MILFORD HAVEN WATERWAY
ENVIRONMENTAL SURVEILLANCE GROUP

GRŴP CADW GOLWG AMGYLCHEDDOL
AR DDYFRFFORDD ABERDAUGLEDDAU

Business Report 2010

MILFORD HAVEN WATERWAY ENVIRONMENTAL SURVEILLANCE GROUP

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Report 2010
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MILFORD HAVEN WATERWAY ENVIRONMENTAL SURVEILLANCE GROUP

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Milford Haven Waterway Environmental Surveillance Group

Report 2010

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CHAIRMAN'S FOREWORD

Climate change has become a defining issue of our time. It is a global problem and with solutions that can often be counter to entrenched interests and long held patterns of individual behaviour. What is needed is robust and appropriate data that can be used not only to inform those that are required to implement change but also inform a global community increasingly connected by flows of information, people, commerce and environmental change.

In March 2011 the UK Government issued a Marine Policy Statement (MPS) on behalf of all UK administrations. The MPS will provide a framework for the development of marine planning, marine licensing and other relevant authorisation systems; a key component of the latter being integration with terrestrial planning. Over the last twenty years or so the Milford Haven Waterway Environmental Surveillance Group has been very active in gathering data which has provided an opportunity for researchers and decision-makers to make objective assessments as to the environmental status of the Milford Haven Waterway and perhaps more importantly the trends that such work is revealing.

The data is fully available from local libraries but may also be obtained from the Group's Project Officer.

One of the strengths of the Group is that it is derived from a variety of organisations within both the public and private sectors but working together for mutual benefit. Nevertheless, the success of the Group is entirely down to the enthusiasm and time devoted by Group representatives who both oversee the current projects and make positive suggestions as to the future work programme.

Finally, I would like to pay personal thanks to our Project Officer, Blaise Bullimore, for his persistence in maintaining programme momentum so vital to building this unique data set.

Captain Mark Andrews

Milford Haven Port Authority

Chairman

RHAGAIR Y CADEIRYDD

Y newid yn yr hinsawdd, bellach, yw un o'r nodweddion sy'n diffinio'r oes bresennol . Mae'n broblem fyd-eang , a'r atebion iddi'n gwrthdaro'n aml â buddiannau hirsefydlog a phatrymau ymddygiad oesol unigolion. Yr hyn sydd arnom ei angen yw data cadarn ac addas, y gellir eu defnyddio nid yn unig i gyfarwyddo'r rhai y gofynnir iddynt gyflawni newid, ond hefyd i oleuo cymuned fyd-eang a gysylltir fwyfwy gan y lifoedd o bobl, gwybodaeth, masnach a newid amgylcheddol.

Ym Mawrth 2011 cyhoeddodd Llywodraeth y DU Ddatganiad Polisi Morol (DPM) ar ran pob un o weinyddiaethau'r DU. Bydd y DPM hwnnw'n darparu fframwaith ar gyfer cynllunio morol, trwyddedu morol a systemau awdurdodi perthnasol eraill. Un o gydrannau allweddol y systemau hynny fydd integreiddio'r cynllunio gyda chynllunio tirol. Ers tuag ugain mlynedd bellach, bu Gr_p Goruchwylio Amgylcheddol Dyfrffordd Aberdaugleddau wrthi'n ddiwyd, yn casglu'r data a roddodd gyfle i ymchwilwyr a phenderfynwyr wneud asesiadau gwrthrychol o statws amgylcheddol y Ddyfrffordd, ac yn bwysicach na hynny hwyrach, o'r tueddiadau a ddatgelir gan waith o'r fath.

Mae'r data hyn i gyd yn y llyfrgelloedd lleol, ond maent ar gael hefyd gan Swyddog Prosiect y Grwp.

Un o gryfderau'r Grwp yw ei fod yn tarddu o amrywiaeth o gyrff yn y sectorau cyhoeddus a phreifat, sy'n cydweithio er budd ei gilydd. Er hynny, mae llwyddiant y Grwp i'w briodoli'n llwyr i frwdfrydedd a haelioni ei gynrychiolwyr, sy'n rhoi o'u hamser i gasglu'r data yn ogystal â gwneud awgrymiadau cadarnhaol ar gyfer y rhaglen waith yn y dyfodol.

Yn olaf, hoffwn ddiolch yn bersonol i'n Swyddog Prosiect, Blaise Bullimore, am ei ddyfalbarhad yn cynnal momentwm rhaglen sydd mor bwysig ar gyfer adeiladu'r set ddata unigryw hon.

Y Capten Mark Andrews

Awdurdod Porthladd Aberdaugleddau

Cadeirydd

1. INTRODUCTION

This is the eleventh business report of the Milford Haven Waterway Environmental Surveillance Group (formerly the Milford Haven Waterway Environmental Monitoring Steering Group). It covers the period January to December 2010.

The Milford Haven Waterway Environmental Monitoring Steering Group was established in 1992 following a highly successful one-day conference to examine the issue of oil pollution in Milford Haven. The Group immediately commissioned and published a review of the then current environmental knowledge of the Milford Haven Waterway, which included a description of the nature and extent of monitoring being undertaken on the Waterway at that time. The review made recommendation as to prioritised work plans for the future, covering obvious gaps and omissions in existing monitoring, and this formed the basis of projects contracted by the Group in the following years.

The Group subsequently let a series of contracts to collect data across the full suite of marine habitats within the Haven and, in collaboration with the Environment Agency, carried out systematic water quality surveillance for several years. Studies are resourced by Group members contributing either directly in monetary terms or in kind, and by undertaking or supporting survey and surveillance projects carried out by Group members directly. The value of the Group's data became very clear during the assessment of the environmental impacts of the 1996 Sea Empress oil spill and subsequently in informing environmental assessments of developments.

During the early 2000s, the need to strengthen and increase the formality of the Group's constitution, not least for reasons of financial management and VAT recovery, became increasingly important. The development and agreement of a formal Memorandum of Agreement that met the needs and business concerns of all members of the Group took a considerable time. Following ratification and adoption of the MoA by all the Group's members, financial management of the Group transferred from Pembrokeshire County Council to Milford Haven Port Authority.

During the same period, the surveillance and monitoring obligations on several public bodies arising from, in particular, European directives developed and become clearer; for example the monitoring requirements of the Habitats & Species and the Water Framework Directives. Whilst the Group welcomes the use of data it collects to inform such monitoring, it does not wish to duplicate the efforts of public bodies, or be seen to be undertaking their duties. Rather it wishes to fill the gaps between such work, focus on tasks of the widest common interest to its members, and to synthesise and summarise the information available on the environmental health of the waterway.

Although the outputs are primarily for the benefit of the Group members, reports are lodged with public, academic, government and local school libraries, with the Group's business reports also being circulated to local elected representatives of Welsh, UK and European government.

2. GROUP ACTIVITY 2010

2.1 INTRODUCTION

The Group's work and outputs during the period are summarised below. After the focus on desk-studies over recent years, the emphasis on field-based surveillance has resumed.

A programme of rocky shore surveillance begun in the mid-1960s was continued by the Group in the 1990s. Although the *Sea Empress* Environmental Evaluation Committee surveyed a subset of the long-term sampling stations in 1996 and 1997, the last full suite of sampling was undertaken in 1995 and revisiting this well-established time series has been long overdue.

Whilst the rocky shore baseline data proved immensely valuable in assessing the *Sea Empress* oil spill, it appeared less sensitive than expected for detecting impacts. A critical review of the semi-quantitative, descriptive recording techniques used previously, carried out by the Skomer Marine Nature Reserve in the early 2000s, indicated that they were not especially sensitive for identifying impacts or distinguishing pollution effects from natural change. Following the introduction of quantitative and, it was intended, more sensitive rocky shore monitoring methods in the Skomer MNR in 2003 [1], in 2005 the Countryside Council for Wales (CCW) contracted the establishment of a series of six sites within the Milford Haven waterway at or close to existing MHWESG sites for Habitats Directive feature monitoring; these sites were sampled in 2005 and from 2007 - 2010 using the same methods as the MNR. A brief description of this work, and also subtidal rocky reef biological community monitoring is included in this report.

In order to improve sensitivity of the MHWESG's rocky shore surveillance and to integrate with CCW monitoring in the waterway, the Group's rocky shore specification was revised to incorporate methods developed by the Skomer MNR and also national UK climate monitoring protocols, whilst retaining compatibility with the previous method.

The second project of what is intended, resources permitting, to become long-term programme of bioaccumulation surveillance was contracted during 2010 to Dr Bill Langston from the Marine Biological Association, Plymouth. A summary of the field sampling reports is included in this report; the final report is anticipated in mid 2011 following completion of all the laboratory analyses.

Following recommendations detailed in Dr Richard Warwick's 2006 review of benthic and intertidal sediment macrofauna data (reported and summarised in the 2006 Group business report) sublittoral sediment biology sampling was recommenced in 2008, integrated with the sampling programmes of the Countryside Council for Wales and Environment Agency Wales (under the Habitats Directive and Water Framework Directive respectively). A further sampling round was undertaken in 2010, again carried out from the EAW's research vessel as a contribution in kind to the Group, and the samples were all analysed by the same laboratories to maximise intercomparability. Data has again been delivered and forwarded to CCW who will be undertaking analysis as further in-kind contribution to the work of the Group.

The first of the five projects recommended by Dr David Little in his sediment contaminants and transport review reported in the previous Group business report was begun near the end of 2010. The project aims to forensically evaluate sediment hydrocarbons to quantify and discriminate between various contemporary and historical sources in the waterway and its

[1] Crump, R. G. & Burton, M. (2004). *Skomer Marine Nature Reserve. Littoral monitoring: Development of methods.* CCW West Area Report 27

catchment, including any remaining contamination from the *Sea Empress* oil spill. A contract has been let with ERT, Edinburgh, a marine environmental consultancy with particular expertise in marine hydrocarbon chemistry, to analyse the sediments using state-of-the-art methods. A further contract has been let to Dr Little to interpret and report the results. Archived sediment samples, samples collected from tributary estuaries by CCW using the Skomer Marine Nature Reserve research vessel on behalf of the Group during autumn 2010, together with reference samples were being analysed by ERT at the time this report was being compiled.

Wetland bird surveillance has continued as in previous years and synopses from the Wetland Birds Surveys (WeBS) and Pembrokeshire Coast National Park Authority shelduck surveys are included.

The programme of survey and monitoring associated with the Pembroke Power Station project being undertaken by RWEnpower that was described in the last business report is brought up to date.

Monitoring work being undertaken in the Haven by the Environment Agency Wales to meet information requirements for the EU Water Framework, Nitrates and Shellfish Waters Directives and the UK government Clean Seas Environment Monitoring Programme is summarised.

A brief summary of an investigation being carried out into the spread of the slipper limpet, an invasive non-native molluscan shellfish, provided by Bangor University PhD student Katrin Bohn is also included in this report.

2.2 REESTABLISHMENT OF INTERTIDAL ROCKY SURVEILLANCE

Dr Nova Mieszkowska, UK Marine Biological Association

Executive Summary

A survey of rocky intertidal shores within the Milford Haven Waterway was carried out by The Marine Biological Association of the UK for the Milford Haven Waterway Environmental Surveillance Group in 2010. The aim was to re-establish rocky intertidal surveillance within Milford Haven Waterway using standardised, nationally recognised protocols at six locations where previous surveys had been carried out. The survey was conducted on spring tides between August 9-12th 2010. Protocols combined broadscale surveys of invertebrates and macroalgae using the MarClim SAFCOR methodology with quantitative counts of key structural and functional species and frequency counts for all species encountered within random quadrats in the high, mid and lowshore zones at each site. Where comparable, published historical data was compared to the current status and recent trends within each site, and along the Waterway as a whole. Data collected within Milford Haven Waterway was also placed into a wider geographical context by comparison with the UK MarClim surveys carried out in 2010.

Sites were remarked using permanent fixed markerbolts starting from the same point above MHWS where the highest OPRU marker was located in 1995. Two markerbolts were placed at highshore, midshore and lowshore to mark the outer edges of the survey area and facilitate accurate relocation. Random quadrats were used in the 2010 survey for improved statistical robustness over fixed transects and quadrats so historical transect lines were not remarked.

The rocky intertidal region of Milford Haven Waterway was healthy in 2010. Community composition and abundances of key taxa were characteristic of healthy sites along a gradient of increasing exposure and salinity from the upstream site, Cosheston Folly to the downstream site, Dale Point. There were, however, high numbers of non-native species in comparison to the UK-wide MarClim database, which is likely to have resulted from transference via the high volume of international shipping and recreational vessel traffic to and from the Waterway.

Several species have increased in abundance since previous surveys. *Osilinus lineatus* was slightly impacted by the Sea Empress oil spill in 1996, but increased in abundance on exposed shores in the vicinity of Milford Haven throughout the 2000s in response to climate warming. Abundances within the Waterway are also higher than in the 1980s and 1990s. *Nucella lapillus* increased in abundance at some sites after the TBT ban in the mid-1980s, and was Common at Sawdern Point and Dale Point in 2010, but abundances were still only Frequent at Llanreath and Great Castle Head. A significant decline was recorded for *Ascophyllum nodosum* at Llanreath, where the young population indicated recovery from recent disturbance. Site-specific changes were few. Macroalgal diversity had increased since the 1970s at Cosheston Folly, and a shift in the dominant barnacle from *Chthamalus montagui* to *Semibalanus balanoides* could be seen between 1979, 1995 and 2010 at Great Castle Head. None of these changes appeared to have significantly altered ecosystem structure and function at these sites.

Annual surveys using the same metholodgies are recommended to maintain a time-series to track changes within Milford Haven Waterway and in the wider MarClim UK context. These should include monitoring occurrence and spread of non-native species.

Mieszkowska, N. (2011). *Reestablishment of intertidal rocky surveillance*. A report to the MHWESG fro the Marine Biological Association on ot the UK. 54pp + appendices.

2.3 BIOACCUMULATION SURVEILLANCE IN MILFORD HAVEN WATERWAY 2010

W J Langston, S O'Hara & N D Pope. UK Marine Biological Association

Synopsis of field sampling reports

Introduction

Following on from the MBA surveys undertaken in 2007-2008 for MHWESG, MBA embarked on a follow-on project in 2010, "Bioaccumulation surveillance in Milford Haven Waterway: Phase II". This programme will, as part of its remit, permit an appraisal of temporal response to environmental change over the last 2- 3y – i.e. is water quality improving or deteriorating with respect to bioaccumulation of toxic contaminant groups? The project is re-surveying sites and contaminants in bioindicator species evaluated in the initial study (see Langston et al 2009) and includes additional sampling in the Waterway (Hook, Picton Point, Quoits Mill) together with a further 'reference' site at Appledore, in the Taw/Torridge system, North Devon (in addition to the original Tywi Estuary reference site).

Spring sampling

MBA staff undertook field survey work in Milford Haven between 15 and 18 March 2010. Reference samples for each species were also collected in the Tywi Estuary at this time. Sampling at Appledore was undertaken as soon as possible thereafter on 7 April.

The objective was primarily to collect *Mytilus edulis, Cerastoderma edule* and *Fucus vesiculosus* during a narrow spring sampling window for these species (to maintain consistency with the previous survey and reduce any effect of seasonal variation). Exploratory sampling and observations were made at several additional sites within the Milford Haven Waterway – at Little Milford, Hook, Boulston and Picton Point in the Cleddau Estuaries. Only at the latter site were adequate numbers of mussels, cockles and *Fucus vesiculosus* collectable and hence this station, near the confluence of E&W Cleddau was considered the best option for biomonitoring the upper part of the system, for these species. Further sampling using *Nereis diversicolor* (and *Littorina littorea*) is planned for summer/autumn and is likely to extend biomonitoring in these less saline upstream reaches.

Table 1. Summary of sampling sites and species distributions, spring 2010

Site	Map ref (sites sampled)	Fuc	Myt	Cer
Milford Haven Waterway				
Picton Point	SN005118	+	+	+
Black Tar	SM999093	++	++	++
Lawrenny (Jenkin's Point)	SN009062	++	++	++
Ferry Hill	SN003061	++	++	++
Pembroke Ferry (Ferry Inn)	SM974047	++	++	++
Pembroke River (Pennar)	SM959020	++	++	++
Pembroke River (Pennar Mouth)	SM943028	++	++	++
Angle Bay	SM870027	++	++	++
Dale	SM809065	++	++	++
Tywi Estuary Reference Site				
Tywi (St. Ishmael)	SN361082	++	++	+
Taw/Torridge Reference Site				
Appledore (North Burrows)	SS451313	++	++	++

Key: **Fuc**, *Fucus vesiculosus*; **Myt**, *Mytilus edulis*; **Cer**, *Cerastoderma edule*. + species present and sampled. ++ species numerous and sampled.

Generally, distribution and abundance of *M. edulis, C. edule* and *F. vesiculosus* was similar to that in the previous survey in 2008, although cockles did not seem to be as abundant – an observation supported by personal observation of the MHWESG's representative, Blaise Bullimore who accompanied us in the field for part of this survey. Plentiful samples of *M. edulis, C. edule* and *F. vesiculosus* were collected from the additional reference site at Appledore.

Table 1 (above) summarises grid references and occurrence of individual species.

All biota were returned live to the MBA and immediately submitted to clean-up procedures according to standard protocols in preparation for analysis.

Biometric data, condition and other biological indices

Whole organism size, weight and tissue wet and dry weight data were recorded for all species collected.

Condition indices (CI) for bivalves generally describe the relationship between soft tissue dry weight (meat content) and the organism total size (volume). High CI values are often considered to represent an integrated signal of better 'health' status but may also be a function of greater availability and assimilation of food. The condition index used in this study will be that used in the previous survey.

TOSC: Gills and digestive glands from a further eight mussels from each site were dissected, flash frozen, individually, in eppendorf tubes under liquid nitrogen, before storing at _80˚C n a low temperature freezer. The intention is to determine Total Oxyradical Scavenging Capacity in these tissues as a general indicative marker of oxidative stress.

Reproductive effects: Sex ratios were determined by histological examination of gonadal smears from mussels from the following sites: Black Tar (n=14), Dale (20), Lawrenny (23), Picton Point (32), Appledore (30). These samples were also examined for 'intersex' – the presence of male and female gametes in the same individuals - tentatively an indication of endocrine disruption.

Autumn sampling

MBA staff undertook a second sampling campaign for the remaining bioindicator species *Nereis (=Hediste) diversicolor* and *Littorina littorea* between 3 and 6 October 2010. Reference samples were collected in the Tywi Estuary at this time and sampling at Appledore, N. Devon was undertaken as soon as possible thereafter, 8 October.

The objective was to collect *N. diversicolor* and *L. littorea* at this time of year to maintain consistency with the 2007 survey and minimize any effect of seasonal variation on contaminant burdens. Nine locations were sampled for *Littorina littorea* and ten for *Nereis diversicolor* within the Milford Haven Waterway, and a control sample of each species was obtained from the Tywi Estuary and at Appledore. Because of different habitat preferences, sites for *Nereis* (infaunal sediment dweller) and *Littorina* (grazer; mainly on rock and seaweed) were not always identical but were as close as practical. At some sites casual observations of other biomonitoring species were recorded for future reference (nb clams *Scrobicularia plana* from certain locations were collected and archived, as indicated below).

Generally, the distribution and abundance of *N.diversicolor* and *L.littorea* was similar to that in the previous survey in 2007. The one exception was the limited sample of *N.diversicolor* at Pennar in the Pembroke River. To compensate, an additional sample of *N.diversicolor* was obtained at Quoits Mill, on the opposite bank, where this species was abundant. Plentiful samples of *N.diversicolor* and *L.littorea* were collected from the new reference site at Appledore.

Table 1 (below) summarises grid references and occurrence of individual species.

Table 1. Summary of sampling sites and species distributions, Autumn 2010

Site	Map ref (sites sampled)	Ner	Lit
Milford Haven Waterway			
Picton Point	SN005118	++	++
Lawrenny(Cresswell/Carew Mouth)	SN017063	++	
Lawrenny (Jenkin's Point)	SN009062		++
Landshipping	SN012118	++	
Landshipping Quay	SN008108		++
Dale	SM815075	++	
Dale	SM809066		++
Angle Bay	SM870027		++
Angle Bay	SM869028	++	+
Pembroke River (Pennar)	SM959020	+	++
Pembroke River (Quoits Mill)	SM970011	++	
Pembroke Ferry (Waterloo)	SM983042	++	++
Hook	SM985115	++	++
Tywi Estuary Reference Site			
Tywi (1.2km upstream Ferryside)	SN370117	++	
Tywi (St. Ishmael)	SN361082		++
Taw/Torridge Reference Site			
Appledore (North Burrows)	SS451313	++	++

Key: **Ner,** *Nereis diversicolor*; **Lit,** *Littorina littorea.*
+ species present and sampled.++ species numerous and sampled.

Biota were again returned live to the MBA and immediately submitted to clean-up procedures according to standard protocols in preparation for analysis.

Biometric data for biota was recorded as above and for bivalves will be used to determine Condition Indices.

Samples have been freeze-dried and stored for analysis. To date the digestion of samples for metals analysis has been completed and the analytical programme for a suite of metals is underway.

Analysis of organic determinands, including organotins, is scheduled for late spring/early summer when GCMS equipment becomes available.

2.4 ANNUAL WADERS & WILDFOWL SURVEYS 2009 - 10

A Haycock, Pembrokeshire WeBS Coordinator

Executive summary

The Wetland Bird Survey was carried out on the Cleddau estuary system between September 2009 and March 2010, with additional counts for June and July 2009 made by Jane Hodges during the annual survey of summer shelduck populations .

The methodology used followed that set out in the BTO WeBS Counters Handbook. Three species reached levels of National Importance: wigeon (max. 8227 in November), greenshank (max 40 in October), curlew (1674 in July). Teal fell below the required level (max. 1343 in January), while shelduck numbers (655 in December) were disappointingly low.

A total peak count of 22803 birds between November and February confirms that the estuary system is still of international importance for its waterfowl populations, even though the peak counts were lower for several species than they have been in recent years.

The cold weather in December, January and February probably had an effect on the numbers of birds visiting the estuary, particularly wigeon whose numbers increased by about 3000 in January.

Comparison of counts with the national report for 2008-09 (the most recent that is available) show that for most species, the local trends in populations are similar to those experienced nationally.

Haycock A (2010). *Wildfowl and wader counts on the Milford Haven Waterway, 2009-10*. A report to the Milford Haven Waterway Environmental Surveillance Group. 24pp

2.5 ANNUAL SHELDUCK SURVEYS 2010

J E Hodges, PCNP Ecologist

Executive summary

The Daugleddau Estuary and Milford Haven Waterway hold nationally important numbers of shelducks during the winter months. In addition there is a small summer population which had been the subject of annual summer boat surveys carried out between 1991 and 2009. The summer boat surveys were repeated in 2010 as part of a co-ordinated programme of environmental surveillance in the estuary system. The aims, objectives and methods used, together with the data obtained are described in this report.

The results indicate that in terms of the numbers of broods recorded, 2010 was the poorest year for breeding shelducks in the estuary system since 1994. Predation is thought to have been a major factor in determining the numbers and sizes of broods that made it onto the water in 2010. Disturbance may also have been a contributory factor. In contrast to 2007, 2008 and 2009, however weather is not thought to have had a major influence on the results of the surveys. Data collected for other wetland birds once again underlined the importance of the estuary system during the autumn migration period, especially for curlew, numbers of which have exceeded the threshold of "national importance".

The report concludes with a recommendation for the continuation of the annual surveillance of summer shelduck populations in the estuary system, as part of the Milford Haven Waterway Environmental Surveillance Group's annual work programme..

Hodges, J E (2010). *Daugleddau Estuary and Milford Haven Waterway surveillance of summer shelduck populations: report for 2010.* Report from Pembrokeshire Coast National Park Authority. 8 pp + appendices

2.6 PEMBROKE POWER STATION BASELINE AQUATIC SURVEYS

Neil Richardson, RWE Npower.

This section summarises work undertaken on behalf of RWE as part of the Haven monitoring programme associated with the Pembroke Power Station project.

2.6.1 Marine water quality

Surveys have been undertaken in October 2006; February, May, August 2007; February, June, August, November 2008 – 2010.

Ten stations from mid-channel north of Bulwell Bay to Pembroke Dock were sampled. Sample locations upstream of the cooling water outfall were sampled on the flood tide; sample locations downstream of the cooling water outfall were sampled on the ebb tide.

The following physical parameters measured by in-situ profiling between the seabed and the surface at each sampling station:

- temperature (°C);
- dissolved oxygen (% saturation and mgl^{-1});
- salinity;
- conductivity (μScm^{-1}); and
- redox potential (mV).

Samples taken for chemical analysis as follows:

- in water depths of less than 5m, at mid-depth;
- in water depths from 5 to 10m, at 1m below surface and 1m above sea bed;
- in water depths greater than 10m, at 1m below surface, mid-depth and 1m above sea bed;

were analysed for:

- dissolved metals comprising arsenic, cadmium, chromium, lead, mercury, selenium, boron, copper, nickel and zinc;
- seawater cations and anions including calcium, potassium, sodium, chloride, bromide, fluoride and sulphate;
- total alkalinity;
- total suspended solids;
- pH;
- conductivity;
- biological and chemical oxygen demand;
- nutrients including ammoniacal nitrogen, nitrite, nitrate, ortho-phosphate;
- total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAH) and polychlorinated biphenyls (PCBs);
- phenols;
- cyanide.

Surveys on a similar pattern are planned for 2011.

2.6.2 Fish and invertebrate species

Surveys have been undertaken in October 2006; February, May, August 2007; February, June, August, November 2008 – 2010.

The seasonal baseline surveys of fish and invertebrate communities were undertaken by otter trawl at 13 locations and seine net at 7 intertidal locations between Newton Noyes and Llanreath in the main channel and within Pennar Gut and outermost Pembroke River.

All fish captured in the otter trawls were identified to species level and measured (standard length). Larger individuals were weighed to the nearest 100g with smaller fish bulk-weighed. Invertebrates were identified to the lowest practicable taxonomic level. Numbers of fish caught per 100m trawled were calculated to provide a measure of catch per unit effort (CPUE) to provider a basis for quantitative comparisons as individual trawl lengths can vary significantly.

Fish captured in the intertidal seine net surveys were identified to species level and measured (standard length).

Analyses of the raw data included:

- ANOSIM (analysis of similarity) between 2009 and 2010 data;
- non-metric multi-dimensional scaling (MDS) to investigate seasonal and annual differences;
- multivariate statistical tests using PRIMER, with SIMPER tests to investigate which individual species were driving the dissimilarity where significant differences occurred.
- abundance-biomass comparison (ABC) curves for successive years;
- cluster analysis with a similarity profile (SIMPROF).

Surveys on a similar pattern are planned for 2011.

Fyke netting for eels was carried out experimentally at intertidal locations in the Pennar Gut/Pembroke River area concurrently with the November 2010 fisheries surveys. It is proposed to undertake fyke netting in this area concurrently with seine netting during the 2011 quarterly fisheries surveys.

2.6.3 Intertidal ecology

Surveys have been undertaken in October each year from 2006 to 2010.

Eleven rocky shore and five low shore sediment survey locations were sampled along the south shore of the Haven between Martin's Haven and Pennar Mouth. Data analyses included:

- biotope coding and boundaries;
- species assemblage;
- trochid gastropods population analysis (paired t-tests);
- species presence/absence analysis;
- analysis of large substrate groups;
- biotic benthic cover/abundance analysis.

It is planned to repeat the survey in October 2011.

2.6.4 Ichthyoplankton

Previous monthly surveys were undertaken between September 2006 and September 2007 (fortnightly between April 2007 – May 2007) and in June (twice) and July 2009 through Pennar Mouth and in the main Haven channel east and west of Pennar Mouth.

In 2010 surveys took place on 27 May, 9 June and 14 July 2010, to cover the peak season for ichthyoplankton. Ten, 10 minute, sample tows were taken at each site on each occasion, five each on the ebb and flood tide, and the number of fish and other species, fish eggs and fish larvae quantified.

Repeat surveys are planned for May, June and July 2011.

2.6.5 Eelgrass

Monitoring of the condition of seagrass beds in Pembroke River is a key part of the survey programme to confirm the extent or otherwise of any smothering effects from dredging operations. The survey undertaken in autumn 2009 was the first survey undertaken and provided pre-dredging results.

Further surveys have been carried out:

- on 26 May 2010 following the first phase of dredging to provide a navigable channel to the power station heavy load berth in Pennar Gut; and
- on 27 September 2010 for comparison with the autumn 2009 survey.

Further dredging operations have been in progress in Pennar Gut since late October 2010, which are expected to be completed in April 2011. A further survey is planned for September 2011 to monitor the seagrass beds post-dredging.

2.6.6 Sediment sampling in Pennar Gut

Sediment samples were recovered from four locations in the cooling water intake/jetty approach channel in Pennar Gut in August 2010 using vibro-coring techniques. The purpose was to obtain samples of sediment down to the full depth proposed to be dredged or as near to that depth as possible, for analysis for particle size distribution and chemical content contamination, in connection with the offshore disposal of the arisings from dredging operations.

This was a one-off sampling exercise in connection with the dredging operations in Pennar Gut, which it is not proposed to repeat.

2.6.7 Water temperature

The establishment of a network of continuous temperature monitors in the Haven is in hand and this is expected to come into service during 2011. This will cover a variety of locations from Dakotian MHPA buoy up-Haven to Rudders Boatyard, and provide both near-surface (approx. 0.9m below the surface) and near-bed (approx. 1m above the sea bed) continuous temperature records. The near-surface temperature monitors are likely to be commissioned first.

In addition the power station cooling water intake water temperature will be available from the power station instrumentation system when commissioned.

Continuous salinity monitoring will also be provided at or adjacent to Dakotian buoy, Rudders Boatyard and one intermediate location.

2.7.8. Subtidal benthos

Grab sample surveys were conducted in April, May and September 2010 at locations in Pennar Gut and Pennar Mouth, and in the vicinity of the power station cooling water outfall off Pwllcrochan Flats, between Martin's Haven and Pennar Mouth. A similar survey was carried out in October 2006.

Similar surveys are planned for April, May and September 2011.

2.7 CCW MONITORING

Summarised from contributions from Paul Brazier and Rohan Holt, CCW; Francis Bunker, Aquatic Survey and Monitoring Ltd.

The Countryside Council for Wales have been undertaking monitoring of both intertidal and subtidal rock reef Habitats Directive feature in the Pembrokeshire Marine Special Area of Conservation since 2005. Interim and trials reports have been produced [2] and more comprehensive reports covering the initial five year tranche of work are in production at the time of writing.

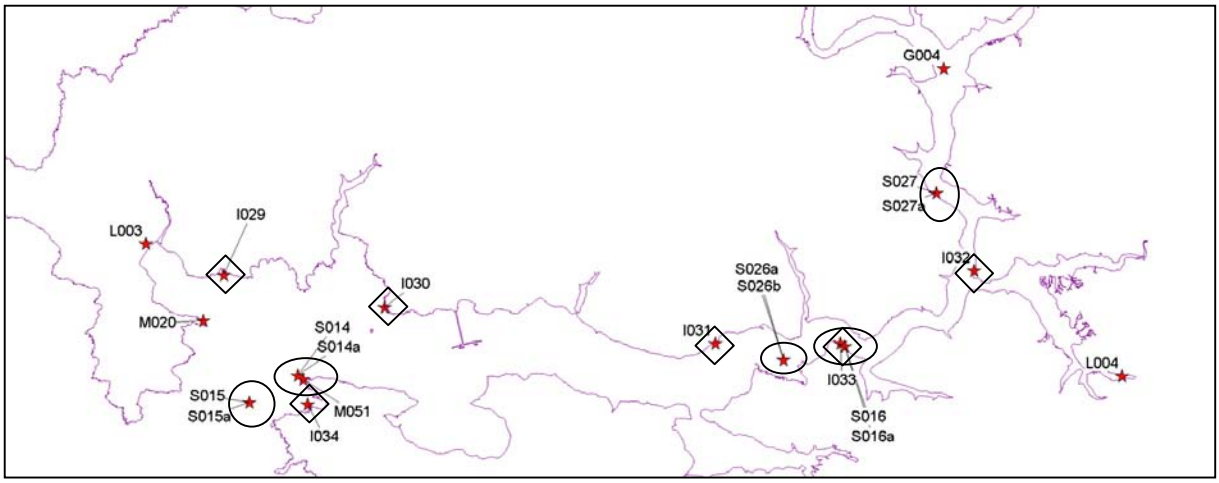
The objectives of the intertidal rock monitoring in Milford Haven were to establish a series of six permanent, fixed monitoring sites representative of the rocky shore habitats within the Haven Waterway and resurvey each annually. The work was planned to include provision for adaptation and development as the conservation objectives for the Pembrokeshire Marine SAC were finalised and as the sensitivity and utility of the techniques proved themselves in such a dynamic environment.

Surveys at each shore consist of quantitative sampling of all species present in four permanently marked $1m^2$ quadrats in the upper, middle and lower shores with photographs being taken to illustrate any changes over time. As well as the quadrat samples, barnacle populations are photographed in 5 x 5 cm quadrats in the upper, middle and lower shore for species determination and enumeration. Also, the length of between 100 and 200 limpets are measured in the middle shore.

The shores studied represent an environmental gradient extending from the ultra sheltered *Ascophyllum nodosum* covered shores of the Daucleddau at Lawrenny to the exposed rocky shores at South Hook Point and West Angle Bay. Sampling is undertaken during spring tides in the last half of August or first half of September to maintain seasonal consistency.

From experience gained elsewhere (such as the Skomer Marine Nature Reserve), it is anticipated that several years data will be required before trends are detectable and to enable genuine change over time to be measured rather than simply inter-year fluctuations. However, preliminary results show the presence of non-native species to have increased on the shores during the study period. Examples of these species include the Australian barnacle *Austrominius modestus*, the slipper limpet *Crepidula fornicata*, the anemone *Haliplanella lineata* and the red pompom weed *Caulacanthus okamuriae*.

[2] For example: Mercer, TS & Brazier, DP, 2009. *Intertidal SAC monitoring: intertidal monitoring of rocky reefs in Milford Haven, Pembrokeshire Marine SAC, August 2007*. CCW Marine Monitoring Report No: 60, Aquatic Survey & Monitoring Ltd. Bollihope, Co. Durham



CCW rocky reef monitoring sites: intertidal sites – diamonds; subtidal sites - ovals

Fixed location monitoring sites were established at multiple depth zones at the 'Warrior' (between the Cleddau Bridge and Cosheston Pill), Thorn Island and Chapel Rocks in 2005, and at Beggar's Reach and Dockyard Bank in 2007. The most complete datasets are from the 2005 sites not only because they have been established for longer, but because visibility and other environmental conditions severely constrains working at the other two sites.

2.8 ENVIRONMENT AGENCY MARINE MONITORING PROGRAMMES IN MILFORD HAVEN

Compiled for MHWESG by Anna Prior, EAW Survey Officer.

Water Framework Directive

The Water Framework Directive (WFD) (2000/60/EEC) requires that all countries throughout the European Union manage the water environment to consistent standards. It integrates the ecological and chemical status of surface water, placing a great emphasis on ecological status. Main aims of the directive are to:

• prevent deterioration in the status of aquatic ecosystems, protect them and improve the ecological condition of waters;

• achieve at least good status for all water bodies by 2015. Where this is not possible and subject to the criteria set out in the Directive, aim to achieve good status by 2021 or 2027.

For the purposes of this directive the Haven is divided into two waterbodies: 'Milford Haven Transitional' which includes the inner estuarine waters upriver from Pennar Gut, and 'Milford Haven Coastal' covering the area from Pennar Gut to St Annes Head. All the routine monthly WFD water surveys conducted in the Haven, combined with other biological element surveys throughout the year, provide data on the ecological status of the waters. This data feeds into preparing assessments and classifications of these waterbodies according to their combined chemical and ecological status. From these assessments River Basin Management Plans are produced.

WFD Surveillance Programme water sampling is conducted on a monthly basis at 8 sample points throughout the Haven from the Environment Agency Coastal Survey Vessel (CSV) Vigilance. Samples for analysis of biological elements such as phytoplankton and chlorophyll are routinely collected alongside supporting elements such as winter nutrients and field determinands including dissolved oxygen, salinity, temperature and turbidity.

Data from yearly fish population studies in Milford Haven transitional waterbody also feeds into informing the ecological component of WFD assessments. Currently, in the autumn two 30-minute otter trawls are conducted at the mouth of Pennar Gut by the CSV. Additionally, seven seine net sampling points (Carew, Pembroke River, Western and Eastern Cleddau Rivers) are surveyed bi-annually in May/June and September-November for further fish population analysis.

Benthic data is collected in the Haven on a 3-yearly cycle, with the last full survey being carried out in 2010. The survey consists of 25 sites in the transitional waters of the Haven and 10 from the coastal waters being sampled with a $0.1m^2$ day grab. Seven of the sites sampled doubled as MHWESG surveillance sites where chemistry and PSA samples were also taken at each site to support the biological data.

With respect to intertidal sampling for WFD Surveillance Programme monitoring, the ecological components studied are macroalgae, saltmarsh and seagrass, and local area teams are responsible for the completion of these surveys. The location of opportunistic macroalgae is mapped in the Haven as a whole and percentage cover and biomass calculated twice every six years. Similarly, transects of salt marshes are also completed twice every six years,

whereas seagrass beds such as those at Angle Bay are surveyed annually for extent and percentage cover.

The latest round of WFD classifications of Milford Haven waters occurred in 2009 which resulted in both Milford Haven coastal and transitional waterbodies being classified as having an overall status (when both chemical and ecological components are taken in account) of 'moderate'. The long term goal in the Haven is to work towards both waterbodies developing a 'good' status by 2027.

(More information can be found in the Western Wales River Basin Management Plan which can be accessed from the Environment Agency website: www.environment-agency.gov.uk/research/planning/33106.aspx)

Nitrates Directive

Milford Haven is currently under review as a candidate polluted water under the Nitrates Directive (91/676/EEC). This directive aims to reduce water pollution caused by nitrates from diffuse pollution sources, primarily agriculture. The current monitoring programme in the Haven was set up in 2009 as an ongoing review of the waters when previous rounds of investigation had provided insufficient evidence of water eutrophication to make a case for designation of Milford Haven as a Polluted Water. Sampling for nutrients currently occurs at seven sample points eight times a year in summer and winter. If data from recent years suggests conclusively that nitrogen compounds from agricultural sources are contributing to eutrophication, Milford Haven will become a designated Polluted Water. This would then have implications for surrounding areas as all land draining in the Polluted Water would be designated as a Nitrate Vulnerable Zone and restrictions would be applied to reduce nitrate leaching into the water as a result of agricultural activities.

Shellfish Waters Directive

The purpose of the Shellfish Waters Directive (SWD) (79/923/EEC) is to safeguard shellfish populations from the harmful consequences resulting from the discharge of polluting substances into the sea. The directive is therefore aimed at protecting the shellfish populations themselves rather than the health of the consumers which is covered by the Shellfish Hygiene Directive.

Currently there are two shellfish waters within the Haven, Milford Haven Carew and Milford Haven Cleddau, and sample points within these are sampled quarterly to fulfil requirements for this directive. Bacterial samples are routinely taken and samples for metals analysis are taken twice a year. Mussels are harvested from the banks of the Carew River every quarter for the analysis and reporting of faecal coliform concentrations in shellfish flesh.

Dangerous Substances Directive

Four sites in the Haven are currently sampled on a quarterly basis for Dangerous Substances Directive (DSD) (76/464/EEC); the outfalls at Haverfordwest, Chevron, Murco and Petroplus/Dragon LNG. In addition EAW also undertake sediment sampling at the Petroplus/Dragon LNG site once a year to monitor concentrations of List 1 substances in the sediment. These are substances which are particularly toxic, persistent and which may accumulate in the environment.

Clean Sea Environment Monitoring Programme (CSEMP)

Current CSEMP monitoring in the Haven is focused on the detection of long term temporal trends and the Environment Agency is responsible for delivering benthic invertebrate community data in Milford Haven at the established Cosheston Point CSEMP site. This is sampled yearly in the spring for 5 replicate biology samples and supporting particle size information which form part of a long-term data set.

CSEMP also requires the collection of data for the analysis of metal contaminants in biota in the Haven and this is fulfilled by the annual collection and analysis of mussel flesh from Lawrenny Quay by land-based local area teams.

2.9 STUDIES ON THE DISTRIBUTION AND PROCESSES LIMITING THE SPREAD OF THE INVASIVE GASTROPOD CREPIDULA FORNICATA IN THE MILFORD HAVEN WATERWAY

Katrin Bohn, Chris Richardson and Stuart Jenkins – School of Ocean Sciences, Bangor University

In an ongoing PhD project based at Bangor University and funded by the Countryside Council for Wales (CCW) and the Bangor Mussels Producers (BMP), we are aiming to understand the distribution, potential spread and impacts of the invasive marine gastropod *Crepidula fornicata* along the Welsh coastline. The Milford Haven Waterway holds an established population of this potentially harmful invader, making it an ideal location to carry out field based experimental work.

The slipper limpet C. fornicata was first introduced into Europe from the North American Atlantic coast in the late 1870s and has since become a common component of the fauna along the east and south coasts of England. On the west coast of the UK, however, it has not yet extended its range to the north of the Milford Haven Waterway, despite its rapid spread within the waterway and the high densities it reaches locally. Previous work carried out in other parts of Europe suggest that this may be due to exposure to low temperatures, by causing high adult mortality during the winter months or hampering their reproductive success during the reproductive season (e.g. Pechenik 1984, Thieltges et al. 2003, 2004, Richard et al. 2006).

The accidental introduction of *C. fornicata* into the Menai Strait and Conwy Bay SAC in North Wales in 2006 and the persistence of some individuals for ~2 years until their successful mechanical removal however suggest that low temperatures may not be the prime reason for their confined occurrence in the Milford Haven Waterway. Ongoing research is therefore aimed at addressing the following objectives:

1) To confirm the most northern distributional limit of C. fornicata in Wales:

Intertidal and subtidal surveys undertaken in 2009 and 2010 confirmed the absence of (detectable) populations of *C. fornicata* outside the Milford Haven Waterway, and highly variable densities inside the Waterway.

2) To study the reproductive biology of C. fornicata in the Milford Haven Waterway

Monthly surveys were conducted between January and November 2010 at different locations within the Milford Haven Waterway to monitor:

the spawning period of females

the abundance of larvae in monthly plankton tows to determine the larval period

the settlement season, by installing settlement panels in the low intertidal and recording the arrival of newly settled spat C. fornicata, and

the air and sea water temperature

The data suggest that neither low winter temperatures nor low summer temperatures are acting as a strong limiting factor for the northward spread of *Crepidula*. Instead, we have observed high larval densities and a long reproductive season similar to those reported from areas elsewhere in Europe where there are lower adult densities and cooler temperatures.

3) To investigate the roles of larval supply, larval habitat selection and post-settlement mortality in determining patterns of adult distribution, and how these may affect the invasion process

The same data as above were used to analyse whether larval supply, larval habitat selection or post-settlement mortality best explain patterns of adult distribution. Preliminary results indicate that post-settlement mortality may primarily determine the distribution of adults. This work will be complemented by laboratory assays undertaken at the School of Ocean Sciences, Bangor University to study the effects of low temperatures on juvenile survival as well as larval settlement behaviour and preferences. Most of all, of course, we are looking forward to another season of field work on the muddy shores of the Milford Haven Waterway in 2011.

We are grateful for the continuous financial and field-work support received by the Countryside Council for Wales, and the opportunity to undertake plankton sampling with the Milford Haven Port Authority. For any queries or comments (this of course includes sightings of slipper limpets in places we are unaware of!) please do not hesitate to contact Katrin Bohn at Katrin.Bohn@bangor.ac.uk.

3. FUTURE WORK PROGRAMME

A medium-term work outline programme identifies tasks for the coming decade, though with the flexibility to bring forward or delay projects depending on the pace of individual projects, unforeseen opportunities to integrate with other projects and the available budget.

Priorities for 2011 include:

- continuation of projects recommended in the David Little sediment review; specifically completion of the sediment contaminant forensics and letting of a contract to undertake a comprehensive sediment profile imaging survey, though fieldwork for this is uinlikely to take place before spring 2012 because of the need to align windows of availability between the Seattle, USA, based contractor and a suitable survey vessel in a period of likely calm weather;
- assessment of the second season of bioaccumulation results. The report of the first bioaccumulation study included recommendations to consider implementing a number of sensitive novel biological effects of contaminants analytical tools. However, as the costs of these tools is high and the recommendations arising from the sediments review were considered to be more urgent, the Group postponed consideration of the tools at that time but will revisit them following receipt of the second bioaccumulation report;
- determination of a refined water quality surveillance programme taking account of monitoring by the Environment Agency to meet Water Framework Directive obligations;

Annual summer shelduck breeding surveillance and wetland bird data collation and reporting will continue,

The Group's budget remains healthy at the present time although public sector spending cuts have resulted in reduced contribution from CCW. Whilst the Group looks forward to welcoming further new members from the new industries around the Haven and, naturally, their contributions, at the same time it is conscious of the resource cuts facing some of the public body members of the Group and anticipates commensurate reductions in their contributions will be likely in the short-term.

APPENDICES

APPENDIX 1: PURPOSE AND TERMS OF REFERENCE

Preamble

The Milford Haven Waterway[3] is an extensive natural inlet of the sea with a long and distinguished maritime history. Its deep waters provide a natural harbour of significant economic importance. It is one of the best examples of a ria system in Britain and supports a particularly diverse range of high quality marine and estuarine habitats and biological communities.

The identification and consideration of political and management issues or the setting of environmental standards are specifically excluded from these Terms of Reference. However, group members are free, and are expected to use the group's outputs to help meet their own requirements.

Purpose

To provide high quality environmental information to enable members of the Group, and other authorities and industry working in and adjacent to the Waterway, to contribute to the maintenance and enhancement of the rich and diverse marine environment of the Waterway.

Terms of Reference

The Milford Haven Waterway Environmental Monitoring Steering Group will:

1. Maintain surveillance of the quality of the marine physico-chemical environment, marine biology and ornithology of the Milford Haven Waterway

2. Undertake surveillance of the foreshore, seabed and waters of the Milford Haven Waterway from a line between St Anne's Head and Sheep Island to the tidal reaches of the Eastern and Western Cleddau Rivers and other tributaries to normal tidal limits by:

2.1 keeping under review all relevant survey, surveillance and monitoring;

2.2 commissioning surveys to fill gaps in knowledge and to establish baselines;

2.3 undertaking surveillance projects;

2.4 maintaining a literature and information database.

3. Jointly maintain, and keep under review, a prioritised programme of survey and surveillance projects.

4. Share technical output equally under joint ownership and copyright.

5. Function as a technical, science based, group.

6. Form and appoint specific sub-groups to undertake specific responsibilities as required.

7. Publish an annual report which will comprise a summary of work undertaken, the executive summaries from individual project reports, a financial statement and the planned work programme.

8. Make its output available to the wider community in addition to its membership.

Membership and Funding

Membership is comprised of statutory authorities, industry and others with an interest in the environmental quality of the Waterway. Membership will be at the invitation and discretion of the Group's existing members.

Each member will contribute to the functioning of the group, either in monetary terms or 'in kind'.

[3] The term Waterway in this document specifically refers to the waters, seabed and foreshore of the Milford Haven Waterway and the Daugleddau Estuary from a line between St Anne's Head and Sheep Island to the tidal reaches of the Eastern and Western Cleddau Rivers and other tributaries to normal tidal limits.

APPENDIX 2: MEMORANDUM OF AGREEMENT

THIS AGREEMENT is made the 1st day of July 2004

BETWEEN:

(1) **ChevronTexaco Limited** whose principal office is at Pembroke Refinery, Pembroke SA71 5SJ

(2) **Countryside Council for Wales** whose principal office is at Llanion House, Llanion Park, Pembroke Dock, Pembrokeshire. SA72 6DY

(3) **Environment Agency (Wales)** whose principal office is at Rivers House, Hawthorn Rise, Haverfordwest, Pembrokeshire. SA61 2BQ

(4) **Milford Haven Port Authority** whose principal office is at Gorsewood Drive, Hakin, Milford Haven, Pembrokeshire SA73 3ER

(5) **Pembrokeshire Coast National Park Authority** whose principal office is at Llanion Park, Pembroke Dock, Pembrokeshire SA72 6DY

(6) **Pembrokeshire County Council** whose principal office is at County Hall, Haverfordwest, Pembrokeshire SA61 ITP

(7) **Petroplus Tankstorage (MH) Ltd** whose principal office is at Waterston, Milford Haven, Pembrokeshire SA71 IDR '

(8) **South Wales Sea Fisheries Committee** whose principal office is at Queens Buildings, Cambrian Place, Swansea SAl 1TW

(9) **Total Refinery** whose principal office is at PO Box 10, Milford Haven, Pembrokeshire SA73 3JD

(10) **Welsh Water-Dwr Cymru** whose principal office is at Pentwyn Road, Nelson, Treharris, Caerphilly. CF46 6LY

(11) **Wildlife Trust South and West Wales** whose principal office is at The Welsh Wildlife Centre, Cilgerran, Cardigan SA43 2TB

Here and after referred to as "the Parties"

RECITAL

The parties have agreed to enter into this agreement to record and regulate the terms of their co-operation in order to provide high quality environmental information to the parties so enabling the parties to contribute to the maintenance and enhancement of the rich and diverse marine environment of the Waterway (as hereinafter defined) and to perform the objects set out in clause 2.2 under the terms of this Agreement

AGREEMENT

The parties agree as follows:

1. INTERPRETATION

1.1 In this agreement unless there be anything in the context inconsistent therewith the following expressions shall have the following meanings:

"Committee" has the meaning ascribed to it by clause 3.1 1. "Group" means the Milford Haven Waterway Environmental Surveillance Group created by this agreement and any agreement supplemental to it

"Group Members" means all of the parties listed above or some of them as the context admits and Group Member shall have a corresponding meaning

"Objects" means the objects of the Group more particularly itemised in clause 2.2

"Waterway" means the waters, seabed and foreshore of the Milford Haven Waterway and the Daugleddau Estuary from a line between St Anne's Head and Sheep Island to the tidal reaches of the Eastern and Western Cleddau Rivers and other tributaries to the normal tidal limits.

2. SCOPE OF THE JOINT VENTURE

2.1 The Group Members agree with one another to enter into this Agreement to provide high quality environmental information to enable the Group Members to contribute to the maintenance and enhancement of the rich and diverse marine environment of the Waterway and to perform the objects set out in clause 2.2 under the terms of this agreement

2.2 The Objects of the Group are:

2.2.1 to maintain surveillance of the quality of the marine physico-chemical environment and marine biology, and ornithology, of the Waterway;

2.2.2 to undertake surveillance of the Waterway by:

2.2.2.1 keeping under review all relevant survey, surveillance and monitoring as well as undertaking surveillance projects when necessary;

2.2.2.2 commissioning surveys to improve current knowledge and establish baselines; and

2.2.2.3 maintaining a literature and information database.

2.2.3 to share technical output equally under joint ownership and copyright

2.2.4 to function as a technical, science based, group

2.2.5 to make its findings available to the wider community in addition to Group Members

2.3 For the avoidance of doubt, nothing in this Agreement shall be deemed to override or in any way restrict the statutory duties or obligations of any of the Group Members

3. CONTROL AND MANAGEMENT

3.1 A committee ("the Committee") comprising of a representative nominated by each of the Group Members will be established for the purposes of:

3.1.1 discussing determining and approving the purpose, Terms of Reference and work programme of the Group

3.1.2 exchanging information

3.1.3 reporting on progress to include publishing an annual report that comprises of a summary of all work undertaken for the year, a financial statement and planned work programme for the forthcoming year

3.1.4 preparing an annual business plan

3.2 Each Group Member shall notify the Chairperson, or Secretary, in writing of their nominated representative and shall be entitled to appoint alternative representatives

3.3 The Committee shall appoint a Chairperson from its number to chair Committee meetings and a Vice Chairperson to chair committee meetings in the absence of the Chairperson. In the absence of both the Chairperson and the Vice Chairperson those nominated representatives present shall appoint one of their number present to act as Chairperson for that particular meeting. The term of office of the Chairperson and the Vice Chairperson will be subject to an annual review

3.4 The quorum for meetings of the Committee shall be 5 nominated representatives of the Group Members. Minutes of all meetings of the Committee shall be taken and kept in designated minute books by the Milford Haven Port Authority and copies of such minutes circulated to Group Members as soon as practicable after each meeting

3.5 Questions arising at a meeting of the Committee, that cannot be resolved by consensus, shall be decided by a majority of votes and each nominated representative shall have one vote. In the case of an equality of votes the Chairperson of the meeting shall have a casting vote. The nominated representatives may regulate the conduct of the meetings of the Committee as they consider appropriate

3.6 The Committee shall be entitled to delegate any of its functions to sub-committees or to other persons as it considers appropriate for the task; provided that the delegation and the reasons therefore are recorded in writing

3.7 Group Members shall not make any decisions on matters of principle relevant to the Terms of Reference of the Group without consulting the Committee

3.8 The Committee will meet as often as necessary or desirable for the purposes of achieving the objects set out in clause 2.2 at a convenient time and venue and any Group Member may call such a meeting by giving to the other Group Members 14 days prior notice in writing to that effect designating the time venue and items for the agenda of the meeting

3.9 The Group Members shall at all times co-operate with each other and act in good faith to enable the Group objects to be attained

4. RESOURCING

4.1 Each of the Group Members will provide either a monetary contribution or some other contribution eg services, premises that shall be agreed by all the Group Members for the furtherance of the Objects of the Group in accordance with the annual business plan referred to in clause 3.1.4. The contributions are to be provided promptly within the time frame agreed for contributions

4.2 Milford Haven Port Authority shall receive all financial contributions by Group Members and shall keep such monies in a separate interest bearing bank account in trust for the Group. Milford Haven Port Authority shall make payments on behalf of the Group in respect of

commitments agreed at clause 4.3 below but may not make any other payments or commitments on behalf of the Group without the prior approval of the Committee. Milford Haven Port Authority shall provide quarterly statements to the Committee in respect of such account

4.3 Under the terms of this Agreement Milford Haven Port Authority shall have the authority to enter into contracts including, without limitation, for the appointment of professionals, advisers and consultants on behalf of the Group subject to the prior approval of the Committee

4.4 No contracts shall be entered into unless there are sufficient funds available within the interest bearing bank account referred to in clause 4.2 to meet the obligations under the contract

5. INTELLECTUAL PROPERTY RIGHTS

5.1 All rights which may now or in the future subsist in respect of or derived from any intellectual property including without limitation all copyright, design rights, registered designs, trade and service marks (whether registered or not) and moral rights (including in all such cases any applications for any such rights or protections and any rights to apply therefore and all renewals continuations extensions renewals and divisions)(the "IP Rights") developed or generated by the Group in pursuance of the Objects shall be owned by the Group Members jointly

5.2 Any Group Member shall be entitled to use any IP Rights free of charge provided that any such use shall not compromise the Objects of the Group and provided further that if any Group Member wishes to license or authorise any third party to use or exploit any IP Rights, such third party shall be required to pay a licence fee calculated on an arms length basis

5.3 All costs and expenses and all receipts in respect of any intellectual property shall be shared equally by the Group Members

5.4 Each Group Member shall retain all IP Rights to all materials, information etc. contributed by that Group Member

6. LIABILITY

The Group Members agree that all losses, damages, costs and/or expenses incurred as a result of participation in the Group and/or any action taken in accordance with this Agreement shall be borne equally by all Group Members provided that if any such losses, damages, costs and/or expenses arise as a result of an act or omission attributable to one or more Group Members, for example a breach of clause 4.2 or if the action of one or more Group Members is not in proper pursuance of the Objects or if the action of one or more Group Members gives rise to a breach of a contract referred to in clause 4.3 or if any Group Member infringes the IP Rights of a third party, then that Group Member or those Group Members shall bear those particular losses, damages, costs and/or expenses and shall indemnify the other Group Members accordingly

7. TERM AND TERMINATION

7.1 The provisions of this Agreement shall come into force on the date stated above

7.2 A Group Member may at any time terminate its participation in respect of this Agreement subject to three months' notice in writing to the Chairperson with no right of return of contribution

7.3 In the event that any Group Member is in breach of this agreement which they fail to remedy within 14 days of written request by the Committee then such Group Member's involvement in the Group may be terminated by notice given to them by the Committee at any time following expiry of the said period of 14 days

7.4 Subject to clauses 7.2 and 7.3 this agreement will terminate on completion of the Objects stated in clause 2

7.5 Upon termination of this agreement the Group shall be terminated forthwith and the parties shall take such further steps as may be necessary in order to wind up the Group in a fair and reasonable manner. The assets of the Group at winding up should be distributed pro rata to the direct financial contributions by Group Members. If a Group Member's participation in the Group is terminated in accordance with clause 7.2 or 7.3 the provisions of clauses 5.1 to 5.3 shall no longer apply in respect of such Group Member

8. GOVERNING LAW

This agreement shall be governed by and construed in all respects in accordance with the laws of the European Union, England and Wales and all parties will submit to the jurisdiction of the courts of England and Wales

9. THIRD PARTIES

Nothing in this Agreement shall create any rights for third parties under the Contracts (Rights of Third Parties) Act 1999. No variation to this Agreement and no supplemental or ancillary agreement to this Agreement shall create any such rights unless expressly so stated in any such agreement by the parties to this Agreement. This does not affect any right or remedy of a third party that exists or is available apart from that Act

10. NO PARTNERSHIP

Nothing in this Agreement shall be construed as establishing or implying any partnership between the Parties hereto and nothing in this Agreement shall be deemed to constitute either of the Parties hereto as the agent of the other Party or authorize either Party (i) to incur any expenses on behalf of the other Party (ii) to enter into any engagement or make any representation or warranty on behalf of the other party (iii) to pledge the credit of or otherwise bind or oblige the other Party or (iv) to commit the other Party in any way whatsoever without in each case obtaining the other Party's prior written consent

11. SUCCESSORS

References in this Agreement to the parties shall include their respective heirs successors in title permitted assigns and personal representatives This Agreement shall be binding upon and enure to the benefit of the parties and their respective successors

12. ASSIGNMENT

No Member may assign its interests in this Agreement without prior approval of the Committee (not to be unreasonably withheld) except that no such approval is required for an assignment to a company in the same group as the Member

13. ARBITRATION

13.1 Any dispute or difference arising out of or in connection with this Agreement shall be referred to the arbitration of a sole arbitrator to be appointed in accordance with Section 16(3) of the Arbitration Act 1996 ("the Act") the seat of such arbitration being hereby designated as London England 13.2 In the event of failure of the parties to make the appointment pursuant to Section 16(3) of the Act the appointment shall be made by the President for the time being of the Chartered Institute of Arbitrators

13.3 The Arbitrator shall decide the dispute in accordance with the substantive laws of England and Wales

APPENDIX 3: CHRONOLOGICAL LIST OF MHWEMSG / MHWESG[4] REPORTS

1992

Hobbs, G and Morgan, C I (eds.) (1992). *A review of the current state of environmental knowledge of the Milford Haven Waterway*. Report from Oil Pollution Research Unit; xi &140pp

Hobbs, G and Morgan, C I (eds.) (1992). *A review of the current state of environmental knowledge of the Milford Haven Waterway; Executive Summary*. Report from Oil Pollution Research Unit, 12pp

MHWEMSG (1992). *Report of the Milford Haven Waterway Environmental Monitoring Steering Group 1992*. 6pp

1993

Hodges, J E (1993). *Daugleddau Estuary and Milford Haven Waterway annual shelduck survey: report for 1993.* Report from Pembrokeshire Coast National Park Authority, 8pp + appendices

1994

Ellis, R & Poole, A (1994). *Cleddau Estuary wader and wildfowl counts 1993 – 94. 20* pp + appendices

Hodges, J E (1995). *Daugleddau Estuary and Milford Haven Waterway annual shelduck survey: report for 1995.* Report from Pembrokeshire Coast National Park Authority,8pp + appendices

Levell, D, Smith, J and Hobbs, G (1994). *Milford Haven macrobenthic survey October 1993*. Report from Oil Pollution Research Unit; xii, 26pp + figures, tables & data appendices.

MHWEMSG (1994). *Report of the Milford Haven Waterway Environmental Monitoring Steering Group 1993/94*. 20pp

Smith, J and Hobbs, G (1994). *Metal concentrations in Milford Haven sea bed sediments - data storage, analysis and initial interpretation*. Report from Oil Pollution Research Unit; v, 8pp + tables & maps

1995

Hodges, J E (1995). *Daugleddau Estuary and Milford Haven Waterway annual shelduck survey: report for 1995.* Report from Pembrokeshire Coast National Park Authority 10pp + appendices

Howe, M (1995). *Monitoring of eelgrass populations in the Milford Haven waterway and Daugleddau Estuary*. Report from Pembrokeshire Coast National Park Authority; 7pp

MHWEMSG (1995). *Report of the Milford Haven Waterway Environmental Monitoring Steering Group 1994/95.* 19pp

[4] The Group changed its name in 2000

Poole, A & Ellis, R (1995). *Cleddau Estuary including Milford Haven Waterway: wildfowl and wader counts 1994 – 95.* 30pp

Rostron, D M (1995). *The macrobenthos of the foreshore soft sediments of Milford Haven, 1994*. Report from SubSea Survey; 2 vols, 17pp + maps, figures & data appendices

1996

Hodges, J E (1996). *Daugleddau Estuary and Milford Haven Waterway annual shelduck survey: report for 1996.* Report from Pembrokeshire Coast National Park Authority, 8pp + appendices

MHWEMSG (1996). *Report of the Milford Haven Waterway Environmental Monitoring Steering Group 1995/96.* 14pp

Poole, A (1996). *Milford Haven and Cleddau Estuary wetland bird survey 1995-96*. 18pp

1997

Hodges, J E (1997). *Daugleddau Estuary and Milford Haven Waterway annual shelduck survey: report for 1997.* Report from Pembrokeshire Coast National Park Authority. 10pp + tables & appendices

MHWEMSG (1997). *Report of the Milford Haven Waterway Environmental Monitoring Steering Group 1996/97.* 36pp

Moore, J J (1997). *Rocky shore transect monitoring in Milford Haven, October 1995.* Report from Oil Pollution Research Unit. OPRU Report No OPRU/14/96. 36pp + appendices

Poole, A (1997). *Milford Haven Waterway and Cleddau Estuary bird survey 1996-97*. 13pp + appendices

1998

Hodges, J E (1998). *Daugleddau Estuary and Milford Haven Waterway annual shelduck survey – report for 1998.* Report from Pembrokeshire Coast National Park Authority. 9pp + tables & appendices

Munro, C (1999). *Monitoring of the rocky sub-littoral of Milford Haven: May-July 1998.* Report from Marine Biological Surveys. v, 38pp + appendices, photographs and videorecording

Poole, A (1998). *Milford Haven Waterway and Cleddau Estuary bird survey 1997-98*. 12pp + appendices

1999

Hodges, J E (1999). *Daugleddau Estuary and Milford Haven Waterway annual shelduck survey – report for 1999.* Report from Pembrokeshire Coast National Park Authority. 8pp + tables & appendices

Irving, R and Worley, A (1999). *Survey of sublittoral Zostera marina bed in Milford Haven. Field Report*. Report from Posford Duvivier. 4pp

Kitts, H (1999). *Quantification of inputs to Milford Haven*. Report from Hyder Ltd. 29pp + tables & appendices

MHWEMSG (1999). *Report of the Milford Haven Waterway Environmental Monitoring Steering Group 1997 - 1999*. 25pp

Poole, A (1999). *Milford Haven Waterway and Cleddau Estuary Bird Survey 1998-99*. 13pp + appendices

Posford Duvivier (2000). *A survey of subtidal Zostera beds in Milford Haven*. 36pp + appendices

2000

Bent, E J (2000). *A review of environmental studies in Milford Haven Waterway 1992 – 2000*. iv, 65 pp + tables & maps

Hodges, J E (2000). *Daugleddau Estuary and Milford Haven Waterway annual shelduck Survey – Report for 2000.* Report from Pembrokeshire Coast National Park Authority. 10pp + tables + appendices

MHWESG (2000). *Milford Haven Waterway Environmental Surveillance Group Annual Report 1999 - 2000*. 20pp & appendices

Poole, A (2000). *Milford Haven waterway and Cleddau Estuary Bird Survey 1999-2000*. 15pp + appendices

2001

Hodges, J E (2001). *Daugleddau Estuary and Milford Haven Waterway surveillance of summer shelduck populations: report for 2001.* Report from Pembrokeshire Coast National Park Authority. 8pp + appendices

Poole, A (2001). *Milford Haven Waterway and Cleddau Estuary bird survey 2000-01*. 14pp + appendices

2002

Hodges, J E (2002). *Daugleddau Estuary and Milford Haven Waterway surveillance of summer shelduck populations: report for 2002.* Report from Pembrokeshire Coast National Park Authority. 8pp + appendices

Poole, A (2002). *Milford Haven Waterway and Cleddau Estuary bird survey 2001-02.* 12pp + appendices

2003

Bent, E J (2003). *Milford Haven Waterway review of work programme 2000 – 2010*. 32pp

Hodges, J E (2004). *Daugleddau Estuary and Milford Haven waterway surveillance of summer shelduck populations: report for 2003.* Report from Pembrokeshire Coast National Park Authority. 9pp + appendices

Poole, A (2003). *Milford Haven Waterway and Cleddau Estuary bird survey 2002-03.* 16pp + appendices

Prosser, M V & Wallace H L (2003). *Milford Haven salt-marsh survey 2002.* Report from Ecological Surveys (Bangor). 2 vols. 58pp + appendices, photographs & maps

2004

Hodges, J E (2004). *Daugleddau Estuary and Milford Haven Waterway surveillance of summer shelduck populations: report for 2004.* Report from Pembrokeshire Coast National Park Authority. 7pp + appendices

Haycock, A (2004). *Milford Haven Waterway and Cleddau Estuary Bird Survey 2003-04.* 14pp + appendices

2005

Atkins (2005). *Development of an Inputs Budget for Milford Haven Waterway.* 68pp + cd database & GIS data

Hodges, J E (2005). *Daugleddau Estuary and Milford Haven Waterway surveillance of summer shelduck populations: report for 2005.* Report from Pembrokeshire Coast National Park Authority. 8pp + appendices

Haycock, A (2005). *Milford Haven Waterway and Cleddau Estuary Bird Survey 2004-05. 7*pp + appendices

2006

Hodges, J E (2006). *Daugleddau Estuary and Milford Haven Waterway surveillance of summer shelduck populations: report for 2005.* Report from Pembrokeshire Coast National Park Authority. 8pp + appendices

Haycock, A (2006). *Milford Haven Waterway and Cleddau Estuary Bird Survey 2004-05. 7*pp + appendices

Warwick, R (2006). *Review of benthic and intertidal sediment macrofauna data and development of a surveillance programme*. 105pp + electronic data annex

2007

Hodges, J E (2007). *Daugleddau Estuary and Milford Haven Waterway surveillance of summer shelduck populations: report for 2006.* Report from Pembrokeshire Coast National Park Authority. 8pp + appendices

2008

Haycock, A (2008). *Wildfowl and wader counts on the Milford Haven Waterway 2006-07* 20pp

Haycock, A (2008). *A review of the status of wetland birds in the Milford Haven waterway and Daugleddau estuary*. A report to the Milford Haven Waterway Environmental Surveillance Group. 122pp

Hodges, J E (2008). *Daugleddau Estuary and Milford Haven Waterway surveillance of summer shelduck populations: report for 2008*. Report from Pembrokeshire Coast National Park Authority. 26pp + appendices

2009

Haycock, A (2009). *Wildfowl and wader counts on the Milford Haven Waterway 2007-08* 20pp

Hodges, J E (2009). *Daugleddau Estuary and Milford Haven Waterway surveillance of summer shelduck populations: report for 2009*. Report from Pembrokeshire Coast National Park Authority. 9pp + appendices

Langston, W J, O'Hara, S, Imamura M & Pope, N D (2009) *Bioaccumulation surveillance in Milford Haven Waterway 2007-2008*. Report to the Milford Haven Waterway Environmental Surveillance Group from the Marine Biological Association Plymouth. 66pp + appendices

Little, D I (2009) *Sediment Contaminants & Transport Review*. A report to the Milford Haven Waterway Environmental Surveillance Group. 368pp + appendices

2010

Haycock A (2010). Wildfowl and wader counts on the Milford Haven Waterway, 2009-10**.** A report to the Milford Haven Waterway Environmental Surveillance Group. 24pp

Hodges, J E (2010). *Daugleddau Estuary and Milford Haven Waterway surveillance of summer shelduck populations: report for 2010.* Report from Pembrokeshire Coast National Park Authority. 8 pp + appendices

Mieszkowska, N. (2011). *Reestablishment of intertidal rocky surveillance*. A report to the MHWESG fro the Marine Biological Association on ot the UK. 54pp + appendices