INITIAL RESULTS FROM THE LUNDY SUBLITTORAL MARINE MONITORING PROGRAMME 1984 - 1990

By

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INTRODUCTION

In 1984, the Nature Conservancy Council established a programme of littoral and sublittoral monitoring studies at Lundy in order to determine the management requirements of the proposed Marine Nature Reserve around the island. These studies were designed to provide information on long term changes in community structure, and the life history (particularly longevity and growth rates) and ecology of marine species of high nature conservation interest.

This paper summarises some of the findings of a report assessing the results of the monitoring programme, as commissioned by English Nature (Fowler and Pilley 1992). Their brief, amongst other specifications, included an analysis of the data (largely in the form of photographic slides) collected since 1984, from both the littoral and sublittoral work undertaken at Lundy and also from similar studies undertaken at the Isles of Scilly. This paper is solely concerned with the sublittoral monitoring studies carried out at Lundy. All tables and figures which appear here are taken from the Fowler and Pilley (1992) report.

RATIONALE

Besides identifying potential marine nature reserve sites for designation, the Nature Conservancy Council (and its successor agency, English Nature) was obliged to manage these sites to conserve their special features. For this to be done, and to determine what the appropriate management requirements of certain marine communities are, it is first necessary to find out as much as possible about these communities, the natural dynamics of their component species and their ecological requirements.

As Hiscock (1985) explains, "Decisions regarding management of marine areas must be based on sound knowledge of the dynamics of the communities being conserved and the likely degree of disturbance that is acceptable. A highly changeable community where species are recruited rapidly and die quickly is much less vulnerable to disturbance that one which is composed of very long-lived, slow-growing species with poor or no recruitment". Photographic monitoring over a long timescale can provide an assessment of species' growth rates, longevity, recruitment potential, their vulnerability to environmental change and any impact on them of man's activities.

The waters around Lundy host a surprising number of colourful Mediterranean-Atlantic species rarely encountered elsewhere in the British Isles (Hiscock 1984); their centres of distribution, in fact, lie far to the south of our waters. Indeed, the presence of these species was a major contributory factor in establishing a marine nature reserve around the island. Although regarded as being of high nature conservation interest because of their rarity, little else was known about these species and communities, and consequently the monitoring studies concentrated on them. Most of these species are part of the circalittoral communities found off the sheltered east coast of Lundy, favouring deep vertical rock surfaces close to silty sediment.

Additionally, during this same period, searches were undertaken for populations of the red band fish *Cepola rubescens*, whose burrows are found in muddy gravel at relatively shallow depths off the east coast. As this work is reported elsewhere (Irving 1989), it is not covered here.

METHODS

Systematic photographic sublittoral monitoring was initiated at the Knoll Pins in August 1983, although some viewpoint photographs of a small cave at this site had been taken in 1981. Here, at about 15m below chart datum, are found a number of Mediterranean-Atlantic species including the rare sunset cup coral *Leptopsammia pruvoti*, the zoanthid anemone *Parazoanthus axinellae* and the red sea finger *Alcyonium glomeratum*. A similar community exists on the submerged cliff at Gannets Rock where monitoring of a vertical transect began in 1984. A community of sea fans *Eunicella verrucosa* and axinellid sponges (in particular *Axinella polypoides* and *Homaxinella subdola*) is found on silty boulders at the north end of Quarry Bay, and individuals here have been monitored since 1984. Counts have also been made of numbers of the sea slug *Tritonia odhneri* found on individual sea fans at this site. Finally, a transect running from shallow to deep water was established at the Knoll Pins to monitor algal depth limits. It was hoped these data could provide indirect information on changes in water turbidity, especially the levels of suspended silt in the water column.

The methods used to monitor these communities are discussed in detail elsewhere (Hiscock 1985; Fowler and Pilley 1992). After some initial experimentation, a standard method was adopted for the sites at the Knoll Pins, Gannets Rock and Quarry Bay sites, incorporating a frame-mounted camera taking overlapping pictures along a set, though temporary, transect line.

The sublittoral monitoring studies have taken place in late July to early August in consecutive years from 1984 to 1987 and in 1990. In 1988, studies took place in September, though no sublittoral monitoring took place in 1989, 1991 or 1992. English Nature are currently reviewing their marine monitoring programme, particularly to determine the most appropriate time intervals between visits to these monitoring sites.

The data produced by the sublittoral monitoring studies have been largely in the form of photographic slides. Subsequent analysis of these has been difficult and is very time-consuming, not least because of the varying quality of the photographs (often due to poor underwater visibility), incomplete area coverage or imprecise site re-location.

Overlapping colour prints of the close-up photographs taken at the Knoll Pins cave site were assembled into mosaics, allowing for the location of individual cup corals to be mapped out and their presence/absence compared from year to year. Difficulties arose with the variable appearance of expanded and contracted *Leptopsammia pruvoti* and *Alcyonium glomeratum* in different years, where protruding individuals created a flash shadow, or where bushy bryozoans (common at the Knoll Pins site) hung down from the roof of the cave and obscured other attached animals. In order to assess growth rates of sea fans and branching sponges, individuals had been photographed with a grid-marked board behind them. Photographs from successive years were then projected onto a single screen for comparison using a photo-mechanical transfer camera.

RESULTS

a CUP CORAL COMMUNITIES AT THE KNOLL PINS

All five species of cup coral which occur in the waters around the British Isles are found at Lundy; four of these are found subtidally at the Knoll Pins site. *Leptopsammia pruvoti* is the largest and its bright yellow colour makes it the most conspicuous. This species is only found at a handful of other sites around south-west Britain. The Devonshire cup coral *Caryophyllia smithii*, by contrast, is a more widespread species (its range extending to the cooler waters of northern Scotland) and is found in far greater numbers. Analysis of the photo-mosaics concentrated on these two species because *Caryophyllia inornatus* could not be reliably distinguished from *C. smithii* in all photographs and the colonies of the carpet coral *Hoplangia durotrix* were very small in 1984 with no changes being detected six years later. Similarly, no discernable changes could be detected in the small colonies of the pink sea finger *Parerythropodium coralloides* during the same period of time, although the differing amounts of expansion of its polyps make this difficult to ascertain.

The numbers of individuals and population densities of *Leptopsammia pruvoti* and *Caryophyllia (C. smithii* and *C. inornatus* combined) at the Knoll Pins site are given in Table 1. It can be seen that the total number of *Leptopsammia* fell by eighteen (equivalent to an annual loss of between 0.5% and 1.5%). No apparent recruitment of new individuals took place during this period, although it is possible that small corals may be obscured by luxuriant growths of faunal turf and cannot be distinguished on the photographs. Similarly, numbers of *Caryophyllia* may also be underestimates as many of these are small individuals (either small *C. smithii* or fully grown *C. inornatus*). However, total numbers appear to have fallen by about the same amount, though some recruitment of new individuals is known to have taken place. This decline is illustrated in Fig. 1, with densities of *Leptopsammia* and *Caryophyllia* populations at Lundy being compared to those from the monitoring site in the Isles of Scilly.

Table 1: Numbers and population densities of *Leptopsammia pruvoti* and *Caryophyllia* (*C. smithii* and *C. inornata* combined) at the Knoll Pins site.

	Leptopsammia pruvoti			*Caryohpyllia smithii & C. inornata* combined	
	No. in 0.817 m²	density/m²		No. in 0.817 m²	density/m²
1983	215	263.2	1983	-	-
1984	211	258.3	1984	-	-
1985	208	254.6	1985	265	324.4
1986	207	253.4	1986	262	320.7
1987	205	250.9	1987	243	297.4
1988	202	247.3	1988	266	325.6
1990	197	241.1	1990	247	302.3

The fifth species of cup coral is *Balanophyllia regia*, another Mediterranean-Atlantic species present only in the south-west. At Lundy it is found in small discrete populations on the low shore at Devil's Kitchen and Gannets Rock, accessible by foot only at low water of spring tides. Numbers of individuals at these sites have also gradually declined during the period 1970-1992 (Fig. 2), though recruitment of new individuals has taken place recently, between 1989 and 1992 (Fowler and Laffoley, in press).

Assessing changes in colonies of the red sea finger *Alcyonium glomeratum* has been difficult as their natural expansion and contraction can change the apparent size of a colony very quickly. Lateral growths near the base of some colonies may grow and develop into separate colonies. The same difficulties have been encountered when studying colonies of the zoanthid anemone *Parazoanthus axinellae*. However, one readily identifiable colony of *P. axinellae* has shown a decline in its number of polyps during the study period. In 1985 approximately forty polyps could be made out, but by 1990, only ten polyps were seen. This decline may be due to the obvious encroachment of two nearby encrusting sponge species on the *Parazoanthus* colony during this time.

It has also been possible to note changes to colonies of the sea squirt *Stolonica socialis* at the Knoll Pins cave site. Again, numbers of one particular group have declined (from twenty-two individuals in 1985 to zero in 1988) but a new small outlying group of three individuals was seen in 1987. It is possible these may be an outgrowth of the larger colony. Certain species of sea squirts are known to exhibit cyclic variation in numbers which have shown up during long-term studies (Lundalv *et al*, 1986) but studies at the Knoll Pins site have not been underway sufficiently long for any similar patterns to be identified.

b AXINELLID SPONGES AT QUARRY BAY

Photographs of individual erect sponges, backed by 2cm grids to facilitate

Figure 1: Average density of *Leptopsammia pruvoti* and *Caryophyllia* spp. at the Knoll Pins, 1983 to 1990; and *L. pruvoti* and *C. smithii* at Site 1, Gap Point, Isles of Scilly, 1984 to 1991.

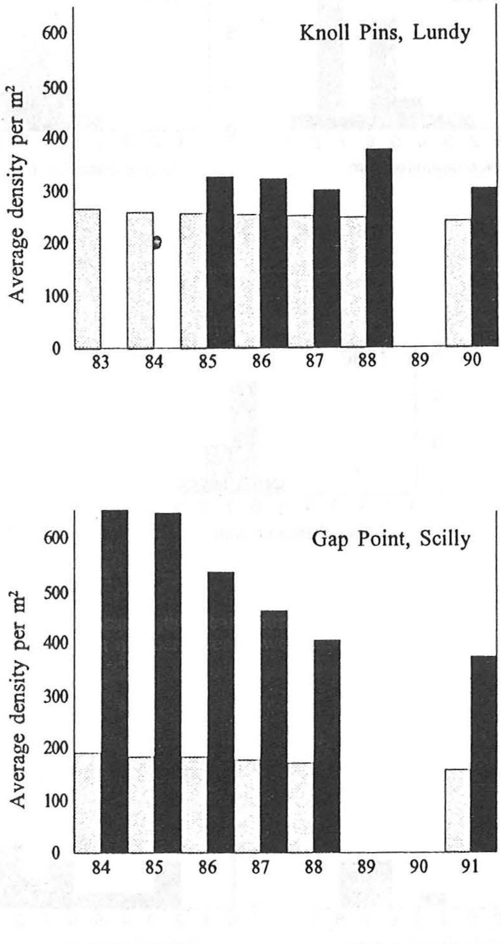
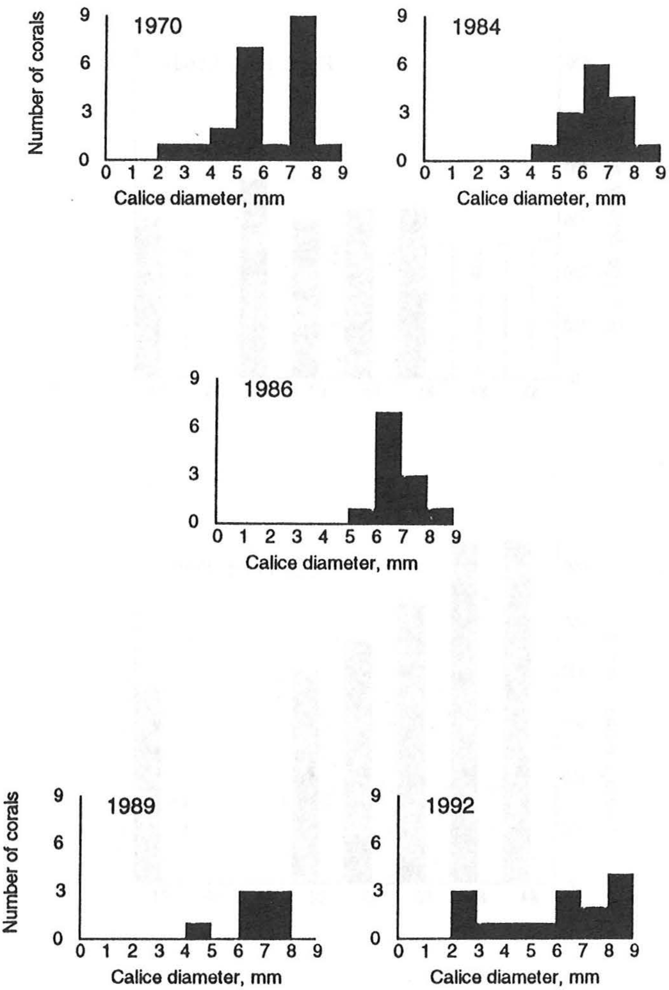


Figure 2: Size frequency distribution of the *Balanophyllia regia* population at the Devil's Kitchen monitoring site, Lundy, 1970 to 1989.



measurements, have shown growth rates in axinellid sponges to be irregular. Generally they grow extremely slowly, but in some years apparent shrinkage has occurred (Table 2 and Fig. 3). There have also been losses of branching sponges at this site, particularly in 1986 after strong easterly gales. No records of new individuals have been noted at this site.

Table 2: Measurements of axinellid sponge growth at Quarry Bay, Lundy. (Dimensions are taken from backing grids, maximum figures, cm)

Year		1984	1985	1986	1987	1988	1990
Axinellid	Height	8.9	10.2	7.6	9.6	-	8.7
1d	Width	4.2	3.8	2.7	4.2	-	4.8
Axinellid	Height	-	10.2	9.5	10.4	11.3	10.2
1e	Width	-	8.4	8.5	8.9	9.0	10.8
Axinellid	Height	2.0	4.0	2.4	4.0	-	2.2
2c	Width	1.2	1.2	2.1	2.0	-	1..9

c. *Eunicella verrucosa* SEA FANS AT QUARRY BAY

Comparisons of photographs of *Eunicella* using backing grids have shown very slow growth of individuals (Table 3 and Fig. 4). Growth takes place at the tips of certain branches at an average rate of 10 to 11mm per annum. This means certain large sea fans may be 40 years old or more. Several individuals have been adversely affected by drift seaweed and dogfish egg purses becoming entangled in their branches leading to local damage of the external living tissue.

Recording of numbers of the sea slug *Tritonia odhneri*, which are beautifully camouflaged amongst the polyps of *Eunicella*, has been inconsistent. Consequently no meaningful conclusions can, as yet, be drawn from this particular study.

Table 3: Growth study of a selected branch of *Eunicella verrucosa* 1b (all measurements in mm)

Year	1984	1985	1986	1987	1990
Total length of branch	270	392	525	686	Stump
Growth in previous year		122	133	161	
No. of growing tips	8	11	13	16	
Growth at each tip (Mean)		11.1	10.2	10.1	

Mean annual growth = 10.5mm/year

d ALGAL LIMITS MONITORING AT THE KNOLL PINS

It was hoped that studies of the lowest depths at which certain foliose algae are found would provide some indication of changes in turbidity levels in the water column. Such changes could be man-induced and arise from activities taking place some distance from the island (for instance sewage dumping, aggregate extraction or the construction of the Severn Tidal Barrage). They could also be caused by natural climatic variations, both in the long-term (for example, increased storm frequency), and in the short-term (such as the amount of cloud cover, plankton bloom, nutrient availability and water temperature). All these variables can affect algal growth to differing extents. Therefore, it is difficult

Figure 3: Sketches taken from slides of the sponge growth study at Quarry Bay, Lundy.

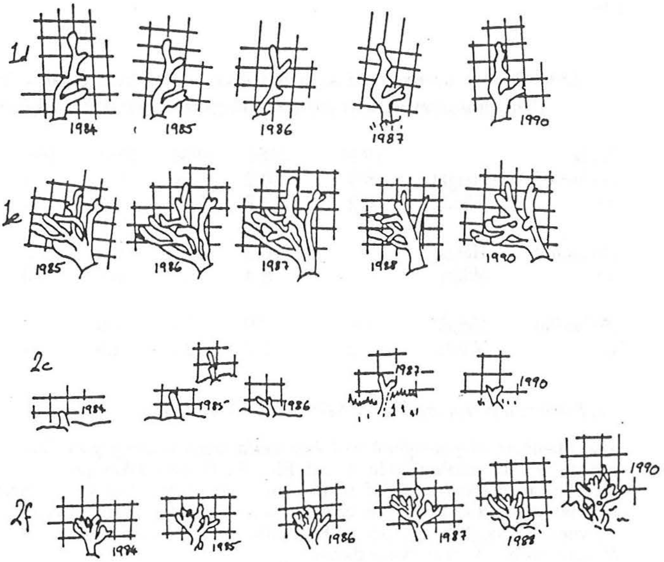
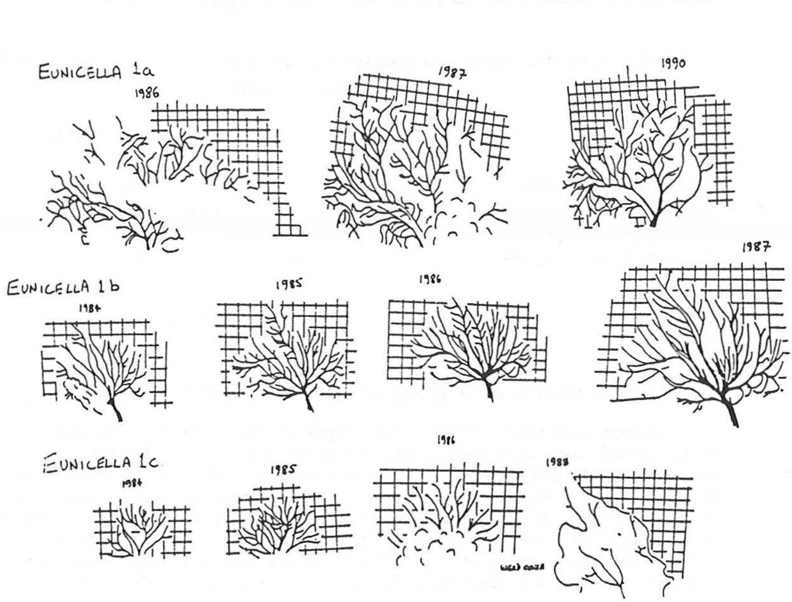


Figure 4: Sections of sea fans from the Quarry Bay Site, Lundy.



from the results obtained so far (Table 4) to detect any meaningful trends from these studies. However, when compared to records from the Isles of Scilly monitoring programme, it would appear that patterns noted so far are related to general climatic conditions in the south-west rather than local variation.

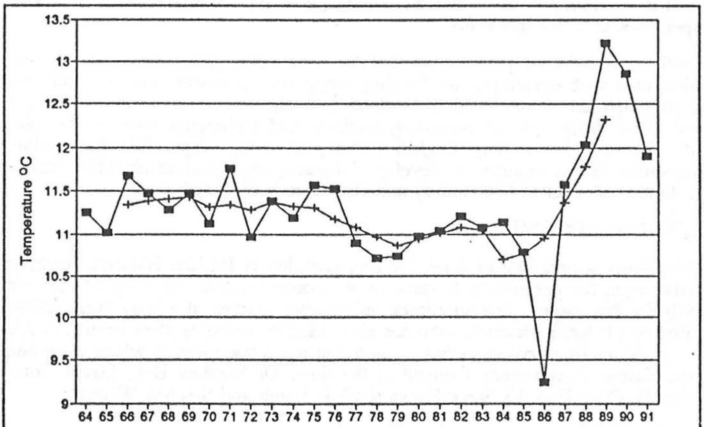
Table 4: Lower depth limit of the main algal zones at outer Knoll Pins (depths are given in metres below chart datum)

	1985	1986	1987	1988	1990	Mean
Lower Limit of Kelp	7.3	~7	10	-	-	8.1
Lower Limit of very dense foliose algae	11.5	~12	14	not surveyed		12.5
Lower Limit of fairly dense foliose algae	13.5	~13	18	-	14.83	
Lower Limit of all foliose algae	21.8	~22	22	22.8	21.5	22.02

e SEA TEMPERATURES

Sea temperature is likely to be an important factor affecting recruitment and survival of species near the northern limits of their distributions. Monthly means, maxima and minima sea surface temperature data were obtained for the Lundy area by Fowler and Pilley (1992) from the Meteorological Office Marine Advisory Service, Bracknell, as collected by staff on the St Gowan's Light Vessel, positioned at 50° 30'N 5°W, from 1964-1990 (Fig. 5). Unfortunately, no equivalent bottom water sea temperature data are available.

Figure 5: Annual and five-year running means for the St Gowans Head and Lundy area, 1964 to 1991



Fowler and Pilley (1992) state: "For the years leading up to the start of the monitoring programme, seasonal and annual temperatures fluctuated little, showing, for example, a range of approximately 0.5°C from 1977 and 1984. In 1985 and 1986 a change occurred, with mean temperatures decreasing to a record low in the winter of 1985/86 and ending 1985 slightly below the long-term mean. Following this unusual low, sea temperatures began to rise again, passing the long-term annual mean in 1988, and continuing upwards to reach a peak during the summer of 1989. Much of this rise can be attributed to unusually warm winters, which enabled temperatures to rise more than normal in spring and summer. Following the hot summer of 1989, temperatures began to fall to a more normal level and had returned to the long-term mean by 1991.''

CONCLUSIONS

The Mediterranean-Atlantic corals present near the edge of their range at Lundy are apparently very long-lived and slow-growing. They are part of sublittoral communities which appear very stable and show very little change during the period of study (Hiscock, in press). No new recruitment of *Leptopsammia pruvoti* has been observed at Lundy, though new, very young individuals have settled at the monitoring site in the Isles of Scilly between visits in 1988 and 1991 (Laffoley and Fowler 1992). This period also coincides with the highest average water temperatures for nearly twenty years and suggests higher sea water temperature may be significant in stimulating reproduction in *Leptopsammia*. The recruitment of young *Balanophyllia regia* at intertidal sites during the same period adds credence to this suggestion. The common and much more widespread *Caryophyllia smithii*, by contrast, has been observed to recruit regularly at the monitoring sites with individuals showing significant growth. It would appear that *Lepotopsammia*, being at the edge of its geographical range, puts more resources into growth and survival than breeding, hence their larger size and longer life span. With their planulae larvae known to be poor swimmers, the small population around Lundy is likely to be a self-sustaining one.

Populations of the sea fan *Eunicella verrucosa* are also likely to be self-sustaining. Significant numbers of these were taken as souvenirs by divers during the 1960s and 1970s and it is thought the populations at Lundy may not yet have fully recovered from this. Because of their slow growth rates they are of particularly high nature conservation importance. Similarly, individuals of the two soft coral species *Alcyonium glomeraturm* and *Parerythropodium coralloides* are thought to be slow-growing and very long-lived. The erect branching sponges too are very slow-growing, with some even shrinking in size. It is interesting to note that this shrinkage in size coincided with the cooler water temperatures of 1985 and 1986.

Finally, it should be pointed out that the monitoring programme was designed and implemented with constraints on funding, equipment, personnel numbers and their time. The large amount of information obtained from the results so far is a testament to the sound initial design of the recording methods and techniques used in this pioneering work. The results will help English Nature, the body responsible for marine nature conservation in this country, to develop and justify management objectives and controls on activities relevant to both Lundy and elsewhere in the south west.

ACKNOWLEDGEMENTS

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