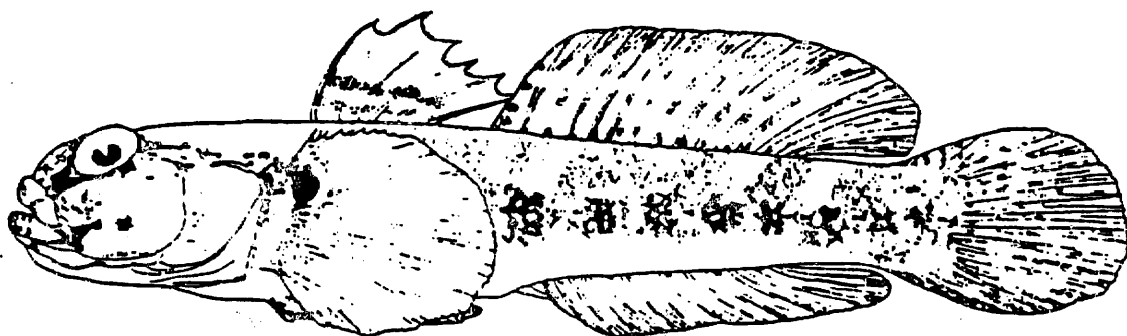


HELFO RD RIVER SURVEY

MONITORING REPORT NO.1



CBRU

SIBTHORP
EUROPEA
CORNISH
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CORNISH
BIOLOGICAL
RECORDS
UNIT

SUSAN HOCKING

1989

Cover drawing:

Couch's Goby (Gobius couchi Miller & Tawil 1974)

reproduced from the Journal of Zoology, 174. p 546, by
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This fish was described as new to science from specimens
discovered in the Helford River in 1974.

It is still present but in considerably reduced numbers.

The maps with this document are based upon the
Ordnance Survey Maps with the sanction of the
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A Report

to the South West Region of the Nature Conservancy Council
from the Cornish Biological Records Unit
with additional funding from the World Wide Fund for Nature

HELFORD RIVER MONITORING SURVEYS

Report No.1

Sue Hocking

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January 1989

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FOREWORD

Just two years after the 1986 survey of the Helford River was completed, it has been possible to monitor some of the transects. To undertake fieldwork, as well as compare and evaluate the results, we have been fortunate in obtaining the services of Mrs Susan Hocking who, with Mr Roger Covey, prepared the first Report. The opportunity has been taken to reproduce in the present Report, the data from all the 1986 transects, whether or not they were re-recorded in 1988.

Sadly, the deterioration of the intertidal fauna and flora, described in 1986, has continued. On rocky shores there is no sign of recovery of dog-whelk populations affected by TBT paints. On soft substrates the eelgrass has vanished intertidally, with associated effects on fauna, whilst cockle, mussel, wrinkle and razorfish populations are still comparatively low. It is now known that the eelgrass (Zostera) is suffering a decline in America and Europe due to a diseased state which is believed to be exacerbated by stress conditions (Appendix 4).

Since the completion of the 1986 survey (Covey & Hocking, 1987), a Report to the Nature Conservancy Council has been completed (Rostron, 1987). This includes offshore as well as onshore survey notes. The vulnerability of the area is emphasised as is the possibility of restoration, given increased public awareness and concern following the River's status as a Voluntary Marine Conservation Area.

The Working Group, under the direction of the Advisory Group, is continuing to take various measures consonant with the voluntary nature of the Conservation Area, its avowed aim being "to achieve by voluntary means, the harmonious use of the river and to monitor the quality of the marine environment." These measures include the production of a leaflet incorporating guidelines for users (Appendix 5); the involvement of local schools in projects; collaboration with South West Water's campaign to improve disposal methods of farm waste and sewage; endorsement of Kerrier District Council's speed limits on the River; encouragement of further legislation to limit TBT paints; backing any measures to preserve fish stocks; partaking in any scientific investigations relating to the health and wealth of the River (e.g. Zostera investigations by the University of Nijmegen), monitoring dog-whelk populations by the Marine Conservation Society and providing material to the Nature Conservancy Council's work in evaluating sheltered marine environments in the U.K.

During 1989, it is anticipated that permanent bolts will be drilled into the rock at the shoreward end of each transect, this being more satisfactory than the present method of paint spots. In the autumn of 1989, it is hoped that the transects which were not visited in 1988, will be re-surveyed, and in 1990, all will be re-surveyed. The aim is to carry out biennial surveys, with sublittoral work in intermediate years.

v

The 1986 survey was funded by the World Wide Fund for Nature and Heinz 'Guardians of the Countryside' (through WWF) with an additional donation from the Duchy. The present Report was conducted by the Cornish Biological Records Unit on contract to the Nature Conservancy Council, the cost of production coming from WWF. In addition WWF is making further funds available for research and management. Some of this money will be used to mark permanently the transect lines in the Helford River.

We are grateful to the above organisations for their continued interest and support.

*Norman Holme and Stella Turk, Scientific Advisors to the VMCA

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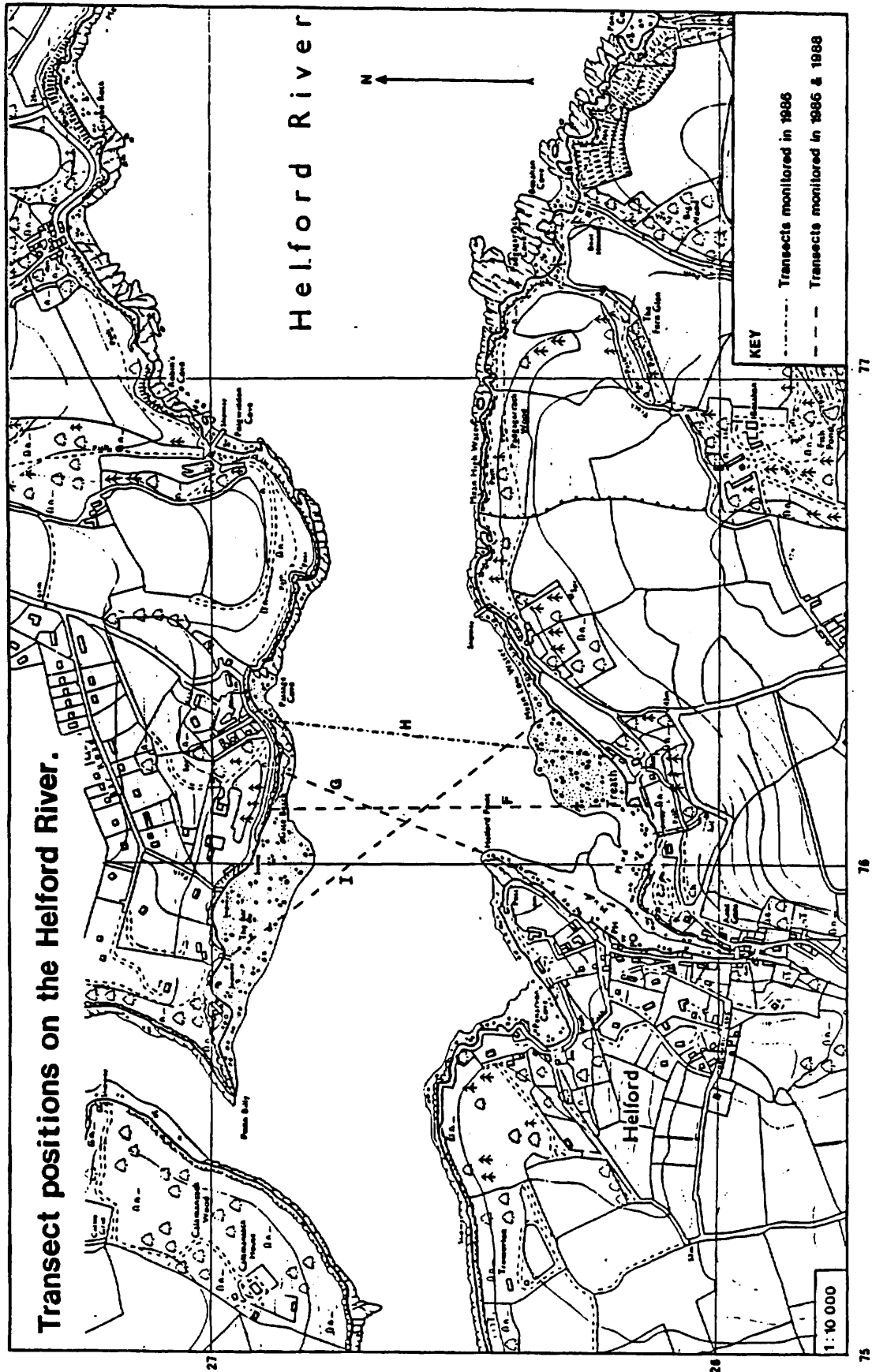
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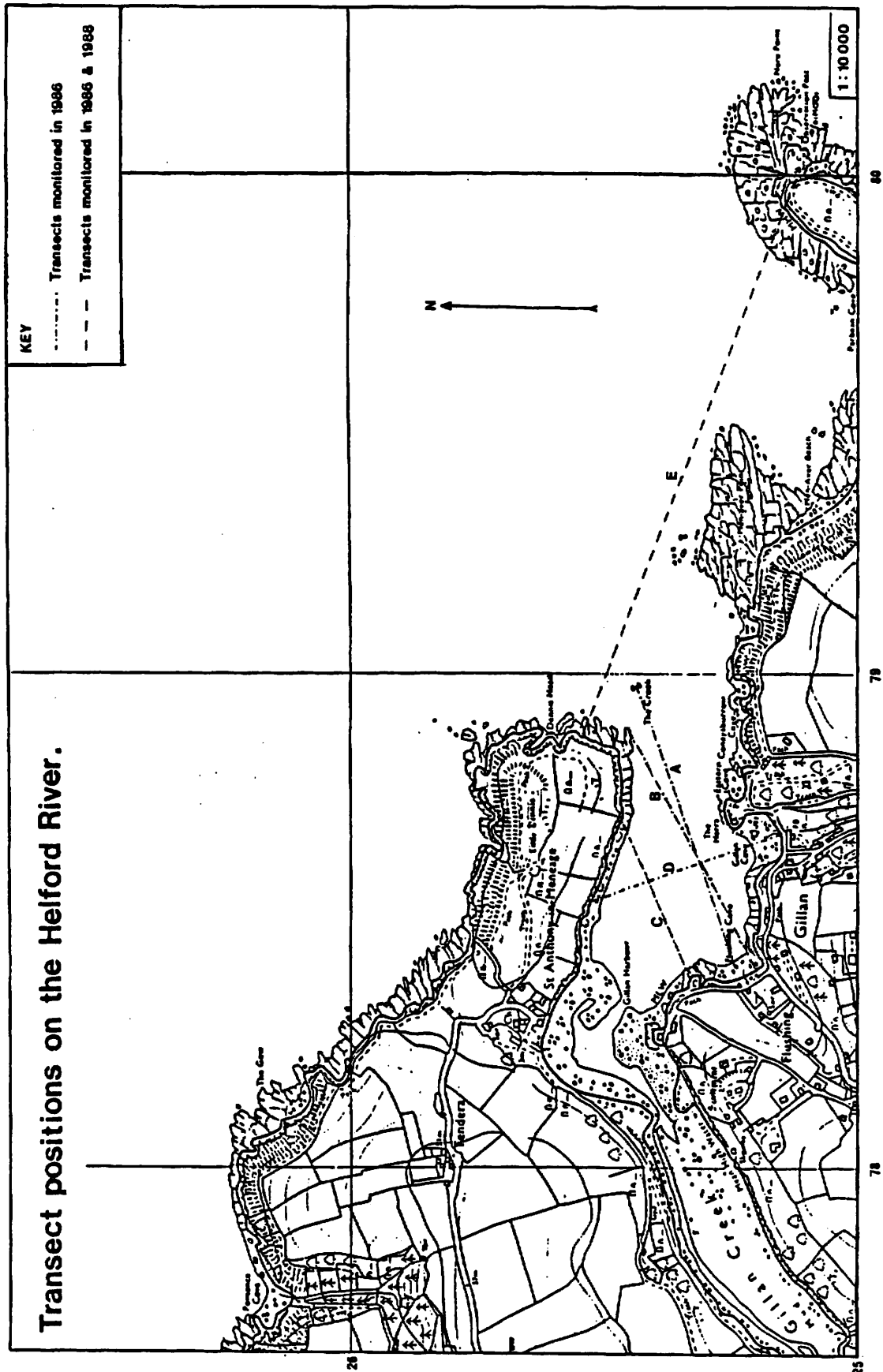
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*It is with sadness and a sense of real loss that the Group
 reports that Dr. Holme died on 10th January. He retained his
 interest in the welfare of the River to the very end: indeed one
 of his last conscious acts was reading through the Foreword to
 this Report a week before his death.





1.

ABSTRACT

The data from transect monitoring in 1988 is compared with the findings of the 1986 Helford River Survey.

Even though the time interval between the two surveys is short, three main trends have emerged. Most notable is the total disappearance of intertidal Zostera marina, a general decrease in numbers of Lanice conchilega, except in areas once occupied by the Zostera beds, where they have shown a marked increase.

2.

OBJECTIVES

The overall objective of the Helford River intertidal monitoring programme is to formulate an inexpensive, quick and therefore easily repeatable baseline monitoring system which should be repeated, at least every two years, to try to detect changes in the flora and fauna of the intertidal zones on the shores of the Helford River. This baseline can then be enlarged upon as circumstances allow. If changes occur they should be detected by this system and more detailed monitoring can then be focussed in the appropriate areas.

The immediate object of the 1988 Helford River Survey is to:-

- a) Implement the first stage of this continued monitoring programme: the first re-recording of a selection of the transects originally surveyed in 1986.
- b) Relocate (and re-mark where necessary) five of the nine transects first recorded during the 1986 survey.
- c) Record surface flora and fauna within quadrats along these transect lines as in the 1986 survey.
- d) Describe biota along the same transect lines with reference to measured ecotones.
- e) Devise and implement a system of fixed point photographs, based on the transect lines and quadrats.

3.

METHODOLOGY

Each transect line is approximately located by a permanent and conspicuous feature at the top of the shore, and is pinpointed exactly by a small, blue paint spot on the rocks.

The position of the transect on the shore is given by sighting a prominent landmark on the opposite bank of the river from the top of the transect line.

A string is then used to mark this line and a tape used to locate the quadrats and to define the positions of major changes in communities (ecotones).

Quadrats are recorded along the transect line at the same intervals as in the 1986 survey - usually 20m apart. A 0.25 m.sq. (50cm x 50cm) quadrat is used and this is placed across the transect such that the line divides the quadrat in half. The longitudinal position is obtained by placing the quadrat immediately downshore of the point being recorded (i.e. the top of the square for the 50m quadrat will be placed on the 50m mark of the tape).

The survey is non-destructive, no digging being carried out. Everything observed living on the surface of each quadrat is listed, as are the species living in the substratum which can be identified by surface signs. The number of individuals of each species is counted: if too numerous, an estimate is given of the percentage of the quadrat they occupy.

The grain size of the substrate is measured using a comparator and an appraisal of the consistency given, following the 'sink' criteria devised by the South West Marine Biology Study Group. Note is also made of any debris (e.g. shells, drift-algae), signs of digging or presence of surface water.

Quadrats are recorded, proceeding down the shore at the intervals given, to the furthest extent exposed at extreme low water.

Photographs are taken of certain selected quadrats (details of positions are given later).

Ecotones are also recorded along the same transect line to pick up anything missed between quadrats. The position of each zone is fixed by measuring from the top of the shore in metres. A brief description of the surface life within each zone is made.

N.B. Care is taken not to walk along the transect line or to drag the tape down the shore as either may damage and alter the surface.

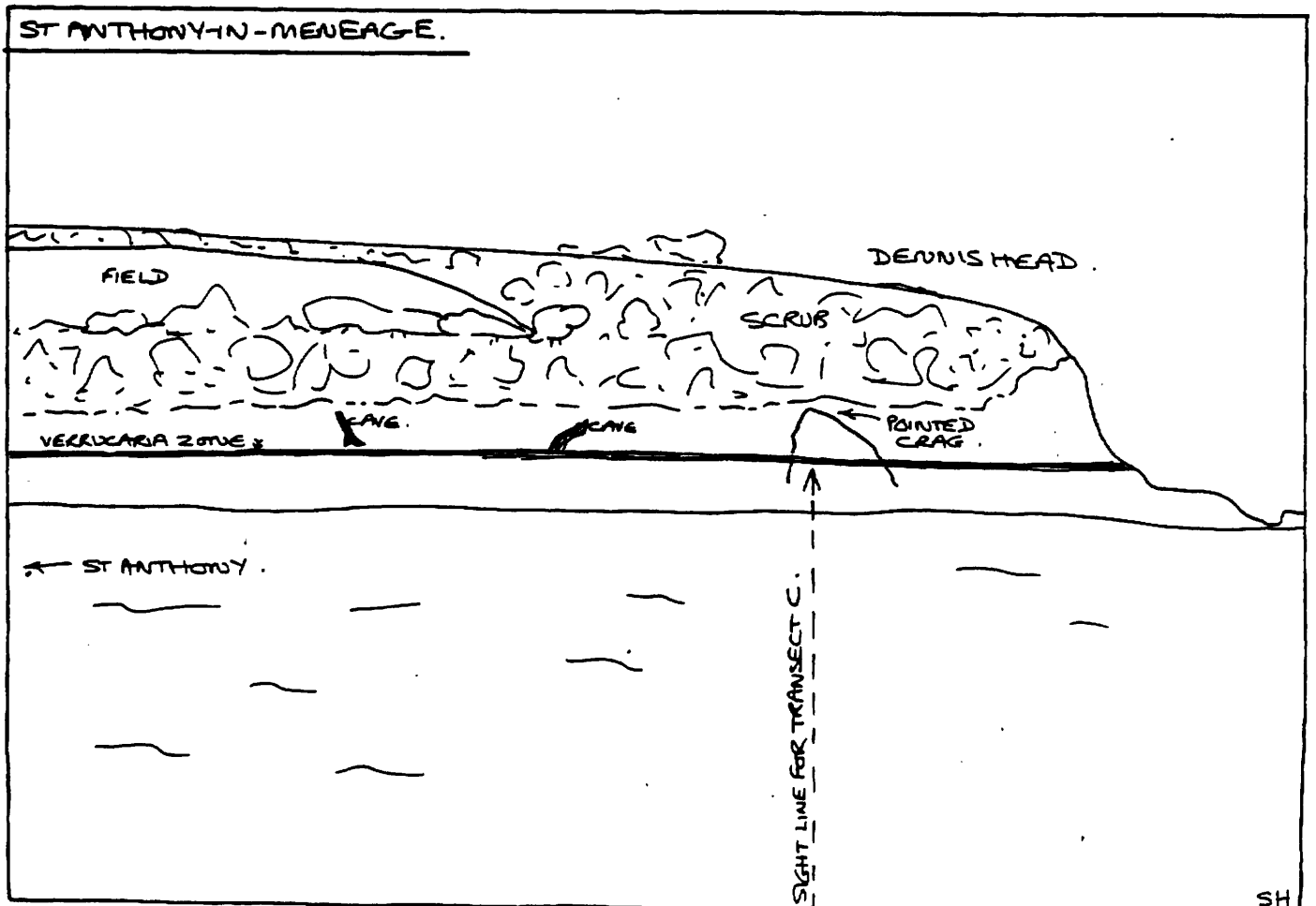
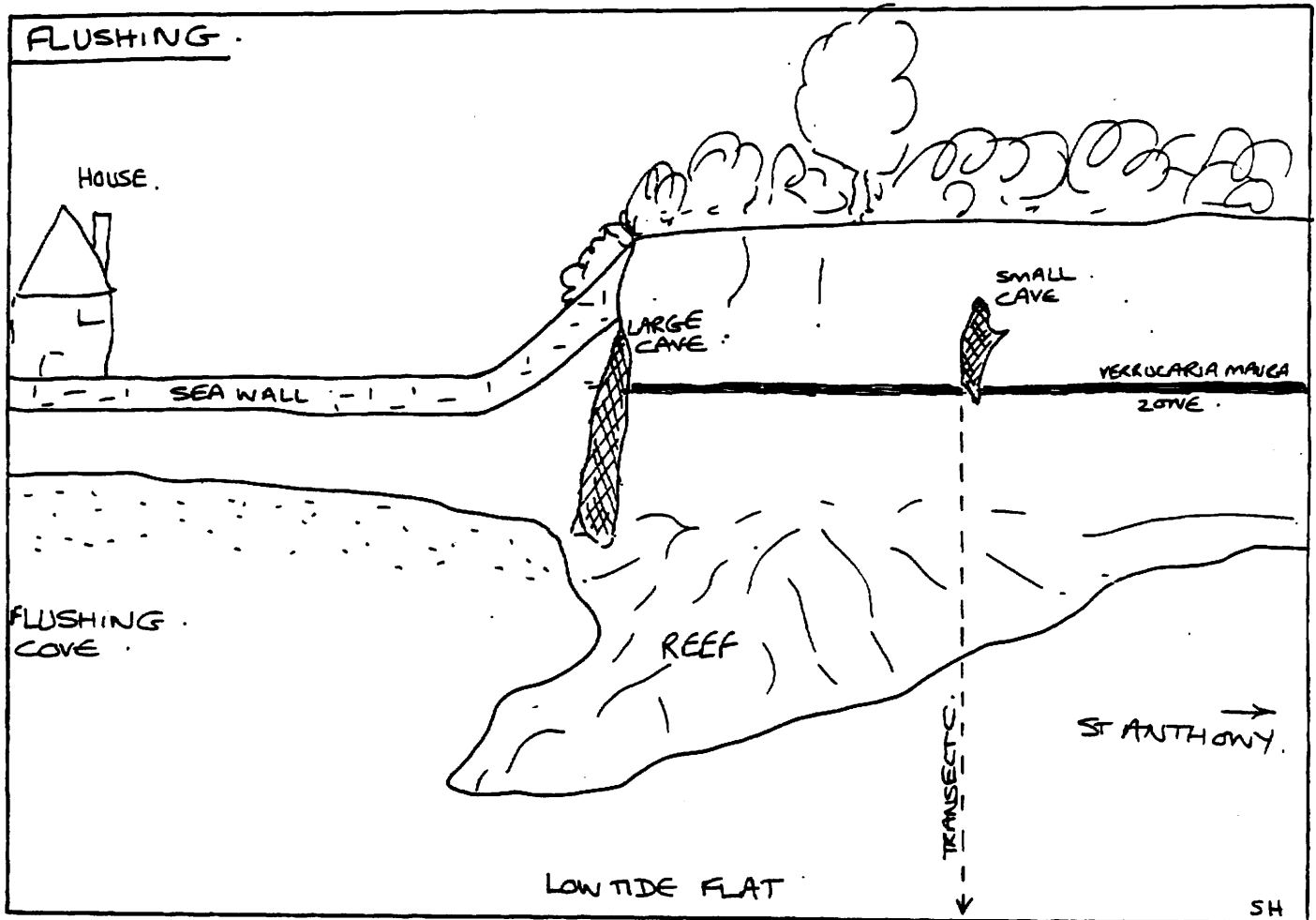
4. LOCATIONS OF TRANSECTS RE-RECORDED IN 1988

4.1 TRANSECT C. FLUSHING COVE

LOCATION SW78382533 to SW78702545

The road down to Flushing Cove comes to a dead end. From here, walk northwards to the rocky reef which cuts across the northern end of the sandy beach. The cliff backing the reef forms a gully and then projects seawards to form a small headland. On the northern side of this headland is a small cave. Transect line C extends from approximately halfway down the southern side of the cave entrance. The exact location is marked by a blue paint spot.

The far end of the Transect is sighted on a pointed triangular rock crag forming part of the cliff near the end of Dennis Head.





Top of Transect C - Flushing Cove



Sight for the far end of Transect C - Dennis Head
Helford Monitoring Report No 1

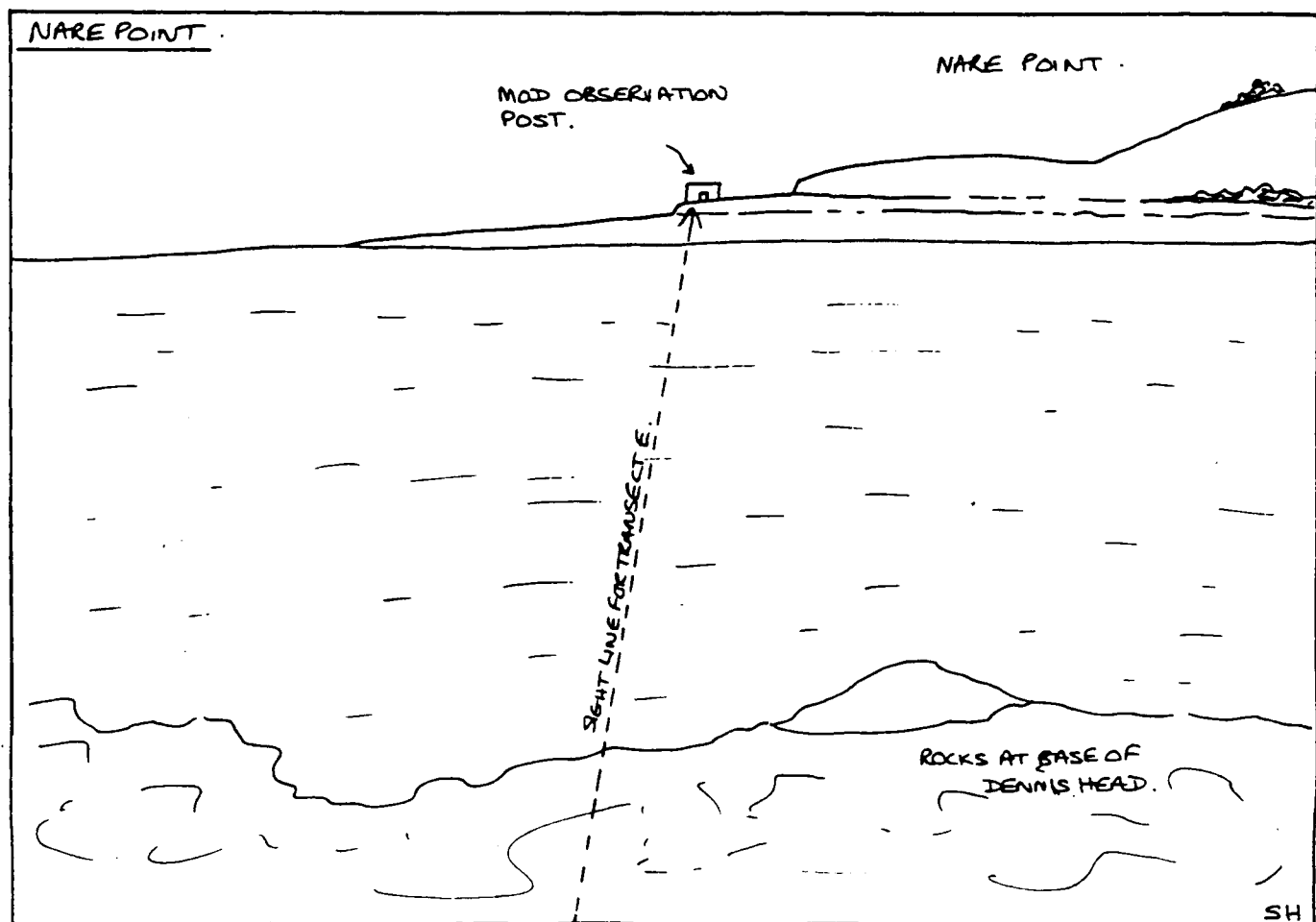
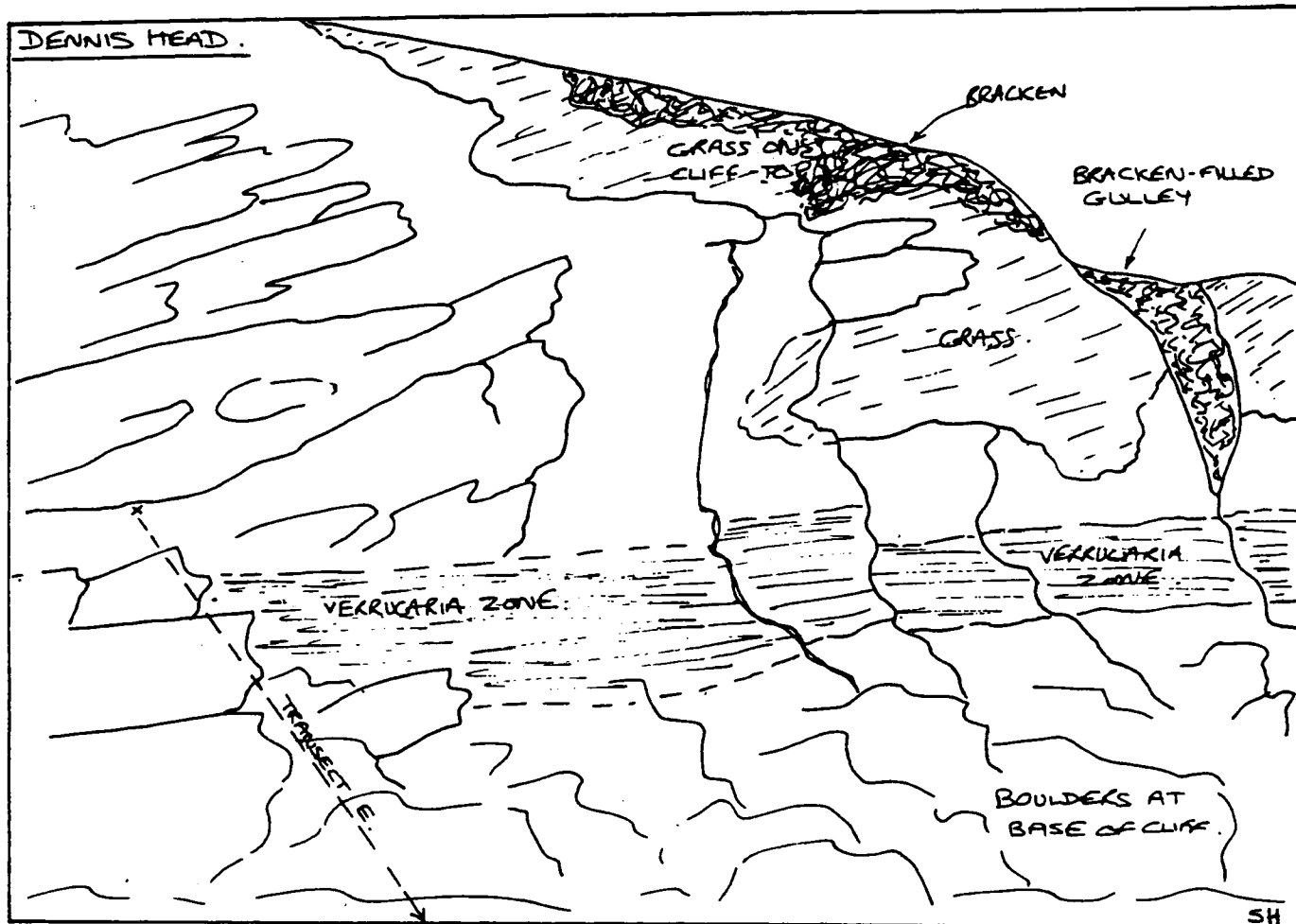
4.2 TRANSECT E

DENNIS HEAD

LOCATION SW78872553 to SW80012512

Walk eastwards from St Anthony-in-Meneage, along the shore on the southern side of Dennis Head. Bear northwards around the end of the headland until you come to the 6 knot speed limit sign on the cliff above you. Just past this and before the first large inlet to the north, is the transect line. Its exact location is marked by a blue paint spot near the bottom of the cliff, at the base of the yellow lichen zone.

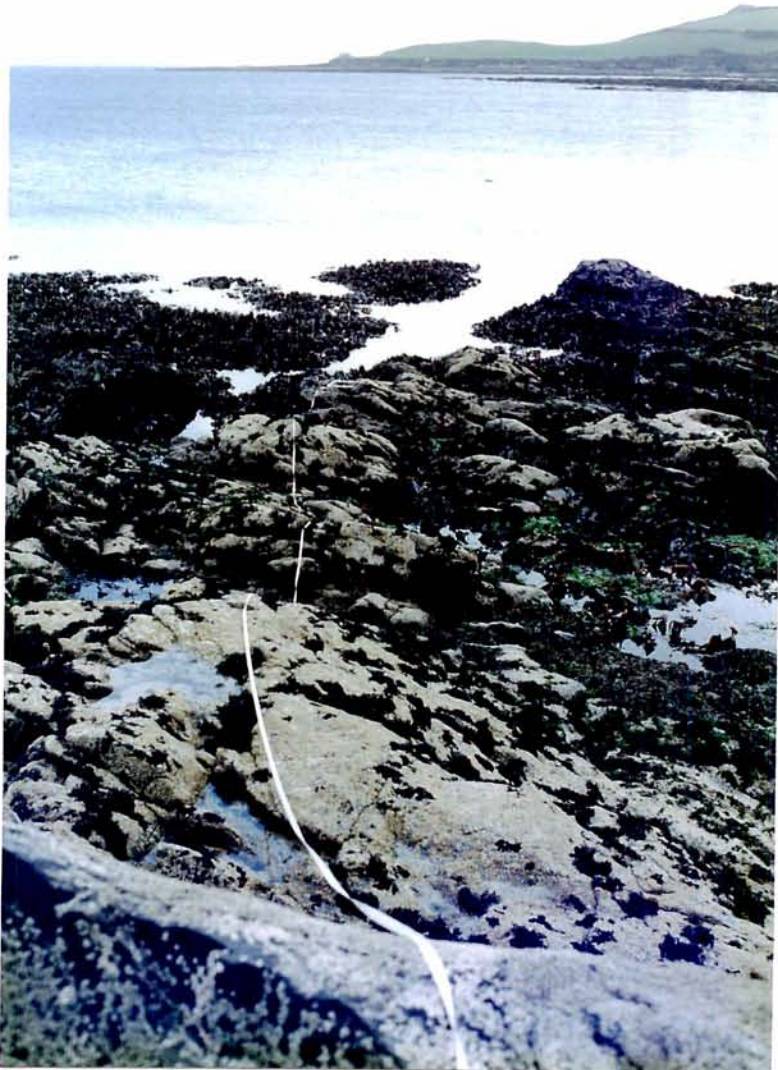
The far end of Transect E is sighted on the Ministry of Defence observation post - the small building visible on the end of Nare Point.



E



Top of Transect E - Dennis Head



Sight for the far end of Transect E - Nare Point
Helford Monitoring Report No 1

TRANSECTS

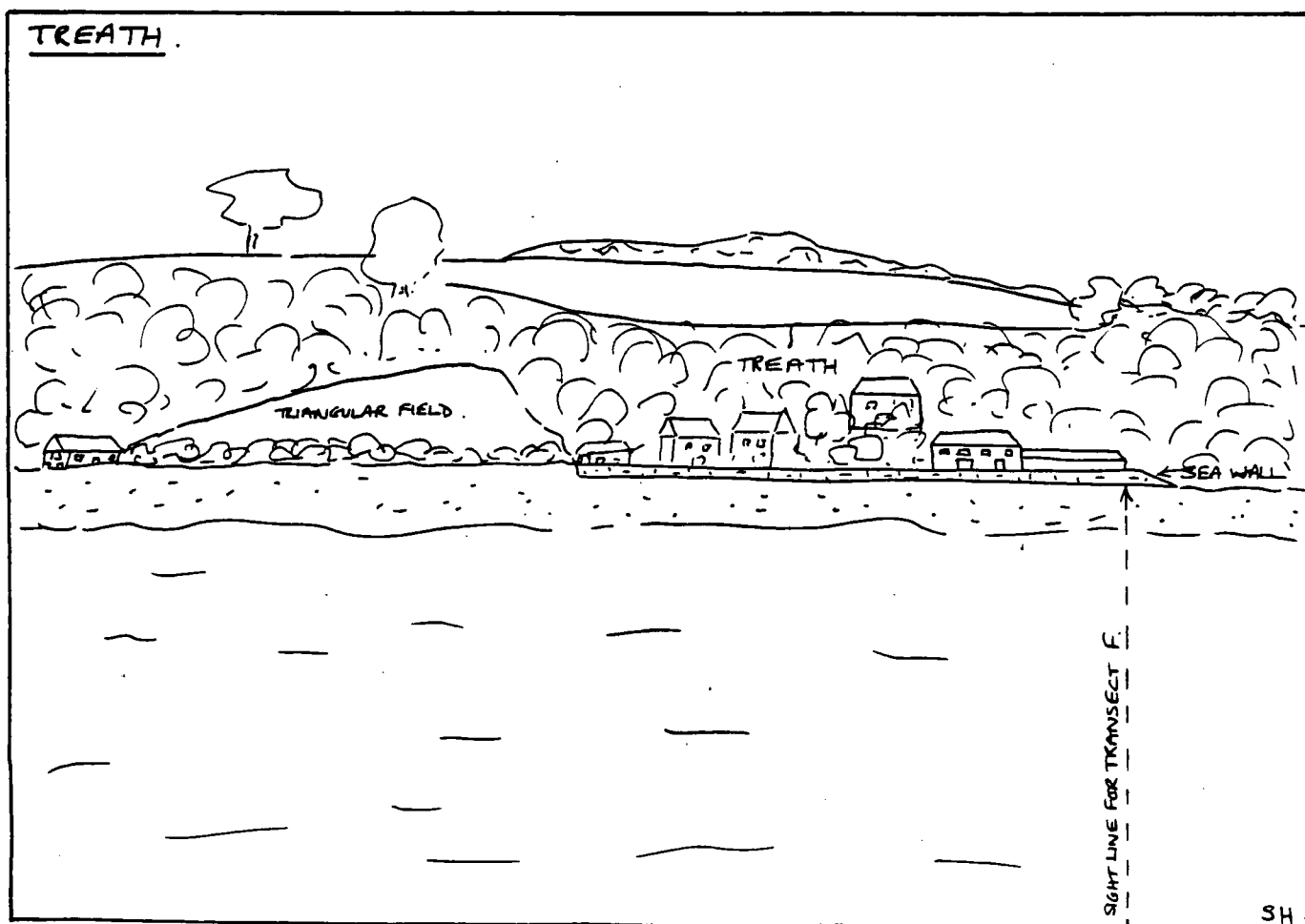
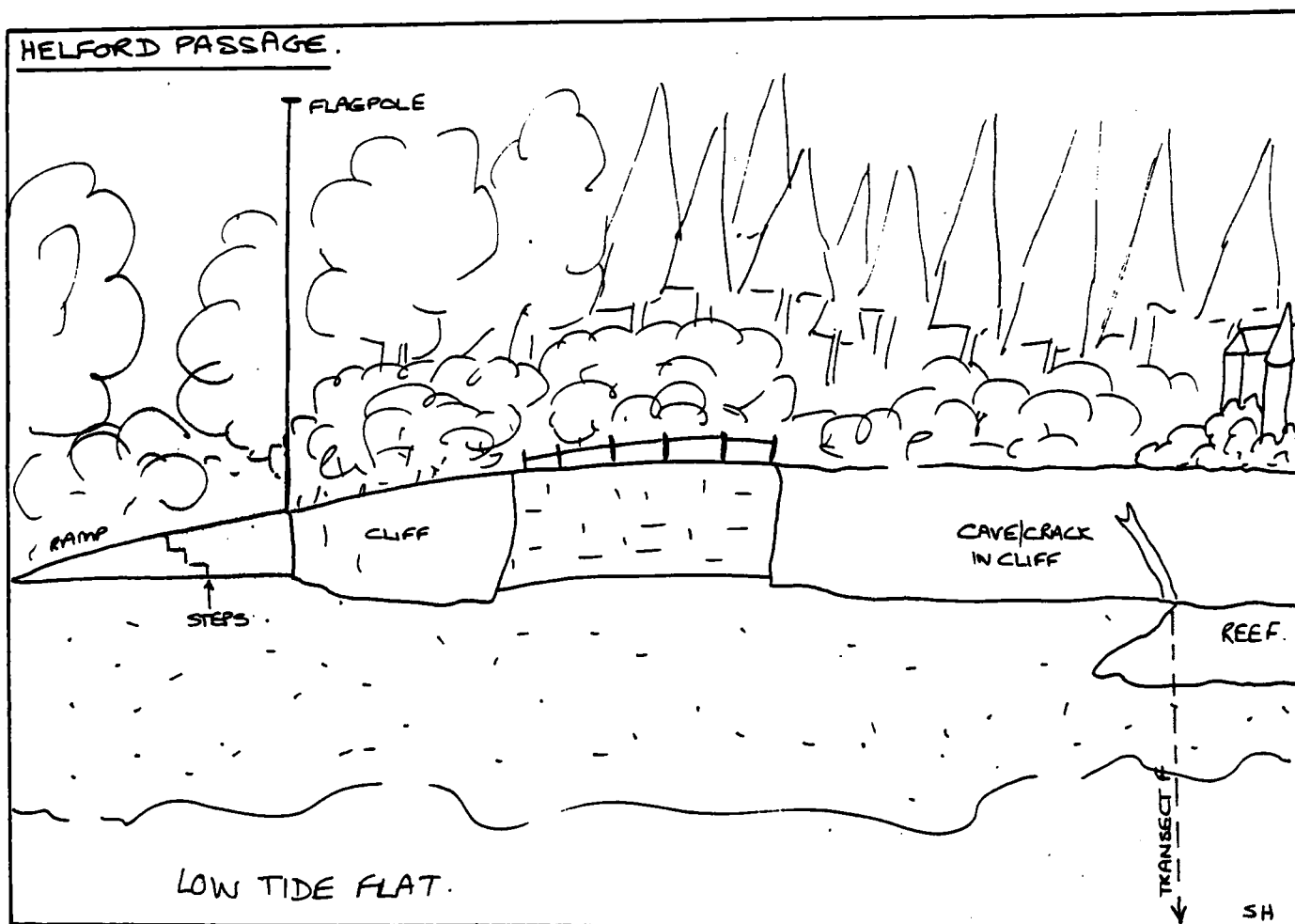
4.3 TRANSECT F

HELFORD PASSAGE

LOCATION SW76112690 to SW76122614

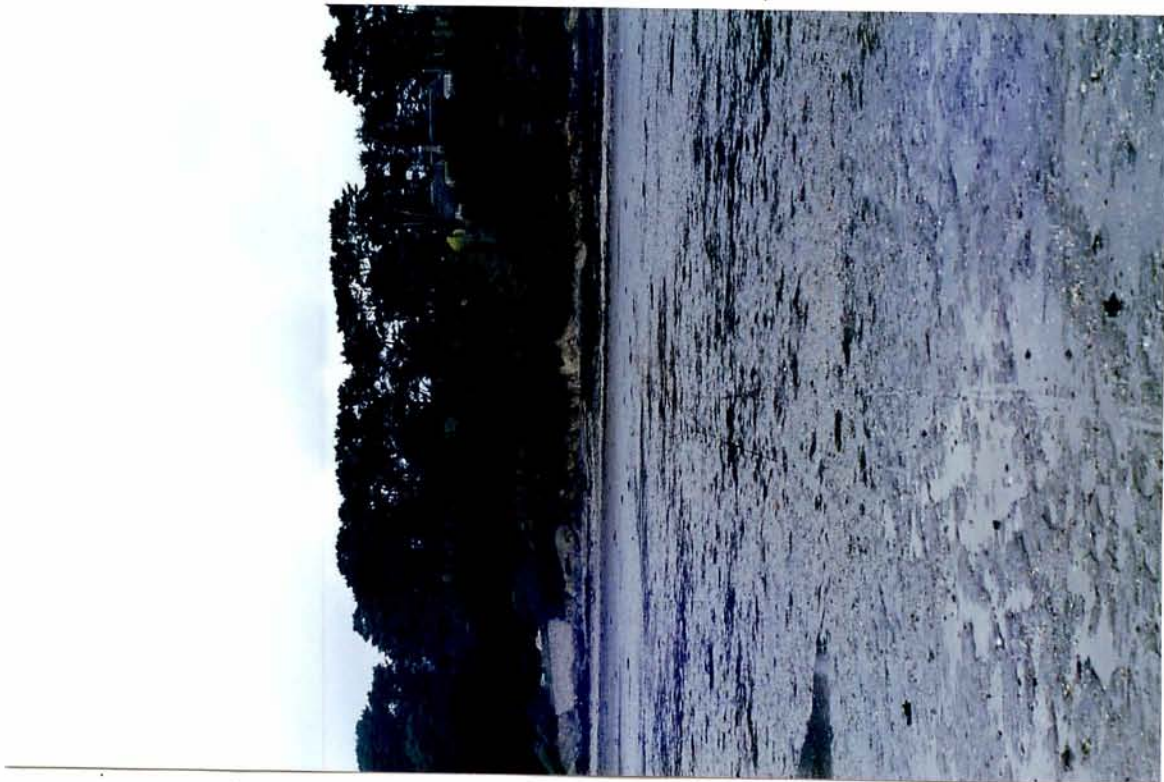
Follow the road down to Helford Passage, past the Ferry Boat Inn and on up the hill behind Gate Beach. The road ends in a slipway onto the beach. From here head eastwards along the shore until you reach a small gully/cave in the cliff, just west of the start of a rocky reef fronting the cliff. The top of Transect F is located on the triangular rock pinnacle in the entrance to the cave/gully. The exact point is marked by a blue paint spot.

The far end of the Transect line is sighted on the western end of a long low building situated behind the western corner of the sea wall at Treath.





Top of Transect F - Helford Passage (Close-up)



Top of Transect F - Helford Passage

F cont.



Sight for the far end of Transect F - Treath

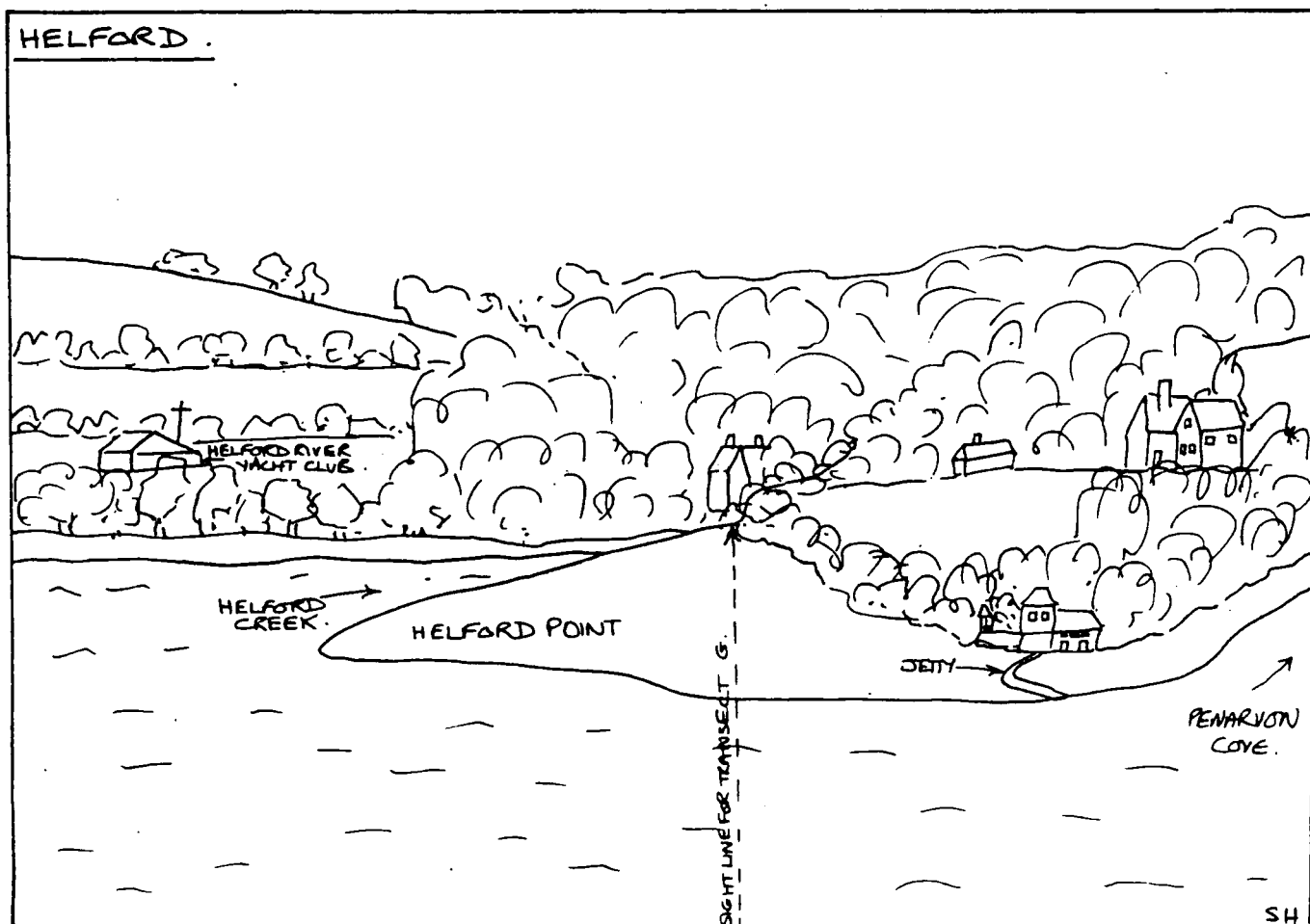
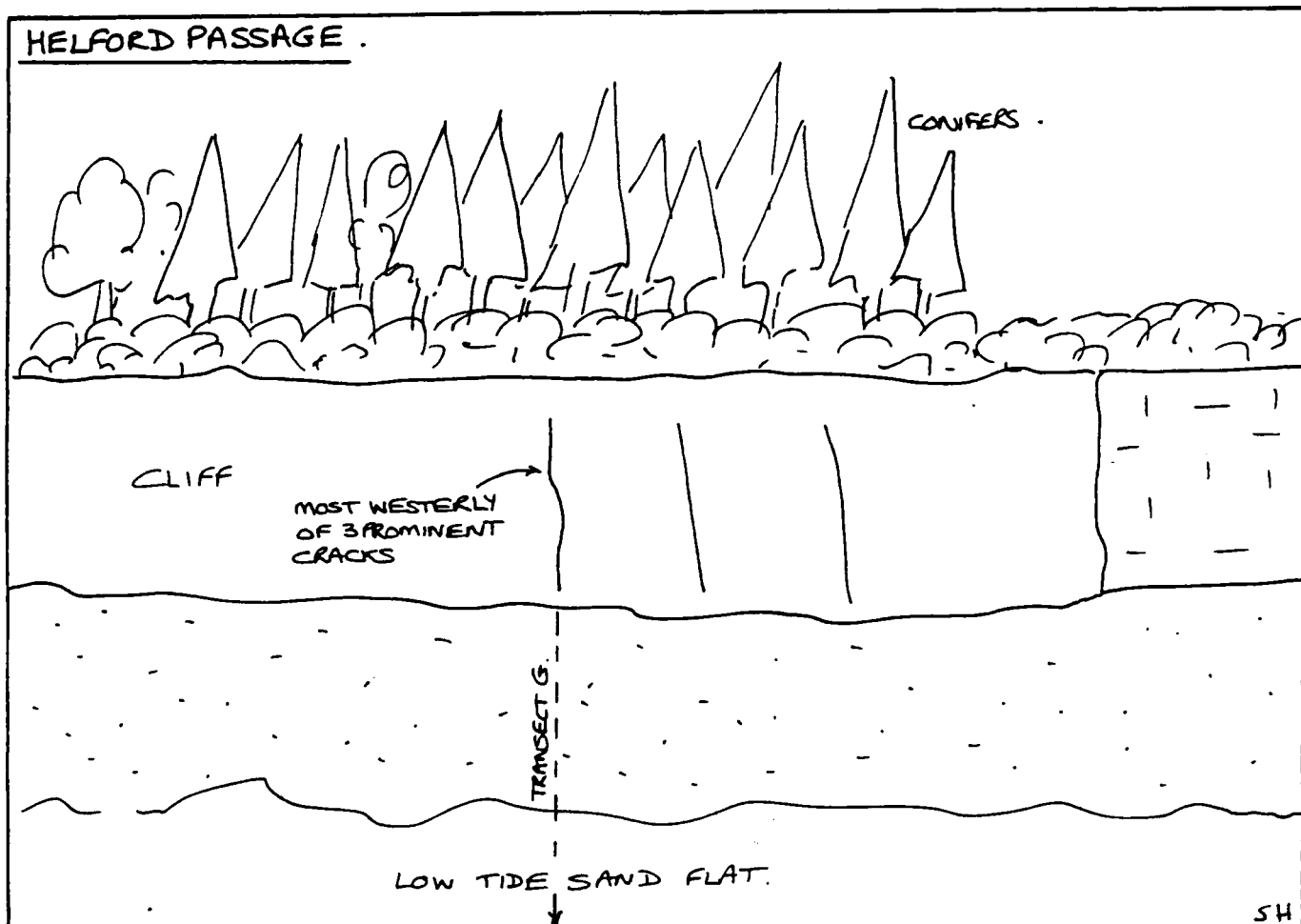
4.4 TRANSECT G HELFORD PASSAGE ZOSTERA BED

LOCATION SW76182686 to SW75792590

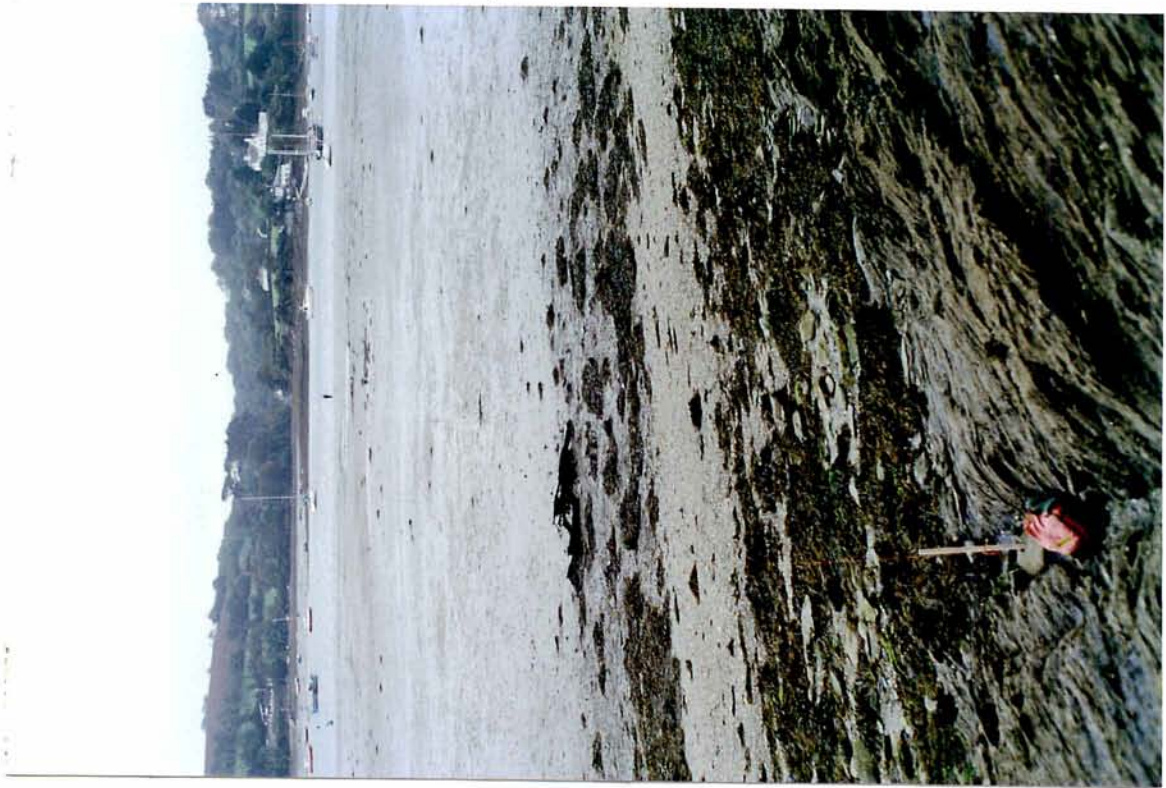
Follow the road down to Helford Passage and walk on to the beach at Passage Cove. Proceed westwards along the beach until the reef at the base of the cliff starts to narrow and you reach three prominent cracks running vertically down the rocks. Transect G runs from the top of the most westerly of the three cracks, the exact point being at the break in slope where the cliff gives way to reef. Here, at the base of the lichen zone, the point is marked with a blue paint spot.

The far end of the Transect is sighted on the gable end of the only house visible at the top of Helford Creek.

TRANSECT G - HELFORD PASSAGE ZOSTERA BED.



G



Sight for far end of Transect G - Helford



Top of Transect G - Helford Passage, Zostera bed

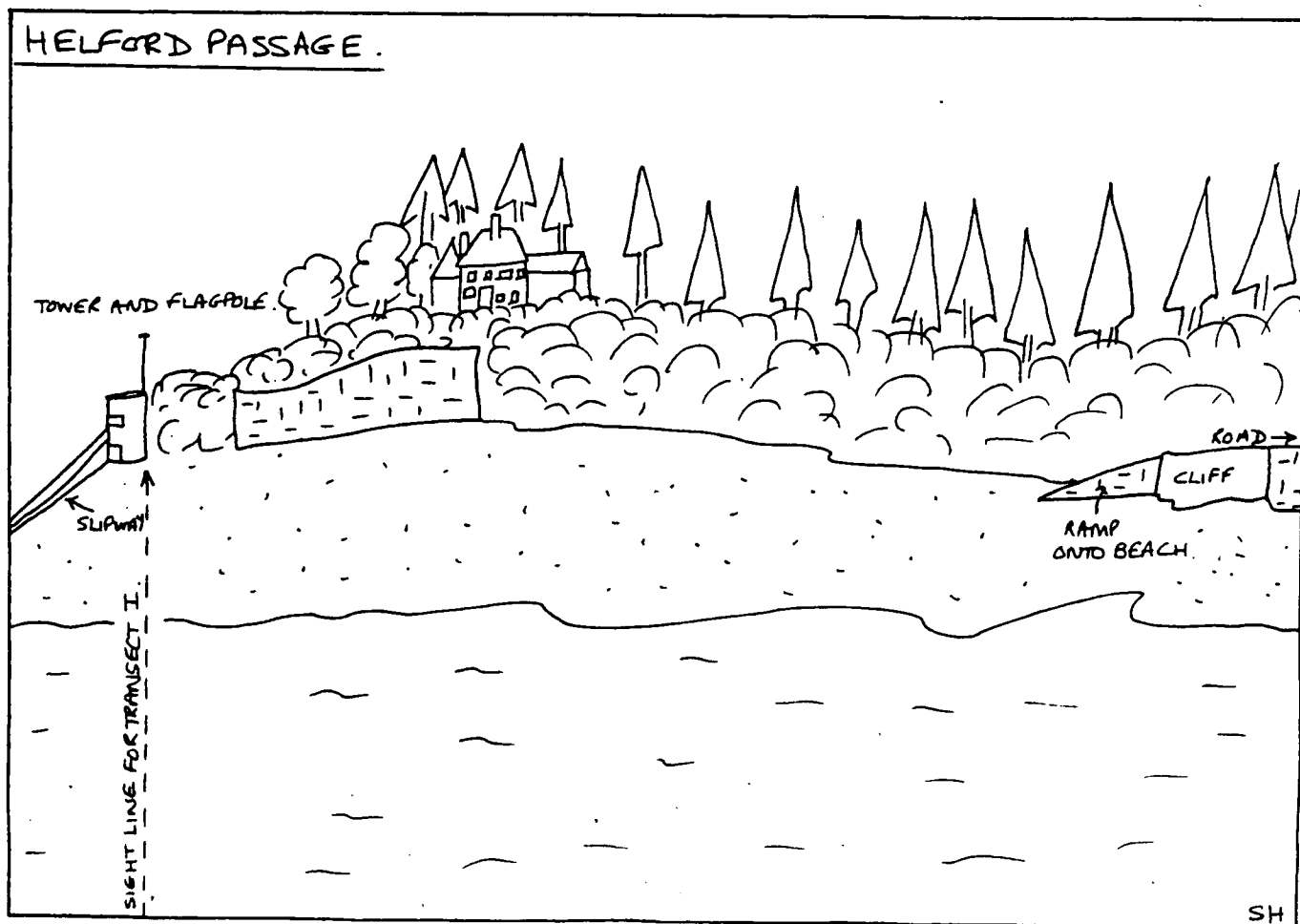
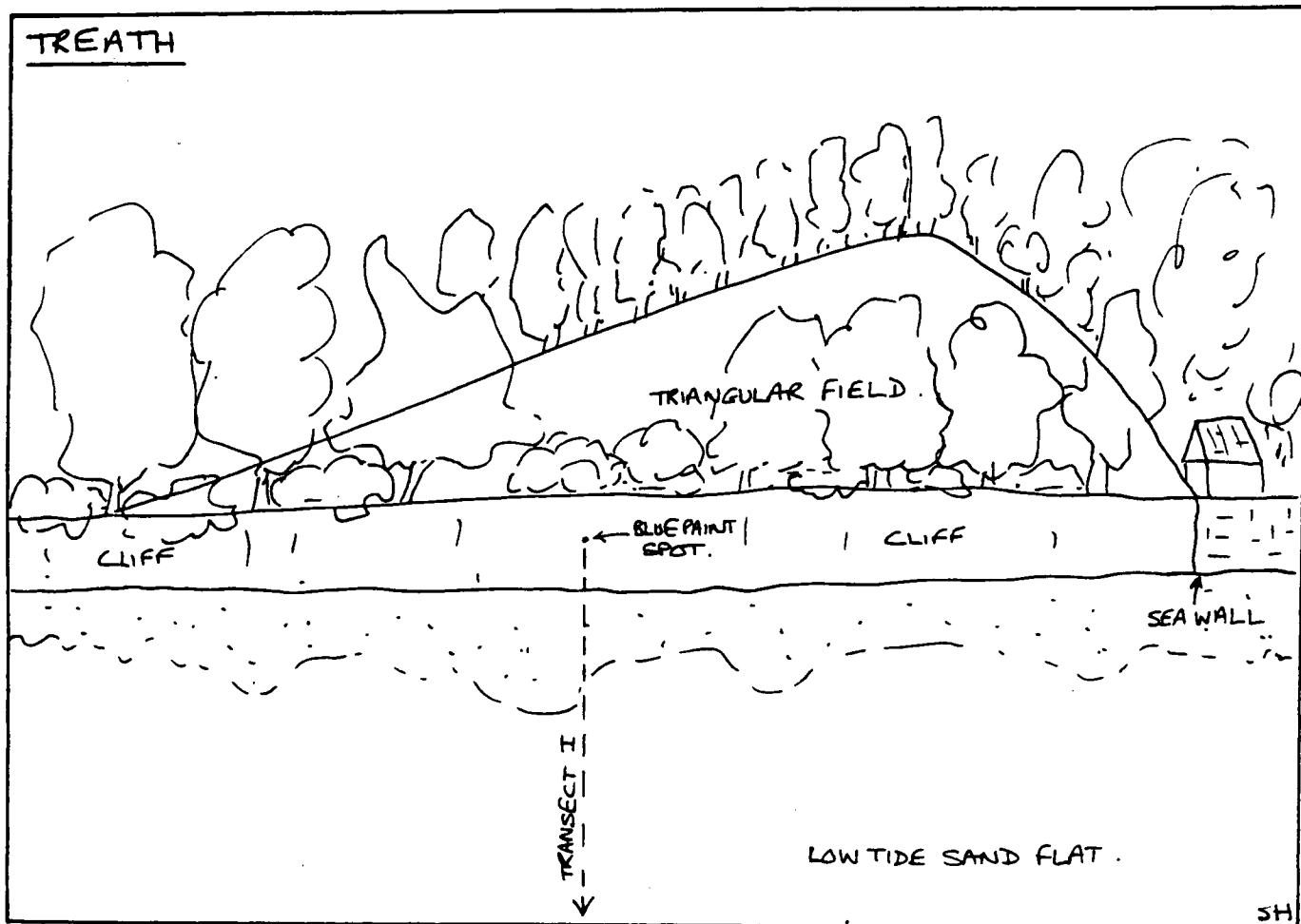
4.5 TRANSECT I

TREATH ZOSTERA BED

LOCATION SW76322632 to SW75792697

Walk east from the car park at Treath (SW75952610), through the Helford River Sailing Club car park and down the slipway on to the beach. Proceed eastwards towards the north-east end of the bar. Backing the cliffs here is a triangular-shaped field. Approximately two-thirds of the way along this, look for a blue paint spot at the top of the lichen zone, on the rocks beneath the overhanging trees. This marks the top of Transect I.

The far end is sighted on the flag pole on the tower at the top of the slipway, to the west of the Bar at Helford Passage.

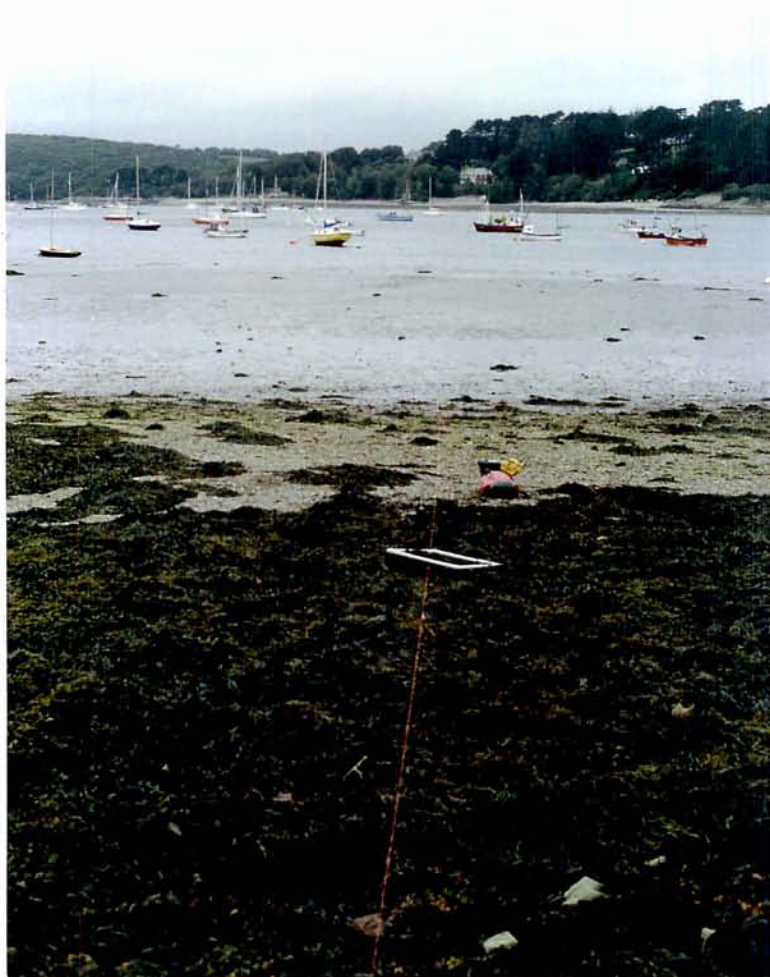




Top of Transect I - Treath, Zostera bed



I cont.



Sight for far end of Transect I - Helford Passage

5

PRESENTATION OF 1988 DATA

5.1 TRANSECT C

FLUSHING COVE

29.9.1988

Tide: 0.6m low at Plymouth (Devonport)

QUADRATS

0m Mostly lichen-covered rock forming the cliff wall on the southern side of the cave entrance.

Bare rock	40%
<u>Verrucaria maura</u>	60%
<u>Littorina saxatilis</u>	x1
<u>Littorina neritoides</u>	x2
<u>Ligia oceanica</u>	Several
Red mite	

5m On a horizontal ledge on the reef at the base of the cliff.

Bare rock	42%
<u>Chthamalus montagu</u>	30%
<u>Chthamalus stellatus</u>	+
<u>Elminius modestus</u>	1%
<u>Littorina saxatilis</u>	+
<u>Patella sp</u>	8%
<u>Catenella repens</u>	+
<u>Verrucaria maura</u>	28%
Unidentified remains of brown algae	+
Red mite	+

10m Situated on the steeply sloping face of the edge of the reef, overhanging the crevice, leading down from the cave.

Bare rock	35%
<u>Chthamalus montagu</u>	45%
<u>Chthamalus stellatus</u>	+
<u>Balanus balanoides</u>	+
<u>Elminius modestus</u>	+
<u>Patella sp.</u>	9%
<u>Mytilus edulis</u>	+
<u>Littorina saxatilis</u>	+
' <u>Lithothamnium</u> '	9%
<u>Fucus spiralis</u>	+
<u>Enteromorpha intestinalis</u>	1%
<u>Catenella repens</u>	+
<u>Verrucaria maura</u> (on pinnacles)	3%

15m On craggy near-horizontal rock platform near the seaward extension of the reef.

Bare rock	3%
<u>Chthamalus montagu</u>	68%
<u>Balanus balanoides</u>	3%
<u>Elminius modestus</u>	1%
<u>Patella sp</u>	10%
<u>Fucus vesiculosus</u>	7%
<u>Enteromorpha intestinalis</u>	7%
<u>Catenella repens</u>	+
<u>Verrucaria maura</u>	1%

20m Nearly 100% cover of Fucus serratus on the edge of the reef, just above sand level and sloping gently seawards.

Attached to the rock were:

<u>Fucus serratus</u>		100%
<u>Balanus perforatus</u>	}	+
<u>Spirorbis rupestris</u>	}	+
<u>Pomatoceros triqueter</u>	}	Under furoid cover
<u>Patella sp</u>	}	+
<u>Chondrus crispus</u>	}	10%
<u>Ulva lactuca</u>		+

Attached to the Fucus were:

<u>Littorina mariae</u>		+
<u>Littorina obtusata</u>		+
<u>Spirorbis spirorbis</u>		+
<u>Enteromorpha intestinalis</u>		+

25m Just off the edge of the reef on the top of the sand flat. The substrate consists of medium-grained sand with scattered pebbles and shell debris, mainly fragments of Ensis sp., Bittium reticulatum, Venus striatula, Gibbula cineraria and Cerastoderma edule.

Bare sand		63%
Shell debris		15%
Pebbles		15%
<u>Fucus serratus</u>		5%
<u>Ulva lactuca</u>		2%
<u>Enteromorpha intestinalis</u>	on pebbles	+
<u>Littorina mariae</u>	on <u>Fucus</u>	+
<u>Spirorbis spirorbis</u>		+
<u>Lanice conchilega</u>		x11

30m Situated on the sand flat. The substrate consists of fine-grained sand and is 90% covered with rotting drifted algal remains - Chorda filum, Fucus serratus, etc.

Beneath the weed were:

<u>Gammarus</u> sp.		+
<u>Lanice conchilega</u>		x40

35m 100% Fine-grained sand

<u>Lanice conchilega</u>		x8
--------------------------	--	----

40m Fine-grained sand containing:

<u>Lanice conchilega</u>		x25
<u>Dumontia incrassata</u>		+

45m Fine-grained sand, flat and puddly

<u>Lanice conchilega</u>		x15
<u>Bittium reticulatum</u>	empty shells	x2
<u>Lanice conchilega</u>	- empty tubes on surface	+

50m Fine-grained sand

Lanice conchilega

x18

55m Fine-grained sand

Lanice conchilega

x18

Shell debris - Gibbula cinerea, Patella sp.

+

60m Fine-grained sand

Lanice conchilega

x10

Ulva lactuca

+

Arenicola sp. - cast and mound

+

65m Fine-grained sand

Lanice conchilega

x27

Bittium reticulatum - empty

+

70m Fine-grained sand

Lanice conchilega

x10

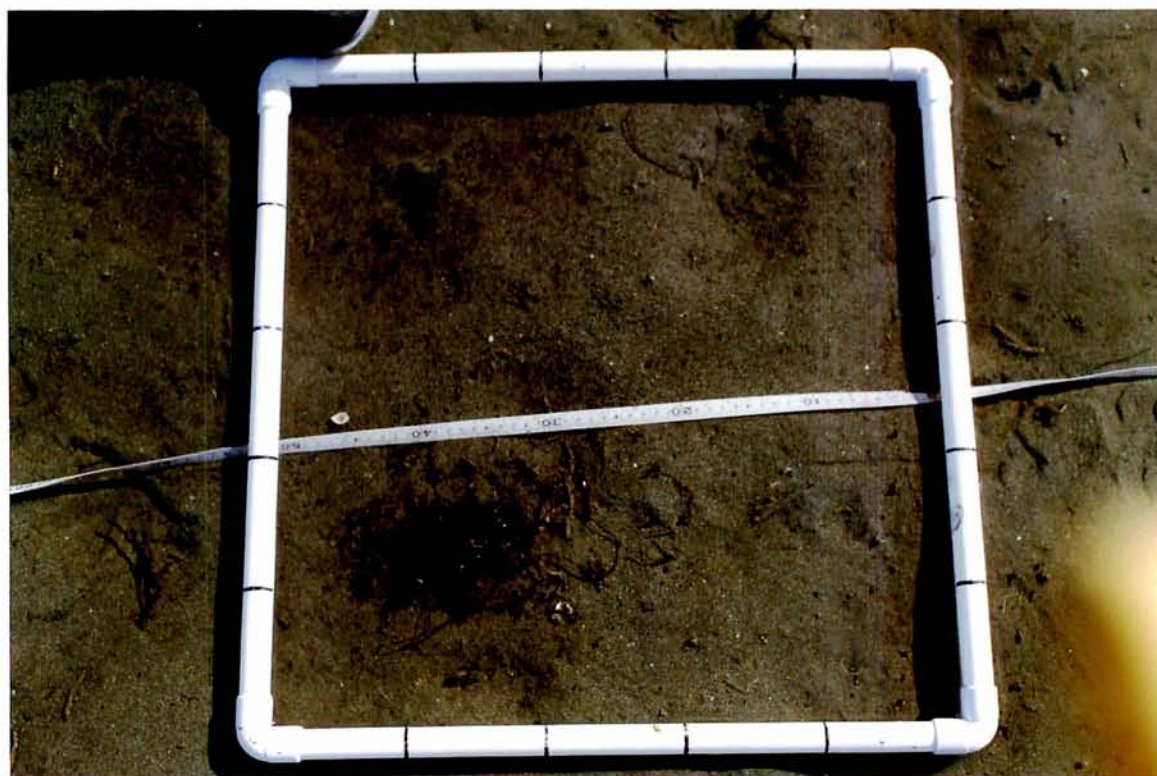
Low tide

N.B. Nearly all the Lanice on the sand-flat appeared to be partially buried and many were level with the sand whilst many more were discovered immediately below the surface. Very few had the beaded fringe intact. It is not known whether this is the result of recent storm damage or a more long-term process of siltation.

C



Transect C - Flushing Cove - 15m Quadrat



Transect C - Flushing Cove - 70m Quadrat

5.2 TRANSECT C

FLUSHING COVE

29.9.1988

ZONATION ALONG TRANSECT LINE

- 0-1m The base of the cliff is mostly bare rock with a covering of Verrucaria maura. Littorina saxatilis, L. neritoides and Ligia oceanica were found hidden in rock crevices.
- 1-3m The Transect line runs along the boundary of the Verrucaria and barnacle zones on the side of the deep crevice leading seawards from the cave at the top of the transect.
- 3-6m The barnacle zone. Almost 50% cover of barnacles present (mostly Chthamalus montaqui, with some C. stellatus and Elminius modestus), whilst the more elevated areas of bare rock support Verrucaria maura. Patella sp. scattered throughout.
- 6-10m The transect line skirts a rock pinnacle and shows a brief zonation of Pelvetia canaliculata and Fucus spiralis which merge. There are scattered specimens of Chthamalus montaqui and Patella sp.
- 10-18m Barnacle zone, as described in 3-6m, except that Balanus balanoides is present.
- 18-26m Fucus serratus (with some Ascophyllum nodosum) giving nearly 100% cover on the lowest and most seaward level of the rocky reef. Attached to the Fucus were Enteromorpha intestinalis, Spirorbis spirorbis, Littorina maria and L. obtusata. Beneath the algal cover were Balanus perforatus, Spirorbis rupestris, Pomatoceros triqueter, Patella sp. and plants of Chondrus crispus.
- 26-30m Beginning of the sand flat where, just beyond the reef, there is a covering of rotting drift algae and occasional boulders with Fucus serratus and Enteromorpha intestinalis attached.
- 30-70m Flat, homogenous, puddly sand punctuated, by Arenicola casts and frequent Lanice conchilega tubes. Little algal or shell debris.

5.3 TRANSECT E

DENNIS HEAD

28.9.1988

Tide: 0.2m low Plymouth (Devonport).

QUADRATS

0m Lichen zone at the base of the cliff

Bare rock	93%
<u>Caloplaca</u> sp.	2%
<u>Verrucaria maura</u>	5%

5m Pelvetia zone on rock sloping seawards from the cliff

Bare rock	approx.3%
<u>Balanus balanoides</u> & <u>Chthamalus montagu</u>	90%
<u>Lichina pygmaea</u>	5%
<u>Pelvetia canaliculata</u>	2%
<u>Littorina saxatilis</u> } in empty barnacle shells	+
<u>Littorina neritoides</u> } " " "	+
<u>Verrucaria maura</u>	+

10m On a rock pinnacle

Bare rock	5%
<u>Verrucaria maura</u>	70%
<u>Chthamalus montagu</u>	24%
<u>Littorina saxatilis</u> & <u>L.neritoides</u> in barnacle shells	1%
Red mite	x1

15m A flat rock platform, a step down on the seaward side of the rock pinnacle. The quadrat spans a system of crevices and hollows which collect water in a pool.

Pool	30%
Bare rock	10%
Barnacles (<u>Chthamalus montagu</u> & <u>Balanus balanoides</u>) occurring both in and out of the pool	57%
Also on the dry rock are:	

<u>Lichina pygmaea</u>	6%
<u>Fucus spiralis</u>	6%
<u>Patella</u> sp.	9%
<u>Anurida maritima</u>	+
<u>Littorina saxatilis</u> & <u>L.neritoides</u> in empty barnacles	+

Also in the pool are:

<u>Actinia equina</u>	x2
<u>Patella</u> sp.	+
<u>Enteromorpha intestinalis</u> - growing on <u>Patella</u> sp.	+
<u>Corallina officinalis</u>	+
<u>Lithothamnion</u>	10%
<u>Spirorbis rupestris</u> on rock	+
<u>Ceramium rubrum</u> agg.	1%
<u>Gibbula umbilicalis</u>	+
<u>Ulva lactuca</u>	+
<u>Hymeniacidon perleve</u>	1%

20m A further step down on a rock platform sloping gently seawards

Bare rock	25%
<u>Fucus vesiculosus</u>	24%
<u>Enteromorpha intestinalis</u>	2%
<u>Audouinella</u> sp.	+
<u>Patella</u> sp.	8%
<u>Littorina mariaae</u>	+
<u>Littorina obtusata</u>	+
<u>Littorina saxatilis</u>	+
<u>Balanus balanoides</u>	5%
<u>Chthamalus montaquei</u>	35%
<u>Elminius modestus</u>	+
<u>Balanus perforatus</u>	+
<u>Actinia equina</u>	+
' <u>Lithothamnia</u> '	1%
<u>Halichondria panicea</u>	+
<u>Hymeniacidon perleve</u>	+
<u>Spirorbis rupestris</u> - on rock	+

25m On a rocky reef sloping gently towards the sea

Bare rock	12%
<u>Chthamalus montaquei</u>	20%
<u>Balanus balanoides</u>	45%
<u>B. perforatus</u>	+
<u>Elminius modestus</u>	1%
<u>Patella</u> sp.	5%
<u>Littorina mariaae</u>	+
<u>L. saxatilis</u>	+
<u>Modiolus</u> sp. - in crevice	+
<u>Spirorbis rupestris</u>	+
<u>Pomatoceros triqueter</u>	+
<u>Halichondria panicea</u>	3%
<u>Enteromorpha intestinalis</u>	3%
<u>Laurencia pinnatifida</u>	6%
<u>Fucus vesiculosus</u>	5%
<u>Cladophora</u> sp.	+

30m This quadrat spans a wide channel between two rock ridges: part of the quadrat is on the landward wall of the crevice and part is across the base of the crack. Algal cover is 100%, made up as follows

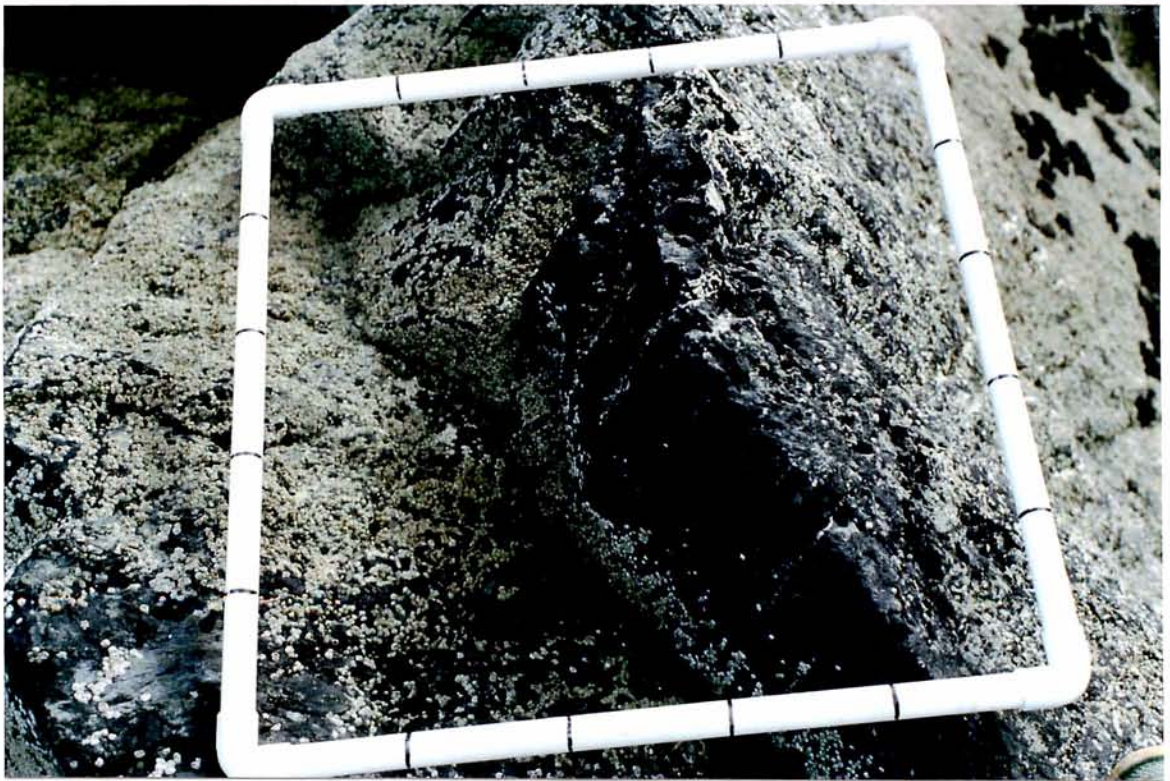
<u>Laminaria digitata</u>	38%
<u>Ulva lactuca</u>	10%
<u>Gigartina stellata</u>	8%
<u>Himanthalia elongata</u>	3%
<u>Laurencia pinnatifida</u>	6%
<u>Corallina officinalis</u>	26%
' <u>Lithothamnia</u> '	3%
<u>Audouinella</u> sp.	+
<u>Ceramium rubrum</u> agg. - on <u>Himanthalia</u>	+
<u>Palmaria palmata</u> (= <u>Rhodymenia</u>)	+
<u>Mesophyllum lichenoides</u>	6%
<u>Cryptopleura ramosa</u>	+
<u>Ralfsia</u> sp.	+
<u>Patina pellucida</u> - on <u>Laminaria</u>	+

<u>Botryllus schlosseri</u> - on <u>Gigartina</u>	+
<u>Hymeniacidon perleve</u>	+
<u>Spirorbis corallinae</u> - on <u>Corallina</u>	+
<u>Gibbula cineraria</u>	x1
<u>Gibbula umbilicalis</u>	x1
<u>Ocenebra erinacea</u>	x1

35m On a horizontal rock platform just above the main kelp zone, with 100% algal cover, as follows

<u>Laminaria digitata</u>	48%
<u>Gigartina stellata</u>	35%
<u>Corallina officinalis</u>	15%
<u>Ulva lactuca</u>	1%
<u>Lithothamnium</u>	+
<u>Himantalia elongata</u>	1%
<u>Cladophora</u> sp.	+
Unidentified red alga	+
<u>Gelidium latifolium</u>	+
<u>Ralfsia</u> sp.	+
<u>Hymeniacidon perleve</u>	+
<u>Halichondria panicea</u>	?
<u>Botryllus schlosseri</u>	+
<u>Gibbula cineraria</u>	x3
<u>Patina pellucida</u> - on kelp	+
<u>Pomatoceros triqueter</u>	+
<u>Ocenebra erinacea</u>	x1
<u>Calliostoma zizyphinum</u>	x1
<u>Spirorbis spirorbis</u>	+
<u>Gammarus</u> sp	+
<u>Nassarius incrassatus</u>	x1

E



Transect E - Dennis Head - 10m Quadrat



Transect E - Dennis Head - 15m Quadrat

E_{cont.}



Transect E - Dennis Head - 20m Quadrat

5.4 TRANSECT E

DENNIS HEAD

28.9.1988

ZONATION ALONG TRANSECT LINE

- 0-1m The base of the cliff. Bare rock supporting patches of Caloplaca sp., Xanthoria parietina and Verrucaria maura.
- 1-3.5m Rock slope from base of cliff, down the shore. Bare except for Verrucaria maura.
- 3.5-6.7m Start of the barnacle zone. Situated on a gentle slope down shore from the base of the cliff. 3.5 is also the start of the Pelvetia canaliculata zone, which extends just over 3m down shore to 6.7m. In the Pelvetia zone are found Chthamalus montagu, Patella sp. (occasional), Lichina pygmaea with Littorina neritoides and L.saxatilis (both frequent) in empty barnacle shells.
- 6.7-7m A narrow Fucus spiralis zone on the landward wall of a channel between the rocks. Present are Patella sp., Chthamalus montagu, Littorina neritoides and L.saxatilis.
- 7-8.3 Marks a narrow and deep channel in the reef, the base of which is occupied by a large rock pool. This pool contains a variety of algae - Laminaria digitata, Enteromorpha intestinalis, Ectocarpus sp., Leathesia difformis, Corallina officinalis, Ulva lactuca and Ceramium rubrum. The rock is encrusted with 'Lithothamnia' and also supports Actinia equina, Patella sp., Balanus balanoides and Hymeniacidon perleve.
- 8.3-9m The seaward face of the crevice sees the recurrence of the Fucus spiralis zone. On the landward-facing slope are Chthamalus montagu, Balanus balanoides, Patella sp., Actinia equina and Lichina pygmaea.
- 9-12m A rock pinnacle on the seaward side of the crevice is at a high enough level to allow Pelvetia canaliculata to colonise. Also in this zone are Lichina pygmaea, Chthamalus montagu, Patella sp. (occasional), with Littorina saxatilis and L.neritoides (frequent) in crevices and empty barnacle shells.
- 12-18m Fucus spiralis and barnacle zone continues on the seaward side of the rock pinnacle with Lichina pygmaea on the rocky projections. Balanus balanoides and Chthamalus montagu are dominant with scattered Elminius modestus. Patella sp. competes with barnacles for space whilst in the wetter cracks are 'Lithothamnia', Enteromorpha intestinalis, Actinia equina, Hymeniacidon perleve, and Mytilus edulis. Within this zone 16.3 to 16.8 is covered by a rock pool lined with 'Lithothamnia', Enteromorpha intestinalis, Ceramium rubrum, Corallina officinalis, Hymeniacidon perleve and Patella sp. Large numbers of small Spirorbis rupestris were colonising limpet scars.

18-35m Barnacle zone, studded with Patella sp. Balanus balanoides dominant, with both species of Chthamalus and Elminius modestus present.

(21.2 to 23.5) Another depression

(29.5 to 30.7) A rock crevice with Laminaria digitata growing at the base.

35-39m A zone of continuous algal cover on the seaward edge of the reef before the drop-off into the kelp zone. The dominant alga is Laminaria digitata with frequent Gigartina stellata. Also present are Ceramium rubrum, Corallina officinalis, Ulva lactuca, Himanthalia elongata, Cladophora sp., Polysiphonia nigrescens, Gelidium latifolium, Cryptopleura ramosa, Callithamnium tetragonum, Lomentaria articulata, Laurencia pinnatifida, Palmaria palmata, Fucus serratus, Ralfsia sp. and 'Lithothamnium'. Amongst the encrusting algae are Pomatoceros triqueter (occasional) and Patella sp. whilst on the rock and algal stipes are patches of Botryllus schlosseri. A few Calliostoma zizyphinum present in crevices.

39m Kelp zone, dominated by Laminaria digitata which supports a multitude of epiphytic algae (including Ceramium rubrum and Palmaria palmata) with bryozoans (Electra pilosa) and Flustrellidra hispida and the hydroid Sycon coronatum. On the kelp fronds and stipes are Patina pellucida (abundant) and Gibbula cineraria as well as some nudibranch spawn.

5.5 TRANSECT F

HELFORD PASSAGE

25.10.1988

QUADRATS

Tide: 0.3m low at Plymouth (Devonport)

0m Bare rock at top of transect

20m Seaward edge of rocky reef which extends from the base of the cliff. The substrate is 95% bed-rock, sloping gently seawards, and 5% pebbles on the seaward edge of the reef (just coming into one corner of the quadrat).

Ascophyllum nodosum 75%
All spp. below on rock, either exposed or under A.nodosum:-
Elminius modestus
Chthamalus montagu
Littorina saxatilis
Littorina obtusata
Actinia equina
Gammarus sp.
Carcinas maenas
Ulva lactuca - juvenile plants
Enteromorpha intestinalis - juvenile plants

40m Substrate of fine-grained sand overlain by approx. 50% cover of granules and pebbles. The black anaerobic layer is only just below the surface.

Lanice conchilega x66
Fucus serratus - 2 juvenile plants +

60m A fine-grained sandy substrate with occasional granules and pebbles on the surface; these (with some scattered shell debris) take up approx. 10% of the quadrat.

Lanice conchilega x116
Littorina littorea x2
Gracilaria verrucosa - attached to pebbles +

N.B. Part of the quadrat is covered by dark sub-surface sand dug by cocklers from just outside the quadrat.

80m 100% fine-grained sand with scattered granules and approx. 15% shell debris.

Lanice conchilega x175
Gracilaria verrucosa - 5 plants +
Ectocarpus sp. +

100m 100% fine-grained sand with scattered shell debris - mainly Bittium reticulatum and Cerastoderma edule.

Lanice conchilega x152
Littorina littorea x2
Gracilaria verrucosa +
Cladophora sp. - on pebble +

120m Substrate consists of fine-grained sand with a scattering of Bittium reticulatum shells.

<u>Lanice conchilega</u>	x57
<u>Gibbula cineraria</u> -juvenile	x1
<u>Gracilaria verrucosa</u> - one plant	+
<u>Ceramium rubrum</u> - one plant	+
<u>Ulva lactuca</u> - on shell debris	+
<u>Cladophora</u> sp. " " "	+
<u>Enteromorpha intestinalis</u>	+

130m The substrate comprises strongly-rippled very fine-grained sand, covered by about 1cm of standing water. Shell debris covers approx. 5% and consists of Venerupis sp., Lucinoma borealis, Bittium reticulatum and Calyptraea chinensis.

<u>Lanice conchilega</u>	x14
<u>Ulva lactuca</u>	x1
<u>Gracilaria verrucosa</u> - on shells	+

140m Strongly-rippled, very fine-grained sand forms a slightly softer and more spongy substrate with approx. 1cm of standing water. Shell debris covers approx.5% and consists of Bittium reticulatum, Cantharidus striatus, Cerastoderma edule and dead Ensis sp. protruding from the sand.

<u>Lanice conchilega</u>	x10
<u>Gracilaria verrucosa</u>	+

160m Rippled very fine-grained sand with puddles forming in the ripple troughs. Shell debris covers about 10% and consists of Cerastoderma edule, Littorina littorea and Bittium reticulatum.

<u>Gracilaria verrucosa</u>	+
<u>Ulva lactuca</u>	+

180m Very fine-grained sand with puddles forming between the ripples. Shell debris covers about 15% of the quadrat.

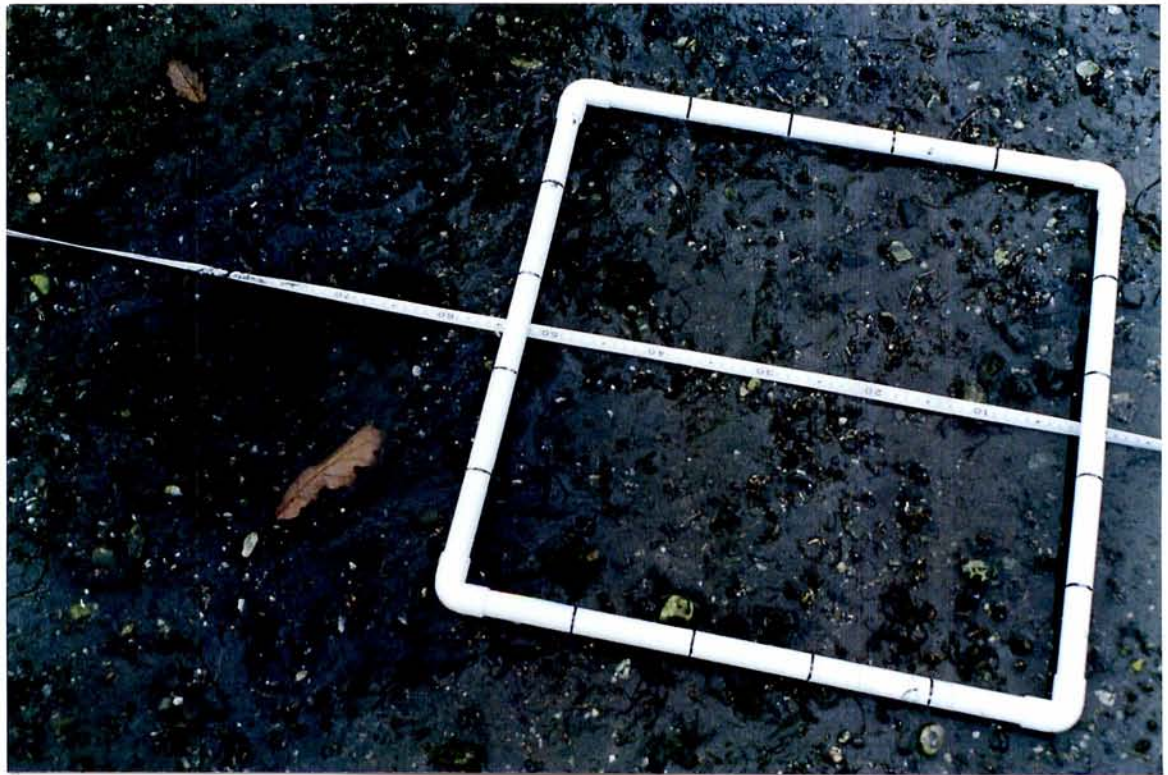
<u>Paqurus bernhardus</u> in shell of <u>Bittium reticulatum</u>	x1
<u>Gracilaria verrucosa</u>	+
<u>Ulva lactuca</u> - one juvenile plant	+

200m Flat, smooth featureless, very fine-grained sand on a gentle slope towards the main channel. Shell debris about 2%.

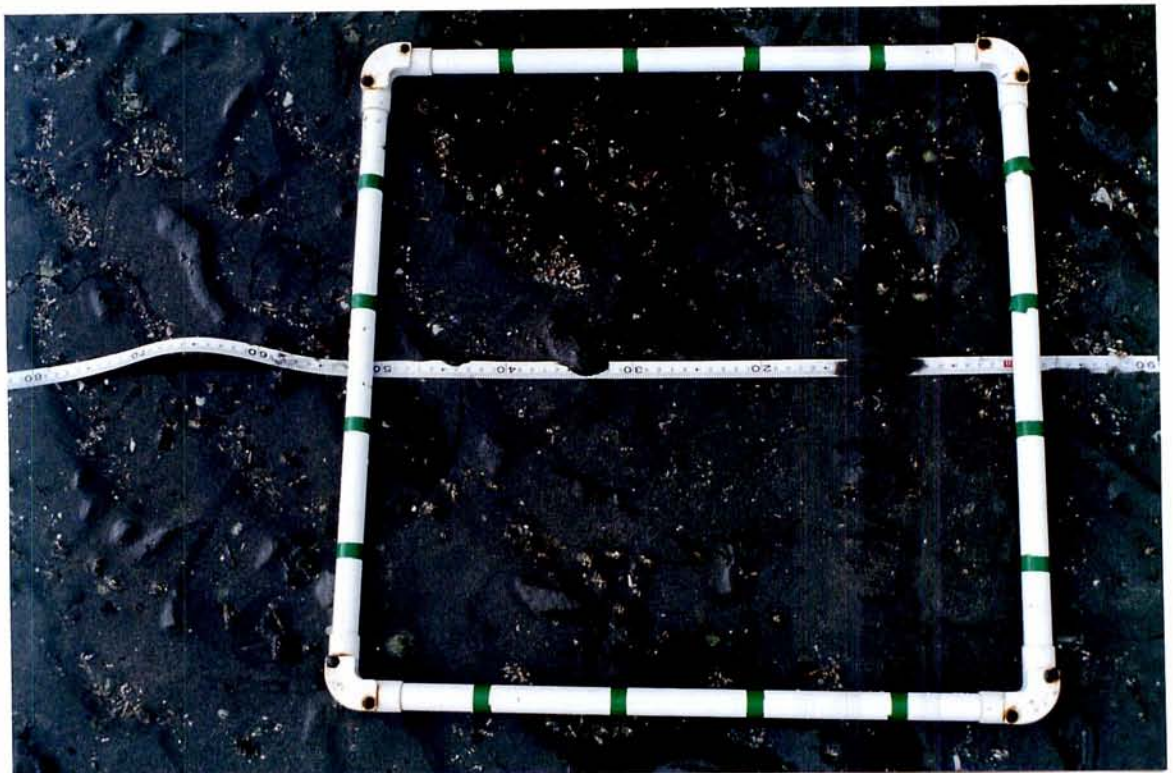
<u>Gracilaria verrucosa</u>	+
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220m Flat, smooth, very fine-grained sand with scattered Bittium reticulatum on the surface.

Extreme low water

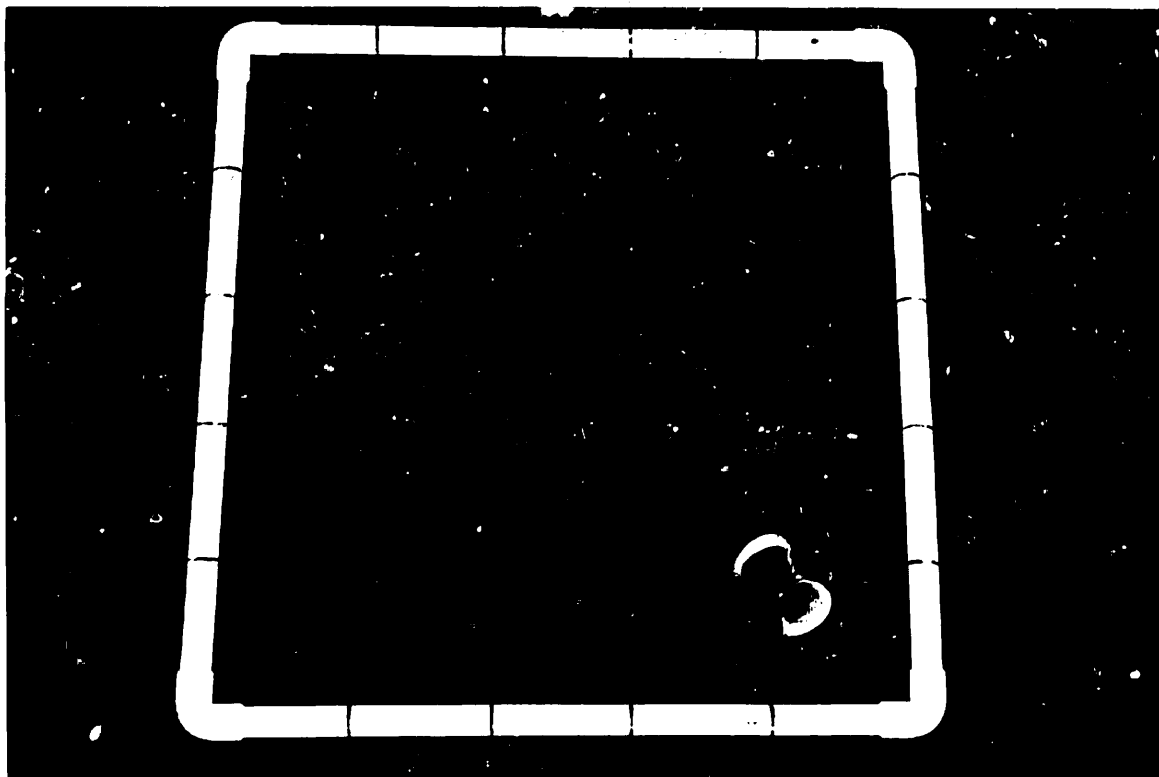


Transect F - Helford Passage - 60m Quadrat

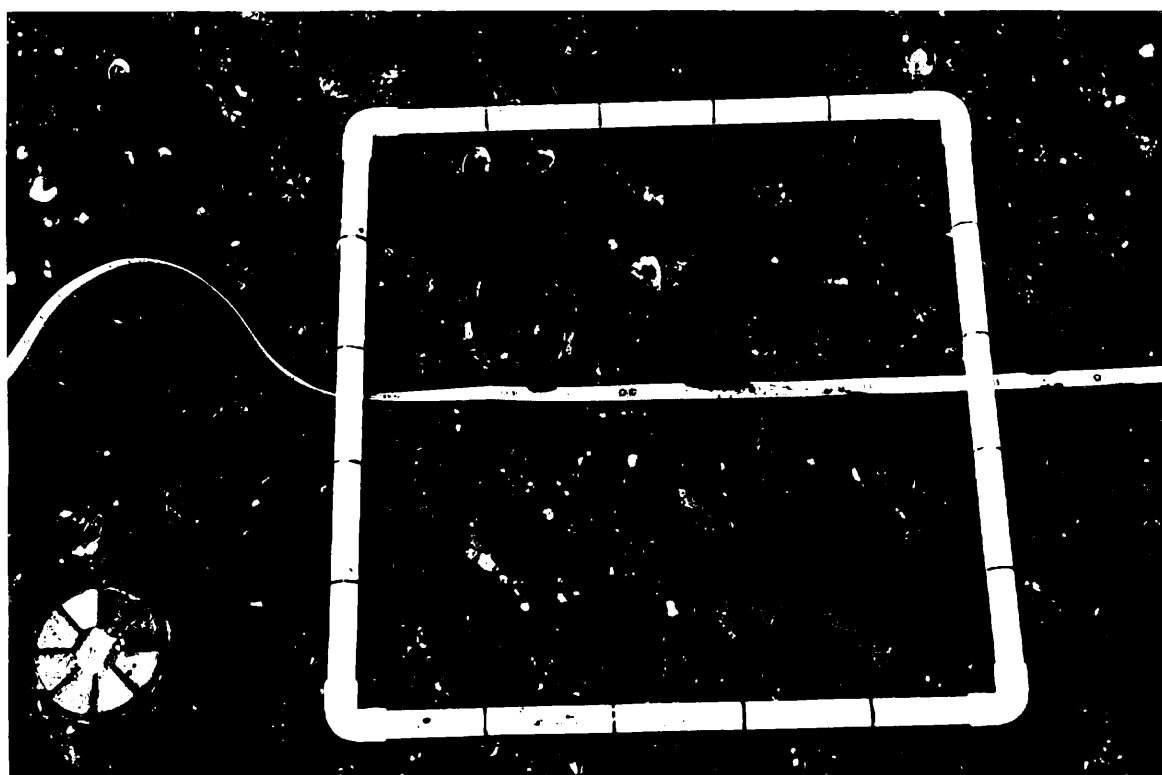


Transect F - Helford Passage - 100m Quadrat

F *cont.*



Transect F - Helford Passage - 120m Quadrat



Transect F - Helford Passage - 130m Quadrat

5.6 TRANSECT F

HELFORD PASSAGE

25.10.1988

ZONATION ALONG TRANSECT LINE

0-8.5m The first zone consists of coarse-grained sand with granules and pebbles, and stretches from the base of the cliff at the starting point of the transect. However, the cliff to the east gives way to a rocky reef and as the transect cuts diagonally eastwards, it crosses the lower part of this reef.

8.5-15.5m Rocky reef

(8.5-10.3m) Pelvetia canaliculata dominant with Catenella repens frequent and both Monodonta lineata and Littorina obtusata occasional.

(10.3-15.5m) Pelvetia canaliculata (co-dominant), Fucus spiralis (co-dominant) with Catenella repens (frequent). Present amongst the algal cover are Actinia equina, Patella sp., Littorina mariae, L. obtusata, L. saxatilis, Monodonta lineata, Chthamalus montagu and Elminius modestus.

15.5-17.5m A gap in the reef where the sandy gravelly substrate extends across the transect line.

17.5-20.5m The second part of the rocky reef. The rock in this zone is covered with dense Ascophyllum nodosum. Also present are Littorina obtusata, L. mariae, Actinia equina and Patella sp.

20.5-31m A zone of medium-grained sand with scattered large slabs of rock. Clumps of Fucus vesiculosus are sparsely distributed throughout.

31-34m A distinct zone of medium-grained sand obscured by a covering of granules. The scattered clumps of Fucus vesiculosus extend into this zone.

34-40m A band of denser Fucus vesiculosus together with F. serratus. The underlying substrate consists of fine-grained sand with scattered pebbles.

40m-200m 40m marks the beginning of the low-tide sand-flat which extends uniformly seawards, firstly consisting of fine and then (at about 125m) very fine-grained sand. The sand is densely colonised by Lanice conchilega and also supports scattered algae - mainly Enteromorpha intestinalis, Gracilaria verrucosa, Ulva lactuca and Ceramium rubrum.

(129-186m) A wetter zone with standing water and sparse Lanice conchilega.

(143m) A patch of spongy soft mud in this region.

(187-191.5m) A raised hummock of firm sand with dense shell debris.

200m to low tide Flat, featureless, smooth, very fine-grained sand supporting little life and sloping gently towards the deep-water channel.

General observations

Although there was no Zostera growing intertidally, much was washed up on the shore after recent easterly gales.

There were several people on the shore collecting winkles: two were collecting commercially and left with a sackful and two more were raking for cockles.

5.7 TRANSECT G HELFORD PASSAGE ZOSTERA BED 26.9.88

Tide: 0.1m low at Plymouth (Devonport)

QUADRATS.

0m The landward end of the transect starts at the base of the cliff wall. The 0m quadrat straddles a deep crevice in the rocky reef which forms the upper part of the shore. The quadrat is mostly bare rock but also contains :-

<u>Pelvetia canaliculata</u>	10%
<u>Verrucaria maura</u>	10%
<u>Littorina saxatilis</u>	x2

7m This quadrat again straddles the rock crevice. The crack here is floored with coarse-grained sand and pebbles. The rock on either side of the crevice supports :-

<u>Fucus</u> sp. (sporeling)	+
<u>Patella</u> sp.	x12
<u>Actinia equina</u>	x1
<u>Chthamalus montagu</u>	40%
<u>Balanus balanoides</u>	20%
<u>Elminius modestus</u>	10%
Bare rock	25%

27m The underlying substrate is fine-grained sand, 40% of which is visible, 30% is overlain by scattered pebbles and 20% is covered by a large stone which supports Elminius modestus, Balanus balanoides, 2x Littorina littorea, Fucus serratus. The latter spreading to cover a further 10% of the quadrat. Spirorbis spirorbis was attached to the F.serratus. The sand area contained 77 Lanice conchilega. The quadrat also contained cast up Ulva lactuca and Ectocarpus sp.

47m The quadrat is predominantly fine-grained sand with a covering of shell debris- mainly Bittium and Cerastoderma edule. The sand contains 23 Lanice conchilega and 2% of the surface is occupied by Ectocarpus sp.

67m 100% very fine-grained sand with little shell debris (just a few large shell fragments), 67 Lanice conchilega and trace amounts of Ectocarpus sp.

87m Very fine-grained sand with 78 Lanice conchilega (many being juveniles). Trace amounts of Ectocarpus sp.

107m Very fine-grained sand. 6 Lanice conchilega and 1 pebble with Enteromorpha intestinalis attached.

127m Very fine-grained sand with a 75% cover of shell debris. Also present were 1 Myxicola infundibulum, Ectocarpus sp. 1 live Cerastoderma edule (just protruding from beneath the surface) and 1x Pagurus bernhardus (juvenile).

N.B. The black anaerobic layer is just below the surface here (<2cm down).

- 147m Very fine-grained 'shallow sink' sand. The substrate is soft and much turned over by digging. There is about 5cm of standing water on the surface in this badly drained area. 15% of the surface is covered with shell debris and 5% Ulva lactuca.
- 167m Firm very fine-grained sand with 5% shell debris including 1 large Cerastoderma edule shell. The quadrat also contained 1 Myxicola infundibulum.
- 187m A firm substrate of very fine-grained sand with approx 5% shell debris, on the surface. Also present were Ceramium rubrum and one Pagurus bernhardus.
- 207m Firm very fine-grained sand. 15% of the quadrat is occupied by part of a hole caused by digging and this has collected shell debris. Also present was one Pagurus bernhardus in a Littorina littorea shell.

G



Transect G - Helford Passage, Zostera bed - 47m Quadrat



Transect G - Helford Passage, Zostera bed - 127m Quadrat

5.8 TRANSECT 6 HELFORD PASSAGE ZOSTERA BED 26.9.1988

ZONATION ALONG TRANSECT LINE.

0m-0.3m The top of the transect is at the base of the cliff wall, where the slope changes from the near vertical cliff to the more gently sloping reef at the top of the shore. The upper 8.7m of the transect cross this reef. 0m occurs just within the lichen zone where the species include Xanthoria parietina, Lecanora atra and Verrucaria maura.

Also present are Littorina saxatilis hidden in rock cracks.

0.3-1.2m A zone dominated by Pelvetia canaliculata. Littorina saxatilis present.

1.2-8.7m Barnacle zone. The crack in the rocks here is wide and 5.4m is the highest level at which the crack is floored with sand. In this zone Chthamalus montagu dominates with occasional Littorina saxatilis, Patella sp. Actinia equina, Littorina littorea and Anurida maritima. 3m from the top of the shore Elminius modestus starts to colonise and at 5m Balanus balanoides also occurs.

8.7-15m A 6m wide fucoid zone. The underlying substrate consisting of very coarse-grained sand topped with scattered shingle and containing occasional large rock slabs - approx. 20x20cm. Growing in this zone, either attached to the rocks or in the sand are a mixture of Fucus spiralis, Fucus vesiculosus, Ascophyllum nodosum (with parasite Polysiphonia lanosa) and Fucus serratus.

15-22m A broad zone dominated by shingle with occasional larger stones overlying coarse/very coarse-grained sand. This zone contains scattered clumps of Fucus vesiculosus.

22-30m 22m marks the point where the gently sloping beach gives way to the near horizontal mud flat. Here a substrate of fine-grained sand is overlain by scattered pebbles. The stones provide anchorage for algae, this zone being dominated by Fucus serratus and Ulva lactuca. Lanice conchilega are frequent, reaching densities of 400/m² at the base of this zone.

30-100m A wide expanse of level, puddled tidal flat. The surface is bare except for occasional shell debris and widely scattered clumps of algae either anchored through the sand or attached to pebbles or shells.

Species noted include:-

Cladostephus spongiosus, Ectocarpus sp. Ulva lactuca, Enteromorpha intestinalis, Chondrus crispus and Fucus vesiculosus. Also, Littorina littorea, Myxicola infundibulum and Lanice conchilega. Arenicola casts were rare and only recorded at 88m on the transect line.

100-106m A stonier area on a bank slightly raised above the rest of the mud-flat. Attached to the stones are Fucus serratus and Enteromorpha intestinalis.

106-119m Level puddly mud-flat covered with frequent shell debris. Signs of digging are frequent although the substrate is quite firm.

119-137m A second, raised bank covered with large blocks of slate, with many pebbles and stones having coarse shell debris trapped amongst them. Growing on the blocks are:- Fucus serratus, Enteromorpha intestinalis, Chorda filum, Ulva lactuca, Pomatoceros triqueter and Elminius modestus. Beneath them were found, Pholis gunnellus, Carcinus maenas, Cancer pagurus, Botryllus leachi, Gibbula cineraria, Littorina littorea and a chiton..

This raised area shows evidence of digging. Holes are clearly visible beside which are piles of dark black, anaerobic sub-mud. The whole area is quite churned up.

137-143m A hollow to seaward of the raised bank. The substrate is soft, very fine-grained and 'shallow sink' (up to 10cm). The area has about 4cm of standing water on the surface.

143-196m A large expanse of level mud-flat containing little visible surface life except for occasional clumps of Fucus serratus, Chorda filum and Ulva lactuca. The surface is littered with large amounts of shell debris and there is much evidence of past digging.

The zone from 150-170m is softer with a slightly 'deeper sink' whereas the rest of this very fine-grained sand is firm.

196-213m Here the tidal flat slopes southwards towards the deep water channel, the substrate consists of firm, very fine-grained sand and the surface is devoid of visible life forms.

213m Marks the extreme low tide mark.

5.9 TRANSECT I

TREATH ZOSTERA BED

25.9.1988

QUADRATS

Tide = 0.4m low at Plymouth (Devonport)

0m Blue paint spot on cliff

10m Total cover of Fucus vesiculosus which were entangled with unfixed plants of F.serratus. Beneath the algal cover is a substrate of coarse-grained sand with scattered granules. Amongst the F.vesiculosus were many Littorina spp. - probably more than indicated below, as many were very small.

Fucus vesiculosus 100%
Littorina spp. approx. x10
 plus drift material - F.serratus & 1 dead Carcinus maenas

20m The substrate here is dominated by shingle overlying coarse-grained sand. Three larger stones were set amongst these granules and attached to these were young plants of Enteromorpha sp., dead Ulva lactuca and Fucus vesiculosus. Beneath the stones were several Elminius modestus, and two juv.Carcinus maenas, with Littorina sp. on the algae.

Enteromorpha sp. 3%
Ulva lactuca 1%
Fucus vesiculosus 2%
Elminius modestus several approx. x20
Carcinus maenas x2
Littorina mariae x8

30m Medium-grained sand with a plentiful cover (approx.50%) of granules and some larger stones (approx.5x7cm). Attached to the larger stones are Enteromorpha sp., Fucus serratus and Ectocarpus sp.

Enteromorpha sp. 2%
Ectocarpus sp. 1%
Fucus serratus 2%
Lanice conchilega in sand between stones (68/m sq.) x17

40m Fine-grained sand forming the top of the low tide mud-flat. Very little growing on surface which is littered with broken shell debris giving approx.10% cover.

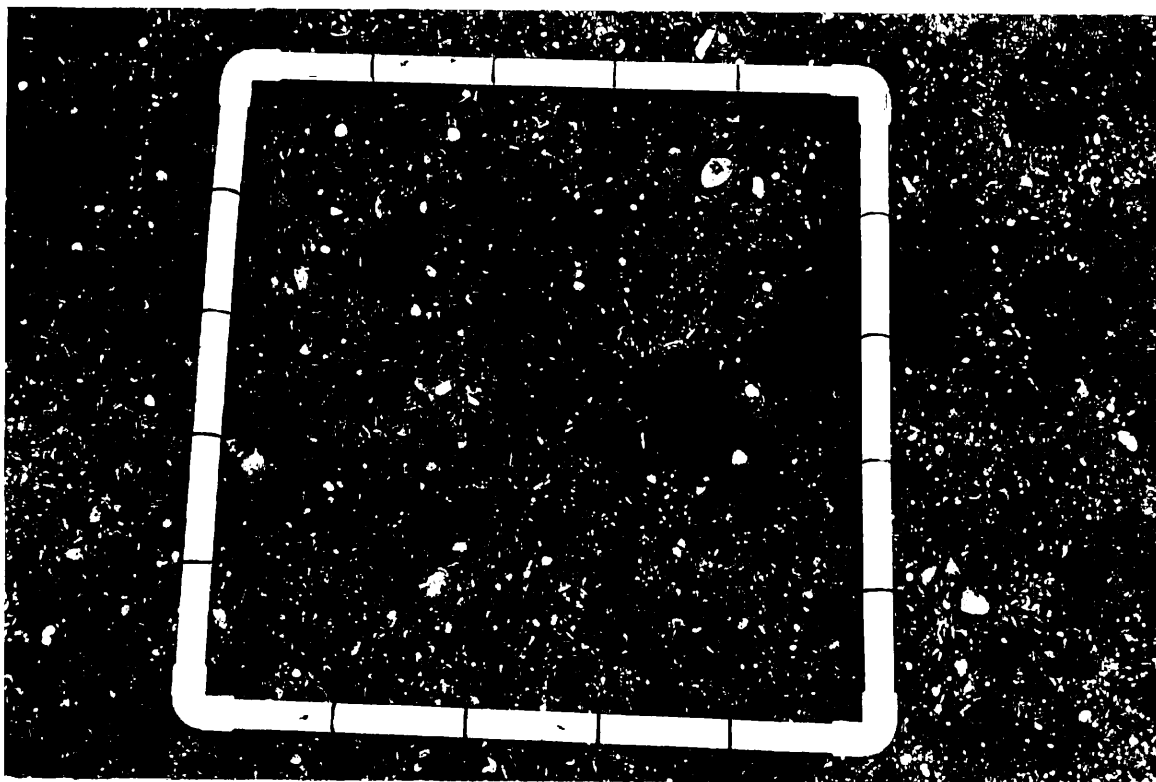
Ceramium rubrum, dead and bleached +
Ectocarpus sp. - on Ceramium +
Lanice conchilega x4

50m Very fine-grained sand, about 50% of which is black and anaerobic, brought to the surface by digging. Contains trace amounts of Ceramium rubrum and 10% shell debris.

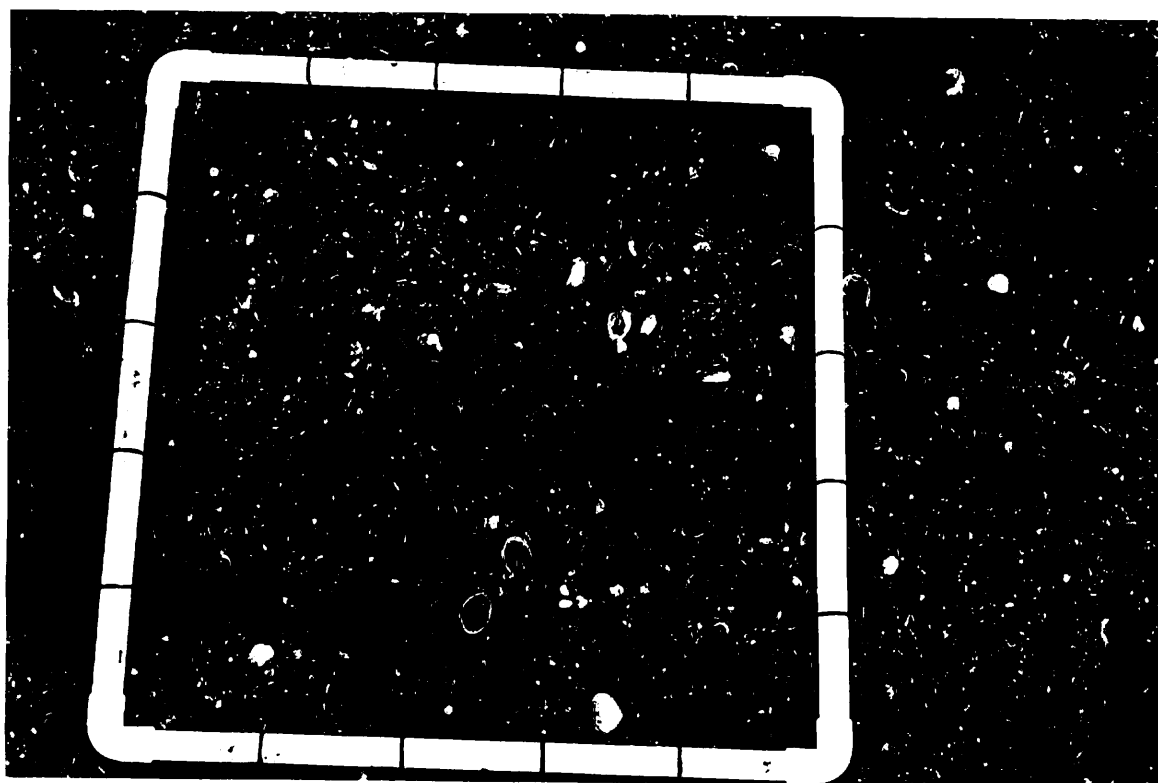
60m Very fine-grained sand, still quite firm with approx. 10-15% shell debris. No surface life visible.

- 70m Very fine-grained sand, some (approx.5%) of which is the anaerobic subsurface layer brought to the surface by digging. This quadrat contains more shell debris (approx 35%) which is comprised of fragments of Cerastoderma edule, Scrobicularia plana, Bittium reticulatum and Littorina saxatilis. Ectocarpus sp. grows on the larger shell fragments.
- 80m Very fine-grained sand and shell debris. The only surface life is a strand of Ulva lactuca attached to a valve of Cerastoderma edule (stuck in the mud) and a trace of Ectocarpus sp. on the mud surface.
- 90m Very fine-grained sand and shell debris and trace amounts of Ectocarpus sp. The sand/silt is softer (approx. 2.5cm sink).
- 100m Soft, very fine-grained sand and a scattering of shell debris. No surface life.
- 110m Very fine-grained sand with scattered shell debris. Three small strands of Ceramium rubrum with attached Ectocarpus.
- 120m Very fine-grained sand with scattered shell debris and a strand of Ceramium rubrum with attached Ectocarpus.
- 130m Bare, very fine-grained sand with sparse shell debris and a strand of Ceramium rubrum.
- 140m Bare, soft, very fine-grained sand with patches of black anaerobic mud at the surface. A scattering of shell debris and no surface life.
- 145m Low water mark

I

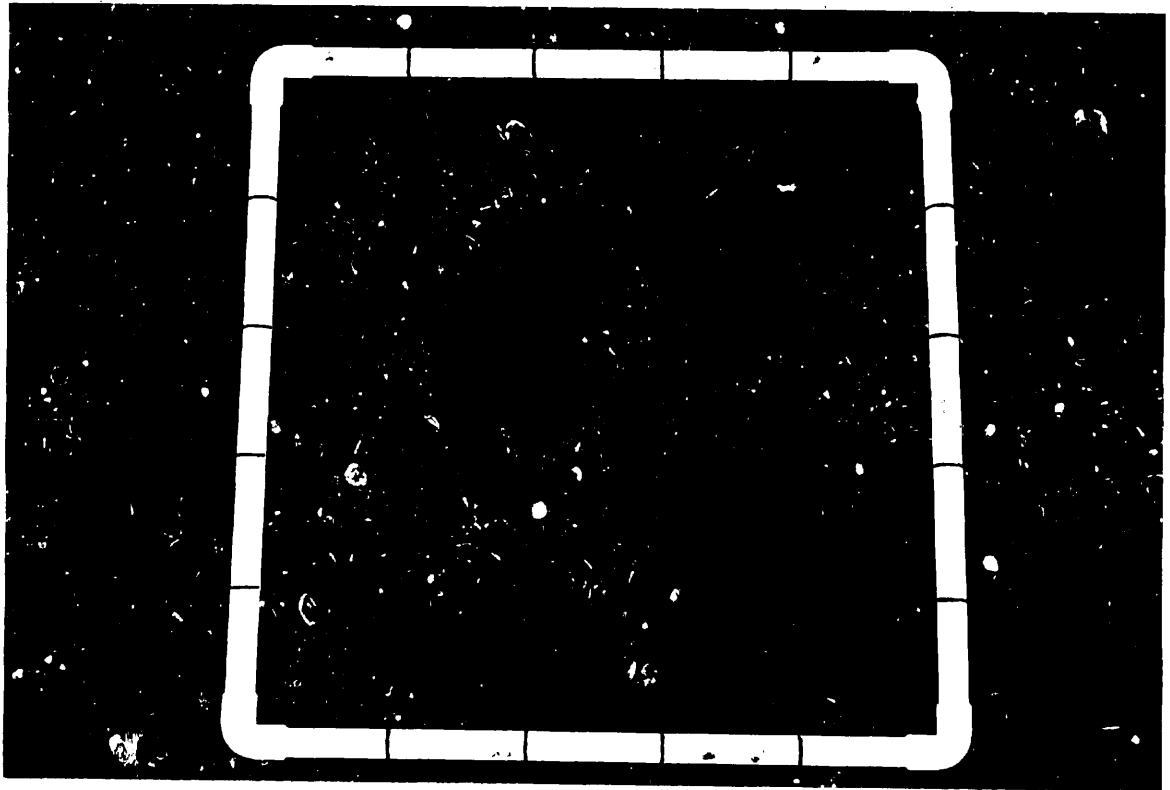


Transect I - Treath, Zostera bed - 50m Quadrat



Transect I - Treath, Zostera bed - 70m Quadrat

I cont.



Transect I - Treath, Zostera bed - 110m Quadrat

5.10 TRANSECT I TREATH ZOSTERA BED 25.9.1988

ZONATION ALONG TRANSECT LINE.

- 0-1.8m The blue dot on the rocks at the break in slope marks the top of the transect. Between 0 and 1.8m is the Lichen zone containing mainly green powdery lichens and Verrucaria maura.
- 1.8-2.1m Pelvetia canaliculata zone. At the top, Bostrychia scorpioides occurs and at the base (and extending into the Fucus spiralis zone below) is Catenella repens.
- 2.1-5.6m Fucus spiralis zone. The upper part (2.1-3.6m) is on rock at the base of the cliff, the rock beneath the algae supporting barnacles (Chthamalus montagui and Elminius modestus) and limpets (Patella sp.). Amongst the algal cover are Monodonta lineata and Anurida maritima. The lower part of the zone (3.6-5.6m) overlies coarse-grained sand with granules and scattered small pebbles on a gentle slope from the cliff base. Littorina obtusata is present on Fucus spiralis.
- 5.6-13.6m F. spiralis gives way to a dense cover of mainly Fucus vesiculosus with occasional Ascophyllum nodosum. The shore continues to slope gently from the base of the cliff towards the mudflat.
- 13.6-28.6m Fucus vesiculosus thins, revealing shingly gravel, pebbles and larger stones amongst the algal cover. The larger stones support Enteromorpha sp., Fucus vesiculosus and occasional F. serratus.
- 28.6-34.3m The substrate changes from here. The grain size diminishes with coarse-grained sand dominant, underlying occasional granules and larger stones which support sparse Fucus vesiculosus and F. serratus.
- 34.3-38.3m 34.3m marks the end of the Fucus vesiculosus and F. serratus zone. The slope becomes very gentle with a substrate of coarse sand, shell debris and a few scattered large stones. The absence of shingle allows Lanice conchilega to colonise, with an average density of approx. 100/m sq.
- 38.3-145m Start of the low tide mud-flat. This area is largely bare, very fine-grained sand with little surface life - just scattered shell debris and occasional Fucus serratus on large stones, with scattered Myxicola infundibulum protruding from their holes. Lanice conchilega are very widely scattered. Here and there small strands of Ceramium rubrum occur and on these, as well as the mud surface, are patches of Ectocarpus species.

The mud-flat is level, with no large erosion hollows, just gentle undulations. Frequent patches of dark black anaerobic sub-surface mud mark the sites of digging.

6.

DISCUSSION OF RESULTS

6.1 The disappearance of *Zostera marina* from the intertidal zone

The most striking change in the transects since 1986 is the total disappearance of *Zostera marina* (Common Eelgrass) from the intertidal zones of the shores at Treath and Helford Passage where it was previously recorded.

Transect F at Helford Passage showed *Zostera* densities of up to 42 plants per 0.25m sq in 1986 and transect G had even greater amounts, up to 66 plants per 0.25m sq. In 1988 all traces of *Zostera marina* had gone. A search of the whole shore revealed none; not a leaf, root or rhizome was left growing. The hummocks that formed the raised beds were still in place and even had the dense deposits of shell debris that collect between the *Zostera* stems and leaves, so the plants were obviously not eroded away by wave action or these relics would also have gone.

The shore at Treath told a similar story. Transect I had crossed the *Zostera* bed and recorded densities of up to 74 plants per 0.25m sq but as at Helford Passage not a trace remained.

The disappearance of the *Zostera* has also meant the loss of associated epiphytic algae, bryozoans, hydroids, gastropods etc.

Worthy of note is the presence of rooted pieces of apparently healthy *Zostera marina* washed up on the strand line at Treath and Helford Passage. These fragments may have been cast up from subtidal beds after recent easterly gales.

6.2 The increase of *Lanice conchilega* in areas previously occupied by *Zostera marina*

Associated with the disappearance of the *Zostera* beds from the shore at Helford Passage is an increase in the numbers of *Lanice conchilega* (Sandmason Worm) in the areas previously occupied by the *Zostera*.

In general on this shore the numbers of *Lanice* show a decrease since 1986 (see C below). However in areas corresponding exactly with those occupied by *Zostera*, the *Lanice* show up to 56-fold increases. This near perfect correlation is seen in quadrats on both Transects F and G at Helford Passage.

At Treath however there did not seem to be this associated invasion of *Lanice*: numbers seem much the same as in 1986 with very slight increases in the top part of the *Zostera* beds and just above them. This is thought to be due to the nature of the shore at Treath, where a sand bar low on the shore dams water draining from further up the beach. This forms a lagoon of standing water to landward of the bar, covering the area once occupied by *Zostera*. This theory is supported by the quadrat data which reveals that those areas showing an increase in *Lanice* are just above the lagoon of standing water.

6.3 The general decrease in numbers of *Lanice conchilega* over the low tide flats

It was noted from Transect C at Flushing and Transects F and G at Helford Passage that numbers of *Lanice conchilega* on the low tide flats have decreased, except in areas once occupied by *Zostera marina*. This decrease was especially noticeable in the quadrats at Flushing where the average decrease over the whole transect was 58%. Here it seemed that the *Lanice* had become partially buried. Very few had their tube fringes intact and the tops of most of their tubes were level with the sand-flat or just below the surface. Disturbance of the surface revealed more *Lanice* buried below. There were also large numbers of broken and empty tubes lying about on the sand surface.

Transects F and G at Helford Passage told a similar story with average decreases of 19% and 62% respectively. As discussed above, Treath Beach showed little change in numbers between 1986 and 1988.

This could be a short-term effect of recent storm damage rather than a more long-term process of increased sedimentation.

In addition to the more noticeable trends discussed above, there were other smaller differences that, although not definite trends, are worthy of mention.

6.4 The increase in numbers of *Myxicola infundibulum* at Treath and Helford Passage.

The numbers of *Myxicola infundibulum* (Slime Tube-worm) on the low tide flats at Treath and Helford Passage show a slight increase. Transect G picked up *Myxicola* in quadrats where there were none in 1986 and this increase seems to be borne out by general observations made walking over the flats.

At Treath, although not picked up in the quadrats, the general descriptions of ecotones made no mention of *Myxicola* in 1986 but describe them as scattered over the flat in 1988.

Once again this is in the approximate area of the *Zostera* bed, but as *Myxicola* are far less numerous than *Lanice*, it is not possible to gather enough data to detect an inverse relationship between the *Myxicola* increase and the disappearance of the *Zostera*. It could be that the lack of *Zostera* makes the *Myxicola* easier to see as they are not easily visible when retracted.

6.5 A decrease in numbers of *Arenicola marina* at Treath

In 1986 *Arenicola marina* (Lugworm) casts and mounds were noted on the low tide flats at Treath in the general description of ecotones (although none were picked up in the quadrats).

In 1988 none were noted in the area of the transect line and, in general, numbers on the shore seemed fewer.

NB Some minor discrepancies thought to be due to slightly different positioning of the top of the transect line occurred causing small changes in the longitudinal positioning of the quadrats down the shore. These differences, although slight, show up on the variable, rocky reefs where ecotones are close together and crevices and pinnacles cause rapid transitions from one to another. Such errors should not occur in future years now that the top of every transect line has been precisely marked with blue paint. It is hoped that these paint spots will be replaced by permanent bolts in due course.

APPENDIX 1

1986 data for transects re-recorded in 1988

(Transects C,E,F,G & I)

1.a) TRANSECT C

FLUSHING COVE

Recorded on 11.3.1986 (except for the reef which was surveyed on 8.4.1986). Tide: 0.6m low at Plymouth (Devonport)

QUADRATS

0m Sheer rock face forming the base of the cliff. No life.

5m Quadrat on the southwest-facing side of a deep gully between the rocks.

<u>Patella</u> sp.	x18
<u>Fucus spiralis</u>	15%
<u>Audouinella</u> sp.	5%
<u>Enteromorpha intestinalis</u>	5%
<u>Hildenbrandia</u> sp.	1%
<u>Littorina saxatilis</u>	approx x68
<u>Chthamalus montagu</u>	approx.12600 35%
<u>Catenella repens</u>	5%
Bare rock	30%

10m Nearly horizontal but slightly seaward sloping rocky ridge. One small pool in centre. approx. 20cm sq.

<u>Patella</u> sp.	x26
<u>Spirorbis</u> sp.	+
<u>Littorina saxatilis</u> agg.	x6
" <u>Lithothamnia</u> "	8%
<u>Hymeniacidon perleve</u>	+
<u>Gastroclonium ovatum</u>	+
<u>Balanus balanoides</u> } 8%	NB all three species together covered appr.40%
<u>Chthamalus stellatus</u> } 2%	
<u>Chthamalus montagu</u> } 90%	
<u>Balanus perforatus</u>	x1
<u>Hildenbrandia</u> sp.	+
<u>Verrucaria maura</u>	+
Bare rock	50%

15m Flat algal-covered rock platform near the sand

<u>Fucus serratus</u>	50%
<u>Gigartina stellata</u>	+
<u>Spirorbis spirorbis</u>	on 3% of <u>Fucus serratus</u>
' <u>Lithothamnia</u> '	25%
<u>Pomatoceros triqueter</u>	+
<u>Verrucaria maura</u> agg.	+
<u>Patella</u> sp.	x5
<u>Littorina mariae</u>	x1
<u>Fucus spiralis</u>	5%
<u>Hymeniacidon perleve</u>	+
<u>Catenella repens</u>	1%
<u>Littorina littorea</u>	x1
Pebbles + bare rock	15%

20m At base of rocks. 80% fine-grained sand, 60% of which is covered with pulverised rotten algal remains. 20% is occupied by a large rock.

<u>Fucus serratus</u>	On rock	25%
<u>Spirorbis spirorbis</u> On <u>Fucus</u>		+
<u>Audouinella</u> sp.	On rock	10%
<u>Chondrus crispus</u>	On rock	
<u>Ulva lactuca</u>	On <u>Chondrus</u>	
<u>Fomatoceros triqueter</u>	On rock	
<u>Anomia ephippium</u>	On rock	
<u>'Lithothamnium'</u>	On rock	
<u>Balanus balanoides</u>	On rock	
<u>Lanice conchilega</u>	In sand	x9
<u>Littorina littoralis</u>	On <u>Fucus</u>	x1

25m Fine-grained, rippled sand. No algae

<u>Lanice conchilega</u>	x16
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30m Fine grained rippled sand, a few algal fragments

<u>Laminaria saccharina</u>	x1
<u>Lanice conchilega</u>	x24

35m Fine-grained rippled sand, a few algal fragments.

<u>Lanice conchilega</u>	x44
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40m Fine-grained rippled sand, a few algal fragments.

<u>Lanice conchilega</u>	x35
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45m Fine grained rippled sand, a few algal fragments.

<u>Lanice conchilega</u>	x46
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50m Fine-grained rippled sand, a few algal fragments.

<u>Lanice conchilega</u>	x55
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55m Fine-grained rippled sand, a few algal fragments.

<u>Lanice conchilega</u>	x47
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60m Fine-grained rippled sand, a few algal fragments.

<u>Lanice conchilega</u>	x38
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65m Fine-grained rippled sand, a few algal fragments

<u>Lanice conchilega</u>	x9
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70m Fine-grained rippled sand, a few algal fragments

<u>Lanice conchilega</u>	x52
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75m	Fine-grained rippled sand, a few algal fragments	
	<u>Lanice conchilega</u>	x41
80m	Fine-grained rippled sand, a few algal fragments	
	<u>Lanice conchilega</u>	x33
85m	Fine-grained rippled sand, a few algal fragments	
	<u>Lanice conchilega</u>	x45
	<u>Eulalia viridis</u> egg sack.	x1
90m	Fine-grained rippled sand, a few algal fragments.	
	<u>Lanice conchilega</u>	x44
95m	Fine-grained rippled sand, a few algal fragments.	
	<u>Lanice conchilega</u>	x21
100m	Fine-grained rippled sand, a few algal fragments.	
	<u>Lanice conchilega</u>	x54

Low tide

1.b) TRANSECT E DENNIS HEAD

12.3.1986 & 26.3.1986

QUADRATS

0m Landward end of transect, mostly bare rock in the Lichen zone. The dominant lichen is the dark orange Caloplaca sp. with little of the more yellow Xanthoria parietina (This is just above the Verrucaria zone).

5m Rocky base of cliff sloping fairly steeply seawards.

<u>Chthamalus stellatus</u>	5% of 16300
<u>C. montagu</u>	95% of 16300
<u>Pelvetia canaliculata</u>	2%
<u>Littorina saxatilis</u> & <u>L. neritoides</u>	of 2700 equal proportions of each. Very small individuals in the cracks between the barnacles.
<u>Lichina pygmaea</u> .	

10m Steeply sloping sheltered landward side of a large crag .

<u>Lichina pygmaea</u>		0.5%
<u>Pelvetia canaliculata</u>		1%
<u>Modiolus</u> sp.	}	x1
' <u>Lithothamnium</u> '	}	in rock pools
<u>Patella</u> sp.	}	x3
<u>Littorina saxatilis</u> & <u>L. neritoides</u>		x1100
<u>Chthamalus montagu</u>		x12500

15m Flat rock platform on the seaward side of the crag. approx. 20% of the quadrat is rock pools.

<u>Lichina pygmaea</u>		10%
<u>Fucus serratus</u>		0.5%
<u>Patella</u> sp.	mostly in pools	x20
<u>Actinia equina</u>		x3
<u>Corallina officinalis</u>	in pools	0.5%
' <u>Lithothamnium</u> '	in pools	20%
<u>Modiolus</u> sp.		x1
<u>Littorina neritoides</u>		x800
<u>Littorina saxatilis</u>	in pool	x1
<u>Chthamalus stellatus</u>		2% of 11700
<u>Chthamalus montagu</u>		98% of 11700
<u>Spirorbis</u> sp.	in pool	+

20m Flat rock platform a step down from Qu. 15m
No pools.

<u>Fucus serratus</u>		5%
<u>Patella</u> sp.		x33
<u>Fucus vesiculosus</u>		5%
<u>Actinia equina</u>	in cracks	x2
<u>Modiolus</u> sp.	V. tiny, amongst barnacles	approx. x10
<u>Balanus balanoides</u>		8% of 14700
<u>Chthamalus montagu</u>		90% of 14700
<u>Chthamalus stellatus</u>		2% of 14700
' <u>Lithothamnium</u> '	in cracks	1%

Modiolus sp. x3
Littorina neritoides) V.tiny amongst barnacles approx. x80
Littorina saxatilis)
 Black shiny encrusting algae on Patella sp.

NB Not a very low tide because of E.wind + only a 0.7 spring, to be continued on a better day.

Continued on 26.3.1986

25m Uneven rock platform sloping south-eastwards.

<u>Patella</u> sp.	x23
<u>Fucus vesiculosus</u>	5%
<u>Fucus serratus</u>	10%
<u>Laurencia pinnatifida</u>	4%
<u>Hymeniacion perleve</u>	1%
<u>Halichondria panicea</u>	0.5%
' <u>Lithothamnia</u> '	15%
<u>Spirorbis borealis</u>	+
<u>Pomatoceros triqueter</u>	+
<u>Balanus balanoides</u>	8% of approx.7500
<u>Chthamalus stellatus</u>	2% of approx.7500
<u>Chthamalus montagu</u>	90% of approx.7500
<u>Hildenbrandia</u> sp.	+
<u>Balanus perforatus</u>	approx. 40
<u>Himantalia elongata</u>	small 'button' x1.
<u>Modiolus</u> sp.	several in cracks & in empty barnacles. +
<u>Mytilus edulis</u>	x1
<u>Littorina neritoides</u>	x6
Bare rock	30%
Barnacles	34%
Black nobbly algae on <u>Patella</u> sp.	+

30m About half the quadrat is rock pool full of Laminaria digitata. Quadrat spans a large deep crack running parallel to the sea.

<u>Corallina officinalis</u>	30%
' <u>Lithothamnia</u> '	2%
<u>Mesophyllum lichenoides</u> (on <u>Corallina</u>)	2%
<u>Anomia ephippium</u>	approx. x50
<u>Himantalia elongata</u>	3%
<u>Gigartina stellata</u>	15%
<u>Hymeniacion perleve</u>	+
<u>Spirorbis spirorbis</u> on <u>Gigartina</u>	+
<u>Gastroclonium ovatum</u>	+
<u>Hildenbrandia</u> sp.	+
<u>Plumaria elegans</u>	+
<u>Laminaria digitata</u>	out of pool 5%; in pool 50%
<u>Eulalia viridis</u> - eggsacks	x1

35m Quadrat is on the seaward side, of a rocky reef sloping steeply down to the water level at low tide, so one corner of the the quadrat is still submerged at low water.

<u>Gigartina stellata</u>	10%
<u>Laminaria digitata</u>	10%
<u>Himantalia elongata</u>	2%

<u>Ulva lactuca</u>		+
<u>Spirorbis borealis</u>	on weeds	+
<u>'Lithothamnium'</u>		35%
<u>Corallina officinalis</u>		7%
<u>Fucus serratus</u>		5%
<u>Pomatoceros triqueter</u>		+
<u>Laurencia pinnatifida</u>		1%
<u>Monodonta lineata</u>		x1
<u>Patella sp.</u>		x1
<u>Anomia ephippium</u> (prob. <u>Heteranomia squamula</u> SM)	approx.	50
<u>Cladophora rupestris</u>		+
<u>Gastroclonium ovatum</u>		2%
<u>Nassarius incrassatus</u>		x1
<u>Gelidium latifolium</u>		2%
<u>Balanus perforatus</u>		x2
<u>Botryllus schlosseri</u>		+

Low tide!

1.c) TRANSECT E.

DENNIS HEAD

1.10.86

ZONATION ALONG TRANSECT LINE

The transect line is situated on rocks of the Devonian Gramscatho beds, sloping gently seawards approx. 20 degrees ESE. The rocks extend from the base of the cliff to low water and beyond descending to sea level in a series of rough steps.

0-0.8m Mainly bare rock with patches of Caloplaca sp. and Xanthoria parietina.

0.8-4m The Verrucaria maura zone starts at 0.8m, intermittent and patchy at first, becoming more continuous down the shore, with Littorina saxatilis and L. neritoides (rather more of the latter) nestling in crevices. Near the base of the zone scattered barnacles appear -- Chthamalus montagui. Ligia sp. present.

4m Start of barnacle zone. The rocks are densely covered with Chthamalus montagui and Littorina neritoides. L. saxatilis nestles between the barnacles and in the crevices. Also present are scattered Patella sp. and patches of Hildenbrandia in crevices. On rock faces with a more sheltered aspect are patches of Lichina pygmaea.

(4.3m) Also present from 4.3m downwards are small clumps of Pelvetia canaliculata.

(7-8.9m) A deep, wide crack. The walls of which are nearly vertical and support patches of Lichina pygmaea, Pelvetia canaliculata and Fucus spiralis. Here a few Balanus balanoides start to appear, scattered throughout the Chthamalus population.

(7.7-8.6m) A rock pool fills the base of the crack. The pool is lined with 'Lithothamnia' and the walls are covered with Corallina sp. The other main alga is Ulva lactuca. Also present are scattered Patella sp. Hymeniacidon perleve, Halichondria panicea and Gigartina stellata. Actinia equina occasional. Enteromorpha intestinalis and Ceramium rubrum Common, with a few Mytilus edulis in the basal crack.

(10.3-11m) A rock pinnacle leads back into the Verrucaria zone, because of its elevation. Verrucaria maura, thinner C. montagui cover, L. saxatilis and L. neritoides.

(11.4-11.7m) Another shallow rock pool in a crevice contains 'Lithothamnia', Patella sp., Cladophora sp., Ulva lactuca, Mytilus edulis, Corallina officinalis.

(12-12.3m) Another patch of Verrucaria zone on a rock pinnacle.

(13.4-18m) The level drops steeply by about 1m and scattered patches of algae occur. Fucus spiralis is present with clumps of Lichina pygmaea and Hymeniacidon perleve. The numbers of Balanus balanoides increase.

This area is a flatter plateau with scattered shallow rock pools containing similar life to that described above). Still plentiful Littorina saxatilis and L. neritoides and scattered Patella sp and Anurida maritima. 1 juvenile Carcinus maenas and Eulalia viridis.

(16.4m) Actinia equina occurs in crevices.

18-22m The level drops in a series of steps. The amount of Fucus spiralis increasing.

(20m) At 20m F. spiralis gives quite thick cover, supporting Littorina sp.

(21.6m) An overhang under which are 'Lithothamnia', Archidoris pseudoargus (juvenile), Balanus perforatus, Pomatoceros triqueter, Halichondria panicea, Hymeniacidon perleve, Patella sp. Spirorbis sp. Mytilus sp. and Balanus balanoides.

22m Fucus serratus appears as the level reaches the lower shore zone of dense algal cover.

22.6m Higher rock with F. spiralis and F. vesiculosus.

26.2-27.7m Another channel brings in the lower shore algal zone.

27.7-29.6m Last area of F. spiralis-covered rock.

29.6m Into the kelp zone-

Fucus serratus
Laminaria digitata
Himanthalia elongata
Laurencia pinnatifida
Callithamnion sp.
Hymeniacidon perleve
Halichondria panicea
Ceramium rubrum
Corallina officinalis
Pomatoceros triqueter
Gibbula cineraria
'Lithothamnia'
Ralfsia sp.

1.d) TRANSECT F

HELFORD PASSAGE

27.3.1986

Tide: 0.4 at Plymouth. (Devonport)

QUADRATS

20m Rocky shore, just before sand starts. Fairly flat rock sloping slightly seawards.

<u>Ascophyllum nodosum</u>	60%
<u>Fucus vesiculosus</u>	20%
<u>Balanus balanoides</u>	approx. 8200
<u>Patella</u> sp.	x3
<u>Hildenbrandia</u> sp.	+
<u>Spirorbis</u> sp.	+
<u>Littorina mariaae</u>	x1
<u>Littorina obtusata</u>	x1
<u>Actinia equina</u>	x1
<u>Pomatoceros triqueter</u>	+
<u>Modiolus</u> sp.	x1
<u>Fucus serratus</u>	1%
Rocks and loose pebbles.	20%

40m Fine grained sand, gently rippled with a few pebbles.

<u>Lanice conchilega</u>	x77
<u>Ceramium rubrum</u>	x1

60m Fine-grained sand, no ripples, with numerous granules, half buried in the sand.

<u>Lanice conchilega</u>	x195
<u>Enteromorpha</u> sp.	+
<u>Ulva lactuca</u>	+
<u>Ectocarpus</u> sp.	+
<u>Littorina saxatilis</u>	x1

80m Fine-grained sand, some faint, disjointed ripples, a few granules and some tiny empty shells.

<u>Gracilaria verrucosa</u>	1%
<u>Enteromorpha</u> sp.	+
<u>Ulva lactuca</u>	+
<u>Littorina littorea</u>	x1
<u>Lanice conchilega</u>	x178

100m Fine-grained sand, more lumpy than rippled, probably due to Zostera trapping sand, shell debris and granules.

<u>Lanice conchilega</u>	x117
<u>Zostera marina</u>	x28
<u>Littorina littorea</u>	x3
<u>Enteromorpha</u> sp.	+
<u>Ectocarpus</u> sp.	1%

120m Very fine-grained sand, very slightly rippled. A few granules and some shell debris.

<u>Zostera marina</u>	x42
<u>Lanice conchilega</u>	x1
<u>Littorina littorea</u>	x1
<u>Ectocarpus</u> sp.	+

130m Very fine-grained sand, slightly rippled. A few pebbles and granules and shell debris (15%).

<u>Zostera marina</u>	10%
<u>Ectocarpus</u> sp.	1%
<u>Ulva lactuca</u>	+
<u>Enteromorpha</u> sp.	+

140m Very fine-grained sand under about 25mm of standing water. A few pebbles and granules with shell debris (approx 10%).

<u>Enteromorpha</u> sp.	+
<u>Ectocarpus</u> sp.	+

160m Very fine-grained sand, slightly rippled, a little shell debris with a few granules. Surface fairly bare.

<u>Enteromorpha intestinalis</u>	+
<u>Enteromorpha</u> sp.	+
<u>Ectocarpus</u> sp.	+
<u>Gracilaria verrucosa</u>	+

180m Very fine-grained sand, no rippling or shell debris, no pebbles or granules.

<u>Enteromorpha</u> sp.	+
<u>Ectocarpus</u> sp.	0.5%

200m Very fine-grained sand and shell debris, no ripples.

<u>Enteromorpha</u> sp.	+
<u>Ectocarpus</u> sp.	1%
<u>Ulva lactuca</u>	+

220m Very fine-grained sand, faintly rippled.

Extreme low tide! Water drops to end of main bar which then seems to shelve away to below low water level.

N.B This transect missed the main Zostera bed.

1.e) TRANSECT G. HELFORD PASSAGE ZOSTERA BED.

7.5.86

QUADRATS

0m Landward end of transect, at the top of the crack in the rocks where it merges into the cliff wall.

The quadrat is mostly bare rock, sloping steeply on either side down to the crack which runs down the centre.

<u>Pelvetia canaliculata</u>		+
<u>Littorina saxatilis</u>	in base of crack	x20
<u>Enteromorpha intestinalis</u>		0.5%
<u>Verrucaria maura</u>		20%
<u>Caloplaca</u> sp.		+
<u>Xanthoria parietina</u>		+

7m The base of the crack in the rocks where it reaches the sand. The quadrat once again straddles the crack which is about 30cm wide here and not very deep. The wide base of the crack is floored by very coarse sand / 'granules', empty shells and several large flat pebbles up to 20x10cm. Overlying this is:-

<u>Fucus spiralis</u>		20%
<u>Littorina littorea</u>		x2
<u>Littorina mariaae</u>	on <u>Fucus</u>	x1
On the sides of the crack are:-		
<u>Patella</u> sp.		x19
<u>Littorina saxatilis</u>	in empty barnacles	x5
<u>Balanus balanoides</u>		50% of 300
<u>Chthamalus montagu</u>		50% of 300

27m Fine-grained sand overlain by a few small pebbles (approx. 2x2cm), a few smaller 'granules' and empty shells with one large stone taking up approx. 25% of the quadrat.

<u>Fucus serratus</u>		50%
<u>Lanice conchilega</u>		x154
<u>Littorina littorea</u>		x6
<u>Littorina saxatilis</u>		x1
<u>Gammarus</u> sp.	Several some approx. 15mm long	
<u>Chiton</u>	on pebble	x1
<u>Balanus balanoides</u>	on large stone	x49
<u>Elminius modestus</u>		x1
<u>Littorina mariaae</u>		x1

47m Fine-grained sand, faintly rippled, one stone approx. 5x3cm.

<u>Lutraria lutraria</u>	empty shell protruding from sand.	x1
<u>Lanice conchilega</u>		x101
<u>Polysiphonia</u> sp.	on <u>Lutraria</u>	+
<u>Ulva lactuca</u>		0.5%
<u>Chaetomorpha</u> sp.		+
<u>Ectocarpus</u> sp.		+
<u>Arenicola</u> sp.	cast	x1

67m Fine-grained sand, faintly rippled.

<u>Lanice conchilega</u>	x160
<u>Ulva lactuca</u>	0.5%
<u>Enteromorpha intestinalis</u>	+
<u>Ectocarpus</u> sp.	+
Anomiids approx. 2mm on <u>Lanice</u> fringe	x7
Hermit Crab in <u>Bittium reticulatum</u> shell	x1

87m Fine-grained sand, gently rippled, no shell debris or stones.

<u>Zostera marina</u>	x66
<u>Lanice conchilega</u>	x71
<u>Ectocarpus</u> sp.	+
<u>Polysiphonia</u> sp.	+
<u>Ulva lactuca</u>	+

25.4.1986

107m Very soft, very fine-grained sand with ankle-deep standing water.

<u>Gracilaria verrucosa</u>	2%
<u>Ectocarpus</u> sp.	+
<u>Enteromorpha</u> sp.	+

127m Very soft 'shallow sink', very fine grained sand, ankle deep standing water.

<u>Ectocarpus</u> sp.	+
<u>Ulva lactuca</u>	+
<u>Enteromorpha</u> sp.	+
<u>Zostera marina</u>	x1

147m Very fine-grained sand.

<u>Cerastoderma edule</u> (juvenile)	x1
<u>Enteromorpha intestinalis</u>	+
<u>Ulva lactuca</u>	+
<u>Ectocarpus</u> sp.	+

167m Very fine-grained sand.

<u>Ulva lactuca</u>	+
<u>Enteromorpha</u> sp.	x1
<u>Ectocarpus</u> sp.	+

187m Very fine-grained sand.

<u>Enteromorpha</u> sp.	1%
<u>Ulva lactuca</u>	1%
<u>Ectocarpus</u> sp.	+

210m Extreme low water.

N.B 7.5.1986 Mud shows signs of fairly recent digging not noticed before. Inshore from the Zostera (not actually on the bed) are hummocks and uneven areas of grey sub-mud brought up from below, obviously the result of bait or shellfish digging.

1.f) TRANSECT G. HELTFORD PASSAGE ZOSTERA BED 25.4.86

ZONATION ALONG TRANSECT LINE.

- 0m Base of cliff supporting Pelvetia canaliculata,
Enteromorpha intestinalis, Littorina saxatilis,
Verrucaria maura, Caloplaca sp and Xanthoria parietina.
- 7m Base of rocks.
- 7-19m Cobbles and gravel with scattered clumps of Fucus vesiculosus.
- 19-22m Fine-grained sand with scattered Lanice conchilega, overlain with a dense cover of Fucus serratus.
- 22-30m Fine-grained sand, with a few small boulders and a sparse cover of Fucus serratus. Increasing numbers of Lanice conchilega. Pools of shallow standing water on the surface.
- 30-37m Boulders and cobbles etc. disappear and shore is dominated by fine-grained sand with many Lanice conchilega.
- 37-77.4m Fine-grained sand dominated by Lanice conchilega, interspersed with Ectocarpus sp. Enteromorpha intestinalis and Ulva lactuca.
- 77.4-82.6m Fine-grained sand with dominant Lanice conchilega and sparse Ectocarpus sp. Enteromorpha intestinalis and Ulva lactuca. Zostera marina appearing very sparsely (about 1 plant 0.25m).
- 82.6m Start of the main Zostera bed.
- 85.8-86.6m Small erosion pan in the Zostera bed. Softer sand, standing water and no Zostera.
- 87.7-88.8m Another erosion pan, as above, no Zostera
- 93.8-96.2m Erosion pan as above but containing very sparse Zostera plants.
- 98.5-100.8m Erosion pan as above, sparse Zostera plants
- 104.7-109.4m Large, deep erosion pan, with ankle-deep standing water; sand very soft and Zostera plants very sparse.
- 109.4-111.7m Soft, fine sand with a rubble of pebbles on the surface. Various algae coming in with the Zostera - Fucus serratus, Ulva lactuca, Enteromorpha intestinalis and Ectocarpus sp.

- 111.7-118.4m Zostera bed here becomes rather lower and is covered with standing water to a depth of about 60cm. Has a much denser cover of other algae here- Ectocarpus sp. Polysiphonia sp., Enteromorpha intestinalis & Ulva lactuca.
- 118.4-120m Erosion pan with softer sand and standing water to a depth of about 8cm. Contains a gravel of shell debris mainly Bittium reticulatum. No Zostera.
- 120-126.6m Reverting to the raised Zostera bed but still with a fair amount of algae - Ulva lactuca, Enteromorpha intestinalis, Polysiphonia sp. Ectocarpus sp.
- 126.6-128.1m Soft sand in erosion pan, ankle deep. Standing water. No Zostera.
- 128.1-130.6m Last piece of Zostera.
- 130.6-133.5m Pebbles and dead shell gravel on very fine grained sand, occasional larger boulders with Fucus serratus growing on them. Ectocarpus sp. and Ulva lactuca growing on sand. No Zostera.
- 133.5-157m Soft very fine grained sand and about 8cm of standing water. plenty of Ectocarpus sp., Enteromorpha intestinalis and Ulva lactuca. Many empty shells lying on the sand surface - mainly Bittium reticulatum. Numerous empty shells of Lutraria lutaria and Ensis sp. protruding open-ended from the sand - possibly an indication of slow erosion.
- 157-181.1m Similar to above but with very little standing water. Soft sand, dead shells on surface and protruding from sand.
- 181.1-187m Changes slightly, no standing water at all - surface of the sand is dry. Lots of empty shells on surface and Enteromorpha intestinalis. Ectocarpus sp. Ulva lactuca growing in the sand.
- 187-203m The algae more or less disappear leaving only a little Ectocarpus sp. Enteromorpha intestinalis, Ulva lactuca and a few pieces of scattered Fucus serratus on moorings. Still numerous dead shells on the surface with Lutraria and Ensis protruding from the sand.
- 203-210m The sand bank starts to slope towards the centre of the River, into the deep water channel. Very smooth, dry surface - no puddles or standing water. Very fine-grained sand with a bare erosive surface and no weed or dead shells.
- 210-215m Waters edge at extreme low tide.
- 215m The edge of the deep water channel.

1.g) TRANSECT I

TREATH ZOSTERA BED

9.5.86

Tide: 0.9m low at Plymouth (Devonport).

QUADRATS

10m Coarse-grained sand with some granules and stones.

<u>Fucus vesiculosus</u>)	30%
<u>Fucus spiralis</u>)	
<u>Cladophora rupestris</u>	5%
<u>Balanus balanoides</u>	x6
<u>Littorina mariae</u>	x2

20m Medium-grained sand with pebbles.

<u>Fucus vesiculosus</u>	50%
<u>Littorina mariae</u>	x3
<u>Spirorbis</u> sp.	x2

30m Medium-grained sand with some granules and pebbles.

<u>Fucus serratus</u>	15%
<u>Fucus vesiculosus</u> and <u>Polysiphonia</u> sp.	10%
<u>Lanice conchilega</u>	x12
<u>Spirorbis</u> sp.	x2

40m Fine-grained sand with a small amount of shell debris and an Arenicola mound.

<u>Ectocarpus</u> sp.	5%
<u>Ceramium rubrum</u>	1%
<u>Ulva lactuca</u>	1%
<u>Zostera marina</u>	x30
<u>Arenicola</u> sp.	x1

50m Very fine-grained sand with approximately 5cm of standing water.

<u>Enteromorpha intestinalis</u>	50%
<u>Ectocarpus</u> sp.	10%
<u>Ulva lactuca</u>	5%
<u>Dumontia incrassata</u>	1%
<u>Ceramium rubrum</u>	1%
<u>Zostera marina</u>	x17

60m Very fine-grained sand with same shell debris.

<u>Ectocarpus</u> sp.	50%
<u>Ulva lactuca</u>	1%
<u>Enteromorpha intestinalis</u>	+
<u>Zostera marina</u>	x62

70m Very fine-grained sand with lots of shell debris (mostly Bittium reticulatum). 20cm of standing water.

<u>Ectocarpus</u> sp.	50%
<u>Dumontia incrassata</u>	5%
<u>Ulva lactuca</u>	1%
<u>Zostera marina</u>	x74

80m Very fine-grained sand with lots of shell debris (mostly Bittium reticulatum).

<u>Enteromorpha intestinalis</u>	60%
<u>Ectocarpus</u> sp.	5%

100m Very fine-grained sand, little shell debris.

<u>Enteromorpha intestinalis</u>	5%
<u>Ectocarpus</u> sp.	+

110m Very fine-grained sand, no shell debris.

<u>Enteromorpha intestinalis</u>	1%
<u>Ceramium rubrum</u>	1%
<u>Ectocarpus</u> sp.	+

1.h) TRANSECT I

TREATH ZOSTERA BED

9.5.86

ZONATION ALONG TRANSECT LINE.

The shore is backed by low cliffs, about 4m high.

- 0m About 2m down from the top of the cliff is a break in slope, from vertical to approx. 30 degrees: this is taken as 0m. Here grows Caloplaca sp. and the beginning of the Verrucaria maura zone.
- 1.8m End of the Verrucaria (and other lichens) zone.
- 1.8-2.1m Zone of Pelvetia canaliculata on rocks.
- 2.1-3.6m Zone of Fucus spiralis, F.vesiculosus and Enteromorpha intestinalis growing on the cliff base.
- 3.6m The base of the cliff.
- 3.6-12.4m A zone of rocks (bed rock poking through the sand, as well as loose slabs) on a beach of coarse-grained sand, with granules and scattered pebbles. Fucus spiralis, F.vesiculosus, Ascophyllum nodosum and Enteromorpha intestinalis grow on the rocks.
- 12.4-32m A beach of coarse-grained sand, granules and scattered pebbles. Very few rocks for attachment of algae which is mainly Fucus vesiculosus and a little F.spiralis (same as above but more scattered). The first specimens of Lanice appear at 30m with a density of 12/m².
- (18.6-26.5m) A mound of sand completely covered with algae - Fucus vesiculosus.
- 32-36m Coarse-grained sand with fewer pebbles and granules. Some scattered algae as above, growing straight out of the sand as well as on rock. Lanice here average 1/m².
- 36-37m Fine-grained sand. Here is a strand line of small empty shells - mainly Bittium reticulatum and some Cantharidus striatus
- 37-39m Fine-grained sand with a scattering of empty shells and weeds - Fucus serratus, Ectocarpus sp. Ulva lactuca, Enteromorpha intestinalis, F.vesiculosus and Polysiphonia sp.
- 39-41m First Zostera plants at a density of 30/m² (sparse). Plenty of Ectocarpus sp. and Halopteris scoparia with Polysiphonia sp. Enteromorpha intestinalis, Ulva lactuca and Dumontia incrassata growing with the Zostera. Scattered across the sand on rocks at this level are F.vesiculosus and Fucus serratus. Lanice are sparse - much fewer than 1/m². There are a few Arenicola mounds and clusters of Littorina littorea here and there.

- 41-58m As above but lower with about 2cm of standing water and many more algae with the Zostera - mainly Enteromorpha intestinalis, Ulva lactuca and Ectocarpus sp., covered with silty material.
- NE 50m Lanice stops here. The sand become softer, very fine-grained and darker grey in colour.
- NE 55m The depth of standing water increases to approx. 5cm
- 58-59m Erosion pan - a hollow with ankle-deep standing water, completely bare except for a few strands of Zostera (approx. 4/m²) a little Ectocarpus and Halopteris with a few strands of Dumontia. The hollow is full of empty shells, mainly Bittium reticulatum.
- 59-76m As from 41-58m but the amount of algae in with the Zostera still increasing and swamping it. More Enteromorpha and Dumontia coming in with the other algae. Plenty of loose silty material washing over the algae. Zostera at 70m averages approx 70/m².
- N.B. Erosion pans at 65.7-66.4m and at 69.5-69.7m with a huge hollow at 70-72.2m. At 70m the water reaches ankle depth.
- 76-81m Proper, raised Zostera bed with paler mud (less grey/black) trapped to form raised hummocks. But the Zostera is still sparse and there are still slimy algae dominating it (although less than on the lower, water-covered Zostera). Also the bed is not continuous and consists of fragments with pools between, probably remnants of a formerly continuous raised bed.
- 81-84m No Zostera now, just dark-grey, very fine-grained sand, with lots of small shell debris scattered over the surface-mainly Bittium reticulatum. The surface is covered in algae mainly Enteromorpha intestinalis, Dumontia incrassata and Ectocarpus sp. There is no standing water here- all that mentioned further up the shore is trapped between the raised Zostera bed and the shore.
- 84-110m Sand becomes even darker grey here, but is still very fine-grained and is covered in small shell debris. The main alga is Enteromorpha intestinalis in close clumps. Other algae are just scattered plants - Dumontia incrassata and Ectocarpus sp. with very occasional Fucus serratus on blocks and moorings. Even at low tide the mud is only 'shallow sink'.
- 110m Extreme low water.
- N.B. There are signs of digging all over the beach even on the raised Zostera bed.

APPENDIX 2

Locations of transects not re-recorded in 1988

(Transects A,B,D & H)

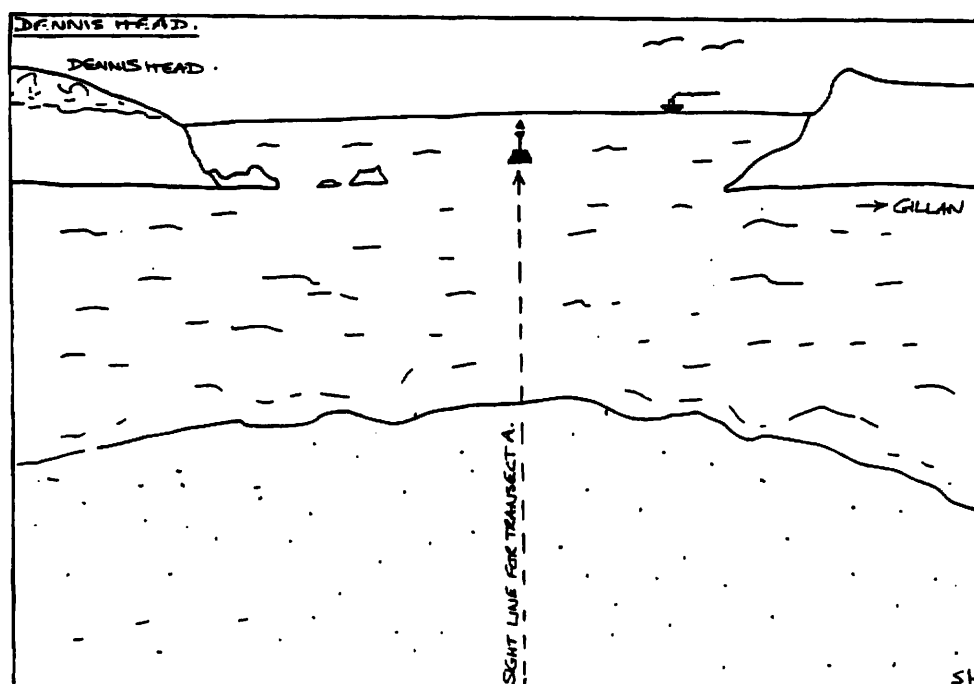
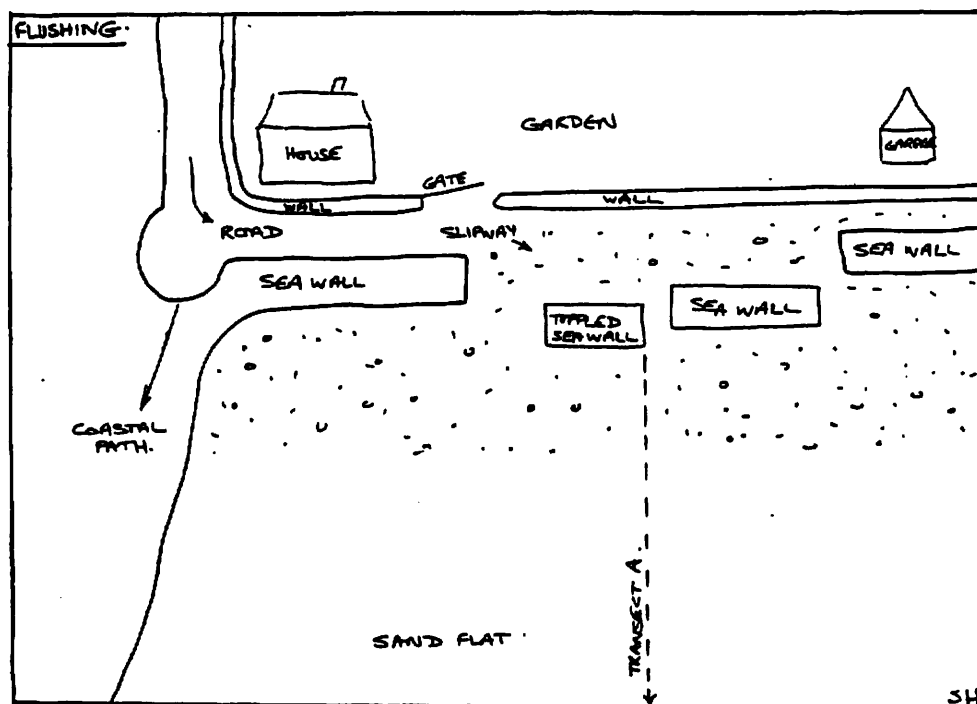
2.a) TRANSECT A FLUSHING COVE WEST

LOCATION SW78392529 to SW78972543

At the top of the shore at Flushing Cove are broken sections of a sea wall. One of the two centre pieces of the wall is slightly further down-shore than the rest. The top of Transect A is situated at the base of the N.W. corner of this toppled sea wall.

The far end of the Transect is sighted on the Crook buoy at the end of Dennis Head

TRANSECT A - FLUSHING COVE WEST.



2.b) TRANSECT B

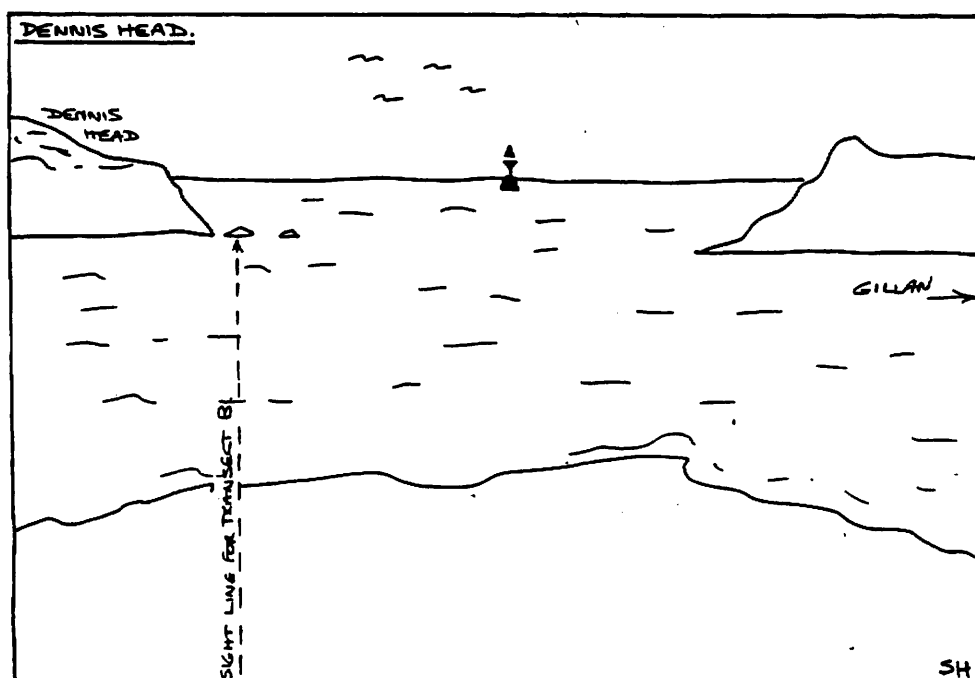
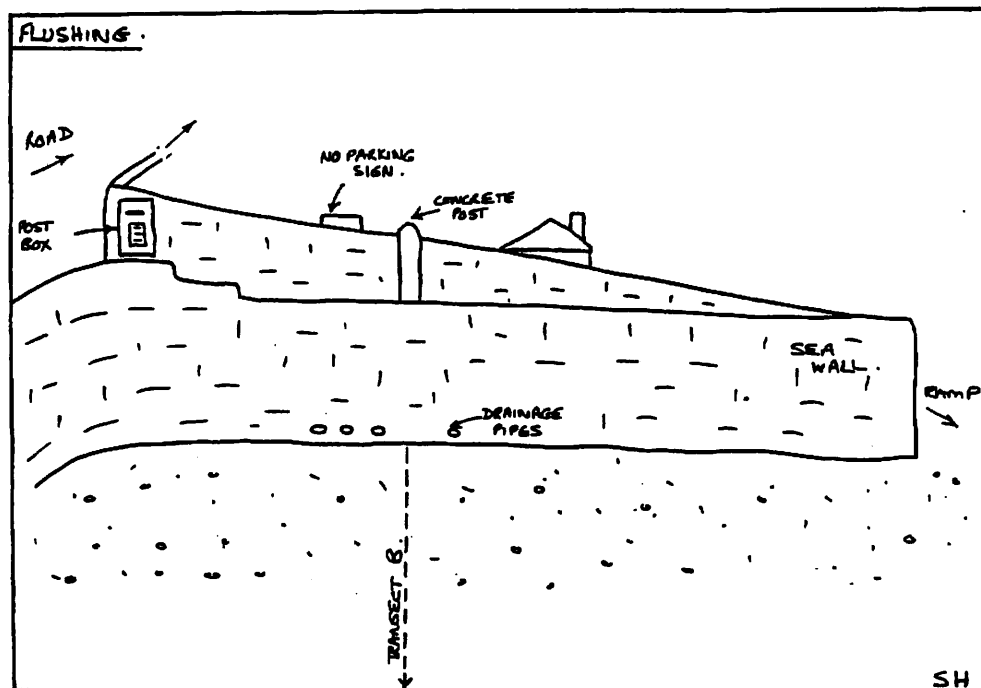
FLUSHING COVE EAST

LOCATION SW78402520 to SW78882545

At the far southern end of Gillan Beach, the sea wall below the road curves round to the N.E., following the contour of the cliff. Just west of the curve, at the base of the wall, is a row of drainage pipes, above which is a concrete post. The top of Transect B is taken from the base of the sea wall, directly below this post.

The far end of the Transect is sighted on the innermost of two rocks visible at the end of Dennis Head.

TRANSECT B - FLUSHING COVE EAST.



2.c) TRANSECT D

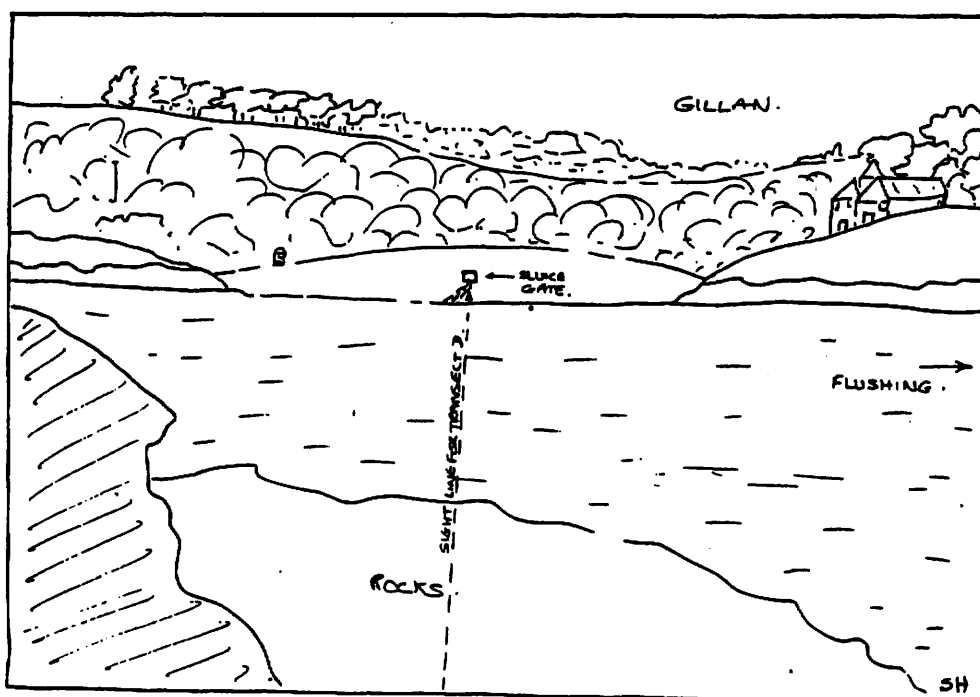
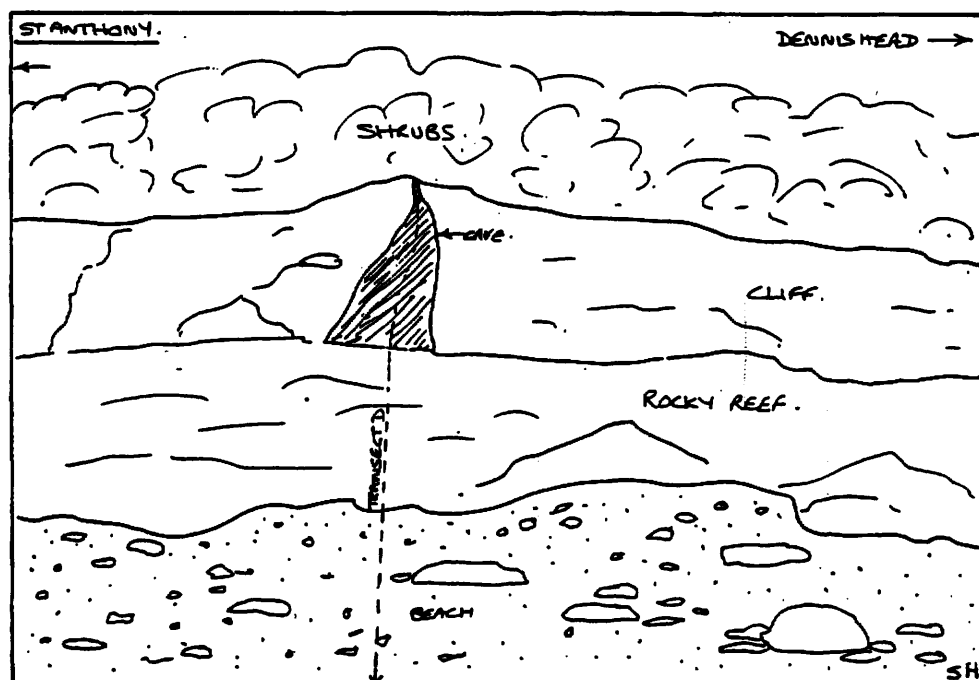
ST ANTHONY-IN-MENEAGE

LOCATION SW78552552 to SW78682516

Walk eastwards from St Anthony-in-Meneage, along the shore on the south side of Dennis Head until you reach a triangular-shaped cave, the height of the cliff. The cave tapers inwards to a crack, and the top of Transect D is situated on this crack at the back of the cave.

The far end of the transect is sighted on the sluice gate at the top of Gillan beach.

TRANSECT D - ST ANTHONY IN MENEAGE.



2.d) TRANSECT H

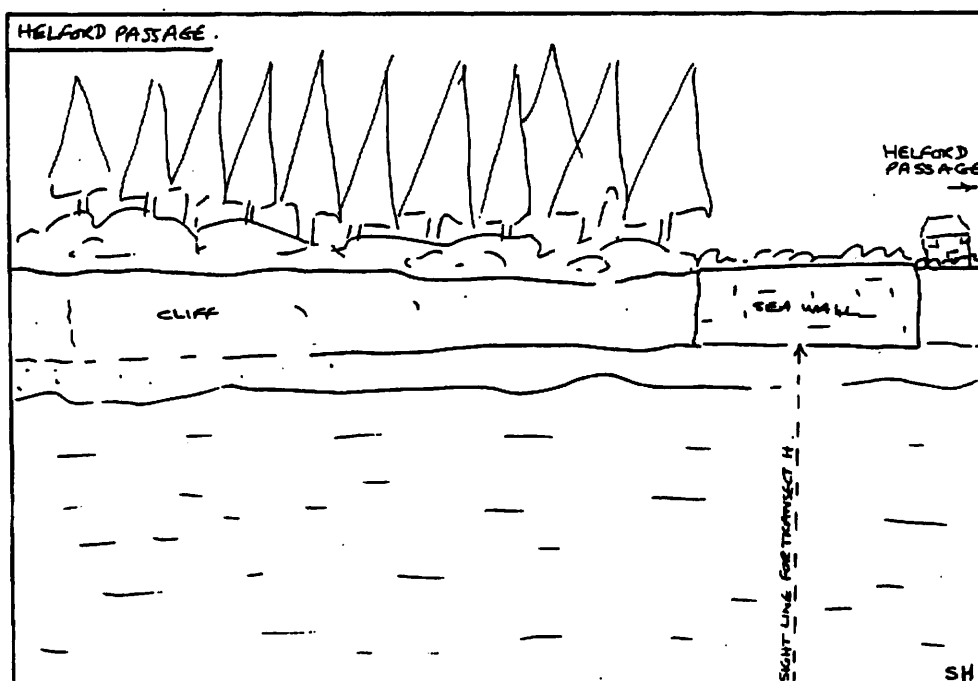
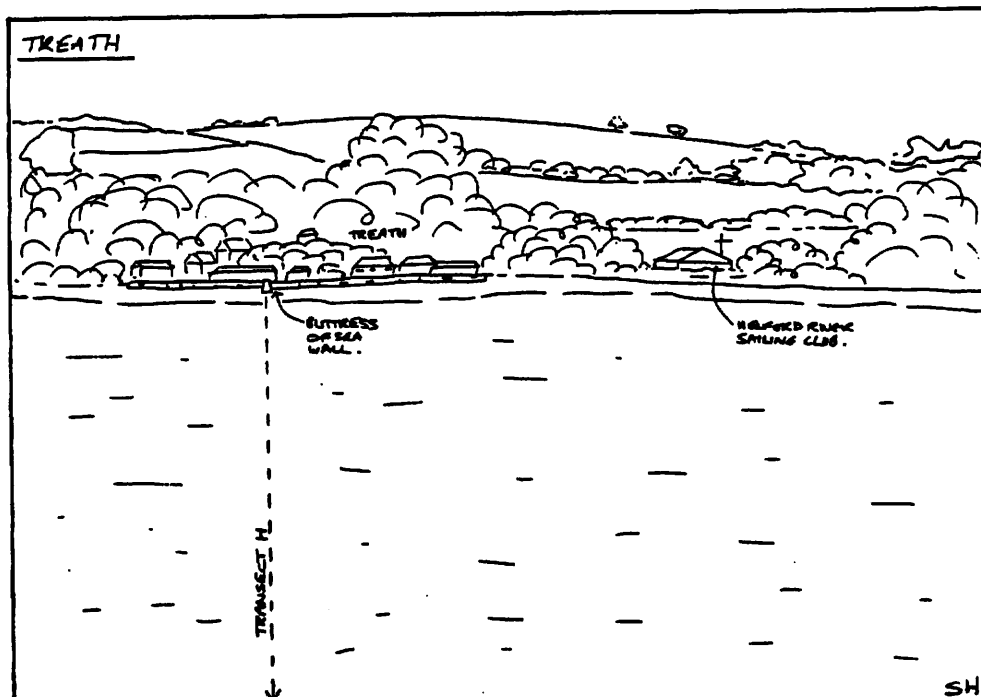
TREATH BAR

LOCATION SW76222622 to SW76292688

Walk east from the car park at Treath (SW75952610) through the Helford River Sailing Club car park and down the slipway to the beach. Proceed eastwards along the base of the sea wall until you come to a prominent buttress below the houses of Treath. The top of Transect H is the base of the most westerly corner of this buttress.

The far end of Transect H is sighted on the prominent grey wall at the base of the road, to the west of the Ferry Boat Inn at Helford Passage.

TRANSECT H - TREATH BAR.



APPENDIX 3

1986 data for transects not re-recorded in 1988

(Transects A,B,D & H)

3.a) TRANSECT A

FLUSHING COVE WEST

10/3/86

QUADRATS

0m Fist-sized pebbles covered in well-rotted brown algae. No life.

5m Smaller egg-sized pebbles. No dead algae on top.

1x Littorina littorea

10m Medium-grained sand overlain by egg-sized pebbles and well rotted algae. No life.

15m Medium-grained sand overlain by flatter pebbles, (average size 5x4cm) overlain by rotten algal remains. No life.

20m Medium-grained sand overlain by various-sized pebbles and boulders from a large 30x20cm rock and fist-sized pebbles to granules. A little rotten algae. No life.

25m Fine-grained sand covered by various sized pebbles, from 15x5cm to granules. Average size approx. 3x3cm. A little rotten algal remains.

1 x Gibbula cineraria

30m Fine-grained sand covered by various sized pebbles, some 20x5cm. Average size 3x3cm. Covered in rotten brown algal remains. No life.

35m Fine-grained sand with some granules and occasional larger rocks (up to 30x15cm) and pebbles (1x2cm). A little dead algal material. No life.

40m Thick brown algal cover approx. 10cm deep. Fine-grained sand below, with a black oily layer just below the surface due to organic decay.

A few Gammarus sp.

45m Mostly bare, fine-grained sand with a few pieces of brown algal cover. No stones. No life.

50m As above for 45m

55m As for 45m

1 x Arenicola cast

60m Fine sand. No algal cover. No life.

65m Fine-grained sand, strongly rippled with the troughs full of fragmented rotten algal remains.

3 x Lanice conchilega.

70m Very fine-grained strongly rippled sand with rotten algal fragments in the troughs.

19 x Lanice conchilega.

75m Very fine-grained, well-rippled sand with rotten algal remains in the troughs.

36 x Lanice conchilega.

80m Very fine-grained, well-rippled sand with rotten algal fragments in the troughs but less than in the above quadrats.

14 x Lanice conchilega.

85m Very fine-grained sand, well-rippled with even less of the rotten algal remains in the troughs.

36 x Lanice conchilega.

90m Very fine-grained sand, less-defined ripples, a little drifted algal remains in the troughs.

43 x Lanice conchilega.

95m Very fine-grained sand, gently rippled with a trace of fragmented algal remains in the troughs.

40 x Lanice conchilega.

100m Very fine-grained rippled sand with a little drifted rotten algae in the troughs.

1 x clump of Gracilaria verrucosa.

48 x Lanice conchilega.

105m Very fine-grained rippled sand with a little rotten drifted algae in the troughs.

58 x Lanice conchilega.

110m Very fine-grained rippled sand with very little rotten drifted algae in the troughs.

60 x Lanice conchilega.

115m Very fine-grained rippled sand, no drifted algal remains.

53 x Lanice conchilega.

120m Very fine-grained rippled sand.

51 x Lanice conchilega.

Dead low tide

3.b) TRANSECT B

FLUSHING COVE EAST

11.3.1986

QUADRATS

- 0m Medium-grained sand with a little coarse-grained sand in patches and a few pebbles approx 3x1cm & 3x2cm. No life.
- 5m Quadrat mostly covered by large flat pebbles average size approx. 7x6cm. Beneath these is medium-grained sand. On the surface are a few pieces of fresh dead seaweed. In the lower half of the quadrat, mixed in with the sand, is a thick deposit of fragmented rotten algal remains.
- 10m The top half of the quadrat consists of medium-grained sand, the lower half comprises coarse-grained sand with occasional granules. No pebbles. A few pieces of fragmented rotting algae. No life.
- 15m Quadrat overlain by a layer of fragmented rotting algae approx. 2cm deep. Below this are a few large cobbles average size 10x5cm. These are underlain by medium-grained sand. No life.
- 20m A little fragmented rotting algae lying on a layer of large flat pebbles, average size approx. 5x5cm. Underneath is a layer of medium-grained sand. No life.
- 25m A small amount of fragmented rotting algae lying patchily on a layer of large flat pebbles (7x7cm average size). Below this is a mixture of medium and coarse-grained sand. No life.
- 30m A little fragmented rotten algae scattered over a layer of small pebbles average size 5x3cm. Below this is mainly coarse sand with some very coarse sand and granules therein. A freshwater stream flowing from the house runs across the transect at this point. No life.
- 35m A few large rocks covering about half of the quadrat, average size approx. 20x20cm. Between the rocks is fine-grained sand and scattered here and there is fragmented rotten algae. The stream flows through this quadrat.
On one rock:-

<u>Pomatoceros triqueter</u>	0.5%
<u>Spirorbis</u> sp.	0.5%
<u>Balanus balanoides</u>	x3

- 40m Fine-grained sand with a few pebbles average size approx. 3x3cm. Stream flows through this quadrat too.

<u>Fucus</u> sp	Too battered to specify	2%
<u>Spiroboris spirorbis</u>	On <u>Fucus</u> sp	+

- 45m Fine-grained sand with a few small pebbles approx. 3x3cm average size. The stream just misses this quadrat but runs close beside it.

<u>Fucus serratus</u>	60%
<u>Spiroboris spirorbis</u>	Abundant on <u>Fucus</u> .

50m Fine-grained sand covers about half of this quadrat, the other half is covered with large rocks - one is 10x20cm the others average 10x5cm.

<u>Pomatoceros triqueter</u>	2%
<u>Fucus serratus</u>	20%
<u>Spirorbis spirorbis</u> On <u>Fucus</u>	+
<u>Lanice conchilega</u>	x1
<u>Balanus balanoides</u>	x2

55m Fine-grained sand overlain in about half of the quadrat by rotten algae. No rocks or pebbles

<u>Venus striatula</u>	x1
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60m Fine-grained sand overlain by pulverised rotten algal remains. No life.

65m Fine-grained sand strongly rippled with a little of the drifted algal fragments in the troughs. No life.

70m Fine-grained sand strongly rippled, a little fragmented algae in the troughs

<u>Lanice conchilega</u>	x4
<u>Arenicola</u> sp. casts	x2

75m Fine-grained sand strongly rippled with a little fragmented algae in the troughs.

<u>Lanice conchilega</u>	x25
<u>Arenicola</u> sp. casts	x2

80m Fine-grained sand, strongly rippled, pulverised, fragmented algal remains in the troughs.

<u>Lanice conchilega</u>	x46
<u>Arenicola</u> sp. casts	x1

85m Fine-grained sand, strongly rippled, a little fragmented, rotten algal matter in the troughs.

<u>Lanice conchilega</u>	x16
<u>Arenicola</u> sp.	x1

90m Fine-grained, rippled sand, a few algal fragments.

<u>Lanice conchilega</u>	x42
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95m Fine-grained, rippled sand, few algal fragments in the troughs

<u>Lanice conchilega</u>	x53
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100m Fine-grained, rippled sand. - No algal remains

<u>Lanice conchilega</u>	x33
<u>Arenicola</u> (casts)	x2

105m Fine-grained, rippled sand. No algal remains.

Lanice conchilega
Arenicola sp. (casts)

x66
x1

110m Fine-grained, rippled sand.

Lanice conchilega

x55

115m Fine-grained rippled sand.

Lanice conchilega
Gracilaria verrucosa

x48
x1

120m Fine-grained, rippled sand, with a little fragmented algae

Lanice conchilega

x41

3.c) TRANSECT D ST ANTHONY IN MENEAGE

12.3.1986 & 8.4.1986

QUADRATS

0m At the top of the rocky shore at the bottom of the cliff.
set back from the main cliff base in a damp shady crack.

<u>Ascophyllum nodosum</u>	25%
<u>Fucus spiralis</u>	3%
<u>Audouinella</u> sp.	40%
<u>Chthamalus montagui</u>	x130
<u>Littorina saxatilis</u>	x2
<u>Hildenbrandia</u> sp.	1.5%

5m Rocky platform sloping gently seawards. A few small rock pools.

<u>Ascophyllum nodosum</u>	75%
<u>Polysiphonia fastigiata</u>	5%
<u>Cladophora rupestris</u>	2%
<u>Ulva lactuca</u>	0.5%
<u>Audouinella</u> sp.	3%
<u>Littorina mariaae</u>	x2

10m Rocky shore as at 5m.

<u>Ascophyllum nodosum</u>)	30%
<u>Polysiphonia fastigiata</u>)	
<u>Patella</u> sp.		x16
<u>Chthamalus montagui</u>		1512

15m Rocky shore as at 5m.

<u>Ascophyllum nodosum</u>)	15%
<u>Polysiphonia fastigiata</u>)	
<u>Patella</u> sp.		x11
<u>Littorina mariaae</u>		x2
<u>Chondrus crispus</u>	in pool	0.5%
<u>Littorina littorea</u>		x1
<u>Chthamalus stellatus</u>		x3
<u>Balanus balanoides</u>		x37
<u>Littorina saxatilis</u>	in pool	x2
' <u>Lithothamnium</u> '		1%
<u>Gammarus</u> sp.	in pool	+
Hydroid	in pool	+

20m Medium-grained sand covers about half the quadrat with several large flat stones, averaging approx. 7x7cm, covering most of the rest.

<u>Fucus serratus</u>	10%
<u>Spirorbis spirorbis</u> on <u>Fucus</u>	+

25m Medium grained sand with a few small pebbles, average size 3x3cm

<u>Fucus serratus</u>	7%
<u>Spirorbis spirorbis</u> on <u>Fucus</u>	+

8.4.1986

30m At the end of the shingle and at the beginning of the low tide-flat, particles consist of granules and similarly-sized shell debris. Loose algae (Laminaria & Gracilaria) cover about half the quadrat.

<u>Venus striatula</u>	x1
<u>Littorina mariaae</u>	x1
<u>Gibbula cineraria</u>	x1

35m Medium grained sand and pebbles.

<u>Fucus serratus</u>	15%
<u>Lanice conchilega</u>	x21
<u>Hildenbrandia</u> sp.	+
<u>Littorina saxatilis</u>	x1
<u>Spirorbis</u> sp.	+
' <u>Lithothamnia</u> '	+
<u>Pomatoceros triqueter</u>	+
<u>Balanus balanoides</u>	Approx. 100
<u>Littorina littorea</u>	x2

40m Medium grained sand and some pebbles approx. 2x2cm.

<u>Littorina littorea</u>	x2
<u>Lanice conchilega</u>	x8
<u>Fucus serratus</u>	15%
<u>Hildenbrandia</u> sp.	+
<u>Spirorbis</u> sp.	+

45m Medium grained sand, strongly and irregularly rippled with a fair number of pebbles 2x2cm.

<u>Gigartina stellata</u>	3%
<u>Fucus serratus</u>	25%
<u>Spirorbis</u> sp.	+
<u>Enteromorpha</u> sp.	+
<u>Ulva lactuca</u>	+
<u>Littorina obtusata</u>	x1
<u>Littorina littorea</u>	x4
<u>Pomatoceros triqueter</u>	+
<u>Hildenbrandia</u> sp.	+

50m Fine-grained sand slightly rippled with a few pebbles 4x4cm

<u>Laminaria saccharina</u>	2%
<u>Fucus serratus</u>	4%
<u>Pomatoceros triqueter</u>	+
' <u>Lithothamnia</u> '	+
<u>Ceramium</u> sp.	1%
<u>Crepidula fornicata</u>	x1
<u>Littorina littorea</u>	x1

55m Fine-grained sand, rippled with pulverised algal remains in troughs.

<u>Lanice conchilega</u>	x13
<u>Arenicola</u> sp. cast	x1

60m Fine-grained, rippled sand.

<u>Pomatoceros triqueter</u>	+
<u>Gracilaria verrucosa</u>	+
<u>Ceramium</u> sp.	+

65m Fine-grained sand. No ripples. Many stones and pebbles approx. 4x4cm

<u>Fucus serratus</u>	10%
' <u>Lithothamnia</u> '	2%
<u>Littorina littorea</u>	x6
<u>Spirorbis</u> sp.	+
<u>Lanice conchilega</u>	x3
<u>Hildenbrandia</u> sp	1%
<u>Gracilaria verrucosa</u>	+
<u>Littorina mariae</u>	x1
<u>Pomatoceros triqueter</u>	+

70m Fine-grained sand between a rubble of loose rocks and pebbles

<u>Gigartina stellata</u>	5%
<u>Fucus serratus</u>	10%
<u>Spirorbis</u> sp.	+
<u>Pomatoceros triqueter</u>	+
<u>Gastroclonium ovatum</u>	+
<u>Hildenbrandia</u> sp	1%
' <u>Lithothamnia</u> '	3%
<u>Ceramium</u> sp	+
<u>Anomia ephippium</u>	x2

75m Fine-grained sand between a rubble of pebbles.

<u>Gigartina stellata</u>	5%
<u>Pomatoceros triqueter</u>	+
' <u>Lithothamnia</u> '	1%
<u>Hildenbrandia</u> sp.	+
<u>Gracilaria verrucosa</u>	2%
<u>Ceramium</u> sp.	+

3.d) TRANSECT H TREATH BAR

8.5.1986

ZONATION ALONG TRANSECT LINE

The top of the beach below the houses at Treath (above the Bar) is backed by a sea wall (further east above the Zostera bed are very low cliffs). The whole beach is covered at high tide, water reaching 1-3m up the sea wall. Growing on the sea wall are Pelvetia canaliculata and Fucus spiralis with scattered Littorina saxatilis. At the very base of the wall is a zone of Enteromorpha intestinalis.

0-0.5m Pebble zone consisting of large, flat stones.

0.5-7.5m 'Granules' and scattered pebbles with larger stones occasionally providing a habitat for Fucus spiralis, F.vesiculosus and Enteromorpha intestinalis. NB 1.3m - the first Lanice appear, very scattered - approx. 1 per sq.m.

7.5-16m 'Granules' with more densely packed pebbles and larger stones supporting algae, giving a definite zone comprising mainly Fucus spiralis, F.vesiculosus and Enteromorpha intestinalis.

16-32m On the Bar below the houses. is the start of a zone of fine grained sand with scattered empty shells and clumps of algae, mainly Fucus vesiculosus and F.serratus. Also in patches on the sand are Ulva lactuca, Enteromorpha intestinalis, Ectocarpus sp., Polysiphonia sp. and Dumontia incrassata. The surface of the sand on the Bar is smooth in places and more pebbly in others. Lanice is scattered over the surface, more densely in some places than others, forming pockets rather than linear zones. The average cover is approx. 25/sq m whereas at 16-18m there is a zone of dense Lanice (approx. 100/sq m), likewise at 30-32m. Numerous casts and mounds (approx. 3-4cm high) of Arenicola sp are found in this zone, showing up well as they have brought up the darker sand from below.

NB Any zonation of these features, along the transect is local as they are randomly scattered across the beach rather than zoned.

32m Sand becomes very fine-grained here with no other obvious changes in surface features.

32-38m Fairly bare patch, no algae, few pebbles, scattered Lanice and Arenicola mounds.

38-40m A more pebbly patch with scattered algae, Lanice and Arenicola mounds.

40-47.2m As above and still pebbly but with about 2cm of standing water on the surface.

NB The zone of densest Arenicola mounds was from 16m to here!

- 47.2-57m A raised bed with no standing water on the surface. Much more pebbly here - very dense pebbles and stones with very little bare sand between - the main areas of sand being that in Arenicola mounds. The sand coarsens to become fine-grained here. The algal cover is more dense on this pebbly area (a feature seen all over the bar where such areas occur). The algal species are the same as above but are more closely packed. Lanice are sparse, struggling up through the stones. Balanus balanoides is attached to the larger stones and Littorina littorea shelters under them.
- 57-60m Slightly lower and less pebbly. Softer sand.
- 60-70.8m Even less pebbly and lower, with about 2cm of standing water on the surface, but still fine-grained sand. The algae are slightly less dense and Lanice are very scattered at <1 per square metre.
- NB At 66.2m is a clump of mussels (one 5cm long) with another clump at 70.5m.
- NB 68.5m Last Lanice seen.
- 70.8-72m Even less pebbly, the sand reverting to very fine-grained. Little standing water. No Lanice.
- 72-95.5m Algal cover becomes much less dense from 72m onwards. There is little Fucus, mainly Enteromorpha intestinalis.
- N.B 72.4-72.9m a very pebbly, raised mound, with Fucus vesiculosus and F.serratus.
- 95.5-110m A zone of large scattered rocks which average football size but some are larger, providing holdfasts for Fucus vesiculosus, F.serratus and barnacles- mainly Balanus balanoides and Elminius modestus. Littorina littorea nestle under the rocks and algae. Between the boulders is a fine-grained sand with pebbles and shell debris. Raised pebbly areas are interspersed with lower, less stony areas covered by standing water. Algae between the boulders are Dumontia incrassata, Enteromorpha intestinalis, Polysiphonia sp. and Ectocarpus sp. Areas of darker sand mark disturbance by digging. No Lanice or Arenicola.
- 110-120m Rocky zone ends, leaving an area of fine-grained sand with scattered pebbles and standing water. The usual algae except there is little Fucus.
- 113m As above but slightly raised so no standing water.
- 117m As above but zone of dense Enteromorpha intestinalis starts.
- 120-130m Return to very fine-grained sand. Dense Enteromorpha gives approx. 75% cover. Less pebbly and more puddly due to the softer finer sand. (similar to 110m and 72m).

130-135m Pebbles more or less die out from here leaving just a few pebbles and larger stones (approx. 5x5cm) scattered on the sand with a few granules and shell debris. Still signs of digging.

NB 130m marks the end of the zone of dense Enteromorpha intestinalis. There are scattered patches of Fucus vesiculosus and F. serratus on rocks and moorings with scattered plants of Enteromorpha intestinalis between.

135m The sand suddenly becomes very soft and falls into the 'shallow sink' category. It is very fine-grained, bordering on silt.

From here to low water mark the sand is in the 'deep sink' category but the surface features are much the same as at 135m. Algae are mainly Enteromorpha intestinalis, Ectocarpus sp. and Polysiphonia sp.

140m As above but covered in approx. 1cm of standing water.

170m (approx) Low tide mark is estimated to be at about 170m but the mud is too deep to cross so exact measurements could not be obtained.

3.e) TRANSECT H TREATH BAR 8.5.1986

Tide: 0.9m low at Plymouth (Devonport)

QUADRATS

10m Mixture of pebbles, stones and shell grit.

<u>Fucus spiralis</u>	45%
<u>Enteromorpha intestinalis</u>	10%

20m Fine-grained sand with Arenicola mounds approx. 5cm high and 10cm diameter.

<u>Ectocarpus</u> sp.	10%
<u>Fucus vesiculosus</u>	8%
<u>Lanice conchilega</u>	x40
<u>Arenicola</u> sp. mounds	x4
<u>Enteromorpha intestinalis</u>	1%

30m Fine grained sand.

<u>Fucus vesiculosus</u>	90%
<u>Enteromorpha intestinalis</u>	+
<u>Lanice conchilega</u>	x51

40m Very fine-grained sand with some shell grit.

<u>Fucus vesiculosus</u>	20%
<u>Ulva lactuca</u>	5%
<u>Ectocarpus</u> sp.	5%
<u>Littorina littorea</u>	x3

50m On a noticeable bank of pebbles (approx. 2x2cm average) infilled between pebbles with fine-grained sand.

<u>Fucus vesiculosus</u>	10%
<u>Enteromorpha intestinalis</u>	2%
<u>Balanus balanoides</u>	x40
<u>Lanice conchilega</u>	x6
<u>Littorina littorea</u>	x2
<u>Littorina mariae</u>	x1

60m Fine-grained sand with some granules and small, sparse pebbles.

<u>Fucus serratus</u>	2%
<u>Dumontia incrassata</u>	1%
<u>Enteromorpha compressa</u>	+
<u>Ulva lactuca</u>	+
<u>Lanice conchilega</u>	x4
<u>Littorina littorea</u>	x1
<u>Littorina mariae</u>	x1

70m Pebbles and fine-grained sand with occasional granules.

<u>Fucus vesiculosus</u>	2%
<u>Pomatoceros triqueter</u>	1%
<u>Enteromorpha intestinalis</u>	+
<u>Cystoseira tamariscifolia</u>	+
<u>Ulva lactuca</u>	+
<u>Mytilis edulis</u>	x2
<u>Littorina littorea</u>	x1

80m Very fine-grained sand with some granules. No pebbles.

<u>Enteromorpha intestinalis</u>	50%
<u>Ectocarpus sp.</u>	5%
<u>Pomatoceros triqueter</u> On dead bivalve shell	+

90m Very fine-grained sand with some granules. 1 large rock covering 10% of the quadrat area.

<u>Fucus vesiculosus</u>	35%
<u>Ectocarpus sp.</u>	2%
<u>Enteromorpha intestinalis</u>	+
<u>Pomatoceros triqueter</u>	+
<u>Balanus balanoides</u>	x60
<u>Littorina mariae</u>	x2
<u>L.littorea</u>	x1

100m Fine-grained sand with pebbles and granules.

<u>Fucus vesiculosus</u>	50%
<u>Enteromorpha intestinalis</u>	5%
<u>Ulva lactuca</u>	5%
<u>Littorina littorea</u>	x2
<u>Littorina mariae</u>	x1
<u>Littorina obtusata</u>	x1

110m Fine-grained sand with few pebbles and small amounts of shell grit.

<u>Enteromorpha intestinalis</u>	10%
<u>Pomatoceros triqueter</u>	+
<u>Eulalia viridis</u> egg sacks	x4

120m Very fine-grained sand with occasional pebbles.

<u>Enteromorpha intestinalis</u>	85%
<u>Fucus serratus</u>	5%
<u>Ectocarpus sp.</u>	5%

130m Very fine-grained sand with some cobbles and granules.

<u>Enteromorpha intestinalis</u>	40%
<u>Fucus serratus</u>	30%
<u>Ceramium rubrum</u>	10%
<u>Dumontia incrassata</u>	+
<u>Ectocarpus sp.</u>	2%
<u>Ulva lactuca</u>	+
<u>Cerastoderma edule</u>	x1

140m Very fine-grained soft sand (20cm sink) No pebbles or granules)

Enteromorpha intestinalis

10%

Polysiphonia sp.

+

Not possible to continue to low water due to the deep mud. Seemed to be as for 140m quadrat, down to the estimated 170m low water mark.

APPENDIX 4

Wasting disease of Zostera

WASTING DISEASE OF ZOSTERA

In the spring of 1988, Dr Holme wrote to Professor C. den Hartog (of the Catholic University of Nijmegen, Holland) an acknowledged international expert on Zostera, expressing our concern on the decline of this plant in the Helford River. In his reply, Prof. Hartog said that diseased beds had been reported in America and Europe as well as southern Britain, and that with a colleague in the U.S.A. (Dr David Porter) intensive research was being undertaken. The primary cause of wasting disease is still not firmly established, but an organism allied to the slime moulds (a species of Labyrinthula) is invariably associated with it, as in the last widespread outbreak in the 1930s. Research is complicated by the fact that Labyrinthula is usually present in plants showing no signs of disease, providing the relationship of the host/parasite is in balance. When beds of Zostera are 'stressed', the parasite can assume epidemic proportions, the typical black lesions (which show up most clearly on the young and brighter green leaves) spreading and rotting whole plants. Stress can be caused by extremes of weather, pollution, and /or human disturbance: other types of seagrass elsewhere in the world, have been damaged by human interference alone.

Professor Hartog and his assistant, Mr Wyn Giesen separately visited Devon and Cornwall (in September and July 1988 respectively), confirming that the disease was present in both counties. At the time, no plants were found in the Helford River, but since then (see the present Report) cast up specimens were found at Helford Passage and have now been sent to Holland.

In 1986, Roger Covey and Sue Hocking located a bed of Dwarf Eelgrass (Zostera noltii) at Calamansack in the vicinity of where it had been recorded in the 1920s and 1960s. As an extension of the 1988 survey, Mrs Hocking with Mr Richard Croome, Dr Paul Gainey and Mrs Pamela Tompsett re-visited the site by boat (kindly loaned by Lt-Cdr and Mrs D. Burford) and found that this bed, too, had disappeared.

That the cause cannot be attributed entirely to extremes of weather, is supported by the fact that in Mount's Bay (at Marazion) Prof. den Hartog found one the healthiest sites of Zostera marina that he has seen for two years, and its study may help to elucidate the cause of such outbreaks of disease. Healthy-looking samples from a larger intertidal bed in Mount's Bay have since been sent to Holland, and it may be significant that neither of these sites are greatly disturbed by humans. Type of substrate and position on shore may be factors that also need to be taken into account. In any event, the Helford River Working Group will be in close touch with the forefront of research, collaborating as appropriate.

Stella Turk

Sources

den Hartog, C., 1987. "Wasting disease" and other dynamic phenomena in *Zostera* beds. Aquatic Botany 27:3-14.

Short, F.T., Ibelings, B.W. & den Hartog, C., 1988. Comparison of a current eelgrass disease to the wasting disease in the 1930s. Aquatic Botany 30:295-304.

APPENDIX 5

Publicity leaflet
of the Helford Voluntary Marine Conservation Area.

FISHERMEN

Please remember that small-mesh monofilament nets catch immature fish (breeding stock have already been depleted) and that all 'mono' nets, if they are lost or discarded, will continue to trap fish and other marine animals.

BOAT USERS

Excessive speed disturbs the mud and sand; anchor chains can damage adjacent seaweeds and eel-grass; to avoid contaminating the water use only legally-recommended anti-fouling paints; do not discharge liquid or solid wastes overboard, and prevent oil and petrol spillage.

DIVERS

Animals should not be destroyed or removed from their habitats – follow the Code of Practice of the Federation of Sub Aqua Clubs.

WATER SKIERS

Speed boat wash erodes sensitive areas as well as being dangerous to other users: water skiing within the 6 knot speed limit area is prohibited.*

BAIT DIGGERS

All digging is harmful to the environment, so keep it to the minimum and please always fill in the holes: these loosen the mud and can be a hazard to others. Please keep disturbance of the sensitive areas to a minimum and do not dig in the eel-grass beds (see map).

SHELLFISH COLLECTORS

Please leave the tradition of 'trigging' on Good Friday to local people, so conserving the cockles which have greatly diminished: watch rather than participate. Please keep disturbance of the sensitive areas to a minimum and do not rake or dig in the eel-grass beds (see map).

FARMERS

Comply with the SWW regulations: discharges of silage and slurry poison streams and the River.

BIOLOGY GROUPS & RESEARCHERS

Follow the Codes of Conduct laid down by the Marine Conservation Society and the Nature Conservancy Council.

* If this byelaw is contravened, notify Kerrier District Council immediately.

Organisations with representatives on the Advisory Group, responsible for its management.

Cadgwith, Helford and District Fishermen's Society Ltd
Conchological Society of Great Britain & Ireland
Constantine Parish Council
Cornish Biological Records Unit
Cornwall County Council
Cornwall Trust for Nature Conservation
Council for the Preservation of Rural England
Falmouth Diving Club
Duchy of Cornwall Oyster Farm
Gweek Parish Council
Helford River Association
Helford River Boatowners' Association
Kerrier District Council
Lady Hamilton Fish
Manaccan Parish Council
MAFF District Fisheries
Marine Biological Association
Marine Conservation Society
Mawnan Parish Council
National Trust
Porthleven Angling Club
Port Navas Yacht Club
Roseland Research Group
Sailaway St Anthony Ltd
St Anthony Parish Meeting
St Keverne Parish Council
St Martin Parish Council
University of Exeter

The following organisations are kept informed, sending representatives to meetings at their discretion.

Cornwall Sea Fisheries Committee
Duchy of Cornwall
Nature Conservancy Council
South West Water

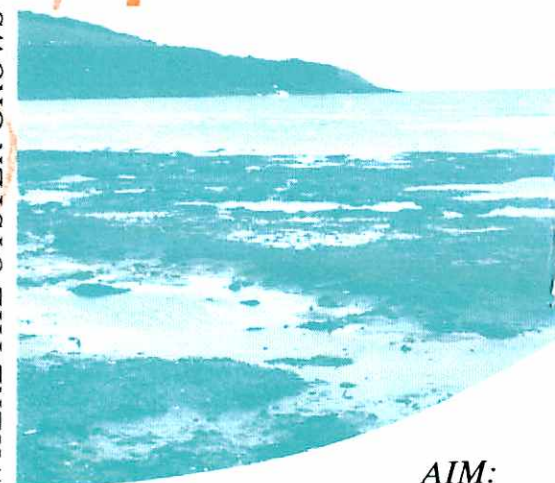


COUCH'S GOBY

A fish described as new to science, discovered in the Helford River in 1974.

HELFORD VOLUNTARY MARINE CONSERVATION AREA

WHERE THE OYSTER GROWS



AIM:

to achieve by voluntary means, the harmonious use of the river and to monitor the quality of the marine environment.

Helford River is a salt water inlet resulting from the drowning of the valley system some 10,000 years ago. It is famous for its beauty, its superb oysters and its sailing facilities. It is also of international importance for the abundance and variety of its marine wildlife.

After fears were expressed in 1983 regarding the deterioration of the River's intertidal life, Cornwall County Council convened a series of meetings of interested groups and individuals. As a result a report was prepared (with funding from the World Wildlife Fund, Heinz 'Guardians of the Countryside' and the Duchy of Cornwall) which set out possible causes and created baselines for future monitoring.

Evidence of deterioration was established, the multiple causes being due to an intensification of use and abuse of the intertidal zone, affecting, in particular, certain silt/sand/gravel areas. In July 1987 the recommendations of the report were accepted and the whole River was designated a Voluntary Marine Conservation Area. Copies of the report are available (at cost price) from the Cornish Biological Records Unit,

The purpose of the designation is to draw attention to the biological importance of the area, to prevent unwitting damage and to discourage undue exploitation of a precious resource.

Please enjoy the Conservation Area, but respect the interests of other people and the marine life, in the following ways:

Eel-grass (*Zostera*) is a grass-like flowering plant which provides shelter and food for a great variety of animals, many of them burrowing forms. Raking and digging disturbs the roots, causing erosion and movement of the mud. The beds which occur between tide-marks at Helford Passage and Treath clearly show such damage. So 'Please keep off the grass'.

The Duchy Oysterage is an important commercial activity on the River, and purity of the water is essential. Therefore avoid contamination and disturbance.

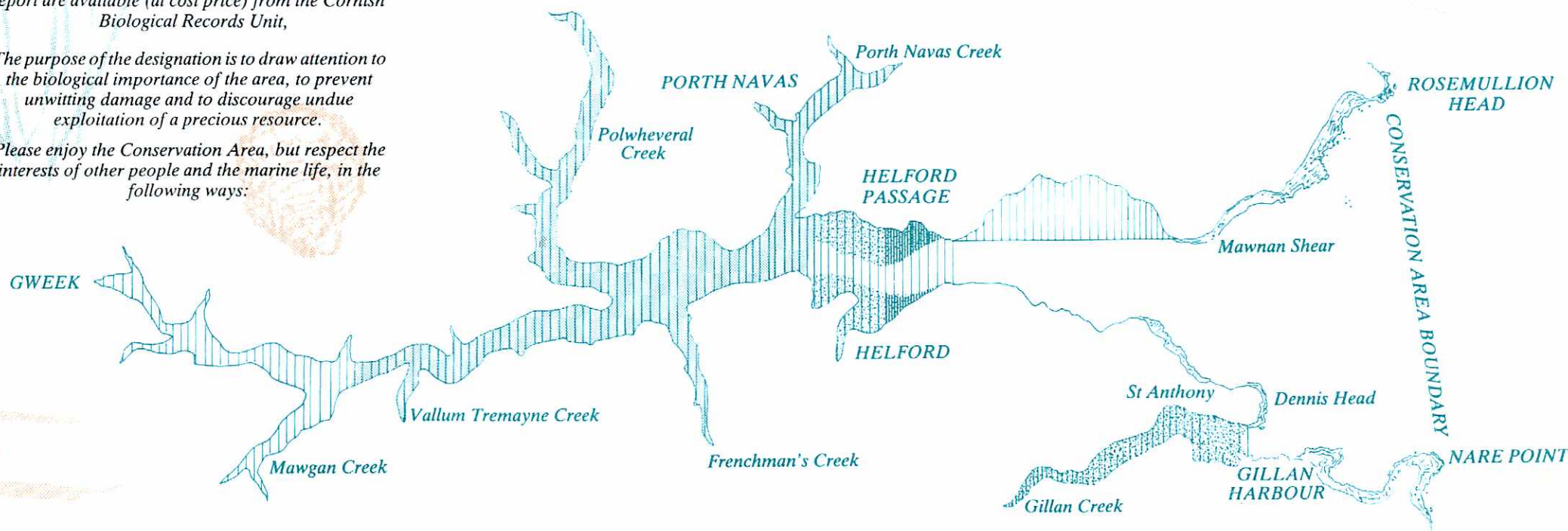
* Whilst this leaflet was in preparation, evidence was found of a drastic reduction of the eel-grass.

Field Study Classes and researchers also have a great responsibility for the environment and should refrain from collecting specimens to avoid further depletion of the marine life. Keep disturbance to a minimum, and always return boulders to their original position. It is possible to make useful observations without destruction and perhaps even contribute to the official monitoring programme.

For further information relating to education and research, contact the Cornish Biological Records Unit, Trevithick Building, Pool, Redruth, TR15 3PL. Telephone (0209) 710424

POLLUTION

If you see signs of pollution in the River, don't hesitate - contact South West Water by asking the telephone operator for Freephone 920 (24 hour service).



DEFINITION OF HELFORD VMCA

The whole River within an imaginary line between Rosemullion and Nare Point, including all creeks to furthest influence of highest spring tides.



1 Nautical Mile