below chart data. The aim of the work undertaken in 1984 was to relocate these species, establish marked monitoring sites and photograph them in a manner which could be repeated in future years.

Similar work had previously been undertaken at Lundy in 1984 (Hiscock, 1984b) and survey personnel already had experience of site marking and photographic techniques. A detailed description of the techniques and equipment used at both Lundy and in the Isles of Scilly is given in that report.

2.2. Methods

The area of greatest interest identified in the 1983 survey was relocated at the surface from memory and a shot line dropped to the seabed. The exact location of a site suitable for photographic monitoring was then marked following an exploration of the area. The location of the site at the surface was recorded by the use of a sighting compass and transit marks were sketched and photographed with Polaroid and standard cameras to enable relocation. The first site selected was a slightly overhanging rock surface about 1.3 m x 1.5 m in area and holding a scattered population of Leptopsammia pruvoti. The second site selected was a few metres west and was of broken rock including near vertical and near horizontal surfaces with a wide range of sponge species and a large area of Parazoanthus axinellae present. An inspection of the area revealed widely scattered crevices suitable for pitons but little rock on which to obtain a purchase for the use of the compressed air drill. However the drill was used in an attempt to place fixings at one metre apart for the location of a 1 m x 1 m quadrat. The penetration of the drill bit was poor the and the use of pitons was reverted to.

At the first site, pitons were driven into crevices at two points and a blue rope tied between to act as a guide. At the second site, three pitons were fixed and a white nylon rope knotted at 50 cm intervals was tied to the pitons. Distant and close-up photographs were taken at each site. Nikonos III and IV were used. For distance photography, the camera was equipped with a 35 mm lens, Subawider supplementary lens and with a Sea and Sea YS 150 flashgun. In one set of distance photographs a 28 mm lens was used. For close-up photographs, the camera was equipped with a 28 mm lens, Nikonos supplementary close-up lens and framer, and an Oceanics 2000 flashgun. Filmstock used was Ektachrome 200, Fujichrome 100 and Kodachrome 64. The equipment used at each site is described in Table 1.

Ektachrome and Fujichrome films were processed each evening using a Jobo rotary processor and Chrome-6 chemicals.

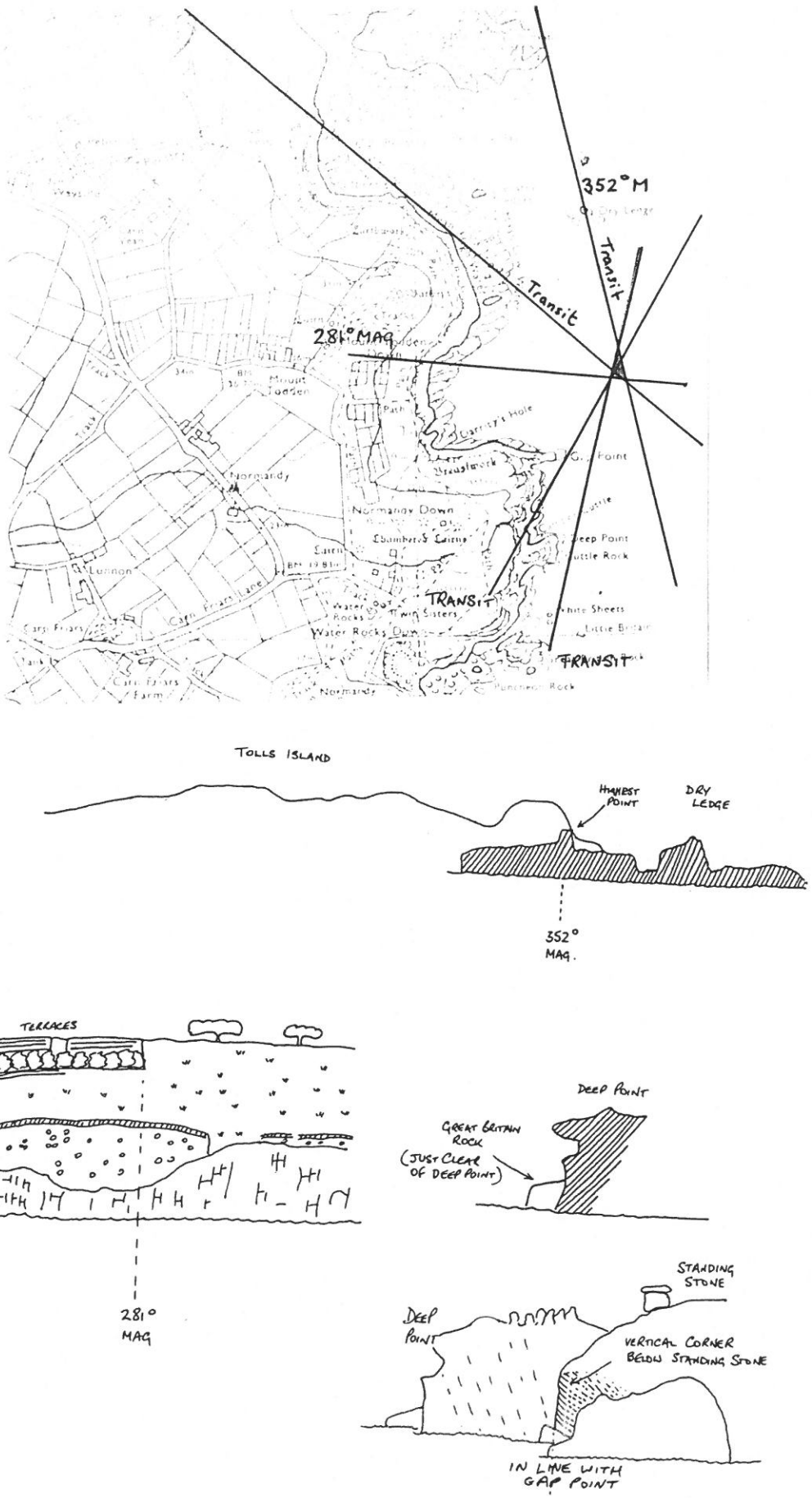


Fig. 2. Location of Gap Point site and transit marks for relocation.

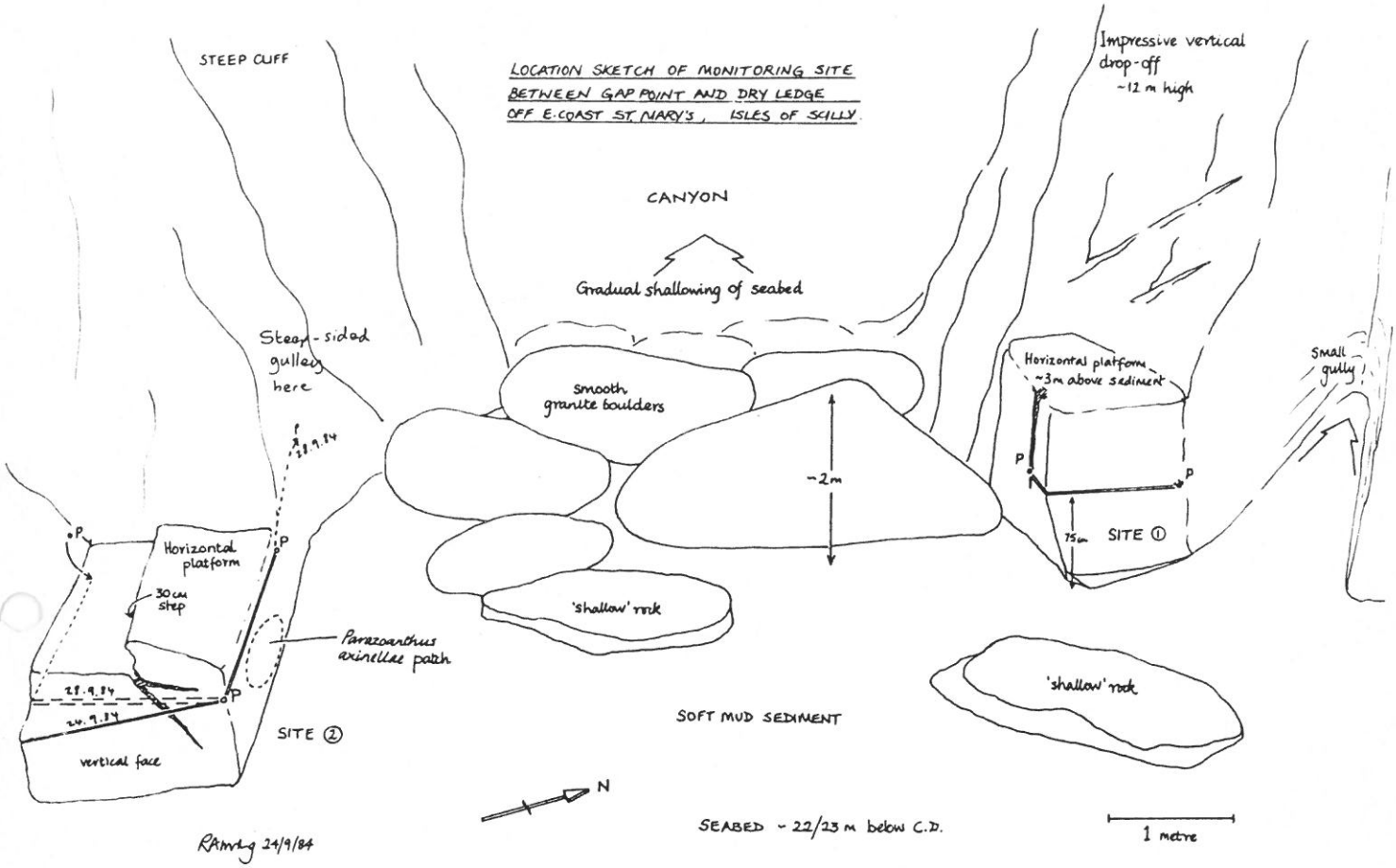


Fig. 3. Topographical features and the position of transect lines. P = piton.

2.3. Results

The location of the site and transit marks for re-location are shown in Fig. 2. Topographical features in the region of the transect lines are shown in Fig. 3. A summary of the results obtained and photographs filed is given in Table 1. Polaroid photographs taken of transit marks did not show them clearly and the sketches of transit marks are used here for a record of site location.

2.4 Discussion and recommendations for future work

There were two major problems in obtaining good results: the irregular topography of rock surfaces which made the collection of overlapping photographs difficult and resulted in some areas being unlit by the flash, and the presence of high levels of suspended silt which resulted in back-scatter from the flash. Relocation of the same picture areas may be difficult in future years and the use of a framer for distance photographs might help. The problem of suspended silt cannot be overcome but the use of a wide angle lens would help by decreasing the camera to subject distance. The following recommendations are the same as for Lundy (Hiscock, 1984b):

- Site marks and fixings established in 1984 should be used in future years.
- Photography of the sites established in 1984 should be undertaken at about the same time of year in 1985.
- 1985 studies should include the comparison of 1984 and 1985 results.

- Equipment for photography should be further tested at base before fieldwork. In particular, this should include the modification of the close-up framer to ensure overlap of adjacent frames and the construction and testing of a frame for distance photography.

- The marker line should be modified to include numbered tags at each 50 cm interval.

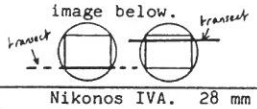
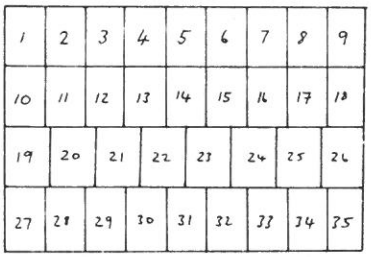
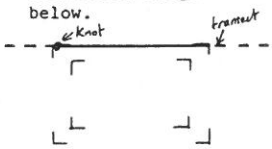
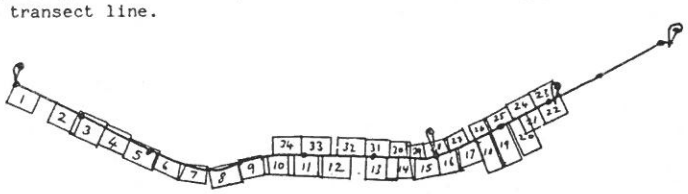
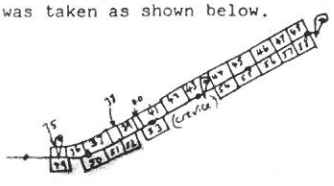
- The basic equipment used should be upgraded to include a 15 mm Nikkor lens.

- Ektachrome 100 or Fujichrome 100 film should be used.

- Films should continue to be processed on-site to ensure a check on quality.

TABLE 1

Description of photographic monitoring work and file number of slides.

Site and date	Equipment and settings	Notes	Comments	Slide Numbers
1. Surface transits 24.9.84	-	-	The sketches of transit marks provide a much better basis for relocation.	SSM/01-04/84 (duplicated)
2. Site 1 24.9.84	Nikonos III, 35 mm lens, Subawider supplementary lens, Sea and Sea YS 150 flashgun, Fujichrome 100, (aperture not recorded).	Two overlapping series of photographs was taken above and below the transect line to give complete coverage of the transect with individual photographs of C. 120 cm (4 slides) and c. 70 cm (13 slides) width.	The photographs with a c. 120 cm field showed too much back-scatter from suspended particles. The closer photographs provided adequate detail for monitoring purposes.	SSM/05-08/84 (c. 120 cm width) SSM/09-21/84 (c. 70 cm width)
3. Site 1 28.9.84	As above. Focus 0.25 m, aperture f 22. Viewfinder image below. 	As above but all c. 60 cm width.	Photographs were of good definition with bright colours. Some areas of shade were present due to irregular topography. The marker line was generally well positioned in the frame. The photographs provided a good basis for monitoring.	SSM/22-38/84 (duplicated)
4. Site 1 28.9.84	Nikonos IVA. 28 mm lens, Nikonos supplementary close-up lens, Oceanics 2000 flashgun, Kodachrome 64, f 11.	An overlapping series of photographs was taken in the sequence shown below using the marker line as an initial guide to position. 	The photographs were of excellent quality with good overlap. Only eight photographs were taken along line 3 and overlap was inadequate in some frames.	SSM/38-73/84 (duplicated)
5. Site 2 28.9.84	Nikonos III. 35 mm lens, Subawider supplementaty lens. Sea and Sea YS 150 flashgun, Fujichrome 100, (aperture not recorded).	Three overlapping series of photographs were taken along the transect line with the line approximately central in the picture area.	The first series of photographs was too distant and scatter from suspended particles high giving poor definition. The second series of photographs was of adequate quality for monitoring but back-scatter was still present and the series was incomplete. The third series was reasonably clear but no marker line was visible.	SSM/74-84/84 (c. 1 m width) SSM/85-89/84 (c. 70 cm width) SSM/90-93/84 (c. 70 m width, upward facing rock)
6. Site 2 28.9.84	Nikonos III, 35 mm lens, Subawider supplementary lens, Sea and Sea YS 150 flashgun, Fujichrome 100, focus 0.25 m, aperture f 22. Viewfinder image as in 3 above.	An overlapping series of photographs were taken above and below the transect line from a distance of 30 to 50 cm away.	Photographs were of good quality with very little scatter due to suspended particles. The line was accurately positioned in the picture area. This series provides the best monitoring set.	SSM/94-115/84 (duplicated)
. Site 2 28.9.84	Nikonos III. 28 mm lens, Sea and Sea YS 150 flashgun. Ektachrome 200, focus 0.7 m, aperture f 22. Viewfinder image below. 	An overlapping series of photographs was taken above and below the transect line from a distance of 60 to 75 cm away.	The 'above line' photographs had the line about central in the picture area. The below line photographs were accurate and line was at the top of the picture area with a marker knot near the left side. The photographs were very blue compared to the Fujichrome pictures. There was some back-scatter from suspended particles.	SSM/116-125/84 ('above line') SSM/126-135/84 (below line)
8. Site 2 28.9.84	Nikonos IV. 28 mm lens, Oceanics 2000 flashgun, Kodachrome 64, aperture f 11.	An overlapping series of photographs was taken below the transect line and, for part of the line, above the transect line. 	The photographs were of very good quality. Some overlaps were poor or there were gaps.	SSM/136-169/84 (duplicated)
9. Site 2 24.9.84	Nikonos IV. 28 mm. lens, Oceanics 2000 flashgun, Kodachrome 64, aperture f 11.	An overlapping series of photographs was taken as shown below. 	The photographs were of very good quality although reflection from muddy surfaces resulted in slight over-exposure. There were some gaps in overlap.	SSM/170-194/84 (176-183 and 189-193 duplicated for set 2)

3. STUDIES OF ZOSTERA MARINA BEDS

3.1. Introduction

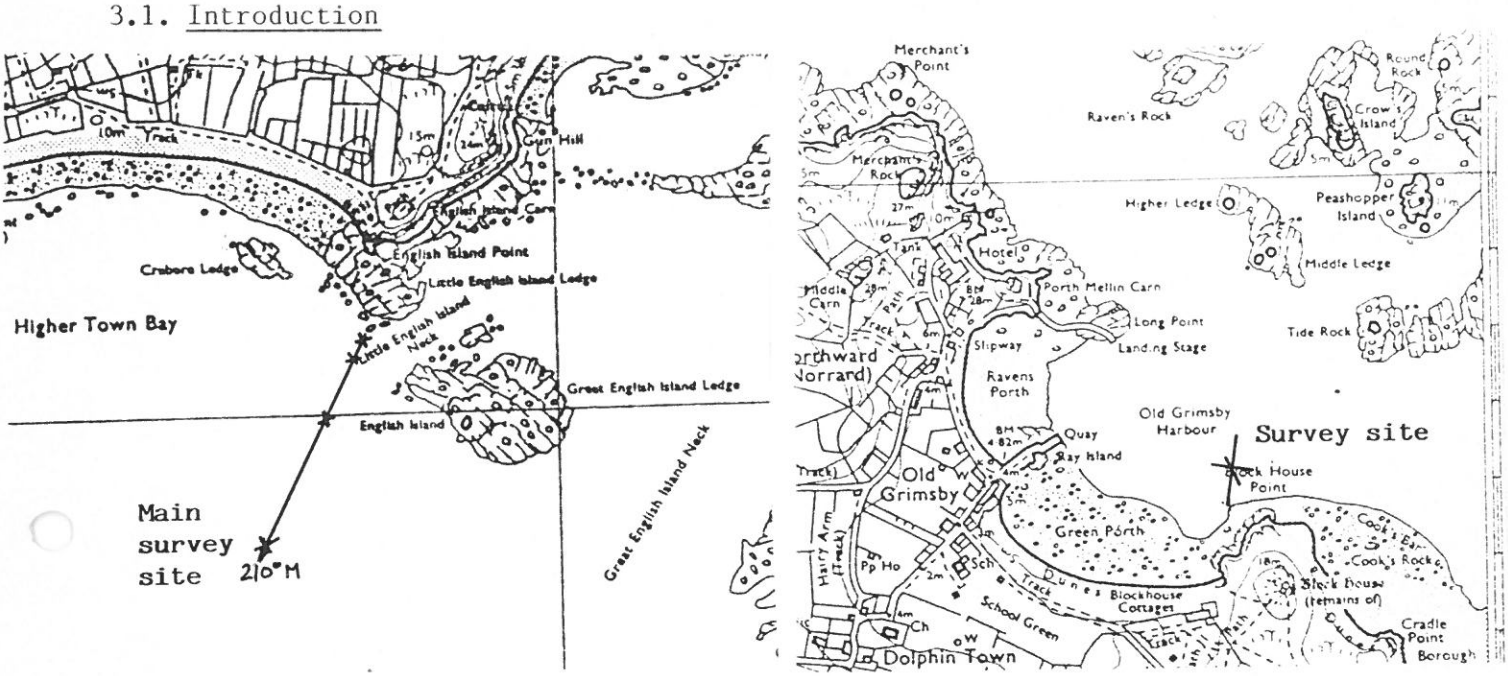


Fig. 4. Location of Zostera bed monitoring sites.

Zostera marina is the only sublittoral flowering plant found in the British Isles. Beds of Zostera occur in shallow wave sheltered sediments in southwest and west Britain. In southwest Britain, the most extensive beds occur in the Isles of Scilly where the sand flats and shallow area between the central island group provide an ideal habitat. The fronds of Zostera are a substratum and shelter for a rich variety of species some of which are only found in association with the plant. Descriptions of Zostera bed communities, including those living in the sediments, are given in Nichols and Harris (1982), Hiscock (1984a) and Rostron (1983).

The size of Zostera beds in the Isles of Scilly has not been calculated and aerial photography offers the best technique for recording the extent and location of beds. However, aerial photographs require 'ground truth' information to ensure that areas occupied by Zostera are not confused with those dominated by algae. Also, although aerial photographs can monitor extent and location of beds, they do not provide information on the health of plants or a description of the species associated with plants. Oblique aerial photographs of areas of sediment colonised by Zostera were taken on 25th September and the work reported here provides a detailed description of the structure and associated biota of beds at English Island and Old Grimsby Harbour (Figs. 1 and 4).

The work undertaken included:

- Marking of dense and sparse beds for identification during aerial survey.
- Measurement of the density of Zostera shoots, leaves and the lengths of leaves in dense and sparse beds.
- Recording the species present associated with the Zostera leaves and shoots including taking illustrative photographs of Zostera bed communities.
- The comparison of beds at English Island Point and Old Grimsby Harbour.

3.2. Marking of beds for aerial photography

The location for a transect line was identified on 23rd September and marked on 24th September. Markers were constructed from c. 20 kg granite boulders attached by 8 m of line to a buoy. A swimmer was towed from the edge of boulders adjacent to the island along the selected line of 210° using transit marks to maintain the bearing. The swimmer selected locations for marking in sequence as follows:

1. Orange buoy. Edge of the boulder zone. Seabed cover:50% Laminaria saccharina, 20% Zostera, 20% sand.

2. Orange buoy. Seabed cover east of marker: 50% L. saccharina and 50% coarse gravel and pebbles. Seabed cover west of marker: Zostera.

3. White buoy. Seabed cover: centre of sparse Zostera with dense Zostera to west.

4. White buoy. Seabed cover: dense Zostera.

5. White buoy. Seabed cover:edge of Zostera bed.

Following aerial photography on 25th September, the area was resurveyed and only markers 1, 2 and 4 were still in place.

3.3. Measurement of Zostera plants

At English Island, measurements of Zostera were made in an area near to the edge of the bed and the location of the outer site in Fig. 4. At Old Grimsby Harbour, measurements were made in the largest dense bed found. For both sites, photographs of shore features were taken from above the site to assist relocation. At Old Grimsby, compass bearings were taken on conspicuous shore features to enable plotting location and assist relocation. Density of shoots was recorded by ten 0.1 m^2 quadrats within the dense Zostera and sparse Zostera. The quadrats were dropped at random onto the survey area by a diver swimming with eyes closed along the surface. For the dense bed, the survey area was anywhere inside the bed a greater distance than 1 m from the edge. Similarly, the survey area for sparse Zostera was anywhere in the bed at least 1 m away from dense Zostera. In each quadrat, the number of shoots emerging from the seabed was counted and the shoots cut at their base and placed in numbered bags. Each leaf was counted and its length measured. The number of flowering shoots in each quadrat was noted and the number of flower heads on each flowering shoot.

3.4. Recording the species associated with Zostera

At English Island and Old Grimsby, lists of conspicuous species present on leaves, bases of shoots and sediment at the base of shoots were made. Records of abundance of species were made as far as possible according to the scale in Appendix 2. Observations were also made of the structure of the Zostera bed. Illustrative photographs were taken using a standard lens system for distance photographs, supplementary lens for close-up photographs and extension tube for macro-photography.

3.5. Results

3.5.1. Introduction. The location of sites is shown in Fig. 4. Lists of species associated with the Zostera beds are given in Table 2. The results of quantitative sampling are summarised in Table 3 and given fully in Appendix 3. Fig. 5 is a sketched section of the southern area of Zostera at English Island. Photographs illustrating the location of beds, species present, and survey activities are included in a series of slides held by NCC and coded SZM/01-35/84.

TABLE 2

Species associated with Zostera marina beds west of English Island and in Old Grimsby Harbour. Abundance notations are given in parenthesis and refer approximately to the scale in Appendix 2.

ENGLISH ISLAND			OLD GRIMSBY
ge of dense bed	Dense bed	Sparse bed	Dense bed
Sediment/base of shoots			
Asparagopsis armata Bryopsis plumosa (O) Ceramiun rubrum (O) Ceramium sp. Cryptopleura ramosa (-) + Enteromorpha sp. (C) Gracilaria verrucosa (O) Jania rubens (O) Polyides rotundus (F) Ulva sp. (-) Arenicola marina (O) Anemonia viridis (C) Anthopleura ballii (O-F) Gibbula cineraria (F) Pomataschistus microps (F) Nassarius reticulatus (C) Luidea ciliaris (R) Scrupocellaria sp. (A) Cerianthus lloydii (R) Chaetopterus variopedatus (R)	Acrosorium uncinatum (O) + Cladophora rupestris (F) Cryptopleura ramosa (F) + Gastroclonium ovatum (R) ?Gracilaria bursa-pastoris (R) Gracilaria verrucosa (O) Ulva sp. (C) Anthopleura ballii (O) Lanice conchilega (R) Nassarius reticulatus (R) Scrupocellaria sp. (C)	Asparagopsis armata (C) + Callophyllis lacineata (O) Ceramium rubrum (F) Chondrus crispus (F) Enteromorpha spp. (C) Jania rubens (-) + Laurencia obtusa (O) Ulva sp. (F) Arenicola marina (R) Callionymus lyra (F) Gibbula magus (F) Pomataschistus microps	Asparagopsis armata (C) + Anemonia viridis Anthopleura ballii (F) Carcinus maenas (R) Luidea ciliaris/sarsi (F) Nassarius reticulatus (O) Paguridae indet. (R) Pomataschistus microps (R) Scrupocellaria sp. (F)
Leaves			
Asparagopsis armata (F) Cladostephus spongiosus (R) Ectocarpoid/diatoms indet. (F/C) Encr. Rhodophyta indet. (O) Lomentaria orcadensis (O) ?Schmitziella endophloea (O) Anemonia viridis (C) Gibbula cineraria (O) Encr. Bryozoa indet. (R) Lucernariopsis campanulata (R) Campanularia angulata (R)	Asparagopsis armata (F) Cladostephus spongiosus (R) Ectocarpoid/diatoms indet. (C-A) Encr. Rhodophyta indet. (O) Lomentaria orcadensis (O) ?Schmitziella endophloea (O) ?Favorinus branchialis (R) Gibbula cineraria (F) Lucernariopsis campanulata (F) ?Obelia sp. (R) Patina pellucida (R) Rissoa sp. (R) Tricolia pullus (R) Membranipora membranacea (R)	Phaeophyta indet. (filament) (F) Ectocarpoid/diatoms indet. (F)	Encr. Rhodophyta indet. (O) ?Rhodophysema sp. Ectocarpoid/diatoms indet. Anemonia viridis (A) ?Bittium reticulatum (R) Diplosoma listerianum (O) Gibbula cineraria (F) ?Rissoa sp. (R) Rissoa membranacea (R)
	Over bed		**Over bed**
	Crenilabrus melops (O) Gobiusculus flavescens (A) ?Labridae indet. (R) Pollachius pollachius (F)		Gobiusculus flavescens (F) Pollachius pollachius (O)

* = on stone and shells
\+ = especially notes as attached to base of shoots

TABLE 3

Number of shoots, flower stalks, leaves, mean leaf length and standard deviation for the ten 0.1 m^2 quadrats sampled in dense and sparse Zostera beds at English Island and the dense bed at Old Grimsby Harbour.

Quadrat number	No. shoots	No. flower stalks	No. leaves	Mean length of leaves & s.d. (cm)
English Island - dense				
1	29	0	92	48.3±27.3
2	16	0	74	68.7±32.2
3	21	0	97	57.0±25.1
4	32	0	127	52.0±21.8
5	26	2	99	73.4±29.9
6	14	1	56	61.5±28.2
7	28	1	108	70.4±26.0
8	32	4	116	49.1±20.1
9	26	0	95	72.4±29.6
10	25	1	94	61.6±26.7
			mean & s.d.= 95.9±19.0	
English Island - sparse				
1	9	0	35	30.3±12.7
2	0	-	-	-
3	3	0	10	15.9± 5.0
4	3	0	14	17.4± 9.2
5	4	0	16	18.8± 7.5
6	2	0	8	17.1± 9.1
7	2	0	7	14.9± 3.85
8	15	0	46	20.5± 9.2
9	2	0	6	20.3± 6.1
10	1	0	5	48.2±13.85
			mean & s.d.= 14.7±14.5	
Old Grimsby Harbour				
1	21	0	90	40.4±16.3
2	24	0	103	38.2±19.9
3	38	0	162	38.0±14.9
4	32	0	132	39.6±16.7
5	22	0	89	42.6±22.2
6	34	0	140	30.8±16.0
7	35	0	145	34.8±14.6
8	34	0	150	33.6±15.0
9	31	0	121	38.1±16.2
10	32	0	135	37.0±16.8
			mean & s.d.= 126.7±25.3	

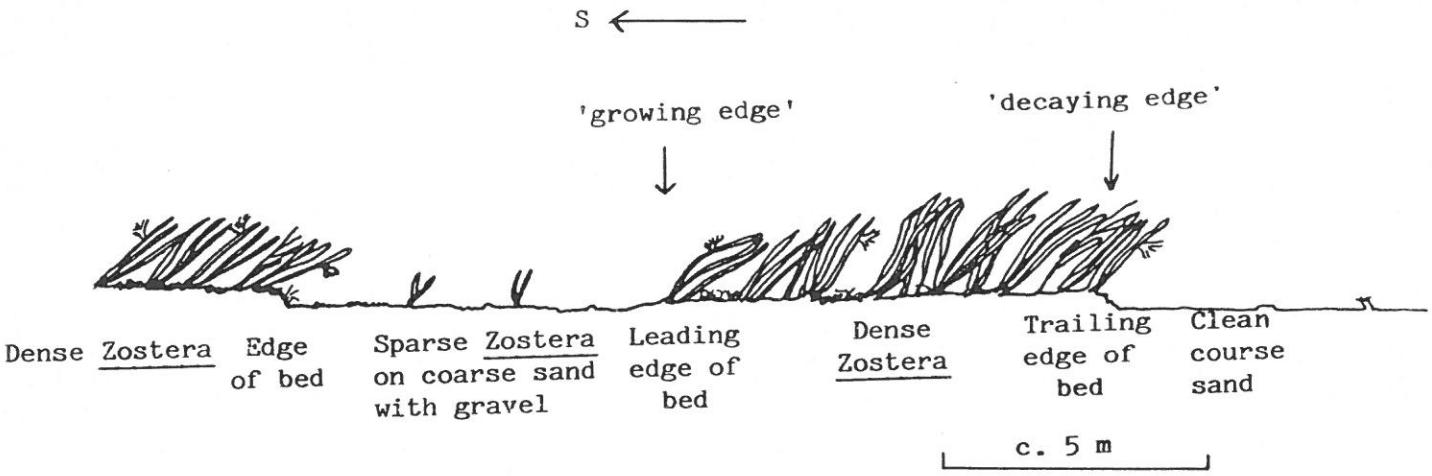


Fig. 5. Sketched section of the Zostera bed at English Island

3.5.2. English Island. At English Island, the Zostera beds commenced south of the areas of sand, gravel and boulders about 50 m from the rock. From here southwards, there were dense stands of Zostera marina in large patches with areas of coarse sand and gravel sometimes with sparse Zostera in between. There were also some buried boulders or bedrock with very large Laminaria saccharina and Himanthalia elongata attached. The majority of Zostera leaves were heavily colonised by ectocarpoid algae and colonial diatoms (Ectocarpus siliculosus and two types of diatoms in samples) with sparse other species listed in Table 2. The ectocarpoid algae were most dense in the centre of the bed and on older plants. The base of plants at the edges of beds were the richest areas encountered in the bed. Records in Table 2 are mainly for the southern edge considered a 'leading edge' or 'growing edge'. A 'trailing edge' or 'decaying edge' was colonised by higher densities of Anthopleura ballii with Cerianthus lloydi and Chaetopterus variopedatus present. The structure of beds illustrated in Fig. 5 was clearly visible in the English Island bed and suggests a dynamic rather than static bed. In the thickest area of Zostera, the bases of plants were surrounded by drift leaves, algae and detached Scrupocellaria sp. (S. reptans in samples). Flower heads (thin 'leaves' on long stalks) were present in a density of about $1/m^2$ in the thickest Zostera and seeds were being produced at the time of the survey. Although Table 3 provides a list of all species seen during the systematic search near to the southern limit of the beds, other species were encountered elsewhere in the bed, near to English Island or on the sediment plain during preliminary surveys and are listed below.

Furcellaria fastigiata. On sandy rock.
Chondrus crispus. On sandy rock.
Corallina officinalis. On sandy rock.
Laminaria ochroleuca. One on rock.
Saccorhiza polyschides. Two seen.
Chorda filum.
Himanthalia elongata. Some large fronds.
Cystoseira baccata. Frequent on rock.
Aglaophenia pluma. On Cystoseira.
Bunodactis verucosa. Occasional on rock, one in drift.
Haliclystus auriculata. Occasional.
Natica alderi (eggs). One on sediment.
?Lichenopora sp. On Cystoseira.
Diplosoma listerianum. On Cystoseira.
Pleuronectes platessa. Two seen.

Species of algae identified from samples but not listed in Table 3 were Ceramium rubrum, ?Asperococcus scaber, Erythrotricha bouyana and Polysiphonia sp.

It was also difficult to distinguish species of algae which settled and had grown in the Zostera bed from drift specimens. Considerable amounts of drift algal debris were recorded floating or rolling through the areas colonised by Zostera. Much of that debris had become entrapped amongst the Zostera and may survive well, grow and reproduce. The drift algae observed are noted below.

Callophyllis laciniata
Dilsea carnosa
Nitophyllum punctatum
Palmaria palmata. On fronds of drift algae.
Calliblepharis ciliata
Porphyra ?purpurea
Sphaerococcus coronopifolius
Chylocladia verticillata
Cystoclonium purpurea
Polyides rotundus
Cryptopleura ramosa
Fucus serratus

3.5.3. Old Grimsby Harbour. The Zostera bed in Old Grimsby Harbour occupied a large area in the south part of the bay. There were patches of bare sand amongst the Zostera bed with no colonisation by Zostera. A small variety of species colonised the Zostera plants and the sediment below and between plants. Species observed are listed in Table 2 and communities present are compared with those at English Island in Section 3.5.4. In addition to species listed in Table 2, two species of algae were noted as drift: Asparagopsis armata and Dictyota dichotoma. Notes were also made of animals present at the edge of the bed. Here, there were more Anthopleura ballii present and leaves had many Rissoa membranacea present (estimated as 1 per 10 leaves). On the sand off the edge of the bed, there were large numbers of Pagurid crabs, Pomataschistus microps, Arenicola marina casts, groups of Nassarius reticulatus and pits indicating the presence of Echinocardium cordatum. One arm of a burrowing ophiuroid was seen.

3.5.4. Comparison of Zostera beds at English Island and Old Grimsby Harbour. Both the descriptive survey and the quantitative sampling results show remarkable differences between the beds at the two sites surveyed. In general, the Old Grimsby Harbour Zostera bed was less rich in abundance and diversity of species than at English Island and the following differences were noted in comparison with English Island:

- Zostera plants were more dense;
- There were many less flower stalks (none in samples);
- Plants were shorter;
- No stauromedusae were seen;
- No encrusting Bryozoa were seen;
- No Campanularia angulata were seen;
- There was less Scrupocellaria sp. present;
- There was less Jania rubens present;
- Anemonia viridis were grey and only one green individual was seen;
- There were many less algae including drift algae;
- There was less Ectocarpus/diatom growth present on leaves;
- Diplosoma listernianum was present on leaves;
- There were more Luidea cilians/sarsi present;
- There was no evidence of bed erosion or 'leading' and 'trailing' edges to the bed;

The major environmental difference between the two sites which may account for the difference in structure of the bed and the associated species is the presence of much stronger tidal streams at English Island. Such tidal streams may encourage growth of the Zostera and algae by enhanced nutrient supply and

encourage the presence of suspension feeding animals by the good food supply flowing water brings. Strong currents will also bring drift algae into the beds and may account for the much higher abundance of drift algae at the English Island site. The greater density of plants at Old Grimsby may cause shading to a sufficient extent to inhibit the growth of algae at the base of plants. Aerial photographs also suggested that the Old Grimsby bed dried to a greater extent than at English Island and this might be important. However, further speculation from this limited study is inappropriate.

3.6. Discussion and recommendations for future work

The work undertaken in this first year of monitoring studies provides a basis for future systematic survey and comparison of Zostera communities in each year. Checklists of species can be compiled and a more appropriate abundance scale developed for the description of species present. The location of the systematic survey site at English Island needs to be better fixed with compass bearings and transit marks to enable accurate relocation although the details given in this respect should be adequate for relocation within a few tens of metres of the 1984 site. However, the work undertaken in 1984 cannot be expected to provide information on the growth or regression of Zostera beds except on a very large scale. Marking of the edge of beds with permanent stakes (more usefully 'corkscrew' shaped steel markers) or the establishment of corner posts for a grid over a patch of Zostera would provide a basis for mapping the size and shape of one bed and useful 'ground truth' for aerial photographs. Vertical colour photographs taken to a defined scale will be important in monitoring the extent and distribution of Zostera beds and can best be achieved by the use of a company specialising in such work. Indeed, such aerial photographs would be essential to the accurate assessment of Zostera extent from year to year in the Isles of Scilly. The alternative, oblique aerial photographs taken by biologists from an uncertain height, will not be easily analysed. The flora and fauna associated with Zostera is clearly different in different areas and an important background to understanding the reasons for any change in the Zostera community at a particular site will be a knowledge of the natural differences in communities. The reasons for these differences also need to be investigated. Such a study would be of high academic interest as well as assisting the management of the area.

The following recommendations are made:

- Species checklists and a more applicable abundance scale for surveys in Zostera beds should be developed.

- Surveys of the English Island and Old Grimsby Harbour sites including descriptive and quantitative work should be undertaken at the same time of year for the next two years to assess the stability of the different community types.

- Markers should be established in the seabed at the English Island site to provide fixed survey marks for the measurement of changes in size and location of a Zostera bed.

- Vertical aerial photography should be undertaken by a specialist company to provide colour transparency photographs to a set scale for mapping. Aerial photographs should be undertaken at the time of the next field survey and at intervals of one or more years.

- Every opportunity should be taken to survey further Zostera beds and measure/assess environmental conditions in the beds particularly exposure to water movement and the depth to the seabed below chart datum level.

4. STUDIES OF LITTORAL UNDERBOULDER COMMUNITIES

4.1. Introduction

Underboulder communities present at several locations in the Isles of Scilly are considered to be especially rich examples from this type of habitat. Two sites were selected for study. The English Island Point site was surveyed in 1983 and noted in Hiscock (1984c). The Samson site was surveyed by R. Mitchell and S. Fowler on various occasions and is adjacent to an area considered particularly rich by S. Smith (Smith and Gault, 1983).

4.2. Methods

At both sites, an area of boulders was selected and their position photographed using a polaroid camera. Boulders were carefully pulled upright in sequence and the location and number of each boulder marked on the polaroid photograph. A photograph of the whole underside of the boulder was taken followed by a series of 0.033 m^2 photographs using a Nikonos IV with supplementary lens and framer and Oceanics 2000 flash. A list of the species present under each boulder was made although no collections were taken so that several identifications are to genus or family only. At Samson, the numbers of individual organisms, the size of colonies or abundance of species was also noted. Abundance was recorded approximately according to the scale in Appendix 4. Further site location photographs were taken with a standard 35 mm camera to provide good quality location photographs for site identification. Close-up photographs of individual species were taken for illustrative purposes. After survey and photography, boulders were returned as accurately as possible to their previous position.

4.3. Results

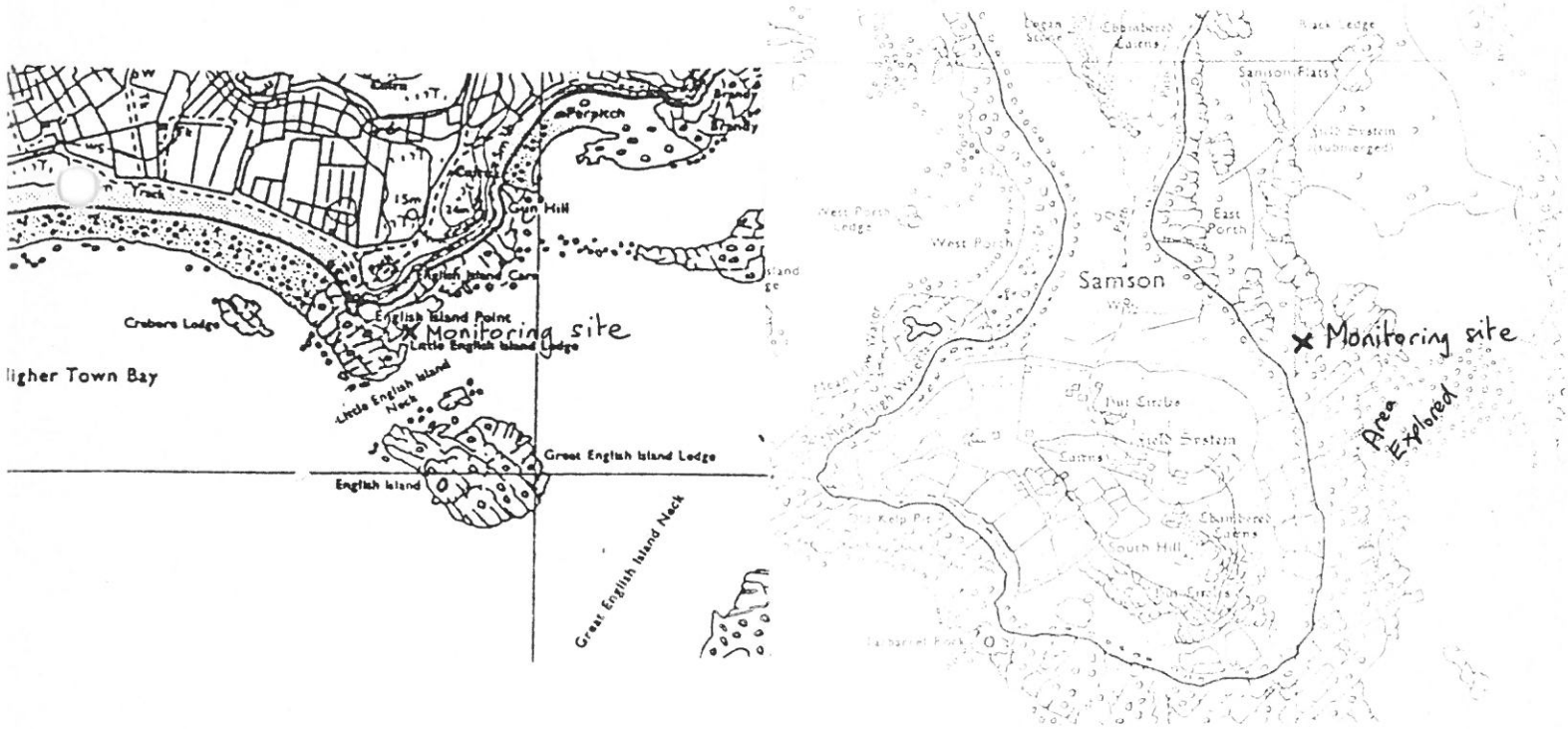


Fig. 6. The location of underboulder monitoring sites at English Island Point and Samson.

The location of the two sites is shown in Fig. 6. Plates 1 to 5 show the location of the viewpoint for photographs and the location of each boulder from that viewpoint. However, those photographs are polaroid pictures, and of inferior quality to 35 mm colour transparency photographs and cannot be expected to photocopy well in reports. Site location sheets incorporating a map and good quality photographs of the boulder area should therefore be prepared. Tables 4 and 5 list the species present under boulders and incorporate a record of the index numbers of photographs of each boulder.

Apart from the five boulders systematically photographed at English Island Point, a large boulder with extensive overhangs (boulder 6) a little higher on the shore was inspected and photographs taken (SBM/62-79/84). Additional conspicuous underboulder species observed here were Corynactis viridis and Crisiidae indet. Boulders on the east side of Little English Island Ledge at c. 0.7 m above chart datum level were also inspected and found to be rich in species including the blue sponge Turpios fugax.

Although lower on the shore, the boulders explored to the south of the Samson monitoring site held a similar underboulder fauna. The species observed and their abundance is listed below. An asterisk marks species not found at the Samson monitoring site.

> Asterina gibbosa (F), Botryllus schlosseri (O), Didemnidae indet. (F), Diplosoma listerianum (F), Encr. Porifera indet. (citrus yellow) (O), Galathea squamifera (C), Gibbula cineraria (C/A), *Hymeniacidon perleve (1), ?Inachus sp. (I), *Liocarcinus puber (F), *Marthasterias glacialis (F), Myxilla sp. (F), Ophlitaspongia seriata (F), Ophiothrix fragilis (O), Pomatoceros triqueter (O), *Psidia longicornis (F), Spirorbinidae indet. (A), *?Syngnathus acus (1), *Verruca stroemia, (few)

Illustrative photographs of species were of limited success. Two sets were of good quality and are filed as SBM/16-35/84 and SBM/95-98/84 Another set was over-exposed due to faulty aperture control of the camera. The quality of these photographs made them unsuitable for lecture or display purposes and they have not been catalogued.

4.4. Discussion and recommendations for future work

The exercise to find, survey and photograph selected underboulder communities has been successfully undertaken and should be capable of repetition in future years if boulders remain in the same place. However, no attempt has been made to analyse quantitative photographs and consideration should be given to the techniques which might be used to undertake this part of the work. Neither has any attempt been made to compare the fauna of different boulders and sites, an exercise which would be interesting at least from an academic point of view. Some practical problems of underboulder monitoring are apparent following the work. Fast-moving mobile species such as crabs, brittle stars and some worms can move out of the picture area before photographs are taken and observation and noting of species present is clearly important. The movement and replacement of stones may damage the communities present and, although not necessarily successful in preventing damage, careful handling and replacement of boulders is essential. One of the first priorities in a monitoring programme must be to establish whether communities remain similar from year to year or whether changes occur. This information is essential to assessing the effects of disturbance.

The following recommendations are made to continue studies as started in 1984.

- The same boulders should be surveyed and photographed in 1985.
- Site location sheets incorporating good guality photographs should be prepared.
- A checklist of species and more appropriate abundance scale should be developed prior to further work.
- Consideration should be given to the methods to be employed to analyse photographs and the 1984 quantatitive photographs should be analysed.
- Descriptions of underboulder communities noted in the field should include counts of numbers of individual organisms or estimates of percentage cover of colonical organisms.

No recommendations are made here for more detailed studies or experiments to assess the sequence and speed of colonisation or the effects of frequent disturbance. Both would provide important information for management particularly on shores where interpretative activities may be planned but are considered outside of the remit of the present programme.

TABLE 4

Species recorded under boulders at English Island Point
with notes on location and photographs taken

Boulder 1. (3.9 m from edge of ledge)

Location photographs: 03, 36.
Underboulder monitoring photographs: 02, 37-40.

Species recorded: Actinia equina, Calliostoma zizyphinum, Didemnidae indet., Doridae indet., Encr. Bryozoa indet., Galathea squamifera, Gibbula cineraria, Marthasterias glacialis (juv.), Polyclinidae indet. (small), Pomatoceros triqueter, Spirobinidae indet., Trivia arctica, Turbicellepora magnicostata.

Boulder 2. (3.9 m from edge of ledge)

Location photographs: 36
Underboulder monitoring photographs: 08, 41-43.

Species recorded: Calliostoma zizyphinum, Didemnidae indet., Encr. Bryozoa indet., Galathea squamifera, Gibbula cineraria, Ophiothrix fragilis, Pisidia longicornis, Pomatocerus triqueter, Spirobinidae indet., Turbicellepora magnicostata.

Boulder 3. (5 m from edge of ledge)

Location photographs: 36
Underboulder monitoring photographs: 09, 44-46.

Species recorded: (the underside of this boulder was on sand and colonisation was at the edge only) Botryllus schlosseri, Didemnidae indet., Encr. Bryozoa indet., Gibbula cineraria, Pomatoceros triqueter, Spirobinidae indet., Turbicellepora magnicostata.

Boulder 4. (5 m from edge of ledge)

Location photographs: 13, 36.
Underboulder monitoring photographs: 12, 47-53.

Species recorded: Actina equina, Amphipoda indet., Aphroditidae indet., Bunodactis verrucosa (juv.), Encr. Bryozoa indet., Galathea squamifera, Gibbula cineraria, Liocarcinus puber, Nassarius incrassutus (2), Pomatoceros triqueter, Porifera indet. (orange, encrusting), Porifera indet. (yellow, encrusting, slimy), Spirobinidae indet., Turbicellepora magnicostata.

Boulder 5. (9.7 m from edge of ledge)

Location photographs: 36.
Underboulder monitoring photographs: 14, 54-61.

Species recorded: Actinia equina, Calliostoma zizyphinum, ?Chlamys sp. (small), Encr. Bryozoa indet., Gibbula cineraria, ?Hildenbrandia sp. (edge), Polyclinidae indet., Porcellana platycheles, Spirorbinidae indet., Turbicellepora magnicostata.

TABLE 5

Species recorded under boulders at Samson with notes on location and photographs taken. The numbers of individuals seen, the size of colonies or abundance is noted for each species. Abundance notations are interpreted in Appendix 5.

Boulder 1. (6.3 m from lage boulder at edge of pool)

Location photographs: 80.
Underboulder monitoring photographs: 81, 105-108.

Species recorded: Actina equina (2), Aphroditidae indet. (1), Asterina gibbosa (4), Botryllus schlosseri (v. small patch), Cirratulidae indet. (1), Didemnidae indet. (O), Didemnum maculosum (v. small patch), Gibbula cineraria (A), Myxilla sp. (small patch), Nucella lapillus (1), Ophiothrix fragilis (1), Polyclinidae indet. (1), Pomatoceros triqueter (1), Spirobinidae indet. (A), Terpios fugax (small patch).

Boulder 2.

Location photographs: 82.
Underboulder monitoring photographs: 82, 108-110.

Species recorded: (the underside of this boulder was bare rock except at the edge). **Bare undersurface:** Asterina gibbosa (1), Spirobinidae indet. (few). **Colonised side:** Asterina gibbosa (1), Clavelina lepadiformis (2), Didemnidae indet. (10%), Diplosoma listerianum (less than 5%), Encr. Bryozoa indet. (small patch, 5%), Encr. Porifera indet. (red) (20%), Polyclinidae indet. (19%), Spirorbinidae indet. (C).

Boulder 3.

Location photographs: 84.
Underboulder monitoring photographs: 83, 111-121.

Species recorded: (the upper part of this boulder was algae covered and the lower part dominated by animals). **Upper part:** Chondrus crispus (F), Encr. Carallinacea indet. (40%), Gelidium latifolium (C), Lomentaria articulata (2), Ulva lactuca (F). **Lower part:** Didemnidae indet. (one small patch), Diplosoma listerianum (less than 5%), Encr. Bryozoa indet. (less than 5%), Encr. Porifera indet. (pink, protruding spiculation) (R), Gibbula cineraria (O), Hymedesmia sp. (large patch), Ophiothrix fragilis (2), ?Ophlitaspongia seriata (extensive thin cover), Polyclinidae (2 spp.) (less than 5%), Spirorbinidae indet. (A).

Boulder 4.

Location photographs: 91, 93.
Underboulder monitoring of photographs: 90, 122-129.

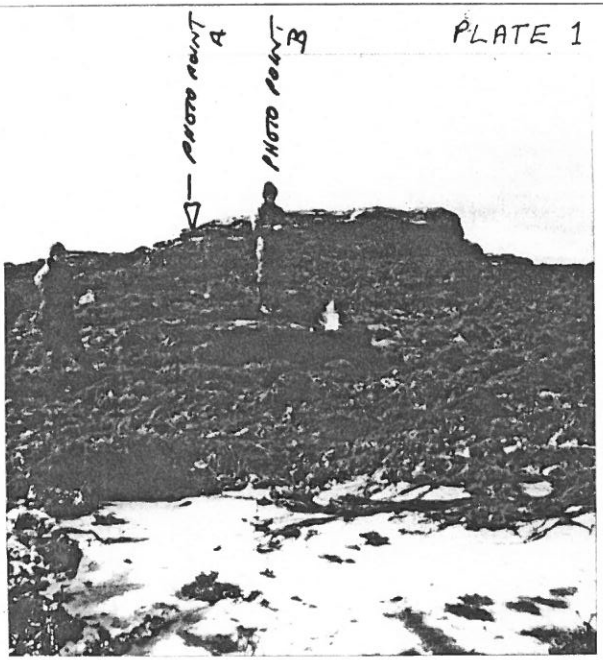
Species recorded: Botryllus schlosseri (1), Cirratulidae indet. (1), Clathrina coriacea (2 small colonies), Dendrodoa grossularia (1), Didemnidae indet. (less than 5%), Diplosoma listerianum (less than 5%), Galathea squamifera (1), Gibbula cineraria (1), Gibbula umbilicalis (1), ?Haliclona sp. (one small patch), Myxilla sp. (5%), Patella vulgata (1), Ophiothrix fragalis (2), Polyclinidae indet. (O), Spirobinidae indet. (A), Terpios fugax (one small patch).

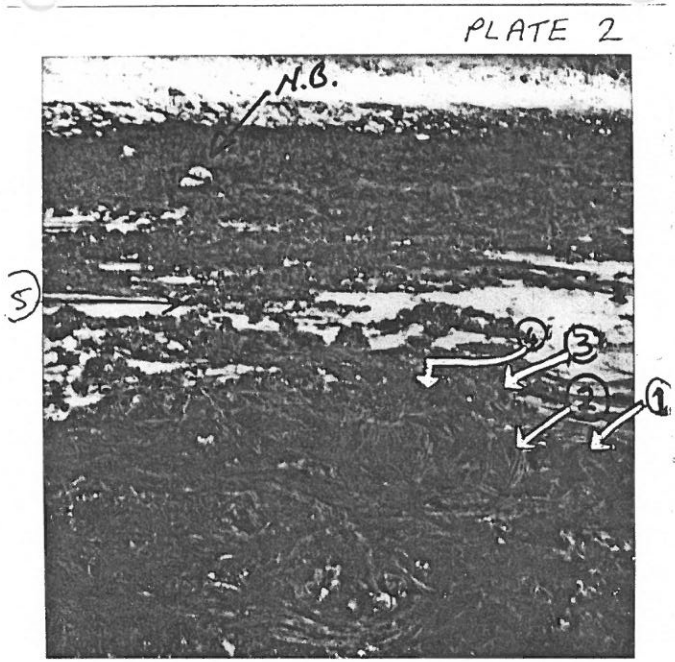
TABLE 5 (continued)

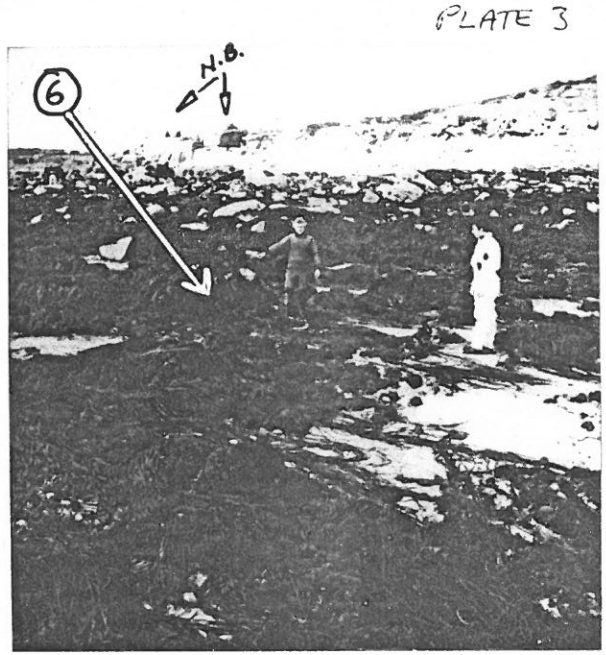
Boulder 5. (8.8 m from large boulder at edge of pool)

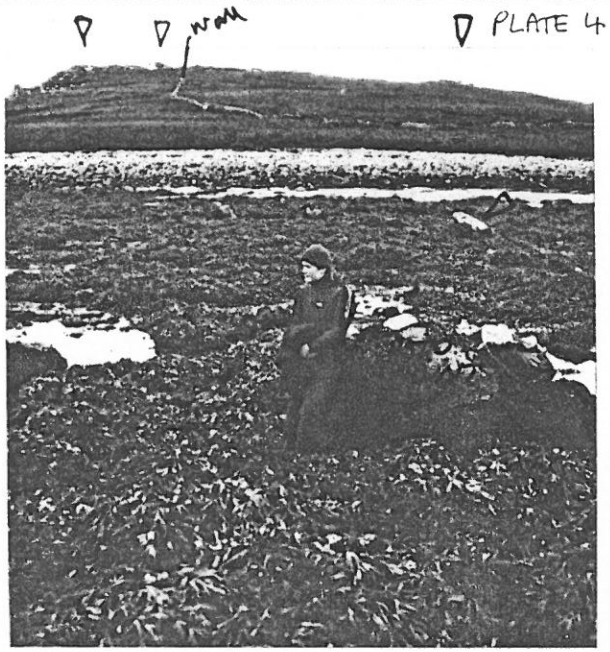
Location photographs: 100.
Underboulder monitoring photographs: 99, 130-136.

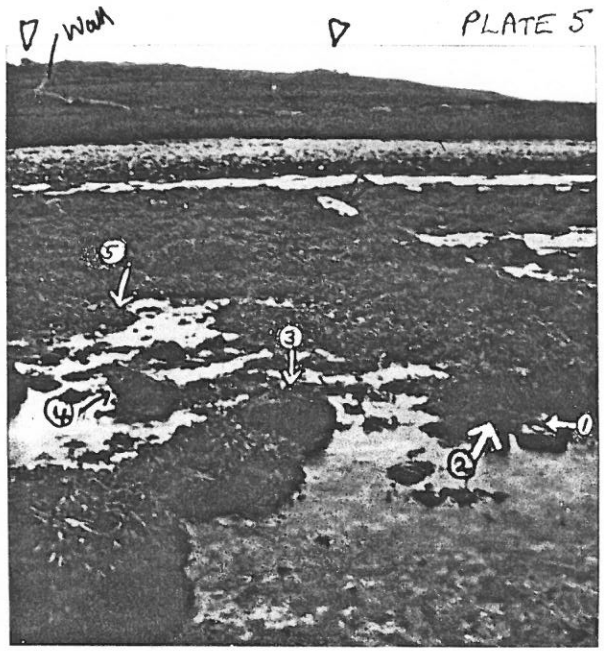
Species recorded: Amphipoda indet. (2), Asterina gibbosa (3), Cirratulidae indet. (3), ?Cordylecladia erecta (R), Didemnidae indet.(O), Encr. Corallinacea indet. (O), Gibbula cineraria (a), ?Haliclona sp. (O), Littorina obtusata (1), Myxilla sp. (R), Polyclinidae indet. (less than 5%), Spirorbinidae indet. (A), Terpios fugax (one small patch).











Plates 1 to 5. Polaroid photographs of boulder monitoring sites.

PLATE 1. English Island Point. Location from which Plates 1 and 2 photographed.
PLATE 2. English Island Point. Location of boulders 1 to 5.
PLATE 3. English Island Point. Location of boulder 6.
PLATE 4. Samson. Location from which Plate 5 photographed.
PLATE 5. Samson. Location of boulders 1 to 5.

5. WORK AT OTHER SUBLITTORAL SITES

Dives were undertaken at four locations (Fig. 1) to provide additional data to that used in compiling the report of the 1983 sublittoral survey (Hiscock, 1984a) and additional photographs. At Big Jolly Rock near Peninnis Head, a large gulley was investigated to describe shallow water communities and establish whether a Dendrodoa - Clathrina community was present there. The community was present. At Giant's Castle, we sought information on the deep water communities present to supplement the small amount of data collected from wave sheltered east coasts in 1983. The study provided a better appreciation of the richness of fauna in general and especially the sponge fauna on these coasts but was disappointing in that the Mediterranean-Atlantic cup corals (Hoplangia durotrix, Caryophyllia inornatus and Leptopsammia pruvoti) and the alcyonacean Parerythropodium hibernicum which were especially searched for, were not found. The dive north of St. Agnes was undertaken after turning back due to heavy seas from our desired site of the The Cove on the south side of St. Agnes where we had hoped to obtain lists of species present on deep sandy rock. The area north of St. Agnes had been surveyed previously and no notes of species present were made on this dive. However, the photographs taken add substantially to those of tide swept cobble communities taken during the 1983 survey. The dive off Deep Point was carried out to study the effects of dumping vehicles there. One dive was undertaken near to the shore where small vehicles launched off the cliff could be expected to reach the seabed or where hard substata were dominated by algae. A further dive was undertaken offshore where larger vehicles were dumped early in 1984 from the ramp of a large landing craft and where circalittoral animal communities were present. The dive revealed the degree of colonisation of vehicles but could not provide information on damage caused to underlying biota. However, in the outer area near the furthest vehicles found, populations of long-lived slow-growing sponges were extremely rich. Such populations occur in the few small bays where circlittoral rock is present sheltered from both wave action and tidal streams on east-facing coasts. It is considered that these populations should be protected from sea-borne dumping, which could be carried out elsewhere.

Two copies of field notes taken during the dives described above have been lodged with the NCC Chief Scientist Team for incorporation into the raw data supplements to the report of the 1983 survey and one copy is maintained in the FSC volume of raw data. 122 photographs have been labelled, sorted and numbered sequentially following the last number of the 1983 slides. Two copies of a list of slides have been lodged with the NCC Chief Scientist Team for incorporation into the 1983 slide catalogue and one copy is maintained in the FSC catalogue.

6. ACKNOWLEDGEMENTS

We express our thanks to Mrs. Hicks of Belmont Guest House for making our stay there so pleasant and for allowing the use of her kitchen for photographic processing. Mark Groves was very helpful with advice on diving sites and we are particularly grateful for his guidance at the Giant's Castle site. Sue Hiscock undertook identification of samples of algae.

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APPENDIX 1

Record of Daily Activities

Saturday 22nd September, 1984

Weather: Sunny intervals and heavy showers. Wind westerly, force 5-6.

Tides : 09:25, 1.6 m
15:15, 4.9 m

Sarah Fowler (SF), Keith Hiscock (KH), Chris Lumb (CL) and Robert Irving (RI) meet at Penzance to load equipment onto M.V. Scillonian III and depart for Isles of Scilly at 09:30. Arrived St. Mary's at 12:30. After dispersing equipment, etc., departed at 15:30 on M.L. Marius Nielson (Skipper Cyril Nicholson - CN) for Gap Point. KH and RI dived to search for and mark monitoring site. CL and SF dived afterwards to further search marked area for sites. Photographs were also taken. The location marked by a line to the surface was a vertical rock face a few square metres in area with Leptopsammia pruvoti present. Returned to harbour at 18:00. Evening discussions of results and work programme.

Sunday 23rd September, 1984

Weather: Sunny with some cloud and a few showers. Wind north-north-west, force 7-8.

Tides : 10:20, 1.2 m
16:40, 5.6 m

Left St. Mary's harbour on M.L. Marius Nielson at 10:30 for Gap Point. KH and RI dived at the bouyed site to establish site markers with compressed air drill and pitons. CL and SF completed the work leaving two adjacent sites ready for photography. Changed location to the shallow areas west of English Island Point on St. Martin's and anchored over the Zostera bed. KH and RI surveyed a potential transect line noting species present and considering survey methods. CL and SF dived in the same area. Photographs were taken for illustration by KH, RI and CL. Returned to St. Mary's harbour at 17:15.

Monday 24th September, 1984

Weather: Sunny with some cloud. Wind north-north-west, force 7-8.

Tides : 11:02, 0.8 m
17;04, 6.0 m

Delayed by $1\frac{1}{2}$ hours due to non-arrival of filled air tanks. Left St. Mary's Harbour on M.L. Marius Nielson at 10:45 for Gap Point. KH and CL dived to photograph monitoring sites. SF and RI dived to take further photographs of sites (SF) and sketch the location of pitons and marker lines. Departed for English Island Point and arrived at c. 13:30. Anchored at proposed start of transect over Zostera bed and attempted to measure distance to shore but after breaking tape in the strong wind and current abandoned attempt. Wind and tide made any systematic survey programme difficult. In order to provide 'ground truth' for possible aerial photography on Tuesday, weighted lines were constructed from c. 20 kg beach boulders attached by 8 m of line

to a bouy. CL was towed by the boat and selected areas characterised by different algae, Zostera and sediments along a transect at 210° from the emergent rock at Little English Island Ledge. Marker buoys were placed at three stations. Returned to St. Mary's Harbour at 16:45. KH processed films in evening.

Tuesday 25th September, 1984

Weather: Sunny with hazy cloud after 11:00 and thicker cloud after 15:00. Wind light westerly.

Tides : 11:49, 0.4 m
17;56, 6.2 m

Some general sorting, shopping and tidying early on. KH, CL, SF and RI departed at 10:15 for airport. Met Roger Mitchell (RM) on his arrival in survey aircraft from Land's End at 11:15. Sorted equipment, team briefed and then plane took-off at 11:31. Aerial photographs and associated notes taken all around the islands. Landed at St. Mary's at 12:38. CN met Gill Bishop (GB) off M.V. Scillonian III at 12:15. RI departed for Land's End airport at 13:00. Departed St. Mary's Harbour at 14:30 on M.L. Marius Nielson for Peninnis Head. SF and GB dived inshore of Big Jolly Rock. Mark Groves in his catamaran 'Firebrand' joined us and offered to locate a deep site where rock pinnacles could be surveyed. After SF and GB returned, KH and CL dived at the pinnacle site with Mark Grove off Giant's Castle. Returned to St. Mary's Harbour at 17:15. Debriefing on aerial photography in evening. KH processed films.

Wednesday 26th September, 1984

Weather: Cloudy in morning with sunny intervals in afternoon. Wind strong westerly at first decreasing during day.

Tides : 12:34, 0.3 m
18:50, 6.3 m

Left St. Mary's Harbour on M.L. Marius Nielson at 09:40 for English Island. Arrived at 10:10. RM landed to start shore surveys. Anchored over outer marker bouy. SF and GB carried out quantitative survey and sampling of dense Zostera. KH and CL listed species present in Zostera bed. At 12:00, diving interrupted for shore work at low water. The main work was location and photography of underboulder communities at north-east of Little English Island Ledge. As the tide rose, the team was re-embarked at St. Martin's Quay and returned to complete work on the Zostera bed. Completed work at 16:00 and returned to St. Mary's Harbour at 16:30. Met Mac Mace at the harbour and discussed Echinus work. Evening work included measuring Zostera samples and processing films. Pat Sargent (PS) (NCC Assistant Regional Officer for Cornwall) appeared.

Thursday 27th September, 1984

Weather: Cloudy with heavy rain at times. Strong southwest wind in morning, decreasing later.

Tides : 13:16, 0.3 m

Left St. Mary's Harbour on M.L. Marius Nielson at 09:40 for St. Agnes. Landed RM, GB and PS on St. Agnes at 10:05. RM and GB discussed Echinus work with Mark Horobin. KH and CL undertook general survey dive north of St. Agnes. Collected landing party and departed St Agnes at 11:40. Arrived

Samson at 13:00 and survey team undertook photographic monitoring of underboulder communities followed by exploration of lower shore. Departed for Tresco at 14:30. Arrived at Old Grimsby, Tresco 15:30. Landed RM and PS. KH, CL, SF and GB undertook survey and sampling of Old Grimsby Harbour Zostera bed. Returned to St. Mary's Harbour at 17:30. Evening work included measuring Zostera samples and processing films.

Friday 28th September, 1984

Weather: Mostly clear skies with a light southwesterly wind.

Tides : 13:56, 0.4 m

Left St. Mary's Harbour on M.L. Marius Nielson at 09:40 for Gap Point. At North Gap Point monitoring site, KH re-photographed Leptopsammia (site 1) using 0.033 m^2 quadrat, CL took two sets of photographs of Site 2 (Subawider and 28 mm lenses), SF took 0.033 m2 photographs at Site 2 and GB sketched rope location of Site 2. Returned to St. Mary's Harbour at 13:30 and returned to accommodation to catch-up with office work.

Saturday 29th September, 1984

Weather: Mostly clear skies with a light southwesterly wind.

Tides: 14:50, 0.8 m

KH packed equipment, etc., for later departure. Left St. Mary's Harbour on M.L. Marius Nielson at approximately 10:30 for Deep Point. KH and Cl dived offshore while SF and GB dived nearshore to survey effects on the seabed at the location where old vehicles are dumped. Returned to St. Mary's Harbour to meet Frances Dipper off the Scillonian at 13:00. KH departed at 16:00.

APPENDIX 2

Scales for the interpretation of abundance notations in sublittoral surveys.

ANIMALS

1. Large solitary species and colonies. For instance, solitary sponges, Alcyonium digitatum, hydroid clumps, large anemones, Pentapora foliacea, Cellepora pumicosa, echinoderms, large solitary tunicates.

ABUNDANT	One or more per 0.1 m^2.
COMMON	One or more per 1 m^2.
FREQUENT	Less than 1 per m^2 but more than about 20 individuals observed.
OCCASIONAL	About 3-20 observed.
RARE	One or two observed.

2. Small solitary species. For instance, Grantia compressa, small anemones, Caryophyllia smithi, Antedon bifida, small solitary tunicates.

ABUNDANT	One or more per 0.01 m^2.
COMMON	One or more per 0.1 m^2.
FREQUENT	One or more per m^2, scattered patches.
OCCASIONAL	Less than one per m^2, scattered small patches.
RARE	Widely scattered individuals, one or two small patches.

3. Small colonial species and crustose species. For instance, encrusting sponges, Corynactis viridis, small hydroids, Polydora ciliata, beds of Mytilus edulis, barnacles, bryozoa, encrusting tunicates.

ABUNDANT	Large confluent colonies with more than 50% cover. More than 100 per 0.01 m^2.
COMMON	Many small or a few large patches with 10% to 50% cover. One or more per 0.01 m^2.
FREQUENT	Scattered patches less than 10% cover overall. One or more per 0.1 m^2.
OCCASIONAL	Scattered small patches less than 1% cover overall. One or more per m^2.
RARE	Widely scattered very small patches or individuals. Less than one per m^2.

ALGAE

Kelps.

ABUNDANT	Plants mostly less than 50 cm apart. Difficult to swim between.
COMMON	Plants 50 cm to 1 m apart.
FREQUENT	Plants 1 to 2 m apart. Easy to swim between.
OCCASIONAL	Plants more than 2 m apart, zone still apparent.
RARE	Few plants present.

Foliose or filamentous undergrowth species.

ABUNDANT	More than 20% cover over most of area.
COMMON	Less than 20% cover but many plants present throughout zone.
FREQUENT	Less than 20% cover and distribution patchy or scattered plants present throughout zone.
OCCASIONAL	Scattered plants present.
RARE	Few plants seen in dive.

Kelp stipe flora.

ABUNDANT	Plants dense on most stipes.
COMMON	Plants present on most stipes but not dense.
FREQUENT	Distribution patchy, plants may be dense on some stipes, absent on others.
OCCASIONAL	Few plants on many stipes.
RARE	Only few plants seen during dive.

Crustose species.

ABUNDANT	More than 50% cover.
COMMON	More than 20% cover.
FREQUENT	More than 5% cover.
OCCASIONAL	Less than 5% cover. Few scattered large patches or many small patches.
RARE	Few patches seen.

APPENDIX 3

Field measurements of numbers of Zostera shoots, leaves and leaf lengths.

ENGLISH ISLAND ZOSTERA – SPARSE

BAG NO.	NO. SHOOTS	LEAF LENGTHS	LEAVES $\bar{x}$	s.d.	n.
11	9	46, 47, 50, 23, 19, 40, 25, 27, 21, 16, 17, 42·5, 43, 41, [illegible] 39, 26, 36, 35, 38 47, 47, 46, 42, 11·5, 13, 8·5, 11·5, 18, 20· 27, 22. [illegible]	30·3	12·70	35
12	0				0
13	3	7·5, 18, 20·5, 21·5, 14, 12, 17·5, 17·5 21, 9.	15·9	5·00	10
14	3	8·5, 22, 25, 26·29, 20, 10, 10·5 5, 6, 7, 18, 27, 29	17·4	9·18	14
15	4	18, 25, 25, 15 6, 21, 26, 23 6·5, 27, 25, 29 9, 13, 16, 17,	18·8	7·47	16
16	2	7·5, 26, 26, 30 / 8, 9, 13, 17·5	17·1	9·12	8
17	2	7·5, 15·5, 16 / 13·5, 14·5, 17, 20	14·9	3·85	7
18	15	24·5, 24·5, 28 / 19, 26, 18·5, 16 / 5·5, 18, 26·5, 27 / 8·5, 19, 23·5, 27·5 / 10·5, 13, 30, 34, 36, 42 / 14, 35, 39, 43 / 9·5, 16, 18 / 6, 13, 14·5 / 10, 20, 23, 25 / 20, 12, / 10, 16, 18·5 / 19·5, / 18, 12, / 24·5, / 17, 12	20·5	9·17	46
19	2	22, 23, 24 / 9, 20, 21 /	20·3	6·06	6
20	1	24, 51, 53, 54, 59	48·2	13·85	5

→ dense flowering

ENGLISH ISLAND
DENSE ZOSTERA

↱ = flower stalk

BAG NO.	NO. SHOOTS	LEAF LENGTHS	LEAF LENGTHS $\bar{x}$	σ_{n-1}	N
1	29	9·5, 31, 58, 59 / 13, 55, 67, 50 / 75, 43, 77, 56, 92 / 10, 44, 76, 85, 94 / 29, 70, 74, 82, 83 / 20, 59, 82, 85, 86 / 79, 95, 96 / 26, 51, 52, 54 / 7, 38, 49 / 35, 67, 77 / 6, 40, 75, 54, 56 / 35, 67, 72, 74 / 31, 61, 65 / 42, 49, 49 / 27, 43, 52 / 9, 37, 57, 70 / 4, 37, 69, 69 / 2, 30, 40, 44 / 3, 39, 50 / 5, 10, 39 / 88 / 10, 38 / 4·5, 15, 31 / 7, 30, 31, 32, 34, 37, 40, 40, 42, 45, 48, 46, 55, 55 / 25, 25, 33, 34, 40, 40, 41, 41, 46, 46, 48, 51, 53, 55, 55, 64, 65, 66, 67, 70, 70 / 9, 18, 18, 22, 24, 26, 26, 29, 29, 31, 32, 33, 34, 35, 36, 41, 42, 44, 45, 46, 49, 52 / 18, 19, 21, 23, 26, 30, 31, 31, 32, 33, 35, 37, 39, 38, 39, 45 / 14, 35, 36 / 86 / 54 / 29 / 25, 25, 29, 31, 31, 33, 37, 38, 40, 40, 41, 43, 45, 46 47, 52 / 9, 19, 22	48·3	27·29	92
3	27	29, 60, 76, 91, 91 / 14, 23, 34, 44, 50 / 40, 69, 76, 79 / 24, 31, 53, 59 / 40, 65, 66, 70, 77 / 43, 75, 94, 100 / 25, 60, 65 / 10, 82 / 60, 65, 58 / 62 / 28, 65, 83, 86 / 6, 27, 33, 44 / 58, 65, 65 / 16, 55, 79, 81, 84 / 81, 83, 90, 25 / 32, 68, 81, 82, 91 / 24, 60, 77, 79, 82 / 79, 90, 92 / 63, 83, 97 / 21, 81, 88, 88, 73 / 18, 18, 74 / 82 / 81 / 22, 24, 26, 27, 29, 30, 31, 33, 34, 35, 37, 41, 44, 45, 52 /	57·0	25·08	97
4	32	40, 73, 74, 71 / 36, 82, 84, 90 / 10, 36, 39 / 75, 75, 78 / 10, 51, 69, 71 / 70, 78, 83 / 7, 38, 65, 66, 73 / 49, 51 / 69, 71, 75 / 9, 61, 66, 66 / 48, 58, 61, 63 / 23, 56, 56 / 19, 63, 76, 77 / 58, 62, 68, 77 / 58, 64 / 27, 77, 81, 83 / 55, 79, 82, 84 / 7, 47, 54, 60 / 46, 59, 57 / 60, 72, 81, 84 / 41, 71, 73, 77 / 33, 63, 66, 74 / 53, 70, 70 / 40, 57, 66, 73 / 32, 40, 42 / 68 / 10, 46, 49 / 15 / 19, 19 / 24, 46, 53 / 63 / 11, 13, 34 / 71, 17, 22, 20, 21, 28, 31, 19, 27, 21, 31, 31, 35, 32, 36, 38, 48, 42, 38, 50, 49, 49, 48, 48.	52	21·8	127

[F x 5] = Flower stalk with 5 flowering heads

Bag No.	No. of Plants	leaf lengths [nos. of flowerheads on any fertile stem]	leaf lengths $\bar{x}$ σ_{n-1} N
7	28	21, 56, 67, 70, 81 / 52, 71, 91, 93 / 22, 51, 89, 90, 94 / 24, 58, 76, 84 / 35, 70, 79, 84 / 25, 72, 91, 92, 97 / 35, 43, 43, 48 / 22, 68, 80, 86 / 83, 95, 96 / 29, 78, 86, 91 / 51, 64, 86 / 46, 94, 96, 99 / 11, 58, 91, 95, 96, 98 / 65, 85, 87 / 47, 78, 83, 92, 101 / 7, 60, 89, 103, 108 / 56, 67, 69 / 8, 51, 90, 91, 99 / 65, 97, 102, 109 / 30, 55, 85, 93, 98 / 31, 74, 90, 91, 94 / 92 / 106 / 98 / 83, 67, 78, 84 / 47, 80, 78, 88 / 55, 65, 71 / 14, 28, 37, 40 / [8 flowerheads – 1 stem only]	70.4, 25.99, 10 8
8	~~28~~ 32	23, 25, 28, 60, 59, 68, 85, 87 / ~~24~~ 15, 26, 35, 57, 60 / 5, 17, 20, 22 / 21, 56, 61 / 77 / 31, 57, 59, 66 / 34, 56, 61 / 38, 61, 62, 70 / 28, 63, 80, 81, 85 / 54, 76, 88, 89 / 35, 64, 67, 75 / 19, 50, 83, 84 / 28, 43, 52 / 32, 60, 63, 64 / 24, 59, 82, 83, 77 / 8.5, 16, 22, 23 / 51, 55, 61, 28 / 37, 67, 68 / 65, 74, 75 / ~~28~~ 5, 42, 61, 67 / 69 / 29, 62, 77, 79 / 27, 31, 42, 43, 61 / 42 / 36, 64, 70, 84 / 12, 33, 34 / 4, 19, 36, 37 / 43, 59, 86, 87 / 27, 38 / 40 / 19, 28, 31 / 23, 32, 35 / 24 / 14 / . [F x 8], [F x 3], ~~3~~ [F x 5], [F x 1]	49.1 ~~3~~, 23.06, 116
9	26	12, 54, 66, 74, 78, 79 / 7, 30, 53 / 50, 74, 80 / 92 / 49, 90, 98, 98 / 48, 59, 67, 92, 93 / 7, 59, 84, 103 / 53, 88, 111, 113, 115, 119 / 43, 90, 93, 106 / 27, 68, 72 / 40, 76, 83, 83 / 62 / 22, 68, 103, 109, 109 / 54, 81, 91, 97 / 65 / 85 / 43, 80, 81, 89 / 49, 83, 84, 88 / 81, 96, 97, 102 ~~128~~ / 49, 50, 105, 117 / 25, 67, 86, 97 / 91 / 93 / 33, 68, 83 / 15, 21, 32 / 36, 86, 111, 120 / 15, 57 / 75, 88, 97 / 11, 23 /	72.4, ~~29~~.57, 95
10	25	13, 46, 74, 74 / 32, 64, 65, 70 / 20, 57, 73, 75 / 49 / 26, 30, 83, 93 / 7, 28, 51, 70 / 7, 13, 8 / 12, 47, 63, 66 / 40, 90, 90, 98 / 22, 67, 81, 83 / 36, 78, 90, 90, 92 / 81 / 52, 90, 91 / 69, 77, 77 / 2, 26, 45, 47 / 75, 90, 97, 98 / 8, 58, 68, 75 / 67, 68, 80 / 59, 62, 85, 96 / 58 / 5, 50, 73, 75 / 68, 69, 78 / 9, 54, 86, 85 / 46, 80, 84 / 28, ~~88~~, 94, 99 / 30, 66, 81, 92 / 61, 71, 72 / 69. [F x 9]	61.6, 26.70, 94

Anomia

BAG No.	No. of SHOOTS	LEAF LENGTHS + [Nos of flowering shoots on 1 stem]	leaf lengths $\bar{x}$	σ_{n-1}	N
6	14	16,30,85,88/43,43,74,75/44,89,100,115,119/ 41,78,82,91/53,76,80,82/61,74,88,92/23,64,85,86/ 60,81,88/22,49,81,63/31,50,59/26,43,54/ 34,68,80,95/90/99/35/59/5/16/18/10,28,31/ [1F x 6]	61·5,	28·22,	56
5	16	18,40,74,76/36,89,91,95/71,85,108,112/9,51,85 97/70,71,72,97,/46,64,66,78/42,98,103,111/ 84,108,109/59,72,104,106/26,73,87,87,99/ 36,88,103,104/11,61,98,100/54,87,89,94/11,14,20/ 58,99,104,106/44,79,80/75,100,101,101/ 45,99,100,107/19,24,76,94/16,30,78/ 12,70,85,91/6,59,96,97,103/ [illegible] 105,113,116,74,76,[illegible]/78/ 39.63.67 / 1F x 11 / 1F x 5 /	73·4,	29·95,	99
2	16	49,93,106,111/15/40,82,92,93/30,91,95,105/ 52,112,117,127/22,23,30,45,99/27,71,84,87/ 9,25,29,30,38/16,61,81,94,109/27,39,57,75/ 20,46,52/20/99/26/88/47,101,111,117/64/ 66/43,82,84,87/38,89,102,108/36,79,97,98/ 37,74,75,85/38,83,93,104,109/	68·7,	32·19,	74

Bag no.	No. of shoots	LEAF LENGTHS [8 no. of flowering plants]	Leaf. Lengths $\bar{x}$	s_{n-1}	s_n
unmarked (=1)	21	18,47,56,62,75 | 37,50,50,60,62 | 36,64,66,69, 69 | 10,17,32,43,51,59,61 | 16,20,34,38,41 | 3,11,34,46,51,47 | 19,45,50,57,63 | 44,48,49 | 18,47,47,54,63 | 18,38,40,45,48 | 22,36,50, 52,58 | 30,38,40,46 | 22,38,42,43,54 | 30,31,44,51 | 26,40,55,58,63 | 7,38,44,51 | 16,20,26,29 | 31,41 | 7,18,22,22 | 24(43 |	40·43,	16·31,	90
8	34	5,15,33,38 | 9,25,29,31 | 19,47,49,51 | 24,36, 50,57 | 21,28,29,32 | 10,15,17 | 12,41,44,47 | 4,34,37,47,51 | 28,35,47,51 | 23,37,39,47 | 12,29,29,32 | 2,13,13 | 8,44,17,36,43,45,50 | 38,42,46,53 | 15,33,41,43 | 16,33,44,45 | 18,22,24 | 21,27,48,52,58 | 17,44,45,50,52 | 24,40,53,56,57 | 36,42,50 | 11,39,53,54,61 | 22,30,43,57,60 | 29,46,52,53 | 27,54,55,51, 59 | 22,30,33,36 | 20,33,35,39 | 18,20,36,37 | 12,39,43 | 14,31,33,35,39 | 5,42,55,61,62 | 17,19,23 | 13,20,28,33 | 15,18,21 | 15,21 | 30,30,28 | 4,13,14 |	33·6,	14·96,	150
4	32	26,54,59,60 | 26,29,53,57,60 | 19,50,50,51,60 | 47 | 10,50,60,62,67,74 | 15,18,62 | 10,11 | 13,40,44,49,50 | 17,25,54,58,62 | 19,52,53,53,52,65 | 13,31,46,50 | 31,34,37 | 14,30,35 | 22,48,54,54,34 | 20,26 | 15,23 | 16,26,47,50,59 | 20,45,48,48,54 | 21,25,28,34 | 12,41,43,45,45 | 32,48,49,59 | 7,40,52,60,63 | 14,26,35,60,50,57 | 11,21,21,23,25,40 | 41,45,52,56 | 10,28,42,59,66 | 44,43,54 | 7,12,30,36,36,46,61 | 38,43 | 39,37,57,70 | 20,37,49,52 | 25,28 |	39·6,	16·69,	132
6	34	13,32,33,46,43 | 12,18,22,41,49 | 9,9,34,44,54, 55 | 21,23,29,53,55 | 15,31,36 | 10,23,24 | 28,31,34,58,57 | 6,12,13,36 | 5,11,16 | 5,14,28, 32 | 11,32,34,38 | 11,51,51,52,53 | 22,26,28,50 | 26,31,36 | 16,29,44,50,56 | 18,18,28,39 | 12,30, 38,45,46 | 17,17,28,43 | 16,38,41,46,49 | 23,32, 32,49 | 31,48,52,53,57,58 | 19,22,31 | 10,11,20, 33,39,58 | 35,33,45,51 | 7,13,36,37,46 | 14,26, 39,50 | 26,31,43 | 9,18 | 7,13,28,30 | 19,20,25,31 | 8,20,23,49,51 | 13,18 | 6,14,32 | 8,13 | 9,14 |	30·8,	16·03,	140

Old Grimsby

Bag no	No. of shoots	leaf length [+ no. flowering spikes]	leaf length $\bar{x}$ s_{n-1} $\tilde{x}$
7	35	12, 23, 27, 34/ 11, 44, 46, 47, 55/ 55/ 21, 36/ 51, 52, 53, 59/ 25, 42, 45, 50/ 30, 40, 41, 45/ 46/ 9, 28, 36, 37/ 27, 31, 35, 48/ 28, 44, 44, 47/ 36, 57, 58, 60/ 14, 16, 39, 45/ 5, 13, 60/ 17, 52, 53, 55, 55/ 30, 39, 50, 49, 55/ 40, 50, 51, 53/ 19, 39, 41, 43/ 37, 37, 47, 52/ 10, 13/ 8, 19, 26, 28/ 44, 47, 54, 63/ 19, 20, 21/ 28, 39, 41/ 15, 19, 35, 45/ 18, 22, 25/ 34, 35, 42, 49/ 37, 42, 48, 51/ 18, 23, 34, 39/ 25, 30, 35/ 35, 41, 44, 56, 62/ 13, 16/ 19, 36, 42, 46, 49/ 28, 33, 35/ 28, 35, 41/ 13, 15/ 9, 43, 45, 51/ 14, 16, 11, 12/ 19, 21, 29/ 9, 20/ 8, 19, 22, 24/	34·8, 14·56, 145
2	24.	16, 34/ 16, 23, 29/ 23, 31, 38/ 17, 43, 45, 49/ 19, 24, 37, 40/ 41, 41, 56, 64/ 30, 51, 69, 69/ 13, 28, 29, 59, 69, 70/ 36, 54, 63, 75/ 30, 61, 72, 76/ 5, 36, 39, 44/ 8, 9, 29, 29, 32, 56, 59/ 37, 37, 52, 52/ 7, 32, 55, 39/ 9, 10, 10/ 3, 11/ 20, 50, 50, 49/ 33, 58, 69, 76, 70, 73/ 4, 13, 16/ 9, 31, 48, 69, 70, 79/ 25, 45, 45/ 12, 17, 27, 31/ 25, 27, 29, 46, 50/ 29, 50, 54, 55/ 16, 23, 27/ ~~[illegible]~~/ 27, 29, 39/	38·20, 19·92, 103
5	22	6, 16, 14, 59, 74, 80, 89/ 36, 37, 56, 68, 62/ 30, 43, 84, 85/ 7, 21, 23, 36/ 10, 40, 60, 64, 71/ 16, 32, 61, 71/ 47, 72, 77, 82/ 31, 43, 47/ 16, 27, 31/ 25, 38, 57, 60, 64/ 13, 33, 39, 43, 46/ 14, 44, 66, 77/ 51/ 22, 23, 23/ 23, 28, 26, 41/ 10, 13, 26, 27/ ~~35~~, 32, 63, 67/ 45/ 21, 30, 50/ 11/ 44, 55, 67, 71, 68/ 24, 26, 37, 39/ ~~[illegible]~~ 8, 9, 49, 55, 69, 76/	42·6, 22·23, 89
10	32	3, 15, 37, 41/ 17, 38, 54, 59, 63/ 16, 16, 26, 48, 56/ 19, 35, 48, 54/ 15, 33, 41, 47, 53/ 29, 38, 46, 57/ 15, 17/ 20, 32, 40, 46/ 27, 46, 58, 61/ 9, 34, 38, 40/ 23, 39, 40, 46/ 18, 22, 25, 45, 46, ~~53~~/ 20, 30, 46, 49/ 15, 23/ 18, 26, 29/ 10, 34, 35/ 6, 24, 26, 38, 54, 57/ 7, 39, 39, 52/ 20, 47, 54, 60/ 12, 24, 33, 45, 60/ 12, 16, 61, 56, 51, 47, 43/ 23, 23, 42/ 26, 38, 48, 55, 57/ 52, 13, 33, 50, 51, 54, 55/ 3, 33, 51, 58/ 21, 19, 62, 56, 48, 53/ 49, 56, 56, 61/ 15, 41, 45, 50/ 21, 36, 49, 56, 60/ 54, 55, 54, 60/ 2, 13/ 9, 12, 14/	37·0, 16·76, 135

Old Grassby

Stag No	No of shoots	Leaf Length (+ no flowering spikes)	Leaf length $\bar{x}$ σ_{n-1} n
3	34	17, 30, 31, 37 / 30, 55, 55, 58 / 5, 27, 29, 55, 55, 57 / 25, 33, 42, 54 / 30, 34, 35, 59, 59 / 28, 49, 53, 58 / 12, 36, 39, 41, 44 / 11, 30 / 20, 25, 32, 44 / 27, 37, 51, 52, 54 / 26, 28, 22, 23, 28, 46 / 24, 27, 31, 42 / 15, 51, 52, 56, 62 / 19, 49, 50, 50 / 42, 43, 47 / 23, 28, 36, 46, / 18, 26, 43, 43 / 22, 34, 37 / 29, 30, 40, 45 / 9, 24, 50, 56, 59 / 21, 47, 52, 56 / 17, 35, 40, 58 / 24, 44, 49, 51, 53 / 12, 40, 60, 62, 65 / 11, 21, 37, 38, 41 / 9, 21, 30, 38, 41, / 30, 51, 56, 67, 65 / 22, 23, 25, 27 / 28, 33, 35, 43 / 17, 30, 36, 50, 59 / 9, 17, 17, 46, 47 / 30, 53, 53, 55, 56 / 42, 51, 52, 59 / 26, 41, 45, 52 / 43, 48, 54, 54 / 11, 27, 30, 33, 53 / 12, 52 / 8, 19 /	38·0, 14·86, 162
9		12, 29, 45, 51 / 29, 35, 36, 44, 58 / 44, 47, 53, 62, 65 / 12, 13, 35, 53, 60 / 9, 44, 45, 51 / 23, 29, 35, 61, 62 / 25, 29, 48, 70, 75 / 18, 39, 39 / 11, 37, 60, 55, 64 / 22, 35, 36 / 23, 33, 39, 43 / 25, 28 / 22, 28, 50, 51, 56 / 17, 23, 39, 43 / 21, 45, 53, 54 / 21, 38, 40, 51 / 36, 15, 54, 62, 73 / 30, 38, 45, 57 / 25, 27, 37 / 9, 19, 31, 32 / 22, 28, 41, 44 / 18, 32 / 25, 27, 33, 57, 64 / 11, 13, 35, 39 / 45, 48, 56, 60 / 27, 35, 39, 65, 69 / 21, 47, 49, 49, 55 / 28 / 10, 14 / 20, 23 / 12, 24, 44, 45 /	38·1, 16·17, 121

Unit 1

23
12
15
21
11

APPENDIX 4

Scales for the interpretation of abundance notations in littoral surveys.

1. Live barnacles (excluding *B. perforatus*) (record adults, spat, cyprids separately)
   Littorina neritoides
   Littorina neglecta
   7 Ex 500 or more per 0.1 m^2-5+ per cm^2
   6 S 300-499 per 0.01 m^2-3-4 per cm^2
   5 A 100-299 per 0.01 m^2-1-2 per cm^2
   4 C 10-99 per 0.01 m^2
   3 F 1-9 per 0.01 m^2
   2 O 1-99 per m^2
   1 R Less than 1 per m^2

2. *Balanus perforatus*
   7 Ex 300 or more per 0.01 m^2
   6 S 100-299 per 0.01 m^2
   5 A 10-99 per 0.01 m^2
   4 C 1-9 per 0.01 m^2
   3 F 1-9 per 0.1 m^2
   2 O 1-9 per m^2
   1 R Less than 1 per m^2

3. *Patella* spp. 10 mm+
   Littorina littorea (juv. & adults)
   Littorina littoralis (adults)
   Nucella lapillus (juv. <3 mm)
   7 Ex 20 or more per 0.1 m^2
   6 S 10-19 per 0.1 m^2
   5 A 5-9 per 0.1 m^2
   4 C 1-4 per 0.1 m^2
   3 F 5-9 per m^2
   2 O 1-4 per m^2
   1 R Less than 1 per m^2

4. *Littorina 'saxatilis'*
   Patella <10 mm
   Anurida maritima
   Hyale nilssoni & other amphipods
   Littorina littoralis (juv.)
   7 Ex 50 or more per 0.1 m^2
   6 S 20-49 per 0.1 m^2
   5 A 10-19 per 0.1 m^2
   4 C 5-9 per 0.1 m^2
   3 F 1-4 per 0.1 m^2
   2 O 1-9 per m^2
   1 R Less than 1 per m^2

5. *Nucella lapillus* >3 mm
   Gibbula spp., *Monodonta lineata*
   Actinea equina, *Idotea granulosa*,
   Carcinus (juv. & recent sett.),
   Ligea oceanica
   7 Ex 10 or more per 0.1 m^2
   6 S 5-9 per 0.1 m^2
   5 A 1-4 per 0.1 m^2
   4 C 5-9 per m^2, locally sometimes more
   3 F 1-4 per m^2, locally sometimes more
   2 O Less than 1 per m^2, loc. sometimes more
   1 R Always less than 1 per m^2

6. *Mytilus edulis*, *Dendrodoa grossularia*
   7 Ex 80% or more cover
   6 S 50-79% cover
   5 A 20-49% cover
   4 C 5-19% cover
   3 F Small patches (5%, 10+ small individuals per 0.1 m^2, 1 ore more large per 0.1 m^2.
   2 O 1-9 small per 0.1 m^2. 1-9 large per m^2. No patches exc. small in crevices
   1 R Less than 1 per m^2

7. *Pomatoceros triqueter*
   5 A 50 or more tubes per 0.01 m^2
   4 C 1-49 tubes per 0.01 m^2
   3 F 1-9 tubes per 0.1 m^2
   2 O 1-9 tubes per m^2
   1 R Less than 1 tube per m^2

8. *Spirorbis* spp.
   5 A 5 or more per cm^2 on appropriate substrata. More than 100 per 0.01 m^2 generally.
   4 C Patches of 5 or more per cm^2, 1-100 per 0.01 m^2 generally.
   3 F Widely scattered small groups, 1-9 per 0.1 m^2 generally
   2 O Widely scattered small groups, less than 10 per 0.01 m^2 generally
   1 R Less than 1 per m^2

9. Sponges, Hydroida, Bryozoa
   5 A Present on 20% or more of suitable surfaces
   4 C Present on 5-19% of suitable surfaces
   3 F Scattered patches, <5% cover
   2 O Small patch or single sprig in 0.1 m^2
   1 R Less than 1 patch over strip, 1 small patch or sprig per 0.1 m^2

10. Flowering plants, lichens, lithothamnia
    7 Ex More than 80% cover
    6 S 50-79% cover
    5 A 20-49% cover
    4 C 1-19% cover
    3 F Large scattered patches
    2 O Widely scattered patches, all small
    1 R Only 1 or 2 patches

11. Algae
    7 Ex More than 90% cover
    6 S 60-89% cover
    5 A 30-59% cover
    4 C 5-29% cover
    3 F Less than 5% cover, zone still apparent
    2 O Scattered plants, zone indistinct
    1 R Only 1 or 2 scattered plants

Other animal species.
Record as percentage cover or approximate average numbers within 0.01, 0.1 or 1 m^2.