Carmarthen Bay and Estuaries/Bae Caerfyrddin ac Aberoedd European Marine Site

comprising:

Carmarthen Bay and Estuaries/Bae Caerfyrddin ac Aberoedd Special Area of Conservation
Carmarthen Bay/Bae Caerfyrddin Special Protection Area
Burry Inlet Protection Area & Ramsar Site

ADVICE PROVIDED BY THE COUNTRYSIDE COUNCIL FOR WALES IN FULFILMENT OF REGULATION 33 OF THE CONSERVATION (NATURAL HABITATS, &c.) REGULATIONS 1994

February 2009

This document supersedes the 'Draft Interim Advice' June 2005

A Welsh version of all or part of this document can be made available on request.

CARMARTHEN BAY AND ESTUARIES SPECIAL AREA OF CONSERVATION

EUROPEAN MARINE SITE

ADVICE PROVIDED BY THE COUNTRYSIDE COUNCIL FOR WALES IN FULFILMENT OF REGULATION 33 OF THE CONSERVATION (NATURAL HABITATS, &c.) REGULATIONS 1994

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SUMMARY: PLEASE READ THIS FIRST

This document contains CCW's advice issued under Regulation 33 of the Conservation (Natural Habitats, &c.) Regulations 1994, for the *Carmarthen Bay and Estuaries Special Area of Conservation* namely conservation objectives and advice on operations. It also includes an explanation of the purpose and format of CCW's "Regulation 33 advice".

This latest version of the Regulation 33 package has been revised to improve consistency across the marine SACs in Wales. The intent of the conservation objectives and of the advice on operations which may cause deterioration or disturbance to the feature is the same as in previous versions. The Conservation Objectives are now shorter and more generic but there has been no change in what is considered to represent Favourable Conservation Status.

Section 1 is a brief introduction to the legal context for Regulation 33 advice.

Section 2 explains in more detail the legal basis and practical requirements for setting conservation objectives for Natura 2000 sites, as understood by CCW. It also explains the legal and practical basis of the operations advice.

Section 3 contains a brief overall description of *Carmarthen Bay and Estuaries SAC*, *Carmarthen Bay SPA* and *Burry Inlet SPA* and *Ramsar site*, current operations taking place with the SAC and information on modifications as a result of human activity.

Section 4 describes habitats and species for which the *Carmarthen Bay and Estuaries SAC* has been selected as a SAC as well as why they are considered important. The information is presented using the same headings as those used to describe the conservation objectives so that useful underpinning information in support of these objectives can easily be referenced.

Section 5 contains CCW's advice as to the conservation objectives (Regulation 33(2)(a)) for the features for which the site has been as a SAC. This includes a vision statement which is a descriptive overview of what needs to be achieved for conservation on the site. It brings together and summarises the Conservation Objectives into a single, integrated statement about the site.

Section 6 contains CCW's advice as to the operations which may cause deterioration or disturbance of the habitats and species for which the site has been selected (Regulation 33(2)(b)). This is provided to assist the relevant authorities and others in understanding the implications of the designation of the site and the requirements of the Habitats Regulations and government policy towards it.

The **Appendices** provide a glossary of terms, a list of other types of protected areas within the SAC and more detail on the elements of Favourable Conservation Status. Other background information such as lists of additional species and habitats of particular note (*e.g.* species and habitats subject to Biodiversity Action Plans or threatened and declining species and habitats identified by the OSPAR Commission) and the variety of biotopes associated with Annex 1 features may be added in due course.

The **Maps** show the boundaries of the SAC, the location of other protected areas which occur within the SAC, and give an indication of the location of features for which the site was designated. Further maps, for example of adjacent designated areas or giving an indication of the location of

habitat components (*e.g.* types of reef or types of mudflat and sandflat), may be added in due course.

1 INTRODUCTION

The 1992 EC Habitats Directive [1] aims to help conserve the diversity of habitats and species across the European Union. It represents one of the ways in which EU member states are fulfilling the commitments they made at the "Earth Summit" in Rio de Janeiro in 1992, for the conservation of the Earth's biological diversity[2].

The Habitats Directive requires member states to take a variety of measures aimed at the conservation of biodiversity. These measures include the designation of Special Areas of Conservation (SACs) on land and sea. Each SAC is to be designated for particular habitats and species, and they are to be managed in ways that help conserve those habitats and species.

The Habitats Directive is given effect in the UK largely through the Conservation (Natural Habitats, &c.) Regulations 1994 ("the Habitats Regulations")[3]. These Regulations set out the powers and duties of UK statutory bodies towards compliance with the requirements of the Habitats Directive. Under these Regulations, SACs together with Special Protection Areas (SPAs) classified under the 1979 EC Birds Directive for the conservation of birds, are called "European sites" and those that include marine areas are called "European marine sites" [4].

Regulation 33 of the Habitats Regulations requires the Countryside Council for Wales (CCW) to advise the relevant authorities[5] for each European marine site in, or partly in, Wales as to "(a) the conservation objectives for that site, and (b) any operations which may cause deterioration of natural habitats or the habitats of species, or disturbance of species, for which the site has been designated." This document contains CCW's advice under Regulation 33 in relation to the *Carmarthen Bay and Estuaries* EMS.

None of the information contained in this document legally binds any organisation (including CCW) to any particular course of action. However, in exercising their functions in accordance with the requirements of the Habitats Directive, as required by the Habitats Regulations, and in accordance with government policy towards Ramsar sites, the relevant authorities should be guided by the advice contained in this document. This applies amongst other things to the establishment of a "management scheme"[6], if such a scheme is established.

Relevant authorities and others may have obligations towards the conservation of habitats and species that are not features for which the Carmarthen Bay and Estuaries EMS has been designated, and such obligations are not affected by this document.

The information contained in this document is based on best available knowledge at time of writing and is subject to review at CCW's discretion. Further guidance relating to European marine sites is published by the National Assembly for Wales (*European marine sites in England and Wales*, June 1998, Department of the Environment and Welsh Office), CCW (*European marine sites: an introduction to management*, 1998, CCW Bangor) and European Commission *Guidelines for the establishment of the Natura 2000 network in the marine environment. Application of the Habitats and Birds Directive, May 2007*.

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[1] Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (OJ No L 206)

[2] Biological diversity is defined as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems." (1992 International Convention on Biological Diversity, Article 2. http://www.biodiv.org/convention/)

[3] SI 1994/2716, HMSO, London. http://www.legislation.hmso.gov.uk/si/si1994/uksi_19942716_en_1.htm)

[4] "Marine area" is defined in Regulation 2 of the Habitats Regulations as "any land covered continuously or intermittently by tidal waters, or any part of the sea in or adjacent to Great Britain up to the seaward limit of territorial waters".

[5] The types of bodies that are "relevant authorities" are identified in Regulation 5 of the Habitats Regulations.

[6] Regulation 34 of the Habitats Regulations.

2 EXPLANATION OF THE PURPOSE AND FORMAT OF INFORMATION PROVIDED UNDER REGULATION 33

The information provided under Regulation 33 is in two parts: the conservation objectives, and the advice on operations. The legal context for each of these elements, the format of the advice and its underlying rationale are explained here. Sections 5 (conservation objectives) and 6 (operations advice) should be read in conjunction with these explanatory notes.

2.1 CONSERVATION OBJECTIVES

2.1.1 LEGAL BACKGROUND

The conservation objectives for a European marine site are intended to represent the aims of the Habitats and Birds Directives in relation to that site. The Habitats Directive requires that measures taken under it, including the designation and management of SACs, be designed to maintain or restore habitats and species of European Community importance at "favourable conservation status" (FCS), as defined in Article 1 of the Directive (see Table 1).

Table 1:
Favourable conservation status as defined in Article 1 of the Habitats Directive

Conservation status of a natural habitat means the sum of the influences acting on a natural habitat and its typical species that may affect its long-term natural distribution, structure and functions as well as the long-term survival of its typical species within the territory referred to in Article 2.

The conservative [sic] status of a natural habitat will be taken as 'favourable' when:

- its natural range and the areas it covers within that range are stable or increasing, and
- the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and
- conservation status of typical species is favourable as defined in [Article] 1(i).

Conservation status of a species means the sum of the influences acting on the species concerned that may affect the long-term natural distribution and abundance of its populations within the territory referred to in Article 2;

The conservation status will be taken as 'favourable' when:

- population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis

Guidance from the European Commission[7] indicates that the Directive intends FCS to be applied at the level of an individual site, as well as to habitats and species across their European range. Therefore, in order to properly express the aims of the Habitats Directive for an individual site, the conservation objectives for a site are essentially to maintain (or restore) the habitats and species of the site at (or to) FCS.

[7] European Commission (2000). *Managing Natura 2000 sites: the provisions of Article 6 of the Habitats Directive 92/43/EEC*. DGXI, Brussels, p.18.

2.1.2 PRACTICAL REQUIREMENTS

In practical terms, the conservation objectives for a site set the standards which must be met if the habitats and species (collectively referred to as "features") are to be at FCS. There are four elements to this. The conservation objectives must

(i) form the basis for proactively identifying what actions, if any, need to be taken by those bodies responsible for the management of operations in and around the site, in order to conserve the features.

(ii) inform the consideration of proposed developments, or "plans or projects"[8], which are likely to significantly affect the features of the site. In order for a plan or project to proceed, it must be ascertained that it will *not* adversely affect the "integrity of a site"[9]. This depends on whether or not the plan or project will adversely affect the conservation status of one or more of the features and therefore requires direct reference to the conservation objectives.

(iii) set the standard against which CCW reports to government on the conservation status of the features on the site. Government in turn will use this information, together with that from other SACs and on the status of habitats and species outside designated sites, to report to the EC on the implementation and effectiveness of the Habitats Directive.

(iv) set the standard against which the appropriateness of management can be judged. If the conservation objectives are not being met it may be due to inappropriate management of the site, or to factors originating outside the site or outside the control of those responsible for management, or a combination.

To achieve this we provide conservation objectives covering all the elements of FCS as set out in the Directive, at the same time as being suitable for guiding the preparation of management plans and testing the acceptability or otherwise of the effects of plans and projects. Table 2 indicates the various aspects of conservation status described in this package to help explain the conservation objectives. CCW also uses a related set of "performance indicators" which supports monitoring[10] and allows judgements to be made about site condition[11] and conservation status of features for purposes such as reporting and review of management.

The results of the monitoring of feature condition combined with information on security and suitability of management and the results of surveillance support the making of judgements about whether or not the conservation objectives are being met. Knowledge of the dynamics of many marine species and communities and their sensitivity is limited. Accordingly, in many cases it is not yet possible to identify values above or below which conservation status would be considered unfavourable. Surveillance[12] is necessary to:

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[8] Plans and projects are certain types of operation that the Habitats Directive and Regulations require be subject to specific procedures. Plans or projects considered likely to have a significant effect on a European (marine) site must be subject to appropriate assessment of their implications for the site in view of the site's conservation objectives. The carrying out of an appropriate assessment must include consultation with CCW, and such consultation is a separate process to the advice in this document. The information in this document is intended to assist in the identification of plans and projects which are likely to require appropriate assessments, and will form the basis for advice given by CCW in relation to individual plans and projects.

[9] "Integrity of the site" is not defined in the legislation, but has been defined by the UK government as "the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified [i.e. designated]". This definition is similar in intent to FCS.

[10] Monitoring is defined as "Surveillance undertaken to ensure that formulated standards are being maintained. The term is also applied to compliance monitoring against accepted standards to ensure that agreed or required measures are being followed." (*A statement on Common Standards Monitoring*, 1998, Joint Nature Conservation Committee, Peterborough . http://www.jncc.gov.uk/page-2198

[11] The status of the site at a particular moment in time.

[12] Surveillance is defined as "a continued programme of surveys systematically undertaken to provide a series of observations in time" (*A statement on Common Standards Monitoring*, 1998, Joint Nature Conservation Committee, Peterborough. http://www.jncc.gov.uk/page-2198

- gain a greater understanding of feature and factor variability,
- provide information which can assist in the interpretation of the results of monitoring of the performance indicators *e.g.* information on trends in other attributes and factors can assist the identification of the causes of changes observed in the performance indicators;
- improve the overall level of understanding of the site, its features and the factors affecting them.

The performance indicators and surveillance requirements for the features of the site are not included in this document. Information about these will be provided by CCW in due course.
Each of the habitat features of the SAC represents part of the range and variation of that feature within the UK and Europe. The SAC and all its features makes up part of a suite of sites across the UK that were selected to represent the range and variation of all relevant features within the UK, and to become part of the pan-European network of conservation areas – Natura 2000. Additional information about the selection of SACs in the UK is provided on the website of the Joint Nature Conservation Committee[13].

TABLE 2:
Elements of favourable conservation status described in this document to help explain the conservation objectives*

(I) For each HABITAT feature

- RANGE – including distribution and extent
- STRUCTURE & FUNCTION – including geology, sedimentology, geomorphology, hydrography & meteorology, water and sediment chemistry and biological interactions
- TYPICAL SPECIES – including species richness, population dynamics and range and as defined for species features (below)
- NATURAL PROCESSES

(II) For each SPECIES feature

- POPULATION – including size, structure, production and physiological health
- RANGE – including areas of the site which the population/individuals use
- SUPPORTING HABITATS & SPECIES – including distribution and extent, structure, function and quality and prey availability & quality.

For both habitats and species information is provided on natural processes, current condition and modifications as a result of human activity.

More detail on why these elements are important is provided in Appendix 4

*The information is limited by the availability of data and in many cases our understanding of these elements is incomplete. All descriptions are therefore based on the best available information at the time of writing.

2.2 OPERATIONS WHICH MAY CAUSE DETERIORATION OR DISTURBANCE

2.2.1 LEGAL CONTEXT

CCW's specific duty in Regulation 33 to give advice on operations that are potentially damaging, needs to be seen in the context of the Habitats Directive, which requires that for a SAC:

- the necessary conservation measures are established which correspond to the ecological requirements of the habitats and species on the site;

[13] http://www.jncc.gov.uk/page-2198

- appropriate steps are taken to avoid deterioration of habitats and significant disturbance of species.
- any plan or project which is likely to have a significant effect on a site is subject to an appropriate assessment in view of the site's conservation objectives.

The operations advice, in combination with the conservation objectives, is designed to assist relevant authorities and other decision-makers in complying with these provisions. The operations advice given in this document is without prejudice to other advice given, including the conservation objectives themselves and other advice which may be given by CCW from time to time in relation to particular operations.

The term "operations" is taken to cover all types of human activity, irrespective of whether they are under any form of regulation or management.[14] This is because the obligations in the Directive are defined by the conservation requirements of the habitats and species, not by existing regulatory or management regimes. Thus the advice contains reference to operations which may not be the responsibility of any of the relevant authorities.

2.2.2 PRACTICAL REQUIREMENTS

Operations manifest themselves through one or more factors[15]. The conservation status of a given habitat or species could potentially be affected by many different types of factor, and hence many different types of operation.[16] The key practical purpose of the Regulation 33 operations advice is to assist in the identification of priorities for management, by identifying operations to which features are both 'sensitive' and 'vulnerable'. Sensitivity is defined as 'the intrinsic intolerance of a habitat, community or individual of a species to damage from an external factor.' Vulnerability is defined as 'the likelihood of exposure of a habitat, community or individual of a species to a factor to which it is sensitive'.[17] Thus the potential for an operation to deteriorate or disturb a feature depends both on the sensitivity of the feature to the operation – through its associated factors - and the location, intensity, duration and frequency of the operation and the factors that it affects or causes.

Formulating the operations advice has three main elements:

1. Identifying factors to which the features are sensitive.
2. Identifying the types of operation that can cause or affect those factors.
3. Assessing the likelihood of those factors (and hence the features) being affected by those operations, in other words the vulnerability of the feature to those effects.

The first and second of these elements relies on current understanding of the inherent sensitivity of features to particular factors, and the effect of operations on factors. Although there will be site-specific elements to this information, it may often rely on information from a variety of sources which are not specific to this site. The third stage is very site-specific, relying on information about the types, location, intensity, duration and so on, of operations occurring or likely to occur in or around the site.

Given that in many cases, information of the type indicated in the previous paragraph is rudimentary, or simply not available a precautionary approach is adopted for the identification of factors and

[14] The term also includes what the Habitats Directive and Regulations call "plans and projects" (see footnote 9).

[15] A factor is defined as "A component of the physical, chemical, ecological or human environment that may be influenced by a natural event or a human activity" (*Sensitivity and mapping of inshore marine biotopes in the southern Irish Sea (Sensmap): Final report.* CCW, Bangor, December 2000.)

[16] The complexity of formulating operations advice is compounded by the "many-to-many" relationship that exists between operations and factors, where an operation may manifest itself through several factors, and a factor may be affected by several operations, in different ways and to different magnitudes.

[17] Adapted from Hiscock, K. [ed] 1996. *Marine Nature Conservation Review: rationale and methods.* Peterborough: JNCC.

operations. This means that where there is uncertainty about the relevance or otherwise of a factor or operation, CCW favours including it in Regulation 33 advice. The output from this process is a list of operations that CCW considers may cause deterioration or disturbance to the features of the site, with accompanying information on the factors through which the each operation affects the feature. The operations advice clearly has to be based on the best available knowledge at the time and is subject to continual review. It necessarily involves an element of risk assessment, both in terms of assessing the likelihood of an operation or factor occurring, and the likelihood of it having an adverse effect on a feature.

CCW's advice to the relevant authorities is that, as a minimum, the extent and management of the operations identified in Section 6 should be reviewed in the context of the conservation objectives. The list should also help identify the types of plans or projects that would be likely to have a significant effect and should be subject to appropriate assessment, noting that such judgements will need to be made on a case-specific basis.

The advice in Section 6 of this document is not a list of prohibited operations, or operations necessarily requiring consultation with CCW, or CCW's consent[18]. The input of the relevant authorities and others is a legal and practical necessity in determining the management needs of the site. Thus, the operations advice is provided specifically with the intention of initiating dialogue between CCW and the relevant authorities.

[18] However, in relation to land included within the SAC, which has been notified as a Site of Special Scientific Interest (SSSI), owners or occupiers require CCW's consent for any operations included in the SSSI notification, and statutory bodies intending to carry out or permit potentially damaging operations must notify CCW and comply with certain other provisions. (Wildlife and Countryside Act 1981, section 28, as amended by the Countryside and Rights of Way Act 2000, section 75). General guidance on the operation of SSSIs is given in the CCW leaflet *Sites of Special Scientific Interest: A guide for landowners and occupiers* (Countryside Council for Wales, Bangor, 2001).

3 SITE DESCRIPTION

3.1 INTRODUCTION

The Carmarthen Bay and Estuaries SAC is a large site encompassing the estuaries of the Rivers Loughor, Tâf and Tywi (coastal plain estuaries) and the Gwendraeth (a bar-built estuary) (Map 1). There are extensive areas of intertidal mudflats and sandflats with large areas of these flats dominated by bivalves. There is a complete sequence of saltmarsh vegetation, from pioneer vegetation through to upper saltmarsh transitions and it is also important for transitions from saltmarsh to sand dune and other habitats. Carmarthen Bay is an extensive shallow bay with a wide variety of seabed types, including mud, sand and rock, although the majority of the seabed is sandy. The SAC includes Helwick Bank, a linear shallow subtidal sandbank that is unusual in being highly exposed to wave and tidal action. The Burry Inlet and Three Rivers system provides a migratory route for salmonids, lampreys and shad.

The Carmarthen Bay and Estuaries SAC is a multiple interest site which has been selected for the presence of ten interest features that qualify under Annex I and Annex II of the Habitats Directive. For the qualifying habitats and species the SAC is considered to be one of the best areas in the UK for:

- Estuaries
- Mudflats and sandflats not covered by seawater at low tide
- Atlantic saltmeadows (*Glauco-Puccinellietalia maritimae*)
- *Salicornia* and other annuals colonising mud and sand
- Large shallow inlets and bays
- Sandbanks which are slightly covered by sea water all the time
- *Alosa* sp. – shad

and to support a significant presence of:

- *Lampetra fluviatilis* – river lamprey
- *Petromyzon marinus* – sea lamprey
- *Lutra lutra* - otter

The features are distributed throughout the SAC with no single feature occupying the entire SAC and with features overlapping in some locations. The SAC boundary and the general location of the Annex I habitat features are shown in Maps 1 & 3. The latter is an indicative map as the extent of most features is not known precisely and some, such as sandbanks, are dynamic and can be highly mobile. A number of habitats and species also have Biodiversity Action Plans or are on other lists specifying conservation action such as, 'Nationally Rare and Scarce Species'.

Two Special Protection Areas occur within the Carmarthen Bay and Estuaries SAC; Carmarthen Bay SPA, and Burry Inlet SPA and Ramsar site (Map 2 ii).

3.1.1 SOURCES AND LIMITATIONS OF SITE INFORMATION

All feature descriptions are based on best available knowledge at the present time and in some cases this is limited. For example no information is available on the composition of fauna and other flora associated with the Atlantic salt meadows saltmarsh communities. Maps showing the distribution of the habitats are indicative only and the feature descriptions are provided on the basis of current knowledge and may be subject to change as knowledge improves.

3.2 SUMMARY SITE DESCRIPTION

The Carmarthen Bay & Estuaries SAC encompasses areas of sea, coast and estuary that support a wide range of different marine habitats and wildlife, some of which are unique in Wales.

In places the SAC landward boundary abuts the boundary of SACs encompassing terrestrial / coastal habitats and species and some intertidal areas that are part of the marine SAC have been notified as Sites of Special Scientific Interest (SSSI) (see Appendix 2). The health of adjacent areas such as the Carmarthen Bay Dunes SAC is intimately linked with that of the estuaries and intertidal areas. The Carmarthen Bay SAC also overlaps wholly or in part with the Burry Inlet and the Carmarthen Bay Special Protection Areas classified under the Birds Directive. The location of these SACs , SPAs and SSSIs are shown in Map 2. Carmarthen Bay is also a Geological Conservation Review site for its Coastal Geomorphology.

All references to depths should be taken as Below Chart Datum (BCD) unless stated otherwise.

a) Range

The Carmarthen Bay & Estuaries SAC covers an area from St.Catherine's Island in the east to just west of Oxwich encompassing the Three Rivers area (Rivers Taf, Tywi and Gwendraeth), the Burry Inlet and Loughor Estuary, and the northern and western parts of the Gower peninsula. It extends out into Carmarthen Bay and includes the Helwick Bank which lies within the Bristol Channel (Map 1).

The features for which the site was selected are distributed throughout the SAC, with no single feature occupying the entire SAC and with some features overlapping in certain locations (Map 3).

b) Structure

i. Geology

Carmarthen Bay was created primarily by the underlying geological features and then infilled with the prevailing mobile substrata and modified by the hydrographic regime. The Bay is underlain and partially bound by Carboniferous and Devonian limestones and sandstones. There are small areas of natural hard substrata in the intertidal zone including bedrock (Wharley Point), scars of cobbles and boulders (Wharley Point, Ferryside, Salmon Point Scar, Whiteford) and mussel beds on cobbles (Salmon Point Scar, Ginst Point, Whiteford Point), but these are poorly represented compared with other inlets in Wales.

ii. Sedimentology

The shores of South Beach (Tenby), Waterwynch Bay, Monkstone beach and Cefn Sidan sands, between the Three River system and the Burry Inlet, are mainly mobile fine and medium sands while the mudflats and sandflats of the Three Rivers system and that of the Burry Inlet and River Loughor are mostly sandy gravel or muddy sand. Sheltered sandy gravel shores are found from the edge of Pendine Sands, stretching around into the mouth of the Three Rivers system, where a variety of different sediment types are found. The mouth of the Three Rivers system is dominated by moderately mobile fine sands that are continually shifted by waves and tidal action and Mid-Flandrian peats are present intertidally and subtidally in this system.

Sediment types range from mobile fine and medium sands, muddy sands, sandy and silty muds, and pure muds, to limited areas of exposed immobilised sandy and / or muddy gravel pavements of glacial provenance. There is a gradation within the distribution of sediments, from mud in the upper, more sheltered regions of the estuaries, to sand at the more wave-exposed mouths of the estuaries. Inputs of fine sediments from rivers into all of the estuaries are small, compared to other sources such as inward migration from the sea.

The seabed sediments of the Helwick Bank area are predominantly uniform, medium fine sands with little or no fine or organic material. The more landward side of Helwick Bank is comprised of finer sands. To the south of the Bank, in deeper water, there are some uniform gravelly sands with no bedforms, as well as irregular sand patches on gravel.

iii. Geomorphology
Carmarthen Bay is an excellent example of a coastline whose outline was moulded by marine and sub-aerial processes throughout the Quaternary period, but where the shoreline and its detail is much more recent in origin. The modern shoreline is a very dynamic one, as a result of the growth of spits, dune and saltmarsh development, changes in intertidal and deeper water bathymetry and erosion of both beaches and cliffs (Geological Conservation Review). There are four estuaries in the SAC formed by the rivers Tywi, Taf, Gwendraeth and Loughor. They form a single functional unit with important interchanges of sediment and biota especially within the 'Three Rivers' which converge and exit into Carmarthen Bay through a common mouth. There has been considerable sedimentation in the Three Rivers and Burry Inlet during and since the rise in sea level in the post-glacial era. The intertidal and subtidal sediments are thought to be derived largely from Carmarthen Bay.

The mudflats and sandflats range from narrow beaches to very expansive areas of gently sloping, almost horizontal, flats, to steeply inclined levees. Many of the saltmarshes are dissected by small creeks and channels, which provide microhabitats within more uniform areas of marsh. Saltpans and small pools add diversity to the site, and are an intrinsic part of many marshes. An important feature of the site is the undisturbed transition to coastal habitats in some areas. The marshes on the southern side of the Burry Inlet between Whiteford Point and Loughor in particular are of national significance in respect of a variety of geomorphological features.

Helwick sandbank is located in open water to the south of Worms Head off the Gower Peninsula. The feature is a linear, very shallow, subtidal sandbank that is the most highly exposed to wave and tidal action of all the Welsh sandbanks.

c) Function
i. Hydrography and meteorology
The SAC is characterised by largely mixed, variable salinity water typical of macrotidal estuaries, and in Carmarthen Bay salinity varies from low to fully marine. During spring tides the tidal range is around 7.5 m at Burry Port, whereas during neap tides it is around 3.6 m. At Ferryside on the Tywi the tidal rage at spring tides is 6.6 m and 2.7 m during neap tides. The tidal range decreases up estuary and the bathymetry of the Loughor Estuary causes a lag time in the progression of the flood tide up the estuary. In the Burry the tidal wave is symmetrical near the mouth but increasingly asymmetrical away from the mouth with the ebb becoming increasingly longer than the flood tide. This results in greater velocities on the flood than the ebb which affects sediment transport. The shallow gradients within the estuary result in large areas of intertidal flats and salt marsh within the estuary.

ii. Water and sediment chemistry
Water quality has been classified as grade A (EAW year 2000 figures) in the Three Rivers system, apart from the upper reaches of the Tywi estuary that has been classified grade B. The Loughor estuary has a water quality rating A. Available nitrogen and phosphorus levels are in excess of the criterion indicating hypernutrification in the upper estuary which has been linked to high numbers of algal cells and chlorophyll *a* concentrations. In addition, there have been inputs of heavy metals from industry and redundant coalmines in the estuaries.

iii Sediment processes
Within the estuaries the extensive sandflats above the mid-shore are fairly stable and flat. Below this the sandflats up to and beyond Loughor bridge are very mobile with large sandwaves and ripples. Sandbanks in the entrance are particularly mobile.

d) Typical species
A variety of intertidal and sublittoral biotopes are present reflecting the range of physiographic conditions. The estuaries of this site support a range of subtidal and intertidal sediments that grade

from sand at the mouth to mudflats in the upper estuary. The fauna of the sediments varies, but includes communities with polychaete and oligochaete worms and areas with extensive cockle beds. The populations of the cockle *Cerastoderma edule* in the Burry Inlet and the Three Rivers are very large compared with other similar estuaries such as the Taw/Torridge and Camel.

The intertidal rock biotopes are subject to sand scour resulting in low species diversity but support barnacles and mussels as well as brown seaweeds on more sheltered cobble areas. Some areas of soft sediment, such as in the Burry inlet support marine communities characterised by the dwarf seagrass *Zostera noltei*. Seagrass stabilises the sediment and is an important source of organic matter as well as providing shelter and surface for attachment by other species and food for wildfowl. The intertidal soft sediment coastline of Carmarthen Bay is characterised by extensive and substantial strandlines with a wealth of invertebrate fauna.

Subtidal habitats are of limited extent due to the estuaries largely draining at low tide. The mobile, sandy sediments are characterised by the presence of low numbers of amphipods, isopods and robust, mobile polychaetes. Species found on the Helwick Bank are mostly characteristic of mobile sands and gravels.

The estuary systems have exceptionally well developed saltmarsh to sand dune transitions, with a complete sequence of saltmarsh vegetation, including transitions to upper saltmeadow and to important sand dune habitats.

3.3 BURRY INLET SPA AND RAMSAR SITE

In 1992 the Burry Inlet was recommended as a Special Protection Area under the Birds Directive (79/409/EEC) because of the site's European ornithological interest. The site qualifies under Article 4.2 of the Directive as it is used regularly by 1 % or more of the biogeographic population of regularly occurring migratory species: knot *Calidris canutus*, oystercatcher *Haematopus ostralegus*, pintail *Anas acuta*, and redshank *Tringa totanus*.

The area qualifies under Article 4.2 of the Directive by regularly supporting at least 20,000 waterfowl, including: curlew *Numenius arquata*, dunlin *Calidris alpina alpina*, grey plover *Pluviatilis squatarola*, shelduck *Tadorna tadorna*, shoveler *Anas clypeata*, teal *Anas crecca*, turnstone *Arenaria interpres*, and wigeon *Anas penelope*[19].

The *Burry Inlet SPA* regularly supports large numbers of overwintering wildfowl and waders that feed in the saltmarshes and on the intertidal areas and is the most important wholly Welsh estuary for overwintering waterfowl and is particularly significant for oystercatcher.

- The site is used regularly by *ca.* 1.6 % of the biogeographic population of migratory and overwintering **oystercatcher**. The 5 year peak mean for 1991/92-1995/96 was 13,590 individuals.
- The site is used regularly by *ca.* 3.0 % of the biogeographic population of migratory and overwintering **pintail**. The 5 year peak mean for 1991/92-1995/96 was 1,772 individuals.
- The *Burry Inlet SPA* is used regularly by *ca.* 0.6 % of the biogeographic population of migratory and overwintering **knot**. The 5 year peak mean for 1991/92-1995/96 was 2,153 individuals.

[19] CCW's advice focuses on the qualifying species for which the SPA was originally classified in 1992, despite the fact that numbers and species composition may have changed on this site since that time. Such population and species composition changes have been documented through the UK SPA Network Review, led by JNCC, which will provide advice to Ministers on any changes in SPA citations required. Depending on the outcome of this review and decisions from DETR and the Welsh Assembly Government, CCW may need to reissue this advice with updated bird information required.

- The *Burry Inlet SPA* is used regularly by *ca.* 0.3 % of the biogeographic population of migratory and overwintering **redshank**. The 5 year peak mean for 1991/92-1995/96 was 616 individuals.

A 5 year mean peak count in excess of 34,960 waterfowl has been recorded (30/06/1999). Waterfowl assemblage species include curlew *Numenius arquata*, dunlin *Calidris alpina alpina*, grey plover *Pluviatilis squatarola*, knot *Calidris canutus*, oystercatcher *Haematopus ostralegus,* pintail *Anas acuta*, redshank *Tringa tetanus*, shelduck *Tadorna tadorna*, shoveler *Anas clypeata*, teal *Anas crecca*, turnstone *Arenaria interpres*, and wigeon *Anas penelope*.

The Burry Inlet is a large estuarine complex; it includes extensive areas of intertidal sand- and mudflats, together with large sand dune systems at the mouth of the estuary. The site contains the largest continuous area of saltmarsh in Wales (2,200 ha). The estuary experiences wide tidal fluctuations (about 8 m), which has the consequence of exposing a large extent of intertidal sediments on a regular basis. These are mostly sandy, but muddy substrates are to be found in more sheltered areas. The plethora of habitats provides for important feeding grounds and resting areas. In places, the extensive mud and sandflats support substantial populations of marine invertebrate species, which provide an important food source for the large numbers of overwintering waterfowl found here.

Specialist feeders such as oystercatcher and knot that feed exclusively on shellfish (cockle *Cerastoderma edulis* and mussel *Mytilus edulis*) outside the breeding season can be vulnerable if in competition with the commercial exploitation of these resources. There is a well established, very intensive hand-gathering cockle fishery in the Burry Inlet, and an increasing demand for mussel seed (for relaying) from the area. One policy to prevent shellfishing from harming birds is to ensure that enough food remains after harvesting to meet most or all of their energy demands. Using simulations with behaviour-based models of the Burry Inlet, Goss-Custard *et al.* (2003) showed that even leaving enough shellfish to meet 100 % of the birds' demands may fail to ensure that birds survive in good condition. Although shellfish may be sufficiently abundant, the actual distribution and density of cockle / mussel beds meant that the birds couldn't consume all these cockles. Increased cockle abundance may not actually help – it is available foraging area that is important. There is also a problem that if birds are displaced by the fishermen – they will then feed in the remaining areas at higher (bird) density and therefore lower efficiency.

Site visits have established a generally lively pattern of flight lines along and across both shorelines and estuary.

3.4. CARMARTHEN BAY SPA

Carmarthen Bay has been designated as a Special Protection Area under the Birds Directive (79/409/EEC) because of the site's European ornithological interest. The site qualifies under Article 4.2 of the Directive as it is used regularly by 1 % or more of the biogeographic population of a regularly occurring migratory species: common scoter *Melanitta nigra*. Non-qualifying species of interest are red throated diver *Gavia stellata*, velvet scoter *Melanitta fusca*, eider *Somateria mollissima*, Manx shearwater *Puffinus puffinus*.

The *Carmarthen Bay SPA* is used regularly by *ca.* 1.1 % of the biogeographic population of migratory and overwintering common scoter. The 5-year peak mean for 1997/98 to 2001/02 was 16,946 individuals with the biogeographic population estimated to comprise of 1.6 million individuals. Within the U.K, Carmarthen Bay is the most important site for migratory and overwintering common scoter.

The first record of common scoter in Carmarthen Bay was made in 1938, when "1000+" were seen off Cefn Sidan .Until recently records were sporadic, often consisting of only partial counts of the Bay. These records showed the number of scoters in the bay to be very variable, probably due to differing census areas as well as reflecting actual changes in scoter numbers. However, data from

1995 to present day show that Carmarthen Bay is regularly used by large numbers of common scoter. Peak counts include 25,000 in 1974 (Sutcliffe, boat count), 19,700 in 1999, and 22,000 in 2000. Aerial surveys of the Bay have been conducted in the past. These provided quick, extensive coverage of the Bay, although ground counts in the northern part of the Bay revealed significantly larger numbers of ducks than aerial counts, indicating that birds are missed from the air
Regular land-based observations of common scoter in Carmarthen bay, particularly since the late 1990s, have established a reasonably regular pattern of numbers and distribution during the course of the winter (L. Smith pers. obs.).

Common scoter return to Carmarthen Bay in late July to early September. There are two peaks, the first relatively small in August/September as birds arrive either straight from breeding grounds or from other staging areas, when birds may moult at the site, the second (normally providing the largest annual numbers) occurring in mid to late winter (December to January). Numbers then fall as scoter start their spring migration to breeding grounds.

The timing of first arrival, the two peaks and eventual departure vary from year to year, probably in response to weather conditions and food availability at other sites in the range. Distribution of common scoter in the Bay also varies within and between years, presumably due primarily to local food availability (and particularly the spat-fall of favoured prey species). Weather and disturbance may also influence the pattern observed on individual days, although the effect of these factors is likely to be more short-lived.

The number of scoter in August 2001 was higher than in previous years, having ranged between 137 and 2,048 over the last five years (WWT Wetlands Advisory Service 2000). The concentration of the 7,299 birds in the east of the Bay, particularly around Pembrey (with only 400 in the north) contrasts with the previous three years, when, although there were far fewer scoter, the majority were located in the north. Although there was a slight decrease in September, numbers were again much higher than previous September counts (range 1,000-4,000), and may have resulted from an earlier than normal westward migration from core areas (perhaps due to weather or low food abundance). There is a fairly even distribution of Common scoter in the north (1998 &1999) or the east (1997 & 2000).

The October total of just under 5,000 compares with October peaks in the preceding two winters of approximately 19,000. Other October counts in those years, however, show much smaller numbers (*ca*. 3,000), immediately prior the main winter arrival. The dip in counts at this time suggests that the initial influx of scoter to Carmarthen Bay is of birds which then move to more southerly wintering areas, replaced by a different sub-population during the winter months. Distribution remained similar to September and to previous October counts. Rhosilli supported very few scoter, although large numbers have only been recorded in this part of the Bay in the two years following the *Sea Empress* oil spill when western areas of the Bay were affected by oil.

The November count recorded much higher numbers, consistent with the arrival of the second influx of scoter (numbers having ranged between 2,721 and 19,710 in previous winters). Although the majority of birds were in the north, Pembrey again held a larger proportion than is usual for November. Counts in December were relatively unchanged and consistent with previous years (12,361 to 13,528). There was, however, a markedly dense concentration, particularly two 2x1 km cells, off Pembrey. Scoter in the north were more evenly spread, the distribution extending east towards Amroth as in previous Decembers. No count was made in January due to consistently poor weather. It should be noted that, in most previous years, the peak count has occurred in this month. February's count of 20,078 was much higher than past counts for this month (range 3,200 to 8,600), the majority in the north (15,650) and fairly close inshore. Numbers remained much higher than normal in March (usually 2,900 to 8,600), although 10,631 were recorded in March 1996, the peak count of that year. Distribution remained very similar to February.

Scoter numbers in Carmarthen Bay in winter 2001/02 were thus somewhat unusual, with higher numbers at the start and end of the late summer/winter period than in previous years. Pembrey held

proportionally more birds than in previous winters, with very concentrated flocks in two 2x1 km cells suggesting perhaps high food abundance in this location, although the observed distribution may have also been an effect of more temporary factors (*e.g.* disturbance) and more frequent observations would have been required to confirm the consistency of this pattern.

Despite small onshore and offshore movements throughout the season, comparison of the distribution maps with the bathymetry indicated on admiralty charts shows that water depth of preferred areas has remained constant: less than 2 m at Pembrey, and less than 5 m in the north of the Bay.

The total number of common scoter observed in Carmarthen Bay 2001/02 exceeded the international 1 % threshold for common scoter (16,000, Wetlands International 2002) and was the third winter in succession that this threshold had been exceeded (L. Smith pers. comm.). Counts in the two winters prior to this (1996/97 and 1997/98) were much lower, following the Sea Empress oil spill. There has been a recovery in numbers subsequently, and the counts obtained in recent years have provided justification for designation of the site as the first UK marine SPA, which was undertaken in 2003.

Numbers of common scoter using the Bay vary throughout and between years. In summer numbers are generally very low as most scoters have migrated to breeding grounds. However, there are occasional records of very large numbers, *e.g.* 10,000 in July 1976. Scoter start returning from breeding grounds in July-August, leading to a peak in numbers in August. The August peak is probably due to scoter passing through to more southerly overwintering grounds, and is typically followed by reduced numbers through September to October. Numbers build again through November, and the annual peak is typically in December–January. From late January numbers slowly decrease until late April, by when most birds have left. Distribution of birds throughout the Bay also changes through the year. In late summer, Cefn Sidan and Pembrey are both very important sites in terms of numbers of scoter, but through the rest of the year Pendine to Amroth is the most favoured area. Lovegrove (1977) reported the preferred areas to be Cefn Sidan / Burry Inlet throughout the season. Whether this is due to genuine changes in distribution of overwintering flocks or to bias in the sampling method is hard to assess. There is probably much movement between sites, and changes in favoured sites, especially from year to year.

The ratio of males to females changes through the season. In late summer there is a strong dominance of males; ratios greater than 9:1 have been recorded as males head south from breeding grounds before females. The number of females increases through to mid-winter when there can be 65 % females and immature birds

Carmarthen Bay is a wide, shallow bay west of the Gower Peninsula. It is approximately 28 km from east to west by 20 km north to south. The surrounding coastline consists of extensive sandflats and dunes to the northeast, and cliffs to the west and southeast. Four important estuaries with sand, mud and saltmarsh habitats flow into the bay.

With its apex in the southwest, the arc of Carmarthen Bay forms a regularly sloping amphitheatre from around 30 m to the shore. The seabed between the 2 m and 10 m isobaths stretches uninterrupted from Worms Head in the east around to Caldey Island in the west, seemingly unaffected by the river channels of the Loughor and the Three Rivers System. An interesting feature off Rhossili Bay is the area of shallowly sloping seabed stretching to the southwest below the 10 m isobath. This area forms a relatively steep sided shelf whose contours are generally 5 m shallower than those parallel to it. To the immediate east of Caldey Island there is a fairly steep drop into deeper water.

The shallow nature of the Bay suits common scoter, which typically occupy waters less than 10 m in depth, allowing them to feed on benthic communities (on and within sand dominated bottom sediments) up to 10 km offshore.

The sediment throughout the Bay varies from clean sand, from Caldey to West Gower, with mixed muddy grounds and muddy sands to the south and west .The seafloor of Carmarthen Bay consists of

wide areas of fine and medium sand interspersed with patches of finer and coarse material. Patches of coarse material and hard ground are found in deeper water and in areas subject to current scour; foremost to mention the areas around Caldey Island and Worms Head. The inshore areas of Saundersfoot Bay are characterised by very fine sand, with further patches also apparent in Rhossili Bay. There are a series of mud and fine sand patches running parallel to the shelf feature described above. The deposition of mud and fine material and general orientation would suggest that they are under the influence of the Loughor Estuary outflow.

Outside the breeding period, common scoter are predominantly marine, resting and feeding in flocks in shallow, inshore waters, generally 500 m to *ca*. 2 km from land, where depth not more than 10 to 20 m and animal food are abundantly accessible. In such conditions scoter are exposed to strong wave action or rapid currents, but more rugged, sheltered coastlines rarely fulfil their requirements.

Feeding areas of the common scoter in Carmarthen Bay have been identified previously. These sites lie in an area starting at Monkstone Point in the west, stretching off Saundersfoot and Amroth, to Pendine Sands in the east, broadly corresponding to an area between the 2 and 5 metre depth isobaths. A smaller number of birds have also been recorded in deeper water (12 to 16 m) off Rhossili Bay / Worms Head.

The potential feeding area (based on distribution and abundance of prey species) within the *Carmarthen Bay SPA* is large, from north of a line stretching east from Tenby across the Bay towards Burry Holms, stopping at a point approximately 8 km south of Pembrey Sands. The majority of this area is above the 10 m isobath, well within the diving ability of the common scoter. A review of nine common scoter diet studies observed that although common scoters take a wide variety of prey items (43 taxa in total), molluscs, and particularly bivalves, were prevalent in all studies. Sizes of prey were reported to range from 7.7 mm to 40 mm shell length.

In marine and brackish-water areas, scoter feed especially on blue mussel *Mytilus edulis*, fewer cockles *Cardium*, clams *Mya* and *Spisula* and other bivalves (*Venus*, *Tellina*, *Macoma*, *Solen*, *Venerupis*, *Cyprina*, *Nucula*, *Saxicava*), and gastropods, dogwhelk *Nassa recitulata*, periwinkles *Littorina*, and laver snails *Hydrobia*. They feed occasionally on crustaceans, particularly isopods (*Idotea*), amphipods (shrimps *Gammarus*), and small crabs (*Carcinus*); annelids (polychaetes); and echinoderms.

In Carmarthen Bay, the largest and most widespread group of benthic invertebrates is characterised by the polychaetes *Spiophanes bombyx*, *Magelona filiformis* and *Chaetozone setosa*, the bivalves *Fabulina fabula*, *Mysella bidentata* and *Chamelea gallina*, and the amphipod *Bathyporeia tenuipes*. This group is classified as belonging to the *Tellina* sub-community of the Shallow *Venus* community with the main biotope being "Sublittoral sand and non-cohesive muddy sand, *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves in infralittoral compacted fine sand". The above invertebrates, foremost the bivalves, are thought to form a good source of food for the scoter in the *Carmarthen Bay SPA*. However, the patchy distribution of prey species, especially those of larger year classes, may be pertinent to the distribution of the common scoter in the *Carmarthen Bay SPA.*

Past records have indicated that birds present in August are moulting. It has been suggested that Cefn Sidan is an important moult site in the Bay, although Woolmer *et al*. (2001) saw no evidence of large numbers of moulting birds. One possible reason for preference by scoter for the east at this time, rather than the mid-north, which is the preferred area throughout the rest of the year, may be its relative lack of marine disturbance. Sea duck prefer areas with low frequency of disturbance by man. This is especially true whilst birds are moulting, when they are particularly vulnerable through their inability to fly. During moult, birds need areas with low disturbance and abundant food although disturbance was suggested to be an important factor determining scoter distribution in a study which failed to find a relationship between scoter and benthic community distribution. The greater usage of Cefn Sidan in the moult period may be explained by the relative lack of disturbance at this site compared to the Pendine to Amroth area.

Common scoter often fly in long formations, and normally at low altitude, but they fly fairly high overland. Between July and October, scoter undergo a post-breeding moult, with males moulting about one month before females. During this moult they shed their flight feathers, and so cannot fly

3.5 OPERATIONS WITHIN THE SAC

The area surrounding Carmarthen Bay and its estuaries is predominantly rural with a relatively small and steadily declining heavy industry centred at Llanelli. The site and surrounding coastline is heavily used for a wide range of commercial and recreational activities. The major coastal settlements include Tenby, Burry Port, Llanelli, Loughor and West Swansea, with Tenby, Saundersfoot and Pendine being tourism hotspots. The coastal settlements give rise to localised pressures on the marine environment.

Extensive reclamation of saltmarshes, undertaken chiefly in the 19th Century, has taken place along the southern shoreline of the Burry Inlet and along the Taf Estuary. Sea defences, including sea walls, rock armour, gabions and groynes, now bound significant stretches of the bay and its estuaries. In addition, protection of coastal railway tracks that straddle the north coast of the Burry Inlet between Llanelli and Burry Port, and between Kidwelly and Ferryside, also act as coastal defences and prevent the inland migration of coastal habitats under a rise in relative sea level.

Aggregate extraction takes place at Helwick Bank which was granted a 7-year license to dredge at a rate of 150,000 tonnes per annum. The saltmarshes found exclusively within the estuaries are extensively grazed, at times, at great intensity.

There are small to medium-scale harbour facilities at Llanelli, Burry Port, Tenby and Saundersfoot, with the total number of moorings (including at Llansteffan, Ferryside and Loughor) approaching 1,000. Some approaches and navigations channels into these facilities are being maintenance-dredged intermittently. Some of the arisings are being used locally at Tenby and Saundersfoot for beach recharge.

Recreational boating of a variety of types is popular throughout the EMS, including sailing, low and high-powered craft (including jet-skis), kayaking and kite surfing. Recreational sea angling is also extremely popular and takes place from the shore and from boats, with a number of charter boats operating within the EMS. Levels of bait collection, including for a variety of marine worms and soft shelled ‘peeler’ crab, are consequently high.

There have been historical changes in sewage treatment and disposal. A historical long-term increase was followed by a relatively recent decrease in solids and nutrients outputs, and changes in disposal points. Most recently there have been short-term variations in discharge locations, volumes and treatment, reportedly with more less-treated outputs via CSOs. Several estuaries are hypertrophic.

The area is very important for commercial shellfish and finfish fisheries. The Burry Inlet cockle fishery is regulated whilst commercial cockle gathering operations in the Three Rivers Estuary and western Carmarthen Bay are not. Since 2004, cockle mass-mortalities have occurred annually for as yet unknown reason(s). Consequently mussel and mussel seed fisheries have intensified and become increasingly more important. Capture fisheries take place for a variety of species including crabs, lobsters, whelks, bass and various flatfish, including rays.

3.6 MODIFICATIONS AS A RESULT OF HUMAN ACTIVITY

Many anthropogenic activities have the potential to affect the structural and functional characteristics of the SAC and these effects are considered to be *significant* where a subsequent detrimental impact

on the species and communities associated with the five habitat features of the SAC would result. An assessment of the conservation status of each of the habitat features was first reported in 2001 and then again in 2007[20].

Various anthropogenic activities currently taking place within the EMS have an influence on the habitat and species features and Section 6 provides additional information on the ways in which activities might affect the features. Some of the activities will have a direct effect whilst others will have an indirect effect, by altering or modifying the physical, chemical and environmental factors and processes (structural and functional characteristics) which affect the habitats and species. Whilst the structural and functional characteristics of the EMS and its habitat and species features are inherently important attributes of the marine ecosystem, it is the effect that these characteristics have on the wildlife of the EMS that is of conservation importance.

Many activities have the potential to create pressure or threat by causing direct damage to habitats, or disturbance to wildlife, for example from noise or high speed activity, or by competing with wildlife for space. Activities currently believed to be actual or potential threats, and either requiring better management or further investigation include (not in any particular order):

- Aggregate extraction
- Levels of exploitation of ecologically important shellfish species (e.g. cockles, mussels and mussel seed, whelks)
- Molluscan shellfish culture ('ranching')
- Creation & maintenance of hard engineered coastal defence works
- Land claim
- Over-grazing
- Bait collection, particularly digging
- High speed power craft (including PWCs)
- Disposal of wastes & debris
- Military activity

In addition to human activities that directly put pressure on and threaten wildlife and their habitats, there are other potential threats to the long term sustainability of marine habitats and wildlife. These are both global and local, and may be indirectly caused or influenced by human activity and include:

- Sea level rise
- Coastal 'squeeze'
- Inadequate fisheries management capability
- Mass mollusc (cockle) mortality events
- Water quality and nutrient enrichment
- Urban water run-off
- Waste & debris
- Modifications to sediment transport
- Short term planning policies and unsustainable development
- Poor public awareness, understanding or interest

Development and management of activities must take account of the EMS, and thus contribute to enabling people and wildlife to co-exist in harmony. However, more information is needed on the distribution, timing and intensity of all activities, but in particular on:

- All forms of commercial fishing
- Angling
- Bait collection of all kinds

[20] Joint Nature Conservation Committee. 2007. Second Report by the UK under Article 17 on the implementation of the Habitats Directive from January 2001 to December 2006. Peterborough: JNCC. Available from: www.jncc.gov.uk/article17

- Recreational high speed boating and water-sports
- Off-road motor sports in intertidal areas
- Unregulated wildfowling
- Unregulated rubbish disposal (fly-tipping)
- Unregulated foreshore development
- Unregulated coastal protection & land claim
- Vessel maintenance (including cleaning and painting antifouling)
- Marine wildlife watching / 'eco-tourism'
- Scientific research
- Marine wildlife welfare

Many anthropogenic activities have the potential to affect the structural and functional characteristics of the EMS and these effects are considered to be significant where a subsequent detrimental impact on the species and communities associated with the habitat and species features would result.

4 FEATURE DESCRIPTIONS

4.1 ESTUARIES

Estuaries are defined in the EU Habitats Interpretation Manual[21] as:

"Downstream part of a river valley, subject to the tide and extending from the limit of brackish waters. River estuaries are coastal inlets where, unlike 'large shallow inlets and bays' there is generally a substantial freshwater influence. The mixing of freshwater and seawater and the reduced current flows in the shelter of the estuary lead to deposition of fine sediments, often forming extensive intertidal mud and sand-flats. Where the tidal currents are faster than flood tides, most sediments deposit to form a delta at the mouth of the estuary."

"An estuary forms an ecological unit with the surrounding terrestrial coastal habitat types"

There are four major types of estuary recognised within the EC definition:

1. Coastal plain estuaries: formed where pre-existing valleys were flooded at the end of the last glaciation and usually less than 30m deep, with a large width-to-depth ratio. The main sub-type of estuary, by area, in the UK.

2. Bar-built estuaries: characteristically have a sediment bar across their mouth and are partially drowned river valleys that have subsequently been inundated. Bar-built estuaries tend to be small but are widespread around the UK coast.

3. Complex estuaries: formed by a variety of physical influences, such as glaciation, river erosion, sea-level change and geological constraints from hard rock outcrops. There are few examples of this sub-type of estuary in the UK.

4. Ria estuaries: drowned river valleys, characteristically found in south-west Britain. The estuarine part of these systems is usually restricted to the upper reaches. The outer parts of these systems are little diluted by freshwater and typically conform to Annex I type 'large shallow inlets and bays'.

Estuaries are widespread throughout the Atlantic coasts of Europe, but approximately one quarter of the area of estuaries in north-western Europe occurs in the UK. The Carmarthen Bay and Estuaries SAC includes coastal plain and bar built estuaries.

4.1.1 Range

[21] Interpretation Manual of European Union Habitats. EUR27, July 2007. European Commission. DG Environment.

Carmarthen Bay & Estuaries SAC is a large estuarine site, encompassing the estuaries of the Rivers Tâf , Tywi, Gwendraeth and Loughor (Burry Inlet). Together they form a single functional unit around the Burry Inlet, with important interchanges of sediment and biota and represent approximately 3.4 % of the UK SAC "**estuary**" resource. The total extent of the intertidal mudflats and sandflats, intertidal hard substrate, subtidal sediment and hard substrate communities, *Salicornia* communities, Atlantic salt meadows and transitional saltmarsh communities is around 9,500 ha.

The saltmarsh to sand dune transition communities are mainly distributed in the Burry Inlet at Pembrey Burrows, but are also recorded from west Taf and Tywi estuaries, west Penrhyn Gwyn and Penclacwydd (Burry Inlet). The noteworthy transitions occur between grazing marsh and dune slacks within semi-fixed dune systems. Such vegetation is present at a small scale at Morfa Uchaf and Llansteffan on the Tywi, near Ginst Point at the mouth of the Taf and, most impressively, at the western end of the Gwendraeth saltmarsh. At the latter location, conservation value is enhanced by the associated transitions from mid-marsh to tall mesotrophic inundation grassland.

4.1.2 Structure and function

The Carmarthen Bay estuaries were created primarily by the underlying geological features and then infilled with the prevailing mobile substrata and modified by the hydrographic regime. The area is underlain and partially bound by Carboniferous and Devonian limestones and sandstones. Overall the variety and distribution of intertidal sediments extends from well-sorted fine to medium sands at the mouths of the estuaries to muddy sand in their middle reaches and mud in the upper reaches and the back of the shores. The subtidal channels are dominated by mobile sands.This site has a variety of undisturbed transitions to coastal habitats.

- The **Tywi** is a typical ria or coastal plain estuary that was created by marine inundation of the river valley.
- The **Taf** is a combination of typical coastal plain and bar-built estuaries. Below Laugharne it is bar-built, due to the easterly growth of Pendine and Laugharne sands; above Laugharne it can be considered a ria or coastal plain estuary.
- The **Gwendraeth** is a typical bar-built estuary that was created by the north westerly extension of the dune/beach coastal barrier, of which Cefn Sidan sands forms the seaward part. The southern part of the Gwendraeth estuary drains extensive areas of saltmarsh.
- The **Loughor** (Burry Inlet) is a typical bar-built estuary.

Barrier beaches at the mouths of the estuaries and adjacent coast are a fundamental feature of the estuaries because they absorb wave energy and protect the lower estuary, which allows fine grained suspended sediments to be deposited on saltmarshes within the relatively sheltered estuaries. Sediment moves along the shores by longshore drift to supply recurved spits at Ginst Point, Tywyn Point, Morfa Heli and Whiteford Point. An exposure of subtidal peat to the south of Salmon Scar may have an important influence on the morphology of the Three Rivers estuaries however, further work is required to evaluate its importance.

The feature is characterised by largely mixed, variable salinity water typical of macrotidal estuaries. The mean tidal range for the estuaries is 5.5 m and the typical salinity range is from 33 - 2 $^{o}/_{oo}$. The tidal curve of these west facing macrotidal estuaries is asymmetric with an ebb duration of almost 10 hours on a spring tide and flood duration of 2-3 hours, the tidal range is at least 6.6m on spring tides. The annual average freshwater flow is 5.6m^3/s from the Loughor, 7.4m^3/s on the Taf, 43.4m^3/s on the Tywi and 4.8m^3/s on the Gwendraeth. Total flow into the Burry Inlet is 10.2 m^3/s. Recent nutrient levels in the water column are unknown, but hypernutrification has occurred in the past in some of the upper estuarine reaches. Sediment nutrient levels are also unknown, but assumed to reflect concentrations in overlying water. The levels of contaminants in the water column and sediments are unknown. However, there have been inputs of heavy metals from industry and redundant coalmines into the estuaries.

The different physiographies and hydrodynamic regimes of the estuaries provide for a wide range of combinations of wave exposure and tidal streams. Generally, above mid-shore the extensive intertidal flats are fairly stable and flat. Below mid-shore the extensive sandflats, are very mobile with frequent large sand waves and ripples. Sandbanks in the entrances of the estuaries are particularly mobile. The estuaries continue to be filled in, driven by rise in relative sea level, superimposed by changes in wind-wave climate.

The Burry Inlet and the Three Rivers system contain an important nursery area for bass *Dicentrarchus labrax* with the juvenile bass presumed to use all of the subtidal habitats during the summer months. The estuaries also provide a migratory route for salmonids, lampreys and shads.

4.1.3 Typical species

The estuaries contain both subtidal and intertidal habitats, although the latter are a lot more extensive in this SAC. In addition to the truly marine habitats and associated wildlife, a wealth of coastal and terrestrial habitats are all part of the estuary complex with, in undisturbed or unmodified situations, transitions from marine communities to brackish, maritime, freshwater and terrestrial habitats. A number of these habitats, such as mudflats and sandflats and saltmarshes are recognised as Annex I habitats in their own right.

The mosaic of habitats within the estuaries supports a large variety of different wildlife communities. In the intertidal and subtidal sediments, there are communities of worms, crustaceans and molluscs depending on the type of sediment, the salinity gradient and degree of exposure of the sediment to wave action and tidal streams. Where there is rocky habitat, green and brown seaweeds generally develop with some communities being characteristic of the variable salinity conditions. Transitions from saltmarsh to brackish, maritime and freshwater communities support their own particular assemblages of plants and animals. The estuaries also support an assemblage of mobile species. Estuaries can provide important nursery areas for fish species and also provide a means by which migratory fish species make the transition between the marine and freshwater environments.

The range of benthic communities in the Three Rivers is strongly influenced by the geology, topography and tidal currents, whilst in the Burry Inlet the major factors are salinity, sediment stability and substratum composition. The mobile, sandy sediments are characterised by the presence of low numbers of amphipods, isopods and robust, mobile polychaetes.

The fauna of intertidal sediments includes communities with polychaete and oligochaete worms and areas with extensive cockle beds and other bivalve molluscs. Forty-three intertidal biotopes were recorded in a mapping survey completed in 2000.

These include communities with polychaete and oligochaete worms and extensive cockle beds on intertidal sediments as well as barnacle and mussel dominated communities in areas of sand scoured intertidal rock. A species assemblage characterised by hydroids, ephemeral seaweeds and the winkle *Littorina littorea* in shallow eulittoral mixed substrata pools is more unusual because of its limited geographic distribution and because it is typically only found associated with mussel beds. Within the SAC it occurs on Salmon Point Scar, east of Burry Port, Whiteford Point, west of Penclacwydd and Loughor Bridge.

Relatively undisturbed transitions between saltmarsh and brackish systems are present. These include swamp, mire, mesotrophic grassland and open vegetation communities, and mostly occur in the mid and upper reaches of the Taf and Tywi Estuaries, around the Gwendraeth Estuary, west Pembrey Burrows, west Landimore Marsh, west and upstream of the bridge in the Loughor estuary.

4.1.4 Natural processes

The structure of estuaries is largely determined by geomorphological and hydrographic factors, with the original shaping forces having their beginnings in the geological origins of the adjacent land areas and the influence of major geological events such as ice ages and periods of higher and lower sea levels. The shape of the estuaries, their macro- and micro-topography, and bathymetry, are important components of the character of the habitats and influences the distribution and abundance of marine life, *i.e.* the features' typical species. It is both determined by, and influences, natural environmental processes and consequently, can be impacted either directly or indirectly (through changes to natural processes) by man.

Estuaries are complex dynamic systems that have a natural tendency to accumulate sediment, thereby changing their form from their original Holocene morphology to a state where tidal energy is dissipated by sub- and intertidal sediment banks. The width and depth of the estuary will therefore change over time towards a state of dynamic equilibrium or "most probable state".

The velocities of currents passing through the mouth are determined partly by the tidal range and partly by the cross sectional area of the mouth itself. If these velocities are higher than the sediment erosion threshold, erosion will widen the channel and lower velocities will ensue. If velocities are lower than the sediment depositional threshold, deposition will narrow the mouth and higher velocities will ensue. In this way, an equilibrium cross section will evolve which balances tidal prism, velocities and erosion/depositional thresholds. Sea level rise means that estuaries will show a natural tendency to translate inland (roll-over) and may erode at the mouth. Where changes in extent are attributable to the estuary adjusting to equilibrium, then the feature should be determined favourable. Where this process is constrained by hard sea defence, then this would be considered as coastal squeeze. (JNCC CSM Estuaries (version 4)).

A complex pattern and combination of physical, chemical and biological conditions and processes operates within estuaries, with many parameters varying temporally and spatially. These parameters establish the baseline conditions in the estuary and continually shape the estuaries and the habitats and wildlife they support. The key parameters are: the flood hydrograph; the nature of the catchment and its influence on freshwater flow and nutrient and sediment input; the nature of the estuary sediment; and the relatively high sediment levels in the estuaries resulting in low water retention within the estuary system and exposure of significant proportions of sediment at low tide. The biological communities of the estuaries have developed in response to these prevailing conditions and the daily patterns of water flow, exposure, sediment movement and water chemistry.

4.1.5 Modifications as a result of human activity

Compared to many estuaries in the UK, the extent of those in the Carmarthen Bay & Estuaries SAC are relatively uncompromised by extensive land claim although all of the estuaries have undergone significant modifications and are readjusting to their modified physical form. In more recent times saltmarsh was lost during the 20th century, largely to land claim, but half of this area has been compensated for by additional saltmarsh due to sediment infilling of the estuaries.

It is expected that tidal levels will gradually rise in response to global climate change through an increase in the rate of sea-level rise. Floodplains along the upper estuary will experience increased tidal inundation and change to saltmarsh. It is important that the upper estuarine floodplains are protected from development in order to allow changes to occur in the upper estuaries.

Available nitrogen and phosphorus levels are in excess of the criterion indicating hypernutrification in the upper estuary which has been linked to high numbers of algal cells and chlorophyll *a* concentrations. In addition, there have been inputs of heavy metals from industry and redundant coalmines in the estuaries. Inputs of fine sediments from rivers into all of the estuaries are small, compared to other sources of material (inward migration from the sea). This is reflected in the character of the estuaries and the habitats within them.

4.2 MUDFLATS AND SANDFLATS NOT COVERED BY SEAWATER AT LOW TIDE

Mudflats and sandflats not covered by seawater at low tide are defined in the EU Interpretation Manual as:

"Sands and muds of the coasts of the oceans, their connected seas and associated lagoons, not covered by sea water at low tide, devoid of vascular plants, usually coated by blue algae and diatoms. They are of particular importance as feeding grounds for wildfowl and waders……. Eelgrass communities are included in this habitat."

In this document they are referred to as the 'intertidal mudflats and sandflats' feature.

There are three major categories of intertidal mudflats and sandflats although in practice they tend to be present as a continuous gradation between these categories depending on the prevailing conditions:

1. Clean sands - in areas exposed to wave action and strong tidal currents. May be found on open coast areas and estuary mouths.
2. Muddy sands – occur on more sheltered shores along the open coast and the lower reaches of estuaries.
3. Mudflats – only form in the most sheltered areas of the coast, usually where large quantities of silt derived from rivers are deposited.

Intertidal mudflats and sandflats form a major component of two other Annex I habitats (estuaries and large shallow inlets and bays) but also occur independently, sometimes covering extensive areas along the open coast.

4.2.1 Range

The SAC includes large areas of intertidal mudflats and sandflats the most extensive being the wide expanses of Llanrhidian Sands, Cefn Padrig and Dafon Sands, in the lower and middle estuary of the Burry Inlet. The mudflats and sandflats cover around 7,000 ha, thus comprising 2.4 % of the UK resource and approximately 10 % of the area of the SAC.

4.2.2 Structure and function

The mudflats and sandflats occur as narrow bands as well as very expansive areas. Some are almost horizontal while others, particularly those adjacent to tidal channels and creeks, are steeply inclined. This diverse range of physiographies and morphologies with varying degrees of physical exposure to wind, waves and tides, gives rise to an equally wide range of hydro- and aerodynamic settings. The sedimentary environments also vary greatly with sediment types ranging from mobile fine and medium sands, muddy sands, sandy and silty muds, and pure muds, to limited areas of exposed immobilised sandy and / or muddy gravel pavements.

There is a gradation within the distribution of sediments, from mud in the upper, more sheltered regions of the estuaries, to sand at the more wave-exposed mouths of the estuaries. The sandy shores of South beach (Tenby), Waterwynch Bay, Monkstone beach and Cefn Sidan sands, between the Three River system and the Burry Inlet, consist mainly of mobile fine and medium sands.

The mudflats and sandflats of the Three Rivers system and that of the Burry Inlet and River Loughor are mostly sandy gravel or muddy sand. Sheltered sandy gravel shores are found from the edge of Pendine Sands, stretching around into the mouth of the Three Rivers system, where a variety of different sediment types are found. The mouth of the Three Rivers system is dominated by moderately mobile fine sands that are continually shifted by waves and tidal action. The intertidal flats of the estuaries are predominantly sandy, although the upper reaches of the rivers are muddy, and each of the tributaries has areas of saltmarsh.

Salinity varies from less saline conditions within the estuaries to fully marine along the more open stretches of coastline in between. Recent nutrient levels in the water column are unknown, but hypernutrification has occurred in the past in some of the upper estuarine reaches. Sediment nutrient levels are also unknown, but assumed to reflect concentrations in overlying water. The levels of contaminants in the water column and sediments are unknown. However, there have been inputs of heavy metals from industry and redundant coalmines into the estuaries.

4.2.3 Typical species

Large areas of the intertidal mudflats and sandflats are dominated by bivalves. In areas of fine sand cockles *Cerastoderma edule* are abundant, along with other bivalves, amphipods and worms. In muddier sediments the sand-gaper *Mya arenaria*, peppery furrow-shell *Scrobicularia plana* and mud-snail *Hydrobia ulvae* are also found in large numbers. The lower Loughor Estuary is one of the few places in the UK where the worm *Ophelia bicornis* has been found. There are also beds of the nationally scarce dwarf eelgrass *Zostera noltei*.

Areas of mobile fine and medium sands such as South Beach and Cefn Sidan sands support large populations of burrowing amphipods and polychaetes. The polychaetes *Nephtys cirrosa* and *Arenicola marina*, the amphipod *Bathyporeia pelagica* and the isopod *Eurydice pulchra* are the most abundant species and, in more stable sediment areas, polychaetes and the cockle *Cerastoderma edule* are found in abundance.

The communities at the mouth of the Three Rivers system are characterised by the Baltic tellin *Macoma balthica*, thin tellin *Angulus tenuis* and polychaetes *Nephty*s spp. Stable sandflats are present in the lower estuary, generally on the upper middle shores. Here tidal streams and salinity fluctuations are reduced, resulting in greater species richness than in the lower shore areas. The communities support typical bivalve / polychaete and amphipod assemblages.

The sediments of Llanrhidian Sands, Cefn Padrig and Dafon Sands are moderately stable, fine and very fine sands. The cockle *Cerastoderma edule* is one of its most characteristic species. In the more stable areas with a higher mud content, the sand gaper *Mya arenaria*, peppery furrow shell *Scrobicularia plana*, the mud snail *Hydrobia ulvae* and amphipods *Corophium* spp. are found in increasing numbers, as are the amphipods *Bathyporeia pilosa* and *Corophium* spp. Nearer the channel muddy areas are dominated by polychaetes and the Baltic tellin *Macoma baltica*.

There are very large populations of cockles in the Burry Inlet and in the Three Rivers, covering just over 940 ha of the intertidal sandy mud and sand habitats. These in turn form the principle food source for oystercatcher in the Burry Inlet SPA and Ramsar site.

Along the high wave energy exposed coastlines of Saundersfoot to Telpyn, Marros to Pendine and along the Pembrey Coast, extensive and complete sequences of exposed sand zonations are present. Species assemblages characerised by the common heart urchin *Echinocardium cordatum* and razor shells *Ensis* sp. occur along Carmarthen Bay on the shallow lower shore where conditions are fully marine. Other associated species include the otter shell *Lutraria lutraria* and the bivalve mollusc *Pharus legumen.* Sites include North Tenby beach, Monkstone Beach, between Monkstone Point and Saundersfoot Harbour, at Marros and Pendine Sands and between Towyn Point and Pembrey Burrows.

The intertidal soft sediment coastline of Carmarthen Bay has extensive and substantial strandlines. A wealth of invertebrate fauna has been identified at locations including Pendine, Pembrey and Whiteford. Sandhoppers are the dominant order of marine invertebrates with three of the five genera found regularly feeding on the algae deposits.

In the Burry Inlet, there are areas of the scarce and specialised biotope characterised by the dwarf seagrass *Zostera noltei* along the Great Pill, between Berges Island and Landimore Marsh, and on Llanrhidian Sands and at Penrhyn Gwyn. As well as stabilising the sediment the seagrass is an important source of food for wildfowl, particularly Brent goose and widgeon that feed on the intertidal beds.

The unusual angiosperm wigeongrass *Ruppia maritima* is recorded from one location in the middle reaches of the Tywi Estuary at Morfa Uchaf. This species grows in soft sediments in sheltered shallow

coastal waters, from full salinity to nearly freshwater, but mainly in brackish waters, including those of estuaries. *R. maritima* attracts in particular waterfowl and fish to feed and rear their young. The currently considered nationally rare polychaete worm *Ophelia bicornis* has been recorded from the sand bars and flats of mobile sand along the Burry Inlet / Loughor Estuary. *Ophelia* feeds on particles of organic material in the sediment and produces swimming planktonic larvae that are very particular about the quality of the sediment that they will colonise.

4.2.4 Natural Processes

Intertidal mudflats and sandflats are dynamic features. Their distribution, extent, shape, topography, aspect and orientation is the product of complex interaction between hydrodynamic and sediment transport processes, sediment supply and coastal morphology. Hydrographic functions that structure intertidal mudflats and sandflats encompass highly dynamic hydrodynamic and other properties that vary with short and long-term natural cycles, climate influences and stochastic events.

The structure of intertidal muflats and sandflats varies depending on the physical conditions and forces acting on them (in particular the degree of exposure to wave action and tidal currents) as well as the nature of the sediments occurring in any one location. The sediments vary from mobile coarse sand in more wave exposed areas to stable, fine sediment expanses of mudflat in estuaries and other marine inlets.

Intertidal mudflats and sandflats support a variety of different wildlife communities. These are predominantly infaunal communities of a variety of different animal species such as worms, molluscs and crustaceans living within the sediment habitat. The type of sediment, its stability and the salinity of the water have a large influence on the wildlife species present.

4.2.5 Modifications as a result of human activity

Cockle mortality has occurred yearly in the Burry Inlet since August 2002 and in the Three Rivers Estuary since August 2005. The mortalities are of a chronic nature and occur mainly during the summer periods. Cockle numbers in the Burry Inlet altered dramatically in 2004 with very few older cockles left on the beds. Cockle numbers in the Three Rivers Estuary decreased in 2006. The mortality events are likely to be multifactoral. There is very little evidence of disease but some evidence of parasite numbers increasing immediately prior to mortality events.

Episodic events of mass mortality involving bivalves have been recorded with increasing frequency and intensity world wide since the 1970s. Mass mortalities have been attributed to a number of potential factors including environmental conditions, climate change, anthropogenic inputs, infectious agents and physiology or genetics of the organism. Environmental aspects linked to mortality include algal blooms, declines in water quality, eutrophication, temperature, salinity, and extreme events such as storms. Despite a number of preliminary investigations in the Burry Inlet and Three Rivers Estuary, the causes of the mortalities are still not clear.

4.3 ATLANTIC SALT MEADOWS

Atlantic salt-meadow (*Glauco-Puccinellietalia maritimae*) is defined in the EU Habitats Interpretation Manual as “Salt-meadows of Baltic, North Sea, English Channel and Atlantic shores”

Eleven different plant communities are represented by this SAC habitat in the UK which occurs on North Sea, English Channel and Atlantic shores.

Atlantic salt meadows develop when plants able to tolerate salty soil conditions colonise soft intertidal sediments of mud and sand in areas protected from strong wave action. The vegetation forms the middle and upper reaches of saltmarshes, where tidal inundation still occurs but with decreasing frequency and duration than areas nearer to the low water mark in estuaries and coastal locations.

The vegetation that is present varies with climate and the frequency and duration of tidal inundation. Grazing by domestic livestock is particularly significant in determining the structure and species composition of the habitat type and in determining its relative value for plants, invertebrates and wintering or breeding waterfowl.

4.3.1 Range

The *Carmarthen Bay and Estuaries SAC* includes the largest expanse of saltmarsh in Wales covering 2478 ha. The extensive saltmarshes of the Carmarthen Bay estuaries have a complete sequence of saltmarsh vegetation, from pioneer vegetation through to upper saltmarsh transitions. The area is also important for transitions from saltmarsh to sand dune and to freshwater and terrestrial vegetation. These are important features of the local saltmarshes and of great biodiversity value.

The estuarine systems have exceptionally well developed saltmarsh to sand dune transitions, where blown sand has modified the upper saltmarsh vegetation. The transition communities are mainly distributed in the Burry Inlet at Pembrey Burrows, but are also recorded from west Taf and Tywi estuaries, west Penrhyn Gwyn and Penclacwydd (Burry Inlet). The noteworthy transitions occur between grazing marsh and dune slacks within semi-fixed dune systems. Such vegetation is present at a small scale at Morfa Uchaf and Llansteffan on the Tywi, near Ginst Point at the mouth of the Taf and, most impressively, at the western end of the Gwendraeth saltmarsh. At the latter location, conservation value is enhanced by the associated transitions from mid-marsh to tall mesotrophic inundation grassland.

The feature has a variety of relatively undisturbed transitions between saltmarsh and brackish (swamp) systems. These include swamp, mire, mesotrophic grassland and open vegetation communities, totalling 98.0 ha. The transition communities are largely distributed in the mid and upper reaches of the Taf and Tywi estuaries, around the Gwendraeth Estuary, west Pembrey Burrows, west Landimore Marsh, west and upstream of the bridge in the Loughor estuary. Transitions to freshwater inundation communities are especially prominent at the western extremity of the Gwendraeth Estuary.

The grazed saltmarshes include upper margins with sea rush *Juncus maritimus* and marsh-mallow *Althaea officinalis*, which are a particularly distinctive ecological feature of this site. The area is also important for transitions from saltmarsh to sand dune and other habitats.

The Burry Inlet has around 1640 ha of Atlantic saltmeadows with the largest extent at Llanrhidian-Landimore (1094.8 ha) then Pen-clawdd (411.8 ha) the Loughor Estuary (273.1 ha) Penrhyn Gwyn (129.97 ha) and the Pembrey coast (106.86 ha). In the Three Rivers complex there is a total of 838 ha (Gwendraeth Estuary: 467 ha, Taf Estuary: 223 ha, and Tywi Estuary: 148 ha).

Transitional low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Sueda maritima* is present over significant areas of the Llanrhidian-Landimore marshes, and also occurs in moderately extensive areas at Pen-clawdd. Elsewhere stands were small and with the exception of the lower Loughor Estuary, poorly developed. Rayed *Aster tripolium* communities are scarce in the Burry Inlet, being present only at Loughor and Pembrey, and even here they are not well developed. In comparison, grazed and ungrazed stands of *P.maritima* communities were noted at all sites, although ungrazed stands are only extensive at the Loughor Estuary where it accounts for around 20% of all saltmarsh vegetation.

Halimione portulacoides saltmarsh communities are relatively poorly represented in the Burry Inlet. Sizeable ungrazed stands are restricted to Penrhyn Gwyn, where they formed good transitions with other units and grazed stands were well developed at Loughor. *Festuca rubra* communities are the second most widespread unit of the Inlet, with extensive (>100 ha) cohesive stands mapped at the Llanrhidian-Landimore site and with sizeable areas (ca. 50 ha) also mapped at Pen-clawdd and Loughor. *Artemisia maritima* communities was recorded at the Pembrey site, with particularly well developed stands along the more inland creek edges and extending towards the lower marsh, at Pen-clawdd. The area of *Juncus maritimus* saltmarsh community along the Burry Inlet is 276.97 ha.

Within the Tree Rivers complex transitional low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Sueda maritima* is present over a significant area (*ca.* 50 ha) on the Gwendraeth, but has only fragmentary representation on the Taf, and on the Tywi is restricted to a small but good quality stand at Morfa Uchaf. Rayed *Aster tripolium* communities are widespread with good stands on all three estuaries. Both grazed and ungrazed types of *P.maritima* communities are present, although ungrazed expressions are uncommon on the Tywi and the Taf. In contrast *Halimione portulacoides* communities are present in large quantities and of good quality on both the lower Taf and the Gwendraeth.

Juncus maritimus-Triglochin maritimus saltmarsh, is poorly represented, but the associated *J.maritimus* is a conspicuous feature of the estuary system with a total cover well in excess of 50 ha and all three sub-communities are well represented, Morfa Uchaf supports a small patch of *Eleocharis uniglumis* with halophytic associates which may be a relic of a former stand now subsumed within the surrounding inundation vegetation.

4.3.2 Structure and function

Many of the saltmarshes are dissected by small creeks and channels, which provide microhabitats within more uniform areas of marsh. Saltpans and small pools add diversity to the site, and are an intrinsic part of many marshes. The marshes on the southern side of the Burry Inlet between Whiteford Point and Loughor are of national significance in respect of a variety of geomorphological features, including creeks, saltpans, erosion cliffs and a variety of sediment types.

The extremely dendritic creek systems of the Burry Inlet and the Gwendraeth are the most extensive, followed by the Pembrey saltings. Short, but still profusely dendritic saltmarsh creeks, are also characteristic features of the smaller saltmarsh expanses along the Taf and the Tywi. Near Clomendy Farm on the middle Tywi Estuary, the predominantly linear pattern of tidal creeks is the result of the excavation of drainage ditches.

Landimore, Llanrhidian and Berthlwyd marshes have developed in sequence from east to west. The mature marshes at Berthlwyd display well developed terraces and an eroding marsh cliff while at Llanrhidian both pans and creeks are present and the marsh is heavily dissected. At Landimore an intricate and deep creek network is present. This sequence of marshes forms a key area for the understanding of saltmarsh dynamics, sediment transport and sea level changes.

4.3.3 Typical species

This extensive site has a complete sequence of saltmarsh vegetation, from pioneer vegetation through to upper saltmarsh transitions. The grazed saltmarshes include upper margins with sea rush *Juncus maritimus* and marsh-mallow *Althaea officinalis* which are a particularly distinctive ecological features of the site. The area is also important for transitions from saltmarsh to sand dune and other habitats.

Notable saltmarsh species and communities include stands containing good populations of *Althaea officinalis* that were extensive at Llanrhidian-Landimore, and also present on Loughor and Penrhyn Gwyn and stands of *Seriphidium maritimum* which were well represented at Pen-clawdd, and also occurred on the other sites, although in lesser quantity. Good populations of *Limonium vulgare* have been recorded at all sites, and were particularly well represented at Llanrhidian-Landimore. Two nationally scarce plant species also occur on the Taf Estuary, namely the rock sea-lavender *Limonium procerum* and bulbous foxtail *Alopecurus bulbosus*.

No information is currently available on the composition of fauna and other flora associated with the Atlantic salt meadows saltmarsh communities although there are descriptions of species that are typically associated with these marshes. The majority of saltmarsh insects are sap-sucking aphids or chewing grasshoppers, while deposit feeders such as *Macoma baltica, Corophium volutator* and *Arenicola marina* and predators like *Nereis diversicolor* and *Nephtys hombergii* are likely to be

present. *Hydrobia ulvae* grazes the microflora from sediment grains and epiphytes. Areas with high structural and plant diversity, particularly where freshwater seepages provide a transition from fresh to brackish conditions, are particularly important for invertebrates.
Saltmarshes are an important resource for wading birds and wildfowl. They act as high tide refuges for birds feeding on adjacent mudflats, as breeding sites for waders, gulls and terns and as a source of food for passerine birds particularly in autumn and winter. In winter, grazed saltmarshes are used as feeding grounds by large flocks of wild ducks and geese.

4.3.4 Natural processes

The location, character, and dynamic behaviour of saltmeadows are governed by four physical factors: sediment supply, tidal regime, wind-wave climate and the movement of relative sea level. There are four elements necessary for the development and growth of a salt marsh: (1) a relatively stable area of sediment that is covered by the tide for a shorter period than the time it is exposed; (2) a supply of suitable sediment available within the period of tidal cover; (3) water velocities that are sufficiently low for some of the sediment to settle out; and (4) a supply of seeds or other propagules for the establishment of vegetation cover.

The topography and microtopography of areas of Atlantic salt meadow are the product of complex interaction between hydrodynamic and sediment transport processes, sediment supply and coastal morphology. These can be highly dynamic and vary with short and long-term natural cycles, climate influences and stochastic events, including: tidal range and excursion, salinity, water temperature and suspended particulate concentrations.

The marsh-edge morphology provides information on the short to medium term trends of marsh morphodynamics. Accreting and stable seaward marsh edges have an accretional ramp upon which pioneer and low-marsh vegetation can become established. Erosional margins are characterised either by the presence of mud-mound topography or by marsh-edge cliffs fronted by toppled cliff blocks with live or dying vegetation, rotational slide or overhanging (cantilever) blocks. Terraced marsh margins indicate episodic erosion and accretion on timescales over decades to centuries.

Creeks and pans of varying size and density are frequent features of the saltmeadows. Creeks absorb tidal energy and assist with the delivery of sediment into saltmarshes. The efficiency of this process depends on creek pattern. Creek density is influenced by vegetation cover, suspended sediment load and tidal influence. Creeks allow pioneer vegetation to become established along their banks higher into the saltmarsh system. Natural salt pans can occur at any level in a saltmarsh. Major erosion of saltmarsh is indicated by internal dissection and enlargement of the drainage network, ultimately leading to the creation of mud basins. Contaminants may be tied up in saltmarsh sediments for relatively long periods of time and shifts in the dynamics of processes can lead to the remobilisation of sediments. Cyclical patterns of erosion and accretion may, therefore, lead to the release and re-deposition of pollutants within the system.

Nutrient levels are a strong influence on the growth of estuarine saltmarsh plants. Nutrient cycling within saltmarshes can also have a significant effect on coastal and estuarine water quality. In this respect, healthy, functional saltmarsh habitat may have an important role to play in the control of nutrients, which are important in determining water quality.

Given favourable conditions, depending on sediment supply and hydrodynamic regime, mudflats evolve into saltmarshes by way of substrate stabilisation by algae, diatoms and early pioneer plants, giving rise to enhanced sediment accretion rates.

4.3.5 Modifications as a result of human activity

Areas of unimproved saltmarsh are subject to grazing by sheep, cattle and horses. The intensity of grazing varies from severe cattle use with accompanying poaching, through moderate to heavy sheep grazing, often resulting in a tight species-poor turf to areas where grazing has been absent for a

considerable time. The grazed saltmarshes include upper margins with sea rush *Juncus maritimus* and marsh-mallow *Althaea officinalis*, which are a particularly distinctive ecological feature of this site. Over grazing can lead to loss of rare plant species and affect bird breeding and feeding habitats and under-grazing can lead to a loss of plant diversity by competitive exclusion.

4.4 *SALICORNIA* AND OTHER ANNUALS COLONISING MUD AND SAND

Salicornia and other annuals colonising mud and sand are defined in the EU Habitats Interpretation Manual as;

"Formations composed mostly or predominantly of annuals, in particular Chenopodiaceae of the genus *Salicornia* or grasses, colonising periodically inundated muds and sands of marine or interior salt marshes. *Thero-Salicornietea, Frankenietea pulverulentae, Saginetea maritimae."*

Of the listed sub-types the Carmarthen Bay & Estuaries SAC includes examples of glasswort swards (*Thero-Salicornietalia*). This form of saltmarsh is widely distributed throughout coastal areas of the EU. In the UK it is widespread in the saltmarshes of England and Wales, but the area of this habitat type is restricted in Scotland and Northern Ireland because of a lack of new sediment for saltmarsh development. Four different plant communities are represented by this SAC habitat in the UK.

4.4.1 Range

This habitat feature is pioneer saltmarsh that colonies intertidal mud and sandflats in areas protected from strong wave action. It is an important precursor to the development of more stable saltmarsh vegetation. *Salicornia* and other annuals colonising mud and sand develops at the lower reaches of the saltmarsh where the plants are frequently flooded by the tide. It can also colonise open creek sides, depressions or pans within saltmarshes, as well as disturbed areas of upper saltmarsh.

Annual *Salicornia* saltmarsh or *Suaeda maritima* saltmarsh is scarce in the Burry Inlet but well represented on the Landimore-Llanrhidian marshes where sizeable stands forming good sequences between pioneer and transitional marsh. These communities are scarce within the Three Rivers complex with small but representative stands of *Salicornia* on both the Taf and the Gwendraeth. The reason for the paucity of the *Salicornia* community is unclear but is probably related to particle size of the substrate: *Spartina* may have the advantage as the initial pioneer.

4.4.2 Structure and function

Salicornia grows on a wide variety of marine sediments in intertidal habitats, ranging from gravels and shelly sands, through silts to fine clays, and is invariably associated with saline, brackish or alkaline substrates. Although an early colonist of soft, unconsolidated sediments, the densest stands tend to be on firm silts and clays. The substrates of *Salicornia* span the tidal range and are often waterlogged for much or all of the time, depending on elevation and drainage conditions. The saturated sediments are typically hypoxic and may develop low redox potentials, even in the surface layers and the plants may avoid root hypoxia by relatively shallow rooting. One consequence is that hydraulic forces generated by tidal flow, perhaps associated with scouring of the sediment and wave action, can be a major source of mortality for *Salicornia* seedlings at lower elevations on a saltmarsh.

Salicornia is extremely tolerant of regular flooding although growth of *S. europaea* is reduced by cultivation under continuous water-logging, in comparison with free drainage at the same salinity. As a halophyte, *Salicornia* is tolerant of exceptionally low water potentials in its root environment, whether they arise from salinity, drought or a combination of both.

Individual populations and taxa of *Salicornia* may be very sensitive to elevational variations associated with microtopography on the gradient from land to sea of tidal saltmarshes. Populations on the lower shore need to be more tolerant of prolonged submergence, tidal scour and water-logging, whereas those at high elevations may experience hypersalinity in summer.

Few grazers feed on the saltmarsh plants directly. In spring and summer *Salicornia* spp. are highly productive and in autumn die back and decompose. Therefore, the majority of *Salicornia* spp.

productivity, and presumably other vascular plant (*i.e. Suaeda maritima*) productivity, enter the food web as detritus. Benthic algae and microphytobenthos play an important role in cycling nutrients, and hundreds of species of bacteria, fungi, and microalgae may be attached to surfaces of vascular plants and sediment. These are grazed by meiofauna (*e.g*. protozoa, foraminifera, nematodes). Mature stands of *Salicornia* and their seeds can be an important food resource for passerine birds and geese. This pioneer saltmarsh habitat also provides sheltered nursery sites for several species of fish.

4.4.3 Typical species

The site is selected as representative of pioneer glasswort *Salicornia* spp saltmarsh in the south-west of the UK. It forms an integral part of the estuarine system, supporting extensive pioneer communities and contributing to a complete sequence of saltmarsh vegetation, including transitions to upper saltmeadow and to important sand dune habitats.

Although *Salicornia* and *Suaeda* are components of several of the communities within the Burry Inlet, stands composed principally of colonising annuals forming annual *Salicornia* saltmarsh or *Suaeda maritima* saltmarsh are scarce. In the Three Rivers complex *S.maritima* saltmarsh is restricted to a single location on the Gwendraeth and stands are fragmentary although typical even though the cover of *Suaeda* is rather low; the community is probably still developing. Associates are restricted to *Salicornia* and *Spartina* with a little *Halimione* and scattered tillers of *Puccinella*.

The *Salicornia* spp. present in the *Carmarthen Bay & Estuaries SAC* reputedly includes the nationally scarce *Salicornia pusilla* at unknown location(s). Also of note is *Spartina anglica* which is presently spreading along the north Gower coastline, occupying increasingly the niche vacated by *Salicornia*, because the southward migration of the channel has increased energy levels. Dunlin, for instance, prefers *Salicornia* to *Spartina* for foraging.

No information is currently available on the composition of fauna and other flora associated with pioneer saltmarsh communities although there are descriptions of species that are typically associated with *Salicornia* marshes.

A reduced marine fauna is usually present which may include the amphipod *Corophium volutator*, the ragworm *Hediste* (*Nereis*) *diversicolor* and often the mud snail *Hydrobia ulvae*. There are often algal films, including diatoms, and algal mats over the substrate surface, but vascular companions are usually very few. Scattered plants of *Puccinella maritima* and *Spartina anglica* occur frequently.

4.4.4 Natural Processes

The location, character, and dynamic behaviour of the *Salicornia* and other annuals feature is governed by four physical factors: sediment supply, tidal regime, wind-wave climate and the movement of relative sea level. There are four elements necessary for the development and growth of a salt marsh:(1) a relatively stable area of sediment that is covered by the tide for a shorter period than the time it is exposed; (2) a supply of suitable sediment available within the period of tidal cover; (3) water velocities that are sufficiently low for some of the sediment to settle out; and (4) a supply of seeds or other propagules for the establishment of vegetation cover.

In temperate regions, such as the saltmarshes of Carmarthen Bay the growing season is generally 7-8 months, and the *Salicornia* is typically a summer-annual. Flowering occurs mainly from mid-August to mid-September and seed germination tends to coincide with low sediment salinities, in winter in Britain. Lower-marsh populations, such as *S. europaea*, tend to germinate earlier than upper marsh ones, *e.g. S. pusilla* (The lower limit of establishment of *Salincornia* on saltmarshes often appears to be set by the time necessary for the seedlings to penetrate the sediment and develop a ring of roothairs, in order to become fully anchored. A threshold period of tidal exposure of 2-3 days for rooting sufficient to resist tidal action on the low part of an estuarine marsh has been suggested.

4.4.5 Modifications as a result of human activity

The area of pioneer *Salicornia* appears to have diminished considerably since the field survey of Charman in 1982. This may be due to a combination of changes in the main channel and vehicular erosion. The main loss appears to have been in the central coastal section of Llanrhidian Marsh. Small clumps of middle and low marsh vegetation persist on small isolated raised hummocks within an expanse of otherwise bare mud.

The waxing and waning fortunes of *Spartina* can be evidenced by their often large inter-annual differences in extent. These are generally brought about by natural environmental conditions which at times can impede the germination, root-taking and subsequent growth of the annual *Salicornia* by way of, for instance, excessive wave action or submergence time. Modifications to the extent of *Spartina* can also be brought about by poaching by livestock, vehicular erosion or by tidal channels cutting into upper mudflats.

4.5 LARGE SHALLOW INLETS AND BAYS

Large shallow inlets and bays are defined in the EU Habitats Interpretation Manual as;

"Large indentations of the coast where, in contrast to estuaries, the influence of freshwater is generally limited. These shallow indentations are generally sheltered from wave action and contain a great diversity of sediments and substrates with a well developed zonation of benthic communities. These communities have generally a high biodiversity."

In the UK, there are several physiographic types of large shallow inlet and bay that meet the EC definition: embayments which are a type of marine inlet typically where the line of the coast follows a concave sweep between rocky headlands, sometimes with only a narrow entrance to the embayment; fjards which are series of shallow basins connected to the sea via shallow and often intertidal sills; rias which are drowned river valley in an area of high relief (known as voes in Scotland).

The feature in this SAC is an embayment and is referred to as a large shallow bay in this document.

4.5.1 Range

Carmarthen Bay is a large shallow bay partially bound by rocky outcrops, with soft sediment communities occupying most of the Bay. It extends from Tenby and Caldy Island in the West to Worms Head on the Gower peninsula in the east (map 1) and covers approximately 43,492ha, comprising 6.5% of the UK resource and around 66% of the *Carmarthen Bay & Estuaries SAC*.

There are a variety of component habitats within Carmarthen Bay given the different seabed types which include mud, sand and rock. This includes a significant presence of one Annex 1 habitat (intertidal mudflats and sandflats) and three Annex II species which occur in the site (Shad, river lamprey and sea lamprey). These are described separately.

4.5.2 Structure and Function

The seafloor of Carmarthen Bay consists of a mixture of sediments although mostly fine sand. The outer / seaward side of the feature is more medium sand with occasional areas of coarse sand and muddy silt. A few rocky outcrops are present, the largest being off Small Ord Point, near Caldey Island. Mid-Flandrian peat beds are exposed as ledges at times along the northern and north-eastern boundary of the large shallow bay. The rocky intertidal areas around the Bay vary from steep cliffs at Tenby to bedrock platforms at Saundersfoot and areas of mixed rock and sediment at Whiteford and Telpyn which are exposed to wave action and sand source.

The physical conditions vary considerably throughout the bay with salinity ranging from low at the estuaries to fully marine. There are also gradients in wave action from sheltered to exposed, and in tidal currents which are strong around exposed headlands and sheltered elsewhere. There is an exchange of sediments with mudflat, sandflats, areas of saltmarsh and dunes all of which are dynamic environments.

The nutrient levels and levels of contaminants in the water column are unknown, but assumed to be low because of the hydrodynamic setting of Carmarthen Bay. Levels of contaminants within the sediment are also unknown, but assumed to reflect concentrations in overlying water.

4.5.3 Typical species

The main sublittoral biotope is associated with sand and non-cohesive muddy sand and generally dominated by small bivalve mussels. At the western end of Carmarthen Bay the fine sand supports abundant marine life much of it buried. This included the brittlestar *Amphiura filiformis*, the necklace shell *Euspira catena*, the burrowing crab *Corystes cassivelaunus*, and the anemone *Sagartiogeton undatus*. There were also bivalve molluscs such as razor shells *Ensis* sp., gapers *Mya* sp., venus shells *Venus* sp. and otter shells *Lutraria lutraria*. Surface life included starfish *Astropecten irregularis*, brittlestars *Ophiura ophiura* and *O. albida*, the common whelk *Buccinum undatum*, reticulated dog whelk *Hinia reticulatr* small flatfish and gobies.

The more varied stable areas of cobble and boulders just west of Woolhouse Rocks are colonised by large numbers of mussels *Mytilus edulis* and sea squirts *Molgula manhattensis*. Where sand scouring occurs hydroids such as *Sertularia argentea*, *Abietinaria abietina*, *Halecium halecinum*, *Hydrallmania falcate* and *Obelia longissima* dominate. At The Yowan there was a wide variety of other attached life including branching sponges such as *Haliclona oculata* and barnacles as well as crustaceans and fish such as bib and poor cod.

In the intertidal zone the cliffs at Tenby and north to Saundersfoot are dominated by lichens such as *Caloplaca* spp. and *Verrucaria* spp., barnacles *Semibalanus balanoides*, and mussels *Mytilus edulis* with patches of fucoid algae *Fucus serratus* and kelps *Laminaria digitata* where the cliffs extend onto the lower shore. Sponges *Grantia compressa* and *Leuconia* sp. and shade-tolerant red seaweeds *Palmaria palmata* , *Plumaria elegans* and coralline algal crusts occupy overhanging areas of bedrock on the lower shore.

The bedrock platforms from Saundersfoot to Amroth are also exposed to wave action and sand scour and are dominated by lichens, barnacles and mussels but also coralline rock pools with daisy anemone *Cereus pedunculatus* on the mid shore, and sponges and anemones in overhangs, on the lower shore.

At Whiteford Point, much of the shore is dominated by a dense cover of *Mytilus edulis* , consolidating cobbles, pebbles and small boulders in some places together with a few large hydroid pools and numerous small pools are found in depressions. These beds can be ephemeral because of winter storms. The piddock communities are present in intertidal zones either within soft (Carboniferous) limestone along Tenby Cliffs and St Catherine's Island or in mid-Flandrian clays, along the Marros and Pendine coast and at Whiteford Burrows.

The most abundant group of organisms found within Carmarthen Bay sediments are polychaetes (accounting for over 50 % of infauna), with molluscs and crustaceans also being abundant. Pembrey Sands at the mouth of the Loughor is dominated by the polychaete *Lanice conchilega*, but the polychaete *Spiophanes bombyx* is also found in large numbers in other areas of the bay. Other polychaetes commonly found are *Magelona filiformis*, *Nephtys cirrosa* and *Chaetozone setosa*. A number of molluscs are widespread in the sandy sediments of the Bay, including *Fabulina fabula*, *Mysella bidentata*, *Abra alba* and *Chamelea gallina*.

Also occurring in the bay are amphipods and echinoderms such as the heart urchin *Echinocardium cordatum* and various brittlestars, including *Ophiura ophiura* that is found in large numbers in the bay. Starfish are also present throughout the bay, as are molluscs such as the small opisthobranch *Philine aperta* and the whelks *Buccinum undatum* and *Hinia* sp.

Rare and scarce species found within the large shallow inlet and bay feature (chiefly after unpublished data from Woolmer 2003) include *Acanthocardia aculeata* (rare cockle), *Achaeus cranchii* (crab), *Atrina fragilis* (fan shell), *Dromia personata*, *Ostrea edulis* (native oyster), and *Padina pavonica* (brown alga), however, the records of *Atrina fragilis, Ostrea edulis, Dromia personata* and *Padina pavonica* date back to pre 1950, with no records since.

Atlantic salmon *Salmo salar* and sea trout *Salmo trutta* are present in many of the rivers and coastal areas of the Bristol Channel with salmon runs in a number of watercourses draining into Carmarthen Bay, including the Rivers Taf, Tywi and Gwendraeth. The migratory European eel *Anguilla anguilla* is commonly found throughout Carmarthen Bay and its estuaries and the SAC appears to be an important nursery and feeding area for a number of fish, including sole *Solea solea*, bass *Dicentrarchus labrax*, plaice *Pleuronectes platessa* and the dab *Limanda limanda*.

4.5.4 Natural processes

The distribution, extent and shape of inlets and bays is a reflection of the underlying geology, with some structures of resistant rock, areas of rock amenable to erosion and zones of geological weakness. Sediment shores and submerged sediment plains are much more dynamic features subject to natural change influenced by factors such as tidal flow, tidal range, currents, weather conditions and aspect.

Shallow inlets and bays are sedimentologically linked with the two couplets of mudflat and saltmarsh, and beach/sandflat and dunes. There is generally an exchange of sediments between these dynamic environments by way of bi-directional sediment transport pathways.

The types of sediment and hard substrata habitats within large shallow inlets and bays are largely determined by the underlying geology and sedimentology, along with orientation and aspect and the influence of the prevailing physical conditions such as the degree of exposure to wave action and tidal currents. These factors, combined with the influence of others, such as water quality (including turbidity) and sediment chemistry, influence the assemblages of marine species associated with the different habitats throughout large shallow inlets and bay.

Sediment granulometry and structure are primary factors in determining biological community structure. Sediment topography is the product of sediment structure and sediment transport determined by hydrodynamic process and these can vary with short and long-term natural cycles, climate influences and stochastic events. The variety of species in *inlets and bays* is often high as a result of wide habitat variety, the wide range of wave exposure, current strength, depth, light and substrate type, and presence of habitats that support high diversity.

4.6 SANDBANKS WHICH ARE SLIGHTLY COVERED BY SEAWATER ALL THE TIME

Sandbanks which are slightly covered by sea water all the time are defined in the EU Habitats Interpretation Manual as:

"elevated, elongated, rounded or irregular topographic features, permanently submerged and predominantly surrounded by deeper water. They consist mainly of sandy sediments, but larger grain sizes, including boulders and cobbles, or smaller grain sizes including mud may also be present on a sandbank. Banks where sandy sediments occur in a layer over hard substrata are classed as sandbanks if the associated biota are dependent on the sand rather than on the underlying hard substrata.

In this document they are referred to as 'subtidal sandbanks'.

Within the UK's inshore waters subtidal sandbanks can be categorised into four main sub-types:

- gravelly and clean sands
- muddy sands;
- eelgrass *Zostera marina* beds;
- maerl beds (composed of free-living Corallinaceae).

A variety of different sandbank types and their associated communities exist in Wales. Of the few moderate sized sandbanks in Wales there are those that are exposed to prevailing winds and currents e.g. Devils Ridge, Bastram Shoal (Pen Llŷn) and Bais Bank (Pembrokeshire) and those that are less exposed to these conditions e.g. the Four Fathom Banks complex and Constable Bank (off Colwyn Bay). As well as these types that occur in fully marine environments there are also extensive mobile sandbanks that exist under reduced or variable salinity and turbid regimes in the Severn Estuary. The sandbanks of the Carmarthen Bay SAC are gravelly and clean sands.

4.6.1 Range

The SAC includes the sandbank of Helwick Bank which is located in open water to the south of Worms Head off the Gower Peninsula (Map 3). The Bank covers an estimated area of around 7,865 ha and the computed average annual volume above the 25 m contour for the years 1993 to 2002 was of the order of 175m cubic metres. With a minimum of 171 m cubic metres and a maximum of 178m cubic metres it is clear that the differences in volume from year to year can be of the order of millions of cubic metres.

4.6.2 Structure and Function

Helwick Bank is a linear, very shallow, subtidal sandbank that is the most highly exposed to wave and tidal action of all the Welsh sandbanks. The Bank is oriented in an east-west direction and is approximately 12 km in length. It consists of two shoal areas (East and West Helwick), with a slightly deeper area between known as Helwick Swatch. The Bank is closely associated with the coastal headland of Port Eynon Point and the current flows around it. The local geology underlying and adjacent to the Helwick Bank, in particular the Carboniferous limestone bedrock of Port Eynon Point close to the bank, and the underlying flat surface of Lias bedrock, are important in determining the hydrodynamic regime, sediment dispersal and deposition and morphological evolution of the sandbank.

The seabed south of the Bank rises from around 32m to between 3-4m on the crests of the East and West Helwick shoals and around 6 m on Helwick Swatch. To the north of the Bank, the seabed falls away to a shallow flat area before rising once again to the coast. To the northwest, the Bank grades into the slightly deeper sand sheet of Carmarthen Bay, and to the south and east, the seabed deepens between 20 and 30 m.

The seabed sediments of the Helwick Bank area are predominantly uniform, medium fine sands with little or no fine or organic material. The more landward side of Helwick Bank is comprised of finer sands. To the south of the Bank, in deeper water, there are some uniform gravelly sands with no bedforms, and areas of irregular sand patches on gravel. There are sand waves along the flanks of the Bank indicating large-scale sand transport and an area of megaripples to the south of the Bank, that merges to the west with an area of sand waves and gravelly sand. These ripples are superimposed on larger bedforms. The asymmetry of these sand waves (plus textural analysis and current modelling) indicate that all the bank has a clockwise sediment bedload circulation pattern, with flood dominant movement on its northern inshore side and ebb dominant movement on its southern offshore side. This circulation pattern is important in maintaining the overall geomorphology of the bank.

The salinity of the water column above the Helwick Bank and that of the interstitial sediment water is considered to be fully marine. The nutrient and contaminant levels in the water column are unknown, but assumed to be low because of the hydrodynamic setting of the Helwick Bank. Sediment nutrient and contaminant levels are also unknown, but assumed to reflect concentrations in overlying water. The oxygen content of the water column above the Helwick Bank and that of the interstitial sediment water is considered to be fully saturated.

The Helwick Bank complex lies within known spawning and nursery grounds for lemon sole *Microstomus kitt*, and within nursery areas for plaice *Pleuronectes platessa*, and whiting *Merlangius merlangus*. The area is also believed to be a nursery area of considerable importance for turbot

Scophthalmus maximus, as evidenced by the presence of juveniles of this species (SWSFC, pers. comm.).

4.6.3 Typical species

The animal communities found in and on Helwick Bank are mostly characteristic of mobile sands and gravels with the exception of those to the south of the bank and many species spend most of their time wholly or partly buried in the sediment.

The sublittoral coarse sediments, mobile sand and gravels on the toe of the bank, the southern part of West Helwick, and main part of East Helwick have communities dominated by *Hesionura elongata, Nephtys cirrosa, Protodriloides chaetifer*. The communities on the north of the bank and in Helwick Channel are characteristic of those on sublittoral sand and non-cohesive muddy sand, with sparse fauna in infralittoral mobile clean sand. They include *Gastrosaccus spinifer, Nephtys cirrosa, Pontocrates arenarius*. The sublittoral coarse sediments, on the south of the bank are dominated by *Bodotria arenosa, Lanice conchilega, Lagis koreni, Mediomastus fragilis*.

The sandbanks show an increasing species richness in deeper waters. The polychaetes *Hesionura elongata* and *Nephtys cirrosa*, and the archiannelid *Protodriloides chaetifer* are all common across the Helwick Bank, and the sediments are dominated in sections by *Nephtys cirrosa* and the mysid *Gastrosaccus spinifer*. All four species are common to fine-medium sand habitats, particularly those subject to high water and sediment movements and where species richness is low. Infaunal samples found an average of 41 species per grab on the Helwick Bank (East) and 37 species per grab on the Helwick Bank (West). Species numbers from two stations on the seaward side of the Helwick Bank were highest, *i.e*. 102 and 103 species for Helwick Bank (East) and Helwick Bank (West) respectively. These two stations in deeper water, with more stable sandy substrates, are therefore considerably more species rich than the shallow water, high energy, sites.

Fish use the Helwick Bank in a number of ways including spawning, nursery and feeding.
Nine species of fish were caught during a 2001 survey with the catch dominated by weaver fish *Echiichthys vipera*, spotted ray *Raja montagui*, grey gurnard *Eutrigla gurnardus*, and sand sole *Solea lascaris*, followed by plaice *Pleuronectes platessa*, and turbot *Scophthalmus maximus*. Blonde ray *Raja brachyra*, and cuckoo ray *Raja naevus*, are also caught in this area (SWSFC, pers. comm.). Some ray species are likely to spawn on the sandbank, for instance thornback ray *Raja clavata*, blonde ray *Raja brachyra*, small-eyed ray *Raja microoculata* and spotted ray *Raja montagui*. The area is also used as a nursery ground, possibly by thornback, small-eyed and spotted rays, because they all favour inshore nursery areas. The extent of the area used by rays is unknown, although research has shown that juvenile thornback rays appear to be highly site-specific, remaining close to the coast for several years, and thornback rays are probably ubiquitous in sand and gravel coastal waters. Sandeels *Ammodytes tobianus* are also thought to spawn on Helwick Bank and the surrounding, seabed. They are a common inshore species and are likely to occur along the length of the Bank and surrounding sandy substrates to a depth of around 30 m. They play a fundamental role in the local marine food web: bass *Dicentrarchus labrax*, whiting *Merlangius merlangus*, cod *Gadus morrhua*, sole *Solea* spp., plaice *Pleuronectes platessa*, brill *Scophthalmus rhombus*, and flounder *Platichthys flesus*, are all known to feed on sandeels. These in turn attract larger predators. Notable species include the southern cumacean *Cumopsis fagei* which has been identified from several stations on Helwick Bank and which is not frequently recorded from British waters, the bryozoan *Hippopodinella lata* at the northernmost limit of its distribution, the gastropod *Chrysallida interstincta* which is rare in the region, and the polychaete *Euzonus flabelligerus* which has a limited number of recordings from UK waters. Some of these species may be under-recorded, rather than truly rare and therefore the information should be treated with caution, until further evidence is available.

4.6.4 Natural processes

Subtidal sandbanks are dynamic features with their size, shape, aspect and orientation, as well as the macro- and micro-topography and sediment characteristics largely determined by the sediment supply and the influence of the hydrodynamic processes affecting each bank. They change shape over time

and while some are ephemeral others may be relatively stable and long established. Mobile sediments that form temporary sandbanks are considered to be associated sediments that should be retained in the system but their location may change.

4.6.5 Modifications as a result of human activity

The Helwick Bank forms a key component of the Bristol Channel sediment system. This larger circulatory system appears to be in gradual decline as sediment is stripped from its bedload parting in the east and lost to the Celtic Sea in the west; The Helwick Bank is an open system both receiving and losing sand to adjacent areas but whose inputs depend primarily on movements from the east, which appear to be in decline.

Annual monitoring data demonstrates a net loss of sand from the Helwick Bank open system, amounting to some 300,000 m^3 per year from the volume contained above the -15 m CD contour. This net loss is primarily due to natural processes but losses due to aggregate extraction in the past have formed a significant proportion of the volume lost. Although it is not possible to distinguish between the processes of natural and artificial losses it is nevertheless clear that, in strictly volumetric terms, losses due to aggregate extraction have not been replenished on the upper levels of the Helwick Bank.

Sea level rise is not considered to have had a significant impact on the identification of sediment losses from the Helwick Bank. Sea level rise has averaged 0.00076 m per year over the past 200 years, an order of magnitude less than the average vertical fall in surface elevation of the crest of the Bank. Since sand removed by aggregate extraction is not re-supplied to the system, the morphology and processes of adjacent coasts may be adversely affected. The net loss of volume affects the areas of greatest concern for the geomorphological integrity of the Helwick Bank. Aggregate extraction continues to take place at Helwick Bank which was granted a new 7-year license to dredge at a rate of 150,000 tonnes per annum.

CCW consider with a very high degree of confidence that the sandbank is in morphological decline. Although this is mainly due to natural processes, it is clear that any further extraction will exacerbate the deterioration of the morphology of the bank and its associated FCS. Furthermore, the behaviour of the sandbank macro-topography, in particular its progressive / ongoing lowering of sandbank crest level relative to the tidal frame, will inevitably result in impacts on the structure, function, and ultimately, on the typical species of the sandbank habitat. The lowering of the crest level will be exacerbated by aggregate extraction, as this is the part of the sandbank where the dredging takes place. This will compromise the conservation objectives relating to the biological interests of the sandbank feature. The conservation objectives integrate the physical and biological characteristics, and all are of equal importance.

There are two concerns in terms of the potential impacts of aggregate extraction on the infauna of Helwick Bank. These are the direct effects of removal of sediment and the animals within it and possible long-term changes in the morphology and physical characteristics of the bank. Long-term changes in morphology are a concern, as a decrease in the height of the bank and/or an increase in the general stability of the bank will affect the biological character of the bank. However, it is very difficult to say precisely how much of a decrease in the height of the bank would cause a significant change in the biology.

4.7 SHAD *ALOSA* SPP.

Shad are herring-like fish that spend most of their adult lives in the sea but spawn in rivers (or, occasionally, in the upper reaches of estuaries) and usually migrate through estuaries in spring on their way to the spawning grounds. Shads in the marine environment are completely dependent on the riverine stage of their life cycle and thus on the appropriate conservation of their riverine habitats. The shad occurs in several rivers in Wales, the most important populations being in the Tywi, Usk, Wye and Severn.

4.7.1 Population dynamics

The River Tywi is thought to be one of only four rivers in Wales where the shad *Alosa sp.* spawns. Twaite shad *Alosa fallax* and Allis shad *A.alosa* have interbred/hybridised in this river and are therefore indistinguishable and genetically identical. For these reasons they are dealt with together.

Spawning success, production and survival of fry and recruitment of juveniles to the population using the site are unknown. The number of shad using the site is also unknown. Recruitment in shads has been shown to be strongly linked to abiotic factors, notably summer temperature. Recruitment seems to be highest in warm years. Contrary, high flows between May and August may result in fry being washed prematurely out to sea.

4.7.2 Range

Shad are found in the River Tywi adjoining the SAC where counts have recorded over 10,000 fish. The River Tywi is one of only four rivers in Wales where there is a known spawning population of shad. The estuary and the surrounding coastal waters are therefore extremely important for this species, as fish must migrate through this area to reach the spawning site. Fish from the other three rivers are also quite likely to use the inshore waters of the *Carmarthen Bay & Estuaries SAC* for feeding.

The migratory habits of shad entering the estuaries of the *Carmarthen Bay & Estuaries SAC* and ascending the rivers to spawn are unknown. However, it must be assumed that the SAC is an important migration route, as evidenced by the presence of both juvenile and adult shads.

4.7.3 Habitat and species

Shad migrate though the waters of the SAC to reach spawning sites in the River Tywi. The Taf-Tywi-Gwendraeth Estuary is also important as a nursery area and it is likely that shad feed in the inshore waters of Carmarthen Bay.

The habitat requirements of shad are not fully understood. On the Rivers Usk and Wye, they are known to spawn at night in a shallow area near deeper pools, where the fish congregate. The eggs are released into the water column, sinking into the interstices between coarse gravel/cobble substrates. Most adults die after spawning, though UK populations appear to have an unusually high proportion of repeat spawners – up to 25 %. After hatching the fry develop and slowly drift downstream. Recruitment seems to be highest in warm years, and high flows between May and August may result in fry being washed prematurely out to sea.

The upstream migration from the estuary appears to be triggered by temperature. Claridge & Gardner (1978) found that migration started when the temperature reached 12 ^{o}C and Aprahamian (1982) confirmed that peak migratory activity occurred at temperatures of 10-14 ^{o}C. Spawning runs are also influenced by other factors, notably estuarine tides and river flows. Shad appear to move up estuaries on spring tides and although migration has been recorded at its peak during relatively high discharge levels, if flows are too high then numbers drop. Obstacles to migration include natural obstacles such as waterfalls, or man-made dams and weirs. Pollution can also create a barrier to movement.
The extent and distribution of suitable habitat for the full size range of juvenile shad in the SAC is unknown, however, it must be assumed that conditions are favourable, as evidenced by their presence. Shad are thought to be adversely affected by poor water quality and temperature also appears to affect recruitment, although this may be more relevant in the riverine phase of the life cycle. Suitable habitats must also include requirements for abundant, suitable prey present.

Feeding requirements of populations within the site and the status of preferred prey species within the site is unknown. However, as the shads utilizing the site are considered to be hybrids, it is assumed that they are not exclusively planktivorous (unlike pure Allis shad), but also feed on small fish, and this is likely to be reflected in their habitat selection. The young fish will feed mainly on

invertebrates, especially estuarine zooplankton, but as they grow they will take larger crustaceans of various types (for example, shrimps and mysids) and also small fish. Adults feed to an appreciable extent on other fish, especially the young of other Clupeidae, such as sprat and herring.

4.7.4 Modifications as a result of human activity

Population declines in many parts of Europe have been attributed to pollution, overfishing and migratory route obstructions.

4.8 RIVER LAMPREY (*LAMPETRA FLUVIATILIS*) AND SEA LAMPREY (*PETROMYZON MARINUS*)

Lampreys are primitive type of fishes that have a distinctive suckered mouth, rather than jaws. The river lamprey *Lampetra fluviatilis* is found only in Western Europe, where it has a wide distribution. The sea lamprey *Petromyzon marinus* occurs over much of the Atlantic coastal area of western and northern Europe and eastern North America where it is found in estuaries and easily accessible rivers.

River lampreys are widespread in the UK, occurring in many rivers. They spend much of their adult life in estuaries and inshore waters but spawn and spend the juvenile part of their life cycle in rivers. The larvae (ammocoetes) spend several years buried in sandy sediment in rivers feeding on organic matter before metamorphosing after around 4 years. Juveniles migrate to estuaries and inshore waters where they feed parasitically on various fish species. Once fully grown, they migrate upstream to spawn. There are a few land-locked populations, including one in Scotland. During their marine phase, river lampreys are predominantly an inshore species feeding on small fish such as herrings and sprats.

Sea lampreys have a similar life cycle to the river lamprey, although much larger and more oceanic, feeding parasitically on big species such as basking sharks. It is an anadromous species (*i.e.* spawning in fresh water but completing its life cycle in the sea). Like the river lamprey, sea lamprey need clean gravel for spawning, and marginal silt or sand for the burrowing juvenile ammocoetes. However, unlike the other species, they tend to spawn in the lower to middle reaches of rivers, in deep, fast-flowing waters. Sea lampreys occur in many Welsh rivers, including the Teifi, Tywi, Usk, Wye, Cleddau and Dee. These sites all include estuaries or areas adjacent to estuaries that are thought to be either part of the migratory route or used by river lampreys.

4.8.1 Population dynamics

River and sea lampreys are difficult to sample and rarely caught by fishermen. Little is known about the spawning success, production and survival of ammocoetes and recruitment of juveniles to the population using the site or the number of adult river and sea lamprey using the site.

4.8.2 Range

The habitat preferences and distribution of individuals within the site are unknown. The migratory habits of river lamprey entering the estuaries of the *Carmarthen Bay & Estuaries SAC* and ascending the rivers to spawn are unknown. However, it must be assumed that the SAC is an important migration route, as evidenced by the presence of ammocoetes and juveniles in the rivers adjoining the SAC. River lampreys migrate through the SAC to reach the River Tywi. Fish from the Rivers Usk and Wye are also quite likely to use the inshore waters of the SAC.

Sea lampreys migrate through the site to reach the River Tywi. Fish from the Rivers Usk and Wye are also quite likely to use the inshore waters of the SAC. Mature adults enter the estuaries from April onwards and migrate some distance upstream, providing that there are no obstacles - natural (*e.g.* waterfalls) or man-made (*e.g.* dams, weirs or pollution barriers). Peak migration usually coincides with temperatures that remain above 10 ^{o}C and continues until temperatures reach 18 ^{o}C. As they are larger than river lamprey this species is probably better able to swim against fast currents. The requirements of sea lamprey during the estuarine and marine phase of the life cycle are not fully

known, but as this species spends much of its time offshore while at sea, the SAC is principally a migration route.

4.8.3 Habitat and species

The spawning areas of river lamprey within or adjacent to the *Carmarthen Bay & Estuaries SAC* are unknown. However, it must be assumed that the area contains important spawning sites as evidenced by the presence of both ammocoetes and adult river lampreys within estuarine and fresh waters.

The feeding habits of juvenile and adult river lampreys in or adjacent to the SAC are also unknown. In the estuaries of major rivers, such as those entering SAC, young river lampreys can be found feeding on a variety of estuarine fish, but particularly herring, sprat and flounder. The adults feed on much the same species in both estuaries and coastal waters. Sprats are abundant during the winter in Carmarthen Bay and flounders are also common and therefore these are likely to be a primary food source. It is not known if lamprey attack sole and bass, which are common in Carmarthen Bay. Anecdotal evidence from anglers suggests that they often inflict extensive damage on these hosts by rasping away large amounts of flesh from the back. Salmon *Salmo salar* and sea trout *Salmo trutta* entering rivers often bear fresh scars attributable to attacks by this species.

The feeding habits of juvenile and adult sea lampreys in or adjacent to the SAC are unknown however there is little evidence for any differences in the food or feeding habits of the juvenile stage of the river lamprey.

4.8.4 Modifications as a result of human activity

River and sea lampreys are difficult to sample and rarely caught by fishermen making it is difficult to accurately assess the conservation status of these species at this site. There are no significant obstructions within the SAC, and the water quality is generally good.

4.9 OTTER (*LUTRA LUTRA*)

The otter *Lutra lutra* is a semi-aquatic mammal which occurs in a wide range of ecological conditions, including inland freshwater and coastal areas. Populations in coastal areas use shallow, inshore marine areas for feeding but also require freshwater for bathing and terrestrial areas for resting and breeding holts. Coastal otter habitat ranges from sheltered wooded inlets to more open, low-lying coasts. Inland populations utilise a range of running and standing freshwaters. These must have an abundant supply of food (normally associated with high water quality), together with suitable habitat, such as vegetated riverbanks, islands, reed beds and woodland, which are used for foraging, breeding and resting.

At present, the majority of the otter population in Great Britain occurs in Scotland, with a significant proportion of this number being found in the north and west of the country. Other strong populations survive in Wales and Ireland. Recent surveys suggest that the otter population is recovering well and recolonising parts of its former range. While the SAC series makes a contribution to securing favourable conservation status for this Annex II species, wider countryside measures, in particular implementation of the UK's Biodiversity Action Plan, are important to its conservation in the UK.

4.9.1 Population dynamics

The number of otters using the site is unknown as is the age frequency and sex ratio. Otters are known to breed about 1 km inland on the Gwendraeth Fach, near the SAC and use the estuary for foraging. The River Tywi SAC (adjacent to the *Carmarthen Bay & Estuaries SAC*) is also considered to be of significant value for otters and there has been evidence of possible breeding near Landimore Marsh[22]. The number of otters breeding within the SAC is unknown although it is likely that they may breed

[22] Geoff Liles, pers comm..

inland, along watercourses adjacent to the SAC and utilise the SAC for foraging. There are also few details about their movement in and out of the SAC.

4.9.2 Range

Otters are known to use most areas of the coast within and adjacent to the SAC. Otters and spraints have been seen on Llanrhidian sands and Llanelli levels and it is likely that otters are coming into the estuary from the River Loughor. Otters are known to use the coast between Llanelli and Burry Port and have been seen crossing the railway line which runs along the coast. Pembrey Forest, adjacent to the SAC is well used by otters and although the Cefn Sidan sands have not been surveyed, it is very likely that otters use them.

The coast within the SAC is well supplied with rivers and streams and it is highly likely that otters travel from one watercourse to another along the coast. Otters living on the coast must have access to freshwater streams and pools for drinking and washing.

4.9.3 Habitat and species

The SAC contains important feeding areas for otters. A survey on the Gower, adjacent to the SAC found signs of otters close to or on the estuaries of many rivers suggesting that otters hunt in the salt marshes and sea surrounding the Gower. An otter has been seen hunting in the sea off Oxwich point and spraints have been found containing remains of crabs. East Marsh is known to be well used by otters where they forage in the network of ditches and dykes, and it is likely that they also use the sands (Geoff Liles, pers. comm.). The estuaries and coast in this area may be particularly important in sustaining otter populations due to the possible shortage of fish populations for example in the Gower rivers however we currently do not know what the otters feed on or the quality of food available to otters within the marine environment. The otters feeding within the SAC are probably not wholly dependent on the coast for food but that they also use the rivers adjacent to the SAC for foraging.

Coastal otters can hunt as far as 100 m offshore in water over 10 m deep, but most feeding is done much closer to shore in water less than 3 m deep. Studies on prey species taken by coastal otters in Scotland and elsewhere indicate that, fish formed more than 90 % of the diet. Other important non-fish prey items taken include crabs and sea urchins, although at a lower level in relation to their abundance than fish species. The different studies of otter diet show that the abundance of different prey items may be highly seasonal. The main hunting areas for otters on the coast are largely determined by the habitat preferences of prey species.

Over most of their range, otters are nocturnal or diurnal, probably due mainly to disturbance and persecution. When otters are not active, otters may sleep in a variety of resting places known as a den, holt or couch. These can be holes in the ground, under tree roots, within rock piles, dense scrub or in quite open places. We currently do not know where otters rest within the SAC due to their secretive nature and current lack of survey work around the coast.

4.9.4 Modifications as a result of human activity

The regular presence of otters in the SAC is important because UK otters are still recovering from a sharp population decline during the 1960s and 1970s due to pollution and exacerbated by hunting and habitat loss**.** Otters are re-colonising marine sites at a slower rate than rivers**.**

5 CONSERVATION OBJECTIVES

This latest version of the Regulation 33package has been revised to improve consistency across the marine SACs in Wales. The intent of the conservation objectives and of the advice on operations which may cause deterioration or disturbance to the feature is the same as in previous versions. The Conservation Objectives are now shorter and more generic but there has been no change in what is considered to represent Favourable Conservation Status.

In order to meet the aims of the Habitats Directive, the conservation objectives seek to maintain (or restore) the habitat and species features, as a whole, at (or to) favourable conservation status (FCS) within the site.

The Vision Statement is a descriptive overview of what needs to be achieved for conservation on the site. It brings together and summarises the Conservation Objectives into a single, integrated statement about the site.

VISION STATEMENT

Our vision for the Carmarthen Bay & Estuaries European Marine Site is one of a high quality marine environment, where the habitats and species of the site are in a condition as good as or better than when the site was selected; where human activities co-exist in harmony with the habitats and species of the site and where use of the marine environment within the European Marine Site is undertaken sustainably.

An integral part of this vision for the Carmarthen Bay & Estuaries European Marine Site is to maintain and – where necessary – restore the site to high ecological status, so that all of its special habitat and species features will be able to sustain themselves in the long-term as part of a naturally functioning ecosystem.

The physical character of Carmarthen Bay continues to be largely unmodified and undisturbed, and the natural processes of tides, waves and currents, and the associated processes of sediment erosion and deposition are allowed to operate without any undue interference, thus forming the foundations for this special ecosystem, which supports a large number of species, including bivalve molluscs, worms, burrowing urchins, brittle-stars and sand-stars.

The four estuaries surrounding Carmarthen Bay continue to form a single functional unit, with important interchanges of sediment and biota. The estuaries of this site will support a wide range of subtidal and intertidal sediments that grade from sand at their mouths to mudflats in the upper estuaries. The fauna of the sediments remains very varied, and includes communities with polychaete and oligochaete worms and areas with extensive cockle beds and other bivalve molluscs.

The site retains its complete sequences of saltmarsh vegetation, from pioneer vegetation, such as glasswort and annual seablite, through to upper, mature saltmarsh meadows of great floral variety and high biodiversity. The area also continues to be important for undisturbed saltmarsh transitions to other coastal habitats, such as shingle, sand dunes and brackish to freshwater habitats.

The abundance of prey, proximity of freshwater and availability of undisturbed resting and breeding sites, allows a large otter population to thrive. They will continue to be found along extensive stretches of the embayment and its estuaries.

The special fish species found in the site, such as the lampreys and shads, will be present in numbers that reflect a healthy and sustainable population supported by well distributed habitat of good quality with sufficient suitable food resources. These migratory fish are allowed to migrate unhindered by

artificial barriers, such as weirs, pollution or depleted flows, and undisturbed to and from any areas of the site they may require, including feeding and spawning grounds.

The Burry Inlet will continue to provide a safe refuge for internationally important numbers of over-wintering waders and wildfowl in the long-term. Curlew, dunlin, grey plover, knot, oystercatcher, pintail, redshank, shelduck, shoveler, teal, turnstone and widgeon can rely on the permanent presence of the environmental conditions necessary to sustain their over-wintering populations, including extent and quality of supporting habitats, and abundance of prey and diversity of prey species. Waders and wildfowl are allowed to inhabit their feeding grounds and resting areas with minimum disturbance, and are allowed to move unhindered between them.

The landscape quality and conservation value of the area continues to be of a very high order, and Carmarthen Bay and its estuaries will become renowned for its recreational value, with human activities being managed and developed in a manner which ensures both compatibility between activities and the sustainable use of the site. Local communities will take pride in their surroundings and work actively to make sustainable improvements for future generations.

The Habitats Directive does not include any intention to exclude human activities (commercial or recreational) from Natura 2000 sites. The aim is to ensure that those activities are undertaken in ways which do not threaten the features the site is designated for.

CONSERVATION OBJECTIVES FOR THE CARMARTHEN BAY AND ESTUARIES SPECIAL AREA OF CONSERVATION

To achieve favourable conservation status all the following, subject to natural processes, need to be fulfilled and maintained in the long-term. If these objectives are not met restoration measures will be needed to achieve favourable conservation status.

HABITAT FEATURES

Sandbanks which are slightly covered by seawater all the time
Estuaries
Mudflats and sandflats not covered by seawater at low tide
Large shallow inlets and bays
Atlantic salt meadows
Salicornia and other annuals colonising mud and sand

RANGE

The overall distribution and extent of the habitat features within the site, and each of their main component parts is stable or increasing.

STRUCTURE AND FUNCTION

The physical biological and chemical structure and functions necessary for the long-term maintenance and quality of the habitat are not degraded. Important elements include;

- geology,
- sedimentology,
- geomorphology,
- hydrography and meteorology,
- water and sediment chemistry,
- biological interactions.

This includes a need for nutrient levels in the water column and sediments to be:

- at or below existing statutory guideline concentrations
- within ranges that are not potentially detrimental to the long term maintenance of the features species populations, their abundance and range.

Contaminant levels in the water column and sediments derived from human activity to be:

- at or below existing statutory guideline concentrations
- below levels that would potentially result in increase in contaminant concentrations within sediments or biota
- below levels potentially detrimental to the long-term maintenance of the features species populations, their abundance or range.

For **Atlantic saltmeadows** this includes the morphology of the saltmarsh creeks and pans

TYPICAL SPECIES

The presence, abundance, condition and diversity of typical species is such that habitat quality is not degraded. Important elements include:

- species richness,s
- population structure and dynamics,
- physiological heath,
- reproductive capacity
- recruitment,
- mobility
- range

As part of this objective it should be noted that:

- populations of typical species subject to existing commercial fisheries need to be at an abundance equal to or greater than that required to achieve maximum sustainable yield and secure in the long term
- the management and control of activities or operations likely to adversely affect the habitat feature, is appropriate for maintaining it in favourable condition and is secure in the long term.

SPECIES FEATURES

Otter
Shad *Alosa* spp.
River lamprey
Sea lamprey

POPULATIONS

The population is maintaining itself on a long-term basis as a viable component of its natural habitat. Important elements are population size, structure, production, and condition of the species within the site.

As part of this objective it should be noted that:

- Contaminant burdens derived from human activity are below levels that may cause physiological damage, or immune or reproductive suppression

RANGE

The species population within the site is such that the natural range of the population is not being reduced or likely to be reduced for the foreseeable future.

As part of this objective it should be noted that

- Their range within the SAC and adjacent inter-connected areas is not constrained or hindered
- There are appropriate and sufficient food resources within the SAC and beyond
- The sites and amount of supporting habitat used by these species are accessible and their extent and quality is stable or increasing

SUPPORTING HABITATS AND SPECIES

The presence, abundance, condition and diversity of habitats and species required to support this species is such that the distribution, abundance and populations dynamics of the species within the site and population beyond the site is stable or increasing. Important considerations include;

- distribution,
- extent,
- structure,
- function and quality of habitat,
- prey availability and quality.

As part of this objective it should be noted that;

- The abundance of prey species subject to existing commercial fisheries needs to be equal to or greater than that required to achieve maximum sustainable yield and secure in the long term.
- The management and control of activities or operations likely to adversely affect the species feature, is appropriate for maintaining it in favourable condition and is secure in the long term.
- Contamination of potential prey species should be below concentrations potentially harmful to their physiological health.
- Disturbance by human activity is below levels that suppress reproductive success, physiological health or long-term behaviour
- For **otter** there are sufficient sources within the SAC and beyond of high quality freshwater for drinking and bathing.

CONSERVATION OBJECTIVES FOR THE BURRY INLET AND CARMARTHEN BAY SPECIAL PROTECTION AREAS

Burry Inlet SPA
curlew *Numenius arquata*
dunlin *Calidris alpina alpine*
grey plover *Pluviatilis squatarola*
knot *Calidris canutus*
oystercatcher *Haematopus ostralegus*
pintail *Anas acuta*
redshank *Tringa tetanus*
shelduck *Tadorna tadorna*
shoveler *Anas clypeata*
teal *Anas crecca*
turnstone *Arenaria interpres*
wigeon *Anas penelope*

Carmarthen Bay SPA
common scoter *Melanitta nigra*

To achieve favourable conservation status all the following, subject to natural processes, need to be fulfilled and maintained in the long-term. If these objectives are not met restoration measures will be needed to achieve favourable conservation status.

(i) The numbers of all SPA bird species are stable or increasing.

(ii) The abundance and distribution of suitable prey are sufficient and appropriate to support the numbers of all SPA bird species.

(iii) All SPA birds are allowed to inhabit their feeding grounds and resting areas with minimum disturbance, and are allowed to move unhindered between them.

(iv) All states of the Conservation Objectives for the supporting habitats and species, subject to natural processes, are fulfilled and maintained in the long-term.

Supporting habitats for bird species of the Burry Inlet SPA include:

- Estuaries
- Mudflats and sandflats not covered by seawater at low tide
- Atlantic salt meadows
- *Salicornia* and other annuals colonising mud and sand

'Large shallow inlets and bays' are the supporting habitat for the common scoter of the Carmarthen Bay SPA.

(v) The management and control of activities or operations likely to be of significant effect to the oystercatchers, is appropriate for maintaining the feature at FCS and is secure in the long-term.

5.1 UNDERSTANDING THE CONSERVATION OBJECTIVES

A dynamic marine environment

The conservation objectives recognise and acknowledge that the features are part of a complex, dynamic, multi-dimensional environment. The structures, functions (environmental processes) and species populations of habitat features are inextricably linked. Marine habitats are complex ecological webs of species, habitat structure and environmental functions that vary dynamically in time and space. Variety and change in habitat structure is primarily driven by environmental and physico-chemical factors, including water movement, water quality, sediment supply and prevailing weather conditions.

The species populations associated with these habitats also vary in time and space and this is, in part, a direct reflection of the variable habitat structure and dynamic environment. It is also the product of stochastic events and the great variation in survival and recruitment of species, particularly those with dispersive reproductive strategies.

Within the dynamism of habitats and species, there is also an element of stability and persistence, where species' and communities' populations as well as physical habitat structure show little overall long-term variation.

Human activities

These conservation objectives recognise and acknowledge that human activity has already modified and continues to modify habitats and species populations in various ways, to varying degrees and at varying spatial and temporal scales, either acutely or chronically. The conservation objectives do not aim to prevent all change to the habitat and species features, or to achieve an indefinable, abstract natural or pristine state, since these would be unrealistic and unattainable aspirations. Rather, they seek to prevent further negative modification of the extent, structure and function of natural habitats and species' populations by human activity and to ensure that degradation and damage to the features that is attributable to human activities or actions is prevented. Consequently, in order to meet the requirements of the Directive and ensure the site makes its appropriate contribution to conservation of biodiversity, the conservation objectives seek to:

- Encompass inherent dynamism rather than to work against it;
- Safeguard features and natural processes from those impacts of human activity that cause damage to the features through the degradation of their range, extent, structure, function or typical species;
- Facilitate, where necessary, restoration of features or components of features that are currently damaged or degraded and in unfavourable condition.

The term *degradation* is used to encompass damage or deterioration resulting only from such human activities or actions as have a detrimental effect on the feature. The magnitude of any degradation is dependent on the longevity and scale of the impact and the conservation importance of the species or habitats on which the impact occurs. This is influenced by:

- the type of human action, its nature, location, timing, frequency, duration and intensity,
- the species or habitats, and their intolerance and recoverability.

Outcomes arising from human action that are likely to be considered detrimental include such effects such as:

- permanent and long-term change of distribution or reduction in extent of a feature or feature component, or temporary modification or reduction sufficiently significant to negatively impact on biota or ecological processes;
- reduction in ecological function caused by loss, reduction or modification of habitat structural integrity;
- interference in or restriction of the range, variety or dynamism of structural, functional or ecological processes, *e.g.*: alteration of habitat structure, obstruction of tidal streams, chronic or

acute thermal, salinity or suspended sediment elevations or reductions;
- hypertrophication or eutrophication;
- contamination by biologically deleterious substances;
- reduction in structure, function and abundance of species populations;
- change in reproductive capacity, success or recruitment of species populations;
- reduction in feeding opportunities of species populations
- reduction of health to a sub-optimal level, or injury, rendering the population less fit for, *inter alia,* breeding, foraging, social behaviour, or more susceptible to disease;
- increase in abundance and range of opportunist species through the unnatural generation of preferential conditions (*e.g.* organic enrichment), at the expense of existing species and communities.
- increase in abundance and range of non-native species.

The following table provided illustrative examples of specific changes and whether they would constitute degradation of the feature.

Degradation	Not Degradation
Reduction in grey seal reproductive potential as a result of sub optimal physiological health caused by high tissue burdens of anthropogenically derived contaminants.	Reduction in grey seal reproductive potential as a result of sub optimal physiological health caused by density dependent incidence of endemic disease.
Modification of a seabed community by organically rich effluent from a new sewage outfall.	Modification of a seabed community as a result of a reduction in organic material entering the sea from a sewage outfall.
Change in seabed community composition as a result of coastal engineering that has altered local wave exposure.	Change in seabed community composition as a result of a cliff fall, the debris from which has altered local wave exposure.
Change to the species composition of a seabed community as a result of an increase in scallop dredging intensity.	Change to the composition of a seabed community as a result of a reduction in scallop dredging intensity.
Permanent reduction of extent of sand and mud-flat as a result of new coastal development.	Permanent reduction of extent of sand and mud-flat as a result of long-term natural changes in sediment transport.
Changes in sediment granulometry as a result of beach recharge operations	Changes in sediment granulometry as a result of natural cliff fall and erosion

It is important to note that many human activities can either be beneficial (reduce or reverse detrimental human influence (*e.g.* improve water quality)), trivial (*e.g.* no significant and/or substantive long-term effect) or benign (no outcome) in terms of their impact on marine habitats and species.

Advice on potentially detrimental human activities is provided in Section 6 (activities or operations which may cause damage or disturbance to features).

Use of the conservation objectives – Site management

The components of favourable conservation status detailed in the conservation objectives have different sensitivities and vulnerabilities to degradation by human activities. Conservation and protection of site features is provided by management, which should be based on levels of risk. The form of management and degree of protection necessary will vary spatially, temporally and from one feature component to another due to their differences in conservation importance and their sensitivity and susceptibility to change as a result of human action. Therefore it needs to be understood that

these conservation objectives require a risk-based approach to the identification, prioritisation and implementation of management action.

Security of management is provided in part by sections 48 to 53 of the 1994 Conservation Regulations, which require the assessment of plans and projects likely to have a significant effect on the site.

Where there is a potential for a plan or project to undermine the achievement of the conservation objectives, CCW will consider the plan/project to be likely to have a significant effect and require appropriate assessment. Unless it is ascertained, following an appropriate assessment, that a plan or project will not undermine the achievement of the conservation objectives, the plan/project should be considered as having an adverse affect on the integrity of the site[23].

Appropriate and secure management of activities may also be provided through a site management plan.

[23] Uncertainty should not result in a conclusion of no adverse affect on site integrity.

6 ADVICE AS TO OPERATIONS WHICH MAY CAUSE DETERIORATION OR DISTURBANCE TO THE FEATURES

The range of different habitat types within each of the SAC's features is extremely wide and marine habitats and species populations are inherently dynamic. The range and scale of both natural and anthropogenic stressors on the marine habitats and species within the SAC are also very large. Human activities have the potential to impose stresses on each habitat's structure and function in many ways that result in acute, chronic or permanent impacts at different spatial scales. Species populations may also be affected at many levels e.g. physiological, genetic, single organism, population and groups of species.

The following table identifies where there is a potential for operations or activities to have an adverse effect on a feature or component of a feature exists. This does not imply a significant actual or existing causal impact. The potential for, and magnitude of, any effect will be dependent on many variables, such as the location, extent, scale, timing and duration of operations or activities, as well as proximity to features that are sensitive to one or more factors induced or altered by the operation. Due to the complexity of the possible inter-relationships between operations or activities and the features, the factors and effects listed in this table are the predicted most likely effects and are not exhaustive.

- The 'activity' column lists potentially damaging operations and gives an indication of their current known status within the SAC. Operations or activities marked with an asterisk (*) may have associated consents, licences, authorisations or permissions which are (or may be) plans or projects, within the meaning of Article 6 of the Habitats Directive. (The potential effects of the construction phase of operations marked with a hash (#) are included in the general operation 'construction'.
- The 'key relevant factors' columns (physical, chemical and biological factors) give an indication of the key mechanisms by which the operation or activity may cause an effect on each habitat feature.
- The 'most likely effects' columns indicate the most likely components of Favourable Conservation Status that might be affected by each operation or activity.
- The 'features' columns indicate which Annex 1 habitats and Annex II species could potentially be affected by the operation or activity.
- The 'advice as to likely required action' column provides an indication of the actions required (from CCW and others) to undertake specific risk assessments of relationships between the operation or activity and relevant features, including any further information that would be necessary to further refine / tailor advice.

Activity	Key Relevant factors			Most likely effects on FCS elements *Habitats*			Most likely effects on FCS elements *Species*			Features											Advice/Action/Notes
	physical	chemical	biological	range	Structure & function	Typical species	population	range	Habitats & species	Inlets & bays	estuaries	Saltmeadows	*Salicornia*	Mud and sandflats	Subtidal sandbanks	shads	lampreys	otters	Cardigan Bay SPA	Burry Inlet SPA	
DOCKS, MARINAS & SHIPPING																					
Dock, harbour & marina structures: construction **Small to medium-scale dock / port facilities at Llanelli, Burry Port,Tenby & Saundersfoot. No facility as yet that can be classified as 'Marina', but future developments are likely to focus on existing facilities at these locations.*	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	Treat as plan or project as appropriate. Consenting bodies ensure appropriate integration, inclusion and consultation Consenting bodies ensure assessment of cumulative effects in association with others plans and projects
Dock, harbour & marina structures: maintenance *Asabove*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	Treat as plan or project as appropriate. Review, revise or establish management practices and spatial, temporal & technical operational limits suitable to secure features at FCS; monitor compliance and enforce.
Dredging: capital * None at present.(c.f. aggregate extraction; also see dredge spoil disposal)	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓			Treat as plan or project as appropriate. Establish best operational practices suitable to secure features at FCS
Dredging: maintenance **Extent unknown. Approaches and navigation channel to Burry Port were dredged in 2007. (c.f. aggregate extraction; also see dredge spoil disposal)*	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓			Treat as plan or project if appropriate. Review, revise or establish management practices and spatial, temporal & technical operational limits suitable to secure features at FCS; monitor compliance and enforce.
Shipping: vessel traffic *No data available.*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	Determine effects of vessel movement on sediment transport, mobilisation and turbidity. Review, revise or establish management practices and spatial, temporal & technical operational limits suitable to secure features at FCS; monitor compliance and enforce. Secure appropriate management of vessels transiting coastal waters to minimise risk to features FCS
Shipping: moorings *Potential exists, but no data available.*	✓				✓	✓				✓	✓			✓							Treat new mooring developments as plan or project as appropriate. Review, revise or establish management practices and spatial, temporal & technical operational limits suitable to secure features at FCS; monitor compliance and enforce. Secure appropriate management of moorings in open coastal locations

Activity	Key Relevant factors			Most likely effects on FCS elements *Habitats*			Most likely effects on FCS elements *Species*			Features											Advice/Action/Notes
	physical	chemical	biological	range	Structure & function	Typical species	population	range	Habitats & species	Inlets & bays	estuaries	Saltmeadows	*Salicornia*	Mud and sandflats	Subtidal sandbanks	shads	lampreys	otters	Cardigan Bay SPA	Burry Inlet SPA	
Shipping: anchoring *No data available.*	✓				✓	✓				✓	✓			✓							Review, revise or establish management practices and spatial, temporal & technical operational limits suitable to secure features at FCS; monitor compliance and enforce. Secure appropriate management of open coastal locations used as commercial anchorages and for casual recreational anchoring
Shipping: vessel maintenance (incl. antifouling) *Not known in site.*		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓			Review, revise or establish management practices and spatial, temporal & technical operational limits suitable to secure features at FCS; monitor compliance and enforce.
Shipping: ballast water discharge *Presumed not to occur within site. Potential exists for effects from shipping transiting offshore in Bristol Channel.*		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				Review, revise or establish management practices and spatial, temporal & technical operational limits suitable to secure features at FCS; monitor compliance and enforce. Secure appropriate management of vessels transiting coastal waters to minimise risk to features FCS
Shipping: refuse & sewage disposal *Presumed not to occur within site. Potential exists for effects from shipping transiting offshore in Bristol Channel.*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Management practices and spatial, temporal & technical operational limits suitable to secure features at FCS; monitor compliance and enforce. Secure appropriate management of vessels transiting coastal waters so as to secure features at FCS Apply existing legal mechanisms, monitor compliance and enforce, to secure features at FCS
Shipping: operational discharges *Presumed not to occur within site. Potential exists for effects from shipping transiting offshore in Bristol Channel.*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Review, revise or establish management practices and spatial, temporal & technical operational limits suitable to secure features at FCS; monitor compliance and enforce. Secure appropriate management of vessels transiting coastal waters so as to secure features at FCS
Shipping: accidents -may be associated with cargo / bunkers discharges *No data since Sea Empress Oil Spill.*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	Maintain, keep under review and improve as appropriate, shipping management and operational practices suitable to secure features at FCS; monitor compliance and enforce. Secure appropriate management of vessels transiting coastal waters so as to secure features at FCS Seek advice from relevant environmental agencies (CCW, EAW)
Shipping: accidents -fuel oil & / or petrochemical discharges *No data since Sea Empress Oil Spill.*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	As above

Activity	Key Relevant factors			Most likely effects on FCS elements *Habitats*			Most likely effects on FCS elements *Species*			Features											Advice/Action/Notes
	physical	chemical	biological	range	Structure & function	Typical species	population	range	Habitats & species	Inlets & bays	estuaries	Saltmeadows	*Salicornia*	Mud and sandflats	Subtidal sandbanks	shads	lampreys	otters	Cardigan Bay SPA	Burry Inlet SPA	
Shipping: accidents -non-petrochemical cargo losses / discharges *Rare; most recent in February 2008 when a container containing acetic anhydride came aground at Paviland Bay near Pitton Green (South Gower).*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Maintain, keep under review and improve as a appropriate, management and operational practices suitable to secure features at FCS; monitor compliance and enforce. Secure appropriate management of vessels transiting coastal waters so as to secure features at FCS Seek advice from relevant environmental agencies (CCW, EAW)
Shipping: accidents - salvage operations *No data available.*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	Maintain, keep under review and improve as a appropriate, management and operational practices suitable to secure features at FCS; monitor compliance and enforce. Secure appropriate management of vessels transiting coastal waters so as to secure features at FCS Provide environmental advice to salvage managers and salvors.
CIVIL ENGINEERING																					
Construction * *Widespread along the north side of Burry Inlet, with current construction hotspots at Loughor, Llanelli and Burry Port.*	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	Treat as plan or project, taking into account proposed subsequent operational use and maintenance. Consenting bodies ensure appropriate integration, inclusion and consultation. Consenting bodies ensure assessment of cumulative effects in association with others plans and projects
Land claim * *Past extensive reclamation of saltmarshes along the southern shoreline of the Burry Inlet and along the Taf Estuary. No proposals at present.*	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	Treat as plan or project as appropriate, taking into account proposed subsequent operational use and likely effects.
Coast protection: hard defence (sea walls / breakwaters) *# *Locally extensive; comprehensively mapped. Worms Head – St Govans.*	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	Treat as plan or project as appropriate, taking into account long term management requirements & predicted climatic impacts
Coast protection: hard defence (railways) *# *Locally extensive; coastal tracks straddle the north coast of the Burry Inlet between Llanelli and Burry Port, and between Kidwelly and Ferryside.*	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	As above

Activity	Key Relevant factors			Most likely effects on FCS elements *Habitats*			Most likely effects on FCS elements *Species*			Features											Advice/Action/Notes
	physical	chemical	biological	range	Structure & function	Typical species	population	range	Habitats & species	Inlets & bays	estuaries	Saltmeadows	*Salicornia*	Mud and sandflats	Subtidal sandbanks	shads	lampreys	otters	Cardigan Bay SPA	Burry Inlet SPA	
Coast protection: soft defence *# *Locally extensive; comprehensively mapped. Worms Head – St Govans.*	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						As above
Coast protection: groynes *# *Worms Head – St Govans. Localised: Amroth, Ferryside (traditional timber), Llanelli (rock).*	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						As above
Coast protection: beach replenishment *# *Localised: Tenby and Saundersfoot as means of disposal of harbour dredgings. At Amroth recharge of shingle beach.*	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							As above
Coast protection: storm surge / tidal barrage **#Historical proposal in Loughor Estuary. Local interest remains. Development interest feasible.*	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	Treat as plan or project as appropriate.
Barrage: amenity *# *Historical proposal in Loughor Estuary. Local interest remains. Development interest feasible.*	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	As above
Foreshore deposit of rock, rubble *etc*. *Anecdotal & opportunistic observations*	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓	✓	Continued surveillance and monitoring. Appropriate implementation of SSSI procedures.
Artificial reef *# *Development interest feasible.*	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Treat as plan or project as appropriate.
Hard-engineered freshwater watercourses *# *Presence mapped.*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	As above
Power station *# *Development interest feasible.*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	As above
Pipelines *# *Gas pipeline beneath Loughor Estuary.*	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Treat as plan or project as appropriate, taking into account long- term management requirements & likely effects.
Power / communication cables *# *Development interest feasible. (Overhead cables at Loughor.)*	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	As above
WASTE DISPOSAL																					

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	physical	chemical	biological	range	Structure & function	Typical species	population	range	Habitats & species	Inlets & bays	estuaries	Saltmeadows	*Salicornia*	Mud and sandflats	Subtidal sandbanks	shads	lampreys	otters	Cardigan Bay SPA	Burry Inlet SPA	
Effluent disposal: domestic * *Widespread & common EAW & DCWW datasets of locations and inputs; EAW assessments: Historical changes in sewage treatment and disposal. Historical long-term increase; relatively recent decrease in solids and nutrients outputs, and changes in disposal points; recent short-term variations in discharge locations, volumes and treatment (reportedly more less-treated outputs vian CSOs). Hypertrophication within estuaries.*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	Treat new discharges and proposed changes to existing discharges as plan or project as appropriate.
Effluent disposal: industrial * *As above.*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	As above
Effluent disposal: thermal * *None known*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	As above
Sludge dumping * *None at present*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	Treat as plan or project as appropriate.
Inorganic wastes & debris (including refuse & litter) *Widespread & common incl. fly-tipping & illegal waste disposal: varies in scale from sporadic small-scale opportunistic fly-tipping to commercial fly-tipping, although generally confined to specific locations.*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	Maintain, keep under review and improve as appropriate port waste management plans Secure appropriate promulgation & enforcement of national and international dumping at sea measures so as to minimise risk to features' FCS Education & awareness raising
Dredge spoil disposal * *Nearest dredge material disposal sites are in the outer Swansea Bay and SW of Milford Haven, used for disposal of maintenance dredgings from local harbours & ports. Local, small scale relocation used for beach replenishment at small Pembrokeshire harbours. Burry Port dredgings from navigation channel disposed adjacent to channel.*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	Treat proposed spoil disposal outwith a designated spoil disposal site as plan or project as appropriate. Develop and implement best practice appropriate for disposal sites

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	physical	chemical	biological	range	Structure & function	Typical species	population	range	Habitats & species	Inlets & bays	estuaries	Saltmeadows	*Salicornia*	Mud and sandflats	Subtidal sandbanks	shads	lampreys	otters	Cardigan Bay SPA	Burry Inlet SPA	
Urban & industrial run-off *Widespread & common, but no known specific data.*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	Continued surveillance and monitoring of inputs and water quality by EAW.Continued development and promulgation of good practice. Maintain review of consents to take account of new scientific information.Include in assessment of plans and projects as appropriate
Agricultural run-off *Widespread & common Hypertrophication within estuaries.*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	Continued surveillance and monitoring of inputs and water quality by EAW; continued development and promulgation of good practice.
EXPLOITATION OF LIVING RESOURCES																					
Trawling: beam *No information available. Not pursued?*	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		Where appropriate, review, revise or establish, monitor and enforce operational limits (spatial, temporal, technical, effort) suitable to secure features at FCS. Treat new fisheries and new gear as plan or project as appropriate. Monitor and manage fisheries so that populations of prey species subject to existing commercial fisheries are equal to, or at greater abundance, than that required to achieve maximum sustainable yield.
Trawling: otter *Little info; none quantitative; indicative spatial. Reportedly throughout bay. Local small vessels. Reputedly occasional incursions by larger, foreign flagged vessels and / or vessels exceeding SWSFC byelaw VCU limit. Frequency and intensity unknown.*	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		As above .
Dredging: toothed *Not known to occur.*	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓	✓				✓		Treat new fisheries and new gear as plan or project as appropriate. Monitor and manage fisheries so that populations of prey species subject to existing commercial fisheries are equal to, or at greater abundance, than that required to achieve maximum sustainable yield.
Dredging: bladed – mussel *Local, minor, occasional (Burry Port channel).*	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓	✓				✓	✓	As above
Dredging: bladed – mussel seed *Intermittently at a few localised areas. Licensed under SWSFC byelaw after assessment and consultation with CCW.*	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓	✓				✓	✓	Where appropriate, review, revise or establish, monitor and enforce operational limits (spatial, temporal, technical, effort) suitable to secure features at FCS. Treat new fisheries and new gear as plan or project as appropriate. Monitor and manage fisheries so that populations of prey species subject to existing commercial fisheries are equal to, or at greater

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	physical	chemical	biological	range	Structure & function	Typical species	population	range	Habitats & species	Inlets & bays	estuaries	Saltmeadows	*Salicornia*	Mud and sandflats	Subtidal sandbanks	shads	lampreys	otters	Cardigan Bay SPA	Burry Inlet SPA	
																					abundance, than that required to achieve maximum sustainable yield.
Dredging: bladed - oyster Not known to occur.	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓	✓				✓		Treat new fisheries and new gear as plan or project as appropriate. Monitor and manage fisheries so that populations of prey species subject to existing commercial fisheries are equal to, or at greater abundance, than that required to achieve maximum sustainable yield.
Dredging: mechanical – cockle *Not known to occur. Not a "fishing instrument of an approved pattern" under SWSFC byelaw 40*	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓						✓	As above .
Dredging: deep hydraulic (e.g. WJID) *Interest exists; potential for legal or illegal development. Some forms of gear permitted under SWSFC byelaw; some forms prohibited under Welsh Statutory Instrument 2003 No. 607.*	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓				✓		Treat new fisheries and new gear as plan or project as appropriate. Establish, monitor and enforce operational limits (spatial, temporal, technical, effort) suitable to secure features at FCS. Monitor and manage fisheries so that populations of prey species subject to existing commercial fisheries are equal to, or at greater abundance, than that required to achieve maximum sustainable yield.
Dredging: shallow hydraulic (*e.g.* suction) *Not known to occur.*	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓				✓		As above
Netting: bottom-set gill *Extensively throughout Bay; information unclear as to gear type; frequency and intensity unknown, but reportedly seasonally substantial.*	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		Review, revise or establish, monitor and enforce operational limits (spatial, temporal, technical, effort) suitable to secure features at FCS. Monitor and manage fisheries so that populations of prey species subject to existing commercial fisheries are equal to, or at greater abundance, than that required to achieve maximum sustainable yield.
Netting: bottom-set tangle / trammel *Extensively throughout Bay; information unclear as to gear type; frequency and intensity unknown but reportedly seasonally substantial.*	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		As above
Netting: surface-set gill *Extensively throughout Bay; information unclear as to gear type; frequency and intensity unknown.*	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		As above

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	physical	chemical	biological	range	Structure & function	Typical species	population	range	Habitats & species	Inlets & bays	estuaries	Saltmeadows	*Salicornia*	Mud and sandflats	Subtidal sandbanks	shads	lampreys	otters	Cardigan Bay SPA	Burry Inlet SPA	
Netting: beach seine *Carms open beaches, Three Rivers confluence, Burry Inlet; information unclear as to gear type; frequency and intensity unknown.*	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			As above
Netting: demersal seine *Not known to occur.*	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		Treat new fisheries and new gear as plan or project as appropriate. Establish, monitor and enforce operational limits (spatial, temporal, technical, effort) suitable to secure features at FCS. Monitor and manage fisheries that populations of prey species subject to existing commercial fisheries are equal to, or at greater abundance, than that required to achieve maximum sustainable yield.
Netting: beach-set gill *Carms open beaches, Three Rivers confluence, Burry Inlet; variable & seasonal; information unclear as to gear type; frequency and intensity unknown.*	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓		✓	Review, revise or establish, monitor and enforce operational limits (spatial, temporal, technical, effort) suitable to secure features at FCS. Monitor and manage fisheries so that populations of prey species subject to existing commercial fisheries are equal to, or at greater abundance, than that required to achieve maximum sustainable yield.
Netting: other (*e.g.* fyke) *Potential exists.*	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	Treat new fisheries and new gear as plan or project as appropriate. Establish, monitor and enforce operational limits (spatial, temporal, technical, effort) suitable to secure features at FCS. Monitor and manage fisheries so that populations of prey species subject to existing commercial fisheries are equal to, or at greater abundance, than that required to achieve maximum sustainable yield.
Potting: lobster / crab *Mainly confined to SW Gower coast and deep rocky areas in Bay. No quantified information.*	✓		✓		✓	✓	✓	✓	✓	✓	✓				✓						Review, revise or establish, monitor and enforce operational limits (spatial, temporal, technical, effort) suitable to secure features at FCS. Monitor and manage fisheries so that populations of prey species subject to existing commercial fisheries are equal to, or at greater abundance, than that required to achieve maximum sustainable yield.
Potting: prawn *Not known to occur.*	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓	✓						Treat new fisheries and new gear as plan or project as appropriate. Establish, monitor and enforce operational limits (spatial, temporal, technical, effort) suitable to secure features at FCS. Monitor and manage fisheries so that populations of prey species subject to existing commercial fisheries are equal to, or at greater abundance, than that required to achieve maximum sustainable yield.

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	physical	chemical	biological	range	Structure & function	Typical species	population	range	Habitats & species	Inlets & bays	estuaries	Saltmeadows	*Salicornia*	Mud and sandflats	Subtidal sandbanks	shads	lampreys	otters	Cardigan Bay SPA	Burry Inlet SPA	
Potting: whelk *Substantial but little precise information other than effort widely distributed; has shifted and continues to shift further offshore into deeper water.*	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓	✓						Review, revise or establish, monitor and enforce operational limits (spatial, temporal, technical, effort) suitable to secure features at FCS. Monitor and manage fisheries so that populations of prey species subject to existing commercial fisheries are equal to, or at greater abundance, than that required to achieve maximum sustainable yield.
Line: long-line *Historically small scale; relatively recent increases; substantial but unquantified. Mainly NE quadrant of Bay / off estuary entrances; mainly seasonal (targeting bass).*	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			As above
Line: handline *Limited, mainly NE quadrant of Bay.*	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓				As above
Electro-fishing: molluscs *Interest exists. Field developmental investigation 2007-08 in the very west of the Bay.*	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		✓		Treat new fisheries and new gear as plan or project as appropriate. Establish, monitor and enforce operational limits (spatial, temporal, technical, effort) suitable to secure features at FCS. Monitor and manage fisheries so that populations of prey species subject to existing commercial fisheries are equal to, or at greater abundance, than that required to achieve maximum sustainable yield.
Fisheries; predator control *Historical culling of oystercatchers in Burry Inlet. Anecdotal & unattributable reports of commercial net-fishermen shooting seals in NE quadrant of Bay.*	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	Enforce relevant wildlife protection legislation.
Hand gathering: cockles (excluding access issues) *Major commercial fisheries. Casual private collection.*	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓						✓	Review, revise or establish, monitor and enforce operational limits (spatial, temporal, technical, effort) suitable to secure features at FCS. Monitor and manage fisheries so that populations of prey species subject to existing commercial fisheries are equal to, or at greater abundance, than that required to achieve maximum sustainable yield.
Hand gathering: mussels (excluding access issues) *Major commercial fisheries. Casual private collection.*	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓						✓	As above .
Hand gathering: mussel seed (excluding access issues)*Major commercial fisheries. Casual private collection.*	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓						✓	As above .

Activity	Key Relevant factors			Most likely effects on FCS elements *Habitats*			Most likely effects on FCS elements *Species*			Features											Advice/Action/Notes
	physical	chemical	biological	range	Structure & function	Typical species	population	range	Habitats & species	Inlets & bays	estuaries	Saltmeadows	*Salicornia*	Mud and sandflats	Subtidal sandbanks	shads	lampreys	otters	Cardigan Bay SPA	Burry Inlet SPA	
Hand gathering: razor clam (including salting) *Mainly known from Saundersfoot & Rhossili. Frequency and intensity unknown, though anecdotal reports suggest possibly increasing*	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓		✓	✓			✓	As above
Hand gathering: other bivalves *Gathering various long-live, slow growing bivalve species (e.g. Mya, Lutraria) reported from Tenby / Saundersfoot & Rhosilli; frequency and intensity unknown.*	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓							As above
Hand gathering: winkles *Gower & Tenby / Saundersfoot*	✓		✓		✓	✓	✓	✓	✓	✓	✓										As above
Hand gathering: crustacean / shellfish *No information.*	✓		✓		✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	As above
Hand gathering: algae & plants for human consumption (*e.g. Porphyra, Salicornia*) *Little information; none quantitative. Burry Inlet. Exact locations, frequency and intensity unknown.*	✓		✓		✓	✓	✓	✓	✓		✓	✓	✓	✓						✓	As above
Hand gathering: access and vehicle use *Integral to cockle fisheries and mussel seed collection (and intertidal mussel SO)*	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						✓	As above
Hand / mechanical gathering: algae for chemical extraction / biomass *No information.*	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓						✓	Treat new fisheries and new gear as plan or project as appropriate. Monitor and manage fisheries so that populations of prey species subject to existing commercial fisheries are equal to, or at greater abundance, than that required to achieve maximum sustainable yield.
Bait collection: digging *Widespread; locally intense. No quantified frequency, effort or distribution information.*	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓						✓	Urgent review and establishment of adequate spatial, temporal, technical and effort operational limits to secure features at FCS; monitor compliance and enforce Appropriate implementation of SSSI procedures Education & awareness raising

Activity	Key Relevant factors			Most likely effects on FCS elements *Habitats*			Most likely effects on FCS elements *Species*			Features											Advice/Action/Notes
	physical	chemical	biological	range	Structure & function	Typical species	population	range	Habitats & species	Inlets & bays	estuaries	Saltmeadows	*Salicornia*	Mud and sandflats	Subtidal sandbanks	shads	lampreys	otters	Cardigan Bay SPA	Burry Inlet SPA	
Bait collection: pump *Widespread; no quantified, frequency or effort distribution information. (Main target; black lug)*	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓						✓	Urgent review and establishment of adequate spatial, temporal, technical and effort operational limits to secure features at FCS; monitor compliance and enforce Appropriate implementation of SSSI procedures Education & awareness raising
Bait collection: boulder turning *Widespread;locally intense. No quantified frequency, effort or distribution information.*	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓									✓	As above
Collection, for aquarium / curio trade *No quantified frequency, effort or distribution information.*	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						Review, revise or establish, monitor and enforce operational limits (spatial, temporal, technical, effort) suitable to secure features at FCS
Grazing of saltmarsh *Significant. Stocking level information not acquired. Stock management variable.*	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							As above
CULTIVATION OF LIVING RESOURCES																					
Aquaculture: algae *Not known to occur.*	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓							Treat new proposed developments as plan or project as appropriate. Review consenting procedures.
Aquaculture: finfish -sea cages or impoundments * *Not known to occur.*		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓			As above
Aquaculture: crustaceans - sea cages or impoundments * *Not known to occur.*		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓			As above
Aquaculture: molluscan 'ranching' * *Several Order applications for mussel bottom culture extant. (Subject to plan / projects assessment.)*	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓							As above
Aquaculture: molluscan 'farming' * (molluscan culture using trestles, ropes, cages or other structures) *Not known to occur.*		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	As above
Aquaculture: land based semi-enclosed / recirculation * *Interest expressed. Ragworm farm operational at Pendine***.**		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓			Consider as industrial effluent Treat new proposed developments as plan or project as appropriate.

Activity	Key Relevant factors			Most likely effects on FCS elements *Habitats*			Most likely effects on FCS elements *Species*			Features											Advice/Action/Notes
	physical	chemical	biological	range	Structure & function	Typical species	population	range	Habitats & species	Inlets & bays	estuaries	Saltmeadows	*Salicornia*	Mud and sandflats	Subtidal sandbanks	shads	lampreys	otters	Cardigan Bay SPA	Burry Inlet SPA	
Aquaculture: predator control *Not known to occur yet, but likely future operation: potential potting of green crab in mussel SOs.*	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	Establish, monitor and enforce operational limits (spatial, temporal, technical, effort) suitable to secure features at FCS.
Aggregation devices (*e.g.* 'crab tiles')*Localised use of tyres. Tiles not known to be used.*	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓				✓		✓	As above
EXPLOITATION OF NON-LIVING RESOURCES																					
Water abstraction * *Abstraction from freshwater inputs site-wide.*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓			Treat new proposed developments as plan or project as appropriate. Review existing consents
Aggregate extraction * (mineral & biogenic sands & gravels) *Seven-year license granted in 2007 to dredge Helwick Bank at a rate of 150,000 tonnes per annum.*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓				Treat as plan or project as appropriate.
Oil & gas exploration: seismic survey * *Unlikely to be pursued.*	✓					✓	✓	✓	✓							✓	✓				Treat new proposed developments as plan or project as appropriate.
Oil & gas exploration & production: drilling operations * *Unlikely to be pursued.*	✓	✓			✓	✓	✓	✓	✓	✓						✓	✓	✓			As above
Oil & gas exploration & production: operational * & accidental discharges *Unlikely to be pursued.*	✓	✓			✓	✓	✓	✓	✓	✓						✓	✓				As above .
Renewable energy generation: tidal barrage *# *Historical proposal in Loughor Estuary. Local interest remains.*	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Treat as plan or project as appropriate.
Renewable energy generation: tidal impoundment **# Development interest feasible.*	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	As above
Renewable energy generation: tidal current turbine **# Low possibility of development interest; site low suitability.*	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓		As above
Renewable energy generation: wave energy *# *Low possibility of development interest; site low suitability.*	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓				As above

Activity	Key Relevant factors			Most likely effects on FCS elements *Habitats*			Most likely effects on FCS elements *Species*			Features											Advice/Action/Notes
	physical	chemical	biological	range	Structure & function	Typical species	population	range	Habitats & species	Inlets & bays	estuaries	Saltmeadows	*Salicornia*	Mud and sandflats	Subtidal sandbanks	shads	lampreys	otters	Cardigan Bay SPA	Burry Inlet SPA	
Renewable energy generation: offshore wind **# Development interest feasible.*	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓				✓				✓	✓	As above
POLLUTION RESPONSE																					
Oil spill response: at sea *Reactive only. No recent activity (since 1996-97 Sea Empress oil spill).*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Develop and maintain appropriate pollution response contingency plans Inclusion and maintenance of information on site features and sensitivity to at-sea response activities in West Wales standing Environment Group pollution response advice contingency plan
Oil spill response: shore cleaning – washing *Reactive only. No recent activity (since 1996-97 Sea Empress oil spill).*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	As above
Oil spill response: shore cleaning - chemical *Reactive only. No recent activity (since 1996-97 Sea Empress oil spill).*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	As above
Oil spill response: shore cleaning - physical *Reactive only. No recent activity (since 1996-97 Sea Empress oil spill).*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	As above
Oil spill response: shore cleaning - ancillary activities (access creation, vehicular impacts, wildlife rescue) *Reactive only. No recent activity (since 1996-97 Sea Empress oil spill).*	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	Develop and maintain appropriate pollution response contingency plans Inclusion and maintenance of information on site features and sensitivity to on-shore cleaning activities in West Wales standing Environment Group pollution response advice contingency plan Treat as plan or project as appropriate.
RECREATION																					
Angling Unquantified observations. *Throughout bay; boat and shore; no data available on frequency; intensity unknown. 'Hotspots'. Anecdotal observations of intense pressure, e.g. competitions.*	✓		✓		✓	✓	✓	✓	✓	✓	✓				✓	✓	✓			✓	Education & awareness raising Effort surveillance Establish, monitor and enforce spatial, temporal, technical and effort operational limits suitable to secure features at FCS.
Bait collection: boulder turning *Widespread & common*	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓				✓		✓	As above
Bait collection: digging & other sediment shore collection techniques *Common, widespread with 'hot spots' of activity*	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓				✓		✓	As above

Activity	Key Relevant factors			Most likely effects on FCS elements *Habitats*			Most likely effects on FCS elements *Species*			Features											Advice/Action/Notes
	physical	chemical	biological	range	Structure & function	Typical species	population	range	Habitats & species	Inlets & bays	estuaries	Saltmeadows	*Salicornia*	Mud and sandflats	Subtidal sandbanks	shads	lampreys	otters	Cardigan Bay SPA	Burry Inlet SPA	
Recreational boating: high speed power craft (incl. PWC) *Unquantified; localised, mainly in vicinity of Tenby, Saundersfoot and Burry Port. PWC use off Burry Port & in entrance to Burry Inlet; also western Bay.*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	Education & awareness raising Activity surveillance
Recreational boating: low speed power craft *Unquantified; localised, mainly in vicinity of Tenby, Saundersfoot and Burry Port.*	✓	✓			✓	✓	✓	✓	✓									✓	✓	✓	As above
Recreational boating: sail *Unquantified; localised, mainly around Tenby & Saundersfoot . Little / no traffic from Swansea Bay?*	✓					✓	✓	✓	✓									✓	✓	✓	As above
Recreational boating: canoeing *Infrequent; minimal.*	✓					✓	✓	✓	✓									✓	✓	✓	As above
Recreational boating: other non-mechanically powered craft (*e.g.* kite-surfing, board-sailing, *etc.*) *No information available.*	✓					✓	✓	✓	✓										✓	✓	As above
Recreational boating: moorings *Localised; mainly Tenby / Saundersfoot (ca. 400), Llansteffan / Ferryside (ca. 250) and Burry Port / Loughor (ca. 200).*	✓				✓	✓	✓	✓	✓	✓	✓			✓							Treat new mooring developments as plan or project as appropriate. Review, revise or establish management practices and spatial, temporal & technical operational limits suitable to secure features at FCS; monitor compliance and enforce. Secure appropriate management of moorings in open coastal locations.
Recreational boating: anchoring *No data available. Localised anchoring of recreational angling vessels; mainly NE Bay and lower estuaries.*	✓				✓	✓	✓	✓	✓	✓	✓			✓							Review, revise or establish management practices and spatial, temporal & technical operational limits suitable to secure features at FCS; monitor compliance and enforce. Secure appropriate management of open coastal locations (*ie* outwith MHPA port limits) used as commercial anchorages and for casual recreational anchoring
Surfing *No data available.*																					
Scuba diving, snorkelling *No data available; limited predominantly to rocky areas in SW and SE of Bay.*	✓		✓			✓	✓	✓	✓	✓											Education & awareness raising; develop participation in environmental site feature observation schemes. Activity surveillance.
Spearfishing *No information available.*	✓		✓		✓	✓	✓	✓	✓	✓											Enforce relevant legislation prohibiting spearfishing in UK waters.

Activity	Key Relevant factors			Most likely effects on FCS elements *Habitats*			Most likely effects on FCS elements *Species*			Features											Advice/Action/Notes
	physical	chemical	biological	range	Structure & function	Typical species	population	range	Habitats & species	Inlets & bays	estuaries	Saltmeadows	*Salicornia*	Mud and sandflats	Subtidal sandbanks	shads	lampreys	otters	Cardigan Bay SPA	Burry Inlet SPA	
Coastal access for recreation (bathing, dog walking, coasteering, *etc.*) *Substantial; seasonally skewed; spatially variable. Numbers and spatial distribution unquantified.*	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	Education & awareness raising
Vehicles on foreshore *Widespread, occasional; unquantified observations.*	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	Activity surveillance Education & awareness raising Appropriate implementation of SSSI procedures & access byelaws
Light aircraft *Occasional*	✓					✓	✓	✓	✓										✓	✓	Activity surveillance
Wildfowling *Unquantified observation; assumed to be widespread and common. Foreshore lease maps available.*	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	Activity surveillance Education & awareness raising Review, monitor and enforce spatial, temporal and effort operational limits suitable to secure features at FCS Appropriate implementation of SSSI procedures & access byelaws
Marine wildlife watching / eco-tourism *No data available.*	✓					✓	✓	✓	✓									✓	✓	✓	Activity surveillance
MILITARY ACTIVITIES																					
Military activity: **ordnance ranges** *Regular*	✓	✓			✓	✓	✓	✓	✓	✓	✓			✓	✓			✓	✓	✓	Research potential effects on features
Military activity: **marine exercises** *Unknown*	✓	✓			✓	✓	✓	✓	✓	✓				✓	✓			✓	✓	✓	As above
Military activity: aircraft Regular	✓					✓	✓	✓	✓					✓				✓	✓	✓	Activity surveillance
MISCELLANEOUS OPERATIONS & USES																					
Marine archaeology & salvage *No data available.*	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						✓	Education & awareness raising
Education Regular use of favoured sites	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓			Review, develop and/or implement and monitor best practice suitable to secure features at FCS Appropriate implementation of SSSI procedures & access byelaws Development and encouragement of information exchange

Activity	Key Relevant factors			Most likely effects on FCS elements *Habitats*			Most likely effects on FCS elements *Species*			Features											Advice/Action/Notes
	physical	chemical	biological	range	Structure & function	Typical species	population	range	Habitats & species	Inlets & bays	estuaries	Saltmeadows	*Salicornia*	Mud and sandflats	Subtidal sandbanks	shads	lampreys	otters	Cardigan Bay SPA	Burry Inlet SPA	
Science research *CCW, EAW, SWSFC, Uni. of Wales. Benthic, fish stock & water column sampling. Scoter aerial monitoring. Low tide waterfowl surveys.*	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓			As above
Animal welfare operations & sanctuaries *Bird 'hospitals' located Gower & South Pembrokeshire*	✓	✓	✓			✓	✓	✓	✓									✓	✓	✓	Activity surveillance Education & awareness raising Review, develop and/or implement and monitor best practice suitable to secure features at FCS

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APPENDIX 1Glossary of Terms

Common appreciation of the meaning of the terms employed in these conservation objectives is critical to their understanding. Many terms may be understood differently and are therefore potentially ambiguous. To overcome any preconceptions and to ensure the greatest clarity, the meanings of certain terms for the purpose of this document, are defined below.

baroclinic	Seawater circulation pattern arising when density and pressure gradients are perpendicular to each other
benthos; benthic	The forms of marine life that live on, or in, the sea or ocean bottom. Pertaining to the sea or ocean bottom.
bioaccumulation	The uptake and retention of a 'bioavailable' chemical form from any one of, or all possible external sources (*cf* biomagnification *qv*).
biodiversity	Biodiversity has been widely defined and is understood in various ways. It is widely used to capture the concept of the 'variety of life' and includes genetic, species and community diversity.
biogenic	Produced directly by the physiological activities of organisms, either plant or animal (Baretta-Bekker *et al* 1998 [24]). Biogenic reefs – long-lived, hard, biological structures comprised of large numbers individual organisms such as mussel or sand-tube building worms *Sabellaria*.
biomagnification	The process whereby a chemical, as it is passed through a food chain or food web, builds to increasingly higher concentrations in the tissues of animals at each higher trophic level (*cf* bioaccumulation *qv*).
biotic and abiotic *factors* (*qv*)	Biotic: "Pertaining to life … influences caused by living organisms", *cf* abiotic: "characteristics and elements of the environment (which) influence survival or reproduction of organisms, that are not alive themselves" (Baretta-Bekker *et al ibid*) Influences and elements of both a biological and non-biological nature that: contribute to the composition of a habitat, its structure, function or biology (*i.e.* the factors that the comprise habitat, as defined in Habitats Directive, Article 1f: "*habitat of a species* means an environment defined by specific abiotic and biotic factors, in which the species lives at any stage of its biological cycle"); contribute to a result or to bringing about a result; affect the course of events. Many factors are *processes* (*qv*) Biotic factors include competitive interaction (e.g. for space and food, predation, scavenging and grazing).
bioturbation	Biological perturbation, or reworking, of sediment by organisms, affecting the exchange of organic matter, oxygen, nutrients etc between buried sediment and the sediment surface and overlying waters.
by-catch	"The catch of non-target species and undersized fish of target species." (CCW 2001[25]). "The part of the catch that does not belong to the retained part of the target species of a fishery. … unmarketable component of target species, marketable species which were not aimed for, … accidental catches. The term is often used rather loosely" (Baretta-Bekker *et al ibid*)
contaminant	Anthropogenically synthesised chemicals (e.g. PCBs, biocides etc) and anthropogenically elevated naturally occurring chemical components (e.g. heavy metals) that are toxic or otherwise detrimental to the physiological health or well-being of typical species.
degrade	(*degrade*: to lower in rank or grade, to lower in character, value or position or in complexity; *degraded*: declined in quality or standard. *Chambers Dictionary 1998*). In this document, the meaning of degrade is applied to damage or impairment resulting from such human action as has a detrimental outcome for features. See also section 5.1
demersal	Living on or near the seabed.
detrimental	Causing damage or harm; damaging, disadvantageous
dioecious	Sexes separate, *i.e.* not hermaphrodite
epifauna (-flora, -biota)	Animals (fauna), plants (flora), organisms (biota) that live on top of seabed or other organisms, either attached to them or freely moving over then; *cf* infauna (*qv*)
eutrophic	Waters rich in mineral and organic nutrients that promote a proliferation of plant life, especially algae, which reduces the dissolved oxygen content and often causes the reduction or extinction of

[24] Baretta-Bekker, Duursma & Kuipers (eds) 1998. Encylopedia of marine sciences. Second edition. Springer
[25] CCW 2001. Glossary of marine nature conservation and fisheries. CCW Bangor

	other organisms.
evolve	To alter with time, either remaining *stable* (*qv*) or changing
extent	The area a feature, or one of its components, covers within its natural *range* (*qv*) within the site.
factor	A circumstance, fact, influence or element that: • contributes to composition of a habitat, its structure, function or biology; • contributes to a result or to bringing about a result; • affects the course of events. Many factors are *processes* (*qv*)
functions	Functions are processes that may, directly or indirectly, influence: • the state of a physical habitat; • the marine life associated with that habitat.
habitat components	Contributing to the composition of a habitat. This includes physical and biological sub-habitats e.g. different types of reef, as well as different elements such as particular communities that make up reef habitats
halocline	The boundary zones between layers of seawater at different salinities (see also thermocline and oxyclines). Together with thermoclines, halocline have a strong influence on seawater density, circulation and species distribution
hydrodynamics	The mechanical effects of moving fluids; *i.e.* the motions of the sea. (Baretta-Bekker *et al ibid*)
hydrography	The description of the seas: 1) "marine cartography" (coastlines, bathymetry); 2) "descriptive oceanography" (the "description of water properties, their distribution and variation"; encompasses hydrodynamics *qv*) (Baretta-Bekker *et al ibid*)
hypertrophic	Waters in which mineral and organic nutrients are elevated above natural levels (*cf* eutrophic *qv*).
infauna	Animals that live within sediment
inherent	Existing in and inseparable from something else; innate; **natural;** the relation between a quality or attribute and its subject (Oxford English and Chambers Dictionaries)
inhibit	To hold in or back; to keep back; to restrain or check; to restrict or prevent
maerl	A calcareous red alga (seaweed) that is an important habitat-structuring component. Maerl is very slow growing and maerl beds tend to support particularly rich and biodiverse marine communities.
maximum sustainable yield (MSY)	Maximum use that a renewable resource can sustain without impairing its renewability through natural growth or replenishment. Fishing at MSY levels means catching the maximum proportion of a fish stock that can safely be removed from the stock while, at the same time, maintaining its capacity to produce maximum sustainable returns, in the long term. Considered as an international minimum standard for stock rebuilding strategies (i.e. stocks should be rebuilt to a level of biomass which could produce at least MSY). See EU press release
mega, macro, and meio- (biota / flora / fauna)	The sizes of plants and animals. *Mega*-: no internationally agreed definition, but commonly defined as large enough to be seen discriminated in photographs, 2 cm or larger. *Macro* - large enough to be seen by the naked eye, greater than 0.5 mm, to up to 2cm. *Meio*-: organisms that cannot be observed without a microscope; organisms between 0.03 or 0.06 mm and 0.5 mm (*cf* micro-: organisms invisible to the naked eye, smaller than meiofauna; defined as <32µm) (*Multiple references*)
natural	In this document, the meaning of natural is taken to be as defined in standard English dictionaries: **inherent**, innate, self-sown and uncultivated, not the work of or the direct product of interference by human action; in accordance with nature; relating to or concerning nature; existing in or produced by nature; in conformity with nature; not artificial. ***It does not mean or imply pristine*** (*i.e.* an original, unmodified, state).
oxycline	The boundary zones between layers of seawater with different dissolved oxygen concentrations (see also halocline and thermocline). Strong influence on species distribution.
process	A series of actions, events or changes that vary in space and over time. In this context processes include physical, chemical and biological environmental changes which are inherently natural but which may be modified by human activity (*e.g.* wave action, nutrient fluxes). All processes are factors.
quality (of habitat)	The relative absence of anthropogenic modification of naturalness of habitat extent, structure, function and typical species as a result of, *inter alia*:

	• change in distribution, extent, geology, sedimentology, geomorphology, hydrography, meteorology, water and sediment chemistry and biological interactions; • change in species richness, population structure and dynamics, physiological health, reproductive capacity, recruitment, mobility and range or of anthropogenic modification of suitability of habitat as a result of, inter alia; • level of disturbance • alternation of prey/food supply • contamination of food supply
range	The natural spatial distribution of a feature, habitat, habitat componentor species. Depending on the context, this term either describes the global distribution of the feature or, in the context of the site, the distribution of the feature within the site
safe biological limits	ICES definition of fisheries sustainability. "Within SBL" defined as stock at full reproductive capacity and harvested sustainably. ICES Advice Autumn 2004 & summarised at www.defra.gov.uk/environment/statistics/coastwaters/cwfishstock.htm
salinity	Seawater salinity is measured in parts of salt in one thousand parts water (‰).
salt wedge	When freshwater and seawater meet in an estuary or sheltered marine inlet, the two water masses or different density often do not mix completely. A distinguishable inflowing tongue of dense seawater beneath a less dense layer of freshwater is referred to as a salt wedge. The shape of the salt wedge in Milford Haven is measurably deflected to the south side of the Haven by the earth's rotation.
sessile	Benthic (qv) organisms living attached to the seabed substrate.
species richness	Variety of species. The total number of species: • among a fixed number of individuals; • per unit of surface area (of habitat).
spraint	Descriptive term for otter faeces. Spraint has a distinctive smell and appearance; it contains indigestible food remains from which prey species may be identified.
stable	Tendency towards an equilibrium state in spite of varying external conditions
structure	The composition and arrangement of those: • parts of the feature, • parts of the natural environment, • circumstances, that constitute the feature or are required by the feature for its maintenance in both the long term and foreseeable future.
stochastic	Random, chaotic, possible but unpredictable.
thermocline	A boundary zone between layers of seawater at different temperatures (see also halocline and oxycline). Together with haloclines, thermoclines have strong influences on seawater density, circulation and species distribution.
supporting sediments	Sediments with strong geomorphological / sediment-transport links to the feature. Particularly relevant to areas of sediment exchange and supply.
thermohaline circulation	Seawater circulation driven by density differences caused by seawater temperature and salinity differences.
typical species	Species that are, from time to time, associated with a specified habitat within the site; *i.e.* all species that contribute to the biodiversity of the specified habitat within the site.

APPENDIX 2 List of SSSIs and SPAs partly or wholly within the SAC

Sites of Special Scientific Interest that are partly or wholly within the SAC

Tenby Cliffs & St.Catherine's Island

Waterwynch Bay to Saundersfoot Harbour

Arfordir Saundersfoot – Telpyn/Saundersfood – Telypyn Coast

Afordir Marros – Pentywyn/Marros – Pendine Coast

Twyni Lacham – Pentywyn/Laugharne – Pendine Burrows

Whitehill Down

Aber Taf/Taf Estuary

Afon Tywi

Arfordir Pen-bre/Pembrey Coast

Burry Inlet and Loughor Estuary

Twyni Chwitffordd, Morfa Landimor a Bae Brychdwn/Whiteford Burrows, Landimore Marsh and Broughton Bay

Special Protection Areas that are partly or wholly within the SAC

Bae Caerfyrddin/Carmarthen Bay

Burry Inlet

Locations are shown on Map 2

APPENDIX 3 Important elements of Favourable Conservation status

HABITATS

ELEMENT	Rationale
RANGE	
Distribution	Distribution of habitat features within the site, and also within a national and European context, has a key role in determining the distribution and abundance of typical species. Also important is the distribution within a habitat feature of components of habitat structure (e.g. Sediment granulometry) and of habitat function (e.g. Wave exposure).
Extent	Overall extent, large examples or extensive areas are inherently highly rated and contribute to conservation of structure and function The extents of habitat components, both structural functional are important determining factors of habitat and species diversity.
STRUCTURE	Physical structures of habitat features and their variation are the foundation of habitat diversity and, accordingly, species diversity. Along with environmental processes (function), habitat structure strongly influences where things live.
Geology	Geology at all spatial scales underpins the structure of the habitats, from overall coastal structure, which determine exposure to major environmental processes, to local habitat structure. The range of rock types and the distribution of rock folding, faulting and fracturing determine the overall complexity of shape of the seabed and coast and the diversity of habitats.
Sedimentology	Sedimentology is the result of complex processes significantly influenced by water movement. Sediment granulometry, structure and degree of sorting (from well sorted fine – medium sands and muddy sands to poorly sorted, mixed substrata containing mud, gravel, shell and stones) creates an extremely wide range of sediment habitats.
Geomorphology	
morphology (shape)	The gross shape of features and of individual sections of features is an essential component of habitat structure and contributes to habitat diversity.
topography (surface structure)	Surface relief of all substrates is a fundamentally important component of habitat structure, underpinning biological diversity through the provision of different habitats and microhabitats and a range of depths below sea level or intertidal drying heights. Topography, together with morphology, has a critical influence on hydrodynamic processes. Rock topography is fundamentally determined by geology. The range of rock topography is a particularly important contributor to reef biodiversity. Sediment topography is important in sediment habitats. For example granulometry and slope together determine sediment flats' ability to retain water during low tide (the amount of interstitial water retained is important in determining community composition); the breadth of the shore (related to slope) in combination with shore aspect, is important in determining the degree of wave energy expended on any part of the shore, therefore influencing community composition.
microtopography	Rock microtopography is determined by geology, with surface pits, cracks, fissures, bore-holes etc providing additional niches for marine wildlife. The microtopography of sediment flats is important in determining water runoff (including the formation of rips) and retention and, in turn, influence the distribution of surface biota and granulometry.
orientation and aspect	Orientation and aspect are products of morphology and topography that, in combination with functional processes such as wave or light exposure, extend the variety of niches provided by habitat features. Range and variation in orientation and aspect enhance habitat and species diversity.
bathymetry	Bathymetry is determined by other structural components and by hydrodynamic and sediment processes. Depth of seabed is in turn a critical influence on hydrodynamic processes, such as wave exposure and tidal streams. In combination with water clarity, depth determines light attenuation through the water column thereby contributing directly to community structure. Bathymetric variation within and between individual parts of features enhances habitat and species diversity
FUNCTION	Distribution, extent, abundance and variety of species populations is shaped by spatial and temporal variation of a wide range of physico-chemical and biological processes (functions).
Hydrography & meteorology	Hydrographic & meteorological processes are fundamental to the structure and function of habitats and their species populations. The magnitude of hydrographic factors varies along gradients determined by the underlying geomorphology of the site and complex interactions with other functional processes.
hydrodynamics (water movement)	Water movement is a fundamentally important environmental process that determines the species composition present at any particular location, both directly and indirectly through its effect on other important processes such as nutrient, sediment and dissolved gas transport. The range of relative contributions of tidal streams, wave action and residual currents to water movement is particularly important in determining biological composition.
	Tidal range and rise - fall is of critical importance to structure, function and species population of habitats both directly – determining extent of intertidal areas and the emergence regime; and indirectly through the action of tidal streams.
	Tidal streams (currents): the strength, patterns, relative constancy, lack of attenuation with depth, general bidirectionality and spatial and temporal variations in tidal streams are important in structuring the distribution of species populations; food, sediment and chemical transport processes; water mixing.
	Wave exposure. Wave action is one of the most physically powerful, chaotic and relatively unpredictable processes. Exposure to wave action is determined by habitat morphology, topography, aspect, attenuation with depth and meteorological processes and has a major influence on distribution of species populations; water clarity and water mixing. The range of wave exposure within the site is extreme.
	Residual current flows modify local hydrodynamic and meteorological processes for example through inputs of water masses with elevated suspended sediment loads, temperature and / or nutrients and contaminants.
temperature (water)	Water temperature strongly influences water chemistry and biological processes, such as reproduction and metabolism. The biogeographical location of the sites and the degree of buffering of winter minima and summer coastal warming by oceanic waters (North Atlantic Drift) strongly influences and limits the sea temperature range. Temperature range is important in mediating reproduction and survival of species, shielding submerged species from the more extreme temperatures experienced by intertidal species and reducing the ability of some non-native species to become established. Global processes (global warming, shifts in ocean currents), influenced by climate change, also influence local seawater

ELEMENT	Rationale
	temperature regime temporarily, seasonally or chronically.
light intensity (ambient seabed and water column)	Seabed light intensity has an important influence on community structure, particularly through algal species distribution, mediated by bathymetry, water transparency and localised shading (*e.g.* from overhangs, caves or aspect). Spatial and temporal variation in light intensity has considerable broad and local scale impacts on species population distributions and community variation. Water column light intensity in combination with shelter from extreme water movement and elevated nutrients is important in the occurrence and distribution of seasonal plankton blooms.
Seston concentrations and water transparency (clarity/ turbidity)	Seston (suspended particulate matter) concentrations are critically importance as a food-energy resource, is a factor in sediment processes and deposition including smothering and scouring of biota, and through absorption of light modifing light availability at seabed and in water column. Seston composition and water column loads are determined by the origins of the particulate matter – biological productivity and / or riverine, coastal or oceanic water inputs.
meteorology	
temperature (air)	Air temperature is an important factor in several aspects of intertidal habitat function (heat / cold tolerance, control of reproduction, desiccation, dissolved oxygen, salinity). Although overall air temperature is climate controlled, it is subject to local modifications by habitat structure and species populations.
light (solar irradiance)	Solar irradiance is a fundamental requirement for plant primary production. It is determined by meteorological conditions, and seabed and water column irradiance is mediated as described above. It also has direct effects on temperature, desiccation, UV exposure, dissolved oxygen and salinity in intertidal habitats, where it is mediated by localised shading (*eg* from overhangs, caves or aspect).
humidity	In association with temperature and air movement, humidity is an important factor controlling evaporation, and consequently salinity and the desiccation of intertidal species. Although overall humidity is climate controlled, it is subject to local modifications by habitat structure and species populations.
air movement (wind)	Wind strength, direction and fetch are the fundamental influences on wave action. The effect of air temperature and humidity on intertidal species and communities is strongly influenced by air movement. Although overall air movement is climate controlled, it is subject to local modification by habitat structure and local topography.
precipitation	Rainfall locally modifies salinity in intertidal areas, modifies temperature and humidity and increases transport of terrestrial sediments and other materials (*eg* nutrients, contaminants) into the marine environment. Land use and surface water management influences the effect of heavy rainfall in creating spate events that increase short term flow rates, soil erosion and particulate suspension.
Water & sediment chemistry	
salinity	Salinity is of fundamental physiological and ecological significance. Horizontal and vertical salinity gradients from average fully saline open coast seawater through brackish to freshwater and temporal variation in the gradients are of primary importance in species distribution.
nutrients	Dissolved organic nutrients and trace elements are essential to biochemical processes. Major nutrients in unmodified conditions vary seasonally within ranges characteristic of individual water bodies with the uptake by and decomposition of biota. Acute or chronic anthropogenic elevation causes ecologically important eutrophication or toxic effects.
contaminants	Levels of acutely or chronically toxic anthropogenically synthesised chemicals (*eg* PCBs, biocides etc) and anthropogenic elevation of naturally occurring chemical components (*eg* some hydrocarbons, heavy metals) are critical influences for example on species survival, physiological health, and reproductive capacity
dissolved oxygen	Oxygen availability is of fundamental physiological and ecological significance.Availability is influenced by water movement and surface disturbance, water temperature, sediment granulometry and disturbance, organic content and biological oxygen demand. Reduced oxygen flow and / or increased oxygen demand (through decomposition of trapped organic matter) within sediments tends to result in significantly reduced levels; anaerobic conditions in sediments may result in the formation of toxic substances (*eg* hydrogen sulphide).
Sediment processes	
	Sediment erosion, transport and deposition are critical in determining extent, morphology and functional processes of sediment based habitats and have important functional influences on rock-based habitats. Sediment processes in the site are a reflection of many complex causal processes and are themselves complex, contributing to high habitat and community diversity.
TYPICAL SPECIES	As the rationale for selection of components of species conservation status is similar for both species features and typical species of habitat features the rationale for both has been combined and is given the species table below

TYPICAL SPECIES & SPECIES FEATURES

ELEMENT	Rationale
SPECIES RICHNESS (Variety of species)	Species richness is most likely to be applicable as a component of FCS for typical species of Habitat features. However, the variety of available prey is likely to be important to predatory species features such as dolphins, seals, otter, lamprey and shad, and, as such, it forms an important measure of a species features habitat quality. Biological variety is a key contributor to biodiversity and applies at both taxonomic and genetic levels. Species variety "typical" of different habitats is dependent on the ecological opportunities available (niche diversity), particularly the degree of stress from natural processes. Habitats and communities subject to moderate levels of disturbance tend toward high species diversity. A high proportion of the species in such highly diverse communities are usually present at low frequencies and, individually, may make a small contribution to the overall functioning of the community. Nevertheless, such "species redundancy" is a vital contribution to biodiversity in many marine habitats and communities, and is consequently extremely important in terms of the conservation of the habitat features.

ELEMENT	Rationale
POPULATION DYNAMICS	Species population dynamics are inherently important in maintaining viability of species populations and species variety.
Population size	
Population size (species abundance)	Sizes of species populations vary widely depending on their biology and ecology (e.g. Reproductive, competitive, survival and life history strategies; recruitment, habitat requirements; adaptation to natural processes and factors) and stochastic events. For a species feature, population size is a key measure of the species ecological success or failure. Along with a typical species' distribution, its population size determines its contribution to biodiversity and to habitat structure and function. Populations sizes of small, short-lived, rapidly reproducing species are orders of magnitude greater than large, long-lived, slowly reproducing and infrequently recruiting species. Populations of many species fluctuate widely in response to natural and artificial perturbations and opportunities; many others remain stable for long periods and many of these are particular sensitive to anthropogenic disturbance or habitat degradation.
Contribution to the integrity of wider population	The full range of some species features are only partly encompassed by the site. The long-term viability of the species population may therefore be in part or mainly determined by stock outside the site, and vice versa (e.g. through immigration and emigration, genetic variation etc). The contribution a species population occurring within a site makes to the wider population status is important to the long-term viability of the species as a whole, including that occurring within the site.
Biomass	Biomass is the potential energy of species populations, and thus fundamental to species physiological health, reproductive capacity and energy reserves, and is an energy resource for other species. Sediments with high organic input typically support a species biomass and rate of turnover (productivity) sufficiently high to contribute significantly to the maintenance of predatory typical species such as fish and waders and wildfowl. However, high biomass and low species variety may also be indicative of environmental stress or perturbation. Biomass of different reef habitats is extremely variable, varying with species composition and recruitment, age structure, health and environmental stress and consequently frequently varies widely within a small area of apparently similar habitat for a variety of reasons.
Reproductive success	The ability to successfully reproduce is critical to a species population's long-term viability. Reproductive success is a function of reproductive capability and the survival of young. Reproductive capability is a function of many factors including physiological health, temperature regime and population density. Reduced physiological health and other stressors can reduce reproductive capability as, under these circumstances, most species concentrate internal resources on survival instead of reproduction. For many species (not mammals and birds) gonadal somatic index (ratio between body mass and gonad mass) is a good measure of reproductive capability. High reproductive capability does not necessarily translate to high reproductive success. Survival of young to age of recruitment to the population is a function of reproductive strategy and varies by orders of magnitude depending on the strategy, ecological hazards and stochastic events. Dispersive invertebrate larval stages vary extremely in the numbers surviving from place to place and time to time with weather, currents, availability of food, period spent in the plankton, predation and intrinsic variability in processes killing and removing species e.g competition for food and space, predation. At the other extreme, survival of young marine mammals is very high because of the heavy parental investment in low numbers of offspring. However, the relative survival rates of all strategies are vulnerable to modification by stochastic events.
recruitment	Recruitment of young is critical to the maintenance of species population's long-term viability. Natural variation in successful recruitment is a critical factor contributing to species variety. Many invertebrate and algal species are at least partly dependant on recruitment from outside the feature.
Population structure	
Age frequency	Age frequency is important in determining the degree of success of population reproduction and resilience to perturbation for many species. Variation in population structure contributes to the complexity of community mosaics and to biodiversity. Age or size frequency is an important indicator of a species population's long-term viability.
Sex ratio	Sex ratio is important in determining the degree of reproductive success and therefore the long-term viability of dioecious species populations.
Physiological health	Physiological health is a critical component of a species population's long-term viability. It encompasses both genetic and physiological fitness. Knowledge of the physiology of most marine species is inadequate to directly express health in positive terms. Indicators of healthiness include reproductive capacity (e.g gonadal somatic index) and immunity to disease; and of potential poor health: contaminant burden, immunosuppression, epibiota burden, nutritional state and physical damage.
Immunity to endemic disease	Reduced physiological health, e.g. through raised stress or chemical contamination, typically increases susceptibility to endemic diseases.
Exposure to anthropogenic disease	Certain species may contract diseases of humans and domesticated animals. Certain anthropogenic activity can increase the risk of this. Whilst diseases that can cross such species barriers are few, if it were to occur there is the potential for very significant impact on the wild species population.
RANGE	
Distribution throughout site	Species populations are distributed within their habitats according to their ecological requirements (particularly sessile species). The distribution of most species across and along environmental gradients results in extremely complex mosaic of communities (aggregations of species) that vary over time. The distribution and extent of species are, within constraints of species' adaptation to physical factors and biological interaction, variable in time and space. Modification of structural and functional factors by human action will likely result in alterations to species distribution, extent and abundance.
Distribution of specific behaviours throughout the site	Some mobile species (e.g. dolphins, seals, spider crabs & bass) use different parts of their habitat for different behavioural purposes (e.g. feeding, moulting, breeding). The locations used are usually important for the particular behaviour displayed. Displacement of this behaviour to other less favourable locations can be detrimental to the species.
Mobility (ability to move about the site,	For most non-sessile species the ability to move around unimpeded is a prerequisite to maintenance of viable populations through, inter alia, successful feeding, predation-avoidance and reproduction. This includes both territorial species with localised mobility requirement and highly mobile and / or migratory

ELEMENT	Rationale
within and between features, unimpeded)	species which are dependent on features for a part of their ecological requirements (inter alia otter, seals, sea and river lamprey, shad, herring) Unimpeded mobility of reproductive products, larvae and juveniles of species is critical to the maintenance of viable species populations.
SUPPORTING HABITAT & SPECIES	Any components of habitat conservation status (Table 2.1 above) will apply to typical species of habitat features, and may apply to a species feature where the component is relevant to the conservation of that species feature. The most likely components of habitat conservation status that are relevant to the conservation of species features are given below.
Distribution and extent	
Preferred habitat	The habitat used by the species within the site. For wide ranging species this will likely be the whole area of the site.
Habitats utilised for specific behaviours	The distribution and extent of habitat necessary for specific behaviours, such as feeding, breeding, resting and social behaviour.
Structure & function	
Structural and functional integrity of preferred and specific habitats	The structure and functions that maintain the habitat in a form suitable for the long-term maintenance of the species population. This is linked to habitat quality.
Quality of habitat	The natural quality of habitat features may be reduced by modification of structural components identified above and, including by: the presence and persistence of artificial inert or toxic materials (e.g. synthetic plastics and fibres, hydrocarbons) causing entanglement, smothering or ill-health; decrease in seclusion because of noise and visual disturbance. Human activity with the potential to cause disturbance, affecting behaviour or survival potential includes waterborne leisure and commercial activities, wildlife watching; competition for space, causing displacement, collision, noise and visual disturbance, increased density dependent pressure on preferred sites, exposure to disease (see above); Contamination of prey (see below);
Prey availability	The presence and abundance of prey within the site may contribute to the species presence and its long term viability.
Prey contamination	Contamination of species feature prey can reduce the long-term viability of the species population. Contaminants that bioaccumulate and biomagnify and which affect the species physiological health would be of particular concern.