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Marine monitoring in the Isles of Scilly 1991

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MARINE MONITORING IN THE ISLES OF SCILLY 1991

Sarah L Fowler

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REPORT TO ENGLISH NATURE

The Nature Conservation Bureau Ltd.,
36 Kingfisher Court, Hambridge Road, Newbury, Berkshire RG14 5SJ

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1. Synopsis

A programme of marine biological monitoring was established in the Isles of Scilly in 1984, aimed at detecting change in communities and populations of high nature conservation importance and including studies on Mediterranean-Atlantic species found around the larger islands. Monitoring continued at yearly intervals until 1988, followed by a three year gap until 1991.

This report describes the monitoring carried out in 1991, which covered subtidal sites only. Gap Point and the *Zostera marina* beds at English Island, Samson and Old Grimsby were visited. An initial brief analysis of the results is presented.

From 1984 to 1988 (inclusive) very few changes were recorded within the *Zostera* beds or in the populations of southwestern species in the circalittoral epibenthic communities. For example, there was little change in the numbers of sunset cup corals *Leptopsammia pruvoti,* carpet corals *Hoplangia durotrix* and pink sea finger *Parerythropodium coralloides* colonies at Gap Point. In contrast, considerable changes were recorded in the population structure of the common and widely distributed Devonshire cup coral *Caryophyllia smithii.* In 1991, the communities of southwestern circalittoral species continued to show a very stable and unaltered pattern with the exception of the first apparent recruitment in *Leptopsammia* being recorded since the programme began. The decline in Devonshire cup coral numbers had slowed considerably.

The *Zostera* beds in Scilly are perennial and do not normally vary greatly in extent from year to year. Previous records from English Island had demonstrated the stability of this habitat, but changes took place between 1988 and 1991, including quite serious storm damage which removed areas of eel grass, infestation by *Labyrinthula macrocystis* (considered to be the cause of *Zostera* wasting disease in the 1930s) and colonisation by Jap weed *Sargassum muticum.*

In conclusion, the report discusses the possible application of the results of this marine monitoring programme to assessment of changing climate patterns and oceanic conditions. More information is required on species biology (particularly longevity, growth and recruitment), climate and the effects of change on species of high nature conservation interest in order to determine the aims of marine nature reserve management.

Recommendations include the continuation of the monitoring programmes at the Isles of Scilly and Lundy Marine Nature Reserve; the installation of continuous data loggers at these sites to collect sea water temperature data; repetition of the aerial photography of the Isles of Scilly *Zostera marina* beds; informing other country agencies of the results (particularly with regard to the discovery of *Labyrinthula macrocystis*); and incorporation of the Scilly and Lundy monitoring programmes into a long-term monitoring programme utilising a number of sites in Britain and contributing to a European marine monitoring project such as the former COST 647 Programme.

2. Introduction

Subtidal monitoring work was initiated by the Nature Conservancy Council in the Isles of Scilly in 1984, when a monitoring programme (properly surveillance) was established to investigate species and communities of high nature conservation interest, including Mediterranean-Atlantic species found around the larger islands. The programme was aimed at detecting changes in these communities and populations of species of high nature conservation importance within the Islands, which were proposed for designation as a Marine Nature Reserve. Information on the natural dynamics of these communities was needed in order to determine their conservation requirements. Monitoring continued annually from 1984 until 1988, followed by a break in 1989 and 1990 due to inadequate funding for marine research in NCC.

All visits have been undertaken at the same time of year: late September to early October. The work has concentrated on photographic monitoring of circalittoral faunal populations of high nature conservation interest at Gap Point (including Mediterranean-Atlantic species of anthozoa and rich sponge communities) and monitoring *Zostera marina* beds. The previous reports on this monitoring programme are by Hiscock (1985), Irving (1987) and Fowler (1990).

The *Zostera* beds in Scilly are the most extensive of their kind in southern Britain, matched only perhaps by some areas in Scotland (where, however, the associated communities are much less diverse). The circalittoral communities on the east coast of St. Mary's are of considerable nature conservation interest, for these are present in southwest Britain at the northern limits of their distribution and known from only in a very few areas in the region (notably the islands of Lundy, Scilly and Skomer). Very little information is available on the stability and population dynamics of these communities and species, which makes the development and justification of management strategies for these important sites (proposed and designated Marine Nature Reserves) most difficult. One of the aims of the marine monitoring programme in the Isles of Scilly and at the other southwestern sites was to provide this sort of data.

This report covers the monitoring visit carried out in 1991, three years after the previous visit in 1988. The 1991 survey covered subtidal sites only, at Gap Point and the *Zostera* beds at English Island, Samson and Old Grimsby. An initial brief analysis of the results is presented. The survey log is presented in Appendix 1.

More detailed analyses of all monitoring work undertaken since 1984 in the Isles of Scilly and Lundy Marine Nature Reserve and the development of recommendations for the continuation of these programmes are underway at the time of writing. These will be presented in a separate report to English Nature in early 1992.

3. Previous monitoring results, 1984-1988

During the monitoring period from 1984 to 1988 (inclusive) very few notable changes had been recorded within the *Zostera* beds or in the populations of southwestern species in the circalittoral epibenthic communities. For example, there had been little change in the numbers of sunset cup corals *Leptopsammia pruvoti* present at Gap Point. A few large individuals had been lost from the site, but no recruitment had been recorded and no obvious growth in individual corals noted. The same pattern was noted for carpet corals *Hoplangia durotrix* and pink sea finger *Parerythropodium coralloides* colonies (also Mediterranean-Atlantic species near the edge of their range). In contrast, considerable changes were recorded in the population structure of the common and widely distributed Devonshire cup coral *Caryophyllia smithii.*

The *Zostera* beds in Scilly are perennial and do not normally vary greatly in extent from year to year. Records from English Island had demonstrated the stability of this habitat, and in 1988 an additional site had been marked to extend the range of data collected. This was considered to be a particularly important aspect of the marine monitoring programme because of the news that *Zostera* wasting disease, which had devastated eel grass beds in the 1930s, had been recorded again in the western Atlantic in the early 1980s and in northern Europe in 1986. This disease most seriously affects sublittoral, perennial *Zostera* beds in fully saline sea water, and the beds in Scilly (which are also remote from pollution and most other potential sources of stress which might affect the species) would therefore be important indicators of any new resurgence of the disease. No signs of wasting were recorded in Scilly in 1988, despite a careful search for symptoms, but the importance of continuing the survey programme to ensure that the data set was maintained and site markers were not lost through neglect was stressed when funding was sought to continue the monitoring programme in subsequent years.

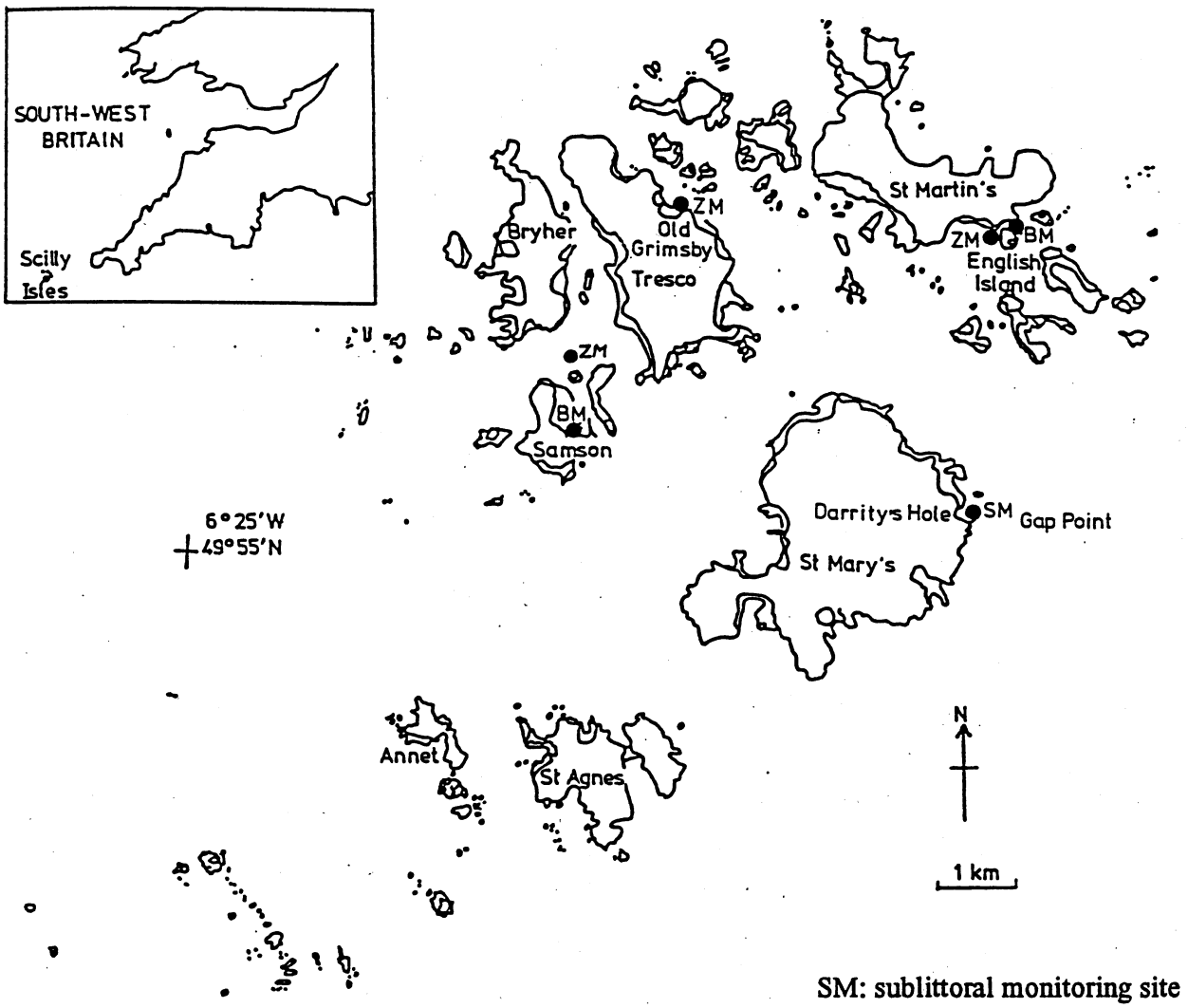
Towards the end of the 1980s, concern was also being expressed over the nature conservation implications of potential sea temperature rise around Britain. Global climatic change was also considered to be likely to result in more frequent extreme weather events, such as severe storms. Both of these factors would be expected to cause changes in marine communities, particularly those comprised of species whose distribution might be limited by sea water temperature (as present in the circalittoral communities at Gap Point) and those which are vulnerable to storm damage (including *Zostera marina* beds). For these reasons, it was considered particularly important that the full marine monitoring programme at Scilly and other sites was continued.

4. Events in 1989 and 1990

Despite the considerations outlined above, the Nature Conservancy Council was unfortunately not able to undertake the marine monitoring studies in 1989 and 1990.

Severe storms hit the Isles of Scilly in both 1989 and 1990 and it was reported that large areas of the *Zostera* beds were destroyed. The *Zostera* bed site markers were lost during this period. Hot summers and mild winters in the late 1980s reportedly also resulted in sea water temperatures during this period being much higher than average throughout the year. (Unfortunately temperature data became difficult to obtain during this period due to lack of Met. Office records following the automation of the Light Vessels. Surface sea water temperatures had previously been recorded by Light Vessel staff). It was speculated that reproduction in some of the Mediterranean-Atlantic species present at Gap Point might take place under these conditions. Changes in the marine communities monitored in Scilly were therefore either known to have taken place to some extent, or considered to be likely during this period.

Figure 1. Location of monitoring sites in the Isles of Scilly (from Hiscock 1985)



SM: sublittoral monitoring site
ZM: *Zostera* monitoring site
BM: Boulder monitoring site

5. Sublittoral monitoring at Gap Point in 1991

5.1 Site location and marking

An anchor with chain attached to a thin line and a flagged and marked pot buoy was put down on the transit marks for the Gap Point site. This landed close to the large boulder in the entrance to the main study site canyon and was made fast among small boulders nearby to act as a marker during the week's work at the site. This is the most effective means of site location, for a current runs past Gap Point and divers put down on the transits without a heavy shot line drift off the site before reaching the bottom at 22-24 m below chart datum. There is always concern, however, that the anchor might actually land on and damage one of the permanent monitoring sites and the anchor must be made fast well away from any steep rock faces to prevent entanglement.

A sub-surface marker buoy and line, located just outside the canyon to assist divers with site identification underwater (see relocation map, Appendix 2), had become detached since the 1988 visit, although its piton was still present.

The first pair of divers were able to locate and rope up much of site 1 using photographs embedded in plastic (the right hand piton is difficult to see without good prior knowledge of the site and was not found). Site 2 was not located during this dive, again due to lack of prior knowledge of the location. It is much closer to site 1 than appears from the relocation drawing. The second pair of divers located and roped site 2, but again failed to find the last piton at site 1. On the third dive at this site a new piton was added at site 1 and photography commenced at both sites. The original piton was still present at the extreme right hand side of site 1 and should be used in preference on subsequent visits. One piton was corroded at site 2 and should be replaced on the next monitoring visit (this was not possible due to lack of time in 1991).

Priority was given to photography of sites 1 and 2. Problems with storms and resulting high turbidity did not enable much time to be spent at site 3 in the adjacent canyon, although the sponge monitoring site with its subsurface marker buoys and some *Eunicella verrucosa* colonies were located on the single dive at this site. Some of the latter were photographed, but it was not always possible to determine which these were. It would be useful to tag the individual colonies for future identification.

5.2 Photographic monitoring

Photography at Gap Point was dogged by a number of misfortunes, although eventually completed satisfactorily. One camera flooded and another apparently had a faulty flash synchronisation, resulting in the films from the first three attempts to take close-ups at site 1 being useless. Another day was lost later on during the week as a result of bad weather, which also complicated the final section of the monitoring visit by causing very poor visibility. These events demonstrated the importance of having plenty of spare cameras available, carrying out development of each day's film every night and planning for extra time for contingencies during monitoring visits.

Wide angle photographs were taken using a Nikonos V camera, 15 mm lens, dedicated wide angle flash and aluminium framer with a 40 cm lens to subject distance and Fuji Professional 100 D film. The results were successful at sites 1 and 2. Additional wide angle photographs were taken of some *Eunicella verrucosa* (without the framer) and of one of the buoys marking site 3.

Close ups of site 1 were eventually completed, both with print film for the right hand side of the site (to make up a photo mosaic) and with colour transparencies for the whole site. A Nikonos V camera, 28 mm lens with supplementary Nikonos close up lens and framer, dedicated flash gun and Fuji Professional 50 D film were used. There was slightly insufficient coverage on the right hand side of site 1, immediately to the right of the top piton, and care should be taken in future years to ensure that this area is fully covered for the photo-mosaic. Additional close up photographs were taken along sections of site 2, concentrating upon large individual sponges and the *Parazoanthus axinellae* colony.

It did not prove possible to locate and photograph all of the *Eunicella* colonies mapped in 1988, due to lack of time and poor visibility hampering their location. Identification of those colonies found was not always certain because only two were photographed in 1988 and five in 1991 (only one colony was recorded in both years). One of those photographed in 1991 was a small colony on a low boulder at the entrance to the main canyon, which may not have been recorded in 1988. The same constraints of time and poor visibility prevented photography of the sponge monitoring rock established in 1988 at site 3.

Table 1 lists the photographs taken in 1991 which are held by English Nature in Peterborough. No duplicates had been made at the time of writing, but copies should be produced and kept with the duplicate sets held by the Joint Nature Conservation Committee's Marine Branch.

Table 1: List of Gap Point sublittoral monitoring photographs, 1991

Photo Nos.	Site	Description
ScyM/91/01 to 16	Gap Point site 1	Close ups from left to right above permanent marker line
ScyM/91/17 to 37	Gap Point site 1	Close ups from left to right below permanent marker line
ScyM/91/38 to 54	Gap Point site 1	Close ups from left to right above temporary (lower) line
ScyM/91/55 to 62	Gap Point site 1	Close ups from left to right below temporary (lower) line
ScyM/91/74 to 109	Gap Point site 2	Monitoring transect close ups
ScyM/91/110 to 115	Gap Point	*Eunicella* nos. 1, 5 & 6
ScyM/91/116	Gap Point	Buoy at site 3
ScyM/91/117-19	Gap Point	*Eunicella* no. 3
ScyM/91/120	Gap Point	Small *Eunicella* (no. 7)
ScyM/91/121 to 142	Gap Point site 1	Monitoring transect (wide angle)
ScyM/91/143 to 179	Gap Point site 2	Monitoring transect (wide angle)
print film	Gap Point site 1	Used to make up photomosaic
SCY/91/135 to 91/138	Gap Point	Land photos: bad weather at monitoring site

5.3 Results

Analysis of the results of the circalittoral monitoring at Gap Point was concentrated upon species of high nature conservation interest and those which were relatively easy to identify from the photographs. These included *Leptopsammia pruvoti*, *Caryophyllia smithii*, (no attempt was made to distinguish the very similar *C. inornatus* which is also present here), *Hoplangia durotrix*, *Parerythropodium coralloides*, *Alcyonium glomeratum*, *Parazoanthus axinellae* and large sponges (both encrusting and erect, few of which were identified). A brief analysis only is presented below, for another more detailed report is in preparation which assesses and analyses data obtained from the whole monitoring programmes in the Isles of Scilly and Lundy Marine Nature Reserve.

The appearance of Site 1 was remarkably similar in 1991 to that in previous years. The numbers and cover of species present were little changed, with very few exceptions. Site 2 also remained fairly similar, although colonies of some species changed to a greater extent. There was also variation between years in the quantities of algae present on upward-facing surfaces.

Algae

These sites were in the upper circalittoral, near the lower limits of erect algal growth. Many of the individual foliose algae present at Site 2 were seen to be perennials, found at the same location year after year, although the size and numbers of their fronds varied (i.e. *Dictopteris membranoptera* and *Myriogramme heterocarpum).* 1986 and 1987 were particularly good years for seaweeds, with very luxuriant growths photographed. Small encrusting coralline algal patches are present on the vertical face of Site 1, and these show very little change in area from year to year.

Porifera

A number of encrusting sponges are found on the vertical face of Site 1, most of which can not be identified from photographs. *Cliona celata* is persistent throughout the monitoring programme at several locations. Some patches grow faster than others and have been observed to engulf *Caryophyllia smithii* over a period of years. Growth rates are also variable for some very thin red crusts. Lobes grow and degenerate on some thicker crustose sponges, which also appear slowly to move around at Site 2.

Many erect sponges are noticeable at Site 2, although again most cannot be identified without samples for analysis. Wide angle view point photographs show that these grow very slowly indeed and little or no change can be picked up from year to year. A few are lost during the course of the monitoring programme. Where erect sponges are present in close up photographs it is possible to see that some small amount of growth has taken place during the monitoring programme. This will be discussed in greater detail in Fowler and Pilley (in preparation).

Alcyonacea

A number of colonies of *Alcyonium glomeratum* at site 1 have been photographed in both an expanded and contracted state during the monitoring programme, which makes analysis difficult from year to

year. Nevertheless, it is possible to see that varying amounts of growth takes place in different colonies. Some have remained relatively unchanged throughout while others have developed out-growths, connected at the base to the original colony, although not always present in exactly the same place from year to year, and new lobes. Some very small colonies of *Parerythropodium coralloides* can be located with difficulty on site 1, and these have shown very little change over the monitoring period.

Actinaria

The main colony of *Parazoanthus axinellae* at Site 2 has been photographed both by wide-angle and close-up systems during the monitoring programme. The former show that the overall area covered by these anemones has changed very little during the monitoring programme. Closer examination of the latter enables growth in individual clumps of polyps to be followed during the monitoring programme. Interestingly, these also change very little, with the numbers of polyps in a single clump sometimes not increasing from year to year.

Scleractinia

A few very small (2-3 mm in diameter, excluding expanded tentacles) and formerly unidentified individuals of the cup coral *Leptopsammia pruvoti* were seen during the monitoring survey and on immediate examination of the photographs taken in 1991. These were initially considered to be young individuals newly settled since the previous survey in 1988 and indeed the first records of recruitment to the population since monitoring commenced in the early 1980s.

On more detailed analysis of photographs from previous years, one of these very small 'new' individuals was found to have been present throughout the seven year monitoring programme, during which period it had not grown noticeably, and another was present at least in those previous years where photographic coverage had included the relevant area of the site. They had been so small and often also partly obscured that they were previously overlooked. A third was present on or very close to the attachment site of a missing large coral. In this location it may formerly have been hidden by the larger individual.

Very close examination of the print film showed one small yellow organism of about 2-3 mm in diameter which was not present in previous years and is possibly an un-expanded *Leptopsammia*, recruited since 1988, although this identification cannot be confirmed by examination of the transparency for this area of the monitoring site. Another extremely small yellow anthozoan, provisionally identified as *Leptopsammia*, is visible at site 1 (on transparency no. 52), although not quite in focus near the edge of the picture. It cannot be seen at all on the poorer quality print film. Its diameter (including expanded tentacles) is approximately 1.5 mm, which is close to the size of the newly released planulae described by Paul Tranter (pers. comm.) This individual has settled onto a small patch of encrusting coralline algae and was not present on the photographs from 1988 which showed the same area of rock clearly.

These two are considered probably to be the first records of *Leptopsammia* recruitment to the Isles of Scilly population since monitoring began. It must, however, be noted that these identifications can only be definitely confirmed or disproved if the individuals are still present in these same locations and have grown sufficiently to be identified with more certainty on a future monitoring visit.

The 'new' *Leptopsammia* identified on the site of a missing large coral can not be aged with any certainty, since it could have been present but obscured during previous monitoring visits. Alternatively, it is possible that it is a clone of the missing coral. Damaged and dying *Leptopsammia* in aquaria have been observed to regenerate tiny new individuals from small portions of remaining healthy tissue (Paul Tranter, pers. comm.). This may also occur in natural conditions when an adult is damaged and could be one explanation for the occurrence of clumps of large *Leptopsammia* found at the monitoring site in the Lundy Marine Nature Reserve (although Hiscock and Howlett, 1976, record that asexual division in *Caryophyllia smithii* produces double, triple and very occasionally quadruple corals, although this has only been recorded in North Devon). Regeneration of new *Leptopsammia* from the tissues of a large coral may also explain why, if this is a 'new' coral at site 1, it is so very much larger than the known size of a planula larva.

The total of two newly settled *Leptopsammia* and one possible new record on the site of a missing coral are considered to represent new additions to the study population. Only the last of these falls within the detailed cup coral counting area of 900 cm^2 (see Figure 2), but six large corals have been lost from the latter section of site 1 since 1984, three of these between 1988 and 1991, bringing the total in this patch down to 25 from an initial count of 30 in 1984. The steady decline in numbers of *Leptopsammia* noted in previous reports therefore continues, demonstrated in Table 2 and Figure 3. The identification of one small coral (diameter 2-3 mm) present at the site for seven years with no significant increase in size during this time demonstrates the extremely slow growth of these invertebrates in the Isles of Scilly. With no obvious growth observed even in such small individuals, it is impossible to make any estimates of age for the larger specimens (which have columns of well over 16 mm in diameter). The opaque nature of the polyp also makes it impossible to determine the size of the underlying skeleton, clearly seen in *Caryophyllia*, and hence to assess calice diameter from photographs.

No previous records of newly settled *Leptopsammia* had been made in the field in England, although *Leptopsammia pruvoti* and the similar species *Balanophyllia regia* had been observed to eject small numbers of planulae of about 1 mm in diameter when kept in aquaria (Paul Tranter, Plymouth Marine Laboratories, and Keith Hiscock, pers. comms). These planulae were poor swimmers and settled quickly (within 48 hours) onto the bottom.

Caryophyllia smithii numbers also continue to decline within the study area. Table 2 and Figure 3 show the marked decline in numbers of the population within the 900 cm^2 cup coral count area. The total number of *C. smithii* fell from 104 in 1984 to 59 in 1991 as a result of losses of 74 corals from

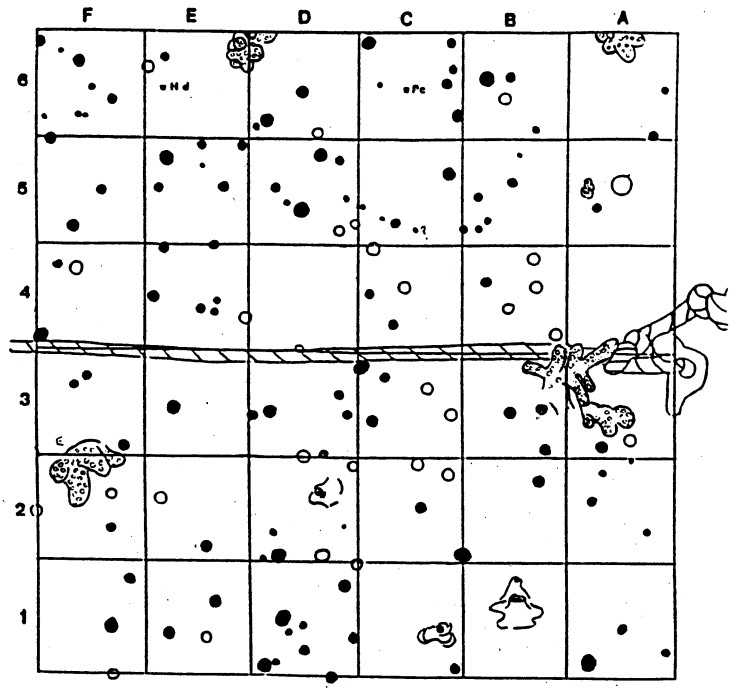
Table 2. Changes in *Caryophyllia smithii* and *Leptopsammia pruvoti* populations within 30 x 30 cm quadrat at site 1, Gap Point, Isles of Scilly from 1984-1991

Grid Square	1984-1985	1985-1986	1986-1987	1987-1988	1988-1991
A1	No change	1 new *C.s.*	No change	No change	1 new *C.s.*
A2	No change	1 new *C.s.*	1 new *C.s.*	No change	3 *C.s.* lost
A3	1 *C.s.* lost	No change	No change	No change	No change
A4	1 new *C.s.*	No change	No change	No change	No change
A5	No change	1 *C.s.* lost	No change	No change	No change
A6	1 new *C.s.*	No change	No change	No change	No change
B1	No change	No change	No change	No change	No change
B2	No change	No change	No change	No change	No change
B3	No change	1 new *C.s.*	No change	2 *C.s.* lost	No change
B4	No change	No change	1 *C.s.* & 1 *L.p.* lost	No change	1 new *C.s.*
B5	No change	4 *C.s.* lost	No change	1 new *C.s.*	1 *C.s.* lost
B6	No change.	2 *C.s.* lost	1 *C.s.* lost	1 new *C.s.*	1 *C.s.* lost
C1	1 *C.s.* lost	No change	No change	No change	No change
C2	No change	1 *C.s.* lost	No change	No change	1 new *C.s.*
C3	No change	1 *C.s.* lost	No change	No change	2 *L.p.* lost
C4	No change	No change	1 *C.s.* lost	No change	No change
C5	1 *C.s.* poss. lost	3 *C.s.* lost	No change	No change	1 *C.s.* lost
C6	1 *C.s.* lost	1 *C.s.* lost	1 *C.s.* lost	No change	No change
D1	1 *C.s.* lost	2 *C.s.* lost	1 *C.s.* lost	2 *C.s.* lost	No change
D2	1 *C.s.* & 1 *L.p.* lost	1 new *C.s.*	2 *C.s.* lost	No change	1 *C.s.* lost
D3	No change	No change	No change	No change	No change
D4	No change	No change	No change	No change	No change?
D5	No change	No change	4 *C.s.* lost & 1 new	No change	1 *C.s.* lost
D6	No change	No change	1 *C.s.* lost	No change	1 new *C.s.*
E1	No change	No change	1 *C.s.* lost & 1 new	No change	1 *C.s.* lost
E2	1 new *C.s.*	No change	No change	1 *C.s.* lost	No change
E3	1 new *C.s.*	1 *C.s.* lost	No change	No change	1 *C.s.* lost & 2 new
E4	1 *C.s.* lost	No change	1 *C.s.* lost	1 *C.s.* & 1 *L.p.* lost	1 new *C.s.*
E5	No change	No change	1 *C.s.* lost	2 *C.s.* lost	1 *C.s.* lost
E6	1 new *C.s.*	1 new *C.s.*	1 *C.s.* lost	No change	1 new *C.s.*
F1	No change	2 *C.s.* lost	No change	1 new *C.s.*	1 *C.s.* lost & 1 new
F2	No change	No change	1 new *C.s.*	1 *C.s.* lost	No change
F3	2 new *C.s.*	1 *C.s.* lost	No change	No change	No change
F4	1 *C.s.* lost	1 *C.s.* lost	No change	No change	1 *L.p.* & 1 *C.s.* lost/ 1 *L.p.* revealed/new?
F5	No change	No change	No change	No change	No change
F6	No change	3 *C.s.* lost	1 *C.s.* lost & 1 new	3 *C.s.* lost	1 *C.s.* lost
Changes:					
Leptopsammia pruvoti	lost:1	no change	lost:1	lost1	(lost:3, 1 new/ revealed): -2
Caryophyllia smithii	(lost:8, new:7):-1	(lost:23, new:5):-18	(lost:17, new:5):-12	(lost:12, new:3):-9	(lost:14, new:9):-5
% change:	<1%	17.5%	14%	12.3%	7.8%

Total 1984:	*Caryophyllia smithii*:	104	*Leptopsammia pruvoti*:	30
Total in 1991:	*Caryophyllia smithii*:	59	*Leptopsammia pruvoti*:	25
Total change:		-45		-5

Figure 2. Sketches of corals present in the "cup coral count area", site 1, Gap Point, in 1984 (above) and 1991 (below)

(Open circles are *Leptopsammia* and solid spots *Caryophyllia)*



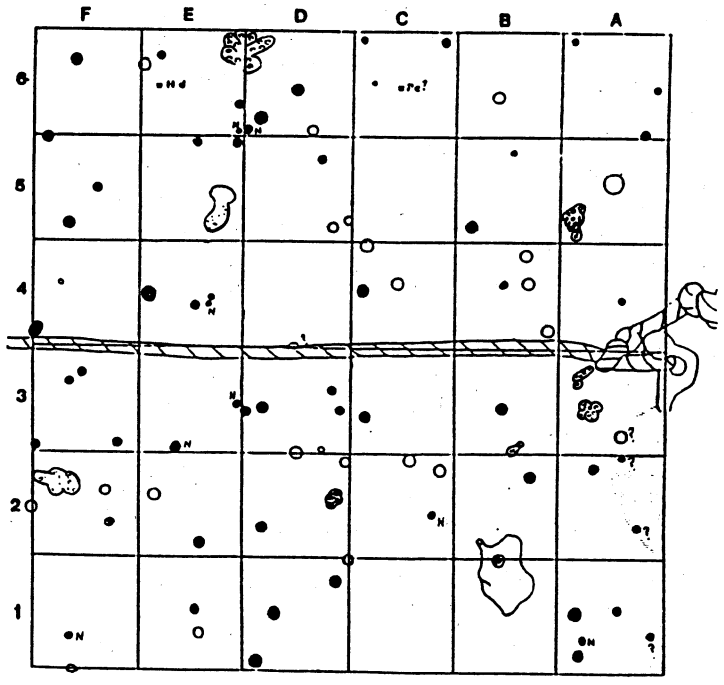
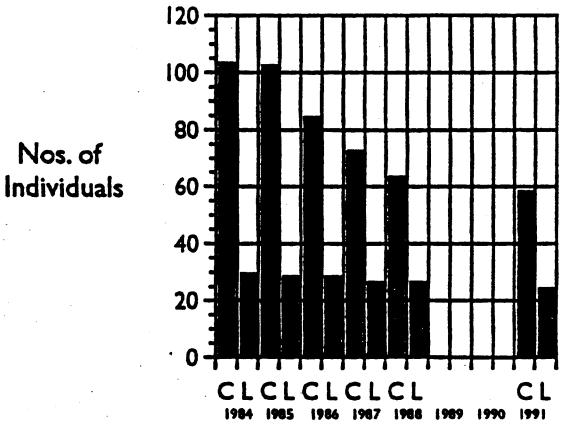


Figure 3. Time/frequency histogrammes for numbers of cup corals in 30x30 cm² quadrat at Site 1, Gap Point

C: Caryophyllia, L: Leptopsammia



the area and settlement of only 29 new individuals. This reduction took place mainly between 1985 and 1988. These observations are in contrast to those made on the Lundy Marine Reserve Knoll Pins population, which has remained much more stable.

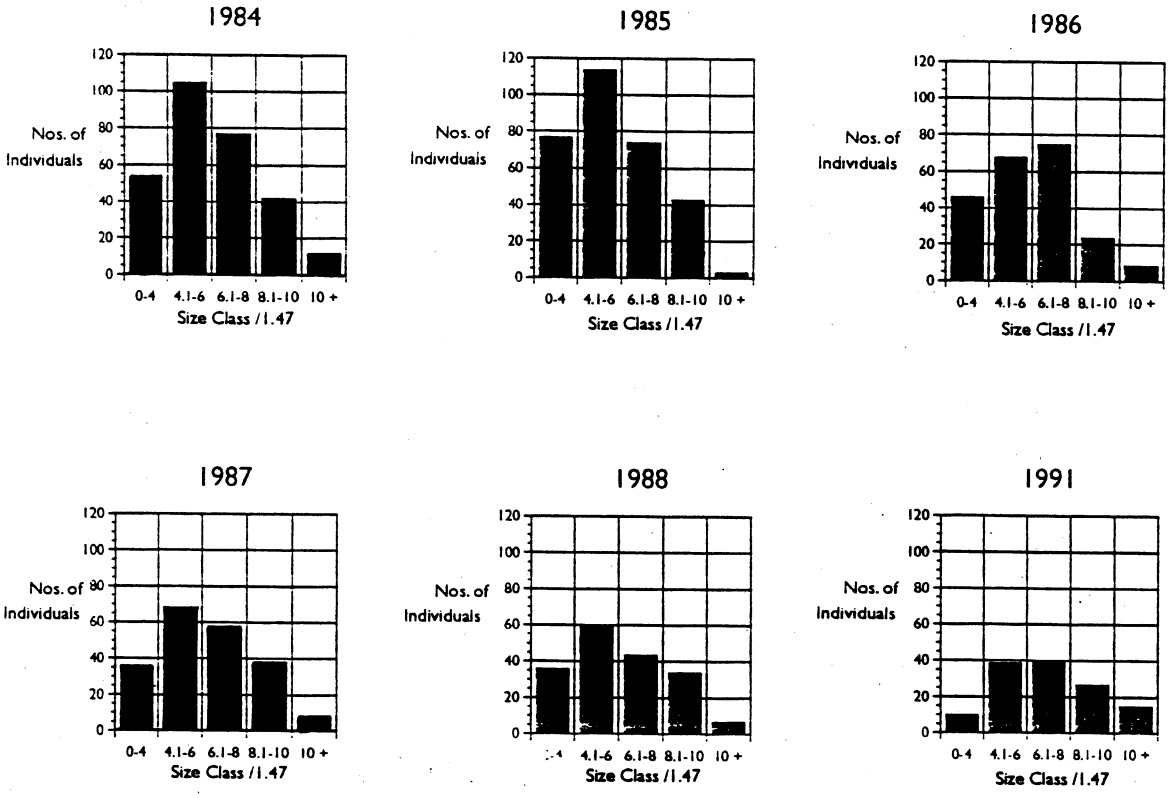
Figure 4 presents data from a much larger area of 0.759 m2 at site 1 and shows how the population size structure has also changed, with fewer small corals being present as the population declines. These size measurements were taken from the photo-mosaics produced for each year. The number of corals measured from this larger area of the photo-mosaic varies from year to year because of the incomplete nature of the photographic coverage and quantities of silt and bryozoan/hydroid turf on the rock face obscuring some areas, as well as a result of the falling population. Thus 1985 was the year of the best photographic coverage and more corals were measured on this year than on any other, although the numbers in the smaller cup coral count area were very similar. The information in Figure 4 is therefore incomplete and should be read in conjunction with the data from Table 2. In particular, it may under-represent smaller corals to a greater extent where these are obscured by other organisms. It was, however, felt that size data should be taken from a larger population to provide a better picture of changes. The very similar *C. inornatus* has also been recorded from this site, but is very difficult to distinguish from *C. smithii* and no attempt has been made to differentiate the two.

Site 1 appeared to be much clearer of hydroid and bryozoan growth in 1991 than in previous years, with the result that some sessile organisms were more easily recognisable than had previously been the case. Among these were small clusters of cup corals tentatively identified as *Hoplangia durotrix*. Many more were fully visible than in previous years, although close examination of former photographs showed that these had always been present, although not formerly so easily identifiable. Little or no changes were observed in the size and numbers of these corals. These cannot be identified definitely from photographs and specimens from rock faces adjacent to the monitoring sites should be taken for confirmation. Their clumped distribution and lack of growth during the study period do not suggest that these are small *C. smithii*, for small specimens of the latter present in 1984 can be seen to grow markedly during the course of the monitoring programme.

Bryozoa

Growth and break down of colonies of *Pentapora foliacea* was observed at Site 2. This growth was of an order of 3 cm per year and therefore took place quite quickly in comparison with other organisms present. The colony was also observed to 'move around' as a result of this growth and contraction.

Figure 4. Size frequency histogrammes for *Caryophyllia smithii* at Site 1, Gap Point, from 1984 to 1991



6. *Zostera marina* monitoring

6.1 Methodology

Three sites were visited during the 1991 monitoring survey: English Island, the Bryher-Tresco-Samson channel and Old Grimsby. The severe storms in 1989 and 1990 had washed out some of the *Zostera* beds and the permanent markers installed at the first two of these sites were no longer present, although that at the Samson site (a subsurface buoy attached to a buried engine block) was reported to have remained in place for more than two years (Cyril Nicholas, pers. comm.). The English Island bed was not visited regularly by C. Nicholas and it was not known when this marker had been lost. The Old Grimsby site had not been marked on the previous visit because it had never been possible to relocate markers here in the past, possibly because this site is well-visited and markers are likely to be removed.

Following discussion on the methodology to be used for the *Zostera* monitoring, it had been decided to discontinue the counting, cutting and measurement of shoots in quadrats, which had been initiated to monitor the 'health' of the beds. The data collected in this way during previous surveys now provided a considerable baseline of information on variation in shoot size. General searches of the *Zostera* beds, observations and photography of flora and fauna associated with the habitat and collections of plants for the herbarium was considered a sufficient record for the purposes of the monitoring programme, together with the mapping of the outline of the *Zostera* bed at English Island from a central marker to observe localised changes in this apparently stable habitat. However, when plants infected by the micro-organism *Labyrinthula macrocystis* were observed in the *Zostera* beds, it was decided to undertake counts of infected and healthy plants in 0.25 m2 quadrats.

At English Island, the marker had been near the outer edge of the *Zostera* bed. Reduction in size of the bed as a result of storm damage meant that the location of the original monitoring area was no longer within the area occupied by *Zostera*. Panoramic viewpoint photographs of the *Zostera* beds in shallow water were taken from the boat. A replacement marker (a spiralled metal rod, 'curly-wurly') was inserted in a similar position near the new outer edge of the eel grass bed. Mapping of the extent of the *Zostera* around the marker was undertaken using a 20 m tape run out on the eight main compass bearings, thus covering an area of 40 m in diameter (see Figure 5). This work took up most of the time available at low water at this site and shoot counts in quadrats to examine the proportion of diseased to healthy plants could not be undertaken, but general searches and photography were carried out by snorkelling and *Zostera* specimens (both healthy and diseased) were taken for the herbarium.

At the other two sites, no attempt was made to insert new site markers, but underwater photographs were taken, counts of healthy and diseased plants made in quadrats and samples taken for the herbarium. Surface photographs were taken at Samson to show the extent of the *Zostera* beds seen from the boat. Poor weather conditions meant that less time was spent on this part of the work than desirable and it was not feasible to install a new marker at Samson and map the baseline of present *Zostera* distribution around it. Table 3 gives the list of photographs taken during *Zostera marina* monitoring in 1991.

Table 3: List of *Zostera marina* monitoring photographs taken in 1991

Photo Nos	Site	Description
SCY/Zm/91/1 to 91/11	English Island	Surface views of *Zostera* beds
SCY/Zm/91/12 to 91/20	English Island	Wide angle underwater views of *Zostera*
SCY/Zm/91/21 to 91/41	Samson	Wide angle underwater views of *Zostera*
SCY/Zm/91/42 to 91/63	Samson	Close-ups of *Zostera*
SCY/Zm/91/64 to 91/69	Samson	Surface views of *Zostera* beds
SCY/Zm/91/70 to 91/77	Samson	Wide angle underwater views of *Zostera*
SCY/Zm/91/78to 91/125	Old Grimsby	Wide angle and close-up underwater views of *Zostera*
SCY/Zm/91/126 to 91/134	Old Grimsby	*Zostera* wasting disease close-ups

Figure 5: Sketch map of *Zostera marina* distribution at English Island

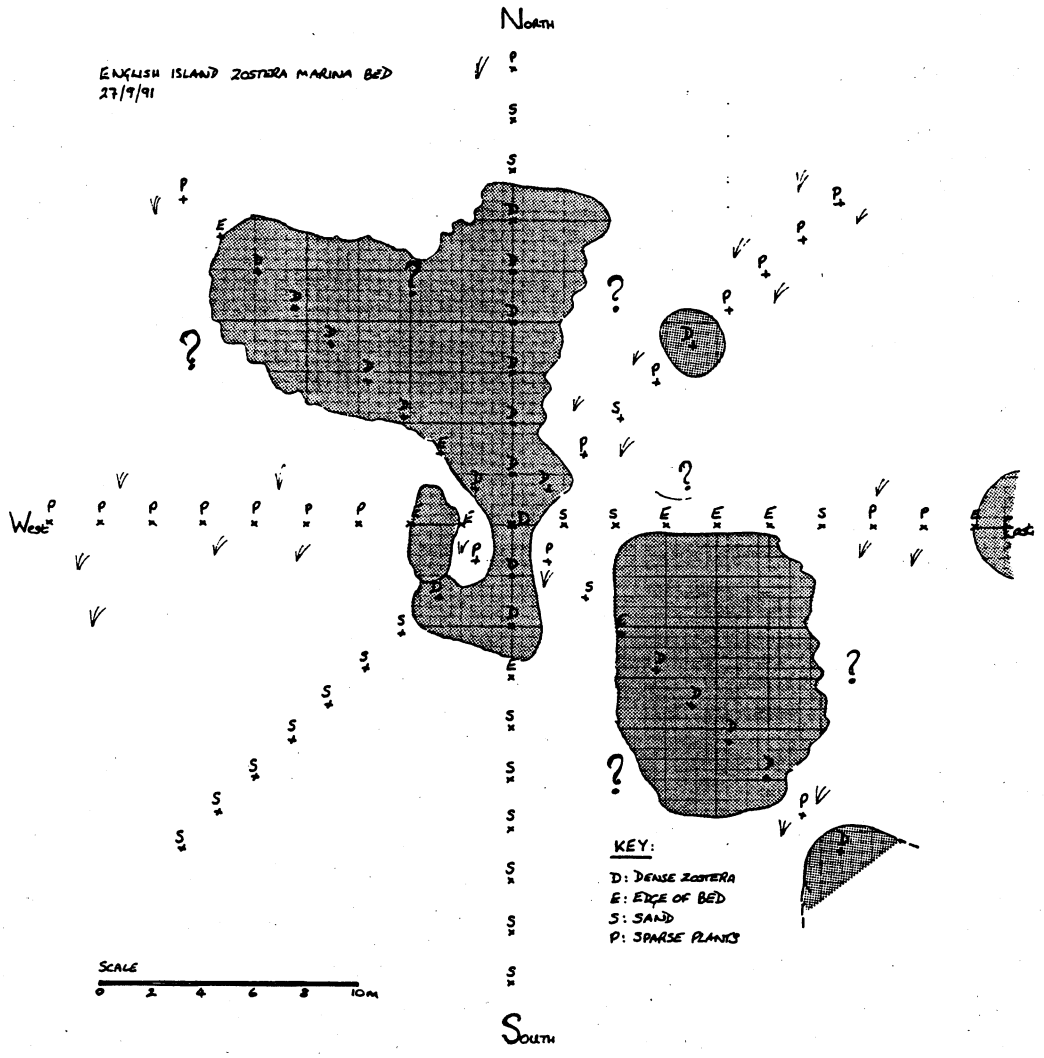


Table 4: Counts of healthy and infected *Zostera marina* shoots (numbers in 0.25 m^2 quadrats):

No. of shoots	No. infected	% infected
Samson-Tresco Channel		
12	4	33.3
7	1	14.3
16	4	25.0
13	7	58.8
8	2	25.0
16	12	75.0
15	2	13.3
26	4	15.4
16	1	6.3
17	7	41.2
23	0	0
22	4	18.2
179	**48**	**26.8**
Old Grimsby Harbour, Tresco		
14	7	50.0
15	5	33.3
17	9	52.9
11	2	18.2
20	5	25.0
9	3	33.3
17	2	11.8
11	4	36.4
18	2	11.1
16	5	31.3
12	1	8.3
9	1	11.1
169	**46**	**27.2**

6.2 Results

Initial observations from the surface indicated that the *Zostera* beds in the vicinity of the monitoring site at English Island had apparently contracted towards the shore, probably as a result of serious storm damage in 1989 and 1990 (Cyril Nicholas, pers. comm.). The beds had also become more patchy in extent than in previous years. When snorkelling, signs of the probable former extent of beds further offshore were apparent in the form of raised areas of consolidated coarse sand and gravel, with a few very sparsely scattered small plants remaining. A sketch of the distribution of *Zostera* around the new marker at English Island is presented in Figure 5. It was not possible to assess the effects of storm damage at the other sites, since the precise locations of the monitoring sites were not known and the marker at Samson had been lost.

Within the *Zostera* beds, other changes were immediately apparent. The non-native brown alga, *Sargassum muticum* (Jap weed) had become established at all the sites visited. This species had not been present during the 1988 survey, but the plants seen were generally up to a metre long and estimated to be scattered at a minimum of about four metres apart. The larger plants were probably in their second year of growth. No shading effects on *Zostera* plants were apparent.

Although the *Zostera* beds appeared healthy, with flowering occurring in a similar proportion of plants to that seen in former years, infection by the micro-organism *Labyrinthula macrocystis* was observed throughout all of the *Zostera* beds visited during the survey and also in many drift plants picked up on the St. Mary's harbour beach after the storm. This infection is apparent as black lesions on young blades as well as on old and decaying plant material. There were also some possible signs of lysis of cell walls visible within new leaves. The infection had not been observed on the previous visit in 1988 at the same time of year, although carefully searched for, using the descriptions and illustrations of the symptoms of the disease presented in Short *et al.* (1988) from material collected during the major outbreak of *Zostera* wasting disease in the 1930s and the new outbreaks recorded over the last decade. Samples of diseased plants were confirmed as having the disease (den Hartog, in lit. 1991).

With the exception of the invasion of *Sargassum muticum*, the flora and fauna of the *Zostera* beds appeared very similar to that seen in previous years. All the divers, however, noticed numbers of a small green wrasse with pale lateral stripe which was apparently previously unknown to them and not remembered as having been seen in Scilly on former visits. This fish was particularly abundant at English Island, but present at all the *Zostera* sites visited. Unfortunately no photographs or specimens of these fish were obtained for purposes of identification. A tentative identification of *Labrus turdus* the green wrasse, a species of Mediterranean sea grass beds, was made in the field report on the basis of its marked similarity to a published photograph of the latter (Dale Rostron, pers. comm.), but there are no records of this from the UK. The fish could have been a juvenile form of *Labrus bergylta* ballan wrasse not previously noted during surveys in the Scillies (G Potts, in lit.). Without a specimen, no firm identification is possible.

7. Conclusions

During the three year period between the monitoring visits in 1988 and 1991, only very slight changes had taken place in the deeper sublittoral sites. The stable circalittoral communities at Gap Point described in previous reports were remarkably unaltered, although Fowler and Pilley (in preparation) describe and assess changes in more detail than has been undertaken in this report. Devonshire cup coral *Caryophyllia smithii* populations have declined considerably, but this rate of decline is slowing.

The most notable result at Gap Point is probably the apparent recruitment of *Leptopsammia pruvoti* to the population at Site 1. Settlement of young *Leptopsammia* has not been recorded since the start of the NCC marine monitoring programme in 1984 and the mainly old, large individuals are slowly being lost from the site. Any recruitment would have to be from the local population, since *Leptopsammia* planulae spend only a short time in the plankton (Hiscock and Tranter, pers. comms) and the Islands are very isolated from any other potential sources of recruits. Unfortunately it cannot be ascertained whether this new recruitment took place during the summer of 1989, 1990 or 1991. It would be most useful to know the precise age of these individuals if successful settlement is to be linked to climatic events (i.e. higher summer temperatures stimulating reproduction in a species at the northern limits of its distribution) and their growth rates observed and interpreted in the future. Settlement of this species has apparently not been previously observed in the wild in Britain (although corals taken from the sea in 1978 produced planulae and very small *Balanophyllia regia*, another Mediterranean cup coral, were recorded by Hiscock on Lundy in 1970, but not since). No information is available on growth rates of young corals of known age or even on the ecology and life cycle of these species in the centre of their range in the Mediterranean. Such data is necessary for defining and justifying the management needs of species of high nature conservation interest.

As a result of storm damage, the *Zostera* beds had been altered to such an extent that the markers for the 'permanent' monitoring sites were lost and their overall extent much reduced. Unfortunately the time scale during which these changes have occurred and the precise events which caused them are not recorded. Additionally, the non-native seaweed *Sargassum muticum*, which had not been present in the beds in 1988, is now well established in some areas. Some presence of *Sargassum* had been reported prior to the 1991 visit, although not quantified.

Of greatest concern is the presence in all the sites surveyed on Scilly of signs of the micro organism *Labyrinthula macrocystis* associated with *Zostera* wasting disease. This was not recorded during the 1988 survey, but it is not known whether it became established in 1989, 1990 or 1991. The opportunity to record the initial rate of progress of the disease has therefore been lost. The reason for the original outbreak and the present resurgence of this disease has been discussed by many authors and reviewed by Short *et al.* (1988), who suggest that an external environmental factor, possibly climatic, initiates an epidemic caused by a widespread pathogen which is otherwise present at low harmless levels. These causative factors may be low levels of insolation, extremes of precipitation, long-term increases in

water temperature, long-term changes in ocean circulation (such as the Russell cycle) and/or local causes such as pollution. Some of these possible causes can be ruled out on Scilly, which is not affected by coastal (mainland) temperature changes, pollution or fresh water run off. This leaves oceanic temperature changes and major regional fluctuations in weather patterns as potential causes of stress, so that Scilly provides a useful control site for examining the progress of *Zostera marina* wasting disease in comparison with mainland areas.

The loss of information which has resulted from the lack of monitoring in Scilly in 1988 and 1989 is most unfortunate, particularly since it arose during a period when the uncertainties about the effects of climatic change and the possible consequences of global warming were being debated. The presence of species at the northern edge of their range suggests that their distribution may be influenced by climatic factors, such as sea water temperature. Recruitment in populations such as those of *Leptopsammia pruvoti* in Scilly may become more frequent if sea water warming does take place and, if studied, could provide a means of following changing marine conditions. *Zostera marina* beds may also be subjected to more damage if stormy conditions become more common or temperature changes stimulate disease. Thus, some of the observations in Scilly in 1991 could in the future possibly be attributed to and linked with the changes associated with, for example, the Russell cycle or oceanic warming.

The provisions for Marine Nature Reserves in the Wildlife and Countryside Act (1981) state that such areas "should be managed ... for the purpose of conserving marine flora or fauna...; or providing ... special conditions for the study of, and research into matters relating to marine flora and fauna..." Indeed, conservation management requires research to be carried out in order for species and communities of high conservation interest to be sufficiently well understood for management aims to be defined. Hiscock (1989), discussing the importance of this sort of information for management of marine ecosystems on Lundy, states that: "Studies of climate, the biology of species and effects of change need to be enhanced, not terminated. Management requires understanding of key information on longevity, growth, recruitment and other factors." It is most important that English Nature continues to undertake and promote marine research programmes at such sites to answer the questions posed when considering marine reserve management.

The results of the marine monitoring programmes at Lundy Marine Nature Reserve and the Isles of Scilly are being analysed and assessed in more detail by Fowler and Pilley (in preparation), who will make detailed recommendations for future marine reserve monitoring programme in their report. The following provide some interim recommendations for the Isles of Scilly, but these should be reassessed when the above report is available. Consideration will also need to be given to other aspects of monitoring, such as assessment of site management objectives, although interpretation of these will also be dependent upon continued information from surveillance programmes monitoring natural change.

8. Interim recommendations

1 The necessity of continuing the Isles of Scilly monitoring programme should be drawn to the attention of the relevant sections of English Nature as soon as possible, to ensure that the research programme in 1992/93 is planned to accommodate the budget necessary for this work. Plans should also be made for detailed marine monitoring in 1992 not only to be undertaken in the Isles of Scilly, but also in the Lundy Marine Nature Reserve. Additionally, funds should be made available as soon as possible to investigate the spread of *Zostera marina* wasting disease on the mainland.

2 Because of the difficulty in obtaining temperature data from the Met. Office since the automation of the Light Vessels, it is suggested that English Nature installs continuous data loggers at Gap Point in the Isles of Scilly and in the Lundy Marine Nature Reserve. These will provide essential data for any existing and future research studies in these sites.

3 Funding should be made available to enable the aerial photography of the Isles of Scilly *Zostera* beds during low water spring tides to be repeated. This must be undertaken as soon as possible, before any further storms cause additional changes. This record will provide a new baseline in case the wasting disease causes mass mortality of plants, as occurred during the disease outbreaks in the 1930s.

4 The other country agencies should also be alerted to the results of this survey, particularly with respect to the *Zostera marina* wasting disease and the Skomer Marine Nature Reserve Monitoring Programme, so that their marine monitoring programmes can be planned with these results in mind.

5 The very stable nature of the southwestern species and communities under examination in Scilly and at other sites in southwest Britain are ideal for such long-term monitoring programmes. English Nature should seek to establish and maintain such a programme at a network of sites in Britain and investigate means of contributing results from these studies to similar European projects, perhaps through the COST 647 programme.

9. Acknowledgements:

My thanks to the survey team: Roger Covey, Dan Laffoley and Dale Rostron for their help and hard work in the field, and to Cyril Nicholas for boat handling and pin-pointing each monitoring site so precisely. Mrs Hicks of the Belmont Guest House made our stay very comfortable and allowed us the run of her kitchen for slide processing until late at night. Greg Pilley waded through hundreds of slides as part of the overall monitoring analysis contract and made analysis of the 1991 results much easier as a result.

10. References:

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Hiscock, K and Howlett, R. 1976. The ecology of *Caryophyllia smithii* Stokes and Broderip on southwestern coasts of the British Isles. In: Drew, E.A., Lythgoe, J.N. and Woods, J.P. (eds). *Underwater Research*. London Academic Press. Pp 319-345.

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Appendix 1

Survey Log: Isles of Scilly Subtidal Monitoring 1991

Team members:

DL Dan Laffoley, English Nature, Peterborough
RC Roger Covey, Joint Nature Conservation Committee, Peterborough
SF Sarah Fowler, The Nature Conservation Bureau, Newbury
DR Dale Rostron, SubSea Surveys, Pembrokeshire
CN Cyril Nicholas, English Nature boatman, Isles of Scilly

Tuesday 24 September 1991

DL and RC departed Peterborough early pm, arrived Newbury 1530 to collect SF and set out again at 1600. Evening meal en route and arrived in Penzance at 2115. DR already at the guesthouse. Calm seas in Mounts Bay, heavy rain overnight.

Wednesday 25 September

Sunny weather, westerly force 2-3.

Departed guesthouse at 0830 and offloaded gear at quay into containers. Scillonian III sailed at 0915, arrived on time after smooth crossing. Equipment offloaded into store or sent up to Belmont Guesthouse by Island Carriers. Cyril Nicholas met team on quay and took remaining gear up to Belmont, where the day's dive plan was discussed. *MV Melza* came in to the quay at 1415, gear loaded up and departed for first dive at Gap Point. Anchor, line and buoy put down on the transit marks. DR and DL dived first to find anchor near large boulder at entrance to the main study canyon, a short distance out from transects 1 and 2. Started roping up site 1 and tried unsuccessfully to find site 2 nearby and buoy at entrance to gully (the latter no longer in place). SF and RC dived second. Tide running made descent a little hard with buoy pulled under the surface and anchor dragged a little. Site 2 roped up successfully (although one piton rather corroded), but the last piton on site 1 was difficult to find and this site not completed, nor photography undertaken. Anchor secured among small boulders at entrance to the gully. Returned to harbour and equipment offloaded by 1800. Dinner out at the Galley (met Russell and Sara Gomm on holiday). Cameras prepared for the next day and batteries charged. Logs written up.

Thursday 26 September.

Mainly sunny, but with some clouds and occasional rainshowers and squally in the morning. Wind NW 2-3. Low water 1320.

Left harbour at 0915 and went to Gap Point. DL and DR dived first, DL with wide angle at site 2 and DR with close-up and slide film at site 1. DR put in an additional piton on the bottom line of site 1 and started photography, but film apparently not winding on (and camera later found to be flooded). RC dived next (with SF as standby) and took close up slide film of site 1.

Moved on to the English Island *Zostera* bed, which was very patchy in comparison with previous years and had many holes (after serious storms since the last monitoring survey which had also removed all previous markers). Signs of the possible former extent of beds further offshore were raised areas of consolidated sand and gravel with very sparsely scattered small plants. *Sargassum* plants of 2-3' were scattered through the bed at a minimum of 12' apart (none had been present in 1988). The *Zostera* in the main part of the bed was flowering and looked healthy at first sight, with usual associated flora and fauna, although some signs of blackening of young leaves was seen and possible signs of lysis of cell walls in small patches on close inspection. [The blackening appeared very similar to the photographs of diseased plants from Roscoff and New Hampshire published by Short *et al.*, 1988]. Some wide angle photographs taken. Left English Island at ~12.30 to avoid going aground at low water and moored in the Eastern Isles for lunch and to check cameras. Flooded camera put into bucket of fresh water after batteries and film removed. Returned to Gap Point. SF dived (with standby) with print film and closeup to make record of detailed cup coral count area at right hand side of site 1. New (since 1988) small *Leptosamnia* found in this area. A few photos of the *Parazoanthus* colony

at site 2 also taken and piton for subsurface marker at entrance to canyon also located (buoy and line missing). RC dived (with standby) with closeup and slide film to complete slide record of site 1. Returned early to harbour. Print film taken in to the chemist for processing. DL, SF and RC called in on Peter Murrish in the Environmental Trust office on the way back while DR transferred the flooded camera into alchol and began the drying out process (leak suspected in lens, not body).

Dinner in at 1800, then wrote up and did processing. First test film (RC's closeup) was almost completely blank (virtually unexposed). Next two films done were SF's *Zostera* film (which was fine) and the other closeup of site 1 (also underexposed - possible flash synchronisation or shutter problem?). Final film was processed (wide-angle from site 2) and found to be OK. Completed at about 2400. Team down to one NCC camera and SF's brought as spare.

Friday 27 September

Fine sunny day, with little cloud in the morning. NW force 3. Clouded over pm and sharp afternoon showers turned to steady rain in the evening. Low water at 1400.

Morning at Gap Point. RC re-photographed half of site 1 with slide film. DL took more wideangles at sites 2 and 1 (repeated), then SF completed site 1 with closeup. After two hour surface interval from RC's first dive, RC and DR dived to check *Eunicella* mapped on the 1988 survey and site 3. Only 3 *Eunicella* found, but buoys in second canyon were still present. Insufficient time to photograph sponge monitoring site.

Moved to English Island pm and DL embedded curly-wurly marker at the new monitoring site. Mapping of this new site was completed with some difficulty in strong tide which flows east at low water. *Zostera* specimens showing signs of disease were collected.

Returned to Gap Point and SF did second dive (with standby) on left hand section of site 2 with closeup lens and slide film. Also found a possibly previously unrecorded *Eunicella* near the large rock in the canyon entrance. Returned to harbour at 1655 in time to collect print film of site 1. Dinner at Belmont followed by processing of four films taken that day and mounting and labelling of previous day's slides. Storms overnight.

Saturday 28 September.

Weather fine in the morning with very light winds after previous night's storms, as Scilly lying in the centre of the low pressure system. Wind increased from the east in the afternoon. Low water 1445.

At Gap Point in the morning, where a swell was coming in from the east and visibility had decreased markedly. DL and RC dived to take up the temporary transect lines and clear the anchor for removal. One of transect lines mislaid in the murk. SF and DR dived next to do more *Eunicella* photography, but had difficulty in finding sites in the poor visibility and only found two *Eunicella*.

Moved to the Samson-Tresco channel near the site marked in 1988 (marker lost in 1990). Photographs taken and the proportion of healthy to diseased plants recorded in 0.25m^2 quadrats, with samples taken. Back early as easterly wind increased. Slide mounting and labelling and *Zostera* pressing in the evening. Dinner out at the Mermaid. Storms overnight up to force 10 from the east.

Sunday 29 September

Easterly storms and strong winds moderated slowly during the day to northerly force 6. No fieldwork undertaken. CN retrieved sunken punts in the morning, while diving team processed, mounted and labelled slides, then went for a windswept walk to view Gap Point from the shore. Called in at Porthloo Terrace on the way back and looked at Diane Nicholas' photographs of the construction of the airport extension. Began packing up in the evening, dinner out.

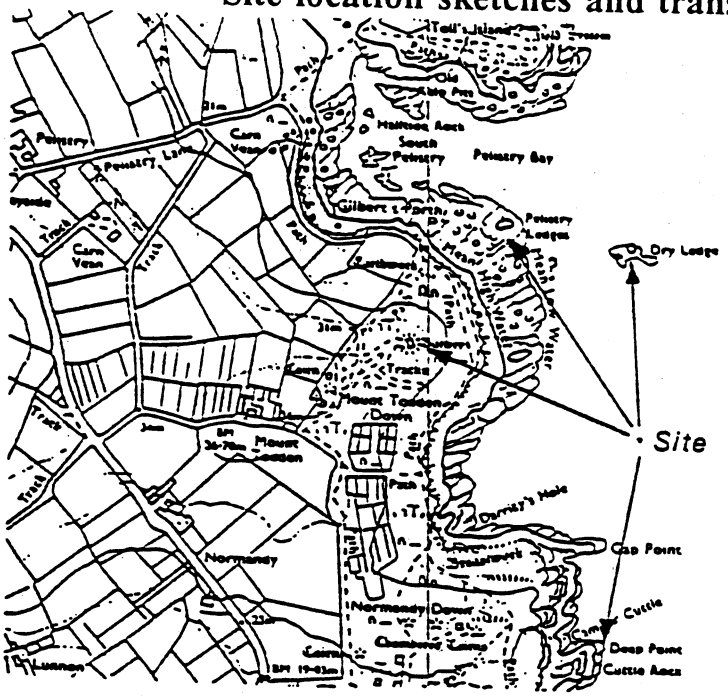
Monday 30 September

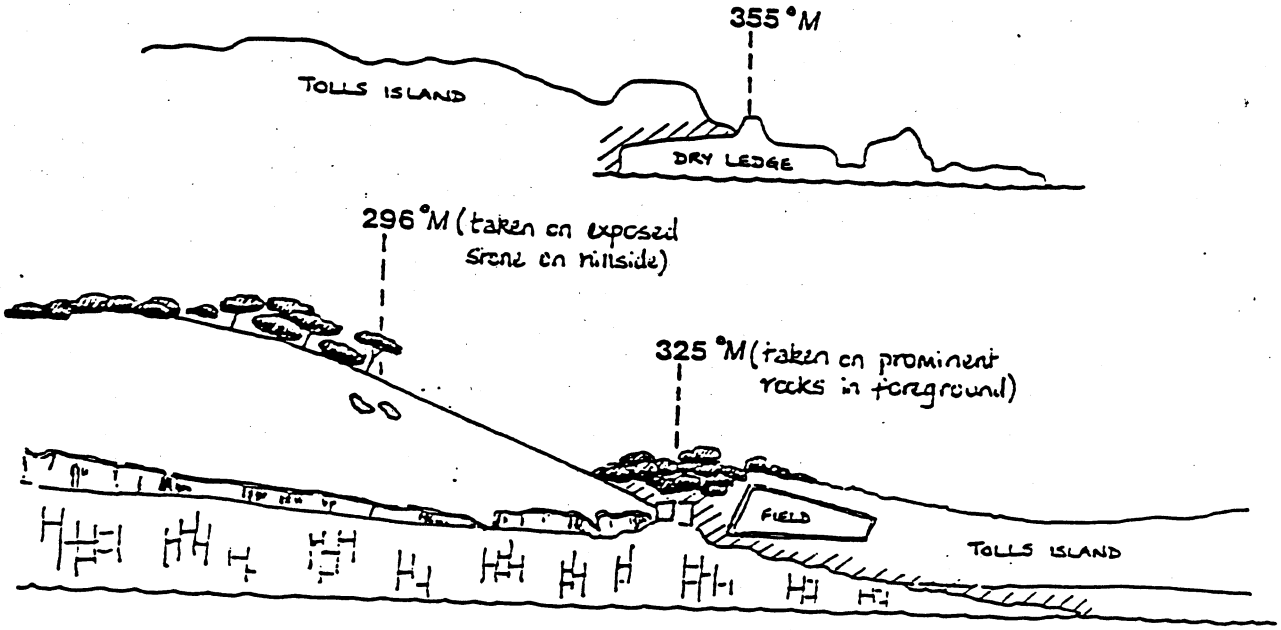
Fine morning weather, sunny and light winds. Winds increased during the afternoon and rain set in.

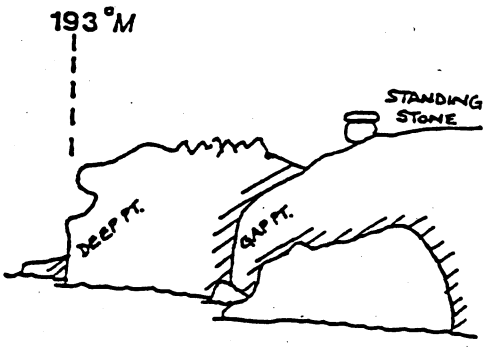
Went to Old Grimsby to look at the *Zostera* bed there. Healthy and diseased plants counted in 0.25m^2 quadrats and photographs taken. Returned to the quay and met Ray Lawman, packed up and went for short walk in the rain before catching Scillonian III which departed at 1645, but arrived at Penzance late in driving rain and wind. Met by Stephen Warman who helped with unloading and car packing. DL and RC set off for Peterborough and DR for Pembroke. SF went with SW for meeting on Fal CZM the next day.

Appendix 2

Site location sketches and transits

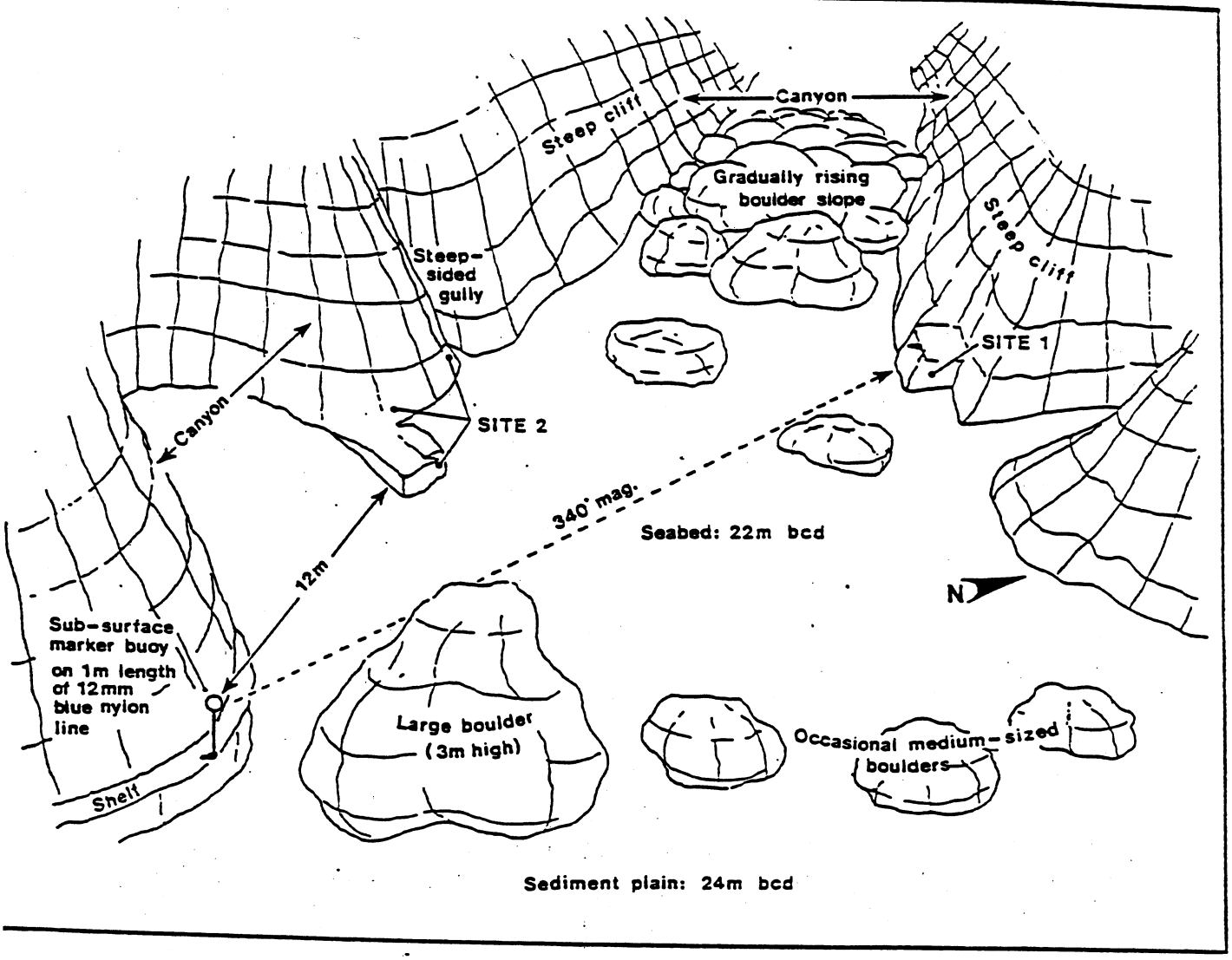




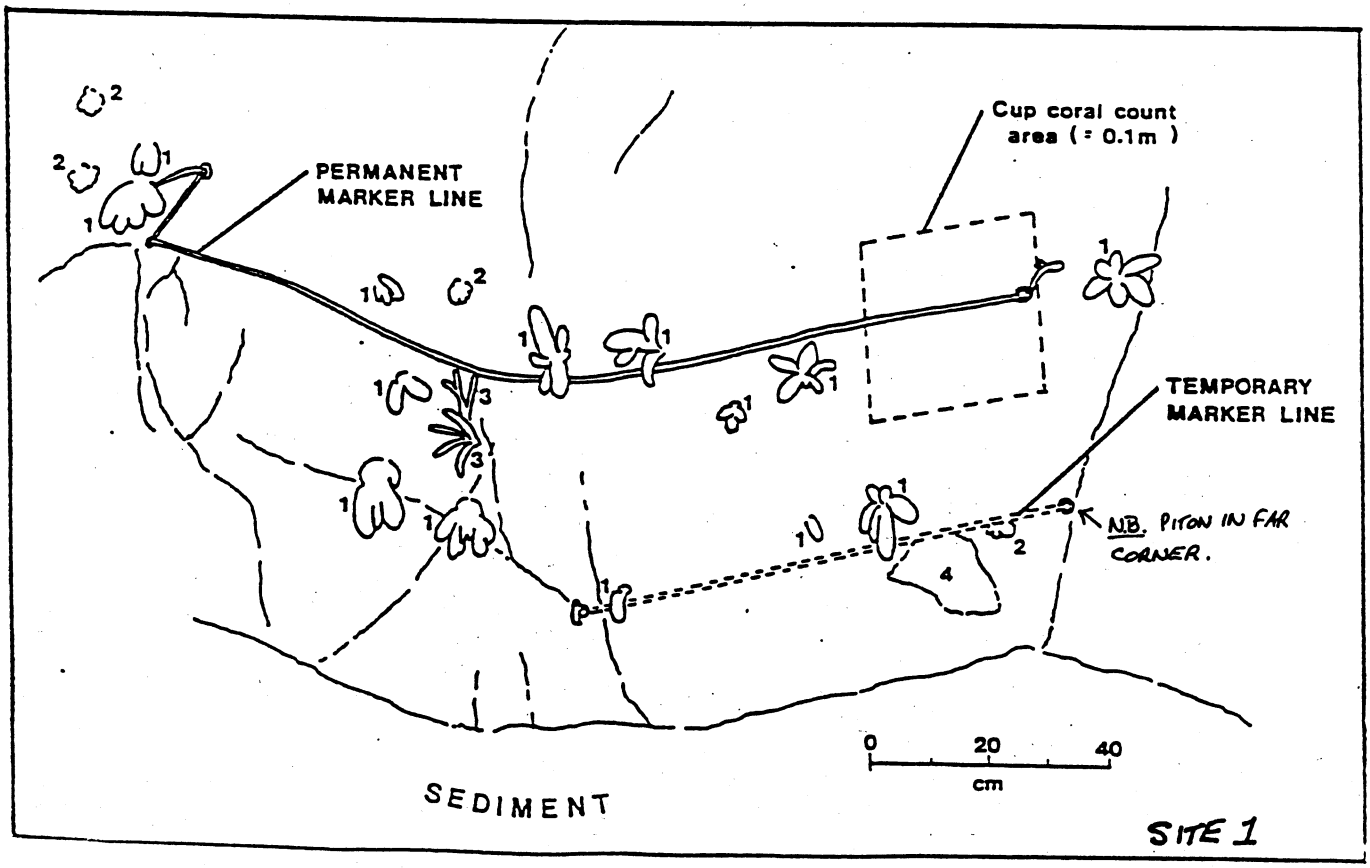


(M = Magnetic)

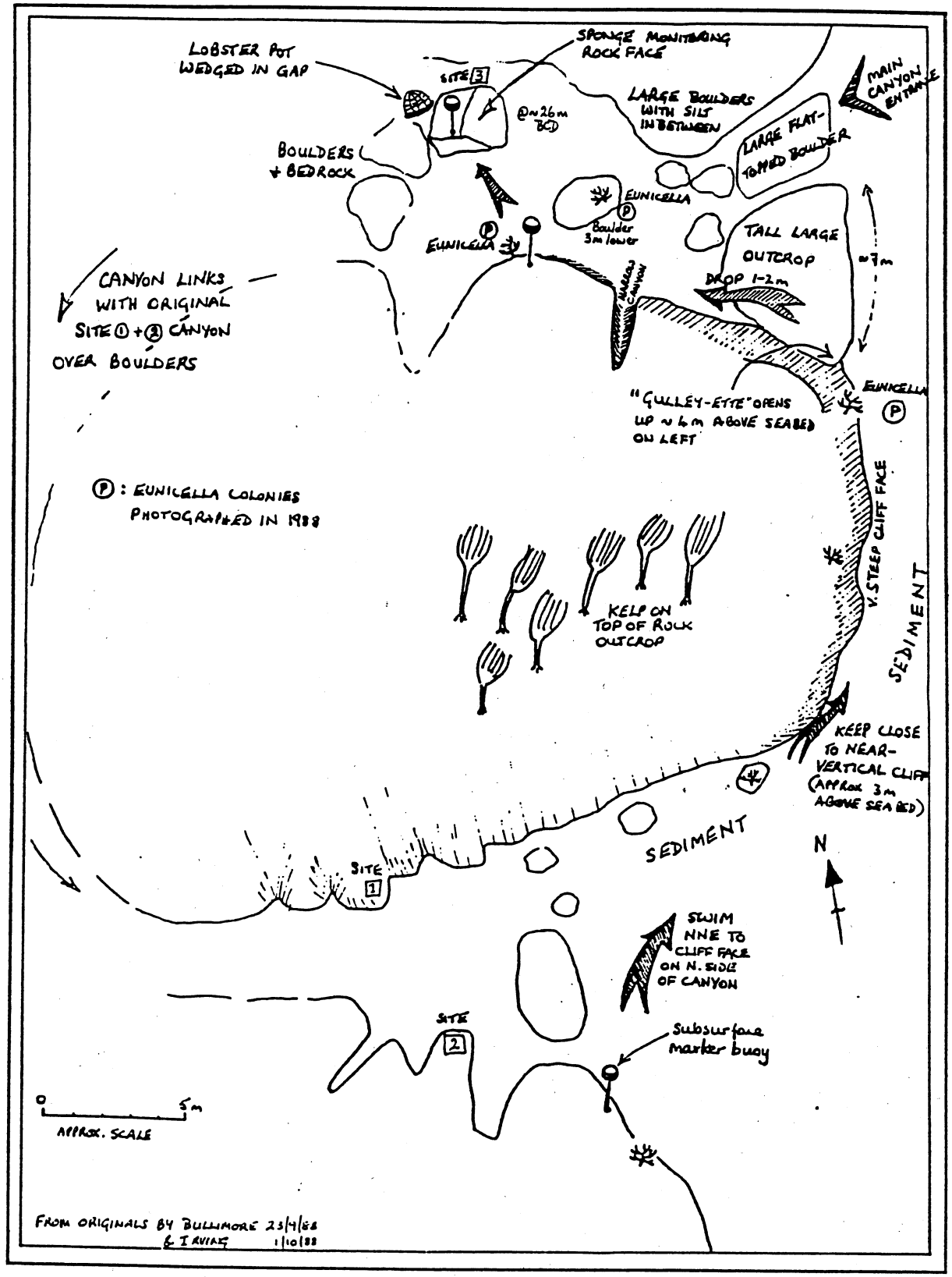
Transit marks and bearings for the re-location of the monitoring site north of Gap Point, St Mary's.

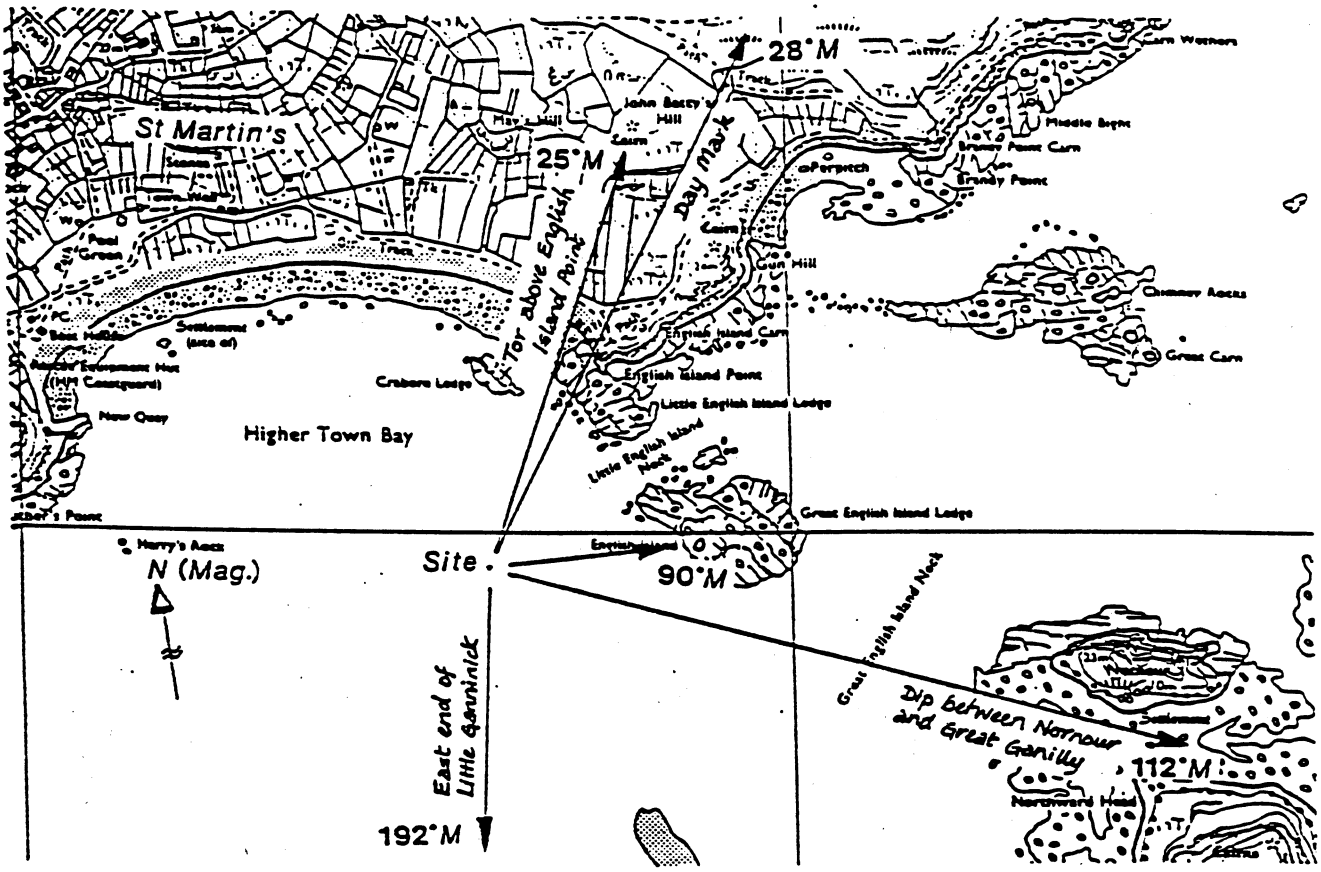


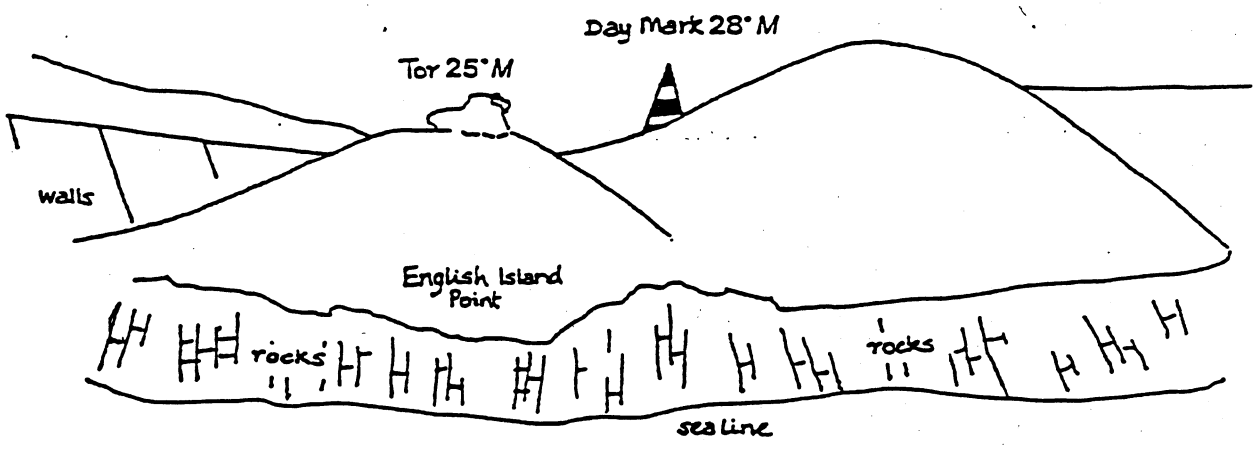
Sketch to show re-location of Site 1 and Site 2, N Gap Point.



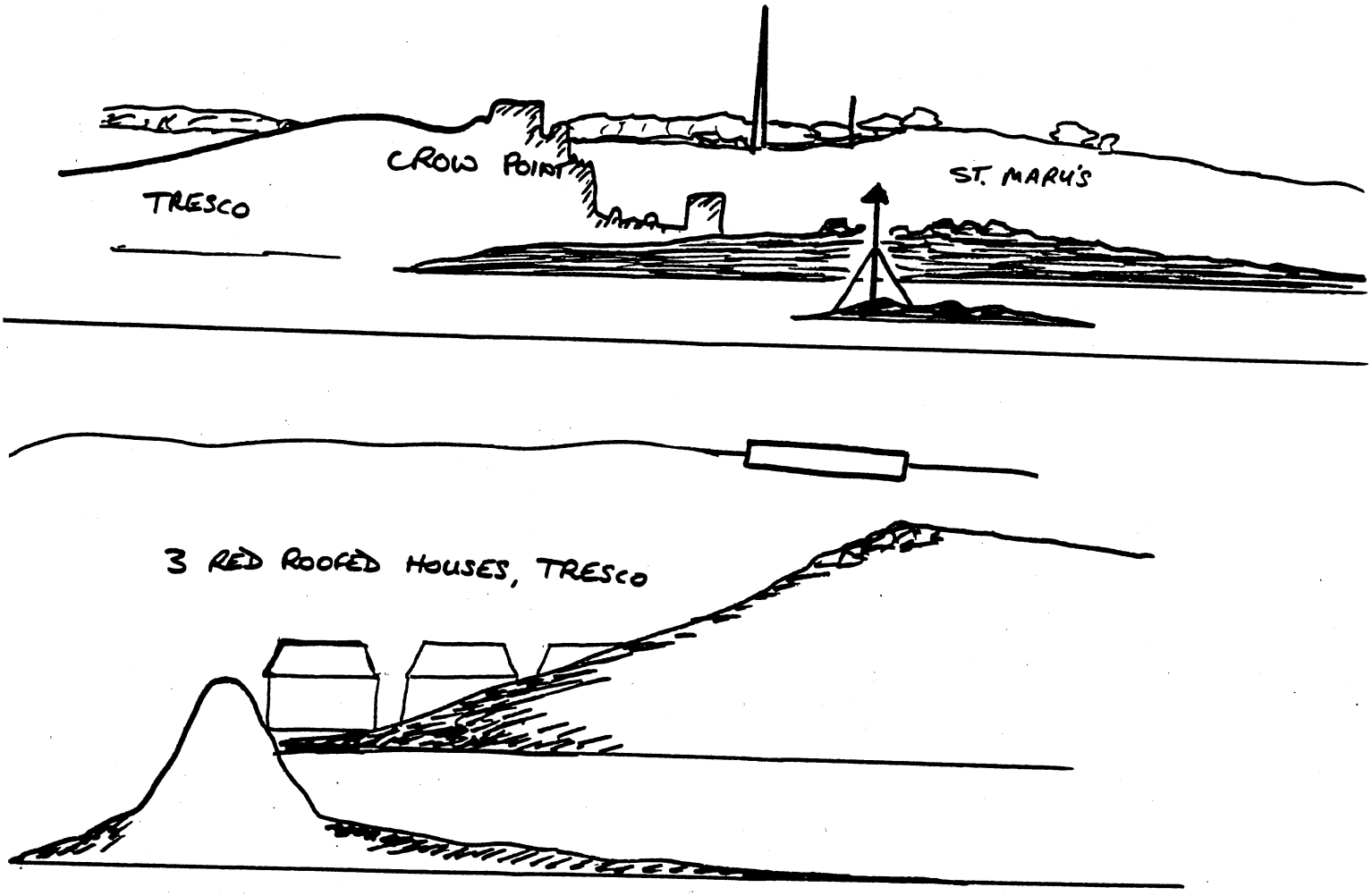
Location sketch for site 3, Gap Point







Transit marks and bearings for the re-location of the Zostera monitoring site at English Island, St Martin's.



Sighting marks for the Samson Zostera marina bed examined in 1991.