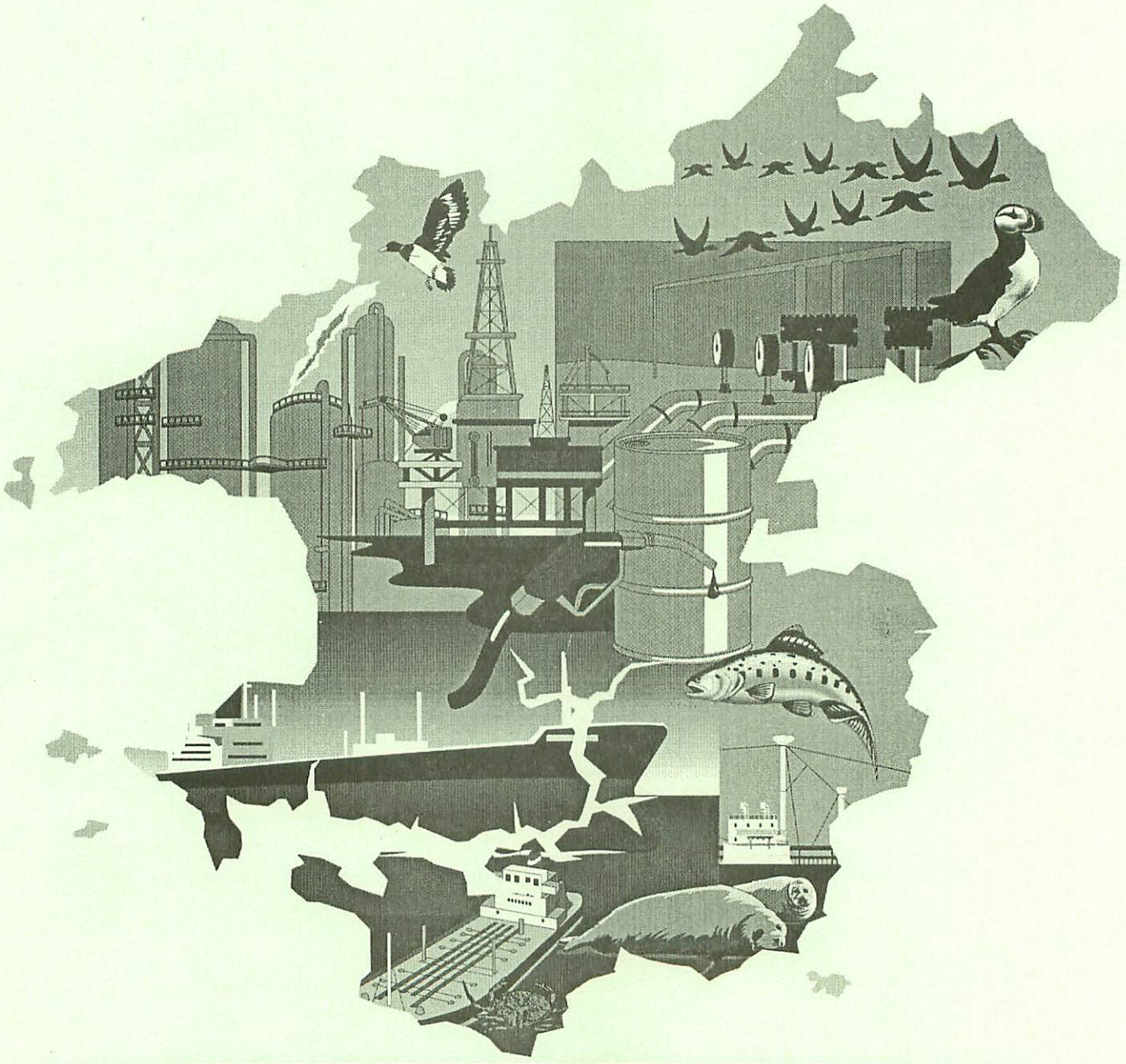
*Report of the*

# MILFORD HAVEN WATERWAY ENVIRONMENTAL MONITORING STEERING GROUP



**MHWEMSG**
**1996/97**

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# INTRODUCTION

This is the fifth annual report of the Milford Haven Waterway Environmental Monitoring Steering Group (MHWEMSG). It refers to the Group's activities and the activities in relation to environmental monitoring in the Haven.

This report contains part of the completed Rocky Transects survey. An entire copy of the report is copied to all of the contributing bodies and several public libraries in the County and is also available for the cost of copying from the offices of the Public Health and Environment Division of the Housing and Regulatory Services Department, Pembrokeshire County Council.

A list of the majority of the projects under Sea Empress Environmental Evaluation Committee (SEEEC) are included for the purpose of the Group records and we may envisage that the results of some of SEEEC's projects will be followed up by the Milford Haven Waterway Environmental Monitoring Steering Group in the future. The substantial work required for SEEEC has impinged upon the Group's work and I would like to thank Group members for their contribution to this report which has been in addition to their normal workload.

**Huw G Evans**
**Chairman**
**Milford Haven Waterway Environmental Monitoring Steering Group**

## HYDROCARBON LEVELS IN MILFORD HAVEN WATERWAY FOLLOWING THE *SEA EMPRESS* OIL SPILL

The Group's 1995/96 report described the results of the initial monitoring of levels of total hydrocarbons (THC) in water following the *Sea Empress* oil spill. Results obtained in February and March 1996 peaked at between 1,220 and 5,380 mg/l (parts per billion) for sites in the lower Haven between Angle and Dale. By the beginning of April 1996 the THC concentration had reduced to between 5.7 and 14 mg/l at the same locations. The mean level in routine mid-channel points had fallen to 2.6 mg/l by May 1996, which were approaching the background levels that would be expected within the Waterway.

The mean THC levels measured throughout the Haven can be examined by looking at changes over time for the sample locations where post-spill survey work has been undertaken by the Group. These results have been summarised by grouping the sample locations into Upper (above the Cleddau Bridge), Middle (between the Cleddau Bridge and Texaco/Elf jetties) and Lower (below the Texaco/Elf jetties) areas as shown in Figures 1 to 3 respectively. Each figure consists of two histograms, the left-hand one showing levels in mg/l (parts per million) from early monitoring using a less sensitive analytical technique. The right-hand histogram shows the results of the ongoing THC monitoring in mg/l.

The results for sample locations in the Upper Haven are shown in Figure 1. This area was the least heavily oiled within the Haven, and is influenced most by riverine inputs. The mean THC concentrations are generally within the expected background levels but vary from a maximum of 14.5 mg/l in April to 0.9 mg/l in October 1996. The Middle Haven results (Figure 2) are less variable, and lower than those in the Upper Haven, despite the monitoring points being in the area of the Waterway with the main concentration of population, sewage discharges and industrial effluent discharges. All the results in this area for mean THC levels since October 1996 have been less than 5 mg/l.

The mouth of the Haven had the highest levels measured in February and March 1996, but from August 1996 to June 1997 the mean results were consistently low, being less than 2.5 mg/l, back to the expected background levels in this area. However the mean result for July 1997 produced a significantly elevated result , as can be seen clearly from Figure 3. This is due to a result of
148 mg/l at a sample point off Chapel Bay. Chapel Bay is a site which was not cleaned by the Joint Response Centre (JRC), and where subsurface unweathered oil was recorded in the mid-shore in March 1997. This sample point may also be impacted by sub-surface oil still present in the mudflats in Angle Bay. Despite extensive cleanup by the JRC in Angle Bay, oil had migrated from original deposits on the upper shore, penetrated porous beach material and spread down the shore by the action of the tide and movement of beach material.

This is indicative of the process which can be expected to occur at other exposed sites where there have been oil "sumps". This would not be highlighted unless, as in this case, it is close to a sample point or picked up during detailed surveys of the shoreline. Although the mean THC concentrations, as measured in the water samples at mid-channel sample points, have returned to expected background values, the total impact of the spill on the Waterway can be assessed only after the results of the full range of SEEEC projects (outlined elsewhere in this Report) become known.

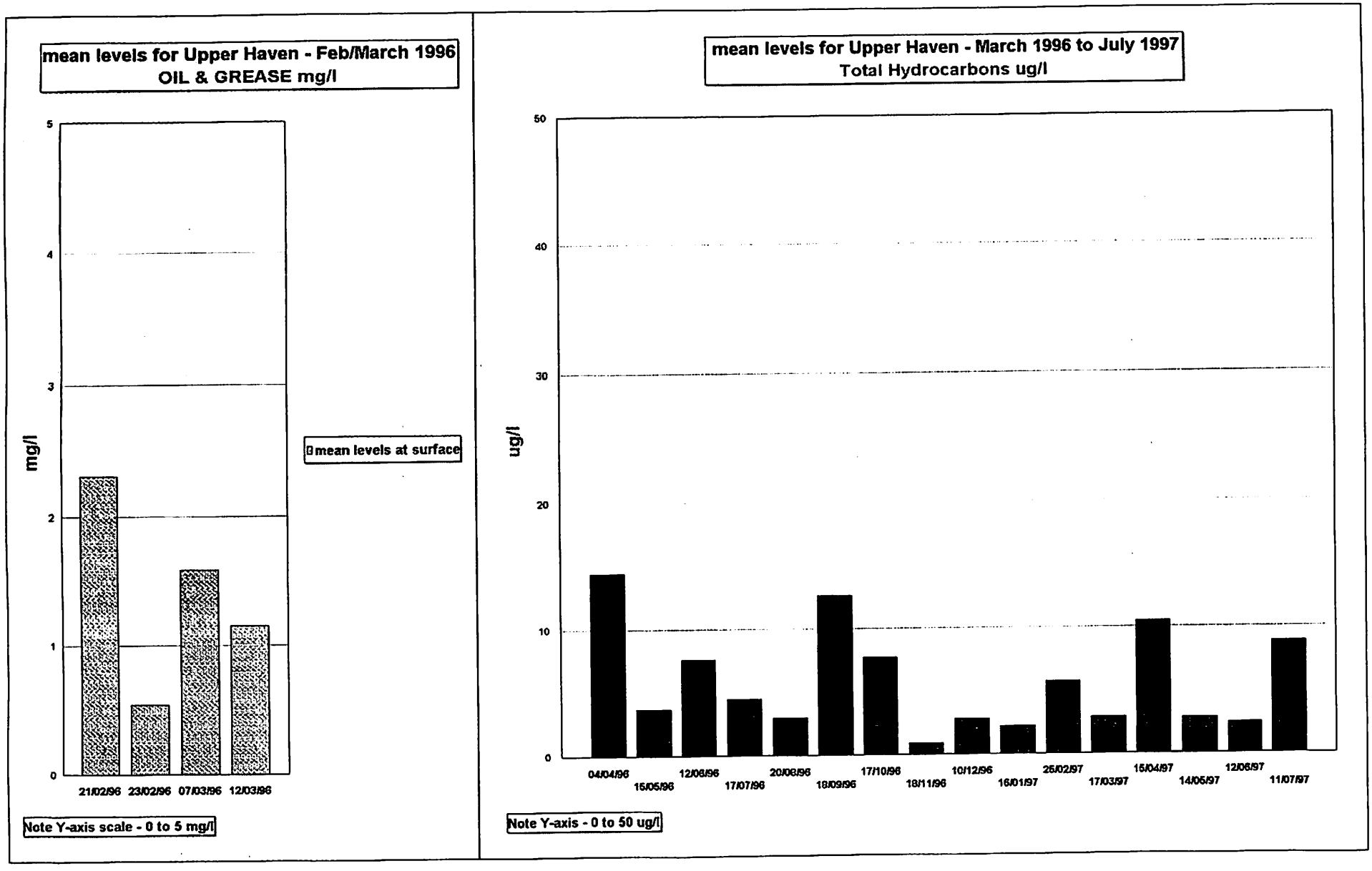
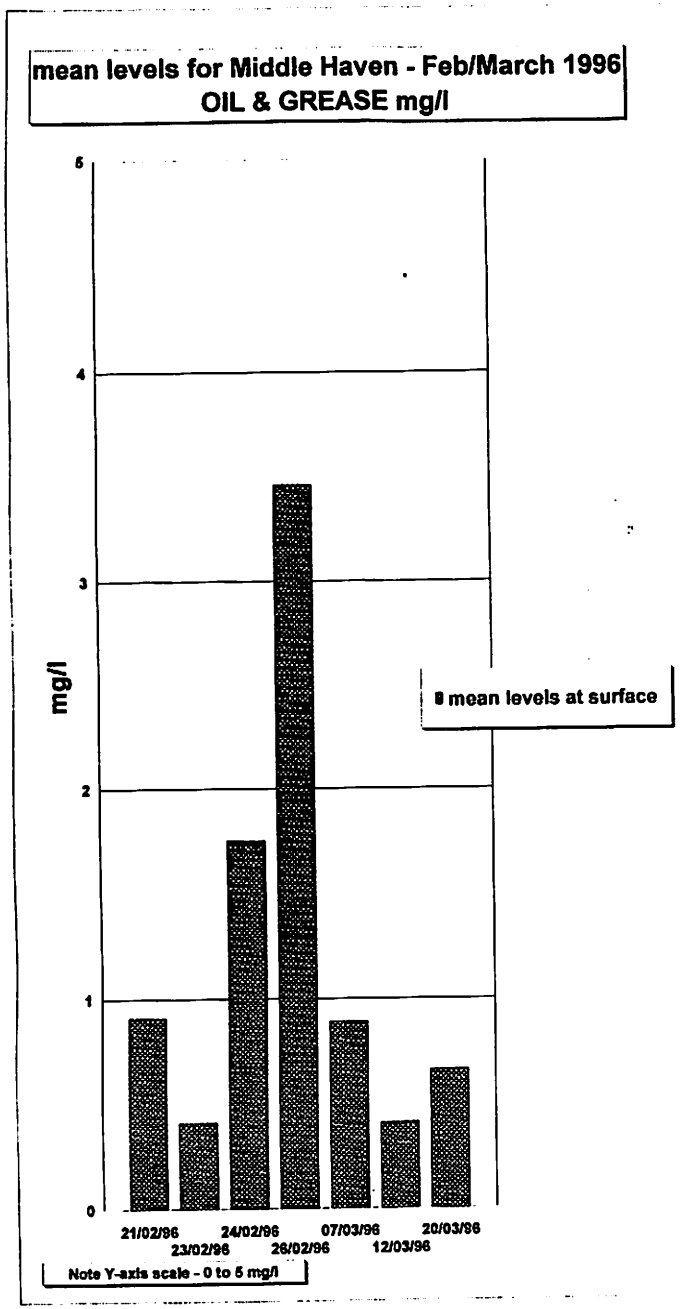



**Fig. 1 - Upper Haven**



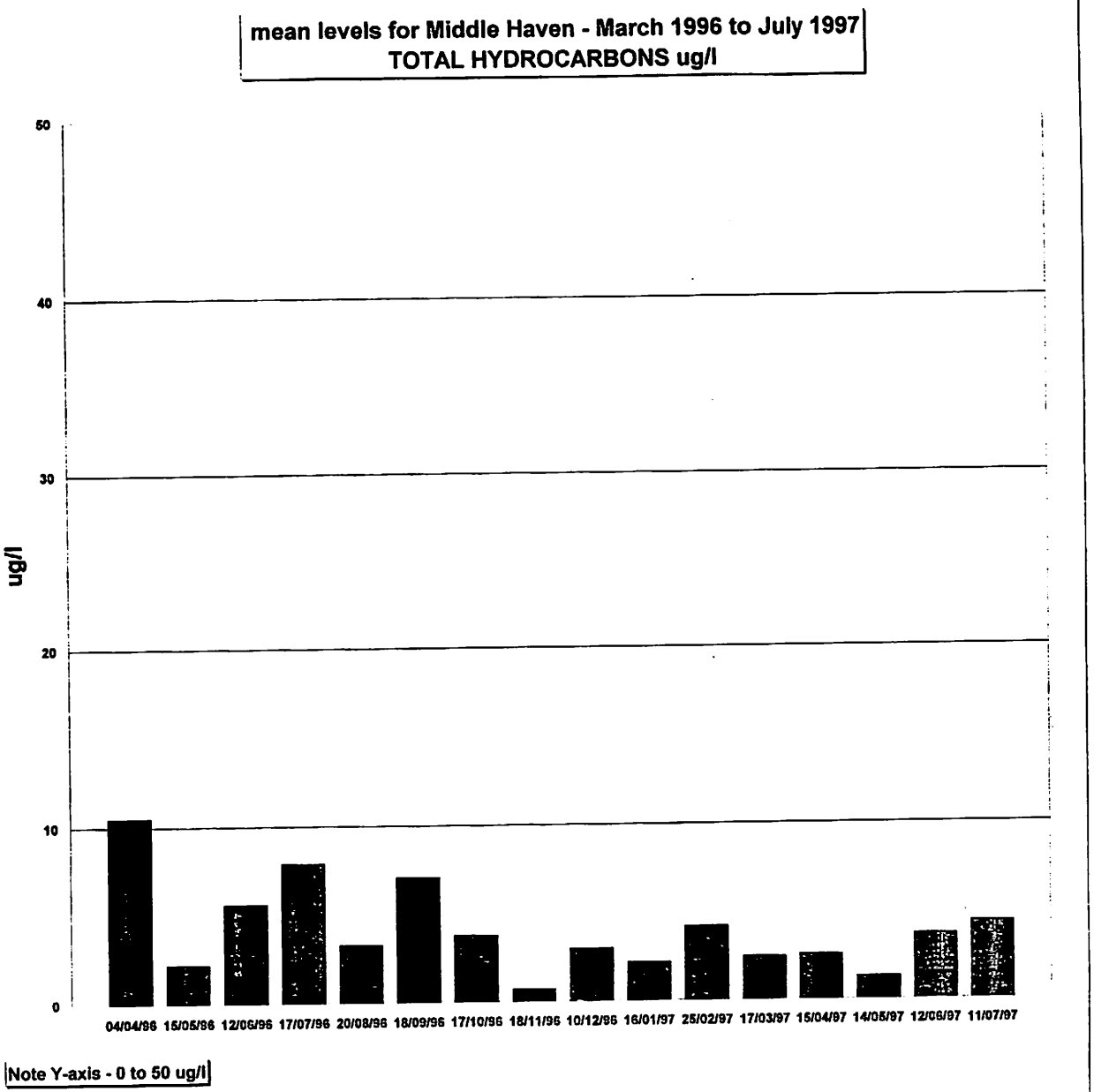
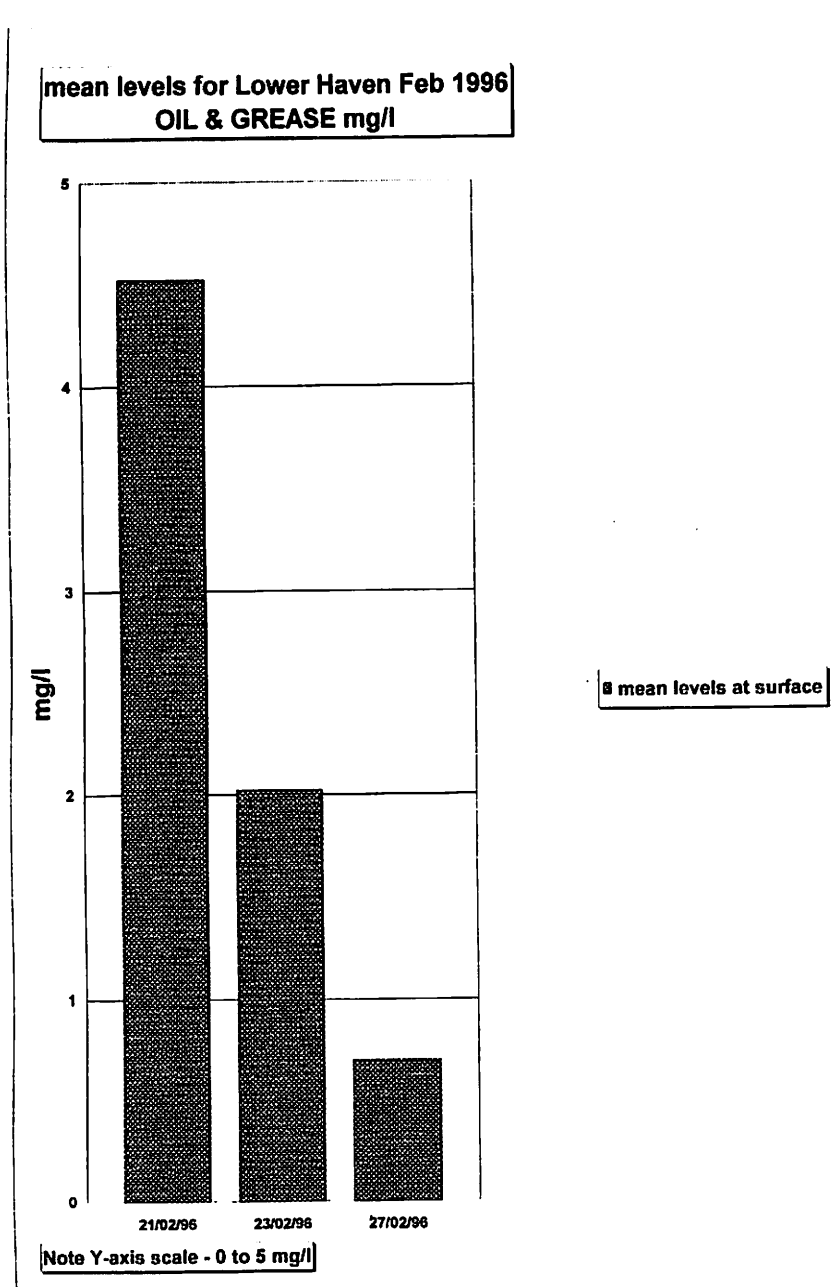




Fig. 2 - Middle Haven



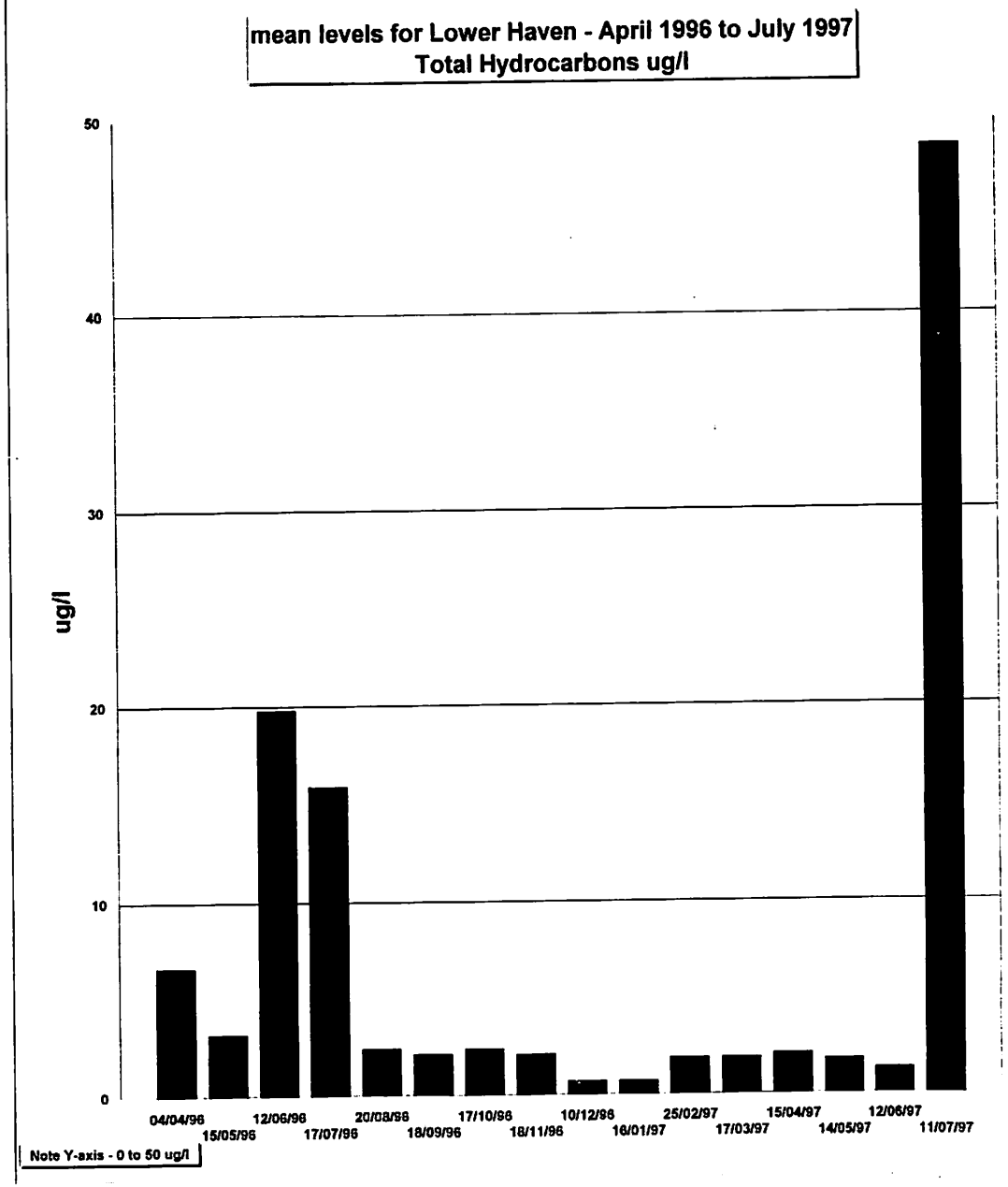




Fig. 3 - Lower Haven

## BATHING WATER QUALITY

Four sites within Milford Haven waterway were tested for bathing water quality from May to September 1996 to determine the microbiological quality under the Bathing Water Directive 76/160/EEC. All four beaches are non-designated. Samples were collected from each site on a weekly basis for 20 weeks by Environmental Health Staff of Pembrokeshire County Council, analysis carried out by Hyder Environmental Laboratories, Bridgend.

### Beaches

| Location | Grid Ref | Sample Point No. |
|---|---|---|
| Dale | SM8130005700 | 39040 |
| Sandy Haven | SM8570007300 | 39192 |
| Gelliswick | SM8870005600 | 39037 |
| West Angle | SM8520003300 | 39032 |

### Water Quality Results 1996

| Beach | % Water Quality Compliance Standards | | | | | 1996 Overall Standard |
|---|---|---|---|---|---|---|
| | Mandatory Parameters | | Guideline Parameters | | | |
| | Faecal Coliform | Total Coliform | Faecal Coliform | Total Coliform | Faecal Streptoccoci | |
| Dale | 100% | 100% | 70% | 90% | 90% | Mandatory |
| Sandy Haven | 100% | 100% | 85% | 95% | 95% | Guideline |
| Gelliswick | 100% | 100% | 60% | 70% | 90% | Mandatory |
| West Angle | 100% | 100% | 75% | 100% | 90% | Mandatory |

### Parameter Compliance Standards

**Mandatory**

| | | |
|---|---|---|
| Faecal Coliform | No more than 2,000 per 100 ml | 95% compliance |
| Total Coliform | No more than 10,000 per 100 ml | 95% compliance |

**Guideline**

| | | |
|---|---|---|
| Faecal Coliform | No more than 100 per 100 ml | 80% compliance |
| Total Coliform | No more than 500 per 100 ml | 80% compliance |
| Faecal Streptococci | No more than 100 per 100 ml | 90% compliance |

## SEA WATER SAMPLING FOLLOWING "SEA EMPRESS" OIL SPILLAGE

### SEA WATER SAMPLE ANALYSIS FOR PHENOLS AND HYDROCARBON OIL CONTENT

| | | ugs/litre hydrocarbons | ugs/litre Phenols |
|---|---|---|---|
| 1. | Martins Haven 29 February 1996 | 15 | 121 |
| 2. | Dale 13 March 1996 | 757 | Analysis not done |
| 3. | Neyland 13 March 1996 | Not detected | 15.7 |
| 4. | Dale 27 March 1996 | 60 | 4.8 |
| 5. | Manorbier 3 April 1996 | 29 | 4.9 |
| 6. | Broad Haven (Haverfordwest) 3 April 1996 | 33 | 5.9 |
| 7. | Whitesands 3 April 1996 | 50 | 6.8 |
| 8. | Tenby North Beach 3 April 1996 | 68 | 6.9 |

Analysis by capillary gas liquid chromatography on a solvent extract from 1 litre of water. The phenol levels on 3 April are regarded as "natural" levels.

# MILFORD HAVEN WATERWAY AND CLEDDAU ESTUARY: WILDFOWL AND WADER COUNTS 1996-97

## Executive Summary

## 1. Introduction

The Cleddau Estuary and Milford Haven Waterway hold large numbers of waterfowl (wildfowl and waders) during the winter months, with numbers of Shelduck, Teal, Dunlin, Curlew and Redshank reaching levels of national importance in most years.

Monthly counts of waterfowl are carried out throughout the autumn and winter as part of the national Wetland Bird Survey (WeBS). Since the winter of 1993-94 these counts have also been incorporated into a rolling programme of research and survey initiated by the MHWEMSG.

## 2. Methods

The dates of the counts are determined by WeBS to coincide with high spring tides. The estuary is divided into fifteen sectors and is counted by a team of observers. Counts normally take place within two hours either side of high tide when most species are assembled in high tide roosts. Sectors are counted by a combination of walking the shore and counting from fixed points depending on accessibility. Complete coverage of all sites was achieved between September 1996 to March 1997.

## 3. Results

During the peak period between November 1996 and February 1997 mean monthly totals of 5472 wildfowl and 8909 waders were present. The peak monthly count for wildfowl was 6896 in January, and for waders was 11,869 also in January. Curlew (max. 1283 in December), Shelduck (max.1023 in January), Wigeon (max. 3351 in November), Teal (max. 2217 in December) and Dunlin (max 8561 in January) exceeded levels of national importance. Dunlin were the most numerous wader, being present in almost double their usual numbers.

Fifty-five species of waterfowl were recorded (excluding gulls), including sixteen species of duck and twenty-three of waders. Divers, grebes, herons, cormorants and geese were also represented, together with mute swan, water rail and moorhen. Unusual species included Red-necked and Slavonian grebes, and a vagrant American wigeon.

## 4. Discussion

The mean midwinter monthly totals of waders and wildfowl were higher than in recent years, although the maximum counts of Curlew, Shelduck, Wigeon and teal were slightly down on 1995-96. Interestingly, Wigeon arrived slightly earlier than usual, and stayed for slightly longer. The large number of Dunlin was unexpected, and any explanation must wait until figures for other estuaries are available for comparison. Great crested grebes were present in relatively large numbers (28 in January), probably due to the cold weather. The cold weather also accounted for the presence of 364 common gulls, 218 Grey plovers and 80 knot during the later part of the winter. Shoveler, Scaup, Pochard and Tufted ducks, where also present in larger numbers than usual. Mute swan numbers increased by about 20 birds in the later winter, due to birds moving to Carew Millpond when Pembroke Millpond was drained for maintenance work. Redshank numbers continued to decline.

The 1996-97 winter showed no firm evidence of any decline due to the *Sea Empress* oil spill. However, it should be noted that any effect may have been masked by cold weather movements, increasing the numbers of birds wintering this far south west. Interpretation of any changes in numbers cannot be made until figures for other estuaries become available.

**Annie Poole**
**WeBS Co-ordinator for Pembrokeshire**
**Pembrokeshire Ornithological Research Committee**
**Dyfed Wildlife Trust.**
**2 June 1997**

## Milford Haven Waterway and Daugleddau Estuary Annual Shelduck Census - 1996

### 1 Introduction and Methods

The Daugleddan Estuary and Milford Haven Waterway hold nationally important numbers of shelducks during the winter months, and a small but significant summer breeding population. The number of breeding shelducks has been assessed at various times during the 1960s and 1970s, and full surveys have been carried out on an annual basis since 1991. In 1993, the annual summer shelduck census was incorporated into the rolling programme devised by the MHWEMSG. The survey was repeated in 1996 by National Park staff using the NPA's small rigid-hulled inflatable boat.

In previous years, fieldwork was carried out in June and late July/early August. In 1996, additional monitoring was carried out in April and May in an attempt to detect any possible impact of the *Sea Empress* oil spill on the breeding population. During the fieldwork, the following information was collected:-

- location and numbers of pairs of shelducks, or single males apparently occupying territories;
- location and numbers of pairs or single adults with broods (June; late July/early August);
- location and numbers of other shelduck present;
- numbers and distribution of other estuary birds;
- identification of shelducks showing any obvious effects of oil pollution (eg, sickness, oiled plumage, unusual behaviour);
- identification of any changes in the expected distribution and numbers of shelducks using the system that could be attributed to the *Sea Empress* oil spill.

All major pills, tributaries and embayments (except The Gann and Westfield Pill, for which information was kindly supplied by local ornthologists) were surveyed from the boat on rising/high spring tides.

### 2 Results

#### 2.1 Shelducks

In June 1996, a total of 16 pairs with broods were located, on the Western Cleddau (8), Eastern Cleddau (3), Cresswell River (2), Carew River (1), and Pembroke River (2). (A pair with a brood was also recorded on The Gann estuary in June.) A total of 87 non-breeding shelducks were recorded, mostly on the Western and Eastern Cleddau and in Pembroke River.

By the end of July/early August, 7 additional broods had appeared on the Western Cleddau (3), Eastern Cleddau (1), Cresswell River (2) and Pembroke River (2). Thus a total of 23 broods, with a total of 197 ducklings were recorded in the estuary system during this survey.

The brood in The Gann and a further brood found in Westfield Pill brings the grand total for the estuary system to: -

| | |
|---|---|
| Number of broods | 25 |
| Number of ducklings | 217 |
| Average number of ducklings/pair | **8.68** |

During April and May, no evidence of any abnormalities in numbers or distribution of shelducks in the estuary system were detected. With the exception of one slightly oiled bird, none of the shelducks present appeared to be in any difficulties as a result of the presence of oil in parts of the estuary system (which were used by shelducks).

## 2.2 Other Estuary Birds

During April and May, small numbers of curlew, Redshank, Ringed plover, Oystercatcher and Dunlin remained in the estuary system. Small numbers of passage migrants, eg Whimbrel, were recorded in May. Wigeon, Teal and Red-breasted merganser were also present, along with resident populations of mallard. There were also small numbers of Canada geese present on the Western Cleddau. By mid-June, numbers of waders and wildfowl present in the estuary system had declined (except for Canada geese) in line with the expected trends. As in previous years, the numbers had risen dramatically by the end of July to over 4000, 2734 of which were Curlew. Most of these birds were almost certainly passage migrants. Common sandpipers, Whimbrel and Greenshank were also among the passage migrants using the estuary system. A total of 206 Canada geese were recorded - slightly down on the 1995 total, although this does not necessarily indicate a decline. The majority of waders present were counted at high tide roosts.

# 3 Discussion of Results

The data obtained in the 1996 survey indicate that this was the best year for breeding shelducks in the estuary system since the current sequence of annual surveys began in 1991. The total number and sizes of the broods recorded probably exceeds the highest counts obtained during the 1960s and 1970s. Several factors, notably a reasonably dry spring and relatively low numbers of ground predators (especially foxes, whose numbers appeared to have been suppressed by a cold winter and outbreaks of mange), are thought to have contributed to a very successful breeding season. No evidence was found to suggest that the *Sea Empress* oil spill had affected the breeding population of shelducks.

# 4 Future monitoring

The annual summer census will be repeated in 1997, as part of the annual monitoring programme co-ordinated by the MHWEMSG.

A detailed account of the 1996 census is given in an unpublished report to the MHWEMSG and The Wildlife Trust's Pembrokeshire Ornithological Research Committee.

**Jane Hodges**
**Pembrokeshire Coast National Park Authority**
**June 1997**

# ROCKY SHORE TRANSECT MONITORING IN MILFORD HAVEN


## Summary

The Milford Haven Waterway Environmental Monitoring Steering Group (MHWEMSG) commissioned OPRU to carry out surveys of rocky shore fauna and flora at fixed transect sites throughout the Haven and the Daugleddau Estuary. The main aim of these surveys was to provide a baseline for future monitoring of the rocky shore life. The work was part of an on-going MHWEMSG programme of baseline and monitoring surveys of the environmental quality of the Haven to assess the effects of pollution and other impacts.

The survey was carried out during periods of low spring tides in October/November 1995 by rocky shore ecologists working in pairs. Twenty four previously established rocky shore transect sites were used as the basis for the site selection and seven additional sites were established to provide further geographic coverage, particularly in the Daugleddau Estuary. One of the new sites was established on the open coast just outside the Haven as a reference site.

The survey methodology was the same as that used in previous rocky shore transect surveys in Milford Haven. Discontinuous belt transects run down the shore on a fixed bearing from a fixed point at the top of the shore. Site location sheets from previous surveys provided directions and information to aid relocation of the already established transects. The stations (3m wide by 30cm deep) were marked at 60cm height intervals along each transect. All conspicuous species of fauna and flora were recorded and their abundance assessed using semi-quantitative abundance scales. A pat of concrete and yellow road paint was used to mark the site and some of the stations. Photographs, sketches and notes were taken along each transect and used to aid description of the habitats and communities and for new site location sheets. Annotated photographs have also been used in new site location sheets which have been prepared for the 31 sites. The sheets are encapsulated in plastic for field use.

Descriptions of each transect site and the habitats and communities found at the stations are given in the results section of the report. The descriptions of the habitats and communities are put in the context of recognised UK rocky shore 'biotopes' which are briefly described in an appendix. Photographs of the sites have also been annotated with biotope codes to show the relationship of the transect stations to the rocky shore biotopes.

The species abundance data have been entered into a computer database and then tabulated as an appendix to the report. Data from two previous surveys of rocky shore transects in Milford Haven (in 1979 and 1982) were also entered into the computer database and a simple comparative analysis used to highlight changes in species abundance. Although some changes in taxonomy and recording methodology require caution when assessing differences in the data, it is clear that some species - and groups of species had undergone significant changes since the earlier surveys. The most notable changes include the following:

Dogwhelks, *Nucella lapillus,* populations declined dramatically between 1982 and 1995, probably due to contamination from the anti-fouling paint additive tributyl-tin (TBT). Populations of the grey topshell *Monodonta lineata* and the edible winkle *Littorina littorea* were also reduced at most sites in the Haven. The reason for these reductions are not known, but it is known that the *Monodonta* populations had been gradually decreasing for many years.

Densities of the Australian Immigrant barnacle *Elminius modesties* were also lower than in 1982. The only significant increase In any animal species was in populations of the beadlet anemone Actinia equina There were decreases In some rocky shore plants - particularly the red algae Dumontia contorta, the fucoids Ascophyllum nodosum and Pelvetia canaliculata, and the black lichen Verrucaria mucosa It is suggested that some of these changes may be due to a slight increase in wave exposure from either increased boat wash or a natural shift in wind direction/strength.

Site specific changes were also described. Changes were particularly marked at Gelliswick where construction of a promenade near to the site is thought to have resulted In some changes to the shore environment.

Overall however, the Milford haven rocky shore communities are considered to be healthy and many are very rich in species. A number of recommendations for future work have been made:

Following the sea empress oil spill of February 1996 it is recommended that a full resurvey of the rocky shore sites is carried out at around the same time of year (i.e. autumn) in 1996 and then annually at selected impacted sites for at least three years to maintain the baseline and monitor any changes in the health of the shores. It is suggested that a pre-survey training day is essential for quality control in any future rocky shore surveys in Milford haven if the rocky shore ecologists have not had recent experience if the methodology used in this programme.

The decline in dog whelk populations is thought to warrant a survey of 'imposex' levels and a monitoring programme to assess whether recovery is underway. It is also suggested that analysis of local weather and shipping data might show whether there has really been an increase in wave-exposure.

More detailed analysis of the data from the 1995 survey and previous surveys would certainly provide more useful information on the ecology of the rocky shore communities in Milford Haven. It is suggested that a research project could be initiated.

## Introduction

The Milford Haven Waterway Environmental Monitoring Steering Group (MHWEMSG) commissioned OPRU (formerly the Field Studies Council Research Centre) to re-establish and expand a series of rocky shore monitoring transects around the Milford Haven waterway in autumn 1995. The purpose of this survey work was to provide baseline information on the quality and quantity of rocky shore life in the Haven for future monitoring. In particular, information could be used for comparative purposes following any future pollution events. A second objective of the study was to compare the 1995 data with those collected during previous surveys and to describe any major changes or trends in the abundances of rocky shore fauna and flora that have taken place.

Twenty-two of the rocky shore transects were established by Moyse and Nelson-Smith (1963) and Nelson-Smith (1964) as part of a research fellowship on the effects of oil pollution undertaken at University College Swansea. These transects have been re-surveyed at intervals since then, mostly by OPRU staff, for the purposes of general monitoring, research studies or as a response to specific oil spills (Table 1).

Two additional transect sites were established during the early seventies. The various published results of these surveys have described the distribution of animals and plant species in Milford Haven and identified changes caused by natural fluctuations or pollution impacts. In some cases

it is clear that perceived changes have actually been due to inaccurate placement of the rocky shore transects. Since 1979 this was largely solved by the preparation of site location sheets, although some sites have been re-established in slightly different positions. For example, the exact placement of the Burton Hawn and Great Castle Head (outer and inner) transects has never been well defined.

To fill-in gaps in the geographical coverage, the MHWEMSG established sites in the upper Daugleddau estuary and re-established a reference site on the open coast near West Dale Bay. This increased the number of monitoring sites from 24 to 31. All but two of the additional sites had previously been surveyed, though not formally established as monitoring sites.

The major oil pollution event resulting from the grounding of the *Sea Empress* in February 1996 has re-emphasised the importance of the rocky shore monitoring study. However, this report does not consider the results of rocky shore survey work after the spill.

The report describes the methodology used for the establishment and marking of new and old monitoring sites, the recording of animals and plants, the storage and analysis of the data and specimens collected. A description is given of each transect sites and the communities of animals and plants present, including a full data appendix. The survey results are compared with previous data and are then discussed. Recommendations are given for future monitoring of the rocky shores of Milford Haven.

*Table 1.* *Previous surveys at the 22 rocky shore monitoring sites. Column headers indicate the years when surveys were carried out. Numbers in the table give the month and year of survey. Brackets 0 indicate that the transect was probably in a different place in the 1995 survey. * indicates that observations rather than systematic recording was carried out (T)) indicates the site is used for teaching by Orielton Field Centre or Dale Fort Field Centre.*

| No. | Name | 61-3 | 6870 | 71-75 | 76-78 | 79 | 82 | 86-89 |
|---|---|---|---|---|---|---|---|---|
| 1 | Dale Point(T) | 6/61 | 3/69 | | (4/77) | 2/79 | 4/82 | |
| 2 | South Hook Point | 9/62 | 3/69 | 8/73 | | 3/79 | 3/82 | 12/88* |
| | | | | 5/74 | | | | |
| 3 | Watchhouse Point | 7/61 | 2/69 | 8/73 | 8/76 | 3/79 | 3/8T | |
| | | | | 7/74 | | | | |
| 4 | Rook's Nest Point | V61 | 2/69 | 8/73 | 8/76 | '4/79 | 782 | |
| | | | | 5/74 | | | | |
| 5 | Musselwick East | (6/61) | 3/69 | 8/73 | 8/76 | 3/79 | 5/82 | |
| | | | | 7/74 | | | | |
| | | | | 5/75 | | | | |
| 6 | Little Castle Head | 7/61 | 3/69 | 8/73<br>4/74 | | 3/79 | | |
| 7 | West Angle Bay | 9/61 | 3/69 | 8/74 | 9/76 | 1/79 | 4/82 | |
| 8 | Point Wood Beach (T) | (6/61) | 7/70 | | (77) | (4/79) | | |
| 9 | Black Rock(T) | (6/61) | 3/69 | | 4/77 | 1/79 | 3/82 | |
| 10 | Gelliswick | 8/62 | 7/69 | 4/74 | | 3/79 | 5/82 | 12/88* |
| 11 | Angle Point(T) | 9/61 | 11/68 | 8/74 | 10/76 | 2/79 | 3/82 | 11/89 |
| 12 | Bullwell | 10/62 | 2/69 | | 3/77 | 3/79 | 4/82 | |
| 13 | The Horseshoe | 10/63 | 3/70 | | 1/78 | 3/79 | 4/82 | 12/88*<br>6/89 |
| 14 | Wear Point | | 4/70 | | 4/77<br>11/77 | | 4/82 | 16/89<br>2/88* |
| 15 | Hazelbeach | 10/62 | 7/70 | | 11/77 | 3/79 | 4/82 | 12/88*<br>6/89 |
| 16 | Cliff Cottages | 6/6Th | ;1/70 | | (4/78) | 4/79 | 3/82 | |
| 17 | Llanreath | 5/63 | 7/69 | | 77 | 2/79 | 4/82 | 11/86* |
| 18 | Pembroke Ferry | 10/62 | 12/68 | | | 3/79 | 4/82 | 12/88* |
| 19 | Burton Hawn | (9/62) | (2/69) | | | (4/79) | | (6/89) |
| 20 | Cosheston Folly | 5/63 | 1/69 | | | 3/79 | 5/82 | 12/88* |
| 21 | Lawrenny Ferry | 8/62 | 2/69 | | 3/77 | 3/79 | 3/82 | 12/88* |
| 22 | Pennar Point | | | 10/72 | 10/76 | 2/79 | 3/82 | 11/86* |
| 23 | Great Castle Head | (6/61) | 2/69 | | | | | |
| | (Outer) | | | | | | | |
| 24 | Great Castle Head | | | (8/73) | | | | |
| | (Inner) | | | | | | | |
| 25 | Sawdern Point (T) | | | | | | | 1/86* |
| 26 | Chapel Bay | | | 7/74 | 3/78 | | | 11/89* |
| 27 | Garron Pill | (9/62) | | | | | | 6/89 |
| 28 | Landshipping (south) | (9/62) | | | | | | |
| 29 | Picton Point | No previous surveys | | | | | | |
| 30 | Black Tar (north) | (9/62) | | | | | | |
| 31 | Benton Castle | No previous surveys | | | | | | |

**Explanatory Notes to accompany Table 1**

61-63 Establishment of transects (Moyse and Nelson-Smith, 1963; Nelson-Smith, 1967).
68-70 Re-survey of transects (Crapp, 1970).
71-75 Surveys following Thuntank 6 oil spill on Thorn Island (Ottway, 1971), oil spill at Pennar Point in November 1972 (Baker, 1976) and *Dona Marika* petroleum spill in Lindsway Bay in 1973 (Baker, 1976).
76-77 Surveys by OPRU staff (unpublished)
1979 Resurvey of transects (Little, 1983)
1982 Resurvey of transects (Woodman *et al.*, 1983)
1/86 Observations following a pipeline spill from Texaco jetty and dispersant usage on shore.
11/86 Observations after a white kerosene spill from vessel *Breaksea*
12/88 Observations after an Iranian light crude oil spill from tanker *El Omar* (Little *et al.*, 1989)
6/89 Establishment of upper shore lichen monitoring quadrats (Mercer, 1989)

11/89 Observations and recording after fuel oil spill from *Texaco Westminster* (Little *et al.*, 1989)

# 2 METHODOLOGY

## 2.1 Field survey

Fieldwork was carried out during the spring tides of 7th to 11th and 22nd to 27th October and on the 7th November 1995. Table 2 details the sites surveyed and Fig. 1 shows the location of the sites.

### Site location and establishment

Thirty sites are located within or at the entrance to Milford Haven and one site is located on the open coast near Dale. Access to sites was either by car and foot or inflatable boat as appropriate. The boat was supplied by the Milford Haven Port Health Authority.

Site location sheets, containing maps, colour photographs and written notes in plastic wallets, were used to aid relocation of previously established sites. New sites, or sites for which there was inadequate relocation information, were established by simply walking around the proposed area and selecting a suitable rocky shore feature - i.e. a bedrock surface of at least 3m width that faced the sea or estuary and extended down to at least the mid-shore level. A fixed datum marker (usually a pat 6f concrete and/or a paint mark) marked the top of most of the existing transects. Where there was no concrete pat, a new one was made with pre-prepared bags of mixed sand and cement and fresh water. A tape was laid down the shore from the fixed datum marker at the top of the transect, along a line defined by a bearing and easily locatable from the previous photographs. A bearing and the necessary photographs for relocation were taken at the new sites.

## Transect stations

Fixed recording stations were established along the transects at all sites. The stations were located at 60 cm height intervals from the fixed datum marker at the top of the shore. At existing sites, many of the upper shore stations were marked with spots of paint. At other existing sites there were usually tape measurements and/or photographs to aid relocation. A cross-staff level (with a 60 cm shaft) was used confirm relocation of the stations on bedrock and to establish the stations on new sites. The number of stations surveyed varied from 21 stations at Watchhouse Point (Site 1), where there is an extensive supralittoral lichen zone, to 9 at Benton Castle (Site 31) where the incoming tide curtailed survey work on the lower shore stations.

*Table 2. Milford Haven rocky shore sites surveyed during October 1995.*

| No. | Name | Grid Ref. | Date | Staff | Notes |
|---|---|---|---|---|---|
| 1 | Dale Point | SM 824 050 | 8.10.95<br>10.10.95 | JM. CM | Swell limited lower shore survey |
| 2 | South Hook Point | SM 867 055 | 25.10.95<br>27.10.95 | AL, DR | Swell limited lower shore survey |
| 3 | Watchhouse Point | SM 836 062 | 27.10.95 | JM, AL | Swell limited lower shore survey |
| 4 | Rook's Nest Point | SM 844 063 | 27.10.95 | JM, AL | Swell and time limited lower shore survey |
| 5 | Musselwick East | SM 823 062 | 8.10.95 | JM, CM | |
| 6 | Little Castle Head | SM 855 064 | 10.10.95 | AL, JW | |
| 7 | West Angle Bay | 5M848031 | 11.10.95 | JM,CM | |
| 8 | Point Wood Beach | SM 821 053 | 10.10.95 | JM, CM | |
| 9 | Black Rock | 5M813061 | 8.10.95 | AL,JW | |
| 10 | Gelliswick | SM 889 054 | 25.10.95 | AL, DR | |
| 11 | Angle Point | SM 875 033 | 11.10.95 | AL, JW | Very poor light and weather limited quality of survey |
| 12 | Bullwell | 5M902039 | 26.10.95 | JM.CM | |
| 13 | The Horseshoe | 5M924046 | 25.10.95 | JM,CM | |
| 14 | Wear Point | SM 938043 | 25.10.95 | JM, CM | Lower shore stations covered in thick mud |
| 15 | Hazelbeach | 5M945045 | 24.10.95 | JM,CM | |
| 16 | Cliff Cottages | SM 811 064 | 8.10.95 | AL, JW | |
| 17 | Llanreath | SM950033 | 23.10.95 | JM.CM | |
| 18 | Pembroke Ferry | SM 976 046 | 24.10.95 | JM, CM | Very poor light and weather limited quality of survey |
| 19 | Burton Hawn | SM 991 053 | 24.10.95 | AL, DR | Very poor light and weather limited quality of survey |
| 20 | Cosheston Folly | SM 996 050 | 24.10.95 | AL, DR | Very poor light and weather limited quality of survey |
| 21 | Lawrenny Ferry | SN008062 | 23.10.95 | AL,DR | |
| 22 | Pennar Point | 5M943029 | 23.10.95 | JM,CM | |
| 23 | Great Castle Head (Outer) | SM 797 056 | 8.11.95 | JM, DR | New site |
| 24 | Great Castle Head (Inner) | SM 850 060 | 10.10.95 | AL, JW | New transect placed in different position from area previously surveyed |
| 25 | Sawdern Point | SM 888 031 | 11.10.95 | JM, CM | New site |
| 26 | Chapel Bay | SM 861 036 | 11.10.95 | AL, JW | New site. Logistics of surveying large boulders limited quality of data for monitoring purposes |
| 27 | Garron Pill | SN 010076 | 23.10.95 | AL, DR | New rocky shore transect positioned below previous lichen monitoring site |
| 28 | Landshipping (South) | SN 004 103 | 9.10.95 | JM, CM | New site |
| 29 | Picton Point | SN 003 116 | 9.10.95 | AL, JW | New site |
| 30 | Black Tar (North) | SM 999 098 | 9.10.95 | AL, JW | New site |
| 31 | Benton Castle | SN 006 068 | 9.10.95 | JM, CM | New site. Incoming tide curtailed lower shore survey |

### Field recording

Comprehensive surveys were made of all conspicuous species at each selected station. The abundances of conspicuous animals, algae and lichens were noted and recorded from a 3 m by 30 cm strip (1.5 m along the shore to each side of the tape, and 30 cm down the shore from the station marker). Pro forma recording forms with species checklist assisted this process and abundances were according to the semi-quantitative abundance scales listed in Appendix 1. The abundance scales used are the established scales as described in Baker and Wolff (1987). Examples of the completed recording forms are given in Appendix 3. Any points of interest on the shores or relating to the populations observed were noted in the field.

The site was photographed from appropriate viewpoints to provide sufficient photographic prints for the preparation of new site location sheets and for the mapping of the rocky shore biotopes present at each site (see section 2.3 below). The equipment used was a Nikon F90 camera with a 28-85 mm zoom lens and a Nikon F30 1 with 50 mm lens, loaded with 400 ASA Kodacolor Gold film.

### Preparation, consolidation and quality control

A pre-survey training and familiarisation session was held for all survey staff on the day before the survey began. The aim of this session was to ensure that everyone was familiar with the various methodologies, recording form formats and abundance scales. While all staff were experienced at rocky shore survey work, it was considered important for them to be familiar with the methodological details of the survey that could improve comparability with the previous survey data from the Milford Haven sites.

Completion of all recording forms and the identification, preservation and labelling of collected specimens was the responsibility of the individual surveyors. However, there was a period of consolidation and quality control after each fieldwork day. This was to ensure that staff were recording species with the same names, had completed all forms satisfactorily and legibly, and that all films had been logged and labelled.

### Note on survey techniques

The use of semi-quantitative abundance scales on fixed discontinuous belt transects is a recognised rocky shore monitoring technique which can identify major changes and many smaller changes in whole communities in a relatively short survey period. It is particularly appropriate for monitoring a large number of sites in a defined survey area. While the data are not amenable to rigorous statistical analysis to provide proof of subtle changes they can clearly show trends over time and along the environmental gradients of shore height, wave exposure, salinity, pollution, etc. A critique of the methodology and other techniques is given in Hiscock (1985) and in Little and Hiscock (1989).

## 2.2 Data analysis

The data from the October 1995 survey were entered into a computer database (DBaseIV) which also holds the data from the 1979 and 1982 surveys. Each record comprises the species name and taxonomic code (Howson, 1987), the site number, the year, and the recorded abundance at each station. The abundances are recorded as the numerical equivalent of the categories, e.g. 4 = Common.

Data comparisons between the 1995 survey and the two previous surveys were carried out with simple algorithms written within the DBaseIV package. Significant changes in species abundances between surveys were highlighted by this process. Where significant changes in a species occurred over a number of sites, or where a number of changes in different species occurred at the same site, they were analysed further (Section 4).

## 2.3 Other survey products

### Site location forms

New site location sheets have been created using the photographs, notes and maps from the survey. An example is given in Appendix 4.

### Biotope maps and descriptions

Annotated photographs and sketches were created for each site to show the distributions of the various defined biotopes present along and adjacent to the transects. An example of annotated photographs from one site is given in Appendix 5. The biotope classification used is according to the MNCR Intertidal Biotope Manual version 6.95 (Connor *et* al., 1995). The rocky shore biotopes found in the marine inlets of SW Britain have been described in more detail in Moore (1995).

### Specimen collection

Specimens of species that could not be identified with any certainty in the field were collected for later identification in the laboratory (usually on the same evening). The MHWEMSG requested that a collection be made of species that an average' rocky shore surveyor might have difficulty identifying. All such specimens were preserved and are held as a collection at OPRU.

# 3 PHYSICAL AND BIOLOGICAL DESCRIPTION OF SITES

The recorded abundances of all taxa at all sites are given in Appendix 8. Descriptions of the main features of each site are given below, including the physical context and characteristics of the communities of animals and plants. Full community descriptions at each site are not provided, since this would involve considerable repetition between sites. Rather, the communities are described in relation to the typical biotopes found on rocky shores in Milford Haven. The biotope classification used is according to Connor (1995) and descriptions of the typical biotopes (adapted from Moore (1995) and. Connor (1995)).

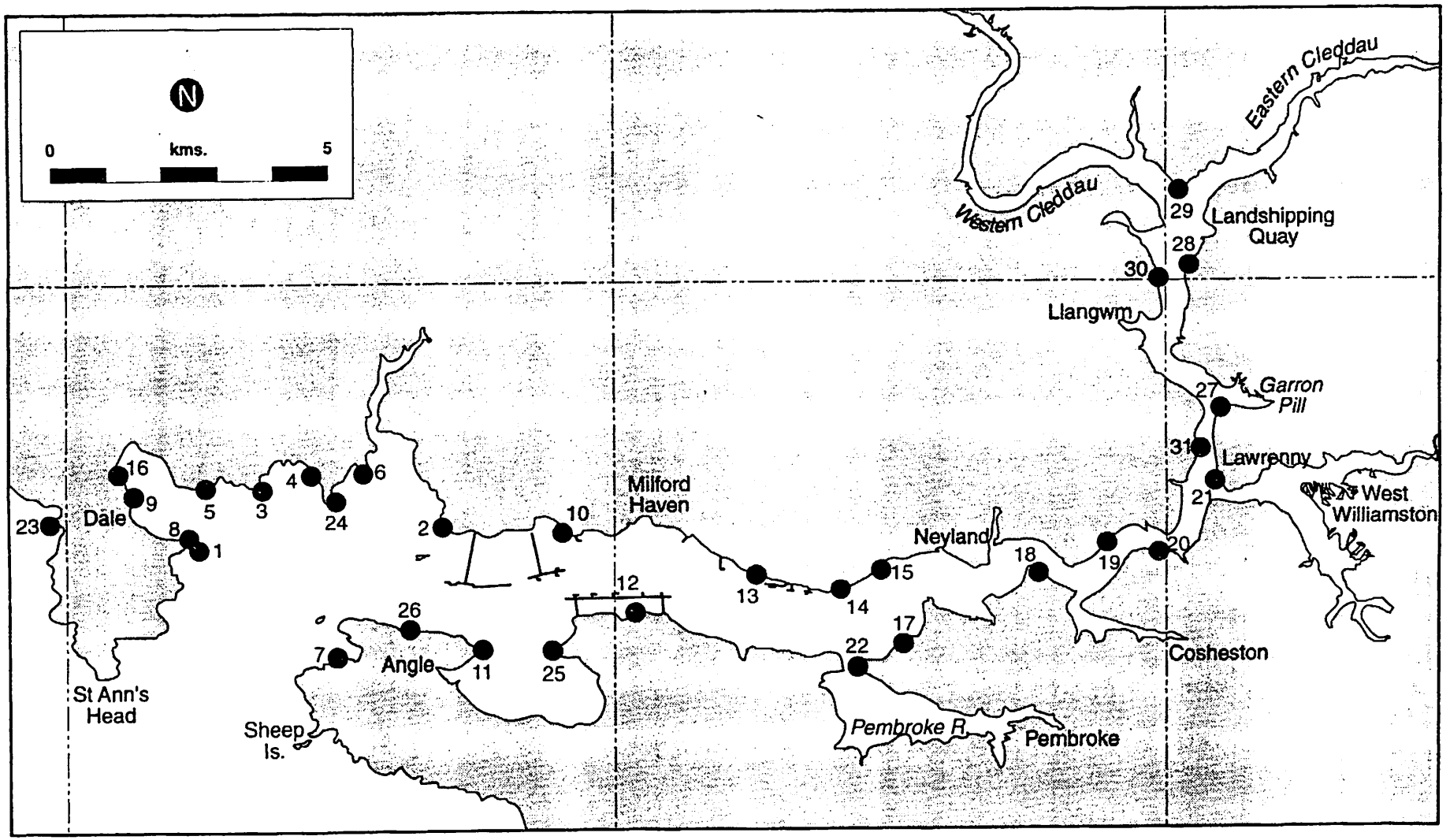



*Fig. 1.* *Locations amd numbering of rocky shore monitoring sites in Milford Haven, October 1995.*

## Conclusions

Comparison of the 1995 data with that from previous surveys is not straightforward but has shown a number of interesting changes. Most notable amongst these are the following:

- A dramatic decline in the densities of Dogwhelks at many sites in Milford Haven, probably due to the effects of TBT anti-fouling paints. The largest reduction was at Musselwick East in Dale Roads near the ship anchorage. It is thought likely that TBT contamination from ships caused the reduction at this site in particular, but it is not known if contamination continues to date.
- A continued decline in the populations of the topshell *Monodonta lineata* Remaining populations of this snail in *1995* were very small, but the cause of the decline not known and may be natural.
- Large reductions in the densities of the edible winkle *Littorina littorea* throughout the Haven. The cause is unknown.
- Reduced cover of the fucoid alga *Ascophyllum nodosum* at sheltered sites in the Haven and Daugleddau. It is suggested that this may be due to increased wave-exposure from boat wash.
- Large changes in the abundances of many species along the Gelliswick transect (site 10). It is thought likely that the construction of the promenade to the west of this site may have resulted in increased siltation of the rocky shore.

Notwithstanding these apparent trends and changes, the 1995 survey data shows that the rocky shore communities of Milford Haven were generally healthy. Although the monitoring methodology cannot be used for a detailed analysis of species diversity between sites and surveys, subjective assessment of the data and personal observations made by the survey team members suggest that many sites also have very rich communities of animals and algae compared to many other inlets in south-west Britain.

The survey methodology is considered to be suitable for monitoring changes in the Milford Haven rocky shore communities, assuming that future surveys are carried out reasonably frequently (every 2 to 3 years) and at approximately the same time of year (i.e. autumn).

# 5 RECOMMENDATIONS

Following the *Sea Empress* oil spill of February 1996 it is recommended that a full re-survey of the rocky shore sites is carried out at around the same time of year (i.e. autumn, before the equinoctial storms) in 1996 and then annually at selected impacted sites for at least 3 years. In general it is recommended that the rocky shore transect sites are re-surveyed at intervals of 3 years. This time scale agrees with that recommended by Woodman et al. (1983) following the 1982 survey. This would maintain a baseline for monitoring, provide information on natural fluctuations in the populations of conspicuous rocky shore species and monitor the general health of the shore communities.

The training day that preceded the survey was a considerable benefit to the survey - ensuring good quality control of the survey methodology and the data. It is considered an important feature for any future rocky shore surveys in Milford Haven where the rocky shore ecologists have not had recent experience of the methodology used in this programme.

The decline in dogwhelk populations and its link to TBT contamination deserves some further studies. In particular, it would be useful to know how much shipping entering Milford Haven still uses TBT anti-fouling paint. It would also be useful to know the status of 'imposex' levels in remaining dogwhelks in the Haven and whether these populations are recovering or getting worse. This could be done by carrying out a survey of imposex and population size frequency at selected sites, and then repeating the survey at intervals of 1 to 3 years.

Some of the changes in rocky shore species suggested that there had been an increase in wave exposure from either increased boat wash or a natural shift in wind direction/strength between 1982 and 1995. An analysis of local weather data and shipping data is recommended to identify any such changes and predict any long term trends.

Inevitably for a survey of this sort, carried out under contract with defined objectives and outputs, there is considerable scope for more data analysis. It is likely that more detailed analysis could uncover potentially interesting information on the ecology of the rocky shore biota. It is suggested that the Committee might consider the means by which a research project could be initiated.

# SEA EMPRESS ENVIRONMENTAL EVALUATION COMMITTEE

## List of Studies as Specified in the Initial Report

These studies are listed with the agreement of the secretary of SEEEC as many will undoubtedly play a part in the Milford Haven Waterway Environmental Monitoring Steering Group in the future.

It is stressed however that any person interested in the results of these studies should wait for the official publication of the SEEEC Report in January 1998 before making enquiries of the SEEEC Secretariat.

Any additional studies for SEEEC not listed here will be included for recording purposes in the next annual report.

| | Timing |
|---|---|
| **FISH (excluding salmonids)** | |
| **Impact on local bass stocks (99)**<br>A comparison with nearby areas and previous years. Important commercial and angling fish. | **Until late 97** |
| **Impact on herring stocks in Milford Haven (100,5)**<br>Locally a genetically distinct stock and so important for conservation (though not commercially significant at present). | **Until July 1997** |
| **Effect of oil on sandeel distribution and on bait-fish: the significance for predators (3/16)**<br>Sandeels are important in the food chain for birds and fish, and are sensitive to the oil as they live in sand. Bait-fish (mostly clupeids) are similarly important in the food chain. Reduction in stocks or high hydrocarbon content in either species could have important knock-on effects. | **Until Sept. 96** |
| **Hydrocarbon levels in territorial fish species (32)**<br>(This proposal will only be taken forward if the previous project shows contamination in sandeels.)<br>Territorial fish are more likely to accumulate hydrocarbons than mobile fish. Wrasse are important ecologically and for angling | |
| **The influence of oil on non-salmonid migratory fish species (elver, lamprey and shad) (18)**<br>Elvers are important in fresh water; the others are important for their rarity. There are few opportunities to assess the impact of oil on these fish. | **Until Spring 97** |
| **Genetic and potentially carcinogenic damage in marine species produced by oil exposure (107)**<br>Understanding the effects of oil on fish tissue is important in assessing the possible hazard of consuming fish, and potential effects on the food chain. | **Until May 97** |
| **Studies of DNA adduct formation (131)**<br>This will examine whether there is a link between PAH concentrations in water and disease in demersal fish - particularly looking for any long term genetic effects. | **Until May 97** |
| **SALMONIDS (Salmon &, Sea Trout)** | |
| **These are economically important fish for both commercial and recreational fishing. They are migratory.** | |
| **Impact on the commercial and recreational migratory salmonid fisheries in west Wales (12)**<br>This will record "catch per unit effort" data by issuing log books to anglers on the Tywi and Teifi (used as control), and by commercial nets. This is necessary as background data is not available for measuring more directly the effect on stock abundance. | **Summer 96 - and reviewed to see if further study required** |
| **Impact on the amenity value of the migratory salmonid fishery (14)** | **Sept 96 - March 98** |

| | Timing |
|---|---|
| Use questionnaires and records of licence sales to check for change in use and amenity value/loss. | |
| **Accumulation and toxicity of oil by salmonids entering the sea as smolts during the spill aftermath (19)** | **Summer 1996** |
| Check hydrocarbon levels in adults returning in summer to see if much oil was accumulated as smolts. | |
| **Influence of crude oil and dispersants on salmonid migratory behaviour (17)** | **Until 1998** |
| Oil could affect salmonids' ability to recognise the river they came from, or may deter their return. | |
| Important to establish the potential for such effects to predict effect on stock levels. | |
| **SHELLFISH** | |
| **Analysis of lobster and crab fisheries and stock biometrics (6)** | **April 96 - April 98** |
| An important commercial fishery. | |
| **Effect of oil on whelk fishery in Carmarthen Bay (4)** | **Until Spring 97** |
| This will check the health of whelks and compare catch data with 1995. An important economic fishery. | |
| **PLANKTON** | |
| **Monitoring of phytoplankton within Milford Haven (115)** | **Until May 97** |
| Record any changes in phytoplankton: these changes can affect other biota. This study will also help provide the ground-truthing for the following one and is important in monitoring the effects of the bioremediation study. | |
| **Impact on phytoplankton and zooplankton populations (20)** | **Until Spring 97** |
| Use remote sensing and ground-truthing to see if oil has affected plankton abundance. | |
| **BENTHOS** | |
| **Macrobenthic survey of Milford Haven waterway (103)** | **Sept. 96** |
| Repeat a 1993 survey A good opportunity to establish the effect of the oil spill. | |
| **Subtidal benthic survey of Milford Haven, Carmarthen Bay and surrounding area (21/30)** | **Oct 97 - Dec 96** |
| This will repeat sampling done in March and examine whether further repeats are needed to assess recovery Links in with previous study In particular, prey species for seaducks will be considered. | |
| **Subtidal benthic survey of Celtic Deep (31)** | **Summer 96** |
| Celtic Deep could be a "sink" for hydrocarbon deposition, and so oil effects may be significant here. | |
| Computer modelling' will be used to check whether it is likely that oil has been deposited here before the survey is given the go-ahead | |
| **SUBTIDAL ROCK** | |
| **Laminaria hyperborea holdfast fauna (28)** | **One off and review** |
| Compare fauna associated with L hyperborea (seaweed) with (Intertidal) L digitata surveys which have shown severe impact on amphipods. | |
| **Assessment of epibenthic communities and species (26)** | **Summer 96 then review** |
| Look at previously surveyed rock communities in areas of high hydrocarbon exposure. | |
| **Permanent monitoring site mid-channel rocks (29)** | **summer 96, but then for long term use** |
| **Set up an area for long term monitoring - useful for assessing any future damage** | |
| **GENERAL** | |
| **Skomer Marine Nature Reserve impact assessment I monitoring (24)** | **on-going - indefinite** |
| **Co-ordination of diver observation reports (33)** | **As required** |
| Collate and investigate if necessary reports from recreational divers. | |

| | Timing |
|---|---|
| **SHORE - GENERAL** | |
| **Assessment of heavily oiled shores (63)**<br>Documenting oil and clean-up impacts on a range of shores. | **Until 98 +** |
| **Completion of analysis of hydrocarbon levels in dead and moribund biota collected from lower shores and strandlines immediately after the spill (81)**<br>Many specimens were collected from the shoreline, including species of ecological or conservation importance. These now need analysis. | **Summer or autumn 96** |
| **Summary and interpretation of accessible field data covering the first 6 weeks (135')**<br>This will pull together a wide variety of field observations and data from the first few weeks of the incident | |
| **Sensitive sessile communities (130)**<br>Assessing the impact of oil and clean-up on cliff fauna and bryozoans at various sites. | **Aug 96 - Jul 97** |
| **Monitoring high biodiversity shore habitats (106)**<br>An examination of biotopes - such as rock pools and under boulders - which harbour a diverse range of species. | **Summer 96** |
| **"Before-After Control Impact Paired Series" sites for marine and coastal impact measurement around Wales (133)**<br>"Before-After Control Impact Paired Series" sites are pairs of sites which are matched to provide proper control data for future incidents and to improve interpretation of Sea Empress data. | **Until 97** |
| **Learning from the Sea Empress oil spill (134)**<br><br>Analyse the monitoring programme and assess its success objectively. | **Until 87, then repeated** |
| **The role of benthic/subaerial algae in coastal ecosystems contaminated with oil (114)**<br>Microscopic algae form the base of many food chains. This would examine how levels change in different areas affected by the oil (algae sometimes colonise disturbed sites), and could link with bioremediation schemes. | **Until Jun 97** |
| **ROCKY SHORE** | |
| **Skomer, Milford Haven, Dale Fort Field Centre and Orielton Field Centre permanent monitoring transects (120,121,122,123)**<br><br>The impact on and recovery of rocky shore communities will be examined over time at permanent sites with pre-impact data. | **Until Jun 97, then review the need in future years** |
| **Paludinella littorina monitoring (68)**<br>A "scheduled" (rare) species of snail. | **Aug 96** |
| **Impact and recovery using Laminaria digitata communities (111)**<br><br>Holdfasts of L digitata (seaweed) constitute more or less standardised habitat units, including representatives of a wide range of macro- and meiobenthos. This study will compare impacted and unimpacted sites at intervals. | **Mar 96 until recovered** |
| **Rock pool communities (65)**<br>Looking at impact and subsequent recovery in highly biodiverse rock pools. At some sites the water in rock pools was replaced by oil. | **Feb 96 - 1yr +** |
| **Investigation of the condition of crustose coralline red algae (66)**<br>Encrusting coralline red algae are of considerable ecological importance, and there is extensive bleaching in some areas affected by oil. | **Until Mar 97** |
| **Recruitment and reproductive potential of Asterina species (71)**<br>West Angle Bay rock pools formerly held an important population of two species of cushion star, one of which was originally identified in this area. These populations were severely impacted by the oil. There is the possibility of reintroducing aquarium-bred Asterina. | **Until Apr 97** |

| | Timing |
|---|---|
| **Permanent lichen quadrat monitoring in West Angle Bay (69)**<br>Assessing whether potentially-destructive clean-up techniques are warranted in two areas heavily impacted by fuel oil (which is severely affecting lichens). | **Until July 2001** |
| **Permanent lichen quadrat monitoring at Sawdern Point (70)**<br>Assess recovery of lichen in an SSSI | **Summer 96** |
| **Autecological studies of sensitive invertebrate populations in Milford Haven (109)**<br>Repeat of 1982-3 study of rocky shore habitat using methods which are more appropriate for some species than simple transects. | **Sep 96 - Oct 97** |
| **Rock pool fauna at West Angle Bay (72)**<br>Look at infauna of Corallina and other red algae in a well-documented area | **Summer 96** |
| **Limpet recruitment and age structure (73)**<br>There was extensive mortality of limpets, which are important in determining the ecology of rocky shores.<br>This assesses recovery at a well-documented site. | **Summer 96** |
| **SEDIMENTS** | |
| **Infauna of heavily oiled shores in Milford Haven Waterway and western Carmarthen Bay (74,75)**<br>To determine the impact on the fauna in sediments in heavily oiled areas. | **Feb 96 for 1 yr. then review** |
| **Infauna in waterfowl feeding I eelgrass areas (76)**<br>To assess impact on wildfowl prey stocks and fauna associated with eelgrass in heavily-oiled embayments before wildfowl return late 1996 | **Feb 96 for 1yr then review** |
| **Eelgrass (Zostera spp.)(77)**<br>The area has important populations of this nationally scarce species. | **Until July 2001** |
| **Strandline fauna (78)**<br>Amphipods in the strandline are important ecologically, and early results suggest they have been badly impacted. | **Summer 96 then review** |
| **Impacts on meiofauna (79)**<br>An initial study to determine if there has been any impact on meiofauna. Data exist for 1994. | **Summer 96 then review** |
| **Monitoring of the long term fate of crude oil in intertidal sediments (129)**<br>Integrate bio-geochemical and sedimentological data in sand and mud systems. | **Until 99** |
| **SALTMARSH** | |
| **Milford Haven saltmarsh survey (61)**<br>Assess impact on National Vegetation Classification saltmarsh communities. | **Aug 96 - Aug 2001** |
| **TERRESTRIAL LICHEN** | |
| **Terrestrial lichen impact monitoring - resurveys of existing permanent lichen quadrats on Skomer Island and Stackpole NNRs (57)**<br>Nationally and internationally important lichen communities, susceptible to airborne pollutants. | **Sep 96** |
| **Terrestrial lichen impact monitoring - resurveys of Teloschistes flavicans (58)**<br>A rare "Schedule 8" lichen. | **Sep 96** |
| **VEGETATION** | |
| **Rare coastal higher plant impact monitoring (60)**<br>Examination of rare plants for possible contamination by oil carried ashore as an aerosol. | **Until Oct 96** |
| **AGRICULTURE** | |
| **Terrestrial sampling programme at key sites - grass, soil etc. (105)**<br>Evaluate impact of oil from an agricultural p9int of view, continuing the work of Welsh Office in Feb 96 and checking hydrocarbon levels and soil at intervals | **Until May 97** |

| | Timing |
|---|---|
| **BIRDS** | |
| **Razorbill survival, Skomer (38)**<br>A nationally important population. Data has been collected since the 197 Os. | **May 97 - Oct 99** |
| **Impacts on the breeding ecology of kittiwakes at Skomer Island (117)**<br>Compare with other UK sites, and previous Skomer data. | **Until May 97** |
| **Survey of breeding seabird colonies in south west Wales (141)**<br>To study the impact of the spill on breeding auks, gulls and other seabirds at a range of sites. | **Until Oct 96** |
| **Impact on breeding cormorant colonies (39)**<br>One of the few breeding species with good historical data available. | **Summer 96 then review need to continue (to 2000)** |
| **Oil contamination of gannets and their nests (139)**<br>Early data suggest gannets may have used contaminated material in their nests, which could affect fertility Grassholm has the fourth second largest gannetry in the world. | **Until Dec 96** |
| **Sampling seabirds' blood for haemalytic anaemia (40)**<br>Various species may have ingested oil and this could affect productivity This was demonstrated in kittiwakes post-Braer. | **Until Dec 96** |
| **Sampling seabird eggs for hydrocarbons (41)**<br>Measure hydrocarbon content in species where this could affect productivity | **Until Mar 97** |
| **Biometrics and gut contents of dead seabirds (43)**<br>To determine prey type and size & determine origin so as to predict the risk to the populations involved. Mainly for auks. | **Until May 97** |
| **Land-based counts of common scoter in Carmarthen Bay (84)**<br>Establish the impact on flock size of the bird worst affected by the spill. | **May 97 - Mar 2001 (review annually)** |
| Aerial survey of scoter, Carmarthen Bay (35)<br>To check land-based counts. RSPB has conducted surveys since the 197 Os. | **Until 2001** |
| Biometrics and gut content analysis of dead scoter from Carmarthen Bay (37)<br>To predict risk to populations and to guide further studies. | **Until May 97** |
| **Repeat breeding survey of common scoter, Scotland and Ireland (36)**<br>Although there are no data on the locations of the breeding sites of the scoter killed in Carmarthen Bay, this is worth a rapid assessment given that the areas were surveyed in 1995. | **Until Oct 96** |
| **Survival rates of rehabilitated guillemots (113)**<br>Use recovered ringed birds to estimate survival rates following cleaning. Will also examine whether survival rates have improved over time. | **Oct 96 - Jan 97** |
| **Review of effectiveness of, and management procedures for, cleaning live oiled birds (xx)**<br>This should result in recommendations on improving the cleaning of oiled birds. In association with the RSPCA | **Until Summer 97** |
| **Waterfowl counts and bioaccumulation, Milford Haven & Cleddau Estuary (42)**<br>Compare with previous wildfowl and wader count data in the most heavily-oiled areas. | **Sept 96 - Sept 99** |
| **MAMMALS** | |
| **Continue and extend monitoring of grey seal breeding success**<br>The area is important for grey seal breeding. | **Aug 96 - Sep 99** |
| **Cetaceans - continue monitoring sightings, and support for the strandings co-ordinator**<br>Monitoring for effects on whales, dolphins etc. | |

| | Timing |
|---|---|
| **AMENITY VALUE** | |
| **Reviewing and refining the assessment of aesthetic impact on the shoreline, and developing criteria**<br>Review methodology to allow quantification of persistent low-level contamination (e.g. following main clean-up) | **Summer 96** |
| **Amenity and public enjoyment impact assessment (124)**<br>Look at public perception of recreation in the area, and survey actual impact on amenities. | **Until Mar 97** |
| **Re-survey of chronic impact on shoreline aesthetic (125)**<br>Quantify objectively the extent and duration of shoreline contamination - for use in assessing impact on amenity value | **Until 1997+** |
| **Impact of oil and clean-up on intertidal and shoreline archaeological sites, features and structures (137)**<br>Document impacts on "submerged forests", wrecks and archaeological horizons in sand dunes and caves. These were all surveyed in 1993-95. | |
| **CLEAN-UP** | |
| **Assessment of environmental impact of clean-up activities (116)**<br>Document clean-up activities and resulting ecological effects, comparing with damage by oil, to assess value of clean-up. | **Until 1998** |
| **CLEAN-UP** | |
| **A review of the effectiveness of the clean-up operation**<br>An independent consultant will be commissioned to review the effectiveness of the clean-up and the management of the 'operation, considering lessons to be learnt. | **Until 97** |
| **The fate of oil on shorelines (22.23,96)**<br>A comparison of untreated shorelines and those treated using a variety of techniques. | |
| **Evaluation of bioremediation techniques (11)**<br>This involves encouraging microbes to degrade oil through addition of nutrients, and could prove valuable in future spills. | **July 96 to Mar 97** |
| **OIL** | |
| **Benchmarking of existing hydrocarbon data for the area affected by the Sea Empress (8)**<br>Establish the baseline concentration of hydrocarbons in sediments etc. for the area, to allow proper assessment of the effect of the Sea' Empress spill. | **Summer 96** |
| **Hydrocarbon data review and quality control (97)**<br>Quality control assessment of the different protocols for sampling and analysing data to make sure that results are directly comparable. | **Until Dec 96** |
| **Refinement of the estimated shoreline figure in the oil budget (119,95)**<br>Use data collected throughout the response to improve the estimate of the amount of oil impacting the coastline. | **Until Aug 96** |
| **Hydrocarbons in the surface microlayer - Milford Haven (2)**<br>Hydrophobic compounds collect in the top 50 microns of the water surface, and are an indicator of persistent contamination after contamination is' no longer detectable in the water column. | **Aug 96 - Mar 98** |
| **Sediment transport paths outside Milford Haven, in relation to long-term transport of Sea Empress oil(98)**<br>Establish information needed for assessing sediment contamination. This information is already available for Milford Haven, but will be extended to probable sinks in Carmarthen Bay etc. Important in 'working out where the oil may have gone and whether it could have future impact. | **Until Dec 96** |

| MODELLING/IMAGES | Timing |
|---|---|
| **Modelling the vapour cloud (118)**<br>A large proportion of the oil evaporated. Spot measures do not show the full extent of the oil vapour coverage, so modelling is needed.<br>**Review of aerial/satellite images and optimisation of procedures and interpretation (140)**<br>Remote sensing images are widely used, but need careful interpretation if they are not to mislead. | **Until Sep 96** |

## FINANCIAL SUMMARY

### Projected Income 1 April 1997 to 31 March 1998

| | £ |
|---|---|
| Texaco | 5,000 |
| Gulf | 5,000 |
| National Power | 6,000 |
| Pembrokeshire Coast National Park Authority | 3,000 |
| Elf | 5,000 |
| Countryside Council for Wales | 5,000 |
| Pembrokeshire County Council | 5,760 |
| | 34,760 |
| Brought Forward | 71,146 |
| | £105,906 |

## Milford Haven Waterway Environmental Monitoring Steering Group

### Financial Statement

### 1st April 1996 - 31st March 1997

| Income | | £ |
|---|---|---|
| 31/12/96 | Texaco | 5,000.00 |
| 31/12/96 | Gulf | 5,000.00 |
| 31/12/96 | National Power | 6,000.00 |
| 31/01/97 | Pembrokeshire Coast National Park Authority | 3,000.00 |
| 31/01/97 | Welsh Water | 3,000.00 |
| 31/01/97 | Transfer from EPA | 5,758.00 |
| 31/01/97 | Elf | 5,000.00 |
| 31/03/97 | Countryside Council for Wales | 5,000.00 |
| | Total Income | 37,758.00 |
| | Brought Forward | 67,976.00 |
| | | 105,734.00 |

| Expenditure | | |
|---|---|---|
| 31/01/97 | Dyfed Wildlife Trust | 1,000.00 |
| 31/01/97 | Field Studies Council | 1,078.64 |
| 31/03/97 | Field Studies Council | 2,369.98 |
| 31/03/97 | Altra Safety & Environment | 4,540.00 |
| 31/03/97 | Environment Agency | 25,000.00 |
| 31/03/97 | OPRU | 600.00 |
| | Total Expenditure | 34,588.62 |
| 31/03/97 | **Income Balance carried forward** | 71,146.00 |

## FUTURE WORK PROGRAMME

| Item No. | | Potential Expenditure |
|---|---|---|
| 6. | Sediment Hotspots | 20,000 |
| 8. | Sediment Sinks | 20,000 |
| 9. | Dyfed Wildlife Trust Wetlands Survey | 1,000 |
| 10. | Contaminant Sourcing | 5,000 |
| 13. | Rocky Sub Littoral Survey<br>@ £7,200 per unit x 5 | 36,000 |
| 15. | Zostera Subtidal Eel Grass Survey | 20,000 |
| | Admin Support | 2,000 |

**PROJECTED TIMETABLE**
**MILFORD HAVEN WATERWAY ENVIRONMENTAL MONITORING STEERING GROUP**
**PROGRAMME OF WORK**

| | ACTIONS | Priority | Cost £000's | 1996 | 1997 | 1998 | 1999 | 2000 | FUTURE |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Database | 1 | 1 | | | | | | |
| 2 | Administrative support | 1 | 2 | | | | | | |
| 3 | Water quality monitoring | 1 | 4.5 | | | | | | |
| 4 | Seabed sediments<br>(i) Biology (5year repeat at selected sites)<br>(ii) hydrocarbon analysis. Part of SEEEC Project (repeat of Groups 93 survey financed by EA/WO) | <br>1<br>1 | | | | | | | |
| 5 | Inter tidal sediments<br>(i) Biology (5 year repeat at selected sites)<br>(ii) metals analysis<br>(iii) hydrocarbon analysis EA | <br>1<br>1<br>1 | <br><br>6 | | | | | | |
| 6 | Sediment "Hotspots" (priorities to be decided from 4 & 5 above) | 1 | 20 | | | | | | |
| 7 | Suspended sediment analysis (linked to 6 above) | 2 | | | | | | | |
| 8 | Sediment sinks (linked to 6 above, done with 7) | 1 | 20 | | | | | | |
| 9 | Wildfowl and wader populations (PORC)<br>(i) wintering<br>(ii) breeding shelduck census (PCNPA) | <br>1<br>1 | <br>1 | | | | | | |
| 10 | Contaminant sourcing<br>(i) water quality input budgets<br>(ii) linked to results of 6 | <br>1<br>1 | <br>5 | | | | | | |
| 11 | Use of Skomer as "reference" | 1 | | | | | | | |
| 12 | GIS system development | 2 | | | | | | | |
| 13 | Rocky shore and seabed monitoring<br>(i) inter tidal survey<br>(ii) seabed survey | <br>1<br>1 | <br>12 | | | | | | |
| 14 | Salt marsh monitoring | 2 | | | | | | | |
| 15 | Inter-tidal Eel grass beds (review following SEEEC work)<br>Sub-tidal Eel Grass Beds | 2 | | | | | | | |
| 16 | Post-spill impact surveys (ad hoc) | 1 | 3 | | | | | | |
| 17 | TBT contamination | 2 | | | | | | | |
| 18 | Bioaccumulation | 2 | | | | | | | |
| 19 | Dredging impacts on sediment transport (MAFF-MHWEMSG to assist) | 2 | | | | | | | |
| 20 | Recreation use survey | 3 | | | | | | | |
| 21 | Bait digging/changes in community structure (linked to results of 5(i) and 15) | 2 | | | | | | | |
| 22 | Intertidal terrestrial invertebrates | 3 | | | | | | | |
| 23 | Review of reports for decision for future research | | | | | | | | |

KEY:

Year of work to be carried out

Possible/suggested period for work in future years given current priorities

# GROUP REPRESENTATIVES

| | | |
|---|---|---|
| 1. | Environment Agency | Mark Williams |
| 2. | Elf Oil UK Ltd } | |
| 3. | Texaco } | John Everett |
| 4. | Gulf } | |
| 5. | National Power | Bob Veale/Anne Heath |
| 6. | Countryside Council for Wales | Stephen Evans |
| 7. | Pembrokeshire County Council | Tom Bennett |
| 8. | Pembrokeshire Coast National Park Authority | Jane Hodges |
| 9. | Welsh Water | Hillary Ford |
| 10. | Dyfed Wildlife Trust | Alison Wheeler |
| 11. | Milford Haven Port Authority | Mark Andrews |
| 12. | South Wales Sea Fisheries Committee | Phil Coates |
| 13. | Welsh Office Environment Division | Dr Havard Prosser |
| | Chairman Pembrokeshire County Council | Huw Evans |