Cover drawing;

Couch's Goby (Gobius couchi Miller & Tawil 1974) reproduced from the Journal of Zoology, 174, p 546, by kind permission of the Zoological Society of London.

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 Controller of HM Stationery Office.

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pages 38, 42 S 83: it is not certain that *Zostera noltii* would have been distinguished from *Z. marina* in the 1978 Report by Holme & Bishop

page 55 Acknowledgements
Add: Marine Biological Association: for loan of fibre glass boat and other equipment
Cornwall County Council: for loan of equipment and other material help
Delete: Miss Philippa Holme

page 81 Celsius/fahrenheit equivalents should read 50/59

Plates 2, S and 10 were provided by Mr. W. J. Rickard. However, during the preparation of the Report, the wrong photograph for No.10 was reproduced, showing fisher folk on Durgan Beach: the correct photo is available if required.
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FOREWORD

The Helford River has long been known as an area of outstanding marine biological significance, recognised by the Nature Conservancy Council as being of International Importance (Powell et al 1978). Formed by the flooding of a river valley when the sea level rose after the last ice age, the Helford is well described as a sheltered arm of the sea. The geology of this drowned valley or ria (not in fact a river or a true estuary) is dealt with in Appendix 1. Due to the little freshwater input, conditions are almost totally marine.

Several marine biologists with personal knowledge of the River's intertidal life over the past two or three decades have expressed concern about the deterioration in the numbers of species and individuals to be found. This suggests that conditions may no longer be as favourable, and this could also affect the local fisheries, oyster farming, food and bait collection and the use of the River for recreation.

Following a proposal to designate the River a Voluntary Marine Conservation Area, it was decided in July 1985 at a meeting of individuals and organisations concerned with the River, to form a Steering Group and, under the control of a Working Party, to mount a twelve-month survey of the River from Rosemullion Head and Nare Point to the upper limits of tidal influence. This report is the result of the survey which involved an assessment of such factors as the influence of visitor pressure, yachting and boating, bait and shellfish collection and fishing.

In association with South West Water, sources of pollution in the streams of the Helford catchment have been investigated and freshwater quality monitored. In order that future changes in the flora and fauna of the River can be monitored, baseline studies have been carried out, with repeatable transects of sensitive shore areas. The exact positions, and results of these transects, together with all other raw data, are lodged at the Cornish Biological Records Unit*, where they are available for future reference.

*Institute of Cornish Studies, Trevenson House, Pool, Redruth, TR15 3RE
This survey was sponsored by Cornwall County Council and was funded by the Heinz "Guardians of the Countryside" campaign, through the World Wildlife Fund. A contribution was also received from the Duchy of Cornwall.

Roger Covey and Susan Hocking
(Project Officers)

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Mr DC Bean, Fisherman and Fish Merchant
Mr WL Collins, Retired Agricultural Valuer
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Mr W S A Jenkins, Boat-hire Proprietor and Farmer
Mr W L Rickard, Farmer
Mr L W Robinson, Assistant County Planning Officer, (Conservation and Countryside), Cornwall County Council

Mrs S M Turk, Research Fellow, University of Exeter (Project Supervisor)
1 Description of Habitats - Intertidal

1.1 Rocky Shores

The occurrence of inter tidal rocky substrata to any significant extent is largely limited to the mouth of the River, with the most diversified reefs being found at Men Aver Point on the south side and Prisk Cove on the north. Although all the rocky shores show the same geology - Devonian Gramscatho beds of interbedded sandstone and argillaceous material - the richness of the flora and fauna varies according to the direction of the bedding-planes relative to the shore, and the degree of wave exposure.

Between Prisk Cove and Parsons Beach the dip of the strata follows the dip of the beach from high to low water, giving a smooth shore with few irregularities such as cracks and crevices, and thus having a low diversity. Conversely at Prisk Cove itself the strata dip along the shore, giving numerous overhangs, cracks, rock pools and damp sheltered niches.

At Nare Point although the shore is uneven with numerous, overhangs etc, the wave exposure is such that the rock surfaces are dominated by barnacles and limpets, with most other flora and fauna being hidden in the sheltered overhangs.

1.1.1 Overhangs

Overhangs in the intertidal represent an ideal habitat for many species. The rock faces are generally shaded, and may retain further moisture as water from rock surfaces above drain over them. Overhang communities occur from the outer headlands up as far as Treath and Helford Passage, but achieve their best development around Durgan, and Bosahan, where conditions are fully saline, shores are steep and wave exposure is limited. Such overhangs are dominated by red alage including Plumaria elegans, Rhodymenia palmata, Lomentaria articulata, Corallina officinalis, Gigartina stellata, Chondrus crispus and 'Lithothamnia', with numerous anemones, purse sponges, tube worms and, in deep cracks, the Common Blenny. In places, colonies of the anemones Metridium senile and Sagartia spp are abundant, with individuals hanging in densities of up to 50 per m2.
1.1.2 Rock Pools

Pools allow colonisation of the intertidal region by many plants and - animals less well adapted to withstand the rigours of desiccation. They will only occur when the rock is uneven and fissured, allowing the trapping of water as the tide recedes. For this reason the most interesting examples may be found in the extensive rocky shores around Men-Aver Point, Nare Point and Prisk Cove, where the shallow incline and uneven nature of the rocks produce numerous pools of varying dimensions. Some are shallow and lagoon-like, others have a small surface area but are deep, with steep sides offering an ideal habitat for many algae, the presence of which in turn provides cover for numerous molluscs, crustaceans and fish. The existence of pools in the lower shore often encourages the growth of shallow sublittoral algae such as Laminaria spp. Lower shore lagoons at Prisk Cove are particularly spectacular, with growth of iridescent Cystoseira tamariscifolia (a Lusitanean species) amongst Laminaria digitata, Himanthalia elongata and Gigartina stellata. The base of many of these pools is scattered with coarse gravel made up of fragments of calcareous seaweed. In mid-shore pools there is a flourishing population of the Giant Goby (Gobius cobito), a local southern species.

Upper-shore pools are more susceptible to environmental extremes of temperature and salinity through being isolated from the sea for longer periods of time. However such pools, particularly if larger and more resistant to environmental changes, may provide a refuge on the upper shore for lower shore species. Often they contain a mat of Corallina officinalis and 'Lithothamnia' with numerous grazing Littorina littorea and Monodonta lineata, the empty shells of which provide homes for the many hermit crabs.

Pools continue to occur up the River as far as Treath and Helford Passage. Due to the steeper nature of these shores the pools are smaller and less diverse, with the exception of reefs between Durgan and Polgwidden; here the shore is at a more shallow angle and some medium-sized pools occur with good algal communities. Due to the more sheltered nature of these shores the pools also contain sublittoral sponges such as Suberites spp, Raspalia hispida, Leucosolenia botryoides, as well as the anemones Anemonia sulcata, Tealia felina, Aiptasia mutabilis, Cereus pedunculatus and the ascidian Clavelina lepadiformis.
1.2 Boulder shores

Shores composed entirely of boulders from high water to low water occur only at Parsons Beach and Parbean Cove, although many other shores have a zone of almost barren stones, boulders and pebbles at high water, above the reef proper.

By virtue of their mobile nature, boulder shores can only become colonised if wave action is reduced to a minimum. If this is the case they offer an ideal habitat for a wide range of species, with the upper surfaces of the boulders being colonised by algae such as Cladophora, Gigartina and fucoids, and at extreme low water, kelp, whilst under and between the boulders is a three-dimensional matrix of interconnected crevices offering shelter, protection from predators, a camouflaged hideaway from which to hunt or merely a moist crack in which to await the incoming tide.

At Parsons Beach the extreme cliff erosion deposits large rocks on the shore, which in time may be colonised. Boulders on the upper shore support little life due to the amount of time they are exposed to air, and also due to their mobility in the winter storms. In the lower shore however, boulders may only be exposed to the air during low spring tides, and are slightly protected by their position, from the erosive backwash of wave action. Many boulders are still turned over in storms and hence their algal cover is limited to the more opportunistic species such as Enteromorpha, Porphyra umbilicalis, Ulva lactuca, Gigartina stellata, and fucoids, whilst only the massive and immobile boulders will be utilised by Laminaria digitata and other kelps.

The diversity of life on and amongst the boulders, reaches a peak in late summer, after the growth and settlement of organisms over the clear calm weather, and before the disturbance of the autumn and winter storms. At such a time the Strawberry Anemones (Actinia fragacea) and Dahlia Anemones (Tealia felina) are common, with the undersides of some boulders being covered by the colonial ascidians Botryllus schlosseri and Botrylloides leachi.
In some areas the boulders are intermixed with sand and here the flora is noticeably different, with Bonnemaisonia hamifera, Dilsea carnosa Callithamnion spp Ahnfeltia plicata and Polyides coprinus.

Underneath and between the boulders are occasional Nucella lapillus, juvenile Cancer pagurus, Porcellana platycheles and Ophiothrix fragilis.

At Parbean Cove although the extent of the shore is much more limited because it is sheltered, by the 'hook' of Nare Point, the diversity is high. Under these boulders are numerous fish species such as Nerophis ophidion, Onus mediterranea and Lepadogaster lepadogaster, many Dahlia anemones, Tealia felina, and occasional echinoderms, Psammechinus miliaris, Asterina gibbosa and Asterias rubens.

In places, the lower shore of both Men-Aver Point and Prisk Cove is composed of boulders with a rich fauna sheltering underneath, including Cornish Suckers (hepadogaster lepadogaster), Butterfish (Pholis gunnellus), Worm Pipefish (Nerophis lumbriciformis), Urchins (Psammechinus miliaris), Brittlestars, Broad-clawed Porcelain Crabs (Porcellana platycheles) Squat Lobsters (Galathea squamifera), Cushion Stars (Asteria gibbosa) and the Blue Sponge (Terpios fugax) etc.

Although such boulder shores are sensitive to human disturbance by the turning of boulders, Parsons Beach and Parbean Cove are not easily accessible to the casual visitor and as such remain free of direct mechanical human interference. The boulder areas of Prisk Cove and Men-Aver are largely protected by their position low down on the shore where they are rarely exposed to human interference.

1.3 Clitter

The existence of clitter, mixed boulder and mud substrata is limited to a small area of Treath on the edge of Helford Creek. Previously clitter occurred on The Bar of Helford Passage but the rock is now covered by increased silt deposition Turk (1984).

The existence of hard substrata on a muddy shore increases the range of species present by providing a solid anchorage. This allows colonisation by sponges, Halichondria panicea, Hymeniacidon sanguinea, barnacles Elminius modestus, Chthamalus montagui, Chthamalus stellatus, with numerous Keeled Tube-worms. Amongst the boulders, sheltering under the fucoids are numerous Edible Winkles, Littorina littorea, and numerous Shore Crabs, Carcinus maenas: The Edible Winkles are frequently harvested by people for their own consumption, but on occasion a commercial gatherer may strip the population.
Treath and The Bar are under constant and heavy pressure from bait diggers and shellfish gatherers who turn the stones frequently and dig around the surrounding soft substrata. This results in algae becoming hidden from the light, and sedentary animals being exposed to the drying effects of wind and sun.

Also worthy of note is a tide pool approximately 100m south-west of Treath slipway. This pool, about 30cm deep, contains rocks upon which grow a diverse range of algae including Laminaria digitata, Antithamnion plumula, Bryopsis plumosa, Ceramium spp. Hypoglossum woodwardi,Dictyota dichotoma as well as the colonial ascidians Botryllus schlosseri, Ascidiella aspersa, and Dendrodoa grossularia. This pool is probably rich due to a combination of factors:

(i) standing water encourages a wide range of species
(ii) the pool is only exposed for a short while on extreme low spring tides
(iii) because of its position on the shore and its small isolated nature, it receives little disturbance.

1.4 Sandy Shores

Due to the comparatively sheltered nature of the Helford River, sandy shores are generally stable, and contain a certain proportion of organic material, so presenting an ideal habitat for many burrowing species.

The occurrence of sand in the River is limited to the lower shores of Gillan and Flushing beaches, and a small area around Treath Slipway, below Kennel Cottages.

(i) Flushing and Gillan

At Flushing Cove a sloping upper beach of stones and gravel gives way to an extensive low tide flat of fine slightly muddy sand. At Gillan Cove, where the beach is of rather coarser sand, the slope is more uniform without a distinct low tide flat.

On the upper part of these shores, beds of Sand Mason Worm, Lanice conchilea, reaching densities of up to 1,000 tubes per m², leave little space for other organisms between and below the forest of tubes. Lower down the shore the density of Lanice decreases, allowing the settlement of other burrowers such as the Lugworm Arenicola marina, and bivalves including Venus striatula, Cerastoderma edule, Callista chione and Venerupis pullastra. Frequent live Solen marginatus are present in Flushing Cove. Other bivalves
which probably occur in this sand, but of which only empty valves were found include *Tellina tenuis* and *Venus fasciata*.

(ii) Treath Slipway (SW 765264)

This area of sand is most notable for its population of *Arenicola marina* and lack of *Lanice conchilega*. Apart from this it seems almost lifeless. All three areas are particularly subject to human disturbance by bait diggers and shellfish collectors. Digging the sand has a similar effect to wave action, loosening the sand and allowing the trapped nutrients and organic matter to be washed away by the tide. Also, many animals not being collected are removed from the sand and cast aside, frequently dying due to the sudden change in their environment.

1.5 Muddy Shores

Where the force of the sea is abated, finer material is deposited and sand is replaced by mud. There is no sharp divide between the sand and mud faunas, but a transitional area inhabited by animals living in a mixture of the two. First there is a firm mixture of sand and mud with an admixture of gravel and stones, which then passes into increasingly soft and sticky mud. The main areas of mud and silt in the River are the creeks and channels of the upper reaches of the River, including the head of Gillan Creek. At Helford Passage and Treath are shores of mixed sand and mud.

1.5.1 True Muddy Shores

The upper reaches and the creeks which feed into the River, provide examples of true muddy shores. All the creeks, except the entrances of Porth Navas and PolYrheveral, dry out at low tide, with just a stream left to wend its way to the main channel. The courses and entrances of these creeks are marked by large mudbanks which are elevated above the level of the main channel.

Shore life may be abundant but variety is very limited, comprising mainly burrowing forms. This being a non-destructive survey, no digging was carried out to examine the infauna, although observation of others digging, and surface-traces, allowed some coverage.

Only a limited community of highly-specialised animals can feed and respire in the clogging environment of a true mudbank. The bivalve *Scrobicularia plana* is adapted to such a habitat and lives buried deep in the mud between tide marks. It is a valuable source of food for the birds that congregate on the mudbanks, as shown by the large numbers of broken shells littering the shores.

Other burrowing bivalves inhabiting the mud include the Sand Gaper *Mya arenaria*, which is found in large numbers on the mudbank in the mouth of Mawgan Creek, and Cockles *Cerastoderma*
edule which occur in lower numbers here than on the sandier
shores downstream.

On the surface of most muddy shores are at least a few scattered
stones and on these are found small amounts of the sponges
Halichondria panicea and Hymeniacidon sanguinea, and the
Gooseberry-tunicate Dendrodoa grossularia. Also present are
occasional specimens of the scidian Ascidiella aspersa and
numerous limpets. Attached either above or beneath stones are
large numbers of the Australian Barnacle, Elminius modestus,
clusters of the Edible Winkle, Littorina littorea and a few
Mussels, Mytilus edulis, whilst sheltering below are usually
present several Shore Crabs, Carcinus maenas.

The Shrimp, Crangon crangon and the Prawn, Palaemon serratus, seem
to thrive on these muddy shores as does the Ragworm Nereis
diversicolor. Fish occasionally found beneath stones include the
Eel, Anguilla anguilla, the Long-spined Sea Scorpion, Taurulus
bubalis and the Common Blenny, Blennius pholis. Native Oysters are
occasionally seen, these usually being juvenile specimens or
gapers.

On these bare muddy shores few or no algae can exist. Where
stones provide a holdfast the colonisers tend to be mainly
Enteromorpha intestinalis, plus some Ulva lactuca and
occasional Fucus serratus.

Nearer the mouth of the estuary, around Pedn Billy and
Frenchman’s Creek, the amount of hard substrata increases and
here a greater variety of life-forms can colonise. The Peacock
Worm, Sabella penicillus occurs where there are stones amongst
the mud, but is currently only left at a few localities, having
decreased drastically in recent years. In the east of Penarvon
Cove is an area of stony ballast; this and scattered mooring-
blocks provide habitats for numerous Plumose Anemones,
Metridium senile, some as much as 8cm in diameter. Also in
these stonier muds are frequent Slime Tube-worms, Myxicola
infundibulum and the Anemone, Cereus pedunculatus. Where most
stable and stony, colonies of Sandmason Worms, Lânice
conchilega occur and the American Slipper Limpet, Crepidula
fornicata, is not uncommon.

The algae of these stonier muds are far more varied. In
addition to Enteromorpha intestinalis, Ulva lactuca, Fucus
serratus and Fucus vesiculosus, are 'Ectocarpoids', Ceramium
rubrum, Plocamium coccineum, Gracillaria verrucosa, Dictyota
dichotoma, Asperococcus fistulosus and Dumontia incrassata. The
alien Japweed, Sargassum muticum (see Appendix 5) is present
and spreading fast here. On the very low shore only exposed at
ELWS, are found Bryopsis plumosa, Griffithsia corallinoides and
Antithamnion plumula.

At Calamansack, just upstream from Pedn Billy, the soft middle
shore mud supports an extensive bed of the Dwarf Eelgrass,
**Zostera noltii**, the only place where this now occurs on the River.

### 1.5.2 Sandy/Muddy Shores

The shores at Helford Passage and Treath grade from sand on the upper shore, through fine sand and silt on the middle and lower shore, to mud on the extreme lower shore. These firmer sandy muds support a further range of organisms.

On upper-lower shore areas, stabilised by stones, greater densities of Sandmason Worm, *Lanice conchilege* occur, whilst further down the shore is little hard substrate, and the burrowing bivalves *Lutraria lutraria*, *Solen marginatus* and *Venerupis* spp were found. Most noteworthy on these firm sandy areas, are the beds of Eelgrass, *Zostera marina*, as they provide a unique habitat supporting and sheltering a great many other organisms, including pipefishes and even, occasionally, Sea Horses!

The leaves of the *Zostera* themselves support colonies of epiphytic algae and hydroids. At Treath the stems and leaves provide shelter for the Grooved Top-shell *Cantharidus striatus*, a south-western species which usually lives on *Zostera*, although it has greatly decreased in numbers with the decline of the Eelgrass. At both Helford Passage and Treath the Netted Dog-whelk *Nassarius reticulatus*, is common amongst the stems and roots of the *Zostera*. The Northern Lucina, *Lucinoma borealis* also lives buried amongst the roots, whilst the Slime Tube-worm, *Myxicola* infundibulum also favours the stability of this substrate and is found throughout the beds, as are Hermit Crabs, *Pagurus* spp which are seasonally abundant on these shores. Edible Cockles, *Cerastoderma edule*, occur most densely in this sandy mud at Helford Passage and Treath, both beneath the *Zostera* and in the stonier areas that surround it.

Many algae live in or amongst the *Zostera*, or cluster in the water filled erosion hollows left by digging. Most common are 'Ectocarpoids' *Enteromorpha intestinalis*, *Ulva lactuca*, *Polysiphonia* spp *Gracillaria verrucosa*, *Dumontia incrassata*, *Ceramium rubrum* and *Fucus serratus*, with smaller amounts of *Halopteris scoparia*.

Mud to seaward of the *Zostera* beds is nearly bare, with just a scattering of 'Ectocarpoids' and occasional clumps of other algae, specially on mooring blocks and large stones. On the surfaces of these blocks are similar species to those described for the true muddy shores - the sponge, *Hymeniacidon sanguinea*, the Australian Barnacle *Elminius modestus*, the Keeled Tube-worm *Pomatoceros triqueter*, whilst sheltering below are the Edible Winkles, *Littorina littorea*, Shore Crab, *Carcinas maenas* and brittle stars.
1.6 Salt Marsh

A salt marsh starts to form when the flow of silt-laden water brought in with every tide is slowed causing it to drop its load of sediment. Flocculation and other mechanical deposition processes gradually build the mudflat upwards, until enough light gets down through the cloudy water to allow plants to grow. These primary colonists such as Glasswort, Salicornia spp, and Cord-grass Spartina spp, accelerate the silt-trapping process by binding the sediment with their stems and roots. Salicornia is one of the main pioneers, sprouting from the bare mud. This salttolerant annual traps up to 3cm of mud per year, mostly in autumn when the plants are at their peak of growth.

Small colonies of Salicornia europaea occur in the Helford, on the stretch of shore opposite Bonallack Wood, south-west of Bishop’s Quay and in Polwheveral Creek. Most extensively it occurs all along the eastern shore of Polpenwith Creek, where a small salt-marsh community has developed. Here at the top of the shore at EHWS is a mixture of salt-marsh plants – Red Fescue Festuca rubra, Sea Couch-grass Agropyron pungens, Spurrey, Spergularia sp, Annual Sea-blite, Suaedia maritima, and Sea Milkwort, Glaux maritima, forming a raised area of mixed grasses and herbs. This then passes seawards into a 3m wide zone of mixed Salicornia europaea and Suaedia maritima, below which are marine algae.

The native Salicornia cannot compete with the vigour and silt-trapping ability of the introduced Spartina which is invading and modifying its habitat. (See Appendix 5) The Spartina can colonise areas of stronger current flow, where native pioneers could not gain a hold. Its rate of trapping sediment is much greater than that of Salicornia, accumulating 5-10cm per year, by the filtering action of its roots and culms and the anchoring power of its extensive roots and rhizomes.

Thus the process of raising the mudbank is greatly accelerated by the invader; creeks will be blocked more rapidly, as islands of Spartina merge and coalesce and the mud level is rapidly raised to that where the surface is flooded only by the spring tides and a variety of land plants – rushes, reeds, grasses, etc – can grow, until the shallower creeks are prematurely converted to dry land.
2 Subtidal Habitats

Below low water the substrata are largely mud and silt down the river from Gweek as far as Pedn Billy. Beyond this the River bed becomes mixed rock and sand, with worn slabs of shale on which are growths of 'Lithothamnia'. The depth of the River (below chart datum) varies from 1m off Groyne Point, around 3-4m between Bosahan and Durgan, then dropping to 7-8m in the mouth.

Around Parbean Cove and the entrance to Gillan Harbour a shallow (1-4m) plain exists. In Parbean Cove the substrate is mixed soft sand, rocks, and some smaller boulders. This area was found to be rich in anemones such as Anemonia sulcata, Tealia felina, Cereus pedunculatus and Aiptasia mutabilis with numerous Slime Tube-worms, Myxicola infundibulum. At the time the area was surveyed (8/9/86) it appeared to have a heavy deposition of organic matter such as dead leaves and broken rotted seaweed. A small area of subtidal Zostera was found, and it is likely that more exists in the mouth of Gillan Harbour as remnants of the previous intertidal bed. Elsewhere in the River, subtidal Zostera beds occur between Bosahan Cove and Treath (SW 769265) and between Durgan and Polgridden Cove (M Deeble, pers comm).

Around August Rock and Prisk Cove the substrate is mixed rock, sand and gravel, with extensive kelp on the reefs. Although Zostera has been recorded from the shallow intertidal lagoons in this area a search failed to find any either intertidally or subtidally. The flora and fauna of these reefs looked at first inspection to be fairly diverse and certainly warrants further work.

Since the survey was confined to the intertidal, few observations have been made, although some diving has been carried out at weekends. A subtidal survey will be undertaken by the Oil Pollution Research Unit, under contract to the Nature Conservancy Council in the summer of 1987, which will complement work carried out in the intertidal region.
3 Past and Present Usage, with Analysis of Pressures

3.1 Ports, quays and mining

Historically the River has a long association with human activities. The double fort at Merthen is believed to be Roman or pre-Roman and was possibly built as a customs post, thus demonstrating the early importance of the River for trading.

Around the 14th Century, Gweek became important as the main port for Helston and surrounding areas. Whilst in the 18th Century Gweek was the port for tin from the mines in the Wendron district to the north. In the last century the quays were alive with small ships carrying emigrants bound for North America. Until about 1932 corn was brought by water to Gweek Mill for grinding, whilst coal, cement and timber continued to be brought in by coastal steamer until the 1960s.

The quays of Bishop's Quay, Merthen, Treath, Porth Navas and possibly Tremayne were used for the burning of lime which was brought by sea. Merthen Quay was also the highest point reached by big Norwegian timber boats bringing mining timber from 18th to early 20th century: Scots Quay in Pohrheveral Creek owes its existence to the once-flourishing stone there were no less than eight granite-quarrying firms operating trade: in Constantine in 1935 (Todd and Laws, 1972). Helford itself was once so busy a port that it supported a customs house.

A past pollution problem of the River was the discharge of mine waste. The largest mine to discharge into the Helford was Wheal Vyvyan at Constantine. Effluent of the fine red ochre type would have been carried effectively in the fast-running Polwheveral Stream, only settling out on meeting the slow salt waters of the creek. Copper and tin were the metals primarily mined at Constantine, with discharges (associated with most Cornish mines) being loaded with many heavy metals including copper, iron, arsenic, lead and zinc. Other mine discharges drained from Wheal Caroline at Trewardreva and Wheal Ann Maria at Budock Vean, where silver lead was mined between 1850 and 1908; Wheal Fortune (1824) and Wheal Lovell, from which discharges ran into Gweek streams; and lastly Wheal Mudgeon, which mined copper and arsenic for a few years in the mid-19th Century, discharging two adits into Vallum Tremayne Creek.
3.2 Fishing

The importance of fishing in the history of the River is demonstrated by the existence of fish cellars at Helford, Frenchman's Creek, Tremayne and Gweek (and almost certainly at Porth Navas and Constantine (D C Bean pers comm)), Here the fish were stacked and pressed to extract the oil prior to packing for export. This involved the inevitable leakage of oil and disposal of rejected fish into the River.

Nowadays many fishing boats still operate from the Helford, fishing offshore and landing their catch elsewhere in Cornwall: Some of the smaller fishing boats sell to 'Lady Hamilton Fish', whilst Bishops Quay and the quay between Frenchman's Creek and Penarvon Cove are still used for landing catches from outside the Helford River.

Very little commercial fishing now takes place in the River itself, apart from occasional ebb-tide netting for Mullet in the upper reaches and the setting of Lobster and Crab pots in the mouth around the areas Mawnan Shear to Rosemullion Head and Dennis Head to Nare Point.

The Helford also supports one of only two well-established fisheries in the UK for the Velvet Swimming Crab (Macropipus puber), the other being in Scotland. Pots of a fine mesh, with a small opening are set very close inshore (less than 200m) since this is where the highest density of crabs occur. They are commonest around the mouth of the River, becoming less common further out towards the headlands of Nare Point and Rosemullion Head. They do however move around in search of food. After a period of prolonged easterly winds the crabs are found to be abundant in the centre of the River amongst dead and rotting weed (D C Bean pers comm).

Also caught in the pots are Shore Crabs (Carcinas maenas), the largest of which are shipped with the Velvet Swimming Crabs to Spain, as well as occasional Lobsters (Homarus vulgaris) and Edible Crabs (Cancer pagurus).

3.3 Oysterage

The breeding of Oysters in this country dates back to before Roman times and is probably one of our oldest industries.
In 1815 an advertisement appeared in The Royal Cornwall Gazette that the oysterage of the Helford was to be let by sealed tender. The Oyster beds were described as "very flourishing". By 1862 and 1863 the oysterage gave employment to twenty men dredging 2,400 tubs per year (Ellis, 1865). These were exported to Plymouth market where they were found to be superior to Fal Oysters and easily sold. The oysterage continued to flourish into the 20th Century. During the 1970s over one million Oysters per year were being taken, with The West Briton reporting (17/6/76) that several million Oysters were laid throughout the River. These Oysters reached a wide range of destinations including direct supply to British and Continental hotels as well as fishmongers.

In 1982 the industry was hit by the introduction of Bonamia ostreae, a protozoan parasite which caused the death of 90 per cent of the Oysters. The Helford oysterage was obliged to cut back its work force, attempt to eradicate the parasite and diversify by supplying other species, such as Mussels and American Clams, Mercenaria mercenaria, the latter, being brought from the polluted waters of the Solent to Helford River for cleaning prior to human consumption. The Oyster cultivation is showing signs of recovery as some beds are now free of the parasite.

Since the oysterage is only cultivating the Native Oyster (Ostrea edulis), the effects of the anti-fouling paints containing tributyltin have not been as noticeable as they would have been if the more sensitive Pacific Oyster (Crassostrea gigas) were being farmed (Appendix 3). In any event it is likely that the outbreak of Bonamia has masked any changes in productivity due to TBT.

The presence of a flourishing oysterage, covering Porth Navas Creek, the lower reaches of Polwheveral Creek and the main River between Pedn Billy and Groyne Point, has in the past helped to restrict the distribution of moorings, and has been a powerful lobby for maintaining water quality and restricting damaging development.

3.4 Trigging (Collecting molluscan shellfish)

Various species of molluscs other than Oysters, particularly cockles, winkles, mussels and limpets have probably always formed part of the diet of those humans who live near the sea. In Cornwall, however, there is a very ancient custom of collecting shellfish - 'trigmeat' - on Good Friday, and within living memory people would wend their way to the nearest shore to gather one or more species as available: on the north coast it would have been mainly limpets and mussels; on the south coast, mainly cockles and winkles. Now limpets are rarely collected for human consumption, and of the others, cockles are probably the most favoured by the majority of people: as these are found only in sheltered areas like the Fal and the Helford
River, people congregate in such places. In earlier times, transport would have been a problem, but the car has changed all that as so much else, and now people, nearly all Cornish and mostly in family groups, travel from much of west Cornwall to 'go trigging' at Helford Passage (which boasts the largest cockle beds in Cornwall), Treath and St Anthony (Fig.1): indeed there would doubtless be more if parking space were available. Even people from Penryn are known to come to the Helford River where the Cockles are purported to taste far nicer than the 'oily Cockles' of the Fal. In the 1986 survey (Appendix 6), one trigger said that 50 years ago, comparatively few people, all very local would have been at Helford Passage on Good Friday: in 1986 there were over 100 (Plate 1), whilst on a particularly fine Good Friday in April 1981, there was a spectacular turn-out: "Armed with rakes, hoes and even garden trowels, the pickers came from all over west Cornwall, their cars filling every available parking space. On each side of the Helford there were estimated to be more than 1,000 digging." (The West Briton 23/4/81). Effect of such trigging after an intensive session the area looks as if it has been ploughed. This loosens the sediment, allowing it to smother any hard substrate, like clutter, shells and gravel on which seaweeds and various sessile animals - such as mussels, anemones, sea-squirts and sponges - fix themselves.

Digging and raking also brings to the surface black oxygen-starved sediment that is initially unsuitable for colonisation. Burrowing animals that are not collected, may be inadvertently destroyed or suffer from a stress which affects their growth. In 1986 most triggers believed that there was an obvious increase in people involved and an equally obvious decrease in cockles, although some held that the population size fluctuated from year to year, rather than actual numbers of cockles. Few of those questioned collected other than on this one day.
Map 2

The Distribution of Oyster and Popular Cockle Beds in the Helford River

[Map showing distribution of oyster and popular cockle beds in the Helford River]
A few people (approximately 20 at Helford Passage) dug for Cockles in the Zostera bed, claiming that this was where the largest were to be found. This has a disastrous effect on the Zostera, loosening the rhizomes and causing erosion pans which natural action can then enlarge (Plates 1, 2 and 3). Also it is likely that these larger individuals represent the mature breeding stock which help to maintain the number of cockles over the rest of the mudflat. The removal of these larger individuals may well result in a drastic reduction in the recruitment ofjuveniles to the population. The larger more mature individuals no longer occur in areas of disturbed mud, for instance The Bar, as they are collected at a smaller size. This is borne out by the fact that many triggers said that the cockles were becoming both fewer and smaller.

Compared with Good Friday, trigging throughout the rest of the year is a relatively restrained affair. Although most local people stop collecting out of season (when there is not an 'R' in the month), many holidaymakers still collect shellfish throughout the summer, giving the stocks no chance to recover and disrupting the settlement of young individuals.

As well as the collection of cockles there has also been commercial collecting of Razor Shells (Ensis spp) for food and/or bait from Gillan Harbour (J Miller pers comm). Also there has been some intensive collection of Mussels (Mytilus edulis) commercially from Helford Passage and Gillan Harbour and consequently they are now very rare (fide Miss P Towner and Mrs H 0 Trench).

During the spring tides of November 1986 a man was seen collecting Edible Winkles (Littorina littorea) by the hundredweight from Treath, Penarvon Cove and The Bar on three consecutive days. Such collection of large numbers must have a serious effect on populations.

3.5 Bait Collection

Bait collection occurs on much the same shores as trigging, ie, Treath, Helford Passage and Gillan Harbour, again causing disturbance and erosion.

Digging for Lugworm (Arenicola maritima) occurs in the mid- and lower reaches of Gillan Creek, around The Bar and at Treath. Ragworm (Nereis diversicolor) are generally dug from muddy shores in Gillan, Treath, and the main channel at Gweek. Additionally some fishermen favour the collection of Amphitrite ligulus (= johnstoni) which occur in beds around Helford Point.

From questionnaire responses (Appendix 2) it appears that approximately one third of all the anglers sampled also collected their own bait from the River. Although this practice has probably been carried out for centuries, a recent rise in the popularity of angling and the amount of leisure
time available to people has resulted in an increase in the amount of bait collection taking place.

3.6 Prawning and Shrimping*

Prawning and Shrimping has been carried out casually and commercially for decades if not centuries. C C Vyvyan (1956) mentions the joys of prawning in Abrahams Bosom, the area in the mouth of Porth Navas Creek, before the Second World War. It is still carried on, limited to summer when the animals are to be found in shallow water. Both local people - and visitors join in, particularly around Gillan Harbour and Helford Passage, but it appears to be mostly a family activity, without a serious commitment to a good catch, although some are fairly dedicated to the acquisition of a free meal. At present levels prawning and shrimping pose no threat to marine life.

3.7 Recreation

The increase in the number of visitors to the River may in part be blamed on the car. The car permits far easier access, allowing people from all over the county and country to visit the River. This pressure is restricted to 'hot spots' where vehicular access is close to the shore, ie Helford Passage, Helford, Penarvon, Gillan Harbour and to a lesser extent, Durgan, all of which are sensitive areas, biologically.

Recreational usage of the River reaches a maximum in summer with both local people and visitors taking part in activities on, in, or by the water. From personal observation during summer 1986, little swimming appeared to take place, although from the visitor survey (Appendix 2) many people said they would be swimming and paddling: perhaps this was just wishful thinking. 1986 was a very poor summer!

Virtually everybody interviewed said they would be walking along the shore to some extent. This is unlikely to cause undue damage except in the area of the Zostera beds.

Boating is probably the most obvious recreation, with yachts and pleasure craft being moored at Porth Navas Creek, the Main Pool (between Helford and Helford Passage), Durgan and Gillan Harbour, throughout the summer and early autumn. Pressures from boating have changed markedly over the last 100 years. Pre-1900 the River was used as a highway, and working boats were much in evidence. As road transport took over from the sea, usage of the River declined until very few boats were to be seen (Plate 4). However, after the Second World War recreational boating gained popularity until it reached the state in which it can be seen today with pleasure boats dominating the lower reaches of the River in summer (Plates 5, 6, 7 and 8).
Sailing activities centre around Helford and Helford Passage, with the bulk of the moorings being situated around this area, up as far as the mouth of Porth Navas Creek where they end due to the oysterage. The number of moorings at Durgan is indirectly controlled by the National Trust, which restricts vehicular access to the village and limits the number of dinghies and tenders which may be left on the beach. In Porth Navas Creek and Gillan Harbour the number of moorings is largely controlled by the area of water left at low tide. Since the bulk of both creeks dries at low tide most of the moorings are concentrated in the deeper water around the creek mouths.

Moorings have been licenced since the mid-1970s, with a charge being levied for each mooring. Since 1984, these moorings have been under the control of 'Helford River Moorings', which also collects dues from visiting yachts mooring overnight. The records for these are shown Table 1 (see over).

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Boat Nights</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>1116</td>
</tr>
<tr>
<td>1986</td>
<td>1532</td>
</tr>
</tbody>
</table>

Table 1: Number of visiting boat overnights for 1985-1986

(J Stephens (pers comm)

It can be seen that in spite of the poor summer of 1985 there was an increase in the number of visiting boats in 1986, another wet summer and it is likely that the total number of boats in the River is also increasing.

Pollution from these boats comes in many forms. Accidental spillage of fuel while filling fuel tanks, and unburnt oil residues from twostroke engines form the major petro-chemical pollutants in the River, although these are limited in extent. Disposal of litter overboard is also a form of pollution, although again this is minimal. Visiting yachts and local day sailors using flush toilets represent a source of raw sewage entering the River directly. From questionnaire responses (Appendix 2) it seems that some people stay on boats moored in the Helford for more than one night: this is likely to compound the problem. Due to the lack of controls on this discharge and the difficulties of implementing any legislation if there were any, it is largely uncontrollable. At present raw sewage from boats does not pose a significant threat, but any increase in discharge could begin to cause problems.
Frequently people travel up and down the River and run aground on the many mudbanks in the upper reaches. Although this does not usually represent an important source of damage to the environment there are exceptions. In 1977 the 'Helford Oyster Farm' received compensation from the insurers of a fishing boat which ran aground on Oyster beds in the Percuil River, a tributary of the Fal.

The major problem caused by boating activity is the leaching of Tri-Butyl Tin (TBT) from anti-fouling paints. This is dealt with in detail in Appendix 3 of this report.

Due to the six-knot speed limit in the River from Durgan upwards, water-skiers are effectively excluded, although some skiing does take place in the calm, water of Tremayne Quay and at Helford Passage in contravention of the Bye-laws.

Several diving charter boats operate from the Helford, but rarely is there diving in the River itself unless the weather is exceptionally bad.

Windsurfing is popular from Helford Passage in particular, with a windsurfing school and board hire being run as part of the 'Ferry Boat Inn' complex.

Motorboats and yachts are available for hire during the summer season from Helford Boatyard, the Ferry Boat Inn and 'Star Hire' of Durgan along with sailing and motor boats from 'Sailaway' in Gillan Harbour.

*Shrimping' probably refers to small prawns, as true shrimps (Crangon vulgaris) are not common in the River.
3.8 Education and Research

The Helford has seen much scientific study in the past with records starting in the early 1800s (Holme and Turk 1986). Between 1899 and 1907 Professor James Clark was Head of Biological Science at Truro Technical College and he and his students recorded extensively and intensively on and offshore, including the River, most of these records being in the Victoria County History of Cornwall (Clark 1906).

In the 1930s the well-known shell collector T G W Fowler collected huge numbers of live specimens on these shores mainly in soft substrata. His specimens are now in many museums, the bulk of them being in the British Museum (Natural History) and the Isles of Scilly Museum. Those in the BM(NH) include over a dozen large specimens of the very rare Spiny Cockle (Acanthocardia aculeata) and many Smooth Venus (Callista chione).

Field and research trips reached a peak in the 1960s and 1970s. More students were passing through higher education, 'and the River was put in easy reach of many colleges and universities by improved road transport. Educational groups came from far afield to examine the rich shores. Between 1965 and 1983 a total of 454 students from Bristol University visited the area over 18 trips (Thompson and Scott 1983). Although they do not believe their activities have engendered the present depletion of the infauna of sediment shores, disturbance can only have hastened the decline. Over the past few decades students from other universities including Reading and London as well as many schools and colleges have visited the River.

Since the shores have become depleted groups find little to interest them, and so the majority visit other sites. This was highlighted in a letter from Dr T E Thompson (Reader in Zoology, Bristol University) who has been visiting the district annually for about 20 years. In a letter to S M Turk (11/4/83) he declared that the shores of Helford River were ... becoming as devoid of life as those of northern France, adding "It is getting difficult for me to find a nice deposition shore in south Cornwall ... Is there anywhere I can go and still see Chaetopterus and Labidoplax, and Golfingia, and Mya, and Adamsia palliata Helford is pretty hopeless now. Peter Miller went there last week and could not even find Gobius paganellus."

Fieldwork is no longer a significant pressure. If, as it is hoped, the River returns to its former biological richness and diversity, sediment shores may again come under the shovel of science. Any such fieldwork should surely need to be controlled to prevent deterioration from taking place again.
3.9 Silage, Slurry, Sewage etc

Dairy farming is the predominant form of agriculture in the catchment area. Within the present economic climate dairying has become far more intense, with an increase in problems posed by disposal of waste and storage of silage. With around 200 farms such forms of pollution are commonplace, with nearly every stream having had a pollution problem at some time or another (F E Collett pers comm).

**Silage**

In order to produce silage, cut grass is stored under anaerobic conditions. Under such conditions the bacteria usually responsible for decay respire anaerobically to produce lactic acid as 'a by-product. This lactic acid in effect pickles the grass with most of its nutritional value still remaining. This allows the silage to be stored for long periods. Inevitably, in the production of silage a small amount of liquor drains out of the base of the silage clamp. If the clamp is properly constructed with an impervious concrete base and drainage system to carry the liquor away from watercourses for treatment then no pollution will occur. However, the wetter the grass used for the silage, the more liquor is produced. In this case the liquor can be too much for the drainage system to cope with and will overflow into streams. Since silage liquor is 200 times stronger than domestic sewage the polluting effect on the receiving watercourse is devastating. Although silage production is limited to five or six weeks in May and June South West Water brought three prosecutions in 1986 for silage liquor pollution in the Helford River catchment alone, indicating the serious nature of the problem (P Collett pers comm).

**Slurry**

Disposal of farm waste in many cases takes the form of traditional 'muck' or slurry spreading. However, with more intensive dairying many farmers spread far more than is necessary as fertiliser, just to dispose of the waste. This material cannot be absorbed by the grass before rain washes it into streams and rivers where it becomes a major pollutant. The run-off of organic and inorganic fertilisers from farm land is a particular problem since it is virtually uncontrollable. Farmers themselves do not wish to see their expensive inorganic fertilisers being washed off their land by rain, but with the vagaries of the English climate there is little that can be done.

Many farmers hose down their yards to remove accumulated waste which rapidly enters streams and thus flows into the estuary. The same effect occurs when heavy rain drains across yards without adequate precautions to prevent contamination of streams, which may also contain pesticides, fungicides, and herbicides.

**Erosion**

Bulb fields around Treath can also cause problems in heavy rain. The furrows running down the hill act as channels...
for rain water, causing it to scour soil from the fields and carry it in suspension to the estuary.

Sewage Disposal of sewage into the River fluctuates a great deal. Outflow from Helford Passage increases by around 500 per cent in the summer months due to the increase in population (P Collett pers comm) Since the sewage is privately treated, no data on the quality of effluent is available. Public sewage treatment works exist at Mawgan, Gweek and Constantine, with septic drainage at Helford, Gweek and Mawnan. These septic drains regularly overflow due to pressure of use allowing raw sewage to enter the River. Additionally some treated sewage from Culdrose is discharged into a tributary stream (Cooper 1961).

Falmouth sewage may also pose a problem in the Helford. Much of Falmouth's sewage is discharged from a pipeline at Pennance Point (known locally as Stack Point): currents sweep this in a clockwise direction, so that in easterly winds it may be washed into the Helford River.

Hendey (1977b) lists diatoms from algae at Treath, and comments that the diatom flora "suggests a certain amount of sewage pollution". Earlier work by Hendey (1977a) discusses the manner in which the diversity of diatom flora decreases during the peak holiday season due to the increased effluents into coastal waters.

Other effluents Two other sources of pollution come from road drainage and the weed killers used to maintain clear fire-breaks. RNAS Culdrose, did stop (in 1985) its method of fire-fighting practice because of the problems caused by the foam used for extinguishing the burning oil pans, but little can be done to obviate a certain amount of pollution that comes from the runways.
Plate 1: Activities of 'Triggers' on Helford Passage Zostera bed. Good Friday 1986 (Mrs P E Tompsett)

Plate 2: ‘Trigging’ on Good Friday at the turn of the century
Plate 3: Erosion Pans, in Zostera beds, due to 'Trigging' activity at Helford Passage (Mrs P E Tompsett)

Plate 4: Raked area of Zostera bed with collected cockles, Helford Passage, Good Friday 1986 (Mrs P E Tompsett)
Plate 5: Aerial view of Helford River, June 1931. Note the total lack of boat activity.

Plate 6: Aerial view of Helford River, Pedn Billy and the mouth of Porth Navas Creek, September 1986 (RNZAS Culdrose).
Plate 7: Aerial view of Penarvon Cove, September 1986 (RNAS Culdrose)

Plate 8: Aerial view of Helford Point and Helford Passage, September 1986 (RNAS Culdrose)
Plate 9: Aerial view towards the mouth of the River, showing Treath and Durgan, September 1986 (RNAS Culdrose)

Plate 10: Previous abundance of oysters on the Helford, in the early part of this century (W J Rickard)
4 Natural Pressures and Associated Changes

Natural pressures can cause stress which makes the environment more vulnerable to mistreatment by humans (and vice versa).

Changes in the environment may be caused by diverse natural phenomena such as high winds or abnormal temperatures.

Vallentin (1896) commented that severe easterly gales in February had substantially changed the area of Helford Bar. A fine layer of sand was thrown up from the main channel over the mud bank covering thriving populations of Slime Tube-worms, Myxicola steenstrupi and Peacock Worms Sabella penicillus, leaving only a few Sabella alive. A short time later Lanice conchilega began to appear and by September they were so numerous they 'resembled a forest in miniature'. Such storm erosion and deposition of sediment can cause large-scale changes, but are very infrequent.

Extremes of temperature are a particular hazard on Cornish shores where extremely low spring tides fall at midday and midnight.

Cold weather may have a particularly severe effect on southern species which are at the northern limit of their distribution. Frosts in winter can kill individuals outright, whilst low water temperatures over summer months may reduce breeding success and cause a decline in population size. Several poor summers in a row will result in extinction of some species.

During the cold weather of January 1987 ice formed in the upper reaches of the Helford and was deposited on mudflats. This, combined with the low ambient temperatures caused defoliation of Zostera noltii (= nana). This may have been due to either frost damage to the leaves, which were then shed, or by sheets of ice forming around the plants then pulling the leaves off as the rising tide refloated the ice. The rhizomes appeared to remain intact and it will only be apparent in summer whether the Zostera bed will recover from this damage.

During the exceptionally cold winter of 1962-1963 large beds of cockles around Tremayne Quay were killed by frost. The area has not been repopulated (D C Bean pers comm).

In summer during low tide the shore is exposed to the drying effects of sun and wind. In exceptionally hot weather some plants and animals will be 'baked' to death. Zostera marina, for example, is very susceptible, half an hour's exposure to warm air on a sunny day being enough to kill the base of the leaves, resulting in eventual death of the rest of the plant.
(Tutin 1941). For this reason increased sedimentation will cause the death of intertidal Zostera beds by raising them further above low water and increasing the length of time they are exposed to the air.

Rotting seaweed piled up on the shore may smother many species, whilst the run-off of nutrients from the decomposing algae may cause changes in the shore ecology. In the past, the widespread practice of collecting seaweed for fertiliser has reduced these effects but nowadays seaweed is left to rot on the shore.
5 Changes in the Habitats, Flora and Fauna, by site

5.1 General Description

Changes in the flora and fauna of the Helford have been widespread and on a large scale. In some cases comparison with past records made us wonder if it was the same shore that we had surveyed, so dissimilar were the results.

Perhaps the most obvious change is the total disappearance of Zostera spp from many areas. Zostera noltii (= nana) was previously recorded from Gweek, Scots Quay, Helford Creek and Calamansack (Margetts and David 1981). It is now only present at Calamansack. A large bed of Zostera noltii and Z marina was recorded in Penarvon Cove in 1949 (Spooner and Holme 1986). By 1978 the Z marina was absent, although Z noltii was still present (Holme 1986). In 1986 we found neither species in the cove. Also absent were the numerous Peacock Worms Sabella penicillus, which had been abundant up till the 1978 survey (Holme 1986); these have almost totally disappeared from all over the River to be replaced by the Sandmason Worm, Lanice conchilega.

Many species of molluscs have suffered a decline in numbers or extinction of populations in the River. Edible Cockles, Cerastoderma edule have been reduced at all sites whilst the cockle bed at Tremayne Quay has disappeared entirely, due to the cold winter of 1962-63 (D C Bean pers comm). Concentrated mussel beds have disappeared from Gillan Harbour and Helford Passage due to commercial harvesting. The Mussel Modiolus adriaticus was collected in large numbers 'from Bosahan shore' in the 1930s by T G W Fowler; none have been found in 1986, although it is possible that isolated individuals may have been overlooked. (NB This species is generally found off-shore.)

Oysters in the River have declined dramatically since the 1982 outbreak of Bonamia ostreae, although the numbers are beginning to show an improvement. (Refer to Plate 9)

The Dog Whelk, Nucella lapillus, has shown a drastic reduction in numbers due to the use of TBT-based anti-fouling paints on boats. In the past this species has been common up-river as far as the mouth of Frenchman's Creek and Pedn Billy. Populations are now restricted to the outer headlands of Nare Point and Rosemullion Head, although even here the populations show a low recruitment of juveniles indicating a poor breeding rate (Appendix 3).

Introduced species (Appendix 5) may have an impact which is not immediately obvious. The Australian Barnacle, Elminius modestus, has become dominant in the upper reaches of the Helford, out-competing Chthamalus spp and Balanus balanoides. Japweed, Sargassum muticum, is becoming much more frequent and there is a risk that it will smother...
the remaining areas of **Zostera**. The introduction of Cord Grass, *Spartina anglica*, to the upper reaches of the estuary has increased the rate of siltation and thus will speed the process of transition from estuary to saltmarsh. This rapid sedimentation may explain an increase in the number of Sand Gapers, *Mya arenaria*.

### 5.2 Helford Passage

The Bar at Helford Passage has suffered a total change in habitat, causing a drastic reduction in the diversity of species present and a reduction in numbers of nearly all surviving organisms with the exception of the Sandmason Worm, *Lanice conchilega*.

Burrows and Turk (1972) recorded a varied fauna, on the surface, amongst the leaves of **Zostera** and in the areas of clitter. Also noted was a tide pool in the **Zostera** bed with a base of clitter which was colonised by a dense bed of *Laminaria saccharina* and some *Saccorhiza polyschides*. In a repeat survey in 1984 (Turk 1984) found the clitter to be silted over, the **Zostera** bed reduced, patchy and eroded and the low-tide pool absent, again due to sedimentation.

The clitter has disappeared due to siltation, along with its associated fauna such as lobular masses of sponges *Hymeniacidon sanguinea* and *Suberites spp*. There is now little hard substrata to provide a habitat for sponges, molluscs, algae and barnacles. Also absent are Variegated Scallops *Chlamys varia*, which used to be plentiful, and Mussels which were common enough to be gathered by local people until commercial harvesting eradicated the population.

The area of the **Zostera** bed is much reduced, with an increase in the number of erosion pans, caused by digging. The rich fauna normally associated with **Zostera** is now totally absent, with organisms such as the Membranous Spire Shells, *Rissoa membranacea*, and the Grooved Top Shell *Cantharidus striatus*, having disappeared in spite of being once plentiful. The tidal pool and associated life has totally disappeared, due to sediment deposition.

The infauna of the sediment is also changed, the Peacock Worm, *Sabella penicillus*, once present in densities of up to 300 per m², is now almost totally absent, with less than 10 worms being found on the whole shore! In contrast the Sandmason Worm has become dominant and thrives in nearly all areas of the shore, reaching densities of over 1000 per m².

Edible Cockles *Cerastoderma edule* have declined in numbers due to the activities of shellfish gatherers (Appendix 6 and Section 3). Due to the reduction in density people are digging a greater area of shore to gather the same number of Cockles and the area of the **Zostera** bed is now frequently dug.
The Common Whelk, *Buccinum undatum*, used to spawn intertidally in large numbers. In the 19th Century they were commercially harvested for food (Rashleigh 1874). In 1972 they were a frequent sight on the shore. The Whelk is now rarely found intertidally in the Helford, although large numbers were seen spawning subtidally in the mouth of the River (depth around 15m) in March 1986.

Treath, Helford Point and Penarvon Cove The shore at Treath has suffered a similar fate to that of Helford Passage, with increased siltation and decreased diversity of marine life.

The Cup-and-Saucer Limpet, *Calyptraea chinensis*, once common on boulders at Treath is now totally absent. This however may be due to climatic variations causing a low rate of reproduction and hence a decrease in population size (Wyatt 1961). The limpet still occurs subtidally at Parbean Cove, and possibly elsewhere subtidally in the River, given suitable substrata. Mussels were once common among the boulders of the clitter shore but the population has, as elsewhere on the River, been eradicated by commercial harvesting, although the clitter still remains. In spite of its similarity with the rich clitter habitat which existed at Helford Passage, the Treath clitter is impoverished as the stones are frequently turned in the search for soft crabs (to be used as bait). The Edible Winkle, *Littorina littorea*, has also been reduced by commercial harvesting.

Within the mud the fauna is much reduced. Gathering of shellfish has caused a decrease in the abundance of cockles and the disturbance of the substrata has led to the disappearance of Razor Shells *Ensis ensis* and *Ensis siliqua* and the burrowing Sea Cucumber, *Labidoplax digitata*, once frequent. The Peacock Worm, *Sabella penipillis*, recorded at densities of up to 100 per m² in 1977 (Turk 1977) is now totally absent, while the Sandmason Worm *Lanice conchilega* is still abundant.

The *Zostera* bed has become sparse, and has been over-run by annual opportunistic algae such as Ectocarpoids, *Ulva* spp, *Dumontia incrassata* etc. The associated molluscan fauna, such as *Rissoa* spp and *Cantharidus striatus*, has virtually disappeared, along with the numerous pipe fish which were to be found in shallow pools amongst the *Zostera*.

Helford Point is the type locality for Couch's Goby, *Gobius couchi*, described as new to science by Miller & El-Tawil (1974). Dr Miller visited the area in spring 1983 eight years after his previous visit, to examine the shore fishes present between low water neaps and extreme low springs to the east of the creek. In a personal communication to one of us (SMT), he wrote "My impression was that the intertidal fauna in general seemed much poorer in comparison to its richness in the early seventies and before. Couch's Goby was present but less numerous than in previous years. I believe that this limited area of intertidal habitat is very susceptible to human interference, in the immediate sense by students of marine
biology and by collectors of shellfish and perhaps also by deterioration in water quality caused by pollution from boats or land-based activities."

Penarvon Cove has valuable comparative material as a result of being surveyed by Mr G M Spooner and Dr N A Holme in 1949 (Spooner and Holme 1986); by Dr N A Holme and Dr Gillian Bishop in 1978 (Holme and Bishop 1978); and by the Project Team in 1986. The following 'species are amongst those which have declined or disappeared.

<table>
<thead>
<tr>
<th>Species</th>
<th>1949</th>
<th>1978</th>
<th>1986</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Eel-grass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Zostera marina)</td>
<td>'Thick meadow'</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td>Dwarf Eel-grass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Zostera noltii)</td>
<td>In environs</td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Peacock Worms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Sabella penicillus)</td>
<td>'Numerous'</td>
<td>Up to 40 per m²</td>
<td>Absent</td>
</tr>
<tr>
<td>Cup-and-Saucer Limpet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Calyptreia chinensis)</td>
<td>'Common'</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td>Variegated Scallop</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Chlamys varia)</td>
<td>'Abundant'</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td>Pullet Carpet-shell</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Venerupis pullastra)</td>
<td>Common</td>
<td>Shells only</td>
<td>Shells only</td>
</tr>
<tr>
<td>Golden Carpet-shell</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(Venerupis aurea)</td>
<td>Common</td>
<td>Shells only</td>
<td>Shells only</td>
</tr>
<tr>
<td>Grooved Razor-shell</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Solen marginatua)</td>
<td>'Many' adults</td>
<td>Two only</td>
<td>Shells only</td>
</tr>
<tr>
<td></td>
<td>and 2 juveniles</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.4 Gillan Harbour

Shores at Gillan may be divided into three distinct categories:

(i) Mid-tide flats of sand, mud and gravel opposite St Anthony's Church, over which trigging and bait collecting takes place.

(ii) Low-tide sand flats at Flushing Cove.

(iii) Beach of coarser sand at Gillan Cove.

All of these shores have suffered a general decline in the bivalve fauna, particularly in the reduction of Razor-fish (Ensis spp.), probably through the activities of bait-diggers. Another bivalve, the Smooth Venus, Callista chione has almost totally disappeared. Echinoderms, represented by the Sea Potato Urchin Echinocardium cordatum have also become rare, although this species was common in the 1960s.

The low-tide flat of Flushing Cove has changed dramatically, the large 'island' of Zostera having disappeared, along with associated fauna such as Lacuna vincta, Rissoa membranacea and R parva. Also gone are the numerous Peacock Worms, Sabella pavonina, and the Lugworm Arenicola marina is much reduced in numbers, whilst as elsewhere, Lanice has increased. Considerable movements of sand have been noted in this area by Mr W S A Jenkins (pers comm).

Beds of mussels, which used to thrive in the restricted area above the Narrows in Gillan Creek are now totally absent, due, it is believed, to commercial over-harvesting.

Nucella lapillus, the Dog Whelk, once frequent in the rocky outer reaches of the Harbour is now totally absent, due to the effects of TBT antifouling paints (Appendix 3)

SUMMARY

1. The Helford River lies within an Area of Outstanding Natural Beauty which is also an Area of Great Scientific Value, and it contains Sites of Special Scientific Interest and Nature Conservation Areas. More importantly for the present study, the River has been recognised internationally for the diversity and wealth of its marine life.

2. Representations to this effect were made in April 1983 to Cornwall County Council in respect of its Cornwall Countryside Local Plan. Note was taken of the statement in the Plan (para 3.30) to the effect that the County Council will encourage the establishment of Voluntary Marine Nature Reserves in Cornwall and the County Council was urged to take the initiative in setting up a Reserve for the Helford River. In June 1984, the County Council's Planning and Employment Committee accepted the case for some kind of conservation agreement for the Helford River and agreed to take the initiative in seeking to create one. The County Planning Officer convened a meeting of District and Parish Councils, other bodies and individuals with a direct or indirect interest in the River, at which there was a large measure of agreement in favour of forming a group with the object of creating a Voluntary Marine Conservation Area in the River and monitoring the changes in its marine biology. The Cornwall County Council decided, therefore, in January 1985, to form a Steering Group with this aim in view. The Group has met twice, in June 1985 and July 1985, but considered that before a decision is made on whether or not to create a marine conservation area, more information is needed. It set up, therefore, a survey project to be administered by a small Working Party to identify the nature and extent of the deterioration in the quality of the River.

Membership of the Working Party:

Mr D C Bean, Fisherman and Fish Merchant
Mr W L Collins, Retired Agricultural Valuer
Dr N A Holme, Principal Scientific Officer, Marine Biological Association of the United Kingdom (Project Supervisor)
Mr W S A Jenkins, Boat-hire Proprietor and Farmer
Mr W L Rickard, Farmer
Mr L W Robinson, Assistant County Planning Officer (Conservation and Countryside) Cornwall County Council
Mrs S M Turk, Research Fellow, University of Exeter (Project Supervisor)

3. The survey was costed at £10,500, to include the funding of two graduates for two/three days a week for 12 months, a boat with equipment, photographs, additional help with visitor surveying, travel expenses, etc: of this amount £10,000 was generously provided by the H J Heinz Company under the auspices of the company's "Guardians of the Countryside" conservation programme in association with the World Wildlife Fund, and the additional £500 was donated by the Duchy of Cornwall.
4. A national advertisement in The New Scientist produced response from 60 applicants of whom six were selected for interview on 8 January, 1986. Mrs Susan Hocking (who had experience of general surveying, mapping and preparing reports during her employment with the Bristol University Lizard Project) and Mr Roger Covey (who had specialist knowledge of marine ecology) were appointed as the team, and they commenced work, under the supervision of Dr Holme and Mrs Turk on 3 February 1986.

5. The present Report is the result of 14 months work. This can be broadly divided into (1) projects designed to form baselines for future monitoring, and (2) a search of past records, reports and statements, published and unpublished, in an attempt to qualify and if possibly quantify any changes as well as assess environmental pressures. The following aspects have been covered:

i) Geology (Appendix 1)

ii) Sea chart data and shore types (Map 1)

iii) Existing 'Areas of restraint' (Map 11)

iv) General description of habitats and sites, accompanied by photographic record (Section 1)

v) Series of repeatable transects, with photographs, on sensitive shores. (In data bank, Cornish Biological Records Unit, Institute of Cornish Studies)

vi) Water-quality survey, compiled from material supplied by South West Water (Figs 7-13)

vii) Compilation of data on anti-fouling TBT paints, with field-work on the dog-whelk Nucella lapillus, primary indicator species for TBT pollution (Appendix 3)

viii) Notes on the species of eel-grass (Zostera) with a list of sites and detailed notes on the main intertidal beds (Appendix 4a and 4b)

ix) Compilation of information on alien plants and animals (Appendix 5).

x) 'Drop-out' points of selected species in up-river range (Map 10)

xi) Visitor survey covering six week of school summer holidays, to cover purpose of visits, means of transport, home county, etc. (This was undertaken by Rosann Sparshott, Michael Birkin and Alastair Stewart, the data being analysed by SH and RC). (Appendix 2 and Figs 2-6)

xii) Survey of cockle-gathering (trigging) on Good Friday undertaken by the team, the supervisors and various individuals (Appendix 6)

xiii) Search of past surveys, lists and correspondence for information with bearing on the present state of the fauna and flora

xiv) Distribution of oyster and popular cockle beds (Map 2)

xv) Land use (Map 3)

xvi) Distribution of moorings (Map 4)

xvii) Catchment areas (Map 11)

1. The Helford River has changed from a working waterway to an area mainly used for recreation. The effect of the former role on its marine life was largely unrecorded; the effect of the latter has been examined and it reveals an alarming decline in the diversity of communities and species, to the extent that the Team observed "in some cases comparison made us wonder if it was the same shore that we had surveyed, so dissimilar were the results" (Section 5)

2. There are many problems in assessing such effects and changes: verbal may be coloured by frailties of human memory, whilst written are reliable but rather scanty. Natural accumulative changes (siltation of creeks) must be taken into account and allowance other natural phenomena (storms, exceptionally hot summers records (eg the made for and cold winters). There is still much to learn—about cyclic appearance of certain species of which population 'explosions' of sea-hares (Aplysia) and certain sea-slugs (Aeolidia) are good examples. However the evidence for a degradation of the intertidal life of many of the non-rocky shores of the Helford River is overwhelming, there being good written as well as anecdotal evidence of a deterioration of intertidal life from the mid-1970s onwards. The main changes are to be seen in the erosion of the eel-grass beds, the silting over of adjacent areas of gravel and clutter and the accompanying destruction of most of the surface life with a reduction or even extinction of the burrowing fauna. (Section 5 and Appendix 10). One species which is almost extinct on the rocky shores within the confines of the River is the dog-whelk, victim of TBT-usage. (Appendix 3) Of the various usages that have become pressures or potential pressures (ie in the present context, capable of causing harm to marine life) the following have been isolated, although it is the combination of activities, especially if following or followed by extremes of weather, that is calculated to cause the most harm.

a. TBT anti-fouling paints: these affect various animals, both water-borne (planktonic) and living on the sea-bed (benthic). One species, the dog-whelk, Nucella, formerly common on reefs throughout the River, is now virtually extinct except at the mouth. These paints will be banned for use on small craft nationally (but only on small craft) from 1 July 1987. (Appendix 3)

b. Silage, slurry, sewage and other effluents: additional housing, partly due to visitor demand, increased water craft, more intensive farming (including the use of silage) and drainage from the roads have all added to the impurity of the water.
Prosecutions have been made by South West Water which is monitoring the streams. (Section 3.9 and Appendix 9).

c. Education and research: the 1960s and 1970s saw a great increase in the number of educational groups (many from outside Cornwall) using Cornish shores, especially those of the Fal Estuary and the Helford River. Many students as well as tutors possessed cars and the cost of petrol had not soared. A certain amount of digging for infauna occurred, especially in those areas that were at the same time the most interesting and the most accessible - namely Helford Passage, Treath, Penarvon and Gillan Harbour. Such activity inevitably involves some damage to the environment, even if infilling is practised. Fewer groups now visit the Helford River because the fauna has become depleted (Section 3.8).

d. 'Trigging' for shellfish: again the advent of the car has changed the pattern of this ancient Cornish tradition of collecting 'trig-meat' on Good Friday. Formerly people went to the nearest shore to collect limpets, mussels, winkles or cockles but now few people visit the north coast where limpets and mussels are abundant: instead they drive to the Helford River where literally hundreds congregate on a fine Good Friday. Most are Cornish but non-Cornish people do join in, and there is some collecting at other times of the year, especially now that there is such a high unemployment level. Of the many people questioned in the survey, nearly all thought that cockles were fewer in number and smaller in size. Some found that larger specimens could be dug in the eel-grass beds and there was ample evidence that such disturbance of the 'grass' roots was adding to the erosion of the beds (Sections 3.0, 3.4, 5 and Appendix 6).

e. Bait-collection: the national increase in angling throughout the country is reflected in the interest in this sport in Cornwall, and means that there is an intensified need for worms and soft crabs. Since many of the worms that are collected are the estuarine rag-worm, abundant in the soft deep muds up-river, the effect is minimised. However, other worms are sought and there has been some commercial collecting of razor-fish and much disturbance of stones in the search for freshly-moulted crabs (Section 3.6)
RECOMMENDATIONS

1. We believe that measures are needed to halt the continuation of degradation of parts of the Helford River.
2. The 'sensitive' areas are all deposition (silt/sand/gravel) shores, namely Helford Passage, Penarvon, Treath and Gillan Harbour (St Anthony Beach, Gillan Cove and Flushing Cove).
3. Although a statutory designation with the use of bye-laws would provide maximum protection of marine life, the traditional use of the River would be afforded greater safeguards by a voluntary designation: therefore we advise the formation of a Voluntary Marine Conservation Area, over-seen by a committee elected by local representatives.
4. A voluntary designation would have the following advantages:
   a. It would draw attention to the importance of the River's marine life.
   b. An increased awareness would hopefully prevent inadvertent damage, and encourage a positive approach to the conservation of the River's marine biological quality.
   c. Should some major development of pollution problem threaten the River there would already be in existence a consultative/ executive body which would provide a medium for any action.
5. Information should be provided by a number of means: production of a brochure which would summarise the purpose of a Voluntary MCA; posters; general publicity through Cornwall County Council, Kerrier District Council, the seven Parish Councils, Cornwall Trust for Nature Conservation, the Marine Conservation Society, Nature Conservancy Council and through the media.
6. A brochure would in essence be a code of conduct, covering the following points:

   a. Educational groups would be encouraged to study the area, but not to remove organisms from the shore or to indulge in the harmful digging that has taken place on many occasions. Instead it would be suggested that they might help monitor the sites by repeat transects, counts and photographs. Those undertaking more advanced studies could be advised on projects that would record, for instance, effects of the withdrawal of TBT paints.

   b. Shellfish collectors and bait-diggers could be asked if they would aid the recovery of the eel-grass beds at Treath and Helford Passage by avoiding digging, on or in the immediate environs of the beds in an attempt to stop further erosion.

   c. Those not traditionally involved in the Good Friday activities of collecting cockles, might agree to watch, rather than participate.

   d. If speed limits on boats were adhered to strictly, and sensitive areas considered in relation to wash, it would increase the stability of such areas.

7. Research should be encouraged (again by post-graduate study) to examine (for instance) methods of increasing the stability of the eel-grass beds and even extending the cockle beds.

8. If the principle of designating the River as a Voluntary Marine Conservation Area is accepted, sources and funding would need to be explored for the future care of the Area.
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SOUTH WEST WATER: for material on water quality surveys
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MARINE CONSERVATION SOCIETY: for providing conservation booklets at a concessionary price
KERRIER DISTRICT COUNCIL: for information on areas of planning constraint
NATURE CONSERVANCY COUNCIL: for access to land-use survey, phase 1
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HELFRD BOATYARD: for information on TBT paints
MR M J BIRKIN: for help with Visitor Survey
MR D J FLUNDER: for supplying photographs
MR M D HALLETT: for help with 'Trigging' Survey
MR R N HOCKING: for help with 'Trigging' Survey
MRS M HOLME: for help with 'Trigging' Survey
MISS PHILIPPA HOLME: for help with 'Trigging' Survey
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MISS R J MURPHY: for information on Spartina and Salicornia
MR R SKINNER: for information on Bosahan foreshore
MISS R SPARSHOTT: for help with Visitor Survey
MR J STEPHENS: for information on Helford River moorings
MR A STEWART: for help with Visitor Survey
MISS V STONE and MR M DEEBLE: for supplying photographs
MRS P E TOMPSETT: for help with 'Trigging' Survey and photographs
APPENDIX 1

Geology of the Helford River

The oldest rocks in the area of the Helford Estuary are sediments of Devonian age. In the Middle Devonian period, over 350 million years ago, the geography of the area was vastly different from that of today. Devon and Cornwall were covered by a vast sea which spread from the south west. Cornwall was on the northern edge of the Western European (Armorican) geosyncline, a rapidly subsiding east/west trough in which rapid accumulation of sediments occurred. It was here that the greywackes, slates and conglomerates of the Gramscatho and Mylor beds, that now outcrop on both river, were deposited.

Sedimentation continued for the next 70 million years, until the end of the Carboniferous Period when the thick sediments of the Devonian/Carboniferous sea were folded and uplifted during the Armorican Orogeny. It was in this period of mountain-building that a large mass of granite was intruded beneath the whole of the south-west peninsula, offshoots of which form all high Cornish moorland including the Carmenellis granite north of the river, the southern margins of which underlie Constantine. In turn, associated with this granite area, are two series of dykes which cross the river at various points. These minor acid intrusions probably acted as feed volcanic activity caused by the emplacement of the granite.

One set of these dykes consist of 'Elvans'. A group crosses the top of Porth Navas Creek - two are seen on the shore half a mile south of Roskillen and another in a small inlet facing Porth Navas. Another two are exposed on the eastern shore of Polwheveral Creek, one near Scott's Quay and the other at it's head. A third set, the main dyke of-which crosses the head of the Helford near Bonallack have been quarried (Flett and Hill 1946).

The second set are Lamprophytes, one dyke being exposed in the cliffs near Mawnan half a mile north east of Toll Point and also in the churchyard there. Another outcrops on the north shore of the estuary about a quarter of a mile west of the Helford-Passage flagstaff and probably the same dyke reappears crossing Frenchman's Pill. Another occurs at the Gew near the mouth of the estuary. (Flett and Hill 1946).
The south west which had risen from the sea during the Armorican Orogeny was part of a land mass only two or three hundred miles from the equator, the final phase of continental drift not having yet begun.

Next came a series of alternating marine inclusions and periods of uplift which continued for approximately the next 280 million years, until recent times. It was during this period that Britain broke free and drifted north to its present position.

Marine erosion in Tertiary times left several peneplains of differing heights, caused by various marine inclusions, due to the alternate advancing and retreating of the northern ice cap. The most vital of these in the Helford area was the Pliocene inclusion about 12 million years ago, which cut a wide, gently-shelving plain 430'OD, which subsequently emerged, as sea level fell, as the Lizard Platform.

The Helford River is probably an old pre-Pliocene channel formed when the land stood at a higher level. There is little evidence of its ancient history but it is probable that during the Pliocene submergence that cut the Lizard Platform, the river valley was filled with Pliocene marine deposits. These have since been eroded away, restoring the old channel, when the land rose again after the inclusion. As such the Helford is older than the majority of other streams in the area, which were newly initiated in the freshly cut platform.

Other Pleistocene and Recent periods of marine erosion and uplift (3 million 10000 years ago), left a series of platforms, some of which carry ancient beach deposits And are known as raised beached. Some of these occur in the cliffs that fringe the River. One is exposed half a mile south of Rosemullion Head and extends as far as Mawnan. Traces are still visible at Gweek and Dennis Head. These deposits of sand, gravel and boulders rest on a rock ledge 5-15' above present high water. They probably belong to an early part of the last glacial period and are overlain by glacial deposits known as 'Head'. (Flett and Hill 1946).

With all the land elevations, the valleys of the peninsula were successively deepened and in the final retreat of the ice, great volumes of water were released, flooding the lower reaches of the valleys to form rias (drowned river valleys). This sea-level rise continued into recent times as the ice-front retreated farther north. The final flooding of certain valleys in southern Britain may have coincided with the submergence of the land-bridge between Britain and France about 5000 BC.

The most recent deposits in the area are still being formed - the river alluvium currently accumulating at Gweek and in the other creeks at the head of the River.
APPENDIX 2

Visitor Survey, 1986

A survey of the numbers and activities of visitors was carried out at three sites; Helford Passage, Helford and Gillan Harbour (around Gillan, St Anthony and Flushing).

Three temporary helpers (Rosann Sparshott, Michael Birkin and Alastair Stewart) spent three days per week for eight weeks covering the end of July, August and the start of September, the school holiday period. They were provided with a standard questionnaire form (See page 63), which could be filled in whilst they talked to people who were invited to volunteer any further information which could be added on the back of the form. Questionnaire surveys were timed as much as possible to cover the period of low tide, since this is when maximum human disturbance of the shore takes place.

The response from the public was good, with about 900 groups being questioned, only one of which refused to co-operate. Of this number 467 groups were interviewed at Helford Passage, 243 at Helford Village and 186 at Gillan Harbour, the numbers reflecting the relative popularity of each site.

Analysis of the results was carried out in four main categories; travel to the site; size of group; activities on site; and length of stay in the area.

(i) Travel to site (Figure 1)

As may be expected the majority of the groups interviewed had travelled to the location by car. Helford had the highest percentage of car arrivals, probably due to the parking facilities available.

Walking was the next most common form of arrival at Helford Passage and Gillan Harbour, but was noticeably less popular at Helford. The number of arrivals on foot at Helford Passage is likely to be due to the sampling of visitors staying in the Ferry Boat Inn complex. These people would understandably reply that they had walked when questioned since they were already on site. The amount of holiday accommodation at Helford is much more limited. Also several groups arrived at Helford Passage on foot from Durgan and Mawnan Smith. The relatively high number of walkers at Gillan Harbour is probably due to a biased sample. On one of the days surveying took place a party of around 30 people on a Holiday Fellowship walking holiday were questioned in separate groups, giving a false impression of the number of groups arriving on foot.

Arrivals by boat make up approximately one eighth of the visitors at Helford and approximately one tenth at Helford Passage and Gillan Harbour. The slight difference in these figures is probably
due to the site of the sailing club at Helford attracting more yachtsmen. Of the boat arrivals questioned some were day visitors from the Fal, same day/overnight visitors cruising the Cornish coast, while others were yacht-based in the River for the duration of their holiday.

A minor proportion of people arrived on motorbike or bicycle.

(ii) Group Size (Figure 2)

Analysis of group size shows that the bulk of visitors come as couples or family units of four individuals. Less frequent were single individuals, families/groups of three and groups of five or greater.

Helford was more popular with couples than with family groups, probably due to the lack of beach-type facilities for families with children.

(iii) Activities (Figures 7, 8 and 9)

The most popular food gathering activities of visitors in the summer are shrimping/prawning and fishing. At Helford Passage and Gillan Harbour approximately one third of those fishing said they would also be digging for bait. The figure was lower at Helford (around a quarter) perhaps indicating that these shores suffer less from bait collection.

Digging for shellfish was most popular at Helford Passage, where around one tenth of those groups surveyed said they would be engaged in this activity. The figure was much lower at Helford and Gillan Harbour. A few of those surveyed were also 'going winkle collecting' or 'would be collecting specimens'. Since few organised field trips take place now, it is likely that such collecting was carried out by children and adults 'rock-pooling' or collecting shells etc. One visitor was an 'A' Level student from outside Cornwall trying to familiarise himself with a range of marine life.

Once at their chosen location on the banks of the River most of the visitors said they would be walking on the beach and footpaths. However, there were exceptions; less people walked on the beach at Helford due to the lack of a suitable beach. At Helford Passage a large proportion of people stayed close to their point of arrival since they were only visiting the Ferry Boat Inn for lunch.

The most popular watersports appeared to be swimming and paddling in spite of the poor summer weather. Since the question was worded "will you be ..." rather than "have you been ..." " ... involved in any of the following activities" this may be a case of wishful thinking affecting the reply.
Motor boating was more popular than sailing at both Helford and Helford Passage, probably due to boat hire facilities in these places. At Gillan Harbour sailing was more popular due to the yacht hire business 'Sailaway'; and the possibility of dinghies being stored on the beach. Additionally Gillan Creek is less suitable for exploration in a motor boat than the main River, thus reducing the popularity of these boats.

Windsurfing was predictably most popular at Helford Passage due to the presence of the windsurfing school giving tuition and board hire, and easy road access to the beach. The last two factors also account for the relatively high popularity of the sport at Gillan Harbour, board hire being available from 'Sailaway' with easy road access at St Anthony. Windsurfing was less popular at Helford, due—probably to limited road access to the shore, and lack of a suitable beach at low tide, when mud is exposed.

Rowing proved popular both due to people using tenders to reach moored boats, and people generally 'messing about in boats'. Other watersports occurring in small measures include water-skiing, canoeing and diving and snorkelling. The latter was most common at Gillan Harbour where the shallow waters left at low tide are ideal for children snorkelling.

(iv) Length of Stay (Figure 10)

Varied lengths of stay were recorded with peaks at one day (for local day visitors) then 7, 14 and 21 days, the major peak being 14 days, indicating the 2-week length of the average family holiday.
HELFORD RIVER VOLUNTARY MARINE CONSERVATION AREA STEERING GROUP C/O Cornwall Biological Records Unit; Murdoch House, Redruth.

HELFORD RIVER SURVEY AND MONITORING PROJECT

The Helford River is a beautiful area and is also important because of its marine life. We are trying to see whether or not there is a case for making the River a Voluntary Marine Conservation Area. The objective of this Project, therefore, is to make a thorough survey of the River, especially of factors which may have contributed to the recent decline in its inter-tidal life, and to set up a monitoring programme through which future changes can be assessed.

In this connection we need to have information about visitors to we would be very grateful for your help.

1. Date ....................

2. Where is your home?..........................................

3. If you are on holiday, where are you staying?............
   For how long?.............................................

4. How many people are in your family/student group:.......

5. What is the purpose of your visit?
   e.g. holiday, fieldwork, etc., ............................

6. How have you travelled here today? (car, boat, etc.)...

7. During your visit will you be involved in any of the following activities?
   Digging for shellfish ............  Winkle Picking........
   Specimen collecting ............  Bait digging...........
   Shrimping/prawning ............  Fishing ........
   Will you be walking along the beach? ........
   walking along footpaths?............
   staying close to your point of arrival?............

9. Will you be involved in any of the following watersports?
   Sailing ............  Canoeing ............
   Motor boating............  Waterskiing............
   Rowing ............  Windsurfing............
   Diving/Snorkelling............  Swimming ......
   Paddling ............

THANK YOU FOR YOUR HELP
Fig. 2.
Visitors mode of transport to:

- Helford Passage

- St. Anthony

- Helford

[Diagram showing mode of transport with categories: Car, On foot, Bicycle, Motorcycle, Boat, No response]
Figure 3:

VISITOR SURVEY - GROUP SIZE (Question 4)

ST ANTHONY

HELFDOR PASSAGE

HELFDOR
Note: Figures 4, 5 and 6.

Since the categories were not mutually exclusive it was inappropriate to present the responses as percentages. Hence total numbers have been used.
Figure 4: VISITOR SURVEY - INTENDING TO COLLECT FOOD OR SPECIMENS (Question 4)

ST ANTHONY

Number of responses

HELFDOR PASSAGE

HELFDOR
Figure 5:
VISITOR SURVEY - WALKING (Question 8)

ST ANTHONY

Walking along beach
Walking along footpath
Staying close to point of arrival

HELFDOR PASSAGE

Walking along beach
Walking along footpaths
Staying close to point of arrival

HELFDORD
Figure 6:
VISITOR SURVEY - INTENDING TO PARTICIPATE IN WATER SPORTS (Question 9)

ST ANTHONY

Sailing
Motorboating
Rowing
Canoeing
Waterskiing
Windsurfing
Diving/snorkelling
Swimming
Paddling

HELIFORD PASSAGE

Sailing
Motorboating
Rowing
Canoeing
Waterskiing
Windsurfing
Diving/snorkelling
Swimming
Paddling

HELIFORD

Sailing
Motorboating
Rowing
Canoeing
Waterskiing
Windsurfing
Diving/snorkelling
Swimming
Paddling
APPENDIX 3

Tributyltin (TBT) Antifouling Paints: general observations

Types of paints

Modern antifouling paints are organotin-based and contain the most potent biocide ever used by the paint industry – tributyltin or TBT. Of the complex organotin compounds, TBT is the most toxic, partly due to its ability to penetrate biological membranes.

Organotin antifouling paints were first developed in 1961, came into wide use in Britain around 1970, and today are used on most yachts in the United Kingdom. They are popular because they are effective, easy to use and come in a range of colours. There are two main types of these paints self-polishing or copolymer paints and conventional (free-association), paints.

The effects of TBT in the environment

TBT is toxic to both target and non-target organisms alike and occurs at levels known to have lethal effects on a range of marine organisms. Although only minute quantities may be introduced into the water, many organisms accumulate TBT in their tissues, where it may reach toxic levels.

TBT does not spread evenly in the water, but becomes concentrated in the surface micro-layer and trapped in bottom sediments in well-lit water and with time it degrades to harmless inorganic tin, but does so very slowly in turbid waters, or when trapped in sediments (Wood 1986).

Organisms can assimilate TBT directly from the water, from sediments, or from contaminated organisms lower in the food-chain. Tests have been carried out to find the effects of TBT on various species. They show different levels of sensitivity, larvae being more vulnerable than adults.

One of the most sensitive species is the Dog Whelk, Nucella lapillus, in which it is known that less than 0.003 mg/l*can initiate a condition called imposex, in which females take on male characteristics and are then rendered sterile (Bryan et al 1986).

* milligrams per litre.
It is known that at levels of 0.02 mg/l there is significant reduction in the growth of the spat of the Native Oyster, *Ostrea edulis*. At 0.06 mg/l its growth is severely affected and at levels of 0.24 mg/l, predominantly male oysters are produced. (Thain and Waldock 1986)

Concentrations of 0.15 mg/l cause shell-thickening and meat-reduction in the Pacific Oyster, *Crassostreas gigas*, and at 1.6 mg/l growth is stopped altogether. (Waldock and Thain 1983) A level of 0.24 mg/l is known to cause significant reduction in the growth of the spat of the Mussell, *Mytilus edulis*. (Thain and Waldock 1985).

Concentrations of 1.5 and 2.1 mg/l kill larvae of the Shrimp, *Crangan crangan*, and the Sole, *Solea solea*, respectively within a few days, (Thain 1983), whilst at 1.0 mg/l there is a 90 per cent reduction in the growth of the American Lobster, *Homarus americanus*.

Damage to commercially important species may be just the tip of the iceberg. The growth of some species of phytoplankton ceases at levels as low as 0.06 mg/l and this has ramifications higher in the food chain. If the growth of the molluscs on which they feed is retarded, even birds may be affected.*

These facts should be considered bearing in mind that although no figures are available for the Helford, in 1985 levels of 0.13 mg/l were measured in the Fal. (Cleary and Stebbing 1985). The highest concentration recorded in UK waters so far is 2.25 mg/l (Essex marina) (Waldock and Miller 1983) a level above the concentration needed to produce all of the toxic effects listed above.

*Even more alarming to many people, the New Scientist, January 1987, reveals that recent research in America has found that TBT could enter the human food chain. TBT antifouling used on sea-pens by fish farmers has been absorbed by Salmon, and fish bought at local markets were found to contain TBT. Cooking does not destroy or remove the compounds from the fish and as yet the effects of TBT on man are unknown.*
Current Legislation

In 1985 the Department of the Environment wanted to bring in legislation banning the use of TBT on vessels less than 12m long. The Paint Makers Association (PMA) opposed this and won a two-year breathing space in which to find alternative products (ENDS Report 126). The legislation eventually brought in on 13 January 1986 bans the sale and retail sale of TBT in free-association paints but allows copolymers with less than 7.5 per cent organotin (ENDS Report 132) until 1 July 1987, when they will be classified as pesticides instead of paints, and their sale greatly restricted: the circumstances in which they may still be used is currently (March 1987) under review.

Environmentally-safe alternative paints are being developed. However, this ban comes too late for the 1987 boating season, as most boats will already have been painted by July and chandlers intend to go on selling the paints right up to the banning date.

TBT usage on the Helford River

It is difficult to quantify the extent to which TBT is used on the Helford River though attempts can be made to estimate this from the amount of boat usage on the river and the extent to which TBT antifouling is used by boat owners.

Numbers of moorings available

A large proportion of the moorings in the River are owned by the Duchy Cornwall. The main area of Duchy moorings is in the Main Pool between Helford Passage and Treath, where there are 215. Smaller numbers are available at Durgan where there are 64 and Porth Navas Creek where there are 103, totalling 382 Duchy visitor moorings in all.

However this total does not take into account the numbers of moorings on private foreshore, or those in the triangle off Helford Passage, owned and administered by the Ferry Boat Inn, each estimated to number 100 apiece, or those in the 'Fishermen's Block', opposite the Yacht Club, separately run by the fishermen themselves. In addition to this are a further 111 in Gillan Harbour, administered by Anthony Jenkins.

The total of 693 moorings in the whole estuary is still not taking into account the fact that the river is a free anchorage and visitors can lie to their own anchor wherever they like, although the number exercising this right each year is relatively small.

Figures for the years 1985 and 1986 provided by the Duchy Moorings Officer, Jim Stephens, show the usage of Duchy moorings in terms of boat nights:
1985 1116 boat nights
1986 1532 boat nights

These figures do not take into account those people who come in and moor for a few hours only, or those clandestine users who come in late and leave early.

Mr Stephens stresses that the numbers of boats using the River depends very heavily on the weather. The summers of 1985 and 1986 were both exceptionally cold and wet, not ideal boating weather, so taking these factors into account the above figures are probably well below average.

Counts of boats moored in various parts of the River

The numbers of boats moored in the Helford fluctuates throughout the year, with peak usage in the summer months of August and early September, tailing off rapidly in October and November, so very few boats overwinter in the water.

The average numbers of boats in each main mooring area for the peak time of August are taken to show heavy usage:

At Durgan there are usually 32 boats moored, with a further 12 anchored between here and Toll Point if the weather is favourable. In the main pool there are usually about 160 boats moored, whilst Porth Navas Creek has about 116.

Moving further upstream, in good weather there are often two or three yachts anchored off Calamansack and Merthen. The mouth of Polwheveral Creek has a fairly good constant eight boats moored at any time of year, whilst Bishop's Quay usually has a couple of boats in the water.
Gweek has around 30 boats lying at its quays.

Gillan Harbour usually has 85 or so moored, whilst fine weather often sees a couple lying at anchor off Parbean Cove.

This gives a very rough estimate of a weekday maximum of 547 (numbers would increase at weekends).

Local use of TBT antifouling paints

In information obtained from Gweek, Helford and St Anthony boatyards it was found that most of the antifouling paints they stock and sell are TBT-based. All the paints used are on the list of government-approved paint formulations listed in Hansard 27 February 1986, although before the new regulations came into effect on 1 January 1986, all stocked high-TBT-content antifouling preparations. Most popular now is Blakes Tiger Copolymer which St Anthony Boatyard say is used by 90 per cent of their customers, with Blakes Titan also being quite widely used. Some racing boats which require a smoother finish use International's micron 25 and others a copper-based, TBT-free paint.

All three boatyards use these paints on the boats they treat themselves, hosing or scraping down of old paint being carried out on, or close to, the shores of the River from whence it inevitably finds its way back into the water. All three yards pointed out the impossibility of hauling large boats far enough inland to scrape down without danger of it washing back into the River, and none collect the scrapings, let alone dispose of them on land sites with no problem of leaching, as the Government recommends.

The majority of Helford boat-owners applying the antifouling to their own boats tend to buy their paint from the local retailers at one of these yards and thus purchase one of the approved preparations mentioned above. It is probable that they too hose or scrape old paint back into the River.

Helford Boatyard made the point that the approved copolymers are of little use to working fishing boats as they are quickly 'spent' and need renewing in six months. It is documented that leach rates of TBT from boats in moving water is up to ten times that claimed by the manufacturers, liberating a lot of TBT into the water.

An additional problem is the fact that large boats over a certain registered tonnage can use the old high TBT-content paints. It is believed that only one boat on the Helford falls into this category, but nearby Falmouth contains a multitude of large ships, many of which use the old antifouling. When easterly winds prevail, currents bring some of this contaminated water into the Helford so the problem could be compounded from this source.
Nucella as an indicator of TBT pollution

The predatory Dog Whelk, *Nucella lapillus*, is very sensitive to TBT poisoning and as such makes an ideal indicator of the extent of this pollution.

The effect of TBT on *Nucella* is to cause a condition called imposex. Imosex is initiated by levels of TBT as low as 0.003 gll. It is easily measured and can be related directly to levels of TBT to which a population has been exposed.

The effect of imposex is to cause masculinisation of the female. In the early stages of the condition the female grows a penis, which in intermediate stages enlarges to the size of that of the male. In later stages, the deformation causes blockage of the pallial oviduct, preventing the release of egg capsules, effectively sterilising the female. The accumulation of aborted capsules ultimately causes premature death of the female (Gibbs and Bryan 1986). Thus at a moderate to high degree of imposex – over 40 per cent* decline occurs due to the effects on the female. Such a declining population is characterised by few females, few or no egg capsules and a lack of juveniles. Where imposex exceeds a degree of just 5 per cent it is rare to find an unaffected female.

Nucella decline on the Helford

To try and determine the local effects of TBT in the River a study of *Nucella* in was carried out during 1986 as part of the Helford River Project.

The numbers of *Nucella lapillus* in the River have declined rapidly in the past 10-15 years. In a survey of south-west England in 1986 (Bryan et al 1986), found that they were rare or absent from sites over 100km of the Channel

*The degree of imposex cannot be measured as the percentage of penis-bearing females because at all south west sites this would be 100 per cent, so it is expressed in terms of the relative penis-sizes of males and females within each population.*
Map 5.

The distribution of Nucella lapillus on the Helford River, 1986.
coast where they were relatively common in 1967-73. Amongst these was St Anthony where on 24 October 1976, N A Holme and S M Turk reported them to be common. During the present study we found a single individual in the whole of Gillan Harbour. At Helford Passage Crothers,(1975) counted over 100 in April 1973, a locality from which Nucella is now absent.

Few viable populations were found on the Helford in 1986, although scattered or lone individuals were recorded on the rocky shores at Durgan, Parsons Cove, The Gew, the north side of Dennis Head, Flushing Cove and between Penarvon Cove and Frenchman's Creek. The only relatively large populations were at Nare Point, Prisk Cove and below Mawnan Church. (See Map 5).

The Mawnan church population was studied in 1986 by Bryan et al (1986) where they determined a moderate degree of imposex – 54 per cent (higher levels would almost certainly be found higher up the River.)

During the present survey the two remaining populations at Prisk Cove and Nare Point were studied.

As this was a non-destructive survey it was not possible to measure directly the degree of imposex in these Nucella populations, as to do this requires that a number (over 30) individuals are removed from the site and dissected. However it was possible instead to measure the age-structure of each population and estimate the extent of imposex from the population parameters. This is made possible by the work of Bryan et al 1986 who related their detailed measurements of imposex to the overall appearance of a population.

From examination of each site and individual animals an attempt was made to deduce the age profile, density of distribution and amount of recruitment in each population.

The approximate age of a Dog Whelk can be deduced from the morphology of its shell. A Dog Whelk reaches sexual maturity at 2 1/2 – 3 years old. When it stops growing, the shell edge thickens and teeth are developed just inside the rim of the shell mouth. Also helpful is the general appearance: an old shell is larger, worn and encrusted with algae; a young one is clean and well-ribbed. Also noted at each site were the density and distribution of animals on the shore, the types of food available and the occurrence of egg capsules.
Figure 8:
AGE/SIZE/FREQUENCY DISTRIBUTIONS FOR MUCHELLA LAPillus POPULATIONS SAMPLED IN
OCTOBER 1986

PRISK COVE

n = 163
80% with 'teeth'

NARE POINT

n = 174
88% with 'teeth'

Shaded area denotes mature and nearly mature individuals with 'teeth'.
Unshaded area represents juveniles.
Large samples representative of the whole population (over 150 at each site) were examined and the ages of individuals deduced. From this information size: frequency distributions were produced (Figure 7). These can be compared with distributions by Bryan et al (1986), where various population profiles are related to degree of imposex. It can be seen that the Prisk Cove and Nare Point distributions are very similar, both show populations with a high proportion of old animals and very few juveniles, Prisk Cove having 80 per cent mature individuals and Nare Point 88 per cent (Figure 7). These profiles most closely-represent that for Drakes Island, October 1985, an analysis of which showed 55 per cent imposex (Bryan et al 1986). This ties in well with the figure of 54 per cent imposex for the nearby Mawnan Church population obtained by Bryan et al (1986).

Although numbers of individuals at both sites are relatively high, as shown by the densities of 4/m2 at Nare Point and 6/m2 at Prisk Cove, there was no evidence of recruitment, throughout the whole of 1986 no egg capsules were seen at either site. The proportion of mature/old animals was high and the number of juveniles low.

These populations show all the characteristics of those heavily in decline and they face even more drastic reduction since they do not have planktonic larvae if the levels of TBT in the water are not immediately reduced. Imposex is an irreversible condition so only females (if any) not yet in the final stages will be able to breed. Recruitment from outside the area could be the only hope of recovery of these populations.

Other species of Sterroglossan Snails exhibit imposex related to TBT, including the Sting Winkle, Ocenebra erinacea Bryan et al (1986). An attempt was made to analyse this species at Nare Point where a small population exists, but due to the small numbers available for sampling the statistical significance of the results was doubtful.
General notes on eel-grass (Zostera species)

Of all the angiosperms (flowering plants), only a very few species have become fully marine. There are just three British species, all in the genus Zostera, and all three have been reported from the Helford River, although Z. angustifolia now appears to be extinct.

**Zostera marina**

Common eel-grass, Z. marina is both the largest and the commonest species in the Helford River. It is rarely found where the salinity falls below 35g/1, thus emphasising that the River is virtually a sheltered arm of the sea: shelter is essential for all species of eel-grass, which are uprooted by strong wave action.

The substrate requirement varies, but in Britain, Common Eel-grass generally grows on firm muddy sand, as at Helford Passage and Treath where it is rooted in fine/very fine sand mixed with silt. Usually it is in 1 to 4 metres of water, the lower limit being governed by light-intensity and the upper limit by the degree of drying to which it is subjected at low tide: a sandy substrate dries quickly whilst muddy substrate remains moist for much longer. The consistency of the 'soil' in the River is such that there is a considerable exposure of the beds at low tide, particularly at Helford Passage.

Tutin (1941) states that just half an hour's exposure to sun on a warm day may damage and even kill the plants, whilst in freezing weather the mechanical action of ice can tear off leaves and uproot the rhizomes. In Cornwall, the fact that low water springs occur around midnight and midday, makes the intertidal beds particularly vulnerable to extremes of temperature contrasted, for instance, with the west coast of Scotland where low water spring tides are c.6am and 6pm.

**Z. marina** flowers when the sea temperature reaches 18°C, (59°F) usually July in southern England. However seedlings are very rare, and propagation is almost entirely vegetative, by creeping rhizomes which may break off and form separate plants.

The root system traps and binds the silt so that rich organic deposits are formed, often to great depths. On its leaves and in the mud amongst the roots, many species of animals and algae rarely found elsewhere may occur; indeed some are found only with Zostera.

**Distribution, past and present, of Zostera marina in the Helford River, with notes on its status**

Common Eel-grass was abundant around the Cornish coast and the Isles of Scilly up to the 1930s when a serious disease affected it...
throughout its range. However, there is evidence that it lingered on in the same localities in the South West, although much reduced in extent.

**Intertidal beds**

Helford Passage: this is the largest exposure in Cornwall (see Appendix 4b for detailed description but it is under a lot of human pressure from baitdigging and Cockle-collecting—activities doubtless increased by the present high unemployment level. (Sections 3.5, 3.6 and 3.7). A further threat is posed by Japweed (Sargassum muticum), now present in the River: it could invade the shallow erosion pans as has happened in Zostera beds on the Pacific coast of North America.

Treath: as at Helford Passage, there is much erosion with a similar invasion of extraneous algae. What was a continuous bed, is now a series of raised hummocks of growth. (See Appendix 4b for detailed description).

Penarvon Cove: Recorded in September 1949 (Spooner & Holme 1986) when attention was drawn to the 'thick meadows' of Zostera with a large number of Peacock Worms (Sabella penicillus) and Variegated Scallops amongst the plants.

Flushing Cove: -a bank of Zostera was recorded in October 1954 by Holme (1986). It is no longer present.

St Anthony area in shallow water to SE of shore: Records of various molluscs being plentiful on Zostera at grid reference c SW 785255 (S M Turk and Bristol University records 1961-63).

**Subtidal beds**

Bosahan: reported for the first time during the present survey in September 1986.

Parbean Cove: as for Bosahan, October 1986.

Men-aver Point: just within shelter of the Point: Mr J Miller (pers comm) report that in 1976 Z marina was spreading

Dennis Head: to the south: as for Men-aver Point: Mr Miller commented that chains and anchors of moored boats constantly cut the leaves.

Zostera noltii (= Z nana)

Dwarf Eel-grass is, in general, much less common than Z marina and far less is known about its associated fauna and flora. The smallest of the three species, it grows from half-tide mark to low water, and is usually confined to estuaries, on mud banks.
Distribution, past and present of Zostera noltii in the Helford River with notes on its status

Scott's Quay: pre-1927, E A Rees (Thurstan and Vigurs, 1927).

Calamansack: 1951, R W David (Margetts and David (1981) who suggest that this may refer to the same site as the above record).

Below Gweek: 1965, Mrs J A Paton (Margetts and David 1981).


Penarvon Cove: an area of just over 1 hectare was mapped and recorded, February 1978 (Holme and Bishop, 1978). There is now no sign of this bed.

Calamansack: 1986, a dense healthy bed recorded during present survey (see Appendix 4b). The relative inaccessibility of this site adds a large measure of protection.

There was no evidence of digging or erosion, nor were there any extraneous algae.

The exceptionally low temperatures of 12 – 19 January 1987 froze the water on the higher reaches of the Helford River and at Calamansack the plants were torn as the ice was floated by the rising tide.

\[
\text{Zostera angustifolia} = \text{Z hornemanniana}
\]

Distribution, past and present, of Zostera angustifolia in Helford River with notes on its status

Helford Creek, Treath side: September 1949 'a lot' with some Z marina G M Spooner and, N A Holme (Spooner and Holme, 1986); 1951 R W David (Margetts and David, 1981). Now apparently extinct in the River.
Past & present distribution of Zostera spp on the Helford River

Map 6.

- Coastal Zostera beds
- Intertidal Zostera beds
- Site from which Zostera spp. has disappeared
Appendix 4b

Detailed description of Helford Passage, Treath and Calamansack Zostera beds

Helford Passage

The beds of Eel-grass, *Zostera marina*, at Helford Passage, comprise three areas:

(i) The most dense area of *Zostera* is a crescent-shaped raised bed, about 1805m² (one-fifth hectare) in area.

(ii) On the eastern edge of this raised bed is a rim of sparse, eroded, *Zostera* where the seaward edges of the main bed are hit by the easterlies which funnel up the estuary. Worst affected are the tips of the crescent and its centre. The pieces slightly sheltered by the curvature of the arms of the crescent are sparse, but not so obviously eroded.

(iii) To the west of the raised bed is a large expanse of sparse *Zostera* with occasional raised islands within it. This covers an area of approximately 4515m² (nearly half a hectare).

(i) Raised bed

The raised *Zostera* beds are on a firm substrate of fine-grained sand mixed with mud/silt. Just below the surface is a black anaerobic layer. Communities are usually fairly pure, although all but the smallest leaves support epiphytic algae and hydroids. Where digging on the beds has caused erosion hollows, water collects and remains at low tide, and here extraneous weeds are most common. These pools have a softer, stickier substrate and contain little, if any, *Zostera*. There are often large quantities of algae, most commonly: Ectocarpoids, *Ulva lactuca*, *Enteromorpha intestinalis*, *Polysiphonia* spp, *Gracillaria verrucosa* and some *Fucus serratus*.

(ii) Eroded Edge

The eroded eastern edge of this raised bed consists of a tangled mass of white roots and black rhizomes, protruding from the silt, with few or no leaves attached. This zone averages about 5m in width.

(iii) Sparse Zostera

The area of sparse *Zostera* to the west of the raised bed is at the same level as the rest of the mudflat: It is less firm than the main bed and less well-drained at low water and it contains a few small islands of raised bed suggesting that the latter once extended at least partially into this zone.

This area of sparse *Zostera* extends westwards from the flat featureless mudflat adjacent to the raised bed, on to the stony,
pebbly area of the main bar, where it grows intermingled with 
large amounts of Enteromorpha. It is not certain whether the 
Zostera is extending into, or being eroded from, this area. It has 
not previously been recorded from here, but is very inconspicuous, 
mixing with the Enteromorpha and may have been overlooked. The 
most seaward edge of this sparse zone shows evidence of erosion 
with empty shells of Lutraria lutraria and Solen marginatus 
protruding open-ended from the mud (possibly exposed by erosion 
after their death within the mud). Future studies, when compared 
with the 1986 map, will hopefully provide the answer as to whether 
this is an area of erosion or expansion.

This area of sparse Zostera contains more extraneous algae, 
previously because it is less well-drained and remains wetter at 
low tide. Its surface is scattered with Gracillaria verrucosa, 
Enteromorpha intestinalis, Polysiphonia spp, Ulva lactuca, 
Ceramium rubrum and Ectocarpoids.

Treath

The Treath Zostera marina bed has a different profile to that at 
Helford Passage. At the base of the sand and shingle on the lower 
shore, about 40m from the base of the cliff, is an area of sparse 
Zostera, with plants at densities of about 30/m² - 70/m². This 
low-lying area holds standing water at low tide and is about 35m 
wide.

Seaward of this is an area of raised Zostera, elongated parallel 
to the shore. This is so disjointed as to be more a series of 
raised hummocks with pools between than a continuous bed, though 
it is probably a remnant of such a bed.

Seaward of the raised Zostera is well-drained, bare mud, sloping 
seawards to the deepwater channel.

The low-lying Zostera bed contains many weeds – plenty of 
Ectocarpoids, Halopteris scoparia, Polysiphonia spp, Enteromorpha 
intestinalis, Ulva lactuca and Dumontia incrassata. Sand Mason 
Worms (Lanice conchilega) in the bed are sparse (1/m²) and die out 
completely 10m into the bed.

The amount of weed increases downshore towards the raised bed, 
with the deepening standing water, which drains down the shore 
slope and is effectively dammed by the raised bed to seaward. At 
the most shoreward part of the sparse bed the water is about 2cm 
deep and increases seaward to about 15cm at its deepest part.

On the raised bed the Zostera is more sparse than at Helford 
Passage and contains more extraneous algae. The algae and hydroids 
here seem to trap more silt than at Helford Passage and this must 
greatly reduce the light reaching the Zostera.
The whole shore shows evidence of digging, even on the raised hummocks.

Calamansack

The Zostera found at Calamansack is Dwarf Eel-grass, Zostera noltii (= nana). It forms a dense, slightly raised, bed on soft, middle shore mud. It occurs below a zone of scattered Fucus vesiculosus, about 15-20m from the top of the shore. The bed is about 25m wide and 250m long and is sheltered to seaward throughout its length by a raised, 3m wide bar of coarse sand and shell debris. Z noltii is at its thickest just leeward of the bar where a lagoon of standing water forms from water drained downshore and stopped by the bar.

The underlying substrate is soft, deep-sink mud and the surface is covered with pea-sized pellets of mud, presumably balled by the tidal action in the shallow lagoon.

This species of Zostera appears healthy and has little extraneous algae growing with it.
Appendix 5

Alien species

5.1 American Slipper Limpet **Crepidula fornicata**

The Slipper Limpet was first introduced from North America with oysters about 1880, and has spread from East Anglia up the coast to Scotland, and around the south coast to Wales.

Through being enormously prolific the species is now a major pest on Oyster beds, where it smothers the Oysters as well as competing for planktonic food.

Although **Crepidula** was not recorded from Treath, Penarvon Cove, The Bar or Calamansack Point by Spooner and Holme (1949) it had been found previously, although it had obviously not become established. This earlier record was "at Helford" where five specimens were found among beach rubbish by Byne (1935). Probably these were then brought in with Oysters, assuming that they were imported for re-laying, as now.

They are recorded as being generally present in Cornwall by the late 1940s (Jackman 1986). In 1972 Turk and Burrows found them to be common at Helford Passage in chains of up to six individuals. In 1984 they were found to be few, with chains of up to three individuals.

During this survey we have found them to be infrequent but present at Groyne Point, Helford Passage, and Penarvon Cove, with two being found subtidally in Parbean Cove.

5.2 Australian Barnacle **Elminius modestus**

The Australian Barnacle, **Elminius modestus** was first brought into Britain by ships from Australasia during the Second World War. Since then it has spread from its starting point in Chichester Harbour, around Britain and Eire (including Scotland and the Shetlands) by larval dispersal (Hiscock et al 1978).

**Elminius** rapidly became very common, especially in sheltered areas and its arrival has affected the native British Barnacles, especially the Northern Barnacle, **Balanus balanoides**, with which it is in direct competition for space and food in such areas. Further, less obvious, effects from indirect competition are that **Elminius** produces more larval stages in summer than **Balanus** and these reduce or displace other zooplankton, leading to a smaller adult settlement of other species, a factor which may affect a wide range of marine life.

By 1947 small numbers of **Elminius** were found on the Fal (Turk 1971) and from there it spread up and down the coasts of Cornwall. The first record for the Helford River came from Helford Passage in 1963 (Bristol University 1962-63).
Elminius is found mainly upstream from Helford/Helford Passage, where it occurs on loose stones on the muddy shores, being far less common on the rocky shores towards the mouth, where exposure and competition from other Barnacles is greater. In some exposed areas of Cornwall numbers have decreased whereas numbers in the River have increased rapidly, suggesting that shelter and lack of competition from the Southern Barnacles Chthamalus stellatus and *C. montagui* are important factors in its success.

5.3 Japanese Sea Squirt *Styela clava*

This is a distinctive Sea Squirt, with a warty, corrugated test obvious stalk about one third of the total length of up to 12cm; native to Japan, Korea and Siberia, this species is believed to have been accidentally introduced, possibly from Korean waters: At present it is only known in British waters from certain parts of the south coast, where it may become abundant.

First records for the south west are from Plymouth area in 1964. It was then recorded in 1972 at Helford Passage (Burrows & Turk 1972); this is believed to be the first record for Cornwall. Many specimens were found in 1972 but on a return visit in 1984 only two or three were found on a boat hull. In this 1986 survey none have been found.

5.4 Japweed *Sargassum muticum*

*Sargassum muticum* or Japweed is related to the wracks but is very different in appearance, with a narrow, finely-divided frond bearing numerous 'leaflets' and flotation bladders. It grows in fairly sheltered littoral sites, occurring in lagoons, lower shore channels etc. Few plants so far have been noted growing sublittorally, due to the turbidity of the water, however in the clearer Cornish waters, Sargassum will probably spread to colonise the shallow sublittoral zone. In summer it grows at a phenomenal rate and is capable of regenerating from small fragments broken off by storm damage or boat propellors etc.

Sargassum was first found on our coasts in 1972 when Farnham et al (1973) reported finding 30 plants in lagoons at Bembridge on the Isles of Wight. The weed must have been present since at least 1971 and was probably introduced with Pacific Oysters (*Crassostrea gigas*) which are cultivated commercially in the English Channel: Seaweed experts from all over the United Kingdom met in Portsmouth and decided that this introduction was not welcome. A programme was started to try and get rid of the weed but it was already too well-established to be eradicated.

Since 1972 Sargassum has spread along both sides of the English Channel, first east through the Straits of Dover, then westward, probably carried by small boats. By 1977 it had reached Plymouth Sound, where fruitless efforts were made to remove it, and the seaweed continued its spread westward. By 1983 it had reached
Mousehole and the Helford River. The autumn gales of 1982 and 1983 carried much drift material ashore on south Cornish coasts, even as far as the Isles of Scilly where it was found growing on St Agnes in the summer of 1985 (Boalch 1986).

Since its arrival in the Helford Estuary in 1983 Sargassum has gained a firm foothold and has spread rapidly. It occurs mainly near the mouth of the River and has not so far been found further upstream than Calamansack Point.

On the rocky shores near the mouth of the River, Sargassum grows in pools usually in the middle to lower littoral zone, although it was recorded in an upper-middle shore pool at Polgwidden Cove near Durgan on 10 April this year and was found in a similar habitat at Nare Point on 23 April.

On the opposite side of the mouth of the River, at Prisk Cove, Sargassum was recorded on 28 May and again, more extensively on 13 June. It grows in shallow extensive lagoonal pools on the middle shore reef and has spread to cover large areas of this favourable habitat.

On the north side of Dennis Head, between The Gew and Ponsence Cove, where it was seen on 22 July, and further round on the end of Dennis Head, where it was recorded on 1 October, it occurs on the upper-middle shore. In both instances it was filling several pools to such an extent that their surface was completely covered.

At Padgagarrack Cove, a little further up the estuary, Sargassum was recorded on 5 October, growing on sandy substrate at ELWST.

Further upstream, in the absence of middle shore rocks and pools, it tends to grow attached to loose stones and shells lying on the surface of the mudflat, as it needs a hard substrate on which to anchor. It already covers an area of tidal mudflat at Penarvon Cove, quantities of it being exposed on low spring tides, as was observed on 4 November.

On the northern bank, almost opposite this, it grows in the shallows at the mouth of Porth Navas Creek, whilst just upstream from here, at its highest point in the River it grows amongst other algae on the shingle bar of Calamansack Point, where it was recorded on 20 November.

Throughout this summer, several loose pieces of Sargassum were observed floating in the River, mostly in the main pool, around Helford.

One of the reasons the Portsmouth meeting of scientists decided Sargassum was not a welcome introduction to our marine flora was because of the threat it poses to native marine life. Sargassum plants have a high growth rate, immense reproductive output and high regenerative ability. Replacement of native marine plants in
Map 8.

The distribution of Spartina & Salicornia on the Helford River, 1986.

Salicornia supina

Spartina anglica
English waters by Sargassum would disrupt existing ecological relationships and food nets.

Some American marine biologists have studied the relationship between Sargassum and Zostera marina. For example, Druehl (1973) is worried that Sargassum might be replacing Zostera marina on the Pacific coast of North America. There is as yet no evidence of this happening on the Helford, all existing intertidal Zostera being free of the alien. Sargassum is growing on the lower shore mudflat at Penarvon Cove, but is as yet just below the area where the Zostera was recorded in 1978 by N A Holme and G M Bishop, besides which the Zostera had already disappeared from this site before Sargassum arrived in the Helford, so there was no direct competition.

The situation should however be carefully monitored on the Zostera marina at Helford Passage and more particularly on the Zostera marina at Treath and the Zostera nana at Calamansack, where the beds show sections of a lagoonal nature, that stay wet at low tide, where Sargassum could easily gain a foothold.

On amore positive note, it was observed at Penarvon Cove, that Sargassum provided a new habitat for epiphytic red algae in the lower littoral zone. Griffithsia corallinoides, Antithamnium plumula and Polysiphonia spp were all noted growing on Sargassum plants at extreme low water on 4 December this year.

Sargassum certainly cannot be removed or even effectively controlled over anything but a small area. It is established and spreading on our coasts and will continue to colonise suitable stretches of British shoreline.

On the River the areas most likely to be invaded seem to be sheltered sublittoral mudflats exposed only on spring tides. Those further up-river the estuary from Groyne Point are perhaps less ideal because of the absence of suitable lower littoral mudflats, the mud exposed at mean low water leading straight into the deep water channel. However places such as Penarvon Cove, Treath and Gillan Harbour, are probable sites for colonisation. Especially suitable are the shallow, mid and lower littoral lagoons at Prisk Cove (which bear similarities with the Bembridge ledges from where Sargassum started in Britain) and the shallow pools on the Zostera beds at Treath, Helford Passage and Calamansack. Also suitable are middle or lower shore pools on any of the rocky shores which remain full at low tide.
5.5 Cord-grass *Spartina anglica*

The cord-grasses comprise a distinctive genus of stout perennial maritime grasses which live on mudflats and saltmarshes.

The species found on the Helford is vigorous with a long and complicated history. It originates from hybridisation in the late 1800s between the native Small Cord-grass, *Spartina maritima* and the introduced North American species, *Spartina alterniflora*; and thus *Spartina x townsendii* – Townsend's Cord-grass – was produced. It was then from this sterile hybrid that in 1892, on a Lymington saltmarsh, a new species was born. This version of *Spartina x townsendii* accidentally doubled its number of chromosomes to produce a fertile hybrid, a new species in its own right, called *Spartina anglica* – Common Cord-grass. The doubled chromosomes give these plants a rich stock of genes to draw from and they can extend their range into areas unsuitable for either parent. Thus the new species spread rapidly, until today it is found in suitable habitats throughout England and Wales.

*Spartina anglica* was unknown in Cornwall until 1940, since when it has spread rapidly in tidal mud. It is known in the west of the county from Copperhouse Hayle and from Gweek Creek post-1950.

On the Helford, *Spartina* was introduced into Bonallack Creek by a Mr Menear who brought it to the area after the Second World War thinking it would provide cover and attract duck for shooting. It has since spread from here and seems to have increased more rapidly in the past two years (L Collins pers comm). It has spread to the top of Mawgan Creek and is present in Polpenwith and Polwheveral Creeks. In the main channel it extends as far downstream as Bishop's Quay and upstream to Gweek (see Map 8).

Although a relative newcomer, *Spartina* is taking over the role of primary colonist in many places, being one of the main pioneers on the lowest levels of a saltmarsh. The danger of the colonisation of the Helford by this alien is that with its extensive root system and propensity for trapping mud, it seems inevitable that the areas now supporting *Spartina* will continue to silt up rapidly and become saltmarsh. Subsequently the upper reaches of the River will become dry land at a greatly accelerated rate.
5.6 *Laminaria ochroleuca*

This species of *Laminaria* was first reported in British waters when collected in April 1946 in Plymouth Sound (Parke 1948). Surveys in 1948 showed it to occur frequently in the more sheltered parts of Plymouth Sound. Found from just below low water spring tides down to a depth of 8 metres below chart datum, it is thought that the species is a cross-Channel migrant due to its distribution from the western Mediterranean and from the north-eastern Atlantic, being abundant on the coast of Brittany.

The first recording from the Helford was in 1949 (Spooner, 1950) when a few plants were found at Calamansack. No other definite records then occur until 1978 (Turk 1978) when several plants were found in a large deep pool on the lower shore of Bosahan Cove. We also found in 1986 a flourishing population at the Voose, near Bosahan Cove, where it grows at extreme low water spring tides. We failed to find any remnants of the species at Calamansack.

5.7 **Hard Clams Mercenaria mercenaria** and other deliberately-introduced species

The Quahog or Hard-Shell Clam, *Mercenaria mercenaria*, is abundant along the entire Atlantic seaboard of North America. Great quantities are harvested from the wild and eaten raw or made into Chowder.

Because of its economic value, attempts have been made to introduce *Mercenaria* into England. Introductions into several northern estuaries late in the Nineteenth Century failed to produce breeding colonies (Heppell 1961); however in the late 1950s/early 1960s, several *Mercenaria* colonies were discovered in the Solent area. These accidental introductions were successfully cultivated on a commercial scale and were marketed to some London hotels. However in recent years the Solent colonies have been pronounced unfit for human consumption and batches are sent to selected places in Britain for cleansing, amongst these being the Duchy of Cornwall Oyster Farm at Porth Navas where they are kept on the foreshore until purified.

The waters of the west of Britain are too cold for *Mercenaria* to breed as it does in the east of the Channel, where high summer temperatures are reached.

As well as the Hard Clam, three other species are laid at Porth Navas: the Pacific Oyster (*Crassostrea gigas*), New Zealand Oyster (*Ostrea lutaria*) and Manila Clam (*Venerupis semidecussata*). (Information from Hansard 11.7.1985, pp 315-316)
Appendix 6

Trigging Survey
(Also see Section 3-4 and Figures 1-6)

On Friday 28 March 1986, a survey was undertaken on the Helford River to study the traditional Good Friday activity of trigging. The three main trigging areas of Treath, Helford Passage and Gillan Harbour were monitored simultaneously throughout the day.

Origins of triggers

Nowadays with increased mobility people come from further afield to trig and hence numbers carrying out this traditional shellfish collecting have increased. In the past just a handful of locals were to be found on the Helford on Good Friday, as shown by the photo (Plate 10) which depicts a family group trigging at Helford Passage on a Good Friday in the late 1800s.

Today, if only the locals were taken into account the picture would be much the same, with only eight groups of triggers at Treath and Helford in the 1976 survey coming from the area immediately around the banks of the River - Mawnan Smith, Durgan, Budock, Manaccan, Porthallow and St Keverne.

At Gillan Harbour the majority of those questioned - six groups - came from the Lizard Peninsula, probably because it is the most southerly part of the River and more easily accessible from the Lizard.

The remaining 72 groups questioned came from further afield with ten coming from the Helston-Nancegollan area.

At Treath and Helford Passage the majority of triggers were from the north Cornish coast - 18 groups were from the Camborne/Redruth/Stithians area. A large number - 23 groups, came from the Falmouth/Penryn area, many being Fal triggers displaced to the Helford because they complain that the Fal Cockles now have an oily/soapy taste and are quite unpalatable. The furthest west people travelled from was Hayle, and from Truro to the east.

Gillan Harbour had few people from further afield, presumably because of its inaccessibility on the south bank of the River. However, in total, seven groups came from outside Cornwall - from Buckinghamshire, Oxford, Somerset, Devon and Avon, all of whom were on holiday, spending Easter weekend with relatives on the River or in Helston.

The reason for this influx of people from further afield is partly due to people who have moved from the Helford to other parts of Cornwall (or whose parents came from the area) and still like to keep up the family tradition. Others have heard of the custom and decided to join in "because it is traditional".
As was the case in years gone by, it is still a social event but few now cook and eat their catches on the shore. At Helford Passage and Treath most adjourned to the local public houses, whilst at Gillan more people picnicked on the shore.

Ages of triggers

Three generations of triggers are represented in the survey. Just over a third of triggers were in the 25-47 years age group, with nearly a quarter being in their late teens and early twenties. A further quarter were aged 50 and over, most of whom had been trigging on the Helford for 40-50 years. Finally a fifth were aged 14 years and under: some of these were digging; most were just accompanying parents.

Group sizes

Dominant were family groupings with young or retired couples being most common. Then came larger family groups, parents with children in groups of three, four and five being most frequent; larger groups were less common but in some cases several families were trigging together or had been accompanied by friends forming several larger groups of 14-18 people, the largest being one of 33.

Numbers

The numbers trigging on the beaches varies throughout the day. Numbers at Treath can be taken as also being typical of the fluctuations at Helford Passage:

People started arriving at Treath at 10.45am when 18 arrived. Numbers rose rapidly to a peak of 126 at 11.45am, with people working down the shore with the falling tide. Numbers rapidly fell when the public houses opened at noon, being down to 90 by 12.30pm. Consequently at 1.10pm when the tide was lowest numbers had already passed the peak. After the turning of the tide there was another exodus to the pub until by 2pm there were only 40 left on the shore.

Numbers at Helford Passage were similar, with a peak of 132.

Gillan Harbour presents a slightly different picture. People started arriving at around 11am, with 20 being on the shore by 11.25. By 12.15 numbers had reached a peak of 65, falling after the tide had turned to 54 with many groups retiring to the top of the beach for a picnic.

Transport

The vast majority of triggers arrived by car, only a couple of groups having walked to the shore. Shortage of parking space
limits numbers at Helford Passage and especially at St Anthony. Treath has a large car park and therefore does not face such congestion.

Summary

The general picture is of family groups who come only once a year - on Good Friday - to collect enough cockles for their own use and then to have a picnic or go to the pub.

A variety of implements was used - mainly garden forks, rakes or 2-pronged hoes. The target for collection was usually half to one bucketful (150-300 Cockles). A few people were collecting other types of shellfish - at Gillan Harbour, limpets, razor shells, the Smooth Venus and the Rayed Artemis were taken and at Treath winkles, mussels and limpets were also collected.

Many of those questioned said they had trigged on the Helford all their lives 20-30 years on average, though this was up to 50-60 years in the case of the older people. These long-term triggers agreed that more people were collecting cockles now than at any time in the past, attributing it to the advent and increased use of the car. Some now come on Maundy Thursday to avoid the crowds. They also remarked that the new, younger cocklers no longer respect the traditional trigging times.

On the subject of cockle abundance - the general consensus of opinion was that numbers had declined, many remembering collecting sackfuls although some put it down to periodic fluctuations and cockle movements. They also said the cockles are smaller than they used to be.

Many people commented on the increased muddiness of the shore and the appearance of a black, oily layer below the surface. Diversity of life had decreased, they said, with fewer peeler crabs, starfish, eels, mussels and winkles.
Appendix 7

Water Quality

Data from South West Water shows that the water quality of streams in the Helford catchment suffers from great fluctuations.

Peaks of Biochemical Oxygen Demand (BOD) and Suspended Solids frequently occur simultaneously. Biochemical Oxygen Demand is the amount of oxygen required for the break down of organic matter by microbial action. Hence the higher the BOD, the higher is the amount of organic material contained in the stream. Since organic matter is usually in particulate form a high BOD is often accompanied by high suspended solid content, unless the pollutant is silage liquor in which case the stream will have a low suspended solid content and high BOD. Conversely a high suspended solid content does not necessarily indicate an organic pollutant with a high BOD since the solids may be inert particles such as mine waste etc.

The pollution of a stream with organic material having a high BOD will result in a reduction in the amount of dissolved oxygen present for other species. The sudden input of nutrients results in the rapid growth of algae and micro-organisms which de-oxygenate the water, suffocating animals and smothering higher plants.

In the Helford catchment, where streams are short, the problem persists in the marine environment where in the enclosed waters the pollutants will still cause de-oxygenation and nutrient enrichment. Recently a 'slimy' film of material has been observed on the surface of the mud banks in the upper reaches of the estuary. This is thought to be due to deposition of organic pollution on the mudflats by the ebbing tide.

High quantities of organic material can enter streams in two ways, from farmers washing down their yards, and from heavy rain washing accumulated material into the stream. This accumulated material may come from farm yards, fields after 'much'. or slurry spreading or from naturally occurring sources such as dead leaves etc.

Peaks of BOD and suspended solid content generally occur in winter when high rainfall is most likely the cause. Large isolated peaks also occur in summer, due most likely to farmers hosing down their yards. It is possible to tell when heavy rainfall is largely to blame since increased BOD and suspended solids occur all over the catchment, rather than isolated in individual streams.

Nitrate pollution occurs due to soil leaching and is greatly increased by the application of inorganic fertilisers containing nitrates, phosphates and potassium. Nitrification of streams reaches a peak when application of inorganic fertilisers is at a rate greater than a growing crop can absorb the nutrients. The excess will then be easily leached from the soil by rainfall.
causes excessive growth of algae resulting in clogging of watercourses and de-oxygenation of the water by the algal bloom.

Peak levels of nitrate in streams occur in winter, when plants are not growing. Hence little nitrate is being absorbed from the soil and heavy rainfall can leach the nitrates into streams.

Discharges in the catchment were surveyed to assess their likely effect on the River. Most of the discharges were land drains, which are unlikely to cause heavy pollution unless they collect drainage from farmyards etc. Constantine Sewage Works discharges effluent into a stream above Polwheveral Creek at a rate of approximately seven gallons per minute. The receiving stream was clean and fast-flowing with no signs of pollution. The stream feeding into Ponsontueil Creek was judged by South West Water to suffer from organic pollution (Logan 1986 unpublished data). This is probably due to a combination of discharge from a pig farm further upstream, and naturally occurring pollution due to a build up of dead leaves in the woodland.

Run off from Trezise rubbish tip was investigated and found to be causing minimal pollution of streams feeding into Mawgan Creek. Other sources of pollution include overflow from the numerous septic tanks in villages on the banks of the Helford, and discharge from the private sewage treatment works at Helford Passage.

Heavy metal pollution has been measured by South West Water in connection with the shellfish industry and found to be minimal in spite of the past history of mine discharge.
Figure 11: Fluctuations in Water Quality - Polwheveral Bridge (Site 3)

- Nitrate Levels
- Biochemical Oxygen Demand
- Suspended Solid Levels
Appendix 8

Areas of constraint

The whole of the Helford River is designated an Area of Outstanding Natural Beauty under Section 87 of the National Parks and Access to the Countryside Act 1949. The area is within an Area of Great Landscape Value, a designation in which landscape quality should be the prime consideration in determining applications for development. It is also an Area of Great Scientific Value and Cornwall Nature Conservation site, with one area designated as a Site of Special Scientific Interest (SSSI; Merthen Woods) and numerous areas under National Trust ownership.

The Cornwall County Council has taken further steps to conserve the natural beauty by making Tree Preservation Orders over much of the area and obtaining Government approval to two Directions under Article IV of the Town and Country Planning General Development Order; one to control sporadic temporary camping and caravanning, and agricultural buildings, and the other to control Permitted Development extensions, such as garages and exterior painting.

Areas of Great Scientific Value (AGSV)

AGSVs have been designated in Cornwall County Council's Countryside Local Plan (October 1985). The areas were identified from the Structure Plan Ecological Survey, with the following purposes:

a) to act as a "buffer" around the most important and sensitive nature conservation sites and thus give protection from development which might have an adverse effect, whether or not the proposal falls within the site.

b) to provide links between protected sites which will facilitate the movement of wildlife and so increase the general richness and variety of the natural environment.

c) to emphasise the most important area of the County for nature conservation where resources for management and enhancement will be concentrated.

Cornwall Nature Conservation Sites (CNC)

CNC sites are those areas regarded by the Cornwall Trust for Nature Conservation as being representative of the wildlife habitats within the County. These include existing National Nature Reserves and SSSIs as well as potential SSSIs and sites of more local significance.

CNC sites have no statutory significance, nor do they give the planning authority any additional powers to restrict activities which are not subject to planning control. Neither does it give any public or private body right of access or control over such
sites. However these sites will increase awareness of wildlife habitats in the County and will be of particular assistance to farmers, foresters and others involved in land management.

Sites of Special Scientific Interest (SSSI)

Under the 1949 National Parks and Access to the Countryside Act, the NCC has a duty to identify SSSIs which are important for the flora, fauna, or geological or physiographic features. Under Section 28 of the Wildlife and Countryside Act 1981, the NCC is also required to give notice to the local planning authorities and every owner and occupier when a new site is being proposed as an SSSI and allows three months for representation or objections. When notification of an SSSI is being given the NCC has to supply owners and occupiers with details of nature conservation interest and specify any activities not requiring planning permission which might damage that interest. In return the owner or occupier is required to give the NCC three months notice of his intention to carry out any of the activities which he has been told may cause damage to the site. Where it proves impossible to achieve a voluntary management agreement the Secretary of State has power to stop potentially damaging action whilst further safeguarding action is considered, including possible compulsory purchase. In such circumstances compensation will be payable by the NCC for delay and loss of land value.

In addition, Cornwall County Council's Structure Plan says that development which would adversely affect such a site would not normally be permitted. This could include proposals beyond the site such as land drainage, road construction, gravel- or mineral-extraction. Development near an SSSI can cause noise, pollution and disturbance, and physical damage to the site can be caused by increased recreational use in the area.
Appendix 9

"Drop-out" Survey

The "drop-out" survey was carried to create a baseline against which the marine influence within the River can be monitored. The idea being to record the position at which various marine species "drop-out" in the River to be replaced by more estuarine species.

A range of 13 species were surveyed, including Limpets, Anemones, Barnacles, Sponges and selected Phaeophyta and Rhodophyta, as well as a more general survey of the distribution of Fucoids and Rhodophyta. The presence, absence and relative abundance of these species was noted at 14 sites distributed around the River, from Gweek, the limit of tidal influence, to Treath, where it is totally marine.

The Beadlet Anemone, *Actinia equina*, became scarce from Groyne Point (site 2) upwards, being totally absent above Mawgan Creek. Likewise *Patella* spp were absent from the extreme upper-reaches, probably due to the lack of suitable substrata and the length of time the shore is exposed to air at low tide. Of the two Barnacle species surveyed, the Australian Barnacle, *Elminius modestus*, was by far the dominant species in the upper reaches of the River, whilst *Balanus balanoides* was infrequent, and totally absent above Calamansack. The Sponges *Hymeniacidon sanguinea* and *Halichondria panicea* were absent from the top of the River, with *H* sanguinea reaching the highest (Site 11, west of Vallum Tremayne Creek), while the algae *Bostrychia scorpioides* and *Cateriella repens* were abundant at the head of the estuary, becoming absent by Treath.

It is hoped that the accurate record (contained in the base-data) of the species distribution within the Helford will allow a future survey to assess the changes in marine influence. If the River is becoming more estuarine, the reduced marine influence will restrict the distribution of such species as *A* equina to the mouth, whilst an increase in the marine influence will restrict the distribution of estuarine species such as *Bostrychia scorpioides*. 
Appendix 10

Some animal species for which there is evidence of serious decline

Sponges (PORIFERA)

Hymeniacidon sp Once common on Helford Passage flats, but now virtually absent

Hydroids (CNIDARIA: HYDROZOA)

Hydractinia echinata Once almost as common as the abundant juvenile Common Hermit Crabs (*Pagurus bernhardus*), covering the shells that the latter inhabit: now very scarce intertidally

Sea Anemones (CNIDARIA: ANTHOZOA)

Adamsia carciniopados Cloak Anemone Occasional on shells of Prideaux's Hermit Crab (*Pagurus prideauxi*) No records for at least a decade

Calliactis parasitica Parasitic Anemone Not uncommon until the early 1970s, since when there have been no records

Bunodactis verrucosa Gem Pimplet 'Not uncommon' 1972: not seen recently

Metridium senile Plumose Anemone Large ones common at low tide on stones at Helford in 1966: none recently on any of the flats

Bristleworms (POLYCHAETA)

Lanice conchilega Sandmason Worm Known to be able to withstand 'degraded' conditions, this species has increased at the expense of other burrowing creatures

Sabella penicillis Peacock Worm These Tube Worms are now absent where formerly they were present in distinct zones at Helford Passage, Penarvon and Treath

MOLLUSCA

A comparison of marine species present in any one 10km square in Britain and Ireland reveals that SW72 has more species than any other square; and all of these are found within the bounds of the River, as defined for the present survey. Of a total of 263, 137 of these were found living (as apart from shells) between 1960 and 1974.

MOLLUSCA: PROSOBRANCHIA Sea snails

Calyptraea chinensis Cup-and-Saucer Limpet Plentiful in the 1960s on clitter: now seemingly absent between tide-marks
Cantharidus striatus Striated Top-shell Formerly abundant on Eel-grass leaves: now very rare

Littorina littorea Edible Winkle Formerly abundant and large on all the flats: now sparse Some commercial gathering occurs
Nucella lapillus Dog Whelk Very rare or absent where it was formerly common, namely in those areas where there has been a concentration of TBT paint

Rissoa membranacea Membranous Spire-shell Formerly abundant on leaves of Eel-grass: none found for a decade or so

R parva Small Spire-shell As above

MOLLUSCA: LAMELLIBRANCHIA Bivalves

Acanthocardia aculeata Spiny Cockle None found alive for a 'couple of decades Large numbers were taken by a shell-collector in the 1940s, and are now in various museum collections, including the British Museum (Natural History) This is a very local 'southern' species that probably lives to a great age and does not set spat every year

Arctica islandica Iceland Cyprina Certainly once common, as many were taken by a shell-collector in the 1940s, and one was found alive in 1955. Large ones such as were taken in the Helford River in the 1940s could be very old: Holme (1953) suggests that specimens were long-lived and produce spat infrequently, and tagging experiments carried out by Forster (1981a) showed extremely slow growth and he believed that individuals might reach a very substantial age - perhaps 80 years or more

Callista chione Smooth Venus Much scarcer than formerly An unexplained 'wreck' of over a hundred at St Mawes in the Fal in 1982 (Forster & Burrows 1983) suggests that the species might be susceptible to poor water quality This is another 'southern' species that lives to a considerable age, those of maximum size (90mm) being more than 40 years old

Cerastoderma edule Common Cockle It is generally considered that the beds are much less productive, due to heavy pressure of collecting. Whereas a pail could be filled in an hour at Helford Passage now it is said to take a couple of hours to fill a quarter to a third of a pail

Chlamys varia Variegated Scallop None now reported intertidally, but said to be 'fairly commom' at low water in Gillan Harbour by Bristol University students in the 1960s Confirmed by AJ (pers comm)

Ensis spp Razorfish Much less common than formerly Large numbers were taken for bait from Gillan Harbour in the 1970s fide Mr J Miller
Mytilus edulis Mussel Formerly large specimens were scattered over the flats adhering to any hard substratum There were large numbers in the stream in Gillan Creek, but the Mussels were stripped from here in 1983 (Mr J Miller and Miss P Towner pers comm) Similarly, the mussels were removed from Helford Passage (Mrs H 0 Trench in litt 20.10.1983)

CRUSTACEA: DECAPoda Crabs, lobsters, prawns etc

Hermit crabs are fewer, both in numbers of species and individuals

ECHINODERMATA

Echinocardium cordatum Sea Potato Urchin Once common in Gillan Harbour Now rare

FISH

Gobius couchi Couch's Goby has declined in numbers (Dr P Miller in litt) at Helford, and there is probably a similar reduction of numbers of most intertidal species
FISHERMEN
Please remember that small mesh monofilament nets catch immature fish (breeding stock has already been depleted) and that all 'morma' 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
Anchovies 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 5 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 'rigging' 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 slurry 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 below is contravened, notify Kerrier District Council immediately.

Organisations with representatives on the Advisory Group, responsible for its management:
- Cadgwith, Helston and District Fishermen’s Society Ltd
- Conchological Society of Great Britain & Ireland
- Constamine Parish Council
- Cornish Biological Records Unit
- Cornwall County Council
- Cornwall Trust for Nature Conservation
- Council for the Preservation of Rural England
- Falmouth Diving Club
- Looe Bay of Cornwall Oyster Farm
- Gweek Parish Council
- Helston River Association
- Helston River Boatmen’s Association
- Kerrier District Council
- Lady Hamilton Fish
- Manazan Parish Council
- MAFF District Fisheries
- Marine Biological Association
- Marine Conservation Society
- Mawnan Parish Council
- National Trust
- Portreath Angling Club
- Port Navas Yacht Club
- Roseland Research Group
- Sairway St Anthony Ltd
- S. Anthoy 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
- Dairy of Cornwall
- Nature Conservancy Council
- South West Water

WHERE THE OYSTER GROWS

COUCIF'S GOBY
A fish described as new to science, discovered in the Helford River in 1974.

July 1988/3506

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 oyster and 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 attended by groups of interested groups and individuals. The resulting 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 saltmarsh 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 Cornwall Biological Records Unit.

The purpose of the designation is to draw attention to the biological importance of the area, to prevent unwarranted damage and to encourage undisturbed 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:

DEFINITION OF HELFORD VMCA
The whole River within an imaginary line between Rosemullion and Nare Point, including all creeks to maximum tidal influence of highest spring tides.

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 Trethevy clearly show such damage. So ‘Please keep off the grass’.

The Duchy Oysterge 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 Cornwall Biological Records Unit, Trevithick Building, Fore, Redruth, TR13 1PL. Telephone (0020) 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 900/24 hour service.