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SURVEYS OF HARBOURS, RIAS AND ESTUARIES IN SOUTHERN BRITAIN
MILFORD HAVEN AND THE ESTUARY OF THE RIVERS CLEDDAU

Volume 1

Report

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SURVEYS OF HARBOURS, RIAS AND ESTUARIES IN SOUTHERN BRITIAN
MILFORD HAVEN

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SURVEYS OF HARBOURS, RIAS AND ESTUARIES IN SOUTHERN BRITAIN

PREFACE TO REPORTS

The marine inlets of southern Britain are almost all formed from drowned valleys. They vary in shape, size, depth and salinity according to their historic and present hydrographic influences. All are more-or-less sheltered from wave action and have therefore been the focus of many urban and port developments. Some support or have supported important fisheries and several are currently being developed for shellfish and fin fish farming. Many of these inlets are known to include marine or estuarine habitats and communities which are rarely encountered in the British Isles. Some are already known as rich areas for marine life. However, little is known of the ecosystems present within many of these areas and new and potential developments make description and comparison urgent if scientific interests are to be taken into account during planning. Therefore the Nature Conservancy Council has commissioned the Field Studies Council to undertake surveys over an initial three year period from 1985 to 1988.

Some of the inlets included in the study are already well documented and may need little survey work. Others require a considerable amount of field work and analysis of data.

Our work consists of both a review of available information and field work.

The aims of the information review are to:

1. Describe the areas in terms of their physical attributes.
2. Review the results of previous marine biological and related studies both published and unpublished.
3. Review fisheries, boating activities, port operations, diving activities, educational activities, research studies and other marine resource usage.
4. Catalogue available information .

Items of published and unpublished information are entered onto computer files and can be retrieved by area or subject. A paper copy of each entry is maintained in a loose-leaf file ordered by area.

Where field work is carried out, it will aim to:

1. Collect information on the habitats present and the abundance of species in those habitats at sites selected to include a wide range of different shore and seabed types, areas of known conservation importance, or where rare species are or might be present.
2. Collect photographs of the habitats, communities and species present.

For each area where surveys are undertaken, the following reports are produced:

Volume 1 - Report of field surveys
Volume 2 - Species distribution records
Volume 3 - Field data
Volume 4 - Catalogue of photographs

Keith Hiscock
October 1985

SURVEYS OF HARBOURS, RIAS AND ESTUARIES IN SOUTHERN BRITAIN
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SYNOPSIS

Milford haven and the estuary of the Rivers Cleddau (the Daucleddau) are situated at the south-west tip of Wales. The area under tidal influence includes over 110 km of coastline but with an entrance only 3.5 km wide. There is a main channel with some large bays near the entrance and muddy creeks (pills) at intervals along the length of the inlet. Geologically, the area is predominantly of Old Red Sandstone but with areas of Millstone Grit and Limestone. The inlet is a ria and the steep-sided valley east of the Cleddau Bridge continues into the subtidal. This results in the presence of extensive rocky shores which continue underwater as steep rock or boulder slopes in places. Mud flats are present in the wider parts of Milford Haven and in the pills. Sandy beaches are present near to the entrance. The seabed is predominantly of muddy sediments but with much shell and coarse material mixed-in in Milford Haven whilst, in the narrow Daucleddau, cobbles and shell gravel are generally present. Depths in excess of 10 m below chart datum are present throughout Milford Haven and the Daucleddau as far east as Beggars Reach (almost 20 km from the entrance) and in excess of 5 m to Black Tar (a further 4 km). Freshwater input to the system is about $7.5 \times 10^5 m^3$ per day, the average amounting to 0.4% of the tidal prism at neap tides and thus causing appreciable dilution only in the narrower landward parts of the inlet. The area has been an important centre for shipping and light industry for hundreds of years and currently provides sheltered berths for oil tankers at three refineries. Recent developments have included the cultivation of oysters and rearing of fin fish within the sheltered waters of the Daucleddau.

Milford Haven and the Daucleddau have been the subject of many studies particularly since about 1960. These have provided descriptions of rocky intertidal and sediment subtidal communities in particular as well as records of effects of oil industry development and oil pollution in Milford Haven. Several studies have also been undertaken of the hydrography of the inlet.

The present survey and a previous NCC commissioned survey in 1978/79 aimed to collect further information on the marine habitats and communities present in Milford Haven and the Daucleddau, particularly in areas and habitats inadequately sampled previously. The habitats present and abundance of conspicuous species were recorded on the shore and in the subtidal by diving. A dredge was used on one day to collect samples for analysis of species living in sediments. Fourteen intertidal, 17 subtidal diving and seven dredge sites were surveyed and sampled in 1985. Description of habitats and communities was based on these data together with the results of rocky shore and sediment shore surveys undertaken during work funded by the Institute of Petroleum, and with the results of surveys during 1978/79 of 37 sublittoral sites during the South-west Britain Sublittoral Survey. Ten intertidal and seven subtidal habitat/community types are described and the distribution of habitats and communities discussed in relation to hydrography and other factors.

The area is considered to include a wide range of habitats and communities, several of which are of scientific and/or nature conservation interest. Particular attention is drawn to the muddy-sand beaches near the entrance to the Haven, the sheltered or very sheltered bedrock shores in Milford Haven and the Daucleddau, creek muds and mud banks, subtidal bedrock and stable boulders in the Haven, artificial substrata in the Haven, wave sheltered/tidal stream exposed hard substrata in the eastern Haven and Daucleddau, areas of maerl near Stack Rock and areas of muddy sand colonised by Zostera marina. Fourteen algae and three animal species are noted as of particular scientific interest in their presence in Milford Haven and the Daucleddau.

SURVEYS OF HARBOURS, RIAS AND ESTUARIES IN SOUTHERN BRITAIN
MILFORD HAVEN AND THE ESTUARIES OF THE RIVERS CLEDDAU

1. INTRODUCTION AND HISTORICAL PERSPECTIVE

Milford Haven and its upper reaches, the Daucleddau Estuary, extend from the entrance between St. Anne's Head and Sheep Island to the confluence of the Eastern and Western Cleddau Rivers at Picton Point (Fig. 1). The area of tidal influence includes over 110 km of coastline but with an entrance only 3.5 km wide.

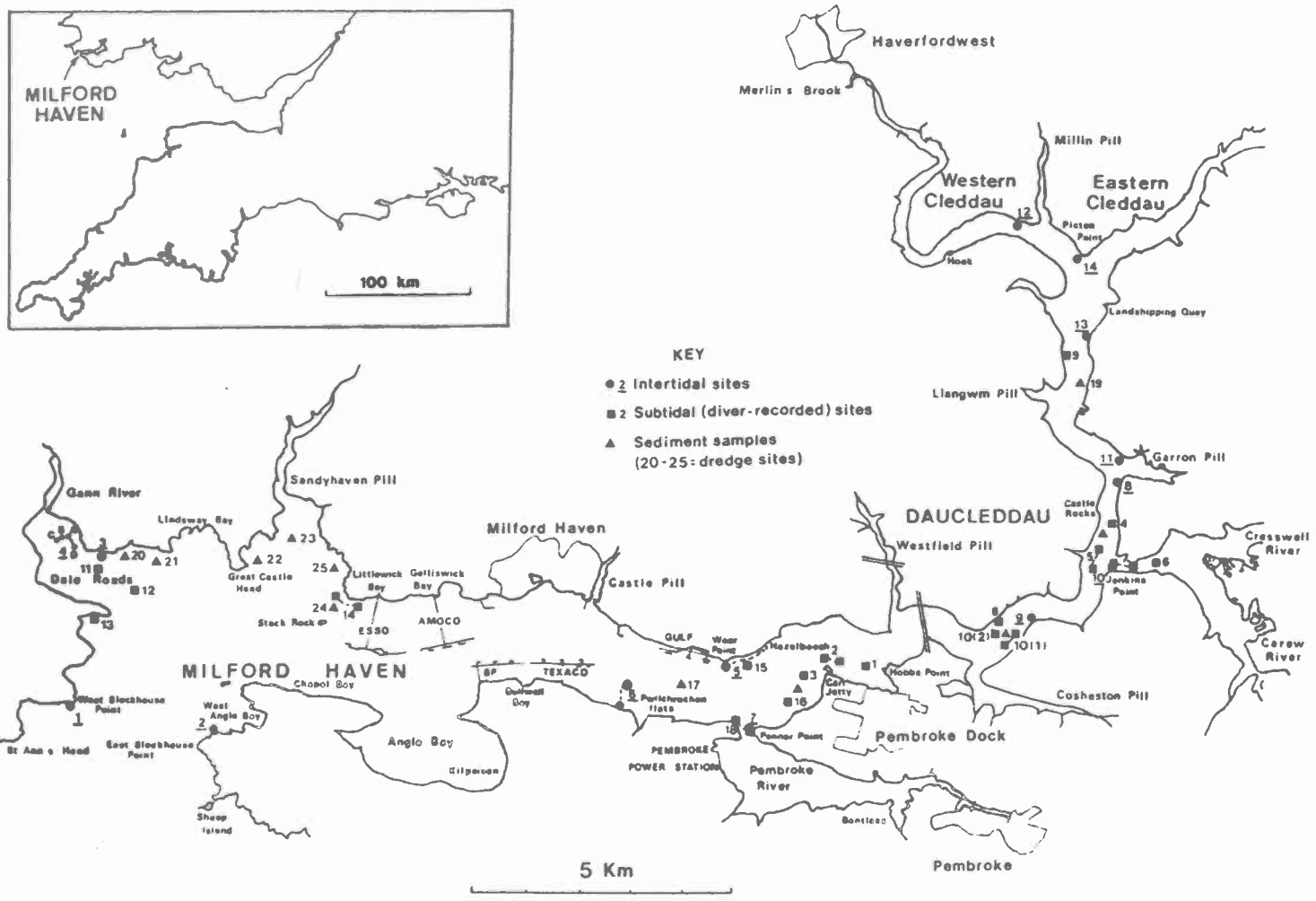

Fig. 1. Milford Haven and the Daucleddau Estuary including the location of sites surveyed and sampled in 1985.

The history of Pembrokeshire is summarised by John (1976). The importance of Milford Haven as a sheltered harbour forms an important part of this history. Shakespeare in Cymbeline wrote '..... how far it is to this same blessed Milford; and by the way, tell me how Wales was made so happy as t'inherit such a haven'. Daniel Defoe sang it s praise and Nelson in 1803 said Milford Haven was the only seaport for commerce on the west coast of Britain and that it rivalled Trincomalee in Ceylon as the greatest harbour he had ever seen.

Pembrokeshire has throughout history looked inwards to its sheltered waterway to provide its communication and trading connections with the rest of the world, and it has been the fortune and misfortune of those sea links that have determined the health of the local economy.

The Normans arrived at the end of the 11th century and settled on the land around Milford Haven and the Daucleddau. They built defensive castles to protect their rich agricultural land and settlements. By the 13th Century imports of wine, salt and spices and luxury goods were balanced by the export of wool, hides, grain, herring and other agricultural products.

During the 17th and 18th centuries coastal sea-trade developed rapidly, trading with most of Europe and later America adding to the Bristol Channel, Irish Sea and English Channel ports of earlier years. At the same time the wool trade was largely being replaced by coal, limestone and slate. The limestone was of particular importance in the Carew-Cresswell complex of inlets and in the upper Daucleddau where the limestone was extensively quarried. Here, large numbers of creeks were excavated into the limestone to provide access by water for its export. Other sites included the quarries near Pembroke Castle on Pembroke River. Later, West Angle Bay and West Williamston were a major source of limestone for the construction of the coastal forts, built during the period 1850-1870, around the shores of Milford Haven.

Throughout the period from the 14th century to the beginning of this century, coal has been extracted from the Pembrokeshire coalfield and in particular during the industrial revolution the high quality anthracite was much in demand. The coal that was not within easy reach of Saundersfoot harbour was shipped out from the small quays and jetties around the confluence of the Eastern and Western Cleddau rivers. One of the earliest areas to ship out coal and culm from its thriving mining community was Landshipping. Later, Cresswell Quay, Hook Quay and Little Milford were among important coal exporting points.

A combination of factors brought about the decline of coal mining and export in Pembrokeshire. In particular, industrial expertise developed techniques which could use cheaper coal from the inland collieries so that there was less demand for the local anthracite which was expensive to mine as the local coalfield is made up of thin, disturbed seams.

After about 1850, cargo vessels became larger and coal had to be brought down the Daucleddau in barges to Llangwm Pool or Lawrenny for trans-shipment. This process proved expensive and the development of railways provided cheaper land routes which ultimately signaled the end of Pembrokeshire's sea trading tradition. The last colliery at Hook continued until 1947.

The largest single factor in 19th century development of the waterway was the establishment of the Royal Naval Dockyard in 1814. The town of Pembroke Dock grew with the ship-building yards which at their peak in 1865 employed around 3000 men, and were considered important enough to warrant the provision, by the army, of a large garrison. The Dockyard gained a great reputation for innovations in naval ship-building and excellent workmanship. During the latter part of the 19th century the shipyard gradually declined, with a short spell of increased work in the First World War. Finally the yard was closed at short notice in 1926 causing a great deal of local hardship (John, 1975).

The town of Milford Haven was founded in 1793 but only reached a peak in the years 1900-1914 when the fishery in the western approaches was developed. By 1914, about 2000 local people were employed in the fishing industry with 66 trawlers and 150 smacks (Gilpin, 1960). Over-fishing and economic factors caused fluctuations in the fortunes of the fishery. During the Second World War fishing grounds recovered somewhat and a record total catch was made in 1946 from which point the decline of the fishery continued. By 1972 only 12 trawlers were registered and now there are 5 or 6 trawlers operating from Milford Docks, although the docks continue to be used intermittently as shipment terminals for deep sea trawl catches.

Wooden ships and boats were built at several sites around the Haven, with local craftsmen using local timber and most of the sails, fittings and ropes were made in the area. Thus employment was provided for hundreds of families.

Neyland was a planned settlement to accompany and service Isambard Kingdom Brunel's terminus of the South Wales railway connecting with the Atlantic passenger service and the Irish packet service, this magnificent terminus and quay were short-lived as improved inland communications favoured other ports. The long derelict area is now a flourishing marina.

Ferry terminal facilities were re-established in 1979 for the British and Irish line at Pembroke Dock and until January 1986 services to and from Eire operated from there.

Milford Haven was once famous for its native oyster (Ostrea edulis) fishery with shellfish exported from the area from before 1600 until about 1866 (George, 1964). After 1850 the fishery declined and one of the best sites for oyster culture is now occupied by Milford Docks and railway station. Even in 1912-13 twenty boats from Angle were landing a thousand oysters a day. There has been no large-scale commercial dredging in the Haven since the 'oyster epidemic' of 1920-21 (Wright, 1923). This epidemic was probably the final nail in the coffin of the commercial fishery which had almost certainly declined due to over-exploitation (Cole, 1951). Small scale dredging continues with just one fishing boat dredging for native oysters within the Daucleddau when weather conditions prevent fishing outside the Haven. Over recent years the rearing of oysters, largely Crassostrea gigas has been revived, upstream of the Cleddau bridge.

There is an annual herring fishery in Milford Haven based on the migration of herring into the Haven to spawn from early February to mid April. Herring are mentioned (John, 1974) as being one of the exports from Pembrokeshire in the 13th Century. The size of the fish stock from which the herring are taken is estimated to be in the order of 10 million fish (Clarke & King, 1985).

The population in this area has always varied with the changing economy. The fortunes of such interests as the Atlantic sea-trade (George, 1964), whaling, shellfish gathering, exploitation of the mineral wealth of the area, the naval presence and fisheries have been mirrored until recently by fluctuations in the size and affluence of the local settlements with large changes in the centres of population. To some extent this continues, as firms move into the area, only to find that over the years, it is uneconomic to be so far removed from the industrial centres of Britain, and close down again.

Sudden migrations of population no longer occur as people have the ability to travel larger distances to their place of work and by the

provisions of the welfare state that buffer the unemployed from the very worst effects of poverty.

2. PHYSICAL CONDITIONS

2.1. Geology and topography

The coastal solid geology of Milford Haven and the Daucleddau is summarised in Fig. 2 and is described in George (1970). In this area the topography is largely dictated by the underlying rock with bays cut into softer rocks and headlands and ridges formed by anticlines in harder strata. Land bordering the area is not generally steeply sloping although some low cliffs backed by wooded slopes occur at intervals on the southern and eastern shores of the waterway. Inland areas rise to a height of about 50 to 70 m, exceptionally to 100 m. The rocks of Pembrokeshire have been tilted so that they are younger towards the southeast, and have been much folded and faulted.

The Eastern and Western Cleddau rivers run south through Ordovician and then Silurian rocks before crossing an unconformity. These younger carboniferous rocks, break the age sequence and include the coal measures. Within that area lie the once important anthracite mines and quays mentioned by George (1964) and Edwards (1963) close to the confluence of the two rivers. Just south of this there is a band of Millstone Grit extending down to Llangwm on the Daucleddau. Further south the eastern bank is bounded by the main Limestone facies while the western bank is on rocks of the Old Red Sandstone which continue as the major rock type throughout the whole of the rest of the Daucleddau and Milford Haven. Extensive thrust faulting has caused Pre-Cambrian igneous rocks to outcrop at Castle Rocks. This resistant rock forms a near vertical submarine cliff at this the narrowest point on the estuary.

The north-south trend of the Daucleddau river is interrupted where the river turns and follows the line of the Ritec thrust fault westwards from Pembroke Ferry to Dale before again turning to the southwest.

Softer limestone shales at Angle, Pembroke River and Cosheston have been eroded to form bays. The main limestone outcrops are at Pembroke Dock, at Angle and within the Carew-Cresswell creek system.

Silurian sedimentary rocks outcrop in Lindsway Bay, whilst the contemporaneous Skomer Volcanic series is found locally around the shores of the Gann Flats, where a Pleistocene kame terrace has been largely removed providing sand and gravel for the construction industry.

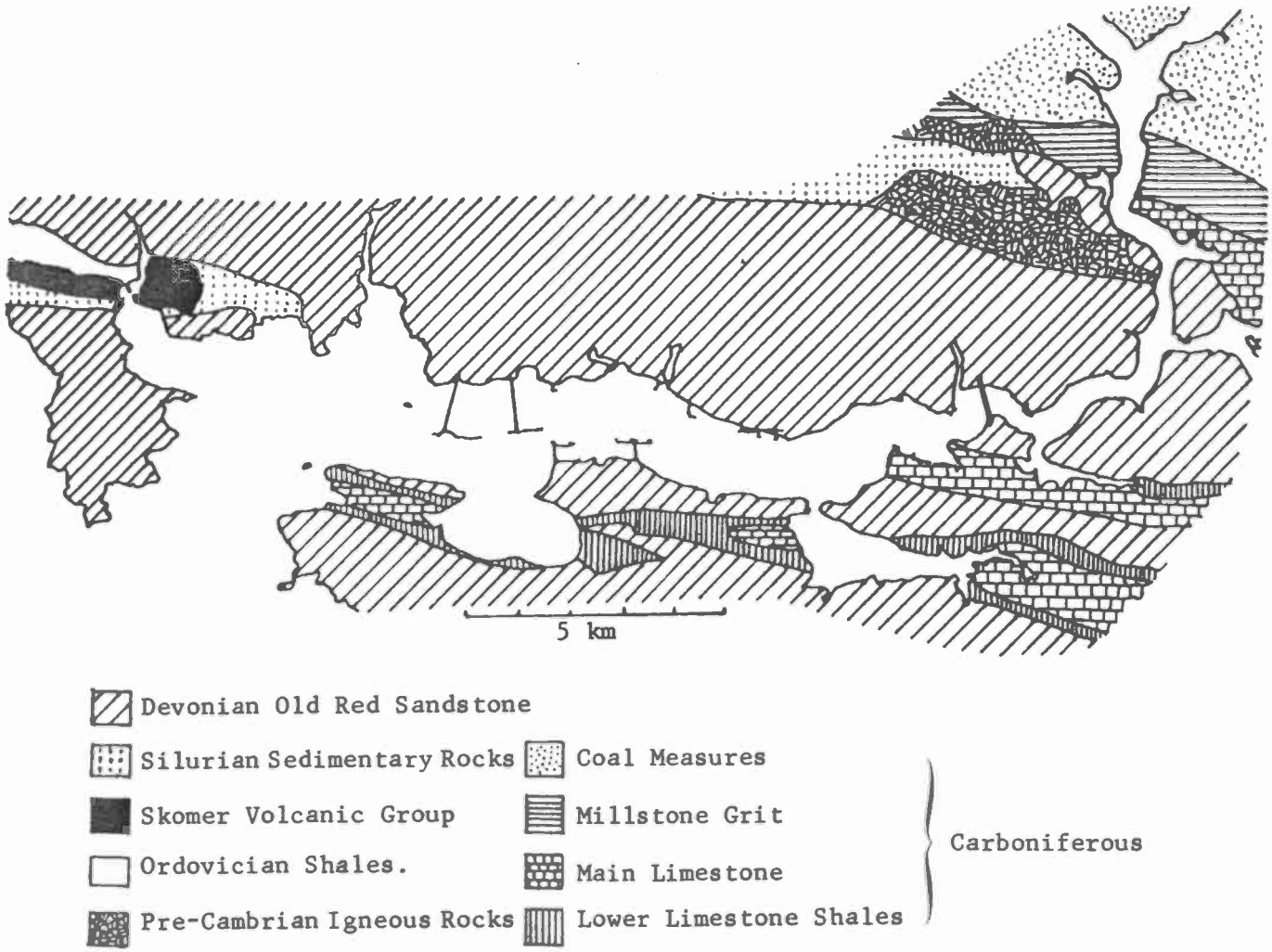

Fig. 2. Coastal solid geology of Milford Haven and the Daucleddau.

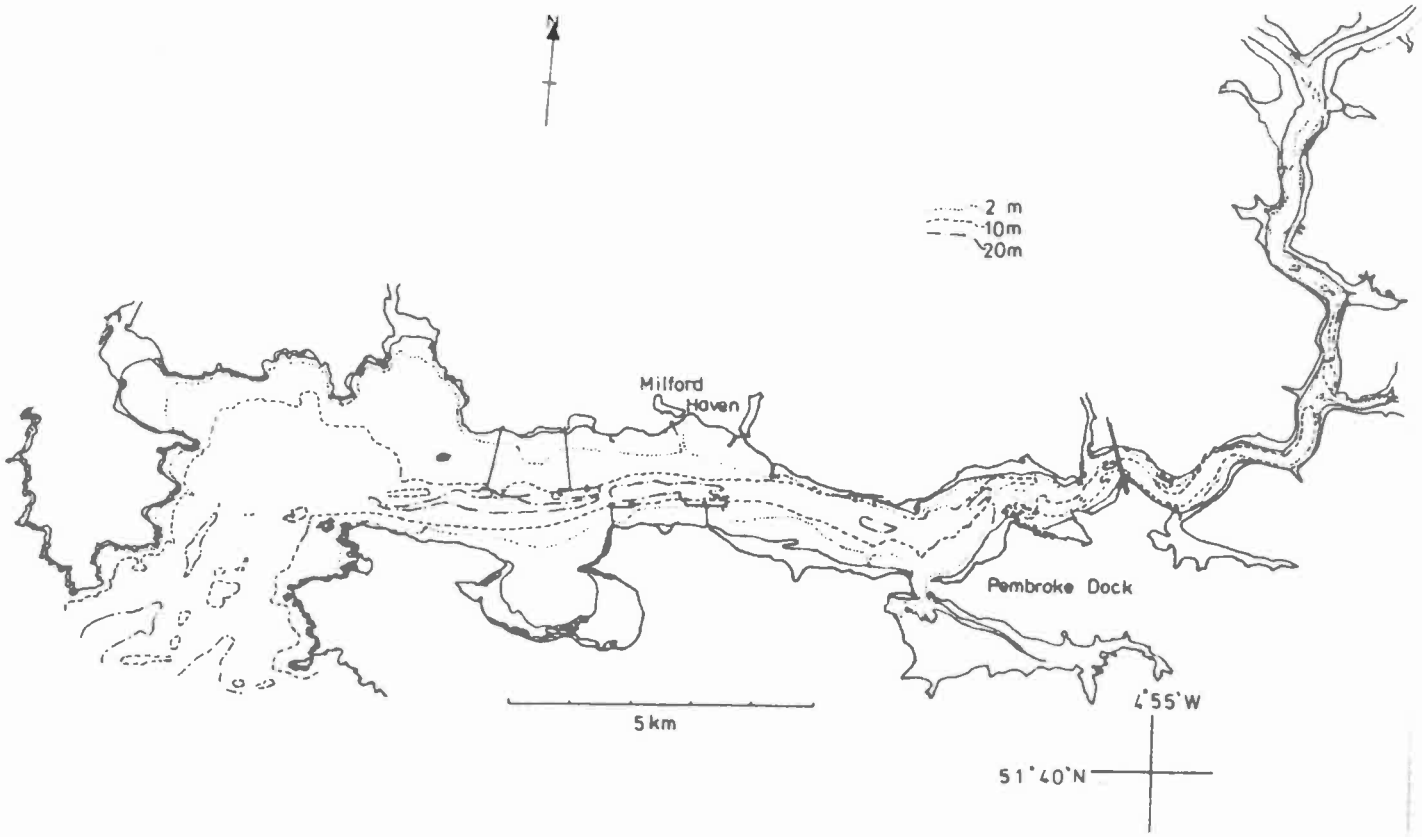

Fig. 3. Main depth contours. From Admiralty charts 3274 and 3275.

2.2. Hydrography

2.2.1. Bathymetry. Fig. 3 shows depth contours within the area studied. Depths in excess of 10m below chart datum are present throughout Milford Haven and the Daucleddau as far east and north as Beggars Reach and in excess of 5 m to Black Tar. At the entrance to Milford Haven and for much of the estuary, the seabed slopes steeply adjacent to the shore, but in the middle reaches the bottom gradient is slight and there is no deep water adjacent to the shore.

2.2.2. Temperature. Records of sea surface temperatures taken by Dale Fort Field Centre in Dale Roads from 1955 to 1962 and published in Nelson-Smith (1965) indicate a range from 7°C to 16°C through the year. A similar temperature range is likely to be present throughout Milford Haven and thermograph records obtained during studies by the CEGB demonstrated that temperatures were similar to the St Govan's Light Ship in the Bristol Channel as far upstream as the Warrior site east of Pembroke Ferry. However, within the enclosed areas of the Daucleddau, the temperature range is likely to be much greater. Case (1981) described the temperature profiles recorded during an equinoxial spring tide period with heavy fresh water input in March 1978. She found a maximum difference of 1 deg. C in bottom temperatures at the Cleddau Bridge compared to surface temperature at Llangwm Pill. Temperatures will be higher during summer and neap tide periods but lower during cold periods in winter compared to the open coast because of retention of water masses within the estuary. Also, inputs from land drainage are colder and

warmer in winter and summer respectively than sea temperatures (de Turville, 1977). At Carr Jetty, temperature maxima were recorded in summer during the middle of the flood tides. It was hypothesised (Carr, 1972 b) that insolation of the mud flats at Pwllcrochan and Pennar Flats was sufficient to raise the water temperature by the recorded 5 degrees C above the daily minimum on sunny days.

Recently daily temperature readings have been taken at the fish farm at the Warrior site near Pembroke Ferry. These are available for research but are confidential (B. Bateman, pers. comm.).

The cooling water from Pembroke Power Station is discharged into Milford Haven just to the west of Pennar Mouth and effects on seawater temperature have been documented by the CEGB who established 7 thermographs fixed at sites from Esso jetty to the Warrior site. Continuous records were kept from 1966 to 1976 and the results were reported by Carr (1972 a, b and c) and de Turville (1975 a, b and 1977). These records were supplemented by a combined aerial infra-red survey and boat survey in 1974 (Adams and Carr, 1975, Carr and Spencer, 1975). They discovered that the cooling water plume, which emerges at about 7 deg. C above ambient temperature, hugs the south side of Milford Haven during the ebb tide and much of the flood tide but quickly mixes with the receiving water. The thermographs situated at Gulf jetty and the Milford Haven Conservancy Board jetty did not register temperatures significantly different from that of open coast water. Significantly enhanced temperatures were recorded at the Texaco and Carr jetties and these were attributed to the plume of cooling water. At the Texaco jetty a mean temperature rise of the order of 1 deg. C per GW of power output occurred in winter (de Turville, 1977). Thus, during peak output, e.g. throughout much of the miners' strike (1984-85), the temperature enhancement would have been about 2 deg. C in winter and 4 deg. C in summer at this site. In general over the area studied from the Warrior jetty to Esso jetty the heating effect of the outfall was of the order 0.2 - 0.6 deg. C during the years 1971-1975, and this was smaller than the natural variation in temperature within sites (assessed for 5 years prior to the start-up of the Power station (Carr, 1972)). Case (1981) considered that the enhancement may be of considerable significance as the increase is a sizeable proportion of the daily variation and could therefore extend the range of southern species in the area of the Cleddau Bridge westwards.

2.2.3. Freshwater input and salinity. The catchment area is shown in Fig. 4.

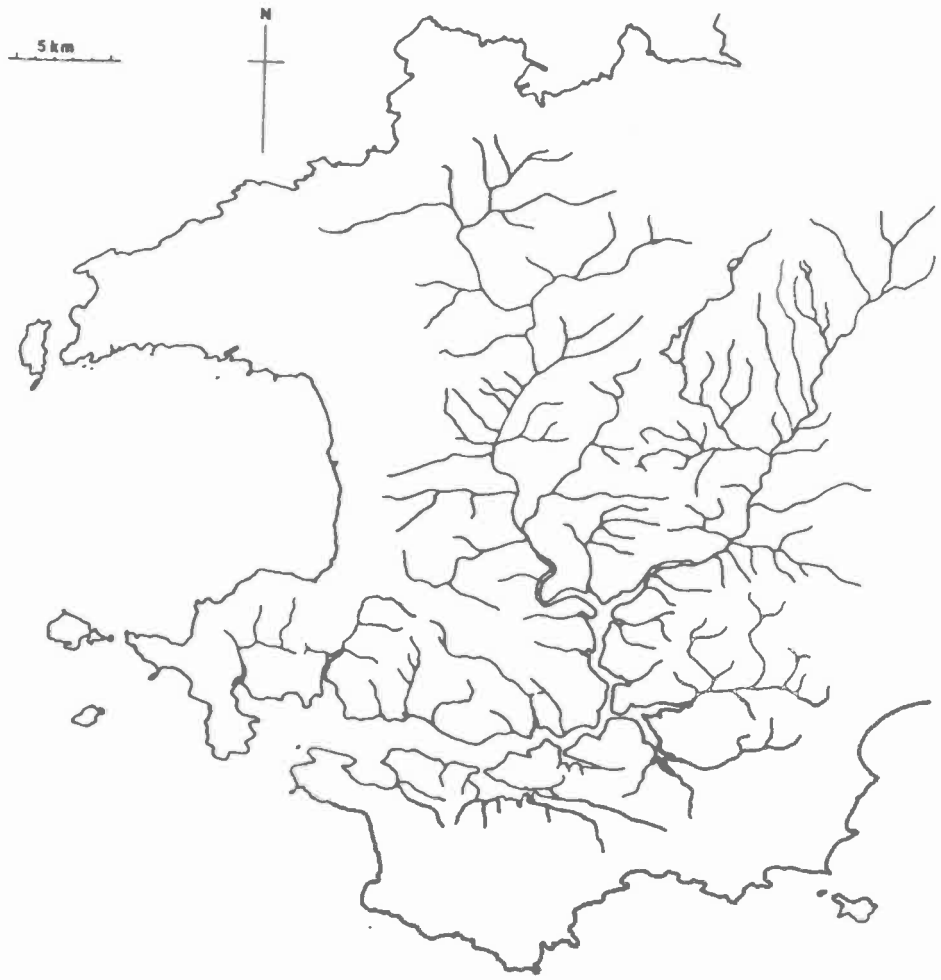

Fig. 4. The catchment area of Milford Haven.

The hydrography of the estuary including sediments has been studied by a number of scientists including representatives from the South West Wales River Authority, the Hydraulics Research Laboratory, I.C.I. Paints Division and Posford, Pavry and Partners. The resulting information is diverse and often contradictory.

The Department of Chemical Engineering at Swansea in conjunction with the Welsh National Water Development Authority (now the Welsh Water Authority) have made detailed studies of sections of the estuary in order to produce working models of pollutant distribution and transport. A highly organised procedure of recording hydrographical measurements was established by this group in the summer of 1973. This covered a period of 8 consecutive days when freshwater flow was expected to be minimal and least variable. A detailed account of the planning of the field survey and its execution is given by Forster (1974). An explanation of the methods used to present the data is given by Williams and Jolly (1975).

West (1978) has written an account of a complementary study of the river system above Landshipping undertaken in a two-week period in August 1977.

The results and conclusions deduced from the above studies were presented and summarised by Case (1981) and are outlined below.

The Eastern and Western Cleddau Rivers contribute approximately 21% of the freshwater input to Milford Haven (West, 1978). The Carew and Cresswell Rivers are 'influential' contributors, smaller inputs include the Pembroke and Gann Rivers and Sandyhaven Pill.

Williams and Jolly (1975) estimated the total freshwater input as 7.5×10^5 m^3 per day, the average amounting to 0.4% of the tidal prism of neap tides and causing appreciable dilution only in the narrower landward parts of the estuary.

Average rainfall for the Haven catchment was approximately 127 cm per annum, from average rainfall charts for 1916-1950 (Oliver, 1959).

The tidal prism has been estimated as $1.8 \times 10^8 m^3$ between the estuarine mouth (undefined) and the junction of the Cleddau Rivers at Picton Point (Nelson-Smith, 1965).

The waters of the Milford Haven inlet are essentially well mixed and fully marine for the first 16 km east of the entrance, to about Neyland, salinity rarely falling significantly below that of sea water in this area (Williams and Jolly, 1975).

The water column is less well mixed with a pronounced salt wedge developing upstream of Cosheston Pill. The maximum vertical difference in salinity occurring near Llangwm. There are great seasonal differences with the vertical salinity gradients being far more pronounced in summer when the less dense warmer fresh water tends to stay on the surface instead of mixing with the rest of the water column. The largest fluctuations in surface salinities with general mixing of fresh and sea water throughout the column occurs well above the confluence of the Eastern and Western Cleddau rivers (Case, 1981).

Upstream of Neyland the horizontal surface salinity gradient rapidly changes with distance upstream. Fig. 5 is reproduced from Nelson-Smith (1965) and shows the surface isohalines recorded during February.

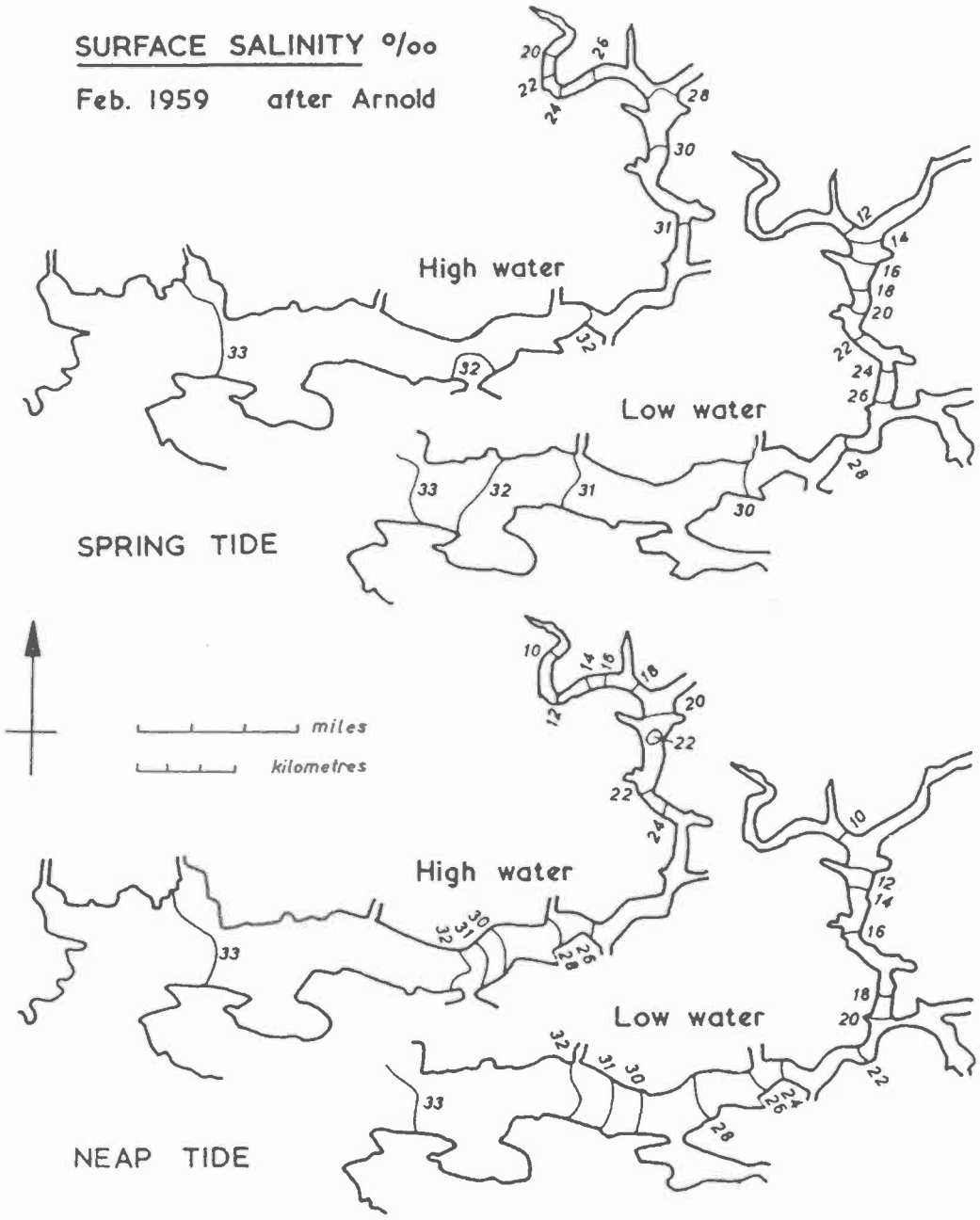

Fig. 5. Surface isohalines from Milford Haven and the Daucleddau. From Nelson-Smith (1965).

On the basis of hydrological characteristics, Nash and Collins (1982) arrived at a division of the estuary with boundaries drawn at the Cleddau Bridge and just below Llangwm, these correspond reasonably well with the boundaries between Nelson-Smith's (1965) ecological zones 2, 3 and 4 (Fig. 6).

Twice daily salinity readings are made at the Warrior site which are available for research but not for publication (B. Bateman, pers. comm.).

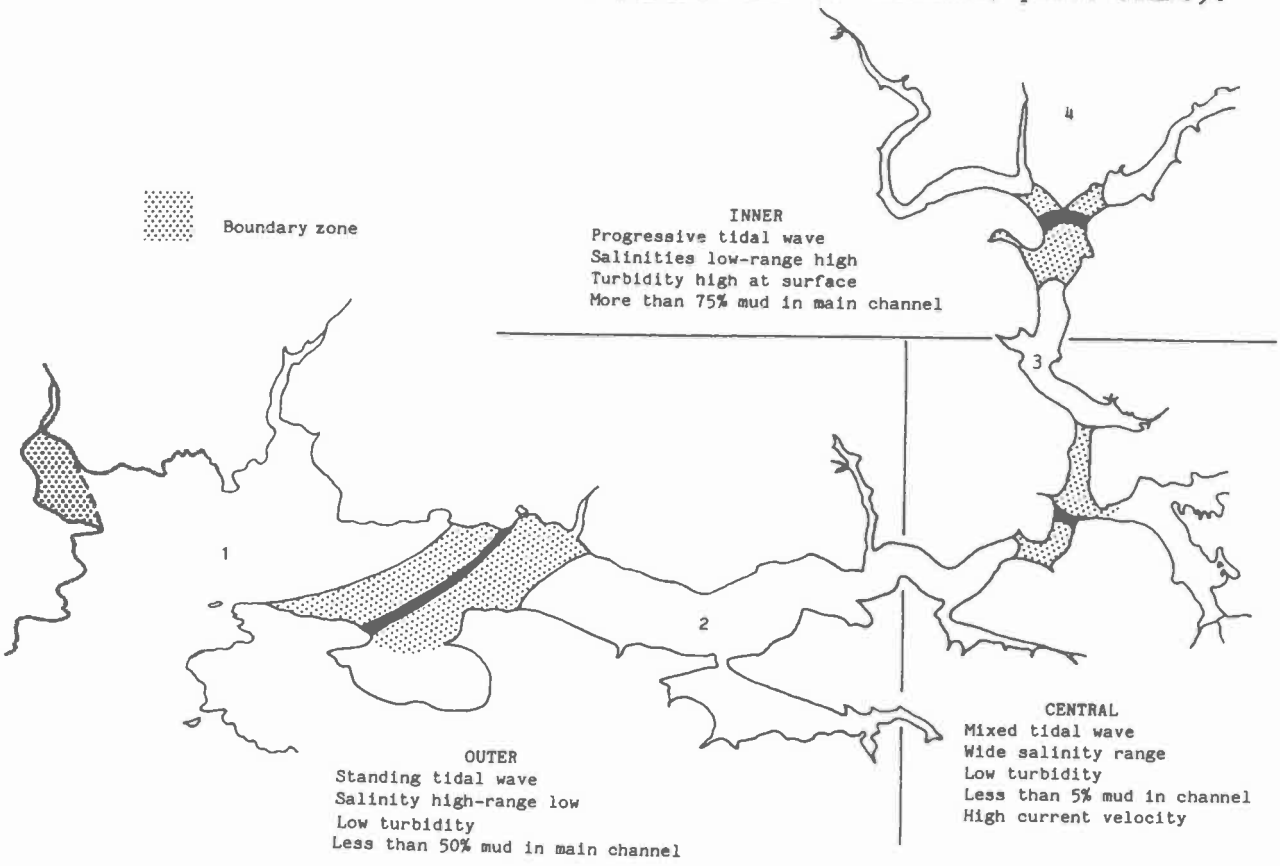

Fig. 6. Estuarine characteristics and ecological zones (after Nelson-Smith, 1965, and Nash and Collins, 1982).

2.2.4. Suspended sediment and turbidity. Levels of suspended sediment are very variable both with tidal cycle and weather conditions, but Milford Haven and the lower Daucleddau are considered low compared with other estuaries (Nash and Collins, 1982) whilst from Llangwm northwards levels are high with a maximum of 84 mg/l recorded at Picton Point corresponding to the ebb run-off from mud flats. This is compared with maximum values between Neyland and Lawrenny of 16 mg/l.

2.2.5. Tidal streams. Water movements have been studied by several groups (Posford, Pavry and Partners, 1959; Nelson-Smith, 1965; Williams, 1971; and Williams and Jolly, 1975). These and more recent measurements are discussed and reviewed by Case (1981) and summarised below.

During spring tidal cycles the currents developed within Milford Haven are everywhere moderate to strong, the maximum mid-channel currents as given on the Admiralty charts are summarised in Fig. 7.

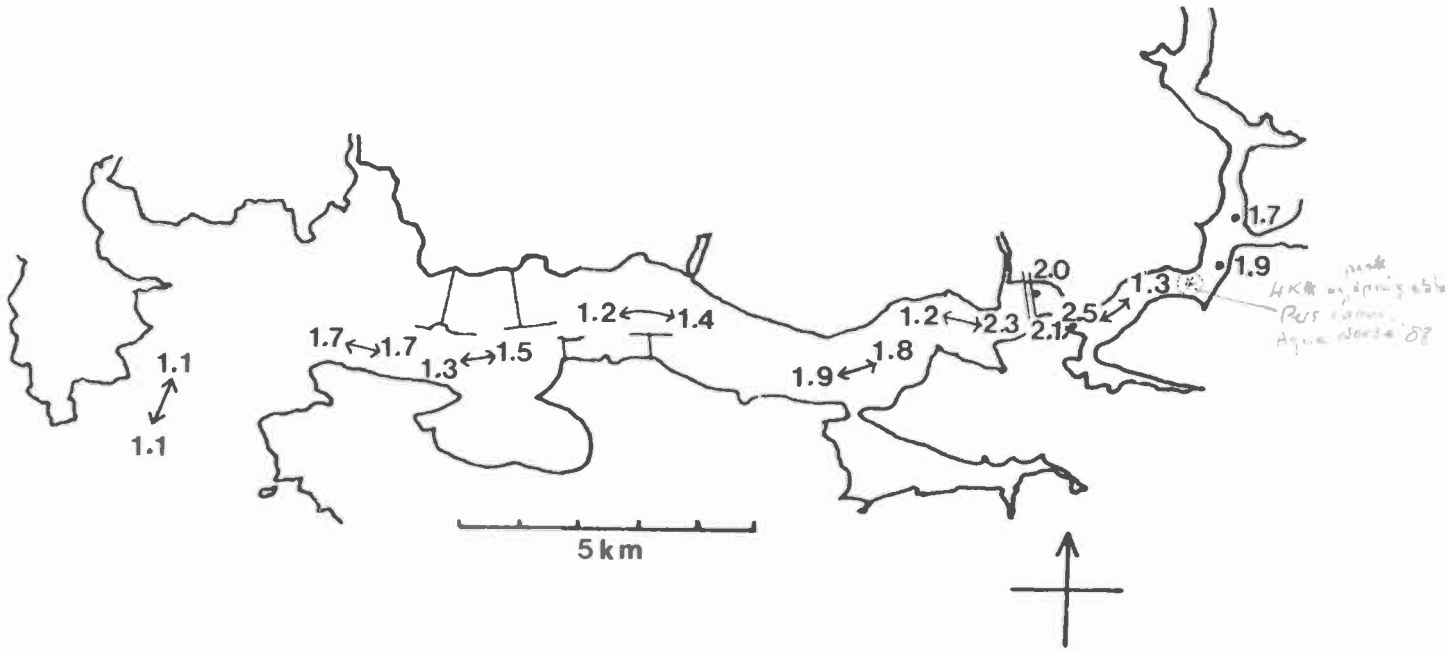

Fig. 7. Velocity of surface tidal streams (in knots) in Milford Haven. Streams run parallel to the coast. Data on spring tide velocities from Admiralty Charts 3274 and 3275 are shown with the ebb velocity first, followed by the flood velocity. Single figures (marked •) refer to maximum velocities quoted in Posford, Pavry and Partners (1959).

The strongest currents develop in the area between Hobbs Point and Burton. Close to shore, currents may be much stronger at headlands or bends, for instance at the Nato jetty, just to the east of the Cleddau Bridge, or they may be much weaker in sheltered bays and along depositional stretches and in certain cases may even run contrary to the general tidal direction where the entrances to creeks or pills cause eddies in the water movement.

Recently, Gunn and Yenigun (1985) have developed a mathematical model of tidal motion in Milford Haven from the entrance to Hobbs Point. The model suggests that strong tidal currents occur only in the main channel and follow the direction of the channel. Tidal currents are affected by wind strength and direction.

2.2.6. Exposure to wave action. The predominant oceanic swells in the area are from the southwest and so the mouth of Milford Haven is exposed to strong wave action particularly on headlands such as St. Anne's Head, Dale Point, Great Castle Head and Watch House Point. Shores of intermediate exposure predominate within Milford Haven with very sheltered shores within bays, creeks and in the lee of promontories.

Ballantine (1962) did pioneer work on the relationship between wave action and the communities that develop on rocky shores using the coast around the Dale peninsula. Moyse and Nelson-Smith (1963), Nelson-Smith (1967) and Crapp (1970) all used Ballantine's scale of exposure to assess the relative exposures of the shores they studied within the Haven. Ballantine's scale was considered inapplicable for shores east of Hazelbeach as estuarine influences

began to affect the patterns of distribution of the organisms used in the scheme. Little, A.E. (1983) attempted to assess the applicability of Ballantine's exposure scale on the same shores after a lapse of nearly two decades since Ballantine's study and suggested that long-term temporal changes in species distributions and differences in taxonomic expertise and seasonal timing of fieldwork could result in anomalous perceptions of exposure unless the scheme is applied with great care.

2.3. Substratum types

The nature of the seabed and shores have been described by the Hydraulics Research Laboratory (1958), Posford Pavry and Partners (1959) and Nelson-Smith (1965). These accounts have been summarized by Williams (1971). Considerable general information on the nature of the bottom deposits is indicated on Admiralty charts 3274 and 3275. Sediments from biological benthic surveys in 1975, 1982 and 1984 have been described for up to 135 sites in the area bounded by a line between East and West Blockhouses and a line between Hobb's Point and Llanstadwell. (Addy, 1976; Abbiss et al., 1982; Rostron et al., 1984 and Little, D.I. et al., in press). Morris (1985) has described the sediments from 30 intertidal sites from Neyland northwards into Hanton Farm and Minwear Wood on the Western and Eastern Cleddau Rivers, respectively.

Rocky or stony shores occur throughout the length of the estuary and the river cliffs along the edges of the Haven are nearly everywhere steep. At the mouth, the coastline is generally of high rocky cliffs, often with shoals, reefs and submerged rocks offshore. The entrance to the Haven is cleft by a large irregular rocky outcrop (Chapel Rocks) and there are reefs off Thorn Island, Great Castle Head and along the eastern side of the mouth (West Angle Bay to Sheep Island).

The sediment shores of the inlet cover a wide range from the wave exposed sandy beaches at Millbay (St. Anne's Head), Watwick and Lindsway to the virtually entirely muddy shores of the Pembroke River, the Carew and Cresswell Rivers and the Pills such as those at Garron, Sprinkle, Llangwm and Mill Bay. The large bays and inlets with sediments intermediate between these extremes include the Gann Flats, Sandyhaven Pill, Angle Bay and Gelliswick Bay. The Gann Flats is an area of very mixed substrate underlain by periglacial head and fluvioglacial gravels which are exposed in places. These latter contain some large boulders which increase the range of available microhabitats over much of the area. The substratum types were mapped and summarised by Bassindale and Clark (1959), though as the sediments are mobile the map will certainly be out of date. The Sandyhaven Estuary sediments have been studied and characterised by King (1977). His scheme for the identification of intertidal sediments has been modified and used (Little, D.I., 1984 and Little, D.I. et al., 1986) to produce facies maps of Angle Bay and Sandyhaven Pill. Similar maps for Carew and Cresswell Rivers, Pwllcrochan, the Gann Flats and the Pembroke River are in preparation (Little, D.I., pers. comm.)

In the central part of Milford Haven from Milford Haven town and Bullwell east to Neyland and Pembroke Dock, there are extensive fringing mud banks which are only exposed by spring tides. These overlie and are interspersed with mixed substrates of sandy mud, gravel, stones and shells.

Morris (1985) found the intertidal sediments of the Daucleddau Estuary to be predominantly medium to fine silt. Coarser sediments were described from within most of the Eastern Cleddau and at the confluence of the Carew and Cresswell rivers. He described the sediments in the channel of the Eastern

Cleddau as fine sand at the most northerly site by Minwear Wood fining down to medium silt at a site close to Picton Point, the junction of the E & W Cleddau Rivers. The Western Cleddau showed no longitudinal sedimentary gradient, the whole area accreting fine sediment, both from the main channel and from the feeder streams and river. Williams and Jolly (1975) observed that in this area north of Picton Point the shores were surrounded by low banks often with fringing saltmarsh.

The distribution of subtidal sediments of Milford Haven as far east as Pembroke Dock is shown in Fig. 8. This shows the essentially heterogeneous character of the sediments in the area. In general terms, the proportion of mud in the bottom sediments correlates well with the divisions deduced by Nelson-Smith (1965) with bottom sediments predominantly muddy (greater than 75% silt and clay) above Llangwm, scoured with very little mud (less than 5%) from Neyland to Lawrenny and with, further downstream, an intermediate situation less than 50% silt and clay (Abbiss et al., 1982).

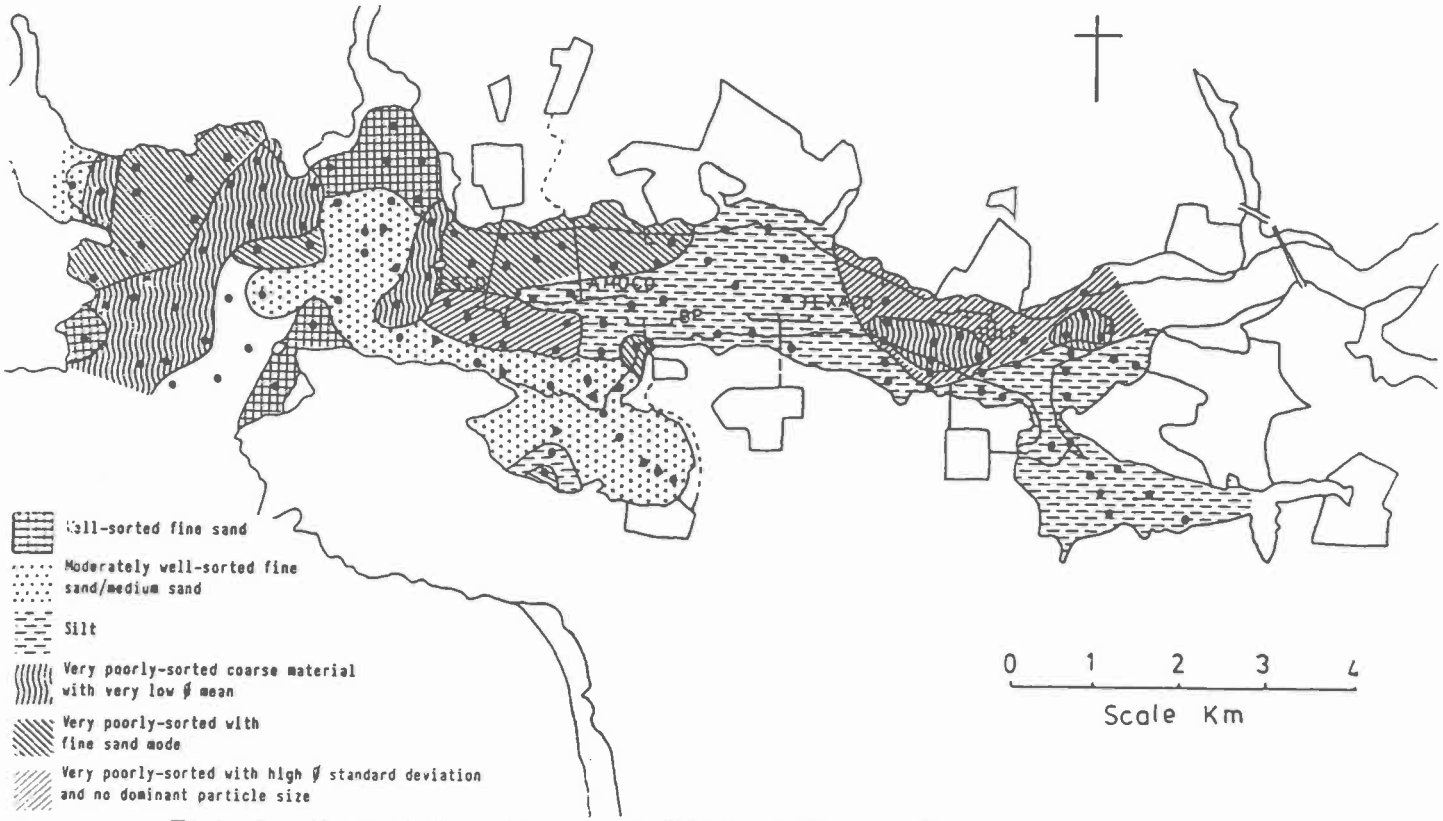

Fig. 8. Subtidal sediments in Milford Haven (from Rostron, 1982).

Throughout most of the Milford Haven and Daucleddau there are stones and shells present on the bed and wherever the current is strong the surface of the sediment appears far more coarse than it is when a sample is dug and analysed. This is because currents continuously remove the finer sediments leaving a surface littered with coarser material.

Case (1981) has confirmed the above observation in her detailed description of the surface substrata at each of 14 transects from Neyland to Black Tar. She described some small areas of soft substratum at Neyland, Pembroke Dock and Burton Cliff but at these and other sites east to Mill Bay the substrata were predominantly cobbles and pebbles with boulders, bedrock, gravel and shells. Muddy sediments were covered with scattered cobbles and

pebbles at Whalecwm and Lawrenny. In the area of Castle Reach bedrock predominated with pebbles and shells in the deeper channel. North of Garron Point to Black Tar the bed was largely soft sediment with occasional boulders and cobbles and extensive beds of Crepidula shells, both living and empty.

Little, D.I. et al. (in press) have summarised the sediment characteristics of the Milford Haven area east to the Cleddau Bridge from the benthic surveys of 1982 and 1984 (Abbiss et al., 1984). Most of the sediments were poorly sorted (that is, with a mixture of sediment sizes) though the sands in the bays close to the mouth were well-sorted. The sands in Angle Bay, Sandyhaven, Watwick and offshore at Gelliswick all had small quantities of finer material. An area to the northwest of Dale Point has the highest concentration of mud found in the estuary mouth. This area is similar to and separated by a zone of higher wave action from areas north of the Esso and Amoco jetties. These areas are characterised by moderate wave action and low current speeds.

Increasing percentage mud with distance eastwards from the mouth is illustrated in Fig. 9. The main sedimentological factor upstream appears to be current speed. Close to the Gulf jetty, current velocity in the main channel is sufficient to winnow much of the fine mud, leaving a coarse shell gravel lag deposit. Lateral gradients from the main channel were also apparent, as at Pwllcrochan, with a fine sand offshore missing from muddier intertidal sediments.

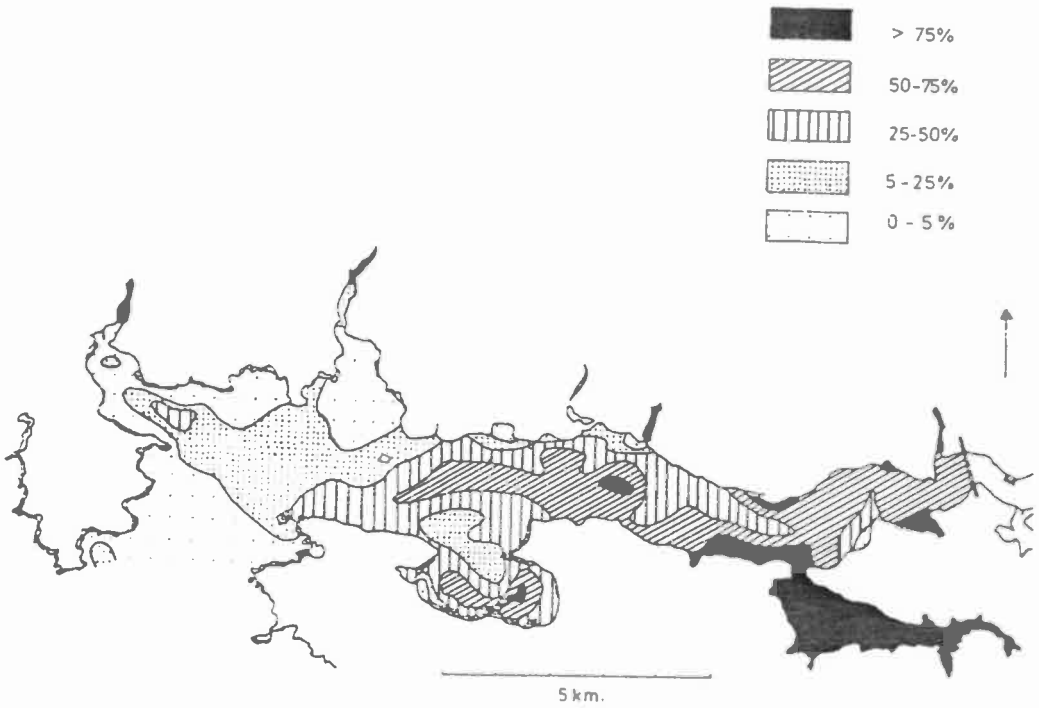

Fig. 9. Percentage mud (finer than 63 μm) in Milford Haven sediments (from Abiss et al, 1982).

3. HUMAN FACTORS

3.1. Ownership and management of the coast

Although a large part of the coastline lies within a National Park the land is largely under private ownership. The National Park is charged with 1) the preservation of the natural beauty, and 2) the promotion of its enjoyment by the public. These objectives are fulfilled through the stringent enforcement of planning regulations and the co-operation of landowners with the Park Authorities. Borders of the National Park adjacent to the area under consideration are shown in Fig. 10.

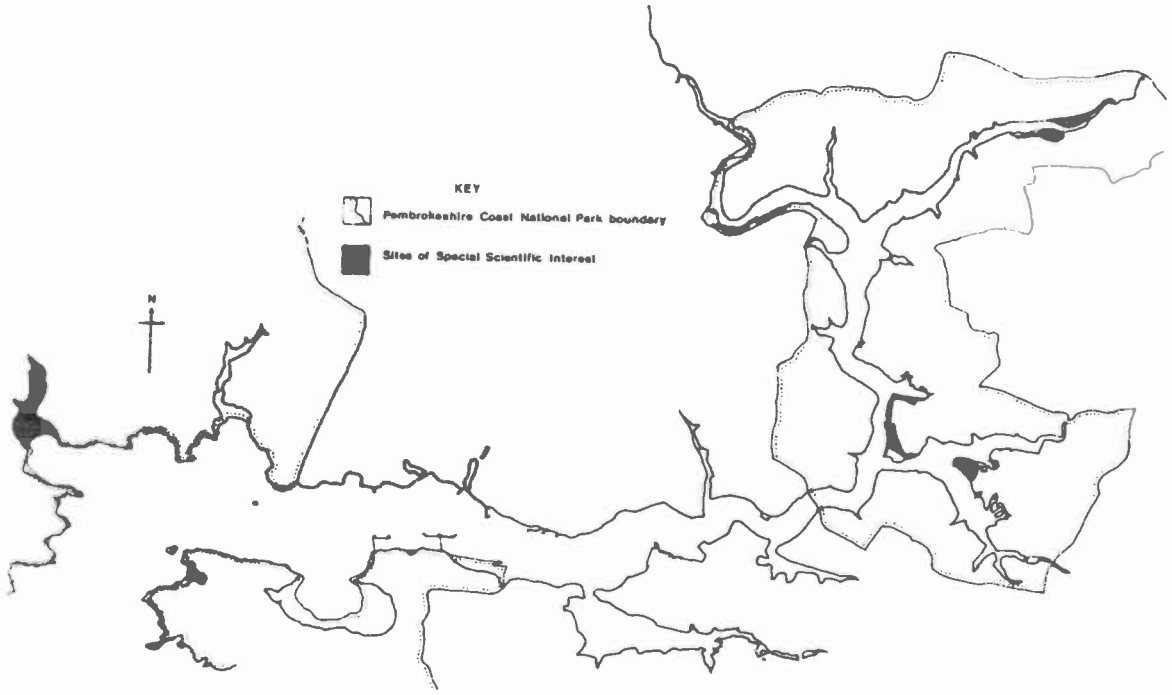

Fig. 10. Borders of the Pembrokeshire National Park and location of Sites of Special Scientific Interest.

Most of the coastline from Sandy Haven and Angle Bay in the west to the Cleddau Bridge in the east is managed by oil companies or is occupied by the ports of Milford Haven and Pembroke Dock. To the west of this central industrialised and urban area the land is used for farming, whilst to the east the shores are mainly bordered by privately owned woodland with some agricultural land.

3.2. Domestic effluents and storm drains

Williams (1971) described the effluent inputs and Williams and Jolly (1975) produced a summary table of 18 industrial and domestic effluents into Milford Haven (their Table 12) (Fig. 11).

Fig. 11. Location of effluents entering the Milford Haven and the Daucleddau (from WWRA, 1970 and correction, 1986).

West (1978) concluded that BOD load on the upper estuary was small and within the assimilation capacity of the estuary and that coliform data suggested low levels of pollution. Suspended solids were found to be variable but were relatively high in the vicinity of steep salinity gradients in both Cleddau rivers. Chlorophyll and organic suspended solids were generally low but the Haverfordwest discharge was detectable.

Since those studies a sewage treatment works has come into operation just below Haverfordwest on Merlin's Brook and a new storm drain has been built just below the tidal barrier at Pembroke. Incidents of pollution from silage liquor are infrequent in the area but are a cause of concern to the Welsh Water Authority as the numbers of silage clamps have increased with recent changes in agricultural practice.

3.3. Industry and industrial effluents

The main industry in the area is the oil industry which was largely developed during the late 1950's and 1960's. The social and economic impact of the industry is discussed by John (1976) and Slavin (1985). At the peak of refinery activity there were four refineries and an oil-fired power station operating under strict anti-pollution measures both to prevent and contain oil spills and to control the levels of oil released in their effluent. These measures and their effectiveness are discussed in Dudley (1971 b). The effluents, despite the low levels of oil contained in them (on average 10 p.p.m oil) constitute the largest input of oil into Milford Haven because of the large volumes involved. Abbiss *et al.*, (1982) estimated oil input to be 125 gallons daily from effluents alone.

Water quality has been investigated by the Welsh National Development Authority and the Department of Chemical Engineering, University of Wales, Swansea, with the long term aim of producing working mathematical models of pollution distribution and transport. Reports include Forster (1974), Williams and Jolly (1975), West (1978), and Case (1981).

Little, D.I. et al., (in press) investigated the levels of trace metals and hydrocarbons in the sediments of Milford Haven in 1978 and 1982. The results indicated that total hydrocarbon loads were predominantly anthropogenic and ranged from 1 ugg^{-1} in coarser sediments to 615 ugg^{-1} in finer sediments with some indications of a slight increase between the surveys. These concentrations are similar to other moderately polluted estuaries and harbours with fine sediments.

The data suggested that in spite of the successful management of the oil industry's effluents and shipping, some signs of both localised and general contamination of the soft sediments were appearing after twenty five years of development. This was attributed to the overwhelming importance of sedimentological factors in transporting and trapping contaminants in the estuary.

Since these studies, one refinery and the oil transhipment terminal have closed and two catalytic cracking plants have commenced operations, a reflection of the more careful use of oil reserves since the oil crisis of 1974 and the ensuing re-evaluation of the resource.

Other industries in the area are light manufacturing and service industries with one creamery at Haverfordwest.

3.4. Extraction of water.

The catchment area is shown in Fig. 4 (Section 2.2.3). The water supply for the area is abstracted from the Eastern Cleddau at Canaston Bridge at a rate of about 9 million gallons per day (m.g.d) (0.5 m^3/s) (West, 1978). Above this are two reservoirs, Rose Bush and Llys-y-fran, to regulate the flow rate in the river. There is extraction of varying amounts, up to 2.5 m.g.d (0.12 m^3/s), from the Western Cleddau at Crowhill. Flow rates are monitored on the latter at Prendergast Mill and on the Eastern Cleddau at Canaston Bridge. Water is extracted in extremely variable amounts from streams flowing into the system by farmers chiefly for the irrigation of early potato crops.

3.5. Port users

The Harbour Master's Office controls the movement of vessels to and from the Haven. The largest vessels using the port are the tankers visiting the jetties of the refineries. Marine and Port Services operate tugs and other small vessels used during mooring operations at refinery jetties. The Ministry of Defence maintains an armaments depot and jetty at Newton Noyes and a small Naval depot at Carr jetty, Pembroke dockyard. Targets used by the tank range at Castlemartin and the missle ranges at Aberporth are stored at moorings within Milford Haven as are a series of concrete barges used for storage in war time. The British and Irish ferry service to the Republic of Ireland has ceased operations from a recently constructed berth at Pembroke Dock. Celtic Sea Services operate from their jetty near Hobb's Point. Milford Haven docks, once the home of a thriving fishing fleet, is now relatively quiet with only 5 or 6 local trawlers, 2 survey vessels per week, occasional coastal tankers in for repairs and infrequent shipments of grain or

fertilizer. Small ship building and repairs are also conducted at Pembroke Dock.

A single craft makes daily pleasure cruises from Hobb's Point up to Llangwm on the Daucleddau or down river to Stack Fort.

The numerically largest group of users of the waterway are those involved in boating for leisure. There are facilities for launching at about 20 sites from Dale and Angle in the west to Llangwm and Lawrenny in the north and east. There are 6 boat parks and swinging moorings for approximately 1200 small craft between Dale, Angle, Hobb's Point, Lawrenny, Llangwm and several smaller sites.

A new marina on the site of the Great Western Railway terminus at Neyland has at present berths for 160 boats and plans to provide berths for 440 yachts by the end of 1986. The dredgings from this have been used to fill and partially dam Westfield Pill just above the bridge (OS. SR 967062). Chandlery facilities are available at Dale, Milford Haven, Burton, Neyland, Lawrenny and Pembroke Dock.

Local boats involved in spare time and seasonal fisheries include a gill-net fishery for spawning herring from early February to mid April during which an estimated minimum of 500,000 fish are landed amounting to approximately 5% of the number of spawning fish (Clarke and King, 1985).

3.6. Educational

The Field Studies Council has two field centres, at Dale and Orielton, visited by an annual total of around 4,000 studying on courses of a week's duration from March to November. Several days of field work are likely to be spent on particular sections of the coastline of Milford Haven and the Daucleddau.

The National Park offer courses of field study, particularly for juniors and also have an extensive programme of walks and talks that continue throughout the year.

Many schools, colleges and University groups organise their own visits to the area for field study and the National Park Authority has a liaison officer to assist these groups with their activities.

Many of the sites used for field studies are of high conservation interest and their regular use could result in local deterioration. This was seen by the National Park Authority (National Park Committee, 1977) to be a potential threat rather than an existing danger.

3.7. Mariculture

There are rainbow trout rearing farms at two sites at present, situated at the Warrior site east of Pembroke Ferry and just north and east of Burton Hawn. The former at present has a peak of 70,000 fish in suspended cages.

There are oyster farms at Whalecombe and West Williamston and at the mouth of Garron Pill, the latter two rearing around 4.5 million oysters on about 6 acres of trestles. Mussels are reared at one site near Lawrenny.

Recently oysters in the main channels of the Daucleddau and Carew/Creswell rivers have suffered from balling, a condition which greatly

reduces the growth of the animal while shell growth continues. It is suspected that the use of tributyl tin (T.B.T.) in antifouling paints may be wholly or partly responsible. Recent concern on the use of the extremely toxic T.B.T. has resulted in a recommendation from the Government to paint manufacturers that its use should be phased out of anti-fouling paint as soon as possible.

3.8. Established nature conservation importance

The ecological interest of the area is due to the rarity of fully saline sheltered rocky shores and subtidal areas on the western coast of Britain, and because the whole of western Britain lies on a junction between the northern or boreal-arctic and the southern or Lusitanean flora and fauna. For instance, Hiscock, S. and Maggs (1984) reported on several species of red algae which reach their northern limit within Milford Haven and the Daucleddau.

The deep water of the drowned river valley or ria provides ample scope for comparisons between those communities that tend to become established under the differing conditions of current speed, wave action and suspended sediment which are found in the virtually fully marine conditions that exist from the Cleddau Bridge to the open sea. Also there is a wide variety of substrata present within the fully saline area, giving many different habitats and allowing for the development of many types of community.

The unique nature of the area, the proximity of two field study centres and of University College Swansea have made the Haven the focus of attention for many studies, covering aspects of its climate, geology, hydrology, biology, sedimentology, industrial archaeology and historical anthropology.

The area is also bordered in part by the Pembrokeshire Coast National Park which includes most of the coastline in two separate areas (Fig. 10) (Section 3.1). The first is an inland area which includes the whole of the Eastern Cleddau, the east bank of the Western Cleddau from Hanton Farm (SH 972140) to Black Hill (SM 970128), then both banks of the Western Cleddau, Carew and Cresswell Rivers, and the Daucleddau down to the bend west of Millbay (SM 992-4 050-3). The second covers the open coast on either side of Milford Haven and extends along the internal coastline to Littlewick Bay on the north side (SM 875053) and to the stream crossing Pwllcrochan Flats at Martinshaven (SM 923036). Boundary changes are proposed which will affect some of the above (Pembrokeshire Coast National Park, 1986).

There are many areas considered to be of special scientific interest either bordering or including intertidal stretches of the Milford Haven and Daucleddau system. The status of these sites is in a state of flux as they are at present under review by the Nature Conservancy Council (NCC). Up to the end of November 1985, renotifications for six of the twelve originally designated or newly proposed Sites of Special Scientific Interest had been processed by the NCC as required under the 1981 Wildlife and Countryside Act. These are described in Table 1 and are shown in Fig. 10. Some of the sites are of geological as well as biological interest.

The steep slopes bordering the Daucleddau and Eastern and Western Cleddau rivers support remnants of ancient sessile oak woodland with SSSI's at Minwear Wood, Hook and Lawrenny Wood. Within these are many now unusual and rare species. The lichen communities of the latter site alone include 140 epiphytic and 66 saxicolous lichen species.

TABLE 1 Sites of Special Scientific Interest and local nature reserves in the Milford Haven and the Daucleddau.

Site names	Status of SSSI				National Grid Reference	Site Area (ha)	Date of notification	Intertidal included	Habitats included	WWTNC local nature
	Notified under Sect. 23 National Parks and Access to Countryside Act 1949	Listed as at 1 Jan 1949	Renotified under 1981 Act	Proposed or awaiting action						
Crabhall Saltings (renamed & enlarged - Gann Estuary)	/	/	/	-	SM812070	5 & 45	1954 extension	/	1,2,3,4,5 6,7,10,12	-
Dale Point	/	/	-	Possible reductn.	SM823052	17	1954	/	5,6,13	-
Hook Wood	/	-	/	-	SM979117	3	1954	-	?	-
West Angle Bay	-	/	-	/	SM850033	29	-	-	4,6,10,13	-
Minwear Wood	-	-	Renotified 1985	-	SN042138	13.8	1985	-	?	-
Slebech Reed	-	-	Renotified 1985	/	SN053142	16.2	1985	/	?	-
Lawrenny Wood	-	-	/	-	SN010069	36.4	-	-	?	-
Daucleddau	-	-	-	/	SM985045 -SN003115	?	-	/	?	-
Carew Cresswell	-	-	-	/	1:25000 sheet SN00/10	?	-	/	?	-
Pembroke River	-	-	-	/	SM80/90	?	-	/	?	-
Angle Bay	-	-	-	/	SM80/90	?	-	/	?	-
Limestone Cliffs Pembroke Castle	-	-	-	/	SM982016	?	-	?	?	-
Brunt Hill	-	-	-	-	SM817073	?	-	-	-	/
West Williamston	-	-	/	-	SN026060	19.1	/	/	-	/
Upper Mill Pond Pembroke	-	-	-	-	SM996016	?	-	EHWST	-	/
Old Mill Grounds Haverfordwest	-	-	-	-	SM953161	?	-	?	-	/

The sheltered complex of disused quarries, creeks and ungrazed saltmarsh, on the carboniferous limestone promontory at West Williamston, has a wide range of habitats supporting an exceptional variety of species with over 230 higher plants, a large number of which are scarce species.

The Gann Estuary is an extremely diverse small estuary with a wide intertidal foreshore supporting a varied invertebrate fauna in and on the heterogeneous mosaic of bedrock, shingle, sand and mud. The 30 hectares of saltmarsh here are the most diverse in Milford Haven with numerous rare saltmarsh plants. The extraction of sand and gravel from the fluvio glacial moraine deposits behind the Pickle ridge, used for airfield building in World War II, left an area of brackish lagoon which has the highest diversity of plants in the area with 130 of the 200 species recorded from there. A wide variety of wading birds feed and roost in the Gann Estuary in autumn and winter.

Although the sand and mud flats and salt marshes of Milford Haven and the Daucleddau are small compared with those of other estuaries in Britain, they nevertheless support internationally important numbers of shelduck and teal over-wintering amongst the many creeks and inlets.

Of great conservation interest are the seabird colonies of Skokholm, Skomer and Grassholm, together a National Nature Reserve, the first two being situated within 20 km of the mouth of Milford Haven, and therefore potentially vulnerable to pollution incidents resulting from the oil port's activities.

4. PREVIOUS STUDIES

4.1. Introduction

A large number of studies have been undertaken of the biology of Milford Haven and the Daucleddau estuary. These are briefly discussed here, listed in Table 2 and full abstracts are given in the Harbours, Rias and Estuaries Information File.

4.2. Rocky intertidal. Many surveys on the distribution and abundance of rocky intertidal organisms within Milford Haven and its environs have been conducted and are recorded in Evans (1949), Moyse and Nelson-Smith (1963) and Nelson-Smith (1964, 1965 and 1967). Moyse and Nelson-Smith's studies were largely based on the results obtained from the examination of discontinuous belt transects located at 30 sites throughout the area augmented by presence/absence data from subsidiary sites to facilitate the mapping of species distributions.

Crapp (1971b) resurveyed twenty-two of the original thirty transects established by Moyse and Nelson-Smith. More restricted surveys were carried out by the Field Studies Council in the following ten years. In 1979 and 1982 twenty-one transects were resurveyed. Results of these studies and of follow-up work after oiling incidents have been reported by Blackman et al. (1973), Baker (1976a), Dicks and Hartley (1982), Little, A.E. (1983), Woodman et al. (1983) and Woodman and Little, A.E. (1985). The studies have indicated that there was no general deterioration in the rocky shore communities throughout the period from 1960 - 1982. It was felt that the extensive tidal flushing and the policy of preventing the beaching of any spilled oil may have resulted in diverting the effects of oil pollution away from the rocky shore communities. Localised effects attributed to chronic oil pollution were

identified and summarised by Woodman and Little, A.E. (1985). Little, A.E. (1985, 1986) has conducted a 12 month trial of autecological studies on 6 taxa at three sites in Milford Haven.

Crothers (1970) studied the distribution of crabs on rocky shores around Dale. Williams (1959) wrote an ecological account of the algae in the vicinity of St. Anne's Head. The CEGB have conducted rocky shore surveys concentrating on the immediate vicinity of the cooling water outfall at Pwllcrochan, (J. Coughlan in Jarman and de Turville, 1977).

4.3. Sediment intertidal. Intertidal sediment sites from the western part of Milford Haven were described by Crapp, Withers and Sullivan (1971). They recorded the macrofauna along transects between tidemarks at Lindsway Bay, West Angle Bay, Mun Sands, the east shore of Angle Bay and West Llanion Pill. They also reported that well established beds of Nereis virens were exploited by bait diggers at Hakin Point, Wear Point and Llanreath, and that cockles were collected from Angle Bay, whilst lugworms and razorfish were both collected from many sites including Angle Bay and Dale Beach.

Thirty one sites from Neyland to Uzmaston on the western Cleddau and Minwear on the eastern Cleddau, were examined by Morris (1985). The sites were surveyed to determine the distribution and composition of the macrofaunal communities in the sediments, the physical characteristics of the sediments and the distribution within the sediments of trace metals and aliphatic and aromatic hydrocarbons.

Bassindale and Clarke (1960) described aspects of the ecology of the muddy beach at the Gann Flats, Dale. This rich area has been the subject of a survey over five years (Rainbow and Campbell, unpublished data). Preliminary results suggest that there have been great changes in the faunal communities of this area. It is probable that though sediments of the area would appear to be those of a soft shore such as would be expected to be accreting sediment, the sediments are being eroded over much of the area, thus favouring a different fauna.

The CEGB has conducted biological shore surveys since 1968 in the area close to the cooling water outfall of the power station at Pwllcrochan. Spencer (1975) reported that they could not detect any changes in the biota of the area due to the warming action of the cooling water plume (Milford Haven Monitoring Committee, minutes of the 14th Meeting, 1975).

A study of the die-back of Spartina anglica was reported by Baker et al (1984).

4.4. Rocky subtidal. Early faunistic records of hard sub-tidal substrata along transects across the Daucleddau were made by divers using SCUBA (Self-Contained Underwater Breathing Apparatus). These were reported in Bailey et al (1967) and Knight-Jones and Nelson-Smith (1976).

During 1978 and 1979 about thirty sites were surveyed to describe the habitats observed and to record the composition of the macrofloral and faunal communities as part of the Southwest Britain Sublittoral Survey for the Nature Conservancy Council. The findings were briefly summarised in Hiscock, K. (1981). The detailed results of those surveys are included as Appendix I of this report.

Seventeen sites from Neyland to Black Tar were the object of detailed qualitative transect surveys following slight modifications of the methods of Bailey et al. (1967) and Knight-Jones and Nelson-Smith (1976). This work is described in Case (1981) and is discussed in Nelson-Smith and Case (1984).

4.5. Sediment subtidal. Crothers (1969) has described the distribution of crabs during the summer in the shallow water of Dale Roads from 1964 to 1966.

Work for the Institute of Petroleum has included three surveys on the distribution of benthic macrofauna in Milford Haven. These were carried out in 1974-1975, reported by Addy (1976 and 1979) and in 1982 and 1984 reported in Rostron (1983) and (1985) respectively. The sites surveyed, of which there were up to 135, were within the area from East and West Blockhouse to Llanstadwell, the latter survey concentrating on the area around the oil company jetties and Pembroke River.

The communities around the jetties showed signs of disturbance and were thought to be unstable (Rostron, 1985). Pembroke River was thought to have maintained a reasonably high diversity of taxa in comparison with other estuarine areas in the British Isles (Rostron, 1985).

4.6. Fish and fisheries. Studies of the spawning grounds and associated fishery, for herring, Clupea harengus, have been described by Nelson-Smith (1964b), Clarke (1984) and Clarke and King (1985). They found the grounds to be extensive and to occur from the area near Pembroke Dock to Beggars Reach, and considered the current fishery unlikely to be a serious threat to the fish stocks.

Historically the oyster fishery was important in Milford Haven but stocks had declined by the beginning of this century, Walton (1914). Studies have been concluded on the state of shellfish stocks and on pilot studies for reintroduction and culture by Wright (1923) and Cole (1951 and 1953). Studies on pollution effects, competitors and parasites have been undertaken by Cole and Baird (1953), Gregory (1973), Harwood (1981) and the Tidal Waters Unit of the Welsh Water Authority (1982 and 1984).

4.7. Studies on effects of oil pollution. Many reports and papers have been written on the effects of oil pollution on the biota of Milford Haven. The earliest (George, 1961) dates from the beginning of the oil industry interest in the area. Moyse and Nelson-Smith (1963, 1965) and Nelson-Smith (1964a, 1967) used a semi-quantitative interrupted belt transect technique to survey the shore of Milford Haven and also made qualitative notes on subsidiary sites in order to describe the distribution of conspicuous rocky shore species and provide a basic account of the shore ecology against which subsequent surveys could be compared.

Crapp's monitoring programme for the Haven (1970a) included 22 of the sites described by Moyse and Nelson-Smith and also included studies of the effects of effluent discharge at Wear Point and in Littlewick Bay on the adjacent shore communities. These latter sites continued to be studied by subsequent workers (Baker, 1972, 1973 and 1976b; Addy, 1978; Petpiroon and Dicks, 1982). The Littlewick Bay effluent, from a refinery which ceased to operate in 1983, had an effect which maintained atypical shore communities within about 200 m on either side of the effluent outfall. Subsequent observations are being made documenting the gradual recovery of the shore

communities. The Wear Point effluent had no observable effect on shore life (Petpiroon, 1982).

The effect of refinery effluents on the intertidal flora and fauna on jetty piles has been discussed by Pugh (1980) and Roblin (1983a and b), in conjunction with the above work, three years' study on the effects of the refinery effluent on the sublittoral flora and fauna of jetty piles in Milford Haven were reported in Hiscock and Cartlidge (1980), Hiscock et al. (1981) and Hiscock et al (1982).

The effects of oil pollution and cleaning on the ecology of saltmarshes were discussed by Cowell (1969), Cowell and Baker (1969) and Baker (1971a and b).

The effects of individual oil spills on the rocky shore life of Milford Haven were reported by Crapp (1970a), Ottway (1971) and Blackman et al, (1973). The effects of these incidents have always , thus far, been confined to localised areas and their frequency has been such that it would be difficult to find examples of polluted rocky shores from the effects of oil spills or their cleaning in Milford Haven.

4.8. Field experiments. Many field experiments involving the study of the effects of treatments of oil and dispersants on the communities of various habitats have been and continue to be conducted by members of the Oil Pollution Research Unit.

The habitats included in these experiments have ranged from soft sediment shores dominated by lugworms (Crapp et al., 1971 and Levell, 1972 and 1976), eel grass (Baker et al., 1984) and saltmarsh vegetation (Baker, 1971b, c and e and 1984) through to rocky shores of all degrees of wave exposure (Thomas et al., 1983).

4.9. Reference Works. The largest reference work up to October 1980 on studies of the natural history of the area is A Natural History Bibliography of Pembrokeshire by Comont (1980), but the sublittoral zone section of this is incomplete, and for large runs of field notes (see, e.g. Nature in Wales) no details are given.

The Dale Fort Marine Fauna, 2nd edition (Crothers, 1966) was produced largely from the collections and records kept at Dale Fort. However, since the supporting specimens have been lost, the value of the work is diminished. Currently, the zoologists of the National Museum of Wales, Cardiff, are undertaking a study to provide validation of the species records. It is, however, a fund of useful information, particularly on the historical distribution of bait and commercial species.

The references of Walton (1914) and Cole (1955) provided much of the information quoted on the fisheries.

TABLE 2

Summary of published marine biological studies in the region of Milford Haven and the Daucleddau.

Author	Date of Publication	Area	Notes
		ROCKY INTERTIDAL	
Algae			
Burrows et al.	1957	District around Dale Fort	List of marine algae.
Hiscock, S. and Maggs	1984	Pembrokeshire including Milford Haven	Distribution and ecology of unusual species of marine algae in S.W. Britain.
Jones and Williams	1966	District around Dale	List distribution maps and observations.
Thomas	1953	SW Pembrokeshire	List of marine algae.
Williams	1959	District around St. Ann's Head	Ecology of marine algae (MSc Thesis).
Lichens			
Ferry	1971	District around Dale Peninsula	List and distribution notes on lichens.
Ferry and Sheard	1969	Dale Peninsula	Distribution of supra-littoral lichens and key.
Wade	1960	Dale Peninsula	List and notes.
Animals			
Crisp, Moyse and Nelson-Smith	1964	Pembrokeshire including Milford Haven	Affects of severe winter on marine life in Britain. Species distributions and abundance changes after winter 1962-3.
Crothers	1970	Dale Peninsula	Distribution of crabs.
Crothers	1973	Pembrokeshire	Shell morphology in populations of Nucella lapillus.

Author	Date of Publication	Area	Notes
Animals (Cont.)			
Crothers	1974	Pembrokeshire	Variation in shell morphology populations of Nucella lapillus.
Little, A.E.	1985	Milford Haven	Seasonal studies on selected shore organisms (pilot study).
Little, A., Dicks, and Crothers	1986	Milford Haven	
Naylor and Haatela	1966	Milford Haven and Daucleddau	Habitat preferences and interspersion of species within the super species Jaera albifrons.
Nelson-Smith and Gee	1966	Milford Haven and Daucleddau	Serpulid tubeworms, their distribution (includes aids to identification and descriptions).
General shore ecology			
Bailey	1978	Milford Haven and Daucleddau	Field course investigation fauna and flora distribution.
Ballantine	1961	Dale Peninsula	Descriptions of the shore communities found under different conditions of wave exposure. Also a biologically-defined exposure scale for the comparative description of rocky shores.
Evans	1949	South Pembrokeshire	General intertidal ecology.
Nelson-Smith and Case	1984	Milford Haven and Daucleddau	Includes aspects of shore ecology.

Author	Date of Publication	Area	Notes
General shore ecology (Cont). **Research Fellowship, University College, Swansea to enable studies of the marine ecology of Milford Haven prior to industrial development**			
Arnold	1959	Milford Haven	Report.
Moyse and Nelson-Smith	1963	Dale Peninsula and vicinity	Distribution of littoral plants and animals (1961-63).*
Nelson-Smith	1964a	Milford Haven and Daucleddau	Aspects of the marine ecology, a major account. PhD Thesis.
Nelson-Smith	1965	Milford Haven and Daucleddau	Physical description of the estuary.
Nelson-Smith	1967	Milford Haven and Daucleddau	Distribution of littoral plants and animals (1961-63).
Continuation of the above studies during industrialisation			
Crapp	1970a 1971b	Milford Haven and Daucleddau	Distribution of littoral plants and animals (1968-70).* PhD Thesis.
Little, A.E.	1983	Milford Haven and Daucleddau	Distribution of littoral plants and animals (1972-79).*
Woodman, Little, A.E and Dicks	1983	Milford Haven and Daucleddau	Distribution of littoral plants and animals (1982).*
Woodman, Little, A.E.	1985	Milford Haven and Daucleddau	Distribution of littoral plants and animals (1982).*

* These studies based on the surveying of transects. From 1976 onwards these were permanently marked.

Author	Date of Publication	Area	Notes
		SEDIMENT INTERTIDAL	
Bailey	1978	Rivers Syfynwy and Eastern Cleddau, estuarine sites. Blackpool Mill and Landshipping Quay.	Studies of fauna and flora of the river from source to estuary. Comprehensive list of macroinvertebrates (1969-?1974).
Baker, Wilson and Levell	1984a	Milford Haven from mouth of Carew-Cresswell	Mapping of Spartina dieback (1983).
Burd	1986	Great Britain including Milford Haven	NCC Saltmarsh Review
Bassindale and Clarke	1960	Gann Flat	Studies on the ecology of a muddy beach mapping of sediments and macrofauna (1957-59).
Charman	Unpublished	Milford Haven	Detailed maps of salt-marsh vegetation and site cards for NCC Saltmarsh Review Sept/Oct 1982.
Crapp, Withers and Sullivan	1971	Milford Haven Lindsway Bay - West Llanion Pill	Studies on ecology of sandy and muddy beaches 1968-1970.
Crothers	1969	Dale Roads	Distribution of crabs in Dale Roads in summer.
Coughlan	1969	Pwllcrochan	A preliminary species list.
Dalby	1970	Milford Haven	Saltmarshes - a distribution of flora.
Edington, Morgan and Morgan	1973	Gann Flat and Gann River estuary	Feeding patterns of wading birds.
Levell	1972	West Angle Bay and other sedi-ment shores	Mentions 2 monthly survey of permanent transect and existence of species list for other shores.
Morris	1985	Daucleddau and E & W Cleddau rivers	Benthic fauna and physico/chemical analysis of sediment (1984) at 30 sites.

Author	Date of Publication	Area	Notes
Rostron	1983	Milford Haven from E & W Blockhouses to Llanreath	Benthic fauna and physico/chemical analysis of sediment (1982) at 34 intertidal sites.
Rostron	1985	Milford Haven from Stack Fort to Milford Haven Conservancy Board Jetty and Pembroke River	Benthic fauna and physico/chemical analysis of sediment (1984) at 27 intertidal sites.
Rostron et al.	(in press)	(As above two surveys)	Ecology of the benthic fauna related to physico/chemical parameters.
Wilkinson	1980	Milford Haven	A review of estuarine benthic algae and their environment.
		ROCKY SUBTIDAL	
Bailey et al.	1967	Daucleddau	Some methods for transect, across steep rocks and channels.
Knight-Jones and Nelson-Smith	1976	Daucleddau	Ecology of hard substrates using above techniques.
Case	1981	Daucleddau	Extension of above work (PhD Thesis).
Nelson-Smith and Case	1984	Daucleddau	Summary of above work.
Hiscock, K.	1981	SW Britain including Milford Haven and Daucleddau	Summary of the communities on hard substrates within context of the whole of SW Britain.
Hiscock, S. and Maggs	1984	SW Britain including Milford Haven and Daucleddau	Summary of interesting algal distributions throughout SW Britain.
Hunnam, P. and Brown, G	1975	Pembrokeshire including Milford Haven	Distribution of nudibranchs.
Ryland	1960	Milford Haven	Notes on fouling Polyzoa.

Author	Date of Publication	Area	Notes
		SEDIMENT SUBTIDAL	
Surveys of the benthic macrofauna and sediment characteristics for the Institute of Petroleum			
Addy	1976	Milford Haven	1) 1974-5.
Addy	1979	Milford Haven	An examination of the above study and others in relation to oil industry activity. (PhD Thesis).
Rostron	1983	Milford Haven	2) An extensive survey of 135 subtidal and intertidal soft sediment sites from the mouth to Llanstadwell (1982).
Rostron	1985	Milford Haven and Pembroke River	3) Concentrated on the area around the oil company jetties and in Pembroke River.
Rostron, Little, D. and Howells	(in press)	Milford Haven	A summary of the above surveys with hydrocarbon and heavy metal analysis of sediments.
Hartley	1981	Milford Haven	Organic carbon and macrofaunal vertical zonation in sediments.
		FISH AND FISHERIES	
Clarke	1984	Milford Haven and Daucleddau	The Milford Haven herring stock; studies on early spring spawning movements.
Clarke and King	1985	Milford Haven and Daucleddau	The Milford Haven herring stock; studies on early spring spawning movements including maps of spawning.grounds
Cole	1951	Milford Haven and Daucleddau	The British oyster industry and its problems.

Author	Date of Publication	Area	Notes
Cole	1953	Milford Haven and Daucleddau	Report on the possibility of reviving oyster culture in Milford Haven.
Cole and Baird	1973	Milford Haven and Daucleddau	The American slipper limpet Crepidula fornicata in Milford Haven.
Gregory	1973	Milford Haven and Daucleddau	An investigation of the trace metal concentrations in shellfish from the S. Wales coastline. (Undergraduate Thesis).
Harwood	1981	Milford Haven and Daucleddau	Viral contamination of shellfish and shellfish harvesting waters - Preliminary report.
Nelson-Smith	1964b	Milford Haven and Daucleddau	Herring in Milford Haven.
Nicholls	1961	Daucleddau	Compass netsmen of Llangwm.
Tidal Waters Unit	1982	Severn, Swansea Bay, Milford Haven, Menai Straits	Review of biology and bioaccumulation studies.
Tidal Waters Unit	1984	Daucleddau	River Cleddau fish kill, August 1983. An appraisal by predictive modelling.
Walton	1914	Milford Haven	A preliminary survey of the shell fisheries.
Wright	1923	Milford Haven	Report on a preliminary survey of the natural oyster beds in the S. Wales district with suggestions towards their improvement.

Author	Date of Publication	Area	Notes
		EFFECTS OF OIL SPILLS AND CLEAN-UP	
Baker	1971a	Milford Haven inc. Pembroke River	Effects of oil pollution and cleaning on the ecology of saltmarshes (PhD Thesis).
Baker	1971b	Milford Haven inc. Pembroke River	Seasonal effects of oil pollution on saltmarsh vegetation.
Baker	1971c*	Milford Haven inc. Pembroke River	The effects of a single oil spillage.
Baker	1971d*	Milford Haven inc. Pembroke River	Seasonal effects of oil pollution on saltmarsh vegetation.
Baker	1971e*	Milford Haven inc. Pembroke River	Effects of cleaning of saltmarsh.
Baker	1976a	Milford Haven	Ecological changes in Milford Haven during its history as an oil port.
Blackman et al.	1973	Mouth of Milford Haven. Musselwick East to South Hook Point	The 'Dona Marika' oil spill (1973).
Coughlan and Spencer	1967	Milford Haven	Effects of oil spillages on ecological survey.
Crapp	1970 a&b	Milford Haven	The biological effects of marine oil pollution and shore cleansing.
Crapp	1971a*	Milford Haven	The biological consequences of emulsifier cleansing.
Crapp	1971c*	Milford Haven	Chronic oil pollution.
Cowell	1969	Pembrokeshire and Cornwall	Effects of oil pollution on saltmarsh communities in Pembrokeshire and Cornwall.
Cowell and Baker	1969	Milford Haven	Recovery of a saltmarsh from pollution by crude oil.
Cowell (ed.)	1971	Milford Haven and other areas	Symposium proceedings includes above work. *

Author	Date of Publication	Area	Notes
George	1961	Milford Haven	Oil pollution of marine organisms (1960).
Nelson-Smith	1968a	Milford Haven	The effects of oil pollution and emulsifier cleansing on marine life in SW Britain.
Nelson-Smith	1968b	Milford Haven and Cornwall	Biological consequences of oil pollution and shore cleansing spills in 1960, 62 and 67.
Nelson-Smith (ed.)	1972	Milford Haven	Review of oil pollution and ecology.
Ottway	1971	Milford Haven	The 'Thuntank 6' oil spill.
Thomas, Baker and Hall	1983	Britain and Eire including Milford Haven	Observations on the natural cleaning of experimentally oiled rocky shores of different exposure to wave action.
Wilson, Baker and Oldham	1984	Milford Haven	Long term effects of heavy fuel oil on a saltmarsh at Martin's Haven, Milford Haven.
		EFFECTS OF REFINERY EFFLUENTS	
Addy	1978	Littlewick Bay	Biological and hydrographic survey of Littlewick Bay Milford Haven June 1977.
Archer-Thompson	1979	Littlewick Bay	The effects of refinery effluent on the invertebrate intertidal fauna and flora (MSc Thesis).
Baker	1972	Milford Haven	3 effluents examined for effects on shores.
Baker	1973	Milford Haven	Biological effects of refinery effluents review paper.
Baker	1976b	Milford Haven	Biological effects of refinery effluents review paper.

Author	Date of Publication	Area	Notes
Crapp	1970a	Milford Haven	Includes chapters on the shore communities in the vicinity of two refinery effluents
Crapp	1971c*	Milford Haven	Chronic oil pollution effects including the input from effluents.
Cowell (ed.)	1971	Milford Haven	Symposium proceeding includes above paper. *
Hiscock, K. and Cartlidge	1980	Milford Haven	Effects on refinery effluents on the sub-littoral fauna and flora of jetty piles.
Hiscock, Cartlidge and Little, A.E.	1981	Milford Haven	Effects of refinery effluents on the sub-littoral fauna and flora of jetty piles June and Nov. 1980.
Hiscock, Rostron (Cartlidge) and Little, A.E.	1982	Milford Haven	Effects of refinery effluents on the sub-littoral fauna and flora of jetty piles June and Nov. 1981.
Iball and Crump	1982	Littlewick Bay	The use for teaching purposes of a rocky shore receiving industrial effluent.
Petpiroon, Dicks and Iball	1982	Littlewick Bay	Environmental effects (1969-1981) of a refinery effluent.
Petpiroon	1982	Littlewick Bay and Wear Point	Biological effects of coastal oil refinery effluents (including 3 in Milford Haven) (PhD Thesis).
Pugh	1980	Milford Haven	Effects of refinery effluents on the inter-tidal fauna and flora of jetty piles 1980.
Reynard	1973	Milford Haven	Reproductive potential of limpets near a refinery effluent.

Author	Date of Publication	Area	Notes
Roblin	1983a	Milford Haven	Intertidal surveillance of jetty piles.
Roblin	1983b	Milford Haven	Intertidal surveillance of jetty piles.
		OILING EXPERIMENTS	
Abbiss et al.	1981	Sandyhaven Pill Milford Haven	Fate and effects of dispersant treated crude oil compared with untreated oil in sheltered intertidal sediments.
Baker	1971b, c & e	Spartina marshes in Milford Haven	Effects of oils and of emulsifiers, burning and cutting for clean-up of saltmarshes.
Baker et al.	1984b	SW Britain inc. Milford Haven	Fate and effects of dispersant treated crude oil compared with untreated oil in sheltered intertidal sediments in a variety of intertidal habitats throughout southwest Britain.
Crapp, Withers and Sullivan	1971	West Angle Bay	Lugworm (Arenicola marina) beds sprayed with dispersant BP1002.
Little, D.I. et al.	1981	Sandyhaven Pill	Fate and effects of dispersant treated crude oil compared with untreated oil in sheltered intertidal sediments in a variety of intertidal habitats throughout southwest Britain.
Levell	1972	Sandyhaven Pill	The effect of Kuwait crude oil and the dispersant BP1100X on the lugworm.
Levell	1976	Sandyhaven Pill	The effect of Kuwait crude oil and the dispersant BP1100X on the lugworm.

Author	Date of Publication	Area	Notes
Thomas, Baker and Hall	1983	Britain and Eire inc. Milford Haven	Observation on the natural cleaning of experimentally oiled rocky shores of different exposure to wave action.
		GENERAL AND MISCELLANEOUS	
Crothers	1966	South Pembroke-shire including Milford Haven and the Daucleddau	Marine fauna: includes distribution notes. Reference collections of specimens absent.
Barrett	1959	Area around Dale and Skokholm	Bird records.
Comont	1980	Pembrokeshire inc. Milford Haven	A natural history bibliography: marine section incomplete.
Coughlan	1969	Milford Haven	The occurrence of the immigrant ascidian Styela clava.
Gabriel plankton.	1974	Milford Haven	A report on the
Gabriel et al.	1975	Milford Haven	Temporal changes in plankton of an indus-trialised estuary.
Nelson-Smith	1977	British estuaries inc. Milford Haven	Review of biology and physical character.
Oliver	1959	Dale Peninsula	The climate (1921-1958).
Oliver	1960	Dale Peninsula	Wind and vegetation (1921-1958).

5. SURVEY AIMS AND METHODS

5.1. Introduction

The aims of the 1985 field survey were:

1. To collect further information on the habitats present and on the abundance of species in those habitats at sites where little or no previous work had been carried out, in areas of known or likely nature conservation importance, or where rare or unusual species might be present.

2. To collect photographs of the habitats, communities and species present.

5.2. Intertidal survey methods

5.2.1. Introduction. Survey methods for both intertidal rocky shores and subtidal hard substrata were based on techniques already developed for use in NCC surveys. Techniques new to surveys being undertaken for NCC by FSC had to be developed for intertidal and subtidal sediment sampling. Checklists were used throughout to ensure recording to a consistent style and, for species abundance data, in a form ready for recording on computer files. Examples of recording sheets are not included in this volume of the report but are held in Volume 3.

In the Milford Haven survey we planned to fill in the gaps in our knowledge of the area gained from studies undertaken for the Institute of Petroleum (IP) (Little, A.E., 1983 and Westwood et al., 1983) and for the Nature Conservancy Council during the Southwest Britain Survey, Hiscock, K. (1981).

5.2.2. Epibiota of rocky and sediment shores. At each site selected for survey, the team determined the sort of work which would be carried out. On some shores this was a systematic description of the abundance of species in the main habitats/communities present at different heights on the open shore. Records were also made from habitats such as overhangs, gullies, rockpools and under boulders. Recording from the lower shore and in unusual habitats took precedence over recording on the open shore for most of the sites in Milford Haven as good records for the main open shore communities at more than 20 sites are available from the 1979 and 1982 surveys carried out for the IP.

Using tidal height predictions made for half hour intervals through the day, the height of sea level above chart datum was established and a cross staff used to level the shore at each 0.5 m interval so that a record could be made of the height of the main zones. The botanist and zoologist decided on the location of each of the distinctly different habitats to be surveyed, which normally included the lower shore (LS), lower midshore (LMS), midshore (MS), upper midshore (UMS), upper shore (US) and splash zone (Spl) as well as the other habitats. The quantity of each species was recorded according to the appropriate abundance scale (Appendix 2). Specimens were collected where necessary for identification. Sketches of the site location and site profile, or of any other important features, were prepared and photographs of the shore and of species present were taken from various angles. Data was later transferred to the NCC Rocky Shore Recording Sheet, a habitat description sheet and plant and animal recording sheets.

5.2.3. Infauna of sediment shores. In this survey only two sediment shores were examined as a large number of sites in the area have recently been included in detailed infaunal surveys. They are reported in Rostron (1983 and 1985) and Morris (1985).

At each site selected, the shore habitats present were recorded on the NCC Sediment Shore Recording Sheet. The abundance of species visible at the surface was noted. Since the majority of species present were infaunal, sampling was necessary. A general dig for large or widely dispersed species was accompanied by the sieving of a 15 cm x 0.1 m^2 sample, using a 1 mm mesh sieve, from each of the visibly differentiated sediment types found. These samples were examined in the laboratory. No samples were taken for sedimentological analysis.

The samples taken from each roughly assessed sediment type are noted below:

West of Musselwick East (3)

Fine sand around Extreme Low Water of Spring Tides (ELWST) with no clear anoxic boundary	General examination
Fine sand around ELWST	1 x 0.1 m^2 through 1 mm mesh
Fine sand around ELWST with a layer of rounded pebbles at around 5 cm depth with some clay	1 x 0.1 m^2 through 1 mm mesh
Pebbles and sandy sediment amongst boulders and cobbles	General examination and 1 x 0.1 m^2 through 1 mm mesh
Stony patch, lower midshore (LMS)	General examination

Pwllcrochan Flats (6)

Shingle spit, lower shore (LS)	General examination
Muddy sand overlying a layer of grey clay and shell gravel at around ELWST	General examination and 1 x 0.1 m^2 through 1 mm mesh
Sandy mud and shell gravel at around ELWST	1 x 0.1 m^2 through 1 mm mesh

5.3. Subtidal survey methods

5.3.1. Epibiota of subtidal rock and sediments. Subtidal areas were surveyed from deep to shallow water or offshore to onshore with some spot dives. A drift dive was undertaken at one location. The team leader determined the separate habitats from which records were to be made as they were encountered on the seabed. At each survey station, the habitat type was described and abundance of conspicuous species was recorded according to the

scales given in Appendix 2. Photographs were taken to illustrate habitats, communities and species using Nikonos underwater cameras equipped with wide angle, close-up or standard lenses and with high or low power flash guns as appropriate. Specimens were collected where necessary for species identification. Site location information, substratum type, topographical features and other habitat details were recorded on the Sublittoral Habitat Recording Sheet. Species data were recorded on the plant and animal checklists.

Sites in the exposed mouth of the Milford Haven were inaccessible during the fieldwork period due to adverse weather conditions.

Sediment samples collected by pipe dredge were examined for the epibiota on larger material.

5.3.2. Infauna of subtidal sediments. Staff of the National Museum of Wales collected sediment samples during dives at 5 sites for qualitative examination of the macro infauna. These samples were sieved in the field, fixed, preserved and retained by them for the identification of the molluscs and annelids.

Dredging was undertaken from the MV 'Jolise'. A pipe dredge 1 m long by 25 cm diameter, constructed of 5 mm steel, was used to collect sediment from each sample site. Sites selected in the mouth of Milford Haven were inaccessible due to sea and weather conditions. Sites were chosen to augment the extensive programme described by Rostron (1983 and 1985).

Each dredge sample, of variable volume from around 10 to 30 litres, was emptied into a skip. Notes were made on the nature of the sediment and any conspicuous species. Coarse material was removed on a 5 mm mesh sieve and samples of surface epibiota were either noted and thrown back or retained. The material was then washed over a 1 mm mesh. The samples were transferred to sealed containers and fixed in formalin with the vital stain eosin. These were returned to OPRU for sorting. Molluscs and annelids were forwarded to the National Museum of Wales, Cardiff, for identification. No samples were taken for granulometric analysis.

5.4. Data analysis and presentation

5.4.1. Abundance of conspicuous species. Records of the abundance of conspicuous species in separate habitats at each site were entered into the data management program described by Hobbs (1985). Print-out from these files has enabled a clear view of the distribution and habitat preferences of each species. Inspection of site records has been used to identify the different habitats and communities encountered during survey and to classify them. The abundance of species in examples of those habitats has been tabulated directly from field records with addition of any laboratory identifications.

5.4.2. Sediment samples. Intertidal specimens were identified in the field or returned alive to the laboratory for identification. Preserved sediment samples were further washed over a 1 mm mesh sieve to remove formalin and remaining fine sediment. The samples were each spread out in a white tray, covered with water, and biological material extracted.

The dredge samples were sorted and molluscs and annelids were sent to the National Museum of Wales where they were identified. Specimens from other phyla await identification.

6. SURVEY RESULTS

6.1. Introduction

The location of sites surveyed is listed in Table 3 and illustrated in Fig. 1 (Section 1). Fourteen intertidal and eighteen subtidal sites were surveyed and sampled in 1985. A further seven sites were sampled with a pipe dredge.

A summary of the distribution of species from the 1985 surveys is given in Volume 2 of this report and field data are copied in Volume 3. Specimens are held by the Oil Pollution Research Unit and the National Museum of Wales, Cardiff. Data on the annelids and molluscs from the pipe dredge samples are given in Appendix 3.

The most remarkable feature of the Milford Haven and Daucleddau inlet is the extent of both intertidal and subtidal hard substrata which enables the description of species distribution in relation to a range of other environmental variables which vary from open coast to the confluence of the Eastern and Western Cleddau rivers. The presentation of results emphasises these features.

The main results of surveys in 1978, 1979, 1982 and 1985 are summarised in Sections 6.2 and Table 4 in terms of the distribution of conspicuous species in relation to their occurrence within Milford Haven and the Daucleddau. Table 5 shows the abundance of conspicuous species at a steeply sloping site at Burton Cliff and is representative of some of the most scientifically interesting communities present in the area.

Descriptions of particularly characteristic or unusual habitats and community types are included in Sections 6.3. and 6.4.

6.2. Species distributions

The distribution of widely occurring conspicuous species has been summarised in Table 4. The table was compiled from the records of all OPRU hard substrate surveys including rocky shore transect studies in 1979 and 1982, the Southwest Britain Sublittoral Survey in 1978 and 1979 and the 1985 Harbours, Rias and Estuaries survey. Incidental records by S. Hiscock and A. E. Little have also been incorporated. The notes against each species also refer to the records of Moyse and Nelson-Smith (1963), Nelson-Smith (1967) and the Dale Fort Marine Fauna (Crothers, 1966). The left hand column of the table includes those species for which there were records at three or more sites, or where the species was at least frequent at two sites. The right hand column, included for completeness, comprises species recorded at only one site or infrequently from two sites.

TABLE 3 Sites surveyed in 1985 and survey staff

Site No.	Site name	Date Surveyed	Ordnance survey Grid Ref.	Initials of Survey staff
	INTERTIDAL SURVEY			
1	West Blockhouse	14.10.85	SM818035	DR, AEL
2	East Blockhouse	14.10.85	SM843030	KH, SW
3	West of Musselwick East Sandflats	14.10.85	SM816065-818064	SW, DR
4	Musselwick East	14.10.85	SM824062	AEL, KH
5	Wear Spit	15.10.85	SM939043-941043	AEL, KH
6	Pwllcrochan	15.10.85	SM920034-922041	SW, DR
7	Pennar Gut	15.10.85	SM943030	SW, DR
8	South of Garron Pill	15.10.85	SN009075	DR, SW
9	Cosheston Folly (yellow cable marker)	16.10.85	SM993050	AEL, KH
10	East of Jenkins Point	16.10.85	SN009060	AEL, KH
11	Mouth of Garron Pill	16.10.85	SN009079	DR, KH, AEL
12	Eastwood Farm (opp. Hook)	16.10.85	SM991102	AEL, KH
13	Woodhouse, Landshipping	16.10.85	SN004004	DR, SW
14	Picton Point	16.10.85	SN003117	AEL, KH
	SUBTIDAL SURVEY			
1	Dockyard Bank (deep)	15.07.85	SM963042	KH,SH,DR,AEL
2	Dockyard Bank (west)	15.07.85	SM956043-958042	SH, KH
3	West of Carr Spit	15.07.85	SM954041	AEL, DR
4	Lawrenny Park	16.07.85	SN009066	AEL, DR
5	Off Williamston Pill	16.07.85	SN005061-007063	SH, KH
6	East Lawrenny Creek	16.07.85	SN016061	AEL, DR
7	West of Lawrenny Creek	16.07.85	SN008061-012060	KH, SH
8	Burton Cliff	17.07.85	SM989050	KH, SH
9	Knap Farm	17.07.85	SM999099	AEL, DR
10(1)	Target Trot	17.07.85	SM990047-991048	KH, SH
10(2)	Target Trot	17.07.85	SM989048	DR, AEL
11	Dale Shelf 1	18.07.85	SM824058	SH, KH
12	Dale Shelf 2	18.07.85	SM828056	KH, SH
13	Castlebeach Bay	18.07.85	SM823050	AEL, DR
14	NE. of Stack Rock	18.07.85	SM866053-872052	SH, DR
15	E. of Wear Point	19.07.85	SM941042-941043	AEL, DR
16	W. of Martello Tower (Llanreath)	19.07.85	SM949035	KH, SH
17	Power Station outfall	19.07.85	SM930038	AM, AT
18	N. Pennar Gut	19.07.85	SM911030-942029	KH, SH

Sites at which sediment samples were taken for analysis at the National Museum of Wales

(AM = A. Mackie, AT = A. Trew)

Site No.	Site name	Date Surveyed	Ordnance survey Grid Ref.	Initials of Survey staff
5(S)	Mid Channel S. of Castle Rocks	16.07.85	SN007065	AM, AT
6(S)	E. Lawrenny Creek	16.05.85	SN016061	AM, AT
10(S)	Target Trot	17.07.85	SM989048	AM, AT
19(S)	Off Sam's Wood	17.07.85	SN002093	AM, AT
16(S)	NW. of Martello Tower (Llanreath)	10.07.85	SM951038	AM, AT
17(S)	Power Station outfall	19.07.85	SM930038	AM, AT

Sites at which pipe dredge samples were taken on 18.07.85 for analysis at the National Museum of Wales and OPRU

Site No.	Dredge Samples	Ordnance Survey Grid Ref.
20	D1	SM827061
21	D2	SM832059
22	D3	SM853060
23	D4	SM859064
24	D5 & D6	SM867051
25	D7	SM865059

Table 4

The distribution of conspicuous species in relation to their occurrence in Milford Haven and the Daucleddau.

Mouth. Refers to sites from Stack Rock Fort and Chapel Bay westwards to West Blockhouse and East Blockhouse intertidally and to Chapel Rocks and the North side of Sheep Island subtidally.

Middle reaches. Refers to sites from Jenkins Point to Gelliswick Bay and Angle Bay. The Cann flats are also included in this group.

Upper reaches. Refers to sites from Lawrenny Ferry northwards. Intertidal sites extend to East Wood Farm in the Western Cleddau, Picton Point and Landshipping to the east. Subtidal sites extend north to Picton Point.

Species recorded only from mouth

Widely distributed species

Species name	Notes
Gelidium pusillum	Subtidally
Scinaia forcellata	
Scinaia turgida	
Naccaria wiggii	
Bonnemaisonia asparagoides	
Schmitzia hiscockiana	
Plocamium cartilagineum	
Schottera nicaeensis	
Lithothamnium corallioides	
Mesophyllum lichenoides	
Phymatolithon calcareum	
Schmitziella endophloea	
Callophyllis laciniata	
Kallymenia reniformis	
Meredithia microphylla	
Lomentaria orcadensis	
Callithamnion sepositum	
Callithamnion tetragonum	
Ceramium shuttleworthianum	
Halurus equisetifolius	
Sphondylothamnion multifidum	
Drachiella spectabilis	
Membranoptera alata	
Myriogramme heterocarpum	
Myriogramme sp.	
Phycodrys rubens	
Radicilingua thysanorhizans	

Species recorded at one site or infrequently from one or two sites

Species name	Notes
Entophysalis sp. = Dermocarpa sp.	
Gelidiella sp.	On maerl
Gymnogongrus devoniensis	West of Esso jetty (1978)
Porphyrodiscus simulans	On maerl
Grateloupia dichotoma	
Gloiosiphonia capillaris	
Rhodophysema elegans	
Gastroclonium ovatum	
Rhodymenia delicatula	
Rhodymenia pseudopalmata (Spiky)	
Rhodymenia holmesii	
Ceramium ciliatum	
Ceramium flabelligerum	
Ceramium strictum	
Spermothamnion repens	
Spermothamnion irregular	
Apoglossum ruscifolium	Subtidally
Polysiphonia elongata	
Polysiphonia ?foetidissima	
Pterosiphonia parasitica	
Goniotrichum alsidii	
Erythrotrichia carnea	
Porphyropsis coccinea	
Pseudolithoderma extensum	Crusts not identified from most sites
Zanardinia prototypus	No records since 1979
Sphacelaria sp.	

Table 4. (con't.)

Widely distributed species

Species name	Notes
Pterosiphonia thuyoides	
Ralfsia sp.	Records not systematic
Arthrocladia villosa	
Desmarestia viridis	
Sporochnus pedunculatus	
Chorda filum	Sheltered bays
Alaria esculenta	
Halopteris filicina	
Dictyopteris membranacea	
Taonia atomaria	
Himanthalia elongata	
Cystoseira tamariscifolia	
Halidrys siliquosa	
Chaetomorpha spp.	Specimens not identified further
Bryopsis hypnoides	
Haliphysema tumanowiczii	
Leucosolenia coriacea	
Myxilla incrustans	
Myxilla rosacea	
Corymorpha nutans	
Aglaophenia pluma	Intertidally
Alcyonium digitatum	
Caryophyllia smithii	
Corynactis viridis	
Balanus perforatus	
Idotea granulosa	Sheltered mouth
Gammarus locusta	Sheltered mouth Records not systematic ?Freshwater influence
Goneplax rhomboides	
Crisiidae indet.	
Crisia denticulata	
Chartella papyracea/ ?Securiflustra securifrons	
Cellaria sp.	
Scrupocellaria reptans	
Bugula turbinata	

Species recorded at one site or infrequently from one or two sites

Species name	Notes
Chaetomorpha capillaris	Records incomplete specimens await identification
Chaetomorpha linum	Records incomplete specimens await identification
Cladophora hutchinsiae	Records incomplete specimens await identification
Cladophora pygmaea	Records incomplete specimens await identification
Cladophora rupestris	Records incomplete specimens await identification
Berkeleya rutilans	
Leuconia barbata	Intertidal - sheltered
Polymastia boletiformis	Recorded from the only deep open water site surveyed
Axinella infundibuliformis	
Diphasia attenuata	
Aglaophenia pluma	
Isozoanthus sulcatus	
Notomastus latericeus	Shelter
Phyllodoce mucosa	Shelter
Nereidae indet.	
Nephtys sp.	Shelter
Hydroides norvegica	
Spirorbis tridentatus	
Verruca stroemia	
Balanus balanus	
Pyrogoma anglicum	
Hyas araneus	
Patella aspersa	
Patella depressa	
Acmaea virginea	
Nassarius incrassatus	
Faceline sp.	
Lichenopora sp.	
Pentapora foliacea	
Luidia ciliaris	

Table 4. (con't.)

Widely distributed species		Species recorded at one site or infrequently from one or two sites	
Species name	Notes	Species name	Notes
Asterina gibbosa			
Henricia oculata			
Marthasterias glacialis			
Echinus esculentus			
Cucumaria spp.			
Pycnoclavella aurilucens			
Aplidium punctum			
Distomus variolosus			
Blennius pholis			
	Species recorded predominantly from the mouth		
Gelidium latifolium	Mouth and Cosheston Folly		
Calliblepharis jubata	Unusual in surveys		
Rhodophyllis divaricata	Large plants restricted to mouth. Smaller plants up to Target Trot		
Phyllophora crispa			
Corallina sp.	Mouth and Cosheston		
Grateloupia filicina var filicina	Mouth and Jenkins Point		
Lomentaria articulata	Mouth and Pennar Gut		
Rhodomenia pseudopalmata	Mouth and S. Garron Pill		
Plumaria elegans	Intertidal shade in mouth and Wear Point		
Acrosorium uncinatum	Subtidally in mouth intertidally at Cosheston Folly and Jenkins Point		
Delessaria sanguinea	Mouth, Target Trot and Jenkins Point		
Heterosiphonia plumosa			
Polysiphonia urceolata			
Porphyra spp.			
Algae indet. (brown and red encrusting)	Subtidally in mouth and Wear Point		
Asperococcus sp.			
Desmarestia aculeata			
Desmarestia ligulata			
Laminaria hyperborea	Records incomplete possibly east to Cosheston Folly		

Table 4. (con't.)

Widely distributed species

Species name	Notes
Saccorhiza polyschides	East to Pennar Point
Cladostephus spongiosus	East to Bullwell
Dictyota dichotoma	Mouth and Target Trot
Pachymatisma johnstonia	Mouth and Dockyard bank
Suberites carnosus	Mouth and Carr Spit
Cliona celata (massive form)	
Haliclona oculata	Throughout area but more common in mouth
Eudendrium ramosum	
Eulalia viridis	Open coast to Bullwell (1982)
Onthamalus montagui	Open coast to Hazelbeach and Llanreath (1982)
Onthamalus stellata	Open coast to Hazelbeach and Bullwell (1982)
Patina pellucida	Mouth and Lawrenny
Littorina neritoides	Mouth to Horseshoe and Bullwell (1982)
Polycera spp.	
Umbonula littoralis	
Ascidia mentula	Sheltered mouth sites and middle reaches

Species recorded at one site or infrequently from one or two sites

Species name	Notes

Species recorded only from middle reaches

Gymnogongrus griffithsiae	Probably genuinely rare. Several isolated records	Peysonnelia dubyi	Crusts not systematically identified
Gigartina teedii	Near Point to ?Jenkins Point	Antithamnion plumula Var. crispum	
Apoglossum ruscifolium	Intertidal (known from open coast)	Seirospora seirosperma	
		Polysiphonia ?nigra	
Rhodomela confervoides	Intertidal (known from open coast)	Haliclona simulans	
		Mycale macilenta	
Raspailia hispida	Dockyard bank to S. Garron Pill	Microciona atrasanguinea	
Halichondria ?bowerbankii		Clava multicornis	?under recorded (not identified in IP surveys)
Diadumene cincta	Llanreath to Target Trot		
Sagartia elegans mineata		Abietinaria abietina	
Sagartia elegans nivea		Lineus longissimus	
Polymnia nebulosa		Cirriformia tentaculata	
Palaemon serratus	Intertidally	Sabella penicillus	
Macropodia rostrata		Protula tubularia	
		Galathea strigosa	Pellcrochan
		Inachus phalangium	

Table 4. (con't.)

Widely distributed species

Species name	Notes
Turritella communis	
Nassarius reticulatus	
Vesicularia spinosa	
Schizoporella linearis	Cosheston Trot and Burton Cliff
Psammechinus miliaris	
Taurulus bubalis	

Species recorded at one site or infrequently from one or two sites

Species name	Notes
Diodora aperta	
Tricolia pullus	
Eubranchus tricolor	
Aeolidia papillosa	Can be found on open coast locally
Chlamys opercularis	
Bugula plumosa	
Alcyonidium hirsutum	
Asterias rubens	
Ciona intestinalis	
Polycarpa sp.	
Polycarpa rustica	Carr Spit
Cryptosula pallasiana	

Species recorded predominantly from middle reaches.

Solieria chordalis	North of Stack Fort then abundant at Wear Point and in the mouth of Pennar Gut
Polyides rotundus	Castle Reach and amongst pebbles in middle reaches (known to be common on open coast in sand filled tide pools
Gracilaria verrucosa	Up to mouth of Garron Pill most commonly on shells and pebbles in areas with muddy sediment (also found on open coasts)
Gymnogongrus crenulatus	Sheltered bays in mouth, middle reach including Gann flats
Gigartina acicularis	Sheltered bays in the mouth, middle reach to Jenkins Point
Holmsella pachyderma	As host Gracilaria verrucosa
Griffithsia corallinoides	
Griffithsia devoniensis	Intertidally, Rare in mouth and present at Knap Farm
Laurencia hybrida	Sheltered mouth sites and middle reaches up to Jenkins Point
Polysiphonia spp.	
Suberites domuncula	
Polymastia mamillaris	

Table 4. (con't.)

Widely distributed species

Species name	Notes
Stelligera stuposa	Middle reach, Castle Beach and Lawrenny Wood
Hymeniacidon perleve	Predominantly from dockyard bank to Lawrenny
Dysidea fragilis	Occasionally in mouth and up to Lawrenny Wood
Anemonia viridis	
Sagartia troglodytes	
Cereus pedunculatus	
Actinothoe sphyrodeta	
Prostheceraeus vittatus	Most common in middle reaches, recorded from Dale Point to Lawrenny Wood
Polydora spp.	Intertidally where limestone, stable shells or thick "Lithothamnion" encrusted pools occur
Paguridae indet.	Most common in the middle reaches found up to south of Garron Pill
Cancer pagurus	Most common in the middle reaches but occurring from sheltered mouth to Jenkins Point
Calathea squamifera	From sheltered mouth to Pennar Gut and Wear Point
Inachus/Macropodia spp.	
Ocenebra erinacea	
Mytilus edulis	Present throughout and known to occur in abundance on open coast shores but in Milford Haven most common on muddy shingle or mud flats in middle reaches. Pwllcrochan to Cosheston Folly and in tributary estuaries. Records from East Wood Farm. NB: Mytilus galloprovincialis not separated
Ostrea edulis	Middle reaches up to Garron Pill
Alcyonidium gelatinosum = A. polyoum	Sheltered mouth to Picton Point
Bowerbankia sp.	From 'off Lawrenny' to Dale Roads
Antedon bifida	Dockyard bank to Wear Spit and Pennar areas only
Diplosoma listerianum	Dockyard Bank to Lawrenny Wood
Ciona intestinalis	

Species recorded at one site or infrequently from one or two sites

Species name	Notes

Table 4. (con't.)

Widely distributed species		Species recorded at one site or infrequently from one or two sites	
Species name	Notes	Species name	Notes
Species recorded only in upper reaches (from Lawrenny Ferry Northwards)			
		Pedicellina cernua	S. of Garron Pill large amounts
		Spirularia spirularia	
		Sagartia elegans venusta	Lawrenny wood only (elsewhere open coast)
Species recorded predominantly in Upper Reaches			
Tubularia indivisa	1978-9 Picton Point, Beggars Reach and Chapel Rocks. 1985 Lawrenny Wood and Burton Cliff	Bostrychia scorpioides	
Sertularia argentea	Knap Farm to Wear Point		
Crepidula fornicata	Landshipping to Wear Point		
Bowerbankia imbricata	From Cosheston to Landshipping		
Anguilla anguilla	From Jenkins Point upstream		
Species recorded in Middle Reaches and Mouth			
Gelidium pusillum	Intertidally from Lawrenny to all but most exposed sites in mouth		
Halarachnion ligulatum	Mouth and current swept cobbles in middle reaches		
Calliblepharis ciliata			
Ahnfeltia plicata			
Phyllophora traillii			
Stenogramme interrupta	Mouth and current swept cobbles in middle reaches		
Phymatolithon polymorphum	Mouth and Wear Spit ?other sites		
Dumontia contorta	Little recorded in 1985 but intertidally found in middle reaches and sheltered mouth sites (1979 and 1982)		
Palmaria palmata	Intertidal up to South of Garron Pill where shore rocks steep		
Cordylecladia erecta	Under recorded		
Ceramium rubrum (agg.)	Subtidally from mouth to Target Trot		

Table 4. (con't.)

Widely distributed species		Species recorded at one site or infrequently from one or two sites	
Species name	Notes	Species name	Notes
Griffithsia flosculosa	Sheltered mouth and middle reaches to Beggars Reach 1978-9 and to Jenkins Point 1985		
Acrosorium reptans	Mouth and current swept sites in middle reaches		
Mitophyllum punctatum	Intertidally sheltered bays. Subtidally from exposed coast and current swept areas in middle reaches		
Brongniartella byssoides			
Chondria dasyphylla	Exposed mouth to Jenkins Point		
Rhodomela confervoides	Subtidally		
Algae indet. (brown and red encr.)	Intertidally		
Scytosiphon lomentaria	In rock pools middle reaches and mouth		
Laminaria saccharina	East to Jenkins Point		
Axinellidae indet.			
Hymeniacidon perleve	East to Jenkins Point		
Amphilectus fucorum	Sheltered mouth to Cosheston		
Hemimycale columella			
Ophlitaspongia seriata	East to Pennar Mouth		
Hydractinia echinata	East to Llanreath		
Halecium spp.			
Sertularella polyzonias	Sheltered mouth to ?Lawrenny		
Plumularia setacea	Sheltered mouth to Jenkins Point		
Nemertesia antennina	East to Burton Cliff		
Nemertesia ramosa	East to Burton Cliff		
Sarcodictyon roseum	East to Burton Cliff		
Cerianthus lloydii	East to Carr Spit		
Harmothoe impar	Sheltered mouth to Cosheston		
Lanice conchilega	Under recorded from mouth to mouth of Garron Pill		
Bispira volutacornis			
Filograna implexa/Salmacina dysteri			
Spirorbinidae on Gigartina/Chondrus	Common at most easterly record, Pembroke Ferry		
Spriorbinidae on "Lithothamnion"	Sheltered mouth to Cosheston		

Table 4. (con't.)

Widely distributed species

Species name	Notes
Chthamalus montagui	1982 to Llanreath and Hazelbeach
Palaemon serratus	East to Burton Cliff
Porcellana platycheles	Sheltered mouth to Jenkins Point
Pisidea longicornis	Sheltered mouth to Cosheston
Liocarcinus puber	East to Pembroke Ferry
Gibbula umbilicalis	Sheltered mouth to Cosheston
Monodonta lineata	1985 easterly limit Pwllcrochan, in 1982 found at 6 sites east to Lawrenny
Littorina neglecta	1982 exposed mouth east to Hazelbeach and Pembroke Ferry
Calyptraea chinensis	from off Lawrenny to Littlewick
Crepidula fornicata	From Sprinkle Pill to Pwllcrochan may have extended range in middle reaches since 1982
Trivia arctica	East to Carr Spit
Trivia monacha	East to Carr Spit
Limacia clavigera	
Antiopella cristata	
Heteranomia squamula	From sheltered mouth and middle reaches
Phoronis hippocrepia	
Schizoporella unicornis	From sheltered mouth and middle reaches
Parasmittina trispinosa	East to Lawrenny
Escharoides coccinea	Open coast to Pennar Point
Cellepora pumicosa	East to Burton Cliff
Flustrellidra hispida	East to Cosheston
Asterias rubens	East to Lawrenny
Ophiothrix fragilis	East to Lawrenny
Ophiura/Amphipholis	
Amphipholis squamata	
Distaplia rosea	
Morchellium argus	
Thorogobius ephippiatus	East to Dockyard Bank

Species recorded at one site or infrequently from one or two sites

Species name	Notes

Table 4. (cont.)

Widely distributed species		Species recorded at one site or infrequently from one or two sites	
Species name	Notes	Species name	Notes
	Rare in upper reaches compared with middle and mouth		
Cystoclonium purpureum	Intertidally, middle reaches up to Garron Pill and sheltered mouth sites (known to occur locally on exposed shores near sand)		
Gigartina stellata	From S. of Garron Pill to exposed open coast		
Rhodophyta indet. (pink encr.)	From Beggars Reach to exposed open coasts. Not systematically identified		
Lomentaria clavellosa	1978-9 from S. of Garron Pill to mouth. 1985 from Lawrenny to mouth		
Antithamnion plumula	Intertidally from S. of Garron Pill to open coast		
Cryptopleura ramosa	Intertidally from mouth of Garron Pill to open coast		
Laminaria digitata	Intertidally from mouth of Garron Pill, subtidally from Lawrenny Wood to open coast		
Cliona sp.	To Lawrenny		
Haliclona oculata	To Lawrenny Wood		
?Amphilectus fucorum	East to Lawrenny Wood		
Cliona sp. (boring stages)			
Plumaria setacea	East to Lawrenny Wood		
Actinia equina	East to S. of Garron Pill		
Urticina felina	To Lawrenny		
Branchiomma vesiculosum	To Lawrenny Wood		
Myxicola infundibulum	To Lawrenny Wood		
Spirorbinidae indet. (on fucoids)	To S. of Garron Pill		
Polyplacophora indet.	East to Garron Pill		
Patella vulgata	Exposed coasts to Beggars Reach		
Calliostoma zizyphinum			
Gibbula cineraria	From moderate exposure to S. of Garron Pill		
Littorina saxatilis(agg)	East to Landshipping		
Nucella lapillus	To S. of Garron Pill		
Archidoris pseudoargus	To Lawrenny Wood		

Table 4. (con't.)

Widely distributed species

Species name	Notes
Electra pilosa	Common east to Lawrenny Wood
Bugula flabellata	Common east to Lawrenny Wood
Didemnidae Indet.	From sheltered mouth to Lawrenny Wood
Ascidiella aspersa	From sheltered mouth to Lawrenny Wood
Botryllus schlosseri	East to Lawrenny Wood
Botrylloides leachi	Recorded from open coast east to Lawrenny Wood

Species recorded at one site or infrequently from one or two sites

Species name	Notes

Species records from Upper and Middle Reaches

Tubularia larynx	Burton Cliff to Picton Point
Eudendrium spp.	
Obelia geniculata	
Laomedia flexuosa	Middle reaches to Picton Point
Sertularia argentea	From Wear Point to Knap Farm
Hydrallmania falcata	Middle reaches to Knap Farm
Sertularia cupressina	
Urticina eques	Intertidally, Cosheston to mouth of Garron Pill, subtidally, Carr Spit to Knap Farm
Metridium senile	To Knap Farm
Buccinum undatum	Pennar to Lawrenny Wood
Ostrea edulis	Mainly in area close to Lawrenny from Llanreath 1979
Cerastoderma edule	To East Wood Farm
Scrupocellaria scruposa	Llanreath to Lawrenny Wood
Bicellariella ciliata	Wear Point to S. of Garron Pill
Celleporella hyalina	To S. of Garron Pill
Valkeria uva	Middle reaches and upper to Knap Farm
Ascidiella aspersa	
Styela clava	Wear Point to Llangum
Gobius niger	Knap Farm to Wear Point and Pennar
Pholis gunnellis	Middle reaches and upper reaches to Landshipping
Syngnathus sp.	Wear Point to Knap Farm

Table 4. (con't.)

Widely distributed species		Species recorded at one site or infrequently from one or two sites	
Species name	Notes	Species name	Notes
Rare in mouth compared with upper and middle reaches			
Dendrodoa grossularia	Dominant in infra-littoral fringe in middle reaches up to Beggars Reach		
Pomatoschistus spp.	(P. microps/P. minutus) Everywhere from sheltered entrance to Beggars Reach		
Species recorded throughout area (see notes for distribution limits)			
Audouinella spp.	From Landshipping and Llangwm to all except most exposed areas	Pleurobranchus pileus	Llanreath
Catenella caespitosa	Everywhere except wave exposed sites on open coast to Picton Point	Flustra foliacea	Scattered records common on Dockyard Bank
Chondrus crispus	To Landshipping	Crenilabrus melops	
Antithamnion cruciatum	Subtidally to Black Tar, intertidally to Cosheston Folly. Most common towards inner limit		
Antithamnion plumula	Subtidally to Black Tar, intertidally to Mouth of Garron Pill. Most common towards inner limit		
Antithamnion spirographidis	Subtidally to Lawrenny, intertidally to Landshipping		
Callithamnion spp.	2 spp. subtidally to Knapp Farm, 4 sp. intertidally to Mouth of Garron Pill. Most common towards inner limits and on Jetty piles		
Ceramium rubrum (agg) (intertidally)	to Landshipping from open coast		
Ceramium spp.	To Lawrenny wood		
Cryptopleura ramosa	Intertidally to Garron Pill, subtidally to Knap farm		
Hypoglossum woodwardii	Intertidally from Landshipping to Pullcrochan subtidally from Landshipping to open coast often deepest weed		
Polyneura gmelinii	Most common foliose red subtidally throughout to Knap Farm		
Polysiphonia nigrescens	Intertidally middle and upper to Picton Point. Subtidally throughout to open coast		

Table 4. (con't.)

Widely distributed species

Species name	Notes
Ectocarpales indet.	(Species not identified)
Ascophyllum nodosum	From flat wave exposed sites to well inside both Cleddau rivers (Nelson-Smith, 1967)
Fucus serratus	From fully exposed open coast to Eastwood Farm (an extension of the upper limit observed by Nelson-Smith, 1967)
Fucus spiralis	From sheltered mouth far into East and West Cleddau rivers (Nelson-Smith, 1967)
Fucus vesiculosus	From exposed sites (bladderless form) far into both East and West Cleddau rivers (furthest position of all red and brown macroalgae, Nelson-Smith, 1967)
Pelvetia canaliculata	From exposed sites far into both East and West Cleddau rivers
Enteromorpha spp.	
Ulva spp.	
Cladophora spp.	Intertidally from open coast to mouth of Garron Pill, subtidally from Knap Farm to Pennar
Bryopsis plumosa	Intertidally from open coast, subtidally to Knap Farm
Bacillariophyta indet. not systematically recorded	
Scypha ciliata	Chapel Rocks to Beggars Reach
Scypha compressa	Rare in mouth compared with upper and middle reaches
Halichondria panicea	All areas but more common in middle and upper reaches
Dynamena pumilla	Throughout to East Wood Farm
Aglaophenia plume	Throughout to Beggars Reach
Urticina felina	All except most exposed sites
Terebellidae indet	Throughout from mouth to Beggars Reach
Pomatoceros spp.	
Spirorbinidae indet on rock	Most common from sheltered mouth to Lawrenny
Balanus crenatus	Subtidally from mouth to ?Hook, confirmed to Llangwm

Species recorded at one site or infrequently from one or two sites

Species name	Notes

Table 4. (cont.)

Widely distributed species

Species name	Notes
Semibalanus balanoides	Throught area to Landshipping. Dominant shore barnacle from open coast to Bullwell on south shore and to South Hook Point on the north shore
Elminius modestus	Common from sheltered mouth up to Picton Point, recorded as Frequent at East Wood Farm and also present in low numbers on exposed open coast sites
Paguridae indet	recorded from areas with soft sediment up to Knapp Farm
Cancer pagurus	Scattered throughout up to Knap Farm
Carcinus maenas	Everywhere from sheltered mouth to East Wood Farm
Anuride maritima	
Patella vulgata	From exposed mouth to Beggars Reach (1985). Co-dominant with barnacles in exposed and moderately exposed shores
Calliostoma zizyphinum	Suitable substrates up to Black Tar (1978)
Littorina mariae/ obtusata	from moderately exposed mouth to Picton Point
Alcyonidium diaphanum = Alcyonidium gelatinosum	
Membranipora membranacea	Scattered sites from Beggars Reach to mouth
Bugula plumosa	Throughout
Clavelina lepadiformis	From open coast to Lawrenny wood
Polycarpa sp	From open coast and from Lawrenny wood
Botryllus schlosseri	From open coast to Beggars Reach
Scyliorhinus canalicula	Scattered throughout
Ctenolabrus rupestris	Everywhere but most common upstream

Species recorded at one site or infrequently from one or two sites

Species name	Notes

TABLE 5

Abundance of conspicuous species on subtidal hard substrata at Burton Cliff (Site 8)

Upper Infralittoral Small and large boulders at 10.4 to 2 m.	Lower infralittoral/Upper circalittoral Large and small boulders at 2 to 6 m. (Algae in shallow depths). * = Animals most abundant in deeper region x = Animals most abundant in shallow depths.	Circalittoral. Large and small boulders at 6 to 10 m.	Circalittoral plain of boulders, cobbles and pebbles at 10 to 12 m.
ABUNDANT SPECIES			
Dendrodoa grossularia	Dendrodoa grossularia	Halichondria panicea (piped)	Balanus crenatus
COMMON SPECIES			
Laminaria digitata	Halichondria panicea (piped)*		
FREQUENT SPECIES			
Dilsea carnosa	Hypoglossum woodwardii	Raspailia hispida	Sertularia polyzonias
Palmaria palmata	Polyneura gmelinii	Amphilectus fucorum	Actinothoe sphyrodeta
Callithamnion sp.	Callithamnion sp.	Porifera indet. (pink, tasselated)	Ocenebra erinacea
Antithamnion plumula	Scypha ciliata x	Hydrallmania falcata	Bugula plumosa
Hypoglossum woodwardii	Raspailia hispida *	Nemertesia antennina	Parasmittina trispinosa
Polyneura gmelinii	Dysidea fragilis	Actinothoe sphyrodeta	
Laminaria sp(p). (sporlings)	Hydrallmaria falcata *	Bugula plumosa	
Eudendrium ?capillare	Aglaophenia pluma x	Dendrodoa grossularia	
	Bugula plumosa		
	Eudendrium ?capillare		
OCCASIONAL SPECIES			
Phyllophora pseudoceranoides	Antithamnion plumula	Dysidea fragilis	Myxilla sp. (yellow)
Phyllophora traillii	Amphilectus fucorum *	Porifera indet. (brown, slimy)	Porifera indet. (encrusting, yellow)
Polysiphonia sp.	Porifera indet. (pink, tasselated)	Scrupocellaria scruposa	Hydrallmania falcata
Laminaria saccharina	Nemertesia antennina *	Botrylloides leachii	Nemertesia antennina
Ulva sp.	Nemertesia ramosa *	Ctenolabrus rupestris	Urticina felina
Halichondria panicea (piped)	Carcinus maenas *		Elminius modestus
Porifera indet. (pink, tasselated)	Scrupocellaria scruposa *		Bicellariella ciliata
Pomatoceros sp.	Ascidiella aspera *		Alcyonidium sp. (encrusting)
Gibbula cineraria	Ctenolabrus rupestris *		
Bicellariella ciliata			
Bugula plumosa			
RARE SPECIES			
Griffithsia flosculosa	Porifera indet. (orange, encr.)	Suberites carnosus	Amphilectus fucorum
Scypha ciliata	Tubularia indivisa	Stelligera stuposa	Halecium sp.
Porifera indet. (orange encr.)	Actinothoe sphyrodeta	Microciona atrasanguinea	Plumularia sp.
Botryllus schlosseri	Terebellidae indet.	Tubularia indivisa	Sagartia elegans mineata
	Prostheceraeus vittatus	Aglaophenia pluma	Sagartia troglodytes
	Paguridae indet.	Sarcodictyon roseum	Paguridae indet.
	Gibbula cineraria	Terebellidae indet.	Macropodia sp.
	Bicellariella ciliata	Filograna implexa/ Salmacina dysteri	Polycera quadrilineata
		Carcinus maenas	Cellepora pumicosa
		Macropodia sp.	Dendrodoa grossularia
		Palaemon serratus	Ascidiella aspersa
		Calliostoma zizyphinum	Botylloides leachii
		Parasmittina trispinosa	Pomataschistus sp.
		Alcyonidium diaphanum	

6.3. Intertidal habitat and communities.

6.3.1. Introduction. The following summary of habitats and communities present in Milford Haven and the Daucleddau includes reference to rocky shore sites surveyed during this and other studies. Each site is listed followed by the source and site number. Sites surveyed during the Harbours, Rias and Estuaries survey in 1985 are given a site number only. The additional studies referred to are noted below:

IP 1979 refers to surveys of fixed transect sites as part of the
IP 1982 Milford Haven monitoring scheme. (Little, A.E., 1983 and Woodman et al., 1983).
IP 1982-3 refer to sites visited during studies of selected shore organisms (Little, A.E., 1985).
SWBS (1978, 1979) refer to sites examined during the South West Britain sublittoral survey.

6.3.2. Wave exposed bedrock and stable boulder shores at the entrance to Milford Haven.

West Blockhouse (Very exposed) 1
Dale Point IP 1982 (1)
S. Hook IP 1982 (2)
Watch House Point IP 1982 (3)
Rooks Nest Point IP 1982 (4)

These shores have extensive splash and maritime lichen zones supporting a rich lichen flora with the first higher plants recorded at around 13 m above chart datum (CD). The mid shore is dominated by barnacles and limpets with little or no macro algal cover on open rock faces. The sublittoral fringe is dominated by pink encrusting algae with Alaria esculenta at West Blockhouse. These shores are similar to those of the open coast nearby, though as inshore sand is more common outside Milford Haven, so sublittoral fringe communities are comparatively rich inside the Haven.

6.3.3. Moderately exposed bedrock and stable boulder shores with some sandy beaches.

East Blockhouse 2., IP 1982-3
Musselwick East 3
Little Castle Head IP 1979 (6)
West Angle Bay IP 1982 (7)
West of Chapel Bay (Stable boulder shore, sublittoral fringe bedrock slope) IP 1982-3, SWBS (1978)

The splash and maritime lichen zone of these sites is variable in extent with local topography. On fairly open rock surfaces salt tolerant higher plants are found down to around 11 m above CD at Little Castle Head and to 9 m at West Angle Bay. The mid shore on open bedrock is dominated by fucoid algae and Laurencia pinnatifida. These shores have a rich and varied lower shore biota particularly in crevices, under overhangs and beneath boulders. The rock pools at West Angle Bay are rich.

6.3.4. Clean sand. Exposed or moderately exposed shores.

Watwick Bay
Millbay (St. Anne's Head)
Castle Beach (Dale)
Lindsway Bay
Mun Sands. Sandyhaven (in part)
West Angle Bay

Areas of clean sand are widely separated and restricted in extent and remain largely unstudied. West Angle Bay and Lindsway Bay both support examples of the Crustacean-polychaete community described by Bishop and Holme (1980). They considered the community at the former site to be, probably, the best developed of the six examples described for southwest Wales, whilst that at the latter site was thought to be a good representative example of the type. Mun Sands supports a good representative community of the Tellina type described by the above authors.

6.3.5. Sheltered bedrock or stable boulder shores.

Cliff Cottage Beach (lower shore = gann flats) IP 1982 (16)
Gann Flats - minority of lower shore 4
Black Rock - (sublittoral fringe muddy sand) IP 1982 (9)
Gelliswick IP 1982 (10)
Angle Point (sublittoral fringe muddy sand) IP 1982 (11)
Bullwell (sublittoral fringe soft mud) IP 1982 (12)
Horseshoe (sublittoral fringe soft mud) IP 1982 (22)
Pennar Point IP 1982 (22)
Entrance to Pennar Gut 7
Wear Spit 5 and IP 1982 (4)
Hazelbeach IP 1982 (15)
Pwllcrochan - habitat present but minor 6

The splash and maritime zones are generally limited to around 8 m above CD, less in localised shelter. These shores fringe the stretch of Milford Haven within which the refineries and the towns of Milford Haven, Neyland and Pembroke Dock are found. The most interesting and rich are those at Hazelbeach, Bullwell, Pennar Point and Wear Spit. The latter shore supported a particularly rich attached fauna and flora with several notable algal species, Solieria chordalis, Gigartina acicularis and Gigartina teedii. The sponge fauna was varied and well developed.

6.3.6. Very sheltered bedrock or stable boulder shores.

Pembroke Ferry IP 1982 (18)
Cosheston Folly 9
Jenkins Point 10
Lawrenny Ferry IP 1982 (21)
South of Garron Pill 8

From Pembroke Ferry northwards to the mouth of Garron Pill steep bedrock and boulder shales on the lower shore were dominated by Dendrodoa grossularia.

The sublittoral fringe in this area was rich with gradually diminishing numbers of species from Cosheston Folly to South of Garron Pill. Several species common on rocky shores reach their limit of penetration into the

estuary within this stretch including Gibbula umbilicalis, recorded limit Cosheston Folly; Laurencia hybrida, recorded limit Jenkins Point; Monodonta lineata and Buccinum undatum, recorded limit below Castle Rocks and Gracilaria verrucosa, Patella vulgata and Nucella lapillus recorded limit in Beggars Reach. Also decreasing in variety though not in abundance in this stretch are the thick epiphytes on macroalgae which include hydroids, bryozoans and fine red algae, of the latter Griffithsia flosculosa, Cryptopleura ramosa, Palmaria palmata and several species from each of the genera Antithamnion, Callithamnion and Polysiphonia were amongst the most common. Large Anguilla anguilla were common under boulders from Jenkins Point northwards.

6.3.7. Very sheltered bedrock or stable boulder shores. North of Beggars Reach.

Woodhouse, Landshipping 13
Picton Point 14
East Wood Farm 12

Each of these sites is fairly isolated with mud nearby. The upper shores had patches of saltmarsh vegetation between boulders or bedrock outcrops.

At all sites the flora and fauna are impoverished with the most northerly site (East Wood Farm) having the poorest variety of life (18 species recorded compared with 31 at Woodhouse, Landshipping. The mid shore rocks and boulders are dominated by fucoid algae. There are no limpets, dog whelks or top shells above Beggars Reach and of the red algal species only Polysiphonia lanosa is found upstream as far as East Wood Farm. At this site, barnacles Elminius modestus and Balanus crenatus are confined to lower shore boulders and the only molluscs recorded here were scattered Littorina littorea and Mytilus edulis on the lower shore and Littorina 'saxatilis' under stones on the upper shore. Amongst the many species, reaching their limit of penetration in this stretch were, Semibalanus balanoides, Littorina obtusata, Littorina mariae and Halichondria panicea.

6.3.8. Muddy sands on moderately exposed to sheltered shores or where currents prevent heavy silt deposition.

Gann Flat 4
Dale Beach
Gelliswick
Pwllcrochan 6
Sandyhaven Pill and Mun Sands (in part)
Angle Bay (in part) (Rostron, 1983)

Dale Beach and the Gann Flat together are of great scientific interest as the substrates are very heterogeneous. There are representative communities of the Echino/Siliqua and Arenicola types and the Pullastra community at the Gann is probably the richest in southwest Wales (Bishop and Holme, 1980). It is unusual for examples of so many communities to be so close together and accessible for teaching purposes. Bait digging is considered a problem.

6.3.9. Muddy fine and very fine sands, very sheltered from wave action but exposed to tidal streams and variable salinity.

Carew/Cresswell confluence (Black mixen)) Morris (1985)
Minwear Wood Eastern Cleddau)

Minwear Wood is an unusual site with an impoverished community composed of firm sands colonised almost exclusively by Aricidae minuta, Streblospio benedicti and oligochaetes with Macoma balthica rare. At the Carew/Creswell site in very fine sand Aricidae minuta has not been recorded, additional species present are Nephtys hombergii, Pygospio elegans and one ampharetid species, with rare Eteone ?longa, Tharyx marioni and nematodes.

6.3.10. Creek muds and mud banks on the lower shores of the middle reach of Milford Haven.

Carew/Creswell Rivers	Morris, 1985	
Pembroke River	Rostron, 1985	
Angle Bay (in part)	Rostron, 1983	
West of Wear Point (in part)	)	
Llanreath to Pennar	)	Lower shore banks
Pwllcrochan (in part)	)	of soft mud.
Milford Town shelf	)	

These areas are small when compared with estuaries such as the Humber or outer Thames though they support a large variety and quite large numbers of overwintering waders and wildfowl. The area as a whole is thought to be of regional importance for Curlew and Knot, of National importance for Wigeon, Grey Plover, Greenshank and Redshank and may be internationally important for Shelduck and Teal (1% of individuals of a population for two or more monthly counts per year) (Haycock pers. comm.). In the central area of Milford Haven the mud banks have high levels of organic matter and the infauna is dominated by Melinna palmata and Nephtys hombergii.

Mudflat communities in Pembroke River are comparable with those found elsewhere in Britain (Rostron, 1985) with Hydrobia ulvae, Pygospio elegans, Manayunkia aestuarina, Cerastoderma edule, Abra tenuis and nematodes. At a few sites close to the south shore several species including Phoronis ?muelleri were abundant, and notable.

Bishop and Holme (1980) recorded that the Arenicola communities in Angle Bay were particularly rich and that the Scrobicularia community at Pwllcrochan was probably the richest of 3 known sites in West Wales.

6.3.11. Creek muds and mud banks from Williamston Pill northwards.

Williamston Pill	)	
Garron Pill	)	
Llangwm Pill	)	Morris, 1985
Sprinkle Pill	)	
Landshipping Quay	)	
Western Cleddau	)	
Lower half of the Eastern Cleddau	)	

These areas are included with those in the last section in counts of overwintering wildfowl and waders. These muds support an increasingly impoverished fauna with those in the Western Cleddau and in the mouth of the Eastern Cleddau showing signs of ecological disturbance (Morris, 1985). However, from Llangwm south to Williamston Pill there was no marked gradient of estuarine species with Nephtys hombergii present throughout. Species successful in low salinity conditions were restricted to the innermost areas of Pembroke River, Williamston Pill, Garron Pill and the north side of the Carew/Creswell rivers. The sediment macrofauna of these areas included high

densities of Manayunkia aestuarina, Streblospio benedicti, oligochaetes and nematodes.

6.4 Subtidal habitats and communities.

6.4.1. Introduction. A wide range of subtidal habitats is present in Milford Haven and the list below reflects the emphasis in these surveys on in situ recording of conspicuous species on hard substrata. However, compared with other marine inlets, bedrock and boulder surfaces do occur over large areas in the subtidal so these are especially prominent in the habitats described. Sites are listed by name followed by the year of survey and site number or letter.

6.4.2. Wave exposed bedrock and boulders exposed to moderate tidal streams near the entrance.

West of Thorn Island (78/24) +1 to 6 m	Steep broken bedrock slope with many steep sided gullies.
West Blockhouse (78/25) 0 to 8 m	Broken bedrock slope with many steep sided gullies.
North of Sheep Island (78/26) +1 to 12 m	Steep bedrock extending to gradual slope of very broken rock with boulder-filled gullies to 7m. Bedrock outcrops with gravel-filled gullies at 11m.
Chapel Rocks (78/27) 12.4 to 14.5 m	Gently sloping plain of broken bedrock with flat boulders and some crevices.
Dale Point (78/28) 3 to 7.5 m	Broken rock slope.

Extensive areas of subtidal bedrock occur in wave exposed situations in the mouth of Milford Haven. These include all the headlands on the Dale and Angle Peninsulae. At West Blockhouse and Dale Point, steeply dipping rock strata formed gullies and ridges running east-west (perpendicular to the coast at these sites). Chapel rocks are low-lying submerged reefs offshore in the entrance to Milford Haven.

Communities present were very similar to those of the open coast and included a dense Laminaria hyperborea forest which extended to as deep as 8 m but generally to about 4 m bcd. Rock below the kelp was encrusted with coralline algae and colonised by a wide variety of foliose algae which extended deeper than the kelp to dominate upward facing surfaces to a depth of about 12 m. The most frequent algae were Calliblepharis ciliata, Rhodophyllis divaricata, Plocamium cartilagineum, Acrosorium uncinatum, Radicilingua thysanorhizans, Cryptopleura ramosa and Delesseria sanguinea. Species particularly abundant deeper than the kelp forest were Heterosiphonia plumosa, Hypoglossum woodwardii, Myriogramme bonnemaisonia, Dictyota dichotoma and Dictyopteris membranacea. Epibiota on kelp stipes was luxuriant and included Membranoptera alata, Palmaria palmata, Phycodrys rubens and Lomentaria articulata. Infralittoral animal communities included rich populations of erect Bryozoa, particularly species of Bugula and Scrupocellaria under overhangs together with sponges and tunicates, especially Morchellium argus. Sublittoral fringe communities were well-developed being dominated by crustose

coralline algae and some Corallina officinalis with Alaria esculenta and Laminaria digitata present and an assemblage of animal species typical of this subzone on the open coast including Umbonula littoralis, Amphilectus fucorum, Halichondria panicea, Aglaophenia pluma, Balanus crenatus and, at Thorn Island, Dendrodoa grossularia. Circalittoral animal communities studied at Chapel Rocks were very diverse with a predominance of erect Bryozoa and some Hydrozoa including Nemertsia spp. and Halecium halecinum with Pentapora foliacea and Alcyonidium diaphanum (=gelatinosum) also present in large amounts. Many species were only found at these sites on the open coast (see Table 1) during a previous study, large areas of seabed at Chapel Rocks were found to be dominated by Molgula manhattensis.

The following sites were less exposed but are included under the same categories:

South of Stack Rocks (78/19)	4 to 7 m	Occasional bedrock outcrops.
Great Castle Head (78/21)	1.5 to 5 m	Broken bedrock slope with steep gullies extending to plain of mobile boulders and cobbles.
Watchhouse Point (78/23)	0 to 3 m	Broken bedrock slope with large open gullies and steep narrow gullies.
	3 to 5.5 m	Gradual slope of low bedrock ridges with boulder/cobble bottoms.
	5.5 to 9 m	Scattered boulders and mobile pebbles (in muddy sand plain).

These sites were subject to less wave action and most likely higher turbidity than the previous locations. They were more silty and algae dominated to only shallow depths. There was generally a narrow fringe of kelp with Laminaria digitata and L. hyperborea extending to about 2 m bcd. Plants of L. hyperborea were large and densely colonised by epiphytes. Algal communities in the infralittoral were similar to the open coast although the population of Drachiella spectabilis was particularly notable at some sites. Animal communities under overhangs were colonised by dense erect Bryozoa and with notably large amounts of Clavelina lepadiformis, Dendrodoa grossularia, Botryllus schlosseri and Botrylloides leachii present.

6.4.3. Moderately wave exposed bedrock and stable boulders in Milford Haven.

West of Chapel Bay (78/20) +0.5 to 2.5 m	Bedrock in the infralittoral extending to boulders then to cobbles and shell gravel with scattered boulders.
Dale Roads, North (78/22) 3 m	Scattered boulders on mud.
Montreal Rocks (79/H) 5 to 6 m	Silty bedrock reefs.
Castle Beach Bay (85/13) ca 2 m	Bedrock and boulders.

Communities present here were characteristic of fully saline but moderately sheltered and turbid conditions. Shallow rocks were dominated by a forest of Laminaria hyperborea with L. saccharina and Saccorhiza polyschides mixed-in. Where boulders occurred on sediment, L. saccharina was often dominant. A wide variety of foliose and crustose algae were present with Calliblepharis ciliata and Cryptopleura ramosa particularly common. Unusual species of algae included Cordylecladia erecta, Grateloupia filicina, Schmitzia hiscockiana, Drachiella spectabilis and Cutleria multifida. Animals present in the sublittoral fringe and on vertical or overhanging surfaces were a reduced open coast community. On these surfaces and below the main area of algal domination, erect Bryozoa were abundant including species of Bugula and Bowerbankia pustulosa with Didemnid tunicates and Distomus variolus often recorded.

6.4.4. Wave sheltered small boulders, cobbles and shells in sediment exposed to moderate tidal currents in the outer Haven.

West of Chapel Bay (78/20) 2 to 5 m	Cobbles on shell gravel.
Wards Pier (79/C) 3 m	Boulders and cobbles on mud.
Between Amoco and Esso Jetties 1 m (transect surveys for IP in 1986)	Shells and some cobbles in muddy sand.

These areas include a generally impoverished community with elements of that described in Section 6.4.7. Small boulders held species such as Suberites domuncula and Antedon bifida while shells were bored by Cliona sp. and Phoronis hippocrepia. Cobbles were usually dominated by Balanus crenatus.

6.4.5. Wave sheltered artificial substrata exposed to moderate currents.

Milford Haven Conservancy Board jetty (78)/15) 0 to 5 m	(steel piles and concrete)
Angle lifeboat slip (78/18) 0 to 1 m	(concrete)
Jetty 4, Esso Jetty (79/E) 1 to 11.5 m	(coated metal)
West Dolphin, Esso Jetty (79/G) +1 to 16 m	(coated metal)
Amoco jetty (Monitoring studies in 1979-81) +1 to 7 m	(coated metal)
Target Trot (barges) (85/10.1) 0 to 1.5 m bsl	sides and bottom of concrete barge

These artificial substrata held broadly similar communities characterised by sponges, Metridium senile, Antedon bifida and ascidians with only a narrow band of algae near to low water level. The concrete barges at Target Trot held a different fauna though still predominantly of sponges and ascidians.

6.4.6. Wave sheltered bedrock and boulders extending to cobbles exposed to moderate or strong tidal streams.

Opposite Sprinkle Pill (78/2) 0 to 2.5 m	
Black Tar (78/3) 0 to 2.5 m	Slope of steep boulders and bedrock.
Knap Farm (85/9) 0 to 1.5 m	Slope of boulders.
S. Garron Pill (78/4b) +1 to 11m	Bedrock cliffs, boulders, cobbles and pebble slopes.
Castle Rocks (78/5) 0 to 11.5 m	Bedrock cliffs in steps and ledges with boulders and rock outcrops near level seabed.
S. Side Cosheston Trot (78/6) 0.5 to 15.5 m	Boulder and bedrock slopes and cliffs.
Burton Cliff (78/7, 85/8) 0 to 11 m	Steep broken bedrock slope.
Pembroke Ferry (78/8) 0 to 15 m	Boulders and cobbles.
Hobbs Point (78/8a) 0 to 6 m	Stone jetty then broken rock slope.
Lawrenny Park (85/4)	
Dockyard Bank (85/1 and 2) 13 to 23 m	Steep bedrock slope and cliff with boulders at base.
East of Wear Point (85/15) 4 to 5 m and 11 to 12 m	Boulders.

Communities in this habitat were characteristic of areas of bedrock or stable boulders in rias. The community type as described here spans a wide range of sites and environmental conditions from almost fully marine conditions at Wear Point and Dockyard Bank to conditions of variable salinity and high turbidity at Black Tar. Changes in community along this gradient were mainly of progressive impoverishment and separation of distinctive communities has not been undertaken. The site at Burton Cliff (Site 85/8) provided a good example of the communities present which are listed in Table 5.

Communities were basically very similar having a fringe of Laminaria digitata with Palmaria palmata on the substratum below in very shallow depths. The main undergrowth algae were fine filamentous species (Antithamnion and Callithamnion spp. mainly, with some Griffithsia spp.) and foliose species included Polyneura gmelinii and Hypoglossum woodwardii in particularly high abundance. Dendrodoa grossularia was dominant on rock surfaces from above chart datum level (not at Black Tar) to about 8 m. Other ascidians which were particularly frequent were Polycarpa sp. and Clavelina lepadiformis. Dense growths of sponges occurred, particularly massive and piped forms of Halichondria panicea and often tasellated colonies of Halichondria bowerbankii

and Amphilectus fucorum. Scypha ciliata and Scypha compressa were often present especially in shallow depths. Branching sponges, Raspailia hispida and Stelligera stuposa were present. Dysidea fragilis grew as large cushion-shaped masses. Actinothoe sphyrodeta was often present. Bugula plumosa was the most commonly occurring erect bryozoan and Bicellaria ciliata was often present. The estuarine goby, Gobius niger was noted at several sites and the goldsinny wrasse Ctenolabrus rupestris was a common feature amongst boulders. Distinct differences occurred between sites with some species being present in large amounts at some locations but not others. At Lawrenny Park (Site 85/4), anemones (Urticina eques, U. felina and Cereus pedunculatus) were particularly common compared to other sites. Metridium senile was recorded at sites furthest from the sea. Hydroid assemblages present seemed different at different sites with Tubularia indivisa, Sertularella polyzonias, Hydrallmania falcata, Nemertesia spp. and Sertularia argentea common at one site or other.

Depth of algal penetration ranged from 6 m at Burton Cliff (4 m at the more shaded Pembroke Ferry) to 1.0 to 1.5 m at Black Tar. Dense Laminaria digitata were present only to about 1 m even in the western part of the Daucleddau and extended no deeper than about 2 m.

6.4.7. Wave sheltered cobbles, pebbles and shells exposed to moderate tidal streams.

Opposite Sprinkle Pill (78/2) 0.5 to 5 m	Cobbles and mussels on gravel.
Knap Farm (85/9) 1.5 to 3.5 m	Cobbles and shells
Llangwm (78/4)	Scattered cobbles on sediment.
Beacon NW of Benton Wood (78/4a) +1 to 4 m	Cobbles, pebbles and boulders.
Carr Spit (78/9) 0.5 to 12 m	Cobbles and small boulders.
West Carr Spit (85/3) 3 m	Cobbles on muddy sand.
East of Wear Point (85/15) 2 to 4 m; 12 to 13 m	Cobbles and small boulders.
Pwllcrochan (Power Station outfall) (78/14, 85/17) 0.5 to 10.5 m	Scattered pebbles on mud.
Pennar Mouth (78/12, 85/18) +1 to 1 m	Small boulders and pebbles.
1 to 3 m	Steep clay slope with boulders and cobbles.
4 to 5 m	Occasional boulders and cobbles.

This habitat included stable or unstable cobbles and large shells often with small boulders. Shells were predominantly old Ostrea edulis shells in Milford Haven and Crepidula fornicata in the Daucleddau. Communities present on these hard substrata became more impoverished with increasing distance from the open sea and some changes in communities occurred. Algae were mainly fine filamentous species including Antithamnion spp. and Callithomnion spp. with the rarely found Griffithsia devoniensis present throughout but particularly abundant furthest from the sea. Laminaria saccharina was present in the

shallower depths. Foliose algae were less abundant but included large amounts of Stenogramme interrupta in places and the alien species Solieria chordalis at two locations. Algae were absent below about 2.5 m bcd and hard substrata were colonised (in Milford Haven) by a fairly large variety of species including Balanus crenatus, Elminius modestus, Pomatoceros sp., Calyptera chinensis, erect and encrusting Bryozoa and several ascidian species especially Dendrodoa grossularia, Distaplia rosea and Ascidiella aspersa. Antedon bifida, Suberites ficus and Alcyonidium diaphanum were frequent in places. Urticina felina, U. eques, Crepidula fornicata, Halichondria panicea and Sertularia argentea were particularly frequent upstream. The Indo-Pacific ascidian Styela clava was present in small numbers. Species in sediment pockets between cobbles were also often characteristic of this habitat and included Cereus pedunculatus, Lanice conchilega and Myxicola infundibulum. Pagurid crabs (particularly downstream) and Carcinus maenas (particularly upstream) were often present. At the most upstream locations, Metridium senile and Mytilus edulis colonised this habitat.

6.4.8. Level sediment with small shells, pebbles and shell gravel.

Picton Point (78/1) 0 to 1.5 m	Rippled muddy sand.
Opposite Sprinkle Pill (78/2) 2.5 m	Sandy mud.
Black Tar (78/3, 85/9) 2.5 m	Mud with shell fragments.
Off Williamston Pill (85/5) 3 m	Muddy sand with cobbles and shells.
Carr Spit (78/9, 85/3) 5 to 7 m	Mud with scattered cobbles
NW of Martello Tower, Llanreath (85/16) 4 m	Mud with shells.
Pennar Pool (78/10) 5 m	Mud.
Pennar Mouth (79/A, 85/18) 5 m	Mud.
Power Station Channel (78/1) 1.5 m	Mud.
West of Wear Point (78/13) 13 to 15 m	Muddy gravel, shells and stones.
North Pennar Gut 4.5 to 7 m	
Pwllchrochan Flats (78/14) 0.5 to 10.5 m	Mud with scattered pebbles.
Milford Haven Conservancy Jetty (78/15) 3 m	Mud and muddy gravel.
Wards Pier (79/C) 3 to 4 m	Mud with scattered pebbles.
Between Esso and Amoco Jetties (79/D) 0 to 2 m	Muddy sand.

West of Esso Jetty (78/16, 85/14) 0.5 to 3.5 m	Rippled sand with shell debris. Maerl below 3 m
Littlewick Bay (79/F) 0 to 2 m	Muddy sand, some maerl.
South Stack Rocks (78/19) 4 to 7 m	Mud and pebbles.
West Chapel Bay (78/20) 0 to 4.5 m	Coarse sand and gravel to muddy sand to mud.
Montreal Rocks (79/H)	Muddy sand.
Longoar Bay (79/I) +1 to 2 m	Muddy sand with shells.
Watch House Point (78/23) 5.5 to 8 m	Muddy sandy gravel
West of Thorn Island (78/24)	Rippled sand plain.

Sediment communities were not thoroughly investigated and are therefore included in one section here. Also, many of the sediments were mixed with hard substrata in the form of cobbles and large shells which provided a substratum for the majority of conspicuous species. Burrowing species or species living in the sediment which were widely distributed included Cereus pedunculatus, Terebellid worms, Lanice conchilega, Carcinus maenas and pagurid crabs (colonised by Hydractinia echinata in places). Many species were recorded only or mainly from Milford Haven including Myxicola infundibulum, Branchiomma vesiculosum, Goneplax rhomboides, Liocarcinus depuratur, Ophiura albida and Pomatoschistus sp(p). Muddy sand near to the confluence of the Eastern and Western Cleddau Rivers was sparsely colonised by Arenicola marina (casts), Carcinus maenas and pagurid crabs with dense Lanice conchilega in some locations upriver. The hydroid Corymorpha nutans was recorded from a few sites near to the entrance to Milford Haven. The typically estuarine Gobius niger was recorded at a few widely separated locations. Where muddy sand was present in shallow depths, Zostera marina was recorded. At one site exposed to fairly strong tidal streams, maerl (Phymatolithon calcareum) was present. The flora attached to the maerl was very rich with 55 species recorded from samples. The most abundant species were: Spermothamnion irregularis, Gracilaria verrucosa, Stenogramme interrupta, Ceramium rubrum, Nitophyllum punctatum, Brongniartella byssoides, Scinaia turgida, Delesseria sanguinea, Cladophora sp., Polysiphonia nigrescens, P. nigra, P. urceolata, P. elongata, Porphyra sp., Rhodomela confervoides, Dictyota dichotoma, Arthrocladia villosa and Griffithsia corallinoides.

7. DISCUSSION AND CONCLUSIONS

7.1. Distribution of habitats

Both intertidal areas and fringes of subtidal areas of Milford Haven and the Daucleddau include substantial areas of hard substrata especially bedrock and boulders. In localised areas such as at Dockyard Bank, off the Warrior Site, at Cosheston Trot and at Burton Cliff, extensive subtidal hard substrata occur including bedrock cliffs and boulder slopes. These features are a reflection of the steep sided nature of a ria and also the strong tidal streams which prevent deposition of sediment in many areas. The creeks,

pills, bays and tributaries are exceptions and are generally of sediment with a fringe of rock above mid tide level or with saltmarsh vegetation. Only near to the entrance of Milford Haven are there sandy beaches. The range of subtidal sediments in Milford Haven and the Daucleddau is very broad and reflects wave action and depth near the entrance and strength of tidal/river flow within sheltered parts of the inlet. Muddy sediments are predominantly found off the south shore in the wider parts of Milford Haven and all have a high shell content. In the Daucleddau, much of the bottom is of coarse material in the main channel. The areas colonised by maerl in the region of Stack Rock are unusual for coastal areas and marine inlets of south-west Britain.

TABLE 6

Number of species in the main groups of rocky sublittoral organisms present from the entrance to Milford Haven to Picton Point at the head of the Daucleddau Estuary. Blocks of sites were used to ensure the inclusion of locations where a wide range of habitats was represented and with full records of algae and animals at several of the sites. Site locations are shown in Appendix 1. Taken from the results of the 1978/79 survey and copied from Hiscock (1980).

Coastline included	N. Sheep Island to Watchhouse Point	Great Castle Head to Littlewick Bay	West dolphin, Esso jetty to Milford Conservancy Board jetty	Wards Pier to Pembroke Perry	Burton Cliff to Castle Rocks	South of Gowan Pill to Llangwm	Black Tar to Picton Point
Distance along the waterway from Sheep Island (km)	0 -3.0	4.0 -6.5	6.5 -9	10.5 -17.5	19.2 -22.5	23.2 -24.6	25.5 -27.5
Survey site nos.	22,23, 24,25, 26,27, 28.	F,G,19, 20*,H, I,21.	15*,D, 16*, 18*,E.	8,8a, 9,10*, 11*,12, A,13, 14*,B, C.	5,6, 7.	4,4a, 4b.	1*, 2*, 3*.
Algae	57	71	36	38	26	19	6
Porifera	14	10	8	9	7	4	1
Hydrozoa	9	10	6	7	8	6	4
Anthozoa	6	10	8	9	5	3	3
Polychaeta	4	2	3	4	1	1	0
Phoronidae	0	1	0	1	0	0	0
Cirripedia	2	4	2	2	2	2	2
Decapoda	5	6	7	4	3	2	3
Mollusca	6	2	4	10	7	5	3
Bryozoa	14	10	8	7	6	3	3
Echinodermata	8	7	3	3	0	0	0
Ascidiacea	9	7	9	8	6	4	0
Total number of species	134	140	94	102	71	49	25

*Rock terminated at shallow depths.

7.2. Distribution of species in relation to environmental conditions.

Within the area of study, trends of species distribution reflect a successive impoverishment of species richness with increasing distance from the sea. This is illustrated for sublittoral hard substrata in Table 6 which was compiled following the 1978 and 1979 surveys. Some species thrive

especially in the shelter of Milford Haven and some appear to be predominant in areas upriver but none are freshwater species (see Table 4, Section 6.2). Environmental conditions which change from the open sea to the confluence of the Rivers Cleddau include salinity, suspended sediment concentrations (and therefore turbidity), temperature range, minimum and maximum temperatures and shelter from wave action. The decrease in downward penetration of algae with increasing distance from the coast is clearly linked to increase in suspended sediment which includes effects on light penetration and siltation. Other changes are less easy to link to specific environmental conditions although salinity is most likely to be of importance. The strength of water movement also appears to be important as some species typical of the open coast wave-exposed sites are missing from most of the central part of the study area but reappear at sites in the north of the area, extremely sheltered from wave action but exposed to strong tidal streams. In general, conditions for marine species become more stressful with increasing distance from the sea.

Areas of marked change in species present and in the richness of subtidal communities correspond well with the boundary areas already suggested by Nelson-Smith (1965) (Fig. 6) and based on rocky shore species.

7.3. Comparison with other areas.

Physiographically similar marine inlets to Milford Haven already studied during the current surveys include the River Tamar, River Fowey, River Fal and Salcombe/Kingsbridge Estuary. All include steep narrow channels and have intertidal and subtidal bedrock present in places over much of their length. Broadly similar communities occur in similar habitats in each but particular features are better developed in some than others. Milford Haven and the Daucleddau included subtidal rock communities similar in composition and extent to those of the Tamar and better developed than other inlets surveyed. Rocky shore and subtidal communities in the Daucleddau did not show the transition from marine to almost freshwater conditions that are such a remarkable feature of the Tamar. Only the Fal and Milford Haven have so far been found to have live maerl present. The St. Mawes Bank maerl bed is much better developed and included two species of maerl compared to the one at Stack Rock in Milford Haven. However, analysis of the species of algae attached to a standard-size sample of maerl from the two locations revealed 55 species from Milford Haven and 51 from Falmouth. The apparent impoverishment of the Fal bed has already been noted in the report of that survey (Rostron, 1986).

The characteristic species and communities of the various inlets studied suggest that the area described here is most closely similar to that in the region of Plymouth although there are features in common with many other inlets.

8. ASSESSMENT OF SCIENTIFIC INTEREST AND NATURE CONSERVATION IMPORTANCE OF MILFORD HAVEN AND THE DAUCLEDDAU

8.1. Introduction

The assessment of scientific interest and nature conservation importance has been undertaken through a general evaluation which follows the criteria outlined by Ratcliffe (1971) (Section 8.2) and by ranking the conservation importance of the habitats and communities encountered and of species considered of conservation interest (Section 8.3). The conclusion of these

exercises is given in Section 8.4. The criteria used here to assess conservation importance are applied in the manner outlined in the NCC 'Handbook for the Preparation of Management Plans' (1st edition, February 1983) but defined in relation to northeast Atlantic marine ecosystems. The definitions were first used in the management plan for the Lundy marine nature reserve and have subsequently been used for the Skomer marine nature reserve management plan and to evaluate marine ecosystems in the Isles of Scilly and the area of Bardsey and the Lleyn Peninsula. They are to be used for each area included in the Surveys of Harbours, Rias and Estuaries but are provisional until comparison of the majority of areas is possible. Where comparisons are made on a 'Regional' basis, the region is southwest Britain from north Pembrokeshire around to Portland Bill. For Milford Haven and the Daucleddau, the area included in this assessment is the tidal coastline and seabed north and east from St Anne's Head and Sheep Island.

8.2. General evaluation

Size. Milford Haven and the Daucleddau extend 28 km from the entrance at St Anne's Head and Sheep Island to Picton Point and a further 8 km from the confluence of the Western and Eastern Cleddau to Haverfordwest in the west and Black Pool Mill in the east. The Haven is 3.5. km wide at its entrance with a width in excess of 1 km to Pembroke Dock and between about 200 and 500 m beyond this. The total coastline of tidal waters is about 110 km in length. Most of the shores within the inlet are rocky although muddy sediments occupy creeks and bays. Jetties associated mainly with oil terminals provide a further extensive habitat of piles.

Diversity. Diversity of marine habitats and their associated communities is very high ranging from open coast wave exposed rock and coarse sediments to wave sheltered rock and fine sediments on the shore and from the wave and tide exposed rock and sediment of the entrance to the extensive rocky or coarse sediment of the tide swept main channel and finer sediments of creeks. This diversity of natural communities is added to by the presence of man-made structures particularly the jetty piles and harbour walls.

Diversity (richness) of species is high particularly at the entrance to the Haven in moderately wave-sheltered conditions but is reduced with increasingly sheltered conditions, reduced again in the region of Pembroke Dock and the Cleddau bridge and again in the northern part of the Daucleddau.

Naturalness. Natural communities are present on rock and sediments and appear little affected by man. Exceptions are the alien species Spartina anglica, Styela clava and Crepidula fornicata, the latter species being the dominant in some areas. Also some unusual species appear to be restricted in distribution to the areas in which temperatures are enhanced by the cooling water from Pembroke Power Station. These include Solieria chordalis, fertile Gigartina teedii and Antedon bifida. Communities occurring in muddy substrata have shown signs of increasing ecological disturbance over the years 1974 to 1984 (OPRU surveys).

Extensive areas of artificial substrata are colonised by communities which would not occur on natural substrata.

Rarity. Tables 7 and 8 indicate rarely encountered habitats, communities and species which occur in Milford Haven and the Daucleddau. Several features of the physiography of Milford Haven are rarely encountered including the presence of extensive rocky surfaces in both the intertidal and subtidal of an

extremely sheltered marine inlet. Several species of algae reach the known northern limit of distribution in Milford Haven and several animal taxa are recorded as reaching their southern or northern limit there. Several species are rarely encountered.

Fragility (vulnerability). The signs of ecological disturbance of muddy sediment communities have already been mentioned. However, most of the communities on the shore and underwater appear to be fairly resilient to the effects of chronic pollution which have occurred up to now although effects on marine communities near to discharges have been found. However, the area is under continual threat from pollution incidents, industrial development, population growth, agricultural practices and the rapid recent development of fish farming. However, the statement that "Milford Haven suffers pollution from its oil refinery and is now of relatively little biological interest (Ratcliffe, 1976) should be ignored.

Typicalness. Communities present on rocky substrata and in sediments are typical of the conditions of wave and tidal stream exposure and salinity variability to which they are exposed.

Recorded history. There has been a very large amount of study in the area since about 1960. Records of intertidal fauna and flora have been kept since the late 1940's and these culminated in the publication of the Dale Fort Marine Fauna in 1966. The abundance of rocky shore species along transects was recorded both in the early and the late 1960's and re-surveys have been carried out since, enabling some interpretation of the degree of change in those communities. Aspects of sublittoral communities were first investigated by diving in the early 1960's but detailed recording by remote sampling (sediments) and diving (hard substrata) were not undertaken until the 1970's. Repeat sampling of sediment communities has revealed changes in the abundance and distribution of some species.

Position in an ecological/geographical unit. There are some areas adjacent to the marine part of the inlet which are of known nature conservation importance and much of the undeveloped shoreline is within the Pembrokeshire Coast National Park. Most of these adjacent areas are along the Daucleddau where the most interesting marine communities also exist.

Potential value. There are no areas where rehabilitation is required to produce habitats or communities of scientific interest or to restore previously rich areas.

Intrinsic appeal. There are two contrasting elements to the appeal of Milford Haven and the Daucleddau. Visitors are attracted by the scenery of the open coast and the sheltered Daucleddau and its creeks but are also fascinated by the massive tankers which berth at the very large jetties. Beaches at the entrance to Milford Haven are used for leisure but there is little recreational use of shores in the Daucleddau and the area is not generally attractive to divers.

Research and educational value. Shores near the entrance to the inlet already provide teaching sites for the study of a wide range of marine habitats and communities. The area also provides opportunities for the study of the impact of oil industry activity on the marine environment and a wide range of research studies including ecological survey and field experiments have been carried out in Milford Haven. The proximity of Dale Fort Field

Centre, Orielton Field Centre and the Oil Pollution Research Unit to Milford Haven is particularly important.

8.3. Identification/confirmation of important features.

Features of littoral and sublittoral ecosystems in the area of Milford Haven and the Daucleddau Estuary are evaluated here in terms of their International, National, Regional or Local importance. Table 7 lists the main habitat/community types encountered, Table 8 lists species which are considered of scientific interest in their presence in the survey area. The rating of importance is made broadly according to the following definitions.

International. Communities which are outstandingly good examples of their type in the Northeast Atlantic. Communities recorded at only a very few locations in the Northeast Atlantic.

Species which are recorded at only a few locations in the Northeast Atlantic. Species recorded in higher abundance in the area under consideration than anywhere else in the Northeast Atlantic or where the area is one of only a very few locations where large quantities are recorded.

National. Communities which are outstandingly good examples of their type in Britain. Communities recorded in only a very few marine inlets or estuaries in Britain. Both of these definitions refer to communities which are or are likely to be widely occurring in other inlets and estuaries in the Northeast Atlantic.

Species which are recorded at only a few locations in Britain but are more widespread in other parts of the Northeast Atlantic. Species recorded in higher abundance at the inlet or estuary under consideration than in any other elsewhere in Britain or where the site is one of only a very few locations where large quantities are recorded in Britain.

Regional. Communities which are present in inlets and estuaries elsewhere in Britain but which are outstandingly good examples of their type in the inlet or estuary under consideration or are as good examples as similar communities present elsewhere in Britain. Communities recorded at only a few locations in inlets and estuaries in southwest Britain.

Species which are unrecorded or recorded at only a few locations in inlets and estuaries in southwest Britain but are widespread in other inlets and estuaries or on the open coast in other parts of Britain. Species recorded in higher abundance in the area under consideration than in any other inlet or estuary in southwest Britain or where the site is one of only a very few locations where large quantities are recorded in southwest Britain.

Local. Communities which are widespread in inlets and estuaries in southwest Britain with as good or better examples at several other locations.

The selection only of species which are of higher than Local importance precludes the use of this category in the species lists.

8.4. Conclusion.

Milford Haven and the Daucleddau Estuary have many features which make them of high scientific interest. The presence of naval and commercial developments has clearly affected many habitats within Milford Haven where construction has destroyed some but the jetties and harbour walls have created new ones. Effects of pollution from effluents appears to be mainly localised and intertidal and subtidal communities have not been greatly affected. The marine communities in Milford Haven are generally of Regional importance because of the extensive area of rocky shore communities typical of sheltered conditions and because of the very rich communities present in or on some sediments or mixed substrata. However, the greatest scientific interest and nature conservation importance of the area lies in the areas of very sheltered steep-sided rocky surfaces extending from Dockyard Bank upstream to Black Tar. Here, communities typical of sheltered marine inlets occur on the shore and underwater. The subtidal communities are especially important and are mainly remote from port developments in a scenically attractive part of the inlet. Their presence should be highly regarded and care exercised in relation to developments which might effect their integrity.

TABLE 7.

Classification, description and evaluation of the conservation importance of habitats/community types present in Milford Haven and the Daucleddau and encountered during the survey.

Classification (based on Section 6.3).	Description	Provisional suggested importance
INTERTIDAL		
1. Wave exposed bedrock and stable boulder shores at the entrance to Milford Haven. (Section 6.3.2)	Communities present here are similar to those of the open coast and are dominated by limpets and barnacles over most of the shore with an extensive maritime lichen community above and a sublittoral fringe dominated by encrusting calcareous algae below.	Local
2. Moderately wave exposed bedrock and stable boulder shores with some sandy beaches near the entrance to Milford Haven. (Section 6.3.3)	The broken nature of rock surfaces and variable degree of localised shelter together with the presence of overhangs, crevices, small caves, boulders and rockpools leads to the presence of a rich variety of community types with an especially rich cryptic fauna. Rock pools at West Angle are the type locality for *Asterina phylactica*.	Regional
3. Sheltered bedrock or stable boulder shores within Milford Haven. (Section 6.3.5)	These shores are often fringed by sand or muddy sand on the lower shore and at these locations communities are representative of sheltered rocky shore communities but are not particularly rich nor do they include unusual species. However, where hard substrata occur near to low water, communities of algae and animals are rich and varied with several rarely encountered species or species not usually found on the shore occurring. The rating of importance refers to the latter shore type and includes areas at Wear Spit, Hazelbeach, Bullwell and the entrance to Pennar Gut in particular.	Regional

Table 7 (Continued)

4. Very sheltered bedrock or stable boulder shores in the Daucleddau. (Section 6.3.6)	This habitat occurs along an extensive stretch of the Daucleddau and near the entrances to the pills. Shores are often steeply sloping and are generally dominated by fucoids with sparse limpets and barnacles. Communities are typical of extremely wave sheltered conditions and are impoverished compared to the open coast. The lower shore is generally dominated by Dendrodoa grossularia with some sublittoral species in shaded places. The suggested importance relates to the sparsity if this very sheltered habitat in South Wales.	Regional
5. Clean sand and exposed or moderately exposed shores near the entrance to Milford Haven. (Section 6.3.4)	Communities living in sandy beaches appear to have a fairly restricted fauna, or have not been studied.	Local
6. Muddy sands on moderately exposed to sheltered shores in Milford Haven. (Section 6.3.8)	These shores are rich in species particularly where the muddy sands are mixed with coarser substrata at Dale Beach and the Gann Flats. Here, several different community types occur and their history of study and importance for teaching/research makes them of especially high interest. The Gann SSSI extends to MLW.	Regional/ National
7. Muddy sands in the Eastern Cleddau. (Section 6.3.9)	The presence of a sandy substratum so far up the estuary is unusual and therefore of some importance.	Regional
8. Creek muds and mud banks in Milford Haven and Daucleddau. (Section 6.3.10/11)	Muds occur in areas out of the main tidal flows in Milford Haven and in the creeks including Pembroke river which occur at intervals along Milford Haven and the Daucleddau. These areas have fairly rich intertidal communities for their type but their main conservation importance is linked to bird populations and the assessment is based mainly on ornithological interest.	Regional
9. Muddy sands in bays and inlets with intermittent clay deposition. (Section 6.3.10/11)	Where muddy sand or silt flats are lime-rich and overlain with a thin film of clay, conditions favour Zostera spp and Enteromorpha spp supporting large numbers of herbivorous wilfowl (wigeon).	Regional

Table 7 (Continued)

SUBTIDAL

10. Wave exposed bedrock near the entrance to Milford Haven. (Section 6.4.2)	Bedrock surfaces within the entrance to Milford Haven usually extend to only shallow depths and within the infralittoral before encountering sediment. Circalittoral rock is present at Chapel Rocks. Communities present include species common on the open coast.	Local
11. Moderately wave exposed bedrock and stable boulders in Milford Haven. (Section 6.4.3)	These communities are fairly rich in algae and animals and are typical of wave-sheltered locations where fully marine conditions exist. Several rare or unusual species occur.	Regional
12. Wave sheltered boulders and cobbles exposed to moderate tidal currents in in Milford Haven. (Section 6.4.4)	These substrata support an interesting community of algae in shallow water but have a fairly impoverished community dominated by barnacles in deeper water.	Local
13. Wave sheltered artificial substrata exposed to moderate tidal currents in Milford Haven. (Section 6.4.5)	The extensive systems of jetties and harbour walls in Milford Haven provide a habitat colonised by communities which are very different from those present on natural hard substrata including many species present in abundance not found or rarely found in other habitats.	Regional
14. Wave sheltered bedrock and boulders extending to cobbles exposed to moderate tidal streams in inner Milford Haven and the Daucleddau. (Section 6.4.6)	Steeply sloping or vertical bedrock and boulder surfaces occur at a large number of sites from Dockyard Bank north to Black Tar. Algal communities are limited in depth, penetration and and variety but animal communities include a high abundance of a small range of species characteristic of ria communities. The examples in Milford Haven and the Daucleddau are the best developed and most extensive known in southwest Britain although richer communities in similar situations are known to exist in Britain.	National

Table 7 (Continued)

15. Wave sheltered cobbles and pebbles exposed to moderate tidal streams in Milford Haven and the Daucleddau. (Section 6.4.7)	These habitats are most notable for the rich and characteristic algal communities which occur in Milford Haven particularly at Wear Point and in Pennar Mouth where Gigartina teedii and Soleiria chordalis are present. In the circalittoral, animal communities are a reduced rock community. Assessment is based mainly on algal communities.	Regional
16. Level sediment with shells, stones and and shell gravel. (Section 6.4.8)	Epibiota on level sediment is sparsely distributed and poor in species. Infaunal communities are fairly rich in species and typical of the sediment type they inhabit though affected to some extent by dredging and possibly effluents near to areas of commercial activity in Milford Haven.	Local/ Regional
17. Muddy sand with scattered maerl on the north side of Milford Haven near Stack Rock. (Section 6.4.8)	Maerl (calcified free-living Rhodophyta) is a rarely encountered habitat in southwest Britain with the best developed beds at Falmouth. Nevertheless, the areas of scattered live maerl in Milford Haven supported a slightly larger variety of epiphytes than recorded at Falmouth.	Regional
18. Muddy sand colonised by Zostera marina (Section 6.4.8)	Zostera marina occurs in most of of the rias being studied in southern Britain and examples with richer communities occur elsewhere. However, in South Wales, there are few examples and the assessment reflects this.	Regional

Table 8

Species of high scientific interest recorded during intertidal and subtidal surveys within Milford Haven, Daucleddau and Eastern & Western Cleddau rivers. Records included from 1976, 1978, 1979, 1980, 1981, 1982 and 1985.

Species	Notes	Suggested Importance
ALGAE		
Gelidiella calcicola	New species being described Maggs and Guiry (in press).	Regional
Solieria chordalis	First recorded in Milford Haven in 1978, since then increasing in both distribution and abundance. In 1985 abundant at two sites. Elsewhere in Britain recorded only from the South Coast (Chesil, Fleet, Weymouth and Falmouth).	Regional/ National
Gymnogongrus devoniensis	Northern limit in mainland Britain. Recorded in Milford Haven in 1978. Distribution Cornwall, Devon, Galway, Mayo, Down and France (Scholter, 1968).	National
Griffithsia devoniensis	Northern limit. First recorded in 1978. Common throughout sheltered sites. Elsewhere rare or locally distributed on the South coast.	National
Phyllophora traillii	Probably not unusual but rarely recorded because of small size.	Unknown
Stenogramme interrupta	Towards Northern limit (Ramsey) particularly abundant in mouth.	Regional
Gigartina acicularis	Northern limit in Britain.	Regional
Gigartina teedii	Extremely rare species in Britain. Only record of tetrosporangial plants. All other records of this species are from Cornwall and S. Devon.	National
Grateloupia doryphora	Discovered at Pembroke Ferry in January 1987 by S. Hiscock. Only known from a few locations in the Solent and recorded there as an unusual species.	Regional/ National
Rhodymenia delicatula	Under-recorded, very inconspicuous.	

Table 8 (Continued)

Phymatolithon calcareum) Lithothamnion corallioides)	No records of live maerl between Abersoch and Milford Haven probably under-recorded.	Regional
Antithamnion crispun	Rarely recorded; may be under-recorded.	
ANIMALS		
Asterina phyllactica	West Angle Bay is the type locality of this recently described species (Emson & Crump, 1979).	National
Halichondria bowerbankii	Rarely recorded elsewhere, found commonly on steep subtidal current swept bedrock throughout Milford Haven and the Daucleddau.	Regional
Dysidea fragilis	Within Milford Haven a cushion-like growth form unusual on open coasts is commonly found.	Regional

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APPENDIX 1

Results of sublittoral surveys undertaken in 1978 and 1979.

INTRODUCTION

Surveys of sublittoral habitats and communities were undertaken in Milford Haven as part of the Southwest Britain Sublittoral Survey (Hiscock, 1980). The work is described here together with records of habitats, communities and species not incorporated into the text of the main report. The survey teams were:

1978 (July 5th to 11th and October 11th): Annette Little, Keith Hiscock, Dale Rostron, Sue Hiscock, Nigel McCarter, Ruth Mensikov, Ian Bowler and Tim Brooks.

1979 (August 29th and September 5th): Annette Little, Keith Hiscock, Christine Maggs, Sue Hiscock and Francis Bunker.

METHODS

Survey

During the July 1978 survey, two botanists and two zoologists were responsible for the description of plant and animal communities whilst the remaining staff undertook the description of habitats and collection of material for laboratory identification. In October 1978 and in 1979, survey staff undertook both the recording of communities and habitats. Sites were selected to ensure that as wide a range of habitats as possible were surveyed in the time available. The sites were chosen by the inspection of maps and charts to include locations exposed to different environmental conditions. Also, a fairly regular spacing of sites was sought to enable mapping of boundaries. Sites were surveyed at coastal intercepts of the 10 km Ordnance Survey Grid where this was possible. Checklists were used throughout the survey and recording to ensure that species lists and habitat descriptions were comparable from worker to worker and site to site. The species included on those checklists are listed in Table 1. Field records were made on laminated plastic writing boards whilst one of the team (KH) used an underwater tape recorder to enable a larger number of tasks to be completed during each dive. Records were transferred to checklists and an edge-punched card for habitat data. Records of the abundance of species were made according to the scales shown in Table 2. Species which could not be identified with certaintly in the field were usually collected and subsequently identified.

Photography

Photographs of the different habitat types, communities and species were taken with a Nikonos underwater camera, electronic flash and, where required, a supplementary lens for close-up photography.

Interpretation of results

Sites were numbered sequentially from East to West for the 1978 survey sites and were lettered from East to West for 1979 survey sites. Descriptions

of the habitats present at each site were prepared from the edge-punched cards and site recording sheets. Lists of the species present at each site were used to prepare a list of sites at which each species occurred together with notes on habitat preferences. Two diagrams were prepared illustrating the distribution and abundance of species with depth at sites where particularly thorough records were available.

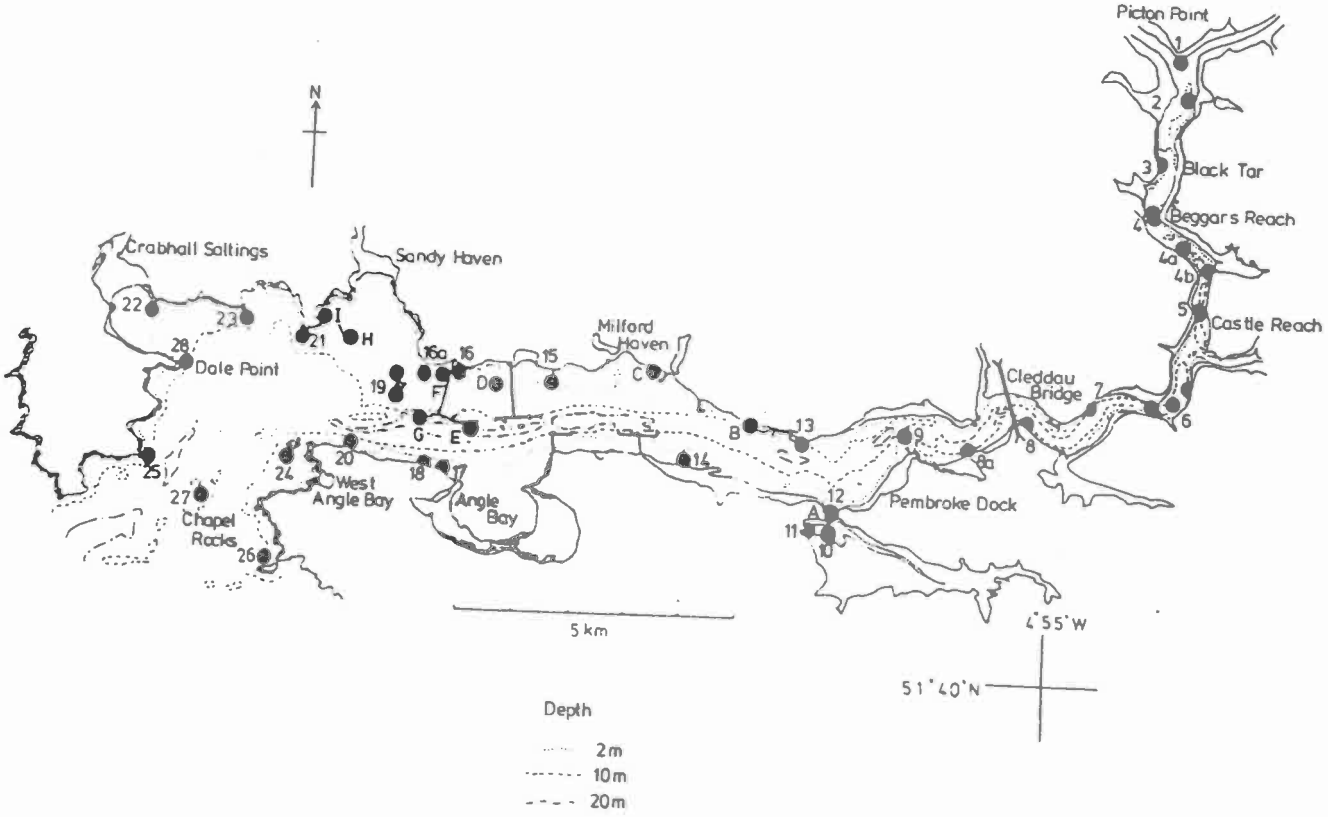

Fig. 1. Location of sites surveyed in 1978 and 1979.

RESULTS

The 44 sites studied are shown in Fig. 1 and listed, with a description of the main site features, in Table 3. The main results of the survey are summarised as an annotated species list at the end of the text. The zonation of species at two locations is shown in Figs. 2 and 3. Other results and conclusions have been incorporated into the Discussion section of the main report. Data sheets and copies of edge-punched cards are held by the NCC and by OPRU. Photographs have been deposited with the NCC with copies of some retained by OPRU.

TABLE 1.

List of taxa to be searched for and noted at each survey station. The numbers following names of animal taxa refer to the scale to be used in estimating abundance.

ALGAE

RHODOPHYTA

Scinaia forcellata
Scinaia turgida
Naccaria wiggii
Asparagopsis armata
Bonnemaisonia hamifera
Bonnemaisonia asparagoides
Schizymenia dubyi
Furcellaria lumbricalis
Polyides rotundus
Halarachnion ligulatum
Calliblepharis ciliata
Cystoclonium purpureum
Rhodophyllis divaricata
Plocamium cartilagineum
Sphaerococcus coronopifolius
Gracilaria verrucosa
Ahnfeltia plicata
Phyllophora crispa
Phyllophora pseudoceranoides
Phyllophora trailii
Schottera nicaeensis
Stenogramme interrupta
Chondrus crispus
Gigartina acicularis
Gigartina stellata
Gigartina teedii
Gigartina pistillata
Corallina sp.
Jania sp.
'Lithothamnia'
Mesophyllum lichenoides
Dilsea carnosa
Callophyllis laciniata
Kallymenia reniformis
Meredithia microphylla
Palmaria palmata
Lomentaria clavellosa
Lomentaria orcadensis
Rhodymenia delicatula
Rhodymenia pseudopalmata
R. pseudopalmata var. ellisiae
R. pseudopalmata var. pseudopalmata
Antithamnion plumula
Antithamnion sp.
Ceramium rubrum
Ceramium sp.
Griffithsia flosculosa
Griffithsia corallinoides
Halurus equisetifolius
Ptilota plumosa
Sphondylothamnion multifidum
Acrosorium reptans
Acrosorium uncinatum
Cryptopleura ramosa
Apoglossum ruscifolium
Hypoglossum woodwardii
Delesseria sanguinea
Membranoptera alata
Myriogramme sp.
Nitophyllum punctatum
Phycodrys rubens
Polyneura gmelinii
Polyneura hilliae
Radicilingua thysanorhizans
Dasya sp.
Heterosiphonia plumosa
Brongniartella byssoides
Chondria dasyphylla
Chondria sp.
Halopitys incurvus
Polysiphonia sp.
Pterosiphonia complanata
Pterosiphonia parasitica
Pterosiphonia pennata
Pterosiphonia thuyoides
Rhodomela confervoides
Porphyra sp.
'Encrusting browns/reds'

PHAEOPHYTA

Ectocarpus sp.
'Aglaozonia parvula'
Cutleria multifida
Zanardinia prototypus
Arthrocladia villosa
Desmarestia aculeata
Desmarestia ligulata
Desmarestia viridis
Carpomitra costata
Sporochnus pedunculatus
Chorda filum
Laminaria digitata
Laminaria hyperborea
Laminaria saccharina
Laminaria ochroleuca
Saccorhiza polyschides
Alaria esculenta
Halopteris filicina
Cladostephus spongiosus
Dictyopteris membranacea
Dictyota dichotoma
Padina pavonia
Taonia atomaria
Cystoseira foeniculacea
Cystoseira nodicaulis
Cystoseira tamariscifolia
Cystoseira sp.
Halidrys siliquosa

CHLOROPHYTA

Enteromorpha sp.
Codium sp.
Ulva sp.
Cladophora sp.
Bryopsis plumosa
Bryopsis hypnoides

TABLE 1 (Cont.)

ANIMALS

ROCK-LIVING SPECIES (ON PEBBLES AND LARGER)

PORIFERA
Pachymatisma johnstonia 1
Polymastia boletiformis 1
Polymastia mammilaris 1
Clathrina coriacea 3
Ciocalypta penicillus 1
Cliona celata 1
Suberites carnosus 1
Suberites domuncula 1
Tethya aurantia 1
Haliclona oculata 1
Stelligera stuposa 1
Axinella dissimilis 1
other 'axinellids' 1
Hymeniacidon perleve 1/3
Dysidea fragilis 1
Amphilectus fucorum 1/3
Halichondria panicea 3
encrusting sponges 3

HYDROZOA
Tubularia indivisa 2
Halecium halecinum 1/2
Amphisbetia operculata 3
Sertularia 'argentea' 3
Hydrallmania falcata 3
Kirchenpaeuria pinnata 3
Plumularia setacea 3
Aglaophenia spp. 3
Nemertesia ramosa 2
Nemertesia antennina 2
Gymnangium montagui 3

ANTHOZOA
Alcyonium digitatum 1
Alcyonium glomeratum 1
Eunicella verrucosa 1
Aiptasia couchi 1
Anemonia sulcata 1
Cereus pedunculatus 1
Tealia felina 1
Diadumene sp. 1
Metridium senile 1
Sagartia troglodytes 1
Sagartia elegans (small) 1
Sagartia elegans (large) 1
Actinothoë sphyrodeta 1
Aurelia (scyphistomae) 2
Caryophyllia smithi 2
Balanophyllia regia 2
Corynactis viridis 2/3
Parazoanthus dixoni 3
Epizoanthus couchi 2

ANNELIDA
Pomatoceros triqueter 2
Bispira volutacornis 1
Filograna implexa 1
Polydora sp. 3
Sabellaria spinulosa 2

PHORONIDAE
Phoronis hippocrepia 3

CRUSTACEA-CIRRIPEDIA
Balanus crenatus 3
Balanus perforatus 3
Verruca stroemia 3
Pyrgoma anglicum p/a

CRUSTACEA-DECAPODA
Caprellidae (in swarms)(2)
Jasiidae (tubes) (2)
Cancer pagurus 1
Homarus vulgaris 1
Palinurus elephas 1
Pagurus sp. 1
Galathea squamifera 1
Galathea strigosa 1
Carcinus maenas 1
Macropipus puber 1
Maia squinado 1
Palaemon serratus 1

MOLLUSCA
Patella sp(p). 2
Acmaea virginea 2
Gibbula cineraria 1
Buccinum undatum 1
Mytilus edulis 3
Modiolus modiolus 3
Anomiidae 2
Hiatella arctica 2
Crepidula fornicata 2

BRYOZOA
'Crisiidae' 3
Bugula plumosa 3
Bugula turbinata 3
Scrupocellaria sp(p). 3
Cellaria sinuosa 3
Flustra foliacea 3
Securiflustra securifrons 3
Cellepora pumicosa 1
Porella compressa 3
Pentapora foliacea 1
Parasmittina trispinosa 3
Escharoides coccineus 3
Umbonula littoralis 3
Electra pilosa 3
other encrusting bryozoa 3
Alcyonidium gelatinosum 1
Bowerbankia sp. 3

ECHINODERMATA
Asterias rubens 1
Marthasterias glacialis 1
Henricia oculata 1
Luidea ciliaris 1
Ophiothrix fragilis 2/3
Ophiocomina nigra 2
Antedon bifida 2/3
Echinus esculentus 1
Holothuria forskali 1
Cucumaria spp. 1

ASCIDIACEA
Clavelina lepadiformis 2
Dendrodoa grossularia 2
Molgula manhattensis 2
Stolonica socialis 2
Ascidia mentula 1
Ascidiella sp. 2
Polyclinum aurantium 2
'Polyclinidae' 2
Botryllus schlosseri 2
Didemnum sp(p). 2
Diplosoma listerianum 3
Ciona intestinalis 2
Distaplia rosea 2

PISCES
Labrus mixtus
Labrus bergylta
Crenilabrus melops
Ctenolabrus rupestris
Thorogobius ephippiatus
Pholis gunnellus
Chapparrudo flavescens

NO SCALE

SEDIMENT EPIFAUNA (ON COARSE GRAVEL & SMALLER)

COELENTERATA
Corymorpha nutans 2
Cereus pedunculatus 1
Peachia hastata 1
Ilyanthus mitchelli 1
Cerianthus lloydii 1
Virgularia mirabilis 1

ANNELIDA
Terebellidae 1
Sabellaria alveolata 3
Sabella penicillus 1
Myxicola infundibulum 1
Arenicola marina (casts) 1
Lanice conchilega 2

CRUSTACEA-DECAPODA
Goneplax rhomboides 1
Munida bamffica 1
Nethrops norvegicus 1
Macropipus spp. 1
Carcinus maenas 1
Pagurus sp. 1
Crangon crangon 1

MOLLUSCA
Gibbula magus 1
Buccinum undatum 1
Turritella communis 1
Nassarius reticulatus 1
Modiolus modiolus 3
Pecten maximus 1

ECHINODERMATA
Astropecten irregularis 1
Ophiura/Amphipholis 2
Ophiothrix fragilis 2/3
Ophiocomina nigra 2

PISCES
Gobiidae 1

TABLE 2.

Abundance scales used in 1978 and 1979 surveys.

ANIMALS

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

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

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

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

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

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

ALGAE

Kelps.

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

Foliose or filamentous undergrowth species.

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

Kelp stipe flora.

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

Crustose species.

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

TABLE 3.

Site number, name location and site features. Ordnance Survey Grid squares are given as letters. Exposure grades are determined from the scale given in Hiscock (1979). Depths are relative to chart datum.

Site No.	Site Name	O. S. Grid Reference	Depths Studied (to nearest 0.5 m)	Site Features
1	Picton Point	SN 003115	0-1.5 m	Extremely sheltered from wave action, exposed to tidal streams. Substrate was primarily of rippled muddy sand with some cobbles and small scattered boulders. A large tree on the bottom provided habitat diversity. Large numbers of empty Cerastoderma edule shells.
2	Opposite Sprinkle Pill	SN 006107	0.5-2.5 m	Extremely sheltered from wave action, moderately exposed to tidal streams. Infralittoral fringe was a mixture of highly fissured rock and pebbles. Then a pebble slope with a few boulders and large mussel beds onto a sandy mud plain at 2.5 m with large numbers of Cerastoderma edule shells with occasional rocks. Habitat diversity was increased by presence of wood, cans and other debris.
3	Black Tar	SM/SN 000095	0.5-2.5 m	Extremely sheltered from wave action, moderately exposed to tidal streams. The substrate consisted of small pebbles and mud from +0.8 - 0 m, then a steep boulder and rock slope merged into a plain of muddy cobbles and shells inshore, and mud with shell fragments further on. Habitat diversity increased by a tyre at 1.5 m.
4	Llangwm	SM/SN 000086	3.5-9 m	Extremely sheltered from wave action, exposed to tidal streams. The substrate consisted of muddy shell fragments with a few larger stones.
4a	Beacon north-west of Benton Wood	SN 007078	+1-4 m	Extremely sheltered from wave action, exposed to tidal streams. The substrate consisted of a slope of small boulders and stones down to 3 m where the bottom flattened on to a plain of small pebbles and shells (mostly Crepidula).

TABLE 3 (Cont).

Site No.	Site Name	O. S. Grid Reference	Depths Studied (to nearest 0.5 m)	Site Features
4b	South of Garron Pill	SN 009075	+1-11 m	Extremely sheltered from wave action, exposed to tidal streams. The substrate consisted of a steep bedrock slope with small cliffs to 3.5 m, then a fairly steep slope of stones to 9.5 m where a gently sloping plain of stones extended to the maximum depth of 11 m.
5	Castle Rocks	SN 008069	0-11.5 m	Extremely sheltered from wave action, exposed to tidal streams. The substrate consisted of bedrock cliffs descending in a series of steps with ledges piled with muddy boulders, pebbles and gravel. At 11.5 m the bottom consisted of a plain of pebbles and boulders with occasional bedrock outcrops all covered in thin flocculent mud.
6	Cosheston Trot South Side	SM/SN 000050	0.5-15.5 m	Extremely sheltered from wave action, exposed to tidal streams. The substrate consisted of a steep broken boulder and bedrock slope with some cliffs, overhangs, crevices, caves and potholes. This merged into a steep slope of small boulders bound together by sponges. At 10 m a gentle slope of pebbles decreasing in size to about 5 cm diameter at the deepest part, 15.5 m. Some large rock outcrops and boulders at all depths. Thin flocculent mud was present on the slope but not at the bottom where the pebbles are probably mobile under spring ebb and flood conditions.
	Cosheston Trot North Side	SM 999052	1-8 m	The substrate consisted of a very gentle slope of small boulders and pebbles which continued into a pebble slope extending to 8 m, where the bottom was of mixed gravel and muddy sand. The gravel was bare and in lumps, suggesting that it was highly mobile.

TABLE 3 (Cont).

Site No.	Site Name	O. S. Grid Reference	Depths Studied (to nearest 0.5 m)	Site Features
7	Burton Cliff	SM 988051	0-11 m	Extremely sheltered from wave action and exposed to tidal streams, especially at greater depths. The substrate consisted of a steep broken bedrock slope with some boulders and crevices followed by a broken boulder and pebble plain with muddy gravel between. The slope levelled out to a maximum depth of 11 m. There was a thick cover of mud at shallow depths, but at the bottom the mud was thin and flocculent with evidence of scour.
8	Pembroke Ferry	SM 977047 (1977)	0-15 m	Extremely sheltered from wave action and semi-exposed to tidal streams. The substrate consisted of a gentle unbroken slope of stable pebbles and small boulders. The plain at the base of the slope was of pebbles. There were isolated outcrops of bedrock. The substrate was covered with a thin layer of flocculent mud.
8a	Hobbs Point	SM 967043	0-6 m	Extremely sheltered from wave action and exposed to tidal streams. The substrate consisted of a man-made jetty, and below this there was broken rock slope with much debris. All surfaces were covered with silt.
9	Carr Spit	SM 955044	0.5-12 m	Extremely sheltered from wave action and semi-exposed to tidal streams. The substrate consisted of an extensive area of stable cobbles and dead oyster shells which sloped imperceptibly from 0.3 to 0.5 m. At the edge of this spot there was a little steep rock, then a steep slope with large amounts of debris such as large kelp stipes, bottles, car tyres, newspapers, etc. Underneath the debris there was thick mud. At about 7 m the debris petered out and the slope continued more gently with scattered cobbles with mud between. From 10 to 12 m there

(Continued)

TABLE 3 (Cont).

Site No.	Site Name	O. S. Grid Reference	Depths Studied (to nearest 0.5 m)	Site Features
				was more continuous cover of cobbles with scattered small boulders and many dead oyster shells. There was a sewage outfall nearby. All surfaces were covered in very light silt.
10	Pennar Pool	SM 942026	? 5 m	Extremely sheltered from wave action and sheltered from tidal currents. The substrate was a flat unbroken plain of mud at least 50 cm deep. No life observed.
11	Power Station Channel	SM 938025	1.5 m	Extremely sheltered from wave action and sheltered from tidal streams. The substrate was a man-made channel with mud in the bottom at least 50 cm deep. Very little life observed.
12	East to West Pennar Points	SM 942030-943030	+1-6 m	Extremely sheltered from wave action and exposed to tidal currents. On the east side the substrate consisted of muddy stones continuing onto a mixed sediment of small stones and muddy gravel to about 4 m, where a channel with steep sides was cut to about 6 m, with only a narrow shelf on the western side. The sides of this trench consisted of small stones covered in flocculent mud and a few patches of bare grey clay. There was some bare rock in the middle of the trench.
13	West of Wear Point	SM 937042	0-15 m	Extremely sheltered from wave action and semi-exposed to tidal streams. The substrate consisted of pebbles and small boulders extending to 13 m, below which was a mixed substrate of muddy gravel, shells and stones extending to 15 m.
14	Pwllcrochan Flats	SM 916038	0.5-10.5 m	Very sheltered from wave action and semi-exposed to tidal streams. The substrate consisted of an extensive mud flat gradually and the more steeply sloping towards the shipping channel to the north. There were a few scattered pebbles. There was a power station cooling water outfall nearby.

TABLE 3 (Cont).

Site No.	Site Name	O. S. Grid Reference	Depths Studied (to nearest 0.5 m)	Site Features
15	Milford Haven Conservancy Board Jetty	SM 892052	0-3 m	Sheltered from wave action and semi-exposed to tidal streams. The substrate consisted of a vertical concrete wall from 0 to 1.2 m, then a steep slope to 1.5 m and then vertical to 2 m. An overhang extended at least 2 m under the jetty except where the support columns were situated. The substrate under the jetty was a mixture of pebbles, shell fragments and mud with much debris such as pipes, cans and metal bars. There was evidence of tidal scour around the bars of the jetty. South of the jetty the substrate was a mixture of stones, mud and muddy gravel.
16	East of Esso Jetty	SM 875053	1-1.5 m	Semi-exposed to wave action and semi-exposed to tidal streams. The substrate consisted of a gentle unbroken slope of clean sand to 1.2 m. Then a mixed substrate of small stones, pebbles and sand. Everywhere the substrate was underlain by mud. There was evidence of scour.
16a	West of Esso Jetty	SM 868053	0.5-3.5 m	Semi-exposed to wave action and tidal streams. The substrate consisted of 'maerl' overlying sand at 0.5 m. In places there were patches of pebbles. At 3 m maerl gave way to rippled sand with scattered shells and stones. There was evidence of scour.
17	Angle Lifeboat Slip	SM 872035	0-1 m	Sheltered from wave action and semi-exposed to tidal streams. The substrate consisted of a wedge-shaped concrete block which provided the base for the slipway. An extensive inshore wall provided a rich habitat for a varied fauna and there were caves in the concrete in places.
18	East of Chapel Bay	SM 865036	0-3 m	Sheltered from wave action and semi-exposed to tidal streams. The substrate consisted of a boulder slope to about 2 m. Then a plain of mixed muddy sand, gravel and shell fragments with occasional large boulders. There were patches of thin silt.

TABLE 3 (Cont).

Site No.	Site Name	O. S. Grid Reference	Depths Studied (to nearest 0.5 m)	Site Features
19	South of Stack Rocks	SM 864049	1.8-6.8 m	Exposed to wave action and semi-exposed to tidal currents. The substrate from 3.8 m downwards was a broken gradual slope of pebbles and muddy gravel with occasional bedrock outcrops and some boulders. There was evidence of scour.
20	West of Chapel Bay	SM 856038	+0.5-5 m	Semi-exposed to both wave action and tidal streams. The substrate consisted of a rock slope down to 0 m, then for a short distance from the shore a gradual slope of coarse sand and gravel, with some mud mixed in, which graded into muddy sand and then to pure mud at about 4.5 m.
21	Great Castle Head	SM 847058	1.5-6.5 m	Very exposed to wave action and semi-exposed to tidal streams. The substrate consisted of a broken bedrock slope with many steep-sided gullies and crevices with some caves and overhangs. At about 5 m the slope became more gradual, with many large boulders. At about 50 m from the shore there was a plain of small pebbles with scattered large boulders and muddy gravel between. Much of the area was covered with fine silt. The boulders and pebbles were probably mobile during storms; there was evidence of scour.
22	Dale Roads North	SM 820062	3 m	[Restricted survey only.] Semi-exposed to wave action and sheltered from tidal streams. The substrate consisted of a flat plain of thick mud overlain with an easily disturbed layer of flocculent mud. Habitat diversity was provided by scattered pebbles and boulders.
23	Watch House Point	SM 836061	0-9 m	Very exposed to wave action and semi-exposed to tidal streams. The substrate consisted of a steep broken bedrock slope with large open gullies, narrow steep-sided gullies and overhangs. The gulley bottoms were filled with pebbles and boulders. In deeper water the gulley sides were coated in flocculent mud. In

(continued)

TABLE 3 (Cont).

Site No.	Site Name	O. S. Grid Reference	Depths Studied (to nearest 0.5 m)	Site Features
23	Watch House Point (cont.)			deeper water from 3 m there was a more gradual slope of small pebbles with scattered boulders, muddy sand and gravel. From 5.5 m the substrate consisted of a plain of 'glutinous, muddy, sandy gravel' with widely scattered stones extending to 8 m.
24	West of Thorn Island	SM 845038	+1-6 m	Very exposed to wave action and semi-exposed to tidal streams. Nearshore the substrate consisted of a steep bedrock slope with many deep, steep-sided gullies, some dead-end gullies, and open muddy caves. The broken slope merged into an area of boulders and stones and then onto a rippled sand plain and further out to small stones again. There was a thin layer of silt especially in the gullies.
25	West Blockhouse	SM 820035	0-8 m	Very exposed to wave action and exposed to tidal streams. The substrate consisted of a broken bedrock slope with many steep-sided gullies running at right angles to the coast. The rock surface was smooth. This slope continued to 8 m to a plain of boulders, pebbles and clean gravel. There was evidence of scour.
26	North of Sheep Island	SM 842017	+1-12 m	Very exposed to wave action and semi-exposed to tidal sdreams. The substrate from 0 to 2 m consisted of a steep broken bedrock slope. Then the slope angle decreased with very broken rock with gullies part filled with boulders and pebbles down to 7 m. Then the gullies were filled with coarse gravel. Then there was a coarse gravel plain with bedrock outcrops to 11 m followed by a flat plain of rippled gravel.

TABLE 3 (Cont).

Site No.	Site Name	O. S. Grid Reference	Depths Studied (to nearest 0.5 m)	Site Features
27	Chapel Rocks	SM 830029	12.5-14.5 m	Very exposed to wave action and semi-exposed to tidal streams. The substrate consisted of a gently sloping plain of broken bedrock from 12.5 to 14.5 m, with flat boulders and some crevices. There was a 1 to 2 cm covering of silt and some patches of gravel.
28	Dale Point (1976)	SM 825052	3-7.5 m	Exposed to wave action and semi-exposed to tidal streams. The substrate consisted of a broken rock slope with some overhangs, ridges and patches of stones. The rocks dip steeply south and the ridges run at right angles to the shore. All surfaces were covered with flocculent mud.
1979 sites				
A	Pennar Mouth	SN 943028	+1.5-5 m	Very sheltered from wave action, exposed to tidal streams. Adjacent to the eastern shore there was a gradual slope extending several tens of metres offshore. Near to the shore, the seabed was of pebbles and small boulders scattered over the surface. The shelf terminated in a steep slope of muddy pebbles and boulders which descended to a level seabed of mud with scattered pebbles and small boulders.
B	North of Gulf Jetty	SM 925047	+2-9 m	Very sheltered from wave action, sheltered from tidal streams. A gradually sloping mud bottom with widely scattered pebbles and small boulders present.
C	Wards Pier	SM 913048	3-4 m	Sheltered from wave action, semi-exposed to tidal streams, a gradually sloping mud bottom with widely scattered pebbles and small boulders.

TABLE 3 (Cont).

Site No.	Site Name	O. S. Grid Reference	Depths Studied (to nearest 0.5 m)	Site Features
D	Between Amoco and Esso Jetties	SM 879053	+1-2 m	Sheltered from wave action, exposed to tidal streams. Adjacent to and continuous with the shore was a slope of small and some large boulders on coarse sand. At about 0 m, a sparse bed of Zostera marina was present on muddy sand with scattered shell gravel. About 100 m offshore and 2 m depth, a dense bed of Zostera was present on muddy sand.
E	Jetty 4, Esso Jetty	SM 875044	+1-11.5 m	Sheltered from wave action, semi-exposed to tidal streams. A vertical jetty pile with a horizontal spur at -0.5 m.
F	Littlewick Bay	SM 873053	0-2.5 m	Sheltered from wave action, semi-exposed to tidal streams. Adjacent to and continuous with the shore was a fringe of large boulders on sand which terminated at +0.2 m. A very gently sloping seabed of muddy sand with some stones and shells was present to about -2 m with a sparse bed of Zostera marina. About 80 m offshore the bottom was of small stones and shells with muddy sand in between and some maerl present.
G	West Dolphin, Esso Jetty	SM 869046	+1-16 m	Sheltered from wave action, semi-exposed to tidal streams. A sloping ca. 80 cm diameter jetty pile.
H	Montreal Rocks	SM 855058	5-6 m	Semi-exposed to wave action and tidal streams. To the north of Montreal Rocks, the seabed was of coarse bare gravel with some shells in large waves. Near to the rocks, the seabed was of muddy sand with scattered stones and shells. The reef was of broken rock with some silt present on the rock.
I	Longoar Bay	SM 850062	+1-2 m	Semi-exposed to wave action, sheltered from tidal streams. A level plain of muddy sand with shells and a sparse bed of Zostera marina present. Muddy gravel present offshore.

Upper reach. Extremely sheltered from wave action and semi-exposed to tidal streams. (E. Cosheston Trot, south side.)

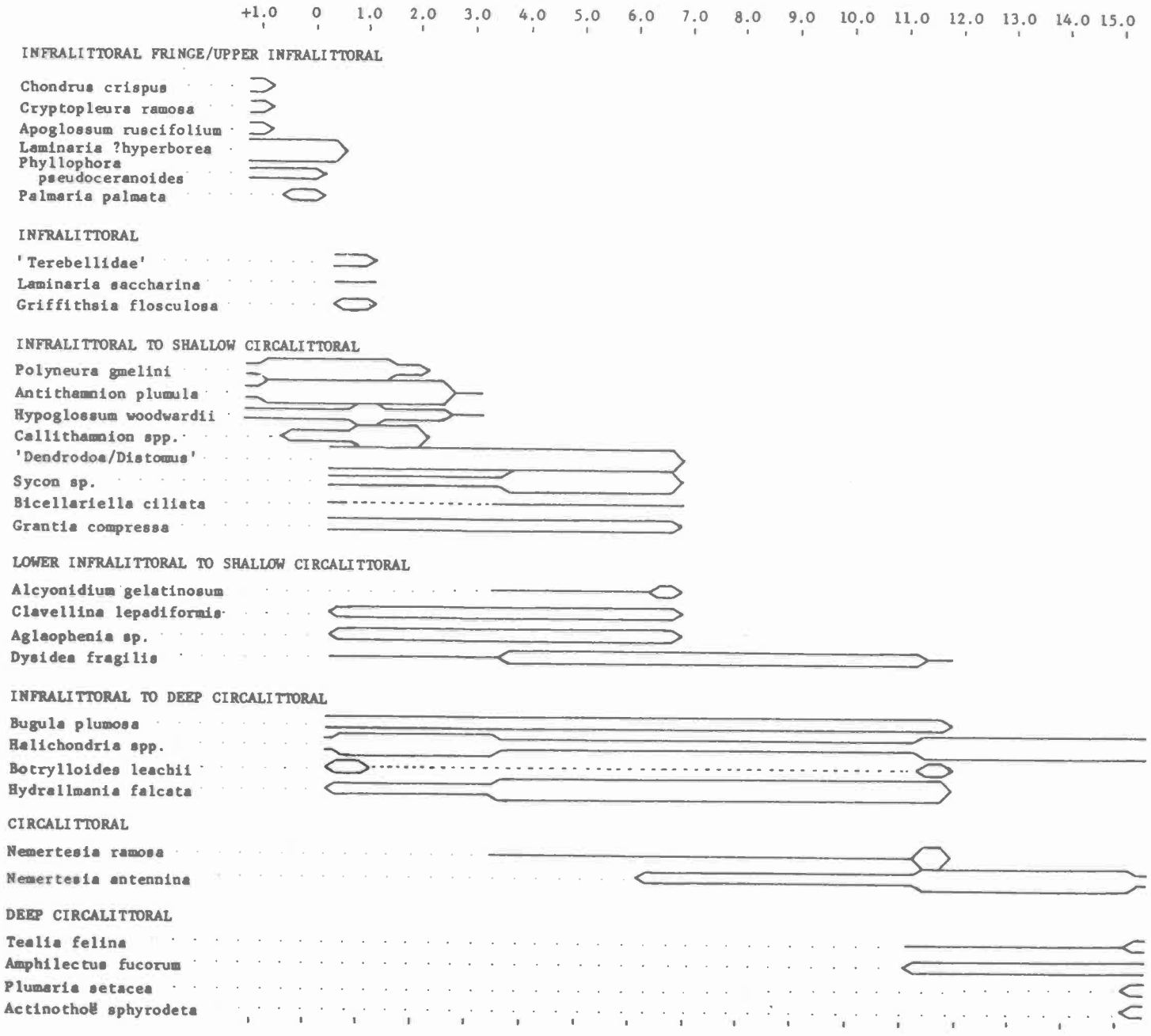

Fig. 2. Zonation of species at East Cosheston Trot (south side) in the Daucleddau

Mouth of Milford Haven exposed to strong wave action and semi-exposed to tidal streams. (Watch House Point.)

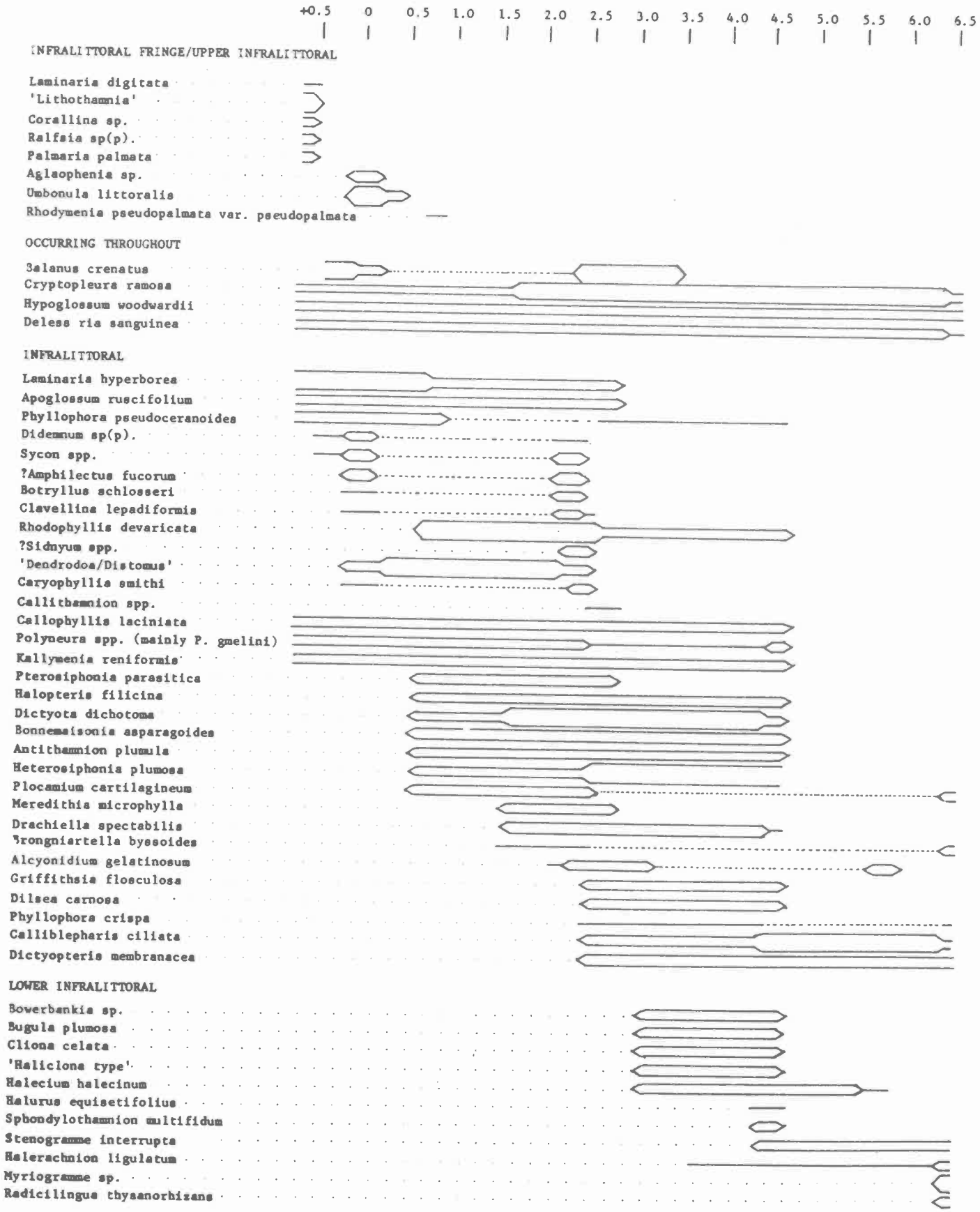

Fig. 3. Zonation of species at Watch House Point in the outer part of Milford Haven.

List of all species observed and collected in Milford Haven and the Daucleddau during subtidal surveys in 1978 and 1979.

In each case descriptions of distribution start with those stations highest up the estuary and proceed towards the mouth of Milford Haven.

'Present' denotes found in sample collected at site.

ALGAE

Species for which systematic records were collected (check list species):

On stable hard substrata.

RHODOPHYTA

Bonnemaisonia asparagoides: recorded as Occasional from 0.8 m to 1.8 m, South of Stack Fort, Dale Point (1976) and West Blockhouse Point. (1976). (19, 23, 25, 28).

Polyides rotundus: recorded as Frequent at 0 m at Castle Rocks and Occasional at +1 m between Esso and Amoco Jetties. (5, D, I).

Halarachnion ligulatum: recorded as Rare from 0 m to 1.7 m at Carr Spit. Frequent to Occasional from 2.4 m to 3.4 m west of Chapel Bay. Rare to Occasional from 4.6 m to 6.6 m at Watch House Point. Occasional at 5 m at West Blockhouse Point. Present at Dale Point (1976). (9, 20, 23, 25, 28).

Calliblepharis ciliata: recorded as the dominant alga at Carr Spit with 50% at 0 m, Frequent at 0.7 m and Occasional at 1.7 m. Common at 3-5 m South of Stack Rocks. Present at Great Castle Head, 6.8 m. Frequent at 2.7 m, 20% cover at 4.8 m at Watch House Point and Frequent at 6 m at West Blockhouse, 5 m. Localised patches where cover was 100%. Frequent at 0.5 m at North of Sheep Island, 40% at 5 m at Montreal Rocks. (9, 19, 20, 21, 23, 25, 26, 28, H, I).

Rhodophyllis divaricata: recorded at Carr Spit, then found at all stations from Milford Haven Conservancy Board Jetty to North of Sheep Island. Has a patchy distribution but in places cover may be more widespread, i.e. Watch House Point, 1.8 m, 20%. (9, 15, 18, 19, 20, 21, 23, 25, 26, D, H, I).

Plocamium cartilagineum: recorded at all sites to the west of South of Stack Rocks, with patchy localised distribution within a site. Found intermittently at all depths from 0.5 m to 6.0 m. Generally occasional to Frequent but common at 0.5 m on the North of Sheep Island, and dominant (20% cover) at 1-2 m at Great Castle Head. (19, 20, 21, 23, 25, 26, H, I).

Gymnogongrus devoniensis: confirmed as present West of Esso Jetty. (16a).

Ahnfeltia plicata: recorded as Present at east of Chapel Bay and Occasional at 0.4 m at west of Chapel Bay in sand at +1 m. Zostera bed between Esso and Amoco Jetties and in sand and stones at 0.3 m at Littlewick Bay. (18, 20, D, F).

Phyllophora crispa: presence confirmed at two stations. Rare at 2.7 and 6.6 m at Watch House Point; possibly present at Great Castle Head but young collected specimens could not be distinguished from Schottera nicaeensis. (21, 23, 25, H).

Phyllophora pseudoceranoides: found intermittently from Beacon northwest of Benton Wood to West Blockhouse from top stations out to Milford Haven Conservancy Board Jetty. Extended to 2 m at West Blockhouse. Occasional to Rare over most sites but more common at the uppermost stations with 5% cover recorded at 0 m at Beacon northwest of Benton Wood, South of Garron Pill to Castle Rocks. Not recorded for a continuous stretch of stations from Carr Spit to Pwllcrochan Flats. (4a, 4b, 5, 6, 7, 15, 19, 20, 21, 23, 25).

Schottera nicaeensis: Two records confirmed. Present at West Blockhouse and Montreal Rocks, possibly also at Great Castle Head to Milford Haven Conservancy Board pier. (?14, ?21, 25, H).

Chondrus crispus: recorded intermittently from Castle Rocks to West Blockhouse. Occasional to Frequent from 0-1 m from Castle Rocks to Burton Cliff. Occasional at 1.4 m at West Pennar Point. Present at East Chapel Bay, 2-3 m and Occasional at 3 m at West Blockhouse. Frequent between Esso and Amoco jetties at +1 m, Frequent at Littlewick Bay at 0.3 m. (5, 6, 7, 11, 18, 25, D, F, I).

Corallina sp.: Common at +0.5 m at West Blockhouse, recorded in 1976. 5% cover at +0.5 m, North of Sheep Island. (25, 26).

'Lithothamnia': recorded intermittently from Beacon northwest of Benton Wood to the mouth of the Haven (with increasing cover). Rare to Occasional from Beacon northwest of Benton Wood to Carr Spit 0-1 m. Frequent at Jetty 4, Esso Jetty and at Pennar Point, 1.4 m. 5% cover at Great Castle Head at 1.2 m. 30% at Watch House Point at +0.7 m. 40% locally, 90% at West Blockhouse at 3 m, 10% at 5 m. 10% at North of Sheep Island at 0.5 m. 80% at 1-1.5 m, 80% at 3 m. (4a, 5, 9,12, 19, 20, 25, 26, G., H, I).

Dilsea carnosa: widespread but uncommon from Cosheston to West Blockhouse from 0.4 to 0 m, Rare to Occasional. (6, 7, 18, 20, 23, 25, H).

Kallymenia reniformis: recorded in the mouth of the Haven from south of Stack Rocks to North of Sheep Island. Occasional to Frequent from 0.7 m to 6 m. (19, 21, 23, 25, 26, 28, H, I).

Meredithia microphylla: recorded from two stations, at Watch House Point at 1.8 m, found occasionally on walls, and at 2.7 m in about the same density. Also Occasional at 3 m at North of Sheep Island. Recorded in 1976 from Dale Point and from West Blockhouse, 1.5 m. (23, 25, ?26, 28)

Lomentaria clavellosa: recorded very intermittently from South of Garron Pill to Watch House Point. Occasional to Rare from 0.7 to 3.0 m. Inside Pennar Gut (Occasional to Frequent at, 0-1 m), Wards Pier, Milford Shelf (Occasional at 3 m), Littlewick Bay (epiphytic on Zostera at 1.3 m). (4b, 6, 9, 18, 20, 23, A, C, F, H).

Lomentaria orcadensis: one isolated record from opposite Sprinkle Pill where it was found in the collected sample, then a long gap until turning up again

in the samples from South of Stack Rocks, and west of Chapel Bay. Records during diving from Watch House Point, West Blockhouse and North of Sheep Island; for the first two of these L. orcdensis is more common with depth. Rare at 0.8 m, 2.7. Occasional at 5-6.6 m, but at North of Sheep Island recorded as Frequent at 0.5 and 1.5 m. Not recorded at greater depths. (2, 19, 20, ?21, 23, 25, 26, 28).

Rhodymenia pseudopalmata var. ellisiae: Present in a sample collected between 6 and 8 m from Great Castle Head. Also present at Montreal Rocks. (21, H).

Rhodymenia pseudopalmata var. pseudopalmata: intermittent records from South of Stack Rocks to Dale Point. Present in collected samples for South of Stack Fort and Dale Point. Recorded as Occasional on walls at 5 m and Present at 6 m at West Blockhouse and as Rare at 0.8 and 6.6 m at Watch House Point. Possibly present but not verified at Great Castle Head. (19, 23, 25, 28, H, I).

Antithamnion spp./Callithamnion spp./Polysiphonia spp./Griffithsia spp.: these five red alga genera are very difficult to separate underwater and are also hard to assess for percentage cover since they appear as transparent red.

Antithamnion plumula: identified from the majority of stations from opposite Sprinkle Pill to Watch House Point. (2, 3, 4a, 4b, 5, 6, 9, 12, 15, 18, 19, 20, 21, 23, 25, 28, A, C, D, F, Frequent at G.)

Callithamnion sp.: recorded at Cosheston Trot, 20% at 0.8 m, 10% at 1.8 and 2.5 m, Occasional at +0.2 m. Opposite Sprinkle Pill, Present at 1 and 2 m. Black Tar, Frequent at 0.2 m. Beacon northwest of Benton Wood, Present at 0 m, 1 m, 2 m. South of Garron Pill, Present at +1.0, 1 and 2 m. Castle Rocks, Present at 0, 1, 2 m. East Pennar Point, Occasional at 1.4 m, Frequent at 2.5 and 3.5 m. Milford Conservancy Pier, Present at 0-2 m. Great Castle Head, Present at 1.2 m. Watch House Point, Rare at 1.8 m. Esso Jetty 4, Common at 0.5 m on horizontal surface. Littlewick Bay, epiphytic on Graciliaria at 0.8 m. Montreal Rocks, tops of rocks at 5-6 m. (2, 3, 4a, 4b, 5, 6, 12, 15, 21, 23, E, F, H).

Griffithsia corallinoides: showed different distribution from the other three Griffithsia spp. Present at all stations of the central region of the Haven from East Pennar Point to West Chapel Bay, from +0.5 to 3.4 m. Usually Rare to Occasioal but was Common at 1.5 m on the Milford Haven Conservancy Board Pier. (12, 14, 15, 19, 20, D, E, F).

Griffithsia flosculosa: recorded from scattered stations from Beacon northwest of Benton Wood to Watch House Point. (2, 4a, 5, 18, 20, 23, A, C, E, F, G, H, I).

Griffithsia devoniensis: found to be present in high densities at sites furthest inland in shallow water, but also found at East Pennar Point. Opposite Sprinkle Pill, 40% at 0.2 m, 20% at 0.5 m. Present at 1 and 2 m. Black Tar, Frequent at 0.2 m, 10% at 0.8 m. East Pennar Point, Occasional at 2.5 and 3.5 m. (2, 3, 4a, 4b, 5, 12, A).

Polysiphonia spp: recorded from stations from Opposite Sprinkle Pill to North of Sheep Island. No attempt was made to identify these to species level. (2, 3, 4, 18, 19, 21, 25, A, E, G, I).

Dasya sp.: Present South of Garron Pill. (4b).

Ceramium rubrum: Frequent at 0.4 m in West Chapel Bay and in similar depth epiphytic on Zostera at Littlewick Bay. Dominant under canopy species amongst Zostera (10% cover) in Longoar Bay. (20, D, H, I).

Ceramium spp: recorded as Rare at Carr Spit at 0.7 m and at West Chapel Bay at 3.4 m. Present in samples from Castle Rocks. Frequent in Littlewick Bay both as an epiphyte on Chorda filum and on stones. Epiphytic on Zostera, at +0.5 m, between Amoco and Esso Jetties. (5, 9, 20, D, F).

Halurus equisetifolius: recorded from Watch House Point. Rare at 4.8 m North of Sheep Island, Present between 0-3 m. Also recorded at West Blockhouse (1976) where it was found to be Common at 0.5 m. (23, 25, 26).

Sphondylothamnion multifidum: recorded from three sites. Present between 6-8 m at Great Castle Head. Occasional at 4.8 m at Watch House Point. Rare at 3 m at West Blockhouse. (21, 23, 25).

Acrosorium uncinatum: recorded from four stations, at two of which it was an important component of the foliose algal cover. At Watch House Point A. uncinatum and Cryptopleura ramosa together formed 30-40% cover at 1.8 m, 10% cover at 2.7 m, 15% cover at 4.8 m, and was Frequent at 6.6 m. At West Blockhouse A. uncinatum and C. ramosa provided 40% cover at 3 m, 20% at 5 m, and A. uncinatum 10% at 6 m. Also recorded from Great Castle Head and North of Sheep Island. (21, 23, 25, 26, 28, H).

Cryptopleura ramosa: recorded at most stations from Beacon northwest of Benton Wood to North of Sheep Island. In the upper part of the Haven down to South of Burton Cliff, recorded as Occasional to Frequent with maximum depth of 2 m. 30% cover at Carr Spit at 0.1 m. From Watch House Point a mixed record for Acrosorium uncinatum and C. ramosa was made, as they occur together. This mixture was recorded as 30-40% cover at 1.8 m at Watch House Point and 40% at 3 m , 20% at 5 m at West Blockhouse. (4a, 4b, 5, 6, 7, 14, 15, 19, 20, 21, 23, 25, 26, D, E, G, H, I).

Apoglossum ruscifolium: recorded intermittently from Beacon northwest of Benton Wood to Watch House Point. Most records from Rare to Frequent in shallow water. One deeper than 2.7 m; found present in collections from 6-8 m at Great Castle Head. Upstream, it was recorded at Beacon northwest of Benton Wood and Castle Rocks. (4a, 5, 6, 15, 21, 23, D, G).

Hypoglossum woodwardii: recorded at most sites from Opposite Sprinkle Pill to North of Sheep Island. Generally Occasional to Frequent through all depths occupied by red algae. Deepest recorded alga from Opposite Sprinkle Pill down to Cosheston Trot. Very Common at 2 m Opposite Sprinkle Pill and at 0.8 m at Cosheston Trot. (2, 3, 4b, 5, 6, 7, 9, 12, 15, 18, 20. 21, 23, 25, 26, B, C, H, I).

Delesseria sanguinea: two isolated records at Beacon northwest of Benton Wood and at Burton Cliff. Then recorded at all stations from East Chapel Bay to North of Sheep Island. Generally Occasional to Frequent in shallow water. Rare towards lower algal limit. (4a, 7, 18, 20, 21, 23, 25, 26, G, H).

Myriogramme sp.: recorded from three sites. Common towards lower limit of algae at stations in the mouth of Milford Haven. 10–20% cover at 6 m on bedrock and boulders at West Blockhouse and 10–20% cover on rock outcrops at Watch House Point. Also recorded at Great Castle Head. (21, 23, 25, H).

Nitophyllum punctatum: recorded intermittently from Carr Spit to North of Sheep Island. Usually Rare to Occasional but Frequent at 3.5 m at East Pennar Point. (9, 12, 14, 18, 20, 21, 25, 26, D).

Phycodrys rubens: recorded on rock at Great Castle Head. Present on kelp stipes at sites from West Chapel Bay to West Blockhouse. (21, 23, 25, G).

Polyneura gmelinii: recorded from most sites from Opposite Sprinkle Pill to North of Sheep Island. Found at all depths. Rare to Frequent, present in high densities at a few sites. Opposite Sprinkle Pill, 5% cover at 2 m. Cosheston Trot, 5–10% cover at +0.2 m, 20% at 2.5 m. West Blockhouse, 25% cover at 3 m, 15% cover at 5 m. (4a, 4b, 5, 6, 7, 9, 12, 14, 15, 20 21, 23, 25, 26, A, E, G, H).

Polyneura hilliae: Recorded but not confirmed.

Radicilingua thysanorhizans: recorded from Watch House Point where Frequent at 6 m and from West Blockhouse where Frequent on walls at 3 m, Frequent at 5 m, and was the most abundant species with 30% cover at 6 m. (23, 25).

Heterosiphonia plumosa: recorded from Carr Spit (Rare at 0.7 m) to North of Sheep Island. Density very variable. Most common at Watch House Point, 20% at 2.7 m and 30% at 4.8 m. Not commmon in shallow water. (9, 12, 19, 20, 21, 23, 25, 26, 28, D, H, I).

Brongniartella byssoides: recorded intermittently from East Pennar Point to North of Sheep island. Rare to Frequent from 0.5 to 6.6 m. 5% cover at 3 m at North of Sheep Island. (12, 15, 19, 23, 25, 26).

Chondria dasyphylla: recorded from Pwllcrochan Flats (Rare at 2 m) and from West Chapel Bay where Frequent at 1.4, 2.4 and 3.4 m on substrata going from boulders with gravel between, through small stones to surface mud. Also Frequent between Esso and Amoco Jetties in clearings in the Zostera bed, Occasional in Littlewick Bay. (14, 20, D, F, I).

Pterosiphonia parasitica: recorded from three sites. Present from South Stack Fort at 0.5–2.5 m. Occasional at Watch House Point, at 0.8 m, locally Frequent at 1.8 and 2.7 m. Present in sample from North of Sheep Island. (19, 23,26).

Rhodomela confervoides: very scattered records from Beacon northwest of Benton Wood to West Blockhouse. Occasional to Frequent at four sites, but very common at 0.0–0.5 m at Milford Haven Conservancy Board pier and 15% cover at West Blockhouse. (4a, 5, 15, 19, 20, 25, A).

Encrusting reds/browns: isolated records for encrusting reds from Beacon northwest of Benton Wood, Occasional at 0 m, Castle Rocks, 1% cover at 1 m and at North of Sheep Island, 5% cover at 1.0–1.5 m and 10% at 3 m. (4a, 5, 26).

Ralfsia sp.: recorded as Occasional at +0.7 m at Watch House Point and Frequent at 3 m at West Blockhouse. (23, 25).

PHAEOPHYTA

Cladostephus sp.: Rare at +0.5 m between Amoco and Esso jetties on Zostera. (4a, 5, 26, F).

'Aglaozonia parvula' (diploid phase of Cutlaria multifida): Occasional at 3 m and Frequent at 5 m at West Blockhouse. (25).

Zanardinia prototypus: Rare at 5 m at West Blockhouse. (25).

Arthrocladia villosa: confirmed record of Occasional at 2.4 m at West Chapel Bay. Record from Carr Spit (Rare at 0.7 m) is not confirmed. (?9, 20).

Desmarestia aculeata: recorded from a group of five sites from Milford Haven Conservancy Board Jetty to West Blockhouse. Occasional to Frequent from 0.5 to 5.0 m. (15, 18, 19, 20, 25).

Desmarestia ligulata: recorded from three sites. Milford Haven Conservancy Board jetty, Occasional at 0.5 m. South of Stack Fort, Present at 0.5-5 m. Watch House Point, Rare at 1.8 m. (15, 19, 23).

Desmarestia viridis: Present in sample collected from Watch House Point. (23).

Laminaria digitata: identification of kelp plants at upriver stations was difficult, and there was a lack of consistency in the records made. However, it appears that L. digitata was Common to Abundant on suitable substrata down to 0 m from Beacon northwest of Benton Wood to Burton Cliff. At East Pennar Point, probable record to 1.8 m, and at Great Castle Head to 1.2 m. At Watch House Point, Rare at +0.7 m, and at North of Sheep Island Abundant at 0.5 m. (4a, 4b, 5, 7, 12, 21, 23, ?D, E, G).

Laminaria hyperborea: identification of kelp plants at upriver sites was difficult. It appears that L. hyperborea was Abundant at around 0 m but rarely penetrated below 2 m from Beacon northwest of Benton Wood down to East Pennar Point. Penetration into the sublittoral was greater at sites in the mouth of Milford Haven. Abundant at +0.7-0.8 m, Common at 1.8 m and Frequent at 2.7 m at Watch House Point. Common to Abundant at 3 m, Frequent at 5 m and Rare at 7 m at West Blockhouse Point. Super-abundant at 0.5-1.5 m and Common to Abundant at 3 m at North of Sheep Island. (4a, 4b, 5, 6, 18, 19, 20, 21, 23, 25, 26, 28, G, I).

Laminaria saccharina: recorded from Cosheston Trot to North of Sheep Island. Most common in the lower middle reaches of Milford Haven from East Pennar Point to West Chapel Bay. Found from 0 m at Milford Haven Conservancy Board Jetty to 3.8 m at Pwllcrochan Flats. Common to Abundant at 1.4 and 2.0 m at East Pennar Point. Super-abundant at 0-0.5 m at Milford Haven Conservancy Board Jetty where undivided plants were upwards of 2 m in length, and at East Chapel Bay plants 3-4 m in length were Frequent at 2-3 m. Abundant at 0.3 m at Littlewick Bay on sandy slope with stones. Common to Abundant at West

Chapel Bay at 1.4 m. At the North of Sheep Island, L. saccharina did not appear on the continuous bedrock but was present on stable boulders on bedrock/shingle plain. (6, 9, 12, 14, 15, 18, 20, 25, 26, A, C, D, F, G, I).

Saccorhiza polyschides: Rare at 0.4 m at West Chapel Bay on boulders with gravel between Rare at 1.0 m on small stones at Longoar Bay. (20, I).

Laminaria sporelings: noted as Occasional to Frequent at sites from Beacon northwest of Benton Wood to East Pennar Point and at Watch House Point. Records almost certainly incomplete. (4a, 5, 6, 9,12, 23, I).

Alaria esculenta: Present in shallow (less than 3 m) water at West Blockhouse. (25).

Halopteris filicina: recorded at three sites in the mouth of Milford Haven. Present in sample from 6-8 m at Great Castle Head. Occasional to Frequent from 0.8-4.8 m at Watch House Point. Rare from 5 m at West Blockhouse. (21, 23, 25, I).

Dictyopteris membranacea: recorded at the same sites as Halopteris filicina. Shallowest record, Frequent at 1.2 m at Great Castle Head. At Watch House Point, Occasional to Frequent from 2.3 to 6.6 m. At West Blockhouse, Frequent at 3 m, 10% at 5 m and 5% cover at 6 m. (21, 23, 25).

Dictyota dichotoma: recorded at most stations from Milford Haven Conservancy Board Jetty to North of Sheep Island, from 0.5 m. Generally Rare to Frequent but Abundant at two sites. For example, at Watch House Point, 10% at 1.8 m, 15% at 2.7 m, and at West Blockhouse, 10% at 5 m and 20% at 6 m. Very large plants found at 0.5 m on the vertical wall of the Milford Haven Conservancy Board Jetty. (15, 18, 19, 21, 23, 25, 26, G, I.)

Taonia atomaria: recorded at West Blockhouse. Rare at 6 m on boulders, and during 1976 Common on boulders at 1.5 m in the same locality. (25).

Halidrys siliquosa: recorded at West Chapel Bay where it was Occasional at 0.4 and 1.4 m. Occasional on boulders in gravel, and Rare at 3.0 m in Longoar Bay. (20, I).

CHLOROPHYTA

Enteromorpha spp.: recorded from the south side of Milford Haven from East Pennar Point to West of Chapel Bay, from 1.2 to ?3.5 m. Area sheltered from wave action but tideswept. Particulary common at East Pennar Point. 30% cover at 1.4 m, which, with Ulva sp., provided the dominant undergrowth flora. Also Abundant at Pennar Gut and at Jetty 4, Esso Jetty on the south side of Jetty piles. (12, 14, 18, 20, A, E, F, I).

Ulva sp.: widespread from Beacon northwest of Benton Wood to West Chapel Bay. Particularly common at points near freshwater or sewage input, e.g. South Garron Pill, Common at +1 m. Carr Spit, 30% cover at 0.1 m. East Pennar Point, 30% at 1.4 m. (4a, 4b, 5, 7, 9, 12, 14, 15, 18, 20, A, C, D, E, G, I).

Cladophora spp.: isolated records westwards as Rare to Frequent at depths from 0.3 to 3.5 m, from East Pennar Point to Dale Point (1976). (12, 14, 20, 28, F, I).

Bryopsis plumosa: isolated records westwards from Pwllcrochan Flats. Occasional at 1.2 m. Milford Haven Conservancy Board, Occasional at 0 m. At West Chapel Bay, Rare at 1.4 m. Between Amoco and Esso jetties, Occasional at 1 m. (14, 15, 20, C, D, E, F, I).

Bryopsis hypnoides: Present in a sample collected from 0.5–2.5 m, South of Stack Fort. (19).

Growing in sediment

ANGIOSPERMAE

Zostera sp.: Present at 1.2 m East of Esso Jetty in area subject to scour. Clean sand, shells and small stones. west of Esso Jetty. Upriver of Beacon northwest of Benton Wood, Rare Zostera plants were apparently rooted and surviving at 0 to 1 m. (?4a, 16, D).

Epilithic on hard mobile substrata

Scinaia forcellata: recorded from East Chapel Bay. Rare at 2.8 m on small stones, some of which were being dragged along with current. Rare in clearing of Zostera at 1 m, between Amoco and Esso jetties. (18, D).

Stenogramme interrupta: recorded intermittently from Carr Spit to Dale Point (1976). Occasional to Common on shells, small stones and pebbles, from 0.1 to 6.6 m. Rare to Occasional, found on bedrock. Between Amoco and Esso jetties, Rare on stones in dense Zostera at 1 m. (9, 12, 19, 20, 23, 28, D, I).

Gracilaria verrucosa: recorded as Frequent in areas of soft mobile substratum with small stones or shells stable for part of the year. Frequent from 0.5, 1.2 and 3 m. Common at 2 m in Longoar Bay. (5, 14, 18, 20, C, D, F, I).

Chorda filum: recorded at stations in the lower middle reaches of Milford Haven from Pwllcrochan Flats to West Chapel Bay in areas sheltered from wave action, where the substratum may be mobile in winter. Rare to Frequent from 1.2 to 3 m. At 1 m in Zostera bed between Amoco and Esso jetties, Abundant at 0.3 m at Littlewick Bay. (14, 16, 18, 20, D, F, I).

Epiphytic on kelp stipes and holdfasts

Membranoptera alata: recorded at four stations from West Chapel Bay to North of Sheep Island. Occasional to Common on kelp stipes. Common at +0.2 to 0.5 m. Occasional to Frequent at 0.8 to 1.8 m. Epilithic at 1.0 m on pier pile at Jetty 4, Esso Jetty (E). (20, 21, 23, 26, E, G, I).

Palmaria palmata: recorded as Common at 0 m at Castle Rocks and Rare at Cosheston Trot at +1.2 m. Common to Abundant at shallow depths from Chapel Bay to North of Sheep Island. (6, 20, 21, 23, 25, 6, G, I).

Phycodrys rubens: recorded from West Chapel Bay to North of Sheep Island, from +0.7 to 5 m. (20, 26, I).

Callophyllis laciniata: recorded as Occasional at 1.8 m at Watch House Point and Rare at West Dolphin Esso Jetty. (G).

Cryptopleura ramosa: Frequent to Abundant at four sites. Great Castle head to North of Sheep Island from +0.7 to 5 m. (21, 23, 25, 26).

Additional Records (non check list species) (records not necessarily collected systematically).

Epilithic on stable hard substrata, or on sediment substrata

Scinaia forcellata: Rare on stones at 1 m at Longoar Bay. (I).

Furcellaria lumbricalis: On occasional stones East of Ward's Pier. Present at Littlewick Bay and between Amoco and Esso Jetties, +1 to +0.5 m. (C, D, F).

Solieria chordalis: Recorded at East Pennar Point, dominant foliose alga on stones. 5% cover at 2.5 m. 20% cover at 3.5 m. (12).

Gymnogongrus crenulatus: recorded as Common at +0.5 m at West Blockhouse in 1976. Occasional at 3.5 m at Longoar Bay. (I).

Maerl: dominant, 100% cover at 0.5 to 3 m at West of Esso Jetty, covering sandy sediment. Dense maerl debris with some living at 3.3 m at Littlewick Bay. (16a, F).

Phymatolithon calcareum: Rare at 1 m between Amoco and Esso Jetties. (D).

Callophyllis laciniata: recorded at stations from East Chapel Bay to West Blockhouse from +0.7 to 4.8 m. (18, 20, 21, 23, 25, 28, D, I).

Palmaria palmata: epilithic records at scattered sites from Cosheston Trot to Watch House Point. Large plants noted at East Pennar Point. (6, 12, 18, 23, D, E, F).

As an epiphyte on Laminaria hyperborea, recorded as Rare at Cosheston Trot at +1.2 m, then Common to Abundant at shallow depths from West Chapel Bay to North of Sheep Island. (6, 20, 21, 23, 25, 26).

?Cordylecladia erecta: recorded at west of Chapel Bay. Rare at 0.4 m and Occasional at 3.5 m at Longoar Bay. (20, I).

Chylocladia verticillata: Frequent, epiphytic on Zostera at +0.5 m between Amoco and Esso Jetties. Epiphytic on Zostera at 1.3 m at Littlewick Bay. (D, F).

Plumularia elegans: Present at West Dolphin, Esso Jetty. (G).

Acrosorium reptans: Rare on stones in dense Zostera at 1 m between Amoco and Esso Jetties. (D).

Drachiella spectabilis: recorded at stations in the mouth of Milford Haven. Rare to Frequent on bedrock from 1.8 to 8 m. (21, 23, 24, 26, 28).

Polysiphonia nigrescens: Recorded at Jetty 4, Esso Jetty and Littlewick Bay. (E, F).

?Bangia: on hydroids on Zostera at +0.5 m between Amoco and Esso Jetties. (D).

Porphyra sp.: recorded as epiphytic on Zostera at +0.5 m between Amoco and Esso Jetties. P. laciniata Frequent to Occasional there and at Jetty 4, Esso Jetty. (D, E).

Diatom film with Derbesia/Vaucheria: large patches on mud at 3 m at east of Ward's pier. Occasional clumps in silt at 0.8 m at Littlewick Bay. (14, B, C, D, F).

Colonial diatoms: not recorded systematically. Frequent at 1.4 m and 2.4 m at West Chapel Bay on gravel. (20).

Ectocarpus sp.: epilithic between Amoco and Esso Jetties and at Jetty 4, Esso Jetty. Frequent at Littlewick Bay and Longoar Bay, epilithic on Chorda filum. (D, E, F, I).

Asperococcus sp.: recorded from East and West Chapel Bay sites. Occasional from 2 to 3 m. (18, 20).

?Punctaria sp.: recorded at East Chapel Bay, Frequent at 2-3 m. (18).

Sphacelaria sp.: recorded in 1976 at Dale Point.

Fucus serratus: recorded as Occasional at +1 m at South of Garron Pill. (4b).

?Vaucheria sp.: recorded at Pwllcrochan Flats with up to 15% cover from 1.2 to 1.8 m. (14).

Epiphytic on Laminaria spp. or Fucus spp. (L. hyperborea stipe flora unless otherwise noted).

Ectocarpus sp.: Present on fronds of Laminaria sp. at Cosheston Trot at +1.2 m and between Amoco and Esso Jetties. (6, D).

Chaetomorpha sp: Present on stipes at 0.4 m at West of Chapel Bay. (20).

Laminaria digitata: Occasional on stipes at Great Castle Head. (21).

Dictyota dichotoma: On rippled fronds on West Dolphin, Esso Jetty. (G).

Antithamnion plumula: Present at epiphyte on torn Laminaria fronds on West of Dolphin, Esso Jetty. (G).

Griffithsia flosculosa: recorded as Rare at 2.7 m at Watch House Point. (4a, 5, 6, 7, 9, 18, 23).

Polysiphonia sp.: recorded at isolated sites from Great Castle Head, Occasional at 1.2 m. Watch House Point, Common at 0.7 m, and North of Sheep Island, localised patches, Occasional, at 0.5 m. (21, 23, 26, E, F).

Hypoglossum woodwardii: recorded as Frequent at 0.5 m at North of Sheep Island. (26).

Lomentaria articulata: recorded as Occasional at 0.5 m at North of Sheep Island. (26).

Lomentaria clavellosa: epiphytic on Polyneura at Jetty 4, Esso Jetty. (E).

Rhodymeniocolax sp.: Present in sample from Montreal Rocks. (H).

ANIMALS

Species for which systematic records were collected (checklist species):

On stable hard substrata

PORIFERA

Leucosolenia (Clathrina) coriacea: recorded from South Stack Rocks, Occasional. Great Castle Head, Frequent, small specimens. From West Blockhouse, Occasional at 2 m under an overhang. (19, 21, 25).

Pachymatisma johnstoni: recorded from three sites in the mouth of Milford Haven. Common on crevice walls 1.5–6.5 m at Great Castle Head. Rare in cave West of Thorn Island and Rare at West Blockhouse. (21, 24, 25).

Polymastia boletiforme: recorded as Occasional at 13.5 m at Chapel Rocks. (27).

Polymastia mamillaris: recorded as Rare at South Stack Rock and at 3.3 m at Thorn Island. Occasional at Pennar Gut. (19, 24, A).

Cliona sp.: recorded as boring form at sites from Carr Spit to West Blockhouse. Rare to Occasional at all sites. Massive form Rare at Chapel Rocks. (9, 12, 15, 19, 25, 27, 28, A, C, D, F).

Suberites carnosus: recorded at North of Sheep Island, Lifeboat Slip Angle, and from Dale Point, Rare in 1976. Suberites sp. at Littlewick Bay. (17, 26, 28, F).

Suberites domuncula: recorded at sites from Hobbs Point to West Thorn Island. Generally Rare to Occasional at +1–15 m but Frequent large specimens were recorded East and West of Pennar Point and were found Common at 0–1 m at Milford Haven Conservancy Board Jetty, especially on the corners (presumably thrives in strong currents). (8a, 9, 12, 13, 14, 15, 19, 24, A, C, D, G).

Haliclona oculata: recorded intermittently from Beacon northwest of Benton Wood to Chapel Rocks. Generally Rare to Occasional from 1.5–13.5 m.

Records from Hobbs Point and northward were October records. (4a, 4b, 8a, 17, 19, 23, 24, 27).

Axinellidae indet: recorded at sites from South Garron Pill to Chapel Rocks. Raspailia hispida: recorded at South Garron Pill, Cosheston Trot and Hobbs Point from 6-15.5 m. Unidentified axinellids from four stations between East and West Pennar Point to Chapel Rocks. Axinella infundibuliformis: Occasional at 13.5 m at Chapel Rocks. (4b, 6, 8a, 12, 17, 24, 27).

Dysidea fragilis: recorded at most sites from South of Garron Pill to Chapel Rocksa. Rare to Occasional at most sites from 0-13.5 m. Very Common at 4.3 m at Burton Cliff. Common at 6 m at Hobbs Point and at 13.5 m at Chapel Rocks. Sometimes under overhangs but also on open rock surfaces. (4b, 5, 6, 8, 8a, 12, 17, 19, 20, 24, 25, 26, 27, 28 (1976), A).

Amphilectus fucorum: recorded at scattered sites from Burton Cliff to West Blockhouse in infralittoral fringe at West Chapel Bay, West Thorn Island and at West Blockhouse. Upstream records are Frequent to Common from 6 m downwards at Pembroke Ferry and Hobbs Point. At Milford Haven Conservancy Board Jetty, Common at 0-1.6 m, especially on the corners. Occasional on holdfasts at Littlewick Bay. (7, 8a, 12, 15, 20, 24, 25, G).

Halichondria spp.: H. panicea including fingered and pipe forms. Recorded from Opposite Sprinkle Pill to Castle Rocks. Common to Abundant below kelp, dependant only on suitable substrata. Up to 100% cover in places. At Cosheston Trot, Common from 1 m, increased to 30% cover at 11 m. At Pembroke Ferry, 20% cover below kelp, and at Hobbs Point Frequent at 6 m. Some very large specimens included. 'Fingered' and 'pipe' forms were recorded from stations down to Hobbs Point.

Halichondria panicea: normal form. Also recorded from sites from South of Stack Fort to West Blockhouse. Rare to Frequent from +1-8 m. (2, 3, 4a, 4b, 5, 6, 8, 8a, 19, 24, 25, 28, C, G).

COELENTERATA: HYDROZOA

Tubularia indivisa: recorded at isolated stations from Picton Point to Chapel Rocks. Occasional to Frequent from 1-13.5 m. Abundant at one site from 5.5-8.5 m at South of Garron Pill. (1, 4a, 4b, 5, 13, 27).

Tubularia larynx: recorded as Very Common at 2.2 m at Castle Rocks, and one large colony on stranded tree at 1 m at Picton Point. (1, 5).

Halecium halecinum: recorded intermittently from Carr Spit to Chapel Rocks from 0.5-13.5 m. Occasional at sites from Carr Spit to Pwllcrochan Flats. Frequent to Common from West Chapel Bay to Chapel Rocks. (9, 13, 14, 20, 24, 27, 28).

Sertularia argentea: recorded at sites from South Llangwm to Milford Haven Conservancy Board Jetty from 0-8.8 m. Occasional to Common. (4, 4a, 4b, 6, 7, 15).

Hydrallmania falcata: recorded at sites from Black Tar to south of Stack Rock, all subject to fairly strong currents. Found from 0.8 m at Cosheston Trot down to 15 m maximum at west of Wear Point. Rare to Occasional at 0.8-0.3 m, more frequent deeper. 10% cover at 4 m at Cosheston Trot. (3, 4a, 6, 8, 9, 12, 13, 14, 19).

Plumularia setacea: recorded at sites from Cosheston Trot to West Thorn Island. Only Very Common on vertical faces at Great Castle Head. Otherwise, Rare to Frequent below kelp, except at West Thorn Island where recorded as Present in the infralittoral fringe. (6, ?7, 12, 20, 21, 24).

Aglaophenia spp.: recorded at sites from Pembroke Ferry to Chapel Rocks. Pembroke Ferry record was for A. pluma, Frequent at 1-6 m. This species also recorded on Halidrys sp. at 0 m at Beacon northwest of Benton Wood. Other records were from west of Esso Jetty. Localised patches from the infralittoral fringe to 13.5 m. Rare at 4-4.5 m at Penner Mouth. (4a, 8, 16, 19, 23, 24, 25, 27, 28, A).

Obelia sp.: Common at 2 m. Between Amoco and Esso Jetties (F).

Nemertesia ramosa: recorded from South Llangwm to Chapel Rock except for a stretch from Carr Spit to Pwllcrochan Flats. Generally more common in deeper water, that is, below 3 m. Large amounts recorded at 11 m at Cosheston Trot. Also Common at 13.5 m at Chapel Rocks. Recorded as Occasional at 0-1.6 m on Milford Haven Conservancy Board Jetty and at 1 m on the Lifeboat Slip at Angle. Most records were from current-swept areas. (4, 6, 7, 8, 8a, 15, 17, 19, 27 28).

Nemertesia antennina: intermittently recorded from Cosheston Trot to Chapel Rock, though not recorded from Carr Spit to Milford Haven Conservancy Board Jetty. Rare to Frequent at most stations down to 13.5 m, but Common at 11 m at Cosheston Trot and Very Common on vertical surfaces at Great Castle Head. (6, 8, 8a, 16a, 21, 24, 25, 27).

COELENTERATA: ANTHOZOA

Alcyonium digitatum: recorded at most sites from Angle Lifeboat Slip to Chapel Rocks, as Rare to Occasional at 1-13.5 m. Frequent at Great Castle Head, though specimens small. (17, 21, 24, 25, 27, 28).

Anemonia sulcata: recorded as Rare in shallow water, 1-0.5 m, from sites in the middle reaches of Milford Haven. (12, 13, 14, A, C, D, F).

Cereus pedunculatus: recorded at most sites from Cosheston Trot (North side) to West Blockhouse Point as Rare to Occasional on concrete, bedrock and stable boulders. Common to Abundant on areas of small stones, gravel, sand or mud, in maerl and between pebbles, from +0.2-12 m. (6, 7, 9, 12, 13, 15, 16, 17, 19, 20, 23, 24, 25, 28, A, C, D, F).

Urticina (=Tealia) felina: recorded at most sites except in the mouth of the Haven, from +1-11 m, mostly from areas of boulders, stones, gravel or sand. T. felina var. lofotensis (U. eques) recorded at Llangwm and at Beacon northwest of Benton Wood, and at North of Gulf Jetty (Rare). (2, 3, 4, 4a, 4b, 5, 7, 8, 9, 12, 13, 14, 15, 16, 19, 20, 21, 26, A, B, F).

Diadumene cincta: generally Occasional to Frequent in shallow water south of Garron Pill. (4b)

Metridium senile: recorded at two groups of sites from Opposite Sprinkle Pill to Llangwm and from west of Wear Point to Angle Lifeboat Slip. From 1-4.7 m on stable boulders, concrete, on a tyre at Black Tar and on iron at West Wear Point. (2, 3, 4, 13, 14, 15, 17, B).

Sagartia spp.: Common at Burton Cliff at 8.8 m. Common in shallow water, Occasional deeper at west of Wear Point. (7, 13).

Sagartia ?troglodytes recorded at five scattered sites from Carr Spit to West Chapel Bay. Occasional to Common, -1-10 m on boulders or stone. (9, 13, 17, 18, 20).

Sagartia elegans (small): recorded at five scattered sites from Llangwm to south of Stack Rocks. Occasional to Common on rock, boulders or stones from 0.5-7.7 m. S .elegans in Zostera bed at Littlewick Bay, Frequent. (4, 5, 9, 15, 19).

Sagartia elegans venusta: Occasional at 2-3 m amongst small stones, muddy sand and maerl at Littlewick Bay. (F).

Sagartia elegans mineata: recorded as Frequent to Common at -1m at Angle Lifeboat Slip. (17).

Sagartia elegans rosea (large): recorded as Rare on a stone plain at 11 m at Cosheston Trot, south side. (6)

Sagartiogeton laceratus: recorded as scattered at West Chapel Bay. (20).

Sagartiogeton undatus: Rare on mud at Ward's Pier. (C).

Actinothoe sphyrodeta: recorded at sites from Cosheston Trot to west of Wear Point. Rare to Occasional in shallow water. Common where found at depth, as at 8.8 m at Burton Cliff and Pembroke Ferry. Recorded from substrata of stones. (6, 7, 8, 9, 13).

Caryophyllia smithii: recorded at all sites from South Stack Rocks to Chapel Rocks. Rare to Common on vertical faces and under overhangs from 0 m. Frequent to Common on open rock at West Thorn Island, Dale Point (1976) and Chapel Rocks. (19, 20, 21, 23, 24, 25, 26, 27, 28).

Corynactis viridis: recorded from two sites. Rare at West Blockhouse and Common at Great Castle Head, though only as isolated individuals. (21, 25).

ANNELIDA: POLYCHAETA

Pomatoceros triqueter: recorded at scattered sites from Beacon northwest of Benton Wood to North of Sheep Island, generally Rare to Occasional from +1.5 to 12 m, but Common at Carr Spit at 6.2 m, South Stack Rock and Watchhouse Point on mobile rock at 2.3 m. (4a, 4b, 9, 12, 16, 18, 19, 20, 23, 24, 26, 28, B, D).

Bispira volutacornis: one group recorded from Pembroke Ferry (1977). Rare to Occasional at three sites in the mouth of the Haven. (8, 23, 24, 28).

Filograna implexa: Common under stones at 4.3 m at Burton Cliff. Rare at West Thorn Island. Present at Chapel Rocks at 13.5 m. (7, 24, 27).

Sabellaria spinulosa: recorded only at East Chapel Bay, a band along rock adjacent to sand at 0.5 m. (18).

PHORONIDA

Phoronis hippocrepia: recorded at West Blockhouse. One group at 8 m on rock adjacent to a sand plain. Rare on Ostrea shell at Ward's Pier. (25, C).

CRUSTACEA

Balanus crenatus: recorded at Picton Point. Scattered on stones at 0.1 m, possibly Present at Beacon northwest of Benton Wood, then at most sites from Cosheston Trot to Chapel Rocks. Generally Frequent to Abundant at any depth at which there was a substratum of semi-stable stones, where it was often the dominant organism or one of a characteristic pair. For example, at Pembroke Ferry the bottom plain was characterised by B. crenatus and Actinothoe sphyrodeta, and at West Wear Point at 1.5 m rocks were dominated by B. crenatus and Dendrodoa grossularia, and at 12.5 m by B. crenatus and Hydrallmania falcata. Also Frequent to Abundant at sites in the mouth of Milford Haven in the infralittoral fringe. (23, 24, 25). (1, ?4a, 6, 8, 9, 12, 13, 14, 15, 16a, 18, 19, 20, 23, 24, 25, 27, 28, A, B, D, F).

Balanus perforatus: recorded as Occasional at South Stack Rocks and Rare at 13.5 m at Chapel Rocks. (19, 27).

Verruca stroemia: recorded as Rare from Pwllcrochan Flats and East Chapel Bay at 0.5 m. Very Common on Laminaria hyperborea stipes at Great Castle Head. (14, 18, 21).

Cancer pagurus: recorded at scattered sites from Black Tar to West Thorn Island. Rare to Occasional at most sites, but at Milford Haven Board Conservancy Jetty, Frequent in cracks in the Jetty and Common on the sediment plain off the Jetty. (3, 8a, 9, 12, 13, 15, 16, 19, 24).

Homarus vulgaris: one record in a hole at 2.2 m at Castle Rocks. (5).

Pagurus spp.: recorded from most sites from Black Tar to Chapel Rocks at all depths. Generally Rare to Frequent on flat or gradually sloping broken or soft substrata. Common at 2.2 m at Castle Rocks, at 7.7 m at Llangwm, and at 4.3 m at Burton Cliff (large specimens in Buccinum shells). At 8.8 m at Burton Cliff small specimens Common. Also Common at Carr Spit. Abundant between East and West Pennar Points. (3, 4, 4a, 4b, 5, 7, 9, 12, 13, 14, 16a, 19, 20, 23, 27, A, B, F).

Carcinus maenas: recorded at most sites at all depths from Picton Point to Great Castle Head, Rare to Common. At Hobbs Point, large numbers were feeding

on carrion. (1, 3, 4, 4a, 5, 6, 7, 8a, 9, 12, 13, 14, 15, 16, 20, 21, A, C, D).

Liocarcinus puber: recorded only at four scattered sites. Widely separated individuals recorded at Pembroke Ferry (1977), Carr Spit and West of Thorn Island. Very Common South of Stack Rock. (8, 9, 19, 24, A, C, D).

Maia squinado: recorded at three sites in the mouth of the Haven. One or two individuals per site down to 16 m. (26, 27, 28 (1976), F).

MOLLUSCA

Patella sp.: record of one individual in the infralittoral fringe at West Blockhouse. (25).

Acmaea virginea: record of one individual in the infralittoral fringe at West Blockhouse. (25).

Gibbula cineraria: recorded as Rare to Frequent at scattered sites in shallow water, but at Burton Cliff as Occasional at 4.3 m and at Carr Spit as Occasional at 6.2 m. On algae at Angle Lifeboat Slip, West Chapel Bay, Littlewick Bay and Dale Point. (4a, 6, 7, 9, 12, 17, 19, 20, 26, 28,(1976), F).

Buccinum undatum: one live specimen recorded at 7.7 m at Llangwm, and one at 4 m at Beacon northwest of Benton Wood. Rare to Occasional at Ward's Pier. (4, 4a, C).

Mytilus edulis: Common at Opposite Sprinkle Pill where discontinuous clumped beds extended from 0.5-1.5 m. Otherwise recorded as Rare to Occasional at top four stations (0-2.5 m) and above 0 m at Angle Lifeboat Slip. (1, 2, 3, (?4), 17).

Anomiidae indet.: recorded from Carr Spit. Present under stones on slope from 0.5-12 m. (9).

Crepidula fornicata: Frequent to Common at all sites and depths from Opposite Sprinkle Pill to South of Garron Pill. No live specimens found at Castle Rocks or below except at Carr Spit where widely separated individuals were recorded from 0.5-12 m and East and West Pennar Points, Occasional. (2, 3, 4, 4a, 4b, 9, 12).

BRYOZOA

Crisiidae indet: recorded as isolated sprigs or clumps under overhangs at West Blockhouse and West Chapel Bay, and also at Angle Lifeboat Slip, West of Thorn Island and Dale Point. (17, 20, 24, 25, 28).

Bugula plumosa: recorded at most sites from Black Tar, where it was the dominant organism on rock at 0.8 m, to Chapel Rocks where it was Common at 12.5 m. Generally Occasional to Frequent on bedrock, boulders and stable stones in shallow water, but Frequent to Very Common on vertical walls or under overhangs. At South Stack Rock small bedrock outcrops from 3.8-6.8 m

were dominated by erect Bryozoa, including B. plumosa. (3, 4, 5, 6, 7, 9, 12, 14, 15, 17, 19, 20, 21, 23, 24, 25, 27, A, B).

Bugula turbinata: recorded from Angle Lifeboat Slip and then from sites in the mouth of the Haven as generally Occasional to Frequent from the sublittoral fringe to 7.5 m, but Common at 13.5 m at Chapel Rock. (17, 23, 24, 25)

Bugula fulva: recorded as Present at Burton Cliff. (7).

Bugula flabellata: recorded as Present on oyster shells at Carr Spit, stones offshore at Watchhouse Point, and small bedrock outcrops at South of Stack Rock from 3.8 m. Fairly Common at 13.5 m at Chapel Rock. (9, 19, 23, 27).

Scrupocellaria scruposa: recorded from South of Garron Pill and East and West Pennar Point where it was Rare on tunicates at 4 m. (4b, 12).

Scrupocellaria reptans: recorded from West Chapel Bay, Occasional under overhangs and at West of Thorn Island where it was fairly common. (20, 24).

Scrupocellaria sp.: recorded at Cosheston Trot, small amounts at 0.8 m. Watchhouse Point, small patches in shallow water. At West Blockhouse Point, Occasional under overhangs. (6, 23, 25).

Cellaria sp.: recorded from Chapel Rocks, Occasional at 13.5 m and C. sinuosa, a few sprigs under overhangs at West Blockhouse. (25, 27).

Celleporaria (= Cellepora) pumicosa: recorded at Watchhouse Point. Occasional offshore and Present in samples from Carr Spit and South of Stack Rocks. (9, 19, 23).

Pentapora foliacea: recorded at Chapel Rocks. Common at 13.5 m. (27).

Escharoides cocinnea: large patches on small mobile boulders and stones at 2.3 m at Watchhouse Point, and Present on stones from East Pennar Point. (12, 23).

Umbonula littoralis: recorded at five sites from Angle Lifeboat Slip to West Blockhouse. Generally Frequent to Abundant in the sublittoral fringe, though Rare at Angle Lifeboat Slip and Present in a sample collected from 6-8 m at West Blockhouse Point. (17, 20, 23, 24, 25).

Electra pilosa: recorded at scattered sites from Picton Point to West Thorn Island. Found on rocks at Picton Point, Opposite Sprinkle Pill and East Chapel Bay. On algae at Burton Cliff on Laminaria hyperborea, at West Chapel Bay, at Watchhouse Point on Cryptopleura, and at West Thorn Island. Present on Delesseria at Angle Lifeboat Slip. All records from 0-2 m. (1, 2, 7, 17, 18, 20, 23, 24, D).

Alcyonidium gelatinosum: recorded at sites from Castle Rocks to Chapel Rocks, from 1-13.5 m. Rare to Abundant on substrata from bedrock to small mobile boulders and stones. (5, 6, 7, 8, 8a, 12, 13, 14, 15, 19, 20, 21, 23, 24, 25, 27, 28).

Alcyonidium mytili: Present on rocks collected at Picton Point and East Chapel Bay, the latter recorded as Alcyonidium mytili/?polyoum. (1, 18).

Bowerbankia sp.: patchily distributed from Llangwm to West Thorn Island. Generally Rare to Frequent on bedrock, boulders and stones. Recorded on a lump of metal at West Wear Point and under an overhang at West Chapel Bay. Specimens from Angle Lifeboat Slip and Watchhouse Point were identified as B. pustulosa. (4, 4a, 9, 12, 13, 14, 17, 19, 20, 23, 24, A, D, F.)

ECHINODERMATA

Asterias rubens: recorded at most sites from Pembroke Ferry (1977) to Chapel Rocks, generally Rare to Frequent but Common at Pwllcrochan Flats and South of Stack Rocks. Present at all depths. (8, 8a, 9, 12, 13, 14, 16, 17, 19, 20, 21, 24, 25, 26, 27, D, F).

Marthasterias glacilis: recorded at four sites in the mouth of the Haven. Generally Rare, Occasional at Chapel Rocks. (19, 25, 26, 27).

Henricia oculata: Distribution similar to the above. Generally Rare but Occasional at Dale Point and Common at Great Castle Head. (19, 21, 25, 27, 28).

Luidea ciliaris: recorded as Rare at West Thorn Island. (24).

Ophiothrix fragilis: Juveniles Frequent at Carr Spit and Common at Great Castle Head. Occasional off Milford Haven Conservancy Board Jetty. Occasional at Pennar Mouth. Juveniles at North of Gulf Jetty. (9, 15, 21, A, B).

Antedon bifida: recorded as Frequent to Common at most sites from Carr Spit to South of Stack Rocks. Generally Present in groups which were sometimes very close, from 1-9 m. At Dale Point, recorded as Occasional single individuals, and Occasional at Pennar Mouth at +1-5 m. Common to Frequent at North of Gulf Jetty. Rare at C and F. (9, 12, 13, 14, 15, 16, 17, 19, 28 (1976), A, B, C, F, G).

Echinus esculentus: recorded at West Blockhouse, a single individual, and at Chapel Rocks, Common at 13.5 m. (25, 27).

Cucumaria sp.: recorded from sites in the mouth of the Haven. Common in cracks at Great Castle Head. Rare in a muddy cleft at West Blockhouse, and at Watchouse Point, Occasional to Common at three other sites. (21, 23, 24, 25, 28, (1976)).

CHORDATA: ASCIDIACEA

Clavelina lepadiformis: recorded at most sites from Castle Rocks to Chapel Rocks. Generally Occasional in the upper Haven, and Frequent to Common in the mouth of the Haven, though there was great variation between East and West Pennar Point and Watchhouse Point. (5, 6, 7, 9, 12, 13, 15, 17, 19, 20, 21, 23, 24, 25, 26, 27, 28 (1976), C).

Dendrodoa grossularia: this species was not distinguished during the field survey from Distomus variolosus. Specimens from stones in the upper Haven were found to be D. grossularia, whilst those on kelp holdfasts in tight clusters at stations in the mouth of the Haven were found to be D. variolosus. Summary for both types together: Recorded as dominant on rocks in shallow water, where such exist from South Garron Pill to West Wear Point. Present on stones in shallow water from Pwllcrochan Flats to East Chapel Bay. Frequent to Abundant amongst Laminaria and on vertical surfaces or under overhangs, from West Chapel Bay to Great Castle Head, Watchhouse Point and West Thorn Island. Present on some stones at West Blockhouse and Frequent patches at Dale Point from 3-7.5 m (1976). West Chapel Bay record was confirmed for D. variolosus. (4a, 4b, 5, 6, , 8, 8a, 12, 13, 14, 15, 18, 20, 21, 23, 24, 25, 28, B, F).

Ascidia mentula: recorded as Rare at North of Gulf Jetty, Angle Lifeboat Slip and Dale Point (1976), and under an overhang at Watchhouse Point. Occasional at Watchhouse Point and Ward's Pier. (17, 23, 28 (1976), B, C.)

Ascidiella aspersa: recorded as Present in the sublittoral fringe at Milford Haven Conservancy Board Jetty. Occasional also in the sublittoral fringe at Beacon northwest of Benton Wood and South Garron Pill. Frequent at 1-3 m at Pennar Mouth. Occasional at Ward's Pier. Rare, growing on L. saccharina at 2 m at Littlewick Bay. (4a, 4b, 15, A, C, F).

Polyclinidae indet.: recorded as Occasional at Castle Rocks, 2.2 m. Frequent at Dale Point (1976) and widespread at Chapel Rocks at 13.5 m. Sidnyum sp. Occasional under an overhang at 2.4 m at Watchhouse Point. S. turbinatum Common on Milford Haven Conservancy Board Jetty and Present at Great Castle Head. Aplidium punctum Frequent at 3 m at West Thorn Island and Common under overhangs at West Blockhouse. Generally Occasional to Rare at Pennar Mouth, Rare between Esso and Amoco Jetties. (5, 15, 21, 23, 24, 25, 27, 28, A, D).

Botryllus schlosseri: recorded from Beacon northwest of Benton Wood to Dale Point. Rare to Occasional in shallow water at most sites, but at 6.2 m at Carr Spit and at 11 m at Cosheston Trot, and Frequent in shallow water at Pembroke Ferry (1977). Elsewhere, Occasional to Very Common at some sites restricted to the sublittoral fringe, at others Present only in deeper water. At Milford Haven Conservancy Board Jetty and Great Castle Head many very large colonies were recorded, particularly on red algae and on kelp holdfasts. Also on algae at Castle Rock, Burton Cliff, and at Ward's Pier. (4a, 4b, 5, 6, 7, 8, 9, 12, 13, 15, 17, 20, 21, 23, 24, 25, 28, C, D).

Didemnum sp(p).: recorded as quite Common on Milford Haven Conservancy Board Jetty at 0-1.6 m, as Occasional colonies in the sublittoral fringe to 2.2 m at Watchhouse Point, and present in shallows at West Thorn Island. (15, 23, 24).

Diplosoma listerianum: recorded at Cosheston Trot, one patch at 0.8 m, and Present in a sample from Milford Haven Conservancy Board Jetty. (6, 15).

Distaplia rosea: recorded at isolated sites from Carr Spit to West Thorn Island. Rare to Occasional from 3.3 m, though generally in deeper water on stones and pebbles offshore. (9, 12, 19, 23, 24).

Ciona intestinalis: Occasional on small boulders at Ward's Pier. (C).

CHORDATA: PISCES

Crenilabrus melops: recorded from Burton Cliff. One individual at 4.3 m. (7).

Ctenolabrus rupestris: recorded at South Garron Pill where Frequent. Small specimens were observed at 5.5 m, and at Cosheston Trot where two individuals were observed. Many deeper than kelp at Pembroke Ferry. (4b, 6, 8).

Thorogobius ephippiatus: recorded at West Thorn Island where several were observed, all in muddy holes. (24).

Pholis gunnellus: Present at Carr Spit at 6.2 m. (9).

On/in coarse gravel and smaller

Corymorpha nutans: records of single individuals from West Chapel Bay and Watchhouse Point. At West of Thorn Island, Common inshore and Frequent to Occasional offshore. (20, 23, 24).

Cerianthus lloydi: records from West of Wear Point to West Thorn Island. Generally Rare to Occasional from 0-8 m. Common South of Stack Rock at 1.8-6.8 m. (13, 19, 20, 23, 24, 28).

Terebellidae indet: recorded from Llangwm to West Thorn Island. Generally Rare to Frequent, though Common at East and West Pennar Points, South Stack Fort and at Watchhouse Point. Present at different depths at different sites, from 0.5-8 m. Polymnia nebulosa identified from Carr Spit and Great Castle Head. (4, 4a, 5, 6, 7, 8, 9, 12, 14, 19, 20, 21, 23, 24, C).

Sabella penicillus (= pavonina): one record of a single specimen at East and West Pennar Point. (12).

Myxicola infundibulum: recorded at sites from Carr Spit to Watchhouse Point. Rare to Occasional from 2-7 m, except at East to West Pennar Point where it was Frequent to Common, and at Watchhouse Point where it was Frequent. (9, 12, 13, 16a, 19, 23, A, C, D, F).

Arenicola marina (casts): recorded as Occasional at Picton Point 0-1 m (1).

Lanice conchilega: recorded as Occasional, large specimens at 0.5 m at Carr Spit and as Rare in deep water at East to West Pennar Point, West of Wear Point and at West Blockhouse. Also as locally Abundant at Pwllcrochan Flats; Occasional at Dale Point. Common at 4-5 m at Penner Mouth. (9, 12, 13, 14, 25, 28, A).

Goneplax rhomboides (=angulata): holes Common in offshore sediments, West of Chapel Bay. A few possible Goneplax holes at Watchhouse Point. (20, 23).

Liocarcinus spp.: recorded as Common South of Stack Rock. Rare at West of Esso Jetty and Occasional Liocarcinus depurator at Watchhouse Point, possibly a characteristic species here. Also at Watchhouse Point, Liocarcinus

?marmoreus Occasional. Liocarcinus arcuatus Rare, at 2 m at Ward's Pier (D). (See also under hard substratum list). (16a, 19, 23).

Crangon crangon: record of one specimen in burrow at 1 m West of Esso Jetty. Possibly at Ward's Pier. (16a).

Turritella communis: recorded at Pwllcrochan Flats, Rare, and at East of Esso Jetty, present on large stones. (14, 16).

Nassarius reticulatus: recorded as Rare at West of Wear Point at 0 m. Also at 2 m at Littlewick Bay. (13, F).

Ophiura/Amphipholis sp.(p): recorded from Carr Spit westwards to West Thorn Island. Generally Rare to Occasional. Frequent West of Thorn Island and Frequent to Abundant at West Chapel Bay, where these animals were characteristic of nearshore sandy sediments. Specimens collected from Carr Spit and West Chapel Bay and identified as Ophiura albida. Amphiura sp. recorded as Rare, West of Wear Point. (9, 13, 14, 19, 20, 24).

Gobiidae indet: recorded from Beacon northwest of Benton Wood, south and west to Chapel Rocks. Generally Rare to Frequent but Common at Pwllcrochan Flats and at West of Esso Jetty. Restricted to shallow inshore water at West Chapel Bay and West of Wear Point. Other records to 3.5 m. (Certainly includes several species). (4a, 5, 12, 13, 14, 16, 19, 20, C, I).

Additional records (non-checklist species)

Colonial protozoan: dominant in places South of Garron Pill. (4b).

Haliphysema tumenowiczii: Present on algae at Dale Point (1976). (28).

Scypha sp.: recorded at sites from Beacon northwest of Benton Wood to Chapel Rocks. Generally Occasional to Frequent but Common in places at South of Garron Pill and South side of Cosheston Trot, from 0-13.5 m. Depth range restricted at some sites. Present on both red and brown algae at some sites. (4a, 4b, 6, 9, 17, 19, 21, 23, 27, 28).

Grantia (= Sycpha) compressa: recorded as characterstic with Scypha spp. and Dendrodoa grossularia at Cosheston Trot. Frequent at 0.8 and 4 m. Occasional at 0.4 m. Also recorded at Castle Rocks. (5, 6).

Axinella infundibuliformis: recorded as Occasional at Chapel Rocks. (27).

Hemimycale columella: recorded at the North side of Cosheston Trot and then at sites in the mouth of the Haven. Generally Occasional to Frequent small patches. Common at Chapel Rocks at 13.5 m. Also recorded at Watchhouse Point and West of Thorn Island. (6, 23, 24, 27, 28 (1976).

Myxilla sp.: Present at West of Esso Jetty. (16a).

Eudendrium sp.: possible record at Llangwm. Confirmed record at South of Stack Rock. Eudendrium ramosum Present at Angle Lifeboat Slip and ?Eudendrium ramosum under an overhang at 2.6 m at Watchhouse Point. (?4, 17, 19, 23).

Laomedea (= Campanularia) flexuosa: recorded as Present at Carr Spit. (9).

Obelia dichotoma: recorded as Common at Milford Haven Conservancy Board Jetty and Present at Angle Lifeboat Slip, Frequent at Beacon northwest of Benton Wood. (4a, 15, 17, D).

Sertularia cupressina: Recorded at four sites, from Opposite Sprinkle PIll to West Wear Point, at depths from 1.5 m. Frequent at Opposite Sprinkle Pill, Rare to occasional elsewhere. (2, 3, 12, 13).

Diphasia attenuata: Present at Angle Lifeboat Slip. (17).

Sertularella polyzonias: recorded as Present at Carr Spit. Several single sprigs 7-9 m at North Gulf Jetty. (9, D).

Abietinaria abietina: recorded as Present at Carr Spit. (9).

Kirchenpaueria pinnata: Occasional small specimens on Zostera at Littlewick. (F).

Prostheceraeus vittatus: records of single individuals at Cosheston Trot, East to West Pennar Point and Dale Point (1976). Occasional at Penner Mouth at +1-1 m. (6, 12, 28, A).

Branchiomma vesiculosum: recorded as Rare at scattered sites from East and West Pennar Point to Dale Point. Frequent to Common amongst cobbles and shells at Carr Spit, 0.5-12 m. Occasional at 2.5 m at Littlewick Bay. (9, 12, 13, 23, 24, 28, D, F).

Protula tubularia: recorded as Present at Carr Spit. (9).

Elminius modestus: recorded in the infralittoral fringe at Picton Point and Opposite Sprinkle Pill, then isolated records from all depths. For instance, one group observed at 9.5 m at South Garron Pill, Occasional to Frequent on stones at 0.5 m at Carr Spit. Also recorded at Burton Cliff and South of Stack Rock. (1, 2, 4b, 7, 9, 19).

Inachus sp./Macropodia sp: recorded from Pembroke Ferry to Great Castle Head. Common in shallow water at East to West Pennar Point. Otherwise Rare to Occasional. (8, 12, 14, 16).

Porcellana longicornis: recorded as Common at 6.2 m at Carr Spit. (9).

Hyas araneus: recorded as Rare at Great Castle Head (21).

Macropodia rostrata: Present inside Pennar Gut and off Ward's Pier (A, D).

Achelia echinata: recorded as Present at Beacon northwest of Benton Wood. (4a).

Patina pellucida: record of juveniles in the sublittoral fringe at West Blockhouse Point. (25).

Calliostoma zizyphinum: recorded at scattered sites from the North side of Cosheston Trot to Chapel Rock. Rare at most sites from 2-13.5 m but Common along with large hermit crabs amongst boulders from 2-4.3 m at Burton Cliff. (6, 7, 13, 27, 28).

Ocenebra erinacea: recorded as Present at Hobbs Point, Milford Haven Conservancy Board Jetty, and West of Esso Jetty. (8a, 15, 16a).

Tricolia pullus: recorded as present at Carr Spit. (9).

Calyptraea chinensis: recorded as Common on stable stones and cobbles from the North side of Cosheston Trot and from Carr Spit. Rare to Occasional from East and West Pennar Point, West of Wear Point, and South of Stack Rock from +0.1-7.7 m. Frequent from 1-5 m at Pennar Mouth. Rare North of Gulf Jetty. Occasional at Littlewick Bay. (6, 9, 12, 13, 19, A, B, F).

Aeolidia papillosa: one recorded at 6.2 m at Carr Spit. (9).

Antiopella cristata: recorded as Rare at Cosheston Trot, Pwllcrochan Flats, South of Stack Rocks and at Chapel Rocks. (6, 14, 19, 27).

Limacia clavigera: recorded as Present at 6.2 m at Carr Spit and as Common, feeding on Membranipora sp. on kelp at Angle Lifeboat Slip. (9, 17).

Archidoris pseudoargus: recorded as Rare at Watchhouse Point and Dale Point. (23, 28).

Polycera spp.: recorded as Occasional at Chapel Rocks. Polycera quadrilineata, Frequent at Dale Point and Common South of Stack Rock. (19, 27, 28).

Eubranchus tricolor: recorded as Rare at Pwllcrochan Flats. (14).

Facelina sp.: recorded as Rare South of Stack Rock. (19).

Ostrea edulis: recorded as Occasional at Beacon northwest of Benton Wood and at South of Garron Pill, and as Rare at east to west Pennar Points and off Milford Haven Conservancy Board Jetty. Many empty shells north and east of Carr Spit. (4a, 4b, 12, 15).

Chlamys opercularis: one specimen recorded attached to a rock at Carr Spit. (9).

Cerastoderma edule: large numbers of shells with some live specimens recorded from Picton Point, 0-1 m, and Opposite Sprinkle Pill, 1.5-2.5 m. Shells only mentioned at Black Tar. (1, 2, ?3).

Venus fasciata: recorded as Occasional at Pwllcrochan Flats. (14).

Mysia undata: identified from sample collected at Burton Cliff. (7).

Vesicularia spinosa: recorded at 4 m at East to West Pennar Point. (12).

Pedicellina cernua: large amounts observed on Tubularia. South of Garron Pill. (4b).

Lichenopora spp.: recorded as Occasional at Dale Point (1976). (28).

Chartella papyracea: recorded South of Stack Rock where it was locally Common, at maximum depth of dive 6-8 m. (19).

Bicellariella (= Bicellaria) ciliata: recorded South of Garron Pill as Occasional and rather small, and Rare at stations westwards to West of Wear Point. (4b, 6, 9, 13).

Spinularia spinulosa: recorded as Present at Cosheston Trot (South side). (6).

Escharoides coccinea: recorded as Present in a sample from Watchhouse Point. (23).

Schizoporella linearis: recorded on stones at 15.5 m at Cosheston Trot, south side, and at Burton Cliff, 2-4.3 m. (6, 7).

Valkeria sp.: some colonies Frequent at East to West Pennar Point in trench at 8 m and at Milford Haven Conservancy Board Jetty. (12, 15).

?Labidoplax sp.: Eight individuals observed in mud at Watchhouse Point. (23).

Ophiura albida: Rare at 2.5 m at Littlewick Bay (F).

Asterina gibbosa: recorded as Occasional West of Thorn Island. (24).

Psammechinus miliaris: one recorded from 0.5 m at Carr Spit. (9).

Pycnoclavella aurilucens: recorded in the mouth of the Haven at Great Castle Head, Watchhouse Point and Chapel Rocks in deeper water. Rare to Occasional. (21, 23, 27).

Styela clava: recorded as Common at Llangwm and Occasional at Beacon northwest of Benton Wood. (4, 4a).

Botrylloides leachii: recorded at intermittent sites from Cosheston Trot south and west to Watchhouse Point, from 0.8 to 12 m. Generally recorded as Present or Occasional but Common at South of Stack Rock. (6, 12, 17, 19, 23).

?Polycarpa sp.: recorded in the sublittoral fringe at Watchhouse Point. (23).

Scyliorhinus canicula: records of single individuals at Castle Rock and Burton Cliff. (5, 7).

Callionymus sp.: recorded as Occasional. Large individuals plus some small ones at West of Esso Jetty. (16a).

Pleuronectes sp.: one recorded at Pwllcrochan Flats. (14).

Epifauna present on plants

Obelia geniculata: recorded as Present on kelp at sites from Beacon northwest of Benton Wood to West of Esso Jetty. (4a, 4b, 14, 16).

Obelia dichotoma: On Zostera marina at Littlewick Bay. Obelia sp. Rare on kelp at Littlewick Bay. (F).

Balanus crenatus: recorded on Delesseria sanguinea at Angle Lifeboat Slip and Present on red and brown algae at Carr Spit. (9, 17).

Syllidae indet.: recorded as Common at Carr Spit at 6.2 m and Present South of Stack Rock. (9, 19).

Membranipora membranacea: recorded as Present on kelp fronds, at sites from Beacon northwest Benton Wood, South and West to Great Castle Head. At Carr Spit and sites to the north and east Colonies were small and circular. Common at Great Castle Head. (4a, 7, 8, 9, 14, 20, 21, D. F).

APPENDIX 2

Abundance scales for rocky shore species.

1. Live barnacles (except B. perforatus) (record adults, spat, cyprids separately); Littorina neritoides Littorina neglecta

7 Ex	500 or more per 0.01 m^2, 5+ per cm^2
6 S	300-499 per 0.01 m^2, 3-4 per cm^2
5 A	100-299 per 0.01 m^2, 1-2 per cm^2
4 C	10-99 per 0.01 m^2
3 F	1-9 per 0.01 m^2
2 O	1-99 per m^2
1 R	Less than 1 per m^2

2. Balanus perforatus

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

3. Patella spp. 10 mm+, Littorina littorea (juv. & adults), Littorina mariae/obtusata (adults), Nucella lapillus (juv., <3 mm)

7 Ex	20 or more per 0.1 m^2
6 S	10-19 per 0.1 m^2
5 A	5-9 per 0.1 m^2
4 C	1-4 per 0.1 m^2
3 F	5-9 per m^2
2 O	1-4 per m^2
1 R	Less than 1 per m^2

4. Littorina 'saxatilis', Patella <10 mm, Anurida maritima, Hyale nilssoni and other amphipods, Littorina mariae/obtusata juv.

7 Ex	50 or more per 0.1 m^2
6 S	20-49 per 0.1 m^2
5 A	10-19 per 0.1 m^2
4 C	5-9 per 0.1 m^2
3 F	1-4 per 0.1 m^2
2 O	1-9 per m^2
1 R	Less than 1 per m^2

5. Nucella lapillus (>3 mm), Gibbula spp., Monodonta lineata, Actinea equina, Idotea granulosa, Carcinus (juv. & recent settlement), Ligia oceanica

7 Ex	10 or more per 0.1 m^2
6 S	5-9 per 0.1 m^2
5 A	1-4 per 0.1 m^2
4 C	5-9 per m^2, sometimes more
3 F	1-4 per m^2, loc. sometimes more
2 O	Less than 1 per m^2. locally sometimes more
1 R	Always less than 1 per m^2

6. Mytilus edulis, Dendrodoa grossularia

7 Ex	80% or more cover
6 S	50-79% cover
5 A	20-49% cover
4 C	5-19% cover
3 F	Small patches, 5%, 10+ small individuals per 0.1 m^2, 1 or more large per 0.1 m^2
2 O	1-9 small per 0.1 m^2, 1-9 large per m^2; no patches except small in crevices
1 R	Less than 1 per m^2

7. Pomatoceros spp.

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

8. Spirorbinidae

5 A	5 or more per cm^2 on appropriate substrata; more than 100 per 0.01 m^2 generally
4 C	Patches of 5 or more per cm^2; 1-100 per 0.1 m^2 generally
3 F	Widely scattered small groups; 1-9 per 0.1 m^2 generally
2 O	Widely scattered small groups; less than 1 per 0.1 m^2 generally
1 R	Less than 1 per m^2

9. Sponges, hydroids, Bryozoa

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

10. Flowering plants, lichens, lithothamnia

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

11. Algae

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

Other animal species: record as percentage cover or approx. numbers within 0.01, 0.1 or 1 m^2.

APPENDIX 2

Abundance scale used for surveys of nearshore sublittoral areas in south-west Britain.

ANIMALS

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

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

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

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

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

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

ALGAE

Kelps.

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

Foliose or filamentous undergrowth species.

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

Kelp stipe flora.

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

Crustose species.

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

APPENDIX 3

List of polychaete and mollusc species and numbers of individuals, or note of abundance, from pipe dredge samples collected on 18.7.85 and identified at the National Museum of Wales. Sample size was variable and so numbers are not quantitative. Figures for many Cirratulidae, Maldanidae and Lumbrineridae are rough estimates as numbers were too large to count. Two dredge samples were taken at Site 24. The list below gives NMW dredge (Station) numbers, the site numbers used in this report, total number of species in each sample and sediment type.

Dredge 6 (24b)	73 species	gravel/mud/maerl
Dredge 1 (20)	54 species	gravel/mud
Dredge 2 (21)	45 species	sand/mud
Dredge 4 (23)	45 species	fine sand
Dredge 5 (24a)	40 species	gravel/mud/maerl
Dredge 3 (22)	34 species	coarse sand
Dredge 7 (25)	17 species	dead maerl

List of Mollusca from Milford Haven
for N. Little : collected July 1985

Stn 1 M

Abra alba	dominant - numerous
Cultellus pellucidus	common
Thyasira flexuosa	common
Nucula turgida	(2)
Calyptraea chinensis	(2)
Arctica islandica	(1)

Stn 2 M

Abra alba	dominant - very numerous
Cultellus pellucidus	common - numerous
Thyasira flexuosa	common - numerous
Mysella bidentata	common - numerous
Nucula turgida	(15)
Corbula gibba	2
Dosinia lupinus	1
Venus striatula	1
Venus ovata	1
Acanthocardia juv c.f. echinata	1
Spisula elliptica	1
Lucinoma borealis	1

Stn 3 M

Abra alba	dominant - (20)
Cultellus pellucidus	(3)
Nucula turgida	(2)
Venus striatula	(2)
Mysella bidentata	(1)
Montacuta ferruginea	(1)

Stn 4

Abra alba	dominant - numerous
Nucula turgida	common
Cultellus pellucidus	common
Venus striatula	common

Mysella bidentata	(12)
Thyasira flexuosa	(3)
Tellina fabula	(4)
Abra prismatica	(2)
Acanthorcardia juv. c.f. echinata	(2)
Musculus discors	(2)
Corbula gibba	(1)
Spisula elliptica	(1)

Stn 5

Mysella bidentata	(5)
Nucula nucleus	(3)
Hiatella arctica	(2)
Abra alba	(1)

Stn 6

Abra alba	dominant - common
Ensis juv. c.f. ensis	(3)
Hiatella arctica	(2)
Veneripus pullastra	(2)
Mya juv.	(2)
Lucinoma borealis	(1)
Mysella bidentata	(1)
Cultellus pellucidus	(1)
Calyptraea chinensis	(2)

Stn 7

Abra alba	(10)
Ensis sp. juv.	(4)
Venus striatula	(2)
Nucula turgida	(1)
Corbula gibba	(1)
Spisula elliptica	(1)

MILFORD HAVEN PIPE DREDGE SAMPLES (18.7.85) - ANNELIDA

Family		Species	1	2	3	4	5	6	7
POLYNOIDAE	1	Lepidonotus squamatus	-	-	-	-	-	2	-
	2	Gattyana cirrosa	-	-	-	2	-	-	-
	3	Harmothoe impar	-	-	-	-	1	5	-
	4	Harmothoe imbricata JUV	-	-	-	-	-	2	-
	5	Harmothoe glabra	1	-	-	-	-	-	-
	6	Malmgrenia cf marphysae	-	1	-	-	-	-	-
		HARMOTHOINAE JUV.	2	-	-	5	1	3	-
SIGALIONIDAE	7	Sigalion mathildae	-	-	-	5	-	-	-
	8	Sthenelais boa	1	-	-	-	-	14	-
	9	Sthenelais limicola	-	4	-	-	-	-	-
	10	Pholoe minuta	19	2	6	62	35	53	1
PHYLLODOCIDAE	11	Eteone arctica?	-	-	-	-	-	4	-
	12	Eteone longa	1	3	1	-	-	4	-
	13	Eumida sanguinea	-	-	-	31	1	1	1
		Eumida? JUV	-	1	-	-	-	-	-
	14	Pterocirrus sp.	-	-	3	1	-	3	-
	15	Anaitides mucosa	1	-	-	1	-	6	-
	16	Anaitides subulifera	1	-	-	1	-	-	-
HESIONIDAE	17	Syllidia armata	1	-	-	5	15	104	1
	18	Kefersteinia cirrata	-	-	-	-	-	4	-
	19	Gyptis capensis	-	1	-	-	-	-	-
	20	Gyptis rosea	-	-	-	-	1	-	-
SYLLIDAE	21	Typosyllis variegata?	-	-	-	-	-	2	-
	22	Eusyllis blomstrandi	1	-	-	-	-	-	-

Family		Species	1	2	3	4	5	6	7
	23	Pionosyllis lamelligera	-	-	1	-	-	-	-
	24	Odontosyllis ctenostoma	-	-	-	-	-	1	-
	25	Odontosyllis fulgurans	-	-	-	1	-	-	-
	26	Odontosyllis gibba	-	-	-	-	1	1	-
	27	Amblyosyllis formosa	-	-	-	-	1	-	-
	28	Syllides benedicti	-	-	-	-	3	-	-
	29	Syllides sp.	-	-	1	-	2	-	-
	30	Exogone hebes	1	-	-	-	-	1	-
	31	Exogone naidina	1	-	-	-	-	-	-
	32	Exogone verugera	-	-	-	-	4	-	-
	33	Sphaerosyllis bulbosa	-	-	-	-	1	-	-
	34	Autolytus sp.	3	-	-	1	-	5	-
NEREIDAE	35	Websterinereis glauca	-	-	-	-	-	3	-
	36	Platynereis dumerilii	-	-	1	1	1	7	-
	37	Eunereis longissima	1	1	-	-	-	2	-
	38	NEREIDAE sp.	1	-	-	-	-	-	-
NEPHTYIDAE	39	Nephtys caeca	-	-	-	-	1	-	-
	40	Nephtys cirrosa	-	-	4	-	-	-	-
	41	Nephtys hombergi	16	51	-	27	1	4	-
		Nephtys JUV.	3	1	2	4	1	-	-
SPHAERODORIDAE	42	Ephesiella abyssorum	-	-	-	-	-	7	-
	43	Sphaerodoropsis minuta	-	-	1	3	1	1	-
GLYCERIDAE	44	Glycera alba	-	4	-	1	-	-	-
	45	Glycera tridactyla	-	-	1	3	-	37	-

Family		Species	1	2	3	4	5	6	7
GONIADIDAE	46	Glycinde nordmanni	1	-	-	-	-	-	-
	47	Goniada maculata	3	6	-	-	-	-	-
EUNICIDAE	48	Nematonereis unicornis	6	1	2	-	1	28	-
LUMBRINERIDAE	49	Lumbrineris gracilis	31	11	6	3	9	103	5
DORVILLEIDAE	50	Protodorvillea kefersteini	-	-	2	-	7	56	2
	51	Schistomeringos eliasoni	-	1	-	-	-	3	-
ORBINIIDAE	52	Scoloplos armiger	5	1	-	1	1	8	-
	53	ORBINIIDAE sp. INDET.	-	1	-	-	-	-	-
PARAONIDAE	54	Aricidea catherinae?	-	-	-	-	-	2	-
	55	Paradoneis lyra	2	-	1	-	-	18	-
SPIONIDAE	56	Scolelepis tridentata	-	-	-	-	-	1	-
	57	Aonides oxycephala	-	-	-	-	-	9	-
	58	Malacoceros vulgaris	-	-	-	-	-	2	-
	59	Spio armata	2	-	-	-	-	1	-
	60	Spio sp.	74	10	1	11	3	8	1
	61	Spiophanes bombyx	7	1	-	26	1	-	-
	62	Spiophanes kroyeri	-	3	-	-	-	-	-
	63	Polydora caulleryi	1	-	-	-	-	1	-
	64	Polydora flava	21	1	-	-	1	4	-
	65	Polydora caeca	-	-	3	-	-	-	-
	66	Polydora quadrilobata	12	-	-	-	-	-	-
MAGELONIDAE	67	Magelona alleni	-	1	-	-	-	-	-
	68	Magelona filiformis	-	-	6	2	1	-	-
	69	Magelona mirabilis	-	-	2	5	-	-	-

Family		Species	1	2	3	4	5	6	7
CIRRATULIDAE	70	Cirriformia tentaculata	-	-	-	-	7	17	-
	71	Caulleriella alata	1	-	1	-	1	2	-
	72	Caulleriella killariensis	2	4	-	-	-	2	-
	73	Caulleriella zetlandica	2	-	-	-	-	2	-
	74	Caulleriella? sp.	3	-	-	-	-	-	-
	75	Chaetozone setosa	-	-	1	30	-	1	-
	76	Chaetozone sp.	100	50	1	8	3	50	-
FLABELLIGERIDAE	77	Diplocirrus glaucus	4	13	1	1	-	11	-
SCALIBREGMATIDAE	78	Scalibregma inflatum	1	1	-	1	1	2	-
	79	Scalibregma sp.	11	3	-	-	7	7	-
OPHELIIDAE	80	Ophelina acuminata	1	14	-	-	-	1	-
CAPITELLIDAE	81	Notomastus latericeus	40	-	12	4	2	68	-
	82	Mediomastus fragilis	-	-	1	-	-	6	-
MALDANIDAE	83	Euclymene oerstedi?	60	40	-	13	7	15	1
	84	Praxillella affinis?	50	60	1	2	-	8	-
	85	Clymenura sp.	8	-	-	-	-	1	-
OWENIIDAE	86	Owenia fusiformis	-	1	-	8	-	-	-
	87	Myriochele sp.	-	-	-	-	-	1	-
SABELLARIIDAE	88	Sabellaria spinulosa	1	-	-	-	-	-	-
AMPHARETIDAE	89	Melinna palmata	41	8	-	2	-	1	-
	90	Ampharete lindstroemi	29	12	1	6	5	18	5
	91	Amphicteis midas	2	-	-	-	-	-	-

Family		Species	1	2	3	4	5	6	7
TEREBELLIDAE	92	Phisidia aurea	-	-	-	-	1	-	-
	93	Nicolea venustula	1	-	-	6	-	3	-
	94	Eupolymnia nebulosa	-	-	-	-	-	1	-
	95	Lanice conchylega	4	2	9	203	15	-	2
	96	Pista cristata	4	-	-	-	22	11	9
	97	Thelepus setosus	-	-	-	-	-	1	-
	98	Polycirrus sp.	-	-	1	-	30	4	5
TRICHOBRANCHIDAE	99	Terebellides stroemi	-	1	-	-	-	4	-
SABELLIDAE	100	Megalomma vesiculosum	2	-	-	-	-	-	-
	101	Jasminiera caudata	-	-	-	-	-	2	-
SERPULIDAE	102	Pomatoceros lamarcki	37	-	9	-	-	1	-
		NO. OF SPECIES	48	33	28	33	36	64	11